FINAL
Preliminary Assessment Report
Camp Ripley, Minnesota

Perfluorooctane-Sulfonic Acid (PFOS) and Perfluorooctanoic Acid (PFOA) Impacted Sites
ARNG Installations, Nationwide

November 2019

Prepared for:

Army National Guard Headquarters
111 S. George Mason Drive
Arlington, VA 22204

US Army Corps of Engineers, Baltimore District
2 Hopkins Plaza
Baltimore, MD 21201

Prepared by:

AECOM
12420 Milestone Center Drive, Suite 150
Germantown, MD 20876
aecom.com

Contract Number: W912DR-12-D-0014
Delivery Order: W912DR17F0192

Table of Contents

Tables

Figures

Appendices

Acronyms and Abbreviations

AASF	Army Aviation Support Facility
ACUB	Army Combatile Use Buffer
AECOM	AECOM Technical Services, Inc.
AFFF	aqueous film forming foam
AOI	area of interest
AR	alcohol resistant
ARNG	Army National Guard
BAL	Bruce A. Liesch Associates, Inc
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CMA	Combined Maintenance Activity
CSM	conceptual site model
CSMS	Combined Support Maintenance Shop
DHS	Department of Homeland Security
EMTC	Emergency Management Training Center
FTA	fire training area
MNARNG	Minnesota Army National Guard
n.d.	no date
PA	Preliminary Assessment
PCE	Progressive Consulting Engineers
PFAS	per- and poly-fluoroalkyl substances
PFOA	perfluorooctanoic acid
PFOS	perfluorooctanesulfonic acid
ppt	parts per trillion
SI	Site Inspection
UMD	University of Minnesota Duluth
US	United States
USACE	United States Army Corps of Engineers
USACHPPM	United States Army Center for Health Promotion and Preventative Medicine
USAEHA	United States Army Environmental Hygiene Agency
USAF	United States Air Force
USEPA	United States Environmental Protection Agency
USPFO	United States Property and Fiscal Office
VSI	visual site inspection
WWTP	waste water treatment plant

Executive Summary

The United States (US) Army Corps of Engineers Baltimore District on behalf of the Army National Guard (ARNG) Installations & Environment Division, Cleanup Branch contracted AECOM Technical Services, Inc. (AECOM) to perform Preliminary Assessments (PAs) and Site Inspections (SIs) for Perfluorooctanesulfonic acid (PFOS) and Perfluorooctanoic acid (PFOA) Impacted Sites at ARNG Facilities Nationwide. The ARNG is assessing potential effects on human health related to processes at facilities that used per- and poly-fluoroalkyl substances (PFAS) (a suite of related chemicals), primarily in the form of aqueous film forming foam released during firefighting activities or training, although other PFAS sources are possible. In addition, the ARNG is assessing businesses or operations adjacent to the ARNG facility (not under the control of ARNG) that could potentially be responsible for a PFAS release.

AECOM completed a PA for PFAS at Camp Ripley near Little Falls, Minnesota, to assess potential PFAS release areas and exposure pathways to receptors. Camp Ripley is owned by the State of Minnesota and managed by the Minnesota Department of Military Affairs. In addition, the Department of Natural Resources provides technical support to the facility. The performance of this PA included the following tasks:

- Reviewed data resources to obtain information relevant to suspected PFAS releases
- Conducted a 2-day site visit on 26 and 27 September 2018
- Interviewed current and retired Camp Ripley personnel during the site visit including Minnesota ARNG environmental managers, the current Camp Ripley Fire and Emergency Services Fire Chief, the retired City of Randall Fire Chief, Airfield personnel, deployable unit personnel, purchasing staff, and Range Facility Management personnel
- Completed visual site inspections at known or suspected PFAS release locations and documented with photographs
- Developed a conceptual site model (CSM) to outline the potential release and pathway of PFAS for the Areas of Interest (AOIs) and the facility

Six AOIs related to potential PFAS release were identified at Camp Ripley during the PA. The AOIs are shown on **Figure ES-1** and described below:

Area of Interest	Name	Used by	Potential Release Dates
AOI 1	TriMax Discharge Area	MNARNG	Early 2000s
AOI 2	Burn Pit FTA	MNARNG and USAF	1980s
AOI 3	DHS Demonstration	MNARNG and DHS	2014
AOI 4	CMA Discharge Area	MNARNG	2010
AOI 5	WWTP and Sludge Spread Site	MNARNG	1987 to present
AOI 6	Stormwater Infiltration Basin	MNARNG and DHS	1980s

Based on documented potential PFAS releases at these AOIs, there is potential for exposure to PFAS contamination in surface soil, surface water, and sediment to site workers, construction workers, trespassers, and recreational users via ingestion and inhalation; subsurface soil to construction workers via ingestion and inhalation; and groundwater to site workers, construction workers, trespassers, off-facility recreational users, and off-facility residents via ingestion. Potential off-facility PFAS release areas exist upgradient of Camp Ripley (**Figure ES-2**). It is unknown whether the potential off-facility release areas affect Camp Ripley. The CSM for Camp Ripley is shown on **Figure ES-3**.

CLIENT	ARNG
PROJECT	Preliminary Assessment for PFAS at Camp Ripley, MN

REVISED	7/29/2019	GIS BY	MS	7/29/2019
SCALE	1:19,800	CHK BY	BN	7/29/2019
Base Map: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c)		PM	RG	7/29/2019

▭ Area of Interest	— River/Stream	● Domestic Well
▨ Potential PFAS Release	— Canal/Ditch	● Irrigation Well
⬚ No Suspected Release	→ Surface Water Flow Direction	✦ Other/Unknown
🟩 Facility Boundary	- ▶ Inferred Groundwater Flow Direction	

N

Summary of Findings

AECOM

12420 Milestone Center Drive
Germantown, MD 20876

Figure ES-1

Q:\Projects\ENV\GEARS\GEO\ARNG PFAS\900-CAD-GIS\920-GIS or Graphics\MXD\MN\Camp_Ripley_Figures\Camp_Ripley_PA_Figures\Fig_ES-1_Camp_Ripley_Summary.mxd

CLIENT	ARNG			
PROJECT	Preliminary Assessment for PFAS at Camp Ripley, MN			
REVISED	7/29/2019	GIS BY	MS	7/29/2019
SCALE	1:6,000	CHK BY	BN	7/29/2019
Base Map: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c)		PM	RG	7/29/2019

▨	Potential PFAS Release
🟩	Facility Boundary
☁	Water Body
—	River/Stream

N

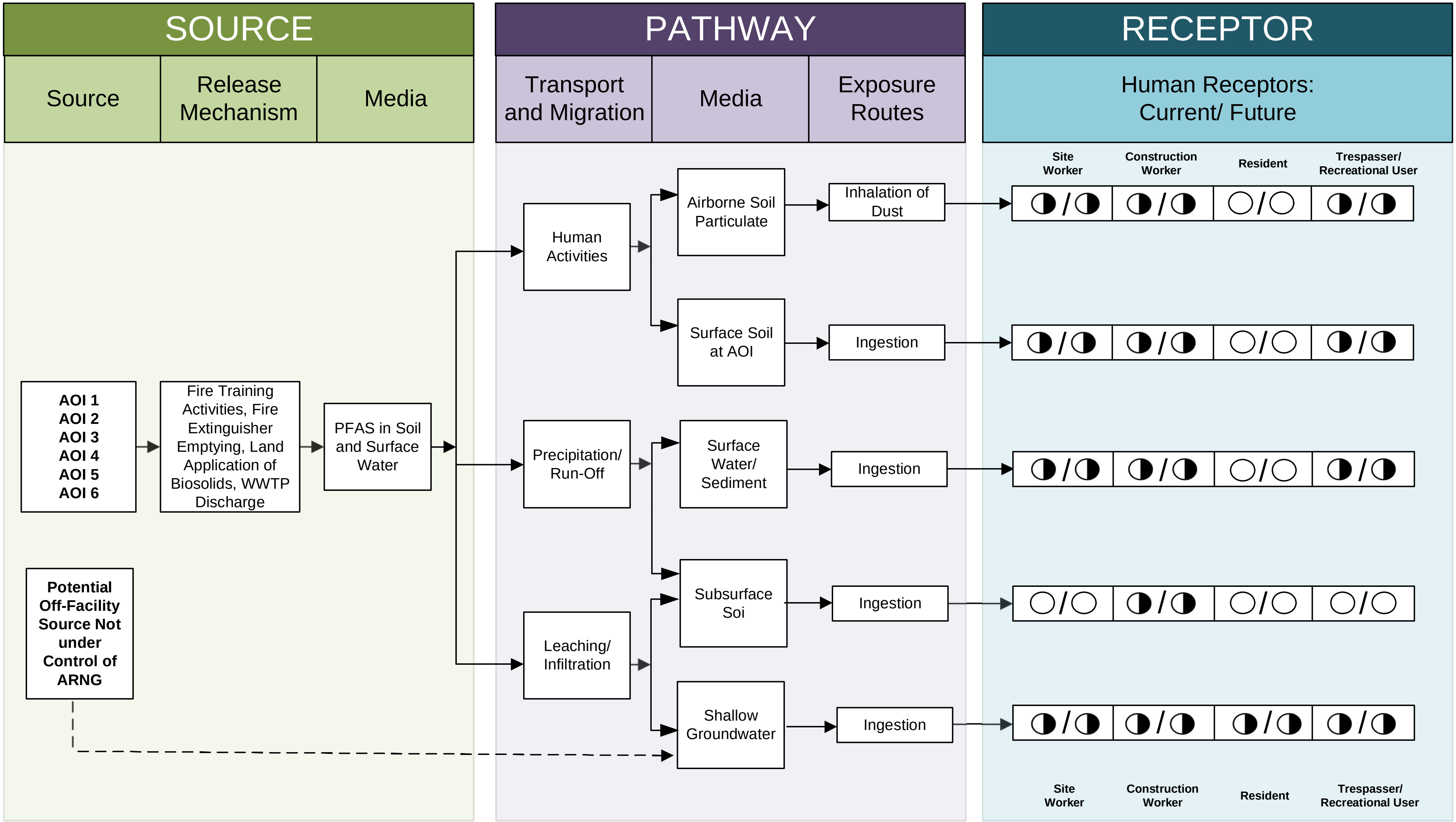
Summary of Findings Adjacent Sources

AECOM

12420 Milestone Center Drive
Germantown, MD 20876

Figure ES-2

Q:\Projects\ENV\GEARS\GEO\ARNG PFAS\900-CAD-GIS\920-GIS or Graphics\MXD\MN\Camp_Ripley_Figures\Camp_Ripley_PA_Figures\Fig_ES-2_Camp_Ripley_Summary_Adjacent_Sources.mxd



LEGEND

—□ Flow-Chart Stops

→ Flow-Chart Continues

- - → Partial / Possible Flow

○ Incomplete Pathway

◑ Potentially Complete Pathway

● Complete Pathway

Notes:
1. The resident and recreational user receptors refer to an off-site resident and recreational user.
2. Dermal contact exposure pathway is incomplete for PFAS.

Figure ES-3
Preliminary Conceptual Site Model
Camp Ripley

1. Introduction

1.1 Authority and Purpose

The United States (US) Army Corps of Engineers (USACE) Baltimore District on behalf of the Army National Guard (ARNG) Installations & Environment Division, Cleanup Branch contracted AECOM Technical Services, Inc. (AECOM) to perform *Preliminary Assessments (PAs) and Site Inspections (SIs) for Perfluorooctanesulfonic acid (PFOS) and Perfluorooctanoic acid (PFOA) Impacted Sites at ARNG Facilities Nationwide* under Contract Number W912DR-12-D-0014, Task Order W912DR17F0192, issued 11 August 2017. The ARNG is assessing potential effects on human health related to processes at their facilities that used per- and poly-fluoroalkyl substances (PFAS) (a suite of related chemicals), primarily releases of aqueous film forming foam (AFFF) released during firefighting activities or training, although other sources of PFAS are possible. In addition, the ARNG is assessing businesses or operations adjacent to the ARNG facility (not under the control of ARNG) that could potentially be responsible for a PFAS release.

PFAS are classified as emerging environmental contaminants that are garnering increasing regulatory interest due to their potential risks to human health and the environment. PFAS formulations contain highly diverse mixtures of compounds. Thus, the fate of PFAS compounds in the environment varies. The regulatory framework at both federal and state levels continues to evolve. The US Environmental Protection Agency (USEPA) issued Drinking Water Health Advisories for PFOA and PFOS in May 2016, but there are currently no promulgated national standards regulating PFAS in drinking water. In the absence of federal maximum contaminant levels, some states have adopted their own drinking water standards for PFAS. The State of Minnesota has adopted screening values of 35 parts per trillion (ppt) for PFOA and 15 ppt for PFOS (Minnesota Department of Health, 2019). These values are more protective than the USEPA value of 70 ppt, individually or combined.

This report presents findings of a PA for PFAS at Camp Ripley, near Little Falls, Minnesota, in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended, the National Oil and Hazardous Substances Pollution Contingency Plan (40 Code of Federal Regulations Part 300), and USACE requirements and guidance.

This PA Report documents the known fire training areas (FTAs) as well as additional locations where PFAS may have been released into the environment at Camp Ripley. The term PFAS will be used throughout this report to encompass all PFAS chemicals being evaluated, including PFOS and PFOA, which are key components AFFF.

1.2 Preliminary Assessment Methods

The performance of this PA included the following tasks:

- Reviewed data resources to obtain information relevant to suspected PFAS releases
- Conducted a 2-day site visit on 26 and 27 September 2018
- Interviewed current and retired Camp Ripley personnel during the site visit including Minnesota ARNG (MNARNG) environmental managers, the current Camp Ripley Fire and Emergency Services Fire Chief, the retired City of Randall Fire Chief, Airfield personnel, deployable unit personnel, purchasing staff, and Range Facility Management personnel
- Completed visual site inspections at known or suspected PFAS release locations and documented with photographs
- Developed a conceptual site model (CSM) to outline the potential release and pathway of PFAS for the Areas of Interest (AOIs) and the facility

1.3 Report Organization

This report has been prepared in accordance with the USEPA *Guidance for Performing Preliminary Assessments under CERCLA* (USEPA, 1991). The report sections and descriptions of each are:

- **Section 1 – Introduction:** identifies the project purpose and authority and describes the facility location, environmental setting, and methods used to complete the PA
- **Section 2 – Fire Training Areas:** describes the FTAs at the facility identified during the site visit
- **Section 3 – Non-Fire Training Areas:** describes other locations of potential PFAS releases at the facility identified during the site visit
- **Section 4 – Emergency Response Areas:** describes areas of potential PFAS release at the facility, specifically in response to emergency situations
- **Section 5 – Adjacent Sources:** describes sources of potential PFAS release adjacent to the facility that are not under the control of ARNG
- **Section 6 – Conceptual Site Model:** describes the pathways of PFAS transport and receptors at each AOI
- **Section 7 – Conclusions:** summarizes the data findings and presents the conclusions of the PA
- **Section 8 – References:** provides the references used to develop this document
- **Appendix A** – Data Resources
- **Appendix B** – Preliminary Assessment Documentation
- **Appendix C** – Photographic Log

1.4 Facility Location and Description

Camp Ripley is in Morrison County in central Minnesota near Little Falls, approximately 20 miles southwest of Brainerd (**Figure 1-1**). The State of Minnesota purchased 12,000 acres of land from the Northwestern Improvement Company in 1931, formally establishing Camp Ripley. Since 1951, the State of Minnesota has purchased additional land expanding Camp Ripley to a total of 53,000 acres. The facility is bordered by the Crow Wing River to the north and the Mississippi River to the east.

Camp Ripley is currently a maneuver and training center owned by the State of Minnesota and managed by the Minnesota Department of Military Affairs. In addition, the Department of Natural Resources provides technical support to the facility. The missions of Camp Ripley are to provide realistic joint and combined arms training, provide support for state emergencies, and provide resources that add value to the community.

1.5 Facility Environmental Setting

Camp Ripley is on the western Lake Section of the Central Lowland physiographic province. The level to slightly rolling topography of Camp Ripley is a result of glacial drift during the Pleistocene Epoch (US Army Environmental Hygiene Agency [USAEHA], 1994). Ground-surface elevations range from 1,140 to 1,550 feet above mean sea level. Regionally, topography slopes to the east-southeast toward the Mississippi River, where the elevations at Camp Ripley are lowest. The most prominent geomorphologic feature at Camp Ripley is the St. Croix moraine. This moraine occupies most of the facility, forming a rough belt of uneven hummocky topography containing numerous hills, associated depressions, lakes, and wetlands (University of Minnesota Duluth [UMD], no date [n.d.]). These higher-relief landforms cover about half of Camp Ripley. Lower-relief landforms, such as outwash plain, old lakebeds, and alluvium, cover about 40 percent. The remaining areas consist of level terrain and water features (USAEHA, 1994).

1.5.1 Geology

Surficial deposits at Camp Ripley consist of ice-contact and outwash deposits of the St. Croix moranic system. The outwash deposits were created by glacial meltwaters that flowed through the Mississippi and Crow Wing River valleys, depositing the poorly sorted sands and gravels in a band a few miles wide along both sides of the rivers (US Army Center for Health Promotion and Preventative Medicine [USACHPPM], 2000). The moraine is composed primarily of a heterogeneous mixture of glacial sediment consisting predominantly of sandy deposits laid down as flow tills, outwash, and lacustrine sediment by the Rainy and Superior lobes during the St. Croix glaciation of the Late Wisconsin Period. These deposits overlie the Hewitt till, a loamy glacial deposit laid down by the Wadena lobe during an earlier glacial advance (UMD, n.d.). Thicknesses of these unconsolidated deposits vary considerably across Camp Ripley, ranging from 20 feet to more than 200 feet (USACHPPM, 2000).

Bedrock at Camp Ripley consists of Precambrian age metamorphic rocks (USAEHA, 1994). Slate, schist, and metamorphosed mafic and intermediate volcanics compose the bedrock under Camp Ripley. Depth to bedrock at Camp Ripley varies and can be 150 feet or greater (USACHPPM, 2000).

1.5.2 Hydrogeology

In the region surrounding Camp Ripley, the main water-bearing units are composed of heterogeneous glacial sediments and lacustrine sandy deposits (Progressive Consulting Engineers, [PCE] n.d.; Quinn, 2006). Occasional sand and gravel components are intercepted at some well locations (Bruce A. Liesch Associates, Inc [BAL], 1987). Clay layers have been encountered throughout Camp Ripley, but no laterally extensive confining layers exist within the unconsolidated deposits (PCE, n.d.).

Depth to groundwater varies from at or near the surface at the northern and eastern boundaries of the facility to as deep as 288 feet in the higher elevations of the morainic areas (UMD, n.d.) and is largely dependent on topography (USACHPPM, 2000). Shallow groundwater elevations measured in the upland regions represent perched groundwater conditions, and the main water-bearing zone is approximately 30 feet below ground surface in the cantonment area (Foth and Van Dyke, 1997).

The regional groundwater flow is east-southeast toward the Mississippi River and is defined by a drainage divide west of Camp Ripley. Groundwater originating east of this divide follows the east-southeast flow path to the discharge boundaries of Little Elk Creek to the southwest and the Crow Wing and Mississippi Rivers to the north and east (UMD, n.d.). The complex glacial topography creates localized variations in the groundwater flow paths, where recharge occurs at topographic highs and discharge occurs in adjacent topographic lows. In some areas, the shallow groundwater is thought to be in communication with the many kettle lakes and wetland areas (USACHPPM, 2000).

Camp Ripley has three production wells, Well L, Well N, and Well H that provide drinking water to the facility, and several private and domestic wells are present along the facility boundary (**Figure 1-2**). Groundwater samples for PFAS analysis were collected at Camp Ripley in March 2017 at several locations. Results for PFAS compounds were below the State of Minnesota screening levels at all locations.

Since the geologic makeup of the Camp Ripley area aquifer consists primarily of coarse-grained glacial and lacustrine deposits, the permeability is considered high. Groundwater studies and flow modeling have characterized the hydraulic conductivity of the glacial deposits at Camp Ripley from well pump tests and grain size analyses. Calculated hydraulic conductivities from the grain size analyses vary widely and range from 9.7 feet/day for dense clay loam till to 334 feet/day for coarse sand and gravel deposits (Quinn, 2006). A pumping test that was performed at an on-facility groundwater supply well in the cantonment area exhibited very rapid recharge. The hydraulic conductivity of sediments near this well was calculated to be 408 feet/day (PCE, n.d.).

Natural recharge to the groundwater aquifer system in the Camp Ripley area is primarily through surface infiltration through the glacial outwash deposits east of the drainage divide (Quinn 2006). Groundwater level results from the Argonne National Labs 2003 groundwater flow model suggest that Lake Alexander may contribute to the groundwater recharge (UMD n.d.). Groundwater in the cantonment area discharges to the Mississippi River, creating a hydrogeologic boundary along the eastern side of Camp Ripley (UMD, n.d.). Secondary discharge includes pumping for irrigation and drinking water consumption.

1.5.3 Hydrology

Camp Ripley has abundant surface water as a result of the glacial processes that shaped the landscape including small inland lakes, wetlands, and streams (MNARNG, 2018) (**Figure 1-3**).

Camp Ripley is bordered on the north by the Crow Wing River and on the east by the Mississippi River. The Little Elk River flows west to east, approximately 4 miles south of Camp Ripley. Several wetlands and lakes exist in the range areas and are thought to be in communication with the groundwater. Six surface water bodies originate on Camp Ripley and flow off facility to the Mississippi River, the Crow Wing River, and the Little Elk River.

The three major watersheds on Camp Ripley are the Crow Wing River, City of Little Falls-Mississippi River, and the Fish Trap Creek watersheds (**Figure 1-3**). The Little Elk River watershed is a minor watershed unit. The Crow Wing River watershed receives direct runoff from about 17 square miles of the northern part of the facility, which is mostly undeveloped. There are no known point source discharges. The City of Little Falls-Mississippi River watershed is the largest watershed on the facility, covering about 45 square miles. Almost all of the surface drainage from the northern, central, and southern areas of the facility is in the City of Little Falls-Mississippi River watershed. The Little Elk River watershed receives runoff from about 12 square miles on the southern and southwestern parts of the facility, and numerous small lakes contribute drainage to the Little Elk River. The Fish Trap Creek watershed is the smallest watershed on the facility and drains an area of about 10 square miles in the western part of Camp Ripley (USASCHPPM, 2000; UMD, n.d.).

1.5.4 Climate

The climate at Camp Ripley has wide variations in temperature, ample summer rainfall, and a persistent winter snow cover. Spring, summer, and fall temperatures are temperate, while occasional Artic outbreaks occur during the winter (MNARNG, 2018). The average temperature is 43.35 degrees Fahrenheit (World Climate, 2019). The mean annual precipitation at Camp Ripley is 26.26 inches, and the mean annual snowfall is about 44 inches, occurring almost entirely from November through March.

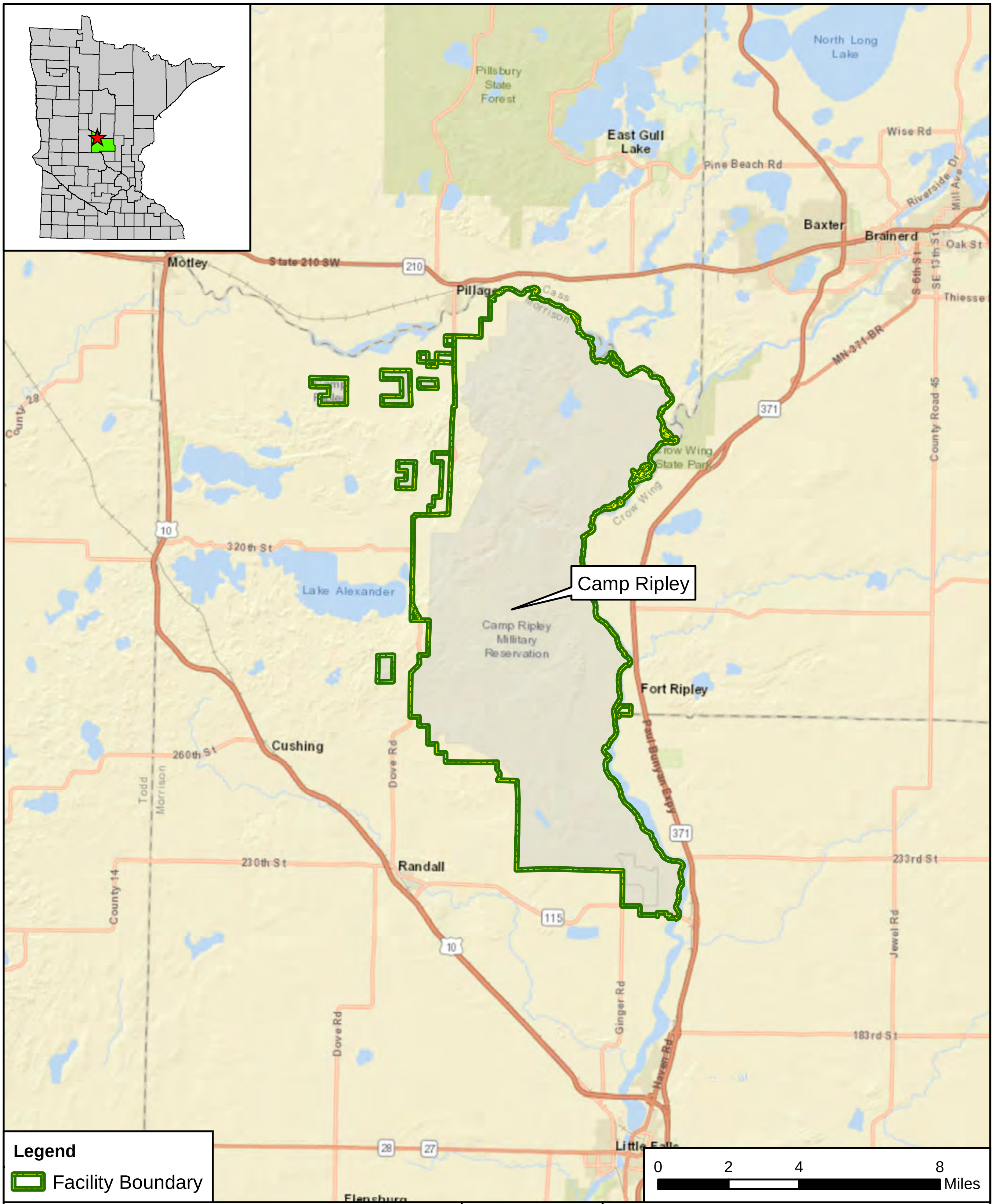
1.5.5 Current and Future Land Use

Camp Ripley is a controlled access facility for military training supported by maneuver training; weapons familiarization and qualification; aviation and armor gunnery; military occupational specialty producing and leadership provision of a central maintenance facility; direct service support in all classes of supply; provision of personnel services and chaplain services; and military morale, welfare, and recreation activities. The MNARNG is responsible for the protection and management of the natural and cultural resources at Camp Ripley and may restrict public access to the facility when conducting military training; however, many opportunities for public access and use exist including cross country skiing, deer and turkey hunts, fishing, bird watching, walking, and camping (MNARNG, 2018).

Currently, Camp Ripley is deficient in maneuver area acreage and improvements to existing lands are planned to meet current and projected training requirements. Planned improvements include upgrading existing roads and trails, constructing new maneuver corridors, and creating new assembly areas.

In 2004, the MNARNG approved the Camp Ripley Army Compatible Use Buffer (ACUB) Program establishing a three mile buffer (110,000 acres) around the facility to combat encroachment concerns, especially noise, and in 2015, Camp Ripley was designated the first state sentinel landscape in the US to promote natural resource sustainability around the facility. In an effort to expand services to private landowners within the ACUB Program and extend out to a 10-mile radius around the facility, in 2016, Camp Ripley was designated as a federal Sentinel Landscape. The federal designation will allow Camp Ripley to more effectively compete for federal funding from agencies beyond the Department of Defense and to better align federal, state and local programs that could support private landowners in a Sentinel Landscape (MNARNG, 2018).

Reasonably anticipated future land use is not expected to change from the current land use described above.



CLIENT	ARNG			
NOTES	Preliminary Assessment for PFAS at Camp Ripley, MN			
REVISED	3/11/2019	GIS BY	MS	3/11/2019
SCALE	1:253,440	CHK BY	JZ	3/11/2019
Base Map: Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI,		PM	RG	3/11/2019

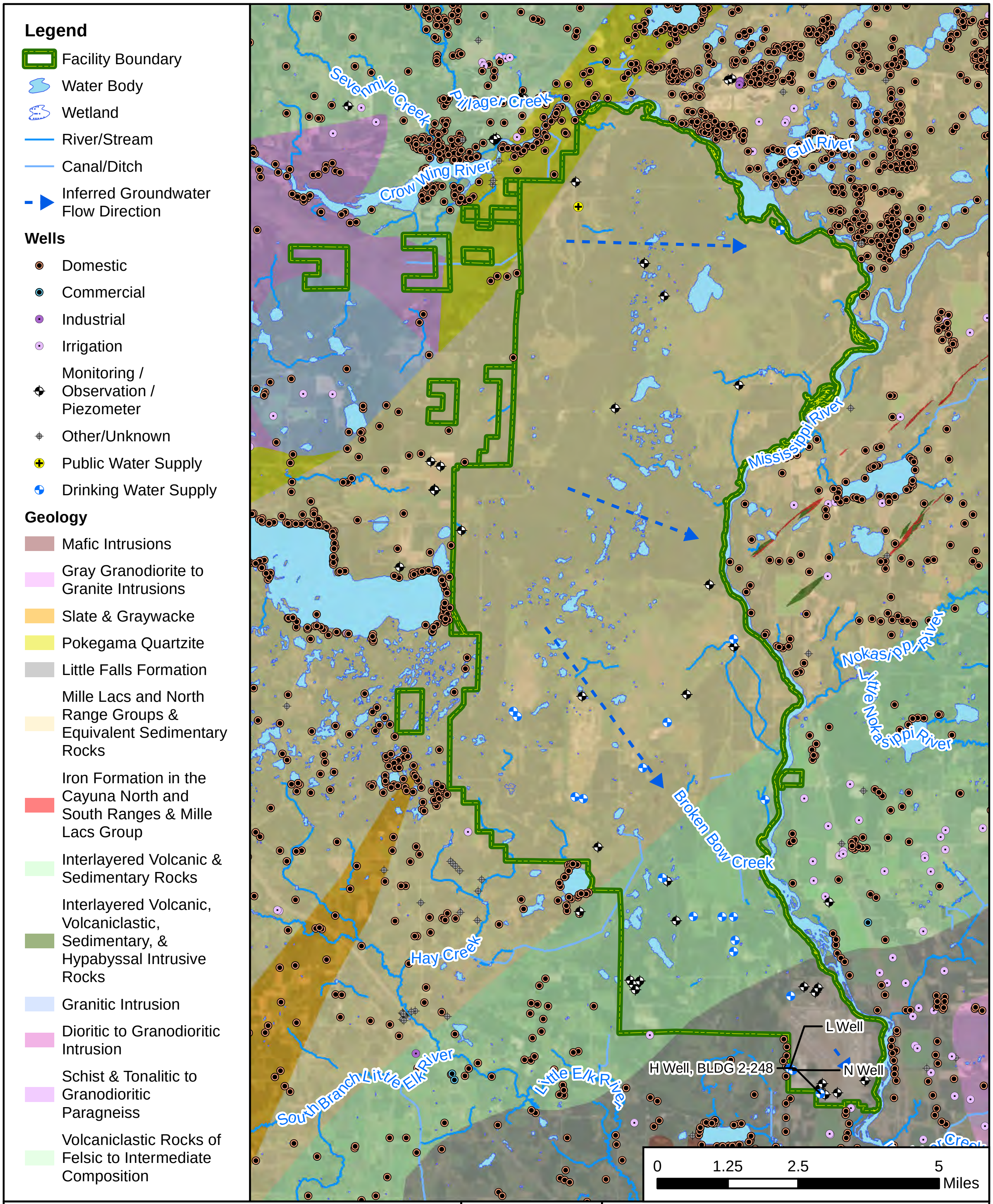
N

Facility Location

AECOM
12420 Milestone Center Drive
Germantown, MD 20876

Figure 1-1

Q:\Projects\ENV\GEARS\GEO\ARNG PFAS\900-CAD-GIS\920-GIS or Graphics\MXD\MN\Camp_Ripley_Figures\Camp_Ripley_PA_Figures\Fig_1-1_Camp_Ripley_Facility_Location.mxd



CLIENT	ARNG			
NOTES	Preliminary Assessment for PFAS at Camp Ripley, MN			
REVISED	4/12/2019	GIS BY	MS	4/12/2019
SCALE	1:158,400	CHK BY	BN	4/12/2019
Base Map: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS,		PM	RG	4/12/2019

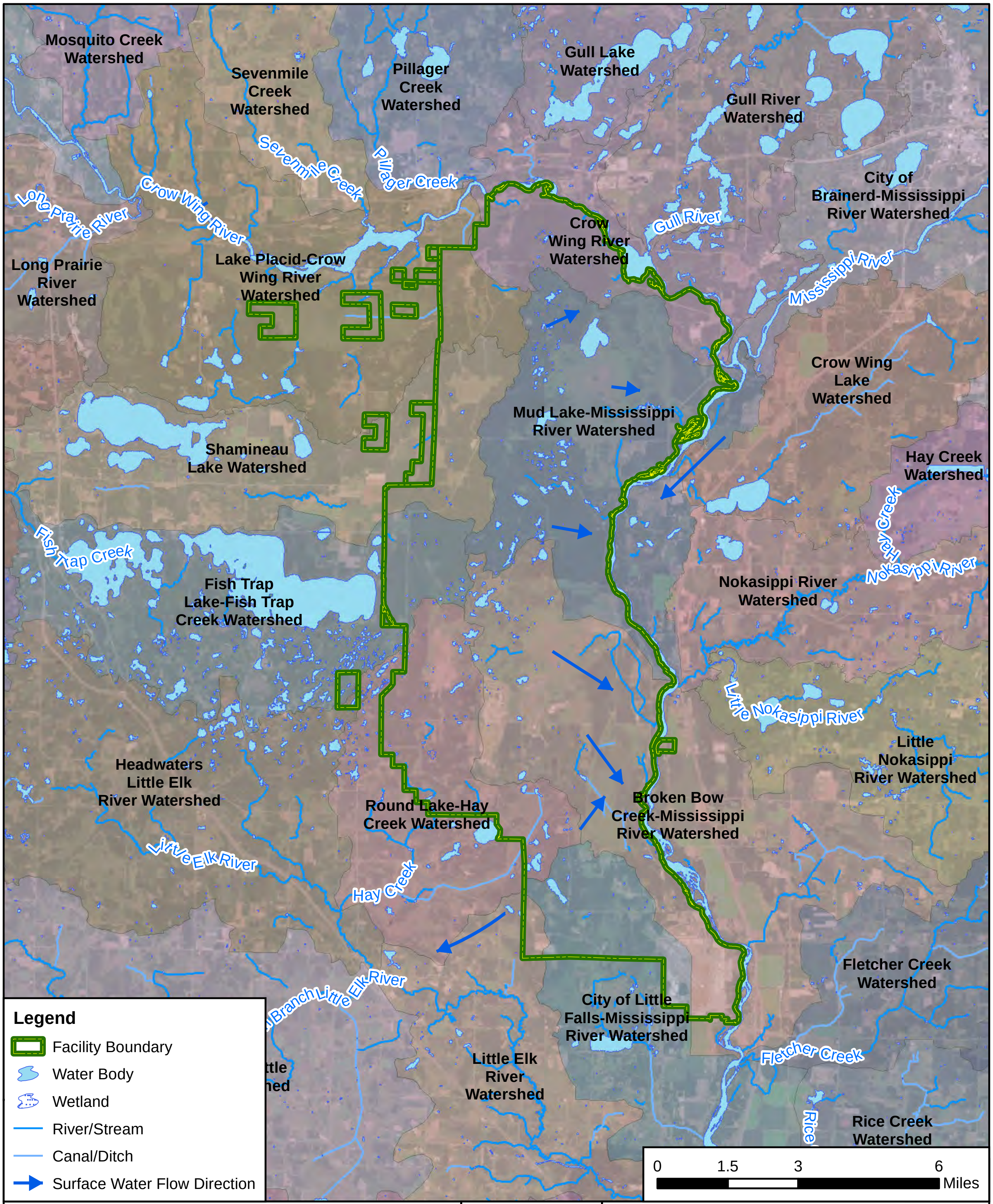
N

Groundwater Features

AECOM
12420 Milestone Center Drive
Germantown, MD 20876

Figure 1-2

Q:\Projects\ENV\GEARS\GEO\ARNG PFAS\900-CAD-GIS\920-GIS or Graphics\MXD\MN\Camp_Ripley_Figures\Camp_Ripley_PA_Figures\Fig_1-2_Camp_Ripley_Groundwater.mxd



CLIENT	ARNG			
NOTES	Preliminary Assessment for PFAS at Camp Ripley, MN			
REVISED	3/12/2019	GIS BY	MS	3/12/2019
SCALE	1:190,080	CHK BY	BN	3/12/2019
Base Map: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS,		PM	RG	3/12/2019

N

Surface Water Features

AECOM
12420 Milestone Center Drive
Germantown, MD 20876

Figure 1-3

Q:\Projects\ENV\GEARS\GEO\ARNG PFAS\900-CAD-GIS\920-GIS or Graphics\MXD\MN\Camp_Ripley_Figures\Camp_Ripley_PA_Figures\Fig_1-3_Camp_Ripley_Surface_Water.mxd

2. Fire Training Areas

Three FTAs were identified within the Camp Ripley facility during the PA. A description of each FTA is presented below, and the FTA locations are shown on **Figure 2-1**. Photographs of the FTAs appear in **Appendix C**.

2.1 Current Fire Station (Building 8-197)

Camp Ripley Fire and Emergency Services was established in 2007 and responds to all fire emergencies at the facility. The current Fire Station (Building 8-197) is immediately northeast of the Ray S. Miller Army Airfield runway, south of the intersection of Chickamauga Road and Ott Road. The geographic coordinates are 46°05'38.5"N and 94°21'35.4"W (**Figure 2-1**). Camp Ripley Fire and Emergency Services has three fire trucks and three all-terrain vehicles with AFFF capacity. Nozzle testing has not been conducted at Camp Ripley, and the fire trucks are washed at the current Fire Station (Building 8-197). Wash water is discharged to a stormwater drain.

Bulk AFFF is stored in the State Warehouse (Building 2-223) and transferred to Camp Ripley fire trucks at the current Fire Station (Building 8-197) on an as-needed basis. According to the purchasing supervisor, AFFF was last ordered in 2011. During the site visit, approximately 300-gallons of Ansul® three percent AFFF and 55-gallons of Phos-Chek® Class A foam were observed at the State Warehouse (Building 2-223). The geographic coordinates of the State Warehouse (Building 2-223) are 46°04'38.1"N and 94°21'02.8"W (**Figure 2-1**). There are no known potential releases of PFAS at the State Warehouse (Building 2-223); therefore, this area is not considered a potential release area.

Camp Ripley Fire and Emergency Services conducts annual training with water only. The MNARNG 434th Support Maintenance Company, established in 2010, trains with Camp Ripley Fire and Emergency Services and assists in fire emergency response at Camp Ripley. The 434th stores three fire trucks with AFFF capacity at the old Combined Support Maintenance Shop (CSMS) (Building 2-166) (**Figure 2-1**). There are no known potential releases of PFAS at the old CSMS (Building 2-166); therefore, this area is not considered a potential release area.

Currently, Camp Ripley uses Purple K mobile fire extinguishers at the airfield. However, historically, the facility had six or seven TriMax 30 fire extinguishers. During interviews with Camp Ripley Fire and Emergency Services personnel, one potential release area was identified adjacent to the current Fire Station (Building 8-197) where training occurred. The geographic coordinates are 46°05'37.5"N and 94°21'41.5"W (**Figure 2-1**). At this potential release area, one TriMax 30 fire extinguisher was discharged directly to the ground by the MNARNG in the early 2000s. However, interviewees were unsure whether the fire extinguisher that was discharged contained AFFF or was a training fire extinguisher. The discharged material was allowed to dissipate in the grass. No information regarding the concentration or type of AFFF potentially discharged was available.

2.2 Burn Pit FTA

During an interview with the former Randall Fire Department Fire Chief, a Burn Pit FTA was identified at the north end of the Camp Ripley runway. The geographic coordinates are 46°05'56.4"N and 94°22'03.7"W (**Figure 2-1**). The former Randall Fire Department Fire Chief recalled one coordinated fire training event at the Burn Pit FTA in the late 1980s with the MNARNG and the US Air Force's (USAF) 133rd Airlift Wing from Minneapolis. Fuel was ignited during the training exercise and the fire was extinguished with AFFF by the MNARNG and the USAF. No information was available with regard to the concentration, type, or amount of AFFF used during the fire training event. Other retired MNARNG personnel indicated the Burn Pit FTA may have been used for fire training exercises on multiple occasions.

2.3 Camp Ripley Emergency Management Training Center

On 4 November 2014, Camp Ripley Fire and Emergency Services hosted a training exercise performed by the Minnesota Public Safety Division of the Department of Homeland Security (DHS) Emergency Management at the Camp Ripley Emergency Management Training Center (EMTC). The geographic coordinates of the DHS demonstration are 46°05'24.1"N and 94°20'37.3"W (**Figure 2-1**). During the training exercise one gallon or less of Chemguard C363 3 percent x 6 percent alcohol resistant (AR)-AFFF concentrate was mixed with 100 gallons of water and used to perform practical training exercises, dispensing the foam to the ground, by the DHS. The MNARNG and local municipalities also participated in the training exercises. According to a 2014 Memorandum for Record (**Appendix A**), the foam was used sparingly, and following the training event, no residues were visible in the area where the foam was used. Camp Ripley Fire and Emergency Services personnel indicated that all 100 gallons of the foam mixture were not used during the event. The final disposition of the remaining foam mixture could not be determined during the PA; however, interviewees indicated that the remaining foam mixture was most likely dispensed to the stormwater sewer, which drains to an infiltration basin approximately 100 yards from the Mississippi River.

CLIENT	ARNG			
NOTES	Preliminary Assessment for PFAS at Camp Ripley, MN			
REVISED	3/12/2019	GIS BY	MS	3/12/2019
SCALE	1:14,400	CHK BY	BN	3/12/2019
Base Map: Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI,		PM	RG	3/12/2019

N

Fire Training Areas

AECOM
12420 Milestone Center Drive
Germantown, MD 20876

Figure 2-1

Q:\Projects\ENV\GEARS\GEO\ARNG PFAS\900-CAD-GIS\920-GIS or Graphics\MXD\MN\Camp_Ripley_Figures\Camp_Ripley_PA_Figures\Fig_2-1_Camp_Ripley_Fire_Training_Areas.mxd

3. Non-Fire Training Areas

Six non-fire training areas where AFFF was potentially released were also identified during the PA. A description of each non-FTA is presented below, and the non-FTAs are shown on **Figure 3-1**. Photographs of the non-FTAs appear in **Appendix C**.

3.1 Building 2-203

The City of Randall, approximately 8 miles west of Camp Ripley, provided fire emergency response for structural fires in the cantonment area at Camp Ripley from the 1970s until 2010. From the 1970s until the 1980s, in the event of a fire emergency at the facility, the City of Randall utilized two fire trucks, a 530 and 530C, owned by Camp Ripley and stored at Building 2-203 for firefighting. The geographic coordinates of Building 2-203 are 46°04'42.0"N and 94°21'02.6"W (**Figure 3-1**). No information was available regarding if the fire trucks stored at Building 2-203 were washed or whether or not the fire trucks had maintenance issues; however, it was noted that nozzle testing was not conducted with AFFF. Building 2-203 had floor drains plumbed to an oil-water separator, which routed to the sanitary sewer and the waste water treatment plant at Camp Ripley. Building 2-203 was renovated in 2009 or 2010 and is now used by the Department of Public Safety Force Protection. According to the retired Randall Fire Chief, no emergency response events occurred at Camp Ripley from the 1970s until 2010 that required the use of AFFF. There are no known potential releases of PFAS at Building 2-203; therefore, this area is not considered a potential release area.

3.2 Building 2-272

According to the retired Randall Fire Chief, Camp Ripley did not start using or storing AFFF until the 1980s. At that time, fixed-wing aircraft from the USAF’s 133rd Airlift Wing began arriving at Camp Ripley to conduct winter operations. During winter operations, the USAF’s 133rd Airlift Wing would fly a crash rescue truck to Camp Ripley from Minneapolis and man the truck during incoming flights. Bulk AFFF and the crash rescue truck were stored in the west bay of Building 2-272 to support the operations. The geographic coordinates of Building 2-272 are 46°04'36.9"N and 94°21'09.2"W (**Figure 3-1**). The current roads and grounds supervisor at Building 2-272 did not recall training with AFFF, truck washing, or maintenance issues with the USAF’s fire truck. The crash rescue truck was returned to Minneapolis with the USAF’s 133rd Airlift Wing each spring; however, the bulk AFFF, which belonged to Camp Ripley, remained stored in Building 2-272. No information was available on the amount, type, or concentration of AFFF stored in Building 2-272. Floor drains in Building 2-272 are connected to the sanitary sewer. There are no known potential releases of PFAS at Building 2-272; therefore, this area is not considered a potential release area.

3.3 Building 8-195

The Ray S. Miller Army Airfield at Camp Ripley was paved in 1986 or 1987, after which a large crash rescue truck (011A) was brought to the facility by the Airfield Fire Chief and stored at the old hangar (Building 8-195). The geographic coordinates of the old hangar (Building 8-195) are 46°05'33.6"N and 94°21'09.1"W (**Figure 3-1**). When the USAF’s 133rd Airlift Wing was not at Camp Riley for winter operations, volunteers would standby with this crash rescue truck at the old hangar (Building 8-195) during incoming flights. The lead mechanic at the old hangar (Building 8-195) did not recall any maintenance issues with this crash rescue fire truck; however, he did indicate that any serious maintenance issues would have required repair at the old CSMS (Building 2-166). Building 8-195 was renovated in 2010 and is currently a Morale Welfare Recreation facility. There are no known potential releases of PFAS at Building 8-195; therefore, this area is not considered a potential release area.

3.4 United States Property and Fiscal Office Warehouse and the Combined Maintenance Activity Shop

Unused or expired fire equipment from MNARNG facilities are shipped to the United States Property and Fiscal Office (USPFO) warehouse at Camp Ripley. The fire equipment, including TriMax fire extinguishers, are stored and/or processed at the USPFO prior to reutilization or disposition. The geographic coordinates of the USPFO warehouse are 46°04'53.3"N and 94°21'47.0"W (**Figure 3-1**). According to USPFO warehouse interviewees TriMax fire extinguishers have been returned to the warehouse for disposition. Seven TriMax fire extinguishers from the St. Paul Army Aviation Support Facility (AASF) Holman Field were received emptied, nine TriMax fire extinguishers from the St. Cloud AASF containing AFFF were received full and are at the warehouse, and 6-7 units from Camp Ripley were received, but it was unknown if the units were received full or emptied at the airfield. No issues regarding AFFF leakage from the equipment were noted by the USPFO.

Due to the presence of compressed gas cylinders, TriMax fire extinguishers must be demilitarized prior to final disposition. Demilitarization of the TriMax fire extinguishers requires the equipment to be physically destroyed by the Combined Maintenance Activity (CMA) Shop at Camp Ripley. The geographic coordinates of the CMA are 46°04'52.0"N and 94°22'02.5"W (**Figure 3-1**). For demilitarization, the USPFO equipment specialist furnishes special instructions regarding the degree of physical destruction of the equipment to the CMA. However, because AFFF is not regulated as a hazardous substance, no instructions regarding disposal of the AFFF mixture in the tanks are given to the CMA. According to CMA interviewees, AFFF was dispensed once to the ground outside by the MNARNG during demilitarization of a TriMax 30 fire extinguisher in approximately 2017. The AFFF was then allowed to dissipate in the grass. The geographic coordinates of the location where the TriMax 30 fire extinguisher was emptied are 46°04'59.1"N and 94°22'05.9"W (**Figure 3-1**). At the time of the site visit, nine TriMax 30 fire extinguishers containing AFFF shipped from the St. Cloud AASF were at the USPFO warehouse awaiting demilitarization.

3.5 Waste Water Treatment Plant

The Camp Ripley Waste Water Treatment Plant (WWTP) is south of the intersection of Bettenburg Avenue Road and Highway 115 (**Figure 3-1**). The geographic coordinates are 46°04'29.1"N and 94°20'13.2"W. The Camp Ripley WWTP is a Class B Facility with a continuous discharge to the Mississippi River. Camp Ripley has been permitted to perform land application of sludge from the WWTP since 1987 south of Argonne Road between Gettysburg Road and 140th Avenue at the Sludge Spread Site. The geographic coordinates are 46°06'22.8"N and 94°22'57.2"W. Camp Ripley deposits less than 320 tons of sludge at the Sludge Spread Site per year. Because the WWTP does not contain a treatment system for PFAS it is possible that land application of sludge containing PFAS at the Sludge Spread Site and WWTP discharge of PFAS to the Mississippi River has occurred.

3.6 Stormwater Infiltration Basin

Based on interviews, the disposition of the remaining foam mixture used during the fire training event at the EMTC (**Section 2.3**) was most likely dispensed to the stormwater sewer system. The volume of mixture dispensed would have been less than the original 100 gallons which was made for the training event. The stormwater sewer system, in the cantonment area drains to the stormwater infiltration basin located north of Chickamauga Road, approximately 100 yards from the Mississippi River (**Figure 3-1**). The geographic coordinates are 46°05'42.87"N and 94°20'05.44"W.

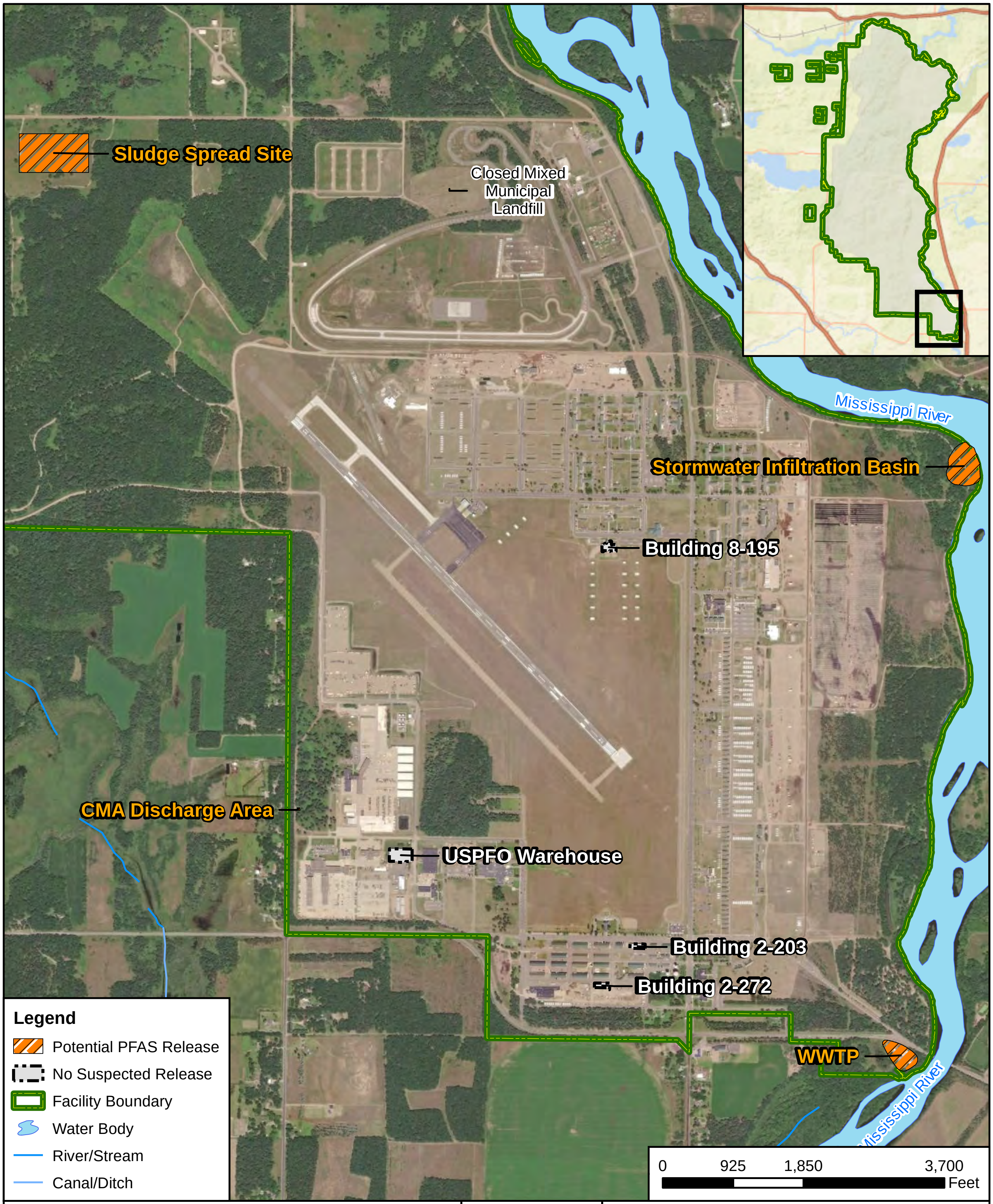
3.7 Landfills

One former landfill, the Camp Ripley Closed Mixed Municipal Landfill, exists at Camp Ripley in the cantonment area. The geographic coordinates are 46°06'19.8"N and 94°21'40.2"W (**Figure 3-1**). The former Landfill, which occupies approximately 11 acres, accepted a variety of wastes from the facility until its closure in 1988. Several small landfills also exist within the training areas.

Landfills are not usually a primary potential release area of PFAS, but materials disposed of in landfills may create a secondary source of contamination. Such materials, to name a few, may include sludge from a WWTP that processes PFAS-laden water, used AFFF storage containers, or products associated with waterproofing uniforms or boots. At Camp Ripley, no information obtained indicates PFAS-related materials were disposed of in the landfill.

3.8 Prescribed Burns

Prescribed fires are used at Camp Ripley to enhance the military training environment and reduce hazards. The prescribed burns primarily aim to manage native prairie grass and woody encroachment, enhance seed production, control brush, reduce fuel-hazards, and improve forest management and habitats for species in greatest conservation need (MNARNG, 2018). According to interviewees, water and Class A foams (which do not contain PFAS) are used for suppression during wildland fires and prescribed burns at Camp Ripley. AFFF is not used during wildland fire and prescribed burn operations.



CLIENT	ARNG			
NOTES	Preliminary Assessment for PFAS at Camp Ripley, MN			
REVISED	5/31/2019	GIS BY	MS	5/31/2019
SCALE	1:22,200	CHK BY	BN	5/31/2019
Base Map: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI,		PM	RG	5/31/2019

N

Non-Fire Training Areas

AECOM
12420 Milestone Center Drive
Germantown, MD 20876

Figure 3-1

Q:\Projects\ENV\GEARS\GEO\ARNG PFAS\900-CAD-GIS\920-GIS or Graphics\MXD\MN\Camp_Ripley_Figures\Camp_Ripley_PA_Figures\Fig_3-1_Camp_Ripley_Non-Fire_Training_Areas.mxd

4. Emergency Response Areas

Camp Ripley personnel identified one emergency response area during the PA. The emergency response area is shown on **Figure 4-1**.

4.1 Crash Site

On 13 March 1993, two MNARNG rotary-winged aircraft engaged in routine low-level training flights at Camp Ripley collided midflight about 15 miles down range. The geographic coordinates of the crash site are 46° 12′ 45.5872″ N and 94° 23′ 52.5914″ W (**Figure 4-1**). According to interviewees, there was not a post-crash fire and three to four feet of snow covered the ground at the time of the crash. Therefore, AFFF was not used at the crash site, and this area is not considered a potential release area.

CLIENT	ARNG			
NOTES	Preliminary Assessment for PFAS at Camp Ripley, MN			
REVISED	3/12/2019	GIS BY	MS	3/12/2019
SCALE	1:4,800	CHK BY	BN	3/12/2019
Base Map: Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI,		PM	RG	3/12/2019

N

Emergency Response Area

AECOM
12420 Milestone Center Drive
Germantown, MD 20876

Figure 4-1

Q:\Projects\ENV\GEARS\GEO\ARNG PFAS\900-CAD-GIS\920-GIS or Graphics\MXD\MN\Camp_Ripley_Figures\Camp_Ripley_PA_Figures\Fig_4-1_Camp_Ripley_Emergency_Response_Areas.mxd

5. Adjacent Sources

Four potential off-facility sources of PFAS near Camp Ripley, not under the control of the MNARNG, were identified during the PA. One potential off-facility source is a chrome plating facility. The other three potential off-facility sources were identified through the terms of the Cuyuna Agreement with the Range Fire Chiefs Association, which allows surrounding communities to use AFFF from Camp Ripley for response to emergency events outside of the facility. If AFFF from Camp Ripley is used for an emergency event outside the facility, the AFFF is replaced by the responding agency that used the AFFF. A description of each potential off-facility source is presented below, and the locations of are shown on **Figure 5-1**.

5.1 Coal Train Collision

On 14 June 1984 two Burlington Northern Railroad Company coal trains collided head-on in a wooded area near Motley, Minnesota, approximately one mile south of the intersection of Highway 210 and Bridgeman Road in May Township. The geographic coordinates of the collision are 46°19'22.1"N and 94°34'46.9"W (**Figure 5-1**). A massive fire resulted from the collision, and approximately 100 gallons of AFFF concentrate were taken from Camp Ripley by Firemen from the cities of Motley, Staples, and Pillager to extinguish the fire. Motley is approximately 30 miles north of Camp Ripley.

5.2 Fuel Tanker Accident

According to interviewees, a fuel tanker rolled over on Highway 371 near Brainerd, Minnesota, sometime in the 1990s. The fuel tanker did not catch fire; however, AFFF was dispensed to smother the fuel vapors. Approximately 100 gallons of AFFF concentrate were taken from Camp Ripley for this emergency event. The exact location of the fuel tanker rollover could not be determined. Brainerd is approximately 25 miles north of Camp Ripley.

5.3 Central Minnesota Ethanol Cooperative Fire

On 29 October 2007 smoldering wood chips in a gasification silo at the Central Minnesota Ethanol Cooperative caused the roof of the silo to explode and collapse. Approximately 300 gallons of AR-AFFF concentrate were taken from Camp Ripley by the Little Falls Fire Department to respond to the emergency event. The Central Minnesota Ethanol Co-op is about five miles south of Camp Ripley. The geographic coordinates are 46°01'16.0"N and 94°20'20.8"W (**Figure 5-1**).

5.4 Keystone Automotive

One additional source of PFAS, not adjacent to Camp Ripley was identified in a report by Delta Consultants titled *Perfluorocarbon (PFC)-Containing Firefighting Foams And Their Use In Minnesota*: Keystone Automotive (Delta Consultants, 2010). Keystone Automotive is a chrome plating operation in Brainerd, Minnesota (**Figure 5-1**). Historically, Keystone Automotive used Fumetrol™ 140 Mist Suppressant to reduce surface tension in chrome plating baths and reduce emissions of hexavalent chromium from the plating solution. Fumetrol™ 140 Mist Suppressant contains PFAS between 1 percent and 7 percent by weight. The company reportedly used approximately 30 gallons per year of the solution before switching to a different mist suppressant in September 2007 (US Health and Human Services, 2008). Brainerd is approximately 25 miles north of Camp Ripley.

CLIENT	ARNG			
PROJECT	Preliminary Assessment for PFAS at Camp Ripley, MN			
REVISED	3/12/2019	GIS BY	MS	3/12/2019
SCALE	1:6,000	CHK BY	BN	3/12/2019
Base Map: Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), MapmyIndia, ©		PM	RG	3/12/2019

Legend

▨ Potential PFAS Release
🟩 Facility Boundary
Water Body
— River/Stream

N

Adjacent Sources

AECOM
12420 Milestone Center Drive
Germantown, MD 20876

Figure 5-1

Q:\Projects\ENV\GEARS\GEO\ARNG PFAS\900-CAD-GIS\920-GIS or Graphics\MXD\MN\Camp_Ripley_Figures\Camp_Ripley_PA_Figures\Fig_5-1_Camp_Ripley_Adjacent_Sources.mxd

6. Preliminary Conceptual Site Model

Based on the PA findings, six AOIs were identified at Camp Ripley: AOI 1 TriMax Discharge Area, AOI 2 Burn Pit FTA, AOI 3 DHS Demonstration, AOI 4 CMA Discharge Area, AOI 5 WWTP and Sludge Spread Site, and AOI 6 Stormwater Infiltration Basin. The AOI locations are shown on **Figure 6-1**. Potential off-facility PFAS release areas exist upgradient of Camp Ripley, it It is unknown whether the potential release areas affect the facility (**Figure 6-2**). The following sections describe the CSM components and the specific CSM developed for each AOI. The CSM identifies the three components necessary for a potentially complete exposure pathway: (1) source, (2) pathway, (3) receptor. If any of these elements are missing, the pathway is considered incomplete.

In general, the potential PFAS exposure pathways are ingestion and inhalation. Human exposure via the dermal contact pathway may occur, and current risk practice suggests it is an insignificant pathway compared to ingestion; however, exposure data for dermal pathways is sparse and continues to be the subject of PFAS toxicological study. Receptors for Camp Ripley include site workers, construction workers, trespassers, off-facility recreational users, and off-facility residents. The CSMs for each AOI indicate which specific receptors could potentially be exposed to PFAS.

6.1 AOI 1 TriMax Discharge Area

AOI 1 is the TriMax Discharge Area adjacent to the current Fire Station (Building 8-197). Potential PFAS releases to soil by the MNARNG occurred once in the early 2000s when a TriMax 30 fire extinguisher was discharged to the ground. Interviewees were unsure whether the fire extinguisher that was discharged contained AFFF or was a training fire extinguisher.

PFAS are water soluble and can migrate readily from soil to groundwater, which is estimated to be at approximately 30 feet below ground surface in the cantonment area at Camp Ripley (Foth and Van Dyke, 1997). Because it is possible PFAS releases to surface soil at AOI 1 have occurred, PFAS may have migrated from the surface soil to the groundwater via leaching. Drinking water for Camp Ripley is drawn from three production wells at the facility, Well L, Well N and Well H, and several private and domestic wells are present along the facility boundary. Drinking water samples from Well L, Well N, and Well H were analyzed for PFAS in 2017. All results for PFAS were below the State of Minnesota screening levels.

Ground-disturbing activities to soil at AOI 1 may result in site worker, construction worker, and trespasser exposure to potential PFAS contamination. Ground-disturbing activities to subsurface soil could result in construction worker exposure. Therefore, the exposure pathways for inhalation of soil particles and ingestion of surface soil are potentially complete for these receptors. The facility drinking water supply wells are located to the southwest of AOI 1. Based on the east-southeastern groundwater flow direction at Camp Ripley, potential PFAS releases at AOI 1 would not impact the drinking water supply wells. In addition, there are no domestic or private wells outside of the eastern facility boundary on the west side of the Mississippi River. Therefore, the drinking water exposure pathway for site workers, construction workers, trespassers, and off-facility residents is incomplete. No surface water features flow through AOI 1; therefore, surface water and sediment exposure pathways are also incomplete. The CSM for AOI 1 is shown on **Figure 6-3**.

6.2 AOI 2 Burn Pit FTA

AOI 2 is the Burn Pit FTA. One coordinated fire training event occurred at the Burn Pit FTA in the late 1980s with the MNARNG and the USAF’s 133rd Airlift Wing from Minneapolis; however, the burn pit may have been used for coordinated fire training exercises on multiple occasions.

Because potential PFAS releases to surface soil at AOI 2 have occurred, PFAS may migrate from the surface soil to the groundwater via leaching. The pathways and receptors for AOI 2 are the same as described in **Section 6.1**. The CSM for AOI 2 is shown on **Figure 6-3**.

6.3 AOI 3 DHS Demonstration

AOI 3 is the DHS Demonstration at the EMTC. On 4 November 2014, one gallon or less of Chemguard C363 3 percent x 6 percent AR-AFFF concentrate was mixed with 100 gallons of water and used to perform practical training exercises by the Minnesota Public Safety Division of the DHS, the MNARNG, and local municipalities. Camp Ripley Fire and Emergency Services personnel indicated that all of the foam mixture was not used during the event, but the final disposition of the remaining foam mixture could not be determined.

Because potential PFAS releases to surface soil at AOI 3 have occurred, PFAS may migrate from the surface soil to the groundwater via leaching. Ground-disturbing activities to surface soil at AOI 3 may result in site worker, construction worker, and trespasser exposure to potential PFAS contamination. Ground-disturbing activities to subsurface soil could result in construction worker exposure. Therefore, the exposure pathways for inhalation of soil particles and ingestion of soil are potentially complete for these receptors. AOI 3 is northeast of the facility drinking water supply wells. Based on the location of AOI 3 and the east-southeastern groundwater flow direction at Camp Ripley, the drinking water supply wells are not impacted by potential PFAS releases at AOI 3, and the exposure pathway for groundwater to all receptors is incomplete. AOI 3 is less than one-half mile from the Mississippi River. Due to the proximity of the AOI to this surface water body, it is possible that shallow groundwater from AOI 3 interacts with the surface water and sediment at the Mississippi River. Therefore, the surface water and sediment exposure pathways for site workers, construction workers, trespassers, and off-facility recreational users via ingestion are potentially complete. The CSM for AOI 3 is shown on **Figure 6-4**.

6.4 AOI 4 CMA Discharge Area

AOI 4 is the CMA Discharge Area. Potential PFAS releases to soil by the MNARNG occurred once in approximately 2010 when AFFF was dispensed to the ground outside during demilitarization of a TriMax 30 fire extinguisher by the MNARNG. AOI 4 is approximately 300 feet southeast of Well L, 300 feet southwest of Well N, and less than three-quarters of a mile northeast of Well H.

Because potential PFAS releases to surface soil have occurred at AOI 4, PFAS may have migrated from the surface soil to the groundwater via leaching. Ground-disturbing activities to surface soil at AOI 4 may result in site worker, construction worker, and trespasser exposure to potential PFAS contamination. Ground-disturbing activities to subsurface soil could result in construction worker exposure. Therefore, the exposure pathways for inhalation of soil particles and ingestion of soil are potentially complete for these receptors. Due to the close proximity of the facility drinking water supply wells to AOI 4, potential PFAS releases at this AOI may impact the drinking water at the facility. In addition, based on the east-southeastern groundwater flow direction, it is possible domestic and private wells outside of the southern facility boundary near the main gate may be impacted. Therefore, the drinking water exposure pathway for site workers, construction workers, trespassers, and off-facility residents is potentially complete. No surface water features flow through or near AOI 4; therefore, surface water and sediment exposure pathways are also incomplete. The CSM for AOI 4 is shown on **Figure 6-5**.

6.5 AOI 5 WWTP and Sludge Spread Site

AOI 5 is the WWTP and the Sludge Spread Site. Camp Ripley has been permitted to perform land application of sludge from the WWTP at the Sludge Spread Site since 1987. Because the WWTP does not contain a treatment system for PFAS and March 2017 post-treatment results had detections for PFAS below the State of Minnesota screening levels, it is possible that land application of sludge containing PFAS at the Sludge Spread Site and WWTP discharge of PFAS containing effluent to the Mississippi River has occurred.

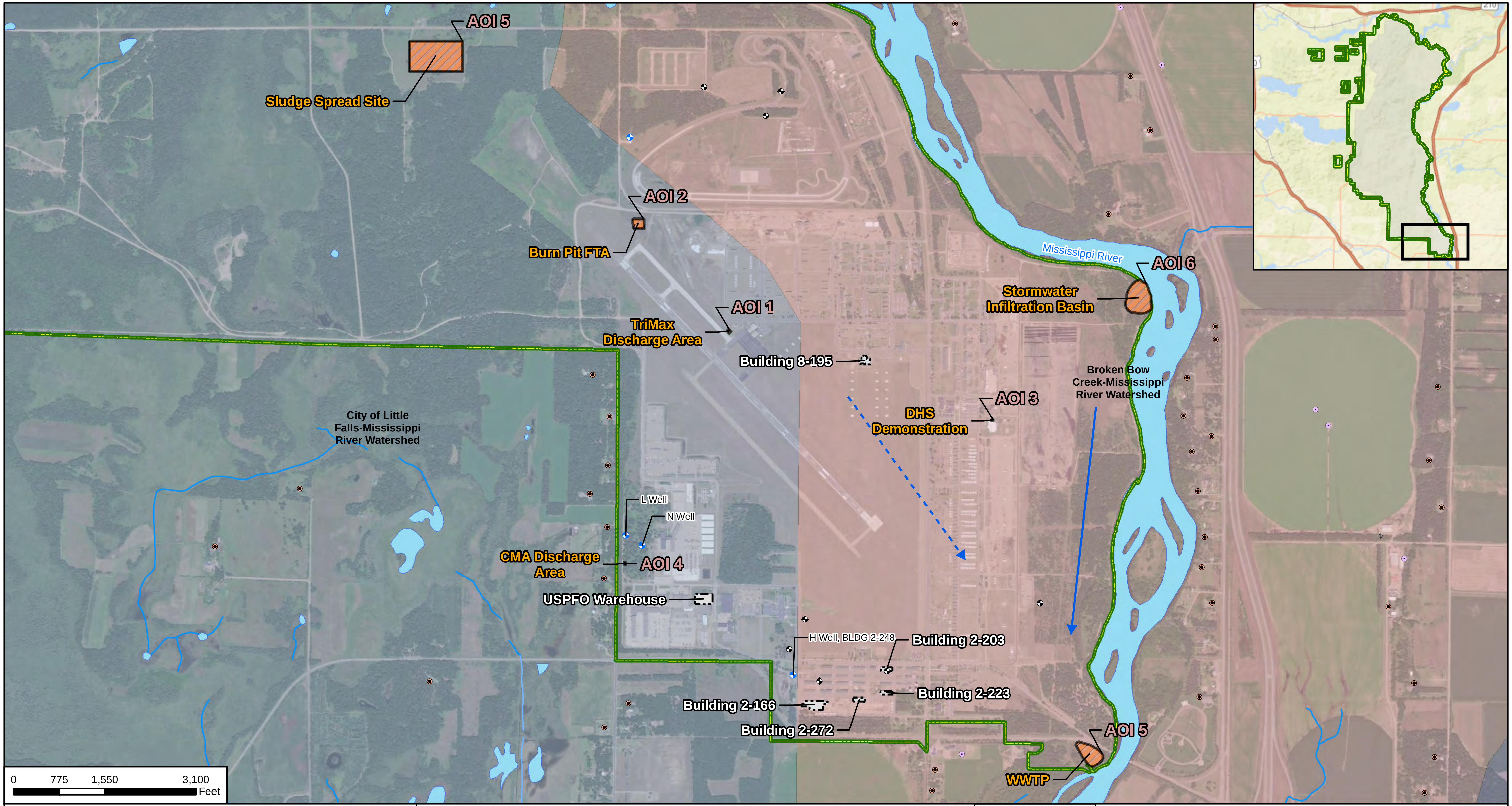
Because land application of sludge that may contain PFAS has occurred at the northern location of AOI 5, PFAS may have migrated from the surface soil to the groundwater via leaching. Ground-disturbing activities to surface soil at AOI 5 may result in site worker, construction worker, and trespasser exposure to potential PFAS contamination. Ground-disturbing activities to subsurface soil could result in construction worker exposure. Therefore, the exposure pathways for inhalation of soil particles and ingestion of soil are potentially complete for these receptors. Based on the east-southeastern groundwater flow direction at Camp Ripley, the northern location of AOI 5 (Sludge Spread Site) is upgradient of the facility drinking water supply wells and a drinking water well (Well #23) at the northwest end of the cantonment area. In addition, it is possible domestic and private wells outside of the southern facility boundary near the main gate are impacted. Therefore, the drinking water exposure pathway for site workers, construction workers, trespassers, and off-facility residents is potentially complete. Because discharge of PFAS from the WWTP to the Mississippi River may have occurred, off-facility surface water and sediment exposure pathways for site workers, construction workers, trespassers, and off-site recreational users are also potentially complete. The CSM for AOI 5 is shown on **Figure 6-6**.

6.6 AOI 6 Stormwater Infiltration Basin

AOI 6 is the Stormwater Infiltration Basin. One gallon or less of Chemguard C363 3 percent x 6 percent AR-AFFF concentrate was mixed with 100 gallons of water and used to perform practical training exercises at the EMTC (**Section 6.3**). Camp Ripley Fire and Emergency Services personnel indicated that all of the foam mixture was not used during the event, but the final disposition of the remaining foam mixture was most likely disposed of in the stormwater sewer system within the cantonment which drains to a stormwater infiltration basin.

Because a potential PFAS release to surface soil at AOI 6 has occurred, PFAS may migrate from the surface soil to the groundwater via leaching. Ground-disturbing activities to surface soil at AOI 6 may result in site worker, construction worker, and trespasser exposure to potential PFAS contamination. Ground-disturbing activities to subsurface soil could result in construction worker exposure. Therefore, the exposure pathways for inhalation of soil particles and ingestion of soil are potentially complete for these receptors.

Maintenance activities to the basin my result in site workers, construction workers, and trespassers being exposed to potential PFAS contamination in surface water and sediment via ingestion; therefore, the exposure pathways for these receptors are potentially complete. AOI 6 is less than 100 yards from the eastern facility boundary and Mississippi River. Due to the proximity of the AOI to this surface water body, it is possible that shallow groundwater from AOI 6 interacts with the surface water and sediment of the Mississippi River. Therefore, surface water and sediment exposure pathways for off-facility recreational users via ingestion are also potentially complete. AOI 6 is northeast of the facility drinking water supply wells. Based on the location of AOI 6 and the east-southeastern groundwater flow direction at Camp Ripley, the drinking water supply wells are not likely impacted by potential PFAS releases at AOI 6, and the exposure pathway for groundwater to all receptors is incomplete. The CSM for AOI 6 is shown on **Figure 6-4**.



CLIENT	ARNG
PROJECT	Preliminary Assessment for PFAS at Camp Ripley, MN

REVISED	7/29/2019	GIS BY	MS	7/29/2019
SCALE	1:19,800	CHK BY	BN	7/29/2019
Base Map: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c)		PM	RG	7/29/2019

▭ Area of Interest
▨ Potential PFAS Release
⬚ No Suspected Release
▭ Facility Boundary
Water Body
River/Stream
Canal/Ditch
→ Surface Water Flow Direction
⇢ Inferred Groundwater Flow Direction
● Domestic Well
● Irrigation Well
✦ Other/Unknown
● Drinking Water Supply Well
◆ Monitoring Well

N

Areas of Interest

AECOM

12420 Milestone Center Drive
Germantown, MD 20876

Figure 6-1

Q:\Projects\ENV\GEARS\GEO\ARNG PFAS\900-CAD-GIS\920-GIS or Graphics\MXD\MN\Camp_Ripley_Figures\Camp_Ripley_PA_Figures\Fig_6-1_Camp_Ripley_AOIs.mxd

CLIENT	ARNG			
PROJECT	Preliminary Assessment for PFAS at Camp Ripley, MN			
REVISED	7/29/2019	GIS BY	MS	7/29/2019
SCALE	1:6,000	CHK BY	BN	7/29/2019
Base Map: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c)		PM	RG	7/29/2019

▨ Potential PFAS Release
🟩 Facility Boundary
Water Body
— River/Stream
→ Surface Water Flow Direction
- → Inferred Groundwater Flow Direction
● Domestic Well

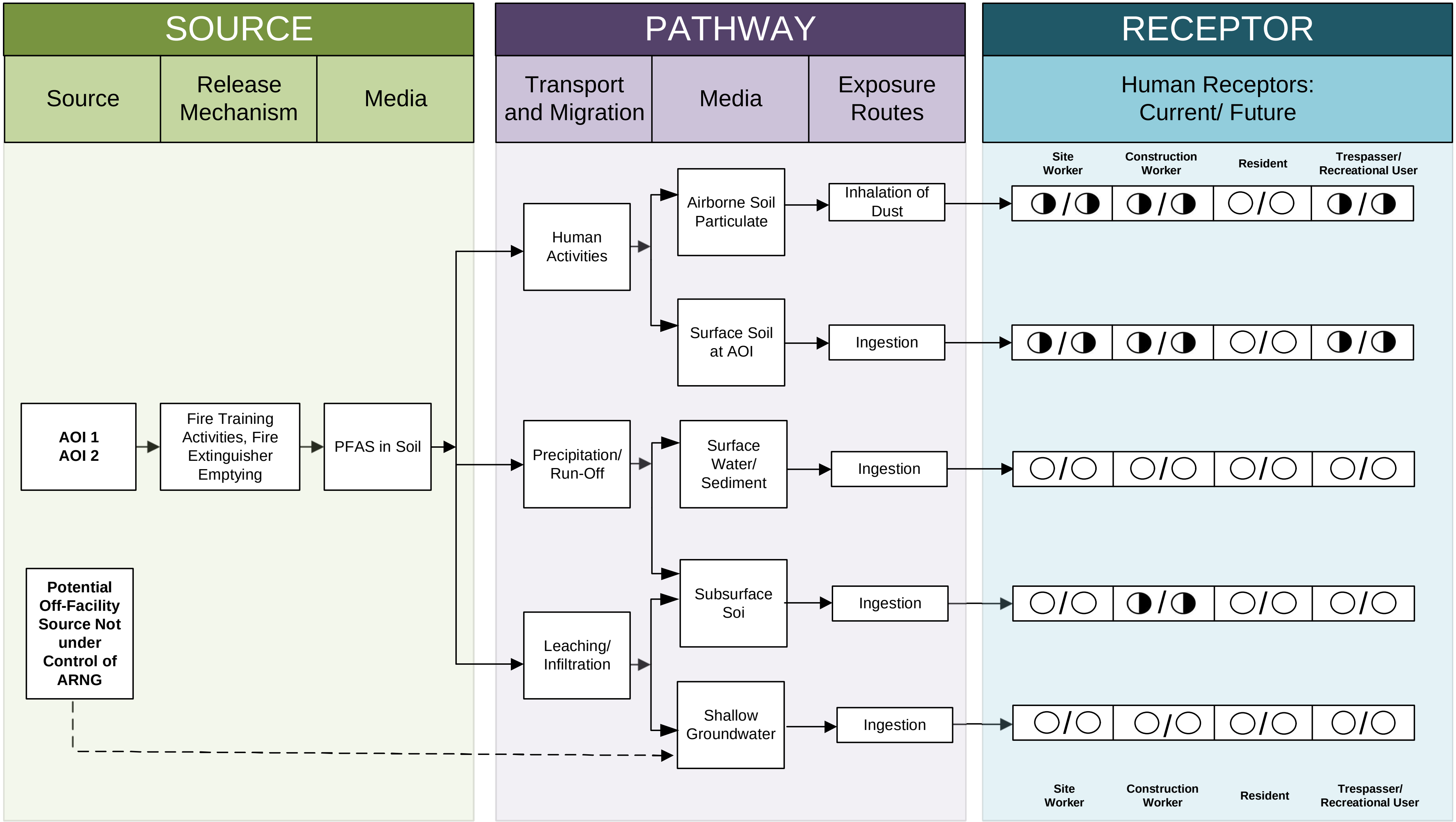
N

Areas of Interest Adjacent Sources

AECOM
12420 Milestone Center Drive
Germantown, MD 20876

Figure 6-2

Q:\Projects\ENV\GEARS\GEO\ARNG PFAS\900-CAD-GIS\920-GIS or Graphics\MXD\MN\Camp_Ripley_Figures\Camp_Ripley_PA_Figures\Fig_6-2_Camp_Ripley_AOIS_Adjacent_Sources.mxd



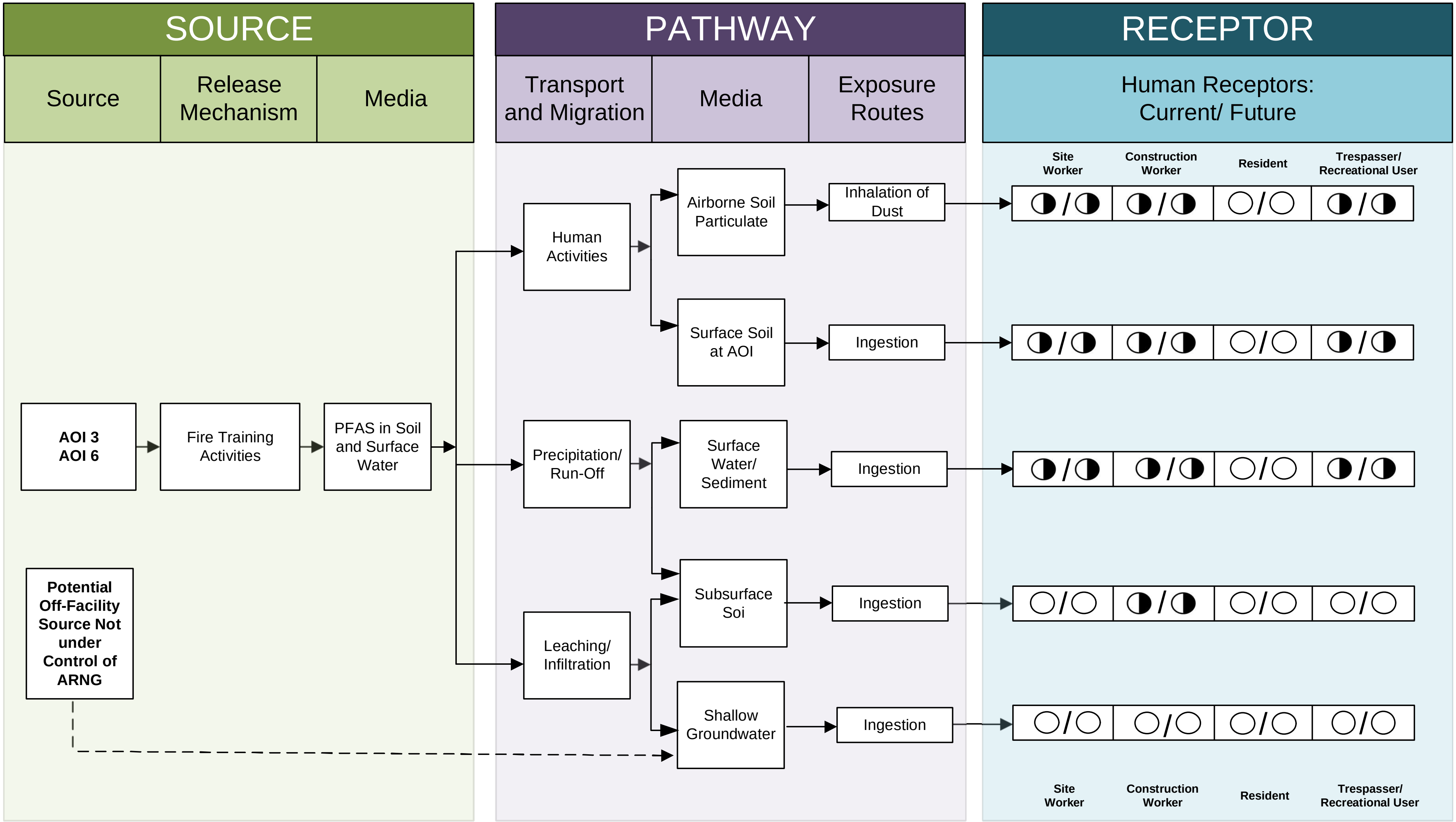
Exposure Route	Site Worker	Construction Worker	Resident	Trespasser/ Recreational User
Inhalation of Dust (Airborne Soil Particulate)	◑/◑	◑/◑	○/○	◑/◑
Ingestion (Surface Soil at AOI)	◑/◑	◑/◑	○/○	◑/◑
Ingestion (Surface Water/ Sediment)	○/○	○/○	○/○	○/○
Ingestion (Subsurface Soi)	○/○	◑/◑	○/○	○/○
Ingestion (Shallow Groundwater)	○/○	○/○	○/○	○/○

LEGEND

Flow-Chart Stops
Flow-Chart Continues
Partial / Possible Flow
○ Incomplete Pathway
◑ Potentially Complete Pathway
● Complete Pathway

Notes:
1. The resident and recreational user receptors refer to an off-site resident and recreational user.
2. Dermal contact exposure pathway is incomplete for PFAS.

Figure 6-3
Preliminary Conceptual Site Model
AOI 1 TriMax Discharge Area and AOI 2 Burn Pit FTA



LEGEND

—□ Flow-Chart Stops

—▶ Flow-Chart Continues

- - ▶ Partial / Possible Flow

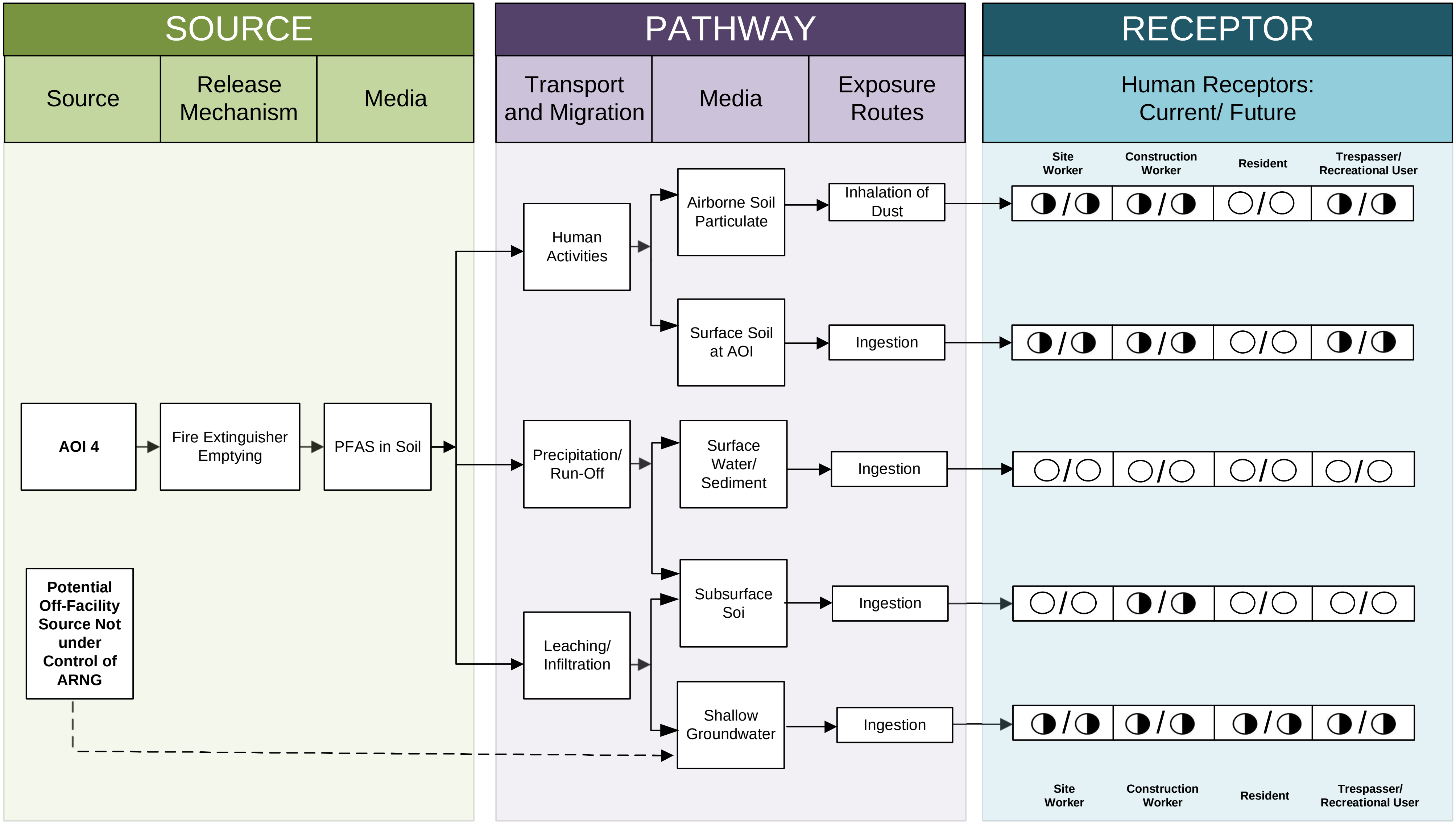
○ Incomplete Pathway

◑ Potentially Complete Pathway

● Complete Pathway

Notes:
1. The resident and recreational user receptors refer to an off-site resident and recreational user.
2. Dermal contact exposure pathway is incomplete for PFAS.

Figure 6-4
Preliminary Conceptual Site Model
AOI 3 DHS Demonstration and AOI 6 Stormwater Infiltration Basin



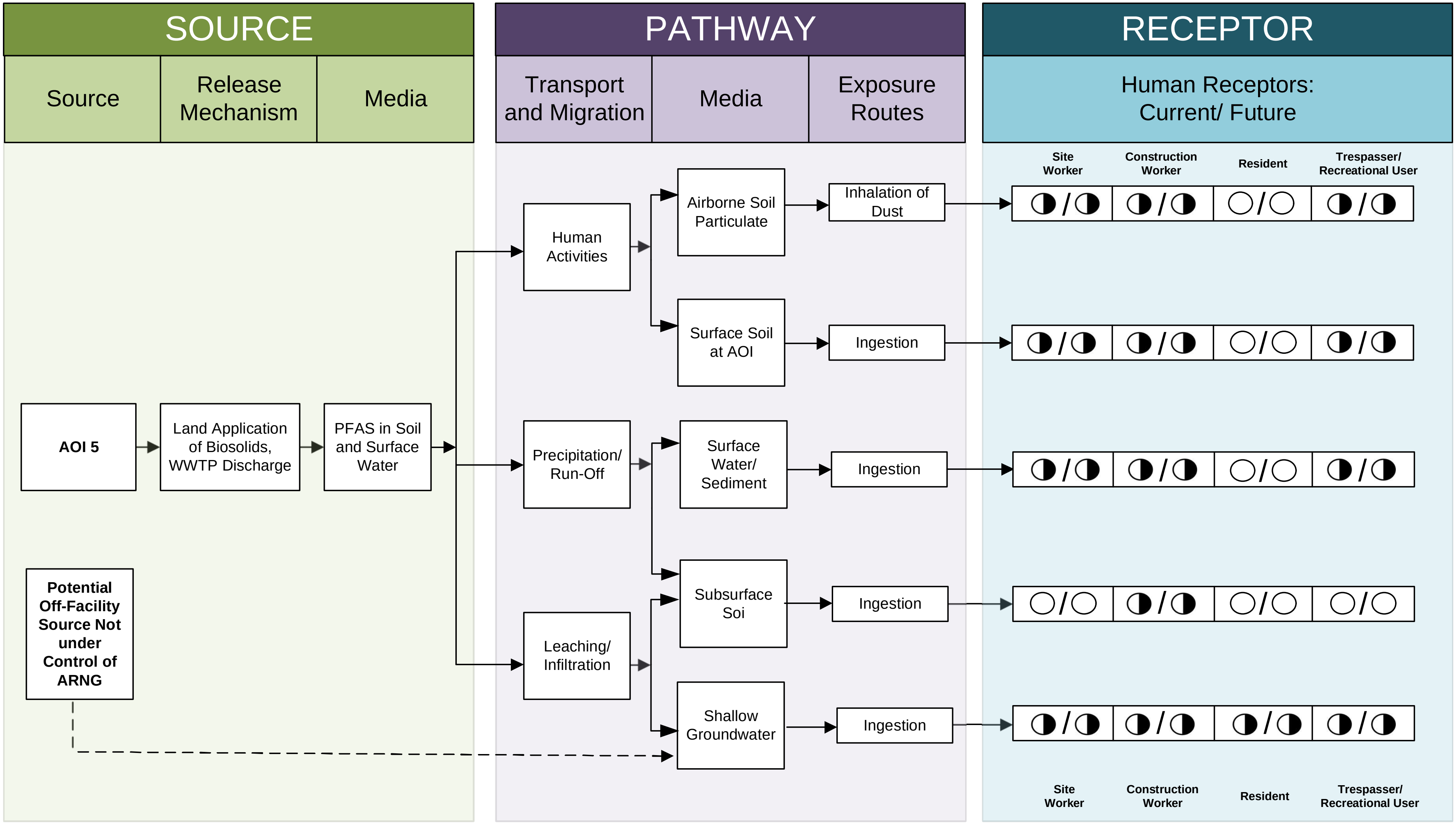
Media	Exposure Routes	Site Worker	Construction Worker	Resident	Trespasser/ Recreational User
Airborne Soil Particulate	Inhalation of Dust	◑/◑	◑/◑	○/○	◑/◑
Surface Soil at AOI	Ingestion	◑/◑	◑/◑	○/○	◑/◑
Surface Water/ Sediment	Ingestion	○/○	○/○	○/○	○/○
Subsurface Soi	Ingestion	○/○	◑/◑	○/○	○/○
Shallow Groundwater	Ingestion	◑/◑	◑/◑	◑/◑	◑/◑

LEGEND

Flow-Chart Stops
Flow-Chart Continues
Partial / Possible Flow
○ Incomplete Pathway
◑ Potentially Complete Pathway
● Complete Pathway

Notes:
1. The resident and recreational user receptors refer to an off-site resident and recreational user.
2. Dermal contact exposure pathway is incomplete for PFAS.

Figure 6-5
Preliminary Conceptual Site Model
AOI 4 CMA Discharge Area



LEGEND

- ─□ Flow-Chart Stops
- ──▶ Flow-Chart Continues
- - - -▶ Partial / Possible Flow
- ○ Incomplete Pathway
- ◐ Potentially Complete Pathway
- ● Complete Pathway

Notes:
1. The resident and recreational user receptors refer to an off-site resident and recreational user.
2. Dermal contact exposure pathway is incomplete for PFAS.

Figure 6-6
Preliminary Conceptual Site Model
AOI 5 WWTP and Sludge Spread Site

7. Conclusions

This report presents a summary of available information gathered during the PA on the use and storage of AFFF and other PFAS-related activities at Camp Ripley. The PA findings are based on the information presented in **Appendix A** and **Appendix B**.

7.1 Findings

Five AOIs related to potential PFAS release were identified at Camp Ripley (**Table 7-1**) during the PA (**Figure 7-1**):

Table 7-1: AOIs at Camp Ripley

Area of Interest	Name	Used by	Potential Release Dates
AOI 1	TriMax Discharge Area	MNARNG	Early 2000s
AOI 2	Burn Pit FTA	MNARNG and USAF	1980s
AOI 3	DHS Demonstration	MNARNG and DHS	2014
AOI 4	CMA Discharge Area	MNARNG	2010
AOI 5	WWTP and Sludge Spread Site	MNARNG	1987 to present
AOI 6	Stormwater Infiltration Basin	MNARNG	2014

Based on documented potential PFAS releases at these AOIs, there is potential for exposure to PFAS contamination in surface soil, surface water, and sediment to site workers, construction workers, trespassers, and recreational users via ingestion and inhalation; subsurface soil to site workers and construction workers via ingestion and inhalation; and groundwater to site workers, construction workers, trespassers, recreational users, and off-facility residents via ingestion. Potential off-facility PFAS release areas exist upgradient of Camp Ripley, it. It is unknown whether the potential release areas affect the facility (**Figure 7-2**).

The following areas discussed in **Section 2** through **Section 5** were determined to have no suspected release (**Table 7-2**).

Table 7-2: No Suspected Release Areas at Camp Ripley

No Suspected Release Area	Used by	Rationale for No Suspected Release Determination
Building 2-223	MNARNG	There are no known potential releases of PFAS at the State Warehouse (Building 2-223); therefore, this area is not considered a potential release area.
Building 2-166	MNARNG	There are no known potential releases of PFAS at the old CSMS (Building 2-166); therefore, this area is not considered a potential release area.

No Suspected Release Area	Used by	Rationale for No Suspected Release Determination
Building 2-203	MNARNG and the City of Randall Fire Department	There are no known potential releases of PFAS at Building 2-203; therefore, this area is not considered a potential release area.
Building 2-272	MNARNG and USAF 133rd Airlift Wing	There are no known potential releases of PFAS at the Building 2-272; therefore, this area is not considered a potential release area.
Building 8-195	MNARNG	There are no known potential releases of PFAS at Building 8-195; therefore, this area is not considered a potential release area.

7.2 Uncertainties

A number of information sources were investigated during this PA to determine the potential for PFAS-containing materials to have been present, used, or released at the facility. Historically, documentation of PFAS use was not required because PFAS were considered benign. Therefore, records were not typically kept by the facility or available during the PA on the use of PFAS in training, firefighting, or other non-traditional activities, or on its disposition.

The conclusions of this PA are predominantly based on the information provided during interviews with personnel who had direct knowledge of PFAS use at the facility. Sometimes the provided information was vague or conflicted with other sources. Gathered information has a degree of uncertainty due to the absence of written documentation, the limited number of personnel with direct knowledge due to staffing changes, the time passed since PFAS was first used (1969 to present), and a reliance on personal recollection. Inaccuracies may arise in potential PFAS release locations, dates of release, volume of releases, and the concentration of AFFF used. There is also a possibility the PA has missed a source of PFAS, as the science of how PFAS may enter the environment continually evolves.

In order to minimize the level of uncertainty, readily available data regarding the use and storage of PFAS were reviewed, retired and current personnel were interviewed, multiple persons were interviewed for the same potential source area, and potential source areas were visually inspected. **Table 7-3** summarizes the uncertainties associated with the PA.

Table 7-3: Uncertainties

Area of Interest	Source of Uncertainty
All AOIs	No or limited information was available on the type, amount, and concentration of AFFF used at each AOI.
AOI 1 TriMax Discharge Area	Interviewees were unsure whether the fire extinguisher that was discharged contained AFFF or was a training fire extinguisher with dish soap.
AOI 2 Burn Pit FTA	The frequency of AFFF fire training activities at AOI 2 could not be determined during the PA. One coordinated fire training event was recalled; however, AOI 2 may have been used on multiple occasions.
AOI 3 DHS Demonstration and AOI 6 Stormwater Infiltration Basin	Camp Ripley Fire and Emergency Services personnel indicated that all of the foam mixture was not used during the event. The final disposition of the remaining foam mixture could not be determined; however, interviewees indicated that the remaining

Area of Interest	Source of Uncertainty
	foam mixture was most likely dispensed to the stormwater sewer, which drains the stormwater infiltration basin located north of Chickamauga Road.
AOI 4 CMA Discharge Area	Camp Ripley turned in 6-7 Tri-Max units to USPFO, but it is unknown if the units were emptied prior to shipment or if the contents were emptied at AOI 4.
AOI 5 WWTP and Sludge Spread Site	The WWTP does not contain a treatment system for PFAS and March 2017 post-treatment results had detections for PFAS below the State of Minnesota screening levels. Therefore, land application of sludge containing PFAS at the Sludge Spread Site and discharge of PFAS to the Mississippi River may have occurred.
All AOIs	The USAF's 133rd Airlift Wing conducted winter operations at Camp Ripley each winter. No information was available regarding the USAF's use of PFAS during winter operations.

Potential off-facility sources PFAS release areas exist upgradient of Camp Ripley. It is unknown whether or not the off-facility sources affect the Camp Ripley.

7.3 Potential Future Actions

Interviews and records (covering 1970s to present) indicate that current or former ARNG activities may have resulted in potential PFAS releases at the 5 AOIs identified during the PA. Based on the CSMs developed for the AOIs, there is potential for receptors to be exposed to PFAS contamination in soil, groundwater, surface water, and sediment at these AOIs. **Table 7-4** summarizes the rationale used to determine if the AOIs should be considered for further investigation under the CERCLA process and undergo a SI.

ARNG evaluates the need for an SI at Camp Ripley based on the presence of a PFAS release. possible receptors, and the migration of PFAS contamination to resources.

Table 7-4 PA Findings Summary

Area of Interest	AOI Location	Rationale	Potential Future Action
AOI 1 TriMax Discharge Area	46°05'37.5"N 94°21'41.5"W	Approximately 12 gallons of AFFF concentrate used once in the early 2000s	Proceed to an SI, focus on soil and groundwater
AOI 2 Burn Pit FTA	46°05'56.4"N 94°22'03.7"W	AFFF fire training activities have been conducted at AOI 2. The frequency of training, and amount, type, and concentration of AFFF used is unknown.	Proceed to an SI, focus on soil and groundwater
AOI 3 DHS Demonstration	46°05'24.1"N 94°20'37.3"W	One gallon or less of Chemguard C363 3 percent x 6 percent AR-AFFF concentrate used once in 2014	Proceed to an SI, focus on soil, surface water, and sediment

Area of Interest	AOI Location	Rationale	Potential Future Action
AOI 4 CMA Discharge Area	46°04'59.1"N 94°22'05.9"W	Approximately 1-2 gallons of AFFF concentrate used once in approximately 2017	Proceed to an SI, focus on soil and groundwater
AOI 5 WWTP and Sludge Spread Site	46°06'22.8"N 94°22'57.2"W	Land application of sludge containing PFAS (less than 320 tons per year) at AOI 5 and discharge of PFAS from the WWTP to the Mississippi River may have occurred	Proceed to an SI, focus on soil, groundwater, surface water, and sediment
AOI 6 Stormwater Infiltration Basin	46°05'42.87"N 94°20'05.44"W	One gallon or less of Chemguard C363 3 percent x 6 percent AR-AFFF concentrate may have been disposed of in the stormwater sewer system	Proceed to an SI, focus on soil, groundwater, surface water, and sediment

CLIENT	ARNG			
PROJECT	Preliminary Assessment for PFAS at Camp Ripley, MN			
REVISED	7/29/2019	GIS BY	MS	7/29/2019
SCALE	1:19,800	CHK BY	BN	7/29/2019
Base Map: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c)		PM	RG	7/29/2019

▭ Area of Interest
▨ Potential PFAS Release
⬚ No Suspected Release
🟩 Facility Boundary
— River/Stream
— Canal/Ditch
→ Surface Water Flow Direction
⇢ Inferred Groundwater Flow Direction
● Domestic Well
● Irrigation Well
✦ Other/Unknown

N

Summary of Findings

AECOM

12420 Milestone Center Drive
Germantown, MD 20876

Figure 7-1

Q:\Projects\ENV\GEARS\GEO\ARNG PFAS\900-CAD-GIS\920-GIS or Graphics\MXD\MN\Camp_Ripley_Figures\Camp_Ripley_PA_Figures\Fig_7-1_Camp_Ripley_Summary.mxd

CLIENT	ARNG			
PROJECT	Preliminary Assessment for PFAS at Camp Ripley, MN			
REVISED	7/29/2019	GIS BY	MS	7/29/2019
SCALE	1:6,000	CHK BY	BN	7/29/2019
Base Map: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c)		PM	RG	7/29/2019

▨ Potential PFAS Release
▭ Facility Boundary
≈ Water Body
— River/Stream

N

Summary of Findings Adjacent Sources

AECOM
12420 Milestone Center Drive
Germantown, MD 20876

Figure 7-2

Q:\Projects\ENV\GEARS\GEO\ARNG PFAS\900-CAD-GIS\920-GIS or Graphics\MXD\MN\Camp_Ripley_Figures\Camp_Ripley_PA_Figures\Fig_7-2_Camp_Ripley_Summary_Adjacent_Sources.mxd

8. References

Bruce A. Liesch Associates, Inc (BAL). 1987. *Camp Ripley Hydrogeologic Investigation, Test Drilling and 24 Hour Pumping Test*.

Delta Consultants. 2010. *Perfluorocarbon (PFC)-Containing Firefighting Foams And Their Use In Minnesota.* June.

Foth and Van Dyke. 1997. *Water Quality Survey, Camp Ripley, Minnesota*.

National Ground Water Association. 2018. *Groundwater and PFAS: State of Knowledge and Practice*. January.

Minnesota Army National Guard (MNARNG). 2018. Integrated Natural Resource Management Plan (INRMP). Camp Ripley Training Site. Plan Period 2018-2022.

Minnesota Department of Health. 2019. *Human Health-Based Water Guidance Table.* Available at http://www.health.state.mn.us/divs/eh/risk/guidance/gw/table.html (Accessed 25 April 2019).

Progressive Consulting Engineers (PCE). No Date. *Wellhead Protection Plan for Camp Ripley*, Little Falls, Minnesota.

Quinn, John J. 2006. *Delineation of a Wellhead Protection Zone and Delineation of Flowpaths from Potential Groundwater Contaminant Source Areas at Camp Ripley, Little Falls, Minnesota.* Environmental Science Division, Argonne National Laboratory.

United States Army Center for Health Promotion and Preventative Medicine (USACHPPM). 2000. *Firing Range Study Number 32-EE-3330-00, Conceptual Site Model for the Firing Range/Impact Area Risk Assessment, Camp Ripley, Minnesota.*

United States Army Environmental Hygiene Agency (USAEHA). 1994. *Groundwater Quality Survey Number 38-36-K2SY-94, Camp Ripley National Guard Training Area, Little Falls, Minnesota*.

United States Department of Health and Human Services. 2008. *Health Consultation, PFOS Detections in the City of Brainerd, Minnesota*. August.

United States Environmental Protection Agency (USEPA). 1991. *Guidance for Performing Preliminary Assessments under CERCLA.* September.

University of Minnesota Duluth (UMD). n.d. *Camp Ripley Aquifer Protection Plan.* Geological Sciences Department.

World Climate. 2019. *Average Weather Data for Little Falls, Minnesota.* Available at http://www.worldclimate.com/climate/us/minnesota/little-falls (Accessed 13 December 2018)

Appendix A
Data Resources

Data Resources will be provided separately on CD. Data Resources for Camp Ripley include:

Camp Ripley Leases, Licenses, and Permits

- 1996 Camp Ripley Boundary Survey
- 2017 Camp Ripley Certificate of Title

Camp Ripley AFFF Release Documentation

- 2008 PFCs in Minnesota's Ambient Environment Progress Report
- 2008 Health Consultation Report
- 2009 PFCs and Class B Firefighting Foam
- 2010 PFCs and Their Use in Minnesota
- 2011 PFC Survey and Sampling Activities
- 2014 Camp Ripley Memorandum for Record
- 2018 Camp Ripley Preliminary Assessment Sign-In Sheet

Camp Ripley Fire Fighting Training Documentation

- 2018 RFMSS Fire Training Report for Central Lakes College

Previous Investigations Completed at Camp Ripley

- No date Camp Ripley Aquifer Protection Plan
- No date Camp Ripley Stream Discharge Report
- 2002 Camp Ripley Compliance Sampling Program Report
- 2006 Wellhead Protection Report
- 2013 Camp Ripley Operational Range Assessment Phase II Report
- 2016 Groundwater Monitoring Report for the Old Landfill
- 2018 Camp Ripley Training Site Integrated Natural Resource Management Plan

Camp Ripley Facility Maps

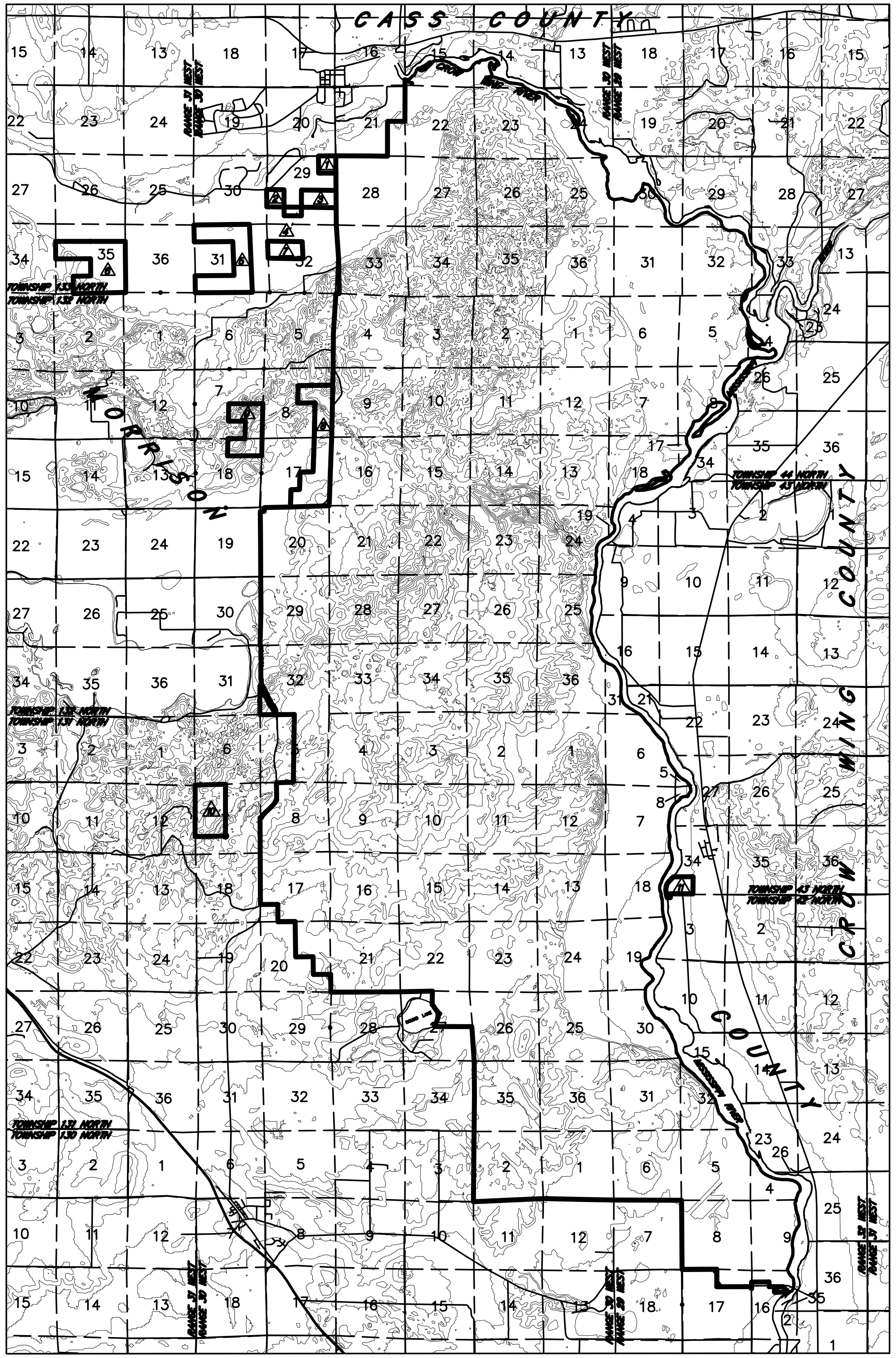
- 2007 Camp Ripley Installation Map
- 2019 Helicopter Crash Site Map

Camp Ripley EDR Report

- 2018 Camp Ripley EDR Report

BOUNDARY SURVEY OF CAMP RIPLEY MILITARY RESERVATION

AND OUTLOT PROPERTIES



SHEET 1 OF 4 SHEETS

△ DENOTES OUTLOT PARCEL

SURVEY FOR: **MINNESOTA DEPARTMENT OF MILITARY AFFAIRS**

PROPERTY LOCATION: Morrison and Crow Wing Counties, Minnesota

OUTLOT DESCRIPTIONS:

Outlot 1
The Northeast Quarter of the Northeast Quarter of Section 29, Township 133, Range 30, Morrison County.

Outlot 2
The Northwest Quarter of the Southwest Quarter of Section 29, Township 133, Range 30, Morrison County.

Outlot 3
The North Half of the Southeast Quarter of Section 29, Township 133, Range 30, Morrison County.

Outlot 4
The North Half of the Southeast Quarter of the Southwest Quarter of Section 29, Township 133, Range 30, Morrison County.

Outlot 5
The North Half of the Northwest Quarter; the West Half of the Northeast Quarter; the West Half of the Southeast Quarter; and the South Half of the Southwest Quarter, all in Section 31, Township 133, Range 30, Morrison County.

Outlot 6
The South Half of the Northwest Quarter; the South Half of the Northeast Quarter; the Southeast Quarter; and the Southeast Quarter of the Southwest Quarter, all in Section 35, Township 133, Range 31, Morrison County.

Outlot 7
The South Half of the Northwest Quarter of Section 32, Township 133, Range 30, Morrison County.

Outlot 8
The South Half of the Northeast Quarter and the East Half of the Southeast Quarter of Section 8; the East Half of the Northeast Quarter, the Northeast, Southeast and Southwest Quarters of the Southeast Quarter; the east 30 acres of the Northwest Quarter of the Southeast Quarter, and the east 10 acres of the Southeast Quarter of the Southwest Quarter, Section 17, all in Township 132, Range 30, Morrison County.

Outlot 9
The North Half of the Southeast Quarter and the Southeast Quarter of the Southeast Quarter of Section 7; and the North Half of the Northeast Quarter of Section 18, all in Township 132, Range 30, Morrison County.

Outlot 10
The Northwest Quarter and the North Half of the Southwest Quarter of Section 7, Township 131, Range 30. Morrison County.

Outlot 11
Government Lot 4, Section 34, Township 43, Range 32, Crow Wing County.
and
That part of Government Lot 1, Section 3, Township 42, Range 32, Crow Wing County, described as follows:

> Beginning at the northeast section corner of said Section 3; thence west along the north section line of said Section 3 for a distance of 4371 feet to the place of beginning; thence south at a right angle for a distance of 295 feet; thence west at a right angle to a point on the east river bank, Mississippi River; thence north along said river bank to a point of intersection of said north section line of said Section 3; thence east along said section line to place of beginning.

CAMP RIPLEY DESCRIPTIONS

Rosing Township, Morrison County.

Township 133, Range 30

Those parts of Sections 14, 15, 23, 24 and 25 lying south and west of the Crow Wing River, except those parts owned by Minnesota Power and Light.

Section 22.

The East Half of the Southeast Quarter of Section 21.

Sections 26, 27, 28, 33, 34, 35 and 36.

Township 133, Range 29

Those parts of Section 30 lying south and west of the Crow Wing River, except those parts owned by Minnesota Power and Light.

Those parts of Sections 29, 31, 32 and 33 lying south and west of the Crow Wing River.

Rail Prairie Township, Morrison County.

Township 132, Range 29

Those parts of Sections 4 and 5 lying south and west of the Crow Wing River.

Sections 6, 7, 8, 17, 18, 19 and 31.

Township 132, Range 29

Sections 1, 2, 3, 4, 9,10, 11, 12, 13, 14, 15, 16.

Section 20, EXCEPT that part of the Northwest Quarter of the Northwest Quarter described as follows:

> Beginning at the northwest corner of said Northwest Quarter of the Northwest Quarter; thence south, assumed bearing, 302.66 feet along the west line of said Northwest Quarter of the Northwest Quarter; thence North 88 degrees 21 minutes 53 seconds East 297.81 feet; thence North 0 degrees 31 minutes 40 seconds East 297.90 feet to the north line of said Northwest Quarter of the Northwest Quarter; thence South 89 degrees 17 minutes 23 seconds West 300.46 feet along said north line to the point of beginning.

Sections 21, 22, 23, 24, 25, 26, 27, 28, 29.

CAMP RIPLEY DESCRIPTIONS (CONTINUED)

Section 32, except highways.

Sections 33, 34, 35, and 36.

Cushing Township, Morrison County.

Township 131, Range 30.

Sections 1, 2, 3, 4.

The East Half of Section 5.

The Northeast Quarter; Southeast Quarter; Southwest Quarter; East Half of the Northwest Quarter; and that part of the Southwest Quarter of the Northwest Quarter lying southeast of County Road No. 1, all in Section 8.

Sections 9, 10, 11, 12, 13, 14, 15, 16.

The Northeast Quarter; Southeast Quarter; Northwest Quarter; and the Northwest Quarter, Northeast Quarter and Southeast Quarter of the Southwest Quarter, all in Section 17.

The Northeast Quarter and the Northeast Quarter of the Southeast Quarter of Section 20.

Sections 21, 22, 23, 24, 25, 26.

The Northeast Quarter and the East 200 feet of Government Lot 2 of Section 27.

Sections 35 and 36.

Township 131, Range 29

Sections 5, 6, 7, 8, 18, 19, 30, 31 and 32.

Darling Township, Morrison County.

Township 130, Range 30

Sections 1 and 2.

Green Prairie Township, Morrison County.

Township 130, Range 29

Sections 4, 5, 6, 8 and 9.

Section 16:

That part of Section 16 beginning with a point on the south right of way line of Trunk Highway No. 115 which is 100 feet south and 2403.3 feet east of the northwest corner of the Southwest Quarter of the Northwest Quarter of said Section 16 as the point of beginning; thence west of said south right of way line 551 feet; thence south and at a right angle 150 feet; thence west 120 feet; thence north 150 feet to said south right of way line; thence west 290.1 feet; thence south and at a right angle 414 feet; thence east and parallel with said south right of way line 1201.3 feet; thence South 64 degrees 39 minutes East 75 feet to the bank of the Mississippi River; thence northeasterly along said bank 44.7 feet to the southwesterly line of a tract of land marked "borrow pit"; thence northwesterly on this line 540 feet, more or less, to the point of beginning. LESS THE FOLLOWING 2 DESCRIBED PARCELS:

> The west 290.1 feet of the above described premises
> And
> The west 78 feet of that part of Government Lot 2 described as follows:
>
> > Beginning with a point on the south right of way line of Trunk Highway No. 115 which is 100 feet south and 2403.3 feet east of the northwest corner of the Southwest Quarter of the Northwest Quarter of said Section 16 as the point of beginning; thence west of said south right of way line 551 feet; thence south at a right angle for a distance of 150 feet; thence go northeasterly for a distance of 30 feet to a point which is 142 feet south of said south right of way line and also 29 feet east of the west line of the parcel herein described; thence go northeasterly for a distance of 190 feet and 9 inches to said south right of way line at a point therein which is 156 feet east of the point of beginning of the parcel of land herein described; thence go 156 feet west to said point of beginning.

Government Lot 2 in Section 16, EXCEPT that part thereof described as follows: Beginning at a point on the north line of said Lot 2, 1400 feet east of the northwest corner thereof; thence southeasterly along a line making an angle of 33 degrees 30 minutes with said lot line in the southeast quadrant, to the west bank of the Mississippi River; thence northerly along said west river bank to the north line of said lot; thence west along said north line to point of beginning, which lies northeasterly of the following described line:

> From a point on the west line of said Section 16, distant 1302.3 feet south of the northwest corner thereof, run northeasterly at an angle of 89 degrees 55 minutes with said west line for a distance of 2380.7 feet to the point of beginning of the line to be described; thence deflect to the right at an angle of 49 degrees 30 minutes and run southeasterly for a distance of 900 feet, more or less, to the band of the Mississippi River and there terminating.

All that part of Government Lot 1 in Section 16 lying east of a line parallel with and 1320 feet east of the west boundary line of said Lot 1.

Lot 1 of Section 16 less the east 16.15 acres, being the west 1320 feet of the said Lot 1.

The north 30 acres of the Northwest Quarter of the Northwest Quarter and that portion of Lot 2 in Section 16 described as follows:

> Beginning at a point in the north line of said Lot 2, 1400 feet east, measured along said lot line from the northwest corner thereof; thence southeasterly along a line making an angle of 33 degrees 30 minutes with said lot line in the southeast quadrant, to the west bank of the Mississippi River; thence northerly along said west river bank to the north line of said lot; thence west along the north line of said lot to the point of beginning.

The North Half of the Northeast Quarter of Section 17 and that part of the Southeast quarter of the Northeast Quarter of Section 17 described as follows:

> Beginning at a point on the east line of said Section 17, distant 1335.3 feet south of the northeast corner thereof; thence run northwesterly at an angle of 89 degrees 40 minutes with said east section line for a distance of 157.3 feet; thence run southeasterly at an angle of 44 degrees 50 minutes for a distance of 223.2 feet; thence run north at an angle of 44 degrees 50 minutes for a distance of 157.3 feet to the point of beginning.

CERTIFICATION:

To the Minnesota Department of Military Affairs:
This is to certify that this map or plat and the survey on which it is based were made in accordance with "Minimum Standard Detail Requirements for ALTA/ACSM Land Title Surveys," (except paragraphs 5c, d, g, h, i, j, and k.) jointly established and adopted by ALTA, ACSM and NSPS in 1999; and includes items 1, 2, 4, of Table A thereof; and pursuant to the accuracy standards (as adopted by ALTA and ACSM and in effect on the date of this certification) of an urban survey. The positional uncertainties resulting from the survey measurements made on the survey do not exceed the allowable positional tolerance.

Dated: September 29, 2003
Revised: October 2, 2003

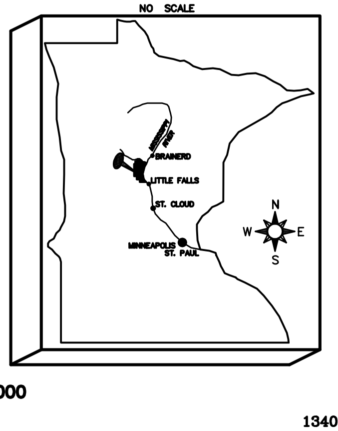
Anderson Engineering of Minnesota, LLC

by: ____________________
Jack Balke
Minnesota License No. 20281

NOTES:

1. The orientation of this bearing system is based on the Morrison County Coordinate Grid (NAD 83-96).
2. No title work was provided for the preparation of this survey to verify the legal description or the existence of any easements or encumbrances.
3. The locations of the Crow Wing and Mississippi Rivers were determined by aerial photography provided by MARKHURD dated May 1, 1996.

VICINITY MAP
NO SCALE



0 5000 10000 15000 25000
SCALE IN FEET

Anderson Engineering of Minnesota, LLC
CIVIL ENGINEERING AND LAND SURVEYING
13400 15th AVENUE NORTH, SUITE B, PLYMOUTH, MN 55441 TEL (763) 383-1084 FAX (763) 383-1089

STATE OF MINNESOTA

OFFICE OF THE ATTORNEY GENERAL

SUITE 1800
445 MINNESOTA STREET
ST. PAUL, MN 55101-2134
TELEPHONE: (651) 297-2040

July 21, 2017

CERTIFICATE OF TITLE

STATE OF MINNESOTA, PROJECT TITLE: Battalion Headquarters, Transient Training; W912LM-17-2-2004; NGB PN 270281 / MN PN 17126

LOCATION OF SITE: Camp Ripley, Little Falls, Minnesota.

I hereby certify that the State of Minnesota is possessed of fee simple title in the hereinafter described real property, as evidenced by a warranty deed from Northwestern Improvement Company, recorded August 10, 1931, in Book 90 of Deeds, Page 486 of the official records of the County of Morrison; a warranty deed from Topeka Land Company, recorded June 1, 1942, in Book 110 of Deeds, Page 280 of the official records of the County of Morrison; a warranty deed from School District No. 12, recorded September 12, 1950, in Book 127 of Deeds, Page 542 of the official records of the County of Morrison; a warranty deed from George T. Porterfield, recorded May 5, 1953, in Book 133 of Deeds, Page 430 of the official records of the County of Morrison; a warranty deed from Jessie Swanson, recorded January 2, 1930, in Book 94 of Deeds, Page 60 of the official records of the County of Morrison; a warranty deed from Andrew and Christina Lundgren, recorded January 2, 1930, in Book 94 of Deeds, Page 63 of the official records of the County of Morrison; a warranty deed from Arthur E. and Olga T. Anderson, recorded January 2, 1930, in Book 94 of Deeds, Page 65 of the official records of the County of Morrison; a warranty deed from Lloyd R. and Mae Anderson, recorded January 2, 1930, in Book 94 of Deeds, Page 62 of the official records of the County of Morrison; a warranty deed from Joseph E. and Hildegard Anderson, recorded January 2, 1930, in Book 94 of Deeds, Page 61 of the official records of the County of Morrison; and Axel A. and Harriet E. Anderson, recorded January 20, 1930, in Book 94 of Deeds, Page 64 of the official records of the County of Morrison; by a Quit Claim Deed N.P. and Malinda S. Swanson, recorded February 15, 1930, in Book 93 of Deeds, Page 191; and by the certified copy of the Final Certificate of the eminent domain actions known as State v. Sprandel, et al., and State v. Anderson, et al., recorded in Book A-27 of Judgments, Page 168 of the official records of the County of Morrison and by the Quit Claim Deed from the County of Morrison dated June 11, 1976;

that such title in said real property is good, valid and sufficient, and subject to no liens or encumbrances.

I further certify that the interest of the State of Minnesota in and to said real property is adequate to justify the expenditure of public funds of the State of Minnesota in the improvement thereof for Army National Guard purposes and subject to the limitations set forth in Title 10, USC, Chapter 1803, as amended, and that the intended use of said lands and improvements by the Minnesota Army National Guard is in compliance with applicable statutes, local laws, and ordinances. Said real property, referred to as the "Cantonment Area," is described as follows:

> Beginning at a point on the west bank of the Mississippi River and the north right- of-way line of Minnesota Trunk Highway No. 115 in Government Lot 2, Section 16, Township 130 North, Range 29 West 5th P.M.; thence west along said right- of-way line which is fifty feet (50') north of the center line of said highway to a point on the west section line of Section 16, same township and range, said point being 125.0 feet north of the west 1/16 corner of the NW 1/4 of said Section 16, thence west and northerly along the north right-of-way line of said highway to a point on the west section line of Section 8, same township and range, said point being fifty feet (50') north of the SW corner of said Section 8; thence north along the section line to the SW corner of Section 5, same township and range; thence north along the section line to the NW corner of said Section 5; thence east along the section line to a point on the west bank of the Mississippi River; thence southerly along the said west bank to point of beginning. And that portion of Lot 2, Section 16, Township 130 North , Range 29 West, beginning at a point on the north line of said Lot 2, 1400 feet east, measured along said lot line from the northwest corner thereof; thence southeasterly along a line making an angle of 33 degrees 30 minutes with said lot line in the southeast quadrant to the west bank of the Mississippi River, thence northerly along said west bank of the Mississippi River bank to the north line of said lot; thence west along the north line of said lot to place of beginning. The above-described real property contains 2,060 acres, more or less.

Subject to the following exceptions:

1. A pole line easement to the Cuyuna Range Power Company;
2. That part of Government Lot One (1) in Section 5, Township 130 North, Range 29 West, known as the Green Prairie Cemetery;
3. A utility easement to Aquila, Inc. - PNG (now known as "Minnesota Energy Resources Corporation"); and

4. A lease to Allete, Inc. d/b/a Minnesota Power, for solar field purposes.

Being the lands referred to in Agreement No. W912LM-17-2-2004, between the United States and the State of Minnesota for the construction of the Minnesota National Guard Battalion Headquarters, Transient Training NGB PN 270281 / MN PN 17126 at Camp Ripley, Little Falls, Minnesota. The lands referred to in Agreement No. W912LM-17-2-2004 are located within the Cantonment Area described above at approximately N 46-5-46.6 W 94-21-12.

This Certificate is made upon reliance on prior Certificates of Title by the Attorney General to the same property dated September 14, 1982, April 6, 1979, supplement thereto dated August 6, 1982, and supplement thereto dated June 8, 1983, Certificate of Title dated January 14, 1985, Certificate of Title dated April 2, 1985, Certificate of Title dated November 13, 1986, Certificate of Title dated June 29, 1989, Certificate of Title dated October 19, 1989, Certificate of Title dated January 8, 1990, Certificate of Title dated December 7, 1990, Certificate of Title dated May 21, 1992, Certificate of Title dated December 9, 1992, Certificate of Title dated June 25, 1993, Certificate of Title dated August 31, 1993, Certificate of Title dated November 16, 2009, and by a review of the Morrison County real estate records from the date of the above-referenced Certificates of Title until the date of 11:30 a.m., May 19, 2017.

Dated: 7/21/17

LORI SWANSON
Attorney General
State of Minnesota

Jeff J. Th

JEFFERY S. THOMPSON (#027107X)
Assistant Attorney General
445 Minnesota Street, Suite 1800
St. Paul, MN 55101-2134
Telephone: (651) 757-1312

1858

STATE OF MINNESOTA

OFFICE OF THE ATTORNEY GENERAL

LORI SWANSON
ATTORNEY GENERAL

102 STATE CAPITOL
ST. PAUL, MN 55155
TELEPHONE: (651) 296-6196

June 29, 2017

National Guard Bureau
Office of the Chief Counsel
1411 Jefferson Davis Highway, Suite 11300
Arlington, VA 22202-3231

Please be advised that the undersigned has duly appointed Jeffery S. Thompson and Joan M. Eichhorst as Assistant Attorneys General. In that capacity they are authorized and empowered to execute and fulfill the duties of the Office of Attorney General according to the laws of the State of Minnesota. Further, they may render and execute documents as my authorized legal representatives.

Very truly yours,

LORI SWANSON
Attorney General
State of Minnesota

Facsimile: (651) 297-4193 • TTY: (651) 297-7206 • Toll Free Lines: (800) 657-3787 (Voice), (800) 366-4812 (TTY) • www.ag.state.mn.us
An Equal Opportunity Employer Who Values Diversity ♻Printed on 50% recycled paper (15% post consumer content)

PFCs in Minnesota's Ambient Environment:

2008 Progress Report

Minnesota Pollution Control Agency

Table of Contents

PFC Acronym Glossary

Groups

PFCs – perfluorochemicals or perfluorinated compounds
PASs – perfluoroalkyl surfactants
PFCAs – perfluorocarboxylic acid
PFSAs – polyfluorinated alkyl substances
FTOH – fluorotelomer alcohols
PFAAs – perfluoroalkyl acids

Individual

PFBA – perfluorobutanoic acid
PFBS – perfluorobutane sulfonate
PFPeA – perfluoropentanoic acid
PFHxA – perfluorohexanoic acid
PFHxS – perfluorohexane sulfonate
PFHpA – perfluoroheptanoic acid
PFOA – perfluorooctanoic acid
PFOS – perfluorooctane sulfonate
PFOSA – perfluorooctane sulfonamide
PFNA – perfluorononanoic acid
PFDA – perfluorodecanoic acid
PFUnA – perfluoroundecanoic acid
PFDoA – perfluorododecanoic acid
N-EtFOSE – N-ethyl perfluorooctanesulfonamidoethanol
N-MeFOSE – N-methyl perfluorooctanesulfonamidoethanol

Other Acronyms

AFFF – aqueous fire fighting foam
ECF – electrochemical fluorination
WWTP – wastewater treatment plant

Executive Summary

Perfluorochemicals (PFCs) are a group of fully-fluorinated carbon-based compounds that repel both oil and water and are very resistant to breakdown in the environment. These properties have led to their use in numerous industrial and consumer products. Specific PFCs of interest in Minnesota include PFOS (perfluorooctane sulfonate), PFOA (perfluorooctanoic acid) and PFBA (perfluorobutanoic acid).

Manufacture of PFCs in Minnesota began in the late 1950s by 3M Corporation at its Cottage Grove Facility. 3M ceased production of PFOS and PFOA in 2002 after several studies showed that PFCs were bioaccumulating in humans and wildlife worldwide. In 2004, PFCs were detected in drinking water supplies in several eastern Twin Cities suburbs; sources of the contamination were traced to legal disposal of 3M manufacturing wastes. The Minnesota Pollution Control Agency (MPCA) and the Minnesota Department of Health (MDH) have since identified contaminated wells and provided clean drinking water to affected consumers.

PFCs are released to the environment through manufacturing processes, industrial use, and the use of PFC-containing consumer products. PFCs, like PFOS and PFOA, are also formed from the breakdown of other fluorinated compounds such as fluorotelomer alcohols produced by DuPont. In order to identify potential sources of PFCs to the environment it is critical to understand the fate and transport processes governing these compounds.

It is now known that PFCs are ubiquitous environmental contaminants. This is a concern because some PFCs (such as PFOS and PFOA) are persistent, bioaccumulative and toxic. The worldwide presence of PFCs in humans and animals provides strong evidence that exposure to this group of chemicals is through general environmental exposure and is not limited to known point sources or areas of contamination. Although all routes of exposure have yet to be clearly defined, exposure likely occurs through a variety of pathways including drinking water, food and food packaging, and use of consumer products containing PFCs.

In Minnesota, it has been apparent since 2006 that PFCs may be present at concentrations of potential concern in the ambient environment (i.e., away from 3M disposal sites). The MPCA negotiated a Consent Order with 3M in May 2007. The Consent Order provided funding for additional monitoring of PFCs around Minnesota and intense remediation efforts at the 3M manufacturing and waste disposal sites. Since then, the MPCA has made a number of important discoveries regarding PFCs in Minnesota's ambient environment.

Some of the results to date presented in this report include the following findings. Several lakes in the Twin Cities and portions of the Mississippi River have elevated concentrations of PFOS in fish tissue, which has resulted in fish consumption advisories. Sampling indicates that, although present, PFC concentrations in shallow ambient ground water are well below health advisory concentrations. Most sampled waste water treatment plant influent, effluent, and sludge has detectable concentrations of PFCs. PFCs were detected in permitted landfills leachate, landfill gas, and landfill gas condensate, as well as in ground water upgradient and downgradient of the facility. More detail and additional results are presented in the report, including several extensive data sets in the appendices.

Introduction

Perfluorochemicals (PFCs) are a group of fully-fluorinated carbon-based compounds that repel both oil and water and are very resistant to breakdown in the environment. These properties have led to the use of PFCs in numerous industrial and consumer products. PFOS[*] (perfluorooctane sulfonate), PFOA (perfluorooctanoic acid), and PFBA (perfluorobutanoic acid) are examples of individual PFCs of concern in Minnesota. Common applications of PFCs include non-stick coatings for cookware, stain repellants, paper coatings, food packaging, fire-fighting foams, lubricants, wetting agents, corrosion inhibitors, cleaning products, cosmetics, and pesticide applications.

At this time, PFOS, PFOA, and PFBA are the PFCs of greatest interest in Minnesota due to their persistence, toxicity, and/or widespread detection in the environment and biota.

Manufacture of PFCs in Minnesota began in the late 1950's by 3M Corporation at its Cottage Grove Facility. After research found that PFOS could be measured in not just wildlife but also humans from around the world, 3M began the process of phasing out of the manufacture of the 8-carbon PFCs (PFOS and PFOA) and PFOS-related products in 2000. The phase out of PFOS production in Minnesota was completed in 2002. Since that time, 3M has worked to develop new technologies based on shorter chain PFCs such as perfluorobutane sulfonate (PFBS).

Although PFCs have been in commercial use for nearly 50 years they have only recently been detected in the global environment. It is now known that PFCs are ubiquitous environmental contaminants; they have been detected globally in lakes, rivers, oceans, sediment, soil, precipitation, air, biota, sewage sludge, and wastewater effluent. This is a concern because some PFCs are persistent, bioaccumulative and toxic. Several studies indicate that most wildlife and humans worldwide have at least some PFCs in their blood. While many sources of PFC exposure remain unknown, it is likely that exposure to PFCs occurs through consumption of contaminated food and water, and the use of numerous PFC-containing commercial products.

In 2004, PFCs detected in drinking water supplies in several eastern Twin Cities suburbs were traced to legal disposal of 3M manufacturing wastes, which occurred in the 1950s and later at four different locations. The Minnesota Pollution Control Agency (MPCA) and the Minnesota Department of Health (MDH) have since identified contaminated wells and provided clean drinking water to affected consumers. Most of the drinking-water problems have been characterized and brought under control. However, PFCs have been detected in all other environmental settings tested to date in Minnesota.

---

[*] Please refer to the acronym glossary at the beginning of this document for a complete list of acronyms used.

The May 2007 Consent Order with 3M paid for additional monitoring of PFCs around Minnesota as well as intense remediation efforts at the 3M manufacturing and waste disposal sites. From this work, the MPCA has learned that:

- The use of PFCs in industrial, commercial and consumer product applications continues even though 3M ceased production of PFOA and PFOS in 2002. Manufacturers in other countries continue to produce PFOA and PFOS for use in products that are legally exported and used for beneficial purposes in the U.S. and around the globe.

- Past and present PFC usage provides pathways for release into the environment that cannot be solely attributed to 3M, which developed the original PFC chemistry.

The MPCA is therefore pursuing a broader approach to addressing PFCs effectively, both in the short and long term:

Consent Order with 3M

In 2007, the MPCA negotiated a Consent Order (legally binding agreement) with 3M on the PFC contamination in Minnesota. The issues addressed in the Consent Order are as follows:

- Rigorous, robust cleanup plan
- Recognition of MPCA jurisdiction
- Municipal and private drinking water supplies
- Future actions on PFBA
- Additional studies on health and environmental effects
- Cooperation from 3M on sharing research and information
- Preservation of MPCA's right to take action in the future

- Investigations – ongoing studies to understand the presence, extent, sources, movement and fate of PFCs in the environment
- Remediation– vigorous and effective completion of cleanups at the 3M PFC waste disposal areas in Woodbury, Oakdale, Cottage Grove, and the Washington County Landfill
- Regulation – monitoring at wastewater treatment plants (WWTPs) and operating solid waste facilities; establishment of water quality criteria (site-specific standards) to protect fish for human consumption; permit requirements for facilities discharging into impaired waters
- Partnerships – with MDH, Minnesota Department of Natural Resources (MDNR), United States Environmental Protection Agency (EPA) and others to better characterize the risks of exposure to PFCs in the environment
- Data Management – efficient tracking, storage, retrieval and usage of all data including environmental samples; remedial investigations
- Communications – regular meetings with affected local officials and legislators; extensive web pages detailing agency actions and findings

The MPCA's investigation of PFCs in the ambient environment, along with supporting information gleaned from the scientific literature, is presented in this interim report. Several studies are still in progress, and more studies will likely be proposed in the future.

Investigation of PFCs in the Ambient Environment

A number of PFC projects have been completed or are underway. Brief descriptions of projects underway or completed by the MPCA and its partners are provided below, alphabetically.

Air and Precipitation Monitoring

Ambient air and precipitation samples are being collected to screen for PFC concentrations in urban and rural environments.

Aqueous Film-Forming Foam (AFFF) Use

Two AFFF projects are underway. One is a survey of PFC-containing AFFF users in Minnesota regarding their use of AFFF in fire fighting training. The other is a case study of PFC concentrations in sediment and shallow ground water at a site of known AFFF discharge during fire fighting training.

Fish Tissue and Surface Water Monitoring

Fish tissue and surface water samples are being collected in selected urban and rural lakes for two purposes. The first is to better understand the extent and magnitude of PFC contamination in commonly harvested fish species in lakes and rivers with high fishing pressure. Second, results will be used to evaluate bioaccumulation of PFCs in fish fillet tissue.

Food Web Studies

Two studies are underway at Lake Johanna to help develop better understanding about how PFCs move through the aquatic food web. Water, sediment, and aquatic organisms from Lake Johanna are being analyzed for PFC content as part of an aquatic food web study. Additionally, swallow eggs, chicks, and their food insects are being analyzed to determine differences in PFC concentrations in different locations and environmental media, identify which PFCs contribute to the differences, and to calculate accumulation rates.

Ground Water Monitoring

Samples of ground water were collected from wells in vulnerable, shallow aquifers in urban and agricultural areas. Sample results provided information about PFC impacts to ground water from potentially many different sources: industrial and municipal stormwater infiltration, land use, precipitation infiltration, surface water infiltration, pesticides, land application of biosolids, and/or atmospheric deposition.

Lake Calhoun PFOS Source Investigation

Elevated concentrations of PFOS in fish tissue from Lake Calhoun were a surprise. Storm water and rain water samples from the Lake Calhoun storm watershed will be collected to identify major sources of PFCs to Lake Calhoun, if major sources exist. This study is still in progress.

Land Use Influence of PFOS Concentrations in Fish Tissue

This project will utilize GIS, statistical analysis, and other information to analyze watershed characteristics and other factors that may influence PFOS concentrations in fish tissue.

Literature Reviews

On an ongoing basis, science indices, journals, reports, and regulatory news about PFC research results or policy development are searched. Review of the current literature keeps the MPCA and MDH up-to-date on research being conducted worldwide on PFC fate and transport, toxicology, risk assessment, and standard setting.

Mississippi River Sampling

The EPA is coordinating an effort to evaluate the range of concentrations of PFCs in water of the Mississippi River from the headwaters in Minnesota to the confluence with the Ohio River in Cairo, Illinois. In conjunction with the Water Quality Task Force members of the Upper Mississippi River Basin Association, approximately 200 surface water samples are being collected from key locations in the Mississippi River between Lake Itasca, Minnesota, and Cairo, Illinois.

Soil Microcosm Studies with EPA Labs

In cooperation with EPA, soil microcosms are being used to evaluate the potential for particular PFC compounds to break down in ground water and to measure the adsorption characteristics and mobility of PFCs in the ground water environment. Microcosms have been constructed using aquifer sediment spiked with PFC compounds. Periodic analysis of the microcosms will provide data on PFC fate and transport in ground water.

Urban Watershed Study

Stormwater inputs to PFC-impaired lakes will be sampled to develop better understanding about how PFCs move through an urban watershed to a lake.

Wastewater Treatment Plant PFC Release Assessment

Influent, effluent and sludge from WWTPs were sampled to assess the contribution of these facilities as potential sources of PFCs in Minnesota's environment. Facilities were selected to represent a variety of treatment technologies and influent sources (i.e. residential, commercial, industrial). Sources, environmental fate, and potential exposure pathways of PFCs detected at wastewater treatment facilities will be evaluated.

Water Quality Criteria Development

Water quality criteria were developed for PFOS and PFOA; PFBA is still in process. The process involves literature reviews of toxicity data, including 3M aquatic toxicity tests. Site-specific criteria are in place for PFOS and PFOA in Lake Calhoun and the Mississippi River. In Lake Calhoun, the chronic criteria (protective of both human health and aquatic life) are 12 ng/L for PFOS and 1.62 µg/L for PFOA. In the Mississippi River, the chronic criteria are 6 ng/L for PFOS and 2.7 µg/L for PFOA. Go to http://www.pca.state.mn.us/cleanup/pfc/index.html#pfos for more information.

Wildlife/Ecological Risk Assessment

To assess ecological risks from PFCs, MPCA filled a gap in National Park Service sampling, and expanded the study area for assessing targeted "persistent, bioaccumulative, toxicants" (PBTs), including PFCs, in bald eagles that nest along portions of the Mississippi and St. Croix Rivers. The sampling will allow monitoring of trends in PFC concentration and bald eagle nesting success over time. The number and development of young in nests are assessed in the study area, and eagle nestling blood samples were collected for analysis of PFCs.

The purpose of these studies is to determine the distribution and extent of PFC contamination in Minnesota's ambient environment. However, these studies can only assess concentrations of PFCs in various media. In order to give context and meaning to the data, it is critical to first understand the fate and transport of PFCs in the environment. The following section provides a brief discussion of direct and indirect sources of PFCs, as well as fate and transport in relevant environmental media.

Sources, Fate and Transport of PFCs in the Ambient Environment*

*Please refer to Appendix B for a more detailed discussion of the fate and transport of PFCs.

The variety and number of fluorinated compounds currently in production comprise an enormous number of chemicals. Drugs, anesthetics, chemotherapeutic agents, pesticides, refrigerants, such as chlorofluorocarbons (CFCs), as well polymers such as Teflon and Goretex, are a few of the thousands of products made from fluorinated carbon compounds [2].

***Perfluorinated compound** – a compound in which all available carbon atoms are bound to fluorine atoms.*

PFOA and PFOS are examples of perfluorinated surfactants. They are often found in surface water samples and are almost always found in wildlife and humans. While it is clear that these are not naturally occurring compounds – they are entirely human-made – how these compounds have become so widely distributed in our environment in often very remote locations is less understood. Studies have shown that PFOA, for example, is likely "ubiquitous in the northern hemisphere" [3].

The direct release of these compounds to the environment through manufacturing processes represents one way chemicals like PFOA or PFOS get into the environment. However, several recent studies show that PFOA and PFOS can be generated as byproducts when other fluorinated compounds break down. This means that the fate of other fluorinated compounds is important to understanding how chemicals like PFOA and PFOS are released to and persist in the environment.

Perfluorinated surfactants are made either through *electrochemical fluorination* (ECF) or through a *telomerization* manufacturing process [2, 4]. ECF is the process that 3M used to produce fluorinated compounds. ECF was used to produce the fluorinated surfactants PFOA and PFOS that are used in fire-fighting foams (AFFF), paints, polishes, films, and lubricants. ECF is the only process used to directly produce PFOA and PFOS, with over 6 million pounds produced in 2000 [4]. The major contributors to environmental loads appear to be through the use of PFOA and perfluorononanoic acid (PFNA) [5]. Other chemicals produced through ECF include the compounds used to make fabric stain repellents, carpet treatments, and paper coating materials [2, 4].

DuPont uses the telomerization process to make fluorinated compounds [2]. Unlike the PFCs made through 3M's ECF process, Dupont's method is often used to make *fluorotelomer alcohols* (FTOHs)[2]. FTOHs are not used directly in products. Instead, FTOHs are used as intermediates in the manufacture of other products, where they are often present in residual amounts of up to 4% by weight [6]. There are many types of fluorinated compounds that are used in a wide variety of products.

Chemicals like PFOA and PFOS are resistant to degradation which makes them persistent in the surface water, soil, and ground water. Moody *et al.* [7] studied a creek into which fire-fighting foam (AFFF) was spilled. PFOA, perfluorohexanoic acid (PFHxA, a chemical similar to PFOA), and PFOS were present in the surface water and in fish tissue for several years after the spill. They were also detected in ground water underneath a site where AFFF fire-fighting foam was used [8]. These studies focused on surface water or ground water contamination where there was a clear source or a spill. The widespread, low-level contamination of soil, ground water, and surface water in remote locations is difficult to explain, however, because it is unlikely that PFOA and similar chemicals that are non-volatile could be transported to areas far from a likely source.

Unlike PFOA, the FTOHs produced by DuPont are volatile and can be found in the air. FTOH will break down into PFOA (Fig. 1) and related chemicals in the atmosphere [3, 9] such as perfluorodecanoic acid (PFDA, a compound similar to PFOA). With over 10 million pounds of FTOH produced per year, enough FTOH is manufactured yearly to maintain the current observed concentrations of PFOA and related compounds in the environment [9]. FTOHs also break down in wastewater treatment plants, where up to 10% of FTOH can be converted to PFOA and similar compounds [10, 11].

$CF_3 - CF_2 - CF_2 - CF_2 - CF_2 - CF_2 - CF_2 - CF_2 - CH_2 - CH_2 - OH$ (8:2 FTOH)

$\downarrow$

Degradation process in
sewage treatment plant or atmosphere

$\downarrow$

$CF_3 - CF_2 - CF_2 - CF_2 - CF_2 - CF_2 - CF_2 - COOH$ (PFOA)

Figure 1. Conversion of 8:2 fluorotelomer alcohol into PFOA.

The degradation of FTOHs to PFOA and related chemicals can explain other observations:

- The appearance of PFDA in fish samples in Minnesota is consistent with the breakdown of FTOH to PFDA, because PFDA has no significant history of intentional industrial production [12].
- According to DeSilva and Mabury (2006), 89% of PFOA in human blood samples from the Midwest is attributable to PFOA that originated from telomerization production methods [12].
- Recent MPCA studies show that various perfluorinated surfactants – including PFOA and PFOS – were present in air samples in 2008 [13]. The presence of these compounds in the air can be partially explained by the breakdown of FTOH molecules in the atmosphere. 3M discontinued manufacture of these PFCs in 2002.
- Minnesota ground water monitoring shows PFOA, perfluoropentanoic acid (PFPeA), perfluorohexanoic acid (PFHxA), perfluoroheptanoic acid (PFHpA), and perfluorononoic acid (PFNA) at trace or low concentrations that are widespread under ambient conditions, with no known or likely sources of these compounds [14]. The degradation of FTOH

compounds in the air or in the soil is a plausible source of these detections in the ambient environment.

Polymers made from fluorinated chemicals are produced in far greater volumes than the fluorinated surfactants discussed above. Very little information, however, has been published regarding their fate in the environment [4].

Polymers typically resist breaking down. The breakdown of polymers made from fluorinated chemicals is expected to add only a very slight amount of PFOA and similar chemicals to the environment [15]. However, the polymers used widely for oil and water-resistant coatings on food-contact paper products have been found to degrade into FTOH and subsequently to PFOA [16]. The degradation of this water-resistant coating chemical was found to occur in the intestinal tract and the blood of laboratory animals, representing a significant source of exposure to PFCs [16].

Indoor air concentrations of fluorinated chemicals used to make fabric and carpet coatings are roughly 10-20 times greater than outdoor concentrations of the same chemicals [17]. These compounds may, in turn, break down into PFOS [18]. This could expose people to PFOS through ingestion and inhalation inside of homes that contain fabric coating products.

In soil, PFOS has been found to adsorb to various minerals, with adsorption increasing with PFOS concentration[19]. However, PFOS apparently adsorbs to soil less than other pollutants [19]. Some research shows that the mobility of PFOS and PFOA in ground water can change depending on the ground water conditions [20]. Adsorption variability might be important in how far and how fast these contaminants spread in aquifers away from spills or disposal sites.

Distribution of PFCs in Minnesota's Environment

In Minnesota, it has been apparent since 2006 that PFCs may be present at concentrations of potential concern beyond the disposal sites and the groundwater contamination associated with them. Since then, the MPCA has made a number of important discoveries regarding PFCs in Minnesota's ambient environment. The following section provides a brief discussion of the results to date of several completed and on-going studies at the MPCA. For more detailed analytical results, please refer to Appendix A.

Twin Cities Metro Area Lakes - Fish and Water

In April 2007, the MPCA found elevated concentrations of PFOS in fish taken from Lake Calhoun in Minneapolis. PFOS is the most bioaccumulative PFC in fish, and this finding was of concern to the city of Minneapolis and people who fish in this popular lake. MDH issued new fish consumption advisories for the lake. Sampling was expanded to other metro-area fishing lakes, and additional findings were announced later in 2007 and early 2008. In addition to Calhoun, Lake Johanna and Lake Elmo received one meal per month fish-consumption advisories. For the most part these lakes have no groundwater connection with the waste sites, and the source(s) of contamination are still not identified [21]. Figure 2 illustrates the 2006-2008 Twin Cities metro area fish sampling results. MPCA has ongoing projects underway, including an aquatic food web study and a stormwater runoff study, to better understand the distribution of PFCs in Minnesota's aquatic environment.

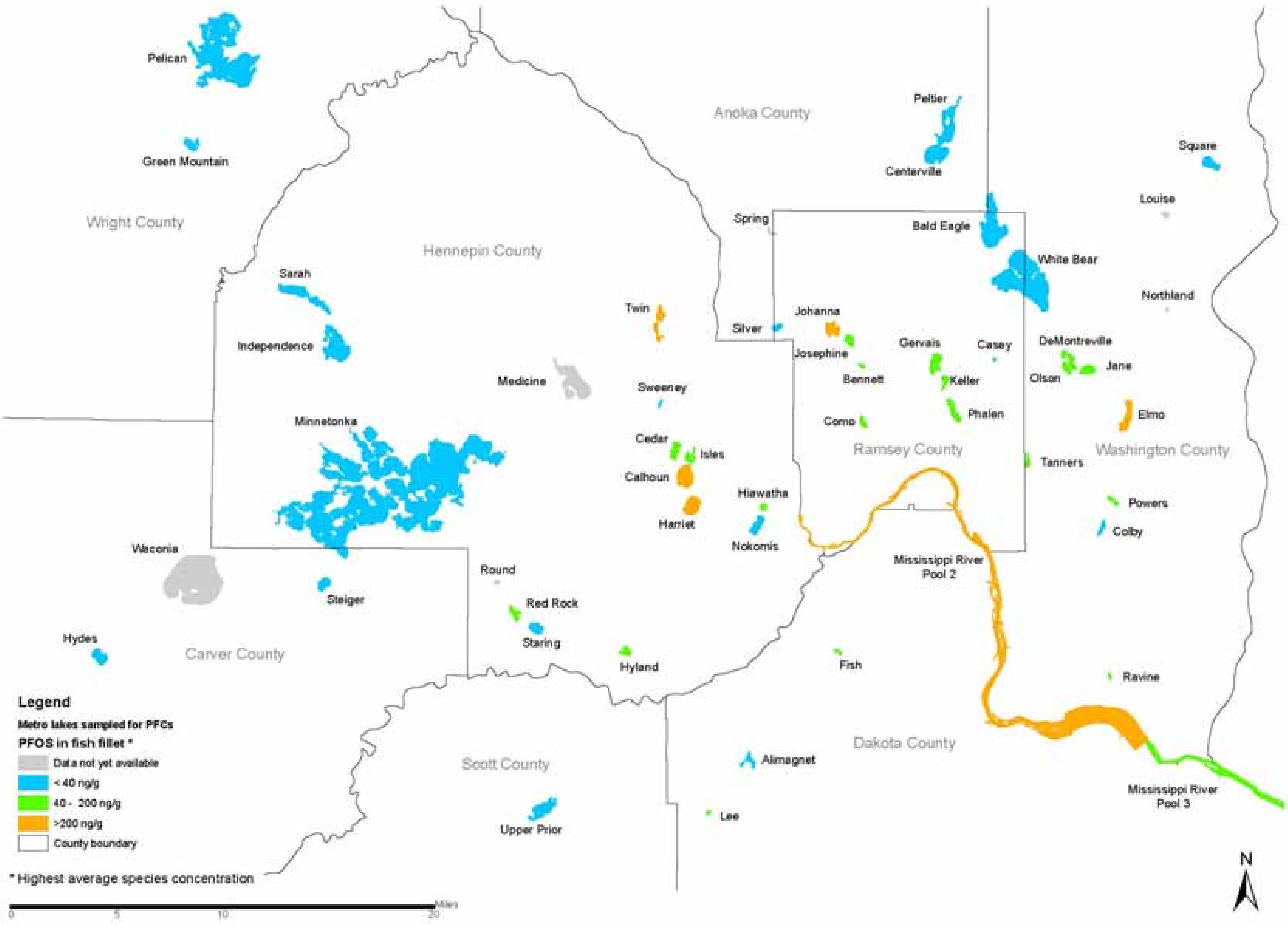


Figure 2. Fish Tissue Sampling Results for Twin Cities' Area Lakes (2006 – 2008).

Mississippi River Sampling

Fish have been collected from various reaches of the Mississippi River and analyzed for PFCs since 2005. Elevated concentrations of PFOS in fish tissue have resulted in MDH fish consumption advisories for at least one species in Pool 2, Pool 3, Pool 4, and Pools 5, 5a, and 6 (Fig. 2). Fish were sampled in the Mississippi River near Brainerd, and the PFOS concentrations in the Brainerd-area fish were low.

Ground Water

Ambient shallow ground water was sampled for PFCs in urban and agricultural areas of Minnesota during 2006 and 2007. Sampling was conducted by MPCA in cooperation with the Minnesota Department of Agriculture (MDA). Wells were selected in vulnerable aquifers. PFCs were detected in ambient shallow ground water at concentrations below MDH health guidelines. PFBA was the most commonly detected PFC, and it was the PFC detected at the highest concentration. Most of the PFC detections above the reporting limit were in the Twin Cities Metro Area. Land uses associated with the wells that had detected PFC concentrations were Industrial, Commercial, Sewered Residential, and Agricultural [22].

Air Monitoring

Air samples have been collected at two Minnesota sites, one urban and one rural. PFOS, PFOA, and PFBA were detected in air at both locations. Total concentrations were approximately 50% higher in the urban location. Additionally, 7 PFCs not detected in the rural location were detected at the urban location. Very few studies have measured and reported air concentrations of PFOS and PFOA. Minnesota's air results are within the range of PFOS and PFOA concentrations in air reported by others [23, 24]. A suburban location is currently being monitored for PFCs in air, but results are not yet available.

AFFF Fire-Fighting Foam

In 2008, MPCA hired a contractor to survey likely users of PFC-containing fire-fighting foam regarding their use of foam in both fire suppression training and in fire fighting. Survey questions were related to frequency of foam use, volume of foam used, location of foam used, and brands/types of foam used. Approximately 67% of municipal fire departments (522 of 785), all 16 fire training school, all three airports with fire departments, and both refineries with fire departments responded to the survey. Identified fire training locations were screened and ranked for relative risk based on type of foam used and proximity to potential human or environmental receptors: drinking water wells, well head protection areas and source water protection areas, surface water, wetlands, and karst geology.

Approximately 20 current or former fire training areas were identified as having a high potential for PFC contamination to drinking water, ground water, soil, and/or surface water. MDH and MPCA are conducting follow-up sampling and investigations of high-risk sites. The first round of sampling will focus on drinking water wells in proximity to fire training activities.

Wastewater Treatment Plants

The MPCA conducted a survey for PFCs in wastewater effluent at 28 municipal and industrial WWTPs across the state in 2007. A number of sample locations showed low concentrations of PFCs. The city of Brainerd's plant had elevated concentrations (see box). The Brainerd finding, traced to a chrome-plating facility, raised questions about the potential for PFCs to enter surface waters through permitted WWTP discharges to surface water. More facilities were sampled in 2008, and results were consistent with 2007 findings [21].

Permitted Landfills

Through monitoring conducted in 2006-7, the MPCA found PFCs in ground water, leachate, landfill gas, and gas condensate at a number of landfills. These findings suggest that PFCs may be released from consumer, commercial and demolition wastes. However, the concentrations were very low in ground water, and in most cases, results suggested that landfills were not acting as sources of PFC impacts to ground water. No drinking-water wells were affected [21].

Soil Microcosms

In collaboration with EPA's National Exposure Research Laboratory, MPCA is investigating the fate of PFCs in ground water. Soil collected from beneath the ground water table at the Washington County Landfill was brought to the laboratory.

Microcosms were prepared using this soil under anaerobic conditions, and PFOS and PFOA were added to the microcosms at known concentrations. Samples of these microcosms on a quarterly basis showed that, while these compounds resist degradation, the adsorption of these compounds to the soil changes with time. This is possibly due to changing oxidation/reduction conditions within the microcosms. These results have important implications to the fate of PFC in the vicinity of landfills where oxidation/reduction status changes spatially.

Brainerd WWTP Case Study

The PFOS concentrations in the Brainerd wastewater treatment plant influent, effluent and sludge were significantly higher than other WWTPs sampled around the state. In response to the noteworthy result, Brainerd Public Utilities (BPU), operator of the WWTP, hired a consultant to collect wastewater samples from locations around the city to try to determine the source of the PFOS. PFOS was detected in samples from five locations. Four concentrations ranged from 0.08 - 1.18 μg/L. The fifth sample concentration, collected at a manhole in an industrial park, had a PFOS concentration of 49.8 μg/L. **[1]**.

Keystone Automotive, a chrome plating operation specializing in automobile bumpers, is located in the industrial park adjacent to the manhole with the highest PFOS concentration sample. Keystone used a PFOS-containing surfactant product in its chrome plating bath. The PFOS-containing surfactant product reduces surface tension, which in turn helps reduce emissions of hexavalent chromium from the plating solution – an important worker-safety issue. In September 2007, Keystone switched to a different mist suppressant that does not contain PFCs. Ongoing monitoring is being conducted to monitor the effectiveness of the new mist suppressant. Monitoring will continue to document the effect that the product change has over time on PFOS discharge concentrations [1].

PFCs in Humans and Wildlife: Exposure and Effects

That PFCs are found throughout the world is not surprising due to their presence in a wide variety of industrial, commercial, and consumer products. The world-wide presence of PFCs in humans and animals provides strong evidence that exposure to this group of chemicals is through general environmental exposure and is not limited to known point sources or areas of contamination. The exact sources and routes of all exposures are unknown, although efforts are underway to evaluate the primary sources.

Several studies of human blood samples from around the world have found that nearly all people tested have some PFCs in their blood [25, 26]. A number of studies have also tried to assess potential routes of exposure [27-30]. Although all routes of exposure have yet to be clearly defined, exposure likely occurs through a variety of pathways, including drinking water, food and food packaging, and use of consumer products containing PFCs. Once people are exposed to PFCs, they are very slowly eliminated and stay in the body for many years [31].

PFCs have also been shown to bioaccumulate in wildlife, including top predators such as polar bears, bald eagles, mink, and seals; PFCs also bioaccumulate in fish. However, unlike other persistent organic pollutants, PFCs bind to protein rather than fatty tissues making it difficult to predict tissue concentrations using typical bioaccumulation models.

Human Exposure via Drinking Water

As a result of the manufacturing activities in Minnesota and the accompanying waste disposal, some eastern Twin Cities suburbs were found to have higher concentrations of PFCs in ground water when compared to the general environment. Several studies suggest that PFCs readily move through the soil and enter the ground water. Through investigations conducted by MDH and MPCA, it was discovered that some area residents were being exposed to PFCs through their drinking water (Table 1). Over 1,300 wells in the eastern Twin Cities suburbs have been tested, and MDH, MPCA, and 3M have worked with affected parties to provide safe drinking water by supplying alternative sources of water or assisting with water filtration to remove PFCs.

Testing of ground water in the eastern Twin Cities suburbs over the past several years suggests concentrations of PFCs have remained stable and have not increased. MDH and MPCA staff continues to test wells in the area to monitor any changes in concentrations or movement of the PFC ground water plume.

To date, most of the drinking water supplies located away from the eastern Twin Cities suburbs that have been tested have no detectable PFCs. Although PFBA was detected in several wells, the concentrations found were below levels of health concern established by the MDH. Testing of additional drinking water sources throughout Minnesota will continue to evaluate potential exposure to PFCs through drinking water.

Table 1. PFCs detected in Minnesota Drinking Water

	PFOS[a]	PFOA[a]	PFBA[a]
East Metro Area			
Municipal wells	ND[b] – 0.9	ND – 0.9	ND – 2.2
Private wells	ND - 3.5	ND - 2.2	ND - 12
Other Areas			
Municipal wells	ND	ND	ND – 0.4
Private wells	ND	ND	ND - 0.5
Criteria set by MDH			
Health Risk Limit (HRL)	0.3	0.5[c]	-
Health Based Value (HBV)	-	-	7

[a] Concentrations are in µg/L (ppb, parts per billion)

[b] ND = not detected

[c] In September 2008, MDH proposed lowering the HRL for PFOA to 0.3 µg/L.

Human Exposure via Fish Consumption

There are numerous reports documenting the presence of PFCs in fish and animals throughout the world [32-36]. In cooperation with the DNR and MDH, the MPCA has been testing fish in Twin Cities metro area lakes and rivers as well as selected outstate water bodies for the presence of PFCs to evaluate the potential for human exposure through the consumption of fish.

Fish from 56 different lakes as well as several reaches of the Mississippi and St. Croix Rivers have been tested for PFCs. PFOS, the primary PFC found to accumulate in fish fillet tissue, has been found in various fish species from several different lakes and river reaches at concentrations such that the MDH has issued site specific consumption guidelines for fish for the affected waters. Other PFCs detected in Minnesota fish include PFPeA, PFHxA, PFHxS, PFOSA, PFNA, PFDA, and PFUnA (Appendix A).

Human Health Risk

Although there are only a few studies investigating the effects of PFCs on human health, it is an area of active scientific research. The majority of studies evaluating the human health effects of PFCs have been conducted using animal models. While most studies have focused on PFOS and PFOA, information is growing for other PFCs such as PFBA and PFHxS.

In studies evaluating the health of 3M workers exposed to PFCs during manufacturing processes, no clear associations between adverse health effects and exposure were found [37]. It should be noted that the people evaluated in these studies were healthy workers who may not represent the average population. Three recent studies evaluated the health effects of PFCs on newborn babies associated with concentrations of PFCs in the blood of their mothers [38-40]. Each study found PFC concentrations in the mother's blood correlated to decreases in measures of growth in the newborns. Participants in these studies were exposed to PFCs through typical life activities, not as a result of known point sources of contamination.

As part of an agreement in a class action lawsuit against DuPont, a health study (The C8 Health Project) of 70,000 people in West Virginia and Ohio exposed to PFOA in drinking water is being undertaken to determine if there are any health effects related to PFOA exposure. Participants in this project live in areas of known drinking water contamination due to industrial activities.

Preliminary reports suggest a relationship between PFOA exposure and elevated cholesterol levels. Additional reports are pending [41].

In animal studies, PFCs have been associated with adverse effects including, but not limited to, altered cholesterol and thyroid hormone levels, suppression of the immune system, and developmental effects such as increased neonatal mortality, decreased body weight and weight gain in newborns and delayed eye opening. Animal studies generally form the basis of establishing human health criteria.

Human Health Criteria

Minnesota Department of Health

Following the discovery of PFCs in ground water in the East Metro Area, the MDH developed drinking water criteria for PFOS, PFOA and PFBA. Under emergency rule making authority enacted by the Minnesota Legislature, the MDH promulgated in rule Health Risk Limits (HRLs) of 0.3 μg/L* for PFOS and 0.5 μg/L for PFOA in August 2007. In September 2008, MDH proposed lowering the HRL for PFOA from 0.5 μg/L to 0.3 μg/L. In February 2008, MDH established a health based value (HBV) of 7 μg/L for PFBA. PFBA is thought to be less toxic than PFOS and PFOA because of its shorter half-life in rodents. HRLs and HBVs are concentrations of chemical-specific ground water contaminants that MDH has determined would result in little or no appreciable harm to people drinking the water daily over a lifetime. The process of determining HRLs and HBVs are the same; however, HBVs have not been promulgated in rule.

Due to limited toxicity information available for other PFCs, such as PFBS, PFHxS, and PFHxA, which have been found at very low concentrations in some wells, drinking water criteria cannot be developed for these chemicals at this time. The MDH continues to monitor PFC research activities and will re-evaluate criteria as new information becomes available.

In addition to the health criteria for PFOA, PFOS and PFBA established by the MDH for drinking water, values for the protection of human health have also been developed by other regulatory and health agencies in the U.S as well as in Europe. As described below, drinking water values developed by other agencies range from 0.04 - 9 μg/L for PFOA and 0.1 - 0.9 μg/L for PFOS.

New Jersey

In 2007, the New Jersey Department of Environmental Protection (NJDEP) provided preliminary guidance to the Pennsgrove Water Supply Company to assess public health implications due to PFOA in the system's drinking water [42]. The NJDEP recommended a preliminary health-based guidance in drinking water of 0.04 μg/L PFOA, which is the lower end of the range of several values derived from non-cancer and cancer endpoints in different species.

The drinking water value the NJDEP developed is based on comparisons between target blood levels of humans and actual or predicted blood levels of experimental animals. The difference between the New Jersey and the Minnesota values for PFOA is primarily due to use of a larger uncertainty factor and different water intake rates.

MDH had several concerns regarding the New Jersey approach, including the ability to accurately estimate a serum concentration associated with observed effects, the potential for episodic serum

---

*μg/L (micrograms per liter) = ppb (parts per billion) concentrations given the short half-life of PFOA in the female rat, and the uncertainty regarding the serum to water ratio. In developing its HBVs for PFOA and PFOS, MDH has chosen to utilize an animal model that it believes is more relevant to humans and a more traditional risk assessment methodology.

EPA

In 2006, the EPA set a site-specific drinking water action level of 0.5 μg/L for PFOA for the communities surrounding the DuPont Washington Works Facility in West Virginia [43]. Based on the scientific information available regarding the toxicity and the toxicokinetics of PFOA, EPA recommends that steps be taken to eliminate or reduce exposure to PFOA in the vicinity of the Washington Works Facility. Through a Consent Order, the EPA determined, "As required by Section 1431 of the SDWA (Safe Drinking Water Act) and for purposes of this Order, EPA has determined that C-8 [PFOA and its salts] is a contaminant present in or likely to enter a PWA [public water system] or a USDW [under ground source of drinking water] which may present an imminent and substantial endangerment to human health at concentrations at or above 0.50 μg/L in drinking water"[44]. In 2009, the EPA established provisional health advisories for PFOS and PFOA of 0.2 μg/L and 0.4 μg/L, respectively.

North Carolina

In 2007, the North Carolina Division of Water Quality in the Department of Environment and Natural Resources established a Public Health Goal of 0.63 μg/L for PFOA [45, 46] based on the same studies used by MDH. The difference between the North Carolina and the Minnesota values for PFOA is primarily due to use of a different water intake rate.

United Kingdom

The Food Standards Agency issued Tolerable Daily Intakes (TDIs) that are equivalent to drinking water concentrations of 9 μg/L for PFOA and 0.9 μg/L for PFOS. The evaluation conducted by the Food Standards Agency was based on the same experimental studies used by MDH; however, a dose-metric (a measurable physical/chemical property that corresponds to a compound's ability to cause a biological effect, such as toxicity) adjustment to account for species differences in half-life was not included [47-49].

Germany

In 2006, the German Ministry of Health established maximum tolerable concentrations for combined total exposure to PFOA and PFOS in drinking water and recommended that concentrations of PFOA and PFOS be combined in evaluations as they are considered to have comparable toxicity[50]. The Ministry issued a "strictly health-based guide value" for combined total exposure to PFOA and PFOS in drinking water of 0.3 μg/L. As a "health-based precautionary value", the Ministry established a drinking water value of 0.1 μg/L to account for exposure to other perfluorinated chemicals in addition to PFOA and PFOS due to the possibility of toxic risks which have yet to be identified and which may be attributed to additional perfluorinated chemicals with shorter or longer carbon chains than PFOA and PFOS. The Ministry recommends that efforts are to be made to reduce levels of total perfluorinated chemicals to less than the health-based precautionary value.

Ecotoxicity of PFCs

Several laboratory studies have demonstrated the toxicity of PFOS to aquatic organisms such as algae, invertebrates, fish, and ducks; PFOS toxicity in bobwhite quail has also been determined[51]. Mysid shrimp and chironomids, aquatic invertebrates that are important components in fresh water food webs, appear to be the most sensitive aquatic organisms tested to date. PFOS exhibits moderately acute toxicity in fathead minnows (*Pimephales promelas*). See Appendix C for a more detailed description of the available toxicity data.

A recent study of the effects of PFCs on marine mussels indicated that some PFCs (PFOA, PFNA, PFDA, and PFHxS) act as *chemosensitizers* (compounds that increase sensitivity to other chemicals) by interfering with a cell's ability to rid itself of toxic chemicals [52]. This interference could allow toxic substances that would normally be excreted to accumulate in the cell where they may have an adverse effect. Humans and other animals have cellular defense mechanisms similar to marine mussels.

PFCs as Potential Endocrine Disruptors

Several studies have shown that various PFCs have the potential to disrupt the endocrine systems of animals [53-59]. Laboratory studies of rats indicate that exposure to PFDA interfered with cholesterol transport and the production of steroid hormones, which resulted in reduced serum testosterone [56]. Exposure of rodents to PFOA has been associated with adverse effects on the testes [54]. PFOS has been shown to disrupt circulating levels of thyroid hormones in rats [57]. In cell cultures, FTOHs increased the number of estrogen receptors and induced MCF-7 breast cancer cell proliferation [55]. FTOHs were shown to be estrogenic *in vivo* in the male medaka (*Oryzias latipes*) as indicated by the induction of vitellogenin (a protein typically produced only in females) [58]. PFOS, PFOA, and certain FTOHs were also shown to be estrogenic *in vitro* [59].

Summary and Outlook

PFCs have a number of beneficial uses in myriad industrial, commercial, and consumer products due to their unique ability to repel both water and oil, and to resist breakdown. However, these same properties also contribute to their persistence, toxicity, ability to travel long distances to remote areas, and propensity to bioaccumulate in animals and humans. It is now known that PFCs are ubiquitous environmental contaminants that have been detected in a variety of settings, including humans and biota, worldwide.

There are many potential sources of PFC release to the environment, and humans and wildlife are exposed to PFCs through a variety of pathways. Several effects of exposure to PFCs have been documented in laboratory studies, including decreased growth and altered development in newborns, immune suppression, endocrine disruption, and increased sensitivity to other chemicals. Drinking water criteria and fish consumption advisories have been established to protect human health in Minnesota.

MPCA has conducted a number of studies of PFCs in the ambient environment, and several studies are still in progress. The goal of these studies is to determine the extent and distribution of PFC contamination in MN, and to determine likely sources of contamination. To date, PFCs have been detected in variety of environmental settings in Minnesota including surface water, ground water, air, soil, and fish.

The current PFC investigations are providing important clues to the origins, fate and consequences of PFCs in Minnesota's ambient environment, and will guide follow-up studies in the coming year. There is still much to learn, however. What do detections in fish, water, blood and other settings mean to people and the environment? How do PFCs move to remote parts of the planet? What are the ongoing sources of PFC release to the environment?

Despite having few human health studies, enough concerns are raised from existing human- and animal-based PFC toxicity studies to suggest that further environmental monitoring and health risk assessments are appropriate and necessary to answer questions of human and ecological risk. There are few established benchmarks against which to compare concentrations found in sampling work. Fortunately, the MPCA and MDH are not alone researching these challenging questions.

As is fitting for a global problem, scientists in government, academia and industry around the world are regularly adding to the scientific knowledge about environmental fate, movement, degradation, exposure and risks to humans and animals. The EPA is also becoming more active in the analytical and regulatory aspects of PFCs.

Minnesota agencies are in frequent contact with researchers worldwide and are partnering in some projects to represent Minnesota's interests. These complementary efforts at the state, national and international levels are key to solving the complex scientific questions about PFCs, and providing reliable information that citizens, government and industry are counting on to make good decisions.

References

1. MDH *Health Consultation, PFOS Detections in the City of Brainerd, Minnesota*; Minnesota Department of Health: St. Paul, Minnesota, August 13, 2008, 2008; p 28.
2. Banks, R. E.; Smart, B. E.; Tatlow, J. C., *Organofluorine Chemistry: Principles and Commercial Applications*. Plenum Press: New York, 1994; p 644.
3. Wallington, T. J.; Hurley, M. D.; Xia, J.; Wuebbles, D. J.; Sillman, S.; Ito, A.; Penner, J. E.; Ellis, D. A.; Martin, J.; Mabury, S. A.; Nielsen, O. J.; SulbaekAndersen, M. P., Formation of C7F15COOH (PFOA) and Other Perfluorocarboxylic Acids during the Atmospheric Oxidation of 8:2 Fluorotelomer Alcohol. *Environ. Sci. Technol.* **2006,** *40*, (3), 924-930.
4. Schultz, M.; Barofsky, D.; Field, J., Fluorinated Alkyl Surfactants. *Environmental Engineering Science* **2003,** *20*, (5), 487-501.
5. Liu, J.; Lee, L. S., Effect of Fluorotelomer Alcohol Chain Length on Aqueous Solubility and Sorption by Soils. *Environ. Sci. Technol.* **2007,** *41*, (15), 5357-5362.
6. Dinglasan-Panlilio, M. J. A.; Mabury, S. A., Significant Residual Fluorinated Alcohols Present in Various Fluorinated Materials. *Environ. Sci. Technol.* **2006,** *40*, (5), 1447-1453.
7. Moody, C. A.; Martin, J. W.; Kwan, W. C.; Muir, D. C. G.; Mabury, S. A., Monitoring Perfluorinated Surfactants in Biota and Surface Water Samples Following an Accidental Release of Fire-Fighting Foam into Etobicoke Creek. *Environ. Sci. Technol.* **2002,** *36*, (4), 545-551.
8. Moody, C. A.; Hebert, G. N.; Strauss, S. H.; Field, J. A., Occurrence and persistence of perfluorooctanesulfonate and other perfluorinated surfactants in groundwater at a fire-training area at Wurtsmith Air Force Base, Michigan, USA*J. Environ. Monit.***2003,** *5*, 341-345.
9. Ellis, D. A.; Martin, J. W.; DeSilva, A. O.; Mabury, S. A.; Hurley, M. D.; SulbaekAndersen, M. P.; Wallington, T. J., Degradation of Fluorotelomer Alcohols: A Likely Atmospheric Source of Perfluorinated Carboxylic Acids. *Environ. Sci. Technol.* **2004,** *38*, (12), 3316-3321.
10. Wang, N.; Szostek, B.; Folson, P. W.; Sulecki, L. M.; Capka, V.; Buck, R. C.; Berti, W. R.; Gannon, J. T., Aerobic biotransformation of 14C-labeled 8-2 telomer B alcohol by activated sludge from a domestic sewage treatment plant. *Environmental Science and Technology* **2005,** *39*, 531-538.
11. Ning Wang, B. S., Robert C. Buck, Patrick W. Folsom, Lisa M. Sulecki, Vladimir Capka, William R. Berti, and John T. Gannon Fluorotelomer Alcohol Biodegradation-Direct Evidence that Perfluorinated Carbon Chains Breakdown *Environ. Sci Technol.* **2005,** *39* 7516-7528.
12. DeSilva, A. O.; Mabury, S. A., Isomer Distribution of Perfluorocarboxylates in Human Blood: Potential Correlation to Source. *Environ. Sci. Technol.* **2006,** *40*, (9), 2903-2909.
13. MPCA, Air Monitoring Unit - data. In 2008.
14. Erickson, M., Results of 2006 Sampling of Shallow Ground Water for Perfluorinated Chemicals. In Agency, M. P. C., Ed. Minnesota Pollution Control Agency: St. Paul, Minnesota, 2007.

15. Russell, M. H.; Berti, W. R.; Szostek, B.; Buck, R. C., Investigation of the Biodegradation Potential of a Fluoroacrylate Polymer Product in Aerobic Soils. *Environ. Sci. Technol.* **2008,** *42*, (3), 800-807.
16. D'Eon, J. C.; Mabury, S. A., Production of Perfluorinated Carboxylic Acids (PFCAs) from the Biotransformation of Polyfluoroalkyl Phosphate Surfactants (PAPS): Exploring Routes of Human Contamination. *Environ. Sci. Technol.* **2007,** *41*, (13), 4799-4805.
17. Shoeib, M.; Harner, T.; Wilford, B. H.; Jones, K. C.; Zhu, J., Perfluorinated Sulfonamides in Indoor and Outdoor Air and Indoor Dust: Occurrence, Partitioning, and Human Exposure. *Environ. Sci. Technol.* **2005,** *39*, (17), 6599-6606.
18. Martin, J. W.; Muir, D. C. G.; Moody, C. A.; Ellis, D. A.; Kwan, W. C.; Solomon, K. R.; Mabury, S. A., Collection of Airborne Fluorinated Organics and Analysis by Gas Chromatography/Chemical Ionization Mass Spectrometry. *Anal. Chem.* **2002,** *74*, (3), 584-590.
19. Johnson, R. L.; Anschutz, A. J.; Smolen, J. M.; Simcik, M. F.; Penn, R. L., The Adsorption of Perfluorooctane Sulfonate onto Sand, Clay, and Iron Oxide Surfaces. *J. Chem. Eng. Data* **2007,** *52*, (4), 1165-1170.
20. Ferrey, M.; Adair, C.; Wilson, J. T. In *Sorption of PFOA and PFOS to aquifer sediment.*, PFAA Days: Recent Advances in Perfluoroalkyl Acid (PFAA) Research., Research Triangle Park, North Carolina, 2008; Research Triangle Park, North Carolina, 2008.
21. MPCA *Investigating PFCs in Minnesota: Current Status, May 2008*; Minnesota Pollution Control Agency: May 2008, 2008.
22. Erickson, M. *Results of 2006 Sampling of Shallow Ground Water for Perfluorinated Chemicals*; Minnesota Pollution Control Agency: St. Paul, Minnesota, April 17, 2007, 2007; p 10.
23. Barber, J. L., Urs Berger, Chakra Chaemfa, Sandra Huber, Annika Jahnke, Christian Temme, Kevin C. Jones, Analysis of per- and polyfluorinated alkyl substances in air samples from Northwest Europe. *Journal of Environmental Monitoring* **2007,** *9*, 530-541.
24. Kim, S.-K.; Kannan, K., Perfluorinated Acids in Air, Rain, Snow, Surface Runoff, and Lakes: Relative Importance of Pathways to Contamination of Urban Lakes. *Environ. Sci. Technol.* **2007,** *41*, (24), 8328-8334.
25. Olsen, G. W.; Church, T. R.; Miller, J. P.; Burris, J. M.; Hansen, K. J.; Lundberg, J. K.; Armitage, J. B.; Herron, R. M.; Medhdizadehkashi, Z.; Nobiletti, J. B.; O'Neill, E. M.; Mandel, J. H.; Zobel, L. R., Perfluorooctanesulfonate and other fluorochemicals in the serum of American Red Cross adult blood donors. *Environ Health Perspect* **2003,** *111*, (16), 1892-901.
26. Calafat, A. M.; Wong, L. Y.; Kuklenyik, Z.; Reidy, J. A.; Needham, L. L., Polyfluoroalkyl Chemicals in the US Population: Data from the National Health and Nutrition Examination Survey (NHANES) 2003–2004 and Comparisons with NHANES 1999–2000. *Environmental Health Perspectives* **2007,** *115*, (11), 1596.
27. Washburn, S. T.; Bingman, T. S.; Braithwaite, S. K.; Buck, R. C.; Buxton, L. W.; Clewell, H. J.; Haroun, L. A.; Kester, J. E.; Rickard, R. W.; Shipp, A. M., Exposure assessment and risk characterization for perfluorooctanoate in selected consumer articles. *Environ Sci Technol* **2005,** *39*, (11), 3904-10.
28. Fromme, H.; Midasch, O.; Twardella, D.; Angerer, J.; Boehmer, S.; Liebl, B., Occurrence of perfluorinated substances in an adult German population in southern Bavaria. *Int Arch Occup Environ Health* **2007,** *80*, (4), 313-9.

29. Ericson, I.; Marti-Cid, R.; Nadal, M.; Van Bavel, B.; Lindstrom, G.; Domingo, J. L., Human exposure to perfluorinated chemicals through the diet: intake of perfluorinated compounds in foods from the Catalan (Spain) market. *J Agric Food Chem* **2008,** *56*, (5), 1787-94.
30. Trudel, D.; Horowitz, L.; Wormuth, M.; Scheringer, M.; Cousins, I. T.; Hungerbuhler, K., Estimating consumer exposure to PFOS and PFOA. *Risk Anal* **2008,** *28*, (2), 251-69.
31. Olsen, G.; Ehresman, D.; Froehlich, J.; Burris, J.; Butenhoff, J., Evaluation of the half-life (t 1/2) of elimination of perfluorooctanesulfonate (PFOS), perfluorohexanesulfonate (PFHS) and perfluorooctanoate (PFOA) from human serum. Abstract TOXC017. In FLUOROS: 2005.
32. Giesy, J. P.; Kannan, K., Global distribution of perfluorooctane sulfonate in wildlife. *Environ Sci Technol* **2001,** *35*, (7), 1339-42.
33. Bossi, R.; Strand, J.; Sortkjaer, O.; Larsen, M. M., Perfluoroalkyl compounds in Danish wastewater treatment plants and aquatic environments. *Environ Int* **2008,** *34*, (4), 443-50.
34. Kannan, K.; Hansen, K. J.; Wade, T. L.; Giesy, J. P., Perfluorooctane sulfonate in oysters, Crassostrea virginica, from the Gulf of Mexico and the Chesapeake Bay, USA. *Arch Environ Contam Toxicol* **2002,** *42*, (3), 313-8.
35. Kannan, K.; Newsted, J.; Halbrook, R. S.; Giesy, J. P., Perfluorooctanesulfonate and related fluorinated hydrocarbons in mink and river otters from the United States. *Environ Sci Technol* **2002,** *36*, (12), 2566-71.
36. Kannan, K.; Tao, L.; Sinclair, E.; Pastva, S. D.; Jude, D. J.; Giesy, J. P., Perfluorinated compounds in aquatic organisms at various trophic levels in a Great Lakes food chain. *Arch Environ Contam Toxicol* **2005,** *48*, (4), 559-66.
37. Olsen, G. W.; Zobel, L. R., An analysis of the 2000 fluorochemical (perfluorooctanoate, PFOA) medical surveillance program at 3M Company's Antwerp (Belgium), Cottage Grove (Minnesota), and Decatur (Alabama) facilities. Final Report. In 2006.
38. Apelberg, B. J.; Goldman, L. R.; Calafat, A. M.; Herbstman, J. B.; Kuklenyik, Z.; Heidler, J.; Needham, L. L.; Halden, R. U.; Witter, F. R., Determinants of fetal exposure to polyfluoroalkyl compounds in Baltimore, Maryland. *Environ Sci Technol* **2007,** *41*, (11), 3891-7.
39. Fei, C.; McLaughlin, J. K.; Tarone, R. E.; Olsen, J., Perfluorinated chemicals and fetal growth: a study within the Danish National Birth Cohort. *Environ Health Perspect* **2007,** *115*, (11), 1677-82.
40. Washino, N.; Saijo, Y.; Sasaki, S.; Kato, S.; Ban, S.; Konishi, K.; Ito, R.; Nakata, A.; Iwasaki, Y.; Saito, K., Correlations Between Prenatal Exposure to Perfluorinated Chemicals and Reduced Fetal Growth. *Cancer* **2008,** *116*, (11).
41. Fletcher, T.; Savitz, D.; Steenland, K., The C8 Science Panel Website. In 2007.
42. Protection, N. J. D. o. E., Guidance for PFOA in Drinking Water at Pennsgrove Water Supply Company. In 2007.
43. USEPA, Memorandum to Walker Smith from Christopher Weis: Hazard Evaluations and Revised Site-Specific Threshold for Perfluorooctanoate (PFOA or C8; CAS #335-67-1) in drinking water near the DuPont Washington Works Facility, West Virginia. In 2006.
44. USEPA, SDWA 1431 Consent Order - DuPont Washington Works Facility. In 2006.
45. Quality, N. C. D. o. W. Interim Drinking Water Value. http://h2o.enr.state.nc.us/csu/documents/IMACBasisC8.pdf

46. Pollutants, N. C. S. A. B. o. T. A. Proceedings of the February 22, 2007 meeting. http://www.ncair.org/toxics/risk/sab/proceed/121.pdf
47. Committee on Toxicity of Chemicals in Food, C. P., and the Environment, COT statement of the tolerable daily intake for perfluorooctanoic acid. In 2006.
48. Committee on Toxicity of Chemicals in Food, C. P., and the Environment, COT statement on the tolerable daily intake for perfluorooctance sulfonate. In 2006.
49. Inspectorate, D. W., Guidance on the water supply (water quality) regulations 2000/1 specific to PFOS (perfluorooctane sulphonate) and PFOA (perfluorooctanoic acid) concentrations in drinking water. In 2007.
50. Commission, G. M. o. H. D. W., Provisional evaluation of PFT in drinking water with the guide substances perfluorooctanoic acid (PFOA) and perfluorooctane sulfonate (PFOS) as examples. . In 2006.
51. UNEP *Report of the persistent organic pollutants review committee on the work of its second meeting*; United Nations Environment Programme: 2006.
52. Stevenson, C. N.; MacManus-Spencer, L. A.; Luckenbach, T.; Luthy, R. G.; Epel, D., New perspectives on perfluorochemical ecotoxicology: inhibition and induction of an efflux transporter in the marine mussel, Mytilus californianus. *Environ Sci Technol* **2006,** *40*, (17), 5580-5.
53. Jensen, A. A.; Leffers, H., Emerging endocrine disrupters: perfluoroalkylated substances. *Int J Androl* **2008,** *31*, (2), 161-9.
54. Biegel, L. B.; Liu, R. C. M.; Hurtt, M. E.; Cook, J. C., Effects of Ammonium Perfluorooctanoate on Leydig-Cell Function: In Vitro, in Vivo, and ex Vivo Studies. *Toxicology and Applied Pharmacology* **1995,** *134*, (1), 18-25.
55. Maras, M.; Vanparys, C.; Muylle, F.; Robbens, J.; Berger, U.; Barber, J. L.; Blust, R.; De Coen, W., Estrogen-Like Properties of Fluorotelomer Alcohols as Revealed by MCF-7 Breast Cancer Cell Proliferation. *Environmental Health Perspectives* **2006,** *114*, (1), 100.
56. Shi, Z.; Zhang, H.; Liu, Y.; Xu, M.; Dai, J., Alterations in gene expression and testosterone synthesis in the testes of male rats exposed to perfluorododecanoic acid. *Toxicol Sci* **2007,** *98*, (1), 206-15.
57. Thibodeaux, J. R., Perfluorooctane Sulfonate-Induced Thyroid Hormone Disruption in the Rat. **2005**.
58. Ishibashi, H.; Yamauchi, R.; Matsuoka, M.; Kim, J. W.; Hirano, M.; Yamaguchi, A.; Tominaga, N.; Arizono, K., Fluorotelomer alcohols induce hepatic vitellogenin through activation of the estrogen receptor in male medaka (Oryzias latipes). *Chemosphere* **2008,** *71*, (10), 1853-9.
59. Liu, C.; Du, Y.; Zhou, B., Evaluation of estrogenic activities and mechanism of action of perfluorinated chemicals determined by vitellogenin induction in primary cultured tilapia hepatocytes. *Aquatic Toxicology* **2007,** *85*, (4), 267-277.

January 2009

Report Coordinator: Summer Streets

Primary Contributors: Mindy Erickson, PhD, Mark Ferrey, Paul Hoff, Laura Solem, PhD, Summer Streets

Minnesota Pollution Control Agency

520 Lafayette Road
Saint Paul, MN 55155
www.pca.state.mn.us

Appendix A

PFC Monitoring Data Collected by the MPCA

Table A1. Perfluorinated Compounds in Rural Ambient Shallow Ground Water, October 2007

Location ID	Type	PFBA	PFPeA	PFHxA	PFHpA	PFOA	PFNA	PFDA	PFUnA	PFDoA	PFBS	PFHxS	PFOS	PFOSA
FINE	Spring	< 2.51	< 2.51	< 2.51	< 2.51	< 2.51	< 2.51	< 2.51	< 2.51	< 2.51	< 5.01	< 5.01	< 5.01	< 2.51
BURR	Spring	< 2.46	< 2.46	< 2.46	< 2.46	< 2.46	< 2.46	< 2.46	< 2.46	< 2.46	< 4.92	< 4.92	< 4.92	< 2.46
RAINY	Spring	2.43	< 2.43	< 2.43	< 2.43	< 2.43	< 2.43	< 2.43	< 2.43	< 2.43	< 4.86	< 4.86	< 4.86	< 2.43
747009	Monitoring Well	22	< 2.54	< 2.54	< 2.54	< 2.54	< 2.54	< 2.54	< 2.54	< 2.54	< 5.07	< 5.07	< 5.07	< 2.54
492127	Monitoring Well	< 2.55	< 2.55	< 2.55	< 2.55	< 2.55	< 2.55	< 2.55	< 2.55	< 2.55	< 5.09	< 5.09	< 5.09	< 2.55
747010	Monitoring Well	< 2.47	< 2.47	< 2.47	< 2.47	< 2.47	< 2.47	< 2.47	< 2.47	< 2.47	< 4.95	< 4.95	< 4.95	< 2.47
244529	Monitoring Well	< 2.47	< 2.47	< 2.47	< 2.47	< 2.47	< 2.47	< 2.47	< 2.47	< 2.47	< 4.94	< 4.94	< 4.94	< 2.47
431151	Monitoring Well	< 2.46	< 2.46	< 2.46	< 2.46	< 2.46	< 2.46	< 2.46	< 2.46	< 2.46	< 4.91	< 4.91	< 4.91	< 2.46
244492	Monitoring Well	< 2.50	< 2.50	< 2.50	< 2.50	< 2.50	< 2.50	< 2.50	< 2.50	< 2.50	< 5.00	< 5.00	< 5.00	< 2.50
747014	Monitoring Well	**32.2**	< 2.50	< 2.50	< 2.50	< 2.50	< 2.50	< 2.50	< 2.50	< 2.50	< 4.99	< 4.99	< 4.99	< 2.50
747011	Monitoring Well	6.38	< 2.54	< 2.54	< 2.54	< 2.54	< 2.54	< 2.54	< 2.54	< 2.54	< 5.08	< 5.08	< 5.08	< 2.54
747012	Monitoring Well	3.14	< 2.45	< 2.45	< 2.45	< 2.45	< 2.45	< 2.45	< 2.45	< 2.45	< 4.89	< 4.89	< 4.89	< 2.45
747014	Monitoring Well	20.4	< 2.45	< 2.45	< 2.45	< 2.45	< 2.45	< 2.45	< 2.45	< 2.45	< 4.89	< 4.89	< 4.89	< 2.45
747015	Monitoring Well	3.37	< 2.38	< 2.38	< 2.38	< 2.38	< 2.38	< 2.38	< 2.38	< 2.38	< 4.76	< 4.76	< 4.76	< 2.38
747016	Monitoring Well	**63**	< 2.49	< 2.49	< 2.49	< 2.49	< 2.49	< 2.49	< 2.49	< 2.49	< 4.98	< 4.98	< 4.98	< 2.49
747018	Monitoring Well	< 2.51	< 2.51	< 2.51	< 2.51	< 2.51	< 2.51	< 2.51	< 2.51	< 2.51	< 5.01	< 5.01	< 5.01	< 2.51
747019	Monitoring Well	< 2.61	< 2.61	< 2.61	< 2.61	< 2.61	< 2.61	< 2.61	< 2.61	< 2.61	< 5.22	< 5.22	< 5.22	< 2.61
639515 [a]	Monitoring Well	23.3	< 11.6	< 3.88	< 2.49	< 2.49	< 2.49	< 2.49	< 2.49	< 2.49	< 4.98	< 4.98	< 4.98	< 2.49
639515 [b]	Monitoring Well	22	< 9.04	< 4.26	< 2.45	< 2.45	< 2.45	< 2.45	< 2.45	< 2.45	< 4.89	< 4.89	< 4.89	< 2.45
623617 [a]	Monitoring Well	6.65	< 2.49	< 2.49	< 2.49	< 2.49	< 2.49	< 2.49	< 2.49	< 2.49	< 4.98	< 4.98	< 4.98	< 2.49
623617 [a,c]	Monitoring Well	4.21	< 2.50	< 2.50	< 2.50	< 2.50	< 2.50	< 2.50	< 2.50	< 2.50	< 5.01	< 5.01	< 5.01	< 2.50
623617 [b]	Monitoring Well	3.97	< 2.55	< 2.55	< 2.55	< 2.55	< 2.55	< 2.55	< 2.55	< 2.55	< 5.10	< 5.10	< 5.10	< 2.55
equipment blank [c]	N/A	< 2.49	< 2.49	< 2.49	< 2.49	< 2.49	< 2.49	< 2.49	< 2.49	< 2.49	< 4.99	< 4.99	< 4.99	< 2.49

All units are nanograms per liter (parts per trillion)

[a] sample collected early in the purge

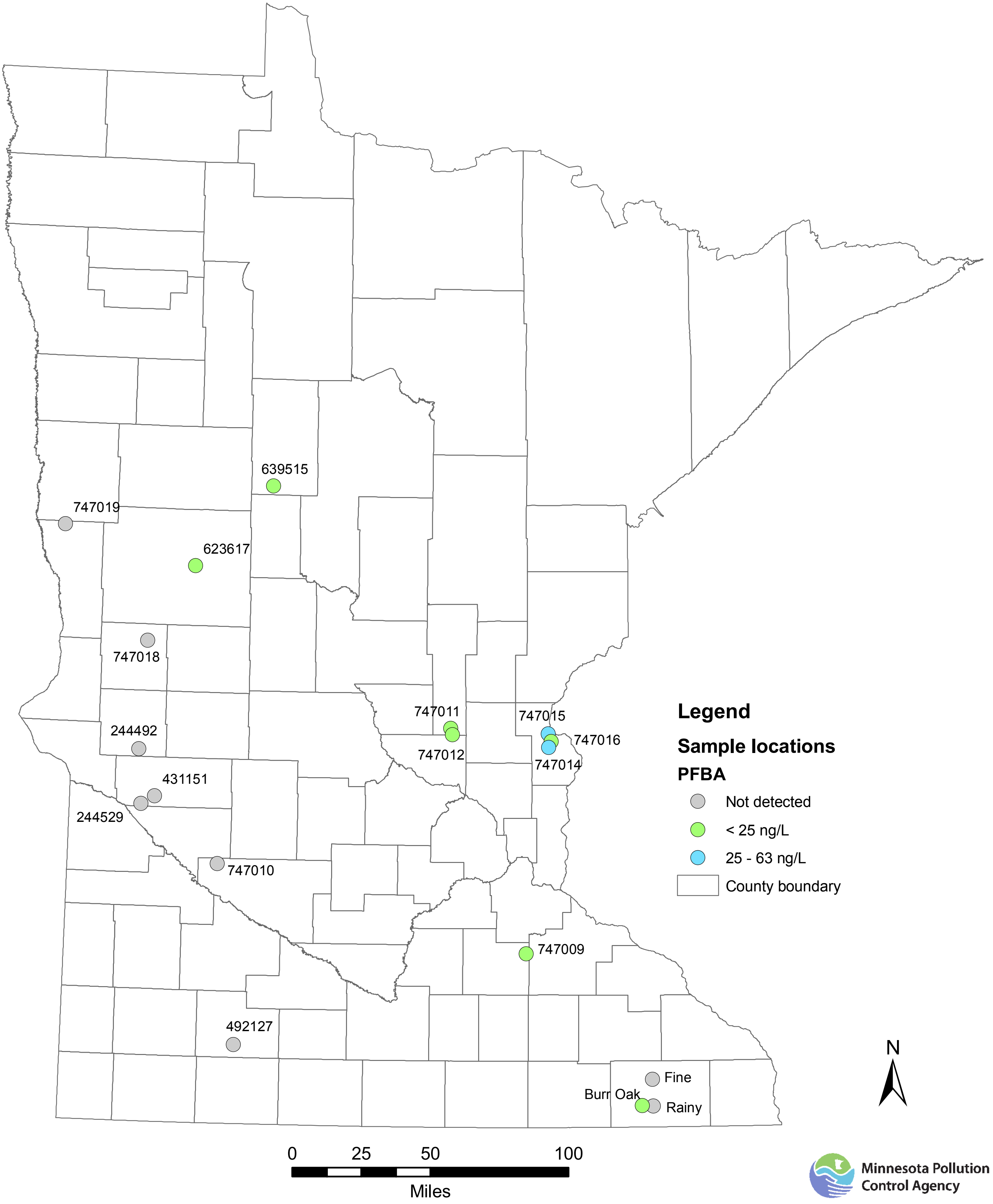
[b] sample collected late in the purge

[c] dedicated teflon tubing used for this sample

< indicates less than the detection limit. Number following the symbol represents the detection limit

Grayed detected values indicate that the detected concentration is below the Reporting Level of 25 ng/L

PFBA in Shallow Ground Water in Rural Areas
October 2007



Minnesota Pollution Control Agency

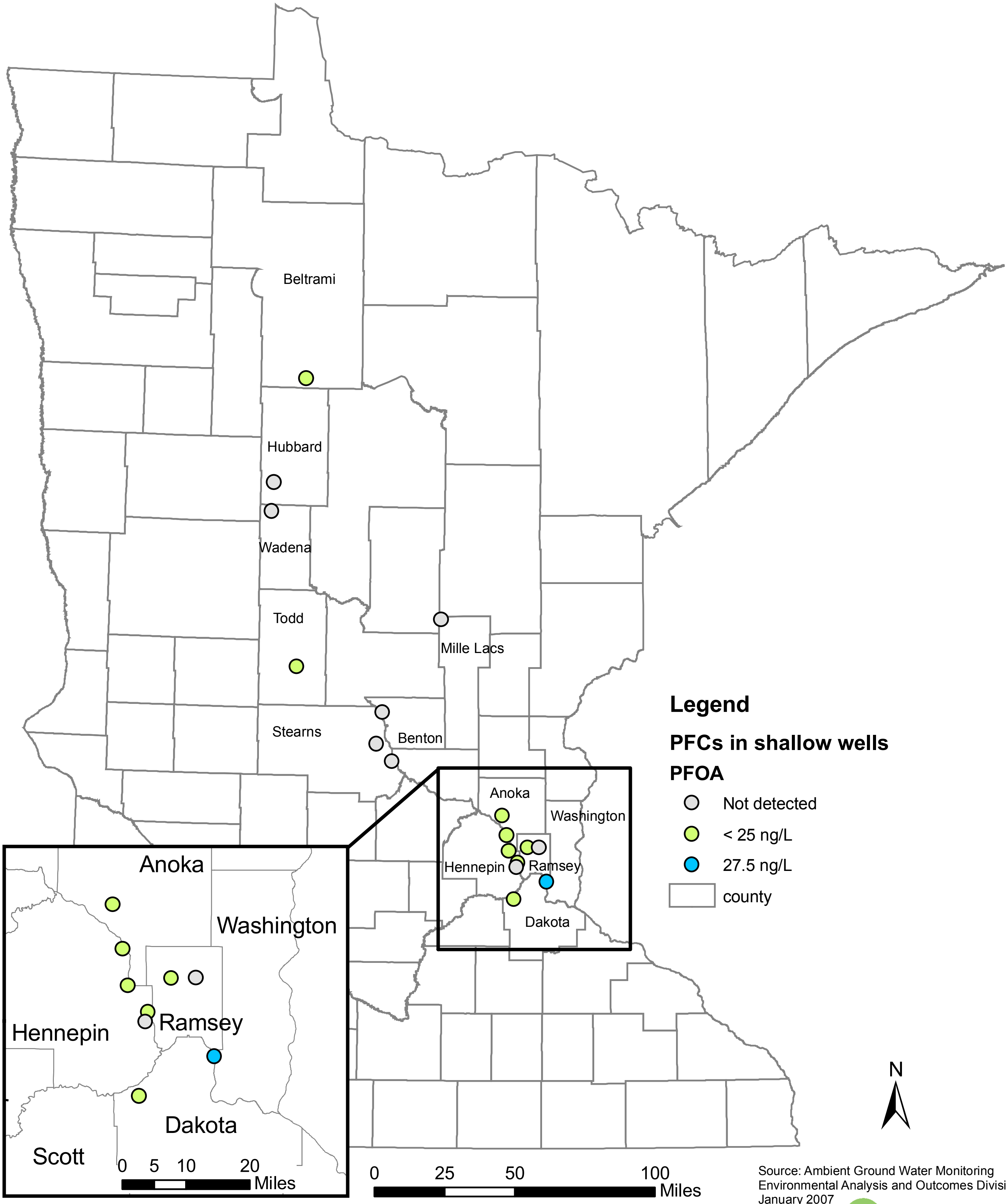
Table A2. Perfluorinated Compounds in Urban Ambient Shallow Ground Water, 2006 - 2007

Ambient ID	Sample Date [a]	Land Use	City	County	PFBA	PFOA	PFOS	PFPeA	PFHxA	PFHpA	PFBS	PFHxS	PFNA
2495	November 2006	Sewered residential	Anoka	Anoka	**43.4**	17.2	< 2.29	8.54	7.72	15.1	< 2.80	9.85	< 0.929
2495	December 2006	Sewered residential	Anoka	Anoka	12.5	12.7	< 2.22	3.05	2.66	6.86	3.1	3.64	< 1.14
2495	November 2007	Sewered residential	Anoka	Anoka	14.8	19.7	< 5.07	4.61	4.15	2.92	< 5.07	< 5.07	< 2.54
1071	November 2006	Industrial	Minneapolis	Hennepin	**61.3**	< 1.11	< 2.31	1.71	1.35	< 2.63	5.37	< 2.57	< 0.934
1071	December 2006	Industrial	Minneapolis	Hennepin	**59.5**	1.33	< 2.24	2.75	1.38	< 1.38	7.05	< 2.24	< 1.14
1071	November 2007	Industrial	Minneapolis	Hennepin	**61.8**	< 2.64	< 5.27	< 3.05	< 3.27	< 4.54	< 5.27	< 5.27	< 2.64
1070	November 2006	Industrial	Arden Hills	Ramsey	**279**	17	3.49	< 53.7	10.5	8.37	< 2.83	4.66	< 1.55
1070	December 2006	Industrial	Arden Hills	Ramsey	**266**	24.8	< 2.25	13.4	14.8	6.94	< 14.3	7.46	1.21
8180	November 2006	Sewered residential	Vadnais Heights	Ramsey	**347**	< 1.11	< 2.41	6.87	< 0.946	1.58	< 2.81	< 2.56	< 0.930
8180	December 2006	Sewered residential	Vadnais Heights	Ramsey	**468**	1.1	< 2.23	6.33	< 1.05	< 1.05	< 2.21	< 2.23	< 1.14
8180	November 2007	Sewered residential	Vadnais Heights	Ramsey	**230**	< 2.55	< 5.10	5.8	< 2.55	< 2.98	< 5.10	< 5.10	< 2.55
1069	November 2006	Industrial	Newport	Washington	**716**	**27.5**	**37**	**38.8**	24.1	7.07	24.4	**77.8**	< 0.929
1069	December 2006	Industrial	Newport	Washington	**922**	23	19.7	**55.8**	**31.1**	5.91	**39.9**	**69.6**	< 1.14
1069	November 2007	Industrial	Newport	Washington	**51.1**	32.4	7.26	10.2	6.82	2.78	< 5.12	< 5.12	< 2.56
1060	November 2006	Commercial	Burnsville	Dakota	22	8.84	2.79	5.01	2.38	3.7	< 2.83	< 2.58	< 0.938
1021	November 2006	Industrial	Minneapolis	Hennepin	**43.6**	8.58	< 2.28	3.1	2.94	2.16	< 2.79	2.92	< 0.923
1021	November 2007	Industrial	Minneapolis	Hennepin	**30.5**	7.17	< 10.3	< 5.13	< 5.13	< 5.13	< 10.3	< 10.3	< 5.13
2505	November 2006	Sewered residential	Minneapolis	Hennepin	**43.9**	1.36	2.39	2.91	< 0.944	< 1.10	< 2.80	< 2.56	< 0.929
2505	November 2007	Sewered residential	Minneapolis	Hennepin	**49.7**	< 2.54	< 5.08	< 2.54	< 2.54	< 2.54	< 5.08	< 5.08	< 2.54
2522	November 2006	Sewered residential	Minneapolis	Hennepin	20.4	6.64	**31**	4.78	3.11	< 2.73	< 5.77	24.4	< 2.98
2522	November 2007	Sewered residential	Minneapolis	Hennepin	11.6	4.06	13.7	< 4.81	< 4.08	< 5.60	< 5.17	6.01	< 2.59
12702	November 2006	Sewered residential	Bemidji	Beltrami	1.34	7.28	18.2	1.44	2.45	1.4	< 2.28	6.7	< 1.18
8192	November 2006	Transitional	Rice	Benton	< 2.87	< 2.39	< 5.53	< 2.51	< 2.59	< 2.59	< 5.47	< 5.53	< 2.83
12731	November 2006	Non-sewered residential	Garrison	Mille Lacs	23.4	< 1.00	< 2.30	< 1.05	< 1.22	< 1.37	< 2.28	< 2.30	< 1.18
1097	November 2006	Undeveloped	St. Cloud	Stearns	< 2.86	< 2.39	< 5.52	< 2.50	< 2.58	< 2.58	< 5.46	< 5.52	< 2.82
1099	November 2006	Commercial	St. Cloud	Stearns	5.02	< 2.52	< 5.82	< 2.64	< 2.72	< 2.72	< 5.76	< 5.82	< 2.97
8177	November 2006	Commercial	Long Praire	Todd	3.76	7.86	2.78	1.06	3.64	1.15	< 2.23	**45.7**	< 1.15
1107	November 2006	Undeveloped	Bemidji	Wadena	< 1.18	< 0.988	< 2.28	< 1.03	< 1.07	< 1.07	< 2.25	< 2.28	< 1.16
8176	November 2006	Sewered residential	Park Rapids	Wadena	< 1.21	< 1.02	< 2.34	< 1.06	< 1.10	< 1.10	< 2.32	< 2.34	< 1.20

All units are nanograms per liter (parts per trillion)
PFDA, PFUnA, PFDoA, and PFOSA were also analyzed, but were not detected in any sample
< indicates less than the detection limit. Number following the symbol represents the detection limit
Grayed detected values indicate that the detected concentration is below the Reporting Level of 25 ng/L
QA/QC of these results are in-process

[a] November 2006 samples were collected using a minimum purge protocol; Other samples were collected using a standard purge protocol

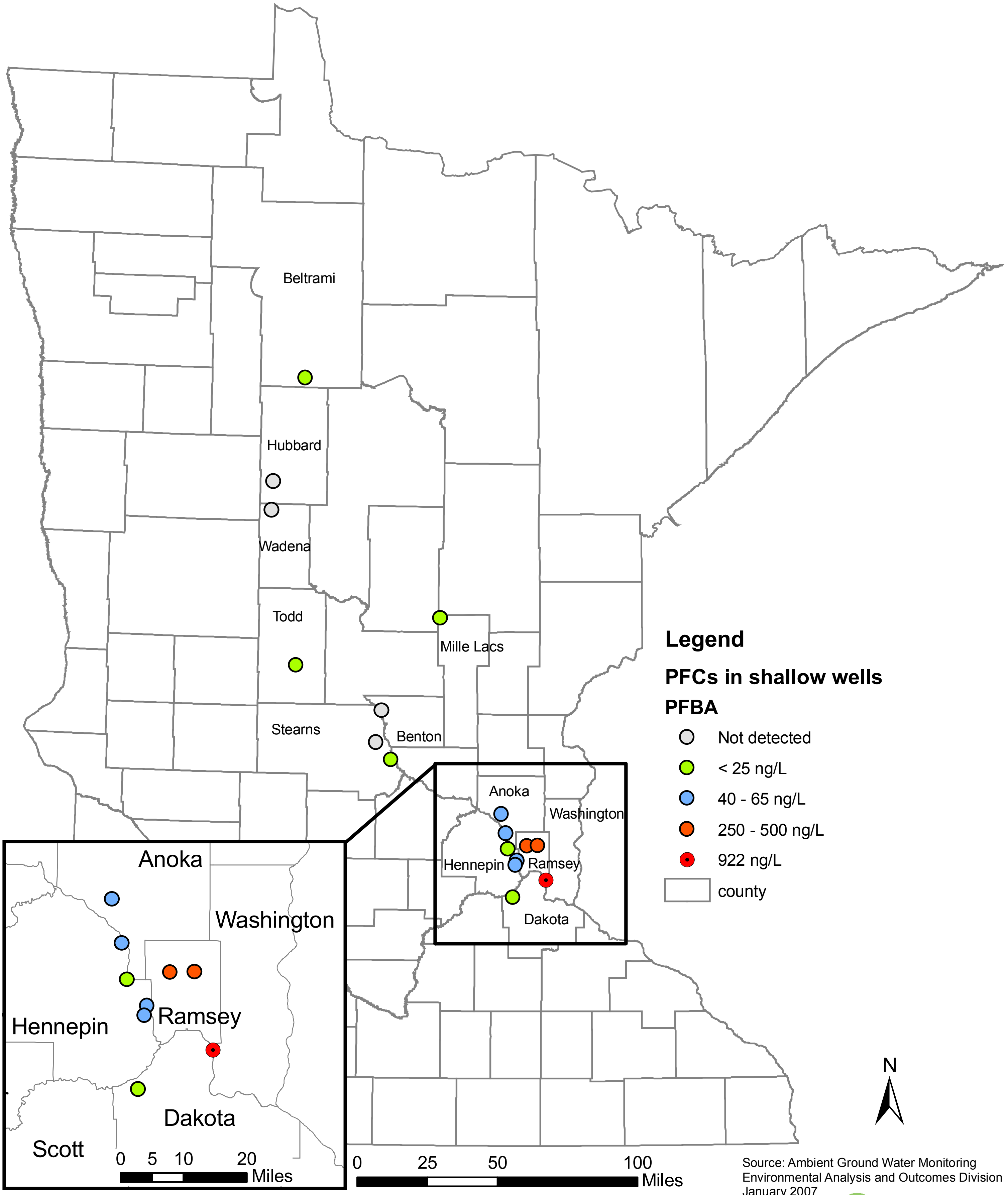
PFOA in Shallow Ground Water
November/December 2006 Sampling



Source: Ambient Ground Water Monitoring
Environmental Analysis and Outcomes Division
January 2007

Minnesota Pollution Control Agency

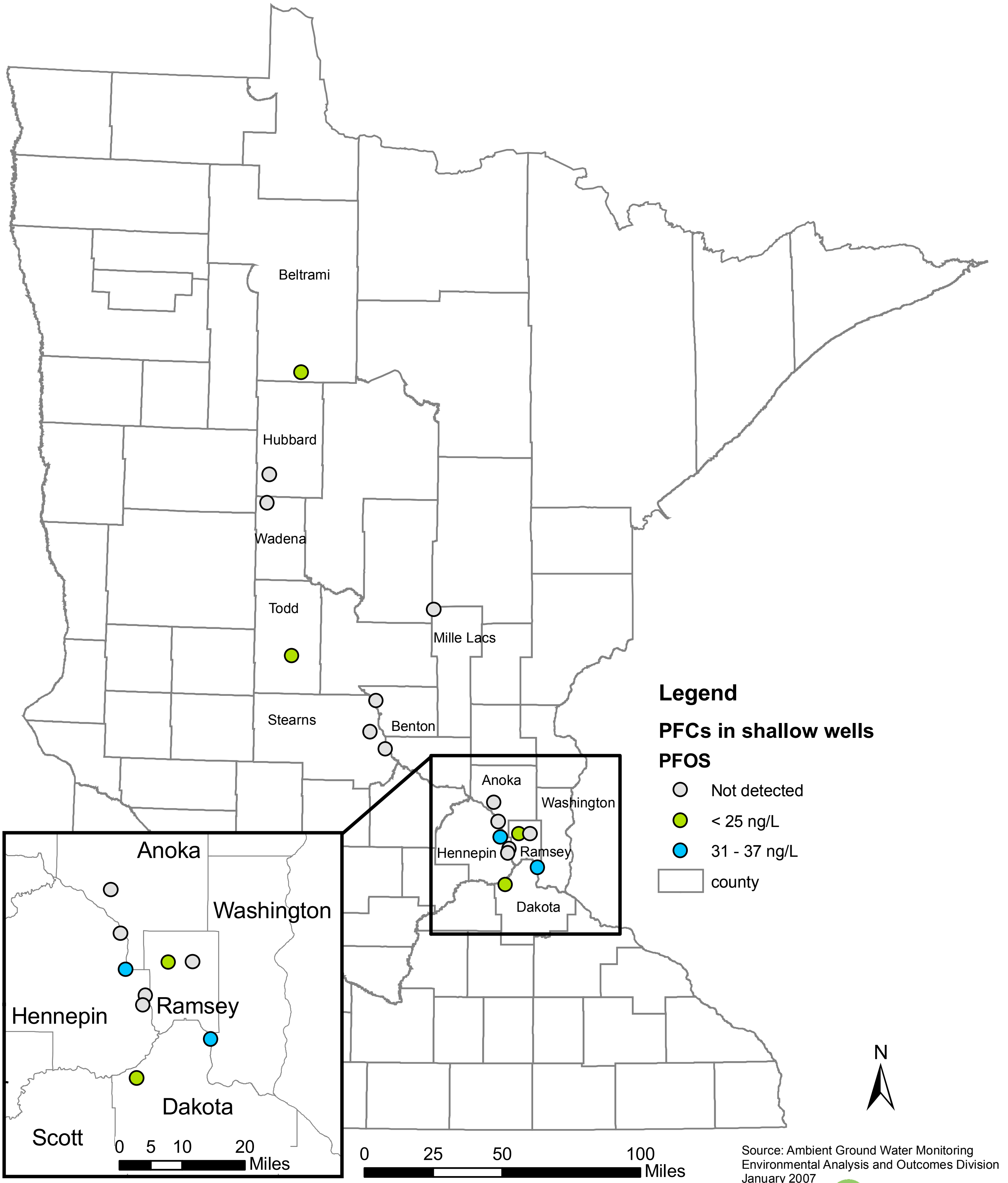
PFBA in Shallow Ground Water
November/December 2006 Sampling



Source: Ambient Ground Water Monitoring
Environmental Analysis and Outcomes Division
January 2007

Minnesota Pollution
Control Agency

PFOS in Shallow Ground Water
November/December 2006 Sampling



Source: Ambient Ground Water Monitoring
Environmental Analysis and Outcomes Division
January 2007

Minnesota Pollution Control Agency

Table A3. 2006 Surface Water Samples

				ng/L (ppt)												
	location	date	depth	PFBA	PFPeA	PFHxA	PFHpA	PFOA	PFNA	PFDA	PFUnA	PFDoA	PFBS	PFHxS	PFOS	PFOSA
St. Croix River #1	1mile North of Wildriver State Park access (Nevers Dam) and 4 miles South of Wildriver State Park access	11/8/2006	surface	3.37	< 2.54	< 2.62	< 2.62	< 2.42	< 2.86	< 2.77	< 3.24	< 2.48	< 5.54	< 5.60	< 5.60	< 2.26
St. Croix River #2		11/8/2006	surface	< 4.82	< 4.22	< 4.35	< 4.35	< 4.02	< 4.75	< 4.60	< 5.38	< 4.12	< 9.20	< 9.30	< 9.30	< 3.75
St. Croix River #3		11/8/2006	surface	5.77	< 2.52	< 2.60	< 2.60	< 2.41	< 2.84	< 2.75	< 3.22	< 2.47	< 5.51	< 5.57	< 5.57	< 2.25
Mississippi River Pool 3 #1	dock 5	11/9/2006	surface	547	31.3	16.4	4.14	32.5	< 2.94	< 2.85	< 3.33	< 2.55	47.3	26.5	19	< 2.33
Mississippi River Pool 3 #2	Kings Cove - mid channel	11/9/2006	surface	412	29.5	15.8	4.76	31.4	< 2.94	< 2.84	< 3.33	< 2.55	55.2	27.1	23.1	< 2.32
Mississippi River Pool 3 #3	Kings Cove - lower	11/9/2006	surface	192	24	14.7	3.3	27.3	< 2.95	< 2.86	< 3.35	< 2.56	67.1	17.7	37.8	< 2.33
Calhoun (Hennepin) #1	north	11/15/2006	surface	25.4	5.07	4.35	3.3	18.1	< 2.81	< 2.72	< 3.18	< 2.44	< 5.44	< 5.50	105	< 2.22
Calhoun (Hennepin) #2	middle	11/15/2006	surface	24.2	4.43	4.41	3.72	20.5	< 2.86	< 2.77	< 3.24	< 2.48	< 5.54	< 5.60	115	2.57
Calhoun (Hennepin) #3	south	11/15/2006	surface	26.7	< 4.59	5.25	3.57	20.7	< 2.84	< 2.75	< 3.22	< 2.47	< 5.51	< 5.57	104	< 2.25
	Lake ID															
Tettegouche (Lake) A	38-0231	11/9/2006	surface	< 11.2	< 1.49	< 1.08	< 1.08	1.42	1.32	< 1.14	< 1.34	< 1.02	< 2.28	< 2.31	< 2.31	< 0.932
Tettegouche (Lake) B	38-0231	11/9/2006	12"	< 6.48	< 1.02	< 1.24	< 1.16	1.19	< 1.15	< 1.11	< 1.30	< 0.994	< 2.22	< 2.24	< 2.24	< 0.906
Dyers (Cook)	16-0634	11/9/2006	surface	< 4.88	< 1.36	< 1.02	< 1.76	< 0.947	< 1.12	< 1.08	< 1.26	< 0.967	< 2.16	< 2.18	< 2.18	< 0.881
Long Lake (Kandiyohi)	34-0066	11/8/2006	surface	10.3	< 1.04	< 1.07	< 1.07	< 0.992	< 1.17	< 1.13	< 1.32	< 1.01	< 2.26	< 2.29	< 2.29	< 0.922
Sagatagan (Sterns) A	73-0092	11/8/2006	surface	11.7	< 1.70	< 1.10	1.34	1.85	< 1.20	< 1.17	< 1.36	< 1.04	< 2.33	< 2.36	< 2.36	< 0.952
Sagatagan (Sterns) B	73-0092	11/8/2006	12"	15.2	< 1.04	< 1.07	< 1.07	1.39	< 1.17	< 1.14	< 1.33	< 1.02	< 2.27	< 2.30	< 2.30	< 0.926
Long Lake (Itasca)	31-0570	11/9/2006	surface	11.3	< 1.02	< 1.05	< 1.05	0.988	< 1.15	< 1.11	< 1.30	< 0.998	< 2.23	< 2.25	< 2.25	< 0.909

Table A4. 2007 Brainerd Area Mississippi River Surface Water Samples

Sample ID	Collection Date	Collection Time	Site Description	Lat	Lon	PFOS	PFOA	PFBA	PFBS	PFPeA	PFHxA	PFHpA	PFNA	PFDA	PFUnA	PFDoA	PFHxS	PFOSA
BR101707-01	10/17/2007	14:12	above paper plant	46.38189	94.17927	< 9.87	< 4.94	6.29	< 9.87	< 4.94	< 4.94	< 5.36	< 4.94	< 4.94	< 4.94	< 4.94	< 9.87	< 4.94
BR101707-02	10/17/2007	14.14	above paper plant (dup)	46.38189	94.17927	< 5.04	< 2.52	5.37	< 5.04	< 2.52	< 2.52	< 4.41	< 2.52	< 2.52	< 2.52	< 2.52	< 5.04	< 2.52
BR101707-03	10/17/2007	16:15	monitoring station S002-640	46.34826	94.20765	< 4.97	< 2.49	5.43	< 4.97	< 4.75	< 2.76	< 2.87	< 2.49	< 2.49	< 2.49	< 2.49	< 4.97	< 2.49
BR101707-04	10/17/2007	16:16	monitoring station S002-640 (dup)	46.34826	94.20765	< 4.94	< 2.47	4.45	< 4.94	< 2.47	< 2.68	< 3.07	< 2.47	< 2.47	< 2.47	< 2.47	< 4.94	< 2.47
BR101707-05	10/17/2007	16:00	at WWTP discharge	46.33363	94.23067	93.6	5.67	4.35	20.2	< 4.15	3.56	< 2.61	2.58	< 2.51	< 2.51	< 2.51	< 5.02	< 2.51
BR101707-06	10/17/2007	16:01	at WWTP discharge (dup)	46.33363	94.23067	102	4.99	5.55	26	< 3.53	4.49	< 2.95	3.07	< 2.54	< 2.54	< 2.54	< 5.09	< 2.54
BR101707-07	10/17/2007	15:53	below WWTP discharge	46.33114	94.23488	< 5.06	< 2.53	3.9	< 5.06	< 2.88	< 2.53	< 3.40	< 2.53	< 2.53	< 2.53	< 2.53	< 5.06	< 2.53
BR101707-08	10/17/2007	15:55	below WWTP discharge (dup)	46.33114	94.23488	< 5.10	< 2.55	6.97	< 5.10	< 2.73	< 2.55	< 2.55	< 2.55	< 2.55	< 2.55	< 2.55	< 5.10	< 2.55
BR101707-09			Trip Blank			< 4.97	< 2.49	< 2.49	< 4.97	< 2.49	< 2.49	< 2.49	< 2.49	< 2.49	< 2.49	< 2.49	< 4.97	< 2.49

Table A5. Mississippi River Surface Water Samples, June 2008

all samples collected at approximately 12 inches below surface

	ng/L (ppt)												
	PFBA	**PFPeA**	**PFHxA**	**PFHpA**	**PFOA**	**PFNA**	**PFDA**	**PFUnA**	**PFDoA**	**PFBS**	**PFHxS**	**PFOS**	**PFOSA**
Pool 3	23.1	3.99	3.6	3.56	5.95	< 2.53	< 2.53	< 2.53	< 2.53	< 5.06	< 5.06	5.32	< 2.53
Pool 3	24.1	< 4.06	5.22	< 2.96	6.34	< 2.66	< 2.56	< 2.56	< 2.56	< 5.11	6.6	6.44	< 2.56
Pool 3	26.1	< 3.17	4.22	3.47	11	< 2.45	< 2.45	< 2.45	< 2.45	< 4.89	5.31	5.82	< 2.45
Pool 3	33.5	< 4.03	4.82	3.37	8.62	< 2.92	< 2.51	< 2.51	< 2.51	< 5.01	6.52	6.95	< 2.51
Pool 3	36.1	7.18	5.43	< 4.80	8.96	< 4.80	< 4.80	< 4.80	< 4.80	< 9.61	< 9.61	< 9.61	< 4.80
Pool 3	35.4	5.97	4.26	< 2.81	8.79	< 2.41	< 2.41	< 2.41	< 2.41	< 4.82	< 4.82	5.98	< 2.41
Pool 3	31.6	< 2.51	4.18	< 2.51	10.1	< 2.51	< 2.51	< 2.51	< 2.51	< 5.02	5.55	5.66	< 2.51
Pool 3	15.2	< 3.65	3.79	< 2.60	3	< 2.49	< 2.49	< 2.49	< 2.49	< 4.98	< 4.98	< 4.98	< 2.49
Pool 3	14.7	< 3.77	< 2.62	< 2.68	5.18	< 2.50	< 2.50	< 2.50	< 2.50	< 5.01	< 5.01	6.11	< 2.50
Pool 3	12.4	< 2.47	< 2.47	< 2.58	3.93	< 2.47	< 2.47	< 2.47	< 2.47	< 4.94	5.04	4.95	< 2.47
Pool 3	9.7	< 2.50	3.11	< 2.50	3.19	< 2.50	< 2.50	< 2.50	< 2.50	< 5.00	< 5.00	6.75	< 2.50
Pool 2	8.06	< 2.76	3	< 2.50	4.24	< 3.50	< 2.50	< 2.50	< 2.50	< 4.99	< 4.99	< 4.99	< 2.50
Pool 2	8.44	< 5.84	< 2.47	3.58	3.96	< 3.10	< 2.47	< 2.47	< 2.47	< 4.94	< 4.94	< 4.94	< 2.47
Pool 2	6.38	< 2.47	3.09	< 3.03	< 2.47	< 2.47	< 2.47	< 2.47	< 2.47	< 4.94	< 4.94	< 4.94	< 2.47
Pool 2	14.7	< 2.44	4.72	< 2.44	5.86	< 2.44	< 2.44	< 2.44	< 2.44	< 4.88	< 4.88	< 4.88	< 2.44
Pool 2	11.2	< 4.90	5.62	< 4.90	< 4.90	< 4.90	< 4.90	< 4.90	< 4.90	< 9.79	< 9.79	< 9.79	< 4.90
Pool 2	12.3	< 2.47	4.12	< 2.47	3.2	< 2.47	< 2.47	< 2.47	< 2.47	< 4.95	< 4.95	< 4.95	< 2.47
Pool 2	12.3	< 2.88	4.5	< 2.72	3.73	< 2.52	< 2.52	< 2.52	< 2.52	< 5.05	< 5.05	< 5.05	< 2.52
Pool 2	10	< 2.55	< 2.55	< 2.55	3.44	< 2.55	< 2.55	< 2.55	< 2.55	< 5.10	< 5.10	< 5.10	< 2.55
Pool 2	16.7	< 2.47	2.53	< 2.47	5.11	< 2.47	< 2.47	< 2.47	< 2.47	< 4.94	< 4.94	< 4.94	< 2.47
Pool 2	14.5	< 2.48	2.59	< 2.48	3.68	< 2.48	< 2.48	< 2.48	< 2.48	< 4.96	< 4.96	< 4.96	< 2.48
Pool 2	14.6	< 2.42	5.23	< 2.42	4.18	< 2.42	< 2.42	< 2.42	< 2.42	< 4.83	< 4.83	< 4.83	< 2.42

Table A6. 2008 Surface Water

	Cty Rd 9 Drainage Ditch							Rice Lake							Fish Lake						
	ng/L (ppt)							ng/L (ppt)							ng/L (ppt)						
	1	2	3	**avg**	**median**	**min**	**max**	1	2	3	**avg**	**median**	**min**	**max**	1	2	3	**avg**	**median**	**min**	**max**
PFBA	18.6	15.3	14.1	16.0	15.3	14.1	18.6	12.9	12.1	10.9	12.0	12.1	10.9	12.9	3.46	3.81	3.74	3.7	3.7	3.5	3.8
PFPeA	24	25.7	26.9	25.5	25.7	24	26.9	16.5	18.5	18.3	17.8	18.3	16.5	18.5	< 4.20	< 2.53	< 2.55	<dl	<dl	<dl	<dl
PFHxA	81.6	80.5	76.3	79.5	80.5	76.3	81.6	43.2	56.6	54	51.3	54.0	43.2	56.6	5.2	4.82	4.56	4.9	4.8	4.6	5.2
PFHpA	18.7	19.7	19	19.1	19	18.7	19.7	15	17.9	15.2	16.0	15.2	15.0	17.9	< 5.96	< 7.60	< 6.09	<dl	<dl	<dl	<dl
PFOA	59	56.5	48.1	54.5	56.5	48.1	59	38.2	38.8	42	39.7	38.8	38.2	42.0	4.6	3.67	4.23	4.2	4.2	3.7	4.6
PFNA	< 2.54	3.06	< 5.04	3.1	3.06	3.06	3.06	< 2.54	< 2.49	< 2.53	<dl	<dl	<dl	<dl	< 2.53	< 2.53	< 2.55	<dl	<dl	<dl	<dl
PFDA	< 2.54	< 2.49	< 5.04	<dl	<dl	<dl	<dl	< 2.54	< 2.49	< 2.53	<dl	<dl	<dl	<dl	< 2.53	< 2.53	< 2.55	<dl	<dl	<dl	<dl
PFUnA	< 2.54	< 2.49	< 5.04	<dl	<dl	<dl	<dl	< 2.54	< 2.49	< 2.53	<dl	<dl	<dl	<dl	< 2.53	< 2.53	< 2.55	<dl	<dl	<dl	<dl
PFDoA	< 2.54	< 2.49	< 5.04	<dl	<dl	<dl	<dl	< 2.54	< 2.49	< 2.53	<dl	<dl	<dl	<dl	< 2.53	< 2.53	< 2.55	<dl	<dl	<dl	<dl
PFBS	37	42.9	48.4	42.8	42.9	37	48.4	28.6	27.5	27.3	27.8	27.5	27.3	28.6	< 5.06	< 5.06	< 5.10	<dl	<dl	<dl	<dl
PFHxS	353	384	363	367	363	353	384	236	255	253	248	253	236	255	15.1	17.6	17.3	16.7	17.3	15.1	17.6
PFOS	132	140	102	125	132	102	140	110	108	122	113	110	108	122	19.7	9.78	8.84	12.8	9.8	8.8	19.7
PFOSA	< 2.54	< 2.49	< 5.04	<dl	<dl	<dl	<dl	< 2.54	< 2.49	< 2.53	<dl	<dl	<dl	<dl	< 2.53	< 2.53	< 2.55	<dl	<dl	<dl	<dl

Table A7. Mississippi and Minnesota River water samples collected for PFC analysis, April 2008

Note: data from other rivers (Elk and Snake rivers are tributaries of the Mississippi; MN-16 is removed from the watersheds)

Site Description	estimated value								ng/L (ppt)						
Minnesota	**Collection Date**	**Collection Time**	**PFBA**	**PFPeA**	**PFHxA**	**PFHpA**	**PFOA**	**PFNA**	**PFDA**	**PFUnA**	**PFDoA**	**PFBS**	**PFHxS**	**PFOS**	**PFOSA**
Mississippi River: County Road 7 near Bemidji, MN	4/29/2008	7:38	< 2.58	< 3.69	< 2.58	< 2.58	< 2.58	< 2.58	< 2.58	< 2.58	< 2.58	< 5.15	< 5.15	< 5.15	< 2.58
Mississippi River: State Hwy 197 in Bemidji, MN	4/29/2008	8:25	< 3.39	< 4.66	< 2.57	< 2.57	< 2.57	< 2.57	< 2.57	< 2.57	< 2.57	< 5.13	< 5.13	< 5.13	< 2.57
Mississippi River: Grand Rapids, MN	4/29/2008	10:45	6.57	< 3.58	< 2.52	< 2.52	< 2.52	3.18	< 2.52	< 2.52	< 2.52	< 5.03	< 5.03	< 5.03	< 2.52
Mississippi River: Grand Rapids, MN (dup)	4/29/2008	10:46	< 3.80	< 3.73	< 2.55	< 2.55	< 2.55	< 2.55	< 2.55	< 2.55	< 2.55	< 5.10	< 5.10	< 5.10	< 2.55
Mississippi River: County Hwy 1 in Aitkin, MN	4/29/2008	12:58	< 3.77	< 3.32	< 2.47	< 3.52	< 2.47	< 2.47	< 2.47	< 2.47	< 2.47	< 4.94	< 4.94	< 4.94	< 2.47
Mississippi River: above paper plant in Brainerd, MN	4/29/2008	15:05	5.42	< 3.43	< 2.58	< 4.99	< 2.58	< 2.58	< 2.58	< 2.58	< 2.58	< 5.15	< 5.15	< 5.15	< 2.58
Mississippi River: boat landing below paper plant in Brainerd, MN	4/29/2008	16:05	< 3.35	< 3.51	< 2.53	< 2.53	< 2.53	< 2.53	< 2.53	< 2.53	< 2.53	< 5.06	< 5.06	< 5.06	< 2.53
Mississippi River: park dock near monitoring station S002-640 in Brainerd, MN	4/29/2008	16:45	6.7	< 4.63	< 2.54	< 2.73	< 2.54	< 2.54	< 2.54	< 2.54	< 2.54	< 5.09	< 5.09	< 5.09	< 2.54
Mississippi River: near Fort Ripley, MN	4/30/2008	7:37	5.34	< 5.68	< 5.07	< 4.84	< 4.97	< 2.50	< 2.50	< 2.50	< 2.50	< 5.01	< 5.01	< 5.01	< 2.50
Mississippi River: downstream of Platte River near Rice, MN	4/30/2008	8:48	3.95	< 3.04	< 2.56	< 4.85	< 4.97	< 2.56	< 2.56	< 2.56	< 2.56	< 5.12	< 5.12	< 5.12	< 2.56
Mississippi River: at Sauk Rapids, MN	4/30/2008	9:34	6.87	< 5.36	< 6.37	< 5.15	< 7.13	< 7.80	< 2.54	< 2.54	< 2.54	< 5.08	< 5.08	< 5.08	< 2.54
Mississippi River: near Clearwater, MN, downstream of St. Cloud WWTP	4/30/2008	10:20	4.23	< 3.90	< 3.84	< 5.77	< 2.80	< 2.59	< 2.59	< 2.59	< 2.59	< 5.18	< 5.18	< 5.18	< 2.59
Mississippi River: near Clearwater, MN, downstream of St. Cloud WWTP (dup)	4/30/2008	10:21	7.07	< 6.88	< 2.54	< 3.38	< 2.54	< 6.72	< 2.54	< 2.54	< 2.54	< 5.07	< 5.07	< 5.07	< 2.54
Elk River: north of Clear Lake – junction cty #20 & #16	4/30/2008	11:15	6.57	< 5.11	< 7.54	< 5.06	< 4.11	< 7.38	< 2.50	< 2.50	< 2.50	< 4.99	< 4.99	< 4.99	< 2.50
Snake River: near Mora, MN – boat landing on cty #6	4/30/2008	12:50	4.1	< 3.20	< 5.90	< 5.82	< 2.52	< 2.52	< 2.52	< 2.52	< 2.52	< 5.04	< 5.04	< 5.04	< 2.52
Creek to Rice Lake: near Duluth, MN – cty #9 crossing	4/30/2008	16:05	< 5.16	11.9	31.3	16.2	36.4	< 5.51	< 5.16	< 5.16	< 5.16	16.2	168	58.2	< 5.16
Rum River: just above the confluence with Miss. River	5/9/2008	17:30	8.31	< 3.56	< 2.53	< 4.26	< 2.53	< 2.53	< 2.53	< 2.53	< 2.53	< 5.06	< 5.06	< 5.06	< 2.53
Mississippi River: Elk River	5/9/2008	18:00	6.14	< 2.49	< 2.58	< 3.49	< 2.49	< 5.65	< 2.49	< 2.49	< 2.49	< 4.98	< 4.98	< 4.98	< 2.49
Mississippi River: Brooklyn Park	5/9/2008	4:30	< 4.83	< 6.61	< 4.83	< 6.39	< 4.83	< 4.83	< 4.83	< 4.83	< 4.83	< 9.66	< 9.66	< 9.66	< 4.83
Mississippi River: Hidden Falls, above Minn River	5/9/2008	1:30	5.51	< 3.51	< 2.46	< 4.03	< 2.46	< 2.46	< 2.46	< 2.46	< 2.46	< 4.93	< 4.93	< 4.93	< 2.46
Minnesota River: at Fort Snelling before confluence	5/9/2008	12:30	3.41	< 2.51	< 2.51	< 4.33	< 2.51	< 2.51	< 2.51	< 2.51	< 2.51	< 5.03	< 5.03	< 5.03	< 2.51
Minnesota River: at Fort Snelling before confluence (dup)	5/9/2008	12:30	< 2.57	< 2.57	< 2.57	< 2.57	< 2.57	< 2.57	< 2.57	< 2.57	< 2.57	< 5.14	< 5.14	< 5.14	< 2.57
Mississippi River: St. Paul, 494 Bridge below WWTP	5/9/2008	11:30	6.89	< 6.91	< 2.51	< 6.85	< 2.51	< 3.92	< 2.51	< 2.51	< 2.51	< 5.02	< 5.02	< 5.02	< 2.51
Mississippi River: St. Paul, 494 Bridge below WWTP (dup)	5/9/2008	11:30	3.64	< 2.52	< 2.52	< 2.92	< 2.52	< 3.60	< 2.52	< 2.52	< 2.52	< 5.05	< 5.05	< 5.05	< 2.52
Mississippi River: Nininger, above 3M	5/9/2008	10:30	9.64	< 6.98	< 2.49	< 5.16	2.79	< 2.49	< 2.49	< 2.49	< 2.49	< 4.98	< 4.98	< 4.98	< 2.49
Mississippi River: Nininger, above 3M (dup)	5/9/2008	10:30	6.11	< 3.09	< 2.54	< 5.16	< 2.54	< 3.28	< 2.54	< 2.54	< 2.54	< 5.07	< 5.07	< 5.07	< 2.54
Mississippi River: Hastings below 3M	5/9/2008	9:30	13.5	< 2.92	< 2.57	< 4.87	2.8	< 2.57	< 2.57	< 2.57	< 2.57	< 5.13	< 5.13	5.23	< 2.57
Mississippi River: Hastings below 3M (dup)	5/9/2008	9:30	11.3	< 2.49	< 2.49	< 4.83	3.75	< 3.45	< 2.49	< 2.49	< 2.49	< 4.98	< 4.98	< 4.98	< 2.49
Minnesota River: Ortonville	5/7/2008	13:30	5.47	< 2.69	< 2.54	< 2.89	< 2.54	< 3.08	< 2.54	< 2.54	< 2.54	< 5.07	< 5.07	5.16	< 2.54
Minnesota River: Granite Falls	5/7/2008	10:00	4.4	< 2.84	< 2.48	< 3.30	< 2.48	< 5.04	< 2.48	< 2.48	< 2.48	< 4.97	< 4.97	< 4.97	< 2.48
Minnesota River: Mankato, above Blue Earth	5/6/2008	4:30	2.72	< 3.40	< 2.52	< 3.24	< 2.52	< 3.15	< 2.52	< 2.52	< 2.52	< 5.05	< 5.05	< 5.05	< 2.52
Minnesota River: Mankato, downriver of Blue Earth	5/6/2008	3:30	< 2.48	< 2.48	< 2.48	< 3.82	< 2.48	< 2.48	< 2.48	< 2.48	< 2.48	< 4.96	< 4.96	< 4.96	< 2.48
Minnesota River: Mankato, downriver of Blue Earth (dup)	5/6/2008	3:30	3.05	< 6.85	< 2.53	< 3.43	< 2.53	< 2.53	< 2.53	< 2.53	< 2.53	< 5.06	< 5.06	< 5.06	< 2.53
Minnesota River: Downriver of Seven Mile Creek	5/6/2008	2:30	3.39	< 2.49	< 2.49	< 2.92	< 2.49	< 2.49	< 2.49	< 2.49	< 2.49	< 4.98	< 4.98	< 4.98	< 2.49

Table A8. Mississippi and Minnesota River water samples collected for PFC analysis, August 2008

estimated value

Minnesota

Site Description	Collection Date	Collection Time	PFBA	PFPeA	PFHxA	PFHpA	PFOA	PFNA	PFDA	PFUnA	PFDoA	PFBS	PFHxS	PFOS	PFOSA
Mississippi River: County Road 7 near Bemidji, MN	8/18/2008	17:02	2.62	< 2.48	< 2.48	< 3.29	< 2.48	3.01	< 2.48	< 2.48	< 2.48	< 4.96	< 4.96	< 4.96	< 2.48
Mississippi River: State Hwy 197 in Bemidji, MN	8/18/2008	17:30	3.29	< 2.51	< 2.51	< 2.51	2.62	< 2.51	< 2.51	< 2.51	< 2.51	< 5.03	< 5.03	< 5.03	< 2.51
Mississippi River: Grand Rapids, MN	8/19/2008	8:45	3.94	< 2.53	< 2.53	< 2.53	< 2.53	< 2.53	< 2.53	< 2.53	< 2.53	< 5.06	< 5.06	< 5.06	< 2.53
Mississippi River: Grand Rapids, MN (dup)	8/19/2008	8:46	3.56	< 2.50	< 2.50	< 2.50	< 2.50	< 2.50	< 2.50	< 2.50	< 2.50	< 5.01	< 5.01	< 5.01	< 2.50
Mississippi River: County Hwy 1 in Aitkin, MN	8/19/2008	11:15	4.83	< 2.49	< 2.49	< 2.49	< 2.49	< 2.49	< 2.49	< 2.49	< 2.49	< 4.97	< 4.97	< 4.97	< 2.49
Mississippi River: above paper plant in Brainerd, MN	8/19/2008	12:40	3.52	< 2.56	< 2.56	< 2.56	< 2.56	4.24	< 2.56	< 2.56	< 2.56	< 5.12	< 5.12	< 5.12	< 2.56
Mississippi River: near paper plant in Brainerd, MN	8/19/2008	14:15	4.73	< 2.47	< 2.47	< 2.47	< 2.47	< 2.47	< 2.47	< 2.47	< 2.47	< 4.94	< 4.94	< 4.94	< 2.47
Mississippi River: monitoring station S002-640 in Brainerd, MN	8/19/2008	15:02	4.36	< 2.49	< 2.49	< 2.49	< 2.49	< 2.49	< 2.49	< 2.49	< 2.49	< 4.97	< 4.97	< 4.97	< 2.49
Mississippi River: at WWTP discharge in Brainerd, MN	8/19/2008	15:47	5.28	< 4.92	< 4.92	< 4.92	9.5	7.19	< 4.92	< 4.92	< 4.92	83	< 9.84	151	< 4.92
Mississippi River: at WWTP discharge in Brainerd, MN (dup)	8/19/2008	15:48	6.07	< 2.47	3.35	< 2.47	4.42	5.88	< 2.47	< 2.47	< 2.47	87.8	< 4.94	170	< 2.47
Mississippi River: below WWTP discharge in Brainerd, MN	8/19/2008	15:58	4.96	< 2.50	< 2.50	< 2.50	< 2.50	3.01	< 2.50	< 2.50	< 2.50	< 4.99	< 4.99	< 4.99	< 2.50
Mississippi River: below WWTP discharge in Brainerd, MN (dup)	8/19/2008	15:59	4.4	< 2.50	< 2.50	< 2.50	< 2.50	< 2.50	< 2.50	< 2.50	< 2.50	< 5.01	< 5.01	< 5.01	< 2.50
Mississippi River: near Fort Ripley, MN	8/19/2008	18:00	3.51	< 2.50	< 2.50	< 2.50	< 2.50	4.19	< 2.50	< 2.50	< 2.50	< 5.00	< 5.00	< 5.00	< 2.50
Mississippi River: downstream of Platte River near Rice, MN	8/20/2008	8:06	3.65	< 2.48	< 2.48	< 2.48	< 2.48	2.65	< 2.48	< 2.48	< 2.48	< 4.96	< 4.96	< 4.96	< 2.48
Mississippi River: at Sauk Rapids, MN	8/20/2008	9:15	5.48	< 2.50	< 2.50	< 2.50	< 2.50	3.92	< 2.50	< 2.50	< 2.50	< 4.99	< 4.99	< 4.99	< 2.50
Mississippi River near Clearwater, downstream of St. Cloud WWTP	8/20/2008	10:40	3.9	< 2.48	< 2.48	< 2.48	2.5	< 2.48	< 2.48	< 2.48	< 2.48	< 4.96	< 4.96	< 4.96	< 2.48
Mississippi River near Clearwater, downstream of St. Cloud WWTP (dup)	8/20/2008	10:41	5.1	< 2.48	< 2.48	< 2.48	< 2.48	2.79	< 2.48	< 2.48	< 2.48	< 4.96	< 4.96	< 4.96	< 2.48

Site Description	Collection Date	Collection Time	PFBA	PFPeA	PFHxA	PFHpA	PFOA	PFNA	PFDA	PFUnA	PFDoA	PFBS	PFHxS	PFOS	PFOSA
Mississippi River: Elk River	8/19/2008		11.1	< 2.50	< 2.50	< 2.50	2.97	< 2.50	< 2.50	< 2.50	< 2.50	< 5.01	< 5.01	< 5.01	< 2.50
Rum River: just above the confluence with Miss. River	8/19/2008	16:43	7.2	< 2.52	< 2.52	< 2.52	< 2.52	< 2.52	< 2.52	< 2.52	< 2.52	< 5.04	< 5.04	< 5.04	< 2.52
Mississippi River: Brooklyn Park	8/19/2008	10:04	8.15	< 2.52	< 2.52	3.98	2.54	< 2.52	< 2.52	< 2.52	< 2.52	< 5.03	< 5.03	< 5.03	< 2.52
Mississippi River: Hidden Falls, above Minn River	8/19/2008	14:36	10.2	< 2.50	2.58	3.87	7.66	< 2.50	< 2.50	< 2.50	< 2.50	< 4.99	< 4.99	< 4.99	< 2.50
Minnesota River: at Fort Snelling before confluence	8/19/2008	13:57	6.64	< 2.54	3.18	< 2.54	4.5	< 2.54	< 2.54	< 2.54	< 2.54	< 5.08	< 5.08	< 5.08	< 2.54
Minnesota River: at Fort Snelling before confluence (dup)	8/19/2008	13:57	5.94	2.84	2.72	< 2.58	4.02	< 2.58	< 2.58	< 2.58	< 2.58	< 5.15	< 5.15	< 5.15	< 2.58
Mississippi River: St. Paul, 494 Bridge below WWTP	8/19/2008	11:56	14.2	< 2.53	4.96	3.81	7.19	< 2.53	< 2.53	< 2.53	< 2.53	< 5.06	< 5.06	6.02	< 2.53
Mississippi River: St. Paul, 494 Bridge below WWTP (dup)	8/19/2008	11:56	15.3	3	6.03	2.72	7.25	< 2.61	< 2.61	< 2.61	< 2.61	< 5.22	< 5.22	6.2	< 2.61
Mississippi River: Nininger, above 3M	8/19/2008	10:48	23.2	3.69	6.29	4.42	8.55	< 2.57	< 2.57	< 2.57	< 2.57	< 5.15	< 5.15	7.95	< 2.57
Mississippi River: Nininger, above 3M (dup)	8/19/2008	10:48	21.1	3.41	4.87	3.18	8	< 2.54	< 2.54	< 2.54	< 2.54	5.61	< 5.07	8.13	< 2.54
Mississippi River: Hastings below 3M	8/19/2008	10:00	69.9	4.68	8.12	4.15	19.3	< 2.55	< 2.55	< 2.55	< 2.55	13.4	9.36	17.7	< 2.55
Mississippi River: Hastings below 3M (dup)	8/19/2008	10:00	63.9	7.1	8.44	3.19	19.6	< 2.58	< 2.58	< 2.58	< 2.58	13.6	9.87	16.7	< 2.58
Minnesota River: Ortonville	8/22/2008	10:50	3.01	< 2.54	< 2.54	< 2.54	< 2.54	< 2.54	< 2.54	< 2.54	< 2.54	< 5.08	< 5.08	< 5.08	< 2.54
Minnesota River: Granite Falls	8/22/2008	9:00	3.37	< 2.55	< 2.55	< 2.55	< 2.55	< 2.55	< 2.55	< 2.55	< 2.55	< 5.10	< 5.10	< 5.10	< 2.55
Minnesota River: Mankato, above Blue Earth	8/21/2008	12:00	2.82	< 2.49	< 2.49	< 2.49	< 2.49	< 2.49	< 2.49	< 2.49	< 2.49	< 4.98	< 4.98	< 4.98	< 2.49
Minnesota River: Mankato, downriver of Blue Earth	8/21/2008	12:05	< 2.55	< 2.55	< 2.55	< 2.55	< 2.55	< 2.55	< 2.55	< 2.55	< 2.55	< 5.10	< 5.10	< 5.10	< 2.55
Minnesota River: Downriver of Blue Earth (dup)	8/21/2008	11:20	< 2.54	< 2.54	< 2.54	< 2.54	< 2.54	< 2.54	< 2.54	< 2.54	< 2.54	< 5.09	< 5.09	< 5.09	< 2.54
Minnesota River: Downriver of Seven Mile Creek	8/21/2008	11:20	< 5.17	< 5.17	< 5.17	< 5.17	< 5.17	< 5.17	< 5.17	< 5.17	< 5.17	< 10.3	< 10.3	< 10.3	< 5.17

2005 MPCA PFC Fish Data

Mississippi River Pool 2 Fish PFC analysis

MPCA Species & Sample ID #	Sample Date	Analyzed as Fillet or Whole Fish	Wt (g)	Ln (cm)	Age/ sex (yrs/ m-f)	PFOA ng/g (ppb)	PFOS ng/g (ppb)	PFOSA ng/g (ppb)	PFPeA ng/g (ppb)	PFDA ng/g (ppb)	PFUnA ng/g (ppb)	PFDoA ng/g (ppb)
Walleye												
WE-1	10/3/05	Fillet	3275	70	7/m	<0.581	13.1	1.35	<1.42	<0.644	<0.572	<0.682
WE-2	10/3/05	Fillet	1079	54	3/f	<0.614	75.5	3.61	<1.79	0.789	<0.604	1.21
WE-3	10/3/05	Fillet	1230	49	2/f	<0.591	180	26.4	<1.44	1.67	<0.581	1.03
WE-4	10/3/05	Fillet	3125	70	7/f	<0.538	45.5	3.35	<1.31	1.43	<0.529	<0.631
Carp												
Carp-1	10/3/05	Fillet	1771	53	4/m	1.24	347	21.4	<5.96	3.85	2.19	3.01
Carp-2	10/3/05	Fillet	2532	55	5/f	<0.602	73.5	<0.572	<5.87	1.26	<0.592	<0.706
Carp-3	10/3/05	Fillet	2416	57	5/m	<0.590	175	2.02	5.76	2.16	0.992	<0.693
Carp-4	10/3/05	Fillet	4675	61	6/f	<0.608	420	7.67	<5.93	4.06	1.36	0.957
Carp-5	10/3/05	Fillet	5175	62	6/f	<0.605	66.4	0.908	<5.90	1.68	0.803	<0.710
SM Bass												
SMB-1	10/3/05	Fillet	285	26	5/m	<0.619	269	34.1	<1.51	4.4	3.38	8.35
SMB-2	10/3/05	Fillet	252	26	4/m	<0.596	336	22.7	<1.45	5.05	3.36	6.03
SMB-3	10/3/05	Fillet	165	22	4/f	<0.607	167	6.77	<1.48	4.33	3.5	4
SMB-4	10/3/05	Fillet	303	28	5/m	<0.615	158	20.4	<1.50	3.4	2.47	3.81
SMB-5	10/3/05	Fillet	135	22	4/f	<0.591	122	6.16	<1.44	2.75	2.33	3.71
SMB-6	10/3/05	Fillet	215	26	4/f	<0.578	156	8.43	<1.41	3.79	3.17	5.17
White Bass												
WB-1	10/3/05	Fillet	416	31	2/f	<0.609	510	8.43	<1.48	6.55	3.08	2.31
WB-2	10/3/05	Fillet	780	37	4/f	<0.600	102	2.75	<1.83	2.6	<0.591	<0.705
WB-3	10/3/05	Fillet	441	32	2/f	<0.605	240	3.28	<1.48	3.88	1.71	1.27
WB-4	10/3/05	Fillet	219	24	1/f	1.17	1860	166	<1.53	17.5	9.07	11.1
WB-5	10/3/05	Fillet	665	38	4/f	<0.602	83.6	2.35	<1.47	1.88	0.93	1.02
Other												
SMBuffalo	10/3/05	fillet	2633	49	?/f	<0.605	374	32.7	<5.90	2.79	2.65	4.17
Emerald Shiner	10/3/05	Composite of 16 whole fish	28	3 to 5 cm	na	<0.603	93.5	8.63	<5.87	1.76	0.734	<0.706
Gizzard Shad	10/3/05	Composites of 29 whole fish from L8616-13	149 166 157	8 to 15 cm	na	A<0.618 B<0.605 C<0.598	52.7 71.5 120	10.7 11.1 18.5	19.1 15.3 13.7	<0.684 <0.670 0.841	<0.608 <0.595 <0.588	<0.725 <0.710 0.861

< = less than the detection limit; number following this symbol represents the detection limit

2005 MPCA PFC Fish Data

Mississippi River Lake Pepin Fish PFC analysis

MPCA Species & Sample ID #	Sample Date	Analyzed as Fillet or Whole Fish	Wt (g)	Ln (cm)	Age/ sex (yrs/ m-f)	PFOA ng/g (ppb)	PFOS ng/g (ppb)	PFOSA ng/g (ppb)	PFPeA ng/g (ppb)	PFDA ng/g (ppb)	PFUnA ng/g (ppb)	PFDoA ng/g (ppb)
Walleye												
WE-1	10/4/05	Fillet	741	42	1/f?	<0.603	47	1.52	<5.88	<0.668	<0.593	<0.708
WE-2	10/4/05	Fillet	861	47	2/f	<0.574	63.1	2.34	<5.60	1.53	<0.565	<0.674
WE-3	10/5/05	Fillet	2483	55	3/f	<0.605	49.4	1.77	<5.90	<0.670	<0.595	<0.710
WE-4	10/5/05	Fillet	1079	47	2/f	<0.579	83.4	2.14	<5.65	1.2	<0.569	<0.679
WE-5	10/5/05	Fillet	2252	60	5/f	<0.907	39.3	1.38	<1.86	<0.670	<0.595	<0.710
WE-6	10/5/05	Fillet	1180	47	3/m	<0.581	47.4	1.83	<1.50	1.07	<0.572	<0.682
Carp												
Carp-1	9/27/05	Whole Fish	3011	52	4/f	<0.587	65.5	2.9	<5.72	1.2	1.12	<0.688
Carp-2	9/27/05	Whole Fish	2626	53	4/m	<0.585	90.7	1.6	<5.71	2	1.21	<0.687
Carp-3	9/27/05	Whole Fish	3019	54	4/m	<0.594	99.6	1.64	<5.79	3.07	1.6	0.876
Carp-4	9/27/05	Fillet	4975	59	6/f	<0.603	46.3	<0.573	<5.88	<0.668	<0.593	<0.708
Carp-5	9/27/05	Fillet	2730	56	6/m	<0.598	59.9	0.724	<5.83	1.17	0.662	<0.701
Carp-5 (dup)	9/27/05	Fillet(duplicate)	2730	56	6/m	<0.607	51.1	0.581	<5.92	0.926	0.602	<0.712
SM Bass												
SMB-1	9/27/05	Fillet	792	35	3/m	<0.583	103	2.69	<1.42	1.92	1.07	0.82
SMB-1(dup)	9/27/05	Fillet (duplicate)	792	35	3/m	<0.647	116	2.56	<2.05	2.31	1.21	0.928
SMB-2	9/27/05	Fillet	553	35	4/f	<0.592	66.2	1.19	<1.45	1.04	<0.582	<0.694
SMB-3	9/27/05	Fillet	729	36	4/f	<0.673	95.6	1.79	<2.56	1.85	0.692	1.06
SMB-4	9/27/05	Whole Fish	303	27	3/m	<0.584	175	3.98	<2.52	3.57	1.28	0.924
SMB-5	9/27/05	Whole Fish	1205	39	5/f	<0.611	172	3.28	<1.49	3.2	1.25	1.35
White Bass												
WB-1	10/4/05	Fillet	640	33	4/m	<0.603	114	3.37	<2.78	1.06	<0.594	<0.708
WB-2	10/4/05	Fillet	812	36	4/f	<0.605	100	2.08	<1.80	1.45	<0.595	<0.710
WB-3	10/4/05	Whole Fish	692	33	3/m	<0.604	223	5.71	<1.77	4.26	1.89	1.61
WB-4	10/5/05	Whole Fish	446	28	1/f	<0.599	194	4.45	<1.46	3.3	1.1	1.12
WB-4(dupl)	10/5/05	Whole fish(dup)	446	28	1/f	<0.585	165	4.24	<1.43	3.11	1.52	1.14
WB-5	10/5/05	Whole Fish	664	33	4/m	<0.576	248	4.92	<1.40	3.37	1.47	1.26
Other												
Gizzard Shad	9/23/05	Composites of 38 whole fish	1436	~15	na	A<0.672 B<0.581 C<0.588	37.9 33.4 47.1	2.27 1.87 2.45	18.5 17.2 17.8	0.694 0.817 <0.651	<0.594 <0.571 <0.578	<0.709 <0.681 <0.690
Emerald Shiner	9/27/05	Composites of 40 whole fish	117	~8	na	A<0.579 B<0.607 C<0.602	105 107 90.9	2.15 0.706 1.4	2.17 2.44 2.02	2.57 2.6 2.59	0.877 1.17 0.927	<0.679 <0.712 <0.707

< = less than the detection limit; number following this symbol represents the detection limit

2006 MPCA PFC Fish Data

	Average PFOS Concentration [ng/g; ppb]							
	Bluegill	**Smallmouth Bass**	**Largemouth Bass**	**White Bass**	**Walleye**	**Northern Pike**	**White Sucker**	**Channel Catfish**
Mississippi River pool 3	170 (5)	ns	ns	132 (5)	ns	ns	ns	ns
Mississippi River pool 4	85 (5)	ns	ns	ns	ns	ns	ns	ns
Mississippi River pool 5	65 (5)	96 (5)	85 (5)	ns	54 (4)	111 (5)	ns	10 (2)
Mississippi River pool 5a	61 (5)	73 (5)	ns	ns	65 (5)	ns	ns	14 (4)
St. Croix River: Taylors Falls to Danbury	<dl (5)	<dl (5)	ns	ns	<dl (5)	<dl (5)	<dl (5)	ns
Lake Calhoun	319 (5)	ns	ns	ns	ns	ns	49 (5)	ns

numbers listed are: average PFOS concentration (# of fish)
<dl – less than the detection limit ≈ 5 ng/g
ns – not sampled

Samples were analyzed for the 13 different perfluorochemicals listed.

			CAS #
PFBA	C-4	perfluorobutanoic acid	375-22-4
PFBS	C-4	perfluorobutane sulfonate	375-73-5
PFPeA	C-5	perfluoropentanoic acid	2706-90-3
PFHxA	C-6	perfluorohexanoic acid	307-24-4
PFHxS	C-6	perfluorohexane sulfonate	355-46-4
PFHpA	C-7	perfluoroheptanoic acid	375-85-9
PFOA	C-8	perfluorooctanoic acid	335-67-1
PFOS	C-8	perfluorooctane sulfonate	1763-23-1
PFOSA	C-8	perfluorooctane sulfonamide	754-91-6
PFNA	C-9	perfluorononanoic acid	375-95-1
PFDA	C-10	perfluorodecanoic acid	335-76-2
PFUnA	C-11	perfluoroundecanoic acid	2058-94-8
PFDoA	C-12	perfluorododecanoic acid	307-55-1

2006 MPCA PFC Fish Data

Mississippi River Pool 3 Fish PFC analysis

MPCA Species & Sample ID	Sample Date	Fillet or Whole Fish	Wt (g)	Ln (cm)	Age/ sex (yrs/ m-f)	PFOS ng/g (ppb)	PFOA ng/g (ppb)	PFBA ng/g (ppb)	PFOSA ng/g (ppb)	PFDA ng/g (ppb)	PFUnA ng/g (ppb)	PFDoA ng/g (ppb)
Bluegill												
BG-1	11/9/06	Fillet	102	17	3/M	440	<1.52	<6.70	1.42	8.05	5.09	4.41
BG-1	11/9/06	Whole Fish	102	17	3/M	815	<1.46	<1.75	6.5	12.3	6.13	4.70
BG-2	11/9/06	Fillet	135	17	3/M	108	<1.46	<8.68	3.62	5.36	5.79	14.6
BG-2	11/9/06	Whole Fish	135	17	3/M	187	<1.48	<1.76	10.2	7.6	6.46	14.2
BG-3	11/9/06	Fillet	152	18	3/M	123	<1.51	<1.81	<1.41	3.17	<2.01	1.55
BG-3	11/9/06	Whole Fish	152	18	3/M	186	<1.28	0.91	1.03	5.59	2.17	2.34
BG-4	5/2006	Fillet	177	18.5	3/F	87.5	<1.48	<1.77	<1.38	2.36	<1.98	<1.51
BG-5	5/2006	Fillet	160	18	3/M	92.1	<1.47	<1.75	<1.37	<1.67	<1.96	<1.50
White Bass												
WB-1	11/9/06	Fillet	33	12.5	1/J	122	<1.48	<8.00	11.5	4.88	<1.98	2.28
WB-1	11/9/06	Whole Fish	33	12.5	1/J	134	<1.79	<1.70	14.5	6.11	1.73	3.09
WB-2	11/9/06	Fillet	34	13	1/J	154	<1.49	<3.14	8.75	5.9	2.83	2.23
WB-2	11/9/06	Whole Fish	34	13	1/J	161	<1.51	<2.86	10.3	9.5	2.53	2.73
WB-3	11/9/06	Fillet	34	13	1/J	150	<2.51	<1.80	10.9	5.28	2.09	2.92
WB-3	11/9/06	Whole Fish	34	13	1/J	148	<1.51	<6.58	15.1	7.3	2.75	4.06
WB-4	11/9/06	Fillet	44	13	1/J	148	<1.48	<2.65	10.6	4.55	<1.90	2.71
WB-4	11/9/06	Whole Fish	44	13	1/J	153	<1.48	<4.99	17	7	2.06	4.13
WB-5	11/9/06	Fillet	41	14.5	1/J	86.7	<1.51	<6.24	6.58	4.14	<2.01	<1.54
WB-5	11/9/06	Whole Fish	41	14.5	1/J	114	<2.10	1.3	7.9	6.33	1.34	1.18
Other												
Emerald Shiner	11/9/06	Composite of 38 whole fish		~4.5		84.2	<1.43	<1.71	5.21	4.33	<1.91	2.17
Gizzard Shad	11/9/06	Composite of 33 whole fish		~9		17.9	<1.25	<1.94	1.53	<1.42	<1.66	<1.27

Mississippi River Pool 4 Fish PFC analysis

MPCA Species & Sample ID	Sample Date	Fillet or Whole Fish	Wt (g)	Ln (cm)	Age/ sex (yrs/ m-f)	PFOS ng/g (ppb)	PFOA ng/g (ppb)	PFBA ng/g (ppb)	PFOSA ng/g (ppb)	PFDA ng/g (ppb)	PFUnA ng/g (ppb)	PFDoA ng/g (ppb)
Bluegill												
BG-1	5/2006	Fillet	262	20	4/F	98.3	<1.43	<1.70	<1.33	2.51	<1.90	<1.46
BG-2	5/2006	Fillet	152	17.5	3/M	28.1	<1.47	<1.75	<1.37	<1.67	<1.96	<1.50
BG-3	5/2006	Fillet	158	18	3/F	45.5	<1.52	<1.82	<1.42	<1.73	<2.03	<1.55
BG-4	5/2006	Fillet	125	16	3/M	152	<1.48	<1.76	<1.37	3.26	2.76	2.7
BG-5	5/2006	Fillet	146	18	3/M	101	<1.39	<1.66	<1.29	2.04	2.46	2.13

Mississippi River Pool 5 Fish PFC analysis												
MPCA Species & Sample ID	Sample Date	Fillet or Whole Fish	Wt (g)	Ln (cm)	Age/ sex (yrs/ m-f)	PFOS ng/g (ppb)	PFOA ng/g (ppb)	PFBA ng/g (ppb)	PFOSA ng/g (ppb)	PFDA ng/g (ppb)	PFUnA ng/g (ppb)	PFDoA ng/g (ppb)
Bluegill												
BG-1	11/6/06	Fillet	172	19	4/F	40.3	<1.51	<1.81	<1.41	<1.72	<2.01	<1.54
BG-2	11/6/06	Fillet	252	20	4/J	94.7	<1.38	<1.64	<1.28	2.17	<1.83	<1.40
BG-3	11/6/06	Fillet	199	21	4/M	42.7	<1.43	<1.71	<1.33	1.74	<1.91	<1.46
BG-4	11/6/06	Fillet	189	19	4/F	69.6	<1.54	<1.84	<1.44	1.97	<2.06	<1.57
BG-5	11/6/06	Fillet	114	17	3/F	77.2	<1.51	<1.81	<1.41	2.4	<2.01	<1.54
Smallmouth Bass												
SMB-1	5/2006	Fillet	1512	45	8/F	150	<1.48	<1.76	1.63	3.27	<1.97	<1.50
SMB-2	5/2006	Fillet	131	19	2/J	83.5	<1.45	<1.73	<1.35	2.49	<1.93	<1.48
SMB-3	5/2006	Fillet	449	29	4/M	47.7	<1.50	<1.80	1.86	2.13	<2.00	<1.53
SMB-4	5/2006	Fillet	262	26.5	3/F	93.5	<1.48	<1.77	<1.38	2.59	<1.98	<1.51
SMB-5	5/2006	Fillet	565	33	5/M	104	<1.45	<1.74	1.35	2.25	<1.94	<1.48
Largemouth Bass												
LMB-1	5/2006	Fillet	456	30	6/F	82.9	<1.43	<1.70	<1.33	2.59	<1.90	<1.46
LMB-2	5/2006	Fillet	1043	39	7/M	74.3	<1.45	<1.73	<1.35	1.66	<1.93	<1.48
LMB-3	5/2006	Fillet	689	34	6/F	85.8	<1.38	<1.64	<1.28	2.48	<1.83	<1.40
LMB-3 (dup)	5/2006	Fillet	689	34	6/F	96.5	<1.36	<2.56	<1.27	2.74	<1.82	<1.39
LMB-4	5/2006	Fillet	455	29	4/M	107	<1.41	<1.69	<1.32	3.74	<1.88	<1.44
LMB-5	5/2006	Fillet	502	31	5/M	74.6	<1.50	<1.80	<1.40	2.57	<2.00	<1.53
Walleye												
WAE-1	5/2006	Fillet	1000	47	7/M	34.3	<1.54	<1.83	<1.43	<1.75	<2.05	<1.57
WAE-1 (dup)	5/2006		1000	47	7/M	26.5	<1.54	<1.84	<1.44	<1.76	<2.06	<1.57
WAE-2	5/2006	Fillet	339	31	3/J	60.6	<1.48	<1.76	1.94	1.73	<1.97	<1.50
WAE-3	5/2006	Fillet	362	33	3/J	93.2	<1.47	<1.75	1.49	<1.67	<1.96	<1.50
WAE-4	5/2006	Fillet	965	43	5/M	27.1	<1.48	<1.77	1.97	<1.69	<1.98	<1.51
Northern Pike												
NOP-1	5/2006	Fillet	1457	58	8/F	91.2	<1.45	<1.74	3.43	1.79	<1.94	<1.48
NOP-2	5/2006	Fillet	2568	64	8/F	224	<1.47	<1.75	5.54	2.34	<1.96	<1.50
NOP-2 (dup)	5/2006	Fillet	2568	64	8/F	235	<1.37	<1.64	4.98	2.39	<1.82	<1.40
NOP-3	5/2006	Fillet	214	28	2J	130	<1.47	<1.75	2.87	2.63	<1.96	<1.50
NOP-4	5/2006	Fillet	710	45	6/J	12.2	<1.42	<1.70	2.52	<1.62	<1.89	<1.45
NOP-5	5/2006	Fillet	1498	42	6/F	97.5	<1.5	<1.80	2.86	1.93	<2.00	<1.53
Channel Catfish												
CCF-1	5/2006	Fillet	485	31	?/J	9.59	<1.51	<1.81	<1.41	<1.72	<2.01	<1.54
CCF-2	5/2006	Fillet	1956	52	5/M	<3.32	<1.44	<1.72	<1.34	<1.64	<1.92	<1.47
Other												
Gizzard Shad	11/6/06	Composites of 40 whole fish		~13		20.1	<1.48	<1.76	<1.37	<1.68	<1.97	<1.50

Mississippi River Pool 5a Fish PFC analysis												
MPCA Species & Sample ID	Sample Date	Fillet or Whole Fish	Wt (g)	Ln (cm)	Age/ sex (yrs/ m-f)	PFOS ng/g (ppb)	PFOA ng/g (ppb)	PFBA ng/g (ppb)	PFOSA ng/g (ppb)	PFDA ng/g (ppb)	PFUnA ng/g (ppb)	PFDoA ng/g (ppb)
Bluegill												
BG-1	5/2006	Fillet	164	17	3/M	34.6	<1.32	<1.58	<1.23	<1.50	<1.76	<1.35
BG-2	5/2006	Fillet	168	18	3/M	99.2	<1.50	<2.18	<1.39	<1.70	<2.00	<1.53
BG-3	5/2006	Fillet	284	20	4/M	82.9	<1.26	<1.55	<1.17	1.65	<1.68	<1.29
BG-4	5/2006	Fillet	199	20	4/M	34	<1.60	<1.91	<1.49	<1.82	<2.13	<1.63
BG-5	5/2006	Fillet	188	19	4/F	55.5	<1.36	<1.63	<1.27	<1.55	<1.82	<1.39
Smallmouth Bass												
SMB-1	5/2006	Fillet	813	36	7/M	52.3	<1.50	<1.79	<1.39	<1.70	<2.00	<1.53
SMB-2	5/2006	Fillet	819	36	7/M	116	<1.41	<1.68	1.39	2.89	<1.88	<1.44
SMB-3	5/2006	Fillet	746	35	6/F	67.1	<1.50	<1.79	1.43	<1.70	<2.00	<1.53
SMB-4	5/2006	Fillet	377	28	4/M	84.6	<1.48	<1.77	<1.38	2.74	<1.98	<1.51
SMB-5	5/2006	Fillet	672	34	6/M	45	<1.45	<2.38	<1.35	<1.65	<1.93	<1.48
Walleye												
WAE-1	5/2006	Fillet	740	41	5/F	56.4	<1.48	<1.76	1.83	<1.68	<1.97	<1.50
WAE-2	5/2006	Fillet	1454	49	6/F	49.3	<1.49	<1.78	2.15	<1.70	<1.99	<1.52
WAE-3	5/2006	Fillet	1125	47	6/F	41	<1.54	<1.84	1.53	<1.76	<2.06	<1.57
WAE-4	5/2006	Fillet	195	25.5	2/J	75.4	<1.41	<2.14	<1.32	<1.61	<1.88	<1.44
WAE-5	5/2006	Fillet	2158	55	9/F	103	<1.47	<1.75	1.66	2.74	<1.96	<1.50
Channel Catfish												
CCF-1	5/2006	Fillet	2086	57	6/M	<3.26	<1.41	<1.69	<1.32	<1.61	<1.88	<1.44
CCF-2	5/2006	Fillet	1489	46	4/F	18.3	<1.38	<1.64	<1.28	2.34	<1.83	<1.40
CCF-3	5/2006	Fillet	1147	41	3/F	9.55	<1.55	<1.85	<1.44	<1.77	<2.07	<1.58
CCF-4	5/2006	Fillet	738	39	2/F	13.4	<1.46	<1.99	<1.36	<1.66	<1.95	<1.49

St. Croix River Fish PFC analysis												
MPCA Species & Sample ID	Sample Date	Fillet or Whole Fish	Wt (g)	Ln (cm)	Age/ sex (yrs/ m-f)	PFOS ng/g (ppb)	PFOA ng/g (ppb)	PFBA ng/g (ppb)	PFOSA ng/g (ppb)	PFDA ng/g (ppb)	PFUnA ng/g (ppb)	PFDoA ng/g (ppb)
Bluegill												
BG-1	8/11/06	Fillet	94	16.5	3/F	<3.57	<1.93	<3.85	<1.44	<1.77	<2.07	<1.58
BG-1(Dup)	8/11/06	Fillet	94	16.5	3/F	<3.48	<1.51	<1.81	<1.41	<1.72	<2.01	<1.54
BG-1	8/11/06	Whole Fish	94	16.5	3/F	<3.38	<1.47	<1.75	<1.37	<1.67	<1.96	<1.50
BG-2	8/11/06	Fillet	60	13	2/M	<4.21	<1.54	<4.56	<1.44	<1.76	<2.06	<1.57
BG-2	8/11/06	Whole Fish	60	13	2/M	4.22	<1.46	<1.75	<1.36	<1.66	<1.95	<1.49
BG-3	8/11/06	Fillet	78	14.5	2/F	<3.38	<1.47	<1.88	<1.37	<1.67	<1.96	<1.50
BG-3	8/11/06	Whole Fish	78	14.5	2/F	3.40	<1.53	<1.82	<1.42	<1.74	<2.04	<1.56
BG-4	8/11/06	Fillet	76	14	2/M	<3.37	<1.46	<2.49	<1.36	<1.66	<1.95	<1.49
BG-4	8/11/06	Whole Fish	76	14	2/M	4.07	<1.41	<1.69	<1.32	<1.61	<1.88	<1.44
BG-5	8/11/06	Fillet	73	15	2/J	<3.48	<1.51	<4.78	<1.41	<1.72	<2.01	<1.54
BG-5	8/11/06	Whole Fish	73	15	2/J	<3.54	<1.54	<1.83	<1.43	<1.75	<2.05	<1.57
Smallmouth Bass												
SMB-1	8/11/06	Fillet	926	37	6/M	<3.41	<1.51	<8.80	<1.38	<1.69	<1.98	<1.51
SMB-1	8/11/06	Whole Fish	926	37	6/M	1.52	<1.50	<1.80	<1.40	<1.71	<2.00	<1.53
SMB-2	8/11/06	Fillet	435	29	4/M	<3.50	<1.52	<1.82	<1.42	<1.73	<2.03	<1.55
SMB-2	8/11/06	Whole Fish	435	29	4/M	1.16	<1.45	<1.74	<1.35	<1.66	<1.94	<1.48
SMB-3	8/11/06	Fillet	428	30	4/F	<3.41	<1.48	<1.77	<1.38	<1.69	<1.98	<1.51
SMB-3	8/11/06	Whole Fish	428	30	4/F	<3.32	<1.44	<2.80	<1.34	<1.64	<1.92	<1.47
SMB-4	8/7/06	Fillet	419	27	4/F	<3.48	<1.51	<1.81	<1.41	<1.72	<2.01	<1.54
SMB-5	8/7/06	Fillet	440	28	4/M	<3.52	<1.53	<1.82	<1.42	<1.74	<2.04	<1.56
Walleye												
WE-1	8/15/06	Fillet	796	40	5/M	<3.48	<1.51	<1.81	<1.41	<1.72	<2.01	<1.54
WE-2	8/4/06	Fillet	1124	46	6/F	<3.57	<1.55	<1.85	<1.44	<1.77	<2.07	<1.58
WE-3	8/4/06	Fillet	401	33	3/J	<3.37	<1.46	<1.75	<1.36	<1.66	<1.95	<1.49
WE-4	8/4/06	Fillet	287	28	3/J	<3.40	<1.48	<2.38	<1.37	<1.68	<1.97	<1.50
WE-5	8/7/06	Fillet	405	32	3/J	<3.29	<1.43	<1.70	<1.33	<1.62	<1.90	<1.46
Northern Pike												
NOP-1	8/16/06	Fillet	629	43	6/J	<3.33	<1.45	<1.73	<1.35	<1.65	<1.93	<1.48
NOP-2	8/15/06	Fillet	476	42	6/F	<3.17	<1.38	<1.64	<1.28	<1.57	<1.83	<1.40
NOP-3	8/16/06	Fillet	1068	48	7?/ M	<3.30	<1.43	<1.71	<1.33	<1.63	<1.91	<1.46
NOP-3 (dup)	8/16/06	Fillet	1068	48	7?/ M	<3.27	<1.42	<1.70	<1.32	<1.62	<1.89	<1.45
NOP-4	8/7/06	Fillet	1365	58	8/M	<3.27	<1.42	<1.70	<1.32	<1.62	<1.89	<1.45
NOP-5	8/16/06	Fillet	526	43	6/F	<3.48	<1.51	<1.81	<1.41	<1.72	<2.01	<1.54
White Sucker												
WTS-1	8/15/06	Fillet	358	31	3/J	<3.33	<1.45	<1.73	<1.35	<1.65	<1.93	<1.48
WTS-2	8/15/06	Fillet	572	36	3/F	<3.21	<1.39	<1.67	<1.30	<1.59	<1.86	<1.42
WTS-3	8/15/06	Fillet	519	33	3/F	<3.33	<1.45	<1.73	<1.35	<1.65	<1.93	<1.48

2006 MPCA PFC Fish Data

Lake Calhoun Fish PFC analysis												
MPCA Species & Sample ID	Sample Date	Fillet or Whole Fish	Wt (g)	Ln (cm)	Age/ sex (yrs/ m-f)	PFOS ng/g (ppb)	PFOA ng/g (ppb)	PFBA ng/g (ppb)	PFOSA ng/g (ppb)	PFDA ng/g (ppb)	PFUnA ng/g (ppb)	PFDoA ng/g (ppb)
Bluegill												
BG-1	11/15/06	Fillet	59	15.5	3/F	373	<1.40	<1.88	1.63	7.13	2.92	4.23
BG-1	11/15/06	Whole Fish	59	15.5	3/F	493	<1.43	1.38	2.60	14.9	4.92	5.53
BG-2	11/15/06	Fillet	62	13	2/F	356	<1.42	<1.70	3.46	7	4.1	6.18
BG-2	11/15/06	Whole Fish	62	13	2/F	438	<1.43	<2.74	4.27	13.34	6.82	9.19
BG-3	11/15/06	Fillet	65	15	3/F	181	<1.50	<1.80	1.95	3.28	2.79	4.49
BG-3	11/15/06	Whole Fish	65	15	3/F	280	<1.39	<2.09	5.51	6.9	4.63	5.92
BG-4	11/15/06	Fillet	60	16	3/F	311	<1.46	<1.75	4.69	5.64	3.34	4.72
BG-4	11/15/06	Whole Fish	60	16	3/F	590	<1.50	<2.79	6.43	12.0	5.67	8.10
BG-5	11/15/06	Fillet	68	16	3/F	373	<1.51	<1.81	3.92	8.02	4.01	5.9
BG-5	11/15/06	Whole Fish	68	16	3/F	528	<1.45	<1.97	3.47	13.9	7.73	9.96
White Sucker												
WTS-1	11/15/06	Fillet	250	29	2/M	<3.52	<1.53	<1.82	<1.42	<1.74	<2.04	<1.56
WTS-1	11/15/06	Whole Fish	250	29	2/M	2.91	<1.50	<1.79	<1.39	0.92	<2.00	<1.53
WTS-1 (dup)	11/15/06	Whole Fish	250	29	2/M	1.96	<1.52	<1.82	<1.42	<1.73	<2.03	<1.55
WTS-2	11/15/06	Fillet	309	31	2/J	<3.40	<1.48	<1.76	<1.37	<1.68	<1.97	<1.50
WTS-2 (dup)	11/15/06	Fillet	309	31	2/J	<3.37	<1.46	<1.75	<1.36	<1.66	<1.95	<1.49
WTS-2	11/15/06	Whole Fish	309	31	2/J	<3.23	<2.29	<1.67	<1.30	<1.59	<1.87	<1.43
WTS-3	11/15/06	Fillet	179	27	2/J	<3.54	<1.54	<1.83	<1.43	<1.75	<2.05	<1.57
WTS-3	11/15/06	Whole Fish	179	27	2/J	<3.24	<1.41	<1.68	<1.60	<1.60	<1.88	<1.44
WTS-4	11/15/06	Fillet	660	35	3/J	49.1	2.39	<1.82	<1.42	4.39	<2.04	1.98
WTS-4	11/15/06	Whole Fish	660	35	3/J	77	2.28	<1.82	3.72	5.44	1.76	2.65
WTS-5	11/15/06	Fillet	335	29	2/J	<3.26	<1.41	<1.69	<1.32	<1.61	<1.88	<1.44
WTS-5	11/15/06	Whole Fish	335	29	2/J	<3.40	<1.48	<6.33	<1.47	<1.68	<1.97	<1.50

< = less than the detection limit; number following this symbol represents the detection limit

Twin Cities Metro Lakes

	Average PFOS Concentration [ng/g; ppb]								
	Bluegill	**Bluegill (comp)**	**Black Crappie**	**Black Crappie (comp)**	**Largemouth Bass**	**Northern Pike**	**Walleye**	**White Sucker**	**Yellow Perch (comp)**
Bald Eagle	<dl (5)	<dl (5)	8 (5)	ns	6 (5)	ns	ns	ns	ns
Cedar (Hennepin)	28 (5)	34 (5)	ns	ns	72 (4)	ns	ns	ns	ns
Cedar (Scott)	<dl (5)	<dl (5)	ns	ns	6 (5)	ns	<dl (1)	ns	ns
Centerville	9 (5)	9 (5)	ns	ns	Ns	9 (7)	ns	ns	ns
Colby	22 (5)	23 (5)	14 (5)	14(5)	Ns	ns	ns	ns	ns
Como	26 (5)	28 (5)	66 (5)	ns	30 (1)	42 (4)	ns	ns	ns
Demontreville	12 (5)	8 (5)	ns	ns	46 (5)	ns	ns	ns	ns
Elmo	242 (5)	302 (5)	495 (5)	ns	544 (5)	ns	ns	ns	ns
Gervais	93 (5)	100 (5)	157 (5)	ns	184 (5)	ns	ns	ns	ns
Green Mountain	<dl (5)	<dl (5)	ns	ns	ns	ns	ns	ns	ns
Harriet	114 (5)	89 (5)	ns	ns	148 (5)	ns	ns	ns	ns
Hiawatha	26 (5)	27 (5)	40 (5)	ns	ns	28 (6)	ns	ns	ns
Hydes	<dl (5)	<dl (5)	<dl (6)	ns	ns	5 (5)	ns	ns	ns
Independence	5 (5)	<dl (5)	<dl (5)	ns	ns	<dl (2)	ns	ns	ns
Jane	22 (5)	8 (5)	25 (8)	ns	47 (5)	ns	ns	ns	ns
Johanna	212 (6)	250 (5)	222 (3)	ns	ns	ns	ns	ns	ns
Josephine	87 (6)	93 (6)	ns	ns	ns	ns	ns	ns	ns
Keller	69 (5)	70 (5)	ns	ns	ns	ns	ns	ns	ns
Minnetonka	<dl (5)	7 (5)	8 (5)	ns	ns	9 (3)	ns	ns	ns
Nokomis	10 (7)	ns	10 (5)	ns	ns	ns	ns	ns	ns
Olson	17 (5)	15 (5)	ns	ns	42 (5)	ns	ns	ns	ns
Peltier	12 (5)	ns	ns	ns	ns	14 (5)	ns	ns	ns
Phalen	69 (5)	50 (5)	104 (3)	ns	142 (5)	ns	ns	ns	ns
Powers	40 (5)	65 (5)	51 (5)	ns	ns	69 (3)	ns	ns	42 (5)
Prior (Upper)	5 (5)	<dl (5)	ns	ns	6 (5)	ns	ns	ns	ns
Ravine	23 (5)	19 (5)	60 (5)	ns	63 (5)	ns	ns	ns	ns
Red Rock	41 (5)	35 (5)	103 (5)	ns	69 (5)	ns	ns	ns	ns
Sarah	7 (5)	<dl (4)	<dl (5)	ns	ns	10 (5)	ns	ns	ns
Silver	24 (5)	34 (5)	33 (5)	35 (5)	ns	ns	17 (4)	ns	ns
Square	<dl (5)	<dl (5)	5 (5)	ns	<dl (5)	ns	ns	ns	ns
Tanners	76 (5)	55 (5)	118 (5)	ns	80 (5)	ns	ns	ns	ns
White Bear	5 (5)	6 (5)	25 (2)	ns	9 (5)	ns	ns	ns	ns

River Reaches

	Average PFOS Concentration [ng/g; ppb]								
	Bluegill	**Bluegill (comp)**	**Smallmouth Bass**	**Largemouth Bass**	**White Bass**	**Walleye**	**Northern Pike**	**White Sucker**	**Channel Catfish**
Mississippi River									
Brainerd area	10 (2)	ns	13 (5)	ns	ns	9 (5)	7 (3)	ns	ns
St. Croix River									
Washington County Bluff Park area	23 (5)	12 (5)	15 (5)	ns	82 (1)	17 (5)	ns	ns	ns

numbers listed are: average PFOS concentration (# of fish)
<dl – less than the detection limit ≈ 5 ng/g
ns – not sampled
comp – composite; tissue from several fish is combined then PFCs are measured

Samples were analyzed for the 13 different perfluorochemicals listed.

			CAS #
PFBA	C-4	perfluorobutanoic acid	375-22-4
PFBS	C-4	perfluorobutane sulfonate	375-73-5
PFPeA	C-5	perfluoropentanoic acid	2706-90-3
PFHxA	C-6	perfluorohexanoic acid	307-24-4
PFHxS	C-6	perfluorohexane sulfonate	355-46-4
PFHpA	C-7	perfluoroheptanoic acid	375-85-9
PFOA	C-8	perfluorooctanoic acid	335-67-1
PFOS	C-8	perfluorooctane sulfonate	1763-23-1
PFOSA	C-8	perfluorooctane sulfonamide	754-91-6
PFNA	C-9	perfluorononanoic acid	375-95-1
PFDA	C-10	perfluorodecanoic acid	335-76-2
PFUnA	C-11	perfluoroundecanoic acid	2058-94-8
PFDoA	C-12	perfluorododecanoic acid	307-55-1

Bald Eagle Lake Fish PFC analysis

Species & Sample ID	Sample Date	Tissue	Wt (g)	Ln (cm)	Age/ sex (yrs)	PFOS ng/g (ppb)	PFOA ng/g (ppb)	PFBA ng/g (ppb)	PFOSA ng/g (ppb)	PFDA ng/g (ppb)	PFUnA ng/g (ppb)	PFDoA ng/g (ppb)
Bluegill												
BGS-1	5/2/07	Fillet	22	9.5	2/J	<4.98	<2.49	<2.49*	<2.49	<2.49	<2.49	<2.49
BGS-4	5/2/07	Fillet	11	8	1/J	<4.39	<2.19	<2.19*	<2.19	<2.19	<2.19	<2.19
BGS-5	5/2/07	Fillet	25	11	2/M	<4.93	<2.46	<2.46*	<2.46	<2.46	<2.46	<2.46
BGS-6	5/2/07	Fillet	79	15.5	5/M	<4.76	<2.38	<2.38*	<2.38	<2.38	<2.38	<2.38
BGS-9	5/2/07	Fillet	88	16	5/M	<4.61	<2.30	<2.30*	<2.30	<2.30	<2.30	<2.30
BGS-comp	5/2/07	Fillet	50a	12a		<4.78	<2.39	<2.39	<2.39	<2.39	<2.39	<2.39
Black Crappie												
BKS-1	5/2/07	Fillet	95	17.5	4/F	10.5	<2.50	<2.50*	<2.50	<2.50	<2.50	<2.50
BKS-2	5/2/07	Fillet	98	17	4/F	7.24	<2.39	<2.39*	<2.39	<2.39	<2.39	<2.39
BKS-3	5/2/07	Fillet	236	24	7/F	7.89	<2.35	<2.35	<2.35	<2.35	<2.35	<2.35
BKS-4	5/2/07	Fillet	104	19	5/J	4.69	<2.30	<2.30	<2.30	<2.30	<2.30	<2.30
BKS-5	5/2/07	Fillet	97	18	5/F	7.54	<2.58	<2.58	<2.58	<2.58	<2.58	<2.58
Largemouth Bass												
LMB-1	5/2/07	Fillet	992	38	7/F	<5.00	<2.50	<2.50*	<2.50	<2.50	<2.50	<2.50
LMB-2	5/2/07	Fillet	684	34	6/F	<4.69	<2.35	<2.35*	<2.35	<2.35	<2.35	<2.35
LMB-3	5/2/07	Fillet	764	34	6/F	6.18	<2.35	<2.35*	<2.35	<2.35	<2.35	<2.35
LMB-4	5/2/07	Fillet	452	31	5/F	<4.81	<2.40	<2.40*	<2.40	<2.40	<2.40	<2.40
LMB-5	5/2/07	Fillet	560	31.5	5/M	<5.03	<2.51	<2.51*	<2.51	<2.51	<2.51	<2.51

Cedar Lake Fish PFC analysis (Hennepin County)

Species & Sample ID	Sample Date	Tissue	Wt (g)	Ln (cm)	Age/ sex (yrs)	PFOS ng/g (ppb)	PFOA ng/g (ppb)	PFBA ng/g (ppb)	PFOSA ng/g (ppb)	PFDA ng/g (ppb)	PFUnA ng/g (ppb)	PFDoA ng/g (ppb)
Bluegill												
BGS-1	2007	Fillet	24	12	3/F	33.5	<2.50	<2.50	<2.50	<2.50	<2.50	<2.50
BGS-5	2007	Fillet	56	15.5	5/J	31	<2.39	<2.39	<2.39	2.46	<2.39	<2.39
BGS-6	2007	Fillet	25	11.5	2/F	17.9	<2.50	<2.50	<2.50	<2.50	<2.50	<2.50
BGS-8	2007	Fillet	47	14.5	4/F	30.9	<2.37	<2.37	<2.37	3.11	<2.37	<2.37
BGS-10	2007	Fillet	24	12	2/J	27.8	<2.51	<2.51	<2.51	5.25	3.77	<2.51
BGS-comp	2007	Fillet	31a	12a		34	<2.42	<2.42	<2.42	2.99	<2.42	2.56
Largemouth Bass												
LMB-1	2007	Fillet	531	33	5/M	53.8	<2.46	<2.46	<2.46	4.88	3.54	2.58
LMB-2	2007	Fillet	488	31	5/F	70.8	<2.40	<2.40	<2.40	6.7	3.49	3.39#
LMB-3	2007	Fillet	1166	43	10/F	56.3	<2.48	<2.48	<2.48	8.27	4.61	3.25#
LMB-4	2007	Fillet	1592	46	11/F	108	<2.42	<2.42	<2.42	5.22	3.67	5.27#
LMB-4(dup)		Fillet				103	<2.45	<2.45	<2.45	6.37	4.05	5.02#

Cedar Lake Fish PFC analysis (Scott County)												
Species & Sample ID	Sample Date	Tissue	Wt (g)	Ln (cm)	Age/ sex (yrs)	PFOS ng/g (ppb)	PFOA ng/g (ppb)	PFBA ng/g (ppb)	PFOSA ng/g (ppb)	PFDA ng/g (ppb)	PFUnA ng/g (ppb)	PFDoA ng/g (ppb)
Bluegill												
BGS-1	8/24/07	Fillet	16	9	1/J	<4.81	<2.40	<2.40	<2.40	<2.40	<2.40	<2.40
BGS-4	8/24/07	Fillet	19	10	2/J	<6.76	<2.49	<2.49	<2.49	<2.49	<2.49	<2.49
BGS-5	8/24/07	Fillet	97	17	6/M	<4.81	<2.40	<2.40	<2.40	<2.40	<2.40	<2.40
BGS-6	8/24/07	Fillet	31	NA	4/M	<4.95	<2.48	<6.43	<2.48	<2.48	<2.48	<2.48
BGS-9	8/24/07	Fillet	82	16	5/M	<4.81	<2.40	<2.40	<2.40	<2.40	<2.40	<2.40
BGS-comp	8/24/07	Fillet	59a	12a		<4.85	<2.43	<2.43	<2.43	<2.43	<2.43	<2.43
Largemouth Bass												
LMB-1	8/24/07	Fillet	1292	41	9/M	6.24	<2.46	<2.46	<2.46	<2.46	<2.46	<2.46
LMB-2	8/24/07	Fillet	1528	NA	9/F	<4.90	<2.45	<2.45	<2.45*	<2.45	<2.45	<2.45
LMB-3	8/24/07	Fillet	1264	40	8/F	<4.67	<2.34	<2.34	<2.34*	<2.34	<2.34	<2.34
LMB-4	8/24/07	Fillet	857	40	8/M	<4.88	<2.44	<2.44	<2.44*	<2.44	<2.44	<2.44
LMB-5	8/24/07	Fillet	1110	42	9/M	<4.74	<3.85	<2.37	<2.37*	<2.37	<2.37	<2.37
LMB-5(dup)		Fillet				<5.03	<2.51	<2.51	<2.51*	<2.51	<2.51	<2.51
Walleye												
WE-1	8/24/07	Fillet	714	43	7/M	<4.95	<2.48	<4.04	<2.48*	<2.48	<2.48	<2.48

Centerville Lake Fish PFC analysis												
Species & Sample ID	Sample Date	Tissue	Wt (g)	Ln (cm)	Age/ sex (yrs)	PFOS ng/g (ppb)	PFOA ng/g (ppb)	PFBA ng/g (ppb)	PFOSA ng/g (ppb)	PFDA ng/g (ppb)	PFUnA ng/g (ppb)	PFDoA ng/g (ppb)
Bluegill												
BGS-1	2007	Fillet	69	15	4/F	12.8	<2.43	<2.43	<2.43	<2.43	<2.43	<2.43
BGS-2	2007	Fillet	62	14.5	4/M	6.24	<2.45	<2.45	<2.45	<2.45	<2.45	<2.45
BGS-4	2007	Fillet	42	12.5	3/J	9.94	<2.45	<2.45	<2.45	<2.45	<2.45	<2.45
BGS-8	2007	Fillet	61	15	4/F	<4.95	<2.48	<2.48	<2.48	<2.48	<2.48	<2.48
BGS-9	2007	Fillet	74	15	4/M	6.74	<2.48	<2.48	<2.48	<2.48	<2.48	<2.48
BGS-comp	2007	Fillet	72a	15a		8.71	<2.23	<2.23	<2.23	<2.23	<2.23	<2.23
Northern Pike												
NP-1	2007	Fillet	1609	58	4/F	9.01	<2.49	<2.49	<2.49	<2.49	<2.49	<2.49
NP-2	2007	Fillet	878	49	4/J	10.2	<2.48	<2.48	<2.48	<2.48	<2.48	<2.48
NP-3	2007	Fillet	793	46	4/J	9.03	<2.43	<2.43	<2.43	<2.43	<2.43	<2.43
NP-4	2007	Fillet	1067	56.5	4/J	6.3	<2.74	<2.50	<2.50	<2.50	<2.50	<2.50
NP-5	2007	Fillet	1183	54	4/M	7.84	<2.51	<2.51	<2.51	<2.51	<2.51	<2.51
NP-6	2007	Fillet	1546	65	5/M	11.4	<2.40	<2.40	<2.40	<2.40	<2.40	<2.40
NP-7	2007	Fillet	896	51	4/M	10.6	<2.44	<2.44	<2.44	<2.44	<2.44	<2.44

Colby Lake Fish PFC analysis

Species & Sample ID	Sample Date	Tissue	Wt (g)	Ln (cm)	Age/ sex (yrs)	PFOS ng/g (ppb)	PFOA ng/g (ppb)	PFBA ng/g (ppb)	PFOSA ng/g (ppb)	PFDA ng/g (ppb)	PFUnA ng/g (ppb)	PFDoA ng/g (ppb)
Bluegill												
BGS-4	6/6/07	Fillet	21	9.5	1/M	21.7	<2.44	<2.44*	<2.44	3.01	<2.44	<2.44
BGS-5	6/6/07	Fillet	31	12	2/F	23.9#	<2.46	<4.03*	<2.46	<2.46	<2.46	<2.46
BGS-7	6/6/07	Fillet	34	12.5	2/J	32.8	<2.49	<3.10*	<2.49	<2.49	<2.49	<2.49
BGS-9	6/6/07	Fillet	35	12	2/F	13#	<2.50	<2.50*	<2.50	<2.50	<2.50	<2.50
BGS-10	6/6/07	Fillet	29	11	2/F	18.9#	<2.49	<2.49*	<2.49	<2.49	<2.49	<2.49
BGS-comp	6/6/07	Fillet	23a	NA		23.4	<2.40	<2.40	<2.40	<2.40	<2.40	<2.40
Black Crappie												
BKS-2	6/6/07	Fillet	42	14	3/F	16.6	<2.50	<2.50*	<2.50	2.84	<2.50	<2.50
BKS-4	6/6/07	Fillet	47	14.5	3/M	13.2#	<2.45	<2.45	<2.45	<2.45	<2.45	<2.45
BKS-5	6/6/07	Fillet	47	14.5	3/M	12.6#	<2.35	<2.35	<2.35	<2.35	<2.35	<2.35
BKS-7	6/6/07	Fillet	46	15	3/M	14.6	<2.44	<2.44	<2.44	<2.44	<2.44	<2.44
BKS-8	6/6/07	Fillet	34	13.8	3/F	12	<2.48	<2.48	<2.48	<2.48	<2.48	<2.48
BKS-comp	6/6/07	Fillet	37a	13a		14.3	<2.43	<2.43	<2.43	<2.43	<2.43	<2.43

Como Lake Fish PFC analysis

Species & Sample ID	Sample Date	Tissue	Wt (g)	Ln (cm)	Age/ sex (yrs)	PFOS ng/g (ppb)	PFOA ng/g (ppb)	PFBA ng/g (ppb)	PFOSA ng/g (ppb)	PFDA ng/g (ppb)	PFUnA ng/g (ppb)	PFDoA ng/g (ppb)
Bluegill												
BGS-3	5/1/07	Fillet	31	11	2/F	39#	<2.34	<2.34*	3.54	3.71	4.66	5.99
BGS-4	5/1/07	Fillet	29	11	2/J	32.6#	<2.50	<2.50*	3.8	3.88	3.84	5.21
BGS-6	5/1/07	Fillet	99	16	5/M	34.2	<2.50	<2.50*	4.2	<2.50	<2.50	4.03
BGS-8	5/1/07	Fillet	61	14.5	4/M	20.6	<2.43	<2.43*	2.84	<2.43	2.75	3.72
BGS-10	5/1/07	Fillet	93	16	5/F	23.1	<2.49	<2.49*	<2.49	<2.49	2.65	3.08
BGS-comp	5/1/07	Fillet	47a	13a		28.1	<2.49	<2.49	2.98	<2.49	<2.49	4.45
Black Crappie												
BKS-1	5/1/07	Fillet	141	17	4/M	59.7	<2.42	<2.42*	3.09	10.6	6.52	7.93
BKS-2	5/1/07	Fillet	69	16	4/M	44.9	<2.53	<2.53*	<2.53	6.69	3.16	6.07
BKS-3	5/1/07	Fillet	408	28	8/F	104	<2.36	<2.36*	3.14	15.2	9.09	10.5
BKS-4	5/1/07	Fillet	158	20.5	5/M	57.6	<2.30	<2.30*	<2.30	10.6	5.96	6.95
BKS-5	5/1/07	Fillet	817	32	10/F	63.4	<2.50	<2.50*	<2.50	10.3	4.97	5.88
Largemouth Bass												
LMB-1	5/1/07	Fillet	867	37	7/F	29.5	<2.40	<2.40*	2.42	4.04	4.35	6.68
Northern Pike												
NP-1	5/1/07	Fillet	2129	66	5/M	54.4	<2.48	<2.48*	20	7.7	3.93	5.08
NP-1(dup)	5/1/07	Fillet				45.2	<2.36	<2.36*	18.6	7.69	5.03	6.22
NP-2	5/1/07	Fillet	838	49	4/M	34.6	<2.45	<2.45*	15.8	5.92	4.83	8.47
NP-3	5/1/07	Fillet	858	48	4/M	44.7	<2.48	<2.48*	15.6	5.5	5.12	6.45
NP-4	5/1/07	Fillet	746	49	4/M	47.3	<2.43	<2.43*	19.1	7.51	5.23	7.42

Demontreville Lake Fish PFC analysis

Species & Sample ID	Sample Date	Tissue	Wt (g)	Ln (cm)	Age/ sex (yrs)	PFOS ng/g (ppb)	PFOA ng/g (ppb)	PFBA ng/g (ppb)	PFOSA ng/g (ppb)	PFDA ng/g (ppb)	PFUnA ng/g (ppb)	PFDoA ng/g (ppb)
Bluegill												
BGS-1	4/30/07	Fillet	26	11	2/F	27.1#	<2.49	<2.49*	<2.49	3.04	<2.49	<2.49
BGS-5	4/30/07	Fillet	20	11	2/F	35.3#	<2.42	<2.42*	<2.98	<2.42	<2.42	<2.42
BGS-6	4/30/07	Fillet	75	14	4/M	<5.00	<2.50	<2.50*	<2.50	<2.50	<2.50	<2.50
BGS-8	4/30/07	Fillet	137	17.5	6/M	11.9	<2.42	<2.42*	<2.42	<2.42	<2.42	<2.42
BGS-10	4/30/07	Fillet	134	18.5	7/M	<5.00	<2.50	<2.50*	<2.50	<2.50	<2.50	<2.50
BGS-comp	4/30/07	Fillet	64a	13a		8.46	<2.42	<2.42	<2.42	<2.42	<2.42	<2.42
Largemouth Bass												
LMB-1	4/30/07	Fillet	686	33	5/M	41.8	<2.42	<2.42*	<2.42	<2.42	<2.42	<2.42
LMB-2	4/30/07	Fillet	1012	39	7/F	32.9	<2.50	<2.5*	<2.50	<2.50	<2.50	<2.50
LMB-2(dup)	4/30/07	Fillet				25.8	<2.43	<2.43*	<2.43	<2.43	<2.43	<2.43
LMB-3	4/30/07	Fillet	612	33	5/F	27	<2.40	<2.40*	<2.40	<2.40	<2.40	<2.40
LMB-4	4/30/07	Fillet	1023	39	7/M	44.9	<2.48	<2.48*	<2.48	<2.48	<2.48	<2.48
LMB-5	4/30/07	Fillet	877	37.5	7/M	84.4	<2.30	<2.30*	<2.30	<2.30	2.88	<2.30

Elmo Lake Fish PFC analysis

Species & Sample ID	Sample Date	Tissue	Wt (g)	Ln (cm)	Age/ sex (yrs)	PFOS ng/g (ppb)	PFOA ng/g (ppb)	PFBA ng/g (ppb)	PFOSA ng/g (ppb)	PFDA ng/g (ppb)	PFUnA ng/g (ppb)	PFDoA ng/g (ppb)
Bluegill												
BGS-2	5/2/07	Fillet	16	10	2/J	291#	<2.48	<2.48*	<2.48	<2.48	<2.48	<2.48
BGS-4	5/2/07	Fillet	19	10	2/M	217#	<2.49	<2.49*	<2.49	<2.49	<2.49	<2.49
BGS-8	5/2/07	Fillet	42	13	3/J	149	<2.48	<2.48	<2.48	<2.48	<2.48	<2.48
BGS-9	5/2/07	Fillet	30	12.5	3/J	233	20.1	<4.24	<4.24	<4.24	<4.24	<4.24
BGS-10	5/2/07	Fillet	35	13	3/F	345	<3.11	<3.11	<3.11	<3.11	<3.11	<3.11
BGS-comp	5/2/07	Fillet	25a	11a		302	<2.43	<2.43	<2.43	<2.43	<2.43	<2.43
Black Crappie												
BKS-1	5/2/07	Fillet	228	24	7/F	374	<2.36	<2.36	<2.36	3.13	<2.36	<2.36
BKS-2	5/2/07	Fillet	369	28	8/F	574	<2.42	<2.42	<2.42	6.38	<2.42	<2.42
BKS-3	5/2/07	Fillet	292	25.5	7/F	550	<2.34	<2.34	<2.34	3.42	<2.34	<2.34
BKS-4	5/2/07	Fillet	209	22	6/F	534	<2.63	<2.36	<2.36	3.82	<2.36	<2.36
BKS-5	5/2/07	Fillet	189	23	6/F	443	<2.56	<2.56	<2.56	3.14	<2.56	<2.56
Largemouth Bass												
LMB-1	5/2/07	Fillet	470	31	5/M	643	<2.54	<2.54	<2.54	4.44	<2.54	<2.54
LMB-2	5/2/07	Fillet	672	35	6/F	431	<2.43	<2.43*	<2.43	<2.43	<2.43	<2.43
LMB-3	5/2/07	Fillet	894	37	7/F	653	<2.50	<2.50*	<2.50	3.94	<2.50	<2.50
LMB-3(dup)	5/2/07	Fillet				660	<2.51	<2.51*	<2.51	4.06	<2.51	<2.51
LMB-4	5/2/07	Fillet	1062	39	7/F	711	<2.40	<2.40*	<2.40	4.32	<2.40	<2.40
LMB-5	5/2/07	Fillet	698	33	5/M	281	<2.55	<2.55	<2.55	<2.55	<2.55	<2.55

Gervais Lake Fish PFC analysis

Species & Sample ID	Sample Date	Tissue	Wt (g)	Ln (cm)	Age/sex (yrs)	PFOS ng/g (ppb)	PFOA ng/g (ppb)	PFBA ng/g (ppb)	PFOSA ng/g (ppb)	PFDA ng/g (ppb)	PFUnA ng/g (ppb)	PFDoA ng/g (ppb)
Bluegill												
BGS-2	5/1/07	Fillet	6	7.5	1/J	175#	<2.69	<2.69*	<2.69	5.73	2.7	<2.69
BGS-5	5/1/07	Fillet	6	7	1/J	107#	<3.50	<3.50*	<3.50	5.43	3.57	<3.50
BGS-7	5/1/07	Fillet	75	16	5/F	148	<2.31	<2.31	<2.31	6.44#	<2.31	<2.31
BGS-9	5/1/07	Fillet	90	17	6/F	90.5	<2.46	<2.46	<2.46	2.57#	<2.46	<2.46
BGS-10	5/1/07	Fillet	68	15	4/F	39.9	<2.30	<2.30	<2.30	<2.30	<2.30	<2.30
BGS-comp	5/1/07	Fillet	34a	10a		100	<2.45	<2.45	<7.35	3.8	<2.45	<2.45
Black Crappie												
BKS-1	5/1/07	Fillet	171	23	6/F	132	<2.36	<2.36	<2.36	4.33	<2.36	<2.36
BKS-2	5/1/07	Fillet	86	16	4/M	166	<2.31	<2.31*	<2.31	9.5	3.37	<2.31
BKS-3	5/1/07	Fillet	122	19	5/M	206	<2.35	<2.35	<2.35	11.4	4.08	2.78
BKS-4	5/1/07	Fillet	180	22	6/M	170	<2.29	<2.29*	<2.29	10.9	5.09	8.41
BKS-5	5/1/07	Fillet	65	16	4/F	112	<2.38	<2.38*	<2.38	4.65	<2.38	<2.38
Largemouth Bass												
LMB-1	5/1/07	Fillet	2268	47	11/F	159	<2.49	<2.49*	<2.49	6.23	2.97	<2.49
LMB-2	5/1/07	Fillet	488	31	5/M	153	<2.31	<2.31	<2.31	6.24	3.95	<2.31
LMB-3	5/1/07	Fillet	385	29	4/M	227	<2.36	<2.36*	<2.36	10.7	5.79	2.38
LMB-4	5/1/07	Fillet	661	33	5/M	221	<2.13	<2.13	<2.13	8.67	6.23	5.87
LMB-5	5/1/07	Fillet	311	28	4/F	158	<2.19	<2.19	<2.19	7.42	3.85	<2.19

Green Mountain Lake Fish PFC analysis

Species & Sample ID	Sample Date	Tissue	Wt (g)	Ln (cm)	Age/sex (yrs)	PFOS ng/g (ppb)	PFOA ng/g (ppb)	PFBA ng/g (ppb)	PFOSA ng/g (ppb)	PFDA ng/g (ppb)	PFUnA ng/g (ppb)	PFDoA ng/g (ppb)
Bluegill												
BGS-1	5/9/07	Fillet	50	13.5	3/J	<4.85	<2.43	<2.43	<2.43	<2.43	<2.43	<2.43
BGS-3	5/9/07	Fillet	118	17.5	6/M	<4.98	<2.49	<2.49	<2.49	<2.49	<2.49	<2.49
BGS-5	5/9/07	Fillet	133	19	7/M	<4.90	<2.45	<2.45	<2.45	<2.45	<2.45	<2.45
BGS-6	5/9/07	Fillet	85	16	5/F	<4.85	<2.43	<2.43	<2.43	<2.43	<2.43	<2.43
BGS-8	5/9/07	Fillet	50	13.5	3/M	<4.85	<2.43	<2.43	<2.43	<2.43	<2.43	<2.43
BGS-comp	5/9/07	Fillet	65a	14a		<4.88	<2.44	<2.46	<2.44	<2.44	<2.44	<2.44

Harriet Lake Fish PFC analysis

Species & Sample ID	Sample Date	Tissue	Wt (g)	Ln (cm)	Age/sex (yrs)	PFOS ng/g (ppb)	PFOA ng/g (ppb)	PFBA ng/g (ppb)	PFOSA ng/g (ppb)	PFDA ng/g (ppb)	PFUnA ng/g (ppb)	PFDoA ng/g (ppb)
Bluegill												
BGS-5	8/17/07	Fillet	17	9	1/J	108	<2.40	<2.40	<2.40	4.91	<2.40	<2.40
BGS-6	8/17/07	Fillet	42	10	2/F	78.1	<2.48	<2.48	<2.48	<2.48	<2.48	<2.48
BGS-7	8/17/07	Fillet	12	7	1/J	124	<2.43	<2.43	<2.43	6.98	<2.43	<2.43
BGS-9	8/17/07	Fillet	30	11	2/M	95.9	<2.46	<2.46	<2.46	<2.46	<2.46	<2.46
BGS-10	8/17/07	Fillet	73	NA	4/M	163	<2.40	<2.40	<2.40	4.98	5.27#	4.12
BGS-comp	8/17/07	Fillet	41a	13a		89.3	<2.44	<2.44	<2.44	2.59	<2.44	<2.44
Largemouth Bass												
LMB-1	8/17/07	Fillet	373	30	4/F	146	<5.38	<2.49	<2.49*	8.74	4.59	2.78
LMB-2	8/17/07	Fillet	554	34	6/F	20.5	<3.66	<2.46	<2.46*	5.4	<2.46	<2.46
LMB-3	8/17/07	Fillet	355	29	4/J	150	<2.39	<2.39	<2.39*	9.25	3.71	3.64
LMB-4	8/17/07	Fillet	963	39	8/M	254	<4.20	<2.43	<2.43*	10	5.28	7.1
LMB-5	8/17/07	Fillet	866	40	8/F	170	<2.42	<2.42	<2.42	10.1	4.65	3.66

Hiawatha Lake Fish PFC analysis												
Species & Sample ID	Sample Date	Tissue	Wt (g)	Ln (cm)	Age/ sex (yrs)	PFOS ng/g (ppb)	PFOA ng/g (ppb)	PFBA ng/g (ppb)	PFOSA ng/g (ppb)	PFDA ng/g (ppb)	PFUnA ng/g (ppb)	PFDoA ng/g (ppb)
Bluegill												
BGS-2	2007	Fillet	73	16	5/M	35	<2.48	<2.48	<2.48	<2.48	<2.48	<2.48
BGS-6	2007	Fillet	94	18	6/M	15.7	<2.48	<2.48	<2.48	<2.48	<2.48	<2.48
BGS-7	2007	Fillet	36	13	3/F	15.5	<2.48	<2.48	<2.48	<2.48	<2.48	<2.48
BGS-9	2007	Fillet	8	8	1/J	31.8	<2.43	<2.43	<2.43	<2.43	<2.43	<2.43
BGS-10	2007	Fillet	5	7.8	1/J	31.9	<3.55	<3.55	<3.55	<3.55	<3.55	<3.55
BGS-comp	2007	Fillet	42a	12a		27.3	<2.42	<2.42	<2.42	<2.42	<2.42	<2.42
Black Crappie												
BKS-1	2007	Fillet	73	19	5/F	36.6	<2.50	<2.50	<2.50	2.7	<2.50	<2.50
BKS-2	2007	Fillet	103	21.5	6/M	71.7	<2.35	<2.35	<2.35	3.94	<2.35	4.75
BKS-3	2007	Fillet	71	18	4/F	35.1	<2.30	<2.30	<2.30	2.32	<2.30	<2.30
BKS-4	2007	Fillet	83	18	4/F	33.5	<2.45	<2.45	<2.45	<2.45	<2.45	<2.45
BKS-5	2007	Fillet	64	17	4/F	21	<2.50	<2.50	<2.50	<2.50	<2.50	<2.50
Northern Pike												
NP-1	6/19/07	Fillet	1140	56	4/M	17.1	< 2.49	< 2.49	3.65	< 2.49	< 2.49	< 2.49
NP-2	6/19/07	Fillet	738	46	4/F	36.7	< 4.60	< 2.49	2.64	< 2.49	2.98	2.58
NP-3	6/19/07	Fillet	927	51	4/M	16.7	< 2.51	< 2.51	2.95	< 2.51	< 2.51	< 2.51
NP-4	6/19/07	Fillet	1192	NA	4/F	59.5	< 2.46	< 2.46	6.2	4.33	3.6	4.99
NP-4(dup)						65.4	< 2.46	< 2.46	5.25	4.86	3.06	5.58
NP-5	6/19/07	Fillet	2530	74	6/F	14.5	< 2.46	< 2.46	4.17	< 2.46	< 2.46	< 2.46
NP-6	6/19/07	Fillet	3700	77	6/F	25.6	< 2.49	< 2.49	3.86	< 2.49	2.72	< 2.49

Hydes Lake Fish PFC analysis

Species & Sample ID	Sample Date	Tissue	Wt (g)	Ln (cm)	Age/ sex (yrs)	PFOS ng/g (ppb)	PFOA ng/g (ppb)	PFBA ng/g (ppb)	PFOSA ng/g (ppb)	PFDA ng/g (ppb)	PFUnA ng/g (ppb)	PFDoA ng/g (ppb)
Bluegill												
BGS-1	7/24/07	Fillet	9	7	1/J	<5.05	<2.53	<2.53	<2.53	<2.53	<2.53	<2.53
BGS-5	7/24/07	Fillet	9	9	1/J	<5.08	<2.54	<2.54	<2.54	<2.54	<2.54	<2.54
BGS-6	7/24/07	Fillet	130	17	6/F	<4.85	<2.43	<2.43	<2.43	<2.43	<2.43	<2.43
BGS-7	7/24/07	Fillet	127	17	6/M	<4.83	<2.42	<2.42	<2.42	<2.42	<2.42	<2.42
BGS-10	7/24/07	Fillet	123	17.5	6/F	<4.95	<2.48	<2.48	<2.48	<2.48	<2.48	<2.48
BGS-10(dup)		Fillet				<4.90	<2.45	<2.45	<2.45	<2.45	<2.45	<2.45
BGS-comp	7/24/07	Fillet	62a	12a		<4.41	<2.20	<2.20	<2.20	<2.20	<2.20	<2.20
Black Crappie												
BKS-1	7/24/07	Fillet	124	20	5/F	<4.88	<2.44	<2.45	<2.44*	<2.44	<2.44	<2.44
BKS-1(dup)		Fillet				<4.93	<2.46	<2.46	<2.46*	<2.46	<2.46	<2.46
BKS-2	7/24/07	Fillet	178	23	6/F	<4.90	<2.95	<2.45	<2.45*	<2.45	<2.45	<2.45
BKS-3	7/24/07	Fillet	167	22.5	6/F	<4.78	<4.24	<2.39	<2.39*	<2.39	<2.39	<2.39
BKS-4	7/24/07	Fillet	206	24	7/F	<4.88	<2.44	<2.44	<2.44*	<2.44	<2.44	<2.44
BKS-5	7/24/07	Fillet	224	25	7/M	<4.90	<2.45	<2.45	<2.45*	<2.45	<2.45	<2.45
BKS-6	7/24/07	Fillet	220	25	7/F	<4.90	<2.87	<2.45	<2.45*	<2.45	<2.45	<2.45
Northern Pike												
NP-1	7/24/07	Fillet	2170	68	5/M	<4.93	<2.46	<2.46	<2.46	<2.46	<2.46	<2.46
NP-2	7/24/07	Fillet	631	48	4/M	<4.41	<2.20	<2.20	<2.20	<2.20	<2.20	<2.20
NP-3	7/24/07	Fillet	741	46	4/F	<4.52	<2.26	<2.26	<2.26	<2.26	<2.26	<2.26
NP-4	7/24/07	Fillet	2342	68	6/J	<4.69	<2.35	<2.35	<2.35	<2.35	<2.35	<2.35
NP-4(dup)						<4.65	<2.33	<2.33	<2.33	<2.33	<2.33	<2.33
NP-5	7/24/07	Fillet	3445	74	6/F	4.76	<2.37	<2.37	<2.37	<2.37	<2.37	<2.37

Independence Lake Fish PFC analysis

Species & Sample ID	Sample Date	Tissue	Wt (g)	Ln (cm)	Age/ sex (yrs)	PFOS ng/g (ppb)	PFOA ng/g (ppb)	PFBA ng/g (ppb)	PFOSA ng/g (ppb)	PFDA ng/g (ppb)	PFUnA ng/g (ppb)	PFDoA ng/g (ppb)
Bluegill												
BGS-4	7/24/07	Fillet	13	10	2/J	5.1	<2.50	<2.50	<2.50	<2.50	<2.50	<2.50
BGS-6	7/24/07	Fillet	14	10	2/J	<4.88	<2.44	<2.44	<2.44	<2.44	<2.44	<2.44
BGS-7	7/24/07	Fillet	14	9.5	1/J	5.41	<2.50	<2.50	<2.50	<2.50	<2.50	<2.50
BGS-8	7/24/07	Fillet	45	14	4/F	<4.83	<2.42	<2.42	<2.42	<2.42	<2.42	<2.42
BGS-9	7/24/07	Fillet	55	15	4/M	<4.85	<2.43	<2.43	<2.43	<2.43	<2.43	<2.43
BGS-comp	7/24/07	Fillet	45a	13a		<4.88	<2.44	<2.44	<2.44	<2.44	<2.44	<2.44
Black Crappie												
BKS-1	7/24/07	Fillet	70	18	4/F	<4.95	<2.48	<2.48	<2.48	<2.48	<2.48	<2.48
BKS-2	7/24/07	Fillet	78	19	5/F	<4.65	<2.33	<2.33	<2.33	<2.33	<2.33	<2.33
BKS-3	7/24/07	Fillet	81	18	4/M	<5.00	<2.50	<3.22	<2.50	<2.50	<2.50	<2.50
BKS-4	7/24/07	Fillet	81	19	5/M	<4.93	<2.46	<2.46	<2.46	<2.46	<2.46	<2.46
BKS-5	7/24/07	Fillet	139	22	6/F	<4.93	<2.46	<2.46	<2.46	<2.46	<2.46	<2.46
Northern Pike												
NP-1	7/24/07	Fillet	2000	57	4/F	<5.54	<2.40	<2.40	<2.40	<2.40	<2.40	<2.40
NP-2	7/24/07	Fillet	3700	76	6/M	<4.90	<2.45	<2.45	<2.45	<2.45	<2.45	<2.45
NP-2(dup)						<4.95	<2.48	<2.48	<2.48	<2.48	<2.48	<2.48

Jane Lake Fish PFC analysis

Species & Sample ID	Sample Date	Tissue	Wt (g)	Ln (cm)	Age/ sex (yrs)	PFOS ng/g (ppb)	PFOA ng/g (ppb)	PFBA ng/g (ppb)	PFOSA ng/g (ppb)	PFDA ng/g (ppb)	PFUnA ng/g (ppb)	PFDoA ng/g (ppb)
Bluegill												
BGS-4	6/07	Fillet	16	10.5	2/J	20.7	<2.46	<2.46*	<2.46	<2.46	<2.46	<2.46
BGS-6	6/07	Fillet	99	18	6/F	8.62#	<2.50	<2.50*	<2.50	<2.50	<2.50	<2.50
BGS-7	6/07	Fillet	73	17.2	6/M	46.3	<2.44	<2.44*	<2.44	<2.44	<2.44	<2.44
BGS-7(dup)						36.5#	<2.48	<2.48*	<2.48	<2.48	<2.48	<2.48
BGS-8	6/07	Fillet	18	10.6	2/J	12.2#	<2.50	<2.50*	<2.50	<2.50	<2.50	<2.50
BGS-10	6/07	Fillet	95	NA	4/M	<4.95	<2.48	<2.48*	<2.48	<2.48	<2.48	<2.48
BGS-comp	6/07	Fillet	43a	13a		7.76	<2.46	<2.46	<2.46	<2.46	<2.46	<2.46
Black Crappie												
BKS-1	6/07	Fillet	65	15	3/M	13.6#	<2.40	<2.40*	<2.40	<2.40	<2.40	<2.40
BKS-2	6/07	Fillet	109	18.2	5/M	26.2	<2.40	<2.40*	<2.40	<2.40	<2.40	<2.40
BKS-3	6/07	Fillet	78	17.8	4/F	10.2#	<2.48	<2.48*	<2.48	<2.48	<2.48	<2.48
BKS-4	6/07	Fillet	63	16.5	4/M	39.7	<2.48	<2.48	<2.48	<2.48	<2.48	<2.48
BKS-5	6/07	Fillet	96	19.5	5/M	34.2	<2.45	<2.45	<2.45	<2.45	<2.45	<2.45
BKS-6	6/07	Fillet	99	21	6/F	19.5	<2.46	<2.46	<2.46	<2.46	<2.46	<2.46
BKS-7	6/07	Fillet	115	20	5/M	34.8#	<2.43	<2.43	<2.43	<2.43	<2.43	<2.43
BKS-7(dup)						21.9#	<2.42	<2.42	<2.42	<2.42	<2.42	<2.42
BKS-8	6/07	Fillet	108	19	5/M	21.7	<2.46	<2.46	<2.46	<2.46	<2.46	<2.46
Largemouth Bass												
LMB-1	6/07	Fillet	507	33	5/M	35.1	<2.49	<2.49	<2.49	<2.49	<2.49	<2.49
LMB-2	6/07	Fillet	535	36	7/M	38.1	<2.49	<2.49	<2.49	<2.49	<2.49	<2.49
LMB-3	6/07	Fillet	599	33	5/M	83.4	<3.65	<5.00	<2.49	3.32	2.82	<2.49
LMB-4	6/07	Fillet	525	36	7/M	25.8	<2.43	<2.43	<2.43	<2.43	<2.43	<2.43
LMB-5	6/07	Fillet	809	NA	6/F	53.6	<2.44	<2.97	<2.44	<2.44	<2.44	<2.44

Johanna Lake Fish PFC analysis

Species & Sample ID	Sample Date	Tissue	Wt (g)	Ln (cm)	Age/ sex (yrs)	PFOS ng/g (ppb)	PFOA ng/g (ppb)	PFBA ng/g (ppb)	PFOSA ng/g (ppb)	PFDA ng/g (ppb)	PFUnA ng/g (ppb)	PFDoA ng/g (ppb)
Bluegill												
BGS-1	6/19/07	Fillet	71	16	5/M	183	<2.44	<2.44*	<2.44	<2.44	<2.44	<2.44
BGS-2	6/19/07	Fillet	56	14.5	4/M	184#	<2.43	<2.43*	<2.43	4.02	<2.43	<2.43
BGS-3	6/19/07	Fillet	94	18	6/M	176#	<2.40	<2.40*	<2.40	3.85	3.86	7.34
BGS-6	6/19/07	Fillet	42	13	3/M	207#	<2.46	<2.46*	<2.46	5.69	4.3	3.58
BGS-7	6/19/07	Fillet	55	16	4/M	230	<2.49	<2.52*	<2.49	3.73	<2.49	<2.49
BGS-8	6/19/07	Fillet	57	15.5	4/M	292	<2.44	<2.44*	<2.44	<2.44	<2.44	<2.44
BGS-comp	6/19/07	Fillet	55a	14a		250	<2.45	<2.45	<2.45	3.24	<2.45	2.65
Black Crappie												
BKS-1	6/19/07	Fillet	89	NA	4/M	384	<2.34	<2.34	<2.34	8.92	3.94	3.31
BKS-2	6/19/07	Fillet	83	20	5/F	213	<2.44	<3.06	<2.44	4.51	<2.44	<2.44
BKS-3	6/19/07	Fillet	94	20	5/F	70.3	<2.48	<2.48	<2.48	2.66	<2.48	<2.48

2007 MPCA PFC Fish Data

Josephine Fish PFC analysis

Species & Sample ID	Sample Date	Tissue	Wt (g)	Ln (cm)	Age/sex (yrs)	PFOS ng/g (ppb)	PFOA ng/g (ppb)	PFBA ng/g (ppb)	PFOSA ng/g (ppb)	PFDA ng/g (ppb)	PFUnA ng/g (ppb)	PFDoA ng/g (ppb)
Bluegill												
BGS-1	5/24/06	Fillet	37	11	2M	73.4	< 2.43	< 2.43	< 2.43	< 2.43	< 2.43	< 2.43
BGS-2	5/24/06	Fillet	58	14	4/F	52.5	< 2.49	< 2.49	< 2.49	< 2.49	< 2.49	< 2.49
BGS-4	5/24/06	Fillet	68	16	5/M	50.2	< 2.46	< 2.46	< 2.46	< 2.46	< 2.46	< 2.46
BGS-5	5/24/06	Fillet	44	13.1	3/F	102	< 2.51	< 2.51	< 2.51	< 2.51	< 2.51	< 2.51
BGS-10	5/24/06	Fillet	38	13.2	3M	55.6	< 2.46	< 2.46	< 2.46	< 2.46	< 2.46	< 2.46#
BGS-12	5/24/06	Fillet	36	13	3/M	188	< 2.50	< 2.50	< 2.50	3.07	< 2.50	< 2.50
BGS-comp	5/24/06	Fillet	42a	14a		92.6	< 2.48	< 2.48	< 2.49	< 2.48	2.98	< 2.48

Keller Lake Fish PFC analysis

Species & Sample ID	Sample Date	Tissue	Wt (g)	Ln (cm)	Age/sex (yrs)	PFOS ng/g (ppb)	PFOA ng/g (ppb)	PFBA ng/g (ppb)	PFOSA ng/g (ppb)	PFDA ng/g (ppb)	PFUnA ng/g (ppb)	PFDoA ng/g (ppb)
Bluegill												
BGS-1	7/07	Fillet	50	13.5	3/M	26.2	<2.45	<2.45	<2.45	<2.45	<2.45	<2.45
BGS-2	7/07	Fillet	54	14.5	4/J	64.6	<2.35	<2.35	<2.35	2.5	<2.35	<2.35
BGS-5	7/07	Fillet	56	14	4/M	97.1	<2.46	<2.46	<2.46	4.88	4.31	<2.46
BGS-7	7/07	Fillet	58	15	4/F	50.1	<2.46	<2.46	<2.46	4.47	2.99	<2.46
BGS-10	7/07	Fillet	58	15	4/M	106	<2.49	<2.49	<2.49	4.81	3.77	2.73
BGS-comp	7/07	Fillet	53a	15a		70	<2.10	<2.10	<2.10	2.67	<2.10	<2.10

Minnetonka Fish PFC analysis

Species & Sample ID	Sample Date	Tissue	Wt (g)	Ln (cm)	Age/sex (yrs)	PFOS ng/g (ppb)	PFOA ng/g (ppb)	PFBA ng/g (ppb)	PFOSA ng/g (ppb)	PFDA ng/g (ppb)	PFUnA ng/g (ppb)	PFDoA ng/g (ppb)
Bluegill												
BGS-1	6/21/07	Fillet	72	15.5	5/F	< 4.90	< 2.45	< 2.45	< 2.45	< 2.45	< 2.45	< 2.45
BGS-4	6/21/07	Fillet	69	13.2	3/F	< 4.93	< 2.46	< 2.46	< 2.46	< 2.46	< 2.46	< 2.46
BGS-5	6/21/07	Fillet	54	12	2/F	< 4.98	< 2.49	< 2.49	< 2.49	< 2.49	< 2.49	< 2.49
BGS-9	6/21/07	Fillet	16	10	2/J	< 5.03	< 2.51	< 2.51	< 2.51	< 2.51	< 2.51	< 2.51
BGS-10	6/21/07	Fillet	15	10	2/J	< 4.98	< 2.49	< 2.49	< 2.49	< 2.49	< 2.49	< 2.49
BGS-comp		Fillet	49a	13a		7.47	< 2.50	< 2.50	< 2.50	< 2.50	< 2.50	< 2.50
Black Crappie												
BKS-1	6/22/07	Fillet	464	34	11/F	7.16	< 2.51	< 2.51	< 2.51	< 2.51	< 2.51	< 2.51
BKS-1(dup)						8.04	< 2.37	< 2.37	< 2.37	< 2.37	< 2.37	< 2.37
BKS-2	6/22/07	Fillet	300	28	8/F	6.22	< 2.49	< 2.49	< 2.49	< 2.49	< 2.49	< 2.49
BKS-3	6/22/07	Fillet	192	24	7/M	10.9	< 2.46	< 2.46	< 2.46	< 2.46	< 2.46	< 2.46
BKS-4	6/22/07	Fillet	121	21	6/F	< 4.92	< 2.46	< 2.46	< 2.46	< 2.46	< 2.46	< 2.46
BKS-5	6/22/07	Fillet	90	19	5/F	< 5.03	< 2.51	< 4.18	< 2.51	< 2.51	< 2.51	< 2.51
Northern Pike												
NP-1	6/15/07	Fillet	2987	71	5/F	10.3	< 2.48	< 2.48	< 2.48	< 2.48	< 2.48	< 2.48
NP-2	6/15/07	Fillet	3700	80	6/M	7.83	< 2.50	< 2.50	< 2.50	< 2.50	< 2.50	< 2.50
NP-3	6/15/07	Fillet	1830	62	4/F	7.61	< 2.49	< 2.49	< 2.49	< 2.49	< 2.49	< 2.49

Nokomis Fish PFC analysis

Species & Sample ID	Sample Date	Tissue	Wt (g)	Ln (cm)	Age/ sex (yrs)	PFOS ng/g (ppb)	PFOA ng/g (ppb)	PFBA ng/g (ppb)	PFOSA ng/g (ppb)	PFDA ng/g (ppb)	PFUnA ng/g (ppb)	PFDoA ng/g (ppb)
Bluegill												
BGS-1	7/17/07	Fillet	25	11	2/M	10.8	<2.44	<2.44	<2.44	<2.44	<2.44	<2.44
BGS-2	7/17/07	Fillet	73	16	5/M	9.21	<2.38	<2.38	<2.38	<2.38	<2.38	<2.38
BGS-3	7/17/07	Fillet	58	15	4/M	13.4	<2.50	<2.50	<2.50	<2.50	<2.50	<2.50
BGS-4	7/17/07	Fillet	31	11	2/M	7.71	<2.49	<3.00	<2.49	<2.49	<2.49	<2.49
BGS-5	7/17/07	Fillet	55	14	4/F	6.45	<2.45	<2.45	<2.45	<2.45	<2.45	<2.45
BGS-6	7/17/07	Fillet	49	14.5	4/F	7.23	<2.43	<2.43	<2.43	<2.43	<2.43	<2.43
BGS-7	7/17/07	Fillet	69	15	4/M	11.4	<2.45	<2.45	<2.45	<2.45	<2.45	<2.45
Black Crappie												
BKS-1	7/17/07	Fillet	84	18.5	5/M	11.7	<2.49	<2.49	<2.49*	<2.49	<2.49	<2.49
BKS-2	7/17/07	Fillet	74	17.8	4/M	10.1	<2.46	<2.46	<2.46*	<2.46	<2.46	<2.46
BKS-3	7/17/07	Fillet	72	17.5	4/F	12.3	<2.45	<2.45	<2.45*	<2.45	<2.45	<2.45
BKS-4	7/17/07	Fillet	67	16.2	4/M	7.66	<2.45	<4.34	<2.45*	<2.45	<2.45	<2.45
BKS-5	7/17/07	Fillet	91	19	5/M	8.18	<2.79	<2.44	<2.44*	<2.44	<2.44	<2.44

Olson Lake Fish PFC analysis

Species & Sample ID	Sample Date	Tissue	Wt (g)	Ln (cm)	Age/ sex (yrs)	PFOS ng/g (ppb)	PFOA ng/g (ppb)	PFBA ng/g (ppb)	PFOSA ng/g (ppb)	PFDA ng/g (ppb)	PFUnA ng/g (ppb)	PFDoA ng/g (ppb)
Bluegill												
BGS-1	4/30/07	Fillet	19	10	2/F	7.8#	<2.34	<2.34*	<2.34	<2.34	<2.34	<2.34
BGS-2	4/30/07	Fillet	21	10	2/J	21.1#	<2.50	<2.50*	<2.50	<2.50	<2.50	<2.50
BGS-5	4/30/07	Fillet	33	13	3/J	24.7	<3.97	<3.97	<3.97	<3.97	<3.97	<3.97
BGS-8	4/30/07	Fillet	51	15	4/J	9.28	<2.44	<2.44	<2.44	<2.44	<2.44	<2.44
BGS-9	4/30/07	Fillet	85	15	4/F	<4.85	<2.43	<2.43	<2.43	<2.43	<2.43	<2.43
BGS-comp	4/30/07	Fillet	40a	13a		14.5	<2.46	<2.46	<2.46	<2.46	<2.46	<2.46
Largemouth Bass												
LMB-1	4/30/07	Fillet	1148	41	9/M	45.7	<2.40	<2.40*	<2.40	2.84	2.87	<2.40
LMB-2	4/30/07	Fillet	1170	39	7/M	43.6	<2.44	<2.44*	<2.44	2.51	2.85	<2.44
LMB-3	4/30/07	Fillet	1159	39	7/M	19.7	<2.45	<2.45*	<2.45*	<2.45	3.04	<2.45
LMB-4	4/30/07	Fillet	1379	42	9/M	77.5	<2.40	<2.40*	<2.40*	2.87	<2.40	<2.40
LMB-5	4/30/07	Fillet	1024	37	7/F	24.9	<2.40	<2.40*	<2.40	<2.40	<2.40	<2.40
LMB-5(dup)	4/30/07	Fillet				24.5	<2.49	<2.49*	<2.49	<2.49	<2.49	<2.49

Peltier Lake Fish PFC analysis

Species & Sample ID	Sample Date	Tissue	Wt (g)	Ln (cm)	Age/ sex (yrs)	PFOS ng/g (ppb)	PFOA ng/g (ppb)	PFBA ng/g (ppb)	PFOSA ng/g (ppb)	PFDA ng/g (ppb)	PFUnA ng/g (ppb)	PFDoA ng/g (ppb)
Bluegill												
BGS-1	2007	Fillet	58	15	4/M	17.6	<2.44	<2.44	<2.44*	<2.44	<2.44	<2.44
BGS-2	2007	Fillet	87	15.8	5/F	9.52	<2.48	<2.48	<2.48*	<2.48	<2.48	<2.48
BGS-3	2007	Fillet	50	13	3/F	15.1	<4.27	<2.45	<2.45*	<2.45	<2.45	<2.45
BGS-4	2007	Fillet	34	12.3	3/J	10.9	<2.50	<2.50	<2.50*	<2.50	<2.50	<2.50
BGS-5	2007	Fillet	30	11.5	2/F	7.53	<3.43	<2.50	<2.50*	<2.50	<2.50	<2.50
Northern Pike												
NP-1	2007	Fillet	607	45	4/J	20.7	<2.78	<2.65	<2.49	<2.49	<2.49	<2.49
NP-2	2007	Fillet	658	43	4/J	14.5	<2.43	<2.43	<2.43	<2.43	<2.43	<2.43
NP-3	2007	Fillet	764	51	4/J	8.2	<2.40	<2.40	<2.40	<2.40	<2.40	<2.40
NP-4	2007	Fillet	883	50	4/F	13.6	<2.49	<2.49	<2.49	<2.49	<2.49	<2.49
NP-5	2007	Fillet	1161	54	4/J	13.1	<2.48	<2.48	<2.48	<2.48	<2.48	<2.48

Lake Phalen Fish PFC analysis

Species & Sample ID	Sample Date	Tissue	Wt (g)	Ln (cm)	Age/ sex (yrs)	PFOS ng/g (ppb)	PFOA ng/g (ppb)	PFBA ng/g (ppb)	PFOSA ng/g (ppb)	PFDA ng/g (ppb)	PFUnA ng/g (ppb)	PFDoA ng/g (ppb)
Bluegill												
BGS-2	5/1/07	Fillet	19	10	2/J	156#	<2.49	<2.49*	<2.49	5.23	2.99	<2.49
BGS-4	5/1/07	Fillet	25	11.5	2/J	82.7#	<2.50	<2.50*	<2.50	3.14	<2.50	<2.50
BGS-6	5/1/07	Fillet	55	11.5	2/F	60.6	<2.36	<2.36	<2.36	<2.36	<2.36	<2.36
BGS-9	5/1/07	Fillet	101	16	5/M	93.4	<2.48	<2.48	<2.48	2.48#	<2.48	<2.48
BGS-10	5/1/07	Fillet	73	15	4/F	53.8	<2.38	<2.38	<2.38	2.61#	<2.38	<2.38
BGS-comp	5/1/07	Fillet	53a	12a		45.3	<2.42	<2.42	<2.42	<2.42	<2.42	<2.42
BGS-comp(dup)	5/1/07	Fillet				55	<2.24	<2.24	<2.24	<2.24	<2.24	<2.24
Black Crappie												
BKS-1	5/1/07	Fillet	26	12	2/J	42.1#	<2.39	<2.39*	<2.39	<2.39	<2.39	<2.39
BKS-2	5/1/07	Fillet	58	14	3/M	104	<2.42	<2.42*	<2.42	5.29	<2.42	<2.42
BKS-3	5/1/07	Fillet	67	17	4/M	67.7#	<2.36	<2.36*	<2.36	3.05	<2.36	<2.36
Largemouth Bass												
LMB-1	5/1/07	Fillet	1212	41	9/F	183	<2.49	<2.49*	<2.49	9.46	3.99	2.66
LMB-2	5/1/07	Fillet	596	33.5	5/M	136	<2.45	<2.45	<2.45	7.64	4.67	<2.45
LMB-2(dup)	5/1/07	Fillet				129	<2.48	<2.48	<2.48	6.14	3.88	<2.48
LMB-3	5/1/07	Fillet	1279	43	10/F	128	<2.34	<2.34*	<2.34	5.38	3.08	<2.34
LMB-4	5/1/07	Fillet	1415	42	9/F	147#	<2.35	<2.35*	<2.35	4.96	<2.35	<2.35
LMB-4(dup)	5/1/07	Fillet				147#	<2.44	<2.44*	<2.44	5.28	3.61	<2.44
LMB-5	5/1/07	Fillet	1872	43	10/F	120	<2.34	<2.34*	<2.34	3.63	<2.34	<2.34

Powers Lake Fish PFC analysis

Species & Sample ID	Sample Date	Tissue	Wt (g)	Ln (cm)	Age/ sex (yrs)	PFOS ng/g (ppb)	PFOA ng/g (ppb)	PFBA ng/g (ppb)	PFOSA ng/g (ppb)	PFDA ng/g (ppb)	PFUnA ng/g (ppb)	PFDoA ng/g (ppb)
Bluegill												
BGS-1	7/07	Fillet	31	13	3/F	48.5	<2.48	<2.48	<2.48	<2.48	<2.48	<2.48
BGS-2	7/07	Fillet	66	15	4/M	45	<2.50	<2.50	<2.50	<2.50	<2.50	<2.50
BGS-6	7/07	Fillet	59	16.5	6/M	44.8	<2.48	<2.48	<2.48	<2.48	<2.48	<2.48
BGS-9	7/07	Fillet	58	17	6/M	26.6	<2.40	<2.40	<2.40	<2.40	<2.40	<2.40
BGS-10	7/07	Fillet	40	NA	5/F	32.7	<2.45	<2.45	<2.45	<2.45	<2.45	<2.45
BGS-comp	7/07	Fillet	43a	13a		65.3	<2.48	<2.48	<2.48	<2.48	<2.48	<2.48
Black Crappie												
BKS-1	7/07	Fillet	99	20	5/M	63.9	<2.39	<2.39	<2.39*	<2.39	<2.39	<2.39
BKS-2	7/07	Fillet	100	20	5/F	59.9	<2.35	<2.35	<2.35*	2.49	<2.35	<2.35
BKS-3	7/07	Fillet	109	19	5/F	53.3	<4.84	<2.45	<2.45*	2.47	<2.45	<2.45
BKS-4	7/07	Fillet	108	20	5/F	33.6	<2.49	<4.64	<2.49	<2.49	<2.49	<2.49
BKS-5	7/07	Fillet	105	19	5/F	42.9	<2.34	<2.34	<2.34	<2.34	<2.34	<2.34
Northern Pike												
NP-1	7/07	Fillet	2233	70	6/M	71.1	<2.49	<2.49	<2.49	3.08	2.64	<2.49
NP-2	7/07	Fillet	1680	64	5/M	71.9	<2.50	<2.50	<2.50	3.04	<2.50	<2.50
NP-3	7/07	Fillet	NA	70	6/J	62.8	<2.48	<2.48	<2.48	2.73	2.56	<2.48
Yellow Perch												
YP-comp	7/07	Fillet	34a	15a		41.6	<2.36	<2.36	<2.36	<2.36	<2.36	<2.36

Prior (Upper) Lake Fish PFC analysis

Species & Sample ID	Sample Date	Tissue	Wt (g)	Ln (cm)	Age/ sex (yrs)	PFOS ng/g (ppb)	PFOA ng/g (ppb)	PFBA ng/g (ppb)	PFOSA ng/g (ppb)	PFDA ng/g (ppb)	PFUnA ng/g (ppb)	PFDoA ng/g (ppb)
Bluegill												
BGS-2	8/23/07	Fillet	29	12	3/M	5.25	<2.46	<2.46	<2.46	<2.46	<2.46	<2.46
BGS-4	8/23/07	Fillet	27	11	2/F	<4.95	<2.48	<2.48	<2.48	<2.48	<2.48	<2.48
BGS-6	8/23/07	Fillet	41	13	3/F	<4.81	<2.40	<2.40	<2.40	<2.40	<2.40	<2.40
BGS-8	8/23/07	Fillet	48	13	3/F	<5.00	<2.50	<2.50	<2.50	<2.50	<2.50	<2.50
BGS-10	8/23/07	Fillet	85	16	5/M	<4.98	<2.49	<2.49	<2.49	<2.49	<2.49	<2.49
BGS-comp	8/23/07	Fillet	38a	12a		<4.98	<2.49	<2.49	<2.49	<2.49	<2.49	<2.49
Largemouth Bass												
LMB-1	8/23/07	Fillet	576	33	5/M	<4.90	2.8	<2.45	<2.45*	<2.45	<2.45	<2.45
LMB-2	8/23/07	Fillet	653	35	6/F	6.14	<2.49	<19.6	<2.49*	2.62	<2.49	<2.49
LMB-3	8/23/07	Fillet	503	32	5/M	<4.93	<2.46	<2.46	<2.46*	<2.46	<2.46	<2.46
LMB-4	8/23/07	Fillet	370	31	5/F	<4.76	<2.38	<2.38	<2.38*	<2.38	<2.38	<2.38
LMB-5	8/23/07	Fillet	744	37	7/F	<4.95	<2.48	<2.48	<2.48*	<2.48	<2.48	<2.48

Ravine Lake Fish PFC analysis

Species & Sample ID	Sample Date	Tissue	Wt (g)	Ln (cm)	Age/ sex (yrs)	PFOS ng/g (ppb)	PFOA ng/g (ppb)	PFBA ng/g (ppb)	PFOSA ng/g (ppb)	PFDA ng/g (ppb)	PFUnA ng/g (ppb)	PFDoA ng/g (ppb)
Bluegill												
BGS-1	4/30/07	Fillet	30	10	2/M	10.3	<2.46	<2.46	<2.46	<2.46	<2.46	<2.46
BGS-4	4/30/07	Fillet	35	12	3/J	10.8	<4.67	<4.67	<4.67	<4.67	<4.67	<4.67
BGS-5	4/30/07	Fillet	23	10	2/M	45.1	<2.49	<2.49	<2.49	<2.49	<2.49	<2.49
BGS-9	4/30/07	Fillet	206	19.5	7/M	29.3	<2.29	<2.29	<2.29	<2.29	<2.29	<2.29
BGS-9(dup)	4/30/07	Fillet				30.3	<2.45	<2.45	<2.45	<2.45	<2.45	<2.45
BGS-10	4/30/07	Fillet	97	16	5/M	19.3	<2.48	<2.48	<2.48	<2.48	<2.48	<2.48
BGS-comp	4/30/07	Fillet	60a	13a		19.4	<2.43	<2.43	<2.43	<2.43	<2.43	<2.43
Black Crappie												
BKS-1	4/30/07	Fillet	52	15	3/F	55.9	<2.48	<2.48*	<2.48*	<2.48	<2.48	<2.48
BKS-2	4/30/07	Fillet	43	15	3/J	64.5	<2.42	<2.42*	<2.42*	<2.42	<2.42	<2.42
BKS-3	4/30/07	Fillet	42	14	3/J	77.8	2.69	<2.56*	<2.56	<2.56	<2.56	<2.56
BKS-4	4/30/07	Fillet	50	15	3/J	60.4	<2.31	<2.31*	<2.31	<2.31	<2.31	<2.31
BKS-5	4/30/07	Fillet	45	14	3/F	41.3	<2.35	<2.35*	<2.35*	<2.35	<2.35	<2.35
Largemouth Bass												
LMB-1	4/30/07	Fillet	725	32.5	5/M	50.6	<2.40	<2.40*	<2.40*	<2.40	<2.40	<2.40
LMB-2	4/30/07	Fillet	890	35	6/M	36	<2.13	<2.13*	<2.13*	<2.13	<2.13	<2.13
LMB-3	4/30/07	Fillet	911	34.5	6/F	65.2	<2.38	<2.38*	<2.38*	<2.38	<2.38	<2.38
LMB-4	4/30/07	Fillet	1084	36.5	7/M	107	<2.40	<2.40*	<2.40*	<2.40	<2.40	<2.40
LMB-5	4/30/07	Fillet	1011	33	5/M	53.8	<2.31	<2.31*	<2.31*	<2.31	<2.31	<2.31

Red Rock Lake Fish PFC analysis

Species & Sample ID	Sample Date	Tissue	Wt (g)	Ln (cm)	Age/ sex (yrs)	PFOS ng/g (ppb)	PFOA ng/g (ppb)	PFBA ng/g (ppb)	PFOSA ng/g (ppb)	PFDA ng/g (ppb)	PFUnA ng/g (ppb)	PFDoA ng/g (ppb)
Bluegill												
BGS-6	8/17/07	Fillet	5	10	2/J	42	<2.40	<2.40	<2.40	<2.40	<2.40	<2.40
BGS-7	8/17/07	Fillet	43	13.9	4/J	32.7	<2.48	<2.48	<2.48	<2.48	<2.48	<2.48
BGS-8	8/17/07	Fillet	61	15.2	5/M	42.2	<2.43	<2.43	<2.43	<2.43	<2.43	<2.43
BGS-9	8/17/07	Fillet	130	18.2	7/M	58.3	<2.45	<2.45	<2.45	<2.45	<2.45	<2.45
BGS-10	8/17/07	Fillet	57	14	4/F	29.2	<2.44	<2.44	<2.44	<2.44	<2.44	<2.44
BGS-comp	8/17/07	Fillet	27a	11a		35.2	<2.38	<3.02	<2.38	<2.38	<2.38	<2.38
Black Crappie												
BKS-1	8/17/07	Fillet	81	17	4/F	79.9	<2.48	<2.48	<2.48	2.73	<2.48	<2.48
BKS-2	8/17/07	Fillet	102	20	5/F	97.1	<2.48	<2.48	<2.48	3.07	<2.48	<2.48
BKS-3	8/17/07	Fillet	149	21	6/M	153	<2.49	<2.49	<2.49	3.69	<2.49	<2.49
BKS-4	8/17/07	Fillet	283	27	8/F	115	<2.43	<2.43	<2.43	3.62	<2.43	<2.43
BKS-5	8/17/07	Fillet	122	19	5/F	68.6	<2.49	<2.49	<2.49	2.95	<2.49	<2.49
Largemouth Bass												
LMB-1	8/17/07	Fillet	666	38	7/M	85.7	<2.76	<2.42	<2.42*	2.67	<2.42	<2.42
LMB-2	8/17/07	Fillet	527	33	5/F	60.6	<2.60	<2.44	<2.44*	2.69	<2.44	<2.44
LMB-3	8/17/07	Fillet	566	33	5/J	64.5	<2.46	<2.46	<2.46*	3.22	<2.46	<2.46
LMB-4	8/17/07	Fillet	591	33	5/F	57.4	<2.48	<2.48	<2.48*	<2.48	<2.48	<2.48
LMB-5	8/17/07	Fillet	716	36	7/M	74.4	<3.99	<2.33	<2.33*	3.07	<2.33	<2.33

2007 MPCA PFC Fish Data

Sarah Lake Fish PFC analysis

Species & Sample ID	Sample Date	Tissue	Wt (g)	Ln (cm)	Age/ sex (yrs)	PFOS ng/g (ppb)	PFOA ng/g (ppb)	PFBA ng/g (ppb)	PFOSA ng/g (ppb)	PFDA ng/g (ppb)	PFUnA ng/g (ppb)	PFDoA ng/g (ppb)
Bluegill												
BGS-3	7/16/07	Fillet	70	17	6/F	6.12	<2.48	<2.48	<2.48	<2.48	<2.48	<2.48
BGS-4	7/16/07	Fillet	86	18	7/M	6.21#	<2.49	<2.49	<2.49	<2.49	<2.49	<2.49
BGS-6	7/16/07	Fillet	74	17	6/F	7.97	<2.49	<2.49	<2.49	<2.49	<2.49	<2.49
BGS-7	7/16/07	Fillet	10	7	1/J	8.51	<2.43	<2.43	<2.43	<2.43	<2.43	<2.43
BGS-9	7/16/07	Fillet	15	9.2	1/J	<5.00	<2.50	<2.50	<2.50	<2.50	<2.50	<2.50
BGS-comp	7/16/07	Fillet	52a	13a		<4.90	<2.45	<2.45	<2.45	<2.45	<2.45	<2.45
Black Crappie												
BKS-1	7/16/07	Fillet	NA	21	6/F	<4.95	<2.48	<2.48	<2.48	<2.48	<2.48	<2.48
BKS-2	7/16/07	Fillet	NA	20	5/M	<5.00	<2.50	<2.50	<2.50	<2.50	<2.50	<2.50
BKS-3	7/16/07	Fillet	NA	24	7/F	<4.83	<2.42	<2.42	<2.42	<2.42	<2.42	<2.42
BKS-4	7/16/07	Fillet	NA	20	5/M	<4.76	<2.38	<9.45	<2.38	<2.38	<2.38	<2.38
BKS-5	7/16/07	Fillet	NA	21	6/M	<4.93	<2.46	<2.46	<2.46	<2.46	<2.46	<2.46
Northern Pike												
NP-1	7/16/07	Fillet	3440	70.7	6/F	7.88	<2.64	<2.45	<2.45	<2.45	<2.45	<2.45
NP -2	7/16/07	Fillet	4052	85	7/F	10.8	<2.49	<2.49	<2.49	<2.49	<2.49	<2.49
NP -2(dup)		Fillet				14.4	<2.43	<2.43	<2.43	<2.43	<2.43	<2.43
NP -3	7/16/07	Fillet	3821	85	8/F	13.6	<2.45	<2.45	<2.45	<2.45	<2.45	<2.45
NP -4	7/16/07	Fillet	3229	81.5	7/F	7.45	<2.42	<2.42	<2.42	<2.42	<2.42	<2.42
NP -5	7/16/07	Fillet	1757	66	5/M	9.6	<2.39	<2.39	<2.39	<2.39	<2.39	<2.39

Silver Lake Fish PFC analysis

Species & Sample ID	Sample Date	Tissue	Wt (g)	Ln (cm)	Age/ sex (yrs)	PFOS ng/g (ppb)	PFOA ng/g (ppb)	PFBA ng/g (ppb)	PFOSA ng/g (ppb)	PFDA ng/g (ppb)	PFUnA ng/g (ppb)	PFDoA ng/g (ppb)
Bluegill												
BGS-3	5/4/07	Fillet	64	16	5/M	24	<2.40	<2.40	<2.40	<2.40	3.38	<2.40
BGS-4	5/4/07	Fillet	38	13	3/F	19.6	<2.43	<2.43	<2.43	<2.43	2.53	<2.43
BGS-5	5/4/07	Fillet	36	13	3/F	24.4#	<2.42	<2.42	<2.42	<2.42	<2.42	<2.42
BGS-7	5/4/07	Fillet	43	14	4/F	31.3	<2.48	<2.48	<2.48	<2.48	<2.48	<2.48
BGS-9	5/4/07	Fillet	32	13	3/F	21.4	<2.42	<2.42	<2.42	<2.42	<2.42	<2.42
BGS-comp	5/4/07	Fillet	59a	14a		33.7	<2.44	<2.44	<2.44	<2.44	<2.44	2.89
Black Crappie												
BKS-1	5/4/07	Fillet	69	16	5/F	26.6#	<2.46	<2.46	<2.46	2.92	<2.46	<2.46
BKS-4	5/4/07	Fillet	63	17	4/M	36.6	<2.48	<2.48	<2.48	3.39	<2.48	3.38
BKS-6	5/4/07	Fillet	67	18	5/M	45	<2.49	<2.49	<2.49	4.52	<2.49	2.89
BKS-7	5/4/07	Fillet	67	18	5/M	28.6	<2.50	<2.50	<2.50	3.88	3.11	3.05
BKS-10	5/4/07	Fillet	296	27	8/F	29.3#	<2.43	<2.43	<2.43	3.77	3.08	<2.43
BKS-10(dup)						26.2	<2.44	<2.44	2.65	<2.44	<2.44	<2.44
BKS-comp	5/4/07	Fillet	110	19		34.9	<2.45	<2.45	<2.45	<2.45	<2.45	<2.45
BKS-comp(dup)						33.5	<2.48	<2.48	<2.48	<2.48	<2.48	<2.48
Walleye												
WE-1	5/4/07	Fillet	453	50	9/M	10.2	<2.40	<4.84	2.71	<2.40	<2.40	<2.40
WE-1(dup)						10.8	<2.42	<2.42	4.2	<2.42	<2.42	<2.42
WE-2	5/4/07	Fillet	486	52	10/M	18.8	<2.44	<2.44	4.65	2.8	2.85	<2.44
WE-3	5/4/07	Fillet	371	27	4/M	10.5	<2.49	<2.49	5.31	<2.49	<2.49	<2.49
WE-4	5/4/07	Fillet	1200	46	8/M	26.6	<2.33	<2.33	4.82	2.99	2.49	2.96

Square Lake Fish PFC analysis

Species & Sample ID	Sample Date	Tissue	Wt (g)	Ln (cm)	Age/ sex (yrs)	PFOS ng/g (ppb)	PFOA ng/g (ppb)	PFBA ng/g (ppb)	PFOSA ng/g (ppb)	PFDA ng/g (ppb)	PFUnA ng/g (ppb)	PFDoA ng/g (ppb)
Bluegill												
BGS-2	5/2/07	Fillet	15	18.5	7/F	<4.57	<2.28	<2.28*	<2.28	<2.28	<2.28	<2.28
BGS-4	5/2/07	Fillet	21	10	2/F	<4.69	<2.35	<2.35*	<2.35	<2.35	<2.35	<2.35
BGS-8	5/2/07	Fillet	44	12.5	3/F	<4.72	<2.36	<2.36*	<2.36	<2.36	<2.36	<2.36
BGS-9	5/2/07	Fillet	84	16	5/M	<4.88	<2.44	<2.44*	<2.44	<2.44	<2.44	<2.44
BGS-10	5/2/07	Fillet	111	17.5	6/M	<4.95	<2.48	<2.48*	<2.48	<2.48	<2.48	<2.48
BGS-comp	5/2/07	Fillet	53a	13a		<4.72	<2.36	<2.36	<2.36	<2.36	<2.36	<2.36
Black Crappie												
BKS-1	5/2/07	Fillet	74	16.5	4/M	<4.93	<2.46	<2.46*	<2.46	<2.46	<2.46	<2.46
BKS-2	5/2/07	Fillet	125	18.5	5/M	5.2	<2.44	<2.44*	<2.44	<2.44	<2.44	<2.44
BKS-3	5/2/07	Fillet	94	18	5/M	<4.76	<2.38	<2.38*	<2.38	<2.38	<2.38	<2.38
BKS-4	5/2/07	Fillet	80	17	4/F	<4.90	<2.45	<2.45	<2.45	<2.45	<2.45	<2.45
BKS-5	5/2/07	Fillet	126	20	5/M	<4.98	<2.49	<2.49	<2.49	<2.49	<2.49	<2.49
Largemouth Bass												
LMB-1	5/2/07	Fillet	309	26.5	3/M	<4.67	<2.34	<2.34*	<2.34	<2.34	<2.34	<2.34
LMB-2	5/2/07	Fillet	301	28	3/M	<4.88	<2.44	<2.44*	<2.44	<2.44	<2.44	<2.44
LMB-3	5/2/07	Fillet	284	27.5	3/F	<4.81	<2.40	<2.40*	<2.40	<2.40	2.88	<2.40
LMB-4	5/2/07	Fillet	383	29.5	4/F	<5.00	<2.50	<2.50*	<2.50	<2.50	<2.50	<2.50
LMB-5	5/2/07	Fillet	316	28	3/M	<5.03	<2.51	<2.51*	<2.51	<2.51	<2.51	<2.51

Tanners Lake Fish PFC analysis

Species & Sample ID	Sample Date	Tissue	Wt (g)	Ln (cm)	Age/ sex (yrs)	PFOS ng/g (ppb)	PFOA ng/g (ppb)	PFBA ng/g (ppb)	PFOSA ng/g (ppb)	PFDA ng/g (ppb)	PFUnA ng/g (ppb)	PFDoA ng/g (ppb)
Bluegill												
BGS-1	6/12/07	Fillet	89	17	6/M	61.1#	<2.46	<2.46	<2.46	<2.46	<2.46	<2.46
BGS-2	6/12/07	Fillet	32	12.5	3/F	87#	<2.30	<2.30	<2.30	<2.30	<2.30	<2.30
BGS-5	6/12/07	Fillet	93	18	7/F	56.6	<2.48	<2.48	<2.48	<2.48	<2.48	<2.48
BGS-7	6/12/07	Fillet	89	16.5	6/F	70.4	<2.44	<2.44	<2.44	<2.44	<2.44	<2.44
BGS-10	6/12/07	Fillet	12	10	2/J	105	<2.49	<2.49	<2.49	4.36	<2.49	<2.49
BGS-comp	6/12/07	Fillet	50a	13a		55	<2.44	<2.59	<2.44	<2.44	<2.44	<2.44
Black Crappie												
BKS-1	6/12/07	Fillet	69	18	4/M	265	<2.45	<2.45	<2.45*	6.3	<2.45	<2.45
BKS-2	6/12/07	Fillet	63	15	3/M	75.9	<2.46	<2.46	<2.46	<2.46	<2.46	<2.46
BKS-3	6/12/07	Fillet	56	18	4/F	91.2	<2.38	<3.96	<2.38	2.82	<2.38	<2.38
BKS-4	6/12/07	Fillet	80	18.5	4/M	94.6	<2.39	<2.39	<2.39	<2.39	<2.39	<2.39
BKS-5	6/12/07	Fillet	56	17	4/F	64	<2.81	<2.40	<2.40	<2.40	<2.40	<2.40
Largemouth Bass												
LMB-1	6/12/07	Fillet	378	NA	4/F	96.5	<2.43	<3.18	<2.43	6.05	4.62	4.11
LMB-2	6/12/07	Fillet	619	NA	5/F	75.7	<2.44	<2.44	<2.44	4.86	4.42	8.37
LMB-3	6/12/07	Fillet	576	35	6/F	76.6	<2.39	<2.39	<2.39	3.56	4.73	3.4
LMB-4	6/12/07	Fillet	823	37	7/M	74.9	<2.44	<2.44	<2.44	3.44	<2.44	4.2
LMB-5	6/12/07	Fillet	1570	50	12/F	74.1	<2.56	<2.56	<2.56*	3.33	<2.56	<2.56

White Bear Lake Fish PFC analysis

Species & Sample ID	Sample Date	Tissue	Wt (g)	Ln (cm)	Age/ sex (yrs)	PFOS ng/g (ppb)	PFOA ng/g (ppb)	PFBA ng/g (ppb)	PFOSA ng/g (ppb)	PFDA ng/g (ppb)	PFUnA ng/g (ppb)	PFDoA ng/g (ppb)
Bluegill												
BGS-2	5/2/07	Fillet	26	10	2/F	<4.88	<2.44	<2.44*	<2.44	<2.44	<2.44	<2.44
BGS-3	5/2/07	Fillet	8	7	1/J	<8.13	<4.07	<4.07*	<4.07	<4.07	<4.07	<4.07
BGS-5	5/2/07	Fillet	32	12	3/J	<4.81	<2.40	<2.40*	<2.40	<2.40	<2.40	<2.40
BGS-7	5/2/07	Fillet	171	19	7/M	4.77	<2.28	<2.28*	<2.28	<2.28	<2.28	<2.28
BGS-8	5/2/07	Fillet	111	25.5	5/F	5.08	<2.34	<2.34*	<2.34	<2.34	<2.34	<2.34
BGS-comp	5/2/07	Fillet	64a	13a		6.06	<2.31	<2.31	<2.31	<2.31	<2.31	<2.31
Black Crappie												
BKS-1	5/2/07	Fillet	172	21	6/F	18.4	<2.44	<2.44*	<2.44	<2.44	<2.44	<2.44
BKS-2	5/2/07	Fillet	525	30	10/F	30.8	<2.54	<2.54*	<2.54	3.51	<2.54	<2.54
Largemouth Bass												
LMB-1	5/2/07	Fillet	811	35	6/M	<4.81	<2.40	<2.40*	<2.40	<2.40	<2.40	<2.40
LMB-2	5/2/07	Fillet	845	36.5	7/F	9.07	<2.49	<2.49*	<2.49	<2.49	<2.49	<2.49
LMB-3	5/2/07	Fillet	638	34	6/M	<4.76	<2.38	<2.38*	<2.38	<2.38	<2.38	<2.38
LMB-4	5/2/07	Fillet	515	31	5/M	<4.85	<2.43	<2.43*	<2.43	<2.43	<2.43	<2.43
LMB-5	5/2/07	Fillet	503	31	5/M	<4.85	<2.43	<2.43*	<2.43	<2.43	<2.43	<2.43

St. Croix River Fish PFC analysis

Species & Sample ID	Sample Date	Tissue	Wt (g)	Ln (cm)	Age/ sex (yrs)	PFOS ng/g (ppb)	PFOA ng/g (ppb)	PFBA ng/g (ppb)	PFOSA ng/g (ppb)	PFDA ng/g (ppb)	PFUnA ng/g (ppb)	PFDoA ng/g (ppb)
Bluegill												
BGS-3	7/19/07	Fillet	86	15.5	5/F	<4.83	<2.42	<2.42	<2.42	<2.42	<2.42	<2.42
BGS-5	7/19/07	Fillet	83	14.5	4/F	33.1	<2.45	<2.45	<2.45	<2.45	<2.45	<2.45
BGS-7	7/19/07	Fillet	122	18.5	7/M	<4.95	<2.48	<2.48	<2.48	<2.48	<2.48	<2.48
BGS-8	7/19/07	Fillet	76	15	4/M	22.3	<2.40	<2.40	<2.40	<2.40	<2.40	<2.40
BGS-10	7/19/07	Fillet	80	15	4/M	13.1	<2.44	<2.65	<2.44	<2.44	<2.44	<2.44
BGS-comp	7/19/07	Fillet	82a	15a		12	<2.42	<2.42	<2.42	<2.42	<2.42	<2.42
BGS-comp(dup)						16.4	<2.46	<2.46	<2.46	<2.46	<2.46	<2.46
Walleye												
WE-1	7/19/07	Fillet	670	45	8/M	8.34	<2.45	<3.85	<2.45*	<2.45	<2.45	<2.45
WE-2	7/19/07	Fillet	695	44	7/M	13.8	<2.35	<2.35	<2.35*	<2.35	<2.35	<2.35
WE-3	7/19/07	Fillet	641	42	6/M	12	<2.42	<2.42	<2.42*	<2.42	<2.42	<2.42
WE-4	7/19/07	Fillet	919	48	9/M	40.2	<2.42	<2.42	<2.42*	<2.42	<2.42	<2.42
WE-5	7/19/07	Fillet	890	48	9/M	12.7	<2.49	<2.49	<2.49	<2.49	<2.49	<2.49
White Bass												
WHB-1	7/19/07	Fillet	403	34	5/F	81.8	<2.50	<2.50	<2.50	2.63	<2.50	<2.50
Smallmouth Bass												
SMB-1	7/19/07	Fillet	573	35	3/M	12.3	<2.29	<2.29	<2.29	<2.29	<2.29	<2.29
SMB-2	7/19/07	Fillet	730	38	4/M	29.1	<2.45	<2.45	<2.45	<2.45	<2.45	<2.45
SMB-2(dup)						31.4	<2.22	<2.22	<2.22	<2.22	<2.22	<2.22
SMB-3	7/19/07	Fillet	425	30	1/M	<4.90	<2.45	<2.45	<2.45	<2.45	<2.45	<2.45
SMB-4	7/19/07	Fillet	286	29	1/M	5.44	<2.33	<2.33	<2.33	<2.33	<2.33	<2.33
SMB-5	7/19/07	Fillet	252	27	1/M	11.2	<2.48	<2.48	<2.48	<2.48	<2.48	<2.48

Mississippi River Brainerd area Fish PFC analysis												
Species & Sample ID	Sample Date	Tissue	Wt (g)	Ln (cm)	Age/ sex (yrs)	PFOS ng/g (ppb)	PFOA ng/g (ppb)	PFBA ng/g (ppb)	PFOSA ng/g (ppb)	PFDA ng/g (ppb)	PFUnA ng/g (ppb)	PFDoA ng/g (ppb)
Bluegill												
BGS-1	8/13/07	Fillet	50	14	4/J	7.38	<2.44	<2.47	<2.44*	<2.44	<2.44	<2.44
BGS-2	8/13/07	Fillet	59	13.3	3/F	12.3	<2.45	<2.45	<2.45*	<2.45	<2.45	<2.45
Walleye												
WE-1	8/13/07	Fillet	225	31	5/J	9.42	<2.35	<2.35	<2.35*	<2.35	<2.35	<2.35
WE-2	8/13/07	Fillet	625	43	7/F	8	<2.48	<2.48	<2.48*	<2.48	<2.48	<2.48
WE-3	8/13/07	Fillet	325	32	5/F	7.69	<2.46	<2.46	<2.46*	<2.46	<2.46	<2.46
WE-4	8/13/07	Fillet	1425	49	9/M	10.4	<2.42	<2.42	<2.42*	<2.42	<2.42	<2.42
WE-5	8/13/07	Fillet	1850	54	11/ M	8.75	<2.35	<2.35	<2.35*	<2.35	<2.35	<2.35
WE-5(dup)						8.99	<2.43	<8.25	<2.43*	<2.43	<2.43	<2.43
Northern Pike												
NP-1	8/13/07	Fillet	301	33	3/J	7.15	<2.35	<2.35	<2.35*	<2.35	<2.35	<2.35
NP-2	8/13/07	Fillet	1050	51	4/F	6.29	<2.46	<2.46	<2.46*	<2.46	<2.46	<2.46
NP-3	8/13/07	Fillet	1450	54	4/F	7.62	<2.27	<2.27	<2.27*	<2.27	<2.27	<2.27
Smallmouth Bass												
SMB-1	8/13/07	Fillet	1275	44	6/F	12.5	<2.44	<3.29	<2.44*	<2.44	<2.44	<2.44
SMB-2	8/13/07	Fillet	1300	39	4/M	12.1	<2.27	<2.27	<2.27*	<2.27	<2.27	<2.27
SMB-3	8/13/07	Fillet	900	36	3/M	11.3	<2.33	<2.33	<2.33*	<2.33	<2.33	<2.33
SMB-4	8/13/07	Fillet	1850	41	5/M	8.82	<2.43	<2.43	<2.43*	<2.43	<2.43	<2.43
SMB-5	8/13/07	Fillet	225	23	2/J	18	<2.40	<11.8	<2.92*	<2.40	<2.40	<2.40

< = less than the detection limit; number following this symbol represents the detection limit
* estimated values with a negative bias
# estimated values with a positive bias

2008 MPCA Metro Lakes Fish PFC Data

Twin Cities Metro Lakes

	Average PFOS Concentration [ng/g; ppb]							
	Bluegill	**Bluegill (comp)**	**Black Crappie**	**Black Crappie (comp)**	**Largemouth Bass**	**Northern Pike**	**Pumpkinseed**	**Pumpkinseed (comp)**
Alimagnet	24.27 (6)	24.7 (6)	31.38 (6)	31.60 (6)	ns	ns	ns	ns
Bennett	40.12 (6)	36.8 (6)	46.52 (5)	58.50 (4)	ns	51.38 (5)	ns	ns
Calhoun	203.80 (5)	267 (4)	267.17 (6)	ns	425.60 (5)	ns	ns	ns
Casey	ns	ns	12.45 (5)	14.50 (5)	ns	ns	ns	ns
Cedar (Hennepin)	50.09 (8)	ns	68.15 (2)	ns	136.74 (5)	ns	ns	ns
Fish	76.08 (6)	73.70 (6)	101.68 (5)	98.60 (6)	ns	134.60 (5)	17.48 (5)	15.70 (6)
Harriet	137.00 (5)	ns	138.40 (5)	ns	227.40 (5)	ns	ns	ns
Hyland	12.44 (5)	ns	23.92 (5)	ns	43.06 (5)	ns	ns	ns
Isles	68.40 (3)	ns	166.97 (6)	ns	197.00 (5)	ns	ns	ns
Lee	22.47 (6)	20.80 (6)	38.24 (5)	29.30 (4)	ns	ns	ns	ns
Pelican	<dl (5)	ns	<dl (5)	ns	<dl (5)	ns	ns	ns
Starring (5/30/08)	22.27 (3)	ns	ns	ns	26.40 (4)	ns	ns	ns
Starring (6/24/08)	10.07 (2)	ns	15.86 (5)	ns	32.50 (1)	ns	ns	ns
Steiger	5.75 (3)	ns	5.69 (1)	ns	9.55 (5)	ns	ns	ns
Sweeney	26.20 (5)	ns	28.47 (3)	ns	49.52 (5)	ns	ns	ns
Twin	396.80 (6)	ns	419.00 (5)	ns	480.40 (5)	ns	ns	ns

Numbers listed are: average PFOS concentration (# of fish)
<dl – less than detection limit (approx. 2.5 ng/g)
ns – not sampled
comp – composite; tissue from several fish is combined prior to analysis

2008 MPCA Metro Lakes Fish PFC Data

Note: This summary table is only for concentrations of PFDA in fish from lakes listed below.

Twin Cities Metro Lakes

	Average PFDA Concentration [ng/g; ppb]							
	Bluegill	**Bluegill (comp)**	**Black Crappie**	**Black Crappie (comp)**	**Largemouth Bass**	**Northern Pike**	**Pumpkinseed**	**Pumpkinseed (comp)**
Alimagnet	3.69 (1)	<dl (5)	3.93 (5)	5.57 (6)	ns	ns	ns	ns
Bennett	4.74 (4)	3.38 (6)	6.67 (5)	6.66 (4)	ns	5.92 (5)	ns	ns
Calhoun	4.60 (5)	5.12 (4)	7.28 (6)	ns	11.00 (5)	ns	ns	ns
Casey	ns	ns	<dl (5)	<dl (5)	ns	ns	ns	ns
Cedar (Hennepin)	4.15 (6)	ns	5.23 (2)	ns	9.03 (5)	ns	ns	ns
Fish	2.91 (4)	4.16 (6)	5.48 (5)	6.17 (6)	ns	7.24 (5)	<dl (5)	<dl (5)
Harriet	4.03 (5)	ns	4.8 (5)	ns	8.03 (5)	ns	ns	ns
Hyland	2.55 (1)	ns	3.96 (4)	ns	4.83 (5)	ns	ns	ns
Isles	4.14 (3)	ns	8.87 (6)	ns	8.85 (5)	ns	ns	ns
Lee	3.03 (3)	<dl (6)	4.70 (5)	3.82 (4)	ns	ns	ns	ns
Pelican	<dl (5)	ns	<dl (5)	ns	<dl (5)	ns	ns	ns
Starring (5/30/08)	<dl (3)	ns	ns	ns	2.59 (1)	ns	ns	ns
Starring (6/24/08)	<dl (2)	ns	<dl (5)	ns	<dl (1)	ns	ns	ns
Steiger	<dl (4)	ns	<dl (2)	ns	<dl (5)	ns	ns	ns
Sweeney	3.17 (4)	ns	5.00 (3)	ns	5.66 (5)	ns	ns	ns
Twin	3.04 (6)	ns	5.04 (5)	ns	5.02 (5)	ns	ns	ns

Numbers listed are: average PFDA concentration (# of fish)
<dl – less than detection limit (approx. 2.5 ng/g)
ns – not sampled
comp – composite; tissue from several fish is combined prior to analysis

2008 MPCA Metro Lakes Fish PFC Data

Note: This summary table is only for concentrations of PFUnA in fish from lakes listed below.

Twin Cities Metro Lakes

	Average PFUnAConcentration [ng/g; ppb]							
	Bluegill	**Bluegill (comp)**	**Black Crappie**	**Black Crappie (comp)**	**Largemouth Bass**	**Northern Pike**	**Pumpkinseed**	**Pumpkinseed (comp)**
Alimagnet	3.65 (2)	<dl (5)	<dl (5)	2.65 (6)	ns	ns	ns	ns
Bennett	3.06 (6)	3.09 (6)	<dl (5)	3.01 (4)	ns	4.51 (3)	ns	ns
Calhoun	2.71 (2)	2.93 (4)	3.28 (3)	ns	6.21 (5)	ns	ns	ns
Casey	ns	ns	<dl (5)	<dl (5)	ns	ns	ns	ns
Cedar (Hennepin)	2.66 (2)	ns	3.05 (1)	ns	5.75 (5)	ns	ns	ns
Fish	2.74 (3)	<dl (6)	<dl (5)	<dl (6)	ns	5.11 (5)	<dl (5)	<dl (5)
Harriet	2.84 (3)	ns	<dl (5)	ns	3.85 (5)	ns	ns	ns
Hyland	<dl (5)	ns	<dl (5)	ns	3.80 (3)	ns	ns	ns
Isles	2.62 (2)	ns	5.49 (4)	ns	6.67 (5)	ns	ns	ns
Lee	<dl (6)	<dl (6)	3.61 (1)	<dl (4)	ns	ns	ns	ns
Pelican	<dl (5)	ns	<dl (5)	ns	<dl (5)	ns	ns	ns
Starring (5/30/08)	<dl (3)	ns	ns	ns	<dl (4)	ns	ns	ns
Starring (6/24/08)	<dl (2)	ns	<dl (5)	ns	<dl (1)	ns	ns	ns
Steiger	<dl (4)	ns	<dl (2)	ns	<dl (5)	ns	ns	ns
Sweeney	4.44 (3)	ns	4.87 (1)	ns	4.73 (5)	ns	ns	ns
Twin	4.58 (6)	ns	4.58 (4)	ns	6.07 (5)	ns	ns	ns

Numbers listed are: average PFUnA concentration (# of fish)
<dl – less than detection limit (approx. 2.5 ng/g)
ns – not sampled
comp – composite; tissue from several fish is combined prior to analysis

2008 MPCA Metro Lakes Fish PFC Data

Note: This summary table is only for concentrations of PFDoA in fish from lakes listed below.

Twin Cities Metro Lakes

	Average PFDoA Concentration [ng/g; ppb]							
	Bluegill	**Bluegill (comp)**	**Black Crappie**	**Black Crappie (comp)**	**Largemouth Bass**	**Northern Pike**	**Pumpkinseed**	**Pumpkinseed (comp)**
Alimagnet	2.57 (1)	<dl (5)	<dl (5)	<dl (6)	ns	ns	ns	ns
Bennett	3.02 (1)	<dl (6)	<dl (5)	<dl (4)	ns	3.26 (4)	ns	ns
Calhoun	3.68 (2)	4.15 (4)	2.90 (2)	ns	6.32 (5)	ns	ns	ns
Casey	ns	ns	<dl (5)	<dl (5)	ns	ns	ns	ns
Cedar (Hennepin)	2.76 (1)	ns	2.68 (1)	ns	5.51 (5)	ns	ns	ns
Fish	3.21 (1)	<dl (6)	<dl (5)	<dl (6)	ns	3.84 (5)	<dl (5)	<dl (5)
Harriet	2.80 (1)	ns	<dl (5)	ns	3.38 (3)	ns	ns	ns
Hyland	<dl (5)	ns	<dl (5)	ns	<dl (5)	ns	ns	ns
Isles	<dl (3)	ns	6.24 (5)	ns	7.27 (5)	ns	ns	ns
Lee	<dl (6)	<dl (6)	<dl (5)	<dl (4)	ns	ns	ns	ns
Pelican	<dl (5)	ns	<dl (5)	ns	<dl (5)	ns	ns	ns
Starring (5/30/08)	<dl (3)	ns	ns	ns	<dl (4)	ns	ns	ns
Starring (6/24/08)	<dl (2)	ns	<dl (5)	ns	<dl (1)	ns	ns	ns
Steiger	<dl (4)	ns	<dl (2)	ns	<dl (5)	ns	ns	ns
Sweeney	3.66 (5)	ns	4.49 (1)	ns	5.90 (5)	ns	ns	ns
Twin	2.84 (1)	ns	2.88 (3)	ns	3.46 (4)	ns	ns	ns

Numbers listed are: average PFDoA concentration (# of fish)
<dl – less than detection limit (approx. 2.5 ng/g)
ns – not sampled
comp – composite; tissue from several fish is combined prior to analysis

Table A9. 2007 Wastewater Treatment Plant Influent (ng/L)

AREA	PLANT NAME	Sample ID	PFBA	PFPeA	PFHxA	PFHpA	PFOA	PFNA	PFDA	PFUnA	PFDoA	PFBS	PFHxS	PFOS	PFOSA
North	ALSSD	ALS	12	< 4.39	8.98	4.59	30.4	< 4.95	< 4.79	< 5.60	< 4.29	15.6	32.2	21.9	< 3.91
South	Austin	AUS-D	22.1	2.63	3.35	< 2.68	6.46	< 2.92	< 2.83	< 3.31	< 2.53	< 5.66	8.03	6.52	< 2.31
South	Austin	AUS-I	19.6	3.51	2.95	< 2.42	4.39	< 2.52	< 2.44	< 3.62	< 2.19	< 4.89	< 4.94	< 9.39	< 1.99
North	BoiseCascade	BOI	362	< 4.28	< 4.41	< 4.41	< 4.08	< 4.82	< 4.67	< 5.46	< 4.18	< 4.67	< 9.43	< 9.43	< 3.81
North	Brainerd	BRA	< 11.6	< 4.39	8.47	4.88	9.93	< 4.94	< 4.78	< 5.60	< 4.28	109	45.9	811	< 3.90
Central	DodgeCenter	DOD	83.3	< 2.76	< 2.85	< 2.85	6.27	< 3.11	< 3.01	< 3.52	< 2.70	< 6.02	7.14	19	< 2.46
Central	Eagle Point	EAG	656	31.3	22.9	5.59	17.1	< 4.13	< 4.13	< 4.13	< 4.13	67.1	19.9	< 8.28	< 4.13
North	Fergus Falls	FER	33	< 4.19	< 4.32	< 4.32	5.08	< 4.72	< 4.57	< 5.34	< 4.09	< 14.5	< 9.24	14.7	< 3.73
Central	Flint Hills	FLI	40.2	< 17.6	17.2	< 16.7	9.08	< 6.19	< 6.19	< 6.19	< 6.19	31.6	27.5	54.6	< 6.19
North	Hibbing	HIB	20.2	< 4.15	< 4.28	< 4.28	61.1	9.44	< 4.52	< 5.29	< 4.05	< 13.3	16.4	< 17.9	< 3.69
Central	Hutchinson	HUT	37	< 3.90	< 4.02	< 4.02	4.95	< 4.39	< 4.25	< 4.97	< 3.81	75.8	11.5	80.8	< 3.47
Central	Marathon-Ashland	MAR	1020	62.6	44.8	15	20	4.21	< 4.07	< 4.07	< 4.07	180	131	256	< 4.07
Central	Maynard	MAY	26	4.13	4.99	< 2.70	8.51	< 2.95	< 2.86	< 3.34	< 2.56	< 5.72	< 5.78	< 5.78	4.43
Central	Melrose	MEL	< 12.0	< 4.38	< 4.52	< 4.52	5.18	< 4.93	< 4.78	< 5.59	< 4.28	< 9.56	< 9.66	< 9.66	< 3.90
Central	Metro Plant	MET-1	58.1	8.58	12.9	6.52	21	< 4.38	< 4.38	< 4.38	< 4.38	38.8	12.4	35.3	< 4.38
Central	Metro Plant	MET-2	86.8	9.09	14.1	6.64	21.8	< 4.14	< 4.14	< 4.14	< 4.14	32.7	14.1	34.9	< 4.14
Central	Montivedeo	MON	32.9	< 3.17	< 3.27	< 3.27	9.47	6.82	7.74	< 4.04	< 3.10	< 6.91	< 8.28	< 6.99	< 2.82
South	Morton	MOR-1	< 4.03	< 4.03	< 4.03	< 4.03	< 4.03	< 4.03	< 4.03	< 4.03	< 4.03	21.2	< 8.06	< 8.06	< 4.03
South	Morton	MOR-2	< 4.05	< 4.05	< 4.05	< 4.05	< 4.05	< 4.05	< 4.05	< 4.05	< 4.05	9.38	< 8.11	< 8.11	< 4.05
South	Owatonna	OWA	35.2	9.29	15.4	< 3.85	19.5	< 4.20	< 4.07	< 4.76	< 3.65	< 8.14	< 8.23	< 8.23	< 3.32
North	Paynesville	PAY	38	< 4.39	< 4.53	< 4.53	< 4.18	< 4.95	< 4.79	< 5.60	< 4.29	< 9.58	< 9.68	< 9.68	< 3.91
South	Pipestone	PIP	18.9	52.4	< 2.57	< 2.57	3.32	3.4	< 2.72	< 3.18	< 2.44	< 5.44	< 5.50	< 5.50	< 2.22
South	Red Wing	RED	97.7	< 3.79	9.59	< 3.91	13.5	6.65	< 4.14	< 4.84	< 3.70	< 13.2	< 8.36	< 8.36	< 3.37
South	Rochester	ROC	36.8	< 4.04	5.06	< 4.17	17.7	< 4.55	< 4.41	< 5.15	< 3.94	< 8.81	10.4	< 10.7	< 3.59
Central	Me.CoSeneca	SEN	110	< 3.38	9.31	< 3.48	28.7	8.53	< 3.68	< 4.31	< 3.30	118	187	171	< 3.01
Central	St. Cloud	STC	< 12.0	< 4.41	6.81	6.81	16.5	< 4.96	< 4.80	< 5.62	< 4.30	< 11.2	21.5	< 9.71	< 3.92
North	Thief River F	THI	< 13.8	< 4.23	< 4.37	< 5.57	43.6	5.36	< 4.62	< 5.40	< 4.13	< 12.9	< 9.33	< 9.33	< 3.77
Central	Willmar	WIL	45.7	< 3.70	< 3.81	< 3.81	7.25	4.87	< 4.03	< 4.72	< 3.61	< 8.07	< 8.15	< 8.15	< 3.29
North	WLSSD	WLS	71.8	< 9.21	5.84	7.3	14	< 4.80	< 4.65	< 5.44	< 4.16	< 14.8	< 9.39	< 9.39	< 3.79
South	Worthington	WOR	61.9	< 3.90	< 4.02	< 4.02	4.28	< 4.39	< 4.25	< 4.97	< 3.80	< 8.50	< 8.59	< 8.59	< 3.47

Estimated values based on QA review

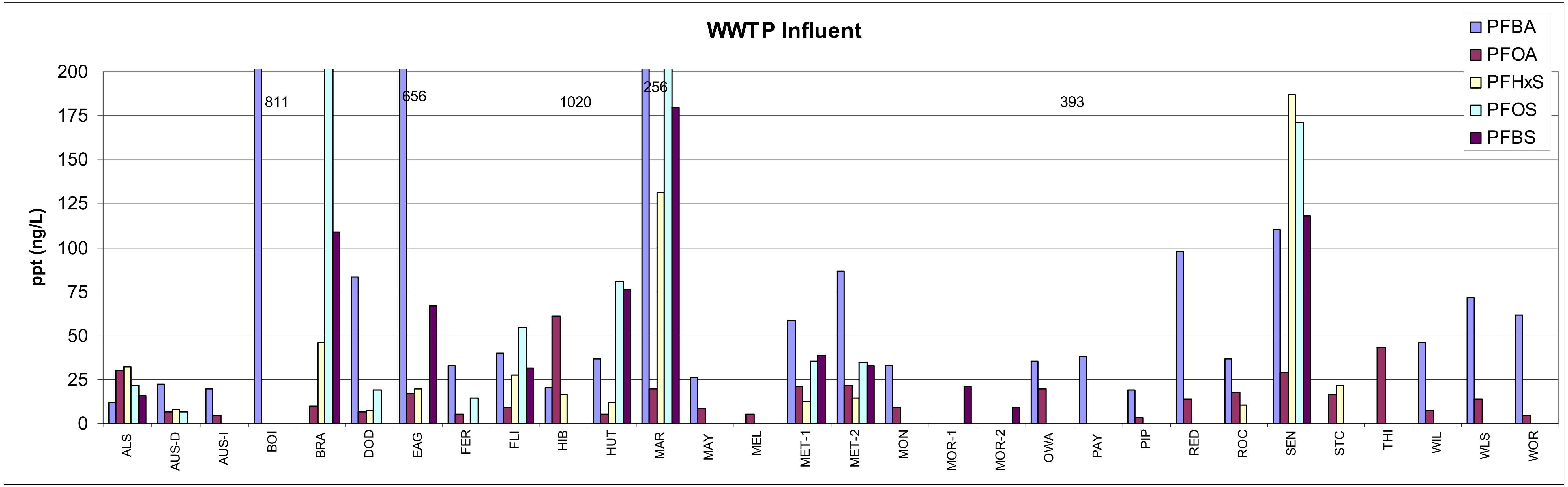


Figure A1. PFCs in WWTP Influent, 2007.

Table A10. 2007 Wastewater Treatment Plant Effluent in (ng/L)

AREA	PLANT NAME	Sample ID	PFBA	PFPeA	PFHxA	PFHpA	PFOA	PFNA	PFDA	PFUnA	PFDoA	PFBS	PFHxS	PFOS	PFOSA
North	ALSSD	ALS	32.4	4.9	11.5	2.78	13.2	5.31	< 2.87	< 3.36	< 2.57	17.3	40.8	18.4	< 2.35
South	Austin	AUS	21.5	5.12	5.27	< 2.65	5.99	< 2.90	< 2.81	< 3.28	< 2.51	< 5.61	< 5.67	< 6.54	< 2.29
North	BoiseCascade	BOI	68.3	< 4.26	< 4.39	< 4.39	4.99	< 4.80	< 4.64	< 5.43	< 4.16	< 9.29	< 9.39	< 9.39	< 3.79
North	Brainerd	BRA	50.3	< 2.49	12.3	6.25	19	14.1	< 2.71	< 3.17	< 2.43	107	10.6	1510	< 2.21
Central	DodgeCenter	DOD	23.4	9.88	4.8	< 2.57	7.56	< 2.81	< 2.72	< 3.18	< 2.44	< 5.44	< 5.50	< 5.50	< 2.22
Central	Eagle Point	EAG	565	21.2	27.6	6.57	22.5	4.38	3.53	< 2.57	< 2.57	29.6	21.9	< 5.14	< 2.57
North	Fergus Falls	FER	18.2	2.73	10.5	3.07	9.03	10.3	< 2.81	< 3.29	< 2.52	8.1	< 5.68	< 5.68	< 2.29
Central	Flint Hills	FLI	148	< 9.91	23.6	6.86	10	< 2.59	< 2.59	< 2.59	< 2.59	< 5.17	45	57.5	5.21
North	Hibbing	HIB	22	48.1	30.7	8.24	63.5	31.4	7.33	< 3.29	< 2.52	7.2	8.57	12.8	< 2.29
Central	Hutchinson	HUT	35	40.5	40.2	4.87	31.8	< 2.93	3.7	< 3.32	< 2.54	26.6	12.9	42.6	< 2.32
Central	Marathon-Ashland	MAR	79.3	< 6.26	< 6.26	< 6.26	< 6.26	< 6.26	< 6.26	< 6.26	< 6.26	< 12.5	< 12.5	< 12.5	< 6.26
Central	Maynard	MAY	27	4.55	7.82	3.37	15	< 3.10	< 3.00	< 3.51	< 2.69	< 6.01	< 6.07	< 6.07	2.57
Central	Melrose	MEL	13.6	< 2.60	< 2.68	< 2.68	3.54	4.22	< 2.83	< 3.31	< 2.54	< 5.67	< 5.73	< 5.73	< 2.31
Central	Metro Plant	MET-1	120	16	27.4	15	50.5	15.2	7.56	< 2.64	< 2.64	25.7	26.5	110	< 2.64
Central	Metro Plant	MET-2	75.2	12.5	25.9	15	50.4	12.1	6.68	< 2.56	< 2.56	22	25.7	87.4	< 2.56
Central	MSP Airport	MSP-1	23.5	18.8	53.9	31.3	120	18.1	82.8	6.61	8.02	7.17	28.5	23.8	5.82
Central	MSP Airport	MSP-2	41.1	63.2	108	51.8	148	30.4	115	12.5	13	18	74.9	393	< 2.53
Central	Montivedeo	MON	17.8	36.5	14.7	2.86	26.5	3.78	3.29	< 3.30	< 2.52	< 5.64	9.55	< 5.70	< 2.30
South	Morton	MOR-1	< 2.60	< 2.60	< 2.60	< 2.60	3.38	< 2.60	< 2.60	< 2.60	< 2.60	< 5.20	< 5.20	< 5.20	< 2.60
South	Morton	MOR-2	< 4.45	< 4.45	< 4.45	< 4.45	< 4.45	< 4.45	< 4.45	< 4.45	< 4.45	< 8.91	< 8.91	< 8.91	< 4.45
South	Owatonna	OWA	17.9	39.8	20.9	3.73	32.1	< 2.88	4.33	< 3.27	< 2.50	< 5.58	< 5.64	< 6.79	< 2.28
North	Paynesville	PAY	75.6	14.9	19.6	10.6	33.5	9.3	< 4.53	< 5.30	< 4.06	< 9.06	10.8	< 9.16	< 3.70
South	Pipestone	PIP	50.3	6.05	8.16	4.15	18.7	4.41	< 2.93	< 3.42	< 2.62	< 5.85	< 5.92	10.1	2.95
South	Red Wing	RED	53.6	8.79	30.2	4.97	22.7	< 4.76	< 4.61	< 5.39	< 4.13	13.9	20.2	< 12.1	< 3.76
South	Rochester	ROC	31.3	79.2	28.8	45.6	39.9	8.01	5.44	< 3.30	< 2.52	< 5.64	10.9	15.3	3.03
Central	Me.CoSeneca	SEN	42.4	40.1	39.3	13.3	64.1	7.92	4	< 3.28	< 2.51	39.8	53.1	58.5	< 2.29
Central	St. Cloud	STC	43.7	5.66	23.9	4.32	27.1	10.2	< 2.81	< 3.28	< 2.51	12.4	27.7	6.84	< 2.29
Central	Willmar	WIL	36.8	< 2.57	4.99	2.74	5.86	< 2.90	< 2.81	< 3.28	< 2.51	< 5.61	< 5.67	< 11.4	< 2.29
North	WLSSD	WLS	31.1	3.18	6.53	3.48	14.2	8.48	< 2.76	< 3.23	< 2.47	16.2	< 5.58	16	< 2.25
South	Worthington	WOR	14.9	7.36	3.44	< 2.66	6.04	< 2.90	< 2.81	< 3.29	< 2.52	< 5.63	< 5.69	< 5.69	< 2.30

Estimated values based on QA review

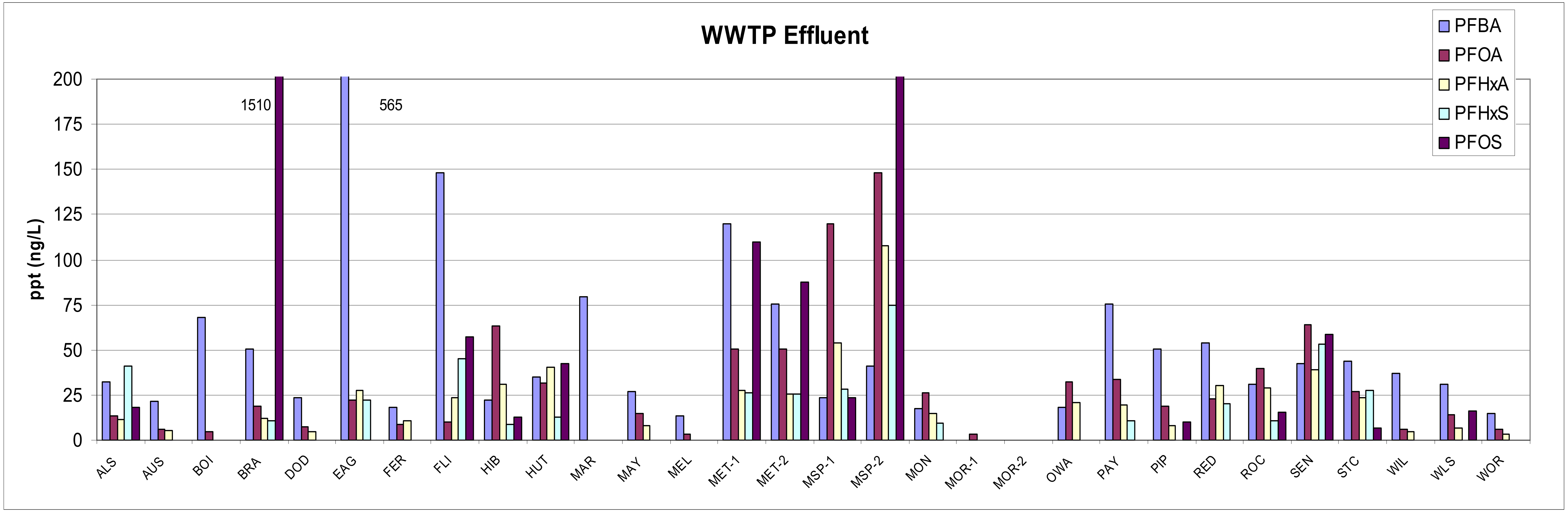


Figure A2. PFCs in WWTP Effluent, 2007.

Table A11. 2007 Wastewater Treatment Plant Sludge (ng/g dry weight)

AREA	PLANT NAME	Sample ID	PFBA	PFPeA	PFHxA	PFHpA	PFOA	PFNA	PFDA	PFUnA	PFDoA	PFBS	PFHxS	PFOS	PFOSA	% Moisture
North	ALSSD	ALS	< 4.59	< 4.59	< 4.59	< 4.59	17.3	18.7	13.8	9.76	< 4.59	< 9.18	< 9.18	99	14.2	90.1
South	Austin	AUS	-	< 0.770	< 0.817	< 0.794	1.06	3.89	1.92	< 0.982	< 0.752	< 5.05	< 5.09	< 5.09	< 2.05	96.8
North	BoiseCascade	BOI-A	< 0.194	< 0.194	< 0.194	< 0.194	< 0.194	< 0.194	< 0.194	< 0.194	< 0.194	< 0.389	< 0.389	< 0.389	< 0.194	17.2
North	BoiseCascade	BOI-P	0.254	< 0.191	< 0.191	< 0.191	< 0.191	< 0.191	< 0.191	< 0.191	< 0.191	< 0.382	< 0.382	< 0.382	< 0.191	50.6
North	BoiseCascade	BOI-S	< 0.401	< 1.15	< 0.849	< 0.299	< 0.266	0.45	< 0.201	< 0.201	< 0.201	< 0.818	< 0.703	< 0.713	< 0.201	0.37
North	Brainerd	BRA	< 0.869	< 0.677	3.47	0.877	3.68	20.1	3.99	5.9	2.22	< 11.3	2.77	861	2.98	95
Central	DodgeCenter	DOD	-	1.33	< 0.624	< 0.624	5.6	7.6	18.8	5.16	3.91	< 1.32	2.46	24.6	6.87	95.8
Central	Eagle Point	EAG	2.47	0.617	2.7	< 0.590	6.02	2.21	20.7	4.65	4.65	< 1.25	< 2.58	22.4	4	95.3
North	Fergus Falls	FER	2.74	< 1.33	3.15	< 0.727	4.04	62.7	6.16	11.8	1.43	< 1.45	< 1.45	21.4	3.52	98.1
North	Hibbing	HIB	< 1.80	< 0.799	< 0.778	< 0.752	2.48	2.67	1.72	2.04	2.17	< 2.04	< 1.50	8.18	< 0.752	93.9
Central	Hutchinson	HUT	-	29.4	13	4.73	54.6	10.1	57.2	6.16	11.6	5.6	3.99	304	10.8	97.9
Central	Melrose	MEL	1.56	< 0.595	< 0.676	< 0.532	2.17	6.69	2.82	3.29	0.976	< 1.09	< 1.38	3.94	3.28	94.4
Central	Metro Plant	MET-1	7.27	4.52	6.58	< 2.73	24.5	23.3	36.9	19.2	19.2	< 5.46	< 8.33	267	16.3	98.7
Central	Metro Plant	MET-2	10.6	3.72	9.8	< 3.31	22.9	14.3	29.7	15.3	13.6	< 6.62	< 15.0	261	12.3	98.7
Central	Montivedeo	MON	-	4.17	2.88	1.03	19	22.4	73.5	15.6	13	< 2.39	3.45	39.7	28	96.7
South	Owatonna	OWA		4.48	17	3.05	32.1	4.13	89.1	3.55	11.7	< 4.23	< 3.95	30.8	17.4	96.1
South	Red Wing	RED	-	< 0.941	2.97	< 0.970	3.14	2.86	2.93	< 1.20	< 0.919	< 6.17	< 6.22	< 6.22	< 2.51	97.4
South	Rochester	ROC	1.65	< 0.633	0.952	< 0.633	3.76	3.31	6.29	2.64	2.06	< 3.21	4.83	21.2	3.88	93
Central	Me.CoSeneca	SEN	-	< 0.493	1.12	0.548	6.8	3.59	10.7	3.81	2.19	< 3.23	< 3.26	141	4.53	94.9
Central	St. Cloud	STC	< 0.792	< 1.03	4.55	< 0.792	7.32	4.89	15.7	3.86	1.39	< 5.32	3.59	20.4	2.4	96.6
Central	Willmar	WIL	-	< 0.958	1.85	1.29	3.1	5.87	2.24	1.93	< 0.936	< 6.28	< 6.34	< 6.34	< 2.56	97.5
North	WLSSD	WLS	6.75	< 1.85	< 1.85	< 1.85	4.43	4.12	4.72	4.24	< 1.85	< 4.14	< 3.69	18.7	11.5	98
South	Worthington	WOR	-	4.46	< 2.38	< 2.38	3.24	< 2.60	3.86	< 2.95	< 2.25	< 5.05	< 5.09	8.88	3.72	98.9

Estimated values based on QA review

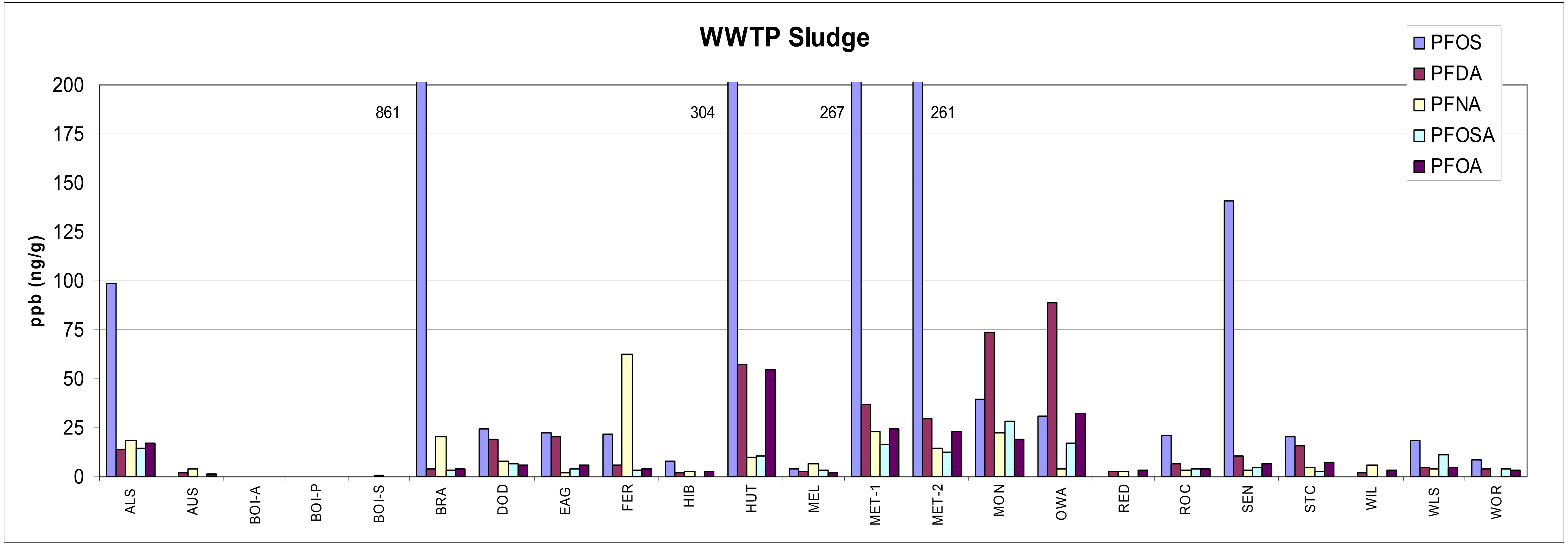


Figure A3. PFCs in WWTP Sludge, 2007.

Table A12. 2008 Wastewater Treatment Plant Influent in (ng/L)

		CLIENT ID	PFBA	PFPeA	PFHxA	PFHpA	PFOA	PFNA	PFDA	PFUnA	PFDoA	PFBS	PFHxS	PFOS	PFOSA
ALL	Albert Lea	PF-ALL-IN	< 6.10	< 3.90	14.7	< 3.90	< 3.90	< 3.90	< 3.90	< 3.90	< 3.90	< 7.80	< 7.80	< 7.80	< 3.90
ALX	Alexandria Lakes Area	PF-ALX-IN	< 4.63	< 6.47	22.5	6.65	10.8	4.09	< 3.33	< 3.33	< 3.33	< 6.66	15.9	< 6.66	< 3.33
AUS	Austin	PF-AUS-IN	< 5.07	< 5.07	< 5.07	< 5.07	< 5.07	< 5.07	< 5.07	< 5.07	< 5.07	< 10.1	< 10.1	33.5	< 5.07
BIG	Big Lake	PF-BIG-IN	14.2	< 3.05	10.6	16	422	< 2.59	< 2.59	< 2.59	< 2.59	< 5.18	< 5.18	< 5.18	< 2.59
BRD	Brainerd	PF-BRD-IN	< 6.62	< 11.8	8.75	< 5.73	6.9	< 7.81	< 5.73	< 5.73	< 5.73	< 11.5	< 11.5	29.5	< 5.73
CNF	Cannon Falls	PF-CNF-IN	7.17	< 6.94	< 3.42	< 3.42	38.4	< 3.42	< 3.42	< 3.42	< 3.42	< 6.84	< 6.84	< 6.84	< 3.42
CRK	Crookston	PF-CRK-IN	< 2.52	< 2.79	34.2	10.4	25	25.4	6.51	< 2.52	< 2.52	< 5.04	< 5.04	11.7	3.03
DDC	Dodge Center	PF-DDC-IN	9.17	< 6.81	8.36	< 2.58	3.23	< 2.58	< 2.58	< 2.58	< 2.58	< 5.16	< 5.16	32.2	< 2.58
EVL	Eveleth	PF-EVL-IN	4.93	< 7.92	< 3.57	< 3.57	6.84	< 3.57	< 3.57	< 3.57	< 3.57	< 7.13	< 7.13	< 7.13	< 3.57
FAR	Faribault	PF-FAR-IN	9.92	< 2.56	< 2.56	< 2.56	7.19	< 2.56	< 2.56	< 2.56	< 2.56	< 5.11	< 5.11	< 5.11	< 2.56
FHR	Flint Hills Resources LP	PF-FHR-IN	NQ	487	< 14.7	< 7.91	< 2.80	< 2.80	< 2.80	< 2.80	< 2.80	130	18.1	43.5	< 2.80
GRR	Grand Rapids	PF-GRR-IN	<3.88	<12.1	<6.19	<19.8	<6.19	<6.19	<6.19	<6.19	<6.19	<12.4	<12.4	<12.4	<6.19
HIB	Hibbing	PF-HIB-IN	3.26	< 4.13	6.99	< 4.18	26.7	< 2.61	< 2.61	< 2.61	< 2.61	< 5.23	< 5.23	< 5.23	< 2.61
HUT	Hutchinson	PF-HUT-IN	24.6	< 8.18	11.5	< 5.48	< 5.48	< 5.48	< 5.48	< 5.48	< 5.48	< 11.0	11.2	19.8	< 5.48
ISL	Isle	PF-ISL-IN	7.86	< 3.30	5.11	< 3.30	3.95	< 3.30	< 3.30	< 3.30	< 3.30	< 6.59	< 6.59	< 6.59	< 3.30
LES	Le Sueur/Henderson	PF-LES-IN	< 6.02	< 6.02	< 6.02	< 6.02	98.9	< 6.02	< 6.02	< 6.02	< 6.02	< 12.0	< 12.0	< 12.0	< 6.02
MSP	MAC – Minneapolis/St. Paul Intl Airport														
MAN	Mankato	PF-MAN-IN	< 5.31	< 5.38	12.1	< 5.31	31.6	7.77	< 5.31	< 5.31	< 5.31	< 10.6	< 10.6	< 10.6	< 5.31
MPL	Maple Lake	PF-MPL-IN	8.03	< 2.54	4.93	< 2.54	< 4.05	< 2.54	< 2.54	< 2.54	< 2.54	< 5.08	< 8.59	< 5.08	< 2.54
EAP	Met Council – Eagles Point	PF-EAP-IN	401	18.8	13.8	< 5.36	14	< 5.36	< 5.36	< 5.36	< 5.36	< 10.7	< 10.7	34	< 5.36
MWP	Met Council – Metropolitan	PF-MWP-IN	58.3	< 8.70	10.8	< 6.05	16.1	< 6.05	< 6.05	< 6.05	< 6.05	< 12.1	< 12.1	16.4	< 6.05
RMT	Met Council – Rosemount	PF-RMT-IN	25.2	6.05	7.37	< 5.78	10.2	< 5.78	< 5.78	< 5.78	< 5.78	< 11.6	< 11.6	< 11.6	< 5.78
SEN	Met Council – Seneca	PF-SEN-IN	10.3	< 7.30	13.4	11.3	40.5	< 7.30	< 7.30	< 7.30	< 7.30	< 14.6	23.7	< 14.6	< 7.30
MON	Montevideo	PF-MON-IN	< 4.73	< 5.08	7.62	< 4.73	12	5.57	< 4.73	< 4.73	< 4.73	19.2	< 9.46	< 9.46	< 4.73
MOR	Moorhead	PF-MOR-IN	< 6.02	< 13.4	< 6.02	< 6.02	6.4	< 6.02	< 6.02	< 6.02	< 6.02	< 12.0	< 12.0	< 12.0	< 6.02
NUM	New Ulm	PF-NUM-IN	< 5.10	< 5.10	6.29	< 5.10	< 5.10	< 5.10	< 5.10	< 5.10	< 5.10	< 10.2	< 10.2	< 10.2	< 5.10
OWA	Owatonna	PF-OWA-IN	4.98	< 3.18	7.6	4.97	9.61	< 3.18	< 3.18	< 3.18	< 3.18	< 6.37	< 6.37	< 6.37	< 3.18
PAY	Paynesville	PF-PAY-IN	9.92	< 5.65	< 5.10	7.82	6.8	5.88	< 5.10	< 5.10	< 5.10	< 10.2	< 10.2	< 10.2	< 5.10
PNI	Pine Island	PF-PNI-IN	7.49	< 5.32	2.93	< 2.56	7.38	< 2.56	< 2.56	< 2.56	< 2.56	< 5.12	< 5.12	176	< 2.56
PRN	Princeton	PF-PRN-IN	21.4	< 6.63	3.67	< 2.79	4.17	< 3.36	< 2.79	< 2.79	< 2.79	< 5.58	< 5.58	< 5.58	< 2.79
ROC	Rochester (dups)	PF-ROC-INA	3.48	< 6.25	6.11	3.44	4.59	< 2.56	< 2.56	< 2.56	< 2.56	< 5.13	< 5.13	< 5.13	< 2.56
ROY	Royalton														
SIL	Silver Lake	PF-SIL-IN	< 4.78	< 6.13	< 4.78	< 4.78	5.18	< 5.64	< 4.78	< 4.78	< 4.78	< 9.57	< 9.57	36.4	< 4.78
STC	St. Cloud	PF-STC-IN	7.38	< 4.27	9.63	6.58	6.98	3.06	< 2.61	< 2.61	< 2.61	< 5.22	< 5.22	12.2	< 2.61
STJ	St. James	PF-STJ-IN	< 4.86	< 5.87	< 6.04	< 4.86	< 4.86	< 4.86	< 4.86	< 4.86	< 4.86	21.8	< 9.73	27.4	< 4.86
WAB	Wabasha	PF-WAB-IN	20.3	< 8.92	6.16	< 2.72	8.85	< 2.72	< 2.72	< 2.72	< 2.72	< 5.44	< 5.44	15.9	< 2.72
WAR	Warroad	PF-WAR-IN	< 3.47	< 2.60	21.7	5.2	16.3	5.51	< 2.60	< 2.60	< 2.60	< 5.21	< 5.21	< 5.21	< 2.60
WIN	Winona	PF-WIN-IN	12.7	4.18	10	5.04	13.5	< 2.72	< 2.72	< 2.72	< 2.72	< 5.43	12.2	8.63	< 2.72
WLS	WLSSD	PF-WLS-IN	< 16.8	< 12.0	< 12.0	< 12.0	< 12.0	< 12.0	< 12.0	< 12.0	< 12.0	< 24.0	< 24.0	< 24.0	< 12.0
XCL	Xcel Energy - Prairie Island Nuclear	PF-XCL-IN	20.3	< 3.38	5.47	< 2.50	5.53	< 2.50	< 2.50	< 2.50	< 2.50	< 4.99	< 4.99	< 4.99	< 2.50

not sampled

*Estimated value

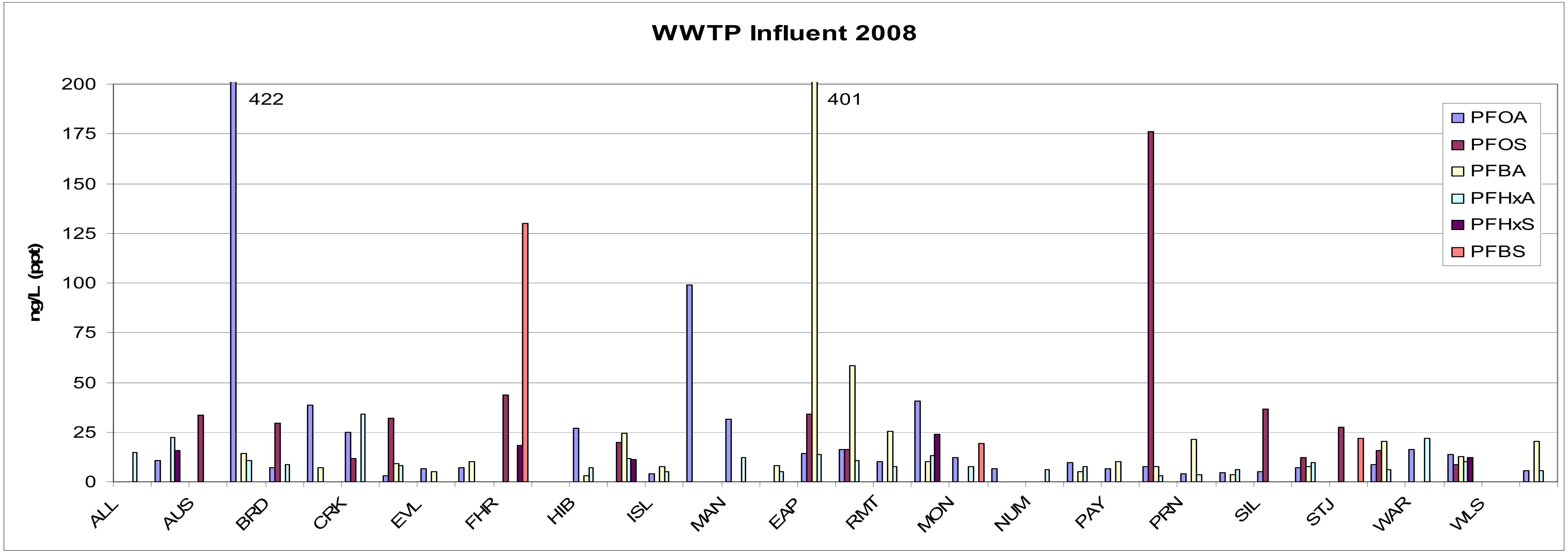


Figure A4. PFCs in WWTP Influent, 2008.

Table A13. 2008 Wastewater Treatment Plant Effluent in (ng/L)

		CLIENT ID	PFBA	PFPeA	PFHxA	PFHpA	PFOA	PFNA	PFDA	PFUnA	PFDoA	PFBS	PFHxS	PFOS	PFOSA
ALL	Albert Lea	PF-ALL-EF	4.06	5.79	10.1	3.96	8.48	2.77	< 2.45	< 2.45	< 2.45	< 4.91	< 4.91	< 4.91	< 2.45
ALX	Alexandria Lakes Area	PF-ALX-EF	5.4	12.6	37.7	7.31	30.5	7.36	< 2.57	< 2.57	< 2.57	< 5.15	23.8	9.46	< 2.57
AUS	Austin	PF-AUS-EF	3.51	7.28	6.04	2.92	5.72	< 2.46	< 2.46	< 2.46	< 2.46	< 4.91	< 4.91	< 4.91	< 2.46
BIG	Big Lake	PF-BIG-EF	18.1	45.4	41.1	6.44	49	< 5.02	< 5.02	< 5.02	< 5.02	17.6	< 10.0	< 10.0	5.98
BRD	Brainerd	PF-BRD-EF	< 7.56	< 4.86	7.41	< 5.72	8.82	6.45	< 4.86	< 4.86	< 4.86	< 9.72	< 9.72	45	< 4.86
CNF	Cannon Falls	PF-CNF-EF	4.11	9.16	24.3	17.5	17.1	7.13	< 2.58	< 2.58	< 2.58	< 5.17	< 5.17	< 5.17	< 2.58
CRK	Crookston	PF-CRK-EF	< 10.5	< 10.3	45.8	10.6	33.3	33.3	5.25	< 2.67	< 2.67	< 5.34	21.1	8.02	2.89
DDC	Dodge Center	PF-DDC-EF	7.79	< 2.62	7.07	4.9	12.2	< 2.62	< 2.62	< 2.62	< 2.62	< 5.25	< 5.25	< 5.25	< 2.62
EVL	Eveleth	PF-EVL-EF	3.94	< 4.25	3.05	2.6	9.48	< 2.48	< 2.48	< 2.48	< 2.48	< 4.95	< 4.95	< 4.95	< 2.48
FAR	Faribault	PF-FAR-EF	< 6.14	2.83	5.02	< 2.61	5.66	< 2.61	< 2.61	< 2.61	< 2.61	< 5.22	< 5.22	< 5.22	< 2.61
FHR	Flint Hills Resources LP	PF-FHR-EF	128	< 5.50	12.2	5.87	5.48	< 2.63	< 2.49	< 2.49	< 2.49	18.5	42.9	32.5	3.06
GRR	Grand Rapids	PF-GRR-EF	7.38	<11	<3.48	<16.7	6.52	<2.58	<2.58	<2.58	<2.58	<5.16	<5.16	<5.16	<2.58
HIB	Hibbing	PF-HIB-EF	4.38	< 2.48	11.4	5.91	18.6	5.66	3.72	< 2.48	< 2.48	10.1	< 4.95	< 4.95	< 2.48
HUT	Hutchinson	PF-HUT-EF	7.19	9.52	22.7	4.5	20.4	< 2.55	< 2.55	< 2.55	< 2.55	5.39	11	52.3	< 2.55
ISL	Isle	PF-ISL-EF	15.7	15.7	69.1	19.2	43.8	20.2	9.51	< 4.95	< 4.95	< 9.91	< 9.91	13.8	< 4.95
LES	Le Sueur/Henderson	PF-LES-EF	31.1	< 4.84	6.34	< 5.53	11.9	4.18	< 2.52	< 2.52	< 2.52	< 5.04	< 5.04	< 5.04	< 2.52
MSP	MAC – Minneapolis/St. Paul Intl Airport	PF-MSP-P1	19.2	38.1	79.2	34.1	91.1	20.1	50.4	5.63	3.01	< 5.03	19.2	40.9	< 2.51
MSP	MAC – Minneapolis/St. Paul Intl Airport	PF-MSP-P2	9.78	11.6	25.9	9.89	33	50.3	12.2	20.4	2.84	5.62	27.2	60.3	2.84
MAN	Mankato	PF-MAN-EF	9.17	34	56	11.2	63.3	4.89	2.63	< 2.54	< 2.54	16.6	< 5.08	< 5.08	< 2.54
MPL	Maple Lake	PF-MPL-EF	7.23	< 2.78	6.72	3.42	3.98	< 2.58	< 2.58	< 2.58	< 2.58	20.4	< 5.15	< 5.15	< 2.58
EAP	Met Council – Eagles Point	PF-EAP-EF	541	18	34	13.1	34.5	3.8	< 2.60	< 2.60	< 2.60	53.2	105	489	< 2.60
MWP	Met Council – Metropolitan	PF-MWP-EF	61.1	11.1	28.7	17.8	43.5	60.6	4.8	9.38	< 2.57	19.8	13	80.2	< 2.57
RMT	Met Council – Rosemount	PF-RMT-EF	130	17.8	36.9	19.3	99.5	8.28	< 5.39	< 5.39	< 5.39	21	15.1	18.3	< 5.39
SEN	Met Council – Seneca	PF-SEN-EF	13.1	10.9	32.3	12.5	28.3	9.42	3.18	< 2.54	< 2.54	21.1	20.5	32.9	< 2.54
MON	Montevideo	PF-MON-EF	5.23	14.5	21.6	3.46	21.1	4.38	< 2.57	< 2.57	< 2.57	26.2	< 5.14	< 5.14	< 2.57
MOR	Moorhead	PF-MOR-EF	< 3.84	8.71	26	6.53	26.4	5.7	< 2.48	< 2.48	< 2.48	< 4.95	11.9	15.8	< 2.48
NUM	New Ulm	PF-NUM-EF	27.7	48.2	71.4	25.7	53	< 2.59	< 2.59	< 2.59	< 2.59	< 5.19	< 5.19	< 5.19	< 2.59
OWA	Owatonna	PF-OWA-EF	10.4	34.7	59.5	9.35	84.5	2.58	7	< 2.51	< 2.51	7.24	< 5.03	< 5.03	< 2.51
PAY	Paynesville	PF-PAY-EF	< 11.8	< 5.82	27.7	8.62	33.9	9.45	4	< 2.52	< 2.52	< 5.03	< 5.03	7.84	< 2.52
PNI	Pine Island	PF-PNI-EF	6	5.21	7.18	< 5.05	11.6	< 5.05	< 5.05	< 5.05	< 5.05	267	< 10.1	545	< 5.05
PRN	Princeton	PF-PRN-EF	9.19	26.5	34	6.02	34.1	< 2.57	3.83	< 2.57	< 2.57	5.44	< 5.15	< 5.15	< 2.57
ROC	Rochester	PF-ROC-EFA	12.8	31.7	40.7	30.2	37	7.9	4.1	< 2.49	< 2.49	13.8	< 4.97	< 4.97	< 2.49
ROY	Royalton	PF-ROY-EF	6.77	<4.94	<4.94	<4.94	<4.94	<4.94	<4.94	<4.94	<4.94	<9.87	<9.87	<9.87	<4.94
SIL	Silver Lake	PF-SIL-EF	< 4.65	< 5.30	10.6	4.84	17.8	4.88	< 3.27	< 3.27	< 3.27	< 6.55	8.83	20.5	< 3.27
STC	St. Cloud	PF-STC-EF	16.5	< 4.73	42.5	< 5.01	26.7	6.14	2.75	< 2.53	< 2.53	< 5.06	11	11	< 2.53
STJ	St. James	PF-STJ-EF	7.33	16.2	11.8	4.63	10.3	< 2.53	< 2.53	< 2.53	< 2.53	47.3	< 5.06	91.5	< 2.53
WAB	Wabasha	PF-WAB-EF	18.4	18.3	18.2	5.15	25.4	< 2.54	< 2.54	< 2.54	< 2.54	5.93	< 5.09	5.24	2.76
WAR	Warroad	PF-WAR-EF	4.41	< 4.42	47.6	13	21	8.13	< 2.48	< 2.48	< 2.48	< 4.96	< 4.96	6	4.32
WIN	Winona	PF-WIN-EF	10.8	5.79	22.1	3.64	20.9	2.98	< 2.64	< 2.64	< 2.64	< 5.28	14.5	16.4	< 2.64
WLS	WLSSD	PF-WLS-EF	29.6	< 5.88	11.5	10.5	21.7	6.1	4.37	< 2.48	< 2.48	39.1	< 4.97	15.2	< 2.48
XCL	Xcel Energy - Prairie Island Nuclear	PF-XCL-OUT	20.1	5.21	3.9	< 2.50	4.95	< 3.02	< 2.50	< 2.50	< 2.50	< 4.99	< 4.99	< 4.99	< 2.50

*Estimated value

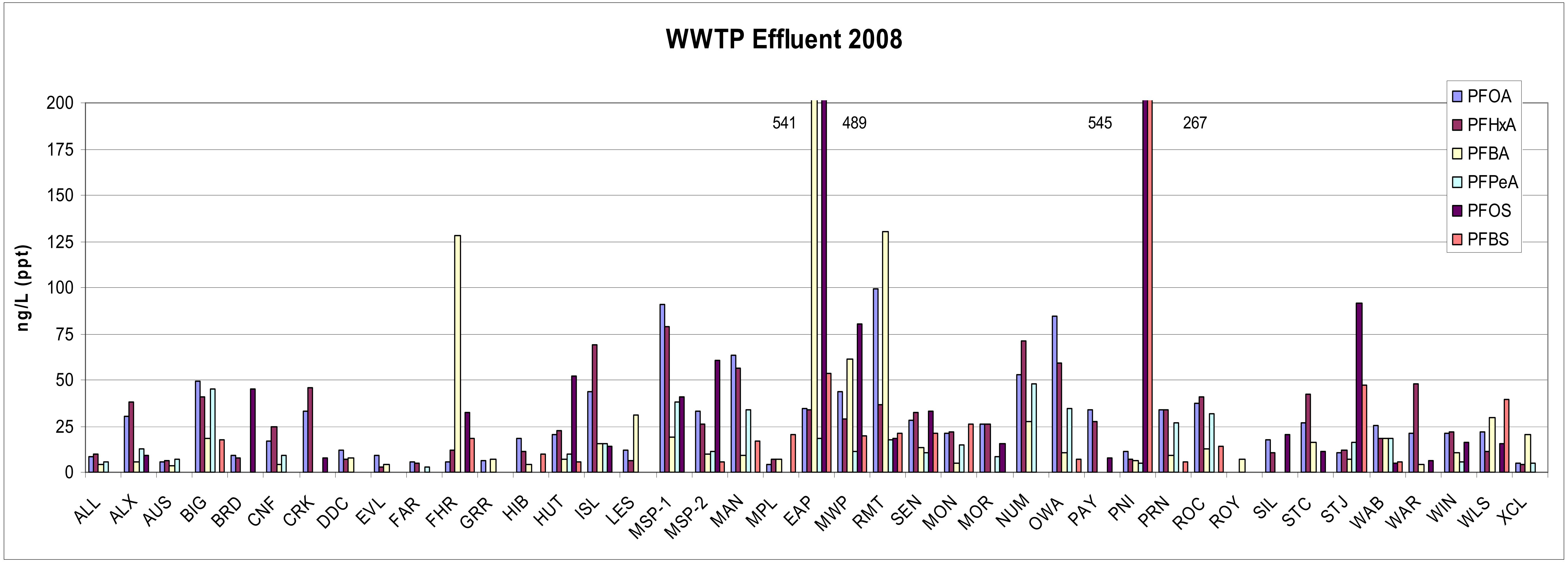


Figure A5. PFCs in WWTP Effluent, 2008.

Table A14. 2008 Wastewater Treatment Plant Sludge in (ng/g)

		CLIENT ID	PFBA	PFPeA	PFHxA	PFHpA	PFOA	PFNA	PFDA	PFUnA	PFDoA	PFBS	PFHxS	PFOS	PFOSA	% Moisture
ALL	Albert Lea	PF-ALL-SL	< 3.36	< 3.36	< 3.36	< 3.36	5.9	6.78	14.7	4.95	3.45	< 6.71	< 6.71	18.5	14	99.3
ALX	Alexandria Lakes Area															
AUS	Austin	PF-AUS-SL	< 0.748	< 0.748	< 0.748	< 0.748	< 0.748	1.45	0.955	< 0.932	< 1.96	< 1.50	< 1.51	4.15	< 0.748	96.7
BIG	Big Lake															
BRD	Brainerd	PF-BRD-SL	<5.17	<5.17	10.6	<5.17	<5.17	11.6	5.89	10	5.19	<10.3	<10.3	442	<5.17	98.1
CNF	Cannon Falls															
CRK	Crookston															
DDC	Dodge Center															
EVL	Eveleth															
FAR	Faribault															
FHR	Flint Hills Resources LP															
GRR	Grand Rapids															
HIB	Hibbing															
HUT	Hutchinson	PF-HUT-SL	< 9.37	15.3	21.1	< 9.37	35.4	< 9.37	< 9.37	< 9.37	< 9.37	< 18.7	< 18.7	< 18.7	< 9.37	analyzed as aqueous sample
ISL	Isle															
LES	Le Sueur/Henderson															
MSP	MAC – Minneapolis/St. Paul Intl Airport															
MAN	Mankato	PF-MAN-SL	3.31	< 1.85	15.9	1.95	17.4	4.38	13.1	3.61	9.95	< 2.24	13.1	88.4	24.8	97.8
MPL	Maple Lake															
EAP	Met Council – Eagles Point															
MWP	Met Council – Metropolitan	PF-MWP-SL	9.2	< 2.31	8.27	3.87	14.2	49.7	17.3	297	11.2	< 4.61	4.98	253	19.4	98.9
RMT	Met Council – Rosemount															
SEN	Met Council – Seneca	PF-SEN-SL	< 0.512	< 0.551	5.5	1.26	9.15	9.86	26.3	13.5	10.2	< 1.02	11.4	350	6.04	95.1
MON	Montevideo	PF-MON-SL	< 1.67	< 1.67	3.18	< 1.67	15.9	31.7	51	41.5	16	< 3.35	< 3.35	36.4	23.4	98.5
MOR	Moorhead															
NUM	New Ulm	PF-NUM-SL	4.42	< 4.46	19.2	6.82	27.7	4.09	24.1	6.42	7.3	< 2.63	3.42	18.5	6.96	98.1
OWA	Owatonna															
PAY	Paynesville															
PNI	Pine Island															
PRN	Princeton															
ROC	Rochester	PF-ROC-SLA	0.43	< 0.321	1.82	< 0.321	3.75	4.92	13.6	4.73	6.16	< 0.641	< 5.23	7.42	2.42	92.2
ROY	Royalton															
SIL	Silver Lake															
STC	St. Cloud	PF-STC-SL	< 0.760	< 0.760	11.3	< 1.25	6.91	6.84	11	4.08	5.1	< 1.52	< 5.08	11.6	1.35	96.8
STJ	St. James	PF-STJ-SL	< 0.674	< 0.674	1.45	< 0.674	1.8	0.814	5.88	3.09	5.85	< 1.35	1.7	252	8.53	96.3
WAB	Wabasha															
WAR	Warroad															
WIN	Winona	PF-WIN-SL	< 4.48	< 3.46	12.3	< 1.79	14	26.3	23.4	12.7	15.4	< 3.58	6.6	91.1	6.94	98.6
WLS	WLSSD	PF-WLS-SL	< 0.848	< 0.848	1.94	< 0.848	3.2	3.3	5.14	4.48	2.14	< 1.70	< 1.70	16	1.31	70.7
XCL	Xcel Energy - Prairie Island Nuclear															

not sampled

*Estimated value

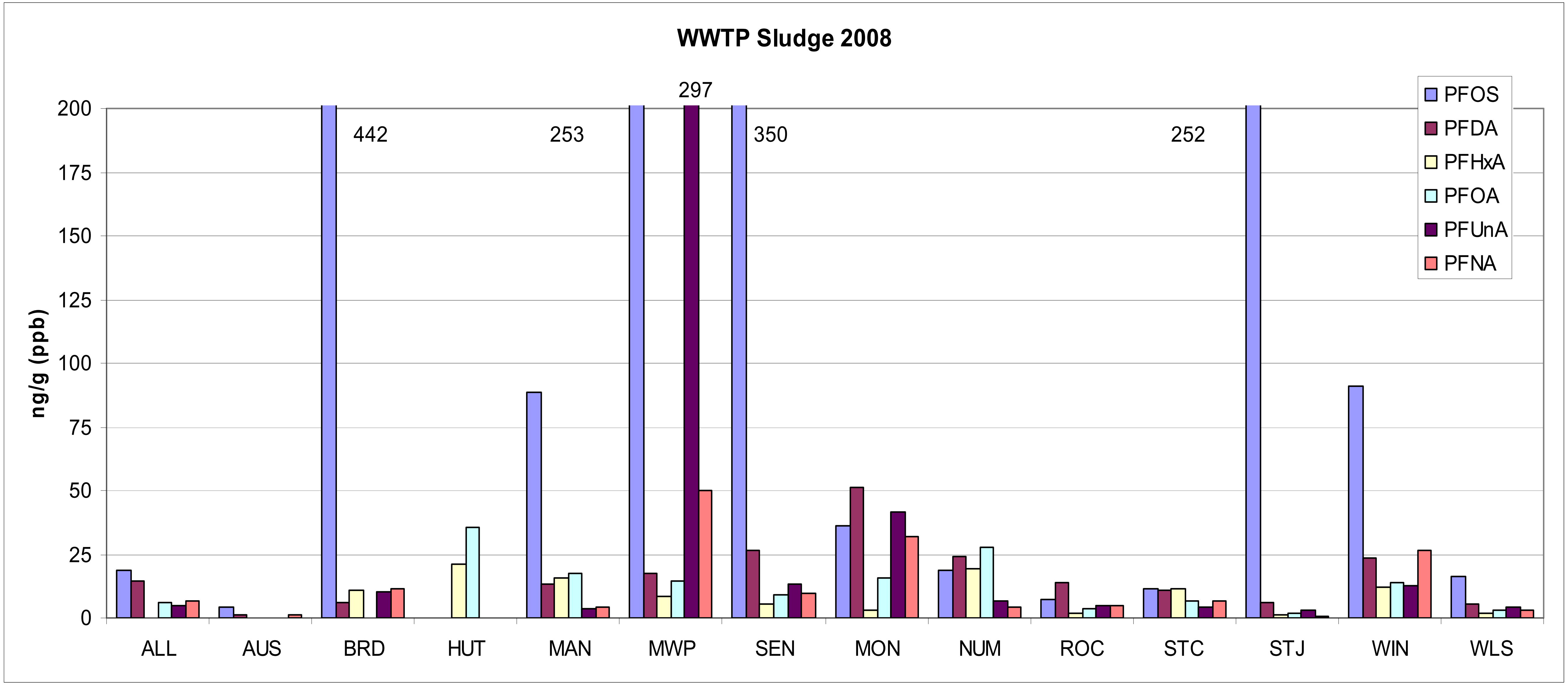


Figure A6. PFCs in WWTP Sludge, 2008.

Table A15. Draft Results from Red Rock Road Air Sampling Site

Sample 4	96hrs Filter *	96hrs Front puf/xad **	96hrs Back puf ***	Particulate	Gaseous	Total Air Concentration
UNITS	ng/sample	ng/sample	ng/sample	pg/m^3	pg/m^3	pg/m^3
PFBA	< 0.500	13.06	1.32	ND	11.4	11.4
PFPeA	< 0.500	0.542	< 0.500	ND	0.4	0.4
PFHxA	< 0.500	1.95	< 0.500	ND	1.6	1.6
PFHpA	< 0.500	0.542	< 0.500	ND	0.4	0.4
PFOA	2.77	20.2	< 0.500	2.2	16.1	18.3
PFNA	< 0.500	0.526	11.4	ND	9.5	9.5
PFDA	< 0.500	< 0.500	< 0.500	ND	ND	ND
PFUnA	< 0.500	< 0.500	< 0.500	ND	ND	ND
PFDoA	< 0.500	< 0.500	< 0.500	ND	ND	ND
PFBS	< 1.00	< 1.00	< 1.00	ND	ND	ND
PFHxS	< 1.00	< 1.00	< 1.00	ND	ND	ND
PFOS	2.63	2.29	< 1.00	2.1	1.8	3.9
PFOSA	< 0.500	1.7	< 0.500	ND	1.4	1.4

Total sample air volume was 1257.9 m^3 air

Sample 5	96hrs Filter *	96hrs Front puf/xad raw	96hrs Front puf/xad **	96hrs Back puf ***	96hrs Total	Total air volume	Particulate	Gaseous	Total Air Concentration
UNITS	ng/sample	ng/sample	ng/sample	ng/sample	ng/sample	m^3 Air	pg/m^3	pg/m^3	pg/m^3
PFBA	< 0.500	19.9	18.56	1.04	19.60	1252.1	ND	15.7	15.7
PFPeA	< 0.500	0.627	0.627	< 0.500	0.63	1252.1	ND	0.5	0.5
PFHxA	< 0.500	1.01	1.01	< 0.500	1.01	1252.1	ND	0.8	0.8
PFHpA	< 0.500	0.554	0.554	< 0.500	0.55	1252.1	ND	0.4	0.4
PFOA	2.84	2.92	2.92	< 0.500	5.76	1252.1	2.3	2.3	4.6
PFNA	< 0.500	5.43	5.43	5.71	11.14	1252.1	ND	8.9	8.9
PFDA	< 0.500	< 0.500	< 0.500	< 0.500	< 0.5	1252.1	ND	ND	ND
PFUnA	< 0.500	< 0.500	< 0.500	< 0.500	< 0.5	1252.1	ND	ND	ND
PFDoA	< 0.500	< 0.500	< 0.500	< 0.500	< 0.5	1252.1	ND	ND	ND
PFBS	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	1252.1	ND	ND	ND
PFHxS	< 1.00	5.49	5.49	< 1.00	5.49	1252.1	ND	4.4	4.4
PFOS	3.22	2.72	2.72	< 1.00	5.94	1252.1	2.6	2.2	4.7
PFOSA	< 0.500	< 0.500	< 0.500	< 0.500	< 0.5	1252.1	ND	ND	ND

Total sample air volume was 1252.1 m^3 air

Sample 6	72hrs Filter *	72hrs Front puf/xad **	72hrs Back puf ***	Particulate	Gaseous	Total Air Concentration
UNITS	ng/sample	ng/sample	ng/sample	pg/m^3	pg/m^3	pg/m^3
PFBA	< 0.500	10.66	1.07	ND	12.4	12.4
PFPeA	< 0.515	0.653	< 0.500	ND	0.7	0.7
PFHxA	< 0.500	1.06	< 0.500	ND	1.1	1.1
PFHpA	< 0.500	0.636	< 0.500	ND	0.7	0.7
PFOA	1.82	6.21	< 0.500	1.9	6.6	8.5
PFNA	< 0.500	6.56	5.49	ND	12.7	12.7
PFDA	< 0.500	< 0.500	< 0.500	ND	ND	ND
PFUnA	< 0.500	< 0.500	< 0.500	ND	ND	ND
PFDoA	< 0.500	< 0.500	< 0.500	ND	ND	ND
PFBS	< 1.00	< 1.00	< 1.00	ND	ND	ND
PFHxS	< 1.11	< 1.00	< 1.00	ND	ND	ND
PFOS	6.46	2.19	< 1.00	6.8	2.3	9.1
PFOSA	< 0.500	0.926	< 0.500	ND	1.0	1.0

Total sample air volume was 945.8 m^3 air

Sample 7	72hrs Filter *	72hrs Front puf/xad raw	72hrs Front puf/xad **	72hrs Back puf ***	72hrs Total	Total air volume	Particulate	Gaseous	Total Air Concentration
UNITS	ng/sample	ng/sample	ng/sample	ng/sample	ng/sample	m^3 Air	pg/m^3	pg/m^3	pg/m^3
PFBA	< 0.500	13.1	11.76	1.96	13.72	937.8	ND	14.6	14.6
PFPeA	< 0.500	< 0.500	< 0.500	< 0.500	< 0.500	937.8	ND	ND	ND
PFHxA	< 0.500	2.13	2.13	< 0.500	2.13	937.8	ND	2.3	2.3
PFHpA	< 0.500	< 0.500	< 0.500	0.515	< 0.500	937.8	ND	ND	ND
PFOA	4.78	13.4	13.4	< 0.500	18.18	937.8	5.1	14.3	19.4
PFNA	< 0.500	6.46	6.46	7.12	13.58	937.8	ND	14.5	14.5
PFDA	< 0.500	< 0.500	< 0.500	1.1	< 0.5	937.8	ND	1.2	1.2
PFUnA	< 0.500	< 0.500	< 0.500	< 0.500	< 0.5	937.8	ND	ND	ND
PFDoA	< 0.500	< 0.500	< 0.500	< 0.500	< 0.5	937.8	ND	ND	ND
PFBS	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	937.8	ND	ND	ND
PFHxS	< 1.54	< 1.98	< 1.00	< 1.00	< 1.00	937.8	ND	ND	ND
PFOS	6.31	2.21	2.21	< 1.00	8.52	937.8	6.7	2.4	9.1
PFOSA	< 0.500	0.745	0.745	< 0.500	0.75	937.8	ND	0.8	0.8

Total sample air volume was 937.8 m^3 air

* Filter: Front end fiberglass filter captures most particulates and aerosols

** Front puf/xad: This section of sampling train will capture all PFCs in gaseous form
and any ultra fine particles that may escape capture on filter. Blank-corrected.

*** Back puf: Secondary polyurethane packing designed to capture any breakthough of gaseous PFCs
from front puf/xad. May also be used as a QC indicator of overall collection efficiency

Table A15. Continued

Sample 8	72hrs Filter *	72hrs Front puf/xad **	72hrs Back puf ***	Particulate	Gaseous	Total Air Concentration
UNITS	ng/sample	ng/sample	ng/sample	pg/m^3	pg/m^3	pg/m^3
PFBA	< 0.500	7.46	1.07	ND	8.6	8.6
PFPeA	< 0.500	< 0.500	< 0.500	ND	ND	ND
PFHxA	< 0.500	0.955	< 0.500	ND	1.0	1.0
PFHpA	< 0.500	0.636	< 0.500	ND	0.6	0.6
PFOA	1.62	1.67	< 0.500	1.6	1.7	3.3
PFNA	< 0.500	8.7	5.49	ND	14.3	14.3
PFDA	< 0.500	1.87	< 0.500	ND	ND	1.9
PFUnA	< 0.500	< 0.500	< 0.500	ND	ND	ND
PFDoA	< 0.500	< 0.500	< 0.500	ND	ND	ND
PFBS	< 1.00	< 1.00	< 1.00	ND	ND	ND
PFHxS	< 1.00	< 1.00	< 1.00	ND	ND	ND
PFOS	7.83	4.96	< 1.00	7.9	5.0	12.9
PFOSA	< 0.500	< 0.500	< 0.500	ND	ND	ND

Total sample air volume was 991.8 m^3 air

* Filter: Front end fiberglass filter captures most particulates and aerosols

** Front puf/xad: This section of sampling train will capture all PFCs in gaseous form and any ultra fine particles that may escape capture on filter. Blank-corrected.

*** Back puf: Secondary polyurethane packing designed to capture any breakthough of gaseous PFCs from front puf/xad. May also be used as a QC indicator of overall collection efficiency

Appendix B

Sources, Fate, and Transport of PFCs in the Environment

Direct Sources of Perfluorinated Chemicals to the Environment

The variety and number of fluorinated compounds currently in production comprise an enormous group of chemicals including drugs, anesthetics, chemotherapeutic agents, many pesticides, and refrigerants, as well polymers such as Teflon® and Goretex® [1]. The environmental fate of most of these compounds is unknown.

This summary is focused primarily on perfluorinated surfactants which include perfluorooctanoic acid (PFOA) and perfluorooctane sulfonate (PFOS) and related compounds that have been the focus of intense environmental study. Perfluorinated surfactants are consistently detected in almost every surface and ground water sample and are almost always found in wildlife and humans. While it is clear that these are not naturally occurring compounds – they are entirely human-made – how these compounds have become so widely distributed in our environment in often very remote locations is less understood. Studies have shown that PFOA, for example, is likely "ubiquitous in the northern hemisphere" without a clear source of that widespread contamination [2]

The direct release of these compounds to the environment through manufacturing processes represents one route of exposure to chemicals like PFOA or PFOS. However, several recent studies show that they can also be generated through the degradation of other fluorinated compounds or products that are not of serious environmental concern.

Fluorinated surfactants are synthesized via two primary methods: through electrochemical fluorination (ECF) or through a telomerization manufacturing process[1, 3]. ECF is the process that 3M uses to produce fluorinated compounds. This process begins with sulfonyl fluorides, fluoroalkyl iodides, or carbonyl fluorides, and results in numerous perfluorinated carbon (PFC) compound isomers and byproducts. It results in isomeric mixtures of PFC that are typically 30% branched isomers and 70% straight carbon chain isomers [1, 3]. ECF was used to produce the fluorinated surfactants PFOA and PFOS, non-volatile perfluorinated surfactants that are used in fire-fighting foams (aqueous film-forming foams, or AFFF), paints, polishes, films, and lubricants. ECF is the only process used to directly produce PFOA and PFOS, with over 6 million pounds produced in 2000 [3].

The major contributors to environmental loads appear to be direct sources from the use of PFOA and the ammonia salts of perfluorononanoic acid (PFNA) in fluoropolymer manufacturing [4]. The chemicals produced through ECF from sulfonyl fluorides include PFOS, *N*-methylperfluorooctanesulfonamidoethanol (*N*-MeFOSE), and *N*-ethylperfluorooctanesulfonamidoethanol (*N*-EtFOSE)[1, 3]. The latter two volatile sulfonamide alcohols are themselves building blocks for a variety of polymers, chemical intermediates, and other perfluoroalkyl substances, and were used to produce carpet treatments and paper coating materials[3]. Due to their volatility, *N*-MeFOSE, and *N*-EtFOSE have been found in atmospheric samples.

A primary use of fluorinated chemicals is in the synthesis of fluorinated polymers. Polyfluoroalkylphosphate surfactants (PAPs), for example, are produced from *N*-EtFOSE and have been used in food contact paper products since 1974. *N*-MeFOSE was the primary ingredient in the production of polymers used for coating fabrics and carpets, such as 3M's ScotchGard® products [5]. sOf the compounds produced through the ECF process, 3% were used in fire-fighting foams, 10% were used as industrial surfactants and coatings, 37% were used in textile, leather, and carpet coatings, and 41% of fluorinated alkyl substances were used for paper and packaging.

Telomerization*,* is DuPont's process of manufacturing fluorinated alkyl compounds[1]. In this process, only chemicals that consist of straight-carbon chains are produced (as opposed to straight or branched perfluorinated chains produced by ECF process). This is the now the major fluorotelomer manufacturing process since 3M phased out production of PFOA and PFOS in 2000.

Unlike the ECF process, telomerization is often used to make fluorotelomer alcohols (FTOHs)[1], which are characterized by the presence of a terminal ethanol group. FTOHs vary in the number of fluorinated carbons that are attached to the alcohol group. Due to the feedstock and the chemical manufacturing method, they always contain an even number of carbons. FTOHs are not used directly in commercial applications. Rather, they are used as reactive intermediates in the manufacture of other fluorosurfactants and PFC polymer products, where they are often present in residual amounts of up to 4% by weight [6].

Indirect Sources of Fluorinated Chemicals to the Environment

Fluorotelomer Alcohols

The fate of fluorinated and perfluorinated compounds is dependent on the particular chemical in question and the surrounding environment. Due to the high strength of the fluorine-carbon bond, fluorinated chemicals are typically very stable and highly resistant to biological and abiotic degradation. However, some carbon-fluorine bonds are biodegradable under aerobic conditions [7], and recent studies have demonstrated that some fluorinated chemicals can degrade in ways that partially explain patterns of PFC contamination observed in the environment.

Several studies have demonstrated that perfluorocarboxylic acids (PFCAs, which include PFOA and PFBA, perfluorobutanoic acid) and perfluoroalkanesulfonates (such as PFOS and PFBS, perfluorobutane sulfonate) are extremely persistent in surface water, soil, and ground water, and are unlikely to break down. Moody, et al. [8] reported that the PFCAs PFOA and perfluorohexanoic acid (PFHxA) as well as PFOS, were very persistent in surface water into which fire-fighting foam was spilled, and were detected in fish liver tissue over years of sampling after the spill. PFCAs were also persistent in ground water where AFFF fire-fighting foam was used for training[9]. These studies focused on surface water or ground water contamination that was attributable to an identifiable source or spill. The reasons for widespread, low-level contamination of soil, ground water, and surface water in the ambient environment, however, are not clear, because it is difficult to explain how non-volatile PFCA salts such as PFOA could be transported to areas far from a likely source of these chemicals.

FTOHs are usually precursors to the production of fluoropolymers used in paper and carpet treatments, paints, adhesives, waxes, and polishes. They are considered semi-volatile, but their environmental fate is dictated by their partitioning behavior [10]. They have a vapor pressure of 140 – 990 Pa and partition into the atmosphere, where they have been detected at concentrations of 17 - 135 picograms m^{-3} [11]. FTOH is known to break down abiotically in the atmosphere with roughly a 20 day half-life, yielding the corresponding PFCAs such as perfluorodecanoic acid (PFDA) [2, 11]. With over 10 million pounds of FTOH produced per year, Ellis et al. [11] concluded that enough FTOH is manufactured yearly to maintain currently observed concentrations of PFCAs in the environment. The process of FTOH degrading to PFCAs may account for the estimated 0.4 tons of PFOA deposited in the arctic annually [2]. FTOHs can also undergo biological breakdown to PFCAs (e.g. PFOA), during aerobic treatment of wastewater treatment plant (WWTP) sludge via beta-oxidation. Between 1 – 10% of FTOH is converted to PFOA in this treatment process [7, 10].

The degradation of FTOHs to PFCAs is consistent with the observations made of the distribution of PFC in other studies:

- The appearance of PFDA in fish samples in Minnesota is consistent with the breakdown of 10:2 FTOH to PFDA. The longer chain PFCAs have no significant history of intentional industrial production [12], and there is no known natural source of long-chain PFCAs [11].

- DeSilva and Mabury [12] report that 98% of human blood samples from the Midwest in 2004-2005 consist of straight-chain, telomere-based PFOA, implying that only 11% of the PFOA exposure was to ECF-derived PFOA. They attributed 89% of the PFOA to fluorotelomer-based production methods.

- Recent MPCA studies show that various perfluorinated surfactants – including PFOA and PFOS – were present in the atmosphere in 2008. The presence of these compounds in the air can be explained by the photodecomposition of FTOH molecules in the atmosphere. 3M discontinued manufacture of these PFCs in 2000.

- Minnesota ground water monitoring shows PFOA, PFPeA (perfluoropentanoic acid), PFHxA, PFHpA (perfluoroheptanoic acid), and PFNA at low concentrations that are widespread under ambient conditions, with no known or likely sources of these compounds. The degradation of FTOH compounds to these corresponding PFCAs is a plausible source of these PFCA detections in the ambient environment.

Fluorinated Polymers

Fluorinated polymers are produced in far greater volumes than the fluorinated surfactants. However, very little has been published regarding the fate and behavior of fluorinated polymers in the environment [3]

Synthetic polymers in general are typically very resistant to biological or non-biological degradation. Studies on fluoroacrylate polymers indicate that these compounds have a 1200 year half-life and the biodegradation of fluoroacrylate polymers is expected to add only a very slight amount of PFCA to the global pool of PFCAs [13]. However, PAPs – polymers used extensively for oil and water-resistant coatings on food contact paper products – degrade into FTOHs and subsequently to a toxic fluorotelomer aldehyde intermediate, which, in turn, degrades to fluorotelomer carboxylic acids such as PFOA [5]. The degradation of PAPs was found to occur in the gastrointestinal tract and bloodstream of laboratory animals. *With PAPs representing 20% of all PFCs produced for paper coatings, this represents a significant source of exposure to PFCAs like PFOA.*[5].

PAPs are typically generated from monomers of *N*-EtFOSE, which are produced through the ECF process described above. Studies conducted by 3M indicated that *N*-EtFOSE can aerobically degrade to PFOS in wastewater in 35 days. Another study found that biodegradation of *N*-EtFOSE in wastewater did not generate PFOS in wastewater [14], although it did anaerobically degrade to related compounds. This work suggested that the transformation of *N*-EtFOSE to PFOS may not occur within the typical hydraulic residence time of a WWTP, and implied that any PFOS in WWTP effluent is likely due to PFOS present in the in influent. It appears that much of the PFOS in a WWTP is removed. Shultz et al [3] estimated that 98% of PFOS was removed in WWTPs.

N-MeFOSE was typically used to manufacture fluorinated-polymer coatings for fabric and carpet. Shoeib et al [15] found that indoor air concentrations of *N*-MeFOSE and *N*-EtFOSE were roughly 10-20 times greater than outdoor concentrations. It has been suggested that these compounds can break down into PFOS directly in the atmosphere [16] thereby providing a route of human exposure to PFOS ingestion and inhalation inside the home where these products have been used. The breakdown of *N*-MeFOSE and *N*-EtFOSE to PFOS may also explain in part the presence of PFOS in remote environments, since *N*-MeFOSE and *N*-EtFOSE volatilize and can be transported through the atmosphere, eventually breaking down to PFOS [17]. However, it may also be possible for PFOS to condense onto atmospherically mobile aerosol particles that are then transported over long distances and eventually deposited in remote locations [17].

In soil, PFOS has been found to adsorb to various iron minerals, with adsorption increasing with PFOS concentration [18]. However, PFOS apparently adsorbs to soil less than hydrocarbons of similar size [18]. Other studies with PFC surfactants show that the organic carbon concentrations in the soil and PFC size are the most important factors influencing sorption to soil [19]. In addition, low pH and high Ca^{+2} in soil solution increases the adsorption of these compounds, suggesting that electrostatic interactions are important in the sorption of PFOS and other PFC surfactants to soil and sediment [19]. Microcosm studies conducted on ground-water sediment collected from the Washington County landfill [20] indicated that adsorption of PFOS and PFOA may be dependent on the oxidation/reduction status of the ground water, implying that these compounds may become more mobile in highly reduced ground water aquifers.

References

1. Banks, R. E.; Smart, B. E.; Tatlow, J. C., *Organofluorine Chemistry: Principles and Commercial Applications*. Plenum Press: New York, 1994; p 644.
2. Wallington, T. J.; Hurley, M. D.; Xia, J.; Wuebbles, D. J.; Sillman, S.; Ito, A.; Penner, J. E.; Ellis, D. A.; Martin, J.; Mabury, S. A.; Nielsen, O. J.; SulbaekAndersen, M. P., Formation of C7F15COOH (PFOA) and Other Perfluorocarboxylic Acids during the Atmospheric Oxidation of 8:2 Fluorotelomer Alcohol. *Environ. Sci. Technol.* **2006,** *40*, (3), 924-930.
3. Schultz, M.; Barofsky, D.; Field, J., Fluorinated Alkyl Surfactants. *Environmental Engineering Science* **2003,** *20*, (5), 487-501.
4. Liu, J.; Lee, L. S., Effect of Fluorotelomer Alcohol Chain Length on Aqueous Solubility and Sorption by Soils. *Environ. Sci. Technol.* **2007,** *41*, (15), 5357-5362.
5. D'Eon, J. C.; Mabury, S. A., Production of Perfluorinated Carboxylic Acids (PFCAs) from the Biotransformation of Polyfluoroalkyl Phosphate Surfactants (PAPS): Exploring Routes of Human Contamination. *Environ. Sci. Technol.* **2007,** *41*, (13), 4799-4805.
6. Dinglasan-Panlilio, M. J. A.; Mabury, S. A., Significant Residual Fluorinated Alcohols Present in Various Fluorinated Materials. *Environ. Sci. Technol.* **2006,** *40*, (5), 1447-1453.
7. Wang, N.; Szostek, B.; Folson, P. W.; Sulecki, L. M.; Capka, V.; Buck, R. C.; Berti, W. R.; Gannon, J. T., Aerobic biotransformation of 14C-labeled 8-2 telomer B alcohol by activated sludge from a domestic sewage treatment plant. *Environmental Science and Technology* **2005,** *39*, 531-538.
8. Moody, C. A.; Martin, J. W.; Kwan, W. C.; Muir, D. C. G.; Mabury, S. A., Monitoring Perfluorinated Surfactants in Biota and Surface Water Samples Following an Accidental Release of Fire-Fighting Foam into Etobicoke Creek. *Environ. Sci. Technol.* **2002,** *36*, (4), 545-551.
9. Moody, C. A.; Hebert, G. N.; Strauss, S. H.; Field, J. A., Occurrence and persistence of perfluorooctanesulfonate and other perfluorinated surfactants in groundwater at a fire-training area at Wurtsmith Air Force Base, Michigan, USA *J. Environ. Monit.* **2003,** *5*, 341-345.
10. Ning Wang, B. S., Robert C. Buck, Patrick W. Folsom, Lisa M. Sulecki, Vladimir Capka, William R. Berti, and John T. Gannon Fluorotelomer Alcohol Biodegradation-Direct Evidence that Perfluorinated Carbon Chains Breakdown *Environ. Sci Technol.* **2005,** *39.* 7516-7528.
11. Ellis, D. A.; Martin, J. W.; DeSilva, A. O.; Mabury, S. A.; Hurley, M. D.; SulbaekAndersen, M. P.; Wallington, T. J., Degradation of Fluorotelomer Alcohols: A Likely Atmospheric Source of Perfluorinated Carboxylic Acids. *Environ. Sci. Technol.* **2004,** *38*, (12), 3316-3321.
12. DeSilva, A. O.; Mabury, S. A., Isomer Distribution of Perfluorocarboxylates in Human Blood: Potential Correlation to Source. *Environ. Sci. Technol.* **2006,** *40*, (9), 2903-2909.

13. Russell, M. H.; Berti, W. R.; Szostek, B.; Buck, R. C., Investigation of the Biodegradation Potential of a Fluoroacrylate Polymer Product in Aerobic Soils. *Environ. Sci. Technol.* **2008,** *42*, (3), 800-807.
14. Boulanger, B.; Vargo, J. D.; Schnoor, J. L.; Hornbuckle, K. C., Evaluation of Perfluorooctane Surfactants in a Wastewater Treatment System and in a Commercial Surface Protection Product. *Environ. Sci. Technol.* **2005,** *39*, (15), 5524-5530.
15. Shoeib, M.; Harner, T.; Wilford, B. H.; Jones, K. C.; Zhu, J., Perfluorinated Sulfonamides in Indoor and Outdoor Air and Indoor Dust: Occurrence, Partitioning, and Human Exposure. *Environ. Sci. Technol.* **2005,** *39*, (17), 6599-6606.
16. Martin, J. W.; Muir, D. C. G.; Moody, C. A.; Ellis, D. A.; Kwan, W. C.; Solomon, K. R.; Mabury, S. A., Collection of Airborne Fluorinated Organics and Analysis by Gas Chromatography/Chemical Ionization Mass Spectrometry. *Anal. Chem.* **2002,** *74*, (3), 584-590.
17. Wania, F.; Mackay, D., Tracking the distribution of persistent organic pollutants. *Environmental Science and Technology ; VOL. 30 ; ISSUE: 9 ; PBD: Sep 1996* **1996**, pp. 390A-396A ; PL:.
18. Johnson, R. L.; Anschutz, A. J.; Smolen, J. M.; Simcik, M. F.; Penn, R. L., The Adsorption of Perfluorooctane Sulfonate onto Sand, Clay, and Iron Oxide Surfaces. *J. Chem. Eng. Data* **2007,** *52*, (4), 1165-1170.
19. Higgins, C. P.; Luthy, R. G., Sorption of Perfluorinated Surfactants on Sediments. *Environ. Sci. Technol.* **2006,** *40*, (23), 7251-7256.
20. Ferrey, M.; Adair, C.; Wilson, J. T. In *Sorption of PFOA and PFOS to aquifer sediment.*, PFAA Days: Recent Advances in Perfluoroalkyl Acid (PFAA) Research., Research Triangle Park, North Carolina, 2008; Research Triangle Park, North Carolina, 2008.

Appendix C

Summary of PFC Toxicity Studies

*Please note: This is not an exhaustive list and other studies may exist that the author was not aware of at the time of printing.

Species or Type of Assay	**Compound and Exposure Concentrations** (mg/kg bw/day unless otherwise noted)	**Endpoint**	**Effect Concentration** (mg/kg bw/day unless otherwise noted)	**Reference**
Rat 90 day oral exposure	PFOS potassium salt 0, 30, 100, 300, 1000, 3000	Death Changes in organ and body weight	LC_{50} = 100 LOAEL = 30	Goldenthal et al., 1978
Rat 2 generation reproductive toxicity	PFOS potassium salt 0.1, 0.4, 1.6, 3.2 by gavage	Significant reduction pup weight gain in F1 generation	LOAEL = 0.4 NOAEL = 0.1	Christian et al., 1999
Rat 2-year dietary study	PFOS 0.06 – 0.23 (males) 0.07 – 0.21 (females)	Histopathological changes in liver	LOAEL (both sexes) = 40.08 μg/g in liver And 13.9 mg/L in serum	Covance Laboratories, Inc. 2002
Rhesus monkeys 90 day gavage	PFOS potassium salt 0, 0.5, 1.5, 4.5	100% Death Gastrointestinal toxicity	4.5 LOAEL = 0.5	Goldenthal et al., 1978
Cynomolgus monkeys 26 weeks	PFOS	Thymic atrophy (females) Reduced HDL, cholesterol, triiodo-thyronine, total bilirubin (males)	LOEL = 0.03 Corresponding to mean concentrations in female and male sera and liver of 19.8 μg/mL and 14.5 μg/g, respectively	Covance Laboratories, Inc. 2002
Fathead minnow (*Pimephales promelas*) 96 h and 42 d	PFOS lithium salt	Death	LC_{50} (96h) = 4.7 mg/L NOEC (42d) = 0.3 mg/L	OECD, 2002
Mysid shrimp (*Mysis bahia*)	PFOS lithium salt	Death	LC_{50} (96h) = 3.6 mg/L NOEC = 0.25 mg/L	OECD, 2002
Aquatic midge (*Chironomous tentans*)	PFOS	Growth and survival	NOEC (10d) = 0.0491 mg/L	Macdonald et al., 2004
Green Algae (*Pseudokirchnerilla subcapitata*)	PFOS	Cell density	IC_{50} (96h) = 48.2 mg/L NOEC = 5.3 mg/L	Boudreau et al., 2003
Mallard duck (*Anas platyrhyncos*) 21 weeks in feed	PFOS	Reduced testes size and decreased spermatogenesis	10 mg/kg diet corresponding to serum and liver concentrations of 87.3 μg/mL and 60.9 μg/g, respectively	3M, 2003

Species or Type of Assay	**Compound and Exposure Concentrations** (mg/kg bw/day unless otherwise noted)	**Endpoint**	**Effect Concentration** (mg/kg bw/day unless otherwise noted)	**Reference**
Bobwhite quail (*Colinus virginianus*) 21 weeks in feed	PFOS	Increase in liver weight (female) Increased incidence of small testes size (male) Reduced chick survivability as a percentage of eggs set	10 mg/kg diet	3M, 2003
Marine Mussel (*Mytilus californianus*)	PFNA PFDA	Inhibition of p-glycoprotein cellular efflux transporter resulting in chemosensitization	IC50 (PFNA) = 4.8 μM IC50 (PFDA) = 7.1 μM	Stevenson et al., 2006
Male Rats 14 day oral	PFDoA 1, 5, 10	Decreased absolute testes weight Increased total serum cholesterol Increased luteinizing hormone Decreased testosterone Reduced mRNA expression of genes involved in cholesterol transport and steroid synthesis	10 10 10 5 and 10 5 and 10	Shi et al., 2007
Medaka (*Oryzias latipes*)				
MCF-7 Breast Cancer Cells *In vitro*	6:2 and 8:2 FTOH	Breast cancer cell proliferation	10 μM	Maras et al., 2006
Tilapia Hepatocytes *In vitro*	PFOS PFOA 6:2 FTOH 8:2 FTOH	Estrogenicity determined by vitellogenin induction	3.1×10^{-7} M 5.1×10^{-7} M 1.1×10^{-6} M 7.5×10^{-7} M	Liu et al., 2007

Other useful toxicity studies:

3M, **2008**. *Ecotoxicity of and Derivation of Preliminary Safe Water Concentrations for Perfluorobutyric Acid (PFBA)*. Presented at North American SETAC, Tampa, Florida, 2008.

Jensen, A and H. Leffers, 2008. *Review Article: Emerging endocrine disrupters: perfluoroalkylated substances*, International Journal of Andrology, **31**, 161-169.

Health Consultation

PFOS DETECTIONS IN THE
CITY OF BRAINERD, MINNESOTA

CITY OF BRAINERD, CROW WING COUNTY, MINNESOTA

AUGUST 13, 2008

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Agency for Toxic Substances and Disease Registry
Division of Health Assessment and Consultation
Atlanta, Georgia 30333

Health Consultation: A Note of Explanation

An ATSDR health consultation is a verbal or written response from ATSDR to a specific request for information about health risks related to a specific site, a chemical release, or the presence of hazardous material. In order to prevent or mitigate exposures, a consultation may lead to specific actions, such as restricting use of or replacing water supplies; intensifying environmental sampling; restricting site access; or removing the contaminated material.

In addition, consultations may recommend additional public health actions, such as conducting health surveillance activities to evaluate exposure or trends in adverse health outcomes; conducting biological indicators of exposure studies to assess exposure; and providing health education for health care providers and community members. This concludes the health consultation process for this site, unless additional information is obtained by ATSDR which, in the Agency's opinion, indicates a need to revise or append the conclusions previously issued.

You May Contact ATSDR Toll Free at
1-800-CDC-INFO
or
Visit our Home Page at: http://www.atsdr.cdc.gov

HEALTH CONSULTATION

PFOS DETECTIONS IN THE CITY OF BRAINERD, MINNESOTA

CITY OF BRAINERD, CROW WING COUNTY, MINNESOTA

Prepared By:
Minnesota Department of Health
Under Cooperative Agreement with the
The U.S. Department of Health and Human Services
Agency for Toxic Substances and Disease Registry

FOREWORD

This document summarizes public health concerns regarding perfluorochemical contamination in Minnesota. It is based on a formal site evaluation prepared by the Minnesota Department of Health (MDH). A number of steps are necessary to do such an evaluation:

- Evaluating exposure: MDH scientists begin by reviewing available information about environmental conditions at the site. The first task is to find out how much contamination is present, where it is found on the site, and how people might be exposed to it. Usually, MDH does not collect its own environmental sampling data. We rely on information provided by the Minnesota Pollution Control Agency (MPCA), U.S. Environmental Protection Agency (EPA), and other government agencies, businesses, and the general public.

- Evaluating health effects: If there is evidence that people are being exposed—or could be exposed—to chemical substances, MDH scientists will take steps to determine whether that exposure could be harmful to human health. The report focuses on public health—the health impact on the community as a whole—and is based on existing scientific information.

- Developing recommendations: In the evaluation report, MDH outlines its conclusions regarding any potential health threat posed by a site, and offers recommendations for reducing or eliminating human exposure to contaminants. The role of MDH in dealing with individual sites is primarily advisory. For that reason, the evaluation report will typically recommend actions to be taken by other agencies—including EPA and MPCA. However, if there is an immediate health threat, MDH will issue a public health advisory warning people of the danger, and will work to resolve the problem.

- Soliciting community input: The evaluation process is interactive. MDH starts by soliciting and evaluating information from various government agencies, the organizations responsible for cleaning up the site, and the community surrounding the site. Any conclusions about the site are shared with the groups and organizations that provided the information. Once an evaluation report has been prepared, MDH seeks feedback from the public. *If you have questions or comments about this report, we encourage you to contact us.*

Please write to:

Community Relations Coordinator
Site Assessment and Consultation Unit
Minnesota Department of Health
625 Robert Street N. / Box 64975
St. Paul, MN 55164-0975

OR call us at:

(651) 201-4897 *or* 1-800-657-3908
(toll free call—press "4" on your touch tone phone)

On the web: http://www.health.state.mn.us/divs/eh/hazardous/index.html

I. Summary of Background and History

Summary

In the spring of 2007, the Minnesota Pollution Control Agency (MPCA) initiated a study of perfluorochemicals (PFCs) in influent, effluent, and sludge at public and private wastewater treatment plants (WWTPs) across the state of Minnesota. The study was done to determine if PFCs were present in these waste streams and could therefore be a source of PFCs to the broader environment. The study was also partly in response to the detection of elevated levels of PFOS in fish tissue in Lake Calhoun in Minneapolis, an urban lake with no known nearby PFC disposal sites or other obvious source of PFCs. PFOS has been shown to be toxic to the liver, thyroid, and to produce developmental effects in animal studies, and the presence of PFOS in fish in Lake Calhoun and other Minnesota lakes has resulted in the issuance of fish consumption advisory by the Minnesota Department of Health (MDH) to limit human exposure to PFOS.

MDH was asked for assistance by Brainerd Public Utilities (BPU) in evaluating the results of the MPCA study, which showed elevated levels of PFOS at the BPU WWTP (see below). The results of MDH's evaluation show that the discharge of PFOS containing treated water from the WWTP represents no apparent public health hazard at this time as PFOS levels in the river water and fish appear to be low.

Background

Starting in April 2007, the MPCA collected samples from 28 public and private wastewater treatment plants for analysis for 13 PFCs by Axys Analytical Services, British Columbia, Canada. Samples of influent (n=32), effluent (n=28), and sludge (n=23) were analyzed. The plants were located in all parts of the state. The survey was designed to provide as broad a range of data as possible across Minnesota. The sampling locations and data from the study, divided into three geographical regions, are presented in Appendix 1. Many of the plants located in rural areas had very low or non-detectable concentrations of PFCs, while plants located in larger urban areas consistently had detections of multiple PFCs. Other areas under study by the MPCA that could serve as potential sources of PFCs in the environment include land disposal facilities, ambient surface water, groundwater, and ambient air.

Several of the plants had elevated levels of individual or multiple PFCs that could reasonably be attributed to local sources, including known PFC contamination in nearby wells (e.g. Marathon-Ashland refinery in St. Paul Park, Washington County – an area where groundwater and drinking water wells have been impacted by nearby PFC manufacturing and waste disposal) or the known use of PFC containing products at a facility (e.g. MSP International Airport – where PFC-containing fire fighting foams have been used in emergency response). The most notable exception was perfluorooctane sulfonate (PFOS) found in the influent, effluent, and sludge from the City of Brainerd WWTP (operated by Brainerd Public Utilities, or BPU). The plant also serves the adjacent City of Baxter. The cities of Brainerd and Baxter are located about 135 miles northwest of St. Paul, along the Mississippi River. This plant had the highest detections of PFOS in all three media of any of the wastewater treatment plants tested. The April 2007 PFOS concentrations at Brainerd were as follows:

- Influent: 0.811 micrograms per liter (µg/L)
- Effluent: 1.51 µg/L

- Sludge: 861 micrograms per kilogram (µg/kg)

These values are higher than any levels previously reported in scientific literature, although the data are limited (see below). PFOS is one of the more well-studied PFCs, from an environmental and toxicological standpoint, and has been a focus in Minnesota in drinking water and fish tissue due to its toxicity in animal studies and ability to bioaccumulate in wildlife and humans.

BPU has continued to collect samples from the WWTP, and from several locations within the collection system to monitor PFOS levels. The sample results have varied somewhat; this is not unexpected given the number of factors that likely affect daily wastewater flow rates into the system. Grab sample data for PFOS at the BPU treatment plant are as follows:

Table 1: PFOS Levels at the BPU WWTP, µg/L

Location	**7/24/2007**	**8/13/2007**	**10/25/2007**	**11/14/07**
Influent	0.954	0.121	0.598	0.326
Effluent	0.544	0.189	0.814	0.335

The MPCA announced the preliminary findings of the wastewater treatment plant study in a press release issued on July 20, 2007. The PFOS levels found at the Brainerd WWTP were described in the press release as significantly higher than other plants in the study. As a result, the MPCA Citizen’s Board postponed a decision on a request by the City of Brainerd for a permit to expand their WWTP. The city applied for the permit because of growing demands on their wastewater treatment capacity – a result of local population growth and an expanding industrial base. Subsequently, the City of Brainerd (through BPU) initiated an investigation to determine the source(s) of the PFOS detected at the treatment plant. BPU staff requested assistance from MDH staff in analyzing drinking water samples, and in evaluating possible sources of PFOS to the WWTP.

The initial BPU investigation (implemented by Barr Engineering Company, Minneapolis, MN) involved the collection of 35 samples of wastewater from the treatment plant and numerous locations spread throughout the city. The samples were collected using new polyethylene bailers which were lowered into the waste stream (typically through an open manhole in the case of samples collected in the city), filled, and then decanted into sample containers provided by the laboratory. The samples were analyzed by MPI Research (formerly Exygen Research) of State College, PA for the presence of 13 PFCs, including PFOS. The sample locations are shown in Figure 1, while the data are presented in Appendix 2. Both were provided to MDH by Barr Engineering Company staff. The detection limits achieved by the MPI Research laboratory were very low, and the data quality appears to be good.

The results from samples collected at the treatment plant itself were generally consistent with the MPCA results for PFOS and other PFCs. Results for samples taken in the wastewater collection system, away from the WWTP and out in the city, were more variable. PFOS was detected in five samples, four of which were at concentrations ranging from 0.08 to 1.18 µg/L. The fifth sample, collected at a manhole on 10th Street, just south of Madison Street in an industrial park (location 17 in Figure 1) had a PFOS concentration of 49.8 µg/L.

Subsequent investigations have tentatively identified the sources of some of the minor detections of PFOS to the wastewater treatment system as a metal working facility, a printing shop, and a state-owned hospital facility. The likely major source is described in the following section.

PFC Investigations at Keystone Automotive

Keystone Automotive, a chrome plating operation specializing in automobile bumpers, is located in the industrial park adjacent to the manhole at sample location 17. Representatives from Keystone Automotive contacted BPU staff to inform them that the company used a legal surfactant product that likely contained PFOS in their operations. The product is added to a chrome plating bath to reduce surface tension, which in turn helps reduce emissions of hexavalent chromium from the plating solution. Hexavalent chromium can be released into the air with the bursting of bubbles formed below the surface of the tank solutions during electroplating. This is important from a worker safety and environmental standpoint, as hexavalent chromium is toxic through both inhalation and dermal contact, and is considered a human carcinogen (ATSDR 2000). The location of Keystone Automotive, relative to this sample location and the BPU treatment plant, is shown in Figure 1. Photographs of the chrome plating tank at Keystone Automotive are shown in Figure 2.

The product used by Keystone Automotive was identified as Fumetrol™ 140 Mist Suppressant (Atotech USA, Rock Hill, SC). Available Material Safety Data Sheets (MSDS) for the product indicate that it contains an “organic fluorosulfonate” between 1% and 7% by weight. The company reported using 16 fluid ounces per day of the product in their chrome plating tank to maintain surface tension (and hence hexavalent chromium emissions) below EPA required limits (K. Anderson, Keystone Automotive, personal communication 2007). This amount of product used (approximately 30 gallons per year), coupled with the reported average water flow rate through the facility of approximately five gallons per minute (5 gpm), would appear to be responsible for the majority of the PFOS found in samples at the BPU treatment plant.

The initial response to the determination that the chrome plating bath at Keystone Automotive was the most likely source of PFOS in the BPU wastewater treatment system was the installation of a temporary granular activated carbon (GAC) filter on the facility’s wastewater stream. The filter was constructed in a plastic tub, and consisted of 550 pounds of GAC. GAC is effective at removing PFOS from drinking water, and has been successfully used to remove PFCs from the wastewater stream at the 3M-Cottage Grove facility (MDH 2005). The intent of the filter was to serve as a temporary measure while other mist suppressant products (that reportedly did not contain PFOS) were obtained from the company’s suppliers and tested.

MDH staff consulted with 3M staff, due to their experience with GAC treatment for PFCs, to try to determine if the filter system would be effective in removing PFOS from the wastewater stream, and if so, for how long it would be effective. Based on calculations done by 3M staff that initially assumed a PFOS influent concentration of 50 µg/L (the PFOS level in the July sample collected at the manhole near Keystone Automotive), 3M estimated that the system would effectively remove PFOS for a period of approximately 17½ days (G. Hohenstein, 3M, personal communication 2007).

Samples were collected by BPU staff at Keystone Automotive after the initial single GAC filter had been in operation for approximately six days. The results showed an influent PFOS concentration to the GAC filter of 185 µg/L, and an effluent PFOS concentration after the GAC filter of 210 µg/L. The influent PFOS concentration was 3.7 times higher than that used in the calculations made by 3M and as a result, the time to PFOS breakthrough of the filter would have been something less than five days instead of 17½ days. Clearly the GAC filter was not removing the PFOS, and was in fact serving as a reservoir of PFOS and releasing it back into the wastewater stream. It must be stated that 3M staff based their calculations on data from treatment systems at their own facilities. The wastewater stream at Keystone Automotive is much different in terms of its composition, pH, and other factors which can significantly affect the adsorption of PFOS onto the activated carbon. The addition of the second GAC unit in series with the first likely resulted in only a temporary reduction in PFOS levels.

In early September 2007, Keystone Automotive switched to a different mist suppressant, MSP 28™ (also from Atotech USA). While the MSDS from the manufacturer/distributor of this product does not describe its composition, it reportedly does not contain PFOS or other PFCs. Initial testing has shown it to be effective at meeting the surface tension limits established by EPA. It has been slightly more costly, however than the previous product used by Keystone Automotive, mainly because higher quantities have been needed to meet surface tension limits.

Because PFOS continued to be detected at the BPU WWTP at elevated concentrations even after Keystone Automotive switched products, BPU has worked with Keystone Automotive to try to identify where PFOS remains within their facility. The process involved sampling at the location where the Fumetrol™ 140 Mist Suppressant was used (the chrome plating tank), and moving downstream to include the rinse tanks. Initial samples were collected in October 2007 and analyzed by MPI Research. The chrome plating tank solution had a PFOS concentration of 1,650 µg/L, while the final (of four) rinse tank had a PFOS concentration of 306 µg/L. The lower photograph in Figure 2 shows bumpers being moved from the chrome plating bath to the rinse tanks. Drippage of plating fluid from the bumpers into the rinse tanks can be seen, which is likely responsible for the detection of PFOS in the rinse tanks.

Additional samples were collected in November 2007 for analysis of 13 PFCs by MPI Research, and the results are shown in Appendix 3. A number of different plating solutions were sampled in addition to the chrome plating tanks. These other plating solutions (nickel, copper) are located “upstream” of the chrome plating tank in the process line and were generally low in PFOS, 1.25 µg/L or less. The chrome plating tank solution had a PFOS concentration of 823 µg/L. The level of another PFC, perfluorobutane sulfonate (PFBS, a four-carbon PFC) was 176,000 µg/L in this tank. PFOS was detected at a concentration of 33,000 µg/L in the Electroclean tank solution. The high PFBS and PFOS levels in these two samples are almost certainly estimates, as the samples were diluted and levels this high would normally be outside the calibration range of the instruments used for the analysis. A sample of the replacement fume suppressant product, MSP 28™, showed low levels of PFCs, including PFOS at a concentration of 0.437 µg/L.

To help verify and expand on the findings of the November samples, several additional samples were collected at Keystone Automotive by BPU staff in December 2007 for analysis at the MDH Public Health Laboratory in St. Paul, Minnesota. The samples were analyzed for seven PFCs, and the results are shown in Table 2. Multiple dilutions were required for some samples due to the high concentrations of PFCs; the sample results have been adjusted accordingly so that the data are comparable. Formal report limits were also elevated due to the dilutions used.

Table 2: Dec. 2007 Keystone Automotive Samples Analyzed by MDH, µg/L

Sample Location	PFBA	PFPeA	PFBS	PFHxS	PFOS
Chrome Tank	nd	nd	97,039	19.11	1,635
Soak Tank	11.96	8.05	84.6	nd	373
ElectroClean Tank	38.67	19.04	136	nd	2,757
Floor Drain water	nd	nd	48	nd	278
New Soak Solution	nd	nd	nd	nd	nd
New ElectroClean Solution	nd	nd	nd	nd	2.16

nd = not detected (<30 µg/L).

Two of the samples (new soak solution and new ElectroClean solution) were of stock solutions made up in the company laboratory, and were not from the process area. One showed a low level of PFOS, 2.16 µg/L. The floor drain receives water used to clean parts removed from the final rinse tank, and discharges to the on-site wastewater treatment system. The rinse tanks become contaminated with PFOS (and PFBS) from the carryover of chrome plating solution on automobile bumpers or other products to the rinse tanks (as shown in Figure 2). While the expectation was that the PFOS concentration in the chrome tank should have dropped after the switch was made to the low-PFC containing MSP 28™ in September, 2007, the MDH results for the chrome tank are similar to the initial sample collected in October and analyzed by MPI Research, and higher than the November sample. Such variability may be normal, as no systematic study of this type of operation has been conducted, no standard sampling protocol exists, and very little is known about the behavior of PFOS in plating baths.

It may take some time for the PFOS (and PFBS) to be flushed through the plating tanks and piping at the Keystone Automotive facility. The process could be accelerated by removing and cleaning what appears to be the main source of PFOS, the chrome solution tank. PFOS is likely bound in part to organic matter and sludge in the tank, which could be contributing to the continuing detections of PFOS. The tanks are reportedly cleaned and the sludge thermally treated (and metals recovered) at an out-of-state hazardous waste treatment facility every five years; the company is reportedly at the mid-point of this cycle (K. Anderson, Keystone Automotive, personal communication 2008). Thermal treatment at a high temperature has the capability of destroying PFCs. In the meantime, Keystone Automotive continues to be the main contributor of PFOS to the Brainerd wastewater collection and treatment system.

Drinking Water Samples

When the PFOS detections in the BPU WWTP were first announced, there was immediate concern that the city's drinking water could be contaminated, as potable water used for drinking, cooking, bathing, etc. likely makes up a large portion of the water entering the WWTP. MDH staff moved quickly to collect samples from the city drinking water treatment plant for analysis at the MDH laboratory. Samples were collected on July 25, 2007; no PFCs were detected in the samples. Samples were collected from the Brainerd drinking water plant and the drinking water treatment plant in the adjacent City of Baxter at about the same time by the City of Brainerd for analysis at MPI Research. No PFOS or PFOA was detected in any of the five samples from the two plants; trace amounts of two other PFCs were found in some of the samples.

After processing, sludge generated at the BPU WWTP is land applied on agricultural fields at several locations near the city. Because of the high levels of PFOS detected in sludge samples collected at the plant, and the high mobility of PFOS in the environment, BPU officials collected samples from two residential wells located near the agricultural fields for analysis by the MDH laboratory. No PFCs were detected in either well. Crop samples (alfalfa, corn) were also collected from the fields and submitted to the MDH laboratory for future analysis. The MDH laboratory has not yet developed methodology for extracting PFCs from solid matrices, so the samples are being stored (frozen) until such a time as they can be analyzed. PFOS does not degrade naturally, so even an extended period of storage should not significantly affect any PFOS that could be contained in the plants.

Mississippi River Fish and Surface Water Data

In August 2007, Minnesota Department of Natural Resources (DNR) staff, at the request of MPCA staff, collected samples of four species of fish in the Mississippi River for analysis of the fillets for 13 PFCs, including PFOS. The fish were collected approximately ¼ mile below the BPU WWTP outfall to the river (shown in Figure 1), which would be about at river mile 1001 (L. Solem, MPCA, personal communication 2008). The samples were analyzed by Axys Analytical Laboratory in British Columbia, Canada. No other PFCs besides PFOS were detected in any of the fish samples. Summary statistics (provided by the MPCA) for PFOS in the 15 fish samples are presented in Table 3.

Table 3: Average PFOS Concentration, Mississippi River Fish, µg/kg

	Bluegill	**Smallmouth Bass**	**Northern Pike**	**Walleye**
Mississippi River, Brainerd area	10 (2)*	13 (5)	7 (3)	9 (5)

* average PFOS concentration (# fish).

These levels of PFOS are significantly lower than the threshold value used by MDH to consider issuing contaminant-specific fish consumption advice, which is currently 38 µg/kg of PFOS in edible fish tissue. This threshold is based on a reference dose derived from a toxicological study conducted in monkeys (Seacat et. al 2002) that is also the basis for MDH drinking water criteria for PFOS (see below).

The average PFOS levels found by the MPCA are comparable to levels reported in carp in the upper Mississippi River by Ye et al. (2007) in an as-yet unpublished study conducted by EPA. That study, which measured PFOS levels in carp fillets in three sections of the Mississippi River, reported a median PFOS level of 8.1 µg/kg in nine carp collected at river mile 937. This site is located between the cities of Brainerd and St. Cloud, Minnesota and was intended as a “background” location. Higher median levels (25.9 and 40.2 µg/kg) were found in carp fillets from further down the Mississippi River (in an area known as Pool 2), in the vicinity of St. Paul at river miles 833 and 816, respectively. These samples were collected near identified sources of PFC discharge to the Mississippi River, such as landfills and the 3M-Cottage Grove facility. Samples of carp fillets collected by the MPCA in 2005 from Pool 2 of the Mississippi River and analyzed for PFCs showed a higher median level of PFOS, 175 µg/kg (McCann et. al 2007). Samples collected further downstream in 2005 by the MPCA in Lake Pepin (Pool 4) had a median PFOS level of 50 µg/kg.

In October, 2007, MPCA staff collected surface water samples from the Mississippi River at several locations above, at, and below the BPU WWTP outfall to the river for analysis for PFCs. PFOS was reportedly not detected in surface water samples collected above and below the BPU WWTP outfall. PFOS was detected at approximately 0.1 µg/L in samples of river water collected right at the point of the WWTP outfall (see Figure 1). The river was reportedly near flood stage at the time the samples were collected, and rapid dilution may explain why PFOS was not detected below the WWTP.

Site Visit

On Monday, February 11, 2008 MDH staff conducted a site visit at Keystone Automotive, located at 2110 10th Street South in Brainerd, Minnesota. The purpose of the site visit was to observe the facilities plating operation, especially the chrome plating area. Keystone Automotive is reportedly one of the largest chrome bumper repair and plating facilities in the Unites States.

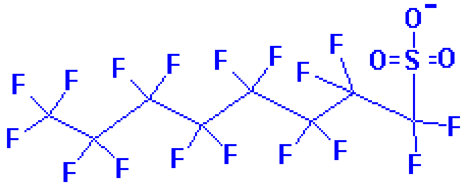
Keystone Automotives' main business is the repair and re-plating of chrome automobile parts, including bumpers, headlight fixtures, and other "shiny" parts for vintage and modern vehicles. The electroplating process consists of the layering of copper, nickel, and chrome on the parts in successive operations. Following each plating solution (copper, nickel, and chrome) are cleaning solution baths and/or rinse tanks to remove the plating solutions. The rinse tanks consist of four tanks in series. Water flow is from the final rinse tank back towards the first rinse tank, and ultimately to the electroplating tank and on-site wastewater treatment plant. Parts are moved on racks between the various plating baths and rinse tanks.

The chrome plating solution is orange in color, and the "foam" layer on the surface of the chrome plating solution is a result of the use of the surfactant-based fume suppressant (see Figure 2). Drippage (or carry-over) of plating solution from the bumpers into the rinse tanks can be seen in Figure 2 as well. After the plating process is complete, the racks of parts are removed, cleaned with a spray hose (which drains into a floor drain), dried, buffed and wrapped for shipment to the customer.

MDH staff also toured the wastewater treatment plant operated by BPU, which is located at 7933 Highland Scenic Road in Brainerd. The purpose of the tour was to observe the basic plant layout, and the locations where PFC samples were collected. A schematic of the plant was provided by BPU staff.

II. Discussion

Perfluorooctane sulfonate (PFOS; $C_8F_{17}SO_3^-$) based products were produced by 3M in the United States until 2002. 3M ended production over concerns about the mobility and persistence of PFOS in the environment, bioaccumulation of PFOS by animals, and long half-life in humans (3M 2000). PFOS is still manufactured elsewhere in the world, however.



Chemical Structure of Perfluorooctane sulfonate, PFOS

The carbon-fluorine bond is a high-energy bond, one of the strongest known among organic molecules. As a result, the chemical structure of PFOS makes it extremely resistant to natural breakdown, and it is persistent once released to the environment. The structure of PFCs in general makes them excellent surfactants. The word surfactant is an acronym for 'surface active agent' - a molecule that lowers surface tension in a liquid. This property in particular helps make PFOS-based mist suppressants effective at reducing hexavalent chromium emissions from chrome plating tanks.

On the basis of its physical properties, PFOS is essentially non-volatile, and would not be expected to evaporate from water (OECD 2002). In soil-water mixtures, PFOS has a strong tendency to remain in water due to its solubility (typically 80% remains in water and 20% in soil). PFOS is expected to be mobile in water at equilibrium (3M 2003).

PFOS has been detected in the blood plasma and tissues of wildlife from across the globe, including seals, otters, dolphins, aquatic birds, bald eagles, polar bears, freshwater and saltwater fish, and reptiles (Giesy and Kannan 2001). This landmark study showed that PFOS is widely distributed in the global environment. Levels of PFOS were higher in fish-eating and predatory animals than in their typical prey, indicating that PFOS bioconcentrates as it moves up the food chain. Bald eagles from the Midwestern U.S. showed the highest levels of PFOS in blood plasma in the study, and mink from the Midwestern U.S. showed the highest levels in tissue (liver).

Estimated bioconcentration factors (BCF) for PFOS in fish range from 200 to 1,500 in carp and 1,124 to 4,013 in bluegills (OECD 2002). For benthic invertebrates, a BCF of approximately 1,000 for PFOS has been estimated by Kannan et al. (2005). A study by Martin et al. (2004) in Lake Ontario demonstrated that PFOS could be found throughout the food web in the lake, at all trophic levels, and that contaminated sediment was a major source. These studies clearly demonstrate that low levels of PFOS in water and sediment have the ability to become concentrated in fish populations. The study by Kannan et al. (2005) also suggests that a considerable amount of PFOS is transferred to the next generation through the eggs of fish. Other PFCs do not appear to bioconcentrate as significantly as PFOS, which may be due to a positive relationship between the hydrophobicity of various surfactants such as PFCs and their ability to bioconcentrate (Tolls and Sijm 1995).

A decreasing gradient of PFOS levels in aquatic invertebrates and two species of fish in an estuary and the North Sea was observed with distance from the port of Antwerp, Belgium (Van de Vijver et al. 2003; Hoff et al. 2003). 3M operated a manufacturing plant in Antwerp for many years where PFOS was made.

The BPU WWTP had the highest level of PFBS ($C_4F_9SO_3^-$) in WWTP effluent samples collected by the MPCA (see Appendix 1). According to information from 3M (3M 2004), PFBS is persistent in the environment, is not metabolized in living organisms, but unlike PFOS, does not bioconcentrate or accumulate in organisms. It is non-volatile, very soluble in water, and does not partition to sediments. It has shown very low toxicity in animal studies, including reproductive and developmental studies.

PFC Studies at Wastewater Treatment Plants

Previous studies of PFCs at wastewater treatment plants in the Twin Cities metro area (Oliaei et al. 2006), Iowa (Boulanger et al. 2005), six cities around the southeast United States (3M 2001), Kentucky and Georgia (Loganathan et al. 2007), New York state (Sinclair and Kannan 2007), the Pacific Northwest (Schultz et al. 2006) and Denmark (Bossi et al. 2007) have identified the presence of low levels of PFOS in WWTP influent, effluent, and sludge. Table 4 shows the ranges of PFOS reported in the various studies; single values represent one location.

Table 4: Range of PFOS Levels Reported in WWTP Influent, Effluent, and Sludge

Study	WWTP Location	Influent, ug/L	Effluent, ug/L	Sludge, ug/kg
Logonathan et al. 2007	Rural Kentucky Urban Georgia	0.007 - 0.016 0.0025 -0.0079	0.008 - 0.028 0.0018 - 0.013	8.2 – 110 38 – 77
Sinclair & Kannan 2006	New York State (6 locations)	Not reported	0.003 – 0.068	< 10 - 65
Boulanger et al. 2007	Iowa	0.40[1]	0.026	Not reported
3M 2001	6 Cities, SE US	Not reported	0.041 – 5.29[2]	60 - 3,120[2]
Oliaei et al. 2006	St. Paul, MN	0.053	0.081	37 - 397
Schultz et al. 2006	NW US	0.015	0.018	53
Bossi et al. 2007	Denmark (6 loc.)	<0.0015 - 0.01	<0.0015 – 0.18	4.8 – 74.1
MPCA 2007	Statewide median	0.0353	0.0305	24.6

[1] Estimated concentration due to analytical problem.

[2] Maximum value is for the Decatur, Alabama WWTP.

In the 3M six-city study (3M 2001), four cities where PFCs were manufactured or used (supply cities), and two control cities in the southeastern United States were targeted for evaluation of various media for PFCs, including WWTP effluent and sludge. One of the cities in the study, Decatur, Alabama was the location of a 3M manufacturing plant for PFOS-containing products until 2002. The PFOS data for the Decatur WWTP are much higher than WWTP data for other cities in this study, or in other published studies. If the results for the Decatur WWTP are removed, the data from the various published studies generally fall within the same range. Median values in the statewide study conducted by the MPCA also fall within the same general range. Clearly, a major source of PFOS in wastewater such as the 3M plant in Decatur or the discharge from Keystone Automotive in Brainerd can significantly increase PFOS levels at an individual WWTP. Conversely, the finding of elevated levels of PFOS in WWTP influent, effluent, or sludge is an indicator that a local source is likely present.

According to the 3M study (3M 2001) and other published reports, PFOS readily adsorbs to soil/sediment/sludge matrices. Due to the acidic nature of PFOS, once adsorbed, it forms strong bonds with sludge particles and does not readily desorb. This chemical interaction or partitioning to solids in wastewaters is typical of many organic contaminants and may explain the relatively higher levels of PFOS in WWTP sludge compared to the concentration of PFOS in the wastewater at the same plant.

Levels of other PFCs analyzed for in the various studies described above were generally much lower or not detected, with the exception of perfluorooctanoic acid (PFOA), a PFC still used in various industrial and commercial applications. PFOA does not appreciably bioconcentrate in fish or other animals in the aquatic environment (Kannan et al. 2005).

Use of PFOS-Containing Fume Suppressants in the Metal Plating Industry

On October 9, 2007 EPA published a proposed expanded “Significant New Use Rule” (SNUR; 40 CFR Part 721.9582) in the Federal Register (72 FR 57222) regarding perfluoroalkyl sulfonates not already covered in previous rules under the Toxic Substances Control Act (TSCA). The proposed rule requires manufacturers and importers to notify EPA at least 90 days before beginning to manufacture or import the chemicals listed in the SNUR. The SNUR lists four exemptions from the rule for specific uses of PFOS containing compounds, including:

- Use as an ant-erosion additive in fire-resistant phosphate ester aviation hydraulic fluids;
- Use as a component of a photoresist substance, etchant or anti-reflective coating in the semiconductor and electronic device industries;
- Use is coatings for surface tension, static discharge, and adhesion control for analog and digital imaging films, papers, and printing plates; and
- Use as a fume/mist suppressant in metal finishing and plating baths.

The first three exemptions had been described in previous SNURs; the final exemption was new. Exemptions to SNURs are presumably granted by EPA because alternative products are not available, are too costly, or are not effective. In the case of the metal plating industry, a comment submitted to EPA (presumably from industry) and included in the October 9, 2007 federal register notice stated that “the releases of (PFOS) associated with the industry are comparably of much less concern than those related to nickel and hexavalent chromium which result when (PFOS) fume suppressants are not used.” In its response to the comment, EPA acknowledged this fact and stated that it had included an exemption for this use in the rule, but “encourages the continued exploration for possible substitutes.” Clearly there are costs and benefits associated with the use of PFOS containing mist suppressants in the metal plating industry. The proposed expanded SNUR was to become final in November 2007.

In a memorandum from the regional administrator of EPA Region 5 (which includes Minnesota) to officials at EPA headquarters, Region 5 described the use of PFOS containing mist suppressants in the metal plating industry and made several recommendations for further action (EPA 2007). EPA has estimated that no more than eight metric tons of PFOS containing compounds are used per year in the U.S. in the metal plating industry, but that specific amounts used or released by metal platers are not reported. In the memorandum, EPA Region 5 recommended that EPA consider PFOS in a residual risk assessment of the chrome plating industry already being conducted, that EPA consider delaying the final implementation of the expanded SNUR to gather additional information, that further investigation of the discharge of PFOS from the metal plating industry to local wastewater plants be conducted, and that any additional PFOS compounds in the plating industry be identified and included in the expanded SNUR. Nevertheless, the SNUR became final in November, 2007.

In a report on PFOS prepared in part for the Environment Agency for England and Wales, consultants to that Agency evaluated the environmental risks associated with current uses of PFOS (RPA 2004). The report estimated that 10,000 kilograms (10 metric tons) of PFOS were used per year in chromium plating in the European Union (EU), by far the largest use of PFOS in any industrial sector. The report went on to identify this use as a potential risk to the freshwater and marine food chains, and proposed that the use of PFOS containing mist suppressants be phased out in favor of alternative methods of reducing hexavalent chromium emissions.

The switch to a mist suppressant (MSP 28™) with a very low level of PFOS (0.437 µg/L), seems to be working for Keystone Automotive, meeting surface tension requirements to limit hexavalent chromium emissions (K. Anderson, Keystone Automotive, personal communication 2007). The effect (either positive or negative) of the residual presence of the previous, PFOS-containing product on the performance of the current product is unclear, however. If this product continues to be effective, at a similar cost to the PFOS containing product, it appears that based on this facility there is an alternative that may be acceptable to the industry at large.

With the switch in products, levels of PFOS in wastewater from the Keystone Automotive facility should decline over time. Removing the contents of the chrome plating tank, which appears to be the main source of PFOS, would speed up the process. The PFOS contained in the tank would likely be destroyed during thermal treatment of the sludge from the tank. Cleaning out the remaining tanks all at one time may not be advisable, as it could generate a "slug" of PFOS to the BPU WWTP and ultimately to the Mississippi River that could have deleterious effects on microorganisms in the treatment plant and aquatic organisms in the river near the outfall of the treatment plant.

Evaluation of Toxicity and Exposure

PFOS is well absorbed orally, but is not absorbed well through inhalation or dermal contact (OECD 2002). Exposure to high levels of PFOS is acutely toxic in test animals. Chronic exposure to PFOS at high doses results in liver toxicity and mortality, with a steep dose-response curve for mortality in rats and primates (OECD 2002; Seacat et. al 2002). Indications of toxicity observed in 90-day rat studies include increases in liver enzymes and other adverse liver effects, gastrointestinal effects, blood abnormalities, weight loss, convulsions, and death. Various reproductive studies of rats followed for two generations showed postnatal deaths and other developmental effects in offspring of female rats exposed to relatively low doses of PFOS (OECD 2002). These studies demonstrate that exposure to PFOS can result in adverse effects on the offspring of rats exposed while pregnant. Further information on the toxicity of PFOS, including a list of the various studies reviewed by MDH to establish reference doses, drinking water values and fish consumption advice can be found on the MDH website at http://www.health.state.mn.us/divs/eh/groundwater/perfluorohrls.html.

A completed exposure pathway exists when people come into contact with contaminated soil, sediments, water, air, or other environmental media. For a completed exposure pathway to represent a public health hazard, the concentration of contaminants must exceed levels of health concern and the exposure must be frequent or intense enough for the body to absorb the contaminants at levels that could increase the risk of adverse health effects.

At Keystone Automotive, there is little potential for exposure to PFOS except for staff who may have added the PFOS-containing fume suppressant directly to the chrome plating tank. Minor exposure could have occurred through dermal contact or incidental ingestion during that process. Because plating solutions typically are very corrosive and are electrified, direct contact with the solutions themselves by other employees is minimal, and protective equipment is worn.

There is also little potential for exposure to PFOS at the BPU WWTP. Employees at such facilities typically do not come into contact with wastewater for any length of time, and protective equipment is typically worn. Sludge from the WWTP does contain high levels of PFOS because of its affinity for binding with sludge. The application of the sludge on local agricultural fields does not appear to have impacted the nearest drinking water wells, perhaps because the PFOS is bound tightly enough to prevent significant leaching. It is not clear, however if crops grown on the fields have taken up PFOS from the sludge, as this issue has not been widely studied. If crops do absorb PFOS from soils, PFOS could be entering the human foodchain if the crops are eaten directly, or more likely fed to animals that are in turn used to provide milk or meat.

It is also possible that direct human contact with soil where the sludge has been incorporated could be of potential health concern, depending on the level of PFOS in the soil. The MPCA has established a Soil Reference Value (SRV) for PFOS of 2,000 ug/kg for PFOS based on a residential exposure scenario (MPCA 2007a). An SRV represents the concentration of a contaminant in soil at or below which normal dermal contact, inhalation, and/or ingestion are unlikely to result in an adverse human health effect. They are typically used to evaluate if contaminant levels in shallow soil could pose a long-term human health risk. The PFOS level in the sludge from the BPU WWTP was 861 ug/kg. If sludge containing this level of PFOS was applied repeatedly to the same field, the concentrations could exceed the SRV over time.

Human exposure to PFOS originating from the Keystone Automotive facility could also occur when the discharge from the BPU WWTP enters the Mississippi River. Exposure could occur through direct contact or ingestion during swimming or wading, or through ingestion of PFOS contaminated fish. Based on water and fish samples collected by the MPCA, however, it appears that the PFOS is quickly diluted to non-detectable levels in the river (based on one sample event) and that levels of PFOS in fish are well below current MDH guidelines for issuing contaminant-specific fish consumption advice. Additional data would be helpful to determine if levels of PFOS in the river or local fish population changes over time, or with changing river conditions. Sediment data would also be useful.

Child Health Considerations

ATSDR recognizes that the unique vulnerabilities of infants and children make them of special concern to communities faced with contamination of their water, soil, air, or food. Children are at greater risk than adults from certain kinds of exposures to hazardous substances at waste disposal sites. They are more likely to be exposed because they play outdoors and they often bring food into contaminated areas. They are smaller than adults, which means they breathe dust, soil, and heavy vapors close to the ground. Children also weigh less, resulting in higher doses of chemical exposure per body weight. The developing body systems of children can sustain permanent damage if toxic exposures occur during critical growth stages. Most importantly, children depend completely on adults for risk identification and management decisions, housing decisions, and access to medical care.

Opportunities for exposure by children to PFOS at the Keystone Automotive facility, the Brainerd wastewater treatment plant, or sanitary sewer system should be minimal. Some exposure to PFOS or related compounds could occur in the Mississippi River near the WWTP outfall, although the exposure would be brief based on surface water data. Exposure to PFOS from the consumption of fish from the Mississippi River near Brainerd appears to be below levels of health concern.

III. Conclusions

The presence of PFOS at Keystone Automotive and the BPU WWTP poses no apparent public health hazard directly to employees of either facility or the general public. The discharge of PFOS containing treated water from the WWTP also represents no apparent public health hazard at this time as PFOS levels in the river water and fish appear to be low. An alternate surfactant product is currently being used by Keystone Automotive and levels of PFOS in wastewater from their facility and at the BPU WWTP are expected to drop over time. Further sampling would be helpful, however. The land spreading of sludge from the BPU WWTP represents an indeterminate public health hazard. This indeterminate conclusion is based on the fact that little is known about the levels of PFOS in agricultural fields where the sludge is applied, and the uptake of PFOS by crops in the fields (and potential entry into the foodchain) has not been studied.

IV. Recommendations

1. To more quickly reduce PFOS levels in wastewater coming from their facility, Keystone Automotive should consider implementing the cleanout of the chrome plating tank ahead of the normal five year schedule.
2. BPU should continue to monitor PFOS levels at the WWTP.
3. Employees of Keystone Automotive and BPU should limit their exposure to PFOS contaminated plating solutions, wastewater, and sludge.
4. One set of additional samples of water, sediments, and fish should be collected from the Mississippi River near the BPU WWTP outfall in 2008 to characterize PFOS levels over time.
5. The MDH Public Health Laboratory should analyze the crop samples obtained from the agricultural fields where sludge from the BPU WWTP was applied to determine if the crops have taken up PFOS from the soils.
6. Soil samples from the agricultural fields should be collected for analysis for PFCs.

V. Public Health Action Plan

MDH’s Public Health Action Plan for the site will consist of:

1. A letter to the EPA, MPCA, city and county authorities, and industry representatives with a copy of this report advising them of these conclusions and recommendations;
2. Review of any additional available data;
3. Working with the MPCA and the chrome plating industry in Minnesota to determine if other businesses use PFOS-containing surfactant products, and to encourage the use of PFOS-free products or alternative plating processes where possible;
4. Working with the MPCA on a follow-up investigation of other WWTPs in Minnesota, including those whose customers include chrome plating shops; and
5. Working with the EPA on similar efforts in Region 5 and nationwide.

VI. References

3M 2000. Correspondence from William A. Weppner, 3M Company, to Charles Auer, US Environmental Protection Agency. June 16, 2000.

3M 2001. Environmental Monitoring – Multi-City Study Executive Summary. 3M Environmental Laboratory, June 25, 2001.

3M 2003. Environmental and Health Assessment of Perfluorooctane Sulfonate Acid and its Salts. 3M Company, St. Paul, Minnesota. August 20, 2003.

3M 2004. Ecotoxicology, Environmental Fate and Health Testing of Perfluorobutane Sulfonate. 3M Company, St. Paul, Minnesota. April 26, 2004.

ATSDR 2000. Toxicological Profile for Chromium. U.S. Department of Health and Human Services, Agency for Toxic Substances and Disease Registry, Atlanta, GA. September 2000.

Bossi, R., Strand, J., Sortkjaer, O., and Larsen, M.M. 2007. Perfluoroalkyl compounds in Danish wastewater treatment plants and aquatic environments. Environment International (2007), doi:10.1016/j.envint.2007.10.002.

Boulanger, B., Vargo, J.D., Schnoor, J.L., and Hornbuckle, K.C. 2005. Evaluation of perfluorooctane surfactants in a wastewater treatment system and in a commercial surface protection product. Environmental Science and Technology 39: 5524-5530.

EPA 2007. Memorandum from Mary A. Gade, Regional Administrator Region 5 to James B. Gulliford, Assistant Administrator Office of Prevention, Pesticides, and Toxic Substances, Robert J. Meyers, Acting Assistance Administrator Office of Air and Radiation, and Benjamin Grumbles, Assistant Administrator Office of Water. U.S. EPA, Region 5, Chicago, IL. October 11, 2007.

Giesy, J.P., and Kannan, K. 2001. Global distribution of perfluorooctane sulfonate in wildlife. Environmental Science and Technology 35: 1339-1342.

Hoff, P.T., Van de Vijver, K., Van Dongen, W., Esmans, E.L., Blust, R., and De Coen, W.M. 2003. Perfluorooctane sulfonic acid in bib (*Trisopterus luscus*) and plaice (*Pleuronectes platessa*) from the western scheldt and the Belgian North Sea: distribution and biochemical effects. Environmental Toxicology and Chemistry 22: 608-614.

Kannan, K., Tao, L., Sinclair, E., Pastva, S.D., Jude, D.J., and Giesy, J.P. 2005. Perfluorinated compounds in aquatic organisms at various trophic levels in a great lakes food chain. Archives of Environmental Contamination and Toxicology 48: 559-566.

Loganathan, B.G., Sajwan, K.S., Sinclair, E., Kumar, K.S., and Kannan, K. 2007. Perfluoroalkyl sulfonates and perfluorocarboxylates in two wastewater treatment facilities in Kentucky and Georgia. Water Research (2007), doi:10.1016/j.waters.2007.06.045.

Martin, J.W., Whittle, D.M., Muir, D.C.G., and Mabury, S.A. 2004. Perfluoroalkyl contaminants in a food web from Lake Ontario. Environmental Science and Technology 38: 5379-5385.

McCann, P., Kelly, J., and Solem, L. 2007. Perfluorochemicals in Fish Fillets from Minnesota. Minnesota Department of Health, St. Paul, MN, Minnesota Pollution Control Agency, St. Paul, MN. http://www.health.state.mn.us/divs/eh/fish/pfcposter.pdf.

MDH 2005. Health Consultation on Perfluorochemical Releases at the 3M Cottage Grove Facility. Minnesota Department of Health, St. Paul, Minnesota, February 18, 2005.

MPCA 2007a. Soil Reference Values (SRVs) for PFOA and PFOS. Memorandum from Emily Hansen, MPH to Kathryn Sather, May 8, 2007.

OECD 2002. Hazard Assessment of Perfluorooctane Sulfonate (PFOS) and its Salts. Organization for Economic Cooperation and Development. November 21, 2002.

Oliaei, F., Kriens, D., and Kessler, K. 2006. Investigation of Perfluorochemical (PFC) Contamination in Minnesota Phase One. Report to Senate Environment Committee, February 2006.

RPA 2004. Perfluorooctane Sulphonate: Risk Reduction Strategy and Analysis of Advantages and Drawbacks. Final Report prepared for the Department for Environment, Food, and Rural Affairs, and the Environment Agency for England and Wales. Risk & Policy Analysts, Ltd, in association with BRE Environment. August 3, 2004.

Seacat, A.M., Thomford, P.J., Hansen, K.J., Olsen, G.W., Case, M.T., Butenhoff, J.L. 2002. Subchronic toxicity studies on perfluorooctane sulfonate potassium salt in cynomolgus monkeys. Toxicol Sciences, 68: 249-64.

Schultz, M.M., Higgins, C.P., Huset, C.A., Luthy, R.G., Barofsky, D.F., and Field, J.A. 2006. Fluorochemical mass flows in a municipal wastewater treatment plant. Environmental Science and Technology 40: 7350-7357.

Sinclair, E., and Kannan, K. 2006. Mass loading and fate of perfluoroalkyl surfactants in wastewater treatment plants. Environmental Science and Technology 40: 1408-1414.

Tolls, J., and Sijm, D.T.H.M. 1995. A preliminary evaluation of the relationship between bioconcentration and hydrophobicity for surfactants. Environmental Toxicology and Chemistry 14: 1675-1685.

Van de Vijver, K.I., Hoff, P.T., Van Dongen, W., Esmans, E.L., Blust, R., and De Coen, W.M. 2003. Exposure patterns of perfluorooctane sulfonate in aquatic invertebrates from the western scheldt estuary and the southern North Sea. Environmental Toxicology and Chemistry 22: 2037-2041.

Ye, X., Schoenfuss, H.L., Jahns, N.D., Delinsky, A.D., Strynar, M.J., Varns, J., Nakayama, S., Helfant, L., and Lindstrom, A.B. 2007. Perfluorinated compounds in common carp (*Cyprinus carpio*) fillets from the upper Mississippi River. Submitted to Environment International.

Preparer of Report

James Kelly, M.S.
Health Assessor
Site Assessment and Consultation Unit
Minnesota Department of Health
tel: (651) 201-4910
james.kelly@health.state.mn.us

CERTIFICATION

This Brainerd PFOS Detections Health Consultation was prepared by the Minnesota Department of Health under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). It is in accordance with approved methodology and procedures existing at the time the health consultation was begun. Editorial review was completed by the Cooperative Agreement partner.

Trent LeCoultre
Technical Project Officer, SPS, SSAB, DHAC, ATSDR

The Division of Health Assessment and Consultation, ATSDR, has reviewed this public health consultation and concurs with the findings.

Gregory V. Ulirsch for AY

Alan Yarbrough
Chief, State Program Section, SSAB, DHAC, ATSDR

Figure 2
Keystone Automotive Chrome Plating Tank

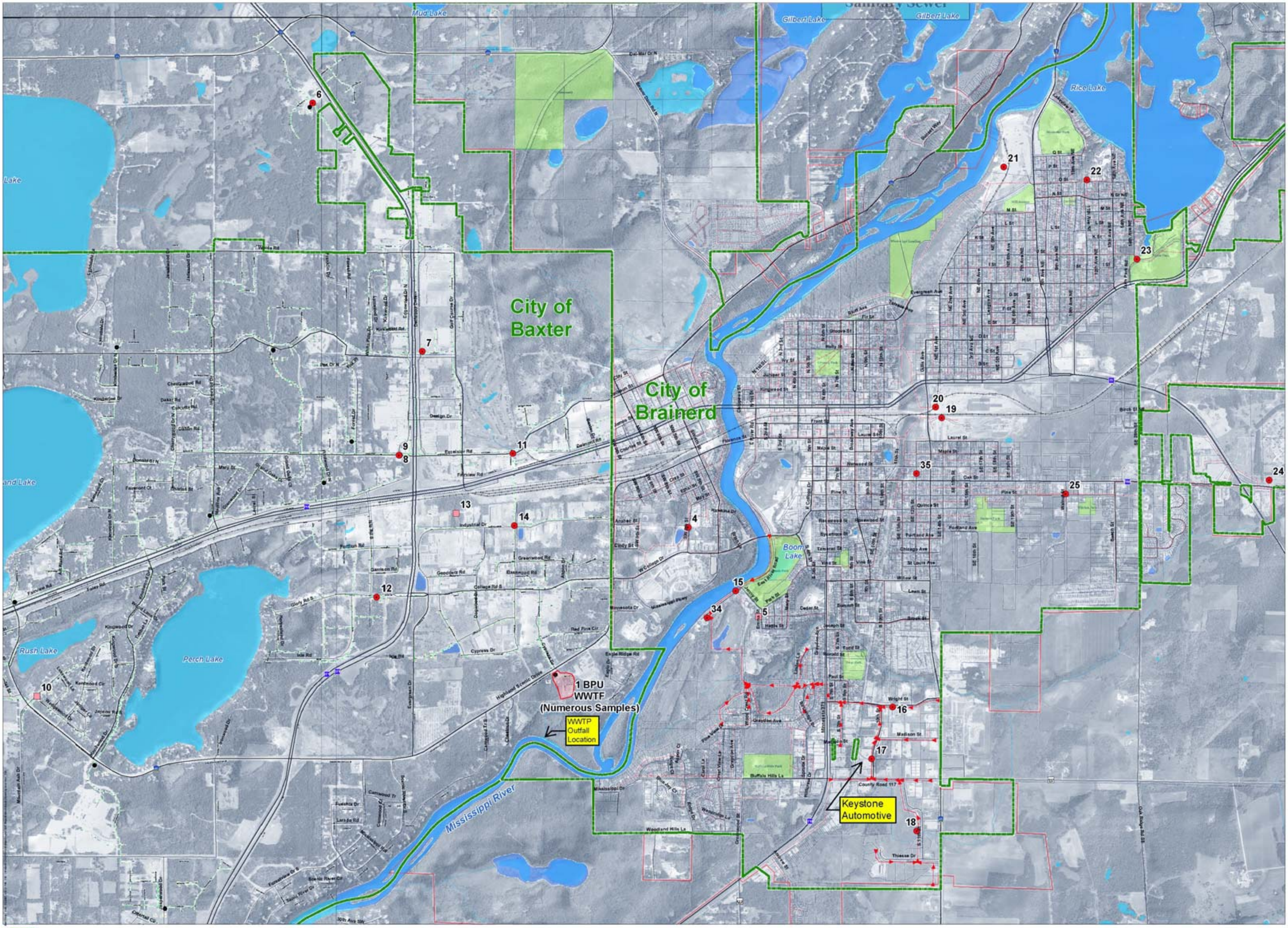


Figure 1
(Prepared by Barr Engineering)

PFC SAMPLING LOCATIONS
Collected July 24, 25, and 26th, 2007

Appendix 1: MPCA 2007 WWTP Sampling Data - Influent, ug/L

REGION	**PLANT NAME**	**PFBA**	**PFPeA**	**PFHxA**	**PFHpA**	**PFOA**	**PFNA**	**PFDA**	**PFUnA**	**PFDoA**	**PFBS**	**PFHxS**	**PFOS**	**PFOSA**
North	Alexandria	0.012	< 0.00439	0.00898	0.00459	0.0304	< 0.00495	< 0.00479	< 0.00560	< 0.00429	0.0156	0.0322	0.0219	< 0.00391
North	BoiseCascade	0.362	< 0.00428	< 0.00441	< 0.00441	< 0.00408	< 0.00482	< 0.00467	< 0.00546	< 0.00418	< 0.00467	< 0.00943	< 0.00943	< 0.00381
North	Brainerd	< 0.0116	< 0.00439	0.00847	0.00488	0.00993	< 0.00494	< 0.00478	< 0.00560	< 0.00428	0.109	0.0459	0.811	< 0.00390
North	Fergus Falls	0.033	< 0.00419	< 0.00432	< 0.00432	0.00508	< 0.00472	< 0.00457	< 0.00534	< 0.00409	< 0.0145	< 0.00924	0.0147	< 0.00373
North	Hibbing	0.0202	< 0.00415	< 0.00428	< 0.00428	0.0611	0.00944	< 0.00452	< 0.00529	< 0.00405	< 0.0133	0.0164	< 0.0179	< 0.00369
North	Paynesville	0.038	< 0.00439	< 0.00453	< 0.00453	< 0.00418	< 0.00495	< 0.00479	< 0.00560	< 0.00429	< 0.00958	< 0.00968	< 0.00968	< 0.00391
North	Thief River F	< 0.0138	< 0.00423	< 0.00437	< 0.00557	0.0436	0.00536	< 0.00462	< 0.00540	< 0.00413	< 0.0129	< 0.00933	< 0.00933	< 0.00377
North	WLSSD	0.0718	< 0.00921	0.00584	0.0073	0.014	< 0.00480	< 0.00465	< 0.00544	< 0.00416	< 0.0148	< 0.00939	< 0.00939	< 0.00379
Central	DodgeCenter	0.0833	< 0.00276	< 0.00285	< 0.00285	0.00627	< 0.00311	< 0.00301	< 0.00352	< 0.00270	< 0.00602	0.00714	0.019	< 0.00246
Central	Flint Hills	0.0402	< 0.00176	0.0172	< 0.00167	0.00908	< 0.00619	< 0.00619	< 0.00619	< 0.00619	0.0316	0.0275	0.0546	< 0.00619
Central	Hutchinson	0.037	< 0.00390	< 0.00402	< 0.00402	0.00495	< 0.00439	< 0.00425	< 0.00497	< 0.00381	0.0758	0.0115	0.0808	< 0.00347
Central	Marathon-Ashland	1.02	0.0626	0.0448	0.015	0.02	0.00421	< 0.00407	< 0.00407	< 0.00407	0.18	0.131	0.256	< 0.00407
Central	Maynard	0.026	0.00413	0.00499	< 0.00270	0.00851	< 0.00295	< 0.00286	< 0.00334	< 0.00256	< 0.00572	< 0.00578	< 0.00578	0.00443
Central	Melrose	< 0.012	< 0.00438	< 0.00452	< 0.00452	0.00518	< 0.00493	< 0.00478	< 0.00559	< 0.00428	< 0.00956	< 0.00966	< 0.00966	< 0.00390
Central	Metro - Eagle Point	0.656	0.0313	0.0229	0.00559	0.0171	< 0.00413	< 0.00413	< 0.00413	< 0.00413	0.0671	0.0199	< 0.00828	< 0.00413
Central	Metro - Seneca	0.11	< 0.00338	0.00931	< 0.00348	0.0287	0.00853	< 0.00368	< 0.00431	< 0.00330	0.118	0.187	0.171	< 0.00301
Central	Metro - Main Plant	0.0581	0.00858	0.0129	0.00652	0.021	< 0.00438	< 0.00438	< 0.00438	< 0.00438	0.0388	0.0124	0.0353	< 0.00438
Central	Metro - Main Plant	0.0868	0.00909	0.0141	0.00664	0.0218	< 0.00414	< 0.00414	< 0.00414	< 0.00414	0.0327	0.0141	0.0349	< 0.00414
Central	MSP Airport	0.0235	0.0188	0.0539	0.0313	0.12	0.0181	0.0828	0.00661	0.00802	0.00717	0.0285	0.0238	0.00582
Central	MSP Airport	0.0411	0.0632	0.108	0.0518	0.148	0.0304	0.115	0.0125	0.013	0.018	0.0749	0.393	< 0.00253
Central	Montivedeo	0.0329	< 0.00317	< 0.00327	< 0.00327	0.00947	0.00682	0.00774	< 0.00404	< 0.00310	< 0.00691	< 0.00828	< 0.00699	< 0.00282
Central	St. Cloud	< 0.012	< 0.00441	0.00681	0.00681	0.0165	< 0.00496	< 0.00480	< 0.00562	< 0.00430	< 0.0112	0.0215	< 0.00971	< 0.00392
Central	Willmar	0.0457	< 0.00370	< 0.00381	< 0.00381	0.00725	0.00487	< 0.00403	< 0.00472	< 0.00361	< 0.00807	< 0.00815	< 0.00815	< 0.00329
South	Austin	0.0196	0.00351	0.00295	< 0.00242	0.00439	< 0.00252	< 0.00244	< 0.00362	< 0.00219	< 0.00489	< 0.00494	< 0.00939	< 0.00199
South	Austin	0.0221	0.00263	0.00335	< 0.00268	0.00646	< 0.00292	< 0.00283	< 0.00331	< 0.00253	< 0.00566	0.00803	0.00652	< 0.00231
South	Morton	< 0.004	< 0.00403	< 0.00403	< 0.00403	< 0.00403	< 0.00403	< 0.00403	< 0.00403	< 0.00403	0.0212	< 0.00806	< 0.00806	< 0.00403
South	Morton	<0.004	< 0.00405	< 0.00405	< 0.00405	< 0.00405	< 0.00405	< 0.00405	< 0.00405	< 0.00405	0.00938	< 0.00811	< 0.00811	< 0.00405
South	Owatonna	0.0352	0.00929	0.0154	< 0.00385	0.0195	< 0.00420	< 0.00407	< 0.00476	< 0.00365	< 0.00814	< 0.00823	< 0.00823	< 0.00332
South	Pipestone	0.0189	0.0524	< 0.00257	< 0.00257	0.00332	0.0034	< 0.00272	< 0.00318	< 0.00244	< 0.00544	< 0.00550	< 0.00550	< 0.00222
South	Red Wing	0.0977	< 0.00379	0.00959	< 0.00391	0.0135	0.00665	< 0.00414	< 0.00484	< 0.00370	< 0.0132	< 0.00836	< 0.00836	< 0.00337
South	Rochester	0.0368	< 0.00404	0.00506	< 0.00417	0.0177	< 0.00455	< 0.00441	< 0.00515	< 0.00394	< 0.00881	0.0104	< 0.00107	< 0.00359
South	Worthington	0.0619	< 0.00390	< 0.00402	< 0.00402	0.00428	< 0.00439	< 0.00425	< 0.00497	< 0.00380	< 0.00850	< 0.00859	< 0.00859	< 0.00347
	No. of Detects	26	11	18	10	28	10	3	2	2	13	16	13	2
	Mean	0.1188	0.0241	0.0197	0.0140	0.0242	0.0098	0.0685	0.0096	0.0105	0.0557	0.0405	0.1479	0.0051
	Std. Dev.	0.2101	0.0180	0.0217	0.0107	0.0326	0.0064	0.0246	0.0025	0.0027	0.0428	0.0406	0.1612	0.0013
	Median	0.0391	0.0093	0.0095	0.0067	0.0138	0.0067	0.0828	0.0096	0.0105	0.0327	0.0207	0.0353	0.0051
	Max.	1.84	0.063	0.108	0.0518	0.148	0.0304	0.115	0.0125	0.013	0.18	0.187	0.811	0.00582

Appendix 1: MPCA 2007 WWTP Sampling Data - Effluent, ug/L

REGION	**PLANT NAME**	**PFBA**	**PFPeA**	**PFHxA**	**PFHpA**	**PFOA**	**PFNA**	**PFDA**	**PFUnA**	**PFDoA**	**PFBS**	**PFHxS**	**PFOS**	**PFOSA**
North	Alexandria	0.0324	0.0049	0.0115	0.00278	0.0132	0.00531	< 0.00287	< 0.00336	< 0.00257	0.0173	0.0408	0.0184	< 0.00235
North	BoiseCascade	0.0683	< 0.00426	< 0.00439	< 0.00439	0.00499	< 0.00480	< 0.00464	< 0.00543	< 0.00416	< 0.00929	< 0.00939	< 0.00939	< 0.00379
North	Brainerd	0.0503	< 0.00249	0.0123	0.00625	0.019	0.0141	< 0.00271	< 0.00317	< 0.00243	0.107	0.0106	1.51	< 0.00221
North	Fergus Falls	0.0182	0.00273	0.0105	0.00307	0.00903	0.0103	< 0.00281	< 0.00329	< 0.00252	0.0081	< 0.00568	< 0.00568	< 0.00229
North	Hibbing	0.022	0.0481	0.0307	0.00824	0.0635	0.0314	0.00733	< 0.00329	< 0.00252	0.0072	0.00857	0.0128	< 0.00229
North	Paynesville	0.0756	0.0149	0.0196	0.0106	0.0335	0.0093	< 0.00453	< 0.00530	< 0.00406	< 0.00906	0.0108	< 0.00916	< 0.00370
North	Thief River Falls													
North	WLSSD	0.0311	0.00318	0.00653	0.00348	0.0142	0.00848	< 0.00276	< 0.00323	< 0.00247	0.0162	< 0.00558	0.016	< 0.00225
Central	DodgeCenter	0.0234	0.00988	0.0048	< 0.00257	0.00756	< 0.00281	< 0.00272	< 0.00318	< 0.00244	< 0.00544	< 0.00550	< 0.00550	< 0.00222
Central	Flint Hills	0.148	< 0.00991	0.0236	0.00686	0.01	< 0.00259	< 0.00259	< 0.00259	< 0.00259	< 0.00517	0.045	0.0575	0.00521
Central	Hutchinson	0.035	0.0405	0.0402	0.00487	0.0318	< 0.00293	0.0037	< 0.00332	< 0.00254	0.0266	0.0129	0.0426	< 0.00232
Central	Marathon-Ashland	0.0793	< 0.00626	< 0.00626	< 0.00626	< 0.00626	< 0.00626	< 0.00626	< 0.00626	< 0.00626	< 0.0125	< 0.0125	< 0.0125	< 0.00626
Central	Maynard	0.027	0.00455	0.00782	0.00337	0.015	< 0.00310	< 0.00300	< 0.00351	< 0.00269	< 0.00601	< 0.00607	< 0.00607	0.00257
Central	Melrose	0.0136	< 0.00260	< 0.00268	< 0.00268	0.00354	0.00422	< 0.00283	< 0.00331	< 0.00254	< 0.00567	< 0.00573	< 0.00573	< 0.00231
Central	Metro - Eagle Point	0.565	0.0212	0.0276	0.00657	0.0225	0.00438	0.00353	< 0.00257	< 0.00257	0.0296	0.0219	< 0.00514	< 0.00257
Central	Metro - Seneca	0.0424	0.0401	0.0393	0.0133	0.0641	0.00792	0.004	< 0.00328	< 0.00251	0.0398	0.0531	0.0585	< 0.00229
Central	Metro - Main Plant	0.12	0.016	0.0274	0.015	0.0505	0.0152	0.00756	< 0.00264	< 0.00264	0.0257	0.0265	0.11	< 0.00264
Central	Metro - Main Plant	0.0752	0.0125	0.0259	0.015	0.0504	0.0121	0.00668	< 0.00256	< 0.00256	0.022	0.0257	0.0874	< 0.00256
Central	MSP Airport													
Central	Montivedeo	0.0178	0.0365	0.0147	0.00286	0.0265	0.00378	0.00329	< 0.00330	< 0.00252	< 0.00564	0.00955	< 0.00570	< 0.00230
Central	St. Cloud	0.0437	0.00566	0.0239	0.00432	0.0271	0.0102	< 0.00281	< 0.00328	< 0.00251	0.0124	0.0277	0.00684	< 0.00229
Central	Willmar	0.0368	< 0.00257	0.00499	0.00274	0.00586	< 0.00290	< 0.00281	< 0.00328	< 0.00251	< 0.00561	< 0.00567	< 0.0114	< 0.00229
South	Austin	0.0215	0.00512	0.00527	< 0.00265	0.00599	< 0.00290	< 0.00281	< 0.00328	< 0.00251	< 0.00561	< 0.00567	< 0.00654	< 0.00229
South	Morton	< 0.00260	< 0.00260	< 0.00260	< 0.00260	0.00338	< 0.00260	< 0.00260	< 0.00260	< 0.00260	< 0.00520	< 0.00520	< 0.00520	< 0.00260
South	Morton	< 0.00445	< 0.00445	< 0.00445	< 0.00445	< 0.00445	< 0.00445	< 0.00445	< 0.00445	< 0.00445	< 0.00891	< 0.00891	< 0.00891	< 0.00445
South	Owatonna	0.0179	0.0398	0.0209	0.00373	0.0321	< 0.00288	0.00433	< 0.00327	< 0.00250	< 0.00558	< 0.00564	< 0.00679	< 0.00228
South	Pipestone	0.0503	0.00605	0.00816	0.00415	0.0187	0.00441	< 0.00293	< 0.00342	< 0.00262	< 0.00585	< 0.00592	0.0101	0.00295
South	Red Wing	0.0536	0.00879	0.0302	0.00497	0.0227	< 0.00476	< 0.00461	< 0.00539	< 0.00413	0.0139	0.0202	< 0.0121	< 0.00376
South	Rochester	0.0313	0.0792	0.0288	0.0456	0.0399	0.00801	0.00544	< 0.00330	< 0.00252	< 0.00564	0.0109	0.0153	0.00303
South	Worthington	0.0149	0.00736	0.00344	< 0.00266	0.00604	< 0.00290	< 0.00281	< 0.00329	< 0.00252	< 0.00563	< 0.00569	< 0.00569	< 0.00230
	No. of Detects	26	20	23	20	26	15	9	0	0	12	14	12	4
	Mean	0.0659	0.0204	0.0186	0.0084	0.0231	0.0099	0.0051			0.0272	0.0232	0.1621	0.0034
	Std. Dev.	0.1030	0.0194	0.0127	0.0089	0.0186	0.0070	0.0026			0.0217	0.0153	0.2790	0.0013
	Median	0.0359	0.0112	0.0196	0.0049	0.0189	0.0085	0.0043			0.0197	0.0211	0.0305	0.0030
	Max.	0.565	0.0792	0.0402	0.0456	0.0641	0.0314	0.00756			0.107	0.0531	1.51	0.00521

not sampled

Appendix 1: MPCA 2007 WWTP Sampling Data - Sludge, ug/kg

REGION	PLANT NAME	PFBA	PFPeA	PFHxA	PFHpA	PFOA	PFNA	PFDA	PFUnA	PFDoA	PFBS	PFHxS	PFOS	PFOSA	% Moisture
North	Alexandria	< 4.59	< 4.59	< 4.59	< 4.59	17.3	18.7	13.8	9.76	< 4.59	< 9.18	< 9.18	99	14.2	90.1
North	BoiseCascade	< 0.194	< 0.194	< 0.194	< 0.194	< 0.194	< 0.194	< 0.194	< 0.194	< 0.194	< 0.389	< 0.389	< 0.389	< 0.194	17.2
North	BoiseCascade	0.254	< 0.191	< 0.191	< 0.191	< 0.191	< 0.191	< 0.191	< 0.191	< 0.191	< 0.382	< 0.382	< 0.382	< 0.191	50.6
North	BoiseCascade	< 0.401	< 1.15	< 0.849	< 0.299	< 0.266	0.45	< 0.201	< 0.201	< 0.201	< 0.818	< 0.703	< 0.713	< 0.201	0.37
North	Brainerd	< 0.869	< 0.677	3.47	0.877	3.68	20.1	3.99	5.9	2.22	< 11.3	2.77	861	2.98	95
North	Fergus Falls	2.74	< 1.33	3.15	< 0.727	4.04	62.7	6.16	11.8	1.43	< 1.45	< 1.45	21.4	3.52	98.1
North	Hibbing	< 1.80	< 0.799	< 0.778	< 0.752	2.48	2.67	1.72	2.04	2.17	< 2.04	< 1.50	8.18	< 0.752	93.9
North	Paynesville														
North	Thief River F														
North	WLSSD	6.75	< 1.85	< 1.85	< 1.85	4.43	4.12	4.72	4.24	< 1.85	< 4.14	< 3.69	18.7	11.5	98
Central	DodgeCenter		1.33	< 0.624	< 0.624	5.6	7.6	18.8	5.16	3.91	< 1.32	2.46	24.6	6.87	95.8
Central	Flint Hills														
Central	Hutchinson		29.4	13	4.73	54.6	10.1	57.2	6.16	11.6	5.6	3.99	304	10.8	97.9
Central	Marathon-Ashland														
Central	Maynard														
Central	Melrose	1.56	< 0.595	< 0.676	< 0.532	2.17	6.69	2.82	3.29	0.976	< 1.09	< 1.38	3.94	3.28	94.4
Central	Metro - Eagle Point	2.47	0.617	2.7	< 0.590	6.02	2.21	20.7	4.65	4.65	< 1.25	< 2.58	22.4	4	95.3
Central	Metro - Seneca		< 0.493	1.12	0.548	6.8	3.59	10.7	3.81	2.19	< 3.23	< 3.26	141	4.53	94.9
Central	Metro - Main Plant	7.27	4.52	6.58	< 2.73	24.5	23.3	36.9	19.2	19.2	< 5.46	< 8.33	267	16.3	98.7
Central	Metro - Main Plant	10.6	3.72	9.8	< 3.31	22.9	14.3	29.7	15.3	13.6	< 6.62	< 15.0	261	12.3	98.7
Central	MSP Airport														
Central	Montivedeo		4.17	2.88	1.03	19	22.4	73.5	15.6	13	< 2.39	3.45	39.7	28	96.7
Central	St. Cloud	< 0.792	< 1.03	4.55	< 0.792	7.32	4.89	15.7	3.86	1.39	< 5.32	3.59	20.4	2.4	96.6
Central	Willmar		< 0.958	1.85	1.29	3.1	5.87	2.24	1.93	< 0.936	< 6.28	< 6.34	< 6.34	< 2.56	97.5
South	Austin		< 0.770	< 0.817	< 0.794	1.06	3.89	1.92	< 0.982	< 0.752	< 5.05	< 5.09	< 5.09	< 2.05	96.8
South	Morton														
South	Owatonna		4.48	17	3.05	32.1	4.13	89.1	3.55	11.7	< 4.23	< 3.95	30.8	17.4	96.1
South	Pipestone														
South	Red Wing		< 0.941	2.97	< 0.970	3.14	2.86	2.93	< 1.20	< 0.919	< 6.17	< 6.22	< 6.22	< 2.51	97.4
South	Rochester	1.65	< 0.633	0.952	< 0.633	3.76	3.31	6.29	2.64	2.06	< 3.21	4.83	21.2	3.88	93
South	Worthington		4.46	< 2.38	< 2.38	3.24	< 2.60	3.86	< 2.95	< 2.25	< 5.05	< 5.09	8.88	3.72	98.9
	No. of Detects	8	8	13	6	20	20	20	17	14	1	6	17	16	
	Mean	4.16	6.59	5.39	1.92	11.36	11.19	20.14	6.99	6.44	5.60	3.52	126.66	9.11	
	Std. Dev.	3.33	6.05	4.50	1.14	13.05	13.52	24.31	5.51	5.58	1.14	1.60	188.25	7.28	
	Median	2.605	4.32	3.15	1.16	5.02	5.38	8.50	4.65	3.07	5.60	3.52	24.60	5.70	
	Range	<1.8-7.27	<0.19-29.4	<0.19-17	<0.19-3.05	<0.19-54.6	<0.19-62.7	<0.19-89.1	<0.19-19.2	<0.19-19.2	<0.38-5.6	<0.38-4.83	<0.38-861	<0.19-28	

not sampled

Appendix 2

DRAFT: 08/05/07

PRELIMINARY Summary of PFC Monitoring in the Cities of Brainerd and Baxter
Prepared for Brainerd Public Utilities

Map ID	City	Sample Location Information	Sample Date	Sample Time	MPI Research Analytical Results - LC/MS/MS - Units in ug/L (ppb), unless noted otherwise							
	City of Brainerd WWTP Samples				PFOS	PFBA	PFPeA	PFHxA	PDHpA	PFOA	PFNA	PFDA
1	Brainerd/Baxter	WWTP Facility - Early Influent (in lab building)	7/24/2007	11:20	0.830	ND	ND	NQ	ND	ND	ND	ND
1	Brainerd/Baxter	WWTP Facility - Combined Influent Late	7/24/2007	17:41	0.799	ND	0.261	ND	ND	0.108	ND	ND
1	Brainerd/Baxter	WWTP Facility - Influent (MPCA Split)	7/25/2007	11:05	0.954	ND	0.335	ND	ND	ND	ND	ND
1	Baxter/Brainerd	WWTP Facility - Baxter Influent	7/24/2007	17:20	NQ	ND	0.412	NQ	ND	0.0818	ND	ND
1	Baxter/Brainerd	WWTP Facility - Baxter Influent	7/25/2007	11:35	ND	ND	0.533	ND	ND	0.118	ND	ND
1	Brainerd/Baxter	WWTP Facility - Primary Clarifier	7/24/2007	17:30	0.938	ND	0.260	ND	ND	0.0564	ND	ND
1	Brainerd/Baxter	WWTP Facility - Primary Clarifier - Field Duplicate	7/24/2007	17:30	0.947	ND	0.283	ND	ND	0.0720	ND	ND
1	Brainerd/Baxter	WWTP Facility - RBC Effluent	7/24/2007	17:35	1.26	ND	ND	ND	ND	0.0537	ND	ND
1	Brainerd/Baxter	WWTP Facility - Early Effluent	7/24/2007	11:15	0.544	ND	ND	ND	ND	ND	ND	ND
1	Brainerd/Baxter	WWTP Facility - Effluent (MPCA Split)	7/25/2007	11:05	0.870	ND	ND	ND	ND	ND	ND	ND
1	Brainerd/Baxter	WWTP Facility - Combined Effluent Late	7/24/2007	17:40	1.11	ND	ND	ND	ND	0.0648	ND	ND
1	Brainerd/Baxter	WWTP Facility - Effluent @ Outfall (MPCA Split)	7/25/2007	11:25	0.857	ND	ND	ND	ND	ND	ND	ND
1	Brainerd/Baxter	WWTP Facility - Sludge, **units in ng/g**	7/24/2007	11:05	1183	ND	ND	NQ	ND	NQ	6.71	ND
1	Brainerd/Baxter	WWTP Facility - Sludge (MPCA Split), **units in ng/g**	7/25/2007	11:10	1040	ND	ND	NQ	ND	4.84	7.38	ND
	City of Brainerd Water Treatment Plant Samples											
5	Brainerd	Brainerd WTP Effluent - Unfluoridated Tap	7/24/2007	11:50	ND	ND	ND	0.0271	ND	ND	ND	ND
5	Brainerd	Brainerd WTP Influent - Influent Water	7/26/2007	9:10	ND	ND	ND	ND	ND	ND	ND	ND
5	Brainerd	Brainerd WTP Influent - Effluent Finished H20	7/26/2007	9:15	ND	ND	ND	ND	ND	ND	ND	ND
	City of Baxter Water Treatment Plant Samples											
13	Baxter	Baxter WTP - Baxter #1 Water Plant	7/24/2007	14:30	ND	0.0864	ND	1.097	ND	ND	ND	ND
10	Baxter	Baxter WTP @Mtn Ash Dr/Highland Scenic	7/24/2007	13:45	ND	ND	ND	ND	ND	ND	ND	ND
	Other City of Brainerd Samples											
15	Brainerd	Manhole @ East River Rd & Emma	7/24/2007	15:00	ND	ND	0.317	0.0774	ND	0.0490	ND	ND
34	Brainerd	Main Pump Station Inside Building Trench Floor	7/25/2007	11:55	1.17	ND	0.368	ND	ND	ND	ND	ND
4	Brainerd	SW 6th Lift Station north of College Rd on SW 6th	7/24/2007	11:30	ND	ND	0.253	0.141	ND	ND	ND	ND
4	Brainerd	SW 6th Lift Station north of College Rd on SW 6th Field Duplicate	7/24/2007	11:30	ND	ND	0.200	0.126	ND	0.0433	ND	ND
16	Brainerd	Wright St. East of So. 10th	7/24/2007	15:10	ND	ND	ND	0.0333	ND	NQ	ND	ND
17	Brainerd	Manhole on 10th St. south of Madison Street	7/24/2007	15:20	49.8	ND	ND	0.0918	ND	0.0270	ND	ND
18	Brainerd	South Industrial Park Lift	7/24/2007	15:40	ND	ND	0.857	NQ	ND	0.0413	ND	ND
19	Brainerd	South side of tracks - BNSF Old Machine Shop	7/24/2007	15:55	ND	ND	0.987	0.0552	ND	0.0381	ND	ND
20	Brainerd	North side of tracks - BNSF Repair Shop	7/24/2007	16:05	ND	ND	0.656	0.0289	ND	0.0923	0.118	ND
21	Brainerd	Southwest corner of property - Wausau	7/24/2007	16:20	ND	ND	ND	NQ	ND	0.0415	ND	ND
22	Brainerd	10th Ave. & O St. Lift Station	7/24/2007	16:40	ND	ND	0.128	ND	ND	0.0467	ND	ND
23	Brainerd	Lum Park Lift Station	7/24/2007	16:45	1.18	ND	ND	ND	ND	0.0381	ND	ND
24	Brainerd	State Hospital Lift Station	7/24/2007	16:55	0.218	ND	ND	ND	ND	0.0712	0.122	ND
25	Brainerd	Walnut & Pine Lift Station	7/24/2007	17:10	0.0803	ND	0.140	ND	ND	NQ	ND	ND
35	Brainerd	Manhole on SE 12th north of Oak St.	7/25/2007	14:45	ND	ND	ND	0.0394	ND	ND	ND	ND
	Other City of Baxter Samples											
6	Baxter	Forest Rd & Edmunds Dr.	7/24/2007	13:00	ND	ND	0.158	0.0673	ND	NQ	ND	ND
7	Baxter	East side of 371 - Ford Store near Body Works	7/24/2007	13:20	ND	ND	0.270	NQ	ND	ND	ND	ND
8	Baxter	In front of Northern Bank @ Edgewood	7/24/2007	13:25	ND	ND	0.564	ND	ND	ND	ND	ND
9	Baxter	West stream of Edgewood and Excelsior	7/24/2007	13:30	ND	ND	0.586	ND	ND	NQ	ND	ND
11	Baxter	Excelsior & Cypress Lift Station	7/24/2007	14:00	ND	ND	0.586	NQ	ND	0.0345	ND	ND
12	Baxter	Wal-Mart Lift Station @ Elder & Glory	7/24/2007	14:20	ND	ND	1.11	NQ	ND	0.0611	ND	ND
14	Baxter	West of Industrial Park Rd & Cypress Dr	7/24/2007	14:40	ND	ND	2.37	0.0989	ND	0.0408	ND	ND

ND = Not detected. Response less than 0.0125 ug/L.

NQ = Not quantifiable. Response between 0.0125 and 0.025 ug/L.

NOTE: Laboratory batch QA/QC passed applicable criteria. However final lab data review is on-going.

Prepared by Barr Engineering

Appendix 2

PRELIMINARY Summary of PFC Monitoring in the Cities of Brainerd and Baxter
Prepared for Brainerd Public Utilities

DRAFT: 08/05/07

Map ID	City	Sample Location Information	Sample Date	Sample Time	MPI Research Analytical Results - LC/MS/MS - Units in ug/L (ppb), unless noted otherwise				
	City of Brainerd WWTP Samples				PFUnA	PFDoA	PFBS	PFHS	FOSA
1	Brainerd/Baxter	WWTP Facility - Early Influent (in lab building)	7/24/2007	11:20	ND	ND	0.294	ND	ND
1	Brainerd/Baxter	WWTP Facility - Combined Influent Late	7/24/2007	17:41	ND	ND	NQ	ND	ND
1	Brainerd/Baxter	WWTP Facility - Influent (MPCA Split)	7/25/2007	11:05	ND	ND	0.304	ND	ND
1	Baxter/Brainerd	WWTP Facility - Baxter Influent	7/24/2007	17:20	ND	ND	ND	NQ	ND
1	Baxter/Brainerd	WWTP Facility - Baxter Influent	7/25/2007	11:35	ND	ND	ND	ND	ND
1	Brainerd/Baxter	WWTP Facility - Primary Clarifier	7/24/2007	17:30	ND	ND	0.242	ND	ND
1	Brainerd/Baxter	WWTP Facility - Primary Clarifier - Field Duplicate	7/24/2007	17:30	ND	ND	0.239	ND	ND
1	Brainerd/Baxter	WWTP Facility - RBC Effluent	7/24/2007	17:35	ND	ND	0.227	ND	ND
1	Brainerd/Baxter	WWTP Facility - Early Effluent	7/24/2007	11:15	ND	ND	0.241	ND	ND
1	Brainerd/Baxter	WWTP Facility - Effluent (MPCA Split)	7/25/2007	11:05	ND	ND	0.248	ND	ND
1	Brainerd/Baxter	WWTP Facility - Combined Effluent Late	7/24/2007	17:40	ND	ND	0.340	ND	ND
1	Brainerd/Baxter	WWTP Facility - Effluent @ Outfall (MPCA Split)	7/25/2007	11:25	0.141	ND	0.278	ND	ND
1	Brainerd/Baxter	WWTP Facility - Sludge, **units in ng/g**	7/24/2007	11:05	NQ	ND	21.3	ND	ND
1	Brainerd/Baxter	WWTP Facility - Sludge (MPCA Split), **units in ng/g**	7/25/2007	11:10	NQ	ND	17.6	ND	ND
	City of Brainerd Water Treatment Plant Samples								
5	Brainerd	Brainerd WTP Effluent - Unfluoridated Tap	7/24/2007	11:50	ND	ND	ND	ND	ND
5	Brainerd	Brainerd WTP Influent - Influent Water	7/26/2007	9:10	ND	ND	ND	ND	ND
5	Brainerd	Brainerd WTP Influent - Effluent Finished H20	7/26/2007	9:15	ND	ND	ND	ND	ND
	City of Baxter Water Treatment Plant Samples								
13	Baxter	Baxter WTP - Baxter #1 Water Plant	7/24/2007	14:30	ND	ND	ND	ND	ND
10	Baxter	Baxter WTP @Mtn Ash Dr/Highland Scenic	7/24/2007	13:45	ND	ND	ND	ND	ND
	Other City of Brainerd Samples								
15	Brainerd	Manhole @ East River Rd & Emma	7/24/2007	15:00	ND	ND	ND	ND	ND
34	Brainerd	Main Pump Station Inside Building Trench Floor	7/25/2007	11:55	ND	ND	0.311	ND	ND
4	Brainerd	SW 6th Lift Station north of College Rd on SW 6th	7/24/2007	11:30	ND	ND	ND	ND	ND
4	Brainerd	SW 6th Lift Station north of College Rd on SW 6th Field Duplicate	7/24/2007	11:30	ND	ND	ND	NQ	ND
16	Brainerd	Wright St. East of So. 10th	7/24/2007	15:10	ND	ND	ND	ND	ND
17	Brainerd	Manhole on 10th St. south of Madison Street	7/24/2007	15:20	ND	ND	19.1	ND	ND
18	Brainerd	South Industrial Park Lift	7/24/2007	15:40	ND	ND	ND	ND	ND
19	Brainerd	South side of tracks - BNSF Old Machine Shop	7/24/2007	15:55	ND	ND	ND	ND	ND
20	Brainerd	North side of tracks - BNSF Repair Shop	7/24/2007	16:05	NQ	ND	ND	ND	ND
21	Brainerd	Southwest corner of property - Wausau	7/24/2007	16:20	ND	ND	ND	ND	ND
22	Brainerd	10th Ave. & O St. Lift Station	7/24/2007	16:40	ND	ND	ND	ND	ND
23	Brainerd	Lum Park Lift Station	7/24/2007	16:45	ND	ND	ND	ND	ND
24	Brainerd	State Hospital Lift Station	7/24/2007	16:55	ND	ND	ND	ND	ND
25	Brainerd	Walnut & Pine Lift Station	7/24/2007	17:10	ND	ND	ND	NQ	ND
35	Brainerd	Manhole on SE 12th north of Oak St.	7/25/2007	14:45	ND	ND	ND	ND	ND
	Other City of Baxter Samples								
6	Baxter	Forest Rd & Edmunds Dr.	7/24/2007	13:00	ND	ND	ND	ND	ND
7	Baxter	East side of 371 - Ford Store near Body Works	7/24/2007	13:20	ND	0.104	ND	ND	ND
8	Baxter	In front of Northern Bank @ Edgewood	7/24/2007	13:25	ND	ND	ND	ND	ND
9	Baxter	West stream of Edgewood and Excelsior	7/24/2007	13:30	ND	ND	ND	ND	ND
11	Baxter	Excelsior & Cypress Lift Station	7/24/2007	14:00	ND	ND	ND	ND	ND
12	Baxter	Wal-Mart Lift Station @ Elder & Glory	7/24/2007	14:20	ND	ND	ND	ND	ND
14	Baxter	West of Industrial Park Rd & Cypress Dr	7/24/2007	14:40	0.210	ND	ND	ND	ND

ND = Not detected. Response less than 0.0125 ug/L.
NQ = Not quantifiable. Response between 0.0125 and 0.025 ug/L.
NOTE: Laboratory batch QA/QC passed applicable criteria. However final lab data review is on-going.

Prepared by Barr Engineering

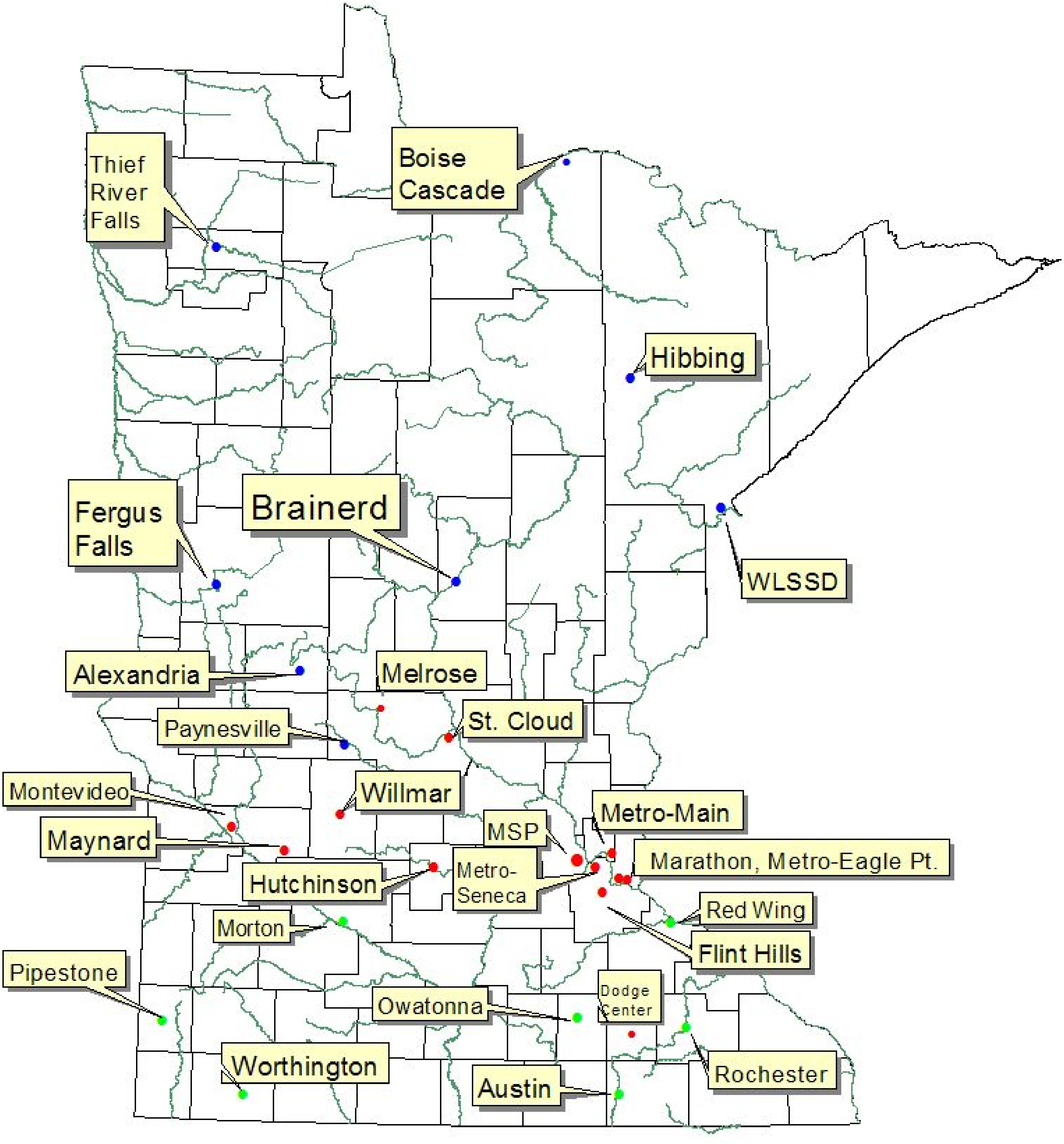
Appendix 3: PFC Data for Keystone Automotive, 11/14/07
Samples Analyzed by MPI Research (ug/L)

	C4 Acid	C5 Acid	C6 Acid	C7 Acid	C8 Acid	C9 Acid	C10 Acid
Sample ID	**Perfluorobutanoic Acid**	**Perfluoropentanoic Acid**	**Perfluorohexanoic Acid**	**Perfluoroheptanoic Acid**	**Perfluorooctanoic Acid**	**Perfluorononanoic Acid**	**Perfluorodecanoic Acid**
Bright nickel solution Bn4	0.479	ND	NQ	ND	ND	ND	ND
Semi bright nickel solution SBN	0.0572	ND	0.0989	ND	ND	ND	ND
Copper Tank	ND	ND	0.878	ND	ND	ND	ND
Clarifier of DMP waste treatment system*	ND	ND	ND	ND	ND	ND	ND
Chrome solution*	86.4	4.25	488	ND	ND	ND	ND
Last Chrome Rinse*	ND	ND	ND	ND	ND	ND	ND
AC-326 acid solution*	ND	ND	22.5	ND	ND	ND	ND
Electroclean solution--Electrodet SE*	58.1	31.3	12.6	ND	ND	19.9	ND
Soak clean solution--A69-CH*	32.2	18.1	6.40	ND	ND	ND	ND
Rust inhibitor-Koretard 322	0.0280	ND	0.160	ND	ND	ND	ND
Chrome surfactant--MSP-28	0.542	2.22	ND	ND	ND	0.0302	0.520

	C11 Acid	C12 Acid	PFBS	PFHS	PFOS	FOSA
Sample ID	**Perfluoroundecanoic Acid**	**Perfluorododecanoic Acid**	**Perfluorobutane-sulfonate**	**Perfluorohexanesulfonate**	**Perfluorooctane-sulfonate**	**Perfluorooctane-sulfonamide**
Bright nickel solution Bn4	ND	ND	2.31	0.0694	0.476	ND
Semi bright nickel solution SBN	ND	ND	3.78	0.118	0.818	ND
Copper Tank	ND	ND	0.280	ND	1.25	ND
Clarifier of DMP waste treatment system*	ND	ND	70.9	ND	96.1	ND
Chrome solution*	ND	ND	176,000	20.1	823	ND
Last Chrome Rinse*	ND	ND	595	ND	247	ND
AC-326 acid solution*	ND	ND	ND	ND	ND	ND
Electroclean solution--Electrodet SE*	ND	ND	348	3.01	33,000	ND
Soak clean solution--A69-CH*	ND	ND	656	ND	823	ND
Rust inhibitor-Koretard 322	ND	ND	ND	ND	0.282	ND
Chrome surfactant--MSP-28	0.0324	0.443	ND	ND	0.437	ND

ND = Not detected = Response less than 0.0125 ug/L (0.025 ug/L for C8 Acid).
NQ = Not quantifiable = Response between 0.0125 ug/L and 0.025 ug/L.

^ Sample diluted 100 times prior to analysis, therefore, ND = Response less than 1.25 ug/L.



MPCA 2007 WWTP Sample Locations

Minnesota
Pollution
Control
Agency

PFCs and Class B Firefighting Foam

Remediation • January 2009

What do doughnut bags, outdoor clothing, stain-resistant carpet, non-stick frying pans, aircraft hydraulic oils, and certain firefighting foams have in common? They contain man-made chemicals called perflurochemicals (PFCs). Many kinds of PFCs have been used for several decades to make products stain resistant, water repellant, slippery, and long lasting. Without PFCs, the cooking grease would seep through our fast-food bags, our car seats and carpets would be more stained, and fighting a petroleum fire might be more difficult.

In recent years, scientists have found that PFCs may cause long-lasting environmental contamination, including uptake into humans' bodies. Of particular concern is the possibility that PFCs in Class B firefighting foam may be able to travel from a fire training area to a city's municipal or private wells. Sampling will be done in 2009 to investigate that possibility.

PFC Background

The Minnesota- based 3M Company in Cottage Grove developed PFCs in the late 1940's. PFCs have properties that make them great surfactants. Their chemical structure makes them extremely resistant to change or breakdown. Once released to the environment, they remain there for a very long time. They also travel long distances through soil and into the ground water in a relatively short time. As a result, PFCs have been found in soil, sediments, water, wildlife and humans throughout the world. The way PFCs have become so widespread is not well understood.

Because of the unexpected worldwide spread of PFCs, 3M discontinued manufacture of products containing PFOS and PFOA (two of the PFC chemicals) in 2002. 3M's Class B firefighting foam was included. PFC chemicals continue to be produced by other methods and in different forms by 3M and other companies across the world. Some of these products may travel through air and breakdown to problematic PFCs.

Wastes from 3M's manufacturing processes were placed at several disposal sites in Washington County. PFCs have been found in the ground water in areas of Washington and Dakota Counties, and in surface water and wastewater effluent in other parts of the state. PFCs have also been found in some fish in the greater metropolitan area. Filters containing activated carbon or reverse osmosis units are now filtering PFCs from wells with PFC levels that exceed the Minnesota Department of Health's (MDH) health-based exposure limits. Fish consumption advisories have been issued for some lakes.

Health Concerns

The potential health significance of PFCs in drinking water is under study at both the state and federal levels. Much of this research consists of toxicological studies in laboratory animals. At high concentrations, two types of PFCs, perfluorooctane sulfonic acid (PFOA) and perfluorooctonate sulfonate (PFOS), have been shown to cause harmful changes in the liver and developmental problems (e.g., delays in growth and maturation) in the offspring of rats and mice exposed during pregnancy. A limited number of other PFC chemicals are also being studied.

There are few studies of health effects in people. As part of its worker health and safety program, 3M routinely monitored the health of its workers. No significant or consistent health effects have been identified in these workers. Three studies of newborn babies and PFC levels in the mother's blood found a very small decrease in birth weight or other measures of growth with increasing PFC levels in the mother. A large health study of 70,000 people exposed to the type of PFC called PFOA in drinking water in Ohio and West Virginia is currently underway but it will be some time before results are available. In general, the studies in people have shown that the levels of PFCs in the environment may be linked to changes in the body, but the studies have not shown specific illness in people.

Firefighting Foam

There are many kinds of firefighting foam. The use of foam has saved many lives and prevented huge property losses. Many manufacturers have made firefighting foams, but the exact content of those foams is often not disclosed.

Class A foam has come into widespread use in recent years for wildfire, structure and other fires. A detergent-like "surfactant" in the Class A foam makes the firefighting water "wetter" and more able to penetrate combustible material. **Class A foams typically do not contain PFC chemicals.**

PFCs and Class B foam training near wells

In the early 1960's, 3M and the U.S. Navy developed Class B "aqueous film forming foam" (AFFF) type foams. Class B foams are used on flammable petroleum fires and spills. Some or most Class B foams have had PFCs as part of their formulation, in particular PFOS.

Some foam manufacturers have changed processes and materials to eliminate or minimize PFC content in foam. However many foam manufacturers may not know or reveal PFC content of current or past formulations.

As part of the overall investigation of PFCs in Minnesota, the Minnesota Pollution Control Agency (MPCA) and MDH have started looking at the pattern of firefighting foam training.

Most Minnesota cities use ground water as a drinking water source. Many municipal wells are near a fire station or fire training locations. There is a possibility that fire training sites where Class B foams were repeatedly used may have allowed PFCs to enter municipal or private drinking water wells.

In 2008 an MPCA contractor, Delta Environmental, surveyed Minnesota's fire service on past foam use – two-thirds of fire departments provided information. Many departments have used and trained with Class B foam. The foam was usually used in small amounts; however, it may only take a small amount of chemical to affect ground water. MDH has taken the survey data and compared it to municipal well locations and characteristics. Most cities that use wells have wellhead protection plans that map the areas where spills and pollution may reach a well. Fire chiefs should become familiar with these plans. Cities with wells that are vulnerable because of their shallow depth or coarse soils or their proximity to foam training locations have been identified. MDH will be sampling wells in many of those cities in spring of 2009. If PFCs are found, MDH will notify the water utility.

MPCA will be sampling soil near 25 or so Class B foam training sites in the spring of 2009 to see if PFCs remain in the soil and ground water. Fire chiefs will be notified before sampling to request site access and permission. Results will be provided back to the cities.

Next Steps

Results from the first round of sampling are expected in summer 2009. In the meantime, the State Chiefs' Association and the State Fire Marshal will be asked to help suggest guidance to Minnesota's fire service on Class B foam. Likely, that guidance will include:

- using Class B foam on flammable liquids like gasoline, but not routinely using on other combustible liquids such as diesel or fuel oil
- using non-PFC training foams or detergents during training
- investigating PFC content of the currently sold Class B foams

Additional information about PFCs is available on the MPCA and MDH web pages at: www.pca.state.mn.us/cleanup/pfc/index.html or www.health.state.mn.us/divs/eh/hazardous/topics/pfcs/index.html.

Contact Information

If you need help or have a question, your MPCA contact can be reached at 651-296-6300 or 800-657-3864.

PFC technical information and MPCA's sampling:
Nile Fellows, nile.fellows@pca.state.mn.us
Doug Wetzstein, doug.wetzstein@pca.stat.mn.us

Pollution issues related to firefighting:
Steve Lee, steve.lee@pca.state.mn.us
Jim Stockinger, jim.stockinger@pca.state.mn.us

PERFLUOROCARBON (PFC)-CONTAINING FIREFIGHTING FOAMS AND THEIR USE IN MINNESOTA

DELTA PROJECT NO. 19382DEL08

Prepared for:

Minnesota Pollution Control Agency
520 Lafayette Road
St. Paul, MN 55155

Prepared by:

Delta Consultants
5910 Rice Creek Parkway, Suite 100
Shoreview, MN 55126
(651) 639-9449

June 30, 2010

TABLE OF CONTENTS

List of Tables

List of Graphs

List of Appendices

PERFLUOROCARBONS IN FIREFIGHTING FOAM AND THEIR USE IN MINNESOTA

1.0 INTRODUCTION

1.1 Purpose

Delta Consultants (Delta) has worked under contract with the Minnesota Pollution Control Agency (MPCA) investigating perfluorochemicals in Class B firefighting foams and their use in Minnesota. Previous information regarding this investigation was presented in the following reports:

- Perfluorocarbon (PFC)-Containing Firefighting Foams and Their Use In Firefighting Training in Minnesota, dated June 30, 2008 (the June 2008 Report); and,
- Addendum to PFC-Containing Firefighting Foams and Their Use In Firefighting Training in Minnesota, dated October 22, 2008 (the October 2008 Addendum Report);
- Firefighting Training Area Site Reconnaissance, Pine Bend Flint Hills Refinery, Marathon Refinery, Burnsville Fire Training Center, and Site Access for 21 Fire Departments, dated April 3, 2009 (the April 2009 Report);
- Report of Site Reconnaissance and Sampling at Select Firefighting Foam Training Areas in Minnesota, dated June 30, 2009 (the June 2009 Report); and,
- Report of Investigation Activities at Select Firefighting Foam Training Areas and Foam Discharge Sites in Minnesota, dated February 10, 2010 (the February 2010 Report).

This report condenses the previous reports and includes PFC sampling conducted by others at the following fire foam training and fire sites:

- Duluth Air National Guard Base at the Duluth International Airport;
- Western Area Fire Training Academy (WAFTA) in St. Bonifacius;
- Up North Plastics in Cottage Grove; and,
- Kings Cover Marina in Hastings.

1.2 Background

As a part of an overall investigation of PFCs in Minnesota, the MPCA and Minnesota Department of Health (MDH) started looking at firefighting foams as a possible source of PFCs in the environment. In 2008 PFCs were researched as a constituent of firefighting foams. Municipal fire departments, fire departments at major oil refineries and airports, and fire training schools in the State were surveyed regarding their use of Class B firefighting foams. Additionally, various persons in the State with fire fighting knowledge and experience were interviewed. A survey questionnaire mailed out to the fire departments concentrated on the use of firefighting foams in training based on the assumption that training areas where firefighting foams were discharged repeatedly at the same location would be at greater risk for the introduction of PFCs into the environment via the breakdown of the foam. The firefighting training sites were then ranked for their potential to release PFCs to sensitive environments based on a number of criteria: the types and amounts of foam used in training, the frequency of the training events, the environmental setting of the firefighting training site, and the presence of nearby water supply wells. The results of the research, survey and training site ranking were presented in the June 2008 and October 2008 Addendum Reports. Both reports are available on the MPCA website at www.pca.state.mn.us/cleanup/pfc/index.html. A brief summary of the research and survey findings are presented in Sections 6.0 and 7.0 of this report.

Based on the site ranking, twenty-one firefighting training sites were chosen for further investigation. The additional investigation included site reconnaissance, sampling of the groundwater and/or soil, and/or additional interviews. Information and data collected at these “priority” sites were documented in the April 2009, June 2009 and February 2010 Reports. These reports are also available on the MPCA website.

During the course of the PFC-Firefighting Foam investigation it was decided that the locations of several fires where large quantities of PFC-containing foams were utilized would also be investigated for the possible release of PFCs to the environment. Information and data collected at the River Grove Marina in Inver Grove Heights, and the Kandiyohi County Landfill in New London, were included in the above-referenced reports. Reports of PFC sampling related to firefighting foam conducted by the MPCA and other consultants at the Duluth Air National Guard Base in Duluth, the WAFTA site in St. Bonifacius, the Up North Plastics facility in Cottage Grove, and the Kings Cove Marina in Hastings, are available at the MPCA. The investigation activities and results for all of these sites are discussed in Sections 6.0 and 7.0 of this report.

2.0 PFCs in FIREFIGHTING FOAM

Perflourocarbons or perfluorochemicals (PFCs) are a class of man-made chemicals derived from hydrocarbons, where the hydrogen atoms have been replaced by fluorine atoms. PFCs are characterized by chains of carbon atoms of varying lengths to which fluorine atoms are strongly bonded, making PFCs durable and hard to break down (1). PFCs have been used since the 1950s to produce industrial and consumer products that are heat and stain resistant, water repellant, and film-forming (2). PFCs have been used in a variety of products including stain-resistant fabrics and carpet, coatings for food packaging, non-stick cookware, and firefighting foams (2)(3)(4).

2.1 Chemistry of PFCs

The PFC class of chemicals includes three groups of PFCs pertinent to the discussion of PFCs in firefighting foam: perfluorocarboxylates, perfluorinated sulfonates, and fluorotelomer sulfonates (5).

Perfluorocarboxylates are fully fluorinated carbon molecules with a carboxylate group on the end of the chain. Perfluorinated sulfonates are fully fluorinated carbon molecules with a sulfonate group on the end of the chain. Fluorotelomer sulfonates are partially fluorinated molecules. Examples of the PFC chemicals within each group are described in Table A, below.

TABLE A - PFC CHEMICALS

Chemical Group	**Chemical Acronym**	**Chemical Name**	**CAS Registry No.**	**No. of Fluorinated Carbon Chains**
Perfluorinated carboxylic acids	PFBA	perfluorobutanoic acid	375-22-4	4
	PFPeA	perfluoro-n-pentanoic acid	2706-90-3	5
	PFHxA	perfluorohexanoic acid	307-24-4	6
	PFHpA	perfluoroheptanoic acid	375-85-9	7
	PFOA	perfluorooctanoic acid	335-67-1	8
	PFNA	perfluorononanoic acid	375-95-1	9
	PFDA	perfluorodecanoic acid	335-76-2	10
	PFUnA	perfluoroundecanoic acid	2058-94-8	11
	PFDoA	perfluorododecanoic acid	307-55-1	12
	PFTA	perfluorotridecanoic acid	not determined	not determined
Perfluorinated sulfonates	PFBS	perfluorobutane sulfonate	29420-49-3	4
	PFHxS	perfluorohexane sulfonate	355-46-4	6
	PFOS	perfluorooctane sulfonate	1763-23-1	8
Fluorotelomer sulfonates	6:2 FtS	1-octanesulfonic acid, 3,3,4,4,5,5,6,6,7,7,8,8,8-tridecafluoro-, ammonium salt	--	6
	8:2 FtS	--	--	8

PFCs are made using one of two methods: the Simons electro-chemical fluorination (ECF) developed by 3M; or, a telomerization process (6).

2.1.1 ECF Process

The ECF process used by 3M generates fully fluorinated compounds in branched- and straight-chains with both even and odd numbers of perfluorocarbons (6)(7). The chemical of interest in the ECF process is perfluorooctanesulfonyl fluoride (POSF), $C_8F_{17}SO_2F$. The final degradation product of POSF and its derived products include perfluorinated sulfonates and perfluorinated carboxylic acids (8). While perfluorinated carboxyl acids are associated with both the ECF process and the telomerization process (see Section 2.1.2), perfluorinated sulfonates only result from the ECF process (9).

2.1.2 Telomerization Process

The telomerization process creates fluorinated telomers that are different from ECF-made fluorinated molecules in that they only have an even number of fluorinated carbon atoms and the molecule is predominantly straight-chained (6)(7). In addition, the fluorotelomerization process inserts an ethyl group between the fluoroalkyl chain and the functional group on the end, which differentiates the atom from an ECF-process fluorinated molecule. Fluorotelomer sulfonates are made using a telomerization process, and perfluorinated carboxylic acids may be present in the final product as a result of unreacted or partially reacted starting materials or intermediate (10).

2.2 PFCs in Firefighting Foam

There are several classes of fires, depending on the material that is burning. Class B fires involve the burning of flammable liquids such as gasoline, fuel oil, cleaning fluids and solvents. Aqueous film-forming foam (AFFF) was developed in the 1960s for use on Class B fires. AFFF has a fluorochemical-based surfactant that rapidly forms a film across the fire surface, which prevents the release of flammable fuel vapors and excludes oxygen from the fuel surface (11).

3M was the original manufacturer of fluorochemical-based AFFF in the 1960s, using the ECF process. As indicated in Section 2.1.1, PFCs made using the ECF process can contain or degrade to perfluorinated sulfonates and perfluorinated carboxylic acids. As part of 3M’s voluntary production phase out of PFOS chemicals, they stopped manufacturing PFOS-based AFFF in 2002.

DuPont, Ansul, Chemguard and other firefighting foam manufacturers use telomer-based fluorochemical surfactants in their AFFF. The telomer-based foams are not made with, and do not break down to, PFOS. According to the Fire Fighting Foam Coalition (www.fffc.org), telomer-based firefighting foams contain predominantly (75 to 80%) six-chain carbon fluorosurfactants (6:2 FtS), with varying percentages of eight-chain or higher homologues (8:2 FtS). While telomer-based surfactants are not made with PFOA, low levels of PFOA may be present as a byproduct (13).

Class B AFFF is typically purchased in five-gallon buckets. These foam concentrates are mixed into the water using an in-line eductor or other proportioning/mixing device. The foam concentrate/water solution can then be fed through one of two types of discharge devices, either a nozzle-aspirated foam system (NAFS) or a compressed air foam system (CAFS). Both systems produce a finished foam that is a combination of water, air and foam concentrate. Class B AFFF concentrates may or may not have expiration dates included on the product container, but foam manufacturers Chemguard and Ansul indicate that Class B foam should have a shelf life of 20 to 25 years if stored properly.

Class A firefighting foams, used to extinguish wood and grass fires, are detergent-based foams with a hydrocarbon-based surfactant, not a fluorochemical-based surfactant (14). Class A foams are not known to contain PFCs and are not considered a source of PFCs.

Training foams are similar to Class A and Class B foams but are made specifically for fire training exercises and do not contain chemical components for firefighting performance. Training foams are available from most manufacturers and are generally less expensive because they do not contain (costly) fluorinated surfactant components. Training foams are not made with PFCs.

2.3 The USEPA and PFOA and PFOS

In 1999 the U.S. Environmental Protection Agency (USEPA) began an investigation into PFOS after receiving data from 3M that PFOS was persistent, bioaccumulative and unexpectedly toxic (15). Ultimately 3M ceased production of PFOS-based chemistry in 2002, including the production of PFOS-based firefighting foams.. 3M also identified PFOA in human blood as part of their PFOS studies (15), and in June 2000 the USEPA expanded their investigation to include other PFCs, including PFOA.

In 2002 and 2007 the USEPA published significant new use rules (SNURs) under the Toxic Substances Control Act (TSCA) to limit the manufacture or import of perfluoroalkyl sulfonate chemicals, including PFOS and PFHxS. According to the initial 2002 SNUR, 3M was the only manufacturer in the U.S. of PFOS-based chemicals included in the SNUR.

In January 2006, USEPA and eight major PFC manufacturing companies (3M/Dyneon, Arkema, Inc., AGC Chemicals/Asahi Glass, Ciba Specialty Chemicals, Clariant Corporation, Daikin, E.I. duPont de Nemours and Company, and Solvay Solex) created the 2010/15 PFOA Stewardship Program. The companies committed to reduce facility emissions and product content of PFOA, PFOA precursor chemical, or PFOA-related homologues by 95 percent by 2010, and to work toward eliminating emissions and product content by 2015. As part of the program the companies submit annual reports on their progress toward reaching the goals. Information regarding the 2010/15 PFOA Stewardship Program is available at www.regulations.gov in docket EPA-HQ-OPPT-2006-0621.

Members of the Fire Fighting Foam Coalition that make telomer-based AFFF agents are in position to meet the goals of the PFOA Stewardship Program before 2015 by using C6-based fluorosurfactants that provide the same fire protection characteristics as C8-based foams. Incorporating these new fluorosurfactants in AFFF will require some reformulation and perhaps re-approval of most Class B foams between 2010 and 2015 (16).

3.0 USE OF FIREFIGHTING FOAMS IN MINNESOTA

In order to gain an understanding of the organizations in Minnesota that utilize firefighting foam, the types and quantities of firefighting foam being used, and the locations where the foams are being used in training exercises, the websites of firefighting organizations were reviewed, individuals commonly known to be involved in or associated with firefighting in Minnesota were interviewed, and the users of firefighting foams in Minnesota were surveyed regarding their foam use.

3.1 Interviews with Minnesota Firefighting Organizations

Several individuals commonly known to be involved in or associated with firefighting in Minnesota were interviewed regarding the use of firefighting foams in Minnesota. The interviews were presented in the June 2008 Report. Key findings of these interviews are as follows: the two oil refineries in Minnesota—the Marathon Oil refinery in St. Paul Park and the Flint Hills Resources Pine Bend refinery in Rosemount—have their own dedicated fire departments; that the Minnesota Department of Natural Resources (MDNR) trains firefighters at the Minnesota Interagency Fire Center in Grand Rapids using training foam; the Minnesota State Colleges and Universities (MNSCU) system has sixteen schools with firefighting training programs, and they switched from the use of AFFF to soap-based foams for training in approximately 2004; and that generally AFFF is not used for training exercises because its too expensive.

3.2 Survey Mailing to Minnesota Firefighting Organizations

Questionnaires regarding the use of firefighting foam were mailed to 785 fire departments in Minnesota in April and May 2008. The questionnaire surveyed the departments on current and historical types and amounts of firefighting foam used in firefighting and fire training, the locations of the fire training areas, and the fate of the spent training foam. In addition to municipal fire departments, questionnaires were mailed to the following potential firefighting foam users in Minnesota:

- All of the airports with dedicated fire departments: Minneapolis-St. Paul International Airport (MSP); Rochester International Airport; and, the Duluth International Airport.
- The following 16 colleges with firefighter training programs: Itasca Community College in Grand Rapids; Alexandria Technical College; St. Cloud Technical College; Minnesota West Community College in Marshall; Ridgewater College in Willmar; South Central College in North Mankato; Riverland Community College in Austin; Pine Technical College in Pine City; Hennepin Technical Colleges in Plymouth and Eden Prairie; Northland Community Colleges in Thief River Falls and East Grand Forks; Central Lakes College in Brainerd; Minnesota State Community College in Moorhead; Mesabi Range Community College in Virginia; and, Lake Superior Technical College in Duluth. Southwest State University in Marshall, Minnesota indicated that they do not offer a firefighting training program and that their program is only a business administration program for fire chiefs and captains.
- 2 petroleum refineries; and,
- Camp Ripley in Little Falls.

Completed questionnaire surveys were presented in the June 2008 Report and October 2008 Addendum Report.

3.3 Survey Results

Results of the completed surveys received from the municipal fire departments, airports, firefighting training schools, refineries, and Camp Ripley are presented in Sections 3.3.1 through 3.3.5.

3.3.1 Survey Results - Municipal Fire Departments

A total of 522 completed questionnaires were received from the 785 municipal fire departments that were surveyed, a response rate of 66%. Copies of the completed questionnaires were included in the June 2008 Report and October 2008 Addendum Report. The following general findings and statistics were ascertained from the questionnaires:

- Fifty-two (or 10%) of the responding municipal fire departments do not use firefighting foam at all.
- Of the responding municipal fire departments that utilize firefighting foam, 243 (or 52%) use only Class A foams.
- Of the remaining 227 responding municipal fire departments that utilize Class B firefighting foams, approximately 50% do not train with Class B foam but only use Class B foam for fire response.
- Of the municipal fire departments that train with Class B foam, 28% of the departments train at multiple or different locations for every training session, or at live burns only. Thus there is not one specific training location.
- The remaining municipal fire departments that train with Class B foam repeatedly at the same location were ranked based on the potential for PFCs to enter sensitive environments. The ranking criteria are discussed in Section 5.0.

3.3.2 Survey Results – Airports

Of the seven airports operated by the Metropolitan Airports Commission, (Crystal, Lake Elmo, Flying Cloud, Anoka County-Blaine, St. Paul, Lakeville and Minneapolis-St. Paul International (MSP), only MSP has its own fire department. Other MAC airports are served by the municipal fire departments in which they are located. Currently the MSP fire department trains with foam at the Lake Superior College Emergency Response Training Center (ERTC) in Duluth. Prior to 2001 training with 3M-brand Class B foam was conducted at two different locations on the northwest portion of the airport.

The Rochester Airport Fire Department also trains with foam at the ERTC facility in Duluth. However, the Federal Aviation Administration (FAA) requires annual testing of fire equipment. The foam equipment tests require a short burst of foam to show that the fire trucks are functioning properly. Less than 5 gallons of Chemguard-brand Class B foam is used annually for equipment testing.

The City of St. Cloud Fire Department is responsible for fire response at the St. Cloud Airport. The St. Cloud Fire Department trains with Chemguard-brand Class B foam at two locations, including the fire station near the airport.

The 148th Fighter Wing of the Minnesota Air National Guard is responsible for fire and emergency services at the Duluth International Airport. The unit no longer trains at the airport with firefighting foam. The MPCA is investigating two former fire training areas at the Duluth Airport for PFCs.

3.3.3 Survey Results - Firefighting Training Schools

Survey questionnaires were returned by all sixteen MNSCU firefighting training schools. Only two of the schools hold training exercises on campus with Class B foam: Lake Superior College in Duluth; and, Northland College in East Grand Forks.

3.3.4 Survey Results - Petroleum Refineries

Both the Marathon Refinery in St. Paul Park and the Flint Hills Resources Pine Bend Refinery in Rosemount have their own in-house fire departments, and both refineries have on-site fire fighting training facilities where spent Class B foam is collected and routed through their in-house wastewater treatment plants. The fire department at the Marathon Refinery uses approximately 50 to 100 gallons of Ansul-brand ThunderStorm Class B foam per semi-annual training event; prior to 2000 they used 3M-brand foam. Other municipal departments train at the Marathon Refinery fire training area, using foam provided by the Marathon Refinery fire department. Fire foam training at the Pine Bend Refinery in Rosemount takes place approximately 20 to 25 times during the training season from April through November, and approximately 5 to 10 gallons of Ansul –brand ThunderStorm Class B foam is used per training event. The Pine Pend Refinery fire department used 3M-brand Class B foam historically, and has a stockpile of approximately 50,000 gallons of 3M-brand foam on hand. Other area municipal departments train at the refinery training grounds with foam provided by the refinery.

The former Conoco-Phillips oil refinery in Wrenshall, Minnesota ceased operation in the early 1980s. The City of Wrenshall Volunteer Fire Department indicated that the refinery had their own fire fighting equipment, but that the Wrenshall Fire Department responded to any fire calls. The department trained at the Wrenshall refinery with Class B foam when it was in operation.

3.3.5 Survey Results - Camp Ripley

The Fire and Emergency Services Coordinator for Camp Ripley indicated that his position at Camp Ripley had been created in approximately 2007, and he was not familiar with historical firefighting practices at Camp Ripley. No firefighting training with foam is currently being conducted at Camp Ripley.

4.0 RANKING OF FIREFIGHTING FOAM TRAINING SITES

The training sites where Class B firefighting foam is or was used on more than one occasion were ranked in order to identify those with the highest potential to release PFCs to sensitive environments. The sites were ranked according to the criteria listed in Section 4.1. A relative numerical score was assigned for each criterion that was meant to reflect the relative importance of each parameter with respect to its potential to release PFCs to the environment, and the sensitivity of the environmental receptors.

4.1 Ranking Criteria

The criteria are listed below in brief; a more detailed description of the ranking criteria were presented in the June 2008 Report. The following criteria were considered in ranking training sites on their potential to release PFCs to sensitive environments:

1) Brand of foam used for training. Due to the known content of PFOS and PFOA in firefighting foams manufactured by 3M, training sites where 3M foams were currently or formerly used in training were ranked higher.
2) Amount of foam used in training.
3) Proximity to nearby surface waters.
4) Proximity to nearby wetlands.
5) Proximity to karst geological areas.
6) Proximity to wellhead protection areas (WPA) and/or source water assessment areas (SWAA).
7) The presence of water supply wells nearby.

Since spent training foam are released to the ground or go to a storm sewer at most training sites, the final destination of the spent foam was not considered as a ranking criteria.

4.2 Ranking Results

A total of 80 municipal fire departments' training sites, 3 airport fire departments, 2 firefighting training schools, and 3 petroleum refineries were ranked. Rankings for the municipal fire departments are presented in **Table 1, *Class B Foam Use Ranking Summary, Minnesota Municipal Fire Departments***, and rankings for the training schools, airports, and refineries are presented in **Table 2, *Class B Foam Use Ranking Summary, Minnesota Airport and Refinery Fire Departments and Training Schools***. Individual profiles for each of the ranked sites were included in the June 2008 Report and October 2008 Addendum Report.

Total scores assigned to the firefighting foam training sites ranged from 7 to 33. The highest scores were assigned to sites generally located in a wellhead protection or source water protection area and/or a karst area, had water supply wells located within ¼-mile, a wetland and/or surface water body located within ¼-mile of the training site, and 3M foams are or were used for training. A total of 21 sites were considered for follow-up investigations, as listed below:

- *Minneapolis/St. Paul International Airport former training areas*: MSP Airport is located in a WPA and an active karst area, with up to 40 gallons of foam used annually for training. From 1983 through 2001, fire foam training with 3M-brand Class B foam was conducted east of Cargo Road near the present location of the glycol management facility. Foam training prior to 1983 took place at an area located northeast of the current FedEx facility. Both the pre- and post-1983 former fire foam training areas were re-worked and excavated to some extent during construction associated with the addition of a new airport runway in 2001. Storm water from this area of the airport drains to a holding pond near the southwest corner of the MSP Airport.
- *Marathon Refinery, St. Paul Park:* Marathon Refinery is located in an active karst area near the Mississippi River, with approximately 250 gallons of Ansul-brand foam used annually for training. The Marathon Refinery historically used 3M-brand Class B foams through approximately 2000. Fire foam training is conducted at fire training grounds located near the southwest corner of the refinery. Spent foam and water is routed to an on-site waste water treatment plant.
- *Flint Hills Pine Bend Refinery, Rosemount:* Pine Bend refinery is located in a transition karst area, with approximately 300 gallons of Ansul-brand foam used annually for training. Foams manufactured by 3M were historically used in training. Fire foam training is conducted at fire training grounds near the southwest corner of the refinery. Spent foam is collected into a lined holding area from which it is pumped out and disposed through an on-site waste water treatment plant.
- *Kenyon Fire Department foam training area:* Bi-annual training with 3M-brand foam is conducted on Slee Street, between Cross and Pine Streets at the east end of town. The training area is located in a SWAA and an active karst area.
- *Claremont Fire Department training and foam demonstration areas:* Annual to bi-annual training with 3M-brand foam is conducted on a paved surface in front of the fire station on Front Street, where spent foam and water drain to a storm sewer. In the fall of 2008 a fire foam demonstration was held behind the station. The fire station is located in a SWAA and a transition karst area.
- *Harmony Fire Department foam training areas:* Foam training has occurred at two locations: historically in front of the fire station on Main Avenue South, and more recently at the municipal tree/brush dump south of the fire station. Foam training with Ansul-brand foam takes place annually or less. Both areas are located in a SWAA and an active karst area.
- *Bemidji Fire Department foam training site:* Annual training is conducted with five gallons or less 3M-brand foam at the Bemidji Regional Airport. The airport is located in a WPA with surface waters and wetlands adjacent to the airport and shallow municipal wells located nearby.
- *Fridley Fire Department training site:* Historically, training with 3M-brand firefighting foam took place at the North Metro Fire Training Center on 71st Avenue in Fridley. A training structure was built in 1994/1995 over a burn pit that had been used for foam training. The training center is located in a WPA and a transition or covered karst area.
- *Burnsville Fire Department training site:* The Burnsville Fire Department has trained three times with Ansul-brand foam at the ABLE Fire Training Center since it was built in 1989, and the last training exercise was in 2004. The fire training center is located at the southeast corner of the intersection of Cliff Road and River Ridge Boulevard in Burnsville. The training center is located in a WPA and appears to be situated in an active karst area. Municipal wells are located nearby.
- *Goodview Fire Department training area:* Occasional training (approximately six times in the last twenty years) is conducted on a paved area in front of the fire station located at 4140 W. 5th Street. Spent foam and water drain to a storm sewer which discharges into the backwaters of the

Mississippi River. The fire station and the discharge area are located in a WPA and an active karst area.

- *North St. Paul Fire Department training site:* Semi-annual training with 3M-brand foam takes place at the North St. Paul Public Works facility on 1st Street North. The site is located in a WPA and covered karst area.
- *Richfield Fire Department:* The Richfield Fire Department historically trained occasionally with 3M foam behind the Richfield Ice Arena, located at 636 East 66th Street. The ice arena is located in a WPA and covered karst area, with municipal wells nearby. Surface runoff from the training area would drain to nearby Legion Lake.
- *Rochester Fire Department:* Historically, annual training with 3M-brand foam took place in a parking lot near the northwest corner of the Olmsted County Fairgrounds in Rochester. The site is located in a WPA and active karst area.
- *Luverne Fire Department:* A one-time fire foam demonstration took place in approximately 2005 at the Luverne municipal tree/brush dump. A burn pan was used, and the soils around the burn pan were cleaned up with a payloader afterwards. The site is located in a WPA, and a shallow municipal water supply well located nearby.
- *Lake Superior College Emergency Response Training Center (ERTC):* The potential exists for historical use of 3M or other brand foams at the ERTC from approximately 1994 through 1996. Training foam has been used at the facility since 1996. An on-site wetland is located adjacent to the foam training area, and the St. Louis River nearby. This site was selected for sampling after inquiries received by the MPCA regarding this facility.

Although originally identified as priority sites, additional information collected during follow-up activities that clarified foam use precluded the following sites from sampling: Pierz Fire Department; Cottage Grove Fire Department; Alexandria Fire Department; Myrtle Fire Department; Preston Fire Department; two training sites used by the Brooklyn Center Fire Department; and South Central College in Mankato. Since the MPCA conducted a PFC investigation at the former fire training area at the Duluth International Airport, no further investigation was conducted for this project. Additional inquiries regarding the fire training areas utilized by the Maynard and Hutchinson Fire Departments found that the Maynard Fire Department only uses Class A foam, and the Hutchinson Fire Department did not train with Class B foam at the former training location on the Crow River.

4.3 Additional Foam Discharge Sites

During the course of the PFC/Firefighting Foam project, additional incidents of firefighting foam discharge were brought to the attention of the MPCA. Further investigation was made into foam use at the following sites:

- *Kings Cove Marina, Hastings(a):* In October 2002 a fire at the Kings Cove Marina destroyed several boats which were dry-docked at the west end of the marina. Several fire departments responded to the fire with various brands of Class B foam, apparently including approximately 305 gallons of 3M foam. This firefighting event may have released firefighting foam directly to the Mississippi River. Fish tissue sampling by the MPCA has identified PFCs in fish collected from the Mississippi River in the Hastings area.
- *River Grove Marina, Inver Grove Heights:* A fire occurred on a docked boat at the River Grove Marina on September 26, 2009. The Inver Grove Fire Department responded to the fire with, in

part, Ansul-brand Class B foam, which was discharged onto the burning boat and docks on the Mississippi River.

- *Kandiyohi County Landfill, New London:* A fire occurred at the Kandiyohi County Landfill over several days at the end of October 2009. Several fire departments responded to the fire, and approximately 545 gallons of 3M Class B foam was used on the fire.
- *Crystal Airport:* The Brooklyn Center Fire Chief related that several fire departments responded to a large hangar fire at the Crystal Airport in 2006. Interviews with responding departments found that Class B foam was not used at the hangar fire, but had been used at several plane crash sites at the airport.
- *Up North Plastics, Cottage Grove*(a)*:* A fire occurred at the business of Up North Plastics in December 2002. Its been estimated that upwards of 4,000 gallons of foam were used to extinguish the fire. Spent foam migrated into ditches and wetlands north of the facility, and to a storm sewer outlet south of the facility across Jamaica Road. Up North Plastics property is located within an area being investigated to identify sources of PFCs found in private wells in the Langdon and River Acres neighborhoods of Cottage Grove.
- *Western Area Fire Training Academy (WAFTA), St. Bonifacius*(a)*:* The WAFTA training facility was operated from 1974 through 1990, at the site of a former Nike Missile launch facility. The site was being investigated by the MPCA for other contaminants when, in May 2006, fourteen monitoring wells were sampled for PFCs. PFCs were detected in several of the wells.
- *Duluth International Airport*(a)*:* The Duluth Air National Guard Base and the Duluth Air Force Base both historically used two fire training areas located on the northeast side of the Duluth International Airport for Class B foam training.

(a) Further investigation and subsequent sampling at these sites was conducted by consultants other than Delta on behalf of the MPCA. Since firefighting foams were discharged at these sites, they are being included in this report.

5.0 SITE RECONNAISSANCE AND SAMPLE COLLECTION

Generally, the same or similar procedures were followed for site reconnaissance and sampling at the municipal fire department foam training areas. These procedures were presented in previous reports that detail specific site investigations. The sites where sampling was not conducted by Delta, or were not included in previous reports, are discussed in sections 5.1 through 5.5.

5.1 Sample Collection at the Kandiyohi County Landfill

Groundwater samples were collected for PFC analysis from two existing wells at the Kandiyohi County Landfill. Monitoring well DMW-1A is located upgradient of the C&D portion of the landfill where the fire occurred, and DMW-3 is located approximately 300 to 350 feet away in a roughly downgradient direction. The wells at Kandiyohi County Landfill were sampled on two occasions, in January and May 2010. Soil borings were not advanced at the landfill and soil samples were not collected.

5.2 Sample Collection at WAFTA

Groundwater samples were collected for PFC analysis from fourteen existing wells at the WAFTA site. The groundwater sampling was conducted in May 2006 by ENSR Corporation and is summarized in their report, *Phase II Site Investigation at Former Nike Missile Base MSP-70/Western Area Fire Training Academy,* dated October 2006. Monitoring well MW-4 was situated within the former fire training area, and the other wells were located side-gradient and downgradient of the training area. Monitoring well BG-4 was situated furthest downgradient of the training area, near the southeast corner of the WAFTA site. Soil samples were not collected for PFC analysis at WAFTA. The MPCA followed-up in 2008 and 2009 with sampling of nearby residential water wells for PFCs.

5.3 Sample Collection at the Kings Cove Marinas

At site of the fire at Kings Cove Marina in Hastings, two surface water and two sediment samples were collected from the adjacent Mississippi River where spent foam accumulated. One surficial soil sample was collected where foam was discharged on land. Sampling at Kings Cove Marina was conducted by West Central Environmental Consultants (WCEC). A data report detailing the sampling at Kings Cove Marina was submitted to the MPCA by WCEC on March 8, 2010.

5.4 Sample Collection at Duluth International Airport

Six soil borings were advanced within two former fire foam training areas at the Duluth International Airport for the purpose of collecting groundwater samples only. The sampling was conducted in October 2007 by BB&E, LLC, as presented in their *Groundwater Sampling Report, Duluth Air National Guard Base* dated December 19, 2007. Soil samples were not collected for PFC analysis at the fire training areas. The MPCA is following up with sampling of residential water wells in the area for PFCs.

5.5 Sample Collection at Up North Plastics

Five surficial soil samples were collected from the storm water ditch to which spent foam and water from the Up North Plastics fire reportedly drained. Four sediment and two surface water samples were also collected from a pond at the end of the storm water ditch. Groundwater samples were collected from three irrigation wells which are located at distances up to 1.5 miles away from the Up North Plastics facility. Sampling associated with the Up North Plastics fire was conducted by WCEC in July 2009. WCEC submitted a data report dated September 22, 2009, to the MPCA detailing this sampling.

6.0 SAMPLING RESULTS

Soil and sampling results are summarized in **Table 4, *Soil and Sediment Analytical Results, PFCs***. Groundwater and surface water sampling results are summarized in **Table 5, *Groundwater and Surface Water Analytical Results, PFCs***. The amount of foam used in training or at a fire response, and the foam brands and the last known approximate date of training or date of foam discharge at a fire, are included on the tables.

Samples were submitted to either Axys Analytical Services LTD (Axys) or MPI Research for analysis of PFCs. Duplicate samples were collected at select sites and submitted to both laboratories for comparison purposes. Samples collected at the WAFTA site were analyzed by the MDH and by Exygen Research, which later became Axys. The laboratories used for analysis are noted in Tables 4 and 5.

According to research, one important factor for the transport of anionic perfluorinated surfactants in soil is the organic content of the soil; soil partition coefficients were found to be linearly related to organic carbon content, and sorption of the anionic perfluorinated surfactants to soil particles increased with increasing perfluorinated chain length (17). Therefore, soil samples collected for PFC analysis at select sites were also submitted to Pace Analytical Services for laboratory analysis of total organic carbon (TOC) via EPA Method SW9060.

6.1 Laboratory Analytical Results, Soil and Sediment Sampling

Laboratory analysis detected PFCs in 52 of the 80 soil and sediment samples analyzed for this project (see **Table 4**). The highest PFC concentrations detected in soil or sediment samples were found in the soil samples collected at the Bemidji Airport and the Richfield Ice Arena, and the sediment sample collected from the on-site wetland at the Lake Superior College ERTC. The Bemidji Fire Department trains annually with foam at the Bemidji Airport. Training with Class B foam ceased at the ERTC in 1996, and Class B foam training by the Richfield Fire Department stopped in 1999. 3M-brand Class B foam was used, or was likely used, at all three sites.

Class B foam manufactured by 3M was used, or was likely used (based on the date of foam use and the popularity of the foam) at all of the sites sampled as part of this project, except for the following: the ABLE fire training center in Burnsville; the fire foam training areas in Luverne and Harmony; the River Grove Marina fire; and, the storm sewer associated with the Goodview Fire Station. While PFOS is associated with 3M-brand foam, PFOS was detected in the soil at the sites in Burnsville, Luverne and Goodview. However, the PFOS detected in the storm water sediment sample collected in Goodview may or may not be associated with foam use at the Goodview Fire Station since storm water runoff is collected from numerous points along the storm sewer. Ansul-brand foam was used for training at the Burnsville site, however, the Burnsville Assistant Fire Chief indicated that the use of 3M-brand foam cannot be absolutely ruled out. The Harmony Fire Department indicated they train with Ansul-brand foam. The brand of foam used at the Luverne site for demonstration is unknown.

Analytical data for all of the soil and sediment samples indicates that perfluorinated sulfonates, especially PFOS, are present at higher concentrations than perfluorinated carboxylic acids. PFOS was the PFC compound detected most often in the soil/sediment samples, with PFOS detected in 45 of the 80 samples analyzed. The next most-detected compounds were PFHxS and PFOA, which were detected in 36 of the soil/sediment samples. These trends are illustrated in **Graph 1**, ***Soil and Sediment PFC Concentrations***.

For the purpose of analyzing PFC concentrations trends with depth and with elapsed time between the last foam use and sampling date, PFOS soil concentration data were compared from the fire foam training sites where 3M-brand foam was used. This included PFOS data from foam training sites in Bemidji, Claremont, Rochester, Richfield, and Fridley. No trends were apparent in analyzing PFOS concentrations at shallow (0 to 4 feet bgs) and deep (4 to 8 feet bgs) depths, and no trends were apparent in comparing PFOS concentrations, and PFOS concentration increases/decreases with depth, to the length of elapsed time between the sampling and the last foam training. This lack of data trend may be due to the varying amounts of foam and water used, and different types of soils, and bare soil or grassy training sites versus paved training areas.

No trends are apparent between PFC compound concentrations and TOC concentrations. As expected, TOC concentrations are higher in the shallower soil samples.

6.2 Soil Laboratory Results versus State PFC Soil Reference Values

The MDH has defined soil reference values (SRVs) for a number of chemical compounds, which are soil contaminant concentrations above which an unacceptable risk to human health is predicted, dependent upon different exposure scenarios. The SRVs may or may not apply to the foam training areas or the fire sites; they are presented in this report for comparison purposes only.

Tier 1 SRVs assume that human exposure to contaminants is chronic and occurs in a residential site setting. Tier 2 SRVs assume contaminant exposures for industrial and recreational property uses. The MPCA has defined soil Tier 1 Residential SRVs, Tier 2 Recreational SRVs, and Tier 2 Industrial SRVs for only the following PFC compounds:

	Tier 1 Residential SRV	*Tier 2 Recreational SRV*	*Tier 2 Industrial SRV*
PFOS	2,100 ng/g	2,600 ng/g	14,000 ng/g
PFOA	2,100 ng/g	2,500 ng/g	13,000 ng/g
PFBA	77,000 ng/g	94,000 ng/g	500,000 ng/g

ng/g: nanograms per gram, which is equivalent to parts-per-billion.

None of the PFC concentrations detected in soil or sediment samples collected for this project met or exceeded any of the MPCA SRVs.

6.3 Groundwater and Surface Water Sampling Results

Laboratory analysis detected PFCs in 68 of the 72 groundwater and surface water samples analyzed for this project (see **Table 5**). Groundwater or surface water samples with the highest PFOS concentrations were found in samples collected at the WAFTA site. Water samples with the highest PFOA concentrations were collected at MSP Airport, WAFTA, and Duluth International Airport. Class B foams made by 3M were used, or were likely used based on the date of foam use, at all of these sites in the past.

The PFC compounds most often detected in groundwater and surface water samples were perfluorinated carboxylic acids. PFOA was detected in 59 of the 72 water samples collected during this project, and PFBA was detected in 58 water samples. PFHxA and PFPeA were detected in 55 and 53 of the water samples, respectively. This trend is illustrated in **Graph 2**, ***Groundwater and Surface Water PFC Concentrations.***

PFCs were detected in surface waters near the following fire foam training areas or fire sites where Class B foam was used: Richfield; MSP Airport; Goodview; River Grove Marina; Lake Superior College ERTC; Kings Cove Marina; and Up North Plastics. With the exception of Lake Superior College ERTC, the sampled bodies of water receive storm water runoff from areas other than the foam training or foam discharge sites. The PFCs detected in the surface waters may be attributed to the firefighting foam, or they may be from an unidentified source. At the ERTC in Duluth, it appears that only runoff from the fire training area enters that wetland.

At sites where 3M-brand foam were not used (the ABLE fire training center in Burnsville; the fire foam training areas in Luverne and Harmony; and, the storm sewer associated with the Goodview Fire Station), PFOS was detected in the groundwater or surface water. As discussed in Section 2.2, PFOS is associated with firefighting foams made by 3M. The source of PFOS at the ABLE fire training center in Burnsville, and at the training areas in Luverne and Harmony, is not known. The storm sewer outlet sampled in Goodview collects storm water from a large area where other sources of PFOS may exist.

6.4 Groundwater PFC Concentrations Versus Minnesota HRLs

The MDH has defined drinking water standards or values for the following PFC compounds: PFOS, PFOA, PFBA, and PFBS. The State drinking water Health Risk Limit (HRL) for both PFOS and PFOA in drinking water is 300 nanograms per liter (ng/L), which is equivalent to parts-per-trillion. The chronic exposure Health Based Value (HBV) for both PFBA and PFBS is 7,000 ng/L. The HBVs are developed by the MDH as interim guidance until a HRL can be established. A Risk Assessment Advice (RAA) for perfluorohexane sulfonate (PFHxS) does not specify numerical health-based limits or values.

The PFOS HRL was exceeded in at least one groundwater sample collected from the following sites:

- WAFTA

- Marathon Refinery
- Bemidji Airport
- ABLE fire training center in Burnsville
- MSP Airport

The PFOA HRL was exceeded in at least one groundwater sample collected from the following sites:

- MSP Airport
- WAFTA
- Duluth Airport
- ABLE fire training center in Burnsville
- Richfield Ice Arena

The surface water sample collected from the on-site wetland at the Lake Superior College ERTC had PFOS and PFOA concentrations that exceeded the drinking water HRLs. The HBVs for PFBA and PFBS were not exceeded in any of the water samples collected during this project.

6.5 State Surface Water Criteria for PFCs

The MPCA has developed site-specific ambient surface water quality criteria for only two PFC compounds, PFOA and PFOS. PFOA and PFOS criteria haven been developed for the surface waters of Lake Calhoun and for a portion of the Mississippi River, in accordance with Minnesota Rules, Chapter 7050.0218, *Methods for Determination of Criteria for Toxic Pollutants, for which Numerical Standards Not Promulgated.* Ambient surface water quality criteria have not been developed for any of the surface water bodies sampled as part of this project.

6.6 Ambient Groundwater Concentrations in Minnesota

In October 2007, ambient groundwater samples were collected by the MPCA from springs and monitoring wells in rural Minnesota for analysis of thirteen PFC compounds, including PFOA and PFOS. Sampling data is presented in the MPCA document *PFCs in Minnesota's Ambient Environment: 2008 Progress Report.* Twenty-two groundwater samples were analyzed for PFCs. The only PFC compound detected was PFBA, which was detected in thirteen samples at concentrations ranging from 2.43 ng/l to 63 ng/l.

In November-December 2006 and November 2007, the MPCA collected twenty-six ambient groundwater samples in urban areas of Minnesota, excluding those in Washington County where PFCs in groundwater are linked releases at historic 3M dumps. The samples were analyzed for nine PFC compounds, including PFOA and PFOS. Every PFC analyte was detected in at least one groundwater sample. Detected PFBA concentrations ranged from 1.34 ng/l to 468 ng/l. PFOA concentrations ranged from 1.1 ng/l to 24.8 ng/l. PFOS concentrations ranged from 2.39 ng/l to 31 ng/l.

In comparing groundwater sampling results from those sites sampled during this project in the rural areas of Minnesota (Harmony, Luverne, Bemidji, and Kandiyohi County) the PFBA concentrations as well as the number of other PFC analytes detected were considered. The PFC concentrations detected in groundwater at the firefighting foam training sites in Harmony, Luverne and Bemidji cannot be attributed to ambient concentrations. At the Kandiyohi County Landfill, where only low levels of PFBA have been detected in the well sample collected downgradient of the site of the fire, the PFBA concentrations may or may not be due to ambient levels.

Ambient concentrations of PFBA, PFOA and PFOS in groundwater found at urban locations were compared to the data collected at the remaining firefighting training sites or fire sites. The PFC concentrations detected in groundwater at the sites in Richfield, Fridley, Burnsville, and at MSP Airport, Duluth Airport, WAFTA, Marathon Refinery, and MW-3 at the Flint Hills Resources Pine Bend Refinery cannot be attributed to ambient concentrations. The PFBA, PFOA and PFOS concentrations detected in groundwater samples collected at the North St. Paul training area and the Crystal Airport, and in the upgradient groundwater samples (B-5, B-6 and B-7) at MSP Airport and the upgradient sample (MW-1) at the Pine Bend Refinery may or may not be due to ambient levels.

7.0 RECEPTOR SURVEYS AND ASSESSMENT OF RISK

The execution of receptor surveys and an evaluation of potential risks associated with PFC impacts identified during this project was not part of the scope of work, with one exception: a water well receptor survey was conducted around the former firefighting foam training area in Richfield due to the known presence of private wells in the area (see Section 7.2). The MPCA is not aware of anyone drinking water that has been impacted with PFCs above drinking water criteria due to the use of firefighting foam. The chemicals associated with firefighting foams of most concern at this time are PFOS and PFOA. According to the Minnesota Department of Health, nearly all people have some amount of PFCs in their blood. Studies by the Center for Disease Control and Prevention (CDC) published in 2007 found that PFOS, PFOA and PFHxS were detected in approximately 98% of the population (18). Research relied upon by the MDH in setting HRLs for drinking water indicates the health concerns associated with exposure to PFOS are effects on the liver and thyroid; health concerns related to PFOA are effects on the liver, slowed development in fetuses, reduced number of red blood cells, and changes to the immune system (19). While less is known about the potential health effects of telomerized compounds, the fact that they are showing up in more locations where firefighting foams are being used may mean that more study is warranted.

7.1 MDH Municipal Well Sampling

One of the risks associated with PFCs in groundwater is to human health should a potable water well be drawing water from impacted groundwater. There are municipal supply wells located near several of the “priority” sites where groundwater impacted by PFCs have been identified, including Bemidji, Luverne, Burnsville, and Richfield. The MPCA and MDH have worked together to identify public supply wells that may be at risk due to their proximity to firefighting foam training areas or large fire sites where Class B foam was discharged. The MDH has sampled supply wells near several fire foam training areas in the “priority” cities and elsewhere, and while low levels of some PFC compounds were detected in municipal well water samples, none of the concentrations have exceeded the HRLs or HBVs.

7.2 Well Receptor Survey, Richfield

As presented in the February 2010 Report, a water well survey was conducted in the area adjacent to or within one-quarter mile to the east, south and southeast of, the former Richfield fire foam training area at the Richfield Ice Arena, in reference to the easterly or potential southeasterly groundwater flow direction. The survey included a search of the MDH County Well Index (CWI), and walking and mailing surveys to identify private water wells. The survey identified several sealed and abandoned water supply wells and groundwater monitoring wells in the survey area. No active wells, other than the municipal wells which were being sampled by MDH, were identified within ¼-mile downgradient of the former fire training area.

7.3 Well Receptor Survey, WAFTA

A groundwater receptor survey conducted by ENSR Corporation identified several water supply wells within one-half mile of the WAFTA site. Sampling of the nearby water wells by the MPCA in 2008 and 2009 did not identify PFCs in any of the wells.

7.4 Well Information, Duluth International Airport

According to the *Groundwater Sampling Report* by BB&E, LLC, there are no drinking water wells in the immediate area of the former firefighting foam training areas, and there are no plans to install water supply wells on airport property. The nearest residential water supply wells identified in a groundwater receptor survey conducted in association with this site are located approximately 1.25 miles away. The residential wells are currently being sampled for PFCs under the oversight of the MPCA.

8.0 FINDINGS AND RECOMMENDATIONS

8.1 PFCs in Class B Foam

Based on the literature review, interviews with knowledgeable persons, and survey of firefighting foam manufactures, the surfactant in Class B firefighting foams contain PFCs. The Class B foams manufactured by 3M prior to 2002 using the ECF manufacturing process contain, or break down to, perfluorinated sulfonates. Class B foams made by other manufacturers using a telomerization process contain, or break down to, fluorotelomer sulfonates and perfluorinated carboxylic acids.

8.2 Class B Foam Use in Minnesota

Based on the survey of Minnesota firefighting organizations, and assuming that the 66% response rate by municipal fire departments is representative of the entire State, approximately 10% of the municipal fire departments do not use firefighting foam at all, approximately 58% of the municipal fire departments use only Class A foams, approximately 15% of the municipal fire departments use Class B foam for fire response but do not train with Class B foam, and approximately 15% of the municipal fire departments use and train with Class B foam.

The two active oil refineries in the State have their own fire departments and their own on-site fire training areas where Class B foam is used in training and as needed for extinguishing fires.

Of the sixteen MNSCU firefighting training schools, only two of the schools hold training exercises or held training exercises on campus with Class B foam: Lake Superior College ERTC in Duluth; and, Northland College in East Grand Forks.

Firefighting training with Class B foam is no longer conducted at MSP Airport or the Duluth International Airport. Training at these airports with 3M-brand Class B foam was conducted in the past.

Firefighting training with Class B foam at the WAFTA site in St. Bonifacius ceased in 1990. Firefighting foam is not used in training exercises at the SCALE Regional Public Safety Training Facility in Jordan, which opened in 2008. Firefighting foam training is not conducted at Camp Ripley.

Class B foams have been used, and will continue to be used on Class B fires across the State in order to protect public safety, the safety of firefighters, and property. Class B foams are not classified as a hazardous substance, nor has the MPCA or other regulatory entity placed any restrictions on the use of Class B foams.

8.3 Sampling Findings

This project has identified PFCs in soil, sediments, surface water and groundwater at locations where various brands of Class B firefighting foams were used. PFCs were found in soils and groundwater at sites where several years have passed since the last training event or since foam was discharged at a fire. PFC compounds associated with 3M's ECF manufacturing process (i.e. perfluorinated sulfonates) were detected at training sites where 3M-brand foams were not used.

Groundwater is impacted with PFOA and/or PFOS at concentrations exceeding the State drinking water HRLs at the following sites:

- WAFTA site in St. Bonifacius
- Marathon Refinery in St. Paul Park
- Bemidji Regional Airport
- ABLE fire training center in Burnsville
- MSP Airport
- Duluth International Airport
- Richfield Ice Arena

While these locations have PFOA and/or PFOS concentrations in groundwater that exceed the State drinking water Criteria, at this time the MPCA is not aware of anyone drinking water contaminated with PFCs due to the use of firefighting foams that exceed drinking water criteria. Sampling of private water wells in the area of the WAFTA and Duluth International Airport firefighting foam training sites did not detect PFCs in any of the wells. A groundwater receptor survey conducted in the area of the Richfield Ice Arena did not identify any active private water wells.

The PFC concentrations in soils at all sites where samples were collected are all well below the current clean-up criteria.

Firefighting foam training sites with minimal use of Class B foams exhibited low levels of PFCs in groundwater, but concentrations are not exceeding current standards. Therefore, those training sites ranked lower than the 21 “priority” sites do not appear to be a risk to human health or the environment and will not be subject to further action at this time, unless additional information is obtained that would change the ranking of a site.

8.4 State Recommendations on the Use of Class B Firefighting Foam

The MPCA, in conjunction with the Minnesota Department of Public Safety and the Minnesota State Colleges and Universities, has prepared a “Best Practices Today for Class B Firefighting Foam” document, a copy of which is included in **Appendix A**. The Best Practices document recognizes the importance of the use of Class B firefighting foam to fight Class B fires-- it protects the public, it protects the firefighters working to protect us, and it protects property. The Best Practice document presents information and recommendations on the use of foam on fires and spills, foam training, foam types, firefighters’ health, and foam disposal, and includes the following recommendations:

- Use Class B foams as necessary on Class B fires, but use Class A foams for Class A fires.
- Use training foam, and not Class B foam, in training exercises if possible. Training foams do not appear to contain PFCs.
- Training with Class B foams in wellhead protection areas or near public or private water supply wells should be avoided whenever possible.

8.5 Recommendations for Further Assessment

While the MPCA is not aware of anyone drinking water contaminated with PFCs above drinking water criteria associated with firefighting foam use, several sites still warrant some additional investigation. Based on the information presented in this report and previous reports, following are recommendations for further assessment with regards to PFCs at firefighting foam training sites or fire sites where Class B foam was used:

1. Conduct groundwater receptor surveys to evaluate risk at the following sites where PFOA and/or PFOS concentrations in groundwater exceeded the State HRLs:
    - Marathon Refinery in St. Paul Park
    - Bemidji Regional Airport
    - ABLE fire training center in Burnsville
    - MSP Airport
2. Conduct a groundwater receptor survey to evaluate risk in the area of the Lake Superior College ERTC due to elevated PFOS and PFOA concentrations in the wetland adjacent to the training area.
3. Continue to monitor groundwater for PFCs at the existing monitoring well located downgradient of the fire site at the Kandiyohi County Landfill. Since the foam discharge occurred less than one year ago, it may take time for potential PFC impacts to migrate through the soil to the water table, and to migrate with groundwater to the location of well DMW-3. Consider installing a monitoring well closer to the site of the fire if site activities and land use nearer the fire site are conducive to the presence of a monitoring well.
4. At the time of sampling at Crystal Airport, there was no water in Shingle Creek. Since PFCs were detected in a sediment sample collected on the down stream side of Crystal Airport, but none were detected upstream, water samples should be collected at or near the locations of the previous sediment samples to test for PFCs in Shingle Creek adjacent to Crystal Airport.
5. Follow up with inquiries, and sampling if warranted, at any large fires that occur or have occurred where Class B foams are used extensively.

9.0 REMARKS

The recommendations contained in this report represent Delta's professional opinions based upon the currently available information and are arrived at in accordance with currently accepted professional standards. This report is based upon a specific scope of work requested by the client. The contract between Delta and its client outlines the scope of work, and only those tasks specifically authorized by that contract or outlined in this report were performed. This report is intended only for the use of Delta's client and anyone else specifically identified in writing by Delta as a user of this report. Delta will not and cannot be liable for unauthorized reliance by any other third party. Other than as contained in this paragraph, Delta makes no express or implied warranty as to the contents of this report.

Nancy Rodning

Date: June 30, 2010

Nancy Rodning
Project Geologist

Reviewed by:

Date: June 30, 2010

John Estes
Project Manager

10.0 REFERENCES

(1) 3M. *The Science of Organic Fluorochemistry.* EPA-HQ-OPPT-2002-0043-0006. February 5, 1999.

(2) Minnesota Department of Health (MDH). *Hazardous Substances in Minnesota, Perfluorochemicals and Health*. March 2008. http://www.health.state.mn.us/divs/eh/hazardous/topics/pfcshealth.html

(3) Minnesota Pollution Control Agency (MPCA). Fact Sheet *Perfluorochemicals, Past, present and future actions.* February 2007.

(4) United States Environmental Protection Agency (USEPA). *Basic Information on PFOA.* http://www.epa.gov/opptintr/pfoa/pubs/pfoainfo.htm#steps

(5) Schultz, Melissa M., Barofsky, Douglas F., and Field, Jennifer A. *Quantitative Determination of Fluorotelomer Sulfonates in Groundwater by LC MS/MS.* Environmental Science & Technology. Vol. 38, no. 6, pp. 1828-1835. 2004.

(6) U.S. Environmental Protection Agency (USEPA). Perfluorooctanoic Acid (PFOA), Fluorinated Telomers; Request for Comment, Solicitation of Interested Parties for Enforceable Consent Agreement Development, and Notice of Public Meeting. EPA-HQ-OPPT-2003-0012-0001. Federal Register, Vol. 68, No. 73, Wednesday, April 16, 2003.

(7) Moody, Cheryl A. and Field, Jennifer A. *Perfluorinated Surfactants and the Environmental Implications of Their Use in Fire-Fighting Foams.* Environmental Science & Technology. Vol. 34, No. 18, pp. 3864-3870. September 2000.

(8) Scheffey, Joseph L., P.E. and Hanauska, Christopher P., P.E., Hughes Associates, Inc. *Status Report on Environmental Concerns Related to Aqueous Film Forming Foam (AFFF).* May 2002.

(9) 3M. Environmental and Health Assessment of Perfluorooctane Sulfonic Acid and Its Salts. August 20, 2003.

(10) Parsons, John R, Saez, Monica, Dolfing, Jan, and DeVoogt, Pim. *Biodegradation of Perfluorinated Compounds.* Reviews of Environmental Contamination and Toxicology, Vol. 196, pp. 53-71. 2008.

(11) Stevens, Larry H. *Foam Basics (4-Part Series).* Fire Rescue Magazine. Vol. 15, no. 9, pp. 53-57+, November 1997. Vol. 15, no. 10, pp. 42-46+, December 1997. Vol. 16, no. 1, pp. 61-64+, January 1998. Vol. 16, no. 2, pp. 60-64, February 1998.

(12) Oliaei, Fardin, Kriens, Don, and Kessler, Katrina. Investigation of Perfluorochemical (PFC) Contamination in Minnesota, Phase One; Report to State Environment Committee. February 2006.

(13) Korzeniowski, Dr. Stephen, E.I. DuPont de Nemours & Co., Inc. *Fluorotelomer Products in the Environment – An Update.* 3rd Reebok Foam Seminar, September 3, 2007.

(14) Davis, Larry and Colletti, Dominic. *The Rural Firefighting Handbook.* Lyons Publishing, Royersford, PA. 2002.

(15) USEPA Notice. Perfluorooctanoic Acid (PFOA), Fluorinated Telomers; Request for Comment, Solicitation of Interested Parties for Enforceable Consent Agreement Development, and Notice of Public Meeting. Federal Register, Vol. 68, No. 73. Wednesday, April 16, 2003. EPA-HQ-OPPT-2003-0012-0001.

(16) Cortina, Tom. Aircraft Rescue and Firefighting Requires the Best Foam Available: AFFF. Asia Pacific Fire, pp. 25-28. June 2009.

(17) Moody, Cheryl A, Hebert, Gretchen N., Strauss, Steven H., and Field, Jennifer A. *Occurrence and Persistence of Perfluorooctanesulfonate and Other Perfluorinated Surfactants in Groundwater at a Fire-training Area at Wurtsmith Air Force Base, Michigan, USA.* Journal of Environmental Monitoring, Vol. 5, pp. 341-345. 2003.

(18) Center for Disease Control and Prevention (CDC). *National Report on Human Exposure to Environmental Chemicals; Spotlight on Polyfluorochemicals.* August 2007.

(19) Minnesota Department of Health (MDH). *Health Risk Limits for Perfluorochemicals, Report to the Minnesota Legislature 2008.* Final Report, January 15, 2008.

TABLES

TABLE 1
CLASS B FOAM USE RANKING SUMMARY
MINNESOTA MUNICIPAL FIRE DEPARTMENTS
Delta Project No. 19382DEL08

Department	Training Location	SITE RANKING CRITERIA							OVERALL SITE RANKING	Notes
		Foam Type: 3M current or former use in training =8	Annual Class B Foam Usage in Training: 5 gal or less=2; 6 to 10 gal=4; >10 gal=6	Surface Water Nearby: within 1/4 mile=3; within 1 mile=1; No=0	Wetlands Nearby: within 1/4 mile=3; within 1 mile=1; No=0	Karst Area: Active=5; Transition=4; Covered=2; No=0	Water Wells Nearby: within 1/4 mile=3; within 1 mile=1; No=0	WPA/SWAA: site in WPA and/or SWAA=5; within 1/4 mile=4; within 1 mile=2; No=0		
Richfield	Richfield ice arena, 636 E. 66th St.	8	6	3	3	2	3	5	30	sampled soil, groundwater, surface water, upgradient groundwater
Fridley	300 71st Av., Fridley (North Metro Fire Training Center)	8	2	3	3	4	3	5	28	sampled soil, groundwater, sediment
Luverne	Tree dump 1/2 mile south of city on Hwy 75, east side of road.	8	6	3	3	0	3	5	28	sampled soil, groundwater
North St. Paul	No. St. Paul Public Works, 2303 1st St. N.	8	6	3	1	2	3	5	28	sampled soil, groundwater, surface water
Brooklyn Center	Fire station #1 6250 Brooklyn Blvd.	8(a)	6	1	1	4	3	5	28	follow-up site visit indicated no Class B foam training.
	Fire station #2 6500 Dupont Av. N.	8(a)	6	1	1	4	3	5	28	follow-up site visit indicated no Class B foam training.
Preston	Fillmore County Fairgrounds Fillmore St. & Cty. Hwy. 12, Preston	8	2	3	3	5	3	4	28	follow-up interview indicated one-time training at specified location only.
Kenyon	Fire station, 714 2nd St.	8	2	3	1	5	3	5	27	sampled soil
Cottage Grove	Fire Station 2, 8641 80th St. S.	8	2	3	3	5	1	5	27	follow-up interview indicated training with Class A foam only.
Bemidji	Bemidji Airport (Class B)	8	4	3	3	0	3	5	26	follow-up interview indicated foam brand unknown; sampled soil, groundwater
Northfield	City street shop, 1710 Riverview Drive.	8	2	3	3	5	3	1	25	haven't trained with foam in 10-15 years, and only trained when new equipment purchased.
Rochester	2021 41st St. NW	8	2	1	1	5	3	5	25	sampled soil
Burnsville	ABLE Fire Training Center Cliff Rd & River Ridge Blvd.	0	4	3	3	5	3	5	23	sampled soil, groundwater
Claremont	Front of fire hall on Front St.	8	2	1	0	4	3	5	23	sampled soil
Clearbrook	Tank farm on south edge of town.	8(a)	4	3	3	0	3	2	23	Fire Chief wasn't sure the type of foam used. Spent foam caught on floating lids at tank farm.
Linwood Twp	Behind fire station, 22870 Typo Creek Dr., Stacy	8	4	3	3	0	3	2	23	
Littlefork	Fire hall, McPherson & 3rd Av	8(a)	2	3	3	0	3	4	23	follow-up attempts unsuccessful
St. Clair	City of St. Clair	8(a)	6	3	1	2	3	0	23	follow-up attempts unsuccessful
Alexandria	Various, including VoTech, Magellan tank farm, live burns.	8[a]	2	3	1	0	3	5	22	historical training with Class B foam at Magellen tank farm only.
Golden Valley	7800 Golden Valley Road	0	6	3	1	4	3	5	22	
Hutchinson	205 3rd Av. SE	8	4	1	1	0	3	5	22	no on-site foam training, historically trained with foam at 3M facility in town.
	1300 Adams St. SE	8	4	3	1	0	3	2	21	

TABLE 1

CLASS B FOAM USE RANKING SUMMARY
MINNESOTA MUNICIPAL FIRE DEPARTMENTS
Delta Project No. 19382DEL08

		SITE RANKING CRITERIA								
Department	**Training Location**	**Foam Type: 3M current or former use in training =8**	**Annual Class B Foam Usage in Training: 5 gal or less=2; 6 to 10 gal=4; >10 gal=6**	**Surface Water Nearby: within 1/4 mile=3; within 1 mile=1; No=0**	**Wetlands Nearby: within 1/4 mile=3; within 1 mile=1; No=0**	**Karst Area: Active=5; Transition=4; Covered=2; No=0**	**Water Wells Nearby: within 1/4 mile=3; within 1 mile=1; No=0**	**WPA/SWAA: site in WPA and/or SWAA=5; within 1/4 mile=4; within 1 mile=2; No=0**	**OVERALL SITE RANKING**	**Notes**
Myrtle	Myrtle ballfield	8(a)	2	1	0	5	1	5	22	follow-up interview indicated use of Class A foam only.
Perham	Near parking entrance of Prairie Winds Middle School	8(a)	4	1	1	0	3	5	22	various brands Class B foam, more training with class A than Class B. Switched to POK stick last year.
Pierz	Intersection of 25 and 27, Pierz	8	2	3	3	0	1	5	22	follow-up interview indicated one-time training at specified location only.
St. Paul	1683 Energy Park Dr., St. Paul	8	4	1	1	5	3	0	22	
Crosslake	Joint City/County maintenance facility, 13870 Whipple.	8(a)	2	3	3	0	3	2	21	training location confirmed with City, could not confirm type of foam used.
Fairmont	City shop park lot, 417 E. Margaret St.	8	6	3	3	0	1	0	21	
Goodview	Across street from fire station, 4140 W. 5th St.	0	2	3	3	5	3	5	21	sampled surface water, sediment
Mankato	Fire Sta. #1, 300 Madison Av.	8	4	1	0	5	1	2	21	
Marshall	Marshall Merit Center, Cty Rd 33 (1001 W. Erie Rd.)	8(a)	6	3	3	0	1	0	21	
Harmony	Fire hall, Main Av. S. and Brush dump, east of intersection of 139 & Gordon Rd.	0	2	3	3	5	1	5	19	sampled soil and groundwater
Hugo	5223 140th St. N.	0	2	3	3	4	3	4	19	
	4630 Fable Rd. Ct. N.	0	2	3	3	4	3	5	20	
Minneapolis	25 37th Ave. NE	8	2	3	1	4	1	0	19	
Rosemount	14700 Shannon Pkwy	8	2	1	1	2	3	2	19	
Winona	Central Fire Sta., 451 E. 3rd.	0	2	3	1	5	3	5	19	
	Technical College, 1250 Homer Rd.	0	2	3	3	5	3	0	16	
Cannon Falls	Cannon Valley fair grounds, Cannon Falls	0	2	3	3	5	1	4	18	
Lanesboro	Lanesboro ball park parking lot, County Road 8	0	2	3	3	5	1	4	18	
Loretto	259 Medina St. N.	8	2	1	1	0	1	5	18	
Plymouth	Fire Station, 13250 Co. Rd. 6	0	2	1	1	2	1	5	12	
	Fire Station, 3300 Dunkirk Ln.	0	2	3	3	2	3	5	18	
	Fire Station, Old Rockford Rd.	0	2	3	3	2	3	5	18	
Waconia	7550 Airport Rd.	0	4	3	3	0	3	0	13	
	26 Maple St. S.	0	4	3	1	0	3	5	16	
	8075 Paradise Lane	0	4	3	3	0	3	5	18	
Montevideo	Fire station, 103 Canton Av.	8	2	3	3	0	1	0	17	

TABLE 1
CLASS B FOAM USE RANKING SUMMARY
MINNESOTA MUNICIPAL FIRE DEPARTMENTS
Delta Project No. 19382DEL08

Department	Training Location	SITE RANKING CRITERIA							OVERALL SITE RANKING	Notes
		Foam Type: 3M current or former use in training =8	Annual Class B Foam Usage in Training: 5 gal or less=2; 6 to 10 gal=4; >10 gal=6	Surface Water Nearby: within 1/4 mile=3; within 1 mile=1; No=0	Wetlands Nearby: within 1/4 mile=3; within 1 mile=1; No=0	Karst Area: Active=5; Transition=4; Covered=2; No=0	Water Wells Nearby: within 1/4 mile=3; within 1 mile=1; No=0	WPA/SWAA: site in WPA and/or SWAA=5; within 1/4 mile=4; within 1 mile=2; No=0		
Apple Valley	Fire Sta. #1, 15000 Hayes Rd.	0	2	1	3	2	3	5	16	
	Apple Valley central maintenance facility, 6442 140th St. W.	0	2	1	3	2	3	4	15	
Elysian	Fire hall, 212 E. Main	0	2	3	3	2	1	5	16	
Norwood	City vacant lot at South & Rush Streets	0	2	1	3	2	3	5	16	
Paynesville	City airport	0	2	3	3	0	3	5	16	
Pelican Rapids	2nd Av. NW & 4th St.	0	2	3	3	0	3	5	16	
St. Cloud	Open field near Sta. 2 700 41st Av N.	0	6	3	1	0	1	5	16	
	Sta. 4, 1550 45th Av SE	0	6	1	3	0	1	4	15	
Waldorf	Main Street	0	6	1	1	2	1	5	16	
Buffalo Lake	315 N. Main St., at Main & Church Sts.	8	2	1	1	0	1	2	15	
Hamburg	181 Broadway	0	2	3	3	2	3	2	15	
Lake Johanna	Varies, mostly at Station 3, 5545 Lexington Ave.	0	4	3	3	2	3	0	15	
Richmond	Industrial lot, 3 lots west of Main & 191st Av, on the north side of Main.	0	2	3	3	0	3	4	15	
Sartell-LeSauk	Fire hall, 220 4th Ave. S.	0	2	3	3	0	3	4	15	
Silver Lake	Public Works storage area, 305 E. Main St.	0	2	3	3	0	3	4	15	
Upsala	110 W. Elm Av., Upsala	0	4	3	3	0	3	2	15	
Welcome	NE corner of Dugan St. S. and Mill St.	0	2	1	3	0	3	5	14	
Albert Lea	Frank Av., near dog pound	0	2	1	1	2	3	4	13	
Cass Lake	Railroad ROW by 8 Railroad St. NW, Cass Lake	0	4	1	1	0	3	4	13	
Glenville	High school football field	0	2	3	1	4	3	0	13	
New York Mills	City utility gravel parking lot, west side of town, between Centennial Dr. W. and Hwy. 10.	0	2	3	3	0	3	2	13	
Pine River	Fair grounds	0	2	1	1	0	1	5	10	
	School grounds on 1st Street	0	2	3	3	0	1	4	13	
Waseca	Waseca Cty Fairground, area of grand stand.	0	4	1	1	2	1	4	13	

TABLE 1

CLASS B FOAM USE RANKING SUMMARY
MINNESOTA MUNICIPAL FIRE DEPARTMENTS
Delta Project No. 19382DEL08

		SITE RANKING CRITERIA								
Department	**Training Location**	**Foam Type: 3M current or former use in training =8**	**Annual Class B Foam Usage in Training: 5 gal or less=2; 6 to 10 gal=4; >10 gal=6**	**Surface Water Nearby: within 1/4 mile=3; within 1 mile=1; No=0**	**Wetlands Nearby: within 1/4 mile=3; within 1 mile=1; No=0**	**Karst Area: Active=5; Transition=4; Covered=2; No=0**	**Water Wells Nearby: within 1/4 mile=3; within 1 mile=1; No=0**	**WPA/SWAA: site in WPA and/or SWAA=5; within 1/4 mile=4; within 1 mile=2; No=0**	**OVERALL SITE RANKING**	**Notes**
Cloquet	Gravel pit next to city garage at 410 Armory Road	0	2	1	3	0	1	5	12	
Maynard	Mable St. & Sherman	0	2	1	1	0	3	5	12	follow-up interview indicated use of Class A foam only.
Newfolden	Fire hall	0	2	3	1	0	1	5	12	
Randall	At lot across the street from the fire station.	0	2	0	3	0	3	4	12	
Alborn	Albrook School, 7427 Seville Rd., Saginaw (demonstration)	0	2	1	3	0	1	0	7	
	Alborn Fire Hall, 6390 Hwy. 7, Alborn (training & demo).	0	2	3	3	0	3	0	11	
Appleton	Appleton Public Works bldg. 427 S. Munsterman St.	0	4	1	3	0	3	0	11	
Dilworth	Fire hall, 709 1st Av NW	0	2	3	1	0	3	2	11	
Evansville	East end of town, (new) Council Circle.	0	2	1	3	0	1	4	11	
Hibbing	2320 Brooklyn Dr.	0	2	1	1	0	3	4	11	
Hoyt Lakes	Triple ballfields or near Hoyt Lakes fire hall, 123-1/2 Kennedy Memorial Dr.	0	2	3	3	0	3	0	11	
Mapleton	Street in front of fire hall, 103 3rd Av NE	0	2	1	0	2	1	5	11	
Northrop	Behind fire hall, 211 N. Bridgeman	0	2	0	1	0	3	5	11	
Dunnell-Lake Fremont	Old ball diamond, N. Seeley Av., Dunnell	0	2	1	1	0	1	4	9	
Ellsburg	Fire hall, 1763 Melrude Rd., Melrude, MN	0	2	3	3	0	1	0	9	
Porter	Fire hall, 301 Lone Tree Street	0	4	3	1	0	1	0	9	
Tyler	Corner of Bradley & Applebee	0	6	1	1	0	1	0	9	
Blackhoof	3148 Cty. Rd. 5, Barnum	0	2	1	1	0	3	0	7	
Breckenridge	1312 Minnesot Av.	0	4	1	1	0	1	0	7	
Wolverton	Gravel road in front of fire hall, 301 Hwy 75, Wolverton	0	2	3	1	0	1	0	7	

Notes:

(a) Foam type or training use not specified, 3M foam use for training assumed.

WPA: Wellhead Protection Area

SWAA: Source Water Assessment Area

TABLE 2
CLASS B FOAM USE RANKING SUMMARY
MINNESOTA AIRPORT AND REFINERY FIRE DEPARTMENTS AND TRAINING SCHOOLS
Delta Project No. 19382DEL08

				Site Ranking Criteria							
Entity	**Location**	**Training Location**	**Notes**	**Foam Type: 3M current or former use in training=8**	**Annual Class B Foam Usage in Training: 5 gal or less=2; 6 to 10 gal=4; >10 gal=6**	**Surface Water Nearby: within 1/4 mile=3; within 1 mile=1; No=0**	**Wetlands Nearby: within 1/4 mile=3; within 1 mile=1; No=0**	**Karst Area: Active=5; Transition=4; Covered=2; No=0**	**Water Wells Nearby: within 1/4 mile=3; within 1 mile=1; No=0**	**WPA/SWAA: site in WPA and/or SWAA=5; within 1/4 mile=4; within 1 mile=2; No=0**	**Site Ranking**
Alexandria Technical College	1601 Jefferson St. Alexandria	Various locations	Foam provided by various fire departments.	Foam training at various locations, foam provided by other fire departments. Site not ranked.							
Central Lakes College	501 W. College Drive, Brainerd	Various fire departments		Multiple training locations, site not ranked.							
Hennepin Technical College	13100 Collegeview Dr. Eden Prairie	Parking lots of school		Use of Class A and training foam only; no Class B foam use. Site not ranked.							
Hennepin Technical College	1820 Xenium Ln. N. Plymouth	Hennepin Technical College, 13100 College View Dr., Eden Prairie		Class A foam use only, site not ranked.							
Itasca Community College	1831 E. Hwy. 169 Grand Rapids	Not applicable		Foam not used in training, site not ranked.							
Lake Superior College	11501 Hwy 23 Duluth	On-site	Training foam type Kidde Trainol. Other departments train with Trainol.	8	2	3	3	0	1	0	17
Mesabi Range College	1001 Chestnut St. Virginia	Various fire departments and on-site.		Class A foam use only, site not ranked.							
Minnesota State Community & Technical College	2900 28th Av. S. Moorhead	Various fire departments; no training with foam on campus.	Foams supplied by local fire departments.	Multiple training locations, site not ranked.							
Minnesota West Comm & Tech College	607 W. Main St., #100 Marshall	Various fire departments: Granite Falls, Luverne, Jackson, Lake Wilson, and Merit Center in Marshall	Training foam type unknown.	Multiple training locations, site not ranked.							
Northland College	1101 Hwy 1 East Thief River Falls	Various fire departments	Foam training done at off-site locations using other departments' foam.	Class A foam use only, multiple training locations; site not ranked.							
Northland College	2022 Central Av. NE East Grand Forks	Two grassy areas and a parking lot on campus.	Stopped using Class B protein foam more than 5 years ago.	0	6	1	1	0	0	0	8
Pine Technical College	900 4th St. SE Pine City	Various house burns, training as requested.	Foam supplied by other fire departments.	Class A foam use only, multiple training locations; site not ranked.							

TABLE 2
CLASS B FOAM USE RANKING SUMMARY
MINNESOTA AIRPORT AND REFINERY FIRE DEPARTMENTS AND TRAINING SCHOOLS
Delta Project No. 19382DEL08

				Site Ranking Criteria							
Entity	**Location**	**Training Location**	**Notes**	**Foam Type: 3M current or former use in training=8**	**Annual Class B Foam Usage in Training: 5 gal or less=2; 6 to 10 gal=4; >10 gal=6**	**Surface Water Nearby: within 1/4 mile=3; within 1 mile=1; No=0**	**Wetlands Nearby: within 1/4 mile=3; within 1 mile=1; No=0**	**Karst Area: Active=5; Transition=4; Covered=2; No=0**	**Water Wells Nearby: within 1/4 mile=3; within 1 mile=1; No=0**	**WPA/SWAA: site in WPA and/or SWAA=5; within 1/4 mile=4; within 1 mile=2; No=0**	**Site Ranking**
St. Cloud Technical College	1540 Northway Drive St. Cloud	Various fire departments		Multiple training locations, site not ranked.							
South Central College	1920 Lee Blvd North Mankato	On-site (10%) and at various fire departments (90%).	Training with various foam brands, whatever the trainee dept. has on hand and whatever is least expensive.	es that there is no on-site training with Class B foam.							
Ridgewater College	2101 NW 15th Av Willmar	Off-site at various fire departments: Litchfield, Ortonville, Prinsburg, Morris		Class A foam use only, multiple training locations; site not ranked.							
Riverland Community College	1900 8th Av NW Austin	Have not trained in many years, recall one training event in Preston, MN.	Foam brands not specified.	Class A and training foam use only, multiple training locations; site not ranked.							
Flint Hills Resources, Pine Bend Refinery Fire Dept.	Rosemount	SW corner of refinery site, 1255 Clayton Blvd.	3M Foams (FC 600F, FC 602, ATC 3x3, FC 603) no longer used for training. Ansul Thunderstorm FC600A used for training. Other departments train on site.	8	6	1	1	4	3	0	23
Marathon Petroleum Refinery	St. Paul Park	Refinery fire training grour	Switched from 3M to Ansul Thunderstorm foam in ~2000. Use ~250 gallon foam for training; non-training foam use varies. Site located in Special Well Construction Area.	8	6	3	3	5	3	2	30
Former Wrenshall Refinery	Highway 1, Wrenshall	Per Wrenshall Fire Chief, historic training with foam on-site.		8(b)	6(c)	3	3	0	3	2	25(c)
Camp Ripley	15000 Hwy 115 Little Falls	No on-site training with foam.	Class A foam type Fire-Trol Fire Foam 103B	No on-site training with foam, Class A foam use only; site not ranked.							

TABLE 2

CLASS B FOAM USE RANKING SUMMARY

MINNESOTA AIRPORT AND REFINERY FIRE DEPARTMENTS AND TRAINING SCHOOLS

Delta Project No. 19382DEL08

				Site Ranking Criteria							
Entity	**Location**	**Training Location**	**Notes**	**Foam Type: 3M current or former use in training=8**	**Annual Class B Foam Usage in Training: 5 gal or less=2; 6 to 10 gal=4; >10 gal=6**	**Surface Water Nearby: within 1/4 mile=3; within 1 mile=1; No=0**	**Wetlands Nearby: within 1/4 mile=3; within 1 mile=1; No=0**	**Karst Area: Active=5; Transition=4; Covered=2; No=0**	**Water Wells Nearby: within 1/4 mile=3; within 1 mile=1; No=0**	**WPA/SWAA: site in WPA and/or SWAA=5; within 1/4 mile=4; within 1 mile=2; No=0**	**Site Ranking**
Metropolitan Airports Commission at Minneapolis/St. Paul Airport	MSP	Trained until recently at Humphrey remote ramp or de-icing pad. Plugged drains, collected spent foam for off-site disposal	Ansul 3% used for training. Historic use of military protein foam in 1960s/1970s. Historic use of 3M foam through ~2000. Class A foam type 1% Lorcon.	8	6	3	3	5	3	5	33
Rochester Airport Fire Dept.	Rochester	Various on-site locations as selected by FAA Inspector, usually a runway. "Short bursts" of foam required in training by FAA. Firefighters train at facility in Duluth.		0	2	3	3	5	3	0	16
Minnesota Air National Guard - Duluth International Airport	Duluth	No current on-site training with foam.	Active site investigation for PFCs at former fire training site under direction of MPCA. 3M foam still used in fire response.	8(b)	6	3	3	0	3	0	23

Notes:

(a) Foam type or training use not specified, 3M foam use for training assumed.

(b) 3M foam not currently used in training, but currently used in fire response. Site ranked based on use of foam in fire response.

(c) Ranking assumes maximum use of 3M foam in training exercises.

WPA: Wellhead Protection Area

SWAA: Source Water Assessment Area

DELTA

TABLE 3
Sample Collection Summary
Minnesota Firefighting Foam Training and Discharge Sites
Delta Project No. 19382DEL08

		Sampled Media							
Site	**# Borings Advanced**	**Boring Soil Samples**	**Surface Soil Samples**	**Groundwater from Borings**	**Groundwater from Existing Well**	**Upgradient Groundwater**	**Sediment**	**Surface Water**	**Notes**
MSP Airport Minneapolis, MN	7			X	X	X	X	X	Soil samples not collected from borings.
Marathon Refinery St. Paul Park	0				X	X			Sampled existing wells only, no borings advanced.
Flint Hills Resources Pine Bend Refinery Rosemount	0				X	X			Sampled existing wells only, no borings advanced.
Kenyon Fire Department Training Site Slee Street Kenyon	2	X							Groundwater not encountered in borings.
Claremont Fire Department Training Site Claremont Fire Station, Behind	2	X							Groundwater not encountered in borings.
Claremont Fire Department Training Site Claremont Fire Station, Front	1	X							Groundwater not encountered in borings.
Harmony Fire Department Training Sites Harmony Municipal Tree/Brush Dump	2	X		X					
Harmony Fire Department Training Sites Harmony Fire Station	2	X							Groundwater not encountered in borings.
Bemidji Fire Department Training Site Bemidji Regional Airport	2	X		X					
Fridley Fire Department Training Site North Metro Fire Training Center Fridley	2	X		X			X		Sediment sample collected from an on-site wetland.
Burnsville Fire Department Training Site ABLE Fire Training Center Burnsville	3	X		X					Groundwater collected from boring B-3 only.
Goodview Fire Department Training Site Storm Sewer Discharge Point Goodview	0						X	X	Samples collected at storm sewer discharge point only.
No. St. Paul Fire Department Training Site No. St. Paul Public Works Facility	2	X	X	X					
Richfield Fire Department Training Site Richfield Ice Arena	4	X		X		X		X	
Rochester Fire Department Training Site Olmsted County Fairgrounds Rochester	2	X							Groundwater not encountered in borings.
Luverne Fire Department Training Site Municipal Tree/Brush Dump Luverne	3	X		X					
Lake Superior College ERTC Duluth	0		X				X	X	Samples collected at underground pipe discharge point and from on-site wetland.
River Grove Marina Inver Grove Heights	0						X	X	
Kandiyohi County Landfill New London	0				X	X			Sampled existing wells only, no borings advanced.
Crystal Airport Crystal	2	X	X	X			X		
Kings Cove Marina Hastings	0		X				X	X	
Up North Plastics Cottage Grove	0		X				X	X	Samples collected along storm water ditch and associated pond.
WAFTA St. Bonifacius	0				X				Sampled existing wells only.
Duluth International Airport Former Fire Training Areas	6			X					Soil samples not collected from borings.

TABLE 4

Soil and Sediment Analytical Results, PFCs
Minnesota Fire Foam Training and Discharge Sites
Delta Project No. 19382DEL08

				Perfluorinated carboxylic acids									Perfluorinated sulfonates			
				Perfluorobutanoic acid (PFBA)	**Perfluoro-n-pentanoic acid (PFPeA)**	**Perfluorohexanoic acid (PFHxA)**	**Perfluoroheptanoic acid (PFHpA)**	**Perfluorooctanoic acid (PFOA)**	**Perfluorononanoic acid (PFNA)**	**Perfluorodecanoic acid (PFDA)**	**Perfluoroundecanoic acid (PFUnA)**	**Perfluorododecanoic acid (PFDoA)**	**Perfluorobutanoic sulfonate (PFBS)**	**Perfluorohexane sulfonate (PFHxS)**	**Perflourooctane sulfonate (PFOS)**	**Perfluorooctane sulfonylamide (PFOSA)**
#Perfluorinated Carbon Chains:				**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**4**	**6**	**8**	**8**
Harmony Fire Dept. Training Area, Tree/Brush Dump																
Training Frequency:	Annual or less since ~2006															
Last Training Event(1):	2008															
Foam Usage per Training Event:	5 gallons or less															
Foam Brand:	variety, including Ansulite															
Sample ID	**Sample Depth**	**Sample Date**	**Laboratory**													
Harmony B-1 SL 0-4'	0-4 ft.	4/23/2009	Axys	< 0.0955	< 0.0955	< 0.0955	< 0.0955	< 0.0955	< 0.0955	< 0.0955	< 0.0955	< 0.0955	< 0.191	< 0.191	< 0.191	< 0.0955
Harmony B-1 SL 4-8'	4-8 ft.	4/23/2009	Axys	< 0.101	< 0.101	< 0.101	< 0.101	< 0.101	< 0.101	< 0.101	< 0.101	< 0.101	< 0.201	< 0.201	< 0.201	< 0.101
Harmony B-2 SL 0-4'	0-4 ft.	4/23/2009	Axys	< 0.0947	< 0.0947	< 0.0947	< 0.0947	< 0.0947	< 0.0947	< 0.0947	< 0.0947	< 0.0947	< 0.189	< 0.189	< 0.189	< 0.0947
Harmony B-2 SL 4-8'	4-8 ft.	4/23/2009	Axys	< 0.0962	< 0.0962	< 0.0962	< 0.0962	< 0.0962	< 0.0962	< 0.0962	< 0.0962	< 0.0962	< 0.192	< 0.192	< 0.192	< 0.0962
Harmony Fire Dept. Training Area, Harmony Fire Station																
Training Frequency:	Annual or less, 1994 thru 1999															
Last Training Event(1):	1999															
Foam Usage per Training Event:	5 gallons or less															
Foam Brand:	variety, including Ansulite															
Sample ID	**Sample Depth**	**Sample Date**	**Laboratory**													
Harmony B-3 SL 0-4'	0-4 ft.	4/23/2009	Axys	< 0.0977	**0.2**	< 0.0977	**0.161**	< 0.0977	**0.125**	< 0.0977	< 0.0977	< 0.0977	< 0.195	< 0.195	< 0.195	< 0.0977
Harmony B-3 SL 4-8'	4-8 ft.	4/23/2009	Axys	< 0.0950	< 0.0950	< 0.0950	< 0.0950	< 0.0950	< 0.0950	< 0.0950	< 0.0950	< 0.0950	< 0.190	< 0.190	< 0.190	< 0.0950
Harmony B-4 SL 0-4'	0-4 ft.	4/23/2009	Axys	< 0.0989	**0.253**	**0.133**	**0.15**	< 0.0989	< 0.0989	< 0.0989	< 0.0989	< 0.0989	< 0.198	< 0.198	< 0.198	< 0.0989
Harmony B-4 SL 4-8'	4-8 ft.	4/23/2009	Axys	< 0.100	< 0.100	< 0.100	< 0.100	< 0.100	< 0.100	< 0.100	< 0.100	< 0.100	< 0.200	< 0.200	< 0.200	< 0.100

TABLE 4
Soil and Sediment Analytical Results, PFCs
Minnesota Fire Foam Training and Discharge Sites
Delta Project No. 19382DEL08

				Perfluorinated carboxylic acids									Perfluorinated sulfonates			
				Perfluorobutanoic acid (PFBA)	**Perfluoro-n-pentanoic acid (PFPeA)**	**Perfluorohexanoic acid (PFHxA)**	**Perfluoroheptanoic acid (PFHpA)**	**Perfluorooctanoic acid (PFOA)**	**Perfluorononanoic acid (PFNA)**	**Perfluorodecanoic acid (PFDA)**	**Perfluoroundecanoic acid (PFUnA)**	**Perfluorododecanoic acid (PFDoA)**	**Perfluorobutanoic sulfonate (PFBS)**	**Perfluorohexane sulfonate (PFHxS)**	**Perflourooctane sulfonate (PFOS)**	**Perfluorooctane sulfonylamide (PFOSA)**
#Perfluorinated Carbon Chains:				**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**4**	**6**	**8**	**8**
Burnsville Fire Dept. Training Area, ABLE Fire Training Center																
Training Frequency:	3 times since 1989															
Last Training Event(1):	2004															
Foam Usage per Training Event:	5-10 gallons															
Foam Brand:	Ansul															
Sample ID	**Sample Depth**	**Sample Date**	**Laboratory**													
Burnsville B-1 SL 0-4'	0-4 ft.	4/24/2009	Axys	**1.73**	**5.32**	**3.27**	**6.72**	**11.4**	**10.2**	**4.37**	**0.537**	**0.542**	< 0.192	**2.63**	**102**	< 0.0962
Burnsville B-1 SL 4-8'	4-8 ft.	4/24/2009	Axys	**0.132**	**1.54**	**1.77**	**8.46**	**14.8**	< 0.0956	< 0.0956	< 0.0956	< 0.0956	< 0.191	**11**	**1.62**	< 0.0956
Burnsville B-2 SL 0-4'	0-4 ft.	4/24/2009	Axys	**0.796**	**3.08**	**1.69**	**1.05**	**5.78**	**7.92**	< 0.0992	< 0.0992	< 0.0992	< 0.198	< 0.198	**2.8**	< 0.0992
Burnsville B-2 SL 4-8'	4-8 ft.	4/24/2009	Axys	**1.83**	**4.81**	**3.97**	**4.14**	**0.355**	< 0.0985	< 0.0985	< 0.0985	< 0.0985	< 0.197	**1.2**	< 0.197	< 0.0985
North St. Paul Fire Dept. Training Area, Public Works Facility																
Training Frequency:	semi-annual, 5-10 times total															
Last Training Event(1):	2008															
Foam Usage per Training Event:	5-10 gallons															
Foam Brand:	3M															
Sample ID	**Sample Depth**	**Sample Date**	**Laboratory**													
No St Paul B-1 SL 0-4'	0-4 ft.	5/6/2009	Axys	< 0.0926	< 0.0926	< 0.0926	< 0.0926	< 0.0926	< 0.0926	< 0.0926	< 0.0926	< 0.0926	< 0.185	< 0.185	< 0.185	< 0.0926
No St Paul B-1 SL 4-8'	4-8 ft.	5/6/2009	Axys	< 0.0998	< 0.0998	< 0.0998	< 0.0998	< 0.0998	< 0.0998	< 0.0998	< 0.0998	< 0.0998	< 0.200	< 0.200	< 0.200	< 0.0998
No St Paul B-2 SL 0-4'	0-4 ft.	5/6/2009	Axys	< 0.0954	< 0.0954	< 0.0954	< 0.0954	< 0.0954	< 0.0954	< 0.0954	< 0.0954	< 0.0954	< 0.191	< 0.191	< 0.191	< 0.0954
No St Paul B-2 SL 4-8'	4-8 ft.	5/6/2009	Axys	< 0.0978	< 0.0978	< 0.0978	< 0.0978	< 0.0978	< 0.0978	< 0.0978	< 0.0978	< 0.0978	< 0.196	< 0.196	< 0.196	< 0.0978
No St Paul B-3 SL 0-2'	0-2 ft.	5/6/2009	Axys	< 0.0972	< 0.0972	< 0.0972	< 0.0972	**0.107**	< 0.0972	< 0.0972	< 0.0972	< 0.0972	< 0.194	< 0.194	**0.623**	< 0.0972

TABLE 4
Soil and Sediment Analytical Results, PFCs
Minnesota Fire Foam Training and Discharge Sites
Delta Project No. 19382DEL08

				Perfluorinated carboxylic acids									Perfluorinated sulfonates			
				Perfluorobutanoic acid (PFBA)	Perfluoro-n-pentanoic acid (PFPeA)	Perfluorohexanoic acid (PFHxA)	Perfluoroheptanoic acid (PFHpA)	Perfluorooctanoic acid (PFOA)	Perfluorononanoic acid (PFNA)	Perfluorodecanoic acid (PFDA)	Perfluoroundecanoic acid (PFUnA)	Perfluorododecanoic acid (PFDoA)	Perfluorobutanoic sulfonate (PFBS)	Perfluorohexane sulfonate (PFHxS)	Perflourooctane sulfonate (PFOS)	Perfluorooctane sulfonylamide (PFOSA)
#Perfluorinated Carbon Chains:				**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**4**	**6**	**8**	**8**
Richfield Fire Dept. Training Area, Richfield Ice Arena																
Training Frequency:	occasional															
Last Training Event$^{(1)}$:	1999															
Foam Usage per Training Event:	30-40 gallons															
Foam Brand:	3M															
Sample ID	**Sample Depth**	**Sample Date**	**Laboratory**													
Richfield B-1 0-4'	0-4 ft.	5/7/2009	Axys	< 0.0932	**0.226**	**0.191**	**0.433**	**1.36**	**1.44**	**0.095**	< 0.0932	< 0.0932	< 0.186	**1.26**	**104**	**0.21**
Richfield B-1 4-8'	4-8 ft.	5/7/2009	Axys	**0.322**	**1.43**	**0.905**	**0.592**	**1.11**	**1.89**	< 0.0966	< 0.0966	< 0.0966	< 0.193	**1.44**	**102**	< 0.0966
Richfield B-2 0-4'	0-4 ft.	5/7/2009	Axys	**0.464**	**1.33**	**1.07**	**0.85**	**2.32**	**5.03**	**0.306**	< 0.186	< 0.186	< 0.373	**13**	**401**	**0.47**
Richfield B-2 4-8'	4-8 ft.	5/7/2009	Axys	**1.04**	**4.52**	**4.7**	**3.28**	**5.02**	**4.83**	< 0.379	< 0.379	< 0.379	< 0.757	**32.2**	**666**	< 0.379
Richfield B-3 0-4'	0-4 ft.	5/7/2009	Axys	< 0.0942	< 0.0942	**0.314**	**0.309**	**1.49**	< 0.0942	< 0.0942	< 0.0942	< 0.0942	< 0.188	**21.9**	**56.4**	< 0.0942
Richfield B-3 4-8'	4-8 ft.	5/7/2009	Axys	**0.173**	**0.439**	**1.02**	**0.283**	**0.336**	< 0.104	< 0.104	< 0.104	< 0.104	**0.57**	**2.35**	**9.33**	< 0.104
Richfield B-4 0-8'	0-8 ft.	10/8/2009	Axys	< 0.0956	< 0.0956	< 0.0956	< 0.0956	**0.129**	< 0.0956	< 0.0956	< 0.0956	< 0.0956	< 0.191	**0.236**	**4.52**	< 0.0956
Kenyon Fire Dept. Training Area, Slee Street																
Training Frequency:	bi-annual															
Last Training Event$^{(1)}$:	2004															
Foam Usage per Training Event:	< 5 gallons															
Foam Brand:	variety, including 3M															
Sample ID	**Sample Depth**	**Sample Date**	**Laboratory**													
Kenyon B-1 SL 0-4'	0-4 ft.	5/15/2009	Axys	< 0.0963	< 0.0963	< 0.0963	**0.111**	< 0.0963	< 0.0963	< 0.0963	< 0.0963	< 0.0963	< 0.193	< 0.193	< 0.193	< 0.0963
Kenyon B-1 SL 0-4'	0-4 ft.	5/15/2009	MPI	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Kenyon B-1 SL 4-8'	4-8 ft.	5/15/2009	Axys	< 0.0944	< 0.0944	< 0.0944	< 0.0944	< 0.0944	< 0.0944	< 0.0944	< 0.0944	< 0.0944	< 0.189	< 0.189	< 0.189	< 0.0944
Kenyon B-1 SL 4-8'	4-8 ft.	5/15/2009	MPI	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Kenyon B-2 SL 0-4'	0-4 ft.	5/15/2009	Axys	< 0.0937	< 0.0937	< 0.0937	< 0.0937	< 0.0937	< 0.0937	< 0.0937	< 0.0937	< 0.0937	< 0.187	< 0.187	< 0.187	< 0.0937
Kenyon B-2 SL 0-4'	0-4 ft.	5/15/2009	MPI	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Kenyon B-2 SL 4-8'	4-8 ft.	5/15/2009	Axys	< 0.0943	< 0.0943	< 0.0943	< 0.0943	< 0.0943	< 0.0943	< 0.0943	< 0.0943	< 0.0943	< 0.189	< 0.189	< 0.189	< 0.0943
Kenyon B-2 SL 4-8'	4-8 ft.	5/15/2009	MPI	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2

TABLE 4

Soil and Sediment Analytical Results, PFCs
Minnesota Fire Foam Training and Discharge Sites
Delta Project No. 19382DEL08

				Perfluorinated carboxylic acids									**Perfluorinated sulfonates**			
				Perfluorobutanoic acid (PFBA)	**Perfluoro-n-pentanoic acid (PFPeA)**	**Perfluorohexanoic acid (PFHxA)**	**Perfluoroheptanoic acid (PFHpA)**	**Perfluorooctanoic acid (PFOA)**	**Perfluorononanoic acid (PFNA)**	**Perfluorodecanoic acid (PFDA)**	**Perfluoroundecanoic acid (PFUnA)**	**Perfluorododecanoic acid (PFDoA)**	**Perfluorobutanoic sulfonate (PFBS)**	**Perfluorohexane sulfonate (PFHxS)**	**Perflourooctane sulfonate (PFOS)**	**Perfluorooctane sulfonylamide (PFOSA)**
#Perfluorinated Carbon Chains:				**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**4**	**6**	**8**	**8**
Claremont Fire Dept. Training Area, Back of Fire Station																
Training Frequency:	1 time															
Last Training Event(1):	Fall 2008															
Foam Usage per Training Event:	5 gallons or less															
Foam Brand:	3M															
Sample ID	**Sample Depth**	**Sample Date**	**Laboratory**													
Claremont B-1 SL 0-4'	0-4 ft.	5/15/2009	Axys	< 0.0907	< 0.0907	< 0.0907	< 0.0907	< 0.0907	< 0.0907	< 0.0907	< 0.0907	< 0.0907	< 0.181	< 0.181	**0.308**	< 0.0907
Claremont B-1 SL 0-4'	0-4 ft.	5/15/2009	MPI	**0.413**	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	**0.773**	<0.2	<0.2
Claremont B-1 SL 4-8'	4-8 ft.	5/15/2009	Axys	< 0.0966	< 0.0966	< 0.0966	< 0.0966	< 0.0966	< 0.0966	< 0.0966	< 0.0966	< 0.0966	< 0.193	**0.224**	**0.321**	< 0.0966
Claremont B-1 SL 4-8'	4-8 ft.	5/15/2009	MPI	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Claremont B-2 SL 0-4'	0-4 ft.	5/15/2009	Axys	< 0.0936	< 0.0936	**0.385**	< 0.0936	**0.154**	< 0.0936	< 0.0936	< 0.0936	< 0.0936	**0.491**	**1.65**	**24.7**	**0.129**
Claremont B-2 SL 4-8'	4-8 ft.	5/15/2009	Axys	< 0.0958	< 0.0958	< 0.0958	< 0.0958	< 0.0958	< 0.0958	< 0.0958	< 0.0958	< 0.0958	< 0.192	< 0.192	**0.25**	< 0.0958
Claremont Fire Dept. Training Area, Front of Fire Station																
Training Frequency:	annually or less															
Last Training Event(1):	approximately 2007															
Foam Usage per Training Event:	5 gallons or less															
Foam Brand:	3M															
Sample ID	**Sample Depth**	**Sample Date**	**Laboratory**													
Claremont B-3 SL 0-4'	0-4 ft.	5/15/2009	Axys	**0.114**	**0.167**	**0.427**	**0.232**	**0.174**	< 0.0912	< 0.0912	< 0.0912	< 0.0912	**2.39**	**5.25**	**3.46**	< 0.0912
Claremont B-3 SL 4-8'	4-8 ft.	5/15/2009	Axys	< 0.0935	< 0.0935	< 0.0935	< 0.0935	< 0.0935	< 0.0935	< 0.0935	< 0.0935	< 0.0935	< 0.187	**0.561**	**0.988**	< 0.0935

TABLE 4

Soil and Sediment Analytical Results, PFCs
Minnesota Fire Foam Training and Discharge Sites
Delta Project No. 19382DEL08

				Perfluorinated carboxylic acids									**Perfluorinated sulfonates**			
				Perfluorobutanoic acid (PFBA)	**Perfluoro-n-pentanoic acid (PFPeA)**	**Perfluorohexanoic acid (PFHxA)**	**Perfluoroheptanoic acid (PFHpA)**	**Perfluorooctanoic acid (PFOA)**	**Perfluorononanoic acid (PFNA)**	**Perfluorodecanoic acid (PFDA)**	**Perfluoroundecanoic acid (PFUnA)**	**Perfluorododecanoic acid (PFDoA)**	**Perfluorobutanoic sulfonate (PFBS)**	**Perfluorohexane sulfonate (PFHxS)**	**Perflourooctane sulfonate (PFOS)**	**Perfluorooctane sulfonylamide (PFOSA)**
#Perfluorinated Carbon Chains:				**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**4**	**6**	**8**	**8**
Luverne Fire Dept. Training Site, Tree/Brush Dump																
Training Frequency:	1 time															
Last Training Event(1):	2005															
Foam Usage per Training Event:	5 gallons															
Foam Brand:	unknown															
Sample ID	**Sample Depth**	**Sample Date**	**Laboratory**													
Luverne B-1 SL 0-4'	0-4 ft.	5/22/2009	Axys	< 0.0962	< 0.0962	< 0.0962	< 0.0962	< 0.0962	< 0.0962	< 0.0962	< 0.0962	< 0.0962	< 0.192	< 0.192	< 0.481	< 0.241
Luverne B-1 SL 0-4'	0-4 ft.	5/22/2009	MPI	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Luverne B-1 SL 4-8'	4-8 ft.	5/22/2009	Axys	< 0.0981	< 0.0981	< 0.0981	< 0.0981	< 0.0981	< 0.0981	< 0.0981	< 0.0981	< 0.0981	< 0.196	< 0.196	< 0.490	< 0.245
Luverne B-1 SL 4-8'	4-8 ft.	5/22/2009	MPI	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Luverne B-2 SL 0-4'	0-4 ft.	5/22/2009	Axys	< 0.0954	< 0.0954	< 0.0954	< 0.0954	< 0.0954	< 0.0954	< 0.0954	< 0.0954	< 0.0954	< 0.191	< 0.191	**0.481**	< 0.239
Luverne B-2 SL 0-4'	0-4 ft.	5/22/2009	MPI	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Luverne B-2 SL 4-8'	4-8 ft.	5/22/2009	Axys	< 0.100	< 0.100	< 0.100	< 0.100	< 0.100	< 0.100	< 0.100	< 0.100	< 0.100	< 0.200	< 0.200	< 0.500	< 0.250
Luverne B-2 SL 4-8'	4-8 ft.	5/22/2009	MPI	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Luverne B-3 SL 0-4'	0-4 ft.	5/22/2009	Axys	< 0.0974	< 0.0974	< 0.0974	< 0.0974	< 0.0974	< 0.0974	< 0.0974	< 0.0974	< 0.0974	< 0.195	< 0.195	< 0.487	< 0.244
Luverne B-3 SL 0-4'	0-4 ft.	5/22/2009	MPI	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Luverne B-3 SL 4-8'	4-8 ft.	5/22/2009	Axys	< 0.0984	< 0.0984	< 0.0984	< 0.0984	< 0.0984	< 0.0984	< 0.0984	< 0.0984	< 0.0984	< 0.197	< 0.197	< 0.492	< 0.246
Luverne B-3 SL 4-8'	4-8 ft.	5/22/2009	MPI	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Fridley Fire Dept. Training Site, North Metro Fire Training Center																
Training Frequency:	occasional															
Last Training Event(1):	1994/1995															
Foam Usage per Training Event:	< 5 gallons															
Foam Brand:	3M															
Sample ID	**Sample Depth**	**Sample Date**	**Laboratory**													
Fridley B-1 SL 0-4'	0-4 ft.	5/27/2009	Axys	**0.242**	**0.422**	**0.413**	**0.27**	**0.291**	**0.144**	< 0.100	< 0.100	< 0.100	< 0.201	**1.25**	**43**	< 0.100
Fridley B-1 SL 4-8'	4-8 ft.	5/27/2009	Axys	< 0.101	< 0.101	< 0.101	< 0.101	< 0.101	< 0.101	< 0.101	< 0.101	< 0.101	< 0.201	< 0.201	**2.45**	< 0.101
Fridley B-2 SL 0-4'	0-4 ft.	5/27/2009	Axys	**1.34**	**1.67**	**2.78**	**0.735**	**0.699**	< 0.102	< 0.102	< 0.102	< 0.102	**3.01**	**23.4**	**3.48**	< 0.102
Fridley B-2 SL 4-8'	4-8 ft.	5/27/2009	Axys	**0.601**	**1.13**	**1.53**	**0.335**	**0.493**	< 0.0950	< 0.0950	< 0.0950	< 0.0950	**1.32**	**14.2**	**1.31**	< 0.0950
Fridley B-3 Sediment 6"	0.5 ft.	5/27/2009	Axys	< 0.0966	< 0.0966	< 0.0966	< 0.0966	< 0.0966	< 0.0966	< 0.0966	< 0.0966	< 0.0966	< 0.193	< 0.193	**18.3**	< 0.0966

TABLE 4

Soil and Sediment Analytical Results, PFCs
Minnesota Fire Foam Training and Discharge Sites
Delta Project No. 19382DEL08

				Perfluorinated carboxylic acids									**Perfluorinated sulfonates**			
				Perfluorobutanoic acid (PFBA)	**Perfluoro-n-pentanoic acid (PFPeA)**	**Perfluorohexanoic acid (PFHxA)**	**Perfluoroheptanoic acid (PFHpA)**	**Perfluorooctanoic acid (PFOA)**	**Perfluorononanoic acid (PFNA)**	**Perfluorodecanoic acid (PFDA)**	**Perfluoroundecanoic acid (PFUnA)**	**Perfluorododecanoic acid (PFDoA)**	**Perfluorobutanoic sulfonate (PFBS)**	**Perfluorohexane sulfonate (PFHxS)**	**Perflourooctane sulfonate (PFOS)**	**Perfluorooctane sulfonylamide (PFOSA)**
#Perfluorinated Carbon Chains:				**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**4**	**6**	**8**	**8**
Rochester Fire Dept. Training Area, Olmsted County Fairgrounds																
Training Frequency:	annual															
Last Training Event(1):	2001/2002															
Foam Usage per Training Event:	5 gallons or less															
Foam Brand:	3M															
Sample ID	**Sample Depth**	**Sample Date**	**Laboratory**													
Rochester B-1 SL 0-4'	0-4 ft.	5/28/2009	Axys	**0.207**	< 0.0979	< 0.0979	< 0.0979	< 0.0979	< 0.0979	< 0.0979	< 0.0979	< 0.0979	< 0.196	**0.361**	**0.559**	< 0.0979
Rochester B-1 SL 4-8'	4-8 ft.	5/29/2009	Axys	< 0.0957	< 0.0957	< 0.0957	< 0.0957	< 0.0957	< 0.0957	< 0.0957	< 0.0957	< 0.0957	< 0.191	< 0.191	< 0.191	< 0.0957
Rochester B-2 SL 0-4'	0-4 ft.	5/28/2009	Axys	**0.142**	< 0.0999	**0.173**	< 0.0999	< 0.0999	< 0.0999	< 0.0999	< 0.0999	< 0.0999	< 0.200	**1.7**	**1.12**	< 0.0999
Rochester B-2 SL 4-8'	4-8 ft.	5/29/2009	Axys	< 0.0949	< 0.0949	< 0.0949	< 0.0949	< 0.0949	< 0.0949	< 0.0949	< 0.0949	< 0.0949	< 0.190	< 0.190	< 0.190	< 0.0949
Goodview Fire Station, Storm Drain Outflow																
Training Frequency:	6 times in 20 years															
Last Training Event(1):	2004/2005															
Foam Usage per Training Event:	5 gallons															
Foam Brand:	Ansul															
Sample ID	**Sample Depth**	**Sample Date**	**Laboratory**													
Goodview Sed-1	0-6 in.	10/19/2009	Axys	< 0.0883	< 0.0883	< 0.0883	< 0.0883	< 0.0883	< 0.0883	< 0.0883	< 0.0883	< 0.0883	< 0.177	< 0.177	**0.332**	< 0.0883
Bemidji Fire Dept. Training Area, Bemidji Airport																
Training Frequency:	annual															
Last Training Event(1):	2008/2009															
Foam Usage per Training Event:	5 gallons															
Foam Brand:	3M															
Sample ID	**Sample Depth**	**Sample Date**	**Laboratory**													
Bemidji B-1 SL 0-4'	0-4 ft.	11/5/2009	Axys	< 0.0951	< 0.0951	**0.216**	< 0.0951	**0.118**	< 0.0951	< 0.0951	< 0.0951	< 0.0951	< 0.190	**3.12**	**55.7**	**0.112**
Bemidji B-1 SL 4-8'	4-8 ft.	11/5/2009	Axys	< 0.0913	< 0.0913	< 0.0913	< 0.0913	**0.498**	< 0.0913	< 0.0913	< 0.0913	< 0.0913	**0.267**	**3.98**	**56**	< 0.0913
Bemidji B-2 SL 0-4'	0-4 ft.	11/5/2009	Axys	**0.184**	**0.322**	**1.44**	**0.143**	**1.31**	**0.099**	< 0.0933	< 0.0933	< 0.0933	< 1.87	**13.9**(2)	**1200**(2)	**18.5**
Bemidji B-2 SL 4-8'	4-8 ft.	11/5/2009	Axys	< 0.276	< 0.276	**0.411**(2)	**0.917**(2)	**19.6**(2)	< 0.276	< 0.276	< 0.276	< 0.276	**0.957**(2)	**147**(2)	**606**(2)	< 0.276

TABLE 4

Soil and Sediment Analytical Results, PFCs
Minnesota Fire Foam Training and Discharge Sites
Delta Project No. 19382DEL08

				Perfluorinated carboxylic acids									Perfluorinated sulfonates			
				Perfluorobutanoic acid (PFBA)	Perfluoro-n-pentanoic acid (PFPeA)	Perfluorohexanoic acid (PFHxA)	Perfluoroheptanoic acid (PFHpA)	Perfluorooctanoic acid (PFOA)	Perfluorononanoic acid (PFNA)	Perfluorodecanoic acid (PFDA)	Perfluoroundecanoic acid (PFUnA)	Perfluorododecanoic acid (PFDoA)	Perfluorobutanoic sulfonate (PFBS)	Perfluorohexane sulfonate (PFHxS)	Perflourooctane sulfonate (PFOS)	Perfluorooctane sulfonylamide (PFOSA)
#Perfluorinated Carbon Chains:				**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**4**	**6**	**8**	**8**
River Grove Marina Fire, Inver Grove Heights																
Date of Foam Discharge:	9/26/2009															
Foam Usage	15 gallons															
Foam Brand:	Ansul															
Sample ID	**Sample Depth**	**Sample Date**	**Laboratory**													
River Grove Sed-1	0-6 in.	11/18/2009	MPI	<0.333	<0.333	<0.333	<0.333	<0.333	<0.333	<0.333	<0.333	<0.333	<0.667	<0.667	<0.667	<0.333
River Grove Sed-2	0-6 in.	11/18/2009	MPI	<0.333	<0.333	<0.333	<0.333	<0.333	<0.333	<0.333	<0.333	<0.333	<0.667	<0.667	<0.667	<0.333
River Grove Sed-3	0-6 in.	11/18/2009	MPI	<0.333	<0.333	<0.333	<0.333	<0.333	<0.333	<0.333	<0.333	<0.333	<0.667	<0.667	<0.667	<0.333
Lake Superior College ERTC																
Training Frequency:	unknown, 1994-1996															
Last Training Event(1):	1996															
Foam Usage per Training Event:	unknown															
Foam Brand:	3M or other															
Sample ID	**Sample Depth**	**Sample Date**	**Laboratory**													
ERTC SS-1	0-6 in.	11/25/2009	Axys	< 0.0998	**0.205**	**0.794**	**0.139**	**0.495**	< 0.0998	< 0.0998	< 0.0998	< 0.0998	< 0.200	**3.49**	**83.5**	**4.54**
ERTC Sed-1	0-6 in.	11/25/2009	Axys	< 0.0917	< 0.0917	< 0.0917	< 0.0917	**0.225**	< 0.0917	< 0.0917	< 0.0917	< 0.0917	< 0.183	**1.2**	**57.5**	**6.52**
ERTC Sed-2	0-6 in.	11/25/2009	Axys	**0.218**	**0.536**	**1.72**	**0.268**	**1.26**	**0.184**	**0.101**	**0.174**	< 0.0933	**1.47**	**19.6**	**538**	**181**
MSP Airport																
Training Frequency:	unknown															
Last Training Event(1):	2001															
Foam Usage per Training Event:	5-10 gallons															
Foam Brand:	3M															
Sample ID	**Sample Depth**	**Sample Date**	**Laboratory**													
MSP Sed-1	0-6 in.	1/19/2010	Axys	< 0.484	< 0.484	< 0.484	< 0.484	**1.8**	**1.89**	**17.3**	**2.5**	**15.6**	< 0.968	< 0.968	**8.84**	**3.55**

TABLE 4

Soil and Sediment Analytical Results, PFCs
Minnesota Fire Foam Training and Discharge Sites
Delta Project No. 19382DEL08

				Perfluorinated carboxylic acids									Perfluorinated sulfonates			
				Perfluorobutanoic acid (PFBA)	Perfluoro-n-pentanoic acid (PFPeA)	Perfluorohexanoic acid (PFHxA)	Perfluoroheptanoic acid (PFHpA)	Perfluorooctanoic acid (PFOA)	Perfluorononanoic acid (PFNA)	Perfluorodecanoic acid (PFDA)	Perfluoroundecanoic acid (PFUnA)	Perfluorododecanoic acid (PFDoA)	Perfluorobutanoic sulfonate (PFBS)	Perfluorohexane sulfonate (PFHxS)	Perflourooctane sulfonate (PFOS)	Perfluorooctane sulfonylamide (PFOSA)
#Perfluorinated Carbon Chains:				**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**4**	**6**	**8**	**8**
Crystal Airport																
Date of Foam Discharge:	June 2009															
Foam Usage per Training Event:	unknown															
Foam Brand:	Fire Aide 2000															
Sample ID	**Sample Depth**	**Sample Date**	**Laboratory**													
Crystal B-1 SL 0-4'	0-4 ft.	1/20/2010	Axys	< 0.486	< 0.486	< 0.486	< 0.486	< 0.486	< 0.486	< 0.486	< 0.486	< 0.486	< 0.972	< 0.972	< 0.972	< 0.486
Crystal B-1 SL 4-8'	4-8 ft.	1/20/2010	Axys	< 0.493	< 0.493	< 0.493	< 0.493	< 0.493	< 0.493	< 0.493	< 0.493	< 0.493	< 0.985	< 0.985	< 0.985	< 0.493
Crystal B-2 SL 0-4'	0-4 ft.	1/20/2010	Axys	< 0.488	< 0.488	< 0.488	< 0.488	< 0.488	< 0.488	< 0.488	< 0.488	< 0.488	< 0.977	< 0.977	< 0.977	< 0.488
Crystal B-2 SL 4-8'	4-8 ft.	1/20/2010	Axys	< 0.490	< 0.490	< 0.490	< 0.490	< 0.490	< 0.490	< 0.490	< 0.490	< 0.490	< 0.979	< 0.979	< 0.979	< 0.490
Crystal SS-1	2 ft.	1/20/2010	Axys	< 0.498	**0.929**	< 0.498	< 0.498	< 0.498	< 0.498	< 0.498	< 0.498	< 0.498	< 0.996	< 0.996	< 0.996	< 0.498
Crystal Sed-1	0-6 in.	1/20/2010	Axys	< 0.513	< 0.513	< 0.513	< 0.513	< 0.513	< 0.513	< 0.513	< 0.513	< 0.513	< 1.03	< 1.03	< 1.03	< 0.513
Crystal Sed-2	0-6 in.	1/20/2010	Axys	**0.467**	**1.16**	< 0.404	**0.491**	**0.654**	**0.412**	**0.863**	**1.17**	**2.47**	< 0.807	**1.03**	**7.1**	**1.45**
Kings Cove Marina, Hastings Fire																
Date of Foam Discharge:	October 2002															
Foam Usage	305 gallons															
Foam Brand:	3M															
Sample ID	**Sample Depth**	**Sample Date**	**Laboratory**													
Kings Cove Marina Soil	Surficial	12/3/2009	MPI	<0.333	<0.333	<0.333	<0.333	<0.333	<0.333	**1.11**	**2.07**	**10.4**	<0.667	<0.667	<0.667	<0.333
Kings Cove Marina Sed 1	Surficial	12/3/2009	MPI	<0.333	<0.333	<0.333	<0.333	**0.841**	<0.333	<0.333	<0.333	<0.333	<0.667	<0.667	**1.34**	<0.333
Kings Cove Marina Sed 2	Surficial	12/3/2009	MPI	<0.333	<0.333	**0.773**	<0.333	**0.736**	<0.333	<0.333	<0.333	<0.333	<0.667	**4.44**	**6.12**	<0.333

TABLE 4

Soil and Sediment Analytical Results, PFCs
Minnesota Fire Foam Training and Discharge Sites
Delta Project No. 19382DEL08

				Perfluorinated carboxylic acids									Perfluorinated sulfonates			
				Perfluorobutanoic acid (PFBA)	**Perfluoro-n-pentanoic acid (PFPeA)**	**Perfluorohexanoic acid (PFHxA)**	**Perfluoroheptanoic acid (PFHpA)**	**Perfluorooctanoic acid (PFOA)**	**Perfluorononanoic acid (PFNA)**	**Perfluorodecanoic acid (PFDA)**	**Perfluoroundecanoic acid (PFUnA)**	**Perfluorododecanoic acid (PFDoA)**	**Perfluorobutanoic sulfonate (PFBS)**	**Perfluorohexane sulfonate (PFHxS)**	**Perflourooctane sulfonate (PFOS)**	**Perfluorooctane sulfonylamide (PFOSA)**
#Perfluorinated Carbon Chains:				**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**4**	**6**	**8**	**8**
Up North Plastics, Cottage Grove Fire																
Date of Foam Discharge:	12/1/2002															
Foam Usage	4,000 gallons or more															
Foam Brand:	unknown															
Sample ID	**Sample Depth**	**Sample Date**	**Laboratory**													
Up North Plastics Soil 1	Surficial	7/16/2009	Axys	**2.45**	**0.419**	**0.682**	**0.189**	**1.18**	**0.342**	**0.642**	**2.46**	**1.27**	**0.296**	**20.6**	**258**	**8.91**
Up North Plastics Soil 2	Surficial	7/16/2009	Axys	**0.985**	< 0.0982	**0.205**	**0.115**	**0.381**	< 0.0982	< 0.0982	**0.341**	**0.343**	< 0.196	**2.07**	**59.1**	**2.99**
Up North Plastics Soil 3	Surficial	7/16/2009	Axys	**0.203**	< 0.101	< 0.101	< 0.101	< 0.101	< 0.101	< 0.101	< 0.101	< 0.101	< 0.202	< 0.202	< 0.202	< 0.101
Up North Plastics Soil 4	Surficial	7/16/2009	Axys	< 0.0964	< 0.0964	**0.233**	< 0.0964	**0.172**	< 0.0964	**0.097**	**1.88**	< 0.0964	< 0.193	**3.91**	**355**	**16.5**
Up North Plastics Soil 5	Surficial	7/16/2009	Axys	**3.82**	**0.628**	**0.477**	**0.266**	**8.29**	< 0.0964	< 0.0964	**0.122**	**0.128**	**0.199**	**0.712**	**7.48**	**0.428**
Up North Plastics Sed 1	Surficial	7/16/2009	Axys	**0.659**	< 0.0965	< 0.0965	< 0.0965	**0.406**	< 0.0965	< 0.0965	< 0.0965	< 0.0965	< 0.193	< 0.193	**1.15**	< 0.0965
Up North Plastics Sed 2	Surficial	7/16/2009	Axys	**3.37**	**0.195**	**0.19**	< 0.110	**0.957**	**0.113**	< 0.110	**0.165**	**0.713**	**0.284**	**1.65**	**104**	**0.782**
Up North Plastics Sed 3	Surficial	7/16/2009	Axys	**14.2**	**1.94**	**1.32**	**0.608**	**14.6**	< 0.104	< 0.104	< 0.104	**0.188**	< 0.207	**0.764**	**16.3**	< 0.104
Up North Plastics Sed 4	Surficial	7/16/2009	Axys	**2.35**	**0.265**	**0.143**	< 0.119	**1.49**	< 0.119	**0.331**	**0.657**	**1.24**	< 0.238	**0.596**	**13.6**	**0.325**
Up North Plastics Sed Dup	Surficial	7/16/2009	Axys	**1.25**	< 0.102	< 0.102	< 0.102	**0.726**	< 0.102	< 0.102	< 0.102	< 0.102	< 0.204	< 0.204	**1.67**	< 0.102

Notes:

PFC results are in nanograms per gram (ng/g), which is equivalent to parts per billion.

PFC compounds soil results reported on a dry weight basis.

Bolded type indicates detection above the laboratory method detection limit.

Non-detect results presented as less than the laboratory detection limit.

Axys: Axys Analytical Services LTD

MPI: MPI Research

(1) Last training event prior to sampling, dates are approximate

(2) Results based on analysis of a dilution of the sample extract.

TABLE 5

Groundwater and Surface Water Analytical Results, PFCs
Minnesota Fire Foam Training and Discharge Sites
Delta Project No. 19382DEL08

			Perfluorobutanoic acid (PFBA)	**Perfluoro-n-pentanoic acid (PFPeA)**	**Perfluorohexanoic acid (PFHxA)**	**Perfluoroheptanoic acid (PFHpA)**	**Perfluorooctanoic acid (PFOA)**	**Perfluorononanoic acid (PFNA)**	**Perfluorodecanoic acid (PFDA)**	**Perfluoroundecanoic acid (PFUnA)**	**Perfluorododecanoic acid (PFDoA)**	**Perfluorobutanoic sulfonate (PFBS)**	**Perfluorohexane sulfonate (PFHxS)**	**Perflourooctane sulfonate (PFOS)**	**Perfluorooctane sulfonylamide (PFOSA)**
#Perfluorinated Carbon Chains:			**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**4**	**6**	**8**	**8**
Health-Based Limits:			**7000(2)**	**ND**	**ND**	**ND**	**300(3)**	**ND**	**ND**	**ND**	**ND**	**7000(2)**	**RAA(4)**	**300(3)**	**ND**
Harmony Fire Dept. Training Area, Tree/Brush Dump															
Training Frequency:	Annual or less since ~2006														
Last Training Event(1):	2008														
Foam Usage per Training Event:	5 gallons or less														
Foam Brand:	variety, including Ansulite														
Sample ID	**Sample Date**	**Laboratory**													
Harmony B-1 GW	4/23/2009	Axys	**7.3**	**3.27**	**2.67**	< 2.49	**7**	< 2.49	< 2.49	< 2.49	< 2.49	< 4.98	< 4.98	**8.33**	< 2.49
Harmony B-2 GW	4/23/2009	Axys	**9.04**	**2.52**	< 2.46	< 2.46	**6.92**	< 2.46	< 2.46	< 2.46	< 2.46	< 4.92	< 4.92	**6.74**	< 2.46
North St. Paul Fire Dept. Training Area, Public Works Facility															
Training Frequency:	semi-annual, 5-10 times total														
Last Training Event(1):	2008														
Foam Usage per Training Event:	5-10 gallons														
Foam Brand:	3M														
Sample ID	**Sample Date**	**Laboratory**													
No St Paul B-1 GW	5/6/2009	Axys	**137**	**13.3**	**13.2**	**8.83**	**13.8**	< 3.49	< 3.49	< 3.49	< 3.49	< 6.99	**14.1**	< 6.99	< 3.49
No St Paul B-2 GW	5/6/2009	Axys	**145**	**15.5**	**14.1**	**8.22**	**13.2**	< 2.50	< 2.50	< 2.50	< 2.50	< 5.01	**14.8**	< 5.01	< 2.50
Richfield Fire Dept. Training Area, Richfield Ice Arena															
Training Frequency:	occasional														
Last Training Event(1):	1999														
Foam Usage per Training Event:	30-40 gallons														
Foam Brand:	3M														
Sample ID	**Sample Date**	**Laboratory**													
Richfield B-1 GW	5/7/2009	Axys	**1070**	**3470**	**3500**	**819**	**50.3**	< 18.8	< 18.8	< 18.8	< 18.8	**737**	**76.2**	< 37.7	< 18.8
Richfield B-2 GW	5/7/2009	Axys	**1240**	**4890**	**4170**	**1920**	**1330**	< 91.4	< 91.4	< 91.4	< 91.4	< 183	< 183	< 183	< 91.4
Richfield B-3 GW	5/7/2009	Axys	**201**	**331**	**888**	**217**	**458**	< 66.7	< 66.7	< 66.7	< 66.7	**293**	**689**	< 133	< 66.7
Legion Lake SW-1	8/27/2009	Axys	**4.02**	<7.21	< 2.51	**3.55**	**5.69**	**3.63**	**3.92**	< 2.51	< 2.51	< 5.02	< 5.02	**13.2**	< 2.51
*Richfield B-4 GW 29 ft.	10/8/2009	Axys	**228**	**10.3**	**10.3**	**5.43**	**38.7**	< 2.48	< 2.48	< 2.48	< 2.48	< 4.96	**71.4**	< 4.96	< 2.48

TABLE 5

Groundwater and Surface Water Analytical Results, PFCs
Minnesota Fire Foam Training and Discharge Sites
Delta Project No. 19382DEL08

			Perfluorobutanoic acid (PFBA)	Perfluoro-n-pentanoic acid (PFPeA)	Perfluorohexanoic acid (PFHxA)	Perfluoroheptanoic acid (PFHpA)	Perfluorooctanoic acid (PFOA)	Perfluorononanoic acid (PFNA)	Perfluorodecanoic acid (PFDA)	Perfluoroundecanoic acid (PFUnA)	Perfluorododecanoic acid (PFDoA)	Perfluorobutanoic sulfonate (PFBS)	Perfluorohexane sulfonate (PFHxS)	Perfluorooctane sulfonate (PFOS)	Perfluorooctane sulfonylamide (PFOSA)
		#Perfluorinated Carbon Chains:	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**4**	**6**	**8**	**8**
		Health-Based Limits:	**7000(2)**	**ND**	**ND**	**ND**	**300(3)**	**ND**	**ND**	**ND**	**ND**	**7000(2)**	**RAA(4)**	**300(3)**	**ND**
Luverne Fire Dept. Training Site, Tree/Brush Dump															
Training Frequency:	1 time														
Last Training Event(1):	2005														
Foam Usage per Training Event:	5 gallons														
Foam Brand:	unknown														
Sample ID	**Sample Date**	**Laboratory**													
Luverne B-1 GW 8 ft.	5/22/2009	Axys	< 2.53	< 2.53	< 2.53	< 2.53	< 2.53	< 2.53	< 2.53	< 2.53	< 2.53	< 5.05	**18.1**	< 5.05	< 2.53
Luverne B-1 GW 8 ft.	5/22/2009	MPI	<25.0	<25.0	<25.0	<25.0	<25.0	<25.0	<25.0	<25.0	<25.0	<25.0	<25.0(5)	<25.0	<25.0
Luverne B-2 GW 12 ft.	5/22/2009	Axys	< 2.55	< 2.55	**3.78**	< 2.55	**2.73**	< 2.55	< 2.55	< 2.55	< 2.55	< 5.10	**22.8**	**18.4**	< 2.55
Luverne B-2 GW 12 ft.	5/22/2009	MPI	<25.0	<25.0	<25.0	<25.0	<25.0	<25.0	<25.0	<25.0	<25.0	<25.0	**25.1**	<25.0(7)	<25.0
Luverne B-3 GW 12 ft.	5/22/2009	Axys	< 2.53	**3.99**	**11.3**	< 2.53	**3.39**	< 2.53	< 2.53	< 2.53	< 2.53	< 5.07	**21.4**	**20.1**	< 2.53
Luverne B-3 GW 12 ft.	5/22/2009	MPI	<25.0	<25.0	<25.0(6)	<25.0	<25.0	<25.0	<25.0	<25.0	<25.0	<25.0	**28.8**	<25.0(8)	<25.0
Fridley Fire Dept. Training Site, North Metro Fire Training Center															
Training Frequency:	occasional														
Last Training Event(1):	1994/1995														
Foam Usage per Training Event:	< 5 gallons														
Foam Brand:	3M														
Sample ID	**Sample Date**	**Laboratory**													
Fridley B-1 GW	5/27/2009	Axys	**37.6**	**34**	**27.1**	**23.2**	**32.7**	< 4.27	< 4.27	< 4.27	< 4.27	**15.2**	**98.9**	**21.9**	< 4.27
Fridley B-2 GW	5/27/2009	Axys	**88.3**	**97.2**	**166**	**59.5**	**86.8**	< 5.39	< 5.39	< 5.39	< 5.39	**182**	**1330**	**35**	< 5.39
MSP Airport															
Training Frequency:	unknown														
Last Training Event(1):	2001														
Foam Usage per Training Event:	5-10 gallons														
Foam Brand:	3M														
Sample ID	**Sample Date**	**Laboratory**													
MSP Airport B-1 GW	5/29/2009	Axys	**279**	**909**	**1640**	**317**	**988**	**42**	< 41.2	< 41.2	< 41.2	**332**	**3090**	< 82.5	< 41.2
MSP Airport B-2 GW	5/29/2009	Axys	**190**	**507**	**817**	**198**	**958**	< 48.8	< 48.8	< 48.8	< 48.8	**286**	**2920**	< 97.6	< 48.8
MSP Airport B-3 GW	5/29/2009	Axys	**151**	**148**	**477**	< 135	**12000**	< 135	< 135	< 135	< 135	< 269	**21200**	**281**	< 135
MSP Airport B-4 GW	5/29/2009	Axys	< 1250	< 1250	**3140**	**5830**	**286000**	< 1250	< 1250	< 1250	< 1250	< 2500	**145000**	< 2500	< 1250
*MSP Airport B-5 GW	1/19/2010	Axys	**103**	**81.3**	**168**	**17.5**	**7.29**	< 2.63	< 2.63	< 2.63	< 2.63	160	110	< 5.26	< 2.63
*MSP Airport B-6 GW	1/19/2010	Axys	**58.6**	**60.4**	**187**	**44.6**	**11.2**	< 2.55	< 2.55	< 2.55	< 2.55	**64.1**	**204**	**11**	< 2.55
*MSP Airport B-7 GW	1/19/2010	Axys	**130**	**233**	**114**	< 2.53	**3.77**	< 2.53	< 2.53	< 2.53	< 2.53	**7.77**	< 5.05	< 5.05	< 2.53
CWN-14A GW	1/19/2010	Axys	**40.9**	**32.3**	**42.2**	**17.8**	**19.1**	< 2.54	< 2.54	< 2.54	< 2.54	< 5.07	**19.3**	**15.6**	< 2.54
CWN-15A GW	1/19/2010	Axys	**72**	**15.3**	**20.2**	**7.27**	**56.9**	< 2.75	< 2.75	< 2.75	< 2.75	**9.45**	**202**	< 5.50	< 2.75
Signature MW-2 GW	1/19/2010	Axys	**83.7**	**96.8**	**162**	**69.7**	**79.5**	< 6.57	< 5.40	< 5.40	< 5.40	**151**	**1780**	**953**	< 5.40
MSP SW-1	1/19/2010	Axys	**46.8**	**46**	**82.1**	**24.6**	**50.1**	**13.4**	**13.9**	< 2.46	< 2.46	**46.5**	**184**	**39**	< 2.46

TABLE 5

Groundwater and Surface Water Analytical Results, PFCs
Minnesota Fire Foam Training and Discharge Sites
Delta Project No. 19382DEL08

			Perfluorobutanoic acid (PFBA)	Perfluoro-n-pentanoic acid (PFPeA)	Perfluorohexanoic acid (PFHxA)	Perfluoroheptanoic acid (PFHpA)	Perfluorooctanoic acid (PFOA)	Perfluorononanoic acid (PFNA)	Perfluorodecanoic acid (PFDA)	Perfluoroundecanoic acid (PFUnA)	Perfluorododecanoic acid (PFDoA)	Perfluorobutanoic sulfonate (PFBS)	Perfluorohexane sulfonate (PFHxS)	Perflourooctane sulfonate (PFOS)	Perfluorooctane sulfonylamide (PFOSA)
		#Perfluorinated Carbon Chains:	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**4**	**6**	**8**	**8**
		Health-Based Limits:	**7000(2)**	**ND**	**ND**	**ND**	**300(3)**	**ND**	**ND**	**ND**	**ND**	**7000(2)**	**RAA(4)**	**300(3)**	**ND**
Marathon Refinery															
Training Frequency:	semi-annual														
Last Training Event(1):	2009														
Foam Usage per Training Event:	50-100 gallons														
Foam Brand:	Ansul, historical use of 3M														
Sample ID	**Sample Date**	**Laboratory**													
Marathon MW-101	8/20/2009	MPI	**183**	**403**	**150**	**12.4**	**36.7**	<2.5	<2.5	<2.5	<2.5	**479**	**3710**	**93.2**	<2.5
*Marathon MW-912	8/20/2009	MPI	**462**	**298**	**51.5**	**21.8**	**17.5**	<2.5	<2.5	<2.5	<2.5	**37.0**	**1580**	**731**	<2.5
Marathon SP-11	8/20/2009	MPI	**182**	**458**	**171**	**52.2**	**35.6**	**20.7**	<2.5	<2.5	<2.5	**369**	**4910**	**5770**	<2.5
Marathon MW-172	8/20/2009	MPI	**59.8**	**245**	**154**	**25.1**	**15.5**	**11.4**	<2.5	<2.5	<2.5	**49.0**	**1220**	**1330**	<2.5
Marathon MW-156	8/20/2009	MPI	**220**	**1730**	**527**	**200**	**73.1**	**26.9**	<2.5	**2.58**	<2.5	**462**	**10500**	**14900**	<2.5
Marathon MW-156 Dupl.	8/20/2009	MPI	**221**	**1660**	**534**	**184**	**81.4**	**23.7**	<2.5	**2.93**	<2.5	**502**	**8930**	**11700**	**2.62**
Burnsville Fire Dept. Training Area, ABLE Fire Training Center															
Training Frequency:	3 times since 1989														
Last Training Event(1):	2004														
Foam Usage per Training Event:	5-10 gallons														
Foam Brand:	Ansul														
Sample ID	**Sample Date**	**Laboratory**													
Burnsville B-3 GW 44.5 ft.	8/27/2009	Axys	**146**	**422**	**281**	**447**	**1260**	**81.7**	**17.8**	< 2.52	< 2.52	**12.8**	**279**	**522**	< 2.52
Goodview Fire Station, Storm Drain Outflow															
Training Frequency:	6 times in 20 years														
Last Training Event(1):	2004/2005														
Foam Usage per Training Event:	5 gallons														
Foam Brand:	Ansul														
Sample ID	**Sample Date**	**Laboratory**													
Goodview SW-1	10/19/2009	Axys	< 2.53	< 2.53	**4.78**	< 2.53	**4.49**	**2.56**	**2.82**	< 2.53	< 2.53	< 5.06	< 5.06	**8.19**	< 2.53
Bemidji Fire Dept. Training Area, Bemidji Airport															
Training Frequency:	annual														
Last Training Event(1):	2008/2009														
Foam Usage per Training Event:	5 gallons														
Foam Brand:	3M														
Sample ID	**Sample Date**	**Laboratory**													
Bemidji B-1 GW 15 ft.	11/5/2009	Axys	**4.14**	**3.85**	**14.5**	**3.75**	**49**	< 2.50	< 2.50	< 2.50	< 2.50	**19.1**	**227**	**483**	< 2.50
Bemidji B-2 GW 15 ft.	11/5/2009	Axys	**21.1**	**55.5**	**340**	**33.8**	**200**	< 12.2	< 12.2	< 12.2	< 12.2	**129**	**1490**	**789**	< 12.2

TABLE 5

Groundwater and Surface Water Analytical Results, PFCs
Minnesota Fire Foam Training and Discharge Sites
Delta Project No. 19382DEL08

			Perfluorobutanoic acid (PFBA)	Perfluoro-n-pentanoic acid (PFPeA)	Perfluorohexanoic acid (PFHxA)	Perfluoroheptanoic acid (PFHpA)	Perfluorooctanoic acid (PFOA)	Perfluorononanoic acid (PFNA)	Perfluorodecanoic acid (PFDA)	Perfluoroundecanoic acid (PFUnA)	Perfluorododecanoic acid (PFDoA)	Perfluorobutanoic sulfonate (PFBS)	Perfluorohexane sulfonate (PFHxS)	Perflouroocatne sulfonate (PFOS)	Perfluorooctane sulfonylamide (PFOSA)
		#Perfluorinated Carbon Chains:	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**4**	**6**	**8**	**8**
		Health-Based Limits:	**7000(2)**	**ND**	**ND**	**ND**	**300(3)**	**ND**	**ND**	**ND**	**ND**	**7000(2)**	**RAA(4)**	**300(3)**	**ND**
River Grove Marina Fire, Inver Grove Heights															
Date of Foam Discharge:	9/26/2009														
Foam Usage	15 gallons														
Foam Brand:	Ansul														
Sample ID	**Sample Date**	**Laboratory**													
River Grove SW-1	11/18/2009	MPI	**3.54**	<2.5	<2.5	<2.5	**2.79**	<2.5	<2.5	<2.5	<2.5	**4.00**	<2.5	<2.5	<2.5
*River Grove SW-2	11/18/2009	MPI	**4.23**	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	**3.43**	<2.5	<2.5	<2.5
Lake Superior College ERTC															
Training Frequency:	unknown, 1994-1996														
Last Training Event(1):	1996														
Foam Usage per Training Event:	unknown														
Foam Brand:	3M or other														
Sample ID	**Sample Date**	**Laboratory**													
ERTC SW-1	11/25/2009	Axys	**257**	**537**	**1790**	**348**	**991**	**31.8**	**3.45**	< 2.51	< 2.51	**1870**	**9390**	**11300**	**360**
Kandiyohi County Landfill Fire															
Date of Foam Discharge:	10/1/2009														
Foam Usage	545 gallons														
Foam Brand:	3M, Ansul														
Sample ID	**Sample Date**	**Laboratory**													
Kandiyohi DMW-1A	1/12/2010	Axys	< 2.43	< 2.43	< 2.43	< 2.43	< 2.43	< 2.43	< 2.43	< 2.43	< 2.43	< 4.87	< 4.87	< 4.87	< 2.43
Kandiyohi DMW-3	1/12/2010	Axys	**6.1**	< 2.51	< 2.51	< 2.51	< 2.51	< 2.51	< 2.51	< 2.51	< 2.51	< 5.01	< 5.01	< 5.01	< 2.51
Kandiyohi DMW-1A	5/4/2010	Axys	< 2.49	< 2.49	< 2.49	< 2.49	< 2.49	< 2.49	< 2.49	< 2.49	< 2.49	< 4.99	< 4.99	< 4.99	< 2.49
Kandiyohi DMW-3	5/4/2010	Axys	**11**	< 2.49	< 2.49	< 2.49	< 2.49	< 2.49	< 2.49	< 2.49	< 2.49	< 4.98	< 4.98	< 4.98	< 2.49
Crystal Airport															
Date of Foam Discharge:	June 2009														
Foam Usage	unknown														
Foam Brand:	Fire Aide 2000														
Sample ID	**Sample Date**	**Laboratory**													
Crystal B-1 GW 5.5 ft.	1/20/2010	Axys	**16.2**	< 2.56	< 2.56	< 2.56	< 2.56	< 2.56	< 2.56	< 2.56	< 2.56	< 5.12	< 5.12	< 5.12	< 2.56
Crystal B-2 GW 6 ft.	1/20/2010	Axys	**37.3**	< 2.50	< 2.50	< 2.50	**2.65**	< 2.50	< 2.50	< 2.50	< 2.50	< 5.01	< 5.01	**5.27**	< 2.50

TABLE 5

Groundwater and Surface Water Analytical Results, PFCs
Minnesota Fire Foam Training and Discharge Sites
Delta Project No. 19382DEL08

			Perfluorobutanoic acid (PFBA)	Perfluoro-n-pentanoic acid (PFPeA)	Perfluorohexanoic acid (PFHxA)	Perfluoroheptanoic acid (PFHpA)	Perfluorooctanoic acid (PFOA)	Perfluorononanoic acid (PFNA)	Perfluorodecanoic acid (PFDA)	Perfluoroundecanoic acid (PFUnA)	Perfluorododecanoic acid (PFDoA)	Perfluorobutanoic sulfonate (PFBS)	Perfluorohexane sulfonate (PFHxS)	Perflourooctane sulfonate (PFOS)	Perfluorooctane sulfonylamide (PFOSA)
#Perfluorinated Carbon Chains:			**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**4**	**6**	**8**	**8**
Health-Based Limits:			**7000(2)**	**ND**	**ND**	**ND**	**300(3)**	**ND**	**ND**	**ND**	**ND**	**7000(2)**	**RAA(4)**	**300(3)**	**ND**
Flint Hills Resources Pine Bend Refinery															
Training Frequency:	20-25 times per year														
Last Training Event(1):	2009														
Foam Usage per Training Event:	20-25														
Foam Brand:	Ansul, historical use of 3M														
Sample ID	**Sample Date**	**Laboratory**													
*FHR Pine Bend MW-1	1/21/2010	Axys	**179**	**12.5**	**10.1**	< 2.45	**4.63**	< 2.45	< 2.45	< 2.45	< 2.45	**8.67**	**25.9**	**28.5**	< 2.45
FHR Pine Bend MW-3	1/21/2010	Axys	**310**	**136**	**251**	**43.7**	**49.1**	< 2.48	< 2.48	< 2.48	< 2.48	**181**	**516**	**245**	< 2.48
FHR Pine Bend MW-111	1/21/2010	Axys	**156**	**7.58**	**3.62**	< 2.42	**3.92**	< 2.42	< 2.42	< 2.42	< 2.42	< 4.84	< 4.84	< 4.84	< 2.42
Kings Cove Marina, Hastings Fire															
Date of Foam Discharge:	October 2002														
Foam Usage	305 gallons														
Foam Brand:	3M														
Sample ID	**Sample Date**	**Laboratory**													
Kings Cove Marina SW-1	12/3/2009	MPI	**180**	**10.2**	**9.87**	**3.41**	**25.8**	< 2.5	< 2.5	< 2.5	< 2.5	**17.5**	**17.8**	**13.7**	< 2.5
Kings Cove Marina Dup (SW-1)	12/3/2009	MPI	**177**	**10.0**	**8.83**	**2.95**	**22.9**	< 2.5	< 2.5	< 2.5	< 2.5	**18.7**	**17.9**	**13.4**	<2.5
Kings Cove Marina SW-2	12/3/2009	MPI	**170**	**9.93**	**10.5**	**3.05**	**25.4**	< 2.5	< 2.5	< 2.5	< 2.5	**16.8**	**19.1**	**16.2**	< 2.5
Duluth International Airport															
Training Frequency:	unknown														
Last Training Event:	pre-2007														
Foam Usage per Training Event:	unknown														
Foam Brand:	3M and/or Chemguard														
Sample ID	**Sample Date**	**Laboratory**													
Duluth Intl. Airport GWS-1	10/2007	Axys	**2310**	**7160**	**13000**	**1340**	**4800**	< 45.7	< 45.7	< 45.7	< 45.7	**2000**	**626**	< 91.3	< 45.7
Duluth Intl. Airport GWS-2	10/2007	Axys	**482**	**1090**	**3590**	**534**	**4640**	**13.1**	< 12.4	< 12.4	< 12.4	**913**	**3440**	< 24.8	< 12.4
Duluth Intl. Airport Dup (GWS-2)	10/2007	Axys	**496**	**1250**	**4370**	**522**	**4250**	< 12.6	< 12.6	< 12.6	< 12.6	**953**	**3320**	< 25.2	< 12.6
Duluth Intl. Airport GWS-3	10/2007	Axys	**1900**	**6940**	**10800**	**1760**	**6790**	**88.5**	< 43.6	< 43.6	< 43.6	**2020**	**1690**	**98.8**	< 43.6
Duluth Intl. Airport GWS-4	10/2007	Axys	**1110**	**4780**	**11500**	**2000**	**8780**	< 31.9	< 31.9	< 31.9	< 31.9	**1630**	**4070**	< 63.8	< 31.9
Duluth Intl. Airport GWS-5	10/2007	Axys	**6.25**	**1.66**	**3.06**	**1.96**	**6.18**	< 0.991	< 0.991	< 0.991	< 0.991	**2.87**	**33.5**	**3.41**	< 0.991
Duluth Intl. Airport GWS-6	10/2007	Axys	**694**	**1750**	**2750**	**497**	**1500**	**14.8**	< 10.3	< 10.3	< 10.3	**776**	**1880**	< 20.6	< 10.3

TABLE 5

Groundwater and Surface Water Analytical Results, PFCs
Minnesota Fire Foam Training and Discharge Sites
Delta Project No. 19382DEL08

			Perfluorobutanoic acid (PFBA)	Perfluoro-n-pentanoic acid (PFPeA)	Perfluorohexanoic acid (PFHxA)	Perfluoroheptanoic acid (PFHpA)	Perfluorooctanoic acid (PFOA)	Perfluorononanoic acid (PFNA)	Perfluorodecanoic acid (PFDA)	Perfluoroundecanoic acid (PFUnA)	Perfluorododecanoic acid (PFDoA)	Perfluorobutanoic sulfonate (PFBS)	Perfluorohexane sulfonate (PFHxS)	Perflouroooctane sulfonate (PFOS)	Perfluorooctane sulfonylamide (PFOSA)
		#Perfluorinated Carbon Chains:	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**4**	**6**	**8**	**8**
		Health-Based Limits:	**7000**$^{(2)}$	**ND**	**ND**	**ND**	**300**$^{(3)}$	**ND**	**ND**	**ND**	**ND**	**7000**$^{(2)}$	**RAA**$^{(4)}$	**300**$^{(3)}$	**ND**
WAFTA, St. Bonifacius															
Training Frequency:	unknown														
Last Training Event:	6/12/1905														
Foam Usage per Training Event:	unknown														
Foam Brand:	unknown														
Sample ID	**Sample Date**	**Laboratory**													
WAFTA BG-2	5/11/2006	MDH	< 1000	< 1000	< 1000	NA	**1000**	NA	NA	NA	NA	< 500	**200**$^{(J)}$	< 500	NA
WAFTA BG-4	5/11/2006	MDH	**800**$^{(J)}$	**3200**	**2300**	NA	**2100**	NA	NA	NA	NA	< 500	**2100**	**2200**	NA
WAFTA MW-1	5/11/2006	MDH	< 1000	< 1000	**300**$^{(J)}$	NA	**7400**	NA	NA	NA	NA	< 500	**200**$^{(J)}$	< 500	NA
WAFTA MW-2	5/11/2006	MDH	**2400**	**8900**	**7800**	NA	**7900**	NA	NA	NA	NA	**600**	**9900**	**9500**	NA
WAFTA MW-3	5/10/2006	MDH	< 1000	< 1000	**300**$^{(J)}$	NA	< 1000	NA	NA	NA	NA	**200**$^{(J)}$	**5100**	**22000**	NA
WAFTA MW-4	5/10/2006	MDH	**9900**	**42000**	**30000**	NA	**43000**	NA	NA	NA	NA	**1500**	**42000**	**118000**	NA
WAFTA MW-4	5/10/2006	Exygen	**14100**	**66300**	**43600**	NA	**41100**	NA	NA	NA	NA	**1820**	**43800**	**114000**	NA
WAFTA MW-5	5/10/2006	MDH	< 1000	**200**$^{(J)}$	**300**$^{(J)}$	NA	**700**$^{(J)}$	NA	NA	NA	NA	< 500	**700**	**2100**	NA
WAFTA MW-5	5/10/2006	Exygen	< 1000	< 1000	< 1000	NA	< 1000	NA	NA	NA	NA	< 1000	< 1000	**1460**	NA
WAFTA MW-7	5/11/2006	MDH	**1200**	**3800**	**3400**	NA	**1000**	NA	NA	NA	NA	**200**$^{(J)}$	**2300**	**3900**	NA
WAFTA MW-8	5/10/2006	MDH	**90**$^{(J)}$	**400**$^{(J)}$	**300**$^{(J)}$	NA	**100**$^{(J)}$	NA	NA	NA	NA	< 500	< 500	**1300**	NA
WAFTA MW-8	5/10/2006	Exygen	< 1000	< 1000	< 1000	NA	< 1000	NA	NA	NA	NA	< 1000	< 1000	< 1000	NA
WAFTA MW-9	5/11/2006	MDH	< 1000	< 1000	< 1000	NA	< 1000	NA	NA	NA	NA	< 500	< 500	< 500	NA
WAFTA MW-10	5/10/2006	MDH	**700**$^{(J)}$	**2000**	**2000**	NA	**2300**	NA	NA	NA	NA	**500**	**12000**	**27000**	NA
WAFTA MW-10	5/10/2006	Exygen	< 1000	**3350**	**3320**	NA	**2270**	NA	NA	NA	NA	< 1000	**11600**	**18400**	NA
WAFTA MW-11	5/10/2006	MDH	< 1000	< 1000	< 1000	NA	< 1000	NA	NA	NA	NA	< 500	< 500	< 500	NA
WAFTA MW-11	5/10/2006	Exygen	< 1000	< 1000	< 1000	NA	< 1000	NA	NA	NA	NA	< 1000	< 1000	< 1000	NA
WAFTA MW-12	5/11/2006	MDH	< 1000	< 1000	< 1000	NA	< 1000	NA	NA	NA	NA	< 500	< 500	< 500	NA
WAFTA MW-13	5/10/2006	MDH	< 1000	< 1000	< 1000	NA	< 1000	NA	NA	NA	NA	< 500	**300**$^{(J)}$	< 500	NA

TABLE 5

Groundwater and Surface Water Analytical Results, PFCs
Minnesota Fire Foam Training and Discharge Sites
Delta Project No. 19382DEL08

			Perfluorobutanoic acid (PFBA)	Perfluoro-n-pentanoic acid (PFPeA)	Perfluorohexanoic acid (PFHxA)	Perfluoroheptanoic acid (PFHpA)	Perfluorooctanoic acid (PFOA)	Perfluorononanoic acid (PFNA)	Perfluorodecanoic acid (PFDA)	Perfluoroundecanoic acid (PFUnA)	Perfluorododecanoic acid (PFDoA)	Perfluorobutanoic sulfonate (PFBS)	Perfluorohexane sulfonate (PFHxS)	Perflourooctane sulfonate (PFOS)	Perfluorooctane sulfonylamide (PFOSA)
		#Perfluorinated Carbon Chains:	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**4**	**6**	**8**	**8**
		Health-Based Limits:	**7000(2)**	**ND**	**ND**	**ND**	**300(3)**	**ND**	**ND**	**ND**	**ND**	**7000(2)**	**RAA(4)**	**300(3)**	**ND**
Up North Plastics Fire															
Date of Foam Discharge:	December 2002														
Foam Usage	4,000 gallons or more														
Foam Brand:	uknown														
Sample ID	**Sample Date**	**Laboratory**													
Up North Plastics SW-1	7/16/2009	Axys	**1230**	**64.3**	**34.5**	**12**	**242**	< 2.52	< 2.52	< 2.52	< 2.52	**20.7**	**32.4**	< 5.04	< 2.52
Up North Plastics SW-2	7/16/2009	Axys	**436**	**36.1**	**26.9**	**9.43**	**78.3**	**3.37**	< 2.53	< 2.53	< 2.53	**9.42**	**7.4**	< 5.06	< 2.53
Up North Plastics SW Dup	7/16/2009	Axys	**572**	**39.4**	**28.1**	**9.92**	**87.5**	< 2.50	< 2.50	< 2.50	< 2.50	**10.3**	**10.8**	**7.64**	< 2.50
Up North Plastics Zywiec Irrigation Well 1	7/29/2009	MDH	**1242.3**	**51.4**	0	NA	0	NA	NA	NA	NA	0	0	0	NA
Up North Plastics Zywiec Irrigation Well 2	7/29/2009	MDH	**447**	0	0	NA	0	NA	NA	NA	NA	0	0	0	NA
Up North Plastics Zywiec Irrigation Well 3	7/29/2009	MDH	**2133.6**	**106.2**	**61**	NA	**55**	NA	NA	NA	NA	0	0	0	NA
Up North Plastics Smallidge	7/29/2009	MDH	**1046.3**	**51.6**	0	NA	**53.3**	NA	NA	NA	NA	0	0	0	NA

Notes:

All results and standards are in nanograms per liter (ng/L), which is equivalent to parts per trillion.

Axys: Axys Analytical Services LTD

MPI: MPI Research

MDH: Minnesota Department of Health Environmental Laboratory.

Exygen: Exygen Research

Bolded type indicates detection above the laboratory method detection limit.

Highlighted concentrations exceed the HBV or HRL.

(1) Last training event prior to sampling, dates are approximate

(2) Health-Based Value (HBV) for chronic exposure defined by the Minnesota Department of Health.

(3) Health Risk Limit (HRL) for drinking water defined by the Minnesota Department of Health.

(4) Risk Assessment Advise (RAA) set by the Minnesota Department of Health for PFHxS does not specify numeric values.

ND: No health-based limit defined.

(5) Manually Calculated Result is 18.9

(6) Manually Calculated Result is 17.1

(7) Manually Calculated Result is 23.3

(8) Manually Calculated Result is 21.7

(J) Analyte positively identified, result is below reporting limit and is estimated.

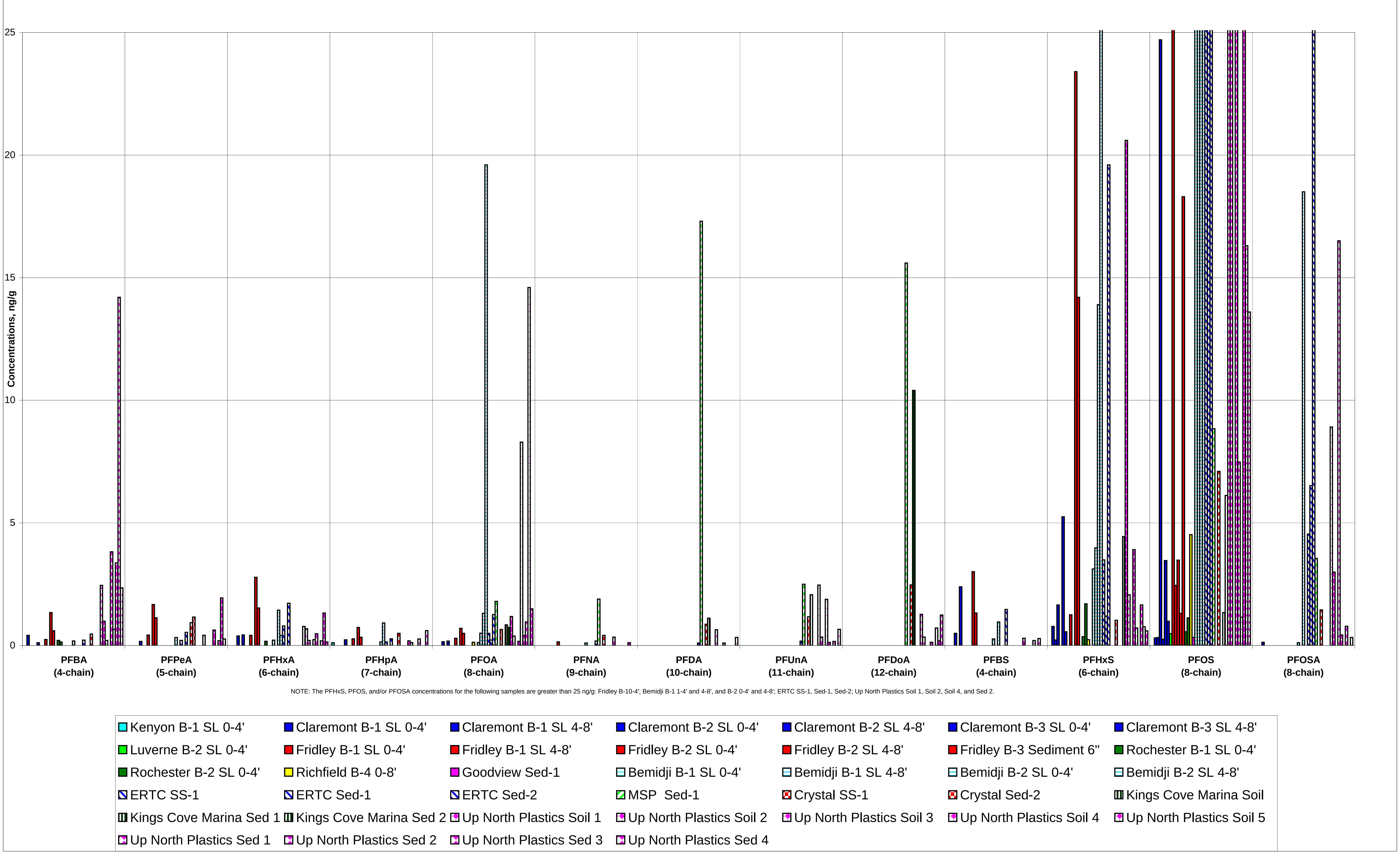
*Sample collected upgradient of fire foam training or discharge area, intended to act as "background" sample.

NA: Not analyzed

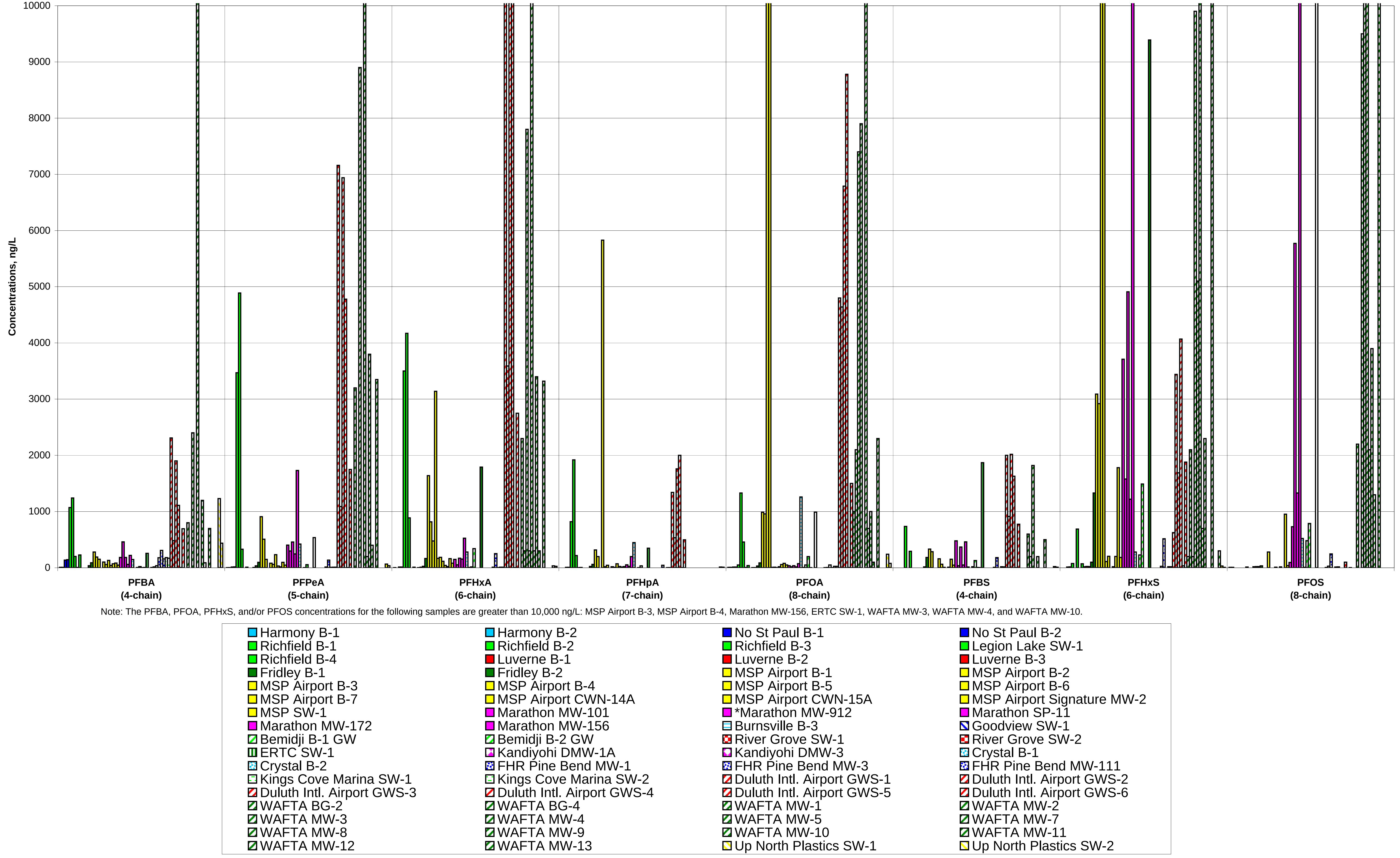
GRAPHS

Graph 1	Soil and Sediment PFC Concentrations
Graph 2	Groundwater and Surface Water PFC Concentrations

GRAPH 1
Soil and Sediment PFC Concentrations



NOTE: The PFHxS, PFOS, and/or PFOSA concentrations for the following samples are greater than 25 ng/g: Fridley B-10-4'; Bemidji B-1 1-4' and 4-8', and B-2 0-4' and 4-8'; ERTC SS-1, Sed-1, Sed-2; Up North Plastics Soil 1, Soil 2, Soil 4, and Sed 2.



GRAPH 2
Groundwater and Surface Water PFC Concentrations

Note: The PFBA, PFOA, PFHxS, and/or PFOS concentrations for the following samples are greater than 10,000 ng/L: MSP Airport B-3, MSP Airport B-4, Marathon MW-156, ERTC SW-1, WAFTA MW-3, WAFTA MW-4, and WAFTA MW-10.

APPENDIX A

Best Practices Today for Class B Firefighting Foam

Minnesota
STATE COLLEGES
& UNIVERSITIES

Minnesota Pollution
Control Agency

MINNESOTA
PUBLIC SAFETY
STATE FIRE
MARSHAL
EST. 1905

Best Practices Today for Class B Firefighting Foam

- Perfluorochemicals (PFCs) are a group of chemicals developed by 3M Corp for use in products to make them water repellent, stain-resistant, slippery and longer lasting.
- PFCs are not natural and do not seem to break down in the environment. Once in the environment, they may be taken up by living things, and build up (bioaccumulate) within the tissue of plants, animals and people.
- Scientists have been surprised to find PFCs in approximately 98% of all humans, including people in remote areas who have never had contact with the modern world. Studies in Minnesota have shown PFCs to be present in some ground and surface waters, air, soil and fish. Studies are underway to see if PFCs create health or developmental problems in people.
- PFCs are used in Class B firefighting foams to increase their effectiveness and make them long lasting.
- The Minnesota Pollution Control Agency (MPCA) is working on a study to understand the potential of firefighting foam as a source of PFCs in the environment. Soil and groundwater at approximately 20 firefighting training sites will be evaluated for PFCs. Minnesota Department of Health is sampling some municipal wells near foam training sites.
- Results from this work will be able late in 2009. MPCA, MnSCU Fire/EMS/Safety Center, and Fire Marshal's Office have developed guidelines for the training and use of Class B fire fighting foam until more answers on foam are known.

Use of foam on fires and spills

First, Class B firefighting foam has been a lifesaver. It is meant for flammable liquid fires and flammable liquid pools, or for combustible liquid fires. So use it if you have a flammable liquid like gasoline on fire or a big gasoline pool in a place where it could ignite or where it would do damage if it did ignite. Don't automatically use it for a diesel fuel spill, unless the diesel fuel is on fire or the situation is endangering life and property. Don't automatically blanket non-leaking flammable liquid tanks unless the situation really calls for it.

Second, don't use Class B foam on car fires, ordinary structure fires, wildland fires, or other inappropriate situations. Class A foams are meant for those situations, Class A foams are not thought to contain PFCs.

Foam training

Foam training sessions should include discussion of when foam use is necessary, when it can be helpful for safety, and when its use is inappropriate.

If possible, use training foams in training. Training foams are not thought to contain PFCs. Class B foam training should not be done near surface waters or storm sewer inlets which would allow foam to quickly drain to water.

PFCs can quickly pass through soil to groundwater. If your city has municipal wells your city water superintendent will have a map of the "well head protection area" which shows where the city's wells draw their water from. Training in those protection areas or in areas near private wells should be avoided. Train on soil where possible, and pick organic soils as opposed to sandy and gravelly soils if possible. That will increase the likelihood that PFCs in the foam are retained in the soil and don't quickly wash through to groundwater.

Foam types

There are many types of PFCs. Apparently all the AFFF type Class B foams have some PFC content of various types. Ethanol resistant AFFF foams apparently also contain types of PFCs. Class A foams are not thought to contain PFCs.

Firefighters' Health

Use foams to protect the public, your firefighters, and valuable property. There is no current concern that PFCs can enter firefighters' bodies by occasional skin contact or inhalation during firefighting or training.

Disposal

At this time the best disposal of Class B foams is to use it appropriately on Class B flammable liquid spills and fires. Liquids can't be put into the garbage. If Class B foam is sent down the sanitary sewer it will go to the city's wastewater treatment plant and the PFCs in the foam probably will pass straight on through to the river or lake without being broken down. So for now, the best advice is to store it safely where the containers won't get damaged until it gets used or until there are better disposal options available. That likely will be quite some time.

Jim Stockinger - Emergency Response Specialist
Emergency Response Unit
Minnesota Pollution Control Agency
also
Fire Training Captain
Linwood Fire Department

Steve Lee - Manager
Emergency Response and Preparedness
Minnesota Pollution Control Agency

Don Beckering, State Director
Fire/EMS/Safety Center
Minnesota State Colleges and Universities

Jerry Rosendahl, State Fire Marshal
Fire Marshal Division
Department of Public Safety

PERFLUOROCARBON (PFC)-CONTAINING FIREFIGHTING FOAMS AND THEIR USE IN MINNESOTA:

SURVEY AND SAMPLING ACTIVITIES, STATE FISCAL YEAR 2011

ANTEA GROUP PROJECT NO. 45618DEL04
June 30, 2011

Prepared for:
Minnesota Pollution Control Agency
520 Lafayette Road
St. Paul, MN 55155

Prepared by:
Antea™Group
5910 Rice Creek Parkway
Suite 100
Shoreview, MN 55126
651 639 9449

c-pfc1-19

TABLE OF CONTENTS

List of Tables

List of Appendices

PERFLUOROCARBON (PFC)-CONTAINING FIREFIGHTING FOAMS AND THEIR USE IN MINNESOTA: SURVEY AND SAMPLING ACTIVITIES, STATE FISCAL YEAR 2011

1.0 INTRODUCTION

1.1 Purpose

Antea™ Group (formerly Delta Consultants) has worked under contract with the Minnesota Pollution Control Agency (MPCA) investigating perfluorochemicals in Class B firefighting foams and the use of Class B firefighting foams in Minnesota. Previous information regarding this investigation was presented in the following reports:

- Perfluorocarbon (PFC)-Containing Firefighting Foams and Their Use In Firefighting Training in Minnesota, dated June 30, 2008 (the June 2008 Report);
- Addendum to PFC-Containing Firefighting Foams and Their Use In Firefighting Training in Minnesota, dated October 22, 2008 (the October 2008 Addendum Report);
- Firefighting Training Area Site Reconnaissance, Pine Bend Flint Hills Refinery, Marathon Refinery, Burnsville Fire Training Center, and Site Access for 21 Fire Departments, dated April 3, 2009 (the April 2009 Report);
- Report of Site Reconnaissance and Sampling at Select Firefighting Foam Training Areas in Minnesota, dated June 30, 2009 (the June 2009 Report);
- Report of Investigation Activities at Select Firefighting Foam Training Areas and Foam Discharge Sites in Minnesota, dated February 10, 2010 (the February 2010 Report);
- Perfluorocarbon (PFC)-Containing Firefighting Foams and Their Use in Firefighting Training in Minnesota, dated June 30, 2010 (the June 2010 Report);
- Perfluorocarbon (PFC)-Containing Firefighting Foams and Their Use in Minnesota: Well Receptor Surveys and Follow-Up Sampling at Select Sites, dated November 15, 2010 (the November 2010 Report);
- Perfluorocarbon (PFC)-Containing Firefighting Foams and Their Use in Minnesota: Sampling at the Lake Superior College Emergency Response Training Center, Duluth, dated February 25, 2011 (the February 2011 Report); and,
- Perfluorocarbon (PFC)-Containing Firefighting Foams and Their Use in Minnesota: Sampling at the Hidden Harbor Marina, Burnsville Wetland, and Bemidji Private Wells dated May 13, 2011 (the May 2011 Report).

This report summarizes data and information for activities conducted for the "PFC/Firefighting Foam" project during the Minnesota State Fiscal Year of 2011.

1.2 Background

As a part of an overall investigation of PFCs in Minnesota, the MPCA and Minnesota Department of Health (MDH) have been investigating firefighting foams as a possible source of PFCs in the environment. Aqueous film-forming foam, or Class B AFFF, has a fluorochemical-based surfactant that rapidly forms a film across the fire surface, which prevents the release of flammable fuel vapors and excludes oxygen from the fuel surface. PFCs have been identified in soil, sediment, surface water and groundwater samples collected from locations in Minnesota where various brands of Class B AFFF have been used repeatedly in training exercises or in large quantity to extinguish fires.

Municipal fire departments, fire departments at major oil refineries and airports in Minnesota, fire training schools in the State, and other knowledgeable persons were surveyed and interviewed regarding their use and knowledge of firefighting foams. Firefighting training sites and fire sites where Class B AFFF is or was used were ranked for their potential to release PFCs to the environment based on a number of criteria, including the following: the types and amounts of foam used, the frequency of the training events, the environmental setting of the site, and the presence of nearby receptors such as water supply wells and surface waters. The results of the survey and site ranking were presented in the June 2008 Report and October 2008 Addendum Report. Both reports are available on the MPCA website at www.pca.state.mn.us/cleanup/pfc/index.html.

Based on the site ranking, a number of firefighting training sites and fire sites where Class B AFFF was discharged were selected for further investigation. Additional investigation activities included site reconnaissance, in-depth interviews with knowledgeable persons, and/or sampling of potentially affected media including groundwater, soil, surface water and/or sediments. Information and data collected at these select sites were documented in the April 2009, June 2009, February 2010, June 2010, November 2010, February 2011 and May 2011 Reports. These reports are also available on the MPCA website. The investigation activities found that PFCs are present in the environment (soil, groundwater, surface water and/or sediment) at sites where Class B AFFF was discharged repeatedly in training exercises or where large amounts of Class B foam were utilized on Class B fires. The investigations have also identified PFCs in surface water or groundwater at concentrations above the State Health Risk Limits (HRLs) for drinking water at the following sites:

- a former firefighting training area behind the Richfield Ice Arena in Richfield;
- two former firefighting training areas at Minneapolis-St. Paul International (MSP) Airport;
- a firefighting training area at the Marathon Refinery in St. Paul Park;
- the Apple Valley-Burnsville-Lakeville-Eagan (ABLE) Training Center in Burnsville;
- a firefighting training area at the Bemidji Regional Airport; and,
- a firefighting training area at the Lake Superior College Emergency Response Training Center (ERTC) in Duluth.

PFC concentrations above the HRLs in groundwater were also identified by environmental consultants other than Antea Group at a former firefighting training area at the Duluth International Airport and at the Western Area Fire Training Academy (WAFTA) in St. Bonifacius. Sampling results for these sites are presented briefly in the June 2010 Report.

Laboratory results for all PFC sampling conducted in association with this PFC/Firefighting Foam project are summarized in **Table 1, *Groundwater and Surface Water PFC Analytical Results***, and **Table 2, *Soil and Sediment Analytical Results, PFCs and TOC (Total Organic Carbon)***.

One of the risks associated with PFCs in groundwater is to human health should a potable water well be drawing water from an impacted groundwater aquifer. The MPCA and MDH have worked together to identify public supply wells that may be at risk due to their proximity to firefighting foam training areas or large fire sites where Class B AFFF was discharged. The MDH has sampled water supply wells near several fire foam training areas and while low levels of some PFC compounds were detected in municipal well water samples, none of the water samples had PFC concentrations higher than the HRLs or State Health-Based Values (HBVs). Groundwater sampling conducted by the MDH is discussed briefly in the June 2010 Report.

Based on the presence of PFCs at levels above the HRLs in groundwater at the former firefighting training area in Richfield and the known presence of private water supply wells in the area, a receptor survey was conducted in the vicinity of the former training area in order to identify potential receptors of impacted groundwater. The survey identified several sealed and abandoned water supply wells and groundwater monitoring wells in the survey area, but no active water supply wells other than the municipal wells which were being sampled by MDH. Results of the receptor survey for the former firefighting training area in Richfield are presented in the February 2010 Report. Receptor survey results for the Duluth International Airport and the WAFTA site in St. Bonifacius are also briefly presented in the June 2010 Report.

In 2006 and 2007 a number of groundwater samples collected by the MPCA from multiple rural and urban locations in Minnesota were analyzed for PFCs as part of a State-wide monitoring effort of PFCs in the ambient environment. The results of that sampling and a comparison of groundwater data collected as part of the ambient sampling and the sampling done as part of the PFCs/Firefighting Foam project were presented in the June 2010 Report. Ambient sampling data is presented in the MPCA document *PFCs in Minnesota's Ambient Environment: 2008 Progress Report.*

At the end of the State Fiscal Year 2010, the following recommendations for additional work for the PFC/Firefighting Foam project were made in the June 2010 Report:

1. Conduct groundwater receptor surveys to evaluate risk at the following sites where PFOA and/or PFOS concentrations in groundwater exceeded the State HRLs:
    - Marathon Refinery in St. Paul Park
    - Bemidji Regional Airport
    - ABLE Training Center in Burnsville
    - Minneapolis-St. Paul International Airport (MSP)
2. Conduct a groundwater receptor survey to evaluate risk in the area of the Lake Superior College ERTC due to elevated PFOS and PFOA concentrations in the wetland adjacent to the training area.

3. Continue to monitor groundwater for PFCs at the existing monitoring well located downgradient of the fire site at the Kandiyohi County Landfill. Since the foam discharge occurred less than one year ago, it may take time for potential PFC impacts to migrate through the soil to the water table, and to migrate with groundwater to the location of monitoring well DMW-3. Consider installing a monitoring well closer to the site of the fire if site activities and land use nearer the fire site are conducive to the presence of a monitoring well.
4. At the time of sampling at Crystal Airport in January 2010, there was no water in Shingle Creek. Since PFCs were detected in a sediment sample collected on the downstream side of Crystal Airport, but none were detected in an upstream sediment sample, water samples should be collected at or near the locations of the previous sediment samples to test for PFCs in Shingle Creek adjacent to Crystal Airport.
5. Follow up with inquiries, and sampling if warranted, at any large fires that occur or have occurred where Class B AFFF is used extensively.

2.0 SCOPES OF WORK CONDUCTED IN STATE FISCAL YEAR 2011

As a result of finding PFCs at concentrations above the HRLs in groundwater or surface water at the sites identified in Section 1.2, receptor surveys were conducted in the vicinities of these sites in Fiscal Year 2011, except for the former firefighting training area in Richfield where a receptor survey was conducted in Fiscal Year 2010. The purpose of the receptor surveys was to identify potential receptors of PFC-impacted groundwater or surface water. Based on results of the receptor surveys, private wells near the Marathon Refinery, Bemidji Regional Airport, and Lake Superior College ERTC, and surficial water bodies near Lake Superior College ERTC and the ABLE Training Center, were sampled for PFCs.

Additional follow-up PFC sampling was also conducted in Fiscal Year 2011 at two sites: (1) groundwater samples were collected from two existing monitoring wells at the Kandiyohi County Landfill, where Class B AFFF was used on a fire in October 2009; and, (2) surface water and sediment samples were collected from Shingle Creek, adjacent to Crystal Airport.

2.1 Work Order SFDE1107-2

To address the recommendations included in the June 2010 Report, Antea Group performed the following scope of work under MPCA Work Order SFDE1107-2, dated July 23, 2010:

1. Conducted groundwater receptor surveys in the vicinity of current or former firefighting training sites at the following locations: Marathon Refinery in St. Paul Park; Bemidji Regional Airport; ABLE Training Center in Burnsville; MSP Airport; and, Lake Superior College ERTC in Duluth.
2. Conducted additional groundwater sampling from two existing wells at the Kandiyohi Landfill.
3. Conducted additional sediment and surface water sampling at Shingle Creek adjacent to the Crystal Airport in Crystal.

4. Prepared a report summarizing work performed as part of the scope of work (the November 2010 Report).

2.1.1 Groundwater Receptor Surveys

Groundwater receptor surveys conducted in the vicinity of the current or former firefighting training sites identified in Section 2.1 included the following activities:

- Walking surveys were conducted in order to identify all houses and businesses, surface water bodies, water wells, and any other features that may be a groundwater receptor. The walking surveys included the area within 500 feet upgradient and side-gradient of the sites and 1/2-mile downgradient of the sites. Hydrological resources used in determine groundwater flow directions at each of the sites are presented in the November 2010 Report.
- Information regarding the potable water source and water wells at the properties identified during the walking surveys was obtained from property owners or tenants. Information was obtained through personal interviews or via well survey questionnaires that were either left at a property or sent in the mail.
- Inquiries were made as necessary with the water supply utility regarding municipal water sources, municipal well locations, and the availability of municipal water in the area of the sites.
- The MDH County Well Index (CWI) was searched in order to identify registered water wells located within the survey areas.

Details and results for each of the receptor surveys are presented in the November 2010 Report. The November 2010 Report included references Findings of the surveys are summarized in **Table 3, *Well Receptor Summary for Select Firefighting Foam Training Sites in Minnesota***. The receptor surveys identified the following potential groundwater receptors:

- Marathon Refinery: As presented in the November 2010 Report, the inferred groundwater flow direction is generally to the southwest. An April 2008 groundwater elevation contour map prepared by URS in association with a petroleum release at the Marathon Refinery (unrelated to the firefighting foam area at the refinery) indicated a slightly more southerly groundwater flow direction at the southeast portion of the refinery property. Thus the receptor survey performed for this PFC/Firefighting Foam project included an area within 1/2-mile to the south and southwest of the firefighting training area at the refinery. A figure showing the October 2010 receptor survey area, inferred groundwater flow directions, returned well survey questionnaires, and a MDH CWI map of wells in the survey area and associated well logs are included as **Appendix A**.

  Of the eleven wells shown on the CWI map in the receptor survey area, eight are either monitoring wells, remedial wells, or abandoned wells. The remaining three wells mapped by the CWI, Unique Well nos.

441942, 576171, and 429870, are domestic wells registered to Willie Brown or Willie's Hidden Harbor. The well questionnaire survey identified five active water supply wells at or owned by the Hidden Harbor Marina. In addition to the three wells mentioned above Unique Well nos. 268354 and 559256 are registered to Harbor Village #2 and Willie's Hidden Harbor, respectively; however, these wells were not mapped on the CWI. According to the owner of the Hidden Harbor Marina, the five wells are used for a variety of purposes, including wash water and drinking water. The City of St. Paul Park confirmed that the Hidden Harbor Marina is not connected to the municipal water supply. The Hidden Harbor Marina is located approximately 0.3 miles south of the fire training area at Marathon Refinery. Discussion of sampling of the wells owned by the Hidden Harbor Marina is presented in **Section 2.3.1**.

The Mississippi River is located approximately 600 feet west of the firefighting training area at the Marathon Refinery. Previous sampling of water, sediments and fish tissue from the Mississippi River as part of the PFC/Firefighting Foam project and other unrelated State projects has identified PFCs in all sampled media. Therefore, the MPCA decided that additional sampling of surface water and sediment from the Mississippi River near the Marathon Refinery would not provide useful data for this project due to the previously identified presence of PFCs in the river and other regional PFC groundwater impacts associated with former 3M landfills in Washington County.

- Bemidji Regional Airport: As presented in the November 2010 Report, the regional groundwater flow direction in the area of the Bemidji Regional Airport is generally to the southeast. The initial receptor survey conducted in October 2010 identified one active water supply well within 1/2-mile downgradient of the Airport. The identified well is at the Kraus Anderson construction shop located to the southeast. However, review of the MDH CWI identified multiple residential wells located between 3/4-mile and 1 mile east and southeast of the firefighting training area at the Bemidji Regional Airport. An expansion of the receptor survey was conducted under a later Work Order, as discussed in **Section 2.3**.

  Grass Lake is located approximately 1/2-mile south-southwest of the firefighting foam training area at the Bemidji Regional Airport. According to personnel with the City of Bemidji Street Department, stormwater flow from the airport is ultimately routed to a wetland to the north of the Airport, thus, Grass Lake does not receive stormwater runoff from the Airport. A figure showing the October 2010 receptor survey area, inferred groundwater flow direction, returned well survey questionnaires, and a MDH CWI map of wells in the area and associated well logs are included as **Appendix B**. Discussion of the subsequent, expanded receptor survey is presented in **Section 2.3.3**.
- ABLE Training Center: As presented in the November 2010 Report, the regional groundwater flow direction in the area of the ABLE Training Center is generally to the northwest, toward the Minnesota River. A figure

showing the receptor survey area, completed well survey questionnaires, and a MDH CWI map of wells in the area of the ABLE Training Center and associated well logs are included as **Appendix C**. No active water supply wells were identified by the receptor survey, except for three municipal wells that were previously sampled twice by the MDH for PFCs. A wetland or pond located across Cliff Road from the ABLE Training Center was identified as a potential receptor for groundwater or stormwater runoff from the site.

- MSP Airport: As presented in the November 2010 Report, the regional groundwater flow direction in the area of MSP Airport is generally to the southeast, toward the Minnesota River. A figure showing the receptor survey area, inferred groundwater flow direction, and a MDH CWI map indicating the lack of wells within the survey area are included as **Appendix D**. No water supply wells or surface waters were identified within the receptor survey area. The Minnesota River is located approximately 1.8 miles southeast of the former firefighting training areas at MSP Airport.
- Lake Superior College ERTC: As presented in the November 2010 Report, the inferred groundwater flow direction in the area of the ERTC is generally to the south, toward the St. Louis River. However, localized features such as creeks that flow to the southeast and a historical gravel pit to the west may influence groundwater flow at the ERTC. Therefore the receptor survey included areas within 1/2-mile to the west and southeast. A figure showing the receptor survey area, inferred regional groundwater flow direction, completed well survey questionnaires, and a MDH CWI map of wells in the area of the ERTC are included as **Appendix E**. No well logs for the wells identified in the survey area were available on the CWI. Five active water supply wells were identified during the walking survey at nearby houses on Highway 23 in Duluth. One of the wells is shared by two houses. The City of Duluth Public Works Department confirmed that municipal water is not currently utilized by the identified houses. In addition, two creeks flow near the firefighting practice area at the ERTC, which apparently join up before flowing southward beneath Highway 23 to the backwater of the St. Louis River. One of the creeks appears to flow through a wetland located adjacent to the firefighting practice area. Sediments and surface waters of the wetland and creek were sampled previously.

Based on the results of the receptor surveys the following recommendations were made in the November 2010 Report:

- pursuit of access to the five wells at the Hidden Harbor Marina for PFC sampling;
- pursuit of access to the Kraus Anderson shop well in Bemidji for PFC sampling;
- completion of an expanded receptor survey to include private wells further east and southeast of the Bemidji Regional Airport;
- pursuit of access to the wetland or pond near the ABLE Training Center in Burnsville for PFC sampling of wetland surface water and sediment; and,

- pursuit of access to the residential wells near the Lake Superior College for PFC sampling, and access to the ERTC for follow-up surface water and sediment sampling for PFCs.

2.1.2 Follow-Up Sampling at Kandiyohi County Landfill

In October 2009 approximately 545 gallons of Class B AFFF were used on a fire at the Kandiyohi County Landfill. Groundwater samples were collected from existing landfill monitoring wells DMW-1A and DMW-3 in January 2010 and May 2010. Well DMW-1A is located upgradient of the fire area, and DMW-3 is located approximately 300 to 350 feet downgradient of the fire area. A figure illustrating the approximate area of the fire and the referenced monitoring wells is included in **Appendix F**. No PFCs were identified in either sample collected from DMW-1A, and only low levels of perflourobutanoic acid (PFBA) were found in the samples collected from DMW-3 (see **Table 1)**. Additional sampling was recommended in the June 2010 Report to assess groundwater conditions over time downgradient of the fire area.

Follow-up groundwater samples were collected from DMW-1A and DMW-3 on August 12, 2010, for PFC analysis. The samples were submitted to Axys Analytical Services for analysis of PFCs.

Laboratory analysis did not detect any PFCs in the (upgradient) DMW-1A sample and only a low concentration of PFBA in the (downgradient) DMW-3 sample, which is consistent with previous sampling results (see **Table 1**). Details of and results for the follow-up sampling at Kandiyohi County Landfill are presented in the November 2010 Report.

Continued groundwater sampling from DMW-1A and DMW-3 was recommended in the November 2010 Report. However, the MPCA decided that additional sampling was not warranted at that time since the nearest potential groundwater receptor is located approximately one-half mile southwest of the fire area at the landfill, and significant concentrations of PFCs have been not detected in DMW-3. With the passage of more time to allow for PFCs, if present, to reach the monitoring wells, re-sampling of DMW-1A and DMW-3 should be reconsidered.

2.1.3 Follow-Up Sampling at Shingle Creek

Interviews with responding municipal fire departments around the Crystal Airport in Crystal indicated that Class B AFFF may have been used in the past to respond to plane crash-related fires at the Crystal Airport. Generally, storm water runoff flows through various pathways and drainage ditches across the airport grounds to Shingle Creek. Shingle Creek flows along the east side of Crystal Airport to the southeast, emptying into Twin Lake. In a project unrelated to the PFC/Firefighting Foam project, PFCs were identified in fish samples collected from Twin Lake, including high levels of PFOS. The source of the PFOS in the fish collected from Twin Lake has not been identified to date.

Soil, groundwater, and sediment sampling for PFCs was conducted at Crystal Airport in January 2010 from several locations, including upstream and downstream locations in Shingle Creek adjacent to Crystal Airport. A figure showing the January 2010 sample locations is included in **Appendix G**. Due to the winter season and lack of water in the creek, only sediment samples were collected from the Shingle Creek in January 2010. Sampling results identified several PFC compounds in the downstream sediment sample; PFCs were not detected above laboratory detection limits in the sediment sample collected from the upstream location in Shingle Creek (see **Table 2**). The January 2010 sampling event at Crystal Airport is presented in the February 2010 and June 1010 Reports. The June 2010 Report recommended surface water sampling and follow-up sediment sampling from Shingle Creek for PFCs.

Follow-up sediment samples and surface water samples were collected from Shingle Creek on October 1, 2010, from the same locations upstream and downstream of the Crystal Airport as the January 2010 samples. A figure showing the October 2010 sample locations is included in **Appendix G**. The samples were submitted to Axys Analytical Services for analysis of PFCs.

Laboratory results for surface water samples Crystal SW-1 (upstream sample) and Crystal SW-2 (downstream sample) detected concentrations of several PFC compounds; all of the concentrations were below the State HRLs (see **Table 1**). Although the HRLs are not necessarily applicable to the surface water in Shingle Creek, they are presented here and in Table 1 for comparison purposes only. The PFC concentrations detected in the upstream sample were slightly higher than those detected in the downstream sample. Details of the sampling and laboratory results for the surface water samples only are presented in the November 2010 Report; the laboratory results for the sediment sample were not available at the time of the November 2010 Report.

Laboratory results for the upstream and downstream sediment samples (Crystal Sed-3 and Crystal Sed-4, respectively) collected on October 1, 2010, were received after the November 2010 Report was finalized. Laboratory results are included in **Table 2**. Laboratory analysis did not detect any PFCs in the upstream Crystal Sed-3 sample. Low concentrations (less than 5 nanograms-per-gram (ng/g), which is roughly equivalent to parts-per-billion) of several PFC compounds were detected in the downstream Crystal Sed-4 sample. The PFC concentrations in Crystal Sed-4 were slightly lower than concentrations detected in downstream sample Crystal Sed-2 collected in January 2010. PFC concentrations in all sediment samples collected from Shingle Creek were below MPCA Tier 1 Soil Reference Values (SRVs). Although the Tier 1 SRVs are not necessarily applicable to sediments in Shingle Creek, they are presented here and in Table 2 for comparison purposes only.

Based on the relatively low concentrations of PFCs detected in sediment and surface water samples collected from Shingle Creek adjacent to Crystal Airport, no further sampling is recommended at this time.

2.2 Work Order SFDE1111

Antea Group performed the following scope of work under MPCA Work Order SFDE1111, dated October 20, 2010, based on results of the groundwater receptor survey and previous creek and wetland sampling at the Lake Superior College ERTC in Duluth:

1. An access agreement was implemented between the MPCA and Lake Superior College for additional PFC sampling of surface waters and sediments at the ERTC.

2. Access agreements were implemented between nearby well owners and the MPCA for PFC sampling of their water wells.
3. Surface water and sediment samples were collected at the ERTC from the wetland and the creek located adjacent to the ERTC fire training area for PFC analysis.
4. Water samples were collected from two of the (five) private water wells located within one-half mile of the ERTC for analysis of PFCs.
5. Sediment, surface water and well water samples were analyzed by a State-contracted laboratory for analysis of PFCs.
6. A report was prepared summarizing the work performed as part of the scope of work (the February 2010 Report).

2.2.1 Follow-up Sampling at Lake Superior College ERTC

Previous sampling in November 2009 of surface water and sediments from a wetland at the ERTC, as well as sampling of soil and creek sediment below the outfall for a 6-inch perforated pipe that runs beneath the fire training area identified PFC concentrations present in all of the media sampled (see **Tables 1 and 2**). A laboratory data table specific to samples collected at and in the vicinity of the ERTC is included in **Appendix H**. A Site Map showing sample locations at the ERTC is included in **Appendix H**. The concentrations of PFOA and PFOS detected in the surface water sample (ERTC SW-1) collected from the wetland were higher than the HRLs. Although the HRLs are not necessarily applicable to surface waters of the State, there was a concern that elevated concentrations of PFOA and PFOS could reach groundwater or a drinking water aquifer that is utilized by nearby water supply wells.

An access agreement between the MPCA and Lake Superior College was executed on November 8, 2010, allowing access for PFC sampling of a wetland and a creek at the ERTC. A copy of the access agreement is included in the February 2011 Report.

Sediment and surface water samples were collected by Antea Group on November 18, 2010, at or near the locations of previous sediment and surface water samples. Sample locations are shown on the Site Map included in Appendix H. In addition, a surface water sample was collected from the creek. Sediment and surface water samples collected from the wetland were labeled “ERTC Sed-3” and “ERTC SW-2”. The sediment and surface water samples collected from the creek were labeled “ERTC Sed-4” and “ERTC SW-3.” The samples were submitted to Axys Analytical Services for analysis of PFCs.

Laboratory analysis detected approximately similar PFC concentrations in ERTC Sed-4 as previous creek sediment sample ERTC Sed-1, and in ERTC Sed-3 as previous wetland sediment sample ERTC Sed-2 (see **Table 2**). PFC concentrations in all sediment samples, and soil sample ERTC SS-1 collected previously, were below MPCA Tier 1 SRVs. Although the Tier 1 SRVs are not necessarily applicable to soils and sediments at the ERTC, they are presented here and in Table 2 for comparison purposes only.

The PFC concentrations detected in wetland surface water sample SW-2 were lower than concentrations in the November 2009 wetland sample SW-1 (see **Table 1**). PFOS concentrations detected in both surface water samples SW-1 and SW-2 exceeded the HRL, with concentrations of 11,300 nanograms per liter (ng/L) and 7,640 ng/L, respectively. The PFOA concentration of 991 ng/L detected in the November 2009 SW-1 sample exceeded the HRL of 300 ng/L, but the PFOA concentration of 290 ng/L detected in SW-2 in November 2010 was below the HRL. The PFOS concentration of 7,630 ng/L detected in the creek surface water sample (ERTC-SW-3) also exceeded the HRL. Although the HRLs are not necessarily applicable to surface waters at the ERTC, they are presented here for comparison purposes only.

Details of and results for the follow-up sampling at Lake Superior College ERTC are presented in the February 2011 Report.

2.2.2 Well Sampling near Lake Superior College ERTC

The groundwater receptor survey conducted in September and October 2010 identified six residences within one-half mile of the ERTC that utilized drinking water from five private wells; two of the houses shared one well (see **Table 3**). The locations of the residences are shown on a map of the ERTC surrounding area included in **Appendix H**. The City of Duluth Public Works Department confirmed that the houses within the receptor survey area are not connected to the municipal water supply, but that a water main is available to one of the properties, at 11825 Highway 23.

Access agreements were sent to the owners of the identified residences with private wells, requesting access to their residences to collect water samples from private wells for analysis of PFCs. Three of the well owners provided access to the MPCA and Antea Group as their contractor to sample their wells. However, a sampling appointment for the residence at 11825 Highway 23 s was cancelled and was not rescheduled. Copies of the access agreements are included in the February 2011 Report.

On November 19, 2010, water samples were collected from private wells at two residences located within one-half mile of the Lake Superior College ERTC, at 10801 and 11601 Highway 23 in Duluth. The sample collected from the residence at 10801 Highway 23 was labeled “ERTC-10801,” and the sample collected at 11601 Highway 23 was labeled “ERTC-11601.” The samples were submitted to Axys Analytical Services for analysis of PFCs.

The only PFC compounds detected in the water well samples collected from the private water wells at 10801 and 11601 Highway 23 were PFOS and perfluorohexane sulfonate (PFHxS). The PFOS concentrations of 6.49 ng/L and 7.26 ng/L were below the HRL of 300 ng/L. The concentrations of PFHxS detected in the well water samples were 11.2 ng/L and 9.63 ng/L; the RAA for PFHxS does not include a numerical standard. All of the other PFC compounds were not detected above laboratory detection limits in either well water sample. Sample results are included on **Table 1**. Sample results were provided to the home owners.

Details of and results for the private well sampling associated with the Lake Superior College ERTC are presented in the February 2011 Report.

2.3 Work Order SFDE1113

Antea Group performed work under MPCA Work Order SFDE1113, dated November 30, 2010, based on results of the groundwater receptor surveys conducted in the vicinities of the firefighting training areas at the following locations: Marathon Refinery, Bemidji Regional Airport, and the ABLE Training Center. The scope of work performed under Work Order SFDE1113 included the following activities:

1. An access agreement was executed between the MPCA and the owner of the Hidden Harbor Marina to allow sampling of five water supply wells at the Marina for PFC analysis. Water samples were collected from these wells and submitted for laboratory analysis of PFCs.
2. An access agreement was executed between the MPCA and the City of Burnsville to allow surface water and sediment sampling for PFCs at the wetland or pond located on City property north of the ABLE Training Center. A surface water sample and a sediment sample were collected and submitted for laboratory analysis of PFCs.
3. A well receptor survey was conducted for the neighborhood located approximately 3/4-mile east of the Bemidji Regional Airport.
4. Access agreements were executed between the MPCA and select well owners in Bemidji for sampling of their water wells for PFCs. Water samples were collected from the select wells and submitted for laboratory analysis of PFCs.
5. A report was prepared summarizing the work performed as part of the scope of work (the May 2010 Report).

2.3.1 Sampling at the Hidden Harbor Marina

Sampling of select existing groundwater monitoring wells near and upgradient of the firefighting training area at the Marathon Refinery was conducted in August 2009. Laboratory analysis of five water samples plus one duplicate sample identified PFCs in all of the samples, including PFOS concentrations above the HRL. The laboratory analytical results are included in **Table 1**. Sampling at the Marathon Refinery is discussed in the February 2010 Report.

As discussed in **Section 2.1.1**, the groundwater receptor survey conducted in the vicinity of Marathon Refinery in October 2010 identified five water supply wells owned by the owner of the Hidden Harbor Marina, as follows:

- Unique Well No. 268354 at the marina workshop that is used for non-potable uses such as toilets and cleaning boats (labeled “Well A- Hidden Harbor” for sampling purposes).
- Unique Well No. 559256 at the marina that supplies water to the on-site restaurant and to marina boat customers (“Well B-Hidden Harbor”).
- A residential well located at the house associated with the marina. This house is currently being used as the shower house for marina customers. The unique well number for this well is unknown (“Well C-Hidden Harbor”).

- A residential well located at the house at 1001 Oak Street, just south of the marina. The unique well number for this well is unknown (“Well D-Hidden Harbor”).
- Unique Well No. 429870 at the house at 115 10th Avenue West, just south of the marina (“Well E-Hidden Harbor”).

Unique Well nos. 441942 and 576171 are likely associated with Well C and Well D, however, insufficient information was readily available to match up the physical wells with the unique well numbers. A figure showing the locations of the sampled wells at the Hidden Harbor Marina is included as **Appendix I**.

An access agreement between the MPCA and the owner of the Hidden Harbor Marina allowed for sampling of the above-identified wells. Water samples were collected from all five wells on March 3, 2011. The well samples were labeled as indicated above and submitted to Axys Analytical Services for analysis of PFCs.

Laboratory results for the well samples collected at the Hidden Harbor Marina are summarized on **Table 1**. Laboratory analysis detected low levels of perfluorinated carboxylic acids in three of the Hidden Harbor Marina well samples: the water well at the restaurant (Unique No. 559256/Well B), and the houses at 1001 Oak Street (Well D) and 115 10th Avenue West (Unique No. 429870/Well E). All detected PFC concentrations were below the HRL or other drinking water health-based values defined by the MDH (see **Table 1**). Sampling results were provided to the owner of the Hidden Harbor Marina.

The PFC compound that was detected above the HRL at the Marathon Refinery was PFOS, which is a perfluorinated sulfonate. No perfluorinated sulfonates were detected in any of the Hidden Harbor Marina well samples, only perfluorinated carboxylic acids were detected in the Hidden Harbor Marina well samples. Based on the different types of PFC compounds detected in the wells at the Marathon Refinery and the Hidden Harbor wells, the PFC impacts in groundwater at the Hidden Harbor Marina do not appear to be from the firefighting training area at the Marathon Refinery.

The City of St. Paul Park is included in an area of Washington County known to have low levels of PFC groundwater impacts associated with landfills where 3M wastes were historically dumped. Assessment and monitoring data associated with the 3M wastes in Washington County are available at the MPCA and MDH websites.

Details of and results of the Hidden Harbor Marina well sampling are presented in the May 2011 Report.

2.3.2 Sampling at Wetland Near the ABLE Training Center

Groundwater sampling was conducted at the ABLE Training Center in August 2009. A groundwater sample was collected from soil boring B-3. (Attempts to collect groundwater samples from borings B-1 and B-2 were unsuccessful.) Laboratory analysis of the groundwater sample (Burnsville B-3 GW 44.5 ft.) detected several PFCs in the sample, including PFOA and PFOS at concentrations above the HRL (see **Table 1**).

As discussed in **Section 2.1.1**, the groundwater receptor survey conducted in the vicinity of the ABLE Training Center did not identify any water supply wells except for the municipal wells already sampled by the MDH. A wetland or pond located across Cliff Road from the ABLE Training Center was identified as a potential receptor for storm water runoff. The wetland is on property owned by the City of Burnsville.

An access agreement executed between the MPCA and the City of Burnsville allowed for sampling of the surface water and sediment from the wetland for PFCs. A surface water sample (Burnsville Pond SW-1) and a sediment sample (Burnsville Pond Sed-1) were collected from the wetland on April 20, 2011. The sample locations are shown on a figure included as **Appendix J**. The well samples were submitted to Axys Analytical Services for analysis of PFCs.

The laboratory results for the surface water sample collected at the Burnsville wetland are included on **Table 1**. Low levels of perfluorinated carboxylic acids were detected in the surface water sample, at concentrations below the HRL or other drinking water health-based values defined by the MDH. The State drinking water criteria are not necessarily applicable to surface waters, but are discussed here for comparison purposes only. There are no surface water criteria for PFCs applicable to the sampled wetland in Burnsville. Details of the sampling from the Burnsville wetland, and laboratory results for the surface water sample only, are presented in the May 2011 Report; the laboratory results for the sediment sample were not available at the time of the May 2011 Report.

Laboratory results for the sediment sample collected from the Burnsville wetland were received after the May 2011 Report was finalized. Laboratory results are included in **Table 2**. Laboratory analysis detected relatively low concentrations of PFCs in the Burnsville Pond Sed-1 sample, at concentrations below the MPCA Tier 1 SRVs. Although the Tier 1 SRVs are not necessarily applicable to sediments at the wetland in Burnsville, they are presented here and in Table 2 for comparison purposes only.

The types of PFC compounds detected in soil and groundwater samples collected from soil borings at the ABLE Training Center are similar to those detected in the Burnsville Pond samples. The PFCs detected in the Burnsville pond/wetland may or may not be from the ABLE Training Center, as stormwater runoff entering the pond/wetland may be picking up PFCs from other potential sources in the area. An assessment of other potential PFC sources in the area was not completed as part of this project. Since the PFC concentrations in the Burnsville Pond samples were relatively low an assessment of other potential PFC sources in the area does not appear to be warranted at this time.

2.3.3 Expanded Well Survey and Sampling Near the Bemidji Regional Airport

Soil and groundwater sampling was conducted in November 2009 at the area in front of the fire station at the Bemidji Regional Airport, where the Bemidji Fire Department trains periodically with Class B AFFF. Soil and groundwater samples were collected from two soil borings, B-1 and B-2. Laboratory analysis of the groundwater samples identified several PFCs, including PFOS at concentrations above the HRL (see **Table 1**).

As discussed in Section 2.1.1, Antea Group conducted a groundwater receptor survey in October 2010 of the area located within one-half mile south and southeast of the training area at the Bemidji Airport. This initial receptor survey identified one active water supply well, the Kraus Anderson shop well. Information regarding the October 2010 receptor survey is presented in the November 2010 Report.

Other domestic water wells were known to exist outside the October 2010 receptor survey area. The MDH expressed some concern that shallow domestic wells located in a neighborhood between 3/4-mile and 1 mile east of the fire foam training area at the airport could potentially be impacted by the PFC groundwater impacts. Thus, a recommendation was made in the November 2010 Report to conduct a receptor survey in this area and sample a select number of wells identified in the survey.

Well survey letters were mailed to the owners of 33 properties in the neighborhood immediately east of the Bemidji Regional Airport in December 2010. Completed well surveys were returned by 17 well owners; the completed surveys identified 13 active wells in the neighborhood. A table summarizing all properties surveyed and survey responses received is included in **Appendix K**. A map showing the survey area is also included in **Appendix K**.

Of the thirteen active wells identified during the survey, six of the wells were selected for PFC sampling. The wells were selected so as to sample from varying depths and locations within the survey neighborhood. A seventh well, the well at the Kraus Anderson shop, was also selected for PFC sampling.

Access agreements between the MPCA and the selected seven well owners allowed for the sampling of their wells for PFCs. The wells were sampled on March 24, 2011, with the following exception: the well owner at 2120 Anne Street NW was not available on the day of sampling. The locations of the wells sampled are included on the map of the survey area included in **Appendix K**. A laboratory-supplied sample jar, nitrile sampling gloves, and cooler were left at 2120 Anne Street NW by Antea Group personnel on March 24, 2011. The property owner collected a sample from the well on March 29, 2011 and shipped the sample in the cooler provided to Antea Group. The well samples were labeled as follows:

- Bemidji 2021 Anne
- Bemidji 2326 Bardwell
- Bemidji 3481 Laurel
- Bemidji 2316 Bardwell
- Bemidji 2103 Anne
- Bemidji Kraus Anderson
- Bemidji 2120 Anne

Water samples were submitted to Axys Analytical Services for laboratory analysis of PFCs. Details of the sampling from the wells in Bemidji are presented in the May 2011 Report; the laboratory results for the water samples were not available at the time of the May 2011 Report.

Laboratory analysis of the well samples did not detect any PFCs in the following samples: Bemidji 2021 Anne, Bemidji 2326 Bardwell, Bemidji 3481 Laurel, and, Bemidji 2120 Anne. Low levels of PFBA were detected in the Bemidji 2316 Bardwell and Bemidji Kraus Anderson samples, at concentrations higher than PFBA levels detected in soil boring samples B-1 and B-2 collected at the airport. Low levels of PFHxS and PFOS were detected in the Bemidji 2103 Anne sample. All PFC concentrations detected were below the HRLs or HBVs. Laboratory results are included on **Table 1**.

The well at 2103 Anne Street NW is reportedly 55 feet deep; a search of the MDH CWI did not locate the well log. This is the only well sampled where PFOS was detected; PFOS is the PFC compound detected in groundwater above the HRL at the Bemidji Regional Airport borings. The wells at 2021 and 2120 Anne Street NW are located on adjoining properties to 2103 Anne Street NW and are both reportedly 30 feet deep; no PFCs were detected in either of these wells. The well at 2326 Bardwell Drive NW is reportedly 52 feet and is situated roughly between the firefighting training area at the Bemidji Regional Airport and the house at 2103 Anne Street NW and is of similar depth to the well at 2103 Anne Street NW; however, no PFCs were detected in the well sample collected at 2326 Bardwell Drive NW.

The data collected during this investigation is inconclusive in determining whether or not the PFCs detected in the wells at 2103 Anne Street NW, 2316 Bardwell Drive NW, and the Kraus Anderson shop are due to the discharge of Class B AFFF at the Bemidji Regional Airport.

3.0 CONCLUSIONS AND RECOMMENDATIONS

3.1 MSP Airport

No potential groundwater receptors were identified in the receptor survey area at MSP Airport. Antea Group recommends no further actions at this time with regards to PFCs in the soil and groundwater at the former fire training areas at MSP Airport.

3.2 Kandiyohi County Landfill

Three rounds of groundwater sampling have been collected from existing monitoring wells since the October 2009 fire at the Kandiyohi County Landfill. Laboratory analyses of the groundwater samples have detected similar concentrations of PFBA in DMW-3, which is presumably located downgradient of the site of the landfill fire. No other PFC compounds were detected in groundwater samples from DMW-3, and no PFCs have been detected in upgradient groundwater samples collected from DMW-1A.

At all of the firefighting foam training sites where groundwater was sampled as part of the PFC/Firefighting Foam investigation, foam training occurred either historically or over the course of several years time. There are no other sites besides the Kandiyohi County Landfill where groundwater was sampled so soon after the release of Class B AFFF, thus, there are no comparable sites to evaluate “breakthrough” data for PFC migration through soil and groundwater to a monitoring point. The lack of significant concentrations of PFCs detected in groundwater at DMW-3 may be due to travel time associated with both the migration of PFC-containing Class B AFFF from the surface of the landfill where foam was discharged to the water table, and the transport of PFCs in groundwater to the location of DMW-3.

Antea Group recommends additional sampling of groundwater at DMW-1A and DMW-3 to continue monitoring for PFCs in groundwater associated with the October 2009 discharge of firefighting foam. If significant concentrations of PFCs are detected at DMW-3 in the future, sampling for PFCs at the private well located approximately 1/2-mile downgradient should be considered.

3.3 Crystal Airport

Based on the relatively low concentrations of PFCs detected in soil and groundwater samples collected at Crystal Airport and in sediment and surface water samples collected from Shingle Creek adjacent to Crystal Airport, no further sampling at Crystal Airport or Shingle Creek is recommended at this time.

3.4 Lake Superior College ERTC

Based on the sediment and water samples collecting during this assessment, the elevated levels of PFCs detected in the creek and wetland sediment and surface water samples at the ERTC do not appear to be impacting the nearby drinking water supply wells at or above drinking water standards. According to the former and current program supervisors at the ERTC, Class B AFFF is no long used in training. The former program supervisor interviewed as part of this PFC/Firefighting Foam investigation indicated Class B AFFF hadn't been used at the ERTC since approximately 1996. No further assessment of PFCs at the Lake Superior College ERTC is recommended at this time.

3.5 Marathon Refinery

Sampling results for the water well samples collected from the five wells at the Hidden Harbor Marina indicate concentrations of PFCs are below the State HRL or other drinking water health-based values defined by the MDH. Based on the type of PFC compounds detected in the wells at the Marathon Refinery and the Hidden Harbor wells, the PFC impacts in groundwater at the Hidden Harbor Marina do not appear to be from the firefighting training area at the Marathon Refinery. The Marathon Refinery's fire department switched from 3M Class B alcohol resistant (AR)-AFFF to Ansul-brand AR-AFFF in approximately 2000. Spent foam and water used at the fire training area at the refinery is routed via storm sewers to an on-site wastewater treatment plant. No further well sampling at Marathon Refinery or the Hidden Harbor Marina in association with the PFC/Firefighting Foam project is recommended at this time.

3.6 ABLE Training Center, Burnsville

Relatively low levels of PFCs were detected in the surface water and sediment samples collected from the pond or wetland located downgradient of the ABLE Training Center. According to fire department personnel from Apple Valley, Burnsville, Lakeville and Eagan interviewed during this PFC/Firefighting Foam investigation, Class B AFFF has not been used at the ABLE Training Center since approximately 2004. No further sampling in association with PFCs identified at the ABLE Training Center in Burnsville is recommended at this time.

3.7 Bemidji Regional Airport

PFC concentrations detected in groundwater samples collected from nearby private wells were below the State HRL or other drinking water health-based values defined by the MDH. PFC concentrations detected in nearby municipal wells sampled by the MDH were also below the HRL or other drinking water health-based values. According to the training officer for the Bemidji Fire Department, they no longer train with Class B AFFF but use dish soap instead for training purposes. No further PFC sampling at the Bemidji Regional Airport or nearby wells appears warranted at this time.

3.8 Large Fire Sites

Sampling conducted as part of the MPCA's PFCs/Firefighting Foam investigation has identified PFCs in soil, groundwater, surface water and sediments at sites where significant quantities of Class B AFFF were discharged either repeatedly over time at a training site, or during a fire response. While the use of Class B AFFF is necessary and should be used to protect lives and property at a Class B fire, the release or migration of PFC-containing Class B AFFF to non-paved surfaces or surface water bodies will likely result in the release of PFCs to the environment. The release of PFC-containing Class B AFFF in or near environmentally sensitive areas such as Wellhead Protection Areas, areas with shallowly underlying karst bedrock, or lakes or streams may inadvertently provide an exposure pathway that may potentially impact human health via drinking water, direct exposure, or fish consumption. At large fire sites were significant quantities of Class B AFFF are discharged, the MPCA may want to assess the environmental setting, the presence of nearby surface waters, the presence of water supply wells in the area, and the potential risk posed to identified receptors. Water sample collection from private wells or surface water bodies for PFCs may be warranted dependent upon results of the assessment.

4.0 REMARKS

The recommendations contained in this report represent Antea Group's professional opinions based upon the currently available information and are arrived at in accordance with currently accepted professional standards. This report is based upon a specific scope of work requested by the client. The contract between Antea Group and its client outlines the scope of work, and only those tasks specifically authorized by that contract or outlined in this report were performed. This report is intended only for the use of Antea Group's client. Antea Group will not and cannot be liable for unauthorized reliance by any other third party. Other than as contained in this paragraph, Antea Group makes no express or implied warranty as to the contents of this report.

Nancy Rodning

Nancy Rodning
Project Geologist

Date: July 1, 2011

Reviewed by:

John Estes
Project Manager

Date: July 1, 2011

TABLES

TABLE 1
Groundwater and Surface Water PFC Analytical Results
Minnesota Fire Foam Training and Discharge Sites

			Perfluorobutanoic acid (PFBA)	Perfluoro-n-pentanoic acid (PFPeA)	Perfluorohexanoic acid (PFHxA)	Perfluoroheptanoic acid (PFHpA)	Perfluorooctanoic acid (PFOA)	Perfluorononanoic acid (PFNA)	Perfluorodecanoic acid (PFDA)	Perfluoroundecanoic acid (PFUnA)	Perfluorododecanoic acid (PFDoA)	Perfluorobutanoic sulfonate (PFBS)	Perfluorohexane sulfonate (PFHxS)	Perflurooctane sulfonate (PFOS)	Perfluorooctane sulfonylamide (PFOSA)
#Perfluorinated Carbon Chains:			**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**4**	**6**	**8**	**8**
Health-Based Limits:			**7000(1)**	**ND**	**ND**	**ND**	**300(2)**	**ND**	**ND**	**ND**	**ND**	**7000(1)**	**RAA(3)**	**300(2)**	**ND**
Sample ID	**Date**	**Laboratory**													
Harmony B-1 GW	4/23/2009	Axys	**7.3**	**3.27**	**2.67**	< 2.49	**7**	< 2.49	< 2.49	< 2.49	< 2.49	< 4.98	< 4.98	**8.33**	< 2.49
Harmony B-2 GW	4/23/2009	Axys	**9.04**	**2.52**	< 2.46	< 2.46	**6.92**	< 2.46	< 2.46	< 2.46	< 2.46	< 4.92	< 4.92	**6.74**	< 2.46
No St Paul B-1 GW	5/6/2009	Axys	**137**	**13.3**	**13.2**	**8.83**	**13.8**	< 3.49	< 3.49	< 3.49	< 3.49	< 6.99	**14.1**	< 6.99	< 3.49
No St Paul B-2 GW	5/6/2009	Axys	**145**	**15.5**	**14.1**	**8.22**	**13.2**	< 2.50	< 2.50	< 2.50	< 2.50	< 5.01	**14.8**	< 5.01	< 2.50
Richfield B-1 GW	5/7/2009	Axys	**1070**	**3470**	**3500**	**819**	**50.3**	< 18.8	< 18.8	< 18.8	< 18.8	**737**	**76.2**	< 37.7	< 18.8
Richfield B-2 GW	5/7/2009	Axys	**1240**	**4890**	**4170**	**1920**	**1330**	< 91.4	< 91.4	< 91.4	< 91.4	< 183	< 183	< 183	< 91.4
Richfield B-3 GW	5/7/2009	Axys	**201**	**331**	**888**	**217**	**458**	< 66.7	< 66.7	< 66.7	< 66.7	**293**	**689**	< 133	< 66.7
Legion Lake SW-1	8/27/2009	Axys	**4.02**	<7.21	< 2.51	**3.55**	**5.69**	**3.63**	**3.92**	< 2.51	< 2.51	< 5.02	< 5.02	**13.2**	< 2.51
*Richfield B-4 GW 29 ft.	10/8/2009	Axys	**228**	**10.3**	**10.3**	**5.43**	**38.7**	< 2.48	< 2.48	< 2.48	< 2.48	< 4.96	**71.4**	< 4.96	< 2.48
Luverne B-1 GW 8 ft.	5/22/2009	Axys	< 2.53	< 2.53	< 2.53	< 2.53	< 2.53	< 2.53	< 2.53	< 2.53	< 2.53	< 5.05	**18.1**	< 5.05	< 2.53
Luverne B-1 GW 8 ft.	5/22/2009	MPI	<25.0	<25.0	<25.0	<25.0	<25.0	<25.0	<25.0	<25.0	<25.0	<25.0	<25.0(4)	<25.0	<25.0
Luverne B-2 GW 12 ft.	5/22/2009	Axys	< 2.55	< 2.55	**3.78**	< 2.55	**2.73**	< 2.55	< 2.55	< 2.55	< 2.55	< 5.10	**22.8**	**18.4**	< 2.55
Luverne B-2 GW 12 ft.	5/22/2009	MPI	<25.0	<25.0	<25.0	<25.0	<25.0	<25.0	<25.0	<25.0	<25.0	<25.0	**25.1**	<25.0(6)	<25.0
Luverne B-3 GW 12 ft.	5/22/2009	Axys	< 2.53	**3.99**	**11.3**	< 2.53	**3.39**	< 2.53	< 2.53	< 2.53	< 2.53	< 5.07	**21.4**	**20.1**	< 2.53
Luverne B-3 GW 12 ft.	5/22/2009	MPI	<25.0	<25.0	<25.0(5)	<25.0	<25.0	<25.0	<25.0	<25.0	<25.0	<25.0	**28.8**	<25.0(7)	<25.0
Fridley B-1 GW	5/27/2009	Axys	**37.6**	**34**	**27.1**	**23.2**	**32.7**	< 4.27	< 4.27	< 4.27	< 4.27	**15.2**	**98.9**	**21.9**	< 4.27
Fridley B-2 GW	5/27/2009	Axys	**88.3**	**97.2**	**166**	**59.5**	**86.8**	< 5.39	< 5.39	< 5.39	< 5.39	**182**	**1330**	**35**	< 5.39
MSP Airport B-1 GW	5/29/2009	Axys	**279**	**909**	**1640**	**317**	**988**	**42**	< 41.2	< 41.2	< 41.2	**332**	**3090**	< 82.5	< 41.2
MSP Airport B-2 GW	5/29/2009	Axys	**190**	**507**	**817**	**198**	**958**	< 48.8	< 48.8	< 48.8	< 48.8	**286**	**2920**	< 97.6	< 48.8
MSP Airport B-3 GW	5/29/2009	Axys	**151**	**148**	**477**	< 135	**12000**	< 135	< 135	< 135	< 135	< 269	**21200**	**281**	< 135
MSP Airport B-4 GW	5/29/2009	Axys	< 1250	< 1250	**3140**	**5830**	**286000**	< 1250	< 1250	< 1250	< 1250	< 2500	**145000**	< 2500	< 1250
*MSP Airport B-5 GW	1/19/2010	Axys	**103**	**81.3**	**168**	**17.5**	**7.29**	< 2.63	< 2.63	< 2.63	< 2.63	160	110	< 5.26	< 2.63
*MSP Airport B-6 GW	1/19/2010	Axys	**58.6**	**60.4**	**187**	**44.6**	**11.2**	< 2.55	< 2.55	< 2.55	< 2.55	**64.1**	**204**	**11**	< 2.55
*MSP Airport B-7 GW	1/19/2010	Axys	**130**	**233**	**114**	< 2.53	**3.77**	< 2.53	< 2.53	< 2.53	< 2.53	**7.77**	< 5.05	< 5.05	< 2.53
CWN-14A GW	1/19/2010	Axys	**40.9**	**32.3**	**42.2**	**17.8**	**19.1**	< 2.54	< 2.54	< 2.54	< 2.54	< 5.07	**19.3**	**15.6**	< 2.54
CWN-15A GW	1/19/2010	Axys	**72**	**15.3**	**20.2**	**7.27**	**56.9**	< 2.75	< 2.75	< 2.75	< 2.75	**9.45**	**202**	< 5.50	< 2.75
Signature MW-2 GW	1/19/2010	Axys	**83.7**	**96.8**	**162**	**69.7**	**79.5**	< 6.57	< 5.40	< 5.40	< 5.40	**151**	**1780**	**953**	< 5.40

TABLE 1
Groundwater and Surface Water PFC Analytical Results
Minnesota Fire Foam Training and Discharge Sites

			Perfluorobutanoic acid (PFBA)	Perfluoro-n-pentanoic acid (PFPeA)	Perfluorohexanoic acid (PFHxA)	Perfluoroheptanoic acid (PFHpA)	Perfluorooctanoic acid (PFOA)	Perfluorononanoic acid (PFNA)	Perfluorodecanoic acid (PFDA)	Perfluoroundecanoic acid (PFUnA)	Perfluorododecanoic acid (PFDoA)	Perfluorobutanoic sulfonate (PFBS)	Perfluorohexane sulfonate (PFHxS)	Perfluorooctane sulfonate (PFOS)	Perfluorooctane sulfonylamide (PFOSA)
#Perfluorinated Carbon Chains:			**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**4**	**6**	**8**	**8**
Health-Based Limits:			**7000(1)**	**ND**	**ND**	**ND**	**300(2)**	**ND**	**ND**	**ND**	**ND**	**7000(1)**	**RAA(3)**	**300(2)**	**ND**
Sample ID	**Date**	**Laboratory**													
MSP SW-1	1/19/2010	Axys	**46.8**	**46**	**82.1**	**24.6**	**50.1**	**13.4**	**13.9**	< 2.46	< 2.46	**46.5**	**184**	**39**	< 2.46
Marathon MW-101	8/20/2009	MPI	**183**	**403**	**150**	**12.4**	**36.7**	<2.5	<2.5	<2.5	<2.5	**479**	**3710**	**93.2**	<2.5
*Marathon MW-912	8/20/2009	MPI	**462**	**298**	**51.5**	**21.8**	**17.5**	<2.5	<2.5	<2.5	<2.5	**37.0**	**1580**	**731**	<2.5
Marathon SP-11	8/20/2009	MPI	**182**	**458**	**171**	**52.2**	**35.6**	**20.7**	<2.5	<2.5	<2.5	**369**	**4910**	**5770**	<2.5
Marathon MW-172	8/20/2009	MPI	**59.8**	**245**	**154**	**25.1**	**15.5**	**11.4**	<2.5	<2.5	<2.5	**49.0**	**1220**	**1330**	<2.5
Marathon MW-156	8/20/2009	MPI	**220**	**1730**	**527**	**200**	**73.1**	**26.9**	<2.5	**2.58**	<2.5	**462**	**10500**	**14900**	<2.5
Marathon MW-156 Dupl.	8/20/2009	MPI	**221**	**1660**	**534**	**184**	**81.4**	**23.7**	<2.5	**2.93**	<2.5	**502**	**8930**	**11700**	**2.62**
Well A - Hidden Harbor	3/3/2011	Axys	< 2.51	< 2.51	< 2.51	< 2.51	< 2.51	< 2.51	< 2.51	< 2.51	< 2.51	< 5.02	< 5.02	< 5.02	< 2.51
Well B - Hidden Harbor	3/3/2011	Axys	**94.3**	**3.11**	< 2.49	< 2.49	< 2.49	< 2.49	< 2.49	< 2.49	< 2.49	< 4.98	< 4.98	< 4.98	< 2.49
Well C - Hidden Harbor	3/3/2011	Axys	< 2.51	< 2.51	< 2.51	< 2.51	< 2.51	< 2.51	< 2.51	< 2.51	< 2.51	< 5.03	< 5.03	< 5.03	< 2.51
Well D - Hidden Harbor	3/3/2011	Axys	**965**	**67.5**	**34.4**	< 11.8	**61.5**	< 11.8	< 11.8	< 11.8	< 11.8	< 23.5	< 23.5	< 23.5	< 11.8
Well E - Hidden Harbor	3/3/2011	Axys	**542**	< 16.5	< 16.5	< 16.5	< 16.5	< 16.5	< 16.5	< 16.5	< 16.5	< 33.1	< 33.1	< 33.1	< 16.5
Burnsville B-3 GW 44.5 ft.	8/27/2009	Axys	**146**	**422**	**281**	**447**	**1260**	**81.7**	**17.8**	< 2.52	< 2.52	**12.8**	**279**	**522**	< 2.52
Burnsville Pond SW-1	4/20/2011	Axys	**10.8**	< 2.55	< 2.55	**2.82**	**4.16**	< 2.55	< 2.55	< 2.55	< 2.55	< 5.10	< 5.10	< 5.10	< 2.55
Goodview SW-1	10/19/2009	Axys	< 2.53	< 2.53	**4.78**	< 2.53	**4.49**	**2.56**	**2.82**	< 2.53	< 2.53	< 5.06	< 5.06	**8.19**	< 2.53
Bemidji B-1 GW 15 ft.	11/5/2009	Axys	**4.14**	**3.85**	**14.5**	**3.75**	**49**	< 2.50	< 2.50	< 2.50	< 2.50	**19.1**	**227**	**483**	< 2.50
Bemidji B-2 GW 15 ft.	11/5/2009	Axys	**21.1**	**55.5**	**340**	**33.8**	**200**	< 12.2	< 12.2	< 12.2	< 12.2	**129**	**1490**	**789**	< 12.2
Bemidji 2021 Anne	3/24/2011	Axys	< 2.50	< 2.50	< 2.50	< 2.50	< 2.50	< 2.50	< 2.50	< 2.50	< 2.50	< 4.99	< 4.99	< 4.99	< 2.50
Bemidji 2326 Bardwell	3/24/2011	Axys	< 2.46	< 2.46	< 2.46	< 2.46	< 2.46	< 2.46	< 2.46	< 2.46	< 2.46	< 4.91	< 4.91	< 4.91	< 2.46
Bemidji 3481 Laurel	3/24/2011	Axys	< 2.52	< 2.52	< 2.52	< 2.52	< 2.52	< 2.52	< 2.52	< 2.52	< 2.52	< 5.05	< 5.05	< 5.05	< 2.52
Bemidji 2316 Bardwell	3/24/2011	Axys	**5.04**	< 2.56	< 2.56	< 2.56	< 2.56	< 2.56	< 2.56	< 2.56	< 2.56	< 5.12	< 5.12	< 5.12	< 2.56
Bemidji 2103 Anne	3/24/2011	Axys	< 2.48	< 2.48	< 2.48	< 2.48	< 2.48	< 2.48	< 2.48	< 2.48	< 2.48	< 4.96	**6.52**	**5.76**	< 2.48
Bemidji Kraus Anderson	3/24/2011	Axys	**6.68**	< 2.51	< 2.51	< 2.51	< 2.51	< 2.51	< 2.51	< 2.51	< 2.51	< 5.02	< 5.02	< 5.02	< 2.51
Bemidji 2120 Anne	3/29/2011	Axys	< 2.48	< 2.48	< 2.48	< 2.48	< 2.48	< 2.48	< 2.48	< 2.48	< 2.48	< 4.97	< 4.97	< 4.97	< 2.48
River Grove SW-1	11/18/2009	MPI	**3.54**	<2.5	<2.5	<2.5	**2.79**	<2.5	<2.5	<2.5	<2.5	**4.00**	<2.5	<2.5	<2.5
*River Grove SW-2	11/18/2009	MPI	**4.23**	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	**3.43**	<2.5	<2.5	<2.5

TABLE 1
Groundwater and Surface Water PFC Analytical Results
Minnesota Fire Foam Training and Discharge Sites

			Perfluorobutanoic acid (PFBA)	Perfluoro-n-pentanoic acid (PFPeA)	Perfluorohexanoic acid (PFHxA)	Perfluoroheptanoic acid (PFHpA)	Perfluorooctanoic acid (PFOA)	Perfluorononanoic acid (PFNA)	Perfluorodecanoic acid (PFDA)	Perfluoroundecanoic acid (PFUnA)	Perfluorododecanoic acid (PFDoA)	Perfluorobutanoic sulfonate (PFBS)	Perfluorohexane sulfonate (PFHxS)	Perflourooctane sulfonate (PFOS)	Perfluorooctane sulfonylamide (PFOSA)
#Perfluorinated Carbon Chains:			**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**4**	**6**	**8**	**8**
Health-Based Limits:			**7000(1)**	**ND**	**ND**	**ND**	**300(2)**	**ND**	**ND**	**ND**	**ND**	**7000(1)**	**RAA(3)**	**300(2)**	**ND**
Sample ID	**Date**	**Laboratory**													
ERTC SW-1	11/25/2009	Axys	**257**	**537**	**1790**	**348**	**991**	**31.8**	**3.45**	< 2.51	< 2.51	**1870**	**9390**	**11300**	**360**
ERTC SW-2	11/18/2010	Axys	**76.8**	**144**	**476**	**66.2**	**290**	**22.4**	< 2.49	< 2.49	< 2.49	**315**	**2630**	**7640(1)**	**134(1)**
ERTC SW-3	11/18/2010	Axys	**35**	**62.8**	**366**	**39.5**	**234**	**5.62**	< 2.49	< 2.49	< 2.49	**135**	**1510**	**7630**	**385**
ERTC-10801	11/29/2010	Axys	< 2.50	< 2.50	< 2.50	< 2.50	< 2.50	< 2.50	< 2.50	< 2.50	< 2.50	< 5.00	**11.2**	**6.49**	< 2.50
ERTC-11601	11/29/2010	Axys	< 2.47	< 2.47	< 2.47	< 2.47	< 2.47	< 2.47	< 2.47	< 2.47	< 2.47	< 4.95	**9.63**	**7.26**	< 2.47
Kandiyohi DMW-1A	1/12/2010	Axys	< 2.43	< 2.43	< 2.43	< 2.43	< 2.43	< 2.43	< 2.43	< 2.43	< 2.43	< 4.87	< 4.87	< 4.87	< 2.43
Kandiyohi DMW-3	1/12/2010	Axys	**6.1**	< 2.51	< 2.51	< 2.51	< 2.51	< 2.51	< 2.51	< 2.51	< 2.51	< 5.01	< 5.01	< 5.01	< 2.51
Kandiyohi DMW-1A	5/4/2010	Axys	< 2.49	< 2.49	< 2.49	< 2.49	< 2.49	< 2.49	< 2.49	< 2.49	< 2.49	< 4.99	< 4.99	< 4.99	< 2.49
Kandiyohi DMW-3	5/4/2010	Axys	**11**	< 2.49	< 2.49	< 2.49	< 2.49	< 2.49	< 2.49	< 2.49	< 2.49	< 4.98	< 4.98	< 4.98	< 2.49
Kandiyohi DMW-1A	8/12/2010	Axys	< 2.54	< 2.54	< 2.54	< 2.54	< 2.54	< 2.54	< 2.54	< 2.54	< 2.54	< 5.09	< 5.09	< 5.09	< 2.54
Kandiyohi DMW-3	8/12/2010	Axys	**7.61**	< 2.48	< 2.48	< 2.48	< 2.48	< 2.48	< 2.48	< 2.48	< 2.48	< 4.95	< 4.95	< 4.95	< 2.48
Crystal B-1 GW 5.5 ft.	1/20/2010	Axys	**16.2**	< 2.56	< 2.56	< 2.56	< 2.56	< 2.56	< 2.56	< 2.56	< 2.56	< 5.12	< 5.12	< 5.12	< 2.56
Crystal B-2 GW 6 ft.	1/20/2010	Axys	**37.3**	< 2.50	< 2.50	< 2.50	**2.65**	< 2.50	< 2.50	< 2.50	< 2.50	< 5.01	< 5.01	**5.27**	< 2.50
Crystal SW-1	10/1/2010	Axys	**35.7**	**5.54**	**5.62**	**3.31**	**6.28**	< 2.48	< 2.48	< 2.48	< 2.48	< 4.97	< 4.97	**8.18**	< 2.48
Crystal SW-2	10/1/2010	Axys	**25.4**	**4.58**	**4.91**	< 2.58	**5.95**	< 2.58	< 2.58	< 2.58	< 2.58	< 5.16	< 5.16	< 5.16	< 2.58
*FHR Pine Bend MW-1	1/21/2010	Axys	**179**	**12.5**	**10.1**	< 2.45	**4.63**	< 2.45	< 2.45	< 2.45	< 2.45	**8.67**	**25.9**	**28.5**	< 2.45
FHR Pine Bend MW-3	1/21/2010	Axys	**310**	**136**	**251**	**43.7**	**49.1**	< 2.48	< 2.48	< 2.48	< 2.48	**181**	**516**	**245**	< 2.48
FHR Pine Bend MW-111	1/21/2010	Axys	**156**	**7.58**	**3.62**	< 2.42	**3.92**	< 2.42	< 2.42	< 2.42	< 2.42	< 4.84	< 4.84	< 4.84	< 2.42
Kings Cove Marina SW-1	12/3/2009	MPI	**180**	**10.2**	**9.87**	**3.41**	**25.8**	< 2.5	< 2.5	< 2.5	< 2.5	**17.5**	**17.8**	**13.7**	< 2.5
Kings Cove Marina Dup (SW-1)	12/3/2009	MPI	**177**	**10.0**	**8.83**	**2.95**	**22.9**	< 2.5	< 2.5	< 2.5	< 2.5	**18.7**	**17.9**	**13.4**	<2.5
Kings Cove Marina SW-2	12/3/2009	MPI	**170**	**9.93**	**10.5**	**3.05**	**25.4**	< 2.5	< 2.5	< 2.5	< 2.5	**16.8**	**19.1**	**16.2**	< 2.5
Duluth Intl. Airport GWS-1	10/2007	Axys	**2310**	**7160**	**13000**	**1340**	**4800**	< 45.7	< 45.7	< 45.7	< 45.7	**2000**	**626**	< 91.3	< 45.7
Duluth Intl. Airport GWS-2	10/2007	Axys	**482**	**1090**	**3590**	**534**	**4640**	**13.1**	< 12.4	< 12.4	< 12.4	**913**	**3440**	< 24.8	< 12.4
Duluth Intl. Airport Dup (GWS-2)	10/2007	Axys	**496**	**1250**	**4370**	**522**	**4250**	< 12.6	< 12.6	< 12.6	< 12.6	**953**	**3320**	< 25.2	< 12.6
Duluth Intl. Airport GWS-3	10/2007	Axys	**1900**	**6940**	**10800**	**1760**	**6790**	**88.5**	< 43.6	< 43.6	< 43.6	**2020**	**1690**	**98.8**	< 43.6
Duluth Intl. Airport GWS-4	10/2007	Axys	**1110**	**4780**	**11500**	**2000**	**8780**	< 31.9	< 31.9	< 31.9	< 31.9	**1630**	**4070**	< 63.8	< 31.9
Duluth Intl. Airport GWS-5	10/2007	Axys	**6.25**	**1.66**	**3.06**	**1.96**	**6.18**	< 0.991	< 0.991	< 0.991	< 0.991	**2.87**	**33.5**	**3.41**	< 0.991

TABLE 1
Groundwater and Surface Water PFC Analytical Results
Minnesota Fire Foam Training and Discharge Sites

			Perfluorobutanoic acid (PFBA)	Perfluoro-n-pentanoic acid (PFPeA)	Perfluorohexanoic acid (PFHxA)	Perfluoroheptanoic acid (PFHpA)	Perfluorooctanoic acid (PFOA)	Perfluorononanoic acid (PFNA)	Perfluorodecanoic acid (PFDA)	Perfluoroundecanoic acid (PFUnA)	Perfluorododecanoic acid (PFDoA)	Perfluorobutanoic sulfonate (PFBS)	Perfluorohexane sulfonate (PFHxS)	Perflourooctane sulfonate (PFOS)	Perfluorooctane sulfonylamide (PFOSA)
#Perfluorinated Carbon Chains:			4	5	6	7	8	9	10	11	12	4	6	8	8
Health-Based Limits:			7000(1)	ND	ND	ND	300(2)	ND	ND	ND	ND	7000(1)	RAA(3)	300(2)	ND
Sample ID	**Date**	**Laboratory**													
Duluth Intl. Airport GWS-6	10/2007	Axys	**694**	**1750**	**2750**	**497**	**1500**	**14.8**	< 10.3	< 10.3	< 10.3	**776**	**1880**	< 20.6	< 10.3
WAFTA BG-2	5/11/2006	MDH	< 1000	< 1000	< 1000	NA	**1000**	NA	NA	NA	NA	< 500	**200(J)**	< 500	NA
WAFTA BG-4	5/11/2006	MDH	**800(J)**	**3200**	**2300**	NA	**2100**	NA	NA	NA	NA	< 500	**2100**	**2200**	NA
WAFTA MW-1	5/11/2006	MDH	< 1000	< 1000	**300(J)**	NA	**7400**	NA	NA	NA	NA	< 500	**200(J)**	< 500	NA
WAFTA MW-2	5/11/2006	MDH	**2400**	**8900**	**7800**	NA	**7900**	NA	NA	NA	NA	**600**	**9900**	**9500**	NA
WAFTA MW-3	5/10/2006	MDH	< 1000	< 1000	**300(J)**	NA	< 1000	NA	NA	NA	NA	**200(J)**	**5100**	**22000**	NA
WAFTA MW-4	5/10/2006	MDH	**9900**	**42000**	**30000**	NA	**43000**	NA	NA	NA	NA	**1500**	**42000**	**118000**	NA
WAFTA MW-4	5/10/2006	Exygen	**14100**	**66300**	**43600**	NA	**41100**	NA	NA	NA	NA	**1820**	**43800**	**114000**	NA
WAFTA MW-5	5/10/2006	MDH	< 1000	**200(J)**	**300(J)**	NA	**700(J)**	NA	NA	NA	NA	< 500	**700**	**2100**	NA
WAFTA MW-5	5/10/2006	Exygen	< 1000	< 1000	< 1000	NA	< 1000	NA	NA	NA	NA	< 1000	< 1000	**1460**	NA
WAFTA MW-7	5/11/2006	MDH	**1200**	**3800**	**3400**	NA	**1000**	NA	NA	NA	NA	**200(J)**	**2300**	**3900**	NA
WAFTA MW-8	5/10/2006	MDH	**90(J)**	**400(J)**	**300(J)**	NA	**100(J)**	NA	NA	NA	NA	< 500	< 500	**1300**	NA
WAFTA MW-8	5/10/2006	Exygen	< 1000	< 1000	< 1000	NA	< 1000	NA	NA	NA	NA	< 1000	< 1000	< 1000	NA
WAFTA MW-9	5/11/2006	MDH	< 1000	< 1000	< 1000	NA	< 1000	NA	NA	NA	NA	< 500	< 500	< 500	NA
WAFTA MW-10	5/10/2006	MDH	**700(J)**	**2000**	**2000**	NA	**2300**	NA	NA	NA	NA	**500**	**12000**	**27000**	NA
WAFTA MW-10	5/10/2006	Exygen	< 1000	**3350**	**3320**	NA	**2270**	NA	NA	NA	NA	< 1000	**11600**	**18400**	NA
WAFTA MW-11	5/10/2006	MDH	< 1000	< 1000	< 1000	NA	< 1000	NA	NA	NA	NA	< 500	< 500	< 500	NA
WAFTA MW-11	5/10/2006	Exygen	< 1000	< 1000	< 1000	NA	< 1000	NA	NA	NA	NA	< 1000	< 1000	< 1000	NA
WAFTA MW-12	5/11/2006	MDH	< 1000	< 1000	< 1000	NA	< 1000	NA	NA	NA	NA	< 500	< 500	< 500	NA
WAFTA MW-13	5/10/2006	MDH	< 1000	< 1000	< 1000	NA	< 1000	NA	NA	NA	NA	< 500	**300(J)**	< 500	NA
Up North Plastics SW-1	7/16/2009	Axys	**1230**	**64.3**	**34.5**	**12**	**242**	< 2.52	< 2.52	< 2.52	< 2.52	**20.7**	**32.4**	< 5.04	< 2.52
Up North Plastics SW-2	7/16/2009	Axys	**436**	**36.1**	**26.9**	**9.43**	**78.3**	**3.37**	< 2.53	< 2.53	< 2.53	**9.42**	**7.4**	< 5.06	< 2.53
Up North Plastics SW Dup	7/16/2009	Axys	**572**	**39.4**	**28.1**	**9.92**	**87.5**	< 2.50	< 2.50	< 2.50	< 2.50	**10.3**	**10.8**	**7.64**	< 2.50
Up North Plastics Zywiec Irrigation Well 1	7/29/2009	MDH	**1242.3**	**51.4**	0	NA	0	NA	NA	NA	NA	0	0	0	NA
Up North Plastics Zywiec Irrigation Well 2	7/29/2009	MDH	**447**	0	0	NA	0	NA	NA	NA	NA	0	0	0	NA
Up North Plastics Zywiec Irrigation Well 3	7/29/2009	MDH	**2133.6**	**106.2**	**61**	NA	**55**	NA	NA	NA	NA	0	0	0	NA

TABLE 1
Groundwater and Surface Water PFC Analytical Results
Minnesota Fire Foam Training and Discharge Sites

			Perfluorobutanoic acid (PFBA)	Perfluoro-n-pentanoic acid (PFPeA)	Perfluorohexanoic acid (PFHxA)	Perfluoroheptanoic acid (PFHpA)	Perfluorooctanoic acid (PFOA)	Perfluorononanoic acid (PFNA)	Perfluorodecanoic acid (PFDA)	Perfluoroundecanoic acid (PFUnA)	Perfluorododecanoic acid (PFDoA)	Perfluorobutanoic sulfonate (PFBS)	Perfluorohexane sulfonate (PFHxS)	Perflourooctane sulfonate (PFOS)	Perfluorooctane sulfonylamide (PFOSA)
#Perfluorinated Carbon Chains:			**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**4**	**6**	**8**	**8**
Health-Based Limits:			**7000(1)**	**ND**	**ND**	**ND**	**300(2)**	**ND**	**ND**	**ND**	**ND**	**7000(1)**	**RAA(3)**	**300(2)**	**ND**
Sample ID	**Date**	**Laboratory**													
Up North Plastics Smallidge	7/29/2009	MDH	**1046.3**	**51.6**	0	NA	**53.3**	NA	NA	NA	NA	0	0	0	NA

Notes:

All results and standards are in nanograms per liter (ng/L), which is equivalent to parts per trillion.

Axys: Axys Analytical Services LTD

MPI: MPI Research

MDH: Minnesota Department of Health Environmental Laboratory.

Exygen: Exygen Research

Bolded type indicates detection above the laboratory method detection limit.

Highlighted concentrations exceed the Health-Based Limit.

(1) Health-Based Value (HBV) for chronic exposure defined by the Minnesota Department of Health.

(2) Health Risk Limit (HRL) for drinking water defined by the Minnesota Department of Health.

(3) Risk Assessment Advice (RAA) set by the Minnesota Department of Health for PFHxS does not specify numeric values.

ND: No health-based limit defined.

(4) Manually Calculated Result is 18.9

(5) Manually Calculated Result is 17.1

(6) Manually Calculated Result is 23.3

(7) Manually Calculated Result is 21.7

(J) Analyte positively identified, result is below reporting limit and is estimated.

*Sample collected upgradient of fire foam training or discharge area, intended to act as "background" sample.

NA: Not analyzed

TABLE 2
Soil and Sediment Analytical Results, PFCs and TOC
Minnesota Fire Foam Training and Discharge Sites

				Perfluorobutanoic acid (PFBA)	Perfluoro-n-pentanoic acid (PFPeA)	Perfluorohexanoic acid (PFHxA)	Perfluoroheptanoic acid (PFHpA)	Perfluorooctanoic acid (PFOA)	Perfluorononanoic acid (PFNA)	Perfluorodecanoic acid (PFDA)	Perfluoroundecanoic acid (PFUnA)	Perfluorododecanoic acid (PFDoA)	Perfluorobutanoic sulfonate (PFBS)	Perfluorohexane sulfonate (PFHxS)	Perflourooctane sulfonate (PFOS)	Perfluorooctane sulfonylamide (PFOSA)	Mean Total Organic Carbon (TOC)
#Perfluorinated Carbon Chains:				**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**4**	**6**	**8**	**8**	**--**
Tier 1 Residential SRV:				**77000**	**ND**	**ND**	**ND**	**2100**	**ND**	**ND**	**ND**	**ND**	**ND**	**ND**	**2100**	**ND**	**ND**
Tier 2 Recreational SRV:				**94000**	**ND**	**ND**	**ND**	**2500**	**ND**	**ND**	**ND**	**ND**	**ND**	**ND**	**2600**	**ND**	**ND**
Tier 2 Industrial SRV:				**500000**	**ND**	**ND**	**ND**	**13000**	**ND**	**ND**	**ND**	**ND**	**ND**	**ND**	**14000**	**ND**	**ND**
Sample ID	**Sample Depth**	**Sample Date**	**Laboratory**														
Harmony B-1 SL 0-4'	0-4 ft.	4/23/2009	Axys	< 0.0955	< 0.0955	< 0.0955	< 0.0955	< 0.0955	< 0.0955	< 0.0955	< 0.0955	< 0.0955	< 0.191	< 0.191	< 0.191	< 0.0955	3230
Harmony B-1 SL 4-8'	4-8 ft.	4/23/2009	Axys	< 0.101	< 0.101	< 0.101	< 0.101	< 0.101	< 0.101	< 0.101	< 0.101	< 0.101	< 0.201	< 0.201	< 0.201	< 0.101	1720
Harmony B-2 SL 0-4'	0-4 ft.	4/23/2009	Axys	< 0.0947	< 0.0947	< 0.0947	< 0.0947	< 0.0947	< 0.0947	< 0.0947	< 0.0947	< 0.0947	< 0.189	< 0.189	< 0.189	< 0.0947	6150
Harmony B-2 SL 4-8'	4-8 ft.	4/23/2009	Axys	< 0.0962	< 0.0962	< 0.0962	< 0.0962	< 0.0962	< 0.0962	< 0.0962	< 0.0962	< 0.0962	< 0.192	< 0.192	< 0.192	< 0.0962	1260
Harmony B-3 SL 0-4'	0-4 ft.	4/23/2009	Axys	< 0.0977	**0.2**	< 0.0977	**0.161**	< 0.0977	**0.125**	< 0.0977	< 0.0977	< 0.0977	< 0.195	< 0.195	< 0.195	< 0.0977	2380
Harmony B-3 SL 4-8'	4-8 ft.	4/23/2009	Axys	< 0.0950	< 0.0950	< 0.0950	< 0.0950	< 0.0950	< 0.0950	< 0.0950	< 0.0950	< 0.0950	< 0.190	< 0.190	< 0.190	< 0.0950	1770
Harmony B-4 SL 0-4'	0-4 ft.	4/23/2009	Axys	< 0.0989	**0.253**	**0.133**	**0.15**	< 0.0989	< 0.0989	< 0.0989	< 0.0989	< 0.0989	< 0.198	< 0.198	< 0.198	< 0.0989	2380
Harmony B-4 SL 4-8'	4-8 ft.	4/23/2009	Axys	< 0.100	< 0.100	< 0.100	< 0.100	< 0.100	< 0.100	< 0.100	< 0.100	< 0.100	< 0.200	< 0.200	< 0.200	< 0.100	1500
Burnsville B-1 SL 0-4'	0-4 ft.	4/24/2009	Axys	**1.73**	**5.32**	**3.27**	**6.72**	**11.4**	**10.2**	**4.37**	**0.537**	**0.542**	< 0.192	**2.63**	**102**	< 0.0962	21700
Burnsville B-1 SL 4-8'	4-8 ft.	4/24/2009	Axys	**0.132**	**1.54**	**1.77**	**8.46**	**14.8**	< 0.0956	< 0.0956	< 0.0956	< 0.0956	< 0.191	**11**	**1.62**	< 0.0956	2240
Burnsville B-2 SL 0-4'	0-4 ft.	4/24/2009	Axys	**0.796**	**3.08**	**1.69**	**1.05**	**5.78**	**7.92**	< 0.0992	< 0.0992	< 0.0992	< 0.198	< 0.198	**2.8**	< 0.0992	22300
Burnsville B-2 SL 4-8'	4-8 ft.	4/24/2009	Axys	**1.83**	**4.81**	**3.97**	**4.14**	**0.355**	< 0.0985	< 0.0985	< 0.0985	< 0.0985	< 0.197	**1.2**	< 0.197	< 0.0985	12400
Burnsville Pond Sed-1	0-6 in.	4/20/2011	Axys	< 0.0986	< 0.0986	< 0.0986	< 0.0986	< 0.0986	< 0.0986	**0.168**	**0.371**	**0.787**	< 0.197	< 0.197	**0.87**	**0.122**	NA
No St Paul B-1 SL 0-4'	0-4 ft.	5/6/2009	Axys	< 0.0926	< 0.0926	< 0.0926	< 0.0926	< 0.0926	< 0.0926	< 0.0926	< 0.0926	< 0.0926	< 0.185	< 0.185	< 0.185	< 0.0926	19600
No St Paul B-1 SL 4-8'	4-8 ft.	5/6/2009	Axys	< 0.0998	< 0.0998	< 0.0998	< 0.0998	< 0.0998	< 0.0998	< 0.0998	< 0.0998	< 0.0998	< 0.200	< 0.200	< 0.200	< 0.0998	624
No St Paul B-2 SL 0-4'	0-4 ft.	5/6/2009	Axys	< 0.0954	< 0.0954	< 0.0954	< 0.0954	< 0.0954	< 0.0954	< 0.0954	< 0.0954	< 0.0954	< 0.191	< 0.191	< 0.191	< 0.0954	27400
No St Paul B-2 SL 4-8'	4-8 ft.	5/6/2009	Axys	< 0.0978	< 0.0978	< 0.0978	< 0.0978	< 0.0978	< 0.0978	< 0.0978	< 0.0978	< 0.0978	< 0.196	< 0.196	< 0.196	< 0.0978	796
No St Paul B-3 SL 0-2'	0-2 ft.	5/6/2009	Axys	< 0.0972	< 0.0972	< 0.0972	< 0.0972	**0.107**	< 0.0972	< 0.0972	< 0.0972	< 0.0972	< 0.194	< 0.194	**0.623**	< 0.0972	12700
Richfield B-1 0-4'	0-4 ft.	5/7/2009	Axys	< 0.0932	**0.226**	**0.191**	**0.433**	**1.36**	**1.44**	**0.095**	< 0.0932	< 0.0932	< 0.186	**1.26**	**104**	**0.21**	2170
Richfield B-1 4-8'	4-8 ft.	5/7/2009	Axys	**0.322**	**1.43**	**0.905**	**0.592**	**1.11**	**1.89**	< 0.0966	< 0.0966	< 0.0966	< 0.193	**1.44**	**102**	< 0.0966	355
Richfield B-2 0-4'	0-4 ft.	5/7/2009	Axys	**0.464**	**1.33**	**1.07**	**0.85**	**2.32**	**5.03**	**0.306**	< 0.186	< 0.186	< 0.373	**13**	**401**	**0.47**	8370
Richfield B-2 4-8'	4-8 ft.	5/7/2009	Axys	**1.04**	**4.52**	**4.7**	**3.28**	**5.02**	**4.83**	< 0.379	< 0.379	< 0.379	< 0.757	**32.2**	**666**	< 0.379	6100
Richfield B-3 0-4'	0-4 ft.	5/7/2009	Axys	< 0.0942	< 0.0942	**0.314**	**0.309**	**1.49**	< 0.0942	< 0.0942	< 0.0942	< 0.0942	< 0.188	**21.9**	**56.4**	< 0.0942	13100
Richfield B-3 4-8'	4-8 ft.	5/7/2009	Axys	**0.173**	**0.439**	**1.02**	**0.283**	**0.336**	< 0.104	< 0.104	< 0.104	< 0.104	**0.57**	**2.35**	**9.33**	< 0.104	36900
Richfield B-4 0-8'	0-8 ft.	10/8/2009	Axys	< 0.0956	< 0.0956	< 0.0956	< 0.0956	**0.129**	< 0.0956	< 0.0956	< 0.0956	< 0.0956	< 0.191	**0.236**	**4.52**	< 0.0956	NA
Kenyon B-1 SL 0-4'	0-4 ft.	5/15/2009	Axys	< 0.0963	< 0.0963	< 0.0963	**0.111**	< 0.0963	< 0.0963	< 0.0963	< 0.0963	< 0.0963	< 0.193	< 0.193	< 0.193	< 0.0963	26300
Kenyon B-1 SL 0-4'	0-4 ft.	5/15/2009	MPI	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	NA
Kenyon B-1 SL 4-8'	4-8 ft.	5/15/2009	Axys	< 0.0944	< 0.0944	< 0.0944	< 0.0944	< 0.0944	< 0.0944	< 0.0944	< 0.0944	< 0.0944	< 0.189	< 0.189	< 0.189	< 0.0944	23600
Kenyon B-1 SL 4-8'	4-8 ft.	5/15/2009	MPI	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	NA
Kenyon B-2 SL 0-4'	0-4 ft.	5/15/2009	Axys	< 0.0937	< 0.0937	< 0.0937	< 0.0937	< 0.0937	< 0.0937	< 0.0937	< 0.0937	< 0.0937	< 0.187	< 0.187	< 0.187	< 0.0937	13300
Kenyon B-2 SL 0-4'	0-4 ft.	5/15/2009	MPI	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	NA

TABLE 2
Soil and Sediment Analytical Results, PFCs and TOC
Minnesota Fire Foam Training and Discharge Sites

				Perfluorobutanoic acid (PFBA)	Perfluoro-n-pentanoic acid (PFPeA)	Perfluorohexanoic acid (PFHxA)	Perfluoroheptanoic acid (PFHpA)	Perfluorooctanoic acid (PFOA)	Perfluorononanoic acid (PFNA)	Perfluorodecanoic acid (PFDA)	Perfluoroundecanoic acid (PFUnA)	Perfluorododecanoic acid (PFDoA)	Perfluorobutanoic sulfonate (PFBS)	Perfluorohexane sulfonate (PFHxS)	Perflourooctane sulfonate (PFOS)	Perfluorooctane sulfonylamide (PFOSA)	Mean Total Organic Carbon (TOC)
#Perfluorinated Carbon Chains:				**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**4**	**6**	**8**	**8**	**--**
Tier 1 Residential SRV:				**77000**	**ND**	**ND**	**ND**	**2100**	**ND**	**ND**	**ND**	**ND**	**ND**	**ND**	**2100**	**ND**	**ND**
Tier 2 Recreational SRV:				**94000**	**ND**	**ND**	**ND**	**2500**	**ND**	**ND**	**ND**	**ND**	**ND**	**ND**	**2600**	**ND**	**ND**
Tier 2 Industrial SRV:				**500000**	**ND**	**ND**	**ND**	**13000**	**ND**	**ND**	**ND**	**ND**	**ND**	**ND**	**14000**	**ND**	**ND**
Sample ID	**Sample Depth**	**Sample Date**	**Laboratory**														
Kenyon B-2 SL 4-8'	4-8 ft.	5/15/2009	Axys	< 0.0943	< 0.0943	< 0.0943	< 0.0943	< 0.0943	< 0.0943	< 0.0943	< 0.0943	< 0.0943	< 0.189	< 0.189	< 0.189	< 0.0943	25600
Kenyon B-2 SL 4-8'	4-8 ft.	5/15/2009	MPI	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	NA
Claremont B-1 SL 0-4'	0-4 ft.	5/15/2009	Axys	< 0.0907	< 0.0907	< 0.0907	< 0.0907	< 0.0907	< 0.0907	< 0.0907	< 0.0907	< 0.0907	< 0.181	< 0.181	**0.308**	< 0.0907	217000
Claremont B-1 SL 0-4'	0-4 ft.	5/15/2009	MPI	**0.413**	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	**0.773**	<0.2	<0.2	NA
Claremont B-1 SL 4-8'	4-8 ft.	5/15/2009	Axys	< 0.0966	< 0.0966	< 0.0966	< 0.0966	< 0.0966	< 0.0966	< 0.0966	< 0.0966	< 0.0966	< 0.193	**0.224**	**0.321**	< 0.0966	14800
Claremont B-1 SL 4-8'	4-8 ft.	5/15/2009	MPI	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	NA
Claremont B-2 SL 0-4'	0-4 ft.	5/15/2009	Axys	< 0.0936	< 0.0936	**0.385**	< 0.0936	**0.154**	< 0.0936	< 0.0936	< 0.0936	< 0.0936	**0.491**	**1.65**	**24.7**	**0.129**	184000
Claremont B-2 SL 4-8'	4-8 ft.	5/15/2009	Axys	< 0.0958	< 0.0958	< 0.0958	< 0.0958	< 0.0958	< 0.0958	< 0.0958	< 0.0958	< 0.0958	< 0.192	< 0.192	**0.25**	< 0.0958	7500
Claremont B-3 SL 0-4'	0-4 ft.	5/15/2009	Axys	**0.114**	**0.167**	**0.427**	**0.232**	**0.174**	< 0.0912	< 0.0912	< 0.0912	< 0.0912	**2.39**	**5.25**	**3.46**	< 0.0912	35200
Claremont B-3 SL 4-8'	4-8 ft.	5/15/2009	Axys	< 0.0935	< 0.0935	< 0.0935	< 0.0935	< 0.0935	< 0.0935	< 0.0935	< 0.0935	< 0.0935	< 0.187	**0.561**	**0.988**	< 0.0935	453
Luverne B-1 SL 0-4'	0-4 ft.	5/22/2009	Axys	< 0.0962	< 0.0962	< 0.0962	< 0.0962	< 0.0962	< 0.0962	< 0.0962	< 0.0962	< 0.0962	< 0.192	< 0.192	< 0.481	< 0.241	12500
Luverne B-1 SL 0-4'	0-4 ft.	5/22/2009	MPI	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	NA
Luverne B-1 SL 4-8'	4-8 ft.	5/22/2009	Axys	< 0.0981	< 0.0981	< 0.0981	< 0.0981	< 0.0981	< 0.0981	< 0.0981	< 0.0981	< 0.0981	< 0.196	< 0.196	< 0.490	< 0.245	13300
Luverne B-1 SL 4-8'	4-8 ft.	5/22/2009	MPI	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	NA
Luverne B-2 SL 0-4'	0-4 ft.	5/22/2009	Axys	< 0.0954	< 0.0954	< 0.0954	< 0.0954	< 0.0954	< 0.0954	< 0.0954	< 0.0954	< 0.0954	< 0.191	< 0.191	**0.481**	< 0.239	10300
Luverne B-2 SL 0-4'	0-4 ft.	5/22/2009	MPI	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	NA
Luverne B-2 SL 4-8'	4-8 ft.	5/22/2009	Axys	< 0.100	< 0.100	< 0.100	< 0.100	< 0.100	< 0.100	< 0.100	< 0.100	< 0.100	< 0.200	< 0.200	< 0.500	< 0.250	14400
Luverne B-2 SL 4-8'	4-8 ft.	5/22/2009	MPI	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	NA
Luverne B-3 SL 0-4'	0-4 ft.	5/22/2009	Axys	< 0.0974	< 0.0974	< 0.0974	< 0.0974	< 0.0974	< 0.0974	< 0.0974	< 0.0974	< 0.0974	< 0.195	< 0.195	< 0.487	< 0.244	7860
Luverne B-3 SL 0-4'	0-4 ft.	5/22/2009	MPI	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	NA
Luverne B-3 SL 4-8'	4-8 ft.	5/22/2009	Axys	< 0.0984	< 0.0984	< 0.0984	< 0.0984	< 0.0984	< 0.0984	< 0.0984	< 0.0984	< 0.0984	< 0.197	< 0.197	< 0.492	< 0.246	39500
Luverne B-3 SL 4-8'	4-8 ft.	5/22/2009	MPI	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	NA
Fridley B-1 SL 0-4'	0-4 ft.	5/27/2009	Axys	**0.242**	**0.422**	**0.413**	**0.27**	**0.291**	**0.144**	< 0.100	< 0.100	< 0.100	< 0.201	**1.25**	**43**	< 0.100	55700
Fridley B-1 SL 4-8'	4-8 ft.	5/27/2009	Axys	< 0.101	< 0.101	< 0.101	< 0.101	< 0.101	< 0.101	< 0.101	< 0.101	< 0.101	< 0.201	< 0.201	**2.45**	< 0.101	1670
Fridley B-2 SL 0-4'	0-4 ft.	5/27/2009	Axys	**1.34**	**1.67**	**2.78**	**0.735**	**0.699**	< 0.102	< 0.102	< 0.102	< 0.102	**3.01**	**23.4**	**3.48**	< 0.102	11400
Fridley B-2 SL 4-8'	4-8 ft.	5/27/2009	Axys	**0.601**	**1.13**	**1.53**	**0.335**	**0.493**	< 0.0950	< 0.0950	< 0.0950	< 0.0950	**1.32**	**14.2**	**1.31**	< 0.0950	19800
Fridley B-3 Sediment 6"	0.5 ft.	5/27/2009	Axys	< 0.0966	< 0.0966	< 0.0966	< 0.0966	< 0.0966	< 0.0966	< 0.0966	< 0.0966	< 0.0966	< 0.193	< 0.193	**18.3**	< 0.0966	14800
Rochester B-1 SL 0-4'	0-4 ft.	5/28/2009	Axys	**0.207**	< 0.0979	< 0.0979	< 0.0979	< 0.0979	< 0.0979	< 0.0979	< 0.0979	< 0.0979	< 0.196	**0.361**	**0.559**	< 0.0979	4100
Rochester B-1 SL 4-8'	4-8 ft.	5/29/2009	Axys	< 0.0957	< 0.0957	< 0.0957	< 0.0957	< 0.0957	< 0.0957	< 0.0957	< 0.0957	< 0.0957	< 0.191	< 0.191	< 0.191	< 0.0957	1440
Rochester B-2 SL 0-4'	0-4 ft.	5/28/2009	Axys	**0.142**	< 0.0999	**0.173**	< 0.0999	< 0.0999	< 0.0999	< 0.0999	< 0.0999	< 0.0999	< 0.200	**1.7**	**1.12**	< 0.0999	4780
Rochester B-2 SL 4-8'	4-8 ft.	5/29/2009	Axys	< 0.0949	< 0.0949	< 0.0949	< 0.0949	< 0.0949	< 0.0949	< 0.0949	< 0.0949	< 0.0949	< 0.190	< 0.190	< 0.190	< 0.0949	431

TABLE 2
Soil and Sediment Analytical Results, PFCs and TOC
Minnesota Fire Foam Training and Discharge Sites

				Perfluorobutanoic acid (PFBA)	**Perfluoro-n-pentanoic acid (PFPeA)**	**Perfluorohexanoic acid (PFHxA)**	**Perfluoroheptanoic acid (PFHpA)**	**Perfluorooctanoic acid (PFOA)**	**Perfluorononanoic acid (PFNA)**	**Perfluorodecanoic acid (PFDA)**	**Perfluoroundecanoic acid (PFUnA)**	**Perfluorododecanoic acid (PFDoA)**	**Perfluorobutanoic sulfonate (PFBS)**	**Perfluorohexane sulfonate (PFHxS)**	**Perflourooctane sulfonate (PFOS)**	**Perfluorooctane sulfonylamide (PFOSA)**	**Mean Total Organic Carbon (TOC)**
#Perfluorinated Carbon Chains:				**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**4**	**6**	**8**	**8**	**--**
Tier 1 Residential SRV:				**77000**	**ND**	**ND**	**ND**	**2100**	**ND**	**ND**	**ND**	**ND**	**ND**	**ND**	**2100**	**ND**	**ND**
Tier 2 Recreational SRV:				**94000**	**ND**	**ND**	**ND**	**2500**	**ND**	**ND**	**ND**	**ND**	**ND**	**ND**	**2600**	**ND**	**ND**
Tier 2 Industrial SRV:				**500000**	**ND**	**ND**	**ND**	**13000**	**ND**	**ND**	**ND**	**ND**	**ND**	**ND**	**14000**	**ND**	**ND**
Sample ID	**Sample Depth**	**Sample Date**	**Laboratory**														
Goodview Sed-1	0-6 in.	10/19/2009	Axys	< 0.0883	< 0.0883	< 0.0883	< 0.0883	< 0.0883	< 0.0883	< 0.0883	< 0.0883	< 0.0883	< 0.177	< 0.177	**0.332**	< 0.0883	NA

TABLE 2
Soil and Sediment Analytical Results, PFCs and TOC
Minnesota Fire Foam Training and Discharge Sites

Sample ID	Sample Depth	Sample Date	Laboratory	Perfluorobutanoic acid (PFBA)	Perfluoro-n-pentanoic acid (PFPeA)	Perfluorohexanoic acid (PFHxA)	Perfluoroheptanoic acid (PFHpA)	Perfluorooctanoic acid (PFOA)	Perfluorononanoic acid (PFNA)	Perfluorodecanoic acid (PFDA)	Perfluoroundecanoic acid (PFUnA)	Perfluorododecanoic acid (PFDoA)	Perfluorobutanoic sulfonate (PFBS)	Perfluorohexane sulfonate (PFHxS)	Perflouroctane sulfonate (PFOS)	Perfluorooctane sulfonylamide (PFOSA)	Mean Total Organic Carbon (TOC)
#Perfluorinated Carbon Chains:				**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**4**	**6**	**8**	**8**	**--**
Tier 1 Residential SRV:				**77000**	**ND**	**ND**	**ND**	**2100**	**ND**	**ND**	**ND**	**ND**	**ND**	**ND**	**2100**	**ND**	**ND**
Tier 2 Recreational SRV:				**94000**	**ND**	**ND**	**ND**	**2500**	**ND**	**ND**	**ND**	**ND**	**ND**	**ND**	**2600**	**ND**	**ND**
Tier 2 Industrial SRV:				**500000**	**ND**	**ND**	**ND**	**13000**	**ND**	**ND**	**ND**	**ND**	**ND**	**ND**	**14000**	**ND**	**ND**
Bemidji B-1 SL 0-4'	0-4 ft.	11/5/2009	Axys	< 0.0951	< 0.0951	**0.216**	< 0.0951	**0.118**	< 0.0951	< 0.0951	< 0.0951	< 0.0951	< 0.190	**3.12**	**55.7**	**0.112**	6230
Bemidji B-1 SL 4-8'	4-8 ft.	11/5/2009	Axys	< 0.0913	< 0.0913	< 0.0913	< 0.0913	**0.498**	< 0.0913	< 0.0913	< 0.0913	< 0.0913	**0.267**	**3.98**	**56**	< 0.0913	535
Bemidji B-2 SL 0-4'	0-4 ft.	11/5/2009	Axys	**0.184**	**0.322**	**1.44**	**0.143**	**1.31**	**0.099**	< 0.0933	< 0.0933	< 0.0933	< 1.87	**13.9**(1)	**1200**(1)	**18.5**	3540
Bemidji B-2 SL 4-8'	4-8 ft.	11/5/2009	Axys	< 0.276	< 0.276	**0.411**(1)	**0.917**(1)	**19.6**(1)	< 0.276	< 0.276	< 0.276	< 0.276	**0.957**(1)	**147**(1)	**606**(1)	< 0.276	487
River Grove Sed-1	0-6 in.	11/18/2009	MPI	<0.333	<0.333	<0.333	<0.333	<0.333	<0.333	<0.333	<0.333	<0.333	<0.667	<0.667	<0.667	<0.333	NA
River Grove Sed-2	0-6 in.	11/18/2009	MPI	<0.333	<0.333	<0.333	<0.333	<0.333	<0.333	<0.333	<0.333	<0.333	<0.667	<0.667	<0.667	<0.333	NA
River Grove Sed-3	0-6 in.	11/18/2009	MPI	<0.333	<0.333	<0.333	<0.333	<0.333	<0.333	<0.333	<0.333	<0.333	<0.667	<0.667	<0.667	<0.333	NA
ERTC SS-1	0-6 in.	11/25/2009	Axys	< 0.0998	**0.205**	**0.794**	**0.139**	**0.495**	< 0.0998	< 0.0998	< 0.0998	< 0.0998	< 0.200	**3.49**	**83.5**	**4.54**	NA
ERTC Sed-1	0-6 in.	11/25/2009	Axys	< 0.0917	< 0.0917	< 0.0917	< 0.0917	**0.225**	< 0.0917	< 0.0917	< 0.0917	< 0.0917	< 0.183	**1.2**	**57.5**	**6.52**	NA
ERTC Sed-2	0-6 in.	11/25/2009	Axys	**0.218**	**0.536**	**1.72**	**0.268**	**1.26**	**0.184**	**0.101**	**0.174**	< 0.0933	**1.47**	**19.6**	**538**	**181**	NA
ERTC Sed-3	0-6 in.	11/18/2010	Axys	**0.118**	**0.202**	**1.01**	**0.171**	**0.75**	**0.149**	< 0.0955	**0.174**	**0.156**	**0.318**	**7.1**	**476**(1)	**207**(1)	NA
ERTC Sed-4	0-6 in.	11/28/2010	Axys	< 0.0933	**0.135**	**0.628**	**0.119**	**0.581**	< 0.0933	< 0.0933	< 0.0933	< 0.0933	< 0.187	**3.52**	**51.3**	**1.95**	NA
MSP Sed-1	0-6 in.	1/19/2010	Axys	< 0.484	< 0.484	< 0.484	< 0.484	**1.8**	**1.89**	**17.3**	**2.5**	**15.6**	< 0.968	< 0.968	**8.84**	**3.55**	NA
Crystal B-1 SL 0-4'	0-4 ft.	1/20/2010	Axys	< 0.486	< 0.486	< 0.486	< 0.486	< 0.486	< 0.486	< 0.486	< 0.486	< 0.486	< 0.972	< 0.972	< 0.972	< 0.486	458
Crystal B-1 SL 4-8'	4-8 ft.	1/20/2010	Axys	< 0.493	< 0.493	< 0.493	< 0.493	< 0.493	< 0.493	< 0.493	< 0.493	< 0.493	< 0.985	< 0.985	< 0.985	< 0.493	5610
Crystal B-2 SL 0-4'	0-4 ft.	1/20/2010	Axys	< 0.488	< 0.488	< 0.488	< 0.488	< 0.488	< 0.488	< 0.488	< 0.488	< 0.488	< 0.977	< 0.977	< 0.977	< 0.488	3840
Crystal B-2 SL 4-8'	4-8 ft.	1/20/2010	Axys	< 0.490	< 0.490	< 0.490	< 0.490	< 0.490	< 0.490	< 0.490	< 0.490	< 0.490	< 0.979	< 0.979	< 0.979	< 0.490	569
Crystal SS-1	2 ft.	1/20/2010	Axys	< 0.498	**0.929**	< 0.498	< 0.498	< 0.498	< 0.498	< 0.498	< 0.498	< 0.498	< 0.996	< 0.996	< 0.996	< 0.498	NA
Crystal Sed-1	0-6 in.	1/20/2010	Axys	< 0.513	< 0.513	< 0.513	< 0.513	< 0.513	< 0.513	< 0.513	< 0.513	< 0.513	< 1.03	< 1.03	< 1.03	< 0.513	NA
Crystal Sed-2	0-6 in.	1/20/2010	Axys	**0.467**	**1.16**	< 0.404	**0.491**	**0.654**	**0.412**	**0.863**	**1.17**	**2.47**	< 0.807	**1.03**	**7.1**	**1.45**	NA
Crystal Sed-3	0-6 in.	10/1/2010	Axys	< 0.376	< 0.376	< 0.376	< 0.376	< 0.376	< 0.376	< 0.376	< 0.376	< 0.376	< 0.752	< 0.752	< 0.752	< 0.376	NA
Crystal Sed-4	0-6 in.	10/1/2010	Axys	< 0.474	< 0.474	< 0.474	< 0.474	< 0.474	< 0.474	< 0.474	**0.661**	**1.65**	< 0.949	< 0.949	**4.64**	**1.13**	NA
Kings Cove Marina Soil	0-4 in.	12/3/2009	MPI	<0.333	<0.333	<0.333	<0.333	<0.333	<0.333	**1.11**	**2.07**	**10.4**	<0.667	<0.667	<0.667	<0.333	NA
Kings Cove Marina Sed 1	0-4 in.	12/3/2009	MPI	<0.333	<0.333	<0.333	<0.333	**0.841**	<0.333	<0.333	<0.333	<0.333	<0.667	<0.667	**1.34**	<0.333	NA
Kings Cove Marina Sed 2	0-4 in.	12/3/2009	MPI	<0.333	<0.333	**0.773**	<0.333	**0.736**	<0.333	<0.333	<0.333	<0.333	<0.667	**4.44**	**6.12**	<0.333	NA

TABLE 2
Soil and Sediment Analytical Results, PFCs and TOC
Minnesota Fire Foam Training and Discharge Sites

				Perfluorobutanoic acid (PFBA)	**Perfluoro-n-pentanoic acid (PFPeA)**	**Perfluorohexanoic acid (PFHxA)**	**Perfluoroheptanoic acid (PFHpA)**	**Perfluorooctanoic acid (PFOA)**	**Perfluorononanoic acid (PFNA)**	**Perfluorodecanoic acid (PFDA)**	**Perfluoroundecanoic acid (PFUnA)**	**Perfluorododecanoic acid (PFDoA)**	**Perfluorobutanoic sulfonate (PFBS)**	**Perfluorohexane sulfonate (PFHxS)**	**Perflourooctane sulfonate (PFOS)**	**Perfluorooctane sulfonylamide (PFOSA)**	**Mean Total Organic Carbon (TOC)**
#Perfluorinated Carbon Chains:				**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**4**	**6**	**8**	**8**	**--**
Tier 1 Residential SRV:				**77000**	**ND**	**ND**	**ND**	**2100**	**ND**	**ND**	**ND**	**ND**	**ND**	**ND**	**2100**	**ND**	**ND**
Tier 2 Recreational SRV:				**94000**	**ND**	**ND**	**ND**	**2500**	**ND**	**ND**	**ND**	**ND**	**ND**	**ND**	**2600**	**ND**	**ND**
Tier 2 Industrial SRV:				**500000**	**ND**	**ND**	**ND**	**13000**	**ND**	**ND**	**ND**	**ND**	**ND**	**ND**	**14000**	**ND**	**ND**
Sample ID	**Sample Depth**	**Sample Date**	**Laboratory**														
Up North Plastics Soil 1			Axys	**2.45**	**0.419**	**0.682**	**0.189**	**1.18**	**0.342**	**0.642**	**2.46**	**1.27**	**0.296**	**20.6**	**258**	**8.91**	NA
Up North Plastics Soil 2			Axys	**0.985**	< 0.0982	**0.205**	**0.115**	**0.381**	< 0.0982	< 0.0982	**0.341**	**0.343**	< 0.196	**2.07**	**59.1**	**2.99**	NA
Up North Plastics Soil 3			Axys	**0.203**	< 0.101	< 0.101	< 0.101	< 0.101	< 0.101	< 0.101	< 0.101	< 0.101	< 0.202	< 0.202	< 0.202	< 0.101	NA
Up North Plastics Soil 4			Axys	< 0.0964	< 0.0964	**0.233**	< 0.0964	**0.172**	< 0.0964	**0.097**	**1.88**	< 0.0964	< 0.193	**3.91**	**355**	**16.5**	NA
Up North Plastics Soil 5			Axys	**3.82**	**0.628**	**0.477**	**0.266**	**8.29**	< 0.0964	< 0.0964	**0.122**	**0.128**	**0.199**	**0.712**	**7.48**	**0.428**	NA
Up North Plastics Sed 1			Axys	**0.659**	< 0.0965	< 0.0965	< 0.0965	**0.406**	< 0.0965	< 0.0965	< 0.0965	< 0.0965	< 0.193	< 0.193	**1.15**	< 0.0965	NA
Up North Plastics Sed 2			Axys	**3.37**	**0.195**	**0.19**	< 0.110	**0.957**	**0.113**	< 0.110	**0.165**	**0.713**	**0.284**	**1.65**	**104**	**0.782**	NA
Up North Plastics Sed 3			Axys	**14.2**	**1.94**	**1.32**	**0.608**	**14.6**	< 0.104	< 0.104	< 0.104	**0.188**	< 0.207	**0.764**	**16.3**	< 0.104	NA
Up North Plastics Sed 4			Axys	**2.35**	**0.265**	**0.143**	< 0.119	**1.49**	< 0.119	**0.331**	**0.657**	**1.24**	< 0.238	**0.596**	**13.6**	**0.325**	NA
Up North Plastics Sed Dup			Axys	**1.25**	< 0.102	< 0.102	< 0.102	**0.726**	< 0.102	< 0.102	< 0.102	< 0.102	< 0.204	< 0.204	**1.67**	< 0.102	NA

Notes:

PFC results and standards are in nanograms per gram (ng/g), which is equivalent to parts per billion.

TOC results are in milligrams per kilogram (mg/kg), which is equivalent to parts per million.

Tier 1 Residential SRV: Minnesota soil reference value for chronic human exposure in a residential setting.

Tier 2 Recreational SRV: Minnesota soil reference value for exposure in a recreational setting.

Tier 2 Industrial SRV: Minnesota soil reference value for exposure in an industrial setting.

PFC compounds soil results reported on a dry weight basis.

ND: No SRV defined.

Axys: Axys Analytical Services LTD

MPI: MPI Research

TOC analyses performed by Pace Analytical Services.

Bolded type indicates detection above the laboratory method detection limit.

NA: not analyzed

(1) Results based on analysis of a dilution of the sample extract.

TABLE 3
WELL RECEPTOR SURVEY SUMMARY FOR SELECT FIRFIGHTING FOAM TRAINING SITES IN MINNESOTA
OCTOBER - NOVEMBER 2010

Site # From Receptor Survey Map	Property Address	Property Occupant	Water Supply Well (Yes or No)	Well Use	Use of Public Water Supply?	How Determined	Public Water Supply Connection Confirmed?	Comments
BEMIDJI REGIONAL AIRPORT								
1	3824 Moberg Dr. NW	Bemidji Regional Airport	No	NA	Yes	Interview, Airport Manager	No	
2	3507 Gillet Dr. NW	Rausch Cold Weather Testing Facility	No	NA	Yes	Interview, site personnel	No	
3	3700 Norris Ct. NW	Bureau of Criminal Apprehension, MN Dept. of Public Safety	No	NA	Yes	Interview, site personnel	No	
4	3622 Moberg Dr. NW	Great River Dentistry	No	NA	Yes	Questionnaire returned	No	
5	3600 Moberg Dr. NW	Indoor Auto Mall	No	NA	Yes	Interviews, current and previous site owners	No	Well no. 169190 was a water supply well at this site; well has been sealed.
6	3500 Moberg Dr. NW	Quality Inn	No	NA	Yes	Interview, site manager	No	
7	3300 Gillett Dr. NW	Paul Bunyan Elementary & ISD #31 Offices	No	NA	Yes	Interview, school district business manager	No	
8	Gillett Dr. NW	City of Bemidji Water Treatment Facility	No	NA	Yes	Interview, City of Bemidji Public Works	No	
9	3168 Adams Av. NW	Kraus Anderson Construction Co.	Yes	Non-potable		Interview, site personnel	No	
10	3920 Hwy. 2 W.	MNDOT Northwest District	No	NA	Yes	Interview, site personnel	No	
ABLE TRAINING CENTER, BURNSVILLE								
Site	River Ridge Blvd.	ABLE Fire Training Center	No	NA	Yes	Interview, Burnsville Fire Chief	No	
1	12205 River Ridge Blvd.	Northern Tool & Equipment	No	NA	Yes	Interview, site personnel	No	
2	12101 Interstate 35W S.	Dodge of Burnsville	No	NA	Yes	Questionnaire returned	No	
3	600 121st St. W.	Walser Suburu	No	NA	Yes	Interview, site personnel	No	
4	12001 Interstate 35W S.	All State Self Storage	No	NA	Yes	Interview, site personnel	No	
5	11937 Interstate 35W S.	Chalet Driving Range	No	NA	Yes	Interview, property owner	No	Several groundwater monitoring wells related to a historical dump are located on the property.
6	Pleasant Av.	Archery range, tree/brush dump	No	NA	No	Interview, Burnsville Public Works	No	
7	201 121st St. W.	Bury & Carlson, concrete/asphalt recycling	No	NA	Yes	Interview, site personnel	No	
8	25 Cliff Rd. W.	Rivers Edge Business Center	No	NA	Yes	Questionnaire returned	No	
9	15 Cliff Rd. W.	American Electric Motion	No[1]	NA	Yes	Questionnaire not returned	No	
10	12259 Nicollet Av.	Nicollet Business Campus II	Unknown	NA	Yes	Questionnaire returned	No	Managed by Wellington Management
11	12270 Nicollet Av.	Nicollet Business Campus	No	NA	Yes	Questionnaire returned	No	Managed by Wellington Management
12	50 River Ridge Ct.	Burnsville Public Works	Yes	Municipal	Yes	Interviews with Public Works personnel	NA	City well nos. 1, 2, 4, 5, 7, 8 nearby, locations indicated by Public Works personnel. No other water supply in survey area known to Public Works personnel.
13	12200 River Ridge Blvd.	Vacant/undeveloped	Yes	Industrial	NA	Site visit; correspondence with State, County.	No	Unique well no. 229108, industrial well, registered active. Buildings recently demolished and site razed. Site currently vacant. State and County cannot confirm current well status. No wells were observed on the property.
LAKE SUPERIOR COLLEGE ERTC, DULUTH								
Site	11501 Hwy. 23	Lake Superior College ERTC	No	NA	Yes	Interview, Program Supervisor	Yes	
1	10401 Hwy. 23	Residence	No	NA	No	Interview, homeowner	City Public Works confirmed no connection	Residence connected to private well at 10423 Hwy. 23.
2	10423 Hwy. 23	Residence	Yes	Drinking	No	Based on other interviews	City Public Works confirmed no connection	Questionnaire not returned.
3	11801 Hwy. 23	Residence	Yes	Drinking	No	Interview, homeowner	City Public Works confirmed no connection	
4	11601 Hwy. 23	Residence	Yes	Drinking	No	Interview, homeowner	City Public Works confirmed no connection	Well depth 411 feet.
5	11605 Hwy. 23	Residence	Yes	Drinking	No	Interview, homeowner	City Public Works confirmed no connection	New well pump recently installed, depth to water ~75 feet.
6	11825 Hwy. 23	Residence	Yes	Drinking	No	Interview, homeowner	City Public Works confirmed no connection	

TABLE 3
WELL RECEPTOR SURVEY SUMMARY FOR SELECT FIRFIGHTING FOAM TRAINING SITES IN MINNESOTA
OCTOBER - NOVEMBER 2010

Site # From Receptor Survey Map	Property Address	Property Occupant	Water Supply Well (Yes or No)	Well Use	Use of Public Water Supply?	How Determined	Public Water Supply Connection Confirmed?	Comments
MSP AIRPORT								
1	7150 Humphrey Drive	Humphrey Terminal	No	NA	Yes	Interview, Mark Wacek, MAC	No	
2	Humphrey Drive	Humphrey Terminal Parking Ramp	No	NA	Yes	Interview, Mark Wacek, MAC	No	
3	34th Ave. S.	MSP Fire Station No. 1	No	NA	Yes	Interview, Mark Wacek, MAC	No	
4	34th Ave. S.	Hangars 4-8	No	NA	Yes	Interview, Mark Wacek, MAC	No	
5	2825 Cargo Rd.	FedEx	No	NA	Yes	Interview, Mark Wacek, MAC	No	
6	Cargo Rd.	UPS	No	NA	Yes	Interview, Mark Wacek, MAC	No	
7	MSP Airport	South airfield lighting electrical center	No	NA	Yes	Interview, Mark Wacek, MAC	No	
8	MSP Airport	Glycol Management Facility	No	NA	Yes	Interview, Mark Wacek, MAC	No	
MARATHON REFINERY, ST. PAUL PARK								
1	729 Factory St.	Residence, vacant	No	NA	Yes	Questionnaire not delivered	Yes	Questionnaire returned by Post Office, marked "vacant". Municipal water connection confirmed by City Public Works Dept; assume no water supply well on property.
2	812 Front St.	Residence	No	No	Yes	Questionnaire not returned	Yes	Two houses located on property, owned by Hidden Harbor Marina. Marina owner not aware of water wells on property.
3	388 9th Ave.	Hidden Harbor Marina	Yes	Potable uses	No	Interview, property owner	Confirmed no connection	Five water supply wells located on property.
4	Lions Levee Park	7th Ave. W.	NA	NA	NA	Site reconnaissance	NA	No buildings with water service.

Notes:

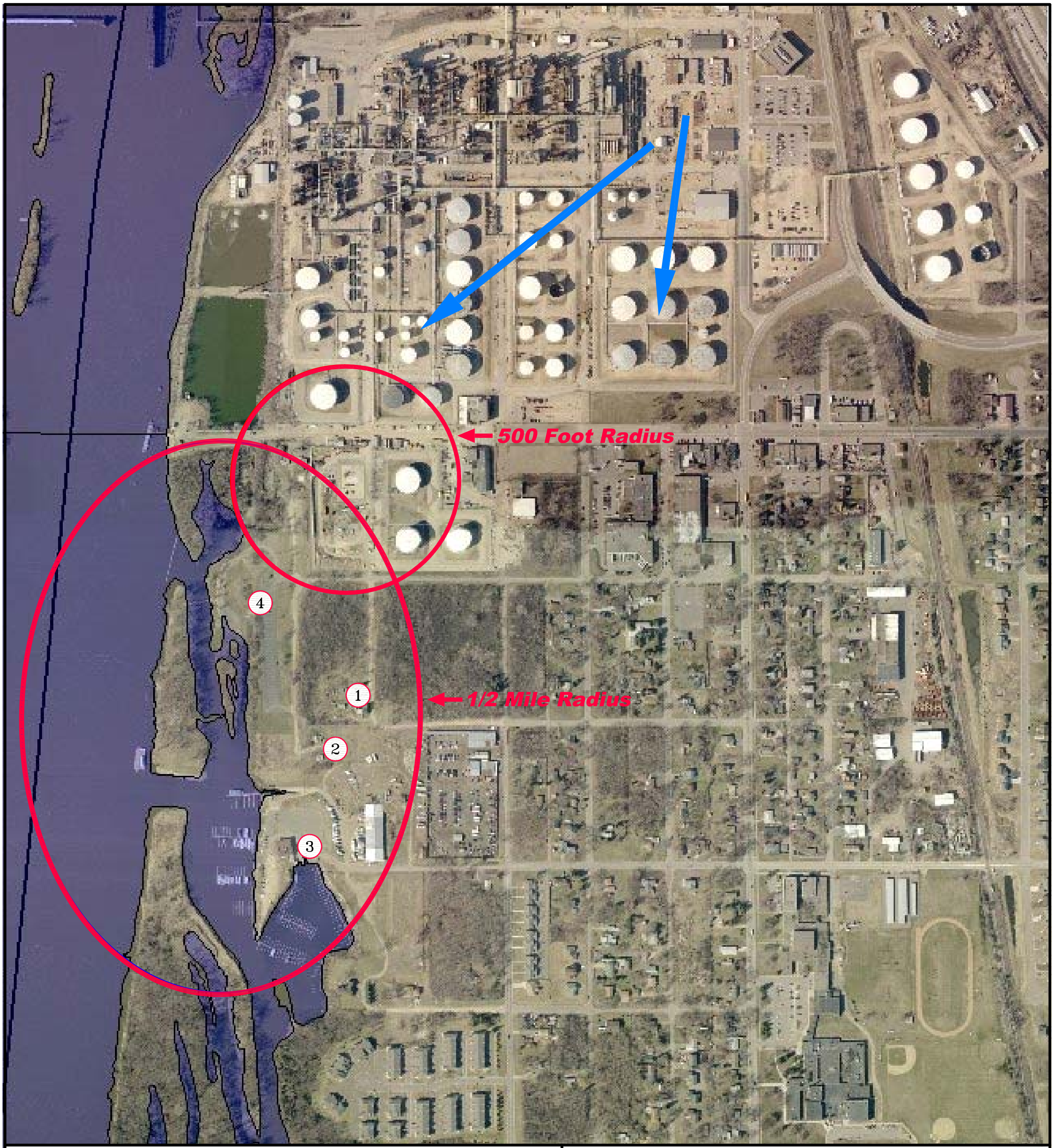
Sites included on this Table are depicted on applicable Well Receptor Survey figures included in report.

[1] Receptor Survey Questionnaire indicated that if questionnaire was not returned it would be assumed that the property has no water wells, basements or sumps.

NA - Not Applicable

Appendix A

Marathon Refinery Groundwater Receptor Survey Documents



LEGEND:

Property Occupant

① Residence – 729 Factory St.
② Residence – 812 Front St.
③ Hidden Harbor Marina – 388 9th Ave.
④ Lions Levee Park – 7th Ave. S.

→ Inferred Groundwater Flow Direction

North

FIGURE
RECEPTOR SURVEY
MARATHON OIL FIRE TRAINING AREA
ST. PAUL PARK, MINNESOTA

PROJECT NO. 45618DEL04	PREPARED BY NR	DRAWN BY DD
DATE 06/30/11	REVIEWED BY	FILE NAME Marathon–1

anteagroup™

– via telephone 10-26-10

Receptor Survey Questionnaire

PROPERTY ADDRESS: 388 9th Av. W - Hidden Harbor Marina

1. Is there, or has there ever been, a water well on the property? [✓ **Yes**] **No** **Unknown**

If you answered **No or Unknown**, proceed to Question 2. 5 wells on property

1a. If you answered **Yes**, is the well *active* (in use), *abandoned* (not in use), or *sealed* (decommissioned following Minnesota Department of Health [MDH] Well Code guidelines).

X ACTIVE ________ABANDONED ________SEALED

1b. How deep is (was) the well? ______FEET (if depth is unknown check here ______)

1c. In what year was the well installed (if known)? ___________ Bought property

1d. If the well was abandoned, what year was the well sealed? ~1 year ago

3e. If the well is active, for what purpose is it used? Example: (drinking water, lawn sprinkler, cooling, etc.)

1f. Where on the property is (was) the well located? 1 - Maintenance
1-Restaurant 1-Boats 1-Hosing 1-Drink water

1g. If there is currently a water supply well on the property, would you grant access to the property in order to obtain a water sample from either an indoor or outside faucet (at no cost to property owner)?

Yes **No** 810 + 812 Front St - owned by Marina

Name________________________

Telephone Number________________________DAY or EVENING (please circle one and state best time to reach you)

2. Is a public water supply currently utilized by the property? **Yes** [✓ **No**]

3. May we contact you for further information if necessary? If so, please provide your name and telephone number.

Name Tim Kennedy

Telephone Number 651-400-0846 DAY or EVENING (please circle one and state best time to reach you)

Please complete this form and mail it back to Delta in the enclosed self-addressed stamped envelope. Delta thanks you in advance for taking the time to complete this form.

If you have any questions, or need help completing this form, please feel free to contact Nancy Rodning, Delta Consultants, at (651)697-5152 or 1-800-477-7411, or Nile Fellows, MPCA, at 651-757-2352.

Nancy Rodning
5910 RICE CREEK PARKWAY • SUITE 100
ST. PAUL, MINNESOTA 55126 USA

UNITED STATES POSTAGE
PITNEY BOWES
$ 000.44⁰

DELTA

VAC

PROPERTY OWNER OR TENANT
729 FACTORY STREET
ST. PAUL PARK, MN 55071

VAC

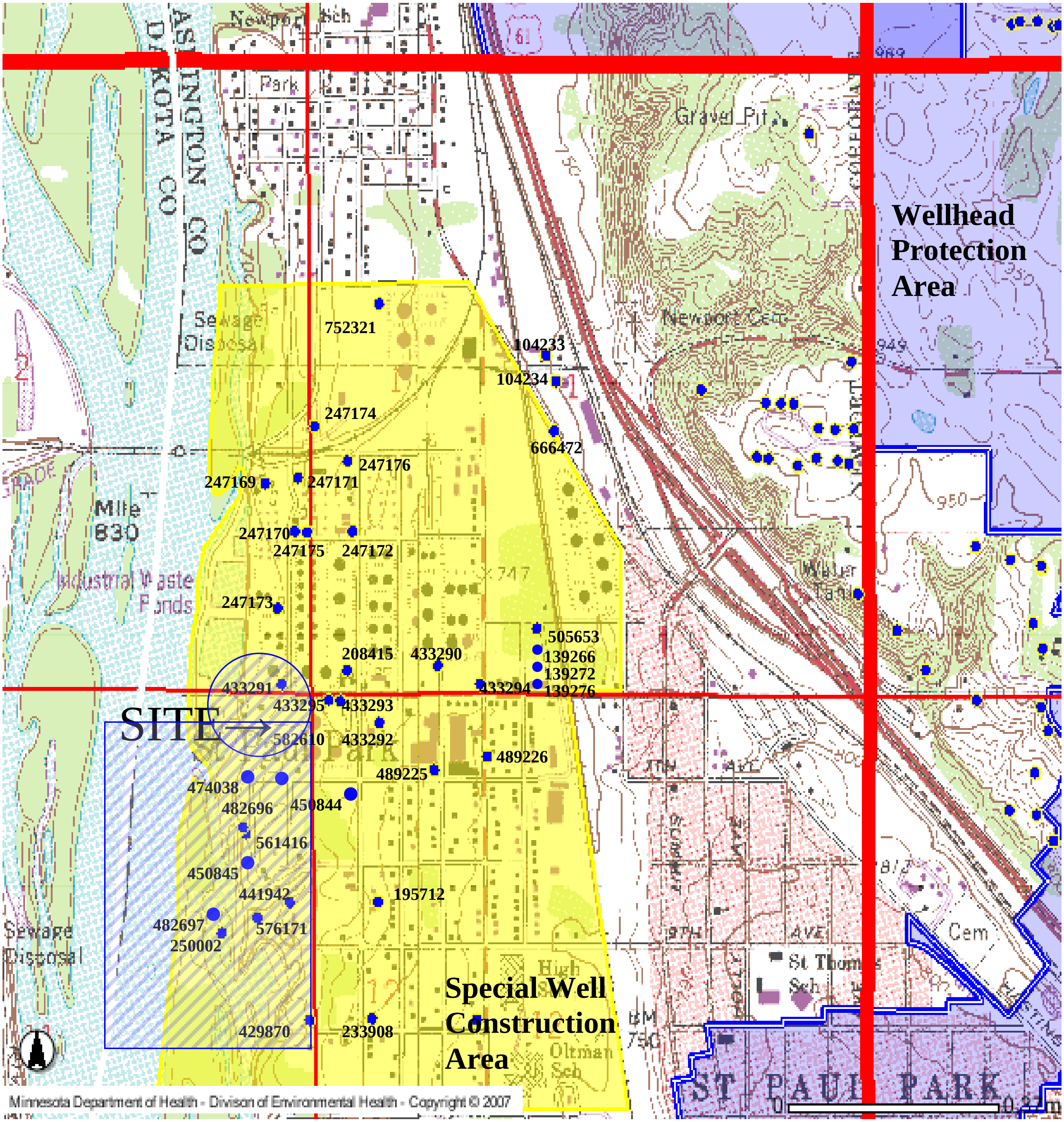
NIXIE 550 4E 1
RETURN TO SENDER
VACANT
UNABLE TO

NOT A SOLICITATION

BC: 55126502

55071[illegible]5023

MARATHON PETROLEUM REFINERY CWI Well Map



▨ Approximate Area of Receptor Survey

Minnesota Unique Well No.

250002

County Washington
Quad Inver Grove Heights
Quad ID 103D

MINNESOTA DEPARTMENT OF HEALTH

WELL AND BORING RECORD

Minnesota Statutes Chapter 103I

Entry Date 07/25/1995
Update Date 05/11/2005
Received Date

Well Name WILLIE'S HIDDEN HARBOR

Township	Range	Dir	Section	Subsections	Elevation	690 ft.
27	22	W	11	ADBDCD	Elevation Method	7.5 minute topographic map (+/- 5 feet)

Geological Material	Color	Hardness	From	To
PRAIRIE DU CHIEN GROUP			0	146
JORDAN SANDSTONE			146	230
ST. LAWRENCE FORMATION			230	235

R E M A R K S
GAMMA LOGGED 6-6-1995.
WELL SEALED 07-15-1996 BY 62119

Located by: Minnesota Geological Survey
Method: Digitized - scale 1:24,000 or larger (Digitizing Table)
Unique Number Verification: Information from owner
Input Date: 07/18/1996
System: UTM - Nad83, Zone15, Meters
X: 499426 Y: 4965451

Borehole Geophysics Yes
First Bedrock Prairie Du Chien Group
Last Strat St.Lawrence
Aquifer Multiple
Depth to Bedrock 0 ft.

Well Depth	Depth Completed	Date Well Completed
235 ft.	235 ft.	

Drilling Method --

Drilling Fluid
--

Well Hydrofractured? ☐ Yes ☐ No
From Ft. to Ft.

Use Abandoned Status Sealed

Casing Type Steel (black or low carbon) Joint No Information Drive Shoe? ☐ Yes ☐ No Above/Below 0 ft.

Casing Diameter	Weight	Hole Diameter
4 in. to 220 ft.	lbs./ft.	

Open Hole from 220 ft. to 235 ft.

Screen NO Make Type

Diameter	Slot/Gauze	Length	Set Between

Static Water Level
14 ft. from Land surface Date Measured 06/06/1995

PUMPING LEVEL (below land surface)
ft. after hrs. pumping g.p.m.

Well Head Completion
Pitless adapter manufacturer Model
☐ Casing Protection ☐ 12 in. above grade
☐ At-grade (Environmental Wells and Borings ONLY)

Grouting Information Well Grouted? ☐ Yes ☐ No

Nearest Known Source of Contamination
__feet __direction __type
Well disinfected upon completion? ☐ Yes ☐ No

Pump ☐ Not Installed Date Installed
Manufacturer's name Model number __ HP 0 Volts
Length of drop Pipe _ft. Capacity _g.p.m Type Material

Abandoned Wells Does property have any not in use and not sealed well(s)? ☐ Yes ☐ No

Variance Was a variance granted from the MDH for this well? ☐ Yes ☐ No

Well Contractor Certification

License Business Name	Lic. Or Reg. No.	Name of Driller
Minnesota Geological Survey	MGS	

County Well Index Online Report

250002

Printed 11/3/2010
HE-01205-07

Minnesota Unique Well No.

268354

County Washington
Quad Inver Grove Heights
Quad ID 103D

MINNESOTA DEPARTMENT OF HEALTH

WELL AND BORING RECORD

Minnesota Statutes Chapter 103I

Entry Date 02/07/2007
Update Date 03/01/2011
Received Date

Well Name HARBOR VILLAGE #2

Township	Range	Dir	Section	Subsections	Elevation	718 ft.
27	22	W	11	ADADCA	Elevation Method	Calc from NED (National Elevation Dataset)

Well Depth	Depth Completed	Date Well Completed
0 ft.	0 ft.	0

Drilling Method

Drilling Fluid

Well Hydrofractured? ☐ Yes ☐ No
From Ft. to Ft.

Use Public Supply/non-comm.-transient PWS ID Source

Casing Type Joint Drive Shoe? ☐ Yes ☐ No Above/Below ft.

Casing Diameter	**Weight**	**Hole Diameter**

Open Hole from ft. to ft.

Screen

Diameter	**Slot/Gauze**	**Length**	**Set Between**

Geological Material	**Color**	**Hardness**	**From**	**To**

Static Water Level
ft. from Date Measured

PUMPING LEVEL (below land surface)
ft. after hrs. pumping g.p.m.

Well Head Completion
Pitless adapter manufacturer Model
☐ Casing Protection ☐ 12 in. above grade
☐ At-grade (Environmental Wells and Borings ONLY)

Grouting Information Well Grouted? ☐ Yes ☐ No

NO REMARKS

Located by: Washington Cty.
Method: GPS SA Off (averaged)
Unique Number Verification: Info/GPS from data source
Input Date: 06/10/2009
System: UTM - Nad83, Zone15, Meters
X: 499620 Y: 4965494

Nearest Known Source of Contamination
0 feet __direction __type
Well disinfected upon completion? ☐ Yes ☐ No

Pump ☐ Not Installed Date Installed
Manufacturer's name Model number __ HP _ Volts
Length of drop Pipe _ft. Capacity _g.p.m Type Material

Abandoned Wells Does property have any not in use and not sealed well(s)? ☐ Yes ☐ No

Variance Was a variance granted from the MDH for this well? ☐ Yes ☐ No

Well Contractor Certification

License Business Name Lic. Or Reg. No. Name of Driller

First Bedrock
Aquifer
Last Strat
Depth to Bedrock ft.

County Well Index Online Report

268354

Printed 6/29/2011
HE-01205-07

Minnesota Unique Well No.
429870

County Washington
Quad Inver Grove Heights
Quad ID 103D

MINNESOTA DEPARTMENT OF HEALTH

WELL AND BORING RECORD

Minnesota Statutes Chapter 103I

Entry Date 08/15/1991
Update Date 09/29/2005
Received Date

Well Name BROWN, WILLIE

Township	Range	Dir	Section	Subsections	Elevation	
27	22	W	11	DAAAAA	Elevation Method	733 ft. CALC FROM 2-FOOT COUNTY DEM

Well Depth	Depth Completed	Date Well Completed
220 ft.	220 ft.	02/23/1987

Drilling Method Non-specified Rotary

Well Address
215 10TH AV W
ST PAUL PARK MN 55071

Geological Material	Color	Hardness	From	To
GRAVEL	BROWN	SOFT	0	8
LIME	YELLOW	HARD	8	165
SANDROCK	YELLOW	SOFT	165	220

Drilling Fluid Bentonite

Well Hydrofractured? ☐ Yes ☐ No
From Ft. to Ft.

Use Domestic

Casing Type Steel (black or low carbon) Joint Welded Drive Shoe? ☑ Yes ☐ No Above/Below 1 ft.

Casing Diameter	Weight	Hole Diameter
8 in. to 8 ft.	18 lbs./ft.	12 in. to 8 ft.
4 in. to 189 ft.	11 lbs./ft.	8 in. to 18 ft.

Open Hole from 189 ft. to 220 ft.

Screen NO Make Type

Diameter	Slot/Gauze	Length	Set Between

Static Water Level
40 ft. from Land surface Date Measured 02/23/1987

PUMPING LEVEL (below land surface)
80 ft. after 2 hrs. pumping 20 g.p.m.

Well Head Completion
Pitless adapter manufacturer Model
☐ Casing Protection ☐ 12 in. above grade
☐ At-grade (Environmental Wells and Borings ONLY)

NO REMARKS

Located by: Minnesota Geological Survey
Method: Digitization (Screen) - Map (1:24,000)
Unique Number Verification: Information from owner
Input Date: 09/07/2005
System: UTM - Nad83, Zone15, Meters
X: 499675 Y: 4965234

Grouting Information Well Grouted? ☑ Yes ☐ No

Grout Material: Neat Cement from 0 to 189 ft. 5 yrds.

Nearest Known Source of Contamination
75 feet N direction Sewer type
Well disinfected upon completion? ☐ Yes ☐ No

Pump ☐ Not Installed Date Installed 04/03/1987
Manufacturer's name GRUNDFOS Model number SP-2-12 HP 0.5 Volts 230
Length of drop Pipe 84 ft. Capacity 12 g.p.m Type Submersible Material Galvanized

Abandoned Wells Does property have any not in use and not sealed well(s)? ☐ Yes ☑ No

Variance Was a variance granted from the MDH for this well? ☐ Yes ☐ No

First Bedrock Prairie Du Chien Group
Last Strat Jordan
Aquifer Jordan
Depth to Bedrock 8 ft.

Well Contractor Certification

License Business Name	Lic. Or Reg. No.	Name of Driller
Kimmes-Bauer	19521	ANDERSON, L.

County Well Index Online Report

429870

Printed 11/3/2010
HE-01205-07

Minnesota Unique Well No.
433291

County Washington
Quad Inver Grove Heights
Quad ID 103D

MINNESOTA DEPARTMENT OF HEALTH
WELL AND BORING RECORD
Minnesota Statutes Chapter 103I

Entry Date 06/07/1993
Update Date 03/06/2002
Received Date

Well Name ASHLAND PETROLEUM MW-102

Township	Range	Dir	Section	Subsections	Elevation	725 ft.
27	22	W	2	DDDDCC	Elevation Method	7.5 minute topographic map (+/- 5 feet)

Well Depth	Depth Completed	Date Well Completed
47 ft.	47 ft.	04/26/1989

Drilling Method Non-specified Rotary

Drilling Fluid
--

Well Hydrofractured? ☐ Yes ☐ No
From Ft. to Ft.

Use Monitor well

Casing Type Steel (black or low carbon) Joint Welded Drive Shoe? ☐ Yes ☑ No Above/Below 3 ft.

Casing Diameter	Weight	Hole Diameter
8 in. to 13 ft.	lbs./ft.	
4 in. to 22 ft.	lbs./ft.	

Open Hole from 22 ft. to 47 ft.

Screen NO Make Type

Diameter	Slot/Gauze	Length	Set Between

Well Address

ST PAUL PARK MN 55071

Geological Material	Color	Hardness	From	To
DRIFT, SAND & CLAY	BLACK		0	6
LIMEROCK	YEL/TAN		6	47

Static Water Level
ft. from Date Measured

PUMPING LEVEL (below land surface)
ft. after hrs. pumping g.p.m.

Well Head Completion
Pitless adapter manufacturer Model
☐ Casing Protection ☐ 12 in. above grade
☐ At-grade (Environmental Wells and Borings ONLY)

REMARKS
M.G.S. NO. 2788.
27-22-2 DDDDCC
ELEV 725-+5
103-D

Located Minnesota Geological Survey
Unique Number Verification Information from owner
System UTM - Nad83, Zone15, Meters

Method Digitization (Screen) - Map (1:24,000)
Date 02/13/2004
X: 499596 Y: 4966070

Grouting Information Well Grouted? ☑ Yes ☐ No

Grout Material: Neat Cement from 0 to 22 ft. 8.5 bags

Nearest Known Source of Contamination
__feet __direction __type
Well disinfected upon completion? ☐ Yes ☐ No

Pump ☐ Not Installed Date Installed
Manufacturer's name Model number __ HP 0 Volts
Length of drop Pipe _ft. Capacity _g.p.m Type Material

Abandoned Wells Does property have any not in use and not sealed well(s)? ☐ Yes ☐ No

Variance Was a variance granted from the MDH for this well? ☐ Yes ☐ No

Cuttings Yes
First Bedrock Prairie Du Chien Group
Last Strat Prairie Du Chien Group

Aquifer Prairie Du Chien Group
Depth to Bedrock 6 ft.

Well Contractor Certification

License Business Name	Lic. Or Reg. No.	Name of Driller
Keys Well Co.	62012	SAMPSON, C.

County Well Index Online Report

433291

Printed 6/29/2008
HE-01205-07

Minnesota Unique Well No.
441942

County	Washington
Quad	Inver Grove Heights
Quad ID	103D

MINNESOTA DEPARTMENT OF HEALTH

WELL AND BORING RECORD

Minnesota Statutes Chapter 103I

Entry Date	08/14/1991
Update Date	09/29/2005
Received Date	

Well Name WILLIE'S HIDDEN HARBOR

Township	Range	Dir	Section	Subsections	Elevation
27	22	W	11	ADADBA	727 ft.

Elevation Method CALC FROM 2-FOOT COUNTY DEM

Well Depth	Depth Completed	Date Well Completed
240 ft.	240 ft.	10/29/1984

Drilling Method Non-specified Rotary

Well Address
388 9TH AV W
ST PAUL PARK MN 55071

Drilling Fluid
Bentonite

Well Hydrofractured? ☐ Yes ☐ No
From Ft. to Ft.

Use Domestic

Casing Type Steel (black or low carbon) Joint Welded Drive Shoe? ☑ Yes ☐ No Above/Below 1 ft.

Geological Material	Color	Hardness	From	To
SAND	BROWN	SOFT	0	25
LIME	YELLOW	HARD	25	170
SAND ROCK	BROWN	SOFT	170	200
SAND ROCK	BLUE	HARD	200	240

Casing Diameter	Weight	Hole Diameter
8 in. to 25 ft.	18 lbs./ft.	12 in. to 25 ft.
4 in. to 203 ft.	11 lbs./ft.	8 in. to 200 ft.

Open Hole from 203 ft. to 240 ft.

Screen NO Make Type

Diameter	Slot/Gauze	Length	Set Between

Static Water Level
25 ft. from Land surface Date Measured 10/29/1987

PUMPING LEVEL (below land surface)
30 ft. after 2 hrs. pumping 50 g.p.m.

Well Head Completion
Pitless adapter manufacturer WHITEWATER Model SU4X5
☐ Casing Protection ☐ 12 in. above grade
☐ At-grade (Environmental Wells and Borings ONLY)

NO REMARKS

Grouting Information Well Grouted? ☑ Yes ☐ No

Grout Material: Neat Cement from 0 to 203 ft. 4 yrds.

Located by: Minnesota Geological Survey	Method: Digitization (Screen) - Map (1:24,000)
Unique Number Verification: Information from owner	Input Date: 09/07/2005
System: UTM - Nad83, Zone15, Meters	X: 499620 Y: 4965527

Nearest Known Source of Contamination
75 feet E direction Septic tank/drain field type
Well disinfected upon completion? ☑ Yes ☐ No

Pump ☐ Not Installed Date Installed 12/03/1987
Manufacturer's name GRUNDFOS Model number SP-2-12 HP 1.5 Volts 230
Length of drop Pipe 42 ft. Capacity 10 g.p.m Type Submersible Material Galvanized

Abandoned Wells Does property have any not in use and not sealed well(s)? ☐ Yes ☑ No

Variance Was a variance granted from the MDH for this well? ☐ Yes ☐ No

First Bedrock Prairie Du Chien Group
Last Strat Jordan
Aquifer Jordan
Depth to Bedrock 25 ft.

Well Contractor Certification

License Business Name	Lic. Or Reg. No.	Name of Driller
Kimmes-Bauer	19521	ANDERSON, L.

County Well Index Online Report

441942

Printed 11/3/2010
HE-01205-07

Minnesota Unique Well No.

450845

County Washington
Quad Inver Grove Heights
Quad ID 103D

MINNESOTA DEPARTMENT OF HEALTH

WELL AND BORING RECORD

Minnesota Statutes Chapter 103I

Entry Date 12/21/1992
Update Date 02/14/2008
Received Date

Well Name PIRNIE, MALCOLM

Township	Range	Dir	Section	Subsections	Elevation	ft.
27	22	W	11	AAD	Elevation Method	

Well Depth	Depth Completed	Date Well Completed
54 ft.	54 ft.	10/17/1988

Drilling Method --

Drilling Fluid
--

Well Hydrofractured? ☐ Yes ☐ No
From Ft. to Ft.

Use Monitor well

Casing Type Joint No Information Drive Shoe? ☐ Yes ☐ No Above/Below ft.

Geological Material	Color	Hardness	From	To

Casing Diameter	Weight	Hole Diameter

Open Hole from ft. to ft.

Screen Make Type

Diameter	Slot/Gauze	Length	Set Between

Static Water Level
35 ft. from Land surface Date Measured 12/21/1988

PUMPING LEVEL (below land surface)
ft. after hrs. pumping g.p.m.

Well Head Completion
Pitless adapter manufacturer Model
☐ Casing Protection ☐ 12 in. above grade
☐ At-grade (Environmental Wells and Borings ONLY)

REMARKS
END OF FRONT ST.
MW 5

Grouting Information Well Grouted? ☐ Yes ☑ No

Nearest Known Source of Contamination
__feet __direction __type
Well disinfected upon completion? ☐ Yes ☐ No

Pump ☐ Not Installed Date Installed
Manufacturer's name Model number __ HP _ Volts
Length of drop Pipe _ft. Capacity _g.p.m Type Material

Abandoned Wells Does property have any not in use and not sealed well(s)? ☐ Yes ☐ No

Variance Was a variance granted from the MDH for this well? ☐ Yes ☐ No

First Bedrock
Last Strat
Aquifer
Depth to Bedrock ft.

Well Contractor Certification

Thein Well Co.	34050	
License Business Name	Lic. Or Reg. No.	Name of Driller

County Well Index Online Report

450845

Printed 11/3/2010
HE-01205-07

Minnesota Unique Well No.
474038

County Washington
Quad Inver Grove Heights
Quad ID 103D

MINNESOTA DEPARTMENT OF HEALTH
WELL AND BORING RECORD
Minnesota Statutes Chapter 103I

Entry Date 12/21/1992
Update Date 09/01/2009
Received Date

Well Name CITY OF ST.PAUL PARK

Township	Range	Dir	Section	Subsections	Elevation ft.
27	22	W	11	AA	Elevation Method

Well Depth	Depth Completed	Date Well Completed
19 ft.	18 ft.	11/11/1991

Drilling Method --

Drilling Fluid
--

Well Hydrofractured? ☐ Yes ☐ No
From Ft. to Ft.

Use Monitor well

Casing Type Joint No Information Drive Shoe? ☐ Yes ☐ No Above/Below ft.

Casing Diameter **Weight** **Hole Diameter**

Open Hole from ft. to ft.

Screen Make Type

Diameter **Slot/Gauze** **Length** **Set Between**

Geological Material	Color	Hardness	From	To
FILL W/ SILTY SAND & LEAN CLAY	BLK/BRN		0	10
LEAN CLAY	DK. BRN	V.SOFT	10	17
SAND FINE GRAINED (VERY LOOSE)	BROWN		17	19

Static Water Level
11 ft. from Land surface Date Measured 11/11/1991

PUMPING LEVEL (below land surface)
ft. after hrs. pumping g.p.m.

Well Head Completion
Pitless adapter manufacturer Model
☐ Casing Protection ☑ 12 in. above grade
☐ At-grade (Environmental Wells and Borings ONLY)

REMARKS
MW 107
NEAR 7TH AVE & FRONT ST., ST.PAUL PARK

Grouting Information Well Grouted? ☑ Yes ☐ No

Grout Material: Neat Cement from to 4.5 ft.

Nearest Known Source of Contamination
__feet __direction __type
Well disinfected upon completion? ☐ Yes ☐ No

Pump ☐ Not Installed Date Installed
Manufacturer's name Model number __ HP _ Volts
Length of drop Pipe _ft. Capacity _g.p.m Type Material

Abandoned Wells Does property have any not in use and not sealed well(s)? ☐ Yes ☐ No

Variance Was a variance granted from the MDH for this well? ☐ Yes ☐ No

First Bedrock
Last Strat
Aquifer
Depth to Bedrock ft.

Well Contractor Certification

Twin City Testing	M0112	NELSON, T.
License Business Name	Lic. Or Reg. No.	Name of Driller

County Well Index Online Report

474038

Printed 11/3/2010
HE-01205-07

Minnesota Unique Well No.
482696

County Washington
Quad Inver Grove Heights
Quad ID 103D

MINNESOTA DEPARTMENT OF HEALTH

WELL AND BORING RECORD

Minnesota Statutes Chapter 103I

Entry Date 04/22/2003
Update Date 04/25/2007
Received Date

Well Name W-200

Township	Range	Dir	Section	Subsections	Elevation
27	22	W	11	AADCBC	702 ft.

Elevation Method 7.5 minute topographic map (+/- 5 feet)

Well Depth	Depth Completed	Date Well Completed
195 ft.	195 ft.	09/18/1992

Drilling Method Non-specified Rotary

Well Address
100 3RD W
ST PAUL PARK MN 55071

Geological Material	Color	Hardness	From	To
DRIFT			0	3
LIMESTONE			3	155
SANDSTONE			155	195

Drilling Fluid --

Well Hydrofractured? ☐ Yes ☐ No
From Ft. to Ft.

Use Abandoned Status Sealed

Casing Type Steel (black or low carbon) Joint Welded Drive Shoe? ☑ Yes ☐ No Above/Below ft.

Casing Diameter	Weight	Hole Diameter
14 in. to 3 ft.	55.57 lbs./ft.	17.5 in. to 3 ft.
8 in. to 155 ft.	28.55 lbs./ft.	13 in. to 155 ft.

Open Hole from 170 ft. to 195 ft.

Screen NO Make Type

Diameter	Slot/Gauze	Length	Set Between

Static Water Level
46 ft. from Land surface Date Measured 09/18/1992

PUMPING LEVEL (below land surface)
ft. after hrs. pumping g.p.m.

Well Head Completion
Pitless adapter manufacturer Model
☑ Casing Protection Y ☐ 12 in. above grade
☐ At-grade (Environmental Wells and Borings ONLY)

R E M A R K S
WELL SEALED 08-16-2000 BY 62012
ORIGINAL USE : MONITOR WELL

Located by: Minnesota Department of Health
Method: GPS SA Off (averaged)
Unique Number Verification: N/A
Input Date: 08/15/2000
System: UTM - Nad83, Zone15, Meters
X: 499487 Y: 4965714

Grouting Information Well Grouted? ☑ Yes ☐ No

Grout Material	From	To	Amount
Neat Cement		3 ft.	2 bags
Neat Cement		170 ft.	4 yrds.
Neat Cement		155 ft.	5 yrds.

Nearest Known Source of Contamination
__feet __direction __type
Well disinfected upon completion? ☐ Yes ☐ No

Pump ☐ Not Installed Date Installed
Manufacturer's name Model number __ HP _ Volts
Length of drop Pipe _ft. Capacity _g.p.m Type Material

First Bedrock Prairie Du Chien Group
Last Strat Jordan
Aquifer Jordan
Depth to Bedrock 3 ft.

Abandoned Wells Does property have any not in use and not sealed well(s)? ☐ Yes ☑ No

Variance Was a variance granted from the MDH for this well? ☐ Yes ☐ No

Well Contractor Certification

License Business Name	Lic. Or Reg. No.	Name of Driller
Keys Well Co.	62012	CONTONIKOLAS.

County Well Index Online Report

482696

Printed 11/3/2010
HE-01205-07

Minnesota Unique Well No.
482697

County Washington
Quad
Quad ID

MINNESOTA DEPARTMENT OF HEALTH

WELL AND BORING RECORD

Minnesota Statutes Chapter 103I

Entry Date 09/01/2009
Update Date 09/01/2009
Received Date

Well Name ASHLAND PETROLEUM COMPANY

Township	Range	Dir	Section	Subsections	Elevation	ft.
27	22	W	11	ACD	Elevation Method	

Well Depth	Depth Completed	Date Well Completed
47 ft.	47 ft.	09/09/1992

Drilling Method Non-specified Rotary

Well Address
100 3RD AV W 55071
ST PAUL PARK MN 55071

Drilling Fluid
Other

Well Hydrofractured? ☐ Yes ☐ No
From Ft. to Ft.

Use Monitor well

Casing Type Steel (black or low carbon) Joint Welded Drive Shoe? ☐ Yes ☑ No Above/Below ft.

Geological Material	**Color**	**Hardness**	**From**	**To**
DRIFT	BLACK	SOFT	0	3
LIMESTONE	BROWN	HARD	3	47

Casing Diameter	**Weight**	**Hole Diameter**
12 in. to 2.5 ft.	lbs./ft.	12 in. to 22 ft.
6 in. to 22 ft.	lbs./ft.	6 in. to 47 ft.

Open Hole from 22 ft. to 47 ft.

Screen NO Make Type

Diameter	**Slot/Gauze**	**Length**	**Set Between**

Static Water Level
32.25 ft. from Land surface Date Measured 09/09/1992

PUMPING LEVEL (below land surface)
34 ft. after 1.25 hrs. pumping 11 g.p.m.

Well Head Completion
Pitless adapter manufacturer Model
☑ Casing Protection Y ☐ 12 in. above grade
☐ At-grade (Environmental Wells and Borings ONLY)

REMARKS
WELL LABELED: W-108

Grouting Information Well Grouted? ☑ Yes ☐ No

Grout Material: Neat Cement from to 22 ft. 10 bags

Nearest Known Source of Contamination
__feet __direction __type
Well disinfected upon completion? ☐ Yes ☑ No

Pump ☐ Not Installed Date Installed
Manufacturer's name Model number __ HP _ Volts
Length of drop Pipe _ft. Capacity _g.p.m Type Material

Abandoned Wells Does property have any not in use and not sealed well(s)? ☐ Yes ☑ No

Variance Was a variance granted from the MDH for this well? ☐ Yes ☐ No

Well Contractor Certification

Keys Well Co.	62012	CONTONIKOLAS.
License Business Name	Lic. Or Reg. No.	Name of Driller

First Bedrock
Last Strat
Aquifer
Depth to Bedrock ft.

County Well Index Online Report

482697

Printed 11/3/2010
HE-01205-07

Minnesota Unique Well No.

559256

County	Washington
Quad	Inver Grove Heights
Quad ID	103D

MINNESOTA DEPARTMENT OF HEALTH

WELL AND BORING RECORD

Minnesota Statutes Chapter 103I

Entry Date	08/22/1996
Update Date	03/01/2011
Received Date	

Well Name WILLIES HIDDEN HARBOR

Township	Range	Dir	Section	Subsections	Elevation	692 ft.
27	22	W	11	ADBDDA	Elevation Method	Calc from NED (National Elevation Dataset)

Well Depth	Depth Completed	Date Well Completed
234 ft.	234 ft.	05/17/1996

Drilling Method Non-specified Rotary

Well Address
388 9TH AV
ST PAUL PARK MN 55071

Drilling Fluid
--

Well Hydrofractured? ☐ Yes ☐ No
From Ft. to Ft.

Use Public Supply/non-comm.-transient PWS ID 5820301 Source S01

Casing Type Steel (black or low carbon) Joint Welded Drive Shoe? ☑ Yes ☐ No Above/Below 1 ft.

Geological Material	**Color**	**Hardness**	**From**	**To**
SAND	BROWN	SOFT	0	25
LIME	YELLOW	SOFT	25	34
LIME	YELLOW	HARD	34	45
SHALE	BLUE	HARD	45	55
LIME	YELLOW	HARD	55	137
SANDROCK	YELLOW	SOFT	137	141
SANDROCK	YELLOW	SOFT	141	190
SANDROCK	GRAY	MEDIUM	190	227
SANDROCK	GRAY	MEDIUM	227	234

Casing Diameter	**Weight**	**Hole Diameter**
8 in. to 24 ft.	28.55 lbs./ft.	12 in. to 34 ft.
4 in. to 225 ft.	10.79 lbs./ft.	8 in. to 225 ft.

Open Hole from 225 ft. to 234 ft.

Screen NO Make Type

Diameter	**Slot/Gauze**	**Length**	**Set Between**

Static Water Level
0 ft. from Land surface Date Measured 05/17/1996

PUMPING LEVEL (below land surface)
30 ft. after hrs. pumping 20 g.p.m.

Well Head Completion
Pitless adapter manufacturer WHITEWATER Model SU4X5.5
☐ Casing Protection ☐ 12 in. above grade
☐ At-grade (Environmental Wells and Borings ONLY)

REMARKS
GAMMA LOGGED 5-17-1996.
27-22-11 ADBDDB
ELEV 688-+5
103-D
WELL #1

Grouting Information Well Grouted? ☑ Yes ☐ No

Grout Material: Neat Cement from 0 to 225 ft. 6.5 yrds.

Located by: Washington Cty.
Unique Number Verification: Info/GPS from data source
System: UTM - Nad83, Zone15, Meters

Method: GPS SA Off (averaged)
Input Date: 06/10/2009
X: 499471 Y: 4965491

Nearest Known Source of Contamination
60 feet E direction Septic tank/drain field type
Well disinfected upon completion? ☐ Yes ☐ No

Pump ☑ Not Installed Date Installed 06/13/1996
Manufacturer's name GRUNDFOS Model number 25S10-7 HP 1 Volts 230
Length of drop Pipe 42 ft. Capacity 20 g.p.m Type Submersible Material

Abandoned Wells Does property have any not in use and not sealed well(s)? ☐ Yes ☐ No

Variance Was a variance granted from the MDH for this well? ☐ Yes ☐ No

Borehole Geophysics Yes
First Bedrock Prairie Du Chien Group
Last Strat St.Lawrence

Aquifer Multiple
Depth to Bedrock 25 ft.

Well Contractor Certification

License Business Name	Lic. Or Reg. No.	Name of Driller
Kimmes-Bauer	19521	PEINE, J.

County Well Index Online Report

559256

Printed 6/29/2011
HE-01205-07

Minnesota Unique Well No.
561416

County Washington
Quad Inver Grove Heights
Quad ID 103D

MINNESOTA DEPARTMENT OF HEALTH

WELL AND BORING RECORD

Minnesota Statutes Chapter 103I

Entry Date 04/22/2003
Update Date 04/25/2007
Received Date

Well Name RW-5

Township	Range	Dir	Section	Subsections	Elevation	
27	22	W	11	AADCCB	705 ft.	Elevation Method 7.5 minute topographic map (+/- 5 feet)

Well Depth	Depth Completed	Date Well Completed
75 ft.	75 ft.	07/06/1995

Drilling Method Non-specified Rotary

Well Address

ST PAUL PARK MN 55071

Drilling Fluid Bentonite

Well Hydrofractured? ☐ Yes ☐ No
From Ft. to Ft.

Use Other (specify in remarks)

Casing Type Steel (black or low carbon) Joint No Information Drive Shoe? ☐ Yes ☑ No Above/Below ft.

Geological Material	Color	Hardness	From	To
LIMESTONE	TAN	HARD	0	40
LIMESTONE	TAN	SOFT	40	45
LIMESTONE	TAN	HARD	45	70
LIMESTONE	TAN	SOFT	70	75

Casing Diameter	Weight	Hole Diameter
8 in. to 25 ft.	lbs./ft.	12 in. to 25 ft.
		8 in. to 75 ft.

Open Hole from 25 ft. to 75 ft.

Screen NO Make Type

Diameter	Slot/Gauze	Length	Set Between

Static Water Level
30 ft. from Land surface Date Measured 07/06/1995

PUMPING LEVEL (below land surface)
75 ft. after 2 hrs. pumping 30 g.p.m.

Well Head Completion
Pitless adapter manufacturer Model
☐ Casing Protection ☐ 12 in. above grade
☐ At-grade (Environmental Wells and Borings ONLY)

REMARKS
WELL LOCATION: 700 BLOCK OF FRONT ST. ST. PAUL PARK, MN 55071
WATER STARTED COMING AT 32'
USE-REMEDIAL

Grouting Information Well Grouted? ☑ Yes ☐ No

Grout Material: Neat Cement from to 24 ft. 8 bags

Located by: Minnesota Department of Health
Method: GPS SA Off (averaged)
Unique Number Verification: N/A
Input Date: 08/15/2000
System: UTM - Nad83, Zone15, Meters
X: 499494 Y: 4965698

Nearest Known Source of Contamination
_feet _direction _type
Well disinfected upon completion? ☐ Yes ☑ No

Pump ☐ Not Installed Date Installed
Manufacturer's name Model number _ HP _ Volts
Length of drop Pipe _ft. Capacity _g.p.m Type Material

Abandoned Wells Does property have any not in use and not sealed well(s)? ☐ Yes ☐ No

Variance Was a variance granted from the MDH for this well? ☐ Yes ☐ No

First Bedrock Prairie Du Chien Group
Last Strat Prairie Du Chien Group
Aquifer Prairie Du Chien Group
Depth to Bedrock ft.

Well Contractor Certification

License Business Name	Lic. Or Reg. No.	Name of Driller
Traut M.J. Well Co.	71536	ROBBIE&JEFF

County Well Index Online Report

561416

Printed 4/10/2009
HE-01205-07

Minnesota Unique Well No.

576171

County Washington
Quad Inver Grove Heights
Quad ID 103D

MINNESOTA DEPARTMENT OF HEALTH

WELL AND BORING RECORD

Minnesota Statutes Chapter 103I

Entry Date 09/25/1996
Update Date 12/30/2004
Received Date

Well Name WILLIES HIDDEN HARBOR

Township	Range	Dir	Section	Subsections	Elevation	702 ft.
27	22	W	11	ADACCA	Elevation Method	Calc from DEM (USGS 7.5 min or equiv.)

Well Depth	Depth Completed	Date Well Completed
200 ft.	200 ft.	07/17/1996

Drilling Method Non-specified Rotary

Drilling Fluid
--

Well Hydrofractured? ☐ Yes ☐ No
From Ft. to Ft.

Use Domestic

Casing Type Steel (black or low carbon) Joint Welded Drive Shoe? ☑ Yes ☐ No Above/Below 0 ft.

Casing Diameter	Weight	Hole Diameter
4 in. to 189 ft.	lbs./ft.	12 in. to 30 ft. 8 in. to 189 ft.

Open Hole from 189 ft. to 200 ft.

Screen NO Make Type

Diameter	Slot/Gauze	Length	Set Between

Static Water Level
12 ft. from Land surface Date Measured 07/17/1996

PUMPING LEVEL (below land surface)
20 ft. after 1 hrs. pumping 30 g.p.m.

Well Head Completion
Pitless adapter manufacturer Model
☐ Casing Protection ☑ 12 in. above grade
☐ At-grade (Environmental Wells and Borings ONLY)

Well Address
388 9TH AV
ST PAUL PARK MN

Geological Material	Color	Hardness	From	To
SAND	BROWN	SOFT	0	30
ROCK	TAN	HARD	30	132
SANDROCK	YELLOW	SOFT	132	189
SANDROCK	YELLOW	HARD	189	200

REMARKS
27-22-11
ELEV 103-D

Located by: Minnesota Department of Health
Method: Digitization (Screen) - Map (1:24,000)
Unique Number Verification: N/A
Input Date: 10/24/2003
System: UTM - Nad83, Zone15, Meters
X: 499527 Y: 4965490

Grouting Information Well Grouted? ☑ Yes ☐ No

Grout Material: Neat Cement from 2 to 160 ft. 54 bags

Nearest Known Source of Contamination
100 feet W direction Body of water type
Well disinfected upon completion? ☐ Yes ☐ No

Pump ☑ Not Installed Date Installed 07/18/1996
Manufacturer's name OWNER'S Model number HP 0 Volts
Length of drop Pipe ft. Capacity g.p.m Type Submersible Material

Abandoned Wells Does property have any not in use and not sealed well(s)? ☐ Yes ☑ No

Variance Was a variance granted from the MDH for this well? ☐ Yes ☑ No

Well Contractor Certification

License Business Name	Lic. Or Reg. No.	Name of Driller
Schroepfer Well Co.	62119	SCHROEPFER, T

First Bedrock Prairie Du Chien Group
Aquifer Jordan
Last Strat Jordan
Depth to Bedrock 30 ft.

County Well Index Online Report

576171

Printed 11/3/2010
HE-01205-07

Minnesota Unique Well No.
582610

County Washington
Quad
Quad ID

MINNESOTA DEPARTMENT OF HEALTH

WELL AND BORING RECORD

Minnesota Statutes Chapter 103I

Entry Date
Update Date 09/01/2009
Received Date

Well Name ASHLAND PETROLEUM COMPANY

Township	Range	Dir	Section	Subsections	Elevation ft.
27	22	W	11	AAA	Elevation Method

Well Depth	Depth Completed	Date Well Completed
193 ft.	193 ft.	07/28/1997

Drilling Method Non-specified Rotary

Well Address
BROADWAY & MAIN ST
ST PAUL PARK MN 55071

Geological Material	Color	Hardness	From	To
FILL	BLACK	SOFT	0	2
LIMESTONE	TAN	HARD	2	158
SANDSTONE	TAN	MEDIUM	158	193

Drilling Fluid
--

Well Hydrofractured? ☐ Yes ☐ No
From Ft. to Ft.

Use Remedial

Casing Type Steel (black or low carbon) Joint No Information Drive Shoe? ☑ Yes ☐ No Above/Below ft.

Casing Diameter	Weight	Hole Diameter
6 in. to 173 ft.	lbs./ft.	12 in. to 173 ft.
		6 in. to 193 ft.

Open Hole from 173 ft. to 193 ft.

Screen NO Make Type

Diameter	Slot/Gauze	Length	Set Between

Static Water Level
20 ft. from Land surface Date Measured 07/28/1997

PUMPING LEVEL (below land surface)
ft. after hrs. pumping g.p.m.

Well Head Completion
Pitless adapter manufacturer Model
☑ Casing Protection Y ☐ 12 in. above grade
☐ At-grade (Environmental Wells and Borings ONLY)

REMARKS
ENGINEER - BAYWEST
WELL NUMBERED W-205

Grouting Information Well Grouted? ☑ Yes ☐ No

Grout Material: Neat Cement from to 173 ft. 110 bags

Nearest Known Source of Contamination
25 feet W direction _type
Well disinfected upon completion? ☐ Yes ☐ No

Pump ☐ Not Installed Date Installed
Manufacturer's name Model number _ HP _ Volts
Length of drop Pipe _ft. Capacity _g.p.m Type Material

Abandoned Wells Does property have any not in use and not sealed well(s)? ☐ Yes ☑ No

Variance Was a variance granted from the MDH for this well? ☐ Yes ☑ No

First Bedrock
Last Strat
Aquifer
Depth to Bedrock ft.

Well Contractor Certification

License Business Name	Lic. Or Reg. No.	Name of Driller
Keys Well Co.	62012	MARK & KEVIN

County Well Index Online Report

582610

Printed 11/3/2010
HE-01205-07

Appendix B

Bemidji Regional Airport Groundwater Receptor Survey Documents, October 2010 Survey

LEGEND:

→ Inferred Groundwater Flow Direction

Property Occupant

①	Bemidji Regional Airport
②	Rausch Cold Weather Testing Facility
③	Bureau of Criminal Apprehension, MN Dept. of Public Safety
④	Great River Dentistry
⑤	Indoor Auto Mall
⑥	Quality Inn
⑦	Paul Bunyan Elementry & ISD #31 Offices
⑧	City of Bemidji Water Treatment Facility
⑨	Kraus Anderson Construction Co.
⑩	MNDOT Northwest District

↑ North

FIGURE
RECEPTOR SURVEY
BEMIDJI FIRE DEPARTMENT FIRE TRAINING AREA
BEMIDJI AIRPORT
BEMIDJI, MINNESOTA

PROJECT NO. 45618DEL04	PREPARED BY NR	DRAWN BY DD
DATE 06/30/11	REVIEWED BY	FILE NAME Bemidji–1

anteagroup™

Receptor Survey Questionnaire — over Telephone 10-11-10 12:50pm

PROPERTY ADDRESS: Quality Inn 3500 Vicksburg Dr.

1. Is there, or has there ever been, a water well on the property? **Yes** [✓ **No**] **Unknown**

If you answered **No or Unknown**, proceed to Question 2.

1a. If you answered **Yes**, is the well *active* (in use), *abandoned* (not in use), or *sealed* (decommissioned following Minnesota Department of Health [MDH] Well Code guidelines).

______ACTIVE ________ABANDONED ________SEALED

1b. How deep is (was) the well? _______FEET (if depth is unknown check here _______)

1c. In what year was the well installed (if known)? ____________

1d. If the well was abandoned, what year was the well sealed?_________

3e. If the well is active, for what purpose is it used? Example: (drinking water, lawn sprinkler, cooling, etc.)____________________

1f. Where on the property is (was) the well located?____________________

1g. If there is currently a water supply well on the property, would you grant access to the property in order to obtain a water sample from either an indoor or outside faucet (at no cost to property owner)?

Yes **No**

Name____________________

Telephone Number____________________DAY or EVENING (please circle one and state best time to reach you)

2. Is a public water supply currently utilized by the property? [✓ **Yes**] **No**

3. May we contact you for further information if necessary? If so, please provide your name and telephone number.

Name Kevin Rakow-GM

Telephone Number 218-444-7708 DAY or EVENING (please circle one and state best time to reach you)

Please complete this form and mail it back to Delta in the enclosed self-addressed stamped envelope. Delta thanks you in advance for taking the time to complete this form.

If you have any questions, or need help completing this form, please feel free to contact Nancy Rodning, Delta Consultants, at (651)697-5152 or 1-800-477-7411, or Nile Fellows, MPCA, at 651-757-2352.

Not the Holiday Inn.

via telephone 10-11-10

Receptor Survey Questionnaire

PROPERTY ADDRESS: 3600 Moberg DR NW - Indoor Auto Mall

1. Is there, or has there ever been, a water well on the property? **Yes** [✓ **No**] **Unknown**

If you answered **No or Unknown**, proceed to Question 2.

1a. If you answered **Yes**, is the well *active* (in use), *abandoned* (not in use), or *sealed* (decommissioned following Minnesota Department of Health [MDH] Well Code guidelines).

______ACTIVE ________ABANDONED ________SEALED

1b. How deep is (was) the well? ______FEET (if depth is unknown check here ______)

1c. In what year was the well installed (if known)? __________

1d. If the well was abandoned, what year was the well sealed?________

3e. If the well is active, for what purpose is it used? Example: (drinking water, lawn sprinkler, cooling, etc.)____________________

1f. Where on the property is (was) the well located?____________________

1g. If there is currently a water supply well on the property, would you grant access to the property in order to obtain a water sample from either an indoor or outside faucet (at no cost to property owner)?

Yes **No**

Name____________________

Telephone Number____________________DAY or EVENING (please circle one and state best time to reach you)

2. Is a public water supply currently utilized by the property? [✓ Yes] No

3. May we contact you for further information if necessary? If so, please provide your name and telephone number.

Name Todd Lowth

Telephone Number 218-751-3140 DAY or EVENING (please circle one and state best time to reach you)

Please complete this form and mail it back to Delta in the enclosed self-addressed stamped envelope. Delta thanks you in advance for taking the time to complete this form.

If you have any questions, or need help completing this form, please feel free to contact Nancy Rodning, Delta Consultants, at (651)697-5152 or 1-800-477-7411, or Nile Fellows, MPCA, at 651-757-2352.

11/3/10 – Former Holiday Inn. Well Registered. Knowing no well, on city water. Former owner is Gary Canglehoff Properties

DELTA

PHONE COMMUNICATION RECORD

Date 11-3-10 Time 12:00

Person Contacted Incoming ☐ Outgoing ☒ Gary Gangelhoff, Bemidji

Phone 218-444-6900 Project No.

Project Name/Location

Contacted by Nancy R

Participants

Subject well 169190 - Holiday Inn. (Indoor Auto Mall)

Notes

there was a well there in the 1970's, there was no city water then.

(City water came to area). Well was capped. the ~~new~~ convention center addition was built over the location of that well.

Receptor Survey Questionnaire

PROPERTY ADDRESS: Great River Dentistry, 3622 Moberg Drive NW, Bemidji

1. Is there, or has there ever been, a water well on the property? **Yes** [✓ **No**] **Unknown**

If you answered **No or Unknown**, proceed to Question 2.

1a. If you answered **Yes**, is the well *active* (in use), *abandoned* (not in use), or *sealed* (decommissioned following Minnesota Department of Health [MDH] Well Code guidelines).

______ACTIVE ________ABANDONED ________SEALED

1b. How deep is (was) the well? ______FEET (if depth is unknown check here ______)

1c. In what year was the well installed (if known)? ___________

1d. If the well was abandoned, what year was the well sealed?________

3e. If the well is active, for what purpose is it used? Example: (drinking water, lawn sprinkler, cooling, etc.)________________________

1f. Where on the property is (was) the well located?________________________

1g. If there is currently a water supply well on the property, would you grant access to the property in order to obtain a water sample from either an indoor or outside faucet (at no cost to property owner)?

Yes **No**

Name________________________

Telephone Number________________________DAY or EVENING (please circle one and state best time to reach you)

2. Is a public water supply currently utilized by the property? [✓ **Yes**] **No**

3. May we contact you for further information if necessary? If so, please provide your name and telephone number.

Name Douglas R. Williams, DDS

Telephone Number 218-751-4216 DAY or EVENING (please circle one and state best time to reach you)

Please complete this form and mail it back to Delta in the enclosed self-addressed stamped envelope. Delta thanks you in advance for taking the time to complete this form.

If you have any questions, or need help completing this form, please feel free to contact Nancy Rodning, Delta Consultants, at (651)697-5152 or 1-800-477-7411, or Nile Fellows, MPCA, at 651-757-2352.

Receptor Survey Questionnaire

via telephone
10-11-10

PROPERTY ADDRESS: 3700 Norris Ct NW

1. Is there, or has there ever been, a water well on the property? **Yes** [✓ **No**] **Unknown**

If you answered **No or Unknown**, proceed to Question 2.

1a. If you answered **Yes**, is the well *active* (in use), *abandoned* (not in use), or *sealed* (decommissioned following Minnesota Department of Health [MDH] Well Code guidelines).

______ACTIVE ______ABANDONED ______SEALED

1b. How deep is (was) the well? ______FEET (if depth is unknown check here ______)

1c. In what year was the well installed (if known)? ______

1d. If the well was abandoned, what year was the well sealed?______

3e. If the well is active, for what purpose is it used? Example: (drinking water, lawn sprinkler, cooling, etc.)______

1f. Where on the property is (was) the well located?______

1g. If there is currently a water supply well on the property, would you grant access to the property in order to obtain a water sample from either an indoor or outside faucet (at no cost to property owner)?

Yes **No**

Name______

Telephone Number______DAY or EVENING (please circle one and state best time to reach you)

2. Is a public water supply currently utilized by the property? [✓ **Yes**] **No**

3. May we contact you for further information if necessary? If so, please provide your name and telephone number.

Name Jim Dougherty, MN Bureau of Criminal Apprehension

Telephone Number 218-755-6050 DAY or EVENING (please circle one and state best time to reach you)

Please complete this form and mail it back to Delta in the enclosed self-addressed stamped envelope. Delta thanks you in advance for taking the time to complete this form.

If you have any questions, or need help completing this form, please feel free to contact Nancy Rodning, Delta Consultants, at (651)697-5152 or 1-800-477-7411, or Nile Fellows, MPCA, at 651-757-2352.

Receptor Survey Questionnaire

PROPERTY ADDRESS: 3300 Gillett Dr NW - Paul Bunyan ISD #31

1. Is there, or has there ever been, a water well on the property? **Yes** [✓ **No**] **Unknown**

If you answered **No or Unknown**, proceed to Question 2.

1a. If you answered **Yes**, is the well *active* (in use), *abandoned* (not in use), or *sealed* (decommissioned following Minnesota Department of Health [MDH] Well Code guidelines).

______ACTIVE ________ABANDONED ________SEALED

1b. How deep is (was) the well? ______FEET (if depth is unknown check here ______)

1c. In what year was the well installed (if known)? __________

1d. If the well was abandoned, what year was the well sealed?________

3e. If the well is active, for what purpose is it used? Example: (drinking water, lawn sprinkler, cooling, etc.)____________________

1f. Where on the property is (was) the well located?____________________

1g. If there is currently a water supply well on the property, would you grant access to the property in order to obtain a water sample from either an indoor or outside faucet (at no cost to property owner)?

Yes **No**

Name____________________

Telephone Number____________________DAY or EVENING (please circle one and state best time to reach you)

2. Is a public water supply currently utilized by the property? [✓ **Yes**] **No**

3. May we contact you for further information if necessary? If so, please provide your name and telephone number.

Name Chris - Business Manager

Telephone Number 218-333-3100 DAY or EVENING (please circle one and state best time to reach you)

Please complete this form and mail it back to Delta in the enclosed self-addressed stamped envelope. Delta thanks you in advance for taking the time to complete this form.

If you have any questions, or need help completing this form, please feel free to contact Nancy Rodning, Delta Consultants, at (651)697-5152 or 1-800-477-7411, or Nile Fellows, MPCA, at 651-757-2352.

via Telephone
10-21-10

Receptor Survey Questionnaire

PROPERTY ADDRESS: 3507 Gillet Dr NW - Rausch Cold Weather Testing

1. Is there, or has there ever been, a water well on the property? **Yes** [✓ **No**] **Unknown**

If you answered **No or Unknown**, proceed to Question 2.

1a. If you answered **Yes**, is the well *active* (in use), *abandoned* (not in use), or *sealed* (decommissioned following Minnesota Department of Health [MDH] Well Code guidelines).

______ACTIVE ________ABANDONED ________SEALED

1b. How deep is (was) the well? _______FEET (if depth is unknown check here _______)

1c. In what year was the well installed (if known)? ____________

1d. If the well was abandoned, what year was the well sealed?_________

3e. If the well is active, for what purpose is it used? Example: (drinking water, lawn sprinkler, cooling, etc.)____

1f. Where on the property is (was) the well located?______________________________

1g. If there is currently a water supply well on the property, would you grant access to the property in order to obtain a water sample from either an indoor or outside faucet (at no cost to property owner)?

Yes **No**

Name____

Telephone Number__________________________________DAY or EVENING (please circle one and state best time to reach you)

2. Is a public water supply currently utilized by the property? [✓ **Yes**] **No**

3. May we contact you for further information if necessary? If so, please provide your name and telephone number.

Name Jason

Telephone Number 218-751-0016 DAY or EVENING (please circle one and state best time to reach you)

Please complete this form and mail it back to Delta in the enclosed self-addressed stamped envelope. Delta thanks you in advance for taking the time to complete this form.

If you have any questions, or need help completing this form, please feel free to contact Nancy Rodning, Delta Consultants, at (651)697-5152 or 1-800-477-7411, or Nile Fellows, MPCA, at 651-757-2352.

Receptor Survey Questionnaire — via telephone 10-14-10

PROPERTY ADDRESS: 3920 Hwy 2 West - MNDOT

1. Is there, or has there ever been, a water well on the property? **Yes** [✓ **No**] **Unknown**

If you answered **No or Unknown**, proceed to Question 2.

1a. If you answered **Yes**, is the well *active* (in use), *abandoned* (not in use), or *sealed* (decommissioned following Minnesota Department of Health [MDH] Well Code guidelines).

______ACTIVE ________ABANDONED ________SEALED

1b. How deep is (was) the well? _______FEET (if depth is unknown check here _______)

1c. In what year was the well installed (if known)? ____________

1d. If the well was abandoned, what year was the well sealed?_________

3e. If the well is active, for what purpose is it used? Example: (drinking water, lawn sprinkler, cooling, etc.)____________________

1f. Where on the property is (was) the well located?____________________

1g. If there is currently a water supply well on the property, would you grant access to the property in order to obtain a water sample from either an indoor or outside faucet (at no cost to property owner)?

Yes **No**

Name____________________

Telephone Number____________________DAY or EVENING (please circle one and state best time to reach you)

2. Is a public water supply currently utilized by the property? [✓ **Yes**] **No**

3. May we contact you for further information if necessary? If so, please provide your name and telephone number.

Name Dan Tricka

Telephone Number 218-755-6507 DAY or EVENING (please circle one and state best time to reach you)

Please complete this form and mail it back to Delta in the enclosed self-addressed stamped envelope. Delta thanks you in advance for taking the time to complete this form.

If you have any questions, or need help completing this form, please feel free to contact Nancy Rodning, Delta Consultants, at (651)697-5152 or 1-800-477-7411, or Nile Fellows, MPCA, at 651-757-2352.

via telephone

Receptor Survey Questionnaire

PROPERTY ADDRESS: Kraus Anderson Const. Shop 3168

1. Is there, or has there ever been, a water well on the property? [✓ **Yes**] **No** **Unknown**

If you answered **No or Unknown**, proceed to Question 2.

1a. If you answered **Yes**, is the well *active* (in use), *abandoned* (not in use), or *sealed* (decommissioned following Minnesota Department of Health [MDH] Well Code guidelines).

__✓__ACTIVE ________ABANDONED ________SEALED

1b. How deep is (was) the well? __~20__FEET (if depth is unknown check here _______)

1c. In what year was the well installed (if known)? ____________

1d. If the well was abandoned, what year was the well sealed?_________

3e. If the well is active, for what purpose is it used? Example: (drinking water, lawn sprinkler, cooling, etc.) [illegible] (power wash), bathrooms No drinking

1f. Where on the property is (was) the well located?________________________

1g. If there is currently a water supply well on the property, would you grant access to the property in order to obtain a water sample from either an indoor or outside faucet (at no cost to property owner)?

Yes **No**

Name________________________________

Telephone Number________________________DAY or EVENING (please circle one and state best time to reach you)

2. Is a public water supply currently utilized by the property? **Yes** **No**

3. May we contact you for further information if necessary? If so, please provide your name and telephone number.

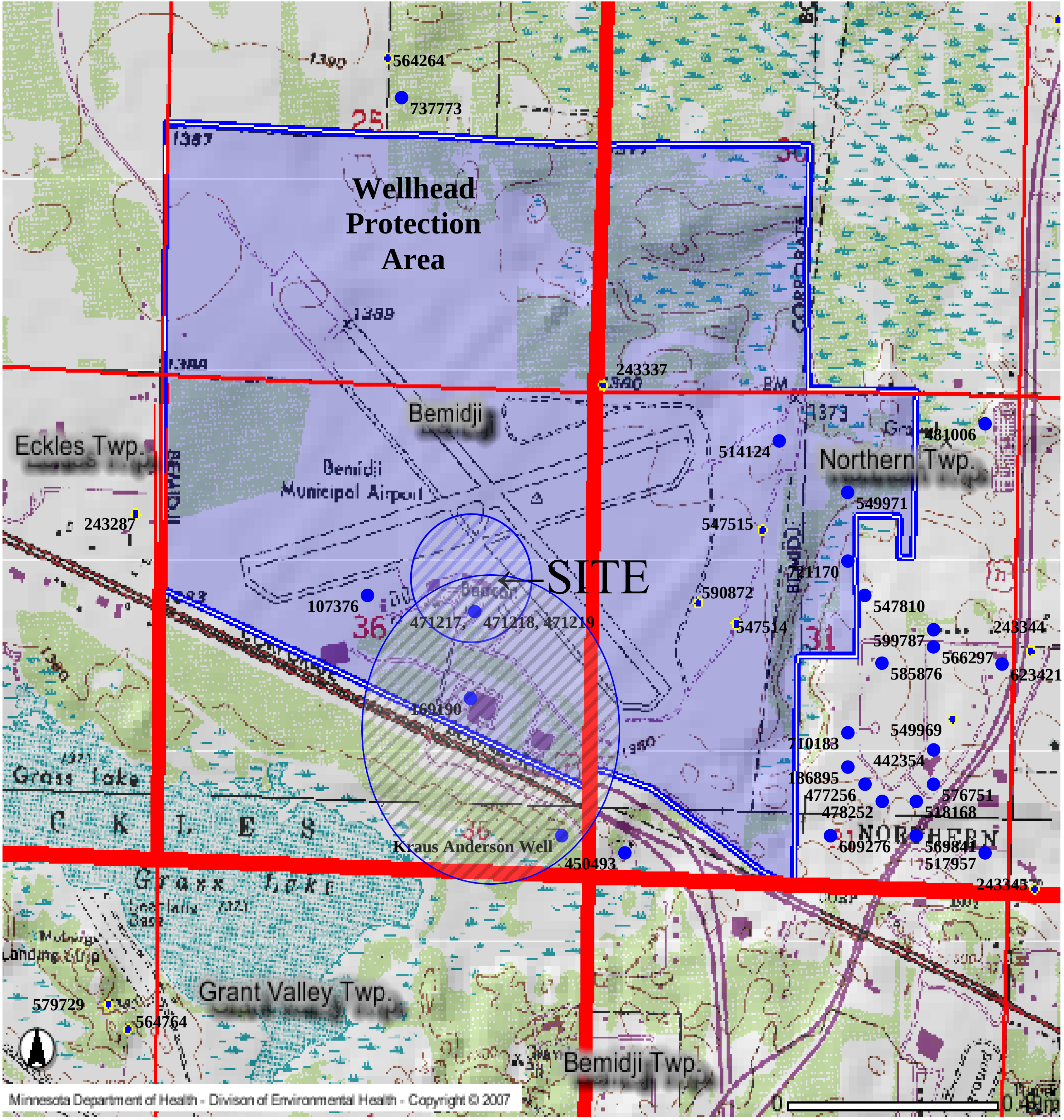
Name________________________________

Telephone Number 218-751-4207 DAY or EVENING (please circle one and state best time to reach you)

Please complete this form and mail it back to Delta in the enclosed self-addressed stamped envelope. Delta thanks you in advance for taking the time to complete this form.

If you have any questions, or need help completing this form, please feel free to contact Nancy Rodning, Delta Consultants, at (651)697-5152 or 1-800-477-7411, or Nile Fellows, MPCA, at 651-757-2352.

BEMIDJI AIRPORT CWI Well Map



▨ Approximate Area of Receptor Survey (October 2010)

Minnesota Unique Well No.
169190

County Beltrami
Quad
Quad ID

MINNESOTA DEPARTMENT OF HEALTH

WELL AND BORING RECORD

Minnesota Statutes Chapter 103I

Entry Date 02/28/1989
Update Date 03/11/2005
Received Date

Well Name HOLIDAY INN

Township	Range	Dir	Section	Subsections
147	34	W	36	

Elevation ft.
Elevation Method

Well Depth	Depth Completed	Date Well Completed
86 ft.	86 ft.	03/14/1980

Drilling Method Non-specified Rotary

Drilling Fluid
--

Well Hydrofractured? ☐ Yes ☐ No
From Ft. to Ft.

Use Commercial

Casing Type Steel (black or low carbon) Joint Welded Drive Shoe? ☐ Yes ☐ No Above/Below ft.

Geological Material	**Color**	**Hardness**	**From**	**To**
FINE SAND	BROWN	SOFT	0	43
CLAY	GRAY	HARD	43	55
BOULDERS		HARD	55	74
SAND	GRAY	SOFT	74	86

Casing Diameter	**Weight**	**Hole Diameter**

Open Hole from ft. to ft.

Screen YES Make JOHNSON Type stainless steel

Diameter	**Slot/Gauze**	**Length**	**Set Between**
	15		76 ft. and 86 ft.

Static Water Level
10 ft. from Land surface Date Measured 03/14/1980

PUMPING LEVEL (below land surface)
70 ft. after 60 hrs. pumping 100 g.p.m.

Well Head Completion
Pitless adapter manufacturer Model
☐ Casing Protection ☐ 12 in. above grade
☐ At-grade (Environmental Wells and Borings ONLY)

REMARKS
FRONT SECTION 36

Grouting Information Well Grouted? ☑ Yes ☐ No

Nearest Known Source of Contamination
__feet __direction __type
Well disinfected upon completion? ☑ Yes ☐ No

Pump ☐ Not Installed Date Installed
Manufacturer's name Model number __ HP _ Volts
Length of drop Pipe _ft. Capacity _g.p.m Type Material

Abandoned Wells Does property have any not in use and not sealed well(s)? ☐ Yes ☐ No

Variance Was a variance granted from the MDH for this well? ☐ Yes ☐ No

First Bedrock
Last Strat
Aquifer
Depth to Bedrock ft.

Well Contractor Certification

License Business Name	Lic. Or Reg. No.	Name of Driller
Diamond Water Wells	18446	WADDELL, L.

County Well Index Online Report

169190

Printed 4/3/2009
HE-01205-07

Minnesota Unique Well No.
186895

County Beltrami
Quad
Quad ID

MINNESOTA DEPARTMENT OF HEALTH

WELL AND BORING RECORD

Minnesota Statutes Chapter 103I

Entry Date 02/28/1989
Update Date 03/11/2005
Received Date

Well Name RUEBEN ROBERTSON

Township	Range	Dir	Section	Subsections	Elevation	ft.
147	33	W	31	DC	Elevation Method	

Well Depth	Depth Completed	Date Well Completed
66 ft.	66 ft.	08/16/1984

Drilling Method Cable Tool

Drilling Fluid
--

Well Hydrofractured? ☐ Yes ☐ No
From Ft. to Ft.

Use Domestic

Casing Type Galvanized Joint Threaded Drive Shoe? ☑ Yes ☐ No Above/Below 1 ft.

Casing Diameter	Weight	Hole Diameter
2 in. to 62 ft.	3.75 lbs./ft.	

Geological Material	Color	Hardness	From	To
SAND & CLAY	YELLOW	HARD	0	18
SAND	YELLOW	HARD	18	42
SAND & CLAY	YELLOW	HARD	42	61
SAND	YELLOW	HARD	61	66

Open Hole from ft. to ft.

Screen YES Make JOHNSON Type stainless steel

Diameter	Slot/Gauze	Length	Set Between
1.3	8	4	62 ft. and 66 ft.

Static Water Level
18 ft. from Land surface Date Measured 08/16/1984

PUMPING LEVEL (below land surface)
18 ft. after 120 hrs. pumping 10 g.p.m.

Well Head Completion
Pitless adapter manufacturer Model
☐ Casing Protection ☑ 12 in. above grade
☐ At-grade (Environmental Wells and Borings ONLY)

NO REMARKS

Grouting Information Well Grouted? ☐ Yes ☑ No

Nearest Known Source of Contamination
75 feet E direction Other type
Well disinfected upon completion? ☑ Yes ☐ No

Pump ☐ Not Installed Date Installed 08/16/1984
Manufacturer's name TAIT Model number 5CAT HP 0.5 Volts 110
Length of drop Pipe 21 ft. Capacity 6 g.p.m Type Jet Material Galvanized

Abandoned Wells Does property have any not in use and not sealed well(s)? ☐ Yes ☐ No

Variance Was a variance granted from the MDH for this well? ☐ Yes ☐ No

Well Contractor Certification

License Business Name	Lic. Or Reg. No.	Name of Driller
Nelson Well Drilling	04121	NELSON, L.

First Bedrock
Last Strat
Aquifer
Depth to Bedrock ft.

County Well Index Online Report

186895

Printed 4/3/2009
HE-01205-07

Minnesota Unique Well No.
442354

County Beltrami
Quad
Quad ID

MINNESOTA DEPARTMENT OF HEALTH

WELL AND BORING RECORD

Minnesota Statutes Chapter 103I

Entry Date 11/08/1990
Update Date 02/04/2004
Received Date

Well Name KERNMER, KAY

Township	Range	Dir	Section	Subsections	Elevation	ft.
147	33	W	31		Elevation Method	

Well Depth	Depth Completed	Date Well Completed
52 ft.	52 ft.	10/06/1989

Drilling Method Non-specified Rotary

Well Address
2316 BARDWELL DR NW
BEMIDJI MN 5660

Geological Material	Color	Hardness	From	To
SAND	YELLOW	SOFT	0	15
SAND	BLUE	SOFT	15	35
CLAY	BLUE	SOFT	35	43
SAND	YELLOW	MEDIUM	43	52

Drilling Fluid
--

Well Hydrofractured? ☐ Yes ☐ No
From Ft. to Ft.

Use Domestic

Casing Type Plastic Joint No Information Drive Shoe? ☐ Yes ☐ No Above/Below 1 ft.

Casing Diameter	Weight	Hole Diameter
		6.25 in. to 52 ft.

Open Hole from ft. to ft.

Screen YES Make SMITH Type stainless steel

Diameter	Slot/Gauze	Length	Set Between
	12	4	ft. and ft.

Static Water Level
15 ft. from Land surface Date Measured 10/06/1989

PUMPING LEVEL (below land surface)
ft. after hrs. pumping 40 g.p.m.

Well Head Completion
Pitless adapter manufacturer Model
☐ Casing Protection ☐ 12 in. above grade
☐ At-grade (Environmental Wells and Borings ONLY)

R E M A R K S
NORTH OF THE EAST END OF THE AIRPORT

Grouting Information Well Grouted? ☑ Yes ☐ No

Grout Material: Neat Cement from to ft.

Nearest Known Source of Contamination
__feet __direction __type
Well disinfected upon completion? ☑ Yes ☐ No

Pump ☐ Not Installed Date Installed
Manufacturer's name Model number __ HP _ Volts
Length of drop Pipe _ft. Capacity _g.p.m Type Material

Abandoned Wells Does property have any not in use and not sealed well(s)? ☐ Yes ☑ No

Variance Was a variance granted from the MDH for this well? ☐ Yes ☐ No

First Bedrock
Aquifer
Last Strat
Depth to Bedrock ft.

Well Contractor Certification

License Business Name	Lic. Or Reg. No.	Name of Driller
Aqua Well Drilling	04463	YERBICH, A.

County Well Index Online Report

442354

Printed 4/3/2009
HE-01205-07

Minnesota Unique Well No.

450493

County Beltrami
Quad
Quad ID

MINNESOTA DEPARTMENT OF HEALTH

WELL AND BORING RECORD

Minnesota Statutes Chapter 103I

Entry Date	03/03/1991
Update Date	07/24/2000
Received Date	

Well Name OLSON, RON

Township	Range	Dir	Section	Subsections	Elevation ft.
147	33	W	31	CCC	Elevation Method

Well Depth	Depth Completed	Date Well Completed
47 ft.	47 ft.	09/23/1987

Drilling Method Jetted

Well Address

BEMIDJI MN 56601

Geological Material	Color	Hardness	From	To
SAND			0	39
CLAY	BLUE		39	43
SAND	BLUE		43	47

Drilling Fluid
--

Well Hydrofractured? ☐ Yes ☐ No
From Ft. to Ft.

Use Domestic

Casing Type Galvanized Joint Threaded Drive Shoe? ☑ Yes ☐ No Above/Below 1 ft.

Casing Diameter	Weight	Hole Diameter
2 in. to 42 ft.	3 lbs./ft.	

Open Hole from ft. to ft.

Screen YES Make JOHNSON Type

Diameter	Slot/Gauze	Length	Set Between
1.3	12	48	43 ft. and 47 ft.

Static Water Level
14 ft. from Land surface Date Measured 09/23/1987

PUMPING LEVEL (below land surface)
ft. after hrs. pumping g.p.m.

Well Head Completion
Pitless adapter manufacturer Model
☐ Casing Protection ☑ 12 in. above grade
☐ At-grade (Environmental Wells and Borings ONLY)

NO REMARKS

Grouting Information Well Grouted? ☐ Yes ☐ No

Nearest Known Source of Contamination
__feet __direction __type
Well disinfected upon completion? ☑ Yes ☐ No

Pump ☐ Not Installed Date Installed
Manufacturer's name Model number __ HP _ Volts
Length of drop Pipe _ft. Capacity _g.p.m Type Material

Abandoned Wells Does property have any not in use and not sealed well(s)? ☐ Yes ☑ No

Variance Was a variance granted from the MDH for this well? ☐ Yes ☐ No

Well Contractor Certification

License Business Name	Lic. Or Reg. No.	Name of Driller
		SIZER, G.

First Bedrock
Last Strat
Aquifer
Depth to Bedrock ft.

County Well Index Online Report

450493

Printed 4/3/2009
HE-01205-07

Minnesota Unique Well No.
471217

County Beltrami
Quad
Quad ID

MINNESOTA DEPARTMENT OF HEALTH
WELL AND BORING RECORD
Minnesota Statutes Chapter 103I

Entry Date 09/25/1992
Update Date 08/28/2007
Received Date 06/24/1991

Well Name BEMIDJI AVIATION MW-1

Township	Range	Dir	Section	Subsections	Elevation ft.
147	34	W	36	ACD	Elevation Method

Well Depth	Depth Completed	Date Well Completed
20 ft.	20 ft.	06/06/1991

Drilling Method Other

Drilling Fluid
--

Well Hydrofractured? ☐ Yes ☐ No
From Ft. to Ft.

Use Abandoned Status Sealed

Casing Type Steel (black or low carbon) Joint Threaded Drive Shoe? ☐ Yes ☑ No Above/Below 2 ft.

Casing Diameter	Weight	Hole Diameter
2 in. to 10 ft.	lbs./ft.	8 in. to 20 ft.

Geological Material	Color	Hardness	From	To
CONCRETE	WHITE		0	1
SAND - MODERATE	YEL/BRN		1	6
SAND - DARK, YELL/BRN			6	14
SAND - PALE, YELL/BRN			14	20

Open Hole from ft. to ft.

Screen YES Make JOHNSON Type stainless steel

Diameter	Slot/Gauze	Length	Set Between
2	20	10	10 ft. and 20 ft.

Static Water Level
15 ft. from Land surface Date Measured 06/06/1991

PUMPING LEVEL (below land surface)
ft. after hrs. pumping g.p.m.

Well Head Completion
Pitless adapter manufacturer Model
☐ Casing Protection ☐ 12 in. above grade
☐ At-grade (Environmental Wells and Borings ONLY)

REMARKS
MONITORING WELL IS USED TO CK THE SPREAD OF GAS IN THE GROUND WATER.
WELL SEALED 10-05-1993 BY 75330
ORIGINAL USE MW - MONITOR WELL - #1
DRILLING METHOD - HOLLOW ROD

Grouting Information Well Grouted? ☑ Yes ☐ No

Grout Material: Bentonite from 9 to 10 ft.
Grout Material: Neat Cement from to 9 ft.

Nearest Known Source of Contamination
__feet __direction __type
Well disinfected upon completion? ☐ Yes ☐ No

Pump ☐ Not Installed Date Installed
Manufacturer's name Model number __ HP _ Volts
Length of drop Pipe _ft. Capacity _g.p.m Type Material

Abandoned Wells Does property have any not in use and not sealed well(s)? ☐ Yes ☑ No

Variance Was a variance granted from the MDH for this well? ☐ Yes ☐ No

Well Contractor Certification

License Business Name	Lic. Or Reg. No.	Name of Driller
Valnes Well Co.	75330	VALNES, T.

First Bedrock
Last Strat
Aquifer
Depth to Bedrock ft.

County Well Index Online Report

471217

Printed 4/3/2009
HE-01205-07

Minnesota Unique Well No.
471218

County Beltrami
Quad
Quad ID

MINNESOTA DEPARTMENT OF HEALTH

WELL AND BORING RECORD

Minnesota Statutes Chapter 103I

Entry Date 09/25/1992
Update Date 10/16/2008
Received Date 06/24/1991

Well Name BEMIDJI AVIATION MW-2

Township	Range	Dir	Section	Subsections
147	34	W	36	ACD

Elevation ft.
Elevation Method

Well Depth	Depth Completed	Date Well Completed
20 ft.	20 ft.	06/06/1991

Drilling Method Other

Well Address
2 HY W
MN

Drilling Fluid
--

Well Hydrofractured? ☐ Yes ☐ No
From Ft. to Ft.

Use Abandoned Status Sealed

Casing Type Steel (black or low carbon) Joint Threaded Drive Shoe? ☐ Yes ☑ No Above/Below 2 ft.

Geological Material	Color	Hardness	From	To
CONCRETE	WHITE		0	1
SAND - MODERATE YELL/BRN			1	6
SAND - DARK YELL/BRN			6	14
SAND - PALE YELL/BRN			14	20

Casing Diameter	Weight	Hole Diameter
2 in. to 10 ft.	lbs./ft.	8 in. to 20 ft.

Open Hole from ft. to ft.

Screen YES Make JOHNSON Type stainless steel

Diameter	Slot/Gauze	Length	Set Between
2	10	10	10 ft. and 20 ft.

Static Water Level
16 ft. from Land surface Date Measured 06/06/1991

PUMPING LEVEL (below land surface)
ft. after hrs. pumping g.p.m.

Well Head Completion
Pitless adapter manufacturer Model
☐ Casing Protection ☐ 12 in. above grade
☐ At-grade (Environmental Wells and Borings ONLY)

REMARKS
MW WELL IS USED TO CHECK THE SPREAD OF GASOLINE IN THE GROUND WATER.
WELL SEALED 10-05-1993 BY 75330
ORIGINAL USE MW - MONITOR WELL - #2
DRILLING METHOD - HOLLOW ROD

Grouting Information Well Grouted? ☑ Yes ☐ No

Grout Material: Bentonite from 9 to 10 ft.
Grout Material: Neat Cement from to 9 ft.

Nearest Known Source of Contamination
__feet __direction __type
Well disinfected upon completion? ☐ Yes ☐ No

Pump ☐ Not Installed Date Installed
Manufacturer's name Model number __ HP _ Volts
Length of drop Pipe _ft. Capacity _g.p.m Type Material

Abandoned Wells Does property have any not in use and not sealed well(s)? ☐ Yes ☑ No

Variance Was a variance granted from the MDH for this well? ☐ Yes ☐ No

First Bedrock
Last Strat
Aquifer
Depth to Bedrock ft.

Well Contractor Certification

License Business Name	Lic. Or Reg. No.	Name of Driller
Valnes Well Co.	75330	VALNES, T.

County Well Index Online Report

471218

Printed 4/3/2009
HE-01205-07

Minnesota Unique Well No.
471219

County Beltrami
Quad
Quad ID

MINNESOTA DEPARTMENT OF HEALTH

WELL AND BORING RECORD

Minnesota Statutes Chapter 103I

Entry Date 09/25/1992
Update Date 10/16/2008
Received Date 06/24/1991

Well Name BEMIDJI AVIATION MW-3

Township	Range	Dir	Section	Subsections	Elevation ft.
147	34	W	36	ACD	Elevation Method

Well Depth	Depth Completed	Date Well Completed
20 ft.	20 ft.	06/06/1991

Drilling Method --

Well Address
2 HY W
MN

Drilling Fluid
--

Well Hydrofractured? ☐ Yes ☐ No
From Ft. to Ft.

Use Abandoned Status Sealed

Casing Type Steel (black or low carbon) Joint Threaded Drive Shoe? ☐ Yes ☑ No Above/Below 2 ft.

Casing Diameter	**Weight**	**Hole Diameter**
2 in. to 10 ft.	lbs./ft.	8 in. to 20 ft.

Geological Material	**Color**	**Hardness**	**From**	**To**

Open Hole from ft. to ft.

Screen YES Make JOHNSON Type stainless steel

Diameter	**Slot/Gauze**	**Length**	**Set Between**
2	10	10	10 ft. and 20 ft.

Static Water Level
15.5 ft. from Land surface Date Measured 06/06/1991

PUMPING LEVEL (below land surface)
ft. after hrs. pumping g.p.m.

Well Head Completion
Pitless adapter manufacturer Model
☐ Casing Protection ☐ 12 in. above grade
☐ At-grade (Environmental Wells and Borings ONLY)

REMARKS
MW WELL IS TO CHECK TO SPREAD OF GASOLINE IN THE GROUND WATER.
WELL SEALED 10-05-1993 BY 75330
ORIGINAL USE MW - MONITOR WELL

Grouting Information Well Grouted? ☑ Yes ☐ No

Grout Material: Bentonite from 9 to 10 ft.
Grout Material: Neat Cement from to 9 ft.

Nearest Known Source of Contamination
__feet __direction __type
Well disinfected upon completion? ☐ Yes ☐ No

Pump ☐ Not Installed Date Installed
Manufacturer's name Model number __ HP _ Volts
Length of drop Pipe _ft. Capacity _g.p.m Type Material

Abandoned Wells Does property have any not in use and not sealed well(s)? ☐ Yes ☑ No

Variance Was a variance granted from the MDH for this well? ☐ Yes ☐ No

First Bedrock
Last Strat
Aquifer
Depth to Bedrock ft.

Well Contractor Certification

Valnes Well Co.	75330	VALNES, T.
License Business Name	Lic. Or Reg. No.	Name of Driller

County Well Index Online Report

471219

Printed 4/3/2009
HE-01205-07

Minnesota Unique Well No.
477256

County Beltrami
Quad
Quad ID

MINNESOTA DEPARTMENT OF HEALTH

WELL AND BORING RECORD

Minnesota Statutes Chapter 103I

Entry Date 04/04/1992
Update Date 07/24/2000
Received Date

Well Name PETSCHE, WILLIAM

Township	Range	Dir	Section	Subsections	Elevation	ft.
147	33	W	31	DDB	Elevation Method	

Well Depth	Depth Completed	Date Well Completed
54 ft.	54 ft.	07/03/1991

Drilling Method Cable Tool

Well Address
2323 ALGEE CT NW
MN

Geological Material	Color	Hardness	From	To
SAND	YELLOW		0	27
CLAY			27	48
SAND			48	54
CLAY & ROCK	BLACK		54	

Drilling Fluid
--

Well Hydrofractured? ☐ Yes ☐ No
From Ft. to Ft.

Use Domestic

Casing Type Steel (black or low carbon) Joint Threaded Drive Shoe? ☑ Yes ☐ No Above/Below 3 ft.

Casing Diameter	Weight	Hole Diameter
4 in. to 50 ft.	lbs./ft.	

Open Hole from ft. to ft.

Screen YES Make COOK Type stainless steel

Diameter	Slot/Gauze	Length	Set Between
2	12	4	50 ft. and 54 ft.

Static Water Level
26 ft. from Land surface Date Measured 07/03/1991

PUMPING LEVEL (below land surface)
38 ft. after 30 hrs. pumping 15 g.p.m.

Well Head Completion
Pitless adapter manufacturer MAASS Model
☐ Casing Protection ☐ 12 in. above grade
☐ At-grade (Environmental Wells and Borings ONLY)

NO REMARKS

Grouting Information Well Grouted? ☐ Yes ☑ No

Nearest Known Source of Contamination
__feet __direction __type
Well disinfected upon completion? ☐ Yes ☐ No

Pump ☐ Not Installed Date Installed
Manufacturer's name AERMOTOR Model number __ HP 0.5 Volts 220
Length of drop Pipe 30 ft. Capacity _g.p.m Type Submersible Material Plastic

Abandoned Wells Does property have any not in use and not sealed well(s)? ☐ Yes ☑ No

Variance Was a variance granted from the MDH for this well? ☐ Yes ☐ No

Well Contractor Certification

License Business Name	Lic. Or Reg. No.	Name of Driller
Lahman Well Drilling	04051	LAHMAN, C.

First Bedrock
Last Strat
Aquifer
Depth to Bedrock ft.

County Well Index Online Report

477256

Printed 4/3/2009
HE-01205-07

Minnesota Unique Well No.
478252

County Beltrami
Quad
Quad ID

MINNESOTA DEPARTMENT OF HEALTH

WELL AND BORING RECORD

Minnesota Statutes Chapter 103I

Entry Date 09/19/1991
Update Date 07/24/2000
Received Date

Well Name SHIPPER, SHARON

Township	Range	Dir	Section	Subsections	Elevation ft.
147	33	W	31	ACC	Elevation Method

Well Depth	Depth Completed	Date Well Completed
50 ft.	50 ft.	07/01/1991

Drilling Method Non-specified Rotary

Well Address
2405 ALYCE CT
BEMIDJI MN 56601

Geological Material	Color	Hardness	From	To
SAND	BROWN		0	19
SAND	GRAY		19	26
SILTY CLAY	GRAY		26	30
SAND	GRAY		30	50

Drilling Fluid Bentonite

Well Hydrofractured? ☐ Yes ☐ No
From Ft. to Ft.

Use Domestic

Casing Type Plastic Joint No Information Drive Shoe? ☐ Yes ☑ No Above/Below 1 ft.

Casing Diameter	Weight	Hole Diameter
4 in. to 45 ft.	lbs./ft.	8.8 in. to 50 ft.

Open Hole from ft. to ft.

Screen YES Make JOHNSON Type plastic

Diameter	Slot/Gauze	Length	Set Between
4	23	5	45 ft. and 50 ft.

Static Water Level
12 ft. from Land surface Date Measured 07/01/1991

PUMPING LEVEL (below land surface)
38 ft. after 60 hrs. pumping 30 g.p.m.

Well Head Completion
Pitless adapter manufacturer STEEL MASS Model J
☐ Casing Protection ☐ 12 in. above grade
☐ At-grade (Environmental Wells and Borings ONLY)

NO REMARKS

Grouting Information Well Grouted? ☑ Yes ☐ No

Grout Material: Neat Cement from 40 to 10 ft.

Nearest Known Source of Contamination
100 feet direction Septic tank/drain field type
Well disinfected upon completion? ☑ Yes ☐ No

Pump ☐ Not Installed Date Installed 07/02/1991
Manufacturer's name AERMOTOR Model number SD12-50 HP 0.5 Volts 230
Length of drop Pipe 35 ft. Capacity 9 g.p.m Type Submersible Material Plastic

Abandoned Wells Does property have any not in use and not sealed well(s)? ☐ Yes ☑ No

Variance Was a variance granted from the MDH for this well? ☐ Yes ☐ No

Well Contractor Certification

License Business Name	Lic. Or Reg. No.	Name of Driller
North Star Drilling	49588	FELL, B.

First Bedrock
Last Strat
Aquifer
Depth to Bedrock ft.

County Well Index Online Report

478252

Printed 4/3/2009
HE-01205-07

Minnesota Unique Well No.

514124

County Beltrami
Quad
Quad ID

MINNESOTA DEPARTMENT OF HEALTH

WELL AND BORING RECORD

Minnesota Statutes Chapter 103I

Entry Date 03/09/1993
Update Date 03/11/2005
Received Date

Well Name FRONTIER HOMES INC

Township	Range	Dir	Section	Subsections	Elevation	ft.
147	33	W	31	BAA	Elevation Method	

Well Depth	Depth Completed	Date Well Completed
56 ft.	56 ft.	09/28/1992

Drilling Method Cable Tool

Drilling Fluid
--

Well Hydrofractured? ☐ Yes ☐ No
From Ft. to Ft.

Use Domestic

Casing Type Steel (black or low carbon) Joint Welded Drive Shoe? ☑ Yes ☐ No Above/Below ft.

Geological Material	**Color**	**Hardness**	**From**	**To**
SAND	YELLOW		0	56

Casing Diameter	**Weight**	**Hole Diameter**
4 in. to 52 ft.	11 lbs./ft.	

Open Hole from ft. to ft.

Screen YES Make COOK Type stainless steel

Diameter	**Slot/Gauze**	**Length**	**Set Between**
4	10	4	52 ft. and 52 ft.

Static Water Level
18 ft. from Land surface Date Measured 09/28/1992

PUMPING LEVEL (below land surface)
33 ft. after 30 hrs. pumping 15 g.p.m.

Well Head Completion
Pitless adapter manufacturer MAASS Model
☐ Casing Protection ☐ 12 in. above grade
☐ At-grade (Environmental Wells and Borings ONLY)

NO REMARKS

Grouting Information Well Grouted? ☐ Yes ☐ No

Nearest Known Source of Contamination
__feet __direction __type
Well disinfected upon completion? ☑ Yes ☐ No

Pump ☐ Not Installed Date Installed
Manufacturer's name Model number __ HP _ Volts
Length of drop Pipe _ft. Capacity _g.p.m Type Material

Abandoned Wells Does property have any not in use and not sealed well(s)? ☐ Yes ☑ No

Variance Was a variance granted from the MDH for this well? ☐ Yes ☐ No

First Bedrock
Last Strat
Aquifer
Depth to Bedrock ft.

Well Contractor Certification

Lahman Well Drilling	04051	LAHMAN, C.
License Business Name	Lic. Or Reg. No.	Name of Driller

County Well Index Online Report

514124

Printed 4/3/2009
HE-01205-07

Minnesota Unique Well No.
518168

County Beltrami
Quad
Quad ID

MINNESOTA DEPARTMENT OF HEALTH
WELL AND BORING RECORD
Minnesota Statutes Chapter 103I

Entry Date 03/09/1993
Update Date 02/04/2004
Received Date

Well Name KOLP, RICHARD

Township	Range	Dir	Section	Subsections	Elevation	ft.
147	33	W	31	DAC	Elevation Method	

Well Depth	Depth Completed	Date Well Completed
54 ft.	54 ft.	10/20/1992

Drilling Method Non-specified Rotary

Well Address
3611 LAUREL DR NW
MN

Drilling Fluid
Revert

Well Hydrofractured? ☐ Yes ☐ No
From Ft. to Ft.

Use Domestic

Casing Type Plastic Joint No Information Drive Shoe? ☐ Yes ☐ No Above/Below ft.

Geological Material	**Color**	**Hardness**	**From**	**To**
SAND	YELLOW	SOFT	0	27
CLAY	BLUE	SOFT	27	31
SAND	BLUE	HARD	31	54

Casing Diameter	**Weight**	**Hole Diameter**
4 in. to 50 ft.	lbs./ft.	8.5 in. to 30 ft.
		6.25 in. to 54 ft.

Open Hole from ft. to ft.

Screen YES Make JOHNSON Type

Diameter	**Slot/Gauze**	**Length**	**Set Between**
2	12	4	50 ft. and 54 ft.

Static Water Level
16 ft. from Land surface Date Measured 10/20/1992

PUMPING LEVEL (below land surface)
16 ft. after 120 hrs. pumping 35 g.p.m.

Well Head Completion
Pitless adapter manufacturer MAASS Model 4J1
☐ Casing Protection ☐ 12 in. above grade
☐ At-grade (Environmental Wells and Borings ONLY)

REMARKS
DICK'S MARINE

Grouting Information Well Grouted? ☑ Yes ☐ No

Grout Material: Neat Cement from 7 to 30 ft.
Grout Material: Cuttings from 30 to 39 ft.

Nearest Known Source of Contamination
60 feet South West direction Septic tank/drain field type
Well disinfected upon completion? ☑ Yes ☐ No

Pump ☐ Not Installed Date Installed 10/22/1992
Manufacturer's name STA-RITE Model number 10SP4C02T HP 0.5 Volts 220
Length of drop Pipe 40 ft. Capacity 10 g.p.m Type Submersible Material

Abandoned Wells Does property have any not in use and not sealed well(s)? ☐ Yes ☑ No

Variance Was a variance granted from the MDH for this well? ☐ Yes ☐ No

Well Contractor Certification

Nelson Well Drilling	04121	REED, G.
License Business Name	Lic. Or Reg. No.	Name of Driller

First Bedrock
Aquifer
Last Strat
Depth to Bedrock ft.

County Well Index Online Report

518168

Printed 4/3/2009
HE-01205-07

Minnesota Unique Well No.

547810

County Beltrami
Quad
Quad ID

MINNESOTA DEPARTMENT OF HEALTH

WELL AND BORING RECORD

Minnesota Statutes Chapter 103I

Entry Date 10/26/1994
Update Date 02/04/2004
Received Date

Well Name OLSON, REID & KATHY

Township	Range	Dir	Section	Subsections	Elevation	ft.
147	33	W	31	ACC	Elevation Method	

Well Depth	Depth Completed	Date Well Completed
55 ft.	55 ft.	06/23/1994

Drilling Method Non-specified Rotary

Well Address
2321 ANNE ST NW
BEMIDJI MN 56601

Geological Material	Color	Hardness	From	To
SAND	YELLOW	SOFT	0	30
CLAY	YELLOW	SOFT	30	45
SAND	YELLOW	HARD	45	55

Drilling Fluid
Bentonite

Well Hydrofractured? ☐ Yes ☐ No
From Ft. to Ft.

Use Domestic

Casing Type Plastic Joint No Information Drive Shoe? ☐ Yes ☐ No Above/Below ft.

Casing Diameter	Weight	Hole Diameter
4 in. to 50 ft.	lbs./ft.	8 in. to 30 ft. 6.25 in. to 55 ft.

Open Hole from ft. to ft.

Screen YES Make Type stainless steel

Diameter	Slot/Gauze	Length	Set Between
2	10	5	50 ft. and 55 ft.

Static Water Level
18 ft. from Land surface Date Measured 06/23/1994

PUMPING LEVEL (below land surface)
18 ft. after 120 hrs. pumping 20 g.p.m.

Well Head Completion
Pitless adapter manufacturer Model
☐ Casing Protection ☐ 12 in. above grade
☐ At-grade (Environmental Wells and Borings ONLY)

NO REMARKS

Grouting Information Well Grouted? ☑ Yes ☐ No

Grout Material: Bentonite from 8 to 30 ft. 3 bags

Nearest Known Source of Contamination
75 feet S direction Septic tank/drain field type
Well disinfected upon completion? ☑ Yes ☐ No

Pump ☐ Not Installed Date Installed
Manufacturer's name Model number HP Volts
Length of drop Pipe ft. Capacity g.p.m Type Material

Abandoned Wells Does property have any not in use and not sealed well(s)? ☐ Yes ☑ No

Variance Was a variance granted from the MDH for this well? ☐ Yes ☐ No

Well Contractor Certification

License Business Name	Lic. Or Reg. No.	Name of Driller
Nelson Well Drilling	04121	REED, G.

First Bedrock
Last Strat
Aquifer
Depth to Bedrock ft.

County Well Index Online Report

547810

Printed 4/3/2009
HE-01205-07

Minnesota Unique Well No.
549969

County Beltrami
Quad Peterson Lake
Quad ID 329C

MINNESOTA DEPARTMENT OF HEALTH

WELL AND BORING RECORD

Minnesota Statutes Chapter 103I

Entry Date 01/01/1980
Update Date 01/03/2005
Received Date

Well Name LOREN, ROBERT

Township	Range	Dir	Section	Subsections	Elevation	1380 ft.
147	33	W	31	ABD	Elevation Method	Calc from DEM (USGS 7.5 min or equiv.)

Well Depth	Depth Completed	Date Well Completed
108 ft.	108 ft.	03/24/1995

Drilling Method Non-specified Rotary

Drilling Fluid Bentonite

Well Hydrofractured? ☐ Yes ☐ No
From Ft. to Ft.

Use Domestic

Casing Type Plastic Joint Glued Drive Shoe? ☑ Yes ☐ No Above/Below ft.

Casing Diameter	Weight	Hole Diameter
4 in. to 96 ft.	1.87 lbs./ft.	8.3 in. to 30 ft.
		6.25 in. to 108 ft.

Open Hole from ft. to ft.

Screen YES Make COOK Type stainless steel

Diameter	Slot/Gauze	Length	Set Between
2	12	12	96 ft. and 108 ft.

Geological Material	Color	Hardness	From	To
SAND	BROWN	SOFT	0	49
CLAY	GRAY	MEDIUM	49	67
SAND	GRAY	SOFT	67	72
CLAY AND SAND	GRAY	MEDIUM	72	93
SAND	YELLOW	MEDIUM	93	108

Static Water Level
12 ft. from Land surface Date Measured 03/24/1995

PUMPING LEVEL (below land surface)
108 ft. after 120 hrs. pumping 75 g.p.m.

Well Head Completion
Pitless adapter manufacturer MONITOR Model
☐ Casing Protection ☐ 12 in. above grade
☐ At-grade (Environmental Wells and Borings ONLY)

NO REMARKS

Grouting Information Well Grouted? ☑ Yes ☐ No

Grout Material: Neat Cement from 7 to 30 ft. 4 bags

Located Beltrami Cty. Soil & Water Cons. Dist.
Method GPS SA On (averaged)
Unique Number Verification Information from owner
Date N/A
System UTM - Nad83, Zone15, Meters
X: 356185 Y: 5262812

Nearest Known Source of Contamination
55 feet W direction Septic tank/drain field type
Well disinfected upon completion? ☑ Yes ☐ No

Pump ☐ Not Installed Date Installed 03/24/1995
Manufacturer's name GOULD Model number 48LE30 HP 3 Volts 230
Length of drop Pipe 80 ft. Capacity 70 g.p.m Type Submersible Material

Abandoned Wells Does property have any not in use and not sealed well(s)? ☐ Yes ☑ No

Variance Was a variance granted from the MDH for this well? ☐ Yes ☐ No

First Bedrock
Last Strat
Aquifer
Depth to Bedrock ft.

Well Contractor Certification

License Business Name	Lic. Or Reg. No.	Name of Driller
Bradseth Well Co.	04527	BRADSETH, C.

County Well Index Online Report

549969

Printed 6/25/2008
HE-01205-07

Minnesota Unique Well No.
566297

County Beltrami
Quad
Quad ID

MINNESOTA DEPARTMENT OF HEALTH
WELL AND BORING RECORD
Minnesota Statutes Chapter 103I

Entry Date 12/20/1995
Update Date 02/04/2004
Received Date

Well Name BEWELY, DAVID

Township	Range	Dir	Section	Subsections	Elevation	ft.
147	33	W	31	ACD	Elevation Method	

Well Depth	Depth Completed	Date Well Completed
55 ft.	55 ft.	11/14/1995

Drilling Method Non-specified Rotary

Well Address
2120 ANNE ST
BEMIDJI MN 56601

Geological Material	Color	Hardness	From	To
SAND	BROWN	SOFT	0	12
CLAY	GRAY	MEDIUM	12	19
SAND, GRAVEL	GRAY	MEDIUM	19	28
CLAY	GRAY	MEDIUM	28	41
SAND	BROWN	SOFT	41	55

Drilling Fluid Bentonite

Well Hydrofractured? ☐ Yes ☐ No
From Ft. to Ft.

Use Domestic

Casing Type Plastic Joint No Information Drive Shoe? ☐ Yes ☑ No Above/Below ft.

Casing Diameter	Weight	Hole Diameter
4 in. to 51 ft.	lbs./ft.	6.75 in. to 55 ft.

Open Hole from ft. to ft.

Screen YES Make HALBURTON Type stainless steel

Diameter	Slot/Gauze	Length	Set Between
2	12	4	51 ft. and 55 ft.

Static Water Level
13 ft. from Land surface Date Measured 11/14/1995

PUMPING LEVEL (below land surface)
22 ft. after 60 hrs. pumping 25 g.p.m.

Well Head Completion
Pitless adapter manufacturer MONITOR Model SNAPPY
☐ Casing Protection ☐ 12 in. above grade
☐ At-grade (Environmental Wells and Borings ONLY)

NO REMARKS

Grouting Information Well Grouted? ☑ Yes ☐ No

Grout Material: Bentonite from 8 to 30 ft. 2 bags

Nearest Known Source of Contamination
60 feet W direction Septic tank/drain field type
Well disinfected upon completion? ☑ Yes ☐ No

Pump ☐ Not Installed Date Installed 11/15/1995
Manufacturer's name MYERS Model number HP 0.5 Volts 230
Length of drop Pipe ft. Capacity 10 g.p.m Type Submersible Material

Abandoned Wells Does property have any not in use and not sealed well(s)? ☑ Yes ☐ No

Variance Was a variance granted from the MDH for this well? ☐ Yes ☑ No

Well Contractor Certification

License Business Name	Lic. Or Reg. No.	Name of Driller
Aqua Well Drilling	04463	SCANDIN, R.

First Bedrock
Last Strat
Aquifer
Depth to Bedrock ft.

County Well Index Online Report

566297

Printed 4/3/2009
HE-01205-07

Minnesota Unique Well No.

569841

County Beltrami
Quad
Quad ID

MINNESOTA DEPARTMENT OF HEALTH

WELL AND BORING RECORD

Minnesota Statutes Chapter 103I

Entry Date 12/20/1995
Update Date 07/24/2000
Received Date

Well Name HURLEY, LLOYD

Township	Range	Dir	Section	Subsections	Elevation	ft.
147	33	W	31	DDC	Elevation Method	

Well Depth	Depth Completed	Date Well Completed
57 ft.	57 ft.	11/20/1995

Drilling Method Non-specified Rotary

Well Address
BANDWELL PARK
MN

Geological Material	Color	Hardness	From	To
SAND	BROWN	SOFT	0	22
CLAY	BROWN	SOFT	22	24
SAND	BROWN	SOFT	24	30
SAND	GRAY	SOFT	30	57

Drilling Fluid
Other

Well Hydrofractured? ☐ Yes ☐ No
From Ft. to Ft.

Use Domestic

Casing Type Plastic Joint No Information Drive Shoe? ☐ Yes ☐ No Above/Below ft.

Casing Diameter	Weight	Hole Diameter
4 in. to 52 ft.	lbs./ft.	8 in. to 57 ft.

Open Hole from ft. to ft.

Screen YES Make HOWARD SMITH Type stainless steel

Diameter	Slot/Gauze	Length	Set Between
2	12	5	52 ft. and 57 ft.

Static Water Level
17 ft. from Land surface Date Measured 11/20/1995

PUMPING LEVEL (below land surface)
ft. after hrs. pumping g.p.m.

Well Head Completion
Pitless adapter manufacturer Model
☐ Casing Protection ☐ 12 in. above grade
☐ At-grade (Environmental Wells and Borings ONLY)

REMARKS
BANDWELL PARK

Grouting Information Well Grouted? ☑ Yes ☐ No

Grout Material: Neat Cement from 8 to 40 ft. 1 yrds.

Nearest Known Source of Contamination
__feet __direction __type
Well disinfected upon completion? ☑ Yes ☐ No

Pump ☐ Not Installed Date Installed
Manufacturer's name STA-RITE Model number __ HP 0.5 Volts 230
Length of drop Pipe _ft. Capacity 10 g.p.m Type Submersible Material

Abandoned Wells Does property have any not in use and not sealed well(s)? ☐ Yes ☑ No

Variance Was a variance granted from the MDH for this well? ☐ Yes ☑ No

Well Contractor Certification

License Business Name	Lic. Or Reg. No.	Name of Driller
Sizer Water Well	04620	PINK, C.

First Bedrock
Last Strat
Aquifer
Depth to Bedrock ft.

County Well Index Online Report

569841

Printed 4/3/2009
HE-01205-07

Minnesota Unique Well No.
576751

County Beltrami
Quad
Quad ID

MINNESOTA DEPARTMENT OF HEALTH
WELL AND BORING RECORD
Minnesota Statutes Chapter 103I

Entry Date 03/06/1997
Update Date 02/04/2004
Received Date

Well Name WIEBOLT, DARWIN

Township	Range	Dir	Section	Subsections	Elevation	ft.
147	33	W	31	DAD	Elevation Method	

Well Depth	Depth Completed	Date Well Completed
55 ft.	55 ft.	06/07/1996

Drilling Method Non-specified Rotary

Well Address
LUELE DR
BEMIDJI MN 56601

Geological Material	Color	Hardness	From	To
SAND	BROWN	SOFT	0	10
SAND	GRAY	SOFT	10	45
CLAY	BROWN	MEDIUM	45	49
SAND	GRAY	SOFT	49	55

Drilling Fluid
Bentonite

Well Hydrofractured? ☐ Yes ☐ No
From Ft. to Ft.

Use Domestic

Casing Type Plastic Joint No Information Drive Shoe? ☐ Yes ☑ No Above/Below ft.

Casing Diameter	Weight	Hole Diameter
4 in. to 51 ft.	lbs./ft.	6.75 in. to 55 ft.

Open Hole from ft. to ft.

Screen YES Make JOHNSON Type stainless steel

Diameter	Slot/Gauze	Length	Set Between
2	12	4	51 ft. and 55 ft.

Static Water Level
20 ft. from Land surface Date Measured 06/07/1996

PUMPING LEVEL (below land surface)
30 ft. after 60 hrs. pumping 20 g.p.m.

Well Head Completion
Pitless adapter manufacturer MONITOR Model SNAPPY
☐ Casing Protection ☐ 12 in. above grade
☐ At-grade (Environmental Wells and Borings ONLY)

NO REMARKS

Grouting Information Well Grouted? ☑ Yes ☐ No

Grout Material: Bentonite from 8 to 30 ft. 2 bags

Nearest Known Source of Contamination
60 feet S direction Septic tank/drain field type
Well disinfected upon completion? ☑ Yes ☐ No

Pump ☐ Not Installed Date Installed 06/14/1996
Manufacturer's name STA-RITE Model number HP 0.75 Volts 230
Length of drop Pipe 40 ft. Capacity 12 g.p.m Type Submersible Material

Abandoned Wells Does property have any not in use and not sealed well(s)? ☐ Yes ☑ No

Variance Was a variance granted from the MDH for this well? ☐ Yes ☑ No

First Bedrock
Aquifer
Last Strat
Depth to Bedrock ft.

Well Contractor Certification

License Business Name	Lic. Or Reg. No.	Name of Driller
Aqua Well Drilling	04463	SCANDIN, R.

County Well Index Online Report

576751

Printed 4/3/2009
HE-01205-07

Minnesota Unique Well No.

585876

County Beltrami
Quad
Quad ID

MINNESOTA DEPARTMENT OF HEALTH

WELL AND BORING RECORD

Minnesota Statutes Chapter 103I

Entry Date 09/26/1997
Update Date 10/08/2008
Received Date

Well Name OTTERTAIL REALTY

Township	Range	Dir	Section	Subsections	Elevation	ft.
147	33	W	31	ADC	Elevation Method	

Well Depth	Depth Completed	Date Well Completed
57 ft.	57 ft.	06/14/1997

Drilling Method Non-specified Rotary

Well Address
1925 ANN ST NW
BEMIDJI MN

Geological Material	Color	Hardness	From	To
NO RECORD			0	57

Drilling Fluid Bentonite

Well Hydrofractured? ☐ Yes ☐ No
From Ft. to Ft.

Use Domestic

Casing Type Plastic Joint No Information Drive Shoe? ☐ Yes ☐ No Above/Below ft.

Casing Diameter	Weight	Hole Diameter
4 in. to 53 ft.	lbs./ft.	8.5 in. to 30 ft. 6.25 in. to 57 ft.

Open Hole from ft. to ft.

Screen YES Make JOHNSON Type stainless steel

Diameter	Slot/Gauze	Length	Set Between
2	12	4	53 ft. and 57 ft.

Static Water Level
18 ft. from Land surface Date Measured 06/14/1997

PUMPING LEVEL (below land surface)
20 ft. after 2 hrs. pumping 30 g.p.m.

Well Head Completion
Pitless adapter manufacturer SNAPPY Model 8PL41U
☐ Casing Protection ☐ 12 in. above grade
☐ At-grade (Environmental Wells and Borings ONLY)

NO REMARKS

Grouting Information Well Grouted? ☑ Yes ☐ No

Grout Material: Neat Cement from 0 to 30 ft. 3 bags

Nearest Known Source of Contamination
78 feet N direction Septic tank/drain field type
Well disinfected upon completion? ☐ Yes ☐ No

Pump ☐ Not Installed Date Installed 06/17/1997
Manufacturer's name MEYERS Model number 2N52-12 HP 0.5 Volts 220
Length of drop Pipe 40 ft. Capacity 12 g.p.m Type Submersible Material

Abandoned Wells Does property have any not in use and not sealed well(s)? ☐ Yes ☑ No

Variance Was a variance granted from the MDH for this well? ☐ Yes ☑ No

First Bedrock
Last Strat
Aquifer
Depth to Bedrock ft.

Well Contractor Certification

License Business Name	Lic. Or Reg. No.	Name of Driller
Nelson Well Drilling	04121	REED, G.

County Well Index Online Report

585876

Printed 4/3/2009
HE-01205-07

Minnesota Unique Well No.
599787

County Beltrami
Quad
Quad ID

MINNESOTA DEPARTMENT OF HEALTH

WELL AND BORING RECORD

Minnesota Statutes Chapter 103I

Entry Date 05/10/1999
Update Date 03/11/2005
Received Date

Well Name HWMENIK, JAMES

Township	Range	Dir	Section	Subsections	Elevation ft.
147	33	W	31		Elevation Method

Well Address
1898 ANN ST

Geological Material	Color	Hardness	From	To
SAND	BROWN	SOFT	0	15
SAND	GRAY	SOFT	15	28
CLAY	GRAY	SOFT	28	47
SAND	BROWN	SOFT	47	55

NO REMARKS

First Bedrock
Last Strat
Aquifer
Depth to Bedrock ft.

Well Depth	Depth Completed	Date Well Completed
55 ft.	55 ft.	04/17/1998

Drilling Method Non-specified Rotary

Drilling Fluid
Bentonite

Well Hydrofractured? ☐ Yes ☐ No
From Ft. to Ft.

Use Domestic

Casing Type Plastic Joint No Information Drive Shoe? ☐ Yes ☐ No Above/Below ft.

Casing Diameter	Weight	Hole Diameter
4 in. to 55 ft.	lbs./ft.	

Open Hole from ft. to ft.

Screen YES Make JOHNSON Type stainless steel

Diameter	Slot/Gauze	Length	Set Between
2	12	5	50 ft. and 55 ft.

Static Water Level
15 ft. from Land surface Date Measured 04/17/1998

PUMPING LEVEL (below land surface)
ft. after hrs. pumping g.p.m.

Well Head Completion
Pitless adapter manufacturer SNAPPY Model
☐ Casing Protection ☐ 12 in. above grade
☐ At-grade (Environmental Wells and Borings ONLY)

Grouting Information Well Grouted? ☑ Yes ☐ No

Grout Material: from 8 to 30 ft. 2 bags

Nearest Known Source of Contamination
55 feet North West direction Tanks type
Well disinfected upon completion? ☐ Yes ☐ No

Pump ☐ Not Installed Date Installed
Manufacturer's name STA RITE Model number HP 0.5 Volts 230
Length of drop Pipe ft. Capacity 10 g.p.m Type Submersible Material

Abandoned Wells Does property have any not in use and not sealed well(s)? ☐ Yes ☑ No

Variance Was a variance granted from the MDH for this well? ☐ Yes ☐ No

Well Contractor Certification

License Business Name	Lic. Or Reg. No.	Name of Driller
Sizer Water Well	04620	PINK, C.

County Well Index Online Report

599787

Printed 4/3/2009
HE-01205-07

Minnesota Unique Well No.
609276

County Beltrami
Quad
Quad ID

MINNESOTA DEPARTMENT OF HEALTH

WELL AND BORING RECORD

Minnesota Statutes Chapter 103I

Entry Date 07/01/1998
Update Date 07/24/2000
Received Date

Well Name DAHL, JOHN

Township	Range	Dir	Section	Subsections	Elevation	ft.
147	33	W	31	DCB	Elevation Method	

Well Depth	Depth Completed	Date Well Completed
60 ft.	60 ft.	04/14/1998

Drilling Method Non-specified Rotary

Well Address
BARDWELL PARK
BEMIDJI MN 56601

Geological Material	Color	Hardness	From	To
SAND	BROWN		0	25
CLAY	BRN/GRY		25	35
SAND	BROWN		35	50
SAND	GRAY		50	60

Drilling Fluid Bentonite

Well Hydrofractured? ☐ Yes ☑ No
From Ft. to Ft.

Use Domestic

Casing Type Plastic Joint No Information Drive Shoe? ☐ Yes ☑ No Above/Below ft.

Casing Diameter	Weight	Hole Diameter
4 in. to 55 ft.	lbs./ft.	8.8 in. to 60 ft.

Open Hole from ft. to ft.

Screen YES Make CERTAINTEED Type plastic

Diameter	Slot/Gauze	Length	Set Between
4	23	5	55 ft. and 60 ft.

Static Water Level
12 ft. from Land surface Date Measured 04/14/1998

PUMPING LEVEL (below land surface)
40 ft. after 60 hrs. pumping 30 g.p.m.

Well Head Completion
Pitless adapter manufacturer Model
☐ Casing Protection ☑ 12 in. above grade
☐ At-grade (Environmental Wells and Borings ONLY)

NO REMARKS

Grouting Information Well Grouted? ☑ Yes ☐ No

Grout Material: Bentonite from 0 to 30 ft.

Nearest Known Source of Contamination
50 feet direction Septic tank/drain field type
Well disinfected upon completion? ☑ Yes ☐ No

Pump ☐ Not Installed Date Installed
Manufacturer's name Model number HP Volts
Length of drop Pipe ft. Capacity g.p.m Type Material

Abandoned Wells Does property have any not in use and not sealed well(s)? ☐ Yes ☑ No

Variance Was a variance granted from the MDH for this well? ☐ Yes ☑ No

First Bedrock
Last Strat
Aquifer
Depth to Bedrock ft.

Well Contractor Certification

License Business Name	Lic. Or Reg. No.	Name of Driller
North Star Drilling	49588	FELL, B.

County Well Index Online Report

609276

Printed 4/3/2009
HE-01205-07

Minnesota Unique Well No.

623421

County Beltrami
Quad
Quad ID

MINNESOTA DEPARTMENT OF HEALTH

WELL AND BORING RECORD

Minnesota Statutes Chapter 103I

Entry Date 03/07/2000
Update Date 03/11/2005
Received Date

Well Name HASKELL, JAMES

Township	Range	Dir	Section	Subsections	Elevation ft.
147	33	W	31	ADC	Elevation Method

Well Depth	Depth Completed	Date Well Completed
64 ft.	64 ft.	04/12/1999

Drilling Method Non-specified Rotary

Well Address
1931 ANNE ST NW
BEMIDJI MN 56601

Drilling Fluid Bentonite

Well Hydrofractured? ☐ Yes ☑ No
From Ft. to Ft.

Use Domestic

Casing Type Plastic Joint No Information Drive Shoe? ☐ Yes ☑ No Above/Below ft.

Geological Material	Color	Hardness	From	To
SNAD	BROWN	MEDIUM	0	15
SAND/GRAVEL	BROWN	MEDIUM	15	30
CLAY	GRAY	MEDIUM	30	35
CLAYFINE SAND	BROWN	MEDIUM	35	45
CLAY/SANDY	GRAY	MEDIUM	45	55
SAND	GRAY	MEDIUM	55	64

Casing Diameter	Weight	Hole Diameter
4 in. to 60 ft.	lbs./ft.	6.75 in. to 64 ft.

Open Hole from ft. to ft.

Screen YES Make WESCO Type stainless steel

Diameter	Slot/Gauze	Length	Set Between
4	12	4	60 ft. and 64 ft.

Static Water Level
14 ft. from Land surface Date Measured 04/12/1999

PUMPING LEVEL (below land surface)
20 ft. after 1 hrs. pumping 30 g.p.m.

Well Head Completion
Pitless adapter manufacturer MERRILL Model MCK4100
☐ Casing Protection ☑ 12 in. above grade
☐ At-grade (Environmental Wells and Borings ONLY)

NO REMARKS

Grouting Information Well Grouted? ☑ Yes ☐ No

Grout Material: Bentonite from 8 to 30 ft. 2 bags

Nearest Known Source of Contamination
100 feet North East direction Septic tank/drain field type
Well disinfected upon completion? ☑ Yes ☐ No

Pump ☐ Not Installed Date Installed 04/29/1999
Manufacturer's name GOULD Model number 10SB05 HP 0.5 Volts 230
Length of drop Pipe 30 ft. Capacity 10 g.p.m Type Submersible Material

Abandoned Wells Does property have any not in use and not sealed well(s)? ☐ Yes ☑ No

Variance Was a variance granted from the MDH for this well? ☐ Yes ☑ No

Well Contractor Certification

License Business Name	Lic. Or Reg. No.	Name of Driller
Aqua Well Drilling	04463	EVANS, T.

First Bedrock
Last Strat
Aquifer
Depth to Bedrock ft.

County Well Index Online Report

623421

Printed 4/3/2009
HE-01205-07

Minnesota Unique Well No.
710183

County Beltrami
Quad
Quad ID

MINNESOTA DEPARTMENT OF HEALTH
WELL AND BORING RECORD
Minnesota Statutes Chapter 103I

Entry Date
Update Date 05/03/2006
Received Date 12/22/2004

Well Name

Township	Range	Dir	Section	Subsections	Elevation	ft.
147	33	W	31	DAD	Elevation Method	

Well Depth	Depth Completed	Date Well Completed
84 ft.	84 ft.	06/17/2004

Drilling Method Non-specified Rotary

Well Address
BARDWELL CT
BEMIDJI MN 56601

Drilling Fluid
Bentonite

Well Hydrofractured? ☐ Yes ☑ No
From Ft. to Ft.

Use Domestic

Casing Type Plastic Joint No Information Drive Shoe? ☐ Yes ☑ No Above/Below ft.

Geological Material	Color	Hardness	From	To
SAND	BROWN	SOFT	0	22
FINE SAND	GRAY	SOFT	22	45
SAND	BROWN	SOFT	45	84

Casing Diameter	Weight	Hole Diameter
4 in. to 80 ft.	lbs./ft.	6.75 in. to 84 ft.

Open Hole from ft. to ft.

Screen YES Make JOHNSON Type stainless steel

Diameter	Slot/Gauze	Length	Set Between
2	10	4	80 ft. and 84 ft.

Static Water Level
15 ft. from Land surface Date Measured 06/17/2004

PUMPING LEVEL (below land surface)
30 ft. after 1 hrs. pumping 35 g.p.m.

Well Head Completion
Pitless adapter manufacturer MERRILL Model
☐ Casing Protection ☐ 12 in. above grade
☐ At-grade (Environmental Wells and Borings ONLY)

REMARKS
WELL LOCATION: LOT 17 BLOCK 1 BARDWELL CT. BEMIDJI

Grouting Information Well Grouted? ☑ Yes ☐ No

Grout Material: High solids bentonite from to 30 ft. 2 bags

Nearest Known Source of Contamination
200 feet South East direction Septic tank/drain field type
Well disinfected upon completion? ☑ Yes ☐ No

Pump ☐ Not Installed Date Installed 06/23/2004
Manufacturer's name RED JACKET Model number 50F211 HP 0.5 Volts 230
Length of drop Pipe 40 ft. Capacity 12 g.p.m Type Submersible Material

Abandoned Wells Does property have any not in use and not sealed well(s)? ☐ Yes ☑ No

Variance Was a variance granted from the MDH for this well? ☐ Yes ☑ No

First Bedrock
Last Strat
Aquifer
Depth to Bedrock ft.

Well Contractor Certification

Aqua Well Drilling	04463	CESOLINI, C.
License Business Name	Lic. Or Reg. No.	Name of Driller

County Well Index Online Report

710183

Printed 4/3/2009
HE-01205-07

Minnesota Unique Well No.
721170

County Beltrami
Quad
Quad ID

MINNESOTA DEPARTMENT OF HEALTH
WELL AND BORING RECORD
Minnesota Statutes Chapter 103I

Entry Date
Update Date 08/02/2006
Received Date 01/12/2006

Well Name COOP. DEVELOPMENT

Township	Range	Dir	Section	Subsections	Elevation	ft.
147	33	W	31	ACB	Elevation Method	

Well Depth	Depth Completed	Date Well Completed
72 ft.	72 ft.	04/18/2005

Drilling Method Non-specified Rotary

Well Address
2419 BORING CT NW
BEMIDJI MN 56601

Geological Material	Color	Hardness	From	To
SAND	BROWN	MEDIUM	0	28
CLAY	BLUE	MEDIUM	28	56
SAND	BROWN	HARD	56	72

Drilling Fluid Bentonite

Well Hydrofractured? ☐ Yes ☑ No
From Ft. to Ft.

Use Domestic

Casing Type Plastic Joint No Information Drive Shoe? ☐ Yes ☑ No Above/Below ft.

Casing Diameter	Weight	Hole Diameter
4 in. to 60 ft.	lbs./ft.	8.5 in. to 30 ft. 6.25 in. to 72 ft.

Open Hole from ft. to ft.

Screen YES Make JOHNSON Type stainless steel

Diameter	Slot/Gauze	Length	Set Between
4	10	12	60 ft. and 72 ft.

Static Water Level
15 ft. from Land surface Date Measured 04/18/2005

PUMPING LEVEL (below land surface)
20 ft. after 2 hrs. pumping 100 g.p.m.

Well Head Completion
Pitless adapter manufacturer Model
☐ Casing Protection N ☑ 12 in. above grade
☐ At-grade (Environmental Wells and Borings ONLY)

NO REMARKS

Grouting Information Well Grouted? ☑ Yes ☐ No

Grout Material: Bentonite from to 30 ft. 3 bags

Nearest Known Source of Contamination
__feet __direction __type
Well disinfected upon completion? ☑ Yes ☐ No

Pump ☐ Not Installed Date Installed 04/21/2005
Manufacturer's name GOULD Model number 556530 HP 3 Volts 230
Length of drop Pipe 40 ft. Capacity 70 g.p.m Type Submersible Material

Abandoned Wells Does property have any not in use and not sealed well(s)? ☐ Yes ☑ No

Variance Was a variance granted from the MDH for this well? ☐ Yes ☑ No

Well Contractor Certification

License Business Name	Lic. Or Reg. No.	Name of Driller
Nelson Well Drilling	04121	REED, J.

First Bedrock
Last Strat
Aquifer
Depth to Bedrock ft.

County Well Index Online Report

721170

Printed 4/3/2009
HE-01205-07

Appendix C

Burnsville ABLE Training Center Groundwater Receptor Survey Documents

LEGEND:

△ City Well

Property Occupant

1. Northern Tool & Equipment
2. Dodge of Burnsville
3. Walser Subaru
4. All State Self Storage
5. Chalet Driving Range
6. Archery range, tree/brush dump
7. Bury & Carlson, concrete/asphalt recycling
8. Rivers Edge Business Center
9. American Electric Motion
10. Nicollet Business Campus II
11. Nicollet Business Campus
12. Burnsville Public Works
13. Vacant/Undeveloped

LEGEND:

→ Inferred Groundwater Flow Direction

North

FIGURE
RECEPTOR SURVEY
ABLE FIRE TRAINING CENTER
BURNSVILLE, MINNESOTA

PROJECT NO. 45618DEL04	PREPARED BY NR	DRAWN BY DD
DATE 06/30/11	REVIEWED BY	FILE NAME Burnsville-1

anteagroup

Receptor Survey Questionnaire

In Person Interview 8-17-10

PROPERTY ADDRESS: 12205 River Ridge Blvd - Northern Tool & Equip

1. Is there, or has there ever been, a water well on the property? **Yes** [✓ **No**] **Unknown**

If you answered **No or Unknown**, proceed to Question 2. Not aware of any

1a. If you answered **Yes**, is the well *active* (in use), *abandoned* (not in use), or *sealed* (decommissioned following Minnesota Department of Health [MDH] Well Code guidelines).

______ACTIVE ________ABANDONED ________SEALED

1b. How deep is (was) the well? ______FEET (if depth is unknown check here ______)

1c. In what year was the well installed (if known)? ___________

1d. If the well was abandoned, what year was the well sealed?________

3e. If the well is active, for what purpose is it used? Example: (drinking water, lawn sprinkler, cooling, etc.)____

1f. Where on the property is (was) the well located?________________________________

1g. If there is currently a water supply well on the property, would you grant access to the property in order to obtain a water sample from either an indoor or outside faucet (at no cost to property owner)?

Yes **No**

Name____

Telephone Number________________________________DAY or EVENING (please circle one and state best time to reach you)

2. Is a public water supply currently utilized by the property? [✓ **Yes**] **No**

3. May we contact you for further information if necessary? If so, please provide your name and telephone number.

Name Store Manager

Telephone Number________________________________DAY or EVENING (please circle one and state best time to reach you)

Please complete this form and mail it back to Delta in the enclosed self-addressed stamped envelope. Delta thanks you in advance for taking the time to complete this form.

If you have any questions, or need help completing this form, please feel free to contact Nancy Rodning, Delta Consultants, at (651)697-5152 or 1-800-477-7411, or Nile Fellows, MPCA, at 651-757-2352.

Receptor Survey Questionnaire

PROPERTY ADDRESS: John Adamich => Dodge of Burnsville
12101 Hwy 35W

1. Is there, or has there ever been, a water well on the property? **Yes** [✓ **No**] **Unknown**

If you answered **No or Unknown**, proceed to Question 2.

1a. If you answered **Yes**, is the well *active* (in use), *abandoned* (not in use), or *sealed* (decommissioned following Minnesota Department of Health [MDH] Well Code guidelines).

______ACTIVE ________ABANDONED ________SEALED

1b. How deep is (was) the well? ______FEET (if depth is unknown check here ______)

1c. In what year was the well installed (if known)? __________

1d. If the well was abandoned, what year was the well sealed?________

3e. If the well is active, for what purpose is it used? Example: (drinking water, lawn sprinkler, cooling, etc.)______________________________

1f. Where on the property is (was) the well located?____________________

1g. If there is currently a water supply well on the property, would you grant access to the property in order to obtain a water sample from either an indoor or outside faucet (at no cost to property owner)?

Yes **No**

Name______________________________

Telephone Number______________________________DAY or EVENING (please circle one and state best time to reach you)

2. Is a public water supply currently utilized by the property? [✓ **Yes**] **No**

3. May we contact you for further information if necessary? If so, please provide your name and telephone number.

Name John Adamich => Dodge of Burnsville

Telephone Number 612/237-8001 (cell) DAY or EVENING (please circle one and state best time to reach you)

Please complete this form and mail it back to Delta in the enclosed self-addressed stamped envelope. Delta thanks you in advance for taking the time to complete this form.

If you have any questions, or need help completing this form, please feel free to contact Nancy Rodning, Delta Consultants, at (651)697-5152 or 1-800-477-7411, or Nile Fellows, MPCA, at 651-757-2352.

Receptor Survey Questionnaire

PROPERTY ADDRESS: 12101 Hwy 35 W South Burnsville

1. Is there, or has there ever been, a water well on the property? **Yes** [✓ **No**] **Unknown**

If you answered **No or Unknown**, proceed to Question 2.

1a. If you answered **Yes**, is the well *active* (in use), *abandoned* (not in use), or *sealed* (decommissioned following Minnesota Department of Health [MDH] Well Code guidelines).

______ACTIVE ________ABANDONED ________SEALED

1b. How deep is (was) the well? ______FEET (if depth is unknown check here _______)

1c. In what year was the well installed (if known)? __________

1d. If the well was abandoned, what year was the well sealed?_________

3e. If the well is active, for what purpose is it used? Example: (drinking water, lawn sprinkler, cooling, etc.)____________________

1f. Where on the property is (was) the well located?____________________

1g. If there is currently a water supply well on the property, would you grant access to the property in order to obtain a water sample from either an indoor or outside faucet (at no cost to property owner)?

Yes **No**

Name John Adamich

Telephone Number CELL 612 237-8001 [✓ DAY] or EVENING (please circle one and state best time to reach you)

2. Is a public water supply currently utilized by the property? [✓ **Yes**] **No**

3. May we contact you for further information if necessary? If so, please provide your name and telephone number.

Name John Adamich

Telephone Number CELL 612-237-8001 DAY or EVENING (please circle one and state best time to reach you)

Please complete this form and mail it back to Delta in the enclosed self-addressed stamped envelope. Delta thanks you in advance for taking the time to complete this form.

If you have any questions, or need help completing this form, please feel free to contact Nancy Rodning, Delta Consultants, at (651)697-5152 or 1-800-477-7411, or Nile Fellows, MPCA, at 651-757-2352.

– In Person Interview
8-17-10

Receptor Survey Questionnaire

PROPERTY ADDRESS: 600 121st St. W. – Walser Suburu

1. Is there, or has there ever been, a water well on the property? **Yes** [✓ **No**] **Unknown**

Not aware of

If you answered **No or Unknown**, proceed to Question 2.

1a. If you answered **Yes**, is the well *active* (in use), *abandoned* (not in use), or *sealed* (decommissioned following Minnesota Department of Health [MDH] Well Code guidelines).

______ACTIVE ________ABANDONED ________SEALED

1b. How deep is (was) the well? _______FEET (if depth is unknown check here _______)

1c. In what year was the well installed (if known)? ____________

1d. If the well was abandoned, what year was the well sealed?_________

3e. If the well is active, for what purpose is it used? Example: (drinking water, lawn sprinkler, cooling, etc.)____

1f. Where on the property is (was) the well located?______________________________

1g. If there is currently a water supply well on the property, would you grant access to the property in order to obtain a water sample from either an indoor or outside faucet (at no cost to property owner)?

Yes **No**

Name_______________________________________

Telephone Number_________________________________DAY or EVENING (please circle one and state best time to reach you)

2. Is a public water supply currently utilized by the property? **Yes** **No**

3. May we contact you for further information if necessary? If so, please provide your name and telephone number.

Name_______________________________________

Telephone Number_________________________________DAY or EVENING (please circle one and state best time to reach you)

Please complete this form and mail it back to Delta in the enclosed self-addressed stamped envelope. Delta thanks you in advance for taking the time to complete this form.

If you have any questions, or need help completing this form, please feel free to contact Nancy Rodning, Delta Consultants, at (651)697-5152 or 1-800-477-7411, or Nile Fellows, MPCA, at 651-757-2352.

in Person Interview
8-17-10

Receptor Survey Questionnaire

PROPERTY ADDRESS: 12001 Hwy 35 - All State Self Storage

1. Is there, or has there ever been, a water well on the property? **Yes** [✓ **No**] **Unknown**

If you answered **No or Unknown**, proceed to Question 2.

1a. If you answered **Yes**, is the well *active* (in use), *abandoned* (not in use), or *sealed* (decommissioned following Minnesota Department of Health [MDH] Well Code guidelines).

______ACTIVE ________ABANDONED ________SEALED

1b. How deep is (was) the well? ______FEET (if depth is unknown check here ______)

1c. In what year was the well installed (if known)? ________

1d. If the well was abandoned, what year was the well sealed?________

3e. If the well is active, for what purpose is it used? Example: (drinking water, lawn sprinkler, cooling, etc.)________

1f. Where on the property is (was) the well located?________

1g. If there is currently a water supply well on the property, would you grant access to the property in order to obtain a water sample from either an indoor or outside faucet (at no cost to property owner)?

Yes **No**

Name________

Telephone Number________DAY or EVENING (please circle one and state best time to reach you)

2. Is a public water supply currently utilized by the property? [✓ **Yes**] **No**

3. May we contact you for further information if necessary? If so, please provide your name and telephone number.

Name Owner/Manager

Telephone Number________DAY or EVENING (please circle one and state best time to reach you)

Please complete this form and mail it back to Delta in the enclosed self-addressed stamped envelope. Delta thanks you in advance for taking the time to complete this form.

If you have any questions, or need help completing this form, please feel free to contact Nancy Rodning, Delta Consultants, at (651)697-5152 or 1-800-477-7411, or Nile Fellows, MPCA, at 651-757-2352.

Receptor Survey Questionnaire

PROPERTY ADDRESS: 11937 HWY 35W CHAMP GOLF

1. Is there, or has there ever been, a water well on the property? [✓ **Yes**] **No** **Unknown**

If you answered **No or Unknown**, proceed to Question 2.

PLEASE CONTACT FRED CAMPBELL @ MPCA

1a. If you answered **Yes**, is the well *active* (in use), *abandoned* (not in use), or *sealed* (decommissioned following Minnesota Department of Health [MDH] Well Code guidelines).

______ACTIVE ________ABANDONED ________SEALED

1b. How deep is (was) the well? ______FEET (if depth is unknown check here ______)

1c. In what year was the well installed (if known)? __________

1d. If the well was abandoned, what year was the well sealed?________

3e. If the well is active, for what purpose is it used? Example: (drinking water, lawn sprinkler, cooling, etc.)____________________

1f. Where on the property is (was) the well located?____________________

1g. If there is currently a water supply well on the property, would you grant access to the property in order to obtain a water sample from either an indoor or outside faucet (at no cost to property owner)?

Yes **No**

Name MICHAEL McGOWAN

Telephone Number (952) 890-1081 DAY or EVENING (please circle one and state best time to reach you)

2. Is a public water supply currently utilized by the property? [✓ **Yes**] **No**

3. May we contact you for further information if necessary? If so, please provide your name and telephone number.

Name ABOVE

Telephone Number____________________ DAY or EVENING (please circle one and state best time to reach you)

Please complete this form and mail it back to Delta in the enclosed self-addressed stamped envelope. Delta thanks you in advance for taking the time to complete this form.

If you have any questions, or need help completing this form, please feel free to contact Nancy Rodning, Delta Consultants, at (651)697-5152 or 1-800-477-7411, or Nile Fellows, MPCA, at 651-757-2352.

11-3-10 No water supply wells, just monitoring wells.

In Person Interview - 8-17-10

Receptor Survey Questionnaire

PROPERTY ADDRESS: Bury + Carlson - 201 121st St. NW

1. Is there, or has there ever been, a water well on the property? **Yes** [✓ **No**] **Unknown**

If you answered **No or Unknown**, proceed to Question 2.

1a. If you answered **Yes**, is the well *active* (in use), *abandoned* (not in use), or *sealed* (decommissioned following Minnesota Department of Health [MDH] Well Code guidelines).

______ACTIVE ________ABANDONED ________SEALED

1b. How deep is (was) the well? ______FEET (if depth is unknown check here _______)

1c. In what year was the well installed (if known)? ____________

1d. If the well was abandoned, what year was the well sealed?_________

3e. If the well is active, for what purpose is it used? Example: (drinking water, lawn sprinkler, cooling, etc.)____________________

1f. Where on the property is (was) the well located?____________________

1g. If there is currently a water supply well on the property, would you grant access to the property in order to obtain a water sample from either an indoor or outside faucet (at no cost to property owner)?

Yes **No**

Name____________________

Telephone Number____________________DAY or EVENING (please circle one and state best time to reach you)

2. Is a public water supply currently utilized by the property? [✓ **Yes**] **No**

3. May we contact you for further information if necessary? If so, please provide your name and telephone number.

Name____________________

Telephone Number____________________DAY or EVENING (please circle one and state best time to reach you)

Please complete this form and mail it back to Delta in the enclosed self-addressed stamped envelope. Delta thanks you in advance for taking the time to complete this form.

If you have any questions, or need help completing this form, please feel free to contact Nancy Rodning, Delta Consultants, at (651)697-5152 or 1-800-477-7411, or Nile Fellows, MPCA, at 651-757-2352.

Receptor Survey Questionnaire

PROPERTY ADDRESS: **Rivers Edge Business Center, 25 W. Cliff Road, Burnsville**

1. Is there, or has there ever been, a water well on the property? **Yes** [✓ **No**] **Unknown**

If you answered **No or Unknown**, proceed to Question 2.

1a. If you answered **Yes**, is the well *active* (in use), *abandoned* (not in use), or *sealed* (decommissioned following Minnesota Department of Health [MDH] Well Code guidelines).

______ACTIVE ________ABANDONED ________SEALED

1b. How deep is (was) the well? _______FEET (if depth is unknown check here _______)

1c. In what year was the well installed (if known)? ____________

1d. If the well was abandoned, what year was the well sealed?_________

3e. If the well is active, for what purpose is it used? Example: (drinking water, lawn sprinkler, cooling, etc.)____

1f. Where on the property is (was) the well located?________________________________

1g. If there is currently a water supply well on the property, would you grant access to the property in order to obtain a water sample from either an indoor or outside faucet (at no cost to property owner)?

Yes **No**

Name____

Telephone Number__________________________________DAY or EVENING (please circle one and state best time to reach you)

2. Is a public water supply currently utilized by the property? [✓ **Yes**] **No**

3. May we contact you for further information if necessary? If so, please provide your name and telephone number.

Name MICHAEL VALENTINE, MANAGING PARTNER

Telephone Number 612-850-4374 [✓ DAY] or EVENING (please circle one and state best time to reach you)

Please complete this form and mail it back to Delta in the enclosed self-addressed stamped envelope. Delta thanks you in advance for taking the time to complete this form.

If you have any questions, or need help completing this form, please feel free to contact Nancy Rodning, Delta Consultants, at (651)697-5152 or 1-800-477-7411, or Nile Fellows, MPCA, at 651-757-2352.

Receptor Survey Questionnaire

PROPERTY ADDRESS: 12259 (12250-12268) Nicollet Avenue, Burnsville

1. Is there, or has there ever been, a water well on the property? **Yes** **No** [✓ **Unknown**]

If you answered **No or Unknown**, proceed to Question 2.

1a. If you answered **Yes**, is the well *active* (in use), *abandoned* (not in use), or *sealed* (decommissioned following Minnesota Department of Health [MDH] Well Code guidelines).

______ACTIVE ________ABANDONED ________SEALED

1b. How deep is (was) the well? ______FEET (if depth is unknown check here ______)

1c. In what year was the well installed (if known)? ___________

1d. If the well was abandoned, what year was the well sealed?________

3e. If the well is active, for what purpose is it used? Example: (drinking water, lawn sprinkler, cooling, etc.)____

1f. Where on the property is (was) the well located?________________________________

1g. If there is currently a water supply well on the property, would you grant access to the property in order to obtain a water sample from either an indoor or outside faucet (at no cost to property owner)?

Yes **No**

Name________________________________

Telephone Number________________________________DAY or EVENING (please circle one and state best time to reach you)

2. Is a public water supply currently utilized by the property? [✓ **Yes**] **No**

3. May we contact you for further information if necessary? If so, please provide your name and telephone number.

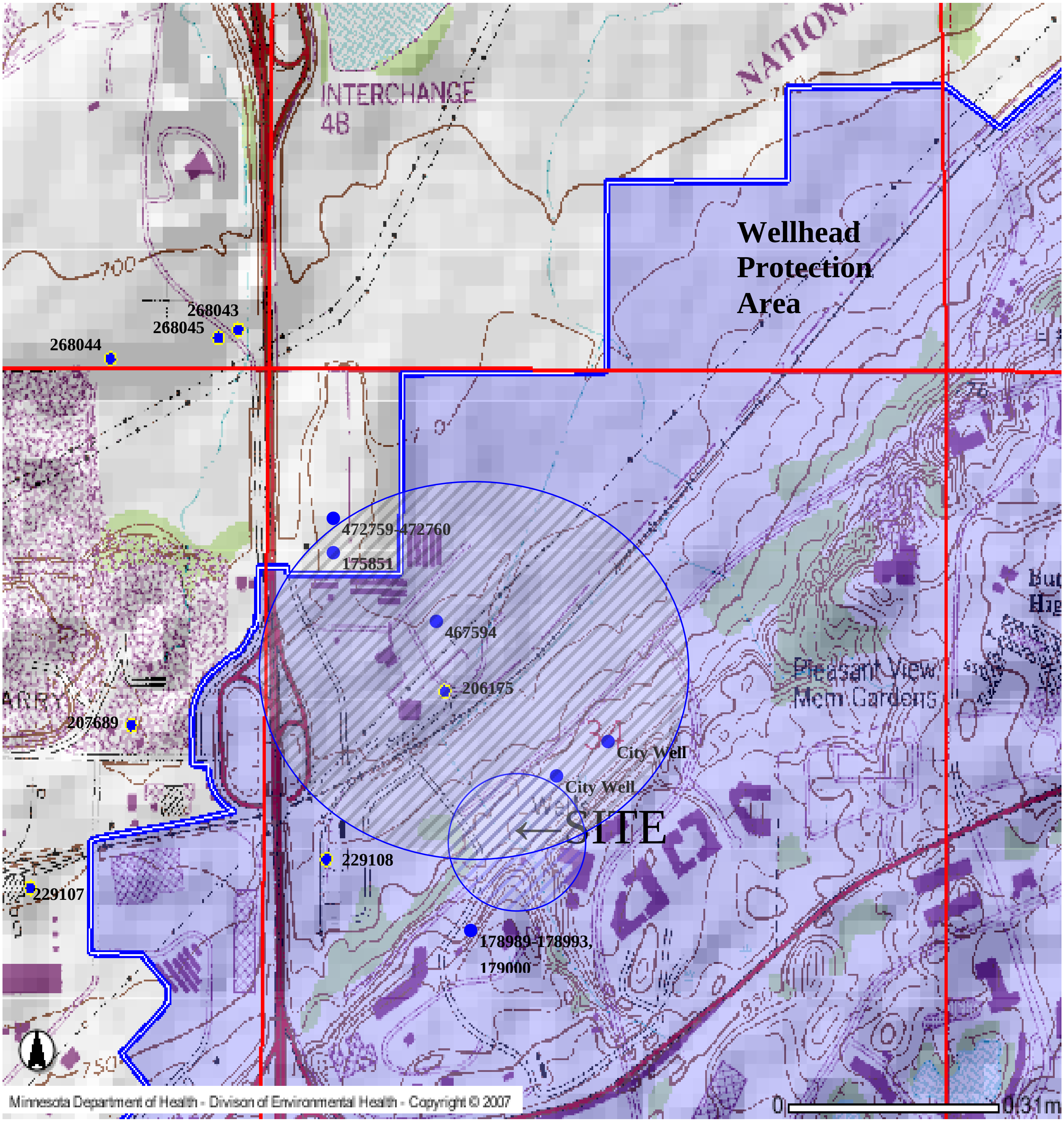
Name Vick Kaur - Wellington Mgmt.

Telephone Number 651-999-5537 [✓ DAY] or EVENING (please circle one and state best time to reach you)

Please complete this form and mail it back to Delta in the enclosed self-addressed stamped envelope. Delta thanks you in advance for taking the time to complete this form.

If you have any questions, or need help completing this form, please feel free to contact Nancy Rodning, Delta Consultants, at (651)697-5152 or 1-800-477-7411, or Nile Fellows, MPCA, at 651-757-2352.

BURNSVILLE CWI Well Map



Minnesota Department of Health - Divison of Environmental Health - Copyright © 2007

▨ Approximate Area of Receptor Survey

Minnesota Unique Well No.
175851

County Dakota
Quad
Quad ID

MINNESOTA DEPARTMENT OF HEALTH

WELL AND BORING RECORD

Minnesota Statutes Chapter 103I

Entry Date 06/22/2001
Update Date
Received Date

Well Name BURNSVILLE TW

Township	Range	Dir	Section	Subsections	Elevation ft.
27	24	W	34	BCD	Elevation Method

Well Depth	Depth Completed	Date Well Completed
100 ft.	100 ft.	04/16/1980

Drilling Method Non-specified Rotary

Drilling Fluid
--

Well Hydrofractured? ☐ Yes ☐ No
From Ft. to Ft.

Use Test well

Casing Type Steel (black or low carbon) Joint No Information Drive Shoe? ☑ Yes ☐ No Above/Below 2 ft.

Casing Diameter	Weight	Hole Diameter
6 in. to 60 ft.	20 lbs./ft.	

Open Hole from 60 ft. to 160 ft.

Screen NO Make Type

Diameter	Slot/Gauze	Length	Set Between

Geological Material	Color	Hardness	From	To
DRIFT			0	17
SHAKOPEE	YELLOW	HARD	17	100

Static Water Level
5 ft. from Land surface Date Measured 04/16/1980

PUMPING LEVEL (below land surface)
ft. after hrs. pumping g.p.m.

Well Head Completion
Pitless adapter manufacturer Model
☐ Casing Protection ☑ 12 in. above grade
☐ At-grade (Environmental Wells and Borings ONLY)

NO REMARKS

Grouting Information Well Grouted? ☑ Yes ☐ No

Grout Material: Neat Cement from 0 to 60 ft. 2.5 yrds.

Nearest Known Source of Contamination
__feet __direction __type
Well disinfected upon completion? ☑ Yes ☐ No

Pump ☐ Not Installed Date Installed 05/16/1980
Manufacturer's name DEMPSTER Model number 15C2-59-S1 HP 0.5 Volts 115
Length of drop Pipe 54 ft. Capacity 20 g.p.m Type Submersible Material Galvanized

Abandoned Wells Does property have any not in use and not sealed well(s)? ☐ Yes ☐ No

Variance Was a variance granted from the MDH for this well? ☐ Yes ☐ No

First Bedrock
Last Strat
Aquifer
Depth to Bedrock ft.

Well Contractor Certification

License Business Name	Lic. Or Reg. No.	Name of Driller
Stevens Well Co.	27194	KADERLIK, C.

County Well Index Online Report

175851

Printed 4/2/2009
HE-01205-07

Minnesota Unique Well No.
178989

County Dakota
Quad
Quad ID

MINNESOTA DEPARTMENT OF HEALTH

WELL AND BORING RECORD

Minnesota Statutes Chapter 103I

Entry Date 06/22/2001
Update Date
Received Date

Well Name BURNSVILLE MW

Township	Range	Dir	Section	Subsections	Elevation	ft.
27	24	W	34		Elevation Method	

Well Depth	Depth Completed	Date Well Completed
110 ft.	110 ft.	06/00/1981

Drilling Method Non-specified Rotary

Well Address
12111 RIVER RIDGE
BURNSVILLE MN

Geological Material	Color	Hardness	From	To
DRIFT	BLACK	SOFT	0	11
LIMEROCK	YELLOW	HARD	11	65
SANDSTONE	YELLOW	SOFT	65	68
LIMEROCK	YEL/GRY	HARD	68	110

Drilling Fluid
--

Well Hydrofractured? ☐ Yes ☐ No
From Ft. to Ft.

Use Monitor well

Casing Type Steel (black or low carbon) Joint Welded Drive Shoe? ☐ Yes ☑ No Above/Below ft.

Casing Diameter	Weight	Hole Diameter
12 in. to 11 ft.	49 lbs./ft.	18.5 in. to 11 ft.
6 in. to 70 ft.	19 lbs./ft.	12 in. to 70 ft.

Open Hole from 70 ft. to 110 ft.

Screen NO Make Type

Diameter	Slot/Gauze	Length	Set Between

Static Water Level
ft. from Date Measured

PUMPING LEVEL (below land surface)
ft. after hrs. pumping 200 g.p.m.

Well Head Completion
Pitless adapter manufacturer Model
☐ Casing Protection ☐ 12 in. above grade
☐ At-grade (Environmental Wells and Borings ONLY)

NO REMARKS

Grouting Information Well Grouted? ☑ Yes ☐ No

Grout Material: Neat Cement from 0 to 70 ft.

Nearest Known Source of Contamination
__feet __direction __type
Well disinfected upon completion? ☐ Yes ☐ No

Pump ☐ Not Installed Date Installed
Manufacturer's name Model number __ HP _ Volts
Length of drop Pipe _ft. Capacity _g.p.m Type Material

Abandoned Wells Does property have any not in use and not sealed well(s)? ☐ Yes ☐ No

Variance Was a variance granted from the MDH for this well? ☐ Yes ☐ No

First Bedrock
Last Strat
Aquifer
Depth to Bedrock ft.

Well Contractor Certification

License Business Name	Lic. Or Reg. No.	Name of Driller
Stevens Well Co.	27194	KADERLIK, C.

County Well Index Online Report

178989

Printed 4/2/2009
HE-01205-07

Minnesota Unique Well No.

178990

County Dakota
Quad
Quad ID

MINNESOTA DEPARTMENT OF HEALTH

WELL AND BORING RECORD

Minnesota Statutes Chapter 103I

Entry Date 06/22/2001
Update Date 06/22/2001
Received Date

Well Name BURNSVILLE MW

Township	Range	Dir	Section	Subsections	Elevation	ft.
27	24	W	34		Elevation Method	

Well Depth	Depth Completed	Date Well Completed
110 ft.	110 ft.	06/00/1981

Drilling Method Non-specified Rotary

Well Address
12111 RIVERRIDGE BL
BURNSVILLE MN

Geological Material	Color	Hardness	From	To
DRIFT	BLACK	SOFT	0	11
LIMEROCK	YELLOW	HARD	11	65
SANDSTONE	YELLOW	SOFT	65	68
LIMEROCK	YEL/GRY	HARD	68	94
SANDSTONE	YELLOW	SOFT	94	100
LIMEROCK	YELLOW	M.HARD	100	110

Drilling Fluid
--

Well Hydrofractured? ☐ Yes ☐ No
From Ft. to Ft.

Use Test well

Casing Type Steel (black or low carbon) Joint No Information Drive Shoe? ☐ Yes ☑ No Above/Below 110 ft.

Casing Diameter	Weight	Hole Diameter
12 in. to 11 ft.	49 lbs./ft.	18.5 in. to 11 ft.
6 in. to 70 ft.	19 lbs./ft.	12 in. to 70 ft.

Open Hole from 70 ft. to 110 ft.

Screen NO Make Type

Diameter	Slot/Gauze	Length	Set Between

Static Water Level
ft. from Date Measured

PUMPING LEVEL (below land surface)
ft. after hrs. pumping 200 g.p.m.

Well Head Completion
Pitless adapter manufacturer Model
☐ Casing Protection ☐ 12 in. above grade
☐ At-grade (Environmental Wells and Borings ONLY)

REMARKS
MONITORING WELL SHAKOPEE.

Grouting Information Well Grouted? ☑ Yes ☐ No

Grout Material: Neat Cement from 0 to 70 ft.

Nearest Known Source of Contamination
__feet __direction __type
Well disinfected upon completion? ☐ Yes ☐ No

Pump ☐ Not Installed Date Installed
Manufacturer's name Model number __ HP _ Volts
Length of drop Pipe _ft. Capacity _g.p.m Type Material

Abandoned Wells Does property have any not in use and not sealed well(s)? ☐ Yes ☐ No

Variance Was a variance granted from the MDH for this well? ☐ Yes ☐ No

First Bedrock
Aquifer
Last Strat
Depth to Bedrock ft.

Well Contractor Certification

License Business Name	Lic. Or Reg. No.	Name of Driller
Stevens Well Co.	27194	KADERLIK, C.

County Well Index Online Report

178990

Printed 4/2/2009
HE-01205-07

Minnesota Unique Well No.
178991

County Dakota
Quad
Quad ID

MINNESOTA DEPARTMENT OF HEALTH

WELL AND BORING RECORD

Minnesota Statutes Chapter 103I

Entry Date 06/22/2001
Update Date
Received Date

Well Name BURNSVILLE MW

Township	Range	Dir	Section	Subsections	Elevation ft.
27	24	W	34		Elevation Method

Well Depth	Depth Completed	Date Well Completed
110 ft.	110 ft.	06/00/1981

Drilling Method Non-specified Rotary

Well Address
12111 RIVER RIDGE BL

Geological Material	**Color**	**Hardness**	**From**	**To**
DRIFT	BLACK	SOFT	0	12
LIMEROCK	YELLOW	HARD	12	94
SANDSTONE	YELLOW	SOFT	94	99
LIMEROCK	YELLOW	M.HARD	99	110

Drilling Fluid
--

Well Hydrofractured? ☐ Yes ☐ No
From Ft. to Ft.

Use Monitor well

Casing Type Steel (black or low carbon) Joint Welded Drive Shoe? ☐ Yes ☑ No Above/Below ft.

Casing Diameter	**Weight**	**Hole Diameter**
12 in. to 12 ft.	49 lbs./ft.	18.5 in. to 12 ft.
6 in. to 70 ft.	19 lbs./ft.	12 in. to 70 ft.

Open Hole from 70 ft. to 110 ft.

Screen NO Make Type

Diameter	**Slot/Gauze**	**Length**	**Set Between**

Static Water Level
ft. from Date Measured

PUMPING LEVEL (below land surface)
ft. after hrs. pumping 200 g.p.m.

Well Head Completion
Pitless adapter manufacturer Model
☐ Casing Protection ☐ 12 in. above grade
☐ At-grade (Environmental Wells and Borings ONLY)

R E M A R K S
IN THE PUMP SECTION LOCK BOXES & RECORDERS WERE USED.

Grouting Information Well Grouted? ☐ Yes ☐ No

Nearest Known Source of Contamination
__feet __direction __type
Well disinfected upon completion? ☐ Yes ☐ No

Pump ☐ Not Installed Date Installed
Manufacturer's name Model number __ HP _ Volts
Length of drop Pipe _ft. Capacity _g.p.m Type Material

Abandoned Wells Does property have any not in use and not sealed well(s)? ☐ Yes ☐ No

Variance Was a variance granted from the MDH for this well? ☐ Yes ☐ No

First Bedrock
Last Strat
Aquifer
Depth to Bedrock ft.

Well Contractor Certification

Stevens Well Co.	27194	KADERLIK, C.
License Business Name	Lic. Or Reg. No.	Name of Driller

County Well Index Online Report

178991

Printed 4/2/2009
HE-01205-07

Minnesota Unique Well No.
178992

County Dakota
Quad
Quad ID

MINNESOTA DEPARTMENT OF HEALTH

WELL AND BORING RECORD

Minnesota Statutes Chapter 103I

Entry Date 06/22/2001
Update Date 06/22/2001
Received Date

Well Name BURNSVILLE MW

Township	Range	Dir	Section	Subsections
27	24	W	34	

Elevation ft.
Elevation Method

Well Depth 220 ft.
Depth Completed 220 ft.
Date Well Completed 06/00/1981

Drilling Method Non-specified Rotary

Well Address
12111 RIVER RIDGE BL
MN

Drilling Fluid
--

Well Hydrofractured? ☐ Yes ☐ No
From Ft. to Ft.

Use Monitor well

Casing Type Steel (black or low carbon) Joint Welded Drive Shoe? ☐ Yes ☑ No Above/Below ft.

Geological Material	Color	Hardness	From	To
CLAY	BLACK	SOFT	0	21
COARSE GRAVEL	GRAY	SOFT	21	35
LIMESTONE	YELLOW	M.HARD	35	38
LIMEROCK CAVERN	YELLOW	SOFT	38	39
LIMEROCK	YELLOW	M.HARD	39	45
LIMEROCK CAVERN	YELLOW	SOFT	45	48
LIMEROCK	YELLOW	HARD	48	65
SANDSTONE	YELLOW	SOFT	65	68
LIMEROCK	YELLOW	SOFT	68	96
SANDSTONE W/LIMEROCK LENS	YELLOW	SOFT	96	104
LIMEROCK	YELLOW	M.HARD	104	125
LIMEROCK	GRAY	HARD	125	155
SANDROCK ONEOTA	DK. GRY	HARD	160	160
SANDSTONE/ JORDAN	DK. GRY	M.HARD	160	220

Casing Diameter	Weight	Hole Diameter
12 in. to 35 ft.	lbs./ft.	18.5 in. to 35 ft.
6 in. to 185 ft.	lbs./ft.	12 in. to 183 ft.

Open Hole from ft. to ft.

Screen NO Make Type

Diameter	Slot/Gauze	Length	Set Between

Static Water Level
ft. from Date Measured

PUMPING LEVEL (below land surface)
ft. after hrs. pumping g.p.m.

Well Head Completion
Pitless adapter manufacturer Model
☐ Casing Protection ☐ 12 in. above grade
☐ At-grade (Environmental Wells and Borings ONLY)

REMARKS
JORDAN EVERY 8-10 FEET HAD HARD LENSES.

Grouting Information Well Grouted? ☐ Yes ☐ No

Nearest Known Source of Contamination
__feet __direction __type
Well disinfected upon completion? ☐ Yes ☐ No

Pump ☐ Not Installed Date Installed
Manufacturer's name Model number __ HP _ Volts
Length of drop Pipe _ft. Capacity _g.p.m Type Material

Abandoned Wells Does property have any not in use and not sealed well(s)? ☐ Yes ☐ No

Variance Was a variance granted from the MDH for this well? ☐ Yes ☐ No

First Bedrock
Last Strat
Aquifer
Depth to Bedrock ft.

Well Contractor Certification

License Business Name	Lic. Or Reg. No.	Name of Driller
Stevens Well Co.	27194	KADERLIK, C.

County Well Index Online Report

178992

Printed 4/2/2009
HE-01205-07

Minnesota Unique Well No.
178993

County Dakota
Quad
Quad ID

MINNESOTA DEPARTMENT OF HEALTH

WELL AND BORING RECORD

Minnesota Statutes Chapter 103I

Entry Date 06/22/2001
Update Date
Received Date

Well Name BURNSVILLE MW

Township	Range	Dir	Section	Subsections	Elevation ft.
27	24	W	34		Elevation Method

Well Depth	Depth Completed	Date Well Completed
220 ft.	220 ft.	06/00/1981

Drilling Method Non-specified Rotary

Well Address
12111 RIVER RIDGE BL

Drilling Fluid
--

Well Hydrofractured? ☐ Yes ☐ No
From Ft. to Ft.

Use Monitor well

Casing Type Steel (black or low carbon) Joint Welded Drive Shoe? ☐ Yes ☑ No Above/Below ft.

Geological Material	**Color**	**Hardness**	**From**	**To**
DRIFT	BLACK	SOFT	0	11
LIMEROCK	YELLOW	HARD	11	94
SANDSTONE	YELLOW	SOFT	94	100
LIMEROCK	YELLOW	HARD	100	163
SANDSTONE	WHT/GRY	M.HARD	163	220

Casing Diameter	**Weight**	**Hole Diameter**
12 in. to 11 ft.	49 lbs./ft.	18.5 in. to 11 ft.
6 in. to 183 ft.	19 lbs./ft.	12 in. to 183 ft.

Open Hole from 183 ft. to 220 ft.

Screen NO Make Type

Diameter	**Slot/Gauze**	**Length**	**Set Between**

Static Water Level
ft. from Date Measured

PUMPING LEVEL (below land surface)
ft. after hrs. pumping 200 g.p.m.

Well Head Completion
Pitless adapter manufacturer Model
☐ Casing Protection ☐ 12 in. above grade
☐ At-grade (Environmental Wells and Borings ONLY)

REMARKS
LOCK BOXES & RECORDERS

Grouting Information Well Grouted? ☐ Yes ☐ No

Nearest Known Source of Contamination
__feet __direction __type
Well disinfected upon completion? ☐ Yes ☐ No

Pump ☐ Not Installed Date Installed
Manufacturer's name Model number __ HP _ Volts
Length of drop Pipe _ft. Capacity _g.p.m Type Material

Abandoned Wells Does property have any not in use and not sealed well(s)? ☐ Yes ☐ No

Variance Was a variance granted from the MDH for this well? ☐ Yes ☐ No

First Bedrock
Aquifer
Last Strat
Depth to Bedrock ft.

Well Contractor Certification

License Business Name	Lic. Or Reg. No.	Name of Driller
Stevens Well Co.	27194	KADERLIK, C.

County Well Index Online Report

178993

Printed 4/2/2009
HE-01205-07

Minnesota Unique Well No.
179000

County Dakota
Quad
Quad ID

MINNESOTA DEPARTMENT OF HEALTH

WELL AND BORING RECORD

Minnesota Statutes Chapter 103I

Entry Date 06/22/2001
Update Date
Received Date

Well Name BURNSVILLE MW

Township	Range	Dir	Section	Subsections	Elevation	ft.
27	24	W	34		Elevation Method	

Well Depth	Depth Completed	Date Well Completed
220 ft.	220 ft.	06/00/1981

Drilling Method Non-specified Rotary

Well Address
121111 RIVER RIDGE BL
BURNSVILLE MN

Geological Material	Color	Hardness	From	To
DRIFT	BLACK	SOFT	0	11
LIMEROCK	YELLOW	HARD	11	66
SANDSTONE	YELLOW	SOFT	66	69
LIMEROCK	YELLOW	HARD	69	159
SANDROCK	DK. GRY	HARD	159	165
SANDSTONE	WHT/GRY	SOFT	165	220

Drilling Fluid
--

Well Hydrofractured? ☐ Yes ☐ No
From Ft. to Ft.

Use Monitor well

Casing Type Steel (black or low carbon) Joint Welded Drive Shoe? ☐ Yes ☑ No Above/Below 2.5 ft.

Casing Diameter	Weight	Hole Diameter
12 in. to 11 ft.	49 lbs./ft.	18.5 in. to 11 ft.
6 in. to 183 ft.	19 lbs./ft.	12 in. to 183 ft.

Open Hole from 183 ft. to 220 ft.

Screen NO Make Type

Diameter	Slot/Gauze	Length	Set Between

Static Water Level
ft. from Date Measured

PUMPING LEVEL (below land surface)
ft. after hrs. pumping 200 g.p.m.

Well Head Completion
Pitless adapter manufacturer Model
☐ Casing Protection ☐ 12 in. above grade
☐ At-grade (Environmental Wells and Borings ONLY)

NO REMARKS

Grouting Information Well Grouted? ☑ Yes ☐ No

Grout Material: Neat Cement from 0 to 183 ft.

Nearest Known Source of Contamination
__feet __direction __type
Well disinfected upon completion? ☐ Yes ☐ No

Pump ☐ Not Installed Date Installed
Manufacturer's name Model number __ HP _ Volts
Length of drop Pipe _ft. Capacity _g.p.m Type Material

Abandoned Wells Does property have any not in use and not sealed well(s)? ☐ Yes ☐ No

Variance Was a variance granted from the MDH for this well? ☐ Yes ☐ No

First Bedrock
Last Strat
Aquifer
Depth to Bedrock ft.

Well Contractor Certification

License Business Name	Lic. Or Reg. No.	Name of Driller
Stevens Well Co.	27194	KADERLIK, C.

County Well Index Online Report

179000

Printed 4/2/2009
HE-01205-07

Minnesota Unique Well No.
206175

County Dakota
Quad Bloomington
Quad ID 104D

MINNESOTA DEPARTMENT OF HEALTH

WELL AND BORING RECORD

Minnesota Statutes Chapter 103I

Entry Date 10/19/1990
Update Date 06/22/2001
Received Date

Well Name BURNSVILLE

Township	Range	Dir	Section	Subsections	Elevation
27	24	W	34	BDC	725 ft.

Elevation Method 7.5 minute topographic map (+/- 5 feet)

Well Depth	Depth Completed	Date Well Completed
220 ft.	220 ft.	12/20/1963

Drilling Method --

Drilling Fluid --

Well Hydrofractured? ☐ Yes ☐ No
From Ft. to Ft.

Use Abandoned Status Inactive

Casing Type Steel (black or low carbon) Joint No Information Drive Shoe? ☐ Yes ☐ No Above/Below 0 ft.

Casing Diameter	Weight	Hole Diameter
6 in. to 180 ft.	lbs./ft.	
6 in. to 180 ft.	lbs./ft.	

Open Hole from ft. to ft.

Screen NO Make Type

Diameter	Slot/Gauze	Length	Set Between

Well Address
12111 RIVER RIDGE BL
BURNSVILLE MN

Geological Material	Color	Hardness	From	To
FILL			0	12
SHAKOPEE-ONEOTA DOLOMITE			12	168
JORDAN SANDSTONE			168	220

Static Water Level
ft. from Date Measured

PUMPING LEVEL (below land surface)
0 ft. after hrs. pumping 200 g.p.m.

Well Head Completion
Pitless adapter manufacturer Model
☐ Casing Protection ☐ 12 in. above grade
☐ At-grade (Environmental Wells and Borings ONLY)

REMARKS
ABANDONED OPEN HOLE ARTESIAN FLOW OPEN HOLE
CASING: 010 TO 0012;006 TO 0180.

Located United States Geological Survey
Method Digitized - scale 1:24,000 or larger (Digitizing Table)
Unique Number Verification N/A
Date N/A
System UTM - Nad83, Zone15, Meters
X: 477578 Y: 4959030

Grouting Information Well Grouted? ☐ Yes ☐ No

Nearest Known Source of Contamination
_feet _direction _type
Well disinfected upon completion? ☐ Yes ☐ No

Pump ☐ Not Installed Date Installed
Manufacturer's name Model number _ HP 0 Volts
Length of drop Pipe _ft. Capacity _g.p.m Type Material

Abandoned Wells Does property have any not in use and not sealed well(s)? ☐ Yes ☐ No

Variance Was a variance granted from the MDH for this well? ☐ Yes ☐ No

First Bedrock Prairie Du Chien Group
Last Strat Jordan
Aquifer Jordan
Depth to Bedrock 12 ft.

Well Contractor Certification

License Business Name	Lic. Or Reg. No.	Name of Driller
Tri-state Well Co.	27118	

County Well Index Online Report

206175

Printed 6/26/2008
HE-01205-07

Minnesota Unique Well No.

229108

County	Dakota
Quad	Bloomington
Quad ID	104D

MINNESOTA DEPARTMENT OF HEALTH

WELL AND BORING RECORD

Minnesota Statutes Chapter 103I

Entry Date	05/20/1991
Update Date	03/08/2007
Received Date	

Well Name NORTHWESTERN STATES CEMENT CO.

Township	Range	Dir	Section	Subsections	Elevation	743 ft.
27	24	W	34	CBCABA	Elevation Method	7.5 minute topographic map (+/- 5 feet)

Well Depth	Depth Completed	Date Well Completed
270 ft.	270 ft.	10/04/1963

Drilling Method --

Well Address

BURNSVILLE MN

Geological Material	**Color**	**Hardness**	**From**	**To**
GLACIAL DRIFT			0	27
SHAKOPEE-ONEOTA DOLOMITE			27	179
JORDAN SANDSTONE			179	270

Drilling Fluid
--

Well Hydrofractured? ☐ Yes ☐ No
From Ft. to Ft.

Use Industrial

Casing Type Steel (black or low carbon) Joint No Information Drive Shoe? ☐ Yes ☐ No Above/Below 0 ft.

Casing Diameter	**Weight**	**Hole Diameter**
20 in. to 29 ft.	lbs./ft.	
12 in. to 194 ft.	lbs./ft.	

Open Hole from 194 ft. to 270 ft.

Screen NO Make Type

Diameter	**Slot/Gauze**	**Length**	**Set Between**

Static Water Level
-1 ft. from Land surface Date Measured 10/04/1963

PUMPING LEVEL (below land surface)
14 ft. after hrs. pumping 360 g.p.m.

Well Head Completion
Pitless adapter manufacturer Model
☐ Casing Protection ☐ 12 in. above grade
☐ At-grade (Environmental Wells and Borings ONLY)

REMARKS
WELL FLOWS DON'T KNOW HOW HIGH ABOVE GROUND LEVEL.
LINER PIPE GROUTED WITH PURE CEMENT.

Located Minnesota Geological Survey
Method Digitization (Screen) - Map (1:24,000)
Unique Number Verification Information from owner
Date 08/30/2004
System UTM - Nad83, Zone15, Meters
X: 477296 Y: 4958679

Grouting Information Well Grouted? ☑ Yes ☐ No

Grout Material: Neat Cement from to ft.

Nearest Known Source of Contamination
__feet __direction __type
Well disinfected upon completion? ☐ Yes ☐ No

Pump ☐ Not Installed Date Installed
Manufacturer's name Model number __ HP 0 Volts
Length of drop Pipe _ft. Capacity _g.p.m Type Material

Abandoned Wells Does property have any not in use and not sealed well(s)? ☐ Yes ☐ No

Variance Was a variance granted from the MDH for this well? ☐ Yes ☐ No

First Bedrock Prairie Du Chien Group
Last Strat Jordan
Aquifer Jordan
Depth to Bedrock 27 ft.

Well Contractor Certification

License Business Name	Lic. Or Reg. No.	Name of Driller
Tri-state Well Co.	27118	BENEKE, R.

County Well Index Online Report

229108

Printed 6/26/2008
HE-01205-07

Minnesota Unique Well No.
467594

County Dakota
Quad Bloomington
Quad ID 104D

MINNESOTA DEPARTMENT OF HEALTH

WELL AND BORING RECORD

Minnesota Statutes Chapter 103I

Entry Date 12/04/1992
Update Date 10/01/2008
Received Date

Well Name MW-1

Township	Range	Dir	Section	Subsections	Elevation	ft.
27	24	W	34	BBA	Elevation Method	

Well Depth	Depth Completed	Date Well Completed
22 ft.	22 ft.	10/09/1990

Drilling Method Power Auger

Well Address
121ST ST & PLEASANT LM
BURNSVILLE MN

Geological Material	Color	Hardness	From	To
SAND FILL	BROWN	MEDIUM	0	3
SWAMP DEPOSIT	BLACK	SOFT	3	13
SANDY SILTY CLAY	BROWN	SOFT	13	18
COARSE SAND	BROWN	MEDIUM	18	22

Drilling Fluid
--

Well Hydrofractured? ☐ Yes ☐ No
From Ft. to Ft.

Use Monitor well

Casing Type Steel (black or low carbon) Joint Threaded Drive Shoe? ☐ Yes ☑ No Above/Below 3 ft.

Casing Diameter	Weight	Hole Diameter
2 in. to 16.5 ft.	lbs./ft.	8.25 in. to 21.5 ft.

Open Hole from ft. to ft.

Screen YES Make JOHNSON Type stainless steel

Diameter	Slot/Gauze	Length	Set Between
2	10	5	16.3 ft. and 21.3 ft.

Static Water Level
19 ft. from Land surface Date Measured 10/09/1990

PUMPING LEVEL (below land surface)
ft. after hrs. pumping g.p.m.

Well Head Completion
Pitless adapter manufacturer Model
☐ Casing Protection ☑ 12 in. above grade
☐ At-grade (Environmental Wells and Borings ONLY)

R E M A R K S
121ST ST. & PLEASANT AVE., BURNSVILLE
BURNSVILLE IND. PARK 3RD ADDITION, BLOCK 3, LOT 1
DAKOTA COUNTY PERMIT #90-6095; MW 1

Grouting Information Well Grouted? ☑ Yes ☐ No

Grout Material:	Neat Cement	from 2 to 14 ft.	0.05 yrds.
Grout Material:	CONCRETE	from to 2 ft.	

Nearest Known Source of Contamination
1500 feet North West direction Landfill type
Well disinfected upon completion? ☐ Yes ☑ No

Pump ☐ Not Installed Date Installed
Manufacturer's name Model number HP Volts
Length of drop Pipe ft. Capacity g.p.m Type Material

Abandoned Wells Does property have any not in use and not sealed well(s)? ☐ Yes ☐ No

Variance Was a variance granted from the MDH for this well? ☐ Yes ☐ No

First Bedrock
Last Strat
Aquifer
Depth to Bedrock ft.

Well Contractor Certification

License Business Name	Lic. Or Reg. No.	Name of Driller
American Eng Testing	M0024	ROMAN, B.

County Well Index Online Report

467594

Printed 4/2/2009
HE-01205-07

Minnesota Unique Well No.
472759

County Dakota
Quad
Quad ID

MINNESOTA DEPARTMENT OF HEALTH

WELL AND BORING RECORD

Minnesota Statutes Chapter 103I

Entry Date 09/29/2008
Update Date 09/29/2008
Received Date

Well Name MW-1

Township	Range	Dir	Section	Subsections	Elevation	ft.
27	24	W	34	BB	Elevation Method	

Well Depth	Depth Completed	Date Well Completed
22 ft.	21 ft.	09/18/1990

Drilling Method Power Auger

Well Address

BURNSVILLE MN

Geological Material	Color	Hardness	From	To
FILL, MIX OF SILT OR FLY ASH & PEA			0	1
PEAT	BLACK		1	3
ORG CLAY W/ FEW SHELLS, ROOTS PEAT	GRAY	SOFT	3	8
SANDY LEAN CLAY SOME GRAVEL	BROWN	SOFT	8	9
LEAN CLAY W/ SAND	BROWN	SOFT	9	17
SANDY LEAN CLAY W/ SOME GRAVEL STI	GRY/BRN		17	22

Drilling Fluid
--

Well Hydrofractured? ☐ Yes ☐ No
From Ft. to Ft.

Use Monitor well

Casing Type Steel (black or low carbon) Joint Threaded Drive Shoe? ☐ Yes ☑ No Above/Below 2.7 ft.

Casing Diameter	Weight	Hole Diameter
2 in. to 10.5 ft.	lbs./ft.	8 in. to 20.5 ft.

Open Hole from ft. to ft.

Screen YES Make WESCO Type stainless steel

Diameter	Slot/Gauze	Length	Set Between
2	10		10.5 ft. and 20.5 ft.

Static Water Level
14.1 ft. from Land surface Date Measured 09/18/1990

PUMPING LEVEL (below land surface)
ft. after hrs. pumping g.p.m.

Well Head Completion
Pitless adapter manufacturer Model
☐ Casing Protection ☑ 12 in. above grade
☐ At-grade (Environmental Wells and Borings ONLY)

REMARKS
LOCATION: MAP ATTACHED TO WELL LOG

Grouting Information Well Grouted? ☑ Yes ☐ No

Grout Material: Neat Cement from to 5.5 ft.

Nearest Known Source of Contamination
__feet __direction __type
Well disinfected upon completion? ☐ Yes ☑ No

Pump ☐ Not Installed Date Installed
Manufacturer's name Model number __ HP _ Volts
Length of drop Pipe _ft. Capacity _g.p.m Type Material

Abandoned Wells Does property have any not in use and not sealed well(s)? ☐ Yes ☐ No

Variance Was a variance granted from the MDH for this well? ☐ Yes ☐ No

First Bedrock
Aquifer
Last Strat
Depth to Bedrock ft.

Well Contractor Certification

Gislason, John	M0070	BRABENDER, K.
License Business Name	Lic. Or Reg. No.	Name of Driller

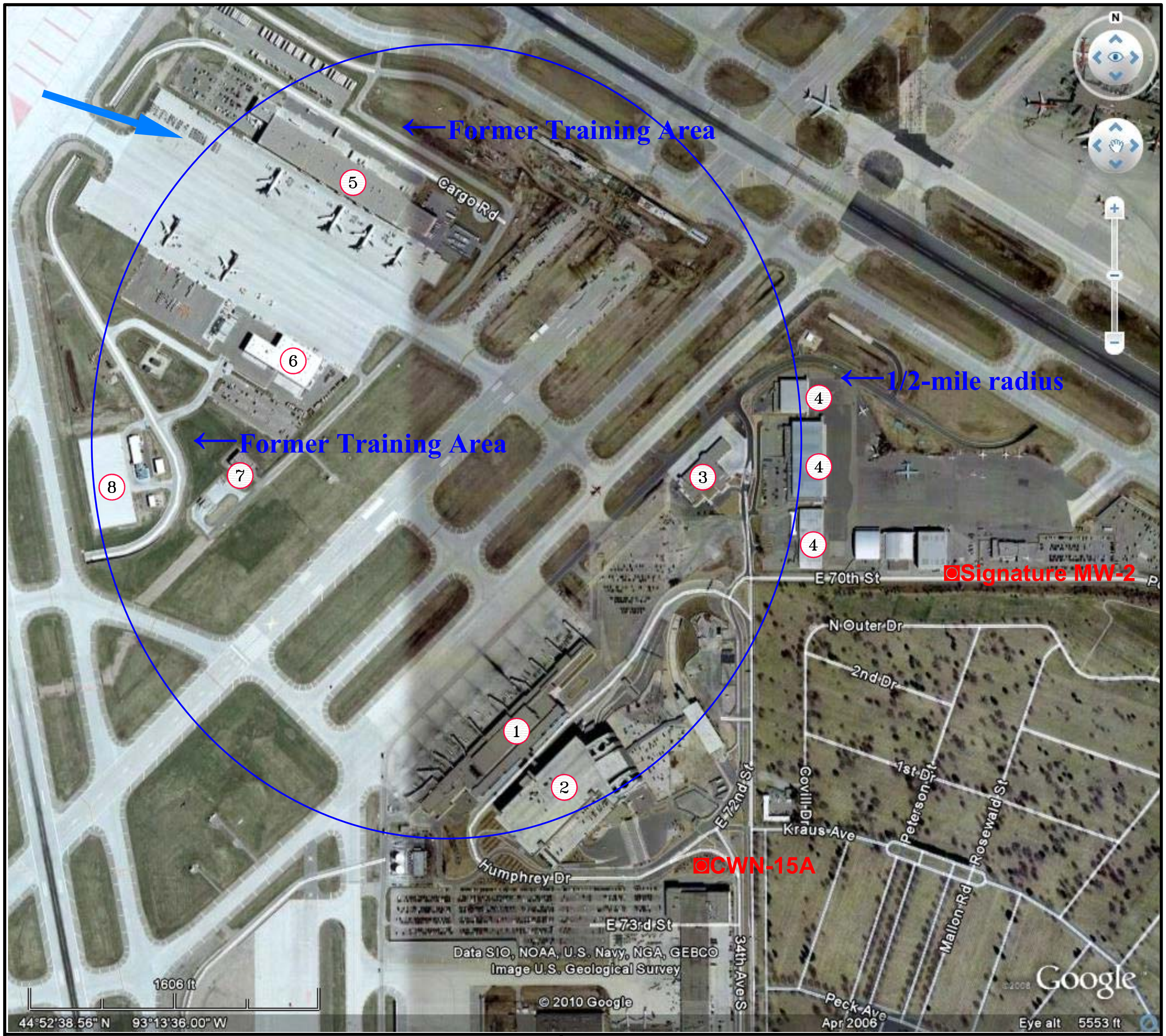
County Well Index Online Report

472759

Printed 4/2/2009
HE-01205-07

Appendix D

MSP Airport Groundwater Receptor Survey Documents



LEGEND:

🟥	Monitoring Well
➡	Inferred Groundwater Flow Direction

Property Occupant

①	Humphrey Terminal
②	Humphrey Terminal Parking Ramp
③	MSP Fire Station No. 1
④	Hangers 4–8
⑤	FedEx
⑥	UPS
⑦	South airfield lighting electrical center
⑧	Glycol Management Facility

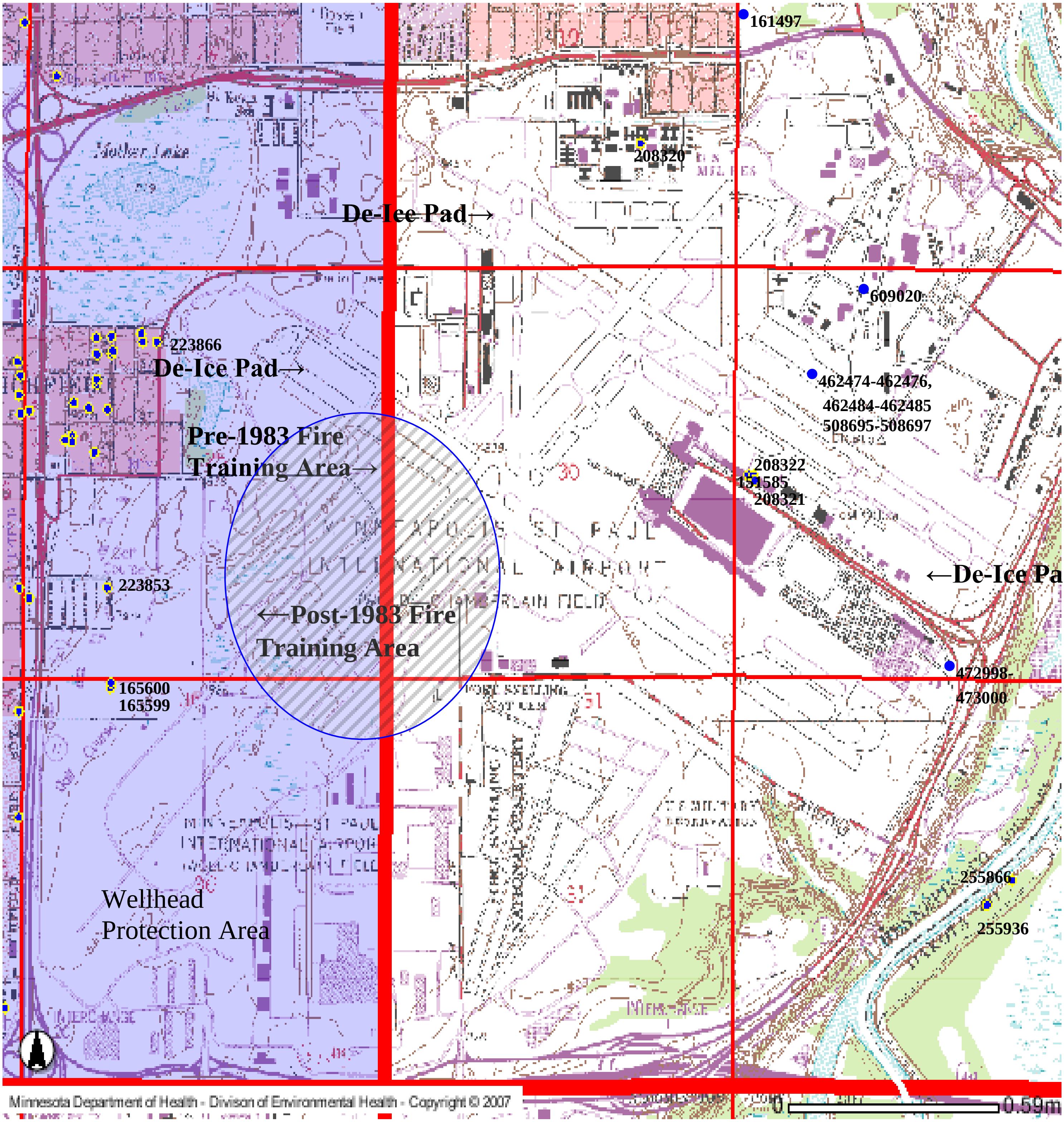
↑ North

FIGURE
RECEPTOR SURVEY
FORMER FIRE TRAINING AREAS
MSP AIRPORT
MINNEAPOLIS, MINNESOTA

PROJECT NO.	PREPARED BY	DRAWN BY
45618DEL04	NR	DD
DATE	REVIEWED BY	FILE NAME
06/30/11		MSP Airport–1

anteagroup

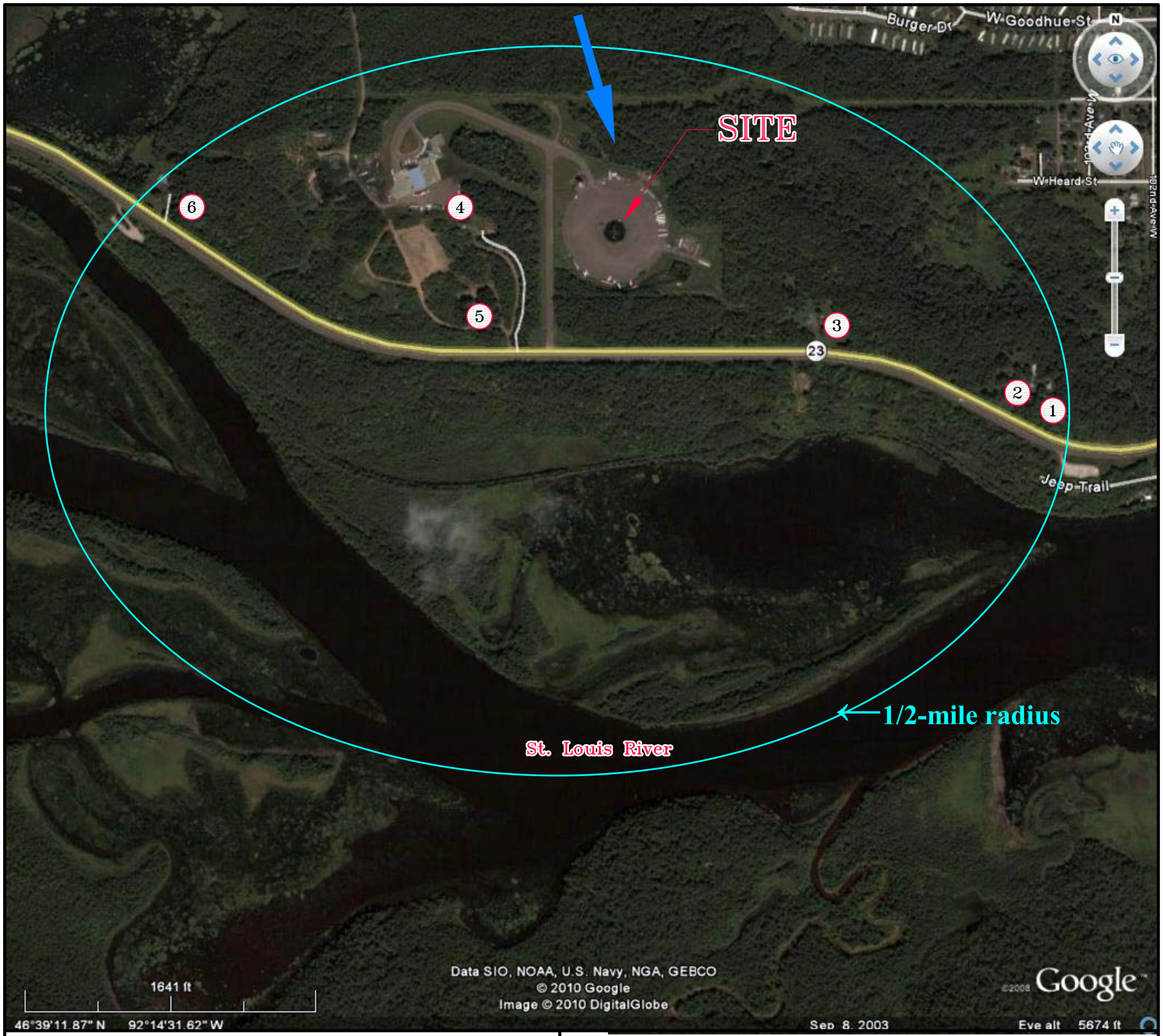
MINNEAPOLIS-ST. PAUL INTERNATIONAL AIRPORT CWI Well Map



▨ Approximate Area of Receptor Survey

Appendix E

Lake Superior College ERTC Receptor Survey Documents



LEGEND:

→ Inferred Groundwater Flow Direction

Property Occupant

① Residence – 10401 Hwy 23
② Residence – 10423 Hwy 23
③ Residence – 11801 Hwy 23
④ Residence – 11601 Hwy 23
⑤ Residence – 11605 Hwy 23
⑥ Residence – 11825 Hwy 23

↑ North

FIGURE
RECEPTOR SURVEY
LAKE SUPERIOR COLLEGE ERTC
11501 HIGHWAY 23
DULUTH, MINNESOTA

PROJECT NO.	PREPARED BY	DRAWN BY
45618DEL04	NR	DD
DATE	REVIEWED BY	FILE NAME
06/30/11		Superior-1

anteagroup

via telephone 11-2-10

Receptor Survey Questionnaire

PROPERTY ADDRESS: 11825 Hwy 23

1. Is there, or has there ever been, a water well on the property? [✓ Yes] No Unknown

If you answered **No or Unknown**, proceed to Question 2.

1a. If you answered **Yes**, is the well *active* (in use), *abandoned* (not in use), or *sealed* (decommissioned following Minnesota Department of Health [MDH] Well Code guidelines).

_____ACTIVE _____ABANDONED _____SEALED

1b. How deep is (was) the well? _____FEET (if depth is unknown check here _____)

1c. In what year was the well installed (if known)? _____

1d. If the well was abandoned, what year was the well sealed?_____

3e. If the well is active, for what purpose is it used? Example: (drinking water, lawn sprinkler, cooling, etc.) All domestic

1f. Where on the property is (was) the well located?_____

1g. If there is currently a water supply well on the property, would you grant access to the property in order to obtain a water sample from either an indoor or outside faucet (at no cost to property owner)?

[✓ Yes] No

Name Bob Esperson

Telephone Number 218-626-2746 DAY or EVENING (please circle one and state best time to reach you)
218-393-4966

2. Is a public water supply currently utilized by the property? Yes [✓ No]

3. May we contact you for further information if necessary? If so, please provide your name and telephone number.

Name_____

Telephone Number_____ DAY or EVENING (please circle one and state best time to reach you)

Please complete this form and mail it back to Delta in the enclosed self-addressed stamped envelope. Delta thanks you in advance for taking the time to complete this form.

If you have any questions, or need help completing this form, please contact Nancy Rodning, Delta Consultants, at (651)697-5152 or 1-800-477-7411, or MPCA Project Manager Nile Fellows at 651-757-2352.

Receptor Survey Questionnaire

- via telephone 10-26-10

PROPERTY ADDRESS: 10401 Hwy 23

1\. Is there, or has there ever been, a water well on the property? [✓ **Yes**] **No** **Unknown**

If you answered **No or Unknown**, proceed to Question 2.

1a. If you answered **Yes**, is the well *active* (in use), *abandoned* (not in use), or *sealed* (decommissioned following Minnesota Department of Health [MDH] Well Code guidelines).

______ACTIVE X ABANDONED ________SEALED

1b. How deep is (was) the well? ______FEET (if depth is unknown check here _______)

1c. In what year was the well installed (if known)? ___________

1d. If the well was abandoned, what year was the well sealed?_________

3e. If the well is active, for what purpose is it used? Example: (drinking water, lawn sprinkler, cooling, etc.)________________________________

1f. Where on the property is (was) the well located? Well didn't have good water. Use well from next door - nephew's well water

1g. If there is currently a water supply well on the property, would you grant access to the property in order to obtain a water sample from either an indoor or outside faucet (at no cost to property owner)?

Yes **No**

Name Ruth McIntyre

Telephone Number 218-626-1128 DAY or EVENING (please circle one and state best time to reach you)

2\. Is a public water supply currently utilized by the property? **Yes** [✓ **No**]

3\. May we contact you for further information if necessary? If so, please provide your name and telephone number.

Name________________________________

Telephone Number____________________________DAY or EVENING (please circle one and state best time to reach you)

Please complete this form and mail it back to Delta in the enclosed self-addressed stamped envelope. Delta thanks you in advance for taking the time to complete this form.

If you have any questions, or need help completing this form, please feel free to contact Nancy Rodning, Delta Consultants, at (651)697-5152 or 1-800-477-7411, or Nile Fellows, MPCA, at 651-757-2352.

Receptor Survey Questionnaire - In Person Interview

PROPERTY ADDRESS: 11605 W Hwy 23

1. Is there, or has there ever been, a water well on the property? [✓ **Yes**] **No** **Unknown**

If you answered **No or Unknown**, proceed to Question 2.

1a. If you answered **Yes**, is the well *active* (in use), *abandoned* (not in use), or *sealed* (decommissioned following Minnesota Department of Health [MDH] Well Code guidelines).

X ACTIVE ________ABANDONED ________SEALED

1b. How deep is (was) the well? _______FEET (if depth is unknown check here _______)

1c. In what year was the well installed (if known)? ?

1d. If the well was abandoned, what year was the well sealed?_________

Pump - 150'
Water - 75'

3e. If the well is active, for what purpose is it used? Example: (drinking water, lawn sprinkler, cooling, etc.) all - drinking, etc

1f. Where on the property is (was) the well located? in house

1g. If there is currently a water supply well on the property, would you grant access to the property in order to obtain a water sample from either an indoor or outside faucet (at no cost to property owner)?

[✓ **Yes**] **No**

Name Jerry Ferrori

Telephone Number 626 3525 DAY or EVENING (please circle one and state best time to reach you)

2. Is a public water supply currently utilized by the property? **Yes** **No**

3. May we contact you for further information if necessary? If so, please provide your name and telephone number.

Name________________________________

Telephone Number________________________DAY or EVENING (please circle one and state best time to reach you)

Please complete this form and mail it back to Delta in the enclosed self-addressed stamped envelope. Delta thanks you in advance for taking the time to complete this form.

If you have any questions, or need help completing this form, please feel free to contact Nancy Rodning, Delta Consultants, at (651)697-5152 or 1-800-477-7411, or Nile Fellows, MPCA, at 651-757-2352.

In Person Interview

Receptor Survey Questionnaire

PROPERTY ADDRESS: 10801 Hwy 23 Duluth 55808

1. Is there, or has there ever been, a water well on the property? **[✓ Yes]** **No** **Unknown**

If you answered **No or Unknown**, proceed to Question 2.

1a. If you answered **Yes**, is the well *active* (in use), *abandoned* (not in use), or *sealed* (decommissioned following Minnesota Department of Health [MDH] Well Code guidelines).

X ACTIVE ________ABANDONED ________SEALED

1b. How deep is (was) the well? _______FEET (if depth is unknown check here ?)

1c. In what year was the well installed (if known)? 1950s

1d. If the well was abandoned, what year was the well sealed?_________

3e. If the well is active, for what purpose is it used? Example: (drinking water, lawn sprinkler, cooling, etc.) drinking, etc

1f. Where on the property is (was) the well located? house corner - SE corner

1g. If there is currently a water supply well on the property, would you grant access to the property in order to obtain a water sample from either an indoor or outside faucet (at no cost to property owner)?

Yes **No**

Name John McIntosh

Telephone Number 218-213-7850 cell DAY or EVENING (please circle one and state best time to reach you)

2. Is a public water supply currently utilized by the property? **Yes** **[✓ No]**

3. May we contact you for further information if necessary? If so, please provide your name and telephone number.

Name______________________

Telephone Number______________________DAY or EVENING (please circle one and state best time to reach you)

Please complete this form and mail it back to Delta in the enclosed self-addressed stamped envelope. Delta thanks you in advance for taking the time to complete this form.

If you have any questions, or need help completing this form, please feel free to contact Nancy Rodning, Delta Consultants, at (651)697-5152 or 1-800-477-7411, or Nile Fellows, MPCA, at 651-757-2352.

Receptor Survey Questionnaire

PROPERTY ADDRESS: 11601 HIGHWAY 23, DULUTH, MN 55808

1. Is there, or has there ever been, a water well on the property? [✓ Yes] No Unknown

If you answered **No or Unknown**, proceed to Question 2.

1a. If you answered **Yes**, is the well *active* (in use), *abandoned* (not in use), or *sealed* (decommissioned following Minnesota Department of Health [MDH] Well Code guidelines).

X ACTIVE ________ABANDONED ________SEALED

1b. How deep is (was) the well? 411 FEET (if depth is unknown check here ________)

1c. In what year was the well installed (if known)? 1991

1d. If the well was abandoned, what year was the well sealed? – NA –

3e. If the well is active, for what purpose is it used? Example: (drinking water, lawn sprinkler, cooling, etc.) DRINKING WATER, SHOWERS, LAUNDRY USE

1f. Where on the property is (was) the well located? APPROXIMATELY 40' NORTHWEST OF THE HOUSE IN THE REAR YARD AREA

1g. If there is currently a water supply well on the property, would you grant access to the property in order to obtain a water sample from either an indoor or outside faucet (at no cost to property owner)?

[✓ Yes] No

Name DIXON E. BASTIE

Telephone Number (218) 348-2287 [✓ DAY] or EVENING (please circle one and state best time to reach you)

2. Is a public water supply currently utilized by the property? Yes [✓ No]

3. May we contact you for further information if necessary? If so, please provide your name and telephone number.

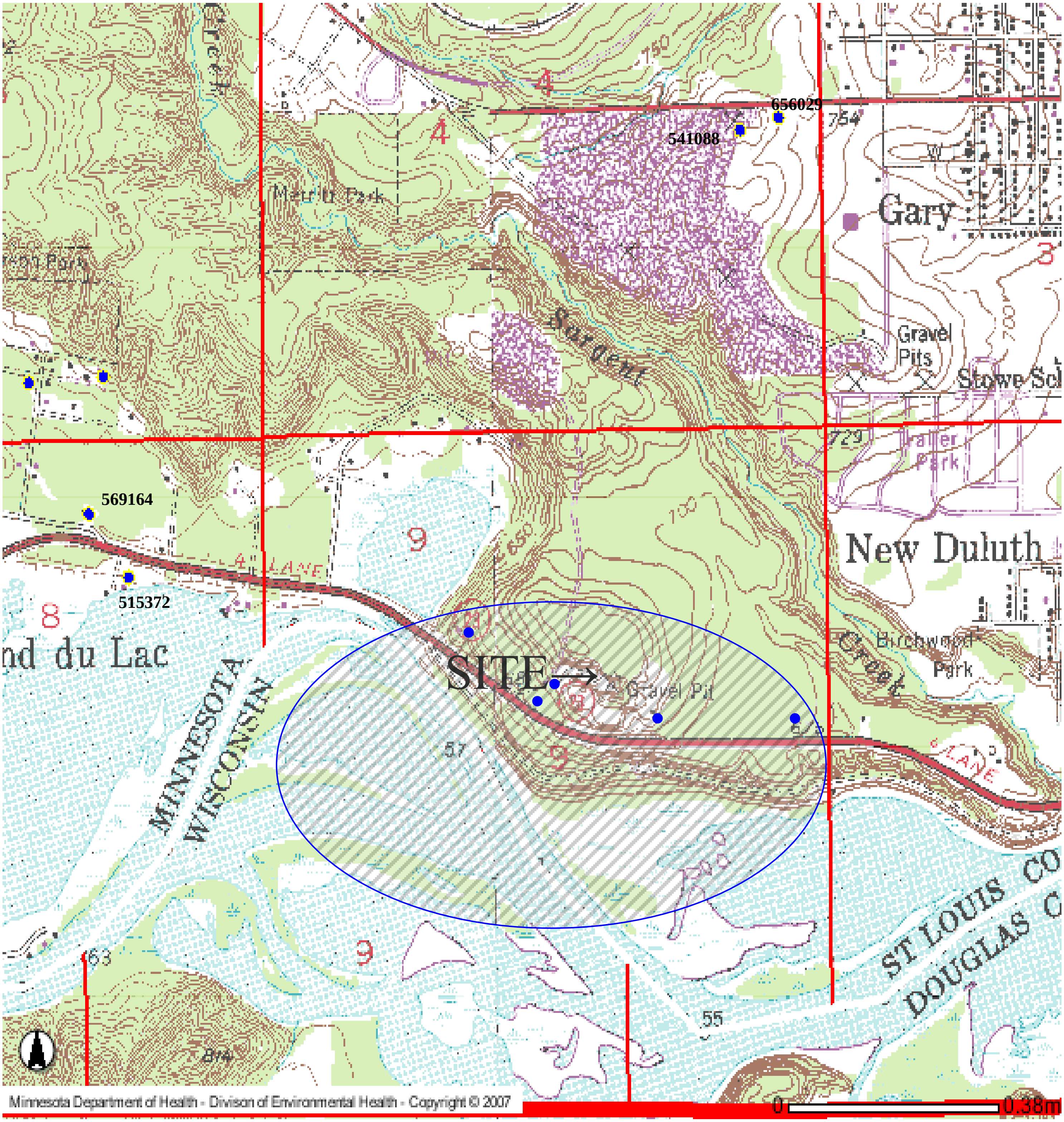
Name – SEE ABOVE –

Telephone Number________________ DAY or EVENING (please circle one and state best time to reach you)

Please complete this form and mail it back to Delta in the enclosed self-addressed stamped envelope. Delta thanks you in advance for taking the time to complete this form.

If you have any questions, or need help completing this form, please feel free to contact Nancy Rodning, Delta Consultants, at (651)697-5152 or 1-800-477-7411, or Nile Fellows, MPCA, at 651-757-2352.

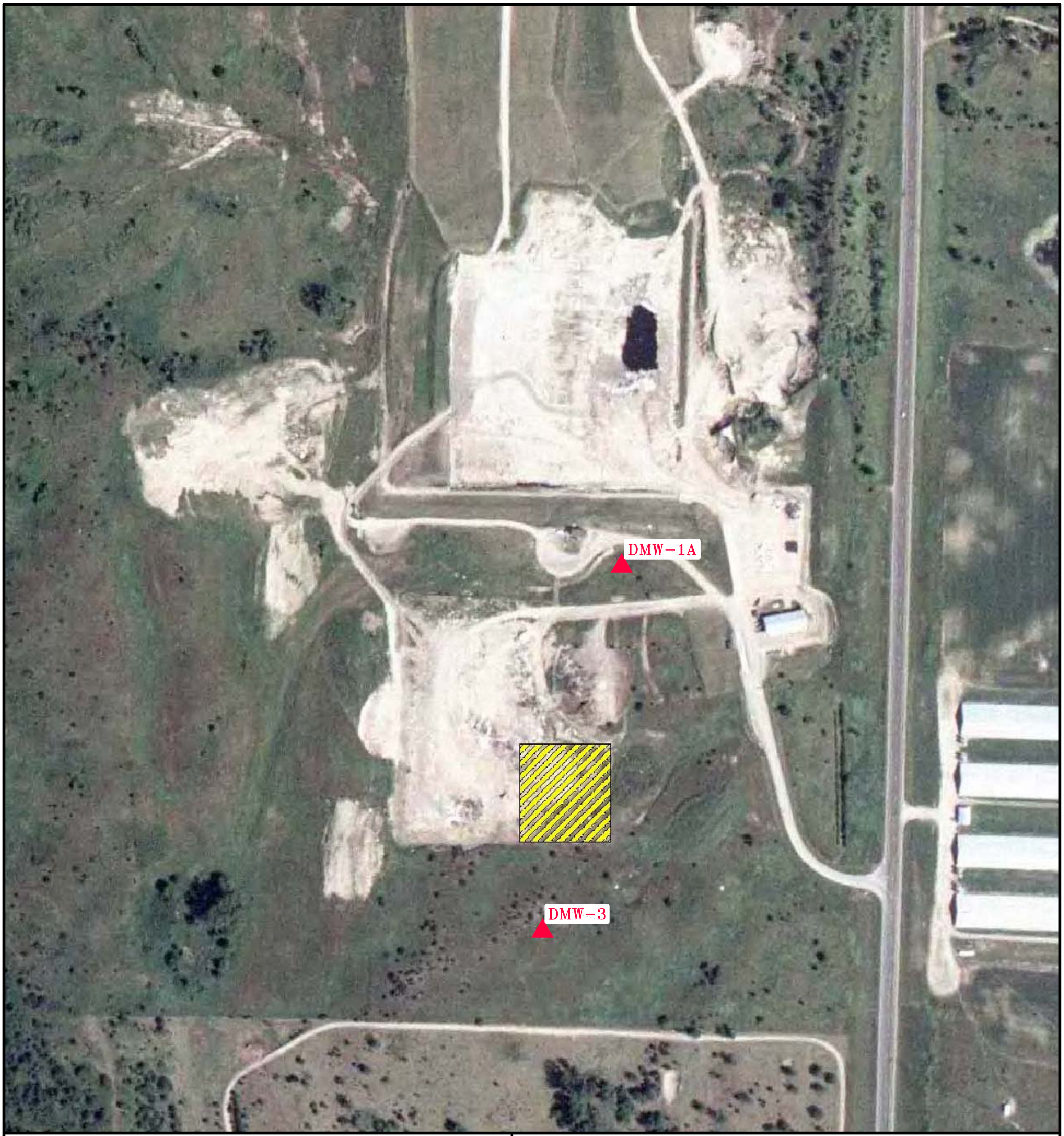
LAKE SUPERIOR COLLEGE - DULUTH CWI Well Map



▨ Approximate Area of Receptor Survey

Appendix F

Kandiyohi County Landfill Sample Location Map



LEGEND:

▲ Sample Location

▨ Foam Use Area

North

0 350
SCALE IN FEET

FIGURE
SAMPLE LOCATIONS
KANDIYOHI LANDFILL
NEW LONDON, MINNESOTA

PROJECT NO.	PREPARED BY	DRAWN BY
45618DEL04	NR	DD
DATE	REVIEWED BY	FILE NAME
06/20/11		Kandiyohi-1

anteagroup

Appendix G

Crystal Airport Sample Location Maps

LEGEND:

▲ Sample Location

● Boring Location

North

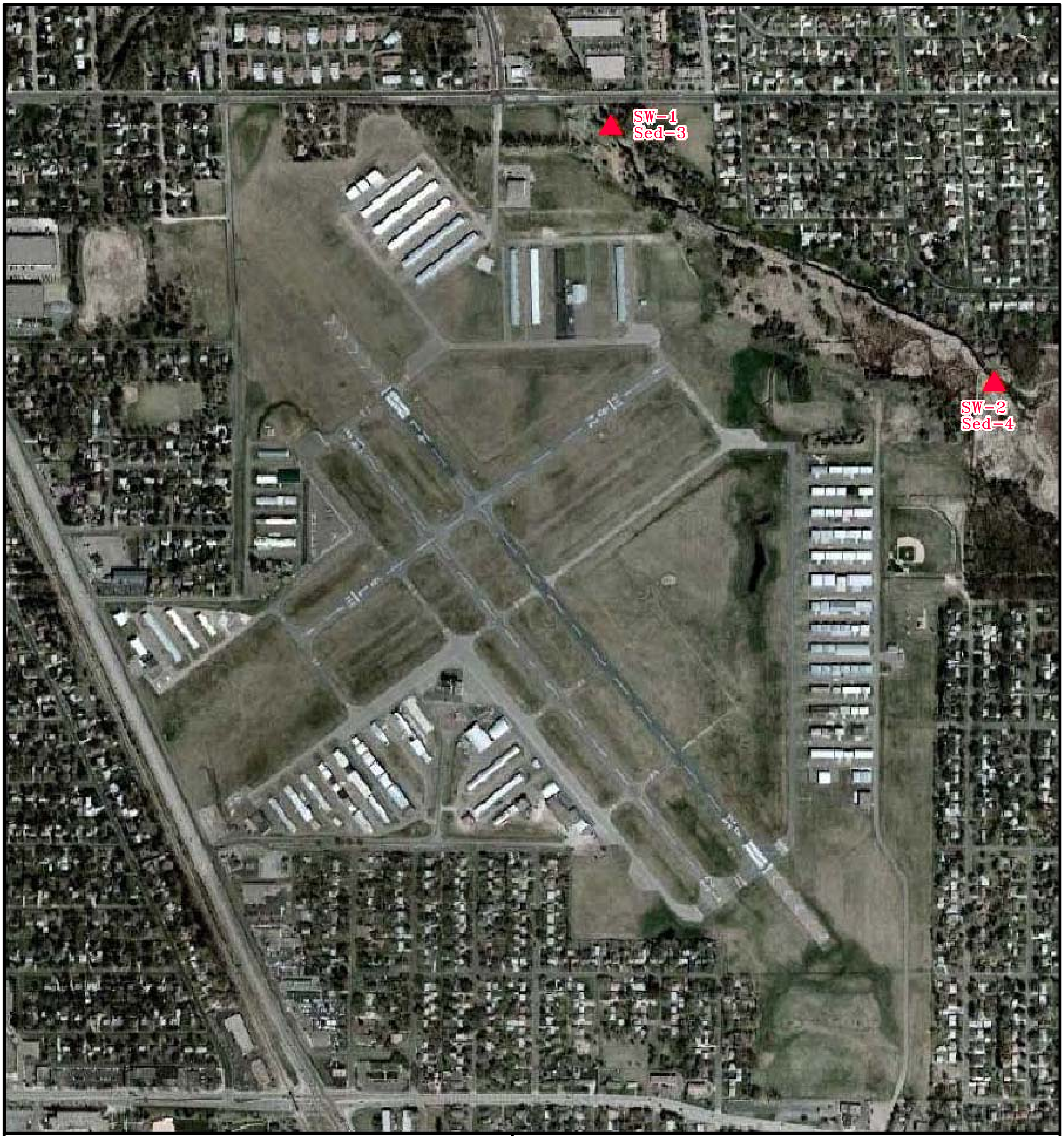
0 750

SCALE IN FEET

FIGURE
JANUARY 2010 PFC SAMPLING LOCATIONS
CRYSTAL AIRPORT
CRYSTAL, MINNESOTA

PROJECT NO.	PREPARED BY	DRAWN BY
45618DEL04	NR	DD
DATE	REVIEWED BY	FILE NAME
06/20/11		Crystal-3

anteagroup



LEGEND:

▲ Sample Location

North

0 750

SCALE IN FEET

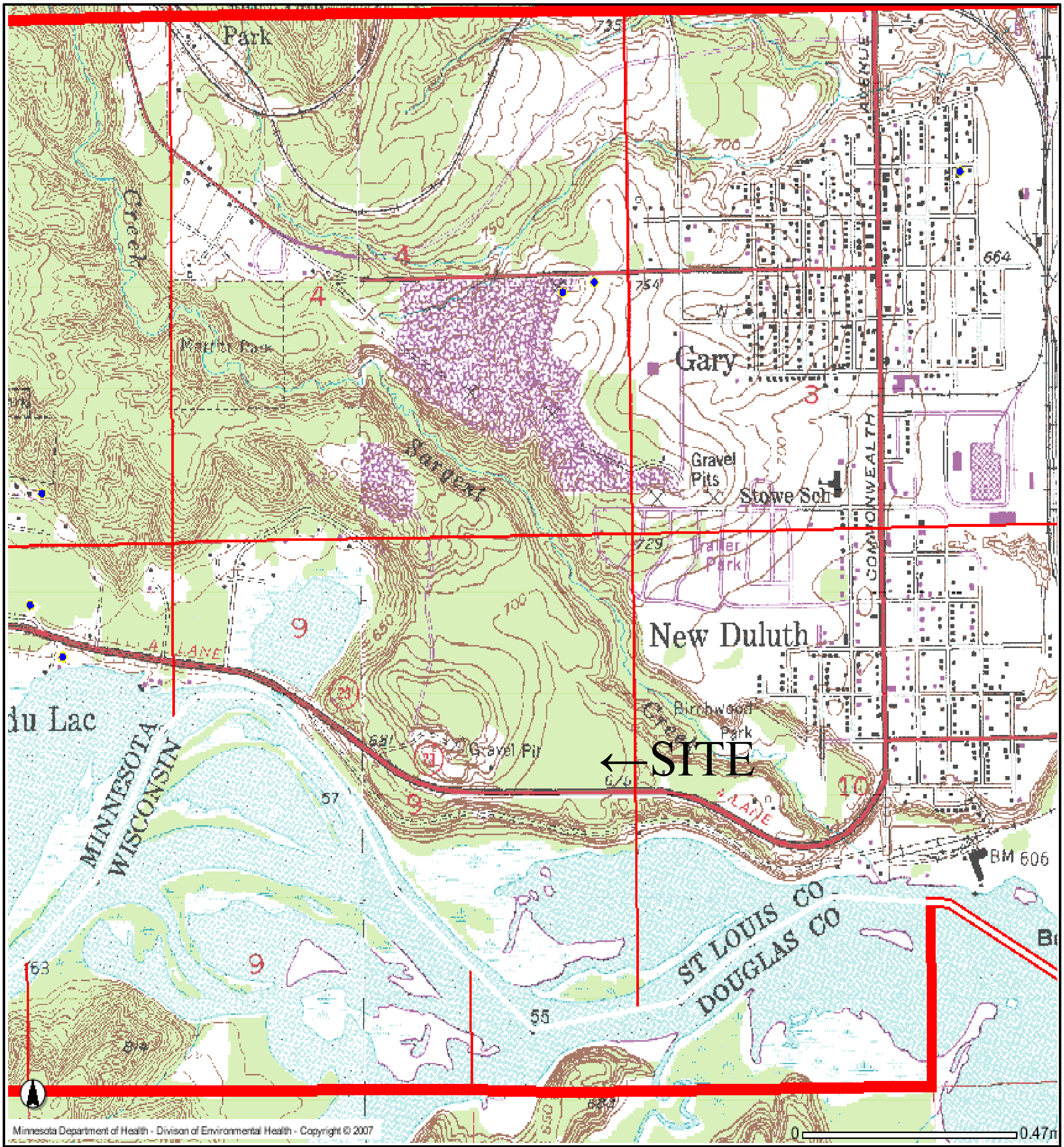
FIGURE
OCTOBER 2010 SAMPLE LOCATIONS
CRYSTAL AIRPORT
CRYSTAL, MINNESOTA

PROJECT NO.	PREPARED BY	DRAWN BY
45618DEL04	NR	DD
DATE	REVIEWED BY	FILE NAME
06/20/11		Crystal-1

anteagroup™

Appendix H

Lake Superior College ERTC Sample Location Maps and Analytical Summary Table



Minnesota Department of Health - Divison of Environmental Health - Copyright © 2007

LEGEND:

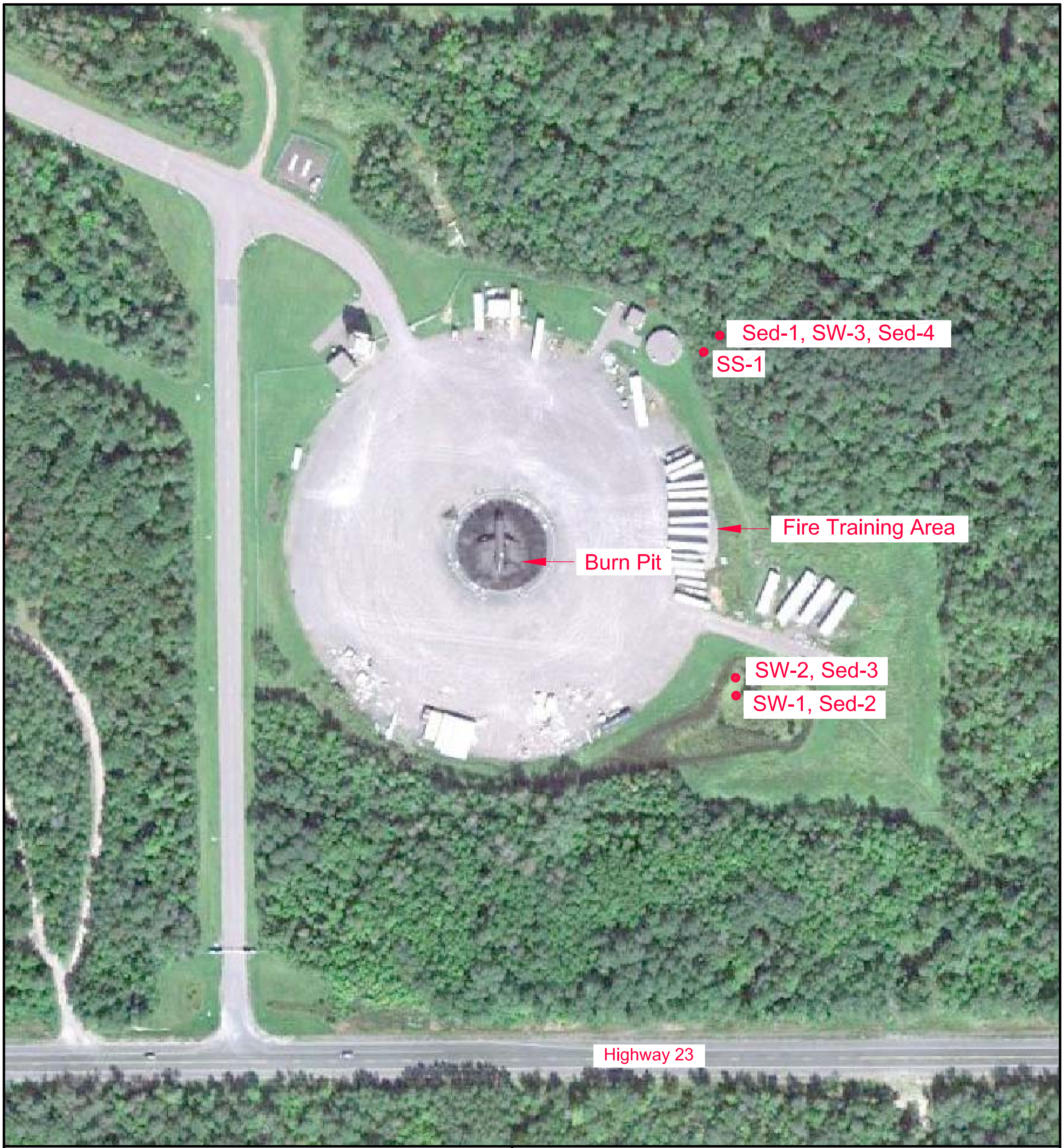
● Well Locations

North

FIGURE 1
SITE LOCATION MAP
LAKE SUPERIOR COLLEGE ERTC
11501 HWY 23
DULUTH, MINNESOTA

PROJECT NO. 45618DEL02	PREPARED BY NR	DRAWN BY DD
DATE 02/18/11	REVIEWED BY	FILE NAME Duluth-1

anteagroup™



LEGEND:

● Sample Locations

FIGURE 2
SITE MAP
LAKE SUPERIOR COLLEGE ERTC
11501 HWY 23
DULUTH, MINNESOTA

PROJECT NO.	PREPARED BY	DRAWN BY
45618DEL02	NR	DD
DATE	REVIEWED BY	FILE NAME
02/18/11		Duluth-2

anteagroup

FIGURE 3
SURROUNDING AREA MAP
LAKE SUPERIOR COLLEGE ERTC
11501 HWY 23
DULUTH, MINNESOTA

PROJECT NO. 45618DEL02	PREPARED BY NR	DRAWN BY DD
DATE 02/21/11	REVIEWED BY	FILE NAME Duluth–3

PFC Analytical Results for Lake Superior College ERTC Samples
Antea Group Project No. 45618DEL0

		Perfluorobutanoic acid (PFBA)	Perfluoro-n-pentanoic acid (PFPeA)	Perfluorohexanoic acid (PFHxA)	Perfluoroheptanoic acid (PFHpA)	Perfluorooctanoic acid (PFOA)	Perfluorononanoic acid (PFNA)	Perfluorodecanoic acid (PFDA)	Perfluoroundecanoic acid (PFUnA)	Perfluorododecanoic acid (PFDoA)	Perfluorobutanoic sulfonate (PFBS)	Perfluorohexane sulfonate (PFHxS)	Perflourooctane sulfonate (PFOS)	Perfluorooctane sulfonylamide (PFOSA)
#Perfluorinated Carbon Chains:		**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**4**	**6**	**8**	**8**
Tier 1 Residential SRV, ng/g:		**77000**	**ND**	**ND**	**ND**	**2100**	**ND**	**ND**	**ND**	**ND**	**ND**	**ND**	**2100**	**ND**
Tier 2 Recreational SRV, ng/g:		**94000**	**ND**	**ND**	**ND**	**2500**	**ND**	**ND**	**ND**	**ND**	**ND**	**ND**	**2600**	**ND**
Tier 2 Industrial SRV, ng/g:		**500000**	**ND**	**ND**	**ND**	**13000**	**ND**	**ND**	**ND**	**ND**	**ND**	**ND**	**14000**	**ND**
Drinking Water Health-Based Limits, ng/L:		**7000(1)**	**ND**	**ND**	**ND**	**300(2)**	**ND**	**ND**	**ND**	**ND**	**7000(1)**	**RAA(3)**	**300(2)**	**ND**
Sample ID	**Sample Date**													
Wetland Samples														
ERTC Sed-2	11/25/2009	**0.218**	**0.536**	**1.72**	**0.268**	**1.26**	**0.184**	**0.101**	**0.174**	< 0.0933	**1.47**	**19.6**	**538**	**181**
ERTC Sed-3	11/18/2010	**0.118**	**0.202**	**1.01**	**0.171**	**0.75**	**0.149**	< 0.0955	**0.174**	**0.156**	**0.318**	**7.1**	**476(D)**	**207(D)**
ERTC SW-1	11/25/2009	**257**	**537**	**1790**	**348**	**991**	**31.8**	**3.45**	< 2.51	< 2.51	**1870**	**9390**	**11300**	**360**
ERTC SW-2	11/18/2010	**76.8**	**144**	**476**	**66.2**	**290**	**22.4**	< 2.49	< 2.49	< 2.49	**315**	**2630**	**7640(D)**	**134(D)**
Creek Samples														
ERTC Sed-1	11/25/2009	< 0.0917	< 0.0917	< 0.0917	< 0.0917	**0.225**	< 0.0917	< 0.0917	< 0.0917	< 0.0917	< 0.183	**1.2**	**57.5**	**6.52**
ERTC Sed-4	11/18/2010	< 0.0933	**0.135**	**0.628**	**0.119**	**0.581**	< 0.0933	< 0.0933	< 0.0933	< 0.0933	< 0.187	**3.52**	**51.3**	**1.95**
ERTC SW-3	11/18/2010	**35**	**62.8**	**366**	**39.5**	**234**	**5.62**	< 2.49	< 2.49	< 2.49	**135**	**1510**	**7630**	**385**
Private Well Water Samples														
ERTC-10801	11/19/2010	< 2.50	< 2.50	< 2.50	< 2.50	< 2.50	< 2.50	< 2.50	< 2.50	< 2.50	< 5.00	**11.2**	**6.49**	< 2.50
ERTC-11601	11/19/2010	< 2.47	< 2.47	< 2.47	< 2.47	< 2.47	< 2.47	< 2.47	< 2.47	< 2.47	< 4.95	**9.63**	**7.26**	< 2.47

Notes:

All samples were analyzed by Axys Analytical Services LTD of British Columbia, Canada.

Sediment results and standards are in nanograms per gram (ng/g), which is approximately equivalent to parts-per-billion.

Surface water and well water results and water standards are in nanograms per liter (ng/L), which is approximately equivalent to parts-per-trillion.

Non-detect results are expressed as "less than" the laboratory detection limit.

Bolded type indicates detection above the laboratory method detection limit.

Tier 1 Residential SRV: Minnesota soil reference value for chronic human exposure in a residential setting.

Tier 2 Recreational SRV: Minnesota soil reference value for exposure in a recreational setting.

Tier 2 Industrial SRV: Minnesota soil reference value for exposure in an industrial setting.

PFC compounds soil results reported on a dry weight basis.

(1) Health-Based Value (HBV) for chronic exposure defined by the Minnesota Department of Health.

(2) Health Risk Limit (HRL) for drinking water defined by the Minnesota Department of Health.

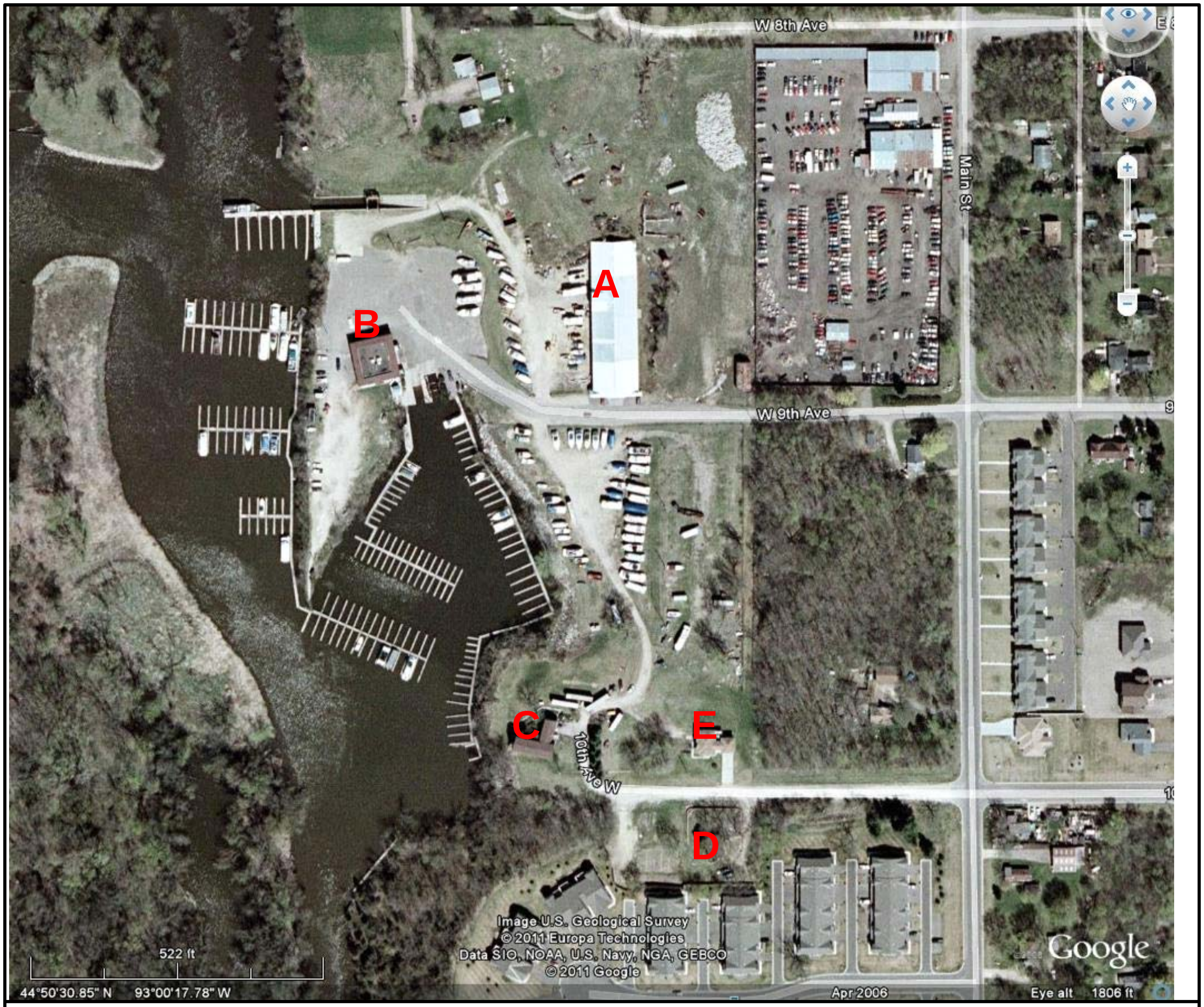
(3) Risk Assessment Advise (RAA) set by the Minnesota Department of Health for PFHxS does not specify numeric values.

ND: No State or Federal values or limits defined.

(D) Dilution performed on sample by laboratory.

Appendix I

Hidden Harbor Marina Well Location Map



Hidden Harbor Marina Water Supply Wells

Well A	Located in the marina workshop, used for non-potable uses. Unique Well #268354.
Well B	Located in the parking lot north of the restaurant/bar. Restaurant/bar and marina docks connected to this well. Unique Well #559256
Well C	Located in backyard of marina house. This house is currently being used as the shower house for use by marina customers. Unique Well # unknown.
Well D	Located in the crawl space of the house at 1001 Oak Street. Unique Well # unknown.
Well E	Located in the house basement at 115 10th Avenue West. Unique Well #429870

North

FIGURE
SAMPLING LOCATIONS
HIDDEN HARBOR MARINA
ST. PAUL PARK, MINNESOTA

PROJECT NO.	PREPARED BY	DRAWN BY
45618DEL04	NR	DD
DATE	REVIEWED BY	FILE NAME
06/21/11		H Harbor-1

anteagroup™

Appendix J

Burnsville ABLE Training Center Sample Location Map

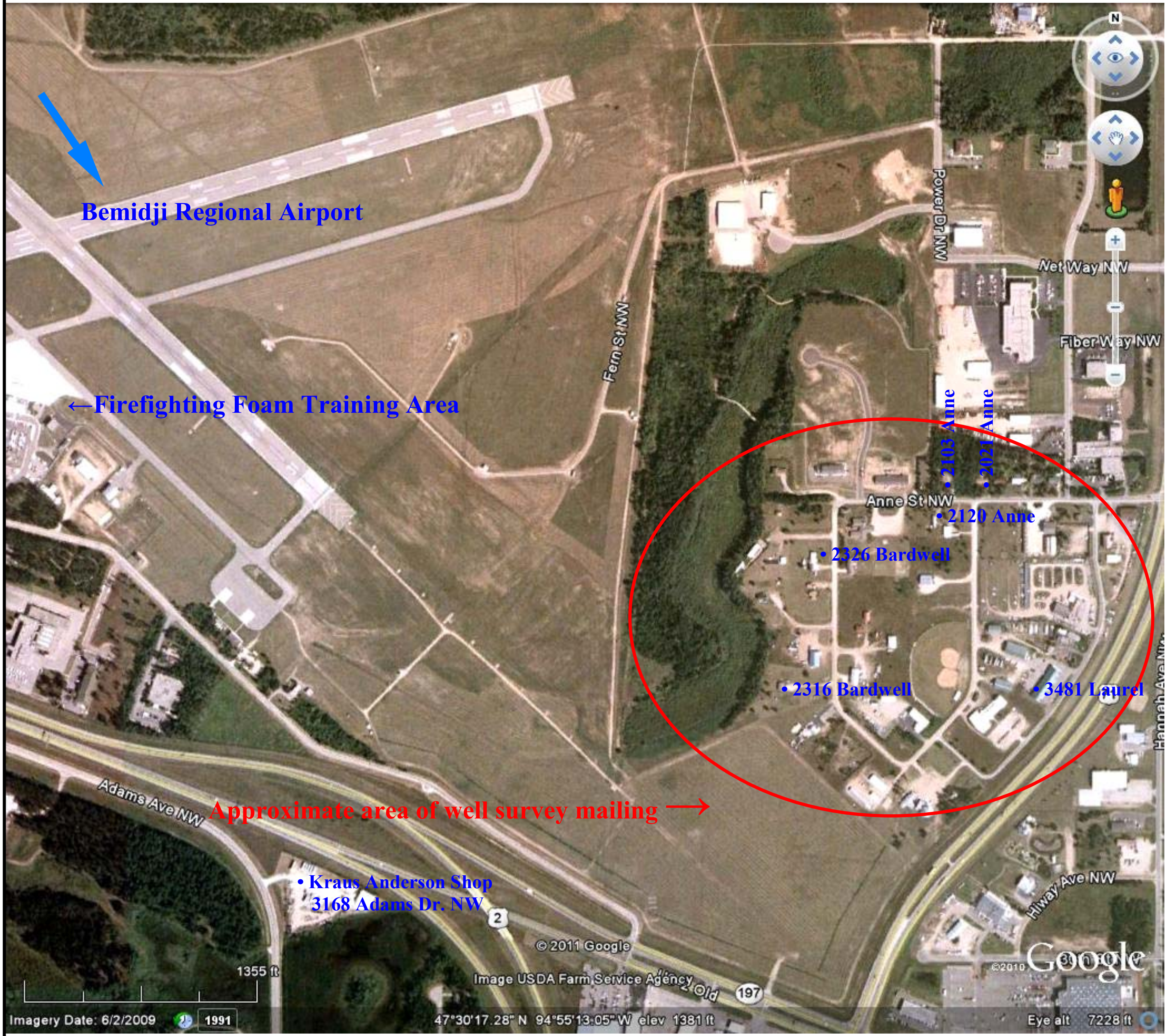
FIGURE
SAMPLING LOCATIONS
ABLE TRAINING CENTER
BURNSVILLE, MINNESOTA

PROJECT NO.	PREPARED BY	DRAWN BY
45618DEL04	NR	DD
DATE	REVIEWED BY	FILE NAME
06/21/11		ABLE-1

anteagroup

Appendix K

Bemidji Regional Airport December 2010 Well Receptor Survey and Well Sampling Documents



LEGEND

→ Inferred Groundwater Flow Direction

FIGURE
DECEMBER 2010 RECEPTOR SURVEY AND
WELL SAMPLE LOCATIONS
BEMIDJI REGIONAL AIRPORT
BEMIDJI, MINNESOTA

PROJECT NO.	PREPARED BY	DRAWN BY
45618DEL04	NR	DD
DATE	REVIEWED BY	FILE NAME
06/30/11		Bemidji–2

anteagroup

WELL RECEPTOR SURVEY RESULTS
BEMIDJI FIRE DEPARTMENT TRAINING AREA - BEMIDJI REGIONAL AIRPORT
March 2011

ADDRESS	WELL? Yes/No	UNIQUE WELL NO.	ACTIVE? Yes/No	WELL USE	WELL DEPTH	COMMENTS
2405 Alyce Court NW		478252				No questionnaire returned.
1826 Anne Street NW						No questionnaire returned.
1925 Anne Street NW		585876				No questionnaire returned.
2001 Anne Street NW						No questionnaire returned.
2014 Anne Street NW						No questionnaire returned.
2015 Anne Street NW						No questionnaire returned.
2021 Anne Street NW	yes		yes	drinking, lawn	30 feet	Well installed 1972, basement. Municipal water also being utlilized.
2027 Anne Street NW						No questionnaire returned.
2103 Anne Street NW	yes		yes	all household uses	55 feet	Well installed 1987, front yard. No municipal water being utilized.
2120 Anne Street NW	yes	566297	yes	drinking, lawn	unknown	Well installed ~1995, located between shop and trailer house. No municipal water being utilized.
2220 Anne Street NW						No questionnaire returned.
2127 Bardwell Drive NW	yes	549971	no	NA	unknown	Well installed 1997, abandoned/sealed 2010. Located just north of building. Municipal water being utilized.
2201 Bardwell Drive NW	yes		yes	lawn irrigation	65 feet	Well installed 1995, east side of office portion of building. Municipal water being utilized.
2212 Bardwell Drive NW	no		NA	NA	NA	Reported no well, no municipal water.
2231 Bardwell Drive NW	yes		yes	lawn irrigation	44 feet	Well installed 1995. Accessible via outside faucet. Municipal water also being utilized.
2310 Bardwell Drive NW						No questionnaire returned.
2316 Bardwell Drive NW	yes	442354	yes	all household uses	100+ feet	Well installed 1989. Municipal water not being utilized.
2322 Bardwell Drive NW	yes		yes	bathroom utilities	unknown	Well installed 1997, northeast corner of the property. No municipal water being utilized.
2324 Bardwell Drive NW						No questionnaire returned.
2326 Bardwell Drive NW	yes		yes	all household uses	52 feet	Well installed 1992, front of house. Municipal water also being utilized.
2532 Bardwell Drive NW						No questionnaire returned.
3354 Laurel Drive NW	yes		yes	lawn irrigation	unknown	Located between building and fence.
3455 Laurel Drive NW	yes		no	NA	NA	Well sealed 2010, northwest corner of property.
3481 Laurel Drive NW	yes	576751 710183	yes	drinking	60 feet	No municipal water being utilized.

WELL RECEPTOR SURVEY RESULTS
BEMIDJI FIRE DEPARTMENT TRAINING AREA - BEMIDJI REGIONAL AIRPORT
March 2011

ADDRESS	WELL? Yes/No	UNIQUE WELL NO.	ACTIVE? Yes/No	WELL USE	WELL DEPTH	COMMENTS
2134 Bardwell Drive NW	yes		yes	drinking	60 feet	No municipal water being utilized.
3501 Laurel Drive NW	yes		yes	irrigation	100 feet?	Well installed 1987, 10 ft. north of office building. Not used for drinking water. Municipal water also being utilized.
3611 Laurel Drive NW	yes	518168	yes	toilets, washing boats	unknown	Bemidji Marine. Bottled water for drinking. No municipal water being utilized.
3709 Laurel Drive NW	yes		yes	irrigation, pressure wash	unknown	One active and two sealed wells (2010). Well located between the two site buildings. Municipal water also being utilized.
2221 Tod Court NW	no		NA	NA	NA	Reported no well, no municipal water.
2225 Tod Court NW						[1]Survey returned NSN; remailed to property owner tax address.
2402 Tracy Court NW						No questionnaire returned.
2408 Tracy Court NW						[1]Survey returned NSN; remailed to property owner tax address.
3810 Whispering Meadows Court NW						No questionnaire returned.
3813 Whispering Meadows Court NW						No questionnaire returned.
3168 Adams Drive NW	yes		yes	pressure wash, bathrooms	~20 feet	Telephone interview, October 2010, Kraus Anderson Construction Shop

Notes:

(1) mail returned by Post Office, "no such number."

Water sample collected for PFC analysis.

Antea Group

NGMN-FMO 8 December 2014

MEMORANDUM FOR RECORD

SUBJECT: CRTC Fire and Emergency Services Training at CR Emergency Management Training Center (EMTC) (November 2014)

1. On 13 October 2014, NGMN-FME was notified by CRTC ENV that Camp Ripley Fire and Emergency Services intend to host a training event. The training is to be performed by Mr. Robert Berg Minnesota Public Safety Division of Homeland Security Emergency Management. The training will utilize fire foam as one of their practical exercises. The Safety Data Sheet (SDS) for the specified foam to be used Chemguard C363 follows for reference.

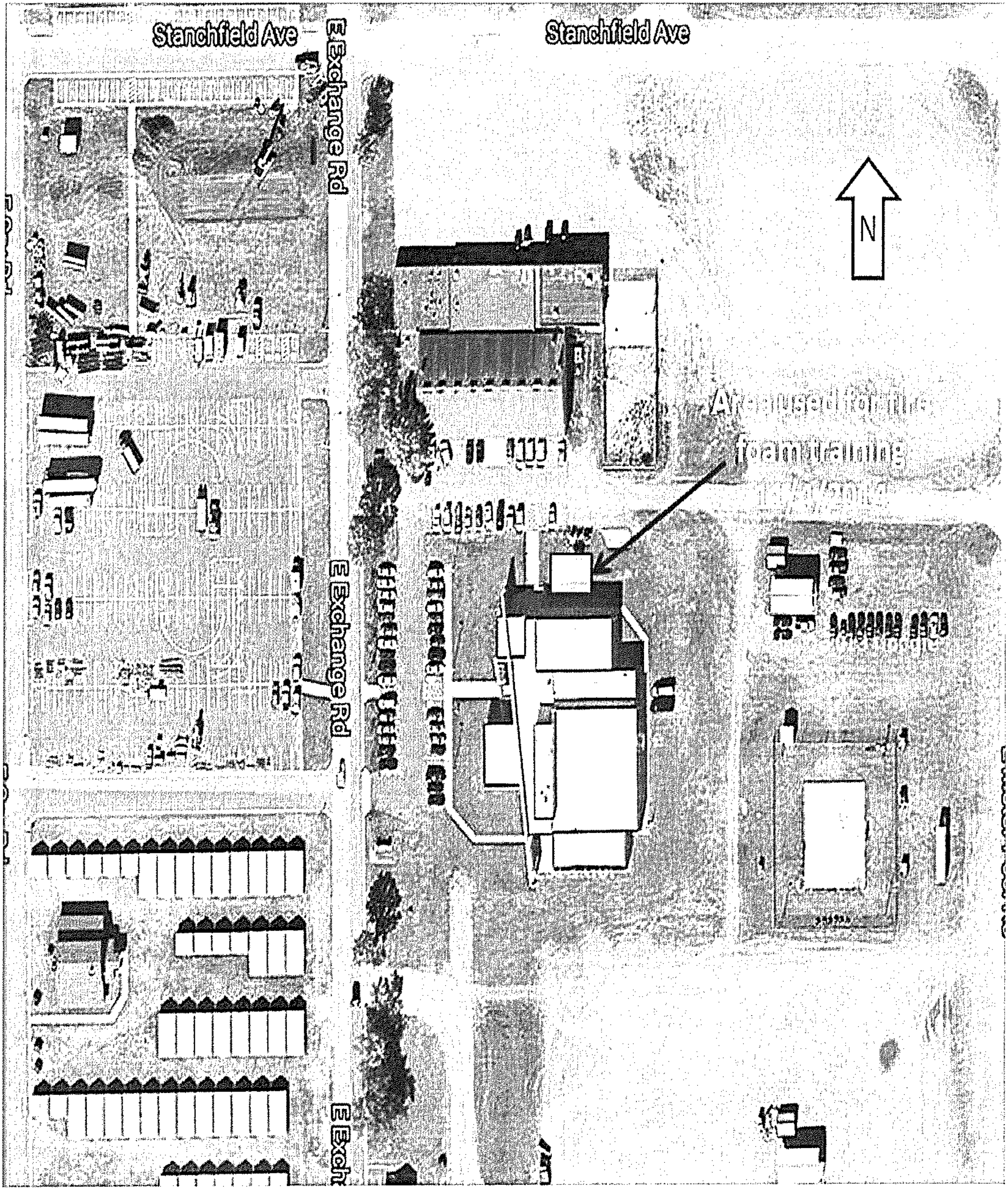
2. On 4 November 2014 one gallon or less of the referenced Chemguard C363 was mixed with 100 gallons of water with in the fire fighting apparatus that applies foam. FES members performed practical exercises applying the foam and water mixture at the CR EMTC. To view the specific location of operators training and were the fire foam was applied, see the diagram that follows for reference.

3. After training event interviews with Mr Patrick Boone (CRTC- FES- Chief) and FES staff. It was stated that the foam was mixed as specified and used sparingly allowing students on hands training. No residues were visible in the area foam was used.

4. NGMN-FME advocates the collection of spent fire fighting foam using a designated area and collection technology (pool). This would allow the spent material to be evaluated insuring compliant disposal. It would also minimize the opportunity for these materials entering and effecting surface or ground water resources at Camp Ripley.

5. POC for this memorandum is Mr Scott Albers at 320-616-2616 or scott.p.albers.nfg@mail.mil.

Camp Ripley Training Center (Emergency Management Training Center) Building 6-78



MATERIAL SAFETY DATA SHEET

Date Prepared: 06/14/2011
Supersedes Date: 05/28/2009

1. CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

Product Name: **Chemguard 3% x 6% AR-AFFF C363**
Chemical Family: Surfactant mixture.
Product Use/Description: Fire-fighting foam concentrate, aqueous film forming foam
Company Identification:
Chemguard, Inc.
Address: 204 South 6th Avenue
Mansfield, Texas 76063 USA
www.chemguard.com
Phone: (817) 473-9964 (For Product Information)
MSDS Preparer: Regulatory Compliance Specialist (817) 473-9964
For Chemical EmergencySpill, Leak, Fire, Exposure, or Accident Call CHEMTREC Day or Night Within USA and Canada: 1-800-424-9300 Outside USA and Canada: +1 703-527-3887 (collect call accepted)
READ THE ENTIRE MSDS FOR A COMPLETE HAZARD ASSESSMENT

2. COMPOSITION / INFORMATION ON INGREDIENTS

CONTAINING HAZARDOUS AND/OR REGULATED COMPONENTS
Chemical Name Percentage CAS Number OSHA PEL
Water 70-80% 7732-18-5 NO
Diethylene glycol monobutyl ether
4-7% 112-34-5 YES
Proprietary hydrocarbon surfactant
proprietary proprietary NO
Proprietary fluorosurfactant proprietary proprietary NO
Polysaccharide gum 1-2% proprietary NO

3. HAZARDS IDENTIFICATION*

**As defined by the OSHA Hazard Communication Standard, 29 CFR 1910.1200. See Section 8 for exposure*
guidelines & Section 11 for toxicology and ingredient specific information.

ROUTES OF EXPOSURE

Eye Contact: This product is a severe eye irritant. Symptoms include stinging, tearing, redness, and swelling of
eyes with possible tissue damage. Vapors may cause eye irritation.
Skin Contact: This product is a mild skin irritant. Symptoms include redness and burning of skin and allergic skin
reaction with eczema and swelling. May be absorbed through the skin in non-toxic amounts.
Ingestion: Swallowing small amounts is not likely to be harmful. Swallowing large amounts may be harmful. May
cause gastrointestinal irritation with nausea, vomiting, and diarrhea.
Inhalation: May cause irritation of the respiratory tract with burning pain in the nose and throat, coughing,

wheezing, shortness of breath and pulmonary edema.
Chronic: None known.
Medical Conditions which May be Aggravated by Inhalation or Dermal Exposure: Persons with unusual (hyper)
sensitivity to chemicals (skin and lung conditions) may experience adverse reactions to this product.
Target Organs: Eye, skin, lungs.
Relevant Routes of Exposure: Eye, skin contact, inhalation.
Interactions with Other Chemicals: None known.
Carcinogenic Potential: This product contains no components present at concentrations equal to or greater than
0.1% listed by IARC, OSHA, NTP, or ACGIH as a carcinogen.

4. FIRST AID MEASURES

Eyes: Immediately flush eyes thoroughly with water. Remove contact lenses after the initial 1-2 minutes and continue flushing for at least 15 minutes, including under lids. Seek immediate medical attention.

Skin: In case of contact, immediately wash with plenty of soap and water for at least 5 minutes. Seek medical attention if irritation or redness occurs. Remove contaminated clothing and shoes. Clean contaminated clothing and shoes before re-use.

Ingestion: Do not induce vomiting without medical advice. Do not induce vomiting or give anything by mouth to an unconscious person. Seek immediate medical attention. Do not leave victim unattended. Vomiting may occur spontaneously. To prevent aspiration of swallowed product, lay victim on side with head lower than waist. If vomiting occurs and the victim is conscious, give water to further dilute the chemical.

Inhalation: If respiratory irritation or distress occurs remove victim to fresh air. Seek immediate medical attention if respiratory irritation or distress continues. Symptoms may be delayed. If breathing is difficult, give oxygen. If breathing as ceased apply artificial respiration using oxygen and a suitable mechanical device such as a bag and a mask.

Notes to Physician: All treatments should be based on observed signs and symptoms of distress in the patient. Consideration should be given to the possibility that overexposure to materials other than this product may have occurred.

5. FIRE FIGHTING MEASURES

Flash Point - No flash to boiling

Lower Explosive Limit – Not Applicable

Upper Explosive Limit – Not Applicable

Hazardous Combustion Products – Hydrocarbons, oxides of carbon, nitrogen and sulfur, hydrofluoric acid and other toxic products.

Unusual Fire & Explosion Hazards – Emits toxic fumes under fire conditions.

Suitable Extinguishing Media – Water, Foam, Carbon Dioxide, Dry Chemical, Halon

Unsuitable Extinguishing Media – Spattering and foaming of product may result from spraying water.

Required Special Protective Measures for Fire-fighters - Standard protection including self-contained breathing apparatus (SCBA) and full fire-fighting turn-out gear (Bunker gear).

Auto Ignition Temperature – Not Applicable

6. ACCIDENTAL RELEASE MEASURES

Personal Precautions: Wear appropriate protective gear for the situation. See Personal Protection information in section 8.

Environmental Precautions: Prevent from entering into soil, ditches, sewers, waterways, and/or groundwater. Dike or retain dilution water or water from firefighting for later disposal. Follow procedure described below under cleanup and disposal of spills.

Cleanup and Disposal of Spill: Exercise appropriate precautions to minimize direct contact with skin or eyes and prevent inhalation of mist. Vacuum or sweep into an appropriate labeled storage container. Do not mix or contaminate with incompatible materials. Do not use water to flush product, as large volumes of foam will develop and slippery conditions may result. Cover container and remove from work area. Avoid creating mist. Ventilate area and wash spill site after material cleanup is complete.

Environmental and Regulatory Reporting: Runoff from fire control or dilution water may cause pollution. Spills may be reportable to the National Response Center (800-424-8802) and to state and/or local agencies.

7. HANDLING AND STORAGE

Minimum/Maximum Storage Temperature: Store at temperatures of 35°F - 120°F.

Handling: Avoid inhalation or contact with eyes, skin or clothing. Store in original container, or appropriate end-use device. If the material freezes, it may be thawed without loss of performance.

Storage: Store in an area that is dry, well ventilated and in tightly closed containers.

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

Occupational Exposure Limits:

No ACGIH TLV or OSHA PEL is assigned to this mixture. Minimize exposure in accordance with good hygiene practice.

Engineering Controls: Where engineering controls are indicated by use conditions or a potential for excessive exposure exists, the following traditional exposure techniques may be used to effectively minimize employee exposures.

Eye Protection: When engaged in activities where product could contact the eye, wear, goggles, and or face shield.

Skin Protection: Skin contact should be minimized through use of latex gloves and suitable long sleeved clothing. Consideration must be given both to durability as well as permeation resistance.

Respiratory Protection: Use local or general ventilation to control exposures below applicable exposure limits or your risk assessment process. For most conditions, no respiratory protection should be needed; however, if material is heated or sprayed, use an approved air-purifying respirator. NIOSH or MSHA approved respirators should be used in the context of respiratory protection program meeting the requirements of the OSHA respiratory protection standard [29 CFR 1910.134] to control exposures when ventilation or other controls are inadequate or discomfort or irritation is experienced. Respirator and/or filter cartridge selection should be based on American National Standards Institute (ANSI) Standards Z88.2 Practices for Respiratory Protection.

Ventilation: Use local exhaust or general dilution ventilation to control exposure within applicable limits.

Other: Have eyewash station in work area.

Work Practice Controls:

Personal hygiene is an important work practice exposure control measure and the following general measures should be taken when working with or handling this material:

(1) Do not store, use, and/or consume foods, beverages, tobacco products, or cosmetics in areas where this material is stored.

(2) Wash hands and face carefully before eating, drinking, using tobacco, applying cosmetics, or using the toilet.

(3) Wash exposed skin promptly to remove accidental splashes or contact with this material.

9. PHYSICAL AND CHEMICAL PROPERTIES

Appearance – opaque thick liquid **Vapor Pressure** – Not Evaluated
Odor – very slight solvent odor **Density** – Not Evaluated
Physical State –thick liquid **Boiling Point** – 100°C (212°F)
Specific Gravity ($H2O=1$) – 1.012 **Melting Point** – 30° F
pH 7.0-8.5 **Solubility in Water** – 100% Soluble
Percentage Volatile by Volume: Not evaluated **Viscosity** 1500 min

10. STABILITY AND REACTIVITY

Stability: Stable.

Conditions to avoid: Unintentional contact with water.
Hazardous Polymerization: Hazardous polymerization will not occur.
Incompatibility with other materials: Strong oxidizing agents
Hazardous Decomposition: Oxides of nitrogen, sulfur and carbon.

11. TOXICOLOGICAL INFORMATION

Toxicity Data for Product: No data available.
Acute Eye and Skin Toxicity Data - Toxicological Information and Interpretation
Diethylene Glycol Monobutyl Ether CAS# 112-34-5
Eye irritation (Rabbits): standard
Skin Irritation (Rabbit): LD 2700 mg/kg
Acute Oral Effects (Rats): LD 5660 mg/kg
Inhalation Toxicity: Not evaluated
Sensitization: Not evaluated
Teratology: Not evaluated
Mutagenicity: Not evaluated
Reproduction: Not evaluated
Chronic Toxicity:
This product does not contain any substances that are considered by OSHA, NTP, IARC or ACGIH to be "probable" or “suspected” human carcinogens.

12. ECOLOGICAL INFORMATION

Ecological Data for Products:
Chemical Oxygen Demand: 254,000 mg/l
Biological Oxygen Demand (20 day): 166,000 mg/l
Biodegradability (B.O.D./C.O.D.) 65%
Total Organic Carbon: 8,300 mg/l
LC50 (96 hour pimephales promelas) Not determined
LC50 (48 hour, daphnia magna) Not determined
Mobility/Bioaccumulation: No data available.

13. DISPOSAL CONSIDERATIONS

Waste Disposal: Chemical additions, processing or otherwise altering this material may make the waste management information presented in this MSDS incomplete, inaccurate or otherwise inappropriate. Dispose of waste material according to local, state and federal regulations.

Container disposal: Empty container retains product residue. Observe all hazard precautions. Do not distribute, make available, furnish or reuse empty container except for storage and shipment of original product. Remove all product residue. Puncture or otherwise destroy empty container and dispose of in a facility permitted for nonhazardous waste.

14. TRANSPORTATION INFORMATION

Hazardous Materials Description/Proper Shipping Name (DOT) (TDG): NOT REGULATED
Hazard Class: Not Applicable
Identification Number: Not Applicable
Required Label Text: Not Applicable
Marine Transportation (IMO / IMDG): Not regulated.
Air Transportation (ICAO / IATA): Not regulated.
Hazardous Substances/Reportable Quantities: Not Applicable

15. REGULATORY INFORMATION

FEDERAL REGULATORY STATUS:
OSHA Hazard Communication Standard, 29 CFR 1910.1200: This product is considered a "hazardous chemical" under this regulation, and should be included in the employer's hazard communication program.
Reportable Quantities Under the Clean Water Act, CERCLA, and EPCRA, 40 CFR 117, 302 and 355:
The product contains no component regulated under section 304 (40 CFR 370).
Clean Air Act:
Diethylene glycol butyl ether / CAS# 112-34-5 (as Glycol ethers) is listed as a hazardous air pollutant (HAP).

SARA Title III Section 313 EPCRA Toxic Chemical Release Inventory (TRI) Reporting. 40 CFR 372:
Diethylene Glycol Monobutyl Ether CAS# 112-34-5 as a **glycol ether**
Status Under the Toxic Substances Control Act, 40 CFR 710:
All chemicals comprising this product are listed on the TSCA Inventory.
SARA Title III Hazard Classes:
Fire Hazard: NO
Reactive Hazard: NO
Release of Pressure: NO
Acute Health Hazard: YES
Chronic Health Hazard: NO
STATE REGULATIONS:
California:
This product does not contain any components that are regulated under California Proposition 65.
Pennsylvania Right To Know Components
Diethylene glycol butyl ether / CAS# 112-34-5 can be found on the list (as Glycol ethers).
INTERNATIONAL REGULATIONS:
Canada DSL/NDSL:
Diethylene glycol butyl ether / CAS# 112-34-5 is listed.

Canada - Ingredient Disclosure List:
Diethylene glycol butyl ether CAS# 112-34-5 is listed.
Status under OSHA Hazard Communication Standard, 29 CFR 1910.1200: This product is considered a "hazardous chemical" under this regulation, and should be included in the employer's hazard communication program.

16. OTHER INFORMATION

Label Requirements:
WARNING! EYE SKIN RESPIRATORY IRRITANT CNS DEPRESSION
WEAR EYE, SKIN AND RESPIRATORY PROTECTION
NFPA Ratings: Health: **1** Flammability: **1** Reactivity: **0**
(NFPA/HMIS Definitions: 0-Least, 1-Slight, 2-Moderate, 3-High, 4-Extreme)
*****Personal Protection rating to be supplied by user depending on use conditions*****

We assigned NFPA and HMIS® ratings to this product based on the hazards of its ingredient(s). Because the customer is most aware of the application of the product, the customer must ensure that the proper personal protective equipment (PPE) is provided consistent with information contained in the product MSDS. This information is intended solely for the use of individuals trained in the particular hazard rating system. They are intended only for rapid, general identification of the magnitude of the specific hazard. To deal adequately with the safe handling of this material, all the information contained in this MSDS must be considered.

ADDITIONAL INFORMATION:

The information contained in this document is given in good faith and based on our current knowledge. It is only an indication and is in no way binding, notably as regards infringement of, or prejudice to third parties through the use of our products. Chemguard guarantees that its products comply with its sales specifications. This information must on no account be used as a substitute for necessary prior tests which alone can ensure that a product is suitable for a given use. Users are responsible for ensuring compliance with local legislation and for obtaining the necessary certifications and authorizations.

END OF MSDS

Name	Position	Phone number
Boone, Pat	Fire Chief	320-616-3174
Brezinka, Jay	Environmental Supervisor	320-616-2618
Ciffra, Jeremy	RFMSS	320-616-2707
Foster, Nate 2012-2016	Airfield Manager	320-616-2780
Jansen, Danielle	Lease Manager	320-616-6158
Jensen, Cassandra	Purchasing Supervisor	320-616-2629
Kuesel, Bill 1972-2013	Retired Randall Fire Chief	
LaForce, Joe	Environmental	3620-616-2621
Olsen, Jimmy SGT	434th Fire Unit	320-616-3002
Tiffany, Alex	GIS	320-616-2622
		320-616-6067

Figliuzza
Hackett > Airfield prior to 2012.

PERSONNEL TRAINED REPORT BY UNIT

START DATE: 01/01/2010
END DATE: 09/25/2018
INSTALLATION: 1-CAMP RIPLEY
FIRE DESK: ALL

Unit	Facility/Airspace Subdivision	Event	Number of Personnel Trained
CENT LAKES COLLEGE	10-137	CIVILIAN UTILIZATION	135
	10-140	CIVILIAN UTILIZATION	240
	7-133	CIVILIAN UTILIZATION	460
	7-134	CIVILIAN UTILIZATION	315
	7-135	CIVILIAN UTILIZATION	1500
	7-153	CIVILIAN UTILIZATION	140
	7-155	CIVILIAN UTILIZATION	255
	9-152 NORTH	CIVILIAN UTILIZATION	1319
	9-152 SOUTH	CIVILIAN UTILIZATION	1653
	9-71	CIVILIAN UTILIZATION	36
	9-72	CIVILIAN UTILIZATION	30
	9-73	CIVILIAN UTILIZATION	6
	9-81	CIVILIAN UTILIZATION	75
	BENNET HILL	TUBING	12
	BULL PEN	UNIT PARTY	200
	CACTF	MILITARY OPERATIONS IN URBAN TERRAIN (MOUT)	76
		MILITARY OPERATIONS IN URBAN TERRAIN (MOUT) FIRE	26
	CACTF A	MILITARY OPERATIONS IN URBAN TERRAIN (MOUT)	23
	CTA05 (CANTONMENT TRAINING AREA 5)	SCENARIO TRAINING - NON FIRE	10
	CTA21 (CANTONMENT TRAINING AREA 21)	EVOC TRAINING	45
	CTA22 (CANTONMENT TRAINING AREA 22)	EVOC TRAINING	45
	CTA23 (CANTONMENT TRAINING AREA 23)	EVOC TRAINING	45
	CTF (MOUT)	FIELD TRAINING EXERCISE (FTX)	40
		MILITARY OPERATIONS IN URBAN TERRAIN (MOUT)	654
	EDC AUDITORIUM	CIVILIAN UTILIZATION	240
	EDC CR 154 (24)	CIVILIAN UTILIZATION	77
	EDC CR 167 (60)	CIVILIAN UTILIZATION	60
	EDC CR 168 (60)	CIVILIAN UTILIZATION	71
	EDC CR 212 (20)	CIVILIAN UTILIZATION	10
	EMTC_BREAKOUT_1	CLASS/CONFERENCE/WORKSHOP	60
	EMTC_BREAKOUT_2	CLASS/CONFERENCE/WORKSHOP	60
	EMTC_BREAKOUT_3	CLASS/CONFERENCE/WORKSHOP	60
	EMTC_BREAKOUT_4	CLASS/CONFERENCE/WORKSHOP	60

Unit	Facility/Airspace Subdivision	Event	Number of Personnel Trained
	EMTC_CLASSROOM_126AB	CLASS/CONFERENCE/WORKSHOP	120
	EMTC_CLASSROOM_126CD	CLASS/CONFERENCE/WORKSHOP	120
	EVOC	EVOC TRAINING	476
		RANGE SET UP - NON FIRE	11
	HANGAR CONFERENCE	CIVILIAN UTILIZATION	76
	RANGE CONTROL 24-199	SAFETY BRIEF	5
	RIPLEY TOWN HALL	CIVILIAN UTILIZATION	55
	STRENGTH	ANNUAL TRAINING	42
		OTHER EVENT	4931

Total For: CENT LAKES COLLEGE **13,874**

GRAND TOTAL: **13,874**

UNIVERSITY OF MINNESOTA DULUTH
GEOLOGICAL SCIENCES DEPARTMENT

CAMP RIPLEY AQUIFER PROTECTION PLAN [APPL]

MANAGEMENT GUIDE #03-002 [MG #03-002]

EXECUTIVE SUMMARY

The University of Minnesota Duluth Geological Sciences Department [UMD] conducted a raster based Geographic Information Systems [GIS] analysis of the Camp Ripley Military Reservation in Morrison County, Minnesota for the purposes of developing an Aquifer Protection Plan [APPL] for the facility. The APPL is based upon a model of aquifer sensitivity to ground water contamination from pollutants introduced at or near the surface. The model was built using DRASTIC: A standardized system for evaluating ground water pollution potential using hydrogeologic settings. Inputs to the DRASTIC model consist of seven parameters that define the intrinsic characteristics of the hydrogeologic system including depth to water, recharge, aquifer media, soils, topography, impact of vadose zone, and hydraulic conductivity of the aquifer. The model output consists of a grid coverage containing relative aquifer sensitivity rankings for the Camp Ripley facility. The rankings are classified into four categories of sensitivity: 1) low, 2) moderate, 3) high, and 4) very high based on the results of the analysis. Results of the Camp Ripley model are in agreement with those determined in similar hydrogeologic settings. The results of the APPL provide a tool to be used in conjunction with groundwater flow and surface runoff models to address known spatial concerns in order to assist in the development of water resource management protocols for proposed activities at the facility.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

1.0 INTRODUCTION

1.1 BACKGROUND

In 1999, the Minnesota Department of Military Affairs [DMA] contracted with the University of Minnesota Duluth [UMD] to develop a Comprehensive Water Management Plan [CWMP] for the Camp Ripley Military Reservation, Little Falls, Minnesota. The purpose of the project is to provide Camp Ripley with water resource management information and technical analysis tools to assist in the development and implementation of a proactive water resource management strategy. Furthermore, the CWMP will provide facilities managers with the requisite data to sustain training at the facility through minimizing the impact or potential impact to the resource.

The CWMP is a cooperative effort, integrating studies and expertise provided by the US Army Center for Health Promotion and Preventative Medicine [USACHPPM], utilizing existing information management systems and is being coordinated by the UMD Department of Geological Sciences. In addition to project coordination, UMD is providing technical and scientific services for the development of the CWMP. The scope of services provided by UMD for development of the CWMP includes collection, evaluation and analysis of existing hydrologic data; additional data acquisition and analysis; integration and compilation of water management and geologic resources data into a Geographic Information System [GIS] database; research and development of GIS analysis and presentation technologies; development of groundwater and surface water flow models; and training for analysis and graphical display of GIS data to support managerial objectives (Figure 1).

A major component of the CWMP is the development of an Aquifer Protection Plan [APPL]. The APPL can be discussed terms of sensitivity modeling. The APPL consists of modeling the sensitivity of ground water resources to contamination based on the physical characteristics of the hydrogeologic system. It is not intended to replace on-site inspections, or to specifically site any type of facility or land use activity. Rather, the APPL is designed to provide a relative index of ground water sensitivity and basis for comparative evaluation of areas with respect to the potential for ground water contamination.

1.2 RATIONALE

The APPL is an integral component of the CWMP, and its development a fundamental product of the groundwater flow and surface runoff models currently in development for Camp Ripley. The purpose of the APPL is to assess the sensitivity of groundwater resources to contamination from pollutants introduced at or near the land surface. The APPL utilized and integrated data collected during Phase I, IA and II of the project into a geographic information systems [GIS] database. The resulting database was used to conduct raster based modeling and build a GIS grid coverage of groundwater sensitivity to contamination. The results of the model are intended to be used as a tool to address known spatial concerns, assess the applicability of the model to the Camp Riley facility, and assist in day to day water resource managerial decisions.

1.3 PROJECT SCHEDULE AND PERSONNEL

Development of the GIS datasets used to build the Camp Ripley APPL and production of the technical report took place between January and July 2003. Mr. Tom Madigan served as lead technical consultant in the development of GIS datasets, conducted the analysis, and authored this report. Dr. Howard Mooers served as technical advisor and provided important insights into the complexity of the Camp Ripley hydrogeology and results of the sensitivity analysis. Mr. Ben Bertsch provided managerial and administrative support to ensure the project kept on track and met the requirements of the CWMP. Mr. John Quinn of the Argonne National Laboratory provided datasets produced from the development of the Camp Ripley ground water flow model for use in the analysis. Ms. Andrea Grygo and Mr. Dave Stark provided GIS support and important information regarding the overall development of the CWMP.

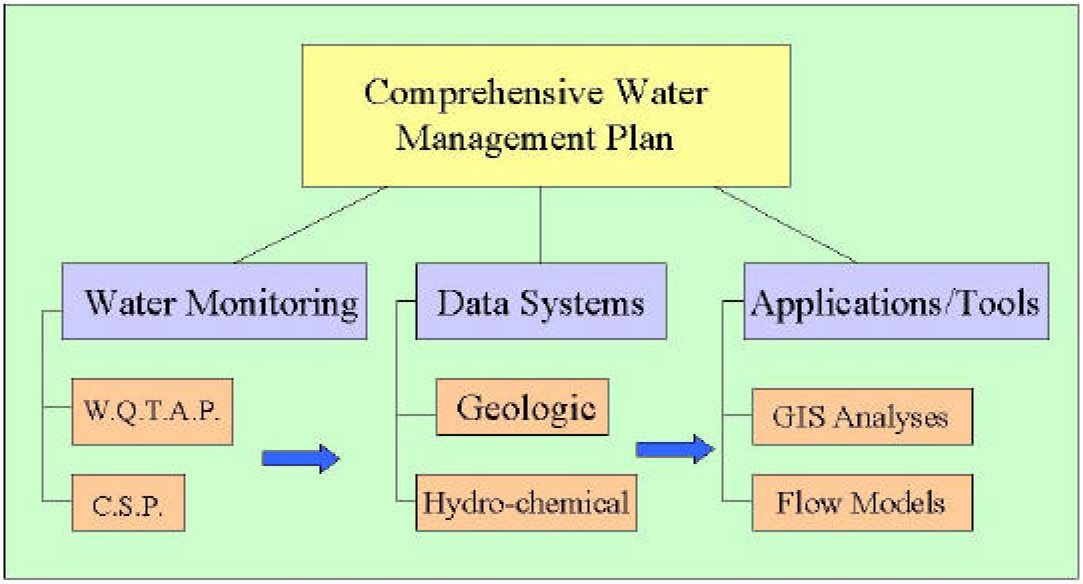


Figure 1. Camp Ripley Comprehensive Water Management Plan.

2.0 PHYSICAL SETTING

2.1 LOCATION

The Camp Ripley Military Reservation is located approximately seven miles north of the city of Little Falls in Morrison County, Minnesota (Figure 2). The facility is bounded by the Crow Wing River and Cass County to the north, the Mississippi River and Crow Wing County to the east, and existing state and county highways to the south and west. Camp Ripley encompasses over 52,000 acres of mixed forest and prairie land in upland settings, and riparian forest with open prairies in bottomlands that provide a setting and location to support the mission of the Department of Military Affairs.

Camp Ripley contains state of the art facilities for military and civilian training, environmental research and protection, recreation, and community outreach activities. These facilities include housing, office buildings, a clinic, classrooms, and military museum. In addition, Camp Ripley's infrastructure is composed of a well developed transportation and communication network. The facilities and infrastructure present at Camp Ripley provide the requisite resources to train soldiers and units that support National Security objectives, provide resources that assist in the protection of public safety for citizens of the State of Minnesota, and allow participation in programs that add value to the local community.

2.2 PHYSIOGRAPHY

The general geomorphological characteristics and spatial distribution of landscape features in and around the Camp Ripley region reflect the effects of glacial advance and retreat across central Minnesota. The most prominent geomorphological feature present within Camp Ripley is the St. Croix moraine (Figure 3). The St. Croix moraine forms a rugged belt of hummocky topography containing numerous hills and associated depressions that occupy the majority of Camp Ripley. The moraine is composed primarily of a mixture of sandy till, outwash sand and gravel, ice-contact sand and gravel, and glaciolacustrine sediment. The hill-hole topography characteristic of the moraine within Camp Ripley is the result of stagnation and melt out of glacial ice during the Late Wisconsin. Bounding the St. Croix moraine on the north and east is a generally flat lying plain formed by meltwater drainage along the course of the Crow Wing and Mississippi rivers following glacial retreat. These "valley train" deposits consist primarily of outwash sand and gravel (Figure 3).

The hydrologic features present within Camp Ripley began to form shortly after glacial retreat. The numerous lakes and wetlands present across the landscape developed as the result of melt out of glacial ice, and subsequent erosion and sedimentation into their topographic basins. Development of the modern surface drainage system began to take shape during postglacial time as well. The surface features present within Camp Ripley reveal a complex sequence of glacial and post-glacial processes operating on the landscape, and record the history of events responsible for their formation. A brief overview of the glacial history of the region is presented below. A comprehensive discussion of the geologic history of the region is available in Mooers (1988).

2.3 GLACIAL HISTORY

The landscape features present across the surface of central Minnesota record the advance and retreat of the Rainy, and Superior lobes during the Late Wisconsin. The first well-documented advance of glacial ice into the region is that of the Rainy lobe. The Rainy lobe advanced from the

Labradorian sector of the Laurentide Ice Sheet and across northeastern Minnesota to its terminal position at the Alexandria moraine during the Hewitt Phase of glaciation (the Hewitt Phase was originally assigned to the Wadena Lobe) (Wright 1972, Goldstein 1985, Meyer 1996, Mooers and Lehr 1997). Wright (1965, 1972) estimated the age of this advance to be approximately 40,000 years before present based on a date obtained from wood fragments lying above the Hewitt till. However, based on various lines of evidence Mooers and Lehr (1997) suggest a date of 21,000 years before present for the Hewitt phase. Regardless of the date, advance and retreat of the Rainy lobe during the Hewitt phase resulted in the deposition of loamy glacial till and formation of the Wadena drumlin field in central Minnesota (Wright 1972, Goldstein 1989, Mooers and Lehr 1997).

Following general retreat of glacial ice into northern Minnesota the ice margin again readvanaced. The Rainy lobe advanced across relatively level terrain in northeastern Minnesota to its terminal position at the St. Croix moraine in the Camp Ripley region, and the Superior lobe advanced out of the Lake Superior basin to its terminal position at the St. Croix moraine in the Twin Cities area. To the north the St. Croix moraine forms an interlobate junction with the Itasca moraine of the Itasca Lobe (Mooers and Lehr 1997). These events represent the Itasca/St. Croix phase of glaciation (Wright 1972, Mooers and Lehr 1997) that culminated approximately 15,500 years before present (Mickelson et al. 1983).

As glacial ice began to retreat from the Itasca and St. Croix moraines a complex sequence of glacial lake formation and meltwater drainage occurred. It was at this time that Glacial Lake Brainerd formed between the retreating ice and higher topography to the west (Goldstein 1985). Based on field observations Goldstein (1985) postulated that catastrophic drainage of Glacial Lake Brainerd to the west through the St. Croix moraine resulted in formation of the Pillager Gap north of Camp Ripley. However, based on other lines of evidence Mooers (1988) suggested that the Pillager Gap formed earlier in the history of landscape development and served as a focus for meltwater drainage for the retreating ice lobes. In any case, the events responsible for the formation of the St. Croix moraine were complete at this time. Formation of the Crow Wing and Mississippi river drainages occurred in response to advance and retreat of glacial ice to the west and east of the region near the end of the Late Wisconsin. The present landscape began to take shape during postglacial time as drainage of glacial meltwater ceased, melt out of stagnant glacial ice occurred, and the modern surficial drainage system developed.

2.4 CLIMATE AND VEGETATION

The climate of central Minnesota is characterized by extreme variations in annual temperature and precipitation. These extremes are a result of the latitudinal position of the state with respect to atmospheric circulation patterns that influence the climate of the United States. Three primary air masses influence the climate of Minnesota. These include cold and dry air masses from the Arctic north, cool and dry air from the Pacific west, and warm and moist air from the Gulf of Mexico. The interaction of these air masses results in the average temperature of Morrison County ranging from 68 degrees F in the summer to 12 degrees F during the winter (Brug and Gorton 1994). The total annual precipitation for the county is about 26 inches. The majority of this usually falls between the months of April and September (Brug and Gorton 1994).

Camp Ripley is located near the western limit of the mixed coniferous-deciduous forest boundary (Wright 1993). The upland vegetation is dominated by spruce, fir, pine, birch, and aspen with oak barrens present in prairie openings while bottomland areas commonly contain green ash, silver maple, and other water-tolerant species. Prior to settlement of the region and clearing of land for agricultural purposes the area was prized for its pine forests that provided a source of lumber for development of sawmills and towns in central Minnesota.

2.5 REGIONAL HYDROGEOLOGY

In order to evaluate ground water sensitivity within Camp Ripley it is important to understand the characteristics of the regional ground water system. Camp Ripley lies within the Glaciated Central ground water region of the United States (Heath 1984). A ground water region is considered a geographical area of similar occurrence of ground water resources (Fetter 1994). The classification of ground water regions is based upon five features common to each ground water system within a given region (Heath 1984): 1) the components of the system and their arrangement, 2) the nature of the water bearing openings of the dominant aquifer(s) with respect to origin, 3) mineral composition of the aquifer matrix, 4) water storage and transmission characteristics, and 5) nature and location of recharge and discharge areas.

In the Camp Ripley region the main water bearing deposits are composed of a heterogeneous mixture of glacial sediment consisting predominantly of sandy deposits laid down as flow tills, outwash, and lacustrine sediment by the Rainy and Superior lobes during the St. Croix phase of glaciation. These deposits overly the Hewitt till, a deposit that forms a semi-confining layer at the base of the regional ground water flow system. The Hewitt till consists of loamy glacial deposits laid down by the Wadena lobe during an earlier advance.

The regional ground water flow system at Camp Ripley is defined by a no-flow boundary along a drainage divide to the west of the facility, Little Elk Creek to the southwest, and the Crow Wing and Mississippi rivers to the north and east (Figure 4). Ground water recharge and the direction of regional flow are primarily controlled by the drainage divide. Groundwater recharge to Camp Ripley occurs east of the drainage divide and regional flow is in an east-southeasterly direction towards the Mississippi River. However, as is commonly the case in complex glacial topography there are local and intermediate flow systems superimposed upon the regional flow system. Local flow systems are commonly associated with morainic areas containing variable topographic relief where recharge occurs at topographic highs and discharge occurs in adjacent topographic lows. Intermediate flow systems have one or more local flow systems between their recharge and discharge areas, and often interact with the regional flow system.

The regional hydrogeology of the project area is quite complex. Therefore, in order to assess aquifer sensitivity is important to take into consideration the amount of variability in both the surface and subsurface characteristics of the project area in order to interpret and apply the results of such an analysis. Moreover, the results of the aquifer sensitivity analysis should be viewed as tool to be used in conjunction with groundwater flow and surface runoff models to address the potential impact of spatial concerns in order to assist in the development of management strategies for proposed activities at the Camp Ripley facility.

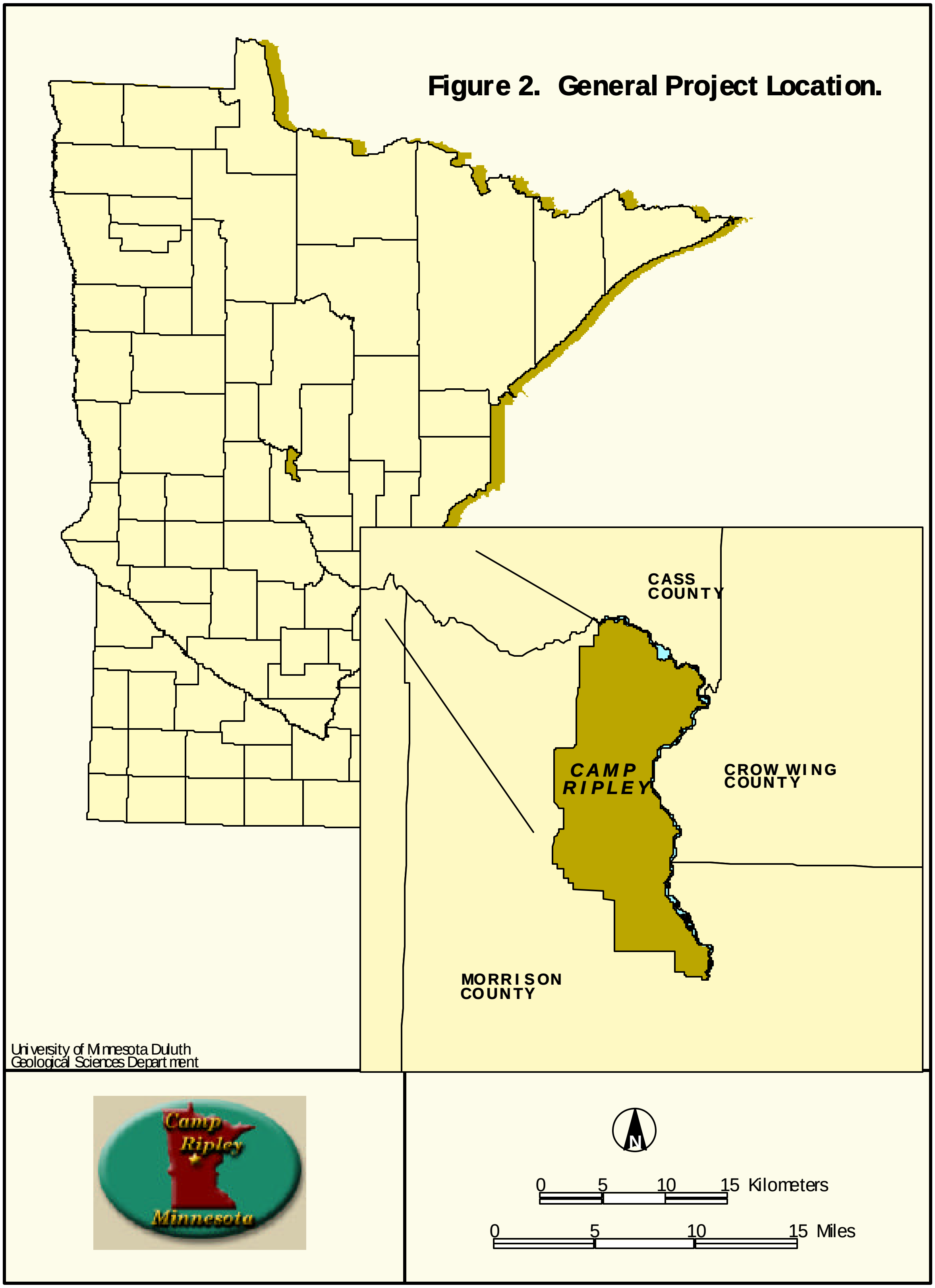


Figure 2. General Project Location.

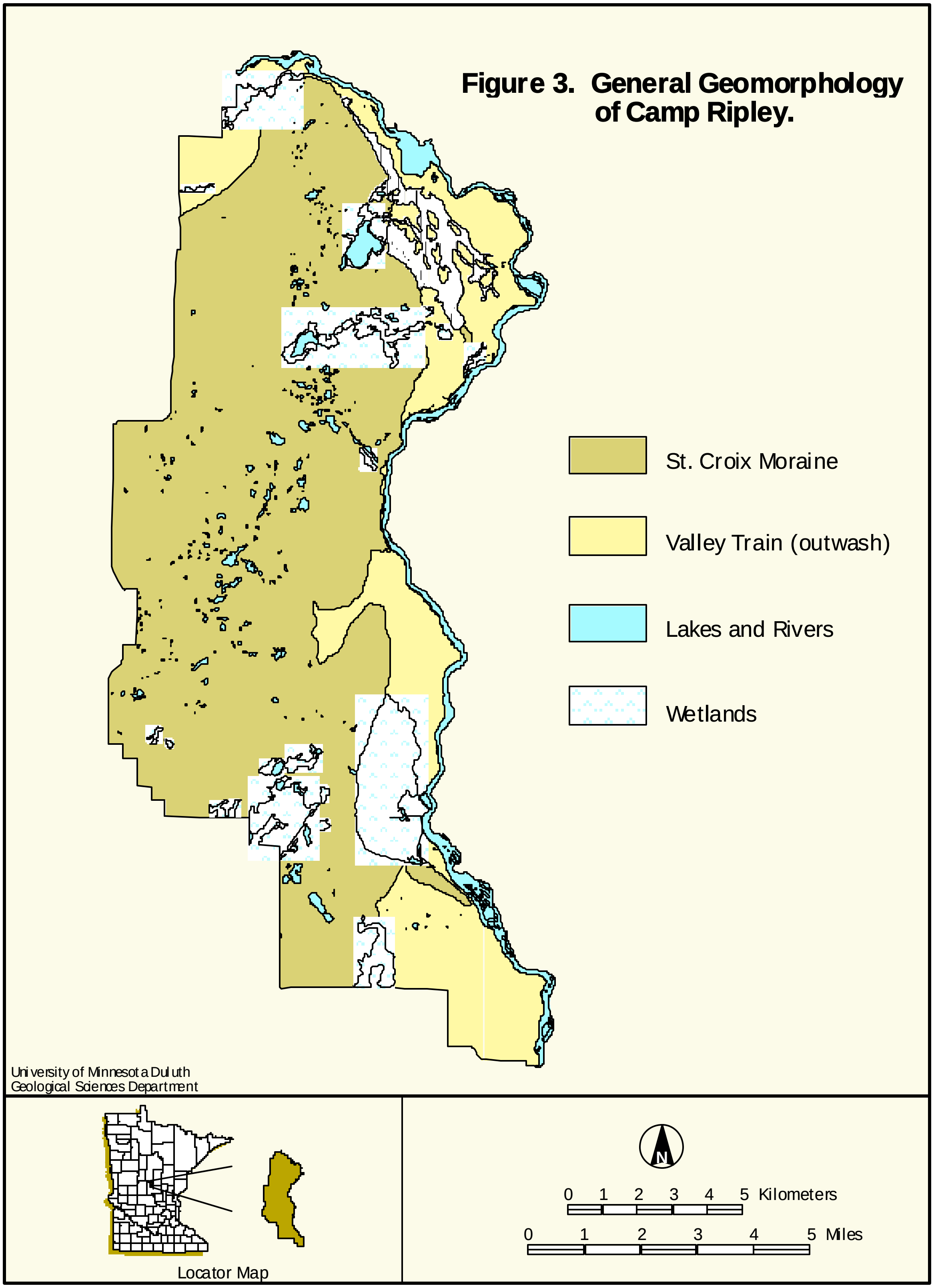


Figure 3. General Geomorphology of Camp Ripley.

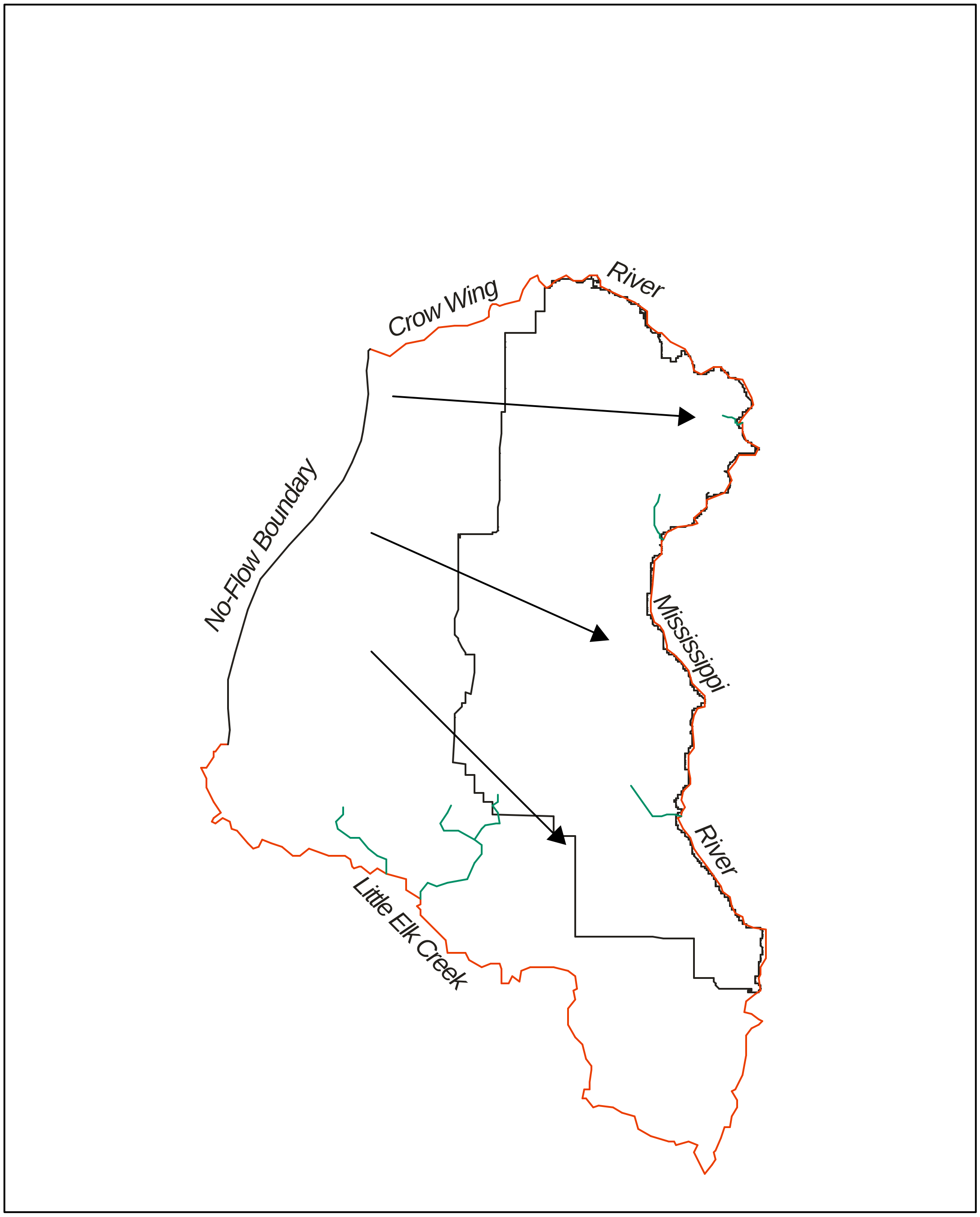


Figure 4. Regional Ground Water Flow System at Camp Ripley.

3.0 TECHNICAL APPROACH

3.1.1 LITERATURE REVIEW

The initial stage in developing the Camp Ripley APPL consisted of conducting a comprehensive literature review to obtain data regarding the physical setting and geologic history of the project area, and to assist in the evaluation and selection of a method for determining ground water pollution potential. Sources of data consulted for the project included publications produced by federal and state agencies including the United States Environmental Protection Agency [USEPA], the United States Department of Agriculture – Soil Conservation Service [USDA-SCS], and the Minnesota Department of Natural Resources [MNDNR]. In addition, technical journals focusing on water resource issues, graduate dissertations and theses produced from geologic studies conducted in Minnesota, and published technical reports produced by local government agencies were consulted.

3.2 METHODS FOR ASSESSING AQUIFER SENSITIVITY

There are numerous methods available that are useful in assessing and modeling the potential for ground water contamination in glacial geologic environments. These methods can be grouped into two major categories based on the criteria and methodology used in evaluating ground water contamination: 1) aquifer sensitivity assessment methods, and 2) ground water vulnerability assessment methods (USEPA 1993a). The main difference between the two categories is in the factors used when considering the potential for ground water contamination. Aquifer sensitivity methods consider only hydrogeologic factors, and are classified as either hydrogeologic setting or scoring methods. In contrast, ground water vulnerability assessment methods consider not only hydrogeologic factors, but also contaminant characteristics and land management factors. However, ground water vulnerability assessment methods use process-based simulation or empirical statistical models requiring knowledge of contaminant fate and transport phenomena that are too complex to evaluate over large areas (Hamerlinck and Arneson, eds. 1998). Therefore, the majority of ground water contamination assessments conducted apply the aquifer sensitivity modeling approach utilizing existing geologic and hydrogeologic data. Additional discussion follows.

When evaluating a method for assessing the potential for ground water contamination it is important to understand the difference between “aquifer sensitivity” and “aquifer vulnerability”. For the purposes of this report aquifer sensitivity refers to the relative ease with which a contaminant released at or near the land surface can migrate to the aquifer of interest. Aquifer sensitivity is a function of the intrinsic characteristics of the hydrogeologic system including the soil surface, unsaturated (vadose) zone, and the aquifer. It is not dependent on contaminant or land use characteristics. Ground water vulnerability refers to the relative ease with which a contaminant applied at or near the land surface can migrate to the aquifer of interest under a specific set of contaminant characteristics, land use practices, and aquifer sensitivity conditions (USEPA 1993a, 1993b).

There need not be a direct correlation between aquifer sensitivity and aquifer vulnerability. For example, an aquifer with a low sensitivity rating that is subject to high contaminant releases or intensive land use may have a high vulnerability rating. Conversely, an aquifer with a high sensitivity rating that is subject to low contaminant releases or limited land use could have a low vulnerability rating.

What is important to understand from this discussion is that aquifer protection is a function of hydrogeologic, contaminant, and land use characteristics. As such, when choosing an appropriate model for use in assessing ground water pollution potential the input data for each of these variables must be readily available and clearly defined. Typically, contaminant input data for use in ground water vulnerability models is not readily available or clearly defined. Moreover, contaminant data is more suited for use in local or point source ground water pollution analysis. Given the size of the Camp Ripley facility and characteristics of available data, UMD chose to evaluate and select an aquifer sensitivity modeling method for use in development of the APPL. A brief description of the models evaluated for use in development of the Camp Ripley APPL is presented below.

3.2.1 AQUIPRO

AQUIPRO was developed as an aquifer vulnerability ranking system for use is in evaluating ground water pollution potential for glacial aquifers in Southwest Michigan (Passero et al. 1989). In this model the authors use the term vulnerability and sensitivity interchangeably. AQUIPRO is based on the assumption that clays and clayey glacial sediment provide an overlying protective layer (confining layer) for glacial aquifers. The method uses a relative ranking system accounting for well depth, average thickness of the overlying confining layer, and confining or semi-confining bedrock layers. The results of analysis using this method are used to indicate an aquifer vulnerability/protective score for individual ground water wells.

3.2.2 DRASTIC

DRASTIC is an acronym for a relative ranking system that evaluates seven parameters defining a hydrogeologic setting: Depth to water, Recharge, Aquifer media, Soil media, Topography, Impact of vadose zone, and Conductivity (Aller et al. 1987). Each parameter is independently assigned a weight and rating value that is used to calculate an index for the parameter. The values calculated for each parameter are then summed to form a numerical index of pollution potential for an area. Typically, this analysis is carried out using a GIS approach where the input data are GRID coverage's of each of the seven parameters.

3.2.3 MINNESOTA'S GEOLOGIC SENSITIVITY

The Minnesota Ground Water Protection Act of 1989 required the Minnesota Department of Natural Resources (MNDNR) to develop criteria, map sensitive areas, and indicate the type of risk to ground water resources that may occur from activities at or near response. In response, MNDNR formed a Geologic Sensitivity Workgroup (GSW) consisting of representatives from several state agencies to develop the criteria for use in mapping sensitive areas (MNDNR 1991). The workgroup developed sensitivity criteria based on the properties of geologic materials overlying the ground water (GSW 1991). The geologic sensitivity criteria are used to compute five overlapping ranges of known or estimated travel times that have been assigned relative sensitivity ratings from Very High to Very Low.

The guidelines for completing sensitivity assessments represent a qualitative approach to assessment of geologic sensitivity of ground water resources and are designed to use data that are already or reasonably obtainable (GSW 1991). The workgroup developed a three level approach to conducting a sensitivity assessment depending on the intended application of the model. A Level 1 assessment estimates the sensitivity of the water table using surface and near surface information. A Level 2 assessment estimates the sensitivity of the water table aquifer using information from the entire vadose zone. A Level 3 assessment evaluates the sensitivity of deep, confined aquifers.

3.2.4 SEEPAGE

SEEPAGE - A System of for Early Evaluation of Pollution Potential of Agricultural Ground Water Environments - was developed the United States Department of Agriculture, Soil Conservation Service (USDA-SCS) (Moore 1988). This method uses a relative ranking system for seven soil/aquifer parameters to calculate Site Index Numbers (SINs). The SINs results calculated for different areas are compared to determine the relative degree of aquifer sensitivity. The method is similar to the DRASTIC approach, but was designed specifically for agricultural environments and places more emphasis on the characteristics of surface soils.

3.2.5 WISCONSIN'S SOIL ATTENUATION POTENTIAL

The University of Wisconsin – Extension developed a classification system to characterize the attenuation potential of Wisconsin soils to surface applied pesticides (Cates and Madison 1990). The method attributes the capacity of soils to attenuate the migration of pollutants from the surface into ground water using seven physical and chemical properties: texture and pH of the surface (A) horizon, texture and permeability of the subsoil (B) horizon, organic matter content, depth of soil solum (combined A & B horizons), and soil drainage class. Variables are assigned a weighted value and then summed to calculate attenuation potential classes ranging from least to best.

3.3 MODEL SELECTION

The criteria used to select a method to evaluate the potential for ground water contamination and development of an APPL for Camp Ripley is based on the objectives and requirements outlined in the CWMP. As such, the model selected for use is based on both administrative and technical criteria. From an administrative standpoint UMD considered the management objectives and goals of the overall project, resources available for preparation of the APPL, and integration of the APPL with other models and datasets currently in development for the CWMP.

From a technical standpoint there are several factors that are important in selecting an assessment method. The validity and applicability of the model are essential in selecting an appropriate assessment method. Therefore, the availability and complexity of existing datasets used for input to the model are considered imperative in selecting a valid modeling method. The size of Camp Ripley and suitability of the method to the local hydrogeologic characteristics was considered because the physical setting, in part, determines the applicability of the model to the project area. Furthermore, the understandability of the model and intended application of the output data by end users was taken into account.

Based on the preceding review of methods and discussion UMD chose to select the DRASTIC aquifer sensitivity modeling method for development of the Camp Ripley APPL. The DRASTIC model provides a GIS based approach assessment method that most closely meets the criteria discussed above, and allows for the ease and flexibility in updating the model should new data become available.

3.4 OVERVIEW OF DRASTIC MODEL

DRASTIC is a standardized methodology used to evaluate the potential for ground water pollution potential in hydrogeologic settings (Aller et al. 1987). The method was developed by a panel of managers, scientists, and private consultants with expertise in the evaluation of ground water systems. The panel included individuals representing federal, state, and local agencies, the Canadian government, and private industry. Through a series of discussions, technical applications, and scientific reviews the panel developed what has become one of the most commonly used methods to evaluate ground water pollution potential in the United States (USEPA 1995).

The DRASTIC method was developed within the framework of the existing classification system of ground water regions of the United States. Using this classification system it is possible to subdivide each ground water region into hydrogeologic settings based on locally specific ground water characteristics. A hydrogeologic setting is defined as a composite description of the major geologic and hydrologic factors which affect and control ground water movement into, through, and out of an area (Aller et al. 1987). The DRASTIC method is based on the concept of hydrogeologic settings and is the acronym describing seven mappable parameters controlling the ground water pollution potential of a specific hydrogeologic setting. The seven parameters include: 1) Depth to ground water, 2) Recharge (Net), 3) Aquifer Media, 4) Soil Media, 5) Topography (slope), 6) Impact of the Vadose Zone Media, and 7) Conductivity (Hydraulic) of the Aquifer. While these parameters do not include the infinite number of variables that can be used to describe the physical characteristics of a hydrogeologic setting they are considered the most important parameters for which data are available, and for assessing the ground water pollution potential of an area.

DRASTIC uses a numerical ranking system to assign a relative index of aquifer sensitivity (IAS) based on the following equation (Aller et al. 1987):

$$IAS = D_w{*}D_r + R_w{*}R_r + A_w{*}A_r + S_w{*}S_r + T_w{*}T_r + I_w{*}I_r + C_w{*}C_r \qquad (3.1)$$

where w and r are weights and ratings assigned to each parameter.

The weights assigned to each parameter are constant, ranging from 1 to 5, and based on the relative importance in evaluating ground water pollution potential as determined by the panel through a consensus approach (Table 1). In essence, the more important a variable is considered to be in evaluating ground water pollution potential the higher its weight will be.

Table 1. Weights assigned to DRASTIC parameters.

DRASTIC Parameter	Weight (relative importance)
Depth to ground water	5
Recharge (net)	4
Aquifer Media	3
Soil Media	2
Topography	1
Impact of vadose zone media	5
Conductivity	3

Numerical rating values for each of the parameters vary from 1 to 10, and are assigned using a range of values obtained by defining the physical characteristics of each parameter within the hydrogeologic setting. The range of values represents data derived through either consulting existing sources of hydrogeologic information, or through conducting field sampling programs. Rating values for D, R, S, T, and C are assigned one value per range, whereas rating values for A and I are assigned a typical rating selected from a set of variable ratings. However, the ratings for each parameter can be adjusted based on specific knowledge of the hydrogeologic setting in question tempered by sound professional judgment.

A brief description of the DRASTIC parameters including tables providing the ranges used for assigning a rating value is presented below. More detailed discussions of each of the parameters used in the Camp Ripley model are presented in the following section.

3.4.1 DEPTH TO WATER

An aquifer is a geologic unit that can store and transmit water at rates fast enough to supply reasonable amounts to wells (Fetter 1994). In simpler terms, an aquifer represents a geologic unit in which all the pore spaces are completed filled (saturated) with water. Ground water within an aquifer occurs in confined, unconfined, or semi-confined conditions. Therefore, one must take care when selecting a value for depth to water based on the characteristics of the aquifer.

In a confined aquifer ground water is generally under pressure; therefore, the elevation of ground water observed in a well can be higher than the elevation of the water table beneath the confining layer. In this case, depth to water is should be measured at the top of the aquifer, which also corresponds to the base of the confining layer. Depth to water in a confined aquifer can be obtained by consulting geologic reports containing maps, cross sections, or well logs.

In an unconfined aquifer the water table represents the expression of the surface below ground level where the pores spaces are completed saturated. In this case, the water table is able to rise and fall under atmospheric pressure. An unconfined aquifer can be present in any type of geologic media and may be seasonal or permanent in nature. However, for the purposes of DRASTIC an unconfined aquifer is chosen as the depth to water table in a geologic unit that yields significant enough quantities of water to be considered an aquifer.

A semi-confined aquifer refers to aquifers that are overlain by a less permeable unit that restricts or retards the flow into or out of the aquifer. Semi-confined aquifers exhibit characteristics ranging from confined to unconfined; therefore, the choice of depth to water is determined by evaluating which characteristic of the aquifer is most dominant and then follow the procedures outlined above.

DRASTIC was designed for the evaluation of unconfined aquifers. The ranges and ratings for depth to water are based on what are considered to be depths where the potential for ground water contamination significantly changes (Table 2). In cases where the depth to ground water is shallow the travel time for a contaminant released at the surface is shorter than ground water occurring at deeper levels. Moreover, the potential for attenuation of a contaminant increases as depth to water increases. These criteria are reflected in the assignment of ratings for the depth to water parameter.

Table 2. DRASTIC Ranges and Ratings for Depth to Ground Water.

DEPTH TO WATER (FEET)	
Range	**Rating**
0-5	10
6-15	9
16-30	7
31-50	5
51-75	3
76-100	2
100+	1

3.4.2 RECHARGE

The primary source of ground water recharge is precipitation that infiltrates through the land surface and percolates into the aquifer. The amount of water that recharges an unconfined aquifer is dependent upon three major factors: 1) the amount of precipitation not lost to evapotranspiration, 2) the vertical hydraulic conductivity of surficial deposits and stratigraphy of the unsaturated zone, and 3) the transmissivity of the aquifer and potentiometric gradient of ground water flow (Fetter 1994:512). In a confined aquifer recharge occurs in areas where the confining layer is absent or a leaky confining layer is present. Recharge may occur through down-flow from a higher aquifer, or through up-flow from a lower aquifer.

In the DRASTIC model, net recharge is defined as the average annual amount of water that penetrates the ground surface and infiltrates to reach the aquifer. However, it is a difficult parameter to measure and any quantification of aquifer recharge must be considered an estimate and not an exact measured value (Korkmaz 1990). As such, the ranges and ratings used in DRASTIC provide some leeway for choosing values that are representative of the recharge for a given study area (Table 3).

The amount of recharge for a given area determines the amount of water available to transport a contaminant introduced at the surface vertically to the water table and horizontally within the aquifer. Moreover, the dispersion and dilution of a contaminant in the unsaturated zone is largely controlled by this parameter.

Table 3. DRASTIC Ranges and Ratings for Recharge (Net).

NET RECHARGE (INCHES/YR)	
Range	**Rating**
0-2	1
3-4	3
4-7	6
8-10	8
10+	9

3.4.3 AQUIFER MEDIA

Aquifer media refers to the consolidated or unconsolidated geologic material that yields sufficient quantities of water for use. Water is contained in aquifers within the pore spaces of clastic sediment and rock and in fractures or solution cavities within non-clastic rocks. Aquifers that yield water from pores spaces have primary porosity, whereas aquifers that yield water from fractures or solution cavities have secondary porosity.

The characteristics of ground water flow in an aquifer are controlled to a great degree by the porosity of the aquifer media. Porosity is defined as the ratio of the volume of void spaces in a geologic unit to the total volume of the geologic unit. Clastic sedimentary geologic units generally have primary porosity that is influenced by grain size, shape, and sorting all of the clastic materials and this contributes to the arrangement or packing of grains within the unit. Packing is important because it largely determines the amount of void spaces available for water storage. In general, sedimentary units that are poorly sorted typically contain a wide range of grain sizes and have lower porosities compared to sedimentary units that are well sorted and contain a small range of grain sizes. Non-clastic rocks generally have secondary porosity and water is stored in and transmitted through fractures and solution cavities within the aquifer.

In DRASTIC the ranges of aquifer media types are given as descriptive names with rating values listed in order of increasing pollution potential (Table 4). The relative pollution potential of each media type is based on information obtained from observations made from studies conducted in various hydrogeologic settings. The method allows for flexibility in selected a rating value based on professional expertise or specialized knowledge of the aquifer media present within a given study area.

Table 4. DRASTIC Ranges and Ratings for Aquifer Media.

AQUIFER MEDIA		
Range	**Rating**	**Typical Rating**
Massive Shale	1-3	2
Crystalline Rock	2-5	3
Weathered Crystalline Rock	3-5	4
Glacial Till	4-6	5
Bedded Sedimentary Rock Sequences	5-9	6
Massive Sandstone	4-9	6
Massive Limestone	4-9	6
Sand and Gravel	4-9	8
Basalt	2-10	9
Karst Limestone	9-10	9

3.4.4 SOIL MEDIA

Soil media refers to the uppermost weathered zone of the earth which typically extends from the land surface to an average depth of 60 inches. Soil formation is a complex process where the interaction and influence of climate, organisms, and topographic factors acting on the soil parent materials over time result in the development of a soil profile. The soil profile contains a number of diagnostic surface and subsurface horizons that are classified on the basis of quantifiable physical and chemical criteria. The genetic horizons potentially developed within a soil profile are typically arranged in the following sequence the O, A, E, B, C and R horizons (Buol et al. 1997). There are a number of other potential arrangements and combinations of soil horizons; however, for the purposes of this project only the aforementioned horizons will be discussed.

The O horizon is a generally associated with organic soils and is characterized as a soil layer dominated by organic materials formed or deposited on either an organic or mineral surface. The A, E, B, C, and R horizons are associated with mineral soils.

The surface A horizon is a soil layer formed at the surface or below an O horizon. It is characterized by the accumulation of organic matter derived from the decay of plant and animal tissue, and various humic compounds. Surface A horizons vary in thickness depending on the factors involved is soil genesis, but are generally thicker where grasses dominate.

An E (elluvial) horizon is a subsurface soil layer formed below the A horizon that is characterized by the elluviation or loss of clay, iron, aluminum and other compounds resulting in a concentration of quartz or other weathering resistant minerals in silt or sand size particles.

The B (illuvial) horizon is a subsurface layer formed below the A and E horizons in which the dominant features are characterized by one or more of the following: 1) illuvial concentration of silicate clay, iron, aluminum, and other compounds alone or in combination, 2) evidence of removal of carbonates, 3) coatings on the faces of peds, 4) alteration of material from its original condition that obliterates the original rock structure, or 5) any combination of these.

The C horizon is a subsurface layer that shows little evidence of alteration by soil forming processes and lack the properties of the O, A, E, and B horizons. The C horizon represents the parent material for soil formation that may or may not be similar to the material in which the other horizons are formed. The R horizon is a layer consisting of consolidated or incompletely weathered bedrock material.

Soils, when present, offer the first line of defense in the protection of an aquifer from contamination. The soil has a significant impact on the timing and amount of water that infiltrates into the ground surface and is available for percolation to recharge the aquifer. Moreover, the amount of organic matter present in the soil has a profound influence on the adsorption and complexation of contaminants released at or near the surface. In DRASTIC the ranges of soil media are based on the soil textural classification chart and given ratings based primarily on grain size (Table 5). In general, finer grained soils (e.g. clays, silts) have a low rating due to their ability to attenuate or slow the migration of contaminates as compared to coarse grained soils (e.g., sands, gravels).

Table 5. DRASTIC Ranges and Ratings for Soil Media.

SOIL MEDIA	
Range	**Rating**
Thin or Absent	10
Gravel	10
Sand	9
Peat	8
Shrinking/aggregated Clay	7
Sandy loam	6
Loam	5
Silt Loam	4
Clay loam	3
Muck	2
Non-shrinking/aggregated Clay	1

3.4.5 TOPOGRAPHY (SLOPE)

Topography refers to general configuration of the land surface including its relief and the position of naturally occurring and cultural features. In the DRASTIC model, topography refers to the percent slope of the land surface and its variability throughout a hydrogeologic setting. Topography largely controls the potential for a contaminant to runoff or remain on the land surface long enough to allow infiltration into the subsurface to occur.

Methods used to calculate percent slopes vary depending on the source consulted for making a determination. Slope can be calculated from topographic maps by measuring the change in elevation over a distance and converting to a percent, consulting published detailed soil survey maps, or using a combination of these two methods. However, in most cases digital elevation models (DEM) of much of the United State are available allowing the user to calculate percent and assign a range of values using GIS technology.

The ranges for topography in the DRASTIC model correspond to the typical ranges identified by the Soil Conservation for percent slope. Flat lying or gently sloping surfaces have low runoff capacity and are typically associated with higher pollution potential. In contrast, steeply sloping surfaces have high runoff capacity and are associated with low pollution potential. This is reflected in the ratings assign for use in each slope range category (Table 6).

Table 6. DRASTIC Ranges and Ratings for Topography.

TOPOGRAPHY (PERCENT SLOPE)	
Range	**Rating**
0-2	10
3-6	9
7-12	5
13-18	3
18+	1

3.4.6 IMPACT OF VADOSE ZONE

The vadose (unsaturated) zone is defined as the zone between the land surface and the water table where the pore spaces are partially or discontinuously saturated with water. The pore spaces within the vadose contain water at less than atmospheric pressure as well as air and other gases. The geologic media that constitute the vadose zone determine the potential for contamination attenuation between the base of the soil media and top of the aquifer. Complex physiochemical processes including biodegradation, neutralization, filtration, volatilization, and dispersion of infiltrated fluids occurs within the vadose zone. Furthermore, the geologic media constrains the migration of fluids through the vadose zone thereby controlling the amount of surface area the fluid is in contact with and the amount of time for available for attenuation.

The selection of vadose zone media is dependent upon whether the aquifer is confined or unconfined. In the case of a confined aquifer the impact of the vadose zone is characterized as having a confining layer regardless of what other geologic media types are present between the soil and top of the aquifer. In the case of an unconfined aquifer the most significant geologic media that influences pollution potential is selected.

In DRASTIC the ranges of impact of vadose zone media are given as descriptive names with rating values listed in order of increasing pollution potential (Table 7). The relative pollution potential of each media type is based on information obtained from observations made from studies conducted in various hydrogeologic studies. The method allows for flexibility in selected a rating value based on professional expertise or specialized knowledge of the vadose zone media present within a given study area.

Table 7. DRASTIC Ranges and Ratings for Impact of Vadose Zone Media.

IMPACT OF VADOSE ZONE MEDIA		
Range	**Rating**	**Typical Rating**
Confining Layer	1	1
Silt/Clay	2-6	3
Shale	2-5	3
Massive Limestone	2-7	6
Massive Sandstone	4-8	6
Bedded Sedimentary Rock Sequences	4-8	6
Sand and Gravel with significant Silt and Clay	4-8	6
Crystalline Rock	2-8	4
Clean Sand and Gravel	6-9	8
Basalt	2-10	9
Karst Limestone	8-10	10

3.4.7 CONDUCTIVITY (HYDRAULIC)

Hydraulic conductivity, or the coefficient of permeability, refers to the ability of an aquifer to transmit water, which in turn largely controls the rate at which ground water and any contaminant contained within the aquifer will flow under a given hydraulic gradient. Hydraulic conductivity is dependent upon the sedimentary characteristics of the aquifer media; thereby, it is a function of the grain size, shape, sorting and packing of the aquifer materials and properties of the fluid passing through the aquifer.

There are a number of methods available to determine the hydraulic conductivity of an aquifer. Values can be obtained by conducting aquifer pumping tests, consulting published hydrogeologic reports, or estimating based on the properties of the sedimentary characteristics of an aquifer (Freeze and Cherry 1979). When possible, hydraulic conductivity values for an aquifer are obtained by conducting laboratory analysis of samples collected from drilling. Four of the most common methods used to determine hydraulic conductivity based on sediment type include: 1) Hazen (1893), 2) Krumbein and Monk (1942), 3) Harleman et al. (1963), and 4) Puckett et al. (1985). Each method was designed for various applications under differing aquifer conditions; however, all are empirical methods used to estimate hydraulic conductivity based on grain size distribution of the aquifer materials. The selection of a specific method to estimate hydraulic conductivity is dependent on the purposes of the analysis; therefore, some level of professional judgment should be exercised when assigning a value.

The ranges and ratings for hydraulic conductivity used in the DRASTIC model represent values where the potential for ground water contamination is considered to significantly change (Table 8). However, the method allows for flexibility in selecting a range and rating value based on professional expertise or specialized knowledge of the ground water flow system.

Table 8. DRASTIC Ranges and Ratings for Conductivity.

CONDUCTIVITY (HYDRAULIC GPD/FT2)	
Range	**Rating**
1-100	1
100-300	2
300-700	4
700-1000	6
1000-2000	8
2000+	10

3.4.8 RELATIONSHIP OF DRASTIC PARAMETERS

Based on the preceding discussion it is apparent that the parameters used in the DRASTIC model are somewhat co-dependent and a function of the hydrogeologic setting of the ground water system. However, each of the parameters must be considered when evaluating the potential for ground water contamination. The model is based on real-world conditions that are observable in the field for a given hydrogeologic setting. Lack of presence of one or more of the parameters can dramatically alter the processes of contaminant attenuation and migration into the aquifer. Data for characterizing each of the DRASTIC parameters needs to be readily available or reasonable obtainable for the model to be valid. In the case of current study area the requisite data sources are available and more than adequately characterized; therefore, application of the DRASTIC model is considered valid for development of the Camp Ripley APPL.

4.0 MODELING METHODS

4.1 CONCEPTUAL MODEL

The second stage in development of the Camp Ripley APPL consisted of developing a conceptual model of ground water contamination potential using information obtained through literature review, and information compiled during Phases IA, I, and II of the CWMP. The conceptual model consisted of review and interpretation of topographic maps, aerial photographs, soils survey information, and drilling data to assign a relative sensitivity ranking of low, moderate, high or very high taking into consideration the following factors: 1) geomorphology, 2) sediment type, and 3) depth to ground water.

The relative sensitivity rankings were then assigned to the detailed geomorphology coverage of the Camp Ripley facility to derive a conceptual model of ground water sensitivity (Table 9: Figure 5). From this analysis the following observations regarding the spatial variation in ground water sensitivity can be made. In general, relatively flat areas that are shallow to ground water and underlain by coarse grained deposits are considered to be highly sensitive to ground water contamination. In these geomorphologic settings there is low runoff potential allowing for precipitation that falls on the surface to infiltrate the soil surface and carry fluids downward through the vadose zone into the shallow aquifer. The high sensitivity areas roughly correspond to the level areas bordering the Crow Wing and Mississippi rivers, the southern and southeastern margins of the Camp Ripley including the cantonment area, and on the southwestern boundary of the facility.

Table 9: Conceptual Model of Ground Water Sensitivity at Camp Ripley.

Camp Ripley Ground Water Sensitivity		
Geomorphic Unit	**Topography, sediment, depth to water**	**Sensitivity**
GLP	Level, coarse grained outwash, shallow	Very high
GLPo	Level, coarse grained outwash, shallow	Very high
HLA	Level, mixed alluvium, shallow	Very high
GRSo	Rolling, coarse grained outwash, moderate	High
GRPof	Rolling, coarse grained outwash, moderate	High
HLP	Level, mixed organics, shallow	High
GLS	Level, glacial till, deep	Moderate
GLSla	Level, lacustrine, deep	Moderate
GRS	Rolling, glacial till, deep	Moderate
GRSch	Rolling, glacial till, deep	Moderate
GRSd	Rolling, glacial till, deep	Moderate
GSCa	Steep, mixed colluvium, moderate	Moderate
GHS	Hummocky, glacial till, very deep	Low
GHSe	Hummocky, sorted gravel, very deep	Low
GHSi	Hummocky, ice contact, very deep	Low
GHSl	Hummocky, lacustrine, very deep	Low
GSS	Steep, glacial till, very deep	Low
GSSe	Steep, sorted gravel, very deep	Low

In contrast, areas considered to have low to moderate sensitivity to ground water contamination area associated with hummocky topography where depth to ground water is much deeper. These geomorphologic settings are characterized by steep slopes with high runoff potential, low infiltration rates, deep water tables, and more extensive vadose zones. The low to moderate sensitivity areas roughly correspond to the rugged topography of the St. Croix moraine that runs through the much of the center of Camp Ripley.

The conceptual model of ground water contamination potential developed for Camp Ripley is based on procedures and data commonly used in making such determinations. While the results of the model are only a relative analysis, they do provide general guidance and reliable information for development of more rigorous models. Furthermore, development of the conceptual model can be used to assist in evaluating the validity of results produced from other models. This approach was taken during the course of building the Camp Ripley APPL for the purposes of quality assurance and quality control.

4.2 GIS DATA DEVELOPMENT

One of the main objectives of the Camp Ripley APPL is to utilize and integrate data collected during the initial phases of the CWMP for use in the analysis and development of a GIS based model of aquifer sensitivity. A GIS based model provides a management tool that can be used to provide facilities management staff with information regarding the impact of proposed training activities on ground water resources, assist in the development of management tools for proposed training activities, and provide a dynamic interactive data visualization tool for assessing environmental impact and response. In order to accomplish these objectives requisite data sets for input to the DRASTIC model were developed from existing data sources and used to build a GIS model of aquifer sensitivity at Camp Ripley.

4.3 DESCRIPTION OF INPUT DATA

Seven GIS grid coverage's representing the DRASTIC parameters were developed and used to conduct a raster based analysis of aquifer sensitivity for the main Camp Ripley facility. The grid cell size resolution chosen for the analysis was set to 100m. The 100m cell size was considered the best resolution given the spatial characteristics of the existing data and the size of the project area. The existing input data sets were compiled at a cell size resolution ranging from a 30m to 200m. At 100m the input data is somewhat generalized, but the amount of data generalization is considered negligible for the modeling purposes. Moreover, when modeling an area the size of Camp Ripley a 100m cell is appropriate for analysis purposes.

In some instances the values determined for the Camp Ripley datasets did not have a direct correlation to the DRASTIC model. For example, the aquifer media present at the facility is dominated by lacustrine sand. DRASTIC does not list lacustrine sand as a choice to provide a rating value under the aquifer media category. Therefore, some level of professional judgment had to be exercised in order to assign a rating value for the aquifer media coverage. In this case, the closest match to lacustrine sand was sandstone. The typical rating for sandstone is 6, but because the lacustrine sand at Camp Ripley is not lithified (i.e., rock) the author chose to select a conservative rating value of 7 in this particular instance. Similar decisions were made throughout assignment of the DRASTIC ratings to the coverage's and in each instance the chosen rating values were taken to err on the side of caution.

4.3.1 CAMP RIPLEY DEPTH TO WATER

A depth-to-water coverage of the Camp Ripley facility was developed using information from a number of data sources. These included estimates of water tables elevations outside of the facility as interpreted from topographic maps, stream discharge data derived from USGS gauging stations along the Crow Wing and Mississippi rivers, water levels observed in monitoring wells throughout Camp

Ripley and surrounding area, and water elevations determined from the Environmental Drilling Program [EnDriP]. Using a Kriging algorithm the water table elevations in the Camp Ripley region were calculated and compiled into a point coverage initially spaced at 200m. The point coverage was then converted to a 200m grid of water table elevations that was clipped to the boundary of the Camp Ripley facility. The Camp Ripley depth-to-water grid was then resampled to 100m and cell values reclassified as integers. The resulting grid was used for assigning DRASTIC weight and rating factors and calculation of the depth to water parameter (Figure 6).

Depth to water at Camp Ripley ranges from zero feet along the northern and eastern boundaries of the facility to a depth of 288 feet within the central morainic area. The calculated values for depth to water using DRASTIC range from a low of 5 to a high of 50 (Table 1: Appendix A). These values are reflective of the variability of the hydrogeologic setting and overall characteristics of ground water flow at Camp Ripley.

4.3.2 CAMP RIPLEY RECHARGE

A recharge coverage of the Camp Ripley facility was developed using a landform-based approach to estimation of ground water recharge (St. George 1994). As discussed earlier it is a difficult parameter to measure for a number of reasons and any quantification of recharge must be considered an estimate. Regardless, recharge values for the Camp Ripley facility are based on regional geomorphologic characteristics of central Minnesota. A digital polygon geomorphology coverage of Morrison County compiled at a scale of 1:100,000 by UMD was used to estimate recharge. Landforms present within the geomorphology coverage were compared to those mapped by St. George (1994), and assigned recharge values using the same procedures. The polygon coverage was then converted to grid coverage containing estimated recharge values for Morrison County at a spacing of 200m. The recharge grid was then clipped to the boundary of Camp Ripley, resampled to 100m, and cell values reclassified as integers. The resulting grid was used for assigning DRASTIC weight and rating factors and calculation of the recharge parameter (Figure 7).

Recharge at Camp Ripley ranges from zero inches through much of the central morainic portion of the Camp Ripley to eight inches along the northern and eastern boundaries of the facility. The calculated values for recharge using DRASTIC range from a low of four to a high of 32 (Table 2: Appendix A). These values are reflective of the overall variability of the geomorphology of the region and characteristics of the vadose zone at Camp Ripley.

4.3.3 CAMP RIPLEY AQUIFER MEDIA

An aquifer media coverage of the Camp Ripley facility was developed using data derived primarily from EnDriP. The EnDriP data collected for this project proved invaluable for interpreting the subsurface geology of Camp Ripley and geologic history of the region. Prior to collecting drilling samples there was little information regarding the sedimentological and stratigraphy or heterogeneity of the aquifer system. Subsurface data from boreholes both within Camp Ripley and off-base provide information on the near-surface material associated with the vadose zone, and the deeper material of the saturated zone. However, in most portions of the site, the boreholes are widely spaced, and the types and arrangement of hydrogeologic units in between them are uncertain.

The data collected provided information about the physical characteristics of the units that was modeled to determine a statistical best estimate of both the near-surface vadose material and the uppermost aquifer. The approach taken was a transition probability geostatistical analysis – TPROGS (Carle 1999), in which multiple equally probable realizations of the subsurface were simulated. The geologic units were assigned to five categories, based on both depositional setting and permeability. These numbered categories were used as model input. Following analysis and simulation of the subsurface, the value of the mode of each model cell was determined to provide a best estimate of the spatial distribution of the five units.

The five categories of aquifer media determined from the TPROGS simulations include: 1) outwash, 2) lacustrine sand, 3) lacustrine silt, 4) lacustrine clay, and 5) glacial till. The aquifer media types of Camp Ripley region was compiled into a point coverage initially spaced at 200m. The point coverage was then converted to a 200m grid of aquifer media that was clipped to the boundary of the Camp Ripley facility. The coverage was then resampled to 100m and cell values reclassified based on lithology. The resulting grid was used for assigning DRASTIC weight and rating factors and calculation of the aquifer media parameter (Figure 8).

Of the five aquifer media types present within the region only four are present inside the boundaries of Camp Ripley. No deposits of lacustrine clay are found within the aquifer. As a whole the aquifer media is dominated by lacustrine sand along with minor amounts of outwash, lacustrine silt, and glacial till. The calculated values of the aquifer media parameter using DRASTIC range from a low of 12 to a high of 24 (Table 3: Appendix A). These values reflect the complexity of the subsurface geology of Camp Ripley.

4.3.4 CAMP RIPLEY SOIL MEDIA

The soils coverage used in the analysis was derived from the digital soils polygon coverage provided to UMD by the Camp Ripley GIS staff in April of 2003. The digital soils coverage contains polygons representing the soil map units delineated by scientists at the Natural Resources Conservation Service. A soil map unit represents an area dominated by one or more types of soil that is identified and named according to the taxonomic classification of the dominant soil. The polygon coverage was converted to a grid with 100m cell size resolution using the soil map unit as the output value. The soil grid coverage contained 37 distinct soil map units whose descriptions are provided in the Soil Survey of Morrison County (Brug and Gorton 1994), and were used to assign a DRASTIC weight and rating in order to calculate the soil media parameter (Figure 9).

The soils present across the Camp Ripley facility are dominated by sands and loamy sands with minor amounts sandy loams, loams, and muck distributed throughout the area. The calculated values for the soil media parameter using DRASTIC range from a low of 4 to a high of 20 (Table 4: Appendix A). The lower values correspond to fine textured soils that have low infiltration rates, whereas the high values correspond to coarse textured soils with high infiltration rates. The distribution of soil types present across Camp Ripley is a function of the factors and processes involved in soil genesis (Jenny 1941, Simonson 1959). Overall the soils within the bounds of the facility are representative of the region as a whole.

4.3.5 CAMP RIPLEY TOPOGRAPHY (SLOPE)

The topography coverage of the Camp Ripley facility was derived from the existing 30m USGS digital elevation model (DEM) of Morrison County. The DEM data consist of a regular array of elevations arranged horizontally as profiles with 30 meter spacing along and between each profile. A percent slope grid for the county was derived directly from the DEM at a 30m cell size resolution, clipped to the boundary of Camp Ripley, resampled to a 100m, and reclassified as an integer grid for use in the analysis. Ranges of percent slope were then used to assign a DRASTIC weight and rating in order to calculate the topography parameter (Figure 10).

Topography characteristics of the area vary from relatively flat, to rolling, to steeply sloping. Flat slopes dominate the northern and eastern boundaries of the areas corresponding with the valley trains of the Crow Wing and Mississippi rivers, whereas the rolling to steep slopes are present within the central morainic area. The calculated values for the topography parameter range from a low of 1 to a high of 10 (Table 5: Appendix A). The topographic variations observed across the Camp Ripley facility are primarily a function of the complex geomorphology and geologic history of the area.

4.3.6 CAMP RIPLEY IMPACT OF VADOSE ZONE

The vadose zone coverage of the Camp Ripley facility was developed using data derived primarily from EnDriP using the same processing techniques as those used to derive the aquifer media coverage. However, the units representing the vadose zone media are a function of the unsaturated portion of the subsurface.

The five categories of vadose zone media determined from the TPROGS simulations include: 1) outwash, 2) lacustrine sand, 3) lacustrine silt, 4) lacustrine clay, and 5) glacial till. The vadose zone media types of the Camp Ripley region were compiled into a point coverage initially spaced at 200m. The point coverage was then converted to a 200m grid of vadose zone media that was clipped to the boundary of the Camp Ripley facility. The coverage was then resampled to 100m and cell values reclassified based on lithology. The resulting grid was used for assigning DRASTIC weight and rating factors and calculation of the impact of vadose zone parameter (Figure 11).

Of the five vadose zone media types present within the region only four are present inside the boundaries of Camp Ripley. No deposits of lacustrine clay are found within the vadose zone. Furthermore, the spatial distribution of vadose media types differs slightly from that determined for the aquifer, but as a whole the vadose zone is also dominated by lacustrine sand with minor amounts of outwash, lacustrine silt, and glacial till. The calculated values of the impact of vadose zone parameter using DRASTIC range from a low of 20 to a high of 40 (Table 6: Appendix A). As is the case with the aquifer media, the impact of vadose zone values reflects the complexity of the subsurface geology of Camp Ripley.

4.3.7 CAMP RIPLEY CONDUCTIVITY (HYDRAULIC)

A hydraulic conductivity coverage of Camp Ripley was derived using the results of grain size analysis from sediment samples taken from the four aquifer media types. The mean grain size of each unit was determined using the four common methods for calculating hydraulic conductivity (see Section 3.4.7). The results of each grain size analysis were summed and used to calculate the geometric mean of all methods. The resultant values were associated with the aquifer media types determined from the TPROGS simulation to produce the hydraulic conductivity coverage, assigned a DRASTIC rating, and calculate the hydraulic conductivity parameter (Figure 12).

The calculated values for the hydraulic conductivity parameter for use in DRASTIC range from a low of 3 to a high of 30 (Table 7: Appendix A). The lower hydraulic conductivity values are associated with the lacustrine silt and glacial till whereas the higher values are associated with the lacustrine sand and outwash.

4.4 GIS ANALYSIS

Following compilation of the requisite datasets and determination of the seven DRASTIC parameters for Camp Ripley a relative index of aquifer sensitivity (IAS) was calculated using Equation 3.1. The calculation was completed by selecting the appropriate fields, in this case the value for each parameter based on its weight and rating, and summing their values to derive an IAS. The analysis area included a 288 by 125 array of cells at a resolution of 100m.

Results of calculations within the boundaries of Camp Ripley represent cell centered IAS values at 100m spacing. Cells outside of the boundaries of Camp Ripley contain NO DATA values. A discussion of the results of the analysis, interpretation of the data, and potential applications of the model are presented in the following section. In addition, recommendations for the deployment and maintenance of the model are presented.

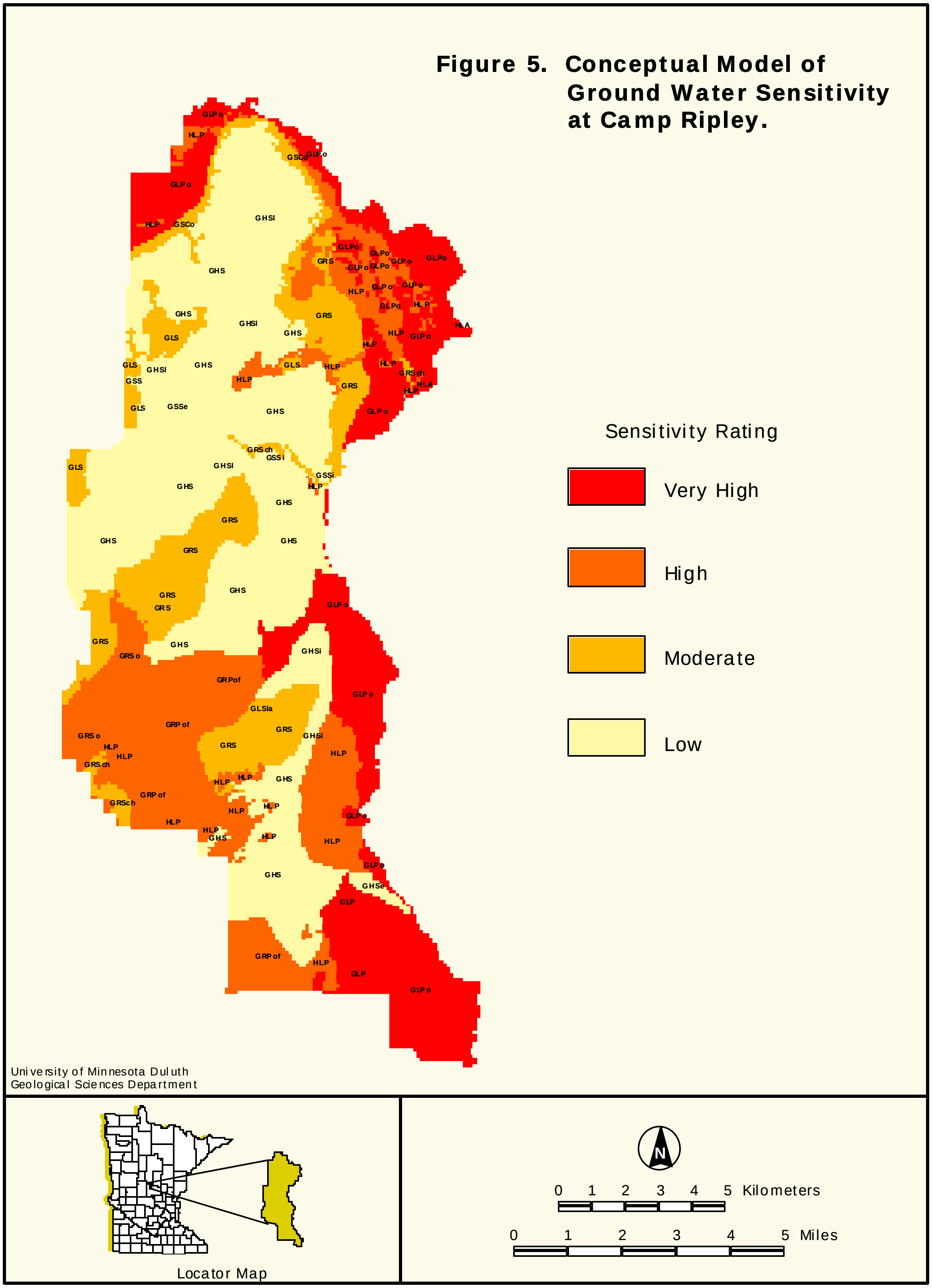


Figure 5. Conceptual Model of Ground Water Sensitivity at Camp Ripley.

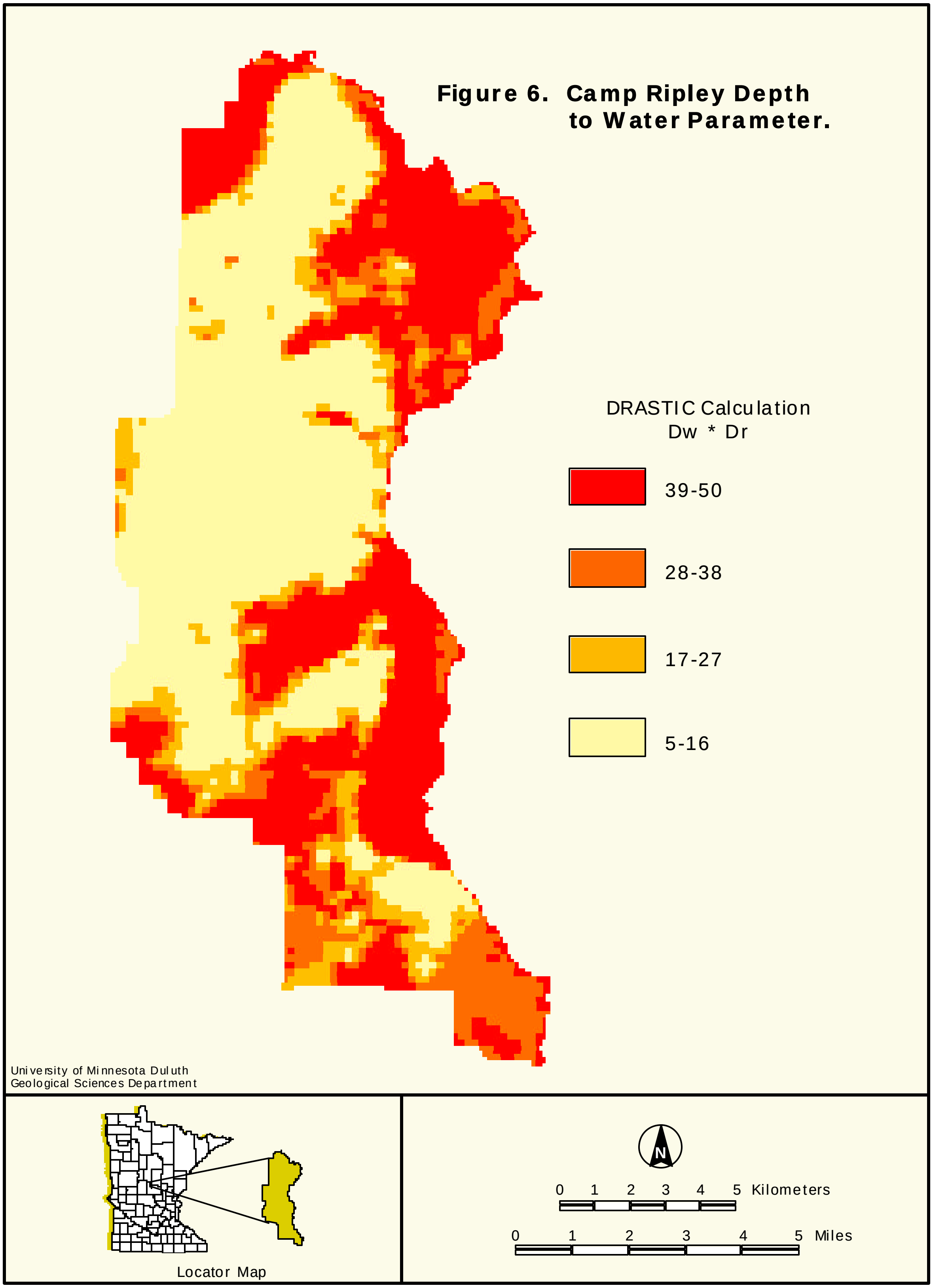


Figure 6. Camp Ripley Depth to Water Parameter.

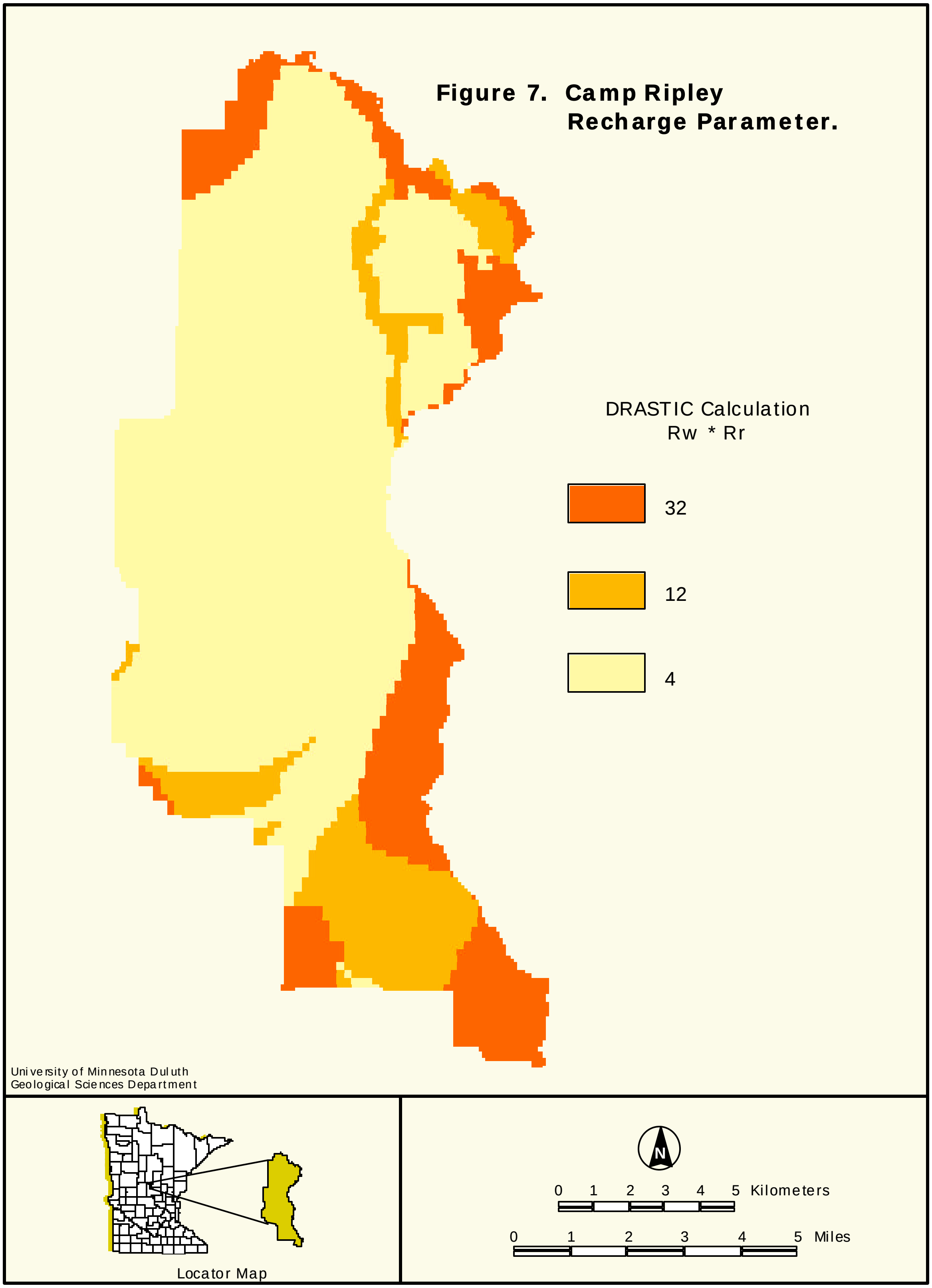


Figure 7. Camp Ripley Recharge Parameter.

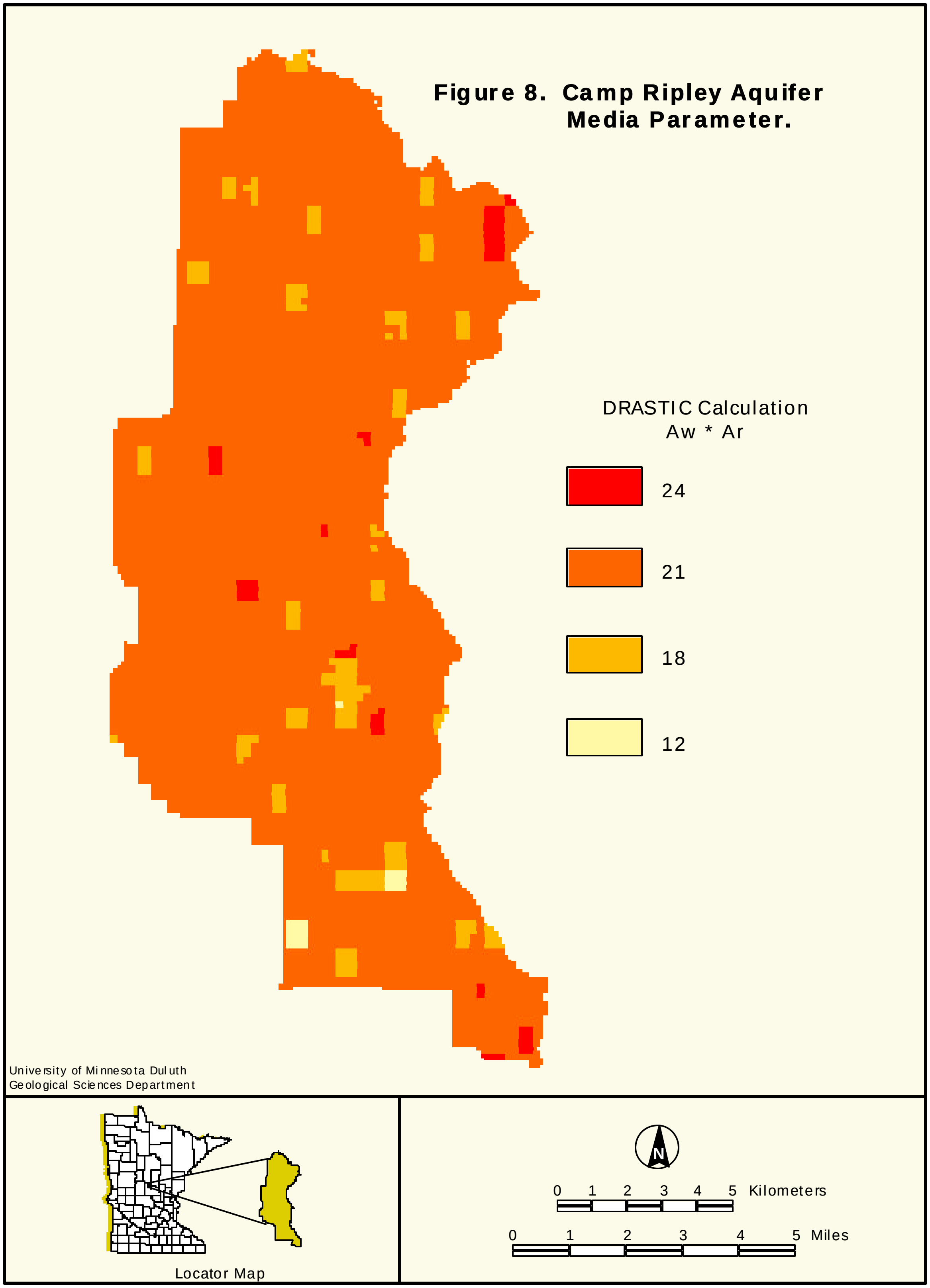


Figure 8. Camp Ripley Aquifer Media Parameter.

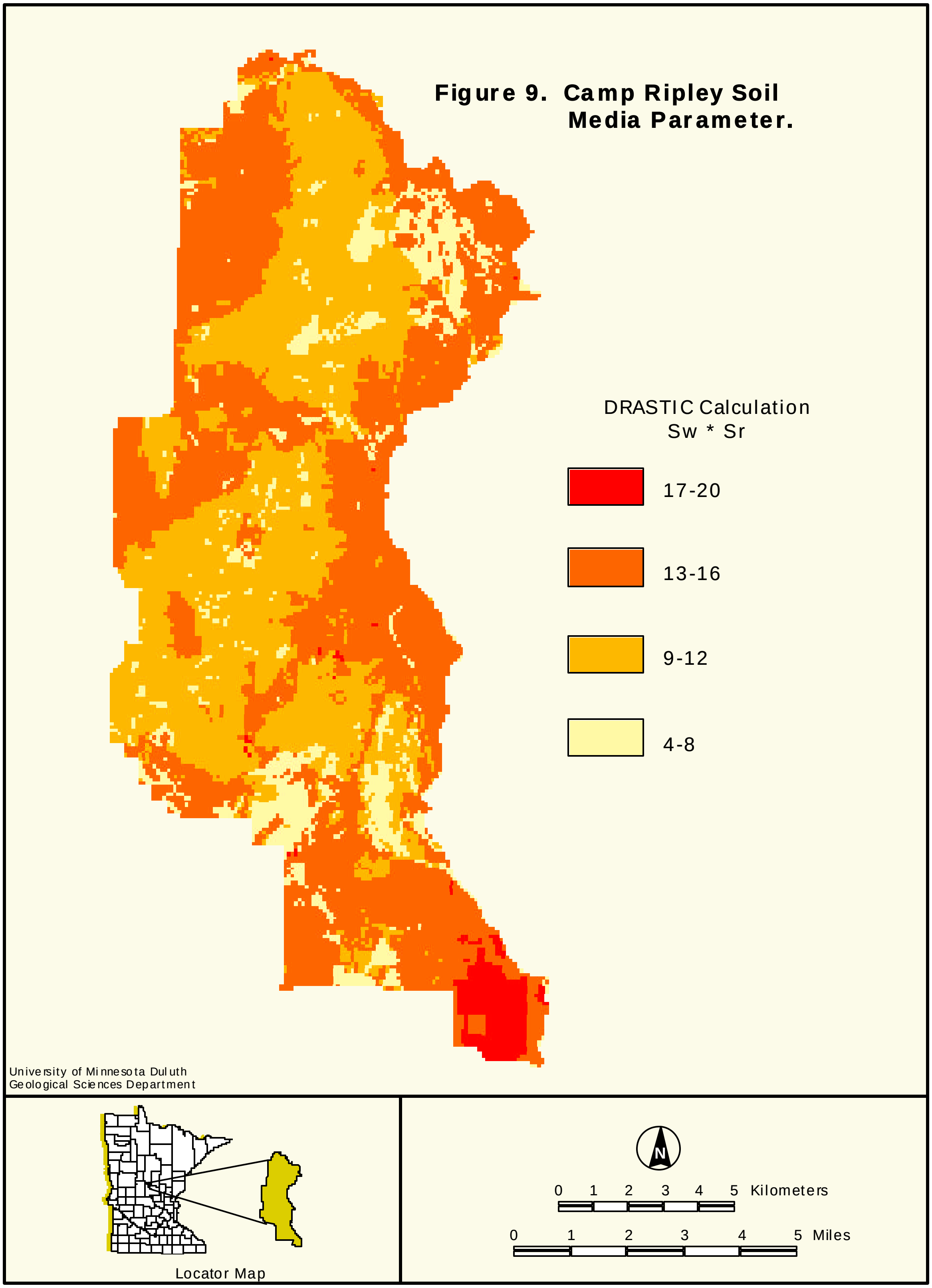


Figure 9. Camp Ripley Soil Media Parameter.

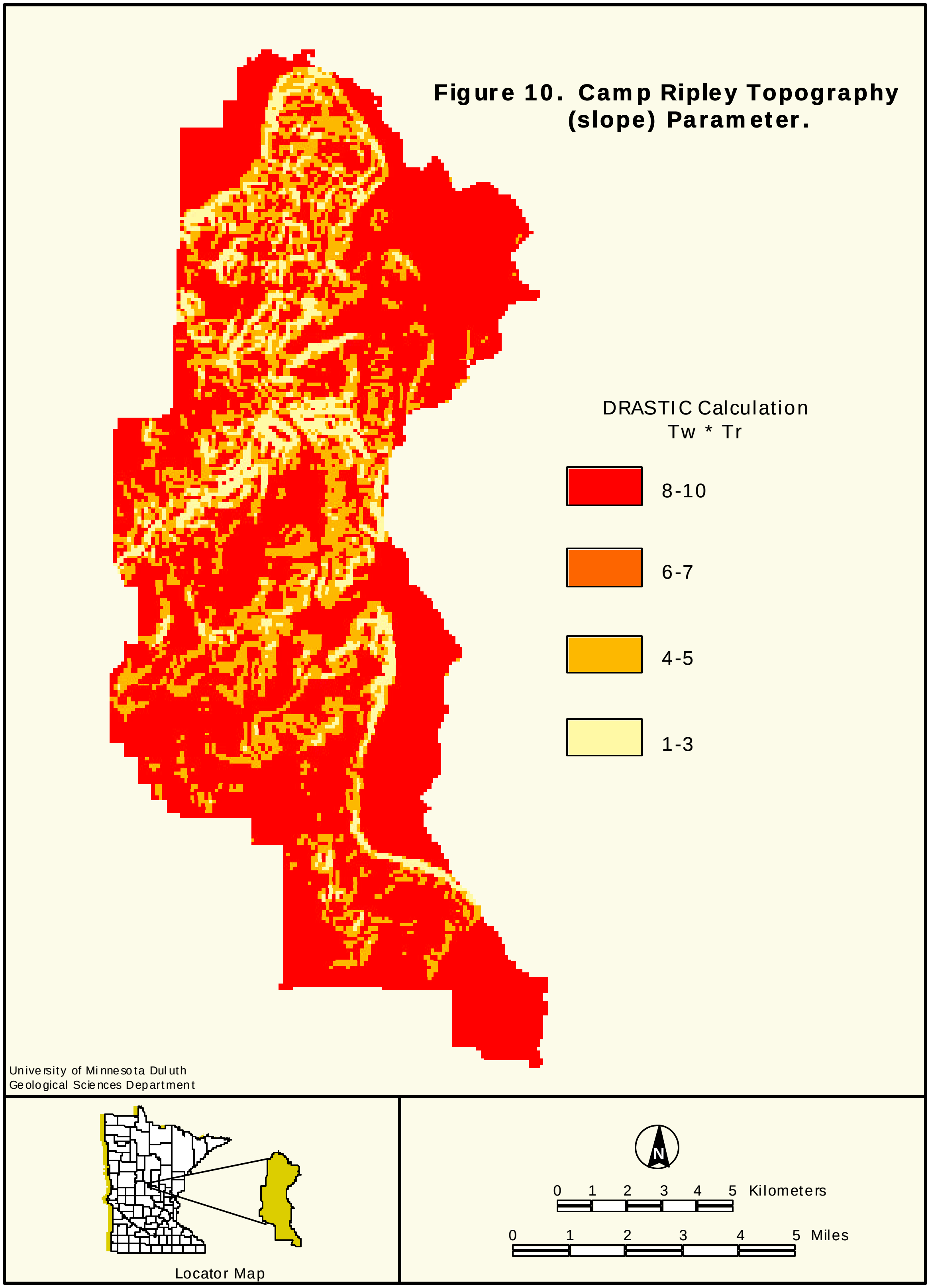


Figure 10. Camp Ripley Topography (slope) Parameter.

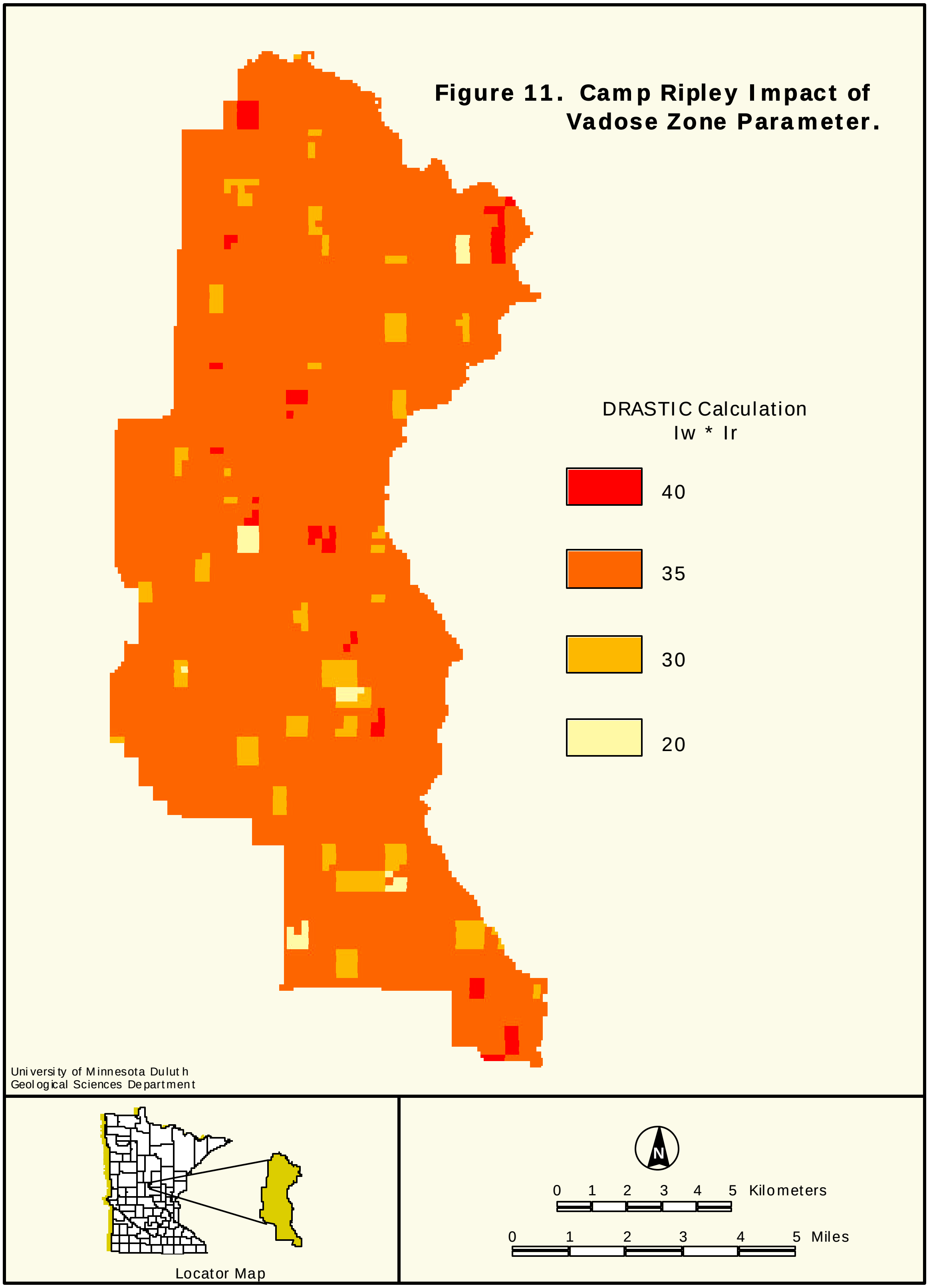


Figure 11. Camp Ripley Impact of Vadose Zone Parameter.

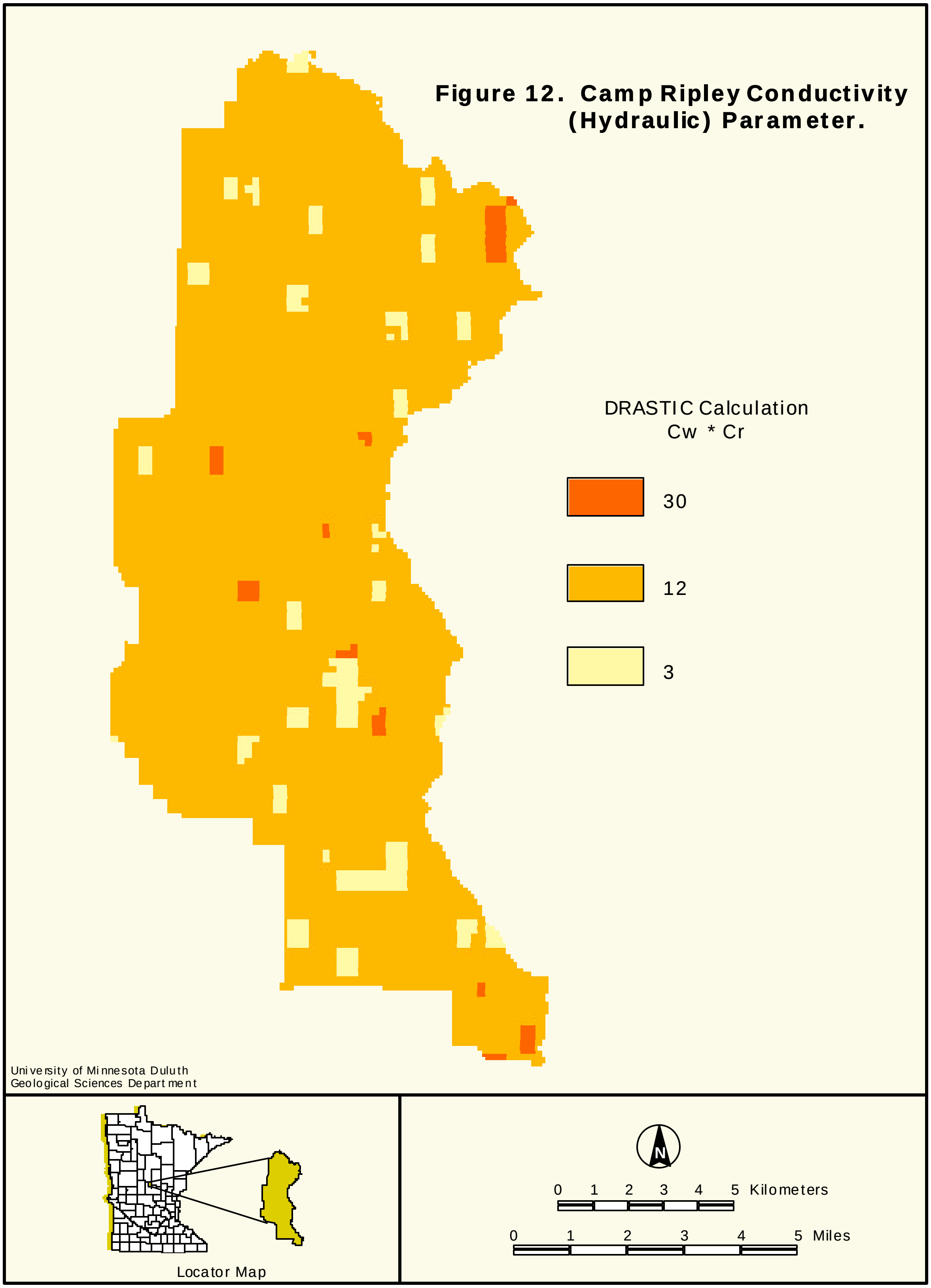


Figure 12. Camp Ripley Conductivity (Hydraulic) Parameter.

5.0 RESULTS

5.1 DISCUSSION

The results of the aquifer sensitivity assessment provide insight into the complexity of the hydrogeology and geomorphology of Camp Ripley, and are considered a reliable representation of the ground water pollution potential of the facility. IAS values calculated for Camp Ripley range from a low of 71 to a high of 202 based on 20,653 cells at 100m resolution. The range values were subdivided into four categories of aquifer sensitivity based on an equal interval classification: 1) low (71-103), 2) moderate (104-136), 3) high (137-169), and 4) very high (170-202). This classification method is commonly used as means to assign a sensitivity ranking for interpretation purposes. The mean value of aquifer sensitivity is 125.6, which correspond to the moderate sensitivity classification. The standard deviation calculated for the aquifer sensitivity assessment is 26.8. A summary of the results derived from the aquifer sensitivity assessment of Camp Ripley based on the DRASTIC model is presented in the following tables (Tables 10 and 11).

Table 10. Results of Aquifer Sensitivity Assessment of Camp Ripley.

Aquifer Sensitvity Assessment – Camp Ripley				
Number of Cells	**Minimum**	**Maximum**	**Average**	**Standard Deviation**
20,653	71	202	125.6	26.8

Table 11. Classification of Aquifer Sensitivity at Camp Ripley.

Aquifer Sensitvity Classification – Camp Ripley	
IAS Interval	**Sensitivity Classification**
71-103	Low
104-136	Moderate
137-169	High
170-202	Very High

A map showing the spatial distribution of aquifer sensitivity at Camp Ripley is provided in Figure 13. Upon initial inspection of the map it may appear that the topography parameter has a dominant impact on the results of the aquifer sensitivity assessment. Yet in the DRASTIC model the topography parameter has the lowest weight of the seven parameters and thus the smallest value in the overall calculation. The topographic characteristics of Camp Ripley; however, are significant to the model as a whole. Within the rugged terrain of the St. Croix moraine the depth to water is high, and recharge relatively low. In contrast, rolling uplands and flat lying plains adjacent to the major drainages are in general shallower to water, and have higher recharge rates. Moreover, these factors coupled with the distribution of soil types, impact of the vadose zone, and physical characteristics of the aquifer including media type and hydraulic conductivity influence the overall potential for ground water contamination. Therefore, it should be apparent that aquifer sensitivity at Camp Ripley is a function of the intrinsic properties of the hydrogeologic setting, which is a function of the overall physical characteristics of the project area.

5.2 INTERPRETATION

The results of the aquifer sensitivity assessment of Camp Ripley using the DRASTIC model can be used in comparison to the results of analyses calculated in other hydrogeologic settings of the Glaciated Central ground water region. The values determined from various hydrogeologic settings within this ground water region provide a control and basis for interpretation of results from the Camp Ripley analysis. Aller et al. (1987) defined and calculated DRASTIC values for 16 distinct hydrogeologic settings within the Glaciated Central ground water region (Table 12).

Table 12. DRASTIC Values for Hydrogeologic Settings in the Glaciated Central Ground Water Region.

DRASTIC Hydrogeologic Settings			
Setting	**Description**	**DRASTIC Index**	**Sensitivity Ranking***
7Aa	Glacial Till Over Bedded Sedimentary Rock	103	Low
7Ab	Glacial Till Over Outwash	137	High
7Ac	Glacial Till Over Solution Limestone	139	High
7Ad	Glacial Till Over Sandstone	107	Low
7Ae	Glacial Till Over Shale	88	Low
7Ba	Outwash	176	Very High
7Bb	Outwash Over Bedded Sedimentary Rock	156	High
7Bc	Outwash Over Solution Limestone	186	Very High
7C	Moraine	135	Moderate
7D	Buried Valley	156	High
7Ea	River Alluvium with Overbank Deposits	134	Moderate
7Eb	River Alluvium without Overbank Deposits	191	Very High
7F	Glacial Lake Deposits	135	Moderate
7G	Thin Till over Bedded Sedimentary Rock	121	Moderate
7H	Beaches, Beach Ridges and Sand Dunes	202	Very High
7I	Swamp/Marsh	160	High

*Based on classifying DRASTIC values into four equal interval categories.

The range of IAS values calculated for Camp Ripley is in agreement with DRASTIC values determined for similar hydrogeologic settings within the Glaciated Central ground water region. What is unique about the Camp Ripley facility is that it contains a range of hydrogeologic settings within its boundaries. For example, in the hummocky topography of the St. Croix moraine the hydrogeologic setting of Camp Ripley could be compared to the following hydrogeologic settings: 1) glacial till over outwash, 2) glacial till over sandstone, or 3) moraine. Typical DRASTIC index values for these types of hydrogeologic settings range from 107 to 137, and fall within the low to moderate sensitivity range with the highest value (137) falling just into the lower part of the high sensitivity ranking (Table 12). Values calculated for Camp Ripley within these types hydrogeologic settings range from 71 to l36 and fall within the low to moderate sensitivity ranking category (Table 11).

While the comparison of Camp Ripley to glacial till over sandstone may seem somewhat tenuous, the subsurface stratigraphy and sedimentology of the base does approximate sandstone. The aquifer media of Camp Ripley is dominated by sand; however, the sand is not lithified and probably not as fractured as sandstone may be. Therefore, a comparison of the two settings seems reasonable.

Other comparable hydrogeologic settings present at Camp Ripley include: 1) outwash, 2) river alluvium without overbank deposits, and 3) swamp/marsh. Typical DRASTIC index values for these types of hydrogeologic settings range from 160-191, and fall within the high to very high sensitivity ranking. These hydrogeologic settings approximate the valley train and associated deposits present along the northern and eastern boundaries of the facility. Values calculated for Camp Ripley within these types hydrogeologic settings range from 137 to 202 and fall within the high to very high sensitivity ranking category (Table 11).

In any event, the range of IAS values calculated for Camp Ripley are comparable to other hydrogeologic settings in the Glaciated Central ground water region, and considered valid given its variability in hydrogeologic and geomorphological characteristics.

The results of the GIS-based aquifer sensitivity model can also be compared to the conceptual model of aquifer sensitivity. Conceptually, relatively flat areas that are shallow to ground water and underlain by coarse-grained deposits are highly sensitive to contamination, whereas areas with hummocky topography that are deep to ground water are less sensitive to contamination. Portions of Camp Ripley considered to be highly sensitivity areas roughly correspond to the outwash plain along the northern and eastern margins of the project area, and low sensitivity areas lies within the rugged topography of the St. Croix moraine.

Analysis of the spatial characteristics of the aquifer sensitivity map indicates that lower IAS values correspond to locations within Camp Ripley that lie within the St. Croix moraine (Figure 13). These areas typically have steep slopes resulting in high runoff and low recharge values, lie high above the water table, contain a variable mixture of soil types, and are underlain by sandy glaciolacustrine deposits. In contrast, locations with high IAS values correspond to locations along the outwash plain (valley train) bordering the northern and eastern sides of the project area (Figure 13). These areas are typically flat lying resulting in low runoff and high recharge values, lie close to the water table, have sandy soils, and are underlain by glacial outwash deposits.

The IAS values for Camp Ripley can be thought of in terms of contaminant travel times. Lower values correspond to longer travel times, and higher values correspond to shorter travel times. For example, in the morainic areas of the facility it should take longer for a contaminant introduced at the surface to reach the aquifer when compared to the valley train areas. The intrinsic properties of the hydrogeologic system control the fate and transport of mechanisms of a contaminant, and ultimately its concentration when and if it reaches the aquifer.

5.3 APPLICATION AND DEPLOYMENT

The model of aquifer sensitivity developed from this GIS analysis is an applicable APPL that can be used by Camp Ripley to meet the objectives of the CWMP. The APPL provides a tool to be used in conjunction with groundwater flow and surface runoff models to address known spatial concerns in order to assist in the development of water resource management protocols for proposed activities at the facility.

The APPL can be used to conduct evaluations of specific areas within the Camp Ripley facility to assist in planning for day-to-day operations or for developing long term water resource management strategies. Potential applications the APPL could be used for as part of day-to-day operations include evaluating the sensitivity of ground water resources to proposed improvements such as building and road construction, assisting in the selection of locations for military training activities in low sensitivity areas, or developing contaminant release response plans for high sensitive areas. From a long term water resource management strategy the APPL could be used along with other

GIS models to address the impacts, if any, of the contaminated soil spread site to ground water resources over time.

The APPL can be deployed for immediate use as part of the CWMP. The APPL is based on a standard methodology for evaluating groundwater pollution potential using a well defined set of criteria and reliable data sources. The data sources were derived from information gathered throughout the course of development of the CWMP. As such, the APPL is considered correct for use in analysis and graphical display to sustain training at the Camp Ripley facility through minimizing the impact or potential impact to water resources.

5.4 MAINTENANCE

The APPL developed for Camp Ripley is built upon data collected, analyzed, and integrated for use throughout the course of the CWMP. The datasets used for the analysis and building of the APPL have been through multiple stages of calibration, and are considered final at this time. However, as is the case with any model, if the input datasets change or if additional data should become available to improve the quality of the model it is recommended that the analysis used to build the APPL be rerun to reflect the changes in the input data. One of the major strengths of the DRASTIC model is in the criteria used to build the model, and ease and flexibility in updating the model should new data become available. This report provides the requisite information to update the model using a straightforward, clearly defined methodology following standard scientific practices using GIS technology. The Camp Ripley APPL should be reviewed annually to assess whether the model needs updating to meet the objectives of the CWMP or any other management strategies developed in the future. This can easily be accomplished by consulting a qualified professional familiar with the geomorphologic and hydrogeologic characteristics of the Camp Ripley area.

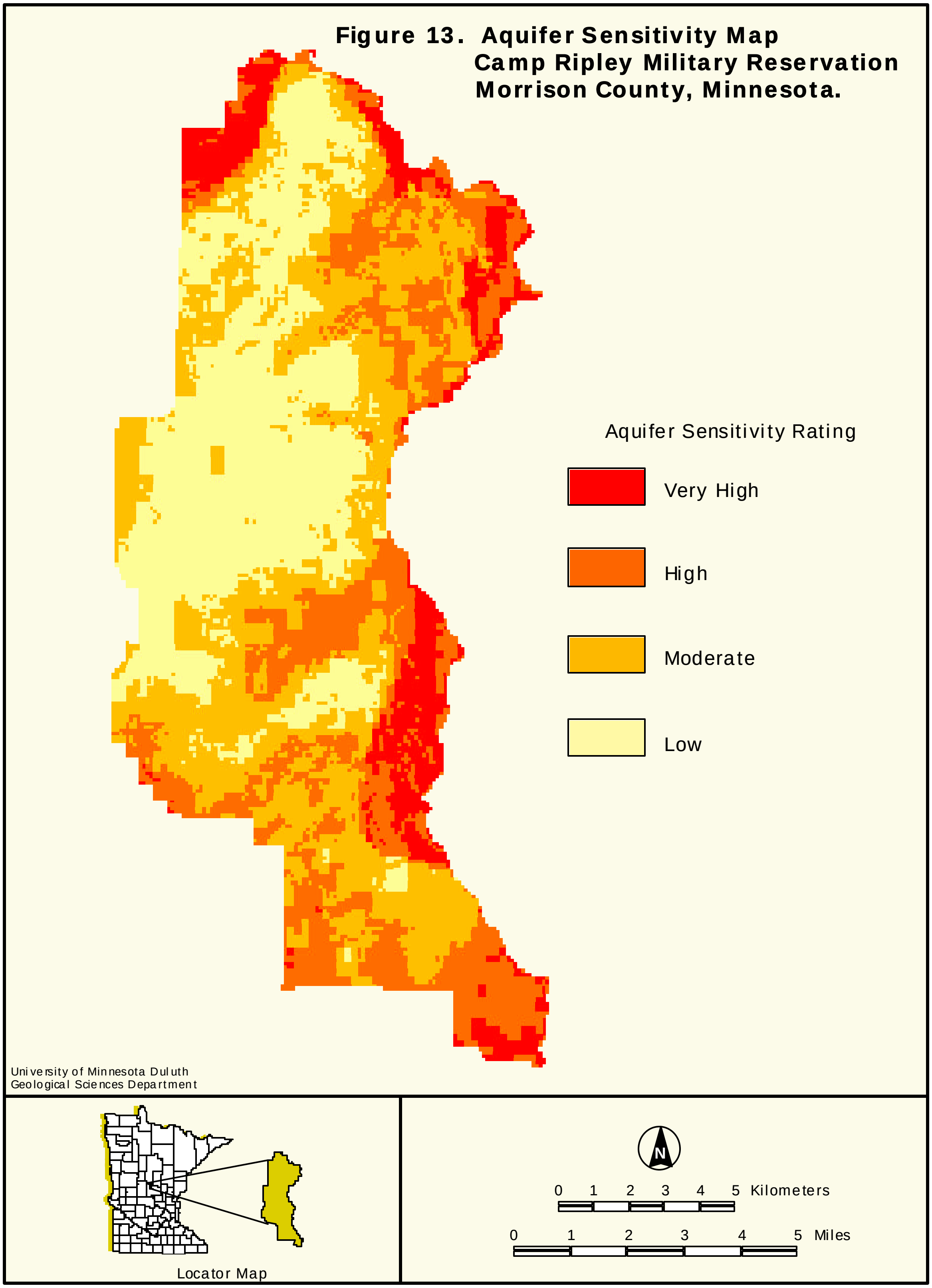


Figure 13. Aquifer Sensitivity Map – Camp Ripley Military Reservation, Morrison County, Minnesota.

REFERENCES

Aller, L., T. Bennett, J. H. Lehr, R. J. Petty, and G. Hackett
1987 *DRASTIC: A Standardized System for Evaluating Ground Water Pollution Potential Using Hydrogeologic Settings.* United States Department of Environmental Protection, Robert S. Kerr Environmental Research Laboratory, Ada, Oklahoma. EPA/600/2-87/035, 622 pp.

Brug, W. H., Jr. and J. F. Gorton
1994 *Soil Survey of Morrison County, Minnesota.* United States Department of Agriculture, Soil Conservation Service, in Cooperation with the Minnesota Agricultural Experiment Station.

Buol, S. W., F. D. Hole, R. J. McCracken, and R. J. Southard
1997 *Soil Genesis and Classification, 4th Edition.* Iowa State University Press, Ames, Iowa.

Carle, S.F.
1999 *T-PROGS: Transition Probability Geostatistical Software, version 2.1.*

Cates, K. J., and F. W. Madison
1990 *Soil Attenuation – Potential Map of Pepin County, Wisconsin.* University of Wisconsin – Extension. Madison, Wisconsin. Soil Map 10.

Clayton, L., and S. R. Moran
1982 *Chronology of Late Wisconsinan Glaciation in Middle North America.* Quaternary Science Reviews 1:55-82.

Fetter, C. W.
1994 *Applied Hydrogeology, 3rd Edition.* Macmillan College Publishing Company, New York, New York, 691 pp.

Freeze, R. A., and J. A. Cherry
1979 *Groundwater*. Prentice-Hall, Englewood Cliffs, New Jersey.

Goldstein, B. S.
1985 *Stratigraphy, Sedimentology, and Late Quaternary History of the Wadena Drumlin Region, Central Minnesota.* Unpublished Ph.D. Dissertation, University of Minnesota, Minneapolis.

Goldstein, B. S.
1989 *Lithology, Sedimentology, and Genesis of the Wadena Drumlin Field, Minnesota, U.S.A.* Sedimentary Geology, v. 62, pp. 241-277.

GSW
1991 *Criteria and Guidelines for Assessing Geologic Sensitivity of Ground Water Resources in Minnesota.* Minnesota Department of Natural Resources, Division of Waters, 122 pp.

Hamerlinck, J. D., and C. S. Arneson, editors
1998 *Wyoming Ground Water Vulnerability Assessment Handbook: Volume 2. Assessing Ground Water Vulnerability to Pesticides.* Spatial Data and Visualization Center Publication SDVC 98-01-2. University of Wyoming, Laramie, Wyoming.

Harleman, D. R. F., P. F. Melhorn, and R. R. Rumer
1963 *Dispersion-Permeability Correlation in Porous Media.* Journal of Hydraulics Division, v. 89, pp. 67-85.

Hazen, A.
1893 *Some Physical Properties of Sands and Gravels, with special reference to their use in filtration.* 24th Annual Report, Massachusetts State Board of Health, pp. 539-556.

Heath, R. C.
1984 *Ground Water Regions of the United States.* U. S. Geological Survey Water Supply Paper 2242.

Jenny, H
1941 *Factors of Soil Formation: A System of Quantitative Pedology.* McGraw Hill, New York.

Korkmaz, N.
1990 *The Estimation of Groundwater Recharge from Spring Hydrographs.* Hydrological Sciences, v. 35, pp. 209-217.

Krumbein, W. C., and G. D. Monk
1942 *Permeability as a Function of the Size Parameters of Unconsolidated Sand.* Transactions of the Petroleum Division, American Institute of Mining and Metallurgical Engineering, v. 51, pp. 153-163.

Meyer, G. N.
1996 Geologic Atlas of Streans County, Minnesota, Part C: Text Supplement, Minnesota, Minnesota Geological Survey, County Atlas Series C-10, 63 pp.

Mickelson, D. M., L. Clayton, D. S. Fullerton, H. W. Borns, Jr.
1983 The Late Wisconsin Glacial Record of the Laurentide Ice Sheet in the United States. In *Late Quaternary Environments of the United States: The Late Pleistocene*, edited by S. C. Porter, pp. 3-37. University of Minnesota Press, Minneapolis.

MNDNR
1991 *A Summary Report to the Legislative Commission of Minnesota Resources, Water Resources Management, Ground Water Sensitivity.* Minnesota Department of Natural Resources, Division of Waters, 10 pp.

Mooers, H. D.
1988 Quaternary History and Ice Dynamics of the Late Wisconsin Rainy and Superior Lobes, Central Minnesota. Unpublished Ph.D. dissertation, University of Minnesota, Minneapolis.

Mooers, H. D. and J. D. Lehr
1997 Terrestrial record of Laurentide Ice Sheet reorganization during Heinrich Events, *Geology*, v. 25, no. 4, pp. 379-381.

Moore, J. S.
1988 *SEEPAGE: A System for Early Evaluation of the Pollution Potential of Agricultural Ground Water Environments.* U.S. Department of Agriculture, Soil Conservation Service. Geology Technical Note 5 (Revision 1). 23 pp.

Passero, R. N., F. J. Cohen, S. J. Dulaney, P. M. Haff, J. P. McNamara, and H. Moaddel
1989 *Aquifer Vulnerability Mapping in Southwest Michigan.* Geological Society of America, North-Central Section, 23rd Annual Meeting. Abstracts with Programs, Geological Society of America.

Puckett, W. E., J. H. Dane, and B. F. Hajek
1985 *Physical and Mineralogical Data to Determine Soil Hydraulic Properties.* Soil Science of America, v. 49, pp. 831-826.

St. George, L. M.
1994 *A Landform Based Approach to the Estimation of Groundwater Recharge in Complex Glacial Topography.* Unpublished M.S. thesis, University of Minnesota, Duluth.

Simonson, R. W.
1959 *Outline of a Generalized Theory of Soil Formation.* Soil Science Society of American: 23:152-156.

USEPA
1993a *A Review of Methods for Assessing Aquifer Sensitivity and Groundwater Vulnerability to Pesticide Contamination.* United States Environmental Protection Agency, Office of Water. EPA 813-R-93-002.

USEPA
1993b Ground *Water Resource Assessment Technical Assistance Document.* United States Environmental Protection Agency, Office of Water.

USEPA
1995 *National Conference on Environmental Problem Solving with Geographic Information Systems.* United States Environmental Protection Agency, Office of Research and Development. EPA/625/R-95/004.

Wright, H. E., Jr.
1972 The Quaternary History of Minnesota. In *Geology of Minnesota: A Centennial Volume*, edited by P. K. Sims and G. B. Morey, pp. 515-547. University of Minnesota, Minnesota Geological Survey, Minneapolis.

Wright, H. E., Jr.
1993 *History of the Landscape in the Itasca Region.* Geological Society of America Special Paper, v. 276, pp. 7-17.

Wright, H. E., Jr. and R. V. Ruhe
1965 Glaciation of Minnesota and Iowa. In *The Quaternary History of the United States*, edited by H. E. Wright, Jr. and D. G. Frey, pp. 29-41. Princeton University Press, Princeton.

APPENDIX A

Table 1. Camp Ripley Depth to Water Parameter.

DEPTH TO WATER PARAMETER			
Range (FT)	**Weight**	**Rating**	**Calculated DRASTIC Value**
0-5	5	10	50
6-15	5	9	45
16-30	5	7	35
31-50	5	5	25
51-75	5	3	15
76-100	5	2	10
100+	5	1	5

Table 2. Camp Ripley Recharge Parameter.

RECHARGE PARAMETER			
Range (inches/yr)	**Weight**	**Rating**	**Calculated DRASTIC Value**
0-2	4	1	4
2-4	4	3	12
7-10	4	8	32

Table 3. Camp Ripley Aquifer Media Parameter

AQUIFER MEDIA PARAMETER			
Aquifer Media Range	**Weight**	**Rating**	**Calculated DRASTIC Value**
Outwash	3	8	24
Lacustrine sand	3	7	21
Lacustrine silt	3	4	12
Glacial Till	3	6	18

Table 4. Camp Ripley Soil Media Parameter.

SOIL MEDIA PARAMETER			
Soil Media Range	**Weight**	**Rating**	**Calculated DRASTIC Value**
Menahga loamy sand, 2-8% slopes	2	8	16
Menahga loamy sand, 8-15% slopes	2	8	16
Fordum-Winterfield complex	2	4	8
Markey muck	2	2	4
Menahga loamy sand, 0-2% slopes	2	8	16
Psamments, nearly level	2	9	18
Meehan loamy sand	2	8	16
Isan sandy loam	2	6	12
Cushing Mahtomedi-DeMontreville Complex, 15-25% slopes	2	6	12
Cushing Mahtomedi-DeMontreville Complex, 8-15% slopes	2	6	12
Cushing Mahtomedi-DeMontreville Complex, 2-8% slopes	2	6	12
Mahtomedi loamy sand, 15-25% slopes	2	8	16
Cathro Muck	2	2	4
Water	2	2	4
Mahtomedi loamy sand, 8-15% slopes	2	8	16
Menahga loamy sand, 25-45% slopes	2	8	16
Menahga loamy sand, 15-25% slopes	2	8	16
Parent loam	2	5	10
Seelyeville Muck	2	2	4

Table 4. Camp Ripley Soil Media Parameter (continued).

SOIL MEDIA PARAMETER			
Soil Media Range	**Weight**	**Rating**	**Calculated DRASTIC Value**
Rifle Muck	2	2	4
Prebish loam	2	5	10
Zimmerman loamy fine sand, 1-4% slopes	2	7	14
Alstad loam	2	5	10
Isanti fine sandy loam	2	5	10
Mahtomedi loamy sand, 2-8% slopes	2	8	16
Soderville loamy fine sand	2	7	14
Pits, gravel	2	10	20
Emmert gravelly loamy sand, 12-40% slopes	2	9	18
Bowstring muck	2	2	4
Udorthents. Loamy	2	5	10
Meehan-Isan Complex	2	8	16
Nokasippi mucky loamy fine sand	2	6	12
Oesterle sandy loam, 0-1% slopes	2	6	12
Chetek sandy loam, 2-8% slopes	2	6	12
Nokay loam	2	5	10
Becker fine sandy loam	2	6	12

Table 5. Camp Ripley Topography Parameter.

TOPOGRAPHY PARAMETER			
Slope Range (%)	**Weight**	**Rating**	**Calculated DRASTIC Value**
0-2	1	10	10
3-6	1	9	9
7-12	1	5	5
13-18	1	3	3
18+	1	1	1

Table 6. Camp Ripley Impact of Vadose Zone Parameter.

IMPACT OF VADOSE ZONE PARAMETER			
Vadose Zone Media Range	**Weight**	**Rating**	**Calculated DRASTIC Value**
Outwash	5	8	40
Lacustrine sand	5	7	35
Lacustrine silt	5	4	20
Glacial Till	5	6	30

Table 7. Camp Ripley Conductivity (Hydraulic) Parameter.

CONDUCTIVITY PARAMETER			
Range (GPD/FT^2)	**Weight**	**Rating**	**Calculated DRASTIC Value**
2500 (outwash)	3	10	30
475 (lacustrine sand)	3	4	12
10 (lacustrine silt)	3	1	3
28 (glacial till)	3	1	3

1.0 Introduction

The University of Minnesota, Duluth Geological Sciences Department (UMD) is under contract with the Department of Military Affairs (DMA) to inventory the surface water and groundwater resources at Camp Ripley, Minnesota.

Stream discharge is often correlated with many physiochemical characteristics of rivers, such as water temperature, channel geomorphology, and habitat diversity. It also limits the distribution and abundance of species and regulates the ecological integrity of flowing water systems. As a result stream discharge is considered to be a "master variable" fundamental to the understanding of many environmental phenomena.

Four automated recorders were installed in six locations to measure stage (elevation) for surface water streams and stormwater outfalls exiting Camp Ripley's eastern boundary and discharging to the Crow Wing and Mississippi Rivers. When possible, periodic discharge measurements were performed to develop a stage vs. discharge relationship. Each stage recorder was assigned a unique identification name. The unique ID is utilized on the figures in this report and corresponds with sample location in the Equis Chemistry database developed for Camp Ripley. The unique ID's are DeParq Woods Stormwater Outfall, Area 22 Washrack Stormwater Outfall, Broken Bow Creek, North Hendrickson Stream, Anzio Stream and Stream 362 respectively and are encountered in this order when driving in a northerly direction through the Camp. The stage recorder monitoring locations are presented on **Figure 1, Camp Ripley Stage Recorder Locations** on the following page.

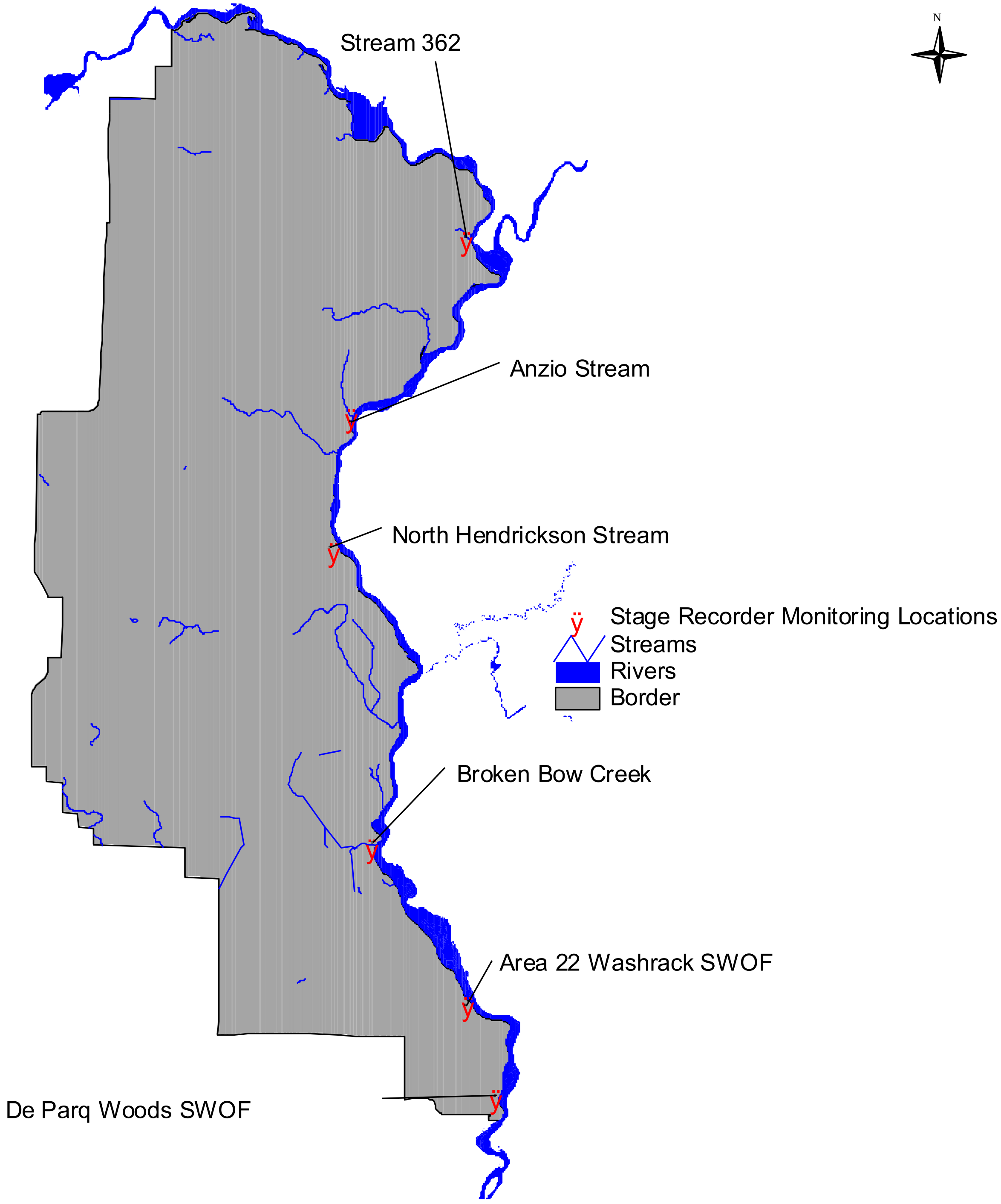


Figure 1, Camp Ripley Stage Recorder Monitoring Locations

Figures 2 – 7 include a lightning bolt representing the individual stage recorder location displayed on a topographic map with an accompanying aerial and digital photograph. The lightning bolt is included to remind the user that the accompanying Arcview Project (str_discharge.apr) contains hotlinks to excel files that contain graphed and raw data for the location. **Table 1, Stage Recorder Summary Information** on the following page provides a synopsis of the stage recorder monitoring location.

The graphed data of stage vs. time and discharge vs. time was provided to Argonne National Labs in July 2002. This data will be utilized in the groundwater flow model for examining typical (or average) stage and discharge for baseflow conditions. This data will be useful for calibrating a groundwater flow model to the fluxes observed in stream flow. In addition, if contaminants are detected in these streams the discharge data would be useful in calculating loads to the Mississippi or Crow Wing River or for future surface water modeling.

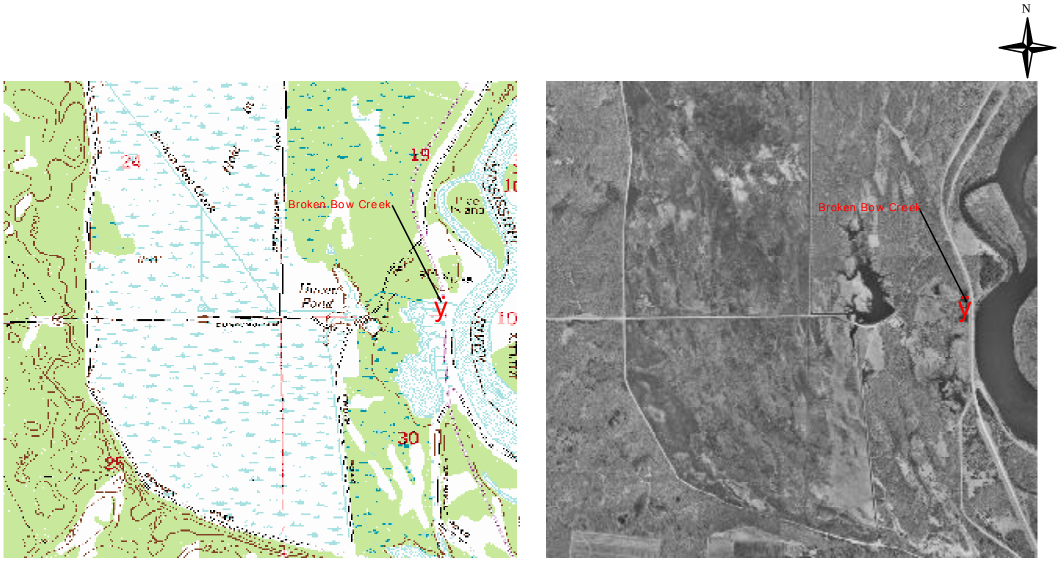
Table 1, Stage Recorder Summary Information

Unique_ID	Serial Numbers	Culvert Number	Culvert Dimensions	Location Information
Broken Bow Creek	S369A0D CPO41CAD	82	Diameter 48” Length 72’	Stage recorder monitoring location is located approximately 100 feet west of East Boundary road (upstream of double culvert 82) on Broken Bow Creek. Broken Bow Creek is located north of Ft. Ripley road and south of Cunningham road. Broken Bow Creek drains Hole in the Day marsh and originates at Prentice Pond. Area surrounding stage recorder is vegetated with pine trees. The stage recorder is located on a portion of stream that appears to have been channelized to drain the marsh. Substrate is primarily sand and gravel. **<u>GPS Coordinates (UTM NAD 83) of Benchmark</u>** Northing 5110272 Easting 393356 Elevation (meters) 347 Elevation (feet) 1140
North Hendrickson Stream	S3699AF CPO41E89	215	Diameter 24” Length 72’	Stage recorder monitoring location is located approximately 300 feet west of East Boundary road (upstream of culvert 215) on an unnamed creek/spring. The creek/spring is located approximately 100 feet south of the intersection of Lake Alott road and East Boundary road. Area is predominantly vegetated with hardwood forest. Large trees and woody debris located both upstream and downstream of stage recorder. Stream is located in a broad valley plain and originates approximately 150 feet west of benchmark/stage recorder as a spring. Substrate is primarily sand. **<u>GPS Coordinates (UTM NAD 83) of Benchmark</u>** Northing 5117946 Easting 392357 Elevation (meters) 351 Elevation (feet) 1154
Anzio Stream	S36971D CP040A4F – Replaced After Flood with CPO42D97	276	Diameter 16” Length 62’	Stage recorder monitoring location is located approximately 120 feet east of East Boundary road (downstream of culvert 276) on the unnamed stream that drains the Trout Pond and the stream that runs parallel to Anzio road. This culvert is a vertical culvert that seems to have masked the seasonal fluctuation of the stream. Stream is located approximately 200 feet south of intersection of East Boundary road and Anzio road. Stream originates north of Casino road. Substrate is comprised of sand, gravel and cobbles. Stage recorder lies in an area vegetated with grasses. **<u>GPS Coordinates (UTM NAD 83) of Benchmark</u>** Northing 5121424 Easting 392817 Elevation (meters) 349 Elevation (feet) 1148
Area 22 Washrack Stormwater Outfall	CPOFA321	NA	NA	Stage recorder monitoring location is located at the outlet of the Area 22 Washrack stormwater outfall approximately 100 feet upstream of the Mississippi River. **<u>GPS Coordinates (UTM NAD 83) of Benchmark</u>** Northing 5106164 Easting 395851
DeParq Woods Stornmwater Outfall	CPOFA972	NA	NA	Stage recorder monitoring location is located at the outlet of the De Parq Woods stormwater outfall before it enters the sedimentation pond. **<u>GPS Coordinates (UTM NAD 83) of Benchmark</u>** Northing 5103729 Easting 396568

2.0 Station Descriptions with Stage and Discharge Graphs

2.1 Broken Bow Creek

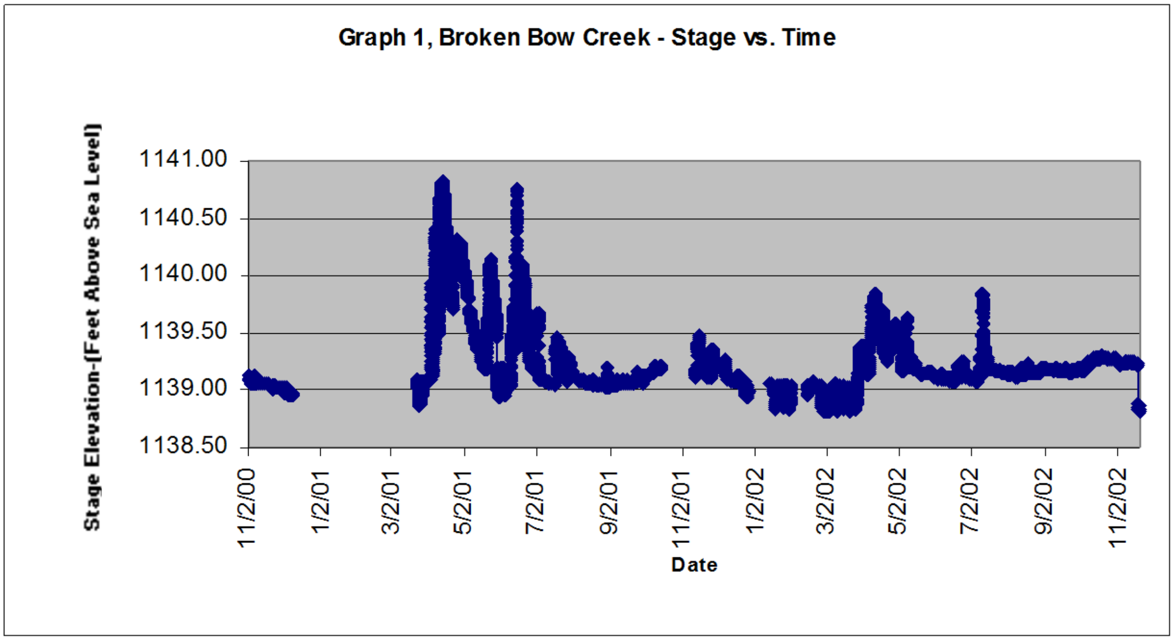
Broken Bow Creek is a perennial stream that originates in Camp Ripley and discharges to the Mississippi River. **Figure 2, Broken Bow Creek** depicts the location of the stage recorder and is presented below.



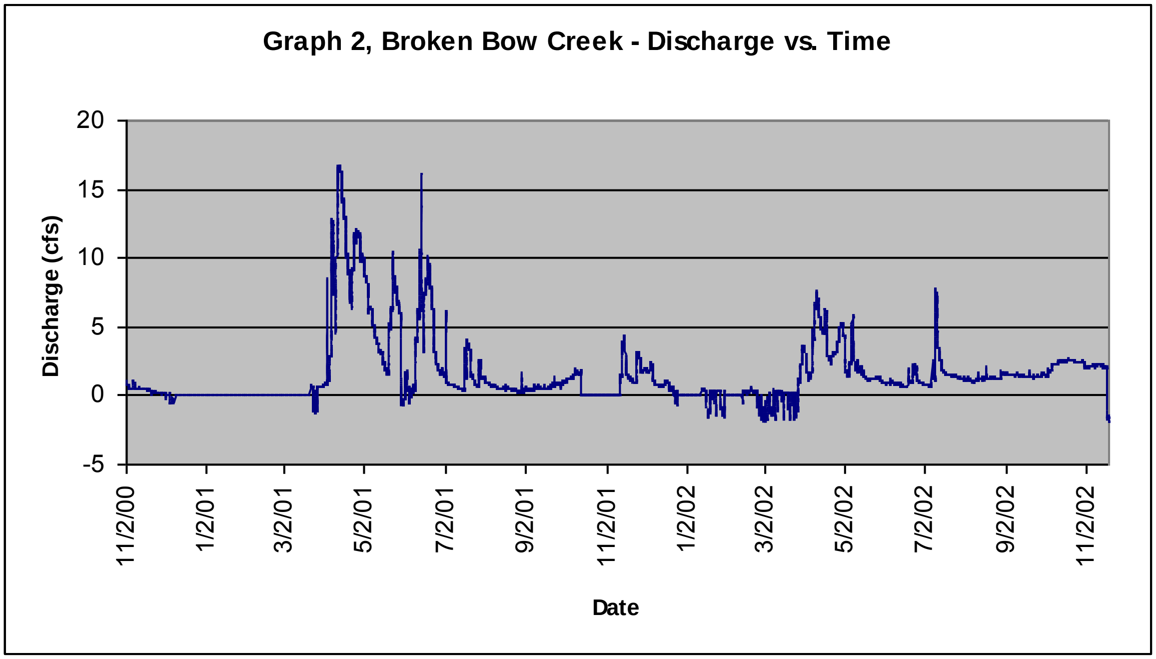
Stage recorder monitoring location is on Broken Bow Creek approximately 100 feet west of culvert number 82 on East Boundary Road. Broken Bow Creek originates at Prentice Pond and drains Hole in the Day Marsh.

Figure 2, Broken Bow Creek

Stream stage levels were recorded from November 2, 2000 to November 19, 2002. Stage elevations ranged from 1138.81 to 1140.82 feet above sea level (FASL) with a median elevation of 1139.15 FASL. **Graph 1, Broken Bow Creek – Stage vs. Time** represents this data and is presented below.

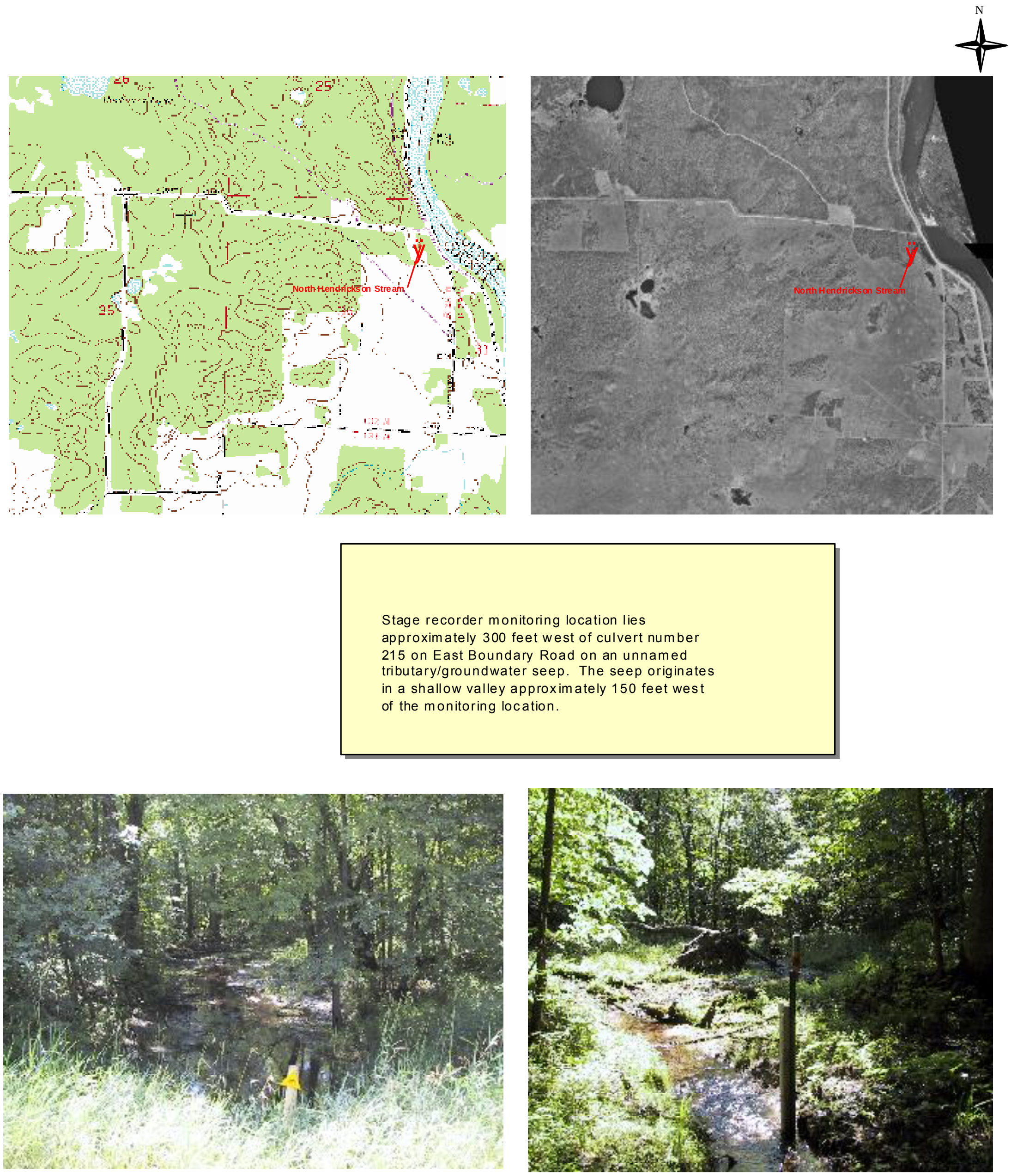


A stage vs. discharge relationship was developed for this stream by measuring discharge in the field and correlating this with stage elevation. A trend line was applied to the graphed data (y = 9.2282x – 10511; R2 = 0.9742) and used to determine discharge through time. Using this approach, the maximum discharge was 16.75 cubic feet per second (CFS) with a median discharge of 1.30 CFS. Broken Bow Creek is characterized by relatively rapid response to rainfall and snowmelt events. Maximum discharges typically occurred in April and May of each year. **Graph 2, Broken Bow Creek – Discharge vs. Time** represents this data and is presented below.



2.2 North Hendrickson Stream

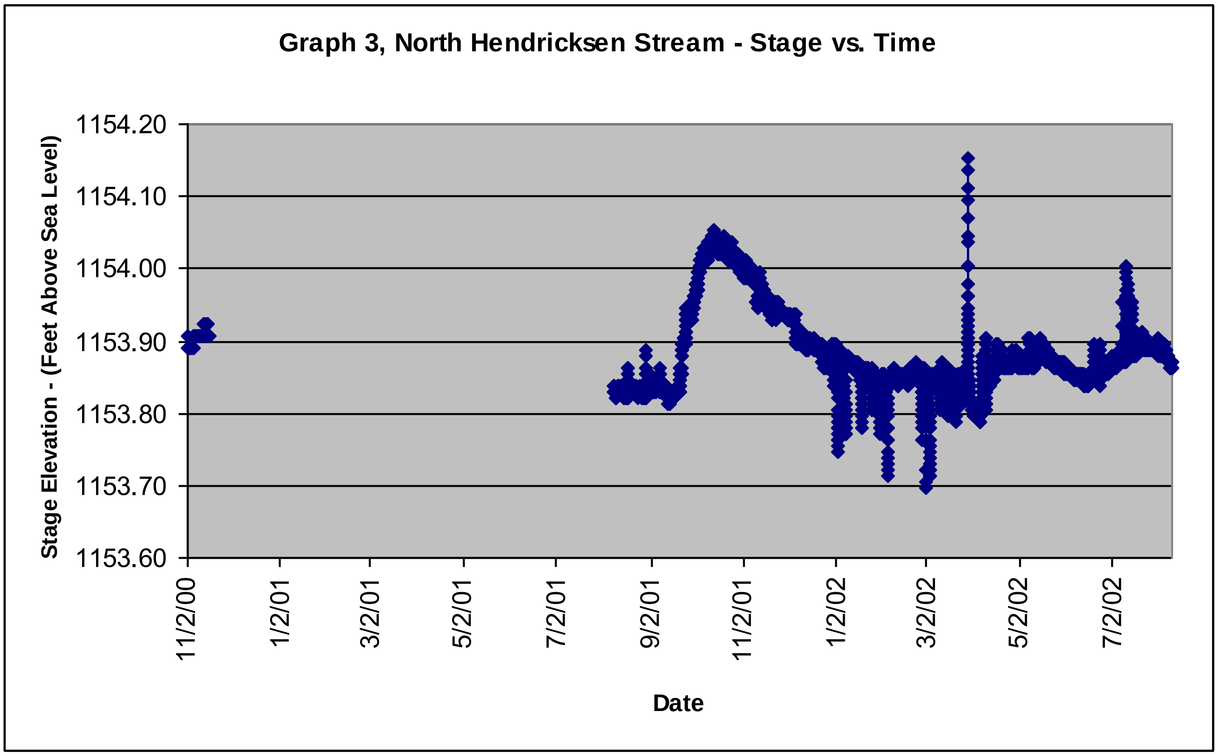
North Hendrickson Stream is a perennial stream/seep that originates in Camp Ripley and discharges to the Mississippi River. **Figure 3, North Hendrickson Stream** depicts the location of the stage recorder and is presented below.



Stage recorder monitoring location lies approximately 300 feet west of culvert number 215 on East Boundary Road on an unnamed tributary/groundwater seep. The seep originates in a shallow valley approximately 150 feet west of the monitoring location.

Figure 3, North Hendrickson Stream

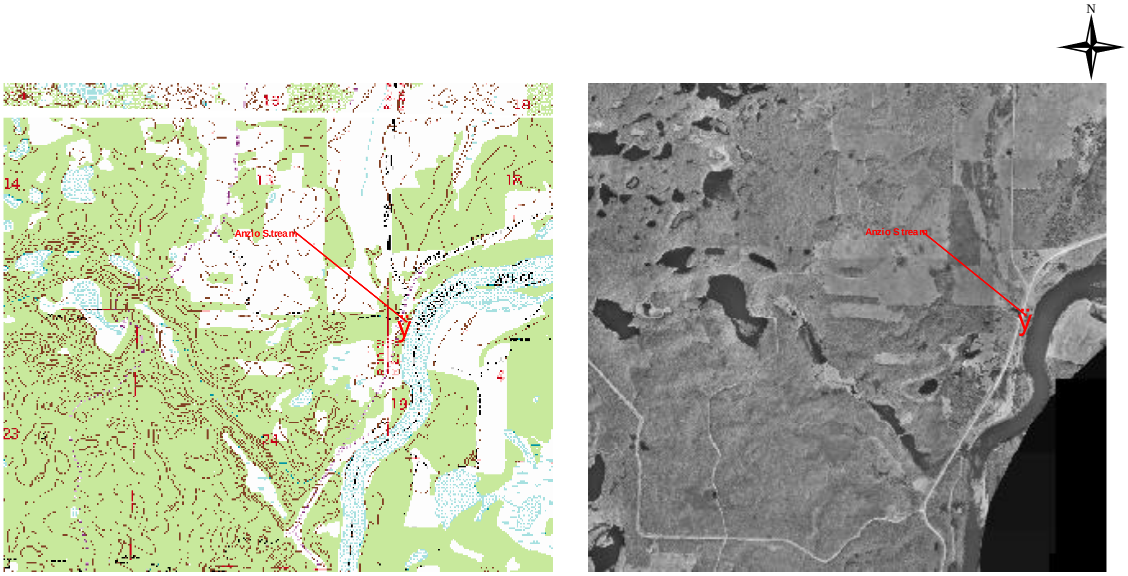
Stream stage levels were recorded from November 2, 2000 to August 9, 2002. Stage elevations ranged from 1153.70 to 1154.15 feet above sea level (FASL). **Graph 3, North Hendrickson Stream – Stage vs. Time** represents this data and is presented below.



A stage vs. discharge relationship was not developed for this stream. Field discharge measurements taken to date range from 0.02 to 0.98 CFS. Due to the shallow nature of the stream velocity measurements were difficult to record and additional field data would be required to build a rating curve. North Hendrickson Stream is characterized by relatively steady baseflow conditions with slow responses to rain or snowmelt. Maximum discharges typically occurred in April and May of each year.

2.3 Anzio Stream

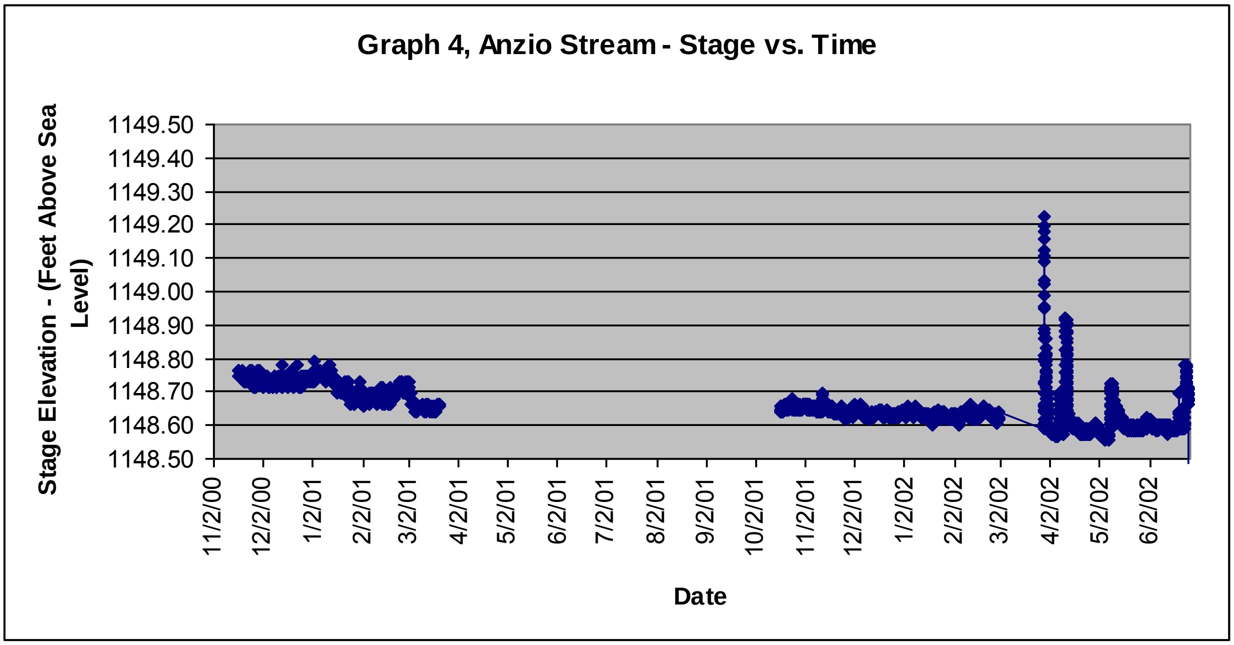
Anzio Stream is a perennial stream that originates in Camp Ripley and discharges to the Mississippi River. **Figure 4, Anzio Stream** depicts the location of the stage recorder and is presented below.



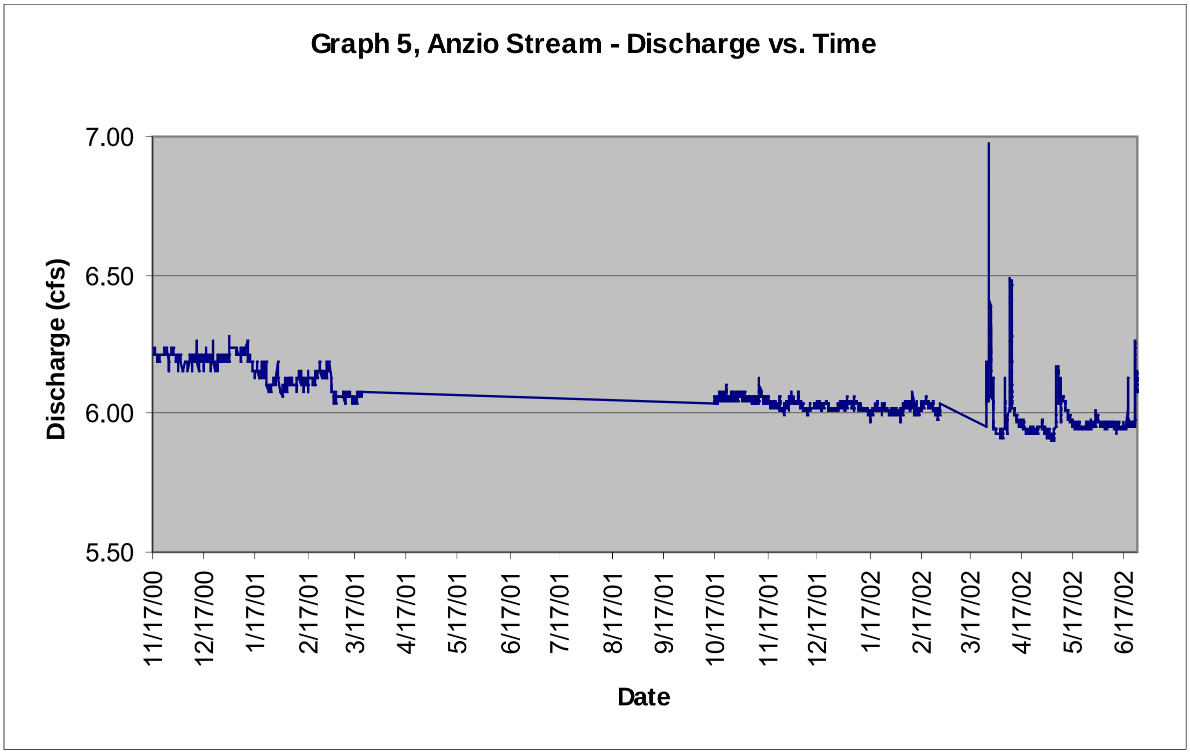
Stage recorder monitoring location is located downstream of culvert 276 approximately 150 feet east of the Trout Pond off of East Boundary Road. Stage recorder was moved to this location due to prior placement being too close to Mississippi River.

Figure 4, Anzio Stream

Stream stage levels were recorded from November 2, 2000 to June 25, 2002. Stage elevations ranged from 1147.83 to 1151.32 feet above sea level (FASL) with a median stage elevation of 1148.64 FASL. **Graph 4, Anzio Stream – Stage vs. Time** represents this data and is presented below.

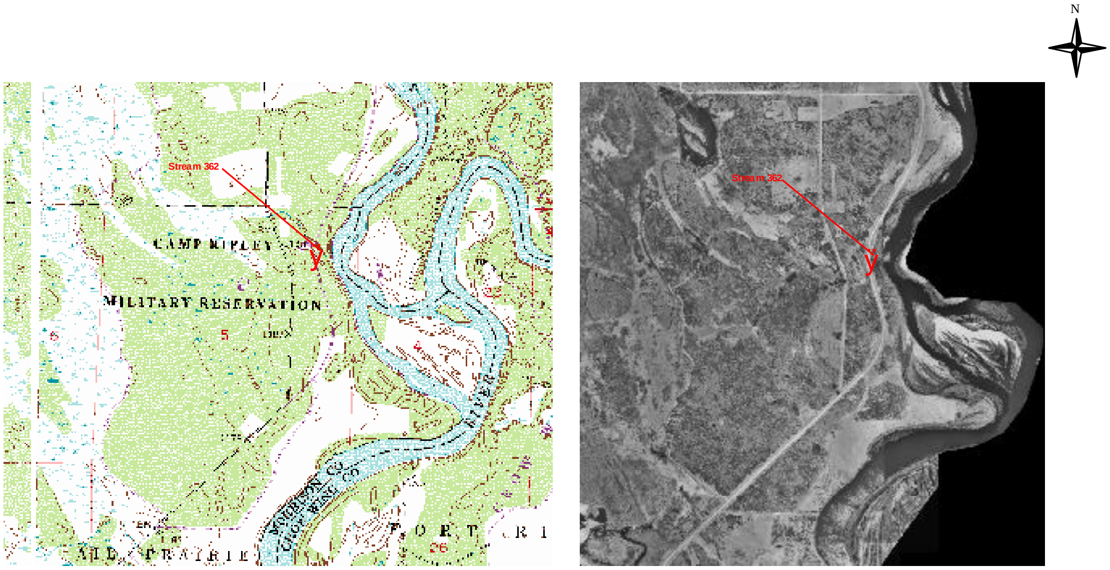


A stage vs. discharge relationship was developed for this stream by measuring discharge in the field and correlating this with stage elevation. A trend line was applied to the graphed data (y = 1.6142x - 1848.1; R2 = 0.7541) and used to determine discharge through time. Using this approach, the maximum discharge was 6.98 cubic feet per second (CFS) with a median discharge of 6.04 CFS. Anzio Stream is characterized by relatively steady baseflow conditions with slow responses to rain or snowmelt. This is most likely due to the trout pond that is located upstream of the stage recorder that regulates flow via a vertical culvert. Maximum discharges typically occurred in April and May of each year. **Graph 5, Anzio Stream– Discharge vs. Time** represents this data and is presented below.



2.4 Stream 362

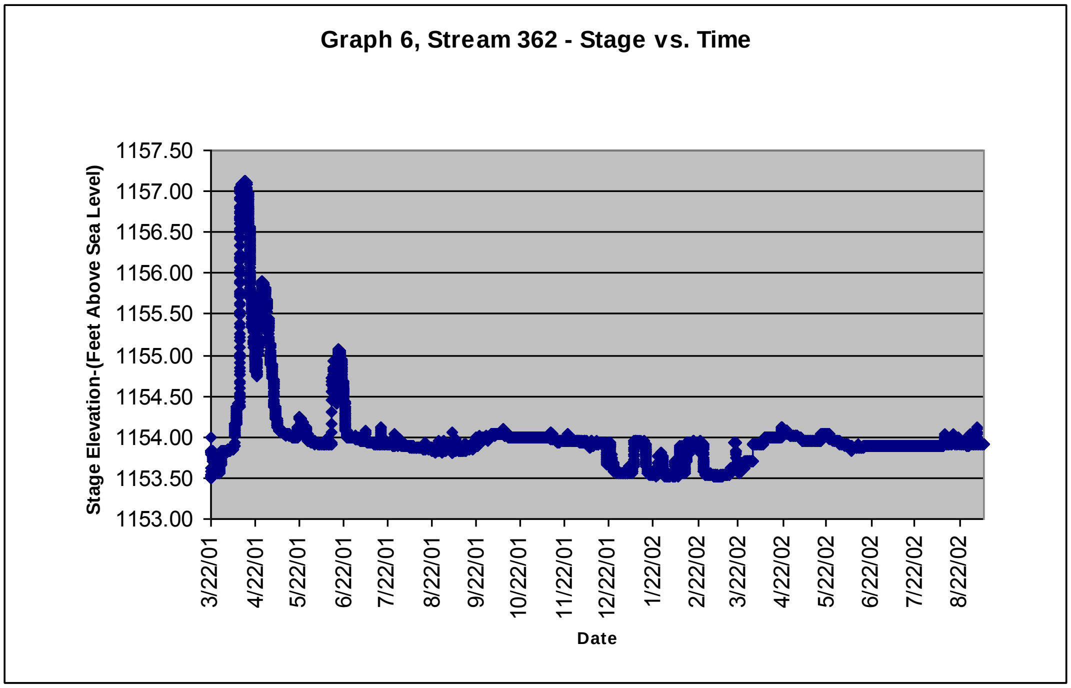
Stream 362 is a perennial stream that originates in Camp Ripley and discharges to the Crow Wing River just upstream from its' confluence with the Mississippi River. **Figure 5, Stream 362** depicts the location of the stage recorder and is presented below.



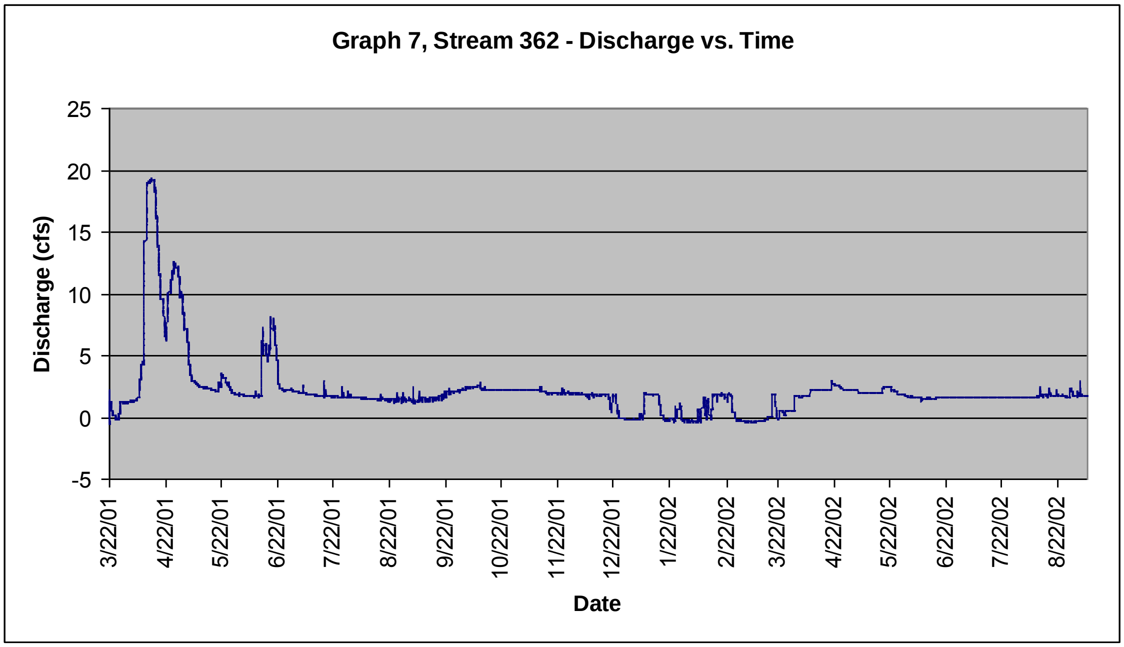
Stage recorder monitoring location is downstream of culvert number 331, approximately 100 feet east of East Boundary Road. Stream drains to the Crow Wing River just upstream of the confluence with the Mississippi River.

Figure 5, Stream 362

Stream stage levels were recorded from March 21, 2001 to September 7, 2002. Stage elevations ranged from 1153.50 to 1157.12 feet above sea level (FASL) with a median stage elevation of 1153.93 FASL. **Graph 6, Stream 362 – Stage vs. Time** represents this data and is presented below.


Graph 6, Stream 362 - Stage vs. Time

A stage vs. discharge relationship was developed for this stream by measuring discharge in the field and correlating this with stage elevation. A trend line was applied to the graphed data ($y = 5.4767x - 6317.9$; $R2 = 0.9916$) and used to determine discharge through time. Using this approach, the maximum discharge was 19.30 cubic feet per second (CFS) with a median discharge of 1.82 CFS. Stream 362 is characterized by relatively rapid responses to rain or snowmelt. Maximum discharges typically occurred in April of each year. **Graph 7, Stream 362 – Discharge vs. Time** represents this data and is presented below.


Graph 7, Stream 362 - Discharge vs. Time

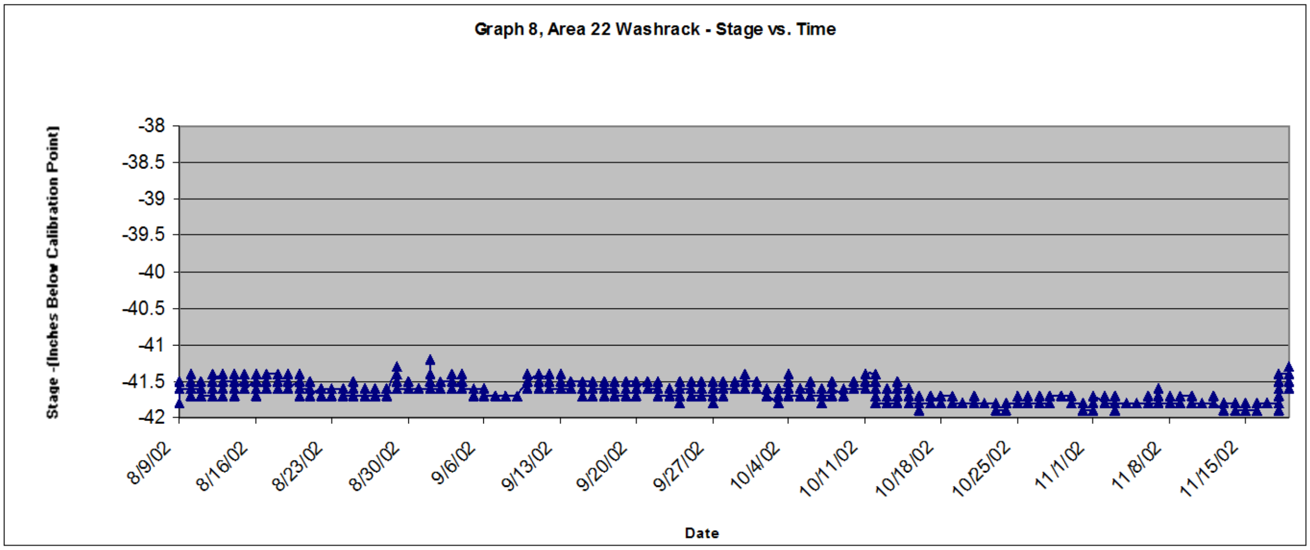
2.5 Area 22 Washrack Stormwater Outfall

The Area 22 Washrack Stormwater Outfall is an engineered structure designed for washing military vehicles. Following a settling process, a skimmer sends the high contamination water directly to the Camp Ripley Wastewater Treatment Plant. The excess water is periodically discharged to the Mississippi River and is regulated by a National Pollution Discharge Elimination System (NPDES) permit. **Figure 6, Area 22 Washrack Stormwater Outfall** depicts the location of the stage recorder and is presented below.

Stage recorder monitoring location is at the Area 22 Washrack Stormwater Outfall approximately 100 feet above the Mississippi River. Stage recorder was installed on the grate shown in the picture below with the bottom on the invert of the outfall.

Figure 6, Area 22 Washrack Stormwater Outfall

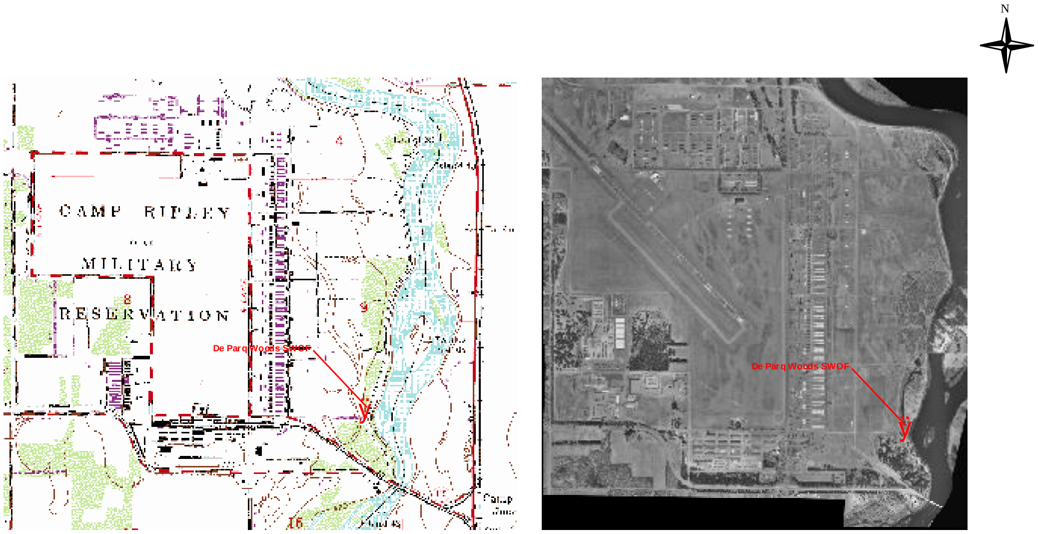
Storm outfall stage levels were recorded from August 9, 2002 to November 19, 2002. Stage measurements ranged from –41.9 to –41.2 inches below the calibration point. The invert of the stormwater outfall was not surveyed so stage measurements were not converted to feet above sea level. **Graph 8, Area 22 Washrack – Stage vs. Time** represents this data and is presented below.



A stage vs. discharge relationship was not developed for this stormwater outfall. Field discharge measurements were not taken due to low flow conditions during monitoring periods. Due to the shallow nature of the stream velocity measurements were difficult to record and additional field data would be required to build a rating curve. No major rain events or discharges occurred during the period of monitoring resulting in a relatively straight-line hydrograph. It is recommended that a stage recorder be installed in this location in the spring of 2003 to better characterize the timing and magnitude of flow from this location.

2.6 DeParq Woods Stormwater Outfall

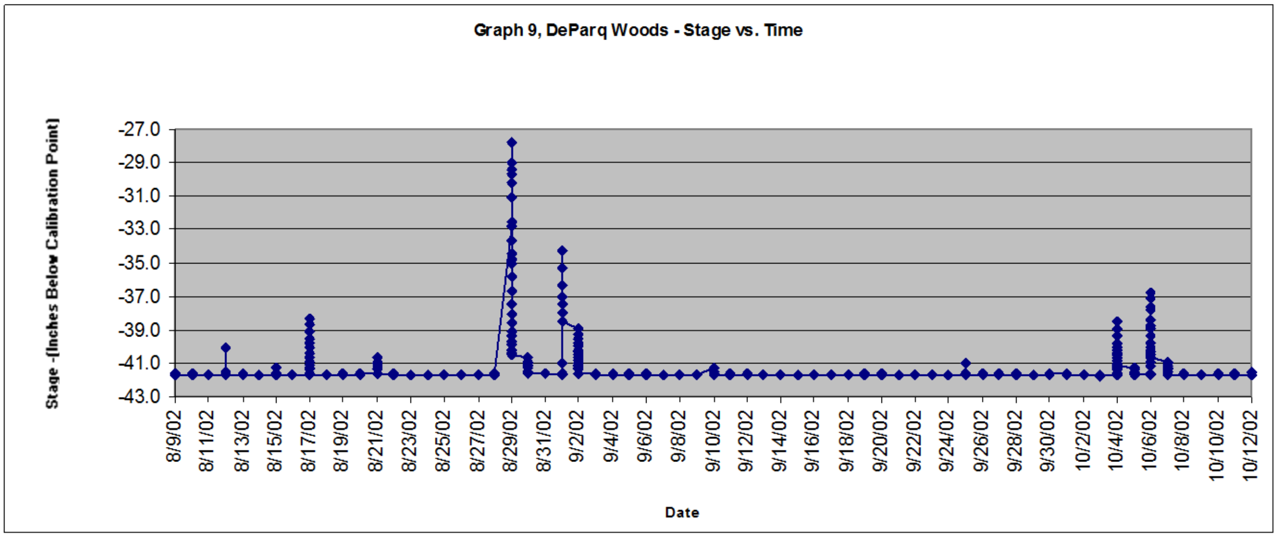
The DeParq Woods Stormwater Outfall is an engineered structure designed for capturing runoff from the southern portion of the cantonment area at Camp Ripley. Below the outfall, a settling pond captures the water and it is either evaporated or infiltrates into the groundwater system adjacent to the Mississippi River. Currently no NPDES permit is in place for this stormwater outfall. **Figure 7, DeParq Woods Stormwater Outfall** depicts the location of the stage recorder and is presented below.



Stage recorder monitoring location is located at the DeParq Woods Stormwater Outfall at the culvert draining into a retention pond. Stage recorder was attached to metal grate shown in picture below.

Figure 7, DeParq Woods Stormwater Outfall

Stormwater outfall stage levels were recorded from August 9, 2002 to October 12, 2002. Stage measurements ranged from –41.8 to –27.8 inches below the calibration point. The invert of the stormwater outfall was not surveyed so stage measurements were not converted to feet above sea level. **Graph 9, DeParq Woods– Stage vs. Time** represents this data and is presented below.



A stage vs. discharge relationship was not developed for this stormwater outfall. Field discharge measurements taken to date range from 0.0225 to 3.0288 CFS but did not fall within the time frame when the stage recorder was installed. Due to the shallow nature of the stormwater outfall velocity measurements were difficult to record and additional field data would be required to build a rating curve. Based on the data recorded, it appears that the outfall remains as a steady hydrograph but rain events quickly cause the hydrograph to rise and fall. It is recommended that a stage recorder be installed in this location in the spring of 2003 to better characterize the timing and magnitude of flow from this location.

2.7 USGS Gauging Stations

In addition to the stage recorder monitoring locations on Camp Ripley, the USGS gauging stations listed below in **Table 2, - USGS Gauging Station Links** were added to the accompanying Arcview Project. The data is accessed via a hotlink to the corresponding webpage listed below. The utility of this will be to quickly access real time stage and discharge data produced at these locations. Should a spill or contamination be detected in a monitored steam, total volume and loads to the receiving water body could be easily determined.

Table 2 – USGS Gauging Station Links

Station Name	**Station Number**	**Realtime Webpage URL**
Mississippi River Near Brainerd	5242300	http://mn.waterdata.usgs.gov/nwis/uv/?site_no=05242300&PARAmeter_cd=00065,00060
Mississippi River at Ft. Ripley Upstream of Nokasippi River	5261000	http://mn.waterdata.usgs.gov/nwis/uv/?site_no=05261000&PARAmeter_cd=00065,00060
Mississippi River Near Royalton	5267000	http://mn.waterdata.usgs.gov/nwis/uv/?site_no=05267000&PARAmeter_cd=00065,00060
Crow Wing River Near Nimrod	5244000	http://mn.waterdata.usgs.gov/nwis/uv/?site_no=05244000&PARAmeter_cd=00065,00060
Crow Wing River Near Pillager	5247500	http://mn.waterdata.usgs.gov/nwis/uv/?site_no=05247500&PARAmeter_cd=00065,00060
Long Prairie River Near Long Prairie	5245100	http://mn.waterdata.usgs.gov/nwis/uv/?site_no=05245100&PARAmeter_cd=00065,00060

Figure 8, USGS Gauging Stations depicts the location of the gauging stations surrounding Camp Ripley and is presented on the next page.

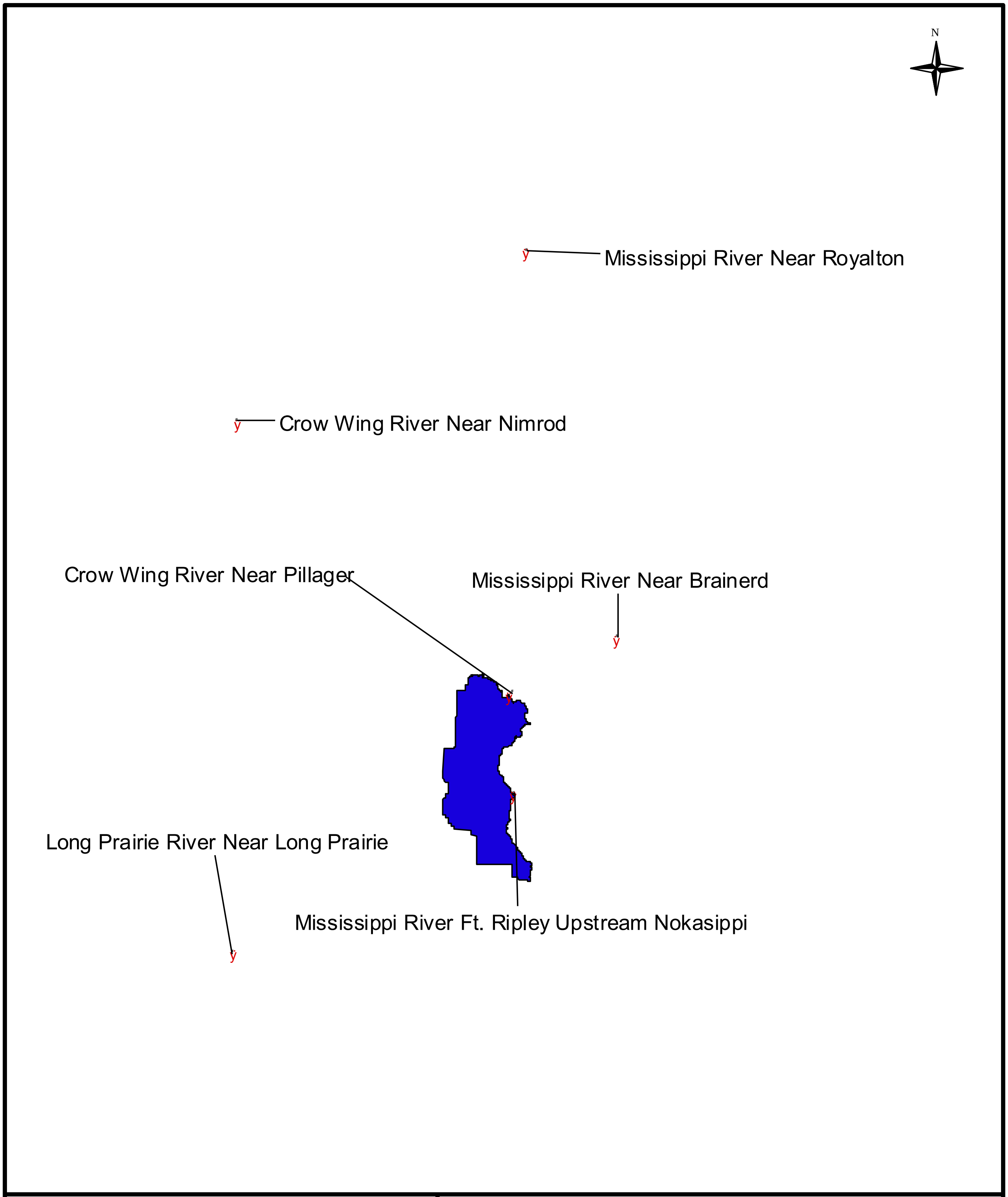


Figure 8, USGS Gauging Stations

3.0 Installation Procedures

The general procedures used to install the stage recorders are documented below:

1. A metal post was driven approximately three feet into the streambed near the edge of the channel.
2. The stage recorder was attached to the metal post so that the bottom of the recorder was on the bottom of the channel.
3. The stage recorder was attached to the metal post with plastic ties.
4. A cyber stake (military location device) was attached to the top of the metal post with plastic ties.
5. A benchmark (2x2 inch wooden stake) was driven into the ground adjacent to the stage recorder on the stream bank.
6. Camp Ripley staff determined the northing, easting and elevation of the benchmark with a Global Positioning System (GPS). Existing GIS data from E2M was used for the locations of the stormwater outfalls.
7. The vertical distance was measured from the benchmark to the calibration line on the stage recorder in order to convert the stage to elevation.
8. A cross-section of the stream channel was surveyed perpendicular to the benchmark location.

4.0 Monitoring Procedures

The stage recorders were monitored periodically from 2000 to 2002. The provided excel spreadsheets indicate the actual range of dates for each monitoring location. In general, the stage recorders were programmed to record stage levels twenty three times per day at one-hour intervals starting at midnight. Each time the stage recorders are visited the following tasks should be completed:

1. Check the battery and replace if required (less than 1.45 volts).
2. Clean the well screen and remove any debris that has accumulated around the stage recorder.
3. Photograph the stage recorder and stream.
4. Calculate discharge (See appendix A and B for blank and completed data sheets).
5. Download the stage levels to a laptop computer.

The following section summarizes the calibration procedures for the Global Water probe used to calculate average stream velocities. This procedure should be completed after changing batteries or after periods of prolonged inactivity.

4.1 Global Water Flow Probe Calibration

1. Press both buttons at the same time for 8 seconds.
2. Press the left button until "mi" appears (this will set it for English measurement).
3. Push the right button then enter the "CAL" (calibration) mode.
4. Set the calibration at 33.31 (**there is a decimal point written on the display face, do NOT use this as the decimal point for calibration or reading**). Use the left button to increase the numbers, and the right button to decrease the numbers.
5. Press the right button, "CAD" should not be displayed.
6. Push the right button, SLEEP will appear. Leave probe in SLEEP mode.
7. To use probe, push the right button until the velocity screen is displayed.

The following section outlines the procedures for calculating discharge at the stage recorder locations.

4.2 Discharge Calculations

Materials Needed:

1. Datasheet - Each stream has its own unique data sheet with the widths pre-determined and is located in Appendix A. If the stream width exceeds that on the data sheet, add additional sections as necessary, maintaining the same width as the previous sections. The datasheets are presented in Appendix A.
2. Global Water Velocity Recorder.
3. Tape Measure.
4. Work boots (water-proof knee boots)
5. Stakes

Discharge Procedures:

1. Secure measuring tape across stream channel using stakes starting at the edge of water.
2. Note LEW, REW (Left/Right Edge of Water facing downstream).
3. Record depth and velocity at intervals determined on datasheet.
   - 3.1. Depth
     - 3.1.1. Use feet increments on Flow Probe (to the nearest .25 feet).
   - 3.2. Velocity

        - 3.2.1. Use right button to show display of "**V**". Use left button to show display of "**av**". The top number is instantaneous velocity – the **bottom** number is the average velocity measured in feet/second.
        - 3.2.2. Place the flow probe in the water at the designated distance on the data sheet.
        - 3.2.3. Turn the flow probe so that the arrow (in the PVC tubing at the bottom) is facing downstream (towards the Mississippi River). You can turn the display box so that it is facing you, while maintaining the arrow placement downstream. Stand to one side of the meter, to not obstruct flow.
        - 3.2.4. Move the flow probe vertically in the water column, but maintaining a continuous distance across the tape measure (ie, 2.5 feet) for 20 to 40 seconds, until the average velocity stabilizes.
        - 3.2.5. Record the bottom number displayed on the probe screen to the datasheet.
        - 3.2.6. Using your index and middle fingers on the left and right buttons, press simultaneously until the velocity readings display 0.0. (If another screen comes up, use the right button to toggle trough the screens until you return to velocity and try to re-zero again).
        - 3.2.7. Place the probe in the water column at the next interval and repeat steps 3.2.3 to 3.2.6. Take measurements at the specified distances on the data sheet until 1) there is insufficient water to measure a depth reading, or 2) you have reached the bank edge.
        - 3.2.8. If an object such as a rock or debris is at the specific point where a measurement is to be taken, move to where the water is open – or to the next specified distance. Note this change on the datasheet.
4. If discharge can not be taken, record the depth of the standing water.
5. Draw and label a sketch of the stream cross-section.

4.3 Downloading Stage Recorders

Materials Needed:
1. Notebook Computer with Ecotone software installed
2. 9-pin parallel cable

Downloading Procedures:
1. Open Ecotone software.
2. Select Preview Data.
    - 2.1. Scroll through the data to see when recording began and stopped and to ensure that data is being recorded. The last reading should be from the hour prior to the current time (so if you're checking at 12:25, the last reading should be at 12:00).
    - 2.2. Note data start and end date on the stream gauging datasheet.
3. Select Download Data
    - 3.1. Select "save all data to new file"
    - 3.2. Save the data to the temp folder on the computer, using the naming convention of "Stream_start date_end date". For example: "Anzio_13Feb02_16July02"
    - 3.3. Double check the file was saved (using Explorer or My Computer)
4. Select Erase Memory.
5. Ensure that battery power is sufficient.
6. Exit

5.0 Data Management

All data is included on the accompanying CD. The following general procedures should be used for data management. Data was transferred from the temp directory on the laptop to (mapped drive\Stream_Discharge_Report\Discharge_Data\Raw_Data location. New subdirectories under discharge data were created that correspond to the stream common names ie. Broken Bow Creek etc. These directories hold all of the data for each unit that was downloaded. These data were combined for each unit and housed in a file named stream name combined records. This data acts as an archive and all other copies on the laptop were deleted. The data was copied into the following spreadsheet for analysis and graphing purposes (mapped drive Stream_Discharge_Report\All_Summarized_Data\stage_recorder_data.xls. The hotlinks daughter directory contains a copy of each stream into its' own directory and serves to open the spreadsheets from the Arcview project str_discharge.apr. When the data is installed in its' final location, the field named Stagedat in the shapefile stagerecall.shp will need to be modified to reflect the location of the excel spreadsheets that they are linked to.

6.0 Data Gaps and Errors

Throughout the course of the project a number of events resulted in data gaps or erroneous data being recorded by the automated stage recorders. This section summarizes the challenges that were encountered with suggestions on how to prevent the problems in the future should Camp Ripley environmental managers choose to continue to utilize the stage recorders.

First, the stage recorders were left in place throughout the winters of 2000/2001 and 2001/2002 in order to monitor baseflow conditions. Although all streams monitored flowed throughout the winter the cold temperatures caused malfunctions in the electronics of the devices. This data was inspected and deleted from the graphs when appropriate. It should be noted that 2000/2001 was a typical winter in terms of temperature and snowpack at Camp Ripley while 2001/2002 was unseasonably warm with low snowfall and sporadic rain events. The stage recorders should be removed in November of each year and reinstalled in March or when ice has left the streams.

In the spring of 2001 the stage recorders at North Hendrickson Stream and Anzio Stream were flooded by backwater from the Mississippi River. These stage recorders were destroyed and the data was lost for these periods. RDS replaced these stage recorders at no cost to Camp Ripley and they were reinstalled. The North Hendrickson stream recorder was reinstalled in the same location with no further problems and the Anzio Stream recorder was reinstalled in a new location further upstream from the Mississippi River to prevent interference from rising waters. The North Hendrickson Stream stage recorder should be relocated due to difficulty in measuring flows in such a small stream. The Anzio Stream stage recorder was highly influenced by the vertical culvert located upstream at the Trout Pond. This stage recorder should be moved to a more favorable location.
The stage recorders initially installed were the WL-40 series products manufactured by Remote Data Systems (RDS). These units were replaced with ecotone recorders, also manufactured by RDS, which utilize a laptop computer for downloading purposes in March 2001. The units were unreliable for downloading data and on a number of occasions had to be mailed to RDS for data retrieval. Most recently, in June 2002, the Anzio Stream and Stream 362 stage recorders failed. These units were mailed to RDS and the data was emailed to UMD. Four new stage recorders are being provided to Camp Ripley at no cost to update to a new design that should prove more reliable. These new stage recorders will be installed when received. Based on a review of the data, Broken Bow Creek and Stream 362 should continue to be monitored and North Hendrickson Stream and Anzio Stream recorders should be relocated in another advantageous location to Camp Ripley environmental managers. Possible placement alternatives include at stormwater outfalls or on the Little Elk River Tributary on the western edge of Camp Ripley.

7.0 Conclusion

This report serves as a briefing of the data collection efforts for inventorying surface water at Camp Ripley. In addition, this report can be utilized as a users guide for future data acquisition for the stage recorders at Camp Ripley. Any questions regarding this report should be directed to Dave Stark at UMD (218-726-7687).

APPENDIX A

STREAM DISCHARGE BLANK DATA SHEETS

- **BROKEN BOW CREEK**
- **NORTH HENDRICKSON STREAM**
- **ANZIO STREAM**
- **STREAM 362**
- **A22WR STORMWATER OUTFALL**
- **DEPARQ WOODS STORMWATER OUTFALL**

Station ID:	**Broken Bow Creek**
Date of Q Measurement:	
Time of Q Measurement:	
Download File Name:	
Download Date Range:	

Discharge - Velocity Area Method

Tape Distance (Feet)	**Width Section (Feet)**	**Depth (Feet)**	**Velocity (Feet/Second)**
0	0.15	0	0
0.3	0.3		
0.6	0.3		
0.9	0.3		
1.2	0.3		
1.5	0.3		
1.8	0.3		
2.1	0.3		
2.4	0.3		
2.7	0.3		
3	0.3		
3.3	0.3		
3.6	0.3		
3.9	0.3		
4.2	0.3		
4.5	0.3		
4.8	0.3		
5.1	0.3		
5.4	0.3		
5.7	0.3		
6	0.3		
6.3	0.3		
6.6	0.15	0	0

Total Width of Stream: ______________(ft)

Record depth and velocity measurements as indicated by the grey sections.
Add or subtract sections as needed.

Notes:
LEW - Left Edge of Water Facing Downstream
REW - Right Edge of Water Facing Downstream

Station ID:	**North Hendrickson Stream**
Date of Q Measurement:	
Time of Q Measurement:	
Download File Name:	
Download Date Range:	

Discharge - Velocity Area Method

Tape Distance **(Feet)**	**Width Section (Feet)**	**Depth** **(Feet)**	**Velocity** **(Feet/Second)**
0	0.1	0	0
0.2	0.2		
0.4	0.2		
0.6	0.2		
0.8	0.2		
1.0	0.2		
1.2	0.2		
1.4	0.2		
1.6	0.2		
1.8	0.2		
2.0	0.2		
2.2	0.2		
2.4	0.2		
2.6	0.2		
2.8	0.2		
3.0	0.2		
3.2	0.2		
3.4	0.2		
3.6	0.2		
3.8	0.2		
4.0	0.1	0	0

Total Width of Stream: _______________(ft)

Record depth and velocity measurements as indicated by the grey sections.
Add or subtract sections as needed.

Notes:
LEW - Left Edge of Water Facing Downstream
REW - Right Edge of Water Facing Downstream

Station ID:	**Anzio Stream**
Date of Q Measurement:	
Time of Q Measurement:	
Download File Name:	
Download Date Range:	

Discharge - Velocity Area Method

Tape Distance (Feet)	Width Section (Feet)	Depth (Feet)	Velocity (Feet/Second)
0.0	0.2	0	0
0.4	0.4		
0.8	0.4		
1.2	0.4		
1.6	0.4		
2.0	0.4		
2.4	0.4		
2.8	0.4		
3.2	0.4		
3.6	0.4		
4.0	0.4		
4.4	0.4		
4.8	0.4		
5.2	0.4		
5.6	0.4		
6.0	0.4		
6.4	0.4		
6.8	0.2	0	0

Total Width of Stream: _______________(ft)

Record depth and velocity measurements as indicated by the grey sections.
Add or subtract sections as needed.

Notes:
LEW - Left Edge of Water Facing Downstream
REW - Right Edge of Water Facing Downstream
Note depth of standing water if discharge not taken:
Note and draw sketch w/ culvert diameter, depth, velocity, and condition of inflow/outflow if used to estimate discharge.

Station ID:	**A22WR Stormwater Outfall**
Date of Q Measurement:	
Time of Q Measurement:	
Download File Name:	
Download Date Range:	

Discharge - Velocity Area Method

Tape Distance (Feet)	Width Section (Feet)	Depth (Feet)	Velocity (Feet/Second)
0	0.15	0	0
0.3	0.3		
0.6	0.3		
0.9	0.3		
1.2	0.3		
1.5	0.3		
1.8	0.3		
2.1	0.3		
2.4	0.3		
2.7	0.3		
3	0.3		
3.3	0.3		
3.6	0.3		
3.9	0.3		
4.2	0.3		
4.5	0.15		

Total Width of Stream: ______________(ft)

Record depth and velocity measurements as indicated by the grey sections.
Add or subtract sections as needed.

Notes:
LEW - Left Edge of Water Facing Downstream
REW - Right Edge of Water Facing Downstream
Note depth of standing water if discharge not taken:
Note and draw sketch w/ culvert diameter, depth, velocity, and condition of inflow/outflow if used to estimate discharge.

Station ID:	**De Parq Woods Stormwater OF**
Date of Q Measurement:	
Time of Q Measurement:	
Download File Name:	
Download Date Range:	

Discharge - Velocity Area Method

Tape Distance (Feet)	Width Section (Feet)	Depth (Feet)	Velocity (Feet/Second)
0	0.15	0	0
0.3	0.3		
0.6	0.3		
0.9	0.3		
1.2	0.3		
1.5	0.3		
1.8	0.3		
2.1	0.3		
2.4	0.3		
2.7	0.3		
3	0.3		
3.3	0.3		
3.6	0.3		
3.9	0.3		
4.2	0.3		
4.5	0.15		

Total Width of Stream: _____________(ft)

Record depth and velocity measurements as indicated by the grey sections.
Add or subtract sections as needed.

Notes:
LEW - Left Edge of Water Facing Downstream
REW - Right Edge of Water Facing Downstream
Note depth of standing water if discharge not taken:
Note and draw sketch w/ culvert diameter, depth, velocity, and condition of inflow/outflow if used to estimate discharge.

APPENDIX B

STREAM DISCHARGE COMPLETED DATA SHEETS

- **BROKEN BOW CREEK**
- **NORTH HENDRICKSON STREAM**
- **ANZIO STREAM**
- **STREAM 362**
- **A22WR STORMWATER OUTFALL**
- **DEPARQ WOODS STORMWATER OUTFALL**

Compliance Sampling Program Report

Table of Contents

Executive Summary

Report

Tables

Figures

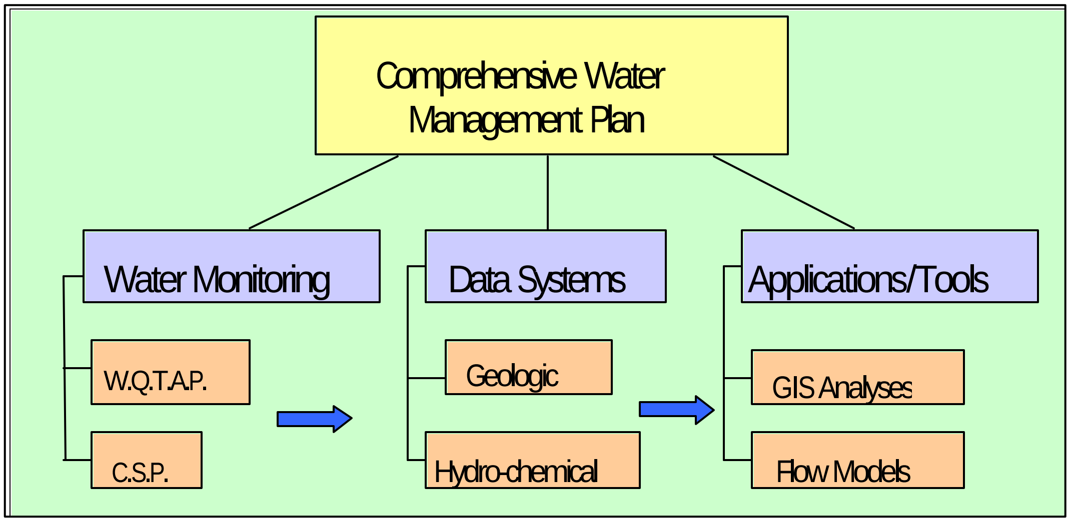
Appendices

1.0 Introduction

As part of the Comprehensive Water Management Plan within the University of Minnesota, Duluth (UMD) Geological Sciences Department and Minnesota Army National Guard (MnANG) contract, UMD is pleased to submit the Camp Ripley Compliance Sampling Program (CSP) Report.

UMD prepared this report in general accordance with the proposal for development of the Camp Ripley CSP dated February 7, 2002 and based on various meetings held with environmental managers at Camp Ripley. **Figure 1**, **Compliance Sampling Program Flowchart,** provides a conceptual representation of the program and is presented in the figure section of this document. This section of the report provides background information on the definition, need and purpose of the project as well as information on the organization of the report.

The CSP was designed as a permit driven sampling and analysis program to assist with water resource management at Camp Ripley. Combined with the Water Quality Trend Analysis Program (WQTAP) which is a proactive non-permit driven water quality program, CSP provides the framework on which to build a Comprehensive Water Management Plan (CWMP). The CWMP being established for Camp Ripley uses standard methods to collect, store, analyze, and report water quality data, with the overall goals being to protect and monitor water resources at Camp Ripley, stay in compliance with permits and support the primary mission of military training.



Schematic showing relationship between various Comprehensive Water Management Plan (CWMP) components.

1.1 CSP Definition

The CSP is composed of the following two major components:

1.) This report that describes routine water quality and soil sampling and analysis at Camp Ripley permitted facilities and facilities that may be permitted in the future.

2.) An interface to the EQuIS Chemistry database that stores the compliance-based test results and regulatory limits defined by the permits or regulations governing each facility.

The CSP addresses the routine water and soil testing performed at the following nine major facilities at Camp Ripley.

1. Demolition Debris Landfill (DDLF);
2. Mixed Municipal Landfill (MMLF);
3. Existing Land Farm Spread Site (ELFSS);
4. Proposed Land Farm Spread Site (PLFSS);
5. Area 22 Washrack NPDES Permit (A22WR);
6. Wastewater Treatment Plant NPDES Permit (WWTP);
7. Drinking Water Plant (DWP);
8. Cantonment Water Supply Wells (CWSW); and,
9. Stormwater Outfalls (SWOF).

Figure 2, Camp Ripley Compliance Sampling Program Facility Locations, displays the location of these facilities at Camp Ripley.

Table 1, **Compliance Sampling Program Summary,** provides an overview of the facilities with the general requirements of the permits and is presented on the next page of this document.

Table 1 – Compliance Sampling Program Summary

Facility	Demolition Debris Landfill	Mixed Municipal Solid Waste Landfill	Existing Land Farm Spread Site	Proposed Land Farm Spread Site	Area 22 Washrack NPDES Permit	Wastewater Treatment Plant NPDES Permit	Drinking Water Plant	Cantonment Water Supply Wells	Stormwater Outfalls
Permit Type	Solid Waste Facility	Solid Waste Facility	Land Treatment Facility	Land Treatment Facility	NPDES/SDS	NPDES/SDS	Public Water Supply	Water Appropriation	N.A.
Permit Regulator	MN PCA	MN PCA	MN PCA	MN PCA	MN PCA	MN PCA	MDH	MN DNR	N.A.
Permit Number or ID	SW-359	Camp Ripley Landfill Closure Plan –Second Draft dated April 15, 1987	PRE0581 - Sept. 29, 2000	Not Assigned	MN0063070	MN 0025721	PWS 5490185	85-3053	N.A.
Permit (Re) Application Date	July 2000	N.A.	September 18, 2000	June 2000	March 19, 2001	January 1, 2007	N.A. - No Permit Issued for PWS	N.A.	N.A.
Permit Issuance Date	February 22, 2002	N.A.	September 29, 2000	Not Assigned	October 24, 1996	June 11, 2002	N.A.	August 14, 2001	N.A.
Permit Expiration Date	February 22, 2007	N.A.	September 29, 2002 or 1,500 cubic yard capacity reached	Not Assigned	September 30, 2001	May 31, 2007	N.A.	N.A.	N.A.
Permit Status	Current	N.A.	Current	Not Assigned	Expired	Current	N.A.	Current	N.A.
Facility Status	Active Landfill	Closed Landfill	Active	Permitting	Active	Active	Active	Active	Unpermitted Stormwater Outfalls
Camp Ripley POC	Jon Kolstad	Scott Albers	Jon Kolstad	Scott Albers/ Jon Kolstad	Joel Wilczek	Joel Wilczek	Joel Wilczek	Joel Wilycek	John Ebert
Regulatory POC	Jason Chan (MN PCA, Brainerd)	Jason Chan (MN PCA, Brainerd)	Sandra Miller-Moren (MN PCA, Brainerd)	Sandra Miller-Moren (MN PCA, Brainerd)	Robin Novotny (MN PCA, Brainerd)	Robin Novotny (MN PCA, Brainerd)	Wally From (MDH, St. Cloud)	Dave Hills (MN DNR)	N.A.
Sampling or Measurement Locations	**Monitoring Wells** 250122 539404 539405 671612	**Monitoring Wells** 250123 250124 250125 250126	**Varies** At location of contamination for characterization. At 12 gridded treatment cells following spreading.	**Monitoring Wells** 671613 671614 671615 671616	**Outfall Number 391M1** SD-001-(Storm Sewer at Mississippi River) **Outfall Number 011** Skimmer to WWTP	**Outfall Number 011** WS-001 (Inflow) WS-002 (Biosolids to Land) SD-001 (Bypass) SD-002 (Main Discharge)	Sampled at Laboratory Sinki in the Drinking Water Plant Building Location ID = LABSINK (Post-treatment sampling)	**Water Supply Wells** 224577 (H) 470668 (L) 622775 (N)	**Stormwater Outfalls** Wastewater Treatment Plant (OF001) De Parcq Woods (OF002) Northern (OF005) Area 22 (OF006)
Sample Matrix	Groundwater	Groundwater	Soil	Groundwater	Water	Water/Soil (Biosolids)	Water	N.A.	Water
Sampling or Measurement Frequency	**3 Times/Year for Baseline Monitoring of New Well 671612** Spring (3/28-4/28) Summer (7/1-8/7) Fall (10/14–11/14) **2 Times/ Year for 250122, 539404, 539405)** Spring (3/28-4/28) Fall (10/14–11/14)	**1 Time/Year** Fall (10/14–11/14)	**Varies** Until </=10 ppm TPH	**3 Times/Year** Spring (3/14-4/21) Summer (6/21-7/31) Fall (10/21–11/21)	**Varies** Daily Flow Estimates Monthly Grab Samples	**Varies** Daily, Weekly, and Monthly Measurements.	**1 Time/Year** Annual testing set by St. Cloud MDH office. **1 Time/3 Years** Rotating schedule set by St. Paul MDH office.	**12 Times/Year** Monthly volume readings	**3 Times/Year** To be sampled 3 times per year following rain events sufficient to produce flow.
Reporting	Spring Water Monitoring Report (By 6/30) Autumn Water Monitoring Report (By 1/31) Annual Water Monitoring Evaluation Report (By 2/1 of following year)	Annual/Fall (By 2/1 of following year)	Form B pre-application. Form C w/in 10 days following application.	Baseline data reported in permit application.	Jan. - Mar. (Quarterly) Apr. – Sept. (Monthly) Oct.- Dec. (Quarterly) (By 21st of month following monitoring)	Jan. – Dec. (Monthly) (By 21st of month following monitoring) Biosolids report due December 31st.	Sampling, analysis and reporting done by MDH. Results provided to Camp Ripley.	Annual (By 2/15 of following year)	Internal memorandum regarding sampling following data collection.
Sampling Parameters or Measurements	**671612** Spring -Tables 1&2 Summer – Tables 1&2 Fall – Tables 1&2 **250122, 539404, 539405** Spring – (See Limits Table in Permit for Shortened List) Fall – (See Limits Tables, Table 2 VOC's only completed in Odd Numbered Years)	**Fall** Table 2	**Pre-Application Testing** TPH/GRO/DRO BTEX MTBE Lead **Post-Application Testing** TPH test less than or equal to 10 ppm or completion of 4 tillage cycles.	**Baseline** MDH List 465E, DRO MTBE, BTEX and GRO. **Operating** BTEX, GRO, DRO (Pending Approval of Permit)	**SD-001 (Miss. River)** Flow (MG) estimated pH TSS Oil and Grease Total Residual Chlorine	**WS-001 (Inflow)** Flow, CBOD, TSS, pH **WS-002 (Biosolids)** Arsenic, Cadmium, Copper, Lead, Mercury, Molybdenum, Nickel, Nitrogen, Ammonia, Nitrogen, Kjeldahl, pH, Phosphorus, Potassium, Selenium, Total Solids, Total Volatile, Percent of Total Zinc **SD-001 (Bypass)** Flow, CBOD, TSS, Fecal Coliform, Q Duration **SD-002 (Main)** CBOD, TSS, pH, Fecal Coliform, DO	**Annual Testing** Colliform Bacteria Total Nitrogen (Nitrite + Nitrate) **Three Year Testing** VOC's IOC's SOC's	Volume of Water Pumping Rate	See analyte list in Appendix E.
Sample Collection or Measurement Responsibility	Interpoll subcontracted by UMD for 2002 Interpoll or contractor chosen by Camp Ripley 2003->	Interpoll subcontracted by UMD for 2002 Interpoll or contractor chosen by Camp Ripley 2003->	Camp Ripley FMOE Personnel 2002 ->	Interpoll subcontracted by UMD for 2002 Interpoll or contractor chosen by Camp Ripley 2003->	Camp Ripley Department of Public Works Personnel 2002 ->	Camp Ripley Department of Public Works Personnel 2002 ->	Minnesota Department of Health Personnel 2002 -> POC–Wally From (St. Cloud) POC-Jeff Thomson (St. Paul)	Camp Ripley Department of Public Works Personnel 2002 ->	UMD staff 2002 Camp Ripley staff or contractor chosen by Camp Ripley 2003->
Sample Processing Facility	Interpoll Labs Inc.	Interpoll Labs Inc.	Interpoll Labs Inc.	Interpoll Labs Inc.	WWTP Laboratory Interpoll (Oil/Grease Only)	WWTP Laboratory	MDH Public Health Laboratory – St. Paul, MN	N.A.	Interpoll Labs Inc. And Natural Resources Research Institute
Results Start Date in EQuIS Chemistry Database	1994	1990	1997 (Data Contained in September 29, 2000 Permit Application).	2002	2001	2001	2001	1999	2001
UMD Entered Data Through This Date into Equis Chemistry Database	Summer 2002	Fall 2001	August 2000	Summer 2002	March 2002	March 2002	Summer 2001	January 2002	Summer 2002

1.2 CSP Purpose

The purpose of CSP is to create a dynamic document and computer database that summarizes the permit based water quality testing performed at regulated facilities within Camp Ripley. This document consolidates all permits into one location along with the tools to manage the data transfer and storage of testing results. These tools will allow environmental managers to view trends in water quality over time and to have ready access to water quality testing results for regulators or concerned citizens.

In addition, the PLFSS and SWOF are being monitored for baseline water quality information. If the facilities are permitted in the future the facility specific information can be added to this document.

1.3 CSP Report Organization

The report is organized as described below:

Section 2.0 – Facility Descriptions

This section provides summary information for each facility on **who** is responsible for sampling the facility, **what** parameters are analyzed, **when** the sampling is completed, **where** the sampling locations are located and **how** the sample results are transferred. The section refers the reader to various appendices that contain this information.

Section 3.0 – Data Management

This section presents an overview of the EQuIS Chemistry Database. This database is the repository of water quality and soil testing results produced from the sampling at CSP facilities. The general techniques for population of the database with Electronic Data Deliverables (EDD's) are included.

Section 4.0 – Recommendations for Implementing CSP at Camp Ripley

This section provides recommendations on how to implement CSP at Camp Ripley along with guidance on updating this document and associated spreadsheets when new permits are issued.

2.0 Facility Information

2.1 Demolition Debris Landfill (DDLF)

The Demolition Debris Landfill (DDLF) consists of 21 acres and is located on the south side of Argonne Road near the intersection with Luzon Road. **Figure 3, Demolition Debris Landfill**, depicts the location of the facility with its' four groundwater-monitoring wells. These monitoring wells are summarized in the table below:

Demolition Debris Landfill - Monitoring Wells				
Station Type	**Minnesota Unique ID**	**Status**	**Compliance/ Detection**	**Comments**
Monitoring Well	250122	Active	Compliance	Far Downgradient
Monitoring Well	539404	Active	Detection	Sidegradient
Monitoring Well	539405	Active	Compliance	Upgradient
Monitoring Well	671612	Active	Compliance	Downgradient

Monitoring results are linked to the six-digit Minnesota Unique ID in the EQuIS Chemistry database. Database records begin in 1994 for this facility.

The Solid Waste Permit for the facility, SW-359, is administered by the Minnesota Pollution Control Agency (MPCA). **Appendix A, Facility Permits/Documentation,** includes a copy of the permit for the DDLF that was issued in February 2002. The facility was originally permitted in July of 1990 and an Environmental Assessment was performed in 1989. The facility has a total ultimate disposal capacity of 288,000 cubic yards of material but only has a permitted capacity of 75,000 cubic yards. During the first 10 years of operations the DDLF has used approximately 33,200 cubic yards of capacity leaving 41,800 cubic yards of permitted capacity (Wenck, 2000).

UMD subcontracted Interpoll Laboratories Inc. (Interpoll) to perform sampling and analysis at the DDLF during 2002. Camp Ripley will have the responsibility of renewing this contract with Interpoll or another laboratory in 2003. Interpoll or other subcontracted laboratories should be instructed to continue providing hard copy testing results along with digital data.

Monitoring requirements for wells 250122, 539404 and 539405 are included in the Limits Table of the facility permit. When the permit was re-issued in 2002 a decision was made by MPCA to reduce sampling requirements at the facility. In general, these wells are to be sampled annually in the spring and fall of each year for a reduced list of analytes and in odd-numbered years for Volotile Organic Compounds (VOCs). Refer to the facility permit for specific analytes.

Monitoring well 671612 installed in late 2001 will be monitored for baseline water quality for three (3) consecutive quarters (spring, summer and fall of 2002). This testing will include the full list of parameters indicated in the Limits Table of the permit listed in Appendix A. After baseline monitoring has been completed, monitoring well 671612 will be sampled according to the frequency outlined in the Limits Table for the existing three monitoring wells.

Appendix B, Compliance Sampling Program Contact List, contains contact information for Jason Chan (MPCA) and Jon Kolstad (Camp Ripley) who are the primary contacts for the facility.

Appendix C, CSP Endnote Bibliography, contains the citation for the final permit issued in February 2002.

Appendix D, Schedule, outlines the range of dates for testing at the DDLF with the required submittals as required in the facility permit. The schedule contains the permit issuance date of February 22, 2002 and the expiration date of February 27, 2007. Permit reapplication is due at the MPCA on August 26, 2006, 180 days prior to the permit expiration date, which is also noted on the schedule. Following baseline monitoring for monitoring well 671612 all monitoring wells will be sampled in the spring and fall of each year.

Appendix E, Compliance Limits, includes a listing of the analytes with their respective Intervention Limits (IL) for the DDLF. The IL is generally set at one quarter of the Health Risk Limit (HRL) as identified by the MN PCA. This limit is included in the EQuIS Chemistry database to compare monitored values to compliance limits.

Appendix F, Electronic Data Deliverable Files and Import Formats, contains two excel spreadsheet used for importing data into the EQuIS Chemistry database for the DDLF. The spreadsheets, referred to as electronic data deliverables (EDDs), are explained in greater detail in section **3.2** of this document.

The first spreadsheet, named DDLF_Edd.xls, is used for importing test results into the EQuIS Chemistry database. The second spreadsheet, named SAMPLEPARAM_PURGE_Edd.xls, is used for importing field parameter measurements and well purging information into the EQuIS Chemistry database.

Each EDD is accompanied by an import format document that describes the fields to be populated. The EDDs and import format documents are presented as shortcuts.

Appendix G, Sampling Protocol for DDLF and MMLF, contains a document that outlines the general procedures for sampling and analysis at these facilities. The document was completed by Twin Cities Engineering and is dated February 12, 1996. This document does not reflect the updates to the permit that were instituted in 2002. Interpoll currently operates at Camp Ripley under a state contract that outlines their standard operating procedures for sampling at the DDLF.

Appendix J, Scope of Work for DDLF, MMLF and PLFSS, includes the scope of work that was written by UMD to contract Interpoll for sampling in 2002. Camp Ripley can utilize this scope of work when renewing the monitoring contract in 2003.

Appendix K, Laboratory Cost Estimates for DDLF, MMLF and PLFSS, includes the original cost estimates provided to UMD by Interpoll. These estimates were given before the new permit for the DDLF was issued and therefore will be higher than the actual costs of monitoring due to decreases in frequency and number of tests performed.

2.2 Mixed Municipal Landfill (MMLF)

The Mixed Municipal Landfill (MMLF) is located south of Argonne Road near the intersection with East Boundary Road and was closed in 1986. **Figure 4, Mixed Municipal Landfill**, depicts the location of the Mixed Municipal Landfill facility with its' four groundwater-monitoring wells. These monitoring wells are summarized in the table below:

Mixed Municipal Landfill – Monitoring Wells				
Station Type	**Minnesota Unique ID**	**Status**	**Compliance/ Detection**	**Comments**
Monitoring Well	250123	Active	Background and Compliance Monitoring	Side-Gradient – Previous I.D. MW-4
Monitoring Well	250124	Active	Compliance Monitoring	Down-Gradient– Previous I.D. MW-5
Monitoring Well	250125	Active	Background Monitoring	Up-Gradient– Previous I.D. MW-3
Monitoring Well	250126	Active	Background and Compliance Monitoring	Side-Gradient– Previous I.D. MW-6

Monitoring results are linked to the six-digit Minnesota Unique ID in the EQuIS Chemistry database. Database records begin in 1990 for this facility.

The post-closure monitoring is administered by the Minnesota Pollution Control Agency (MPCA). **Appendix A, Facility Permits/Documentation,** includes a copy of the Camp Ripley Landfill Closure Plan for MMLF. This plan does not include the monitoring requirements for the MMLF. Currently the monitoring includes testing for Volatile Organic Compounds (VOC's) in the fall of each year.

UMD subcontracted Interpoll Laboratories Inc. (Interpoll) to perform sampling and analysis at the MMLF during 2002. Camp Ripley will have the responsibility of renewing this contract with Interpoll or another laboratory in 2003.

Appendix B, Compliance Sampling Program Contact List, contains contact information for Jason Chan (MPCA) and Scott Albers (Camp Ripley) who are the primary contacts for the facility. Jason Chan administers the permit under the Minnesota Closed Landfill Program.

Appendix C, CSP Endnote Bibliography, contains the citation for the Camp Ripley Landfill Closure Plan.

Appendix D, Schedule, outlines the range of dates for testing at the MMLF with the required submittals. Currently monitoring is only required in the fall of each year with the results from the monitoring accompanying the year end report for the DDLF.

Appendix E, Compliance Limits, includes a listing of the analytes with their respective Intervention Limits (IL) for the MMLF. The IL is generally set at one quarter of the Health Risk Limit (HRL) as identified by the MN PCA. The IL limit is included in the EQuIS Chemistry database to compare monitored values to compliance limits. The compliance limits were adapted from the list of Volatile Organic Compounds (VOC's) listed in the DDLF permit since no formal monitoring document for the MMLF currently exists.

Appendix F, Electronic Data Deliverable Files and Import Formats, contains two excel spreadsheet used for importing data into the EQuIS Chemistry database for the MMLF.

The first spreadsheet, named MMLF_Edd.xls, is used for importing test results into the EQuIS Chemistry database. The second spreadsheet, named SAMPLEPARAM_PURGE_Edd.xls, is used for importing field parameter measurements and well purging information into the EQuIS Chemistry database.

Each EDD is accompanied by an import format document that describes the fields to be populated. The EDDs and import format documents are presented as shortcuts.

Appendix G, Sampling Protocol for DDLF and MMLF, contains a document that outlines the general procedures for sampling and analysis at these facilities. The document is dated February 12, 1996 and does not reflect the decreased monitoring being considered at the MMLF. Interpoll currently operates at Camp Ripley under a state contract that outlines their standard operating procedures for sampling at the MMLF.

Appendix J, Scope of Work for DDLF, MMLF and PLFSS, includes the scope of work that was written to contract Interpoll for sampling in 2002. Camp Ripley can utilize this scope of work when renewing the monitoring contract in 2003.

Appendix K, Laboratory Cost Estimates for DDLF, MMLF and PLFSS, includes the original cost estimates provided to UMD by Interpoll.

2.3 Existing Landfarm Spreadsite (ELFSS)

The Existing Landfarm Spreadsite (ELFSS) is located on the north side of Normandy Road near the intersection with Cody Road. **Figure 5, Existing Landfarm Spreadsite,** depicts the location of the facility with its' twelve cells utilized for spreading petroleum contaminated soil. Monitoring results are linked to the cell number in the EQuIS Chemistry database as displayed below.

Existing Landfarm Spreadsite Sampling Locations

Location ID	Description
Cell 1	Soil Treatment Cell
Cell 2	Soil Treatment Cell
Cell 3	Soil Treatment Cell
Cell 4	Soil Treatment Cell
Cell 5	Soil Treatment Cell
Cell 6	Soil Treatment Cell
Cell 7	Soil Treatment Cell
Cell 8	Soil Treatment Cell
Cell 9	Soil Treatment Cell
Cell 10	Soil Treatment Cell
Cell 11	Soil Treatment Cell
Cell 12	Soil Treatment Cell

The ELFSS is unique in that it ultimately treats waste from a variety of sources including the soil removed at the A22WR grit chamber and from spills that have occurred throughout the base. In order to track the origin of the material placed in each cell, the sys_sample_code field in the Equis Chemistry database is labeled as follows:

Cell4_0897A22WR

This naming convention indicates that the waste was spread in Cell 4, was tested in August of 1997 and originated at the A22WR. Additional information on the naming convention for all fields associated with the ELFSS are contained in **Appendix F, Electronic Data Deliverable Files and Import Formats.**

The site has been in operation since 1993 and is currently permitted to treat approximately 1500 cubic yards of petroleum contaminated soil and as of September 18, 2000 has received and treated 707.5 cubic yards of soil.

Database records include results contained in the Soil Corrective Action Plan listed below.

Appendix A, Facility Permits/Documentation, includes a copy of the Land Treatment of Petroleum Contaminated Soil- Soil Corrective Action Plan Approval dated September 23, 2000. This approval is based on an application dated September 18, 2000 to treat approximately 707.5 cubic yards of petroleum contaminated soil and is also contained within the appendix.

Facilities Management Office – Environmental (FMOE) staff will continue to sample the soil at ELFSS when appropriate and send the samples to Interpoll Laboratories for analysis in 2002. Camp Ripley will have the responsibility of renewing this contract with Interpoll or another laboratory in 2003.

Appendix B, Compliance Sampling Program Contact List, contains contact information for Sandra Miller-Moren (MPCA) and Jon Kolstad (Camp Ripley) who are the primary contacts for the facility.

Appendix C, CSP Endnote Bibliography, contains the citation for the Soil Corrective Action Plan Approval.

Appendix D, Schedule, contains a location for inserting dates for soil testing at the ELFSS. FMOE staff determines this schedule.

Appendix E, Compliance Limits, includes a listing of the analytes for pre and post-application testing. Pre-application testing is performed to characterize the waste prior to spreading. Post application testing is performed to document that soil Total Petroleum Hydrocarbon (TPH) values are equal to or less than 10 parts per million (ppm). The 10-ppm limit is included in the EQuIS Chemistry database to compare monitored values to compliance limits.

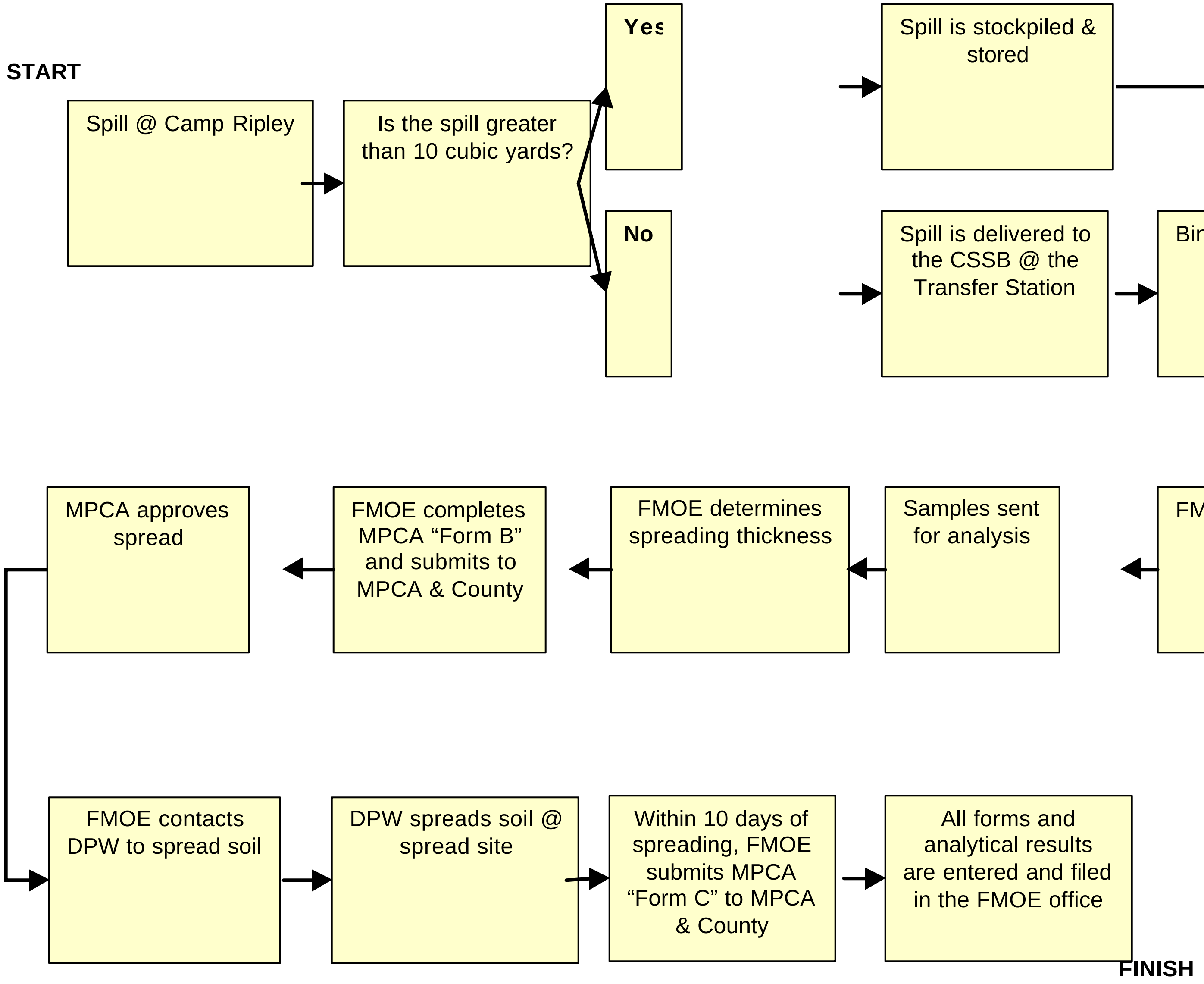
Appendix F, Electronic Data Deliverable Files and Import Formats, contain an excel spreadsheet used for importing data into the EQuIS Chemistry database for the ELFSS.

The spreadsheet, named ELFSS_Edd.xls, is used for importing test results into the EQuIS Chemistry database.

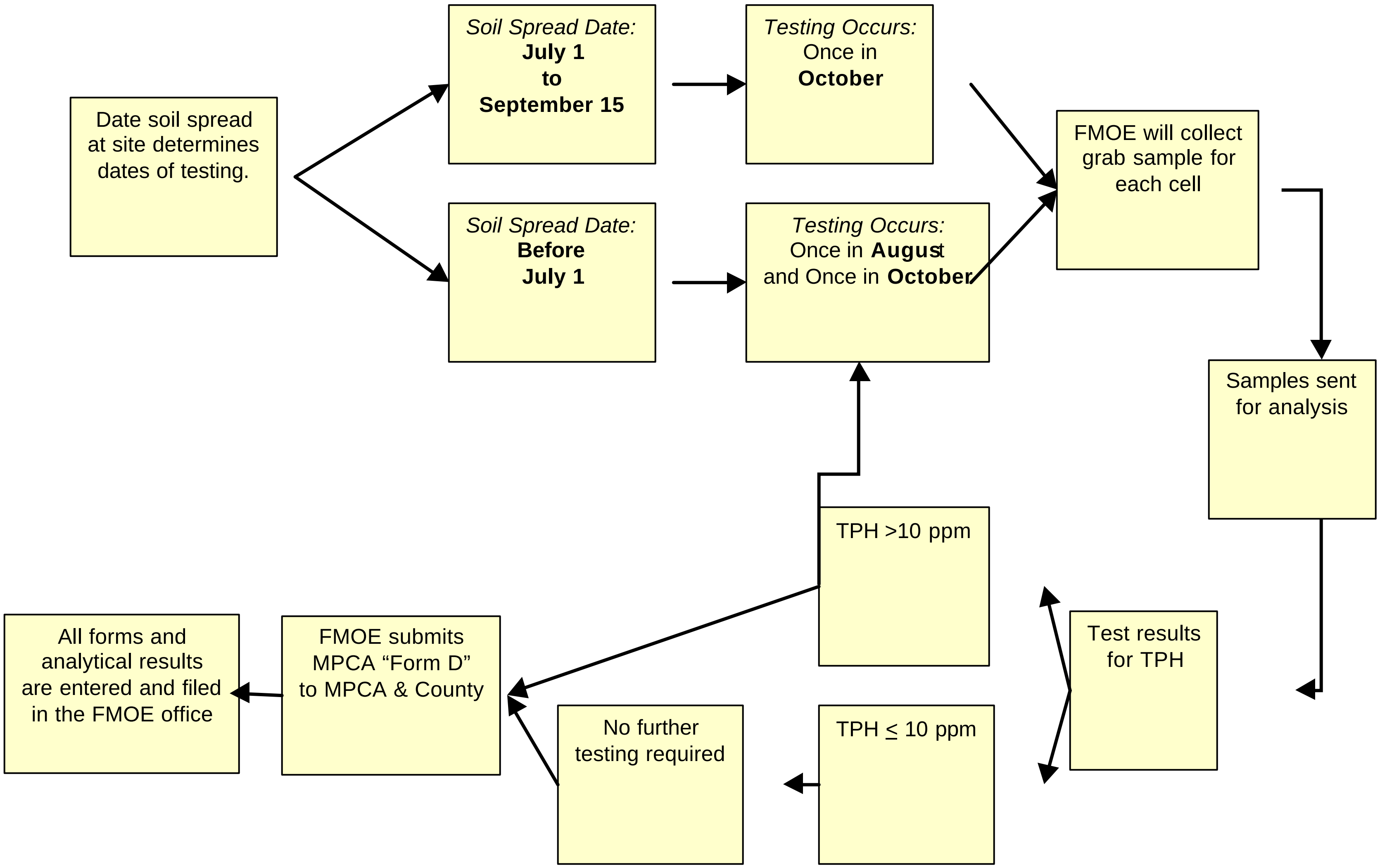
The EDD is accompanied by an import format document that describes the fields to be populated. The EDD and import format documents are presented as shortcuts.

The following two pages, provided by FMOE, visually depict the soil testing and soil spreading procedures currently in place at the ELFSS.

SOIL SPREADING AT THE POL CONTAMINATED SOIL SPREADSITE



SOIL TESTING AT THE POL CONTAMINATED SOIL SPREADSITE



2.4 Proposed Landfarm Spreadsite (PLFSS)

The Proposed Landfarm Spreadsite (PLFSS) is located north of Normandy Road near the intersection with Cody Road and to the west and north of the ELFSS. **Figure 6, Proposed Landfarm Spreadsite**, depicts the location of the proposed facility with its' four groundwater-monitoring wells. These monitoring wells are summarized in the table below:

Proposed Landfarm Spreadsite – Monitoring Wells				
Station Type	**Minnesota Unique ID**	**Status**	**Compliance/ Detection**	**Comments**
Monitoring Well	671613	Active	Background and Compliance Monitoring	Upgradient
Monitoring Well	671614	Active	Background and Compliance Monitoring	Landfarm Deep Middle Boring
Monitoring Well	671615	Active	Background and Compliance Monitoring	Landfill Shallow Middle Boring
Monitoring Well	671616	Active	Background and Compliance Monitoring	Downgradient

Monitoring results are linked to the six-digit Minnesota Unique ID in the EQuIS Chemistry database. Database records begin in 2002 for this facility. If the facility is ultimately permitted additional sampling locations can be added to the database to reflect the individual soil testing in each of the treatment cells. The naming convention should mimic that of the current testing being performed at the ELFSS.

Appendix A, Facility Permits/Documentation, includes a copy of the PLFSS permit application. If a facility permit is issued it should be inserted in this location. Based on this permit application, the Department of Military Affairs (DMA) is attempting to permit approximately 23.7 acres to be used to manage waste materials from DMA maintenance facilities.

UMD subcontracted Interpoll Laboratories Inc. (Interpoll) to perform sampling and analysis at the PLFSS during 2002. Camp Ripley will have the responsibility of renewing this contract with Interpoll or another laboratory in 2003. If the permit is issued, MPCA will determine monitoring requirements for the facility and ultimate capacity.

Appendix B, Compliance Sampling Program Contact List, contains contact information for Jason Chan (MPCA), Scott Albers and Jon Kolstad (Camp Ripley) who are the primary contacts for the facility.

Appendix C, CSP Endnote Bibliography, contains the citation for the permit application at the PLFSS.

Appendix D, Schedule, outlines the range of dates for testing at the PLFSS. Baseline monitoring is scheduled in the spring, summer and fall of 2002 and will coincide with the sampling being performed at the DDLF. If the facility is permitted a monitoring schedule will be developed by MPCA and the dates can be inserted in the schedule.

Appendix E, Compliance Limits, includes a listing of the analytes that will be tested for at the PLFSS during baseline monitoring. MPCA has not assigned intervention limits, as the facility is not yet permitted.

Appendix F, Electronic Data Deliverable Files and Import Formats, contains two excel spreadsheet used for importing data into the EQuIS Chemistry database for the PLFSS.
The first spreadsheet, named PLFSS_Edd.xls, is used for importing test results into the EQuIS Chemistry database. The second spreadsheet, named SAMPLEPARAM_PURGE_Edd.xls, is used for importing field parameter measurements and well purging information into the EQuIS Chemistry database.

Each EDD is accompanied by an import format document that describes the fields to be populated. The EDDs and import format documents are presented as shortcuts.

Appendix J, Scope of Work for DDLF, MMLF and PLFSS, includes the scope of work that was written to contract Interpoll for sampling in 2002. Camp Ripley can utilize this scope of work when renewing the monitoring contract in 2003. The scope of work will need to be adjusted to reflect the required monitoring that will be included in the facility permit.

Appendix K, Laboratory Cost Estimates for DDLF, MMLF and PLFSS, includes cost estimates provided to UMD by Interpoll.

2.5 Area 22 Washrack NPDES Permit (A22WR)

The Area 22 Washrack (A22WR) discharge outfall is located north of Motor Pool Road and east of East Boundary Road along the banks of the Mississippi River. **Figure 7, Area 22 Washrack NPDES Permit** , depicts the location of the discharge to the Mississippi River. The outfall is monitored at the location where the storm sewer enters the Mississippi River as shown on Figure 8. This sampling location is referred to as SD-001 in the permit. Monitoring results are linked to the sampling location OF006 in the EQuIS Chemistry database. This is the naming convention used by E2M for the stormwater outfall locations and is utilized for both the NPDES sampling and stormwater characterization sampling performed by UMD in 2002. Database records begin in 2001 for this facility.

A continuous stage recorder was installed in this location on August 9, 2002. Figure 15, Stage Recorder Location, depicts the location of the stage recorders currently installed at Camp Ripley. The stage recorders will be removed in November 2002 and reinstalled in the spring of 2003.

Area 22 Washrack NPDES Permit Sampling Location		
Location ID	**Description**	**Comments**
OF006	Storm Sewer at Mississippi River	Same as location SD-001 listed in permit.

In addition, the A22WR facility contains a skimmer that discharges to the WWTP sanitary sewer and is handled under the WWTP NPDES permit for that facility and is discussed in the next section.

The National Pollutant Discharge Elimination System (NPDES) and State Disposal System (SDS) permit for the facility, MN-0063070, is administered by the Minnesota Pollution Control Agency (MPCA). **Appendix A, Facility Permits/Documentation,** includes a copy of the A22WR permit. This permit expired on September 30, 2001. When an updated facility permit is issued by MPCA it can be inserted in this location. MPCA is expected to issue a permit renewal in 2002. Also, included in Appendix A is the A22WR permit renewal application submitted to MPCA on March 19, 2001.

Department of Public Works (DPW) staff perform the monitoring for the A22WR. All tests are performed at the Wastewater Treatment Plant Laboratory except for an Oil and Grease test that is currently outsourced to Interpoll Laboratories. The results from the Oil and Grease test are included on the discharge monitoring report and will be populated in the database as described below.

Solids removed from A22WR are tested and land applied at the ELFSS. The testing associated with this material is covered under the ELFSS facility information.

Appendix B, Compliance Sampling Program Contact List, contains contact information for Robin Novotny (MPCA) and Joel Wilczek (Camp Ripley) who are the primary contacts for the facility.

Appendix C, CSP Endnote Bibliography, contains the citation for the expired permit at the A22WR. This citation can be updated when the updated facility permit is issued by MPCA.

Appendix D, Schedule, outlines the dates when monitoring is required and when discharge-monitoring reports (DMR's) must be submitted to MPCA. For the periods of January through March and October through December DMR's are submitted on a quarterly basis. For the period from April through September (when a discharge is most likely to occur) DMR's are submitted on a monthly basis. DMR's are due at MPCA by the 21st of the month following the monitoring period.

Appendix E, Compliance Limits, includes a listing of the measurements and analytes with their respective maximum discharge limitations for A22WR. The maximum discharge limitations are assigned by the MPCA and are the formal compliance limits for the facility. These limits are included in the EQuIS Chemistry database to compare monitored values to compliance limits.

Appendix F, Electronic Data Deliverable Files and Import Formats, contain an excel spreadsheet, named A22WR_Edd.xls, used for importing data into the EQuIS Chemistry database for the A22WR NPDES Permit.

The EDD is accompanied by an import format document that describes the fields to be populated. The EDD and import format documents are presented as shortcuts.

Appendix H, Front End Spreadsheets for WWTP, A22WR and CWSW, contain an excel spreadsheet used for entering discharge monitoring report (DMR) values for A22WR. The spreadsheet is named A22WR_FrontEnd.xls and is presented as a shortcut. DPW staff enters the DMR values directly into this spreadsheet. The database administrator can utilize these spreadsheets for populating the EDD and importing these values into the EQuIS Chemistry database.

Appendix I, Guide to Discharge Monitoring Report Forms, includes details on completing required submittals for Minnesota NPDES permits.

2.6 Wastewater Treatment Plant NPDES Permit (WWTP)

The Wastewater Treatment Plant (WWTP) is located south of Highway 115 near the main entrance to the Camp Ripley facility. **Figure 8, Area Wastewater Treatment Plant**, depicts the location of this facility. The WWTP was constructed in 1932 and underwent significant upgrades in the 1980's. The current treatment process consists of automatic and manual bar screens, an aerated grit chamber, two primary clarifiers, ultraviolet disinfection, one primary anaerobic digester, and one secondary anaerobic digester. The MN PCA classifies this facility as a class B facility. The facility has a continuous discharge (SD 001) to the Mississippi River (Class 2B Water) and is designed to treat domestic strength wastewater at an average wet weather flow of up to 1,440,000 gallons per day.

The WWTP is monitored at the following four locations as shown on Figure 8 and as summarized below.

Wastewater Treatment Plant NPDES Permit Sampling Locations	
Location ID	**Description**
WS001	Influent Flow
WS002	Intermediate: Biosolids to Land
SD001	Bypass
SD002	Main Discharge

Monitoring results are linked to the sampling locations WS001, WS002, SD001 and SD002 in the EQuIS Chemistry database. Database records begin in 2001 for this facility.

The National Pollutant Discharge Elimination System (NPDES) and State Disposal System (SDS) permit for the facility, MN-0025721, is administered by the Minnesota Pollution Control Agency (MPCA). **Appendix A, Facility Permits/Documentation,** includes a copy of the WWTP permit. This permit was reissued on June 11, 2002 and expires on May 31, 2007. Permit reapplication is due 180 days prior to permit expiration.

Department of Public Works (DPW) staff perform the monitoring for the WWTP. All tests are performed at the Wastewater Treatment Plant Laboratory.

Appendix B, Compliance Sampling Program Contact List, contains contact information for Robin Novotny (MPCA) and Joel Wilczek (Camp Ripley) who are the primary contacts for the facility.

Appendix C, CSP Endnote Bibliography, contains the citation for the expired permit at the WWTP.

Appendix D, Schedule, outlines the monthly monitoring periods and when discharge monitoring reports (DMR's) are due at MPCA, by the 21st of the month following the monitoring period.

Appendix E, Compliance Limits, includes a listing of the measurements and analytes with their respective maximum discharge limitations for WWTP. The compliance limits are broken down into the four sampling locations (Inflow, Bypass, Biosolids, and Main Discharge). The maximum discharge limitations are assigned by the MPCA and are the formal compliance limits for the facility. These limits are included in the EQuIS Chemistry database to compare monitored values to compliance limits.

Appendix F, Electronic Data Deliverable Files and Import Formats, contain an excel spreadsheet, named WWTP_Edd.xls, used for importing data into the EQuIS Chemistry database for the WWTP NPDES Permit.

The EDD is accompanied by an import format document that describes the fields to be populated. The EDD and import format documents are presented as shortcuts.

Appendix H, Front End Spreadsheets for WWTP, A22WR and CWSW, contain an excel spreadsheet used for entering discharge monitoring report (DMR) values for WWTP. The spreadsheet is named WWTP_FrontEnd.xls and is presented as a shortcut. DPW staff enters the DMR values directly into this spreadsheet. The database administrator can utilize these spreadsheets for populating the EDD and importing these values into the EQuIS Chemistry database.

Appendix I, Guide to Discharge Monitoring Report Forms, includes details on completing required submittals for Minnesota NPDES permits.

2.7 Drinking Water Plant (DWP)

The Drinking Water Plant (DWP) is located on the south side of Rosenmeier Avenue near the intersection with Artillery Road. **Figure 9, Drinking Water Plant**, depicts the location of the facility. The water treatment plant was constructed in 1988 and is designed to treat 1,440,00 gallons of water per day, but only treats, on average 200,000 gallons per day. Water is sampled from the laboratory sink located in the drinking water plant to maintain compliance with the Safe Drinking Water Act (SDWA). The following table contains the location ID.

Camp Ripley Drinking Water Plant Sampling Location	
Location ID	**Description**
LABSINK	Laboratory Sink located inside the Drinking Water Plant.

Monitoring results are linked to the LABSINK ID in the EQuIS Chemistry database. Database records begin in 2001 for this facility. The results are not linked to the individual water supply wells because the testing is done after the treatment process and is better described by linking to the the sink where the sample is taken.

Appendix A, Facility Permits/Documentation, includes a copy of the most recent report on investigation of the public water supply that was completed by the Minnesota Department of Health (MDH). According to MDH personnel, this report certifies the drinking water system. No permit is issued.

Appendix B, Compliance Sampling Program Contact List, contains contact information for Wally From and Jeff Thomson (MDH) and Joel Wilczek (Camp Ripley) who are the primary contacts for the facility. Wally From is based out of the St. Cloud MDH office and performs the sampling. Jeff Thomsen set's the monitoring schedule and is based out of the St. Paul office. Jeff is the point of contact for having data sent electronically via EDD.

Appendix C, CSP Endnote Bibliography, contains the citation for the Report on the Investigation of Public Water Supply.

Appendix D, Schedule, outlines the current schedule for sampling at the DWP. MDH samples colliform bacteria and total nitrogen on an annual basis. Sampling for non-transient drinking water systems are broken down into contaminant groups by the MDH. These contaminant groups include:

Inorganic Chemicals (IOCs)
Synthetic Organic Compounds (SOC's)
Volatile Organic Compounds (VOC's)

These groups are sampled once every three years. The schedule for sampling these chemical groups is included.

Appendix E, Compliance Limits, includes a listing of all of the chemicals included in each of the chemical groups along with the Maximum Contaminant Level (MCL). MCL's are the highest level of a contaminant that is allowed in drinking water according to the Safe Drinking Water Act. This limit is included in the EQuIS Chemistry database to compare monitored values to compliance limits. For a listing of the current drinking water standards see this link http://www.epa.gov/safewater/mcl.html.

Appendix F, Electronic Data Deliverable Files and Import Formats, contain an excel spreadsheet, named DWP_Edd.xls, used for importing data into the EQuIS Chemistry database for the DWP.

The EDD is accompanied by an import format document that describes the fields to be populated. The EDD and import format documents are presented as shortcuts.

2.8 Cantonment Water Supply Wells (CWSW)

Figure 10, Cantonment Water Supply Wells, shows the location of the three water supply wells addressed in the current Minnesota Department of Natural Resources (MDNR) water appropriation permit for Camp Ripley. These wells are summarized in the table below:

Camp Ripley Water Supply Wells			
Station Type	**Minnesota Unique ID**	**Status**	**Comments**
Water Supply Well	224577	Active	Referred to as the H Well
Water Supply Well	470668	Active	Referred to as the L Well
Water Supply Well	622775	Active	Referred to as the N Well

The Water Appropriation Permit for the facility, 85-3053, is administered by MDNR. **Appendix A, Facility Permits/Documentation,** includes a copy of the permit that was issued on August 14, 2001. The permit authorizes the extraction of 110 million gallons of water per year.

The volume of water extracted and the pumping rates are linked to the six-digit Minnesota Unique ID in the EQuIS Chemistry database. Database records begin in 1999 for this facility.

Appendix B, Compliance Sampling Program Contact List, contains contact information for Dave Hills (MDNR) and Joel Wilczek (Camp Ripley) who are the primary contacts for the facility.

DPW staff record monthly volume and pumping rate readings that are required for maintenance of the permit.

Appendix C, CSP Endnote Bibliography, contains the citation for the Water Appropriation Permit 85-3053 issued August 14, 2001.

Appendix D, Schedule, includes the monthly water use recording dates and when the annual report is due at MDNR.

Appendix E, Compliance Limits, includes a listing of the maximum water withdrawal and pumping rate to stay in compliance with the Water Appropriation Permit.

Appendix F, Electronic Data Deliverable Files and Import Formats, contain an excel spreadsheet, named CWSW_Edd.xls, used for importing data into the EQuIS Chemistry database for the CWSW MDNR Water Appropriation Permit.

The EDD is accompanied by an import format document that describes the fields to be populated. The EDD and import format documents are presented as shortcuts.

Appendix H, Front End Spreadsheets for WWTP, A22WR and CWSW, contain an excel spreadsheet used for entering monthly water volumes and pumping rates for CWSW. The spreadsheet is named CWSW_FrontEnd.xls and is presented as a shortcut. DPW staff enters these values directly into this spreadsheet. The database administrator can utilize this spreadsheet for populating the EDD and importing these values into the EQuIS Chemistry database.

2.9 Stormwater Outfalls (SWOF)

Figures 11 – 14 show the location of four Stormwater Outfalls (SWOF) in relation to each other. These outfalls are summarized in the table below.

Stormwater Outfalls Sampling Locations		
Common Name	**Location ID**	**Description**
Wastewater Treatment Plant Stormwater Outfall	OF001	Stormwater Outfall
De Parcq Woods Stormwater Outfall	OF002	Stormwater Outfall
Northern Stormwater Outfall	OF005	Stormwater Outfall
Area 22 Washrack Stormwater Outfall	OF006	Stormwater Outfall. Same sampling location as the Area 22 Washrack NPDES Permit for SD-001.

Camp Ripley personnel identified these four outfalls as potentially needing to be permitted in the future. UMD personnel are sampling these four locations following three rain events in 2002 to characterize the water quality from the cantonment area.

Stage recorders were installed at the Area 22 Washrack and DeParq Woods stormwater outfalls on August 9, 2002. Figure 15, Stage Recorder Location, depicts the location of the stage recorders currently installed at Camp Ripley. The stage recorders will be removed in November 2002 and reinstalled in the spring of 2003.

Monitoring results are linked to the location ID in the EQuIS Chemistry database. Database records begin in 2002 for these stormwater outfall-sampling locations.

Appendix B, Compliance Sampling Program Contact List, contains contact information for John Ebert and Jon Kolstad (Camp Ripley) who are the primary contacts for the stormwater outfalls.

Appendix D, Schedule, contains a location for inserting dates for water sampling at the SWOF. The current sampling program calls for sampling three times following rain events in 2002.

Appendix E, Compliance Limits, includes a listing of the parameters being analyzed for during 2002 sampling. Aside from the A22WR NPDES permit, which is addressed in section 2.5, no formal discharge values have been set by MPCA for these SWOF locations.

Appendix F, Electronic Data Deliverable Files and Import Formats, contain an excel spreadsheet, named SWOF_Edd.xls, used for importing data into the EQuIS Chemistry database for the SWOF.

The EDD is accompanied by an import format document that describes the fields to be populated. The EDD and import format documents are presented as shortcuts.

3.0 Data Management

3.1 Overview of EQuIS Chemistry Database

EarthSoft, Inc. has developed EQuIS (Environmental Quality Information System), Chemistry. The version of EQuIS Chemistry utilized for CSP employed a Microsoft Access database platform (to be converted to SEQL Server). This environmental database includes data fields and entity relationships necessary to store and manage all the chemical result information produced through the routine data monitoring described in this document. This database was chosen to house water and soil chemistry analytical results associated with CSP because of its' unique ability to present temporal and spatial information and interface with many popular and widely used Commercial Off the Counter Software (COTS).

All sampling results in CSP are associated with a specific sampling location. This location is identified in the database as a x (Northing) and y (Easting) coordinate. The coordinates system is UTM NAD 83 Zone 15. In addition, each sampling location is given a location identifier in the database. For groundwater monitoring and water supply wells, the naming convention adopted for CSP is to use the six-digit Unique ID assigned by the Minnesota Department of Health when the well was installed. A complete listing of Location ID's for the specific sampling locations in CSP are included in the table on the next page.

Table 2 - Sampling Location Naming Conventions

CSP Common Name	Site ID	Location ID	Location Type
Demolition Debris Landfill	DDLF	250122	Monitoring Well
		539404	Monitoring Well
		539405	Monitoring Well
		671612	Monitoring Well
Mixed Municipal Landfill	MMLF	250123	Monitoring Well
		250124	Monitoring Well
		250125	Monitoring Well
		250126	Monitoring Well
Existing Landfarm Spreadsite	ELFSS	Cell1	Soil Treatment Cell
		Cell2	Soil Treatment Cell
		Cell3	Soil Treatment Cell
		Cell4	Soil Treatment Cell
		Cell5	Soil Treatment Cell
		Cell6	Soil Treatment Cell
		Cell7	Soil Treatment Cell
		Cell8	Soil Treatment Cell
		Cell9	Soil Treatment Cell
		Cell10	Soil Treatment Cell
		Cell11	Soil Treatment Cell
		Cell12	Soil Treatment Cell
Proposed Landfarm Spreadsite	PLFSS	671613	Monitoring Well
		671614	Monitoring Well
		671615	Monitoring Well
		671616	Monitoring Well
Area 22 Washrack Stormwater Outfall	A22WR	OF006	Stormwater Outfall and NPDES Permit Sample Location
Wastewater Treatment Plant	WWTP	OF001	Stormwater Outfall
		SD001	NPDES Permit Sample Location (Facility Bypass)
		SD002	NPDES Permit Sample Location (Main Discharge)
		WS001	NPDES Permit Sample Location (Inflow)
		WS002	NPDES Permit Sample Location (Intermediate: Biosolids to Land)
Drinking Water Plant	DWP	LABSINK	Laboratory Sink at Drinking Water Plant
Cantonment Water Supply Wells	CWSW	224577	Water Supply Well
		470668	Water Supply Well
		622775	Water Supply Well
De Parcq Woods Stormwater Outfall	DE_PARCQ_WOODS	OF002	Stormwater Outfall
Northern Stormwater Outfall	NORTHERN_OUTFALL	OF005	Stormwater Outfall

The location naming convention for the ELFSS identifies the specific cell that contains both pre and post application data (e.g. Cell1, Cell2 etc.). WWTP NPDES permit sampling locations are identified as they are listed in the facility permit (e.g. SD001, SD002 and WS001). Surface Water Outfall sampling locations are listed as the outfall numbers in the E2M report (OF001, OF002, OF005 and OF006). The Area 22 Washrack NPDES permit sampling location is the same as the stormwater outfall sampling location and was also named utilizing the E2M naming convention (OF006). The DWP sampling location is listed as LABSINK as these samples are taken in the drinking water plant laboratory sink.

Each sampling event also contains a date field. This combination of information allows the user to view results over time and to investigate chemical concentrations in a spatial context.

A power user interface allows the administrator to interact with the data directly in the database. This is accomplished using pull down menus supplied with the Equis Chemistry product. In addition, a casual user interface may be utilized for viewing and querying information in Arcview. It should be noted that are many different ways to query information in the EquIS Chemistry database.

3.2 Electronic Data Deliverables (EDD's)

Electronic Data Deliverables (EDD's) are preformatted excel spreadsheets utilized for importing data into the EQuIs Chemistry database. EDD spreadsheets are provided for each facility in CSP and are presented in Appendix F, Electronic Data Deliverable files and Import formats, as shortcuts. Facilities that require field parameter and well purging information (DDLF, MMLF and PLFSS) also include two EDD's for this information. Although data can be input directly into Equis, it is highly recommended to utilize the EDD import format as it greatly facilitates analysis of data in addition to saving time. Data is imported by utilizing the import module contained within the main Equis Chemistry interface. The import process contains numerous checks of the data before allowing import into the database. Those checks include ensuring that field lengths are adhered to and that the proper reference tables exist. The user is prompted and an error log is produced if problems arise in the import. The import process is described further in the Equis Chemistry database documentation.

The EDD's fields coincide with specific data tables in the EquIS Chemistry database. Earthsoft publishes a number of established EDD's on their website located at www.earthsoft.com. EDD's for CSP were adopted from the published list or created specifically for the data needs of a facility. The majority of the EDD's are based on the ES Basic format. This format is recognized when "EsBasic" is written on the worksheet tab in the EDD file. Import format documentation is also provided in Appendix F for each EDD. These documents describe the field names and definition for each field in the EDD. The import format documents were originally produced by Earthsoft and were amended to reflect Camp Ripley naming conventions.

When contracting a laboratory to do analytical testing both the EDD and Import Format contained in Appendix F for the facility should be provided to the laboratory. The laboratory should be instructed to populate the EDD per the import format documentation and provide both hard copy and electronic testing results to the database administrator.

4.0 Recommendations for Implementing CSP at Camp Ripley

The following recommendations are provided regarding the implementation of CSP at Camp Ripley.

- One person at Camp Ripley should be assigned the responsibility of administering CSP. Generally, this person would become familiar with this document and perform updates when new permits are issued. In addition, when the EQuIS Chemistry database is turned over to Camp Ripley this person would be responsible for importing data into the EQuIS Chemistry database.

- UMD has scheduled Equis database training for December 16-18 at Camp Ripley. At this time Equis and UMD staff will be available to tutor Camp Ripley staff on the use of the database and updating of this document and associated files (EDD's, Front-End Worksheets and Schedule). All staff involved with regulatory sampling at Camp Ripley should attend.

- During this training, Camp Ripley personnel should develop a list of common queries for their specific reporting purposes. With this information in hand, Equis and UMD staff can assist Camp Ripley personnel with maximizing the use of EDD's and the Equis Chemistry database for reporting to regulatory agencies.

- Future sampling and analysis contracts written by Camp Ripley should contain the requirement that data be emailed to the database administrator with the facility specific EDD. Traditional paper copies of the reports should continue being mailed for reporting to regulatory agencies and as a backup for the electronic data.

- MPCA staff has discussed the possibility of reducing monitoring requirements at MMLF. Camp Ripley staff should request a formal Limits Table for the MMLF from MPCA after the monitoring requirements have been established.

- Following determination of monitoring requirements at MMLF and permitting of the PLFSS a revised sampling protocol should be prepared for DDLF, MMLF and PLFSS. The sampling protocol listed in Appendix G is not current as required in the DDLF permit. This would be a useful document for providing to contractors or if sampling is taken over by Camp Ripley staff in the future.

- Department of Public Works point of contacts should ensure that data is entered into the appropriate front-end worksheet or EDD to facilitate data entry into the Equis Chemistry database. Since this is ultimately the responsibility of the Camp Ripley Equis Chemistry database administrator, it will be their responsibility to choose the method they wish to use (Front-End Worksheets or EDD's) and train respective staff on the procedures. If requested, this staff could attend the training session held on December 16-18.

The CSP report is a dynamic document that will require periodical updates. A logical time to update this document is when a new or revised facility permit is issued. Following is a list of updates that should be completed:

- **Section 2.0:** Review this section to gain an understanding of what pieces of information currently exist in the appendices for a particular facility. Update this section as appropriate.
- **Section 3.0:** Insert additions or deletions from the Sampling Naming Conventions Table.
- **Appendix A:** Obtain an electronic version of the facility permit or scan and insert into the document.
- **Appendix B:** Update the person(s) responsible for the permit at Camp Ripley and the regulatory agency contacts.
- **Appendix C:** Update the bibliography list with the new title and date of the permit or documentation.
- **Appendix D:** Update the schedule with the required sampling and reporting dates.
- **Appendix E:** Update the compliance limits table with any new chemicals to be tested or new compliance limits. This table should contain every chemical or compound and the respective compliance limit if listed in the permit. If a question exists, contact the regulatory agency and request a list of required tests or the appropriate compliance limits.
- **Appendix F:** Update the EDD or import formats if appropriate. The updated EDD must be provided to the appropriate laboratory or person responsible for sending the data to the Camp Ripley database administrator electronically. The import format documents provide documentation on how to populate the EDD.
- **Appendix G:** Obtain an electronic version or scan and insert the new Sampling Protocol into the document if produced.
- **Appendix H:** If a new permit is issued with different monitoring requirements for the WWTP, A22WR or CWSW the front end worksheets will need to be altered to reflect those changes. The goal is to use the front-end work sheet to transfer data electronically from the Department of Public Works staff to the Camp Ripley database administrator. The database administrator will then populate the EDD and import into the database. If chosen, Camp Ripley staff can train DPW staff on populating EDD's directly and discontinue the use of the front-end worksheets.
- **Appendix I:** Obtain an electronic version or scan and insert new Guide to DMR Forms if one is issued with subsequent permits at the WWTP or A22WR.
- **Figures:** Update with new or changed sampling locations.
- **Table:** Update Table 1. This table provides a summary of information on sampling at each facility.
- Update or expand the document or data management system as deemed appropriate by Camp Ripley management.

The EQuIS Chemistry database will be turned over to Camp Ripley in 2003. Keeping this document up to date with current facility permits will aid Camp Ripley staff in managing their compliance-based sampling while building a robust database of water quality records at Camp Ripley.

Delineation of a Wellhead Protection Zone and Determination of Flowpaths from Potential Groundwater Contaminant Source Areas at Camp Ripley, Little Falls, Minnesota

by
John J. Quinn
Environmental Science Division
Argonne National Laboratory
Argonne, IL

Prepared for
Camp Ripley Environmental Program
Department of Military Affairs
15000 Highway 15
Little Falls, MN

Technical Memorandum XX-XXX

Executive Summary

Groundwater at Camp Ripley, Minnesota, is recharged both on- and offsite, and discharges to rivers, wetlands, and pumping wells. The subsurface materials have a wide range of permeabilities and are arranged in a complex fashion because of the region's multiple glacial advances. Correlation of individual glacial geologic units is difficult, even between nearby boreholes, because of the heterogeneities in the subsurface.

This report documents the creation of a numerical model of groundwater flow for Camp Ripley and hydrologically related areas to the west and southwest. The model relies on a hydrogeological conceptual model built on the findings of a University of Minnesota – Duluth drilling and sampling program conducted in 2001. Because of the site's stratigraphic complexity, a geostatistical approach was taken to handle the uncertainty of the subsurface correlation. The U.S. Geological Survey's MODFLOW code was used to create the steady-state model, which includes input data from a variety of sources and is calibrated to monitoring well water levels across much of the site.

Several applications were made using the model. Wellhead protection zone delineations were made for onsite production wells H, L, and N. These zones are based on a probabilistic assessment of the groundwater captured by these wells based on multiple realizations of the study area's stratigraphy and groundwater flowfield. An additional application of the model is the estimation of flowpaths and time-of-travel for groundwater at Camp Ripley's range areas and waste management facilities.

Contents

List of Tables

List of Figures

List of Animations
(on compact disk)

#1 Glacial stratigraphy of Camp Ripley and surrounding area
#2 Glacial stratigraphy in vicinity of Landfarm
#3 Glacial stratigraphy of the five TPROGS materials
#4 TPROGS modeled hydrogeologic units in model layers 1 through 10
#5 Simulated heads in model layers 1 through 10

Disclaimer of Endorsement

Introduction

Camp Ripley (Figure 1) is located near Little Falls, in the center of the state of Minnesota. Although Camp Ripley has no urgent environmental situations requiring remedial action, the facility's environmental managers desired to improve their understanding of the site. With this goal, Camp Ripley partnered with the University of Minnesota – Duluth (UMD) Department of Geological Sciences. UMD performed a multi-year study that included field data collection and database management pertaining to a wide variety of hydrologic and geologic aspects of the site. UMD teamed with Argonne National Laboratory (ANL) for assistance in creating a numerical groundwater flow model of the site.

The purpose of this report is to document the approach, assumptions, results, and conclusions constructing a numerical groundwater used in addressing two site management needs at Camp Ripley. One of these needs is the estimation of the routes and flowrates of groundwater beneath the site's firing ranges and waste management facilities. The second is the delineation of Wellhead Protection (WHP) zones for the three active Camp Ripley production wells: wells H, L, and N. The WHP zones are determined through a probabilistic approach, built on an updated version of a recent site-wide groundwater model (Quinn 2003). Because of the detailed geologic and hydrologic information included in this model, and the probabilistic approach taken to WHP zone delineation, it is considered to be more accurate than a previous model (Minnesota Army National Guard 200__). Specific management strategies and the identification of potential contaminant sources are beyond the scope of the current effort; however, fairly recent information on these subjects is available in Minnesota Army National Guard (200__).

The model was created using the U.S. Geological Survey's MODFLOW code (Harbaugh et al. 2000), with data input and output analysis facilitated using the Groundwater Modeling System (GMS) version 5.1 (EMRL 2004).

Glacial Geologic History of Camp Ripley and Vicinity

Overview

In late Wisconsinan time, central Minnesota was glaciated by the Hewitt phase of the Rainy lobe (Goldstein 1989), which advanced far south and west of the Camp Ripley region and built the Alexandria moraine. Later in the late Wisconsin, glacial lobes advanced into the Camp Ripley vicinity from three directions. These included the Itasca lobe from the north, the Rainy lobe from the northeast, and the Superior lobe from the east.

The Itasca lobe (Mooers and Lehr 1997), the Rainy lobe, and the Superior lobe have been identified as the key components of the Wisconsin glacial history of central Minnesota (Wright 1972, Schneider 1961). The Itasca lobe emanated from the Labradorian spreading center in Canada, and traveled across the Camp Ripley vicinity from the north (Figure 2). A fan-shaped pattern of drumlins indicates radial flow in central Minnesota (Wright 1972). Its drift is gray if unoxidized, yellow-brown if oxidized, and calcareous. Its till is a sandy loam (Schneider 1961). The character of the drift is the result of its Paleozoic carbonate source area.

The Rainy and Superior lobes originated from the northeast, in Canada's Labradorian spreading center, and both created drumlin fields (Schneider 1961, Wright 1972, Goldstein 1998).

The Rainy lobe traveled from the northeast over basalt and other northeastern lithologies, resulting in a drift that is brown and sandy. The Superior lobe flowed out of the Lake Superior basin alongside the Rainy lobe. Like the Rainy drift, the Superior drift is also coarse-grained, but it is red due to a prevalence of rhyolite and red sandstone. The Superior lobe fanned out in central Minnesota, with westward flow to the Camp Ripley vicinity.

Camp Ripley's 50 km^2 are located primarily on an odd interruption in the otherwise smooth curve of the St. Croix moraine (Figure 2). The St. Croix moraine is generally considered to be built of till and ice-contact deposits of the Superior and Rainy lobes. The moraine does not represent the farthest advance of these lobes, as their deposits are found past the moraine in central Minnesota (Goldstein 1998, Schneider 1961).

Findings of Environmental Drilling Program (EnDriP)

In late 2002, UMD conducted a drilling and sampling effort called the Environmental Drilling Program (EnDriP). EnDriP relied on rotasonic drilling and sampling techniques to obtain continuous, high-quality, four-inch diameter core of the Camp Ripley glacial sediments. Nine drilling locations (Figure 3) were selected across the Camp Ripley site to provide information on various aspects of the subsurface, such as depth to bedrock/saprolith, characterization of various portions of the St. Croix moraine, characterization of lowland areas, and information on deep glacial drift units.

Results of the detailed logging of glacial drift materials during the EnDriP field work are described by UMD (2002). Although not all of the nine borehole locations reach bedrock, in combination they provide a good picture of the site's glacial geologic framework (Figure 4). Eleven materials were noted by the EnDriP investigation: saprolith, coarse sand and gravel, silty fine sand, medium sand, fine sand, lacustrine silt, lacustrine clay, silt loam, red sandy till, red/brown sandy loam till, and dense clay loam till. Key attributes include red and brown drift in the south, grey drift above bedrock, interbedded drift examples, and an overall dominance by brown drift. The character of the uppermost sediment varies with location; examples include brown sand, brown till, and red sand.

Well logs for numerous wells drilled on- and offsite were inspected for stratigraphic data. Onsite wells' drilling data were provided by Camp Ripley, while offsite wells' data were obtained from the online County Well Index (Minnesota Department of Health 2006). Drillers' descriptions were interpreted on the basis of direct observations of EnDriP-derived materials. These additional well logs improved the stratigraphic data coverage over the study area.

To provide the reader with an understanding of the complex arrangement of the glacial drift units at and near Camp Ripley, Animation #1 on the attached CD should be viewed. The animation is a visualization of the 11 lithologic units from the EnDriP boreholes and the good-quality regional drilling data.

The EnDriP data suggest that the bulk of the St. Croix moraine at Camp Ripley is sand rather than till. Most of these sands are interpreted to be lacustrine in origin, rather than glaciofluvial (outwash), on the basis of their grain size and sorting. The sands are mainly well-sorted medium sands, fine sands, and silty sands. The medium sands are locally interbedded with silts and clays. The drilling data indicate a previously unrecognized possibility for this portion of the St. Croix moraine: that it is primarily glaciolacustrine in origin. In order to create a large, thick lacustrine deposit, an ice-bounded basin must have been present. This basin likely would have had the Rainy lobe as its eastern boundary, and the Rainy would have been contributing most of the sediment load, on the basis of the sand color. The Superior lobe would have been present on the southern end of the basin. The Itasca lobe would have advanced to the current St. Croix moraine location in the Camp Ripley vicinity, forming the western boundary of the basin. This idea is supported in part by interbedded gray and brown drift as described by UMD (2002) and Schneider (1961). The basin could have collected sediment for a time sufficient to create a thickness of roughly 60 m. Afterwards, melting of all bounding ice would have created the current inverted topography comprised of lacustrine deposits that is now much of Camp Ripley.

Several past investigations (e.g. Goldstein 1998, Carney and Mooers 1998, Schneider 1961) have identified the Itasca, Rainy, and Superior lobes as contemporary at around 15,000 B.P.; however, until now the location of the Itasca lobe has been thought to have been further north than the Camp Ripley area at a time when the Rainy and Superior were present there.

On the basis of the available data, the boundaries of the paleo lake basin are not fully defined; the masked glaciolacustrine deposits could be present north of the Pillager Gap, where the Crow Wing River now flows through the moraine. The St. Croix moraine extends to the north from the Camp Ripley and Pillager Gap vicinity as a product of the Rainy lobe. South and east of Camp Ripley are morainal deposits of the Superior lobe, including the arcuate section connected to the south end of Camp Ripley and the continuation of the moraine to the south (Figure 3). Both the Rainy and Superior lobe portions of the adjacent portions of the St. Croix moraine are likely conventional till moraines, though exceptions may occur locally.

Glacial Geology Summary

The Camp Ripley property and vicinity have geology and topography that are the result of a complex glacial depositional history involving three ice lobes that deposited drift of various character and color. These lobes have been thought of as concurrently active in central Minnesota; however, detailed geologic characterization of the site by UMD (2002) suggest a new, previously unrecognized possibility for the juxtapositioning of the ice lobes and the nature of the St. Croix moraine at Camp Ripley. The lobes appear to have been present in the Camp Ripley vicinity concurrently, depositing well-sorted sands into an ice-bounded lacustrine basin. Occasional ice advances deposited discontinuous till units in the basin at various elevations.

Geologic and Hydrologic Site Characterization

Climate and Topography

Camp Ripley is located in the center of Minnesota, a region of continental climate. Annual precipitation is 66 cm (U.S.D.A. 1994).

The site has a large amount of topographic relief associated with the St. Croix moraine. The lowest point, along the Mississippi River, is about 341 m MSL; the highest point is 453 m MSL.

Surface Water

The site is bounded on the east by the Mississippi River and on the north by the Crow Wing River (Figure 5). The Crow Wing has two dams: the Sylvan dam along the northeastern site boundary and the Pillager dam approximately 12 km upstream of the Sylvan dam. The Elk River is located southwest of the site and is a tributary to the Mississippi. Within and outside of the site boundaries are numerous lakes, and west of the site is a large lake, Lake Alexander. The site has many large wetlands in low areas near the rivers and elsewhere. Drainages from the site are minimal; only a few small creeks leave the site and are tributary to the Mississippi, Crow Wing, or Elk rivers.

The water levels of several lakes close to the Camp Ripley site boundary are monitored frequently by the Minnesota Department of Natural Resources (MDNR 2006). Long-term data from six of these lakes suggest that water levels generally fluctuate by much less than 1 meter (Figure 6).

Aquifer Recharge

Recharge to an aquifer can be a difficult parameter to measure, and often is estimated regionally by relying on numerical model calibration.

St. George (1994) conducted a detailed groundwater model of an area including the Itasca moraine. Because her study area is of a similar climate to Camp Ripley and has similar glacial geologic materials, her estimates of recharge were applied in the Camp Ripley model. St. George delineated recharge zones on the basis of geomorphological map units. Mooers (1996) provides mapping of the geomorphological units in the Camp Ripley region (Figure 7). These units were grouped into six categories (Table 1), which were then compared to relevant units of St. George's study (Table 2). For two of the categories, an adequate match was not available in St. George's units, so estimates were made for the recharge values. The calibrated estimates of St. George, along with the two rough estimates, were used as recharge inputs in the flow model.

At least in the case of the sandy outwash plain, the estimate in Table 2 is similar a value determined through a hydrograph method in a similar setting in Minnesota (Helgesen and Lindholm, 1977).

Hydraulic Conductivity

Hydraulic conductivity (K) is a measure of the permeability of a material with respect to the seepage of water. Hydraulic conductivity can be measured or estimated in a variety of ways. One method is the use of grain size analyses, in which geologic samples are separated according to amounts retained or passing various sized standard screen openings, then information from plots of the grain size distribution is used with empirical formulas to estimate K. UMD performed grain size analyses for a variety of geologic samples obtained during the EnDriP project. These samples provide information for essentially all major materials present in the Camp Ripley subsurface. Results are shown in Table 3. The numbers are similar to expected values in standard texts (e.g. Freeze and Cherry 1979) and compare well to similar units determined by St. George (1994) through model calibration in a similar study area.

Pumping Wells

Pumping stresses in the modeling domain include the active onsite wells H, L, and N, which are the focus of the WHP project, along with several irrigation wells and private wells (Figure 8).

The Minnesota DNR requires Water Appropriation Permits for groundwater or surface water withdrawals over 10,000 gallons per day or one million gallons per year. Through the permitting process, long-term pumping rate information is available for the onsite production wells and those wells that they have replaced (1988 to 2002 from MDNR appropriation permits and 2001 to 2004 from Klinker 2005). These values are summarized in Table 4. Irrigation wells (unique numbers 214597, 214434, 214433, and 121834), which are located south and west of the Cantonment Area, are also included in the model, with pumping rates based on average withdrawal rates over 1988-2002. This information is also included in Table 4. On the basis of the MDNR appropriation database, no other large groundwater users are in the modeling domain.

Most private wells in the modeling domain are assumed to have little impact on the groundwater flowfield in the study area. Therefore most were not included in the model. However, several private wells were included in the model because of their proximity to the Cantonment Area. These wells were located using the County Well Index (MDOH 2006) and are within about 2 km of the Cantonment Area. The private wells include four households along the west edge of the Cantonment Area (unique numbers 451315, 592566, 543433, and 571415), two wells further west of those (224540, 136967), and one well (495271) near the Camp Ripley main gates. The estimated groundwater pumping rate per household of 350 gallons/day (AWWA 2006) was used as model input at each private well location.

Also near the main gates is a commercial establishment (unique number 701091) for which no pumping rate information was available. An assumption was therefore made that the water usage here is 20 times the average daily household rate.

Groundwater Levels

UMD collected hand measurements at numerous wells and continuous (30-minute interval) automated measurements of groundwater levels at four wells. The hand measurements, combined with static water levels noted on drillers' logs for regional wells, are presented in Quinn (2003) as are the continuous water level measurements obtained at four onsite monitoring wells. The data show that long-term fluctuations at the wells are generally within a range of only 0.3 m. This suggests that water level measurements across the site and region are useful in calibrating a regional-scale model. Average values were therefore combined with average monitoring well hand measurements and static water level information to create a set of target water levels for calibration of the model.

Groundwater Flow Model

Conceptual Groundwater Model

Prior to constructing a numerical groundwater flow model, it is important to describe, conceptually, a site's groundwater flow system.

For Camp Ripley and the nearby areas to the west and southwest, precipitation, as rainfall or snowmelt, infiltrates and becomes aquifer recharge. Little water is assumed to run off, on the basis of only a small number of very minor creeks in the entire study area. This internal drainage is also demonstrated by closed topographic depressions that are dry in the bottom (e.g. along Easy Street) and is consistent with the understanding of an abundance of sandy soil and subsoil.

Lakes are assumed to be either flow-through lakes, representing the groundwater flow system, or perched features. Although perched groundwater may be present locally due to a low-permeability lacustrine clay or fine-grained till, most groundwater is assumed to be part of the regional flow system, discharging to the main nearby rivers (Mississippi, Crow Wing, Elk), to wetlands, or to pumping wells.

Flow in the subsurface is complicated by countless irregular contacts between different types of glacial depositional units of widely different permeability. The uncertainty in subsurface correlation is apparent even at the Landfarm Site, an area of relatively dense data. Here, boreholes 50 to 100 m apart show little apparent correlation of stratigraphic contacts because the subsurface changes occur at a scale finer than the borehole spacing (see Animation #2 on the attached CD).

Model Purpose

The purpose of this numerical model is to provide a quantitative tool for groundwater flow at Camp Ripley and hydraulically related areas to the west and southwest. This model is steady state, relying on time-averaged values for factors such as recharge or water level measurements at various observation wells. It is regional in scale, but can be modified to address future local issues, provided sufficient local-scale data are available. Key applications such as wellhead protection zone delineation and forward particle tracking from potential source areas are discussed at the end of this report.

Model Selection

Because this is a porous-media setting, the U.S. Geological Survey's MODFLOW 2000 (Harbaugh et al. 2000) code was selected to model the site. MODFLOW is the world's standard for modeling groundwater flow through porous media, in part because of its documentation, verification, capabilities, and adaptability. MODFLOW can handle a variety of hydrologic and geologic inputs. It is a finite-difference model, relying on a 3D grid for the solution space. MODFLOW 2000 includes parameter estimation capabilities (Hill et al. 2000), which provide a means of optimal estimation of model inputs based on non-linear regression techniques. A companion code, MODPATH (Pollock 1994) produces particle tracking results on the basis of the results from MODFLOW. The particle tracking results illustrate the calculated groundwater movement under advective flow (i.e. in the absence of any retardation processes).

The Groundwater Modeling System (GMS) (EMRL 2004) is a pre- and post-processor for MODFLOW other codes, and includes related tools for subsurface analysis. GMS allows the modeler to work from map information to design a grid that matches the study area's 3D hydraulic boundaries. Many forms of model input may be imported in spreadsheet form, facilitating accurate model setup. GMS also has the option of using Transition Probability Geostatistics (TPROGS) to populate the subsurface permeability framework of its MODFLOW models. TPROGS is discussed in some detail below.

Grid Design and Boundary Conditions

The extent of a modeling domain is determined by evaluating a study area's hydrologic and geologic factors for natural boundaries to groundwater flow. Examples are specified head boundaries, such as along rivers in direct connection with the groundwater flow system, or no-flow boundaries, such as a known or assumed divide in the groundwater flow system.

Much of Camp Ripley is bounded by the Mississippi and Crow Wing rivers (Figure 9). By inspecting water level data for wells across the region to the west and south of Camp Ripley, the location of a north-northeast to south-southwest trending flow divide was estimated. This no-flow divide extends from the Crow Wing River on the north to the Elk River to the south. The no-flow boundary is in-between Lake Alexander and a large lake to the west, Fishtrap Lake. Fishtrap Lake is connected to Lake Alexander. The channel, however rarely has much flow because the water elevations of the two lakes are nearly equal (Minnesota Pollution Control Agency 1999). Because of the low surface water gradient here and the regional groundwater flowfield, the no-flow boundary condition is supported for the western edge of the modeling domain. The bottom of the modeling domain is the saprolith (weathered bedrock) surface (Figure 10).

The upper boundary of the model is the ground surface. The model grid was constructed with uniform 200 m cells. Digital Elevation Model (DEM) data at 60 m spacing were obtained for the region. This data set provides strong control of the upper surface of the glacial drift sequence (Figure 11). Although the locations of the DEM grid nodes do not exactly match the locations of model cell centers, the DEM data were interpolated to the cells by GMS and provide a highly accurate upper surface elevation of the geologic package. An inspection of cell elevations along major rivers showed that river stage was accurately incorporated into the model by relying on the DEM data at 60-m spacing. These cells were each fixed as specified heads.

Ten layers were modeled, by dividing the glacial drift thickness evenly throughout the modeling domain. In this manner, some locations, such as along major rivers, have ten thin, saturated model cells, whereas other places, such as along the St. Croix Moraine, have ten thick cells, and one or more cells below the ground surface may be unsaturated.

Geostatistical Modeling of the Subsurface

The geological structure of the subsurface of Camp Ripley and its vicinity poses a challenge in flow model construction because of the products of the glacial depositional events. The distances between boreholes are such that the correlation of units throughout the site is quite uncertain, because average lens lengths are less that average borehole spacing. An understanding of the distribution of materials is important to the model because the hydraulic conductivities of the units vary so widely.

For this reason, modeling of the geologic framework was performed using a transition probability geostatistics (TPROGS) approach. TPROGS (Carle 1999) determines the volumetric proportions, mean thicknesses, mean lens lengths, and juxtapositional tendencies among a site's hydrogeologic units. It may then be used in conditional simulation: stochastic model runs of multiple, equally probable spatial distributions of the hydrogeologic units, while honoring the hard data. TPROGS analyses may be performed within GMS and results may be imported by GMS into a MODFLOW flow model.

To implement TPROGS, a site's hydrogeology must be simplified into a maximum of five units. For Camp Ripley, the ten glacial hydrogeological materials identified by EnDriP were converted to five units based on similarities of both depositional settings and hydraulic conductivity values (Table 5). Of these five units, lacustrine sand dominates, with a proportion of 70% (Table 6). While Animation #1 illustrated the complexity of the glacial drift with ten different units, Animation #3 displays the results with the simplified groupings of five units. The hydrogeologic framework of the site remains complicated even after being reduced to five materials.

The TPROGS analysis determines the interrelationships of the modeled units through Markov Chains (Carle 1999), which are best in vertical directions because of abundant data relationships. They are inferred for horizontal directions, where data relationships are sparser, according to Walter's Law: any juxtapositional tendencies observed in the vertical direction will also hold true in the horizontal directions.

The TPROGS analysis resulted in geostatistically determined lateral correlation lengths for each material type. These lengths translate to average lens lengths. For the five units, the average lens length for the unit with the greatest correlation, lacustrine clay, was about 100 m. This analysis supports the notion of short correlation of units, as demonstrated in Animation #2.

In the Camp Ripley analysis, different realizations are generated by TPROGS, and each is statistically valid, equally probable, and honoring the hard data. However, the hard data are far apart relative to both the geostatistical ranges (correlations) of the units and the grid spacing. The results of different realizations, therefore, are all quite similar, with lacustrine sand dominating, lesser amounts of till units, lacustrine clay, outwash, and lacustrine silt. An example result for model layer 1 is shown in Figure 12. Units have a random distribution across each model layer, except at locations near boreholes where results are consistent with the hard data. An animation illustrating the TPROGS results for model layers 1 through 10 is shown in Animation #4.

Input Parameters

In addition to the distribution of initial recharge values (Table 2 and Figure 7), the estimated hydraulic conductivity values (Table 5), and the steady-state pumping rates (Table 4), the model also requires information on its interior creeks, lakes, and wetlands (Figures 5 and 9). These were determined to represent an expression of the water table in many instances. In MODFLOW, these types of features can be accommodated in several ways.

The creeks were modeled using the Drain package. A tool in GMS allows the tracing of linear features such as creeks, and cells along the traces are automatically assigned as drain cells. Drain cells require two input parameters: elevation and conductance. Elevations were assigned to cells on the basis of the creek stage. Conductance per unit length was assigned on the basis of estimated values of creek sediment thickness, width, and vertical permeability.

Wetlands were also modeled using the drain package, through the use of another mapping tool in GMS. Wetlands were delineated, and these polygons were each assigned an elevation (wetland elevation) and a conductance per unit area (on the basis of estimated values of wetland sediment thickness and vertical permeability).

Large lakes (Alexander, Round, Green Prairie Fish, and Mud) were modeled using MODFLOW's General Head Boundary Package. In this manner, the lakes' levels are to remain steady, allowing the lakes to be a continuous source or sink for groundwater. In the case of a flow-through lake, the lake would be a source at one end and a sink at the other. A value for conductance per unit area was assigned to the lake sediments on the basis of estimated values of sediment thickness and vertical permeability.

Pumping stresses in the study area were modeled by calculating or estimating average groundwater withdrawals, as described above. These pumping rates were incorporated in the 3D model by assigning the withdrawal across each individual well's screened interval. In a case of a well screen's top and bottom elevations straddling two or more model layers, GMS (EMRL 2004) automatically divides the pumping rate across the model layers on the basis of the proportion of well screen present in each.

Calibration

The calibration tool contained in MODFLOW 2000, PES (Hill et al. 2000), was used for parameter estimation of the model's hydraulic conductivity. Initial values used to begin the parameter estimation process are in Table 5. These values were bounded by appropriate minimum and maximum values, allowing PES to have a wide range of values to explore.

The regression techniques of the PES process resulted in an outwash K of 77 m/d, a lacustrine sand K of 21 m/d, a lacustrine silt K of 1 m/d, a lacustrine clay K of 0.81 m/d, and a till K of 50 m/d. These final values differ by varying degrees from their initial values (Table 5). Lacustrine sand, which dominates the modeled volume of glacial drift increased somewhat; this alone likely improved the overall model calibration because of this unit's prevalence. The glacial till units' K underwent the greatest change. Its relatively high permeability from the PES analysis may be due to generally sandy till materials in the study area.

The match between simulated head values and measured heads at target wells provides an indication of the model's calibration. Three equations for addressing the bulk accuracy of the model are the Mean Error (ME), the Mean Absolute Error (MAE), and the Root Mean Squared Error (RMSE) (Anderson and Woessner 1992). The ME is calculated simply as the mean difference between simulated and measured heads. The MAE is the mean absolute value of the difference between simulated and measured heads. The RMSE, which is generally the best measure of error, is the square root of the average squared difference between simulated and measured heads.

Table 7 presents calibration statistics for the model's target monitoring wells from one realization. Other realizations would have different statistics, but with similar overall quality. Figure 13 illustrates the calibrated heads across the modeling domain. A model that is regional in scale may have difficulty in matching many of the target values. However, this model provides a reasonably good match to the distribution of target heads.

Modeled Flowfield

Animation #5 on the attached CD demonstrates the simulated heads from model layer 1 through model layer 10 for one of the multiple stratigraphic realizations. Other model runs based on other stratigraphic models show similar results. In the animation, the upper layers show many dry zones (areas shown with gray background color) within the glacial drift that result from high topography above the regional water table.

The results suggest that the pumping wells in the southern part of the study area obtain their water from upgradient areas, rather than from infiltration of Mississippi River water or a mixture of infiltrated surface water and groundwater. Water levels in the study area are highest in the Lake Alexander vicinity, consistent with the location of this area relative to model boundaries and the modeling approach for the lake.

The potentiometric surface in the vicinity of smaller lakes was inspected relative to the lake levels and depths. Most of those lakes for which bathymetry data were available (Ferrell, Alott, Long, Cockburn, Fosdick, and Rapoon) were determined to be perched relative to the calibrated model's regional potentiometric surface. These lakes likely exist because of a low-permeability material below the lake bottom and/or low-permeability lake sediments. Modeled flow near Round Lake, located along the southwest edge of the facility boundary, suggest that it is a flow-through lake.

One concern of the Camp Ripley site managers is the groundwater flow direction at the Demo Debris Landfill. On the basis of the model, groundwater flow is to the southeast. However, on the basis of same-day hand measurements at wells 250122, 539404, 539405 (data from 1996 to 2002) and 671612 (data from 2001-2002), the flow direction at this facility ranges from southwest to southeast. The location of this site according to the model is along a potentiometric high, with flow radiating out to the southwest, south, and southeast. It appears that the groundwater flow direction at this site is sensitive to small changes in the flow system, and groundwater flow is not in a uniform direction. Careful assessment of water levels at the site, in the form of additional synoptic measurements and/or continuously logging water level probes, would provide a better understanding of the local flow direction.

Wellhead Protection Zone Delineation

WHP Zone Modeling Approach and Results

The probabilistic method for delineating a WHP zone for wells H, L, and N relies on a numerical modeling and geostatistical approach. Multiple, equally probable realizations of the glacial drift stratigraphy were used to produce multiple numerical groundwater flow models, as described above. This is referred to as a stochastic approach. Forward particle tracking from all cells throughout the 3D model is performed by GMS, which then calculates the percentage of particles captured by each well. The contoured results indicate the probability of each grid cell being in the zone of contribution to each well.

Wells L and N are co-located in the same cell in the numerical grid, so their probabilistic WHP zone is combined. Their WHP zone for their combined average pumping rate extends to the northwest (Figure 14). The probabilistic assessment for the average annual pumping rate indicates that high probabilities are present off-post immediately west of the Cantonment Area. Lower probabilities are present further upgradient on-post. The furthest upgradient portion of the capture zone is in an off-post area, with probabilities of contributing to the L and N capture zone of <30%. The modeling was also performed for the case of using the maximum annual pumping rates for all onsite production wells and irrigation wells (Table 4). The results for the combined L and N capture zone show a slightly larger high-probability area immediately west of the Cantonment Area, with similar results further upgradient (Figure 15).

Well H has a capture zone that also extends to the northwest, and is bifurcated by the combined L and N capture zone (Figure 16). The probabilistic results show that Well H's average pumping creates a high-probability zone of capture on-post, with relatively lower probabilities upgradient in the off-post area immediately west of the Cantonment Area. For the case of maximum annual pumping rates (Table 4), the capture zone is somewhat broader and higher (Figure 17).

Capture zones are not presented for the irrigation wells or the commercial establishment's well. No capture zones were generated for the modeled private wells because of their low pumping rates relative to the scale of the model.

Prior WHP Zone Delineation

A WHP program was initiated for Camp Ripley's production wells several years ago (Minnesota Army National Guard 200__). This plan included management strategies and identification of potential contaminant sources, and was focused on wells H, J, L, and N. Well N is a replacement of former wells K and M, and well J has since become inactive.

The model, however, was a very simplified version of the facility's hydrogeologic framework. Rather than accounting for any spatial variability in the geology, the analysis assumed an unconfined aquifer with uniform properties (hydraulic conductivity, porosity) throughout its thickness and areal extent, uniform recharge (6.65 inches/year, equivalent to one-fourth of the average annual precipitation), and a flat base. The aquifer thickness was set high enough to maintain unconfined conditions. Hydraulic conductivity was assigned based on a value resulting from a pumping test at well L (Driscoll 1990). The porosity value selected was the mid-range value of "glacial till" porosities as listed in Driscoll (1986), despite the subsurface being dominated by other materials. The modeling technique was the analytic element method. The resulting deterministic model shows a WHP zone extending approximately 9 km through onsite and offsite areas (Figure 18). The analytic element method requires a reference point, which is a head value at a certain location, namely a monitoring well. Model accuracy was addressed by comparing model-predicted heads to measured heads at four monitoring wells. Model runs relying on different reference points demonstrated that the model was sensitive to the reference point selected.

Comparison of Results to Prior WHP Model

In terms of overall flow direction in the production well vicinity, the prior model and the current model are similar. However, the prior model was a deterministic model, relying on a single, simplified hydrogeologic model in determining the groundwater flowfield. The current model is supported by an abundant amount of drilling data, which in turn support multiple geostatistical realizations of the subsurface. The multiple numerical groundwater modeling results and the probabilistic particle capture method provide a means of addressing uncertainty in the model's subsurface framework and in the subsequent flow modeling results.

When the combination of the L, N, and H capture zones in Figures 14-17 are compared to that of the prior model (Figure 18), they are similar in orientation. In terms of the breadth of the capture zone, the current model is somewhat wider than the prior. This is mainly because of the multiple realizations of the geostatistically characterized subsurface, which tend to spread out the particle traces. In contrast, the prior model's deterministic approach provided only a single result of a narrowing capture zone. Guidance on WHP delineation may call for variation of a capture zone orientation by 10% in order to resolve some of the uncertainty in the model. In the case of the geostatistical model, this uncertainty is already addressed.

Flowpaths from Potential Groundwater Contaminant Source Areas

On the basis of discussions with Camp Ripley staff, several areas at the facility were selected for analysis of groundwater flowpaths. This analysis was performed by conducting forward particle tracking from the potential source areas using any of the calculated numerical model flowfields. Particles were started in cells of the uppermost active (saturated) model layer beneath the selected site and were tracked to their discharge locations (i.e. surface water or wetland). In this manner, the modeling approach assumes that any contaminants have already traveled through the unsaturated zone. The flowpaths are 3D, and when viewed interactively in 3D, they illustrate a somewhat tortuous flowpath because of preferential flow through higher-permeability model cells and around lower-permeability model cells.

The analysis focused on three impact areas (Leach, Hendrickson, and Hole-in-the-Day), several waste management facilities (Demo Debris Landfill, Sludge Spread Site, Old Mixed Municipal Landfill, and Landfarm Spread Site), two ranges (Demo Range and Old Demo Range) and a proposed training facility (the Y-2 site).

Results projected in 2D are showing in Figures 19-21, with 10-year time-of-travel markers along each flowpath. Large areas are represented by scattered, representative particle starting locations. The particle tracking method assumes advective flow, so that particles move with the bulk groundwater and are not affected by contaminant transport processes such as sorption, dilution, or biological or chemical decay. The results are therefore conservative, in the sense that most contaminants would travel slower than the overall groundwater flow rate.

These results may be used by site managers to understand groundwater flow directions for monitoring well placement. Three-dimensional inspection of the flowpaths would guide decisions regarding well screen depth. The time-of-travel information on the particle traces provides an initial, conservative estimation of the rate of transport of any groundwater contaminants from these potential source areas.

Summary and Recommendations

The model documented in this report relies on a variety of geologic and hydrologic input sources. These data were used in the construction and calibration of the model. Because of the site's underlying stratigraphic complexity, the model has uncertainty inherent in its design, and fixed hydrogeologic contacts in a subsurface model would be difficult to defend. Therefore, by utilizing a geostatistical approach rather than assumed contacts, the variability of the subsurface is addressed explicitly by the model.

A numerical groundwater model may be a dynamic tool that is updated with additional data or modified to address a local groundwater concern. Applications for the model include geologic characterization of sites (through the 3D inspection of borehole data); identification of geologic and hydrologic data gaps; determination of flowpaths, especially for Wellhead Protection studies; remedial design; water resources planning; and permitting. Depending on a model's purpose and scale issues, water levels from the model in this report could be used as boundary conditions for a model focused on a smaller area and designed for a specific purpose.

As described above, the current model, with its geostatistical approach to handling hydrogeological uncertainty, supports WHP zones for wells L, N, and H. This zone is similar in orientation and dimension to a prior model; however, the probabilistic approach of the current model provides a means of delineating the WHP zone on the basis of the relative risk.

The State WHP Program calls for notification of owners of private properties within the WHP zone to take place at least once per year. The communication is to include information on the facility's WHP manager, guidance about aquifer protection and conservation, and contacts for Morrison County, DNR, and MDH regarding septic system compliance and maintenance, agricultural best management practices, water well testing, etc. Signage is to be installed in the WHP zone. On the basis of the current modeling results, site managers should feel confident in maintaining WHP management strategies over land areas consistent with those of the prior evaluation.

As described above, groundwater flow directions at the Demo Debris Landfill appear to vary on the basis of measured water levels. Additional synoptic measurements and/or continuous recorders would provide data for understanding the dynamic nature of the groundwater flow at this facility. Ten-year time of travel from the facility appears to a distance of approximately 400 to 600 m.

Flow at Y-2 site, which may require permitting for graywater discharge from a newly proposed facility, is to the southeast.

References

American Water Works Association (AWWA), 2006, Stats on Tap, http://www.awwa.org/Advocacy/pressroom/statswp5.cfm accessed August 4, 2006.

Anderson, M.P. and W.W. Woessner, 1992, Applied groundwater modeling: simulation of flow and advective transport: San Diego, Academic Press, Inc., 381 p.

Carle, S.F., 1999, T-PROGS: Transition Probability Geostatistical Software, version 2.1: University of California, Davis.

Carney, L.M., and H.D. Mooers, 1998, Landform assemblages and glacial history of a portion of the Itasca moraine, north-central Minnesota: in Patterson, C.J. and Wright, H.E., Jr., eds., Contributions to the Quaternary of Minnesota: Minnesota Geological Survey Report of Investigations 49, St. Paul, Minnesota, p.85-96.

Driscoll, F.G., 1986, Groundwater and Wells: St. Paul, Minnesota, Johnson Controls, 1,089 pp.

Driscoll, F.G., 1990, Pump Test Results for Well L, in Hydrogeologic Report for New Water Well, by Fletcher G. Driscoll and Associates, prepared for Camp Ripley, February 22.

EMRL, 2004, Groundwater Modeling System (GMS), Version 5.1. Provo, Utah: Environmental Modeling Research Laboratory, Brigham Young University.

Freeze, R.A. and J.A. Cherry, 1979, Groundwater: Englewood Cliffs, NJ, Prentice-Hall, Inc., 604 p.

Goldstein, B.S., 1998, Quaternary stratigraphy and history of the Wadena drumlin region, central Minnesota: *in* Patterson, C.J. and Wright, H.E., Jr., eds., Contributions to the Quaternary of Minnesota: Minnesota Geological Survey Report of Investigations 49, St. Paul, Minnesota, p. 61-84.

Goldstein. B.S., 1989, Lithology, sedimentology, and genesis of the Wadena drumlin field, Minnesota, U.S.A.: Sedimentary Geology, vol. 62, p. 241-277.

Harbaugh, A.W., Banta, E.R., Hill, M.C., and McDonald, M.G., 2000, MODFLOW-2000, the U.S. Geological Survey modular ground-water model -- User guide to modularization concepts and the Ground-Water Flow Process: U.S. Geological Survey, Reston, VA, Open-File Report 00-92, 121 p.

Helgesen, J.O., and Lindholm, G.F., 1977, Geology and water-supply potential of the Anoka sand-plain aquifer, Minnesota: Minnesota Department of Natural Resources, Division of Waters, Technical Paper No. 6, 17 p.

Hill, M.C., Banta, E.R., Harbaugh, A.W., and Anderman, E.R., 2000, MODFLOW-2000, the U.S. Geological Survey modular ground-water model -- User guide to the Observation, Sensitivity, and Parameter-Estimation Processes and three post-processing programs: U.S. Geological Survey, Reston, VA, Open-File Report 00-184, 210 p.

Klinker, R., 2005, E-mail correspondence from R. Klinker, Camp Ripley, to J. Quinn, Argonne National Laboratory, June 15.

Minnesota Army National Guard, 200__, Wellhead Protection Program for Camp Ripley Water Supply Wells, 57 pp. plus appendices.

Minnesota Department of Health, 2006, County Well Index, http://www.health.state.mn.us/divs/eh/cwi/ accessed 4/3/06.

Minnesota Department of Natural Resources, 2006, Lake Finder, http://www.dnr.state.mn.us/lakefind/index.html accessed 4/3/06.

Minnesota Pollution Control Agency, 1999, Lake Assessment Program 1997, Fishtrap Lake (ID #49-0137), Morrison County, Minnesota, August.

Mooers, H.D., 1996, Geomorphology of the Brainerd 1:100,000 quadrangle and the development of the Land Type Association layer of the Ecological Classification System, Minnesota Department of Natural Resources - Division of Forestry.

Mooers, H.D. and J.D. Lehr, 1997, Terrestrial record of Laurentide Ice Sheet reorganization during Heinrich events: Geology, vol. 25, no. 11, p. 987-990.

Pollock, D.W., 1994, User's Guide for MODPATH/MODPATH-PLOT, Version 3:
A particle tracking post-processing package for MODFLOW, the U. S. Geological Survey finite-difference ground-water flow model: U. S. Geological Survey, Reston, VA, Open-File Report 94-464.

Quinn, J.J., 2003, Numerical Groundwater Flow Model of Camp Ripley, Minnesota: Environmental Assessment Division, Argonne National Laboratory, prepared for Camp Ripley Environmental Program, Department of Military Affairs, August, 26 p. plus appendices.

St. George, L.M., 1994, A landform-based approach to the estimation of groundwater recharge in complex glacial topography: M.S. thesis, University of Minnesota, 111 p.

Schneider, A.F., 1961, Pleistocene geology of the Randall Region, Central Minnesota: Minneapolis, Minnesota Geological Survey, Bulletin 40, 151 pp.

U.S. Department of Agriculture, 1994, Soil Survey of Morrison County, Minnesota: Soil Conservation Service, 191 p. plus plates.

University of Minnesota – Duluth (UMD), 2002, Environmental Drilling Field Report, prepared by Department of Geological Sciences, prepared for Camp Ripley.

Wright, H.E. Jr., 1972, Quaternary history of Minnesota, in Sims, P.K., and Morey, G.B., eds., Geology of Minnesota: a centennial volume: Minnesota Geological Survey, Minneapolis, Minnesota, p. 515-547.

Table 1. Mooers' (1996) mapping units in the Camp Ripley study area

Grouping in GMS	Code	Geomorphic Association	Glacial Phase	Topographic Expression	Sedimentary Association	Qualifier
A	RSt3S	Rainy Lobe	St. Croix Phase	hummocky	supraglacial drift complex	
B	RSt3O	Rainy Lobe	St. Croix Phase	hummocky	outwash	
C	RSt1O	Rainy Lobe	St. Croix Phase	level	outwash	
C	RSt1Och	Rainy Lobe	St. Croix Phase	level	outwash	outwash channel
B	RSt3I	Rainy Lobe	St. Croix Phase	hummocky	ice contact	
D	RSt1L	Rainy Lobe	St. Croix Phase	level	lacustrine	
A	SSt3S	Superior Lobe	St. Croix Phase	hummocky	supraglacial drift complex	
E	SSt1Lsw	Superior Lobe	St. Croix Phase	level	lacustrine	shallow water lake sands
F	OHo1P	Organic Deposits	Holocene	level	peat	
C	DBe1O	Des Moines Lobe	Bemis Phase	level	outwash	
G	WHe2T	Wadena Lobe	Hewitt Phase	rolling to undulating	till plain	
C	RSt3Och	Rainy Lobe	St. Croix Phase	hummocky	outwash	outwash channel
G	SSt2T	Superior Lobe	St. Croix Phase	rolling to undulating	till plain	
C	F_1A	Fluvial		level	alluvium	

Table 2. St. George's (1994) calibrated recharge values for units relevant to Camp Ripley and estimated recharge values

St. George's (1994) Landforms	Sediment Classification	Calibrated Recharge	Calibrated Recharge	Low End of Range Determined by Sensitivity Analysis	High End of Range Determined by Sensitivity Analysis	Grouping in GMS
		(cm/yr)	(m/d)	(m/d)	(m/d)	
Collapsed outwash	loamy sand	7.6	2.08E-04	1.26E-04	2.49E-04	B
till plain (Wadena)	sandy loam	0.15	4.11E-06	-4.11E-06	8.22E-06	G
outwash fan	sand	15.2	4.16E-04	2.49E-04	5.84E-04	C
outwash plain	sand	21.3	5.84E-04	3.34E-04	7.51E-04	A
Estimated material values:			Estimated Recharge (m/d)			
Fine lacustrine			1.00E-04			E
peat			1.00E-04			F

Table 3. Geometric mean hydraulic conductivities from UMD grain size analyses (source: UMD data).

Unit	Hazen	Krumbein and Monk	Puckett	Harleman	Geometric Mean (all methods) (m/d)
	Geometric Mean K (m/d)				
Dense Clay Loam Till	1.06E-03	7.34E-01	8.63E-03	1.13E-01	2.96E-02
Lacustrine Clay	1.13E-03	1.60E-01	1.35E-01	1.20E-01	4.13E-02
Red Sandy Till	8.14E-03	3.97E+01	8.25E-01	8.69E-01	6.94E-01
Lacustrine Silt	1.69E-02	8.19E-01	1.13E+00	1.80E+00	4.09E-01
Red/Brown Sandy Loam Till	2.40E-02	2.78E+01	1.12E+00	2.38E+00	1.16E+00
Silty Fine Sand	3.26E-02	6.17E+00	1.11E+00	3.15E+00	9.16E-01
Saprolith	6.06E-02	1.44E+01	2.60E+00	6.47E+00	1.96E+00
Fine Sand	3.60E-01	9.32E+00	2.40E+00	2.80E+01	3.87E+00
Medium Sand	3.72E+00	4.77E+01	2.55E+00	3.08E+02	1.93E+01
Coarse Sand/Gravel	5.15E+01	2.50E+02	2.76E+00	3.02E+03	1.02E+02

Table 4. Pumping in the study area

Unique Number or Name	user	ground elev (m)	well depth (m)	Historical Average Pumping (MGY)[1]	Peak Year Pumping (MGY)	Historical Average Pumping (m^3/d)	Peak Year Pumping (m^3/d)
H	production	348.54	18.6	27.6	42.9	285.9	444.4
L	production	348.54	29.9	20.9	34.9	216.5	361.6
N	production	348.54	31.1	24.3	30.0	251.7	310.8
121834	irrigation	350.5	19.5	16.7	16.7	173.0	173.0
214597	irrigation	344.4	21.6	37.7	77.4	390.6	801.9
214433	irrigation	344.4	18.0	57.8	44.1	598.8	456.9
214434	irrigation	344.4	16.5	37.8	27.2	391.6	281.8
451315	private home	350.82	15.2	0.128	0.128	1.326	1.326
592566	private home	347.78	16.5	0.128	0.128	1.326	1.326
543433	private home	348.69	17.1	0.128	0.128	1.326	1.326
571415	private home	348.69	17.1	0.128	0.128	1.326	1.326
701091	restaurant	346.86	17.1	2.560	2.560	26.522	26.522
495271	private home	341.99	16.8	0.128	0.128	1.326	1.326
136967	private home	355.09	27.1	0.128	0.128	1.326	1.326
224540	private home	352.04	22.9	0.128	0.128	1.326	1.326

[1] MGD = million gallons per day

Table 5. TPROGS categories based on EnDriP interpretations.

EnDriP Material Name	TPROGS unit grouping	Initial Modeled Hydraulic Conductivity (m/d)
Lacustrine Clay	lacustrine clay	0.01
Dense Clay Loam Till	tills	0.1
Red/Brown Sandy Loam Till	tills	0.1
Red Sandy Till	tills	0.1
Silt Loam	lacustrine silt	0.1
Lacustrine Silt	lacustrine silt	0.1
Silty Fine Sand	lacustrine silt	0.1
Fine Sand	lacustrine sand	5
Medium Sand	lacustrine sand	5
Coarse Sand/Gravel	outwash	75

Table 6. Proportions of TPROGS categories in Camp Ripley study area

Material	Percentage
Outwash	9.4
Lacustrine_sand	70.2
Lacustrine_silt	2.8
Lacustrine_clay	6.1
Till_units	11.5

Table 7. Calibration statistics for target monitoring wells.

Well	Observed Head (m MSL)	Computed Head (m)	Residual (m)	Absolute value of residual (m)	Squared Residual (m^2)
534079	345.16	344.29	-0.87	0.87	0.75
534077	342.17	344.36	2.19	2.19	4.78
530010	345.95	344.40	-1.55	1.55	2.40
523496	342.90	343.92	1.02	1.02	1.05
523495	342.90	343.95	1.05	1.05	1.09
523494	341.83	343.90	2.06	2.06	4.26
523493	341.77	343.97	2.20	2.20	4.84
523492	343.33	343.85	0.52	0.52	0.27
523491	341.38	343.95	2.58	2.58	6.65
495630	383.13	372.41	-10.73	10.73	115.06
470668	342.47	347.18	4.70	4.70	22.11
470506	367.89	359.52	-8.37	8.37	70.14
466293	344.88	347.55	2.66	2.66	7.10
466292	344.36	347.60	3.23	3.23	10.46
466291	343.97	347.56	3.59	3.59	12.90
466290	344.52	347.50	2.98	2.98	8.90
466289	364.69	365.82	1.13	1.13	1.27
466288	369.51	365.87	-3.64	3.64	13.24
466286	367.13	366.02	-1.11	1.11	1.24
451233	367.28	359.33	-7.95	7.95	63.22
451232	351.74	351.36	-0.38	0.38	0.14
451231	345.95	348.45	2.50	2.50	6.25
451230	356.62	352.57	-4.04	4.04	16.34
451229	373.08	370.06	-3.02	3.02	9.11
224577	343.81	345.31	1.50	1.50	2.24
214597	340.77	343.93	3.16	3.16	9.98
150536	345.34	345.21	-0.13	0.13	0.02
150535	343.20	345.62	2.41	2.41	5.81
671608	349.07	351.57	2.50	2.50	6.23
578602	387.53	380.04	-7.49	7.49	56.09
530012	345.84	344.30	-1.54	1.54	2.37
451238	355.09	355.55	0.45	0.45	0.21
130267	349.61	349.73	0.13	0.13	0.02
			-0.25	2.83	3.76
			ME (m)	MAE (m)	RMSE (m)

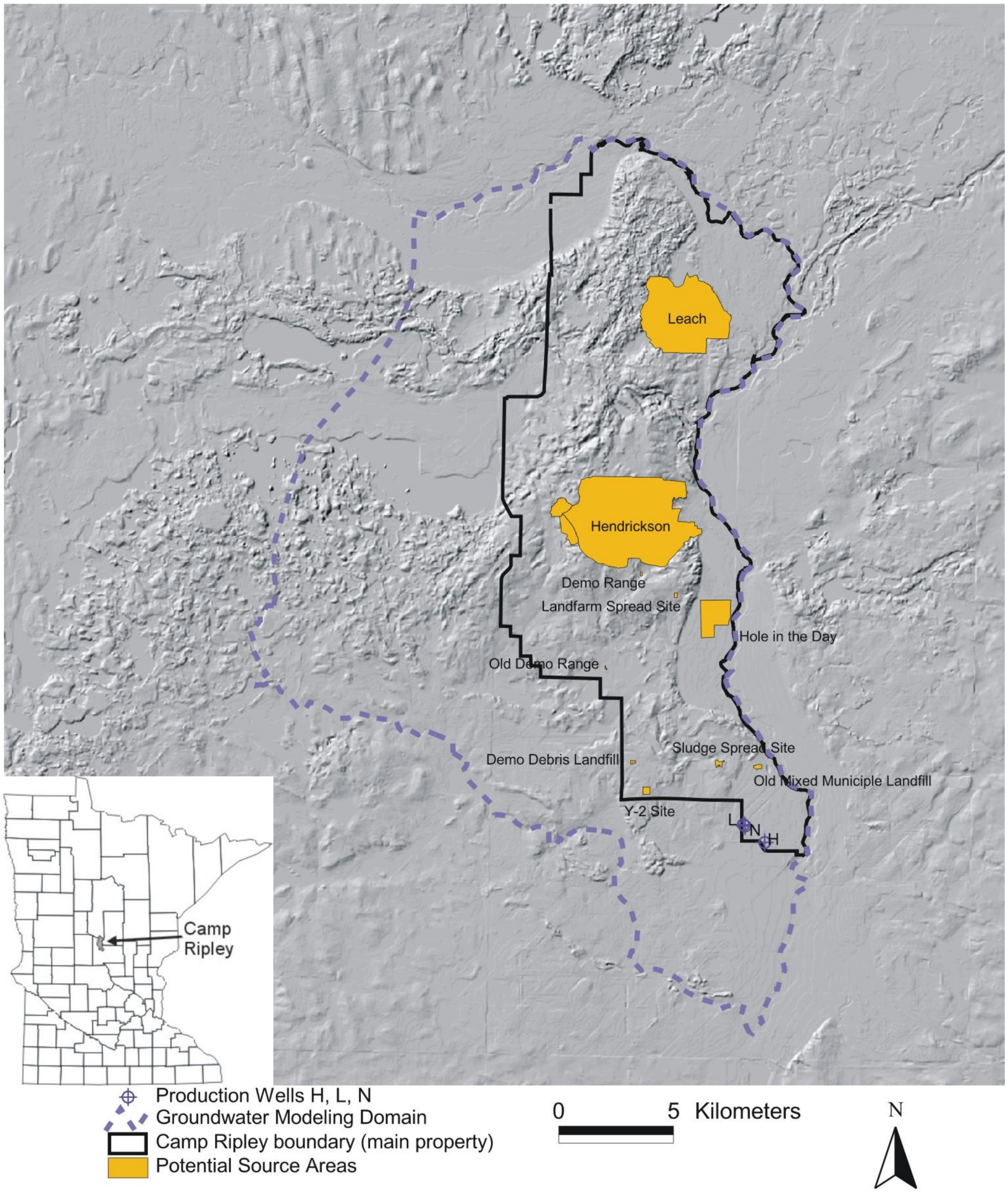


Figure 1. Camp Ripley location, layout, and sources of potential groundwater contamination.

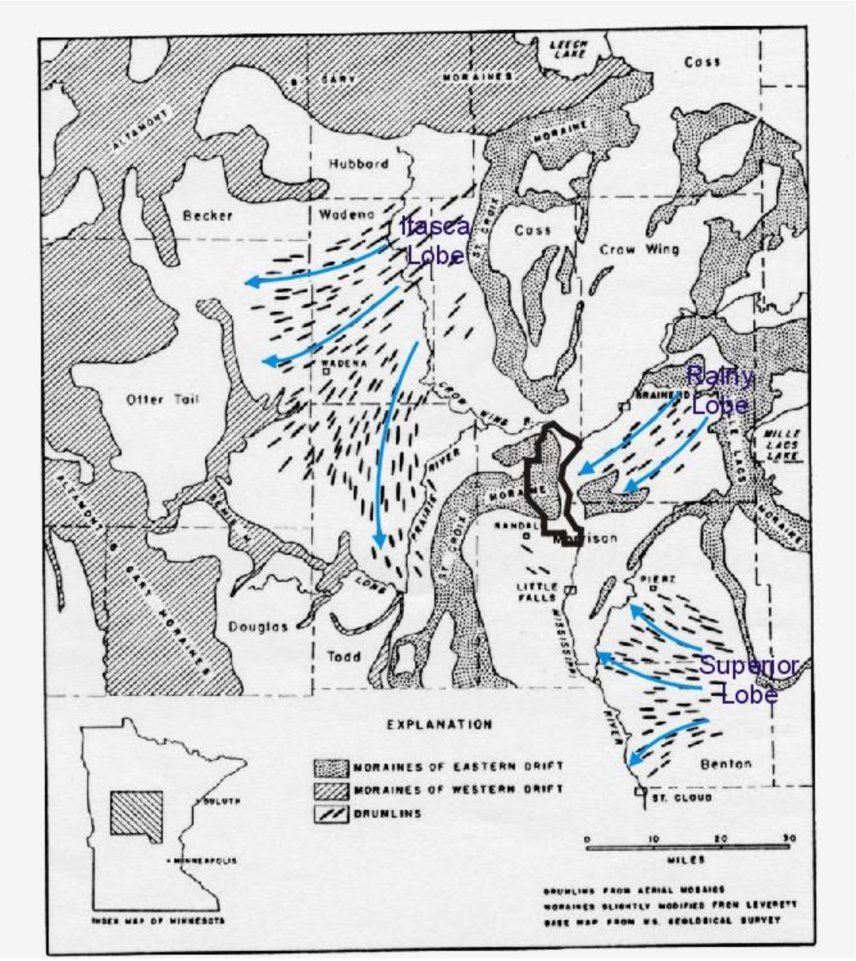


Figure 2. Ice flow directions, end moraines and drumlin fields of the Itasca, Rainy, and Superior lobes in central Minnesota (modified from Schneider 1961).

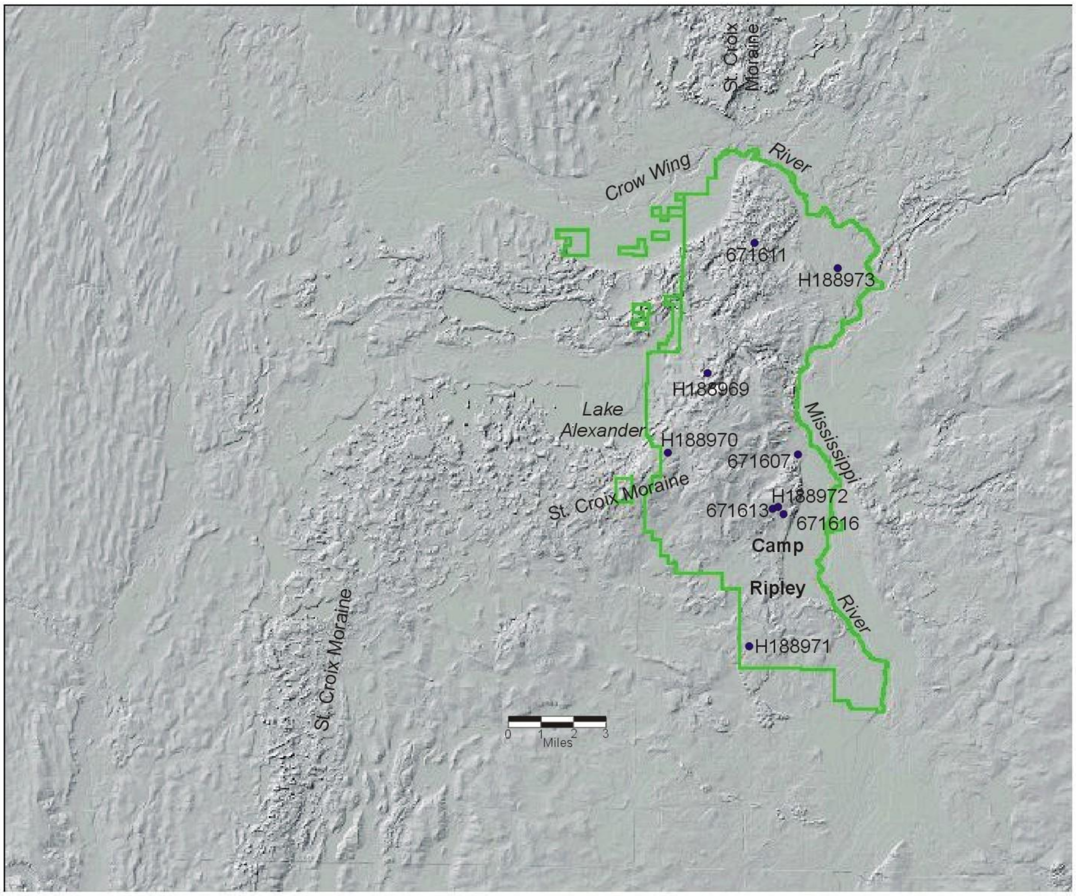


Figure 3. Camp Ripley and vicinity, with the EnDriP drilling locations.

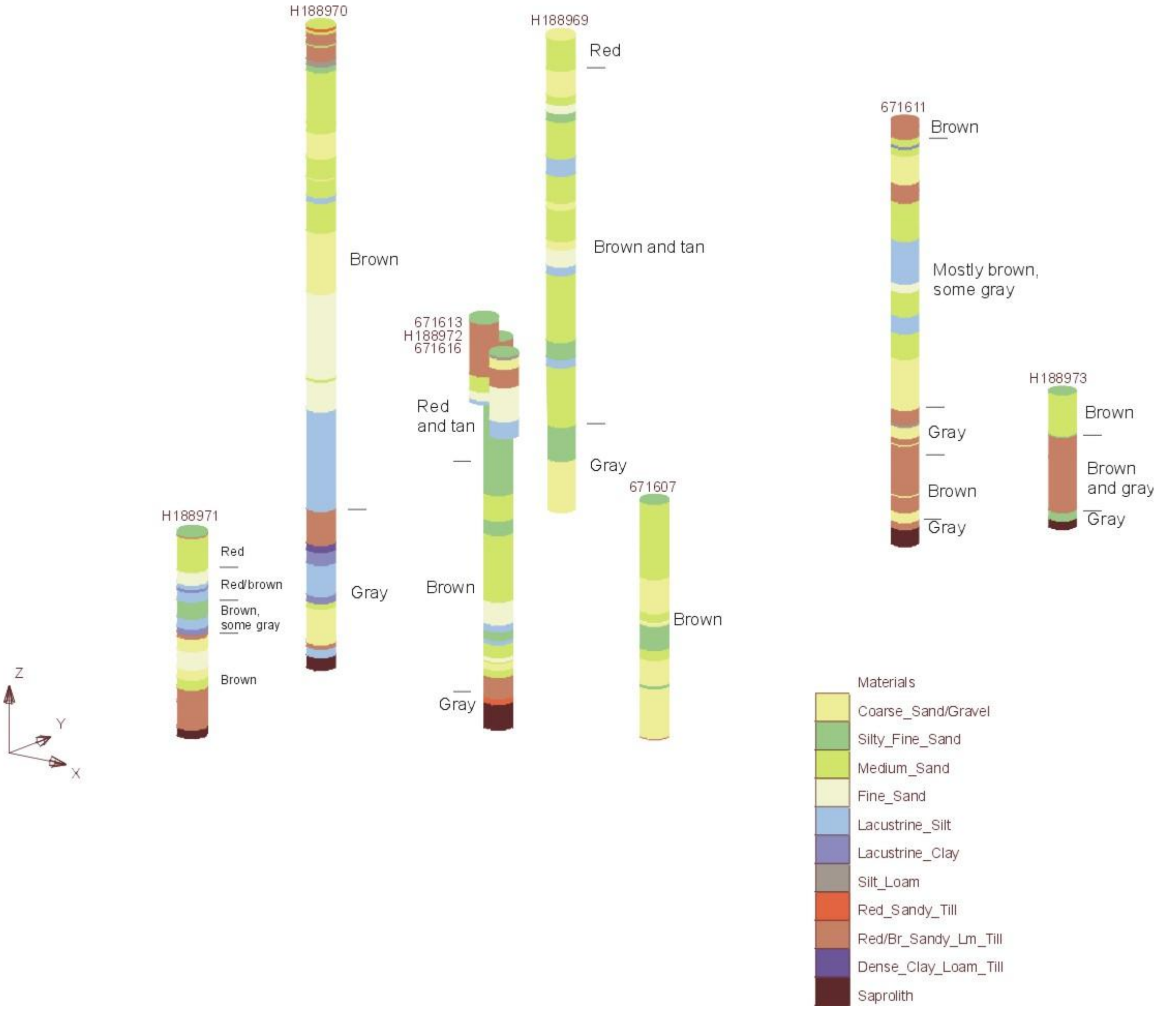


Figure 4. Oblique view of EnDriP borehole stratigraphy and approximate color contact within the drift. (Y direction is due north; X direction is due east.)

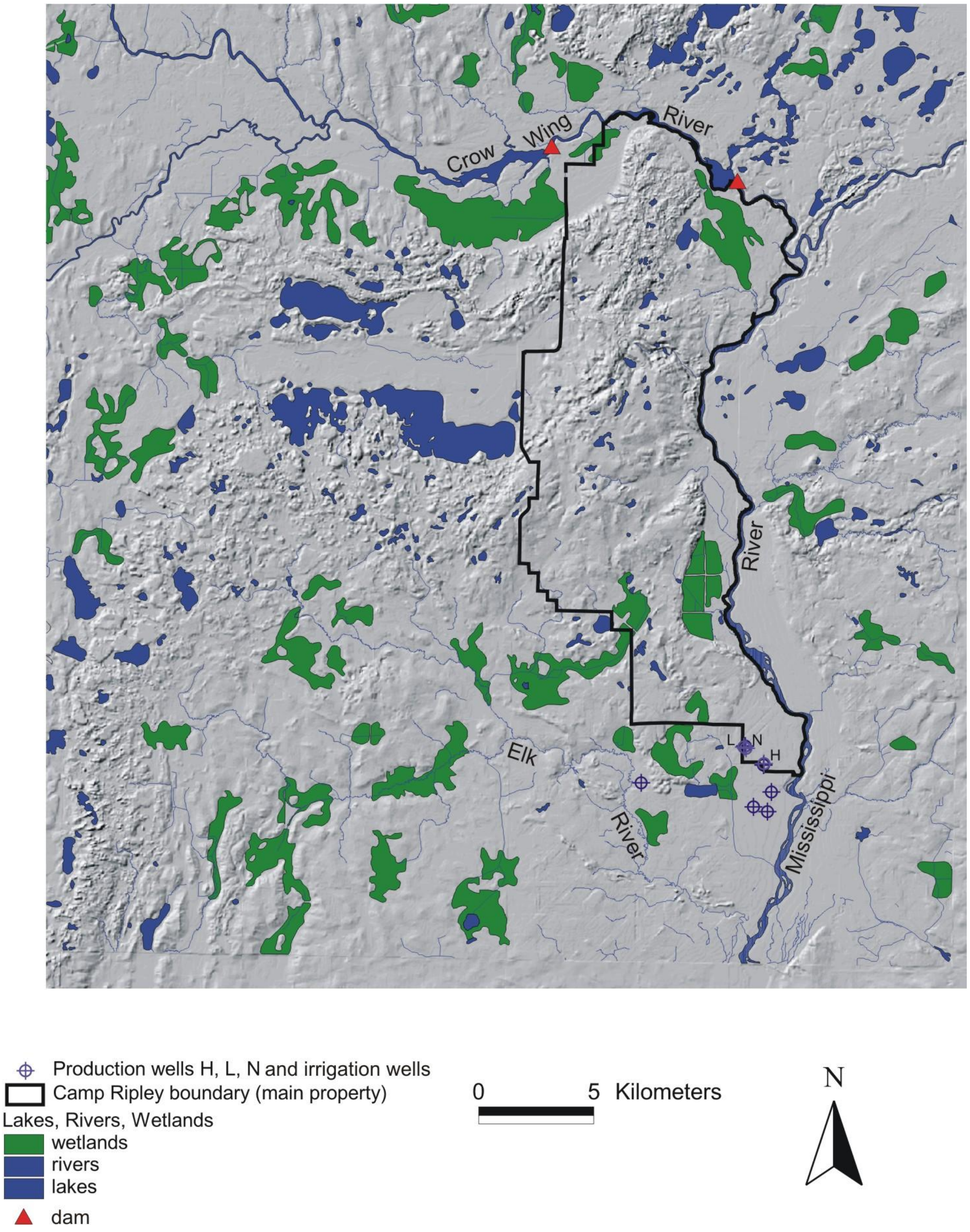


Figure 5. Camp Ripley vicinity surface water features.

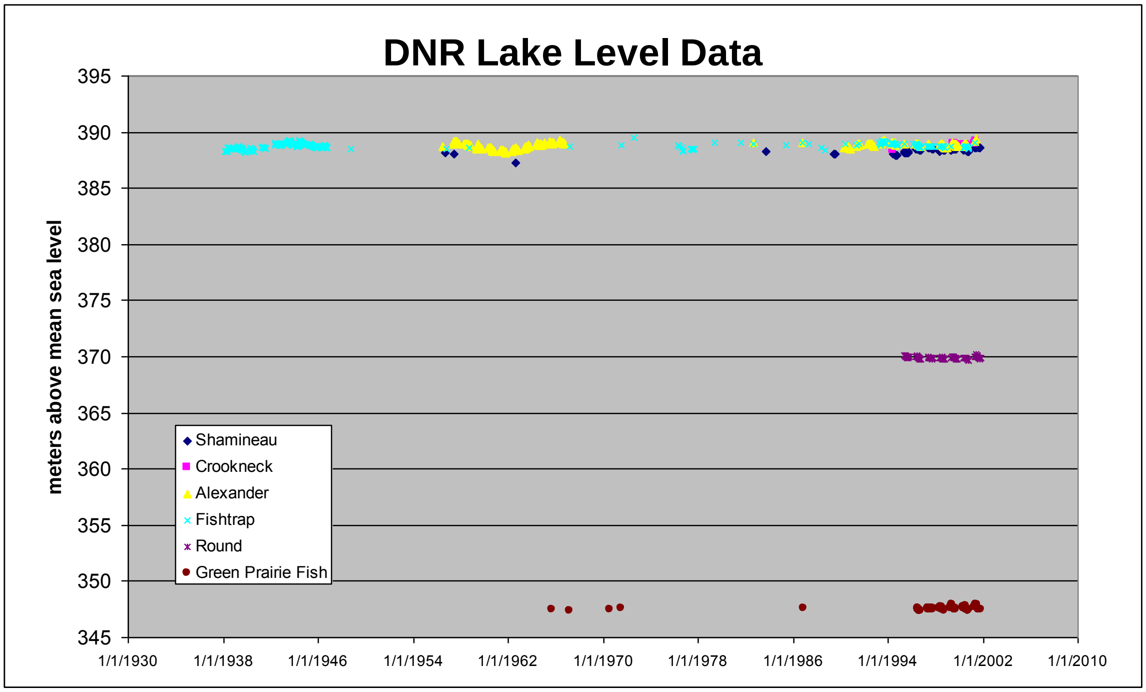


Figure 6. **Water levels at six nearby lakes monitored by DNR.**

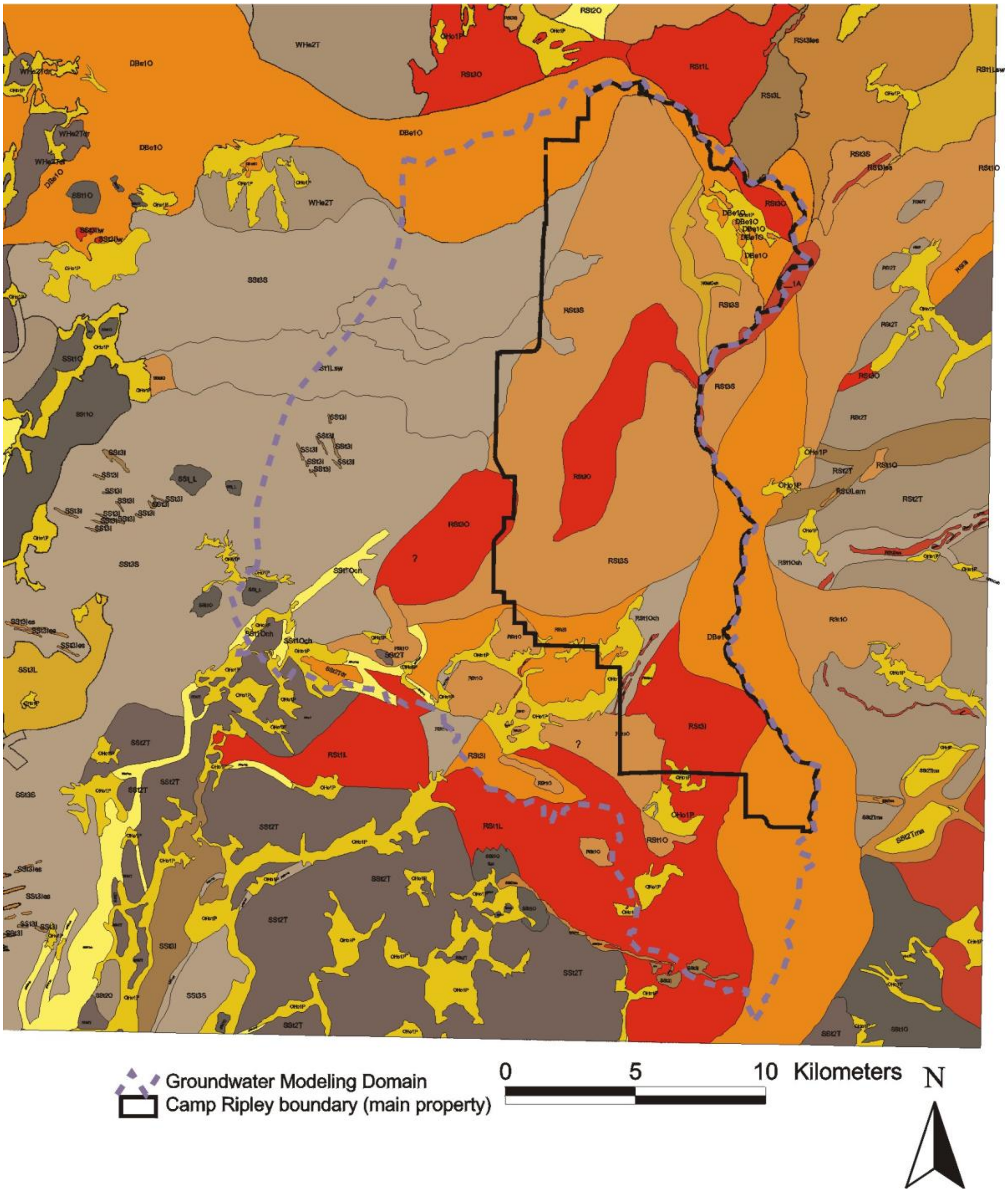


Figure 7. Geomorphological mapping of Mooers (1996) used as the model's recharge zones.

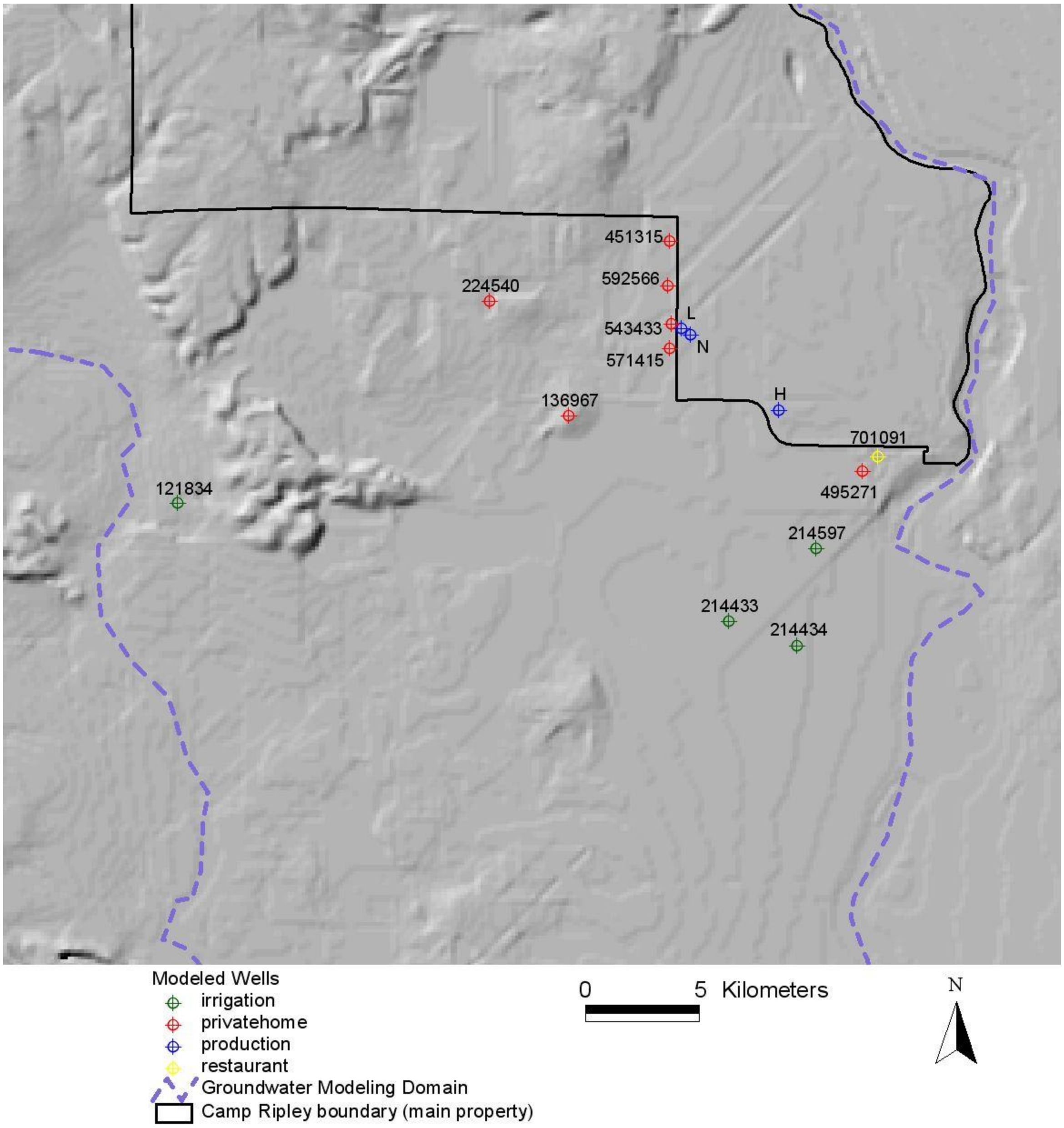


Figure 8. Modeled pumping wells

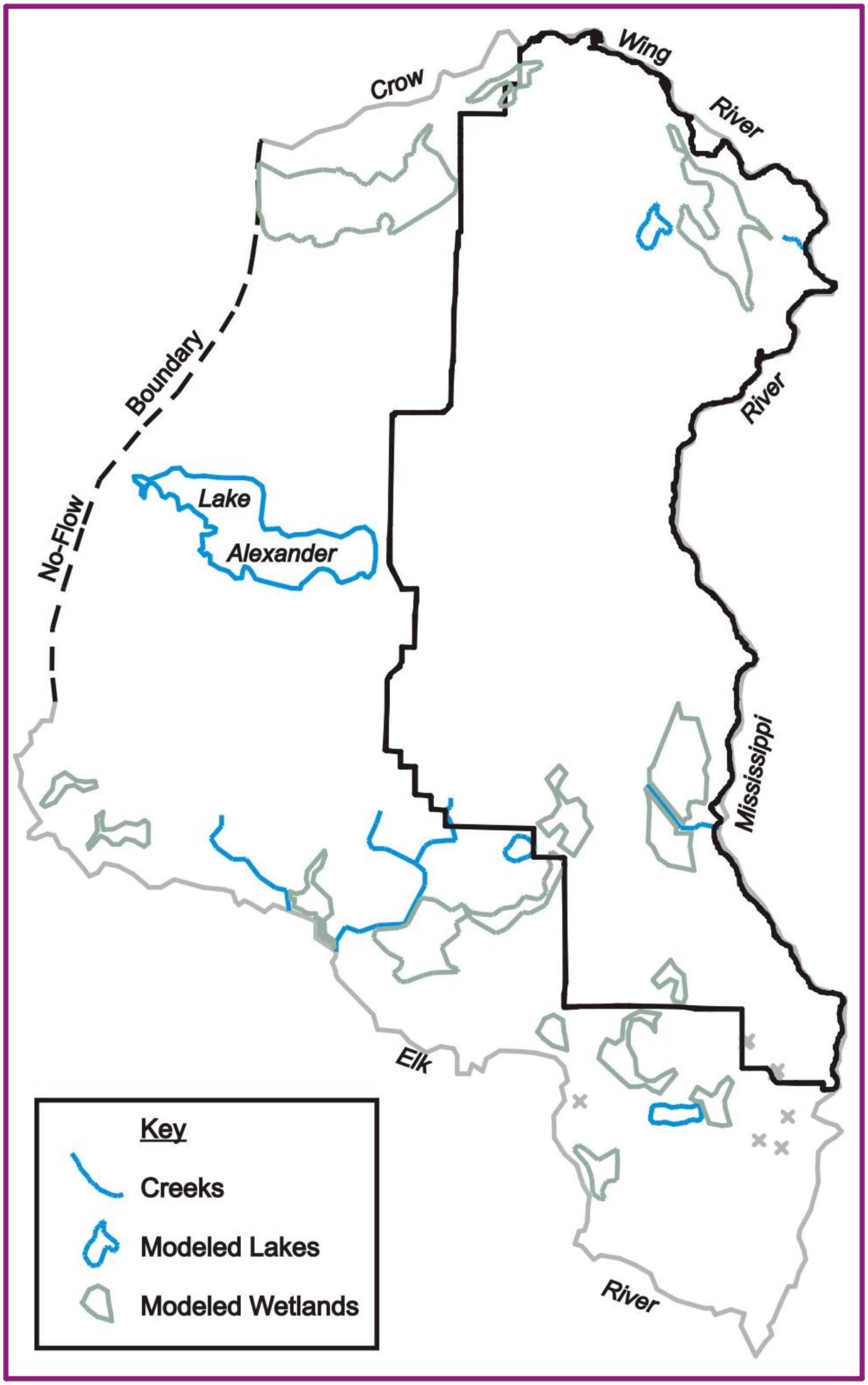


Figure 9. External and internal boundary conditions.

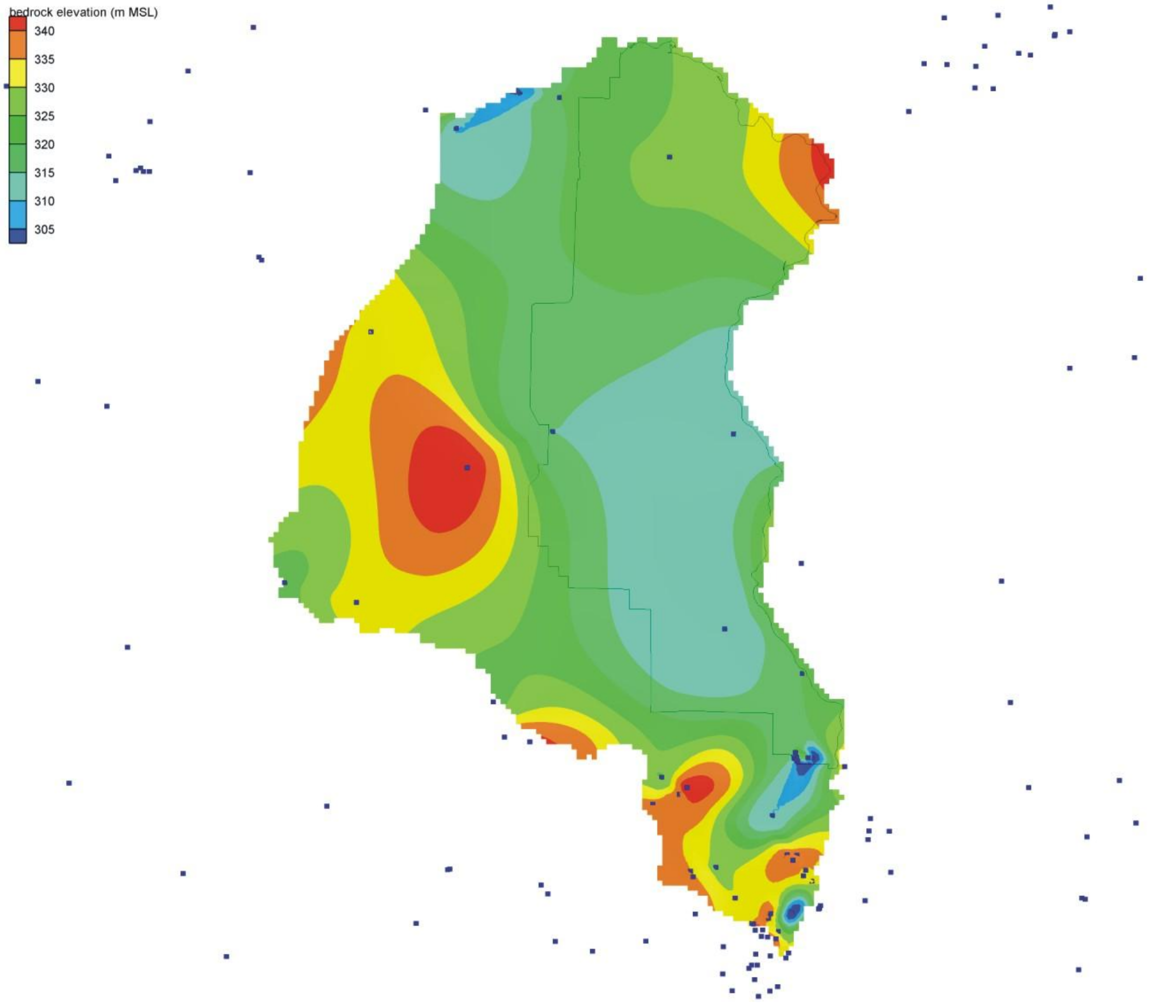


Figure 10. Bedrock surface elevation in model domain.

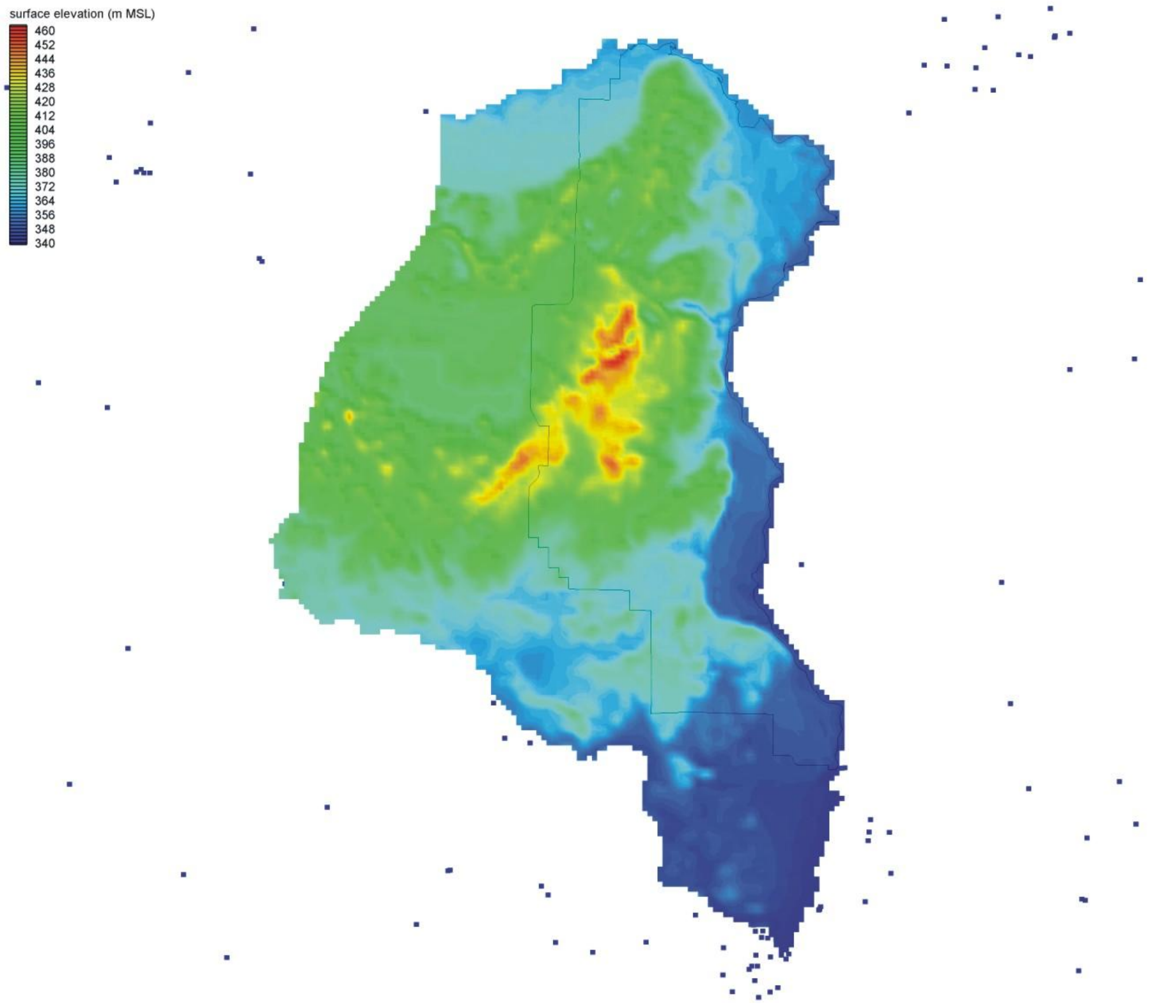


Figure 11. Ground surface elevation in model domain.

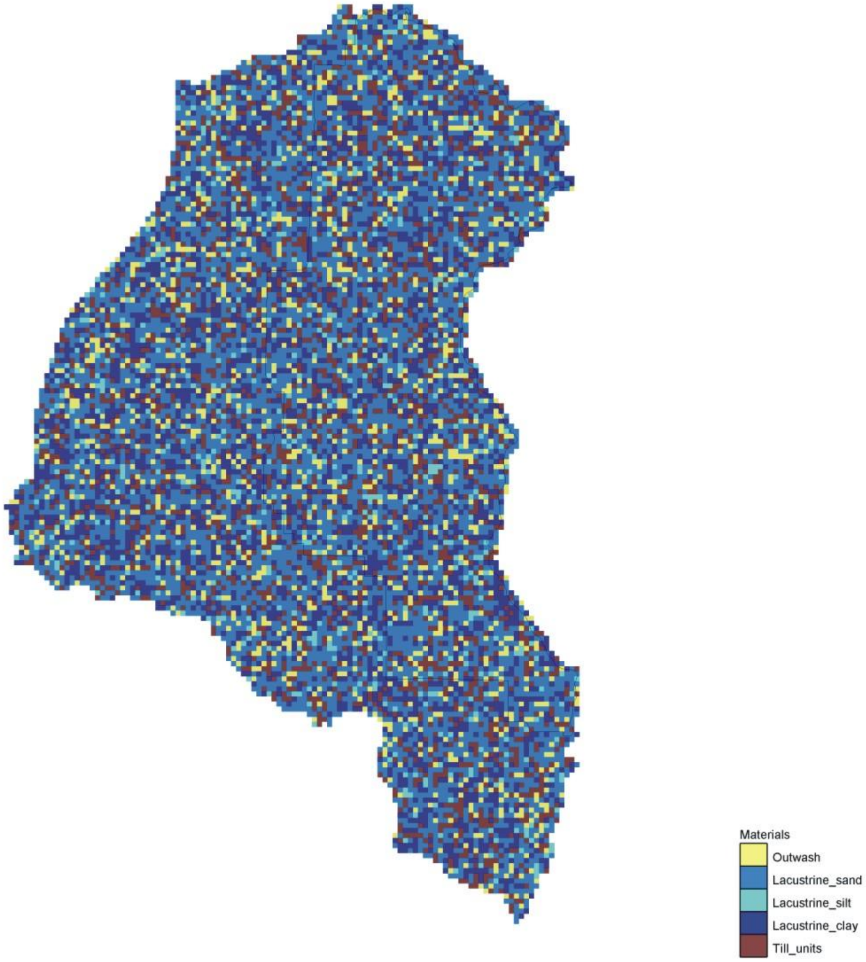


Figure 12. Example TPROGS results for one model layer.

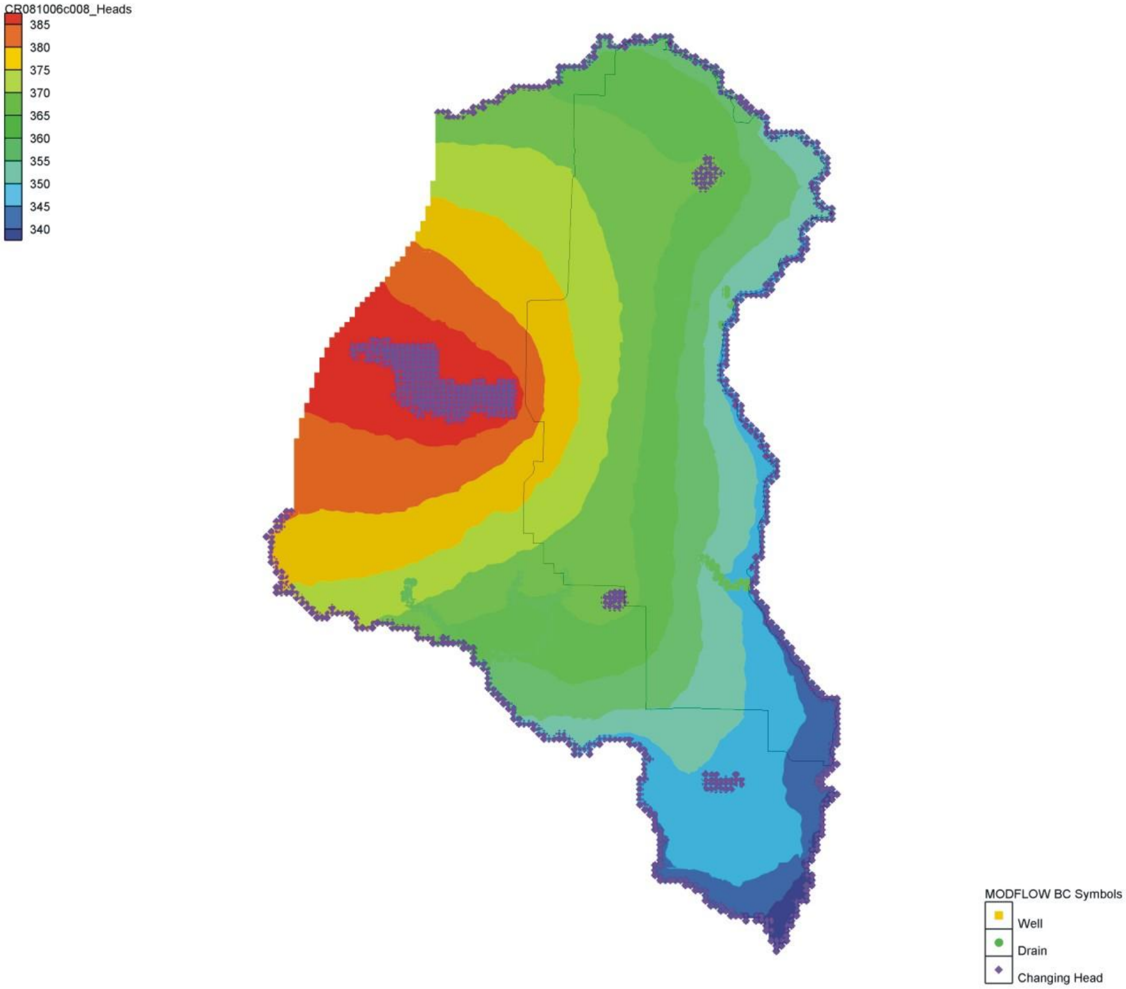


Figure 13. Example of calibrated potentiometric surface from one model realization.

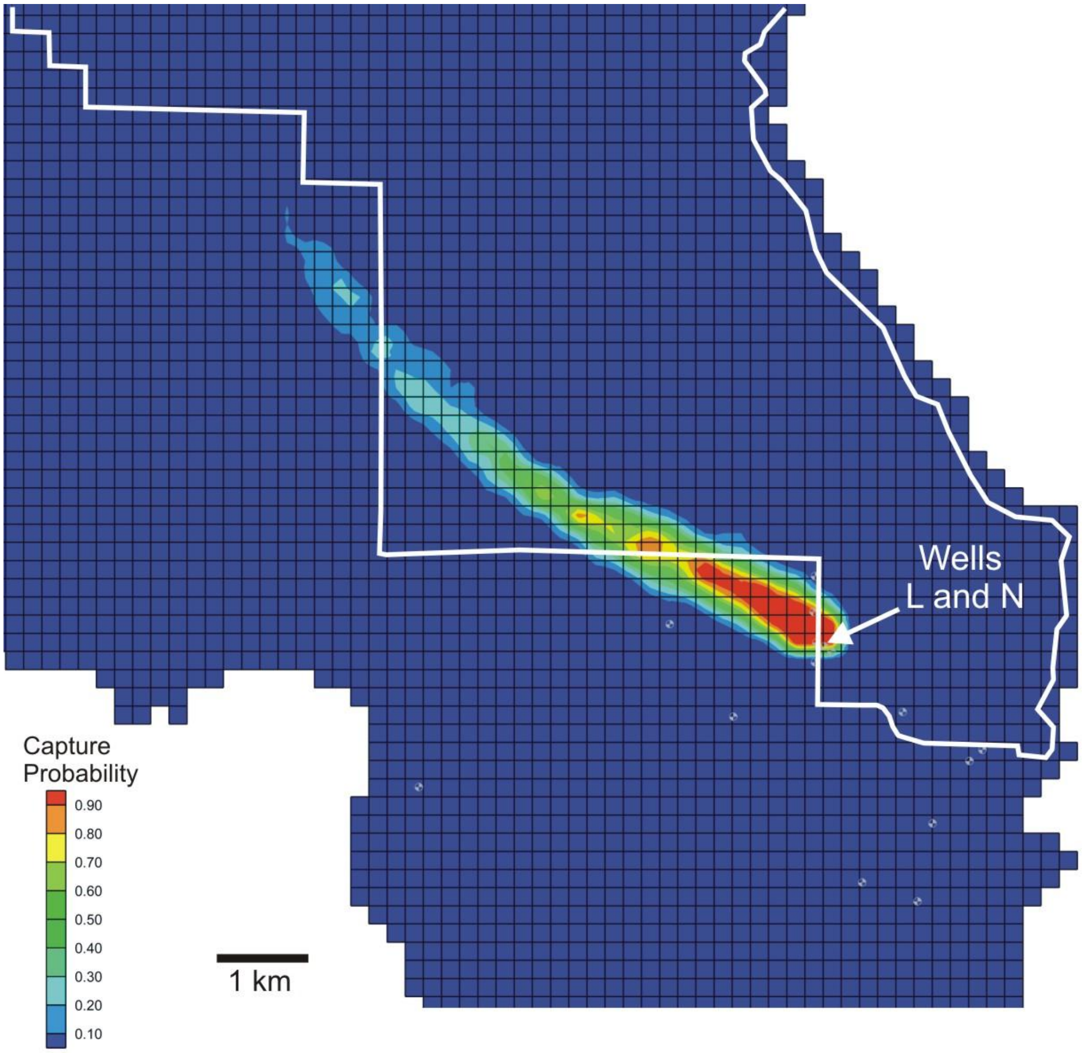


Figure 14. Probabilistic Wellhead Protection zones for production wells L and N (combined) at average annual pumping rates.

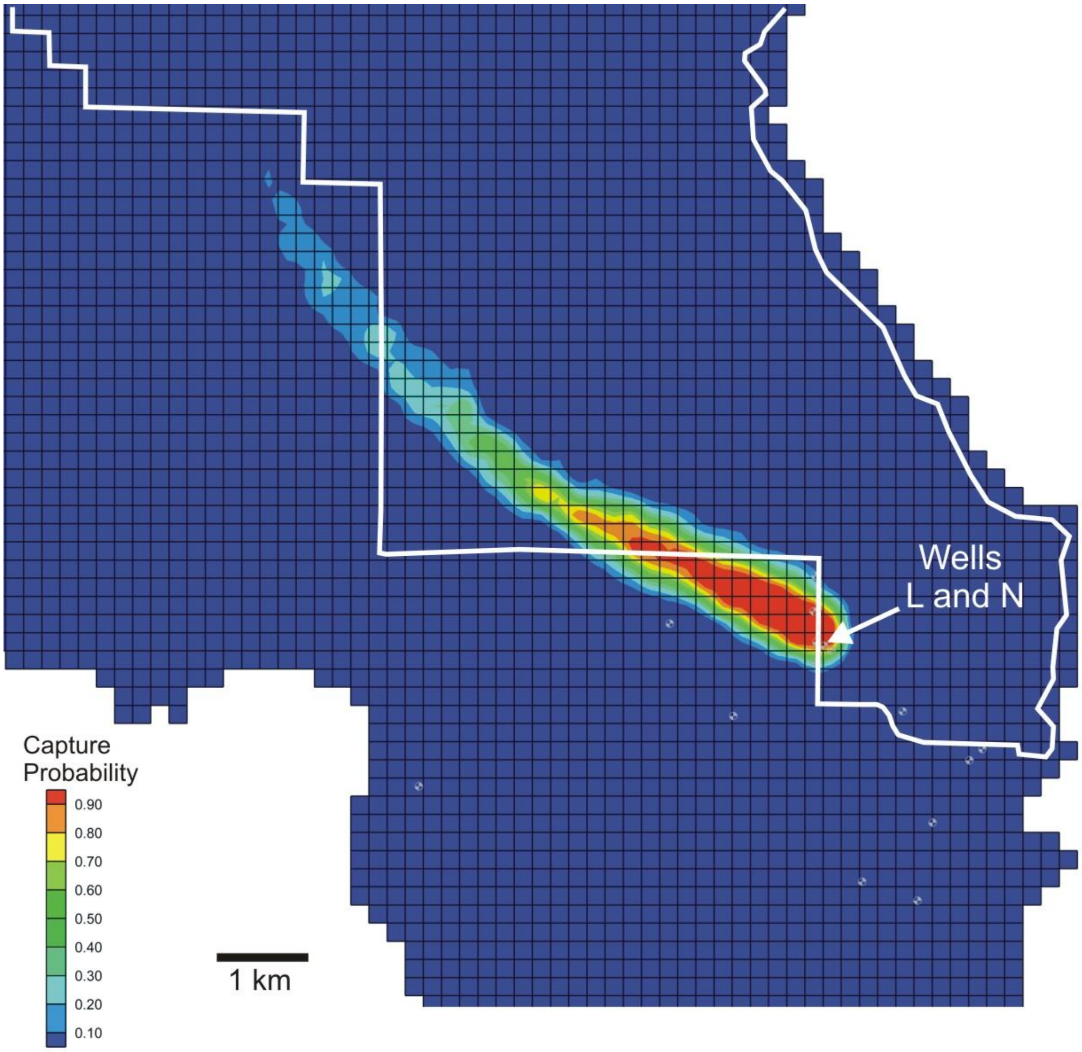


Figure 15. Probabilistic Wellhead Protection zones for production wells L and N (combined) at maximum annual pumping rates.

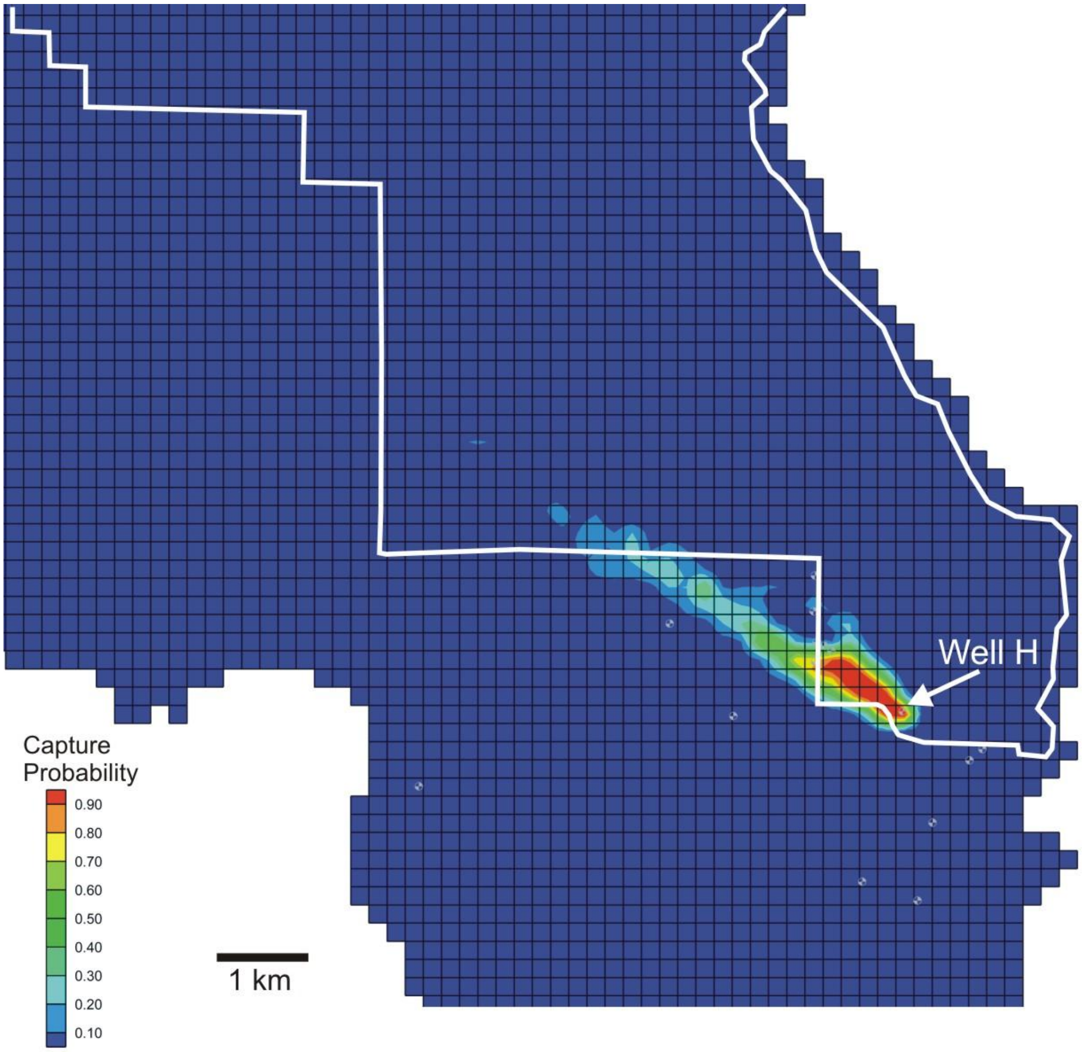


Figure 16. Probabilistic Wellhead Protection zones for production well H at average annual pumping rates.

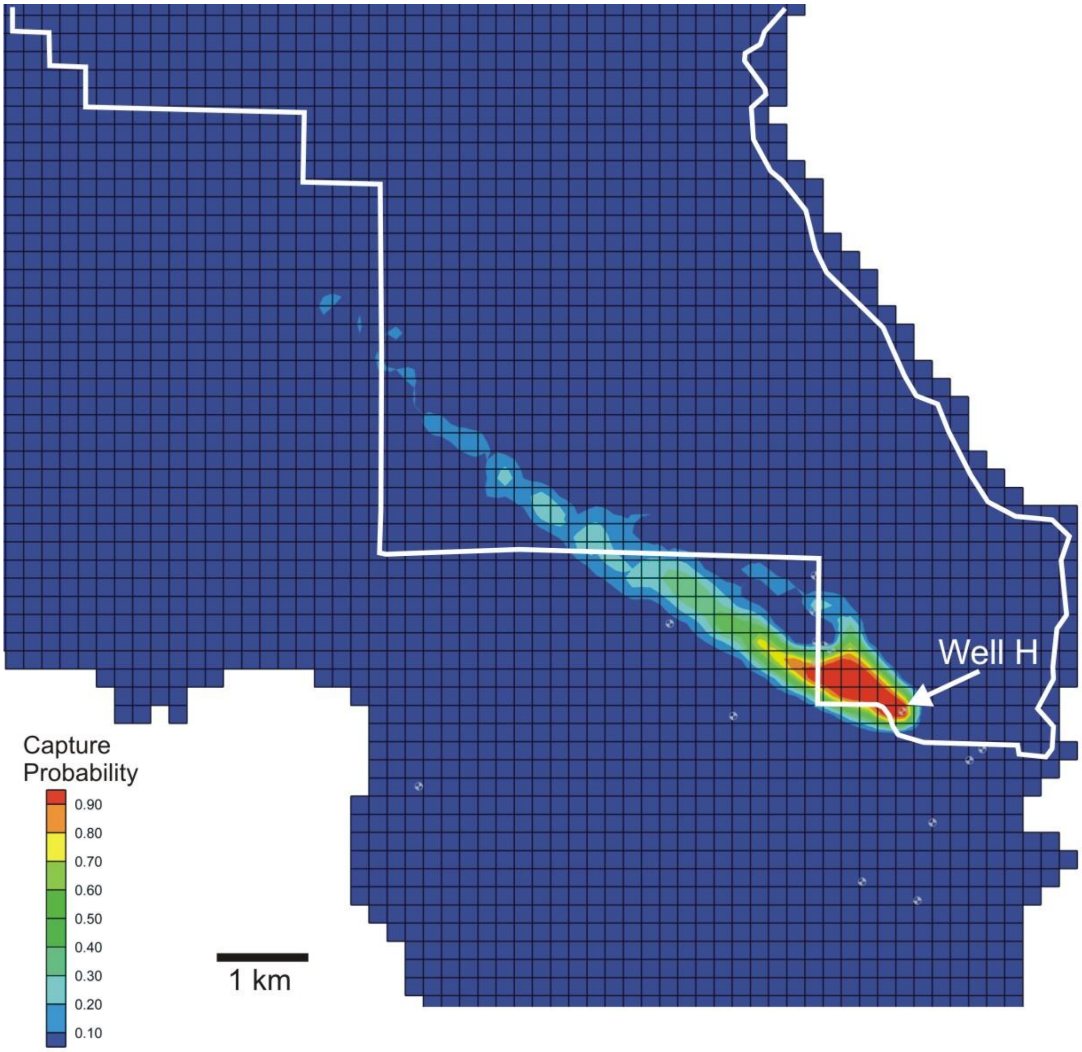


Figure 17. Probabilistic Wellhead Protection zones for production well H at maximum annual pumping rates.

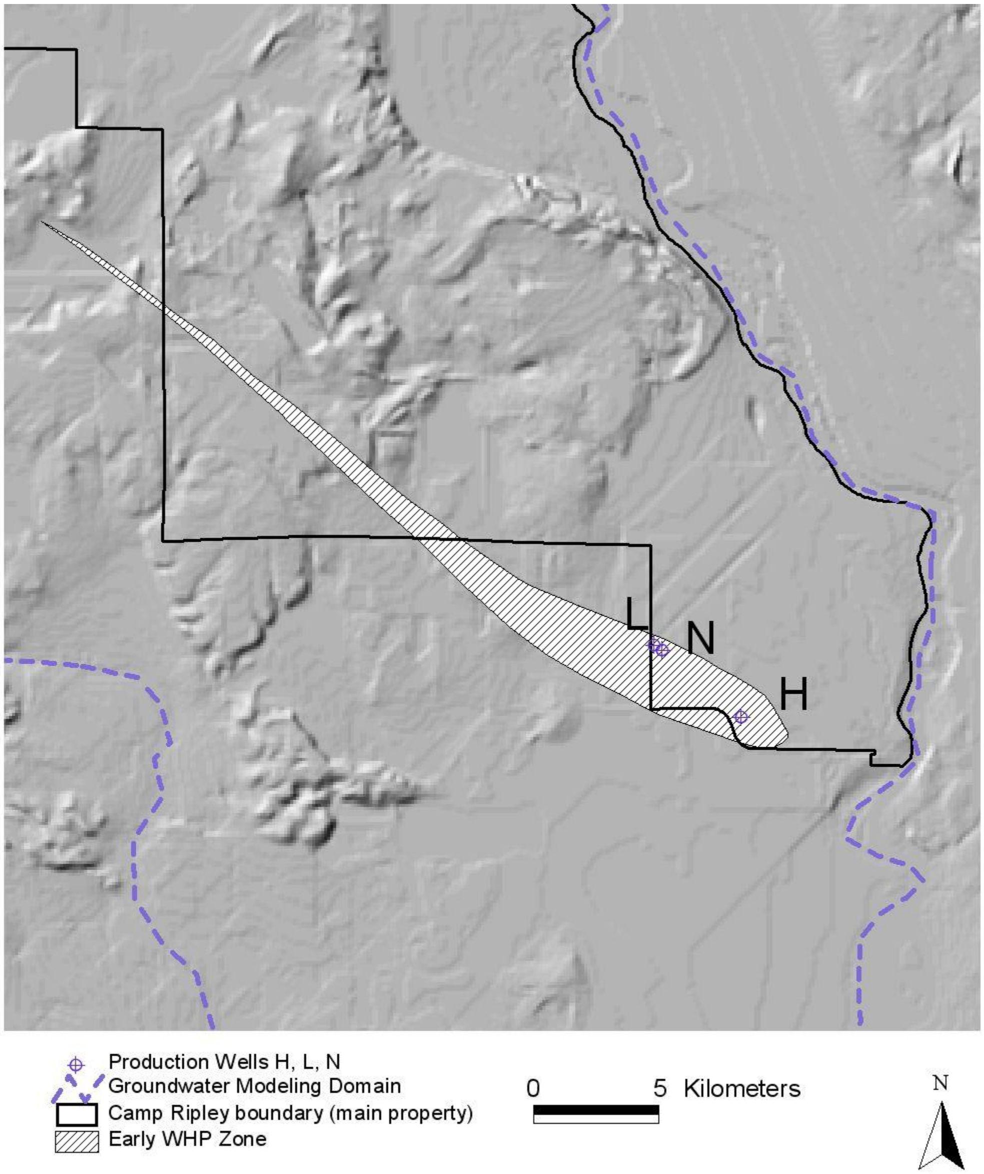


Figure 18. **Prior WHP zone (modified from Minnesota Army National Guard 200_)**

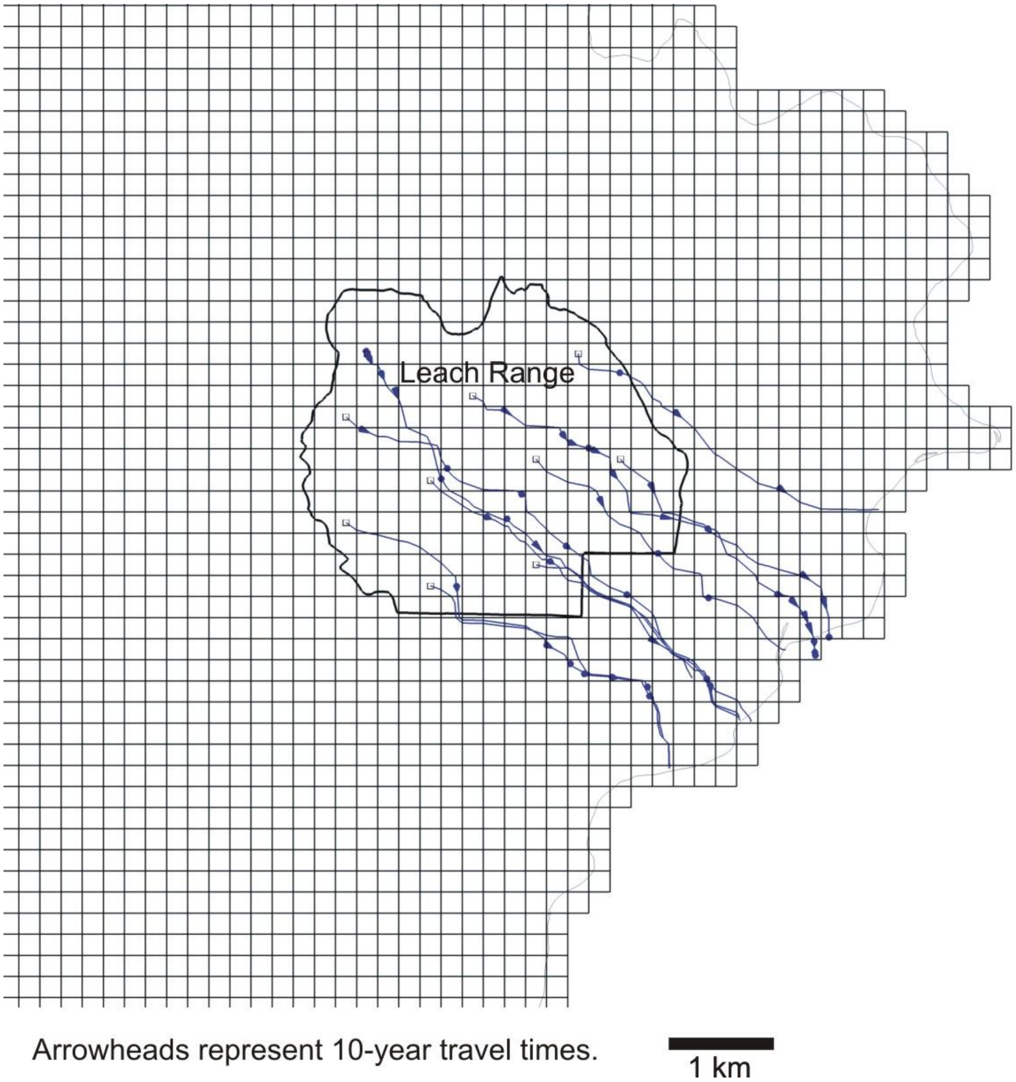


Figure 19. **Particle tracking from the Leach Range to discharge areas.**

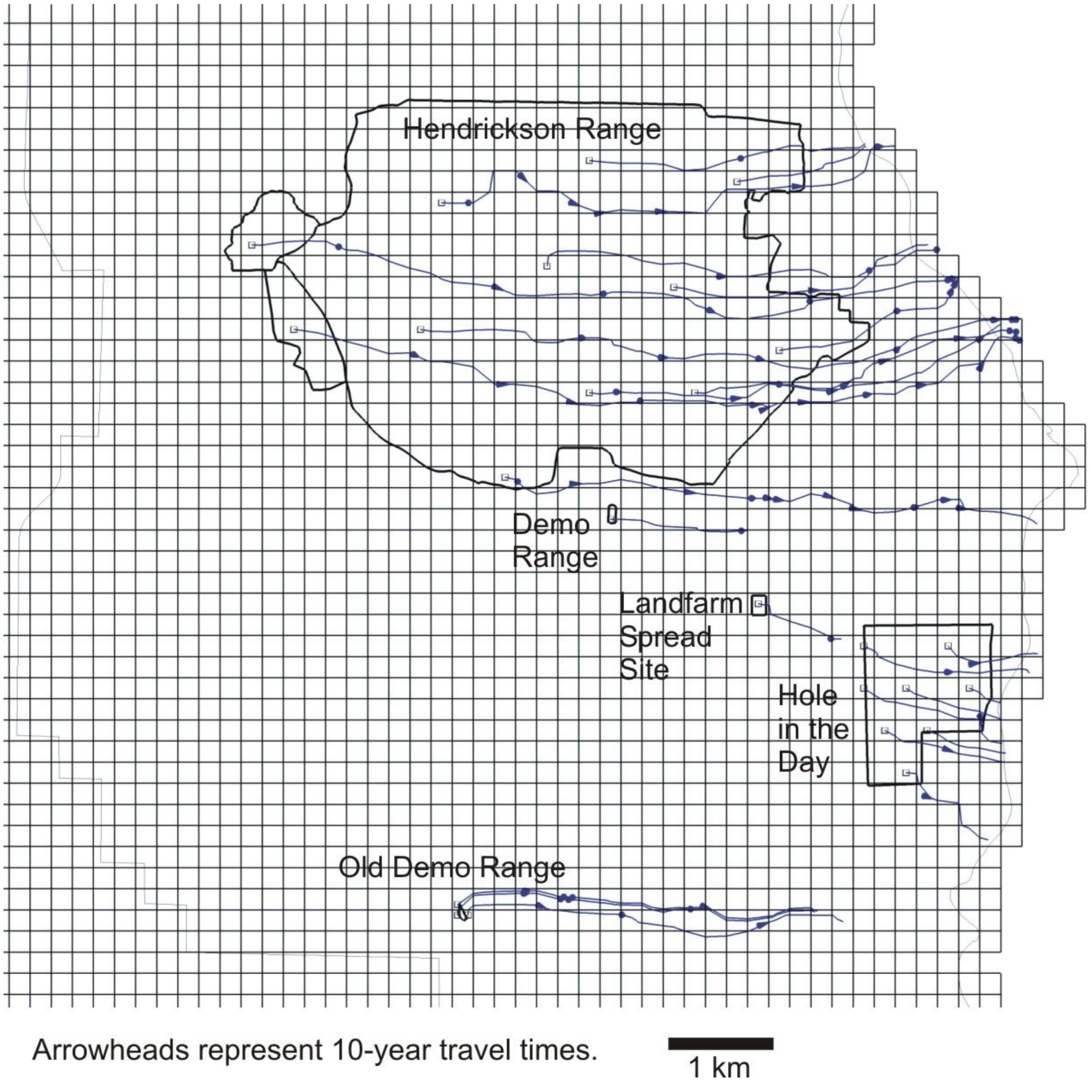


Figure 20. Particle tracking from the Hendrickson Range, Demo Range, Old Demo Range, Landfarm Spread Site, and Hole in the Day Range to discharge areas.

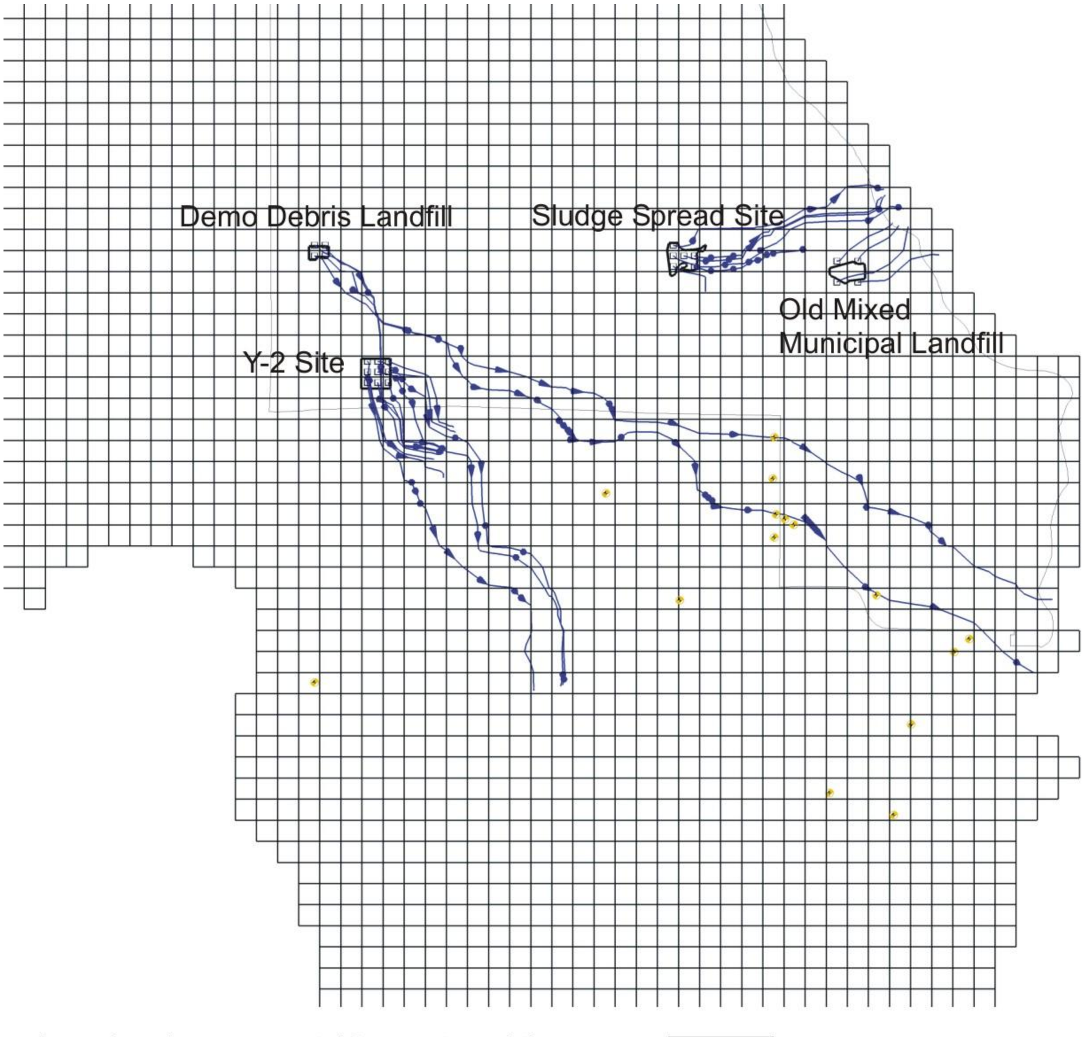


Figure 21. Particle tracking from the Demo Debris Landfill, Sludge Spread Site, Old Mixed Municipal Landfill, and Y-2 Site to discharge areas.

Operational Range Assessment Phase II Report
Camp Ripley, Minnesota
Minnesota Army National Guard

Contract / Delivery Order:	W912DR-09-D-0003 / 0008
Lead Organizations:	U.S. Army Corps of Engineers (USACE) Baltimore District Army National Guard (ARNG) Directorate
Preparation Date:	January 2013

Table of Contents

List of Appendices

List of Figures

List of Tables

Acronyms and Abbreviations

°C	degrees Celsius
°F	degrees Fahrenheit
µg/L	micrograms per liter
APP	Accident Prevention Plan
ARID-GEO	Army Range Inventory Database – Geodatabase
ARNG	Army National Guard
BLM	Biotic Ligand Model
$CaCO_3$	calcium carbonate
COC	chain of custody
CRRL	client-requested reporting limit
CSM	conceptual site model
Cu	copper
DI	deionized
DoD	Department of Defense
DoDD	Department of Defense Directive
DoDI	Department of Defense Instruction
DQO	data quality objective
ISQAPP	Installation-Specific Quality Assurance Project Plan
LOD	Limit of Detection
LOQ	Limit of Quantitation
MCOC	munitions constituents of concern
MDL	method detection limit
mg/L	milligram per liter
MNARNG	Minnesota Army National Guard
MRL	method reporting limit
MS/MSD	matrix spike/matrix spike duplicate
OB/OD	open burn/open detonation
OEDA	Old Engineers’ Demo Area
ORA	Operational Range Assessment
PAL	project action limit

Pb	lead
PETN	pentaerythritol tetranitrate
ppm	parts per million
PQAPP	Programmatic Quality Assurance Project Plan
PTA	Preliminary Technical Approach
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QA/QC	Quality Assurance/Quality Control
QC	Quality control
RDX	cyclotrimethylenetrinitramine
RFMSS	Range Facility Management Support System
RUSLE	Revised Universal Soil Loss Equation
Sb	antimony
SWMR	Surface Water Management Reports
SOP	Standard Operating Procedure
UMD	University of Minnesota Duluth
URS	URS Group, Inc.
USACE	U.S. Army Corps of Engineers
USACHPPM	U.S. Army Center for Health Promotion and Preventive Medicine
USAEHA	United States Army Environmental Hygiene Agency
USAIPH	U.S. Army Institute of Public Health
USEPA	U.S. Environmental Protection Agency
WA	Wet “A” Event
WB	Wet “B” Event
Zn	zinc

Executive Summary

To meet Department of Defense (DoD) requirements and support the U.S. Army's Sustainable Range Program, the Army National Guard (ARNG) Directorate is conducting assessments to determine whether a release or substantial threat of release of munitions constituents of concern (MCOC) from an operational range to an off-range area creates a potentially unacceptable risk to human health or the environment.

An Operational Range Assessment (ORA) Phase I (Phase I) was performed in 2008 (USACE, 2008) to assess whether a potential MCOC source exists on the operational range, a potential MCOC migration mechanism exists, and human and/or sensitive ecological receptors are present at the installation. The Phase I determined that potentially complete source-receptor pathways are present at Camp Ripley.

For operational ranges determined in the Phase I to have a potentially complete source-receptor pathway, the ARNG Directorate conducts an ORA Phase II (Phase II) of potentially complete pathways of MCOC to non-operational areas. This Phase II report presents the evaluation of source-receptor pathways at Camp Ripley in Little Falls, Minnesota. URS Group, Inc. (URS) and ARCADIS/Malcolm Pirnie conducted the assessment under contract W912DR-09-D-0003/0008 with the United States Army Corps of Engineers (USACE) Baltimore District in support of the ARNG Directorate.

The Phase II established whether the source-receptor pathway identified during the Phase I is complete or whether new information was available that would affect the previous conclusions. To determine whether MCOC were leaving the operational range by an identified pathway (e.g., groundwater, surface water) and posed a potential risk to offsite receptors, the ORA team considered existing and new data, including sampling data. The ORA team may accomplish the Phase II by re-evaluating existing information (e.g., prior sampling, reports), through the use of modeling, and/or collecting additional samples. All available information is used to update the conceptual site model (CSM) and to establish a weight-of-evidence case that determines whether there has likely been an MCOC release from the operational range that may pose an unacceptable risk to an off-range receptor.

Camp Ripley encompasses 53,000 acres in Morrison County, Minnesota. The installation is approximately 100 miles northwest of Minneapolis and approximately 10 miles north of Little Falls. Camp Ripley is bordered by the Crow Wing River to the north and the Mississippi River to the east.

Camp Ripley is currently a maneuver and training center operated by the Minnesota Army National Guard (MNARNG) that focuses on providing realistic joint and combined arms training. The total operational area at the installation is 50,727 acres. The small non-operational use areas comprise the cantonment area in the southern part of the installation and part of one of the non-contiguous parcels west of Camp Ripley proper. The outlying parcels to the west, while designated 'operational,' are not currently used for any range training activities.

Training at Camp Ripley occurs on a total of 214 operational range areas that include drop zones, dudded impact areas, field training areas, firing ranges, land navigation courses, training and maneuver areas, other range areas, and aviation range areas (including runways, parking aprons, and landing pads). Of the 214 ranges, 125 were determined to be potential sources of MCOC. Munitions uses at these operational areas include:

- Small, medium, and large caliber arms
- Pyrotechnics and obscurants
- Other munitions systems (including hand grenades, bombs, rockets, missiles, and mines)

Potential pathways for MCOC migration off the operational footprint include surface water pathways and surface water infiltration to groundwater pathways to human and ecological receptors. Primary source areas are two large impact areas and a small arms range complex. Information that indicated possible complete source-receptor connections include:

- Some metals, explosives, and perchlorate detections in historical surface water and groundwater data sets.
- There are numerous creeks, streams, and lakes on or near the ranges and nearly 20 drinking water wells are located across the facility.
- Training at this large installation is significant and has increased over the years, both in the extent (new ranges) and in volume of munitions fired.

Existing environmental data were reviewed during Phase I and reviewed again in considerable detail during Phase II. Data from these investigations were used to refine the CSM and technical approach for Phase II. Based on this review the following conclusions were reached:

- Sediment was eliminated as an independent migration pathway. This is supported by stream observations during site visits and by the soil erosion and sedimentation evaluation conducted by the University of Minnesota, Duluth.
- Explosives data are shown on **Figure ES-1**. The cyclotrimethylenetrinitramine (RDX) and 2,4-DNT detected in a Cantonment Area monitoring well are sporadically present at low concentrations, and do not appear to be range related. Migration of explosives to an off-installation receptor is unlikely to occur from the historical and current detonation areas. Surface water is not affected by explosives (confirmed by chemical analysis). Based on chemical analysis and modeling, effects on groundwater are localized and MCOC do not migrate to receptor locations.
- Of 13 sampled production wells, only few detections of perchlorate were reported with a maximum of only 0.28 µg/L. This is well below the project action limit (PAL) of 15 µg/L.
- Historical metals data collected during dry conditions downstream of the areas of concern do not exceed PALs (see below) except in two minor instances (**Figure ES-2**). Copper was detected in 2002 at 20 µg/L in Frog Lake Stream and in 2001 at 10 µg/L in Yalu Stream. These values exceed the respective subwatershed PALs of 10.6 and 9.5 µg/L. Yalu Creek is the reference location and is not likely influenced by range activity. Because lead—the dominant MCOC in small arms munitions—is not elevated, the minor copper exceedences alone do not suggest a release of any significance.

Because the historical metal data were obtained only during the dry season, the question remained on whether metals could be migrating under “first flush” conditions. This occurs during the early spring thaw when infiltration rates could be higher and there may have been greater contact time of MCOC with the winter’s snow. To fill the data gap, Phase II sampling occurred in one mobilization concurrent with the spring thaw. Surface water samples were collected twice during the first week of April 2012 at six locations: five downstream of potential source areas and one reference (**Figure ES-3**).

Twenty-four hour composite samples were collected to capture diurnal variations except at one location (RP03) where grab samples were collected because of very low water conditions. A recent beaver dam temporarily diverted flow upstream of RP03. Samples were analyzed for dissolved metals (copper, lead, antimony, and zinc), hardness, and Biotic Ligand Model (BLM) parameters. Water quality parameters were also measured during each sampling event. The analytical results discussed below are also summarized in **Figure ES-3**.

All four metals MCOC were detected at least once in the surface water samples. However, none exceeded PALs. For each subwatershed, the lowest hardness value was used to calculate the PALs. **Table ES-1** presents the minimum and average hardness values and PALs for the sample locations associated with each subwatershed.

Table ES-1: Surface Water Hardness Values and Project Action Limits

	Sample Locations Associated with Subwatershed			
	RP01	RP02 and RP03	RP04 and RP05	RP06
	Minimum (and Average) Subwatershed Hardness Values (mg/L as $CaCO_3$)			
	198 (199.5)	122 (156)	199 (201.5)	107 (107.5)
Analyte	**Surface Water Project Action Limits (µg/L)**			
Antimony	5.5	5.5	5.5	5.5
Copper	15	10.6	15.1	9.5
Lead	5.2	3.1	5.3	2.7
Zinc	189	125	190	112

mg/L= milligrams per liter; $CaCO_3$ = calcium carbonate; µg/L = micrograms per liter

The results of surface water sampling during the spring thaw indicate that off-range MCOC migration is not occurring. Specific analytical findings that support this assessment are:

- None of the Phase II metals data from the April 2012 sampling during a first (and possibly heavier) flush of MCOC exceeded surface water PALs.
- Lead concentrations are all below the minimum PAL of 2.7 µg/L, ranging from below detection limit to 1 µg/L. The maximum concentration detected at Camp Ripley during Phase II was 0.058 µg/L. It was detected at this level in samples collected from both the reference location (RP06) and a downstream sample location (RP02).
- The Phase II maximum concentrations of lead (found in RP02 and RP06) and the maximum concentration of copper (at RP04) were not detected in the same sample or

even within the same subwatershed. This indicates metal detections are not range related because these metals typically occur together in small arms munitions.

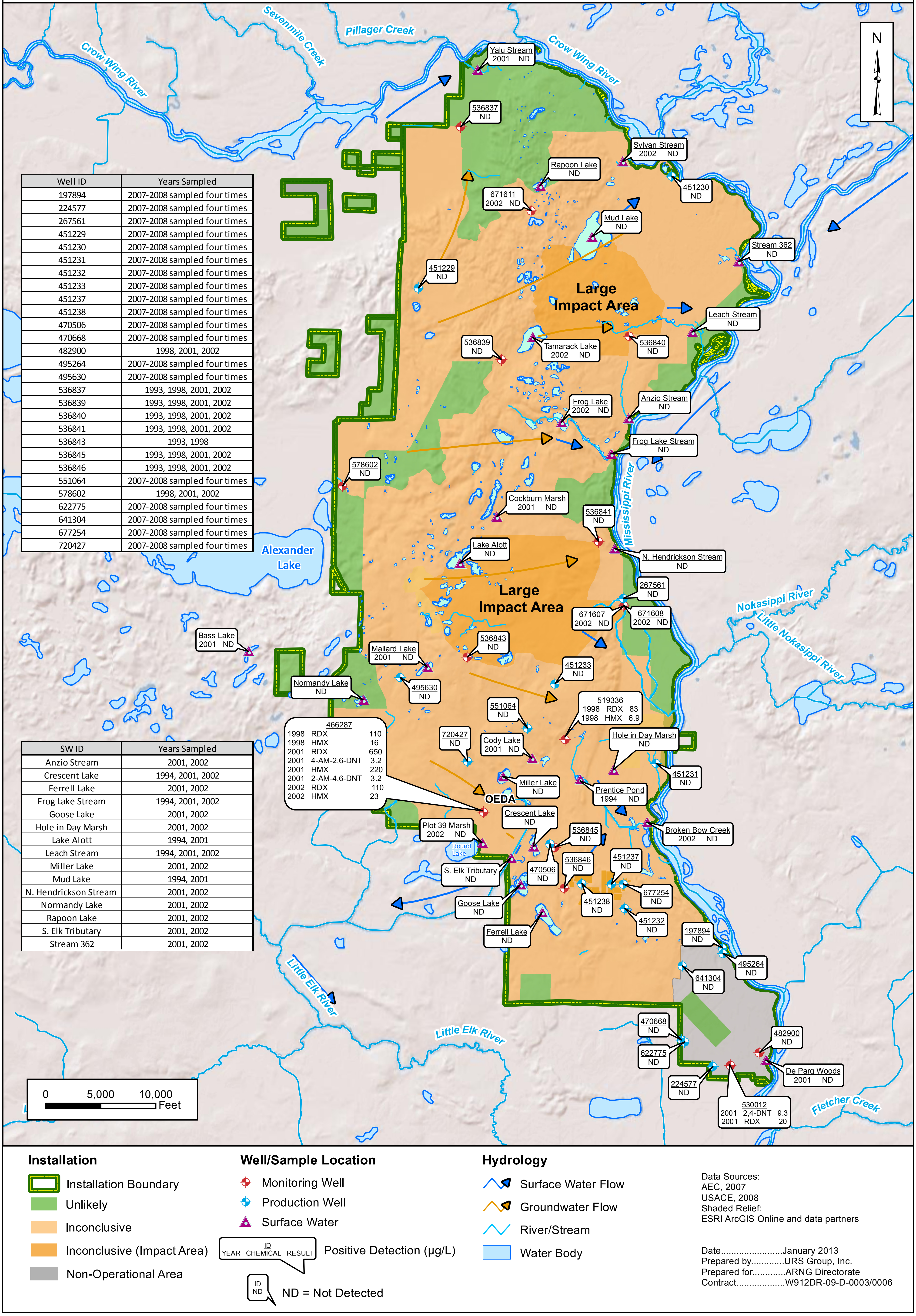
Additionally, data from previous investigations support this conclusion. Consistent with the Phase II data, the previous surface water data collected during dry conditions downstream of the areas of concern do not exceed Phase II PALs except for two minor instances of copper in a sample near RP03 and in a sample near RP06. The recent Phase II copper results at RP03 and RP06 are all below the detection limit. Thus, this metal is not a current concern.

Site conditions at Camp Ripley also provide significant natural barriers for the migration of MCOC from potential source areas. The most likely potential concentrated source areas at Camp Ripley are centrally located on the installation and surrounded by a large buffer zone.

Given the absence or low concentrations of metals and explosives in perimeter surface water and groundwater samples, it is concluded that MCOC are not migrating off range at levels that would pose an unacceptable risk to human and/or ecological receptors. This conclusion is supported by the consistency of the large amount of chemical data, conservative PALs established for this project, and the range layout that constrains potential MCOC sources to the central portion of Camp Ripley.

For the conditions in 2012, data indicate no unacceptable risk to off-range human or ecological receptors from potential sources associated with the operational footprint at Camp Ripley. Operational areas are placed into a review cycle to periodically re-evaluate whether future changes in conditions pose unacceptable risk to off-range human or ecological receptors. Implementation of appropriate best management practices will reasonably ensure no future MCOC migration from potential MCOC sources associated with the operational footprint at Camp Ripley.

Figure ES-1
Explosives in Groundwater and Surface Water
Operational Range Assessment Phase II
Camp Ripley, MN



Well ID	Years Sampled
197894	2007-2008 sampled four times
224577	2007-2008 sampled four times
267561	2007-2008 sampled four times
451229	2007-2008 sampled four times
451230	2007-2008 sampled four times
451231	2007-2008 sampled four times
451232	2007-2008 sampled four times
451233	2007-2008 sampled four times
451237	2007-2008 sampled four times
451238	2007-2008 sampled four times
470506	2007-2008 sampled four times
470668	2007-2008 sampled four times
482900	1998, 2001, 2002
495264	2007-2008 sampled four times
495630	2007-2008 sampled four times
536837	1993, 1998, 2001, 2002
536839	1993, 1998, 2001, 2002
536840	1993, 1998, 2001, 2002
536841	1993, 1998, 2001, 2002
536843	1993, 1998
536845	1993, 1998, 2001, 2002
536846	1993, 1998, 2001, 2002
551064	2007-2008 sampled four times
578602	1998, 2001, 2002
622775	2007-2008 sampled four times
641304	2007-2008 sampled four times
677254	2007-2008 sampled four times
720427	2007-2008 sampled four times

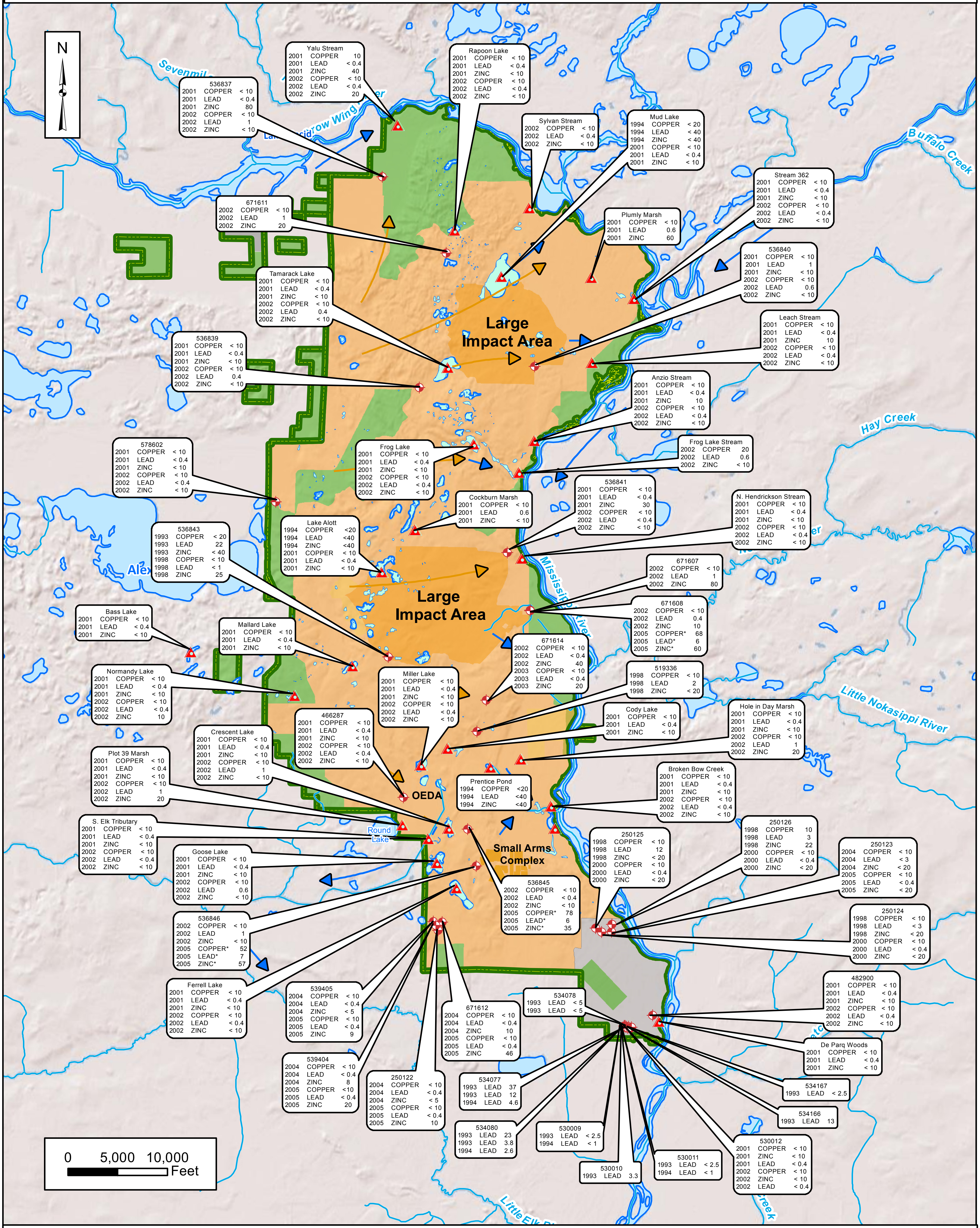
SW ID	Years Sampled
Anzio Stream	2001, 2002
Crescent Lake	1994, 2001, 2002
Ferrell Lake	2001, 2002
Frog Lake Stream	1994, 2001, 2002
Goose Lake	2001, 2002
Hole in Day Marsh	2001, 2002
Lake Alott	1994, 2001
Leach Stream	1994, 2001, 2002
Miller Lake	2001, 2002
Mud Lake	1994, 2001
N. Hendrickson Stream	2001, 2002
Normandy Lake	2001, 2002
Rapoon Lake	2001, 2002
S. Elk Tributary	2001, 2002
Stream 362	2001, 2002

Data Sources:
AEC, 2007
USACE, 2008
Shaded Relief:
ESRI ArcGIS Online and data partners

Date........................January 2013
Prepared by.............URS Group, Inc.
Prepared for.............ARNG Directorate
Contract...................W912DR-09-D-0003/0006

Page Intentionally Left Blank

Figure ES-2
Metals in Groundwater and Surface Water
Operational Range Assessment Phase II
Camp Ripley, MN



Installation

- 🟩 Installation Boundary
- 🟩 Unlikely
- 🟧 Inconclusive
- 🟧 Inconclusive (Impact Area)
- ⬜ Non-Operational Area

Well/Sample Location

- ⊕ Monitoring Well
- ▲ Surface Water Sample

ID YEAR CHEMICAL RESULT	Metals Data (µg/L)

** Field Analytical Method (HACHDR4000)*

Hydrology

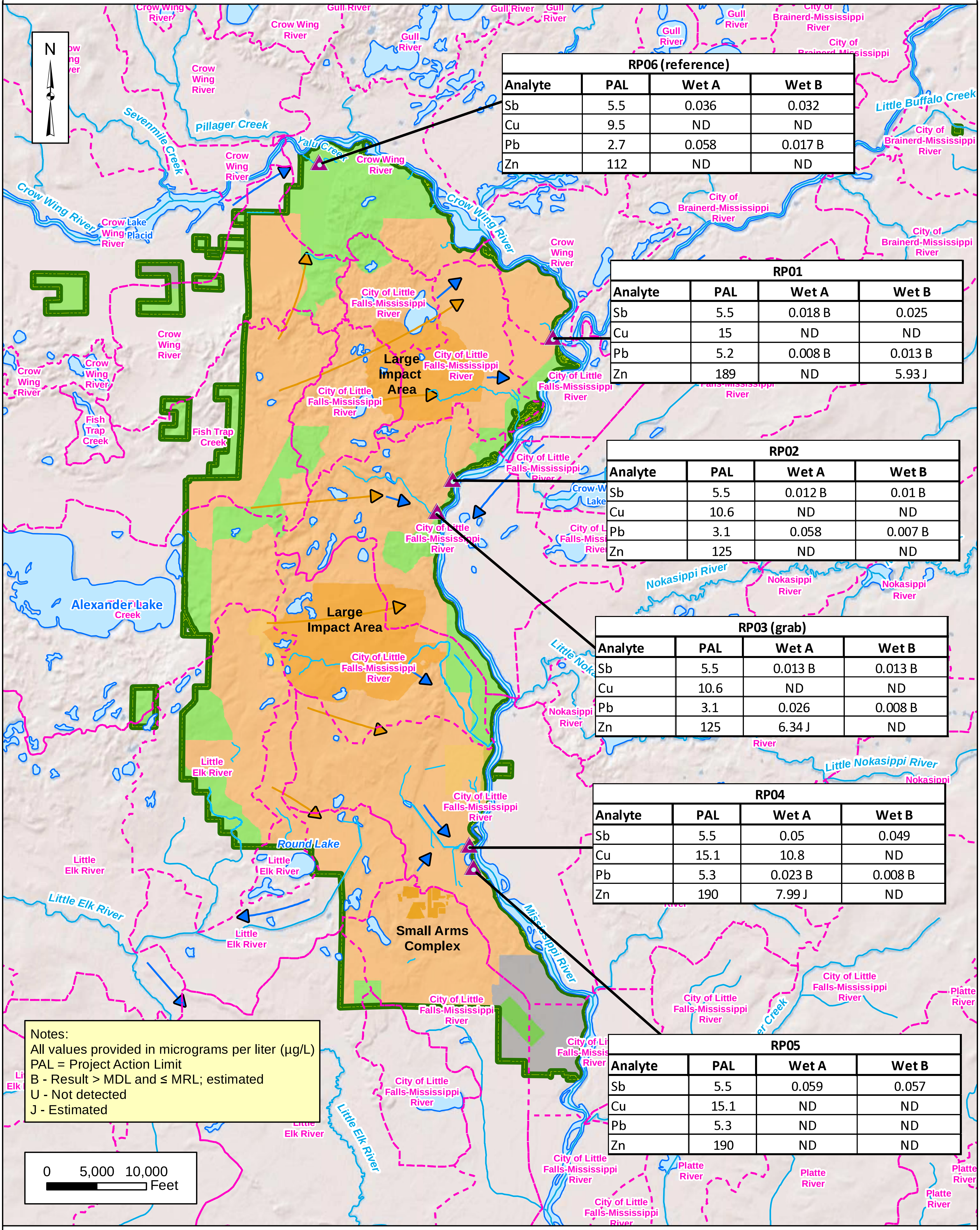
- ▲ Surface Water Flow
- ▲ Groundwater Flow
- River/Stream
- Water Body

Data Sources:
AEC, 2007
USACE, 2008
Shaded Relief:
ESRI ArcGIS Online and data partners

Date.......................January 2013
Prepared by............URS Group, Inc.
Prepared for............ARNG Directorate
Contract.................W912DR-09-D-0003/0006

Page Intentionally Left Blank

Figure ES-3
Phase II Findings
Operational Range Assessment Phase II
Camp Ripley, MN



Notes:
All values provided in micrograms per liter (µg/L)
PAL = Project Action Limit
B - Result > MDL and ≤ MRL; estimated
U - Not detected
J - Estimated

RP06 (reference)

Analyte	PAL	Wet A	Wet B
Sb	5.5	0.036	0.032
Cu	9.5	ND	ND
Pb	2.7	0.058	0.017 B
Zn	112	ND	ND

RP01

Analyte	PAL	Wet A	Wet B
Sb	5.5	0.018 B	0.025
Cu	15	ND	ND
Pb	5.2	0.008 B	0.013 B
Zn	189	ND	5.93 J

RP02

Analyte	PAL	Wet A	Wet B
Sb	5.5	0.012 B	0.01 B
Cu	10.6	ND	ND
Pb	3.1	0.058	0.007 B
Zn	125	ND	ND

RP03 (grab)

Analyte	PAL	Wet A	Wet B
Sb	5.5	0.013 B	0.013 B
Cu	10.6	ND	ND
Pb	3.1	0.026	0.008 B
Zn	125	6.34 J	ND

RP04

Analyte	PAL	Wet A	Wet B
Sb	5.5	0.05	0.049
Cu	15.1	10.8	ND
Pb	5.3	0.023 B	0.008 B
Zn	190	7.99 J	ND

RP05

Analyte	PAL	Wet A	Wet B
Sb	5.5	0.059	0.057
Cu	15.1	ND	ND
Pb	5.3	ND	ND
Zn	190	ND	ND

Legend

Installation/Range
- ▭ Installation Boundary
- 🟩 Unlikely
- ▨ Inconclusive
- 🟧 Inconclusive (Potential Primary Source)
- ▩ Non-Operational Area

Sample Location
- △ Surface Water

Hydrology
- ↗ Surface Water Flow
- ↗ Groundwater Flow
- ∿ River/Stream
- ▭ Water Body
- ⬚ Watershed

Data Sources:
AEC, 2007

Shaded Relief:
ESRI ArcGIS Online and data partners, 2009

Date........................January 2013
Prepared by............URS Group, Inc.

1 Introduction

1.1 Project Purpose and Overview

URS Group, Inc. (URS), with the support of ARCADIS, conducted an Operational Range Assessment (ORA) Phase II (Phase II) study at Camp Ripley for the United States Army Corps of Engineers (USACE) and the Army National Guard (ARNG) Directorate. Phase II was required because of the conclusions of the ORA Phase I (Phase I) study conducted for Camp Ripley (USACE, 2008). Camp Ripley is located near Little Falls, Minnesota (**Figure 1-1**).

During Phase I, readily available information was used to determine whether operational areas had a source of munitions constituents of concern (MCOC), a migration pathway (via surface water or groundwater systems) for MCOC, and potential receptors (human or ecological) along that pathway. The conclusion of the Phase I was that the available information was not sufficient to confirm whether an off-range release of MCOC is occurring at concentrations that present an unacceptable risk to human health and/or sensitive ecological receptors. Therefore, Phase II was required. Phase II is designed to collect and evaluate appropriate data to determine whether an off-range release has occurred at concentrations above risk-based thresholds.

1.2 Project Scope and Drivers

The U.S. Army is conducting assessments at operational ranges to meet the requirements of Department of Defense (DoD) policy and to support the U.S. Army Sustainable Range Program. The ORA is being implemented to fulfill requirements identified implicitly or explicitly in:

- DoD Directive (DoDD) 4715.11 *Environmental and Explosives Safety Management on Operational Ranges Within the United States* (2004)
- DoD Instruction (DoDI) 4715.14 *Operational Range Assessments* (2005)

The DoDD and DoDI require that U.S. Army installations maintain an operational range inventory and evaluate the potential for off-range migration of munitions constituents. The DoDI identifies munitions constituents to be evaluated and lays out a scientifically sound process for assessing and presorting potential off-range environmental impacts of military munitions used on operational ranges. In particular, the DoDI requires the DoD components to respond to a release or substantial threat of release of MCOC from an operational range area to off-range areas when such a release poses an unacceptable risk to human health or the environment.

1.3 Work Authority

Phase II for Camp Ripley was performed under Contract No. W912DR-09-D-0003/0008 with the USACE Baltimore District. The ARNG Directorate is the program manager and provides programmatic coordination, as designated by the Assistant Chief of Staff for Installation Management’s Installation Services Environmental Division. The U.S. Army Institute of Public Health (USAIPH) provides technical assistance to the ARNG Directorate.

1.4 ORA Phase I

In Phase I, 214 operational areas at Camp Ripley were evaluated and placed into one of two possible categories: *Unlikely* or *Inconclusive*. The two categories are defined as follows:

- ***Unlikely* – Periodic Review:**[1] Based on a review of readily available information, the conceptual site model indicates that one or more of the three conditions for a source-receptor interaction is not present (i.e., no source, pathway, or receptor), or where pathways are complete, data are sufficient to indicate no unacceptable risk to human health or the environment. These operational areas are placed into a periodic review cycle to re-evaluate whether a change in conditions has occurred.
- ***Inconclusive* – Phase II Required**: Readily available information is insufficient to ascertain whether MCOC from an operational area is migrating to a potential off-range receptor or the information indicates the potential for such an interaction, but risk levels are uncertain. These sites undergo a Phase II.

Eighty-nine operational areas, specifically a drop zone, aviation ranges, one small arms range, and non-live fire training and maneuver areas, were categorized as *Unlikely*.

One-hundred twenty-five ranges were categorized as *Inconclusive*. These ranges have current and/or historical sources of potential MCOC that were identified during Phase I. Munitions uses at these operational areas include:

- Small caliber arms
- Medium caliber arms
- Large caliber arms
- Pyrotechnics and obscurants
- Other munitions systems (including hand grenades, bombs, rockets, missiles, and mines)

MCOC have the potential to migrate off range via tributaries to the Mississippi River and into the groundwater aquifer (**Figure 1-2**).

1.5 ORA Phase II

The strategy for Phase II was based on the U.S. Environmental Protection Agency's (USEPA's) systematic planning or data quality objective (DQO) process. The application of the DQO process is required by DoDI 4715.14. The DQO process is a sequence of logical steps to address the sampling rationale, decision criteria, and approaches to selecting a sampling design. The DQO process is iterative and helps determine the appropriate type, quantity, and quality of environmental data necessary for making decisions that are technically sound and defensible.

---

[1] All operational ranges must be periodically re-evaluated to determine if there is a release or substantial threat of release of MCOC from an operational range to an off-range area. Range groups categorized as *Unlikely* are to be re-evaluated periodically. Range groups may be re-evaluated if significant changes (e.g., changes in range operations or site conditions, regulatory changes) occur that affect determinations made during Phase I.

Guidance on using the DQO process can be found in *Guidance on Systematic Planning Using the Data Quality Objectives Process* (USEPA, 2006).

The structure of the ORA process is based on the DQOs. Phase I was designed to provide the basis for Step 1 of the DQO process, which leads to the seven-step planning process for Phase II. Phase I is the initial gathering of data that enables construction of a conceptual site model (CSM) and the identification of pathways that could allow MCOC from an on-range source to interact with off-range receptors at concentrations that would pose a potential risk to human health or the environment.

Phase II uses a weight-of-evidence approach to determine whether there is an unacceptable risk to off-range human and ecological receptors from on-range MCOC sources. When appropriate, Phase II includes sampling and analysis of media in the potential pathways for the MCOC identified in Phase I and refined through the preliminary stages of the Phase II evaluation. Phase II was guided in part by the *Army Operational Range Assessment Phase II Investigation Protocol* (USACHPPM,[2] 2009) and the *ARNG ORA Focus for Technical Sampling* (ARNG, 2011).

1.6 Organization of the Report

Phase II results, analyses, and conclusions are presented in this report. The report consists of eight sections and four appendices:

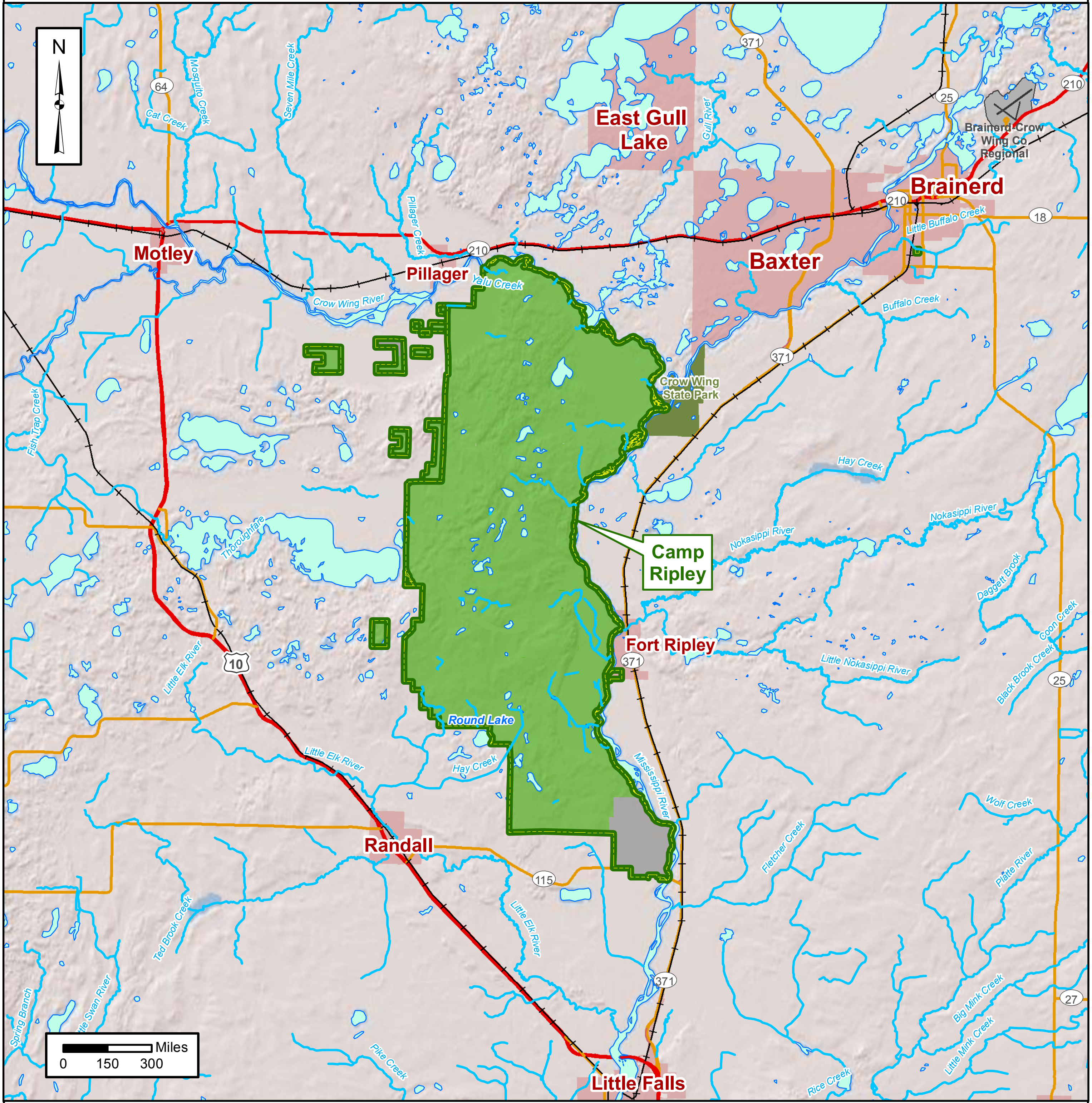
- **Section 1 – Introduction:** Project purpose, background, work authority, and introduction to ORA
- **Section 2 – Installation Overview:** Installation profile, physical features, and summary of previous investigations
- **Section 3 – Phase II**: CSM for the surface water pathway and technical approach for Phase II
- **Section 4 – Methodology**: Methodologies used in Phase II
- **Section 5 – Data Analyses**: Overview of laboratory methods and analyses
- **Section 6 – Data Results**: Results of Phase II
- **Section 7 – Weight-of-Evidence Evaluation and Conclusions**: Summary of the findings and the conclusions of the Phase II
- **Section 8 – References:** List of all documents used in the preparation of the Phase II report
- **Appendix A – Photograph Log**: Photographs taken at the sampling locations
- **Appendix B – Field Forms**: Documents completed in the field: chain of custody (COC), field safety forms, and surface water sample collection logs

---

[2] The U.S. Army Institute of Public Health (USAIPH) was formerly the U.S. Army Center for Health Promotion and Preventive Medicine (USACHPPM).

- **Appendix C – Analytical Tables**: Summary tables with all surface water and Quality Control (QC) sample results
- **Appendix D – Data Usability Summary Reports:** Tier III Data Validation Report prepared for each Sample Delivery Group as assigned by the laboratory

Figure 1-1
Installation Location
Operational Range Assessment Phase II
Camp Ripley, MN



Legend

Installation
- 🟩 Installation Boundary
- 🟩 Operational
- ▨ Other than Operational

Transportation
- Primary Limited Access
- Primary US & State Highways
- Secondary State & County
- Local, Neighborhood, Rural
- Railroad

Hydrology
- River/Stream
- Water Body

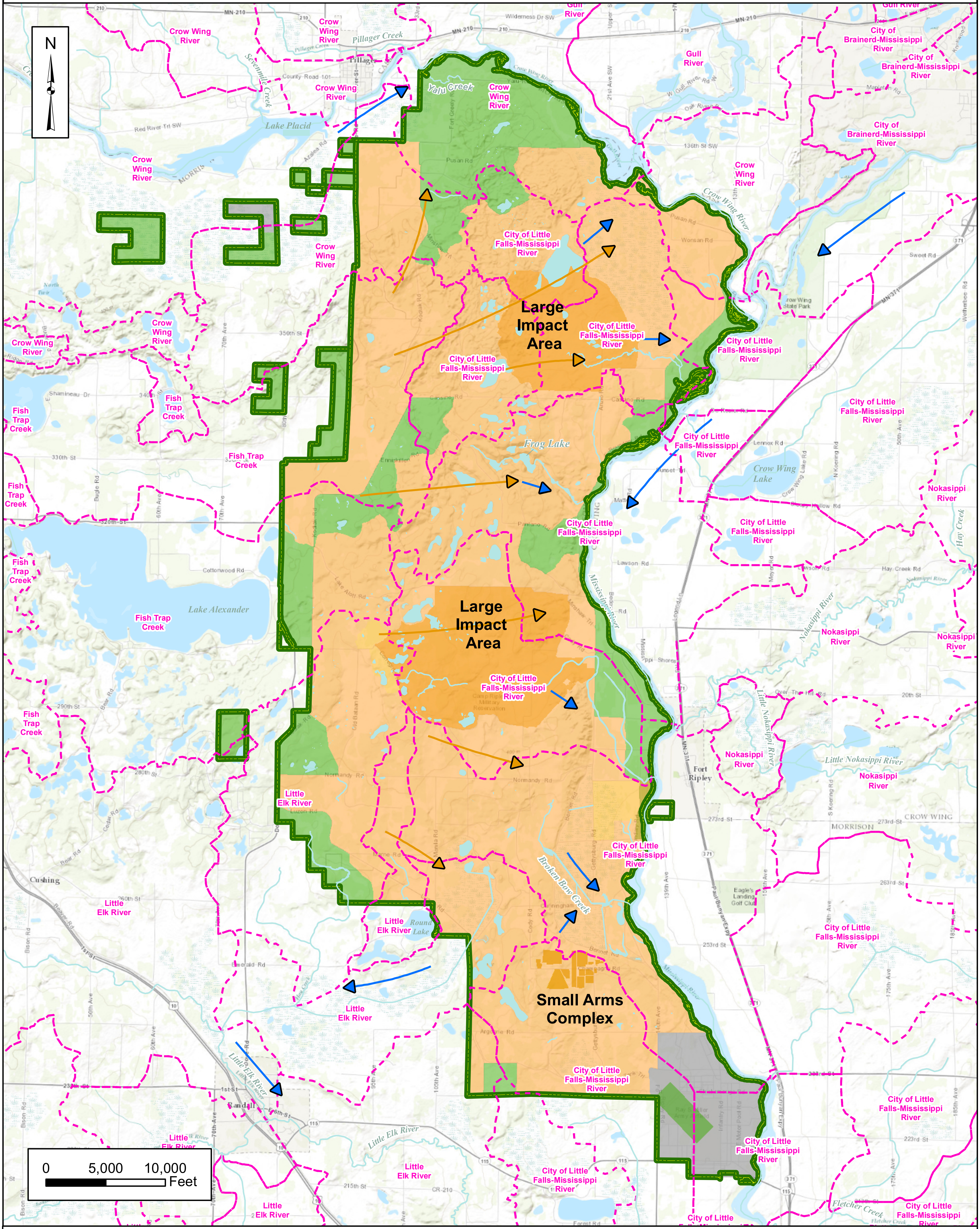
Data Sources:
Anderson Engineering (Camp Ripley), Loucks and Associates (AHATS), MN Army National Guard (TACC & OMS properties), 2004

Street Map: ESRI Street Maps 9.3, North America
Shaded Relief:
ESRI ArcGIS Online and data partners, 2009

Date.........................January 2013
Prepared by............URS Group, Inc.

Page Intentionally Left Blank

Figure 1-2
Operational Range Areas and Hydrology
Operational Range Assessment Phase II
Camp Ripley, MN



Legend

Installation

▭ Installation Boundary

▨ Other than Operational Area

Range Category

🟩 Unlikely

🟧 Inconclusive

🟧 Inconclusive (Impact Area)

Hydrology

Surface Water Flow

Groundwater Flow

Water Body

Wetland

Watershed

Data Sources:
AEC, 2007

Topo: ESRI, DeLorme, NAVTEQ, TomTom, Intermap, AND, USGS, NRCAN, Kadaster NL, IGN, and the GIS User Community

Date.........................January 2013
Prepared by............URS Group, Inc.

Page Intentionally Left Blank

2 Camp Ripley Overview

2.1 Installation Background

Camp Ripley encompasses 53,000 acres in Morrison County, Minnesota. The installation is approximately 100 miles northwest of Minneapolis and approximately 10 miles north of Little Falls. Camp Ripley is bordered by the Crow Wing River to the north and the Mississippi River to the east (**Figure 1-1**).

Camp Ripley is currently a maneuver and training center operated by the Minnesota Army National Guard (MNARNG) that focuses on providing realistic joint and combined arms training. The total operational area at the installation is 50,727 acres (**Figure 1-2**). The small non-operational use areas comprise the cantonment area in the southern part of the installation and part of one of the non-contiguous parcels west of Camp Ripley proper. The outlying parcels to the west, while designated 'operational,' are not currently used for any range training activities.

Training at Camp Ripley includes live-fire weapons training, maneuver exercises, and aviation. An Operational Range Inventory Sustainment update (Army Range Inventory Database-Geodatabase [ARID-GEO], 2006) was submitted to the U.S. Army Environmental Command in 2006. The update identified 214 operational range areas that include drop zones, dudded impact areas, field training areas, firing ranges, land navigation courses, training and maneuver areas, other range areas, and aviation range areas (including runways, parking aprons, and landing pads). Of the 214 ranges, 125 were determined to be potential sources of MCOC. Munitions uses at these operational areas include:

- Small caliber arms
- Medium caliber arms
- Large caliber arms
- Pyrotechnics and obscurants
- Other munitions systems (including hand grenades, bombs, rockets, missiles, and mines)

For the purpose of Phase II, potential MCOC source areas are generally referred to as the large impacts areas and the small arms complex, as shown on **Figure 1-2**.

2.1.1 Climate

The climate at Camp Ripley has wide variations in temperature, ample summer rainfall, and a persistent winter snow cover. The mean annual temperature recorded at the weather station in Little Falls is 43.4 degrees Fahrenheit (°F). The normal winter has 5 to 10 days with low temperatures between –20°F and –30°F (MNARNG, 2003). Spring, summer, and fall temperatures are temperate. Average summer temperatures range between lows of 64.1°F and highs of 73.9°F (MRCC, 2006). The mean annual precipitation at Camp Ripley is 26.4 inches. The mean annual snowfall for Camp Ripley is about 44 inches, occurring almost entirely from November through March (MNARNG, 2003).

2.1.2 Topography

Camp Ripley is on the western Lake Section of the Central Lowland physiographic province. The level to slightly rolling topography of Camp Ripley is a result of glacial drift during the Pleistocene Epoch (U.S. Army Institute of Public Health [USAEHA], 1994). Ground-surface elevations range from 1,140 to 1,550 feet above mean sea level. Regionally, topography slopes to the east-southeast toward the Mississippi River, where the elevations at Camp Ripley are lowest. The most prominent geomorphologic feature at Camp Ripley is the St. Croix moraine. This moraine occupies most of the installation, forming a rough belt of uneven hummocky topography containing numerous hills, associated depressions, lakes, and wetlands (UMD, n.d.). These higher-relief landforms cover about half of Camp Ripley. Lower-relief landforms, such as outwash plains, old lakebeds, and alluvium, cover about 40 percent. The remaining areas consist of level terrain and water features (USAEHA, 1994).

2.1.3 Soil

One soil complex and two soil associations are present at Camp Ripley (MNARNG, 2003), as follows:

- Cushing-Mahtomedi-DeMontreville Complex soils are in a band of upland area that cuts diagonally across Camp Ripley from northeast to southwest. Permeability of these soils ranges from moderate to high, and the water-holding capacity ranges from moderate to low.
- Mahtomedi-Menagha Association soils are generally found on the side slopes of moraines or the adjacent outwash plains. Permeability is high, and the water-holding capacity is low.
- The Hubbard-Duelm-Isan Association soils are associated primarily with flat outwash plains of the Mississippi and Crow Wing Rivers. Permeability is high, and the water-holding capacity is low.

2.1.4 Geology

Surficial deposits at Camp Ripley consist of ice-contact and outwash deposits of the St. Croix morainic system. The outwash deposits were created by glacial meltwaters that flowed through the Mississippi and Crow Wing River valleys, depositing the poorly sorted sands and gravels in a band a few miles wide along both sides of the rivers (USACHPPM, 2000). The moraine is composed primarily of a heterogeneous mixture of glacial sediment consisting predominantly of sandy deposits laid down as flow tills, outwash, and lacustrine sediment by the Rainy and Superior lobes during the St. Croix glaciation of the Late Wisconsin Period. These deposits overlie the Hewitt till, a loamy glacial deposit laid down by the Wadena lobe during an earlier glacial advance (UMD, n.d.). Thicknesses of these unconsolidated deposits vary considerably across Camp Ripley, ranging from 20 feet to more than 200 feet (USACHPPM, 2000).

Bedrock at Camp Ripley consists of Precambrian age metamorphic rocks (USAEHA, 1994). Slate, schist, and metamorphosed mafic and intermediate volcanics compose the bedrock under Camp Ripley. Depth to bedrock at Camp Ripley varies and can be 150 feet or greater (USACHPPM, 2000).

2.1.5 Hydrogeology

In the region surrounding Camp Ripley, the main water-bearing units are composed of heterogeneous glacial sediments and lacustrine sandy deposits (PCE, n.d.; Quinn, 2006). Occasional sand and gravel components are intercepted at some well locations (BAL, 1987). Clay layers have been encountered throughout Camp Ripley, but no laterally extensive confining layers exist within the unconsolidated deposits at Camp Ripley (PCE, n.d.).

Depths to groundwater vary from at or near the surface at the northern and eastern boundaries of the facility to as deep as 288 feet in the higher elevations of the morainic areas (UMD, n.d.) and are largely dependent on topography (USACHPPM, 2000). Shallow groundwater elevations measured in the upland regions represent perched groundwater conditions, and the main water-bearing zone is approximately 180 feet below the surface in the central impact area (Foth and Van Dyke, 1997).

The regional groundwater flow is east-southeast toward the Mississippi River and is defined by a drainage divide west of Camp Ripley; groundwater originating east of this divide follows the east-southeast flow path to the discharge boundaries of Little Elk Creek to the southwest and the Crow Wing and Mississippi Rivers to the north and east (UMD, n.d.). The complex glacial topography creates localized variations in the groundwater flow paths, where recharge occurs at topographic highs and discharge occurs in adjacent topographic lows. In some areas, the shallow groundwater is thought to be in communication with the kettle lakes and wetland areas (USACHPPM, 2000).

Since the geologic makeup of the Camp Ripley area aquifer consists primarily of coarse-grained glacial and lacustrine deposits, the permeability is considered high. Groundwater studies and flow modeling have characterized the hydraulic conductivity of the glacial deposits at Camp Ripley from well pump tests and grain size analyses. Calculated hydraulic conductivities from the grain size analyses vary widely and range from 9.7 feet/day for dense clay loam till to 334 feet/day for coarse sand and gravel deposits (Quinn, 2006). A pumping test that was performed at an on-post groundwater supply well in the cantonment area exhibited very rapid recharge. The hydraulic conductivity of sediments near this well was calculated to be 408 feet/day (PCE, n.d.).

Natural recharge to the groundwater aquifer system in the Camp Ripley area is primarily through surface infiltration on site and off site through the glacial outwash deposits east of the drainage divide (Quinn, 2006). Groundwater level results from the Argonne National Labs 2003 groundwater flow model suggest that Lake Alexander may contribute to the groundwater recharge (UMD, n.d.). Groundwater discharges primarily to the Mississippi River, creating a hydrogeologic boundary along the eastern side of Camp Ripley (UMD, n.d.). Secondary discharge includes pumping for irrigation and drinking water consumption.

2.1.6 Hydrology/Surface Water

Camp Ripley has abundant surface water; according to the *Camp Ripley Integrated Natural Resources Management Plan* (MNARNG, 2003), wetlands total 8,829 acres. As a result of the glacial processes that shaped the landscape, numerous kettle lakes and wetlands are scattered throughout the installation.

Camp Ripley is bordered on the north by the Crow Wing River and on the east by the Mississippi River. The Little Elk River flows west to east, approximately 4 miles south of Camp Ripley. Both the northern and central impact areas have wetlands, lakes, and surface water drainage channels within their boundaries (USACHPPM, 2000). Several of the wetlands and lakes in the operational areas are thought to be in communication with the groundwater and do not flow off installation. Six surface water bodies originate on Camp Ripley and flow off installation, as follows:

- Unnamed intermittent stream flowing in a southeastern direction to the Mississippi River from the eastern portions of the central impact area
- Broken Bow Creek, originating at Prentice Pond and discharging to the southeast into the Mississippi River
- String of ponds and lakes starting with Frog Lake and discharging to the southeast into the Mississippi River
- Ponds and wetlands, including the drainage pattern of the wetlands and ponds, originating in the northern impact area
- Wetland areas in the northwestern corner within the valley train deposits of the Crow Wing River
- Unnamed tributaries, which flow to the southwest to the Elk River

The three major watersheds on Camp Ripley are the Crow Wing River, City of Little Falls-Mississippi River, and Fish Trap Creek watersheds. The Little Elk River watershed is a minor watershed unit. The Crow Wing River watershed receives direct runoff from about 17 square miles of the northern part of the installation, which is mostly undeveloped. There are no known point source discharges. The City of Little Falls-Mississippi River watershed is the largest watershed on the installation, covering about 45 square miles. Almost all of the surface drainage from the northern, central, and southern impact areas is in the City of Little Falls-Mississippi River watershed. The Little Elk River watershed receives runoff from about 12 square miles on the southern and southwestern parts of the installation, and numerous small lakes contribute drainage to the Little Elk River. The Fish Trap Creek watershed is the smallest watershed and drains an area of about 10 square miles in the western part of Camp Ripley. Surface water in the Fish Trap Creek watershed drains to Lake Alexander, west of the installation. The surface water outlet from Lake Alexander to Fish Trap Lake is intermittent, suggesting that Lake Alexander has a significant connection with groundwater (USACHPPM, 2000; UMD, n.d.). Surface-water features, including streams and their flow direction, lakes, ponds, wetlands, and subwatersheds are shown in **Figure 1-2**.

2.2 Summary of Previous Investigations

Existing environmental data were reviewed during Phase I and reviewed again in considerable detail during Phase II. Brief summaries of the previous studies are provided below. Data from these investigations are assessed and presented in detail in Section 3.1. These data are used to refine the CSM and in developing the technical approach for Phase II.

USAEHA. 1990. Geohydrologic Study No. 38-26-K876-90, Camp Ripley National Guard Training Area, Little Falls, Minnesota, 30 May - 6 June 1990.

This report discusses the background of Camp Ripley and the investigation of MCOC (explosives and metals) at the Old Engineers' Demo Area (OEDA). Groundwater and soil samples were collected. Monitoring wells were installed, and well construction forms and drilling logs are included in the report. Metals were determined to not be a concern in either medium. Explosives were tested by high performance liquid chromatography. HMX and RDX were detected in two of 12 soil samples and RDX was found in two of four groundwater samples.

USAEHA. 1990. Memorandum for Commander, Subject: Results from Surface Water Sampling and the Resampling of Groundwater Monitoring Wells at the Engineers' Old Demolition Area and the Crash Reserve Training Site, Camp Ripley, 25-28 September 1990.
Of relevance to the ORA, this memorandum presents analytical results for samples collected in response to the initial USAEHA study (above) at the ODEA. Four groundwater and two surface water samples were tested for explosives by EPA method 97.1. No explosives were found in the surface water. RDX was detected in the same two wells as during the May - June 1990 study; however, as concluded in the USAEHA report, explosives residue seeps slowly into the swampy areas, and RDX is diluted to below detection limits in all surface water samples.

USAEHA. 1994. Groundwater Quality Survey No. 38-26-K2SY-94 Camp Ripley National Guard Training Area, Little Falls, Minnesota 9-20 May 1994.
This report provides the results of a groundwater quality survey including analytical results and groundwater level measurements collected in 1990 and 1992. Sampling included explosives in four existing monitoring wells and in three direct push groundwater samples at the OEDA. Samples were analyzed using high performance liquid chromatography. Explosives were found in groundwater consistent with the previous two sampling events. Another open burn/open detonation (OB/OD) area to the northeast of the OEDA was also evaluated for explosives in soil (none were found) and in groundwater (RDX and HMX were detected).

Foth and van Dyke. 1997. Water Quality Survey, Camp Ripley, Minnesota.
Surface water, sediment, soil, and groundwater samples were collected on the installation and analyzed for explosives and metals. Surface water was collected from 12 water bodies near the perimeter of operational ranges. Explosives were not detected, and metals did not exceed standards for Minnesota Class I domestic consumption surface water. In sediment, explosives and metals were detected in the sediments of one lake located between the large impact areas. Soil samples were collected around the large impact areas and the small arms complex. Explosives were not detected, and metals (including antimony, copper, lead, and zinc) were "within typical background ranges published by the USGS." Groundwater samples were collected at nine locations in the operational area. Explosives were not detected. Total lead exceeded USEPA drinking water maximum contaminant level in samples from all nine locations. This was qualified as probably being naturally occurring.

Bioassays on freshwater shrimp (C. dubia) were inconclusive primarily due to inconsistencies with control sample results.

Fish tissue samples were collected from Leach Stream, Lake Alott, Hagen Pond (very near Broken Bow Creek), and Prentice Pond. Fish consumption analysis was performed on Lake Alott samples because it was considered the "most fishable lake of the group." Based on the metals analyses of the tissues, Lake Alott rated "unlimited fish consumption" established by Minnesota's Department of Health. One qualification to these findings is that the detection limit for antimony was elevated and there is some uncertainty associated with this one metal.

MCOC Sampling at Various Camp Ripley Locations. 1998, 2001, and 2002.

From October 1998 to August 2002, surface water and groundwater were sampled at over 40 locations and analyzed for explosives by SW-846 USEPA 8330 and 8330A. Fifteen of these were monitoring wells. Twenty-five of the locations were sampled more than once. Explosives residues were detected in three wells. Two of these wells are in the operational range area, and the third well is in the cantonment area just south of the cantonment area drinking water wells. No explosives were detected in surface water.

University of Minnesota Duluth (UMD) Geological Sciences Department. 2003. Surface Water Management Reports: Management Guide #03-001. June 2003.

Prepared by the UMD Geological Sciences Department as part of the installation's Comprehensive Water Management Plan, this report evaluated erosion, runoff, and training activities as potentially stressful to surface water at Camp Ripley. To determine erosion potential, surface water susceptibility, and surface water vulnerability, three analyses were used as part of this program and include the Revised Universal Soil Loss Equation, the Surface Water Susceptibility Analysis, and the Surface Water Vulnerability Analysis.

Quinn, John J. 2006. Delineation of a Wellhead Protection Zone and Determination of Flowpaths from Potential Groundwater Contamination Source Areas at Camp Ripley, Little Falls, Minnesota.

This report documents the creation of a numerical model of groundwater flow for Camp Ripley and hydrologically related areas to the west and southwest of the installation. The model can be used for several applications, including estimating flowpaths and time of travel for groundwater at operational areas and waste management facilities. An updated "review draft" of this document (2008) reached similar conclusions although the report was not final at the time of the Phase II.

Minnesota Department of Military Affairs Memorandum Dated 25 August 2008.

This memorandum presents analytical results of sampling from drinking water wells at Camp Ripley. Nineteen wells were tested on four different dates between 2007 and 2008. Samples were tested for explosives by EPA method 529. All of the analytical results were below the minimum detection levels. This memorandum recommended closure of the issue of potential explosive compounds in drinking water wells.

Perchlorate Sampling - Camp Ripley, 2009.

Thirteen drinking water wells were sampled twice in August - September 2009. Samples were tested for perchlorate by method 331 LC/MS. Only trace amounts of perchlorate (0.03 micrograms per liter [µg/L] or less) were detected in five wells.

2.3 Phase I Conceptual Site Model

The Phase I CSM provided the basis for the Phase II. The CSM identified pathways that could allow MCOC from an on-range source to interact with off-range receptors at concentrations that could pose a potential risk to human health or the environment.

The primary source areas at Camp Ripley are firing points, impact areas, small arms ranges, and historical sources. The source areas are within the *Inconclusive* ranges shown in **Figure 1-2**. Given the wide variety of training offered at Camp Ripley, the potential MCOC include explosives, pentaerythritol tetranitrate (PETN), perchlorate, and metals (antimony [Sb], copper [Cu], lead [Pb], and zinc [Zn]).

Potential pathways for MCOC migration off the operational footprint include surface water pathways and surface water infiltration to groundwater pathways to human and ecological receptors.

In demolition areas, shallow groundwater could also be directly exposed to MCOC if craters are deep enough. Potential surface water pathways, including lakes and wetlands, are present throughout the installation. These and other areas are known to be inhabited by threatened and endangered species and are indicative of similar environments off-installation at and around the Crow Wing and Mississippi Rivers. Human receptors downgradient of the ranges in the cantonment area and in surrounding communities include surface water used for recreation and groundwater used for drinking. Based on the regional groundwater flow direction, the locations of high-use ranges, and locations of off-installation supply wells, the area most likely affected would be residents at Round Lake, immediately adjacent to Camp Ripley (**Figure 1-2**). Groundwater pathways were determined to be incomplete for the northeastern and eastern boundary ranges.

As discussed in Section 3.1, additional data review and refinement of the CSM during Phase II resulted in some modifications to the list of MCOC, likely migration pathways, and receptors.

3 ORA Phase II

As described in Section 1.5, the strategy for conducting the Phase II was based on the USEPA systematic planning or DQO process. The DQO process is an iterative sequence of seven logical steps to create a detailed technical approach. The preliminary CSM was developed during Phase I (Step 1 of the DQO process) and updated during Phase II planning. The subsequent steps in the DQO process include the following:

- Identifying the goal of the Phase II ("if-then" statements to determine whether surface water and groundwater pathways are present)
- Identifying information inputs (media to be sampled and analytical methods)
- Defining the study boundaries (which waterways will be sampled depending on the pathways and receptors present)
- Developing the analytical approach (how the data will be analyzed)
- Specifying performance or acceptance criteria (i.e., project action limits [PALs])
- Developing the detailed plan for obtaining data (developing the detailed CSM and technical approach)

The following sections describe the major outputs of the site-specific application of the DQO process, including the updated CSM and the detailed technical approach developed for Phase II.

3.1 Phase II Data Review

Camp Ripley has a proactive and robust approach to managing environmental concerns at the installation, and substantial environmental work has been performed, including groundwater and surface water studies. Data from these studies and observations from URS' project kickoff meeting and site visit were compiled and reviewed.

3.1.1 Discussion and Observations during the Site Reconnaissance (May 2011)

The Phase II kickoff meeting and site visit were held at Camp Ripley in May 2011. During the meeting, installation personnel stated that white phosphorus and nitroglycerine are unlikely MCOC because of their chemical properties, and that existing data show that perchlorate is not present at Camp Ripley. During the site visit, potential surface water sampling locations and approximately 12 groundwater wells (monitoring and production) were assessed for potential sampling. Camp Ripley personnel later provided extensive surface water and groundwater electronic data to URS.

Also, during the site visit, a large new range just south of the southern impact area was being constructed. The initial phase of construction—land clearing—was underway.

After the kickoff meeting and site visit, data from existing studies and URS' observations were used to develop a technical approach.

3.1.2 Pre-Phase II Data Assessment

Past environmental investigations and studies were briefly summarized in Section 2.2. Data from these studies and observations from URS' project kickoff meeting and site visit were compiled and reviewed. The primary areas of concern at Camp Ripley are organized into three sections: (1) cantonment area groundwater (installation potable water supply); (2) OEDA near Round Lake (residents at the lake use groundwater for drinking water; and (3) installation-wide surface water and groundwater pathways. Because the third section is installation-wide, it addresses the worst case-scenario of the large impact areas as the primary potential sources of explosives and the heavily used small arms complex as a potential source of metals.

The pre-Phase II data are evaluated below and assessed relative to the Phase II explosives and metals PALs, which are discussed in detail in Section 3.3.3. For hardness-dependent metals PALs (copper, lead, and zinc), the lowest hardness concentration measured during Phase II was used to calculate the ORA Screening Values and Minnesota Screening Values; the PAL is the lower of the two. **Tables 3-1** and **3-2** list the PALs for explosives and metals, respectively. These tables also summarize the detection limits obtained from the historical data sets. In large part, the detection limits are lower than the PALs.

(1) Cantonment Area. The cantonment area is in the southern-most part of Camp Ripley. Installation potable water is obtained from production wells in this area. Although there are other production wells located across the installation, these are not frequently used and typically supply water for on-range uses. One of three sampling events (10/22/2001) at a monitoring well (530012) in the cantonment area reported small concentrations of explosives (**Figure 3-1**):

9.3 micrograms per liter (µg/L) of 2,4-DNT

20 µg/L of RDX

Both compounds were below detection limits during a prior sampling round (12/15/1998) and a later round (8/3/2002). RDX and 2,4-DNT exceeded the PALs for human exposure of 0.61 and 0.20 µg/L, respectively. In 2007, USACHPPM (now Army Institute of Public Health) requested additional sampling after reviewing the Phase I ORA Report. Consequently, 19 production wells at Camp Ripley (five of which are in the cantonment area) were tested for explosives. Four rounds of sampling were conducted between August 2007 and June 2008. No positive detections were reported (Technical Memorandum dated 25 August 2008). In 2009, 13 production wells (including three in the cantonment area) were tested for perchlorate. A few detections were reported with a maximum of only 0.28 µg/L, which is well below the PAL of 15 µg/L (Camp Ripley, 2009).

Despite the uncertain origins of the few explosive compounds detected in groundwater, the available evidence indicates that they are sporadically present at low concentrations, and does not appear to be range related. In addition, based on the absence of explosives in all installation supply wells and all surface water samples (see **Figures 3-1** and **3-2**), the minor detections in monitoring well 530012 appears to pose minimal human and ecological risks. Therefore, this area is not studied further.

(2) OEDA near Round Lake. The OEDA, which is located on top of a small, flat hill near the southwest edge of Camp Ripley, was used from 1975 to 1989 for ordnance demolition activities. Sampling in the early 1990s revealed explosives MCOC in groundwater at the OEDA (USAEAH, 1990). The concern is that explosives from the OEDA could migrate via groundwater or surface water flow and affect the drinking water wells of local residents. The closest off-installation residents are located at Round Creek, about 2,500 feet southwest of the OEDA (**Figure 3-2**). Although Round Lake borders the installation boundary to the west, residential

Table 3-1: Explosives Detection Limits and PALs

Analyte	Detection Limit (µg/L)		ORA Screening Levels (µg/L)		PAL (µg/L)
	Groundwater	Surface Water	Human Drinking Water	Fresh Water Ecological	
HMX	0.076 - 1.0 (1), 100 (3)	0.076 - 1.0 (1), 100 (3)	780	150	150
RDX	0.08 - 1.0 (1)	0.08 - 1.0 (1)	0.61	190	0.61
TNT	0.05 - 0.9 (1)	0.05 - 0.9 (1)	2.2	90	2.2
TNB	0.026 - 1.0 (1)	0.026 - 1.0 (1)	460	11	11
DNB	0.032 - 0.076 (1)	0.032 - 0.053 (1)	1.5	20	1.5
Tetryl	0.07 - 0.25 (1)	0.07 - 0.25 (1)	63	NA	63
NB	0.044 - 0.1 (1)	0.044 (1)	0.12	270	0.12
2-A-4,6-DNT	0.06 - 0.1 (1)	0.06 - 0.1 (1)	30	20	20
4-A-2,6-DNT	0.05 - 0.083 (1)	0.05 - 0.083 (1)	30	NA	30
DNT-mixture	--	--	0.092	NA	0.092
2,6-DNT	0.04 - 0.25 (1)	0.04 - 0.25 (1)	15	42	15
2,4-DNT	0.04 - 1.0 (1)	0.04 - 1.0 (1)	0.2	44	0.2
2-NT (o)	0.084 - 0.14 (1)	0.084 - 0.14 (1)	0.27	NA	0.27
3-NT (m)	0.09 - 0.17 (1)	0.09 - 0.17 (1)	1.3	750	1.3
4-NT (p)	0.09 - 0.15 (1)	0.09 - 0.15 (1)	3.7	1900	3.7
Nitroglycerin	0.11 - 1.0 (1)	1.0 (1)	1.5	138	1.5
PETN	--	--	16	NA	16
Perchlorate	0.02 (2)	--	15	9300	15

(1) Range of detection limits for analytical results are obtained from the Explosives Analytical Data summary provided by Camp Ripley, USAEHA Memorandum dated 1990, and EPA Method dated September, 2002.

(2) Detection Limit for analytical results is obtained from the 2009 Perchlorate Testing Drinking Water Wells Table provided by Camp Ripley.

(3) Detection Limit of 100 µg/L used for samples collected in 1990 (USAEHA Memorandum, 1990).

µg/L – micrograms per liter

-- No data for this analyte

Table 3-2: Metals Detection Limits and PALs

Analyte	Detection Limit (µg/L)		ORA Screening Levels (µg/L)		Minnesota Screening Criteria (7)	PAL (µg/L)
	Groundwater	Surface Water	Human Drinking Water	Fresh Water Ecological		
Antimony (Sb)	1.0, 20 (1) (2)	20 (1)	6	30	5.5	5.5
Copper (Cu)	10, 20 (1) (3)	10, 20 (1) (3)	620	9.5	10.3	9.5
Lead (Pb)	0.4 - 40 (1) (4)	0.4, 40 (1) (4)	15	2.7	3.5	2.7
Zinc (Zn)	5.0 - 40 (1) (5)	10, 40 (1) (6)	4700	125	112	112

(1) Detection limits analytical results are obtained from the Metals Analytical Data Summary provided by Camp Ripley.

(2) In 1993, the detection limit was 20 µg/L. The majority of the samples were collected in 1998 and analyzed with a detection limit of 1 µg/L.

(3) The majority of the samples were collected during or after 2000 and analyzed with a detection limit of 10 µg/L.

(4) In 1994, the detection limit was 40 µg/L. The majority of the samples were collected during or after 2000 and analyzed with a detection limit of 0.4 µg/L.

(5) In 1993, the detection limit was 40 µg/L. All other samples collected were analyzed with a detection limit of 20 µg/L or below.

(6) In 1994, the detection limit was 40 µg/L. The majority of the samples were collected after 1994 and analyzed with a detection limit of 10 µg/L.

(7) Chronic Standard (https://www.revisor.mn.gov/rules/?id=7050.0222).

µg/L – micrograms per liter

wells are not located on the portion nearest the OEDA (**Inset 3-1**), and extensive marshland exists between Round Lake and the OEDA.

The area's lithology, groundwater and surface water flow directions, modeling results, and analytical data from previous studies were reviewed and incorporated into a CSM to determine if this pathway could be complete.

Inset 3-1. Round Lake and Surrounding Drinking Water Wells
(http://www.health.state.mn.us/divs/eh/cwi/index.html)

Two geologic cross sections were prepared using lithological data from wells at the OEDA and Round Lake (**Figure 3-3**). The locations of the two cross sections are shown on **Figure 3-2**. The area is mainly glacial outwash deposits of poorly stratified gravels and sands (USAEHA, 1990). Significant clayey zones were identified in some of the well log reports of the drinking water wells surrounding Round Lake[3]. Infiltration of the surface water into the sandy outwash material around the OEDA can easily occur; the clayey zones near the residential wells would likely hinder the lateral flow of groundwater.

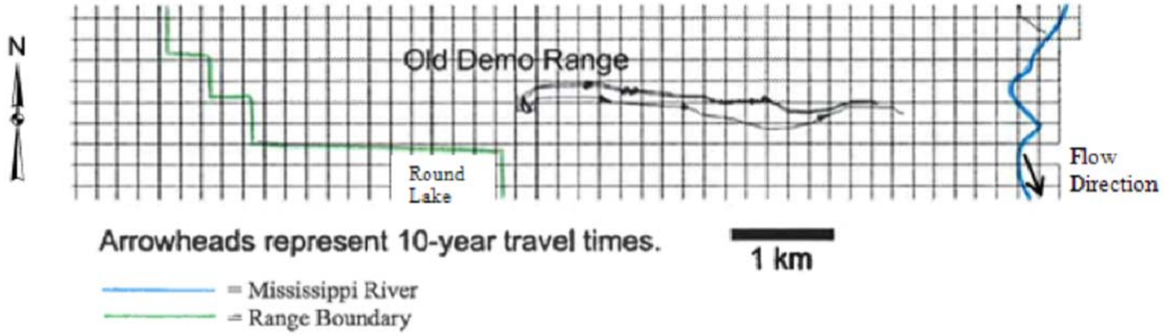
As the surface water infiltrates into the permeable soil, some likely flows radially off the OEDA hill and into the surrounding marsh. The marsh is an indication of relatively stagnant surface flow and likely local groundwater discharge area. Luzon Road, southwest of the OEDA, is slightly elevated topographically and marshland is present on both sides. The nearest flowing stream is the S. Elk Tributary to the southeast. Local groundwater flow is to the southeast towards the S. Elk Tributary (**Figure 3-2**). This was determined using water levels measured by USAEHA in the 1990s from OEDA wells (USAEHA, 1994). In addition, a groundwater flow model was developed and illustrates the path of particles at 10-year increments from the OEDA (Quinn, 2008). According to the model, particles travel to the east from the source area (**Inset 3-2**). Based on these studies it is highly unlikely that surface water or groundwater would flow from the OEDA to the southwest towards Round Lake and reach any residential drinking water wells. In addition, there is vertical separation between the detected contamination (see discussion below) and the depth of the drinking water wells. The two monitoring wells in which explosives were detected, DA-3 and DA-4, are 32 and 20 feet below ground surface (USAEHA, 1990). The depth of the direct push samples in which explosives were detected were not reported but is assumed to

---

[3] http://www.health.state.mn.us/divs/eh/cwi/

be similar to the screened interval of the monitoring wells. In contrast, the 20 residential wells around Round Lake are at depths between 38 and 116 feet with most of these deeper than 50 feet, which is significantly deeper than those wells in which explosives were detected. This vertical separation is another factor precluding MCOC migration from the OEDA to potential receptors.

Inset 3-2. Particle tracking from the Old Engineer's Demo Range to discharge area (Quinn, 2008)



Analytical data from sampling events that occurred in the 1990s and early 2000s provide another line of evidence that the Round Lake residents will not be affected by the explosives MCOC from the OEDA (USAEHA, 1994 and Camp Ripley EQUIS database of water quality program results). Groundwater samples were collected from four monitoring wells and three direct push points, and two surface water samples were collected by USAEHA in the early 1990s. Sample locations and analytical results are presented on **Figure 3-2**. All RDX detections exceeded the PALs for human exposure; several also exceeded the PALs for ecological exposure. Only one detection of HMX (in DA-4) exceeded the PALs for ecological exposure.

The two wells (DA-3 and DA-4) located on the south and east flanks of the hill (and closest to where training occurred) had detections of explosives. DA-1 and DA-2 had none. In the three direct push groundwater samples, HPLR-1 has similar explosive concentrations as in DA-4; HPLR-2 had considerably lower concentrations; and HPLR-3 had none. HPLR-1 is closest to DA-4 (the well with the highest explosives concentrations) and reinforces that the direction of groundwater flow at the OEDA is primarily to the southeast. None of the surface water samples at the OEDA contained explosives. Additionally, surface water samples collected later (2001 and 2002) next to Round Lake and at the downstream end of S. Elk Tributary also contained no explosives. The distribution of explosives indicates that groundwater has been affected in the immediate vicinity of the OEDA and that migration of the MCOC is to the southeast, not towards Round Lake. Surface water appears unaffected.

Although there are explosives present locally in groundwater at the OEDA, migration to an off-installation receptor is unlikely to occur. Surface water is not affected by explosives (confirmed by chemical analysis), and groundwater does not flow in the direction of the residents at Round Lake. Further study of this area is not necessary.

(3) Surface Water and Groundwater Pathways. The glacial soils across the installation are highly permeable and MCOC migration via overland flow is considered negligible. The creeks and streams observed during both site visits were flowing and this appeared to be from groundwater discharge. This conclusion is supported by the June 2003 Camp Ripley Surface Water Management Reports (SWMR; a part of the installation's Comprehensive Water Management Plan) prepared by the UMD Geological Sciences Department. Soil erosion and sedimentation was evaluated using a mathematical model and a surface water susceptibility analysis was conducted. For the first task, predicted soil erosion rates were determined using the Revised Universal Soil Loss Equation (RUSLE model). This model considered soil types, rainfall erosivity, slope length and steepness, and land cover. UMD noted in their report that accepted values for forest erosion is up to 4 tons/acre/year. The RUSLE results for nearly all of Camp Ripley are much lower than this, with values from 0 to 0.97 tons/acre/year, and very small discrete areas with rates up to 2.92 tons/acre/year. Sedimentation does not present a viable MCOC transport mechanism. The second task evaluated surface water susceptibility in terms of slope, distance to surface water (i.e., lakes, stream), land cover, and soil attributes. The results are shown in **Figure 3-4** (UMD Report Figure 16). This figure indicates that much of Camp Ripley has "low" to "lowest" susceptibility ratings. The higher ratings are primarily confined to the central portion of the installation where higher slopes coincide with on-range lakes. Further support is provided in the groundwater model performed by Argonne National Laboratory (2006), which assumed:

> "For Camp Ripley and nearby areas to the west and southwest precipitation (as rainfall or snowmelt) infiltrates and becomes aquifer recharge. It is assumed that only a small amount of water runs off, on the basis of the fact that there are only a few very minor creeks in the entire study area. This internal drainage is also demonstrated by closed topographic depressions that are dry in the bottom…and is consistent with…an abundance of sandy soil and subsoil."

Based on site observations and the SWMR analyses, it is reasonable to conclude that overland sediment transport is not a major migration mechanism, especially outside the operational ranges.

While surface water runoff (including sediment transport) is not considered a significant pathway, surface water infiltration into shallow groundwater at potential source areas and subsequent discharge of groundwater to off-range streams and wetlands is a migration scenario. During past studies, explosives (including perchlorate) and metals data were collected for groundwater and surface water across Camp Ripley.

Extensive sampling for explosives has occurred and those results are summarized on **Figure 3-1**. (Note that for wells with multiple rounds of non-detect data, the years of sampling are listed in the tables on the left side of **Figure 3-1**.) A few detections were reported in three monitoring wells: two of these wells were addressed above (cantonment area and OEDA). The only other monitoring well with minor explosive detections was 519366, which is situated where OB/OD activities used to take place (1958-1974 and again in 1990). This well is northeast of the OEDA. In 1992, USAEHA sampled and detected RDX and HMX in groundwater from three of five wells installed within that OB/OD range. RDX and HMX were again detected in 1998 in well 519336. However, downgradient, no explosives have been detected at the most likely discharge locations (Prentice Pond and Hole in Day Marsh) or in a production well near the installation boundary (451231). In addition, it is likely that explosives are locally present in groundwater at another centrally located range that is currently the most heavily used OB/OD area. During the May 2011 site visit, a deeper crater contained standing water here (possibly shallow groundwater or perched water). However, multiple rounds of production well sampling indicate that explosives are not affecting Camp Ripley's drinking water (Technical Memorandum dated 25 August 2008). In addition, a well (451233) situated directly downgradient of this range contained no explosives.

The data reviewed for the OEDA (see above) shows that the closest off-installation groundwater users at Round Lake are unlikely to be affected by the localized presence of explosives in groundwater at the OEDA. Sampling evidence shows that migration of explosives MCOC from groundwater discharging to surface water is not occurring. Multiple sampling events at streams and lakes across the installation did not reveal a single positive detection of explosives. This was also observed in earlier sampling of surface water near the OEDA (**Figure 3-2**). In 2009, 13 production wells (including three in the cantonment area) were tested for perchlorate by method 331 LC/MS. A few detections were reported with a maximum of only 0.28 µg/L, which is well below the PAL of 15 µg/L (Camp Ripley, 2009). Explosives are, therefore, eliminated as potential MCOC that could cause off-range risks to groundwater and surface water receptors.

Metals results from Camp Ripley's database are shown in **Figure 3-5**. These are discreet results from grab samples. Because there was only one positive detection of antimony in groundwater at 2 µg/L, which is below the PAL of 5.5 µg/L, this compound is not shown on the figure. Also, given the multiple rounds of data available for many locations, only the two most recent events were plotted.

The small arms range complex is an anticipated source of metals MCOC. It is located in the southern portion of the installation. Surface water bodies were not observed in the area during the site visit. The east end of the range complex is about ¾ mile from the nearest Phase II sampling location (RP04 and RP05) with a large intervening marsh. As described above for the installation, infiltration into groundwater is also the major potential migration pathway in this area.

Overall, metals are not a concern from a human exposure perspective. With the exception of three isolated lead detections (Prentice Pond in 1994, and wells 534077 and 534080 in 1993), none of the metals in surface water or groundwater exceed PALs for human exposure.

Ecologically, off-range risks also appear minimal. While detections of metals are found central to the installation, they are not found at the boundaries. Potential reflection of MCOC sources are seen in the following samples:

- Small Arms Range Complex –Wells 536845 and 536846 (detections in there wells were from a field analytical method, not a laboratory)
- Central Large Impact Area –Wells 536843, 671607, and 671608 (the elevated detections in the last well were from a field analytical method)
- Northern Large Impact Area – Plumly Marsh and Mud Lake, and well 536840

However, downgradient/downstream of these locations, surface water samples are nearly free of metals MCOC or with a few detections just at or below the Phase II PALs. The boundary samples relative to the potential source areas are:

- Small Arm Range Complex – Broken Bow Creek to the east, S. Elk Tributary to the west
- Central Large Impact Area – N. Hendrickson Stream

- Northern Large Impact Area – Stream 362, Leach Stream, and Anzio Stream. Note: Frog Lake Stream has a copper and low lead detection above PALs and may reflect a minor effect from the Impact Area.

The surface water data were collected in the summer and fall, which is the driest time of year at Camp Ripley. Thus, these data do not reflect the conditions during a first flush of MCOC during the spring thaw. Whether these conditions would result in generally higher or lower MCOC concentrations is debatable. During the spring thaw the ground may remain frozen and snow melt would flow overland rather than infiltrate. It may be that the first spring thaw is one of the few times surface water runoff rather than groundwater discharge dominates stream base flow.

Range Facility Management Support System Data Review Range Facility Management Support System (RFMSS) data were reviewed and it was determined that range usage has notably increased in all munitions types over the years since Phase I.

3.2 Conceptual Site Model

Based on the information in Section 3.1, the list of MCOC, likely migration pathways, and receptors was modified, and the CSM was revised for Phase II. The updated CSM for the *Inconclusive* areas is illustrated in **Figure 3-6** and summarized in the following sections.

3.2.1 Primary Sources and MCOC

The large impact areas and small arms complex are identified as the primary MCOC sources. Potential MCOC include antimony, copper, lead, and zinc. Based on extensive surface water and groundwater sampling, explosives and perchlorate were eliminated as MCOC.

3.2.2 Pathway Analysis

Potential pathways for MCOC migration from *Inconclusive* areas include precipitation infiltration into shallow groundwater at potential source areas and subsequent discharge of groundwater to off-range streams and wetlands. Overland flow was determined to not be a significant pathway, which is supported by the studies discussed above. Groundwater flow to potential drinking water sources was also eliminated based on historical groundwater data and flow model results described above.

3.2.3 Potential Source: Human Interaction Pathway Analysis

Humans are not a potential receptor at Camp Ripley.

3.2.4 Potential Source: Ecological Interaction Pathway Analysis

Potential ecological receptors on installation and downstream of Camp Ripley (associated with the Mississippi River) that may be affected by MCOC transport include wetlands and sensitive environments (i.e., potential threatened and endangered species and/or habitats). These environments cover approximately 16.7 percent of Camp Ripley and continue downstream. The Blanding's turtle, a Minnesota State-listed threatened species, is found in the area. Additional State- or Federally-listed threatened or endangered species found on the installation include the gray wolf, trumpeter swan, tubercled rein-orchid, and bog bluegrass. The bald eagle is a State species of special concern.

3.3 Phase II Technical Approach

As identified during the DQO process, the project goal for Phase II was to determine whether MCOC are present in the surface water system at concentrations that present an unacceptable risk to the environment off the operational footprint. To fill data gaps identified in the Preliminary Technical Approach (PTA) and during the data review discussed in Section 3.1, Phase II was designed to gather data to quantitatively assess the drainage areas and answer the following questions:

- Are metals MCOC present in the shallow groundwater that has infiltrated within the *Inconclusive* areas and released to the surface water that flows to the Mississippi River?
- What are reference metals MCOC concentrations in surface water upstream of, or in an area unlikely to be unaffected by, the *Inconclusive* areas?
- Do MCOC concentrations in surface water pose an unacceptable risk to ecological receptors?

The Phase II study questions were answered by sampling and analyzing surface water samples collected downstream of the *Inconclusive* areas and from a reference location in an area unlikely to be affected by the *Inconclusive* areas.

Details of the sampling and analysis methodology are presented in Sections 4 and 5, respectively. Details of the DQO planning process and the sampling and analysis methods can be found in the *Programmatic Quality Assurance Project Plan [PQAPP], Operational Range Phase II Assessments, Army National Guard* developed for Phase II (URS/ARCADIS/Pirnie, 2012b), and the Work Plan/Installation-Specific QAPP (ISQAPP) prepared for Phase II at Camp Ripley (URS/ARCADIS/Pirnie, 2012c). The PQAPP has general programmatic information and is a companion to the ISQAPP that includes installation-specific details not in the PQAPP.

The QAPPs are based on procedures in the *Army Operational Range Assessment Phase II Investigation Protocol* (USACHPPM, 2009), the *ARNG ORA Focus for Technical Sampling* (ARNG, 2011), and the USEPA *Guidance on Systematic Planning Using the DQO Process* (USEPA, 2006). ISQAPP Worksheet #11 contains the planning process statements used to develop the technical approach, while ISQAPP Worksheet #17 documents the sampling design and rationale.

3.3.1 Surface Water

Six surface water locations were sampled: five downstream of potential source areas and one reference. The five downstream locations (RP01, RP02, RP03, RP04, and RP05) are situated where surface water is present near the eastern range boundaries (i.e., the dominant flow paths from the ranges that actually reach the installation boundary). RP06 is a reference location. The sample locations are shown on **Figure 3-7**.

As described in Section 2.1.6, the three major watersheds on Camp Ripley are the Crow Wing River, City of Little Falls-Mississippi River, and Fish Trap Creek watersheds (**Figure 1-2**). The Fish Trap Creek watershed is in the west portion of the installation and is not influenced by range activities at the primary areas of concern. Therefore, samples were not needed within this watershed. Samples were taken in the Crow Wing River and City of Little Falls-Mississippi River watersheds. Furthermore, within these two major watersheds, samples were taken in four subwatersheds. The locations of the subwatersheds relative to the areas of concern and the sample(s) taken to evaluate the particular watershed are summarized below.

- RP01 is located within the Crow Wing River watershed, near the northern extent of the City of Little Falls-Mississippi River watershed. It is located due east of the northern portion of the large impact area.
- RP02 and RP03 evaluates water draining between the large impact areas as part of the City of Little Falls-Mississippi River watershed.
- RP04 and RP05 are located within area of the City of Little Falls-Mississippi River watershed, which drains the small arms complex and a portion of the large impact area.

Samples were taken at all locations during one mobilization referred to as the Wet Season (High Flow) Mobilization that would reflect a first (and likely heavier) flush of MCOC concurrent with the spring thaw. Two sampling events, Wet A (WA) and Wet B (WB), were conducted during the mobilization. Because the dominant transport is via infiltration to shallow groundwater and then downgradient discharge, storm event sampling was not considered necessary.

Twenty-four hour composite samples were collected to capture diurnal variations, except at one location (RP03) where grab samples were collected because of very low water conditions. Samples were analyzed for dissolved metals (copper, lead, antimony, and zinc), hardness, and Biotic Ligand Model (BLM) parameters. Water quality parameters were also collected during each sampling event. **Appendix A** presents photographs of each sampling location.

3.3.2 Reference

None of these dominant flow paths from *Inconclusive* ranges have an upstream segment unaffected by range activities. Also, given the very extensive areas covered by the *Inconclusive* ranges, it appears that nearly every stream could be affected by range activities. However, a likely exception is Yalu Creek at the far northern tip of the installation where the reference samples at RP06 were taken. Metals data from locations downstream of the operational areas were compared to results from the reference location to evaluate whether the operational areas are contributing metals MCOC at concentrations higher than reference levels.

3.3.3 Project Action Limits

PALs are established based on the lower of State and local promulgated values or ORA Screening Values. The PAL for antimony is based on Minnesota Screening Criteria (Minnesota Office of the Revisor of Statutes, 2012). For hardness-dependent metals PALs (copper, lead, and zinc), the hardness concentration measured during Phase II were used to calculate the ORA Screening Values and Minnesota Screening Values; the PAL is the lower of the two.

USEPA’s formulas for correcting hardness-dependent screening criteria, which are used to calculate the ORA Screening Values, are most accurate for hardness values between 25 and 400 milligrams per liter (mg/L) (Title 40 Code of Federal Regulations Section 131.36.C.4). Minnesota Screening Criteria formulas are most accurate for hardness values below 400 mg/L (Minnesota Office of the Revisor of Statutes, 2012).

In the ISQAPP, surface water formulas for lead, copper, and zinc were hardness-adjusted based on data from previous investigations at Camp Ripley that indicated low hardness concentration (ranging from below detection to 4.81 mg/L, except for one value of 17.49 mg/L). However, hardness data collected during the Phase II sampling events were considerably higher and were used to calculate the surface water PALs for each of the subwatersheds, as described in Section 2.1.6. For each subwatershed, the lowest hardness value was used to calculate the PALs. **Table 3-3** presents the minimum and average hardness values and PALs for the samples location associated with each subwatershed.

Table 3-3: Surface Water Hardness Values and Project Action Limits

	Sample Locations Associated with Subwatershed			
	RP01	RP02 and RP03	RP04 and RP05	RP06
	Minimum (and Average) Subwatershed Hardness Values (mg/L as $CaCO_3$)			
	198 (199.5)	122 (156)	199 (201.5)	107 (107.5)
Analyte	**Surface Water Project Action Limits (µg/L)**			
Antimony	5.5*	5.5*	5.5*	5.5*
Copper	15*	10.6	15.1*	9.5
Lead	5.2	3.1	5.3	2.7
Zinc	189*	125*	190*	112*

Notes:
mg/L= milligrams per liter; $CaCO_3$ = calcium carbonate; µg/L = micrograms per liter
*Lowest using Minnesota Screening Value equation
PALs are the lower of the ORA Screening Values or Minnesota Screening Values formulas for copper (Cu), lead (Pb), and zinc (Zn), which are hardness dependent. The lowest hardness value for each subwatershed, as provide in the table, was used in the following formulas:

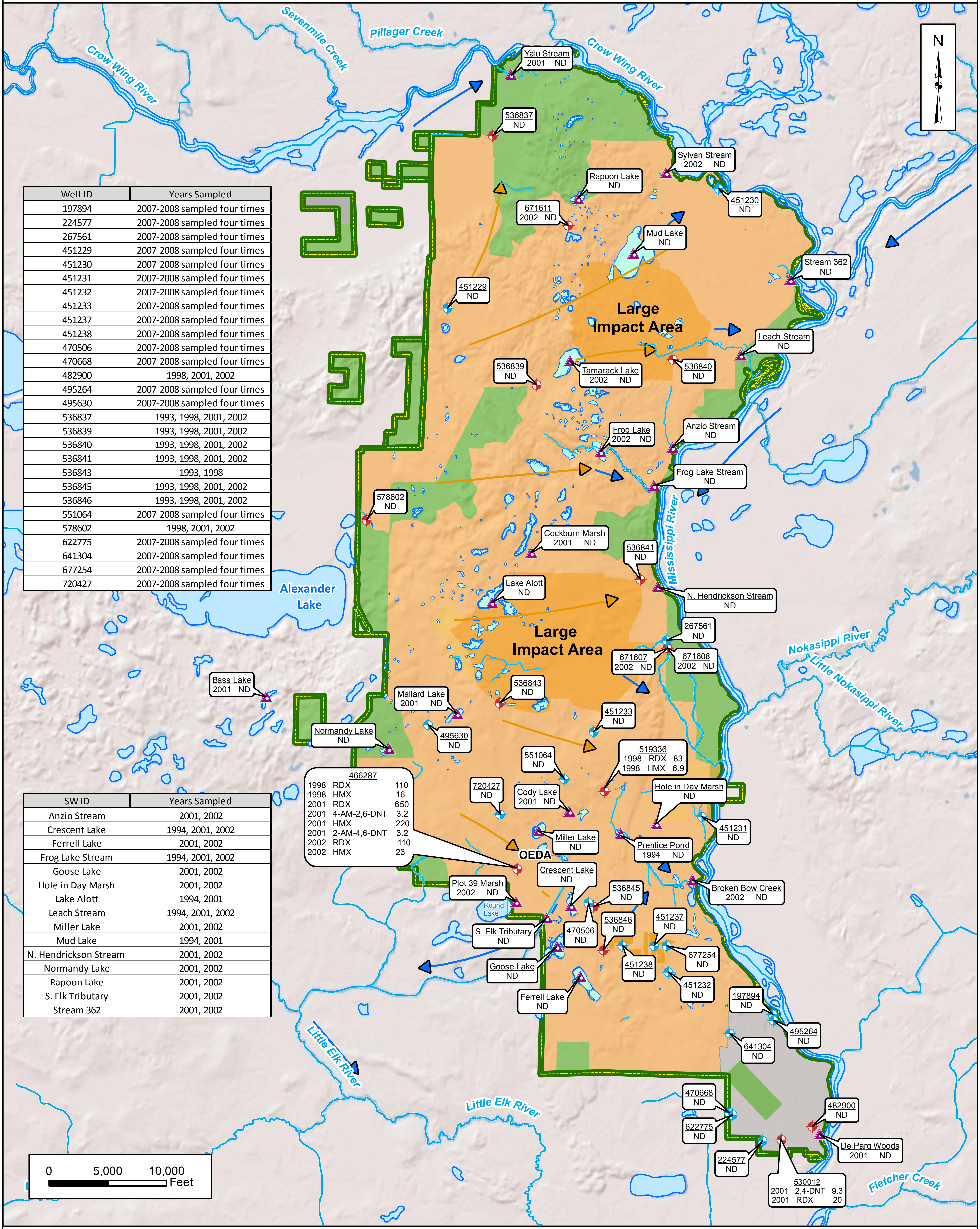
ORA Screening Values

- Cu PAL = (0.96) exp(0.8545 [ln (parts per million [ppm] hardness)] - 1.702)
- Pb PAL = {1.46203 - [ln (ppm hardness) (0.145712)]} exp(1.273 [ln (ppm hardness)] - 4.297)
- Zn PAL = exp(0.85 [ln (ppm hardness)] + 0.50)

Minnesota Screening Values

- Cu PAL = exp(0.620 [ln (parts per million [ppm] hardness)] - 0.570)
- Pb PAL = exp(1.273 [ln (ppm hardness)] - 4.705)
- Zn PAL = exp(0.8473 [ln (ppm hardness)] + 0.7615)

Figure 3-1
Explosives in Groundwater and Surface Water
Operational Range Assessment Phase II
Camp Ripley, MN



Well ID	Years Sampled
197894	2007-2008 sampled four times
224577	2007-2008 sampled four times
267561	2007-2008 sampled four times
451229	2007-2008 sampled four times
451230	2007-2008 sampled four times
451231	2007-2008 sampled four times
451232	2007-2008 sampled four times
451233	2007-2008 sampled four times
451237	2007-2008 sampled four times
451238	2007-2008 sampled four times
470506	2007-2008 sampled four times
470668	2007-2008 sampled four times
482900	1998, 2001, 2002
495264	2007-2008 sampled four times
495630	2007-2008 sampled four times
536837	1993, 1998, 2001, 2002
536839	1993, 1998, 2001, 2002
536840	1993, 1998, 2001, 2002
536841	1993, 1998, 2001, 2002
536843	1993, 1998
536845	1993, 1998, 2001, 2002
536846	1993, 1998, 2001, 2002
551064	2007-2008 sampled four times
578602	1998, 2001, 2002
622775	2007-2008 sampled four times
641304	2007-2008 sampled four times
677254	2007-2008 sampled four times
720427	2007-2008 sampled four times

SW ID	Years Sampled
Anzio Stream	2001, 2002
Crescent Lake	1994, 2001, 2002
Ferrell Lake	2001, 2002
Frog Lake Stream	1994, 2001, 2002
Goose Lake	2001, 2002
Hole in Day Marsh	2001, 2002
Lake Alott	1994, 2001
Leach Stream	1994, 2001, 2002
Miller Lake	2001, 2002
Mud Lake	1994, 2001
N. Hendrickson Stream	2001, 2002
Normandy Lake	2001, 2002
Rapoon Lake	2001, 2002
S. Elk Tributary	2001, 2002
Stream 362	2001, 2002

Installation

- ▭ Installation Boundary
- 🟩 Unlikely
- ▨ Inconclusive
- 🟧 Inconclusive (Impact Area)
- ▩ Non-Operational Area

Well/Sample Location

- ⊕ Monitoring Well
- ⊕ Production Well
- ▲ Surface Water
- ID / YEAR CHEMICAL RESULT — Positive Detection (µg/L)
- ID / ND — ND = Not Detected

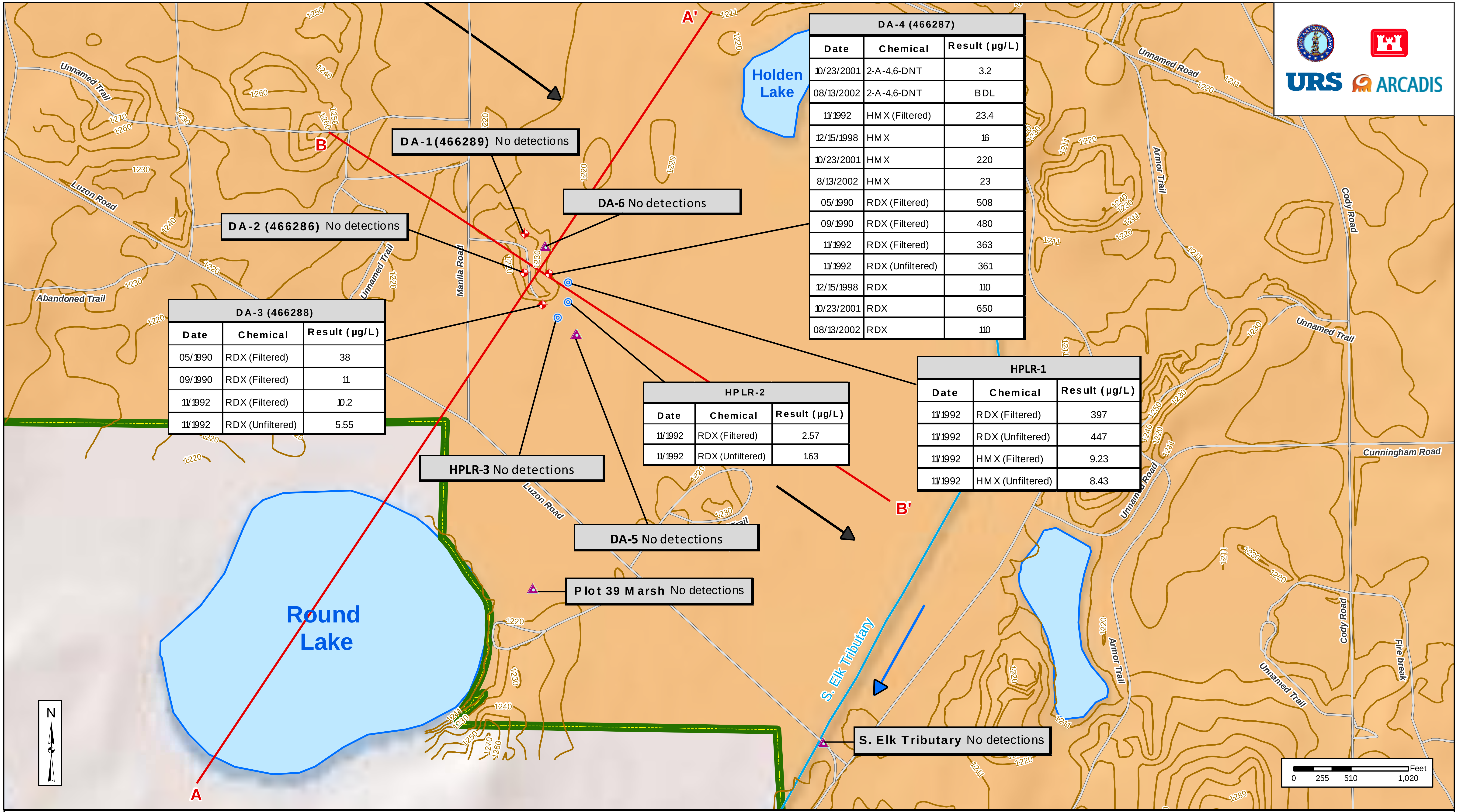
Hydrology

- ➤ Surface Water Flow
- ➤ Groundwater Flow
- River/Stream
- ▭ Water Body

Data Sources:
AEC, 2007
USACE, 2008
Shaded Relief:
ESRI ArcGIS Online and data partners

Date........................January 2013
Prepared by.............URS Group, Inc.
Prepared for............ARNG Directorate
Contract...................W912DR-09-D-0003/0006

Page Intentionally Left Blank



DA-3 (466288)

Date	Chemical	Result (µg/L)
05/1990	RDX (Filtered)	38
09/1990	RDX (Filtered)	11
11/1992	RDX (Filtered)	10.2
11/1992	RDX (Unfiltered)	5.55

DA-4 (466287)

Date	Chemical	Result (µg/L)
10/23/2001	2-A-4,6-DNT	3.2
08/13/2002	2-A-4,6-DNT	BDL
11/1992	HMX (Filtered)	23.4
12/15/1998	HMX	16
10/23/2001	HMX	220
8/13/2002	HMX	23
05/1990	RDX (Filtered)	508
09/1990	RDX (Filtered)	480
11/1992	RDX (Filtered)	363
11/1992	RDX (Unfiltered)	361
12/15/1998	RDX	110
10/23/2001	RDX	650
08/13/2002	RDX	110

HPLR-2

Date	Chemical	Result (µg/L)
11/1992	RDX (Filtered)	2.57
11/1992	RDX (Unfiltered)	163

HPLR-1

Date	Chemical	Result (µg/L)
11/1992	RDX (Filtered)	397
11/1992	RDX (Unfiltered)	447
11/1992	HMX (Filtered)	9.23
11/1992	HMX (Unfiltered)	8.43

Installation

- 🟩 Installation Boundary
- 🟧 Inconclusive

Sampling Location

- ⊕ Monitoring Well
- ◎ Direct-Push
- ▲ Surface Water

BDL - Below Detection Limit
µg/L - Micrograms per Liter

Hydrology and Topography

- ➤ Groundwater Flow (USAEHA, 1994)
- ➤ Surface Water Flow
- ∿ River/Stream
- ▭ Water Body
- ∧ Elevation Contour Line (feet)

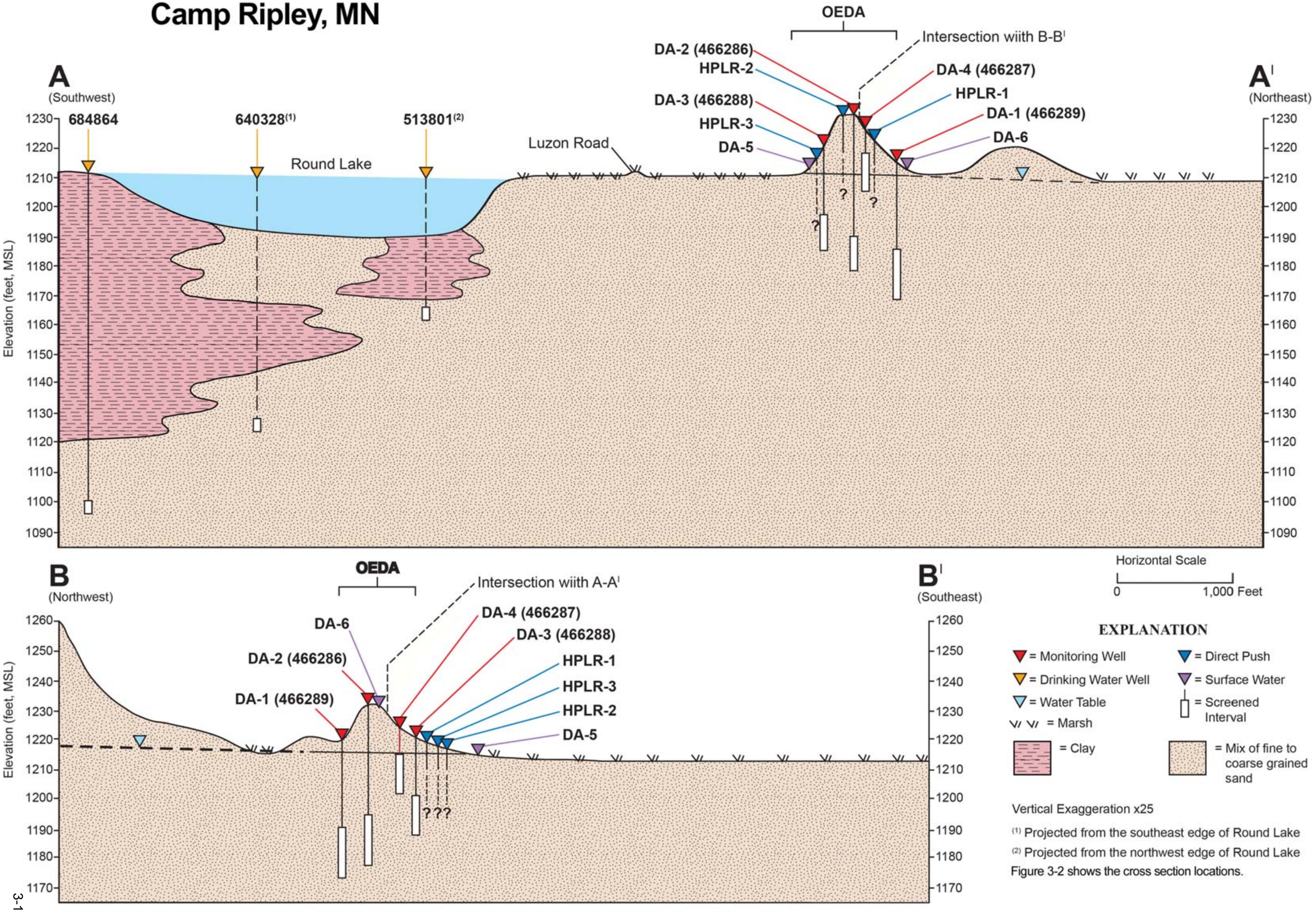
Figure 3-2
Old Engineer's Demo Area
Operational Range Assessment Phase II
Camp Ripley, MN

Data Sources:
AEC, 2007
USACE, 2008
Shaded Relief:
ESRI ArcGIS Online and data partners

Date........................January 2013
Prepared by.............URS Group, Inc.
Prepared for............ARNG Directorate
Contract..................W912DR-09-D-0003/0006

Page Intentionally Left Blank

Figure 3-3. OEDA Cross Sections A-AI and B-BI Camp Ripley, MN



Vertical Exaggeration x25

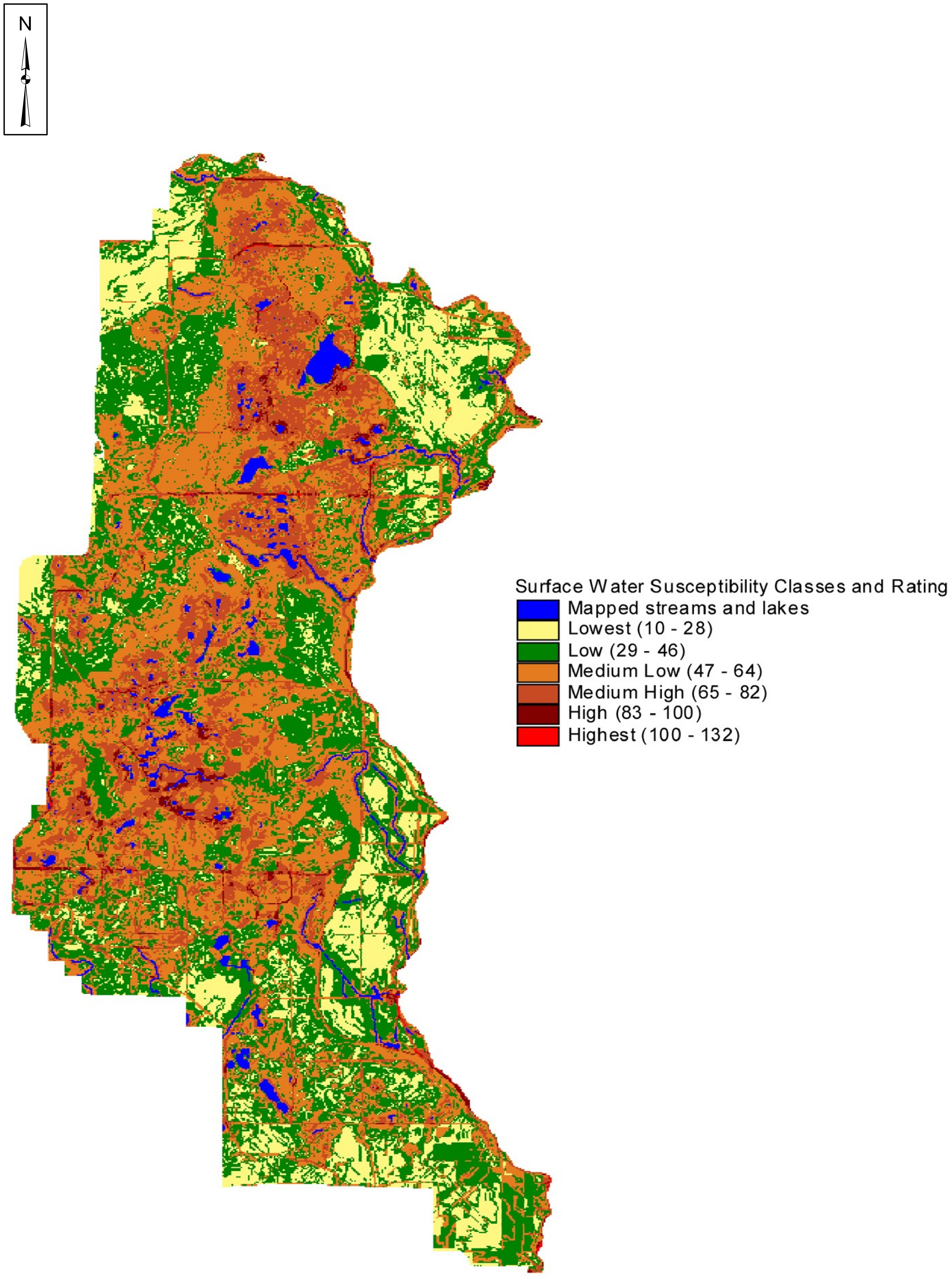
(1) Projected from the southeast edge of Round Lake

(2) Projected from the northwest edge of Round Lake

Figure 3-2 shows the cross section locations.

Page Intentionally Left Blank

Figure 3-4
Surface Water Susceptibility Map
Operational Range Assessment Phase II
Camp Ripley, MN

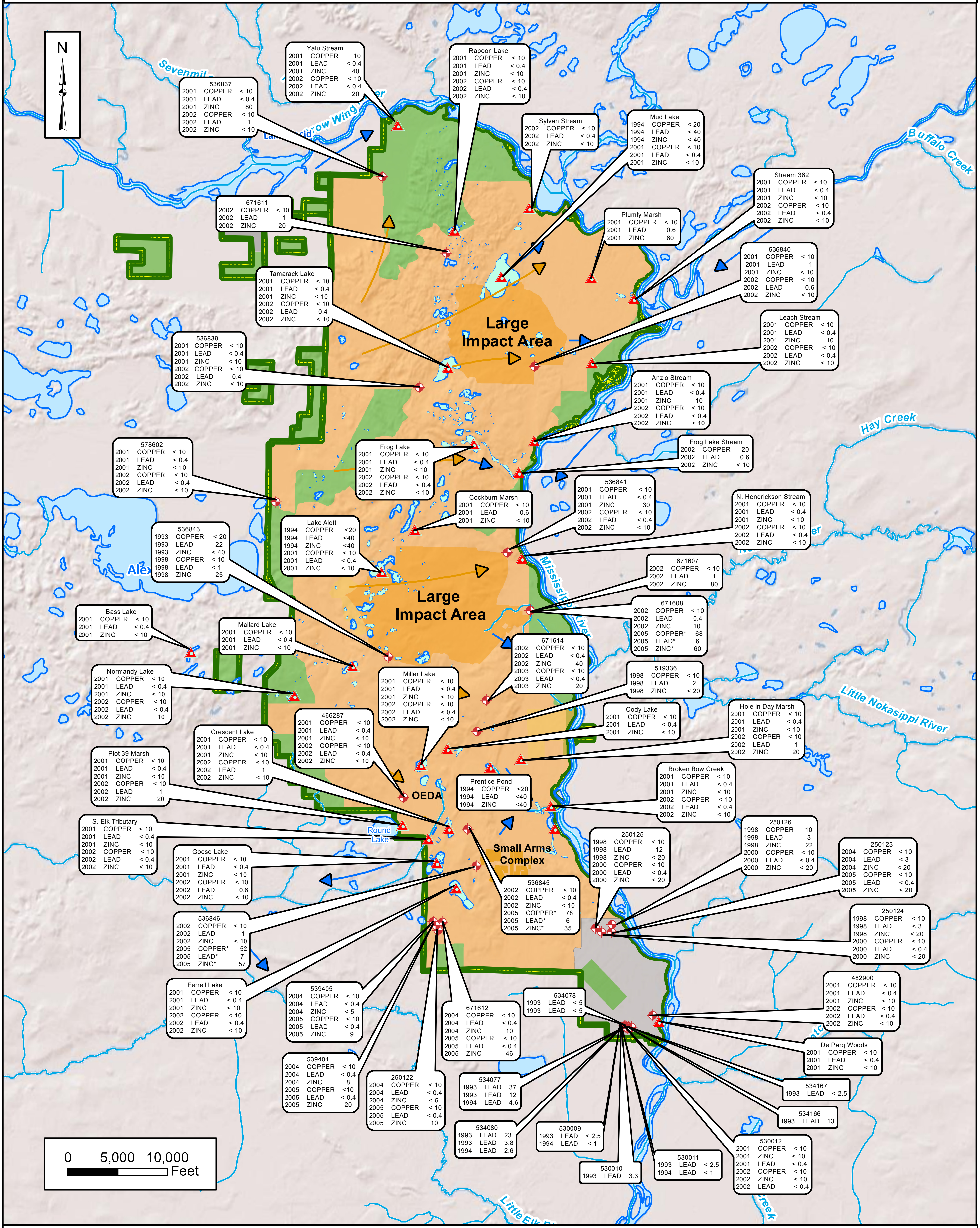


Data Sources:
UMD. n.d. Camp Ripley Aquifer Protection Plan.
Geological Sciences Department

Date........................January 2013
Prepared by............URS Group, Inc.

Page Intentionally Left Blank

Figure 3-5
Metals in Groundwater and Surface Water
Operational Range Assessment Phase II
Camp Ripley, MN



Installation

- 🟩 Installation Boundary
- 🟩 Unlikely
- 🟧 Inconclusive
- 🟧 Inconclusive (Impact Area)
- ⬜ Non-Operational Area

Well/Sample Location

- ⊕ Monitoring Well
- ▲ Surface Water Sample

ID YEAR CHEMICAL RESULT	Metals Data (µg/L)

** Field Analytical Method (HACHDR4000)*

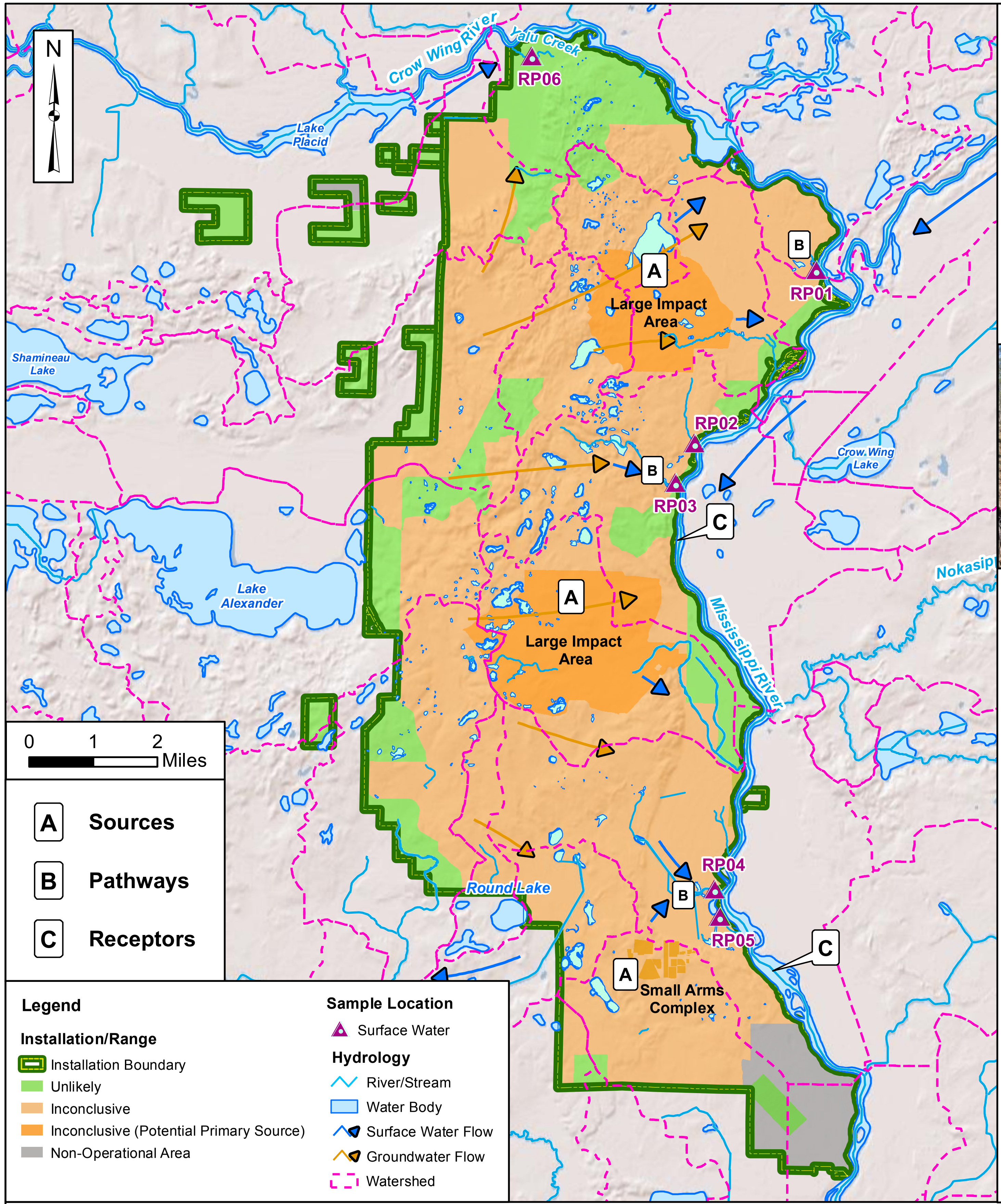
Hydrology

- Surface Water Flow
- Groundwater Flow
- River/Stream
- Water Body

Data Sources:
AEC, 2007
USACE, 2008
Shaded Relief:
ESRI ArcGIS Online and data partners

Date........................January 2013
Prepared by............URS Group, Inc.
Prepared for............ARNG Directorate
Contract..................W912DR-09-D-0003/0006

Page Intentionally Left Blank



B

Pathways

Potential source-area MCOC may migrate from operational areas via surface-water infiltration into shallow groundwater and subsequently discharge to off-range streams and wetlands.

These images, captured during the May 2011 site visit, are examples of the dominant flow paths found on the installation.

C

Receptors

Sensitive environments are present at and around Camp Ripley.

These environments are streams and wetlands that provide habitat for threatened and endangered species, which include the Blanding's turtle (pictured left), Gray wolf, Trumpeter swan, Tubercled rein-orchid, and Bog bluegrass.

This image (taken during the May 2011 site visit) shows a small tributary flowing off installation into the Mississippi River, which is the only off-operational range receptor location.

Pathway Cross-Section Schematic

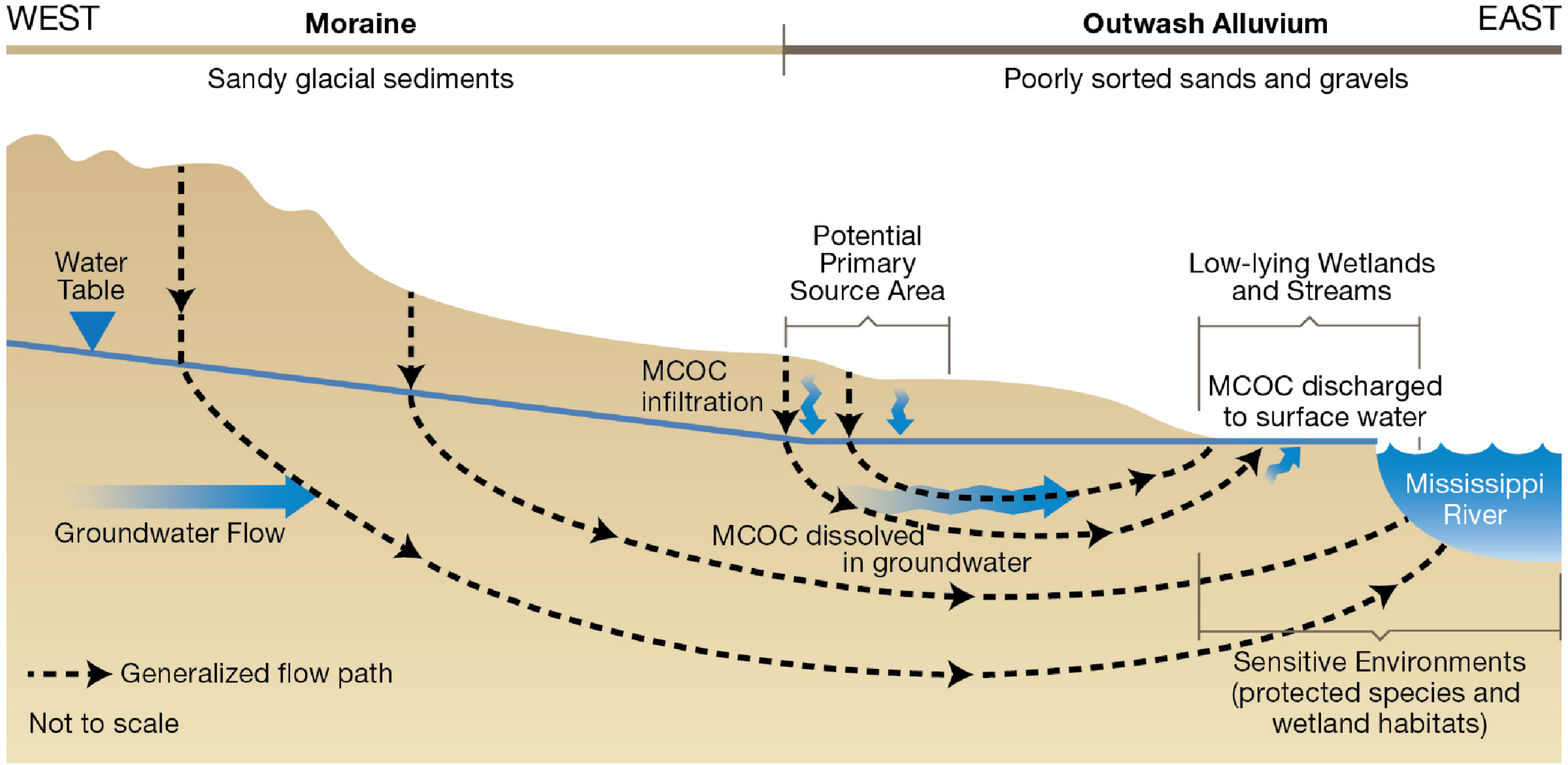


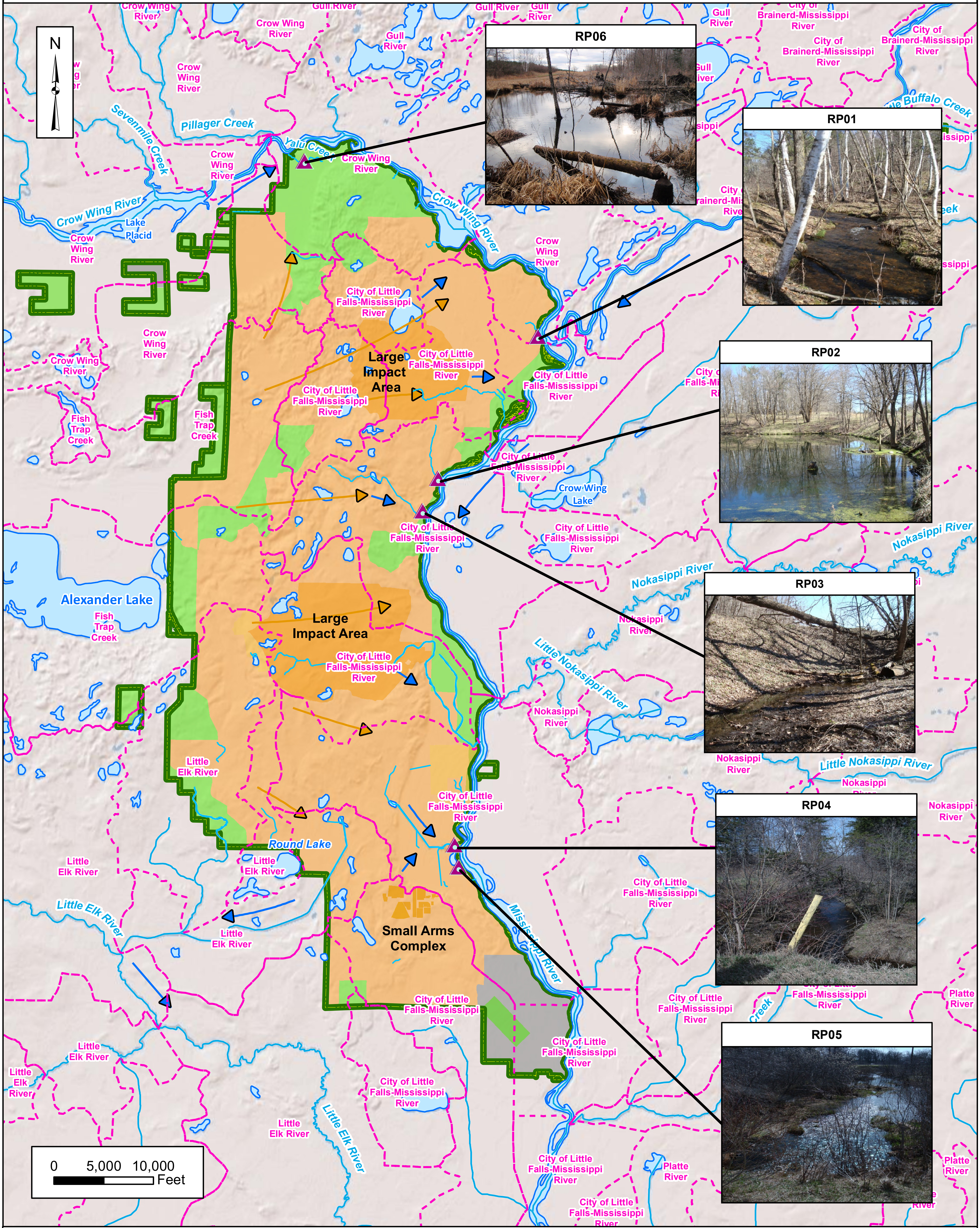
Figure 3-6
Conceptual Site Model
Operational Range Assessment Phase II
Camp Ripley, MN

Data Sources:
AEC, 2007
Minnesota DNR - Division of Waters - Watershed Delineation Project, 2009
Shaded Relief:
ESRI ArcGIS Online and data partners, 2009

Date.........................January 2013
Prepared by............URS Group, Inc.

Page Intentionally Left Blank

Figure 3-7
Phase II Sample Locations
Operational Range Assessment Phase II
Camp Ripley, MN



Legend

Installation/Range
- ▭ Installation Boundary
- 🟩 Unlikely
- 🟧 Inconclusive
- 🟧 Inconclusive (Potential Primary Source)
- ⬜ Non-Operational Area

Sample Location
- ▲ Surface Water

Hydrology
- ↗ Surface Water Flow
- ↗ Groundwater Flow
- River/Stream
- Water Body
- Watershed

Data Sources:
AEC, 2007

Shaded Relief:
ESRI ArcGIS Online and data partners, 2009

Date.........................January 2013
Prepared by............URS Group, Inc.

4 Methodology

Details on the sampling and analytical procedures, along with health and safety plans, are included in the PQAPP (URS/ARCADIS/Pirnie, 2012b); Camp Ripley Work Plan/ISQAPP (URS/ARCADIS/Pirnie, 2012c); and Accident Prevention Plan (APP) (URS/ARCADIS/Pirnie, 2012a). Field activities were conducted in accordance with the ISQAPP, including the Standard Operating Procedures (SOPs) contained in Appendix A of the Camp Ripley QAPP. Safety procedures used during sampling activities were in accordance with the APP.

4.1 Field Methods

In accordance with the ISQAPP, the following field method SOPs, were used for sample collection:

- S-1 Surface Water Sampling – Grab Sampling (describes grab samples)
- S-2 Surface Water Sampling – Composite (describes 24-hour composites)
- S-3 Surface Water Sampling – Clean Hands (describes all special handling)

Any modification to field procedures potentially affecting surface water data usability or quality required same-day approval from the Team Leader, the Project Manager, and the Project Quality Assurance (QA) Manager.

4.2 Sampling Methods

The Wet Season (High Flow) Mobilization occurred during sunny conditions (i.e., little to no precipitation) that reflected a first (and likely heavier) flush of MCOC concurrent with the spring thaw. As specified in **Table 4-1**, which summarizes the collection dates and times for each field sample, sampling occurred on 4 and 5 April 2012. Two 24-hour composite surface water samples were collected at all locations except at RP03. At that location, the stream was not flowing during sample collection. Pooled water was present in the streambed, and a grab sample was collected from the pooled water during each sampling event. After discussion with installation personnel, it was determined that the lack of flow was attributed to a beaver dam upstream and on range. It was also noted that any overflow would have been diverted into the stream where RP02 was located. **Appendix A** provides photographs of each sampling location.

Table 4-1: Dates and Times of Surface Water Sampling

Wet Season (High Flow) Mobilization		
Location	**WA**	**WB**
RP01	4/5/2012; 1240	4/4/2012; 1245
RP02	4/5/2012; 1200	4/4/2012; 0935
RP03	4/5/2012; 1440	4/4/2012; 1615
RP04	4/5/2012; 0940	4/4/2012; 1030
RP05	4/5/2012; 1125	4/4/2012; 1120
RP06	4/5/2012; 1400	4/4/2012; 1330

WA = Wet “A” Event; WB = Wet “B” Event

Based on the hardness data from previous investigations at Camp Ripley and the associated very low screening values for metals used to assess ecological risk, Phase II sampling protocol called for use of the "clean hands/dirty hands" method. Sampling procedures for USEPA Method 1669 – *Sampling Ambient Water for Trace Metals at EPA Water Quality Criteria Levels* (USEPA, 1996) were used to deploy the sample setup and collection at all locations.

Each sample bottle was appropriately labeled using indelible ink and secured in a shipping cooler. Each sample was entered on the COC form with the required analyses. The COC forms are included in **Appendix B**. Each cooler was sealed with the COC inside; custody seals were signed, dated, and placed on opposite corners of the cooler; and the coolers were shipped overnight to the analytical laboratories.

As described in Section 3.3.3, hardness values measured during Phase II sampling were higher than anticipated. While using the "clean hands/dirty hands" method was unnecessary for the laboratory analysis to reach the PALs, there were no negative effects on the results.

4.2.1 Composite Surface Water Sampling

Each composite sample was collected using an Isco 6712 Full-Size Portable Sampler programmed to collect 96 discrete samples over a 24-hour period. The composites were collected in 1-gallon, laboratory-certified clean carboys. All carboys were kept on ice to maintain a temperature of 4 degrees Celsius (°C), plus or minus 2°C, during sampling and until transfer to laboratory-cleaned sampling containers. The field team filtered and collected the samples from each carboy within 48 hours of the start of sample collection.

Field measurements of pH, temperature, dissolved oxygen, turbidity, and specific conductivity were taken at the time of sample collection. A tabulated summary of field parameters is included in **Table B-1** (**Appendix B**).

4.2.2 Grab Surface Water Sampling

At RP03, grab samples were collected directly from the pooled water with ultraclean certified tubing using the clean hands procedures. To prevent contamination, the field team members did not stand in the water while holding the tubing in place for sample collection. Tubing was placed approximately 2/3 up from the bottom of the pooled water throughout sample collection, and field members were careful not to disturb bottom sediments. Prior to collecting samples, approximately 200 milliliters of water was pumped through the tubing and filter and returned to the dry portion of the streambed, downstream of the collection site. Laboratory bottles were filled directly from the tube and filter. Field measurements and sample handling were conducted in the same manner previously described.

4.3 Quality Assurance / Quality Control

Quality Assurance/Quality Control (QA/QC) samples were collected to evaluate the field collection methods and laboratory analytical techniques for surface water samples. The QA/QC samples consisted of duplicate samples, matrix spike/matrix spike duplicate (MS/MSD) samples, and equipment blanks.

4.3.1 Duplicates

Duplicate surface water samples were collected at a rate of at least 1 per 10 samples. Duplicates were collocated samples from two side-by-side Isco samplers and carboy setups. The sample collection tubes from both samplers were attached to a single wooden stake in the center of the stream channel. Duplicate samples were collected simultaneously from the same source under identical conditions, submitted to the laboratory as indistinguishable samples, and labeled accordingly.

4.3.2 Matrix Spike/Matrix Spike Duplicates

MS/MSD samples were collected at a rate of 5 percent. Additional water volume was not needed for metals and hardness MS/MSD analysis in surface water. Sub-samples were pulled from the parent sample by the analytical laboratory.

4.3.3 Equipment Blanks

Equipment blanks were collected at a minimum rate of 5 percent. Using the "clean hands/dirty hands" method, the equipment blank was collected using the entire Isco, carboy sampling train and peristaltic pump sample collection train. Approximately 4 liters of clean deionized (DI) water were pumped through the system and into the carboy. Approximately 100 milliliters of DI water were then pumped from the carboy to purge the transfer pump tubing and 0.45-micron filter. Once the transfer tubing and filter were purged, the equipment blank was collected.

4.4 Investigation-Derived Waste

No hazardous or otherwise contaminated wastes resulted from the collection of the surface water samples.

4.5 Sample Identification

Samples collected were identified using the procedures detailed in the PQAPP. Each sample was labeled with a seven-character identification that consisted of a two-character installation identifier, two-character matrix code, two-character location code, one-character mobilization code, and a one-character sampling event code. Each component of the sample identification is described in the two examples below:

RPSW01WA and RPSW01WB

Where:

RP = Two-character installation identifier for Camp Ripley
SW = Two-character matrix code for surface water
= Two-character location number
W = Mobilization code for the wet season
A or B = Sampling event code

Unique sequential sample numbers began with 01. QC samples (e.g., duplicates and equipment blanks) received unique sequential sample numbers and were not identified as QC samples on the laboratory COC. The samples collected used the unique sequential sample numbers shown in **Table 4-2**.

Table 4-2: Naming Convention for QC Sample Identification

Sampling Code	Identification Number	QC Sample
RPSW01WA/WB-	01	Parent Sample
	02	Duplicate Sample
	03	Equipment Blank

4.6 Unexploded Ordnance Avoidance

Access to sampling areas was coordinated and approved by Range Control. An unexploded ordnance technician performed a visual and instrument-assisted (e.g., Schonstedt) survey of access pathways to sample locations prior to the start of field work. Access routes deemed safe for travel were clearly communicated to field teams. No anomalies were identified.

5 Surface Water System Analyses

5.1 Laboratory Analytical Methods

Surface water samples were submitted to DoD Environmental Laboratory Approval Program-certified laboratories (Accutest and Brooks Rand laboratories) for analysis. The following analytical methods were used for media-specific surface water analysis:

- Munitions-related dissolved metals by USEPA Method 1638 [Brooks Rand Laboratories]
- Dissolved metals needed for the BLM[4] by USEPA Method 6020A [Accutest]
- Anions (sulfate and chloride) for BLM by USEPA Method 300.0 [Accutest]
- Alkalinity for BLM by Standard Method 2320B [Accutest]
- Hardness by method SM 2340B [Accutest]

These analytical methods for MCOC achieve the project quantitation limits of at least one-third, and in most cases one-tenth, of the PALs. Therefore, in the evaluation of analytical data in Section 6, statements about “non-detect” results mean that a chemical was not detected above the laboratory detection limit. Tabulated results for all analyses appear in **Appendix C**.

5.2 Data Validation

A Tier III Data Validation Report was prepared for each Sample Delivery Group as assigned by the laboratory and is included in **Appendix D** of this report. The procedure used information from the PQAPP, ISQAPP, and DoD Quality Systems Manual to define the method quality objectives. The outlier data were qualified according to protocols defined in the USEPA Region V Modifications to the National Functional Guidelines for Organic (September 1994) and Inorganic (April 1993) Data Review (1994).

When issues were identified during the data validation, letter qualifiers were applied to the data to ensure reported concentrations were accurately represented. Inclusion or exclusion of data for further analysis was based on review of analytical qualifiers and performed in accordance with USEPA Region V Modifications to the National Functional Guidelines for Organic (September 1994) and Inorganic (April 1993) Data Review (1994):

- Analytical results bearing the U qualifier (indicating that the analyte was not detected at the Limit of Detection [LOD]) were retained in the data set and considered non-detects. U qualifiers were also assigned to sample concentrations that were less than 5 times the concentrations observed in associated laboratory and field blanks. When samples were U qualified based on blank contamination and the concentration was less than the LOD, the detected concentration was elevated to the LOD. When samples were U qualified based on blank contamination and the detected concentration was greater than the LOD, the detected concentration became the new LOD. If the LOD was elevated above the Limit of Quantitation (LOQ), the LOQ was also elevated.

---

[4] The BLM is a calculation of water quality criteria for copper and lead that accounts for these various water quality parameters.

- Analytical results bearing the J qualifier (indicating that the reported value was estimated because of minor anomalies with the method quality objectives) were retained at the measured concentration.
- Analytical results bearing the B qualifier (indicating that the analyte was detected by the instrument and the result is above the method detection limit [MDL] but less than or equal to the method reporting limit [MRL]) were retained at the measured concentration.
- No data results bear the R qualifier (indicating rejected data points); thus, no data were excluded.

5.3 Data Analysis

Each sample result was compared directly to the PAL for all MCOC parameters examined. The weight-of-evidence approach used in the assessment helped control decision errors. MCOC concentrations from all sample results, general water quality parameters, and site conditions were taken into account to ensure that additional information did not indicate that MCOC conclusions may be in error.

6 Surface Water System Results

This section presents and evaluates surface water data for the metals MCOC in surface water at Camp Ripley. These data answer the one remaining question established in the CSM: Are metals MCOC migrating off range at levels that could cause ecological risks during spring thaw conditions? Relevant data include historical data, which were presented in Sections 2.2 and 3.1.2, and those collected in during Phase II. Phase II results are discussed first and this is followed by a comprehensive evaluation of all metals data.

6.1 Phase II Surface Water Results

Two rounds of data from the five sample locations downstream of the operational footprint were compared to the PALs and to reference concentrations (RP06). The reference sample was used to establish metals concentrations that may be naturally occurring or influenced by non-operational or off-installation activities.

All four metals MCOC were detected at least once in the surface water samples. However, none exceeded PALs. **Table 6-1** presents the maximum concentration of each analyte, the corresponding sample location, and the PALs.

Table 6-1: Sample Locations of Maximum Metals MCOC Concentrations

Analyte	Sample Location of Maximum Concentration	Maximum Concentration (µg/L)	PAL (µg/L)
Antimony	RP05	0.059	5.5
Copper	RP04	10.8	15.1
Lead	RP02 RP06	0.058 0.058	3.1 2.7
Zinc	RP04	7.99 J	190

µg/L – micrograms per liter; J – estimated result

MCOC results are summarized in **Tables 6-2** through **6-7** and on **Figure 6-1**. Complete surface water analytical summary tables are provided in **Appendix C**. Data usability reports are in **Appendix D.**

Very low levels of antimony (less than 0.1 µg/L) were reported in every sample.

Copper and zinc were reported at low levels in most samples. However, small amounts of these metals were also detected in the equipment blank. Thus, any detection within five times the equipment blank concentration was considered to be a non-detect (see **Appendix D**). All detections and revised detection limits are below PALs.

Lead, the primary component of small arms munitions, was reported in most samples at low concentrations significantly below PALs.

Water quality parameters measured in the field (e.g., pH, temperature) are summarized in **Table B-1** (**Appendix B**). These data were generally consistent between samples and sampling events. Because the water at sampling location RP03 was not flowing, the temperature at RP03 was higher than at other locations during both events.

Because metals MCOC do not appear to be migrating from the operational footprint at levels above reference or PALs, running the BLM was not necessary.

6.2 Phase II and Historical Data

All antimony results were either below detection limits or detected at less than 0.1 µg/L, which is significantly below the PAL of 5.5 µg/L.

Histograms of copper, lead, and zinc are shown in **Figures 6-2** through **6-4**. These figures chart the frequency of historical and Phase II metals detections at various concentrations. Detections are color coded by the period in which the samples were collected (i.e., historical data or Phase II data). The distinction between a reference sample and downstream sample is also indicated. The Phase II reference sample was collected from Yalu Creek (RP06). Historical samples were collected from a similar sample location identified as Yalu Stream. Therefore, these samples were considered representative of reference conditions.

Copper was detected during Phase II in only one sample (RP04) at a concentration of 10.8 µg/L, which is below the PAL of 15.1 µg/L. Only two historical copper concentrations exceed PALs (**Figure 6-2**). Copper was detected in Frog Lake Stream at a concentration of 20 µg/L, exceeding the associated PAL of 10.6 µg/L. The results collected from the coinciding Phase II location RP03 (10.2 and 4.29 µg/L) did not exceed the PAL. The other exceedence (10 µg/L) was detected in the reference location, Yalu Stream, and exceeded the associated PAL of 9.5 µg/L. This location was resampled in 2002 and copper was below the detection limit. Other than the two detections, all other historical copper data, which were collected primarily in the interior of the installation and generally in closer proximity to the source areas than the Phase II sample locations, were all below detection limits.

Lead concentrations are all below the minimum PAL of 2.7 µg/L, ranging from below detection limit to 1 µg/L (Figure 6-3). The maximum concentration detected at Camp Ripley during Phase II was 0.058 µg/L. It was detected at this level in samples collected from both the reference location (RP06) and a downstream sample location (RP02). Lead was only detected in one historical sampling location that coincides with a Phase II location. This was in Frog Lake Stream at a concentration of 0.6 µg/L.

Historical and Phase II maximum lead and copper detections were not detected in the same samples or even within the same subwatershed. The maximum lead concentrations were found in southern portion of the installation (historical data) and at RP02 and RP06 (Phase II). The maximum copper concentrations were found in Frog Lake Stream (historical data) and at RP04 (Phase II). This indicates metal detections are not range related because these metals typically occur together in small arms munitions.

All zinc concentrations are significantly below the minimum PAL of 112 µg/L (Figure 6-4). The maximum zinc concentration, a historical result of 60 µg/L, was detected at Plumly Marsh. Two of the six other historical zinc detections were from the reference location (Yalu Stream) at concentrations of 20 and 40 µg/L. In comparison, Phase II reference results were estimated values of 2.21 and 3.26 µg/L at this location. Of the remaining Phase II locations and the coinciding historical locations, zinc was either detected at a low, estimated value or was below detection limits except in Frog Lake Stream (coinciding with Phase II location RP02) in 2002 at 10 µg/L.

Table 6-2: Surface Water Sampling Results – RP01

Sample Event		**Location RP01 - Wet Season**							
Sample Identification		**RPSW01WA01**				**RPSW01WB01**			
Sample Date		**4/5/2011**				**4/4/2011**			
Analyte		**Result**	**Laboratory Qualifier**	**Data Validation Flag**	**Reason Code**	**Result**	**Laboratory Qualifier**	**Data Validation Flag**	**Reason Code**
Metals (µg/L)	**PAL**								
ANTIMONY (Sb)	5.5	0.018	B			0.025			
COPPER (Cu)	15	4.93	U	U	x	9.11	U	U	x
LEAD (Pb)	5.2	0.008	B			0.013	B		
ZINC (Zn)	189	5.05	U	U	x	5.93	J	J	x

Note: Laboratory Qualifier /Data Validation Flag/Reason Code key at end of Table 6-7

Table 6-3: Surface Water Sampling Results – RP02

Sample Event		**Location RP02 - Wet Season**							
Sample Identification		**RPSW02WA01**				**RPSW02WB01**			
Sample Date		**4/5/2011**				**4/4/2011**			
Analyte		**Result**	**Laboratory Qualifier**	**Data Validation Flag**	**Reason Code**	**Result**	**Laboratory Qualifier**	**Data Validation Flag**	**Reason Code**
Metals (µg/L)	**PAL**								
ANTIMONY (Sb)	5.5	0.012	B			0.01	B		
COPPER (Cu)	10.6	4.98	U	U	x	0.946	U	U	x
LEAD (Pb)	3.10	0.058				0.007	B		
ZINC (Zn)	125	4.68	U	U	x	1.14	U	U	x

Note: Laboratory Qualifier /Data Validation Flag/Reason Code key at end of Table 6-7

Table 6-4: Surface Water Sampling Results – RP03

Sample Event		Location RP03 - Wet Season							
Sample Identification		**RPSW03WA01**				**RPSW03WB01**			
Sample Date		**4/5/2011**				**4/4/2011**			
Analyte		**Result**	**Laboratory Qualifier**	**Data Validation Flag**	**Reason Code**	**Result**	**Laboratory Qualifier**	**Data Validation Flag**	**Reason Code**
Metals (µg/L)	**PAL**								
ANTIMONY (Sb)	5.5	0.013	B			0.013	B		
COPPER (Cu)	10.6	10.2	U	U	x	4.29	U	U	x
LEAD (Pb)	3.10	0.026				0.008	B		
ZINC (Zn)	125	6.34	J	J	x	4.01	U	U	x

Note: Laboratory Qualifier /Data Validation Flag/Reason Code key at end of Table 6-7

Table 6-5: Surface Water Sampling Results – RP04

Sample Event		Location RP04 - Wet Season							
Sample Identification		**RPSW04WA01**				**RPSW04WB01**			
Sample Date		**4/5/2011**				**4/4/2011**			
Analyte		**Result**	**Laboratory Qualifier**	**Data Validation Flag**	**Reason Code**	**Result**	**Laboratory Qualifier**	**Data Validation Flag**	**Reason Code**
Metals (µg/L)	**PAL**								
ANTIMONY (Sb)	5.5	0.05				0.049			
COPPER (Cu)	15.1	10.8		J	x	4.64	U	U	x
LEAD (Pb)	5.3	0.023	B			0.008	B		
ZINC (Zn)	190	7.99	J	J	x	3.4	U	U	x

Note: Laboratory Qualifier /Data Validation Flag/Reason Code key at end of Table 6-7

Table 6-6: Surface Water Sampling Results – RP05

Sample Event		Location RP05 - Wet Season							
Sample Identification		**RPSW05WA01**				**RPSW05WB01**			
Sample Date		**4/5/2011**				**4/4/2011**			
Analyte		**Result**	**Laboratory Qualifier**	**Data Validation Flag**	**Reason Code**	**Result**	**Laboratory Qualifier**	**Data Validation Flag**	**Reason Code**
Metals (µg/L)	**PAL**								
ANTIMONY (Sb)	5.5	0.059				0.057			
COPPER (Cu)	15.1	0.318	U	U	x	1.07	U	U	x
LEAD (Pb)	5.3	0.01	U			0.01	U		
ZINC (Zn)	190	0.51	U	U	x	0.7	U	U	x

Note: Laboratory Qualifier /Data Validation Flag/Reason Code key at end of Table 6-7

Table 6-7: Surface Water Sampling Results – RP06

Sample Event		Location RP06 - Wet Season							
Sample Identification		**RPSW06WA01**				**RPSW06WB01**			
Sample Date		**4/5/2011**				**4/4/2011**			
Analyte		**Result**	**Laboratory Qualifier**	**Data Validation Flag**	**Reason Code**	**Result**	**Laboratory Qualifier**	**Data Validation Flag**	**Reason Code**
Metals (µg/L)	**PAL**								
ANTIMONY (Sb)	5.5	0.036				0.032			
COPPER (Cu)	9.5	0.747	U	U	x	4.17	U	U	x
LEAD (Pb)	2.70	0.058				0.017	B		
ZINC (Zn)	112	2.21	U	U	x	3.26	U	U	x

Laboratory Qualifiers

B – The result is above the MDL but less than or equal to the MRL. Result is reported but is considered to be an estimate

U – Result is < the MDL) or client-requested reporting limit (CRRL). Result reported as the MDL or CRRL

Data Validation Flag

J – The numerical value is estimated

U – The analyte was analyzed for, but not detected

Reason Code

x – Field blank contamination

As shown in **Figures 6-2** through **6-4**, there is generally good agreement between the historical data and the Phase II data. All lead and zinc data are below PALs. There are only a couple minor copper exceedences.

6.3 Uncertainty

Several factors may contribute to the uncertainty of the data evaluation. Each factor is described below.

Minor amounts of copper and zinc were detected in the equipment blank (see below). Thus, there is some uncertainty regarding the validity of low detections of these metals in the field samples and the results were qualified during data review. However, analyte concentrations and LODs are significantly below the PALs; therefore, the detection of copper and zinc in the equipment blank does not affect data interpretation with respect to those MCOC.

Equipment Blank Metals Results

	Analytical Result (µg/L)			
Sample Identification	**Copper**	**Lead**	**Zinc**	**Antimony**
RPSW04WA03	2.10	Not detected	1.09 J	Not detected

µg/L – micrograms per liter; J – The numerical value is estimated

Camp Ripley and the region in general experienced a mild winter, resulting in less snowfall and an earlier snowmelt than anticipated. Based on local weather forecasts and communication with installation personnel, the sampling schedule was moved up to the first week of April, the earliest possible week the field team could mobilize to the site. The milder winter likely resulted in a less heavy “first flush” condition than would be experienced during a more normal winter. However, the timing of the sampling event was near ideal, as patches of snow were still present the last week of March.

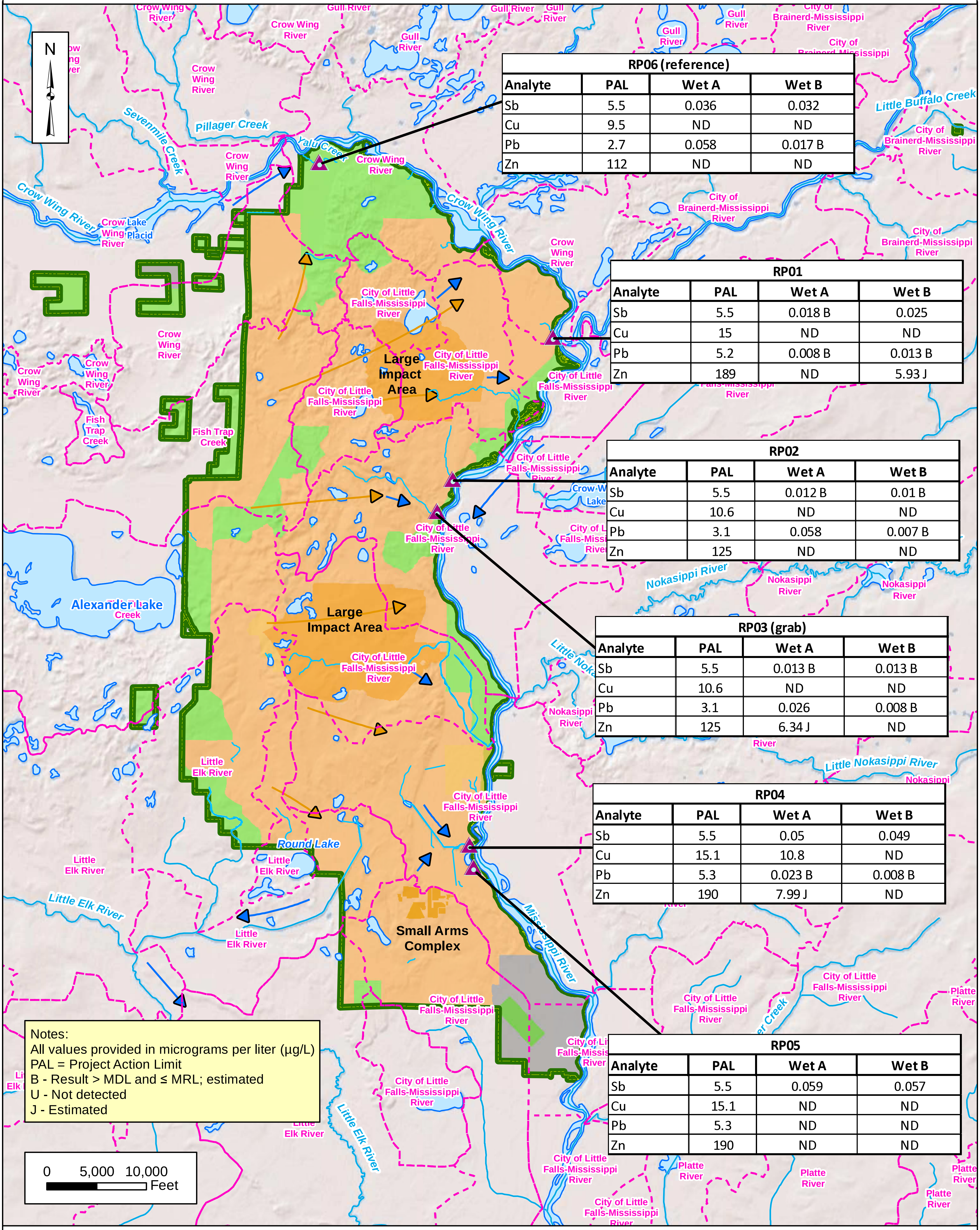
The effect of “first flush” infiltration on MCOC concentrations is complicated because there are competing factors that could either increase or decrease MCOC concentrations at the sampling locations. Snow on the ranges may increase contact time with MCOC at source areas and high infiltration rates during the spring thaw could boost MCOC concentrations in shallow groundwater, which then discharge to surface streams. However, increased infiltration occurs across the entire installation, even in non-source areas (which are much more extensive than the source areas), and could result in significant dilution of MCOC at the downstream discharge points.

Another factor possibly affecting MCOC concentrations in surface water is the potential for the ground to be frozen during “first flush” conditions. If frozen, runoff, rather than infiltration/discharge would be the dominant although temporary transport mechanism.

As described in Section 4.2, grab samples were collected from pooled water at location RP03 because the stream was not flowing during sample collection. A beaver dam upstream and on range diverted overflow into the stream where RP02 is located. The temperature of the pooled water at location RP03 was elevated relative to the temperature of water at all other sample locations, but all other field parameters at RP03 fell within the ranges seen at the other locations (**Table B-1**; **Appendix B**). While the method of sampling at location RP03 was different and temperatures were elevated, metals MCOC results from location RP03 are generally consistent with results from RP02, which is within the same subwatershed, and with other sample results. Hardness values at location RP03 are lower compared to the other downstream sample locations. At RP03, the hardness values were 122 and 128 mg/L, while hardness values at RP01, RP02, RP04, and RP05 were between 181 and 203 mg/L.

Because the Phase II data review and investigation focused on only two seasonal conditions (low flow and first snowmelt), the findings of this Phase II are based on a limited amount of data and do not represent a complete annual cycle of conditions. However, by evaluating data from seasonal extremes, the data collected are considered to be representative of the range of surface water system conditions.

Figure 6-1
Phase II Findings
Operational Range Assessment Phase II
Camp Ripley, MN



RP06 (reference)

Analyte	PAL	Wet A	Wet B
Sb	5.5	0.036	0.032
Cu	9.5	ND	ND
Pb	2.7	0.058	0.017 B
Zn	112	ND	ND

RP01

Analyte	PAL	Wet A	Wet B
Sb	5.5	0.018 B	0.025
Cu	15	ND	ND
Pb	5.2	0.008 B	0.013 B
Zn	189	ND	5.93 J

RP02

Analyte	PAL	Wet A	Wet B
Sb	5.5	0.012 B	0.01 B
Cu	10.6	ND	ND
Pb	3.1	0.058	0.007 B
Zn	125	ND	ND

RP03 (grab)

Analyte	PAL	Wet A	Wet B
Sb	5.5	0.013 B	0.013 B
Cu	10.6	ND	ND
Pb	3.1	0.026	0.008 B
Zn	125	6.34 J	ND

RP04

Analyte	PAL	Wet A	Wet B
Sb	5.5	0.05	0.049
Cu	15.1	10.8	ND
Pb	5.3	0.023 B	0.008 B
Zn	190	7.99 J	ND

RP05

Analyte	PAL	Wet A	Wet B
Sb	5.5	0.059	0.057
Cu	15.1	ND	ND
Pb	5.3	ND	ND
Zn	190	ND	ND

Notes:
All values provided in micrograms per liter (µg/L)
PAL = Project Action Limit
B - Result > MDL and ≤ MRL; estimated
U - Not detected
J - Estimated

Legend

Installation/Range
- ▭ Installation Boundary
- 🟩 Unlikely
- ▨ Inconclusive
- 🟧 Inconclusive (Potential Primary Source)
- ▩ Non-Operational Area

Sample Location
- ▲ Surface Water

Hydrology
- ▶ Surface Water Flow
- ▷ Groundwater Flow
- ∕ River/Stream
- ▭ Water Body
- ⬚ Watershed

Data Sources:
AEC, 2007

Shaded Relief:
ESRI ArcGIS Online and data partners, 2009

Date.........................January 2013
Prepared by............URS Group, Inc.

Page Intentionally Left Blank

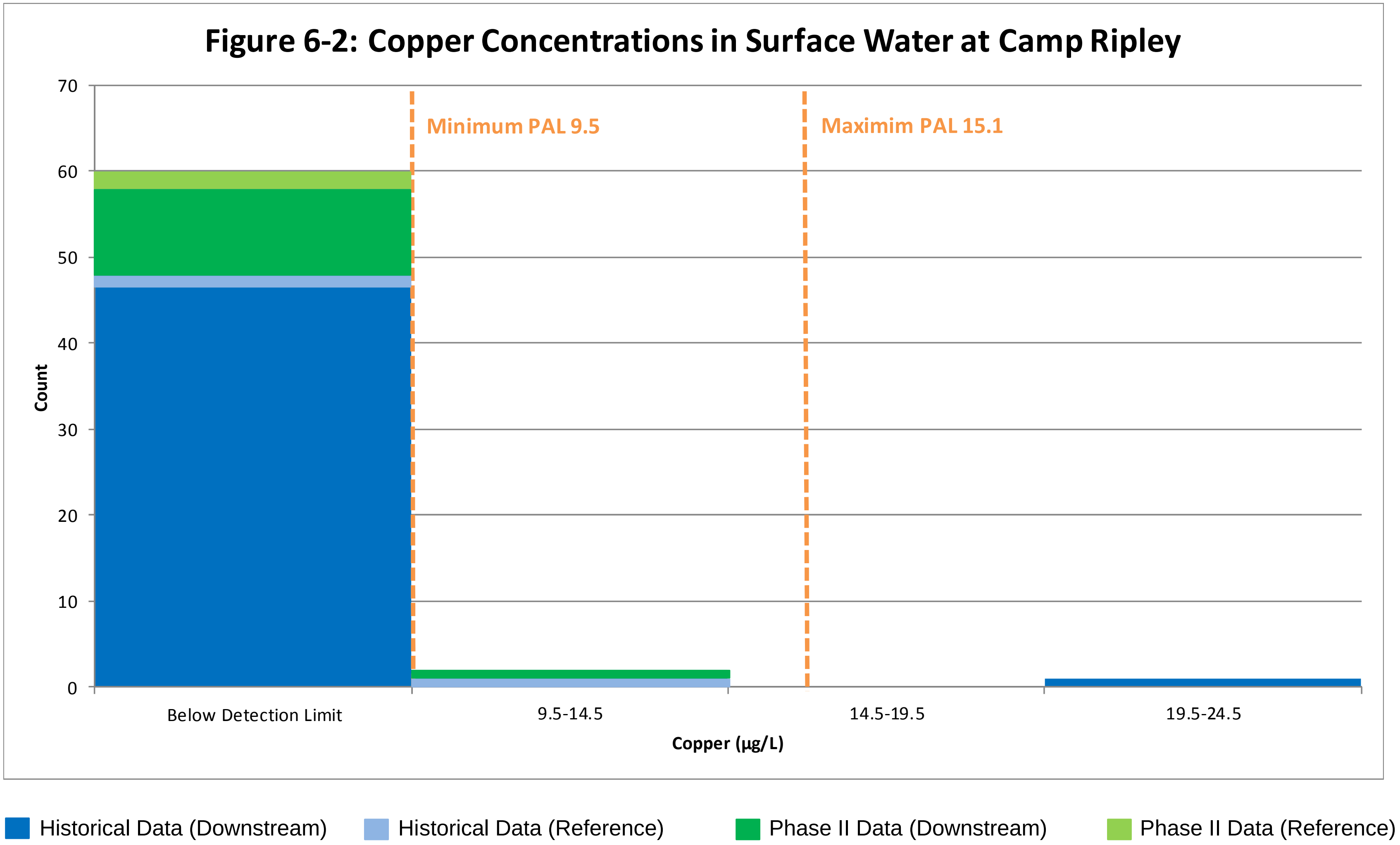


Figure 6-2: Copper Concentrations in Surface Water at Camp Ripley

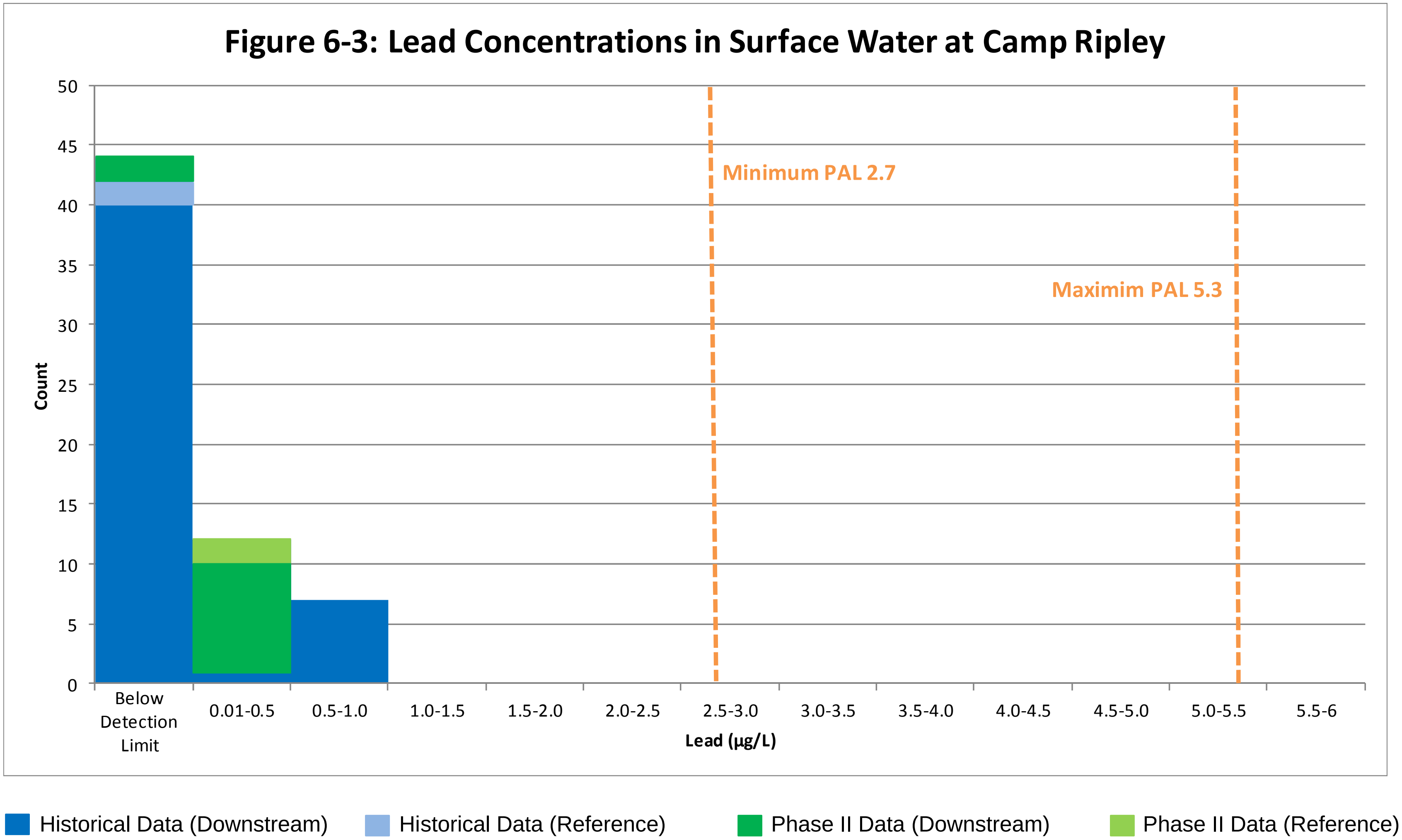


Figure 6-3: Lead Concentrations in Surface Water at Camp Ripley

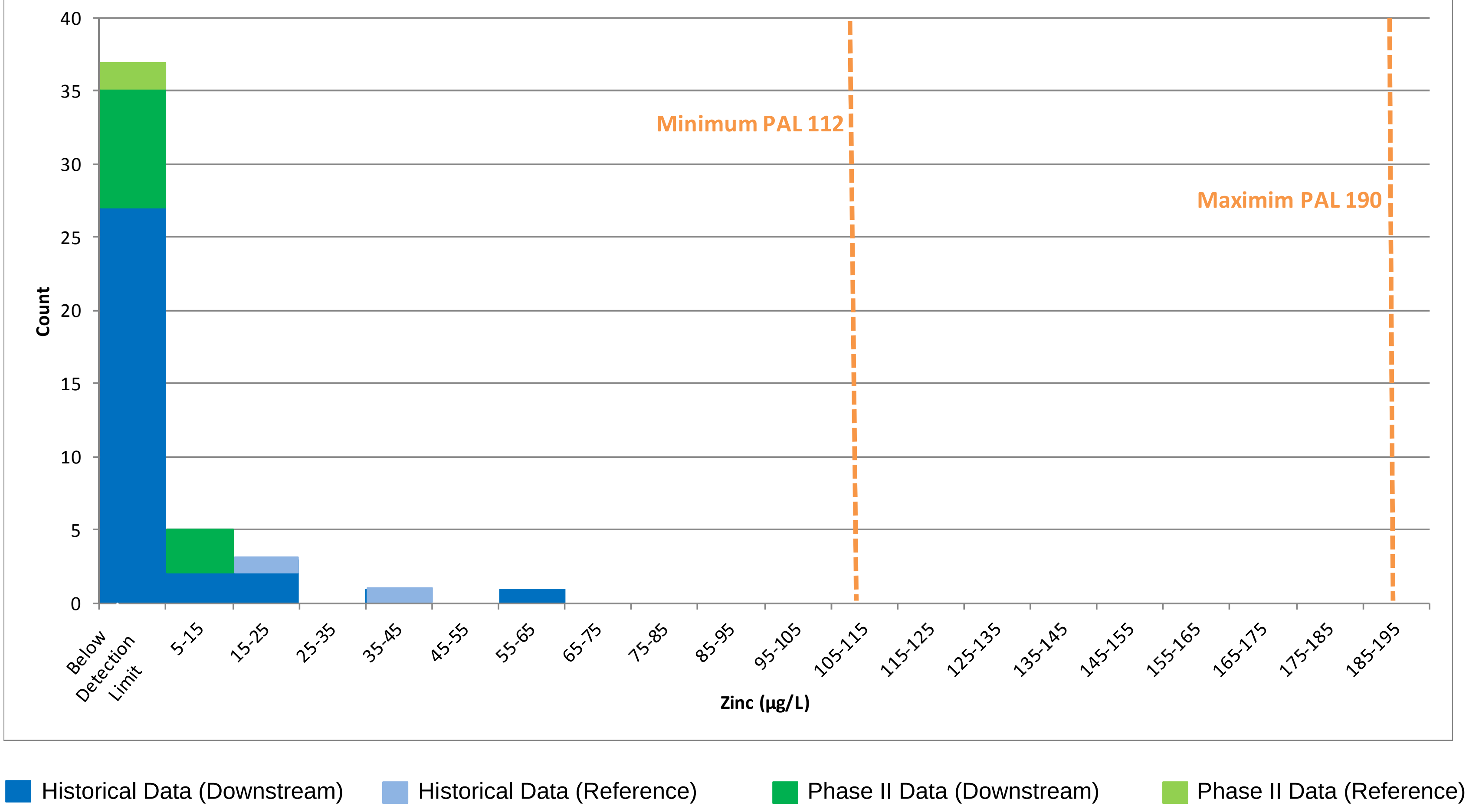


Figure 6-4: Zinc Concentrations in Surface Water at Camp Ripley

7 Weight-of-Evidence Evaluation and Conclusions

7.1 Weight-of-Evidence Evaluation

This Phase II evaluated the potential for Camp Ripley training activities—historical and current—to release MCOC that could migrate off range and cause risk to human and sensitive ecological receptors. The possible MCOC are metals, explosives, and perchlorate and they could migrate via surface water and groundwater systems. Information that indicates possible complete source-receptor connections include:

- Some metals, explosives, and perchlorate detections in historical surface water and groundwater data sets.
- While training occurs predominantly in the central portion of Camp Ripley, there are numerous creeks, streams, and lakes on or near the ranges. There are also nearly 20 drinking water wells situated across the facility.
- At a detonation area, a crater was observed during the site visit that appeared to intersect groundwater.
- If the ground is frozen during “first flush” conditions, runoff, rather than infiltration/discharge would be the dominant although temporary transport mechanism.
- Training at this large installation is significant and has increased over the years, both in the extent (new ranges) and in volume of munitions fired.

However, none of the historical or Phase II data collected at Camp Ripley indicates that MCOC from the ranges are migrating off the operational footprint at levels that cause elevated risk to potential receptors. The transport pathways evaluated included both surface water and groundwater systems, although sampling during Phase II was needed only for surface water. Specific findings that support this assessment are:

- Sediment was eliminated as independent migration pathway. This is supported by stream observations during site visits and by the soil erosion and sedimentation evaluation conducted by the University of Minnesota, Duluth.
- Explosives detected in a cantonment area monitoring well are sporadically present at low concentrations, and do not appear to be range related.
- Migration of explosives to an off-installation receptor is unlikely to occur from the OEDA and other detonation areas. Surface water is not affected by explosives (confirmed by chemical analysis). Effects on groundwater are localized and MCOC do not migrate to receptor locations.
- A few detections of perchlorate in production well samples were reported with a maximum concentration of only 0.28 µg/L, which is well below the PAL of 15 µg/L.
- Historical metals data collected during dry conditions downstream of the areas of concern do not exceed PALs except in two minor instances. Copper was detected in 2002 at 20 µg/L in Frog Lake Stream (coinciding with Phase II location RP03) and in 2001 at 10 µg/L in Yalu Stream (coinciding with Phase II location RP06). These values exceed the

respective subwatershed PALs of 10.6 and 9.5 µg/L, respectively. Yalu Creek is the reference location and is not likely influenced by range activity. Because lead—the dominant MCOC in small arms munitions—is not elevated, the minor copper exceedences alone do not suggest a release of any significance. Also, the recent Phase II copper results at RP03 and RP06 are all below the detection limit. All other historical data collected at locations that coincide with the Phase II sampling locations have results below current PALs, and most are below detection limits.

- None of the Phase II metals data from the April 2012 sampling during a first (and possibly heavier) flush of MCOC exceeded surface water PALs.
- Lead concentrations are all below the minimum PAL of 2.7 µg/L, ranging from below detection limit to 1 µg/L. The maximum concentration detected at Camp Ripley during Phase II was 0.058 µg/L. It was detected at this level in samples collected from both the reference location (RP06) and a downstream sample location (RP02).
- The Phase II maximum concentrations of lead (found in RP02 and RP06) and the maximum concentration of copper (at RP04) were not detected in the same sample or even within the same subwatershed. This indicates metal detections are not range related because these metals typically occur together in small arms munitions.
- Overall, there is generally good agreement between the historical data and the Phase II data. All lead and zinc data are below PALs. There are only two minor copper exceedences in the historical data.

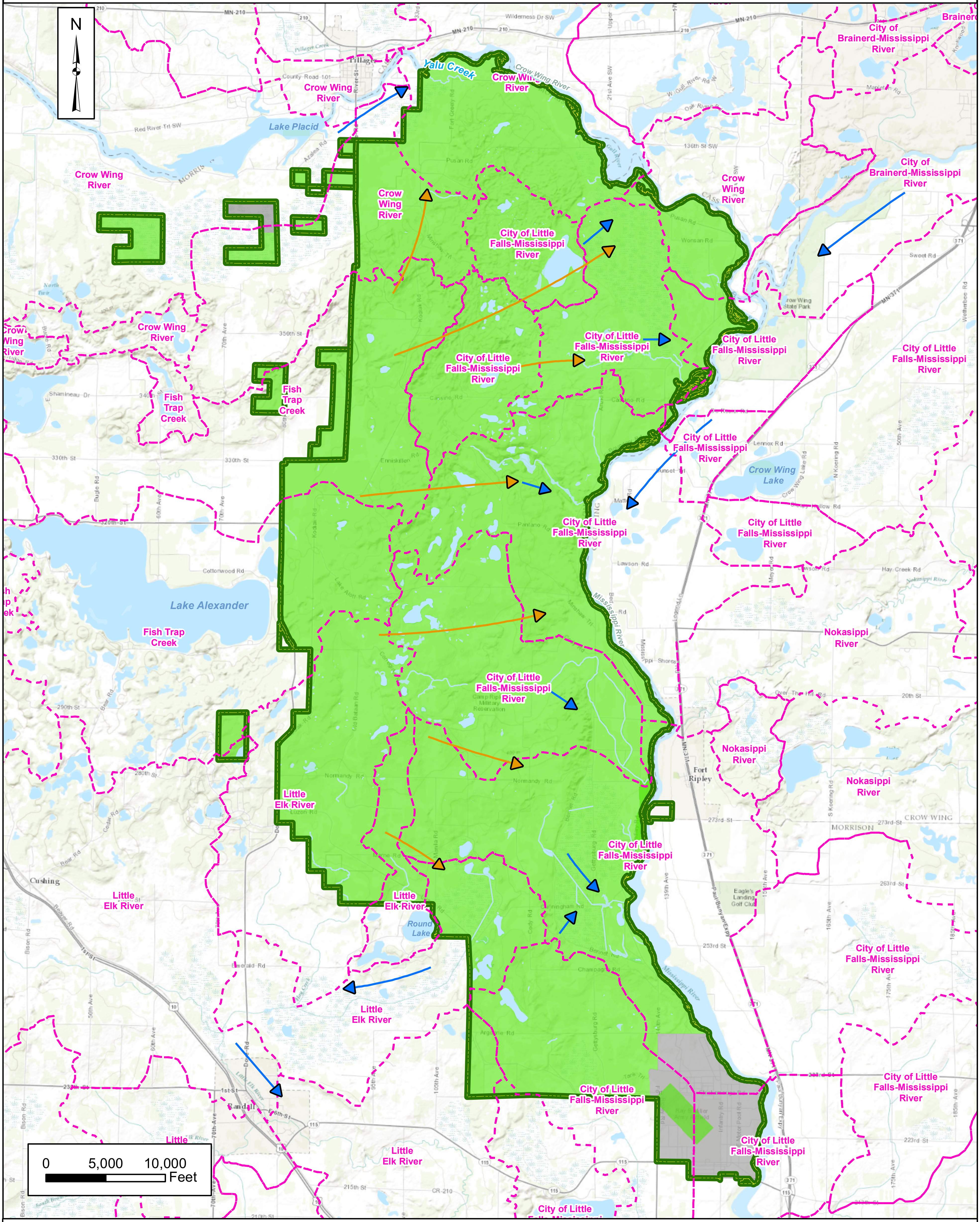
Site conditions at Camp Ripley also provide significant natural barriers for the migration of MCOC from potential source areas. The most likely potential concentrated source areas at Camp Ripley are centrally located on the installation and surrounded by a large buffer zone.

Given the absence or low concentrations of metals and explosives in perimeter surface water and groundwater samples, it is concluded that MCOC are not migrating off range at levels that would pose an unacceptable risk to human and/or ecological receptors. This conclusion is supported by the consistency of the large amount of chemical data, conservative PALs established for this project, and the range layout that constrains potential MCOC sources to the central portion of Camp Ripley.

7.2 Conclusions

For the conditions in 2012, data indicate no unacceptable risk to off-range human or ecological receptors from potential sources associated with the operational footprint at Camp Ripley. Operational areas are placed into a review cycle to periodically re-evaluate whether future changes in conditions pose unacceptable risk to off-range human or ecological receptors (**Figure 7-1**). Implementation of appropriate best management practices will reasonably ensure no future MCOC migration from potential MCOC sources associated with the operational footprint at Camp Ripley.

Figure 7-1
Phase II Summary
Operational Range Assessment Phase II
Camp Ripley, MN



Legend

Installation

▭ Installation Boundary

▨ Other than Operational Area

Phase II Category

🟩 Unlikely

Hydrology

Surface Water Flow

Groundwater Flow

Water Body

Wetland

Watershed

Data Sources:
AEC, 2007

Topo: ESRI, DeLorme, NAVTEQ, TomTom, Intermap, AND, USGS, NRCAN, Kadaster NL, IGN, and the GIS User Community

Date.........................January 2013
Prepared by............URS Group, Inc.

8 References

Army National Guard (ARNG). 2011. *ARNG ORA Focus for Technical Sampling* (ARNG ORA FY12).

Army Range Inventory Database-Geodatabase (ARID-GEO). 2006. U.*S. Army Operational Range Inventory Sustainment FY 2006: Final Packet for Camp Ripley, Minnesota.*

BAL (Bruce A. Liesch Associates, Inc.). 1987. *Camp Ripley Hydrogeologic Investigation, Test Drilling and 24 Hour Pumping Test*.

Department of Defense (DoD). 2004. Department of Defense Directive (DoDD) 4715.11 *Environmental and Explosive Safety Management on Operational Ranges Within the United States*.

DoD. 2005. Department of Defense Instruction (DoDI) 4715.14, *Operational Range Assessments*.

Foth and Van Dyke. 1997. Water Quality Survey, Camp Ripley Minnesota.

Minnesota Office of the Revisor of Statutes. 2012. *Minnesota Administrative Rules*. 2012. Available at https://www.revisor.mn.gov/rules/?id=7050.0222.

Minnesota Army National Guard (MNARNG). 2003. *Integrated Natural Resources Management Plan (INRMP)*. Camp Ripley Training Site. Plan Period 2003 – 2007.

Midwest Regional Climate Center (MRCC). 2006. Climate of the Midwest. Available at http://mcc.sws.uiuc.edu/. Accessed 5 February 2006.

Progressive Consulting Engineers (PCE). n.d. *Wellhead Protection Plan for Camp Ripley, Little Falls, Minnesota.*

Quinn, John J. 2006. *Delineation of a Wellhead Protection Zone and Delineation of Flowpaths from Potential Groundwater Contaminant Source Areas at Camp Ripley, Little Falls, Minnesota*. Environmental Science Division, Argonne National Laboratory. (Review draft version dated 2008.)

United States Army Center for Health Promotion and Preventive Medicine (USACHPPM). 2000. *Firing Range Study No. 32-EE-3330-00, Conceptual Site Model for the Firing Range / Impact Area Risk Assessment, Camp Ripley, Minnesota.*

USACHPPM. 2009. *Army ORA Phase II Investigation Protocol*. July 2009.

United States Army Corps of Engineers (USACE). 2008. *Draft Final Operational Range Assessment Program, Phase I Qualitative Assessment Report, Camp Ripley, Little Falls, Minnesota*. DoD Contract Number W912DR-05-D-0004.

United States Army Environmental Command. 2009. *Procedure for Choosing Screening Values for Operational Range Assessments*. Appendix B. Final Version 5.

United States Army Environmental Hygiene Agency (USAEHA). 1990. *Geohydrologic Study No. 38-26-K876-90, Camp Ripley National Guard Training Area, Little Falls, Minnesota 30 May – 6 June 1990.*

USAEHA. 1994. *Groundwater Quality Survey No. 38-26-K2SY-94, Camp Ripley National Guard Training Area, Little Falls Minnesota*.

United States Army Institute of Public Health (USAIPH). 2012. *Operational Range Assessment Screening Values, Version 6.0*. Updated 21 May 2012.

United States Environmental Protection Agency (USEPA). 2006. *Guidance on Systematic Planning Using the Data Quality Objectives Process,* EPA QA/G-4.

USEPA. 1996. *Sampling Ambient Water for Trace Metals at EPA Water Quality Criteria Levels.*

USEPA. 1994. USEPA Region III Modifications to the National Functional Guidelines for Organic (September 1994) and Inorganic (April 1993) Data Review

University of Minnesota Duluth (UMD). 2003. *Surface Water Management Reports: Management Guide #03-001*. June 2003.

UMD. n.d. *Camp Ripley Aquifer Protection Plan*. Geological Sciences Department.

URS Group, Inc. (URS) /ARCADIS/Pirnie (ARCADIS/Malcolm Pirnie). 2012a. *Accident Prevention Plan, Operational Range Phase II Assessment, Camp Ripley, Minnesota Army National Guard.*

URS/ARCADIS/Pirnie. 2012b. *Army ORA Phase II Programmatic Quality Assurance Project Plan.* January 2012.

URS/ARCADIS/Pirnie. 2012c. *Work Plan/Installation-Specific QAPP, Operational Range Phase II Assessment, Camp Ripley, Minnesota Army National Guard*, submitted by URS January 2012.

APPENDIX A
PHOTOGRAPH LOG

PHOTOGRAPHIC LOG

Client Name: USACE and ARNG	**Location:** Camp Ripley, Sample Location RP01	**Project Number:** 15302622

View of sampling location RP01 taken on 3 April 2012. Photograph is taken facing west (upstream).

PHOTOGRAPHIC LOG

Client Name: USACE and ARNG	**Location:** Camp Ripley, Sample Location RP02	**Project Number:** 15302622

View of sampling location RP02 taken on 3 April 2012. Photograph is taken facing west (upstream).

PHOTOGRAPHIC LOG

Client Name: USACE and ARNG	**Location:** Camp Ripley, Sample Location RP03	**Project Number:** 15302622

View of sampling location RP03 taken on 4 April 2012. Photograph is taken facing east (downstream).

PHOTOGRAPHIC LOG

Client Name: USACE and ARNG	**Location:** Camp Ripley, Sample Location RP04	**Project Number:** 15302622

View of sampling location RP04 taken on 3 April 2012. Photograph is taken facing west (upstream).

Client Name: USACE and ARNG	**Location:** Camp Ripley, Sample Location RP05	**Project Number:** 15302622

View of sampling location RP05 taken on 3 April 2012. Photograph is taken facing south. Upstream is west (to the right of the picture).

PHOTOGRAPHIC LOG

Client Name: USACE and ARNG	**Location:** Camp Ripley, Sample Location RP06	**Project Number:** 15302622

View of sampling location RP06 taken on 5 April 2012. Photograph is taken facing east. Upstream is south (to the right of the picture).

APPENDIX B
FIELD FORMS

Table B-1
Surface Water Field Parameters Table
Operational Range Phase II Assessment
Camp Ripley, MN

Event	Date	Temperature (° Celsius)	Specific Conductance (mS/cm^2)	pH	Dissolved Oxygen (mg/L)	Turbidity (NTU)
RP01						
WA	4/5/2011	8.78	0.402	7.92	12.06	10.91
WB	4/4/2011	9.06	0.402	8.19	12.87	10.99
RP02						
WA	4/5/2011	9.47	0.392	8.25	16.16	0.85
WB	4/4/2011	7.02	0.366	6.69	11.35	1.02
RP03						
WA	4/5/2011	15.92	0.319	7.91	8.82	3.10
WB	4/4/2011	16.42	0.202	7.63	8.15	1.20
RP04						
WA	4/5/2011	4.82	0.364	7.50	12.11	3.74
WB	4/4/2011	5.36	0.358	7.89	15.66	2.10
RP05						
WA	4/5/2011	8.19	0.400	7.98	13.31	0.15
WB	4/4/2011	8.07	0.401	7.38	9.30	0.13
RP06						
WA	4/5/2011	9.78	0.239	7.54	6.77	7.95
WB	4/4/2011	8.70	0.279	7.57	7.37	8.02

mS/cm^2 - millisiemens per square centimeter
mg/L - milligrams per liter
NTU - nephelometric turbidity units

COMPLIANCE AGREEMENT

All project personnel, including visitors, must follow the requirements of this Accident Prevention Plan (APP). In order to document individual agreement with this requirement, all personnel must complete this "Site Safety and Health Plan Compliance Agreement." These agreements will be kept on site and will become part of the permanent project record upon completion of site activities.

I, James M. Cooper (print name), have read the APP for the Fort Ripley; or I have been verbally advised of its contents. I understand and I agree to comply with all of its provisions. I understand that I could be prohibited from working on the project, and I may be subject to disciplinary actions for violating any of the health and safety requirements specified in the APP.

James M. Cooper
Signature

4/02/12
Date

URS, Minneapolis
Company

COMPLIANCE AGREEMENT

All project personnel, including visitors, must follow the requirements of this Accident Prevention Plan (APP). In order to document individual agreement with this requirement, all personnel must complete this "Site Safety and Health Plan Compliance Agreement." These agreements will be kept on site and will become part of the permanent project record upon completion of site activities.

I, Bethany Keller (print name), have read the APP for the Fort Ripley; or I have been verbally advised of its contents. I understand and I agree to comply with all of its provisions. I understand that I could be prohibited from working on the project, and I may be subject to disciplinary actions for violating any of the health and safety requirements specified in the APP.

Bethany Keller
Signature

VRS
Company

4~~5~~-2-12 BK
Date

COMPLIANCE AGREEMENT

All project personnel, including visitors, must follow the requirements of this Accident Prevention Plan (APP). In order to document individual agreement with this requirement, all personnel must complete this "Site Safety and Health Plan Compliance Agreement." These agreements will be kept on site and will become part of the permanent project record upon completion of site activities.

I, Mary Canino (print name), have read the APP for the Fort Ripley; or I have been verbally advised of its contents. I understand and I agree to comply with all of its provisions. I understand that I could be prohibited from working on the project, and I may be subject to disciplinary actions for violating any of the health and safety requirements specified in the APP.

Signature

URS Corporation
Company

4/2/2012
Date

SSBF-4/2/12

SITE SAFETY BRIEFING FORM

Project Name RP Phase II ORA

Project Number 15302622 Date 4-2-12 Time 0915

Location Camp Ripley, MN

Type of Work Phase II - Site Reconnasence

SAFETY TOPICS PRESENTED

Protective Clothing/Equipment long pants/shirt/steel toed

Chemical Hazards Batteries (acid)

Physical Hazards Slip, trip fall around creeks, walking on gravel, weather - change of storms in pm

Biological Hazards Ticks, wild animals

Emergency Procedures call Range Control (320) 616 3137

Hospital/Clinic call RC Phone call RC

Hospital Address N/A

Special Equipment Handling batteries

Other Drive speed limit while on range (25mph)

ATTENDEES

Name (Printed)	Signature
Bethany Keller	Bethany Keller
Mary Canino	
Matt Legg	
James Cooper	James M. Cooper

Meeting Conducted by: Bethany Keller

Site Safety Officer: Bethany Keller

SITE SAFETY BRIEFING FORM

SSBF - 4/3/12

Project Name RP Phase II ORA

Project Number 15302622 Date 4-3-12 Time 0735

Location Camp Ripley

Type of Work SW Sampling - Deploy Wet B 24-hr composite

SAFETY TOPICS PRESENTED

Protective Clothing/Equipment long pants, steel toed shoes, PPE (gloves/glasses / vests) hats

Chemical Hazards Battery acid

Physical Hazards Sun - Slips (down slopes) trips - walking in wooded area

Biological Hazards Bugs - ticks - mosquitos

Emergency Procedures Call Range Control (320) 616- 3137

Hospital/Clinic call RC Phone

Hospital Address N/A

Special Equipment ISCO samplers and marine batteries

Other Lift in pairs, if necessary

ATTENDEES

Name (Printed)	Signature
Bethany Keller	Bethany Keller
Matt Vega	
Mary Canino	

Meeting Conducted by: B. Keller

Site Safety Officer: B. Keller

SSBF- 4/4/12

SITE SAFETY BRIEFING FORM

Project Name Camp Ripley
Project Number 15302622 Date 4-4-12 Time 0915
Location Camp Ripley, MN
Type of Work Surface water sample collection deploy second 24-hr composite

SAFETY TOPICS PRESENTED

Protective Clothing/Equipment Steeltoe boots - tape, long pants, hats PPE (gloves, etc) vests
Chemical Hazards Battery acid & preservatives in bottleware (HCl and HNO3)
Physical Hazards uneven walking area - trips
Biological Hazards Ticks (check all day)
Emergency Procedures Call Range control 320 616 3137
Hospital/Clinic Call RC Phone "
Hospital Address N/A
Special Equipment ISCO samplers - peri pump marine batteries
Other After work/during work- check for bug bites and ticks

ATTENDEES

Name (Printed)	Signature
Matt Legg	
Blake Olvick	
Brian Steffen	
Bethany Keller	Bethany Keller
Mary Canino	

Meeting Conducted by: Bethany Keller
Site Safety Officer: Bethany Keller

SSBF- 4/5/12

SITE SAFETY BRIEFING FORM

Project Name Camp Ripley ORA

Project Number 15302622 Date 4/5/12 Time 0805

Location Camp Ripley, MN

Type of Work SW Sampling, demob equipment

SAFETY TOPICS PRESENTED

Protective Clothing/Equipment long sleeve/pants - hats vests, nitrile gloves

Chemical Hazards Battery acid - preservatives in bottleware

Physical Hazards uneven surfaces, sun (wore sunscreen)

Biological Hazards TICKS & bugs - (taped pants, wear deet (bug spray))

Emergency Procedures Call Range control 320 616 3137

Hospital/Clinic Call RC Phone ↓

Hospital Address N/A - call RC

Special Equipment Samplers (ISCO) batteries, peri pump

Other

work together to pick up heavy equipment, boxes, or coolers

ATTENDEES

Name (Printed)	Signature
Bethany Keller	Betty Keller
Mary Canine	

Meeting Conducted by: Bethany Keller

Site Safety Officer: B Keller

URS	Health, Safety and Environment **PERSONAL PROTECTIVE EQUIPMENT INSPECTION SHEET**	Attachment 029-2 NA Issue Date: July 2000 Revision 6: December 2009

Name of Inspector Bethany Keller **Date Inspected** 4-4-12

	Hard Hats		
1.	The brim or shell does not show signs of exposure and excessive wear, loss of surface gloss, chalking, or flaking.	☐ Yes ☐ No	NA
2.	Suspension system in hard hat does not show signs of deterioration, including cracking, tearing, or fraying.	☐ Yes ☐ No	
3.	The brim or shell is not cracked, perforated, or deformed.	☐ Yes ☐ No	
4.	Employees use hard hats in marked areas.	☐ Yes ☐ No	
5.	Areas requiring hard hat usage are marked.	☐ Yes ☐ No	
	Safety Shoes		
6.	Safety shoes used by employees do not show signs of excessive wear.	☒ Yes ☐ No	
7.	Areas requiring safety shoes are marked. All times	☒ Yes ☐ No	
	Work Gloves		
8.	Gloves are available and worn when needed.	☒ Yes ☐ No	
9.	Gloves are appropriate for the task. (only nitrile needed)	☒ Yes ☐ No	
10.	Gloves do not show signs of excessive wear such as cracks, scrapes, or lacerations, thinning or discoloration, or break-through to the skin.	☒ Yes ☐ No	
	Protective Clothing		
11.	Protective clothing (including traffic control apparel) is worn by employees when required.	☒ Yes ☐ No	
	Hearing Protection		
12.	Noise hazard areas are posted.	☐ Yes ☐ No	NA
13.	Employees are using earplugs or muffs when using noise producing equipment or working in posted noise hazard areas.	☐ Yes ☐ No	
	Safety Glasses		
14.	Eye hazard areas are marked or posted.	☒ Yes ☐ No	
15.	Employees use safety glasses when working in eye hazard areas or working with equipment that produces an eye hazard.	☒ Yes ☐ No	
16.	Face shields are used when required and worn over safety glasses.	☐ Yes ☐ No	NA

REMARKS ***(All "No" answers indicate a hazard which needs to be fixed.)***

NA

URS	Health, Safety and Environment **HOUSEKEEPING INSPECTION SHEET**	Attachment 021-1 NA Issue Date: June 1999 Revision 4: February 2009

Building or Location: Camp Ripley, MN

Inspection Conducted by: Bethany Keller **Date:** 4-4-12

Check Yes, No, or NA for Not Applicable.

General Site Housekeeping

1. Do not block exits or emergency equipment. ☐ Yes ☐ No ☒ NA
2. Do not leave equipment or materials lying on the ground. ☒ Yes ☐ No ☐ NA
3. Keep storage areas free from the accumulation of materials that constitute trip hazards. ☐ Yes ☐ No ☒ NA
4. Remove scrap materials and other debris from work area. ☒ Yes ☐ No ☐ NA
5. Remove combustible scrap and debris by safe means at regular intervals. ☐ Yes ☐ No ☒ NA
6. Store oily rags in metal cans with tight fitting lids. Remove oily rags at the end of the day. ☐ Yes ☐ No ☒ NA

Visibility

7. Ensure that halls, stairways and walkways are well lit. ☐ Yes ☐ No ☒ NA
8. Ensure that well designed light switches are present in areas where walkways are not always lighted. ☐ Yes ☐ No ☒ NA
9. Ensure that dust, smoke or steam does not create poor visibility. ☐ Yes ☐ No ☒ NA
10. Ensure that glare from floodlights or windows does not create poor visibility in work areas. ☐ Yes ☐ No ☒ NA

Stairs

11. Ensure that handrails are tight and at the proper level. ☐ Yes ☐ No ☒ NA
12. Ensure that handrails extend past the top and bottom step. ☐ Yes ☐ No ☒ NA
13. Ensure that white or yellow strips are painted on the first and last step for better visibility. (Not an OSHA requirement – recommendation only). ☐ Yes ☐ No ☒ NA
14. Ensure that steps are not rough or defective. ☐ Yes ☐ No ☒ NA
15. Ensure that stair treads are wide enough and risers consistently spaced. ☐ Yes ☐ No ☒ NA
16. Ensure that stairs are free of obstructions. ☐ Yes ☐ No ☒ NA

Floor Conditions

17. Ensure that floors of every workroom are clean, and so far as possible, in a dry condition. ☐ Yes ☐ No ☒ NA
18. Ensure that floors are not oily, overly waxed, or polished. ☐ Yes ☐ No ☒ NA
19. Where wet floors or processes are present, provide proper drainage and false floors, mats, or other dry standing places. ☐ Yes ☐ No ☒ NA
20. Finish floor surfaces with non-slip coatings where spills are likely. ☐ Yes ☐ No ☒ NA
21. Ensure that floors and passageways are free from protruding nails, splinters, holes, or loose boards. ☐ Yes ☐ No ☒ NA
22. Ensure that floors are free of holes and depressions. ☐ Yes ☐ No ☒ NA
23. Ensure that aisles or pathways are wide enough for easy passage and for carrying objects (48 inches is recommended). ☐ Yes ☐ No ☒ NA

24. Ensure that ramps are covered with non-slip surfaces or matting. ☐ Yes ☐ No ☒ NA
25. Keep carpets or rugs free from loose or frayed edges that may catch boots or shoes. ☐ Yes ☐ No ☒ NA
26. Keep walkways free from extension cords, air hoses and cables. ☐ Yes ☐ No ☒ NA
27. Keep pathways free from boxes, containers, machine parts, or other tripping hazards. ☐ Yes ☐ No ☒ NA

Ground Conditions

28. Ensure that trip hazards are not present. ☒ Yes ☐ No ☐ NA
29. Ensure that fall hazards are not present. ☒ Yes ☐ No ☐ NA

} Not avoidable - Dangers highlighted during all safety meetings

30. Ensure that holes or changes in ground elevation are either filled or guarded. ☐ Yes ☐ No ☒ NA
31. Ensure that muddy walkways are filled with gravel to reduce slipping. ☐ Yes ☐ No ☒ NA
32. Ensure that all employees who work in wet or greasy conditions wear slip resistant footwear. ☐ Yes ☐ No ☒ NA

Equipment

33. Ensure that vehicle steps are of adequate size, surface placement for safe dismounting. ☐ Yes ☐ No ☒ NA
34. Ensure that hand grips or ladders are adequate for getting into and out of equipment. ☐ Yes ☐ No ☒ NA
35. Ensure that ladders have been checked for damage and removed from service if found unsafe. ☐ Yes ☐ No ☒ NA

Identify areas that need attention and describe the corrective actions to be implemented:

None
BK

I certify that the above inspection was performed to the best of my knowledge and ability, based on the conditions present on: 4-4-12

Bethany Keller
Signature

BROOKS RAND LABS
MEANINGFUL METALS DATA

3958 6th Avenue NW
Seattle, WA 98107
Phone: 206-632-6206
Fax: 206-632-6017

samples@brooksrand.com
www.brooksrand.com

Chain of Custody Record

Page 1 of 2

White: LAB COPY
Yellow: CUSTOMER COPY

Client: URS
Contact: Andrea Sansom
Client project ID: 15302622.30000
PO #:

Address: 849 International Dr Suite 320
Linthicum MD 21090
Phone #: 410-487-8955

COC receipt confirmation? [✓ Y] / N
If so, by [✓ email] / fax (circle one)
Email: andrea.sansom@urs.com
Fax #: 410-859-5202

Requested TAT in business days:
☒ 20 (standard)
☐ 15
☐ 10
☐ 5
☐ Other ____
Surcharges apply for expedited turn around times.

	Sample ID	Collection: Date	Collection: Time	Miscellaneous: Sampler (initials)	Miscellaneous: Matrix type – SW	Miscellaneous: # of containers	Miscellaneous: Field filtered? (Y/N)	Field Preservation: Unpreserved / ice only	Field Preservation: HCl / HNO_3 (circle one)	Field Preservation: Other (specify)	Analyses required: Total Hg, EPA 1631	Analyses required: Methyl Hg, EPA 1630	Analyses required: ICP-MS Metals (specify)	Analyses required: As / Se species (specify)	Analyses required: % Solids	Analyses required: Filtration	Analyses required: Other (specify) Metals plus 1638M [illegible]	Analyses required: Other (specify)	Comments
1	RPSW01WB01	4-4-12	1245	BLK	H_2O	1	Y	X									X		
2	RPSW02WB01	4-4-12	0935	BLK	H_2O		Y	X									X		
3	RPSW03WB01	4-4-12	1615	BLK	H_2O	1	Y	X									X		
4	RPSW04WB01	4-4-12	1030	BLK	H_2O	1	Y	X									X		
5	RPSW05WB01	4-4-12	1120	BLK	H_2O	1	Y	X									X		
6	RPSW06WB01	4-4-12	1830	BLK	H_2O	1	Y	X									X		
7	RPSW01WA01	4-5-12	1240	BLK	H_2O	1	Y	X									X		
8	RPSW02WA01	4-5-12	1200	BLK	H_2O	1	Y	X									X		
9	RPSW03WA01	4-5-12	1400	BLK	H_2O	1	X	X									X		
10	RPSW04WA01	4-5-12	0940	BLK	H_2O	1	Y	X									X		use for MS/MSD

Relinquished by: Bethany Kl Date: 4-5-12 Time: 1900
Received by: Date: Time:
Shipping carrier: FedEx # of coolers: 2

Relinquished by: Date: Time:
Received at BRL by: Date: Time:
BRL work order ID: BRL project ID:

BROOKS RAND LABS
MEANINGFUL METALS DATA

3958 6th Avenue NW
Seattle, WA 98107
Phone: 206-632-6206
Fax: 206-632-6017

samples@brooksrand.com
www.brooksrand.com

Chain of Custody Record

Page 2 of 2

White: LAB COPY
Yellow: CUSTOMER COPY

Client: URS
Contact: Andrea Sansom
Client project ID: 15302622.30000
PO #:

Address: 849 International Dr Ste 320
Linthicum MD 21090
Phone #: 410 487 8955

COC receipt confirmation? [✓ Y] / N
If so, by: [✓ email] / fax (circle one)
Email: andrea.sansom@urs.com
Fax #: 410 859 5202

Requested TAT in business days:
☒ 20 (standard)
☐ 15
☐ 10
☐ 5
☐ Other ____

Surcharges apply for expedited turn around times.

		Collection		Miscellaneous				Field Preservation			Analyses required								Comments
	Sample ID	Date	Time	Sampler (initials)	Matrix type — SW	# of containers	Field filtered? (Y/N)	Unpreserved / ice only	HCl / HNO_3 (circle one)	Other (specify)	Total Hg, EPA 1631	Methyl Hg, EPA 1630	ICP-MS Metals (specify)	As / Se species (specify)	% Solids	Filtration	Other (specify) Metals 1638M plus Sm 2340B	Other (specify)	
1	RPSW04WA02	4-5-12	0945	BLK	H_2O	1	Y	X									X		
2	RPSW04WA03	4-5-12	0950	BLK	H_2O	1	Y	X									X		
3	RPSW05WA01	4-5-12	1125	BLK	H_2O	1	Y	X									X		
4	RPSW06WA01	4-5-12	1400	BLK	H_2O	1	Y	X									X		
5																			
6																			
7																			
8																			
9																			
10																			

Relinquished by: Bethany Ki	Date: 4-5-12	Time: 1900	Relinquished by:	Date:	Time:
Received by:	Date:	Time:	Received at BRL by:	Date:	Time:
Shipping carrier: Fed EX	# of coolers: 2		BRL work order ID:	BRL project ID:	

ACCUTEST
LABORATORIES

CHAIN OF CUSTODY

2235 Route 130, Dayton, NJ 08810
Tel: 732-329-0200 FAX: 732-329-3499/3480
www. acutest.com

PAGE 1 OF 2

FED-EX Tracking # 8996 7737 0319
Bottle Order Control # / 20 ana
Accutest Quote # 03
Accutest Job # 30 3 total

Client / Reporting Information

Company Name URS
Street Address 849 International Drive STE 320
City Linthicum State MD Zip 21090
Project Contact E-mail Andrea.Sansom@urs.com
Phone # (410) 487-8955 Fax # (410) 859-5202
Sampler(s) Name(s) Bethany Keller Phone # 614 4320377

Project Information

Project Name: Camp Ripley, Minnesota
Street
City State
Project # 15302622.30000
Client Purchase Order #
Project Manager Laurie Stenberg

Billing Information (if different from Report to)
Company Name
Street Address
City State Zip
Attention:

Requested Analysis (see TEST CODE sheet)

Matrix Codes

DW - Drinking Water
GW - Ground Water
WW - Water
SW - Surface Water
SO - Soil
SL- Sludge
SED-Sediment
OI - Oil
LIQ - Other Liquid
AIR - Air
SOL - Other Solid
WP - Wipe
FB-Field Blank
EB-Equipment Blank
RB- Rinse Blank
TB-Trip Blank

Accutest Sample #	Field ID / Point of Collection	MEOH/DI Vial #	Collection Date	Collection Time	Sampled by	Matrix	# of bottles	HCl	NaOH	HNO3	H2SO4	NONE	DI Water	MEOH	ENCORE	Diss metals for BUM 6010B	DOC 9060M	ALK SM 2320B	Sulfate/chloride 300.0								LAB USE ONLY
	RPSW01WB01		4-4-12	1245	BLK	SW	5	2		1		2				X	X	X	X								
	RPSW02WB01		4-4-12	0935	BLK	SW	5	2		1		2				X	X	X	X								
	RPSW03WB01		4-4-12	1615	BLK	SW	5	2		1		2				X	X	X	X								
	RPSW04WB01		4-4-12	1030	BLK	SW	5	2		1		2				X	X	X	X								
	RPSW05WB01		4-4-12	1120	BLK	SW	5	2		1		2				X	X	X	X								
	RPSW06WB01		4-4-12	1330	BLK	SW	5	2		1		2				X	X	X	X								
	~~RPSW01 WA01~~																								BLK		
	RPSW01WA01		4-5-12	1240	BLK	SW	5	2		1		2				X	X	X	X								
	~~RPSW02WA01~~		~~4-5-12~~	~~1125~~	~~BLK~~	~~SW~~	~~5~~	~~2~~		~~1~~		~~2~~								BLK							
	RPSW03WA01		4-5-12	1440	BLK	SW	5	2		1		2				X	X	X	X								
	RPSW04WA01		4-5-12	0940	BLK	SW	5	2		1		2				X	X	X	X								
	RPSW04WA02		4-5-12	0945	BLK	SW	5	2		1		2				X	X	X	X								

Turnaround Time (Business days)

☒ Std. 15 Business Days
☐ Std. 10 Business Days (by Contract only)
☐ 10 Day *RUSH*
☐ 5 Day *RUSH*
☐ 3 Day *EMERGENCY*
☐ 2 Day *EMERGENCY*
☐ 1 Day *EMERGENCY*
Emergency & Rush T/A data available VIA Lablink

Approved By (Accutest PM): / Date:

Data Deliverable Information

☐ Commercial "A" (Level 1)
☐ Commercial "B" (Level 2)
☐ FULLT1 (Level 3+4)
☐ NJ Reduced
☐ Commercial "C"
☐ NYASP Category A
☐ NYASP Category B
☐ State Forms
☐ EDD Format
☐ Other

Commercial "A" = Results Only
Commercial "B" = Results + QC Summary
NJ Reduced = Results + QC Summary + Partial Raw data

Comments / Special Instructions

Use RPSW04WA01 for MS/MSD

Sample Custody must be documented below each time samples change possession, including courier delivery.

Relinquished by Sampler: 1 Bethany Keller	Date Time: 4-5-12 1900	Received By: 1	Relinquished By: 2	Date Time:	Received By: 2
Relinquished by Sampler: 3	Date Time:	Received By: 3	Relinquished By: 4	Date Time:	Received By: 4
Relinquished by: 5	Date Time:	Received By: 5	Custody Seal # ☐ Intact ☐ Not intact	Preserved where applicable ☐	On Ice ☐ Cooler Temp.

ACCUTEST
LABORATORIES

CHAIN OF CUSTODY

2235 Route 130, Dayton, NJ 08810
Tel: 732-329-0200 FAX: 732-329-3499/3480
www. acutest.com

PAGE 2 OF 2

FED-EX Tracking # 8996 7737
Bottle Order Control #
Accutest Quote # / Accutest Job # 0319/20 and 0330

Client / Reporting Information	Project Information	
Company Name VRS	Project Name: Camp Ripley, MN	
Street Address 849 International Dr Ste 320	Street	Billing Information (if different from Report to)
City Linthicum State MD Zip 21070	City State	Company Name
Project Contact E-mail Andrea.Sansom@urs.com	Project # 15302622	Street Address 30000
Phone # 410 487 8955 Fax # 410 859 5202	Client Purchase Order #	City State Zip
Sampler(s) Name(s) Bethany Kelly Phone # 614 432 0377	Project Manager Laurie Stenberg	Attention:

Accutest Sample #	Field ID / Point of Collection	MEOH/DI Vial #	Collection Date	Collection Time	Sampled by	Matrix	# of bottles	HCl	NaOH	HNO3	H2SO4	NONE	DI Water	MEOH	ENCORE	Diss Metals for BLM 6010B	DOC 9060M	Alk SM 2320B	Sulfate/Chloride 300.0
	RPSW04WA03		4-5-12	0950	BLK	SW	5	2		1		2				X	X	X	X
	RPSW05WA01		4-5-12	1125	BLK	SW	5	2		1		2				X	X	X	X
	RPSW06WA01		4-5-12	1400	BLK	SW	5	2		1		2				X	X	X	X
	RPSW02WA01		4-5-12	1200	BLK	SW	5	2		1		2				X	X	X	X

Requested Analysis (see TEST CODE sheet)

Matrix Codes
DW - Drinking Water
GW - Ground Water
WW - Water
SW - Surface Water
SO - Soil
SL- Sludge
SED-Sediment
OI - Oil
LIQ - Other Liquid
AIR - Air
SOL - Other Solid
WP - Wipe
FB-Field Blank
EB-Equipment Blank
RB- Rinse Blank
TB-Trip Blank

LAB USE ONLY

Turnaround Time (Business days)
☑ Std. 15 Business Days
☐ Std. 10 Business Days (by Contract only)
☐ 10 Day *RUSH*
☐ 5 Day *RUSH*
☐ 3 Day *EMERGENCY*
☐ 2 Day *EMERGENCY*
☐ 1 Day *EMERGENCY*
Emergency & Rush T/A data available VIA Lablink

Approved By (Accutest PM): / Date:

Data Deliverable Information
☐ Commercial "A" (Level 1)
☐ Commercial "B" (Level 2)
☐ FULLT1 (Level 3+4)
☐ NJ Reduced
☐ Commercial "C"
☐ NYASP Category A
☐ NYASP Category B
☐ State Forms
☐ EDD Format
☐ Other
Commercial "A" = Results Only
Commercial "B" = Results + QC Summary
NJ Reduced = Results + QC Summary + Partial Raw data

Comments / Special Instructions
TWO coolers w/ samples
One without
3 total coolers

Sample Custody must be documented below each time samples change possession, including courier delivery.

Relinquished by Sampler: 1 Bethany Kelly	Date Time: 4-5-12 1900	Received By: 1	Relinquished By: 2	Date Time:	Received By: 2
Relinquished by Sampler: 3	Date Time:	Received By: 3	Relinquished By: 4	Date Time:	Received By: 4
Relinquished by: 5	Date Time:	Received By: 5	Custody Seal # ☐ Intact ☐ Not intact	Preserved where applicable ☐	☒ On Ice Cooler Temp.

URS

Site ID: 01WA01
Arrival Time: 1215
Departure Time: 1325

Surface Water Sample Collection Log

Installation Name: Camp Ripley Date: 4-5-12
On-Site Personnel: Canino, Keller
Log Preparer: Keller
Site Location: LAT LONG
46.280068 -94.35282826

Observations

Stream Flow: Low/High/[✓ Normal] Water Color: Clear Odor: None

Field Measurements

Multi-Parameter Probe (Make/Model/#): YSI 556/LaMotte 2020

Temp: 6.78 °C SpC: 0.402 µs/cm pH: 7.92 DO: 12.06 mg/L
%Sat: 103.7 Turbidity: 10.71 NTU

Water Quality Sample Collection Verification

Composite Sampler (Make/Model/#): ISCO

Sample ID: RPSW01WA01 4-5-12 1240

Analytical Group
☐ Explosives ☐ Perchlorate ☑ Dissolved Metals (EPA 6020A) plus Hardness
☑ Dissolved Organic Carbon ☑ Dissolved Metals (EPA 1638M) plus Hardness
☑ Alkalinity ☑ Sulfate, Chloride

Quality Control Samples
☐ Duplicate ☐ MS/MSDs ☐ Field Blank ☐ Equipment Blank

Notes:

URS

Site ID: RP02WA
Arrival Time: 1155
Departure Time: 1210

Surface Water Sample Collection Log

Installation Name: Camp Ripley Date: 4-5-12
On-Site Personnel: Keller, Canino
Log Preparer: Keller
Site Location: ~~N:~~ ~~E:~~
lat 46.23783409 long: -94.39096927

Observations

Stream Flow: Low/High/[✓ Normal] Water Color: Clear Odor: None

Field Measurements

Multi-Parameter Probe (Make/Model/#): YSI 556/La Motte 2020

Temp: 9.47 °C SpC: 0.392 µs/cm pH: 8.25 DO: 16.16 mg/L
%Sat: 138.7 Turbidity: 0.85 NTU

Water Quality Sample Collection Verification

Composite Sampler (Make/Model/#): ISCO

Sample ID: RRSW02WA01 4-5-12 1200

Analytical Group
☐ Explosives ☐ Perchlorate ☒ Dissolved Metals (EPA 6020A) plus Hardness
☒ Dissolved Organic Carbon ☒ Dissolved Metals (EPA 1638M) plus Hardness
☒ Alkalinity ☒ Sulfate, Chloride

Quality Control Samples
☐ Duplicate ☐ MS/MSDs ☐ Field Blank ☐ Equipment Blank

Notes:

URS

Site ID: 03WA01
Arrival Time: 1430
Departure Time: 1530

Surface Water Sample Collection Log

Installation Name: Camp Ripley
Date: 4-5-12
On-Site Personnel: Canino, Keller
Log Preparer: Keller
Site Location: Lat Long:
46.22974455 -94.39638197

Observations NONE - pooled

Stream Flow: [✓ Low]/High/Normal Water Color: Clear Odor: None

Field Measurements

Multi-Parameter Probe (Make/Model/#): YSI 556 / La Motte 2020

Temp: 15.92°C SpC: 0.319 ~~µs~~ ms/cm pH: 7.91 DO: 8.82 mg/L
%Sat: 88.3 Turbidity: 310 NTU

Water Quality Sample Collection Verification

Composite Sampler (Make/Model/#): ~~ISCO~~ grab w/ peri pump

Sample ID: RPSW03WA01 4-5-12 1440

Analytical Group
☐ Explosives ☐ Perchlorate ☒ Dissolved Metals (EPA 6020A) plus Hardness
☒ Dissolved Organic Carbon ☒ Dissolved Metals (EPA 1638M) plus Hardness
☒ Alkalinity ☒ Sulfate, Chloride

Quality Control Samples
☐ Duplicate ☐ MS/MSDs ☐ Field Blank ☐ Equipment Blank

Notes:

BK

URS

Site ID: RP04WA 01 02 03
Arrival Time: 0915
Departure Time: 1040

Surface Water Sample Collection Log

Installation Name: Camp Ripley Date: 4-5-12
On-Site Personnel: Canino, Keller
Log Preparer: Keller
Site Location: ~~N:~~ ~~E:~~
lat: 46.1376428 long: -94.38029408

Observations

Stream Flow: Low/High/[✓ Normal] Water Color: clear Odor: None

Field Measurements

Multi-Parameter Probe (Make/Model/#): YSI 556/LaMotte 2026

Temp: 4.82 °C SpC: 0.364 μs/cm pH: 7.5 DO: 12.11 mg/L
%Sat: 94.1 Turbidity: 3.74 NTU

Water Quality Sample Collection Verification

Composite Sampler (Make/Model/#): ISCO

Sample ID: RPSW04WA01 RPSW04WA02 RPSW04WA03
4-5-12 0940 4-5-12 0945 4-5-12 0950

Analytical Group
☐ Explosives ☐ Perchlorate ☐ Dissolved Metals (EPA 6020A) plus Hardness
☐ Dissolved Organic Carbon ☐ Dissolved Metals (EPA 1638M) plus Hardness
☐ Alkalinity ☐ Sulfate, Chloride

Quality Control Samples
☒ Duplicate ☒ MS/MSDs ☒ Field Blank N/A BK ☒ Equipment Blank

Notes:

BK

URS

Site ID: RP05WA
Arrival Time: 1045
Departure Time: 1130

Surface Water Sample Collection Log

Installation Name: Camp Ripley Date: 4-5-12
On-Site Personnel: Keller, Canino
Log Preparer: Keller
Site Location: ~~N:~~ ~~E:~~
lat: 46.13248229 longs: -94.38085198

Observations

Stream Flow: Low/High/[✓ Normal] Water Color: Clear Odor: None

---

Field Measurements

Multi-Parameter Probe (Make/Model/#): YSI 556/ LaMotte 2020

Temp: 8.19 °C SpC: 0.400 ~~µ~~ms/cm pH: 7.98 DO 13.31 mg/L
%Sat: 107.8 Turbidity: 0.15 NTU

Water Quality Sample Collection Verification

Composite Sampler (Make/Model/#): ISCO

Sample ID: RPSW 05WA 01 4-5-12 1125

Analytical Group
☐ Explosives ☐ Perchlorate ☒ Dissolved Metals (EPA 6020A) plus Hardness
☒ Dissolved Organic Carbon ☒ Dissolved Metals (EPA 1638M) plus Hardness
☒ Alkalinity ☒ Sulfate, Chloride

Quality Control Samples
☐ Duplicate ☐ MS/MSDs ☐ Field Blank ☐ Equipment Blank

Notes:

BK

URS

Site ID: OUWA01
Arrival Time: 1350
Departure Time: 1405

Surface Water Sample Collection Log

Installation Name: Camp Ripley Date: 4-5-12
On-Site Personnel: Canino Keller
Log Preparer: Keller
Site Location: N Lat Long
46.32601 -94.4500207

Observations

Stream Flow: Low/High/[✓ Normal] Water Color: Clear Odor: NONE

Field Measurements

Multi-Parameter Probe (Make/Model/#): YSI 556 / LaMotte 2020

Temp: 9.78°C SpC: 0.239 mS/cm pH: 7.59 DO: 6.77 mg/L
%Sat: 59.5 Turbidity: 7.95 NTU

Water Quality Sample Collection Verification

Composite Sampler (Make/Model/#): ISCO

Sample ID: RPSW0UWA01 4-5-12 1400

Analytical Group
☐ Explosives ☐ Perchlorate ☒ Dissolved Metals (EPA 6020A) plus Hardness
☒ Dissolved Organic Carbon ☒ Dissolved Metals (EPA 1638M) plus Hardness
☒ Alkalinity ☒ Sulfate, Chloride

Quality Control Samples
☐ Duplicate ☐ MS/MSDs ☐ Field Blank ☐ Equipment Blank

Notes:

URS

Site ID: RP01 WB
Arrival Time: 1240
Departure Time: 1310

Surface Water Sample Collection Log

Installation Name: Camp Ripley Date: 4-4-12
On-Site Personnel: Keller, Canina, Legg
Log Preparer: Keller
Site Location: Lat: 46.280068 Long: -94.35282826

Observations

Stream Flow: Low/High/[✓ Normal] Water Color: Clear Odor: None

---

Field Measurements

Multi-Parameter Probe (Make/Model/#): YSI 556/LaMotte 2020

Temp: 9.06 °C SpC: 0.402 ~~µ~~ms/cm pH: 8.19 DO: 12.87 mg/L
%Sat: 110.3 Turbidity: 10.99 NTU

Water Quality Sample Collection Verification

Composite Sampler (Make/Model/#): ISCO

Sample ID: RRSW01WB01 4-4-12 1245

Analytical Group
☐ Explosives ☐ Perchlorate ☒ Dissolved Metals (EPA 6020A) plus Hardness
☒ Dissolved Organic Carbon ☒ Dissolved Metals (EPA 1638M) plus Hardness
☒ Alkalinity ☒ Sulfate, Chloride

Quality Control Samples
☐ Duplicate ☐ MS/MSDs ☐ Field Blank ☐ Equipment Blank

Notes:

BK

URS

Site ID: RP02WB
Arrival Time: 0915
Departure Time: 1000

Surface Water Sample Collection Log

Installation Name: Camp Ripley Date: 4-4-12
On-Site Personnel: Keller, Canino
Log Preparer: Keller
Site Location: ~~N~~: lat ~~E~~— long
46.2378 3409 -94.39096927

Observations

Stream Flow: Low/High/[✓ Normal] Water Color: Clear Odor: None

Field Measurements

Multi-Parameter Probe (Make/Model/#): YSI 556/ LaMotte 2020

Temp: 7.02 °C SpC: 0.366 ~~μ~~ms/cm pH: 6.69 DO: 11.35 mg/L
%Sat: 94.2 Turbidity: 1.02 NTU

Water Quality Sample Collection Verification

Composite Sampler (Make/Model/#): ISCO

Sample ID: RPSW02WB01 4-4-12 0935

Analytical Group
☐ Explosives ☐ Perchlorate ☒ Dissolved Metals (EPA 6020A) plus Hardness
☒ Dissolved Organic Carbon ☒ Dissolved Metals (EPA 1638M) plus Hardness
☒ Alkalinity ☒ Sulfate, Chloride

Quality Control Samples
☐ Duplicate ☐ MS/MSDs ☐ Field Blank ☐ Equipment Blank

Notes:

BK

URS

Site ID: RP03 WB
Arrival Time: 1555
Departure Time: 1620

Surface Water Sample Collection Log

Installation Name: Camp Ripley Date: 4-4-12
On-Site Personnel: Keller, Canino
Log Preparer: Keller
Site Location: ~~N:~~ E: lat 46.22974455
long -94.39638197

Observations

Stream Flow: Low/High/Normal None - puddles Water Color: Clear Odor: None

---

Field Measurements

Multi-Parameter Probe (Make/Model/#): YSI 556/LaMotte 2020

Temp: 16.42 °C SpC: .202 µS/cm pH: 7.63 DO: 8.15 mg/L
%Sat: 83.2 Turbidity: 1.20 NTU

Water Quality Sample Collection Verification

Composite Sampler (Make/Model/#): Grab - per. pump

Sample ID: RPSW03WB01 1615 4-4-12

Analytical Group

☐ Explosives ☐ Perchlorate ☒ Dissolved Metals (EPA 6020A) plus Hardness
☒ Dissolved Organic Carbon ☒ Dissolved Metals (EPA 1638M) plus Hardness
☒ Alkalinity ☒ Sulfate, Chloride

Quality Control Samples

☐ Duplicate ☐ MS/MSDs ☐ Field Blank ☐ Equipment Blank

Notes:

BK

URS

Site ID: RP04WB
Arrival Time: 1020
Departure Time: 1050

Surface Water Sample Collection Log

Installation Name: Camp Ripley
Date: 4-4-12
On-Site Personnel: Keller, Canino, Legg
Log Preparer: Keller
Site Location: N: lat: E: long:
46.1376428 -94.38029408

Observations

Stream Flow: Low/High/[✓ Normal] Water Color: Clear Odor: NONE

Field Measurements

Multi-Parameter Probe (Make/Model/#): YSI 556 / La Motte 2020

Temp: 5.36°C SpC: 0.358 mS/cm pH: 7.89 DO: 15.66 mg/L
%Sat: 122.2 Turbidity: 2.1 NTU

Water Quality Sample Collection Verification

Composite Sampler (Make/Model/#): ISCO

Sample ID: RPSW04WB01 4-4-12 1030

Analytical Group
☐ Explosives ☐ Perchlorate ☒ Dissolved Metals (EPA 6020A) plus Hardness
☒ Dissolved Organic Carbon ☒ Dissolved Metals (EPA 1638M) plus Hardness
☒ Alkalinity ☒ Sulfate, Chloride

Quality Control Samples
☐ Duplicate ☐ MS/MSDs ☐ Field Blank ☐ Equipment Blank

Notes:

BK

URS

Site ID: RP05WB
Arrival Time: 1100
Departure Time: 1200

Surface Water Sample Collection Log

Installation Name: Camp Ripley
Date: 4-4-12
On-Site Personnel: Keller, Camigo, Legg
Log Preparer: Keller
Site Location: ~~N: E:~~
lat. 46.13248229 long: -94.35085198

Observations

Stream Flow: Low/High/[✓ Normal] Water Color: Clear Odor: None

Field Measurements

Multi-Parameter Probe (Make/Model/#): YSI 556/LaMotte 2020

Temp: 8.07 °C SpC: 401 m µs/cm pH: 7.38 DO: 9.30 mg/L
%Sat: 78.3 Turbidity: 0.13 NTU

Water Quality Sample Collection Verification

Composite Sampler (Make/Model/#): ISCO

Sample ID: RPSW05WB01 4-4-12 1120

Analytical Group

☐ Explosives
☐ Perchlorate
☒ Dissolved Metals (EPA 6020A) plus Hardness
☒ Dissolved Organic Carbon
☒ Dissolved Metals (EPA 1638M) plus Hardness
☒ Alkalinity
☒ Sulfate, Chloride

Quality Control Samples

☐ Duplicate ☐ MS/MSDs ☐ Field Blank ☐ Equipment Blank

Notes:

URS

Site ID: RP06WB
Arrival Time: 1325
Departure Time: 1400

Surface Water Sample Collection Log

Installation Name: Camp Ripley Date: 4-4-12
On-Site Personnel: Keller, Canino, Legg
Log Preparer: Keller
Site Location: ~~N:~~ ~~E:~~ lat: 46.32601
long: -94.4500207

Observations

Stream Flow: Low/High/[✓ Normal] Water Color: lgt. Brown Odor: None

Field Measurements

Multi-Parameter Probe (Make/Model/#): YSI 556/ La Motte 2020

Temp: 8.70 °C SpC: 0.279 ~~µ~~ms/cm pH: 7.57 DO: 7.37 mg/L
%Sat: 62.7 Turbidity: 8.02 NTU

Water Quality Sample Collection Verification

Composite Sampler (Make/Model/#): ISCO

Sample ID: RPSW06WB01 1330 4-4-12

Analytical Group
☐ Explosives ☐ Perchlorate ☒ Dissolved Metals (EPA 6020A) plus Hardness
☒ Dissolved Organic Carbon ☒ Dissolved Metals (EPA 1638M) plus Hardness
☒ Alkalinity ☒ Sulfate, Chloride

Quality Control Samples
☐ Duplicate ☐ MS/MSDs ☐ Field Blank ☐ Equipment Blank

Notes:

BK

URS

Multi-parameter Probe Calibration Log Sheet

Date	Initials	Meter #	SC Std Lot #	SC (µs/cm) reading	SC (µs/cm) Check std	pH 4 Std Lot #	pH 4 Reading	pH 7 Std Lot #	pH 7 Reading	pH Check Std	Temp (oC)	Initial DO	Expected Do	Turbidity (NTU)
4/4/12	MC	10506	9187	1,413	1,413	2106053	3.96	2109104	6.99					1.0 = .11 10.0 = 23
4/5/12	MC	10506	9187	1,413	1,444	2106053	3.85	2109104	6.87					1.0 = 1.04 10 = 9.44

Cal-log-April
Camp Ripley
2012

APPENDIX C
ANALYTICAL TABLES

Surface Water Data
Camp Ripley, MN

Sample ID		RPSW01WA01				RPSW01WB01				RPSW02WA01				RPSW02WB01			
Sample Date		4/5/2012				4/4/2012				4/5/2012				4/4/2012			
Metals	**Units**	**Result**	**Laboratory Qualifier**	**Data Validation Flag**	**Reason Code**	**Result**	**Laboratory Qualifier**	**Data Validation Flag**	**Reason Code**	**Result**	**Laboratory Qualifier**	**Data Validation Flag**	**Reason Code**	**Result**	**Laboratory Qualifier**	**Data Validation Flag**	**Reason Code**
Antimony (Sb) (Dissolved)	µg/L	0.018	B			0.025				0.012	B			0.01	B		
Copper (Cu) (Dissolved)	µg/L	4.93	U	U	x	9.11	U	U	x	4.98	U	U	x	0.946	U	U	x
Lead (Pb) (Dissolved)	µg/L	0.008	B			0.013	B			0.058				0.007	B		
Zinc (Zn) (Dissolved)	µg/L	5.05	U	U	x	5.93	J	J	x	4.68	U	U	x	1.14	U	U	x
General Chemistry	**Units**	**Result**	**Laboratory Qualifier**	**Data Validation Flag**	**Reason Code**	**Result**	**Laboratory Qualifier**	**Data Validation Flag**	**Reason Code**	**Result**	**Laboratory Qualifier**	**Data Validation Flag**	**Reason Code**	**Result**	**Laboratory Qualifier**	**Data Validation Flag**	**Reason Code**
Hardness	mg/L	201				198				181				193			

Sample ID		RPSW03WA01				RPSW03WA01				RPSW04WA01				RPSW04WA02 (Duplicate of RPSW04WA01)			
Sample Date		4/5/2012				4/4/2012				4/5/2012				4/5/2012			
Metals	**Units**	**Result**	**Laboratory Qualifier**	**Data Validation Flag**	**Reason Code**	**Result**	**Laboratory Qualifier**	**Data Validation Flag**	**Reason Code**	**Result**	**Laboratory Qualifier**	**Data Validation Flag**	**Reason Code**	**Result**	**Laboratory Qualifier**	**Data Validation Flag**	**Reason Code**
Antimony (Sb) (Dissolved)	µg/L	0.013	B			0.013	B			0.05				0.053			
Copper (Cu) (Dissolved)	µg/L	10.2	U	U	x	4.29	U	U	x	10.8		J	x	0.449	U	U	x
Lead (Pb) (Dissolved)	µg/L	0.026				0.008	B			0.023	B			0.008	B		
Zinc (Zn) (Dissolved)	µg/L	6.34	J	J	x	4.01	U	U	x	7.99	J	J	x	1.24	U	U	x
General Chemistry	**Units**	**Result**	**Laboratory Qualifier**	**Data Validation Flag**	**Reason Code**	**Result**	**Laboratory Qualifier**	**Data Validation Flag**	**Reason Code**	**Result**	**Laboratory Qualifier**	**Data Validation Flag**	**Reason Code**	**Result**	**Laboratory Qualifier**	**Data Validation Flag**	**Reason Code**
Hardness	mg/L	122				128				199				199			

Sample ID		RPSW04WB01				RPSW05WA01				RPSW05WB01				RPSW06WA01			
Sample Date		4/4/2012				4/5/2012				4/4/2012				4/5/2012			
Metals	**Units**	**Result**	**Laboratory Qualifier**	**Data Validation Flag**	**Reason Code**	**Result**	**Laboratory Qualifier**	**Data Validation Flag**	**Reason Code**	**Result**	**Laboratory Qualifier**	**Data Validation Flag**	**Reason Code**	**Result**	**Laboratory Qualifier**	**Data Validation Flag**	**Reason Code**
Antimony (Sb) (Dissolved)	µg/L	0.049				0.059				0.057				0.036			
Copper (Cu) (Dissolved)	µg/L	4.64	U	U	x	0.318	U	U	x	1.07	U	U	x	0.747	U	U	x
Lead (Pb) (Dissolved)	µg/L	0.008	B			0.01	U			0.01	U			0.058			
Zinc (Zn) (Dissolved)	µg/L	3.4	U	U	x	0.51	U	U	x	0.7	U	U	x	2.21	U	U	x
General Chemistry	**Units**	**Result**	**Laboratory Qualifier**	**Data Validation Flag**	**Reason Code**	**Result**	**Laboratory Qualifier**	**Data Validation Flag**	**Reason Code**	**Result**	**Laboratory Qualifier**	**Data Validation Flag**	**Reason Code**	**Result**	**Laboratory Qualifier**	**Data Validation Flag**	**Reason Code**
Hardness	mg/L	202				202				203				108			

Sample ID		RPSW06WB01			
Sample Date		4/4/2012			
Metals	**Units**	**Result**	**Laboratory Qualifier**	**Data Validation Flag**	**Reason Code**
Antimony (Sb) (Dissolved)	µg/L	0.032			
Copper (Cu) (Dissolved)	µg/L	4.17	U	U	x
Lead (Pb) (Dissolved)	µg/L	0.017	B		
Zinc (Zn) (Dissolved)	µg/L	3.26	U	U	x
General Chemistry	**Units**	**Result**	**Laboratory Qualifier**	**Data Validation Flag**	**Reason Code**
Hardness	mg/L	107			

Laboratory Qualifiers Used

U Result is ≤ the MDL or client requested reporting limit (CRRL). Result reported a s the MDL or CRRL.
B Not detected substantially above the level reported in laboratory or field blanks.

Data Validation Flags Used

J Analyte present. Reported value may not be accurate or precise.

Reason Codes Used

x Field blank contamination

µg/L Micrograms per liter
mg/L Milligrams per liter

Surface Water Equipment Blank Data
Camp Ripley, MN

Sample ID		RPSW04WA03			
Sample Date		**4/5/2012**			
Metals	**Units**	**Result**	**Laboratory Qualifier**	**Data Validation Flag**	**Reason Code**
Antimony (Sb) (Dissolved)	µg/L	0.01	U		
Copper (Cu) (Dissolved)	µg/L	2.1			
Lead (Pb) (Dissolved)	µg/L	0.01	U		
Zinc (Zn) (Dissolved)	µg/L	1.09	J		
General Chemistry	**Units**	**Result**	**Laboratory Qualifier**	**Data Validation Flag**	**Reason Code**
Hardness	mg/L	0.04	U		

Laboratory Qualifiers Used

U Result is $\leq$ the MDL or client requested reporting limit (CRRL). Result reported a s the MDL or CRRL.

Data Validation Flags Used

J Analyte present. Reported value may not be accurate or precise.

µg/L Micrograms per liter
mg/L Milligrams per liter

APPENDIX D
DATA USABILITY SUMMARY REPORTS

DATA VALIDATION REPORT - Level III Review

SDG No.: BRL 1214047 **Fraction:** Metals

Laboratory: Brooks Rand Labs **Project:** Camp Ripley/15302622.40000

Reviewer: Naoum Tavantzis **Date:** 08/08/12

This report presents the findings of a review of the referenced data. The report consists/ of this summary, a listing of the samples included in the review, copies of data reports with data qualifying flags applied, data review worksheets, supporting documentation, and an explanation of the data qualifying flags employed. The review performed is based on the USEPA Region V Standard Operating Procedure for Validation of Inorganic (September, 1993) Data. Modifications reflect the level of review requested, the specifications of the project-specific QAPP, and the specifics of the analytical methods employed.

Major Anomalies: None.

Minor Anomalies The following blanks displayed concentrations greater than the method detection limit (MDL) for the following analytes:

Sequence	Blank	Analyte	Concentration	Units
1200274	ICB2	Antimony	0.022	µg/L
		Calcium	0.056	
		Lead	0.009	
		Magnesium	4.09	
		Zinc	0.18	
	RPSW03WA03 (Equipment Blank)	Copper	2.10	
		Magnesium	1.18	
		Zinc	1.09	
1200319		Calcium	8.07	
	B120768-BLK4		6.75	

In addition, the carboy certification lot 12-044 displayed a maximum detection for magnesium greater than the MDL at 18.0 µg/L. The associated field sample result that displayed a detection less than five times the maximum detection found in the carboy was qualified U,t and the concentration detected was raised to the limit of detection (LOD). Bracketing continuing calibration blanks did not displayed detections for any analyte; no data qualifying action was taken based on the initial calibration blank detections. The field sample result less than five times the method blank detection for calcium was qualified U,z. The calcium and magnesium detections found in the equipment blank RPSW03WA03 were previously qualified due to carboy certification failure or a method blank detection and no further data qualifying action was taken based on these detections. The associated field sample results less than five times the equipment blank detections for copper and zinc were qualified U,x and the LOD and the limit of quantitation (LOQ), noted as the MRL by the laboratory, were raised to the concentration detected. The associated field sample results less than ten times the equipment blank detections for copper and zinc were qualified J,x. The laboratory control spike B120606-BS1 displayed percent recoveries greater than the upper control limit of 120% for zinc at 124%. The associated positive field sample results were previously qualified due to equipment blank detections; no data qualifying action was required. The interference check standards displayed detections greater than the absolute value of the LOD for the following:

Date Analyzed	Sequence	Analyte	Concentration	Units
04/18/12	1200274	Antimony	1.787	µg/L
		Copper	12.57	
		Lead	1.383	
		Zinc	21.81	

In addition, the interference check standard in sequence 1200274 displayed a percent recovery greater than the upper control limit of 120% for zinc at 128%. Associated field sample results did not display concentrations for interfering elements at levels approximate to those found in the interference check standard; no data qualifying action was required. The field duplicate pair RPSW04WA01/RPSW04WA02 displayed a difference greater than two times the reporting limit of 0.202 µg/L for copper at 10.35 µg/L and a relative percent difference greater than the control limit of 35% for zinc at 146.3%. The associated field duplicate results were previously qualified due to equipment blank detections; no data qualifying action was required.

Correctable Anomalies: The hardness LOD for several samples was initially reported on the result forms at a value greater than the method reporting limit. The laboratory corrected the LODs, and provided revised result forms.

Comments: Digestion of the samples occurs in the original sample container and matrix spikes created during the analysis are similar to post-digestion spikes. On the basis of this evaluation, the laboratory appears to have followed the specified analytical methods with the exception of anomalies discussed above. All data are usable, as qualified, for their intended purpose based on the data reviewed.

Signed: ______________________
Naoum Tavantzis

Camp Ripley

Job #: 15302622.40000

Laboratory: BrooksRand Labs

SDG #: BRL 1214047

Sample	Client ID	Sample Type	Collected	Matrix	Metals
1214047-01	RPSW01WB01	Sample	4-Apr-12	Water	1
1214047-02	RPSW02WB01	Sample	4-Apr-12	Water	1
1214047-03	RPSW03WB01	Sample	4-Apr-12	Water	1
1214047-04	RPSW04WB01	Sample	4-Apr-12	Water	1
1214047-05	RPSW05WB01	Sample	4-Apr-12	Water	1
1214047-06	RPSW06WB01	Sample	4-Apr-12	Water	1
1214047-07	RPSW01WA01	Sample	5-Apr-12	Water	1
1214047-08	RPSW02WA01	Sample	5-Apr-12	Water	1
1214047-09	RPSW03WA01	Sample	5-Apr-12	Water	1
1214047-10	RPSW04WA01	Sample	5-Apr-12	Water	1
1214047-11	RPSW04WA02	Sample	5-Apr-12	Water	1
1214047-12	RPSW04WA03	Equipment Blank	5-Apr-12	Water	1
1214047-13	RPSW05WA01	Sample	5-Apr-12	Water	1
1214047-14	RPSW06WA01	Sample	5-Apr-12	Water	1

Camp Ripley
Duplicate Results

Client Sample ID:				**RPSW04WA01**		**RPSW04WA02**					
Date Sampled:				**4/5/12**		**12/8/11**					
	Units	**RL**	**5xRL**	**Sample Conc**		**Duplicate Conc**		**%RPD**	**Delta**	**2xRL**	**Pass/ Fail**
Inorganics											
Antimony	µg/L	0.020	0.100	0.050		0.053		5.8%	**0.003**	0.04	Pass
Calcium	µg/L	303	1515	56900		56300		**1.1%**	600	606	Pass
Copper	µg/L	0.101	0.505	10.8		0.449		184.0%	**10.35**	0.202	**Fail**
Hardness	mg/L	0.77	3.85	199		199		**0.0%**	0	1.54	Pass
Lead	µg/L	0.025	0.125	0.023	B	0.008	B	96.8%	**0.015**	0.05	Pass
Magnesium	µg/L	3.03	15.15	13800		14200		**2.9%**	400	6.06	Pass
Zinc	µg/L	0.20	1.00	7.99	J	1.24	J	**146.3%**	6.75	0.4	**Fail**

Control limit [sample]>5xRL use 35%
[sample]<5xRL use Delta<2xRL

Project ID: URS - LT1105
PM: Amanda Royal

BROOKS
RAND
LABS
MEANINGFUL METALS DATA

BRL Report 1214047 Rev. 1
Client PM: Andrea Sansom
Client PO: NCA-11-0071

Value Changed

Sample Results

Sample	Analyte	Fraction	Result	Qualifier	MDL	LOD	MRL	Unit	Batch	Sequence
RPSW01WA01						NAT 8/8/12				
1214047-07	Ca	D	57000		60.6	121	303	µg/L	B120768	1200319
1214047-07	Cu	D	4.93 U	U,x	0.040	~~0.081~~ 4.93	~~0.101~~ 4.93	µg/L	B120606	1200274
1214047-07	Hardness	D	201		0.15	0.35	0.77	mg eq CaCO3/L	[CALC]	N/A
1214047-07	Mg	D	14200		0.61	1.21	3.03	µg/L	B120606	1200274
1214047-07	Pb	D	0.008	B	0.005	0.010	0.025	µg/L	B120606	1200274
1214047-07	Sb	D	0.018	B	0.005	0.010	0.020	µg/L	B120606	1200274
1214047-07	Zn	D	5.05 U	~~J~~ NAT 8/8/12 U,x	0.06	~~0.12~~ 5.05 NAT 8/8/12	~~0.20~~ 5.05	µg/L	B120606	1200274
RPSW01WB01										
1214047-01	Ca	D	55300		60.6	121	303	µg/L	B120768	1200319
1214047-01	Cu	D	9.11 U	U,x	0.040	~~0.081~~ 9.11 NAT 8/8/12	~~0.101~~ 9.11	µg/L	B120606	1200274
1214047-01	Hardness	D	198		0.15	0.35	0.77	mg eq CaCO3/L	[CALC]	N/A
1214047-01	Mg	D	14600		0.61	1.21	3.03	µg/L	B120606	1200274
1214047-01	Pb	D	0.013	B	0.005	0.010	0.025	µg/L	B120606	1200274
1214047-01	Sb	D	0.025		0.005	0.010	0.020	µg/L	B120606	1200274
1214047-01	Zn	D	5.93 J,x	J	0.06	0.12	0.20	µg/L	B120606	1200274
RPSW02WA01										
1214047-08	Ca	D	47400		60.6	121	303	µg/L	B120768	1200319
1214047-08	Cu	D	4.98 U	U,x	0.040	~~0.081~~ 4.98 NAT 8/8/12	~~0.101~~ 4.98	µg/L	B120606	1200274
1214047-08	Hardness	D	181		0.15	0.35	0.77	mg eq CaCO3/L	[CALC]	N/A
1214047-08	Mg	D	15300		0.61	1.21	3.03	µg/L	B120606	1200274
1214047-08	Pb	D	0.058		0.005	0.010	0.025	µg/L	B120606	1200274
1214047-08	Sb	D	0.012	B	0.005	0.010	0.020	µg/L	B120606	1200274
1214047-08	Zn	D	4.68 U	~~J~~ NAT 8/8/12 U,x	0.06	~~0.12~~ 4.68 NAT 8/8/12	~~0.20~~ 4.68	µg/L	B120606	1200274

Sample Results

Value Changed

Sample	Analyte	Fraction	Result	Qualifier	MDL	LOD	MRL	Unit	Batch	Sequence
RPSW02WB01							NAT 8/8/12			
1214047-02	Ca	D	49600		60.6	121	303	µg/L	B120768	1200319
1214047-02	Cu	D	0.946 U	U,x	0.040	~~0.081~~ 0.946	~~0.101~~ 0.946	µg/L	B120606	1200274
1214047-02	Hardness	D	193		0.15	0.35	0.77	mg eq CaCO3/L	[CALC]	N/A
1214047-02	Mg	D	16700		0.61	1.21	3.03	µg/L	B120606	1200274
1214047-02	Pb	D	0.007	B	0.005	0.010	0.025	µg/L	B120606	1200274
1214047-02	Sb	D	0.010	B	0.005	0.010	0.020	µg/L	B120606	1200274
1214047-02	Zn	D	1.14 U	~~J~~ NAT 8/8/12 U,x	0.06	~~0.12~~ 1.14 NAT 8/8/12	~~0.20~~ 1.14	µg/L	B120606	1200274
RPSW03WA01							NAT 8/8/12			
1214047-09	Ca	D	32700		60.6	121	303	µg/L	B120768	1200319
1214047-09	Cu	D	10.2 U	U,x	0.040	~~0.081~~ 10.2	~~0.101~~ 10.2	µg/L	B120606	1200274
1214047-09	Hardness	D	122		0.15	0.35	0.77	mg eq CaCO3/L	[CALC]	N/A
1214047-09	Mg	D	9840		0.61	1.21	3.03	µg/L	B120606	1200274
1214047-09	Pb	D	0.026		0.005	0.010	0.025	µg/L	B120606	1200274
1214047-09	Sb	D	0.013	B	0.005	0.010	0.020	µg/L	B120606	1200274
1214047-09	Zn	D	6.34	J,x J	0.06	0.12	0.20	µg/L	B120606	1200274
RPSW03WB01										
1214047-03	Ca	D	33700		60.6	121	303	µg/L	B120768	1200319
1214047-03	Cu	D	4.29 U	U,x	0.040	~~0.081~~ 4.29 NAT 8/8/12	~~0.101~~ 4.29	µg/L	B120606	1200274
1214047-03	Hardness	D	128		0.15	0.35	0.77	mg eq CaCO3/L	[CALC]	N/A
1214047-03	Mg	D	10600		0.61	1.21	3.03	µg/L	B120606	1200274
1214047-03	Pb	D	0.008	B	0.005	0.010	0.025	µg/L	B120606	1200274
1214047-03	Sb	D	0.013	B	0.005	0.010	0.020	µg/L	B120606	1200274
1214047-03	Zn	D	4.01 U	~~J~~ NAT 8/8/12 U,x	0.06	~~0.12~~ 4.01 NAT 8/8/12	~~0.20~~ 4.01	µg/L	B120606	1200274

Sample Results

Value Changed

Sample	Analyte	Fraction	Result	Qualifier	MDL	LOD	MRL	Unit	Batch	Sequence
RPSW04WA01										
1214047-10	Ca	D	56900		60.6	121	303	µg/L	B120768	1200319
1214047-10	Cu	D	10.8	J,x	0.040	0.081	0.101	µg/L	B120606	1200274
1214047-10	Hardness	D	199		0.15	0.35	0.77	mg eq CaCO3/L	[CALC]	N/A
1214047-10	Mg	D	13800		0.61	1.21	3.03	µg/L	B120606	1200274
1214047-10	Pb	D	0.023	B	0.005	0.010	0.025	µg/L	B120606	1200274
1214047-10	Sb	D	0.050		0.005	0.010	0.020	µg/L	B120606	1200274
1214047-10	Zn	D	7.99	J J,x	0.06	0.12	0.20	µg/L	B120606	1200274
RPSW04WA02						NAT 8/8/12				
1214047-11	Ca	D	56300		60.6	121	303	µg/L	B120768	1200319
1214047-11	Cu	D	0.449 U	U,x	0.040	~~0.081~~ 0.449	~~0.101~~ 0.449	µg/L	B120606	1200274
1214047-11	Hardness	D	199		0.15	0.35	0.77	mg eq CaCO3/L	[CALC]	N/A
1214047-11	Mg	D	14200		0.61	1.21	3.03	µg/L	B120606	1200274
1214047-11	Pb	D	0.008	B	0.005	0.010	0.025	µg/L	B120606	1200274
1214047-11	Sb	D	0.053		0.005	0.010	0.020	µg/L	B120606	1200274
1214047-11	Zn	D	1.24U	U,x ~~J~~ NAT 8/8/12	0.06	~~0.12~~ 1.24	~~0.20~~ 1.24 NAT 8/8/12	µg/L	B120606	1200274
RPSW04WA03										
1214047-12	Ca	D NAT 8/8/12	~~8.07U~~ 12.1U	~~X B~~ U,Z NAT 8/8/12	6.06	12.1	30.3	µg/L	B120768	1200319
1214047-12	Cu	D	2.10		0.040	0.081	0.101	µg/L	B120606	1200274
1214047-12	Hardness	D	0.04	U	0.02	0.04	0.09	mg eq CaCO3/L	[CALC]	N/A
1214047-12	Mg	D NAT 8/8/12	~~1.18~~ 1.21U	NAT 8/8/12 ~~B~~ U,J	0.61	1.21	3.03	µg/L	B120606	1200274
1214047-12	Pb	D	0.010	U	0.005	0.010	0.025	µg/L	B120606	1200274
1214047-12	Sb	D	0.010	U	0.005	0.010	0.020	µg/L	B120606	1200274
1214047-12	Zn	D	1.09	J	0.06	0.12	0.20	µg/L	B120606	1200274

Sample Results

Value Changed

Sample	Analyte	Fraction	Result	Qualifier	MDL	LOD	MRL	Unit	Batch	Sequence
RPSW04WB01						NAT 8/8/12				
1214047-04	Ca	D	57300		60.6	121	303	µg/L	B120768	1200319
1214047-04	Cu	D	4.64 U	U,x	0.040	~~0.081~~ 4.64	~~0.101~~ 4.64	µg/L	B120606	1200274
1214047-04	Hardness	D	202		0.15	0.35	0.77	mg eq CaCO3/L	[CALC]	N/A
1214047-04	Mg	D	14400		0.61	1.21	3.03	µg/L	B120606	1200274
1214047-04	Pb	D	0.008	B	0.005	0.010	0.025	µg/L	B120606	1200274
1214047-04	Sb	D	0.049		0.005	0.010	0.020	µg/L	B120606	1200274
1214047-04	Zn	D	3.40U	U,x ~~J~~ NAT 8/8/12	0.06	~~0.12~~ 3.40 NAT 8/8/12	~~0.20~~ 3.40	µg/L	B120606	1200274
RPSW05WA01						NAT 8/8/12				
1214047-13	Ca	D	57600		60.6	121	303	µg/L	B120768	1200319
1214047-13	Cu	D	0.318U	U,x	0.040	~~0.081~~ 0.318	~~0.101~~ 0.318	µg/L	B120606	1200274
1214047-13	Hardness	D	202		0.15	0.35	0.77	mg eq CaCO3/L	[CALC]	N/A
1214047-13	Mg	D	14100		0.61	1.21	3.03	µg/L	B120606	1200274
1214047-13	Pb	D	0.010	U	0.005	0.010	0.025	µg/L	B120606	1200274
1214047-13	Sb	D	0.059		0.005	0.010	0.020	µg/L	B120606	1200274
1214047-13	Zn	D	0.51U	U,x ~~J~~ NAT 8/8/12	0.06	~~0.12~~ 0.51 NAT 8/8/12	~~0.20~~ 0.51	µg/L	B120606	1200274
RPSW05WB01										
1214047-05	Ca	D	56900		60.6	121	303	µg/L	B120768	1200319
1214047-05	Cu	D	1.07 U	U,x	0.040	~~0.081~~ 1.07	~~0.101~~ 1.07	µg/L	B120606	1200274
1214047-05	Hardness	D	203		0.15	0.35 NAT 8/8/12	0.77	mg eq CaCO3/L	[CALC]	N/A
1214047-05	Mg	D	14800		0.61	1.21	3.03	µg/L	B120606	1200274
1214047-05	Pb	D	0.010	U	0.005	0.010	0.025	µg/L	B120606	1200274
1214047-05	Sb	D	0.057		0.005	0.010	0.020	µg/L	B120606	1200274
1214047-05	Zn	D	0.70 U	U,x ~~J~~ NAT 8/8/12	0.06	~~0.12~~ 0.70 NAT 8/8/12	~~0.20~~ 0.70	µg/L	B120606	1200274

Sample Results

Value Changed

Sample	Analyte	Fraction	Result	Qualifier	MDL	LOD	MRL	Unit	Batch	Sequence
RPSW06WA01						NAT 8/8/12				
1214047-14	Ca	D	33000		60.6	121	303	µg/L	B120768	1200319
1214047-14	Cu	D	0.747 U	U,x	0.040	~~0.081~~ 0.747	~~0.101~~ 0.747	µg/L	B120606	1200274
1214047-14	Hardness	D	108		0.15	0.35	0.77	mg eq CaCO3/L	[CALC]	N/A
1214047-14	Mg	D	6310		0.61	1.21	3.03	µg/L	B120606	1200274
1214047-14	Pb	D	0.058		0.005	0.010	0.025	µg/L	B120606	1200274
1214047-14	Sb	D	0.036		0.005	0.010	0.020	µg/L	B120606	1200274
1214047-14	Zn	D	2.21U	U,x ✓NAT 8/8/12	0.06	~~0.12~~ 2.21	~~0.20~~ 2.21 NAT 8/8/12	µg/L	B120606	1200274
RPSW06WB01						NAT 8/8/12				
1214047-06	Ca	D	31900		60.6	121	303	µg/L	B120768	1200319
1214047-06	Cu	D	4.17 U	U,x	0.040	~~0.081~~ 4.17	~~0.101~~ 4.17	µg/L	B120606	1200274
1214047-06	Hardness	D	107		0.15	0.35	0.77	mg eq CaCO3/L	[CALC]	N/A
1214047-06	Mg	D	6670		0.61	1.21	3.03	µg/L	B120606	1200274
1214047-06	Pb	D	0.017	B	0.005	0.010	0.025	µg/L	B120606	1200274
1214047-06	Sb	D	0.032		0.005	0.010	0.020	µg/L	B120606	1200274
1214047-06	Zn	D	3.26U	U,x ✓NAT 8/8/12	0.06	~~0.12~~ 3.26 NAT 8/8/12	~~0.20~~ 3.26	µg/L	B120606	1200274

DATA VALIDATION WORKSHEET
INORGANIC - ICPMS (Sb, Ca, Cu, Pb, Mg, Zn)

Project: Camp Ripley
Reviewer: Naoum Tavantzis
Date: July 25, 2012

SDG No.: BRL 1214047
Project No.: 15302622.40000

_X_ USEPA Region V Standard Operating Procedure for Validation of Inorganic Data
_X_ SW-846/DoD QSM v4.2
_X_ Project QAPP/SAP

1.0 Chain of Custody/Sample Condition/Raw Data

		Yes	No	NA
1.1	Do Chain-of-Custody forms list all samples which were analyzed?	X		
1.2	Are all Chain-of-Custody forms signed, indicating sample chain-of-custody was maintained?	X		
1.3	Do the traffic Reports, chain-of-custody, and lab narrative indicate any problems with sample receipt, condition of samples, analytical problems or special circumstances affecting the quality of the data?		X	
1.4	Does sample preservation, collection and storage meet method requirement? (For metal: water samples: with Nitric Acid to pH < 2, and soil/sediment samples: 4 $^{O}C \pm 2\ ^{O}C$). Action J(+)/UJ or R(*-)	X		
1.5	Are the digestion logs present and complete with pH values, sample weights, dilutions, final volumes. % solids (for soil samples), and preparation dates? For any missing or incomplete documentation, contact the laboratory for explanation/resubmittal.	X		
1.6	Are the measurement read out records legible and complete (properly labeled, and include all samples and QC)?	X		
1.7	Are the percent solids less than 30%? Action: 10%-30% <10%	X		
	J(+)/R(-) R			

Note:

2.0 Holding Time

		Yes	No	NA
2.1	Have any technical holding times of 6 months, determined from date of collection to date of analysis, been exceeded? Action: R (water or soil)		X	

Note:

3.0 Instrument Calibration

		Yes	No	NA
3.1	Are the Quartlery LOD establishment forms provided for each instrument?	X		
3.2	Is the signal/noise ratio is less than 3:1? If not, is the determination repeated at a higher concentration?	X		
3.3	Are sufficient standards of a blank + one standard & a RL standard OR 3 standards and a blank with one standard at the RL included in the calibration curve? If not, qualify with "R".	X		
3.3.a	If more than one standard is used, are the correlation coefficients > 0.995? Action: J(+)/UJ(-).	X		
3.3.b	If only a one standard is used, is the low level calibration within control limits? Action: J(+)/UJ(-).			X
3.4	Was an initial calibration check standard (ICV) analyzed immediately after instrument system had been calibrated? Action: If no, all associated data are rejected "R".	X		
3.5	Was continuing calibration (CCV) analyzed at a minimum frequency of 10% (every 10 samples) during and at the end of the analytical run? If not, document and flag based on professional judgement.	X		
3.6	Are all calibration standard percent recoveries within the control limits of 90%-110%? ICV and CCV: Action: J(+)/R(-) J(+)/UJ(-) J(+) J(+)(maybe R(+) R(+) < 75% 75%-89% 111%-125% 125%<%R<160% >160%	X		
3.7	Was the high-level check standard included within 10% of the true value?	X		

Note:

4.0 Blanks

		Yes	No	NA
4.1	Were method blank (MB) prepared at the appropriate frequency (one / 20 samples, batch, or matrix)?	X		
4.2	Were calibration blanks (ICB and CCBs) analyzed immediately after each ICV and CCVs? Action: If the frequency of the CCBs does not follow requirement, all associated data are qualified "J".	X		
4.3	Are there reported MB or ICB/CCBs values > DL?	X		
	Blank Result >DL, but <5x LOQ >5x LOQ Sample Result <5x blank >5 blank R (+/-) U J			
4.4	Are there negative blank results with the absolute value > LOQ? If negative blank result is greater than the LOQ, reject all samples as unusable R(+/-).		X	
4.5	Are there reported field blank or equipment blank > ± DL? Use above rules.	X		

Note:

5.0 ICP Interference Check Sample (ICS)

		Yes	No	NA
5.1	Was ICS analyzed at beginning of each ICP run and every 12 hours?	X		
5.2	Are the ICS AB recoveries within 80% - 120%?		X	
5.3	Are the results for unspiked analytes (in ICS A) <LOD?		X	
5.4	If not, are the associated sample Al, Ca, Fe, and Mg concentrations less than the level in the ICS?	X		
	Action: Not Spiked Analytes Spiked analytes ≥DL but <10x |negative| ≥DL and <3x [positive] < 50% 50%-79% 120% J(+)/UJ(-) J(+) J(+)/R(-) J(+)/UJ(-) J(+)			

Note:

6.0 Laboratory Control Sample (LCS)

		Yes	No	NA
6.1	Was an LCS prepared and analyzed at the correct frequency (one / 20 samples, batch, or matrix)? Action: If no, J(+)/R(-) any sample not associated with LCS results.	X		
6.2	Is any LCS recovery outside the control limits?	X		
	Ag & Sb: <20% 20%-49% >150% <170% Others: <40% 40%-69% >130% >150% J(+)/R(-) J(+)/UJ(-) J(+) R(+/-)			

Note:

7.0 Laboratory Duplicates (MD)

		Yes	No	NA
7.1	Were Laboratory duplicates prepared and analyzed at the correct frequency (one / 20 samples, batch, or matrix)? If no, J(+), using professional judgement, analytes not associated with duplicate results.	X		
7.2	Are all RPDs less than 20%? If no, qualify all associated field samples for that analyte J(+) for the matrix from the site.	X		

Note:

8.0 Spike Sample Analysis

		Yes	No	NA
8.1	Was a spiked sample prepared and analyzed at the correct frequency (one / 20 samples, batch, or matrix)? If not, J(+) with professional judgement.	X		
8.2	Are any MS/MSD recovery outside the control limits?		X	
	For all analytes with sample concentration > 4 x spike concentration Matrix Spike %R <30% 30%-74% >125% PDS%R <75% ≥75% Any Any Action J(+)/R(-) J(+)/UJ(-) J(+)/UJ(-) J(+) Matrix Spike %R ≤30% 30%-74% >125% No PDS, Action: J(+)/R(-) J(+)/UJ(-) J(+)			
8.3	Are all RPDs less than 20%? If no, qualify all associated field samples J(+) for the batch.	X		

Note:

9.0 ICP/AA Serial Dilutions (Not for Mercury Analysis)

		Yes	No	NA
9.1	Were serial dilutions performed?	X		
9.2	Was a five-fold dilution performed?	X		
9.3	Did results agree within 10% for [sample] > 50 X DL in the original sample? If no, J(+)	X		
9.4	Where dilution test fails or [sample]<50xLOD, was a post-digestion spike performed? Note any recoveries greater than ±25%D in DV report. Qualify as per MS/MSD directions.	X		
9.5	When both dilution test and post-digestion spikes do not pass, was a method of standard additions used to quantitate the reported sample concentration? If not, ask lab to comment.			X

Note: ______

10.0 Field Duplicate Samples

		Yes	No	NA
10.1	Were any field duplicates submitted for metal analysis?	X		
	For sample results > 5 x RL, a control limit of ≤35% RPD will be used. For sample results < 5 x RL, a control limit of 2 x RL will be used.			
10.2	Are all analyte duplicate results within control limits? If not, qualify all associated field samples for that analyte. J(+) for the matrix from this site.		X	

Note: ______

11.0 Result Verification/ Internal Standards/ Tune

		Yes	No	NA
11.1	Are all MDLs/RLs equal to or less than the reporting limits specified?	X		
11.2	Were all results and detection limits for solid-matrix samples reported on a dry-weight basis?			X
11.3	Were all dilutions reflected in the positive results and detection limits?	X		
11.4	Were the Internal Standard recoveries within 70-130%. Action: J(+)/UJ(-)	X		
11.5	Were the tunes run at a minimum of four times with RSD < 5% for analytes in solution? Action: J(+)/UJ(-)	X		
11.6	Were the tune mass calibrations < 0.1 amu from the true value? Action: J(+)/UJ(-)	X		
11.7	Was the resolution check peak width < 0.9 amu at 10% peak height? Action: J(+)/UJ(-)	X		

Note: ______

12.0 Completeness Calculation

		Yes	No	NA
12.1	Is % completeness within the control limits? (Control limit 90%)	X		
12.2	Number of samples: 14			
12.3	Number of target compounds in each analysis: 6			
12.4	Number of results rejected and not reported: 0			
	% Completeness = (12.1.1 x 12.1.2 - 12.1.3) x 100/(12.1.1 x 12.1.2) % Completeness = 100%			

DATA VALIDATION WORKSHEET

Hardness

Reviewer: Naoum Tavantzis
Date: 6/13/2012
DV Level: II [✓ III] IV
Review Document:
_X_ Guidelines for Data Review of CLP Analytical Services Inorganic Data Packages
_X_ Project QAPP/SAP

Project Name: Camp Ripley
Project Number: 15302622.40000
Laboratory: BrooksRand
SDG No.: BRL 1214047
Test Name: Hardness
Method No.: SM 2340B

1.0 Laboratory Deliverables

		Yes	No	NA
1.1	Do Chain-of-Custody forms list all samples that were analyzed?	X		
1.2	Are all Chain-of-Custody forms signed, indicating sample chain-of-custody was maintained?	X		
1.3	Do sample preservation, collection and storage condition meet method requirement?	X		
	Water: pH<2 Soil/Sediment samples: 4°C + 2°C). Action: Professional judgement or J-(+)/R(-)			
1.4	Do the traffic Reports, chain-of-custody, and lab narrative indicate any problems with sample receipt, condition of samples, analytical problems or special circumstances affecting the quality of the data?		X	

Notes:

2.0 Holding Time

		Yes	No	NA
2.1	Have any technical holding times of 6 months, determined from date of collection to date of analysis, been exceeded? Action: Use professional judgement, then J-(+)/R(-)		X	

Note:

3.0 Instrument Calibration

		Yes	No	NA
3.1	Are the Quartlery LOD establishment forms provided for each instrument?	X		
3.2	Is the signal/noise ratio less than 3:1? If not, is the determination repeated at a higher concentration?	X		
3.3	Are sufficient standards of a blank + one standard & a RL standard OR 3 standards and a blank with one standard at the RL included in the calibration curve? If not, qualify with "R".	X		
3.3.a	If more than one standard is used, are the correlation coefficients > 0.995? Action: J(+)/UJ(-).	X		
3.4	Was an initial calibration check standard (ICV) analyzed immediately after instrument system had been calibrated? Action: If no, all associated data are rejected "R".	X		
3.5	Was continuing calibration (CCV) analyzed at a minimum frequency of 10% (every 10 samples) during and at the end of the analytical run? If not, document and flag based on professional judgement.	X		
3.6	Are all calibration standard percent recoveries within the control limits of 90%-110%? ICV and CCV: < 75% 75%-89% 111%-125% 125%<%R<160% >160% Action: J-(+)/R(-) J-(+)/UJ(-) J+(+) J+(+)(maybe R(+)) R(+)	X		
3.7	Was the high-level check standard included within 10% of the true value?	X		

Note:

11.0 Result Verification/ Internal Standards/ Tune

		Yes	No	NA
11.1	Are all DLs/RLs equal to or less than the reporting limits specified?	X		
11.2	Were all results and detection limits for solid-matrix samples reported on a dry-weight basis?	X		
11.3	Were all dilutions reflected in the positive results and detection limits?	X		
11.4	Is there an Internal Standard associated with all analytes? R(+/-)	X		
11.5	Were the Internal Standard recoveries within 65-125%. Action: J(+)/UJ(-)	X		
11.6	Was a tune performed? If not, R(+/-) all associated samples.	X		
11.7	Were the tunes run at a minimum of four times with RSD < 5% for analytes in solution? Action: J(+)/UJ(-)	X		
11.8	Were the tune mass calibrations < 0.1 amu from the true value? Action: J(+)/UJ(-)	X		
11.9	Was the resolution check peak width < 0.9 amu at 10% peak height? Action: J(+)/UJ(-)	X		

Note:

6.0 Compound Identification and Detection Limit Verification

		Yes	No	NA
6.1	Do detection limits meet those required by the project QAPP and were they properly adjusted for dilution factors and moisture (including adjustment of wet weight aliquot)?	X		
6.2	Did the concentratrion of magnesium and/or calcium exceed the linear range of the instrument? If so, J(+).		X	
6.3	If a concentration exceeded the linear range of the instument, was a dilution performed?	X		

Notes:

7.0 Data Completeness

		Yes	No	NA
7.1	Is % completeness for certainty? (Control limit 90%)	X		
7.1.1	Number of samples: 14			
7.1.2	Number of target compounds in each analysis: 1			
7.1.3	Number of results that are uncertain at comparison criteria standard:			
	% Completeness = (7.1.1 x 7.1.2 - 7.1.3) x 100/(7.1.1 x 7.1.2)			
	% Completeness = 100			

Hardness Calculation

$$\frac{M_{CaCO_3}}{M_{Ca}} = \frac{100.088}{40.08} = 2.497$$

$$\frac{M_{CaCO_3}}{M_{Mg}} = \frac{100.088}{24.305} = 4.118$$

$$[CaCO_3]=2.497[Ca^{2+}]+4.118[Mg^{2+}]$$

Field Samples:

Sample ID:	RPSW01WA01	
	$[Ca^{2+}]$	57000
	$[Mg^{2+}]$	14200.00
Calculated	Hardness:	201
Reported	Hardness:	201

Sample ID:	RPSW01WB01	
	$[Ca^{2+}]$	55300
	$[Mg^{2+}]$	14600
Calculated	Hardness:	198
Reported	Hardness:	198

Sample ID:	RPSW02WA01	
	$[Ca^{2+}]$	47400
	$[Mg^{2+}]$	15300.00
Calculated	Hardness:	181
Reported	Hardness:	181

Sample ID:	RPSW02WB01	
	$[Ca^{2+}]$	49600
	$[Mg^{2+}]$	16700
Calculated	Hardness:	193
Reported	Hardness:	193

Sample ID:	RPSW03WA01	
	$[Ca^{2+}]$	32700
	$[Mg^{2+}]$	9840
Calculated	Hardness:	122
Reported	Hardness:	122

Sample ID:	RPSW03WB01	
	$[Ca^{2+}]$	33700
	$[Mg^{2+}]$	10600.00
Calculated	Hardness:	128
Reported	Hardness:	128

Sample ID:	RPSW04WA01	
	$[Ca^{2+}]$	56900
	$[Mg^{2+}]$	13800
Calculated	Hardness:	199
Reported	Hardness:	199

Sample ID:	RPSW04WA02	
	$[Ca^{2+}]$	56300
	$[Mg^{2+}]$	14200.00
Calculated	Hardness:	199
Reported	Hardness:	199

Sample ID:	RPSW04WA03	
	$[Ca^{2+}]$	8.07
	$[Mg^{2+}]$	1.18
Calculated	Hardness:	0.025
Reported	Hardness:	<3.36

Sample ID:	RPSW04WB01	
	$[Ca^{2+}]$	57300
	$[Mg^{2+}]$	14400
Calculated	Hardness:	202
Reported	Hardness:	202

Hardness Calculation

$$\frac{M_{CaCO_3}}{M_{Ca}} = \frac{100.088}{40.08} = 2.497$$

$$\frac{M_{CaCO_3}}{M_{Mg}} = \frac{100.088}{24.305} = 4.118$$

$$[CaCO_3]=2.497[Ca^{2+}]+4.118[Mg^{2+}]$$

Field Samples:

Sample ID:	RPSW05WA01	
	$[Ca^{2+}]$	57600
	$[Mg^{2+}]$	14100.00
Calculated	Hardness:	202
Reported	Hardness:	202

Sample ID:	RPSW05WB01	
	$[Ca^{2+}]$	56900
	$[Mg^{2+}]$	14800
Calculated	Hardness:	203
Reported	Hardness:	203

Sample ID:	RPSW06WA01	
	$[Ca^{2+}]$	33000
	$[Mg^{2+}]$	6310.00
Calculated	Hardness:	108
Reported	Hardness:	108

Sample ID:	RPSW06WB01	
	$[Ca^{2+}]$	31900
	$[Mg^{2+}]$	6670
Calculated	Hardness:	107
Reported	Hardness:	107

Instrument Calibration

Sequence: 1200274
Instrument: ICP-MS-2
Date: 04/18/2012
Analyte: Cu 63

MDL = .04

Trace Metals by ICP-MS
Method: EPA 1638

Lab ID	True Value	Result	Units	REC & Limits	
1200274-ICB1		0.000	µg/L		
1200274-CAL1	0.1000	0.098	µg/L	98%	
1200274-CAL2	0.2000	0.205	µg/L	103%	
1200274-CAL3	1.000	1.049	µg/L	105%	
1200274-CAL4	5.000	5.295	µg/L	106%	
1200274-CAL5	10.00	10.36	µg/L	104%	
1200274-CAL6	50.00	48.84	µg/L	98%	
1200274-CAL7	100.0	94.07	µg/L	94%	
1200274-CAL8	200.0	186.4	µg/L	93%	
1200274-ICB2		0.056	µg/L		
1200274-ICV1	5.000	5.306	µg/L	106%	90-110
1200274-ICB3		-0.001	µg/L		
1200274-IBL1		-0.002	µg/L		
1200274-IBL2		-0.004	µg/L		
1200274-IBL3		-0.003	µg/L		
1200274-IBL4		-0.003	µg/L		
1200274-SCV2	22.76	22.42	µg/L	99%	75-125
1200274-IFA1	0.00001000	12.57	µg/L	*N/A*	N/A
1200274-IFB1	100.0	114.5	µg/L	115%	80-120
1200274-CCV1	5.000	5.208	µg/L	104%	90-110
1200274-CCB1		-0.003	µg/L		
1200274-CCV2	5.000	5.288	µg/L	106%	90-110
1200274-CCB2		-0.005	µg/L		
1200274-CCV3	5.000	5.380	µg/L	108%	90-110
1200274-CCB3		-0.003	µg/L		
1200274-CCV4	5.000	5.370	µg/L	107%	90-110
1200274-CCB4		-0.005	µg/L		
1200274-CCV5	10.00	10.47	µg/L	105%	90-110
1200274-CCB5		-0.004	µg/L		
1200274-CCV6	10.00	10.61	µg/L	106%	90-110
1200274-CCB6		-0.003	µg/L		

Instrument Calibration

Sequence: 1200274
Instrument: ICP-MS-2
Date: 04/18/2012
Analyte: Mg

Trace Metals by ICP-MS
Method: EPA 1638

MO2 = .61

Lab ID	True Value	Result	Units	REC & Limits	
1200274-ICB1		0.00	µg/L		
1200274-CAL1	3.000	3.05	µg/L	102%	
1200274-CAL2	6.000	5.87	µg/L	98%	
1200274-CAL3	30.00	28.56	µg/L	95%	
1200274-CAL4	200.0	181.9	µg/L	91%	
1200274-CAL5	2000	2009	µg/L	100%	
1200274-CAL6	10000	10300	µg/L	103%	
1200274-CAL7	20000	22170	µg/L	111%	
1200274-CAL8	40000	50620	µg/L	127%	
1200274-ICB2		4.09	µg/L		
1200274-ICV1	200.0	196.3	µg/L	98%	90-110
1200274-ICB3		0.32	µg/L		
1200274-IBL1		0.54	µg/L		
1200274-IBL2		0.30	µg/L		
1200274-IBL3		0.30	µg/L		
1200274-IBL4		0.29	µg/L		
1200274-SCV2	8037	8259	µg/L	103%	75-125
1200274-SCV3	34000	36310	µg/L	107%	75-125
1200274-IFA1	500000	505900	µg/L	101%	80-120
1200274-IFB1	500000	489600	µg/L	98%	80-120
1200274-CCV1	200.0	181.9	µg/L	91%	90-110
1200274-CCB1		0.32	µg/L		
1200274-CCV2	200.0	185.7	µg/L	93%	90-110
1200274-CCB2		0.32	µg/L		
1200274-CCV3	200.0	182.1	µg/L	91%	90-110
1200274-CCB3		0.32	µg/L		
1200274-CCV4	200.0	180.1	µg/L	90%	90-110
1200274-CCB4		0.47	µg/L		
1200274-CCV5	2000	1972	µg/L	99%	90-110
1200274-CCB5		0.49	µg/L		
1200274-CCV6	2000	1909	µg/L	95%	90-110
1200274-CCB6		0.50	µg/L		

Instrument Calibration

Sequence: 1200274
Instrument: ICP-MS-2
Date: 04/18/2012
Analyte: Pb

Trace Metals by ICP-MS
Method: EPA 1638

MDL ≈ .005

Lab ID	True Value	Result ✓	Units	REC & Limits	
1200274-ICB1		0.000 ✓	µg/L		
1200274-CAL1	0.02500	0.025	µg/L	99%	
1200274-CAL2	0.05000	0.050	µg/L	100%	
1200274-CAL3	0.2500	0.269	µg/L	108%	
1200274-CAL4	2.500	2.638	µg/L	106%	
1200274-CAL5	5.000	5.171	µg/L	103%	
1200274-CAL6	10.00	9.856	µg/L	99%	
1200274-CAL7	25.00	23.66	µg/L	95%	
1200274-CAL8	50.00	45.57	µg/L	91%	
1200274-ICB2		0.009	µg/L		
1200274-ICV1	2.500	2.682	µg/L	107%	90-110
1200274-ICB3		-0.002 ✓	µg/L		
1200274-IBL1		-0.0007	µg/L		
1200274-IBL2		-0.002	µg/L		
1200274-IBL3		-0.002	µg/L		
1200274-IBL4		-0.003	µg/L		
1200274-SCV2	19.63	19.52	µg/L	99%	75-125
1200274-IFA1	0.00001000	1.383	µg/L	*N/A*	N/A
1200274-IFB1	0.00001000	2.104	µg/L	*N/A*	N/A
1200274-CCV1	2.500	2.652	µg/L	106%	90-110
1200274-CCB1		-0.002	µg/L		
1200274-CCV2	2.500	2.622	µg/L	105%	90-110
1200274-CCB2		-0.002	µg/L		
1200274-CCV3	2.500	2.604	µg/L	104% ✓	90-110
1200274-CCB3		-0.002 ✓	µg/L		
1200274-CCV4	2.500	2.599	µg/L	104% ✓	90-110
1200274-CCB4		-0.003 ✓	µg/L		
1200274-CCV5	5.000	5.082	µg/L	102% ✓	90-110
1200274-CCB5		-0.002 ✓	µg/L		
1200274-CCV6	5.000	5.185	µg/L	104% ✓	90-110
1200274-CCB6		-0.002 ✓	µg/L		

Instrument Calibration

Sequence: 1200274
Instrument: ICP-MS-2
Date: 04/18/2012
Analyte: Sb

Trace Metals by ICP-MS
Method: EPA 1638

MDL = .005

Lab ID	True Value	Result ✓	Units	REC & Limits	
1200274-ICB1		0.000 ✓	µg/L		
1200274-CAL1	0.02000	0.020	µg/L	100	
1200274-CAL2	0.04000	0.040	µg/L	100	
1200274-CAL3	0.2000	0.200	µg/L	100	
1200274-CAL4	1.000	1.008	µg/L	101	
1200274-CAL5	2.000	2.017	µg/L	101	
1200274-CAL6	4.000	3.967	µg/L	99%	
1200274-CAL7	10.00	9.849	µg/L	98%	
1200274-CAL8	20.00	20.12	µg/L	101	
1200274-ICB2		0.022	µg/L		
1200274-ICV1	1.000	1.075	µg/L	107	90-110
1200274-ICB3		0.001 ✓	µg/L		
1200274-IBL1		0.001	µg/L		
1200274-IBL2		0.0003	µg/L		
1200274-IBL3		0.0002	µg/L		
1200274-IBL4		0.0006	µg/L		
1200274-SCV2	58.30	58.15	µg/L	100	75-125
1200274-IFA1	0.0000100	1.787	µg/L	*N/A*	N/A
1200274-IFB1	0.0000100	2.459	µg/L	*N/A*	N/A
1200274-CCV1	1.000	1.033	µg/L	103	90-110
1200274-CCB1		0.0007	µg/L		
1200274-CCV2	1.000	1.012	µg/L	101	90-110
1200274-CCB2		0.001	µg/L		
1200274-CCV3	1.000	0.999 ✓	µg/L	100 ✓	90-110
1200274-CCB3		0.001 ✓	µg/L		
1200274-CCV4	1.000	0.990 ✓	µg/L	99% ✓	90-110
1200274-CCB4		0.0009 ✓	µg/L		
1200274-CCV5	2.000	2.006 ✓	µg/L	100 ✓	90-110
1200274-CCB5		0.003 ✓	µg/L		
1200274-CCV6	2.000	2.020 ✓	µg/L	101 ✓	90-110
1200274-CCB6		0.002 ✓	µg/L		

Instrument Calibration

Sequence: 1200274
Instrument: ICP-MS-2
Date: 04/18/2012
Analyte: Zn 66

MDL = .06

Trace Metals by ICP-MS
Method: EPA 1638

Lab ID	True Value	Result ✓	Units	REC & Limits	
1200274-ICB1		0.00 ✓	µg/L		
1200274-CAL1	0.2000	0.19	µg/L	97%	
1200274-CAL2	0.4000	0.42	µg/L	105%	
1200274-CAL3	2.000	2.10	µg/L	105%	
1200274-CAL4	5.000	5.13	µg/L	103%	
1200274-CAL5	50.00	51.11	µg/L	102%	
1200274-CAL6	250.0	247.3	µg/L	99%	
1200274-CAL7	500.0	476.9	µg/L	95%	
1200274-CAL8	1000	939.6	µg/L	94%	
1200274-ICB2		0.18	µg/L		
1200274-ICV1	5.000	5.35	µg/L	107%	90-110
1200274-ICB3		-0.001 ✓	µg/L		
1200274-IBL1		0.0001	µg/L		
1200274-IBL2		-0.02	µg/L		
1200274-IBL3		-0.02	µg/L		
1200274-IBL4		-0.01	µg/L		
1200274-SCV2	78.50	74.71	µg/L	95%	75-125
1200274-IFA1	0.00001000	21.81	µg/L	*N/A*	N/A
1200274-IFB1	100.0	127.8	µg/L	*128%*	80-120
1200274-CCV1	5.000	5.32	µg/L	106%	90-110
1200274-CCB1		-0.01	µg/L		
1200274-CCV2	5.000	5.26	µg/L	105%	90-110
1200274-CCB2		-0.01	µg/L		
1200274-CCV3	5.000	5.32	µg/L	106% ✓	90-110
1200274-CCB3		-0.003 ✓	µg/L		
1200274-CCV4	5.000	5.24 ✓	µg/L	105% ✓	90-110
1200274-CCB4		-0.02	µg/L		
1200274-CCV5	50.00	52.20	µg/L	104% ✓	90-110
1200274-CCB5		-0.02 ✓	µg/L		
1200274-CCV6	50.00	52.13 ✓	µg/L	104% ✓	90-110
1200274-CCB6		-0.01	µg/L		

Accuracy & Precision Summary

Batch: B120606
Lab Matrix: Water
Method: EPA 1638

Sample	Analyte	Native	Spike	Result	Units	REC & Limits	RPD & Limits
B120606-BS1	**Laboratory Fortified Blank (1214036)**						
	Pb		0.03030	0.034	µg/L	113% 80-120	
	Zn		4.040	5.00	µg/L	124% 80-120	
B120606-BS2	**Laboratory Fortified Blank (1210062)**						
	Cu		2.020	2.144	µg/L	106% 80-120	
	Mg		60.61	58.68	µg/L	97% 80-120	
	Pb		0.5051	0.532	µg/L	105% 80-120	
	Sb		0.4040	0.367	µg/L	91% 80-120	
	Zn		4.040	4.76	µg/L	118% 80-120	
B120606-SRM1	**Certified Reference Material (1202032, NIST 1643e)**						
	Cu		22.76	22.42	µg/L	99% 75-125	
	Mg		8037	8259	µg/L	103% 75-125	
	Pb		19.63	19.52	µg/L	99% 75-125	
	Sb		58.30	58.15	µg/L	100% 75-125	
	Zn		78.50	74.71	µg/L	95% 75-125	
B120606-DUP1	**Duplicate (1214047-07)**						
	Cu	4.928		4.945	µg/L		0.3% 20
	Mg	14170		14040	µg/L		0.9% 20
	Pb	0.008		0.009	µg/L		19% 20
	Sb	0.018		0.018	µg/L		3% 20
	Zn	5.05		4.83	µg/L		5% 20
B120606-DUP2	**Duplicate (1214047-07)**						
	Cu	4.928		5.191	µg/L		5% 10
	Mg	14170		13180	µg/L		7% 10
	Pb	0.008		ND	µg/L		N/C 10
	Sb	0.018		ND	µg/L		N/C 10
	Zn	5.05		4.63	µg/L		9% 10

Method Blanks & Reporting Limits

Batch: B120768
Matrix: Water
Method: EPA 1638
Analyte: Ca

Sample	Result	Units
B120768-BLK1	3.38	µg/L
B120768-BLK2	4.82	µg/L
B120768-BLK3	4.56	µg/L
B120768-BLK4	6.75	µg/L

DoD QSEM Limit: 15.15

MDL: 6.06
MRL: 30.3

Trace Metals Method BR-0065 Rev 004a (ICP-MS)
1% Nitric Acid Digestion

Batch #(s): B120606, 0603, 0607

Page 1 of 2

Workorder #(s): ~~120~~ cc 4/12/12 1214047, 4037, 4021

Preparation Date and Time*: 4/12/12 10:40

Prepared By: CCE

Date and Time of Finished Preparation: 4/13/12 09:25

* Time is when the first reagents are added.

Sample ID	Sample Vol.(mL)	Acid Added (mL)
BLK1	125	1.25
BLK2		
BLK3		
BLK4		
B120606 BS1		
B120606 BS2/B120603 0607 BS1	↓	↓
Δ 1214047-01	125	1.125
-02		
-03		
-04		
-05		
-06		
-07		
-08		
-09		
-10		
-11		
-12		
-13		
↓ -14	↓	
Δ 1214037-01	125	↓

Sample ID	Sample Vol.(mL)	Acid Added (mL)
Δ 1214037-02	125	1.125
-03		
↓ -04	↓	
Δ 1214021-01	125	
-02		
-03		
-04		
-05		
-06		
-07		
-08		
-09		
-10		
-11		
-12		
-13		
-14		
-15		
-16		
-17		
↓ -18	↓	↓

Balance ID: BL-01
Oven ID: OV-05
HNO₃ ID: 1210059
Bottle lot #: 12-080

circle [✓ 125mL] or 250mL	standard	mL to add to 125mL bottle	mL to add to 250mL bottle	Standard ID
B120606 BS1	DOD Mix	0.125	0.25	1214036
	0.02 ppm Sb	0.063*	0.125	1212065
B120606 BS2 ~~(STD mode BS1)~~ B120603/0607 BS1	ML-1	2.50	5.00	1210062
	0.02 ppm Sb	2.50	5.00	1212065

* = vol rounded up to nearest 0.001th

Spike Witness Initials/Date: MEL 4/12/12

Target Temp: 85°C ± 5°C
Time/Temp* In: M:89°C C:87°C 11:45 4/12/12
Time/Temp* Out: M:91°C C:89°C 4/13/12 09:25
Thermometer ID: TM-01

*** Both measured and corrected temperatures must be recorded.**

Comments: Δ: pre-preserved w/0.1% HNO_3.

Sample Information

Sample	Lab ID	Report Matrix	Type	Sampled	Received
RPSW01WB01	1214047-01	Water	Sample	04/04/2012	04/06/2012
RPSW02WB01	1214047-02	Water	Sample	04/04/2012	04/06/2012
RPSW03WB01	1214047-03	Water	Sample	04/04/2012	04/06/2012
RPSW04WB01	1214047-04	Water	Sample	04/04/2012	04/06/2012
RPSW05WB01	1214047-05	Water	Sample	04/04/2012	04/06/2012
RPSW06WB01	1214047-06	Water	Sample	04/04/2012	04/06/2012
RPSW01WA01	1214047-07	Water	Sample	04/05/2012	04/06/2012
RPSW02WA01	1214047-08	Water	Sample	04/05/2012	04/06/2012
RPSW03WA01	1214047-09	Water	Sample	04/05/2012	04/06/2012
RPSW04WA01	1214047-10	Water	QC Sample	04/05/2012	04/06/2012
RPSW04WA02	1214047-11	Water	Sample	04/05/2012	04/06/2012
RPSW04WA03	1214047-12	Water	Sample	04/05/2012	04/06/2012
RPSW05WA01	1214047-13	Water	Sample	04/05/2012	04/06/2012
RPSW06WA01	1214047-14	Water	Sample	04/05/2012	04/06/2012

Batch Summary

Analyte	Lab Matrix	Method	Prepared	Analyzed	Batch	Sequence
Ca	Water	EPA 1638	04/12/2012	05/02/2012	B120768	1200319
Cu	Water	EPA 1638	04/12/2012	04/18/2012	B120606	1200274
Mg	Water	EPA 1638	04/12/2012	04/18/2012	B120606	1200274
Pb	Water	EPA 1638	04/12/2012	04/18/2012	B120606	1200274
Sb	Water	EPA 1638	04/12/2012	04/18/2012	B120606	1200274
Zn	Water	EPA 1638	04/12/2012	04/18/2012	B120606	1200274

Report Information

Laboratory Accreditation

BRL is accredited by the *National Environmental Laboratory Accreditation Program* (NELAP) through the State of Florida Department of Health, Bureau of Laboratories (E87982) and is certified to perform many environmental analyses. BRL is also certified by many other states to perform environmental analyses. For a current list of our accreditations /certifications, please visit our website at <http://www.brooksrand.com/default.asp?contentID=586>. Results reported relate only to the samples listed in the report.

Field Quality Control Samples

Please be notified that certain EPA methods require the collection of field quality control samples of an appropriate type and frequency; failure to do so is considered a deviation from some methods and for compliance purposes should only be done with the approval of regulatory authorities. Please see the specific EPA methods for details regarding required field quality control samples.

Common Abbreviations

BLK	method blank	**MS**	matrix spike
BRL	Brooks Rand Labs	**MSD**	matrix spike duplicate
BS	laboratory fortified blank	**ND**	non-detect
CAL	calibration standard	**NR**	non-reportable
CCV	continuing calibration verification	**PS**	post preparation spike
COC	chain of custody record	**REC**	percent recovery
CRM	certified reference material	**RPD**	relative percent difference
D	dissolved fraction	**RSD**	relative standard deviation
DUP	duplicate	**SCV**	secondary calibration verification
ICV	initial calibration verification	**SOP**	standard operating procedure
MDL	method detection limit	**SRM**	standard reference material
MRL	method reporting limit	**T**	total recoverable fraction

Definition of Data Qualifiers

(Effective 9/23/09)

B	Detected by the instrument, the result is > the MDL but ≤ the MRL. Result is reported and considered an estimate.
E	An estimated value due to the presence of interferences. A full explanation is presented in the narrative.
H	Holding time and/or preservation requirements not met. Result is estimated.
J	Estimated value. A full explanation is presented in the narrative.
J-M	Duplicate precision (RPD) for associated QC sample was not within acceptance criteria. Result is estimated.
J-N	Spike recovery for associated QC sample was not within acceptance criteria. Result is estimated.
M	Duplicate precision (RPD) was not within acceptance criteria. Result is estimated.
N	Spike recovery was not within acceptance criteria. Result is estimated.
R	Rejected, unusable value. A full explanation is presented in the narrative.
U	Result is ≤ the MDL or client requested reporting limit (CRRL). Result reported as the MDL or CRRL.
X	Result is not BLK-corrected and is within 10x the absolute value of the highest detectable BLK in the batch. Result is estimated.

These qualifiers are based on those previously utilized by Brooks Rand, Ltd., those found in the EPA SOW ILM03.0, Exhibit B, Section III, pg. B-18, and the USEPA Laboratory Data Validation Functional Guidelines for Evaluating Inorganic Analyses; USEPA; July 2002. These supersede all previous qualifiers ever employed by BRL.

Certificate of Analysis

BRL Report 1214047

BROOKS
RAND
LABS
CERTIFIED

Sampling Equipment

Product Number: 11-320 (4L HDPE)

Product Description: 4L HDPE

BRL Lot Number: 11-320

Date of Analysis: November 11th, 2011 (SEQ: 1100828)

Certified Value:

Antimony	<	0.02 μg/L	✓
Calcium	<	30 μg/L	✓
Copper	<	0.10 μg/L	✓
Lead	<	0.025 μg/L	✓
Magnesium	<	3.0 μg/L	✓
Zinc	<	0.20 μg/L	✓

Certified Acceptable For: Trace Metals by EPA 1638, EPA 1640, and EPA 200.8

Approved By: Brittany Nelson
QA Associate, BRL

Signature: ______________________

Date: February 14, 2012

Certificate of Analysis

BROOKS RAND LABS
CERTIFIED

BRL Report 1214047

Sampling Equipment

Product Number:	11-337 (URS carboy)
Product Description:	Carboy
BRL Lot Number:	11-337
Date of Analysis:	December 6th 2011 (SEQ: 1100860)

Certified Value:

Antimony	<	0.02 µg/L ✓
Calcium	<	30 µg/L ✓
Copper	<	0.10 µg/L ✓
Lead	<	0.025 µg/L ✓
Magnesium	<	3.0 µg/L ✓
Zinc	<	0.20 µg/L ✓

Certified Acceptable For: Trace Metals by EPA 1638, EPA 1640, and EPA 200.8

Approved By: Brittany Nelson
QA Associate, BRL

Signature: Brittany Nelson

Date: March 5th, 2012

Certificate of Analysis

BROOKS
RAND
LABS
CERTIFIED

BRL Report 1214047

Sampling Equipment

Product Number:	11-348 (Tubing)
Product Description:	Tubing
BRL Lot Number:	11-348
Date of Analysis:	December 21st, 2011 (SEQ: 1100913)

Certified Value:

Antimony	<	0.02 µg/L ✓
Calcium	<	30 µg/L ✓
Copper	<	0.10 µg/L ✓
Lead	<	0.025 µg/L ✓
Magnesium	<	3.0 µg/L ✓
Zinc	<	0.20 µg/L ✓

Certified Acceptable For: Trace Metals by EPA 1638, EPA 1640, and EPA 200.8

Approved By: Brittany Nelson
QA Associate, BRL

Signature: Brittany Nelson

Date: February 17th, 2012

Certificate of Analysis

BROOKS
RAND
LABS
CERTIFIED

BRL Report 1214047

Sampling Equipment

Product Number: 12-026 (mini-carboy)

Product Description: Carboy

BRL Lot Number: 12-026

Date of Analysis: January 30, 2012 (SEQ: 1100846)

Certified Value:

Antimony	<	0.02 µg/L	✓
Calcium	<	30 µg/L	✓
Copper	<	0.10 µg/L	✓
Lead	<	0.025 µg/L	✓
Magnesium	<	3.0 µg/L	✓
Zinc*	<	0.30 µg/L	✓

*Note: Brooks Rand Labs usually certifies zinc as less than 0.20 µg/L. In this case, 3 carboys were tested and 1 produced a result above acceptable limits. The certification level has been adjusted to reflect this.

Certified Acceptable For: Trace Metals by EPA 1638, EPA 1640, and EPA 200.8

Approved By: Brittany Nelson
QA Associate, BRL

Signature:

Date: March 28, 2012

Certificate of Analysis

BRL Report 1214047

BROOKS
RAND
LABS
CERTIFIED

Sampling Container

Product Number: 12-040 (125 mL HDPE)

Product Description: 125 mL HDPE

BRL Lot Number: 12-040

Date of Analysis: February 23, 2012 (SEQ: 1200125)

Certified Value:

Antimony	<	0.02 µg/L	/
Calcium	<	30 µg/L	/
Copper	<	0.10 µg/L	/
Lead	<	0.025 µg/L	/
Magnesium	<	3.0 µg/L	/
Zinc	<	0.20 µg/L	/

Certified Acceptable For: Trace Metals by EPA 1638, EPA 1640, and EPA 200.8

Approved By: Brittany Nelson
QA Associate, BRL

Signature: Brittany Nelson

Date: March 28, 2012

BRL Report 1214047

BROOKS RAND LABS

CERTIFIED

Certificate of Analysis

Sampling Equipment

Product Number: 12-044 (Tubing)

Product Description: Tubing

BRL Lot Number: 12-044

Date of Analysis: February 16, 2012 (SEQ: 1200111)

Certified Value:

Antimony	<	0.02 µg/L	✓
Calcium	<	30 µg/L	✓
Copper	<	0.10 µg/L	✓
Lead	<	0.025 µg/L	✓
Magnesium*	<	18.0 µg/L	✓
Zinc	<	0.20 µg/L	✓

Brooks Rand Labs usually certifies Mg to below the level of the water-specific MRL which is 3 µg/L. While bottles in this cleaning lot tested above the water MRL for Mg, the results were below the MRL for Hardness.

Certified Acceptable For: Trace Metals by EPA 1638, EPA 1640, and EPA 200.8

Approved By: Brittany Nelson
QA Associate, BRL

Signature:

Date: April 13, 2012

Certificate of Analysis

BRL Report 1214047

BROOKS
RAND
LABS
CERTIFIED

Sampling Equipment

Product Number: 12-070-F (Tubing)

Product Description: Tubing

BRL Lot Number: 12-070-F

Date of Analysis: March 13, 2012 (SEQ: 1200167)

Certified Value:

Antimony	<	0.02 µg/L
Calcium	<	30 µg/L
Copper	<	0.10 µg/L
Lead	<	0.025 µg/L
Magnesium	<	3.0 µg/L
Zinc	<	0.20 µg/L

Certified Acceptable For: Trace Metals by EPA 1638, EPA 1640, and EPA 200.8

Approved By: Brittany Nelson
QA Associate, BRL

Signature:

Date: March 28, 2012

Certificate of Analysis

BROOKS RAND LABS CERTIFIED

BRL Report 1214047

Sampling Equipment

Product Number: C-1201 (capsule filters)

Product Description: Capsule Filters

BRL Lot Number: C-1201

Date of Analysis: March 20, 2012 (SEQ: 1200189)

Certified Value:

Antimony	<	0.02 μg/L	✓
Calcium	<	30 μg/L	✓
Copper	<	0.10 μg/L	✓
Lead	<	0.025 μg/L	✓
Magnesium	<	3.0 μg/L	✓
Zinc	<	0.20 μg/L	✓

Certified Acceptable For: Trace Metals by EPA 1638, EPA 1640, and EPA 200.8

Approved By: Brittany Nelson
QA Associate, BRL

Signature:

Date: April 13, 2012

Case Narrative

Revision 1. The result for sample RPSW04WA03 for Hardness was updated as 0.04 µg/L.

Shipping and Receiving

On April 6, 2012, Brooks Rand Labs (BRL) received fourteen (14) water samples at 8:45 A.M. in a cooler with ice and at a temperature of 3.5 °C. The chain-of-custody form requested analysis for dissolved copper (Cu), lead (Pb), antimony (Sb), zinc (Zn), and hardness (calculated from calcium and magnesium analyses). The samples were received and stored securely according to BRL standard operating procedures (SOP) and EPA methodology.

Preservation and Holding Time

All method and SOP requirements for preservation and holding time were satisfied.

Trace Metals EPA Method 1638 modified (BR-0060)

Analysis is performed by EPA Draft Method 1638 (modified) using inductively coupled plasma - mass spectrometry (ICP-MS). Prior to analysis, the samples are preserved to 1% with ultra-pure nitric acid. Furthermore, samples for total recoverable analysis are heated overnight at 85 °C. Aliquots of digested sample are analyzed utilizing internal standardization. This method incorporates ionization of the sample in an inductively-coupled RF plasma, with detection of the resulting ions by mass spectrometer on the basis of their mass-to-charge ratio.

The Department of Defense (DoD) acceptance criteria for the dilution tests state that the diluted result must be ±10% of the native result. Therefore, when the native sample produces a result of 1 (unit independent), the acceptable range for the dilution duplicate is 0.9 - 1.1 units. However, in the upper limit the relative percent difference (RPD) between the two values is 9.5% whereas in the lower limit the RPD is 10.5%. BRL has set the RPD limit to 10% in the report as this is the closest approximation the LIMS is capable of representing.

All results have been reported to the concentration of the method detection limit (MDL), referred to as the detection limit (DL) in the DoD QSM. The Limit of Quantitation (LOQ) is defined in this report as the method reporting limit (MRL). Results less than or equal to the method detection limit (MDL) are reported at the limit of detection (LOD) and qualified **U**. Results between the MDL and MRL were qualified **B**.

The interference check standard known generally as ICS-A was labeled "IFA". The interference check standard generally known as ICS-AB was labeled "IFB". The information for the interference check standards can be found in the Instrument Calibration pages of the respective analyte and sequence. In cases where the interference check solution has no certified value, the report indicates that the true value is "0.0001 µg/L." In actuality, the true value is 0, but due to a limitation of the LIMS a non-zero value has to be assigned and therefore the recovery has not been calculated and is listed as "N/A" or not applicable.

The digestion method used for the samples took place in the original sample container. Therefore, the matrix spikes were prepared at the instrument and would be the same as post-digestion spikes.

In instances when either the native sample concentration was non-detectable (reported as less than or equal to the MDL) and/or the corresponding matrix duplicate (DUP) result was also non-detectable, the RPD between the two values was not calculated (**N/C**).

In instances where the matrix spike/matrix spike duplicate (MS/MSD) sets were spiked with concentrations less than 25% of the native sample results, the recoveries were not reported (**NR**).

Sequence 1200274

There are known positive interferences for Zn in NIST 1643e, IFA, IFB, and the samples. For NIST 1643e ^{68}Zn will typically recover high; whereas, ^{66}Zn tends to recover high in IFA and IFB, as seen during this analysis. The samples themselves appear to be more similar to NIST 1643e and recover higher for ^{68}Zn. The high bias in ^{68}Zn was evident in the samples such that the results for the dilution tests are always lower than the native result, indicating the positive bias was at least somewhat overcome through dilution. Based on the sample results, ^{66}Zn was reported for the samples, even though ^{66}Zn recovered high in IFB (128%). It should be noted that the ^{68}Zn recovery for IFB was 109%.

SCV1 was re-prepared and analyzed and reported as SCV2.

The initial calibration blank (ICB) 1200274-ICB2 was above the LOD for Cu, Mg, Sb and Zn. It directly followed the high calibration standard and the elevated concentration was likely due to carryover. No samples were bracketed by this ICB and another ICB, which had a low concentration, was analyzed before any samples.

Instrument calibration, meeting all quality control criteria, was successfully achieved on the day of sample analysis.

Batch B120606

The dilution tests were labeled as B120606-DUP2 and B120606-DUP4.

The dilution test B120606-DUP4 did not meet the DoD criteria of being within ± 10% of the initial result for Sb. The native sample result and the dilution test result for the sample were less than 50x the MRL, which meant they were not valid indicators of matrix interference. In addition, the MS/MSD set associated with this test recovered within acceptance criteria. No further action was required.

Two blank spikes (BS) were prepared with this batch. With the exception of Zn, B120606-BS1 was spiked at the level of the LOD and the spikes for Cu, Mg, and Sb were not reported. However, for Zn the spike level was 20x greater than the MRL. As no re-preparation of these samples can be done, all results were qualified **J** as estimates.

Sequence 1200319

Instrument calibration, meeting all quality control criteria, was successfully achieved on the day of sample analysis.

Batch B120768

The dilution tests were labeled as B120768-DUP2 and B120768-DUP4.

The result for the dilution test identified as B120391-DUP2 was less than 50x the MRL, which meant it was not a valid indicator of matrix interference.

The analysis of all the method blanks (BLKs) for Ca were elevated. All sample results not greater than 10x the level of the highest BLK were qualified **X**.

The blank spike (B120768-BS1) for Ca was spiked below the level of the MRL and has not been reported.

Per the client's specific request to adhere to the EPA Draft Method 1638 requirement of non-method blank corrected data, the results were not method blank corrected as described in the calculations section of the relevant BRL SOP(s). This deviates from BRL's standard protocol for trace level data quality and BRL believes that all low-level metals analyses should be method blank corrected and that not doing so may lead to less accurate results. The results from the method blanks that were analyzed are listed in the *Method Blanks & Reporting Limits* section of this report.

We certify that this data package is in compliance with the terms and conditions of the contract, both technically and for completeness, for other than the conditions detailed above. BRL, an accredited laboratory, certifies that the reported results of all analyses for which BRL is NELAP accredited meet all NELAP requirements. For more details, please see the *Report Information* page in your report. Please feel free to contact us if you have any questions regarding this report.

Lydia Greaves

Lydia Greaves
Project Manager
lydia@brooksrand.com

A Royal

Amanda Royal
Project Manager
amanda@brooksrand.com

Sample Containers

Lab ID: 1214047-01
Sample: RPSW01WB01
Report Matrix: Water
Sample Type: Sample
Collected: 04/04/2012
Received: 04/06/2012

Des	Container	Size	Lot	Preservation	P-Lot	pH	Ship. Cont.
A	Bottle HDPE ICP-W	125 mL	12-040	0.1% HNO3 (BRL)	1210054	<2	Cooler

Lab ID: 1214047-02
Sample: RPSW02WB01
Report Matrix: Water
Sample Type: Sample
Collected: 04/04/2012
Received: 04/06/2012

Des	Container	Size	Lot	Preservation	P-Lot	pH	Ship. Cont.
A	Bottle HDPE ICP-W	125 mL	12-040	0.1% HNO3 (BRL)	1210054	<2	Cooler

Lab ID: 1214047-03
Sample: RPSW03WB01
Report Matrix: Water
Sample Type: Sample
Collected: 04/04/2012
Received: 04/06/2012

Des	Container	Size	Lot	Preservation	P-Lot	pH	Ship. Cont.
A	Bottle HDPE ICP-W	125 mL	12-040	0.1% HNO3 (BRL)	1210054	<2	Cooler

Lab ID: 1214047-04
Sample: RPSW04WB01
Report Matrix: Water
Sample Type: Sample
Collected: 04/04/2012
Received: 04/06/2012

Des	Container	Size	Lot	Preservation	P-Lot	pH	Ship. Cont.
A	Bottle HDPE ICP-W	125 mL	12-040	0.1% HNO3 (BRL)	1210054	<2	Cooler

Lab ID: 1214047-05
Sample: RPSW05WB01
Report Matrix: Water
Sample Type: Sample
Collected: 04/04/2012
Received: 04/06/2012

Des	Container	Size	Lot	Preservation	P-Lot	pH	Ship. Cont.
A	Bottle HDPE ICP-W	125 mL	12-040	0.1% HNO3 (BRL)	1210054	<2	Cooler

Lab ID: 1214047-06
Sample: RPSW06WB01
Report Matrix: Water
Sample Type: Sample
Collected: 04/04/2012
Received: 04/06/2012

Des	Container	Size	Lot	Preservation	P-Lot	pH	Ship. Cont.
A	Bottle HDPE ICP-W	125 mL	12-040	0.1% HNO3 (BRL)	1210054	<2	Cooler

Lab ID: 1214047-07
Sample: RPSW01WA01
Report Matrix: Water
Sample Type: Sample
Collected: 04/05/2012
Received: 04/06/2012

Des	Container	Size	Lot	Preservation	P-Lot	pH	Ship. Cont.
A	Bottle HDPE ICP-W	125 mL	12-040	0.1% HNO3 (BRL)	1210054	<2	Cooler

Sample Containers

Lab ID: 1214047-08 **Report Matrix:** Water **Collected:** 04/05/2012
Sample: RPSW02WA01 **Sample Type:** Sample **Received:** 04/06/2012

Des	Container	Size	Lot	Preservation	P-Lot	pH	Ship. Cont.
A	Bottle HDPE ICP-W	125 mL	12-040	0.1% HNO3 (BRL)	1210054	<2	Cooler

Lab ID: 1214047-09 **Report Matrix:** Water **Collected:** 04/05/2012
Sample: RPSW03WA01 **Sample Type:** Sample **Received:** 04/06/2012

Des	Container	Size	Lot	Preservation	P-Lot	pH	Ship. Cont.
A	Bottle HDPE ICP-W	125 mL	12-040	0.1% HNO3 (BRL)	1210054	<2	Cooler

Lab ID: 1214047-10 **Report Matrix:** Water **Collected:** 04/05/2012
Sample: RPSW04WA01 **Sample Type:** QC Sample **Received:** 04/06/2012

Des	Container	Size	Lot	Preservation	P-Lot	pH	Ship. Cont.
A	Bottle HDPE ICP-W	125 mL	12-040	0.1% HNO3 (BRL)	1210054	<2	Cooler

Lab ID: 1214047-11 **Report Matrix:** Water **Collected:** 04/05/2012
Sample: RPSW04WA02 **Sample Type:** Sample **Received:** 04/06/2012

Des	Container	Size	Lot	Preservation	P-Lot	pH	Ship. Cont.
A	Bottle HDPE ICP-W	125 mL	12-040	0.1% HNO3 (BRL)	1210054	<2	Cooler

Lab ID: 1214047-12 **Report Matrix:** Water **Collected:** 04/05/2012
Sample: RPSW04WA03 **Sample Type:** Sample **Received:** 04/06/2012

Des	Container	Size	Lot	Preservation	P-Lot	pH	Ship. Cont.
A	Bottle HDPE ICP-W	125 mL	12-040	0.1% HNO3 (BRL)	1210054	<2	Cooler

Lab ID: 1214047-13 **Report Matrix:** Water **Collected:** 04/05/2012
Sample: RPSW05WA01 **Sample Type:** Sample **Received:** 04/06/2012

Des	Container	Size	Lot	Preservation	P-Lot	pH	Ship. Cont.
A	Bottle HDPE ICP-W	125 mL	12-040	0.1% HNO3 (BRL)	1210054	<2	Cooler

Lab ID: 1214047-14 **Report Matrix:** Water **Collected:** 04/05/2012
Sample: RPSW06WA01 **Sample Type:** Sample **Received:** 04/06/2012

Des	Container	Size	Lot	Preservation	P-Lot	pH	Ship. Cont.
A	Bottle HDPE ICP-W	125 mL	12-040	0.1% HNO3 (BRL)	1210054	<2	Cooler

Shipping Containers

Cooler

Received: April 6, 2012 8:45
Tracking No: 8001 2758 1524 via FedEx
Coolant Type: Ice
Temperature: 3.5 °C ✓

Description: Cooler
Damaged in transit? No
Returned to client? No

Custody seals present? Yes
Custody seals intact? Yes
COC present? Yes

BROOKS RAND LABS
MEANINGFUL METALS DATA

3958 6th Avenue NW
Seattle, WA 98107
Phone: 206-632-6206
Fax: 206-632-6017

samples@brooksrand.com
www.brooksrand.com

Chain of Custody Record

1214047

Page 1 of 2

BRL Report 1214047

White: LAB COPY
Yellow: CUSTOMER COPY

Client: URS	Address: 849 International Dr Suite 320 Linthicum MD 21090	COC receipt confirmation? [✓ Y] / N If so, by: [✓ email] / fax (circle one)
Contact: Andrea Sansom		
Client project ID: 15302622, 30000		Email: andrea.sansom@urs.com
PO #:	Phone #: 410-487-8955	Fax #: 410-859-5202

Requested TAT in business days:
☒ 20 (standard)
☐ 15
☐ 10
☐ 5
☐ Other ____

Surcharges apply for expedited turn around times.

	Sample ID	**Collection**		**Miscellaneous**				**Field Preservation**			**Analyses required** Metals 1638M plus Dm23#								**Comments**
		Date	Time	Sampler (initials)	Matrix type - SW	# of containers	Field filtered? (Y/N)	Unpreserved / ice only	HCl / HNO_3 (circle one)	Other (specify)	Total Hg, EPA 1631	Methyl Hg, EPA 1630	ICP-MS Metals (specify)	As / Se species (specify)	% Solids	Filtration	Other (specify)	Other (specify)	
1	RPSW01WB01	4-4-12	1245	BLK	H_2O	1	Y	X									X		
2	RPSW02WB01	4-4-12	0935	BLK	H_2O	1	Y	X									X		
3	RPSW03WB01	4-4-12	1615	BLK	H_2O	1	Y	X									X		
4	RPSW04WB01	4-4-12	1030	BLK	H_2O	1	Y	X									X		
5	RPSW05WB01	4-4-12	1120	BLK	H_2O	1	Y	X									X		
6	RPSW06WB01	4-4-12	1330	BLK	H_2O	1	Y	X									X		
7	RPSW01WA01	4-5-12	1240	BLK	H_2O	1	Y	X									X		
8	RPSW02WA01	4-5-12	1200	BLK	H_2O	1	Y	X									X		
9	RPSW03WA01	4-5-12	1400	BLK	H_2O	1	X	X									X		
10	RPSW04WA01	4-5-12	0940	BLK	H_2O	1	Y	X									X		Use for MS/MSD

Relinquished by: Bethany Kl	Date: 4-5-12	Time: 1900	Relinquished by:	Date:	Time:
Received by:	Date:	Time:	Received at BRL by:	Date: 4/6/12	Time: 0845
Shipping carrier: Fed Ex	# of coolers: 2		BRL work order ID:	BRL project ID:	

BROOKS RAND LABS
MEANINGFUL METALS DATA

3958 6th Avenue NW
Seattle, WA 98107
Phone: 206-632-6206
Fax: 206-632-6017

samples@brooksrand.com
www.brooksrand.com

Chain of Custody Record

Page 2 of 2

1214047

White: LAB COPY
Yellow: CUSTOMER COPY

Client: URS
Contact: Andrea Sansom
Client project ID: 15302622.30000
PO #:
Address: 849 International Dr Ste 320 Linthicum MD 21090
Phone #: 410 487 8955
COC receipt confirmation? [✓ Y] / N
If so, by: [✓ email] / fax (circle one)
Email: andrea.sansom@urs.com
Fax #: 410 859 5202

Requested TAT in business days:
☒ 20 (standard)
☐ 15
☐ 10
☐ 5
☐ Other ____
Surcharges apply for expedited turn around times.

		Collection		**Miscellaneous**				**Field Preservation**			**Analyses required**								**Comments**
	Sample ID	Date	Time	Sampler (initials)	Matrix type – SW	# of containers	Field filtered? (Y/N)	Unpreserved / ice only	HCl / HNO_3 (circle one)	Other (specify)	Total Hg, EPA 1631	Methyl Hg, EPA 1630	ICP-MS Metals (specify)	As / Se species (specify)	% Solids	Filtration	Other (specify) Metals/1638M plus SM2340B	Other (specify)	
1	RPSW04WA02	4-5-12	0945	BLK	H_2O	1	Y	X									X		
2	RPSW04WA03	4-5-12	0950	BLK	H_2O	1	Y	X									X		
3	RPSW05WA01	4-5-12	1125	BLK	H_2O	1	Y	X									X		
4	RPSW06WA01	4-5-12	1400	BLK	H_2O	1	Y	X									X		
5																			
6																			
7																			
8																			
9																			
10																			

Relinquished by: Bethany Kl	Date: 4-5-12	Time: 1900	Relinquished by:	Date:	Time:
Received by:	Date:	Time:	Received at BRL by:	Date: 4/6/12	Time: 0845
Shipping carrier: Fed EX	# of coolers: 2		BRL work order ID:	BRL project ID:	

Data Qualifying Codes

Two types of data qualifying codes or flags are applied in the course of the data review. The data validation flags indicate data that are not usable for decision-making, more than normally biased and/or variable, or not representative of field conditions. These codes and their definitions are presented below in the hierarchy stipulated in the USEPA Region V Standard Operating Procedures for Validation of CLP Organic (March 2003) and Inorganic Data (September, 1993).

Data Validation Flags

Flag	Interpretation
R	The sample results are rejected due to serious deficiencies in the ability to analyze sample and meet quality control criteria. The presence or absence of the analyte cannot be verified.
U	The analyte was analyzed for, but not detected. The value preceding the U is the Limit of Detection (LOD).
J	The analyte was positively identified, but the associated numerical value is estimated concentration of the analyte in the sample based on its associated quality measures.
N	The analysis indicates the presence of an analyte for which there is presumptive evidence to make a "tentative identification."
C	The sample results are confirmed by other analytical techniques including analysis of a reference standard
UJ	The analyte was not positively identified, but the associated numerical value is estimated concentration of the analyte in the sample based on its associated quality measures.
JN	The analyte is tentatively identified and the value preceding the JN is estimated.

The other type of code used by URS is a “Reason Code”. The reason code indicates the type of quality control failure that led to the application of the data validation flag.

Reason Codes

GC/MS Organics		GC and HPLC Organics		Inorganics and Conventionals	
Code	Interpretation	Code	Interpretation	Code	Interpretation
a	Incorrect or incomplete analytical sequence	a	Incorrect or incomplete analytical sequence	a	Incorrect or incomplete analytical sequence
b	Bubble found in vial >6mm	b	Instrument performance failure	b	Laboratory duplicate imprecision
c	Calibration failure; poor or unstable response	c	Calibration failure; poor or unstable response	c	Calibration failure
d	MS/MSD imprecision	d	MS/MSD imprecision	d	MS/MSD imprecision
e	LCSD imprecision	e	LCSD imprecision	e	LCSD imprecision
f	Field duplicate imprecision	f	Field duplicate imprecision	f	Field duplicate imprecision
g	Tuning failure or poor mass spec performance	g	Dual column confirmation imprecision	g	Duel isotope imprecision
h	Holding time violation	h	Holding time violation	h	Holding time violation
i	Internal standard failure	i	Internal standard failure	k	Cooler receipt temperature exceeds limits
k	Cooler receipt temperature exceeds limits	k	Cooler receipt temperature exceeds limits	l	LCS recovery failure
l	LCS recovery failure	l	LCS recovery failure	m	MS/MSD recovery failure
m	MS/MSD recovery failure	m	MS/MSD recovery failure	n	ICS failure
p	Poor chromatography	p	Poor chromatography	o	Calibration blank contamination
q	Concentration exceeded the linear range	q	Concentration exceeded the linear range	q	Concentration exceeded the linear range
r	Linearity failure in initial calibration	r	Linearity failure in initial calibration	r	Linearity failure in calibration or MSA
s	Surrogate failure	s	Surrogate failure	s	Serial dilution failure
t	TIC	t	Blender blank contamination	t	Blender blank contamination
w	Identification criteria failure	u	No confirmation column	u	BOD minimum depletion did not exceed 2mg/L
x	Field blank contamination	w	Retention time failure	v	Post-digestion spike failure
y	Trip blank contamination	x	Field blank contamination	w	CRDL Standard Failure
z	Method blank contamination	z	Method blank contamination	x	Field blank contamination
				z	Preparation/Method blank contamination

WIDSETH
SMITH
NOLTING

2016 ANNUAL GROUNDWATER MONITORING REPORT

FOR

CAMP RIPLEY CLOSED
MIXED MUNICIPAL LANDFILL
Little Falls, Minnesota

Prepared for:

Mr. Mark Erickson
Minnesota Department of Military Affairs
Minnesota Army National Guard Facilities Management Office
Little Falls, MN 56345

January 23, 2017

WSN No. 0283B0009.016

Baxter/Brainerd Office:
7804 Industrial Park Road
P.O. Box 2720
Baxter, MN 56425-2720
Phone: 218-829-5117
Fax: 218-829-2517

WIDSETH
SMITH
NOLTING

Brainerd/Baxter
7804 Industrial Park Road
PO Box 2720
Baxter, MN 56425-2720

218.829.5117 ☎
218.829.2517 📠
Brainerd@wsn.us.com ✉

WidsethSmithNolting.com

January 23, 2017

Mr. Neal Wilson, P.G.
MPCA
520 Lafayette Road North
St. Paul, Minnesota 55155-4194

RE: Camp Ripley Closed Mixed Municipal Landfill
2016 Annual Groundwater Monitoring Report
WSN No. 0283B0009.016

Dear Mr. Wilson:

This report has been prepared in accordance with Minnesota Rule 7035.2585, item H and Minnesota Rule part 7035.2815, subpart 14, item Q. Item Q requires to report to identify recent and long term trends in water elevations and concentrations of monitored constituents. The report should also evaluate the effect the Camp Ripley Closed Mixed Municipal Landfill (landfill) is having on groundwater and surface water quality, and any recommendations for changes to the system. This report summarizes the sampling events and results for 2016.

The closed landfill occupies approximately 11 acres and is located within the Camp Ripley Training Center (CRTC). More specifically, the landfill is located in the Northeast ¼ of the Northwest ¼ of Section 5, Township 130 North, Range 29 West, Green Prairie Township, Morrison County, Minnesota. The location of the closed landfill is shown on the attached Figure 1.

The Minnesota Pollution Control Agency (MPCA) issued a Letter of Closure to the CRTC Closed Mixed Municipal Landfill on January 29, 1988. Since closure, the landfill's groundwater monitoring network has been sampled and monitored as required. In 2009, the MPCA requested the installation of two new monitoring wells, one along the east border of the landfill and the other on the southeast border. Consequently, monitoring wells MMLF-7 and MMLF-8 were installed during the fall of 2009.

The site is located within the central glacial drift region of Minnesota. The topography of the surrounding area consists of rolling hills and lowlands generally ranging in elevation from 1,140 ft above mean sea level (MSL) to 1,275 ft MSL. Original ground elevation across the landfill varies from approximately 1,160 ft MSL to 1,155 ft MSL from west to east.

In December 2006, J.J. Quinn of the Environmental Science Division of the Argonne National Laboratory published a paper titled Delineation of a Wellhead Protection Zone and Determination of Flow Paths from Potential Groundwater Contaminant Source Areas at the CRTC, Little Falls, Minnesota. The following glacial geological summary for the region is an excerpt from this paper:

> "The geology and topography of the CRTC property and its vicinity are the result of a complex glacial depositional history involving three ice lobes that deposited drifts of various characters and colors. These lobes were thought to have been concurrently active in central Minnesota; however, a detailed geologic characterization of the site by UMD (2002) suggests new, previously unrecognized possibilities for the juxtapositioning of the ice lobes and for the nature of

> the St. Croix moraine at CRTC. The lobes appear to have been present in the vicinity of the CRTC concurrently, depositing well-sorted sands into an ice-bounded lacustrine basin. Occasional ice advances deposited discontinuous till units in the basin at various elevations."

On site geological information has been collected during the installation of the various landfill monitoring wells. Well installation field logs indicate the soil profile consists primarily of fine sand. Previous reports documents depth of bedrock varies from 20 feet below ground surface (BGS) to over 100 feet BGS in the area of the closed landfill. Monitoring wells on the west side of the landfill were installed up to 53 feet BGS and did not encounter bedrock; however, monitoring well installations on the east side of the landfill encountered bedrock as shallow as 28 feet BGS.

The site is located within the Mississippi River watershed. Area waterways include the Mississippi River located approximately 2,000 feet east of the landfill, the Crow Wing River located approximately 13 miles north of the landfill, and the Little Elk River located approximately four miles southwest of the landfill. Green Prairie Fish Lake lies approximately three miles southwest of the landfill.

The groundwater table beneath the landfill is approximately 30 feet BGS. A regional groundwater model reported by Quinn (2006) describes the regional groundwater flow direction as southeast. Historically, groundwater elevation measurements from the landfill monitoring wells and the related flow maps document the local groundwater flow direction is also to the southeast.

Included in this report are the analytical results of the 2016 fall quarter sampling events for the closed landfill's groundwater-monitoring network. The groundwater monitoring network consists of monitoring wells MW-3(MMLF-3), MW-7(MMLF-7), and MW-8(MMLF-8). Their respective locations are displayed on the groundwater contour map included as Figure 2. The fall sampling event was conducted on October 31, 2016, by Widseth Smith Nolting's (WSN) environmental technician, Mike Bogart.

In 2016, the analytical schedule required samples from the three wells be analyzed for the Minnesota Department of Health method 468 volatile organic compounds (VOCs), a group of dissolved metals, and a list of general chemistry parameters. A complete list of the VOCs and the inorganics (metals and general chemistry parameters) is included in Table 1. The analytical results for the 2016 fall sampling event are summarized in Table 2 through Table 7. The tables include analytical data back to the October 2009 sampling event. As shown, the tables include results to the laboratory's reporting limits (RLs) and to their method detection limits (MDLs). In addition, copies of the 2016 analytical reports with test results to the RLs and to the MDLs are included in Appendix A.

The inorganic results for the up gradient sample from monitoring well MW-3, are summarized in Table 2. The table shows the concentrations detected in 2016 are mostly similar to what was identified the last time a sample from MW-3 was required to be analyzed for inorganics, which was in 2014. The results indicate the only analyte exceeding an intervention limit (IL) is manganese. The dissolved metal was detected at a concentration of 62.9 micrograms per liter (ug/L), which is equivalent to parts per billion. This is a slight decrease comparing the results from 2010 to the present. The IL for manganese has been set by the MPCA at 25 ug/L. No other metals exceeded their respective IL. It should be noted, as indicated in the tables, not all of the metals tested for have an IL.

The inorganic results for samples collected from the two down gradient monitoring wells, MW-7 and MW-8, are listed in Table 3 and Table 4, respectively. Comparing the 2016 results to previous results, some of the analytes are higher and the concentrations for others are lower. There is not an identifiable trend for any one analyte except for manganese. Manganese is the only dissolved metal that has exceeded the established IL in the samples from MW-7. In 2016, manganese was detected in MW-7 at a concentration of 593 ug/L; however, the dissolved metal has steadily been decreasing since its historical high of 3,400 ug/L identified in the sample collected on October 26, 2009. Manganese was not detected above the IL in MW-8.

Similar to the results for 2015, the data in Tables 5 and 7 indicate VOCs were not identified in the 2016 samples from MW-3 or MW-8 at or above the laboratory's RLs. Table 6 shows two VOCs were found in the groundwater sample from MW-7 above the laboratory's RLs. Cis-1,2-dichloroethene and ethyl ether were quantified in the sample at concentrations of 3.8 ug/L and 6.9 ug/L, respectively. Both compounds have been quantified in previous samples analyzed from MW-7; however, neither VOC exceeded their individual IL.

The well stabilization parameters were measured and recorded prior to sample collection. A HydroLab Data Sonde 4A water quality multi-probe and a flow through cell were used to measure the stabilization parameters. The well stabilization forms are attached as Appendix B.

The three monitoring wells depths to water measurements were recorded prior to sample collection. The fall groundwater elevations are listed in Table 8 and the associated groundwater flow map is attached as Figure 2. As illustrated on the flow map, MW-7 and MW-8 are downgradient of the closed landfill and MW-3 is in the up gradient position. The 2016 elevations in Table 8, when compared to the fall of 2015, indicate a water table elevation increase of approximately 1.5 feet in MW-3, an increase of about 1 foot in MW-7, and an increase of almost 1.3 feet in MW-8. As shown on the flow map, the groundwater flow direction continues to be consistent with the historical flow direction, which is to the southeast.

Only one compound was identified in the 2016 groundwater samples above its respective IL. Manganese was again identified in the samples from MW-3 and MW-7 above the IL of 25 ug/L. The dissolved metal has exceeded the IL in the samples from MW-3 since 2010 and in the samples from MW-7 as far back as 2009.

The CRTC is in the process of completing the Checklist for Post Closure Care Summary Report Requirements for a Solid Waste Landfill. Included in the checklist is discussion of any past or current exceedances of groundwater performance standards. It should be noted, manganese continues to exceed its respective health risk limit (HRL) in the samples from monitoring wells MW-3 and MW-7; however, the detected concentrations continue to decrease over time. Furthermore, cis-1,2-dichloroethene and ethyl ether were quantified in the 2016 sample from MW-7 at concentrations of 3.8 ug/L and 6.9 ug/L, respectively. Both compounds have been quantified in previous samples analyzed from MW-7; however, neither VOC have ever exceeded their IL.

As shown on Figure 2, the groundwater flow direction beneath the landfill is to the southeast. The closest surface water downgradient of the landfill is the Mississippi River, which is located more than one mile from the landfill. The land between the landfill and the Mississippi River is military reservation controlled by the CRTC. Any groundwater development within miles of the landfill will strictly be for the use of the CRTC. In addition, the drinking water wells for the CRTC are almost two miles south of the landfill.

Considering the analytical results for 2016 and the monitoring well samples historical results, we do not believe it is necessary to make any changes to the landfill's current monitoring system. Also, considering the location of the landfill, we believe it is reasonable to request suspension of future sampling events of the landfill's monitoring system.

Please let me know if there is any additional information that you might need. My direct telephone number is 218.316.3623 or you can send an email to Greg.Smith@wsn.us.com.

Sincerely,

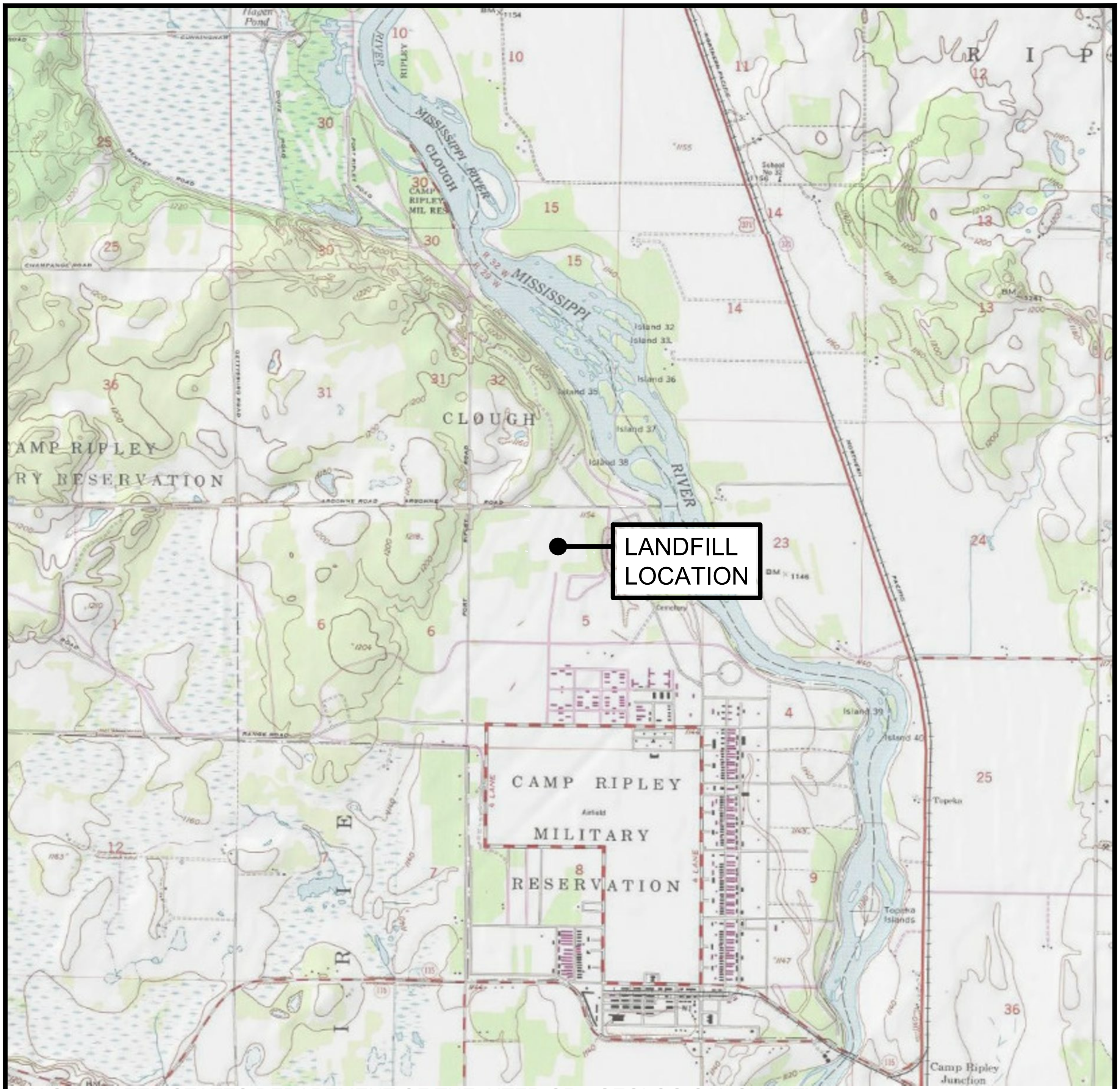
WIDSETH SMITH NOLTING

Gregory W. Smith

Gregory W. Smith, P.G.

Cc: Mr. Mark Erickson, Facilities Management Office, Minnesota Army National Guard

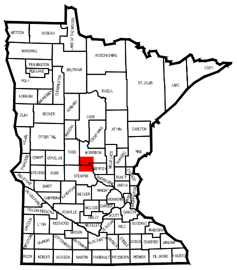
FIGURES



LANDFILL LOCATION

IMAGE: UNITED STATES DEPARTMENT OF THE INTERIOR - GEOLOGICAL SURVEY

AREA LOCATION



SCALE (IN METERS)

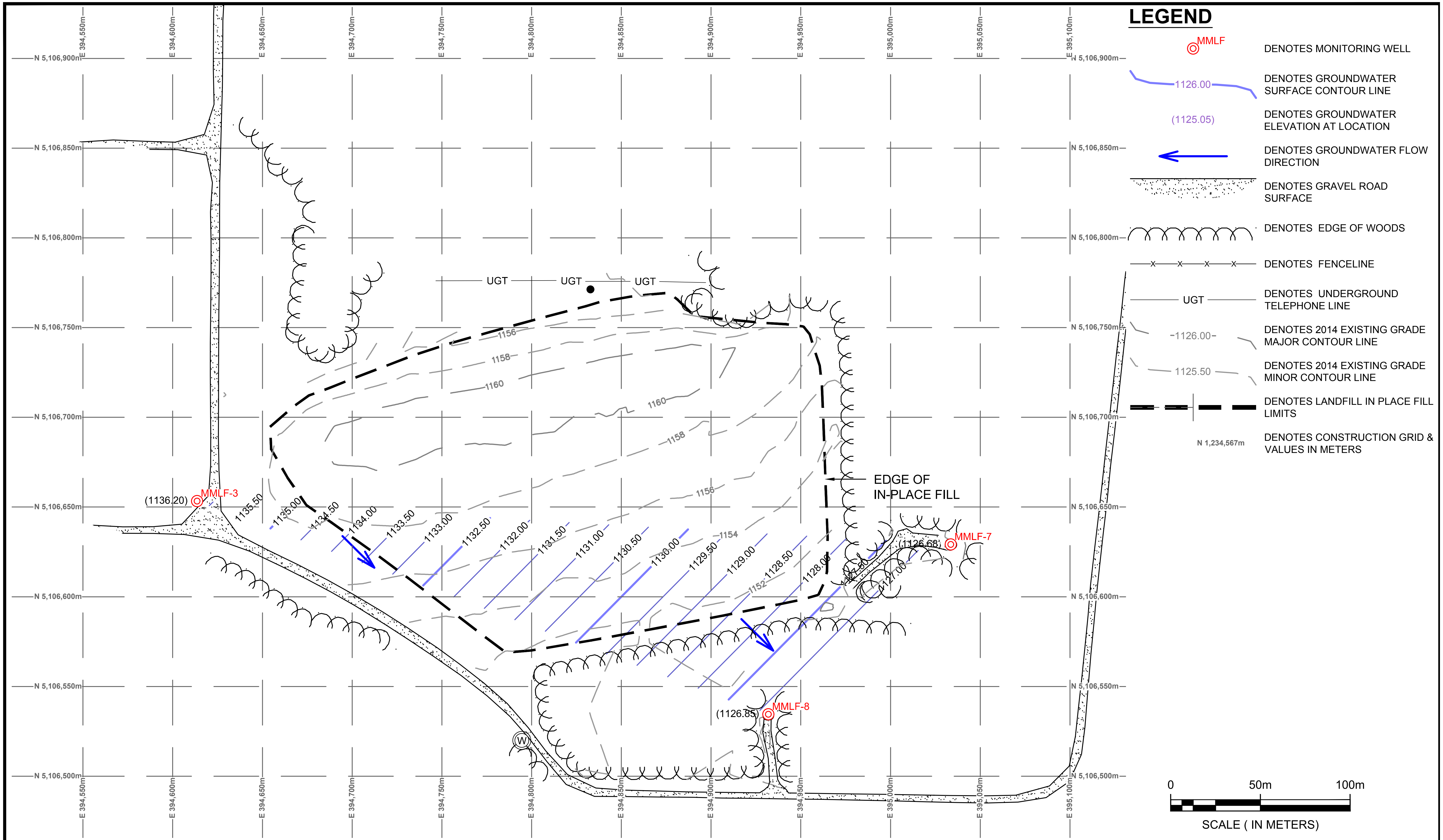
U.S.G.S. QUADRANGLE MAPS:
BELLE PRAIRIE, BELL PRAIRIE NW, FORT RIPLEY, RANDALL EAST
PUBLISHED: 1956, 1956, 1956, 1956
PHOTOREVISED: 1979, 1979, NA, 1979

WIDSETH SMITH NOLTING
Engineering
Architecture
Surveying
Environmental

CLOSED MMSW LANDFILL - 2016 G.W. MONITORING
MN DEPARTMENT OF MILITARY AFFAIRS
LITTLE FALLS, MN

SITE LOCATION MAP

DATE:	
JANUARY 2017	
JOB No.	FIGURE
0283B0009.016	01



REFERENCE NOTE:

HORIZONTAL COORDINATES ARE SHOWN IN GRID METERS BASED ON UTM COORDINATES, ZONE 15 NORTH, NAD83 DATUM. VERTICAL CONTOURS AND ELEVATIONS ARE SHOWN IN FEET BASED ON NAVD.

BASE CONTROL POINT COORDINATES AND ELEVATIONS PROVIDED BY MN DEPT. OF MILITARY AFFAIRS.

WIDSETH SMITH NOLTING
Engineering
Architecture
Surveying
Environmental

NORTH

CLOSED MMSW LANDFILL - 2016 G.W. MONITORING
MN DEPARTMENT OF MILITARY AFFAIRS
LITTLE FALLS, MN

GROUNDWATER ELEVATIONS ON 10-31-16

DATE: JANUARY 2017
JOB No. 0283B0009.016
FIGURE 02

TABLES

Table 1

Parameters for Analysis

Inorganics
Alkalinity, total as calcium carbonate
Ammonia Nitrogen
Arsenic, dissolved
Barium, dissolved
Boron, dissolved
Cadmium, dissolved
Chloride
Chromium, total dissolved
Copper, dissolved
Iron, dissolved
Lead, dissolved
Manganese, dissolved
Mercury, dissolved
Nitrate+Nitrite as Nitrogen
Sodium, dissolved
Sulfate
Suspended Solids, total
Appearance (field and lab)
Dissolved Oxygen (field)
pH (field and lab)
Specific Conductance (field and lab)
Temperature (field and lab)
Turbidity (field)
Static Water Elevation

468 List
1,1,1,2-Tetrachloroethane
1,1,1-Trichloroethane
1,1,2,2-Tetrachloroethane
1,1,2-Trichloroethane
1,1,2-Trichlorotrifluoroethane
1,1-Dichloroethane
1,1-Dichloroethylene (Vinylidene chloride)
1,2-Dichloropropane
trans-1,2-Dichloroethylene
1,2,3-Trichlorobenzene
1,2,3-Trichloropropane
1,2,4-Trichlorobenzene
1,2,4-Trimethylbenzene
1,2-Bromomethane; (Ethylene dibromide); EDB
1,2-Dichlorobenzene (orth)
1,2-Dichloroethane
1,2-Dichloroethylene (cis)
1,2-Dichloropropane
1,3,5-Trimethylbenzene
1,3-Dichlorobenzene (meta-)
1,3-Dichloropropane
1,3-Dichloropropane (cis + trans)
1,4-Dichlorobenzene (para)
2,2-Dichloropropane
2-Chlorotoluene (ortho-)
4-Chlorotoluene (para-)
Acetone
Allyl chloride; (3-Chloropropene)
Benzene
Bromobenzene
Bromochloromethane (Chlorobromomethane)
Bromodichloromethane (Dichlorobromomethane)
Bromoform
Bromomethane (Methyl chloride)
Carbon tetrachloride
Chlorobenzene (monochlorobenzene)
Chlorodibromomethane; (Dibromochloromethane)
Chloroethane
Chloroform
Chloromethane; (Methyl chloride)
Cumene; (Isopropylbenzene)
Dibromochloropropane; (DBCP)
Dibromomethane; Methylene bromide)

Dichlorodifluoromethane
Dichlorofluoromethane
Dichloromethane (methylene chloride)
Ethyl benzene
Ethyl ether
Hexachlorobutadiene
Methyl ethyl ketone (MEK)
Methyl isobutyl ketone; (4-Methyl-2-pentanone)
Methyl tertiary-butyl ether (MTBE)
Naphthalene
n-Butyl benzene
n-Propyl benzene
p-Isopropyltoluene
sec-Butyl benzene
Styrene
tert-Butyl benzene
Tetrachloroethylene; (Perchloroethylene)
Tetrahydrofuran
Toluene
Trichloroethylene; (TCE)
Trichlorofluoromethane
Vinyl Chloride
Xylenes (mixture of o, m, p)

Table 2

Summary of Inorganic Groundwater Quality - MMLF-3
Camp Ripley Closed Mixed Municipal Landfill
State of Minnesota Department of Military Affairs

Parameter	Units	IL	MMLF-3* 10/26/2009	MMLF-3* 11/11/2009	MMLF-3* 12/10/2009	MMLF-3* 11/8/2010	MMLF-3* 11/1/2012	MMLF-3 10/25/2013	MMLF-3 11/12/2014	MMLF-3 11/5/2015	MMLF-3 10/31/2016	MMLF-3** 10/31/2016
Alkalinity	mg/L	NL	NA	NA	NA	120	128	NA	330	NA	104	104
Ammonia Nitrogen	mg/L	NL	NA	NA	NA	<0.01	<0.1	NA	<0.10	NA	<0.10	<0.044
Arsenic (dissolved)	ug/L	2.5	NA	NA	NA	<1.6	<2.5	NA	<2.0	NA	1.8	1.8
Barium (dissolved)	mg/L	0.5	NA	NA	NA	0.027	0.0343	NA	0.0303	NA	0.0236	0.0236
Boron (disolved)	ug/L	250	NA	0.23	0.39	0.17	0.26	NA	<100	NA	<100	22.8J
Cadmium (dissolved)	ug/L	1.0	NA	NA	NA	18	<1	NA	<0.80	NA	<0.40	<0.14
Calcium (dissolved)	mg/L	NL	NA	NA	NA	39	46.1	NA	NA	NA	NA	NA
Cation/Anion Balance	%	NL	NA	NA	NA	NA	1.6	NA	NA	NA	NA	NA
Chloride	mg/L	NL	NA	NA	NA	2	19.8	NA	2.1	NA	<1.0	0.72J
Chromium	ug/L	25.0	NA	NA	NA	<5	<5	NA	<5.0	NA	<10.0	<1.3
Chromium, Trivalent	ug/L	NL	NA	NA	NA	NA	<10	NA	NA	NA	NA	NA
Chromium, Hexavalent	ug/L	NL	NA	NA	NA	<4	<10	NA	NA	NA	NA	NA
Conductance (Field)	umhos/cm	NL	NA	NA	NA	239	266.5	260	224	263	208	208
Conductance (Lab)	umhos/cm	NL	NA	NA	NA	260	360	NA	276	NA	227	227
Copper (dissolved)	ug/L	250	NA	NA	NA	<10	<5	NA	<5.0	NA	<10.0	2.0J
Dissolved Oxygen (Field)	mg/L	NL	NA	NA	NA	NA	3.39	0.68	3.37	2.05	1.85	1.85
Eh (Lab)	mV	NL	NA	NA	NA	150	159	NA	NA	NA	NA	NA
Eh (Field)	mV	NL	NA	NA	NA	NA	532	61	243	109	167	167
Iron (dissolved)	mg/L	NL	NA	NA	NA	0.048	<0.05	NA	<50.0	NA	<0.05	28.9J
Lead (dissolved)	ug/L	1.25	NA	NA	NA	<0.4	<2.5	NA	<2.0	NA	<1.0	0.051J
Magnesium (dissolved)	mg/L	NL	NA	NA	NA	11	12.6	NA	NA	NA	NA	NA
Manganese (dissolved)	mg/L	0.025	NA	NA	NA	0.098	0.0825	NA	0.0808	NA	0.0629	0.0629
Mercury (dissolved)	ug/L	0.5	NA	NA	NA	<0.1	<0.20	NA	<0.20	NA	<0.20	<0.025
Nitrate/Nitrite as N	mg/L	2.5	NA	NA	NA	NA	NA	NA	0.12	NA	0.24	0.24
Nitrate as N	mg/L	NL	NA	NA	NA	<0.05	0.15	NA	NA	NA	NA	NA
Nitrite as N	mg/L	NL	NA	NA	NA	<0.05	<0.1	NA	NA	NA	NA	NA
pH (Field)	Standard Units	NL	NA	NA	NA	7.91	8.17	9.2	7.82	7.98	8.09	8.09
pH (Lab)	Standard Units	NL	NA	NA	NA	8	7.7	NA	8.0	NA	8.0	8.0
Potassium (dissolved)	mg/L	NL	NA	NA	NA	1	1	NA	NA	NA	NA	NA
Sodium (dissolved)	mg/L	NL	NA	NA	NA	3.4	NA	NA	3.2	NA	2.8	2.8
Sulfate	mg/L	NL	NA	NA	NA	13	15.9	NA	15.3	NA	9.0	9.0
Temp (Field)	oC	NL	NA	NA	NA	9.3	8.95	9.62	8.6	9.56	9.9	9.9
Total Dissolved Solids (TDS)	mg/L	NL	NA	NA	NA	160	195	NA	NA	NA	NA	NA
Total Suspended Solids (TSS)	mg/L	NL	NA	NA	NA	30	404	NA	9.2	NA	34.6	34.6
Turbidity	NTU	NL	NA	NA	NA	24	38	83	29.4	70.3	30.4	30.4
Zinc (dissolved)	ug/L	500	NA	NA	NA	<5	<10	NA	NA	NA	NA	NA

NA = Not Analyzed
*Data obtained from previous reports
** = Results reported to the labs method detection limits
IL = Intervention Limit
mg/L = milligrams per liter = parts per million
ug/L = micrograms per liter = parts per billion
NL = Not listed
J = Estimated concentration above the adjusted method detection limit and below the adjusted reporting limit.

Table 3

Summary of Inorganic Groundwater Quality - MMLF-7
Camp Ripley Closed Mixed Municipal Landfill
State of Minnesota Department of Military Affairs

Parameter	Units	IL	MMLF-7* 10/26/2009	MMLF-7* 11/11/2009	MMLF-7* 12/10/2009	MMLF-7* 11/8/2010	MMLF-7* 11/1/2012	MMLF-7 10/25/2013	MMLF-7 11/12/2014	MMLF-7 11/5/2015	MMLF-7 10/31/2016	MMLF-7** 10/31/2016
Alkalinity	mg/L	NL	360	280	330	340	416	NA	121	NA	389	389
Ammonia Nitrogen	mg/L	NL	0.83	0.52	0.33	0.42	1.1	NA	0.19	NA	0.78	0.78
Arsenic (dissolved)	ug/L	2.5	<1	<1	<1	<1.6	<2.5	NA	<2.0	NA	<1.0	<0.48
Barium (dissolved)	mg/L	0.5	0.23	0.39	0.17	0.26	0.44	NA	0.335	NA	0.309	0.309
Boron (disolved)	ug/L	250	72	<40	64	NA	NA	NA	<100	NA	<100	66.2J
Cadmium (dissolved)	ug/L	1.0	<0.2	<0.2	<0.2	<2	<1	NA	<0.80	NA	<0.40	<0.14
Calcium (dissolved)	mg/L	NL	120	86	100	98	128	NA	NA	NA	NA	NA
Cation/Anion Balance	%	NL	NA	NA	NA	NA	1.3	NA	NA	NA	NA	NA
Chloride	mg/L	NL	19	19	20	24	21	NA	3.4	NA	21.1	21.1
Chromium	ug/L	25.0	<5	4	<5	<5	<5	NA	<5.0	NA	<10.0	<1.3
Chromium, Trivalent	ug/L	NL	NA	NA	NA	NA	<10	NA	NA	NA	NA	NA
Chromium, Hexavalent	ug/L	NL	<3	<3	<3	<4	<10	NA	NA	NA	NA	NA
Conductance (Field)	umhos/cm	NL	624	490	574	599	802	850	630	813	777	777
Conductance (Lab)	umhos/cm	NL	750	580	690	690	900	NA	656	NA	817	817
Copper (dissolved)	ug/L	250	<10	<10	<10	<10	<5	NA	<5.0	NA	<10.0	2.4J
Dissolved Oxygen (Field)	mg/L	NL	140	130	130	140	0.88	3.72	4.35	0.98	2.2	2.2
Eh (Lab)	mV	NL	NA	NA	NA	NA	165	NA	NA	NA	NA	NA
Eh (Field)	mV	NL	NA	NA	NA	NA	584	144	257	223	275	275
Iron (dissolved)	mg/L	NL	0.02	<0.01	0.04	0.038	0.051	NA	<0.050	NA	<50.0	13.6J
Lead (dissolved)	ug/L	1.25	<0.4	<0.4	<0.4	<0.4	<2.5	NA	<2.0	NA	<1.0	0.034J
Magnesium (dissolved)	mg/L	NL	28	23	24	25	28.7	NA	NA	NA	NA	NA
Manganese (dissolved)	mg/L	0.025	3.4	2.6	2.2	2.3	2.24	NA	0.593	NA	0.593	0.593
Mercury (dissolved)	ug/L	0.5	<0.1	<0.1	<0.1	<0.1	<0.20	NA	<0.20	NA	<0.20	<0.025
Nitrate/Nitrite as N	mg/L	2.5	NA	0.64	NA	NA	NA	NA	1.5	NA	1.3	1.3
Nitrate as N	mg/L	NL	0.76	NA	0.43	0.38	<0.1	NA	NA	NA	NA	NA
Nitrite as N	mg/L	NL	<0.05	NA	<0.05	<0.05	<0.1	NA	NA	NA	NA	NA
pH (Field)	Standard Units	NL	6.83	6.83	6.9	7.07	7.19	8.16	7.14	6.36	7.07	7.07
pH (Lab)	Standard Units	NL	7.2	7.1	7.2	7.1	7	NA	7.4	NA	7.5	7.5
Potassium (dissolved)	mg/L	NL	2.1	1.6	1.8	2.2	2.9	NA	NA	NA	NA	NA
Sodium (dissolved)	mg/L	NL	16	11	15	13	NA	NA	4.5	NA	6.1	6.1
Sulfate	mg/L	NL	12	7.8	9.6	9.7	6.3	NA	5.2	NA	4	4.0
Temp (Field)	oC	NL	8.3	8.7	7.1	10.6	9.27	8.28	9.5	9.8	10.3	10.3
Total Dissolved Solids (TDS)	mg/L	NL	440	340	400	400	501	NA	NA	NA	NA	NA
Total Suspended Solids (TSS)	mg/L	NL	6	8	2	16	4	NA	3.2	NA	5.2	5.2
Turbidity	NTU	NL	8.2	4	2	2	0.8	40.1	12.5	14.7	10.4	10.4
Zinc (dissolved)	ug/L	500	8	<5	<5	8	<10	NA	NA	NA	NA	NA

NA = Not Analyzed
*Data obtained from previous reports
** = Results reported to the labs method detection limits
IL = Intervention Limit
mg/L = milligrams per liter = parts per million
ug/L = micrograms per liter = parts per billion
NL = Not listed
J = Estimated concentration above the adjusted method detection limit and below the adjusted reporting limit.

Table 4

Summary of Inorganic Groundwater Quality - MMLF-8
Camp Ripley Closed Mixed Municipal Landfill
State of Minnesota Department of Military Affairs

Parameter	Units	IL	MMLF-8* 10/26/2009	MMLF-8* 11/11/2009	MMLF-8* 12/10/2009	MMLF-8* 11/8/2010	MMLF-8* 11/1/2012	MMLF-8 10/25/2013	MMLF-8 11/12/2014	MMLF-8 11/5/2015	MMLF-8 10/31/2016	MMLF-8** 10/31/2016
Alkalinity	mg/L	NL	160	150	170	170	163	NA	337	NA	240	240
Ammonia Nitrogen	mg/L	NL	<0.01	<0.01	<0.01	<0.01	<0.1	NA	<0.10	NA	<0.10	<0.044
Arsenic (dissolved)	ug/L	2.5	<1	<1	<1	<1.6	<2.5	NA	<2.0	NA	<1.0	<0.48
Barium (dissolved)	mg/L	0.5	0.044	0.035	0.029	0.023	0.03	NA	0.0339	NA	0.0501	0.0501
Boron (disolved)	ug/L	250	72	<40	64	NA	NA	NA	<100	NA	<100	23.9J
Cadmium (dissolved)	ug/L	1.0	<0.2	<0.2	<0.2	<2	<1	NA	<0.80	NA	<0.40	<0.14
Calcium (dissolved)	mg/L	NL	54	53	49	52	55.3	NA	NA	NA	NA	NA
Cation/Anion Balance	%	NL	NA	NA	NA	NA	0.58	NA	NA	NA	NA	NA
Chloride	mg/L	NL	13	21	17	17	20.6	NA	14.4	NA	25.9	25.9
Chromium	ug/L	25.0	<5	5.2	<5	<5	<5	NA	<5.0	NA	<10.0	1.3J
Chromium, Trivalent	ug/L	NL	NA	NA	NA	NA	<10	NA	NA	NA	NA	NA
Chromium, Hexavalent	ug/L	NL	<3	<3	<3	<4	<10	NA	NA	NA	NA	NA
Conductance (Field)	umhos/cm	NL	308	326	316	339	384	310	407	499	552	552
Conductance (Lab)	umhos/cm	NL	350	370	380	370	410	NA	420	NA	591	591
Copper (dissolved)	ug/L	250	<10	<10	<10	<10	<5	NA	<5.0	NA	<10.0	<0.86
Dissolved Oxygen (Field)	mg/L	NL	NA	NA	NA	NA	8.75	NA	9.31	7.76	6.83	6.83
Eh (Lab)	mV	NL	150	140	190	140	154	NA	NA	NA	NA	NA
Eh (Field)	mV	NL	NA	NA	NA	NA	514	155	307	224	301	301
Iron (dissolved)	mg/L	NL	<0.01	<0.01	<0.01	<0.01	<0.05	NA	<0.050	NA	<0.050	<2.9
Lead (dissolved)	ug/L	1.25	<0.4	<0.4	<0.4	<0.4	<2.5	NA	<2.0	NA	<1.0	0.023J
Magnesium (dissolved)	mg/L	NL	13	14	12	13	14.2	NA	NA	NA	NA	NA
Manganese (dissolved)	mg/L	0.025	0.081	0.03	0.006	<0.005	<0.01	NA	<0.010	NA	<0.010	0.0053J
Mercury (dissolved)	ug/L	0.5	<0.1	<0.1	<0.1	<0.1	<0.20	NA	<0.20	NA	<0.20	<0.025
Nitrate/Nitrite as N	mg/L	2.5	NA	1.1	NA	NA	NA	NA	0.55	NA	1.8	1.8
Nitrate as N	mg/L	NL	0.65	NA	0.73	0.67	0.48	NA	NA	NA	NA	NA
Nitrite as N	mg/L	NL	<0.05	NA	<0.05	<0.05	<0.1	NA	NA	NA	NA	NA
pH (Field)	Standard Units	NL	7.51	7.05	7.08	7.84	8.44	9.09	7.63	7.5	7.9	7.9
pH (Lab)	Standard Units	NL	7.9	7.8	7.9	7.8	7.7	NA	8	NA	7.59	7.59
Potassium (dissolved)	mg/L	NL	0.6	0.8	0.4	0.75	0.64	NA	NA	NA	NA	NA
Sodium (dissolved)	mg/L	NL	2.6	3.1	2.5	2.8	NA	NA	2.8	NA	3.0	3.0
Sulfate	mg/L	NL	7.4	7.6	7.4	7.4	6.9	NA	5.3	NA	5.7	5.7
Temp (Field)	oC	NL	8.3	8.7	7.1	10.6	7.97	8.34	8	8.2	8.7	8.7
Total Dissolved Solids (TDS)	mg/L	NL	200	200	220	390	235	NA	NA	NA	NA	NA
Total Suspended Solids (TSS)	mg/L	NL	4	4	8	6	5.5	NA	6.4	NA	<2.0	<2.0
Turbidity	NTU	NL	6.8	2.7	10	3.8	1.4	46.7	14.9	14	21	21
Zinc (dissolved)	ug/L	500	<5	<5	<5	<5	10.1	NA	NA	NA	NA	NA

NA = Not Analyzed
*Data obtained from previous reports
** = Results reported to the labs method detection limits
IL = Intervention Limit
mg/L = milligrams per liter = parts per million
ug/L = micrograms per liter = parts per billion
NL = Not listed
J = Estimated concentration above the adjusted method detection limit and below the adjusted reporting limit.

Table 5

Summary of Volatile Organic Compounds Groundwater Quality Data - MMLF-3
Camp Ripley Closed Mixed Municpal Landfill
State of Minnesota Department of Military Affairs

Parameter	Units	IL	MMLF-3* 10/26/2009	MMLF-3* 11/11/2009	MMLF-3* 12/10/2009	MMLF-3* 11/8/2010	MMLF-3* 11/1/2012	MMLF-3 10/25/2013	MMLF-3 11/12/2014	MMLF-3 11/5/2015	MMLF-3 10/31/2016	MMLF-3** 10/31/2016
Acetone	ug/L	175	NA	NA	NA	<4	<25.0	<20.0	<20.0	<20.0	<20.0	<0.64
Allylchloride	ug/L	7.5	NA	NA	NA	<0.16	<4.0	<4.0	<4.0	<5.0	<4.0	<0.25
Benzene	ug/L	2.5	NA	NA	NA	<0.2	<1.0	<1.0	<1.0	<0.50	<0.50	<0.042
Bromobenzene	ug/L	NL	NA	NA	NA	<0.12	<1.0	<1.0	<1.0	<1.0	<0.50	<0.087
Bromochloromethane	ug/L	NL	NA	NA	NA	<0.18	<1.0	<1.0	<1.0	<1.0	<1.0	<0.082
Bromodichloromethane	ug/L	2	NA	NA	NA	<0.12	<1.0	<1.0	<1.0	<1.0	<1.0	<0.068
Bromoform	ug/L	10	NA	NA	NA	<0.13	<4.0	<4.0	<4.0	<5.0	<4.0	<0.11
Bromomethane	ug/L	3	NA	NA	NA	<0.16	<4.0	<4.0	<4.0	<2.5	<4.0	<0.20
Methyl Ethyl Ketone (MEK)/2-Butanone	ug/L	1000	NA	NA	NA	<1.0	<4.0	<5.0	<5.0	<20.0	<5.0	<1.1
n-Butylbenzene	ug/L	NL	NA	NA	NA	<0.18	<1.0	<1.0	<1.0	<2.5	<0.50	<0.16
sec-Butylbenzene	ug/L	NL	NA	NA	NA	<0.17	<1.0	<1.0	<1.0	<1.0	<0.50	<0.094
tert-Butylbenzene	ug/L	NL	NA	NA	NA	<0.16	<1.0	<1.0	<1.0	<1.0	<0.50	<0.051
Carbon tetrachloride	ug/L	0.75	NA	NA	NA	<0.28	<1.0	<1.0	<1.0	<0.50	<1.0	<0.079
Chlorobenzene	ug/L	25	NA	NA	NA	<0.20	<1.0	<1.0	<1.0	<1.0	<0.50	<0.066
Chloroethane	ug/L	NL	NA	NA	NA	<0.24	<1.0	<4.0	<1.0	<2.5	<1.0	<0.12
Chloroform	ug/L	15	NA	NA	NA	<0.20	<1.0	<1.0	<1.0	<1.0	<1.0	<0.21
Chloromethane	ug/L	NL	NA	NA	NA	<0.20	<4.0	<4.0	<4.0	<2.5	<4.0	<0.080
2-Chlorotoluene	ug/L	NL	NA	NA	NA	<0.13	<1.0	<1.0	<1.0	<1.0	<0.50	<0.084
4-Chlorotoluene	ug/L	NL	NA	NA	NA	<0.13	<1.0	<1.0	<1.0	<1.0	<0.50	<0.048
1,2-Dibromo-3-chloropropane	ug/L	NL	NA	NA	NA	<0.23	<4.0	<4.0	<4.0	<5.0	<10.0	<0.60
Dibromochloromethane	ug/L	13	NA	NA	NA	<0.13	<1.0	<1.0	<1.0	<0.50	<4.0	<0.048
1,2-Dibromoethane (EDB)	ug/L	0.001	NA	NA	NA	<0.11	<1.0	<1.0	<1.0	<0.50	<1.0	<0.092
Dibromomethane	ug/L	--	NA	NA	NA	<0.10	<4.0	<4.0	<4.0	<2.5	<1.0	<0.14
1,2-Dichlorobenzene	ug/L	150	NA	NA	NA	<0.096	<1.0	<1.0	<1.0	<0.50	<0.50	<0.078
1,3-Dichlorobenzene	ug/L	150	NA	NA	NA	<0.17	<1.0	<1.0	<1.0	<1.0	<0.50	<0.085
1,4-Dichlorobenzene	ug/L	2.5	NA	NA	NA	<0.084	<1.0	<1.0	<1.0	<1.0	<0.50	<0.081
Dichlorodifluoromethane	ug/L	250	NA	NA	NA	<0.23	<1.0	<1.0	<1.0	<5.0	<1.0	<0.075
1,1-Dichloroethane	ug/L	17.5	NA	NA	NA	<0.20	<1.0	<1.0	<1.0	<1.0	<0.50	<0.055
1,2-Dichloroethane	ug/L	1	NA	NA	NA	<0.17	<1.0	<1.0	<1.0	<0.25	<0.50	<0.072
1,1-Dichloroethene	ug/L	1.5	NA	NA	NA	<0.17	<1.0	<1.0	<1.0	<1.0	<0.50	<0.069
cis-1,2-Dichloroethene	ug/L	17.5	NA	NA	NA	<0.10	<1.0	<1.0	<1.0	<1.0	<0.50	<0.12
trans-1,2-Dichloroethene	ug/L	1.5	NA	NA	NA	<0.23	<1.0	<1.0	<1.0	<1.0	<0.50	<0.15
Dichlorofluoromethane	ug/L	NL	NA	NA	NA	<0.17	<1.0	<1.0	<1.0	<1.0	<1.0	<0.054
1,2-Dichloropropane	ug/L	1.25	NA	NA	NA	<0.19	<4.0	<4.0	<4.0	<1.0	<4.0	<0.066
1,3-Dichloropropane	ug/L	NL	NA	NA	NA	<0.14	<1.0	<1.0	<1.0	<1.0	<0.50	<0.059
2,2-Dichloropropane	ug/L	NL	NA	NA	NA	<0.36	<4.0	<4.0	<4.0	<5.0	<1.0	<0.096
1,1-Dichloropropene	ug/L	NL	NA	NA	NA	<0.21	<1.0	<1.0	<1.0	<1.0	<0.50	<0.082

NA = Not Analyzed
*Data obtained from previous reports
** = Results reported to the labs method detection limits
IL = Intervention Limit
ug/L = micrograms per liter = parts per billion
NL = Not listed

Table 5 (con't)

Summary of Volatile Organic Compounds Groundwater Quality Data - MMLF-3
Camp Ripley Closed Mixed Municpal Landfill
State of Minnesota Department of Military Affairs

Parameter	Units	IL	MMLF-3* 10/26/2009	MMLF-3* 11/11/2009	MMLF-3* 12/10/2009	MMLF-3* 11/8/2010	MMLF-3* 11/1/2012	MMLF-3 10/25/2013	MMLF-3 11/12/2014	MMLF-3 11/5/2015	MMLF-3 10/31/2016	MMLF-3** 10/31/2016
cis-1,3-Dichloropopene	ug/L	0.5	NA	NA	NA	<0.21	<4.0	<4.0	<4.0	<0.50	<0.50	<0.12
trans-1,3-Dichloropropene	ug/L	0.5	NA	NA	NA	<0.16	<4.0	<4.0	<4.0	<0.50	<1.0	<0.15
Diethyl Ether (Ethyl Ether)	ug/L	250	NA	NA	NA	<0.14	<4.0	<4.0	<4.0	<5.0	<4.0	<0.090
Ethylbenzene	ug/L	175	NA	NA	NA	<0.15	<1.0	<1.0	<1.0	<1.0	<0.50	<0.075
Hexachlorobutadiene	ug/L	NL	NA	NA	NA	<0.20	<5.0	<1.0	<1.0	<2.5	<4.0	<0.13
Isopropylbenzene (Cumene)	ug/L	NL	NA	NA	NA	<0.20	<1.0	<1.0	<1.0	<1.0	<0.50	<0.064
p-Isopropyltoluene	ug/L	NL	NA	NA	NA	<0.17	<1.0	<1.0	<1.0	<2.5	<0.50	<0.064
Methylene Chloride	ug/L	0.25	NA	NA	NA	<0.20	<4.0	<4.0	<4.0	<2.5	<4.0	<0.097
Methyl isobutyl ketone	ug/L	75	NA	NA	NA	<0.18	<4.0	<5.0	<5.0	<5.0	<5.0	<0.80
Methyl tert-butyl ether	ug/L	NL	NA	NA	NA	<0.13	<1.0	<1.0	<1.0	<1.0	<0.50	<0.047
Naphthalene	ug/L	75	NA	NA	NA	<0.20	<4.0	<4.0	<4.0	<5.0	<1.0	<0.064
n-Propylbenzene	ug/L	NL	NA	NA	NA	<0.17	<1.0	<1.0	<1.0	<1.0	<0.50	<0.049
Styrene	ug/L	25	NA	NA	NA	<0.15	<1.0	<1.0	<1.0	<1.0	<0.50	<0.056
1,1,1,2-Tetrachloroethane	ug/L	17.5	NA	NA	NA	<0.13	<1.0	<1.0	<1.0	<1.0	<1.0	<0.064
1,1,2,2-Tetrachloroethane	ug/L	0.5	NA	NA	NA	<0.10	<1.0	<1.0	<1.0	<0.50	<0.50	<0.055
Tetrachloroethene	ug/L	7	NA	NA	NA	<0.29	<1.0	<1.0	<1.0	<1.0	<0.50	<0.13
Tetrahydrofuran	ug/L	25	NA	NA	NA	<1.0	<10.0	<10.0	<10.0	<20.0	<10.0	<1.5
Toluene	ug/L	250	NA	NA	NA	<0.20	<1.0	<1.0	<1.0	<1.0	<0.50	<0.059
1,2,3-Trichlorobenzene	ug/L	NL	NA	NA	NA	<0.12	<1.0	<1.0	<1.0	<5.0	<0.50	<0.17
1,2,4-Trichlorobenzene	ug/L	10	NA	NA	NA	<0.15	<1.0	<1.0	<1.0	<1.0	<0.50	<0.14
1,1,1-Trichloroethane	ug/L	150	NA	NA	NA	<0.17	<1.0	<1.0	<1.0	<1.0	<0.50	<0.057
1,1,2-Trichloroethane	ug/L	0.75	NA	NA	NA	<0.11	<1.0	<1.0	<1.0	<0.50	<0.50	<0.064
Trichloroethene	ug/L	NL	NA	NA	NA	<0.19	<1.0	<0.40	<0.40	<0.50	<0.40	<0.044
Trichlorofluoromethane	ug/L	500	NA	NA	NA	<0.19	<1.0	<1.0	<1.0	<1.0	<0.50	<0.055
1,2,3-Trichloropropane	ug/L	10	NA	NA	NA	<0.17	<4.0	<4.0	<4.0	<0.20	<4.0	<0.19
1,1,2-Trichlorotrifluoroethane	ug/L	50	NA	NA	NA	<0.27	<1.0	<1.0	<1.0	<1.0	<1.0	<0.13
1,2,4-Trimethylbenzene	ug/L	NL	NA	NA	NA	<0.18	<1.0	<1.0	<1.0	<1.0	<0.50	<0.068
1,3,5-Trimethylbenzene	ug/L	NL	NA	NA	NA	<0.17	<1.0	<1.0	<1.0	<1.0	<0.50	<0.042
Vinyl Chloride	ug/L	0.05	NA	NA	NA	<0.20	<0.40	<0.40	<0.40	<0.050	<0.20	<0.098
m,p&o-Xylene (Xylene Total)	ug/L	75	NA	NA	NA	<0.32	<3.0	<3.0	<3.0	NA	<1.5	<0.15
m&p-Xylene	ug/L	NL	NA	NA	NA	NA	<2.0	<2.0	NA	<2.0	<1.0	<0.11
o-Xylene	ug/L	NL	NA	NA	NA	NA	<1.0	<1.0	NA	<1.0	<0.50	<0.044

NA = Not Analyzed
*Data obtained from previous reports
** = Results reported to the labs method detection limits
IL = Intervention Limit
ug/L = micrograms per liter = parts per billion
NL = Not listed

Table 6

Summary of Volatile Organic Compounds Groundwater Quality Data - MMLF-7
Camp Ripley Closed Mixed Municpal Landfill
State of Minnesota Department of Military Affairs

Parameter	Units	IL	MMLF-7* 10/26/2009	MMLF-7* 11/11/2009	MMLF-7* 12/10/2009	MMLF-7* 11/8/2010	MMLF-7* 11/1/2012	MMLF-7 10/25/2013	MMLF-7 11/12/2014	MMLF-7 11/5/2015	MMLF-7 10/31/2016	MMLF-7** 10/31/2016
Acetone	ug/L	175	<4	<4	<4	<4	<25.0	<20.0	<20.0	<20.0	<20.0	<0.64
Allylchloride	ug/L	7.5	<0.042	<0.042	<0.042	<0.16	<4.0	<4.0	<4.0	<5.0	<4.0	<0.25
Benzene	ug/L	2.5	0.36	0.43	0.47	0.33	<1.0	<1.0	<1.0	<0.50	<0.50	<0.042
Bromobenzene	ug/L	NL	<0.17	<0.17	<0.17	<0.12	<1.0	<1.0	<1.0	<1.0	<0.50	<0.087
Bromochloromethane	ug/L	NL	<0.082	<0.082	<0.082	<0.18	<1.0	<1.0	<1.0	<1.0	<1.0	<0.082
Bromodichloromethane	ug/L	2	<0.086	<0.086	<0.086	<0.12	<1.0	<1.0	<1.0	<1.0	<1.0	<0.068
Bromoform	ug/L	10	<0.16	<0.16	<0.16	<0.13	<4.0	<4.0	<4.0	<5.0	<4.0	<0.11
Bromomethane	ug/L	3	<0.060	<0.060	<0.060	<0.16	<4.0	<4.0	<4.0	<2.5	<4.0	<0.20
Methyl Ethyl Ketone (MEK)/2-Butanone	ug/L	1000	<1.0	<1.0	<1.0	<1.0	<4.0	<5.0	<5.0	<20.0	<5.0	<1.1
n-Butylbenzene	ug/L	NL	<0.10	<0.10	<0.10	<0.18	<1.0	<1.0	<1.0	<2.5	<0.50	<0.16
sec-Butylbenzene	ug/L	NL	<0.087	<0.087	<0.087	<0.17	<1.0	<1.0	<1.0	<1.0	<0.50	<0.094
tert-Butylbenzene	ug/L	NL	<0.15	<0.15	<0.15	<0.16	<1.0	<1.0	<1.0	<1.0	<0.50	<0.051
Carbon tetrachloride	ug/L	0.75	<0.074	<0.074	<0.074	<0.28	<1.0	<1.0	<1.0	<0.50	<1.0	<0.079
Chlorobenzene	ug/L	25	0.58	<0.14	0.56	0.63	<1.0	<1.0	<1.0	<1.0	<0.50	<0.066
Chloroethane	ug/L	NL	<0.089	<0.089	<0.089	<0.24	<1.0	<4.0	<1.0	<2.5	<1.0	<0.12
Chloroform	ug/L	15	<0.20	<0.20	<0.20	<0.20	<1.0	<1.0	<1.0	<1.0	<1.0	<0.21
Chloromethane	ug/L	NL	<0.068	<0.068	<0.068	<0.20	<4.0	<4.0	<4.0	<2.5	<4.0	<0.080
2-Chlorotoluene	ug/L	NL	<0.080	<0.080	<0.080	<0.13	<1.0	<1.0	<1.0	<1.0	<0.50	<0.084
4-Chlorotoluene	ug/L	NL	<0.11	<0.11	<0.11	<0.13	<1.0	<1.0	<1.0	<1.0	<0.50	<0.048
1,2-Dibromo-3-chloropropane	ug/L	NL	<0.12	<0.12	<0.12	<0.23	<4.0	<4.0	<4.0	<5.0	<10.0	<0.60
Dibromochloromethane	ug/L	13	<0.12	<0.12	<0.12	<0.13	<1.0	<1.0	<1.0	<0.50	<4.0	<0.048
1,2-Dibromoethane (EDB)	ug/L	0.001	<0.12	<0.12	<0.12	<0.11	<1.0	<1.0	<1.0	<0.50	<1.0	<0.092
Dibromomethane	ug/L	--	<0.15	<0.15	<0.15	<0.10	<4.0	<4.0	<4.0	<2.5	<1.0	<0.14
1,2-Dichlorobenzene	ug/L	150	<0.10	<0.10	<0.10	<0.096	<1.0	<1.0	<1.0	<0.50	<0.50	<0.078
1,3-Dichlorobenzene	ug/L	150	<0.13	<0.13	<0.13	<0.17	<1.0	<1.0	<1.0	<1.0	<0.50	<0.085
1,4-Dichlorobenzene	ug/L	2.5	0.61	<0.10	0.53	0.54	<1.0	<1.0	<1.0	<1.0	<0.50	<0.081
Dichlorodifluoromethane	ug/L	250	2	0.56	2.6	2	<1.0	<1.0	<1.0	<5.0	<1.0	<0.075
1,1-Dichloroethane	ug/L	17.5	0.12	0.2	0.19	<0.20	<1.0	<1.0	<1.0	<1.0	<0.50	<0.055
1,2-Dichloroethane	ug/L	1	<0.10	<0.10	<0.10	<0.17	<1.0	<1.0	<1.0	<0.25	<0.50	<0.072
1,1-Dichloroethene	ug/L	1.5	<0.12	<0.12	<0.12	<0.17	<1.0	<1.0	<1.0	<1.0	<0.50	<0.069
cis-1,2-Dichloroethene	ug/L	17.5	6.1	7	8.1	7.2	6.2	8.7	<1.0	4.5	3.8	3.8
trans-1,2-Dichloroethene	ug/L	1.5	<0.053	0.068	<0.053	<0.23	<1.0	<1.0	<1.0	<1.0	<0.50	<0.15
Dichlorofluoromethane	ug/L	NL	1.3	1.4	2.1	1.1	2.5	2.0	<1.0	1.4	<1.0	<0.054
1,2-Dichloropropane	ug/L	1.25	<0.055	<0.055	<0.055	<0.19	<4.0	<4.0	<4.0	<1.0	<4.0	<0.066
1,3-Dichloropropane	ug/L	NL	<0.091	<0.091	<0.091	<0.14	<1.0	<1.0	<1.0	<1.0	<0.50	<0.059
2,2-Dichloropropane	ug/L	NL	<0.063	<0.063	<0.063	<0.36	<4.0	<4.0	<4.0	<5.0	<1.0	<0.096
1,1-Dichloropropene	ug/L	NL	<0.081	<0.081	<0.081	<0.081	<1.0	<1.0	<1.0	<1.0	<0.50	<0.082

NA = Not Analyzed
*Data obtained from previous reports
** = Results reported to the labs method detection limits
IL = Intervention Limit
ug/L = micrograms per liter = parts per billion
NL = Not listed

Table 6 (con't)

Summary of Volatile Organic Compounds Groundwater Quality Data - MMLF-7
Camp Ripley Closed Mixed Municpal Landfill
State of Minnesota Department of Military Affairs

Parameter	Units	IL	MMLF-7* 10/26/2009	MMLF-7* 11/11/2009	MMLF-7* 12/10/2009	MMLF-7* 11/8/2010	MMLF-7* 11/1/2012	MMLF-7 10/25/2013	MMLF-7 11/12/2014	MMLF-7 11/5/2015	MMLF-7 10/31/2016	MMLF-7** 10/31/2016
cis-1,3-Dichloropopene	ug/L	0.5	<0.089	<0.089	<0.089	<0.21	<4.0	<4.0	<4.0	<0.50	<0.50	<0.12
trans-1,3-Dichloropropene	ug/L	0.5	<0.098	<0.098	<0.098	<0.16	<4.0	<4.0	<4.0	<0.50	<1.0	<0.15
Diethyl Ether (Ethyl Ether)	ug/L	250	12	15	17	18	14.7	14.8	<4.0	12	6.9	6.9
Ethylbenzene	ug/L	175	<0.079	<0.079	<0.079	<0.15	<1.0	<1.0	<1.0	<1.0	<0.50	<0.075
Hexachlorobutadiene	ug/L	NL	<0.12	<0.12	<0.12	<0.20	<5.0	<1.0	<1.0	<2.5	<4.0	<0.13
Isopropylbenzene (Cumene)	ug/L	NL	<0.096	<0.096	<0.096	<0.20	<1.0	<1.0	<1.0	<1.0	<0.50	<0.064
p-Isopropyltoluene	ug/L	NL	<0.055	<0.055	<0.055	<0.17	<1.0	<1.0	<1.0	<2.5	<0.50	<0.064
Methylene Chloride	ug/L	0.25	<0.20	<0.20	<0.20	<0.20	<4.0	<4.0	<4.0	<2.5	<4.0	<0.097
Methyl isobutyl ketone	ug/L	75	<0.13	<0.13	<0.13	<0.18	<4.0	<5.0	<5.0	<5.0	<5.0	<0.80
Methyl tert-butyl ether	ug/L	NL	0.11	0.12	0.15	<0.13	<1.0	<1.0	<1.0	<1.0	<0.50	<0.047
Naphthalene	ug/L	75	<0.13	<0.13	<0.13	<0.20	<4.0	<4.0	<4.0	<5.0	<1.0	<0.064
n-Propylbenzene	ug/L	NL	<0.13	<0.13	<0.13	<0.17	<1.0	<1.0	<1.0	<1.0	<0.50	<0.049
Styrene	ug/L	25	<0.079	<0.079	<0.079	<0.15	<1.0	<1.0	<1.0	<1.0	<0.50	<0.056
1,1,1,2-Tetrachloroethane	ug/L	17.5	<0.099	<0.099	<0.099	<0.13	<1.0	<1.0	<1.0	<1.0	<1.0	<0.064
1,1,2,2-Tetrachloroethane	ug/L	0.5	<0.094	<0.094	<0.094	<0.10	<1.0	<1.0	<1.0	<0.50	<0.50	<0.055
Tetrachloroethene	ug/L	7	<0.12	<0.12	<0.12	<0.29	<1.0	<1.0	<1.0	<1.0	<0.50	<0.13
Tetrahydrofuran	ug/L	25	<1.0	<1.0	<1.0	<1.0	<10.0	<10.0	<10.0	<20.0	<10.0	<1.5
Toluene	ug/L	250	<0.20	<0.20	<0.20	<0.20	<1.0	<1.0	<1.0	<1.0	<0.50	<0.059
1,2,3-Trichlorobenzene	ug/L	NL	<0.12	<0.12	<0.12	<0.12	<1.0	<1.0	<1.0	<5.0	<0.50	<0.17
1,2,4-Trichlorobenzene	ug/L	10	<0.073	<0.073	<0.073	<0.15	<1.0	<1.0	<1.0	<1.0	<0.50	<0.14
1,1,1-Trichloroethane	ug/L	150	<0.076	<0.076	<0.076	<0.17	<1.0	<1.0	<1.0	<1.0	<0.50	<0.057
1,1,2-Trichloroethane	ug/L	0.75	<0.11	<0.11	<0.11	<0.11	<1.0	<1.0	<1.0	<0.50	<0.50	<0.064
Trichloroethene	ug/L	NL	<0.16	<0.16	<0.16	<0.19	<1.0	<0.40	<0.40	<0.50	<0.40	<0.044
Trichlorofluoromethane	ug/L	500	<0.095	<0.095	<0.095	<0.19	<1.0	<1.0	<1.0	<1.0	<0.50	<0.055
1,2,3-Trichloropropane	ug/L	10	<0.092	<0.092	<0.092	<0.17	<4.0	<4.0	<4.0	<0.20	<4.0	<0.19
1,1,2-Trichlorotrifluoroethane	ug/L	50	<0.074	<0.074	<0.074	<0.27	<1.0	<1.0	<1.0	<1.0	<1.0	<0.13
1,2,4-Trimethylbenzene	ug/L	NL	<0.042	<0.042	<0.042	<0.18	<1.0	<1.0	<1.0	<1.0	<0.50	<0.068
1,3,5-Trimethylbenzene	ug/L	NL	<0.10	<0.10	<0.10	<0.17	<1.0	<1.0	<1.0	<1.0	<0.50	<0.042
Vinyl Chloride	ug/L	0.05	0.18	0.27	0.59	<0.20	<0.40	<0.40	<0.40	0.12	<0.20	<0.098
m,p&o-Xylene (Xylene Total)	ug/L	75	<0.20	<0.20	<0.20	<0.32	<3.0	<3.0	<3.0	NA	<1.5	<0.15
m&p-Xylene	ug/L	NL	NA	NA	NA	NA	<2.0	<2.0	NA	<2.0	<1.0	<0.11
o-Xylene	ug/L	NL	NA	NA	NA	NA	<1.0	<1.0	NA	<1.0	<0.50	<0.044

NA = Not Analyzed
*Data obtained from previous reports
** = Results reported to the labs method detection limits
IL = Intervention Limit
ug/L = micrograms per liter = parts per billion
NL = Not listed

Table 7

Summary of Volatile Organic Compounds Groundwater Quality Data - MMLF-8
Camp Ripley Closed Mixed Municpal Landfill
State of Minnesota Department of Military Affairs

Parameter	Units	IL	MMLF-8* 10/26/2009	MMLF-8* 11/11/2009	MMLF-8* 12/10/2009	MMLF-8* 11/8/2010	MMLF-8* 11/1/2012	MMLF-8 10/25/2013	MMLF-8 11/12/2014	MMLF-8 11/5/2015	MMLF-8 10/31/2016	MMLF-8** 10/31/2016
Acetone	ug/L	175	<4	<4	<4	<4	<25.0	<20.0	<20.0	<20.0	<20.0	<0.64
Allylchloride	ug/L	7.5	<0.042	<0.042	<0.042	<0.16	<4.0	<4.0	<4.0	<5.0	<4.0	<0.25
Benzene	ug/L	2.5	<0.069	<0.069	<0.069	<0.2	<1.0	<1.0	<1.0	<0.50	<0.50	<0.042
Bromobenzene	ug/L	NL	<0.17	<0.17	<0.17	<0.12	<1.0	<1.0	<1.0	<1.0	<0.50	<0.087
Bromochloromethane	ug/L	NL	<0.082	<0.082	<0.082	<0.18	<1.0	<1.0	<1.0	<1.0	<1.0	<0.082
Bromodichloromethane	ug/L	2	<0.086	<0.086	<0.086	<0.12	<1.0	<1.0	<1.0	<1.0	<1.0	<0.068
Bromoform	ug/L	10	<0.16	<0.16	<0.16	<0.13	<4.0	<4.0	<4.0	<5.0	<4.0	<0.11
Bromomethane	ug/L	3	<0.060	<0.060	<0.060	<0.16	<4.0	<4.0	<4.0	<2.5	<4.0	<0.20
Methyl Ethyl Ketone (MEK)/2-Butanone	ug/L	1000	<1.0	<1.0	<1.0	<1.0	<4.0	<5.0	<5.0	<20.0	<5.0	<1.1
n-Butylbenzene	ug/L	NL	<0.10	<0.10	<0.10	<0.18	<1.0	<1.0	<1.0	<2.5	<0.50	<0.16
sec-Butylbenzene	ug/L	NL	<0.087	<0.087	<0.087	<0.17	<1.0	<1.0	<1.0	<1.0	<0.50	<0.094
tert-Butylbenzene	ug/L	NL	<0.15	<0.15	<0.15	<0.16	<1.0	<1.0	<1.0	<1.0	<0.50	<0.051
Carbon tetrachloride	ug/L	0.75	<0.074	<0.074	<0.074	<0.28	<1.0	<1.0	<1.0	<0.50	<1.0	<0.079
Chlorobenzene	ug/L	25	<0.14	<0.14	<0.14	<0.20	<1.0	<1.0	<1.0	<1.0	<0.50	<0.066
Chloroethane	ug/L	NL	<0.089	<0.089	<0.089	<0.24	<1.0	<4.0	<1.0	<2.5	<1.0	<0.12
Chloroform	ug/L	15	<0.20	<0.20	<0.20	<0.20	<1.0	<1.0	<1.0	<1.0	<1.0	<0.21
Chloromethane	ug/L	NL	<0.068	<0.068	<0.068	<0.20	<4.0	<4.0	<4.0	<2.5	<4.0	<0.080
2-Chlorotoluene	ug/L	NL	<0.080	<0.080	<0.080	<0.13	<1.0	<1.0	<1.0	<1.0	<0.50	<0.084
4-Chlorotoluene	ug/L	NL	<0.11	<0.11	<0.11	<0.13	<1.0	<1.0	<1.0	<1.0	<0.50	<0.048
1,2-Dibromo-3-chloropropane	ug/L	NL	<0.12	<0.12	<0.12	<0.23	<4.0	<4.0	<4.0	<5.0	<10.0	<0.60
Dibromochloromethane	ug/L	13	<0.12	<0.12	<0.12	<0.13	<1.0	<1.0	<1.0	<0.50	<4.0	<0.048
1,2-Dibromoethane (EDB)	ug/L	0.001	<0.12	<0.12	<0.12	<0.11	<1.0	<1.0	<1.0	<0.50	<1.0	<0.092
Dibromomethane	ug/L	--	<0.15	<0.15	<0.15	<0.10	<4.0	<4.0	<4.0	<2.5	<1.0	<0.14
1,2-Dichlorobenzene	ug/L	150	<0.10	<0.10	<0.10	<0.096	<1.0	<1.0	<1.0	<0.50	<0.50	<0.078
1,3-Dichlorobenzene	ug/L	150	<0.13	<0.13	<0.13	<0.17	<1.0	<1.0	<1.0	<1.0	<0.50	<0.085
1,4-Dichlorobenzene	ug/L	2.5	<0.10	<0.10	<0.10	<0.084	<1.0	<1.0	<1.0	<1.0	<0.50	<0.081
Dichlorodifluoromethane	ug/L	250	<0.084	<0.084	<0.084	<0.23	<1.0	<1.0	<1.0	<5.0	<1.0	<0.075
1,1-Dichloroethane	ug/L	17.5	<0.077	<0.077	<0.077	<0.20	<1.0	<1.0	<1.0	<1.0	<0.50	<0.055
1,2-Dichloroethane	ug/L	1	<0.10	<0.10	<0.10	<0.17	<1.0	<1.0	<1.0	<0.25	<0.50	<0.072
1,1-Dichloroethene	ug/L	1.5	<0.12	<0.12	<0.12	<0.17	<1.0	<1.0	<1.0	<1.0	<0.50	<0.069
cis-1,2-Dichloroethene	ug/L	17.5	<0.081	<0.081	<0.081	<0.10	<1.0	<1.0	<1.0	<1.0	<0.50	<0.12
trans-1,2-Dichloroethene	ug/L	1.5	<0.053	<0.053	<0.053	<0.23	<1.0	<1.0	<1.0	<1.0	<0.50	<0.15
Dichlorofluoromethane	ug/L	NL	<0.097	<0.097	<0.097	<0.17	<1.0	<1.0	<1.0	<1.0	<1.0	<0.054
1,2-Dichloropropane	ug/L	1.25	<0.055	<0.055	<0.055	<0.19	<4.0	<4.0	<4.0	<1.0	<4.0	<0.066
1,3-Dichloropropane	ug/L	NL	<0.091	<0.091	<0.091	<0.14	<1.0	<1.0	<1.0	<1.0	<0.50	<0.059
2,2-Dichloropropane	ug/L	NL	<0.063	<0.063	<0.063	<0.36	<4.0	<4.0	<4.0	<5.0	<1.0	<0.096
1,1-Dichloropropene	ug/L	NL	<0.081	<0.081	<0.081	<0.081	<1.0	<1.0	<1.0	<1.0	<0.50	<0.082

NA = Not Analyzed
*Data obtained from previous reports
** = Results reported to the labs method detection limits
IL = Intervention Limit
ug/L = micrograms per liter = parts per billion
NL = Not listed

Table 7 (con't)

Summary of Volatile Organic Compounds Groundwater Quality Data - MMLF-8
Camp Ripley Closed Mixed Municpal Landfill
State of Minnesota Department of Military Affairs

Parameter	Units	IL	MMLF-8* 10/26/2009	MMLF-8* 11/11/2009	MMLF-8* 12/10/2009	MMLF-8* 11/8/2010	MMLF-8* 11/1/2012	MMLF-8 10/25/2013	MMLF-8 11/12/2014	MMLF-8 11/5/2015	MMLF-8 10/31/2016	MMLF-8** 10/31/2016
cis-1,3-Dichloropopene	ug/L	0.5	<0.089	<0.089	<0.089	<0.21	<4.0	<4.0	<4.0	<0.50	<0.50	<0.12
trans-1,3-Dichloropropene	ug/L	0.5	<0.098	<0.098	<0.098	<0.16	<4.0	<4.0	<4.0	<0.50	<1.0	<0.15
Diethyl Ether (Ethyl Ether)	ug/L	250	<0.041	<0.041	<0.041	<0.14	<4.0	<4.0	<4.0	<5.0	<4.0	<0.090
Ethylbenzene	ug/L	175	<0.079	<0.079	<0.079	<0.15	<1.0	<1.0	<1.0	<1.0	<0.50	<0.075
Hexachlorobutadiene	ug/L	NL	<0.12	<0.12	<0.12	<0.20	<5.0	<1.0	<1.0	<2.5	<4.0	<0.13
Isopropylbenzene (Cumene)	ug/L	NL	<0.096	<0.096	<0.096	<0.20	<1.0	<1.0	<1.0	<1.0	<0.50	<0.064
p-Isopropyltoluene	ug/L	NL	<0.055	<0.055	<0.055	<0.17	<1.0	<1.0	<1.0	<2.5	<0.50	<0.064
Methylene Chloride	ug/L	0.25	<0.20	<0.20	<0.20	<0.20	<4.0	<4.0	<4.0	<2.5	<4.0	<0.097
Methyl isobutyl ketone	ug/L	75	<0.13	<0.13	<0.13	<0.18	<4.0	<5.0	<5.0	<5.0	<5.0	<0.80
Methyl tert-butyl ether	ug/L	NL	<0.044	<0.044	<0.044	<0.13	<1.0	<1.0	<1.0	<1.0	<0.50	<0.047
Naphthalene	ug/L	75	<0.13	<0.13	<0.13	<0.20	<4.0	<4.0	<4.0	<5.0	<1.0	<0.064
n-Propylbenzene	ug/L	NL	<0.13	<0.13	<0.13	<0.17	<1.0	<1.0	<1.0	<1.0	<0.50	<0.049
Styrene	ug/L	25	<0.079	<0.079	<0.079	<0.15	<1.0	<1.0	<1.0	<1.0	<0.50	<0.056
1,1,1,2-Tetrachloroethane	ug/L	17.5	<0.099	<0.099	<0.099	<0.13	<1.0	<1.0	<1.0	<1.0	<1.0	<0.064
1,1,2,2-Tetrachloroethane	ug/L	0.5	<0.094	<0.094	<0.094	<0.10	<1.0	<1.0	<1.0	<0.50	<0.50	<0.055
Tetrachloroethene	ug/L	7	<0.12	<0.12	<0.12	<0.29	<1.0	<1.0	<1.0	<1.0	<0.50	<0.13
Tetrahydrofuran	ug/L	25	<1.0	<1.0	<1.0	<1.0	<10.0	<10.0	<10.0	<20.0	<10.0	<1.5
Toluene	ug/L	250	<0.20	<0.20	<0.20	<0.20	<1.0	<1.0	<1.0	<1.0	<0.50	<0.059
1,2,3-Trichlorobenzene	ug/L	NL	<0.12	<0.12	<0.12	<0.12	<1.0	<1.0	<1.0	<5.0	<0.50	<0.17
1,2,4-Trichlorobenzene	ug/L	10	<0.073	<0.073	<0.073	<0.15	<1.0	<1.0	<1.0	<1.0	<0.50	<0.14
1,1,1-Trichloroethane	ug/L	150	<0.076	<0.076	<0.076	<0.17	<1.0	<1.0	<1.0	<1.0	<0.50	<0.057
1,1,2-Trichloroethane	ug/L	0.75	<0.11	<0.11	<0.11	<0.11	<1.0	<1.0	<1.0	<0.50	<0.50	<0.064
Trichloroethene	ug/L	NL	<0.16	<0.16	<0.16	<0.19	<1.0	<0.40	<0.40	<0.50	<0.40	<0.044
Trichlorofluoromethane	ug/L	500	<0.095	<0.095	<0.095	<0.19	<1.0	<1.0	<1.0	<1.0	<0.50	<0.055
1,2,3-Trichloropropane	ug/L	10	<0.092	<0.092	<0.092	<0.17	<4.0	<4.0	<4.0	<0.20	<4.0	<0.19
1,1,2-Trichlorotrifluoroethane	ug/L	50	<0.074	<0.074	<0.074	<0.27	<1.0	<1.0	<1.0	<1.0	<1.0	<0.13
1,2,4-Trimethylbenzene	ug/L	NL	<0.042	<0.042	<0.042	<0.18	<1.0	<1.0	<1.0	<1.0	<0.50	<0.068
1,3,5-Trimethylbenzene	ug/L	NL	<0.10	<0.10	<0.10	<0.17	<1.0	<1.0	<1.0	<1.0	<0.50	<0.042
Vinyl Chloride	ug/L	0.05	<0.10	<0.10	<0.10	<0.20	<0.40	<0.40	<0.40	<0.050	<0.20	<0.098
m,p&o-Xylene (Xylene Total)	ug/L	75	<0.20	<0.20	<0.20	<0.32	<3.0	<3.0	<3.0	NA	<1.5	<0.15
m&p-Xylene	ug/L	NL	NA	NA	NA	NA	<2.0	<2.0	NA	<2.0	<1.0	<0.11
o-Xylene	ug/L	NL	NA	NA	NA	NA	<1.0	<1.0	NA	<1.0	<0.50	<0.044

NA = Not Analyzed

*Data obtained from previous reports

** = Results reported to the labs method detection limits

IL = Intervention Limit

ug/L = micrograms per liter = parts per billion

NL = Not listed

Table 8

Groundwater Elevations
Camp Ripley Closed Mixed Municipal Landfill
State of Minnesota Department of Military Affairs

	MMLF-3	**MMLF-7**	**MMLF-8**
Unique Well Number	250125	774333	773250
Top of Casing Elevation (ft MSL)*	1158.24	1153.51	1156.39
Well Depth (ft)	47	37	40

Date of Data Collection	**MMLF-3**	**MMLF-7**	**MMLF-8**
1982-2007*	1127.96-1136-65	NA	NA
11/1/2012	1133.08 ft.	1122.9 ft.	1122.86 ft.
10/25/2013	1135.06 ft.	1125.07 ft.	1125.88 ft.
11/12/2014	1137.61 ft.	1127.37 ft.	1127.63 ft.
11/5/2015	1134.66 ft.	1125.78 ft.	1125.57 ft.
10/31/2016	1136.20 ft.	1126.68 ft.	1126.85 ft.

*Data from Camp Ripley

NA = Not Available

APPENDIX A

ANALYTICAL REPORTS

Pace Analytical Services, LLC
315 Chestnut Street
Virginia, MN 55792
(218) 742-1042

November 16, 2016

Greg Smith
Widseth, Smith & Nolting
7804 Industrial Park Road
PO Box 2720
Baxter, MN 56425

RE: Project: Camp Ripley MMLF
Pace Project No.: 1278223

Dear Greg Smith:

Enclosed are the analytical results for sample(s) received by the laboratory on November 02, 2016. The results relate only to the samples included in this report. Results reported herein conform to the most current, applicable TNI/NELAC standards and the laboratory's Quality Assurance Manual, where applicable, unless otherwise noted in the body of the report.

If you have any questions concerning this report, please feel free to contact me.

Sincerely,

Melisa Woods

Melisa M Woods
melisa.woods@pacelabs.com
Project Manager

Enclosures

CERTIFICATIONS

Project:	Camp Ripley MMLF
Pace Project No.:	1278223

Minnesota Certification IDs

1700 Elm Street SE Suite 200, Minneapolis, MN 55414
525 N 8th Street, Salina, KS 67401
Alaska Certification UST-107
A2LA Certification #: 2926.01
Alaska Certification #: UST-078
Alaska Certification #MN00064
Alabama Certification #40770
Arizona Certification #: AZ-0014
Arkansas Certification #: 88-0680
California Certification #: 01155CA
Colorado Certification #Pace
Connecticut Certification #: PH-0256
EPA Region 8 Certification #: 8TMS-L
Florida/NELAP Certification #: E87605
Guam Certification #:14-008r
Georgia Certification #: 959
Georgia EPD #: Pace
Idaho Certification #: MN00064
Hawaii Certification #MN00064
Illinois Certification #: 200011
Indiana Certification#C-MN-01
Iowa Certification #: 368
Kansas Certification #: E-10167
Kentucky Dept of Envi. Protection - DW #90062
Kentucky Dept of Envi. Protection - WW #:90062
Louisiana DEQ Certification #: 3086
Louisiana DHH #: LA140001
Maine Certification #: 2013011
Maryland Certification #: 322
Michigan DEPH Certification #: 9909
Minnesota Certification #: 027-053-137
Mississippi Certification #: Pace
Montana Certification #: MT0092
Nevada Certification #: MN_00064
Nebraska Certification #: Pace
New Jersey Certification #: MN-002
New York Certification #: 11647
North Carolina Certification #: 530
North Carolina State Public Health #: 27700
North Dakota Certification #: R-036
Ohio EPA #: 4150
Ohio VAP Certification #: CL101
Oklahoma Certification #: 9507
Oregon Certification #: MN200001
Oregon Certification #: MN300001
Pennsylvania Certification #: 68-00563
Puerto Rico Certification
Saipan (CNMI) #:MP0003
South Carolina #:74003001
Texas Certification #: T104704192
Tennessee Certification #: 02818
Utah Certification #: MN000642013-4
Virginia DGS Certification #: 251
Virginia/VELAP Certification #: Pace
Washington Certification #: C486
West Virginia Certification #: 382
West Virginia DHHR #:9952C
Wisconsin Certification #: 999407970

Virginia Minnesota Certification ID's

315 Chestnut Street, Virginia, MN 55792
Alaska Certification UST-107
Alaska Certification UST-107
Alaska Certification #MN01084
Arizona Department of Health Certification #AZ0785
Minnesota Dept of Health Certification #: 027-137-445
North Dakota Certification: # R-203
Wisconsin DNR Certification # : 998027470
WA Department of Ecology Lab ID# C1007
Nevada DNR #MN010842015-1
Oklahoma Department of Environmental Quality

Duluth Minnesota Cerification ID's

4730 Oneota St., Duluth, MN 55807
Minnesota Dept of Health Certification #: 027-137-152
Wisconsin DNR Certification # : 999446800
North Dakota Certification #: R-105

SAMPLE SUMMARY

Project: Camp Ripley MMLF
Pace Project No.: 1278223

Lab ID	Sample ID	Matrix	Date Collected	Date Received
1278223001	**MW-3**	Water	10/31/16 13:35	11/02/16 10:30
1278223002	**MW-7**	Water	10/31/16 14:30	11/02/16 10:30
1278223003	**MW-8**	Water	10/31/16 15:20	11/02/16 10:30
1278223004	**FLD DUP**	Water	10/31/16 00:00	11/02/16 10:30
1278223005	**Equip Blank**	Water	10/31/16 13:40	11/02/16 10:30
1278223006	**Trip Blank**	Water	10/31/16 00:00	11/02/16 10:30

SAMPLE ANALYTE COUNT

Project: Camp Ripley MMLF
Pace Project No.: 1278223

Lab ID	Sample ID	Method	Analysts	Analytes Reported	Laboratory
1278223001	**MW-3**	EPA 350.1 rev. 2 (1993)	KJD	1	PASI-DUL
		EPA 353.2 rev. 2 (1993)	TMW	1	PASI-DUL
		EPA 200.7	CSD	7	PASI-V
		EPA 200.8	KRV	3	PASI-V
		EPA 7470	MAR	1	PASI-V
		EPA 8260B	DJB	72	PASI-M
		SM 2320B	BEM	1	PASI-V
		SM 2510B	JJH	1	PASI-V
		SM 2540D (1997)	BEM	1	PASI-V
		SM 4500-H+B	JJH	1	PASI-V
		EPA 300.0	DMB	2	PASI-V
1278223002	**MW-7**	EPA 350.1 rev. 2 (1993)	KJD	1	PASI-DUL
		EPA 353.2 rev. 2 (1993)	TMW	1	PASI-DUL
		EPA 200.7	CSD	7	PASI-V
		EPA 200.8	KRV	3	PASI-V
		EPA 7470	MAR	1	PASI-V
		EPA 8260B	DJB	72	PASI-M
		SM 2320B	BEM	1	PASI-V
		SM 2510B	JJH	1	PASI-V
		SM 2540D (1997)	BEM	1	PASI-V
		SM 4500-H+B	JJH	1	PASI-V
		EPA 300.0	DMB	2	PASI-V
1278223003	**MW-8**	EPA 350.1 rev. 2 (1993)	KJD	1	PASI-DUL
		EPA 353.2 rev. 2 (1993)	TMW	1	PASI-DUL
		EPA 200.7	CSD	7	PASI-V
		EPA 200.8	KRV	3	PASI-V
		EPA 7470	MAR	1	PASI-V
		EPA 8260B	DJB	72	PASI-M
		SM 2320B	BEM	1	PASI-V
		SM 2510B	JJH	1	PASI-V
		SM 2540D (1997)	BEM	1	PASI-V
		SM 4500-H+B	JJH	1	PASI-V
		EPA 300.0	DMB	2	PASI-V
1278223004	**FLD DUP**	EPA 350.1 rev. 2 (1993)	KJD	1	PASI-DUL
		EPA 353.2 rev. 2 (1993)	TMW	1	PASI-DUL
		EPA 200.7	CSD	7	PASI-V
		EPA 200.8	KRV	3	PASI-V

SAMPLE ANALYTE COUNT

Project: Camp Ripley MMLF
Pace Project No.: 1278223

Lab ID	Sample ID	Method	Analysts	Analytes Reported	Laboratory
		EPA 7470	MAR	1	PASI-V
		EPA 8260B	DJB	72	PASI-M
		SM 2320B	BEM	1	PASI-V
		SM 2510B	JJH	1	PASI-V
		SM 2540D (1997)	BEM	1	PASI-V
		SM 4500-H+B	JJH	1	PASI-V
		EPA 300.0	DMB	2	PASI-V
1278223005	**Equip Blank**	EPA 350.1 rev. 2 (1993)	KJD	1	PASI-DUL
		EPA 353.2 rev. 2 (1993)	TMW	1	PASI-DUL
		EPA 200.7	CSD	7	PASI-V
		EPA 200.8	KRV	3	PASI-V
		EPA 7470	MAR	1	PASI-V
		EPA 8260B	DJB	72	PASI-M
		SM 2320B	BEM	1	PASI-V
		SM 2510B	JJH	1	PASI-V
		SM 2540D (1997)	BEM	1	PASI-V
		SM 4500-H+B	JJH	1	PASI-V
		EPA 300.0	DMB	2	PASI-V
1278223006	**Trip Blank**	EPA 8260B	DJB	72	PASI-M

ANALYTICAL RESULTS

Project: Camp Ripley MMLF
Pace Project No.: 1278223

Sample: MW-3 **Lab ID: 1278223001** Collected: 10/31/16 13:35 Received: 11/02/16 10:30 Matrix: Water

Parameters	Results	Units	PQL	MDL	DF	Prepared	Analyzed	CAS No.	Qual
350.1 Ammonia	Analytical Method: EPA 350.1 rev. 2 (1993) Preparation Method: EPA 350.1								
Nitrogen, Ammonia	**<0.044**	mg/L	0.10	0.044	1	11/10/16 10:28	11/10/16 14:00	7664-41-7	
353.2 Nitrate + Nitrite pres.	Analytical Method: EPA 353.2 rev. 2 (1993)								
Nitrogen, NO2 plus NO3	**0.24**	mg/L	0.020	0.0035	1		11/11/16 14:47		
200.7 MET ICP, Dissolved	Analytical Method: EPA 200.7 Preparation Method: EPA 200.7								
Barium, Dissolved	**23.6**	ug/L	10.0	0.65	1	11/07/16 16:01	11/08/16 11:26	7440-39-3	
Boron, Dissolved	**22.8J**	ug/L	100	5.9	1	11/07/16 16:01	11/08/16 11:26	7440-42-8	
Chromium, Dissolved	**<1.3**	ug/L	10.0	1.3	1	11/07/16 16:01	11/08/16 11:26	7440-47-3	
Copper, Dissolved	**2.0J**	ug/L	10.0	0.86	1	11/07/16 16:01	11/08/16 11:26	7440-50-8	
Iron, Dissolved	**28.9J**	ug/L	50.0	2.9	1	11/07/16 16:01	11/08/16 11:26	7439-89-6	
Manganese, Dissolved	**62.9**	ug/L	10.0	0.23	1	11/07/16 16:01	11/08/16 11:26	7439-96-5	
Sodium, Dissolved	**2.8**	mg/L	0.50	0.13	1	11/07/16 16:01	11/08/16 11:26	7440-23-5	
200.8 MET ICPMS, Dissolved	Analytical Method: EPA 200.8 Preparation Method: EPA 200.8								
Arsenic, Dissolved	**1.8**	ug/L	1.0	0.48	2	11/07/16 16:01	11/09/16 13:17	7440-38-2	
Cadmium, Dissolved	**<0.14**	ug/L	0.40	0.14	2	11/07/16 16:01	11/08/16 18:47	7440-43-9	
Lead, Dissolved	**0.051J**	ug/L	1.0	0.016	2	11/07/16 16:01	11/08/16 18:47	7439-92-1	
7470 Mercury, Dissolved	Analytical Method: EPA 7470 Preparation Method: EPA 7470								
Mercury, Dissolved	**<0.025**	ug/L	0.20	0.025	1	11/10/16 15:50	11/14/16 09:48	7439-97-6	
8260B MSV Low Level	Analytical Method: EPA 8260B								
Acetone	ND	ug/L	20.0	0.64	1		11/11/16 20:03	67-64-1	
Allyl chloride	ND	ug/L	4.0	0.25	1		11/11/16 20:03	107-05-1	
Benzene	ND	ug/L	0.50	0.042	1		11/11/16 20:03	71-43-2	
Bromobenzene	ND	ug/L	0.50	0.087	1		11/11/16 20:03	108-86-1	
Bromochloromethane	ND	ug/L	1.0	0.082	1		11/11/16 20:03	74-97-5	
Bromodichloromethane	ND	ug/L	1.0	0.068	1		11/11/16 20:03	75-27-4	
Bromoform	ND	ug/L	4.0	0.11	1		11/11/16 20:03	75-25-2	
Bromomethane	ND	ug/L	4.0	0.20	1		11/11/16 20:03	74-83-9	
2-Butanone (MEK)	ND	ug/L	5.0	1.1	1		11/11/16 20:03	78-93-3	
n-Butylbenzene	ND	ug/L	0.50	0.16	1		11/11/16 20:03	104-51-8	
sec-Butylbenzene	ND	ug/L	0.50	0.094	1		11/11/16 20:03	135-98-8	
tert-Butylbenzene	ND	ug/L	0.50	0.051	1		11/11/16 20:03	98-06-6	
Carbon tetrachloride	ND	ug/L	1.0	0.079	1		11/11/16 20:03	56-23-5	
Chlorobenzene	ND	ug/L	0.50	0.066	1		11/11/16 20:03	108-90-7	
Chloroethane	ND	ug/L	1.0	0.12	1		11/11/16 20:03	75-00-3	
Chloroform	ND	ug/L	1.0	0.21	1		11/11/16 20:03	67-66-3	
Chloromethane	ND	ug/L	4.0	0.080	1		11/11/16 20:03	74-87-3	
2-Chlorotoluene	ND	ug/L	0.50	0.084	1		11/11/16 20:03	95-49-8	
4-Chlorotoluene	ND	ug/L	0.50	0.048	1		11/11/16 20:03	106-43-4	
1,2-Dibromo-3-chloropropane	ND	ug/L	10.0	0.60	1		11/11/16 20:03	96-12-8	
Dibromochloromethane	ND	ug/L	4.0	0.048	1		11/11/16 20:03	124-48-1	
1,2-Dibromoethane (EDB)	ND	ug/L	1.0	0.092	1		11/11/16 20:03	106-93-4	

ANALYTICAL RESULTS

Project: Camp Ripley MMLF
Pace Project No.: 1278223

Sample: MW-3 **Lab ID: 1278223001** Collected: 10/31/16 13:35 Received: 11/02/16 10:30 Matrix: Water

Parameters	Results	Units	PQL	MDL	DF	Prepared	Analyzed	CAS No.	Qual
8260B MSV Low Level	Analytical Method: EPA 8260B								
Dibromomethane	ND	ug/L	1.0	0.14	1		11/11/16 20:03	74-95-3	
1,2-Dichlorobenzene	ND	ug/L	0.50	0.078	1		11/11/16 20:03	95-50-1	
1,3-Dichlorobenzene	ND	ug/L	0.50	0.085	1		11/11/16 20:03	541-73-1	
1,4-Dichlorobenzene	ND	ug/L	0.50	0.081	1		11/11/16 20:03	106-46-7	
Dichlorodifluoromethane	ND	ug/L	1.0	0.075	1		11/11/16 20:03	75-71-8	
1,1-Dichloroethane	ND	ug/L	0.50	0.055	1		11/11/16 20:03	75-34-3	
1,2-Dichloroethane	ND	ug/L	0.50	0.072	1		11/11/16 20:03	107-06-2	
1,1-Dichloroethene	ND	ug/L	0.50	0.069	1		11/11/16 20:03	75-35-4	
cis-1,2-Dichloroethene	ND	ug/L	0.50	0.12	1		11/11/16 20:03	156-59-2	
trans-1,2-Dichloroethene	ND	ug/L	0.50	0.15	1		11/11/16 20:03	156-60-5	
Dichlorofluoromethane	ND	ug/L	1.0	0.054	1		11/11/16 20:03	75-43-4	
1,2-Dichloropropane	ND	ug/L	4.0	0.066	1		11/11/16 20:03	78-87-5	
1,3-Dichloropropane	ND	ug/L	0.50	0.059	1		11/11/16 20:03	142-28-9	
2,2-Dichloropropane	ND	ug/L	1.0	0.096	1		11/11/16 20:03	594-20-7	
1,1-Dichloropropene	ND	ug/L	0.50	0.082	1		11/11/16 20:03	563-58-6	
cis-1,3-Dichloropropene	ND	ug/L	0.50	0.069	1		11/11/16 20:03	10061-01-5	
trans-1,3-Dichloropropene	ND	ug/L	1.0	0.044	1		11/11/16 20:03	10061-02-6	
Diethyl ether (Ethyl ether)	ND	ug/L	4.0	0.090	1		11/11/16 20:03	60-29-7	
Ethylbenzene	ND	ug/L	0.50	0.075	1		11/11/16 20:03	100-41-4	
Hexachloro-1,3-butadiene	ND	ug/L	4.0	0.13	1		11/11/16 20:03	87-68-3	
Isopropylbenzene (Cumene)	ND	ug/L	0.50	0.064	1		11/11/16 20:03	98-82-8	
p-Isopropyltoluene	ND	ug/L	0.50	0.064	1		11/11/16 20:03	99-87-6	
Methylene Chloride	ND	ug/L	4.0	0.097	1		11/11/16 20:03	75-09-2	
4-Methyl-2-pentanone (MIBK)	ND	ug/L	5.0	0.80	1		11/11/16 20:03	108-10-1	
Methyl-tert-butyl ether	ND	ug/L	0.50	0.047	1		11/11/16 20:03	1634-04-4	
Naphthalene	ND	ug/L	1.0	0.064	1		11/11/16 20:03	91-20-3	
n-Propylbenzene	ND	ug/L	0.50	0.049	1		11/11/16 20:03	103-65-1	
Styrene	ND	ug/L	0.50	0.056	1		11/11/16 20:03	100-42-5	
1,1,1,2-Tetrachloroethane	ND	ug/L	1.0	0.064	1		11/11/16 20:03	630-20-6	
1,1,2,2-Tetrachloroethane	ND	ug/L	0.50	0.055	1		11/11/16 20:03	79-34-5	
Tetrachloroethene	ND	ug/L	0.50	0.13	1		11/11/16 20:03	127-18-4	
Tetrahydrofuran	ND	ug/L	10.0	1.5	1		11/11/16 20:03	109-99-9	
Toluene	ND	ug/L	0.50	0.059	1		11/11/16 20:03	108-88-3	
1,2,3-Trichlorobenzene	ND	ug/L	0.50	0.17	1		11/11/16 20:03	87-61-6	
1,2,4-Trichlorobenzene	ND	ug/L	0.50	0.14	1		11/11/16 20:03	120-82-1	
1,1,1-Trichloroethane	ND	ug/L	0.50	0.057	1		11/11/16 20:03	71-55-6	
1,1,2-Trichloroethane	ND	ug/L	0.50	0.064	1		11/11/16 20:03	79-00-5	
Trichloroethene	ND	ug/L	0.40	0.044	1		11/11/16 20:03	79-01-6	
Trichlorofluoromethane	ND	ug/L	0.50	0.055	1		11/11/16 20:03	75-69-4	
1,2,3-Trichloropropane	ND	ug/L	4.0	0.19	1		11/11/16 20:03	96-18-4	
1,1,2-Trichlorotrifluoroethane	ND	ug/L	1.0	0.13	1		11/11/16 20:03	76-13-1	
1,2,4-Trimethylbenzene	ND	ug/L	0.50	0.068	1		11/11/16 20:03	95-63-6	
1,3,5-Trimethylbenzene	ND	ug/L	0.50	0.042	1		11/11/16 20:03	108-67-8	
Vinyl chloride	ND	ug/L	0.20	0.098	1		11/11/16 20:03	75-01-4	
Xylene (Total)	ND	ug/L	1.5	0.15	1		11/11/16 20:03	1330-20-7	
m&p-Xylene	ND	ug/L	1.0	0.11	1		11/11/16 20:03	179601-23-1	

ANALYTICAL RESULTS

Project: Camp Ripley MMLF
Pace Project No.: 1278223

Sample: MW-3 **Lab ID: 1278223001** Collected: 10/31/16 13:35 Received: 11/02/16 10:30 Matrix: Water

Parameters	Results	Units	PQL	MDL	DF	Prepared	Analyzed	CAS No.	Qual
8260B MSV Low Level	Analytical Method: EPA 8260B								
o-Xylene	ND	ug/L	0.50	0.044	1		11/11/16 20:03	95-47-6	
Surrogates									
1,2-Dichloroethane-d4 (S)	103	%.	75-125		1		11/11/16 20:03	17060-07-0	
Toluene-d8 (S)	98	%.	75-125		1		11/11/16 20:03	2037-26-5	
4-Bromofluorobenzene (S)	100	%.	75-125		1		11/11/16 20:03	460-00-4	
2320B Alkalinity	Analytical Method: SM 2320B								
Alkalinity, Total as CaCO3	**104**	mg/L	5.0	1.2	1		11/07/16 17:32		
2510B Specific Conductance	Analytical Method: SM 2510B								
Specific Conductance	**227**	umhos/cm	10.0	5.0	1		11/04/16 09:46		
2540D Total Suspended Solids	Analytical Method: SM 2540D (1997)								
Total Suspended Solids	**34.6**	mg/L	2.0	2.0	1		11/04/16 10:49		
4500H+ pH, Electrometric	Analytical Method: SM 4500-H+B								
pH at 25 Degrees C	**8.0**	Std. Units	0.10	0.10	1		11/02/16 14:57		H6
300.0 IC Anions 28 Days	Analytical Method: EPA 300.0								
Chloride	**0.72J**	mg/L	1.0	0.50	1		11/08/16 16:50	16887-00-6	
Sulfate	**9.0**	mg/L	2.0	1.0	1		11/08/16 16:50	14808-79-8	

Sample: MW-7 **Lab ID: 1278223002** Collected: 10/31/16 14:30 Received: 11/02/16 10:30 Matrix: Water

Parameters	Results	Units	PQL	MDL	DF	Prepared	Analyzed	CAS No.	Qual
350.1 Ammonia	Analytical Method: EPA 350.1 rev. 2 (1993) Preparation Method: EPA 350.1								
Nitrogen, Ammonia	**0.78**	mg/L	0.10	0.044	1	11/10/16 10:28	11/10/16 14:01	7664-41-7	
353.2 Nitrate + Nitrite pres.	Analytical Method: EPA 353.2 rev. 2 (1993)								
Nitrogen, NO2 plus NO3	**1.3**	mg/L	0.040	0.0070	2		11/11/16 15:27		
200.7 MET ICP, Dissolved	Analytical Method: EPA 200.7 Preparation Method: EPA 200.7								
Barium, Dissolved	**309**	ug/L	10.0	0.65	1	11/07/16 16:01	11/08/16 11:36	7440-39-3	
Boron, Dissolved	**66.2J**	ug/L	100	5.9	1	11/07/16 16:01	11/08/16 11:36	7440-42-8	
Chromium, Dissolved	**<1.3**	ug/L	10.0	1.3	1	11/07/16 16:01	11/08/16 11:36	7440-47-3	
Copper, Dissolved	**2.4J**	ug/L	10.0	0.86	1	11/07/16 16:01	11/08/16 11:36	7440-50-8	
Iron, Dissolved	**13.6J**	ug/L	50.0	2.9	1	11/07/16 16:01	11/08/16 11:36	7439-89-6	
Manganese, Dissolved	**593**	ug/L	10.0	0.23	1	11/07/16 16:01	11/08/16 11:36	7439-96-5	
Sodium, Dissolved	**6.1**	mg/L	0.50	0.13	1	11/07/16 16:01	11/08/16 11:36	7440-23-5	
200.8 MET ICPMS, Dissolved	Analytical Method: EPA 200.8 Preparation Method: EPA 200.8								
Arsenic, Dissolved	**<0.48**	ug/L	1.0	0.48	2	11/07/16 16:01	11/08/16 18:58	7440-38-2	

ANALYTICAL RESULTS

Project: Camp Ripley MMLF
Pace Project No.: 1278223

Sample: MW-7 **Lab ID: 1278223002** Collected: 10/31/16 14:30 Received: 11/02/16 10:30 Matrix: Water

Parameters	Results	Units	PQL	MDL	DF	Prepared	Analyzed	CAS No.	Qual
200.8 MET ICPMS, Dissolved	Analytical Method: EPA 200.8 Preparation Method: EPA 200.8								
Cadmium, Dissolved	**<0.14**	ug/L	0.40	0.14	2	11/07/16 16:01	11/08/16 18:58	7440-43-9	
Lead, Dissolved	**0.034J**	ug/L	1.0	0.016	2	11/07/16 16:01	11/08/16 18:58	7439-92-1	
7470 Mercury, Dissolved	Analytical Method: EPA 7470 Preparation Method: EPA 7470								
Mercury, Dissolved	**<0.025**	ug/L	0.20	0.025	1	11/10/16 15:50	11/14/16 09:50	7439-97-6	
8260B MSV Low Level	Analytical Method: EPA 8260B								
Acetone	ND	ug/L	20.0	0.64	1		11/11/16 20:25	67-64-1	
Allyl chloride	ND	ug/L	4.0	0.25	1		11/11/16 20:25	107-05-1	
Benzene	ND	ug/L	0.50	0.042	1		11/11/16 20:25	71-43-2	
Bromobenzene	ND	ug/L	0.50	0.087	1		11/11/16 20:25	108-86-1	
Bromochloromethane	ND	ug/L	1.0	0.082	1		11/11/16 20:25	74-97-5	
Bromodichloromethane	ND	ug/L	1.0	0.068	1		11/11/16 20:25	75-27-4	
Bromoform	ND	ug/L	4.0	0.11	1		11/11/16 20:25	75-25-2	
Bromomethane	ND	ug/L	4.0	0.20	1		11/11/16 20:25	74-83-9	
2-Butanone (MEK)	ND	ug/L	5.0	1.1	1		11/11/16 20:25	78-93-3	
n-Butylbenzene	ND	ug/L	0.50	0.16	1		11/11/16 20:25	104-51-8	
sec-Butylbenzene	ND	ug/L	0.50	0.094	1		11/11/16 20:25	135-98-8	
tert-Butylbenzene	ND	ug/L	0.50	0.051	1		11/11/16 20:25	98-06-6	
Carbon tetrachloride	ND	ug/L	1.0	0.079	1		11/11/16 20:25	56-23-5	
Chlorobenzene	ND	ug/L	0.50	0.066	1		11/11/16 20:25	108-90-7	
Chloroethane	ND	ug/L	1.0	0.12	1		11/11/16 20:25	75-00-3	
Chloroform	ND	ug/L	1.0	0.21	1		11/11/16 20:25	67-66-3	
Chloromethane	ND	ug/L	4.0	0.080	1		11/11/16 20:25	74-87-3	
2-Chlorotoluene	ND	ug/L	0.50	0.084	1		11/11/16 20:25	95-49-8	
4-Chlorotoluene	ND	ug/L	0.50	0.048	1		11/11/16 20:25	106-43-4	
1,2-Dibromo-3-chloropropane	ND	ug/L	10.0	0.60	1		11/11/16 20:25	96-12-8	
Dibromochloromethane	ND	ug/L	4.0	0.048	1		11/11/16 20:25	124-48-1	
1,2-Dibromoethane (EDB)	ND	ug/L	1.0	0.092	1		11/11/16 20:25	106-93-4	
Dibromomethane	ND	ug/L	1.0	0.14	1		11/11/16 20:25	74-95-3	
1,2-Dichlorobenzene	ND	ug/L	0.50	0.078	1		11/11/16 20:25	95-50-1	
1,3-Dichlorobenzene	ND	ug/L	0.50	0.085	1		11/11/16 20:25	541-73-1	
1,4-Dichlorobenzene	ND	ug/L	0.50	0.081	1		11/11/16 20:25	106-46-7	
Dichlorodifluoromethane	ND	ug/L	1.0	0.075	1		11/11/16 20:25	75-71-8	
1,1-Dichloroethane	ND	ug/L	0.50	0.055	1		11/11/16 20:25	75-34-3	
1,2-Dichloroethane	ND	ug/L	0.50	0.072	1		11/11/16 20:25	107-06-2	
1,1-Dichloroethene	ND	ug/L	0.50	0.069	1		11/11/16 20:25	75-35-4	
cis-1,2-Dichloroethene	**3.8**	ug/L	0.50	0.12	1		11/11/16 20:25	156-59-2	
trans-1,2-Dichloroethene	ND	ug/L	0.50	0.15	1		11/11/16 20:25	156-60-5	
Dichlorofluoromethane	ND	ug/L	1.0	0.054	1		11/11/16 20:25	75-43-4	
1,2-Dichloropropane	ND	ug/L	4.0	0.066	1		11/11/16 20:25	78-87-5	
1,3-Dichloropropane	ND	ug/L	0.50	0.059	1		11/11/16 20:25	142-28-9	
2,2-Dichloropropane	ND	ug/L	1.0	0.096	1		11/11/16 20:25	594-20-7	
1,1-Dichloropropene	ND	ug/L	0.50	0.082	1		11/11/16 20:25	563-58-6	
cis-1,3-Dichloropropene	ND	ug/L	0.50	0.069	1		11/11/16 20:25	10061-01-5	
trans-1,3-Dichloropropene	ND	ug/L	1.0	0.044	1		11/11/16 20:25	10061-02-6	

ANALYTICAL RESULTS

Project: Camp Ripley MMLF
Pace Project No.: 1278223

Sample: MW-7 **Lab ID: 1278223002** Collected: 10/31/16 14:30 Received: 11/02/16 10:30 Matrix: Water

Parameters	Results	Units	PQL	MDL	DF	Prepared	Analyzed	CAS No.	Qual
8260B MSV Low Level	Analytical Method: EPA 8260B								
Diethyl ether (Ethyl ether)	**6.9**	ug/L	4.0	0.090	1		11/11/16 20:25	60-29-7	
Ethylbenzene	ND	ug/L	0.50	0.075	1		11/11/16 20:25	100-41-4	
Hexachloro-1,3-butadiene	ND	ug/L	4.0	0.13	1		11/11/16 20:25	87-68-3	
Isopropylbenzene (Cumene)	ND	ug/L	0.50	0.064	1		11/11/16 20:25	98-82-8	
p-Isopropyltoluene	ND	ug/L	0.50	0.064	1		11/11/16 20:25	99-87-6	
Methylene Chloride	ND	ug/L	4.0	0.097	1		11/11/16 20:25	75-09-2	
4-Methyl-2-pentanone (MIBK)	ND	ug/L	5.0	0.80	1		11/11/16 20:25	108-10-1	
Methyl-tert-butyl ether	ND	ug/L	0.50	0.047	1		11/11/16 20:25	1634-04-4	
Naphthalene	ND	ug/L	1.0	0.064	1		11/11/16 20:25	91-20-3	
n-Propylbenzene	ND	ug/L	0.50	0.049	1		11/11/16 20:25	103-65-1	
Styrene	ND	ug/L	0.50	0.056	1		11/11/16 20:25	100-42-5	
1,1,1,2-Tetrachloroethane	ND	ug/L	1.0	0.064	1		11/11/16 20:25	630-20-6	
1,1,2,2-Tetrachloroethane	ND	ug/L	0.50	0.055	1		11/11/16 20:25	79-34-5	
Tetrachloroethene	ND	ug/L	0.50	0.13	1		11/11/16 20:25	127-18-4	
Tetrahydrofuran	ND	ug/L	10.0	1.5	1		11/11/16 20:25	109-99-9	
Toluene	ND	ug/L	0.50	0.059	1		11/11/16 20:25	108-88-3	
1,2,3-Trichlorobenzene	ND	ug/L	0.50	0.17	1		11/11/16 20:25	87-61-6	
1,2,4-Trichlorobenzene	ND	ug/L	0.50	0.14	1		11/11/16 20:25	120-82-1	
1,1,1-Trichloroethane	ND	ug/L	0.50	0.057	1		11/11/16 20:25	71-55-6	
1,1,2-Trichloroethane	ND	ug/L	0.50	0.064	1		11/11/16 20:25	79-00-5	
Trichloroethene	ND	ug/L	0.40	0.044	1		11/11/16 20:25	79-01-6	
Trichlorofluoromethane	ND	ug/L	0.50	0.055	1		11/11/16 20:25	75-69-4	
1,2,3-Trichloropropane	ND	ug/L	4.0	0.19	1		11/11/16 20:25	96-18-4	
1,1,2-Trichlorotrifluoroethane	ND	ug/L	1.0	0.13	1		11/11/16 20:25	76-13-1	
1,2,4-Trimethylbenzene	ND	ug/L	0.50	0.068	1		11/11/16 20:25	95-63-6	
1,3,5-Trimethylbenzene	ND	ug/L	0.50	0.042	1		11/11/16 20:25	108-67-8	
Vinyl chloride	ND	ug/L	0.20	0.098	1		11/11/16 20:25	75-01-4	
Xylene (Total)	ND	ug/L	1.5	0.15	1		11/11/16 20:25	1330-20-7	
m&p-Xylene	ND	ug/L	1.0	0.11	1		11/11/16 20:25	179601-23-1	
o-Xylene	ND	ug/L	0.50	0.044	1		11/11/16 20:25	95-47-6	
Surrogates									
1,2-Dichloroethane-d4 (S)	108	%.	75-125		1		11/11/16 20:25	17060-07-0	
Toluene-d8 (S)	100	%.	75-125		1		11/11/16 20:25	2037-26-5	
4-Bromofluorobenzene (S)	101	%.	75-125		1		11/11/16 20:25	460-00-4	
2320B Alkalinity	Analytical Method: SM 2320B								
Alkalinity, Total as CaCO3	**389**	mg/L	5.0	1.2	1		11/07/16 17:40		
2510B Specific Conductance	Analytical Method: SM 2510B								
Specific Conductance	**817**	umhos/cm	10.0	5.0	1		11/04/16 09:54		
2540D Total Suspended Solids	Analytical Method: SM 2540D (1997)								
Total Suspended Solids	**5.2**	mg/L	2.0	2.0	1		11/04/16 10:49		

ANALYTICAL RESULTS

Project: Camp Ripley MMLF
Pace Project No.: 1278223

Sample: MW-7 **Lab ID: 1278223002** Collected: 10/31/16 14:30 Received: 11/02/16 10:30 Matrix: Water

Parameters	Results	Units	PQL	MDL	DF	Prepared	Analyzed	CAS No.	Qual
4500H+ pH, Electrometric	Analytical Method: SM 4500-H+B								
pH at 25 Degrees C	**7.5**	Std. Units	0.10	0.10	1		11/02/16 15:00		H6
300.0 IC Anions 28 Days	Analytical Method: EPA 300.0								
Chloride	**21.1**	mg/L	1.0	0.50	1		11/08/16 17:12	16887-00-6	
Sulfate	**4.0**	mg/L	2.0	1.0	1		11/08/16 17:12	14808-79-8	

Sample: MW-8 **Lab ID: 1278223003** Collected: 10/31/16 15:20 Received: 11/02/16 10:30 Matrix: Water

Parameters	Results	Units	PQL	MDL	DF	Prepared	Analyzed	CAS No.	Qual
350.1 Ammonia	Analytical Method: EPA 350.1 rev. 2 (1993) Preparation Method: EPA 350.1								
Nitrogen, Ammonia	**<0.044**	mg/L	0.10	0.044	1	11/10/16 10:28	11/10/16 14:02	7664-41-7	
353.2 Nitrate + Nitrite pres.	Analytical Method: EPA 353.2 rev. 2 (1993)								
Nitrogen, NO2 plus NO3	**1.8**	mg/L	0.10	0.018	5		11/11/16 15:28		
200.7 MET ICP, Dissolved	Analytical Method: EPA 200.7 Preparation Method: EPA 200.7								
Barium, Dissolved	**50.1**	ug/L	10.0	0.65	1	11/07/16 16:01	11/08/16 11:40	7440-39-3	
Boron, Dissolved	**23.9J**	ug/L	100	5.9	1	11/07/16 16:01	11/08/16 11:40	7440-42-8	
Chromium, Dissolved	**1.3J**	ug/L	10.0	1.3	1	11/07/16 16:01	11/08/16 11:40	7440-47-3	
Copper, Dissolved	**<0.86**	ug/L	10.0	0.86	1	11/07/16 16:01	11/08/16 11:40	7440-50-8	
Iron, Dissolved	**<2.9**	ug/L	50.0	2.9	1	11/07/16 16:01	11/08/16 11:40	7439-89-6	
Manganese, Dissolved	**5.3J**	ug/L	10.0	0.23	1	11/07/16 16:01	11/08/16 11:40	7439-96-5	
Sodium, Dissolved	**3.0**	mg/L	0.50	0.13	1	11/07/16 16:01	11/08/16 11:40	7440-23-5	
200.8 MET ICPMS, Dissolved	Analytical Method: EPA 200.8 Preparation Method: EPA 200.8								
Arsenic, Dissolved	**<0.48**	ug/L	1.0	0.48	2	11/07/16 16:01	11/08/16 19:01	7440-38-2	
Cadmium, Dissolved	**<0.14**	ug/L	0.40	0.14	2	11/07/16 16:01	11/08/16 19:01	7440-43-9	
Lead, Dissolved	**0.023J**	ug/L	1.0	0.016	2	11/07/16 16:01	11/08/16 19:01	7439-92-1	
7470 Mercury, Dissolved	Analytical Method: EPA 7470 Preparation Method: EPA 7470								
Mercury, Dissolved	**<0.025**	ug/L	0.20	0.025	1	11/10/16 15:50	11/14/16 09:52	7439-97-6	
8260B MSV Low Level	Analytical Method: EPA 8260B								
Acetone	ND	ug/L	20.0	0.64	1		11/11/16 20:47	67-64-1	
Allyl chloride	ND	ug/L	4.0	0.25	1		11/11/16 20:47	107-05-1	
Benzene	ND	ug/L	0.50	0.042	1		11/11/16 20:47	71-43-2	
Bromobenzene	ND	ug/L	0.50	0.087	1		11/11/16 20:47	108-86-1	
Bromochloromethane	ND	ug/L	1.0	0.082	1		11/11/16 20:47	74-97-5	
Bromodichloromethane	ND	ug/L	1.0	0.068	1		11/11/16 20:47	75-27-4	
Bromoform	ND	ug/L	4.0	0.11	1		11/11/16 20:47	75-25-2	
Bromomethane	ND	ug/L	4.0	0.20	1		11/11/16 20:47	74-83-9	
2-Butanone (MEK)	ND	ug/L	5.0	1.1	1		11/11/16 20:47	78-93-3	

ANALYTICAL RESULTS

Project: Camp Ripley MMLF
Pace Project No.: 1278223

Sample: MW-8 **Lab ID: 1278223003** Collected: 10/31/16 15:20 Received: 11/02/16 10:30 Matrix: Water

Parameters	Results	Units	PQL	MDL	DF	Prepared	Analyzed	CAS No.	Qual
8260B MSV Low Level	Analytical Method: EPA 8260B								
n-Butylbenzene	ND	ug/L	0.50	0.16	1		11/11/16 20:47	104-51-8	
sec-Butylbenzene	ND	ug/L	0.50	0.094	1		11/11/16 20:47	135-98-8	
tert-Butylbenzene	ND	ug/L	0.50	0.051	1		11/11/16 20:47	98-06-6	
Carbon tetrachloride	ND	ug/L	1.0	0.079	1		11/11/16 20:47	56-23-5	
Chlorobenzene	ND	ug/L	0.50	0.066	1		11/11/16 20:47	108-90-7	
Chloroethane	ND	ug/L	1.0	0.12	1		11/11/16 20:47	75-00-3	
Chloroform	ND	ug/L	1.0	0.21	1		11/11/16 20:47	67-66-3	
Chloromethane	ND	ug/L	4.0	0.080	1		11/11/16 20:47	74-87-3	
2-Chlorotoluene	ND	ug/L	0.50	0.084	1		11/11/16 20:47	95-49-8	
4-Chlorotoluene	ND	ug/L	0.50	0.048	1		11/11/16 20:47	106-43-4	
1,2-Dibromo-3-chloropropane	ND	ug/L	10.0	0.60	1		11/11/16 20:47	96-12-8	
Dibromochloromethane	ND	ug/L	4.0	0.048	1		11/11/16 20:47	124-48-1	
1,2-Dibromoethane (EDB)	ND	ug/L	1.0	0.092	1		11/11/16 20:47	106-93-4	
Dibromomethane	ND	ug/L	1.0	0.14	1		11/11/16 20:47	74-95-3	
1,2-Dichlorobenzene	ND	ug/L	0.50	0.078	1		11/11/16 20:47	95-50-1	
1,3-Dichlorobenzene	ND	ug/L	0.50	0.085	1		11/11/16 20:47	541-73-1	
1,4-Dichlorobenzene	ND	ug/L	0.50	0.081	1		11/11/16 20:47	106-46-7	
Dichlorodifluoromethane	ND	ug/L	1.0	0.075	1		11/11/16 20:47	75-71-8	
1,1-Dichloroethane	ND	ug/L	0.50	0.055	1		11/11/16 20:47	75-34-3	
1,2-Dichloroethane	ND	ug/L	0.50	0.072	1		11/11/16 20:47	107-06-2	
1,1-Dichloroethene	ND	ug/L	0.50	0.069	1		11/11/16 20:47	75-35-4	
cis-1,2-Dichloroethene	ND	ug/L	0.50	0.12	1		11/11/16 20:47	156-59-2	
trans-1,2-Dichloroethene	ND	ug/L	0.50	0.15	1		11/11/16 20:47	156-60-5	
Dichlorofluoromethane	ND	ug/L	1.0	0.054	1		11/11/16 20:47	75-43-4	
1,2-Dichloropropane	ND	ug/L	4.0	0.066	1		11/11/16 20:47	78-87-5	
1,3-Dichloropropane	ND	ug/L	0.50	0.059	1		11/11/16 20:47	142-28-9	
2,2-Dichloropropane	ND	ug/L	1.0	0.096	1		11/11/16 20:47	594-20-7	
1,1-Dichloropropene	ND	ug/L	0.50	0.082	1		11/11/16 20:47	563-58-6	
cis-1,3-Dichloropropene	ND	ug/L	0.50	0.069	1		11/11/16 20:47	10061-01-5	
trans-1,3-Dichloropropene	ND	ug/L	1.0	0.044	1		11/11/16 20:47	10061-02-6	
Diethyl ether (Ethyl ether)	ND	ug/L	4.0	0.090	1		11/11/16 20:47	60-29-7	
Ethylbenzene	ND	ug/L	0.50	0.075	1		11/11/16 20:47	100-41-4	
Hexachloro-1,3-butadiene	ND	ug/L	4.0	0.13	1		11/11/16 20:47	87-68-3	
Isopropylbenzene (Cumene)	ND	ug/L	0.50	0.064	1		11/11/16 20:47	98-82-8	
p-Isopropyltoluene	ND	ug/L	0.50	0.064	1		11/11/16 20:47	99-87-6	
Methylene Chloride	ND	ug/L	4.0	0.097	1		11/11/16 20:47	75-09-2	
4-Methyl-2-pentanone (MIBK)	ND	ug/L	5.0	0.80	1		11/11/16 20:47	108-10-1	
Methyl-tert-butyl ether	ND	ug/L	0.50	0.047	1		11/11/16 20:47	1634-04-4	
Naphthalene	ND	ug/L	1.0	0.064	1		11/11/16 20:47	91-20-3	
n-Propylbenzene	ND	ug/L	0.50	0.049	1		11/11/16 20:47	103-65-1	
Styrene	ND	ug/L	0.50	0.056	1		11/11/16 20:47	100-42-5	
1,1,1,2-Tetrachloroethane	ND	ug/L	1.0	0.064	1		11/11/16 20:47	630-20-6	
1,1,2,2-Tetrachloroethane	ND	ug/L	0.50	0.055	1		11/11/16 20:47	79-34-5	
Tetrachloroethene	ND	ug/L	0.50	0.13	1		11/11/16 20:47	127-18-4	
Tetrahydrofuran	ND	ug/L	10.0	1.5	1		11/11/16 20:47	109-99-9	
Toluene	ND	ug/L	0.50	0.059	1		11/11/16 20:47	108-88-3	

ANALYTICAL RESULTS

Project: Camp Ripley MMLF
Pace Project No.: 1278223

Sample: MW-8 **Lab ID: 1278223003** Collected: 10/31/16 15:20 Received: 11/02/16 10:30 Matrix: Water

Parameters	Results	Units	PQL	MDL	DF	Prepared	Analyzed	CAS No.	Qual
8260B MSV Low Level	Analytical Method: EPA 8260B								
1,2,3-Trichlorobenzene	ND	ug/L	0.50	0.17	1		11/11/16 20:47	87-61-6	
1,2,4-Trichlorobenzene	ND	ug/L	0.50	0.14	1		11/11/16 20:47	120-82-1	
1,1,1-Trichloroethane	ND	ug/L	0.50	0.057	1		11/11/16 20:47	71-55-6	
1,1,2-Trichloroethane	ND	ug/L	0.50	0.064	1		11/11/16 20:47	79-00-5	
Trichloroethene	ND	ug/L	0.40	0.044	1		11/11/16 20:47	79-01-6	
Trichlorofluoromethane	ND	ug/L	0.50	0.055	1		11/11/16 20:47	75-69-4	
1,2,3-Trichloropropane	ND	ug/L	4.0	0.19	1		11/11/16 20:47	96-18-4	
1,1,2-Trichlorotrifluoroethane	ND	ug/L	1.0	0.13	1		11/11/16 20:47	76-13-1	
1,2,4-Trimethylbenzene	ND	ug/L	0.50	0.068	1		11/11/16 20:47	95-63-6	
1,3,5-Trimethylbenzene	ND	ug/L	0.50	0.042	1		11/11/16 20:47	108-67-8	
Vinyl chloride	ND	ug/L	0.20	0.098	1		11/11/16 20:47	75-01-4	
Xylene (Total)	ND	ug/L	1.5	0.15	1		11/11/16 20:47	1330-20-7	
m&p-Xylene	ND	ug/L	1.0	0.11	1		11/11/16 20:47	179601-23-1	
o-Xylene	ND	ug/L	0.50	0.044	1		11/11/16 20:47	95-47-6	
Surrogates									
1,2-Dichloroethane-d4 (S)	104	%.	75-125		1		11/11/16 20:47	17060-07-0	
Toluene-d8 (S)	98	%.	75-125		1		11/11/16 20:47	2037-26-5	
4-Bromofluorobenzene (S)	98	%.	75-125		1		11/11/16 20:47	460-00-4	
2320B Alkalinity	Analytical Method: SM 2320B								
Alkalinity, Total as CaCO3	**240**	mg/L	5.0	1.2	1		11/07/16 17:48		
2510B Specific Conductance	Analytical Method: SM 2510B								
Specific Conductance	**591**	umhos/cm	10.0	5.0	1		11/04/16 09:47		
2540D Total Suspended Solids	Analytical Method: SM 2540D (1997)								
Total Suspended Solids	**<2.0**	mg/L	2.0	2.0	1		11/04/16 10:49		
4500H+ pH, Electrometric	Analytical Method: SM 4500-H+B								
pH at 25 Degrees C	**7.9**	Std. Units	0.10	0.10	1		11/02/16 15:03		H6
300.0 IC Anions 28 Days	Analytical Method: EPA 300.0								
Chloride	**25.9**	mg/L	1.0	0.50	1		11/08/16 17:35	16887-00-6	
Sulfate	**5.7**	mg/L	2.0	1.0	1		11/08/16 17:35	14808-79-8	

Sample: FLD DUP **Lab ID: 1278223004** Collected: 10/31/16 00:00 Received: 11/02/16 10:30 Matrix: Water

Parameters	Results	Units	PQL	MDL	DF	Prepared	Analyzed	CAS No.	Qual
350.1 Ammonia	Analytical Method: EPA 350.1 rev. 2 (1993) Preparation Method: EPA 350.1								
Nitrogen, Ammonia	**0.76**	mg/L	0.10	0.044	1	11/10/16 10:28	11/10/16 14:17	7664-41-7	

ANALYTICAL RESULTS

Project: Camp Ripley MMLF
Pace Project No.: 1278223

Sample: FLD DUP **Lab ID: 1278223004** Collected: 10/31/16 00:00 Received: 11/02/16 10:30 Matrix: Water

Parameters	Results	Units	PQL	MDL	DF	Prepared	Analyzed	CAS No.	Qual
353.2 Nitrate + Nitrite pres.	Analytical Method: EPA 353.2 rev. 2 (1993)								
Nitrogen, NO2 plus NO3	**1.2**	mg/L	0.040	0.0070	2		11/11/16 15:30		
200.7 MET ICP, Dissolved	Analytical Method: EPA 200.7 Preparation Method: EPA 200.7								
Barium, Dissolved	**307**	ug/L	10.0	0.65	1	11/07/16 16:01	11/08/16 11:43	7440-39-3	
Boron, Dissolved	**55.9J**	ug/L	100	5.9	1	11/07/16 16:01	11/08/16 11:43	7440-42-8	
Chromium, Dissolved	**<1.3**	ug/L	10.0	1.3	1	11/07/16 16:01	11/08/16 11:43	7440-47-3	
Copper, Dissolved	**1.7J**	ug/L	10.0	0.86	1	11/07/16 16:01	11/08/16 11:43	7440-50-8	
Iron, Dissolved	**13.0J**	ug/L	50.0	2.9	1	11/07/16 16:01	11/08/16 11:43	7439-89-6	
Manganese, Dissolved	**590**	ug/L	10.0	0.23	1	11/07/16 16:01	11/08/16 11:43	7439-96-5	
Sodium, Dissolved	**6.2**	mg/L	0.50	0.13	1	11/07/16 16:01	11/08/16 11:43	7440-23-5	
200.8 MET ICPMS, Dissolved	Analytical Method: EPA 200.8 Preparation Method: EPA 200.8								
Arsenic, Dissolved	**<0.48**	ug/L	1.0	0.48	2	11/07/16 16:01	11/08/16 19:05	7440-38-2	
Cadmium, Dissolved	**<0.14**	ug/L	0.40	0.14	2	11/07/16 16:01	11/08/16 19:05	7440-43-9	
Lead, Dissolved	**<0.016**	ug/L	1.0	0.016	2	11/07/16 16:01	11/08/16 19:05	7439-92-1	
7470 Mercury, Dissolved	Analytical Method: EPA 7470 Preparation Method: EPA 7470								
Mercury, Dissolved	**<0.025**	ug/L	0.20	0.025	1	11/10/16 15:50	11/14/16 09:54	7439-97-6	
8260B MSV Low Level	Analytical Method: EPA 8260B								
Acetone	ND	ug/L	20.0	0.64	1		11/11/16 21:09	67-64-1	
Allyl chloride	ND	ug/L	4.0	0.25	1		11/11/16 21:09	107-05-1	
Benzene	ND	ug/L	0.50	0.042	1		11/11/16 21:09	71-43-2	
Bromobenzene	ND	ug/L	0.50	0.087	1		11/11/16 21:09	108-86-1	
Bromochloromethane	ND	ug/L	1.0	0.082	1		11/11/16 21:09	74-97-5	
Bromodichloromethane	ND	ug/L	1.0	0.068	1		11/11/16 21:09	75-27-4	
Bromoform	ND	ug/L	4.0	0.11	1		11/11/16 21:09	75-25-2	
Bromomethane	ND	ug/L	4.0	0.20	1		11/11/16 21:09	74-83-9	
2-Butanone (MEK)	ND	ug/L	5.0	1.1	1		11/11/16 21:09	78-93-3	
n-Butylbenzene	ND	ug/L	0.50	0.16	1		11/11/16 21:09	104-51-8	
sec-Butylbenzene	ND	ug/L	0.50	0.094	1		11/11/16 21:09	135-98-8	
tert-Butylbenzene	ND	ug/L	0.50	0.051	1		11/11/16 21:09	98-06-6	
Carbon tetrachloride	ND	ug/L	1.0	0.079	1		11/11/16 21:09	56-23-5	
Chlorobenzene	ND	ug/L	0.50	0.066	1		11/11/16 21:09	108-90-7	
Chloroethane	ND	ug/L	1.0	0.12	1		11/11/16 21:09	75-00-3	
Chloroform	ND	ug/L	1.0	0.21	1		11/11/16 21:09	67-66-3	
Chloromethane	ND	ug/L	4.0	0.080	1		11/11/16 21:09	74-87-3	
2-Chlorotoluene	ND	ug/L	0.50	0.084	1		11/11/16 21:09	95-49-8	
4-Chlorotoluene	ND	ug/L	0.50	0.048	1		11/11/16 21:09	106-43-4	
1,2-Dibromo-3-chloropropane	ND	ug/L	10.0	0.60	1		11/11/16 21:09	96-12-8	
Dibromochloromethane	ND	ug/L	4.0	0.048	1		11/11/16 21:09	124-48-1	
1,2-Dibromoethane (EDB)	ND	ug/L	1.0	0.092	1		11/11/16 21:09	106-93-4	
Dibromomethane	ND	ug/L	1.0	0.14	1		11/11/16 21:09	74-95-3	
1,2-Dichlorobenzene	ND	ug/L	0.50	0.078	1		11/11/16 21:09	95-50-1	
1,3-Dichlorobenzene	ND	ug/L	0.50	0.085	1		11/11/16 21:09	541-73-1	

ANALYTICAL RESULTS

Project: Camp Ripley MMLF
Pace Project No.: 1278223

Sample: FLD DUP **Lab ID: 1278223004** Collected: 10/31/16 00:00 Received: 11/02/16 10:30 Matrix: Water

Parameters	Results	Units	PQL	MDL	DF	Prepared	Analyzed	CAS No.	Qual
8260B MSV Low Level	Analytical Method: EPA 8260B								
1,4-Dichlorobenzene	ND	ug/L	0.50	0.081	1		11/11/16 21:09	106-46-7	
Dichlorodifluoromethane	ND	ug/L	1.0	0.075	1		11/11/16 21:09	75-71-8	
1,1-Dichloroethane	ND	ug/L	0.50	0.055	1		11/11/16 21:09	75-34-3	
1,2-Dichloroethane	ND	ug/L	0.50	0.072	1		11/11/16 21:09	107-06-2	
1,1-Dichloroethene	ND	ug/L	0.50	0.069	1		11/11/16 21:09	75-35-4	
cis-1,2-Dichloroethene	**3.6**	ug/L	0.50	0.12	1		11/11/16 21:09	156-59-2	
trans-1,2-Dichloroethene	ND	ug/L	0.50	0.15	1		11/11/16 21:09	156-60-5	
Dichlorofluoromethane	ND	ug/L	1.0	0.054	1		11/11/16 21:09	75-43-4	
1,2-Dichloropropane	ND	ug/L	4.0	0.066	1		11/11/16 21:09	78-87-5	
1,3-Dichloropropane	ND	ug/L	0.50	0.059	1		11/11/16 21:09	142-28-9	
2,2-Dichloropropane	ND	ug/L	1.0	0.096	1		11/11/16 21:09	594-20-7	
1,1-Dichloropropene	ND	ug/L	0.50	0.082	1		11/11/16 21:09	563-58-6	
cis-1,3-Dichloropropene	ND	ug/L	0.50	0.069	1		11/11/16 21:09	10061-01-5	
trans-1,3-Dichloropropene	ND	ug/L	1.0	0.044	1		11/11/16 21:09	10061-02-6	
Diethyl ether (Ethyl ether)	**6.5**	ug/L	4.0	0.090	1		11/11/16 21:09	60-29-7	
Ethylbenzene	ND	ug/L	0.50	0.075	1		11/11/16 21:09	100-41-4	
Hexachloro-1,3-butadiene	ND	ug/L	4.0	0.13	1		11/11/16 21:09	87-68-3	
Isopropylbenzene (Cumene)	ND	ug/L	0.50	0.064	1		11/11/16 21:09	98-82-8	
p-Isopropyltoluene	ND	ug/L	0.50	0.064	1		11/11/16 21:09	99-87-6	
Methylene Chloride	ND	ug/L	4.0	0.097	1		11/11/16 21:09	75-09-2	
4-Methyl-2-pentanone (MIBK)	ND	ug/L	5.0	0.80	1		11/11/16 21:09	108-10-1	
Methyl-tert-butyl ether	ND	ug/L	0.50	0.047	1		11/11/16 21:09	1634-04-4	
Naphthalene	ND	ug/L	1.0	0.064	1		11/11/16 21:09	91-20-3	
n-Propylbenzene	ND	ug/L	0.50	0.049	1		11/11/16 21:09	103-65-1	
Styrene	ND	ug/L	0.50	0.056	1		11/11/16 21:09	100-42-5	
1,1,1,2-Tetrachloroethane	ND	ug/L	1.0	0.064	1		11/11/16 21:09	630-20-6	
1,1,2,2-Tetrachloroethane	ND	ug/L	0.50	0.055	1		11/11/16 21:09	79-34-5	
Tetrachloroethene	ND	ug/L	0.50	0.13	1		11/11/16 21:09	127-18-4	
Tetrahydrofuran	ND	ug/L	10.0	1.5	1		11/11/16 21:09	109-99-9	
Toluene	ND	ug/L	0.50	0.059	1		11/11/16 21:09	108-88-3	
1,2,3-Trichlorobenzene	ND	ug/L	0.50	0.17	1		11/11/16 21:09	87-61-6	
1,2,4-Trichlorobenzene	ND	ug/L	0.50	0.14	1		11/11/16 21:09	120-82-1	
1,1,1-Trichloroethane	ND	ug/L	0.50	0.057	1		11/11/16 21:09	71-55-6	
1,1,2-Trichloroethane	ND	ug/L	0.50	0.064	1		11/11/16 21:09	79-00-5	
Trichloroethene	ND	ug/L	0.40	0.044	1		11/11/16 21:09	79-01-6	
Trichlorofluoromethane	ND	ug/L	0.50	0.055	1		11/11/16 21:09	75-69-4	
1,2,3-Trichloropropane	ND	ug/L	4.0	0.19	1		11/11/16 21:09	96-18-4	
1,1,2-Trichlorotrifluoroethane	ND	ug/L	1.0	0.13	1		11/11/16 21:09	76-13-1	
1,2,4-Trimethylbenzene	ND	ug/L	0.50	0.068	1		11/11/16 21:09	95-63-6	
1,3,5-Trimethylbenzene	ND	ug/L	0.50	0.042	1		11/11/16 21:09	108-67-8	
Vinyl chloride	ND	ug/L	0.20	0.098	1		11/11/16 21:09	75-01-4	
Xylene (Total)	ND	ug/L	1.5	0.15	1		11/11/16 21:09	1330-20-7	
m&p-Xylene	ND	ug/L	1.0	0.11	1		11/11/16 21:09	179601-23-1	
o-Xylene	ND	ug/L	0.50	0.044	1		11/11/16 21:09	95-47-6	
Surrogates									
1,2-Dichloroethane-d4 (S)	103	%.	75-125		1		11/11/16 21:09	17060-07-0	

ANALYTICAL RESULTS

Project: Camp Ripley MMLF
Pace Project No.: 1278223

Sample: FLD DUP **Lab ID: 1278223004** Collected: 10/31/16 00:00 Received: 11/02/16 10:30 Matrix: Water

Parameters	Results	Units	PQL	MDL	DF	Prepared	Analyzed	CAS No.	Qual
8260B MSV Low Level	Analytical Method: EPA 8260B								
Surrogates									
Toluene-d8 (S)	98	%.	75-125		1		11/11/16 21:09	2037-26-5	
4-Bromofluorobenzene (S)	98	%.	75-125		1		11/11/16 21:09	460-00-4	
2320B Alkalinity	Analytical Method: SM 2320B								
Alkalinity, Total as CaCO3	**377**	mg/L	5.0	1.2	1		11/08/16 16:05		
2510B Specific Conductance	Analytical Method: SM 2510B								
Specific Conductance	**817**	umhos/cm	10.0	5.0	1		11/04/16 09:48		
2540D Total Suspended Solids	Analytical Method: SM 2540D (1997)								
Total Suspended Solids	**2.0**	mg/L	2.0	2.0	1		11/04/16 10:49		
4500H+ pH, Electrometric	Analytical Method: SM 4500-H+B								
pH at 25 Degrees C	**7.6**	Std. Units	0.10	0.10	1		11/02/16 15:06		H6
300.0 IC Anions 28 Days	Analytical Method: EPA 300.0								
Chloride	**21.2**	mg/L	1.0	0.50	1		11/08/16 17:57	16887-00-6	
Sulfate	**4.0**	mg/L	2.0	1.0	1		11/08/16 17:57	14808-79-8	

Sample: Equip Blank **Lab ID: 1278223005** Collected: 10/31/16 13:40 Received: 11/02/16 10:30 Matrix: Water

Parameters	Results	Units	PQL	MDL	DF	Prepared	Analyzed	CAS No.	Qual
350.1 Ammonia	Analytical Method: EPA 350.1 rev. 2 (1993) Preparation Method: EPA 350.1								
Nitrogen, Ammonia	**<0.044**	mg/L	0.10	0.044	1	11/10/16 10:28	11/10/16 14:06	7664-41-7	
353.2 Nitrate + Nitrite pres.	Analytical Method: EPA 353.2 rev. 2 (1993)								
Nitrogen, NO2 plus NO3	**<0.0035**	mg/L	0.020	0.0035	1		11/11/16 14:53		
200.7 MET ICP, Dissolved	Analytical Method: EPA 200.7 Preparation Method: EPA 200.7								
Barium, Dissolved	**<0.65**	ug/L	10.0	0.65	1	11/07/16 16:01	11/08/16 11:46	7440-39-3	
Boron, Dissolved	**9.1J**	ug/L	100	5.9	1	11/07/16 16:01	11/08/16 11:46	7440-42-8	
Chromium, Dissolved	**<1.3**	ug/L	10.0	1.3	1	11/07/16 16:01	11/08/16 11:46	7440-47-3	
Copper, Dissolved	**<0.86**	ug/L	10.0	0.86	1	11/07/16 16:01	11/08/16 11:46	7440-50-8	
Iron, Dissolved	**<2.9**	ug/L	50.0	2.9	1	11/07/16 16:01	11/08/16 11:46	7439-89-6	
Manganese, Dissolved	**<0.23**	ug/L	10.0	0.23	1	11/07/16 16:01	11/08/16 11:46	7439-96-5	
Sodium, Dissolved	**<0.13**	mg/L	0.50	0.13	1	11/07/16 16:01	11/08/16 11:46	7440-23-5	
200.8 MET ICPMS, Dissolved	Analytical Method: EPA 200.8 Preparation Method: EPA 200.8								
Arsenic, Dissolved	**<0.24**	ug/L	0.50	0.24	1	11/07/16 16:01	11/08/16 19:09	7440-38-2	
Cadmium, Dissolved	**<0.068**	ug/L	0.20	0.068	1	11/07/16 16:01	11/08/16 19:09	7440-43-9	
Lead, Dissolved	**0.027J**	ug/L	0.50	0.0082	1	11/07/16 16:01	11/08/16 19:09	7439-92-1	

ANALYTICAL RESULTS

Project: Camp Ripley MMLF
Pace Project No.: 1278223

Sample: Equip Blank **Lab ID: 1278223005** Collected: 10/31/16 13:40 Received: 11/02/16 10:30 Matrix: Water

Parameters	Results	Units	PQL	MDL	DF	Prepared	Analyzed	CAS No.	Qual
7470 Mercury, Dissolved	Analytical Method: EPA 7470 Preparation Method: EPA 7470								
Mercury, Dissolved	**<0.025**	ug/L	0.20	0.025	1	11/10/16 15:50	11/14/16 09:57	7439-97-6	
8260B MSV Low Level	Analytical Method: EPA 8260B								
Acetone	ND	ug/L	20.0	0.64	1		11/11/16 15:39	67-64-1	
Allyl chloride	ND	ug/L	4.0	0.25	1		11/11/16 15:39	107-05-1	
Benzene	ND	ug/L	0.50	0.042	1		11/11/16 15:39	71-43-2	
Bromobenzene	ND	ug/L	0.50	0.087	1		11/11/16 15:39	108-86-1	
Bromochloromethane	ND	ug/L	1.0	0.082	1		11/11/16 15:39	74-97-5	
Bromodichloromethane	ND	ug/L	1.0	0.068	1		11/11/16 15:39	75-27-4	
Bromoform	ND	ug/L	4.0	0.11	1		11/11/16 15:39	75-25-2	
Bromomethane	ND	ug/L	4.0	0.20	1		11/11/16 15:39	74-83-9	
2-Butanone (MEK)	ND	ug/L	5.0	1.1	1		11/11/16 15:39	78-93-3	
n-Butylbenzene	ND	ug/L	0.50	0.16	1		11/11/16 15:39	104-51-8	
sec-Butylbenzene	ND	ug/L	0.50	0.094	1		11/11/16 15:39	135-98-8	
tert-Butylbenzene	ND	ug/L	0.50	0.051	1		11/11/16 15:39	98-06-6	
Carbon tetrachloride	ND	ug/L	1.0	0.079	1		11/11/16 15:39	56-23-5	
Chlorobenzene	ND	ug/L	0.50	0.066	1		11/11/16 15:39	108-90-7	
Chloroethane	ND	ug/L	1.0	0.12	1		11/11/16 15:39	75-00-3	
Chloroform	ND	ug/L	1.0	0.21	1		11/11/16 15:39	67-66-3	
Chloromethane	ND	ug/L	4.0	0.080	1		11/11/16 15:39	74-87-3	
2-Chlorotoluene	ND	ug/L	0.50	0.084	1		11/11/16 15:39	95-49-8	
4-Chlorotoluene	ND	ug/L	0.50	0.048	1		11/11/16 15:39	106-43-4	
1,2-Dibromo-3-chloropropane	ND	ug/L	10.0	0.60	1		11/11/16 15:39	96-12-8	
Dibromochloromethane	ND	ug/L	4.0	0.048	1		11/11/16 15:39	124-48-1	
1,2-Dibromoethane (EDB)	ND	ug/L	1.0	0.092	1		11/11/16 15:39	106-93-4	
Dibromomethane	ND	ug/L	1.0	0.14	1		11/11/16 15:39	74-95-3	
1,2-Dichlorobenzene	ND	ug/L	0.50	0.078	1		11/11/16 15:39	95-50-1	
1,3-Dichlorobenzene	ND	ug/L	0.50	0.085	1		11/11/16 15:39	541-73-1	
1,4-Dichlorobenzene	ND	ug/L	0.50	0.081	1		11/11/16 15:39	106-46-7	
Dichlorodifluoromethane	ND	ug/L	1.0	0.075	1		11/11/16 15:39	75-71-8	
1,1-Dichloroethane	ND	ug/L	0.50	0.055	1		11/11/16 15:39	75-34-3	
1,2-Dichloroethane	ND	ug/L	0.50	0.072	1		11/11/16 15:39	107-06-2	
1,1-Dichloroethene	ND	ug/L	0.50	0.069	1		11/11/16 15:39	75-35-4	
cis-1,2-Dichloroethene	ND	ug/L	0.50	0.12	1		11/11/16 15:39	156-59-2	
trans-1,2-Dichloroethene	ND	ug/L	0.50	0.15	1		11/11/16 15:39	156-60-5	
Dichlorofluoromethane	ND	ug/L	1.0	0.054	1		11/11/16 15:39	75-43-4	
1,2-Dichloropropane	ND	ug/L	4.0	0.066	1		11/11/16 15:39	78-87-5	
1,3-Dichloropropane	ND	ug/L	0.50	0.059	1		11/11/16 15:39	142-28-9	
2,2-Dichloropropane	ND	ug/L	1.0	0.096	1		11/11/16 15:39	594-20-7	
1,1-Dichloropropene	ND	ug/L	0.50	0.082	1		11/11/16 15:39	563-58-6	
cis-1,3-Dichloropropene	ND	ug/L	0.50	0.069	1		11/11/16 15:39	10061-01-5	
trans-1,3-Dichloropropene	ND	ug/L	1.0	0.044	1		11/11/16 15:39	10061-02-6	
Diethyl ether (Ethyl ether)	ND	ug/L	4.0	0.090	1		11/11/16 15:39	60-29-7	
Ethylbenzene	ND	ug/L	0.50	0.075	1		11/11/16 15:39	100-41-4	
Hexachloro-1,3-butadiene	ND	ug/L	4.0	0.13	1		11/11/16 15:39	87-68-3	
Isopropylbenzene (Cumene)	ND	ug/L	0.50	0.064	1		11/11/16 15:39	98-82-8	

ANALYTICAL RESULTS

Project: Camp Ripley MMLF
Pace Project No.: 1278223

Sample: Equip Blank **Lab ID: 1278223005** Collected: 10/31/16 13:40 Received: 11/02/16 10:30 Matrix: Water

Parameters	Results	Units	PQL	MDL	DF	Prepared	Analyzed	CAS No.	Qual
8260B MSV Low Level	Analytical Method: EPA 8260B								
p-Isopropyltoluene	ND	ug/L	0.50	0.064	1		11/11/16 15:39	99-87-6	
Methylene Chloride	ND	ug/L	4.0	0.097	1		11/11/16 15:39	75-09-2	
4-Methyl-2-pentanone (MIBK)	ND	ug/L	5.0	0.80	1		11/11/16 15:39	108-10-1	
Methyl-tert-butyl ether	ND	ug/L	0.50	0.047	1		11/11/16 15:39	1634-04-4	
Naphthalene	ND	ug/L	1.0	0.064	1		11/11/16 15:39	91-20-3	
n-Propylbenzene	ND	ug/L	0.50	0.049	1		11/11/16 15:39	103-65-1	
Styrene	ND	ug/L	0.50	0.056	1		11/11/16 15:39	100-42-5	
1,1,1,2-Tetrachloroethane	ND	ug/L	1.0	0.064	1		11/11/16 15:39	630-20-6	
1,1,2,2-Tetrachloroethane	ND	ug/L	0.50	0.055	1		11/11/16 15:39	79-34-5	
Tetrachloroethene	ND	ug/L	0.50	0.13	1		11/11/16 15:39	127-18-4	
Tetrahydrofuran	ND	ug/L	10.0	1.5	1		11/11/16 15:39	109-99-9	
Toluene	ND	ug/L	0.50	0.059	1		11/11/16 15:39	108-88-3	
1,2,3-Trichlorobenzene	ND	ug/L	0.50	0.17	1		11/11/16 15:39	87-61-6	
1,2,4-Trichlorobenzene	ND	ug/L	0.50	0.14	1		11/11/16 15:39	120-82-1	
1,1,1-Trichloroethane	ND	ug/L	0.50	0.057	1		11/11/16 15:39	71-55-6	
1,1,2-Trichloroethane	ND	ug/L	0.50	0.064	1		11/11/16 15:39	79-00-5	
Trichloroethene	ND	ug/L	0.40	0.044	1		11/11/16 15:39	79-01-6	
Trichlorofluoromethane	ND	ug/L	0.50	0.055	1		11/11/16 15:39	75-69-4	
1,2,3-Trichloropropane	ND	ug/L	4.0	0.19	1		11/11/16 15:39	96-18-4	
1,1,2-Trichlorotrifluoroethane	ND	ug/L	1.0	0.13	1		11/11/16 15:39	76-13-1	
1,2,4-Trimethylbenzene	ND	ug/L	0.50	0.068	1		11/11/16 15:39	95-63-6	
1,3,5-Trimethylbenzene	ND	ug/L	0.50	0.042	1		11/11/16 15:39	108-67-8	
Vinyl chloride	ND	ug/L	0.20	0.098	1		11/11/16 15:39	75-01-4	
Xylene (Total)	ND	ug/L	1.5	0.15	1		11/11/16 15:39	1330-20-7	
m&p-Xylene	ND	ug/L	1.0	0.11	1		11/11/16 15:39	179601-23-1	
o-Xylene	ND	ug/L	0.50	0.044	1		11/11/16 15:39	95-47-6	
Surrogates									
1,2-Dichloroethane-d4 (S)	105	%.	75-125		1		11/11/16 15:39	17060-07-0	
Toluene-d8 (S)	98	%.	75-125		1		11/11/16 15:39	2037-26-5	
4-Bromofluorobenzene (S)	102	%.	75-125		1		11/11/16 15:39	460-00-4	
2320B Alkalinity	Analytical Method: SM 2320B								
Alkalinity, Total as CaCO3	**<1.2**	mg/L	5.0	1.2	1		11/08/16 16:09		
2510B Specific Conductance	Analytical Method: SM 2510B								
Specific Conductance	**<5.0**	umhos/cm	10.0	5.0	1		11/04/16 09:45		
2540D Total Suspended Solids	Analytical Method: SM 2540D (1997)								
Total Suspended Solids	**<2.0**	mg/L	2.0	2.0	1		11/04/16 10:49		
4500H+ pH, Electrometric	Analytical Method: SM 4500-H+B								
pH at 25 Degrees C	**5.9**	Std. Units	0.10	0.10	1		11/02/16 15:08		H6
300.0 IC Anions 28 Days	Analytical Method: EPA 300.0								
Chloride	**<0.50**	mg/L	1.0	0.50	1		11/08/16 18:19	16887-00-6	

ANALYTICAL RESULTS

Project: Camp Ripley MMLF
Pace Project No.: 1278223

Sample: Equip Blank **Lab ID: 1278223005** Collected: 10/31/16 13:40 Received: 11/02/16 10:30 Matrix: Water

Parameters	Results	Units	PQL	MDL	DF	Prepared	Analyzed	CAS No.	Qual
300.0 IC Anions 28 Days	Analytical Method: EPA 300.0								
Sulfate	**<1.0**	mg/L	2.0	1.0	1		11/08/16 18:19	14808-79-8	

Sample: Trip Blank **Lab ID: 1278223006** Collected: 10/31/16 00:00 Received: 11/02/16 10:30 Matrix: Water

Parameters	Results	Units	PQL	MDL	DF	Prepared	Analyzed	CAS No.	Qual
8260B MSV Low Level	Analytical Method: EPA 8260B								
Acetone	ND	ug/L	20.0	0.64	1		11/11/16 15:17	67-64-1	
Allyl chloride	ND	ug/L	4.0	0.25	1		11/11/16 15:17	107-05-1	
Benzene	ND	ug/L	0.50	0.042	1		11/11/16 15:17	71-43-2	
Bromobenzene	ND	ug/L	0.50	0.087	1		11/11/16 15:17	108-86-1	
Bromochloromethane	ND	ug/L	1.0	0.082	1		11/11/16 15:17	74-97-5	
Bromodichloromethane	ND	ug/L	1.0	0.068	1		11/11/16 15:17	75-27-4	
Bromoform	ND	ug/L	4.0	0.11	1		11/11/16 15:17	75-25-2	
Bromomethane	ND	ug/L	4.0	0.20	1		11/11/16 15:17	74-83-9	
2-Butanone (MEK)	ND	ug/L	5.0	1.1	1		11/11/16 15:17	78-93-3	
n-Butylbenzene	ND	ug/L	0.50	0.16	1		11/11/16 15:17	104-51-8	
sec-Butylbenzene	ND	ug/L	0.50	0.094	1		11/11/16 15:17	135-98-8	
tert-Butylbenzene	ND	ug/L	0.50	0.051	1		11/11/16 15:17	98-06-6	
Carbon tetrachloride	ND	ug/L	1.0	0.079	1		11/11/16 15:17	56-23-5	
Chlorobenzene	ND	ug/L	0.50	0.066	1		11/11/16 15:17	108-90-7	
Chloroethane	ND	ug/L	1.0	0.12	1		11/11/16 15:17	75-00-3	
Chloroform	ND	ug/L	1.0	0.21	1		11/11/16 15:17	67-66-3	
Chloromethane	ND	ug/L	4.0	0.080	1		11/11/16 15:17	74-87-3	
2-Chlorotoluene	ND	ug/L	0.50	0.084	1		11/11/16 15:17	95-49-8	
4-Chlorotoluene	ND	ug/L	0.50	0.048	1		11/11/16 15:17	106-43-4	
1,2-Dibromo-3-chloropropane	ND	ug/L	10.0	0.60	1		11/11/16 15:17	96-12-8	
Dibromochloromethane	ND	ug/L	4.0	0.048	1		11/11/16 15:17	124-48-1	
1,2-Dibromoethane (EDB)	ND	ug/L	1.0	0.092	1		11/11/16 15:17	106-93-4	
Dibromomethane	ND	ug/L	1.0	0.14	1		11/11/16 15:17	74-95-3	
1,2-Dichlorobenzene	ND	ug/L	0.50	0.078	1		11/11/16 15:17	95-50-1	
1,3-Dichlorobenzene	ND	ug/L	0.50	0.085	1		11/11/16 15:17	541-73-1	
1,4-Dichlorobenzene	ND	ug/L	0.50	0.081	1		11/11/16 15:17	106-46-7	
Dichlorodifluoromethane	ND	ug/L	1.0	0.075	1		11/11/16 15:17	75-71-8	
1,1-Dichloroethane	ND	ug/L	0.50	0.055	1		11/11/16 15:17	75-34-3	
1,2-Dichloroethane	ND	ug/L	0.50	0.072	1		11/11/16 15:17	107-06-2	
1,1-Dichloroethene	ND	ug/L	0.50	0.069	1		11/11/16 15:17	75-35-4	
cis-1,2-Dichloroethene	ND	ug/L	0.50	0.12	1		11/11/16 15:17	156-59-2	
trans-1,2-Dichloroethene	ND	ug/L	0.50	0.15	1		11/11/16 15:17	156-60-5	
Dichlorofluoromethane	ND	ug/L	1.0	0.054	1		11/11/16 15:17	75-43-4	
1,2-Dichloropropane	ND	ug/L	4.0	0.066	1		11/11/16 15:17	78-87-5	
1,3-Dichloropropane	ND	ug/L	0.50	0.059	1		11/11/16 15:17	142-28-9	
2,2-Dichloropropane	ND	ug/L	1.0	0.096	1		11/11/16 15:17	594-20-7	
1,1-Dichloropropene	ND	ug/L	0.50	0.082	1		11/11/16 15:17	563-58-6	

ANALYTICAL RESULTS

Project: Camp Ripley MMLF
Pace Project No.: 1278223

Sample: Trip Blank **Lab ID: 1278223006** Collected: 10/31/16 00:00 Received: 11/02/16 10:30 Matrix: Water

Parameters	Results	Units	PQL	MDL	DF	Prepared	Analyzed	CAS No.	Qual
8260B MSV Low Level	Analytical Method: EPA 8260B								
cis-1,3-Dichloropropene	ND	ug/L	0.50	0.069	1		11/11/16 15:17	10061-01-5	
trans-1,3-Dichloropropene	ND	ug/L	1.0	0.044	1		11/11/16 15:17	10061-02-6	
Diethyl ether (Ethyl ether)	ND	ug/L	4.0	0.090	1		11/11/16 15:17	60-29-7	
Ethylbenzene	ND	ug/L	0.50	0.075	1		11/11/16 15:17	100-41-4	
Hexachloro-1,3-butadiene	ND	ug/L	4.0	0.13	1		11/11/16 15:17	87-68-3	
Isopropylbenzene (Cumene)	ND	ug/L	0.50	0.064	1		11/11/16 15:17	98-82-8	
p-Isopropyltoluene	ND	ug/L	0.50	0.064	1		11/11/16 15:17	99-87-6	
Methylene Chloride	ND	ug/L	4.0	0.097	1		11/11/16 15:17	75-09-2	
4-Methyl-2-pentanone (MIBK)	ND	ug/L	5.0	0.80	1		11/11/16 15:17	108-10-1	
Methyl-tert-butyl ether	ND	ug/L	0.50	0.047	1		11/11/16 15:17	1634-04-4	
Naphthalene	ND	ug/L	1.0	0.064	1		11/11/16 15:17	91-20-3	
n-Propylbenzene	ND	ug/L	0.50	0.049	1		11/11/16 15:17	103-65-1	
Styrene	ND	ug/L	0.50	0.056	1		11/11/16 15:17	100-42-5	
1,1,1,2-Tetrachloroethane	ND	ug/L	1.0	0.064	1		11/11/16 15:17	630-20-6	
1,1,2,2-Tetrachloroethane	ND	ug/L	0.50	0.055	1		11/11/16 15:17	79-34-5	
Tetrachloroethene	ND	ug/L	0.50	0.13	1		11/11/16 15:17	127-18-4	
Tetrahydrofuran	ND	ug/L	10.0	1.5	1		11/11/16 15:17	109-99-9	
Toluene	ND	ug/L	0.50	0.059	1		11/11/16 15:17	108-88-3	
1,2,3-Trichlorobenzene	ND	ug/L	0.50	0.17	1		11/11/16 15:17	87-61-6	
1,2,4-Trichlorobenzene	ND	ug/L	0.50	0.14	1		11/11/16 15:17	120-82-1	
1,1,1-Trichloroethane	ND	ug/L	0.50	0.057	1		11/11/16 15:17	71-55-6	
1,1,2-Trichloroethane	ND	ug/L	0.50	0.064	1		11/11/16 15:17	79-00-5	
Trichloroethene	ND	ug/L	0.40	0.044	1		11/11/16 15:17	79-01-6	
Trichlorofluoromethane	ND	ug/L	0.50	0.055	1		11/11/16 15:17	75-69-4	
1,2,3-Trichloropropane	ND	ug/L	4.0	0.19	1		11/11/16 15:17	96-18-4	
1,1,2-Trichlorotrifluoroethane	ND	ug/L	1.0	0.13	1		11/11/16 15:17	76-13-1	
1,2,4-Trimethylbenzene	ND	ug/L	0.50	0.068	1		11/11/16 15:17	95-63-6	
1,3,5-Trimethylbenzene	ND	ug/L	0.50	0.042	1		11/11/16 15:17	108-67-8	
Vinyl chloride	ND	ug/L	0.20	0.098	1		11/11/16 15:17	75-01-4	
Xylene (Total)	ND	ug/L	1.5	0.15	1		11/11/16 15:17	1330-20-7	
m&p-Xylene	ND	ug/L	1.0	0.11	1		11/11/16 15:17	179601-23-1	
o-Xylene	ND	ug/L	0.50	0.044	1		11/11/16 15:17	95-47-6	
Surrogates									
1,2-Dichloroethane-d4 (S)	105	%.	75-125		1		11/11/16 15:17	17060-07-0	
Toluene-d8 (S)	99	%.	75-125		1		11/11/16 15:17	2037-26-5	
4-Bromofluorobenzene (S)	102	%.	75-125		1		11/11/16 15:17	460-00-4	

QUALITY CONTROL DATA

Project: Camp Ripley MMLF
Pace Project No.: 1278223

QC Batch: 99747
Analysis Method: EPA 350.1 rev. 2 (1993)
QC Batch Method: EPA 350.1
Analysis Description: 350.1 Ammonia
Associated Lab Samples: 1278223001, 1278223002, 1278223003

METHOD BLANK: 396028
Matrix: Water
Associated Lab Samples: 1278223001, 1278223002, 1278223003

Parameter	Units	Blank Result	Reporting Limit	MDL	Analyzed	Qualifiers
Nitrogen, Ammonia	mg/L	<0.044	0.10	0.044	11/10/16 13:26	

LABORATORY CONTROL SAMPLE: 396027

Parameter	Units	Spike Conc.	LCS Result	LCS % Rec	% Rec Limits	Qualifiers
Nitrogen, Ammonia	mg/L	1	1.1	107	90-110	

MATRIX SPIKE & MATRIX SPIKE DUPLICATE: 396029 396030

Parameter	Units	1277946001 Result	MS Spike Conc.	MSD Spike Conc.	MS Result	MSD Result	MS % Rec	MSD % Rec	% Rec Limits	RPD	Max RPD	Qual
Nitrogen, Ammonia	mg/L	0.43	1	1	1.4	1.4	101	98	90-110	2	10	

MATRIX SPIKE & MATRIX SPIKE DUPLICATE: 396031 396032

Parameter	Units	1278192003 Result	MS Spike Conc.	MSD Spike Conc.	MS Result	MSD Result	MS % Rec	MSD % Rec	% Rec Limits	RPD	Max RPD	Qual
Nitrogen, Ammonia	mg/L	0.90	1	1	1.9	2.0	99	106	90-110	4	10	

Results presented on this page are in the units indicated by the "Units" column except where an alternate unit is presented to the right of the result.

QUALITY CONTROL DATA

Project: Camp Ripley MMLF
Pace Project No.: 1278223

QC Batch: 99748
Analysis Method: EPA 350.1 rev. 2 (1993)
QC Batch Method: EPA 350.1
Analysis Description: 350.1 Ammonia
Associated Lab Samples: 1278223004, 1278223005

METHOD BLANK: 396035
Matrix: Water
Associated Lab Samples: 1278223004, 1278223005

Parameter	Units	Blank Result	Reporting Limit	MDL	Analyzed	Qualifiers
Nitrogen, Ammonia	mg/L	<0.044	0.10	0.044	11/10/16 14:04	

LABORATORY CONTROL SAMPLE: 396034

Parameter	Units	Spike Conc.	LCS Result	LCS % Rec	% Rec Limits	Qualifiers
Nitrogen, Ammonia	mg/L	1	0.96	96	90-110	

MATRIX SPIKE & MATRIX SPIKE DUPLICATE: 396036 396037

Parameter	Units	1278223004 Result	MS Spike Conc.	MSD Spike Conc.	MS Result	MSD Result	MS % Rec	MSD % Rec	% Rec Limits	RPD	Max RPD	Qual
Nitrogen, Ammonia	mg/L	0.76	1	1	1.7	1.7	97	98	90-110	1	10	

MATRIX SPIKE & MATRIX SPIKE DUPLICATE: 396038 396039

Parameter	Units	1278568004 Result	MS Spike Conc.	MSD Spike Conc.	MS Result	MSD Result	MS % Rec	MSD % Rec	% Rec Limits	RPD	Max RPD	Qual
Nitrogen, Ammonia	mg/L	1.4	1	1	2.4	2.3	98	88	90-110	4	10	M1

Results presented on this page are in the units indicated by the "Units" column except where an alternate unit is presented to the right of the result.

QUALITY CONTROL DATA

Project: Camp Ripley MMLF
Pace Project No.: 1278223

QC Batch: 99840
Analysis Method: EPA 353.2 rev. 2 (1993)
QC Batch Method: EPA 353.2 rev. 2 (1993)
Analysis Description: 353.2 Nitrate + Nitrite, preserved
Associated Lab Samples: 1278223001, 1278223002, 1278223003, 1278223004, 1278223005

METHOD BLANK: 396392
Matrix: Water
Associated Lab Samples: 1278223001, 1278223002, 1278223003, 1278223004, 1278223005

Parameter	Units	Blank Result	Reporting Limit	MDL	Analyzed	Qualifiers
Nitrogen, NO2 plus NO3	mg/L	<0.0035	0.020	0.0035	11/11/16 14:36	

LABORATORY CONTROL SAMPLE: 396391

Parameter	Units	Spike Conc.	LCS Result	LCS % Rec	% Rec Limits	Qualifiers
Nitrogen, NO2 plus NO3	mg/L	.5	0.52	105	90-110	

MATRIX SPIKE & MATRIX SPIKE DUPLICATE: 396393 396394

Parameter	Units	1278207001 Result	MS Spike Conc.	MSD Spike Conc.	MS Result	MSD Result	MS % Rec	MSD % Rec	% Rec Limits	RPD	Max RPD	Qual
Nitrogen, NO2 plus NO3	mg/L	0.028	.5	.5	0.52	0.50	98	94	90-110	3	10	

MATRIX SPIKE & MATRIX SPIKE DUPLICATE: 396395 396396

Parameter	Units	1278246001 Result	MS Spike Conc.	MSD Spike Conc.	MS Result	MSD Result	MS % Rec	MSD % Rec	% Rec Limits	RPD	Max RPD	Qual
Nitrogen, NO2 plus NO3	mg/L	ND	.5	.5	0.53	0.53	107	105	90-110	2	10	

Results presented on this page are in the units indicated by the "Units" column except where an alternate unit is presented to the right of the result.

QUALITY CONTROL DATA

Project: Camp Ripley MMLF
Pace Project No.: 1278223

QC Batch: 99825
Analysis Method: EPA 7470
QC Batch Method: EPA 7470
Analysis Description: 7470 Mercury Dissolved
Associated Lab Samples: 1278223001, 1278223002, 1278223003, 1278223004, 1278223005

METHOD BLANK: 396314
Matrix: Water
Associated Lab Samples: 1278223001, 1278223002, 1278223003, 1278223004, 1278223005

Parameter	Units	Blank Result	Reporting Limit	MDL	Analyzed	Qualifiers
Mercury, Dissolved	ug/L	<0.025	0.20	0.025	11/14/16 09:31	

LABORATORY CONTROL SAMPLE: 396315

Parameter	Units	Spike Conc.	LCS Result	LCS % Rec	% Rec Limits	Qualifiers
Mercury, Dissolved	ug/L	2	2.0	100	85-115	

MATRIX SPIKE & MATRIX SPIKE DUPLICATE: 396316 396317

Parameter	Units	1278220001 Result	MS Spike Conc.	MSD Spike Conc.	MS Result	MSD Result	MS % Rec	MSD % Rec	% Rec Limits	RPD	Max RPD	Qual
Mercury, Dissolved	ug/L	<0.025	2	2	2.0	2.0	100	100	75-125	1	15	

MATRIX SPIKE & MATRIX SPIKE DUPLICATE: 396319 396320

Parameter	Units	1278641001 Result	MS Spike Conc.	MSD Spike Conc.	MS Result	MSD Result	MS % Rec	MSD % Rec	% Rec Limits	RPD	Max RPD	Qual
Mercury, Dissolved	ug/L	ND	2	2	2.0	2.1	102	102	75-125	1	15	

Results presented on this page are in the units indicated by the "Units" column except where an alternate unit is presented to the right of the result.

QUALITY CONTROL DATA

Project: Camp Ripley MMLF
Pace Project No.: 1278223

QC Batch: 99412 Analysis Method: EPA 200.7
QC Batch Method: EPA 200.7 Analysis Description: 200.7 MET Dissolved
Associated Lab Samples: 1278223001, 1278223002, 1278223003, 1278223004, 1278223005

METHOD BLANK: 394640 Matrix: Water
Associated Lab Samples: 1278223001, 1278223002, 1278223003, 1278223004, 1278223005

Parameter	Units	Blank Result	Reporting Limit	MDL	Analyzed	Qualifiers
Barium, Dissolved	ug/L	<0.65	10.0	0.65	11/08/16 11:20	
Boron, Dissolved	ug/L	8.2J	100	5.9	11/08/16 11:20	
Chromium, Dissolved	ug/L	<1.3	10.0	1.3	11/08/16 11:20	
Copper, Dissolved	ug/L	<0.86	10.0	0.86	11/08/16 11:20	
Iron, Dissolved	ug/L	<2.9	50.0	2.9	11/08/16 11:20	
Manganese, Dissolved	ug/L	<0.23	10.0	0.23	11/08/16 11:20	
Sodium, Dissolved	mg/L	<0.13	0.50	0.13	11/08/16 11:20	

LABORATORY CONTROL SAMPLE: 394641

Parameter	Units	Spike Conc.	LCS Result	LCS % Rec	% Rec Limits	Qualifiers
Barium, Dissolved	ug/L	500	493	99	85-115	
Boron, Dissolved	ug/L	500	500	100	85-115	
Chromium, Dissolved	ug/L	500	508	102	85-115	
Copper, Dissolved	ug/L	500	483	97	85-115	
Iron, Dissolved	ug/L	10000	10000	100	85-115	
Manganese, Dissolved	ug/L	1000	996	100	85-115	
Sodium, Dissolved	mg/L	20	19.5	98	85-115	

MATRIX SPIKE & MATRIX SPIKE DUPLICATE: 394642 394643

Parameter	Units	1278223001 Result	MS Spike Conc.	MSD Spike Conc.	MS Result	MSD Result	MS % Rec	MSD % Rec	% Rec Limits	RPD	Max RPD	Qual
Barium, Dissolved	ug/L	23.6	500	500	517	511	99	98	70-130	1	20	
Boron, Dissolved	ug/L	22.8J	500	500	516	518	99	99	70-130	1	20	
Chromium, Dissolved	ug/L	<1.3	500	500	511	506	102	101	70-130	1	20	
Copper, Dissolved	ug/L	2.0J	500	500	488	483	97	96	70-130	1	20	
Iron, Dissolved	ug/L	28.9J	10000	10000	10100	9990	101	100	70-130	1	20	
Manganese, Dissolved	ug/L	62.9	1000	1000	1060	1050	100	99	70-130	1	20	
Sodium, Dissolved	mg/L	2.8	20	20	22.4	22.1	98	97	70-130	1	20	

MATRIX SPIKE & MATRIX SPIKE DUPLICATE: 394644 394645

Parameter	Units	1278422001 Result	MS Spike Conc.	MSD Spike Conc.	MS Result	MSD Result	MS % Rec	MSD % Rec	% Rec Limits	RPD	Max RPD	Qual
Barium, Dissolved	ug/L	79.1	500	500	558	564	96	97	70-130	1	20	
Boron, Dissolved	ug/L	ND	500	500	505	518	98	100	70-130	3	20	

Results presented on this page are in the units indicated by the "Units" column except where an alternate unit is presented to the right of the result.

QUALITY CONTROL DATA

Project: Camp Ripley MMLF
Pace Project No.: 1278223

MATRIX SPIKE & MATRIX SPIKE DUPLICATE: 394644 394645

Parameter	Units	1278422001 Result	MS Spike Conc.	MSD Spike Conc.	MS Result	MSD Result	MS % Rec	MSD % Rec	% Rec Limits	RPD	Max RPD	Qual
Chromium, Dissolved	ug/L	ND	500	500	498	508	99	101	70-130	2	20	
Copper, Dissolved	ug/L	ND	500	500	482	486	96	97	70-130	1	20	
Iron, Dissolved	ug/L	ND	10000	10000	9850	9950	98	99	70-130	1	20	
Manganese, Dissolved	ug/L	11.1	1000	1000	988	998	98	99	70-130	1	20	
Sodium, Dissolved	mg/L	2.5	20	20	21.6	22.0	95	98	70-130	2	20	

Results presented on this page are in the units indicated by the "Units" column except where an alternate unit is presented to the right of the result.

QUALITY CONTROL DATA

Project: Camp Ripley MMLF
Pace Project No.: 1278223

QC Batch: 99411 Analysis Method: EPA 200.8
QC Batch Method: EPA 200.8 Analysis Description: 200.8 MET Dissolved
Associated Lab Samples: 1278223001, 1278223002, 1278223003, 1278223004, 1278223005

METHOD BLANK: 394634 Matrix: Water
Associated Lab Samples: 1278223001, 1278223002, 1278223003, 1278223004, 1278223005

Parameter	Units	Blank Result	Reporting Limit	MDL	Analyzed	Qualifiers
Arsenic, Dissolved	ug/L	<0.24	0.50	0.24	11/08/16 18:35	
Cadmium, Dissolved	ug/L	<0.068	0.20	0.068	11/08/16 18:35	
Lead, Dissolved	ug/L	0.046J	0.50	0.0082	11/08/16 18:35	

LABORATORY CONTROL SAMPLE: 394635

Parameter	Units	Spike Conc.	LCS Result	LCS % Rec	% Rec Limits	Qualifiers
Arsenic, Dissolved	ug/L	500	510	102	85-115	
Cadmium, Dissolved	ug/L	500	488	98	85-115	
Lead, Dissolved	ug/L	500	491	98	85-115	

MATRIX SPIKE & MATRIX SPIKE DUPLICATE: 394636 394637

Parameter	Units	1278223001 Result	MS Spike Conc.	MSD Spike Conc.	MS Result	MSD Result	MS % Rec	MSD % Rec	% Rec Limits	RPD	Max RPD	Qual
Arsenic, Dissolved	ug/L	1.8	500	500	520	510	104	102	70-130	2	20	
Cadmium, Dissolved	ug/L	<0.14	500	500	496	483	99	96	70-130	3	20	
Lead, Dissolved	ug/L	0.051J	500	500	503	485	101	97	70-130	4	20	

MATRIX SPIKE & MATRIX SPIKE DUPLICATE: 394638 394639

Parameter	Units	1278422001 Result	MS Spike Conc.	MSD Spike Conc.	MS Result	MSD Result	MS % Rec	MSD % Rec	% Rec Limits	RPD	Max RPD	Qual
Arsenic, Dissolved	ug/L	ND	500	500	500	506	100	101	70-130	1	20	
Cadmium, Dissolved	ug/L	ND	500	500	491	497	98	99	70-130	1	20	
Lead, Dissolved	ug/L	ND	500	500	489	493	98	99	70-130	1	20	

Results presented on this page are in the units indicated by the "Units" column except where an alternate unit is presented to the right of the result.

QUALITY CONTROL DATA

Project: Camp Ripley MMLF
Pace Project No.: 1278223

QC Batch: 446601 Analysis Method: EPA 8260B
QC Batch Method: EPA 8260B Analysis Description: 8260 MSV LL Water
Associated Lab Samples: 1278223001, 1278223002, 1278223003, 1278223004, 1278223005, 1278223006

METHOD BLANK: 2441169 Matrix: Water
Associated Lab Samples: 1278223001, 1278223002, 1278223003, 1278223004, 1278223005, 1278223006

Parameter	Units	Blank Result	Reporting Limit	MDL	Analyzed	Qualifiers
1,1,1,2-Tetrachloroethane	ug/L	ND	1.0	0.064	11/11/16 14:33	
1,1,1-Trichloroethane	ug/L	ND	0.50	0.057	11/11/16 14:33	
1,1,2,2-Tetrachloroethane	ug/L	ND	0.50	0.055	11/11/16 14:33	
1,1,2-Trichloroethane	ug/L	ND	0.50	0.064	11/11/16 14:33	
1,1,2-Trichlorotrifluoroethane	ug/L	ND	1.0	0.13	11/11/16 14:33	
1,1-Dichloroethane	ug/L	ND	0.50	0.055	11/11/16 14:33	
1,1-Dichloroethene	ug/L	ND	0.50	0.069	11/11/16 14:33	
1,1-Dichloropropene	ug/L	ND	0.50	0.082	11/11/16 14:33	
1,2,3-Trichlorobenzene	ug/L	ND	0.50	0.17	11/11/16 14:33	
1,2,3-Trichloropropane	ug/L	ND	4.0	0.19	11/11/16 14:33	
1,2,4-Trichlorobenzene	ug/L	ND	0.50	0.14	11/11/16 14:33	
1,2,4-Trimethylbenzene	ug/L	ND	0.50	0.068	11/11/16 14:33	
1,2-Dibromo-3-chloropropane	ug/L	ND	10.0	0.60	11/11/16 14:33	
1,2-Dibromoethane (EDB)	ug/L	ND	1.0	0.092	11/11/16 14:33	
1,2-Dichlorobenzene	ug/L	ND	0.50	0.078	11/11/16 14:33	
1,2-Dichloroethane	ug/L	ND	0.50	0.072	11/11/16 14:33	
1,2-Dichloropropane	ug/L	ND	4.0	0.066	11/11/16 14:33	
1,3,5-Trimethylbenzene	ug/L	ND	0.50	0.042	11/11/16 14:33	
1,3-Dichlorobenzene	ug/L	ND	0.50	0.085	11/11/16 14:33	
1,3-Dichloropropane	ug/L	ND	0.50	0.059	11/11/16 14:33	
1,4-Dichlorobenzene	ug/L	ND	0.50	0.081	11/11/16 14:33	
2,2-Dichloropropane	ug/L	ND	1.0	0.096	11/11/16 14:33	
2-Butanone (MEK)	ug/L	ND	5.0	1.1	11/11/16 14:33	
2-Chlorotoluene	ug/L	ND	0.50	0.084	11/11/16 14:33	
4-Chlorotoluene	ug/L	ND	0.50	0.048	11/11/16 14:33	
4-Methyl-2-pentanone (MIBK)	ug/L	ND	5.0	0.80	11/11/16 14:33	
Acetone	ug/L	ND	20.0	0.64	11/11/16 14:33	
Allyl chloride	ug/L	ND	4.0	0.25	11/11/16 14:33	
Benzene	ug/L	ND	0.50	0.042	11/11/16 14:33	
Bromobenzene	ug/L	ND	0.50	0.087	11/11/16 14:33	
Bromochloromethane	ug/L	ND	1.0	0.082	11/11/16 14:33	
Bromodichloromethane	ug/L	ND	1.0	0.068	11/11/16 14:33	
Bromoform	ug/L	ND	4.0	0.11	11/11/16 14:33	
Bromomethane	ug/L	ND	4.0	0.20	11/11/16 14:33	
Carbon tetrachloride	ug/L	ND	1.0	0.079	11/11/16 14:33	
Chlorobenzene	ug/L	ND	0.50	0.066	11/11/16 14:33	
Chloroethane	ug/L	ND	1.0	0.12	11/11/16 14:33	
Chloroform	ug/L	ND	1.0	0.21	11/11/16 14:33	
Chloromethane	ug/L	ND	4.0	0.080	11/11/16 14:33	
cis-1,2-Dichloroethene	ug/L	ND	0.50	0.12	11/11/16 14:33	
cis-1,3-Dichloropropene	ug/L	ND	0.50	0.069	11/11/16 14:33	

Results presented on this page are in the units indicated by the "Units" column except where an alternate unit is presented to the right of the result.

QUALITY CONTROL DATA

Project: Camp Ripley MMLF
Pace Project No.: 1278223

METHOD BLANK: 2441169 Matrix: Water
Associated Lab Samples: 1278223001, 1278223002, 1278223003, 1278223004, 1278223005, 1278223006

Parameter	Units	Blank Result	Reporting Limit	MDL	Analyzed	Qualifiers
Dibromochloromethane	ug/L	ND	4.0	0.048	11/11/16 14:33	
Dibromomethane	ug/L	ND	1.0	0.14	11/11/16 14:33	
Dichlorodifluoromethane	ug/L	ND	1.0	0.075	11/11/16 14:33	
Dichlorofluoromethane	ug/L	ND	1.0	0.054	11/11/16 14:33	
Diethyl ether (Ethyl ether)	ug/L	ND	4.0	0.090	11/11/16 14:33	
Ethylbenzene	ug/L	ND	0.50	0.075	11/11/16 14:33	
Hexachloro-1,3-butadiene	ug/L	ND	4.0	0.13	11/11/16 14:33	
Isopropylbenzene (Cumene)	ug/L	ND	0.50	0.064	11/11/16 14:33	
m&p-Xylene	ug/L	ND	1.0	0.11	11/11/16 14:33	
Methyl-tert-butyl ether	ug/L	ND	0.50	0.047	11/11/16 14:33	
Methylene Chloride	ug/L	ND	4.0	0.097	11/11/16 14:33	
n-Butylbenzene	ug/L	ND	0.50	0.16	11/11/16 14:33	
n-Propylbenzene	ug/L	ND	0.50	0.049	11/11/16 14:33	
Naphthalene	ug/L	ND	1.0	0.064	11/11/16 14:33	
o-Xylene	ug/L	ND	0.50	0.044	11/11/16 14:33	
p-Isopropyltoluene	ug/L	ND	0.50	0.064	11/11/16 14:33	
sec-Butylbenzene	ug/L	ND	0.50	0.094	11/11/16 14:33	
Styrene	ug/L	ND	0.50	0.056	11/11/16 14:33	
tert-Butylbenzene	ug/L	ND	0.50	0.051	11/11/16 14:33	
Tetrachloroethene	ug/L	ND	0.50	0.13	11/11/16 14:33	
Tetrahydrofuran	ug/L	ND	10.0	1.5	11/11/16 14:33	
Toluene	ug/L	ND	0.50	0.059	11/11/16 14:33	
trans-1,2-Dichloroethene	ug/L	ND	0.50	0.15	11/11/16 14:33	
trans-1,3-Dichloropropene	ug/L	ND	1.0	0.044	11/11/16 14:33	
Trichloroethene	ug/L	ND	0.40	0.044	11/11/16 14:33	
Trichlorofluoromethane	ug/L	ND	0.50	0.055	11/11/16 14:33	
Vinyl chloride	ug/L	ND	0.20	0.098	11/11/16 14:33	
Xylene (Total)	ug/L	ND	1.5	0.15	11/11/16 14:33	
1,2-Dichloroethane-d4 (S)	%.	105	75-125		11/11/16 14:33	
4-Bromofluorobenzene (S)	%.	103	75-125		11/11/16 14:33	
Toluene-d8 (S)	%.	98	75-125		11/11/16 14:33	

LABORATORY CONTROL SAMPLE & LCSD: 2441170 2441171

Parameter	Units	Spike Conc.	LCS Result	LCSD Result	LCS % Rec	LCSD % Rec	% Rec Limits	RPD	Max RPD	Qualifiers
1,1,1,2-Tetrachloroethane	ug/L	20	21.8	22.4	109	112	75-125	3	30	
1,1,1-Trichloroethane	ug/L	20	20.2	20.1	101	100	74-125	1	30	
1,1,2,2-Tetrachloroethane	ug/L	20	23.0	22.7	115	113	67-131	1	30	
1,1,2-Trichloroethane	ug/L	20	22.1	22.4	111	112	75-125	1	30	
1,1,2-Trichlorotrifluoroethane	ug/L	20	20.2	20.2	101	101	75-125	0	30	
1,1-Dichloroethane	ug/L	20	20.0	19.9	100	99	74-125	0	30	
1,1-Dichloroethene	ug/L	20	20.1	20.3	101	102	74-125	1	30	
1,1-Dichloropropene	ug/L	20	19.0	19.1	95	95	74-125	0	30	
1,2,3-Trichlorobenzene	ug/L	20	21.2	22.8	106	114	63-131	7	30	

Results presented on this page are in the units indicated by the "Units" column except where an alternate unit is presented to the right of the result.

QUALITY CONTROL DATA

Project: Camp Ripley MMLF
Pace Project No.: 1278223

LABORATORY CONTROL SAMPLE & LCSD: 2441170 2441171

Parameter	Units	Spike Conc.	LCS Result	LCSD Result	LCS % Rec	LCSD % Rec	% Rec Limits	RPD	Max RPD	Qualifiers
1,2,3-Trichloropropane	ug/L	20	22.5	22.4	113	112	73-125	1	30	
1,2,4-Trichlorobenzene	ug/L	20	22.3	22.8	111	114	66-126	2	30	
1,2,4-Trimethylbenzene	ug/L	20	21.5	21.8	107	109	74-129	2	30	
1,2-Dibromo-3-chloropropane	ug/L	50	56.8	54.7	114	109	54-129	4	30	
1,2-Dibromoethane (EDB)	ug/L	20	21.3	21.7	107	109	75-125	2	30	
1,2-Dichlorobenzene	ug/L	20	21.5	22.0	107	110	75-125	2	30	
1,2-Dichloroethane	ug/L	20	19.3	19.8	96	99	75-125	3	30	
1,2-Dichloropropane	ug/L	20	20.0	20.4	100	102	75-125	2	30	
1,3,5-Trimethylbenzene	ug/L	20	21.7	21.8	109	109	73-127	0	30	
1,3-Dichlorobenzene	ug/L	20	21.2	21.5	106	107	75-125	1	30	
1,3-Dichloropropane	ug/L	20	20.7	21.4	104	107	69-125	3	30	
1,4-Dichlorobenzene	ug/L	20	20.9	21.3	105	106	75-125	2	30	
2,2-Dichloropropane	ug/L	20	22.5	22.1	113	111	69-125	2	30	
2-Butanone (MEK)	ug/L	100	106	99.6	106	100	48-145	6	30	
2-Chlorotoluene	ug/L	20	21.3	21.1	106	105	74-125	1	30	
4-Chlorotoluene	ug/L	20	21.1	21.2	105	106	73-125	1	30	
4-Methyl-2-pentanone (MIBK)	ug/L	100	112	105	112	105	53-138	7	30	
Acetone	ug/L	100	92.6	94.0	93	94	70-142	2	30	
Allyl chloride	ug/L	20	18.4	18.7	92	93	61-127	1	30	
Benzene	ug/L	20	18.1	18.2	90	91	65-125	0	30	
Bromobenzene	ug/L	20	22.1	22.3	110	112	75-125	1	30	
Bromochloromethane	ug/L	20	19.7	20.6	99	103	75-125	4	30	
Bromodichloromethane	ug/L	20	21.5	22.4	107	112	73-125	4	30	
Bromoform	ug/L	20	21.7	22.7	109	113	69-125	4	30	
Bromomethane	ug/L	20	15.0	18.3	75	92	40-136	20	30	
Carbon tetrachloride	ug/L	20	21.5	21.5	108	107	70-125	0	30	
Chlorobenzene	ug/L	20	20.4	20.6	102	103	75-125	1	30	
Chloroethane	ug/L	20	18.6	19.3	93	97	67-141	4	30	
Chloroform	ug/L	20	20.2	20.4	101	102	75-125	1	30	
Chloromethane	ug/L	20	20.0	20.1	100	100	50-150	0	30	
cis-1,2-Dichloroethene	ug/L	20	20.1	19.9	100	99	75-125	1	30	
cis-1,3-Dichloropropene	ug/L	20	20.7	21.6	104	108	75-125	4	30	
Dibromochloromethane	ug/L	20	20.7	22.1	104	110	75-125	6	30	
Dibromomethane	ug/L	20	22.7	22.2	113	111	75-129	2	30	
Dichlorodifluoromethane	ug/L	20	22.2	21.9	111	110	59-135	1	30	
Dichlorofluoromethane	ug/L	20	20.5	20.7	103	104	74-130	1	30	
Diethyl ether (Ethyl ether)	ug/L	20	19.6	20.7	98	104	66-132	6	30	
Ethylbenzene	ug/L	20	20.2	20.1	101	101	75-125	0	30	
Hexachloro-1,3-butadiene	ug/L	20	24.4	25.1	122	126	72-126	3	30	
Isopropylbenzene (Cumene)	ug/L	20	21.1	21.2	105	106	71-136	1	30	
m&p-Xylene	ug/L	40	41.6	41.9	104	105	75-125	1	30	
Methyl-tert-butyl ether	ug/L	20	20.9	21.0	105	105	73-127	0	30	
Methylene Chloride	ug/L	20	17.4	17.9	87	89	68-128	3	30	
n-Butylbenzene	ug/L	20	21.5	22.2	107	111	70-126	3	30	
n-Propylbenzene	ug/L	20	21.0	21.0	105	105	67-131	0	30	
Naphthalene	ug/L	20	21.6	21.7	108	108	52-134	0	30	
o-Xylene	ug/L	20	21.1	21.7	105	108	75-125	3	30	

Results presented on this page are in the units indicated by the "Units" column except where an alternate unit is presented to the right of the result.

QUALITY CONTROL DATA

Project: Camp Ripley MMLF
Pace Project No.: 1278223

LABORATORY CONTROL SAMPLE & LCSD: 2441170 2441171

Parameter	Units	Spike Conc.	LCS Result	LCSD Result	LCS % Rec	LCSD % Rec	% Rec Limits	RPD	Max RPD	Qualifiers
p-Isopropyltoluene	ug/L	20	22.0	22.4	110	112	74-125	2	30	
sec-Butylbenzene	ug/L	20	21.2	21.5	106	107	69-134	1	30	
Styrene	ug/L	20	20.9	21.1	105	105	75-125	1	30	
tert-Butylbenzene	ug/L	20	21.8	21.4	109	107	71-128	2	30	
Tetrachloroethene	ug/L	20	21.2	20.9	106	105	74-125	1	30	
Tetrahydrofuran	ug/L	200	195	197	97	99	64-142	1	30	
Toluene	ug/L	20	19.1	19.3	95	97	75-125	1	30	
trans-1,2-Dichloroethene	ug/L	20	20.0	20.4	100	102	73-125	2	30	
trans-1,3-Dichloropropene	ug/L	20	21.0	21.6	105	108	75-125	3	30	
Trichloroethene	ug/L	20	20.9	21.0	104	105	75-125	0	30	
Trichlorofluoromethane	ug/L	20	23.4	23.5	117	117	75-126	0	30	
Vinyl chloride	ug/L	20	21.1	21.7	106	108	72-125	3	30	
Xylene (Total)	ug/L	60	62.6	63.6	104	106	75-125	2	30	
1,2-Dichloroethane-d4 (S)	%.				101	100	75-125			
4-Bromofluorobenzene (S)	%.				101	101	75-125			
Toluene-d8 (S)	%.				100	100	75-125			

MATRIX SPIKE SAMPLE: 2441172

Parameter	Units	1278374001 Result	Spike Conc.	MS Result	MS % Rec	% Rec Limits	Qualifiers
1,1,1,2-Tetrachloroethane	ug/L	ND	20	21.4	107	75-127	
1,1,1-Trichloroethane	ug/L	ND	20	21.2	106	66-142	
1,1,2,2-Tetrachloroethane	ug/L	ND	20	20.5	103	70-131	
1,1,2-Trichloroethane	ug/L	ND	20	20.1	101	75-128	
1,1,2-Trichlorotrifluoroethane	ug/L	ND	20	24.1	120	54-150	
1,1-Dichloroethane	ug/L	ND	20	20.5	103	58-147	
1,1-Dichloroethene	ug/L	ND	20	21.9	109	49-150	
1,1-Dichloropropene	ug/L	ND	20	20.3	101	58-147	
1,2,3-Trichlorobenzene	ug/L	ND	20	20.7	103	57-139	
1,2,3-Trichloropropane	ug/L	ND	20	20.5	102	71-127	
1,2,4-Trichlorobenzene	ug/L	ND	20	21.5	108	55-136	
1,2,4-Trimethylbenzene	ug/L	ND	20	21.1	106	67-138	
1,2-Dibromo-3-chloropropane	ug/L	ND	50	49.8	100	63-136	
1,2-Dibromoethane (EDB)	ug/L	ND	20	20.0	100	74-125	
1,2-Dichlorobenzene	ug/L	ND	20	21.0	105	75-125	
1,2-Dichloroethane	ug/L	ND	20	19.0	95	63-133	
1,2-Dichloropropane	ug/L	ND	20	19.9	99	63-138	
1,3,5-Trimethylbenzene	ug/L	ND	20	21.4	107	69-136	
1,3-Dichlorobenzene	ug/L	ND	20	20.9	104	75-125	
1,3-Dichloropropane	ug/L	ND	20	19.7	99	65-135	
1,4-Dichlorobenzene	ug/L	ND	20	20.6	103	70-126	
2,2-Dichloropropane	ug/L	ND	20	23.1	116	39-148	
2-Butanone (MEK)	ug/L	ND	100	88.2	88	50-144	
2-Chlorotoluene	ug/L	ND	20	21.1	106	71-135	
4-Chlorotoluene	ug/L	ND	20	20.9	105	71-131	

Results presented on this page are in the units indicated by the "Units" column except where an alternate unit is presented to the right of the result.

QUALITY CONTROL DATA

Project: Camp Ripley MMLF
Pace Project No.: 1278223

MATRIX SPIKE SAMPLE: 2441172

Parameter	Units	1278374001 Result	Spike Conc.	MS Result	MS % Rec	% Rec Limits	Qualifiers
4-Methyl-2-pentanone (MIBK)	ug/L	ND	100	94.4	94	60-147	
Acetone	ug/L	ND	100	84.0	84	59-150	
Allyl chloride	ug/L	ND	20	19.2	96	38-149	
Benzene	ug/L	ND	20	18.5	92	61-138	
Bromobenzene	ug/L	ND	20	21.2	106	74-130	
Bromochloromethane	ug/L	ND	20	19.7	99	65-137	
Bromodichloromethane	ug/L	ND	20	21.6	108	66-136	
Bromoform	ug/L	ND	20	20.5	103	71-125	
Bromomethane	ug/L	ND	20	21.5	107	30-150	
Carbon tetrachloride	ug/L	ND	20	23.3	116	68-140	
Chlorobenzene	ug/L	ND	20	20.1	100	75-132	
Chloroethane	ug/L	ND	20	21.9	109	55-150	
Chloroform	ug/L	ND	20	20.4	102	64-139	
Chloromethane	ug/L	ND	20	22.9	115	73-150	
cis-1,2-Dichloroethene	ug/L	ND	20	20.1	101	62-138	
cis-1,3-Dichloropropene	ug/L	ND	20	19.9	99	70-125	
Dibromochloromethane	ug/L	ND	20	20.4	102	74-125	
Dibromomethane	ug/L	ND	20	21.1	105	66-138	
Dichlorodifluoromethane	ug/L	ND	20	28.5	143	53-150	
Dichlorofluoromethane	ug/L	ND	20	23.2	116	58-150	
Diethyl ether (Ethyl ether)	ug/L	ND	20	19.2	96	47-145	
Ethylbenzene	ug/L	ND	20	20.2	101	66-141	
Hexachloro-1,3-butadiene	ug/L	ND	20	26.5	133	63-139	
Isopropylbenzene (Cumene)	ug/L	ND	20	21.2	106	65-146	
m&p-Xylene	ug/L	ND	40	40.7	102	72-142	
Methyl-tert-butyl ether	ug/L	ND	20	19.6	98	63-134	
Methylene Chloride	ug/L	ND	20	17.4	87	49-143	
n-Butylbenzene	ug/L	ND	20	22.0	110	67-134	
n-Propylbenzene	ug/L	ND	20	20.9	105	62-142	
Naphthalene	ug/L	ND	20	19.8	99	41-150	
o-Xylene	ug/L	ND	20	20.8	104	66-138	
p-Isopropyltoluene	ug/L	ND	20	22.1	111	64-137	
sec-Butylbenzene	ug/L	ND	20	21.5	108	65-142	
Styrene	ug/L	ND	20	20.3	102	61-142	
tert-Butylbenzene	ug/L	ND	20	21.3	106	69-135	
Tetrachloroethene	ug/L	ND	20	20.9	104	62-142	
Tetrahydrofuran	ug/L	ND	200	177	88	55-150	
Toluene	ug/L	ND	20	19.0	95	66-132	
trans-1,2-Dichloroethene	ug/L	ND	20	21.3	107	48-150	
trans-1,3-Dichloropropene	ug/L	ND	20	20.3	102	65-130	
Trichloroethene	ug/L	ND	20	20.7	103	64-142	
Trichlorofluoromethane	ug/L	ND	20	29.2	146	63-150	
Vinyl chloride	ug/L	ND	20	25.7	128	58-150	
Xylene (Total)	ug/L	ND	60	61.5	103	70-140	
1,2-Dichloroethane-d4 (S)	%.				101	75-125	
4-Bromofluorobenzene (S)	%.				100	75-125	
Toluene-d8 (S)	%.				99	75-125	

Results presented on this page are in the units indicated by the "Units" column except where an alternate unit is presented to the right of the result.

QUALITY CONTROL DATA

Project: Camp Ripley MMLF
Pace Project No.: 1278223

SAMPLE DUPLICATE: 2441173

Parameter	Units	1278374002 Result	Dup Result	RPD	Max RPD	Qualifiers
1,1,1,2-Tetrachloroethane	ug/L	ND	ND		30	
1,1,1-Trichloroethane	ug/L	ND	ND		30	
1,1,2,2-Tetrachloroethane	ug/L	ND	ND		30	
1,1,2-Trichloroethane	ug/L	ND	ND		30	
1,1,2-Trichlorotrifluoroethane	ug/L	ND	ND		30	
1,1-Dichloroethane	ug/L	ND	ND		30	
1,1-Dichloroethene	ug/L	ND	ND		30	
1,1-Dichloropropene	ug/L	ND	ND		30	
1,2,3-Trichlorobenzene	ug/L	ND	ND		30	
1,2,3-Trichloropropane	ug/L	ND	ND		30	
1,2,4-Trichlorobenzene	ug/L	ND	ND		30	
1,2,4-Trimethylbenzene	ug/L	ND	ND		30	
1,2-Dibromo-3-chloropropane	ug/L	ND	ND		30	
1,2-Dibromoethane (EDB)	ug/L	ND	ND		30	
1,2-Dichlorobenzene	ug/L	ND	ND		30	
1,2-Dichloroethane	ug/L	ND	ND		30	
1,2-Dichloropropane	ug/L	ND	ND		30	
1,3,5-Trimethylbenzene	ug/L	ND	ND		30	
1,3-Dichlorobenzene	ug/L	ND	ND		30	
1,3-Dichloropropane	ug/L	ND	ND		30	
1,4-Dichlorobenzene	ug/L	ND	ND		30	
2,2-Dichloropropane	ug/L	ND	ND		30	
2-Butanone (MEK)	ug/L	ND	ND		30	
2-Chlorotoluene	ug/L	ND	ND		30	
4-Chlorotoluene	ug/L	ND	ND		30	
4-Methyl-2-pentanone (MIBK)	ug/L	ND	ND		30	
Acetone	ug/L	ND	ND		30	
Allyl chloride	ug/L	ND	ND		30	
Benzene	ug/L	ND	ND		30	
Bromobenzene	ug/L	ND	ND		30	
Bromochloromethane	ug/L	ND	ND		30	
Bromodichloromethane	ug/L	ND	ND		30	
Bromoform	ug/L	ND	ND		30	
Bromomethane	ug/L	ND	ND		30	
Carbon tetrachloride	ug/L	ND	ND		30	
Chlorobenzene	ug/L	ND	ND		30	
Chloroethane	ug/L	ND	ND		30	
Chloroform	ug/L	ND	ND		30	
Chloromethane	ug/L	ND	ND		30	
cis-1,2-Dichloroethene	ug/L	ND	ND		30	
cis-1,3-Dichloropropene	ug/L	ND	ND		30	
Dibromochloromethane	ug/L	ND	ND		30	
Dibromomethane	ug/L	ND	ND		30	
Dichlorodifluoromethane	ug/L	ND	ND		30	
Dichlorofluoromethane	ug/L	ND	ND		30	
Diethyl ether (Ethyl ether)	ug/L	ND	ND		30	
Ethylbenzene	ug/L	ND	ND		30	

Results presented on this page are in the units indicated by the "Units" column except where an alternate unit is presented to the right of the result.

QUALITY CONTROL DATA

Project: Camp Ripley MMLF
Pace Project No.: 1278223

SAMPLE DUPLICATE: 2441173

Parameter	Units	1278374002 Result	Dup Result	RPD	Max RPD	Qualifiers
Hexachloro-1,3-butadiene	ug/L	ND	ND		30	
Isopropylbenzene (Cumene)	ug/L	ND	ND		30	
m&p-Xylene	ug/L	ND	ND		30	
Methyl-tert-butyl ether	ug/L	ND	ND		30	
Methylene Chloride	ug/L	ND	ND		30	
n-Butylbenzene	ug/L	ND	ND		30	
n-Propylbenzene	ug/L	ND	ND		30	
Naphthalene	ug/L	ND	ND		30	
o-Xylene	ug/L	ND	ND		30	
p-Isopropyltoluene	ug/L	ND	ND		30	
sec-Butylbenzene	ug/L	ND	ND		30	
Styrene	ug/L	ND	ND		30	
tert-Butylbenzene	ug/L	ND	ND		30	
Tetrachloroethene	ug/L	ND	ND		30	
Tetrahydrofuran	ug/L	ND	ND		30	
Toluene	ug/L	ND	ND		30	
trans-1,2-Dichloroethene	ug/L	ND	ND		30	
trans-1,3-Dichloropropene	ug/L	ND	ND		30	
Trichloroethene	ug/L	ND	ND		30	
Trichlorofluoromethane	ug/L	ND	ND		30	
Vinyl chloride	ug/L	ND	ND		30	
Xylene (Total)	ug/L	ND	ND		30	
1,2-Dichloroethane-d4 (S)	%.	105	106	1		
4-Bromofluorobenzene (S)	%.	102	101	1		
Toluene-d8 (S)	%.	99	97	1		

Results presented on this page are in the units indicated by the "Units" column except where an alternate unit is presented to the right of the result.

QUALITY CONTROL DATA

Project: Camp Ripley MMLF
Pace Project No.: 1278223

QC Batch: 99424
Analysis Method: SM 2320B
QC Batch Method: SM 2320B
Analysis Description: 2320B Alkalinity
Associated Lab Samples: 1278223001, 1278223002, 1278223003

METHOD BLANK: 394698
Matrix: Water
Associated Lab Samples: 1278223001, 1278223002, 1278223003

Parameter	Units	Blank Result	Reporting Limit	MDL	Analyzed	Qualifiers
Alkalinity, Total as CaCO3	mg/L	<1.2	5.0	1.2	11/07/16 16:40	

LABORATORY CONTROL SAMPLE: 394699

Parameter	Units	Spike Conc.	LCS Result	LCS % Rec	% Rec Limits	Qualifiers
Alkalinity, Total as CaCO3	mg/L	100	101	101	90-110	

SAMPLE DUPLICATE: 394700

Parameter	Units	1278355001 Result	Dup Result	RPD	Max RPD	Qualifiers
Alkalinity, Total as CaCO3	mg/L	306	309	1	20	

Results presented on this page are in the units indicated by the "Units" column except where an alternate unit is presented to the right of the result.

QUALITY CONTROL DATA

Project: Camp Ripley MMLF
Pace Project No.: 1278223

QC Batch: 99505
Analysis Method: SM 2320B
QC Batch Method: SM 2320B
Analysis Description: 2320B Alkalinity
Associated Lab Samples: 1278223004, 1278223005

METHOD BLANK: 394981
Matrix: Water
Associated Lab Samples: 1278223004, 1278223005

Parameter	Units	Blank Result	Reporting Limit	MDL	Analyzed	Qualifiers
Alkalinity, Total as CaCO3	mg/L	<1.2	5.0	1.2	11/08/16 13:44	

LABORATORY CONTROL SAMPLE: 394982

Parameter	Units	Spike Conc.	LCS Result	LCS % Rec	% Rec Limits	Qualifiers
Alkalinity, Total as CaCO3	mg/L	100	98.0	98	90-110	

SAMPLE DUPLICATE: 394983

Parameter	Units	1278380001 Result	Dup Result	RPD	Max RPD	Qualifiers
Alkalinity, Total as CaCO3	mg/L	35.0	30.9	12	20	

SAMPLE DUPLICATE: 394984

Parameter	Units	1278319001 Result	Dup Result	RPD	Max RPD	Qualifiers
Alkalinity, Total as CaCO3	mg/L	351	362	3	20	

Results presented on this page are in the units indicated by the "Units" column except where an alternate unit is presented to the right of the result.

QUALITY CONTROL DATA

Project: Camp Ripley MMLF
Pace Project No.: 1278223

QC Batch: 99258 Analysis Method: SM 2510B
QC Batch Method: SM 2510B Analysis Description: 2510B Specific Conductance
Associated Lab Samples: 1278223001, 1278223002, 1278223003, 1278223004, 1278223005

METHOD BLANK: 394057 Matrix: Water
Associated Lab Samples: 1278223001, 1278223002, 1278223003, 1278223004, 1278223005

Parameter	Units	Blank Result	Reporting Limit	MDL	Analyzed	Qualifiers
Specific Conductance	umhos/cm	<5.0	10.0	5.0	11/04/16 09:37	

LABORATORY CONTROL SAMPLE: 394058

Parameter	Units	Spike Conc.	LCS Result	LCS % Rec	% Rec Limits	Qualifiers
Specific Conductance	umhos/cm	1413	1372	97	90-110	

SAMPLE DUPLICATE: 394059

Parameter	Units	1278287001 Result	Dup Result	RPD	Max RPD	Qualifiers
Specific Conductance	umhos/cm	131	131	0	20	

SAMPLE DUPLICATE: 394060

Parameter	Units	1278377002 Result	Dup Result	RPD	Max RPD	Qualifiers
Specific Conductance	umhos/cm	873	872	0	20	

Results presented on this page are in the units indicated by the "Units" column except where an alternate unit is presented to the right of the result.

QUALITY CONTROL DATA

Project: Camp Ripley MMLF
Pace Project No.: 1278223

QC Batch: 99273 Analysis Method: SM 2540D (1997)
QC Batch Method: SM 2540D (1997) Analysis Description: 2540D Total Suspended Solids
Associated Lab Samples: 1278223001, 1278223002, 1278223003, 1278223004, 1278223005

METHOD BLANK: 394104 Matrix: Water
Associated Lab Samples: 1278223001, 1278223002, 1278223003, 1278223004, 1278223005

Parameter	Units	Blank Result	Reporting Limit	MDL	Analyzed	Qualifiers
Total Suspended Solids	mg/L	<1.0	1.0	1.0	11/04/16 10:49	

LABORATORY CONTROL SAMPLE: 394105

Parameter	Units	Spike Conc.	LCS Result	LCS % Rec	% Rec Limits	Qualifiers
Total Suspended Solids	mg/L	239	226	95	80-120	

SAMPLE DUPLICATE: 394106

Parameter	Units	1278403001 Result	Dup Result	RPD	Max RPD	Qualifiers
Total Suspended Solids	mg/L	164	176	7	10	

SAMPLE DUPLICATE: 394107

Parameter	Units	1278399001 Result	Dup Result	RPD	Max RPD	Qualifiers
Total Suspended Solids	mg/L		400	17	10	D6

Results presented on this page are in the units indicated by the "Units" column except where an alternate unit is presented to the right of the result.

QUALITY CONTROL DATA

Project: Camp Ripley MMLF
Pace Project No.: 1278223

QC Batch: 99019
Analysis Method: SM 4500-H+B
QC Batch Method: SM 4500-H+B
Analysis Description: 4500H+B pH
Associated Lab Samples: 1278223001, 1278223002, 1278223003, 1278223004, 1278223005

LABORATORY CONTROL SAMPLE: 392989

Parameter	Units	Spike Conc.	LCS Result	LCS % Rec	% Rec Limits	Qualifiers
pH at 25 Degrees C	Std. Units	7	7.0	100	98-102	H6

SAMPLE DUPLICATE: 392990

Parameter	Units	1278220001 Result	Dup Result	RPD	Max RPD	Qualifiers
pH at 25 Degrees C	Std. Units	7.2	7.2	0	10	H6

SAMPLE DUPLICATE: 392991

Parameter	Units	1278201001 Result	Dup Result	RPD	Max RPD	Qualifiers
pH at 25 Degrees C	Std. Units	7.7	7.7	0	10	H6

Results presented on this page are in the units indicated by the "Units" column except where an alternate unit is presented to the right of the result.

QUALITY CONTROL DATA

Project: Camp Ripley MMLF
Pace Project No.: 1278223

QC Batch: 99527 Analysis Method: EPA 300.0
QC Batch Method: EPA 300.0 Analysis Description: 300.0 IC Anions
Associated Lab Samples: 1278223001, 1278223002, 1278223003, 1278223004, 1278223005

METHOD BLANK: 395054 Matrix: Water
Associated Lab Samples: 1278223001, 1278223002, 1278223003, 1278223004, 1278223005

Parameter	Units	Blank Result	Reporting Limit	MDL	Analyzed	Qualifiers
Chloride	mg/L	<0.50	1.0	0.50	11/08/16 14:58	
Sulfate	mg/L	<1.0	2.0	1.0	11/08/16 14:58	

LABORATORY CONTROL SAMPLE: 395055

Parameter	Units	Spike Conc.	LCS Result	LCS % Rec	% Rec Limits	Qualifiers
Chloride	mg/L	50	50.4	101	90-110	
Sulfate	mg/L	50	49.7	99	90-110	

MATRIX SPIKE & MATRIX SPIKE DUPLICATE: 395056 395057

Parameter	Units	1278220001 Result	MS Spike Conc.	MSD Spike Conc.	MS Result	MSD Result	MS % Rec	MSD % Rec	% Rec Limits	RPD	Max RPD	Qual
Chloride	mg/L	0.59J	50	50	50.9	51.0	101	101	90-110	0	20	
Sulfate	mg/L	3.9	50	50	54.1	54.5	101	101	90-110	1	20	

MATRIX SPIKE & MATRIX SPIKE DUPLICATE: 395058 395059

Parameter	Units	1278263001 Result	MS Spike Conc.	MSD Spike Conc.	MS Result	MSD Result	MS % Rec	MSD % Rec	% Rec Limits	RPD	Max RPD	Qual
Chloride	mg/L	20.1	50	50	70.6	70.7	101	101	90-110	0	20	
Sulfate	mg/L	157	50	50	206	206	97	98	90-110	0	20	E

Results presented on this page are in the units indicated by the "Units" column except where an alternate unit is presented to the right of the result.

QUALIFIERS

Project:	Camp Ripley MMLF
Pace Project No.:	1278223

DEFINITIONS

DF - Dilution Factor, if reported, represents the factor applied to the reported data due to dilution of the sample aliquot.

ND - Not Detected at or above adjusted reporting limit.

J - Estimated concentration above the adjusted method detection limit and below the adjusted reporting limit.

MDL - Adjusted Method Detection Limit.

PQL - Practical Quantitation Limit.

RL - Reporting Limit.

S - Surrogate

1,2-Diphenylhydrazine decomposes to and cannot be separated from Azobenzene using Method 8270. The result for each analyte is a combined concentration.

Consistent with EPA guidelines, unrounded data are displayed and have been used to calculate % recovery and RPD values.

LCS(D) - Laboratory Control Sample (Duplicate)

MS(D) - Matrix Spike (Duplicate)

DUP - Sample Duplicate

RPD - Relative Percent Difference

NC - Not Calculable.

SG - Silica Gel - Clean-Up

U - Indicates the compound was analyzed for, but not detected.

N-Nitrosodiphenylamine decomposes and cannot be separated from Diphenylamine using Method 8270. The result reported for each analyte is a combined concentration.

Pace Analytical is TNI accredited. Contact your Pace PM for the current list of accredited analytes.

TNI - The NELAC Institute.

LABORATORIES

PASI-DUL	Pace Analytical Services - Duluth
PASI-M	Pace Analytical Services - Minneapolis
PASI-V	Pace Analytical Services - Virginia

BATCH QUALIFIERS

Batch: 446601

[M5]	A matrix spike/matrix spike duplicate was not performed for this batch due to insufficient sample volume.

ANALYTE QUALIFIERS

D6	The precision between the sample and sample duplicate exceeded laboratory control limits.
E	Analyte concentration exceeded the calibration range. The reported result is estimated.
H6	Analysis initiated outside of the 15 minute EPA required holding time.
M1	Matrix spike recovery exceeded QC limits. Batch accepted based on laboratory control sample (LCS) recovery.

QUALITY CONTROL DATA CROSS REFERENCE TABLE

Project: Camp Ripley MMLF
Pace Project No.: 1278223

Lab ID	Sample ID	QC Batch Method	QC Batch	Analytical Method	Analytical Batch
1278223001	**MW-3**	EPA 350.1	99747	EPA 350.1 rev. 2 (1993)	99827
1278223002	**MW-7**	EPA 350.1	99747	EPA 350.1 rev. 2 (1993)	99827
1278223003	**MW-8**	EPA 350.1	99747	EPA 350.1 rev. 2 (1993)	99827
1278223004	**FLD DUP**	EPA 350.1	99748	EPA 350.1 rev. 2 (1993)	99828
1278223005	**Equip Blank**	EPA 350.1	99748	EPA 350.1 rev. 2 (1993)	99828
1278223001	**MW-3**	EPA 353.2 rev. 2 (1993)	99840		
1278223002	**MW-7**	EPA 353.2 rev. 2 (1993)	99840		
1278223003	**MW-8**	EPA 353.2 rev. 2 (1993)	99840		
1278223004	**FLD DUP**	EPA 353.2 rev. 2 (1993)	99840		
1278223005	**Equip Blank**	EPA 353.2 rev. 2 (1993)	99840		
1278223001	**MW-3**	EPA 200.7	99412	EPA 200.7	99477
1278223002	**MW-7**	EPA 200.7	99412	EPA 200.7	99477
1278223003	**MW-8**	EPA 200.7	99412	EPA 200.7	99477
1278223004	**FLD DUP**	EPA 200.7	99412	EPA 200.7	99477
1278223005	**Equip Blank**	EPA 200.7	99412	EPA 200.7	99477
1278223001	**MW-3**	EPA 200.8	99411	EPA 200.8	99476
1278223002	**MW-7**	EPA 200.8	99411	EPA 200.8	99476
1278223003	**MW-8**	EPA 200.8	99411	EPA 200.8	99476
1278223004	**FLD DUP**	EPA 200.8	99411	EPA 200.8	99476
1278223005	**Equip Blank**	EPA 200.8	99411	EPA 200.8	99476
1278223001	**MW-3**	EPA 7470	99825	EPA 7470	99849
1278223002	**MW-7**	EPA 7470	99825	EPA 7470	99849
1278223003	**MW-8**	EPA 7470	99825	EPA 7470	99849
1278223004	**FLD DUP**	EPA 7470	99825	EPA 7470	99849
1278223005	**Equip Blank**	EPA 7470	99825	EPA 7470	99849
1278223001	**MW-3**	EPA 8260B	446601		
1278223002	**MW-7**	EPA 8260B	446601		
1278223003	**MW-8**	EPA 8260B	446601		
1278223004	**FLD DUP**	EPA 8260B	446601		
1278223005	**Equip Blank**	EPA 8260B	446601		
1278223006	**Trip Blank**	EPA 8260B	446601		
1278223001	**MW-3**	SM 2320B	99424		
1278223002	**MW-7**	SM 2320B	99424		
1278223003	**MW-8**	SM 2320B	99424		
1278223004	**FLD DUP**	SM 2320B	99505		
1278223005	**Equip Blank**	SM 2320B	99505		
1278223001	**MW-3**	SM 2510B	99258		
1278223002	**MW-7**	SM 2510B	99258		
1278223003	**MW-8**	SM 2510B	99258		
1278223004	**FLD DUP**	SM 2510B	99258		
1278223005	**Equip Blank**	SM 2510B	99258		
1278223001	**MW-3**	SM 2540D (1997)	99273		
1278223002	**MW-7**	SM 2540D (1997)	99273		
1278223003	**MW-8**	SM 2540D (1997)	99273		

QUALITY CONTROL DATA CROSS REFERENCE TABLE

Project: Camp Ripley MMLF
Pace Project No.: 1278223

Lab ID	Sample ID	QC Batch Method	QC Batch	Analytical Method	Analytical Batch
1278223004	**FLD DUP**	SM 2540D (1997)	99273		
1278223005	**Equip Blank**	SM 2540D (1997)	99273		
1278223001	**MW-3**	SM 4500-H+B	99019		
1278223002	**MW-7**	SM 4500-H+B	99019		
1278223003	**MW-8**	SM 4500-H+B	99019		
1278223004	**FLD DUP**	SM 4500-H+B	99019		
1278223005	**Equip Blank**	SM 4500-H+B	99019		
1278223001	**MW-3**	EPA 300.0	99527		
1278223002	**MW-7**	EPA 300.0	99527		
1278223003	**MW-8**	EPA 300.0	99527		
1278223004	**FLD DUP**	EPA 300.0	99527		
1278223005	**Equip Blank**	EPA 300.0	99527		

CHAIN-OF-CUSTODY RECORD

WO#: 1278223
PM: MMW
Due Date: 11/16/16
CLIENT: WSN

Widseth Smith Nolting

ALEXANDRIA
610 Fillmore St.
Alexandria, MN 56308-1028
TEL: 320.762.8149
FAX: 320.762.0263

BEMIDJI
315 5th St. NW
Bemidji, MN 56601
TEL: 218.444.1859
FAX: 218.444.1860

BRAINERD/BAXTER
7804 Industrial Park Rd.
Baxter, MN 56425
TEL: 218.829.5117
FAX: 218.829.2517

Cro
TI
F

ENGINEERING ARCHITECTURE

PROJECT NUMBER 0283B0009.016

PROJECT NAME Camp Ripley MMLF

LOCATION Randall, MN

SAMPLERS: *(Signature)* MR

SAMPLERS: *(Print)* Michael Rogert

SAMPLE DESCRIPTION	DATE	TIME	COMP	GRAB	SAMPLE MATERIAL	NUMBER OF CONTAINERS	ANALYSES REQUEST: See Attached List	MDH 468 VOC				REMARKS
MW-3	10/31/16	13:35		X	H_2O	7	X					
MW-7	10/31/16	14:30		X	H_2O	7	X					
MW-8	10/31/16	15:20		X	H_2O	7	X					
FLD DUP	10/31/16	/		X	H_2O	7	X					
Equip Blank	10/31/16	13:40		X	H_2O	7	X					
Trip Blank	10/31/16	/		X	H_2O	2		X				

All Metals (HNO_3) Are Filtered

Relinquished by: *(Signature)* MR	Date / Time 11/1/16 15:00	Received by: *(Signature)*	Relinquished by: *(Signature)*	Date / Time	Received by: *(Signature)*
Relinquished by: *(Signature)*	Date / Time	Received for Laboratory by: *(Signature)*	Date / Time 11-2-16 10:30	Report To: Greg Smith	

SD

Bill To: WSN 0283B0009.016

Distribution: White – Accompanies Shipment; Pink – Project File; Yellow – Laboratory

T = 1.2

№ 6566

H:\OFFICE\FORMS\ENVIRO\Chain of Custody Record.doc

1,1,2-Trichloroethane
1,1,2-Trichlorotrifluoroethane
1,1-Dichloroethane
1,1-Dichloroethylene (Vinylidene chloride)
1,1-Dichloropropene
1,2-Dichloroethylene (trans)

Organics (con't.)

1,2-Dichloropropane
1,3,5-Trimethylbenzene
1,3-Dichlorobenzene (meta-)
1,3-Dichloropropane
1,3-Dichloropropene (cis + trans)
1,4-Dichlorobenzene (para-)
2,2-Dichloropropane
2-Chlorotoluene (ortho-)
4-Chlorotoluene (para-)
Acetone
Allyl chloride (3 chloropropene)
Benzene
Bromobenzene
Bromochloromethane (Chlorobromomethane)
Bromodichloromethane (Dichlorobromomethane)
Bromoform
Bromomethane (Methyl bromide)
Carbon tetrachloride
Chlorobenzene (monochlorobenzene)
Chlorodibromomethane (Dibromochloromethane)
Chloroethane
Chloroform
Chloromethane (Methyl chloride)
Cumene (Isopropylbenzene)
Dibromochloropropane (DBCP)
Dibromomethane (Methylene bromide)
Dichlorodifluoromethane
Dichlorofluoromethane
Dichloromethane (Methylene chloride)
Ethyl benzene
Ethyl ether
Hexachlorobutadiene
Methyl ethyl ketone (MEK)
Methyl isobutyl ketone (4-Methyl-2-pentanone)
Methyl tertiary-butyl ether (MTBE)
Naphthalene
1,2,4-Trimethylbenzene
1,2-Dibromoethane (Ethylene dibromide o EDB)
1,2-Dichlorobenzene (orth-)
1,2-Dichloroethane
1,2-Dichloroethylene (cis-)
n-Butyl benzene
n-Propyl benzene
p-Isopropyltoluene
sec-Butyl benzene
Styrene
tert-Butyl benzene
Tetrachloroethylene (Perchloroethylene)
Tetrahydrofuran
Toluene
Trichloroethylene (TCE)
Trichlorofluoromethane
Vinyl chloride (chloroethene)
Xylenes (mixture of o, m, p)

Inorganics

Alkalinity, total as calcium carbonate
Ammonia Nitrogen
Arsenic, dissolved
Barium, dissolved
Boron, dissolved
Cadmium, dissolved
Chloride
Chromium, total dissolved
Copper, dissolved
Iron, dissolved
Lead, dissolved
Manganese, dissolved
Mercury, dissolved
Nitrate + Nitrite, as N
Sodium, dissolved
Sulfate
Suspended Solids, total
Appearance (b);
Dissolved Oxygen, field
pH (a)
Specific Conductance (a)
Temperature (a)
Turbidity, field
Water Elevation

Parameter Lists for Sampling of Ground Water Monitoring Network

MDH 468 List (Organics)

Analytes

1,1,1,2-Tetrachloroethane
1,1,1-Trichloroethane
1,1,2,2-Tetrachloroethane
1,2,3-Trichlorobenzene
1,2,3-Trichloropropane
1,2,4-Trichlorobenzene

Pace Analytical	Document Name: Sample Condition Upon Receipt Form	Document Revised: 23Feb2015 Page 1 of 1
	Document No.: F-VM-C-001-Rev.09	Issuing Authority: Pace Virginia, Minnesota Quality Office

Sample Condition Upon Receipt

Client Name: Widseth Smith Nolting

Project #:

WO#: 1278223

1278223

Courier: ☐ Fed Ex ☐ UPS ☐ USPS ☐ Client ☐ Commercial ☐ Pace ☒ Other: Sd

Tracking Number:

Custody Seal on Cooler/Box Present? ☐ Yes ☒ No   Seals Intact? ☒ Yes ☐ No

Optional: Proj. Due Date: Proj. Name:

Packing Material: ☐ Bubble Wrap ☐ Bubble Bags ☐ None ☒ Other: Temp Blank? ☒ Yes ☐ No

Thermometer Used: ☒ 140792808   Type of Ice: ☐ Wet ☐ Blue ☐ None ☒ Samples on ice, cooling process has begun

Cooler Temp Read °C: 0.9   Cooler Temp Corrected °C: 1.2   Biological Tissue Frozen? ☐ Yes ☐ No ☒ NA

Temp should be above freezing to 6°C   Correction Factor: +0.3   Date and Initials of Person Examining Contents: 11-2-16

Comments:

Chain of Custody Present?	☒ Yes	☐ No	☐ N/A	1.
Chain of Custody Filled Out?	☒ Yes	☐ No	☐ N/A	2.
Chain of Custody Relinquished?	☒ Yes	☐ No	☐ N/A	3.
Sampler Name and Signature on COC?	☒ Yes	☐ No	☐ N/A	4.
Samples Arrived within Hold Time?	☒ Yes	☐ No	☐ N/A	5.
Short Hold Time Analysis (<72 hr)?	☒ Yes	☐ No	☐ N/A	6. PH
Rush Turn Around Time Requested?	☐ Yes	☐ No	☒ N/A	7.
Sufficient Volume?	☒ Yes	☐ No	☐ N/A	8.
Correct Containers Used?	☒ Yes	☐ No	☐ N/A	9.
-Pace Containers Used?	☒ Yes	☐ No	☐ N/A	
Containers Intact?	☒ Yes	☐ No	☐ N/A	10.
Filtered Volume Received for Dissolved Tests?	☒ Yes	☐ No	☐ N/A	11. Note if sediment is visible in the dissolved containers.
Sample Labels Match COC? -Includes Date/Time/ID/Analysis Matrix: WT	☐ Yes	☒ No	☐ N/A	12. Samples Don't Have Analysis on Them and Bottles Aren't marked FF.
All containers needing acid/base preservation will be checked and documented in the pH logbook.	☒ Yes	☐ No	☐ N/A	See pH log for results and additional preservation documentation
Headspace in Methyl Mercury Container	☐ Yes	☐ No	☒ N/A	13.
Headspace in VOA Vials (>6mm)?	☐ Yes	☒ No	☐ N/A	14.
Trip Blank Present?	☒ Yes	☐ No	☐ N/A	15.
Trip Blank Custody Seals Present?	☐ Yes	☐ No	☒ N/A	
Pace Trip Blank Lot # (if purchased):				

CLIENT NOTIFICATION/RESOLUTION   Field Data Required? ☐ Yes ☐ No

Person Contacted: Date/Time:

Comments/Resolution:

FECAL WAIVER ON FILE Y N   TEMPERATURE WAIVER ON FILE Y N

Project Manager Review: Date: 11/2/16

Note: Whenever there is a discrepancy affecting North Carolina compliance samples, a copy of this form will be sent to the North Carolina DEHNR Certification Office (i.e out of hold, incorrect preservative, out of temp, incorrect containers)

Intra-Regional Chain of Custody

Pace Analytical®
www.pacelabs.com

Workorder: 1278223 **Workorder Name:** Camp Ripley MMLF **Owner Received Date:** 11/2/2016 **Due Date:** 11/16/2016

Received at:
Pace Analytical Virginia
315 Chestnut Street
Virginia, MN 55792
Phone (218) 742-1042

Send To Lab:
Pace Analytical Duluth
4730 Oneota Street
Duluth, MN 55807
Phone (218) 727-6380

Report To:
Melisa M Woods

						Preserved Containers						Requested Analysis												
Item	Sample ID	Sample Type	Collect Date/Time	Lab ID	Matrix	H2SO4						EPA 350.1 rev. 2 (1993)	EPA 353.2 rev. 2 (1993)											LAB USE ONLY
1	MW-3	PS	10/31/2016 13:35	1278223001	Water	1						X	X											
2	MW-7	PS	10/31/2016 14:30	1278223002	Water	1						X	X											
3	MW-8	PS	10/31/2016 15:20	1278223003	Water	1						X	X											
4	FLD DUP	PS	10/31/2016 00:00	1278223004	Water	1						X	X											
5	Equip Blank	PS	10/31/2016 13:40	1278223005	Water	1						X	X											

Transfers	Released By	Date/Time	Received By	Date/Time
1	LC & CP	11/3/16 1400		11/3/16 1400
2		11/3/16 1530		11/3/16 1530
3				
4				

Comments

Cooler Temperature on Receipt 0.4 °C **Custody Seal** [✓ Y] or N **Received on Ice** [✓ Y] or N **Samples Intact** [✓ Y] or N

****In order to maintain client confidentiality, location/name of the sampling site, sampler's name and signature may not be provided on this COC document. This chain of custody is considered complete as is since this information is available in the owner laboratory.*

Pace Analytical	Document Name: Sample Condition Upon Receipt Form	Document Revised: 22Jan2016 Page 1 of 1
	Document No.: F-DUL-C-001-Rev.01	Issuing Authority: Pace Virginia, Minnesota Quality Office

mple Condition pon Receipt

Client Name: IR COC VIRG.

Project #:

Courier: ☐ Fed Ex ☐ UPS ☐ USPS ☐ Client ☐ Commercial ☒ Pace ☐ Other:

acking Number:

stody Seal on Cooler/Box Present? ☒ Yes ☐ No Seals Intact? ☒ Yes ☐ No

Optional: Proj. Due Date: Proj. Name:

cking Material: ☐ Bubble Wrap ☐ Bubble Bags ☒ None ☐ Other: Temp Blank? ☒ Yes ☐ No

rmometer Used: ☒ B00051 Type of Ice: ☒ Wet ☐ Blue ☐ None ☒ Samples on ice, cooling process has begun

ooler Temp Read °C: 1.0 Cooler Temp Corrected °C: 0.4 Biological Tissue Frozen? ☐ Yes ☐ No ☒ NA

np should be above freezing to 6°C Correction Factor: -0.6 °C Date and Initials of Person Examining Contents: RK 11/3/16

				Comments:
hain of Custody Present?	☒ Yes	☐ No	☐ N/A	1.
hain of Custody Filled Out?	☒ Yes	☐ No	☐ N/A	2.
hain of Custody Relinquished?	☒ Yes	☐ No	☐ N/A	3.
ampler Name and Signature on COC?	☐ Yes	☐ No	☒ N/A	4.
amples Arrived within Hold Time?	☒ Yes	☐ No	☐ N/A	5.
hort Hold Time Analysis (<72 hr)?	☐ Yes	☒ No	☐ N/A	6.
ush Turn Around Time Requested?	☐ Yes	☒ No	☐ N/A	7.
ufficient Volume?	☒ Yes	☐ No	☐ N/A	8.
orrect Containers Used?	☒ Yes	☐ No	☐ N/A	9.
-Pace Containers Used?	☒ Yes	☐ No	☐ N/A	
ontainers Intact?	☒ Yes	☐ No	☐ N/A	10.
iltered Volume Received for Dissolved Tests?	☐ Yes	☐ No	☒ N/A	11. Note if sediment is visible in the dissolved containers.
ample Labels Match COC?	☒ Yes	☐ No	☐ N/A	12.
-Includes Date/Time/ID/Analysis Matrix: wt.				
ll containers needing acid/base preservation will be hecked and documented in the pH logbook.	☒ Yes	☐ No	~~☒ N/A~~ 11/3/16 RK	See pH log for results and additional preservation documentation
eadspace in Methyl Mercury Container	☐ Yes	☐ No	☒ N/A	13.
eadspace in VOA Vials (>6mm)?	☐ Yes	☐ No	☒ N/A	14.
rip Blank Present?	☐ Yes	☐ No	☒ N/A	15.
rip Blank Custody Seals Present?	☐ Yes	☐ No	☒ N/A	
ace Trip Blank Lot # (if purchased):				

IENT NOTIFICATION/RESOLUTION

Field Data Required? ☐ Yes ☐ No

Person Contacted: Date/Time:

Comments/Resolution:

ECAL WAIVER ON FILE Y N TEMPERATURE WAIVER ON FILE Y N

roject Manager Review: AP for LMF Date: 11-3-16

te: Whenever there is a discrepancy affecting North Carolina compliance samples, a copy of this form will be sent to the North Carolina DEHNR Certification Office (i.e out of d, incorrect preservative, out of temp, incorrect containers)

Pace Analytical
www.pacelabs.com

Pace Analytical Services, LLC
315 Chestnut Street
Virginia, MN 55792
(218) 742-1042

November 15, 2016

Greg Smith
Widseth, Smith & Nolting
7804 Industrial Park Road
PO Box 2720
Baxter, MN 56425

RE: Project: Camp Ripley MMLF
Pace Project No.: 1278223

Dear Greg Smith:

Enclosed are the analytical results for sample(s) received by the laboratory on November 02, 2016. The results relate only to the samples included in this report. Results reported herein conform to the most current, applicable TNI/NELAC standards and the laboratory's Quality Assurance Manual, where applicable, unless otherwise noted in the body of the report.

If you have any questions concerning this report, please feel free to contact me.

Sincerely,

Melisa Woods

Melisa M Woods
melisa.woods@pacelabs.com
Project Manager

Enclosures

CERTIFICATIONS

Project: Camp Ripley MMLF
Pace Project No.: 1278223

Minnesota Certification IDs

1700 Elm Street SE Suite 200, Minneapolis, MN 55414
525 N 8th Street, Salina, KS 67401
Alaska Certification UST-107
A2LA Certification #: 2926.01
Alaska Certification #: UST-078
Alaska Certification #MN00064
Alabama Certification #40770
Arizona Certification #: AZ-0014
Arkansas Certification #: 88-0680
California Certification #: 01155CA
Colorado Certification #Pace
Connecticut Certification #: PH-0256
EPA Region 8 Certification #: 8TMS-L
Florida/NELAP Certification #: E87605
Guam Certification #:14-008r
Georgia Certification #: 959
Georgia EPD #: Pace
Idaho Certification #: MN00064
Hawaii Certification #MN00064
Illinois Certification #: 200011
Indiana Certification#C-MN-01
Iowa Certification #: 368
Kansas Certification #: E-10167
Kentucky Dept of Envi. Protection - DW #90062
Kentucky Dept of Envi. Protection - WW #:90062
Louisiana DEQ Certification #: 3086
Louisiana DHH #: LA140001
Maine Certification #: 2013011
Maryland Certification #: 322
Michigan DEPH Certification #: 9909
Minnesota Certification #: 027-053-137
Mississippi Certification #: Pace
Montana Certification #: MT0092
Nevada Certification #: MN_00064
Nebraska Certification #: Pace
New Jersey Certification #: MN-002
New York Certification #: 11647
North Carolina Certification #: 530
North Carolina State Public Health #: 27700
North Dakota Certification #: R-036
Ohio EPA #: 4150
Ohio VAP Certification #: CL101
Oklahoma Certification #: 9507
Oregon Certification #: MN200001
Oregon Certification #: MN300001
Pennsylvania Certification #: 68-00563
Puerto Rico Certification
Saipan (CNMI) #:MP0003
South Carolina #:74003001
Texas Certification #: T104704192
Tennessee Certification #: 02818
Utah Certification #: MN000642013-4
Virginia DGS Certification #: 251
Virginia/VELAP Certification #: Pace
Washington Certification #: C486
West Virginia Certification #: 382
West Virginia DHHR #:9952C
Wisconsin Certification #: 999407970

Virginia Minnesota Certification ID's

315 Chestnut Street, Virginia, MN 55792
Alaska Certification UST-107
Alaska Certification UST-107
Alaska Certification #MN01084
Arizona Department of Health Certification #AZ0785
Minnesota Dept of Health Certification #: 027-137-445
North Dakota Certification: # R-203
Wisconsin DNR Certification # : 998027470
WA Department of Ecology Lab ID# C1007
Nevada DNR #MN010842015-1
Oklahoma Department of Environmental Quality

Duluth Minnesota Cerification ID's

4730 Oneota St., Duluth, MN 55807
Minnesota Dept of Health Certification #: 027-137-152
Wisconsin DNR Certification # : 999446800
North Dakota Certification #: R-105

SAMPLE SUMMARY

Project: Camp Ripley MMLF
Pace Project No.: 1278223

Lab ID	Sample ID	Matrix	Date Collected	Date Received
1278223001	**MW-3**	Water	10/31/16 13:35	11/02/16 10:30
1278223002	**MW-7**	Water	10/31/16 14:30	11/02/16 10:30
1278223003	**MW-8**	Water	10/31/16 15:20	11/02/16 10:30
1278223004	**FLD DUP**	Water	10/31/16 00:00	11/02/16 10:30
1278223005	**Equip Blank**	Water	10/31/16 13:40	11/02/16 10:30
1278223006	**Trip Blank**	Water	10/31/16 00:00	11/02/16 10:30

SAMPLE ANALYTE COUNT

Project: Camp Ripley MMLF
Pace Project No.: 1278223

Lab ID	Sample ID	Method	Analysts	Analytes Reported	Laboratory
1278223001	**MW-3**	EPA 350.1 rev. 2 (1993)	KJD	1	PASI-DUL
		EPA 353.2 rev. 2 (1993)	TMW	1	PASI-DUL
		EPA 200.7	CSD	7	PASI-V
		EPA 200.8	KRV	3	PASI-V
		EPA 7470	MAR	1	PASI-V
		EPA 8260B	DJB	72	PASI-M
		SM 2320B	BEM	1	PASI-V
		SM 2510B	JJH	1	PASI-V
		SM 2540D (1997)	BEM	1	PASI-V
		SM 4500-H+B	JJH	1	PASI-V
		EPA 300.0	DMB	2	PASI-V
1278223002	**MW-7**	EPA 350.1 rev. 2 (1993)	KJD	1	PASI-DUL
		EPA 353.2 rev. 2 (1993)	TMW	1	PASI-DUL
		EPA 200.7	CSD	7	PASI-V
		EPA 200.8	KRV	3	PASI-V
		EPA 7470	MAR	1	PASI-V
		EPA 8260B	DJB	72	PASI-M
		SM 2320B	BEM	1	PASI-V
		SM 2510B	JJH	1	PASI-V
		SM 2540D (1997)	BEM	1	PASI-V
		SM 4500-H+B	JJH	1	PASI-V
		EPA 300.0	DMB	2	PASI-V
1278223003	**MW-8**	EPA 350.1 rev. 2 (1993)	KJD	1	PASI-DUL
		EPA 353.2 rev. 2 (1993)	TMW	1	PASI-DUL
		EPA 200.7	CSD	7	PASI-V
		EPA 200.8	KRV	3	PASI-V
		EPA 7470	MAR	1	PASI-V
		EPA 8260B	DJB	72	PASI-M
		SM 2320B	BEM	1	PASI-V
		SM 2510B	JJH	1	PASI-V
		SM 2540D (1997)	BEM	1	PASI-V
		SM 4500-H+B	JJH	1	PASI-V
		EPA 300.0	DMB	2	PASI-V
1278223004	**FLD DUP**	EPA 350.1 rev. 2 (1993)	KJD	1	PASI-DUL
		EPA 353.2 rev. 2 (1993)	TMW	1	PASI-DUL
		EPA 200.7	CSD	7	PASI-V
		EPA 200.8	KRV	3	PASI-V

SAMPLE ANALYTE COUNT

Project: Camp Ripley MMLF
Pace Project No.: 1278223

Lab ID	Sample ID	Method	Analysts	Analytes Reported	Laboratory
		EPA 7470	MAR	1	PASI-V
		EPA 8260B	DJB	72	PASI-M
		SM 2320B	BEM	1	PASI-V
		SM 2510B	JJH	1	PASI-V
		SM 2540D (1997)	BEM	1	PASI-V
		SM 4500-H+B	JJH	1	PASI-V
		EPA 300.0	DMB	2	PASI-V
1278223005	**Equip Blank**	EPA 350.1 rev. 2 (1993)	KJD	1	PASI-DUL
		EPA 353.2 rev. 2 (1993)	TMW	1	PASI-DUL
		EPA 200.7	CSD	7	PASI-V
		EPA 200.8	KRV	3	PASI-V
		EPA 7470	MAR	1	PASI-V
		EPA 8260B	DJB	72	PASI-M
		SM 2320B	BEM	1	PASI-V
		SM 2510B	JJH	1	PASI-V
		SM 2540D (1997)	BEM	1	PASI-V
		SM 4500-H+B	JJH	1	PASI-V
		EPA 300.0	DMB	2	PASI-V
1278223006	**Trip Blank**	EPA 8260B	DJB	72	PASI-M

ANALYTICAL RESULTS

Project: Camp Ripley MMLF
Pace Project No.: 1278223

Sample: MW-3 **Lab ID: 1278223001** Collected: 10/31/16 13:35 Received: 11/02/16 10:30 Matrix: Water

Parameters	Results	Units	Report Limit	DF	Prepared	Analyzed	CAS No.	Qual
350.1 Ammonia	Analytical Method: EPA 350.1 rev. 2 (1993) Preparation Method: EPA 350.1							
Nitrogen, Ammonia	ND	mg/L	0.10	1	11/10/16 10:28	11/10/16 14:00	7664-41-7	
353.2 Nitrate + Nitrite pres.	Analytical Method: EPA 353.2 rev. 2 (1993)							
Nitrogen, NO2 plus NO3	**0.24**	mg/L	0.020	1		11/11/16 14:47		
200.7 MET ICP, Dissolved	Analytical Method: EPA 200.7 Preparation Method: EPA 200.7							
Barium, Dissolved	**23.6**	ug/L	10.0	1	11/07/16 16:01	11/08/16 11:26	7440-39-3	
Boron, Dissolved	ND	ug/L	100	1	11/07/16 16:01	11/08/16 11:26	7440-42-8	
Chromium, Dissolved	ND	ug/L	10.0	1	11/07/16 16:01	11/08/16 11:26	7440-47-3	
Copper, Dissolved	ND	ug/L	10.0	1	11/07/16 16:01	11/08/16 11:26	7440-50-8	
Iron, Dissolved	ND	ug/L	50.0	1	11/07/16 16:01	11/08/16 11:26	7439-89-6	
Manganese, Dissolved	**62.9**	ug/L	10.0	1	11/07/16 16:01	11/08/16 11:26	7439-96-5	
Sodium, Dissolved	**2.8**	mg/L	0.50	1	11/07/16 16:01	11/08/16 11:26	7440-23-5	
200.8 MET ICPMS, Dissolved	Analytical Method: EPA 200.8 Preparation Method: EPA 200.8							
Arsenic, Dissolved	**1.8**	ug/L	1.0	2	11/07/16 16:01	11/09/16 13:17	7440-38-2	
Cadmium, Dissolved	ND	ug/L	0.40	2	11/07/16 16:01	11/08/16 18:47	7440-43-9	
Lead, Dissolved	ND	ug/L	1.0	2	11/07/16 16:01	11/08/16 18:47	7439-92-1	
7470 Mercury, Dissolved	Analytical Method: EPA 7470 Preparation Method: EPA 7470							
Mercury, Dissolved	ND	ug/L	0.20	1	11/10/16 15:50	11/14/16 09:48	7439-97-6	
8260B MSV Low Level	Analytical Method: EPA 8260B							
Acetone	ND	ug/L	20.0	1		11/11/16 20:03	67-64-1	
Allyl chloride	ND	ug/L	4.0	1		11/11/16 20:03	107-05-1	
Benzene	ND	ug/L	0.50	1		11/11/16 20:03	71-43-2	
Bromobenzene	ND	ug/L	0.50	1		11/11/16 20:03	108-86-1	
Bromochloromethane	ND	ug/L	1.0	1		11/11/16 20:03	74-97-5	
Bromodichloromethane	ND	ug/L	1.0	1		11/11/16 20:03	75-27-4	
Bromoform	ND	ug/L	4.0	1		11/11/16 20:03	75-25-2	
Bromomethane	ND	ug/L	4.0	1		11/11/16 20:03	74-83-9	
2-Butanone (MEK)	ND	ug/L	5.0	1		11/11/16 20:03	78-93-3	
n-Butylbenzene	ND	ug/L	0.50	1		11/11/16 20:03	104-51-8	
sec-Butylbenzene	ND	ug/L	0.50	1		11/11/16 20:03	135-98-8	
tert-Butylbenzene	ND	ug/L	0.50	1		11/11/16 20:03	98-06-6	
Carbon tetrachloride	ND	ug/L	1.0	1		11/11/16 20:03	56-23-5	
Chlorobenzene	ND	ug/L	0.50	1		11/11/16 20:03	108-90-7	
Chloroethane	ND	ug/L	1.0	1		11/11/16 20:03	75-00-3	
Chloroform	ND	ug/L	1.0	1		11/11/16 20:03	67-66-3	
Chloromethane	ND	ug/L	4.0	1		11/11/16 20:03	74-87-3	
2-Chlorotoluene	ND	ug/L	0.50	1		11/11/16 20:03	95-49-8	
4-Chlorotoluene	ND	ug/L	0.50	1		11/11/16 20:03	106-43-4	
1,2-Dibromo-3-chloropropane	ND	ug/L	10.0	1		11/11/16 20:03	96-12-8	
Dibromochloromethane	ND	ug/L	4.0	1		11/11/16 20:03	124-48-1	
1,2-Dibromoethane (EDB)	ND	ug/L	1.0	1		11/11/16 20:03	106-93-4	
Dibromomethane	ND	ug/L	1.0	1		11/11/16 20:03	74-95-3	

ANALYTICAL RESULTS

Project: Camp Ripley MMLF
Pace Project No.: 1278223

Sample: MW-3 **Lab ID: 1278223001** Collected: 10/31/16 13:35 Received: 11/02/16 10:30 Matrix: Water

Parameters	Results	Units	Report Limit	DF	Prepared	Analyzed	CAS No.	Qual
8260B MSV Low Level	Analytical Method: EPA 8260B							
1,2-Dichlorobenzene	ND	ug/L	0.50	1		11/11/16 20:03	95-50-1	
1,3-Dichlorobenzene	ND	ug/L	0.50	1		11/11/16 20:03	541-73-1	
1,4-Dichlorobenzene	ND	ug/L	0.50	1		11/11/16 20:03	106-46-7	
Dichlorodifluoromethane	ND	ug/L	1.0	1		11/11/16 20:03	75-71-8	
1,1-Dichloroethane	ND	ug/L	0.50	1		11/11/16 20:03	75-34-3	
1,2-Dichloroethane	ND	ug/L	0.50	1		11/11/16 20:03	107-06-2	
1,1-Dichloroethene	ND	ug/L	0.50	1		11/11/16 20:03	75-35-4	
cis-1,2-Dichloroethene	ND	ug/L	0.50	1		11/11/16 20:03	156-59-2	
trans-1,2-Dichloroethene	ND	ug/L	0.50	1		11/11/16 20:03	156-60-5	
Dichlorofluoromethane	ND	ug/L	1.0	1		11/11/16 20:03	75-43-4	
1,2-Dichloropropane	ND	ug/L	4.0	1		11/11/16 20:03	78-87-5	
1,3-Dichloropropane	ND	ug/L	0.50	1		11/11/16 20:03	142-28-9	
2,2-Dichloropropane	ND	ug/L	1.0	1		11/11/16 20:03	594-20-7	
1,1-Dichloropropene	ND	ug/L	0.50	1		11/11/16 20:03	563-58-6	
cis-1,3-Dichloropropene	ND	ug/L	0.50	1		11/11/16 20:03	10061-01-5	
trans-1,3-Dichloropropene	ND	ug/L	1.0	1		11/11/16 20:03	10061-02-6	
Diethyl ether (Ethyl ether)	ND	ug/L	4.0	1		11/11/16 20:03	60-29-7	
Ethylbenzene	ND	ug/L	0.50	1		11/11/16 20:03	100-41-4	
Hexachloro-1,3-butadiene	ND	ug/L	4.0	1		11/11/16 20:03	87-68-3	
Isopropylbenzene (Cumene)	ND	ug/L	0.50	1		11/11/16 20:03	98-82-8	
p-Isopropyltoluene	ND	ug/L	0.50	1		11/11/16 20:03	99-87-6	
Methylene Chloride	ND	ug/L	4.0	1		11/11/16 20:03	75-09-2	
4-Methyl-2-pentanone (MIBK)	ND	ug/L	5.0	1		11/11/16 20:03	108-10-1	
Methyl-tert-butyl ether	ND	ug/L	0.50	1		11/11/16 20:03	1634-04-4	
Naphthalene	ND	ug/L	1.0	1		11/11/16 20:03	91-20-3	
n-Propylbenzene	ND	ug/L	0.50	1		11/11/16 20:03	103-65-1	
Styrene	ND	ug/L	0.50	1		11/11/16 20:03	100-42-5	
1,1,1,2-Tetrachloroethane	ND	ug/L	1.0	1		11/11/16 20:03	630-20-6	
1,1,2,2-Tetrachloroethane	ND	ug/L	0.50	1		11/11/16 20:03	79-34-5	
Tetrachloroethene	ND	ug/L	0.50	1		11/11/16 20:03	127-18-4	
Tetrahydrofuran	ND	ug/L	10.0	1		11/11/16 20:03	109-99-9	
Toluene	ND	ug/L	0.50	1		11/11/16 20:03	108-88-3	
1,2,3-Trichlorobenzene	ND	ug/L	0.50	1		11/11/16 20:03	87-61-6	
1,2,4-Trichlorobenzene	ND	ug/L	0.50	1		11/11/16 20:03	120-82-1	
1,1,1-Trichloroethane	ND	ug/L	0.50	1		11/11/16 20:03	71-55-6	
1,1,2-Trichloroethane	ND	ug/L	0.50	1		11/11/16 20:03	79-00-5	
Trichloroethene	ND	ug/L	0.40	1		11/11/16 20:03	79-01-6	
Trichlorofluoromethane	ND	ug/L	0.50	1		11/11/16 20:03	75-69-4	
1,2,3-Trichloropropane	ND	ug/L	4.0	1		11/11/16 20:03	96-18-4	
1,1,2-Trichlorotrifluoroethane	ND	ug/L	1.0	1		11/11/16 20:03	76-13-1	
1,2,4-Trimethylbenzene	ND	ug/L	0.50	1		11/11/16 20:03	95-63-6	
1,3,5-Trimethylbenzene	ND	ug/L	0.50	1		11/11/16 20:03	108-67-8	
Vinyl chloride	ND	ug/L	0.20	1		11/11/16 20:03	75-01-4	
Xylene (Total)	ND	ug/L	1.5	1		11/11/16 20:03	1330-20-7	
m&p-Xylene	ND	ug/L	1.0	1		11/11/16 20:03	179601-23-1	
o-Xylene	ND	ug/L	0.50	1		11/11/16 20:03	95-47-6	

ANALYTICAL RESULTS

Project: Camp Ripley MMLF
Pace Project No.: 1278223

Sample: MW-3 **Lab ID: 1278223001** Collected: 10/31/16 13:35 Received: 11/02/16 10:30 Matrix: Water

Parameters	Results	Units	Report Limit	DF	Prepared	Analyzed	CAS No.	Qual
8260B MSV Low Level	Analytical Method: EPA 8260B							
Surrogates								
1,2-Dichloroethane-d4 (S)	103	%.	75-125	1		11/11/16 20:03	17060-07-0	
Toluene-d8 (S)	98	%.	75-125	1		11/11/16 20:03	2037-26-5	
4-Bromofluorobenzene (S)	100	%.	75-125	1		11/11/16 20:03	460-00-4	
2320B Alkalinity	Analytical Method: SM 2320B							
Alkalinity, Total as CaCO3	**104**	mg/L	5.0	1		11/07/16 17:32		
2510B Specific Conductance	Analytical Method: SM 2510B							
Specific Conductance	**227**	umhos/cm	10.0	1		11/04/16 09:46		
2540D Total Suspended Solids	Analytical Method: SM 2540D (1997)							
Total Suspended Solids	**34.6**	mg/L	2.0	1		11/04/16 10:49		
4500H+ pH, Electrometric	Analytical Method: SM 4500-H+B							
pH at 25 Degrees C	**8.0**	Std. Units	0.10	1		11/02/16 14:57		H6
300.0 IC Anions 28 Days	Analytical Method: EPA 300.0							
Chloride	ND	mg/L	1.0	1		11/08/16 16:50	16887-00-6	
Sulfate	**9.0**	mg/L	2.0	1		11/08/16 16:50	14808-79-8	

Sample: MW-7 **Lab ID: 1278223002** Collected: 10/31/16 14:30 Received: 11/02/16 10:30 Matrix: Water

Parameters	Results	Units	Report Limit	DF	Prepared	Analyzed	CAS No.	Qual
350.1 Ammonia	Analytical Method: EPA 350.1 rev. 2 (1993) Preparation Method: EPA 350.1							
Nitrogen, Ammonia	**0.78**	mg/L	0.10	1	11/10/16 10:28	11/10/16 14:01	7664-41-7	
353.2 Nitrate + Nitrite pres.	Analytical Method: EPA 353.2 rev. 2 (1993)							
Nitrogen, NO2 plus NO3	**1.3**	mg/L	0.040	2		11/11/16 15:27		
200.7 MET ICP, Dissolved	Analytical Method: EPA 200.7 Preparation Method: EPA 200.7							
Barium, Dissolved	**309**	ug/L	10.0	1	11/07/16 16:01	11/08/16 11:36	7440-39-3	
Boron, Dissolved	ND	ug/L	100	1	11/07/16 16:01	11/08/16 11:36	7440-42-8	
Chromium, Dissolved	ND	ug/L	10.0	1	11/07/16 16:01	11/08/16 11:36	7440-47-3	
Copper, Dissolved	ND	ug/L	10.0	1	11/07/16 16:01	11/08/16 11:36	7440-50-8	
Iron, Dissolved	ND	ug/L	50.0	1	11/07/16 16:01	11/08/16 11:36	7439-89-6	
Manganese, Dissolved	**593**	ug/L	10.0	1	11/07/16 16:01	11/08/16 11:36	7439-96-5	
Sodium, Dissolved	**6.1**	mg/L	0.50	1	11/07/16 16:01	11/08/16 11:36	7440-23-5	
200.8 MET ICPMS, Dissolved	Analytical Method: EPA 200.8 Preparation Method: EPA 200.8							
Arsenic, Dissolved	ND	ug/L	1.0	2	11/07/16 16:01	11/08/16 18:58	7440-38-2	
Cadmium, Dissolved	ND	ug/L	0.40	2	11/07/16 16:01	11/08/16 18:58	7440-43-9	
Lead, Dissolved	ND	ug/L	1.0	2	11/07/16 16:01	11/08/16 18:58	7439-92-1	

ANALYTICAL RESULTS

Project: Camp Ripley MMLF
Pace Project No.: 1278223

Sample: MW-7 **Lab ID: 1278223002** Collected: 10/31/16 14:30 Received: 11/02/16 10:30 Matrix: Water

Parameters	Results	Units	Report Limit	DF	Prepared	Analyzed	CAS No.	Qual
7470 Mercury, Dissolved	Analytical Method: EPA 7470 Preparation Method: EPA 7470							
Mercury, Dissolved	ND	ug/L	0.20	1	11/10/16 15:50	11/14/16 09:50	7439-97-6	
8260B MSV Low Level	Analytical Method: EPA 8260B							
Acetone	ND	ug/L	20.0	1		11/11/16 20:25	67-64-1	
Allyl chloride	ND	ug/L	4.0	1		11/11/16 20:25	107-05-1	
Benzene	ND	ug/L	0.50	1		11/11/16 20:25	71-43-2	
Bromobenzene	ND	ug/L	0.50	1		11/11/16 20:25	108-86-1	
Bromochloromethane	ND	ug/L	1.0	1		11/11/16 20:25	74-97-5	
Bromodichloromethane	ND	ug/L	1.0	1		11/11/16 20:25	75-27-4	
Bromoform	ND	ug/L	4.0	1		11/11/16 20:25	75-25-2	
Bromomethane	ND	ug/L	4.0	1		11/11/16 20:25	74-83-9	
2-Butanone (MEK)	ND	ug/L	5.0	1		11/11/16 20:25	78-93-3	
n-Butylbenzene	ND	ug/L	0.50	1		11/11/16 20:25	104-51-8	
sec-Butylbenzene	ND	ug/L	0.50	1		11/11/16 20:25	135-98-8	
tert-Butylbenzene	ND	ug/L	0.50	1		11/11/16 20:25	98-06-6	
Carbon tetrachloride	ND	ug/L	1.0	1		11/11/16 20:25	56-23-5	
Chlorobenzene	ND	ug/L	0.50	1		11/11/16 20:25	108-90-7	
Chloroethane	ND	ug/L	1.0	1		11/11/16 20:25	75-00-3	
Chloroform	ND	ug/L	1.0	1		11/11/16 20:25	67-66-3	
Chloromethane	ND	ug/L	4.0	1		11/11/16 20:25	74-87-3	
2-Chlorotoluene	ND	ug/L	0.50	1		11/11/16 20:25	95-49-8	
4-Chlorotoluene	ND	ug/L	0.50	1		11/11/16 20:25	106-43-4	
1,2-Dibromo-3-chloropropane	ND	ug/L	10.0	1		11/11/16 20:25	96-12-8	
Dibromochloromethane	ND	ug/L	4.0	1		11/11/16 20:25	124-48-1	
1,2-Dibromoethane (EDB)	ND	ug/L	1.0	1		11/11/16 20:25	106-93-4	
Dibromomethane	ND	ug/L	1.0	1		11/11/16 20:25	74-95-3	
1,2-Dichlorobenzene	ND	ug/L	0.50	1		11/11/16 20:25	95-50-1	
1,3-Dichlorobenzene	ND	ug/L	0.50	1		11/11/16 20:25	541-73-1	
1,4-Dichlorobenzene	ND	ug/L	0.50	1		11/11/16 20:25	106-46-7	
Dichlorodifluoromethane	ND	ug/L	1.0	1		11/11/16 20:25	75-71-8	
1,1-Dichloroethane	ND	ug/L	0.50	1		11/11/16 20:25	75-34-3	
1,2-Dichloroethane	ND	ug/L	0.50	1		11/11/16 20:25	107-06-2	
1,1-Dichloroethene	ND	ug/L	0.50	1		11/11/16 20:25	75-35-4	
cis-1,2-Dichloroethene	**3.8**	ug/L	0.50	1		11/11/16 20:25	156-59-2	
trans-1,2-Dichloroethene	ND	ug/L	0.50	1		11/11/16 20:25	156-60-5	
Dichlorofluoromethane	ND	ug/L	1.0	1		11/11/16 20:25	75-43-4	
1,2-Dichloropropane	ND	ug/L	4.0	1		11/11/16 20:25	78-87-5	
1,3-Dichloropropane	ND	ug/L	0.50	1		11/11/16 20:25	142-28-9	
2,2-Dichloropropane	ND	ug/L	1.0	1		11/11/16 20:25	594-20-7	
1,1-Dichloropropene	ND	ug/L	0.50	1		11/11/16 20:25	563-58-6	
cis-1,3-Dichloropropene	ND	ug/L	0.50	1		11/11/16 20:25	10061-01-5	
trans-1,3-Dichloropropene	ND	ug/L	1.0	1		11/11/16 20:25	10061-02-6	
Diethyl ether (Ethyl ether)	**6.9**	ug/L	4.0	1		11/11/16 20:25	60-29-7	
Ethylbenzene	ND	ug/L	0.50	1		11/11/16 20:25	100-41-4	
Hexachloro-1,3-butadiene	ND	ug/L	4.0	1		11/11/16 20:25	87-68-3	
Isopropylbenzene (Cumene)	ND	ug/L	0.50	1		11/11/16 20:25	98-82-8	
p-Isopropyltoluene	ND	ug/L	0.50	1		11/11/16 20:25	99-87-6	

ANALYTICAL RESULTS

Project: Camp Ripley MMLF
Pace Project No.: 1278223

Sample: MW-7 **Lab ID: 1278223002** Collected: 10/31/16 14:30 Received: 11/02/16 10:30 Matrix: Water

Parameters	Results	Units	Report Limit	DF	Prepared	Analyzed	CAS No.	Qual
8260B MSV Low Level	Analytical Method: EPA 8260B							
Methylene Chloride	ND	ug/L	4.0	1		11/11/16 20:25	75-09-2	
4-Methyl-2-pentanone (MIBK)	ND	ug/L	5.0	1		11/11/16 20:25	108-10-1	
Methyl-tert-butyl ether	ND	ug/L	0.50	1		11/11/16 20:25	1634-04-4	
Naphthalene	ND	ug/L	1.0	1		11/11/16 20:25	91-20-3	
n-Propylbenzene	ND	ug/L	0.50	1		11/11/16 20:25	103-65-1	
Styrene	ND	ug/L	0.50	1		11/11/16 20:25	100-42-5	
1,1,1,2-Tetrachloroethane	ND	ug/L	1.0	1		11/11/16 20:25	630-20-6	
1,1,2,2-Tetrachloroethane	ND	ug/L	0.50	1		11/11/16 20:25	79-34-5	
Tetrachloroethene	ND	ug/L	0.50	1		11/11/16 20:25	127-18-4	
Tetrahydrofuran	ND	ug/L	10.0	1		11/11/16 20:25	109-99-9	
Toluene	ND	ug/L	0.50	1		11/11/16 20:25	108-88-3	
1,2,3-Trichlorobenzene	ND	ug/L	0.50	1		11/11/16 20:25	87-61-6	
1,2,4-Trichlorobenzene	ND	ug/L	0.50	1		11/11/16 20:25	120-82-1	
1,1,1-Trichloroethane	ND	ug/L	0.50	1		11/11/16 20:25	71-55-6	
1,1,2-Trichloroethane	ND	ug/L	0.50	1		11/11/16 20:25	79-00-5	
Trichloroethene	ND	ug/L	0.40	1		11/11/16 20:25	79-01-6	
Trichlorofluoromethane	ND	ug/L	0.50	1		11/11/16 20:25	75-69-4	
1,2,3-Trichloropropane	ND	ug/L	4.0	1		11/11/16 20:25	96-18-4	
1,1,2-Trichlorotrifluoroethane	ND	ug/L	1.0	1		11/11/16 20:25	76-13-1	
1,2,4-Trimethylbenzene	ND	ug/L	0.50	1		11/11/16 20:25	95-63-6	
1,3,5-Trimethylbenzene	ND	ug/L	0.50	1		11/11/16 20:25	108-67-8	
Vinyl chloride	ND	ug/L	0.20	1		11/11/16 20:25	75-01-4	
Xylene (Total)	ND	ug/L	1.5	1		11/11/16 20:25	1330-20-7	
m&p-Xylene	ND	ug/L	1.0	1		11/11/16 20:25	179601-23-1	
o-Xylene	ND	ug/L	0.50	1		11/11/16 20:25	95-47-6	
Surrogates								
1,2-Dichloroethane-d4 (S)	108	%.	75-125	1		11/11/16 20:25	17060-07-0	
Toluene-d8 (S)	100	%.	75-125	1		11/11/16 20:25	2037-26-5	
4-Bromofluorobenzene (S)	101	%.	75-125	1		11/11/16 20:25	460-00-4	
2320B Alkalinity	Analytical Method: SM 2320B							
Alkalinity, Total as CaCO3	**389**	mg/L	5.0	1		11/07/16 17:40		
2510B Specific Conductance	Analytical Method: SM 2510B							
Specific Conductance	**817**	umhos/cm	10.0	1		11/04/16 09:54		
2540D Total Suspended Solids	Analytical Method: SM 2540D (1997)							
Total Suspended Solids	**5.2**	mg/L	2.0	1		11/04/16 10:49		
4500H+ pH, Electrometric	Analytical Method: SM 4500-H+B							
pH at 25 Degrees C	**7.5**	Std. Units	0.10	1		11/02/16 15:00		H6
300.0 IC Anions 28 Days	Analytical Method: EPA 300.0							
Chloride	**21.1**	mg/L	1.0	1		11/08/16 17:12	16887-00-6	
Sulfate	**4.0**	mg/L	2.0	1		11/08/16 17:12	14808-79-8	

ANALYTICAL RESULTS

Project: Camp Ripley MMLF
Pace Project No.: 1278223

Sample: MW-8 **Lab ID: 1278223003** Collected: 10/31/16 15:20 Received: 11/02/16 10:30 Matrix: Water

Parameters	Results	Units	Report Limit	DF	Prepared	Analyzed	CAS No.	Qual
350.1 Ammonia	Analytical Method: EPA 350.1 rev. 2 (1993) Preparation Method: EPA 350.1							
Nitrogen, Ammonia	ND	mg/L	0.10	1	11/10/16 10:28	11/10/16 14:02	7664-41-7	
353.2 Nitrate + Nitrite pres.	Analytical Method: EPA 353.2 rev. 2 (1993)							
Nitrogen, NO2 plus NO3	**1.8**	mg/L	0.10	5		11/11/16 15:28		
200.7 MET ICP, Dissolved	Analytical Method: EPA 200.7 Preparation Method: EPA 200.7							
Barium, Dissolved	**50.1**	ug/L	10.0	1	11/07/16 16:01	11/08/16 11:40	7440-39-3	
Boron, Dissolved	ND	ug/L	100	1	11/07/16 16:01	11/08/16 11:40	7440-42-8	
Chromium, Dissolved	ND	ug/L	10.0	1	11/07/16 16:01	11/08/16 11:40	7440-47-3	
Copper, Dissolved	ND	ug/L	10.0	1	11/07/16 16:01	11/08/16 11:40	7440-50-8	
Iron, Dissolved	ND	ug/L	50.0	1	11/07/16 16:01	11/08/16 11:40	7439-89-6	
Manganese, Dissolved	ND	ug/L	10.0	1	11/07/16 16:01	11/08/16 11:40	7439-96-5	
Sodium, Dissolved	**3.0**	mg/L	0.50	1	11/07/16 16:01	11/08/16 11:40	7440-23-5	
200.8 MET ICPMS, Dissolved	Analytical Method: EPA 200.8 Preparation Method: EPA 200.8							
Arsenic, Dissolved	ND	ug/L	1.0	2	11/07/16 16:01	11/08/16 19:01	7440-38-2	
Cadmium, Dissolved	ND	ug/L	0.40	2	11/07/16 16:01	11/08/16 19:01	7440-43-9	
Lead, Dissolved	ND	ug/L	1.0	2	11/07/16 16:01	11/08/16 19:01	7439-92-1	
7470 Mercury, Dissolved	Analytical Method: EPA 7470 Preparation Method: EPA 7470							
Mercury, Dissolved	ND	ug/L	0.20	1	11/10/16 15:50	11/14/16 09:52	7439-97-6	
8260B MSV Low Level	Analytical Method: EPA 8260B							
Acetone	ND	ug/L	20.0	1		11/11/16 20:47	67-64-1	
Allyl chloride	ND	ug/L	4.0	1		11/11/16 20:47	107-05-1	
Benzene	ND	ug/L	0.50	1		11/11/16 20:47	71-43-2	
Bromobenzene	ND	ug/L	0.50	1		11/11/16 20:47	108-86-1	
Bromochloromethane	ND	ug/L	1.0	1		11/11/16 20:47	74-97-5	
Bromodichloromethane	ND	ug/L	1.0	1		11/11/16 20:47	75-27-4	
Bromoform	ND	ug/L	4.0	1		11/11/16 20:47	75-25-2	
Bromomethane	ND	ug/L	4.0	1		11/11/16 20:47	74-83-9	
2-Butanone (MEK)	ND	ug/L	5.0	1		11/11/16 20:47	78-93-3	
n-Butylbenzene	ND	ug/L	0.50	1		11/11/16 20:47	104-51-8	
sec-Butylbenzene	ND	ug/L	0.50	1		11/11/16 20:47	135-98-8	
tert-Butylbenzene	ND	ug/L	0.50	1		11/11/16 20:47	98-06-6	
Carbon tetrachloride	ND	ug/L	1.0	1		11/11/16 20:47	56-23-5	
Chlorobenzene	ND	ug/L	0.50	1		11/11/16 20:47	108-90-7	
Chloroethane	ND	ug/L	1.0	1		11/11/16 20:47	75-00-3	
Chloroform	ND	ug/L	1.0	1		11/11/16 20:47	67-66-3	
Chloromethane	ND	ug/L	4.0	1		11/11/16 20:47	74-87-3	
2-Chlorotoluene	ND	ug/L	0.50	1		11/11/16 20:47	95-49-8	
4-Chlorotoluene	ND	ug/L	0.50	1		11/11/16 20:47	106-43-4	
1,2-Dibromo-3-chloropropane	ND	ug/L	10.0	1		11/11/16 20:47	96-12-8	
Dibromochloromethane	ND	ug/L	4.0	1		11/11/16 20:47	124-48-1	
1,2-Dibromoethane (EDB)	ND	ug/L	1.0	1		11/11/16 20:47	106-93-4	
Dibromomethane	ND	ug/L	1.0	1		11/11/16 20:47	74-95-3	

ANALYTICAL RESULTS

Project: Camp Ripley MMLF
Pace Project No.: 1278223

Sample: MW-8 **Lab ID: 1278223003** Collected: 10/31/16 15:20 Received: 11/02/16 10:30 Matrix: Water

Parameters	Results	Units	Report Limit	DF	Prepared	Analyzed	CAS No.	Qual
8260B MSV Low Level	Analytical Method: EPA 8260B							
1,2-Dichlorobenzene	ND	ug/L	0.50	1		11/11/16 20:47	95-50-1	
1,3-Dichlorobenzene	ND	ug/L	0.50	1		11/11/16 20:47	541-73-1	
1,4-Dichlorobenzene	ND	ug/L	0.50	1		11/11/16 20:47	106-46-7	
Dichlorodifluoromethane	ND	ug/L	1.0	1		11/11/16 20:47	75-71-8	
1,1-Dichloroethane	ND	ug/L	0.50	1		11/11/16 20:47	75-34-3	
1,2-Dichloroethane	ND	ug/L	0.50	1		11/11/16 20:47	107-06-2	
1,1-Dichloroethene	ND	ug/L	0.50	1		11/11/16 20:47	75-35-4	
cis-1,2-Dichloroethene	ND	ug/L	0.50	1		11/11/16 20:47	156-59-2	
trans-1,2-Dichloroethene	ND	ug/L	0.50	1		11/11/16 20:47	156-60-5	
Dichlorofluoromethane	ND	ug/L	1.0	1		11/11/16 20:47	75-43-4	
1,2-Dichloropropane	ND	ug/L	4.0	1		11/11/16 20:47	78-87-5	
1,3-Dichloropropane	ND	ug/L	0.50	1		11/11/16 20:47	142-28-9	
2,2-Dichloropropane	ND	ug/L	1.0	1		11/11/16 20:47	594-20-7	
1,1-Dichloropropene	ND	ug/L	0.50	1		11/11/16 20:47	563-58-6	
cis-1,3-Dichloropropene	ND	ug/L	0.50	1		11/11/16 20:47	10061-01-5	
trans-1,3-Dichloropropene	ND	ug/L	1.0	1		11/11/16 20:47	10061-02-6	
Diethyl ether (Ethyl ether)	ND	ug/L	4.0	1		11/11/16 20:47	60-29-7	
Ethylbenzene	ND	ug/L	0.50	1		11/11/16 20:47	100-41-4	
Hexachloro-1,3-butadiene	ND	ug/L	4.0	1		11/11/16 20:47	87-68-3	
Isopropylbenzene (Cumene)	ND	ug/L	0.50	1		11/11/16 20:47	98-82-8	
p-Isopropyltoluene	ND	ug/L	0.50	1		11/11/16 20:47	99-87-6	
Methylene Chloride	ND	ug/L	4.0	1		11/11/16 20:47	75-09-2	
4-Methyl-2-pentanone (MIBK)	ND	ug/L	5.0	1		11/11/16 20:47	108-10-1	
Methyl-tert-butyl ether	ND	ug/L	0.50	1		11/11/16 20:47	1634-04-4	
Naphthalene	ND	ug/L	1.0	1		11/11/16 20:47	91-20-3	
n-Propylbenzene	ND	ug/L	0.50	1		11/11/16 20:47	103-65-1	
Styrene	ND	ug/L	0.50	1		11/11/16 20:47	100-42-5	
1,1,1,2-Tetrachloroethane	ND	ug/L	1.0	1		11/11/16 20:47	630-20-6	
1,1,2,2-Tetrachloroethane	ND	ug/L	0.50	1		11/11/16 20:47	79-34-5	
Tetrachloroethene	ND	ug/L	0.50	1		11/11/16 20:47	127-18-4	
Tetrahydrofuran	ND	ug/L	10.0	1		11/11/16 20:47	109-99-9	
Toluene	ND	ug/L	0.50	1		11/11/16 20:47	108-88-3	
1,2,3-Trichlorobenzene	ND	ug/L	0.50	1		11/11/16 20:47	87-61-6	
1,2,4-Trichlorobenzene	ND	ug/L	0.50	1		11/11/16 20:47	120-82-1	
1,1,1-Trichloroethane	ND	ug/L	0.50	1		11/11/16 20:47	71-55-6	
1,1,2-Trichloroethane	ND	ug/L	0.50	1		11/11/16 20:47	79-00-5	
Trichloroethene	ND	ug/L	0.40	1		11/11/16 20:47	79-01-6	
Trichlorofluoromethane	ND	ug/L	0.50	1		11/11/16 20:47	75-69-4	
1,2,3-Trichloropropane	ND	ug/L	4.0	1		11/11/16 20:47	96-18-4	
1,1,2-Trichlorotrifluoroethane	ND	ug/L	1.0	1		11/11/16 20:47	76-13-1	
1,2,4-Trimethylbenzene	ND	ug/L	0.50	1		11/11/16 20:47	95-63-6	
1,3,5-Trimethylbenzene	ND	ug/L	0.50	1		11/11/16 20:47	108-67-8	
Vinyl chloride	ND	ug/L	0.20	1		11/11/16 20:47	75-01-4	
Xylene (Total)	ND	ug/L	1.5	1		11/11/16 20:47	1330-20-7	
m&p-Xylene	ND	ug/L	1.0	1		11/11/16 20:47	179601-23-1	
o-Xylene	ND	ug/L	0.50	1		11/11/16 20:47	95-47-6	

ANALYTICAL RESULTS

Project: Camp Ripley MMLF
Pace Project No.: 1278223

Sample: MW-8 **Lab ID: 1278223003** Collected: 10/31/16 15:20 Received: 11/02/16 10:30 Matrix: Water

Parameters	Results	Units	Report Limit	DF	Prepared	Analyzed	CAS No.	Qual
8260B MSV Low Level	Analytical Method: EPA 8260B							
Surrogates								
1,2-Dichloroethane-d4 (S)	104	%.	75-125	1		11/11/16 20:47	17060-07-0	
Toluene-d8 (S)	98	%.	75-125	1		11/11/16 20:47	2037-26-5	
4-Bromofluorobenzene (S)	98	%.	75-125	1		11/11/16 20:47	460-00-4	
2320B Alkalinity	Analytical Method: SM 2320B							
Alkalinity, Total as CaCO3	**240**	mg/L	5.0	1		11/07/16 17:48		
2510B Specific Conductance	Analytical Method: SM 2510B							
Specific Conductance	**591**	umhos/cm	10.0	1		11/04/16 09:47		
2540D Total Suspended Solids	Analytical Method: SM 2540D (1997)							
Total Suspended Solids	ND	mg/L	2.0	1		11/04/16 10:49		
4500H+ pH, Electrometric	Analytical Method: SM 4500-H+B							
pH at 25 Degrees C	**7.9**	Std. Units	0.10	1		11/02/16 15:03		H6
300.0 IC Anions 28 Days	Analytical Method: EPA 300.0							
Chloride	**25.9**	mg/L	1.0	1		11/08/16 17:35	16887-00-6	
Sulfate	**5.7**	mg/L	2.0	1		11/08/16 17:35	14808-79-8	

Sample: FLD DUP **Lab ID: 1278223004** Collected: 10/31/16 00:00 Received: 11/02/16 10:30 Matrix: Water

Parameters	Results	Units	Report Limit	DF	Prepared	Analyzed	CAS No.	Qual
350.1 Ammonia	Analytical Method: EPA 350.1 rev. 2 (1993) Preparation Method: EPA 350.1							
Nitrogen, Ammonia	**0.76**	mg/L	0.10	1	11/10/16 10:28	11/10/16 14:17	7664-41-7	
353.2 Nitrate + Nitrite pres.	Analytical Method: EPA 353.2 rev. 2 (1993)							
Nitrogen, NO2 plus NO3	**1.2**	mg/L	0.040	2		11/11/16 15:30		
200.7 MET ICP, Dissolved	Analytical Method: EPA 200.7 Preparation Method: EPA 200.7							
Barium, Dissolved	**307**	ug/L	10.0	1	11/07/16 16:01	11/08/16 11:43	7440-39-3	
Boron, Dissolved	ND	ug/L	100	1	11/07/16 16:01	11/08/16 11:43	7440-42-8	
Chromium, Dissolved	ND	ug/L	10.0	1	11/07/16 16:01	11/08/16 11:43	7440-47-3	
Copper, Dissolved	ND	ug/L	10.0	1	11/07/16 16:01	11/08/16 11:43	7440-50-8	
Iron, Dissolved	ND	ug/L	50.0	1	11/07/16 16:01	11/08/16 11:43	7439-89-6	
Manganese, Dissolved	**590**	ug/L	10.0	1	11/07/16 16:01	11/08/16 11:43	7439-96-5	
Sodium, Dissolved	**6.2**	mg/L	0.50	1	11/07/16 16:01	11/08/16 11:43	7440-23-5	
200.8 MET ICPMS, Dissolved	Analytical Method: EPA 200.8 Preparation Method: EPA 200.8							
Arsenic, Dissolved	ND	ug/L	1.0	2	11/07/16 16:01	11/08/16 19:05	7440-38-2	
Cadmium, Dissolved	ND	ug/L	0.40	2	11/07/16 16:01	11/08/16 19:05	7440-43-9	
Lead, Dissolved	ND	ug/L	1.0	2	11/07/16 16:01	11/08/16 19:05	7439-92-1	

ANALYTICAL RESULTS

Project: Camp Ripley MMLF
Pace Project No.: 1278223

Sample: FLD DUP **Lab ID: 1278223004** Collected: 10/31/16 00:00 Received: 11/02/16 10:30 Matrix: Water

Parameters	Results	Units	Report Limit	DF	Prepared	Analyzed	CAS No.	Qual
7470 Mercury, Dissolved	Analytical Method: EPA 7470 Preparation Method: EPA 7470							
Mercury, Dissolved	ND	ug/L	0.20	1	11/10/16 15:50	11/14/16 09:54	7439-97-6	
8260B MSV Low Level	Analytical Method: EPA 8260B							
Acetone	ND	ug/L	20.0	1		11/11/16 21:09	67-64-1	
Allyl chloride	ND	ug/L	4.0	1		11/11/16 21:09	107-05-1	
Benzene	ND	ug/L	0.50	1		11/11/16 21:09	71-43-2	
Bromobenzene	ND	ug/L	0.50	1		11/11/16 21:09	108-86-1	
Bromochloromethane	ND	ug/L	1.0	1		11/11/16 21:09	74-97-5	
Bromodichloromethane	ND	ug/L	1.0	1		11/11/16 21:09	75-27-4	
Bromoform	ND	ug/L	4.0	1		11/11/16 21:09	75-25-2	
Bromomethane	ND	ug/L	4.0	1		11/11/16 21:09	74-83-9	
2-Butanone (MEK)	ND	ug/L	5.0	1		11/11/16 21:09	78-93-3	
n-Butylbenzene	ND	ug/L	0.50	1		11/11/16 21:09	104-51-8	
sec-Butylbenzene	ND	ug/L	0.50	1		11/11/16 21:09	135-98-8	
tert-Butylbenzene	ND	ug/L	0.50	1		11/11/16 21:09	98-06-6	
Carbon tetrachloride	ND	ug/L	1.0	1		11/11/16 21:09	56-23-5	
Chlorobenzene	ND	ug/L	0.50	1		11/11/16 21:09	108-90-7	
Chloroethane	ND	ug/L	1.0	1		11/11/16 21:09	75-00-3	
Chloroform	ND	ug/L	1.0	1		11/11/16 21:09	67-66-3	
Chloromethane	ND	ug/L	4.0	1		11/11/16 21:09	74-87-3	
2-Chlorotoluene	ND	ug/L	0.50	1		11/11/16 21:09	95-49-8	
4-Chlorotoluene	ND	ug/L	0.50	1		11/11/16 21:09	106-43-4	
1,2-Dibromo-3-chloropropane	ND	ug/L	10.0	1		11/11/16 21:09	96-12-8	
Dibromochloromethane	ND	ug/L	4.0	1		11/11/16 21:09	124-48-1	
1,2-Dibromoethane (EDB)	ND	ug/L	1.0	1		11/11/16 21:09	106-93-4	
Dibromomethane	ND	ug/L	1.0	1		11/11/16 21:09	74-95-3	
1,2-Dichlorobenzene	ND	ug/L	0.50	1		11/11/16 21:09	95-50-1	
1,3-Dichlorobenzene	ND	ug/L	0.50	1		11/11/16 21:09	541-73-1	
1,4-Dichlorobenzene	ND	ug/L	0.50	1		11/11/16 21:09	106-46-7	
Dichlorodifluoromethane	ND	ug/L	1.0	1		11/11/16 21:09	75-71-8	
1,1-Dichloroethane	ND	ug/L	0.50	1		11/11/16 21:09	75-34-3	
1,2-Dichloroethane	ND	ug/L	0.50	1		11/11/16 21:09	107-06-2	
1,1-Dichloroethene	ND	ug/L	0.50	1		11/11/16 21:09	75-35-4	
cis-1,2-Dichloroethene	**3.6**	ug/L	0.50	1		11/11/16 21:09	156-59-2	
trans-1,2-Dichloroethene	ND	ug/L	0.50	1		11/11/16 21:09	156-60-5	
Dichlorofluoromethane	ND	ug/L	1.0	1		11/11/16 21:09	75-43-4	
1,2-Dichloropropane	ND	ug/L	4.0	1		11/11/16 21:09	78-87-5	
1,3-Dichloropropane	ND	ug/L	0.50	1		11/11/16 21:09	142-28-9	
2,2-Dichloropropane	ND	ug/L	1.0	1		11/11/16 21:09	594-20-7	
1,1-Dichloropropene	ND	ug/L	0.50	1		11/11/16 21:09	563-58-6	
cis-1,3-Dichloropropene	ND	ug/L	0.50	1		11/11/16 21:09	10061-01-5	
trans-1,3-Dichloropropene	ND	ug/L	1.0	1		11/11/16 21:09	10061-02-6	
Diethyl ether (Ethyl ether)	**6.5**	ug/L	4.0	1		11/11/16 21:09	60-29-7	
Ethylbenzene	ND	ug/L	0.50	1		11/11/16 21:09	100-41-4	
Hexachloro-1,3-butadiene	ND	ug/L	4.0	1		11/11/16 21:09	87-68-3	
Isopropylbenzene (Cumene)	ND	ug/L	0.50	1		11/11/16 21:09	98-82-8	
p-Isopropyltoluene	ND	ug/L	0.50	1		11/11/16 21:09	99-87-6	

ANALYTICAL RESULTS

Project: Camp Ripley MMLF
Pace Project No.: 1278223

Sample: FLD DUP **Lab ID: 1278223004** Collected: 10/31/16 00:00 Received: 11/02/16 10:30 Matrix: Water

Parameters	Results	Units	Report Limit	DF	Prepared	Analyzed	CAS No.	Qual
8260B MSV Low Level	Analytical Method: EPA 8260B							
Methylene Chloride	ND	ug/L	4.0	1		11/11/16 21:09	75-09-2	
4-Methyl-2-pentanone (MIBK)	ND	ug/L	5.0	1		11/11/16 21:09	108-10-1	
Methyl-tert-butyl ether	ND	ug/L	0.50	1		11/11/16 21:09	1634-04-4	
Naphthalene	ND	ug/L	1.0	1		11/11/16 21:09	91-20-3	
n-Propylbenzene	ND	ug/L	0.50	1		11/11/16 21:09	103-65-1	
Styrene	ND	ug/L	0.50	1		11/11/16 21:09	100-42-5	
1,1,1,2-Tetrachloroethane	ND	ug/L	1.0	1		11/11/16 21:09	630-20-6	
1,1,2,2-Tetrachloroethane	ND	ug/L	0.50	1		11/11/16 21:09	79-34-5	
Tetrachloroethene	ND	ug/L	0.50	1		11/11/16 21:09	127-18-4	
Tetrahydrofuran	ND	ug/L	10.0	1		11/11/16 21:09	109-99-9	
Toluene	ND	ug/L	0.50	1		11/11/16 21:09	108-88-3	
1,2,3-Trichlorobenzene	ND	ug/L	0.50	1		11/11/16 21:09	87-61-6	
1,2,4-Trichlorobenzene	ND	ug/L	0.50	1		11/11/16 21:09	120-82-1	
1,1,1-Trichloroethane	ND	ug/L	0.50	1		11/11/16 21:09	71-55-6	
1,1,2-Trichloroethane	ND	ug/L	0.50	1		11/11/16 21:09	79-00-5	
Trichloroethene	ND	ug/L	0.40	1		11/11/16 21:09	79-01-6	
Trichlorofluoromethane	ND	ug/L	0.50	1		11/11/16 21:09	75-69-4	
1,2,3-Trichloropropane	ND	ug/L	4.0	1		11/11/16 21:09	96-18-4	
1,1,2-Trichlorotrifluoroethane	ND	ug/L	1.0	1		11/11/16 21:09	76-13-1	
1,2,4-Trimethylbenzene	ND	ug/L	0.50	1		11/11/16 21:09	95-63-6	
1,3,5-Trimethylbenzene	ND	ug/L	0.50	1		11/11/16 21:09	108-67-8	
Vinyl chloride	ND	ug/L	0.20	1		11/11/16 21:09	75-01-4	
Xylene (Total)	ND	ug/L	1.5	1		11/11/16 21:09	1330-20-7	
m&p-Xylene	ND	ug/L	1.0	1		11/11/16 21:09	179601-23-1	
o-Xylene	ND	ug/L	0.50	1		11/11/16 21:09	95-47-6	
Surrogates								
1,2-Dichloroethane-d4 (S)	103	%.	75-125	1		11/11/16 21:09	17060-07-0	
Toluene-d8 (S)	98	%.	75-125	1		11/11/16 21:09	2037-26-5	
4-Bromofluorobenzene (S)	98	%.	75-125	1		11/11/16 21:09	460-00-4	
2320B Alkalinity	Analytical Method: SM 2320B							
Alkalinity, Total as CaCO3	**377**	mg/L	5.0	1		11/08/16 16:05		
2510B Specific Conductance	Analytical Method: SM 2510B							
Specific Conductance	**817**	umhos/cm	10.0	1		11/04/16 09:48		
2540D Total Suspended Solids	Analytical Method: SM 2540D (1997)							
Total Suspended Solids	**2.0**	mg/L	2.0	1		11/04/16 10:49		
4500H+ pH, Electrometric	Analytical Method: SM 4500-H+B							
pH at 25 Degrees C	**7.6**	Std. Units	0.10	1		11/02/16 15:06		H6
300.0 IC Anions 28 Days	Analytical Method: EPA 300.0							
Chloride	**21.2**	mg/L	1.0	1		11/08/16 17:57	16887-00-6	
Sulfate	**4.0**	mg/L	2.0	1		11/08/16 17:57	14808-79-8	

ANALYTICAL RESULTS

Project: Camp Ripley MMLF
Pace Project No.: 1278223

Sample: Equip Blank **Lab ID: 1278223005** Collected: 10/31/16 13:40 Received: 11/02/16 10:30 Matrix: Water

Parameters	Results	Units	Report Limit	DF	Prepared	Analyzed	CAS No.	Qual
350.1 Ammonia	Analytical Method: EPA 350.1 rev. 2 (1993) Preparation Method: EPA 350.1							
Nitrogen, Ammonia	ND	mg/L	0.10	1	11/10/16 10:28	11/10/16 14:06	7664-41-7	
353.2 Nitrate + Nitrite pres.	Analytical Method: EPA 353.2 rev. 2 (1993)							
Nitrogen, NO2 plus NO3	ND	mg/L	0.020	1		11/11/16 14:53		
200.7 MET ICP, Dissolved	Analytical Method: EPA 200.7 Preparation Method: EPA 200.7							
Barium, Dissolved	ND	ug/L	10.0	1	11/07/16 16:01	11/08/16 11:46	7440-39-3	
Boron, Dissolved	ND	ug/L	100	1	11/07/16 16:01	11/08/16 11:46	7440-42-8	
Chromium, Dissolved	ND	ug/L	10.0	1	11/07/16 16:01	11/08/16 11:46	7440-47-3	
Copper, Dissolved	ND	ug/L	10.0	1	11/07/16 16:01	11/08/16 11:46	7440-50-8	
Iron, Dissolved	ND	ug/L	50.0	1	11/07/16 16:01	11/08/16 11:46	7439-89-6	
Manganese, Dissolved	ND	ug/L	10.0	1	11/07/16 16:01	11/08/16 11:46	7439-96-5	
Sodium, Dissolved	ND	mg/L	0.50	1	11/07/16 16:01	11/08/16 11:46	7440-23-5	
200.8 MET ICPMS, Dissolved	Analytical Method: EPA 200.8 Preparation Method: EPA 200.8							
Arsenic, Dissolved	ND	ug/L	0.50	1	11/07/16 16:01	11/08/16 19:09	7440-38-2	
Cadmium, Dissolved	ND	ug/L	0.20	1	11/07/16 16:01	11/08/16 19:09	7440-43-9	
Lead, Dissolved	ND	ug/L	0.50	1	11/07/16 16:01	11/08/16 19:09	7439-92-1	
7470 Mercury, Dissolved	Analytical Method: EPA 7470 Preparation Method: EPA 7470							
Mercury, Dissolved	ND	ug/L	0.20	1	11/10/16 15:50	11/14/16 09:57	7439-97-6	
8260B MSV Low Level	Analytical Method: EPA 8260B							
Acetone	ND	ug/L	20.0	1		11/11/16 15:39	67-64-1	
Allyl chloride	ND	ug/L	4.0	1		11/11/16 15:39	107-05-1	
Benzene	ND	ug/L	0.50	1		11/11/16 15:39	71-43-2	
Bromobenzene	ND	ug/L	0.50	1		11/11/16 15:39	108-86-1	
Bromochloromethane	ND	ug/L	1.0	1		11/11/16 15:39	74-97-5	
Bromodichloromethane	ND	ug/L	1.0	1		11/11/16 15:39	75-27-4	
Bromoform	ND	ug/L	4.0	1		11/11/16 15:39	75-25-2	
Bromomethane	ND	ug/L	4.0	1		11/11/16 15:39	74-83-9	
2-Butanone (MEK)	ND	ug/L	5.0	1		11/11/16 15:39	78-93-3	
n-Butylbenzene	ND	ug/L	0.50	1		11/11/16 15:39	104-51-8	
sec-Butylbenzene	ND	ug/L	0.50	1		11/11/16 15:39	135-98-8	
tert-Butylbenzene	ND	ug/L	0.50	1		11/11/16 15:39	98-06-6	
Carbon tetrachloride	ND	ug/L	1.0	1		11/11/16 15:39	56-23-5	
Chlorobenzene	ND	ug/L	0.50	1		11/11/16 15:39	108-90-7	
Chloroethane	ND	ug/L	1.0	1		11/11/16 15:39	75-00-3	
Chloroform	ND	ug/L	1.0	1		11/11/16 15:39	67-66-3	
Chloromethane	ND	ug/L	4.0	1		11/11/16 15:39	74-87-3	
2-Chlorotoluene	ND	ug/L	0.50	1		11/11/16 15:39	95-49-8	
4-Chlorotoluene	ND	ug/L	0.50	1		11/11/16 15:39	106-43-4	
1,2-Dibromo-3-chloropropane	ND	ug/L	10.0	1		11/11/16 15:39	96-12-8	
Dibromochloromethane	ND	ug/L	4.0	1		11/11/16 15:39	124-48-1	
1,2-Dibromoethane (EDB)	ND	ug/L	1.0	1		11/11/16 15:39	106-93-4	
Dibromomethane	ND	ug/L	1.0	1		11/11/16 15:39	74-95-3	

ANALYTICAL RESULTS

Project:	Camp Ripley MMLF
Pace Project No.:	1278223

Sample: Equip Blank **Lab ID: 1278223005** Collected: 10/31/16 13:40 Received: 11/02/16 10:30 Matrix: Water

Parameters	Results	Units	Report Limit	DF	Prepared	Analyzed	CAS No.	Qual
8260B MSV Low Level	Analytical Method: EPA 8260B							
1,2-Dichlorobenzene	ND	ug/L	0.50	1		11/11/16 15:39	95-50-1	
1,3-Dichlorobenzene	ND	ug/L	0.50	1		11/11/16 15:39	541-73-1	
1,4-Dichlorobenzene	ND	ug/L	0.50	1		11/11/16 15:39	106-46-7	
Dichlorodifluoromethane	ND	ug/L	1.0	1		11/11/16 15:39	75-71-8	
1,1-Dichloroethane	ND	ug/L	0.50	1		11/11/16 15:39	75-34-3	
1,2-Dichloroethane	ND	ug/L	0.50	1		11/11/16 15:39	107-06-2	
1,1-Dichloroethene	ND	ug/L	0.50	1		11/11/16 15:39	75-35-4	
cis-1,2-Dichloroethene	ND	ug/L	0.50	1		11/11/16 15:39	156-59-2	
trans-1,2-Dichloroethene	ND	ug/L	0.50	1		11/11/16 15:39	156-60-5	
Dichlorofluoromethane	ND	ug/L	1.0	1		11/11/16 15:39	75-43-4	
1,2-Dichloropropane	ND	ug/L	4.0	1		11/11/16 15:39	78-87-5	
1,3-Dichloropropane	ND	ug/L	0.50	1		11/11/16 15:39	142-28-9	
2,2-Dichloropropane	ND	ug/L	1.0	1		11/11/16 15:39	594-20-7	
1,1-Dichloropropene	ND	ug/L	0.50	1		11/11/16 15:39	563-58-6	
cis-1,3-Dichloropropene	ND	ug/L	0.50	1		11/11/16 15:39	10061-01-5	
trans-1,3-Dichloropropene	ND	ug/L	1.0	1		11/11/16 15:39	10061-02-6	
Diethyl ether (Ethyl ether)	ND	ug/L	4.0	1		11/11/16 15:39	60-29-7	
Ethylbenzene	ND	ug/L	0.50	1		11/11/16 15:39	100-41-4	
Hexachloro-1,3-butadiene	ND	ug/L	4.0	1		11/11/16 15:39	87-68-3	
Isopropylbenzene (Cumene)	ND	ug/L	0.50	1		11/11/16 15:39	98-82-8	
p-Isopropyltoluene	ND	ug/L	0.50	1		11/11/16 15:39	99-87-6	
Methylene Chloride	ND	ug/L	4.0	1		11/11/16 15:39	75-09-2	
4-Methyl-2-pentanone (MIBK)	ND	ug/L	5.0	1		11/11/16 15:39	108-10-1	
Methyl-tert-butyl ether	ND	ug/L	0.50	1		11/11/16 15:39	1634-04-4	
Naphthalene	ND	ug/L	1.0	1		11/11/16 15:39	91-20-3	
n-Propylbenzene	ND	ug/L	0.50	1		11/11/16 15:39	103-65-1	
Styrene	ND	ug/L	0.50	1		11/11/16 15:39	100-42-5	
1,1,1,2-Tetrachloroethane	ND	ug/L	1.0	1		11/11/16 15:39	630-20-6	
1,1,2,2-Tetrachloroethane	ND	ug/L	0.50	1		11/11/16 15:39	79-34-5	
Tetrachloroethene	ND	ug/L	0.50	1		11/11/16 15:39	127-18-4	
Tetrahydrofuran	ND	ug/L	10.0	1		11/11/16 15:39	109-99-9	
Toluene	ND	ug/L	0.50	1		11/11/16 15:39	108-88-3	
1,2,3-Trichlorobenzene	ND	ug/L	0.50	1		11/11/16 15:39	87-61-6	
1,2,4-Trichlorobenzene	ND	ug/L	0.50	1		11/11/16 15:39	120-82-1	
1,1,1-Trichloroethane	ND	ug/L	0.50	1		11/11/16 15:39	71-55-6	
1,1,2-Trichloroethane	ND	ug/L	0.50	1		11/11/16 15:39	79-00-5	
Trichloroethene	ND	ug/L	0.40	1		11/11/16 15:39	79-01-6	
Trichlorofluoromethane	ND	ug/L	0.50	1		11/11/16 15:39	75-69-4	
1,2,3-Trichloropropane	ND	ug/L	4.0	1		11/11/16 15:39	96-18-4	
1,1,2-Trichlorotrifluoroethane	ND	ug/L	1.0	1		11/11/16 15:39	76-13-1	
1,2,4-Trimethylbenzene	ND	ug/L	0.50	1		11/11/16 15:39	95-63-6	
1,3,5-Trimethylbenzene	ND	ug/L	0.50	1		11/11/16 15:39	108-67-8	
Vinyl chloride	ND	ug/L	0.20	1		11/11/16 15:39	75-01-4	
Xylene (Total)	ND	ug/L	1.5	1		11/11/16 15:39	1330-20-7	
m&p-Xylene	ND	ug/L	1.0	1		11/11/16 15:39	179601-23-1	
o-Xylene	ND	ug/L	0.50	1		11/11/16 15:39	95-47-6	

ANALYTICAL RESULTS

Project: Camp Ripley MMLF
Pace Project No.: 1278223

Sample: Equip Blank **Lab ID: 1278223005** Collected: 10/31/16 13:40 Received: 11/02/16 10:30 Matrix: Water

Parameters	Results	Units	Report Limit	DF	Prepared	Analyzed	CAS No.	Qual
8260B MSV Low Level	Analytical Method: EPA 8260B							
Surrogates								
1,2-Dichloroethane-d4 (S)	105	%.	75-125	1		11/11/16 15:39	17060-07-0	
Toluene-d8 (S)	98	%.	75-125	1		11/11/16 15:39	2037-26-5	
4-Bromofluorobenzene (S)	102	%.	75-125	1		11/11/16 15:39	460-00-4	
2320B Alkalinity	Analytical Method: SM 2320B							
Alkalinity, Total as CaCO3	ND	mg/L	5.0	1		11/08/16 16:09		
2510B Specific Conductance	Analytical Method: SM 2510B							
Specific Conductance	ND	umhos/cm	10.0	1		11/04/16 09:45		
2540D Total Suspended Solids	Analytical Method: SM 2540D (1997)							
Total Suspended Solids	ND	mg/L	2.0	1		11/04/16 10:49		
4500H+ pH, Electrometric	Analytical Method: SM 4500-H+B							
pH at 25 Degrees C	**5.9**	Std. Units	0.10	1		11/02/16 15:08		H6
300.0 IC Anions 28 Days	Analytical Method: EPA 300.0							
Chloride	ND	mg/L	1.0	1		11/08/16 18:19	16887-00-6	
Sulfate	ND	mg/L	2.0	1		11/08/16 18:19	14808-79-8	

Sample: Trip Blank **Lab ID: 1278223006** Collected: 10/31/16 00:00 Received: 11/02/16 10:30 Matrix: Water

Parameters	Results	Units	Report Limit	DF	Prepared	Analyzed	CAS No.	Qual
8260B MSV Low Level	Analytical Method: EPA 8260B							
Acetone	ND	ug/L	20.0	1		11/11/16 15:17	67-64-1	
Allyl chloride	ND	ug/L	4.0	1		11/11/16 15:17	107-05-1	
Benzene	ND	ug/L	0.50	1		11/11/16 15:17	71-43-2	
Bromobenzene	ND	ug/L	0.50	1		11/11/16 15:17	108-86-1	
Bromochloromethane	ND	ug/L	1.0	1		11/11/16 15:17	74-97-5	
Bromodichloromethane	ND	ug/L	1.0	1		11/11/16 15:17	75-27-4	
Bromoform	ND	ug/L	4.0	1		11/11/16 15:17	75-25-2	
Bromomethane	ND	ug/L	4.0	1		11/11/16 15:17	74-83-9	
2-Butanone (MEK)	ND	ug/L	5.0	1		11/11/16 15:17	78-93-3	
n-Butylbenzene	ND	ug/L	0.50	1		11/11/16 15:17	104-51-8	
sec-Butylbenzene	ND	ug/L	0.50	1		11/11/16 15:17	135-98-8	
tert-Butylbenzene	ND	ug/L	0.50	1		11/11/16 15:17	98-06-6	
Carbon tetrachloride	ND	ug/L	1.0	1		11/11/16 15:17	56-23-5	
Chlorobenzene	ND	ug/L	0.50	1		11/11/16 15:17	108-90-7	
Chloroethane	ND	ug/L	1.0	1		11/11/16 15:17	75-00-3	
Chloroform	ND	ug/L	1.0	1		11/11/16 15:17	67-66-3	
Chloromethane	ND	ug/L	4.0	1		11/11/16 15:17	74-87-3	
2-Chlorotoluene	ND	ug/L	0.50	1		11/11/16 15:17	95-49-8	
4-Chlorotoluene	ND	ug/L	0.50	1		11/11/16 15:17	106-43-4	

ANALYTICAL RESULTS

Project: Camp Ripley MMLF
Pace Project No.: 1278223

Sample: Trip Blank **Lab ID: 1278223006** Collected: 10/31/16 00:00 Received: 11/02/16 10:30 Matrix: Water

Parameters	Results	Units	Report Limit	DF	Prepared	Analyzed	CAS No.	Qual
8260B MSV Low Level	Analytical Method: EPA 8260B							
1,2-Dibromo-3-chloropropane	ND	ug/L	10.0	1		11/11/16 15:17	96-12-8	
Dibromochloromethane	ND	ug/L	4.0	1		11/11/16 15:17	124-48-1	
1,2-Dibromoethane (EDB)	ND	ug/L	1.0	1		11/11/16 15:17	106-93-4	
Dibromomethane	ND	ug/L	1.0	1		11/11/16 15:17	74-95-3	
1,2-Dichlorobenzene	ND	ug/L	0.50	1		11/11/16 15:17	95-50-1	
1,3-Dichlorobenzene	ND	ug/L	0.50	1		11/11/16 15:17	541-73-1	
1,4-Dichlorobenzene	ND	ug/L	0.50	1		11/11/16 15:17	106-46-7	
Dichlorodifluoromethane	ND	ug/L	1.0	1		11/11/16 15:17	75-71-8	
1,1-Dichloroethane	ND	ug/L	0.50	1		11/11/16 15:17	75-34-3	
1,2-Dichloroethane	ND	ug/L	0.50	1		11/11/16 15:17	107-06-2	
1,1-Dichloroethene	ND	ug/L	0.50	1		11/11/16 15:17	75-35-4	
cis-1,2-Dichloroethene	ND	ug/L	0.50	1		11/11/16 15:17	156-59-2	
trans-1,2-Dichloroethene	ND	ug/L	0.50	1		11/11/16 15:17	156-60-5	
Dichlorofluoromethane	ND	ug/L	1.0	1		11/11/16 15:17	75-43-4	
1,2-Dichloropropane	ND	ug/L	4.0	1		11/11/16 15:17	78-87-5	
1,3-Dichloropropane	ND	ug/L	0.50	1		11/11/16 15:17	142-28-9	
2,2-Dichloropropane	ND	ug/L	1.0	1		11/11/16 15:17	594-20-7	
1,1-Dichloropropene	ND	ug/L	0.50	1		11/11/16 15:17	563-58-6	
cis-1,3-Dichloropropene	ND	ug/L	0.50	1		11/11/16 15:17	10061-01-5	
trans-1,3-Dichloropropene	ND	ug/L	1.0	1		11/11/16 15:17	10061-02-6	
Diethyl ether (Ethyl ether)	ND	ug/L	4.0	1		11/11/16 15:17	60-29-7	
Ethylbenzene	ND	ug/L	0.50	1		11/11/16 15:17	100-41-4	
Hexachloro-1,3-butadiene	ND	ug/L	4.0	1		11/11/16 15:17	87-68-3	
Isopropylbenzene (Cumene)	ND	ug/L	0.50	1		11/11/16 15:17	98-82-8	
p-Isopropyltoluene	ND	ug/L	0.50	1		11/11/16 15:17	99-87-6	
Methylene Chloride	ND	ug/L	4.0	1		11/11/16 15:17	75-09-2	
4-Methyl-2-pentanone (MIBK)	ND	ug/L	5.0	1		11/11/16 15:17	108-10-1	
Methyl-tert-butyl ether	ND	ug/L	0.50	1		11/11/16 15:17	1634-04-4	
Naphthalene	ND	ug/L	1.0	1		11/11/16 15:17	91-20-3	
n-Propylbenzene	ND	ug/L	0.50	1		11/11/16 15:17	103-65-1	
Styrene	ND	ug/L	0.50	1		11/11/16 15:17	100-42-5	
1,1,1,2-Tetrachloroethane	ND	ug/L	1.0	1		11/11/16 15:17	630-20-6	
1,1,2,2-Tetrachloroethane	ND	ug/L	0.50	1		11/11/16 15:17	79-34-5	
Tetrachloroethene	ND	ug/L	0.50	1		11/11/16 15:17	127-18-4	
Tetrahydrofuran	ND	ug/L	10.0	1		11/11/16 15:17	109-99-9	
Toluene	ND	ug/L	0.50	1		11/11/16 15:17	108-88-3	
1,2,3-Trichlorobenzene	ND	ug/L	0.50	1		11/11/16 15:17	87-61-6	
1,2,4-Trichlorobenzene	ND	ug/L	0.50	1		11/11/16 15:17	120-82-1	
1,1,1-Trichloroethane	ND	ug/L	0.50	1		11/11/16 15:17	71-55-6	
1,1,2-Trichloroethane	ND	ug/L	0.50	1		11/11/16 15:17	79-00-5	
Trichloroethene	ND	ug/L	0.40	1		11/11/16 15:17	79-01-6	
Trichlorofluoromethane	ND	ug/L	0.50	1		11/11/16 15:17	75-69-4	
1,2,3-Trichloropropane	ND	ug/L	4.0	1		11/11/16 15:17	96-18-4	
1,1,2-Trichlorotrifluoroethane	ND	ug/L	1.0	1		11/11/16 15:17	76-13-1	
1,2,4-Trimethylbenzene	ND	ug/L	0.50	1		11/11/16 15:17	95-63-6	
1,3,5-Trimethylbenzene	ND	ug/L	0.50	1		11/11/16 15:17	108-67-8	
Vinyl chloride	ND	ug/L	0.20	1		11/11/16 15:17	75-01-4	

ANALYTICAL RESULTS

Project: Camp Ripley MMLF
Pace Project No.: 1278223

Sample: Trip Blank **Lab ID: 1278223006** Collected: 10/31/16 00:00 Received: 11/02/16 10:30 Matrix: Water

Parameters	Results	Units	Report Limit	DF	Prepared	Analyzed	CAS No.	Qual
8260B MSV Low Level	Analytical Method: EPA 8260B							
Xylene (Total)	ND	ug/L	1.5	1		11/11/16 15:17	1330-20-7	
m&p-Xylene	ND	ug/L	1.0	1		11/11/16 15:17	179601-23-1	
o-Xylene	ND	ug/L	0.50	1		11/11/16 15:17	95-47-6	
Surrogates								
1,2-Dichloroethane-d4 (S)	105	%.	75-125	1		11/11/16 15:17	17060-07-0	
Toluene-d8 (S)	99	%.	75-125	1		11/11/16 15:17	2037-26-5	
4-Bromofluorobenzene (S)	102	%.	75-125	1		11/11/16 15:17	460-00-4	

QUALITY CONTROL DATA

Project: Camp Ripley MMLF
Pace Project No.: 1278223

QC Batch: 99747
Analysis Method: EPA 350.1 rev. 2 (1993)
QC Batch Method: EPA 350.1
Analysis Description: 350.1 Ammonia
Associated Lab Samples: 1278223001, 1278223002, 1278223003

METHOD BLANK: 396028
Matrix: Water
Associated Lab Samples: 1278223001, 1278223002, 1278223003

Parameter	Units	Blank Result	Reporting Limit	Analyzed	Qualifiers
Nitrogen, Ammonia	mg/L	ND	0.10	11/10/16 13:26	

LABORATORY CONTROL SAMPLE: 396027

Parameter	Units	Spike Conc.	LCS Result	LCS % Rec	% Rec Limits	Qualifiers
Nitrogen, Ammonia	mg/L	1	1.1	107	90-110	

MATRIX SPIKE & MATRIX SPIKE DUPLICATE: 396029 396030

Parameter	Units	1277946001 Result	MS Spike Conc.	MSD Spike Conc.	MS Result	MSD Result	MS % Rec	MSD % Rec	% Rec Limits	RPD	Max RPD	Qual
Nitrogen, Ammonia	mg/L	0.43	1	1	1.4	1.4	101	98	90-110	2	10	

MATRIX SPIKE & MATRIX SPIKE DUPLICATE: 396031 396032

Parameter	Units	1278192003 Result	MS Spike Conc.	MSD Spike Conc.	MS Result	MSD Result	MS % Rec	MSD % Rec	% Rec Limits	RPD	Max RPD	Qual
Nitrogen, Ammonia	mg/L	0.90	1	1	1.9	2.0	99	106	90-110	4	10	

Results presented on this page are in the units indicated by the "Units" column except where an alternate unit is presented to the right of the result.

QUALITY CONTROL DATA

Project: Camp Ripley MMLF
Pace Project No.: 1278223

QC Batch: 99748
Analysis Method: EPA 350.1 rev. 2 (1993)
QC Batch Method: EPA 350.1
Analysis Description: 350.1 Ammonia
Associated Lab Samples: 1278223004, 1278223005

METHOD BLANK: 396035
Matrix: Water
Associated Lab Samples: 1278223004, 1278223005

Parameter	Units	Blank Result	Reporting Limit	Analyzed	Qualifiers
Nitrogen, Ammonia	mg/L	ND	0.10	11/10/16 14:04	

LABORATORY CONTROL SAMPLE: 396034

Parameter	Units	Spike Conc.	LCS Result	LCS % Rec	% Rec Limits	Qualifiers
Nitrogen, Ammonia	mg/L	1	0.96	96	90-110	

MATRIX SPIKE & MATRIX SPIKE DUPLICATE: 396036 396037

Parameter	Units	1278223004 Result	MS Spike Conc.	MSD Spike Conc.	MS Result	MSD Result	MS % Rec	MSD % Rec	% Rec Limits	RPD	Max RPD	Qual
Nitrogen, Ammonia	mg/L	0.76	1	1	1.7	1.7	97	98	90-110	1	10	

MATRIX SPIKE & MATRIX SPIKE DUPLICATE: 396038 396039

Parameter	Units	1278568004 Result	MS Spike Conc.	MSD Spike Conc.	MS Result	MSD Result	MS % Rec	MSD % Rec	% Rec Limits	RPD	Max RPD	Qual
Nitrogen, Ammonia	mg/L	1.4	1	1	2.4	2.3	98	88	90-110	4	10	M1

Results presented on this page are in the units indicated by the "Units" column except where an alternate unit is presented to the right of the result.

QUALITY CONTROL DATA

Project: Camp Ripley MMLF
Pace Project No.: 1278223

QC Batch: 99840
Analysis Method: EPA 353.2 rev. 2 (1993)
QC Batch Method: EPA 353.2 rev. 2 (1993)
Analysis Description: 353.2 Nitrate + Nitrite, preserved
Associated Lab Samples: 1278223001, 1278223002, 1278223003, 1278223004, 1278223005

METHOD BLANK: 396392
Matrix: Water
Associated Lab Samples: 1278223001, 1278223002, 1278223003, 1278223004, 1278223005

Parameter	Units	Blank Result	Reporting Limit	Analyzed	Qualifiers
Nitrogen, NO2 plus NO3	mg/L	ND	0.020	11/11/16 14:36	

LABORATORY CONTROL SAMPLE: 396391

Parameter	Units	Spike Conc.	LCS Result	LCS % Rec	% Rec Limits	Qualifiers
Nitrogen, NO2 plus NO3	mg/L	.5	0.52	105	90-110	

MATRIX SPIKE & MATRIX SPIKE DUPLICATE: 396393 396394

Parameter	Units	1278207001 Result	MS Spike Conc.	MSD Spike Conc.	MS Result	MSD Result	MS % Rec	MSD % Rec	% Rec Limits	RPD	Max RPD	Qual
Nitrogen, NO2 plus NO3	mg/L	0.028	.5	.5	0.52	0.50	98	94	90-110	3	10	

MATRIX SPIKE & MATRIX SPIKE DUPLICATE: 396395 396396

Parameter	Units	1278246001 Result	MS Spike Conc.	MSD Spike Conc.	MS Result	MSD Result	MS % Rec	MSD % Rec	% Rec Limits	RPD	Max RPD	Qual
Nitrogen, NO2 plus NO3	mg/L	ND	.5	.5	0.53	0.53	107	105	90-110	2	10	

Results presented on this page are in the units indicated by the "Units" column except where an alternate unit is presented to the right of the result.

QUALITY CONTROL DATA

Project: Camp Ripley MMLF
Pace Project No.: 1278223

QC Batch: 99825 Analysis Method: EPA 7470
QC Batch Method: EPA 7470 Analysis Description: 7470 Mercury Dissolved
Associated Lab Samples: 1278223001, 1278223002, 1278223003, 1278223004, 1278223005

METHOD BLANK: 396314 Matrix: Water
Associated Lab Samples: 1278223001, 1278223002, 1278223003, 1278223004, 1278223005

Parameter	Units	Blank Result	Reporting Limit	Analyzed	Qualifiers
Mercury, Dissolved	ug/L	ND	0.20	11/14/16 09:31	

LABORATORY CONTROL SAMPLE: 396315

Parameter	Units	Spike Conc.	LCS Result	LCS % Rec	% Rec Limits	Qualifiers
Mercury, Dissolved	ug/L	2	2.0	100	85-115	

MATRIX SPIKE & MATRIX SPIKE DUPLICATE: 396316 396317

Parameter	Units	1278220001 Result	MS Spike Conc.	MSD Spike Conc.	MS Result	MSD Result	MS % Rec	MSD % Rec	% Rec Limits	RPD	Max RPD	Qual
Mercury, Dissolved	ug/L	ND	2	2	2.0	2.0	100	100	75-125	1	15	

MATRIX SPIKE & MATRIX SPIKE DUPLICATE: 396319 396320

Parameter	Units	1278641001 Result	MS Spike Conc.	MSD Spike Conc.	MS Result	MSD Result	MS % Rec	MSD % Rec	% Rec Limits	RPD	Max RPD	Qual
Mercury, Dissolved	ug/L	ND	2	2	2.0	2.1	102	102	75-125	1	15	

Results presented on this page are in the units indicated by the "Units" column except where an alternate unit is presented to the right of the result.

QUALITY CONTROL DATA

Project: Camp Ripley MMLF
Pace Project No.: 1278223

QC Batch: 99412 Analysis Method: EPA 200.7
QC Batch Method: EPA 200.7 Analysis Description: 200.7 MET Dissolved
Associated Lab Samples: 1278223001, 1278223002, 1278223003, 1278223004, 1278223005

METHOD BLANK: 394640 Matrix: Water
Associated Lab Samples: 1278223001, 1278223002, 1278223003, 1278223004, 1278223005

Parameter	Units	Blank Result	Reporting Limit	Analyzed	Qualifiers
Barium, Dissolved	ug/L	ND	10.0	11/08/16 11:20	
Boron, Dissolved	ug/L	ND	100	11/08/16 11:20	
Chromium, Dissolved	ug/L	ND	10.0	11/08/16 11:20	
Copper, Dissolved	ug/L	ND	10.0	11/08/16 11:20	
Iron, Dissolved	ug/L	ND	50.0	11/08/16 11:20	
Manganese, Dissolved	ug/L	ND	10.0	11/08/16 11:20	
Sodium, Dissolved	mg/L	ND	0.50	11/08/16 11:20	

LABORATORY CONTROL SAMPLE: 394641

Parameter	Units	Spike Conc.	LCS Result	LCS % Rec	% Rec Limits	Qualifiers
Barium, Dissolved	ug/L	500	493	99	85-115	
Boron, Dissolved	ug/L	500	500	100	85-115	
Chromium, Dissolved	ug/L	500	508	102	85-115	
Copper, Dissolved	ug/L	500	483	97	85-115	
Iron, Dissolved	ug/L	10000	10000	100	85-115	
Manganese, Dissolved	ug/L	1000	996	100	85-115	
Sodium, Dissolved	mg/L	20	19.5	98	85-115	

MATRIX SPIKE & MATRIX SPIKE DUPLICATE: 394642 394643

Parameter	Units	1278223001 Result	MS Spike Conc.	MSD Spike Conc.	MS Result	MSD Result	MS % Rec	MSD % Rec	% Rec Limits	RPD	Max RPD	Qual
Barium, Dissolved	ug/L	23.6	500	500	517	511	99	98	70-130	1	20	
Boron, Dissolved	ug/L	ND	500	500	516	518	99	99	70-130	1	20	
Chromium, Dissolved	ug/L	ND	500	500	511	506	102	101	70-130	1	20	
Copper, Dissolved	ug/L	ND	500	500	488	483	97	96	70-130	1	20	
Iron, Dissolved	ug/L	ND	10000	10000	10100	9990	101	100	70-130	1	20	
Manganese, Dissolved	ug/L	62.9	1000	1000	1060	1050	100	99	70-130	1	20	
Sodium, Dissolved	mg/L	2.8	20	20	22.4	22.1	98	97	70-130	1	20	

MATRIX SPIKE & MATRIX SPIKE DUPLICATE: 394644 394645

Parameter	Units	1278422001 Result	MS Spike Conc.	MSD Spike Conc.	MS Result	MSD Result	MS % Rec	MSD % Rec	% Rec Limits	RPD	Max RPD	Qual
Barium, Dissolved	ug/L	79.1	500	500	558	564	96	97	70-130	1	20	
Boron, Dissolved	ug/L	ND	500	500	505	518	98	100	70-130	3	20	

Results presented on this page are in the units indicated by the "Units" column except where an alternate unit is presented to the right of the result.

QUALITY CONTROL DATA

Project: Camp Ripley MMLF
Pace Project No.: 1278223

MATRIX SPIKE & MATRIX SPIKE DUPLICATE: 394644 394645

Parameter	Units	1278422001 Result	MS Spike Conc.	MSD Spike Conc.	MS Result	MSD Result	MS % Rec	MSD % Rec	% Rec Limits	RPD	Max RPD	Qual
Chromium, Dissolved	ug/L	ND	500	500	498	508	99	101	70-130	2	20	
Copper, Dissolved	ug/L	ND	500	500	482	486	96	97	70-130	1	20	
Iron, Dissolved	ug/L	ND	10000	10000	9850	9950	98	99	70-130	1	20	
Manganese, Dissolved	ug/L	11.1	1000	1000	988	998	98	99	70-130	1	20	
Sodium, Dissolved	mg/L	2.5	20	20	21.6	22.0	95	98	70-130	2	20	

Results presented on this page are in the units indicated by the "Units" column except where an alternate unit is presented to the right of the result.

QUALITY CONTROL DATA

Project: Camp Ripley MMLF
Pace Project No.: 1278223

QC Batch: 99411
Analysis Method: EPA 200.8
QC Batch Method: EPA 200.8
Analysis Description: 200.8 MET Dissolved
Associated Lab Samples: 1278223001, 1278223002, 1278223003, 1278223004, 1278223005

METHOD BLANK: 394634
Matrix: Water
Associated Lab Samples: 1278223001, 1278223002, 1278223003, 1278223004, 1278223005

Parameter	Units	Blank Result	Reporting Limit	Analyzed	Qualifiers
Arsenic, Dissolved	ug/L	ND	0.50	11/08/16 18:35	
Cadmium, Dissolved	ug/L	ND	0.20	11/08/16 18:35	
Lead, Dissolved	ug/L	ND	0.50	11/08/16 18:35	

LABORATORY CONTROL SAMPLE: 394635

Parameter	Units	Spike Conc.	LCS Result	LCS % Rec	% Rec Limits	Qualifiers
Arsenic, Dissolved	ug/L	500	510	102	85-115	
Cadmium, Dissolved	ug/L	500	488	98	85-115	
Lead, Dissolved	ug/L	500	491	98	85-115	

MATRIX SPIKE & MATRIX SPIKE DUPLICATE: 394636 394637

Parameter	Units	1278223001 Result	MS Spike Conc.	MSD Spike Conc.	MS Result	MSD Result	MS % Rec	MSD % Rec	% Rec Limits	RPD	Max RPD	Qual
Arsenic, Dissolved	ug/L	1.8	500	500	520	510	104	102	70-130	2	20	
Cadmium, Dissolved	ug/L	ND	500	500	496	483	99	96	70-130	3	20	
Lead, Dissolved	ug/L	ND	500	500	503	485	101	97	70-130	4	20	

MATRIX SPIKE & MATRIX SPIKE DUPLICATE: 394638 394639

Parameter	Units	1278422001 Result	MS Spike Conc.	MSD Spike Conc.	MS Result	MSD Result	MS % Rec	MSD % Rec	% Rec Limits	RPD	Max RPD	Qual
Arsenic, Dissolved	ug/L	ND	500	500	500	506	100	101	70-130	1	20	
Cadmium, Dissolved	ug/L	ND	500	500	491	497	98	99	70-130	1	20	
Lead, Dissolved	ug/L	ND	500	500	489	493	98	99	70-130	1	20	

Results presented on this page are in the units indicated by the "Units" column except where an alternate unit is presented to the right of the result.

QUALITY CONTROL DATA

Project: Camp Ripley MMLF
Pace Project No.: 1278223

QC Batch: 446601 Analysis Method: EPA 8260B
QC Batch Method: EPA 8260B Analysis Description: 8260 MSV LL Water
Associated Lab Samples: 1278223001, 1278223002, 1278223003, 1278223004, 1278223005, 1278223006

METHOD BLANK: 2441169 Matrix: Water
Associated Lab Samples: 1278223001, 1278223002, 1278223003, 1278223004, 1278223005, 1278223006

Parameter	Units	Blank Result	Reporting Limit	Analyzed	Qualifiers
1,1,1,2-Tetrachloroethane	ug/L	ND	1.0	11/11/16 14:33	
1,1,1-Trichloroethane	ug/L	ND	0.50	11/11/16 14:33	
1,1,2,2-Tetrachloroethane	ug/L	ND	0.50	11/11/16 14:33	
1,1,2-Trichloroethane	ug/L	ND	0.50	11/11/16 14:33	
1,1,2-Trichlorotrifluoroethane	ug/L	ND	1.0	11/11/16 14:33	
1,1-Dichloroethane	ug/L	ND	0.50	11/11/16 14:33	
1,1-Dichloroethene	ug/L	ND	0.50	11/11/16 14:33	
1,1-Dichloropropene	ug/L	ND	0.50	11/11/16 14:33	
1,2,3-Trichlorobenzene	ug/L	ND	0.50	11/11/16 14:33	
1,2,3-Trichloropropane	ug/L	ND	4.0	11/11/16 14:33	
1,2,4-Trichlorobenzene	ug/L	ND	0.50	11/11/16 14:33	
1,2,4-Trimethylbenzene	ug/L	ND	0.50	11/11/16 14:33	
1,2-Dibromo-3-chloropropane	ug/L	ND	10.0	11/11/16 14:33	
1,2-Dibromoethane (EDB)	ug/L	ND	1.0	11/11/16 14:33	
1,2-Dichlorobenzene	ug/L	ND	0.50	11/11/16 14:33	
1,2-Dichloroethane	ug/L	ND	0.50	11/11/16 14:33	
1,2-Dichloropropane	ug/L	ND	4.0	11/11/16 14:33	
1,3,5-Trimethylbenzene	ug/L	ND	0.50	11/11/16 14:33	
1,3-Dichlorobenzene	ug/L	ND	0.50	11/11/16 14:33	
1,3-Dichloropropane	ug/L	ND	0.50	11/11/16 14:33	
1,4-Dichlorobenzene	ug/L	ND	0.50	11/11/16 14:33	
2,2-Dichloropropane	ug/L	ND	1.0	11/11/16 14:33	
2-Butanone (MEK)	ug/L	ND	5.0	11/11/16 14:33	
2-Chlorotoluene	ug/L	ND	0.50	11/11/16 14:33	
4-Chlorotoluene	ug/L	ND	0.50	11/11/16 14:33	
4-Methyl-2-pentanone (MIBK)	ug/L	ND	5.0	11/11/16 14:33	
Acetone	ug/L	ND	20.0	11/11/16 14:33	
Allyl chloride	ug/L	ND	4.0	11/11/16 14:33	
Benzene	ug/L	ND	0.50	11/11/16 14:33	
Bromobenzene	ug/L	ND	0.50	11/11/16 14:33	
Bromochloromethane	ug/L	ND	1.0	11/11/16 14:33	
Bromodichloromethane	ug/L	ND	1.0	11/11/16 14:33	
Bromoform	ug/L	ND	4.0	11/11/16 14:33	
Bromomethane	ug/L	ND	4.0	11/11/16 14:33	
Carbon tetrachloride	ug/L	ND	1.0	11/11/16 14:33	
Chlorobenzene	ug/L	ND	0.50	11/11/16 14:33	
Chloroethane	ug/L	ND	1.0	11/11/16 14:33	
Chloroform	ug/L	ND	1.0	11/11/16 14:33	
Chloromethane	ug/L	ND	4.0	11/11/16 14:33	
cis-1,2-Dichloroethene	ug/L	ND	0.50	11/11/16 14:33	
cis-1,3-Dichloropropene	ug/L	ND	0.50	11/11/16 14:33	

Results presented on this page are in the units indicated by the "Units" column except where an alternate unit is presented to the right of the result.

QUALITY CONTROL DATA

Project: Camp Ripley MMLF
Pace Project No.: 1278223

METHOD BLANK: 2441169 Matrix: Water
Associated Lab Samples: 1278223001, 1278223002, 1278223003, 1278223004, 1278223005, 1278223006

Parameter	Units	Blank Result	Reporting Limit	Analyzed	Qualifiers
Dibromochloromethane	ug/L	ND	4.0	11/11/16 14:33	
Dibromomethane	ug/L	ND	1.0	11/11/16 14:33	
Dichlorodifluoromethane	ug/L	ND	1.0	11/11/16 14:33	
Dichlorofluoromethane	ug/L	ND	1.0	11/11/16 14:33	
Diethyl ether (Ethyl ether)	ug/L	ND	4.0	11/11/16 14:33	
Ethylbenzene	ug/L	ND	0.50	11/11/16 14:33	
Hexachloro-1,3-butadiene	ug/L	ND	4.0	11/11/16 14:33	
Isopropylbenzene (Cumene)	ug/L	ND	0.50	11/11/16 14:33	
m&p-Xylene	ug/L	ND	1.0	11/11/16 14:33	
Methyl-tert-butyl ether	ug/L	ND	0.50	11/11/16 14:33	
Methylene Chloride	ug/L	ND	4.0	11/11/16 14:33	
n-Butylbenzene	ug/L	ND	0.50	11/11/16 14:33	
n-Propylbenzene	ug/L	ND	0.50	11/11/16 14:33	
Naphthalene	ug/L	ND	1.0	11/11/16 14:33	
o-Xylene	ug/L	ND	0.50	11/11/16 14:33	
p-Isopropyltoluene	ug/L	ND	0.50	11/11/16 14:33	
sec-Butylbenzene	ug/L	ND	0.50	11/11/16 14:33	
Styrene	ug/L	ND	0.50	11/11/16 14:33	
tert-Butylbenzene	ug/L	ND	0.50	11/11/16 14:33	
Tetrachloroethene	ug/L	ND	0.50	11/11/16 14:33	
Tetrahydrofuran	ug/L	ND	10.0	11/11/16 14:33	
Toluene	ug/L	ND	0.50	11/11/16 14:33	
trans-1,2-Dichloroethene	ug/L	ND	0.50	11/11/16 14:33	
trans-1,3-Dichloropropene	ug/L	ND	1.0	11/11/16 14:33	
Trichloroethene	ug/L	ND	0.40	11/11/16 14:33	
Trichlorofluoromethane	ug/L	ND	0.50	11/11/16 14:33	
Vinyl chloride	ug/L	ND	0.20	11/11/16 14:33	
Xylene (Total)	ug/L	ND	1.5	11/11/16 14:33	
1,2-Dichloroethane-d4 (S)	%.	105	75-125	11/11/16 14:33	
4-Bromofluorobenzene (S)	%.	103	75-125	11/11/16 14:33	
Toluene-d8 (S)	%.	98	75-125	11/11/16 14:33	

LABORATORY CONTROL SAMPLE & LCSD: 2441170 2441171

Parameter	Units	Spike Conc.	LCS Result	LCSD Result	LCS % Rec	LCSD % Rec	% Rec Limits	RPD	Max RPD	Qualifiers
1,1,1,2-Tetrachloroethane	ug/L	20	21.8	22.4	109	112	75-125	3	30	
1,1,1-Trichloroethane	ug/L	20	20.2	20.1	101	100	74-125	1	30	
1,1,2,2-Tetrachloroethane	ug/L	20	23.0	22.7	115	113	67-131	1	30	
1,1,2-Trichloroethane	ug/L	20	22.1	22.4	111	112	75-125	1	30	
1,1,2-Trichlorotrifluoroethane	ug/L	20	20.2	20.2	101	101	75-125	0	30	
1,1-Dichloroethane	ug/L	20	20.0	19.9	100	99	74-125	0	30	
1,1-Dichloroethene	ug/L	20	20.1	20.3	101	102	74-125	1	30	
1,1-Dichloropropene	ug/L	20	19.0	19.1	95	95	74-125	0	30	
1,2,3-Trichlorobenzene	ug/L	20	21.2	22.8	106	114	63-131	7	30	

Results presented on this page are in the units indicated by the "Units" column except where an alternate unit is presented to the right of the result.

QUALITY CONTROL DATA

Project: Camp Ripley MMLF
Pace Project No.: 1278223

LABORATORY CONTROL SAMPLE & LCSD: 2441170 2441171

Parameter	Units	Spike Conc.	LCS Result	LCSD Result	LCS % Rec	LCSD % Rec	% Rec Limits	RPD	Max RPD	Qualifiers
1,2,3-Trichloropropane	ug/L	20	22.5	22.4	113	112	73-125	1	30	
1,2,4-Trichlorobenzene	ug/L	20	22.3	22.8	111	114	66-126	2	30	
1,2,4-Trimethylbenzene	ug/L	20	21.5	21.8	107	109	74-129	2	30	
1,2-Dibromo-3-chloropropane	ug/L	50	56.8	54.7	114	109	54-129	4	30	
1,2-Dibromoethane (EDB)	ug/L	20	21.3	21.7	107	109	75-125	2	30	
1,2-Dichlorobenzene	ug/L	20	21.5	22.0	107	110	75-125	2	30	
1,2-Dichloroethane	ug/L	20	19.3	19.8	96	99	75-125	3	30	
1,2-Dichloropropane	ug/L	20	20.0	20.4	100	102	75-125	2	30	
1,3,5-Trimethylbenzene	ug/L	20	21.7	21.8	109	109	73-127	0	30	
1,3-Dichlorobenzene	ug/L	20	21.2	21.5	106	107	75-125	1	30	
1,3-Dichloropropane	ug/L	20	20.7	21.4	104	107	69-125	3	30	
1,4-Dichlorobenzene	ug/L	20	20.9	21.3	105	106	75-125	2	30	
2,2-Dichloropropane	ug/L	20	22.5	22.1	113	111	69-125	2	30	
2-Butanone (MEK)	ug/L	100	106	99.6	106	100	48-145	6	30	
2-Chlorotoluene	ug/L	20	21.3	21.1	106	105	74-125	1	30	
4-Chlorotoluene	ug/L	20	21.1	21.2	105	106	73-125	1	30	
4-Methyl-2-pentanone (MIBK)	ug/L	100	112	105	112	105	53-138	7	30	
Acetone	ug/L	100	92.6	94.0	93	94	70-142	2	30	
Allyl chloride	ug/L	20	18.4	18.7	92	93	61-127	1	30	
Benzene	ug/L	20	18.1	18.2	90	91	65-125	0	30	
Bromobenzene	ug/L	20	22.1	22.3	110	112	75-125	1	30	
Bromochloromethane	ug/L	20	19.7	20.6	99	103	75-125	4	30	
Bromodichloromethane	ug/L	20	21.5	22.4	107	112	73-125	4	30	
Bromoform	ug/L	20	21.7	22.7	109	113	69-125	4	30	
Bromomethane	ug/L	20	15.0	18.3	75	92	40-136	20	30	
Carbon tetrachloride	ug/L	20	21.5	21.5	108	107	70-125	0	30	
Chlorobenzene	ug/L	20	20.4	20.6	102	103	75-125	1	30	
Chloroethane	ug/L	20	18.6	19.3	93	97	67-141	4	30	
Chloroform	ug/L	20	20.2	20.4	101	102	75-125	1	30	
Chloromethane	ug/L	20	20.0	20.1	100	100	50-150	0	30	
cis-1,2-Dichloroethene	ug/L	20	20.1	19.9	100	99	75-125	1	30	
cis-1,3-Dichloropropene	ug/L	20	20.7	21.6	104	108	75-125	4	30	
Dibromochloromethane	ug/L	20	20.7	22.1	104	110	75-125	6	30	
Dibromomethane	ug/L	20	22.7	22.2	113	111	75-129	2	30	
Dichlorodifluoromethane	ug/L	20	22.2	21.9	111	110	59-135	1	30	
Dichlorofluoromethane	ug/L	20	20.5	20.7	103	104	74-130	1	30	
Diethyl ether (Ethyl ether)	ug/L	20	19.6	20.7	98	104	66-132	6	30	
Ethylbenzene	ug/L	20	20.2	20.1	101	101	75-125	0	30	
Hexachloro-1,3-butadiene	ug/L	20	24.4	25.1	122	126	72-126	3	30	
Isopropylbenzene (Cumene)	ug/L	20	21.1	21.2	105	106	71-136	1	30	
m&p-Xylene	ug/L	40	41.6	41.9	104	105	75-125	1	30	
Methyl-tert-butyl ether	ug/L	20	20.9	21.0	105	105	73-127	0	30	
Methylene Chloride	ug/L	20	17.4	17.9	87	89	68-128	3	30	
n-Butylbenzene	ug/L	20	21.5	22.2	107	111	70-126	3	30	
n-Propylbenzene	ug/L	20	21.0	21.0	105	105	67-131	0	30	
Naphthalene	ug/L	20	21.6	21.7	108	108	52-134	0	30	
o-Xylene	ug/L	20	21.1	21.7	105	108	75-125	3	30	

Results presented on this page are in the units indicated by the "Units" column except where an alternate unit is presented to the right of the result.

QUALITY CONTROL DATA

Project: Camp Ripley MMLF
Pace Project No.: 1278223

LABORATORY CONTROL SAMPLE & LCSD: 2441170 2441171

Parameter	Units	Spike Conc.	LCS Result	LCSD Result	LCS % Rec	LCSD % Rec	% Rec Limits	RPD	Max RPD	Qualifiers
p-Isopropyltoluene	ug/L	20	22.0	22.4	110	112	74-125	2	30	
sec-Butylbenzene	ug/L	20	21.2	21.5	106	107	69-134	1	30	
Styrene	ug/L	20	20.9	21.1	105	105	75-125	1	30	
tert-Butylbenzene	ug/L	20	21.8	21.4	109	107	71-128	2	30	
Tetrachloroethene	ug/L	20	21.2	20.9	106	105	74-125	1	30	
Tetrahydrofuran	ug/L	200	195	197	97	99	64-142	1	30	
Toluene	ug/L	20	19.1	19.3	95	97	75-125	1	30	
trans-1,2-Dichloroethene	ug/L	20	20.0	20.4	100	102	73-125	2	30	
trans-1,3-Dichloropropene	ug/L	20	21.0	21.6	105	108	75-125	3	30	
Trichloroethene	ug/L	20	20.9	21.0	104	105	75-125	0	30	
Trichlorofluoromethane	ug/L	20	23.4	23.5	117	117	75-126	0	30	
Vinyl chloride	ug/L	20	21.1	21.7	106	108	72-125	3	30	
Xylene (Total)	ug/L	60	62.6	63.6	104	106	75-125	2	30	
1,2-Dichloroethane-d4 (S)	%.				101	100	75-125			
4-Bromofluorobenzene (S)	%.				101	101	75-125			
Toluene-d8 (S)	%.				100	100	75-125			

MATRIX SPIKE SAMPLE: 2441172

Parameter	Units	1278374001 Result	Spike Conc.	MS Result	MS % Rec	% Rec Limits	Qualifiers
1,1,1,2-Tetrachloroethane	ug/L	ND	20	21.4	107	75-127	
1,1,1-Trichloroethane	ug/L	ND	20	21.2	106	66-142	
1,1,2,2-Tetrachloroethane	ug/L	ND	20	20.5	103	70-131	
1,1,2-Trichloroethane	ug/L	ND	20	20.1	101	75-128	
1,1,2-Trichlorotrifluoroethane	ug/L	ND	20	24.1	120	54-150	
1,1-Dichloroethane	ug/L	ND	20	20.5	103	58-147	
1,1-Dichloroethene	ug/L	ND	20	21.9	109	49-150	
1,1-Dichloropropene	ug/L	ND	20	20.3	101	58-147	
1,2,3-Trichlorobenzene	ug/L	ND	20	20.7	103	57-139	
1,2,3-Trichloropropane	ug/L	ND	20	20.5	102	71-127	
1,2,4-Trichlorobenzene	ug/L	ND	20	21.5	108	55-136	
1,2,4-Trimethylbenzene	ug/L	ND	20	21.1	106	67-138	
1,2-Dibromo-3-chloropropane	ug/L	ND	50	49.8	100	63-136	
1,2-Dibromoethane (EDB)	ug/L	ND	20	20.0	100	74-125	
1,2-Dichlorobenzene	ug/L	ND	20	21.0	105	75-125	
1,2-Dichloroethane	ug/L	ND	20	19.0	95	63-133	
1,2-Dichloropropane	ug/L	ND	20	19.9	99	63-138	
1,3,5-Trimethylbenzene	ug/L	ND	20	21.4	107	69-136	
1,3-Dichlorobenzene	ug/L	ND	20	20.9	104	75-125	
1,3-Dichloropropane	ug/L	ND	20	19.7	99	65-135	
1,4-Dichlorobenzene	ug/L	ND	20	20.6	103	70-126	
2,2-Dichloropropane	ug/L	ND	20	23.1	116	39-148	
2-Butanone (MEK)	ug/L	ND	100	88.2	88	50-144	
2-Chlorotoluene	ug/L	ND	20	21.1	106	71-135	
4-Chlorotoluene	ug/L	ND	20	20.9	105	71-131	

Results presented on this page are in the units indicated by the "Units" column except where an alternate unit is presented to the right of the result.

QUALITY CONTROL DATA

Project: Camp Ripley MMLF
Pace Project No.: 1278223

MATRIX SPIKE SAMPLE: 2441172

Parameter	Units	1278374001 Result	Spike Conc.	MS Result	MS % Rec	% Rec Limits	Qualifiers
4-Methyl-2-pentanone (MIBK)	ug/L	ND	100	94.4	94	60-147	
Acetone	ug/L	ND	100	84.0	84	59-150	
Allyl chloride	ug/L	ND	20	19.2	96	38-149	
Benzene	ug/L	ND	20	18.5	92	61-138	
Bromobenzene	ug/L	ND	20	21.2	106	74-130	
Bromochloromethane	ug/L	ND	20	19.7	99	65-137	
Bromodichloromethane	ug/L	ND	20	21.6	108	66-136	
Bromoform	ug/L	ND	20	20.5	103	71-125	
Bromomethane	ug/L	ND	20	21.5	107	30-150	
Carbon tetrachloride	ug/L	ND	20	23.3	116	68-140	
Chlorobenzene	ug/L	ND	20	20.1	100	75-132	
Chloroethane	ug/L	ND	20	21.9	109	55-150	
Chloroform	ug/L	ND	20	20.4	102	64-139	
Chloromethane	ug/L	ND	20	22.9	115	73-150	
cis-1,2-Dichloroethene	ug/L	ND	20	20.1	101	62-138	
cis-1,3-Dichloropropene	ug/L	ND	20	19.9	99	70-125	
Dibromochloromethane	ug/L	ND	20	20.4	102	74-125	
Dibromomethane	ug/L	ND	20	21.1	105	66-138	
Dichlorodifluoromethane	ug/L	ND	20	28.5	143	53-150	
Dichlorofluoromethane	ug/L	ND	20	23.2	116	58-150	
Diethyl ether (Ethyl ether)	ug/L	ND	20	19.2	96	47-145	
Ethylbenzene	ug/L	ND	20	20.2	101	66-141	
Hexachloro-1,3-butadiene	ug/L	ND	20	26.5	133	63-139	
Isopropylbenzene (Cumene)	ug/L	ND	20	21.2	106	65-146	
m&p-Xylene	ug/L	ND	40	40.7	102	72-142	
Methyl-tert-butyl ether	ug/L	ND	20	19.6	98	63-134	
Methylene Chloride	ug/L	ND	20	17.4	87	49-143	
n-Butylbenzene	ug/L	ND	20	22.0	110	67-134	
n-Propylbenzene	ug/L	ND	20	20.9	105	62-142	
Naphthalene	ug/L	ND	20	19.8	99	41-150	
o-Xylene	ug/L	ND	20	20.8	104	66-138	
p-Isopropyltoluene	ug/L	ND	20	22.1	111	64-137	
sec-Butylbenzene	ug/L	ND	20	21.5	108	65-142	
Styrene	ug/L	ND	20	20.3	102	61-142	
tert-Butylbenzene	ug/L	ND	20	21.3	106	69-135	
Tetrachloroethene	ug/L	ND	20	20.9	104	62-142	
Tetrahydrofuran	ug/L	ND	200	177	88	55-150	
Toluene	ug/L	ND	20	19.0	95	66-132	
trans-1,2-Dichloroethene	ug/L	ND	20	21.3	107	48-150	
trans-1,3-Dichloropropene	ug/L	ND	20	20.3	102	65-130	
Trichloroethene	ug/L	ND	20	20.7	103	64-142	
Trichlorofluoromethane	ug/L	ND	20	29.2	146	63-150	
Vinyl chloride	ug/L	ND	20	25.7	128	58-150	
Xylene (Total)	ug/L	ND	60	61.5	103	70-140	
1,2-Dichloroethane-d4 (S)	%.				101	75-125	
4-Bromofluorobenzene (S)	%.				100	75-125	
Toluene-d8 (S)	%.				99	75-125	

Results presented on this page are in the units indicated by the "Units" column except where an alternate unit is presented to the right of the result.

QUALITY CONTROL DATA

Project: Camp Ripley MMLF
Pace Project No.: 1278223

SAMPLE DUPLICATE: 2441173

Parameter	Units	1278374002 Result	Dup Result	RPD	Max RPD	Qualifiers
1,1,1,2-Tetrachloroethane	ug/L	ND	ND		30	
1,1,1-Trichloroethane	ug/L	ND	ND		30	
1,1,2,2-Tetrachloroethane	ug/L	ND	ND		30	
1,1,2-Trichloroethane	ug/L	ND	ND		30	
1,1,2-Trichlorotrifluoroethane	ug/L	ND	ND		30	
1,1-Dichloroethane	ug/L	ND	ND		30	
1,1-Dichloroethene	ug/L	ND	ND		30	
1,1-Dichloropropene	ug/L	ND	ND		30	
1,2,3-Trichlorobenzene	ug/L	ND	ND		30	
1,2,3-Trichloropropane	ug/L	ND	ND		30	
1,2,4-Trichlorobenzene	ug/L	ND	ND		30	
1,2,4-Trimethylbenzene	ug/L	ND	ND		30	
1,2-Dibromo-3-chloropropane	ug/L	ND	ND		30	
1,2-Dibromoethane (EDB)	ug/L	ND	ND		30	
1,2-Dichlorobenzene	ug/L	ND	ND		30	
1,2-Dichloroethane	ug/L	ND	ND		30	
1,2-Dichloropropane	ug/L	ND	ND		30	
1,3,5-Trimethylbenzene	ug/L	ND	ND		30	
1,3-Dichlorobenzene	ug/L	ND	ND		30	
1,3-Dichloropropane	ug/L	ND	ND		30	
1,4-Dichlorobenzene	ug/L	ND	ND		30	
2,2-Dichloropropane	ug/L	ND	ND		30	
2-Butanone (MEK)	ug/L	ND	ND		30	
2-Chlorotoluene	ug/L	ND	ND		30	
4-Chlorotoluene	ug/L	ND	ND		30	
4-Methyl-2-pentanone (MIBK)	ug/L	ND	ND		30	
Acetone	ug/L	ND	ND		30	
Allyl chloride	ug/L	ND	ND		30	
Benzene	ug/L	ND	ND		30	
Bromobenzene	ug/L	ND	ND		30	
Bromochloromethane	ug/L	ND	ND		30	
Bromodichloromethane	ug/L	ND	ND		30	
Bromoform	ug/L	ND	ND		30	
Bromomethane	ug/L	ND	ND		30	
Carbon tetrachloride	ug/L	ND	ND		30	
Chlorobenzene	ug/L	ND	ND		30	
Chloroethane	ug/L	ND	ND		30	
Chloroform	ug/L	ND	ND		30	
Chloromethane	ug/L	ND	ND		30	
cis-1,2-Dichloroethene	ug/L	ND	ND		30	
cis-1,3-Dichloropropene	ug/L	ND	ND		30	
Dibromochloromethane	ug/L	ND	ND		30	
Dibromomethane	ug/L	ND	ND		30	
Dichlorodifluoromethane	ug/L	ND	ND		30	
Dichlorofluoromethane	ug/L	ND	ND		30	
Diethyl ether (Ethyl ether)	ug/L	ND	ND		30	
Ethylbenzene	ug/L	ND	ND		30	

Results presented on this page are in the units indicated by the "Units" column except where an alternate unit is presented to the right of the result.

REPORT OF LABORATORY ANALYSIS

QUALITY CONTROL DATA

Project: Camp Ripley MMLF
Pace Project No.: 1278223

SAMPLE DUPLICATE: 2441173

Parameter	Units	1278374002 Result	Dup Result	RPD	Max RPD	Qualifiers
Hexachloro-1,3-butadiene	ug/L	ND	ND		30	
Isopropylbenzene (Cumene)	ug/L	ND	ND		30	
m&p-Xylene	ug/L	ND	ND		30	
Methyl-tert-butyl ether	ug/L	ND	ND		30	
Methylene Chloride	ug/L	ND	ND		30	
n-Butylbenzene	ug/L	ND	ND		30	
n-Propylbenzene	ug/L	ND	ND		30	
Naphthalene	ug/L	ND	ND		30	
o-Xylene	ug/L	ND	ND		30	
p-Isopropyltoluene	ug/L	ND	ND		30	
sec-Butylbenzene	ug/L	ND	ND		30	
Styrene	ug/L	ND	ND		30	
tert-Butylbenzene	ug/L	ND	ND		30	
Tetrachloroethene	ug/L	ND	ND		30	
Tetrahydrofuran	ug/L	ND	ND		30	
Toluene	ug/L	ND	ND		30	
trans-1,2-Dichloroethene	ug/L	ND	ND		30	
trans-1,3-Dichloropropene	ug/L	ND	ND		30	
Trichloroethene	ug/L	ND	ND		30	
Trichlorofluoromethane	ug/L	ND	ND		30	
Vinyl chloride	ug/L	ND	ND		30	
Xylene (Total)	ug/L	ND	ND		30	
1,2-Dichloroethane-d4 (S)	%.	105	106	1		
4-Bromofluorobenzene (S)	%.	102	101	1		
Toluene-d8 (S)	%.	99	97	1		

Results presented on this page are in the units indicated by the "Units" column except where an alternate unit is presented to the right of the result.

QUALITY CONTROL DATA

Project: Camp Ripley MMLF
Pace Project No.: 1278223

QC Batch: 99424
Analysis Method: SM 2320B
QC Batch Method: SM 2320B
Analysis Description: 2320B Alkalinity
Associated Lab Samples: 1278223001, 1278223002, 1278223003

METHOD BLANK: 394698
Matrix: Water
Associated Lab Samples: 1278223001, 1278223002, 1278223003

Parameter	Units	Blank Result	Reporting Limit	Analyzed	Qualifiers
Alkalinity, Total as CaCO3	mg/L	ND	5.0	11/07/16 16:40	

LABORATORY CONTROL SAMPLE: 394699

Parameter	Units	Spike Conc.	LCS Result	LCS % Rec	% Rec Limits	Qualifiers
Alkalinity, Total as CaCO3	mg/L	100	101	101	90-110	

SAMPLE DUPLICATE: 394700

Parameter	Units	1278355001 Result	Dup Result	RPD	Max RPD	Qualifiers
Alkalinity, Total as CaCO3	mg/L	306	309	1	20	

Results presented on this page are in the units indicated by the "Units" column except where an alternate unit is presented to the right of the result.

QUALITY CONTROL DATA

Project: Camp Ripley MMLF
Pace Project No.: 1278223

QC Batch: 99505
QC Batch Method: SM 2320B
Analysis Method: SM 2320B
Analysis Description: 2320B Alkalinity
Associated Lab Samples: 1278223004, 1278223005

METHOD BLANK: 394981
Matrix: Water
Associated Lab Samples: 1278223004, 1278223005

Parameter	Units	Blank Result	Reporting Limit	Analyzed	Qualifiers
Alkalinity, Total as CaCO3	mg/L	ND	5.0	11/08/16 13:44	

LABORATORY CONTROL SAMPLE: 394982

Parameter	Units	Spike Conc.	LCS Result	LCS % Rec	% Rec Limits	Qualifiers
Alkalinity, Total as CaCO3	mg/L	100	98.0	98	90-110	

SAMPLE DUPLICATE: 394983

Parameter	Units	1278380001 Result	Dup Result	RPD	Max RPD	Qualifiers
Alkalinity, Total as CaCO3	mg/L	35.0	30.9	12	20	

SAMPLE DUPLICATE: 394984

Parameter	Units	1278319001 Result	Dup Result	RPD	Max RPD	Qualifiers
Alkalinity, Total as CaCO3	mg/L	351	362	3	20	

Results presented on this page are in the units indicated by the "Units" column except where an alternate unit is presented to the right of the result.

QUALITY CONTROL DATA

Project: Camp Ripley MMLF
Pace Project No.: 1278223

QC Batch: 99258 Analysis Method: SM 2510B
QC Batch Method: SM 2510B Analysis Description: 2510B Specific Conductance
Associated Lab Samples: 1278223001, 1278223002, 1278223003, 1278223004, 1278223005

METHOD BLANK: 394057 Matrix: Water
Associated Lab Samples: 1278223001, 1278223002, 1278223003, 1278223004, 1278223005

Parameter	Units	Blank Result	Reporting Limit	Analyzed	Qualifiers
Specific Conductance	umhos/cm	ND	10.0	11/04/16 09:37	

LABORATORY CONTROL SAMPLE: 394058

Parameter	Units	Spike Conc.	LCS Result	LCS % Rec	% Rec Limits	Qualifiers
Specific Conductance	umhos/cm	1413	1372	97	90-110	

SAMPLE DUPLICATE: 394059

Parameter	Units	1278287001 Result	Dup Result	RPD	Max RPD	Qualifiers
Specific Conductance	umhos/cm	131	131	0	20	

SAMPLE DUPLICATE: 394060

Parameter	Units	1278377002 Result	Dup Result	RPD	Max RPD	Qualifiers
Specific Conductance	umhos/cm	873	872	0	20	

Results presented on this page are in the units indicated by the "Units" column except where an alternate unit is presented to the right of the result.

QUALITY CONTROL DATA

Project: Camp Ripley MMLF
Pace Project No.: 1278223

QC Batch: 99273
Analysis Method: SM 2540D (1997)
QC Batch Method: SM 2540D (1997)
Analysis Description: 2540D Total Suspended Solids
Associated Lab Samples: 1278223001, 1278223002, 1278223003, 1278223004, 1278223005

METHOD BLANK: 394104
Matrix: Water
Associated Lab Samples: 1278223001, 1278223002, 1278223003, 1278223004, 1278223005

Parameter	Units	Blank Result	Reporting Limit	Analyzed	Qualifiers
Total Suspended Solids	mg/L	ND	1.0	11/04/16 10:49	

LABORATORY CONTROL SAMPLE: 394105

Parameter	Units	Spike Conc.	LCS Result	LCS % Rec	% Rec Limits	Qualifiers
Total Suspended Solids	mg/L	239	226	95	80-120	

SAMPLE DUPLICATE: 394106

Parameter	Units	1278403001 Result	Dup Result	RPD	Max RPD	Qualifiers
Total Suspended Solids	mg/L	164	176	7	10	

SAMPLE DUPLICATE: 394107

Parameter	Units	1278399001 Result	Dup Result	RPD	Max RPD	Qualifiers
Total Suspended Solids	mg/L		400	17	10	D6

Results presented on this page are in the units indicated by the "Units" column except where an alternate unit is presented to the right of the result.

QUALITY CONTROL DATA

Project: Camp Ripley MMLF
Pace Project No.: 1278223

QC Batch: 99019 Analysis Method: SM 4500-H+B
QC Batch Method: SM 4500-H+B Analysis Description: 4500H+B pH
Associated Lab Samples: 1278223001, 1278223002, 1278223003, 1278223004, 1278223005

LABORATORY CONTROL SAMPLE: 392989

Parameter	Units	Spike Conc.	LCS Result	LCS % Rec	% Rec Limits	Qualifiers
pH at 25 Degrees C	Std. Units	7	7.0	100	98-102	H6

SAMPLE DUPLICATE: 392990

Parameter	Units	1278220001 Result	Dup Result	RPD	Max RPD	Qualifiers
pH at 25 Degrees C	Std. Units	7.2	7.2	0	10	H6

SAMPLE DUPLICATE: 392991

Parameter	Units	1278201001 Result	Dup Result	RPD	Max RPD	Qualifiers
pH at 25 Degrees C	Std. Units	7.7	7.7	0	10	H6

Results presented on this page are in the units indicated by the "Units" column except where an alternate unit is presented to the right of the result.

QUALITY CONTROL DATA

Project: Camp Ripley MMLF
Pace Project No.: 1278223

QC Batch:	99527	Analysis Method:	EPA 300.0
QC Batch Method:	EPA 300.0	Analysis Description:	300.0 IC Anions

Associated Lab Samples: 1278223001, 1278223002, 1278223003, 1278223004, 1278223005

METHOD BLANK: 395054 Matrix: Water

Associated Lab Samples: 1278223001, 1278223002, 1278223003, 1278223004, 1278223005

Parameter	Units	Blank Result	Reporting Limit	Analyzed	Qualifiers
Chloride	mg/L	ND	1.0	11/08/16 14:58	
Sulfate	mg/L	ND	2.0	11/08/16 14:58	

LABORATORY CONTROL SAMPLE: 395055

Parameter	Units	Spike Conc.	LCS Result	LCS % Rec	% Rec Limits	Qualifiers
Chloride	mg/L	50	50.4	101	90-110	
Sulfate	mg/L	50	49.7	99	90-110	

MATRIX SPIKE & MATRIX SPIKE DUPLICATE: 395056 395057

Parameter	Units	1278220001 Result	MS Spike Conc.	MSD Spike Conc.	MS Result	MSD Result	MS % Rec	MSD % Rec	% Rec Limits	RPD	Max RPD	Qual
Chloride	mg/L	ND	50	50	50.9	51.0	101	101	90-110	0	20	
Sulfate	mg/L	3.9	50	50	54.1	54.5	101	101	90-110	1	20	

MATRIX SPIKE & MATRIX SPIKE DUPLICATE: 395058 395059

Parameter	Units	1278263001 Result	MS Spike Conc.	MSD Spike Conc.	MS Result	MSD Result	MS % Rec	MSD % Rec	% Rec Limits	RPD	Max RPD	Qual
Chloride	mg/L	20.1	50	50	70.6	70.7	101	101	90-110	0	20	
Sulfate	mg/L	157	50	50	206	206	97	98	90-110	0	20	E

Results presented on this page are in the units indicated by the "Units" column except where an alternate unit is presented to the right of the result.

QUALIFIERS

Project:	Camp Ripley MMLF
Pace Project No.:	1278223

DEFINITIONS

DF - Dilution Factor, if reported, represents the factor applied to the reported data due to dilution of the sample aliquot.

ND - Not Detected at or above adjusted reporting limit.

J - Estimated concentration above the adjusted method detection limit and below the adjusted reporting limit.

MDL - Adjusted Method Detection Limit.

PQL - Practical Quantitation Limit.

RL - Reporting Limit.

S - Surrogate

1,2-Diphenylhydrazine decomposes to and cannot be separated from Azobenzene using Method 8270. The result for each analyte is a combined concentration.

Consistent with EPA guidelines, unrounded data are displayed and have been used to calculate % recovery and RPD values.

LCS(D) - Laboratory Control Sample (Duplicate)

MS(D) - Matrix Spike (Duplicate)

DUP - Sample Duplicate

RPD - Relative Percent Difference

NC - Not Calculable.

SG - Silica Gel - Clean-Up

U - Indicates the compound was analyzed for, but not detected.

N-Nitrosodiphenylamine decomposes and cannot be separated from Diphenylamine using Method 8270. The result reported for each analyte is a combined concentration.

Pace Analytical is TNI accredited. Contact your Pace PM for the current list of accredited analytes.

TNI - The NELAC Institute.

LABORATORIES

PASI-DUL	Pace Analytical Services - Duluth
PASI-M	Pace Analytical Services - Minneapolis
PASI-V	Pace Analytical Services - Virginia

BATCH QUALIFIERS

Batch: 446601

[M5]	A matrix spike/matrix spike duplicate was not performed for this batch due to insufficient sample volume.

ANALYTE QUALIFIERS

D6	The precision between the sample and sample duplicate exceeded laboratory control limits.
E	Analyte concentration exceeded the calibration range. The reported result is estimated.
H6	Analysis initiated outside of the 15 minute EPA required holding time.
M1	Matrix spike recovery exceeded QC limits. Batch accepted based on laboratory control sample (LCS) recovery.

QUALITY CONTROL DATA CROSS REFERENCE TABLE

Project: Camp Ripley MMLF
Pace Project No.: 1278223

Lab ID	Sample ID	QC Batch Method	QC Batch	Analytical Method	Analytical Batch
1278223001	**MW-3**	EPA 350.1	99747	EPA 350.1 rev. 2 (1993)	99827
1278223002	**MW-7**	EPA 350.1	99747	EPA 350.1 rev. 2 (1993)	99827
1278223003	**MW-8**	EPA 350.1	99747	EPA 350.1 rev. 2 (1993)	99827
1278223004	**FLD DUP**	EPA 350.1	99748	EPA 350.1 rev. 2 (1993)	99828
1278223005	**Equip Blank**	EPA 350.1	99748	EPA 350.1 rev. 2 (1993)	99828
1278223001	**MW-3**	EPA 353.2 rev. 2 (1993)	99840		
1278223002	**MW-7**	EPA 353.2 rev. 2 (1993)	99840		
1278223003	**MW-8**	EPA 353.2 rev. 2 (1993)	99840		
1278223004	**FLD DUP**	EPA 353.2 rev. 2 (1993)	99840		
1278223005	**Equip Blank**	EPA 353.2 rev. 2 (1993)	99840		
1278223001	**MW-3**	EPA 200.7	99412	EPA 200.7	99477
1278223002	**MW-7**	EPA 200.7	99412	EPA 200.7	99477
1278223003	**MW-8**	EPA 200.7	99412	EPA 200.7	99477
1278223004	**FLD DUP**	EPA 200.7	99412	EPA 200.7	99477
1278223005	**Equip Blank**	EPA 200.7	99412	EPA 200.7	99477
1278223001	**MW-3**	EPA 200.8	99411	EPA 200.8	99476
1278223002	**MW-7**	EPA 200.8	99411	EPA 200.8	99476
1278223003	**MW-8**	EPA 200.8	99411	EPA 200.8	99476
1278223004	**FLD DUP**	EPA 200.8	99411	EPA 200.8	99476
1278223005	**Equip Blank**	EPA 200.8	99411	EPA 200.8	99476
1278223001	**MW-3**	EPA 7470	99825	EPA 7470	99849
1278223002	**MW-7**	EPA 7470	99825	EPA 7470	99849
1278223003	**MW-8**	EPA 7470	99825	EPA 7470	99849
1278223004	**FLD DUP**	EPA 7470	99825	EPA 7470	99849
1278223005	**Equip Blank**	EPA 7470	99825	EPA 7470	99849
1278223001	**MW-3**	EPA 8260B	446601		
1278223002	**MW-7**	EPA 8260B	446601		
1278223003	**MW-8**	EPA 8260B	446601		
1278223004	**FLD DUP**	EPA 8260B	446601		
1278223005	**Equip Blank**	EPA 8260B	446601		
1278223006	**Trip Blank**	EPA 8260B	446601		
1278223001	**MW-3**	SM 2320B	99424		
1278223002	**MW-7**	SM 2320B	99424		
1278223003	**MW-8**	SM 2320B	99424		
1278223004	**FLD DUP**	SM 2320B	99505		
1278223005	**Equip Blank**	SM 2320B	99505		
1278223001	**MW-3**	SM 2510B	99258		
1278223002	**MW-7**	SM 2510B	99258		
1278223003	**MW-8**	SM 2510B	99258		
1278223004	**FLD DUP**	SM 2510B	99258		
1278223005	**Equip Blank**	SM 2510B	99258		
1278223001	**MW-3**	SM 2540D (1997)	99273		
1278223002	**MW-7**	SM 2540D (1997)	99273		
1278223003	**MW-8**	SM 2540D (1997)	99273		

QUALITY CONTROL DATA CROSS REFERENCE TABLE

Project: Camp Ripley MMLF
Pace Project No.: 1278223

Lab ID	Sample ID	QC Batch Method	QC Batch	Analytical Method	Analytical Batch
1278223004	**FLD DUP**	SM 2540D (1997)	99273		
1278223005	**Equip Blank**	SM 2540D (1997)	99273		
1278223001	**MW-3**	SM 4500-H+B	99019		
1278223002	**MW-7**	SM 4500-H+B	99019		
1278223003	**MW-8**	SM 4500-H+B	99019		
1278223004	**FLD DUP**	SM 4500-H+B	99019		
1278223005	**Equip Blank**	SM 4500-H+B	99019		
1278223001	**MW-3**	EPA 300.0	99527		
1278223002	**MW-7**	EPA 300.0	99527		
1278223003	**MW-8**	EPA 300.0	99527		
1278223004	**FLD DUP**	EPA 300.0	99527		
1278223005	**Equip Blank**	EPA 300.0	99527		

CHAIN-OF-CUSTODY RECORD

WO#:1278223 23

PM: MMW Due Date: 11/16/16
CLIENT: WSN

WIDSETH SMITH NOLTING

ALEXANDRIA
610 Fillmore St.
Alexandria, MN 56308-1028
TEL: 320.762.8149
FAX: 320.762.0263

BEMIDJI
315 5th St. NW
Bemidji, MN 56601
TEL: 218.444.1859
FAX: 218.444.1860

BRAINERD/BAXTER
7804 Industrial Park Rd.
Baxter, MN 56425
TEL: 218.829.5117
FAX: 218.829.2517

2
Cro
TI
F/

ENGINEERING ARCHITECTURE

PROJECT NUMBER	0283B0009.016
PROJECT NAME	Camp Ripley MMLF
LOCATION	Randall, MN
SAMPLERS: (Signature)	
SAMPLERS: (Print)	Michael Bogart

SAMPLE DESCRIPTION	DATE	TIME	COMP	GRAB	SAMPLE MATERIAL	NUMBER OF CON-TAINERS	ANALYSES REQUEST: See Attached List	MDH 468 VOC				REMARKS
												All Metals (HNO3) Are Filtered
MW-3	10/31/16	13:35		X	H2O	7	X					
MW-7	10/31/16	14:30		X	H2O	7	X					
MW-8	10/31/16	15:20		X	H2O	7	X					
FLD DUP	10/31/16	/		X	H2O	7	X					
Equip Blank	10/31/16	13:40		X	H2O	7	X					
Trip Blank	10/31/16	/		X	H2O	2		X				

Relinquished by: (Signature)	Date / Time	Received by: (Signature)	Relinquished by: (Signature)	Date / Time	Received by: (Signature)
	11/1/16 13:00				

Relinquished by: (Signature)	Date / Time	Received for Laboratory by: (Signature)	Date / Time	Report To:
			11-2-16 10:30	Greg Smith

SD

Bill To: WSN 0283B0009.016

Distribution: White – Accompanies Shipment; Pink – Project File; Yellow – Laboratory

T=1.2

№ 6566

H:\OFFICE\FORMS\ENVIRO\Chain of Custody Record.doc

1,1,2-Trichloroethane
1,1,2-Trichlorotrifluoroethane
1,1-Dichloroethane
1,1-Dichloroethylene (Vinylidene chloride)
1,1-Dichloropropene
1,2-Dichloroethylene (trans)

Organics (con't.)

1,2-Dichloropropane
1,3,5-Trimethylbenzene
1,3-Dichlorobenzene (meta-)
1,3-Dichloropropane
1,3-Dichloropropene (cis + trans)
1,4-Dichlorobenzene (para-)
2,2-Dichloropropane
2-Chlorotoluene (ortho-)
4-Chlorotoluene (para-)
Acetone
Allyl chloride (3 chloropropene)
Benzene
Bromobenzene
Bromochloromethane (Chlorobromomethane)
Bromodichloromethane (Dichlorobromomethane)
Bromoform
Bromomethane (Methyl bromide)
Carbon tetrachloride
Chlorobenzene (monochlorobenzene)
Chlorodibromomethane (Dibromochloromethane)
Chloroethane
Chloroform
Chloromethane (Methyl chloride)
Cumene (Isopropylbenzene)
Dibromochloropropane (DBCP)
Dibromomethane (Methylene bromide)
Dichlorodifluoromethane
Dichlorofluoromethane
Dichloromethane (Methylene chloride)
Ethyl benzene
Ethyl ether
Hexachlorobutadiene
Methyl ethyl ketone (MEK)
Methyl isobutyl ketone (4-Methyl-2-pentanone)
Methyl tertiary-butyl ether (MTBE)
Naphthalene
1,2,4-Trimethylbenzene
1,2-Dibromoethane (Ethylene dibromide o
EDB)
1,2-Dichlorobenzene (orth-)
1,2-Dichloroethane
1,2-Dichloroethylene (cis-)
n-Butyl benzene
n-Propyl benzene
p-Isopropyltoluene
sec-Butyl benzene
Styrene
tert-Butyl benzene
Tetrachloroethylene (Perchloroethylene)
Tetrahydrofuran
Toluene
Trichloroethylene (TCE)
Trichlorofluoromethane
Vinyl chloride (chloroethene)
Xylenes (mixture of o, m, p)

Inorganics

Alkalinity, total as calcium carbonate
Ammonia Nitrogen
Arsenic, dissolved
Barium, dissolved
Boron, dissolved
Cadmium, dissolved
Chloride
Chromium, total dissolved
Copper, dissolved
Iron, dissolved
Lead, dissolved
Manganese, dissolved
Mercury, dissolved
Nitrate + Nitrite, as N
Sodium, dissolved
Sulfate
Suspended Solids, total
Appearance (b);
Dissolved Oxygen, field
pH (a)
Specific Conductance (a)
Temperature (a)
Turbidity, field
Water Elevation

Parameter Lists for Sampling of Ground Water Monitoring Network

MDH 468 List (Organics)

Analytes

1,1,1,2-Tetrachloroethane
1,1,1-Trichloroethane
1,1,2,2-Tetrachloroethane
1,2,3-Trichlorobenzene
1,2,3-Trichloropropane
1,2,4-Trichlorobenzene

Pace Analytical	Document Name: Sample Condition Upon Receipt Form	Document Revised: 23Feb2015 Page 1 of 1
	Document No.: F-VM-C-001-Rev.09	Issuing Authority: Pace Virginia, Minnesota Quality Office

Sample Condition Upon Receipt

Client Name: Wid seth Smith Nolting

Project #: WO#: 1278223

1278223

Courier: ☐ Fed Ex ☐ UPS ☐ USPS ☐ Client ☐ Commercial ☐ Pace ☒ Other: Sd

Tracking Number:

Custody Seal on Cooler/Box Present? ☐ Yes ☒ No

Seals Intact? ☒ Yes ☐ No

Optional: Proj. Due Date: Proj. Name:

Packing Material: ☐ Bubble Wrap ☐ Bubble Bags ☐ None ☒ Other:

Temp Blank? ☒ Yes ☐ No

Thermometer Used: ☒ 140792808

Type of Ice: ☐ Wet ☐ Blue ☐ None ☒ Samples on ice, cooling process has begun

Cooler Temp Read °C: 0.9

Cooler Temp Corrected °C: 1.2

Biological Tissue Frozen? ☐ Yes ☐ No ☒ NA

Temp should be above freezing to 6°C

Correction Factor: +0.3

Date and Initials of Person Examining Contents: 11-2-16

				Comments:
Chain of Custody Present?	☒ Yes	☐ No	☐ N/A	1.
Chain of Custody Filled Out?	☒ Yes	☐ No	☐ N/A	2.
Chain of Custody Relinquished?	☒ Yes	☐ No	☐ N/A	3.
Sampler Name and Signature on COC?	☒ Yes	☐ No	☐ N/A	4.
Samples Arrived within Hold Time?	☒ Yes	☐ No	☐ N/A	5.
Short Hold Time Analysis (<72 hr)?	☒ Yes	☐ No	☐ N/A	6. PH
Rush Turn Around Time Requested?	☐ Yes	☐ No	☒ N/A	7.
Sufficient Volume?	☒ Yes	☐ No	☐ N/A	8.
Correct Containers Used?	☒ Yes	☐ No	☐ N/A	9.
-Pace Containers Used?	☒ Yes	☐ No	☐ N/A	
Containers Intact?	☒ Yes	☐ No	☐ N/A	10.
Filtered Volume Received for Dissolved Tests?	☒ Yes	☐ No	☐ N/A	11. Note if sediment is visible in the dissolved containers.
Sample Labels Match COC?	☐ Yes	☒ No	☐ N/A	12. Samples Don't Have Analysis on Them and Bottles Aren't marked FF.
-Includes Date/Time/ID/Analysis Matrix: WT				
All containers needing acid/base preservation will be checked and documented in the pH logbook.	☒ Yes	☐ No	☐ N/A	See pH log for results and additional preservation documentation
Headspace in Methyl Mercury Container	☐ Yes	☐ No	☒ N/A	13.
Headspace in VOA Vials (>6mm)?	☐ Yes	☒ No	☐ N/A	14.
Trip Blank Present?	☒ Yes	☐ No	☐ N/A	15.
Trip Blank Custody Seals Present?	☐ Yes	☐ No	☒ N/A	
Pace Trip Blank Lot # (if purchased):				

CLIENT NOTIFICATION/RESOLUTION

Field Data Required? ☐ Yes ☐ No

Person Contacted:

Date/Time:

Comments/Resolution:

FECAL WAIVER ON FILE Y N

TEMPERATURE WAIVER ON FILE Y N

Project Manager Review:

Date: 11/2/16

Note: Whenever there is a discrepancy affecting North Carolina compliance samples, a copy of this form will be sent to the North Carolina DEHNR Certification Office (i.e out of hold, incorrect preservative, out of temp, incorrect containers)

Intra-Regional Chain of Custody

Pace Analytical®
www.pacelabs.com

Workorder: 1278223 **Workorder Name:** Camp Ripley MMLF **Owner Received Date:** 11/2/2016 **Due Date:** 11/16/2016

Received at:

Pace Analytical Virginia
315 Chestnut Street
Virginia, MN 55792
Phone (218) 742-1042

Send To Lab:

Pace Analytical Duluth
4730 Oneota Street
Duluth, MN 55807
Phone (218) 727-6380

Report To:
Melisa M Woods

						Preserved Containers						Requested Analysis												
Item	Sample ID	Sample Type	Collect Date/Time	Lab ID	Matrix	H2SO4						EPA 350.1 rev. 2 (1993)	EPA 353.2 rev. 2 (1993)											LAB USE ONLY
1	MW-3	PS	10/31/2016 13:35	1278223001	Water	\						X	X											
2	MW-7	PS	10/31/2016 14:30	1278223002	Water	\						X	X											
3	MW-8	PS	10/31/2016 15:20	1278223003	Water	\						X	X											
4	FLD DUP	PS	10/31/2016 00:00	1278223004	Water	\						X	X											
5	Equip Blank	PS	10/31/2016 13:40	1278223005	Water	\						X	X											

Transfers	Released By	Date/Time	Received By	Date/Time
1	LCC CP	11/3/16 1400		11/3/16 1400
2		11/3/16 1530		11/3/16 1530
3				
4				

Comments

Cooler Temperature on Receipt 0.4 °C **Custody Seal** [✓ Y] or N **Received on Ice** [✓ Y] or N **Samples Intact** [✓ Y] or N

****In order to maintain client confidentiality, location/name of the sampling site, sampler's name and signature may not be provided on this COC document.*
This chain of custody is considered complete as is since this information is available in the owner laboratory.

Pace Analytical®	Document Name: Sample Condition Upon Receipt Form	Document Revised: 22Jan2016 Page 1 of 1
	Document No.: F-DUL-C-001-Rev.01	Issuing Authority: Pace Virginia, Minnesota Quality Office

mple Condition Jpon Receipt

Client Name: IR COC VIRG.

Project #:

Courier: ☐ Fed Ex ☐ UPS ☐ USPS ☐ Client ☐ Commercial ☒ Pace ☐ Other:

acking Number:

stody Seal on Cooler/Box Present? ☒ Yes ☐ No Seals Intact? ☒ Yes ☐ No

Optional: Proj. Due Date: Proj. Name:

cking Material: ☐ Bubble Wrap ☐ Bubble Bags ☒ None ☐ Other:

Temp Blank? ☒ Yes ☐ No

rmometer Used: ☒ B00051 Type of Ice: ☒ Wet ☐ Blue ☐ None ☒ Samples on ice, cooling process has begun

ooler Temp Read °C: 1.0 Cooler Temp Corrected °C: 0.4 Biological Tissue Frozen? ☐ Yes ☐ No ☒ NA

np should be above freezing to 6°C Correction Factor: -0.6 °C Date and Initials of Person Examining Contents: RK 11/3/16

				Comments:
hain of Custody Present?	☒ Yes	☐ No	☐ N/A	1.
hain of Custody Filled Out?	☒ Yes	☐ No	☐ N/A	2.
hain of Custody Relinquished?	☒ Yes	☐ No	☐ N/A	3.
ampler Name and Signature on COC?	☐ Yes	☐ No	☒ N/A	4.
amples Arrived within Hold Time?	☒ Yes	☐ No	☐ N/A	5.
hort Hold Time Analysis (<72 hr)?	☐ Yes	☒ No	☐ N/A	6.
ush Turn Around Time Requested?	☐ Yes	☒ No	☐ N/A	7.
ufficient Volume?	☒ Yes	☐ No	☐ N/A	8.
orrect Containers Used?	☒ Yes	☐ No	☐ N/A	9.
-Pace Containers Used?	☒ Yes	☐ No	☐ N/A	
ontainers Intact?	☒ Yes	☐ No	☐ N/A	10.
iltered Volume Received for Dissolved Tests?	☐ Yes	☐ No	☒ N/A	11. Note if sediment is visible in the dissolved containers.
ample Labels Match COC?	☒ Yes	☐ No	☐ N/A	12.
-Includes Date/Time/ID/Analysis Matrix: wt.				
ll containers needing acid/base preservation will be hecked and documented in the pH logbook.	☒ Yes	☐ No	~~☒~~ N/A 11/3/16 RK	See pH log for results and additional preservation documentation
eadspace in Methyl Mercury Container	☐ Yes	☐ No	☒ N/A	13.
eadspace in VOA Vials (>6mm)?	☐ Yes	☐ No	☐ N/A	14.
rip Blank Present?	☐ Yes	☐ No	☐ N/A	15.
rip Blank Custody Seals Present?	☐ Yes	☐ No	☐ N/A	
ace Trip Blank Lot # (if purchased):				

IENT NOTIFICATION/RESOLUTION

Field Data Required? ☐ Yes ☐ No

Person Contacted: Date/Time:

Comments/Resolution:

ECAL WAIVER ON FILE Y N

TEMPERATURE WAIVER ON FILE Y N

roject Manager Review: AP for LMF Date: 11-3-16

te: Whenever there is a discrepancy affecting North Carolina compliance samples, a copy of this form will be sent to the North Carolina DEHNR Certification Office (i.e out of d, incorrect preservative, out of temp, incorrect containers)

APPENDIX B

WELL STABILIZATION FORMS

WIDSETH SMITH NOLTING

GROUNDWATER SAMPLING and ELEVATION LOG SHEET

Project Name: Camp Ripley DDLF & MMLF **Project No.** **Location:**

Sampling Date: 10/31/16 **By:** Mike Bogart **Project Manager:**

Sampling Device: **Cleaning Method:**

Purging Method: **Parameter:**

Well Capacity Formula = [ft. H_2O] X [0.16 gals per ft. H_2O (2" well)]

Well No.	T.O.C. Elev.	Depth to Water	G.W. Elev.	Total Well Depth	Water in Casing	Well Capacity	Volume Purged	Color	Turb.	Odor	Time Sampled	Temp	PH	Do	ORP	SpC	Nitrate
DDLF-4		24.16		35.00	10.84	1.73	6.00				11:05						
DDLF-5		27.03		42.00	14.97	2.40	7.50				11:45						
MW-3		22.04		47.00	24.96	4.00	12.00				13:35						
MW-7		26.83		37.00	10.17	1.63	6.00				~~[illegible]~~	14:30					
MW-8		29.54		40.00	10.46	1.67	6.00				15:20						
DDLF-1		28.72															
DDLF-2		19.65															
DDLF-3		27.03															

** Referenced to Top of Well Casing (T.O.C.)*

Comments: MW-7 is FLD DUP Equip Blank 13:40

WIDSETH SMITH NOLTING & ASSOCIATES
MONITORING/TEST WELL STABILIZATION FORM

WIDSETH SMITH NOLTING
Engineering
Architecture
Surveying
Environmental

SITE: Camp Ripley
DATE: 10/31/16
TIME:
SAMPLE DESIGNATION: MW-3
WEATHER CONDITIONS: Overcast
PERSONNEL: MB
PUMP RATE (GPM): 1.00/1.10
WELL DEPTH: 47.00
STATIC LEVEL: 22.04
WELL VOLUME (GAL): 4.00

LOCK:	YES	x	NO	
WELL LABEL:	YES	x	NO	

CONDITION OF WELL: Good
PURGE METHOD: Whale
SAMPLE METHOD: Whale
APPEARANCE: Clear

FIELD DUPLICATE
YES ☐
NO ☒

FLOW CELL USED
YES ☒
NO ☐

EXCEPTIONS TO PROTOCOL: NONE ☐

TIME	TEMP. FAHRENHEIT (+/- 0.5)	SPECIFIC CONDUCTANCE (mS/cm +/- 5%)	DISSOLVED OXYGEN (+/- 0.5 mg/l)	Ph (+/- 0.04 SU)	ORP (mv)	TURBIDITY (+/- 10 NTU)	VOL. REMOVED (gal.)
~~13:20~~	~~50.3~~	~~.258~~	~~.36~~	~~8.08~~	~~231~~	~~39.9~~	~~0.50~~ 4.00
~~13:24~~	~~50.7~~	~~.284~~	~~.36~~	~~8.10~~	~~179~~	~~35.7~~	~~4.00~~ 8.00
~~13:28~~	~~50.2~~	~~.249~~	~~.58~~	~~8.10~~	~~168~~	~~29.6~~	~~7.50~~ 12.00
13:20	49.8	.238	1.48	8.10	160	34.8	4.00
13:24	49.7	.216	1.79	8.10	162	32.5	
13:28	49.8	.208	1.85	8.09	167	30.4	
INITIAL							
2nd RECHARGE							
3rd RECHARGE							

COMMENTS:
TIME SAMPLED 13:35

WIDSETH SMITH NOLTING & ASSOCIATES
MONITORING/TEST WELL STABILIZATION FORM

SITE: Camp Ripley
DATE: 10/31/16
TIME:
SAMPLE DESIGNATION: MW-7
WEATHER CONDITIONS: Overcast / Lt. Rain
PERSONNEL: MB
PUMP RATE (GPM): .50 / .10
WELL DEPTH: 37.00
STATIC LEVEL: 26.83
WELL VOLUME (GAL): 1.63

LOCK:	YES	X	NO	
WELL LABEL:	YES	X	NO	

CONDITION OF WELL: Good
PURGE METHOD: Whale
SAMPLE METHOD: Whale (low Flow)
APPEARANCE: Clear

WIDSETH SMITH NOLTING
Engineering
Architecture
Surveying
Environmental

FIELD DUPLICATE
YES ☒
NO ☐

FLOW CELL USED
YES ☒
NO ☐

EXCEPTIONS TO PROTOCOL: NONE ☐

TIME	TEMP. FAHRENHEIT (+/- 0.5)	SPECIFIC CONDUCTANCE (mS/cm +/- 5%)	DISSOLVED OXYGEN (+/- 0.5 mg/l)	Ph (+/- 0.04 SU)	ORP (mv)	TURBIDITY (+/- 10 NTU)	VOL. REMOVED (gal.)
14:18	50.5	.778	2.21	7.08	273	11.7	2.00
14:22	50.5	.778	2.14	7.07	275	10.6	4.00
14:26	50.5	.777	2.20	7.07	275	10.4	6.00
INITIAL							
2nd RECHARGE							
3rd RECHARGE							

COMMENTS:
TIME SAMPLED 14:30

WIDSETH SMITH NOLTING & ASSOCIATES

MONITORING/TEST WELL STABILIZATION FORM

WIDSETH SMITH NOLTING

Engineering
Architecture
Surveying
Environmental

SITE: Camp Ripley
DATE: 10/31/16
TIME:
SAMPLE DESIGNATION: MW-8
WEATHER CONDITIONS: Overcast / Lt. Rain
PERSONNEL: MB
PUMP RATE (GPM): .50/.10
WELL DEPTH: 40.00
STATIC LEVEL: 29.54
WELL VOLUME (GAL): 1.67

LOCK:	YES	X	NO	
WELL LABEL:	YES	X	NO	

CONDITION OF WELL: Good
PURGE METHOD: Whale
SAMPLE METHOD: Whale
APPEARANCE: Clear

FIELD DUPLICATE
YES ☐
NO ☒

FLOW CELL USED
YES ☒
NO ☐

EXCEPTIONS TO PROTOCOL: NONE ☐

TIME	TEMP. FAHRENHEIT (+/- 0.5)	SPECIFIC CONDUCTANCE (mS/cm +/- 5%)	DISSOLVED OXYGEN (+/- 0.5 mg/l)	Ph (+/- 0.04 SU)	ORP (mv)	TURBIDITY (+/- 10 NTU)	VOL. REMOVED (gal.)
15:04	47.6	.561	6.89	7.58	298	25.8	2.00
15:08	47.6	.562	6.87	7.57	300	23.2	4.00
15:12	47.6	.552	6.83	7.59	301	21.6	6.00
INITIAL							
2nd RECHARGE							
3rd RECHARGE							

COMMENTS:
TIME SAMPLED 15:20

Camp Ripley Training Site Integrated Natural Resource Management Plan

2018-2022

Minnesota Department of Military Affairs

Minnesota Army National Guard

Signature Page for Camp Ripley and AHATS INRMP updates.

Document Title:

2017 Conservation Report

Approval:
Lowell E. Kruse
Brigadier General, Minnesota Army National Guard
Camp Ripley Senior Commander

Signature: Lowell E. Kruse **Date:** 6 Apr 18

Approval:
Mr. Keith Parker
Regional Director
MN-DNR Central Region

Signature: Keith L. [illegible] For Keith Parker **Date:** 2/16/18

Approval:
Mr. Peter Fastbender
Field Supervisor
USFWS , Twin Cities Field Office

Signature: **Date:** 29 March 2018

Update/Review Requirements:

The 2017 Conservation Program Report provides Integrated Natural Resources Management Program (INRMP) accomplishments and therefore represents an annual update to the Camp Ripley Training Center and Arden Hills Army Training Site (AHATS) INRMPs. This report outlines accomplishments for the year of January 1 to December 31, 2017. The report summarizes accomplishments and provides updates to the goals and objectives for the INRMP's of the JFMN (Army). The program areas are as follows: natural resources, cultural resources, flora and fauna surveys, threatened and endangered species management, pest management, noise management, land use management, outreach and recreation.

Document Owner and Office Symbol:
Josh Pennington
MNNG-CRE

Applicability: This document applies to all employees/members of JFMN (Army)

Document History

Document	Effective Date	Update Summary
Camp Ripley INRMP	Jan 2003	2017 Conservation Report
AHATS INRMP	Oct 2007	2017 Conservation Report

Executive Summary

This Integrated Natural Resources Management Plan (INRMP) provides guidance and procedures to enable the Minnesota Army National Guard (MNARNG) to meet its legal responsibilities for managing the natural resources at Camp Ripley. Camp Ripley is a 52,831-acre state owned training site located within Morrison County. An Environmental Assessment was completed in January 1998, with a Finding of No Significant Impact. As a result, this INRMP is an update to the Oct 1997 INRMP for Camp Ripley.
This plan is an update to the INRMP developed in 2003 and is the implementing document for the natural resources management program of MNARNG at Camp Ripley during the period 2018-2022. The INRMP is intended to support and complement the military mission of Camp Ripley while also promoting sound natural resource stewardship principles.

The preparation and implementation of this plan is required by the Sikes Act (16 USC 670a et seq.) and several other Federal directives including regulations and guidance issued by the U.S. (DOD).

The primary mission of MNARNG is to provide the best military training environment possible. The purpose of Camp Ripley is to provide a readily accessible training area to the U.S. Department of Defense (DOD) and other civilian agencies in order to enhance the MNARNG‘s readiness for its federal, state and community mission. Those missions are respectively: respond with active service as directed by the President of the United States in times of national emergency; assist local law enforcement agencies during state emergencies at the direction of the governor; and add value to local communities.

The planning process used in developing this INRMP focused on using key stakeholders from the Minnesota National Guard, the Minnesota Department of Natural Resources, the U.S. Fish and Wildlife Service, and other agencies that have a keen interest in the management of Camp Ripley‘s natural resources. Together, these stakeholders represent the Camp Ripley‘s Integrated Natural Resources Management Planning Committee.

Natural resource management will be driven by the lands primary use, which is military training. The Integrated Training Area Management (ITAM) program and Conservation programs of the MNARNG will be used to manage the cultural and natural resources at Camp Ripley and subsequently implement the INRMP. The ITAM program is the US Army‘s standard for ensuring the sustainability of training lands and management of natural resources to support the military mission. The program is comprised of four components:

Range and Training Land Assessment (RTLA) and Geographic Information System (GIS)
Training Requirements Integration (TRI)
Land Rehabilitation and Maintenance (LRAM)
Environmental Awareness (EA)

The Range and Training Land Assessment program is an ongoing program for inventorying and monitoring the flora and fauna of Camp Ripley. A sub-component of RTLA is the Geographic Information System. GIS is a computer based data management system that allows for the management, analysis, and display of spatial/geographic information. Training Requirements Integration is a program developed to integrate the training mission with natural resource requirements. Land Rehabilitation and Maintenance is an ongoing program whereby erosion control measures and good vegetation management practices are employed to maintain and stabilize the soil. The Environmental Awareness program uses educational material to address environmental issues and provide guidelines to the troops in training, commanders, and the general public. Educational materials include field cards, handbooks, posters, and videotapes.

MNARNG has adopted the Ecosystem Based Management (EBM) approach for managing natural resources. Ecosystem Based Management approaches evolved nationally to meet increasing and often conflicting demands on the nation's natural resource base. The Minnesota DNR defines EBM as ―the collaborative process of sustaining the integrity of ecosystems through partnerships and interdisciplinary teamwork‖. The Department of Defense goal for EBM is ―to ensure that military lands support present and future training and testing requirements while preserving, improving, and enhancing ecosystem integrity‖. The long-term goal is sustainability of Minnesota's ecosystems, the people who live in them, and the economies founded on them.

The overriding direction of the INRMP for Camp Ripley is to “Manage today’s resources for tomorrow’s mission”. This will necessitate that MNARNG strive to not only sustain but also enhance Camp Ripley as a quality military training site. Sustaining natural resources equates to a quality training environment and thereby ensures soldier readiness. This cannot be accomplished independently. MNARNG will rely on its partnership with the Minnesota Department of Natural Resources and other resource agencies in order to fulfill not only its military mission but also its responsibility as good stewards of the land.

The proposed action would have positive cumulative effects on the training sites natural resources and the mission of MNARNG units that utilize the training site because the INRMP consists of numerous activities that have the same goals and objectives of protecting, restoring, and enhancing natural resources at Camp Ripley. Implementation of the INRMP activities would protect, restore, and enhance natural resources at Camp Ripley so that training can occur in a natural environment setting that provides training realism.

Contents

Plan Compliance and Responsibilities

Purpose and Assumptions

The purpose of the Camp Ripley Integrated Natural Resources Management Plan (INRMP) is to provide a comprehensive five-year plan that documents the policies and desired future direction of natural resource programs at Camp Ripley. It is imperative that the plan is consistent with the Site Development Plan (SDP) that the MNARNG has established for Camp Ripley. What‘s more, the INRMP must ensure good stewardship principles for protecting and enhancing natural resources on Camp Ripley. The INRMP focuses on strategic goals, objectives, and policies that will be implemented for each of the natural resource program areas, including the Integrated Training Area Management (ITAM) program components. Several Federal directives including regulations and guidance issued by the U.S. Department of Defense (DOD 4715.3, AR 200-2, AR 200-3) and the Sikes Act (16 USC 670a et seq.) require the preparation and implementation of this plan. The Sikes Act requires an INRMP be developed to ensure no net loss in the capability of military installation lands to support the military mission of the installation‖.

Several important assumptions underlie the development of this plan. The first is that a truly integrated natural resources plan must involve military personnel as primary stakeholders and military training needs must drive the planning process. A second assumption is that the diversity of opinion on military land use needs is adequately represented by staff from the Plans and Training Office and the Camp Ripley Operations Office who are the primary internal stakeholders. A third assumption is that for the development of the revised INRMP, the diversity of public opinion and subject matter expertise in natural resource management is adequately represented by program managers associated with the Planning Committee (Appendix A) who are the primary external stakeholders.

Responsibilities

National Guard Bureau (NGB) Responsibilities

At National Guard Bureau Headquarters, the Chief of the Army National Guard will provide command and technical supervision of the Natural Resources Management Program at installations under their command or jurisdiction. To ensure conservation stewardship and compliance the Chief of the Environmental Programs (NGB-ARE), Chief of Training (NGB-ART) and Chief of Installations and Engineering (NGB-ARI) formed a partnership to implement the ITAM Program. The National Guard Bureau has issued ITAM guidance to the states. The responsibilities for each directorate are:

NGB-ARE staff is responsible for reviewing the INRMP. NGB-ARE is also responsible for managing environmental projects, providing technical assistance and executing funds that support the implementation of INRMP‘s.
NGB-ART staff is responsible for funding and coordinating the ITAM program.
NGB-ARI staff is responsible for providing design and construction support and coordinating proposed construction projects with NGB-ARE and NGB-ART.

MNARNG Responsibilities

The Adjutant General

The Adjutant General (TAG) is ultimately responsible for the operation of Camp Ripley, which includes implementation of this INRMP. As such, TAG ensures that all installation land users are aware of, and comply with, the procedures, requirements, and applicable regulations that accomplish the goals and objectives of the INRMP. The Adjutant General also ensures coordination between MNARNG Directorates with regard to funding, staffing, training, and operation and maintenance of facilities to effectively manage the natural resources on Camp Ripley.

The Adjutant General also provides coordination of Camp Ripley current and planned land uses between those directorates that are in charge of the mission, master planning, environmental management, and legal.

Plans, Operations and Training Officer (POTO)

The Plans, Operations and Training Officer (POTO) have the responsibility for developing current and projected mission requirements, training lands and facility requirements, and coordinating the ITAM program through the Post Commander/Training Site Manager. In addition to scheduling training exercises, the POTO is dedicated to maintaining a high-quality training environment for the MNARNG. Other responsibilities of the POTO include developing a baseline of current and projected training requirements and training lands/facilities for Camp Ripley; assisting the Environmental Office in determining carrying capacity for the installation by providing military usage and training data; and planning for land use based on training requirements while minimizing negative environmental impacts. The ITAM program is integral to fulfilling these responsibilities of the POTO.

Facilities Management Officer (FMO)

The FMO has a full range of responsibilities regarding environmental, financial, construction, engineering, maintenance, and repair of MNARNG facilities. A key responsibility of the FMO is master planning and ensuring that all construction projects comply with environmental regulations. A team of environmental personnel who work directly for the FMO provides statewide support regarding environmental compliance programs and administration of the environmental program. National Environmental Policy Act (NEPA) responsibility rests within the FMO and all staff participate in the environmental review process.

Post Commander

The Camp Ripley Post Commander serves as the training site manager for Camp Ripley. In this capacity, the Post Commander is fully staffed with environmental personnel who have responsibility for all conservation program activities of the MNARNG. In addition to having direct supervision over the Environmental Office, the Post Commander supervises the Operations Office personnel who play a key role in the day-to-day operations of Camp Ripley.

Camp Ripley Operations

The Operations Office has primary responsibility for scheduling of all military and civilian training and for ensuring safety of all personnel while training exercises are being conducted at Camp

Ripley. The Operations Office works in coordination with the Environmental Office and has a direct interface between natural resource management and troops in training. To facilitate a strong working relationship with the Environmental Office, the Operations Office is staffed with a position known as Training Area Coordinator (TAC). The TAC is supported through the ITAM program and is responsible for conducting briefings for military and civilian personnel regarding training area regulations, safety requirements, and specialized environmental management requirements. The TAC essentially bridges the gap between the soldiers and the environment.

Environmental

The Environmental personnel are involved in natural resource planning and implementation for Camp Ripley. This includes, but is not limited to, preparing plans, developing projects, conducting field studies, securing permits, GIS support, preparing reports, and facilitating land use activities between military operations and other natural resource agencies. The environmental personnel who work directly for the Post Commander have full responsibility for MNARNG‘s conservation programs statewide. Environmental personnel who report directly to the FMO have statewide responsibility for MNARNG‘s compliance, restoration and pollution prevention programs statewide.

Public Affairs Officer (PAO)

The PAO serves as the liaison with the public, prepares media presentations, and provides photography support for newsworthy natural resource projects and community events.

Staff Judge Advocate

The Staff Judge Advocate (SJA) has responsibility for all legal requirements as it affects training land use and environmental compliance.

Planning Committee

The planning process used in developing this INRMP focused on using the key stakeholders from the Minnesota National Guard, the MNDNR, the U.S. Fish and Wildlife Service, and other agencies that have a keen interest in the management of Camp Ripley‘s natural resources. Together, these stakeholders represent the Camp Ripley Integrated Natural Resources Management Planning Committee (Appendix A). The primary responsibility of the Planning Committee is to ensure that this INRMP not only satisfies the military mission but also provides a foundation for sound stewardship principles that adequately address the issues and concerns that were raised by all stakeholders. There will be an annual meeting which will review the INRMP and each agency will discuss their accomplishments for that year and their work plans for the next year.

Required and Relevant Environmental Regulations

There are numerous federal and state laws that govern the management of natural and cultural resources on lands that are used by the Department of Defense for training soldiers. The principal law that requires the preparation of an INRMP is the Sikes Act (16 USC 670a et seq.). In the interest of facilitating compliance with the Sikes Act at Army National Guard Training Sites, an All States Memo was prepared by National Guard Bureau. The All States Memo, dated 15 June 2000, provides comprehensive policy guidance to all states that are responsible for preparing an INRMP. Appendix B contains a listing of environmental regulations that impact the development of an INRMP. In accordance with the Sikes Act, this INRMP has been prepared cooperatively with the U.S. Fish and Wildlife Service and the Minnesota Department of Natural Resources (MNDNR).

Environmental Review (NEPA)

The National Environmental Policy Act (NEPA) of 1969 requires federal agencies to consider the potential environmental consequences of proposed actions in the decision making process. The intent of NEPA is to protect, restore and enhance the environment through well-informed federal decisions. The Council for Environmental Quality was established under NEPA to implement and oversee the federal process. The NEPA process involves one of three levels of analysis, as well as accompanying documentation:

A Categorical Exclusion may apply if a proposed action‘s effects are so minor that it is not necessary to prepare an Environmental Assessment or an Environmental Impact Statement. A Record of Environmental Consideration is then prepared and the project may proceed as planned.

An Environmental Assessment (EA) is required when the conditions of a Categorical Exclusion are not met. If analysis of the results of the EA finds that there is no significant impact to the quality of the environment, a Finding of No Significant Impact (FONSI) is issued and then the proposed action may proceed as planned. A 30-day public review period is offered for the EA and, if issued, the FONSI.

An Environmental Impact Statement (EIS) is necessary when any Federal Agency or Department proposes a major federal action significantly affecting the quality of the human environment. An EIS is the typical course of action when an EA does not result in a FONSI.

The National Environmental Policy Act (NEPA) establishes policies and goals for the protection and enhancement of natural resources. The Sikes Act requires that an INRMP, as a proposed federal action, go through the NEPA process. This INRMP requires an environmental review according to NEPA prior to the implementation of the plan objectives. The environmental review will include consultation with Native American Tribes in accordance with the DOD Annotated Policy on Indian Tribes and Alaska Natives (dated 27 October 1999).

Installation Overview

Historic Overview

The historic use of Camp Ripley is an important factor affecting the current condition of the land. In 1920, the Minnesota National Guard was located on a 189-acre site known as Camp Lakeview near Lake City, Minnesota. Because of new technology a larger training site was needed that would be sufficient for all types of military equipment. After a thorough survey, the present site of Camp Ripley was selected as having adequate terrain for training and possibilities of expansion. The new site contained the greater part of what had once been the old 2,000 acre Fort Ripley. It consisted of a highly diversified terrain and was ideal for the training and maneuvering of large numbers of troops.

In June 1931 Camp Ripley was opened to the Minnesota National Guard after the state legislature approved funding for a larger training site. For the next twenty years, Camp Ripley served company and platoon size units of the Minnesota National Guard (Hickok 1987). The training site consisted of approximately 15,275 acres, which is currently the present area south of Normandy road, see Figure (1). During World War II, Camp Ripley was used primarily as a training site for the Minnesota State Guard after the National Guard was federalized. The ranges and other facilities were also used by regular army units stationed at Fort Snelling Minnesota (Hickok 1987). In the early 1950's Camp Ripley's training area expanded 10,396 acres; to approximately 25,671 acres which consisted of the present area south of Lake Alott road as shown in Figure (1). By 1960, Camp Ripley increased in size by 9,134 acres to include the present area between Lake Allot Road and Cassino Road. In the mid to late 1960's the final major additions were made to Camp Ripley. This increased the total acreage to approximately 52,831 acres. The land was purchased by the State of Minnesota and is administered by the Minnesota Department of Military Affairs.

Location and Size

Camp Ripley is located in the central portion of Minnesota approximately 100 miles northwest of the Minneapolis/St. Paul metropolitan area (Figure 2). Camp Ripley lies entirely (with exception of 62 acres in Crow Wing County) within Morrison County and is bordered on the north by the Crow Wing River and on the east by the Mississippi River. The two largest cities within 30 miles of Camp Ripley are Brainerd, located in Crow Wing County, and Little Falls, located in Morrison County. Census shows Brainerd and Baxter to have a combined population of 21,547 (2016 US Census Bureau) and is located 26 miles northeast of Camp Ripley. The Brainerd lakes area is popular with summer tourists; the summer population in the Brainerd area increases by three-fold. Little Falls, with a population of 8,689 (2016 US Census Bureau) is located seven miles south of Camp Ripley. The population of Little Falls increases with summer tourists but not nearly to the extent as Brainerd. Camp Ripley lies within Morrison County and the 8th Congressional District. Camp Ripley occupies a gross area of 52,831 acres, approximately 82.5 square miles. The cantonment area encompasses 2,046 acres of this area. In addition, 1,811 acres of land is not within the posted limits of Camp Ripley. As a result, the net usable training area of Camp Ripley encompasses 48,974 acres of land. Of this amount, 6,380 acres include all impact areas and 42,594 acres are available for a variety of military training exercises.

Training Site Utilization

Camp Ripley was opened to Minnesota National Guard units in 1931, and today is one of eleven National Guard training sites in the United States. Currently, it is the largest state owned military installation. Camp Ripley is utilized throughout the year, and is recognized as one of the primary winter training sites for the National Guard. Camp Ripley is a premier, all season training facility, in support of three missions:

1. Training soldiers for Federal Emergencies at the call of the President
2. Providing support for state emergencies at the call of the State Governor
3. Providing resources that add value for the community.

Camp Ripley supports the federal and state missions for military reserve component training as a 7,800 person, year-round training facility for the National Guard, primarily consisting of units from Minnesota, North Dakota, South Dakota, Wisconsin, Iowa and Illinois. However, other units from throughout the U.S. also choose to train here. Camp Ripley is used for weekend inactive duty training (IDT), two week annual training (AT) and other training activities of both active and reserve components.

Military training is supported by seven broad areas of activity, including maneuver training, weapons familiarization and qualification. The latter includes aviation gunnery and armor gunnery through Tank Table XII, military occupational specialty (MOS) producing and leadership provision of a central maintenance facility, direct service support in all classes of supply, provision of personnel services and chaplain services, and military morale, welfare, and recreation activities.

Civilian training opportunities are focused primarily on law enforcement activities, natural resource education, environmental agencies, and emergency management activities.

The Minnesota National Guard’s strategic plan is to promote Camp Ripley as “The Maneuver Commander’s Training Center of Choice.” As such, the stated mission to accomplish this strategy is threefold including:

1. An all-season training facility
2. A facility for Federal, State and Community agencies
3. A training center capable of supporting military and non-military training, education and support services. Camp Ripley’s primary customers are the military units that utilize Camp Ripley to ensure military readiness.

The demand from military and non-military customers that are training at Camp Ripley has increased about 155% since 2007. This has resulted in an average of 405,637 man-days per year over the last 5-years. The details of this trend are presented in Table 1. The recent increase in man-days was partly due to recent deployments for the global war on terrorism. MNARNG anticipates continued and increased use of Camp Ripley over the next five years as outlined in the Site Development Plan (SDP).

Table 1: Camp Ripley Site Manday Utilization

COMPONENT	2011	2012	2013	2014	2015
Army National Guard	276,480	344,985	347,381	237,589	269,667
Air National Guard	3,081	2,627	2,642	2,147	4,243
Sub-total National Guard	279,561	347,612	350,023	239,736	273,910
Active Duty Army	2,848	8,199	3,707	5,350	20,152
Army Reserve	6,940	10,356	13,703	9,811	6,395
Air Force	1,452	845	2,026	1,597	2,982
Marines	6,932	11,462	10,995	6,364	3,462
Navy	1,235	782	90	520	220
Total DOD	299,490	489,256	364,791	263,558	307,121
Civilian	51,980	56,103	69,023	59,507	51,600
Total DoD and Civilian:	**351,470**	**545,359**	**449,567**	**323,065**	**358,721**

Note: One man-day equals one person training per day

Description of Training Site

Cantonment Area

Camp Ripley's 2,046 acre cantonment area contains the administrative and logistical buildings, troop housing, utilities, and other support facilities for the training site. The cantonment area utilities have all been upgraded within the past 10 years to accommodate higher demand and ensure compliance with environmental regulations. The utilities include electrical power distribution, heating facilities, drinking water system, natural gas system, wastewater treatment facility, stormwater management system, and communication system.

Logistical support services are provided as part of the cantonment area operational activities. Support facilities include warehouses and buildings that store supplies such as ammunition, food, petroleum, and training equipment. The support facilities also include headquarters buildings, troop housing, museum, Medical Unit Training Facility (MUTF), chapel, airfield, Post Exchange, and Camp Ripley Headquarters buildings. The Training Support Unit personnel assigned to Camp Ripley are essential to the operation and maintenance of these support facilities.

The cantonment area also includes several tenant facilities in support of Camp Ripley: CMA North, CMA South, United States Property and Fiscal Office (USPFO), State Director of Logistics (DOL), Facilities Management Office (FMO), Organizational Maintenance Shop (OMS), Regional Training Site Maintenance (RTSM), Regional Training Institute (RTI) and military units assigned to Camp Ripley. The cantonment area also houses the Enforcement Training Center for the Minnesota Department of Natural Resources.

Maneuver Area

Camp Ripley is divided into 12 blocks called maneuver/natural resource management areas (Table 2). These areas were defined through interpretation of infrared aerial photography, study of maps and databases, and discussions between environmental staff and military operations personnel. They integrated expected military use, natural ecosystems, multiple natural resource potentials, and natural resource policy applications within contiguous land units. This co-process of natural resource planning and site development planning has resulted in defined maneuver area boundaries identical to the larger natural resource management areas. Operational scheduling and control of Camp Ripley for military training is accomplished by dividing these Natural Resource Management Units/Maneuver Areas into numbered subunits (also called Training Areas). There are currently 80 training areas established.

Control and scheduling for all uses of Camp Ripley will be accomplished using the Range Facility Management Support System (RFMSS). RFMSS is a computerized scheduling system used to schedule training areas, facilities and ranges.

The scheduling and subsequent land use activities at Camp Ripley will be monitored for each individual training area. Additionally, implementation of this INRMP will be monitored for each training area to ensure compatibility of the training mission with sound natural resource management practices. Each training area has a designated training area number. A description of each training area to include military use, land use and restrictions are provided in the Trainers Handbook.

Table 2. Maneuver Areas/Natural Resource Management Units

Maneuver Area	A	B	C	D	E	F	G	H	I	J	K1	K2
Size (Acres)	2,046	4,001	5,358	9,559	3,478	7,117	3,015	2,123	3,807	2,032	6,391	2,093
MILITARY USE												
Wooded / on-Trail Maneuver	None	Very High	Med.	Very High	None	Low-Med.	Low	None	Med.	Low	High	Med.
Wooded / off-Trail Maneuver	None	Low-Med.	Low	Med.	None	Very Low	None-Low	None	Low	None-Low	Med.	Very Low
Open Field / on-Trail Maneuver	None	High	Low	High	None	Low	None-Low	None	High	None-Low	High	Very Low
Open Field / off-Trail Maneuver	None	High	Low	High	None	Low	None-Low	None	High	None-Low	Very High	Very Low
Assembly/Bivouac	Very High	High	Low	High	None	Low	Very Low	None	High	None-Low	Very High	Med.
# Mortar Points	0	0	0	17	0	7	0	0	12	0	1	2
# Artillery Points	0	11	1	29	0	6	0	0	6	1	41	0
Roads (mi/mi2)	10.2	5.6	3.7	4.9	.9	3.2	2.3	0	5.1	2.1	4.8	2.9
% Area in Ranges	0%	6%	15%	21%	100%	7%	0%	100%	5%	1%	2%	0%
PHYSIOGRAPHY												
Average Slope	2.5%	6.9%	6.0%	7.6%	11.2%	15.1%	20.9%	11.1%	6.4%	4.6%	10.2%	17.8%
Percent of area <8%	97%	71%	54%	72%	44%	26%	5%	35%	73%	40%	52%	11%
VEGETATION												
Open Grass / Brush	--	28%	9%	34%	--	7%	2%	--	28%	2%	18%	3%
Aspen / Birch	--	23%	21%	28%	--	50%	24%	--	23%	22%	46%	17%
Oak / Hardwoods	--	23%	11%	27%	--	34%	60%	--	14%	4%	8%	73%
Jack Pine	--	6%	1%	0%	--	0%	0%	--	14%	1%	14%	0%
Red / White Pine	--	4%	2%	1%	--	2%	0%	--	7%	0%	7%	2%
Misc. Forest	--	1%	0%	0%	--	0%	0%	--	0%	0%	0%	0%
No Data	99%	1%	5%	1%	92%	0%	1%	81%	1%	0%	0%	0%
Wetlands	1%	13%	51%	9%	8%	7%	14%	19%	13%	71%	7%	5%
TOTAL	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

Impact Areas

Approximately 6,380 acres comprise all impact areas on Camp Ripley. The north impact area, known as Leach contains 2,123 acres whereas the south impact area known as Hendrickson contains 3,478 acres. 779 acres of Hole in a Day and A-9 complex make up the remaining dud zone areas. The impact areas are restricted use areas because they may contain unexploded ordinance from weapon systems ranging from 60 mm mortars to 155 mm howitzers.

Ranges

Camp Ripley has 51 ranges; several can be used for small arms and larger caliber weapons. Below Table 3 contains information regarding Camp Ripley's current ranges and training facilities:

Table 3: Camp Ripley Range and Training Facilities

Range	Description
A-1	Small Arms Known Distance Range/25m Zero Range-32 Firing Points
A-2	Combat Pistol Qualification Range (CPQR)-15 Firing Points
A-3	Automatic Record Fire (ARF) Range-16 Firing Points
A-4	Automatic Field Fire (AFF) Range-16 Firing Points
A-5	Military Operations on Urbanized Terrain (MOUT) Assault Course
A-6	Confidence Obstacle Site
A-7	Rappel Tower and Practice Tower
A-9	M203/M320 Grenade Launcher Range-5 Firing Points
A-10	Hand Grenade Qualification Course and Practice Lane
A-11	Ferrell Lake Navigation Course
A-12	25 meter Zero Range-32 Firing Points
A-13	EFMB Litter Obstacle Course
A-14	Live Fire Facility (Shoot House)
A-15	Field Leader Reaction Course
ARNO DZ	Air Drop Zone
B-1	25 meter Zero Range-32 Firing Points
B-2	25 meter Zero Range-32 Firing Points
B-2 SHOOTHOUSE	Military Operations on Urbanized Terrain (MOUT) Assault building
B-3	Gettysburg Road Land Navigation Course
B-4	Mounted Land Navigation Course
B-5	Land Navigation Course
B-6	Engineer Dig Site
B-7	Land Navigation Course
B-8	Tactical Mine Lane
BENNET HILL	3 Ski Runs/1 Tubing Run with Tow Rope
BREACH	Live-Fire Exercise Breach Facility
C	NBC Course
CACTF	Combined Arms Collective Training Facility (MOUT)
CENTER (CRG)	Multi-Purpose Training Range (MPTR)/Scout Recce Range (SGRC)
CLF	Convoy Live Fire Exercise
CTF	Collective Training Facility (MOUT)
D	Shotgun/Pistol Marksmanship Range: South Firing Line=40 Firing Points/North Firing Line=20 Firing Points

DEMO-2	OP-2 Field Demolitions Site
DEMO-4	SEAL CABIN Field Demolitions Site
DEMO-5	Light Demolitions Range
DEMO-6	TA75 Field Demolitions Site
DT-1	Vehicle Driver Training Course
DT-2	Vehicle Driver Training Course
DT-3	Vehicle Driver Training Course
EAST (ERG)	Multi-Purpose Training Range (MPTR)
EVOC	Emergency Vehicle Operators Course
F	Biathlon Course-31 Firing Points/25 meter Zero Range-29 Firing Points/Tactical Training Base
FARP	Forward Area Refueling Point
F&M-1	Fire and Movement Range
F&M-2	Fire and Movement Range
HGR	Hand Grenade Range (Live Grenade Familiarization)
IPBC	Infantry Platoon Battle Course
ISBC	Infantry Squad Battle Course
J	Multi-Purpose Field Fire Range (200m Firing Line)
K	Multi-Purpose Field Fire Range
L	Heavy Demolitions Range
M	25m Zero-32 Firing Points
MK-19	MK-19 Multi-Purpose Gunnery Range (40mm TP ONLY)
MSTC	Medical Simulation Training Center
NORTH (NRG)	Multi-Purpose Machine Gun Range(MPMG); 6 Lanes (lanes 2-5 equipped with 1500m targets)
NRG ECP	Entry Control Point (ECP) Trainer Lane
OP-1	Observation Point
OP-1.5	Observation Point
OP-2	Observation Point
OP-16	Observation Point
OP-19	Observation Point
OP-23	Observation Point
R	Vehicle Recovery Site
React to Contact	IED-Defeat Lane
RIPLEY DZ	Air Drop Zone
SEAL Cabin	Non-Standard Small Arms Range
Scaled Range	Scaled Vehicle Mounted Weapon Systems Course
TUAS	Tactical Unmanned Aircraft System Runway
UAC	Urban Assault Course-Station 3 is the Grenadier Gunnery Trainer (40mm TP ONLY)
W-1	Ferrell Lake Pontoon Bridge Site
W-2	Mississippi River Ribbon Bridge Site
WEST (WRG)	Multi-Purpose Machine Gun (MPMG) Range/Heavy Sniper Lane/Sniper Field Fire
Y-1	Tactical Training Base
Y-2 EAST	Tactical Training Base
Y-2 WEST	Tactical Training Base
Y-4	Tactical Training Base

Philosophy of Land Management at Camp Ripley

The overall philosophy and primary purpose of the INRMP is to implement and defend mission activities. In other words, natural resource management is predicated on the primary land use of Camp Ripley; which is military training. This will be accomplished by using an ecosystem based management approach towards managing natural resources and by implementing the Integrated Training Area Management (ITAM) program. This approach will ensure the sustainability of training lands and resources of Camp Ripley for future generations.

Ecosystem Based Management is a holistic approach towards managing a resource where all parties have an opportunity to provide input in management decisions. The increased operational tempo of military activities has placed more pressure on training lands. Past and continued degradation of natural resources can have a negative effect on the realism of future training exercises.

To meet all environmental laws and regulations the U.S. Army Construction Engineering Research Laboratory (USACERL) has developed the ITAM program. The ITAM program is a comprehensive tool that consists of five components necessary to maintain and improve the condition of natural resources. The five components are as follows:

1. **Range and Training Land Assessment (RTLA)**
   Formerly referred to as the Land Condition Trend Analysis (LCTA), the RTLA program is an ongoing program for land inventory and monitoring.
2. **Land Rehabilitation and Maintenance (LRAM)**
   LRAM is an ongoing program whereby erosion control measures and good vegetation management practices are employed to maintain and stabilize the soil.
3. **Training Requirements Integration (TRI)**
   TRI is a program developed to integrate the training mission with the natural resource requirements.
4. **Sustainable Range Awareness (SRA**)
   Formerly referred to as the Environmental Awareness (EA), the SRA program uses educational material to address environmental issues and provide guidelines to the troops in training, commanders and the general public. Educational materials include field cards, handbooks, posters and videotapes.
5. **Geographic Information System (GIS)**
   GIS is a computer-based program developed to assist in resolving complex land management problems. Data depicting a variety of environmental attributes can be prepared, displayed and analyzed to guide land use decisions.

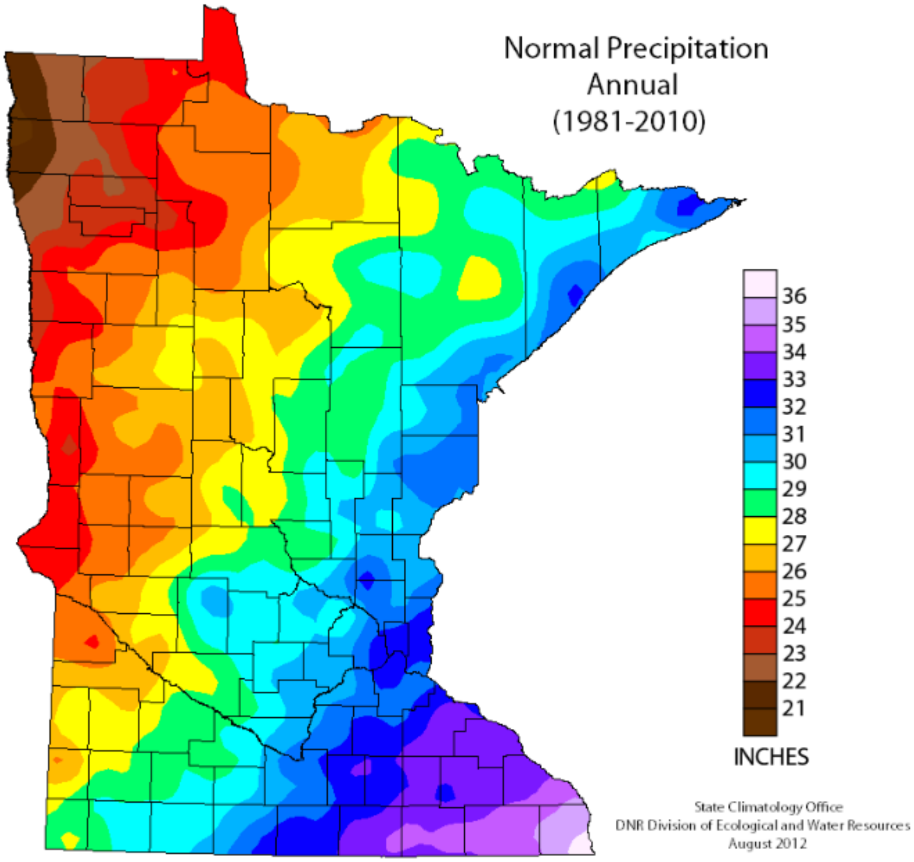
Environmental Overview

Climate

Minnesota has a continental-type climate and is subject to frequent outbreaks of continental polar air throughout the year, with occasional Arctic outbreaks during the cold season. Occasional periods of prolonged heat occur during summer, particularly in the southern portion of Minnesota, when warm air pushes northward from the Gulf of Mexico and the southwestern United States. Pacific Ocean air masses that move across the Western United States produce comparatively mild and dry weather at all seasons. The freeze-free (air temperatures greater than 32° F) growing season generally starts about the second week of May in the south and the first of June in the north and ends about mid-September in the north and during the first week of October in the south. The average growing season is 140 to 150 days for Camp Ripley. For the most part, native vegetation grows for seven months (April to October) and row crops grow for five months (May through September).

Precipitation

The mean annual precipitation at Camp Ripley is approximately 27.5 inches. Approximately two-thirds of the annual precipitation occurs during the growing season from May through September. Thunderstorms are the principal source of precipitation during this time. Normal Precipitation Annual from 1981-2010 is illustrated in figure 1.



State Climatology Office
DNR Division of Ecological and Water Resources
August 2012

Figure 1: Normal Precipitation

Snow Cover

Camp Ripley also receives precipitation in the form of snow. The mean annual snowfall for Camp Ripley is about 47.5 inches. Snow cover of one inch or more over the State occurs on an average of about 110 days annually. Heavy snowfalls of greater than 4 inches are common any time from mid-November through mid-April. Heavy snowfalls with blizzard conditions affect the State on the average about two times each winter. Blizzard conditions are when visibilities are reduced to less than ¼ mile for several hours due to falling and/or blowing snow. Figure 2 depicts Normal Snowfall Annual from 1981-2010:

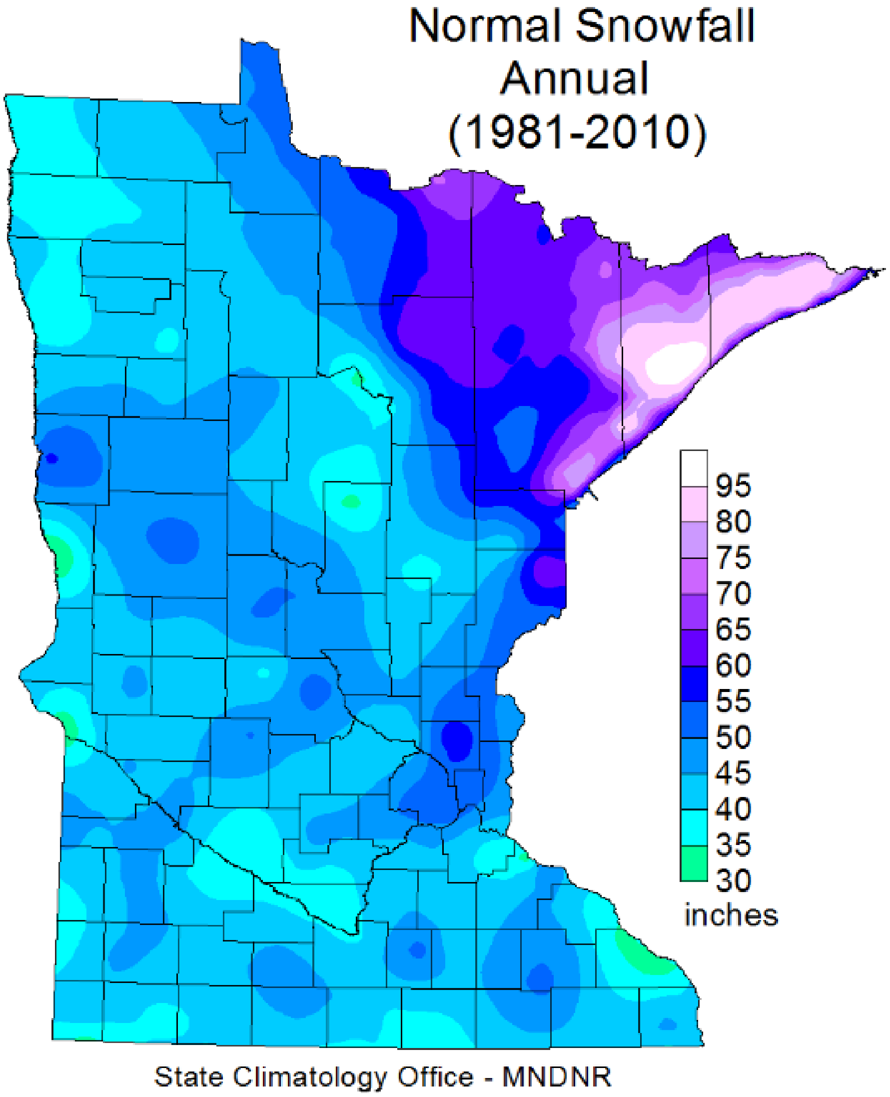


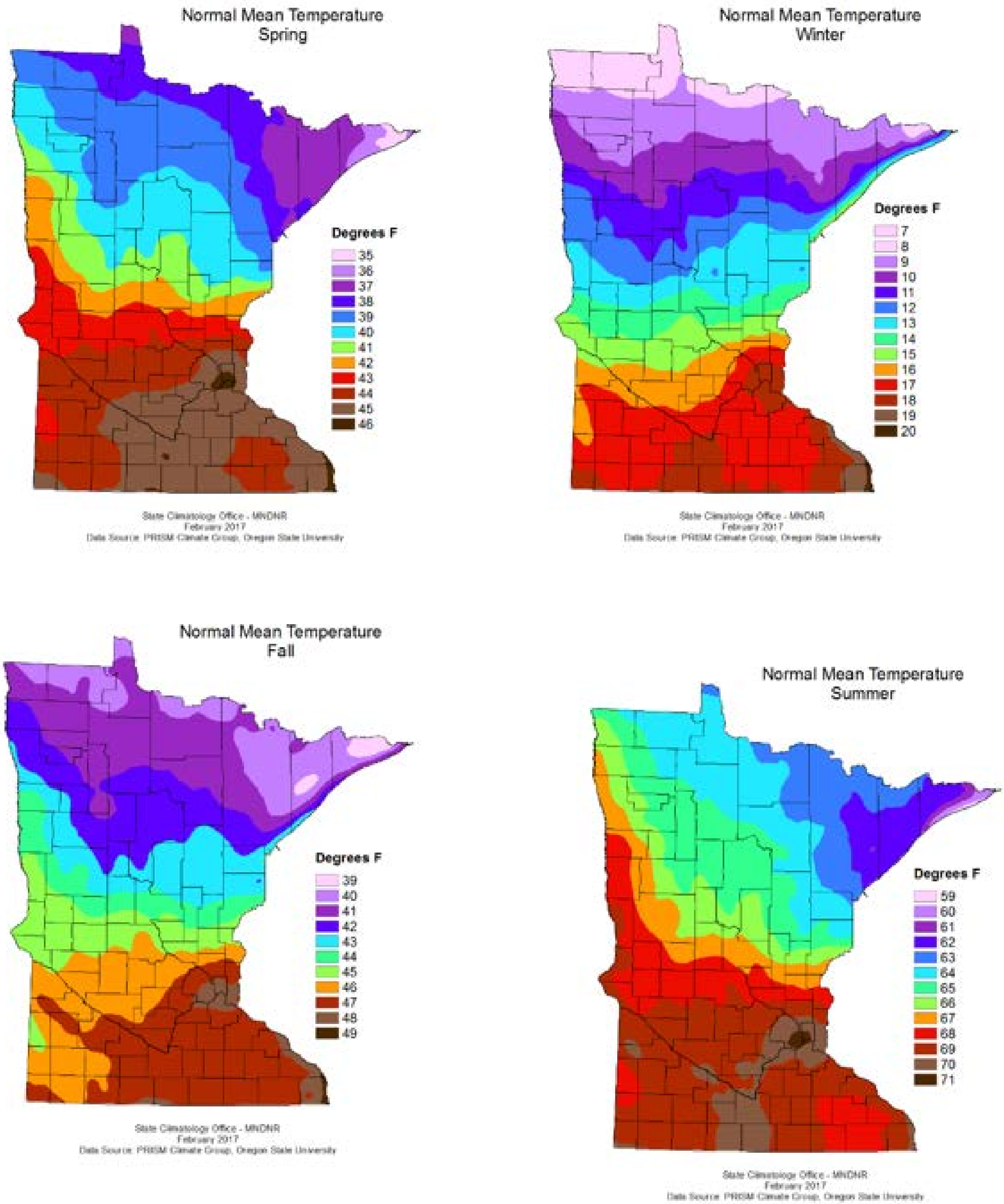
Figure 2: Annual Snowfall

Temperature

The mean annual temperature at Camp Ripley is 41.3 degrees Fahrenheit; however, the temperature variation season to season is quite extreme. The normal mean temperature for the four seasons over the most recent normal period 1981-2010 was winter, 13 degrees Fahrenheit; spring, 42 degrees Fahrenheit; summer, 67 degrees Fahrenheit; and fall, 43.5 degrees Fahrenheit (State Climatology Office DNR Division of Ecological and Water Resources 2012).

Winters are cold, but strong winds and high humidity are generally absent on the coldest days. The normal winter will have normal minimum temperatures of 3 degrees Fahrenheit and normal maximum temperatures of 23 degrees Fahrenheit. The coldest official temperature is - 41 degrees Fahrenheit. Spring, summer and fall temperatures are temperate. Prolonged periods of hot and humid weather are infrequent. The normal summer will have normal minimum temperatures of 55.5 degrees Fahrenheit and normal maximum temperatures of 78 degrees Fahrenheit. The record highest temperature is 101 degrees Fahrenheit. The daily high is approximately 22 degrees higher than the nightly low.

Seasonal Normal Mean Temperature from 1981-2010 is illustrated in figure 3:



Normal Mean Temperature Spring

State Climatology Office - MNDNR
February 2017
Data Source: PRISM Climate Group, Oregon State University

Normal Mean Temperature Winter

State Climatology Office - MNDNR
February 2017
Data Source: PRISM Climate Group, Oregon State University

Normal Mean Temperature Fall

State Climatology Office - MNDNR
February 2017
Data Source: PRISM Climate Group, Oregon State University

Normal Mean Temperature Summer

State Climatology Office - MNDNR
February 2017
Data Source: PRISM Climate Group, Oregon State University

Figure 3: Seasonal mean temperatures

Wind & Sky Cover

In general, northwesterly winds prevail from October until April and southerly winds predominate during the remainder of the year. The average wind speed throughout the year is 8.9 mph (NOAA 1998). The mean sky cover during daylight hours is 62 percent. The monthly values vary from 52 percent in July and August to 71 percent in November and December. During a typical year there are about 100 clear days, 110 partly cloudy days and 155 cloudy days.

Geomorphology & Slope

The surface landscape of Camp Ripley resulted from geologically young glacial deposits, also called overburden, estimated to be between 50 and 400 feet thick. Camp Ripley is located in the Pine Moraine ecological landscape region of Minnesota and has four distinct landforms.

Mississippi Sand Plain
St. Croix Moraine
Steep Outwash
Lake Randall and Swanville Complex of Spillways

The Mississippi Sandplain lies along the eastern edge of Camp Ripley and consists of sandy, well drained soils. The majority of Camp Ripley consists of the St. Croix Moraine complex, which contains complex slopes with high relief and unconnected potholes and drainage. The highest elevation in Morrison County is approximately 1550 feet and occurs in Camp Ripley within this landform. The Steep Outwash landform occurs in the northwestern portion of Camp Ripley. This landform is associated with the edges of the St. Croix moraine and consists of complex and simple slopes with strong relief and undrained potholes. This topography is considered very young in geological terms. Soils are sandy and range from well drained to poorly drained. The remaining landform is the Lake Randall and Swanville Complex of Spillways. This landform is found in the southwest portion of Camp Ripley and consists of low lying, very poorly drained organic soils occupying scoured channels and lakebeds. The area is of very low relief with a high water table. Areas of high silt and clay content are also associated with this landform.

According to the Natural Resource Conservation Service (NRCS) soil survey, high-relief landforms such as moraines and eskers cover about 51 percent of Camp Ripley. Low-relief landforms such as outwash plains, old lakebeds and alluvium cover about 40 percent. The remaining 9 percent are level organic and water features. Landform classes are graphically depicted in Figure 4.

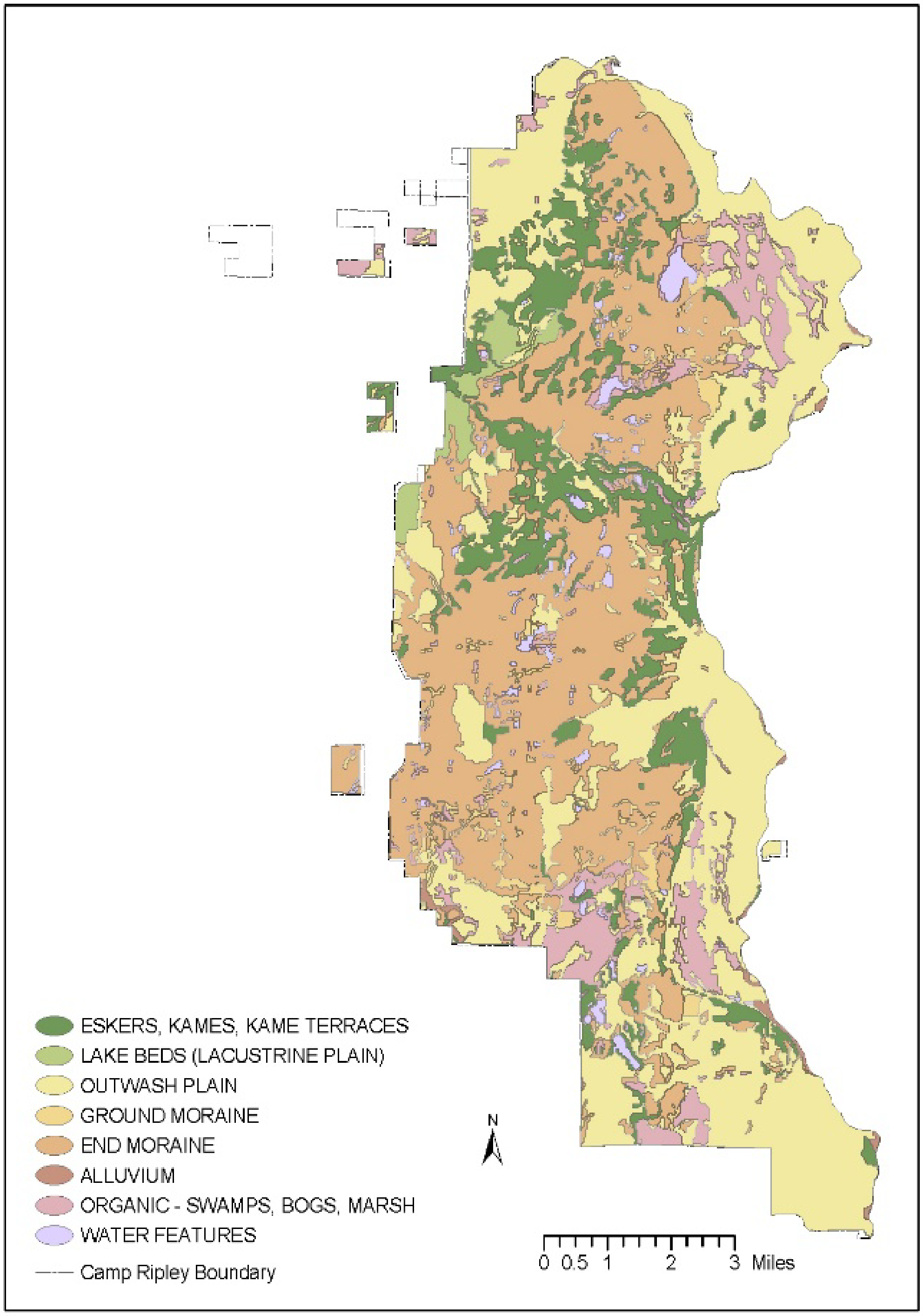


Figure 4: CRTC landforms

Based upon the NRCS soil survey, low dominant terrain slopes of 8 percent grade relief and less are found on 51 percent of the installation. Moderate slopes between 8 to 25 percent grade relief are found on 33 percent of the area and steep slopes greater than 25 percent cover 7 percent of Camp Ripley. The remaining 9 percent of the area is level organic soils and water. Slope classes are graphically depicted in Figure 5.

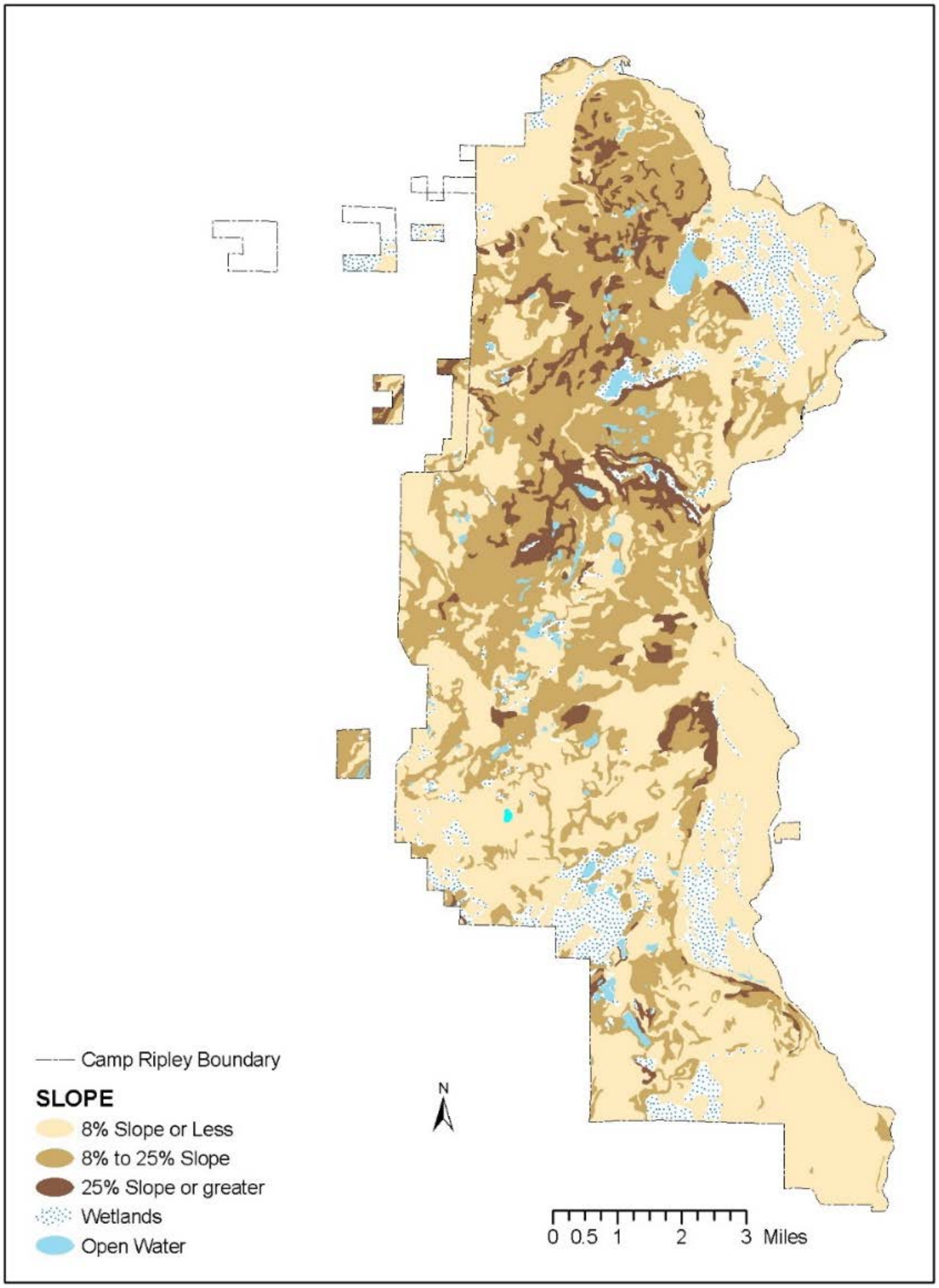


Figure 5: CRTC Slopes

Soils

There are three soil associations within Camp Ripley (Figure 6). Soil Associations

Cushing-Mahtomedi-DeMontreville complex
Mahtomedi-Menagha Association
Hubbard-Duelm-Isan Association

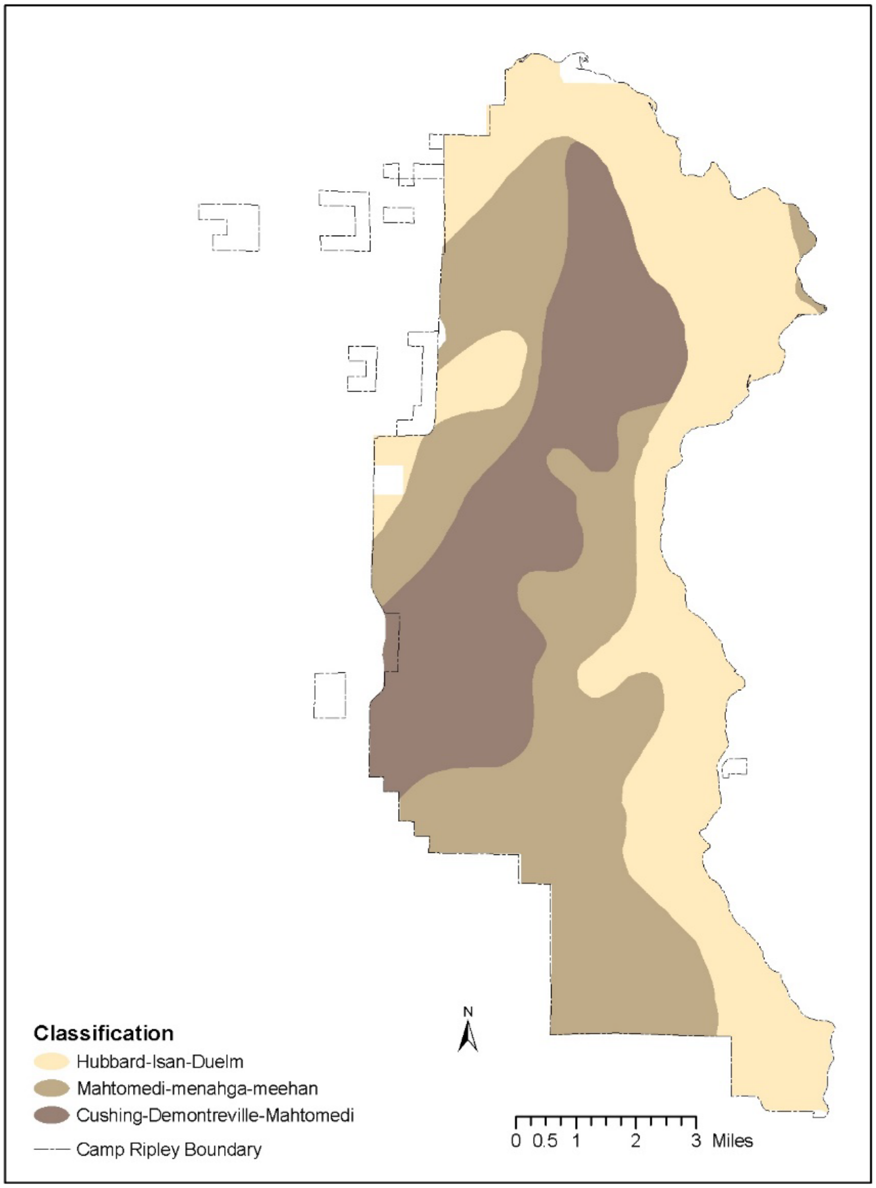


Figure 6: CRTC Soil Associations

The Cushing-Mahtomedi-DeMontreville soil complex is located in a band of upland area that cuts diagonally across Camp Ripley from northeast to southwest. This soil is mapped as a complex because these soils are so small in size or so elaborately mixed that it is impractical to separate them. This complex contains about 40% Cushing soils, 25% Mahtomedi soils, 20%

DeMontreville soils and 15% minor soils. This type of occurrence is attributable to the textural variance of the glacial till parent material, as well as the uneven geomorphic surface that is associated with the St. Croix end moraine. The organic matter content of the Cushing-Mahtomedi-Demontreville soils is low.

The Cushing soils surface layer consists of a very fine sandy loam about five inches thick. The eight inches of subsurface is sandy loam. The subsoil, about 23 inches in depth is brown sandy loam in the upper portion and brown loam in the lower portion. The underlying material, to a depth of at least 60 inches, is brown sandy loam.
Permeability of this soil is moderate in the upper portion and moderately slow in the lower portion. Water capacity is moderate.

The Mahtomedi soils surface layer consist of loamy sand about five inches thick. The five inch thick subsurface layer is loamy or course sand. The subsoil, which varies from 12 to 28 inches in thickness consists of gravelly course sand. The underlying material, to a depth of at least 60 inches, is yellowish-brown gravelly sand. Water infiltration rates are rapid and this soil has a low water holding capacity.

The DeMontreville soils surface layer consists of loamy fine sand about six inches thick. The 21 inch thick subsurface layer is loamy sand. The underlying material to a depth of 60 inches is sandy loam.

The Mahtomedi-Menagha soil association is generally found on the side slopes of moraines or the adjacent outwash plains. The Mahtomedi-Menagha association contains approximately 45% Mahtomedi and 40% Menagha soils. The Mahtomedi soils have been previously described.

The Menahga soils surface layer consists of loamy sand about two inches thick. The three inch thick subsurface layer is sand. The underlying material, which reaches a depth of at least 60 inches, is sand. Similar to the Mahtomedi soils, the water infiltration rate is rapid and has a low water holding capacity.

The Hubbard-Duelm-Isan soil association is primary associated with flat outwash plains of the Mississippi and Crow Wing Rivers. This soil association contains about 48% Hubbard soils, 20% Duelm soils, 12% Isan soils and 20% minor soils. The surface layer for this association consists of loamy sand about seven to nine inches thick. The four to five inch thick subsurface layer is also loamy sand. The subsoil is about 23 inches of sand. The underlying material, to a depth of 60 inches, is brown coarse sand. The water infiltration rate is rapid and this soil has a low water holding capacity.

Natural Resources

Within each of the four principal program areas (Water Resources, Flora, Fauna, Threatened & Endangered (T&E species) and Land Use), specific resource information is provided based on the current situation. During the planning process a list of issues and concerns were identified for each of the principal program areas. The issues and concerns were generated based on past planning activities and research projects. In addition, the Planning Committee and other stakeholders also provided invaluable information in this regard based on their personal experiences and commitments at Camp Ripley.

Water Resources

Camp Ripley is home to an outstanding array of water bodies including small inland lakes, wetlands and streams, which make up 1,054 acres of Camp Ripley's 53,000 acres. Eighteen miles of Mississippi River frontage and 12 miles of Crow Wing River frontage also form the eastern and northern borders of Camp (figure 7). Most of these waters are not subject to active management by CRE personnel, however water control structures and mitigation have been conducted at some sites and others are managed for recreational access.

Miller Lake

Miller Lake is a 27-acre basin with a 1,405 acre watershed that drains via Broken Bow Creek into the Mississippi River. Miller Lake's culvert (#376) was replaced in November 2012 and a water control structure was added. CRE staff maintained the water level control system in accordance with the plan approved by the DNR Fish and Wildlife Division and the DNR Nongame Wildlife Program (MNDNR 2013a). The managed water level has been maintained at approximately 1211.95' in elevation. Between 2012 and the fall of 2014 beaver activity had become an issue. Beavers had raised the water levels to about 20 inches above optimal levels. No nuisance beaver activity was noted in Miller Lake during 2017.

Mississippi River

Four picnic and camping areas are maintained along the river which allow for access to the excellent fishing opportunities found in the Mississippi. This pristine stretch of river is home to a number of popular game fish species including muskellunge (Esox masquinongy), northern pike (Esox Lucius), walleye (Sander vitreus) and smallmouth bass (Micropterus dolomieu).

Lake Alott

This 40 acre lake located in Training Area 36 has a fishing access with boat ramp and dock maintained on the north side. Small boats are stored at this landing for use by soldiers. With a maximum depth of 30 feet Lake Alott is home to a number of popular game fish species including northern pike, walleye, bluegill (Lepomis macrochirus) and black crappie (Pomoxis nigromaculatus).

Fosdick Lake

This 26 acre lake located in Training Area 50 has a fishing access with a dock maintained on the northeast side. With a maximum depth of about 10 feet Fosdick is home to a number of popular game fish species including walleye, largemouth bass (Micropterus salmoides) and black crappie.

Round Lake

This 127 acre lake located on the western edge of Camp Ripley has a fishing access with a boat ramp and a dock maintained on the east side. Boats and camp sites are also maintained at this land site for use by soldiers. There is also a public water access maintained by the DNR on the west side of the lake. With a maximum depth of about 19 feet, Round Lake is home to a number of popular game fish species including walleye, muskellunge, northern pike, largemouth bass and black crappie.

Rapoon Lake

This 16 acre lake located in Training Area 75 has a fishing access on the northeast side. With a maximum depth of about 24 feet, Rapoon is home to a number of popular game fish species including walleye, muskellunge and smallmouth bass.

Ferrell Lake

This 51 acre lake located in Training Area 5 has a fishing access with boat ramp and dock maintained on the southwest side. Small boats are stored at this landing for use by soldiers. With a maximum depth of about 10 feet, Ferrell is home to a number of popular game fish species including northern pike, walleye, bluegill and black crappie.

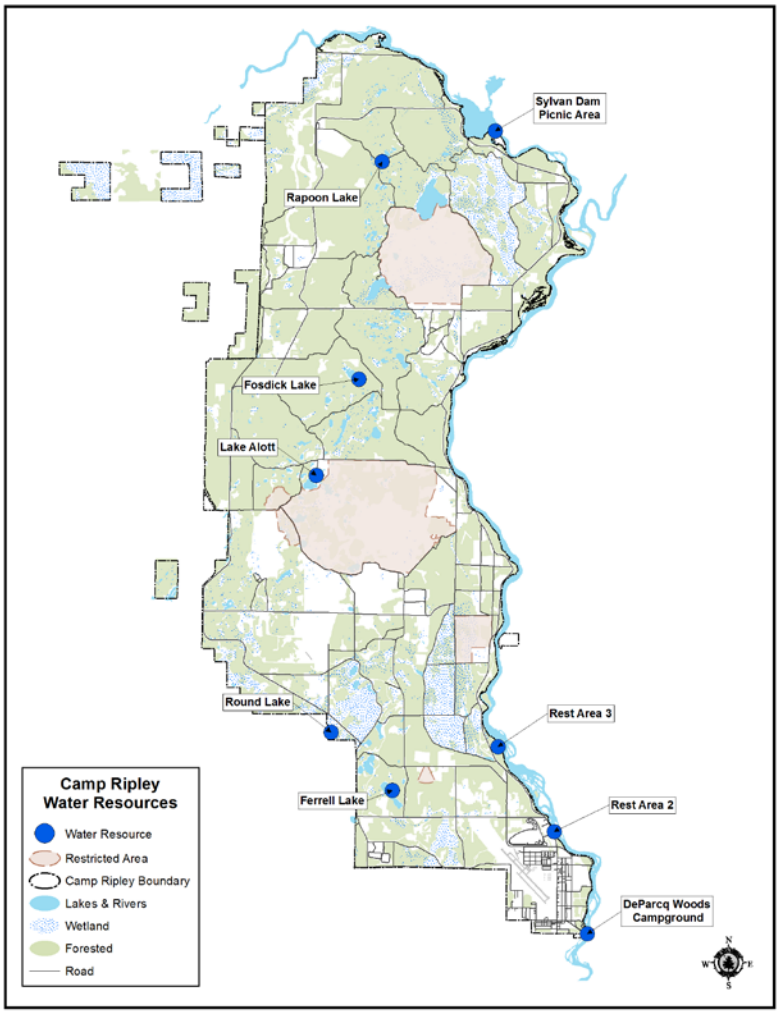


Figure 7: CRTC Water Resources

Flora

A native plant community is a group of native plants that interact with each other and with their environment in ways not greatly altered by modern human activity or by introduced organisms. These groups of native plant species form recognizable units, such as oak savannas, pine forests, or marshes, that tend to repeat over space and time. Native plant communities are classified and described by considering vegetation, hydrology, landforms, soils, and natural disturbance regimes. The ten preliminary plant communities identified on Camp Ripley are illustrated in figure 8.

The Range and Training Land Assessment (RTLA) program, a long-term environmental monitoring program, was initiated at Camp Ripley in 1991. RTLA is a program that provides for inventorying and monitoring biological and physical resource data as a means of quantifying the condition of the land. The program‘s primary function is to evaluate and monitor the impact of military activities on natural resources. Under this system, permanent study plots were established to monitor various vegetation and land use parameters, the plots are referred to as core and special use plots, a total of 81 core and 113 special use plots have been established.

Forest Management History

Forest planning on Camp Ripley dates back to the early 1970‘s. Resource managers developed harvesting plans consistent with forest regulation models developed to optimize commercial value from the aspen and pine forests. Much of the early planning, harvests, and regeneration efforts were aimed at insuring a healthy turnover of the resource in an attempt to provide a continued forest resource. Military trainers and managers did not greatly influence the intended direction of Camp Ripley‘s future forest. Today military training needs drive the overall planning efforts to sustain the character and nature of the forested area on Camp Ripley. Due to this input, the forest cover on Camp Ripley is maintained at extended rotation age in order to maintain a mature growth stage and limit understory. This has been accomplished by designing timber harvests which discourage coppice regeneration and encourage longer aged trees to thrive using selective harvest techniques.

Forest management activities are guided under the objectives described in the Camp Ripley forest management plan.

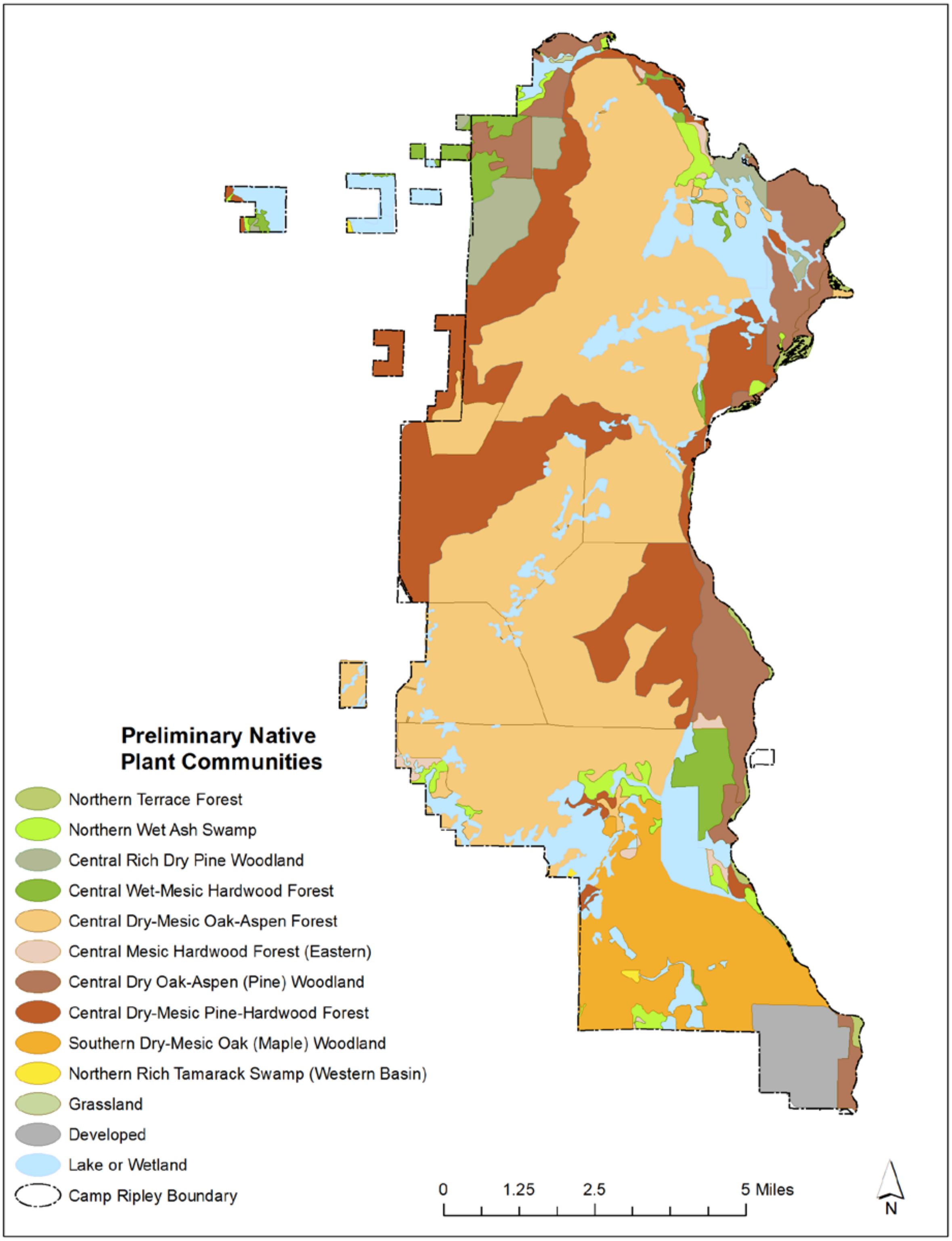


Figure 8: CRTC Native Plant Communities

Grasslands

In August 1997, The Land Condition-Trend Analysis (LCTA) field crew inventoried Camp Ripley‘s grasslands. Using the 1996 Forest Resource Inventory (FRI) as a base, all grasslands labeled ―upland grasses‖ were designated as potential native grasslands. A total of 82 grasslands encompassing 2787 acres were inventoried.

Camp Ripley uses prescribed fire as a management tool to enhance the military training environment, also known as mission-scape. Prescribed fire target objectives include native prairie grass enhancement, woody encroachment prevention, seed production, brush control, fuel-hazard reduction, forest management and habitat improvement for species in greatest conservation need (SGCN). The management strategy for prescribed fire on Camp Ripley is provided within the Integrated Wildland Fire Management Plan (MNARNG 2009a).
Two types of prescribed burns are conducted at Camp Ripley: hazard reduction and training enhancement.

Wetlands “Water”

According to the National Wetlands Inventory (NWI), Classification of Wetlands and Deepwater Habitats (Cowardin et al. 1979), Camp Ripley has 7372.67 acres of wetland. In September 1995 a project to create a more detailed coverage of wetland delineation was implemented. Wetland boundaries were identified using global positioning systems. An additional 1456.26 acres of Camp Ripley were identified as new or existing wetlands. The new wetlands were not classified. Of the 7372.67 acres of NWI, the largest wetland type is (PSS) with 4214.26 acres, or 57%, of the total wetland acres. Type (PEM) wetlands, are the next most prominent wetland with 1128.62 acres, or 15%, of the total wetland acres. The other remaining wetland classifications include (PFO) 961.29 acres, (PUB) 534.43 acres, (L1UB) 513.97 acres and (R2UB) 20.1 acres. Total wetland acres on Camp Ripley is 8828.93.

Listed below is the National Wetlands Inventory Mapping Code Descriptions from the NWI Classification of Wetlands and Deepwater Habitats (Cowardin et al. 1979). Only the mapping code descriptions that are found on Camp Ripley are listed below (figure 9).

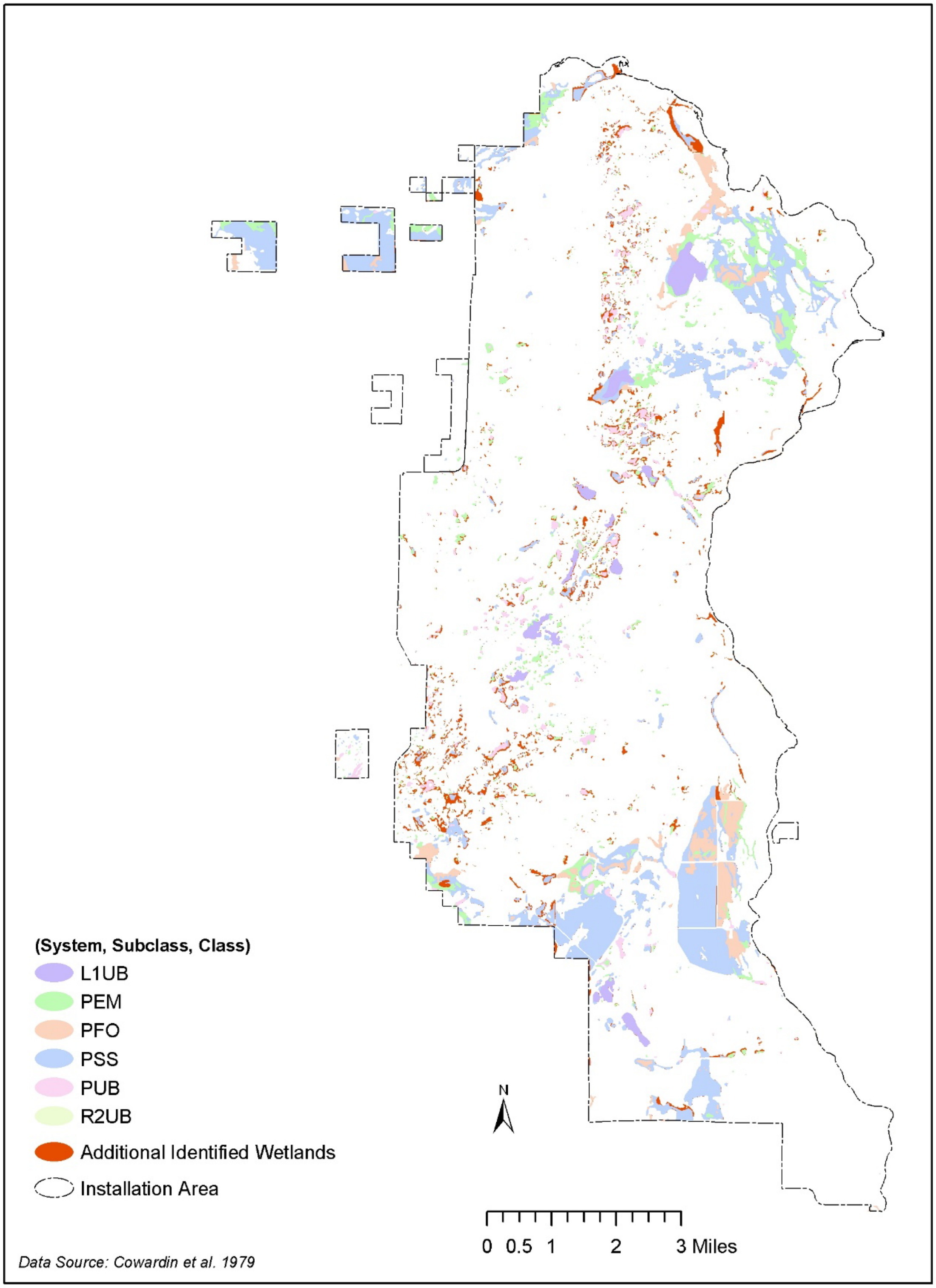


Figure 9: CRTC Wetlands

NWI Classifications that exist on Camp Ripley

Systems

1.) Riverine (R)
(rivers, creeks and streams) - Riverine Systems are contained in natural or artificial channels periodically or continuously containing flowing water. Upland islands or Palustrine wetlands may occur in the channel, but they are not part of the Riverine System.

2.) Lacustrine (L)
(lakes and deep ponds) - Lacustrine System include wetlands and deepwater habitats with all of the following three characteristics: 1) Situated in a topographic depression or a dammed river channel; 2)Lacking trees, shrubs, persistent emergents, emergent mosses or lichens with greater than 30 percent aerial coverage; 3)Total area exceeds 8 hectares (20 acres). Basins or catchments less than 8 hectares in size are included if they have at least one of the following characteristics: A wave-formed or bedrock feature forms all or part of the shoreline boundary; or the catchment has at low water a depth greater than 2 meters (6 feet) in the deepest part of the basin.

3.) Palustrine (P)
(shallow ponds, marshes, swamps and sloughs) - Palustrine Systems include all nontidal wetlands dominated by trees, shrubs, persistent emergents, emergent mosses or lichens, and all such wetlands that occur in tidal areas where salinity due to ocean-derived salts is below 0.5 ppt. Wetlands lacking such vegetation are also included if they exhibit all of the following four characteristics: 1)Are less than 8 hectares (20 acres); 2)Do not have an active wave- formed or bedrock shoreline feature; 3)Have at low water a depth less than 2 meters (6 feet) in the deepest part of the basin; 4)Have a salinity due to ocean-derived salts of less than 0.5 ppt. All water bodies that are less than 8 hectares (20 acres) in size are considered to be in the Palustrine System unless depth information is available, or unless an active wave-formed or bedrock shoreline is visible.

Subsystems

1.) Lower Perennial (R)
This Subsystem is characterized by a low gradient and slow water velocity. There is no tidal influence, and some water flows throughout the year. The substrate consists mainly of sand and mud. The floodplain is well developed. Oxygen deficits may sometimes occur.

2.) Upper Perennial (R)
This Subsystem is characterized by a high gradient and fast water velocity. There is no tidal influence, and some water flows throughout the year. The substrate consists of rock, cobbles, or gravel with occasional patches of sand. There is very little floodplain development.

3.) Intermittent (R)
This Subsystem includes channels that contain water only part of the year, but may contain isolated permanent pools when the flow stops.

4.) Unknown Perennial (R)
This Subsystem designation was created specifically for use when the distinction between lower perennial, upper perennial and tidal cannot be made from aerial photography and no collateral data is available.

5.) Limnetic (L)
Extends outward from Littoral boundary and includes deepwater habitats within the Lacustrine System.

6.) Littoral (L)
Extends from shoreward boundary to 2 meters (6 feet) below annual low water or to the maximum extent of non- persistent emergents, if these grow at greater than 2 meters.

Classes

1.) Rock Bottom (RB)
Includes all wetlands and deepwater habitats with substrates having aerial cover of stones, boulders or bedrock 75 percent or greater and vegetative cover of less than 30 percent. Subclasses include: RB1 = Bedrock & RB2 = Rubble.

2.) Unconsolidated Bottom (UB)
Includes all wetlands and deepwater habitats with at least 25 percent cover of particles smaller than stones (less than 6-7 cm.), and a vegetative cover less than 30 percent.

3.) Aquatic Bed (AB)
Includes wetlands and deepwater habitats dominated by plants that grow principally on or below the surface of the water for most of the growing season in most years. Subclasses include: AB1 = Algal, AB2 = Aquatic Moss, AB3 = Rooted Vascular, AB4 = Floating Vascular, AB5 = Unknown Submergent & AB6 = Unknown Surface.

4.) Open Water/Unknown Bottom (OW)
Open water, no visible vegetation. Earlier maps used the OW class, while present mapping conventions use the UB class.

5.) Rocky Shore (RS)
High energy shoreline characterized by bedrock, stones or boulders which singly or in combination have an aerial cover of 75 percent or more and an aerial coverage by vegetation of less than 30 percent. Subclasses include: RS1 = Bedrock & RS2 = Rubble.
6.) Unconsolidated Shore (BB, FL)
Includes all wetland habitats having unconsolidated substrates with less than 75 percent aerial cover of stones, boulders or bedrock and less than 30 percent aerial cover of vegetation other than pioneering plants. Landforms such as beaches, bars, and flats are included in the Unconsolidated Shore Class.

7.) Streambed (SB)
Includes all wetland contained within the Intermittent Subsystem of the Riverine System and all channels of the Estuarine System or of the Tidal Subsystem of the Riverine System that are completely dewatered at low tide. Subclasses include: SB1 = Bedrock, SB2 = Rubble, SB3 = Cobble-Gravel, SB4 = Sand, SB5 = Mud, SB6 = Organic & SB7 = Vegetated (pioneer plants).

8.) Emergent (EM)
Characterized by erect, rooted, herbaceous hydrophytes, excluding mosses and lichens. This vegetation is present for most of the growing season in most years. Subclasses include: EM1 = Persistent (plants that normally remain standing at least until the beginning of the next growing season) & EM2 = Nonpersistent (plants which fall to the surface of the substrate or below the

surface of the water at the end of the growing season). Earlier maps may also contain the following subclasses: EM3 = Narrow-leaved Nonpersistent, EM4 = Broad-leaved Nonpersistent, EM5 = Narrow-leaved Persistent & EM6 = Broad-leaved Persistent.

9.) Scrub-Shrub (SS)
Woody vegetation less than 6 meters (20 feet) tall. The species include true shrubs, young trees (saplings) or trees that are small or stunted because of environmental conditions. Subclass determination is based on which type represents more than 50 percent of the aerial canopy coverage during the leaf-on period and include: SS1 = Broad- leaved Deciduous, SS2 = Needle-leaved Deciduous, SS3 = Broad-leaved Evergreen, SS4 = Needle-leaved Evergreen, SS5 = Dead, SS6 = Deciduous (used if deciduous woody vegetation cannot be identified on aerial photography as either Broad-leaved or Needle-leaved) & SS7 = Evergreen (used if evergreen woody vegetation cannot be identified on aerial photography as either Broad-leaved or Needle-leaved).

10.) Forested (FO)
Woody vegetation less than 6 meters (20 feet) tall. The species include true shrubs, young trees (saplings) or trees that are small or stunted because of environmental conditions. Subclass determination is based on which type represents more than 50 percent of the aerial canopy coverage during the leaf-on period and include: FO1 = Broad- leaved Deciduous, FO2 = Needle-leaved Deciduous, FO3 = Broad-leaved Evergreen, FO4 = Needle-leaved Evergreen, FO5 = Dead, FO6 = Deciduous & FO7 = Evergreen.

11.) Moss-Lichen (ML)
Areas where mosses or lichens cover substrates other than rock and where emergents, shrubs, or trees make up less than 30 percent of the aerial cover. Subclasses include: ML1 = Moss & ML2 = Lichen.

Invasive Species

Invasive species are non-native species that harm economic, environmental or human health. These species are a threat to the ecological function of areas around the world due to their capability to change the biotic and abiotic characteristics of their environment (U.S. Department of Agriculture 2009). The MNARNG is required by state and federal regulations to prevent the introduction of invasive species; detect and respond rapidly to and control populations of such species in a cost-effective and environmentally sound manner; monitor invasive species populations accurately and reliably; provide for restoration of native species and habitat conditions in ecosystems that have been invaded; conduct research on invasive species and develop technologies to prevent introduction and provide for environmentally sound control of invasive species; and promote public education on invasive species and the means to address them.

Fauna

Threatened and Endangered Species

There are two federally listed species on Camp Ripley. The gray Wolf and the Northern Long eared bat. Since 2001, Camp Ripley has supported two or three wolf packs. At the beginning of 2017, two radio-collared wolves remained on Camp Ripley. Due to a federal court decision, wolves in the western Great Lakes area (including Michigan, Minnesota and Wisconsin) were relisted under the Endangered Species Act, effective December 19, 2014. Wolves continue to be federally classified as threatened in Minnesota. In January 2010, the U.S. Fish and Wildlife Service (USFWS) received a petition from the Center for Biological Diversity requesting that the northern long-eared bat be listed as threatened or endangered under the Endangered Species Act and to designate critical habitat. The USFWS announced on October 2, 2013 (USNARA 2013), that listing the northern long-eared bat was warranted and proposed to list it as endangered throughout its range, which includes Minnesota. However, the USFWS listed the northern long-eared bat as “threatened” under the federal Endangered Species Act in April 2015, largely due to the impact of white-nose syndrome on bat populations. A threatened species is an animal or plant that is likely to become endangered within the foreseeable future throughout all or a significant portion of its range. On April 27, 2016, the USFWS determined that designating critical habitat for northern long-eared bat was not prudent (USFWS 2016b, 2016c).

Species in Greatest Conservation Need

Eighty-eight and 63 species in greatest conservation need (SGCN) have been identified at Camp Ripley. Additional research will be directed toward identifying other SGCN species and management or conservation actions that could be implemented to benefit these species. Camp Ripley songbird surveys were conducted on 90 permanent plots; a total 994 birds of 76 different species were recorded. A satellite radio-transmittered female golden eagle again traveled to her summer habitat above the Arctic Circle, where she occupied her nesting territory. Additional species were monitored including osprey, eastern bluebirds, trumpeter swans, bald eagles, owls and ruffed grouse.

“Minnesota defines species in greatest conservation need (SGCN) as native animals, nongame and game, whose populations are rare, declining or vulnerable to decline and are below levels desirable to ensure their long-term health and stability. Also included are species for which Minnesota has a stewardship responsibility. Stewardship species are those for which populations in Minnesota represent a significant portion of their North American breeding, migrating or wintering population, or species whose Minnesota populations are stable, but whose populations outside of Minnesota have declined or are declining in a substantial part of their range” (MNDNR 2015a).

One of the federal requirements of the Comprehensive Wildlife Conservation Strategy is to manage SGCN by developing a wildlife action plan. “Minnesota’s Wildlife Action Plan, 2015 – 2025” (MNDNR 2015a) is Minnesota’s response to the congressional mandate. The goal of the wildlife action plan is to 1) ensure the long-term health and viability of Minnesota’s wildlife, with a focus on species that are rare, declining or vulnerable to decline; 2) enhance opportunities to enjoy SGCN and other wildlife and to participate in conservation; and 3) acquire the resources necessary to successfully implement the Minnesota Wildlife Action Plan. Additional surveys, monitoring and research will be directed toward identifying other SGCN species on Camp Ripley, and management or conservation actions that could be implemented to benefit these species.

Of the over 2,000 known native wildlife species in Minnesota, 346 species from all major taxonomic groups meet the definition of species in greatest conservation need. All federal and state endangered, threatened and special concern species are included on the SGCN list. Five taxonomic groups have one-third or more of their total species found in Minnesota as SGCN, they are mammals (38%), reptiles (50%), amphibians (36%), tiger beetles (46%) and mussels (60%) (MNDNR 2015a). Eighty-eight SGCN species have been identified on Camp Ripley, including 63 bird species of which 31 are songbirds

Camp Ripley entered into a cooperative agreement with MNDNR in 1989, to institute a comprehensive survey of Camp Ripley‘s flora and fauna. The Minnesota County Biological Survey (MCBS) conducted baseline flora and fauna surveys within the Camp Ripley Military Installation during 1991 and 1992, which provided an inventory of Camp Ripley‘s plants, birds, mammals, herpetofauna, fish, butterflies, riverine mussels and aquatic invertebrates. Camp Ripley provides habitat for a variety of wildlife species including approximately 202 birds, 51 mammals, 23 reptiles and amphibians and 56 species of fish. Additional studies have been conducted at Camp Ripley, through partnerships with the University of Minnesota (red-shouldered hawk, black bear, gray wolf), North Dakota State University (Blanding‘s turtle), and additional Minnesota State Colleges and Universities.

Population studies of fauna will be an ongoing part of the installation's INRMP. Future studies will be funded through the ITAM and Conservation programs, the Federal Reserve Account, MNARNG or by university or other group volunteers on an as-needed basis. The data obtained will be used to help manage the natural resources on Camp Ripley.

Archery Hunt

An annual archery hunt has been held on Camp Ripley since 1954. The hunt is one of the largest archery deer hunts in the United States. It draws national attention due to Camp Ripley‘s healthy deer population and the opportunity to pursue one of Ripley‘s notoriously large bucks. Traditionally 2,000 to 4,000 hunters participate in either of the two 2-day seasons.

Disabled American Veteran Deer Hunt

Camp Ripley has held a Disabled Veteran Deer Hunt since 1992. Hunters are accompanied by volunteers, and escorted to semi-permanent blinds established throughout the southern third of Camp Ripley. This two-day season in October is generally very successful, with an average success rate of 26.8% (Table 15). Participation by the MNDNR, the Veterans Administration Hospital of St. Cloud, Camp Ripley Staff and many volunteers make this an enjoyable and rewarding experience for our Disabled Veterans.

Youth Hunt

Camp Ripley hosted its first youth archery hunt for white-tailed deer in October of 2002. One hundred and 30 alternates, ranging from ages 12-17, were selected for the hunt. Each hunter is required to have an adult mentor who accompanies him or her into the field but not actually hunt. Eighty-seven participated in the hunt, 13 deer were harvested. Refer to table 16 for harvest information.

Land Use

Introduction

Camp Ripley Training Center is the primary training site for the 34th ID's four Combat Brigades; the 1/34 ABCT, 34th CAB, the 84th Troop Command, and the 347th RSG. In addition, 1-145th CAB from the OH ARNG is a perennial user of the installation. The 175th Regional Training Institute (RTI), a Camp Ripley tenant, conducts OES, NCOES, MOSQ, and other Adjutant General directed missions. Today, the 2nd BN (GS) teaches 68W (Combat Medic) courses, 11B (Infantry) MOST and 11B30 courses along with 19D (Armor/Cavalry Scout) courses and Maneuver Advanced Non-Commissioned Officer training. RTI's 1st BN is the TRADOC accredited Center of Excellence Region E headquarters for Officer Candidate School (OCS) and Warrant Officer Candidate School (WOCS). The Regional Training Site Maintenance conducts 16 separate Ordnance courses to include 91 series MOSQ, NCOES, and Senior Leaders Course. The RTS-M also conducts Track and Wheel Recovery, Unit Armor sustainment, MRAP drivers training and maintenance course and the FMTV maintenance course, as well as providing pre-mobilization training and operates as a full time schoolhouse that is also nationally recognized as a Center of Excellence through TRADOC. Based on the doctrinal maneuver area requirements generated by these primary users, Camp Ripley is currently deficient in maneuver area acreage.

Lying at the transition between the Eastern Broadleaf Forest and Northern Laurentian Mixed Forest eco-regions, Camp Ripley is ecologically important and highly diverse. As the largest area of intact wildlife habitat in Morrison County it provides habitat for a variety of species including approximately 600 plants, 202 birds, 51 mammals, 23 reptiles and amphibians and 56 species of fish. In addition the State of Minnesota has designated Camp Ripley as a state game refuge, the largest in the state.

Existing and Proposed Land Use

Improvements to the maneuver area will be geared toward more usage by heavy mechanized units. These improvements are intended to meet current and projected training requirements. The improvements will allow higher quality training while sustaining the environment. No new land acquisition is required and existing land will be sculpted to improve available terrain. Existing roads and trails will be upgraded to accommodate mechanized maneuvers. Road networks will need significant maintenance in the next few years to meet the demands of increased soldier/unit use. New maneuver corridors have been constructed to provide commanders with alternatives, enhancing the decision- making process. Unlike current conditions, alternative maneuver corridors will be available to enhance training realism. Assembly areas, military objectives, and defensive positions will be created.

Developing new ranges and training opportunities while improving existing ones is also a part of the proposed action. The proposed actions will keep pace with weapons and vehicles associated with the Army's mechanized and tank divisions. Figure 32 depicts the 38 locations of these proposed improvements to the maneuver area. Details regarding facility developments and improvements throughout the cantonment and maneuver area are provided in the Site Development Plan.

Public Use Management (recreation)

The MNARNG is responsible for the protection and management of the natural and cultural resources at Camp Ripley. The MNARNG may restrict public access to Camp Ripley when conducting military training in order to provide for a safe training environment for the public and the soldiers.

There are also many opportunities for the public to access and use Camp Ripley. Currently there are several recreational activities that occur at Camp Ripley, they consist of cross country skiing, deer and turkey hunts for currently serving and disabled or retired service members, fishing, bird watching, white pine walking trail, the environmental classroom, Deparcq Woods and Round Lake Camp Grounds.

Camp Ripley Army Compatible Use Buffer

In 2004, the MNARNG approved moving forward with the Camp Ripley Army Compatible Use Buffer (ACUB) Program between the MNDMA and the MNDNR. In 2006, this interagency partnership included the Board of Water and Soil Resources (BWSR) integrating their Reinvest in MN (RIM) easement program to be locally delivered by the Morrison Soil and Water Conservation District. The ACUB initiative is referred to as the “Central Minnesota Prairie to Pines Partnership...preserving our heritage” and is intended to maximize the compatibility of land use adjacent to Camp Ripley and thereby sustain not only the military mission but also the natural environment that Camp Ripley has been nationally recognized for. One of the largest threats to both the mission of Camp Ripley and the surrounding natural landscape is encroachment. Central Minnesota’s population has grown by 140,000 residents between 2000 and 2016. A nearly 23% increase in population in counties such as Benton, Cass, Chisago, Crow Wing, Isanti, Kanabec, Mille Lacs, Morrison, Pine, Sherburne, Stearns, Todd, Wadena and Wright.

A ten-mile buffer was originally selected for the study area for the ACUB boundary based on documented noise complaints. Noise is a significant encroachment issue, the projected noise contours attributable to blast and airfield noise. The ACUB boundary was narrowed to lands that lie within unacceptable noise contour zones (zone 1, 2 and 3) that extend beyond the boundary of Camp Ripley. The noise contours were developed through a noise model prepared by the U.S. Army Public Health Command as part of Camp Ripley’s Environmental Noise Management Plan. The approved ACUB boundary allows for fee and easement acquisitions within a three-mile buffer area surrounding Camp Ripley. This buffer represents 110,000 acres with an end state goal of protecting 75% or 78,000 acres of the buffer. Figure 10 is a representation of the current status of the ACUB program as of January 2018. Parcels in red have fee or conservation easements in place that restrict further development. Parcels in pink are landowners that have expressed interest in the program and are awaiting execution. Limiting factors to execution is primarily the availability of funding.

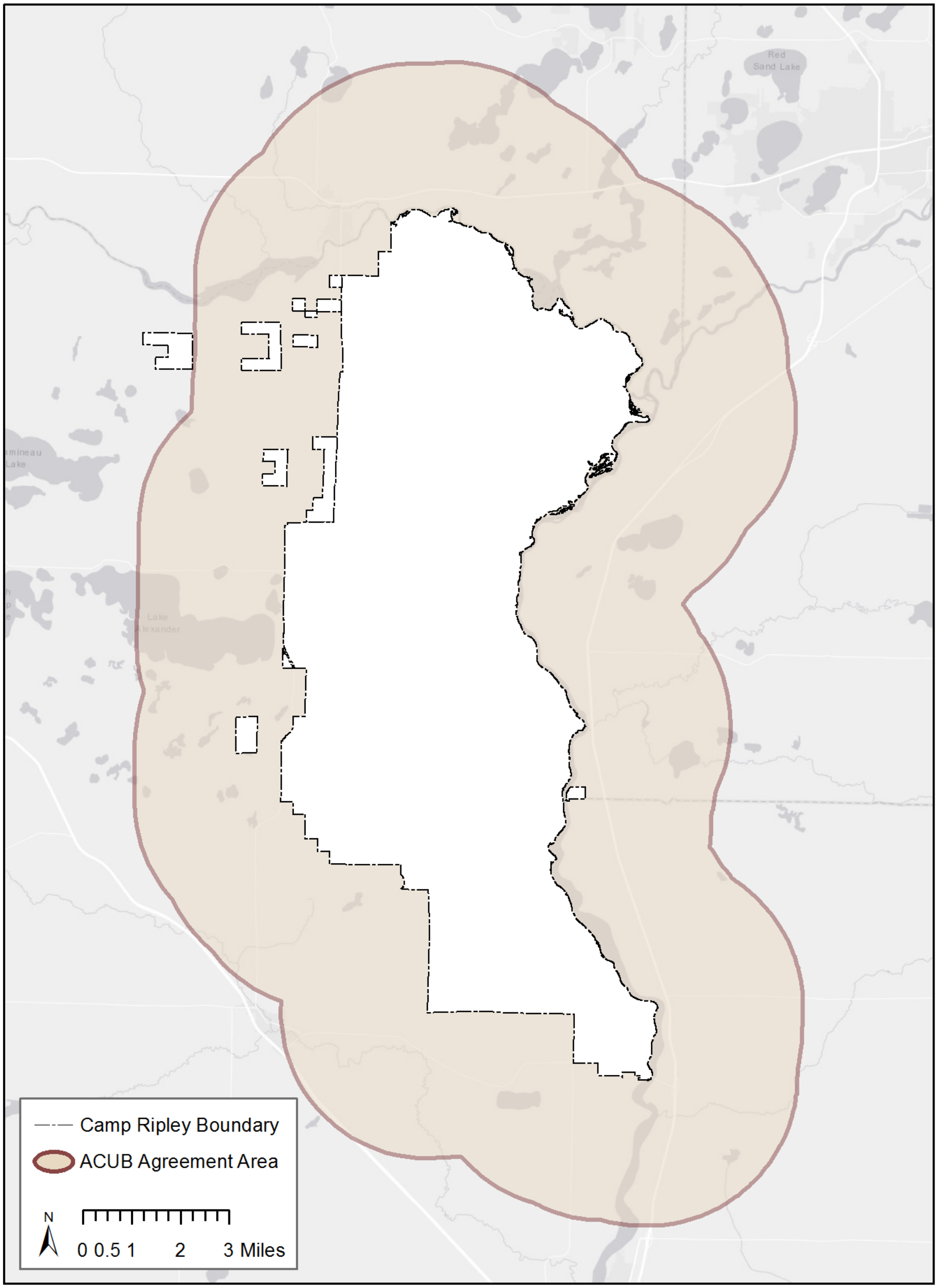


Figure 10: CRTC ACUB Authorized Area

Camp Ripley Sentinel Landscape

In 2013, The US Departments of Defense, Agriculture and Interior announced an initiative titled “The Sentinel Landscape Partnership” (SLP). This created a nationwide federal, local and private collaboration dedicated to promoting natural resource sustainability in areas surrounding military installations. In Minnesota, working lands for agriculture and forestry and other natural lands provide many important public benefits; source and surface water protection, recreational opportunities for hunting and fishing, habitats for species of greatest conservation need, threaten and endangered species, shoreline protection of the Mississippi River, open space, commodity production, and maintaining the rural character of Minnesota. In an effort to expand services to private landowners within the ACUB program and out to a 10-mile radius Camp Ripley, in cooperation with the MN Forest Resources Council staff, applied for a USFS grant to develop a Landscape Stewardship Plan (LSP). The plan would guide development of strategies to foster private forest management, working forests and technical support to landowners. Out of that LSP process came a watershed based map intended to bring forest management goals and objectives into other statewide watershed plans currently underway (MPCA Watershed Restoration and Protection Plans, BWSR One Watershed One Plan and local county water plans.)

In May 2015, Camp Ripley, through state law, (Minnesota Statue 190.33) was designated as the first state sentinel landscape in the Nation. The designation established a state coordinating committee in March 2016. The group is comprised of State Commissioners from BWSR, DNR, DMA and Minnesota Department of Agriculture (MDA). This legislation will allow the MNARNG to more effectively compete for federal funding from agencies beyond just the Department of Defense and to better align federal, state and local programs that could support private landowners in a Sentinel Landscape. Federal agencies such as NRCS, USFS, and USFWS who envision enhancing their program priorities and interests that are complementary to the CRSL joined at the table.

In 2016, Camp Ripley was designated as a federal Sentinel Landscape representing the formal partnership agreement between the US Department of Defense, US Department of Agriculture and the US Department of Interior (Figure 11).

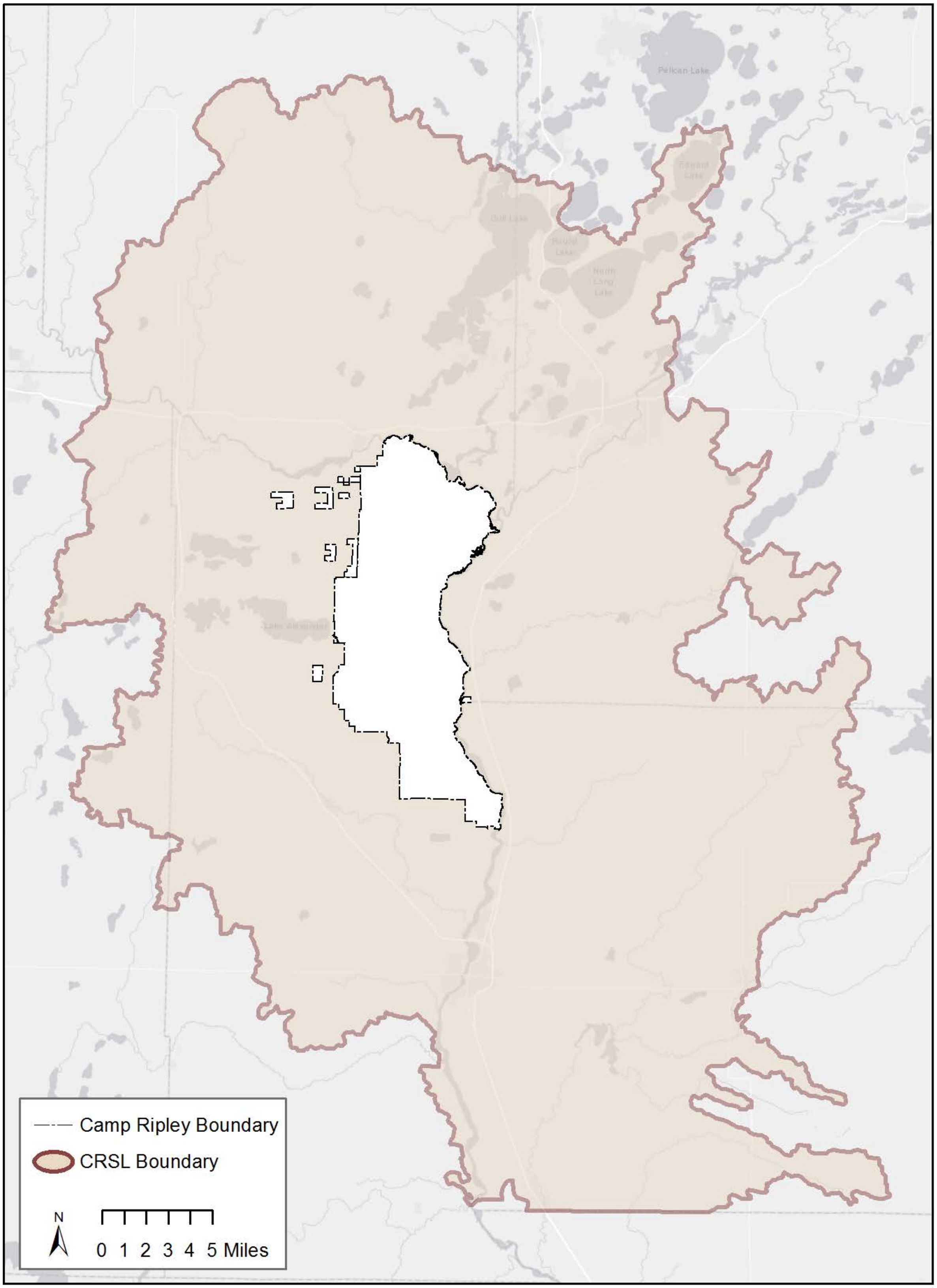


Figure 11: Camp Ripley Sentinel Landscape Boundary

Integrated Training Area Management Program (ITAM)

Introduction

The Integrated Training Area Management (ITAM) program is intended to support and promote land use policies, which allow for sustainable military training and multiple-use outputs from natural resource programs. The ITAM program is supported by the U.S. Department of Defense, the U.S. Army, the U.S. Army National Guard, and the Minnesota National Guard. The preparation and implementation of the ITAM program is required by the AR 350-19 and several other Federal directives including regulations and guidance issued by the Department of the Army.

The increased operational tempo of military activities has placed more pressure on training lands. Past and continued degradation of natural resources can have a negative effect on the realism of future training exercises.

To meet all environmental laws and regulations the U.S. Army Construction Engineering Research Laboratory (USACERL) has developed the ITAM program. The ITAM program is a comprehensive tool that consists of five components necessary to maintain and improve the condition of natural resources. The five components are as follows:

1. Range and Training Land Assessment (RTLA):

Formerly referred to as the Land Condition Trend Analysis (LCTA), the RTLA program is an ongoing program for land inventory and monitoring.

2. Land Rehabilitation and Maintenance (LRAM):

LRAM is an ongoing program whereby erosion control measures and good vegetation management practices are employed to maintain and stabilize the soil.

3. Training Requirements Integration (TRI):

TRI is a program developed to integrate the training mission with the natural resource requirements.

4. Sustainable Range Awareness (SRA):

Formerly referred to as the Environmental Awareness (EA), the SRA program uses educational material to address environmental issues and provide guidelines to the troops in training, commanders and the general public. Educational materials include field cards, handbooks, posters and videotapes.

5. Geographic Information System (GIS):

GIS is a computer-based program developed to assist in resolving complex land management problems. Data depicting a variety of environmental attributes can be prepared, displayed and analyzed to guide land use decisions.

Range and Training Land Assessment (RTLA)

The Range and Training Land Assessment (RTLA) program, a long-term environmental monitoring program was initiated at Camp Ripley in 1991. RTLA is the component of the ITAM Program that provides for the collecting, inventorying, monitoring, managing, and analyzing of tabular and spatial data concerning land conditions and capabilities on an installation. RTLA provides data needed to evaluate the capability of training lands to meet multiple use demands on a sustainable basis. It incorporates a relational database and GIS to support land use planning decision processes. RTLA collects physical and biological resources data to relate land capabilities and conditions to training and testing activities. These data are intended to provide information to effectively manage land use and natural and cultural resources.

Land Rehabilitation and Maintenance (LRAM)

LRAM is the component of the ITAM program that provides a preventive and corrective land rehabilitation and maintenance procedure to reduce the long-term impacts of training on Camp Ripley. LRAM uses technologies such as re-vegetation and erosion control techniques to maintain soils and vegetation required to support Camp Ripley's mission. These specifically designed efforts help to maintain Camp Ripley as a quality military training site and subsequently minimize long-term costs associated with land rehabilitation. LRAM includes programming, planning, designing, and executing land rehabilitation, maintenance, and reconfiguration projects based on requirements and priorities identified in the TRI and RTLA components of ITAM.

Training Requirements Integration (TRI)

TRI is the component of the ITAM Program that provides a decision support procedure that integrates training requirements with land management, training management, and natural and cultural resources management. The integration of all requirements occurs through continuous consultation between operations, range control, natural and cultural resources managers, and other environmental staff members, as appropriate. The INRMP and ITAM work plan are documents that require TRI input.

TRI improves coordination and facilitates cooperation, decision-making, and allocation by providing information regarding land conditions, capability, and any necessary modification of requirements. TRI achieves the "training-environmental" balance and interface that is critical to land management. To achieve this continuous interaction and coordination between the operations/training staff and natural resource/environmental staff a position has been established. This position is known as the “Training Area Coordinator” (TAC). Major responsibilities of the position include: coordinating and monitoring training area use, coordinating training area activities not directly related to training and gathering use data for the RFMSS and overall implementation of the ITAM program.

Sustainable Range Awareness (SRA)

Sustainable Range Awareness (SRA) is the component of the ITAM Program that provides a means to develop and distribute educational materials to land users. Materials relate procedures for sound environmental stewardship of natural and cultural resources and reduce the potential for inflicting avoidable impacts. The SRA intent is to inform land users of restrictions and activities, to avoid and to prevent damage to natural and cultural resources. The SRA component applies to soldiers, installation staff, and other land users. The SRA component also includes efforts to inform environmental professionals and the community about Camp Ripley's mission and training activities.

Geographic Information System (GIS)

The success of the Camp Ripley's ITAM program is greatly dependent on a Geographic Information System (GIS). GIS allows for the development and implementation of computer based technology tools whereby spatial/geographic data about Camp Ripley is stored, manipulated, analyzed, and displayed. MNARNG's manages a centralized GIS using the ArcGIS software suite.

Ecosystem Based Management

Introduction

Ecosystem Based Management (EBM) approaches evolved nationally to meet increasing and often conflicting demands on the nation's natural resource base. The MNDNR defines EBM as the collaborative process of sustaining the integrity of ecosystems through partnerships and interdisciplinary teamwork (MNDNR website). The Department of Defense goal for EBM is ―to ensure that military lands support present and future training and testing requirements while preserving, improving, and enhancing ecosystem integrity. The long-term goal is sustainability of Minnesota's ecosystems, the people who live in them, and the economies founded on them. The Ecological Society of America 1996, defines EBM as ―management of ecosystems driven by explicit goals, executed by policies, protocols, and practices and made adaptable by monitoring and research based on our best understanding of the ecological interactions and processes necessary to sustain ecosystem structure and function‖. For example, the goals, objectives and projects defined in the management plan will be accomplished by following the guidelines in the plan; all management actions will be monitored through the ITAM and Conservation programs; and management will be adapted according to monitoring results--thus, an endless feedback loop. The goal of EBM on Camp Ripley is to ensure that the land supports military training requirements, while preserving and enhancing the ecosystem.

The overall philosophy of land-use management at Camp Ripley can be described as `Dominant Use'. This contrasts with the single-use concept that may be found in a national wilderness area and the multiple-use concept prevailing on most state lands in Minnesota. This framework does not exclude multiple uses of the installation, but insures that the primary mission of military use drives natural resource programs. Army Regulation 200-3 provides guidance for natural resource management at Camp Ripley and states that "consideration will be given to all demands for use of the land and water resources with optimum use being made when consistent with the military mission and sound conservation and environmental concerns. To continue this collaborative process, Camp Ripley has established guidelines for each of the major habitat types on Camp Ripley.

The MNDNR‘s Minnesota County Biological Survey (MCBS) conducts field inventory and evaluation of exemplary, unique, threatened or endangered features of Minnesota's natural environment. In 1991, thirteen separate areas, representing the highest quality natural heritage features on Camp Ripley, were identified by MCBS. Most of these are "mature" forests. These areas encompass approximately 13,300 acres or about 25 percent of the gross land and water area of Camp Ripley. Because some of these occur in large, contiguous blocks and are under one ownership, a rare opportunity exists at Camp Ripley to manage large natural communities with disturbance regimes that most closely mimic natural processes. Fire, wind and mortality from old age are the key change agents in this type of management. Most of these communities are in areas of low to medium troop usage because of their location in steep terrain and in weapons firing danger zones. Of the approximately 13,300 acres identified as Natural Heritage Communities by the Minnesota County Biological Survey, 7,140 acres (Training Areas 56, 65, 73, 74, 75, 76, 78) will be managed as natural. Military training in these areas is not prohibited. However, it is expected to be largely constrained to roads, trails and specific developments by the steep, heavily forested or wet terrain.

Cultural Resources Management

Cultural resources management is the identification of culturally, historically, architecturally and archaeologically significant properties, the management of those properties in a manner that is consistent with applicable state and federal laws and regulations, the mission of Army National Guard, and respectful of the intrinsic values of the properties. The MNARNG must comply with federal laws regarding cultural resources if conducting operations considered a federal undertaking. A federal undertaking means a project, activity or program funded in whole, or in part, under the direct or indirect jurisdiction of a federal agency, including those carried out by, or on behalf of, a federal agency; those carried out with federal assistance; and those requiring a federal permit, license or approval. Construction projects, improvements and activities carried out by the MNARNG through federal funding is defined as a federal undertaking requiring compliance with federal historic preservation laws.

There are also several executive orders, Department of Defense directives, Army regulations, and Army memorandums concerning how the MNARNG executes these laws and manages the cultural resources under its care. The MNARNG also complies with state historic preservation laws which can be found at https://www.revisor.mn.gov/pubs/. While this section of the annual update includes revised numbers, totals, and progress toward goals as well as achievements, it is meant to be only an update. For a more complete information regarding the MNARNG cultural resources program and how it is administered please reference the MNARNG Integrated Cultural Resources Management Plan (ICRMP) (Camp Ripley Environmental Office 2009).

Integrated Pest Management

Integrated Pest Management (IPM) is the use of multiple techniques to prevent or suppress pests in a given situation. The Federal Insecticide, Fungicide and Rodenticide Act, as amended (FIFRA) regulates pesticide use. In 1996, the Department of Defense signed the DOD Instruction 4150.7, DOD Pest Management Program to implement pest management practices and to achieve a 50% reduction in its pesticide use. Although IPM emphasizes the use of nonchemical strategies, chemical control may be an option used in conjunction with other methods.

The MNARNG has completed a pest management plan. The plan describes the pest management requirements, outlines the resources necessary for surveillance and control, and describes the administrative, safety and environmental requirements of the program. Refer to MNARNG Integrated Pest Management Plan for more details regarding pest management.

Guidelines for Pest Management

1. Adopt integrated pest management practices to reduce the potential risks to human health and the environment.
2. Annually assess the extent of invasive species through a methodical identification and quantification process. Areas containing invasive species will be delineated using a global positioning system (GPS) and locations will be geographically referenced for future management. A GIS coverage with attached database files should be maintained.
3. Support an aggressive control program for invasive, noxious, and exotic plants using all methods proven effective with emphasis on

non-chemical control. The invasive and exotic control program should include an integrated involvement among, users, land managers, cooperators, and neighboring public.

4. Annually evaluate control measures that have been employed to assess effectiveness of control and redefine the limits of invasive infestation. Data files and GIS coverages will be updated.
5. Continued control efforts will be made and/or modified under Integrated Pest Management Plan (IPMP) methods until natural or native populations predominate and are sustained.
6. Educational materials will be made available to those individuals using the facility. The education effort will describe the nature and threat of invasive species, techniques that should be employed to prevent the movement or transfer of invasive species to or from the facility, and information about the control measures as part of the Integrated Pest Management program. Public Affairs support will be engaged to inform the public when appropriate.
7. Conduct annual field assessment of tick borne diseases and West Nile Virus.
8. Annual update of IPMP.

Plan Implementation

Introduction

The framework for the implementation chapter of this INRMP is a culmination of the program information that is presented in the six preceding chapters. The issues and concerns identified with in each chapter provide an understanding of the stakeholders ‘perspective on Camp Ripley based on actual field experience and research projects. The ITAM program described in Chapter 5 is critical to the successful implementation of the INRMP since ITAM is viewed as principal program to provide funding support in accomplishing the objectives resulting from the planning process. Finally, Chapter 6 offers an understanding of the management philosophy that has been adopted by MNARNG to support its natural and cultural resource program.
This final chapter of the INRMP outlines the implementation strategy and represents a distinct step in the planning process, marking the end of planning and the beginning of action. In order for implementation to be successful it is imperative that MNARNG address the following activities:

Goals and Objectives of this INRMP are reviewed annually with the US Fish and Wildlife Service and the MN department of Natural Resources. The goals and objectives are found in Appendix 1.

1. Environmental Review
2. Staffing
3. Coordination & Partnerships
4. Goals and Objectives
5. Funding
6. Provisions for updating/revising the INRMP

Environmental Review

This INRMP was evaluated in an Environmental Assessment (EA) including a public review process that resulted in a Finding of No Significant Impact (FNSI). This proposed action of updating the INRMP and subsequent implementation does not have any impacts that exceed any threshold criteria that require an EA. The updated INRMP has been reviewed and approved by the Minnesota Department of Natural Resources and the US Fish and Wildlife Service. A Record of Environmental Consideration (REC) has been prepared with the citing of Categorical Exclusion (B-3) from appendix B of 32 CFR Part 651 —Environmental Analysis of Army Actions‖ that excludes the proposed action from further environmental review. The FNSI for the initial EA for Camp Ripley Site Development Plan and INRMP was signed on 27 Jan 1998.

Staffing
Essential to plan implementation is a balanced team of trained professional and technical staff. Staffing sources for natural resource programs include:

Camp Ripley Environmental Office

Facilities Management Office-Environmental

Camp Ripley GIS Department

Camp Ripley Operations Office

Facilities Management Office-Department of Public Works

MNDNR personnel associated with Camp Ripley

Contractors (e.g. University of Minnesota, The Nature Conservancy, St. Cloud State University)

Coordination & Partnerships

Cooperation, coordination, and communication, both internally and externally, are essential to implement this plan. Camp Ripley‘s Environmental Office currently has an excellent working relationship and partnership with the MNDNR. MNARNG has contracted the services of the MNDNR to conduct numerous studies and provide assistance on management issues on MNARNG properties. This strong working relationship was formalized in 1989 when the first interagency agreement was executed. To continue this strong working relationship a cooperative agreement for the INRMP has been signed by both the MNARNG and the MNDNR (appendix 3). MNARNG has worked diligently to develop partnerships with other external agencies, both governmental and non-governmental. These partnerships will be instrumental in the management of natural resources at Camp Ripley.

A Master cooperative agreement with Minnesota State College and University provide additional opportunities to implement the INRMP objectives. The environmental program and ITAM program provide funding for student interns form St Cloud State University and Central Lakes College (Appendix 4).

Funding

Funding required for the implementation of the INRMP for Camp Ripley over the next five years will be derived from basically four sources of funding.

ARNG I&E is the primary source of funding that supports natural resource programs for the MNARNG through a master cooperative agreement. Environmental program requirements are identified as projects as part of a budget submission through the Conservation Program Pillar.. Table 4 provides a projected budget summary for 2018-2022 to support the full-time environmental staff and projects responsible for implementing all of the conservation programs for the MNARNG.

Table 4: 2018-2022 Projected Budget

Project Name	**2018**	**2019**	**2020**	**2021**	**2022**	***SUM***
Salaries - Conservation Employees	$368,500	$377,700	$387,100	$396,800	$406,800	*$2,669,100*
CLC Salaries/Environmental Interns - Conservation	$20,300	$20,300	$20,300	$20,300	$20,300	*$142,200*
Environmental Conservation Staff TRNG	$4,000	$7,000	$7,000	$8,000	$8,000	*$45,200*
Endangered Species Monitoring	$60,000	$60,000	$60,000	$60,000	$60,000	*$405,000*
Hardware/Software Conservation	$15,000	$2,000	$2,000	$2,000	$2,000	*$23,600*
Hardware/Software for Compliance	$2,000	$2,000	$2,000	$2,000	$2,000	*$14,000*
Aerial Imagery	$0					*$18,000*
ICRMP 5-year update		$35,000				*$35,000*
Annual Consultation meeting with 18 Federally recognized tribes.	$15,000	$15,000	$15,000	$15,000	$15,000	*$105,000*
CNS Mission Travel	$5,000	$5,000	$5,000	$5,000	$5,000	*$36,800*
Cultural Resources Training	$3,000	$5,000	$5,000	$5,000	$5,000	*$31,000*
AHATS INRMP Preparation or Update	$5,000	$5,000	$5,000	$5,000	$5,000	*$32,500*
INRMP Implementation AHATS Fauna	$10,000	$10,000	$10,000	$10,000	$10,000	*$63,000*
INRMP Implementation AHATS Flora	$15,000	$15,000	$15,000	$15,000	$15,000	*$105,000*
Protected Species Mgnt.	$15,000	$15,000	$15,000	$15,000	$15,000	*$97,500*
INRMP Implementation CR Forest Mgnt	$10,000	$20,000	$20,000	$20,000	$20,000	*$120,000*
CR INRMP Preparation or Annual Update	$5,000	$5,000	$5,000	$5,000	$5,000	*$35,000*
INRMP Implementation - SGCN	$20,000	$20,000	$20,000	$20,000	$20,000	*$170,000*
INRMP Implementation - Nuisance	$5,000	$10,000	$10,000	$10,000	$10,000	*$60,500*
INRMP Implementation CR Fauna	$35,000	$35,000	$35,000	$35,000	$35,000	*$240,000*
INRMP Implementation CR Vegetation	$20,000	$20,000	$20,000	$20,000	$20,000	*$147,000*
Bald and Golden Eagle Management	$50,000	$60,000	$60,000	$60,000	$60,000	*$380,000*
NHPA Inventories/Surveys/Evaluation (MA-F)						*$413,000*
NHPA Inventories/Surveys/Evaluation (MA-G)						*$174,000*
NHPA Inventories/Surveys/Evaluation (MA-J)						*$138,000*

Appendices

Appendix 1: INRMP Goals and Objectives

Appendix 2: INRMP Annual Update

Appendix 3: MN DNR Master Cooperative Agreement

Appendix 4: MNSCU Master Cooperative Agreement

Appendix 6: ITAM Workplan

APPENDIX A: CAMP RIPLEY TRAINING CENTER INTEGRATED NATURAL RESOURCES MANAGEMENT PLAN UPDATED GOALS AND OBJECTIVES

Section 1. Camp Ripley Administration

Section / Year	INRMP Goal	2017 Objective	Objective Originally Created	2017 Objective Status	2018 Objective Update
1.1 1/1/2003	Ensure adequate funding and resources to implement Camp Ripley's Conservation program.	1.1.1 Maintain the integration of ITAM and Environmental program to execute resource requirements of the conservation program.	1/1/2003	SUSTAIN	Maintain the integration of ITAM and Environmental program to execute resource requirements of the conservation program
		1.1.2 Update and execute a Cooperative Agreement between MNARNG and the DNR for the management and protection of Camp Ripley's natural and cultural resources and enforcement of applicable laws and regulations.	1/1/2003	SUSTAIN Agreement was executed 1 July 2017 for $204,000.00	Update and execute a Cooperative Agreement between MNARNG and the DNR for the management and protection of Camp Ripley's natural resources and enforcement of applicable laws and regulations.
		1.1.3 Conduct an annual meeting of the Natural Resources Planning Committee to review the annual work plans and for presenting an annual update of INRMP accomplishments from the preceding year.	1/1/2003	SUSTAIN: Meetings are scheduled for March 2018 for the recap of 2017	Conduct an annual meeting of the Natural Resources Planning Committee to review the annual work plans and for presenting an annual update of INRMP accomplishments from the preceding year.
		1.1.4 In 2016, maintain current contracts for services in conducting special natural resources projects at Camp Ripley whenever internal resources are not adequate to meet objectives (e.g., DNR, SCSU, and CLC).	1/1/2003	Inter-agency agreement was developed with Central Lakes College through STEP for $20,000, and an amendment for $5,000 for the execution of 3 interns for animal surveys. Inter-agency agreement was developed with SCSU through ITAM funds for $20,000 for 3 interns for invasive vegetation management	Develop contracts or inter-agency agreements for services in conducting special natural resource projects.

Section 1. Camp Ripley Administration

Section / Year	INRMP Goal	2017 Objective	Objective Originally Created	2017 Objective Status	2018 Objective Update
		1.1.5 Execute land fund projects as needed to supplement INRMP goals as authorized.	12/10/2008	SUSTAIN: Reference forestry section Annual INRMP Update report for completed projects	Execute DNR forestry IA agreement through the land fund
		1.1.6 Develop and maintain a work plan of ITAM projects in the ITAM plan that supports the INRMP implementation.	2010	SUSTAIN: Reference ITAM work Plan and annual conservation report.	Develop and maintain a work plan of ITAM projects in the ITAM plan that supports INRMP implementation and contribute ITAM work plan into annual conservation report.
		1.1.7 Develop and maintain a work plan of environmental projects in the Status Tool for the Environmental Program (STEP) that support the INRMP implementation.	2010	SUSTAIN: STEP projects for FY 18 were developed and approved by NGB staff.	Develop and maintain a work plan of environmental projects in the Status Tool for the Environmental Program (STEP) that supports INRMP implementation.
		1.1.8 Develop and maintain a work plan of wildland fire projects in the Fire and Emergency Services Program that support the INRMP implementation.	**2010**	SUSTAIN: Reference wildland fire management plan	Coordinate with Camp Ripley fire and emergency services, DPW, DNR, and environmental for execution of wildland fire management plan.
1.2 11/01/ 2017	Integrate administration of INRMP with Camp Ripley mission planning:	1.2.1 Maintain administration of the INRMP development, implementation, and updates through the Camp Ripley Environmental Office.	1/1/2003	SUSTAIN	Maintain administration of the INRMP development, implementation and updates through the Camp Ripley Environmental Office.

Section 1. Camp Ripley Administration

Section / Year	INRMP Goal	2017 Objective	Objective Originally Created	2017 Objective Status	2018 Objective Update
		1.2.2 Complete an annual Conservation-INRMP update report. Update, review and obtain signatures with DNR and USFWS.	12/10/2008	Conservation update report was printed in MAR 2017, signatures from DNR and USFWS were obtained DEC 2017. Conservation report will become an appendix to the INRMP along with the updates goals and objectives table.	Complete an annual Conservation-INRMP update report. Update, review and obtain signatures with DNR and USFWS
		1.2.3 Annually integrate long-range natural resources planning with site development planning for the military mission.	1/1/2003	Integration of planning with military development is conducted through sync briefs and engagements such as FIFWEG.	Participate in military development planning through engagement in CR CUB briefs, DCO briefs, and engagements such as FIFEWG, CR Board of Directors, and RCMP.

Section 2: Camp Ripley Cultural Resources

Section/ Goal Created	ICRMP Goal	2017 Objectives	Objective Originally Created	2017Objective Status	2018 Objective Update
2.1 1/13/2016	Update Integrated Cultural Resources Management Plan.	2.1.1 Continue to revise and review the MNARNG Integrated Cultural Resources Management Plan to retain regulatory compliance.	11/20/2013	In Process. ICRMP update in process with a completion date of April planned.	Continue to revise and review the MNARNG Integrated Cultural Resources Management Plan to retain regulatory compliance.
2.2 1/13/2016	Conduct and complete cultural survey of CRTC.	2.2.1 Complete surveys of Maneuver Areas J and G.	11/20/2013	In Process. Commonwealth Heritage group has been contracted for surveys. A completed survey is expected by late Fall 2017.	Complete surveys of Maneuver Areas J, G and F.
2.3 7/16/2009	Continue consultation with Tribes in order to further the partnership that will permit the protection of irreplaceable cultural resources.	2.3.1 Conduct Tribal consultations between MNARNG and all interested Tribal representatives.	10/2012	Completed	Conduct Native American consultation between MNARNG and all interested Tribal representatives at Camp Ripley to familiarize the Historical Preservation Officers with the property and the resources protected within.
2.4 7/16/2009	Enhance MNARNG personnel awareness of and appreciation for cultural resources preservation and improve the effectiveness of their decision making by engaging MNARNG personnel in the development of standard operation procedures, real estate transactions, and on any specific project that might affect cultural resources.	2.4.1 Create a training module for a yearly refresher that will address concerns of individuals that are directly affected by cultural resources management requirements.	11/20/2013	Completed	Work with planners to determine who needs training in regards to cultural resources and section 106 of the national historic preservation act process. Then create a plan tailored to those individuals.

Section 2: Camp Ripley Cultural Resources

Section/ Goal Created	ICRMP Goal	2017 Objectives	Objective Originally Created	2017Objective Status	2018 Objective Update
2.5 7/16/2009	Ensure that scientific and historical data recovered from cultural resources at MNARNG installations are made available with due respect to confidentiality and security to researchers, Tribes and other interested parties.	2.5.1 Continue to interact with graduate students and faculty to gauge interest and determine what types of projects are best suited to the needs and interest of the graduate students seeking thesis projects. Continue to seek avenues for grant funding.	11/20/2013	Completed. Worked with SCSU professors and one graduate student to complete the national register nomination for Valhalla.	Continue to communicate with teachers and students to create internships that create value for Camp Ripley and students.
2.6 7/16/2009	Promote outreach with interested stakeholders in natural and cultural resources and ensure their access to these resources, when possible.	2.6.1 Create a stand-alone cultural resources slide set for use in the environmental classroom and for outreach briefs. Continue with MNARNG archaeology day during Minnesota Archaeology week. Seek cooperation with Tribes and Historical Society groups for Archaeology Day.	11/20/2013	Completed. Working toward finishing the classroom brief as well as purchasing archaeology kits for teaching purposes. Gave presentations for archaeology day as well as for 100 Boy Scouts.	Create a stand-alone cultural resources slide set for use in the environmental classroom and for outreach briefs. Continue with MNARNG archaeology day during Minnesota Archaeology week. Seek cooperation with Tribes and Historical Society groups for Archaeology Day.

Section 3: Camp Ripley Forestry

Section / Year Created	INRMP Goal	2017 Objectives	Objective Originally Created	2017 Objective Status	2018 Objective Update
3.1 12/8/2009	Update the Camp Ripley forest management plan to include progress/action since initial plan dated 2002.	3.1.1 Update the Camp Ripley Forest Management plan.	10/26/2012	In Progress. Four planning meetings have been held with Environmental staff, military leadership and representatives from the DNR. Stantec was contracted to facilitate further meetings and plan writing. To be completed in FY18.	Complete and implement Forest Management plan.
		3.1.2 Review 2 years of 10-year land fund plan, coordinate with military staff to ensure consensus.	10/26/2012	SUSTAIN: Review was completed in FY 17	Review 2 years of 10-year land fund plan, coordinate with military staff to ensure consensus.
3.2 1/1/2003	Provide and maintain a mature forest base with sufficient opportunity for diverse military training exercises that challenge soldiers and leaders to operate in the restrictive terrain of a heavily forested northern landscape.	3.2.1 Maintain forest vegetation inventory for land management planning, and for monitoring changes.	12/10/2008	SUSTAIN	Maintain forest vegetation inventory for land management planning and for monitoring changes.
		3.2.2 Little Falls DNR-Forestry will verify, measure, and evaluate changes to the forest landscape attributed to annual alterations and update the Forest Inventory Module (FIM) data. Begin updating forest inventory in areas of natural disturbances and land conversions to cover approximately 10% Camp Ripley's forested land.	12/8/2011	SUSTAIN	Little Falls DNR-Forestry will verify, measure and evaluate changes to the forest landscape attributed to annual alterations and update the Forest Inventory Module (FIM) data. Coordinate with DNR on conducting, updating and maintaining forest inventory
		3.2.3 Meet to discuss beginning a 10% re-inventory of Camp Ripley.	12/22/2008	SUSTAIN	Delete Objective

Section 3: Camp Ripley Forestry

Section / Year Created	INRMP Goal	2017 Objectives	Objective Originally Created	2017 Objective Status	2018 Objective Update
		3.2.4 Continue to develop and implement management recommendations for each site and continue to develop mission-scape to characterize the landscape as it supports the military mission of Camp Ripley.		SUSTAIN	Develop and implement management recommendations for each site and continue to develop mission-scape to characterize the landscape as it supports the military mission of Camp Ripley.
3.3 1/1/2003	Balance forest diversity on the Training Site by maintaining the integrity of the historic representation of forest composition.	3.3.1 Ensure that range, corridor, or airfield development needs include stump removal and vegetation control for land conversion.	12/10/2008	Airfield over run harvest was conducted.	Delete objective:
		3.3.2 Plant trees in areas that are compatible with Camp Ripley's mission.		SUSTAIN	Plant trees in areas that are compatible with military mission and SGCN.
		3.3.3 Monitor jack pine budworm infested stands in northwest corner of Camp Ripley to determine if treatment is necessary.	12/10/2008	SUSTAIN	Monitor forest for disease or infestation and provide recommendations for treatment of degraded stands.
		3.3.4 Identify additional opportunities to encourage white pine release.	12/8/2011	SUSTAIN: areas throughout the CRTC have been identified. Prescriptions for the sites will be discussed in coming years.	Identify additional opportunities to encourage white pine release.
		3.3.5 Continue reviewing military training activities within the jack pine stands located in the northwest corner of Camp Ripley and see if management for jack pine is compatible.	12/8/2009	SUSTAIN	Review military training activities within the jack pine stands located in the northwest corner of Camp Ripley and see if management for jack pine is compatible.

Section 3: Camp Ripley Forestry

Section / Year Created	INRMP Goal	2017 Objectives	Objective Originally Created	2017 Objective Status	2018 Objective Update
		3.3.6 Implement adaptive forest management strategies to protect and regenerate the oak stands within desired areas.	12/10/2008	SUSTAIN	Implement adaptive forest management strategies to protect and regenerate the oak stands within desired areas.
3.4 1/1/2003	Clearly communicate the administrative procedures and constraints for commercial timber sales, SDP work projects, and firewood permits as controlled by Camp Ripley, administered by the DNR–Forestry Office.	3.4.1 Review a 2-year harvest plan for Camp Ripley.	12/10/2008	SUSTAIN	Review a 2-year harvest plan for Camp Ripley.
		3.4.2 Maintain a point of contact as the DNR forester for all timber sales, firewood permits, or stand treatment contracts. Internal communications should be through Camp Ripley Forester.	11/17/2010	SUSTAIN	Maintain a point of contact with the DNR forester for all timber sales, firewood permits, or stand treatment contracts. Internal communications should be through Camp Ripley Forester.
		3.4.3 Maintain thorough communications with Department of Public Works (DPW)–Roads and Grounds supervisor for all standards to achieve for forestry treatments or timber access road work being completed by CRC–FMO is in compliance with Voluntary Site-level Forest Management Guidelines.		SUSTAIN	Maintain thorough communications with Department of Public Works (DPW)–Roads and Grounds supervisor so that all standards to be achieved for forestry treatments or timber access road work being completed by CRC–FMO is in compliance with Voluntary Site-level Forest Management Guidelines.

Section 3: Camp Ripley Forestry

Section / Year Created	INRMP Goal	2017 Objectives	Objective Originally Created	2017 Objective Status	2018 Objective Update
3.5 1/1/2003	Monitor fire danger levels and control wildfires	3.5.1 Implement objectives in the wildfire management plan.	12/10/2008	SUSTAIN	Implement objectives in the wildfire management plan.

Section 4: Camp Ripley Grasslands

Section/ Goal Created	INRMP Goal	2017 Objectives	Objective Originally Created	2017 Objective Status	2018 Objective Update
4.1 1/1/2003	Restore and manage the grassland communities for the purposes of military training, protection of species, native prairie restoration, and soil stabilization.	4.1.1 Evaluate designated firing point locations and prioritize these units for management needs based on previous year RTLA assessments.	12/11/2008	SUSTAIN: assessed 24 firing point grassland areas in 2017.	Evaluate designated firing point locations and prioritize these units for management needs based on previous year RTLA assessments.
		4.1.2 Assess open maneuver areas and helipads.	Oct. 2010	SUSTAIN	Modified Objective: Utilize ITAM to assess open maneuver areas and helipads.
		4.1.3 Provide survey and evaluate training responses on existing size of maneuver corridors to ensure they meet all training objectives and requirements.	Oct. 2013	SUSTAIN:	Provide survey and evaluate training responses on existing size of maneuver corridors to ensure they meet all training objectives and requirements.
		4.1.4 Implement the BMP practices for controlling invasive plants (Hanson and Malone 2011) within Camp Ripley.	12/2010	SUSTAIN	Implement the BMP practices for controlling invasive plants (Hanson and Malone 2011) within Camp Ripley.
		4.1.5 Update distribution maps of target invasive plant species' populations (common tansy, spotted knapweed, leafy spurge, purple loosestrife, Queen Anne's lace, and baby's breath).	12/11/2010	SUSTAIN. New mapping system was streamlined and tested.	Update distribution maps of target invasive plant species' populations (common tansy, spotted knapweed, leafy spurge, purple loosestrife, Queen Anne's lace and baby's breath).
		4.1.6 Utilize mechanical and chemical removal of target invasive species.	12/11/2010	SUSTAIN	Utilize mechanical and chemical removal of target invasive species.

Section 4: Camp Ripley Grasslands

Section/ Goal Created	INRMP Goal	2017 Objectives	Objective Originally Created	2017 Objective Status	2018 Objective Update
		4.1.7 Large scale chemical treatments of invasive plants will be concentrated within high prioritization areas.	11/14/2011	SUSTAIN	Large scale chemical treatments of invasive plants will be concentrated within high prioritization areas (Hanson and Malone 2011).
		4.1.8 Locate, cut, and treat the areas where buckthorn is present.	11/14/2011	Located and mapped 35 populations in downrange training areas in 2017. Basal bark treated 11 populations.	Delete obj. move to forestry section
		4.1.9 Identify areas where soldiers and staff are often coming in contact with poison ivy and treat by chemical means.	11/14/2011	Treated confidence course, downrange barrier gates and Valhalla White Pine walking trail for poison ivy (*Toxicodendron radicans*) in 2017.	Annually, identify areas where soldiers and staff are often coming in contact with poison ivy and treat by chemical means.
		4.1.10 Use prescribed fire to maintain the grassland compartments to meet training capability needs, native prairie restoration and to control invasive and exotic species.	12/11/2008	Utilized prescribed fire as a management tool on 503 acres of native grasslands in 2016.	Use prescribed fire to maintain the grassland compartments to meet training capability needs, native prairie restoration and to control invasive and exotic species.
		4.1.11 Develop and implement an early detection rapid response plan for potential serious invaders giant hogweed and garlic mustard.	11/17/2014	Completed	Delete Objective:
		4.1.12 Maintain biological control methods for invasive species treatment in areas where accessibility is restricted.	11/17/2014	No new biological control agents were released in 2017.	Delete objective

Section 4: Camp Ripley Grasslands

Section/ Goal Created	INRMP Goal	2017 Objectives	Objective Originally Created	2017 Objective Status	2018 Objective Update
		4.1.13 based on RTLA data and historical military use, implement prescribed burn units: B–2–17, B–5–19, D–30–1, D–31–2, D–35–12, K1–68–82, K1–69–1. Also if time allows, burn FY 15 troop training enhancement burns: B–1–4, B–8–13, B–8–15, D–21–19, D–20–45, D–33–10, and I–61–52.	**11/14/2011**	Completed nine training enhancement burns in 2016.	Modified Objective: Implement prescribed fire as described in wildland fire management plan for troop enhancement on grassland and savannahs.
			11/15/2017		New Objective: Target grasslands that are not vulnerable to maneuver damage to integrate forbs and pollinator specific seed mixes.
			11/15/2017		New Objective: Maintain airfield grassland IAW with CR WASH Plan
4.2 12/11/2008	Minimize troop training interruptions due to accidental impact area and ranges wildfires caused by training activities.	4.2.1 Implement the use of prescribed fire on all impact areas and ranges to reduce fuel hazards (about 13,500 acres).	11/14/2011	Completed all scheduled burns on impact areas and ranges.	Modified Objective: Implement the use of prescribed fire for hazard mitigation on impact areas and grasslands as described in the wildland fire management plan.
		4.2.2 Coordinate with ITAM to plan and implement prescribed burn on maneuver corridor to control woody encroachment.	Oct. 2013	SUSTAIN: prescribed fire treatment applied to grassland portions of corridor only.	Coordinate with ITAM to plan and implement prescribed burn on maneuver corridor to control woody encroachment.

Section 5: Camp Ripley Recreation, Education and Land Use

Section / Goal Created	INRMP Goal	2017 Objectives	Objective Originally Created	2017 Objective Status	2018 Objective Update
5.1 11/15/2017	NEW GOAL: Provide educational opportunities on natural resources of Camp Ripley		11/15/2017		New Objective: Maintain the environmental classroom and provide presentations to various audiences as requested.
					New Objective: Provide presentations to groups as requested and staff time allows.
					New Objective: Serve as a host site and assist in the coordination and implementation of the annual Morrison County Water Festival.
		Objective moved from minimize conflict goal: Maintain the Valhalla educational trail with signs and educational material.	11/14/2011	SUSTAIN: Earth day projects were used for maintenance of the trail.	Maintain the Valhalla educational walking trail with signs and educational material.
5.21/1/2003	Identify and develop land use opportunities for the public.	5.2.1 Conduct two, two-day general public bow hunts for white-tailed deer in cooperation with the DNR, Section of Wildlife.	11/14/2011	SUSTAIN	Conduct two, two-day general public bow hunts for white-tailed deer in cooperation with the DNR, Section of Wildlife. CLC has taken over administration of the hunts. Camp Ripley, DNR and CLC will work in concert on planning and execution going forward.
		5.2.2 Conduct a two-day youth archery white-tailed deer hunt.	11/14/2011	SUSTAIN	Conduct a youth archery white-tailed deer hunt.

Section 5: Camp Ripley Recreation, Education and Land Use

Section / Goal Created	INRMP Goal	2017 Objectives	Objective Originally Created	2017 Objective Status	2018 Objective Update
		5.2.3 Conduct a two-day Disabled American Veterans white-tailed deer hunt.	11/14/2011	SUSTAIN. In 2016, a musky float trip along the Mississippi was conducted in concert with this event.	Conduct a Disabled American Veterans white-tailed deer hunt and continue to grow and integrate float fishing event.
		5.2.4 Conduct a two-day soldier archery white-tailed deer hunt.	11/14/2011	SUSTAIN	Conduct soldier archery white-tailed deer hunt.
		5.2.5 Conduct a three-day deployed soldier muzzleloader white-tailed deer hunt.	11/14/2011	SUSTAIN	Conduct a deployed soldier muzzleloader white-tailed deer hunt.
		5.2.6 Conduct a two-day, Disabled American Veterans wild turkey hunt.	11/14/2011	SUSTAIN	Conduct a Disabled American Veterans wild turkey hunt.
		5.2.7 Conduct two, two-day soldier wild turkey hunts.	11/14/2011	SUSTAIN	Conduct two, two-day soldier wild turkey hunts.
		5.2.8 Hold a National Guard Fishing event, Trolling for the Troops.	11/14/2011	SUSTAIN	Modified Objective: Assist and Coordinate support with Camp Ripley JVB to hold a National Guard Fishing event, Trolling for the Troops.
		5.2.9 Continue to conduct other non-motorized public recreation events such as skiing, nature hikes, or touring as opportunities arise.	11/14/2011	SUSTAIN	Modified Objective: Coordinate with Camp Ripley JVB to host non-motorized recreational opportunities such as canoeing, skiing, snowshoeing, and Val Halla nature hikes.

Section 5: Camp Ripley Recreation, Education and Land Use

Section / Goal Created	INRMP Goal	2017 Objectives	Objective Originally Created	2017 Objective Status	2018 Objective Update
		5.2.10 Maintain the following six recreation areas for picnicking and/or fishing: Area #1 DeParcq Woods Picnic Area, Area #2 Mississippi River Picnic Area, Area #3 Mississippi River Picnic Area, Area #4 Lake Alott Fishing Access, Area #5 Sylvan Dam Picnic Area, and Area #6 Round Lake Picnic Area.	11/14/2011	SUSTAIN	Maintain the following six recreation areas for picnicking and/or fishing: Area #1 DeParcq Woods Picnic Area, Area #2 Mississippi River Picnic Area, Area #3 Mississippi River Picnic Area, Area #4 Lake Alott Fishing Access, Area #5 Sylvan Dam Picnic Area and Area #6 Round Lake Picnic Area.
		5.2.11 Maintain approximately 21.5 miles of cross-country ski trails.	11/14/2011	SUSTAIN	Modified Objective: Coordinate with CR road and grounds to maintain approximately 21.5 miles of cross-country ski trails.
		5.2.12 Conduct a biathlon race biennially.	11/14/2011	SUSTAIN	Delete Objective: Environmental does not play a role in the biathlon races.
		5.2.13 Maintain communication with Minnesota Power regarding the use and management of the Minnesota Power land located on the northern edge of Camp Ripley adjacent to the Crow Wing River.	11/14/2011	SUSTAIN	Maintain communication with Minnesota Power regarding the use and management of the Minnesota Power land located on the northern edge of Camp Ripley adjacent to the Crow Wing River.
			11/15/2017		New Objective: Coordinate and facilitate annual Earth Day volunteer activities and projects for Camp Ripley personnel.
5.3 3/26/2008	Minimize land use conflicts on and off the installation.	5.3.1 Annually enroll 5–10 landowners in the ACUB Program.	11/14/2011	SUSTAIN; enrolled 31 new landowners	Annually enroll 10–15 landowners in the ACUB Program.

Section 5: Camp Ripley Recreation, Education and Land Use

Section / Goal Created	INRMP Goal	2017 Objectives	Objective Originally Created	2017 Objective Status	2018 Objective Update
		5.3.2 Continue to partner with the DNR, BWSR, SWCD, and TNC to implement ACUB.	12/5/2011	SUSTAIN	Continue to partner with the DNR, BWSR, SWCD, and TCF, and TNC to implement ACUB.
		5.3.3 Continue to secure funding to implement ACUB and annually enroll about 2,000 acres of land in the program.	12/5/2011	SUSTAIN: enrolled 2,960.5 acres into the program.	Continue to secure funding to implement ACUB and annually enroll 3,000 acres of land in the program.
		5.3.4 Continue to develop new partnerships to protect natural resources around Camp Ripley.	12/5/2011	SUSTAIN– Camp Ripley Sentinel Landscape (CRSL)	Continue to develop new partnerships to protect natural resources around Camp Ripley.
		5.3.5 Continue to pursue other state and federal funding in support of ACUB including the Lessard-Sams Outdoor Heritage Council Fund, Regional Conservation Partnership Program, and Readiness and Environmental Protection Integration Challenge.	12/5/2011	SUSTAIN	Continue to pursue other state and federal funding in support of ACUB including the Lessard-Sams Outdoor Heritage Council Fund, Regional Conservation Partnership Program and Readiness and Environmental Protection Integration Challenge.
		5.3.8 Participate in NGB sponsored ACUB Working Group.	11/4/2015	SUSTAIN	Modified objective Participate in NGB sponsored ACUB Working Group and CRSL Working Group.
5.4 12/12/2011 updated 11/15/2017	Changed Goal: Ensure adequate funding and resources to implement the Noise Management Program	5.4.1 Maintain administration of the Noise Management Plan development, implementation and updates through the Camp Ripley Environmental Office.	12/12/2011	Modified objective.	New objective: Maintain administration of the Noise Management Plan development, implementation and updates through the Camp Ripley Environmental Office.

Section 5: Camp Ripley Recreation, Education and Land Use

Section / Goal Created	INRMP Goal	2017 Objectives	Objective Originally Created	2017 Objective Status	2018 Objective Update
5.5 11/15/2017	New Goal: Coordinate with Camp Ripley airfield and operations for management of nuisance wildlife and other natural resource related issues.		11/15/2017		New Objective: Provide resources for a Wildlife Aircraft Strike Hazard (WASH) coordinator and work with other directorates to facilitate a working group.
			11/15/2017		New Objective: Develop a Wildlife Aircraft Strike Hazard (WASH) management plan and assist with the identification of resources to implement the plan.
5.6 1/1/2003	Protect and develop improved grounds for functional and aesthetic qualities in the Cantonment Area of Camp Ripley.	5.6.1 Annually inspect cantonment trees for dead, dying or high-risk trees and have them removed.	3/26/2008	SUSTAIN	Annually inspect cantonment trees for dead, dying or high-risk trees and have them removed.
		5.6.2 Reference cantonment landscape plan regarding location and need of nursery to supply landscaping needs.	3/26/2008	SUSTAIN: Reference Bachman landscape plan	Reference cantonment landscape plan regarding location and need of nursery to supply landscaping needs.

Section 6: Camp Ripley Wildlife- Mammals

Section / Goal Created	INRMP Goal	2017 Objectives	Objective Originally Created	2017 Objective Status	2018 Objective Update
6.1 1/1/2003	Maintain white-tailed deer population levels consistent with biological diversity, carrying capacity, and military training needs.	6.1.1 Compile data obtained from the 2015 DNR and DMA goal setting team and determine management strategies.	12/9/2008	2017 hunt information recorded in conservation report update.	Modified Objective: Coordinate with DNR and partners to assess population levels and determine management strategies for special hunts.
		6.1.2 Conduct an aerial white-tailed deer survey in cooperation with the DNR, using DNR and/or UAS aircraft.	12/16/2014	Completed as needed in concert with objective 6.1.1	Delete Objective: Accomplished through objective 6.1.1
		6.1.3 Annually maintain a weather station and measure snow depth as a means to track winter severity on Camp Ripley.	12/16/2014	CRTC staff had been in contact with NWS about possible weather station placement on CRTC. Weather stations exist in Little Falls and Brainerd, an additional station is not needed at Camp Ripley.	Delete Objective
		6.1.4 Utilize CRTC UAS to conduct aerial white-tailed deer survey and determine feasibility of future UAS surveys.	11/6/2015	No UAS survey in 2016. Feasibility research in progress.	Determine feasibility of using CRTC UAS to conduct aerial white-tailed deer surveys.
		6.1.5 Use data from DNR aerial surveys to identify current deer density and set population density goal for CRTC.	11/6/2015	Aerial surveys completed and assessed via objective 6.1.4 and management strategies will be identified through objective 6.1.1	Delete objective: Objective accomplished through 6.1.1
6.2 3/26/2008	Monitor the reproductive success, movements, and mortality of black bears on Camp Ripley.	6.2.1 Monitor six black bears that are currently collared and collar additional bears as determined by DNR researchers.	3/26/2008	SUSTAIN: see black bear section of annual conservation report for update.	Modified Objective: Monitor black bears that are currently collared and collar additional bears as determined by the DNR researchers.

Section 6: Camp Ripley Wildlife- Mammals

Section / Goal Created	INRMP Goal	2017 Objectives	Objective Originally Created	2017 Objective Status	2018 Objective Update
		6.2.2 Monitor nuisance bear activity in accordance with the range regulations.	1/1/2003	SUSTAIN	Monitor nuisance bear activity in accordance with the range regulations.
6.3 1/1/2003	Monitor populations of furbearers for comparison with state and regional data.	6.3.1 Conduct DNR carnivore scent station survey on Camp Ripley, as professional staff time allows.	1/1/2003	Not completed in 2017. Not completed, insufficient professional staffing levels, moved to 2018.	Conduct the DNR carnivore scent station survey on Camp Ripley, as professional staff time allows.
6.4 11/15/2017	New Goal: Manage Nuisance Wildlife on Camp Ripley This goal is a merge from previous goals to manage specifically for beaver and porcupine.	6.4.1 Obtain a permit to remove nuisance beaver and remove beaver, as needed.	1/12003	SUSTAIN: see CRTC beaver section of annual conservation report for update.	Modified Objective: Obtain a permit and facilitate the removal of nuisance mammals as required to prevent impacts with military training.
		6.4.2 Implement nuisance beaver management guidelines, as outlined in permit.	3/26/2008	SUSTAIN	Implement nuisance beaver management guidelines, as outlined in MNNDR beaver permit.
		6.4.3 Assess and/or Install beaver control structures in problem areas only during spring, summer or during natural low-water levels to prevent the washout of dikes and roads, replace broken levelers/deceivers	11/27/2012	SUSTAIN	Assess and /or install beaver control structures in problem areas only during spring, summer or during natural low-water levels to prevent the washout of dikes and roads, as outlined in MNDNR beaver permit.

Section 7: CAMP RIPLEY WILDLIFE–BIRDS

Section / Goal Created	INRMP Goal	2017 Objectives	Objective Originally Created	2017 Objective Status	2018 Objective Update
7.1 1/1/2003	Monitor bird populations on Camp Ripley.	7.1.1 Complete a selected subset of 80 point-count survey plots based upon LiDAR and/or bird population needs.	12/9/2008	Not completed.	Delete Objective: Insufficient staffing levels to accomplish.
		7.1.2 Analyze INRMP bird survey data, including population and species diversity trends, habitat comparisons and correlations with types and intensities of use, and management guidelines using LIDAR comparisons.	3/26/2008	SUSTAIN	Continue to analyze INRMP bird survey data, including population and species diversity trends, habitat comparisons and correlations with types and intensities of use, and management guidelines using LIDAR comparisons.
		7.1.3 Annually update species lists of birds found on Camp Ripley.	1/12003	SUSTAIN	Annually update species lists of birds found on Camp Ripley.
		7.1.4 Monitor ruffed grouse and greater sandhill crane populations on Camp Ripley via spring counts, as professional staff time allows.	1/1/2003	Completed, see CRTC ruffed grouse section of annual conservation report for update.	Monitor ruffed grouse and greater sandhill crane populations on Camp Ripley via spring counts, as professional staff time allows.
		7.1.5 Monitor the red-eyed vireo population on Camp Ripley to determine future research needs.	12/15/2010	Completed, contractor conducted INRMP songbird survey, see CRTC breeding bird section of annual conservation report for update.	Monitor the red-eyed vireo population on Camp Ripley to determine future research needs.
7.2 1/1/2003	Make bluebird-nesting boxes available for cavity nesting songbird species at the Camp Ripley Cemetery.	7.2.1 Monitor and maintain 31 bluebird nest structures.	1/1/2003	Completed, see CRTC bluebird section of annual conservation report for update.	Monitor and maintain bluebird nest structures.

Section 7: CAMP RIPLEY WILDLIFE–BIRDS

Section / Goal Created	INRMP Goal	2017 Objectives	Objective Originally Created	2017 Objective Status	2018 Objective Update
7.3 1/1/2003	Monitor raptor populations on Camp Ripley.	7.3.1 Participate in the statewide survey for owls.	1/1/2003	SUSTAIN: see CRTC owl section of annual conservation report for update.	Participate in the statewide survey for owls.
		7.3.2 Monitor nesting success of ospreys on Camp Ripley.	1/1/2003	SUSTAIN: see CRTC osprey section of annual conservation report for update.	Monitor nesting success of ospreys on Camp Ripley.
7.4 1/1/2003	Maintain species diversity, distribution of waterfowl populations within Camp Ripley.	7.4.1 Recruit volunteer/s to monitor productivity and maintain 30 wood duck nest structures.	3/26/2008	Completed, see CRTC wood duck section of annual conservation report for update.	Recruit volunteer/s to monitor productivity and maintain wood duck nest structures.
7.5 1/1/2003	To protect waterfowl from potential injury due to ingestion of white phosphorus munitions compounds in the impact areas.	7.5.1 Maintain the ban on the firing of white phosphorus munitions into wetlands located in the Leach and Hendrickson impact areas indefinitely.	1/1/2003	SUSTAIN	Maintain the ban on the firing of white phosphorus munitions into wetlands located in the Leach and Hendrickson impact areas indefinitely.
		7.5.2 Improve the ability of forward artillery observers to distinguish wetlands in the impact areas by providing aerial photos with wetland delineations and grid coordinates at the observation points.	1/1/2003	SUSTAIN	Improve the ability of forward artillery observers to distinguish wetlands in the impact areas by providing aerial photos with wetland delineations and grid coordinates at the observation points.
7.6 1/1/2003	Control nuisance bird problems.	7.6.1 Monitor nuisance bird problems, and resolve problems, as needed.	1/1/2003	In 2017, no Cantonment cliff swallow nuisance complaints occurred.	Continue to monitor nuisance bird problems and resolve problems, as needed.

Section 8: CAMP RIPLEY REPTILES AND AMPHIBIANS–INVERTEBRATES–FISHERIES

Section / Goal Created	INRMP Goal	2017 Objectives	Objective Originally Created	2017 Objective Status	2018 Objective Update
8.1 1/1/2003	Continue to monitor the presence and abundance of reptiles and amphibians.	8.1.1 With appropriate professional staffing, review alternative reptile and amphibian survey techniques.	1/1/2003	Not completed, insufficient professional staffing levels, moved to 2018.	With appropriate professional staffing, review alternative reptile and amphibian survey techniques.
		8.1.2 Participate in statewide annual anuran call surveys.	1/1/2003	Completed, see CRTC anuran section of annual conservation report for update.	Participate in statewide annual anuran call surveys.
8.2 1/1/2003	Continue to monitor the presence and abundance of terrestrial and aquatic invertebrates.	8.2.1 With appropriate professional staffing levels, determine need for additional invertebrate surveys and establish schedule.	1/1/2003	SUSTAIN: see CRTC wild bee survey section of annual conservation report for update.	With appropriate professional staffing levels, determine need for additional invertebrate surveys and establish schedule.
8.3 1/1/2003	Protect, establish, manage and enhance the fisheries resources at Camp Ripley.	8.3.1 Annually continue population enhancement through fish stocking.	12/9/2008	No walleyes were available to stock.	Continue population enhancement through fish stocking.
		8.3.2 Facilitate fishing opportunities in Camp Ripley lakes as training permits.	12/9/2008	SUSTAIN	Facilitate fishing opportunities in Camp Ripley lakes as training permits.
			11/15/2017		New Objective: Coordinate and execute aquatic plant surveys in Camp Ripley lakes.
					New Objective: Conduct survey of Rapoon Lake.

Section 8: CAMP RIPLEY REPTILES AND AMPHIBIANS–INVERTEBRATES–FISHERIES

Section / Goal Created	INRMP Goal	2017 Objectives	Objective Originally Created	2017 Objective Status	2018 Objective Update
8.4 1/1/2003	Communicate with DNR for assessment of needs rearing program by the DNR Fish and Wildlife Division in Camp Ripley.	8.4.1 Coordinate fish rearing activities on lakes and ponds used at Camp Ripley.	12/9/2008	SUSTAIN	Coordinate fish rearing activities on lakes and ponds used at Camp Ripley.
					New Objective: Determine feasibility of summer draw down of Miller Lake in order to enhance fish rearing.
8.5 11/4/2013	Monitor aquatic invasive species in Camp Ripley	8.5.1 Conduct aquatic assessments for zebra mussels and other aquatic invasive species. Prioritize based on public accessibility, frequency of military and public use, and seasonal variation in water levels.		SUSTAIN	Conduct aquatic assessments for zebra mussels and other aquatic invasive species. Prioritize based on public accessibility, frequency of military and public use, and seasonal variation in water levels.

Section 9: CAMP RIPLEY PROTECTED SPECIES (includes Federal Threatened and Endangered, State Threatened and Endangered, Species in Greatest Conservation Need (SGCN))

Section / Goal Created	INRMP Goal	2017 Objectives	Objective Originally Created	2017 Objective Status	2018 Objective Update
9.1 1/1/2003	Manage and protect species that are listed as threatened or endangered by the federal government or species listed by the State of Minnesota.	9.1.1 Monitor resident and transient threatened and endangered species that may be present at Camp Ripley and implement management recommendations as noted in the Protected Species Management Plan (Dirks et al. 2010), as funding allows.	1/1/2003	SUSTAIN	Monitor resident and transient threatened and endangered species that may be present at Camp Ripley and implement management recommendations as noted in the Protected Species Management Plan (Dirks et al. 2010), as funding allows.
		9.1.2 Monitor federally threatened gray wolf populations and movements via radio telemetry (Dirks et al. 2010).	1/1/2003	SUSTAIN: see CRTC gray wolf section of annual conservation report for update.	Monitor federally threatened gray wolf populations and movements. (Dirks et al. 2010).
		9.1.3 Monitor wolf mortality incidences and conduct necropsies on dead wolves (Dirks et al. 2010).	12/21/2009	SUSTAIN: no gray wolf mortalities in 2017.	Monitor wolf mortality incidences and conduct necropsies on dead wolves (Dirks et al. 2010).
		9.1.4 Monitor location/s and protect wolf rendezvous sites (Dirks et al. 2010).	12/21/2009	SUSTAIN: no wolf rendezvous site/s located in 2017.	Monitor location/s and protect wolf rendezvous sites (Dirks et al. 2010).
		9.1.5 Protect any known wolf den site/s (Dirks et al. 2010).	12/21/2009	SUSTAIN: no wolf den sites located in 2017	Protect any known wolf den site/s (Dirks et al. 2010).
		9.1.5 Monitor bald eagle nests and provide protection to nests in accordance with the ARNG eagle policy guidance (Dirks et al. 2010).	1/1/2003	SUSTAIN: see CRTC bald eagle section of annual conservation report for update.	Continue to monitor bald eagle nests and provide protection to nests in accordance with the ARNG eagle policy guidance (Dirks et al. 2010).

Section 9: CAMP RIPLEY PROTECTED SPECIES (includes Federal Threatened and Endangered, State Threatened and Endangered, Species in Greatest Conservation Need (SGCN))

Section / Goal Created	INRMP Goal	2017 Objectives	Objective Originally Created	2017 Objective Status	2018 Objective Update
		9.1.7 Conduct monthly bald eagle breeding season surveys (April–July) (Dirks et al. 2010).	12/21/2009	SUSTAIN: see CRTC bald eagle section of annual conservation report for update.	Conduct monthly bald eagle breeding season surveys (February–July) (Dirks et al. 2010).
		9.1.8 Apply for USFWS bald eagle disturbance permit for the Pusan, East Boundary, Rest Area 3 and Frog Lake nests, per aircraft maneuver needs.	12/28/2015	Pursuing Programmatic Agreement objective below.	Delete objective: See Incidental take permit objective below.
		9.1.9 Track application progress of a 5-year Programmatic Agreement (take permit) for bald eagles on Camp Ripley (Dirks et al. 2010).	12/9/2009	SUSTAIN: MNARNG prepared incidental take permit application for submission in 2018.	Apply for an eagle incidental take permit for bald eagles on Camp Ripley and AHATS (Dirks et al. 2010).
		9.1.10 Monitor bald eagle mortalities and determine cause (Dirks et al. 2010).	12/21/2009	SUSTAIN: no bald eagle mortalities occurred in 2017.	Monitor bald eagle injuries and mortalities and determine cause (Dirks et al. 2010).
		9.1.11 Monitor movements of satellite radio-transmitter golden eagle/s in cooperation with Audubon Minnesota and National Eagle Center.	12/16/2014	SUSTAIN: subadult, female captured in March 2015, see CRTC golden eagle section of annual conservation report for update.	Capture one golden eagle and monitor movements of two satellite radio-tagged golden eagles in cooperation with Audubon Minnesota and National Eagle Center.
		9.1.12 Educate users about the presence and importance of protected species.	1/1/2003	SUSTAIN: revised range regulations, range bulletins, and developed backdoor conservation flyer placed in portable toilets downrange.	Educate users about the presence and importance of protected species.

Section 9: CAMP RIPLEY PROTECTED SPECIES
(includes Federal Threatened and Endangered, State Threatened and Endangered, Species in Greatest Conservation Need (SGCN))

Section / Goal Created	INRMP Goal	2017 Objectives	Objective Originally Created	2017 Objective Status	2018 Objective Update
		9.1.13 Develop sampling locations and monitor, via acoustic detector, for presence of northern long-eared bat and other state special concern bat species.	12/16/2013	Northern long-eared bats were listed as federally threatened under the Endangered Species Act in May 2015. Completed, see CRTC bat section of annual conservation report for update.	Delete Objective
		9.1.14 Capture female northern long-eared bats and little brown myotis to determine locations of bat maternity roosts.	12/16/2014	Completed, see CRTC bat section of annual conservation report for update.	Delete Objective: No additional bat captures will occur.
		9.1.15 Continue to monitor Camp Ripley bat population index using a mobile acoustic transect survey.	12/16/2013	SUSTAIN: see CRTC bat section of annual conservation report for update.	Continue to monitor Camp Ripley bat population index using a mobile acoustic transect survey.
		9.1.16 Design and conduct wild bee pollinator survey focusing on federally endangered rusty patched bumble bee (*Bombus affinis*).		Completed, see CRTC wild bee survey section of annual conservation report for update.	Design and conduct wild bee pollinator survey focusing on federally endangered rusty patched bumble bee (*Bombus affinis*).
		9.1.17 Continue to determine the presence/absence of Canada lynx (Dirks et al. 2010) using trail cameras.	12/9/2008	Completed – no Canada lynx detected.	Delete Objective
		9.1.18 Continue a monitoring program for state threatened Blanding's turtles (Dirks et al. 2010).	1/1/2003	SUSTAIN: see CRTC Blanding's turtle section of annual conservation report for update.	Continue a monitoring program for state threatened Blanding's turtles (Dirks et al. 2010).

Section 9: CAMP RIPLEY PROTECTED SPECIES
(includes Federal Threatened and Endangered, State Threatened and Endangered, Species in Greatest Conservation Need (SGCN))

Section / Goal Created	INRMP Goal	2017 Objectives	Objective Originally Created	2017 Objective Status	2018 Objective Update
		9.1.19 Finalize areas of alternate Blanding's turtle nesting enhancement locations and complete habitat enhancement.	11/15/2011	Not completed, insufficient professional staffing levels, moved to 2018.	Finalize areas of alternate Blanding's turtle nesting enhancement locations and complete habitat enhancement.
		9.1.20 In 2018, Monitor red-shouldered hawk populations on Camp Ripley by conducting a play call-back survey.	3/26/2008	Not completed, objective for 2018.	Monitor red-shouldered hawk populations on Camp Ripley by conducting a play call-back survey.
		9.1.21 Develop red-shouldered hawk trap methods and deploy one satellite transmitter.	12/21/2009	Not completed, insufficient professional staffing levels, moved to 2018.	Develop red-shouldered hawk trap methods and deploy one satellite transmitter.
9.2 1/1/2003	Protect populations and habitats of special concern and other rare nongame wildlife species and prevent their decline to threatened or endangered status	9.2.1 Identify SGCN species and complete the final Protected Species Management Plan for Camp Ripley and recommend management actions.	1/1/2003	Not completed, insufficient professional staffing levels, moved to 2018.	Identify funding opportunity for development of Protected Species Management Plan for Camp Ripley and recommend management actions. 9.2.4 NEW Objective: Dependent on availability of funds, develop scope of work for contracted development of protected species management plan. REVIEW – same as above? If so, delete from 9.2.4
		9.2.2 With available funding and staff select SGCN species and develop survey methods to monitor occurrence on Camp Ripley.	12/21/2009	Not completed, insufficient professional staffing levels.	With available funding and staff select SGCN species and develop survey methods to monitor occurrence on Camp Ripley.

Section 9: CAMP RIPLEY PROTECTED SPECIES
(includes Federal Threatened and Endangered, State Threatened and Endangered, Species in Greatest Conservation Need (SGCN))

Section / Goal Created	INRMP Goal	2017 Objectives	Objective Originally Created	2017 Objective Status	2018 Objective Update
		9.2.3 Monitor occurrence and production of trumpeter swans (Dirks et al. 2010).	12/21/2009	SUSTAIN: see Camp Ripley trumpeter swan section.	Monitor occurrence and production of trumpeter swans (Dirks et al. 2010).
		9.2.4 Continue to include annual accomplishments of the Protected Species Management Plan in the annual Conservation Program Report as part of the Camp Ripley and AHATS INRMP updates.	12/21/2009	Completed, see CRTC annual conservation report for update.	NEW Objective: Dependent on availability of funds, develop scope of work for contracted development of protected species management plan. REVIEW – same as above?
		9.2.5 Participate in development of Camp Ripley Forest Management Planning	12/12/2016	SUSTAIN	Participate in development of Camp Ripley Forest Management Planning, to protect populations and habitats of special concern and other rare nongame wildlife species and prevent their decline to threatened or endangered status

Section 10: CAMP RIPLEY GIS

Section/ Goal Created	INRMP Goal	2017 Objectives	Objective Originally Created	2017 Objective Status	2018 Objective Update
10.1 1/1/2003	Achieve and maintain compliance with all mandated GIS requirements.	10.1.1 Complete metadata for all new and updated layers in production GDBs.	Dec. 2009	SUSTAIN	Complete metadata for all new and updated layers in production GDBs.
		10.1.2 Maintain compliance with SDSFIE. This will include data migration to SDSFIE 3.1 (Army Adaptation).	Dec. 2009	SUSTAIN	Maintain compliance with Spatial Data Structure for Facilities, Installations and Environment (SDSFIE).
		10.1.3 Provide appropriate data and documentation in the required format for all Army and NGB data requests.	Dec. 2009	SUSTAIN	Provide appropriate data and documentation in the required format for all Army and NGB data requests.
10.2 1/1/2003	Maintain the MNARNG geographic database with sufficient completeness, consistency and accuracy for reliable query, analysis and application development.	10.2.1 Identify data requirements and procedures in support of environmental/INRMP initiatives. Capture status and update frequency for each required layer.	Dec. 2011	SUSTAIN	Identify data requirements and procedures in support of environmental/INRMP initiatives. Capture status and update frequency for each required layer.
		10.2.2 Store a current copy of the Camp Ripley forest inventory in the GDB. The source of this layer should be the DNR Forest Inventory Module (FIM).	Dec. 2009	SUSTAIN	Store a current copy of the Camp Ripley forest inventory in the GDB. The source of this layer should be the DNR Forest Inventory Module (FIM).

Section 10: CAMP RIPLEY GIS

Section/ Goal Created	INRMP Goal	2017 Objectives	Objective Originally Created	2017 Objective Status	2018 Objective Update
		10.2.3 Maintain ACUB related data layers.	Dec. 2009	SUSTAIN	Maintain ACUB related data layers.
		10.2.4 Ensure copies of digital statewide aerial photos are available to environmental staff.	Dec. 2009	SUSTAIN	Ensure copies of digital statewide aerial photos are available to environmental staff.
10.3 1/1/2003	Maintain hardware and software systems appropriate for the information management needs of Camp Ripley	10.3.1 Ensure GIS related hardware and software requirements are met through coordination with J6.	Dec. 2009	SUSTAIN	Ensure GIS related hardware and software requirements are met through coordination with J6.
10.4 1/1/2003	Develop, implement, and maintain applications to meet the info needs of the MNARNG user community.	10.4.1 Maintain user-friendly web application(s) through ArcGIS Server to support data access needs to help achieve select INRMP goals and objectives.	Dec. 2011	SUSTAIN	Maintain user-friendly web application(s) through ArcGIS Server to support data access needs to help achieve select INRMP goals and objectives.
		10.4.2 Maintain up-to-date content on the digital map library.	Dec. 2009	SUSTAIN	Maintain up-to-date content on the digital map library.
10.5 3/26/2008	Ensure geospatial data and applications support MNARNG enterprise GIS initiatives.	10.5.1 Conduct monthly MNARNG GIS Working Group meetings and participate in the NGB GIS subcommittee.	Dec. 2009	SUSTAIN	Conduct QUARTERLY MNARNG GIS Working Group meetings and participate in the NGB GIS subcommittee.
		10.5.2 Coordinate development and acquisition of geospatial data and applications with other users through the MNARNG GIS Working Group.	Dec. 2009	SUSTAIN	Coordinate development and acquisition of geospatial data and applications with other users through the MNARNG GIS Working Group.

Section 10: CAMP RIPLEY GIS

Section/ Goal Created	INRMP Goal	2017 Objectives	Objective Originally Created	2017 Objective Status	2018 Objective Update
		10.5.3 Make appropriate geospatial data available in a centralized location to reduce redundancy.	Dec. 2009	SUSTAIN	Make appropriate geospatial data available in a centralized location to reduce redundancy.
		10.5.4 Store data in an organized structure allowing end users to more easily locate appropriate data layers.	Dec. 2009	SUSTAIN	Store data in an organized structure allowing end users to more easily locate appropriate data layers.

MINNESOTA ARMY
NATIONAL GUARD

CAMP RIPLEY TRAINING CENTER
AND
ARDEN HILLS ARMY TRAINING SITE
2017 CONSERVATION PROGRAM REPORT

Cover Photography: Monarch (*Danaus plexippus*) caterpillar on common milkweed (Asclepias syriaca), Camp Ripley Training Center, August 2017. Photography by Kari Gordon, Intern, Central Lakes College.

Minnesota Army National Guard

Camp Ripley Training Center

and

Arden Hills Army Training Site

2017 Conservation Program Report

January 1 – December 31, 2017

Division of Ecological and Water Resources
Minnesota Department of Natural Resources
for the
Minnesota Army National Guard

Compiled by
Nancy J. Dietz, Animal Survey Specialist
Brian J. Dirks, Animal Survey Coordinator

MINNESOTA DEPARTMENT OF NATURAL RESOURCES
CAMP RIPLEY SERIES REPORT NO. 27

DEPARTMENT OF
NATURAL RESOURCES

Contact Information:

MNDNR Information Center
500 Lafayette Road
St. Paul, MN 55155-4040
(651) 296-6157   Toll Free 1-888-MINNDNR
(646-6367)
TYY (Hearing Impaired)
(651) 296-5484   1-800-657-3929
www.dnr.state.mn.us

This report should be cited as follows: Minnesota Department of Natural Resources and Minnesota Army National Guard. 2018. Minnesota Army National Guard, Camp Ripley Training Center and Arden Hills Army Training Site, 2017 Conservation Program Report, January 1–December 31, 2017. Compiled by Nancy J. Dietz and Brian J. Dirks, Camp Ripley Series Report No. 27, Little Falls, MN, USA. 167 pp.

TABLE OF CONTENTS

EXECUTIVE SUMMARY

The purpose of this report is to summarize annual accomplishments for the conservation program of the Minnesota Army National Guard (MNARNG) during calendar year 2017. The Camp Ripley and Arden Hills Army Training Site (AHATS) Integrated Natural Resources Management Plans (INRMP) (MNARNG 2003 and MNARNG 2007) provide a comprehensive five-year plan, and document the policies and future desired direction of the conservation programs for the MNARNG. The preparation, implementation and annual updates of INRMPs are required by the Sikes Act (16 USC 670a et seq.), Army policy, and several other federal directives including regulations and guidance issued by the U.S. Department of Defense. An annual review is required to track any changes and evaluate effectiveness of the program with the U.S. Fish and Wildlife Service (FWS), the Minnesota Department of Natural Resources (DNR) and other appropriate state agencies.

The primary goals of conservation program, as established by Camp Ripley, are to maintain ecosystem viability and ensure the sustainability of desired future conditions; to maintain, protect, and improve ecological integrity; to protect and enhance biological communities, particularly sensitive, rare, threatened and endangered species; to protect the ecosystems and their components from unacceptable damage or degradation; and to identify and restore degraded habitats.

The ability to achieve these goals depends directly on the health and condition of the natural resources. Protecting the ecological and biological integrity of the training lands ensures that those lands will continue to provide the vegetation, soil and water resources necessary for sustainable military training. Such protection will also preserve popular outdoor recreational activities at Camp Ripley.

The conservation program must remain flexible if it is to achieve long-term success. The program will achieve and maintain this flexibility by incorporating adaptive management techniques.

Adaptive management is a process by which new information from monitoring data, scientific literature, or both is used to evaluate the success of the management measures currently in place. This information is then used to determine changes in the management approach needed to ensure continued success of the program. The natural resources management program might also be required to adapt to unforeseen changes in military mission and legal requirements.

There has been an ongoing effort by the MNARNG to survey the lands and structures it controls for cultural and archaeological resources in order to accelerate the timeframe of compliance with federal preservation laws. Surveys were conducted in 2016 and 2017 in Maneuver areas J, G and F. An area in Training Area 61 has also been resurveyed. Several construction projects were submitted to the Minnesota State Historic Preservation Office (MNSHPO) as well as tribal consultants for review; all findings concurred that no cultural resources were affected by the proposed activities. An annual American Indian consultation between federally recognized tribes of Minnesota and tribes that have an historical interest in properties now maintained by the MNARNG was held at Camp Ripley Training Center, Minnesota.

Five tracts of timber were prepared for sale and sold, totaling 171 acres. Eleven individuals acquired fuelwood permits allowing harvest of 60 cords of wood. The Minnesota Department of

Military Affairs and Minnesota Department of Corrections worked together to facilitate a fuelwood program for campsites on Camp Ripley. A land fund established by the Minnesota Legislature in 2008 allows the Adjutant General to accumulate timber sale proceeds for the purposes of forest management. Expenditures from the land fund included forest regeneration, forest health, harvest treatment and pine seedling protection.

Prescribed fire was implemented on Camp Ripley with hazard reduction and training enhancement burns occurring on 13,578 acres and 677 acres, respectively. The Department of Biological Sciences at St. Cloud State University conducted large scale terrestrial invasive plant management for spotted knapweed and common tansy. Also native poison ivy (*Toxicodendron radicans*) was treated in locations which posed a threat to the health and safety of training personnel. Extensive search and treatment of common buckthorn commenced in cantonment along with training areas.

Eighty-eight and 63 species in greatest conservation need (SGCN) have been identified at Camp Ripley and AHATS, respectively. Additional research will be directed toward identifying other SGCN species and management or conservation actions that could be implemented to benefit these species. Camp Ripley songbird surveys were conducted on 90 permanent plots; a total 994 birds of 76 different species were recorded. A satellite radio-transmittered female golden eagle again traveled to her summer habitat above the Arctic Circle, where she occupied her nesting territory. Additional species were monitored including osprey, eastern bluebirds, trumpeter swans, bald eagles, owls and ruffed grouse.

Since 2001, Camp Ripley has supported two or three wolf packs. At the beginning of 2017, two radio-collared wolves remained on Camp Ripley. Due to a federal court decision, wolves in the western Great Lakes area (including Michigan, Minnesota and Wisconsin) were relisted under the Endangered Species Act, effective December 19, 2014. Wolves continue to be federally classified as threatened in Minnesota.

Ground and aerial tracking were used to monitor reproductive success, movements and survival of five radio-collared black bears. Camp Ripley also continued to participate in the summer habitat use study of northern long-eared bats, a federally threatened species. Three female northern long-eared bats were captured and radio-transmittered, and thirteen roost trees were identified. In addition, a mobile acoustic bat survey was conducted.

Surveyors again searched Camp Ripley for Blanding's turtles and their nests. Thirty Blanding's turtles were observed and four nests were protected. Eight Blanding's turtle hatchlings were radio-transmittered to determine movements after being directly released into known adult use wetlands. Frog and toad monitoring surveys were conducted. Fisheries management continued within Camp Ripley. In addition, Camp Ripley conducted its first bumble bee survey in collaboration with the Department of Natural Resources.

Camp Ripley was visited by the Minnesota Department of Health four times in an effort to collect blacklegged (deer) ticks and mosquitos to test prevalence of vector-borne diseases. Of the ticks tested, 56.3% and 28.9% of adults and nymphs, respectively, were infected with at least one disease agent and 15.1% and 12.0% of adults and nymphs, respectively, were coinfected with disease agents. The Center for Disease Control and Prevention is examining small mammal host infection rates with *I. scapularis* (blacklegged tick) borne pathogens prior to nymphal emergence in the spring, again at the peak of nymphal emergence, and at the end of the nymphal tick season. The ongoing risk of tick borne disease at Camp Ripley underscores the need for employees and visitors to continue taking precautions against tick bites.

Over 220 willing landowners representing over 25,000 acres are interested and waiting to participate in the Camp Ripley's Army Compatible Use Buffer program. ACUB accomplishments are presented in this document. Camp Ripley Sentinel Landscape Partnership leverages broader support to protect and improve the quality of the region's soil and water resources is also discussed.

Also included in this report is a summary of the Integrated Training Area Management program and how its five component programs are used to meet all environmental laws and regulations, and to maintain and improve the condition of natural resources for training at Camp Ripley. A summary of geographic information systems support of conservation program and resource management plans is discussed.

The environmental team gave 61 presentations, tours and briefs to 2,958 people entailing more than 185 staff hours. Camp Ripley hosted the 13th annual Disabled American Veterans (DAV) wild turkey hunt, ninth annual soldiers turkey hunt and the 16th annual youth archery deer hunt. Camp Ripley also held the 11th annual military member archery deer hunt in conjunction with the 26th annual DAV firearms deer hunt. Camp Ripley's general public archery deer hunt, which is one of the largest archery deer hunts in the United States, was again held in 2017.

AHATS has been surveyed for cultural resources in its entirety and no eligible resources are present at this time. The Land Use Control Remedial Design for the New Brighton/Arden Hills Superfund site condition is under review, but at this time, must be honored by the MNARNG relative to long-range planning, land use and land management practices.

No prescribed fire occurred at AHATS in 2017. AHATS was surveyed during the National Audubon Society's annual Christmas bird count. Breeding bird monitoring was conducted on 13 plots. State endangered Henslow's sparrows were documented. One pair of trumpeter swans produced seven cygnets. Osprey chicks were banded again in 2017 and AHATS staff and volunteers continued a kestrel monitoring project. The AHATS white-tailed deer aerial survey did not occur due to the lack of snow cover and poor survey conditions.

No Blanding's turtle survey was conducted. AHATS staff participated in the summer habitat use study of northern long-eared bats, a federally threatened species. No northern long-eared bats were captured; however three little brown myotis were radio-transmittered. Stationary acoustic surveys also occurred.

AHATS staff participated in the statewide frog and toad monitoring survey. A butterfly survey was conducted by the Saint Paul Audubon Society. The DNR staff conducted a bumble bee capture survey, but no rusty patch bumble bees, a federally endangered species, were observed. The 9th annual soldier archery wild turkey hunt, 12th annual deployed soldier archery deer hunt, and volunteer archery deer hunt were also held at AHATS.

INTRODUCTION

This conservation program report provides Integrated Natural Resources Management Plan (INRMP) accomplishments for the calendar year 2017 for Camp Ripley and Arden Hills Army Training Site (AHATS). It is intended to support and complement the military mission of the Minnesota Army National Guard (MNARNG) while also promoting sound conservation stewardship principles. It is a document that summarizes the activities of the Camp Ripley and AHATS conservation program, and also serves as a component of the annual update to the INRMP. This document can be found in Appendix A of the Camp Ripley (MNARNG 2018a) and AHATS INRMPs (MNARNG 2018b). The INRMP goals and objectives for Camp Ripley and AHATS are updated annually and can be found in Appendix B to the INRMP (MNARNG 2018a).

RESPONSIBILITIES

Camp Ripley Command – Environmental (CRE) personnel are responsible for conservation program planning and implementation for the MNARNG. This includes, but is not limited to, preparing plans, developing projects, implementing projects, conducting field studies, securing permits, geographic information system (GIS) support, preparing reports, and facilitating land use activities between military operations and other natural resource agencies. The environmental personnel who work directly for the Garrison Commander are responsible for MNARNG's conservation programs statewide. Environmental personnel who work directly for the Facilities Management Office have statewide responsibility for MNARNG's compliance, restoration and pollution prevention programs.

PARTNERSHIPS

In the interest of sound conservation, the MNARNG has developed partnerships with a variety of organizations and resource agencies. Some of these partnerships have resulted in formal interagency agreements with the Minnesota Department of Natural Resources (DNR), Divisions of Ecological and Water Resources and Forestry, St. Cloud State University and Central Lakes College in Brainerd, Minnesota. These have been extremely cost effective and beneficial. The MNARNG also relies on expertise of personnel from other state and federal agencies and organizations who contribute significantly to the support of the MNARNG conservation program, including: the Minnesota Board of Water and Soil Resources, U.S. Fish and Wildlife Service, Minnesota Department of Corrections, Minnesota Department of Transportation, Minnesota Department of Agriculture, Minnesota Department of Health, Minnesota Pollution Control Agency, The Nature Conservancy, Morrison Soil and Water Conservation District, Crow Wing Soil and Water Conservation District and Cass County Soil and Water Conservation District. Other partners include the Minnesota Deer Hunters Association, Minnesota State Archery Association and Disabled American Veterans of Minnesota.

The success of the conservation program for the MNARNG is also attributed to a partnership between the environmental and military operations offices, represented by a shared training area coordinator position. This partnership has enabled the MNARNG to provide a quality training experience for its soldiers without sacrificing the integrity of the conservation program.

PROGRAM AREAS

For the purpose of documenting its accomplishments, the conservation program of the MNARNG is divided into the following program areas within each installation: cultural resources, natural resources, land use management and outreach and recreation.

CAMP RIPLEY TRAINING CENTER

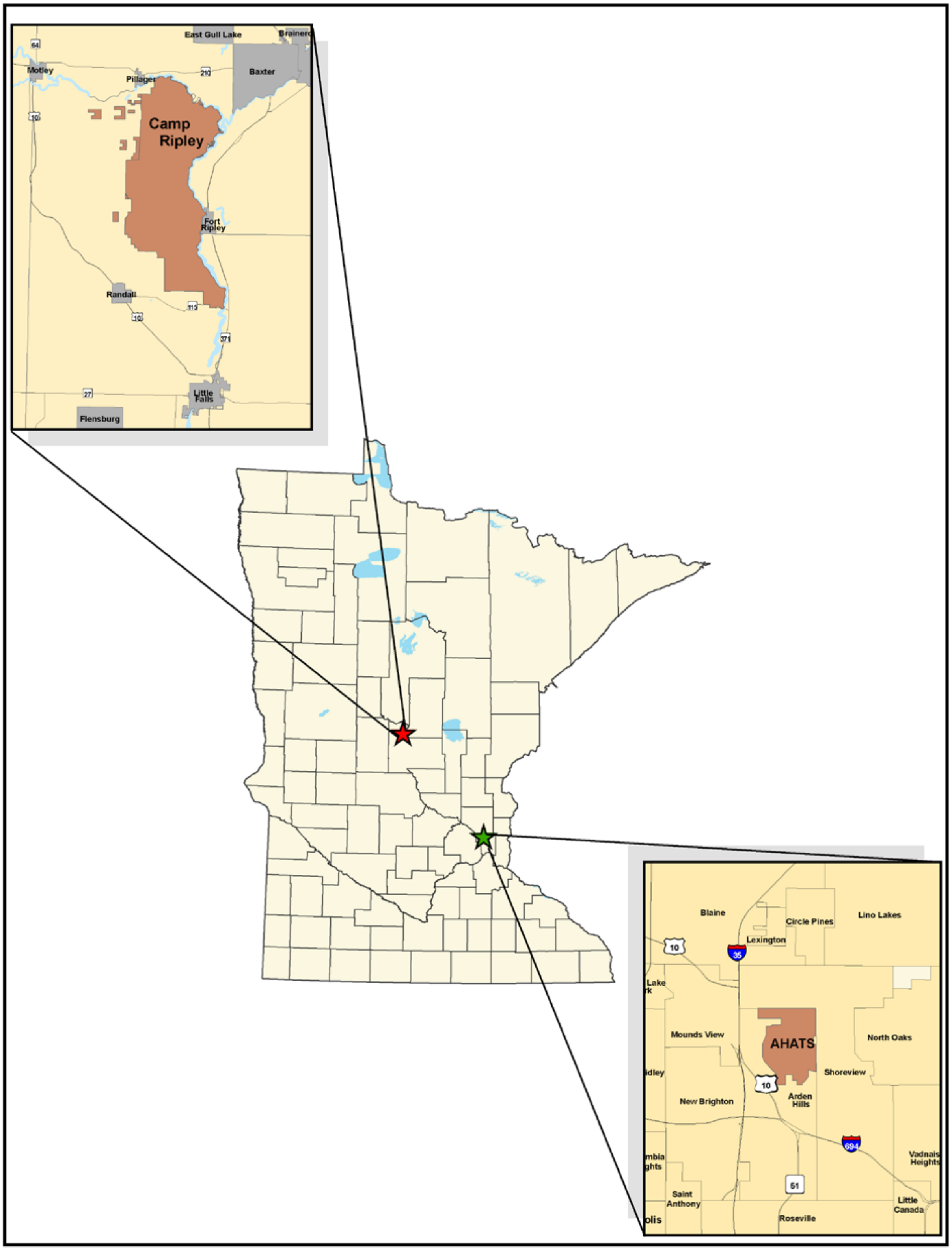
Camp Ripley is located in the central portion of Minnesota approximately 100 miles northwest of the Minneapolis/Saint Paul metropolitan area (Figure 1). According to the 2003 property boundary survey, Camp Ripley occupies 52,699 acres (approximately 82 square miles) within Morrison County and 59 acres within Crow Wing County (52,758 acres total). Camp Ripley is bordered on the north by 11 miles of the Crow Wing River and on the east by 18 miles of the Mississippi River. Land ownership is 98% state land under the administration of the Minnesota Department of Military Affairs (DMA), with the remainder under lease from Minnesota Power, an ALLETE Company.

Camp Ripley's landscape was sculpted during the last glacial period, the Late Wisconsinan. Because the glaciers receded along the northern two-thirds of Camp, a sharp contrast is evident from north to south, both topographically and biologically. The high diversity of life forms (over 600 plant species, 202 migratory and resident bird species, 51 mammal species, and 23 reptile and amphibian species) is also a result of Camp Ripley's location along the forest transition zone in central Minnesota. Dryland forest dominates the landscape, covering 27,875 acres or 55% of the installation. The remainder is almost equally divided between wetlands, dry open grass and brush lands, and other areas.

Camp Ripley’s annual average for military and civilian utilization is 365,000 man-days. Since 2007, more than 3.68 million man-days of training have occurred. Organizations include all branches of the military, many international military units, as well as civilians from a variety of organizations including federal, state and local law enforcement agencies. Camp Ripley supports the federal mission for military training as a 7,800 person, year-round training facility for the National Guard, primarily consisting of units from Minnesota, North Dakota, South Dakota, Wisconsin, Iowa and Illinois. The state training mission focuses primarily on law enforcement activities, natural resource education, environmental agencies and emergency management activities. The central mission of the natural resources management program is to ensure that the multiple demands for land use can be met without sacrificing the integrity of Camp Ripley's training mission and natural resources.

Inventory and monitoring surveys of flora and fauna are an ongoing part of the installation's INRMP that was completed in December 2003 (MNARNG 2003) with annual updates in 2007 (Dirks et al. 2008), 2008 (Dirks and Dietz 2009), 2009 (Dirks and Dietz 2010), 2010 (Dirks and Dietz 2011), 2011 (MNDNR and MNARNG 2012), 2012 (MNDNR and MNARNG 2013), 2013 (MNDNR and MNARNG 2014), 2014 (MNDNR and MNARNG 2015), 2015 (MNDNR and MNARNG 2016), 2016 (MNDNR and MNARNG 2017) and 2017 (MNARNG 2018a). The data obtained will be used to help manage the conservation program and natural resources of the MNARNG.

Figure 1. Location of Camp Ripley Training Center and Arden Hills Army Training Site (AHATS), Minnesota.



CULTURAL RESOURCES

By Patrick Neumann, Minnesota Department of Military Affairs

Program Overview

Cultural resources management is the identification of culturally, historically, architecturally and archaeologically significant properties, the management of those properties in a manner that is consistent with applicable state and federal laws and regulations, the mission of Army National Guard, and respectful of the intrinsic values of the properties. The MNARNG must comply with federal laws regarding cultural resources if conducting operations considered a federal undertaking. A federal undertaking means a project, activity or program funded in whole, or in part, under the direct or indirect jurisdiction of a federal agency, including those carried out by, or on behalf of, a federal agency; those carried out with federal assistance; and those requiring a federal permit, license or approval. Construction projects, improvements and activities carried out by the MNARNG through federal funding is defined as a federal undertaking requiring compliance with federal historic preservation laws. The primary laws regarding cultural resources management are as follows:

1. The National Historic Preservation Act of 1966 (as amended)
2. The Native American Graves Protection and Repatriation Act
3. The National Environmental Policy Act
4. The American Antiquities Act of 1906
5. The Archaeological and Historic Preservation Act of 1974
6. The American Indian Religious Freedom Act of 1978
7. The Energy Independence and Security Act of 2007

There are also several executive orders, Department of Defense directives, Army regulations, and Army memorandums concerning how the MNARNG executes these laws and manages the cultural resources under its care. The MNARNG also complies with state historic preservation laws which can be found at https://www.revisor.mn.gov/pubs/. While this section of the annual update includes revised numbers, totals, and progress toward goals as well as achievements, it is meant to be only an update. For a more complete information regarding the MNARNG cultural resources program and how it is administered please reference the MNARNG Integrated Cultural Resources Management Plan (ICRMP) (Camp Ripley Environmental Office 2009).

Field Survey

There has been an ongoing effort over the last several years by the MNARNG to survey the lands and structures it controls for cultural and archaeological resources. This survey work greatly accelerates the timeframe of compliance with federal preservation laws. A typical survey for historic structures or land for cultural resources can take anywhere from several weeks to several months, depending on the size and complexity of the survey required. The Camp Ripley Command – Environmental (CRE) office of the MNARNG chose to survey the most utilized areas of Camp Ripley as well as its readiness centers across the state (Figure 2). This has led to a greatly reduced turnaround time for permitting construction projects and other maintenance activities. When a federal undertaking is considered, a consultation must occur between the MNARNG and the Minnesota State Historic Preservation Office (MNSHPO) as well as tribal representatives and other interested parties. If the undertaking occurs on un-surveyed land or historic structures, it could take several months or longer to acquire concurrence from the MNSHPO that the MNARNG's plans do not affect any cultural or historic resources. On surveyed land this is reduced to a 30-day review period barring any concerns by the MNSHPO or interested parties.

Surveys were conducted in 2016 and 2017 in Maneuver areas J, G, and F. Though the field portion of the survey and the report review by the MNARNG Cultural Resources Manager have been completed, the final report is required to be reviewed by the Minnesota State Historical Society as well as MNARNG Tribal partners. This review will be completed shortly and the survey officially completed barring any objections or questions from reviewers.

An area in Training Area 61, known as the crow wing west section has also been resurveyed. This area was included in the no disturbance due to cultural resources category as a result of an early survey citing a high probability of cultural remains. This survey work was included in the Maneuver Areas J, G and F survey and will be reviewed along with it. The results of these contracts are pending.

With the completion of this contract, the Section 110 inventory required by the National Historic Preservation Act for Camp Ripley will be completed. This inventory is invaluable in the planning process in order to identify culturally significant areas at Camp Ripley and to avoid them early in the planning process for projects that may disturb these resources.

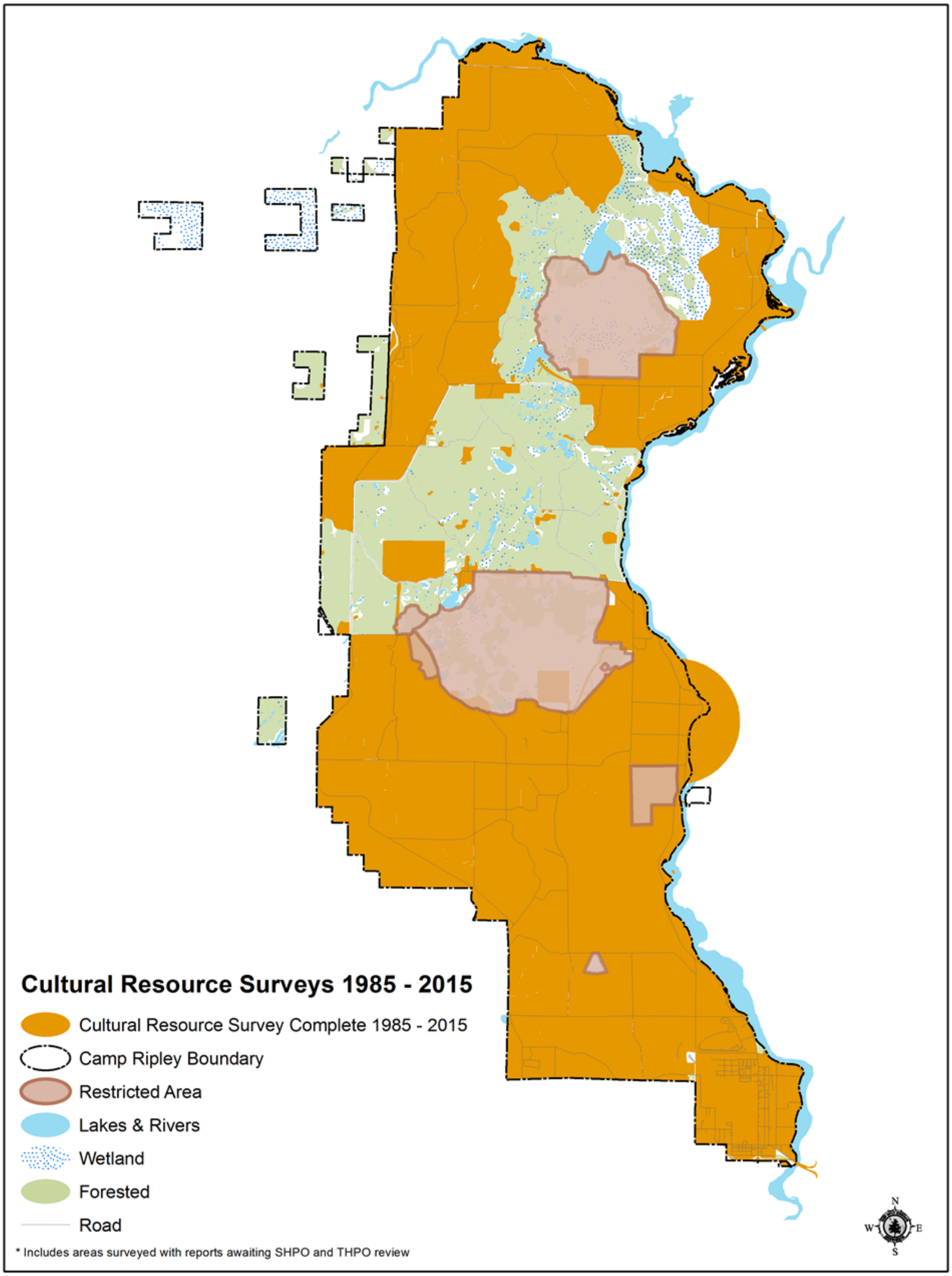
A 30 acre parcel in New Ulm Minnesota was surveyed this year in order to fill the MNARNG cultural resources requirements for a new Field Maintenance Shop that will replace and combine the New Ulm and Northfield shops. The survey located no cultural resources and the project will have no adverse effect on any known resources.

At the end of 2017, approximately 36,533 acres of MNARNG properties have been evaluated for cultural resources or are awaiting review by the MNSHPO and tribes with which the MNARNG consults. All of the data collected in the previous year's survey will be recorded in the cultural resources geographic information system database.

Partnerships

A graduate student from St. Cloud State University will serve an internship at Camp Ripley to gain experience and produce work that will further progress toward a Master of Science degree in cultural resources management. The project chosen by the student in consultation with SCSU professors and the MNARNG is the completion of a National Register Nomination form for the Governor's lodge (Valhalla). The Governor's lodge at Camp Ripley is a log lodge built in the 1930s by the Civilian Conservation Corps as part of the original cantonment construction. It is currently eligible for the register and therefore managed by the MNARNG as an historic structure.

Figure 2. Culturally evaluated areas, Camp Ripley Training Center, Minnesota, 1985 – 2017.



Submittals

Several construction projects have been submitted to the MNSHPO as well as tribal consultants for review in 2016 – 2017. These projects included various earth moving training activities, maintenance of historic structures, as well as downrange construction. All of these projects have been reviewed and MNARNG's finding of no cultural resources being affected received concurrence from MNSHPO and tribal consultants.

Thanks in large part to the previous survey work completed over the last several years, all of the projects were reviewed and found to have no adverse effects in a very short timeframe. Without the early and continuous involvement in the planning stages, the consultation process would have been much longer and much more expensive.

American Indian Tribal Consultations

Face-to-face American Indian consultations are held annually between federally recognized tribes of Minnesota as well as tribes that have an historical interest in properties now maintained by the MNARNG. This year's tribal consultation was held at Camp Ripley on May 31, 2017. The consultation was contracted to be facilitated by Commonwealth Heritage Group, Inc. The decision to hold the consultation at Camp Ripley was made in the previous year's consultation after acknowledging that many of the American Indian Historic Preservation Officers were relatively new and had never seen Camp Ripley. The MNARNG cultural resources management office received replies from six tribes represented by seven individuals in total. The tribes who replied and attended were the Mille Lacs Band of Ojibwe, the Leech Lake Band of Ojibwe, Fond du Lac Band of Lake Superior Chippewa, Bois Forte Band of Chippewa, White Earth Nation, Flandreau Santee Sioux and Shakopee Mdewakonton Sioux. Tribes were invited to discuss the state of the MNARNG cultural resources management program, the conservation program and a way forward for future annual tribal consultation. There was also a tour of some of the cultural resources that are often discussed during consultation, as first hand understanding of the condition of the resource. The meeting was recorded and meeting minutes were provided through contract by Dr. Katie Egan-Bruhy and Mark Bruhy, Commonwealth Heritage Group, Inc.

Tribal consultations are also part of the section 106 submittal process. Tribes are allowed the same 30–day review period allotted to the MNSHPO to address any concerns regarding tribal burials, sacred sites, or archaeological sites. During 2016, there were several instances where tribes did raise concerns about potential impacts, all of which were addressed and found to have no adverse effects to any cultural resources.

The Garrison Commander of Camp Ripley, COL St Sauver, extended an invitation to all of the federally recognized Tribal partners to send the MNARNG their Tribal flags for display. Flags that were received will be displayed at the Camp Ripley town hall along with the flags of other partner nations and states. The flags will also be displayed at events and special occasions where Tribal representatives are present.

NATURAL RESOURCES

Natural resource planning is an integral part of the conservation program for the MNARNG. The MNARNG uses the INRMP as the guidance document for implementing the conservation program. The planning process used in developing the INRMP focuses on using key stakeholders from the MNARNG, Minnesota Department of Natural Resources (DNR), the U.S. Fish and Wildlife Service (USFWS) and other organizations that have an interest in the MNARNG's conservation program. Together, these stakeholders represent the Integrated Natural Resources Management Planning Committee. The primary responsibility of the Planning Committee is to ensure that the INRMP not only satisfies the military mission but also provides a foundation for sound stewardship principles that adequately address the issues and concerns that are raised by all stakeholders. Annually, stakeholders discuss and review the INRMP for Camp Ripley, and present their annual accomplishments and work plans for the next year.

Forestry

The nearly 53,000 acre footprint of Camp Ripley is made up of a variety of cover types with approximately 27,875 acres of forests representing the majority of the land cover. Of these forested areas, oak and northern hardwoods stands represent the majority of the forest. Aspen and birch stands also make up a large proportion of the forest on Camp with interspersed stands of conifer species throughout the installation. Current management strategies maintain an extended age rotation in the forest of Camp Ripley with the majority of stands ranging between 60 and 80 years in age and all forestry activities are done through inter-agency agreement (IAA) with the DNR Division of Forestry.

Projects scheduled in 2017 were primarily focused on forest health and regeneration treatments (Table 1). Hardwood thinning's were prescribed on approximately 160 acres to reduce basal area to approximately 90 square feet per acre. Forest regeneration treatments were largely carried out utilizing clear-cutting with approximately 10% of standing timber reserved in patches throughout the harvest area to take advantage of both coppice sprouting and reseeding by mast trees. These treatments were carried out on approximately 116 acres. Two years' worth of projects were reviewed and identified ample acreage for harvest.

Table 1. Scope of work for forest development, Camp Ripley Training Center, Minnesota, 2017.

Project Number	Project Description	Estimated Cost
CR–Dev17–001	Forest Regeneration treatment on stand 1934 A55	3,120.00
CR–Dev17–002	Forest health/thinning treatment on stands 1599 O65, 1628 O75	24,000.00
CR–Dev17–003	Forest regeneration/health treatment on stand 1730 O54	4,160.00
CR–Dev17–004	Forest health/thinning treatment on stands 1203 O56, 1166 O59	14,725.00
CR–Dev17–005	Forest regeneration treatment on stand 1132 A54	3,600.00
CR–Dev17–006	Forest regeneration/health treatment on stands 579 A55, 615 JP53	3,700.00
CR–Dev17–007	Forest regeneration/health treatment on stands 209 A54	11,460.00
CR–Dev17–008	Provide browse protection to planted jack pine seedlings on site	600.00

Table 1. Scope of work for forest development, Camp Ripley Training Center, Minnesota, 2017.

Project Number	Project Description	Estimated Cost
CR–Dev17–009	Provide browse protection to planted pine seedlings on site 2162	450.00
CR–Dev17–010	Provide browse protection to planted pine seedlings on site 233	500.00
CR–Dev17–011	Provide browse protection to planted pine seedlings on site 3006	525.00
CR–Dev17–012	Provide browse protection to planted pine seedlings on site 2722	1,350.00
CR–Dev17–013	Provide browse protection to planted pine seedlings on site 637	925.00
CR–Dev17–014	Plant and provide browse protection on site 14 COA	2,500.00
CR–Dev17–015	Plant and provide browse protection on site 28 UG	2,500.00
CR–Dev17–016	purchase and install fencing for seedling protection on site 1357	2,500.00
CR–Dev17–017	Evaluate and develop projects to improve white pine stands	700.00
CR–Dev17–018	Supplies: paint, flagging for timber sale development	1,200.00
CR–Dev17–019	Develop and inventory 2000 acres in 2017	8,000.00
CR–Dev17–020	Develop 2 year stand exam list for 2018 – 2019	2,500.00
	FOREST DEVELOPMENT TOTAL	**$86,515.00**

Reforestation

By Jake Kitzmann, Minnesota Department of Military Affairs

Browse protection was applied at eight sites covering 70 acres on Camp Ripley Training Center (CRTC) to protect recently planted seedlings from deer browsing. These sites were planted with a variety of conifer species including red pine (*Pinus resinosa*), white pine (*Pinus strobus*), and jack pine (*Pinus banksiana*) at densities ranging from 350 to 800 trees per acre. For many of the sites this is the third year of browse protection being applied and these applications will continue until the trees have reached approximately 48” in height. This ensures that the terminal bud is out of easy reach of white-tailed deer.

Timber Sales

By Jake Kitzmann, Minnesota Department of Military Affairs

In September, the annual timber auction was conducted by the DNR, Division of Forestry, at Range Control. Five tracts were prepared for sale and sold. The auction results are listed in Table 2 and Figure 3.

The status of existing permits on Camp Ripley is listed below (Tables 3 – 4).

Table 2. Auction timber sales, Camp Ripley Training Center, Minnesota, 2017.

Permit #	Acres	Biomass (tons)[a]	Cords/Species	Revenue	Successful Bidder
B013725	12.6	275	420 Oak Species 13 Mixed Hardwoods	$13,501.77	Hennen Enterprises LLC
B013726	9.0	120	215 Aspen 28 Paper Birch 12 Mixed Hardwoods	$4,028.64	Minnesota Timber LLC
B013727	78.5	275	305 Oak Species 45 Aspen 42 Paper Birch 35 Maple 15 Mixed Hardwoods	$6,622.27	Hennen Enterprises LLC
B013728	21.6	275	320 Aspen 120 Red Oak 105 Jack Pine 24 Mixed Hardwood	$22,549.91	Shawn Fletcher Trucking
B013729	49.5	155	105 Aspen 67 Oak 54 Maple 28 Paper Birch 1 Ash	$3,175.36	Minnesota Timber LLC
2017 TOTAL	**171.2**	**1100**	**1,954 cords**	**$49,877.95**[b]	

[a] Biomass is not totaled into final cords due to different units and whether it is included or added in to sale.

[b] Amount is for only the sold sales and does not include unsold wood.

Figure 3. Location of timber sales, Camp Ripley Training Center, Minnesota, 2017.

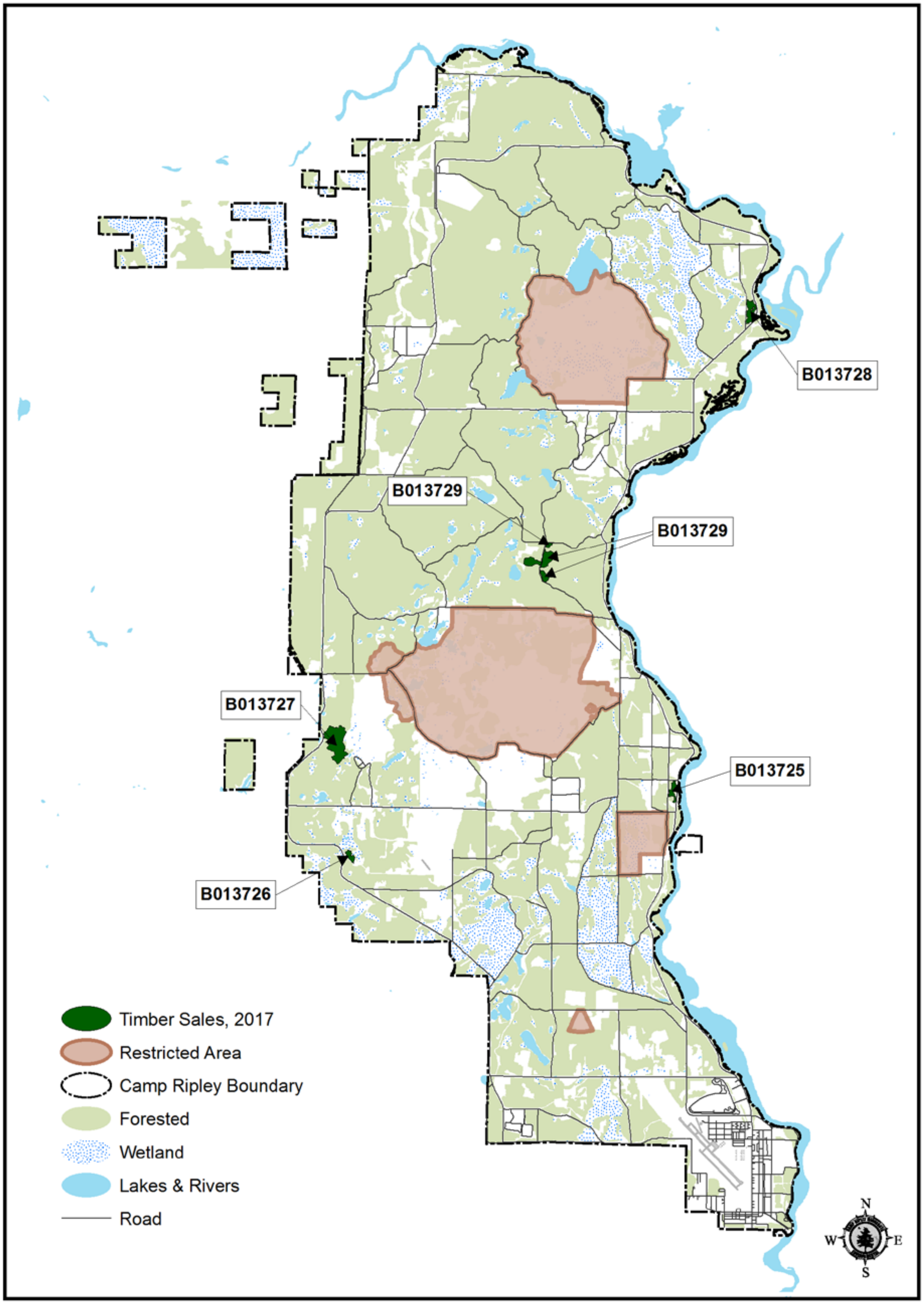


Table 3. Timber sales, Camp Ripley Training Center, Minnesota, 2007 – 2017.

Year	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014[a]**	**2015**	**2016**	**2017**
Acres	188	641	402	237	340.5	168.8	190.8	338.2	266.2	252.1	171.2
Volume	3,624 cds.	12,893 cds.	6,482 cds.	5,505 cds.	6,893.5 cds.	3,452 cds	2,676 cds	4,362 cds	5,340 cds	6,271 cds	1,954 cds
Appraised Value	$67,140.00	$206,326.00	$87,895.00	$78,846.30	$88,648.05	$64,564.55	$35,129.10	$124,195.17	$102,054.39	$97,237.62	$32,327.60
Sold Value	$125,483.56	$406,703.38	$99,786.36	$124,909.25	$98,893.20	$63,291.00	$6,385.75	$116,429.62	$133,305.34	$229,493.95	$49,877.95
Type of Harvest	Regenerate Aspen (138 ac.) Pine Thinning (40 ac.) Military Tactical Training Base (TTB) Development (10 ac.)	Regenerate Aspen (133 ac.) Military Corridor Development (43 ac.) Range Development (464 ac.)	Regenerate Aspen (258 ac.) Military Corridor Development (83 ac.) Pine Thinning (61 ac.)	Regenerate Aspen (32.5 ac.) Digital Multipurpose Training Range (Center Range) (204.5 ac.)	Regenerate Aspen (80.7 ac.) Digital Multipurpose Training Range (Center Range) (228.3 ac.) Remove Aspen from Oak Overstory (31.5 ac.)	Regenerate Aspen (71.6 ac.) Regenerate Jack Pine and Aspen (62.3 ac.) Harwood Thinning (34.9 ac.)	Regenerate Aspen (56.7 ac.) Military Corridor Development (56.2 ac.) Reoffered Sales (77.9 ac.)	Regenerate Aspen (57.9 ac.) Pine Thinning (248.8 ac.) Timber Stand Improvement (31.5 ac.)	Regenerate Aspen (125.5 ac.) Regenerate Jack Pine and Aspen (39.0 ac.) Pine Thinning (56.2 ac.) Variable Density Thinning (45.5 ac.)	Regenerate Aspen (66.4 ac.) Regenerate Jack Pine and Aspen (89.3 ac.) Military Development (96.4 ac.)	Regenerate Aspen (9.0) Regenerate pine and aspen (21.6) Regenerate Oak (12.6) Hardwood thinning (128.0)

[a] Only includes sold stands.

Land Fund

By Jake Kitzmann, Minnesota Department of Military Affairs

During the 2008 session, the Minnesota Legislature enacted legislation (MS 190.25 subd. 3A; Appendices H and I in Dirks and Dietz 2010) to allow the Adjutant General to appropriate funds from a special revenue fund. The land fund was created to accumulate the proceeds resulting from timber sales on Camp Ripley for the purpose of forest development. The legislation provides a funding source for forest management activities, including timber harvest and reforestation on Camp Ripley.

Receipts for timber sales beginning in 2008 are displayed in Table 4. The encumbrances since 2008, 2017 forest development projects and expenditures from the land fund are outlined in Table 5.

Fuelwood Permits

By Tim Notch, Minnesota Department of Military Affairs

For the permit period from April 1 – December 31, there were 11 individuals that acquired fuelwood permits (ten-5 cord; one-10 cord), totaling $300.

In October, Sentence to Serve (STS) crew leaders returned to Camp Ripley for annual chainsaw training. The STS crew felled trees within Training Area 61 along the river that sustained insect damage in previous years.

Insects and Diseases

By Jake Kitzmann, Minnesota Department of Military Affairs

During the 2014 – 2015 field seasons, jack pine budworm (*Choristoneura pinus*) was identified in jack pine (*Pinus banksiana*) stands in the northwestern and northeastern corners of Camp Ripley. In healthy stands these infestations are generally not fatal, and further monitoring will be performed during the coming seasons to determine if treatment is necessary. Further infestation by bark beetles has been noted in the stand in the northeast. The combined infestation has led to widespread mortality in this stand. Current infestations, however, have not spread beyond the fringes of this isolated stand. Furthermore, the first case of oak wilt was identified in Morrison County in 2014; it has not yet been detected on Camp Ripley. In 2016, this diseased stand was sold and aggressive thinning of the stand occurred in 2017. The few remaining trees will be monitored in the coming years.

Table 4. Land fund timber sales receipts, Camp Ripley Training Center, Minnesota, 2008 to October 2017.

Year	Permit #	Expires	Status	Sold Value	Bid Guarantee	Security	Added Timber	Over/Under Run	Final Amount
2008									
	X011138	Mar-2011	Closed	$17,532.00				$3,521.95	$21,053.95
	X011139		Closed	$15,231.78				$662.10	$15,893.88
	X011140		Closed	$34,940.50				$0.00	$34,940.50
	X011141		Closed	$32,530.10				(-$9,993.74)	$22,536.36
	B010655		Closed	$157,773.00				(-$38,572.28)	$119,200.72
	B010656		Closed	$153,830.43				$7,735.90	$161,566.33
								2008 Subtotal	**$375,191.74**
2009									
	B011023	Mar-2011	Closed	$6,332.45				(-$642.62)	$5,689.83
	B011024	Mar-2011	Closed	$14,913.60				$0.00	$14,913.60
	B011025	Mar-2012	Closed	$14,046.74				(-$865.02)	$13,181.72
	B011026	Mar-2011	Closed	$16,214.00				$0.00	$16,214.00
	B011027	Mar-2011	Closed	$3,687.90				$0.00	$3,687.90
	B011028	Mar-2011	Closed	$33,424.40				(-$2,995.56)	$30,428.84
	B011029	Mar-2012	Canceled	$11,167.17					$0.00
								2009 Subtotal	**$84,115.89**
2010									
	B011349	Mar-2012	Closed	$61,231.90				$5,282.17	$66,514.07
	B011350	Mar-2012	Closed	$49,233.65				$5,485.46	$54,719.11
	B011351	Mar-2012	Closed	$5,825.30				$0.00	$5,825.30
	B011353	Mar-2012	Expired	$8,618.40					$1,101.00
								2010 Subtotal	**$128,159.48**
2011									
	B011608	May 31-2013	Expired	$10,245.40					$2,356.44
	BO11685	May 31-2013	Closed	$10,438.95				$0.00	$10,841.92
	BO11686	May 31-2012	Closed	$60,650.40				$0.00	$60,650.40
	BO11687	May 31-2013	Closed	$9,695.35				$0.00	$9,695.35
	BO11688	May 31-2013	Closed	$7,863.35				$0.00	$7,863.35
								2011 Subtotal	**$91,407.46**

Table 4. Land fund timber sales receipts, Camp Ripley Training Center, Minnesota, 2008 to October 2017.

Year	Permit #	Expires	Status	Sold Value	Bid Guarantee	Security	Added Timber	Over/Under Run	Final Amount
2012	B012053	March 31, 2014	Closed	$27,140.15				(-$3,825.50)	$23,314.65
	BO12054	March 31, 2014	Closed	$6,654.75				(-$769.97)	$5,884.78
	BO12055	March 31, 2014	Canceled	Unsold					
	BO12056	March 31, 2014	Canceled	Unsold					
	BO12057	March 31, 2014	Closed	$29,496.10				(-$6,522.22)	$23,636.88
								2012 Subtotal	**$52,836.31**
2013									
	B012438	March 31, 2015	Closed	$3,905.00				$109.30	$4,014.30
	BO12439	March 31, 2015	Canceled	Unsold					
	BO12440	March 31, 2015	Canceled	Unsold					
	BO12441	March 31, 2015	Canceled	Unsold					
	BO12442	March 31, 2015	Canceled	Unsold					
	B012443	March 31, 2015	Closed	$2,480.75				(-$172.92)	$2,307.84
	B012444	March 31, 2015	Canceled	Unsold					
								2013 Subtotal	**$6,322.14**
2014									
	B012744	May 31, 2019	Sold	$3,055.25		$458.29			
	BO12745	May 31, 2016	Closed	$8,242.25				$1,834.01	$10,076.26
	BO12746	May 31, 2019	Active	$2,995.30		$1,914.5	420.25		
	BO12747	May 31, 2016	Closed	$62,954.91					$62,954.91
	BO12748	May 31, 2016	Closed	$13,913.20				$3,276.11	$17,789.31
	B012749	May 31, 2016	Closed	$18,372.60			$594.75	$878.50	$19,845.85
	B012750	May 31, 2016	Unsold	Unsold					
	B012751	May 31, 2016	Closed	$12,484.66			$5,194.60		$14,655.25
								2014 Subtotal	**$125,321.58**
2015									
	B013112	May 31, 2017	Closed	$36,186.92			$1,005.90	$6,385.35	$43,578.17
	B013113	May 31, 2018	Sold	$14,063.97		$2,109.60			
	B013114	May 31, 2017	Closed	$30,918.70				$6,902.04	$37,820.74
	B013115	May 31, 2017	Closed	$21,878.25			$429.97	(-$1,404.52)	$20,903.70
	B013116	May 31, 2017	Closed	$30,257.50				$16,339.05	$46,608.30

Table 4. Land fund timber sales receipts, Camp Ripley Training Center, Minnesota, 2008 to October 2017.

Year	Permit #	Expires	Status	Sold Value	Bid Guarantee	Security	Added Timber	Over/Under Run	Final Amount
								2015 Subtotal	**$148,910.91**
2016									
	B013380	May 31, 2017	Closed	$101,337.63			$1,455.00	$3,232.49	$106,160.10
	B013381	May 31, 2018	Closed	$26,243.35			370.30	$4,839.50	$31,453.15
	B013382	May 31, 2018	Sold	$26,860.45	$1,928.82	$2,100.25			
	B013383	May 31, 2018	Sold	$5,632.10		$844.82			
	B013384	May 31, 2018	Closed	$69,420.42			388.50	$7,081.87	$76,890.74
								2016 Subtotal	**$214,503.99**
2017									
	B013725	May 31, 2019	Sold	$13,501.77		$1,317.15			
	B013726	May 31, 2019	Sold	$4,028.64		604.30			
	B013727	May 31, 2019	Sold	$6,622.27		$993.34			
	B013728	May 31, 2019	Active	$22,549.91		$22,549.91	302.50		
	B013729	May 31, 2019	Sold	$3,175.36		$476.30			
								2017 Subtotal	**$0.00**
SUBTOTALS					**$1,928.82**	**$33,368.46**			**$1,226,769.50**
								Subtotal for Closed 2008 – 2016 Auction Sales	**$1,226,769.50**
								Subtotal received to date for Closed Sales + Bid Guarantees + Securities+ Added Timber	**$1,262.066.78**
Informal Sales									
	F010327	5/15/2009	Canceled	$65.64					$65.64
	F010358	11/30/2009	Closed	$2,541.00					$2,541.00
	F010384	11/30/2009	Closed	$440.00					$440.00
	F010385	11/30/2009	Closed	$600.00					$600.00
	F010431	1/13/2010	Closed	$6,819.00					$6,819.00
	F010486	3/15/2010	Closed	$165.00					$165.00
	F010656	May-2011	Closed	$5,154.00					$5,154.00
	F010657	May-2011	Closed	$143.00					$267.35
	F011082	3/31/2015	Closed	$3,119.30				$944.72	$4,064.02
	F011171	3/31/2014	Closed	$3,038.54			$420.75		$3,400.50
	F011172	3/31/2014	Closed	$4,504.33					$4,004.71
	F011214	4/15/2014	Closed	$50.00					$50.00

Table 4. Land fund timber sales receipts, Camp Ripley Training Center, Minnesota, 2008 to October 2017.

Year	Permit #	Expires	Status	Sold Value	Bid Guarantee	Security	Added Timber	Over/Under Run	Final Amount
	F011299	5/31/2015	Closed	$2,936.94					$2,936.94
	F011414	5/31/2015	Closed	$7,321.06				$184.88	$7,505.94
	F011417	5/31/2016	Closed	$1,988.30				$1,392.62	$3,380.92
	F011781	5/31/2018	Active	$1,147.00		$1,147.00			
	F011782	5/31/2018	Active	$5,087.40		$5,087.40			
								Informal Sales Subtotal	**$41,395.02**
Fuelwood Permits (9/25/08 - 12/31/17)									
		215 (5 cords)	$25/each						$5,375.00
		67 (10 cords)	$50/each						$3,400.00
								Fuelwood Permits Subtotal	**$8,775.00**
								GRAND TOTAL RECEIPTS (9/1/2008 to 10/30/2017)	**$1,576,639.52**

Table 5. Land fund encumbrances, Camp Ripley Training Center, Minnesota, 2009 – 2017.

Land Fund Encumbrances			
Date	**Description[a]**	**Category**	**Amount**
5/6/2009	IAA with DNR–Forestry	Professional services	$20,000.00
8/13/2009	IAA with DNR–Forestry	Professional services and trees	$12,700.00
8/20/2009	Supplies	Forestry supplies	$ 3,492.88
1/14/2010	Supplies	Forestry supplies	$ 68.00
3/25/2010	Supplies	Forestry supplies	$ 52.74
7/29/2010	IAA with DNR–Forestry	Professional services	$59,740.00
11/10/2010	IAA with DNR–Forestry	Professional services (2011)	$59,930.00
10/4/2011	IAA with DNR–Forestry	Professional services (2012)	$73,600.00
3/2/2011	IAA with DNR–Forestry	Professional services	$46,240.00
7/3/2013	IAA with DNR–Forestry	Professional services (2013)	$69,000.00
4/01/2014	IAA with DNR–Forestry	Professional services (2014)	$100,230.00
2014	Adjusted Encumbrances	Canceled tree plantings	-$8,752.00
2015	IAA with DNR–Forestry	Professional services (2015)	$89,462.00
2016	IAA with DNR–Forestry	Professional services (2016)	$80,900.00
2017	Wildland fire equipment	200 gal. Slip-on unit.	$20,040.00
2017	IAA with DNR–Forestry	Professional services (2017)	$86,515.00
		TOTAL	**$713,555.62**

[a] IAA – Interagency Agreement

Vegetation Management

Prescribed Fire

By Timothy Notch, Minnesota Department of Military Affairs

Camp Ripley uses prescribed fire as a management tool to enhance the military training environment, also known as mission-scape. Prescribed fire target objectives include native prairie grass enhancement, woody encroachment prevention, seed production, brush control, fuel-hazard reduction, forest management and habitat improvement for species in greatest conservation need (SGCN). The management strategy for prescribed fire on Camp Ripley is provided within the Integrated Wildland Fire Management Plan (MNARNG 2009a).

Two types of prescribed burns are conducted at Camp Ripley: hazard reduction and training enhancement.

Hazard Reduction

Two of the burn units on Camp Ripley are designated as impact areas. These areas are burned every spring along with 14 other firing ranges to reduce hazardous fuel loads and minimize wildfires due to military training exercises. These are categorized as hazard reduction burns and as such, receive priority in scheduling and implementation (Table 6 and Figure 4).

The fire team completed 17 hazard burn units for a total of 13,578 acres. The unburned unit is Area 10 totaling 612 acres, but an additional hazard burn, Miller Airfield, was completed in the fall. Some of the hazard burns started as wildfires, and fire suppression units responding completed the burns under controlled conditions.

Table 6. Hazard reduction burns, Camp Ripley Training Center, Minnesota, 2017.

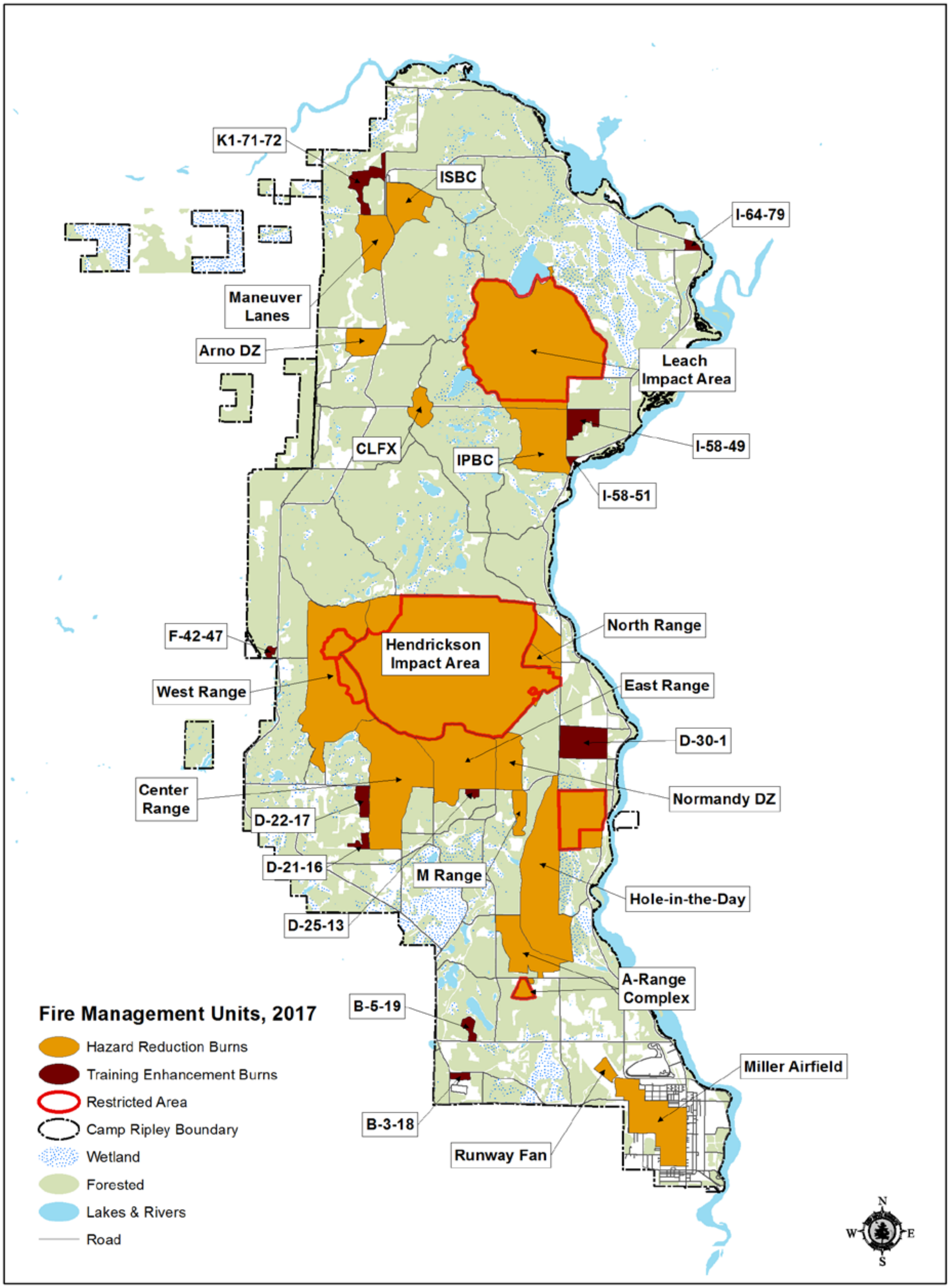
Burn Date	Department	Unit Burn	Acres
3-28-17	DPW/FES/ENV	A–Ranges	**362**
5-04-17	DPW/FES/ENV	Maneuver Lanes	**267**
3-29-17	DPW/FES/ENV	Hole-in-the-Day Marsh	**1,738**
4-04-17	DPW/FES/ENV	Hendrickson Impact Area	**3,840**
3-27-17	DPW/FES/ENV	East Tank Range	**643**
5-09-17	DPW/FES/ENV	CLFX	**118**
Not completed	DPW/FES/ENV	Area 10	612
5-04-17	DPW/FES/ENV	ISBC	**189**
3-21-17	DPW/FES/ENV	West Range	**1,116**
4-11-17	DPW/FES/ENV	Airfield Overrun	**40**
4-05-17	DPW/FES/ENV	IPBC	**503**
4-06-17	DPW/FES/ENV	Center Tank Range	**991**
3-11-17	DPW/FES/ENV	North Range	**80**
3-28-17	DPW/FES/ENV	Leach Impact Area	**2,705**
3-21-17	DPW/FES/ENV	M–Range	**93**
3-27-17	DPW/FES/ENV	Normandy Drop Zone	**235**
3-20-17	DPW/FES/ENV	Arno Drop Zone	**158**
10-11-17	DPW/FES/ENV	Miller Airfield	**500**
Total Burned			**13,578**
Total Unburned			612

Training Enhancement

The training enhancement burns (Table 7 and Figure 4) were completed by CRE staff with assistance from Department of Public Works (DPW) and Fire and Emergency Services (FES). Training enhancement burn units were categorized by highest use for military activities and ecological benefits. These burns are scheduled over a five-year rotation. As Camp Ripley continues to expand and new ranges are developed, existing burn units have conflicted with construction of ranges. Some areas became low priority and were dropped from the fire rotation. The training enhancement burns are of particular importance to the conservation program since the reintroduction of fire is critical to native vegetation management on the installation. Nearly all of Camp Ripley is a fire dependent ecosystem and managing vegetation with fire to meet military objectives also meets ecological management goals. It is of utmost importance to manage native vegetation with an historical fire regime to promote a healthy and thriving ecosystem that can withstand the human demands of the area.

Camp Ripley consists of 11 maneuver areas divided into 80 training areas of which 70 contain designated burn units. These burn units are dynamic in respect to size and shape but are directly related to military land use. Burn plans are prepared for each burn unit, reviewed and permitted by the DNR Division of Forestry prior to execution of the burn. Camp Ripley FES partnered with CRE and DPW staff to implement prescribed fire on these units.

Figure 4. Training enhancement and hazard reduction units burned, Camp Ripley Training Center, Minnesota, 2017.



The 2017 prescribed burn units in the original design were not conducive to quality management of time and resources. The units were, in some cases, combined with adjacent units to form a larger burn unit that could be managed from roadways and trails. This process eliminated the need for break installation (e.g., mineral or mowed) and better suits the need for reducing encroachment in grasslands by allowing fire to run through transition zones into forested areas. Enlarging and combining burn units into one larger unit saves money by reducing the amount of staff time for maintenance of fire breaks. Many burn units are surrounded by a road 33 feet in width which improves crew safety and time management.

Table 7. Training enhancement burns, Camp Ripley Training Center, Minnesota, 2017.

Training Enhancement Units			**Grass Acres**	**Forest Acres**	**Total Acres**	**Actual Burn Date**
Maneuver Area	**Training Area**	**Unit Name**				
B	3	18	23		23	04-08-2017
B	5	19	36		36	04-11-2017
B	8	13	13	3	16	
D	21	16	18		18	05-03-2017
D	22	17	56	6	62	04-06-2017
D	25	13	18		18	03-27-2017
D	30	1	36	206	242	04-17-2017
F	42	47	16		16	05-03-2017
I	58	49	107		107	04-08-2017
I	58	51	11		11	05-09-2017
I	64	79	22		22	04-28-2017
K1	71	72	103	19	122	05-09-2017
K1	79	71	87	40	127	
K2	78	69	6		6	
Total Burned			**446**	**231**	**677**	
Total Unburned			**106**	**43**	**149**	

All goals and objectives were achieved on completed burn units which demonstrates the effectiveness of phenological timing of the burn events**.** The 2018 planned training enhancement burns are found in Camp Ripley INRMP (MNARNG 2018a).

Invasive Species

By Jason Linkert, Minnesota Department of Military Affairs

Invasive species are non-native species that harm economic, environmental or human health. These species are a threat to the ecological function of areas around the world due to their capability to change the biotic and abiotic characteristics of their environment (U.S. Department of Agriculture 2009). The MNARNG is required by state and federal regulations to prevent the introduction of invasive species; detect and respond rapidly to and control populations of such species in a cost-effective and environmentally sound manner; monitor invasive species populations accurately and reliably; provide for restoration of native species and habitat conditions in ecosystems that have been invaded; conduct research on invasive species and develop technologies to prevent introduction and provide for environmentally sound control of invasive species; and promote public education on invasive species and the means to address them.

In 2017, an interagency agreement was established between St. Cloud State University (SCSU) and the Minnesota Department of Military Affairs for invasive species management. Graduate and undergraduate interns work closely with CRE staff in combating terrestrial and aquatic invasive species.

Twenty-five terrestrial invasive plant species have been identified at Camp Ripley (Table 8 and MN Department of Agriculture 2017). Three of these species, leafy spurge (*Euphorbia esula*), common tansy (*Tanacetum vulgare*) and spotted knapweed (*Centaurea maculosa*) are considered prohibited noxious weeds and were the priority for control treatments. Additional invasive species targeted for treatment included European buckthorn (*Rhamnus cathartica*), baby's breath (*Gypsophilia paniculata*), plumeless thistle (*Carduus acanthoides*), bull thistle (*Cirsium vulgare*), Canada thistle (*Cirsium arvense*) and Siberian elm (*Ulmus pumilla*).

Selective Invasive Plant Management

Extensive search and treatment of common buckthorn commenced in cantonment along with training areas downrange using a handheld GPS device to track the species and basal bark application of the herbicide triclopyr to eliminate seed-bearing mother trees. This treatment proved to be the most effective at removing isolated individual plants while being the least labor intensive in comparison with cut stump treatments. A total of 35 populations were documented with six receiving basal bark treatments.

In response to a request from Range Control, SCSU interns treated areas to control native poison ivy (*Toxicodendron radicans*) in locations which posed a threat to the health and safety of training personnel. The A–13 Expert Medical Field Badge Litter Obstacle Course was treated with the herbicide triclopyr. All exterior barrier gates and downrange propane tanks were treated with triclopyr to control the threat of poison ivy. In addition, SCSU interns treated poison ivy on the Valhalla White Pine Walking Trail to reduce the risk to visiting school groups during environmental briefs.

Leafy spurge was located in cantonment in 2017 just south of Range Control. A one-half acre plot was treated with the restricted use pesticide picloram and monitored for re-growth and spread.

Table 8. Invasive plant species, Camp Ripley Training Center, Minnesota.

Family	Scientific Name	Common Name	Minnesota Department of Agriculture Noxious Weed Listing (MNDA 2016)
Brassicaeae	*Berteroa incana*	Hoary alyssum	Not currently listed
Poaceae	*Bromus inermis*	Smooth brome	Not currently listed
Asteraceae	*Carduus nutans*	Musk thistle	Prohibited noxious weed
Asteraceae	*Carduus acanthoides*	Plumeless thistle	Prohibited noxious weed
Asteraceae	*Centurea maculosa*	Spotted knapweed	Prohibited noxious weed

Table 8. Invasive plant species, Camp Ripley Training Center, Minnesota.

Family	Scientific Name	Common Name	Minnesota Department of Agriculture Noxious Weed Listing (MNDA 2016)
Asteraceae	*Chrysopsis villosa* var. *foliosa*	Golden aster	Not currently listed
Asteraceae	*Cirsium arvense*	Canada thistle	Prohibited noxious weed
Asteraceae	*Grindelia squarrosa*	Gum weed	Not currently listed
Asteraceae	*Cirsium vulgare*	Bull thistle	Not currently listed
Asteraceae	*Tanacetum vulgare*	Common tansy	Prohibited noxious weed
Cannabaceae	*Humulus japonicus*	Japanese hops	Prohibited noxious weed
Caryophyllaceae	*Gypsophilia paniculata*	Baby's breath	Not currently listed
Caryophyllaceae	*Euphorbia cyparissias*	Cypress spurge	Not currently listed
Euphorbiaceae	*Euphorbia esula*	Leafy spurge	Prohibited noxious weed
Guttiferae	*Hypericum perforatum*	St. Johnswort	Not currently listed
Fabaceae	*Melilotus alba*	White sweet clover	Not currently listed
Fabaceae	*Melilotus officinalis*	Yellow sweet clover	Not currently listed
Poaceae	*Phalaris arundinacea*	Reed canary grass	Not currently listed
Poaceae	*Phragmites australis*	Common reed	Prohibited noxious weed
Rhamnaceae	*Rhamnus cathartica*	Buckthorn	Prohibited noxious weed
Rhamnaceae	*Rhamnus frangula*	Glossy buckthorn	Prohibited noxious weed
Caryophyllaceae	*Saponaria officinalis*	Bouncing bet	Not currently listed
Anacardiaceae	*Toxicodendron radicans*	Poison ivy (native)	Specially regulated noxious weed
Ulmaceae	*Ulmus pumila*	Siberian elm	Not currently listed
Lythraceae	*Lythrum salicaria*	Purple loosestrife	Prohibited noxious weed
Euphorbiaceae	*Euphorbia cyparissaias*	Cypress spurge	Not currently listed
Apiaceae	*Daucus carota*	Queen Anne's lace	Not currently listed
Iridaceae	*Iris pseudacorus*	Yellow iris	DNR invasive plant

Large Scale Invasive Plant Management

Large scale management included the treatment of 68 acres of spotted knapweed and common tansy. A tractor-mounted boom sprayer mixed with the selective herbicides metsulfuron-methyl and aminopyralid coupled with a surfactant was foliar applied by CRE staff and SCSU interns. Treatments were streamlined by tank mixing herbicides allowing multiple species to be treated with one tank mix per day. High priority areas were targeted from areas that received the highest troop use and presented the highest risk of infestation. Roadways and ditches were the primary target areas on Cassino, Normandy, East and West Boundary roads as these presented the highest risk of spread. Field habitats with heavy tank traffic where all-terrain vehicle access was limited were treated utilizing the tractor mounted boom sprayer.

Water Resources

Camp Ripley is home to an outstanding array of water bodies including small inland lakes, wetlands and streams, which make up 1,054 acres of Camp Ripley's 53,000 acres. Eighteen miles of Mississippi River frontage and 12 miles of Crow Wing River frontage also form the eastern and northern borders of Camp. Most of these waters are not subject to active management by CRE personnel, however water control structures and mitigation have been conducted at some sites and others are managed for recreational access.

Lake and River Resources

By Jake Kitzmann, Minnesota Department of Military Affairs

Miller Lake

Miller Lake is a 27-acre basin with a 1,405 acre watershed that drains via Broken Bow Creek into the Mississippi River. Miller Lake's culvert (#376) was replaced in November 2012 and a water control structure was added. CRE staff maintained the water level control system in accordance with the plan approved by the DNR Fish and Wildlife Division and the DNR Nongame Wildlife Program (MNDNR 2013a). The managed water level has been maintained at approximately 1211.95' in elevation. Between 2012 and the fall of 2014 beaver activity had become an issue. Beavers had raised the water levels to about 20 inches above optimal levels. No nuisance beaver activity was noted in Miller Lake during 2017.

Mississippi River

Four picnic and camping areas are maintained along the river (Figure 5) which allow for access to the excellent fishing opportunities found in the Mississippi. This pristine stretch of river is home to a number of popular game fish species including muskellunge (*Esox masquinongy*), northern pike (*Esox Lucius*), walleye (*Sander vitreus*) and smallmouth bass (*Micropterus dolomieu*).

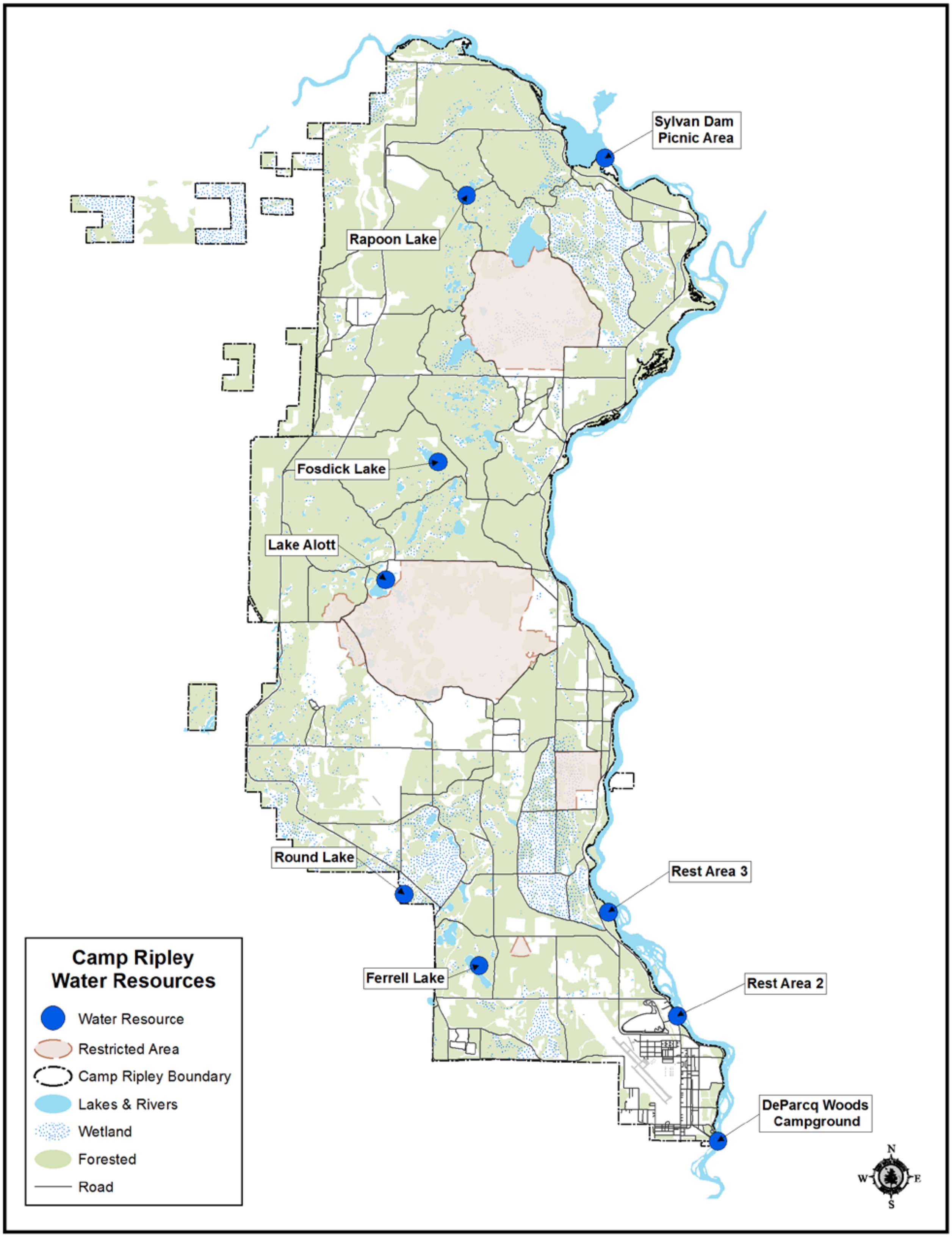
Lake Alott

This 40 acre lake located in Training Area 36 (Figure 5) has a fishing access with boat ramp and dock maintained on the north side. Small boats are stored at this landing for use by soldiers. With a maximum depth of 30 feet Lake Alott is home to a number of popular game fish species including northern pike, walleye, bluegill (*Lepomis macrochirus*) and black crappie (*Pomoxis nigromaculatus*).

Fosdick Lake

This 26 acre lake located in Training Area 50 (Figure 5) has a fishing access with a dock maintained on the northeast side. With a maximum depth of about 10 feet Fosdick is home to a number of popular game fish species including walleye, largemouth bass (*Micropterus salmoides*) and black crappie.

Figure 5. Selected water resources, Camp Ripley Training Center, Minnesota.



Round Lake

This 127 acre lake located on the western edge of Camp Ripley (Figure 5) has a fishing access with a boat ramp and a dock maintained on the east side. Boats and camp sites are also maintained at this land site for use by soldiers. There is also a public water access maintained by the DNR on the west side of the lake. With a maximum depth of about 19 feet, Round Lake is home to a number of popular game fish species including walleye, muskellunge, northern pike, largemouth bass and black crappie.

Rapoon Lake

This 16 acre lake located in Training Area 75 (Figure 5) has a fishing access on the northeast side. With a maximum depth of about 24 feet, Rapoon is home to a number of popular game fish species including walleye, muskellunge and smallmouth bass.

Ferrell Lake

This 51 acre lake located in Training Area 5 (Figure 5) has a fishing access with boat ramp and dock maintained on the southwest side. Small boats are stored at this landing for use by soldiers. With a maximum depth of about 10 feet, Ferrell is home to a number of popular game fish species including northern pike, walleye, bluegill and black crappie.

Wildlife

By Nancy J. Dietz and Brian J. Dirks, Minnesota Department of Natural Resources

Species in Greatest Conservation Need

"Minnesota defines species in greatest conservation need (SGCN) as native animals, nongame and game, whose populations are rare, declining or vulnerable to decline and are below levels desirable to ensure their long-term health and stability. Also included are species for which Minnesota has a stewardship responsibility. Stewardship species are those for which populations in Minnesota represent a significant portion of their North American breeding, migrating or wintering population, or species whose Minnesota populations are stable, but whose populations outside of Minnesota have declined or are declining in a substantial part of their range" (MNDNR 2015a).

One of the federal requirements of the Comprehensive Wildlife Conservation Strategy is to manage SGCN by developing a wildlife action plan. "Minnesota's Wildlife Action Plan, 2015 – 2025" (MNDNR 2015a) is Minnesota's response to the congressional mandate. The goal of the wildlife action plan is to 1) ensure the long-term health and viability of Minnesota's wildlife, with a focus on species that are rare, declining or vulnerable to decline; 2) enhance opportunities to enjoy SGCN and other wildlife and to participate in conservation; and 3) acquire the resources necessary to successfully implement the Minnesota Wildlife Action Plan. Additional surveys, monitoring and research will be directed toward identifying other SGCN species on Camp Ripley, and management or conservation actions that could be implemented to benefit these species.

Of the over 2,000 known native wildlife species in Minnesota, 346 species from all major taxonomic groups meet the definition of species in greatest conservation need. All federal and state endangered, threatened and special concern species are included on the SGCN list. Five taxonomic groups have one-third or more of their total species found in Minnesota as SGCN, they are mammals (38%), reptiles (50%), amphibians (36%), tiger beetles (46%) and mussels (60%) (MNDNR 2015a). Eighty-eight SGCN species have been identified on Camp Ripley, including 63 bird species of which 31 are songbirds.

Birds

Christmas Bird Count

The Christmas Bird Count (CBC) has been coordinated by the National Audubon Society since 1900, and is the oldest continuous nationwide wildlife survey in North America (Sauer et al. 2008). Counts occur within predetermined 15–mile diameter circles located across North America, Mexico and South America. The northwest portion of Camp Ripley is within one of these circles (CBC census code: MNPL) (Figure 6). Each count is conducted during a single calendar day within two weeks of Christmas (December 14 – January 5). For example, the 2017 CBC occurred on January 1, 2018. The Pillager CBC was started in 1999, and the census has occurred 19 times (Minnesota Ornithologists' Union 2018a). CBC data is primarily used to track winter distribution patterns and population trends of various bird species.

The Pillager CBC occurred on January 1, 2018, and was conducted by the DNR staff. The count lasted 3.75 hours. The skies were clear. The temperature ranged from -7° to 2° Fahrenheit, with winds of 6 miles per hour (Weather Underground 2018a). The Crow Wing River was free of ice from Sylvan Dam downstream about 1.7 km. The total number of birds counted and diversity of species was the fourth largest (Table 9) since 2001. The 322 trumpeter swans (*Cygnus buccinator*) observed were the second highest number recorded since 2001. Other notable observations were a belted kingfisher (*Megaceryle alcyon*) and northern shrike (*Lanius excubitor*).

Breeding Bird Monitoring

Camp Ripley provides important breeding and migratory habitat for 63 birds that are species in greatest conservation need (SGCN). Thirty-two SGCN birds including water birds, raptors and songbirds are known to breed on Camp Ripley. Of these SGCN birds 15 are often heard during point count surveys.

Breeding bird surveys have been conducted on permanent plots throughout Camp Ripley since 1991. The full breeding bird survey includes 90 plots that are surveyed as part of long-term population monitoring. The number of plots surveyed each year varies according to training, weather and survey strategy. Development of new ranges on Camp Ripley along with increased military and civilian training can limit access to most permanent survey points. Additionally, certain plots are no longer surveyed due to complete habitat alterations due to gravel pit expansion or development, and installation or expansion of military training ranges and parking lots.

Figure 6. Christmas bird count area within Camp Ripley Training Center, Minnesota, since 2002.

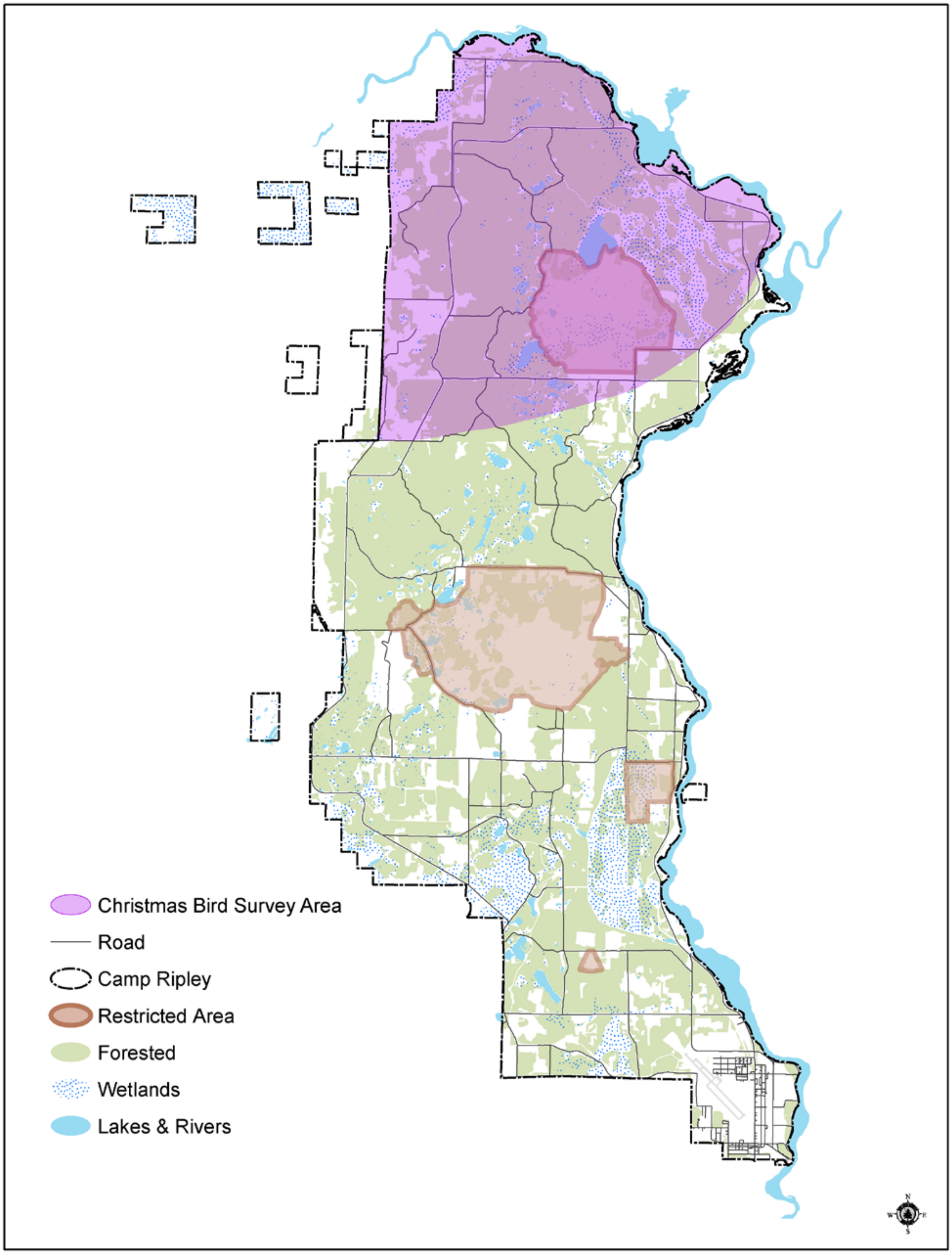


Table 9. Christmas bird count data, Camp Ripley Training Center, Minnesota, 2004 – 2017 [a].

Species	**Scientific Name**	**Count Year**											
		2004	**2005**	**2006**	**2007**	**2009**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
Cackling goose	*Branta hutchinsii*	0	0	0	0	7	0	0	0	0	0	0	**0**
Canada goose	*Branta canadensis*	81	2	4	11	0	18	9	0	0	42	0	**3**
Trumpeter swan	*Cygnus buccinator*	28	26	49	60	69	73	145	201	89	500	33	**322**
Mallard	*Anas platyrhynchos*	0	20	0	0	0	0	110	0	0	40	0	**12**
Common merganser	*Mergus merganser*	0	4	12	0	0	2	4	31	12	51	5	**11**
Ruffed grouse	*Bonasa umbellus*	2	0	0	0	0	0	0	0	0	0	0	**0**
Wild turkey	*Meleagris gallopavo*	5	0	0	0	11	0	0	2	3	0	0	**0**
Bald eagle	*Haliaeetus leucocephalus*	3	4	11	0	0	8	0	0	2	7	1	**4**
Northern goshawk	*Accipiter gentilis*	2	0	0	0	0	0	0	0	0	0	0	**0**
Red-tailed hawk	*Buteo jamaicensis*	1	0	0	0	0	0	0	0	0	0	0	**0**
Rough-legged hawk	*Buteo lagopus*	0	0	0	0	0	0	0	0	0	0	0	**0**
Golden eagle	*Aquila chrysaetos*	1	0	0	0	0	0	0	0	0	0	0	**0**
Unidentified eagle		0	0	0	0	0	0	0	0	0	1	0	**0**
Barred owl	*Strix varia*	0	0	0	0	0	0	0	0	0	2	0	**0**
Belted kingfisher	*Megaceryle alcyon*	1	0	0	0	2	0	0	0	0	0	0	**1**
Red-headed woodpecker	*Melanerpes erythrocephalus*	0	0	0	0	0	0	0	0	0	1	0	**0**
Red-bellied woodpecker	*Melanerpes carolinus*	0	0	0	0	0	0	0	0	0	0	0	**0**
Downy woodpecker	*Picoides pubescens*	0	1	0	0	0	0	0	1	0	2	0	**1**
Hairy woodpecker	*Picoides villosus*	0	0	0	0	0	0	0	0	0	2	0	**0**
Pileated woodpecker	*Dryocopus pileatus*	0	1	0	0	1	0	1	1	0	0	0	**1**
Northern shrike	*Lanius excubitor*	1	0	0	0	0	0	0	0	0	0	0	**1**
Blue jay	*Cyanocitta cristata*	1	3	0	0	1	0	11	0	0	6	0	**2**
American crow	*Corvus brachyrhynchos*	3	2	3	3	6	0	12	1	0	10	7	**1**
Common raven	*Corvus corax*	0	0	0	0	1	0	0	2	1	2	0	**2**
Black-capped chickadee	*Parus atricaillus*	9	12	1	1	2	0	0	0	2	3	0	**3**
Red-breasted nuthatch	*Sitta canadensis*	3	1	0	0	0	0	0	0	0	0	0	**1**
White-breasted nuthatch	*Sitta carolinesis*	0	3	0	0	0	0	0	0	0	3	0	**0**
Bohemian waxwing	*Bombycilla garrulus*	0	0	0	0	0	0	0	0	0	0	0	**0**
Cedar waxwing	*Bombycilla cedrorum*	0	0	0	0	0	0	0	0	0	0	0	**0**
American tree sparrow	*Spizella arborea*	0	0	0	0	9	0	0	0	0	0	0	**0**
Dark-eyed junco	*Junco hyemalis*	0	0	0	0	0	0	0	0	0	0	0	**0**
Northern cardinal	*Cardinalis cardinalis*	0	0	0	0	0	0	0	0	0	0	0	**0**
Common redpoll	*Acanthis flammea*	32	0	0	0	0	0	225	0	0	0	0	**0**
Unidentified siskin/redpoll/finch		0	0	0	0	0	0	0	0	0	4	0	**0**
# Observers		3	4	3	2	2	1	1	1	1	3	2	**2**
TOTAL # INDIVIDUALS		171	79	80	75	109	101	517	239	109	677	46	**365**
TOTAL # SPECIES		15	12	6	4	10	4	8	7	6	16	4	**14**

[a] Due to unsafe road conditions and/or extreme cold weather, no Christmas Bird Count was conducted on Camp Ripley during the 2008 and 2010 count years.

The 2017 songbird survey documented 994 individual birds of 76 species on 90 survey plots (Table 10). Eight of the most common species recorded during breeding bird surveys were red-eyed vireo (*Vireo olivaceus*), ovenbird (*Seiurus aurocapillus*), American redstart (*Setophaga ruticilla*), veery (*Catharus fuscescens*) (SGCN), chestnut-sided warbler (*Setophaga pensylvanica*), scarlet tanager (*Piranga olivacea*), eastern wood-pewee (*Contopus virens*) (SGCN) and song sparrow (*Melospiza melodia*). Note that two of these most common Camp Ripley species are also SGCN.

Camp Ripley's long-term songbird monitoring is helpful in determining population trends for species of concern such as SGCN and other species considered for federal Endangered Species Act listing, such as the golden-winged warbler (Figure 7). Due to this warbler's population decline, in February 2010, the U.S. Fish and Wildlife Service (USFWS) was petitioned to list the golden-winged warbler as threatened or endangered under the ESA. The USFWS has reviewed the petition and issued a "positive finding" that triggers a thorough review of all available information to determine if the golden-winged warbler status warrants protection (USFWS 2017a). Eighty percent of the global breeding population resides in the forests surrounding the Great Lakes. Minnesota was estimated to support 47% of the continental population in 2013 (Pfannmuller et al. 2017a). Golden-winged warblers have been slightly increasing on point count surveys since 2000 (Figure 7) and incidental, auditory observations have increased throughout Camp Ripley in the past ten years.

In the past, we focused on red-eyed vireos populations because they were much more numerous than any other species detected on survey plots. Six plots identified in previous years as being undisturbed sites with high numbers of red-eyed vireos were surveyed. However, the number of red-eyed vireos per plot and the total number on all plots have continued to decline (by more than 70%) since 2000. The number of red-eyed vireos on the six surveyed plots has dropped from a total of 30 – 33 through 2005 to 9 in 2009, 2011 and 2014, 12 in 2012, 13 in 2013 and 16 in 2017. This drop is very noticeable in the field when counts changed from 4 to 8 red-eyed vireos on each plot in prior years, to 1 to 2 on each plot (Figure 8). Although red-eyed vireos are not a SGCN or special concern species, the change in numbers is concerning because the federal Breeding Bird Survey in Minnesota, 1967 – 2015, indicates a nonsignificant stable population trend but tending toward an increase (Pfannmuller et al. 2017a). In addition, other species that use similar habitat, such as ovenbirds, have shown large increases on Camp Ripley during the same time period (Figure 9).

Long-term monitoring will continue on Camp Ripley to monitor songbird population trends and to determine if this is a permanent drop in the number of red-eyed vireos nesting on Camp Ripley or a natural fluctuation or population adjustment from an unusually high number in the 1990s.

Table 10. Songbird survey data, Camp Ripley Training Center, Minnesota, 2000 – 2014 and 2017.

Year	Field Surveyor/s	Number of Permanent Plots Surveyed	Total Number of Birds Documented	Total Number of Species Documented	Average Number of Birds per Plot	Average Number of Species per Plot
2000	Dirks/Brown	92	1,002	66	10.89	6.43
2001	Dirks/Brown	31	316	46	10.19	5.77
2002	Dirks/Brown/ DeJong	30	258	42	8.6	5.83
2003	Dirks/Brown/ DeJong	90	823	68	9.14	5.37
2004	Dirks/Brown/ Burggraff	107	1,129	64	10.55	6.14
2005	Dirks/Brown/ DeJong	89	897	61	10.08	6.20
2006	Dirks/Brown/ DeJong	88	802	64	9.11	5.84
2007	Dirks/Brown/ DeJong	91	994	71	10.92	7.02
2008	Dirks/Brown	89	875	70	9.83	6.60
2009	Dirks	57	563	63	9.87	7.26
2010	Dirks	11	122	25	*	*
2011	Dirks	42	383	51	9.12	6.45
2012	Dirks	6	66	16	*	*
2013	Dirks	61	688	68	11.28	8.18
2014	Dirks	8	95	23	*	*
2017	**Montgomery**	**90**	**994**	**76**	**11.04**	**8.23**

* Not calculated due to low number of plots surveyed in 2010, 2012 and 2014 due to plot access limitations. No breeding songbird surveys were conducted in 2015 – 2016.

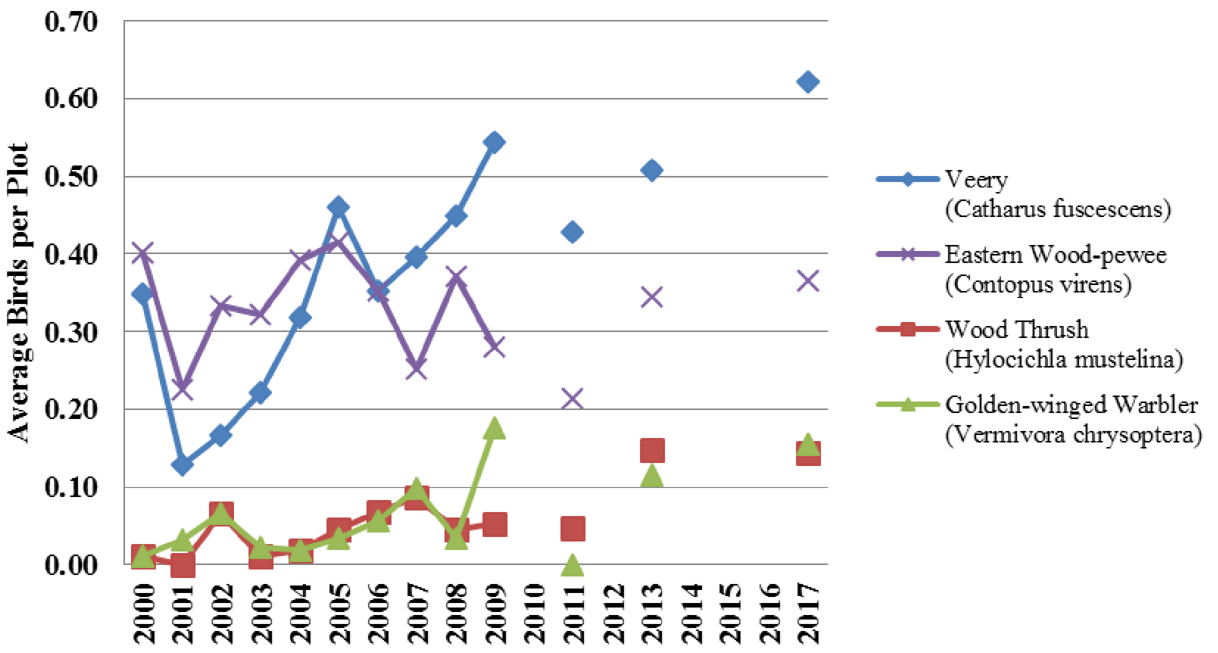


Figure 7. Selected songbirds of greatest conservation need, Camp Ripley Training Center, 2000 to 2013, 2017*.

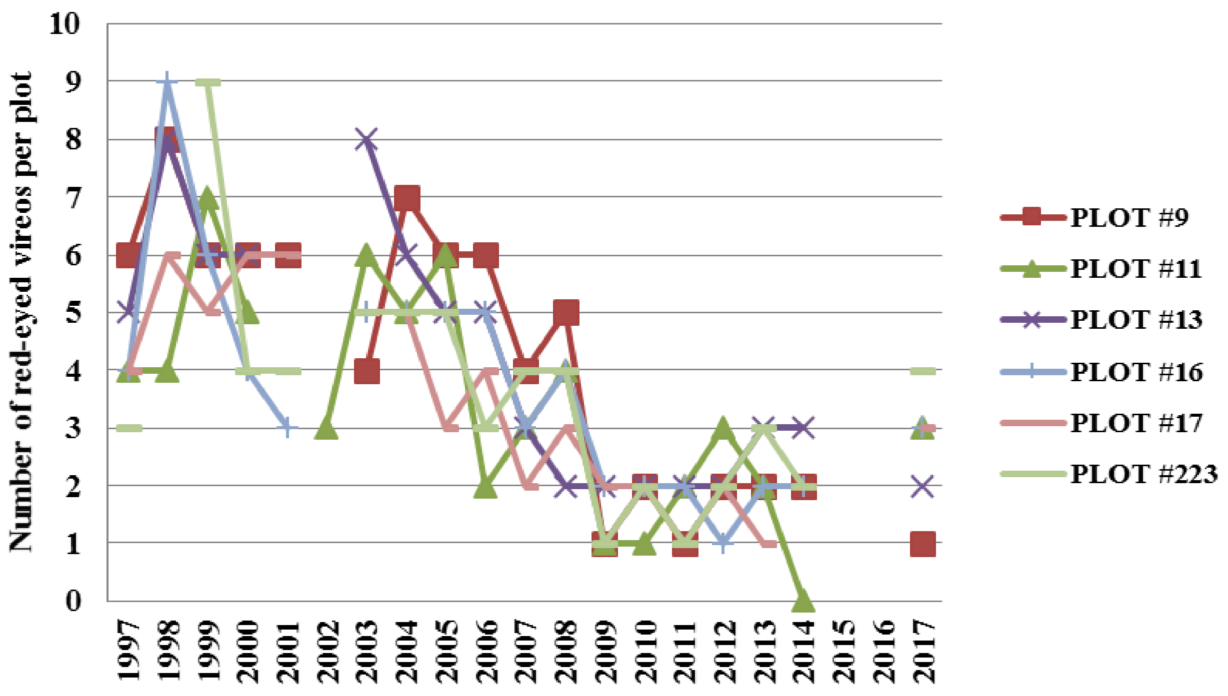
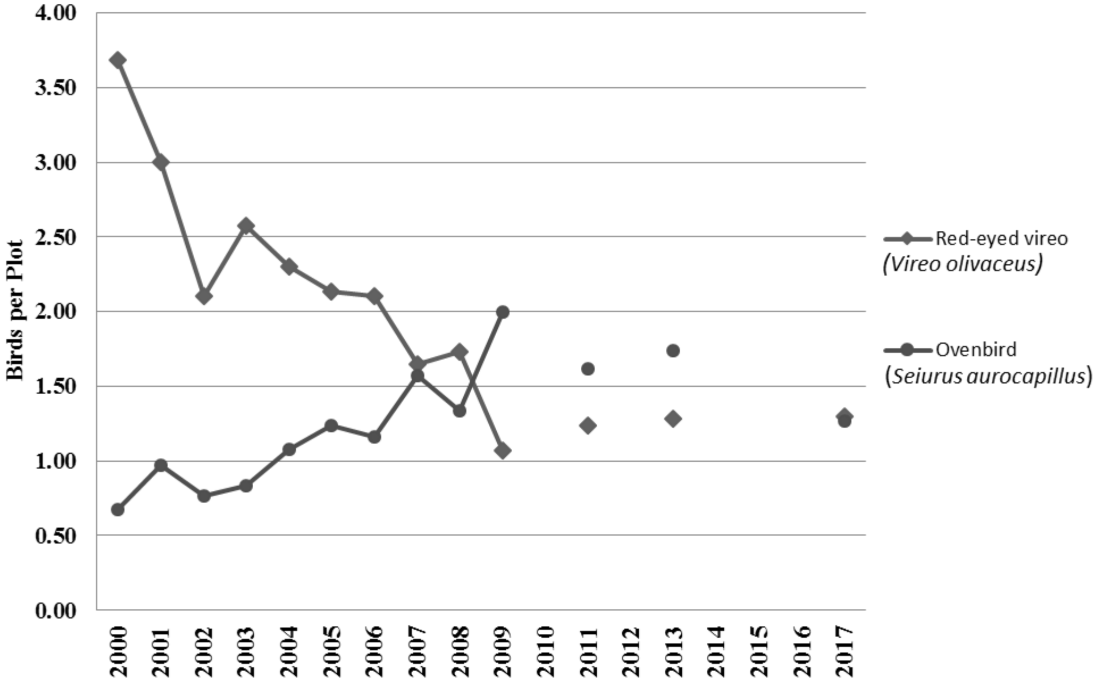


Figure 8. Red-eyed vireos (*Vireo olivaceus*) per plot, Camp Ripley Training Center, 1997-2014*, 2017.

Figure 9. Selected songbird average birds per plot, Camp Ripley Training Center, 2000-2013, 2017*.



* In 2001 and 2002 only 31 and 30 plots were surveyed respectively.
* In 2010, 2012 and 2014 only 11, 6 and 8 permanent plots were surveyed, respectively; therefore the data is not included.

Trumpeter Swan (*Cygnus buccinator*)

Trumpeter swans were a common breeding bird in western Minnesota until the mid-1800s; the last historical record of breeding in the wild was in 1885. Trumpeter swans were considered extirpated in the state. However, reintroduction and recovery efforts, including listing the species as state threatened in Minnesota in 1996, have resulted in more than 5,300 free-flying birds in Minnesota. Due to population increases, trumpeter swans are now a special concern species, a SGCN, and are monitored each year (Dirks et al. 2010) through aerial flights and ground observations by field staff.

The first record of trumpeter swans breeding on Camp Ripley occurred in 1990 when an active nest was located in a wetland north of Normandy Road (Dorff and Nordquist 1993). Trumpeter swans have continued to be documented at various lakes throughout Camp Ripley (1991, 1992, 2009 – 2017) but successful reproduction had not been documented in more than

Table 11. Trumpeter swan production, Camp Ripley Training Center, Minnesota, since 1990.

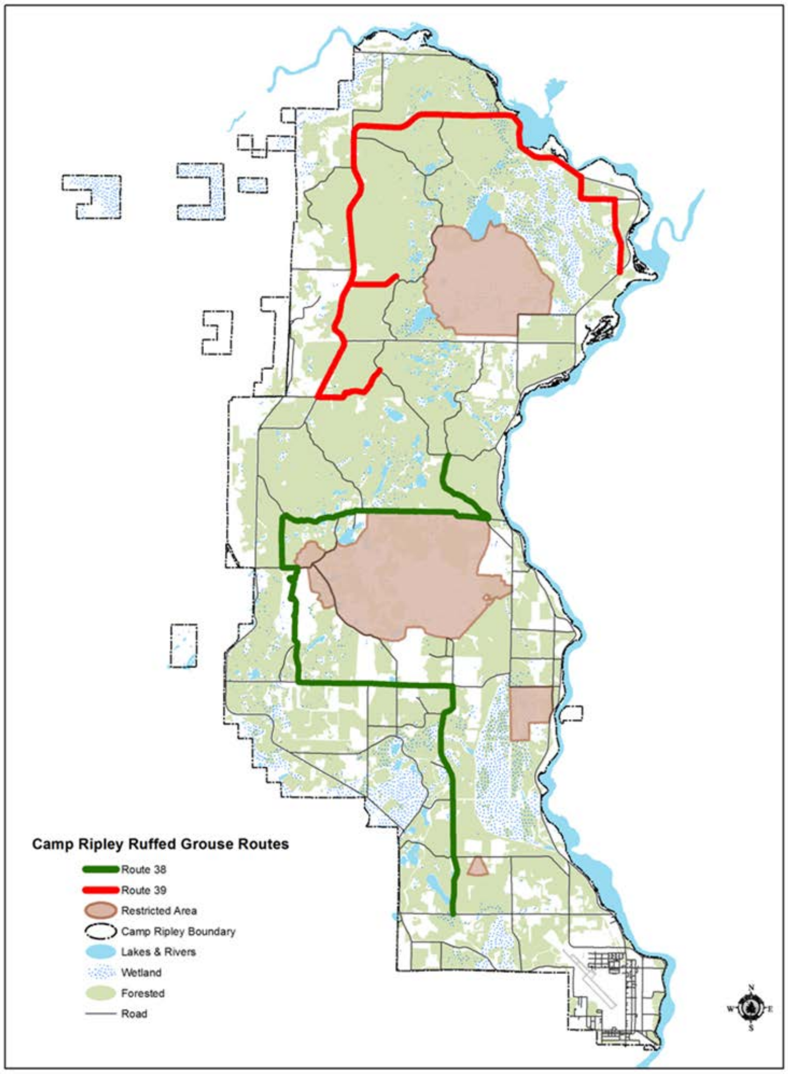
Year	Cygnets Raised
1990	2
2009	Unknown
2010	4
2011	1
2012	8
2013	4
2014	8
2015	5+
2016	Unknown
2017	**10**
Known Total	**37**

ten years until 2010. In late-June and late-July 2017, breeding pairs were observed on Miller Lake (n=3 cygnets), Goose Pond (n=4 cygnets), Marne Marsh (n=3 cygnets), Lookout Lake and F Range pond. No pairs were observed on Mud Lake, Ferrell Lake, Frog Lake, Fosdick Lake, Rapoon Lake or the unnamed pond on the south side of Cassino Road (Table 11).

Ruffed Grouse (*Bonasa umbellus*)

Ruffed grouse drumming counts are conducted on two survey routes (#38 and #39) as part of the DNR's statewide survey throughout ruffed grouse range. The data is used as an index to monitor changes in densities of grouse over time. Route #38, the DNR's official survey route, has been run since 1979. Route #39 was added by Camp Ripley in 1998 (Figure 10) but was not run in 2017. Drumming counts are conducted for four minutes at ten points along each route.

Figure 10. Ruffed grouse spring drumming survey routes, Camp Ripley Training Center, Minnesota, since 1979.



The official count for route #38 occurred on May 3. Nine drums were heard, which is a 20% decrease in drums from 2015 and a 40% decrease from 2013 (Figure 11). Camp Ripley's ruffed grouse population decreased after its most recent high in 1998, but began to rebound in 2003. However, the DNR's two other Little Falls area ruffed grouse routes had decreases in drums per stop since the spring of 2010 (Figure 12).

Although Camp Ripley is not managed specifically for ruffed grouse, habitat is generally stable. Aspen stands of varying age classes provide the best ruffed grouse habitat along both routes. Aspen stands that had been clear-cut along both of these routes have been maturing. Ruffed grouse will benefit as timber harvest for forest management continues in order to maintain a wide range of age classes of aspen.

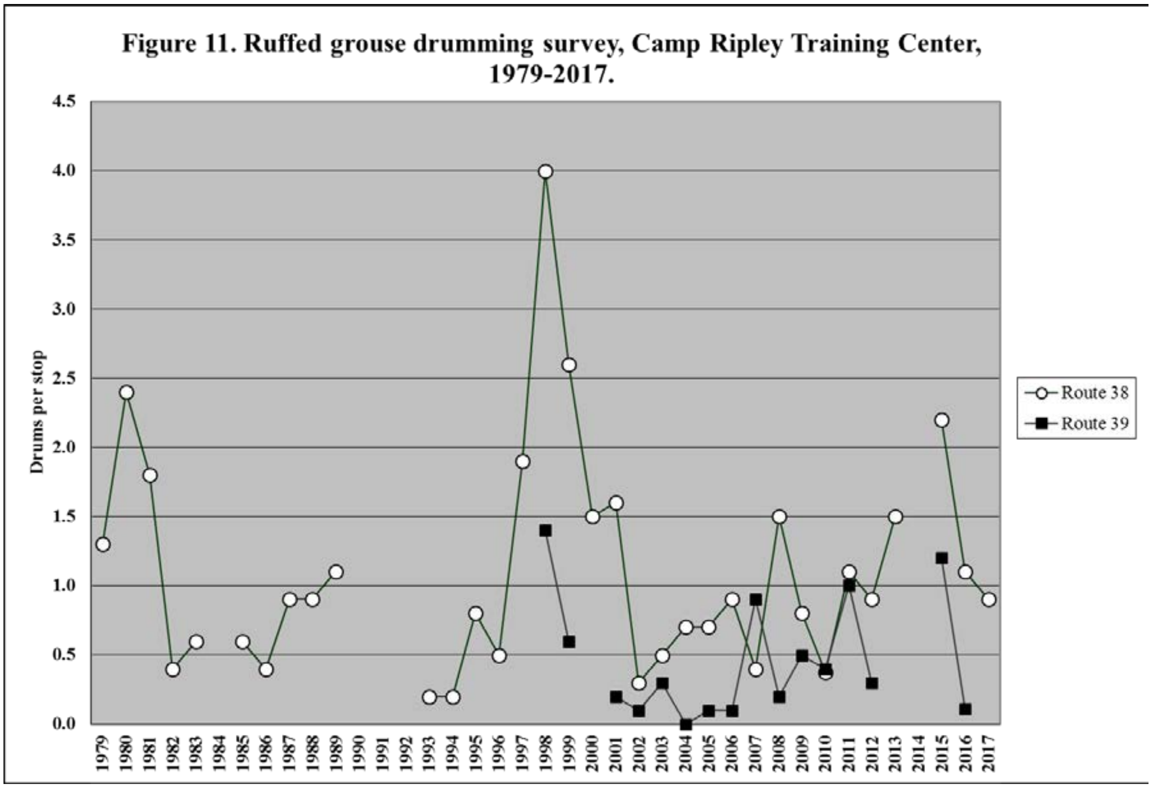
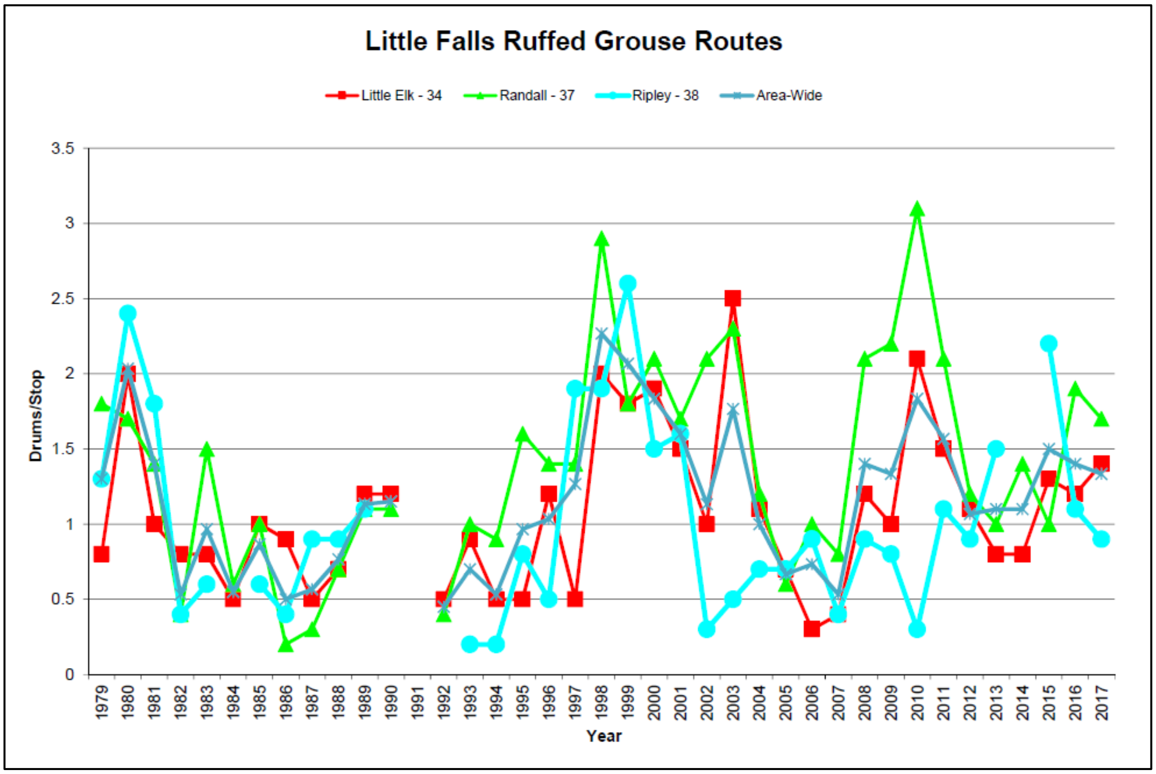


Figure 11. Ruffed grouse drumming survey, Camp Ripley Training Center, 1979-2017.

*Gaps in the graph indicate years when the survey was not conducted. Route #38 had only six stops in 2008 and five stops in 2015.

Figure 12. Ruffed grouse drumming surveys in the DNR Little Falls area, Minnesota, 1979 – 2017.



Osprey (*Pandion haleaetus*)

No ospreys were observed using the Crow Wing River nest platform which was established in 2011. A bald eagle (*Haliaeetus leucocephalus*) pair (Pusan) established a nest in a neighboring tree in the fall of 2014, so it is unlikely that an osprey pair will use the platform in close proximity to an active bald eagle nest. The nest blew down from the platform on Sylvan Reservoir in 2013. In 2014 – 2017, ospreys did not nest on the Sylvan Reservoir platform but nested on the Sylvan Dam platform and raised two young in 2014 – 2015 and one in 2016 – 2017.

Bald Eagle (*Haliaeetus leucocephalus*)

In the lower 48 states, Minnesota has the most nesting pairs of bald eagles at approximately 1,300 (USFWS 2016a). Bald eagles are protected under the Bald and Golden Eagle Protection Act and the Migratory Bird Treaty Act. Both of these acts prohibit killing, selling or otherwise harming or disturbing eagles, their nests or eggs. The U.S. Fish and Wildlife Service (USFWS) released Bald Eagle Management Guidelines for people who are engaged in recreation or land use activities around bald eagles. These guidelines provide information and recommendations regarding how to avoid disturbing bald eagles. Camp Ripley will continue to monitor and protect active or alternate bald eagle nests with no disturbance buffers during breeding and nesting seasons as required by the National Guard Bureau's Eagle Policy Guidance (Dirks and Dietz 2009), Bald and Golden Eagle Protection Act (USFWS 2008a), and Bald Eagle Management Guidelines (USFWS 2007).

Bald eagles are closely monitored at Camp Ripley (Dirks et al. 2010). Since 1991, two to ten territories have been monitored within Camp Ripley, fledging from one to nine young annually (Table 12). Territory size is variable but are spaced apart to ensure sufficient food resources for chicks and to raise young with minimal disturbance from other eagles. Eagle pairs can have more than one nest within a territory.

Table 12. Bald eagle territories and fledglings, Camp Ripley Training Center, Minnesota, 1991 – 2017.

Year	Number of Active Territories	Number of Young Fledged
1991–1992	4	?
1993	2	4
1994	3	5
1995	3	4
1996	3	4
1997	3	6
1998	2	4
1999	3	3
2000	4	8
2001	4	8
2002	2	1
2003	3	4
2004	3	4
2005	5	5
2006	6	1*
2007	5	9
2008	5	5
2009	4	2*
2010	6	3
2011	7	4
2012	6	5
2013	7	6
2014	6	6*
2015	9	9
2016	9	5*
2017	**10**	**7***

* Not all active nests checked for nest success due to military training.

In late March, bald eagles occupied ten territories throughout Camp Ripley (Figure 13). In addition to recent new nests, Pusan and Frog Lake, that were discovered in 2015 and Lake Alott discovered in April 2016. Two additional nests were discovered in 2017, West Range and Fort Ripley. North Range, East Boundary and Fort Ripley nests each fledged one chick. Pusan and Tamarack Lake fledged two chicks. The Mud Lake, Prentice Pond and Frog Lake territories were active but unsuccessful. The Lake Alott and West Range territories were active but productivity was unknown. Rest Area 3 territory was inactive.

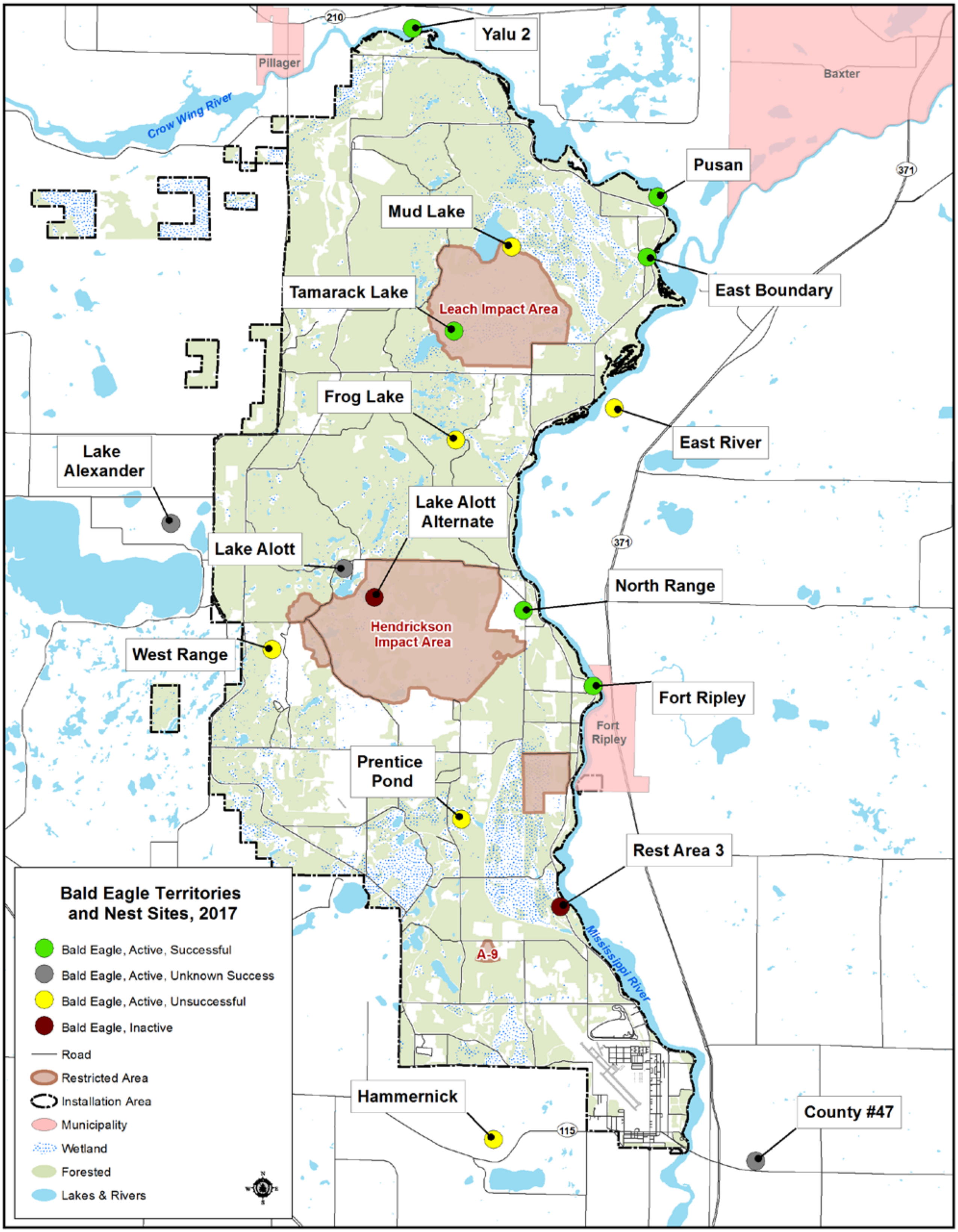
Due to aircraft maneuver training needs during the active bald eagle nesting season, the MNARNG applied for a USFWS bald eagle disturbance permit for nests on Camp Ripley. This was requested by MNARNG helicopter pilots due to the 200 meter horizontal and 300 meter above ground level no disturbance buffers around eagle nests, conflicts with range safety danger zones, and restrictions that do not allow flying low level maneuvers off the installation.

Five eagle territories within one mile of the Camp Ripley boundary were also monitored. The Yalu territory was active and fledged one chick. The Yalu territories' Camp Ripley nest fell in 2014 but was rebuilt on the north side of the Crow Wing River in 2015. The Hammernick nest was rebuilt in the fall 2014. The nest fell during the winter of 2015 but was rebuilt in a different nest tree during 2016. This territory was active but unsuccessful. The East River, County 47 and Lake Alexander territories were active but productivity was unknown.

Golden Eagle (*Aquila chrysaetos*)

Golden eagles in North America are primarily found in Western States and Western Canada. Golden eagles are protected under the Bald and Golden Eagle Protection Act and the Migratory Bird Treaty Act. Both of these acts prohibit killing, selling or otherwise harming or disturbing eagles, their nests or eggs. Golden eagles do not breed in Minnesota, the nearest population of breeding golden eagles is found in Western North Dakota. Golden eagles have been known to use the state for fall migration needs (annually fall counts record 115 – 200 golden eagles at Hawk Ridge Bird Observatory, Duluth, Minnesota) but had not been thought off as a regular winter visitor in the state. However, recent surveys by the National Eagle Center in Wabasha, Minnesota have discovered a regular winter population between 130 – 150 golden eagles along the Mississippi River valley in southeast Minnesota (National Eagle Center 2017).

Figure 13. Bald eagle territories and nest status at and near Camp Ripley Training Center, Minnesota, 2017.



Winter Survey

In 2010, the National Eagle Center began a wintering golden eagle survey in the blufflands region along the Mississippi River in Minnesota, Wisconsin and Iowa. The project was implemented to document regular wintering populations of golden eagles. Golden eagles were previously not considered regular winter inhabitants of the region. Camp Ripley was added as a survey area in 2016. The survey occurred on January 16, 2016 and January 21, 2017. The primary survey observers in 2016 were Brian Dirks, DNR, and Dr. William Faber, CLC Natural Resources Instructor, with two volunteer observers added. Both Camp Ripley DNR staff conducted the survey in 2017. In 2016 and 2017, no golden eagles were observed (Table 13).

Table 13. Golden eagle wintering survey, Camp Ripley Training Center, Minnesota, since 2016.

Species	**Scientific Name**	**Count Year**	
		2016	**2017**
Bald eagle	*Haliaeetus leucocephalus*	0	**3**
Northern goshawk	*Accipiter gentilis*	0	**0**
Red-tailed hawk	*Buteo jamaicensis*	0	**2**
Rough-legged hawk	*Buteo lagopus*	0	**1**
Golden eagle	*Aquila chrysaetos*	0	**0**
Unidentified eagle		1	**0**
# Observers		2	**4**
Observer Hours		8	**12**
TOTAL # INDIVIDUALS		1	**6**
TOTAL # SPECIES		1	**3**

Migration Tracking Project

The National Eagle Center implemented the Golden Eagle Project to 1) understand habitat needs and prey requirements of golden eagles using the blufflands of Southeast Minnesota, Western Wisconsin and Northeast Iowa, 2) determine breeding origins and migration patterns for this population of golden eagles, 3) encourage conservation of critical winter habitats in the blufflands region, and 4) to educate the public about golden eagles (National Eagle Center 2017).

In 2012, the DNR Camp Ripley staff used road-killed deer at baited, remote camera stations to aid in estimating winter gray wolf populations. Staff recorded multiple golden eagles at bait stations in February and March. In subsequent years, staff continued to record golden eagles at bait stations. The DNR staff worked with the DNR Nongame Wildlife Program, Audubon Minnesota and the National Eagle Center to participate in the Golden Eagle Project and to set aside a solar, satellite, backpack transmitter for use on a Camp Ripley wintering golden eagle. In 2015, three baited remote camera stations were used to determine golden eagle presence on Camp Ripley; once a golden eagle began to feed regularly at a station trapping began. On March 10, 2015, a remotely triggered bow-net trap was used to capture a sub-adult female golden eagle (4 year old; #54 - Ripley). An Argos/GPS solar powered, backpack transmitter (Microwave Telemetry) was fit to the eagle by Mark Martell, Audubon Minnesota.

The transmitter was programmed to take multiple GPS locations every day which provides more accurate locations than the backup satellite (Argos) locations. The Argos system is used to relay downloads of the GPS locations. On her spring 2017 migration Ripley left her winter area on March 4 and traveled from Minnesota to Nunavut Territory, Canada, arriving on her summer habitat on April 8. She spent approximately 188 days on her summer habitat, then began her fall migration on October 12 returning to Camp Ripley area on December 10. She spent several days on Camp Ripley then moved southwest of Camp for the winter. Her northern migration, a 1,800 mile journey to her summer habitat, took about 36 days and her southern migration back to her winter habitat in Minnesota took 60 days (Figure 14 and 15).

Ripley's capture as a four year old in 2015 meant that she could potentially breed in 2016. In contrast to Ripley's 2015 summer locations which covered a much broader area, her 2016 locations were concentrated in one area which indicated that she was occupying her first nesting territory. In 2017, she occupied the same small area, which showed that she was nesting in this area for a second time. About 35 – 40% of this female, golden eagle's annual life cycle is spent in migration, therefore conservation of migratory habitat is equally as important as conserving summer and winter habitats.

Owl Surveys

Owl surveys at Camp Ripley began in 1994 and continued annually until 1999. These surveys were placed on a four-year rotation in 2000, but with the threat of West Nile Virus occurring in owl populations, the survey is now conducted every year. Data from these surveys is also used to monitor state and regional owl population trends.

In the past, owls were surveyed at 26 points along one designated route (Route #1) in the spring to determine presence and abundance of owl species (Figure 16). The survey was conducted four times during specified survey periods (March 12 – 24, March 25 – April 6, April 7 – 19, April 20 – May 2). A three minute passive listening period was used at each point. An additional survey route (Route #2) was added in 2004, which covers the interior portion of Camp Ripley. This route was surveyed with similar survey protocol as Route #1.

In 2009, Camp Ripley's survey protocol was changed to reflect protocol designed by the Western Great Lakes Region (WGLR) owl monitoring survey (Grosshuesch 2008). Until 2014, this project was a collaborative effort between Hawk Ridge Bird Observatory, Natural Resources Research Institute, Minnesota Department of Natural Resources and Wisconsin Department of Natural Resources but is now being sponsored solely by the Hawk Ridge Bird Observatory (2017). This survey was developed as a large scale, long-term owl survey to monitor owl populations in the WGLR. It was designed to increase understanding of the distribution and abundance of owl species in the region since few species of owls are adequately monitored using traditional avian survey methods such as breeding bird surveys, songbird point counts or Christmas Bird Counts. Survey protocol uses existing anuran (frog and toad) survey routes, of 10 stops per route, to conduct roadside surveys in Minnesota and Wisconsin. In 2008, the number of survey periods was reduced from three to one period (April 1 – 15) with a five minute passive listening period. The (WGLR) survey analysis of seasonal calling activity data suggested one survey period in April is adequate to detect all species of interest for monitoring purposes. For comparison purposes with the WGLR owl survey the existing Camp Ripley owl survey routes are used and the number of routes at Camp Ripley is based upon 10 stops per route.

Figure 14. Satellite transmittered golden eagle (Ripley) locations, Camp Ripley Training Center, Minnesota, 2017.

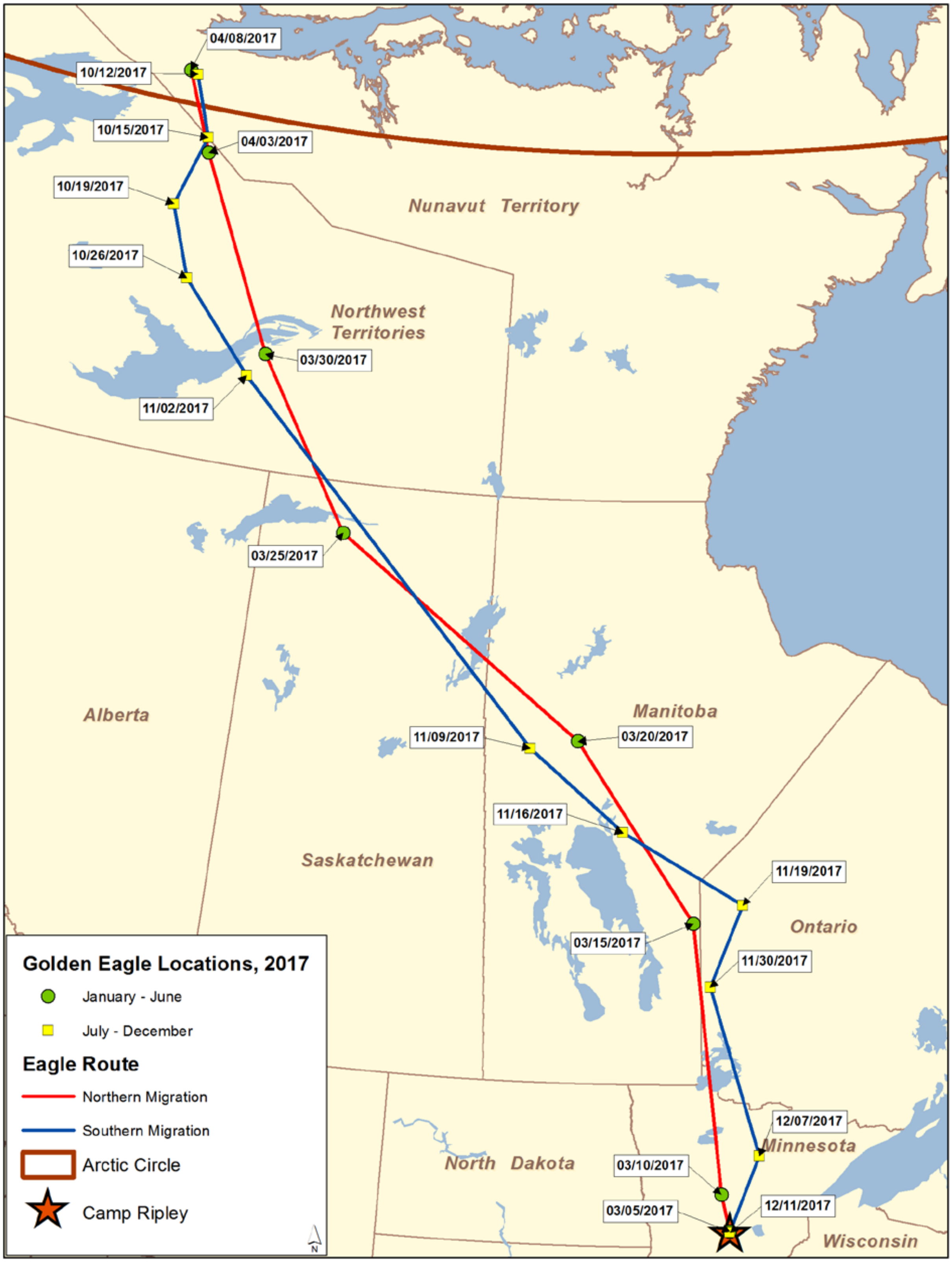


Figure 15. Satellite transmittered golden eagle (Ripley) migration routes, Camp Ripley Training Center, Minnesota, 2015 – 2017.

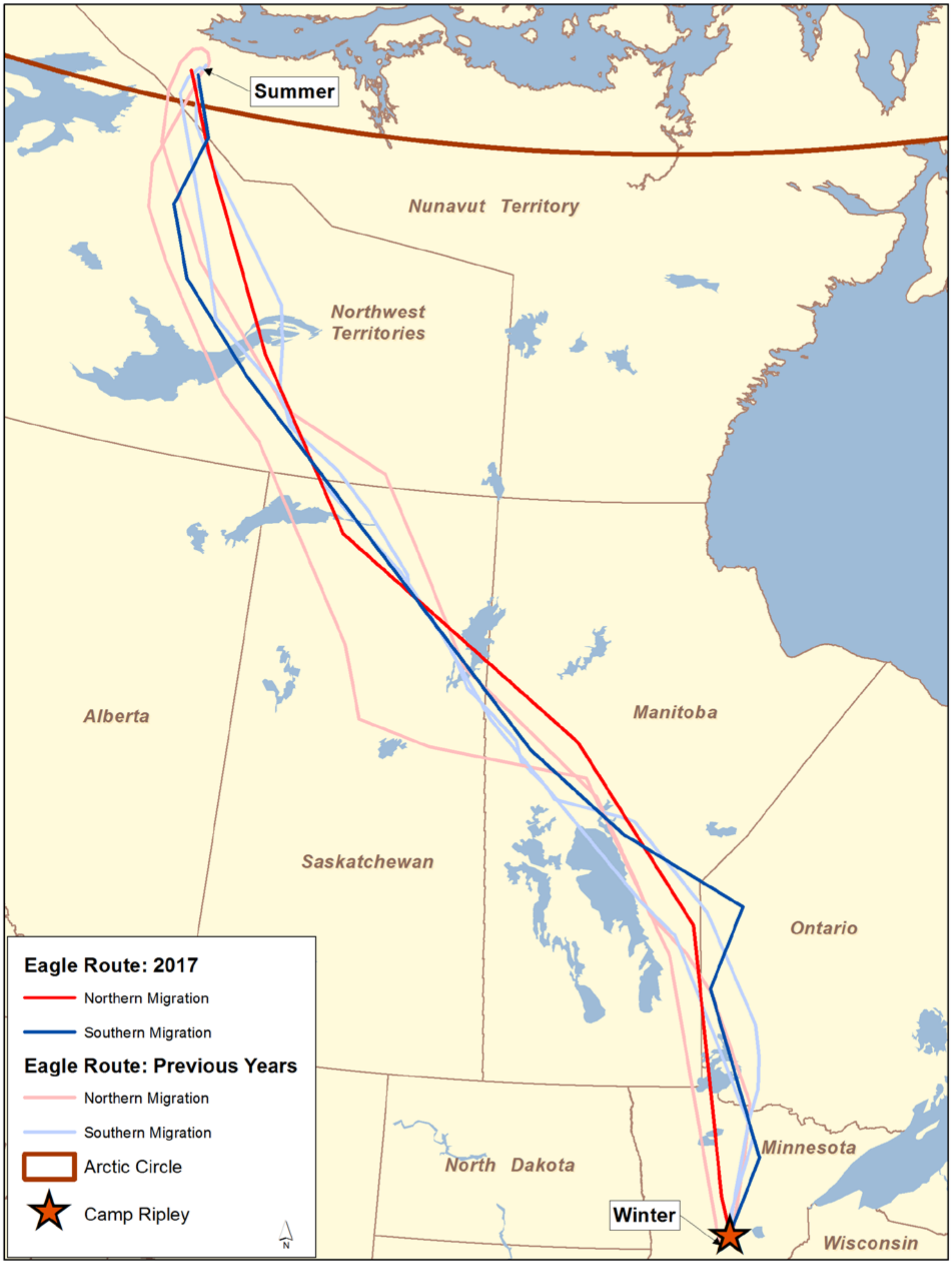
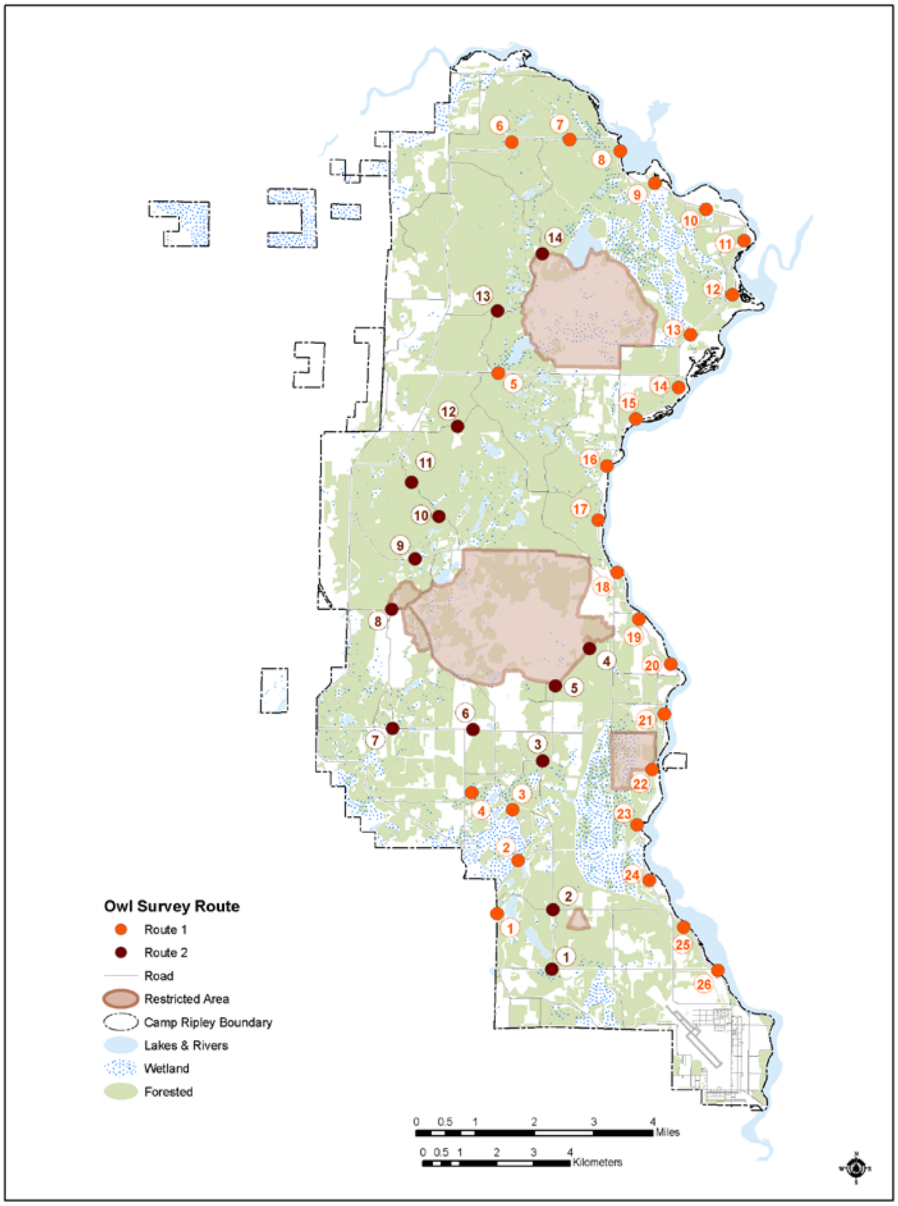


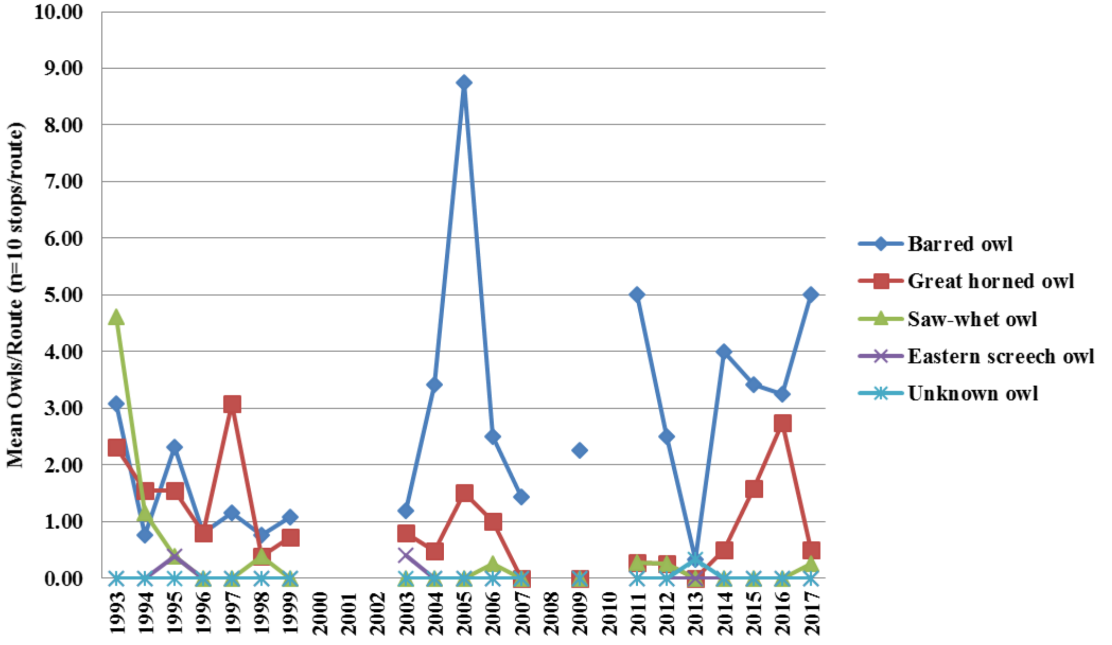
Figure 16. Owl survey routes, Camp Ripley Training Center, Route #1 since 1993 and Route #2 since 2004.



The owl survey for Route #1 and Route #2 (Figure 17) was conducted on April 4. A total of 24 owls were detected during the surveys (4.0 routes). The mean for barred owls (*Strix varia*) was 5.0 owls/route, the third highest since 1993 (Figure 16). The mean for great horned owls (*Bubo virginianus*) was 0.5 owls/route, down significantly from 2.75 in 2016 (Figure 17). One northern saw-whet owl (*Aegolius acadicus*) and no eastern screech-owls (*Megascops asio*) were heard. The overall mean of 5.75 owls/route (Figure 18) is the fourth highest mean during the 19 year history of the survey. And, it is above the Camp Ripley long-term survey mean of 4.08 owls/route.

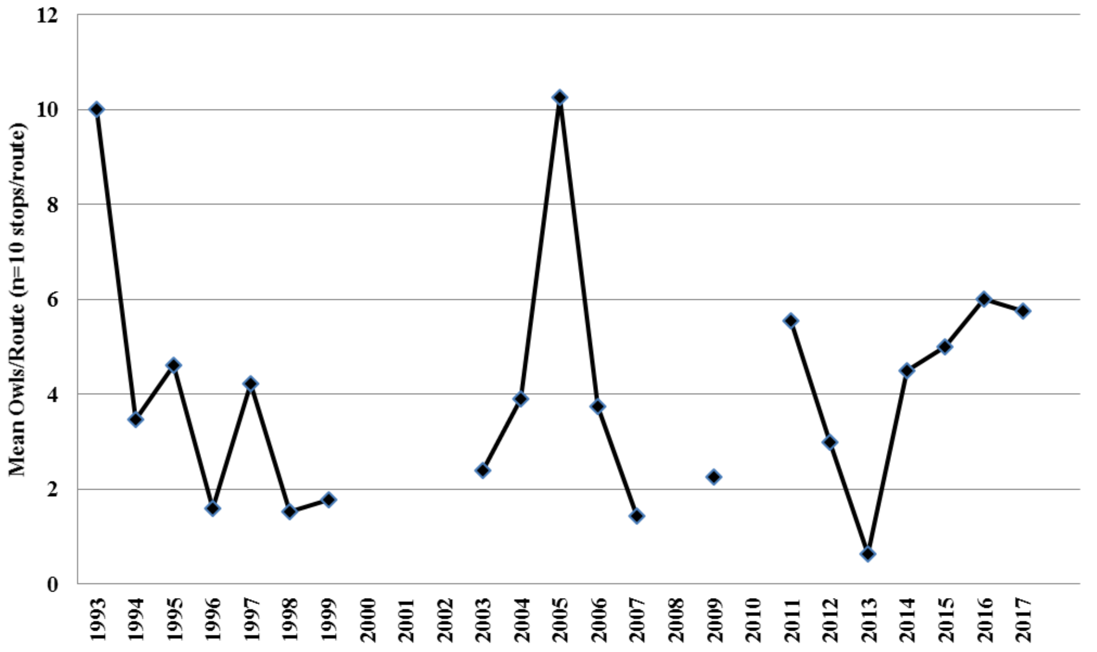
In 2017, Camp Ripley had two and half times as many mean owls/route (5.75) compared to Minnesota's WGLR survey's mean of 2.15 owls/route in 2014 (Grosshuesch and Brady 2015), the most recent information available. In addition, on a neighboring route in east-central Morrison County the barred owl count was zero owls/route in 2014, whereas Camp Ripley's survey averaged 5.0 barred owls/route in 2017 (Figure 17). Camp Ripley's mean owls per route has been either similar to Minnesota's WGLR survey number or has exceeded it since 2005 (Grosshuesch and Brady 2015). Minnesota's WGLR owl survey results are pending for 2015 – 2017.

Figure 17. Mean number of owl per route by species, Camp Ripley Training Center, 1993-2017[a].



[a]Survey data presented with a three minute passive listening period. No surveys were conducted in 2000 – 2002 and 2007, 2008 and 2010.

Figure 18. Overall mean number of owls per route, Camp Ripley Training Center, 1993-2017[a].

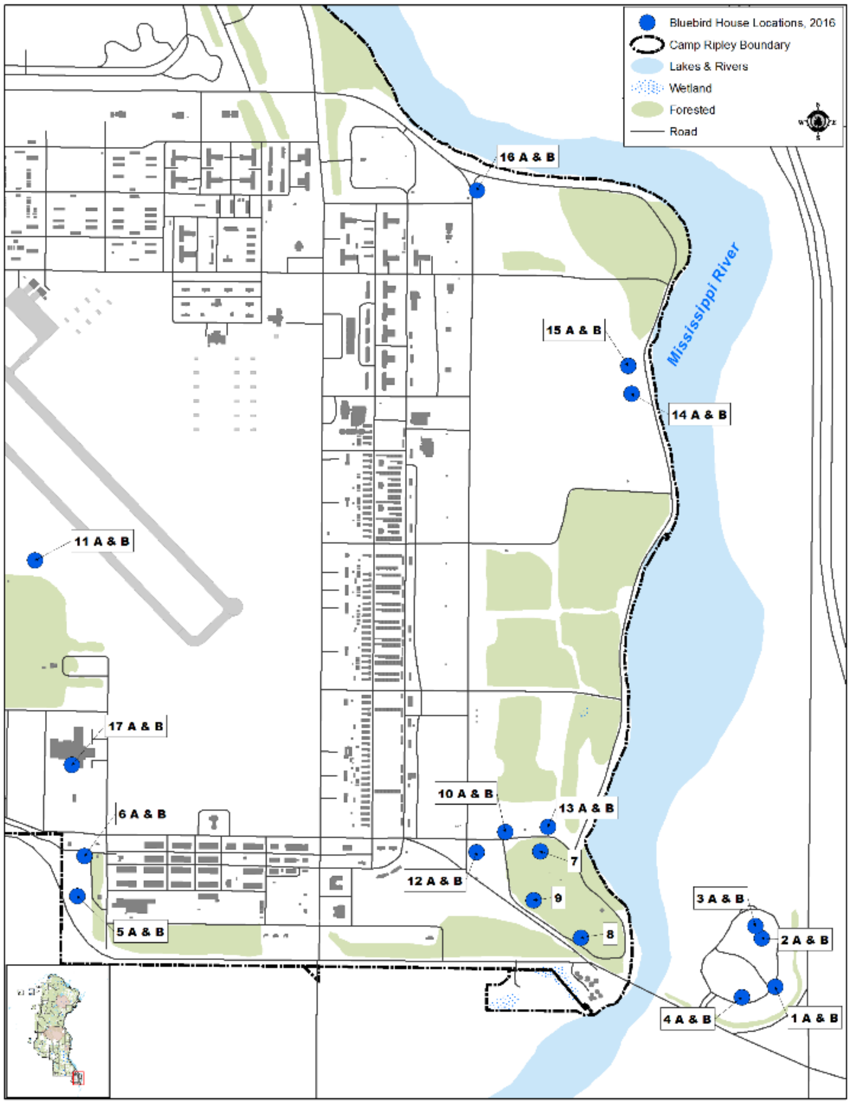


[a]Survey data presented with a three minute passive listening period. No surveys were conducted in 2000 – 2002 and 2007, 2008 and 2010.

Eastern Bluebird (*Sialia sialis*) Nest Boxes

Eastern bluebird populations declined significantly from the 1930s to 1960s due to loss of habitat and competition from other cavity nesting birds particularly non-native European starlings (*Sturnus vulgaris)* and house sparrows (*Passer domesticus*) (MNDNR 2017a). Because of this population decline, nationwide bluebird recovery efforts began with the North American Bluebird Society in 1977 (North American Bluebird Society 2017a) and in 1979 statewide recovery efforts were initiated by the Audubon Chapter of Minneapolis Bluebird Recovery Program of Minnesota (Bluebird Recovery Program of Minnesota 2017a) in cooperation with the Nongame Wildlife Program of the DNR. These recovery efforts provided artificial nest boxes for eastern bluebirds. Camp Ripley established artificial nest boxes in 1994 at the Minnesota State Veterans Cemetery and along the Camp Ripley cantonment fence in 2007 to aid in the eastern bluebird recovery. In addition, the nest boxes at the Minnesota State Veterans Cemetery provide visitors viewing enjoyment.

Figure 19. Location of eastern bluebird houses, Minnesota State Veterans Cemetery and Camp Ripley Training Center cantonment area, since 2016.



In 2008, nest boxes were replaced with Gilbertson PVC artificial nest boxes (North American Bluebird Society 2017b). Bluebird nest box pairs were located in open areas close to scattered trees, at least 300 feet from brush, and more than 500 feet apart. Placing boxes away from brush areas minimizes nest box use by house wrens (*Troglodytes aedon*). These locations have been effective and eliminated use by house wrens from 2009 to 2017.

Thirty-one Gilbertson PVC bluebird nest boxes (Figure 19) were monitored regularly during the breeding season (April to August) by Mike Ratzloff, Minnesota Department of Natural Resources volunteer. Sixteen boxes were occupied by bluebirds, six by tree swallows (*Tachycineta bicolor*), one by black-capped chickadees (*Poecile atricapillus*) (Table 14) and none by house wrens. No successful nesting attempts were made by invasive house sparrows. Only two bluebirds fledged from the nest boxes at the Minnesota State Veterans Cemetery and 54 fledged from nest boxes within the cantonment area. Additionally, 29 tree swallows and six black-capped chickadees successfully fledged. Camp Ripley's bluebird production has been lower in the past three years; however, the long-term mean (2009 – 2017) of 2.5 bluebirds fledged per nest box is higher than the statewide long-term (2005 – 2015) mean of 2.12 (Bluebird Recovery Program of Minnesota 2017b). Regular bluebird house maintenance and monitoring greatly improves the success of bluebird houses.

Table 14. Bluebird and tree swallow fledging production, Camp Ripley Training Center, Minnesota, since 2009.

Year	**Veterans Cemetery**			**Cantonment**		
	# Nest Boxes	**# Bluebirds Fledged**	**# Tree Swallows Fledged**	**# nest boxes**	**# Bluebirds Fledged**	**# Tree Swallows Fledged**
2009	8	17 (5 boxes)	10 (3 boxes)	21	79 (12 boxes)	6 (1 box)
2010	8	17 (5 boxes)	11 (2 boxes)	23	79 (16 boxes)	13 (4 boxes)
2011	8	13 (3 boxes)	19 (4 boxes)	23	53 (11 boxes)	10 (4 boxes)
2012	8	7 (3 boxes)	18 (5 boxes)	23	82 (13 boxes)	1 (2 boxes)
2013	8	16 (4 boxes)	10 (2 boxes)	23	53 (14 boxes)	10 (3 boxes)
2014	8	16 (3 boxes)	9 (2 boxes)	21	79 (13 boxes)	6 (1 box)
2015	8	5 (1 box)	10 (3 boxes)	20	66 (10 boxes)	6 (2 boxes)
2016	8	5 (2 boxes)	17 (3 boxes)	23	43 (12 boxes)	26 (6 boxes)
2017	**8**	**2 (1 box)**	**14 (3 boxes)**	**23**	**54 (11 boxes)**	**15 (3 boxes)**

Mammals

Gray Wolf (*Canis lupus*)

Federal Court Decision

Through federal action and by encouraging the establishment of state programs, the 1973 Endangered Species Act provided for the conservation of ecosystems upon which threatened and endangered species of fish, wildlife and plants depend (USFWS 2008b). The first federal Endangered Species Preservation Act was passed in 1966, and in 1967 gray wolves were classified as endangered and provided limited protection. In 1974, gray wolves were afforded full protection under the federal Endangered Species Act (ESA) of 1973 (MNDNR 2016a). During the mid- to late-1970s the DNR estimated the wolf population at about 1,000 to 1,200; based on 2003 – 2004 and 2007 – 2008 surveys, the population had grown and stabilized at approximately 3,000 animals. The 2016 – 2017 survey estimated that the current population is stable at 2,856 wolves (Erb et al. 2018).

In a proposed rule issued on May 5, 2011, the U.S. Fish and Wildlife Service proposed to remove gray wolves in the Western Great Lakes Distinct Population Segment — which includes Minnesota, Michigan, Wisconsin and portions of adjoining states — from the Federal List of Endangered and Threatened Wildlife because wolves had recovered in this area and no longer required the protection of the Endangered Species Act (USFWS 2011a). The Final Rule to remove Endangered Species Act protection for gray wolves in this area took effect January 27, 2012 (USFWS 2011b). However, due to a federal court decision, wolves in the Great Lakes region were relisted under the Endangered Species Act, effective December 19, 2014 (USFWS 2015). Wolves reverted to the federal protection status they had prior to being removed from the endangered species list in the Great Lakes region. This means wolves are currently federally classified as threatened in Minnesota and endangered elsewhere in the Great Lakes region (MNDNR 2015b).

Wolf Monitoring Background

Besides serving as a National Guard training center, Camp Ripley is also a Minnesota Statutory Game Refuge. Wolves were first documented on Camp Ripley in 1993. Camp Ripley provides good quality habitat for wolves on the southern edge of the Minnesota gray wolf range. In the past 22 years, 51 wolves have been radio-collared and/or ear tagged on Camp Ripley to determine pack size, movements, causes of mortality and possible effects of military training (Table 15).

Comparing survival rates of wolves on and off Camp Ripley may provide additional insight into the effects of delisting and now relisting wolves. Research has demonstrated that military training activities on Camp do not negatively affect wolves and the presence of wolves on Camp has not resulted in any loss of training capabilities. In fact, evidence obtained from this study confirmed that wolves that move off Camp are moving into a more hostile environment where they are exposed to illegal and accidental caused mortality.

Wolf Status and Movements

Since 2001, Camp Ripley has supported two or three wolf packs. In 2017, three wolf packs used Camp Ripley as most or part of their home range. The amount of time each pack spends on Camp varies. The North Pack, which occupies the north half of Camp, usually stays in this area, while only part of the South Pack’s territory is on Camp. In addition, pack sizes vary each year and by time of year. Winter 2016 – 2017 pack estimates from remote cameras and track counts indicate that only three to four wolves were in the South Pack while the North and Miller Lake packs each contained eight wolves. This estimate is similar with the number of wolves in Camp Ripley packs in recent years.

At the beginning of 2017, the only two radio collared wolves on Camp Ripley were in the North Pack. Plans to snare and radio collar additional wolves in January-March 2017, were thwarted because of insufficient snow depth. At one time the breeding female of the North Pack, wolf #40 was originally captured by helicopter and radio collared in February, 2010. She was caught again as an incidental catch during a wolf trapping/collaring project in May 2011. Because of wolf #40s age and condition she was not recaptured in 2015; however, she has continued to be located by remote camera and tracking her failing radio collar. Even though her radio-collar eventually failed in 2017, she was observed twice early in the year during aerial radio tracking (Figure 20) The other collared wolf (#50) has been the breeding male in the North Pack since before he was radio-collared in February 2015.

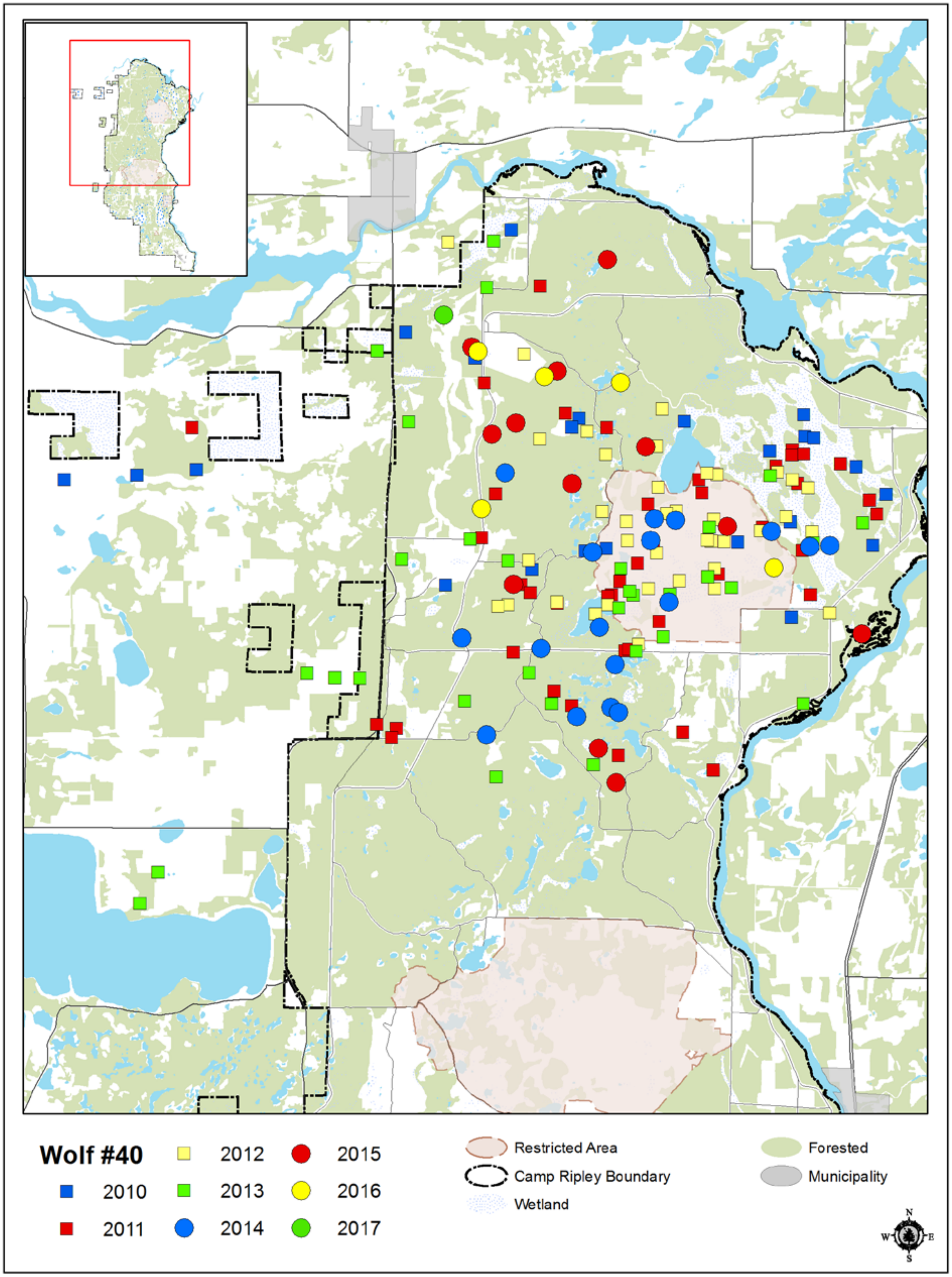
Table 15. Gray wolves captured, Camp Ripley Training Center, Minnesota, since 1996. **(Bold = wolves monitored in 2017)**

Wolf#	Sex	# of Captures	Age at 1st Capture	Date of 1st Capture	Date of Last Capture	Weight (lbs.) at Last Capture	Ear Tag Color & Number (Left/ Right)	Fate	Comments
1	F	1	Yearling	9/10/1996	9/10/1996	57		dead	Illegally trapped/shot in Cass County (8/1997)
2	F	2	Pup	9/19/1996	8/29/1997	42		dead	Illegally shot-poacher
3	F	1	Yearling	9/20/1996	9/20/1996	80		dead	Poisoned
4	M	2	Yearling	9/23/1996	1/31/1998	79		dead	Hit by car
5	F	1	Yearling	2/21/1997	2/21/1997	55		unknown	Dropped collar for data retrieval
6	F	3	4–5 years	2/21/1997	7/24/1998	90		dead	Hit by car
7	M	3	10 month	2/21/1997	2/1/1998	55		dead	Illegally shot-poacher
8	F	1	10 month	2/21/1997	2/21/1997	50		unknown	Dropped collar for data retrieval
9	M	2	3–4 years	2/21/1997	2/3/1998	90		unknown	Pillsbury State Forest
10	M	1	Pup	8/29/1997	8/29/1997	20		dead	Starved? (9/23/2007)
11	F	4	Pup	10/31/1997	2/4/1999	59		dead	Illegally shot in Hillman area? Collar found in swamp
12	M	2	Yearling	11/4/1997	2/3/1998	60		dead	Killed by ADC in Pine County (7/26/1999)
13	M	1	Yearling	2/3/1998	2/3/1998	88		unknown	Dropped collar for data retrieval
14	F	3	Yearling	9/14/1998	1/30/2002	76		unknown	Collar failed –2003
15	M	3	>3 years	2/2/1999	1/17/2001	107		dead	Found dead on Camp (7/2001)
16	F	1	1–2 years	1/18/2001	1/18/2001	65		dead	Found dead in Michigan– Illegally shot (9/2002) (Sue)
17	M	2	1–2 years	9/26/2001	2/4/2004	88		unknown	Missing
18	M	3	3–4 years	11/15/2001	2/25/2003	95		dead	Struck by car on Hwy 371 (Lucky)
19	F	2	1–2 years	1/30/2002	12/13/2002	76		dead	Illegally shot south of Camp
20	F	2	>3 years	1/30/2002	1/30/2006	79		dead	Found dead west of Camp Unk. (8/2007) (Lady)
21	F	1	1–2 years	2/25/2003	2/25/2003	68		dead	Found dead in cornfield (Shot?)
22	M	1	2–3 years	2/4/2004	2/4/2004	100		dead	Killed by ADC 4/24/2004 in Cass County
23	M	2	1–2 years	2/4/2004	1/30/2006	72		dead	Illegally shot during firearms deer season (11/2007) (Smokey)
24	M	1	1–2 years	2/4/2004	2/4/2004	78		unknown	Collar failed
25	M	1	1–2 years	2/4/2004	2/4/2004	83		unknown	Collar chewed off
26	M	1	3–4 years	1/30/2006	1/30/2006	85		dead	Illegally shot during firearms deer season (11/2008) (Sly)
27	M	1	2 years	1/30/2006	1/30/2006	85		dead	Struck by car on Hwy 371
28	M	1	4–5 years	1/30/2006	1/30/2006	103		dead	Illegally shot – was North Pack breeding male (Big Foot)
29	F	1	2 years	1/30/2006	1/30/2006	67	Orange 1/Blue 11	unknown	Collar chewed off –11/2009 North Pack
30	F	1	3 years	1/31/2006	1/31/2006	85		dead	Found during helicopter capture (2/08) killed by wolves (Shep)
31	M	1	4–5 years	3/22/2008	3/22/2008	75		dead	Illegally shot (11/2011) South Pack

Table 15. Gray wolves captured, Camp Ripley Training Center, Minnesota, since 1996. **(Bold = wolves monitored in 2017)**

Wolf#	Sex	# of Captures	Age at 1st Capture	Date of 1st Capture	Date of Last Capture	Weight (lbs.) at Last Capture	Ear Tag Color & Number (Left/ Right)	Fate	Comments
32	F	2	2–3 years	3/22/2008	9/13/2011	76		dead	Illegally killed (arrow) south of Camp Ripley (October 9, 2012)
33	F	1	2 years	3/22/2008	3/22/2008	76		dead	Killed by depredation trapper in Manitoba, Canada (7/2008)
34	M	1	4–5 years	3/22/2008	3/22/2008	92		dead	Illegally shot near Staples, MN on 11/12/2009 (Techno)
35	M	1	Pup	10/6/2009	10/6/2009	55	Metal 2117/2466	unknown	North Pack; VHF collar (Trickster); Collar chewed off Jan. 2010
36	M	1	3 years	2/2/2010	2/2/2010	63	Yellow 34/Yellow 46	dead	Lake Alexander Pack – illegally shot in February 2014 near Cushing, MN
37	M	1	4–5 years	2/3/2010	2/3/2010	77		dead	Killed by wolves in adjacent pack in February 2012
38	F	1	Pup	2/3/2010	2/3/2010	56	Blue 21/Orange 15	unknown	South Pack – satellite collared, failed May 2010
39	M	1	8–10 years	2/3/2010	2/3/2010	97		dead	Died of natural causes February 2012
40	**F**	**1**	**4–6 years**	**2/3/2010**	**5/20/2011**	**69**	**Orange 24/Yellow 29**	**ALIVE**	**North Pack – past breeding female – collar failed 2017**
41	M	1	Pup	9/25/2011	9/25/2011	50	Blue 16/Blue 25	Unknown	Moved to Fergus Fall, MN area from Miller Lake Pack Last location January 2016
42	M	1	Pup	9/26/2011	9/26/2011	40	Yellow 50/Blue 17	unknown	North Pack – not radio–collared
43	F	1	Pup	9/26/2011	9/26/2011	39	Orange 23/Blue 23	unknown	North Pack – not radio–collared
44	M	1	3 years	2/14/2013	2/14/2013	87	Yellow 35/Blue 7	dead	Unknown Pack – illegally shot in early November 2013 near Little Elk WMA
45	F	1	3–4 years	2/14/2013	2/14/2013	77	Orange 8/Orange 20	dead	Unknown Pack – legally harvested during wolf season NE of Rice, MN
46	M	1	1 year	2/27/2015	2/27/2015	65	Yellow 26/Blue 20	DEAD	South Pack – illegally shot December 2015 Rice Lake WMA south of Staples, MN
47	M	1	2–3 years	2/27/2015	2/27/2015	70	Green 7/Green 8	Unknown	South Pack – USGS GPS/Satellite collar programmed to drop off in late February 2016
48	M	1	2–3 years	2/27/2015	2/27/2015	70	White 4/Green 1	unknown	Miller Lake Pack – Missing since June 2015
49	M	1	2–3 years	2/27/2015	2/27/2015	74	Green 2/White 3	Unknown	Miller Lake Pack – USGS GPS/Satellite collar programmed to drop off in April 2016
50	**M**	**1**	**5–6 years**	**2/27/2015**	**2/27/2015**	**70**	**Orange 3/Orange 5**	**ALIVE**	**North Pack – breeding male**
51	M	1	7 years	2/27/2015	2/27/2015	85	White 1/White 2	unknown	Collar chewed off –10/2015 – North Pack

Figure 20. Wolf #40 locations, North Pack, Camp Ripley Training Center, Minnesota, 2010 – 2017.



Black Bear (*Ursus americanus*)

Research

A telemetry-based study of black bears was initiated at Camp Ripley in 1991. The current study is part of a statewide research project conducted by the DNR designed to monitor the body condition, movements and reproductive success of bears in the northern, central and southern parts of Minnesota's bear range. Camp Ripley lies along the southern edge of bear range in Minnesota. The principal objectives of this study include 1) continued monitoring of reproduction and cub survival, 2) additional (improved) measurements of body condition, heart function and wound healing, 3) examination of habitat use and movements with GPS telemetry, 4) investigation of female dispersal near the southern fringe of the expanding bear range (Garshelis et al. 2004), and 5) monitoring the incidence of nuisance bears and in particular any conflicts with soldiers and military training.

Movement and Reproduction

In 2017, ground and aerial tracking were used to monitor reproductive success, movements and survival of five radio collared black bears (Table 16). Researchers are now focusing more on reproductive success and survival than movements and habitat use; therefore most bears on Camp Ripley were located less frequently in 2012 – 2017 than in the past. However, bear 2079 wore a GPS/satellite collar (Telonics) that collected thousands of locations during the year.

Originally radio-collared in June of 2004 as a two year old, Bear 2079 (15 years old in 2017) was fit with a variety of VHF, GPS and satellite collars throughout her life. The thousands of locations obtained from her radio collars provided detailed information on her home range and movements. Although bear 2079 was originally captured on Camp Ripley, and in her early years denned there, she eventually moved south of Camp only returning for short visits most years (Figure 21). Bear 2079s territory covered both sides of U.S. Highway 10 which is a major divided highway. Over her lifetime she successfully crossed Hwy 10 numerous times, but on July 31, 2017 she was hit and killed by a vehicle north of Little Falls, MN. Bear 2079 had 15 cubs, eleven of which lived to be yearlings, and raised one orphaned cub over her lifetime.

All of the four remaining radio-collared bears spent most of the year on Camp Ripley. A total of ten cubs were born to these bears and all of the cubs survived to den in the fall. Bear 2081 (18 years old in 2017) had two cubs in 2017; both were in the den with her during a December den visit. Bear 2124 (eight years old in 2017) has taken up residence within her mother's (bear 2063) former home range in the northeast portion of Camp. She had two cubs in January 2017 and that fall both cubs were observed before she denned in Training Area 64. Bear 2130 (13 years old in 2017) was first collared during den visits in February 2012. She had three cubs in 2017 and all were observed in late fall. Bear 2154 (seven years old in 2017) was first discovered in her den in the winter of 2013 – 2014 and was collared in February 2014. She had two cubs in 2017 which were also observed in late fall.

Table 16. Black bears monitored, Camp Ripley Training Center, Minnesota, 2017.

Bear ID	Sex	Age as of Jan. 2017	Year of First Capture	Age at First Capture	Weight at Last Capture (lbs.)	Ear Tag Color & Number (Front/Back Left//Front/Back/Right)*	Status
2079	F	15	2004	2 yrs.	324 (3/2017)	P–P 301 / P–P 320	**DEAD Vehicle Collision**
2081	F	18	2004	5 yrs.	247 (3/2017)	R–R 265 / B–B 369	**ALIVE**
2092	F	12	2005	Cub	235 (2/2014)	B–B 295 / O–O 231	**ALIVE collar recovered 11/2014. Photo 7/2016 (2079's cub)**
2124	F	8	2009	Cub	194 (3/2017)	Red 273 / White 327	**ALIVE (2063's cub)**
2130	F	13	2012	8 yrs.	264 (3/2017)	W–W 333 / B–B 368	**ALIVE**
2154	F	7	2014	4 yrs.	225 (3/2017)	Lt. Blue 351 / Lt. Blue 298	**ALIVE**

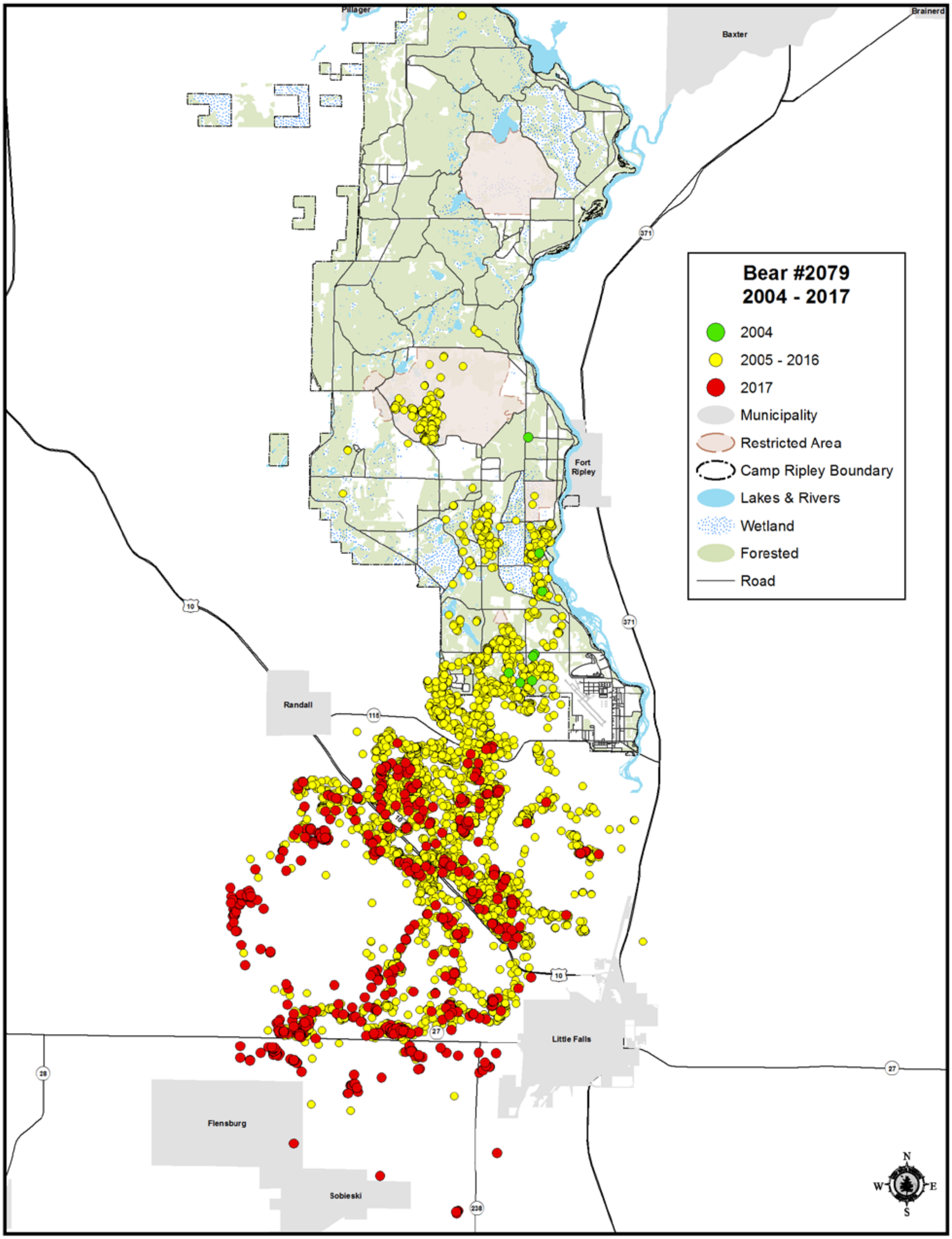
*Y=Yellow; W=White; O=Orange; R=Red; P=Pink; Pu=Purple; B=Blue

Beaver (*Castor canadensis*)

Beaver are an important part of the natural ecosystems at Camp Ripley. This species can have a large effect on the environment in which it lives. In a natural system, beavers create or enlarge wetland areas which trap nutrients and help to reduce flooding by holding and slowly releasing water. However, problems occur in localized areas of Camp Ripley when beavers plug road culverts, flooding and damaging roads. When this occurs, a cooperative effort between the Camp Ripley – Environmental (CRE) office, the DNR and Camp Ripley Department of Public Works (DPW) is initiated to identify problem areas and implement solutions.

All problem areas are inspected by CRE staff, and possible solutions are provided to Camp Ripley's DPW. Some areas require the removal of beaver through trapping. Trapping permits are issued by a local DNR conservation officer. Camp Ripley beaver removal is conducted by the DNR and nuisance beaver trappers at the direction of the DNR staff. During the spring, 43 beavers were removed from problem areas and two during fall. Weather conditions in the fall did not provide good trapping conditions. Beaver removal occurred in the following areas: Marne and Cunningham road intersection (culvert #374; n=10), Luzon Road (n=1) West Range (multiple culverts; n=14), Cody Road (culvert #136; n=1), Rest Area 3 (culverts #78 & #80; n=4), Mississippi River (culverts #45 – #48; n=4) and Yalu Road (culverts #345 & #346; n=9). Beaver trapping will continue in the spring of 2018.

Figure 21. Black bear #2079 locations, Camp Ripley Training Center, Minnesota, 2004 – 2017.



Many problem areas can be addressed through the use of damage control structures, such as Clemson levelers and beaver deceivers. These devices have been used successfully at Camp Ripley in the past, and additional sites are targeted for these devices each year. However, these devices do require maintenance and eventually fail and/or need to be replaced. In 2016, an additional beaver leveler was installed on Yalu Road alongside a working leveler through culvert #346. The existing levelers through the Yalu Road culvert (#346) and neighboring beaver dam were replaced in 2017. Beaver levelers were replaced at Chorwan Road culvert #332 and Mud Lake outlet culvert #348. New levelers were installed in culverts at Fort Greely Road culvert #344 and Normandy Road culvert #166.

Beaver ponds throughout Camp Ripley provide habitat for Blanding's turtles, a state threatened species, and numerous other reptiles and amphibians; as well as provide feeding areas for a variety of wildlife and habitat for waterfowl and other birds. Therefore, it is important that these wetlands not be permanently drawn down or drawn down in fall or winter in order to install these devices. Installation should occur after a temporary draw down in spring or summer, or during natural low-water levels. Research in East-Central Minnesota investigated the effects of a controlled draw down on Blanding's turtle populations. The incidence of mortality was high after the draw down due to predation, road mortality and winterkill (Dorff Hall and Cuthbert 2000).

Bats

"Bats are a critical component of Minnesota's ecosystems. A single bat may eat 1,000 insects per hour, and the state's bats likely provide many millions of dollars in pest control each year (Boyles et al. 2011)" (Swingen et al. 2016). Eight species of bats have been documented in Minnesota: little brown myotis (*Myotis lucifugus*, MYLU), northern long-eared bat (*Myotis septentrionalis*, MYSE), big brown bat (*Eptesicus fuscus*, EPFU), tricolored bat (*Perimyotis subflavus*, PESU), silver-haired bat (*Lasionycteris noctivagans*, LANO), eastern red bat (*Lasiurus borealis*, LABO), hoary bat (*Lasiurus cinereus*, LACI) and evening bat (*Nycticeius humeralis*, NYHU). Four of Minnesota's bat species hibernate in caves and mines (northern long-eared bat, tricolored bat, little brown myotis, and big brown bat) during the winter, and disperse widely across the state in spring, summer, and fall. Very little is known about the summer habitat use of these species" (Swingen et al. 2016 and 2018).

Camp Ripley is home to three bats that are designated state special concern species and SGCN: northern long-eared bat, little brown myotis and big brown bat. Three additional bats are SGCN only: silver-haired bat, eastern red bat and hoary bat. Past stationary acoustic bat surveys have identified all of these bat species occurring on Camp Ripley (Dirks and Dietz 2010).

Northern Long-eared Bat Federal Listing

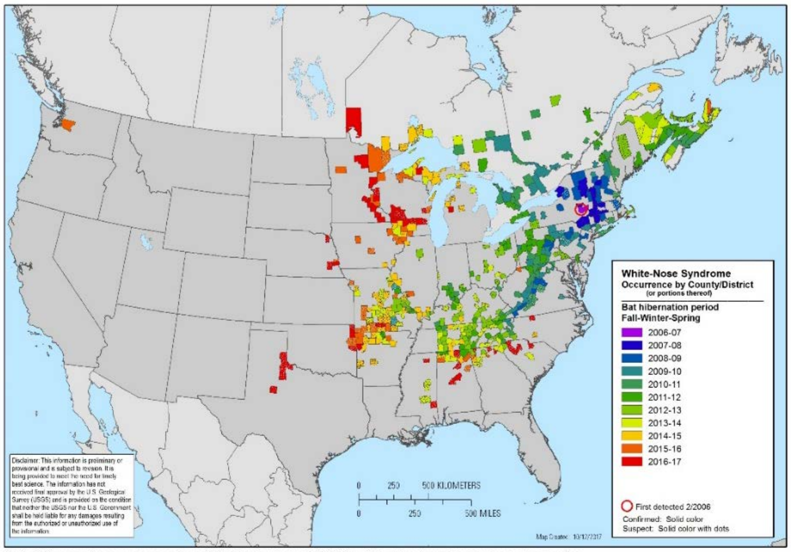
In January 2010, the U.S. Fish and Wildlife Service (USFWS) received a petition from the Center for Biological Diversity requesting that the northern long-eared bat be listed as threatened or endangered under the Endangered Species Act and to designate critical habitat. The USFWS announced on October 2, 2013 (USNARA 2013), that listing the northern long-eared bat was warranted and proposed to list it as endangered throughout its range, which includes Minnesota.

However, the USFWS listed the northern long-eared bat as “threatened” under the federal Endangered Species Act in April 2015, largely due to the impact of white-nose syndrome on bat populations. A threatened species is an animal or plant that is likely to become endangered within the foreseeable future throughout all or a significant portion of its range. On April 27, 2016, the USFWS determined that designating critical habitat for northern long-eared bat was not prudent (USFWS 2016b, 2016c).

White-nose syndrome is threatening bat populations in the eastern United States. “White-nose syndrome (WNS) is caused by the fungus *Pseudogymnoascus destructans* (Pd) that leads to increased winter activity and extremely high mortality rates of cave-hibernating bats (Frick et al. 2010)” (Swingen et al. 2016). Since 2006, WNS has spread from a single central New York cave southward into Alabama; northwestward into Wisconsin, Iowa and Minnesota; and was recently discovered in Texas, Nebraska and Washington (Figure 22). WNS is a fungus that has killed more than 7 million hibernating bats since 2006 in North America with new range expansions of WNS occurring every year (MNDNR 2016b, 2016c, Turner et al. 2011 and White-nose Syndrome 2017; Figure 22). “*P. destructans* was detected in Minnesota in 2013, and bat mortalities from WNS were first recorded during January 2016 at Lake Vermilion – Soudan Underground Mine State Park, near Soudan, Minnesota (MNDNR 2013c, 2016a)” (Swingen et al. 2016).

The northern long-eared bat is known to occur on Camp Ripley (Dirks and DeJong 2007) and has been designated as a state special concern species since 1984. While no winter habitat is known to occur on Camp Ripley, summer and migratory habitat is available. Northern long-eared bats are associated with forested habitats, especially around wetlands (MNDNR 2013b) and roost singly or in colonies underneath bark, in cavities or in crevices of both live and dead trees. Northern long-eared bats begin feeding at dusk by flying through the understory along forested hillsides and ridges feeding

Figure 22. White–nose syndrome (WNS) occurrence in the eastern United States, by county and year, as of April 3, 2017 (White-nose Syndrome 2017).



Citation: White-nose syndrome occurrence map - by year (2017). Data Last Updated: 10/12/2017. Available at: https://www.whitenosesyndrome.org/resources/map.

on insects that they catch in flight using echolocation. The primary threat to northern long-eared bats is WNS. Other threats are loss and degradation of summer habitat, human disturbance of hibernacula, wind turbine operations, timber harvest and forest management (USFWS 2013).

Due to WNS threats to Minnesota's bat populations, including SGCN, the DNR staff developed a mobile acoustic monitoring protocol in 2010 to examine possible bat population changes, has conducted passive acoustic bat surveys and participates in the statewide study of *Endangered Bats, White-Nose Syndrome, and Forest Habitat.* In 2015, the Minnesota legislature approved the statewide project with Environment and Natural Resources Trust Fund funding. The goal of the project is to collect data on the distribution and habitat use of the northern long-eared bat in Minnesota. This project is being conducted by the Minnesota Department of Natural Resources, the University of Minnesota Duluth – Natural Resources Research Institute, and the USDA – Forest Service.

Mobile Acoustic Bat Transect Survey

A mobile acoustic bat transect survey protocol was established in 2010 (Figure 23). The purpose of the mobile survey is to obtain quantitative data about bat populations and to monitor multiple species simultaneously in advance of WNS outbreaks in Minnesota and neighboring states. However, the mobile acoustic transect methodology has several limitations; one of which is it does not work well for all species of bats, including northern long-eared bats, as the route does not travel within forest understory habitats. Therefore, in 2014 and 2015, survey work also included use of stationary acoustic surveys in habitats suited for northern long-eared bats to better identify locations where they occur (MNDNR and MNARNG 2015, 2016). The project's goal is to assess the impacts of WNS on summer distribution of bats by examining changes in bat distribution and activity over successive years.

The DNR staff established a 30-mile mobile transect on Camp Ripley (Figure 23) that passes through common habitat types and could be easily sampled in successive years. Survey protocol (Britzke and Herzog 2009) requires that the acoustic survey be conducted while bats are on maternity range, generally between June 1 and July 15. To record bat echolocations monitoring is conducted on nights with low wind, no rain or fog, and suitable temperatures for bat activity. The Camp Ripley survey was conducted using an ANABAT II (zero crossing) (2010, 2012 – 2013) bat detector mounted on the top of the vehicle, with the microphone pointing straight up. In 2014 – 2017, an ANABAT SD2 (zero crossing) with mobile microphone was used. Surveys were conducted on July 8, 2010, June 26, 2012, July 11, 2013, July 9, 2014, July 8, 2015, June 29, 2016 and July 2, 2017, and the echolocations recorded were analyzed by Christi Spak, DNR Biological Survey (2010 − 2015) and Nancy Dietz, DNR Camp Ripley (2016 − 2017).

The highest number of bat echolocations recorded since the mobile survey began occurred in 2015 (n=132) which was similar to 2010 (n=130) with slightly fewer in 2016 (n=120) and more than 55% greater than what was recorded in 2014 (n=58) and 2017 (n=56) (Figure 24). Of the total bat calls recorded in 2017, the proportion of big brown /silver-haired bat echolocations was similar to 2010 and 2016 but greater than in 2012 – 2015. And, the proportion of red bat echolocations increased from 2010 but decreased from 2013 to 2016 (Figure 25). Examining the five years of survey data, the variable number of total survey echolocation calls, the proportion of big brown/silver-haired bat calls,

Figure 23. Mobile acoustic bat transect survey route, Camp Ripley Training Center, Minnesota, 2010, 2012 – 2017.

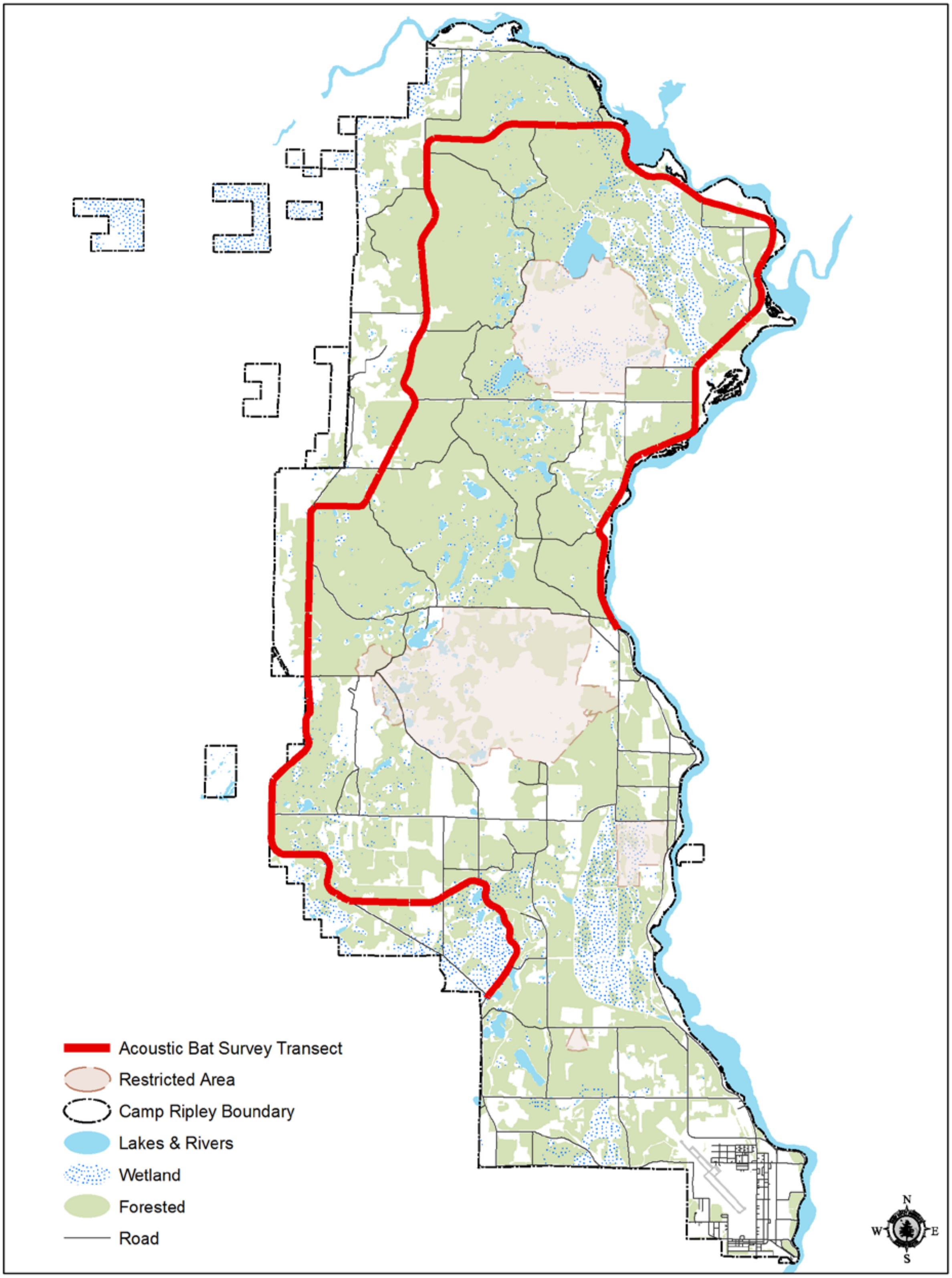


Figure 24. Mobile transect survey number of acoustic bat echolocations recorded, Camp Ripley Training Center, 2010, 2012-2017.

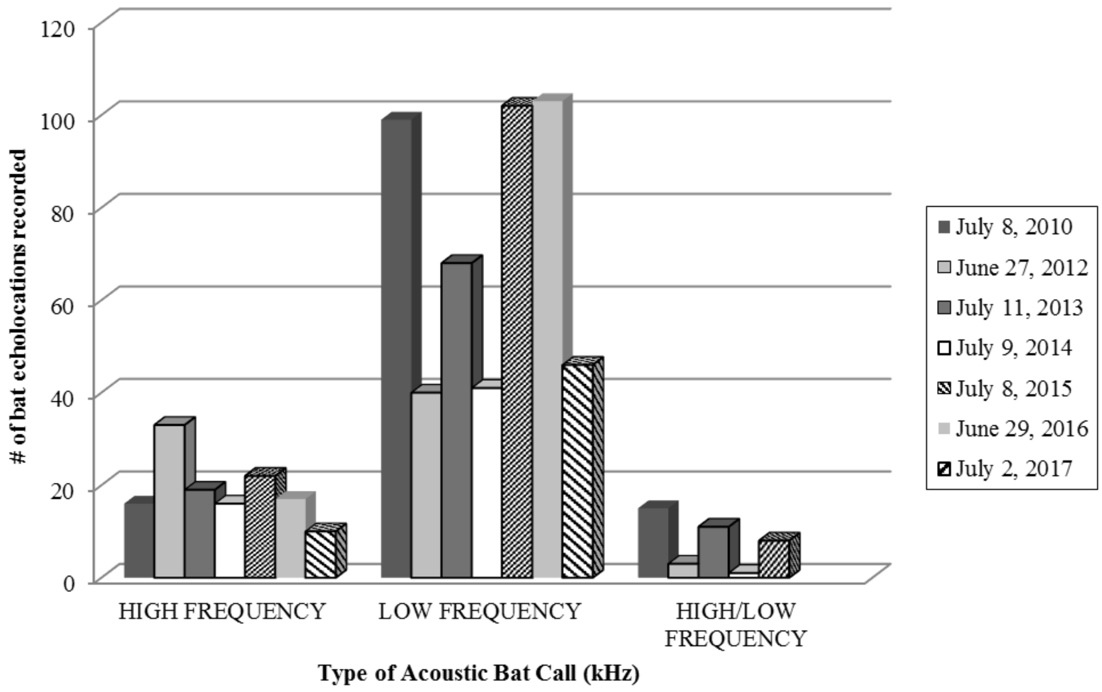
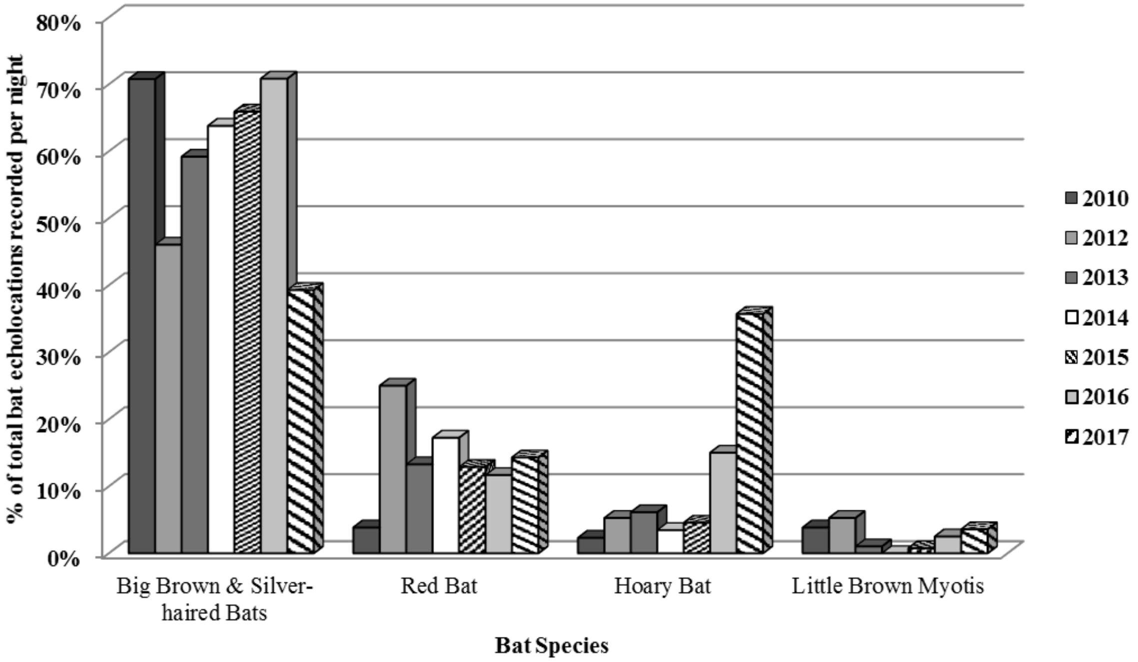


Figure 25. Mobile acoustic transect survey proportion of acoustic bat species echolocations recorded, Camp Ripley Training Center, 2010, 2012-2017.



and the increase in red bat calls do not indicate extensive population declines of these species, at this time. DNR staff plans to continue to sample the mobile transect one to three times annually and additionally set up stationary locations to monitor bat population trends and to measure any impacts of WNS.

Northern Long-eared Bat Research

By Brian Dirks, Nancy Dietz, Morgan Swingen and Dr. Ron Moen, NRRI, UMN−Duluth

Maintaining reproductive success will be critical to the viability of Minnesota’s bat populations as WNS spreads in Minnesota. Obtaining knowledge about maternity roosts before a population decline occurs will be critical for future efforts to reduce negative impacts of forest management and provide high quality habitat to support recovery of bat populations. Even if mortality rates can be reduced, there is still likely to be a drastic reduction in bat populations. Implementing management strategies that minimize mortality will be important as WNS continues to affect Minnesota bats.

Bat Capture and Processing

Fine mesh mist-nets (Avinet Inc., Dryden, NY, USA) were set up along forested roads that could act as travel corridors for bats. Each night, 2–4 mist-nets were set up within 200 m of a central processing location. Mist-nets were opened after sunset, and checked every 15 minutes for 2–5 hours, depending on capture rates and weather conditions. Captured bats were placed in cloth bags until processing.

We identified each captured bat to species by morphology, and determined sex, age, and reproductive condition by physical examination. Each captured bat was weighed and measured, and the wings were inspected for damage as per Reichard and Kunz (2009). Each bat was then fitted with an individually-numbered lipped aluminum wing band (Porzana Ltd., Icklesham, United Kingdom).

Radio-transmitters (A2414 from Advanced Telemetry Systems Inc., Isanti, MN, USA) were attached to pregnant or lactating adult female northern long-eared bat (MYSE) that did not have significant wing damage (wing score < 2). We trimmed a small section of hair in the center of the back and attached the transmitter to the skin using surgical adhesive (Perma-Type, Permatype Company Inc., Plainville, CT, USA). Bats were released at the capture site after processing.

Tracking and Roost Tree Characterization

Bats with radio-transmitters were tracked to their roosts each day until the transmitter failed or the transmitter fell off. Data recorded at each roost included roost type, tree species and decay stage. At dusk, crews returned to the roosts to conduct emergence surveys. During an emergence survey, personnel watched the roost from 30 minutes before sunset to 1 hour after sunset. During the emergence survey we recorded the number of bats emerging in each 10-minute interval, the location of the exit point, and whether or not the bat with the transmitter left the roost.

Crews returned to each roost tree to conduct a more detailed characterization of the roost tree after bats left. This included measuring diameter at breast height (DBH), tree height, decay stage, canopy closure, slope, aspect and recording details about the vegetation surrounding the roost tree. All roost trees were marked with a numbered aluminum tree tag.

Study Area

Bats were captured for the large-scale study at 12 locations around the state of Minnesota in 2017, including Camp Ripley Training Center (CRTC). CRTC covers approximately 53,000 acres of land in Morrison and Crow Wing Counties, including mature pine and hardwood forests. CRTC is also bordered by two major rivers: the Crow Wing River to the north, and the Mississippi River to the east.

Bat Capture Results

We mist-netted bats at nine sites at CRTC on the nights of June 5 – 8, 12, 19 – 20, 22 and 26, 2017 (Figures 26 and 27). We captured and processed 86 bats over 168.3 total net-hours. We captured bats of five species, including northern long-eared bats (Table 17). All of the bats captured were adults, and 41 of the 56 females captured were pregnant at the time of capture. Seventy-seven of the 86 bats captured (89.5%) showed some minor wing damage consistent with that caused by WNS, but none had severe damage.

We attached radio-transmitters to three female northern long-eared bats, one of which was captured at “Trout Pond” on June 7, and two which were captured along the Crow Wing River on June 12.

Table 17. Bats captured by species and sex, Camp Ripley Training Center, Minnesota, June 2017.

	SPECIES and CODE								
Sex	**Big Brown Bat (EPFU)**	**Red Bat (LABO)**	**Hoary Bat (LACI)**	**Silver–haired Bat (LANO)**	**Little Brown Myotis (MYLU)**	**Northern Long–eared Bat (MYSE)**	**Evening Bat (NYHU)**	**Tricolored Bat (PESU)**	**Grand Total**
Male	25	3	0	1	1	0	0	0	**30**
Female	34	5	0	11	3	3	0	0	**56**
Grand Total	**59**	**8**	**0**	**12**	**4**	**3**	**0**	**0**	**86**

Figure 26. Map of bat mist-netting sites at Camp Ripley Training Center, Minnesota, June 2017. The pie chart at each net site indicates the proportion of species captured at that site, and the size of the pie chart represents the total number of bats captured at that site relative to other sites. The sites with zero captures are marked with a black dot.

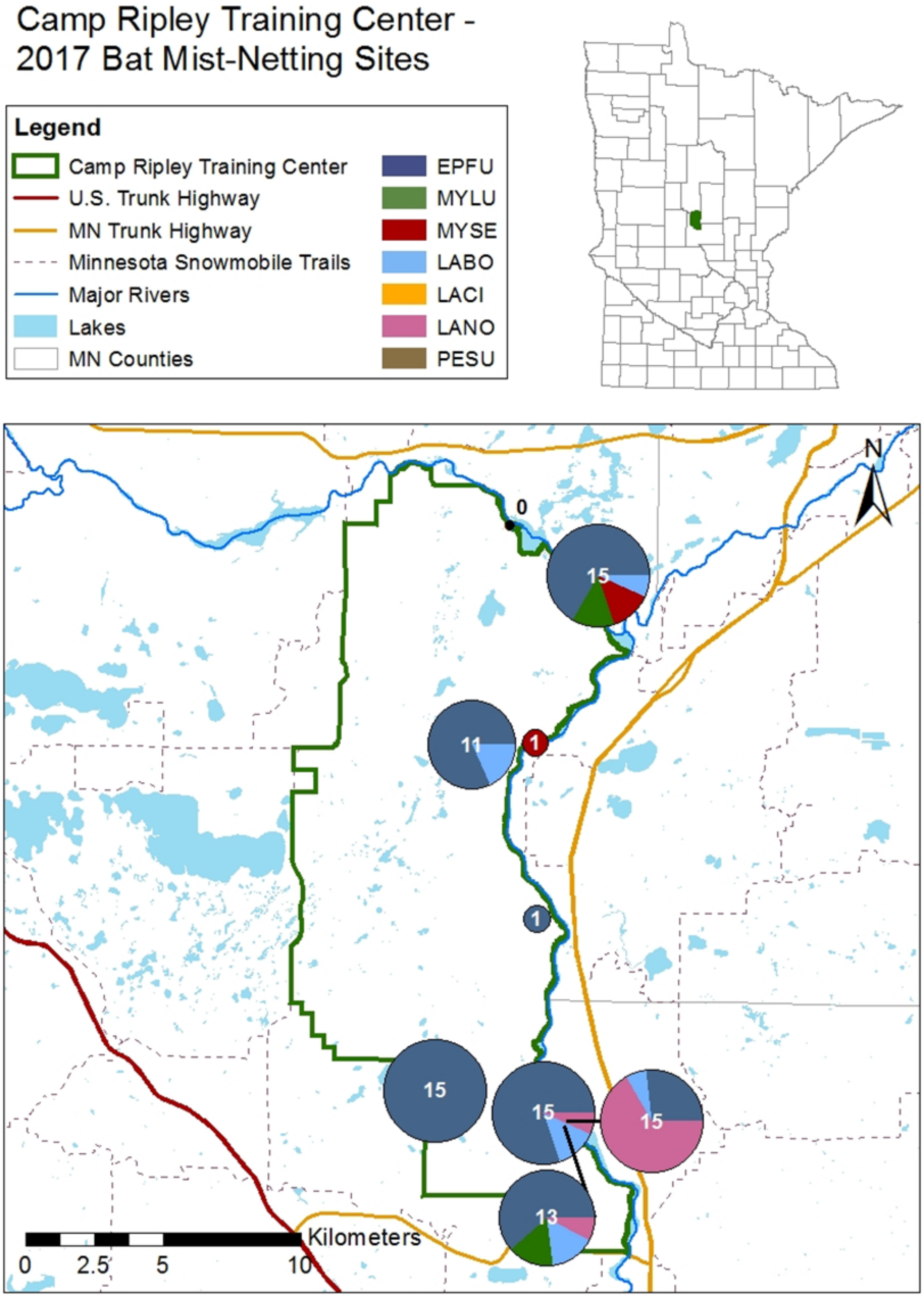
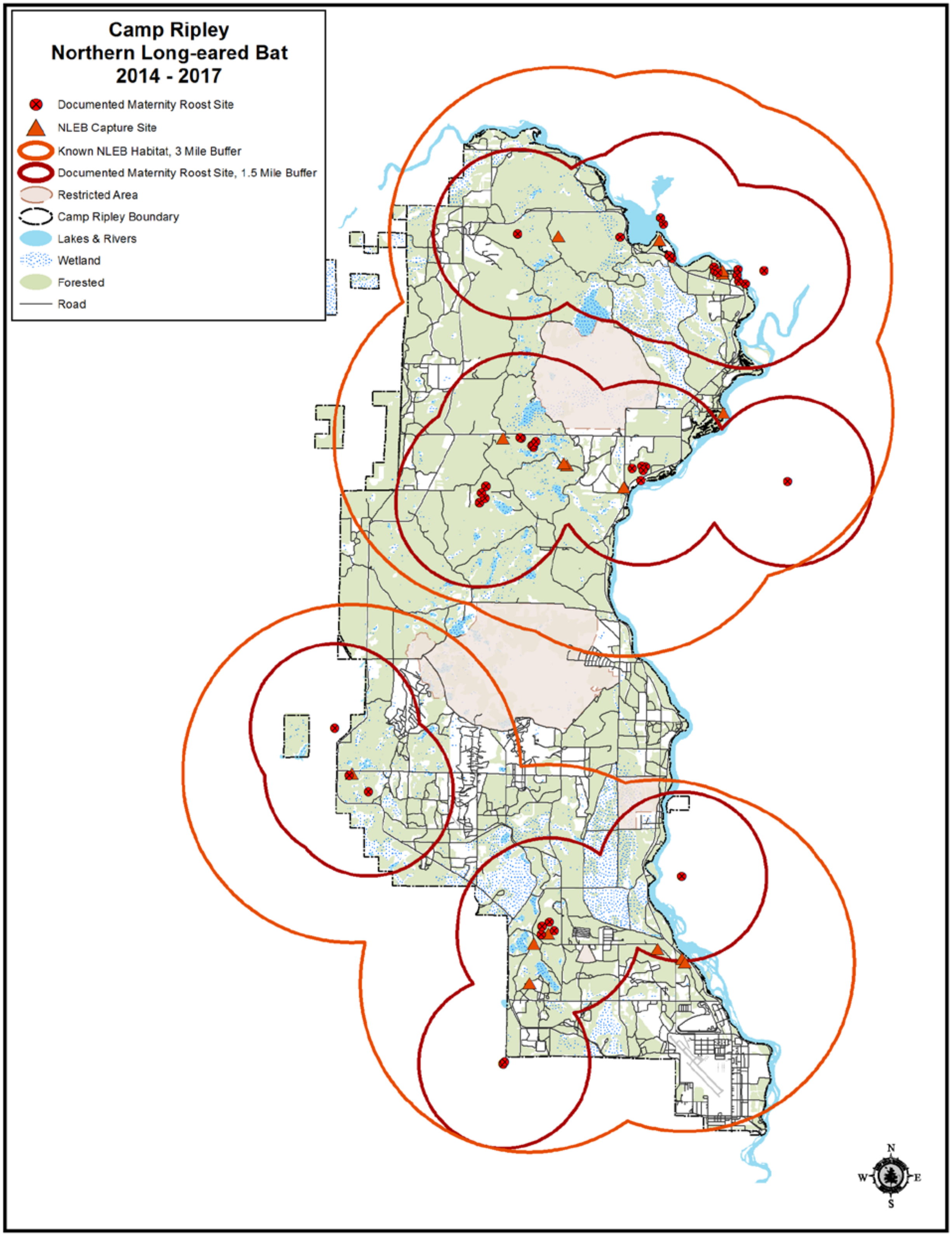


Figure 27. Locations of female northern long-eared bat captures and maternity roosts, Camp Ripley Training Center, Minnesota, 2014 – 2017.



Radio-Telemetry and Roost Characterization

The bats with the radio-transmitters were tracked until the transmitter fell off, which was after 6–8 days. We tracked the bats with the radio-transmitters to thirteen unique roost trees, of ten tree species (Figures 28 and 29). A detailed map of movements between roost trees by the bats with the transmitters are in Figures 30 and 31.

Figure 28. Histogram showing the number of northern long-eared bat roosts by tree species at Camp Ripley Training Center, Minnesota, June 2017. Thirteen total roost trees were identified.

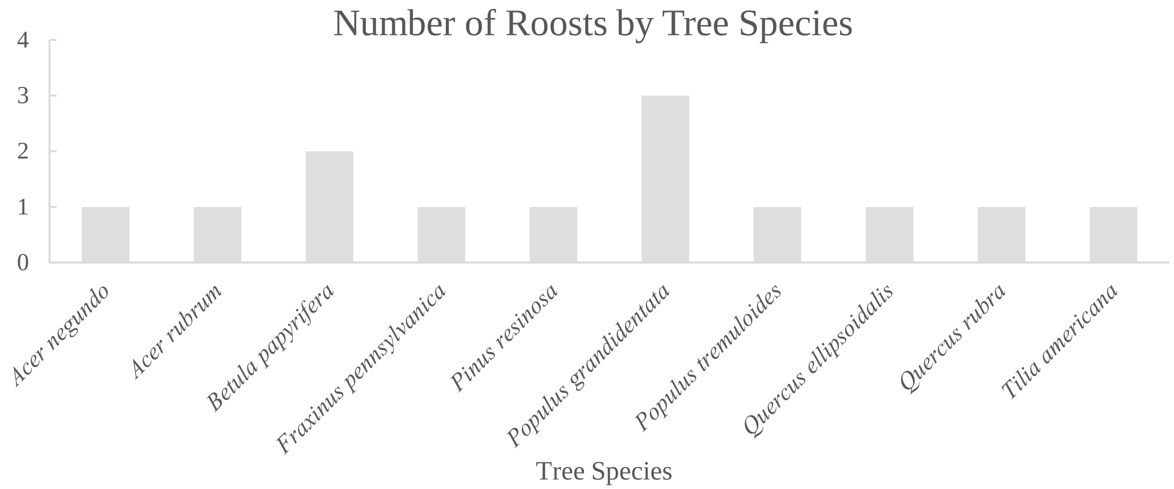


Figure 29. Photos of three roost trees of different species, Camp Ripley Training Center, Minnesota, June 2017. From left to right: paper birch (*Betula papyrifera*) snag, green ash (*Fraxinus pennsylvanica*) snag, and live red pine (*Pinus resinosa*).

Figure 30. Radio-transmittered (165.783) female northern long-eared bat (MYSE) movements and roost tree locations, Camp Ripley Training Center, Minnesota, June 2017.

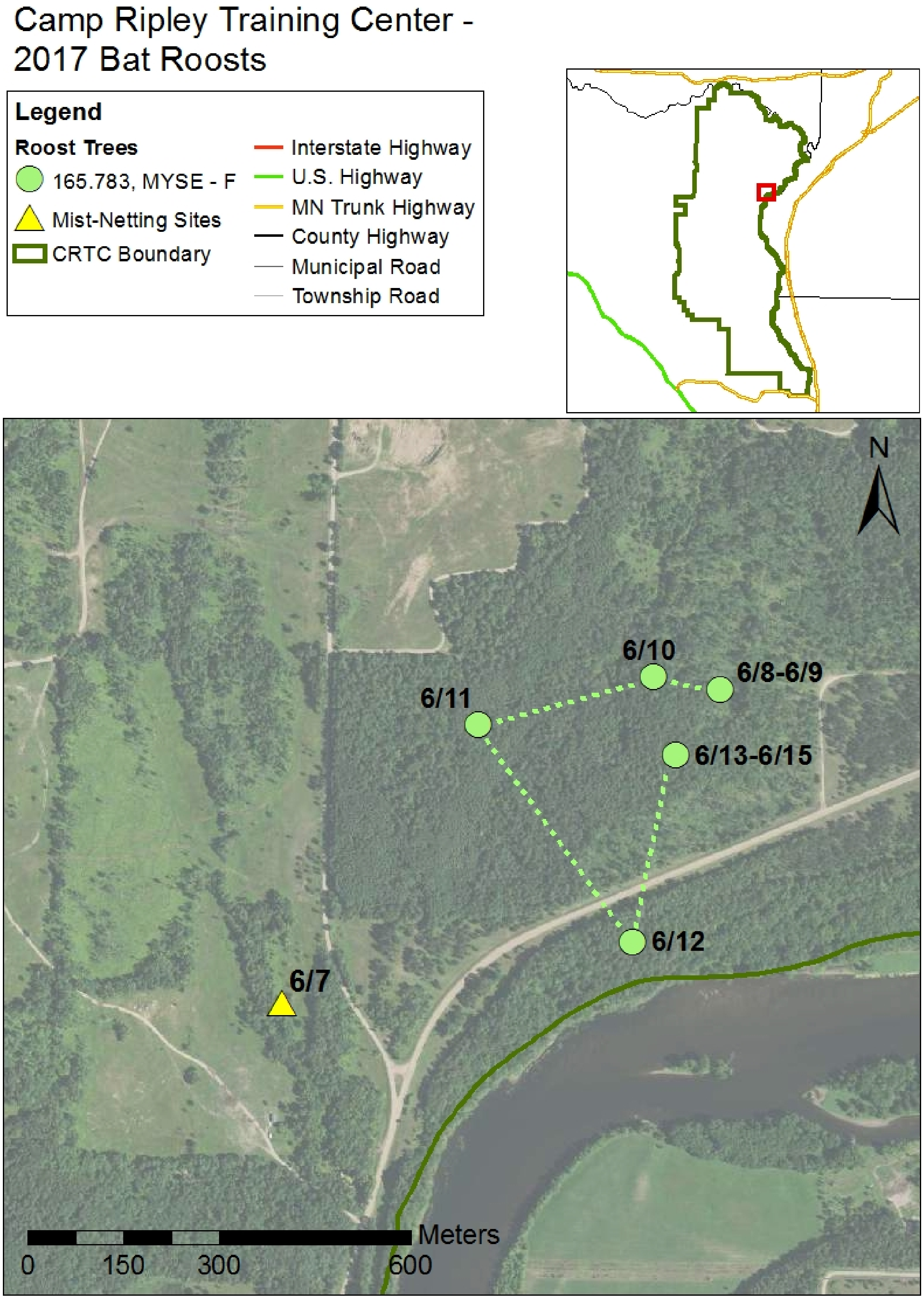
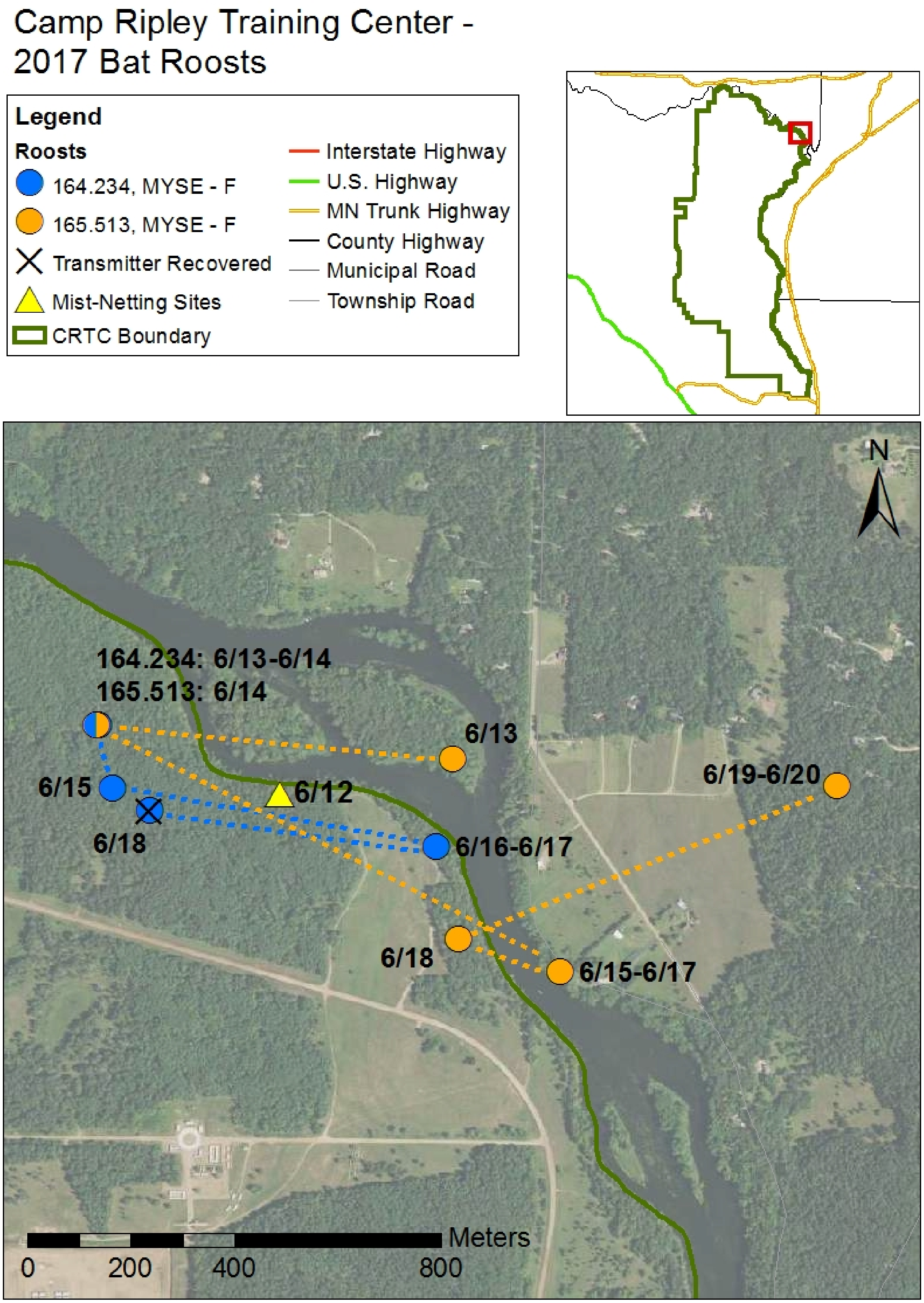


Figure 31. Two radio-transmittered (164.234 and 165.513) female northern long-eared bats (MYSE) movements and roost tree locations, Camp Ripley Training Center, Minnesota, June 2017.

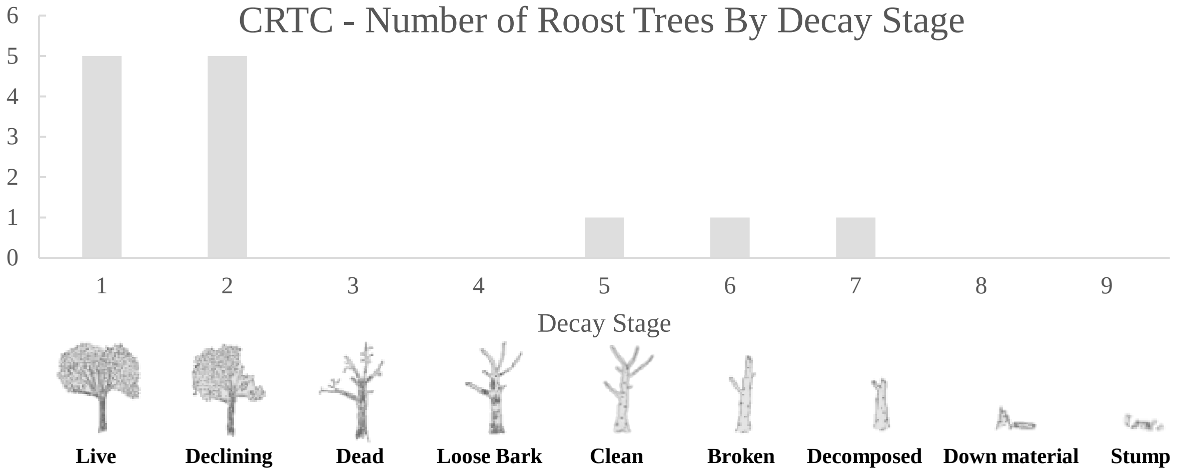


The average distance from the capture location to the first roost was 523 m (range 247 – 857), and the average distance moved between consecutive roosts was 466 m (range: 107 – 1,013). An average of 4.7 roosts were identified for each bat, and these three bats spent an average of 1.4 days (range 1 – 3) in each roost (of those roosting events with known start and end dates).

The roost trees varied in size from 18.7 – 63.8 cm in diameter at breast height (DBH), with an average DBH of 32.9 cm. Roosts were located in both live and dead trees of varying decay stages (Figure 32). Roost tree height ranged from 3.8 m to 20.6 m with an average height of 15.4 m.

Field crews conducted 14 emergence counts on 12 of the 13 identified roost trees. The one roost tree that was not surveyed was located on private land, and crews were not given permission to conduct emergence surveys. Bats were observed exiting the roost tree in 11 of the 14 emergence counts conducted. Colony size (number of bats observed in an emergence count) ranged from one to nine in those 11 emergence counts.

Figure 32. Histogram showing variation in decay stage among 13 northern long-eared bat roost trees identified at Camp Ripley Training Center, Minnesota, June 2017.



Discussion

The three northern long-eared bats tracked at Camp Ripley Training Center used a variety of tree species and moved often, consistent with previous findings in this study and others across the northern long-eared bat range. Under the Endangered Species Act, there are restrictions on tree harvest within 150 feet of known, occupied roost trees between June 1st and July 31st. For more details on these restrictions, please visit the website of the U.S. Fish and Wildlife Service (https://www.fws.gov/Midwest/endangered/mammals/nleb/index.html). We intend to use the data collected in this project to inform future management decisions regarding the northern long-eared bat as WNS continues to spread across the United States.

Capture rates (# of bats captured per net-hour) at CRTC in 2017 (0.51) were higher than in 2016 (0.43) and 2015 (0.23), although average capture rates across the state declined in 2017

(Swingen et al. 2015, Dirks et al. 2016). Many factors may have influenced capture rates including net placement, temperature, insect activity, and moon illumination (Ciechanowski et al. 2007). It is also possible that the cave-roosting bats present at CRTC during the summer hibernate in a cave or mine that has not yet been affected by high mortality from WNS. Winter surveys conducted by the DNR in early 2017 observed a 73% decline in bats counted at Soudan Underground Mine, although declines at other surveyed hibernacula were as low as 31% (MNDNR 2017).

This is one of 13 site-level reports from the 2017 field season. A report summarizing and discussing the results from all 2017 locations will be available in early 2018.

Porcupine (*Erethizon dorsatum*)

Porcupines are the second largest member of the rodent family. While most rodents have a high rate of reproduction along with a high rate of mortality, porcupines have neither. Female porcupines have one litter per year, with usually only one pup. Their winter diet consists of the inner bark of trees and their summer diet consists of a variety of woody and herbaceous vegetation, primarily at ground level (Hazard 1982). Fishers are effective predators of porcupines.

Porcupines can be a nuisance when they gnaw on wooden objects, tires and plastic tubing. Camp Ripley has obtained a porcupine nuisance permit from the DNR since 2008. Porcupines are taken only on problem areas identified by Range Control. Ten nuisance porcupines were taken under the DNR permit in 2017.

Reptiles and Amphibians

Blanding's Turtle (*Emys blandingii*)

By Arika Nyhus, St. Cloud State University Graduate Student and Nancy Dietz, DNR

The Blanding's turtle is a semi-aquatic freshwater turtle commonly known for its bright yellow chin (Congdon and Keinath 2006). This species is found in most parts of the upper Midwest and southeastern Canada, with isolated populations existing in Eastern states and provinces (Congdon et al. 2008). The species is considered threatened or endangered across most of its range and has been listed as state threatened in Minnesota since 1984. A species is considered state threatened if it is likely to become endangered within the foreseeable future throughout all or a significant portion of its range within Minnesota. In 2012, the USFWS was petitioned to include Blanding's turtles as threatened or endangered under the federal Endangered Species Act. The USFWS determined, in July 2015, that the petition presented substantial information that federal listing of Blanding's turtles may be warranted. Therefore, a status review has been initiated and a determination will be made whether to propose Blanding's turtle listing under the Endangered Species Act (USFWS 2016d).

Due to the status of the Blanding's turtle, the DNR has implemented management strategies for the conservation of the species and Camp Ripley has three priority areas (Figures 33 and 34) for conservation management. This species depends upon a variety of wetland types and sizes, and uses sandy upland areas and roadways for nesting. Minnesota’s State Wildlife Action Plan promotes the implementation of best management practices. Major threats impacting the Blanding’s turtle include road mortality, habitat degradation and collection for trade (Congdon and Keinath 2006; Compton 2007; Beaudry and Hunter 2009). Additionally, the Blanding’s turtle is a slow-maturing species (ages 14 – 20) that experiences low reproductive success and high nest predation (Congdon and Keinath 2006). In Michigan, Congdon et al. (1983) reported that nest predation accounted for 82% of nest mortality, with 42% of predation occurring within the first 24 hours. In addition, habitat loss and degradation exacerbate the threats above (MNDNR 2015a).

Since the early 1990s, several management practices have been executed in attempts to conserve the species at Camp Ripley Training Center. These management practices include 1) soldier education and outreach regarding the conservation of the Blanding’s turtle 2) Blanding’s turtle crossing signs in high concentration areas 3) mark recapture of females during nesting season via road surveys, and 4) nest protection with the use of metal cages. After nest emergence, hatchling turtles are direct released into the nearest wetland known to support adult turtles. However, it is uncertain what happens to the hatchlings after they are released. The goal for 2017 was to continue mark recapture of adult females during nesting season and protect known nests via road surveys; as well as determine the survival and spatial ecology of hatchlings released in adult habitat.

A St. Cloud State University graduate student, Arika Nyhus, was recruited to further examine the effectiveness of CRTC’s conservation efforts, population status of Blanding’s turtle on Camp Ripley and to determine movements of direct release hatchlings.

Preliminary trapping was conducted from April 24 to May 25 in an attempt to capture young juveniles to assess recruitment and to determine the age structure of the population. Hoop traps were obtained from the DNR Fisheries in Little Falls. Traps were distributed in areas known to inhabit adults and were set in several wetlands where hatchlings were released after nest emergence from 2009 – 2016. Trapping was conducted during April and May because spring has proven to be the most effective season for trapping success (Sajwaj et al. 1998). Eight single-frame hoop traps were set in several wetland complexes in the Goose Lake area from April 24 to May 9. Ten traps were then distributed from May 9 to May 25 in Marne Marsh and Range Marsh. Traps were baited with 0.25 kg of frozen smelt. Bait was placed in plastic cups with holes drilled in them to allow for scent dispersal but did not allow for distribution of bait. Traps were checked daily and bait was replaced approximately every week. During the first two weeks of trapping, 105 trap nights (number of traps X days set) were recorded; during the second two weeks, 187 trap nights were logged. A total of four Blanding’s turtles were captured during 292 trap nights. Remarkably, all of the turtles captured were unmarked. Each turtle was assigned a unique alpha code to help aid in future identification (AJN, ANW, AJO, AJD). Two males approximately 15 years of age (ANW, AJO) and one 19-year-old female (AJN) were found in Marne Marsh. The oldest turtle captured during trapping was a 22+ male

Figure 33. Blanding’s turtle locations, nest locations and the DNR priority areas for the north portion of Camp Ripley Training Center, Minnesota, 2017.

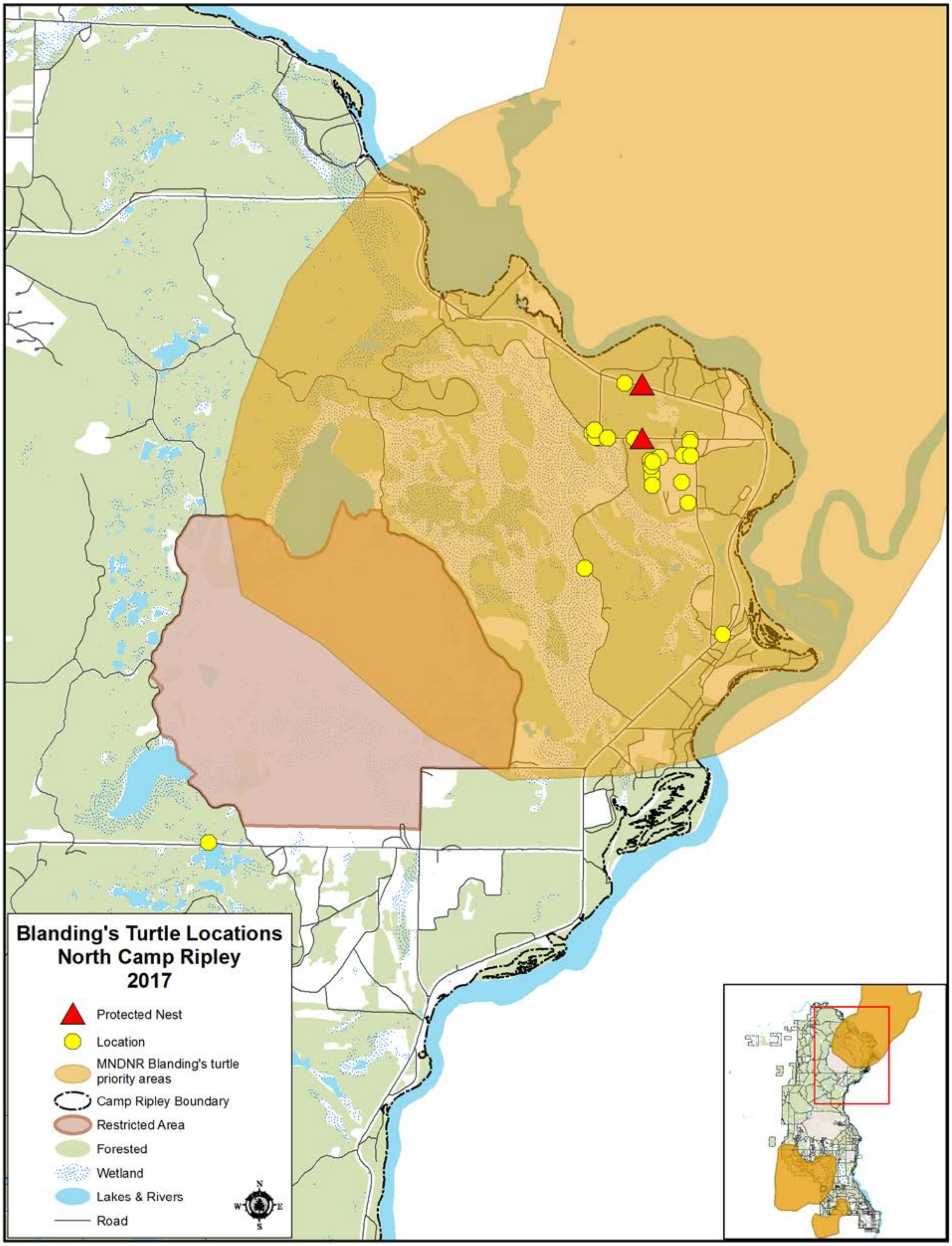
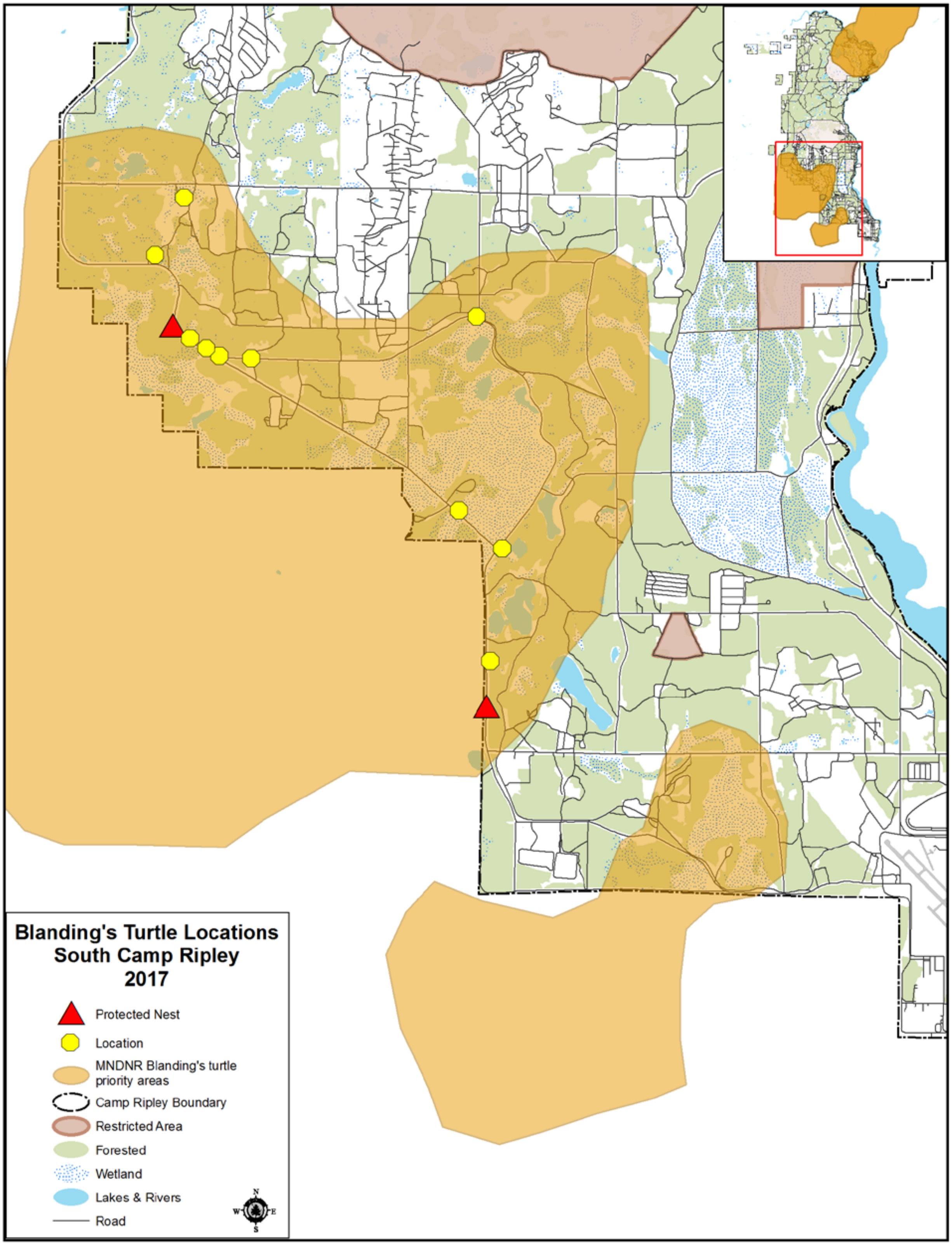


Figure 34. Blanding's turtle locations, nest locations and the DNR priority areas in the south portion of Camp Ripley Training Center, Minnesota, 2017.



located in Range Marsh. Unfortunately, an accurate assessment of recruitment nor an age structure of the population was achieved due to the obscurity of the Blanding's turtle.

Roadside surveys were conducted from June 1 to June 24, 2017. Nesting seasons generally range from early-May to mid-July (Congdon et al. 1983). At Camp Ripley, nesting females are typically observed from June 2 through July 2. Surveys began just prior to the start of nesting season and terminated after two to three days of no turtle sightings. Roads were surveyed by conducting vehicle searches through areas of known nesting activity as well as in areas for potential nesting activity. One to two trucks ran circular routes on the south and north end of Camp Ripley. Any observed tracks were investigated in efforts to locate the turtle and areas away from roads were occasionally checked for nesting females. Periodic road closures due to military training season often limited daily coverage. Thirty Blanding's turtle observations were recorded (Table 18), with the first sighting occurring on June 2 (ACW). Eight of these females were marked (ACW, ??W, AKY, AJK, BDO, BDJ, ABX, PW) while three were unmarked. It was unknown whether the remaining observed turtles had been previously marked. Standard protocol is to watch the turtle and determine if it is nesting. If the female is nesting, surveyors wait until nest completion and identify the turtle. If the female is not nesting, the surveyor may continue road surveys and return to check the status of the female. Unfortunately, none of the unmarked or the unknown turtles were seen again.

Table 18. Summary of Blanding's turtle nest search surveys, Camp Ripley Training Center, Minnesota, 2000 – 2017.

Year	*Survey Period*	*First Female Blanding's Observed*	*First Blanding's Nest Found*	*Last Blanding's Observed*	*Number of Survey Hours*	*Number of Turtles Observed*	*Average Temperature (°F) during Survey Period**	*Average Temperature (°F) during March to May**
2000	May 31–June 23	June 5	No nests	June 14	91.5	11	60	56
2001	June 6–?	June 15	No nests	June 27	79	9	66	41
2002	June 7–June 25	June 11	June 11	June 22	75	19	67	36
2003	June 6–June 22	June 9	June 11	June 17	129.5	10	65	41
2004	June 2–July 2	June 14	June 14	July 2	225	12	61	42
2005	June 6–June 23	June 10	June 12	June 17	225	18	68	44
2006	June 2–June 30	June 2	June 8	June 20	158	10	66	47
2007	June 1–June 21	June 3	June 7	June 20	189	19	68	45
2008	June 4–July 1	June 14	June 18	June 27	243	33	64	39
2009	June 11–June 28	June 11	June 13	June 27	205	17	68	41
2010	June 2–June 24	June 8	June 16	June 19	203	10	64	48
2011	June 3–June 29	June 6	June 13	June 29	208	44	64	40
2012	May 31–June 18	June 2	June 3	June 17	155	46	65	49
2013	June17–July 5	June 19	June 25	July 5	198	37	71	37
2014	June 9–June 27	June 11	June 20	June 22	113	12	69	41
2015	June 10–June 24	June 10	NA	June 19	24	2	64	43
2016	June 1–June 23	June 1	June 2	June 21	198	16	64	45
2017	June 1–June 24	**June 2**	**June 2**	**June 20**	**151**	**30**	**65**	**42**

*Weather Underground online – Brainerd Airport (Weather Underground 2018b)

In the southern region, two nests were protected in 72 hours of effort (ACW, AKY) (Figure 34) and two nests were protected in the northern region in 79 hours of effort (PW, unknown) (Figure 33). After data collection, a 1 X 1 m metal cage was placed over the center of where the eggs were laid and the cage was dug into the ground about three to four inches to prevent predation. Two yellow posts with reflective tape were then positioned to face oncoming traffic to eliminate vehicle disturbance.

Nests were protected and monitored through mid-November and were excavated when no evidence of hatchling emergence existed by late-October to mid-November. Typically, hatchlings emerge 75 – 110 days after the date of nest completion (Congdon et al. 1983). Nest incubation ranged from 93 to 171 days from the date laid to the date of hatching or nest chamber excavation. Fifty percent of protected Blanding's turtle nests had hatched, with a total of 18 hatchlings for the year. Twelve hatchlings were produced on the north end of Camp Ripley (PW) and six eggs hatched successfully on the south end of Camp (AKY). Fourteen eggs from this nest started to progress but stopped at about 80% development. All of the six hatchlings that emerged possessed mild to severe abnormalities to the carapace and the plastron (Figure 35). Standing et al. (2000) reported similar developmental abnormalities in hatchlings from a population in Nova Scotia. One nest (unknown) remained unhatched on the north end of camp as well as one (ACW) on the south. A clutch size of at least eight was found in the northern nest, with one egg containing a hatchling about 80% developed. Unfortunately, the ground was too frozen at the time of excavation to get an accurate clutch size for this nest. However, eighteen eggs ≤50% developed were excavated from the nest on the south end of camp.

Figure 35. Blanding's turtle hatchling plastron abnormalities, Camp Ripley Training Center, Minnesota, 2017.

Embryonic development in the Blanding's turtle has been found to be positively correlated with temperature (Standing et al. 1999). It is believed that the cohort of hatchlings in 2017 were affected due to cooler temperatures during the incubation period. In 2016, nest failure was logged as 22.2% while nest failure for 2017 was recorded at 50%. The average temperature during incubation (June – November) in 2016 was approximately 14.17º C whereas the average temperature in 2017 was 12.3º C. Additionally, the nest of ACW was often found flooded from recent rainfall when doing nest checks. Standing et al. (1999) found that flooding of nests was positively correlated with nest failure. Thus, average temperatures and nest site selection play a critical role in the successful completion of embryonic development and reproductive success. Preventative actions for flooding will be implemented next year by drilling small holes in the 5-inch barriers inside the metal cages.

Following the nest emergence of hatchlings on September 18 and October 5, individuals from each clutch were stored in a 10-liter bucket for data collection. Turtles were measured for midline length and width on the carapace and plastron to the nearest mm using a digital caliper. Mass of the hatchlings was determined using a 20-gram weight limit Pesola scale. Hatchlings were then assigned a number that was attached to the carapace using temporary construction tape. After data was collected from the clutch, hatchlings were separated by weight categories. The weight categories included hatchlings from 7.5-8.5 g, 9-9.5, g, 10-10.5 g, and 11 g or greater. Eight hatchlings were then chosen to be affixed with transmitters using a random number system (Damon and Harvey 1987). Each hatchling affixed with a transmitter was given a unique turtle identification. The identification assigned to each hatchling was related to the identification that was provided to the adult maternal female followed by a consecutive number. The H in front of each identification represents “hatchling” to differentiate between the mothers and the offspring. The unique identifications assigned for 2017 include H_PW01, H_PW02, H_PW03, H_PW04, H_PW05, H_PW06, H_AXY01, H_AXY02.

Figure 36. Blanding’s turtle hatchling with radio-transmitter, Camp Ripley Training Center, Minnesota, 2017.

Transmitters used on the selected hatchlings were model R1614 (Advanced Telemetry Systems, Isanti, Minnesota, USA; 0.3 g) (Figure 36). Each transmitter weighed no more than 5% of the hatchlings’ body mass and transmitters had a maximum battery capacity of 24 days (30 ppm). Transmitters were affixed using a fast drying (5 minutes) epoxy compound. Prior to fitting the transmitter, the carapace of the hatchling was cleaned using water, and time was allowed for the carapace to dry to assure the transmitter set properly. The epoxy was applied to the carapace approximately midway down the turtle between the dorsal line and the marginal scutes. The turtles were then set in buckets individually to allow the epoxy to set. Though the recommended wait time to allow the epoxy to set was 5 minutes, turtles were held for approximately one hour prior to release. Six hatchlings were subsequently escorted to two wetland complexes that support adult conspecifics and where previous cohorts were released: Range Marsh and Goose Lake. From the hatchlings chosen to be tracked, three hatchlings were randomly (Damon and Harvey 1987) selected to be distributed in Goose Lake (H_PW02, H_PW03, H_PW04) and three hatchlings were spread throughout Range Marsh (H_PW01, H_PW05, H_PW06). The remaining two hatchlings were released at the nest site as a pilot study for 2018 (H_AKY01, H_AKY02).

Following the release of hatchlings at the nest site, Goose Lake and Range Marsh, individuals were located every one to three days using a three-element Yagi antenna and a R4100 Scanning Receiver (Advanced Telemetry Systems). After an individual was located, microhabitat data were collected using a 1 X 1 m PVC quadrat frame (Derivation of Daubenmire 1959). Data collected within this frame included total ground cover, detritus cover, emergent vegetation cover, woody vegetation cover, dominant plant species, and water depth. Total ground cover was calculated by estimating the percent of the quadrat frame that had vegetation cover as opposed to water. Detritus cover was documented by evaluating how much dead material laid within the quadrat. Emergent vegetation and woody vegetation cover was calculated by dividing the amount of emergent and woody vegetation present by the total vegetation cover. The dominant plant species was assessed by dividing the cover of species by the total plant cover. Water depth was documented using a meter stick or ruler. Additionally, wetland location, the UTM coordinate of the hatchling, and distance moved was recorded. Wetland location was verified using radio telemetry. The UTM coordinate and distance moved were found by using a GPS unit.

Of the six hatchlings released in Goose Lake and Range Marsh, five retreated to different habitat within the first 48 hours. Only one of the hatchlings (H_PW05) released in Range Marsh remained in this wetland complex. H_PW05 traveled at least 130.06 m into Range Marsh in the 25 days of monitoring (September 18 – October 13) (Figure 37). The other hatchlings escorted to Range Marsh (H_PW01 & H_PW06) moved to the edges of a shrub swamp habitat west of their release points. H_PW01 was located 53.31 m away of the release site in the first 72 hours. From there, the hatchling gradually moved south, traveling a minimum of 123.40 m from September 18 to October 13 (Figure 37). H_PW06 traveled at least 95.06 m south from the date of release to September 25. After 22 days of monitoring, a second transmitter was affixed to the hatchling which was observed for a total of 50 days (September 18 – November 7). It is presumed that the hatchling was tracked to its overwintering site where it remained under 2 cm of mud (Figure 38) from October 5 to November 7, 51.69 m west of its release site (Figure 37).

Figure 38. Radio-transmittered Blanding’s turtle hatchling H_PW06 concealed in soil substrate, Camp Ripley Training Center, Minnesota, 2017.

All of the hatchlings released in Goose Lake also moved to different habitat. H_PW02 was tracked to a tamarack swamp west of the release site. The hatchling traveled at least 203.92 m from September 18 to September 28. H_PW02 then moved east 65.74 m, where it resided on the edge of the tamarack swamp in *Sphagnum* for the duration of the transmitter battery life (September 30 – October 13) (Figure 39). H_PW04 retreated to a sedge swamp known as West Goose Marsh, 450.70 m south of

Figure 37. Locations of Blanding's turtle hatchling H_PW01, H_PW05 and H_PW06 direct released at Range Marsh, Camp Ripley Training Center, Minnesota, 2017.

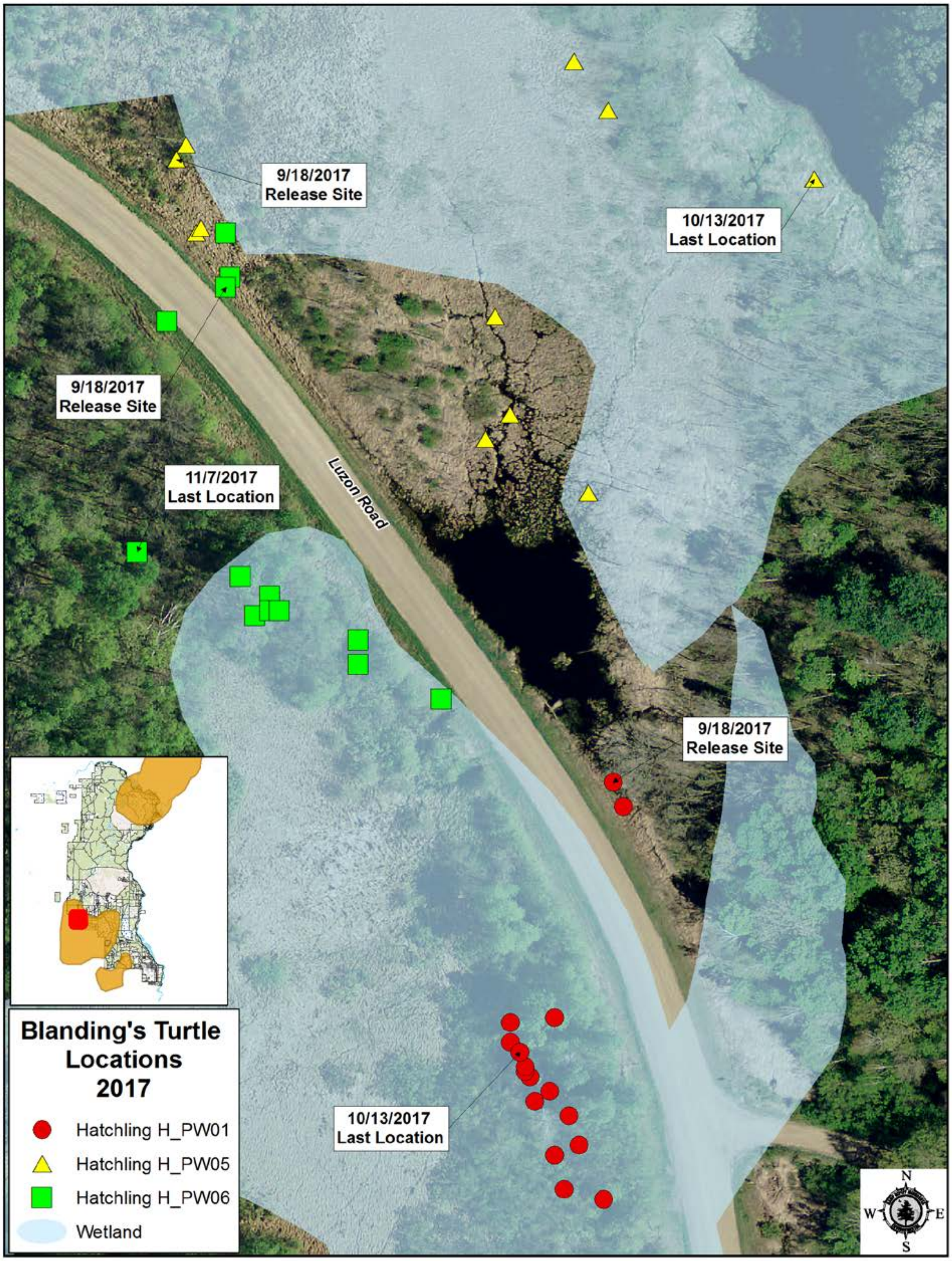
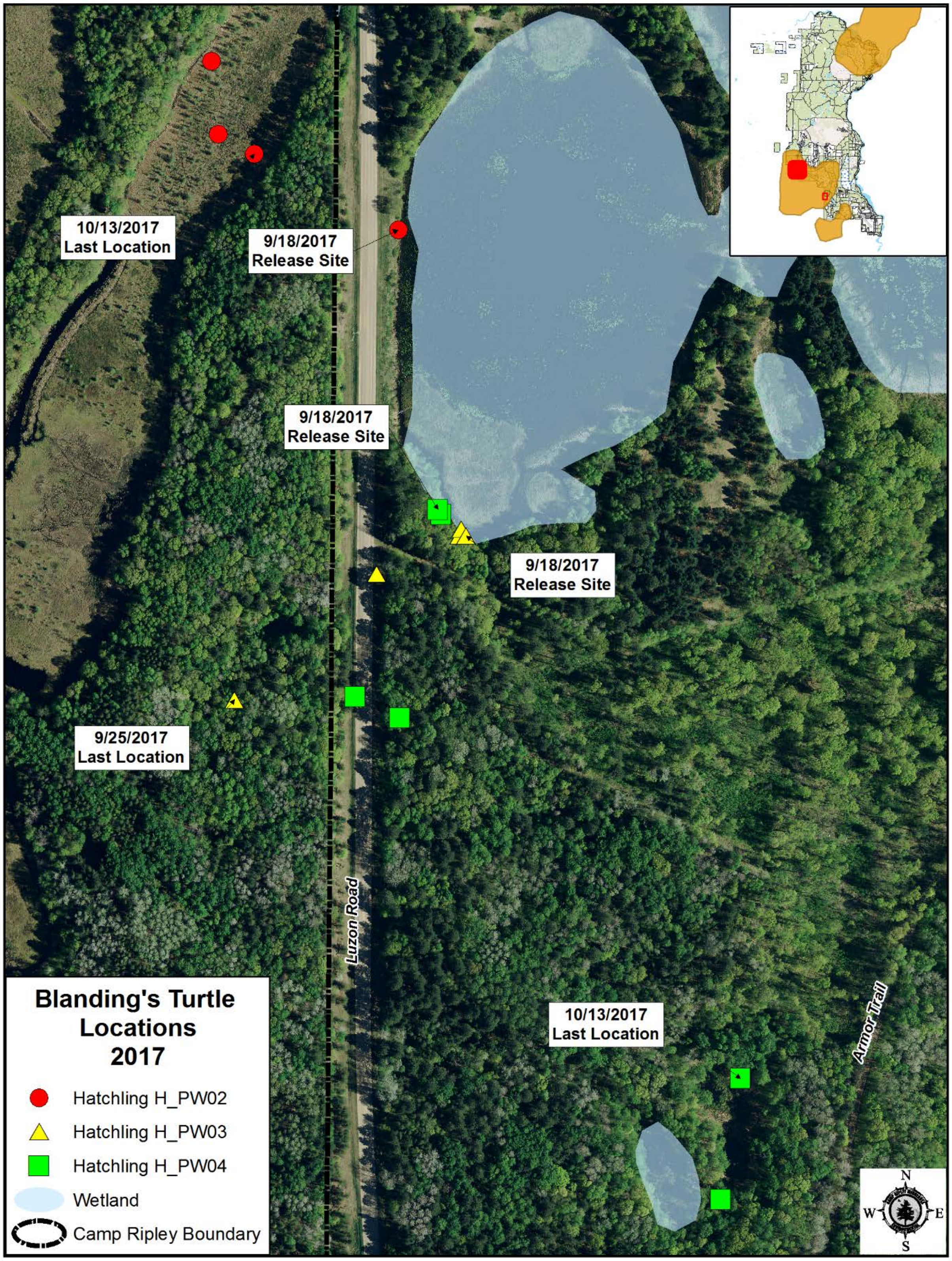


Figure 39. Locations of Blanding’s turtle hatchlings H_PW02, H_PW03 and H_PW04 direct released at Goose Lake, Camp Ripley Training Center, Minnesota, 2017.



the release point. The hatchling gradually moved north to the edge of the wetland, where it took cover under leaf litter in seven cm of water for the last two weeks of monitoring (September 30 – October 13) (Figure 39). Interestingly, on the last day of observation, H_PW04 was located on land 5.38 m away from the recurrent location. The third hatchling (H_PW03) also left Goose Lake and headed 172.93 m west, however, the transmitter fell off of the hatchling after four days of tracking (September 18 – September 22) (Figure 39).

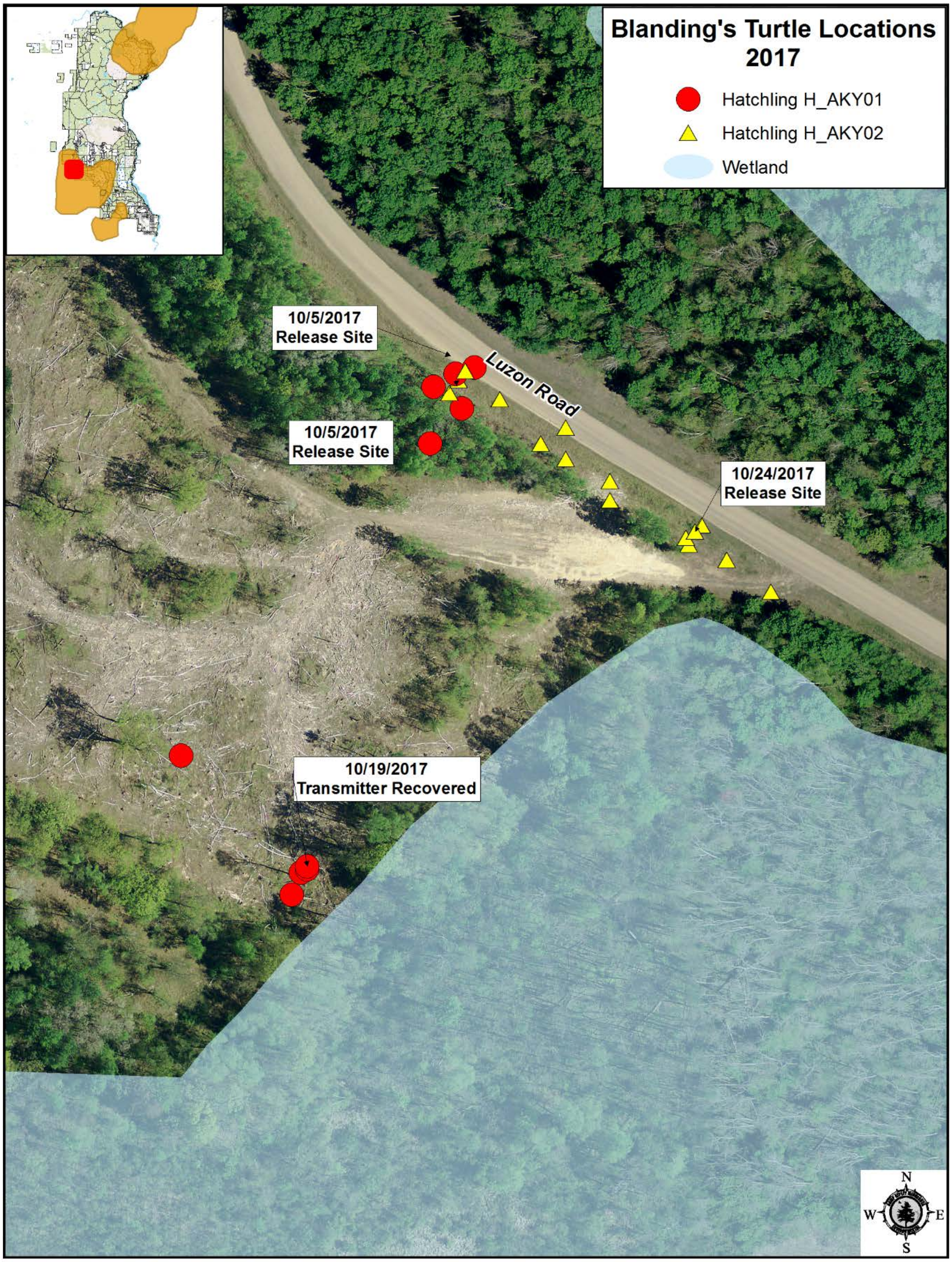
H_AKY01, a hatchling released at the nest site, was tracked 163.88 m west of the release point. From October 11 to October 13, this hatchling traveled at least 126.66 m. This transmitter fell off the turtle and was only observed for ten days (October 5 – October 19) (Figure 40). The other hatchling released at the nest site, H_AKY02, traveled south alongside the road in a continuous depression for 19 days. Following the 19 days of monitoring, a second transmitter was applied to the hatchling. This individual continued to travel south for five more days until it resided in a clump of vegetation for the rest of the duration of the study (October 29 – November 7) (Figure 40). Interestingly, the hatchling was observed in the same location on November 27 when visiting the field site. A metal cage was positioned over the hatchling and will be removed in the spring of 2018.

Historically, it has been thought that hatchlings face high mortality rates from predators and automobiles due to the long overland journey to a wetland habitat (Congdon et al. 1983; Piepgras and Lang 2000). Therefore, direct release of hatchlings in nearby adult wetland habitat was adopted in 2009. This study was intended to determine what happens to the hatchlings once they are released in adult wetland habitat. Our findings suggest that the habitat selected for hatchling release may not be preferable, as all but one hatchling retreated from the release sites. Additionally, all hatchlings survived the duration of the study while traveling across roads and facing the possibility of predation. Four of the six hatchlings released in wetland complexes retreated to the edge of a swamp and were often found concealed in Reed canary grass (*Phalaris arundinacea*), *Sphagnum*, and leaf litter. Additionally, hatchlings resided in water depths ≤40 cm with water depths reducing to 0-7 cm the last week of monitoring. H_AKY02, a hatchling released at the nest site, was found to overwinter on land in a clump of vegetation. Due to these results, it is our goal for 2018 to radio-track hatchlings that are released at the nest site. By releasing hatchlings at the nest site, we can evaluate the current conservation efforts of direct release and modify actions to incorporate the best management practices to assure a long-term stable population.

Anuran Surveys

Frog and toad calling surveys are conducted as part of a larger statewide survey, and have been conducted at Camp Ripley since 1993. The statewide survey began due to growing concern over declining amphibian populations worldwide. Frog and toad abundance estimates are documented by the index level of their chorus, following Minnesota Herpetological Society guidelines (Moriarty, unpublished). If individual songs can be counted and there is no overlap of calls, the species is assigned an index value of one. If there is overlap in calls the index value is two, and a full chorus is designated a three. Anuran surveys are performed at 10 stops along two separate routes at Camp Ripley. The routes are surveyed three times from April through July (Figure 41).

Figure 40. Locations of Blanding’s turtle hatchlings H_AKY01 and H_AKY02 direct released at Goose Lake, Camp Ripley Training Center, Minnesota, 2017.



Both routes were surveyed in 2017, during all three time periods. Surveys were conducted by DNR staff and volunteer Adam Kremer (#50295, 2nd time period only) on the south (#50195) and north (#50295) routes on April 24, May 25 and June 29. During the first survey period, (April 15 – 30) spring peepers (*Pseudacris crucifer*) were near the 24 year high point that occurred in 1994. Several northern leopard frogs (*Rana pipiens*) were also heard (Figure 42 and Table 19). Boreal chorus frog (*Pseudacris maculata*) index values were slightly above their all−time low in 2015 and wood frogs (*Rana sylvatica*) had the eleventh highest index recorded since 1994. During the second survey period (May 15 – June 5), spring peeper's and gray treefrog's (*Hyla chrysoscelis*) index values were both the third highest since 1993 and Cope's gray treefrog's was second highest. American toads (*Anaxyrus americanus*) were also heard calling during the second survey period (Figure 43 and Table 19). The third survey period included calls from northern leopard frog, American toad, gray treefrog, Cope's gray treefrog, mink and green frogs (Table 19). Statewide results, between 1998 and 2015, indicate a marginally-significant increase (p = 0.06) in the proportion of routes where Cope's gray treefrogs were heard; and, a significant increase (p = 0.03) in the proportion of routes where green frogs were heard. No statewide trends were detected in the other 12 species of frogs and toads in Minnesota, indicating overall populations of these species are stable (Larson 2017).

Figure 41. Anuran survey routes, Camp Ripley Training Center, 1993–2017.

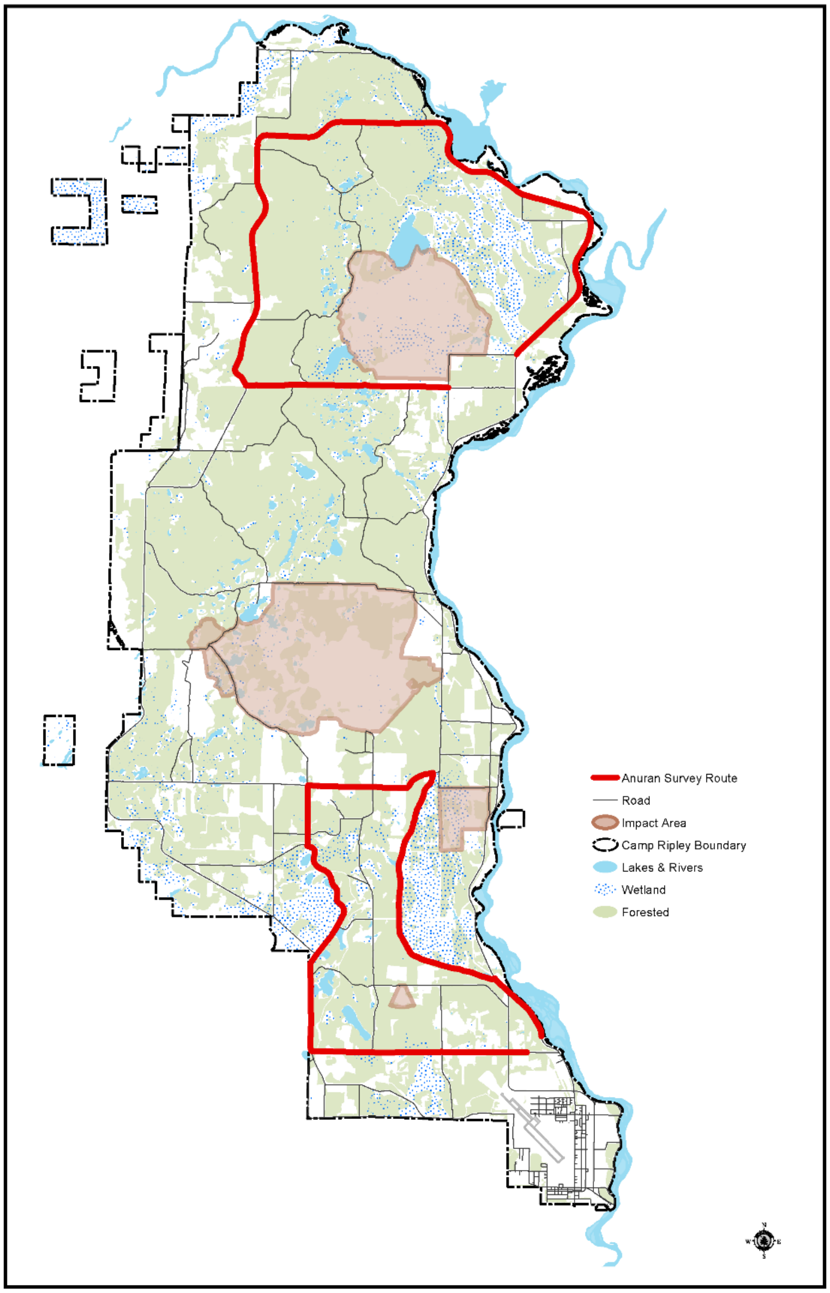


Figure 42. Average anuran index value during the first survey period, Camp Ripley Training Center, Minnesota, 1994 – 2017. Surveys were not conducted during 2008.

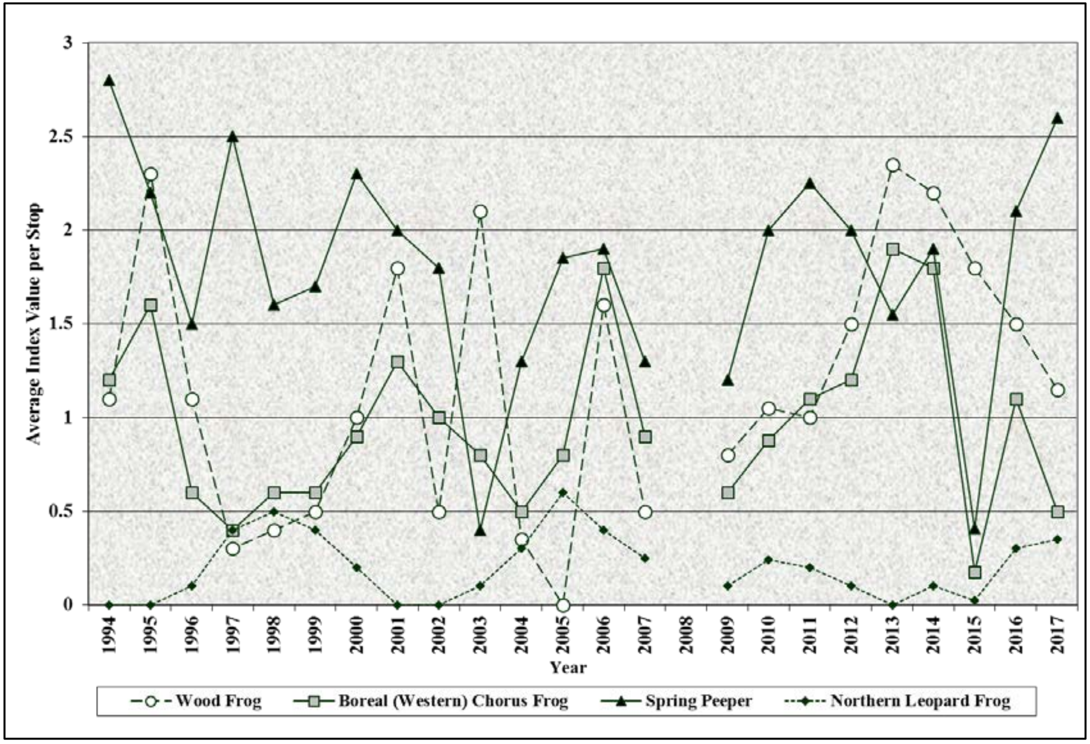


Figure 43. Average anuran index value during the second survey period, Camp Ripley Training Center, Minnesota, 1993 – 2017. Surveys were not conducted during the second survey period in 2005 and 2008.

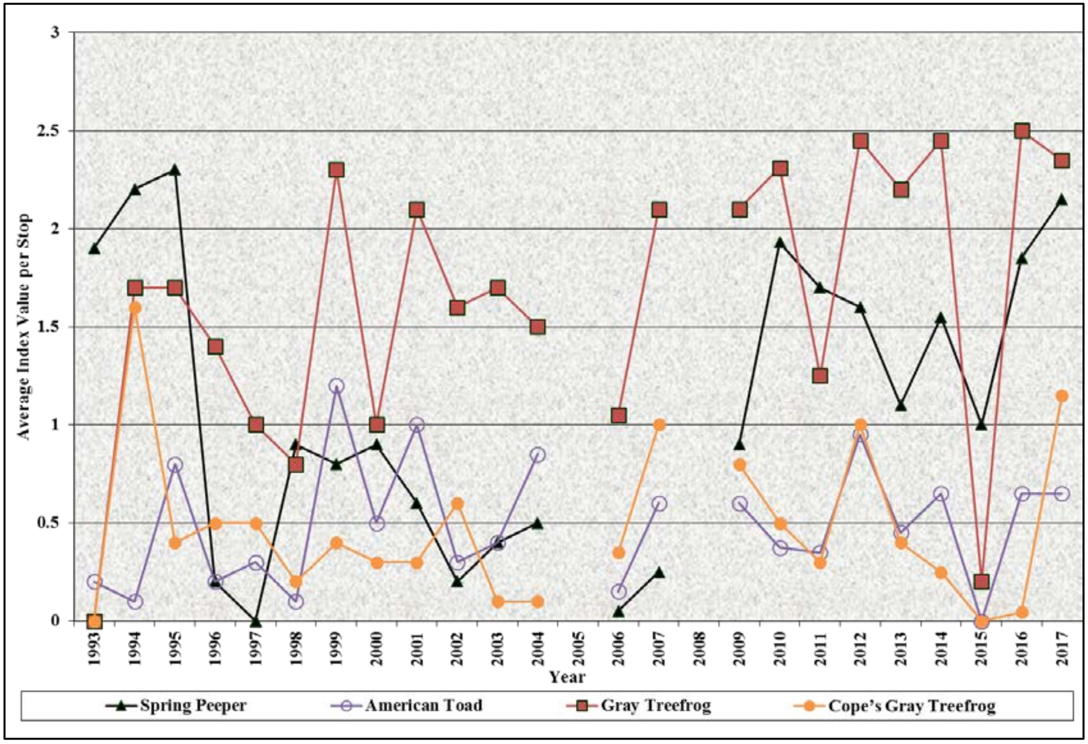


Table 19. Anuran survey index data, Camp Ripley Training Center, Minnesota, 1993 – 2017.

Survey Period 1	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
Wood frog	*	1.1	2.3	1.1	0.3	0.4	0.5	1	1.8	0.5	2.1	0.35	0	1.6	0.5	*	0.8	1.05	1.0	1.5	2.35	2.2	1.8	1.5	**1.15**
Boreal (Western) chorus frog	*	1.2	1.6	0.6	0.4	0.6	0.6	0.9	1.3	1	0.8	0.5	0.8	1.8	0.9	*	0.6	0.88	1.1	1.2	1.9	1.8	0.18	1.1	**0.5**
Spring peeper	*	2.8	2.2	1.5	2.5	1.6	1.7	2.3	2	1.8	0.4	1.3	1.85	1.9	1.3	*	1.2	2.0	2.25	2.0	1.55	1.9	0.41	2.1	**2.6**
Northern leopard frog	*	0	0	0.1	0.4	0.5	0.4	0.2	0	0	0.1	0.3	0.6	0.4	0.25	*	0.1	0.24	0.2	0.1	0	0.1	0.02	0.3	**0.35**
American toad	*	0	0	0	0	0	0	0	0	0	0	0	0.8	0	0	*	0	0	0	0	0	0	0	0	**0**
Gray treefrog	*	0	0	0	0	0	0	0	0	0	0	0	1.35	0	0	*	0	0	0	0	0	0	0	0	**0**
Cope’s gray treefrog	*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*	0	0	0	0	0	0	0	0	**0**
Mink frog	*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*	0	0	0	0	0	0	0	0	**0**
Green frog	*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*	0	0	0	0	0	0.05	0	0	**0**
Survey Period 2	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
Wood frog	2.4	0.1	0	0	0	0	0	0	0	0	0	0	*	0	0	*	0	0	0	0	0	0	0	0	**0**
Boreal (Western) chorus frog	0.4	0.1	0.2	0	0	0	0.1	0.2	0.2	0	0.2	0.2	*	0	0.05	*	0.3	0.56	0.5	0.9	0.7	0.8	0.6	0.25	**0.7**
Spring peeper	1.9	2.2	2.3	0.2	0	0.9	0.8	0.9	0.6	0.2	0.4	0.5	*	0.05	0.25	*	0.9	1.93	1.7	1.6	1.1	1.55	1.0	1.85	**2.15**
Northern leopard frog	0	0	0	0	0	0.1	0.1	0.3	0.1	0	0.1	0.1	*	0.1	0.05	*	0	0.06	0.1	0.05	0.15	0.05	0.15	0.05	**0.15**
American toad	0.2	0.1	0.8	0.2	0.3	0.1	1.2	0.5	1	0.3	0.4	0.85	*	0.15	0.6	*	0.6	0.37	0.35	0.95	0.45	0.65	0	0.65	**0.65**
Gray treefrog	0	1.7	1.7	1.4	1	0.8	2.3	1	2.1	1.6	1.7	1.5	*	1.05	2.1	*	2.1	2.31	1.25	2.45	2.2	2.45	0.2	2.5	**2.35**
Cope’s gray treefrog	0	1.6	0.4	0.5	0.5	0.2	0.4	0.3	0.3	0.6	0.1	0.1	*	0.35	1	*	0.8	0.5	0.3	1.0	0.4	0.25	0	0.04	**1.15**
Mink frog	0	0	0	0.2	0.1	0.1	0	0	0	0	0	0	*	0	0	*	0	0	0	0	0.1	0	0	0	**0**
Green frog	0	0	0	0.1	0.1	0	0	0	0	0	0	0	*	0	0	*	0.1	0	.05	0	0	0	0	0.05	**0**
Survey Period 3	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
Wood frog	*	*	0	0	*	*	*	*	0	0	*	*	0	*	0	*	0	0	0	0	0	0	0	0	**0**
Boreal (Western) chorus frog	*	*	0.1	0	*	*	*	*	0	0	*	*	0	*	0	*	0	0	0	0	0	0	0	0	**0**
Spring peeper	*	*	0	0	*	*	*	*	0	0	*	*	0	*	0	*	0	0	0	0	0	0	0	0	**0**
Northern leopard frog	*	*	0	0	*	*	*	*	0	0	*	*	0	*	0	*	0.3	0	0	0	0	0	0	0	**0.05**
American toad	*	*	0	0	*	*	*	*	0	0	*	*	0	*	0	*	0	0	0.1	0	0	0	0.05	0	**0.05**
Gray treefrog	*	*	0.2	0	*	*	*	*	0.2	0.3	*	*	0.25	*	0.4	*	0.5	0.05	1.8	1.05	0.6	0.15	0.2	0.5	**1.25**
Cope’s gray treefrog	*	*	0	0	*	*	*	*	0	0.3	*	*	0.1	*	0.12	*	0.3	0	0.45	0.2	0.2	0.05	0	0.25	**0.15**
Mink frog	*	*	0.3	0.4	*	*	*	*	0	0.1	*	*	0.05	*	0.06	*	0	0.1	0.15	0.05	0.2	0.2	0.05	0.1	**0.15**
Green frog	*	*	0	0.3	*	*	*	*	0.3	0.1	*	*	0.25	*	0.06	*	0.7	0.25	0.55	0.5	0.25	0.35	0.04	0.56	**0.5**

*No survey conducted

Insects

Monarch Butterfly (*Danaus plexippus*)

Monarch butterflies are found throughout the United States. Eastern populations migrate vast distances of over 3,000 miles between the United States, Canada and central Mexico from breeding grounds to overwintering locations, across multiple generations each year. Adults in a summer generation live for two to six weeks while migratory generations live up to nine months. Monarchs from northern latitude breeding grounds that emerge after mid-August begin to migrate south towards overwintering grounds where they have never been before. When this migratory generation begins the northward journey into the southern U.S., this generation lays eggs and nectars as they breed and migrate north. The generation that re-populates the northern latitude breeding grounds the next spring is the second and third generation of the previous falls' generation (Monarch Joint Venture 2015).

Populations of monarchs are declining in both the eastern and western portions of their North American range. Monarchs are now being considered for protection under the federal Endangered Species Act (ESA). The USFWS is currently conducting a species status assessment to describe the viability of monarch populations which will support ESA decisions. The USFWS anticipates an ESA listing decision by June 2019. The major population threats are breeding, migration and overwintering habitat losses. Insecticides used to control insects are harmful to monarchs. And, herbicides used to control weeds can affect milkweed populations, the only plant that female monarchs use to lay eggs and the only plant its caterpillars eat (Monarch Joint Venture 2015).

Recent comprehensive surveys for monarch butterflies have not been completed on Camp Ripley. Butterfly surveys in 1994 encountered monarchs numerous times between May 21 and October 2. Larvae were observed on common milkweed (Hansen 1994) and observed in 2017 in Training Area 64.

Best management practices for monarch populations on Camp Ripley should include avoiding mowing ditches when monarch larvae are present, late April to mid-August, particularly locations where common milkweed (*Asclepias syriaca*) is present. In addition, limiting insecticide and herbicide use would be beneficial.

Bumble Bees

Historically about 400 native bee species occurred in Minnesota. However, little is known about bees because the most recent state species list was published in 1919. Bumble bees are a group of insect pollinators. Pollinators are critical to the agricultural economy and natural habitats and ecosystems as 90% of the world's flowering plants rely on animal pollinators. "Pollination happens when wind, water and wildlife carry pollen from the anther (male part) to the stigma (female part) of plants" (MNDNR 2017c and

Hatfield et al. 2012). Threats to bumble bee populations include habitat fragmentation, grazing, pesticide use, genetic diversity, pests and diseases, competition with honey bees and climate change (Hatfield et al. 2012). The economic value of pollination services provided by native insects (mostly bees) is estimated at $3 billion dollars annually in the United States (USFWS 2017b).

Five bumble bees are listed as SGCN in Minnesota, including rusty patched bumble bee (*Bombus affinis*), Ashton cuckoo bumble bee (*Bombus bohemicus*), yellowbanded bumble bee (*Bombus terricola*) and golden northern bumble bee (yellow bumble bee; *Bombus fervidus*). Rusty patched bumble bee abundance and distribution has decline by 90% since the late 1990s. Recently the rusty patched bumble bee was listed as federally endangered under the Endangered Species Act. None of the single threats noted above is causing the rusty patched population decline, but the threats working in concert are likely causing the decline (USFWS 2017b). Rusty patched bumble bee range includes Camp Ripley. Recent observations of rusty patched and yellowbanded bumble bees have occurred in southeast Crow Wing County (MNDNR 2016d); therefore, it is likely that they are present on Camp Ripley.

Native Bee Transect Surveys

By Crystal Boyd, DNR, Bee Specialist

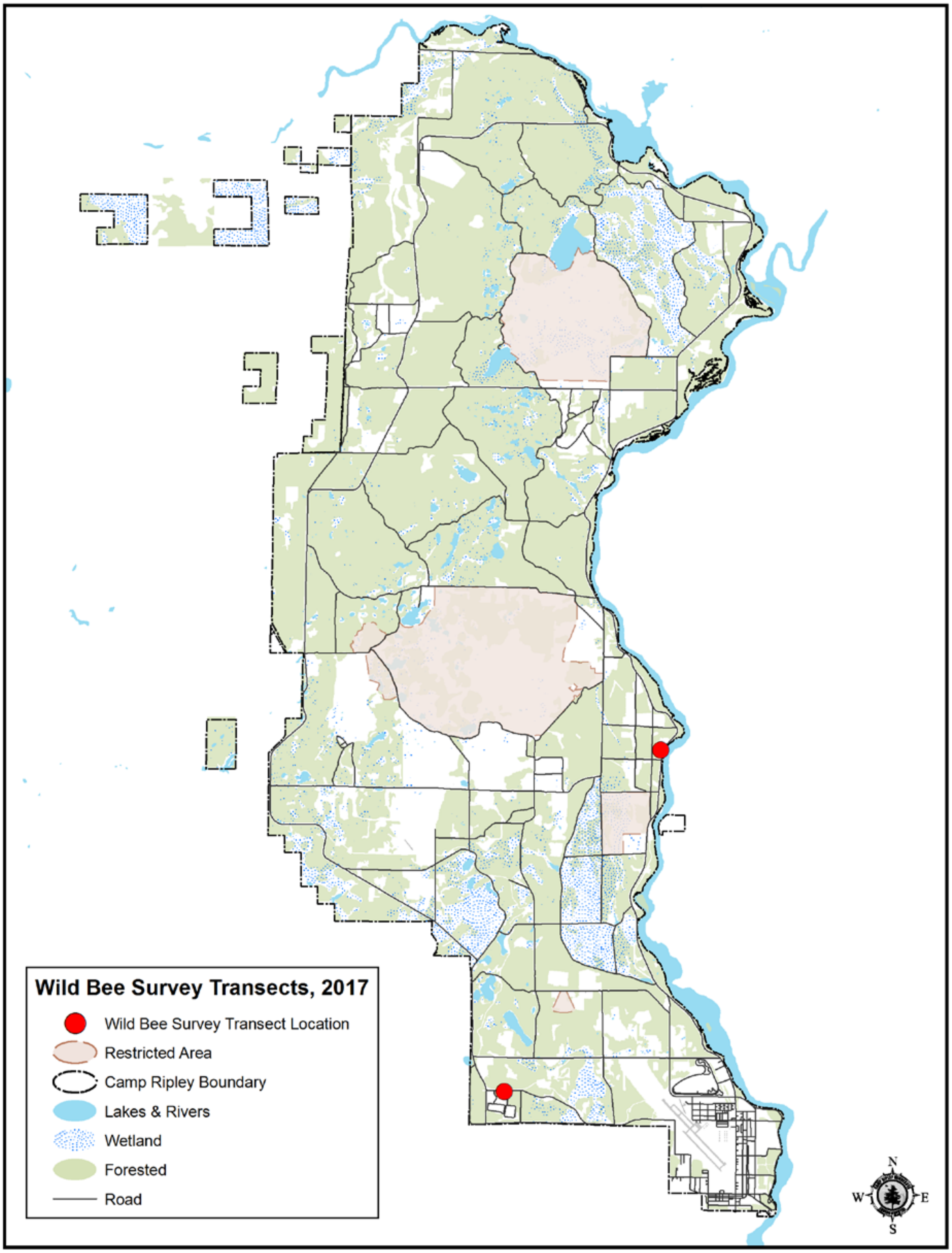
Native pollinators face multiple challenges including habitat loss, pesticides, pathogens and climate change. The Minnesota State Wildlife Action Plan lists five bumble bees as Species in Greatest Conservation Need (SGCNs). In 2017, the rusty patched bumble bee (*Bombus affinis*) was listed as a federally endangered species.

Despite the importance of pollinators, little is known about their distribution in Minnesota. For example, the most recent state species list of bees was published in 1919. To begin filling gaps in knowledge, Crystal Boyd with the DNR's Minnesota Biological Survey (MBS) coordinated native bee surveys at two sites in Camp Ripley during the summer of 2017.

Camp Ripley survey efforts were designed to match the DNR Minnesota Biological Survey methods in other parts of the state. A transect of 24 elevated pan traps was set at each site (Figure 44). The pan traps were filled with water and Dawn dish soap, and bees trapped in the soapy water were collected 24 hours later. In 2017, pan traps were set during the following three events: August 7 – 8, August 22 – 23, and September 21 – 22.

Specimen processing is ongoing. Sorting, pinning, labelling, databasing and identification take place during the off-season. An estimated 200+ specimens were collected during 2017 surveys at Camp Ripley. Species identification from the 2017 surveys on Camp Ripley will be documented in the 2018 conservation report. Data will be archived in the DNR's Observation Database, and specimens will be vouchered with the University of Minnesota Insect Collection (UMSP).

Figure 44. Native wild bee pan survey transect locations, Camp Ripley Training Center, Minnesota, 2017.



Fisheries

By Jake Kitzmann, Minnesota Department of Military Affairs

In 2017, no fish netting or rearing was conducted.

Aquatic Plant Surveys

Surveys of aquatic plant structure were instead conducted on two inland lakes in cooperation with the DNR Ecological and Water Resources staff. On August 14, a survey was conducted of near shore (< 1 m from shore) points on Rapoon Lake and all emergent vegetation was mapped. Rapoon is a 16 acre lake located in Training Area 75. Water clarity is fair with brown staining present. The substrate consists mostly of sand and gravel along with steep gradients along the shoreline. There is no development along its shores with only a small grassy area serving as the launch on the southeast corner. Rapoon Lake has a maximum depth of 24 feet. There were a total of 2.4 acres of floating and emergent plants mapped and 6 species identified (Table 20). This consisted of 2.4 acres of emergent dominated plant communities and no floating leaf plant communities.

Table 20. Floating and emergent taxa, Rapoon Lake, Camp Ripley Training Center, Minnesota, 2017.

Emergent Plants Common Name	**Scientific Name**	**2017 Near Shore Survey**
Three-way sedge	*Dulichium arundinaceum*	X
Arrowhead	*Sagittaria* sp.	X
Broad-leaf arrowhead	*Sagittaria latifolia*	X
	Emergent Plant Species TOTAL	**3**
Floating Leaved Plants Common Name	**Scientific Name**	**2017 Near Shore Survey**
Floating-leaf burreed	*Sparganium* sp.	X
Yellow waterlily	*Nuphar variegata*	X
	Floating-leaved Plant Species TOTAL	**2**
Submerged Plants Common Name	**Scientific Name**	**2017 Near Shore Survey**
Narrow-leaf pondweed	*Potamogeton* sp.	X
	Submerged Plant Species TOTAL	**1**

On September 6, a point intercept survey was conducted on Ferrell Lake. A total of 83 point intercept sample sites at 50 meter intervals and 27 nearshore sites at 100 meter intervals were surveyed and 28 species identified (Table 21). Ferrell Lake is a small lake located within Camp Ripley and has with a maximum depth of approximately 12 feet. This lake has very little military development along its shore and the watershed is dominated by northern hardwood forest. The present development is two cable concrete accesses, one on the southwest side and the other on the northeast side. A dock is located at the southwest access along with a couple row boats for recreational use for soldiers and visitors to the military reservation;

Table 21. Emergent, submerged, floating-leaved and free-floating plant taxa, Ferrell Lake, Camp Ripley Training Center, Minnesota, 2017.

Emergent Plants Common Name	**Scientific Name**	**2017 Lakewide Survey**	**2017 Near Shore Survey**
Spikerush	*Eleocharis* sp.	1	15
Arrowhead	*Sagittaria* sp.	1	41
Broad-leaf arrowhead	*Sagittaria latifolia*		4
	Emergent Plant Species TOTAL	**2**	**3**
Floating-Leaved Plants Common Name	**Scientific Name**	**2017 Lakewide Survey**	**2017 Near Shore**
Watershield	*Brasenia schreberi*	35	96
White waterlily	*Nymphaea odorata*	28	74
	Floating-leaved Plant Species TOTAL	**2**	**2**
Free-Floating Plants Common Name	**Scientific Name**	**2017 Lakewide Survey**	**2017 Near Shore**
Lesser duckweed	*Lemna* sp.		**11**
	Free-floating Plant Species TOTAL	**0**	**1**
Submerged Plants Common Name	**Scientific Name**	**2017 Lakewide Survey**	**2017 Near Shore**
Hornwort	*Ceratophyllum echinatum*		11
Muskgrass	*Chara* sp.	72	22
Needlegrass	*Eleocharis acicularis*		26
Canada waterweed	*Elodea canadensis*	67	96
Water stargrass	*Heteranthera dubia*		4
Quillwort	*Isoetes* sp.		19
Brown-fruited rush	*Juncus pelocarpus*		4
Bushy pondweed	*Najas flexilis*		4
Northern naiad	*Najas gracillima*	14	93
Small nitella	*Nitella tenuissima*		7
Stonewort	*Nitella* sp.		7
Large-leaf pondweed	*Potamogeton amplifolius*	35	56
Ribbon-leaf pondweed	*Potamogeton epihydrus*		48
Variable pondweed	*Potamogeton gramineus*	1	
Illinois pondweed	*Potamogeton illinoensis*	2	
Narrow-leaf pondweed	*Potamogeton* sp.	18	63
Robbin’s pondweed	*Potamogeton robbinsii*	1	7
Humped bladderwort	*Utricularia gibba*	25	56
Minor bladderwort	*Utricularia minor*	14	11
Greater bladderwort	*Utricularia vulgaris*	13	44
Wild celery	*Vallisneria americana*	2	11
Watermoss	Not identified to genus		11
	Submerged Plant Species TOTAL	**12**	**19**

personal boats are allowed but must be clear of any invasive species. Water clarity is excellent allowing for good aquatic vegetation to grow to a depth of about 10 feet. The southeastern portion of the lake is a large bay that produce a dense mat of lily pads and other various aquatic plants. There is very little structure within the lake other than the natural weed line, a couple beaver lodges and sunken wood debris.

Pest Management

Vector-borne Diseases

By Jenna Bjork, DVM, Minnesota Department Health (MDH)

Vector-borne diseases (i.e., illnesses spread by ticks and mosquitoes) are a complex, dynamic and significant health risk to persons who live, work and travel within Minnesota. Dozens of species of ticks and mosquitoes thrive throughout the state but not all of them bite people and not all of them spread disease. For instance, two ticks of primary public health concern include blacklegged deer tick (*Ixodes scapularis*) and wood (dog) tick (*Dermacentor variabilis*). *Ixodes scapularis* may transmit the pathogens that cause several diseases in humans including but not limited to Lyme disease, human anaplasmosis, and babesiosis. In addition, while human disease transmission from *D. variabilis* is rare within the state of Minnesota, diseases such as Rocky Mountain spotted fever and tularemia can have serious and life-threatening consequences. In regards to mosquito borne diseases, one particular mosquito of primary public health concern here in Minnesota is *Culex tarsalis*, our main vector of West Nile virus disease. Other mosquito species may spread diseases and exotic species (e.g., *Aedes japonicus* and *Aedes albopictus*) may be introduced throughout the state as well. For these reasons, MDH conducts annual surveillance for ticks and mosquitoes in order to better understand and communicate the risks of vector-borne disease in Minnesota.

Since 2005, MDH has collected ticks at Camp Ripley and various Minnesota state parks and other high public use areas as part of ongoing efforts to determine long-term infection prevalence with endemic pathogens in *I. scapularis* throughout the state. In 2017, *D. variabilis* ticks that were incidentally collected during these visits were also submitted for testing of the disease agent that causes tularemia, *Francisella tularensis*. In addition to tick surveillance, in 2017 MDH also received resources through the Upper Midwestern Center of Excellence for Vector-borne Disease to perform surveillance for adult mosquitoes at four sites in Minnesota, one of which was Camp Ripley. The purpose of this effort was to provide an updated assessment of the types of mosquitoes present in Minnesota as well as document (and respond, as needed, to) any exotic mosquito species collected.

Methods

Tick Studies

Camp Ripley was visited four times (5/4/17, 6/1/17, 6/20/17 and 7/13/17) in an effort to collect at least 200 *I. scapularis* (100 adult and 100 nymph life stage ticks). Three sites (Training Areas 1, 20/22, and 29) within the Camp were selected for study based on accessibility and optimal blacklegged tick habitat (i.e.

wooded and brushy mesic areas with at least 50% canopy coverage). All sites were sampled on each of the first three visits while only four transects (two transects each of Training Areas 1 and 29) were sampled on 7/13/17. MDH field staff collected ticks by dragging white canvas cloths over the ground along four 100-meter transects established at each site. Staff also collected any ticks found crawling on themselves while walking along each transect. Ticks were stored in vials containing 70% ethanol. The MDH Public Health Laboratory (PHL) will perform polymerase chain reaction (PCR) testing on *I. scapularis* collected at these sites to detect the genetic material of *Borrelia burgdorferi* (Lyme disease), *Anaplasma phagocytophilum* (human anaplasmosis), *Ehrlichia muris eauclairensis* (ehrlichiosis), *Babesia microti* (babesiosis), *Borrelia miyamotoi* (hard tick relapsing fever), and *Borrelia mayonii* (a recently identified form of Lyme disease). *Ixodes scapularis* adults and nymphs will be tested individually while larvae will be tested in pools of 1 – 10 ticks per pool.

While collecting *I. scapularis* at these sites, MDH staff also incidentally collected *D. variabilis* adult ticks on all of these visits as well. These ticks were submitted to the MDH PHL for PCR testing to detect the genetic material of *F. tularensis* (tularemia) and were tested in pools with a maximum of 10 ticks per pool. The minimum infection rate of ticks was calculated by dividing the minimum number of positive ticks per positive pool (i.e., one tick per positive pool) by the total number of ticks tested.

Mosquito Studies

The mosquito magnet trap was located in Training Area 17 in open grassland on the edge of wooded habitat, surrounded by a large wetland. The mosquito magnet used in this effort was a stationary device that utilizes attractants such as carbon dioxide and octenol to lure a broad population of blood-seeking mosquitoes into a fan that blows mosquitoes into a net until collected by the administrator. In general, samples were collected on a weekly basis during the primary mosquito borne disease risk season (i.e., June through September) with the device running on average for 3 – 4 days during the collection period each week. After collection, mosquito samples were frozen until they could be identified to species by MDH staff.

Results

Tick Studies

Over the duration of the four site visits, a total of 584 *I. scapularis* (436 adults, 84 nymphs, and 64 larvae) ticks were collected at Camp Ripley in 2017. *Ixodes scapularis* ticks were found at all sites that were sampled although most nymphs (42 [50%] of 84) and larvae (54 [84%] of 64) were collected within Training Area 20/22 while most adults (276 [63%] of 436) were collected within Training Area 29 (Table 22). Of the

Table 22. *Ixodes scapularis* ticks collected by collection site and life stage, Camp Ripley Training Center, Minnesota, 2017*.

Training Area	**Number of *I. scapularis* Collected**			
	Adults	**Nymphs**	**Larvae**	**Total**
1	52	23	4	79
20/22	106	42	54	202
29	276	18	6	300
Other	2	1	0	3
All Sites	**436**	**84**	**64**	**584**

* Questing tick density within each site cannot be inferred from the data shown here since sampling was not performed equally among each training area.

584 *I. scapularis* ticks collected, 253 ticks (106 adults, 83 nymphs, and 64 larvae) were randomly selected and submitted for testing by PCR for the previously listed pathogens.

In addition, 265 adult *Dermacentor variabilis* ticks were collected incidentally during this effort and tested by PCR for *F. tularensis*. The 265 ticks were divided by sex and collection date into 29 pools (Table 23).

Minimum infection rate (MIR) ranged between 4.7% and 10.1% and did not vary significantly by sex or collection date. Overall, 19 (65.5%) of 29 pools tested positive for *F. tularensis* with an average MIR of 7.2%.

Table 23. *Dermacentor variabilis* ticks collected by sex and collection date, and tested for the disease agent of tularemia (*Francisella tularensis*), Camp Ripley Training Center, Minnesota, 2017.

	Total Number of Ticks Tested	**Number of Positive Pools / Number of Pools Tested (%)**	**MIR***
Sex			
Male	115	8/13 (61.5%)	7.0%
Female	150	11/16 (68.8%)	7.3%
Collection Date			
5/4/17	59	4/7 (57.1%)	6.8%
6/1/17	99	10/11 (90.9%)	10.1%
6/20/17	107	5/11 (45.5%)	4.7%
Total	**265**	**19/29 (65.5%)**	**7.2%**

*MIR = minimum infection rate

Mosquito Studies

Twelve mosquito samples were collected at Camp Ripley between 6/22/17 and 9/30/17. The average length of sampling per week was 89.7 hours (3.7 days) with a range of approximately 47 – 168 hours. A total of 42,445 mosquito specimens were collected and identified to species. The number of mosquitoes collected each week ranged from 51 to 14,287 mosquitoes with the peak collection date occurring on 7/28/17 followed by declining numbers of collected mosquitoes afterwards (Figure 45). The most frequently collected species included the following: 38,463 *Coquillettidia perturbans,* 1,555 *Aedes cinereus,* 922 *Aedes absserratus,* 651 *Aedes vexans,* 518 *Anopheles walkeri,* 115 *Aedes sticticus* and 109 *Aedes trivittatus* (Figure 46). One-hundred twelve other mosquitoes were identified including two *Aedes triseriatus*, one *Aedes japonicus* and one *Culiseta melanura*. Of note, no *Culex tarsalis, Aedes albopictus* or *Aedes aegypti* were collected.

Figure 45. Number of mosquitoes collected by collection week, Camp Ripley Training Center, Minnesota, 2017 (n=42,445).

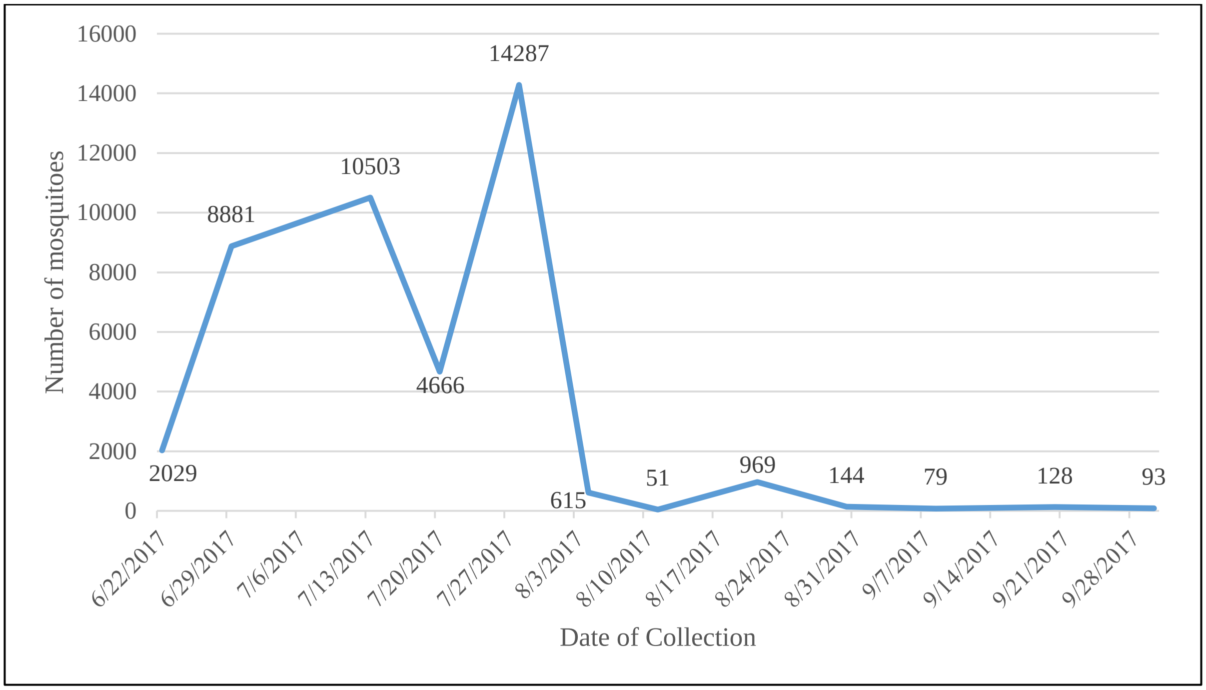
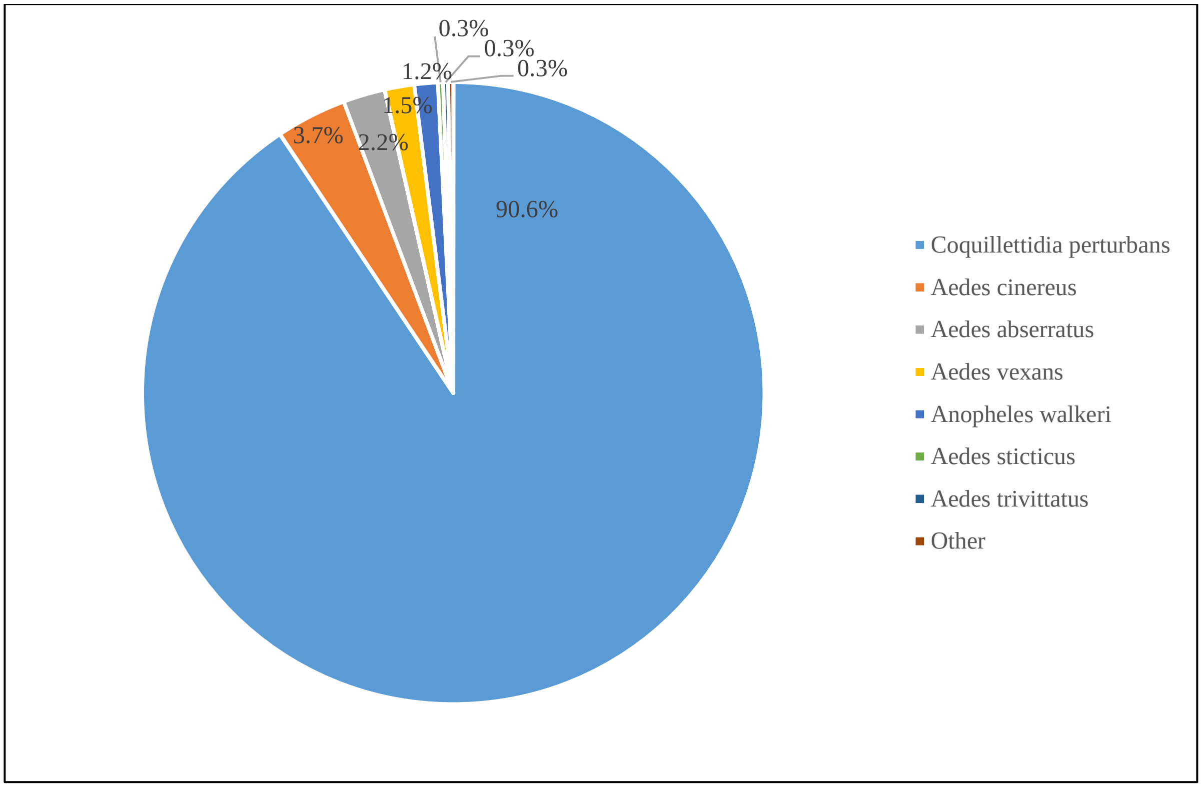


Figure 46. Most frequently identified mosquito species collected, Camp Ripley Training Center, Minnesota, 2017 (n=42,445).



Laboratory Results

Of the 584 *I. scapularis* ticks collected, 253 ticks (106 adults, 83 nymphs and 64 larvae) were randomly selected and tested by PCR for *Borrelia burgdorferi*, *Anaplasma phagocytophilum*, *Ehrlichia muris eauclairensis, Babesia microti, Borrelia miyamotoi,* and *Borrelia mayonii*. Of the 64 larvae tested, none of the 12 pools (range, 1 – 10 ticks per pool) tested positive for any of the disease agents. Of the 106 adults and 83 nymphs tested, approximately 46.2% of adult ticks and 20.5% of nymphs were infected with *B. burgdorferi* with a much lower infection prevalence found with the other pathogens (Table 24). Of the 189 adult tick and nymphs tested, 84 (44.4%) ticks were infected with at least one disease agent while 26 (13.8%) were coinfected with at least two disease agents (Table 25). Infection prevalence varied by the life stage and site in which the ticks were collected although it is important to keep in mind the limitation of small sample sizes when comparing between sites (Table 25). These tick infection prevalence results are comparable to what has been found in past years. Of note, *Borrelia mayonii* has been detected in 1 – 4% of adult ticks and 0 – 2% of nymphs tested from Camp Ripley since we started testing for the disease agent in 2014. Failure to detect this particular disease agent in this year's sample of ticks may not necessarily indicate the absence of the organism circulating in the environment; rather, it may more likely be due to a normally low infection prevalence and low sample size of ticks tested.

Table 24. *Ixodes scapularis* infection prevalence by disease agent, Camp Ripley Training Center, Minnesota, 2017.

Disease Agent	**Adults # Positive/# Tested (%)**	**Nymphs # Positive/# Tested (%)**
Borrelia burgdorferi	49/106 (46.2%)	17/83 (20.5%)
*Anaplasma phagocytophilum**	12/106 (11.3%)	3/83 (3.6%)
Ehrlichia muris eauclairensis	4/106 (3.8%)	2/83 (2.4%)
Babesia microti	11/106 (10.4%)	11/83 (13.3%)
Borrelia miyamotoi	3/106 (2.8%)	3/83 (3.6%)
Borrelia mayonii	0/106 (0%)	0/83 (0%)

*human variant only (excludes other variants)

Table 25. *Ixodes scapularis* infection prevalence* by tick collection site, Camp Ripley Training Center, Minnesota, 2017.

Site	**Adults # Positive/# Tested (%)**		**Nymphs # Positive/# Tested (%)**	
	At least 1 Infection	**Coinfection****	**At least 1 Infection**	**Coinfection****
Training Area 1	12/19 (63.2%)	2/19 (10.5%)	6/23 (26.1%)	3/23 (13.0%)
Training Area 20/22	15/29 (51.7%)	4/29 (13.8%)	10/42 (23.8%)	2/42 (4.8%)
Training Area 29	33/58 (56.9%)	10/58 (17.2%)	8/18 (44.4%)	5/18 (27.8%)
Overall	**60/106 (56.6%)**	**16/106 (15.1%)**	**24/83 (28.9%)**	**10/83 (12.0%)**

*Ticks infected with at least one disease agent
**Ticks infected with at least two disease agents

Discussion

As in past years, MDH found evidence of established *I. scapularis* and *D. variabilis* populations at each of the sites visited within Camp Ripley during the 2017 tick collection effort. Within those populations, evidence of several different tick borne disease agents have been documented in the past (see Appendix A for brief descriptions of the vector-borne diseases discussed in this report). Although we don't yet have tick testing results from the *I. scapularis* ticks collected this year, test results from previous years indicate that we should expect to find relatively similar infection prevalence rates in the 2017 cohort of ticks tested. While infection prevalence may vary from year to year and site to site, on average we have found 42% (386/911) of adult *I. scapularis* and 22% (144/655) of *I. scapularis* nymphs collected from Camp Ripley from 2006 – 2016 to be infected with *Borrelia burgdorferi*. Other tick borne disease agents have been regularly found in *I. scapularis* ticks collected from Camp Ripley but at a lower infection prevalence. For instance, anaplasmosis is the second most commonly reported tick borne disease in Minnesota and on average we have found 10% (91/911) of adult *I. scapularis* and 8% (64/655) of *I. scapularis* nymphs to be infected with *Anaplasma phagocytophilum*. We plan to analyze and summarize our many years of tick infection prevalence data in the near future and will share our findings as soon as they are available.

In contrast to testing *I. scapularis* ticks for several different tick borne disease agents, this is the first year that we have tested *D. variabilis* ticks for *F. tularensis*. In addition to Camp Ripley, we collected and tested ticks from six other sites in Minnesota as well. Four of the seven sites had positive tick pools with an average MIR of 4.1% across all positive sites (range, 2.1% to 7.2%). While the MIR varied across our sites, the range of variation was relatively small and the reasons for this variability are currently not understood. Our results may reflect normal variation in infection prevalence over space and time; however, other factors may impact infection prevalence and could include weather conditions (e.g., temperature and relative humidity), host and vector population density, as well as complex biological dynamics within ticks. Further ecologic studies are needed to fully understand the importance of tick species in the maintenance and transmission of *F. tularensis* in Minnesota.

This was also the first year that we collected mosquitoes from Camp Ripley. Species diversity in the samples was fairly good but likely would have been higher if we initiated sampling earlier in the year to catch more snowmelt *Aedes* species, which are potential vectors of Jamestown Canyon virus. Several *Aedes* species were found in decent numbers but *Coquillettidia perturbans* (cattail mosquitoes) overwhelmed everything in July and August (by far the most abundant species in the samples). This species has one brood of eggs emerge each year and is a significant pest mosquito in Minnesota although may also be a bridge vector for transmission of eastern equine encephalitis to humans. Low numbers of *Ae. triseriatus* (tree hole mosquito) and *Ae. japonicus* (Asian rock pool mosquito) were also collected this year. These species may be vectors of La Crosse encephalitis, a rarely reported endemic disease that is primarily found in southeastern Minnesota. Being that these two species of mosquitoes do not fly far (< 200 yards), their presence in our sampling effort likely indicates that small water-holding containers or tree holes are located near the mosquito magnet. We recommend searching for potential mosquito breeding habitat in the area and removing any small pools of standing water (e.g., fill tree holes or remove/tip over small water-holding containers). A single collected specimen was identified as *Culiseta melanura*, which is an interesting (although not necessarily unexpected) finding in that it is a potential amplifying vector of eastern equine encephalitis. This mosquito species is typically found near black spruce/tamarack bogs or hardwood swamps. No *Cx. tarsalis*, our main West

Nile virus vector, were identified in this effort although this species is more commonly found in agricultural and grassland regions of the state. Considering that Camp Ripley is located within this mosquito's flying distance from optimal agricultural habitat, finding *Cx. tarsalis* within the site is certainly possible. Other potential West Nile virus vectors, such as *Culex pipiens* and *Culex restuans*, were collected in low numbers (n=7) from Camp Ripley this year as well. As expected, no tropical disease vectors such as *Ae. albopictus* (Asian tiger mosquito) or *Ae. aegypti* (yellow fever mosquito) were identified. While none of these findings are particularly remarkable at this time, these mosquito records are extremely useful in documenting the types of mosquitoes present throughout Minnesota.

Based on our tick and mosquito findings from this past year as well as tick testing results from previous years, we strongly recommend that staff and visitors at Camp Ripley take precautions against tick and mosquito bites:

- Repellents containing DEET (20 – 30%) or permethrin are safe and effective against both tick and mosquito bites. Other EPA-approved products, such as picaridin and IR3535, are also available.
- Perform thorough and systematic tick checks at least once a day after being in or near wooded or grassy areas. Ticks must be attached for at least 12 hours to spread anaplasmosis or 24 hours to spread Lyme disease so remove ticks as soon as possible, before they have a chance to spread a disease agent.
- Tumble dry clothing in a dryer on high heat for at least 10 minutes (or at least 60 minutes if wet) to kill any blacklegged (deer) ticks remaining on your clothing. Longer dry times may be needed to kill American dog (wood) ticks.
- Watch for signs of vector-borne disease (e.g., rash, fever, headache, muscle/joint aches), especially from May through October, and tell your doctor about your possible exposure to ticks and mosquitoes if you become sick.

Describing the Seasonality of Host Infection with *Ixodes scapularis*-Borne Pathogens

By Tammi Johnson, Centers for Disease Control and Prevention

Background

The blacklegged tick, *Ixodes scapularis*, is the primary vector to humans in the Minnesota of several human pathogens including *Borrelia burgdorferi* sensu stricto (Lyme disease), *Anaplasma phagocytophilum* (anaplasmosis), *Babesia microti* (babesiosis) and the deer tick lineage of Powassan encephalitis virus. In addition to the above pathogens, two newly discovered disease-causing pathogens have been identified in Minnesota, *Borrelia mayonii* and *Ehrlichia muris eauclairensis*. Immature stages, i.e., larval and nymphal, *Ixodes scapularis* are known to feed on numerous species of small to medium sized mammals as well as birds. Many of the tick borne pathogens transmitted by *I. scapularis* are maintained in enzootic cycles in which the host species serves as not only as a food source for the ticks, but remain infectious for extended periods of time and perpetuate infections in ticks feeding on them. The enzootic maintenance of some *I. scapularis*-borne pathogens, i.e. *B. burgdorferi*, are well understood, while other systems require more research. In the eastern United States, several species of small mammals have been shown to contribute to the enzootic maintenance of *Borrelia burgdorferi*. The enzootic maintenance and reservoir contribution is less well understood for other *I. scapularis*-borne pathogens, especially those that may be transovarially transmitted.

Objective

Small mammals were trapped twice in 2016 at Camp Ripley Minnesota. In June 2016, infection prevalence with *Borrelia* in the host population was > 60%, while host infection prevalence with *Borrelia* was just 3% in October. Although, infection prevalence with *Babesia microti* was high (47%). This research is aimed at providing a better understanding of enzootic transmission cycle in Minnesota. We will determine host infection rates with *I. scapularis*-borne pathogens prior to nymphal emergence in the spring, again at the peak of nymphal emergence, and at the end of the nymphal tick season. We will compare host infection prevalence to larval and nymphal infection prevalence. In addition, we will collect ticks by drag sampling on the grid three times in June. The 2017 work will complete the small mammal/tick/pathogen project that began in 2016 to determine how tick infestation with *I. scapularis* larvae and host infection affect nymphal tick abundance the following year. We will also be collecting ticks in 2017 at the four other sites sampled in 2016, i.e. William O'Brien State Park, St. Croix State Park, Itasca State Park and Chippewa National Forest.

Host infection prevalence should be lowest in the spring prior to nymphal emergence when new cohorts of naïve hosts are borne into the population. We expect host infection prevalence to continue to increase throughout the summer and decrease at the end of the nymphal tick season. Infection rates in nymphal ticks will likely remain relatively constant throughout the season, as most of these ticks were infected as larvae. Larval infection rates are expected to be lowest in the spring and increase throughout the season as host infection rates also increase. Comparisons of host, larval and nymphal infection prevalence may also provide insight into the contribution of co-feeding transmission in this system.

Methods

We live trapped small mammals at Circle of Wagons in Training Area 1 in May and June 2017. This was a non-lethal study. Blood and tissue samples were collected a single time from each animals as described in the field protocol (16-009 (Johnson)) approved by the Centers for Disease Control and Prevention Institutional Animal Care and Use Committee. We also collected all ectoparasites infesting each animal, including fleas and ticks.

All blood, tissue and ectoparasite specimens were sent to the Centers for Disease Control and Prevention, Fort Collins, CO, for processing. To date, all ticks have been identified and all *I. scapularis* will be tested for disease causing pathogens including, *B. burgdorferi*, *B. mayonii*, *A. phagocytophilum*, *B. miyamotoi* and *Ba. microti* within the next year. Upon completion of testing, an addendum to this report will be submitted to describe pathogen detection results.

Results

Small mammals were trapped twice in 2017, once from May 16 – 18 and again from June 14 – 16 at Training Area 1 (Circle of Wagons). In May 2017, only 11 individuals were captured, while in June, 31 individuals were captured (Table 26). The majority of captures were eastern chipmunks (*Tamias striatus*). We also captured a single southern flying squirrel (*Glaucomys volans*) and two masked shrews (*Sorex cinereus*).

As expected, animals captured in May had a lower infestation of larval and nymphal ticks than individuals captured in June, at the peak of immature *I. scapularis* emergence. Most individuals were

Table 26. Small mammals collected at Training Area 1 – Circle of Wagons, Camp Ripley Training Area, May and June 2017.

Scientific Name	Common Name	Total No. Collected (No. collected in May 2017)
Peromyscus spp.	Deer mouse or white-footed mouse	3(1)
Clethrionomys gapperi	Southern red-backed vole	4(2)
Blarina brevicauda	Short-tailed Shrew	1(0)
Glaucomys volans	Southern flying squirrel	1(1)
Sorex cinereus	Masked shrew	2(0)
Tamias striatus	Eastern chipmunk	24(4)
Zapus hudsonicus	Meadow jumping mouse	7(3)

infested with ticks and the most ticks were obtained from eastern chipmunks (Figures 47– 50). Ticks were more abundant in 2017 as compared with 2016, both on infesting animals and actively questing. We did not collect any *I. scapularis* nymphs while dragging the trapping grid in 2016, however, 70 nymphs, numerous larvae, and fewer adult ticks were found (Table 27).

Infection data on small mammals or ticks are pending, but we will provide an update when all samples have been analyzed.

Table 27. Ticks collected from drag sampling of the small mammal grid at three different times, Camp Ripley Training Center, Minnesota, Jun 2017.

Species and Life Stage	Visit 1 June 8	Visit 2 June 13	Visit 3 June 20	Total
Ixodes scapularis				
Larva	24	94	47	165
Nymph	8	23	39	70
Adult	6	3	5	14
Dermacentor variabilis				
Adult	3	5	8	16

Figure 47. Infestation of small mammals with larval ticks Training Area 1 – Circle of Wagons, Camp Ripley Training Center, Minnesota, May 2017.

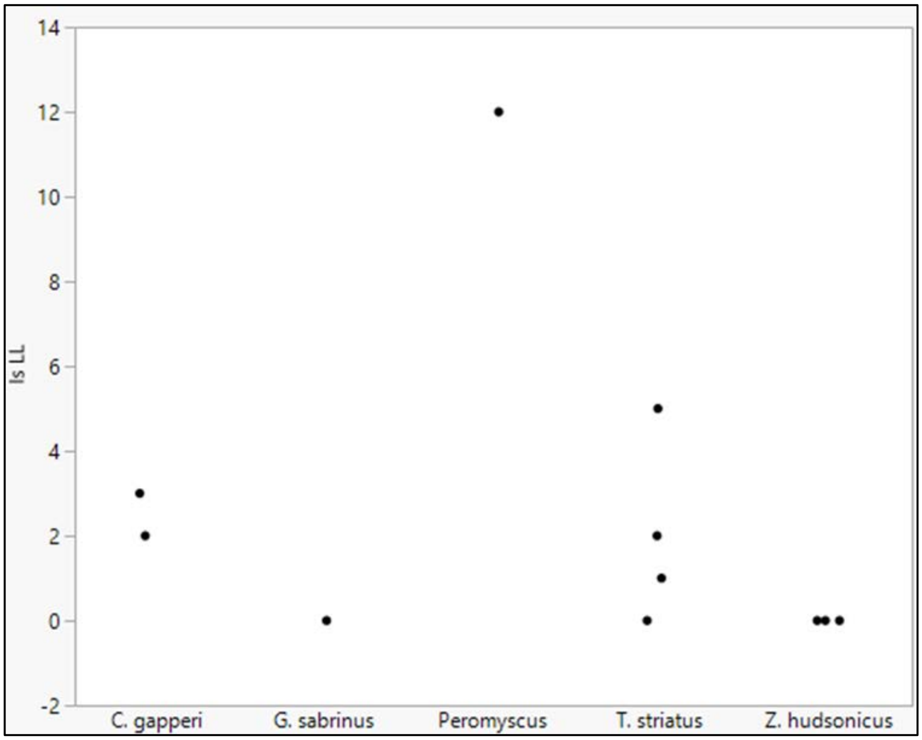


Figure 48. Infestation of small mammals with nymphal ticks in Training Area 1 – Circle of Wagons, Camp Ripley Training Center, Minnesota, May 2017.

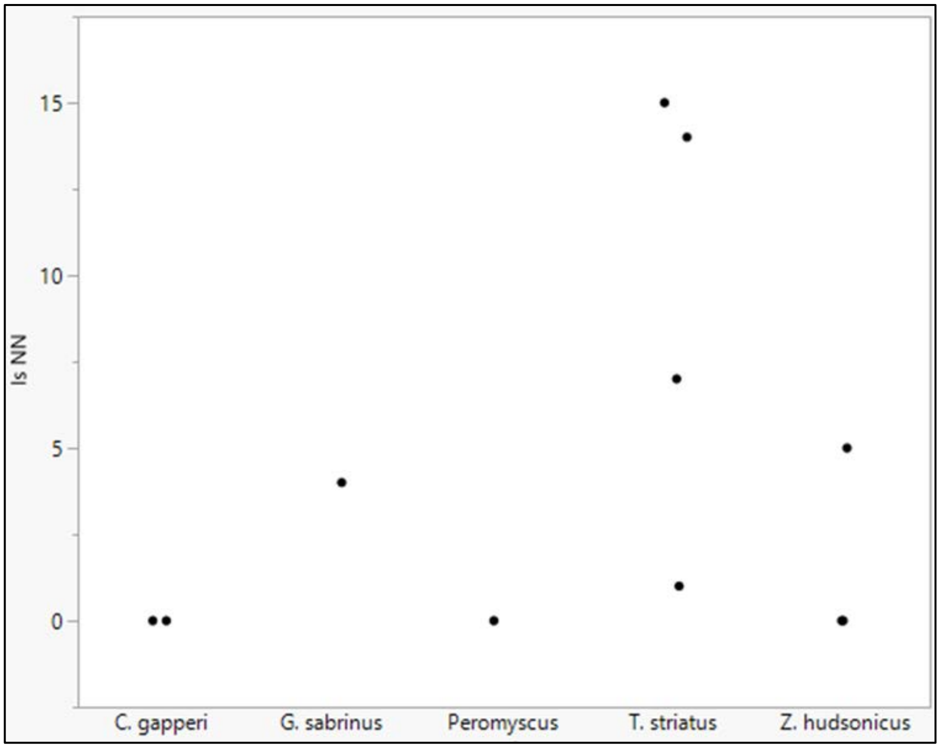


Figure 49. Infestation of small mammals with larval ticks in Training Area 1 – Circle of Wagons, Camp Ripley Training Center, Minnesota, June 2017.

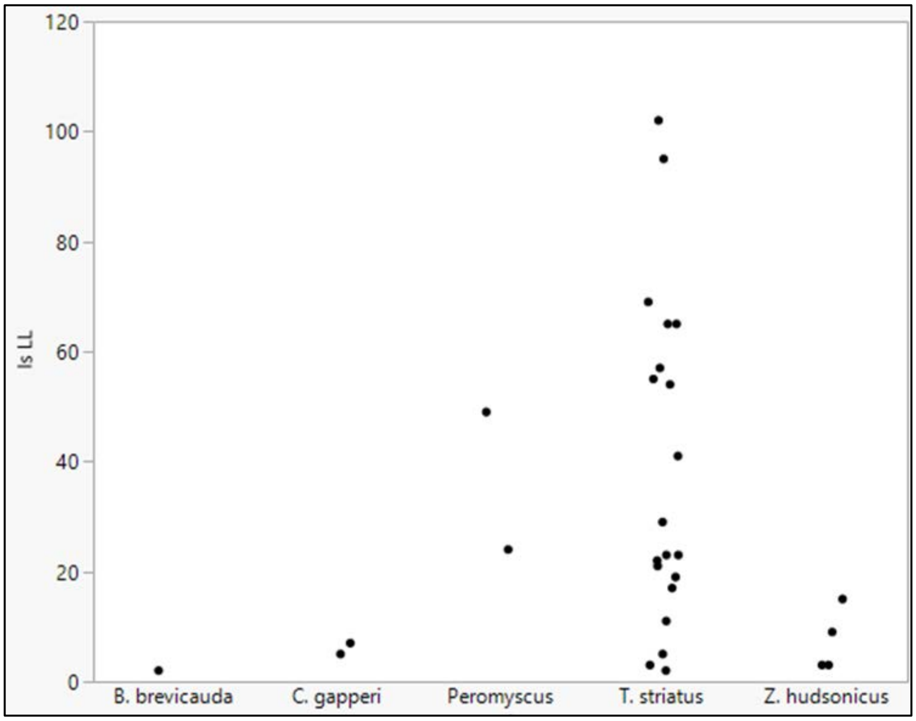
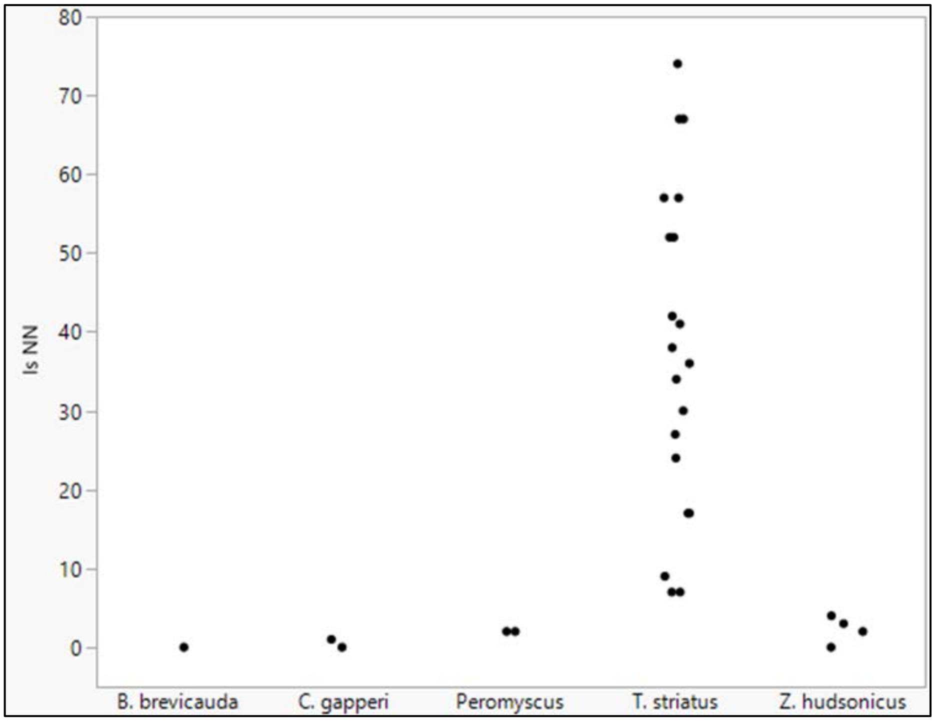


Figure 50. Infestation of small mammals with nymphal in Training Area 1 – Circle of Wagons, Camp Ripley Training Center, Minnesota, June 2017.



LAND USE MANAGEMENT

Army Compatible Use Buffer (ACUB)

By Josh Pennington, Minnesota Department of Military Affairs

Introduction

Section 2811 of the Fiscal Year Department of Defense Authorization Act, passed December 2, 2002, created 10 United States Code (U.S.C.) section mark (§) 2684a, which authorizes a military installation to enter into an agreement with state, local government or private conservation organizations to limit encroachment on lands neighboring the installation. Subsequently, the Headquarters Department of the Army, Director of Training, issued guidance pursuant to a Memorandum dated May 19, 2003, subject: Army Range and Training Land Acquisitions and Army Compatible Use Buffers. The memorandum defines the requirements of an Army Compatible Use Buffer (ACUB) proposal in order for an installation to execute any land acquisition.

Purpose

The purpose of the Camp Ripley Army Compatible Use Buffer (ACUB) program, known locally as "*Central Minnesota Prairie to Pines Partnership…preserving our heritage,*" is to create and enhance a natural undeveloped buffer around Camp Ripley by taking advantage of available opportunities to prevent encroachment and enhance conservation and land management. By securing a buffer, Camp Ripley can continue to offer and provide critically important, high quality military training and operations to ensure combat readiness, as well as mitigate community development encroachment around the Training Center. Through implementation of Camp Ripley's proposal, Camp Ripley will also be contributing to preserving the local heritage and enhancing a regional conservation corridor.

Update

The desired end state of the Camp Ripley ACUB program is to achieve compatible land use across 83,434 acres within Camp Ripley's 110,000 acre buffer area. To date, more than 25,000 acres have been permanently protected through perpetual easements or fee acquisitions. Other compatible lands include 8,053 acres of lakes and rivers and 8,965 acres of state, county or The Nature Conservancy Land. Camp Ripley currently has 40,266 acres either protected or compatible, representing 48% of our overall goal of 83,434, acres.

Over 220 willing landowners representing over 25,000 acres are interested and waiting to participate in the Camp Ripley ACUB program. This program has completed more than 200 land transactions to permanently protect 24,277 acres in conservation easements. Funding levels in 2017 from federal sources include $2.2 million from the Office of the Secretary of Defense's (OSD) Readiness and Environmental Protection Integration (REPI) Program for execution through a new cooperative agreement with The Conservation Fund and $6.7 million from the Army National Guard (ARNG) for execution through a cooperative agreement with the Minnesota Board of Water and Soil Resources. State funding leveraged from these federal dollars includes $1.2 million recommended from the Lessard-Sams Outdoor Heritage Council and $750,000 recommended through the Legislative Citizens Commission of Minnesota Resources for projects within the ACUB boundary.

The Conservation Fund (TCF)

TCF entered into a formal cooperative agreement with the National Guard Bureau in 2017. The agreement number W9133L-17-2-3088 obligated $2,252,766.47 of OSD REPI funding in FY17. These funds will be used to target acquisition opportunities within the ACUB boundary. TCF will work with partners and stakeholders to identify long term take out partners for ownership of property that remains compatible with the mission of Camp Ripley. The first project is targeting 200 acres of potlatch property working with the City of Baxter as an extension to Mississippi River Overlook Park.

Minnesota Board of Water and Soil Resources (BWSR)

The cooperative agreement with the BWSR executed 31 easements in FY 17 to protect 2,643 acres (Figure 51); $2,668,174 was executed with federal ARNG and REPI funding and $509,542 was executed with MN State LSHOC funding for a total of $3,178,174 total execution. In FY 17, $6,667,295 was obligated to BWSR through ARNG funding on modification P17031 on the BWSR Cooperative Agreement.

Minnesota Department of Natural Resources Summary

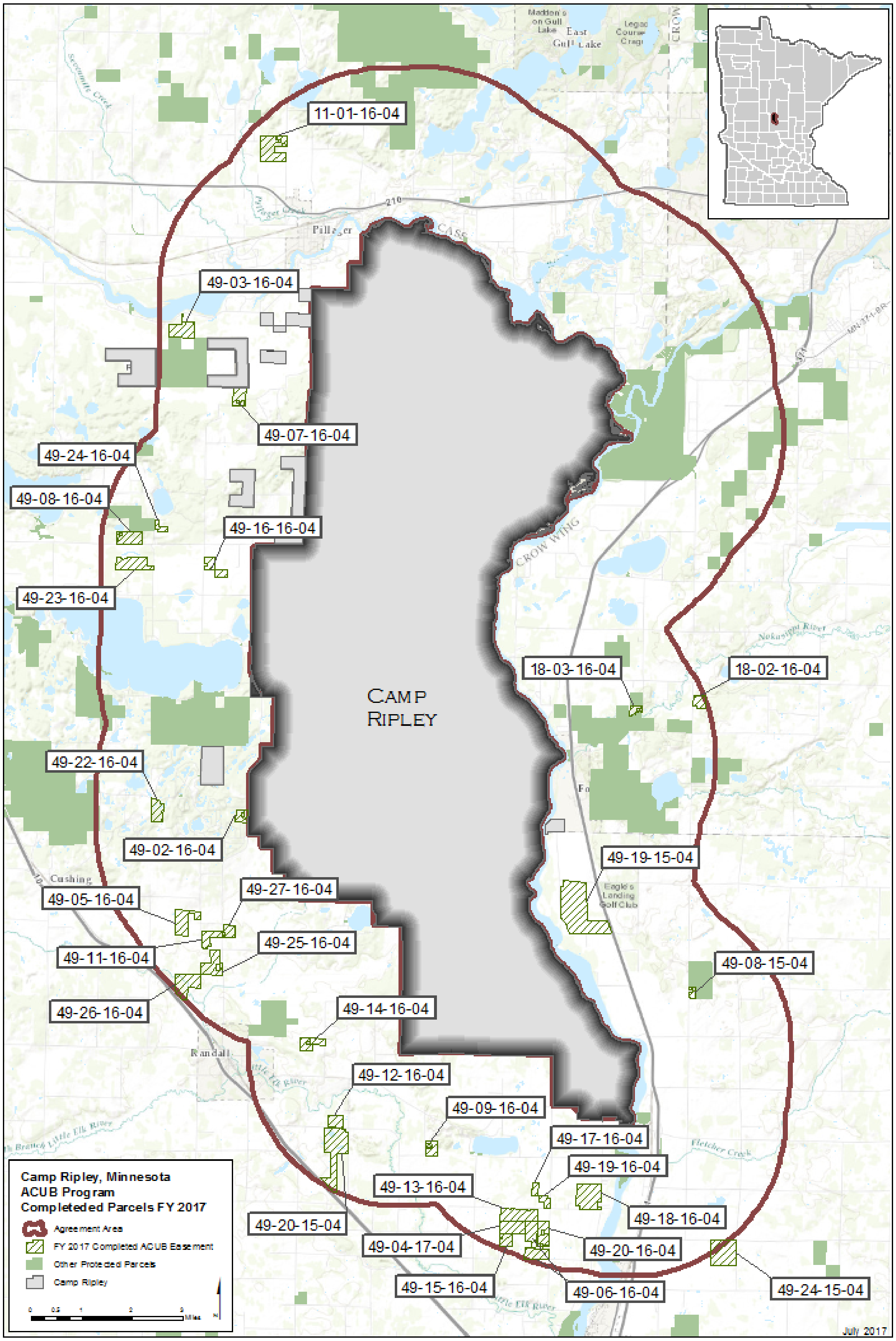
The Minnesota Department of Natural Resources (DNR) no longer maintains an active cooperative agreement with the National Guard Bureau for future funding obligations. The DNR remains an active easement holder in the ACUB boundary and will continue to monitor and enforce easements.

Camp Ripley Sentinel Landscapes (CRSL)

By Josh Pennington, Minnesota Department of Military Affairs

Recognizing the need to protect the Camp Ripley landscape, the Minnesota legislature passed H.F. No. 283, which was signed into law by Governor Mark Dayton in May 2015. Under the law, the adjutant general convened a Sentinel Landscape Coordinating Committee to identify the boundaries of the Camp Ripley Sentinel Landscape and develop a suite of tools and programs that could provide technical and financial assistance to interested landowners within the Sentinel Landscape. With input from local government, stakeholders, and Federal agency partners, the Coordinating Committee identified the desired outcomes of the Camp Ripley Sentinel Landscape partnership: protecting the installation’s military training mission and the landscape’s wildlife management areas, watersheds, and agricultural resources.

Figure 51. ACUB accomplishments for BWSR, Camp Ripley Training Center, Minnesota, fiscal year 2017.



The Camp Ripley Sentinel Landscape includes 34 minor watersheds grouped into 7 sub-watersheds, 40 miles of the Mississippi River, and the Crane Meadows National Wildlife Refuge. Thousands of acres of public and private conservation lands converge on the Camp Ripley Sentinel Landscape, which is also one of the state's most important source water protection areas for drinking water. While coordination across county and city boundaries has long been necessary to protect the quality of cross-border watersheds, the Camp Ripley Sentinel Landscape Partnership is leveraging broader support to protect and improve the quality of the region's soil and water resources. The Minnesota Forest Resource Council is working with landowners to implement forest stewardship plans within the Sentinel Landscape, while Partners for Fish and Wildlife will work with private landowners to restore and enhance fish and wildlife habitat, wetlands and pollinator habitat. These efforts are also resulting in additional opportunities for the community, including expanded trail, water, and natural area access for hunting, fishing and recreation.

The Sentinel Landscape Partnership at Camp Ripley will continue to coordinate and leverage the resources of the Department of Defense Readiness and Environmental Protection Integration Program, USDA's Natural Resources Conservation Service (NRCS), U.S. Fish and Wildlife Service and U.S. Forest Service with state and local partners to advance the goals of the Camp Ripley Sentinel Landscape. Together, these actions will sustain area agriculture, protect the Mississippi River headwaters, and preserve a unique landscape that will allow Camp Ripley to continue to effectively train National Guard members for decades to come. Figure 52 illustrates the boundary of the CRSL.

CRSL was awarded $2.8 million in FY 17 funding under the NRCS Regional Conservation Partnership Program (RCPP) (Figure 53). The Regional Conservation Partnership Program (RCPP) offers new opportunities for the NRCS, conservation partners and agricultural producers to work together to harness innovation, expand the conservation mission and demonstrate the value and efficacy of voluntary, private lands conservation. This RCPP funding will be directed toward Environmental Quality Incentives Program (EQIP), Conservation Stewardship Program (CSP), and Healthy Forest Reserve Program (HFRP) with the CRSL boundary.

Figure 52. Camp Ripley Sentinel Landscapes boundary, Camp Ripley Training Center, Minnesota, 2017.

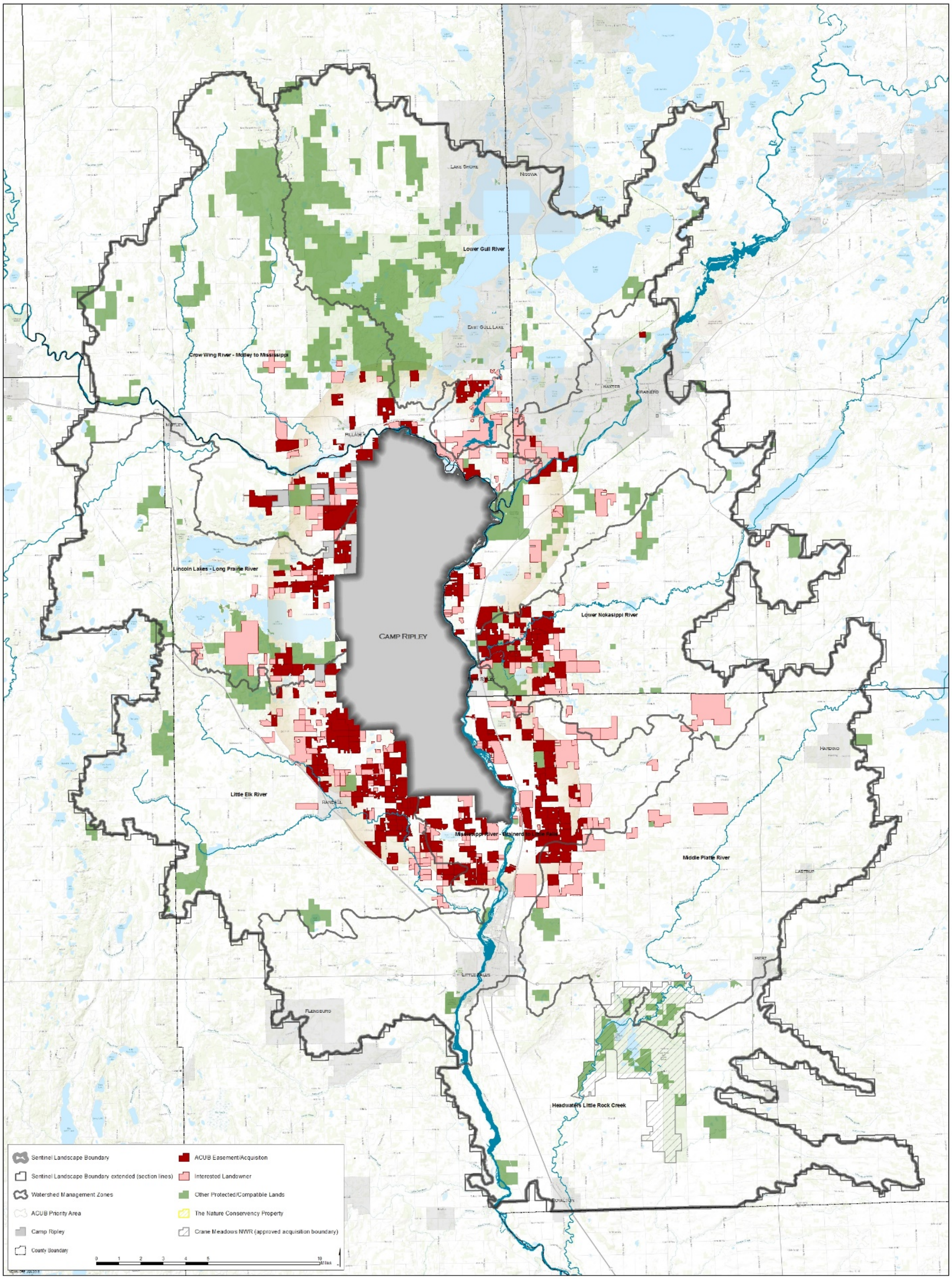
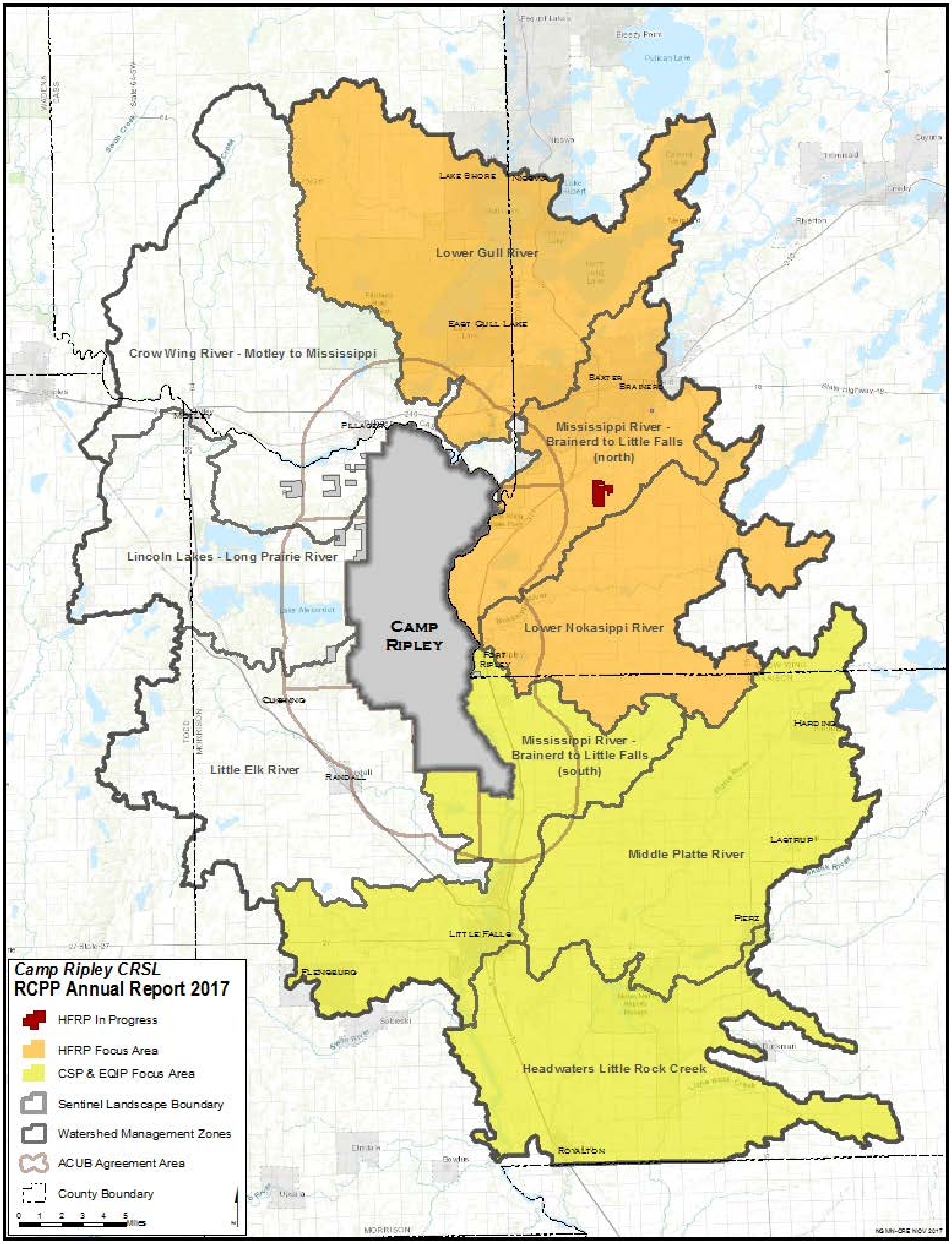


Figure 53. Natural Resources Conservation Service Regional Conservation Partnership Program priority within the Camp Ripley Sentinel Landscape (CRSL), Camp Ripley Training Center, Minnesota, 2017.



Integrated Training Area Management (ITAM)

By Jason Linkert, Timothy Notch, Brian Sanoski, and Adam Thompson, DMA

Program Overview

The increased technology of military weapons and equipment along with the increased operational tempo in support of the global war on terrorism has placed more pressure on training lands. Past and continued degradation of natural resources can have a negative effect on the realism of future training exercises. To meet all environmental laws and regulations, the U.S. Army Construction Engineering Research Laboratory has developed the Integrated Training Area Management (ITAM) program. A report or overview of the ITAM program is documented annually to include all assessments, accomplishments and products purchased or produced from the preceding year. This plan is reviewed annually and revised as mission, accomplishments or environmental changes warrant. Major revisions are formally reviewed every five years to include changes to the introduction, ITAM program, goals and objectives, funding equipment, back log requirements and projected budget.

The ITAM program is a comprehensive tool that consists of five components necessary to maintain and improve the condition of natural resources. Funding requirements to implement the five components identified in the ITAM Work Plan are submitted to National Guard Bureau annually for validation. The five components are:

1. Range and Training Land Assessment
2. Land Rehabilitation and Maintenance
3. Training Requirements Integration
4. Sustainable Range Awareness
5. Geographic Information System

Range and Training Land Assessment (RTLA) Program

The RTLA is the component of the ITAM program that provides for the collecting, inventorying, monitoring, managing and analyzing of tabular and spatial data concerning land conditions on an installation. The RTLA provides data needed to evaluate the capability of training lands to meet multiple use demands on a sustainable basis. It incorporates a relational database and Geographic Information System (GIS) to support land use planning decision processes. This data is intended to provide information to effectively manage land use, natural and cultural resources.

The mission requirements of the military units training on Camp Ripley determine the focus of the RTLA program. It analyzes the training requirements and conducts assessments that evaluate the training lands ability to support those requirements. The results of RTLA provide treatment prescriptions that are forwarded to the LRAM component for execution. The training requirements of Camp Ripley customers are determined using a multi-step process.

1. Review of the Range Facility Management Scheduling System and the Army Range Requirements Model to determine types of units utilizing Camp Ripley

2. Review of current tactics, techniques and procedures being used in theater for which areas soldiers utilize during training
3. Coordinate with units, Range Control and operations to refine and prioritize assessments

The process identified six major types of training conducted on Camp Ripley. While each type of training has its own unique requirements, they do share common characteristics that help form the mission-scape for each training type. The six training types are:

1. Field Artillery
2. Mechanized Maneuver
3. Engineer
4. Patrolling/Convoy Operations
5. Assembly Area/Bivouac
6. Light/Dismounted Infantry

Since the start of the global war on terrorism, added emphasis has been placed on patrol and convoy training by all units that utilize Camp Ripley; while bivouac and assembly area operations have decreased due to the increased reliance on forward operating bases in the theaters of operation and tactical training bases on the installation. As operations overseas are reduced, a return to the 'traditional' training seen before the global war on terrorism will increase the importance of assembly area and bivouac operations.

To support the mission-scape requirements, RTLA currently being conducted includes:

1. Annually assess Camp Ripley's maneuver trails to ensure safe travel by all vehicles (also known as LRAM assessment)
2. Assess the quality and sustainability of artillery firing points
3. Assess woody vegetation and safety hazards in open maneuver areas
4. Assess forest structure and condition for maneuver corridors in Maneuver Area K1
5. Assess site condition and usage of eight observation points
6. Monitor the maneuverability of Camp Ripley's land navigation courses
7. Assess maneuver training areas for historic and potential training or safety hazards
8. Measure visibility through the underbrush of mature forests
9. Maintain landing zone/pick-up zone for woody encroachment and maneuver damage

Range and Training Land Assessment Results

Maneuver Trails. The south half of Camp Ripley was assessed for maneuver training damage. A total of 115 sites have been identified for repair.

Artillery Points. A total of 24 (Set A) field artillery firing points were assessed. Sites were assessed on ten pre-selected attributes such as encroachment, maximum slope and surface-danger zone training conflicts. Each site was given a red, amber or green rating with green being the most suitable land condition for field artillery. Ten firing points scored red and required immediate treatment to remain serviceable as firing points. To avoid future loss of available lands for artillery training it is recommended that a more frequent prescribed fire regime be implemented and fire treatments be allowed to burn into the forest edge to discourage future encroachment.

Open Maneuver and Helipads. All open maneuver areas (350 acres) are assessed annually for woody encroachment, ingress/egress and maneuver damage. Assessments revealed once a year mowing regime is ample to maintain these open areas.

Maneuver Corridor. Maneuver corridors A, B and C were assessed by Camp Ripley staff. A spring prescribed burn was completed for the grassland portion of the maneuver lanes to invigorate the native vegetation. Maneuver Trails were constructed on the forested edge by ITAM staff due to the steep topography of the corridor and concerns over protecting the integrity of the forested islands from prescribed fire effects. Hazard trees were also removed from the interior maneuver trails. Woody encroachment on the grassland portion of the corridor was also treated using a carbide head and a follow up treatment of the broadleaf herbicide triclopyr.

Observation Points. All observation points were assessed. Completed work included repairing maneuver damage on the ingress and egress roads and trails. Assessments indicated no immediate vegetative repair work or improvements were required to maintain existing observation points.

Land Navigation. AHATS Land Navigation Course was assessed for snag density and ease of traverse. Areas of dense snags and brush are noted along transects randomly distributed throughout the course. Movement throughout AHATS was graded easy (little brush density), and there were no areas of dense snags requiring further mitigation.

Hazards and Artifacts. Maneuver Area G (2,913 acres) was assessed for historical training and farm artifacts. Random transects were traversed in designated training areas to locate any hazard to troop training. Four sites were identified, none of which posed an immediate hazard.

Forest Understory. Training Areas 61, 63, 64 and 77 were assessed using 87 random points. A Visual Signal-17 panel was placed at the assessment points and a photograph taken 50 meters away. Each photograph was rated on a 1–5 scale with 1 indicating the panel was completely obscured and 5 denoting that the panel was fully visible. Twenty-six of the 87 plots were denoted as “1” or completely obscured. Future mitigation of these areas may include chemical or mechanical control of vegetation.

Helipads. Fourteen helipads were reviewed to meet end user requirements for training. Helipads require 1,000 feet by 1,500 feet of open space free of woody vegetation and maneuver damage. Mowing 4 times a year meets training objectives to support end user requirements.

Land Rehabilitation and Maintenance (LRAM) Program

Land Rehabilitation and Maintenance is an ongoing program whereby erosion control measures and good vegetation management practices are employed to maintain and stabilize the soil. LRAM is the component of the ITAM program that provides a preventive and corrective land rehabilitation and maintenance procedure to reduce the long-term impacts of training on Camp Ripley. LRAM uses technologies such as re-vegetation and erosion control techniques to maintain soils and vegetation required to support Camp Ripley’s mission. These specifically designed efforts help to maintain Camp Ripley as a quality military training site and subsequently minimize long-term costs associated with land rehabilitation. LRAM includes programming, planning, designing and executing land rehabilitation, maintenance and reconfiguration projects based on requirements and priorities identified in the Training Requirements Integration and RTLA components of the ITAM program. A key component of the LRAM program is an annual assessment that is conducted to document LRAM needs attributable to past years activities.

Land Rehabilitation and Maintenance Results

1. The LRAM Program completed work in the following areas:

    1. Repaired all 93 sites identified in the 2016 maneuver trail assessment.
    2. Continued management on prior year firing points in Training Areas 1, 4, 5, 18, 21, 24, 30 and 72. Treatments included 319 acres of: woody encroachment removal, stumping and grubbing, native grassland seeding, erosion control, maneuver damage repair and herbicide treatment. Maintenance is conducted to improve firing point sight to crest.
    3. A total of 305.5 acres of open maneuver lands were mowed using a batwing mower and tractor.
    4. Fourteen helipads were mowed four times during the summer growing season totaling 21.6 acres. And, four helipads received treatment for maneuver damage.
    5. Forty-five acres of the maneuver corridors received chemical application to control woody encroachment. Snags were removed and maneuver trails were constructed on the grassland edges to preserve the integrity of the forested islands for training concealment.
    6. To support battalion level bivouac, 169.2 acres were mowed using a batwing mower and tractor.
    7. Removed 24 hazard trees (snags) identified in the A-11 land navigation survey.
    8. Historical hazard assessments discovered no further mitigation.
    9. Developed four parking areas in 2016 on off-post DMA lands to improve recreation access. Maintenance was provided to these parking areas to sustain access.
    10. Hydro-seeded solar field viewing area, Cassino maneuver trail expansion, Training Area 23 berms and tank ruts and Training Area 14 berms.
    11. Repaired approximately 400 acres of maneuver damage during the summer annual training period.
    12. Harvested 1,350 pounds of native grass seed (big bluestem, little bluestem, indian grass, gramma and switch grass) for future use on disturbed training areas.
    13. Water purification points (Rest Area #3 and Sylvan) 2.1 acres were mowed using the batwing mower and tractor.
    14. Completion of 0.92 miles additional maneuver trail network to provide access to multipurpose training range (East Range) when alternate access falls within the new enhanced performance ammunition round surface danger zone and range is inaccessible.
    15. Removed 1.5 miles of fencing in TA 16 that posed danger to soldiers training.
    16. Restored 4 acres of native grassland on the airfield.
    17. Restored 5.4 acres of brome grass into native pollinator habitat.

Major equipment purchased this year for the LRAM program included:

1. Felling 29’ Tiltdeck Trailer
2. Vemeer Stump Grinder
3. F-350 Ford 1 ton 4x4 pickup
4. F-250 Ford ¾ ton 4x4 pickup

Training Requirements Integration (TRI)

Training Requirements Integration is a program developed to integrate the training mission with natural resources requirements. TRI is the component of the ITAM Program that provides a decision support procedure that integrates training requirements with land management, training management and natural and cultural resources management. The integration of all requirements occurs through continuous consultation between operations, range control, natural and cultural resources managers and other environmental staff members, as appropriate. The INRMP and ITAM work plan are documents that require TRI input. The ITAM work plan is a web-based program recorded in the Range Complex Master Plan (RCMP) annually.

Sustainable Range Awareness (SRA)

Sustainable Range Awareness is the component of the ITAM Program that provides a means to develop and distribute educational materials to land users. Materials relate procedures for sound environmental stewardship of natural and cultural resources and reduce the avoidable impacts. The SRA intent is to inform land users of restrictions and activities, to avoid and prevent damage to natural and cultural resources. The SRA component applies to soldiers, installation staff and other land users.

The SRA component purchased 10,000 updated laminated Camp Ripley soldier field cards. The field cards have proven to be very popular with the installations’ customers and include information on the back side that supports sustainable land use. Additional field cards will be updated and purchased in 2019 to support map requests and educate end users on Camp Ripley. Annual ITAM accomplishments are published in the local newspaper circular. Purchased 3 educational banners to support educational briefs that are displayed in the Environmental Classroom at Camp Ripley. Additional brochures, pamphlets and maps are produced and distributed annually for further educational uses and per soldier request to support training missions.

Geographic Information System (GIS)

By Craig Erickson and Lee Anderson, Minnesota Department of Military Affairs

As a component of both the Environmental and ITAM programs, GIS is used to support management of those programs and is subsequently used to implement related resource management plans such as the Integrated Natural Resources Management Plan (MNARNG 2003, 2007, 2018a and 2018b), Integrated Cultural Resource Management Plan (Camp Ripley Environmental Office 2009), Forest Management Plan (MNARNG 2002), Integrated Wildland Fire Management Plan (MNARNG 2017a), Protected Species Management Plan (Dirks et al. 2010), Lake Management Plan (Dirks and Dietz 2009), Range Complex Master Plan (MNARNG 2017b) and the Camp Ripley and Arden Hills Army Training Site Development Plan (MNARNG 2014).

This decision support tool is maintained to adapt with end user needs whether used for data development, maintenance, analysis, display or cartographic production. Continuous coordination with program support personnel, other directorates, departments and external entities are required to ensure the most accurate and complete geospatial data is available.

Program coordination both within MNARNG and Army National Guard are facilitated through working groups. The MNARNG GIS Working Group meets quarterly and consists of GIS and Computer Automated Design staff from Camp Ripley Command and the Facilities Management Office with occasional participation from Range Control, and Department of Public Works (DPW). Joint Operations Center (JOC) staff are also consulted on an as-needed basis. At the federal level the Environmental Advisory Committee (EAC) sponsors a GIS/Automation Committee. This group is made up of ten state GIS representatives, to include a representative from Minnesota, the ARNG–I&E GIS Manager and an EAC representative who functions as the working group chair.

Environmental, ITAM, Facilities Management, Information Technology (J6) and Operations (J3) are the core program areas supporting GIS within the MNARNG. The established coordination between these areas has led to an expanded use of GIS in support of other program areas as well. These areas include family assistance, recruiting and retention, Personnel (J1), logistics and public safety. Although not specific to this document it should be noted that GIS personnel also support those efforts outside primary program areas.

The use of consistent datasets and products across common geographic areas (i.e., Camp Ripley and Arden Hills Army Training Site) as well as the required integration between range management and environmental sustainability initiatives has inherently lead to shared efforts regarding GIS support for the Environmental and ITAM programs. As a result, designating specific efforts between these two program areas is not always clear-cut. Therefore, for the sake of simplified reporting, GIS accomplishments and management efforts listed in this section include support beyond the ITAM program.

Data Management

Several MNARNG GIS goals and objectives are defined by federal, Army and National Guard Bureau regulations that govern management of GIS. These regulations pertain to data standardization and conceptual design of the system. The goal is to coordinate data and GIS structure within the states as well as nationally. This coordination and standardization is necessary to keep state and federal efforts synchronized. In accordance with these regulations, Environmental related data layers within the MNARNG GIS repository are compliant with the Spatial Data Structure for Facilities, Installations and Environment (SDSFIE) version 3.1 as well as federal Geographic Data Committee metadata standards.

To support visibility and analysis efforts, standardized geospatial data layers are submitted annually to the Department of the Army and Army National Guard. Specific to ARNG–I&E (Army National Guard–Installations and Environment) are the Common Installation Picture (CIP) layers. The Army Sustainable Range Program (SRP) also has requirements for annual data submissions. These requirements initiate a review of current data layers and coordination with subject matter experts to ensure spatial and attribute data is current, accurate, properly documented and compliant with CIP and SRP Quality Assurance Plans (QAP). In addition to those submissions, there is continued development and maintenance of geospatial data layers based upon MNARNG business needs.

End User Support

- Major efforts in 2017:
    - Implementation of GIS Portal
    - GIS web application platform upgrade
    - Army Compatible Use Buffer
    - Sentinel Landscape Initiative
    - Range Complex Master Plan
    - Range reconciliation between Planning Resource Infrastructure Development and Evaluation (PRIDE), Range Facility Management Scheduling System (RFMSS) and GIS
    - Camp Ripley and AHATS events (hunts, fishing, races and other outreach)
    - Plans and reports (Annual Report, Prescribed Fire Plan, Landscape Plan, Norwegian Soldier Exchange)

- Custom maps (hard copy and digital) continue to be the primary GIS product for non-GIS staff.
    - Total maps: 966 (does not include report graphics).

- All production data has been maintained to SDSFIE and QAP (CIP and SRP) standards.

Information Technology Coordination

The J6 (Information Technology) directorate is responsible for the essential components of GIS and include hardware, software and network support for the MNARNG. With improved network security, the ability for general users to manage these components has become increasingly limited. In order to obtain the necessary permissions and priority to maintain core components of the GIS, a member of the Environmental GIS staff has been functioning as a liaison with the J6 Directorate.

Through this relationship the approval of GIS related software for use on the NGMN domain has been expedited. This has also allowed for more timely installs of newly approved software as well as a J6 point of contact for resolving GIS related software issues.

The four production GIS databases (gER, gINST, gIMG and gMN) reside on J6 production servers. In addition, network storage space has been designated as GIS workspace to better organize GIS project files across multiple functional areas and allow for simplified sharing of projects and project specific data. The integration of GIS data and applications onto J6 systems also allows us to take advantage of in-place continuity of operations and fail over procedures. In addition, it reduces the overhead of hardware costs and maintenance for Environmental and ITAM as well as the other program areas using the system.

GIS staff with privileged level permissions are critical for supporting web based applications. The ability to disseminate a web based interface to interact with data from multiple program areas and sources is a powerful capability of this technology and it will continue to expand within the MNARNG. Understanding data sources and limitations are essential for reliable analysis and information sharing through web applications; as are application development capabilities for improvement of tools and interfaces to present data for specific user needs. This will require continued integration and support between J6 and GIS personnel.

OUTREACH AND RECREATION

By Jake Kitzmann, Minnesota Department of Military Affairs

One of Camp Ripley's missions is to add value to the community. The conservation team does this by being active in many special events. Camp Ripley is a valuable asset to the local community and the state of Minnesota. It is important that Camp Ripley, in particular the conservation team, be interactive with the citizens of our community and the state of Minnesota. Over the past year, the conservation team has helped implement activities such as the Morrison County Water Festival, Earth Day and National Public Lands Day.

Earth Day activities were held on April 20, and consisted of activities for Camp Ripley personnel to actively engage with their environment. Activities included litter pick-up, tree planting and clearing of trails.

The Morrison County Water Festival was held on September 19 – 20 and is a partnership between Morrison County, the Morrison Soil and Water Conservation District, the city of Little Falls, DNR, the USFWS and Camp Ripley. This event brings 5th graders from Morrison County to Camp Ripley for a series of educational events hosted by natural resource professionals.

Camp Ripley was awarded $4,000 from the National Environmental Education Foundation for National Public Lands Day in 2017. On September 30, volunteers from the Minnesota Master Naturalist program assisted in the restoration of a native prairie on 5 acres within the Camp Ripley cantonment area.

Camp Ripley environmental office hosted and participated in several canoeing events on the Mississippi River. The environmental office partnered with the Mississippi River Headwaters Board for a public event, hosted a private event for Camp Ripley personnel, and hosted the Minnesota Nature Conservancy Board of Directors for canoeing events along the river.

The Camp Ripley environmental office has been a long-term partner with various educational institutions within the state. Camp Ripley's conservation team has been involved in local high school job shadow programs. Partnering with local colleges has not only been beneficial to the students but the conservation program as well.

Camp Ripley is also available for environmental presentations and tours. Using the Martin J. Skoglund Environmental Classroom has been a great way to introduce students to conservation and hands-on science. In 2017, the environmental team gave 61 presentations, tours and briefs to 2,958 people entailing more than 185 staff hours.

Hunting Programs

Disabled American Veterans Firearms Wild Turkey Hunt

Camp Ripley hosted the 13th annual Disabled Veterans turkey hunt May 3 – 5, 2017. Beautiful mid-spring conditions welcomed the hunters this year. The hunt was again organized and conducted by the Veterans Administration with support from Camp Ripley staff and the DNR. Thirty hunters participated in this year's turkey hunt, harvesting 12 birds (Table 28).

Table 28. Disabled American Veterans spring wild turkey hunts, Camp Ripley Training Center, Minnesota, 2005 – 2017.

Year	**Turkeys Harvested**	**Hunter Success**	**Permits Issued**	**Number of Hunters**	**Dates**	**Largest Turkey (lbs)**
2005	11	58%	22	19	May 3–4	24
2006	12	48%	27	25	April 25–26	22.5
2007	15	52%	31	29	April 25–26	23.5
2008	27	75%	39	36	April 23–24	23.8
2009	23	66%	40	35	April 22–23	23.6
2010	15	40%	40	37	April 21–22	24.6
2011	16	46%	40	35	April 20–21	Unk.
2012	19	50%	40	38	April 25–26	Unk.
2013	12	38%	40	32	April 24–26	Unk
2014	5	14%	40	36	May 4–6	23.5
2015	10	31%	35	31	May 4–6	22.2
2016	14	42%	37	33	May 3–5	Unk
2017	**12**	**40%**	**38**	**30**	**May 3–5**	**22**
Total	**212**		**469**	**416**		
Avg.	**15**	**46%**	**37**	**32**		

Soldiers Firearms Wild Turkey Hunt

Camp Ripley hosted its ninth annual soldiers turkey hunts on April 24 – 25 and May 15 – 16, 2017. The hunt was organized and conducted by the Environmental Office. This hunt was organized into two, 2-day hunt periods (Table 29).

Table 29. Soldiers spring wild turkey hunt, Camp Ripley Training Center, Minnesota, 2009 – 2017.

Year	**Turkeys Harvested**	**Hunter Success**	**Permits Issued**	**Number of Hunters**	**Dates**	**Largest Turkey (lbs)**
2009	18	64%	45	28	April 27–29	23.8
2010	25	53%	60	47	April 26–28	25.5
2011	27	46%	86	58	April 25–26 April 28–29	23.4
2012	27	53%	86	53	April 30—–May 1 May 3–4	23.5
2013	30	57%	92	52	April 29–30 May 2–3	24.86
2014	29	47%	70	62	May 1–2	24.3
2015	22	41%	100	53	April 30–May1 May 7–8	22.7
2016	26	51%	98	51	April 28–29 May 9–10	23
2017	**24**	**44%**	**104**	**54**	**April 24–25** **May 15–16**	**22.5**
Total	**228**		**741**	**458**		
Avg.	**25.3**	**51%**	**82.3**	**50.5**		

Disabled American Veterans Firearms Deer Hunt

The 26th annual Disabled American Veterans firearms deer hunt on Camp Ripley was held October 3 – 5, 2017. This year 49 hunters participated. The weather was mild and light winds greeted the hunters on the first day of the hunt. Eleven deer were harvested (Table 30).

Table 30. Disabled American Veterans firearms white-tailed deer hunt, Camp Ripley Training Center, Minnesota, 1992 – 2017.

Year	Deer Harvested	Hunter Success	Bucks	Does	Fawns	Permits Issued	Number of Hunters	Dates	Largest Deer (lbs)
1992	7	37%	4	2	1	19	19	Oct. 14–15	152
1993	11	35%	5	4	2	31	31	Oct. 13–14	132
1994	14	35%	3	3	8	42	40	Oct. 12–13	185
1995	6	15%	1	5	0	40	39	Oct. 11–12	142
1996	9	23%	3	4	2	40	39	Oct. 9–10	132
1997	9	23%	2	2	5	40	38	Oct. 8–9	152
1998	11	30%	2	5	4	39	37	Oct. 7–8	129
1999	8	23%	4	3	1	38	35	Oct. 6–7	137
2000	14	37%	5	5	4	40	38	Oct. 4–5	181
2001	4	11%	1	1	2	45	38	Oct. 10–11	123
2002	12	26%	3	8	1	46	46	Oct. 9–10	144
2003	10	20%	4	6	0	50	48	Oct. 8–9	160
2004	15	33%	6	7	2	48	45	Oct. 6–7	184
2005	12	24.5%	3	7	2	52	49	Oct. 5–6	152
2006	9	19.5%	2	6	1	50	46	Oct. 4–5	146
2007	18	31%	7	8	3	59	59	Oct. 3–4	168
2008	9	16%	2	6	1	58	53	Oct. 8–9	180
2009	13	25%	5	4	4	55	52	Oct. 7–8	174
2010	8	12%	2	5	0	60	55	Oct. 6–7	123
2011	12	20%	3	9	0	60	59	Oct. 5–6	170
2012	9	14%	4	3	1	60	56	Oct. 3–4	10 pts, 200 lbs
2013	7	13%	1	5	1	60	54	Oct. 1–2	130
2014	7	15%	2	5	0	55	47	Oct. 7–8	4pts, 117 lbs
2015	7	12%	2	3	2	60	59	Oct. 7–8	132
2016	2	5%	2	0	0	45	42	Oct. 4–6	6 pts
2017	**7**	**14%**	**4**	**1**	**2**	**54**	**49**	**Oct. 3–5**	**8 pts**
Total	**250**		**82**	**117**	**49**	**1,246**	**1,173**		
Avg.	**10**	**23%**	**3**	**5**	**2**	**50**	**46**		

Deployed Soldiers Muzzleloader Deer Hunt

The seventh annual deployed soldiers' muzzleloader deer hunt at Camp Ripley was held November 27 – 29, 2017. Soldiers that had most recently returned from a deployment were given priority for hunt permits. Fifty-six of the 79 (Table 31) soldiers selected attended the hunt. Temperatures were above average with high winds gusting to 20 MPH on the first two days of the hunt. The last day of the hunt saw morning temps hovering in the high teens with a large warm up in the afternoon and south winds gusting to 15 mph.

Table 31. Deployed soldiers muzzleloader white-tailed deer hunt, Camp Ripley Training Center, Minnesota, 2011 – 2017.

Year	Deer Harvested	Hunter Success	Bucks	Does	Fawns	Permits Issued	Number of Hunters	Dates	Largest Deer (antler points/lbs)
2011	14	28%	3	7	4	64	49	Nov. 28–30	8 pts, 150
2012	49	86%	15	25	9	73	57	Nov. 26–28	8 pts, 166
2013	34	85%	17	12	5	61	40	Dec. 2–4	11 pts, 178
2014	29	61%	11	14	4	71	47	Dec. 1–3	10 pts, 175
2015	18	40%	15	1	2	60	45	Nov. 30–Dec. 2	15 pts, 161
2016	17	41%	6	7	4	75	41	Nov. 28–30	11 pts, 170
2017	**27**	**48%**	**13**	**9**	**5**	**79**	**56**	**Nov. 27–29**	**12 pts, 169**
Total	**188**		**80**	**75**	**33**	**423**	**335**		
Avg.	**27**	**56%**	**11.4**	**10.7**	**4.7**	**60**	**48**		

Military Members Archery Deer Hunt

The twelfth annual military member's archery deer hunt was held on October 3 – 5 in conjunction with the Disabled American Veterans firearm hunt on Camp Ripley. Military members were allowed to hunt in any non-restricted areas north of Cassino Road. One hundred fifty permits were available, 106 hunters applied and all were granted a permit to hunt. A total of 55 hunters participated in this year's hunt (Table 32) and three deer were harvested (Table 32).

Table 32. Military members' archery deer hunt, Camp Ripley Training Center, Minnesota, 2006 – 2017.

Year*	Deer Harvested	Hunter Success	Bucks	Does	Fawns	Permits Issued	Number of Hunters	Dates	Largest Deer (lbs)
2006	6	15%	3	3	0	100	39	Oct. 4–5	92
2007	10	17%	1	6	3	123	59	Oct. 3–4	175
2008	14	25%	6	6	2	123	56	Oct. 8–9	141
2009	11	22%	3	7	1	126	51	Oct. 7–8	198
2010	12	13%	5	7	0	135	90	Oct. 6–7	214
2011	2	3%	0	2	0	89	53	Oct. 5–6	Unk.
2012	23	23%	5	12	6	132	96	Oct. 3–4	182
2013	7	6%	2	5	0	150	109	Oct. 1–2	150
2014	8	9%	3	4	1	151	88	Oct. 7–8	10pts/148
2015	10	13%	6	4	0	135	77	Oct. 7–8	10pts/Unk.
2016	3	4%	2	0	1	128	68	Oct. 4–6	Unk.
2017	**13**	**24%**	**4**	**Unk.**	**Unk.**	**106**	**55**	**Oct. 3–5**	**10 pts/Unk.**
Total	**119**		**40**	**56**	**14**	**1,375**	**841**		
Avg.	**10**	**15%**	**3**	**5**	**1**	**115**	**70**		

*****2006–2012 permitted hunters were soldiers who had been mobilized to support the Global War on Terrorism since September 11, 2001.

Youth Archery Deer Hunt

The sixteenth annual youth archery deer hunt was held October 7 – 8, 2017. Like past years the participants were allowed to hunt in any non-restricted areas north of Cassino Road. The hunt was coordinated by the Minnesota Deer Hunters Association, the Minnesota State Archery Association, Camp Ripley and the DNR. In 2017, a total of 75 permits were issued with 41 hunters participating, harvesting four deer (Table 33).

Table 33. Youth archery white-tailed deer hunt, Camp Ripley Training Center, Minnesota, 2002 – 2017.

Year	Deer Harvested	Hunter Success	Bucks	Does	Fawns	Permits Issued	Number of Applicants	Number of Hunters	Dates	Largest Deer (lbs)
2002	13	14.9%	5	3	5	100	267	87	Oct. 12–13	168
2003	10	7.7%	4	5	1	150	216	132	Oct. 11–12	118
2004	9	7.1%	1	7	1	150	217	127	Oct. 9–10	126
2005	20	15%	8	12	0	152	219	133	Oct. 8–9	196
2006	13	9.7%	5	6	2	150	259	133	Oct. 7–8	127
2007	19	14%	6	5	8	150	234	136	Oct. 6–7	141
2008	10	8.1%	3	5	2	150	220	124	Oct. 11–12	114
2009	12	7.5%	2	7	3	150	240	130	Oct. 10–11	120
2010	7	5%	2	5	0	150	250	136	Oct. 9–10	132
2011	9	6%	3	4	2	175	229	153	Oct. 8–9	Unknown
2012	10	7.2%	5	3	2	175	252	139	Oct. 6–7	Unknown

Table 33. Youth archery white-tailed deer hunt, Camp Ripley Training Center, Minnesota, 2002 – 2017.

Year	Deer Harvested	Hunter Success	Bucks	Does	Fawns	Permits Issued	Number of Applicants	Number of Hunters	Dates	Largest Deer (lbs)
2013	10	7.3%	4	3	3	175	273	137	Oct. 12–13	131
2014	5	3%	2	2	1	175	196	134	Oct. 11–12	120
2015	5	7.6 %	3	1	1	175	108	66	Oct. 10–11	135
2016	2	3%	2	0	0	175	86	66	Oct. 8–9	Unknown
2017	**3**	**9.8%**	**2**	**1**	**0**	**175**	**75**	**41**	**Oct. 7–8**	**Unknown**
Total	**157**		**57**	**69**	**30**	**2,460**	**3,338**	**1,868**		
Avg.	**10**	**8.5%**	**3.8**	**5.1**	**2.3**		**217**	**122**		

General Public Archery Deer Hunt

The annual general public archery deer hunt at Camp Ripley continues to be known as one of the largest and most anticipated archery hunts in the nation since its establishment in 1954. This hunt is administered by the Central Lakes College and DNR. Hunters are allowed to apply for one of the two, 2-day seasons in October each year. This year, the hunts were held on October 19 – 20 and October 28 – 29, 2017. Hunters were permitted to use a bonus tag and the one deer limit which was implemented in 2014 was continued in 2017. In 2017, the number of permitted hunters was 2,995. A total of 2,270 hunters participated in the 2016 archery hunts (Table 34) and harvested 113 deer during the two hunts. This near record low number of hunters and associated harvest is in line with current management goals aimed at slightly increasing the deer population on Camp Ripley.

Table 34. General public archery white-tailed deer hunts, Camp Ripley Training Center, Minnesota, 1984 – 2017 (*Years when bonus tags were allowed).

Year	Deer Harvested	Adult Bucks	%	Adult Does	%	Fawns	%	Permits Issued	# of Hunters	Hunter Success	1st Season	2nd Season	Largest Deer (lbs)
1986	257	106	41	83	32	68	26	5,000	3,940	6.5%	OCT. 11–12	OCT. 25–26	243
1987	284	122	43	91	32	71	25	5,000	4,112	6.9%	OCT. 10–11	OCT. 24–25	250
1988	241	91	38	101	42	49	20	5,000	4,090	5.9%	OCT. 8–9	OCT. 22–23	262
1989	215	95	44	75	35	45	21	4,000	3,136	6.9%	OCT. 17–18	OCT. 28–29	226
1990	301	137	46	115	38	49	16	3,500	2,585	11.6%	OCT. 27–28	NOV. 17–18	225
1991	219	87	40	90	41	42	19	4,000	2,217	9.9%	OCT. 19–20	NOV. 30–DEC. 1	232
1992	406	228	56	140	35	38	9	4,500	3,156	12.9%	OCT. 31–NOV. 1	NOV. 21–22	224
1993	287	147	51	82	29	58	20	5,000	4,127	7.0%	OCT. 21–21	OCT. 30–31	237
1994	267	136	51	95	36	36	13	4,000	3,158	8.5%	OCT. 20–21	OCT. 29–30	237
1995	247	102	41	100	41	45	18	4,500	3,564	6.9%	OCT. 19–20	OCT. 28–29	256
1996	160	78	49	55	34	27	17	4,000	3,154	5.1%	OCT. 17–18	OCT. 26–27	248
1997	142	67	47	57	40	18	13	3,000	2,316	6.1%	OCT. 16–17	OCT. 25–26	243
1998	189	116	61	50	26	23	12	3,000	2,291	8.2%	OCT. 15–16	OCT.31– NOV. 1	249
1999	203	100	49	83	41	20	10	3,000	2,335	8.7%	OCT. 21–22	OCT. 30–31	251
2000	375	228	61	109	29	38	10	4,000	3,128	12.0%	OCT. 19–20	OCT. 28–29	247
2001	350	192	55	126	36	32	9	4,500	3,729	9.4%	OCT. 18–19	OCT. 27–28	272
2002	324	186	57	102	31	36	11	4,500	3,772	8.6%	OCT. 17–18	OCT. 26–27	235
2003	318	161	51	120	38	37	11	4,500	3,810	8.3%	OCT. 16–17	OCT. 25–26	247
***2004**	484	218	45	206	43	60	12	4,521	3,836	12.4%	OCT. 21–22	OCT. 30–31	235
***2005**	477	186	39	218	46	73	15	4,522	3,813	12.5%	OCT.20–21	OCT.29–30	245
***2006**	514	165	32	241	47	108	21	5,009	4,351	11.8%	OCT. 19–20	OCT. 28–29	244
***2007**	476	150	32	228	48	98	20	5,014	4,294	11.1%	OCT. 18–19	OCT. 27–28	255
***2008**	516	183	35	220	43	113	22	5,005	4,167	11.9%	OCT. 19–20	OCT. 26–27	234
***2009**	477	190	40	202	42	85	18	5,005	4,126	11.4%	OCT 15–16	OCT 31–NOV 1	265
***2010**	507	187	37	228	45	92	18	5,002	4,293	11.8%	OCT 20–21	OCT 30–31	253
***2011**	422	153	18	185	32	84	20	5,000	4,305	10.2%	OCT 20–21	OCT 29–30	215
***2012**	429	176	41	169	39	84	20	5,003	4,205	9.8%	OCT 18–19	OCT 27–28	215
***2013**	308	116	37	130	42	65	21	5,002	4,488	6.8%	OCT 26–27	NOV 2–3	223
***2014**	145	55	38	65	45	25	17	3,805	2,966	4.8%	OCT 15–16	OCT 25–26	207
2015	204	56	27	40	20	108	53	3,579	2,723	7.5 %	OCT 15–16	OCT 31–NOV 1	239
2016	113	55	49	13	12	44	40	2,995	2,270	5%	Oct 20–21	Oct 29–30	218
***2017**	**263**	**142**	**54**	**97**	**37**	**24**	**9**	**2,570**	**2011**	**13.1%**	**Oct 19–20**	**Oct 28–29**	**UNK**

Disabled Veterans and Deployed Soldiers Fishing Event

In 2017, Camp Ripley environmental staff with the help of other organizations came together for the sixth annual Trolling for the Troops fishing event. Professional fishing guides are teamed up with disabled and deployed veterans along with those currently serving or retired for a day of fishing. The event was held on June 1 and 2, 2017. The event continues to be supported by the American Legion, Veterans of Foreign Wars, Disabled American Veterans, Minnesota National Guard and Upper Mississippi River Smallie Club. The event continues to be a huge success and a 2018 event is being planned.

ARDEN HILLS ARMY TRAINING SITE

The Twin Cities Army Ammunition Plant was one of six Government Owned–Contractor Operated plants built to produce small arms ammunition during World War II. The MNARNG began leasing its current facility in 1972 and the Organizational Maintenance Shop buildings were constructed in 1973. In September 2000, MNARNG acquired accountability for a portion of the 2,347-acre installation. That portion of the Twin Cities Army Ammunition Plant is now known as the Arden Hills Army Training Site (AHATS) (Figure 1). AHATS consists of 1,500 acres, which is available for military training and environmental management. AHATS is located in the northern portion of the city of Arden Hills, approximately eight miles north of Saint Paul and six miles northeast of Minneapolis. Other surrounding municipalities include New Brighton, Mounds View and Shoreview.

Population and monitoring studies along with management of the flora and fauna is an ongoing part of the installation's Integrated Natural Resources Management Plan (INRMP), which was completed in November of 2001 and updated in 2007 (Dirks et al. 2008), 2008 (Dirks and Dietz 2009), 2009 (Dirks and Dietz 2010), 2010 (Dirks and Dietz 2011), 2011 (MNDNR and MNARNG 2012), 2012 (MNDNR and MNARNG 2013), 2013 (MNDNR and MNARNG 2014), 2014 (MNDNR and MNARNG 2015), 2015 (MNDNR and MNARNG 2016), 2016 (MNDNR and MNARNG 2017) and 2017 (MNARNG 2018b). The data obtained will be used to help manage the natural resources on AHATS. Thirty-one mammal species, 147 bird species and 298 plant species have been identified at the training site.

CULTURAL RESOURCES

By Patrick Neumann, Minnesota Department of Military Affairs

Arden Hills Army Training Site is a federally owned property leased to the MNARNG. As a federal property overseen by the MNARNG and funded by federal dollars, all of the same laws and regulations exist for managing cultural resources within the boundaries of AHATS that apply for all other MNARNG controlled properties.

AHATS has been surveyed for cultural resources in its entirety and no eligible resources are present at this time. There are also Advisory Council for Historic Preservation program comments regarding existing structures which completes the section 106 process regarding historic structures for the MNARNG at AHATS. Any future construction at AHATS will be submitted to the Minnesota State Historical Preservation Office and consulting partners for review and will comply with all laws regarding cultural resources. Should any unknown cultural materials be encountered during construction, all construction activities in the vicinity will cease until a cultural survey can be completed.

LAND USE MANAGEMENT

Land Use Control and Remedial Design

By Mary Lee, Minnesota Army National Guard

The Operable Unit 2 (OU2) Land Use Control Remedial Design (LUCRD) New Brighton/Arden Hills Superfund Site passed the Consistency Test and was signed on September 27, 2010. Land Use Controls (LUC) are required as part of the remedies for soil, sediment and groundwater at specific areas within OU2. LUCs are needed because the current concentrations of various contaminants within these areas are above levels that allow for unlimited use or unrestricted exposure. There are no LUCs for military training; however some soil caps and digging restrictions are present on AHATS.

The MNARNG, as part of its community responsibility, wants to make AHATS available for nonmilitary users, including those under age 18. The exposure levels for those under 18 are more restrictive. In order to reach the exposure levels the LUCRD must be amended. OU2 LUCRD Revision 3 passed final consistency on March 27, 2015. This revision changed the remaining balance of the cantonment area to ‘restricted commercial'. At this time the training area is pending the outcome of soil sampling that was completed during summer 2015. Further amendments will need to be submitted for revisions to the LUCRD to the Minnesota Pollution Control Agency by the Army.

As a result, the conditions of the LUCRD must be honored by the MNARNG relative to their long-range planning, land use and land management practices on AHATS. To ensure compliance with the conditions of the LUCRD, MNARNG is hereby referencing the LUCRD and inserting a copy as an appendix to the AHATS Master Plan/Site Development Plan (MNARNG 2009b) and the AHATS INRMP (MNARNG 2007, 2018b), or by updating this annual report. It is understood that any future revisions to the LUCRD will automatically supersede any earlier editions.

NATURAL RESOURCES

Natural resource planning is an integral part of the conservation program for the MNARNG. The MNARNG uses the INRMP as the guidance document for implementing the conservation program. The planning process used in developing the INRMP focuses on using key stakeholders from the MNARNG, the DNR, the U.S. Fish and Wildlife Service and other organizations that have an interest in the MNARNG’s conservation program. Together, these stakeholders represent the Integrated Natural Resources Management Planning Committee. The primary responsibility of the Planning Committee is to ensure that the INRMP not only satisfies the military mission but also provides a foundation for sound stewardship principles that adequately address the issues and concerns that are raised by all stakeholders. Annually, stakeholders discuss and review the INRMP for AHATS, and present their annual accomplishments and work plans for the next year.

Vegetation Management

Prescribed Fire

By Timothy Notch, Minnesota Department of Military Affairs

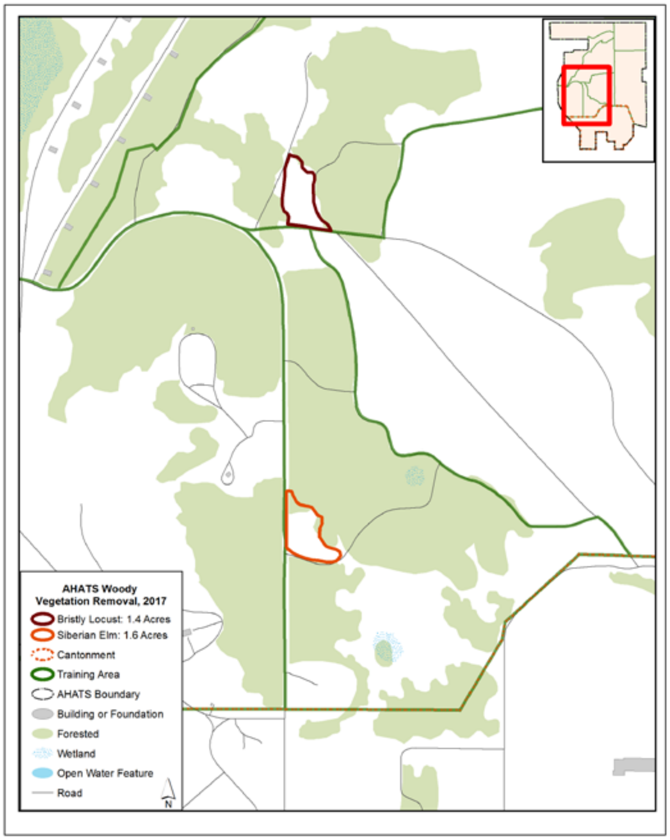
Prescribed fire is used at AHATS as a management tool, similar to Camp Ripley, to enhance the military training environment (also known as mission-scape) and for ecological purposes. Prescribed fire target areas include native prairie grass enhancement and restoration, reducing woody encroachment, invasive and noxious vegetation management, native plant seed production, brush control, fuel-hazard reduction, oak savanna management and to improve habitat for state threatened and endangered species and species in greatest conservation need (MNDNR 2015). The management strategy for prescribed fire on AHATS is provided within the AHATS INRMP (MNARNG 2007, 2018b).

No units were burned in 2017. Continued efforts will be made to coordinate and maintain a fire program on AHATS.

Terrestrial Invasive Species Control

By Jason Linkert, Minnesota Department of Military Affairs

Figure 54. Terrestrial invasive woody vegetation treatment location, Arden Hills Army Training Site, 2017.



Common buckthorn (*Rhamnus cathartica*) and glossy buckthorn (*Rhamnus frangula*) are restricted noxious weeds according to the Minnesota Department of Agriculture. They are both prolific forest invaders in Minnesota that outcompete and prevent the regeneration of native species such as oak in the forest understory. In 2017, Environmental staff from Camp Ripley and AHATS along with St. Cloud State University (SCSU) interns and members of the MNARNG treated buckthorn over a two-day period. Ten acres of buckthorn regeneration was treated in Training Areas 3 and 6 during the week long project (Figure 54). The herbicide triclopyr coupled with a petroleum based bark oil was tanked mixed in backpacks and foliar applied. This treatment is most effective at removing buckthorn seedlings and not harming existing oak species regeneration. The site will require numerous chemical and mechanical treatments over the next few years to prevent stump sprouting and to restore the native oak savanna ecosystem.

SCSU interns also re-treated areas of the boundary fence line in 2017 to limit woody encroachment on the existing fence line and maintain force protection standards. The selective herbicide triclopyr was tank mixed and applied to wild grape (*Vitus riparia*) re-growth and other woody tree species found encroaching on the fence.

Wildlife

By Nancy J. Dietz and Brian J. Dirks, Minnesota Department of Natural Resources

Species in Greatest Conservation Need

"Minnesota defines species in greatest conservation need (SGCN) as native animals, nongame and game, whose populations are rare, declining, or vulnerable to decline and are below levels desirable to ensure their long-term health and stability. Also included are species for which Minnesota has a stewardship responsibility. Stewardship species are those for which populations in Minnesota represent a significant portion of their North American breeding, migrating or wintering population, or species whose Minnesota populations are stable, but whose populations outside of Minnesota have declined or are declining in a substantial part of their range" (MNDNR 2015a).

One of the federal requirements of the Comprehensive Wildlife Conservation Strategy is to manage SGCN by developing a wildlife action plan. "Minnesota's Wildlife Action Plan, 2015–2025" (MNDNR 2015a) is Minnesota's response to the congressional mandate. The goal of the wildlife action plan is to 1) ensure the long-term health and viability of Minnesota's wildlife, with a focus on species that are rare, declining or vulnerable to decline; 2) enhance opportunities to enjoy SGCN and other wildlife and to participate in conservation; and 3) acquire the resources necessary to successfully implement the Minnesota Wildlife Action Plan (MNDNR 2015a). Additional AHATS surveys, monitoring and research will be directed toward identifying other SGCN species, and management or conservation actions that could be implemented to benefit these species.

Of the over 2,000 known native wildlife species in Minnesota, 346 species from all major taxonomic groups meet the definition of species in greatest conservation need. All federal and state endangered, threatened and special concern species are included on the SGCN list. Five taxonomic groups have one-third or more of the total species found in Minnesota as SGCN, they are: mammals (38%), reptiles (50%), amphibians (36%), tiger beetles (46%) and mussels (60%) (MNDNR 2015a). Sixty-three SGCN species occur on AHATS, including 44 SGCN bird species of which 24 are songbirds.

Birds

Christmas Bird Count

The Christmas Bird Count (CBC) has been coordinated by the National Audubon Society since 1900, and has become the oldest continuous nationwide wildlife survey in North America (Sauer et al. 2008). Counts occur within predetermined 15-mile diameter circles located across North America, Mexico and South America. All of AHATS is found within the Saint Paul, north (CBC census code: MNSP) census circle. Each count is conducted during a single calendar day within two weeks of Christmas (December 14 to January 5). The Saint Paul north census was started in 1967, and the census has occurred 50 times (Minnesota Ornithologists' Union 2018b). CBC data is primarily used to track winter distribution patterns and population trends of various bird species.

The 2017 – 2018 CBC at AHATS occurred on Saturday, December 16, 2017, and was conducted by Craig Mullenbach, Tom and Sue McCarthy, Sharon Stiteler, Jerry Hogeboom, Melissa Allard, Amber Burnette, Bob Holtz, Saint Paul Audubon Society volunteers and Mary Lee, AHATS staff. The temperature was 26 degrees Fahrenheit, with winds of 8 miles per hour, and it was mostly cloudy to overcast with no precipitation (Weather Underground 2018c). Four hundred and fourty-three birds of 25 species were counted at AHATS during the annual CBC (Table 35).

Table 35. Christmas bird count data, Arden Hill Army Training Site, winters of 2009 – 2017.

Species	**Scientific Name**	**Dec. 18, 2009**	**Dec. 18, 2010**	**Dec. 17, 2011**	**Dec. 15, 2012**	**Dec. 14, 2013**	**Dec. 20, 2014**	**Dec. 19, 2015**	**Dec. 31, 2016**	**Dec. 16, 2017**
Canada goose	*Branta canadensis*	28	20	2	25			8		
Trumpeter swan	*Cygnus buccinator*	7	2		2					**12**
Wood duck	*Aix sponsa*									**1**
American black duck	*Anas rubripes*									**1**
Mallard	*Anas platyrhynchos*	~1500	~1300	~800	300	625	205	375	35	**228**
Lesser scaup	*Aythya affinis*							1		
Canvasback	*Aythya valisineria*		1							
Common goldeneye	*Bucephala clangula*		6			1		5		**1**
Common merganser	*Mergus merganser*					1				
Bald eagle	*Haliaeetus leucocephalus*	1		4	4	1	3	1	3	**3**
Red-tailed hawk	*Buteo jamaicensis*	6	5	4	4	3	1	3	3	**2**
Rough-legged hawk	*Buteo lagopus*	1			1		5			**1**
Wild turkey	*Meleagris gallopavo*	13	9	22	17	10		1		
Ring-billed gull	*Larus delawarensis*				1			1		
Rock pigeon	*Columba livia*		1	7						**2**
Mourning dove	*Zenaida macroura*			13	8	3	5	48	4	**1**
Great horned owl	*Bubo virginianus*	1		3	3		3	1	1	**1**
Barred owl	*Strix varia*							1		
Red-bellied woodpecker	*Melanerpes carolinus*	1		1		2	1	4	1	**2**
Downy woodpecker	*Picoides pubescens*	1	4	6		6	10	3	3	**4**

Table 35. Christmas bird count data, Arden Hill Army Training Site, winters of 2009 – 2017.

Species	**Scientific Name**	**Dec. 18, 2009**	**Dec. 18, 2010**	**Dec. 17, 2011**	**Dec. 15, 2012**	**Dec. 14, 2013**	**Dec. 20, 2014**	**Dec. 19, 2015**	**Dec. 31, 2016**	**Dec. 16, 2017**
Hairy woodpecker	*Picoides villosus*	1		2	1	3	2	3	1	**2**
Pileated woodpecker	*Dryocopus pileatus*				1			3		
Northern shrike	*Lanius excubitor*		5	1	3	2	1	2		**1**
Blue jay	*Cyanocitta cristata*		2	6		50	5	12	1	**34**
American crow	*Corvus brachyrhynchos*	25	39	16	45	71	100	29	51	**72**
Common raven	*Corvux corax*									**1**
Black-capped chickadee	*Parus atricaillus*	9	10	62	11	48	47	13	20	**25**
White-breasted nuthatch	*Sitta corolinensis*		2	8	4	5	6	6	2	**4**
European starling	*Sturnus vulgaris*							2		**1**
American tree sparrow	*Spizella arborea*	3		52	50	6	3	54	10	
Dark-eyed junco	*Junco hyemalis*				15	2	6	7		**5**
Northern cardinal	*Cardinalis*				4	5		7		**2**
House finch	*Carpodacus mexicanus*							2		**3**
American goldfinch	*Carduelis tristis*		1	20		2		7	3	**13**
House sparrow	*Passer domesticus*				20	1		1		
# Observers		**Unk.**	**Unk.**	**5**	**3**	**4**	**6**	**8**	**6**	**9**
TOTAL # INDIVIDUALS		**1,597**	**1,406**	**1,029**	**521**	**847**	**401**	**600**	**138**	**443**
TOTAL # SPECIES		**14**	**15**	**18**	**20**	**20**	**16**	**27**	**14**	**25**

Breeding Bird Monitoring

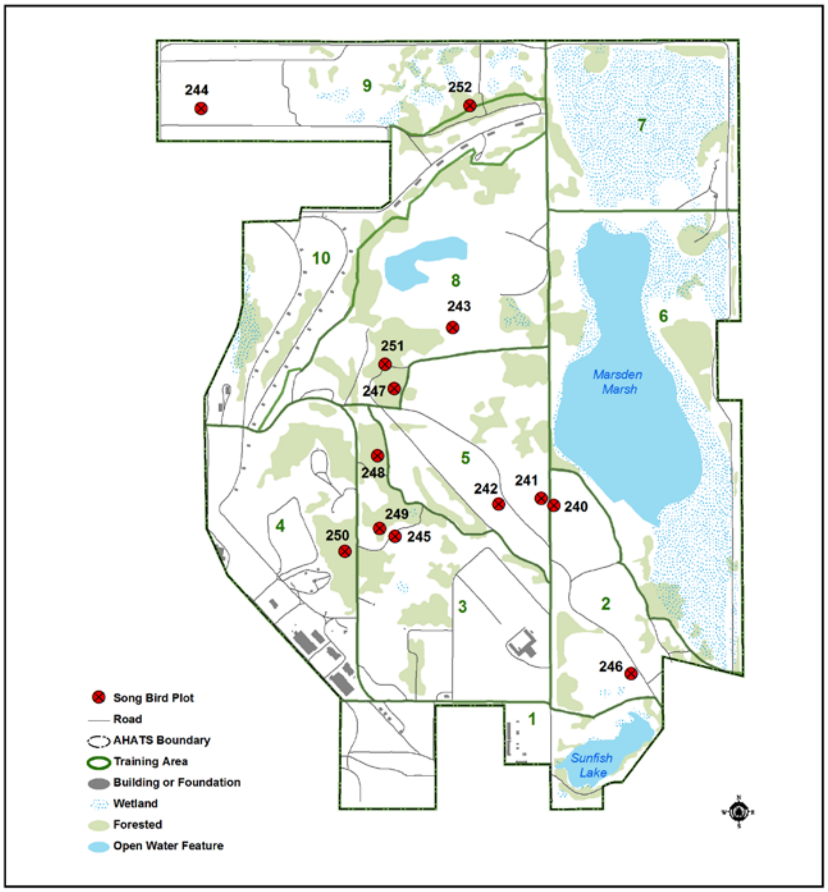
As a natural oasis in a mostly metropolitan area, AHATS provides important breeding and migratory habitat for bird species in greatest conservation need (SGCN). Forty-four SGCN birds have been identified on AHATS (MNDNR 2015a), including 21 known breeding SGCN birds. Four SGCN songbirds (passerines) were recorded during songbird point count surveys in 2017.

Songbird surveys were conducted on 13 permanent plots (Figure 55) on May 31 and June 1, 2017. Surveys have been conducted on these plots since 2001. A total of 167 birds consisting of 44 different species were recorded. Overall, the average number of birds per plot was 12.8 and the average number of species per plot was 10.5 (Table 36 and Figure 56).

Grassland plots (*n*=7) contained 27 bird species and 76 total birds. The highest diversity of songbird species in grassland plots occurred in 2017. The average number of birds found on grassland plots was 10.85 and the average number of species per plot was 8.28 (Table 36 and Figure 56). Population trends of three SGCN grassland songbirds are presented in Figure 57. According to the North American Breeding Bird Survey, Grasshopper sparrow (*Ammodramus savannarum*) populations declined by almost 3% per year between 1966 and 2014, resulting in a cumulative decline of 75%. On

AHATS grasshopper sparrows (a SGCN) had been increasing in abundance since 2001, and were the most abundant grassland plot bird in 2011 but dropped to none in 2012 and 2017. Ten of the past twelve years, clay-colored sparrows (*Spizella pallida*) were the most abundant species recorded on grassland plots (Table 37). Tree and invasive shrub removal is used to limit encroachment of trees and brush into grasslands. Prescribed burning is an important tool to control woody encroachment and to restore and enhance native grasslands. For the first time since 2012, prescribed fire was used in 2016 to manage grasslands on AHATS; however, no prescribed fire was applied in 2017. Grassland birds benefit from the absence of trees due to the lack of perches for predators and brown-headed cowbirds (*Molothrus ater*), a brood parasite. Brushy grasslands are more suitable for edge species, such as the American goldfinch (*Carduelis tristis*), which was the second most abundant bird in grassland plots in 2017.

Figure 55. Permanent songbird survey plots, Arden Hills Army Training Site, Minnesota, 2001–2017.



An additional grassland SGCN bird, the bobolink (*Dolichonyx oryzivorus*), appeared on AHATS survey plot for the first time in six years. Bobolink prefer breeding habitat of moderate to tall vegetation with both grasses and forbs, moderate vegetation densities, absence of woody plants with a moderately developed litter layer (Pfannmuller et al. 2017c). This species population has a statistically valid decline documented, rare or declining habitat and habitat loss hence its SGCN designation. Also, Minnesota’s population represents a significant portion of the North American breeding population. Bobolink were present on an AHATS grassland plot in 2002, 2003, 2005, 2008, 2011 and 2017.

Woodland plots (*n*=6) contained 31 species and 91 total birds. The average number of birds found on woodland plots was 15.2 and the average number of species per plot was 13 (Table 36 and Figure 56). The most abundant birds on woodland plots in 2017 were red-eyed vireo (*Vireo olivaceus*), American goldfinch and American redstart (*Setophaga ruticilla*) (Table 37). Invasive shrub removal also benefits woodland species by releasing native understory species, increasing biodiversity and

Table 36. Summary of songbird surveys, Arden Hills Army Training Site, Minnesota, 2001 – 2017.

Woodland Plots						
Year	**Field Surveyors**	**# of Plots Surveyed**	**Total # of Birds Documented**	**Total # of Species Documented**	**Average # of Birds per Plot**	**Average # of Species per Plot**
2001	Dirks	7	81	25	11.57	8.28
2002	Dirks	7	78	28	11.14	9.14
2003	Dirks	6	84	31	14.00	11.0
2004	Dirks	6	88	36	14.66	12.33
2005	Dirks	6	73	28	12.12	9.83
2006	Dirks	6	74	32	12.13	10.5
2007	Dirks	6	90	34	15.00	11.66
2008	Dirks	6	64	25	10.66	9.66
2009	Dirks	6	73	25	12.16	10.5
2010	Dirks	6	67	26	11.2	10.3
2011	Dirks	6	79	29	13.2	11.66
2012	Dirks	6	71	36	11.8	10.33
2013	Dirks	6	69	27	11.5	10.5
2014	Dirks	5	62	28	12.4	11.0
2015	Dirks	6	67	30	11.2	9.8
2016	Dirks	6	68	24	11.3	9.3
2017	**Dirks**	**6**	**91**	**31**	**15.2**	**13.0**

Grassland Plots						
Year	**Field Surveyors**	**# of Plots Surveyed**	**Total # of Birds Documented**	**Total # of Species Documented**	**Average # of Birds per Plot**	**Average # of Species per Plot**
2001	DeJong	7	37	18	5.28	4.28
2002	DeJong	7	62	22	8.86	9.57
2003	DeJong	7	39	17	5.57	4.57
2004	Burggraff	7	41	19	5.86	4.57
2005	DeJong	7	67	23	9.57	9.71
2006	DeJong	7	75	20	10.71	8.85
2007	DeJong	7	66	21	9.43	8.57
2008	Dirks	7	45	26	6.42	6.0
2009	Dirks	7	46	20	6.71	9.28

Grassland Plots						
Year	Field Surveyors	# of Plots Surveyed	Total # of Birds Documented	Total # of Species Documented	Average # of Birds per Plot	Average # of Species per Plot
2010	Dirks	7	45	16	6.43	5.0
2011	Dirks	7	40	19	5.71	4.57
2012	Dirks	7	39	20	5.57	5.0
2013	Dirks	7	62	25	8.86	8.0
2014	Dirks	5	28	15	5.6	5.0
2015	Dirks	7	62	23	8.86	7.2
2016	Dirks	7	54	21	7.71	6.6
2017	**Dirks**	**7**	**76**	**27**	**10.85**	**8.28**

habitat for birds and other animals. Many native plant species can re-establish from existing seed banks and roots if undesirable plants are controlled (University of Minnesota 2017).

Figure 56. Average number of songbird species per plot, Arden Hills Army Training Site, Minnesota, 2001 to 2017.

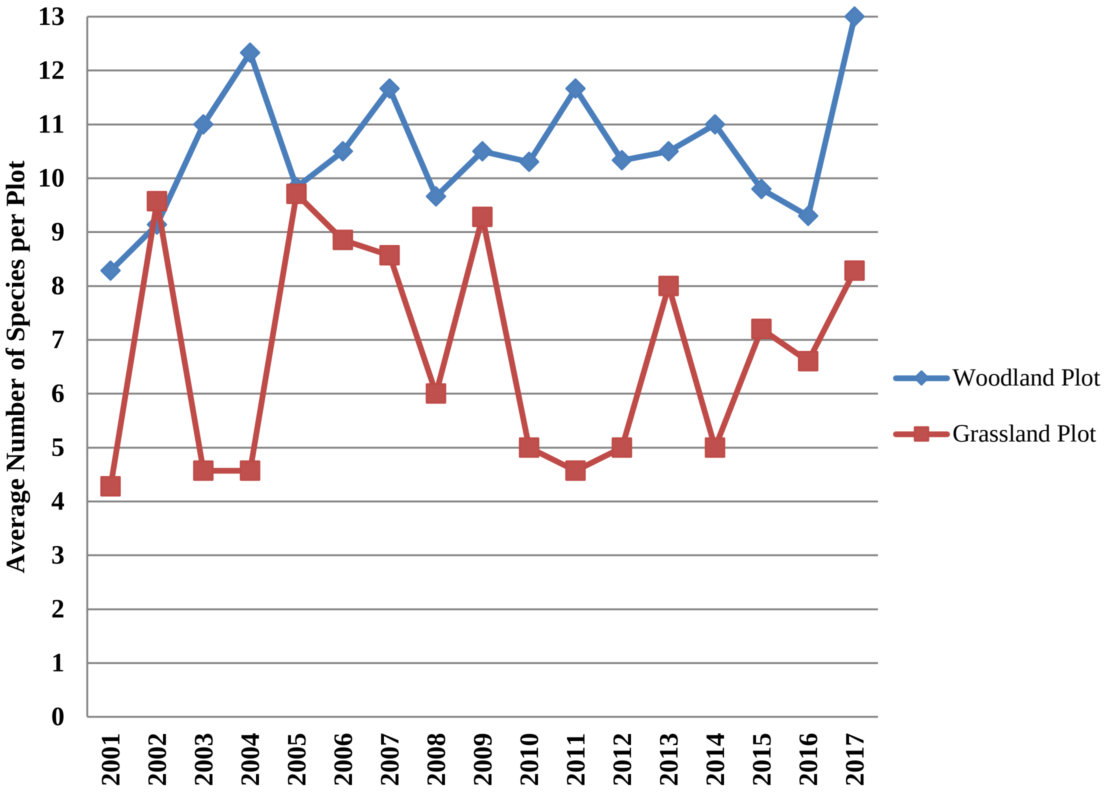


Figure 57. Selected grassland songbird species in greatest conservation need, Arden Hills Army Training Site, Minnesota, 2001 to 2017.

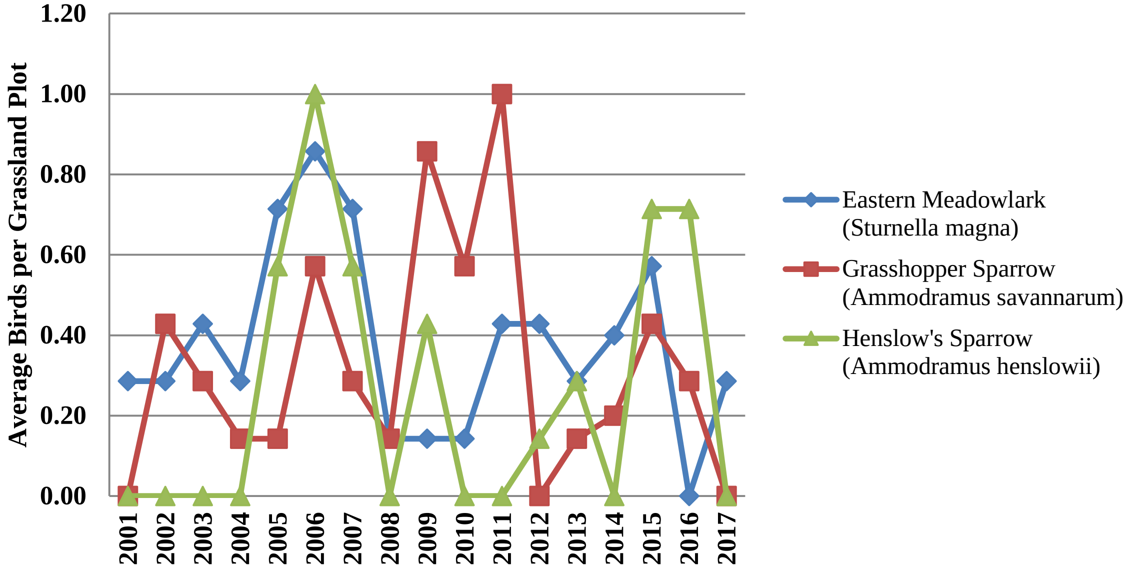


Table 37. Most abundant songbirds observed on plots, Arden Hills Army Training Site, Minnesota, 2006 – 2017. The number of birds documented is indicated in columns.

		Grassland Plots (*n*=7)											
Common Name	**Scientific Name**	**June 2, 2006**	**June 5, 2007**	**July 9, 2008**	**May 29, 2009**	**May 27, 2010**	**June 3&14, 2011**	**June 6, 2012**	**June 7, 2013**	**June 6, 2014[a]**	**May 27, 2015**	**June 2, 2016**	**May 31 & June 1, 2017**
Mourning dove	*Zenaida macroura*			2									
Eastern kingbird	*Tyrannus tyrannus*		5	2	4				4	2	5		
American crow	*Corvus brachyrhynchos*												
Tree swallow	*Tachycineta bicolor*	5			4	5	3		4			4	**7**
Black-capped chickadee	*Poecile atricapillus*												
House wren	*Troglodytes aedon*			4				3					
Sedge wren	*Cistothorus platensis*							3					
Eastern bluebird	*Sialia sialis*		5	4	4		3			2			**7**
Gray catbird	*Dumetella carolinensis*			2				2					
Clay-colored sparrow	*Spizella pallida*	8	11	6	6	11	4	4	10	4	8	5	**10**
Field sparrow	*Spizella pusilla*			4		4	3	5	6	2	4		**6**
Vesper sparrow	*Pooecetes gramineus*		4										
Song sparrow	*Melospiza melodia*												
Henslow’s sparrow	*Ammodramus henslowii*	7	4		3						5	5	
Grasshopper sparrow	*Ammodramus savannarum*				6	4	7						
Brown thrasher	*Toxostoma rufum*											4	
Yellow warbler	*Dendroica petechia*											4	
Common yellowthroat	*Geothlypis trichas*							3		4	7	5	**7**
Red-winged blackbird	*Agelaius phoeniceus*												
Eastern meadowlark	*Sturnella magna*	6	5				3	3		2	4		
Brewer’s blackbird	*Euphagus cyanocephalus*												
American goldfinch	*Carduelis tristis*			2		5	3	3	7	3		6	**8**

Woodland Plots (*n*=6)

Common Name	**Scientific Name**	**June 2, 2006**	**June 5, 2007**	**July 9, 2008**	**May 29, 2009**	**May 27, 2010**	**June 3&14, 2011**	**June 6, 2012**	**June 7, 2013**	**June 6, 2014[a]**	**May 27, 2015**	**June 2, 2016**	**May 31 & June 1, 2017**
Mourning dove	*Zenaida macroura*	4											
Tree swallow	*Tachycineta bicolor*				4								
Great crested flycatcher	*Myiarchus crinitus*		4	3			6		4	5	4	5	
Eastern wood-pewee	*Contopus virens*	6	4	3	5		5	4	6	3		5	**4**
Least flycatcher	*Empidonax minimus*												**4**
Red-eyed vireo	*Vireo olivaceus*				5	5			5		6	4	
Blue jay	*Cyanocitta cristata*			6	6	6	6		4		7	4	
Black-capped chickadee	*Poecile atricapillus*		7		3		7	4					
White-breasted nuthatch	*Sitta carolinensis*			5		5		6	4				
House wren	*Troglodytes aedon*	5	11		3	6	6	6					
Blue-gray gnatcatcher	*Polioptila caerulea*									3			
American robin	*Turdus migratorius*	7		5	6								
Gray catbird	*Dumetella carolinensis*			3							5		
Rose-breasted grosbeak	*Pheuctius ludovicianus*												**4**
Eastern towhee	*Pipilo erythrophthalmus*			3									
Common yellowthroat	*Geothlypis trichas*				5		5	5		6	4		**5**
Yellow warbler	*Dendroica petechia*				3								
Chestnut-sided warbler	*Vermivora ruficapilla*											4	**4**
American redstart	*Setophaga ruticilla*												**6**
Chipping sparrow	*Spizella passerina*									3			
Song sparrow	*Melospiza melodia*			5									
Northern cardinal	*Cardinalis cardinalis*	4	4	3	3								
Indigo bunting	*Passerina cyanea*			3			4		4			4	
Red-winged blackbird	*Agelaius phoeniceus*	4	5	4	3					3			
Brown-headed cowbird	*Molothrus ater*			3		5		4					
Baltimore oriole	*Icterus galbula*				4	5		5	4	3			
American goldfinch	*Carduelis tristis*		4		4	4	4	4	5	4		4	**6**

[a] Only five grassland and five woodland songbird plots were surveyed in 2014.

Trumpeter Swan (*Cygnus buccinator*)

The DNR introduced a pair of wing-clipped trumpeter swans to Marsden Marsh in 1993, and again in 1994. Seven young free-flying wild swans were observed at the wetland during the summer of 1994, presumably after observing the presence of the introduced pair. A wild pair nested at AHATS in 1995, and subsequently raised two cygnets in the wetland. This made AHATS the first site in Ramsey County in approximately 150 years to support the production of cygnets from wild swans.

In 2017, one pair of trumpeter swans was observed on both Sunfish Lake and Marsden Marsh these pairs fledged six and one cygnet, respectively. Trumpeter swans had been listed as threatened in Minnesota but were reclassified in 2013 to a special concern species. Minnesota's population is a significant portion of the North American population. Each year AHATS is monitored for trumpeter swan presence and reproduction (Dirks et al. 2010) (Table 38).

Common Loon (*Gavia immer*)

Although listed as a SGCN, Minnesota has more loons (roughly 12,000) than any other state except Alaska. Threats to loons include human disturbance and pollutants such as lead and mercury. The DNR monitors loon populations with the help of volunteers to improve understanding of what our state bird needs to maintain a strong, healthy presence here (MNDNR 2011b).

Common loons have nested on AHATS wetlands and lakes in the past; however, no effort was made to document if any of those nesting attempts were successful. In 2017, common loons were observed on Sunfish Lake and one chick was fledged. Also, one pair was observed on Marsden Marsh but no chicks were observed.

Table 38. Trumpeter swans raised, Arden Hills Army Training Site, since 1995.

Year	Cygnets Fledged
1995	2
1996	3
1997	1
1998	5
1999	6
2000	0
2001	1
2002	0
2003	2
2004	3
2005	2
2006	7
2007	5
2008	6
2009	1
2010	1
2011	1
2012	0
2013	0
2014	5
2015	5
2016	2
2017	**7**
Total	**60**

Osprey (*Pandion haleaetus*)

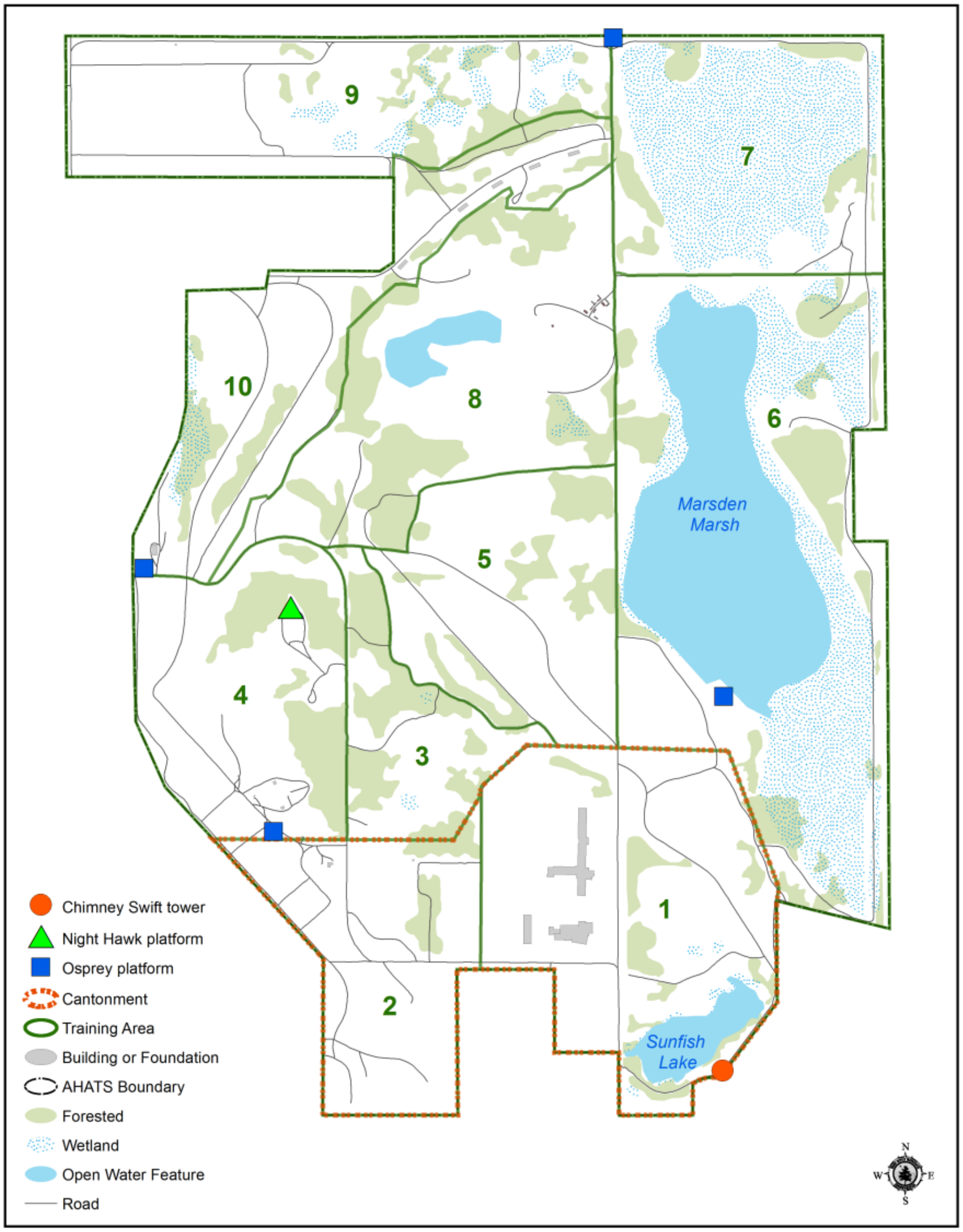
During the 2017 nesting season, an osprey pair was observed on the nesting platform at North Hamline Gate (Figure 58), they fledged two chicks and both were banded (Table 39). Marsden Marsh nest was not active. Banding occurred on July 10, 2017, in cooperation with Audubon Minnesota, Xcel Energy and the Three Rivers Park District.

Table 39. Osprey chicks raised, Arden Hills Army Training Site, since 2001.

Year	Osprey Fledged
2001	3
2002	4
2009	2
2010	2
2011	2
2012	2
2013	3
2014	2
2015	1
2016	5
2017	**2**
Total	**22**

The two new artificial osprey platforms in Training Areas 4 and 10 (Figure 58), both installed in 2013, were not used.

Figure 40. Osprey, chimney swift and common nighthawk nest structures, Arden Hills Army Training Site, since 2013.

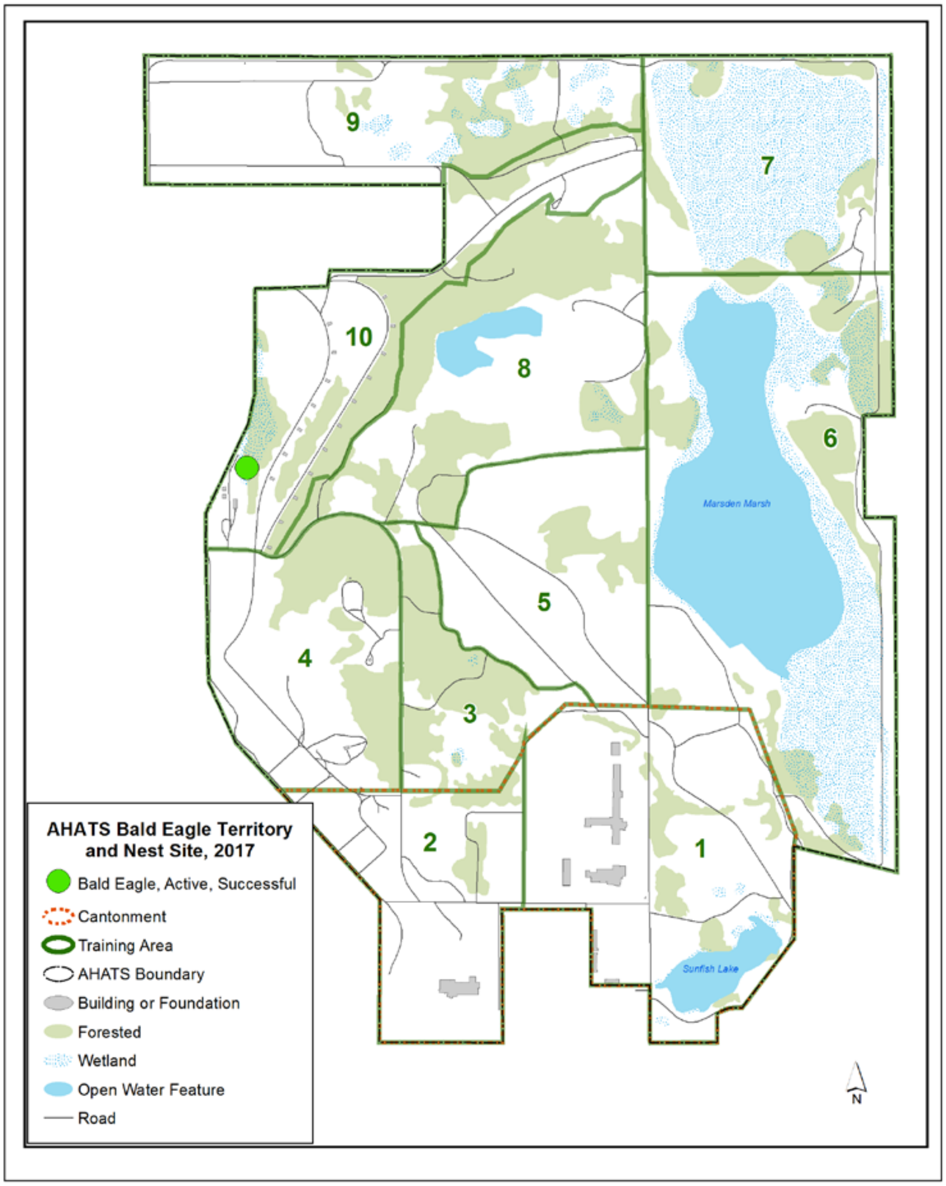


Bald Eagle (*Haliaeetus leucocephalus*)

In the lower 48 states, Minnesota has the most nesting pairs of bald eagles at approximately 1,300. Bald eagle is protected under the Bald and Golden Eagle Protection Act and the Migratory Bird Treaty Act. Both of these acts prohibit killing, selling or otherwise harming or disturbing eagles, their nests or eggs. The U.S. Fish and Wildlife Service (USFWS) released Bald Eagle Management

Guidelines for people who are engaged in recreation or land use activities around bald eagles. These guidelines provide information and recommendations regarding how to avoid disturbing bald eagles. A bald eagle nest was discovered on AHATS in the spring of 2017, the territory was active and produced one chick. In addition, recent surveys by the Saint Paul Audubon Society indicate that AHATS does provide winter habitat as bald eagles have been observed during the Christmas Bird Count in eight of nine count years since 2009 (Table 35).

Figure 58. Bald eagle territory and nest status, Arden Hills Army Training Site, Minnesota, 2017.



American Kestrel (*Falco sparverius*)

American kestrels, a SGCN, have been observed on AHATS for many years and were listed as common in a 1991 assessment (U.S. Army 1991). However, in recent years, substantial population declines have occurred in Minnesota and across their range (MNDNR 2015a). Artificial nest boxes have been installed at AHATS in previous years by the Audubon Society and other local groups to enhance American kestrel populations.

AHATS staff and volunteers began a kestrel project in 2016. The objectives for the study are to determine: 1) if individuals remain in natal (where they were hatched) areas, and if so, for how long after hatching, 2) local movements within and around AHATS and the distance of movement, and 3) if individuals use the same artificial nest box sites annually.

Adult kestrels were captured using bal chatri traps. Each bird was aged, if possible, sex determined, leg banded and measurements taken. Pre-fledging young were removed from artificial nest boxes, leg banded (Figure 59) and returned to the nest box.

Fourteen artificial nest boxes were monitored (Table 40), and six boxes hatched at least one chick. Four nest's eggs did not hatch for unknown reasons. One nest was depredated post juvenile banding.

Figure 59. Leg banded American kestrel pre-fledging chick, Arden Hills Army Training Site, Minnesota, 2017.

Table 40. American kestrel monitoring, Arden Hills Army Training Site, 2016 – 2017.

Year	**Total Artificial Nest Boxes**	**Number of Occupied Nest Boxes**	**Number of Successful Nest Boxes**	**Adults Banded**		**Juveniles Banded**		
				Male	**Female**	**Male**	**Female**	**Unkn.**
2016	13	9	8	2	9	14	20	2
2017	**14**	**10**	**6**	**6**	**2**	**19**	**7**	**2**
Total	**27**	**19**	**12**	**19**		**64**		

Sandhill Crane (*Grus canadensis*)

Sandhill cranes are monitored through a project of the International Crane Foundation. The annual Midwest Crane Count has been conducted since 1976. The purpose of the count is to monitor the abundance and distribution of cranes in the upper Midwest (International Crane Foundation 2010). Mary Lee and volunteer, Amber Burnette surveyed cranes on April 8, 2017 and heard pairs calling from two locations (east Marsden Marsh and County Road I). Two colts were observed near County Road I in 2017.

American Woodcock (*Scolopax minor*)

American woodcock are a forest dwelling shorebird whose breeding distribution is primarily found in the forested regions of the state and along the Minnesota River valley (Pfannmuller et al. 2017b). Successful breeding occurs in shrubland and young forest habitats (McAuley et al. 2013). Woodcock is a Minnesota SGCN and was designated such due to a documented statistically valid population decline (MNDNR 2015a). Population trends are measured using woodcock singing-ground (peenting) surveys on established routes throughout its breeding range. Surveys demonstrated a decline of 0.8 % per year from 1968 – 2012 but surveys from 2002 to 2012 showed no trend (Pfannmuller et al. 2017b).

A woodcock peenting survey occurred on April 6, 2017 from 19:00 to 21:00, several males were observed. During the spring and early summer, Tye Sonney spent approximately 10 hours searching for woodcock nests using the aid of pointing dogs. No nesting woodcock were found but three males were flushed. No chicks were observed.

Common Nighthawk (*Chordeiles minor*)

The common nighthawk is a SGCN in Minnesota. Nighthawks are not well monitored by breeding bird surveys and their populations have been declining. The cause of population decline is unknown but is believed to be related to loss of breeding habitat, pesticide use and nest predation. A wide variety of habitats are used but nesting occurs on the ground on a bare site in an open area (NatureServe 2009). Due to population declines, an artificial common nighthawk structure was constructed and installed in July 2011 (Figure 58). The artificial structure was not used in 2012 – 2017.

Chimney Swift (*Chaetura pelagica*)

Chimney swifts are avian neotropical migrants that are exhibiting a decrease in population. They inhabit rural and urban habitats where suitable roosting and nesting sites are available along with abundant insect populations. These swifts nest primarily in chimneys but will also use the interior walls of silos, barns and uninhabited homes. Natural nest sites include the interior of hollow tree trunks and branches. Recently, populations have become vulnerable as chimney screening and demolition of buildings historically used for nesting/roosting reduces important habitat. In addition, newly constructed chimneys are lined with metal flue pipe which is too smooth for swifts to cling to and may potentially result in entrapment and cause bird deaths (NatureServe 2011). To help reduce population declines artificial nest/roost structures have been developed. A chimney swift tower was installed at AHATS in May 2011 (Figure 58). The artificial tower was not used in 2012 – 2017.

Henslow's Sparrow (*Ammodramus henslowii*)

Henslow's sparrows, a SGCN, have been observed at AHATS eight of the past twelve years during breeding bird surveys and were recorded again in 2016 (Figure 57). None were observed during 2008, 2010, 2011, 2014 and 2017. However, Henslow's were heard singing during the Audubon butterfly survey on July 8, 2017 in Training Area 5. Henslow's sparrows usually breed in grasslands south and east of Minnesota. However, sightings increased in the Minnesota region during the summer of 2005, the year they were first observed at AHATS. Possible causes for increased sightings may be due to a temporary population increase, a temporary population shift from another area, or a true population increase. However, annual monitoring indicates that Henslow's sparrows are frequently using AHATS during breeding season.

Henslow's sparrows are listed as endangered by the DNR and six other states, but are not listed by the USFWS. The nationwide population of this grassland bird species has declined nearly 80% since 1966, due to habitat destruction and/or reforestation (National Audubon Society 2007). The Army Priority List of At-Risk Species gives Henslow's sparrows a two priority ranking. This priority listing allows the Army to work to prevent species at-risk from being added to the threatened and endangered species list through proactive conservation measures (Balbach et al. 2010).

Management for this species should provide for large areas of suitable habitat, prevention of disturbance during the breeding season, and the control of succession (Herkert 2003). Suitable habitat is tall, dense grass with a deep litter layer and scattered tall forbs for perching. Periodic disturbance, such as prescribed fire, is essential to maintaining suitable habitat; even though it will likely reduce the suitability of the grassland during the treatment year. Trees and shrubs should be eliminated in the center and along the edges of grassland areas to discourage predators and nest parasites such as the brown-headed cowbird. Grasslands where Henslow's are located (Burn Units 1–1, 1–2, 5–2, 5–3, 6–1 and 9–1) should be burned or mowed on a minimum of a five year rotation, since it may take several years for the habitat to regain suitable structure for breeding Henslow's sparrows (Dirks et al. 2010). To allow some Henslow's habitat to remain each year, treatment of any of these grassland burn units should be separated by a minimum of three years. Habitat requirements and management for Henslow's sparrows will be included in the development of future habitat restoration plans.

Mammals

Northern Long-eared Bat Research

By Brian Dirks, Nancy Dietz, and Morgan Swigen, NRRI, UMN−Duluth

”Bats are a critical component of Minnesota’s ecosystems. A single bat may eat 1,000 insects per hour, and the state’s bats likely provide many millions of dollars in pest control each year (Boyles et al. 2011)” (Swingen et al. 2016). Eight species of bats have been documented in Minnesota: little brown myotis (*Myotis lucifugus*, MYLU), northern long-eared bats (*Myotis septentrionalis*, MYSE), big brown bats (*Eptesicus fuscus*, EPFU), tricolored bats (*Perimyotis subflavus*, PESU), silver-haired bats (*Lasionycteris noctivagans*, LANO), eastern red bats (*Lasiurus borealis*, LABO), hoary bats (*Lasiurus cinereus*, LACI) and evening bats (*Nycticeius humeralis*, NYHU). Four of Minnesota’s bat species hibernate in caves and mines (northern long-eared bat, tricolored bat, little brown myotis, and big brown bat) during the winter, and disperse widely across the state in spring, summer, and fall. Very little is known about the summer habitat use of these species” (Swingen et al. 2016 and 2018).

Based upon 2007 and 2015 passive acoustic surveys (Dirks and Dietz 2010; MNDNR and MNARNG 2016), AHATS is home to four bats that are designated state special concern species and SGCN, northern long-eared bat, tricolored bat, little brown myotis and big brown bat. Three additional bats are SGCN only, silver-haired bat, eastern red bat and hoary bat.

The northern long-eared bat is federally listed as a threatened species under the Endangered Species Act. Threatened species are animals or plants that are likely to become endangered in the foreseeable future. The USFWS determined, in December 2017, that the petition to list the tricolored bat presented substantial scientific information that federal listing may be warranted. Therefore, a status review was initiated and a determination will be made whether to propose listing tri-colored bats under the Endangered Species Act (USFWS 2016b).

Bat Capture and Processing

Fine mesh mist-nets (Avinet Inc., Dryden, NY, USA) were set up along forested roads that could act as travel corridors for bats. Each night, 2–8 mist-nets were set up within 200 m of a central processing location. Mist-nets were opened after sunset, and checked every 15 minutes for 2–5 hours, depending on capture rates and weather conditions. Captured bats were placed in cloth bags until processing.

We identified each captured bat to species by morphology, and determined sex, age and reproductive condition by physical examination. Each captured bat was weighed and measured, and the wings were inspected for damage as per Reichard and Kunz (2009). Each bat was then fitted with an individually-numbered lipped aluminum wing band (Porzana Ltd., Icklesham, United Kingdom).

Radio-transmitters (A2414 from Advanced Telemetry Systems Inc., Isanti, MN, USA) were attached to pregnant or lactating adult female northern long-eared bat (MYSE) or little brown myotis (MYLU) that did not have significant wing damage (wing score < 2). We trimmed a small section of hair in the center of the back and attached the transmitter to the skin using surgical adhesive (Perma-

Type, Permatype Company Inc., Plainville, CT, USA). Bats were released at the capture site after processing.

Radio-Tracking/Roost Tree Characterization

Bats with radio-transmitters were tracked to their roost each day until the transmitter failed or the transmitter fell off. Data recorded at each roost included roost type, tree species, and decay stage. At dusk, crews returned to the roosts to conduct emergence surveys. During an emergence survey, personnel watched the roost from 30 minutes before sunset to 1 hour after sunset. During the emergence survey we recorded the number of bats emerging in each 10-minute interval, the location of the exit point, and whether or not the bat with the transmitter left the roost.

Crews returned to each roost tree to conduct a more detailed characterization of the roost tree after bats left. This included measuring diameter at breast height (DBH), tree height, decay stage, canopy closure, slope, aspect and recording details about the vegetation surrounding the roost tree. All roost trees were marked with a numbered aluminum tree tag. Buildings used as roosts were not marked with a tag.

Study Area

Bats were captured for the large-scale study at 12 locations around the state of Minnesota in 2017, including Arden Hills Army Training Site (AHATS). AHATS covers 1,500 acres in the Twin Cities Metropolitan area and is comprised of forests, open fields and marsh/wetland. It is located within the city limits of Arden Hills (Ramsey County), and is surrounded by both residential and industrial areas (Figure 60).

Bat Capture Results

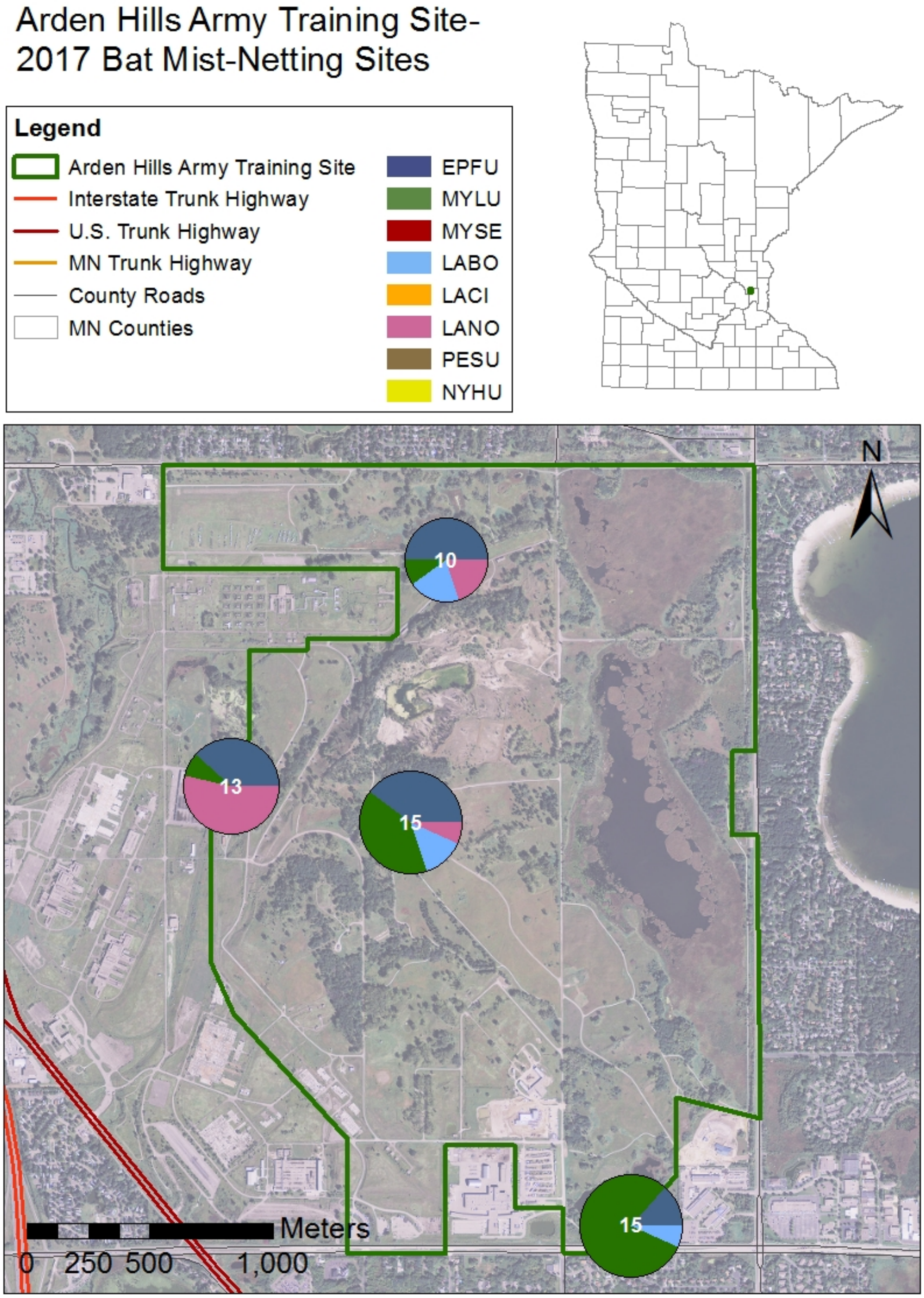
We mist-netted bats at four sites at Arden Hills Army Training Site on the nights of July 5 – 8, 2017 (Figure 60). We captured and processed 53 bats over 124.4 total net-hours. We captured bats of four species, but did not capture any northern long-eared bats (Table 41). Thirty-one of the bats captured were adults, and 22 were juveniles. Twenty-eight bats (53%) showed some wing damage consistent with that caused by WNS, but none had severe damage.

Table 41. Bats captured by species and sex, Arden Hills Army Training Site, July 5 – 8, 2017.

SPECIES and CODE

Sex	**Big Brown Bat (EPFU)**	**Red Bat (LABO)**	**Hoary Bat (LACI)**	**Silver–haired Bat (LANO)**	**Little Brown Myotis (MYLU)**	**Northern long–eared Bat (MYSE)**	**Tricolored Bat (PESU)**	**Evening Bat (NYHU)**	**Grand Total**
Male	10	2	0	7	6	0	0	0	**25**
Female	8	3	0	3	14	0	0	0	**28**
Grand Total	**18**	**5**	**0**	**10**	**20**	**0**	**0**	**0**	**53**

Figure 60. Map of bat mist-netting sites at Arden Hills Army Training Site, July 5 – 8, 2017. The pie chart at each net site indicates the proportion of species captured at that site, and the size of the pie chart represents the total number of bats captured at that site relative to other sites.



Radio-Telemetry/ Roost Characterization

We attached radio-transmitters to three female little brown bats: two of which were captured on the south side of AHATS on the night of July 6, and one of which was captured in Training Area 9 (Figure 60) in the northern part of AHATS on the night of July 8. All three female little brown bats given transmitters were lactating at the time of capture.

The three bats with radio-transmitters were tracked until the transmitter failed or fell off, which was after 5 – 7 days. We tracked the three bats with the radio-transmitters to two unique roosts, both of which were in buildings. Two of the bats with transmitters used the same roost building.

The average distance from the capture location to the first roost was 2,007 m (range: 1,624 **–** 2,199), and each bat used a single roost for the entire tracking period. Therefore, average time spent in each roost could not be calculated because the start and end dates of roosting were not known.

Field crews conducted three emergence counts on the two identified roosts. Bats were observed exiting the roost in all three of the emergence counts. Colony size (number of bats observed in an emergence count) ranged from 25 **–** 480 in those three emergence counts.

Discussion

The three little brown bats tracked at Arden Hills Army Training Site (AHATS) roosted in anthropogenic structures, a habit which has been commonly recorded across their range (Davis and Hitchcock 1965, Anthony et al. 1981, Henry et al. 2002, Bergeson et al. 2015). Little brown bat maternity colonies in buildings often number in the hundreds, with some studies reporting over 1,000 individuals roosting in one location (e.g., Davis and Hitchcock 1965). One of the buildings used in 2017 was also used by bats in 2016, and similar numbers of bats were observed at that building in each year. This may suggest that these bats are wintering in a hibernacula that has not yet experienced high levels of WNS mortality. However, our colony counts could have been inflated in 2017 by bats joining from a nearby maternity colony (a known nearby maternity colony was excluded from a building in 2017).

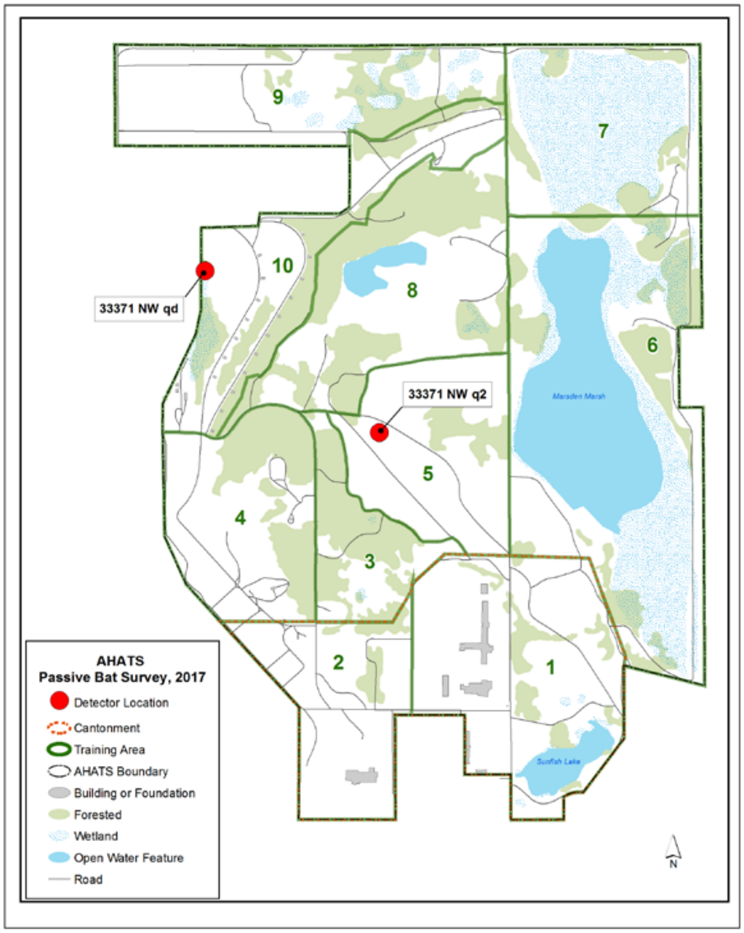
The number of bats captured at AHATS in 2017 was lower than in 2016, even with increased netting effort in 2017 (Dirks et al. 2016). Many factors may have influenced capture rates including net placement and weather. Zero northern long-eared bats were captured at AHATS in 2016 or 2017, although acoustic surveys have recorded northern long-eared bat calls (Minnesota Department of Natural Resources and Minnesota Army National Guard 2015). Northern long-eared bats may exist in smaller numbers in urban areas like that surrounding AHATS due to the lack of large continuous blocks of forest (Johnson et al. 2008).

The first verified evening bat (*Nycticeius humeralis*) recorded in Minnesota was captured at AHATS in July of 2016, however it was unknown if that record represented an incidental record or an established population. Although crews mist-netted at the same site in 2017, no evening bats were captured. This may indicate that the individual captured in 2016 was not part of an established population in the area. However, acoustic surveys of AHATS are ongoing in an effort to document further observations of this species (see Passive Acoustic Survey section below).

Passive Acoustic Bat Survey

Recording bat echolocation “calls” is the most efficient and least intrusive way of identifying different species of bats in a given area (USGS 2014). However, acoustic bat surveys have many variables that contribute to the quantity and quality of echolocation recordings. Bats can be characterized by the ‘volume’ of their echolocation calls, some bats are ‘shouting’ bats and others are ‘whispering’ bats. For example, big brown bats and little brown myotis are shouters, and emit sounds at 110 decibels (if we could hear them) similar to the loudness of a smoke alarm. However, northern long-eared bats produce sounds of 60 decibels, similar to the level of human conversation. Therefore, shouting bats can be heard by the detector at greater distances than whispering bats. Shouting bats can overpower the calls of the whispering bats, such as northern long-eared bat, when they are near the detector together. Northern long-eared bats therefore are more difficult to detect than other bats.

Figure 61. Passive bat acoustic survey, Pettersson D500X full spectrum detector, Arden Hills Army Training Site, Minnesota, 2017.



How sound attenuates in the atmosphere can also influence the quantity and quality of calls recorded and the zone of reception, the physical space where the bat can be detected. Weather conditions such as temperature, wind, humidity and air pressure affect bat activity and call quantity and quality. Also, structural clutter, such as vegetation, can block the path of the calls. In addition, calls recorded can be partial or parts of two species of bats, making bat identification difficult.

The objective for the 2017 passive acoustic bat survey was to place detectors in habitats suited for evening bats and to identify locations where they occur. The first evening bat capture in Minnesota was at AHATS in 2016 (MNDNR and MNARNG 2017). Passive acoustic bat surveys were conducted using Pettersson D500X full spectrum detectors from August 3 to 16, 2017 at two locations (Figure 61). Site 33371NWq2 (12 nights) recorded 16,541 call files and 33371NWqd (14 nights) had 19,000 call files. Calls were reviewed and analyzed by University of Minnesota-Duluth, Natural Resources Research Institute staff using Kaleidoscope Pro (version 4.0.4) and Sonobat (version 4.0.6) automated analysis software. Automated full spectrum software has not been approved by the USFWS for use in identifying presence of northern long-eared bats.

Northern long-eared bats, evening bats and tricolored bat calls were positively identified by Kaleidoscope Pro software at both sites; however, only tricolored bat calls were identified by Sonobat at both sites (Table 42). Presence of all the bat species from passive full spectrum acoustic surveys in 2017 have been confirmed either through captures or zero-crossing acoustic bat surveys (MNDNR and MNARNG 2017, 2016). Qualitative analysis of the evening bat call files are pending to confirm if they are regular visitors to AHATS.

Table 42. Acoustic bat survey results, Pettersson D500X full spectrum detector, Arden Hills Army Training Site, Minnesota, 2017.

AHATS Site Name	**Big Brown Bat (EPFU)**	**Red Bat (LABO)**	**Hoary Bat (LACI)**	**Silver–haired Bat (LANO)**	**Little Brown Myotis (MYLU)**	**Northern long–eared Bat (MYSE)**	**Tricolored Bat (PESU)**	**Evening Bat (NYHU)**	**Not Identified**	**Noise, not bat**	**Grand Total**
KALEIDOSCOPE PRO AUTOMATED ANALYSIS											
33371 NWq2	453	138	123	548	56	2	8	19	8,193	7,001	**16,541**
33371 NWqd	240	91	33	208	81	3	7	7	16,572	1,758	**19,000**
KPro Total	**693**	**229**	**156**	**756**	**137**	**5**	**15**	**26**	**24,765**	**8,759**	**35,541**
SONOBAT AUTOMATED ANALYSIS											
33371 NWq2	277	53	21	157	21	0	3	0	7,926	8,083	**16,541**
33371 NWqd	87	14	18	44	43	0	3	0	8,105	10,686	**19,000**
Sonobat Total	**364**	**67**	**39**	**201**	**64**	**0**	**6**	**0**	**16,031**	**18,769**	**35,541**

White-tailed Deer (*Odocoileus virginianus*) Aerial Survey

Historically, winter white-tailed deer populations at the AHATS and Twin Cities Army Ammunition Plant (TCAAP) properties have fluctuated from an estimated high of 400 in the late 1960s (Jordan et al. 1997) to 30 in 2001 and 2003. Overpopulation of deer may negatively impact vegetation and efforts to restore oak savannah, impact the vegetative structure required for military training and cause hazards due to vehicle collisions along perimeter roadways. Aerial deer surveys are conducted annually to track population changes. The number of deer counted during winter deer surveys had increased to a high of 124 in 2007, but has recently declined (Table 43). No aerial deer survey was conducted in 2017 because there was insufficient snow cover, a requirement for an accurate survey.

Table 43. Aerial surveys of white-tailed deer, Twin Cities Army Ammunition Plant and Arden Hills Army Training Site, 1999 – 2017.

Year	**1999**	**2000**	**2001**	**2002**[a]	**2003**	**2004**	**2005**[a]	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**[a]	**2013**	**2014**	**2015**[a]	**2016**	**2017**[a]
Deer Counted	41	47	30	—	30	47	—	84	124	87	104	72	61	—	41	64	–	6	–

[a] No count conducted

Although the properties are fenced, deer are not completely restricted from moving in and out of AHATS and TCAAP. Since control of the deer population at AHATS and the surrounding area occurs primarily on the training site, management of this population will rely primarily on archery hunting pressure. As the number of deer increased since 2003, the number of hunts and total number of deer harvested also increased to keep the deer herd from becoming too large (See Hunting Programs section in this document for hunt data summaries). The overall reduction in deer numbers is partially due to the harvest of deer in the fall of 2009, 2010, 2012, 2014, 2015, 2016 and 2017 when 66, 52, 53, 42, 25, 25 and 30 deer were harvested, respectively. These are the largest total number of deer harvested since hunts began in 2003. This indicates that hunting pressure has aided reduction in deer numbers and continues to be necessary to reduce and/or maintain the deer population.

Beaver (*Castor canadensis*)

Beaver are an important part of the natural ecosystems at AHATS. This species can have a large effect on the environment in which it lives. In a natural system, beavers create or enlarge wetland areas which trap nutrients and help to reduce flooding by holding and slowly releasing water. However, problems occur in localized areas when beavers plug road culverts, flooding and damaging roads. When this occurs, a cooperative effort between the Environmental Office, the DNR and AHATS Department of Public Works (DPW) is initiated to identify problem areas and implement solutions.

All problem areas are inspected by the Environmental Office and possible solutions are provided to AHATS's DPW. Some areas require the removal of beaver through trapping. AHATS beaver removal is conducted by a nuisance beaver trapper at the direction of the DNR/MNARNG staff. No beaver were removed from AHATS during 2016– 2017.

Many problem areas can be addressed through the use of damage control structures, such as Clemson levelers and beaver deceivers. These devices have been used successfully at AHATS in the past, when installed correctly. However, these devices do require maintenance and eventually fail and/or need to be replaced.

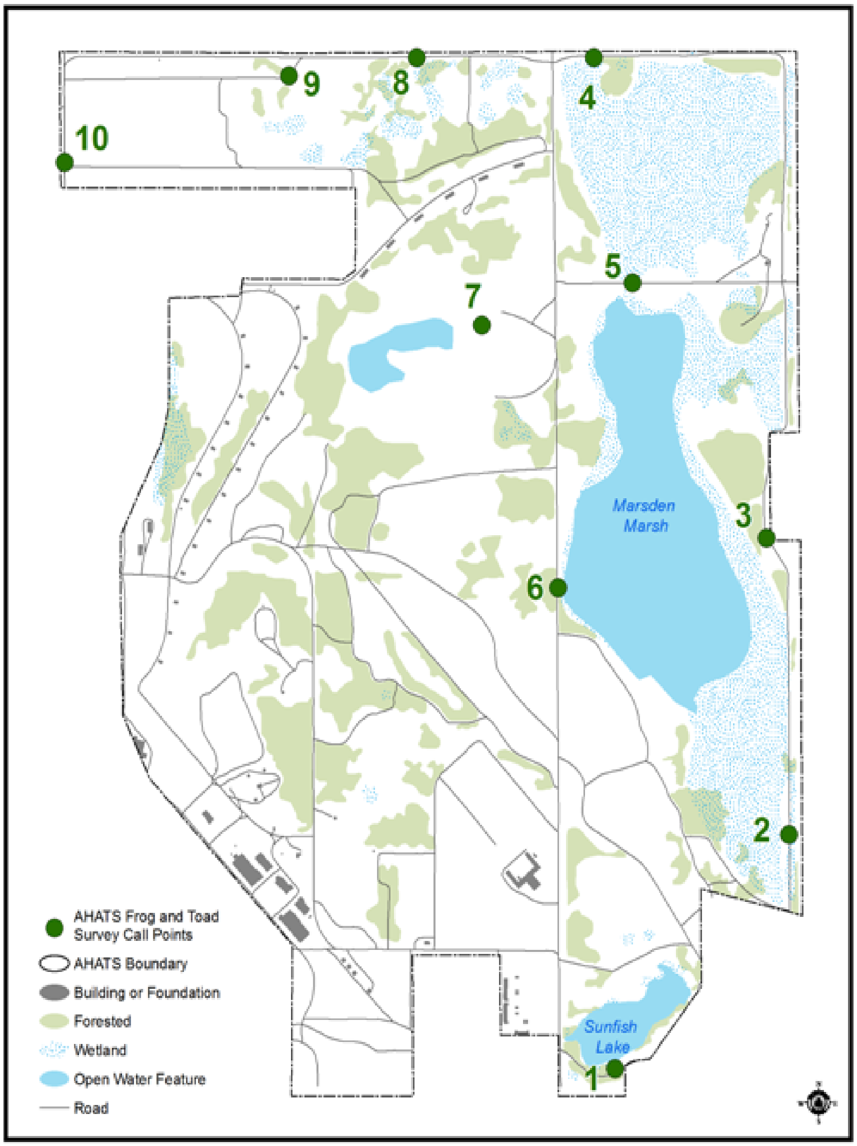
Beaver ponds and wetlands throughout AHATS provide habitat for Blanding's turtles and numerous reptiles and amphibians; as well as provide feeding areas for a variety of wildlife and habitat for waterfowl and other birds. Therefore, it is important that these wetlands not be permanently drawn down or drawn down in fall or winter in order to install these devices. Installation should occur after a temporary drawdown in spring or summer, or during natural low-water levels. Research in east-central Minnesota investigated the effects of a controlled drawdown on Blanding's turtle populations. The incidence of mortality was high after the drawdown due to predation, road mortality and winterkill (Dorff Hall and Cuthbert 2000).

Reptiles and Amphibians

Blanding's Turtle (*Emys blandingii*)

The Blanding's turtle is listed as a state threatened species by the DNR. AHATS is part of a Blanding's turtle priority area as designated by the DNR (Figure 58 in MNDNR and MNARNG 2013). Priority areas are the most important areas in the state for management, protection and research of Minnesota's Blanding's turtle population. In July 2012, the USFWS was petitioned to include Blanding's turtles as threatened or endangered. The USFWS determined, in July 2015, that the petition presented substantial information that federal listing of Blanding's turtles may be warranted. Therefore, a status review was initiated and a determination will be made whether to propose listing Blanding's turtles under the Endangered Species Act (USFWS 2016d). This species depends upon a variety of wetland types and sizes, and uses sandy upland areas and roadways for nesting. Surveys of Blanding's turtles have occasionally occurred at AHATS. Because nest predation is extremely high, road surveys are conducted in known Blanding's habitats to find and protect nests. A Blanding's turtle road survey was not conducted in 2016–2017.

Figure 62. Anuran survey stops, Arden Hills Army Training Site, since 2003.



Anuran Surveys

Frog and toad calling surveys are conducted as part of a larger statewide survey, and have been conducted at AHATS since 1993. The statewide survey began due to growing concern, for the past two decades, over declining amphibian populations worldwide. Frog and toad abundance estimates are documented by the index level of their chorus, following Minnesota Herpetological Society guidelines (Moriarty, unpublished). If individual songs can be counted and there is no overlap of calls, the species is assigned an index value of 1. If there is overlap in calls the index value is 2 and a full chorus is designated a 3. Anuran surveys are performed at ten stops. The routes are surveyed three times from April through July (Figure 62).

Surveys were conducted by Mary Lee, MNARNG, during two of the three survey time periods on April 4 and May 25, 2017. Site #7 was not surveyed during both time periods. Boreal chorus frogs (*Pseudacris maculata*) and wood frogs (*Lithobates sylvaticus*) were detected during the first time period (Figure 63). During the second time period, boreal chorus frogs and gray treefrogs (*Hyla versicolor*) were detected (Figure 64). Spring peepers (*Pseudacris crucifer*) were not detected during either time period but have been detected in four of the last six years. Population trends in 2009 indicated a detectible decrease in the proportion of statewide routes where spring peepers were heard. However, there were no detectible statewide trends for spring peepers in 2015. Interpretation of AHATS results can difficult be due to years when the anuran survey was not conducted, particularly during the third survey period.

Figure 63. Average anuran index value during the first survey period, Arden Hills Army Training Site, 2003, 2004, and 2008 – 2017. Surveys were not conducted from 2005 – 2007.

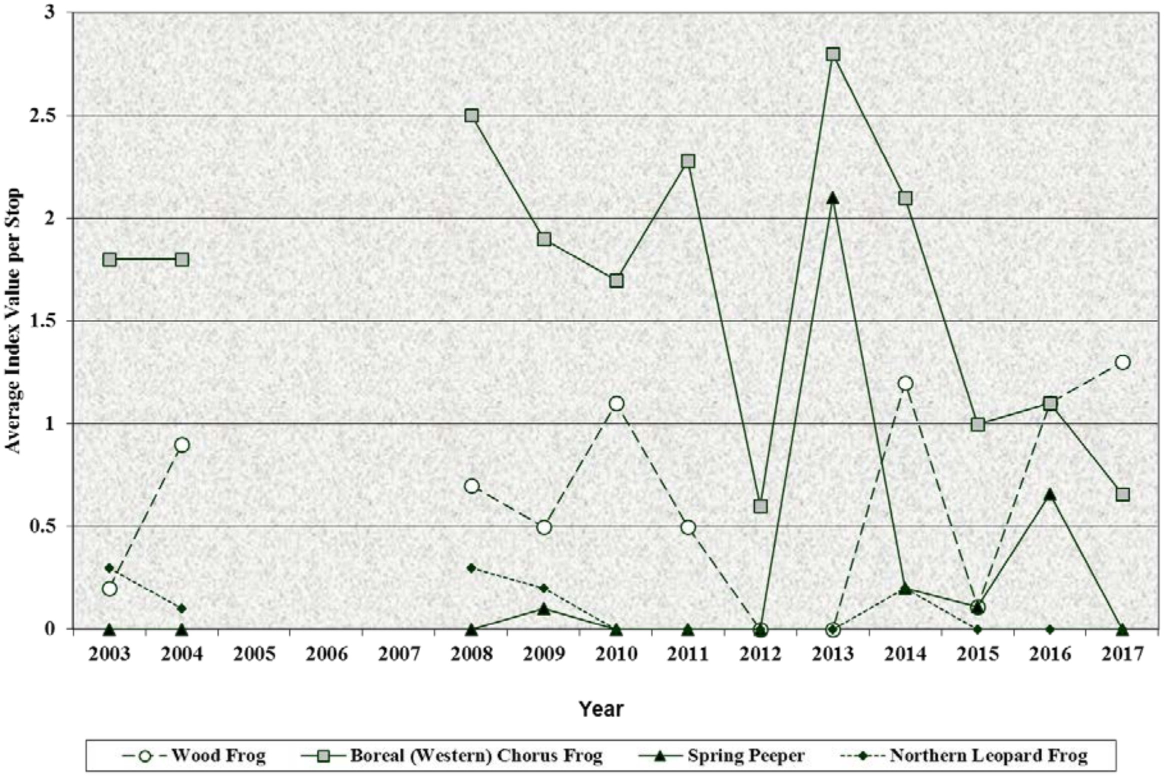
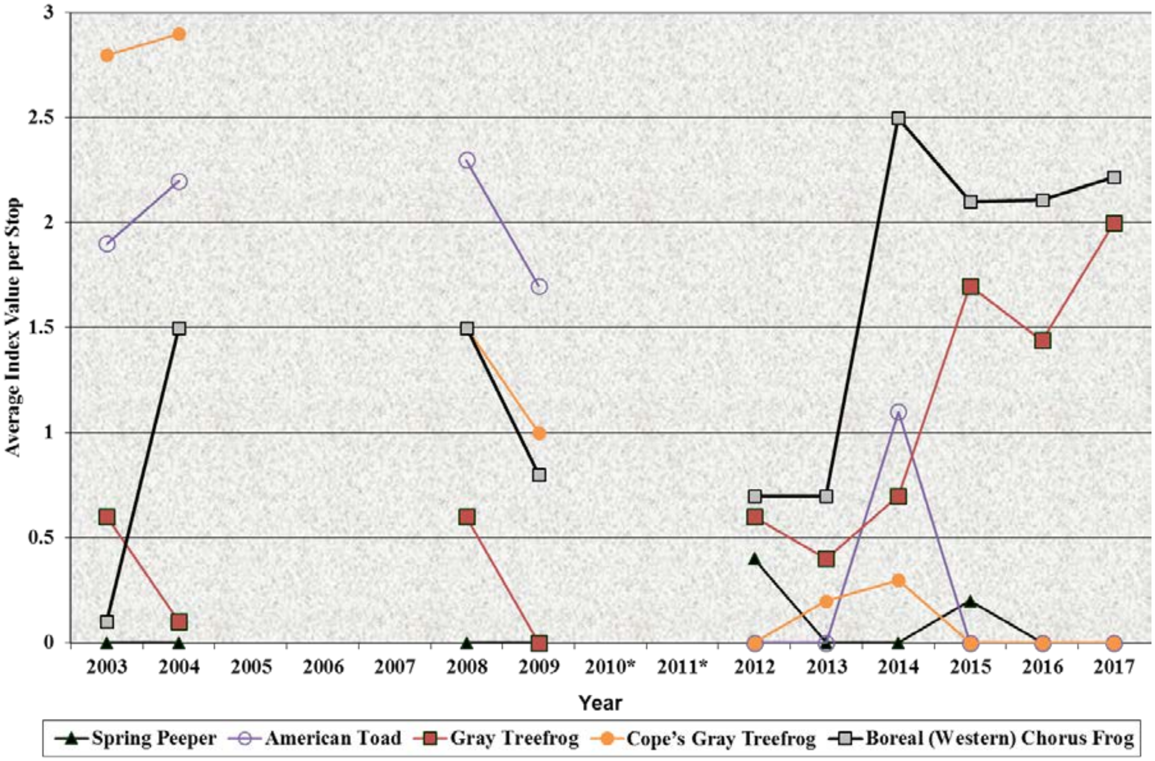


Figure 64. Average anuran index value during the first survey period, Arden Hills Army Training Site, 2003, 2004, 2008, 2009 and 2012 – 2017. Surveys were not conducted from 2005 – 2007, 2010 and 2011.



Insects

Butterfly Survey

The Saint Paul Audubon Society conducted their annual survey for butterflies at AHATS on July 8, 2017. Twelve species were recorded for a total of 30 individuals. In 2016 and 2017, the diversity of butterfly species decreased significantly from 2015 and 2016, as 2015 was one of the highest species diversities observed (Table 44). The number of individual butterflies observed was the lowest since 2001. Cabbage white (*Pieris rapae*) and common wood nymphs (*Cercyonis pegala*) (Figure 65) were the most common species observed in 2017. Common wood nymphs have been observed 15 of the 17 years but numbers have been low the past four years. Cabbage whites have been observed 10 of the past 17 years of the survey; however, in 2017 the largest number were observed (Table 44).

Figure 65. Common wood nymph, Arden Hills Army Training Site, July 8, 2017 (Photographer: Mary Lee).

Table 44. Number of butterflies, Arden Hills Army Training Site, Saint Paul Audubon Society, 2001 – 2017.

Common Name	**Scientific Name**	**July 6, 2001**	**July 14, 2002**	**July 6, 2003**	**July 10, 2004**	**July 9, 2005**	**July 8, 2006**	**June 30, 2007**	**June 29, 2008**	**June 27, 2009**	**June 26, 2010**	**June 26, 2011**	**June 30, 2012**	**June 30, 2013**	**July 3, 2014**	**June 27, 2015**	**July 9, 2016**	**July 8, 2017**
Black swallowtail	*Papilio polyxenes*	1				1	1	1										
Eastern tiger swallowtail	*Papilio glaucus*	4				2			2	1		1	2		1	2	2	
Swallowtail species	*species undetermined*	1		1								2						
Checkered white	*Pontia protodica*	3																
Cabbage white	*Pieris rapae*		5			1		5	5	2	2	5				9	2	**10**
"Whites"	*Pieris species*					1						1					1	
Clouded sulphur	*Colias philodice*	?	2	8		2	6	42			10		6			1	2	**5**
Orange sulphur	*Colias eurytheme*	100s	35	1	1	1		30			6		20	1	4	1	7	**1**
Dainty sulphur	*Nathalis iole*	1																
Sulphur species	*species undetermined*										15		3	2			5	
American copper	*Lycaena phlaeas*		3				2	2	2								1	
Gray copper	*Lycaena dione*	9	1	8														
Bronze copper	*Lycaena hyllus*																	
Edward’s hairstreak	*Satyrium edwardsii*			1														
Coral hairstreak	*Satyrium titus*	2	1	1	1								1			1		
Banded hairstreak	*Satyrium calanus*			1						1				2	2			
Striped hairstreak	*Satyrium liparops*	1						1										
Hairstreak species	*species undetermined*			2						1				3	1	3		
Eastern tailed-blue	*Everes comyntas*	5	100's	4		6	32	34			2	1	5	11	1	2	5	**14**
Western tailed-blue	*Cupido amyntula*													1				
Blues species	*Species undetermined*															1	1	
Spring azure	*Celastrina ladon*									8	6					2	1	**1**
‘Summer’ spring azure	*Celastrina ladon neglecta*	4	1	3						8	1			1			1	
Variegated fritillary	*Euptoieta claudia*	1		1														
Great spangled fritillary	*Speyeria cybele*	12	11	40	9	16	5	13	2	4	17		15	2	2	8	1	**4**
Aphrodite fritillary	*Speyeria aphrodite*	4	4	dozens	19	10	14	2	2	4			5		2	10	1	
Regal fritillary	*Speyeria idalia*																	
Silver-bordered fritillary	*Boloria selene*																	
Fritillary species	*species undetermined*	32	10	14	14+		14	28		14	10		10			26	15	**10**
Silvery checkerspot	*Chlosyne nycteis*				1													
Pearl crescent	*Phyciodes tharos*	11			1													
Northern crescent	*Phyciodes selenis*			7	2		1			1					10	23	1	**1**
Northern pearl crescent	*Phyciodes selenis/tharos*					1	1	7	2									
Crescent species	*species undetermined*		2	4						6	1	16	2	1		7		
Baltimore checkerspot	*Euphydryas phaeton*	15		6	13	5	4	10	1	3	1							
Question mark	*Polygonia interrogationis*		1				2						1					
Silvery checkerspot	*Chlosyne nycteis*				1											3		**2**
Eastern comma	*Polygonia comma*			1			3		2		5		1					
Gray comma	*Polygonia progne*										2					1		

Table 44. Number of butterflies, Arden Hills Army Training Site, Saint Paul Audubon Society, 2001 – 2017.

Common Name	**Scientific Name**	**July 6, 2001**	**July 14, 2002**	**July 6, 2003**	**July 10, 2004**	**July 9, 2005**	**July 8, 2006**	**June 30, 2007**	**June 29, 2008**	**June 27, 2009**	**June 26, 2010**	**June 26, 2011**	**June 30, 2012**	**June 30, 2013**	**July 3, 2014**	**June 27, 2015**	**July 9, 2016**	**July 8, 2017**
Comma species	*species undetermined*																	
Mourning cloak	*Nymphalis antiopa*	2	2	5	2	5		3	2	1	2	2			3	1	3	**1**
American lady	*Vanessa virginiensis*	6	2	1		1		4										
Painted lady	*Vanessa cardui*	5									1							
Vanessa species	*species undetermined*		1															
Red admiral	*Vanessa atalanta*	12+		3			2	11			3		3	1		2	1	**1**
American lady	*Vanessa virginiensis*															1		**1**
Common buckeye	*Junonia coenia*	7	1			1		6						3				
White admiral	*Limenitis arthemis arthemis*								3							6		
Red-spotted purple	*(Limenitis a . astyanax)*								1	1						1		
Viceroy	*Limenitis archippus*	1	2	5		1			2			1		4			4	**1**
Hackberry emperor	*Asterocampa celtis*							2								6		
Northern pearly-eye	*Enodia anthedon*	2	4	7	1	5	9	5			2		1		2	1	3	
Eyed brown	*Satyrodes eurydice*	46	15–20	22	3	5	32	26	1		4				1			**9**
Little wood satyr	*Megisto cymela*								2	7	2	7	1		3	10		
Common ringlet	*Coenonympha tullia*	4							6	11				6		3		
Common wood nymph	*Cercyonis pegala*	dozen	dozen	100–	100+	36	104	173		44	57	7	26		22	58	20	**19**
Monarch	*Danaus plexippus*	11	10	11	1	17	64	38	4	10	3	3	7	2	11	3	1	**5**
Silver-spotted skipper	*Epargyeus clarus*	2	2	1	1	1	2	2		2		1	8	7	7	6		**5**
Northern Cloudywing Skipper	*Thorybes pylades*									1								
Least skipperling	*Ancyloxypha numitor*									1			1					
European skipper	*Thymelicus lineola*	6		dozens	2	1		5	23	32	17	74	2	1	2	29	2	
Peck’s skipper	*Polites peckiums (=coras)*								2			1						
Northern cloudy skipper	*Thorybes pylades*																	
Tawny-edged skipper	*Polites themistocles*	4						1					1					
Long dash	*Polites mystic*							1										
Delaware skipper	*Atrytone logan*	4	7	11	1	4	7	2										**3**
Northern broken -dash	*Wallengrenia egeremet*	1		2			3	15					3					**1**
Mulberry wing	*Poanes massasoit*	1	1	1	3	1	6	1					1	1			2	**3**
Hobomok skipper	*Poanes hobomok*											1				1		
Dion skipper	*Euphyes dion*							1										
Black dash	*Euphyes conspicua*							3										
Dun skipper	*Euphyes vestris*	1		3			8	4			2						3	**7**
Skipper species	*species undetermined*				1		4	2	2	1	3	2	2		1	3	5	
Grass skipper species	*species undetermined*														1			
Total Species*		35	26	32	17	23	20	32	18	22	23	13	20	17	15	31	20	**20**
Total Individuals**					176	124	329	480	66	156	173	125	127	49	76	232	90	**104**

*a species of butterfly and all its subspecies are counted as a single species **total individuals may not be available due to estimates

Monarch Butterfly (*Danaus plexippus*)

Monarch butterflies are found throughout the United States. Eastern populations migrate vast distances of over 3,000 miles between U.S./Canada and central Mexico from breeding grounds to overwintering locations, across multiple generations each year. Adults in a summer generation live for two to six weeks while migratory generations live up to nine months. Monarchs from northern latitude breeding grounds that emerge after mid-August begin to migrate south towards overwintering grounds where they have never been before. When this migratory generation begins the northward journey into the southern U.S., this generation lays eggs and nectars as they breed and migrate north. The generation that re-populates the northern latitude breeding grounds the following spring is the second and third generation of the previous falls' generation (Monarch Joint Venture 2015).

Observations of monarchs have occurred annually since 2001 at AHATS (Figure 65); however, the number of individuals observed has declined since 2007 (Table 44). Populations of monarchs are declining in both the eastern and western portions of their North American range. Monarchs are now being considered for protection under the federal Endangered Species Act. The USFWS is currently conducting a species status assessment to describe the viability of monarch populations which will support ESA decisions. The USFWS anticipates an ESA listing decision by June 2019. The major population threats are breeding, migration and overwintering habitat losses. Insecticides used to control insects are also harmful to monarchs. And, herbicides used to control weeds can affect milkweed populations, the only plant that female monarchs use to lay eggs and the only plant its' caterpillars eat (Monarch Joint Venture 2015).

Figure 65. Monarch (*Danaus plexippus*) caterpillar, Arden Hills Army Training Site, July 8, 2017 (compliments of Maurice Whalen, Saint Paul Audubon Society volunteer).

Best management practices for monarch populations on AHATS should include avoiding mowing ditches when monarch larvae are present, late April to mid-August, particularly locations where common milkweed (*Asclepias syriaca*) is present. In addition, limiting insecticide and herbicide use would be beneficial.

Bumble Bees

By Nancy Dietz and Erica Hoaglund, DNR, Nongame Wildlife Program

Historically about 400 native bee species occurred in Minnesota. However, little is known about bees because the most recent state species list was published in 1919. Bumble bees are a group of insect pollinators. Pollinators are critical to the agricultural economy and natural habitats and ecosystems as 90% of the world's flowering plants rely on animal pollinators. "Pollination happens when wind, water and wildlife carry pollen from the anther (male part) to the stigma (female part) of plants" (MNDNR 2017c and Hatfield et al. 2012). Threats to bumble bee populations include habitat fragmentation, grazing, pesticide use, genetic diversity, pests and diseases, competition with honey bees and climate change (Hatfield et al. 2012). The economic value of pollination services provided by native insects (mostly bees) is estimated at $3 billion dollars annually in the United States (USFWS 2017b).

Five bumble bees are listed as SGCN in Minnesota, they are: rusty patched bumble bee (*Bombus affinis*), Ashton cuckoo bumble bee (*Bombus bohemicus*), yellow-banded bumble bee (*Bombus terricola*) and golden northern bumble bee (yellow bumble bee; *Bombus fervidus*). Rusty patched bumble bee abundance and distribution has decline by 90% since the late 1990s. Recently the rusty patched bumble bee was listed as federally endangered under the Endangered Species Act on March 21, 2017. None of the single threats above are causing the rusty patched population decline, but the threats working in concert are likely causing the decline (USFWS 2017b).

Rusty patched bumble bee range includes AHATS. Rusty patched bumble bee observations occurred in 2016 and 2017 within 7.5 miles of AHATS (Bumble Bee Watch 2018). The cantonment area of AHATS is in a USFWS low potential zone (Figure 66). These zones are areas where maximum dispersal potential for known rusty patched bumble bee locations since 2007. These zones are used to determine where non-lethal survey methods and a scientific recovery permit for surveys are recommended. No lethal bumble bee surveys techniques have occurred on AHATS.

Department of Natural Resources central region nongame wildlife staff and volunteers conducted approximately 25 person hours of bumble bee net capture surveys on AHATS in summer 2017. Some of these surveys were associated with the annual butterfly survey (July 8, 2017) hosted at AHATS as well as incidental to bat surveys (July 6 and 7, 2017). All of these surveys targeted the federally endangered rusty patched bumble bee as well as the candidate species the yellow-banded bumblebee. Neither of these species were encountered on AHATS in summer 2017.

Although neither of the species of federal concern were encountered a total of seven other bumble bee species were encountered in varying abundances. Species encountered during 2017 surveys were: two-spotted bumble bee (*Bombus bimaculatus*), red-belted bumble bee (*Bombus rufocinctus*), common eastern bumble bee (*Bombus impatiens*), brown-belted bumble bee (*Bombus griseocollis*), black-and-gold bumble bee (*Bombus auricomus*), boreal bumble bee (*Bombus borealis*) and lemon cuckoo bumble bee (*Bombus citrinus*).

Rusty patched bumble bee potential zones include a significant number of MNARNG Readiness Centers across the state (Figure 66). Five Readiness Centers in the Minneapolis/St. Paul area are located within USFWS high potential zones where rusty patched bumble bee is likely to be present. And, ten Readiness Centers are found within low potential zones. No bumble bee surveys nor assessment of habitat availability have occurred at MNARNG Readiness Centers.

OUTREACH AND RECREATION

By Mary Lee, MNARNG

Hunting Programs

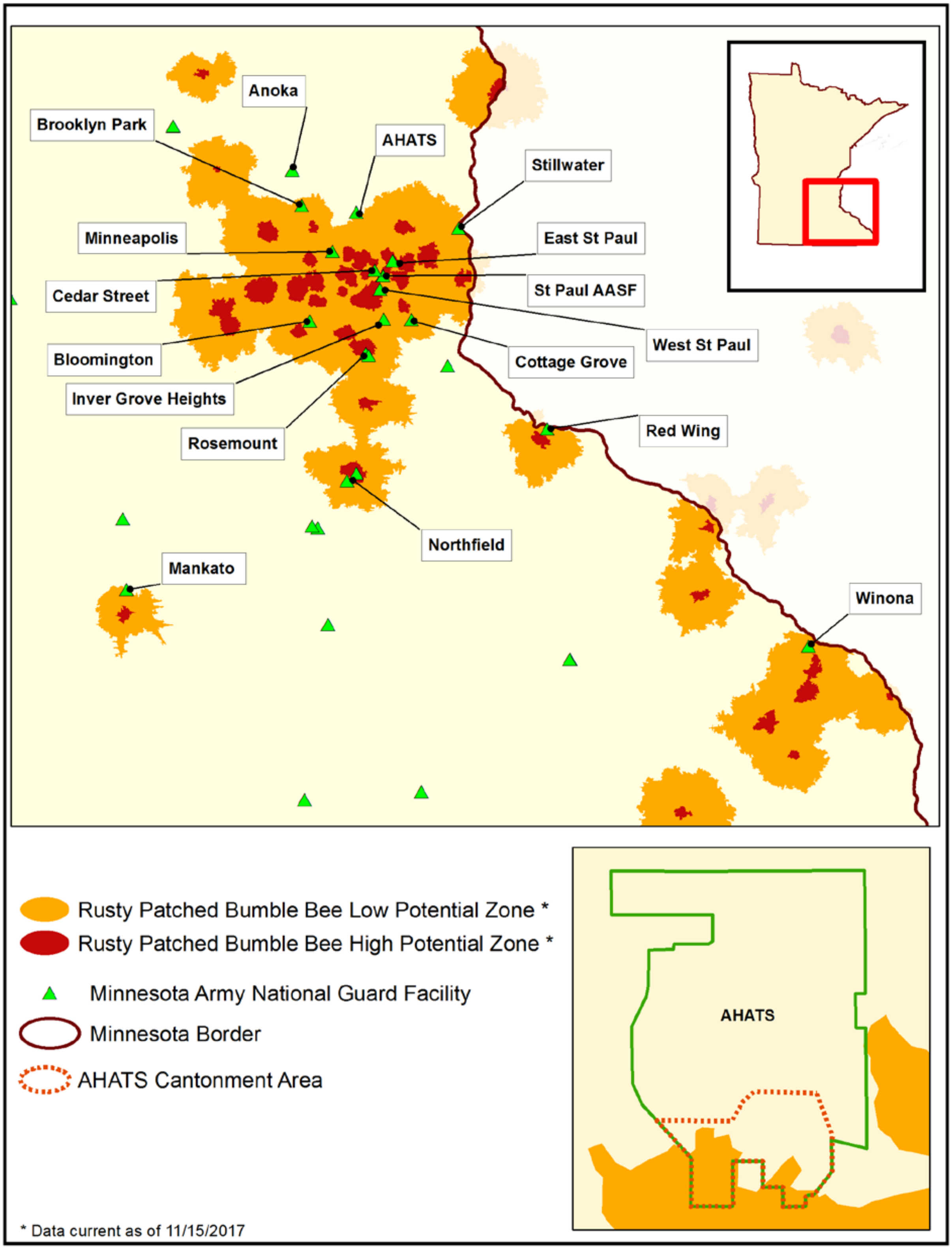
Soldiers Archery Wild Turkey Hunt

AHATS hosted its ninth annual soldier archery turkey hunt on May 10 – 12 and May 13 – 15, 2017. The hunt was organized and conducted by the Environmental staff. Sixteen hunters participated in two, three-day turkey hunts. One hunter was successful, for an overall 6.25% success rate (Table 45).

Table 45. Soldiers wild turkey hunt, Arden Hills Army Training Site, 2009 – 2017.

Year	Turkeys Harvested	Hunter Success	Permits Issued	Number of Hunters	Dates	Largest Turkey (lbs.)
2009	2	25%	8	8	April 15–17	20.9
2010	5 2	100% 33%	10 10	5 6	April 14–16 April 21–23	Unknown
2011	2 1	33% 25%	10 10	6 4	April 15–17 April 18–20	22 lbs.
2012	2 3	33% 50%	10 10	6 6	April 21–22 April 28–29	23 lbs.
2013	1 4	25% 40%	20 17	4 10	April 20–21 April 27–28	Unknown
2014	5 1	29% 33%	20 20	17 3	May 8–10 May 11–13	Unknown
2015	0 4	0 40%	20 20	10 10	April 15–17 April 25–27	Unknown
2016	3 0	25% 0	22 9	12 4	April 29–May1 May 9–11	23 lbs.
2017	**1** **0**	**10%** **0**	**0** **0**	**10** **6**	**May 10–12** **May 13–15**	**Unknown**

Figure 66. Location of rusty patched bumble bee high and low potential zones and MNARNG Readiness Centers, Minnesota, 2017.



Soldiers Archery Deer Hunt

In 2017, the twelfth annual soldiers' archery deer hunt was held on October 16 – 18, October 27 – 29, November 8 – 10 and December 8 – 10. Forty permits for the first three hunts and ten permits for the last hunt were issued to current military members and Minnesota veterans (Table 46).

Table 46. Soldier archery white-tailed deer hunt, Arden Hills Army Training Site, 2006 – 2017.

Year	Deer Harvested	Bucks	Does	Fawns	Number of Hunters
2006	7	2	5	0	33
2007	13	4	5	4	55
2008	21	7	10	4	102
2009	30	8	6	16	104
2010	35	13	20	2	110
2011	24	8	12	4	79
2012	43	18	23	2	101
2013	19	10	8	1	70
2014	29	15	7	7	78
2015	22	8	10	4	81
2016	20	6	11	3	87
2017	**22**	**9**	**11**	**1**	**74**

Volunteer Archery Deer Hunt

Volunteers that support the soldier hunts are allowed an opportunity to hunt at AHATS during the last soldiers hunt on December 8 – 10, 2017. Eight deer were harvested during the combined soldier/volunteer hunt (Table 47).

Table 47. Volunteer archery white-tailed deer hunt, Arden Hills Army Training Site, 2003 – 2017.

Year	Deer Harvested	Bucks	Does	Fawns	Number of Hunters	Dates
2003	13	6	6	1	18	Nov. 28–30
2004	6	4	2	0	19	Nov. 26–28
2005	9	6	2	1	26	Nov. 25–27
2006	19	9	6	4	26	Nov. 24–26
2007	30	10	15	5	35	Nov. 23–25
2008	22	3	17	2	33	Nov. 28–30
2009	28	11	8	9	31	Nov. 27–29
2010	17	3	6	8	20	Nov. 26–28
2011	11	5	3	2	24	Dec. 2–4
2012	10	5	5	0	26	Nov. 30–Dec. 2
2013	8	5	3	0	33	Dec. 6–8
2014	13	6	5	2	31	Dec. 12–14
2015	3	2	1	0	38	Dec. 11–13
2016	5	1	2	1	26	Dec. 9–11
2017	**8**	**4**	**3**	**1**	**28**	**Dec. 8–10**

ACKNOWLEDGEMENTS

The projects in this document were completed through the cooperation of many people associated with Camp Ripley and AHATS. We would like to thank Garrison Commander Colonel Scott St. Sauver and Camp Ripley Senior Commander Brigadier General Lowell Kruse for their continued support. The Camp Ripley Environmental Office is made up of employees from the Minnesota Department of Military Affairs and the DNR who work together to manage the natural resources on Camp Ripley and AHATS in support of the military mission of training soldiers. Josh Pennington, Jake Kitzmann, Patrick Neumann, Mary Lee, Tim Notch, Brian Sanoski, Jason Linkert, and Adam Thompson were all instrumental in completing projects and all contributed to this report. Thanks to Training Area Coordinator Tim Notch of Camp Ripley and Staff Sergeant Janice Hawkins of AHATS, who were instrumental in coordinating our work with the military mission. Camp Ripley's GIS specialists, Craig Erickson and Lee Anderson, provided GIS related support throughout the year and Lee created the maps for this report. We also thank the entire Camp Ripley Range Control staff for their support and tolerance of our activities downrange, especially during times of high military use. Jim Tatro, Todd Hendricks and the Department of Public Works crew helped make access to project sites possible. Thanks to Dan Lais and Tim Crocker with the DNR for providing logistical support and Amanda Sanoski for administrative support for all of the projects throughout the year.

The assistance and advice of many people including John Erb, Dan Stark and David Mech, were greatly appreciated. The bear project was again successful because of the support and fieldwork of Dave Garshelis and Andy Tri. Thanks to the DNR pilot Jason Jenson for another year of safe and productive flight time. We appreciate the support of the DNR Little Falls Area Office including Beau Liddell, Area Wildlife Manager, Tod Tonsager, Assistant Manager and their staff for helping to organize the turkey and deer hunts on Camp Ripley. In addition, we would like to thank Dennis Erie, his staff and volunteers for planning and organizing the Disabled American Veterans wild turkey hunt, white-tailed deer hunt and Trolling for the Troops fishing events. Thanks also to Roger and Jan Ekert, Minnesota State Archery Association, for their coordination and fund raising efforts for the deployed soldier, youth and public archery hunts at Camp Ripley. Foresters John Korzeniowski and Walker Wearne supplied forest management recommendations, prescribed fire and technical support. A special thanks to volunteers Nathan Wesenberg, Adam Maleski, and Arika Nyhus for their time to the bear, wolf, Blanding’s turtle and other projects. Thanks to Camp Ripley bluebird house monitor, Mike Ratzloff. Thank you to Gerda Nordquist, Mags Rhuede (USFWS), Erica Hoaglund and Luke Groff for their expertise and field support on the northern long-eared bat project. We would also like to thank Mark Martell and Amber Burnette for their work on the AHATS American kestrel and osprey projects and Tye Sonney for his woodcock count work. A special thank you to Dr. Bill Faber, CLC, for his support of CLC interns and Dr. Jorge Arriagada, SCSU, for his contributions as project manager. Last but not least, thanks to this year's interns Peter Beam (CLC), Kelsie Hanson (CLC), Kari Gordon (CLC), Joe Weaver (SCSU), Adam Kremer (SCSU) and Dustin Hancock (SCSU) we wouldn't have been able to complete all the projects in this report without their assistance.

LIST OF PRIMARY CONTRIBUTING AUTHORS

Contact Information

Josh Pennington, Department of Military Affairs
Camp Ripley Environmental Program Manager
Camp Ripley Training Center
15000 HWY 115
Little Falls, MN 56345
Office: 320-616-2720

Jake Kitzmann, Natural Resource Manager
Patrick Neumann, Cultural Resources Manager
Craig Erickson, J6 Information Specialist
Lee Anderson, GIS Specialist
Timothy Notch, Training Area Coordinator
Brian Sanoski, ITAM Coordinator
Adam Thompson, RTLA Coordinator
Jason Linkert, LRAM Coordinator
Department of Military Affairs
Camp Ripley Training Center
15000 HWY 115
Little Falls, MN 56345
Office: 320-616-2722 (Kitzmann)
Office: 320-616-2719 (Neumann)
Office: 320-616-2716 (Erickson)
Office: 320-616-2717 (Anderson)
Office: 320-616-3135 (Notch)
Office: 320-616-2789 (Sanoski)
Office: 320-616-3199 (Thompson)
Office: 320-616-2723 (Linkert)

Mary Lee
Environmental Protection Specialist
Arden Hills Army Training Site (AHATS)
Minnesota National Guard
4761 Hamline Avenue North
Arden Hills, MN 55112-5794
Office: 651-282-4420

Brian J. Dirks, Animal Survey Coordinator
Nancy J. Dietz, Animal Survey Specialist
Minnesota Department of Natural Resources
Camp Ripley, 15000 HWY 115
Little Falls, MN 56345
Office: 320-616-2718 (Dirks) -2721 (Dietz)

Jenna Bjork, DVM, MPH
Epidemiologist
Vectorborne Diseases Unit
Minnesota Department of Health
625 Robert Street North
Saint Paul, Minnesota 55164
Phone: 651-201-5803

Crystal Boyd, Wild Bee Specialist
Minnesota Department of Natural Resources
500 Lafayette Rd.
St. Paul, MN 55155-4025
Office: 651-259-5699

Erica Hoaglund, Regional Nongame Specialist
Minnesota Department of Natural Resources
1200 Warner Road
St. Paul, MN 55106
Office: 651-259-5772

Tammi Johnson
Centers for Disease Control and Prevention
3156 Rampert Rd.
Fort Collins, CO 80521
Office: 970-221-6455

Arika Nyhus, Graduate Student Candidate
St. Cloud State University
720 4th Avenue South
St. Cloud, MN 56301-4498
Office: 320-308-2019

Morgan Swingen
Center for Water and the Environment
Natural Resources Research Institute
University of Minnesota, Duluth
Duluth, MN 55812
Office: 218-788-2752

LITERATURE CITED

Anthony, E. L. P., M. H. Stack, and T. H. Kunz. 1981. “Night Roosting and the Nocturnal Time Budget of the Little Brown Bat, *Myotis lucifugus*: Effects of Reproductive Status, Prey Density, and Environmental Conditions.” *Oecologia* 51:151–156.

Balbach, H., M. Perez-Martinez, and E. Keane. 2010. “The Army Priority List of At-Risk Species, 2009 – 2010 Status Update.” Construction Engineering Research Laboratory, Champaign, IL. ERDC/CERL TR–10–21. 30 pp.

Beaudry, F., and M. L. Hunter, Jr. 2009. “Seasonally Dynamic Habitat Use by Spotted (*Clemmys guttata*) and Blanding's Turtles (*Emydoidea blandingii*) in Maine.” *Journal of Herpetology* 43(4), 636 – 645.

Bergeson, S. M., T. C. Carter, and M. D. Whitby. 2015. “Adaptive Roosting gives Little Brown Bats an Advantage over Endangered Indiana Bats.” *The American Midland Naturalist* 174:321–330.

Bluebird Recovery Program of Minnesota. 2017a. “History of the Bluebird Recovery Program.” Website (online) at < http://bbrp.org/about-us/>. Accessed 18 October 2017.

Bluebird Recovery Program of Minnesota. 2017b. “Directory Results 2005 – 2014.” Website (online) at <http://bbrp.org/2016-report-forms/directory-results/>. Accessed 18 October 2017.

Boyles, J. G., P. M. Cryan, G. F. McCracken, and T. K. Kunz. 2011. “Economic importance of bats in agriculture.” *Science* 332:41–42.

Britzke, E.R., and C. Herzog. 2009. “The Use of Acoustic Transects to Document Changes in Bat Distribution and Abundance.” Website (online) at <http://corpslakes.usace.army.mil/employees/bats/refs.cfm>. Accessed 18 December 2012.

Bumble Bee Watch. 2018. “Bumble Bee Sightings Map”. <https://www.bumblebeewatch.org/app/#/bees/map>. Accessed 16 January 2018.

Camp Ripley Environmental Office. 2009. “Minnesota Army National Guard and Camp Ripley Training Site, Integrated Cultural Resources Management Plan, 2009 – 2013.” Camp Ripley Environmental Office, Minnesota Department of Military Affairs, Little Falls, MN. 188 pp.

Ciechanowski, M., T. Zając, A. Biłas, and R. Dunajski. 2007. “Spatiotemporal Variation in Activity of Bat Species Differing in Hunting Tactics: Effects of Weather, Moonlight, Food Abundance, and Structural Clutter.” *Canadian Journal of Zoology* 85:1249–1263.

Compton, B. W. 2007. “Status Assessment for the Blanding's Turtle (*Emydoidea blandingii*) in the Northeast.” Draft report to US Fish and Wildlife Service.

Congdon, J. D., D. W. Tinkle, G. L. Breitenbach, and R. C. van Loben Sels. 1983. “Nesting Ecology and Hatchling Success in the Turtle, *Emydoidea blandingii*.” *Herpetolgica* 39: 417 – 429.

Congdon, J. D., and D. A. Keinath. 2006. “Blanding’s Turtle (*Emydoidea blandingii*): A Technical Conservation Assessment.” USDA Forest Service, Rocky Mountain Region, Species Conservation Project (www. fws. gov/northeast/assabetriver/PDF/Blandings-FinalEA. pdf).

Congdon, J. D., Graham, T. E., Herman, T. B., Lang, J. W., Pappas, M. J., and Brecke, B. J. 2008. "*Emydoidea blandingii* (Holbrook 1838)—Blanding's Turtle." Conservation Biology of Freshwater Turtles and Tortoises. *Chelonian Research Monographs* (5), 15 – 1.

Damon, R. A., and W. R. Harvey. 1987. "Experimental Design, ANOVA, and Regression." Cambridge: Harper and Row.

Daubenmire, R. 1959. "A Canopy-coverage Method of Vegetational Analysis." *Northwest Science* 33: 43 – 64.

Davis, W. H., and H. B. Hitchcock. 1965. "Biology and Migration of the Bat, *Myotis lucifugus*, in New England." *Journal of Mammalogy* 46:296–313.

Dirks, B., and J. DeJong. 2007. "Animal Surveys at the Camp Ripley and Arden Hills Minnesota Army National Guard Training Sites – 2006 Annual Report." Minnesota Department of Natural Resources Camp Ripley Series Report No. 16.

Dirks, B., J. DeJong, N. Dietz, and P. Perry. 2010. "*Draft* Protected Species Management Plan for Camp Ripley Army National Guard Training Site, Little Falls, MN and Arden Hills Army Training Site, Arden Hills, MN." Minnesota Department of Natural Resources, Camp Ripley Series Report No. 20, Little Falls, MN.

Dirks, B., N. Dietz, and J. DeJong. 2008. "Camp Ripley and Arden Hills Minnesota Army National Guard Training Sites – Conservation Program Report, 2007 Annual Report." Minnesota Department of Natural Resources Camp Ripley Series Report No. 17.

Dirks, B., and N. Dietz. 2009. "Camp Ripley and Arden Hills Minnesota Army National Guard Training Sites Conservation Program Report – 2008 Annual Report, January 1 – December 31, 2008." Minnesota Department of Natural Resources Camp Ripley Series Report No. 18, St. Paul, MN.

Dirks, B., and N. Dietz. 2010. "Camp Ripley and Arden Hills Minnesota Army National Guard Training Sites Conservation Program Report – 2009 Annual Report, January 1 – December 31, 2009." Camp Ripley Series Report No. 19, Little Falls, USA. 245 pp.

Dirks, B., and N. Dietz. 2011. "Camp Ripley and Arden Hills Minnesota Army National Guard Training Sites Conservation Program Report – 2010 Annual Report, January 1 – December 31, 2009." Camp Ripley Series Report No. 20, Little Falls, USA. 218 pp.

Dirks, B., N. Dietz, R. Baker, and M. Swingen. 2016. "Summary of Bat Research in Camp Ripley Training Center and Arden Hills Army Training Site, MN 2016." NRRI Technical Report No. NRRI/TR-2016-42E.

Dorff Hall, C. and F. J. Cuthbert. 2000. "Impact of a Controlled Wetland Drawdown on Blanding's Turtles in Minnesota." Chelonian Conservation and Biology 3(4):643 – 649.

Dorff, C., and G. E. Nordquist. 1993. "Animal Surveys at the Minnesota Army National Guard Camp Ripley Training Site, 1991 – 1992. Final Report." Nongame Wildlife and Natural Heritage Programs, Minnesota Department of Natural Resources, St. Paul, MN. 82 pp.

Erb, J., C. Humpal, and B. Sampson. 2018. “Minnesota Wolf Population Update 2017.” Website (online) at <http://files.dnr.state.mn.us/wildlife/wolves/2017/survey-wolf.pdf>. Accessed 23 January 2018.

Frick, W. F., J. F. Pollock, A. C. Hicks, K. E. Langwig, D. S. Reynolds, G. G. Turner, C. M. Butchkoski, and T. H. Kunz. 2010. “An Emerging Disease Causes Regional Population Collapse of a Common North American Bat Species.” *Science* 329:679 – 682.

Garshelis, D. L., P. L. Coy, and K. V. Noyce. 2004. “Ecology and Population Dynamics of Black Bears in Minnesota.” In “*Summaries of Wildlife Research Findings 2003*,” eds. M. W. Don Carlos, R. O. Kimmel, J. S. Lawrence, and M. S. Lenarz,120 – 126. Minnesota Department of Natural Resources. 230 pp.

Grosshuesch, D. A. 2008. “Western Great Lakes Region Owl Monitoring Survey – 2008 Final Report.” Hawk Ridge Bird Observatory, Duluth, Minnesota. 21 pp.

Grosshuesch, D. A., and R.S. Brady. 2015. “Western Great Lakes Region Owl Survey – 2014 Report.” Hawk Ridge Bird Observatory and Wisconsin Bird Conservation Initiative. 23 pp.

Hansen, D.C. 1994. “The Butterflies of Camp Ripley.” Minnesota Department of Natural Resources and Camp Ripley Environmental Office. 65 pp.

Hanson, J., and K. Malone. 2011. “Project Report: Integrated Invasive Terrestrial Plant Management Program Implementation on Camp Ripley Army Training Sites in 2011.” Department of Biological Sciences, St. Cloud State University, December 2011. 92 pp.

Hatfield, R., S. Jepsen, E. Mader, S.H. Black, and M. Shepherd. 2012. “Conserving Bumble Bees, Guidelines for Creating and Managing Habitat for America’s Declining Pollinators.” The Xerces Society for Invertebrate Conservation. 32 pp.

Hawk Ridge Bird Observatory. 2017. “Western Great Lakes Owl Monitoring - Overview.” Website (online) at <http://owlsurvey.hawkridge.org/>. Accessed 18 October 2017.

Hazard, E.B. 1982. “*The Mammals of Minnesota*.” James Ford Bell Museum of Natural History, University of Minnesota Press, Minneapolis, MN. 280 pp.

Henry, M., D. W. Thomas, R. Vaudry, and M. Carrier. 2002. Foraging Distances and Home Range of Pregnant and Lactating Little Brown Bats (*Myotis lucifugus*). *Journal of Mammalogy* 83:767–774.

Herkert, J. R. 2003. “Effects of Management Practices on Grassland Birds: Henslow’s Sparrow.” Northern Prairie Wildlife Research Center, Jamestown, ND. Northern Prairie Wildlife Research Center Online. <http://www.npwrc.usgs.gov/resource/literatr/grasbird/hesp/hesp.htm> (Version 12DEC2003)

International Crane Foundation. 2010. “Annual Midwest Crane Count.” Online at <http://www.savingcranes.org/annual-midwest-crane-count.html >. Accessed 27 September 2010.

Johnson, T. L., C. B. Graham, A. Hojgaard, N. E. Breuner, S. E. Maes, K. A. Boegler, A. J. Replogle, L. C. Kingry, J. M. Petersen, L. Eisen, and R. J. Eisen. “Isolation of the Lyme Disease Spirochete *Borrelia mayonii* from Naturally Infected Rodents in Minnesota.” *Journal of Medical Entomology, In Review*.

Johnson, J. B., J. E. Gates, and W. M. Ford. 2008. “Distribution and Activity of Bats at Local and Landscape Scales within a Rural-Urban Gradient.” *Urban Ecosystems* 11:227–242.

Jordan, P. A., D. G. Paron, and T. Pharis. 1997. “Impact of Winter Browsing by Deer on Oak Regeneration at the Twin Cities Army Ammunition Plant, 1996 – 97.” Department of Fisheries and Wildlife, University of Minnesota. 7 p.

Larson, K. 2017. “1994 – 2015 Minnesota Frog and Toad Calling Survey (MNFTCS), 2015 Survey Report.” Minnesota Department of Natural Resources, Nongame Wildlife Program, MN. 2 pp.

McAuley, Daniel G., Daniel M. Keppie and R. Montague Whiting Jr.. 2013. “American Woodcock (Scolopax minor), version 2.0.” In *The Birds of North America* (P. G. Rodewald, editor). Cornell Lab of Ornithology, Ithaca, New York, USA. Online. <https://doi.org/10.2173/bna.100>. Accessed 5 December 2017

Minnesota Army National Guard. 2002. “Camp Ripley Training Site, Forest Management Plan, Morrison County, Minnesota.” Camp Ripley Environmental Office, Little Falls, MN.

Minnesota Army National Guard. 2007. “Arden Hills Army Training Site, Integrated Natural Resources Management Plan, Ramsey County, Minnesota.” Camp Ripley, Little Falls, MN.

Minnesota Army National Guard. 2009. “Minnesota Army National Guard, Arden Hills Army Training Site, Sustainability Master Plan, Final Report.” 78 pages plus appendices.

Minnesota Army National Guard. 2014. Camp Ripley Site Development Plan. Camp Ripley, Little Falls, MN.

Minnesota Army National Guard. 2017a. “Camp Ripley’s Integrated Wildland Fire Management Plan.” Camp Ripley Army Training Center, Little Falls, MN.

Minnesota Army National Guard. 2017b. FY2018 Range Complex Master Plan. Camp Ripley, Little Falls, MN.

Minnesota Army National Guard. 2018a. “Camp Ripley Training Center, *Draft* Integrated Natural Resources Management Plan Update, 2018.” Camp Ripley, Little Falls, MN. plus appendices.

Minnesota Army National Guard. 2018b. “Arden Hills Army Training Site, *Draft* Integrated Natural Resources Management Plan Update, 2018.” Camp Ripley, Little Falls, MN. plus appendices.

Minnesota Department of Agriculture 2016. “Minnesota Noxious Weeds.” Website (online) < http://www.mda.state.mn.us/plants/pestmanagement/weedcontrol/noxiouslist.aspx>. Accessed 4 January 2016.

Minnesota Department of Natural Resources. 2011b. The Minnesota Department of Natural Resources Website (online). Nature – Common loon (*Gavia immer*) <http://www.dnr.state.mn.us/birds/commonloon.html >. Accessed 12 December 2011.

Minnesota Department of Natural Resources. 2013a. Miller Lake (#49 – 51p) Public Waters Work Permit #2013 – 0125. 3 pp.

Minnesota Department of Natural Resources. 2013b. The Minnesota Department of Natural Resources Website (online). "Species Profile – Northern Myotis (*Myotis septentrionalis*)" <http://www.dnr.state.mn.us/rsg/profile.html?action=elementDetail&selectedElement=AMACC01150>. Accessed 11 December 2013.

Minnesota Department of Natural Resources. 2013c. "Fungus Dangerous to Bats Detected at 2 Minnesota State Parks." Press Release 9 Aug 2013.

Minnesota Department of Natural Resources. 2015a. "Minnesota's Wildlife Action Plan 2015 – 2025, Working with Partners for Wildlife Conservation." 150 pages + appendices.

Minnesota Department of Natural Resources. 2015b. The Minnesota Department of Natural Resources Website (online). "Nature – Gray Wolf" <http://www.dnr.state.mn.us/mammals/wolves/mgmt.html>. Accessed 13 January 2015.

Minnesota Department of Natural Resources. 2016a. "Rare Species Guide, Gray Wolf." Website (online) <http://www.dnr.state.mn.us/rsg/profile.html?action=elementDetail&selectedElement=AMAJA01030>. Accessed 6 January 2016.

Minnesota Department of Natural Resources. 2016b. "White-nose Syndrome and Minnesota's Bats." Website <http://www.dnr.state.mn.us/wns/index.html>. Accessed 26 January 2016.

Minnesota Department of Natural Resources. 2016c. "First Case of White-nose Syndrome, a Disease that can Kill Bats, Confirmed in Minnesota." Press Release 9 March 2016.

Minnesota Department of Natural Resources. 2016d. "Wild Bee Pollinator Surveys in Prairie–Grassland Habitats." September 2016. 20 pp.

Minnesota Department of Natural Resources. 2017a. The Minnesota Department of Natural Resources Website (online). Eastern Bluebird (*Sialia sialis*) < http://www.dnr.state.mn.us/birds/easternbluebird.html>. Accessed 18 October 2017.

Minnesota Department of Natural Resources. 2017b. Bat Disease White-nose Syndrome now Confirmed in Six Minnesota Counties. Press Release 23 March 2017.

Minnesota Department of Natural Resources. 2017c. Minnesota's Pollinators. Website (online) <http://www.dnr.state.mn.us/pollinators/index.html>. Accessed 4 January 2017.

Minnesota Department of Natural Resources and Minnesota Army National Guard. 2012. "Minnesota Army National Guard, Camp Ripley Training Center and Arden Hills Army Training Site, 2011 Conservation Program Report, January 1 – December 31, 2011." Compiled by Nancy J. Dietz and Brian J. Dirks, Camp Ripley Series Report No. 21, Little Falls, MN, USA. 223 pp.

Minnesota Department of Natural Resources and Minnesota Army National Guard. 2013. “Minnesota Army National Guard, Camp Ripley Training Center and Arden Hills Army Training Site, 2013 Conservation Program Report, January 1 – December 31, 2012.” Compiled by Nancy J. Dietz and Brian J. Dirks, Camp Ripley Series Report No. 22, Little Falls, MN, USA. 221 pp.

Minnesota Department of Natural Resources and Minnesota Army National Guard. 2014. “Minnesota Army National Guard, Camp Ripley Training Center and Arden Hills Army Training Site, 2013 Conservation Program Report, January 1 – December 31, 2013.” Compiled by Nancy J. Dietz and Brian J. Dirks, Camp Ripley Series Report No. 23, Little Falls, MN, USA. 205 pp.

Minnesota Department of Natural Resources and Minnesota Army National Guard. 2015. “Minnesota Army National Guard, Camp Ripley Training Center and Arden Hills Army Training Site, 2014 Conservation Program Report, January 1 – December 31, 2014.” Compiled by Nancy J. Dietz and Brian J. Dirks, Camp Ripley Series Report No. 24, Little Falls, MN, USA. 208 pp.

Minnesota Department of Natural Resources and Minnesota Army National Guard. 2016. “Minnesota Army National Guard, Camp Ripley Training Center and Arden Hills Army Training Site, 2015 Conservation Program Report, January 1 – December 31, 2015.” Compiled by Nancy J. Dietz and Brian J. Dirks, Camp Ripley Series Report No. 25, Little Falls, MN, USA. 206 pp.

Minnesota Department of Natural Resources and Minnesota Army National Guard. 2017. “Minnesota Army National Guard, Camp Ripley Training Center and Arden Hills Army Training Site, 2016 Conservation Program Report, January 1 – December 31, 2016.” Compiled by Nancy J. Dietz and Brian J. Dirks, Camp Ripley Series Report No. 26, Little Falls, MN, USA. 207 pp.

Minnesota Ornithologists’ Union. 2018a. “Minnesota Christmas Bird Count, Pillager.” Website (online) at < http://moumn.org/CBC/locations.php?cid=49>. Accessed 2 January 2018.

Minnesota Ornithologists’ Union. 2018b. “Minnesota Christmas Bird Count, St. Paul (North).” Website (online) at < http://moumn.org/CBC/locations.php?cid=228>. Accessed 2 January 2018.

Monarch Joint Venture. 2015. “Monarch Life Cycle and Monarch Migration.” Website (online) at < http://monarchjointventure.org/monarch-biology/monarch-migration/ >. Accessed 23 December 2015.

Moriarty, J. No date. “Instructions for Minnesota Frog and Toad Survey.” *Minnesota Herpetological Society*. Unpublished.

National Audubon Society Watchlist Website. 2007. “Henslow’s Sparrow.” <http://audubon2.org/webapp/watchlist/viewSpecies.jsp?id=104>. Accessed 30 April 2007.

National Eagle Center. 2017. “Golden Eagle Project.” Website (online) at <https://www.nationaleaglecenter.org/golden-eagle-project/golden-eagles-in-minnesota/>. Accessed 27 March 2017.

NatureServe. 2009. “Common Nighthawk (*Chordeiles minor*).” NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available http://www.natureserve.org/explorer. Accessed 13 December 2011.

NatureServe. 2011. “NatureServe Explorer: An online encyclopedia of life [web application]. Chimney Swift.” Version 7.1. NatureServe, Arlington, Virginia. Website (online) at <http://www.natureserve.org/explorer>. Accessed 28 November 2011.

North American Bluebird Society. 2017a. “North American Bluebird Society History.” Website (online) < http://www.nabluebirdsociety.org/Main/nabs%20history.htm>. Accessed 18 October 2017.

North American Bluebird Society. 2017b. “North American Bluebird Society Gilbertson Bluebird Nest Box.” Website (online) < http://www.nabluebirdsociety.org/nestboxes/gilbertson.htm>. Accessed 18 October 2017.

Pfannmuller, L., G. Niemi, J. Green, B. Sample, N. Walton, E. Zlonis, T. Brown, A. Bracey, G. Host, J. Reed, K. Rewinkel, and N. Will. 2017a. The First Minnesota Breeding Bird Atlas (2009 – 2013). “Species Accounts: Red-eyed Vireo, *Vireo olivaceus*, Population Abundance” Website (online) < https://mnbirdatlas.org/species/red-eyed-vireo/> and “Species Accounts: Golden-winged Warbler, *Vermivora chrysoptera*, Population Abundance” Website (online) < https://mnbirdatlas.org/species/golden-winged-warbler/>. Accessed 20 November 2017.

Pfannmuller, L., G. Niemi, J. Green, B. Sample, N. Walton, E. Zlonis, T. Brown, A. Bracey, G. Host, J. Reed, K. Rewinkel, and N. Will. 2017b. The First Minnesota Breeding Bird Atlas (2009-2013). “Species Accounts: American woodcock, *Scolopax minor*, Population Abundance” Website (online) < https://mnbirdatlas.org/species/american-woodcock/>. Accessed 5 December 2017.

Pfannmuller, L., G. Niemi, J. Green, B. Sample, N. Walton, E. Zlonis, T. Brown, A. Bracey, G. Host, J. Reed, K. Rewinkel, and N. Will. 2017c. The First Minnesota Breeding Bird Atlas (2009 – 2013). “Species Accounts: Bobolink, *Dolichonyx oryzivorus*” Website (online) <https://mnbirdatlas.org/species/bobolink/>. Accessed 5 December 2017.

Piepgras, S. and J. Lang. 2000. “Spatial Ecology of Blanding’s Turtle in Central Minnesota.” *Chelonian Conservation and Biology* 3:589 – 601.

Reichard, J. D., and T. H. Kunz. 2009. “White-Nose Syndrome Inflicts Lasting Injuries to the Wings of Little Brown Myotis (*Myotis lucifugus*).” *Acta Chiropterologica* 11:457–464.

Sajwaj, T. D., Piepgras, S. A., and J. W. Lang. 1998. “Blanding's Turtle *(Emydoidea Blandingii)* at Camp Riley: Critical Habits, Population Status and Management Guidelines.” Biology Department, University of North Dakota.

Sauer, J. R., J. E. Hines, and J. Fallon. 2008. “The North American Breeding Bird Survey, Results and Analysis 1966 – 2007.” Version 5.15.2008. USGS Patuxent Wildlife Research Center, Laurel, MD. Online Website <http://www.mbr-pwrc.usgs.gov/bbs/bbs.html>. Accessed October 2008.

Standing, K. L., Herman, T. B., and I. P. Morrison. 1999. “Nesting Ecology of Blanding's Turtle (*Emydoidea blandingii*) in Nova Scotia, the Northeastern Limit of the Species' Range.” *Canadian Journal of Zoology* 77 (10): 1609 – 1614.

Standing, K. L., Herman, T. B., and I. P. Morrison. 2000. “Developmental Abnormalities in a Northeastern Population of Blanding‘s Turtle, *Emydoidea blandingii*.” *Chelonian Conservation and Biology* 3: 661 – 664.

Swingen, M., R. Baker, T. Catton, K. Kirschbaum, G. Nordquist, B. Dirks, and R. Moen. 2016. “Summary of 2016 Northern Long-eared Bat Research in Minnesota.” NRRI Technical Report No. NRRI/TR-2016/41. University of Minnesota Duluth.

Swingen, M., R. Moen, R. Baker, G. Nordquist, T. Catton, K. Kirschbaum, B. Dirks, and N. Dietz. 2018. “Summary of 2017 Bat Research in Minnesota.” NRRI Technical Report No. NRRI/TR-201740. University of Minnesota Duluth.

Turner, G. G., D. M. Reeder, and J. T. H. Coleman. 2011. “A five-year Assessment of Mortality and Geographic Spread of White-nose Syndrome in North American Bats and a Look to the Future.” *Bat Research News* 52:13 – 27.

University of Minnesota. 2017. “Woody vegetation control,” website (online) <http://www.extension.umn.edu/environment/agroforestry/woody-vegetation-control.html>. Accessed 13 January 2017.

U.S. Army Environmental Hygiene Agency. 1991. “Ecological Assessment, Twin Cities Army Ammunition Plant, New Brighton, MN, Feb. 1990 – April 1991.” Aberdeen Proving Ground, MN. Report #21010–5422. 133 pp. plus appendices.

U.S. Department of Agriculture. 2009. “Executive Order #13112.” Federal Laws and Regulations. USDA, website < http://www.invasivespeciesinfo.gov/laws/execorder.shtml >. Accessed 7 January 2009.

U.S. Fish and Wildlife Service. 2007. “National Bald Eagle Management Guidelines.” USFWS, Region 3, website <http://www.fws.gov/migratorybirds/issues/BaldEagle/NationalBaldEagleManagementGuidelines.pdf >. Accessed 3 June 2008.

U.S. Fish and Wildlife Service. 2008a. “Title 16. Conservation, Chapter 5A Protection and Conservation of Wildlife – Bald and Golden Eagle Protection Act.” USFWS, Region 3, website <http://www.fws.gov/permits/mbpermits/regulations/BGEPA.PDF >. Accessed 22 July 2008.

U.S. Fish and Wildlife Service. 2008b. “Endangered Species Act of 1973, Digest of Federal Resource Laws of Interest to the U.S. Fish and Wildlife Service,” website (online) <http://www.fws.gov/laws/lawsdigest/ESACT.html>. Accessed 24 November 2008.

U.S. Fish and Wildlife Service. 2011a. “Fish and Wildlife Service Reopens Comment Period on Revising the List of Endangered and Threatened Wildlife for the Gray Wolf in the Eastern United States.” U.S. Fish and Wildlife Service Website (online) <http://www.fws.gov/midwest/News/release.cfm?rid=451>. Accessed 6 December 2011.

U.S. Fish and Wildlife Service. 2011b. “Gray Wolves Delisted in Western Great Lakes Distinct Population Segment.” U.S. Fish and Wildlife Service website (online) < http://www.fws.gov/midwest/wolf/delisting/index.htm>. Accessed 19 December 2012.

U.S. Fish and Wildlife Service. 2013. “Northern Long-Eared Bat (*Myotis septentrionalis*) Fact Sheet.” U.S. Fish and Wildlife Service, Endangered Species, Midwest Region website (online) < http://www.fws.gov/midwest/endangered/mammals/nlba/nlbaFactSheet.html>. Accessed 11 December 2013.

U.S. Fish and Wildlife Service. 2015. “Gray Wolves in the Western Great Lakes States.” Website <http://www.fws.gov/midwest/wolf/>. Accessed 13 January 2015.

U.S. Fish and Wildlife Service. 2016a. “Bald Eagle, Bald Eagle Breeding Pairs 1990 – 2006.” Website (online) <https://www.fws.gov/Midwest/eagle/population/nos_state_tbl.html>. Accessed 12 October 2016.

U.S. Fish and Wildlife Service. 2016b. “USFWS Endangered Species, Northern long-eared Bat (*Myotis septentrionalis*) Status.” Website <https://www.fws.gov/Midwest/endangered/mammals/nleb/index.html>. Accessed 14 December 2016.

U.S. Fish and Wildlife Service. 2016c. “Environmental Conservation Online System, Northern long-eared Bat (Myotis septentrionalis)” Website <http://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=A0JE#crithab>. Accessed 26 January 2016.

U.S. Fish and Wildlife Service. 2016d. Ecological Services, “Status Reviews for Five Midwestern Reptiles and Amphibians July 1, 2015, Positive 90-Day Findings.” Website (online) <http://www.fws.gov/midwest/es/soc/Batch90DayJuly2015.html>. Accessed 6 January 2016.

U.S. Fish and Wildlife Service. 2017a. “Species of Concern: Golden-winged Warbler, Finding on Petition to List under the Endangered Species Act.” Website (online) <https://www.fws.gov/midwest/es/soc/birds/GoldenWingedWarbler/GWWA90DayFinding.html>. Accessed 20 November 2017

U.S. Fish and Wildlife Service. 2017b. “Rusty Patched Bumble Bee (*Bombus affinis*), Status: Proposed as Endangered.” Website (online) <https://www.fws.gov/midwest/endangered/insects/rpbb/>. Accessed 4 January 2017.

U.S. Geological Survey. 2014. “Identifying Bats by Sound.” Website (online) at http://www.usgs.gov/newsroom/article.asp?ID=3801&from=rss**.** Accessed September 2014.

U.S. National Archives and Records Administration. 2013. Federal Register. Department of Interior, Fish and Wildlife Service. “Endangered and Threatened Wildlife and Plants; 12-Month Finding on a Petition To List the Eastern Small-footed Bat and the Northern Long-Eared Bat as Endangered or Threatened Species; Listing the Northern Long-Eared Bat as an Endangered Species.” 50 CFR Part 17, Vol. 78, No. 191, October 2, 2013.

White-nose Syndrome. 2017. “White-nose Syndrome – Updated White-nose Syndrome map October 12, 2017.” Website (online) at <https://www.whitenosesyndrome.org/resource/updated-white-nose-syndrome-map-october-12-2017>. Accessed 7 December 2017.

Wisconsin Department of Natural Resources. 2016. “Discovery of new bat species in Wisconsin cheers biologists.” Weekly News Article published September 13, 2016. Accessed 14 Sep 2016 at <http://dnr.wi.gov/news/Weekly/article/?id=3723>.

Weather Underground. 2018a. “Weather History, Pillager, Minnesota, January 1, 2018.” Wunderground website (online) <https://www.wunderground.com/history/airport/KBRD/2018/1/1/DailyHistory.html?req_city=&req_state=&req_statename=&reqdb.zip=&reqdb.magic=&reqdb.wmo=>. Accessed 2 January 2018.

Weather Underground. 2018b. “Weather History, Brainerd, Minnesota, June 1 to June 24, 2017 and March 1 to May 31, 2017.” Wunderground website (online) <https://www.wunderground.com/history/airport/KBRD/2017/6/1/CustomHistory.html?dayend=24&monthend=6&yearend=2017&req_city=&req_state=&req_statename=&reqdb.zip=&reqdb.magic=&reqdb.wmo=>. Accessed 3 January, 2018.

Weather Underground. 2018c. “Weather History, Arden Hills, Minnesota, December 16, 2017.” Wunderground website (online) <https://www.wunderground.com/history/airport/KANE/2017/12/16/DailyHistory.html?req_city=&req_state=&req_statename=&reqdb.zip=&reqdb.magic=&reqdb.wmo=>. Accessed 2 January 2018.

Appendix A: Brief Descriptions of Endemic Vector-Borne Diseases in Minnesota.

Tick Borne

- Anaplasmosis – the second most common tick borne disease in Minnesota. It is a bacterial illness caused by *Anaplasma phagocytophilum* and transmitted by the bite of an infected blacklegged (deer) tick. It was formerly known as human granulocytic ehrlichiosis and was first recognized in Minnesota in the mid-1990s. Symptoms usually occur within 1-2 weeks of a tick bite and may include a sudden onset of fever, headache and muscle aches.

- Babesiosis – the third most common tick borne disease in Minnesota. It is caused by a blood parasite, *Babesia microti*, and transmitted by the bite of an infected blacklegged (deer) tick. Many people infected with babesiosis have no symptoms or only mild symptoms. Symptoms such as fever, headache, muscle aches and fatigue may appear within several weeks of a tick bite.

- Ehrlichiosis – a rarely reported form of ehrlichiosis *(Ehrlichia muris eauclairensis*) has been found to be transmitted by the bite of infected blacklegged (deer) ticks in Minnesota and Wisconsin. It was first discovered in 2009 and is similar to anaplasmosis involving symptoms such as fever, headache and muscle/joint aches.

- Hard Tick Relapsing Fever – a recently identified illness caused by the bacteria, *Borrelia miyamotoi*. It was first identified as a cause of human illness in 2011 and is likely transmitted by the bite of an infected blacklegged (deer) tick. To date, low numbers of human disease have been reported from the Northeastern and Upper Midwestern regions of the United States. The most common symptoms have included fever, chills, headache, muscle/joint pain and fatigue.

- Lyme Disease – the most common tick borne disease in Minnesota and in the United States. It is a bacterial illness caused by *Borrelia burgdorferi* and transmitted by the bite of an infected blacklegged (deer) tick. It was discovered in Lyme, CT in 1975 and has since been found increasingly throughout several parts of the Northeastern and Upper Midwestern regions of the United States. Early symptoms typically appear within 30 days of a tick bite and may include rash, fever, headache, fatigue and muscle/joint pain. Other symptoms (e.g., multiple rashes, paralysis on one side of the face, or swelling in one or more joints) may occur weeks to months later if a person is not treated early in the course of illness. A closely related organism, *Borrelia mayonii*, was recently identified in 2013 to cause an illness similar to Lyme disease. To date, this organism has only rarely been found in patients with exposures to blacklegged (deer) ticks in Minnesota and Wisconsin.

- Rocky Mountain Spotted Fever – a very rare bacterial illness, caused by *Rickettsia rickettsii*, that is transmitted by the bite of an infected American dog (wood) tick. It is more commonly reported in south-central and southeastern states although rare cases have been reported in Minnesota. Symptoms may include an abrupt onset of fever, headache, muscle aches, nausea, vomiting and spotted rash. The illness can cause organ failure and death so prompt treatment is recommended in suspect cases

- Tularemia – a very rare bacterial illness caused by *Francisella tularensis* and transmitted by several different routes. For instance, bites from an infected deer fly or American dog (wood) tick may transmit the disease while contact with infected rabbits may also spread the disease. Symptoms vary depending on the route of exposure and may include fever, enlarged lymph nodes, ulcerated skin wound, respiratory or gastrointestinal signs. The illness can cause serious complications and death so prompt treatment is recommended in suspect cases.

Mosquito Borne

- Eastern Equine Encephalitis (EEE) - a rare illness in humans that is maintained in nature through a transmission cycle involving *Culiseta melanura* and birds. Humans may become infected after a bite through an infected bridge vector such as *Coquillettidia perturbans*. Many people infected with EEE virus show no symptoms but some (primarily children) have severe illness. Symptoms may include a sudden onset of headache, fever and vomiting that may progress to disorientation, seizures, coma and death. Although cases have been reported in horses, no human cases have been identified in Minnesota.

- Jamestown Canyon Virus Disease – a rarely reported cause of illness in humans that may be transmitted by several different types of mosquitoes throughout Minnesota, particularly the snowmelt *Aedes* species. The virus is closely related to La Crosse virus although any age group may be affected and cases may occur anytime during the warmer months of the year, most commonly between May and September. Similar to other mosquito borne illnesses, symptoms may include fever, headache, meningitis or encephalitis (inflammation of the central nervous system, including the brain).

- La Crosse Encephalitis – this rare illness is caused by La Crosse virus and transmitted to humans primarily by *Aedes triseriatus* (tree hole mosquito) in Minnesota. Cases have been primarily reported from the southeastern region of Minnesota but the Minnesota Department of Health has had recent case reports from central Minnesota in Stearns County. Most people infected with this virus will have either no symptoms or a mild flu-like illness. Symptoms usually show up suddenly within 1 – 2 weeks of being bitten by an infected mosquito. A small percentage of people (especially children) may develop encephalitis (inflammation of the brain).

- West Nile Virus Disease - West Nile virus (WNV) is transmitted to people through the bite of an infected mosquito. In Minnesota, *Culex tarsalis*, a common mosquito in agricultural regions of western and central Minnesota, is the most important vector in transmitting the virus to humans. Most people infected with West Nile virus will have no symptoms or a mild illness with fever. A small percentage of people (<1%), especially elderly patients, may develop meningitis or encephalitis (inflammation of the central nervous system, including the brain). Approximately 10% of these encephalitis cases are fatal.

DEPARTMENT OF
NATURAL RESOURCES

NONGAME WILDLIFE PROGRAM • MINNESOTA DEPARTMENT OF NATURAL RESOURCES •

STATE OF MINNESOTA
MASTER INTERAGENCY AGREEMENT

This agreement is between the Minnesota Departments of Military Affairs, 15000 Highway 115, Camp Ripley, Little Falls, MN 56345-4173 (“Requesting Agency”), and the Department of Natural Resources, 500 Lafayette Road, St. Paul, MN 55155-4040 ("Providing Agency").

Recitals

1. The Requesting Agency is in need of support in the following areas:
   a. Flora and Fauna Surveys
   b. Biological Research
   c. Wildlife Management Practices
   d. Natural Resource Planning
   e. Technical Report Writing
   f. Environmental Outreach
   g. Protected Species Management
   h. Pest Management
   i. Forest Management
   j. Prescribed Burning
2. Reference Cooperative Agreement, dated 11 September 2002.

Agreement

1 Term of Master Agreement

1.1 Effective date: 1 January 2014, or the date the State obtains all required signatures under Minnesota Statutes Section 16C.05, subdivision 2, whichever is later.
The Providing Agency must not accept work under this master agreement until this master contract is fully executed and the Providing Agency has been notified by the Requesting Agency that it may begin accepting Work Order Agreements.

1.2 Work Order Agreements: The term of work under work order agreements issued under this master agreement may not extend beyond the expiration date of this master agreement.

1.3 Expiration date: 1 January 2019.

2 Scope of Work

2.1 Duties of the Providing Agency.
Provide personnel, transportation, equipment, supplies, and services, for the purposes of accomplishing tasks described in each work order agreement issued. A complete detailed description of required work will be furnished in each work order agreement issued.

The Providing Agency understands that only the receipt of a fully executed work order agreement authorizes the Providing Agency to begin work under this master agreement. Any and all effort, expenses, or actions taken before the work order agreement is fully executed is not authorized under Minnesota Statutes and is under taken at the sole responsibility and expenses of the Providing Agency.

The Providing Agency understands that this master agreement is not a guarantee of a work order agreement. The Requesting Agency has determined that it may have need for the services under this master agreement, but does not commit to spending any money with the Providing Agency.

2.2 Duties of the Requesting Agency. Duties will be furnished in each work order agreement issued.

3 Time

The Providing Agency must comply with all the time requirements described in work order agreements.

4 Consideration and Payment

4.1 (1) **Consideration**. The Requesting Agency will pay for all services performed and, if applicable, ancillary goods or materials supplied, by the Providing Agency for all work order agreements issued under this master agreement. The total compensation for all work order agreements may not exceed One Million Five Hundred Thousand and No/100 Dollars ($1,500,000.00).

(2) **Indirect Costs.** The amount allowed shall not exceed that authorized in OMB Circular A-87.

4.2 Payment

(1) **Invoices**. The Requesting Agency will pay the Providing Agency within 30 days of the Requesting Agency's presentation of an itemized invoice for the services performed or, ancillary goods or materials supplied, and acceptance of such services by the Requesting Agency's Project Manager.

5 Conditions of Payment

All services provided by the Providing Agency under a work order agreement must be performed to the Requesting Agency's satisfaction, as determined at the sole discretion of the Requesting Agency's Project Manager and in accordance with all applicable federal, state, and local laws, ordinances, rules, and regulations. The Providing Agency will not receive payment for work found by the Requesting Agency to be unsatisfactory or performed in violation of federal, state, or local law.

6 Authorized Representatives and Project Managers

The Requesting Agency's Authorized Representative for this master agreement is Ms. Carol Prozinski, Department of Military Affairs, Facilities Management Office, Camp Ripley, 15000 Highway 115, Little Falls, MN 56345-4173, telephone 320.616.2629, or her successor. If the Requesting Agency's Authorized Representative changes at any time during this master agreement, the Requesting Agency must immediately notify the Providing Agency.

The Requesting Agency's Project Manager will be identified in each work order agreement.

The Providing Agency's Authorized Representative is Ms. Kim Montgomery, Department of Natural Resources, 500 Lafayette Road, Box 10, St. Paul, MN 55155-4010, telephone 651.259.5567, or her successor. If the Providing Agency's Authorized Representative changes at any time during this master agreement, the Providing Agency must immediately notify the Requesting Agency.

The Providing Agency's Project Manager will be identified in each work order agreement.

7 Amendments

Any amendment to this master agreement or any work order agreement must be in writing and will not be effective until it has been executed and approved by the same parties who executed and approved the master agreement, or their successors in office.

8 Liability

Each party will be responsible for its own acts and behavior and the results thereof.

9 Ownership Of Materials And Intellectual Property Rights

9.1 The Requesting Agency shall own all rights, title and interest in all of the materials conceived or created by the Providing Agency, or its employees or subcontractors, either individually or jointly with others and which arise out of the performance of this agreement, including any inventions, reports, studies, designs, drawings, specifications, notes, documents, software and documentation, computer based training modules, electronically, magnetically or digitally recorded material, and other work in whatever form ("MATERIALS").

The Providing Agency hereby assigns to the Requesting Agency all rights, title and interest to the MATERIALS. Providing Agency shall, upon request of the Requesting Agency, execute all papers and perform all other acts necessary to assist the Requesting Agency to obtain and register copyrights, patents or other forms of protection provided by law for the MATERIALS. The MATERIALS created under this agreement by the Providing Agency, its employees or subcontractors, individually or jointly with others, shall be considered "works made for hire" as defined by the United States Copyright Act. All of the MATERIALS, whether in paper, electronic, or other form, shall be remitted to the Requesting Agency by the Providing Agency. The Providing Agency's employees and any subcontractors, shall not copy, reproduce, allow or cause to have the MATERIALS copied, reproduced or used for any purpose other than performance of the Providing Agency's obligations under this agreement without the prior written consent of the Requesting Agency's authorized representative except pursuant to the Minnesota Data Practices Act and other applicable laws.

9.2 Providing Agency represents and warrants that MATERIALS produced or used under this agreement do not and will not infringe upon any intellectual property rights of another, including but not limited to patents, copyrights, trade secrets, trade names, and service marks and names.

10 Publicity and Endorsement

Any publicity regarding the subject matter of a work order agreement must identify the Requesting Agency as the sponsoring agency and must not be released without prior written approval from the Requesting Agency's Authorized Representative. For purposes of this provision, publicity includes notices, informational pamphlets, press releases, research, reports, signs, and similar public notices prepared by or for the Providing Agency individually or jointly with others, or any subcontractors, with respect to the program, publications, or services provided resulting from a work order agreement.

11 Termination

11.1 This master agreement and any work order agreements may be canceled by the Requesting Agency or Providing Agency at any time, with or without cause, upon thirty (30) days written notice to the other party. In the event of such a cancellation the Providing Agency shall be entitled to payment, determined on a pro rata basis, for work or services satisfactorily performed.

11.2 Termination for Insufficient Funding. This master agreement and any work order agreements may be canceled by the Requesting Agency or Providing Agency at any time, if funding is not obtained from the Minnesota legislature or other funding source; or if funding cannot be continued at a level sufficient to allow for the payment of the services covered here. Termination must be by written or fax notice to the other party. The Requesting Agency is not obligated to pay for any services that are provided after notice and effective date of termination. However, the Providing Agency will be entitled to payment, determined on a pro rata basis, for services satisfactorily performed to the extent that funds are available. The Requesting Agency will not be assessed any penalty if the master contract or work order is terminated because of the decision of the Minnesota legislature or other funding source, not to appropriate funds. The Requesting Agency must provide the Providing Agency notice of the lack of funding within a reasonable time of the Providing Agency's receiving that notice.

12 Other Provisions

EXHIBIT A, Special Conditions for Contract Work Involving Federal Funds, is attached and incorporated into this agreement.

1. PROVIDING AGENCY
DEPARTMENT OF NATURAL RESOURCES

By: ____________________
Title: Deputy Director
Date: 11/19/13

By: ____________________
Title: Director of Forestry
Date: 11/21/13

2. REQUESTING AGENCY
DEPARTMENT OF MILITARY AFFAIRS

By: ____________________
Major General Richard C. Nash
Title: The Adjutant General
Date: DEC 16 2013

EXHIBIT A
SPECIAL CONDITIONS FOR CONTRACT WORK INVOLVING FEDERAL FUNDS

Master Interagency Agreement between the
Department of Military Affairs and the Department of Natural Resources
(Project No. 14125)

EXHIBIT A
SPECIAL CONDITIONS FOR CONTRACT WORK INVOLVING FEDERAL FUNDS

To the extent applicable, the State is required to insert the substance of the following provisions in all contracts, unless State laws or regulations offer more protection.

1. Applicable Law.

This contract is incidental to the implementation of a Federal program. Accordingly, this contract shall be governed by and construed according to federal law as it may affect the rights, remedies, and obligations of the United States.

2. Governing Regulations.

To the extent not inconsistent with the express terms of the Master Cooperative Agreement (MCA) No. W912LM-10-2-1000 between the National Guard Bureau and the State of Minnesota, the provisions of 32 CFR Part 33, Uniform Administrative Requirements for Grants and Cooperative Agreements, DoD Grant and Agreement Regulations (DoDGARS) (DoD 3210.6-R) as amended, Title 2 Code of Federal Regulations (CFR) Part 225, and NGR 5-1, are hereby incorporated by reference as if fully set forth herein, shall govern this contract.

3. Nondiscrimination.

The Contractor/Vendor covenants and agrees that no person shall be subject to discrimination or denied benefits in connection with the State's performance under the contract. Accordingly, and to the extent applicable, the Contractor/Vendor covenants and agrees to comply with the following national policies prohibiting discrimination:

a. On the basis of race, color or national origin, in Title VI of the Civil Rights Act of 1964 (42 U.S.C. Section 2000d et seq.), as implemented by DoD regulations at 32 CFR Part 195.

b. On the basis of race, color or national origin, in Executive Order 11246 as implemented by Department of Labor regulations at 41 CFR Chapter 60.

c. On the basis of sex or blindness, in Title IX of the Education Amendments of 1972 (20 U.S.C. Section 1681, et seq.), as implemented by DoD regulations at 32 CFR Part 196.

d. On the basis of age, in The Age Discrimination Act of 1975 (42 U.S.C. Section 6101, et seq.), as implemented by Department of Health and Human Services regulations at 45 CFR Part 90.

e. On the basis of handicap, in Section 504 of the Rehabilitation Act of 1973 (29 U.S.C. 794), as implemented by Department of Justice regulations at 28 CFR part 41 and DoD regulations at 32 CFR Part 56.

4. Lobbying.

a. The Contractor/Vendor covenants and agrees that it will not expend any funds appropriated by Congress to pay any person for influencing or attempting to influence an officer or employee of any agency, or a Member of Congress in connection with any of the following covered federal actions. The awarding of any federal contract; the making of any federal grant; the making of any federal loan; the entering into of any CA; and the extension, continuation, renewal, amendment, or modification of any Federal contract, grant, loan, or Cooperative Agreement.

b. The Final Rule, New Restrictions on Lobbying, issued by the Office of Management and Budget and the Department of Defense (32 CFR Part 28) to implement the provisions of Section 319 of Public Law 101-121 (31 U.S.C. Section 1352) is incorporated by reference and the state agrees to comply with all the provisions thereof, including any amendments to the Interim Final Rule that may hereafter be issued.

5. Drug-Free work Place.

The Contractor/Vendor covenants and agrees to comply with the requirements regarding drug-free workplace requirements in of 32 CFR Part 26, which implements Section 5151-5160 of the Drug-Free Workplace act of 1988 (Public Law 100-690, Title V, Subtitle D; 41 U.S.C. 701, et seq.).

6. Environmental Protection.

a. The Contractor/Vendor covenants and agrees that its performance under this Agreement shall comply with:

(1) The requirements of Section 114 of the Clean Air Act (42 U.S.C. Section 7414);

(2) Section 308 of the Federal Water Pollution Control Act (33 U.S.C. Section 1318), that relates generally to inspection, monitoring, entry reports, and information, and with all regulations and guidelines issued thereunder;

(3) The Resources Conservation and Recovery Act (RCRA);

(4) The Comprehensive Environmental Response, Compensation and Liabilities Act (CERCLA);

(5) The National Environmental Policy Act (NEPA);

(6) The Solid Waste Disposal Act (SWDA));

(7) The applicable provisions of the Clean Air Act (42 U.S.C. 7401, et seq.) and Clean Water Act (33 U.S.C. 1251, et seq.), as implemented by Executive Order 11738 and Environmental Protection Agency (EPA) rules at 40 CFR Part 31;

(8) To identify any impact this award may have on the quality of the human environment and provide help as needed to comply with the National Environmental Policy Act (NEPA, at 42 U.S.C. 4321, et seq.) and any applicable federal, state or local environmental regulation.

b. In accordance with the EPA rules, the parties further agree that the Grantee shall also identify to the awarding agency (NGB) any impact this award may have on:

(1) The quality of the human environment, and provide help the agency may need to comply with the National Environmental Policy Act (NEPA, at 42 U.S.C 4321, et seq.) and to prepare Environment Impact Statements or other required environmental documentation. In

such cases, the recipient agrees to take no action that will have an adverse environmental impact (e.g., physical disturbance of a site such as breaking of ground) until the agency provides written notification of compliance with the environmental impact analysis process.

(2) Flood-prone areas, and provide help the agency may need to comply with the National Flood Insurance Act of 1968 and Flood Disaster Protection Act of 1973 (42 U.S.C. 4001, et seq.), which require flood insurance, when available, for federally assisted construction or acquisition in flood-prone areas.

(3) Coastal zones, and provide help the agency may need to comply with the Coastal Zone Management Act of 1972 (16 U.S.C. 1451, et seq.), concerning protection of U.S. coastal resources.

(4) Coastal barriers, and provide help the agency may need to comply with the Coastal Barriers Resource Act (16 U.S.C. 3501 et seq.), concerning preservation of barrier resources.

(5) Any existing or proposed component of the National Wild and Scenic Rivers System, and provide help the agency may need to comply with the Wild and Scenic Rivers Act of 1968 (16 U.S.C. 1271 et seq.).

(6) Underground sources of drinking water in areas that have an aquifer that is the sole or principal drinking water source, and provide help the agency may need to comply with the Safe Drinking Water Act (42 U.S.C 300H-3).

7. Use of United States Flag Carriers.

a. The Contractor/Vendor covenants and agrees that travel supported by U.S. Government funds under this agreement shall use U.S.-flag air carriers (air carriers holding certificates under 49 U.S.C. 41102) for international air transportation of people and property to the extent that such service is available, in accordance with the International Air Transportation Fair Competitive Practices Act of 1974 (49 U.S.C. 40118) and the inter-operative guidelines issued by the Comptroller General of the United States in the March 31, 1981, amendment to Comptroller General Decision B138942.

b. The Contractor/Vendor agrees that it will comply with the Cargo Preference Act of 1954 (46 U.S.C. Chapter 553), as implemented by Department of Transportation regulation at 46 CFR 381.7, and 46 CFR 381.7(b).

8. Debarment and Suspension.

The Contractor/Vendor covenants and agrees to comply with the requirements regarding debarment and suspension in Subpart C of the OMB guidance in 2 CFR Part 180, as implemented by the DoD in 2 CFR Part 1125. The Contractor/Vendor agrees to communicate the requirement to comply with Subpart C to persons at the next lower tier with whom the Contractor/Vendor enters into transactions that are "covered transactions" under Subpart B of 2 CFR part 180 and the DoD implementation in 2 CFR Part 1125.

9. Buy American Act.

The Contractor/Vendor covenants and agrees that it will not expend any funds appropriated by Congress without complying with The Buy American Act (41 U.S.C.10a et seq.). The Buy American Act gives preference to domestic end products and domestic construction material. In addition, the Memorandum of Understanding between the United States of America and the European Economic Community (EEC) on Government Procurement, and the North American Free Trade Agreement

(NAFTA), provide that EEC and NAFTA end products and construction materials are exempted from application of the Buy American Act.

10. Uniform Relocation Assistance and real Property Acquisition Policies

The Contractor/Vendor covenants and agrees that it will comply with CFR 49 part 24, which implements the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 (42 U.S.C. Section 4601 et seq.) and provides for fair and equitable treatment of persons displaced by federally assisted programs or persons whose property is acquired as a result of such programs.

11. Copeland "Anti-Kickback" Act.

The Contractor/Vendor covenants and agrees that it will comply with the Copeland "Anti-Kickback" Act (18 U.S.C. Section 874) as supplemented in Department of Labor regulations (29 CFR Part 3). As applied to this agreement, the Copeland "Anti-Kickback" Act makes it unlawful to induce, by force, intimidation, threat of procuring dismissal from employment, or otherwise, any person employed in the construction or repair of public buildings or public works, financed in whole or in part by the United States, to give up any part of the compensation to which that person is entitled under a contract of employment.

12. Contract Work Hours and Safety Standards Act.

The Contractor/Vendor covenants and agrees that it will comply with Sections 103 and 107 of the Contract Work Hours and Safety Standards Act (40 U.S.C. Sections 3701-3708) as supplemented by Department of Labor regulations (29 CFR Part 5). As applied to this agreement, the Contract Work Hours and Safety Standards Act specifies that no laborer or mechanic doing any part of the work contemplated by this contract shall be required or permitted to work more than 40 hours in any workweek unless paid for all additional hours at not less than 1.5 times the basic rate of pay.

13. Central Contractor Registration and Universal Identifier Requirements.

The Contractor/Vendor covenants and agrees to comply with the Central Contractor Registration and Universal Identifier Requirements as indicated below:

A. Requirement for Central Contractor Registration (CCR)

Unless you are exempted from this requirement under 2 CFR 25.110, you as the recipient must maintain the currency of your information in the CCR until you submit the final financial report required under this award or receive the final payment, whichever is later. This requires that you review and update the information at least annually after the initial registration, and more frequently if required by changes in your information or another award term.

B. Requirement for Data Universal Numbering System (DUNS) Numbers

If you are authorized to make subawards under this award, you:

1. Must notify potential subrecipients that no entity (see definition in paragraph C of this award term) may receive a subaward from you unless the entity has provided its DUNS number to you.

2. May not make a subaward to an entity unless the entity has provided its DUNS number to you.

C. Definitions

For purposes of this award term:

1. Central Contractor Registration (CCR) means the Federal repository into which an entity must provide information required for the conduct of business as a recipient. Additional information about registration procedures may be found at the CCR Internet site (currently at http://www.ccr.gov).

2. Data Universal Numbering System (DUNS) number means the nine-digit number established and assigned by Dun and Bradstreet, Inc. (D&B) to uniquely identify business entities. A DUNS number may be obtained from D&B by telephone (currently 866-705-5711) or the Internet (currently at http://fedgov.dnb.com/webform).

3. Entity, as it is used in this award term, means all of the following, as defined at 2 CFR part 25, subpart C:
   a. A Governmental organization, which is a State, local government, or Indian Tribe;
   b. A foreign public entity;
   c. A domestic or foreign nonprofit organization;
   d. A domestic or foreign for-profit organization; and
   e. A Federal agency, but only as a subrecipient under an award or subaward to a non-Federal entity.

4. Subaward:
   a. This term means a legal instrument to provide support for the performance of any portion of the substantive project or program for which you received this award and that you as the recipient award to an eligible subrecipient.
   b. The term does not include your procurement of property and services needed to carry out the project or program (for further explanation, see Sec. ----.210 of the attachment to OMB Circular A-133, ``Audits of States, Local Governments, and Non-Profit Organizations'').
   c. A subaward may be provided through any legal agreement, including an agreement that you consider a contract.

5. Subrecipient means an entity that:
   a. Receives a subaward from you under this award; and
   b. Is accountable to you for the use of the Federal funds provided by the subaward.

14. Reporting Subawards and Executive Compensation

The Contractor/Vendor covenants and agrees to comply with the Reporting Subawards and Executive Compensation requirements indicated below:

a. Reporting of first-tier subawards.

1. Applicability. Unless you are exempt as provided in paragraph d. of this award term, you must report each action that obligates $25,000 or more in Federal funds that does not include Recovery funds (as defined in section 1512(a)(2) of the American Recovery and

Reinvestment Act of 2009, Pub. L. 111-5) for a subaward to an entity (see definitions in paragraph e. of this award term).

2. Where and when to report.
   i. You must report each obligating action described in paragraph a.1. of this award term to http://www.fsrs.gov.
   ii. For subaward information, report no later than the end of the month following the month in which the obligation was made. (For example, if the obligation was made on November 7, 2010, the obligation must be reported by no later than December 31, 2010.)

3. What to report. You must report the information about each obligating action that the submission instructions posted at http://www.fsrs.gov specify.

b. Reporting Total Compensation of Recipient Executives.

1. Applicability and what to report. You must report total compensation for each of your five most highly compensated executives for the preceding completed fiscal year, if--
   i. the total Federal funding authorized to date under this award is $25,000 or more;
   ii. in the preceding fiscal year, you received--
      (A) 80 percent or more of your annual gross revenues from Federal procurement contracts (and subcontracts) and Federal financial assistance subject to the Transparency Act, as defined at 2 CFR 170.320 (and subawards); and
      (B) $25,000,000 or more in annual gross revenues from Federal procurement contracts (and subcontracts) and Federal financial assistance subject to the Transparency Act, as defined at 2 CFR 170.320 (and subawards); and
   iii. The public does not have access to information about the compensation of the executives through periodic reports filed under section 13(a) or 15(d) of the Securities Exchange Act of 1934 (15 U.S.C. 78m(a), 78o(d)) or section 6104 of the Internal Revenue Code of 1986. (To determine if the public has access to the compensation information, see the U.S. Security and Exchange Commission total compensation filings at http://www.sec.gov/answers/execomp.htm.)

2. Where and when to report. You must report executive total compensation described in paragraph b.1. of this award term:
   i. As part of your registration profile at http://www.ccr.gov
   ii. By the end of the month following the month in which this award is made, and annually thereafter.

c. Reporting of Total Compensation of Subrecipient Executives.

1. Applicability and what to report. Unless you are exempt as provided in paragraph d. of this award term, for each first-tier subrecipient under this award, you shall report the names and total compensation of each of the subrecipient's five most highly compensated executives for the subrecipient's preceding completed fiscal year, if--
   i. in the subrecipient's preceding fiscal year, the subrecipient received--
      (A) 80 percent or more of its annual gross revenues from Federal procurement contracts (and subcontracts) and Federal financial assistance subject to the Transparency Act, as defined at 2 CFR 170.320 (and subawards); and

(B) $25,000,000 or more in annual gross revenues from Federal procurement contracts (and subcontracts), and Federal financial assistance subject to the Transparency Act (and subawards); and

ii. The public does not have access to information about the compensation of the executives through periodic reports filed under section 13(a) or 15(d) of the Securities Exchange Act of 1934 (15 U.S.C. 78m(a), 78o(d)) or section 6104 of the Internal Revenue Code of 1986. (To determine if the public has access to the compensation information, see the U.S. Security and Exchange Commission total compensation filings at http://www.sec.gov/answers/execomp.htm.)

2. Where and when to report. You must report subrecipient executive total compensation described in paragraph c.1. of this award term:

i. To the recipient.

ii. By the end of the month following the month during which you make the subaward. For example, if a subaward is obligated on any date during the month of October of a given year (i.e., between October 1 and 31), you must report any required compensation information of the subrecipient by November 30 of that year.

d. Exemptions

If, in the previous tax year, you had gross income, from all sources, under $300,000, you are exempt from the requirements to report:

i. Subawards, and

ii. The total compensation of the five most highly compensated executives of any subrecipient.

e. Definitions. For purposes of this award term:

1. Entity means all of the following, as defined in 2 CFR part 25:

i. A Governmental organization, which is a State, local government, or Indian tribe;

ii. A foreign public entity;

iii. A domestic or foreign nonprofit organization;

iv. A domestic or foreign for-profit organization;

v. A Federal agency, but only as a subrecipient under an award or subaward to a non-Federal entity.

2. Executive means officers, managing partners, or any other employees in management positions.

3. Subaward:

i. This term means a legal instrument to provide support for the performance of any portion of the substantive project or program for which you received this award and that you as the recipient award to an eligible subrecipient.

ii. The term does not include your procurement of property and services needed to carry out the project or program (for further explanation, see Sec. ---- .210 of the attachment to OMB Circular A-133, ``Audits of States, Local Governments, and Non-Profit Organizations'').

iii. A subaward may be provided through any legal agreement, including an agreement that you or a subrecipient considers a contract.

4. Subrecipient means an entity that:

i. Receives a subaward from you (the recipient) under this award; and

ii. Is accountable to you for the use of the Federal funds provided by the subaward.

5. Total compensation means the cash and noncash dollar value earned by the executive during the recipient's or subrecipient's preceding fiscal year and includes the following (for more information see 17 CFR 229.402(c)(2)):

i. Salary and bonus.

ii. Awards of stock, stock options, and stock appreciation rights. Use the dollar amount recognized for financial statement reporting purposes with respect to the fiscal year in accordance with the Statement of Financial Accounting Standards No. 123 (Revised 2004) (FAS 123R), Shared Based Payments.

iii. Earnings for services under non-equity incentive plans. This does not include group life, health, hospitalization or medical reimbursement plans that do not discriminate in favor of executives, and are available generally to all salaried employees.

iv. Change in pension value. This is the change in present value of defined benefit and actuarial pension plans.

v. Above-market earnings on deferred compensation which is not tax-qualified.

vi. Other compensation, if the aggregate value of all such other compensation (e.g. severance, termination payments, value of life insurance paid on behalf of the employee, perquisites or property) for the executive exceeds $10,000.

STATE OF MINNESOTA
MASTER INTERAGENCY AGREEMENT

This agreement is between the Minnesota Departments of Military Affairs, 15000 Highway 115, Camp Ripley, Little Falls, MN 56345-4173 ("Requesting Agency"), and Minnesota State Colleges and Universities (MNSCU) by and through St. Cloud State University, 720 South 4th Avenue, St. Cloud, MN 56301 ("Providing Agency").

Recitals

1. The Requesting Agency is in need of support in the following areas:
   a. GIS Services
   b. Information Technology Services
   c. Monitoring the Aquatic Environment
   d. Water Quality Monitoring
   e. Invasive Species Management
   f. Flora and Fauna Monitoring
   g. Environmental Outreach
   h. Biological Research
   i. Cultural Resource Inventory and Management
2. Reference Memorandum of Understanding, dated 15 December 2003.

Agreement

1 Term of Master Agreement

1.1 Effective date: 1 January 2014, or the date the State obtains all required signatures under Minnesota Statutes Section 16C.05, subdivision 2, whichever is later.
The Providing Agency must not accept work under this master agreement until this master contract is fully executed and the Providing Agency has been notified by the Requesting Agency that it may begin accepting Work Order Agreements.

1.2 Work Order Agreements: The term of work under work order agreements issued under this master agreement may not extend beyond the expiration date of this master agreement.

1.3 Expiration date: 1 January 2019.

2 Scope of Work

2.1 Duties of the Providing Agency.
Provide personnel, transportation, equipment, supplies, and services, for the purposes of accomplishing tasks described in each work order agreement issued. A complete detailed description of required work will be furnished in each work order agreement issued.

The Providing Agency understands that only the receipt of a fully executed work order agreement authorizes the Providing Agency to begin work under this master agreement. Any and all effort, expenses, or actions taken before the work order agreement is fully executed is not authorized under Minnesota Statutes and is under taken at the sole responsibility and expenses of the Providing Agency.

The Providing Agency understands that this master agreement is not a guarantee of a work order agreement. The Requesting Agency has determined that it may have need for the services under this master agreement, but does not commit to spending any money with the Providing Agency.

2.2 Duties of the Requesting Agency. Duties will be furnished in each work order agreement issued.

3 Time

The Providing Agency must comply with all the time requirements described in work order agreements.

4 Consideration and Payment

4.1 **(1)** **Consideration.** The Requesting Agency will pay for all services performed and, if applicable, ancillary goods or materials supplied, by the Providing Agency for all work order agreements issued under this master agreement. The total compensation for all work order agreements may not exceed Five Hundred Thousand and No/100 Dollars ($500,000.00).

(2) **Indirect Costs.** The amount allowed shall not exceed that authorized in OMB Circular A-87.

4.2 Payment

(1) **Invoices.** The Requesting Agency will pay the Providing Agency within 30 days of the Requesting Agency's presentation of an itemized invoice for the services performed or, ancillary goods or materials supplied, and acceptance of such services by the Requesting Agency's Project Manager.

5 Conditions of Payment

All services provided by the Providing Agency under a work order agreement must be performed to the Requesting Agency's satisfaction, as determined at the sole discretion of the Requesting Agency's Project Manager and in accordance with all applicable federal, state, and local laws, ordinances, rules, and regulations. The Providing Agency will not receive payment for work found by the Requesting Agency to be unsatisfactory or performed in violation of federal, state, or local law.

6 Authorized Representatives and Project Managers

The Requesting Agency's Authorized Representative for this master agreement is Ms. Carol Prozinski, Department of Military Affairs, Facilities Management Office, Camp Ripley, 15000 Highway 115, Little Falls, MN 56345-4173, telephone 320.616.2629, or her successor. If the Requesting Agency's Authorized Representative changes at any time during this master agreement, the Requesting Agency must immediately notify the Providing Agency.

The Requesting Agency's Project Manager will be identified in each work order agreement.

The Providing Agency's Authorized Representative is Ms. Linda Donnay, Office of Sponsored Programs Research and Faculty Development, St. Cloud State University, 210 Administrative Services Building, 720 4th Avenue, St. Cloud, MN 56301, telephone 320.308.4932, or her successor. If the Providing Agency's Authorized Representative changes at any time during this master agreement, the Providing Agency must immediately notify the Requesting Agency.

The Providing Agency's Project Manager will be identified in each work order agreement.

7 Amendments

Any amendment to this master agreement or any work order agreement must be in writing and will not be effective until it has been executed and approved by the same parties who executed and approved the master agreement, or their successors in office.

8 Liability

Each party will be responsible for its own acts and behavior and the results thereof.

9 Ownership Of Materials And Intellectual Property Rights

9.1 The Requesting Agency shall own all rights, title and interest in all of the materials conceived or created by the Providing Agency, or its employees or subcontractors, either individually or jointly with others and which arise out of the performance of this agreement, including any inventions, reports, studies, designs, drawings, specifications, notes, documents, software and documentation, computer based training modules, electronically, magnetically or digitally recorded material, and other work in whatever form ("MATERIALS").

The Providing Agency hereby assigns to the Requesting Agency all rights, title and interest to the MATERIALS. Providing Agency shall, upon request of the Requesting Agency, execute all papers and perform all other acts necessary to assist the Requesting Agency to obtain and register copyrights, patents or other forms of protection provided by law for the MATERIALS. The MATERIALS created under this agreement by the Providing Agency, its employees or subcontractors, individually or jointly with others, shall be considered "works made for hire" as defined by the United States Copyright Act. All of the MATERIALS, whether in paper, electronic, or other form, shall be remitted to the Requesting Agency by the Providing Agency. The Providing Agency's employees and any subcontractors, shall not copy, reproduce, allow or cause to have the MATERIALS copied, reproduced or used for any purpose other than performance of the Providing Agency's obligations under this agreement without the prior written consent of the Requesting Agency's authorized representative except pursuant to the Minnesota Data Practices Act and other applicable laws.

9.2 Providing Agency represents and warrants that MATERIALS produced or used under this agreement do not and will not infringe upon any intellectual property rights of another, including but not limited to patents, copyrights, trade secrets, trade names, and service marks and names.

10 Publicity and Endorsement

Any publicity regarding the subject matter of a work order agreement must identify the Requesting Agency as the sponsoring agency and must not be released without prior written approval from the Requesting Agency's Authorized Representative. For purposes of this provision, publicity includes notices, informational pamphlets, press releases, research, reports, signs, and similar public notices prepared by or for the Providing Agency individually or jointly with others, or any subcontractors, with respect to the program, publications, or services provided resulting from a work order agreement.

11 Termination

11.1 This master agreement and any work order agreements may be canceled by the Requesting Agency or Providing Agency at any time, with or without cause, upon thirty (30) days written notice to the other party. In the event of such a cancellation the Providing Agency shall be entitled to payment, determined on a pro rata basis, for work or services satisfactorily performed.

11.2 **Termination for Insufficient Funding.** This master agreement and any work order agreements may be canceled by the Requesting Agency or Providing Agency at any time, if funding is not obtained from the Minnesota legislature or other funding source; or if funding cannot be continued at a level sufficient to allow for the payment of the services covered here. Termination must be by written or fax notice to the other party. The Requesting Agency is not obligated to pay for any services that are provided after notice and effective date of termination. However, the Providing Agency will be entitled to payment, determined on a pro rata basis, for services satisfactorily performed to the extent that funds are available. The Requesting Agency will not be assessed any penalty if the master contract or work order is terminated because of the decision of the Minnesota legislature or other funding source, not to appropriate funds. The Requesting Agency must provide the Providing Agency notice of the lack of funding within a reasonable time of the Providing Agency's receiving that notice.

12 Other Provisions

EXHIBIT A, Special Conditions for Contract Work Involving Federal Funds, is attached and incorporated into this agreement.

1. PROVIDING AGENCY
ST. CLOUD STATE UNIVERISTY

By:

Title: Provost + VP for Academic Affairs

Date: 11/22/13

2. REQUESTING AGENCY
DEPARTMENT OF MILITARY AFFAIRS

By:
Major General Richard C. Nash

Title: The Adjutant General

Date: DEC 17 2013

EXHIBIT A
SPECIAL CONDITIONS FOR CONTRACT WORK INVOLVING FEDERAL FUNDS

Master Interagency Agreement between the
Department of Military Affairs and Minnesota State Colleges and Universities (MNSCU)
by and through St. Cloud State University
(Project No. 14126)

EXHIBIT A
SPECIAL CONDITIONS FOR CONTRACT WORK INVOLVING FEDERAL FUNDS

To the extent applicable, the State is required to insert the substance of the following provisions in all contracts, unless State laws or regulations offer more protection.

1. Applicable Law.

This contract is incidental to the implementation of a Federal program. Accordingly, this contract shall be governed by and construed according to federal law as it may affect the rights, remedies, and obligations of the United States.

2. Governing Regulations.

To the extent not inconsistent with the express terms of the Master Cooperative Agreement (MCA) No. W912LM-10-2-1000 between the National Guard Bureau and the State of Minnesota, the provisions of 32 CFR Part 33, Uniform Administrative Requirements for Grants and Cooperative Agreements, DoD Grant and Agreement Regulations (DoDGARS) (DoD 3210.6-R) as amended, Title 2 Code of Federal Regulations (CFR) Part 225, and NGR 5-1, are hereby incorporated by reference as if fully set forth herein, shall govern this contract.

3. Nondiscrimination.

The Contractor/Vendor covenants and agrees that no person shall be subject to discrimination or denied benefits in connection with the State's performance under the contract. Accordingly, and to the extent applicable, the Contractor/Vendor covenants and agrees to comply with the following national policies prohibiting discrimination:

a. On the basis of race, color or national origin, in Title VI of the Civil Rights Act of 1964 (42 U.S.C. Section 2000d et seq.), as implemented by DoD regulations at 32 CFR Part 195.

b. On the basis of race, color or national origin, in Executive Order 11246 as implemented by Department of Labor regulations at 41 CFR Chapter 60.

c. On the basis of sex or blindness, in Title IX of the Education Amendments of 1972 (20 U.S.C. Section 1681, et seq.), as implemented by DoD regulations at 32 CFR Part 196.

d. On the basis of age, in The Age Discrimination Act of 1975 (42 U.S.C. Section 6101, et seq.), as implemented by Department of Health and Human Services regulations at 45 CFR Part 90.

e. On the basis of handicap, in Section 504 of the Rehabilitation Act of 1973 (29 U.S.C. 794), as implemented by Department of Justice regulations at 28 CFR part 41 and DoD regulations at 32 CFR Part 56.

4. Lobbying.

a. The Contractor/Vendor covenants and agrees that it will not expend any funds appropriated by Congress to pay any person for influencing or attempting to influence an officer or employee of any agency, or a Member of Congress in connection with any of the following covered federal actions. The awarding of any federal contract; the making of any federal grant; the making of any federal loan; the entering into of any CA; and the extension, continuation, renewal, amendment, or modification of any Federal contract, grant, loan, or Cooperative Agreement.

b. The Final Rule, New Restrictions on Lobbying, issued by the Office of Management and Budget and the Department of Defense (32 CFR Part 28) to implement the provisions of Section 319 of Public Law 101-121 (31 U.S.C. Section 1352) is incorporated by reference and the state agrees to comply with all the provisions thereof, including any amendments to the Interim Final Rule that may hereafter be issued.

5. Drug-Free work Place.

The Contractor/Vendor covenants and agrees to comply with the requirements regarding drug-free workplace requirements in of 32 CFR Part 26, which implements Section 5151-5160 of the Drug-Free Workplace act of 1988 (Public Law 100-690, Title V, Subtitle D; 41 U.S.C. 701, et seq.).

6. Environmental Protection.

a. The Contractor/Vendor covenants and agrees that its performance under this Agreement shall comply with:

(1) The requirements of Section 114 of the Clean Air Act (42 U.S.C. Section 7414);

(2) Section 308 of the Federal Water Pollution Control Act (33 U.S.C. Section 1318), that relates generally to inspection, monitoring, entry reports, and information, and with all regulations and guidelines issued thereunder;

(3) The Resources Conservation and Recovery Act (RCRA);

(4) The Comprehensive Environmental Response, Compensation and Liabilities Act (CERCLA);

(5) The National Environmental Policy Act (NEPA);

(6) The Solid Waste Disposal Act (SWDA));

(7) The applicable provisions of the Clean Air Act (42 U.S.C. 7401, et seq.) and Clean Water Act (33 U.S.C. 1251, et seq.), as implemented by Executive Order 11738 and Environmental Protection Agency (EPA) rules at 40 CFR Part 31;

(8) To identify any impact this award may have on the quality of the human environment and provide help as needed to comply with the National Environmental Policy Act (NEPA, at 42 U.S.C. 4321, et seq.) and any applicable federal, state or local environmental regulation.

b. In accordance with the EPA rules, the parties further agree that the Grantee shall also identify to the awarding agency (NGB) any impact this award may have on:

(1) The quality of the human environment, and provide help the agency may need to comply with the National Environmental Policy Act (NEPA, at 42 U.S.C 4321, et seq.) and to prepare Environment Impact Statements or other required environmental documentation. In

such cases, the recipient agrees to take no action that will have an adverse environmental impact (e.g., physical disturbance of a site such as breaking of ground) until the agency provides written notification of compliance with the environmental impact analysis process.

(2) Flood-prone areas, and provide help the agency may need to comply with the National Flood Insurance Act of 1968 and Flood Disaster Protection Act of 1973 (42 U.S.C. 4001, et seq.), which require flood insurance, when available, for federally assisted construction or acquisition in flood-prone areas.

(3) Coastal zones, and provide help the agency may need to comply with the Coastal Zone Management Act of 1972 (16 U.S.C. 1451, et seq.), concerning protection of U.S. coastal resources.

(4) Coastal barriers, and provide help the agency may need to comply with the Coastal Barriers Resource Act (16 U.S.C. 3501 et seq.), concerning preservation of barrier resources.

(5) Any existing or proposed component of the National Wild and Scenic Rivers System, and provide help the agency may need to comply with the Wild and Scenic Rivers Act of 1968 (16 U.S.C. 1271 et seq.).

(6) Underground sources of drinking water in areas that have an aquifer that is the sole or principal drinking water source, and provide help the agency may need to comply with the Safe Drinking Water Act (42 U.S.C 300H-3).

7. Use of United States Flag Carriers.

a. The Contractor/Vendor covenants and agrees that travel supported by U.S. Government funds under this agreement shall use U.S.-flag air carriers (air carriers holding certificates under 49 U.S.C. 41102) for international air transportation of people and property to the extent that such service is available, in accordance with the International Air Transportation Fair Competitive Practices Act of 1974 (49 U.S.C. 40118) and the inter-operative guidelines issued by the Comptroller General of the United States in the March 31, 1981, amendment to Comptroller General Decision B138942.

b. The Contractor/Vendor agrees that it will comply with the Cargo Preference Act of 1954 (46 U.S.C. Chapter 553), as implemented by Department of Transportation regulation at 46 CFR 381.7, and 46 CFR 381.7(b).

8. Debarment and Suspension.

The Contractor/Vendor covenants and agrees to comply with the requirements regarding debarment and suspension in Subpart C of the OMB guidance in 2 CFR Part 180, as implemented by the DoD in 2 CFR Part 1125. The Contractor/Vendor agrees to communicate the requirement to comply with Subpart C to persons at the next lower tier with whom the Contractor/Vendor enters into transactions that are "covered transactions" under Subpart B of 2 CFR part 180 and the DoD implementation in 2 CFR Part 1125.

9. Buy American Act.

The Contractor/Vendor covenants and agrees that it will not expend any funds appropriated by Congress without complying with The Buy American Act (41 U.S.C.10a et seq.). The Buy American Act gives preference to domestic end products and domestic construction material. In addition, the Memorandum of Understanding between the United States of America and the European Economic Community (EEC) on Government Procurement, and the North American Free Trade Agreement

(NAFTA), provide that EEC and NAFTA end products and construction materials are exempted from application of the Buy American Act.

10. Uniform Relocation Assistance and real Property Acquisition Policies

The Contractor/Vendor covenants and agrees that it will comply with CFR 49 part 24, which implements the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 (42 U.S.C. Section 4601 et seq.) and provides for fair and equitable treatment of persons displaced by federally assisted programs or persons whose property is acquired as a result of such programs.

11. Copeland "Anti-Kickback" Act.

The Contractor/Vendor covenants and agrees that it will comply with the Copeland "Anti-Kickback" Act (18 U.S.C. Section 874) as supplemented in Department of Labor regulations (29 CFR Part 3). As applied to this agreement, the Copeland "Anti-Kickback" Act makes it unlawful to induce, by force, intimidation, threat of procuring dismissal from employment, or otherwise, any person employed in the construction or repair of public buildings or public works, financed in whole or in part by the United States, to give up any part of the compensation to which that person is entitled under a contract of employment.

12. Contract Work Hours and Safety Standards Act.

The Contractor/Vendor covenants and agrees that it will comply with Sections 103 and 107 of the Contract Work Hours and Safety Standards Act (40 U.S.C. Sections 3701-3708) as supplemented by Department of Labor regulations (29 CFR Part 5). As applied to this agreement, the Contract Work Hours and Safety Standards Act specifies that no laborer or mechanic doing any part of the work contemplated by this contract shall be required or permitted to work more than 40 hours in any workweek unless paid for all additional hours at not less than 1.5 times the basic rate of pay.

13. Central Contractor Registration and Universal Identifier Requirements.

The Contractor/Vendor covenants and agrees to comply with the Central Contractor Registration and Universal Identifier Requirements as indicated below:

A. Requirement for Central Contractor Registration (CCR)

Unless you are exempted from this requirement under 2 CFR 25.110, you as the recipient must maintain the currency of your information in the CCR until you submit the final financial report required under this award or receive the final payment, whichever is later. This requires that you review and update the information at least annually after the initial registration, and more frequently if required by changes in your information or another award term.

B. Requirement for Data Universal Numbering System (DUNS) Numbers

If you are authorized to make subawards under this award, you:

1. Must notify potential subrecipients that no entity (see definition in paragraph C of this award term) may receive a subaward from you unless the entity has provided its DUNS number to you.

2. May not make a subaward to an entity unless the entity has provided its DUNS number to you.

C. Definitions

For purposes of this award term:

1. Central Contractor Registration (CCR) means the Federal repository into which an entity must provide information required for the conduct of business as a recipient. Additional information about registration procedures may be found at the CCR Internet site (currently at http://www.ccr.gov).

2. Data Universal Numbering System (DUNS) number means the nine-digit number established and assigned by Dun and Bradstreet, Inc. (D&B) to uniquely identify business entities. A DUNS number may be obtained from D&B by telephone (currently 866-705-5711) or the Internet (currently at http://fedgov.dnb.com/webform).

3. Entity, as it is used in this award term, means all of the following, as defined at 2 CFR part 25, subpart C:
   a. A Governmental organization, which is a State, local government, or Indian Tribe;
   b. A foreign public entity;
   c. A domestic or foreign nonprofit organization;
   d. A domestic or foreign for-profit organization; and
   e. A Federal agency, but only as a subrecipient under an award or subaward to a non-Federal entity.
4. Subaward:
   a. This term means a legal instrument to provide support for the performance of any portion of the substantive project or program for which you received this award and that you as the recipient award to an eligible subrecipient.
   b. The term does not include your procurement of property and services needed to carry out the project or program (for further explanation, see Sec. ----.210 of the attachment to OMB Circular A-133, ``Audits of States, Local Governments, and Non-Profit Organizations'').
   c. A subaward may be provided through any legal agreement, including an agreement that you consider a contract.
5. Subrecipient means an entity that:
   a. Receives a subaward from you under this award; and
   b. Is accountable to you for the use of the Federal funds provided by the subaward.

14. Reporting Subawards and Executive Compensation

The Contractor/Vendor covenants and agrees to comply with the Reporting Subawards and Executive Compensation requirements indicated below:

a. Reporting of first-tier subawards.

1. Applicability. Unless you are exempt as provided in paragraph d. of this award term, you must report each action that obligates $25,000 or more in Federal funds that does not include Recovery funds (as defined in section 1512(a)(2) of the American Recovery and

Reinvestment Act of 2009, Pub. L. 111-5) for a subaward to an entity (see definitions in paragraph e. of this award term).

2. Where and when to report.
   - i. You must report each obligating action described in paragraph a.1. of this award term to http://www.fsrs.gov.
   - ii. For subaward information, report no later than the end of the month following the month in which the obligation was made. (For example, if the obligation was made on November 7, 2010, the obligation must be reported by no later than December 31, 2010.)

3. What to report. You must report the information about each obligating action that the submission instructions posted at http://www.fsrs.gov specify.

b. Reporting Total Compensation of Recipient Executives.

1. Applicability and what to report. You must report total compensation for each of your five most highly compensated executives for the preceding completed fiscal year, if--
   - i. the total Federal funding authorized to date under this award is $25,000 or more;
   - ii. in the preceding fiscal year, you received--
     - (A) 80 percent or more of your annual gross revenues from Federal procurement contracts (and subcontracts) and Federal financial assistance subject to the Transparency Act, as defined at 2 CFR 170.320 (and subawards); and
     - (B) $25,000,000 or more in annual gross revenues from Federal procurement contracts (and subcontracts) and Federal financial assistance subject to the Transparency Act, as defined at 2 CFR 170.320 (and subawards); and
   - iii. The public does not have access to information about the compensation of the executives through periodic reports filed under section 13(a) or 15(d) of the Securities Exchange Act of 1934 (15 U.S.C. 78m(a), 78o(d)) or section 6104 of the Internal Revenue Code of 1986. (To determine if the public has access to the compensation information, see the U.S. Security and Exchange Commission total compensation filings at http://www.sec.gov/answers/execomp.htm.)

2. Where and when to report. You must report executive total compensation described in paragraph b.1. of this award term:
   - i. As part of your registration profile at http://www.ccr.gov
   - ii. By the end of the month following the month in which this award is made, and annually thereafter.

c. Reporting of Total Compensation of Subrecipient Executives.

1. Applicability and what to report. Unless you are exempt as provided in paragraph d. of this award term, for each first-tier subrecipient under this award, you shall report the names and total compensation of each of the subrecipient's five most highly compensated executives for the subrecipient's preceding completed fiscal year, if--
   - i. in the subrecipient's preceding fiscal year, the subrecipient received--
     - (A) 80 percent or more of its annual gross revenues from Federal procurement contracts (and subcontracts) and Federal financial assistance subject to the Transparency Act, as defined at 2 CFR 170.320 (and subawards); and

        (B) $25,000,000 or more in annual gross revenues from Federal procurement contracts (and subcontracts), and Federal financial assistance subject to the Transparency Act (and subawards); and
    ii. The public does not have access to information about the compensation of the executives through periodic reports filed under section 13(a) or 15(d) of the Securities Exchange Act of 1934 (15 U.S.C. 78m(a), 78o(d)) or section 6104 of the Internal Revenue Code of 1986. (To determine if the public has access to the compensation information, see the U.S. Security and Exchange Commission total compensation filings at http://www.sec.gov/answers/execomp.htm.)

2. Where and when to report. You must report subrecipient executive total compensation described in paragraph c.1. of this award term:
    i. To the recipient.
    ii. By the end of the month following the month during which you make the subaward. For example, if a subaward is obligated on any date during the month of October of a given year (i.e., between October 1 and 31), you must report any required compensation information of the subrecipient by November 30 of that year.

d. Exemptions

If, in the previous tax year, you had gross income, from all sources, under $300,000, you are exempt from the requirements to report:
    i. Subawards, and
    ii. The total compensation of the five most highly compensated executives of any subrecipient.

e. Definitions. For purposes of this award term:

1. Entity means all of the following, as defined in 2 CFR part 25:
    i. A Governmental organization, which is a State, local government, or Indian tribe;
    ii. A foreign public entity;
    iii. A domestic or foreign nonprofit organization;
    iv. A domestic or foreign for-profit organization;
    v. A Federal agency, but only as a subrecipient under an award or subaward to a non-Federal entity.

2. Executive means officers, managing partners, or any other employees in management positions.

3. Subaward:
    i. This term means a legal instrument to provide support for the performance of any portion of the substantive project or program for which you received this award and that you as the recipient award to an eligible subrecipient.
    ii. The term does not include your procurement of property and services needed to carry out the project or program (for further explanation, see Sec. ---- .210 of the attachment to OMB Circular A-133, ``Audits of States, Local Governments, and Non-Profit Organizations").
    iii. A subaward may be provided through any legal agreement, including an agreement that you or a subrecipient considers a contract.

4. Subrecipient means an entity that:
    i. Receives a subaward from you (the recipient) under this award; and

ii. Is accountable to you for the use of the Federal funds provided by the subaward.

5. Total compensation means the cash and noncash dollar value earned by the executive during the recipient's or subrecipient's preceding fiscal year and includes the following (for more information see 17 CFR 229.402(c)(2)):

i. Salary and bonus.

ii. Awards of stock, stock options, and stock appreciation rights. Use the dollar amount recognized for financial statement reporting purposes with respect to the fiscal year in accordance with the Statement of Financial Accounting Standards No. 123 (Revised 2004) (FAS 123R), Shared Based Payments.

iii. Earnings for services under non-equity incentive plans. This does not include group life, health, hospitalization or medical reimbursement plans that do not discriminate in favor of executives, and are available generally to all salaried employees.

iv. Change in pension value. This is the change in present value of defined benefit and actuarial pension plans.

v. Above-market earnings on deferred compensation which is not tax-qualified.

vi. Other compensation, if the aggregate value of all such other compensation (e.g. severance, termination payments, value of life insurance paid on behalf of the employee, perquisites or property) for the executive exceeds $10,000.

MINNESOTA
NATIONAL GUARD
ESTABLISHED 1856

Minnesota Army National Guard
ITAM Plan

Plan Period 2018-2022

Minnesota Army National Guard
Camp Ripley
15000 Highway 115
Little Falls, MN 56345

Executive Summary

This Integrated Training Area Management (ITAM) Plan provides the guidance, protocols, goals and objectives to enable the Minnesota Army National Guard (MNARNG) to implement the ITAM Program. The plan is intended to support and complement the military mission of the MNARNG while also promoting sound land management principles. The preparation and implementation of this plan is required by the AR 350-19 and several other Federal directives including regulations and guidance issued by the Department of the Army. The plan will also help determine installation requirements for the ITAM program, thus allowing ITAM coordinators a tool in identifying projects for the ITAM Workplan.

The primary mission of MNARNG is to provide the best military training environment possible. The purpose of Camp Ripley is to provide a readily accessible training area to the U.S. Department of Defense (DOD) and other civilian agencies in order to enhance the MNARNG's readiness for its federal, state and community mission. Those missions are respectively: respond with active service as directed by the President of the United States in times of national emergency; assist local law enforcement agencies during state emergencies at the direction of the state governor; and add value to local communities.

This plan is the implementing document for the ITAM program of MNARNG at Camp Ripley during the period of 2018-2022. The planning process used in developing the ITAM plan focused on using key stakeholders from within the MNARNG. These included but not limited to, Range Control, Operations Office, Environmental Office, Facility Management Office and the Department of Public Works. Together, these stakeholders represent the Camp Ripley's Sustainable Range Program Advisory Committee (SRP-AC). This plan is put together annually by the ITAM Coordinator, Brian Sanoski from input provided by staff within the key stakeholders mentioned above.

This document contains seven chapters as shown in the Table of Contents. Chapter one will provide an introduction and brief description of Camp Ripley. Chapter two will highlight each ITAM program individually; Range and Training Land Assessment (RTLA), Land Rehabilitation and Maintenance (LRAM), Training Requirements Integration (TRI), Sustainable Range Awareness (SRA) and Geographic Information System (GIS). In addition provides a history of the ITAM program, staff, detailed descriptions, and guidelines of existing ITAM programs. Chapter three represents annual goals and objectives of the ITAM program. Chapter four displays a breakdown of annual project descriptions directly correlating to the proposed budget submissions for each of the five years. Chapter five provides a list of equipment per fiscal year that the ITAM program purchased and anticipated replacement years. Chapter six will provide a descriptive back log of projects that have been set aside due to inadequate funding that exceed ITAM's ability to accomplish in a single year. Chapter seven will present a summary of the total cost requirements of each ITAM component per fiscal year.

Table of Contents

List of Tables

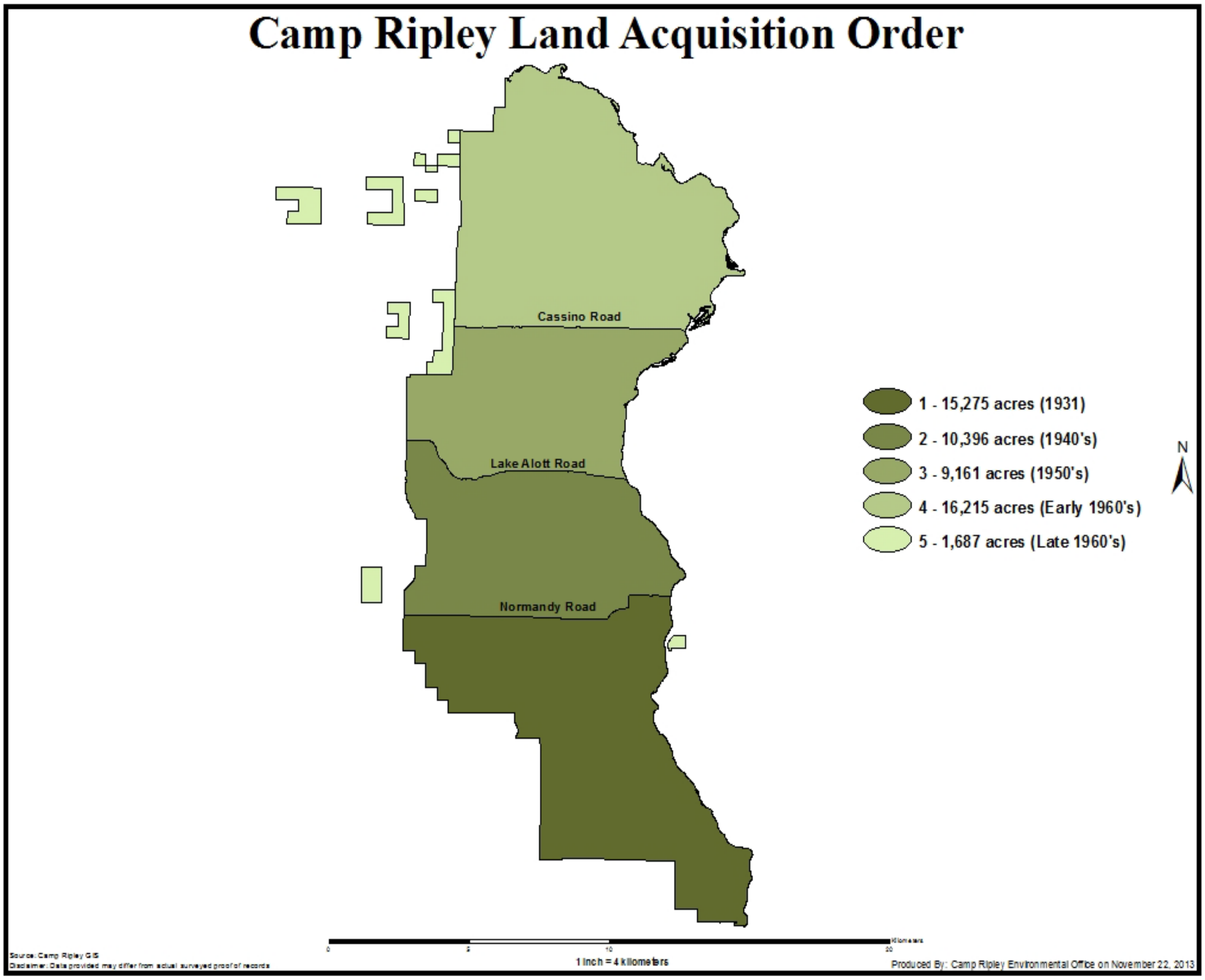
List of Figures

Chapter 1: Introduction

History

In June, 1931 Camp Ripley opened after the state legislature approved funding for a larger training site than what existed at Lake Pepin. For the next twenty years, Camp Ripley served company and platoon size units of the Minnesota National Guard (Hickok 1987). The training site consisted of approximately 15,275 acres, which is currently the present area south of Normandy road. During World War II, Camp Ripley was used primarily as a training site for the Minnesota State Guard after the National Guard was federalized. The ranges and other facilities were also used by regular army units stationed at Fort Snelling Minnesota (Hickok 1987). In the early 1950's Camp Ripley's training area expanded 10,396 acres; to approximately 25,671 acres which consisted of the present area south of Lake Alott road. By 1960, Camp Ripley increased in size by 9,134 acres to include the present area between Lake Allot Road and Casino Road. In the mid to late 1960's the final major additions were made to Camp Ripley. This increased the total acreage to approximately 52,831 acres as displayed in Figure 1.

Figure 1: Land Acquisition

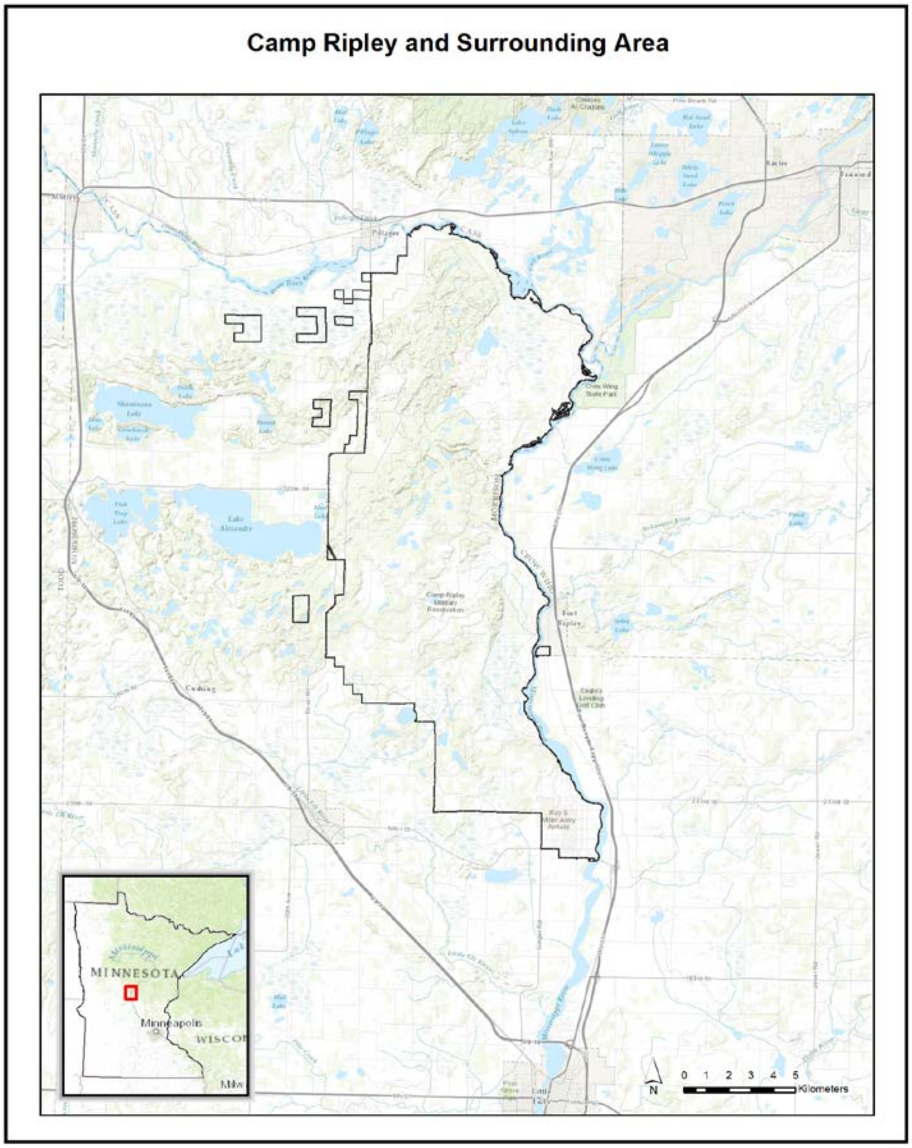


Location and Size

Camp Ripley is located in the central portion of Minnesota approximately 100 miles northwest of the Minneapolis/St. Paul metropolitan area (Figure 2). Camp Ripley lies entirely (with exception of 62 acres in Crow Wing County) within Morrison County and is bordered on the north by the Crow Wing River and on the east by the Mississippi River. The two largest cities within 30 miles of Camp Ripley are Brainerd, located in Crow Wing County, and Little Falls, located in Morrison County. Census shows Brainerd and Baxter to have a combined population of 21,547 and Little Falls to have a population of 8,689 (2016 US Census Bureau). The Brainerd lakes area is popular with summer tourists; the summer population in the Brainerd area increases by three-fold. Camp Ripley lies within the 8th Congressional District.

Camp Ripley occupies a gross area of 52,831 acres, approximately 82.5 square miles. The cantonment area encompasses 2,046 acres of this area. In addition, 1,811 acres of land is not within the posted limits of Camp Ripley. As a result, the net usable training area of Camp Ripley encompasses 48,974 acres of land. Of this amount, 6,380 acres include all impact areas and 42,594 acres are available for a variety of military training exercises.

Figure 2: Regional Map



Training Site Utilization

Military Mission

Camp Ripley was opened to Minnesota National Guard units in 1931, and today is one of eleven National Guard training sites in the United States. Currently, it is the largest state owned military installation. Camp Ripley is utilized throughout the year, and is recognized as one of the primary winter training sites for the National Guard. Camp Ripley is a premier, all season training facility, in support of three missions:

1. Training soldiers for Federal Emergencies at the call of the President
2. Providing support for state emergencies at the call of the State Governor
3. Providing resources that add value for the community.

Camp Ripley supports the federal and state missions for military reserve component training as a 7,800 person, year-round training facility for the National Guard, primarily consisting of units from Minnesota, North Dakota, South Dakota, Wisconsin, Iowa and Illinois. However, other units from throughout the U.S. also choose to train here. Camp Ripley is used for weekend inactive duty training (IDT), two week annual training (AT) and other training activities of both active and reserve components.

Military training is supported by seven broad areas of activity, including maneuver training, weapons familiarization and qualification. The latter includes aviation gunnery and armor gunnery through Tank Table XII, military occupational specialty (MOS) producing and leadership provision of a central maintenance facility, direct service support in all classes of supply, provision of personnel services and chaplain services, and military morale, welfare, and recreation activities.

Civilian training opportunities are focused primarily on law enforcement activities, natural resource education, environmental agencies, and emergency management activities.

The Minnesota National Guard's strategic plan is to promote Camp Ripley as "The Maneuver Commander's Training Center of Choice." As such, the stated mission to accomplish this strategy is threefold including:

1) An all-season training facility
2) A facility for Federal, State and Community agencies
3) A training center capable of supporting military and non-military training, education and support services. Camp Ripley's primary customers are the military units that utilize Camp Ripley to ensure military readiness.

The demand from military and non-military customers that are training at Camp Ripley has increased about 155% since 2007. This has resulted in an average of 405,637 man-days per year over the last 5-years. The details of this trend are presented in Table 1. The recent increase in man-days was partly due to recent deployments for the global war on terrorism. MNARNG anticipates continued and increased use of Camp Ripley over the next five years as outlined in the Site Development Plan (SDP). Staffing levels for Minnesota National Guard units in 2014 is illustrated in Table 2. The locations of the Minnesota National Guard Units utilizing Camp Ripley from across the state are represented in Figure 3. Additional units utilizing Camp Ripley for training exercises beyond the MNARNG are represented in Table 3.

Table 1: Camp Ripley Site Manday Utilization

COMPONENT	2011	2012	2013	2014	2015
Army National Guard	276,480	344,985	347,381	237,589	269,667
Air National Guard	3,081	2,627	2,642	2,147	4,243
Sub-total National Guard	279,561	347,612	350,023	239,736	273,910
Active Duty Army	2,848	8,199	3,707	5,350	20,152
Army Reserve	6,940	10,356	13,703	9,811	6,395
Air Force	1,452	845	2,026	1,597	2,982
Marines	6,932	11,462	10,995	6,364	3,462
Navy	1,235	782	90	520	220
Total DOD	299,490	489,256	364,791	263,558	307,121
Civilian	51,980	56,103	69,023	59,507	51,600
Total DoD and Civilian:	**351,470**	**545,359**	**449,567**	**323,065**	**358,721**

Note: One man-day equals one person training per day

Table 2: Minnesota National Guard Units Utilizing Camp Ripley

Unit	Location	Assigned	Unit	Location	Assigned
175th Regiment (RTI)	Little Falls	88	HHC 34th CBT AVN BDE (HVY)	St. Paul	158
ARNG Element (-), JFHQ-MN	St. Paul	408	Co F 1-189 AVN RGMT, GSAB	Little Falls	51
Medical Det - MNARNG	St. Paul	92	Co C 1-171 AVN, GSAB	St. Cloud	28
			Co B 2-211 AVN, GSAB	St. Cloud	84
Training Center Support Unit	Little Falls	191	Co C 2-211 AVN, GSAB	St. Cloud	85
			2/147 ASLT BN	St. Paul	282
MN Recruiting and Retention	Roseville	166	834 ASB, 34th CAB	St. Paul	498
STARC Totals:		**947**	**AVN BDE Totals:**		**1,186**
84th Troop Command	Minneapolis	38	HHC 1st ABCT, 34th ID	Bloomington	173
682nd ENG BN	Willmar	179	2-136 IN, CAB	Moorhead	897
849th ENGR Co	Litchfield	145	1-194 CAB	Brainerd	953
850th Horizontal ENG Co	Cambridge	196	1-94 CAV, 1BCT	Duluth	651
851st ENGR CO VERT CONSTR	Little Falls	179	2-135 INF BN IBCT	Mankato	980
434 CHEM Co	Northfield	168	1-125 FA RGMT HBCT	New Ulm	648
1-151 FA BN	Montevideo	546	134 BSB, 1st BCT	Little Falls	494
55th Civil Supt Team (WMD)	St. Paul	18	STB 1st BCT, 34th ID	Bloomington	576
34th MP Co	Stillwater	202			
257th MP Co	Monticello	167	**1st BDE Totals:**		**5,372**
Troop Command Totals:		**1,838**	HHD, 347th Regional SPT GRP	Roseville	77
			247th Finance Det	Roseville	28
34th ID, DIV HQ AND HQ BN	Inver Grove	765	147th HR Co	Arden Hills	104
34th DIV and Army Band (DS)	Rosemount	39	224 TRANS Co Light-MDM	Austin	197
			114th TRANS Co	Chisholm	222
34th DIV SEP CO and BN Totals:		**804**	147th Finance Det	Roseville	33
			1903 SPT Det	Little Falls	5
			1904 SPT Det	Little Falls	3
			204th ASMC MED Company	Cottage Grove	89
			RSG Totals:		**758**
34th DIVISION TOTALS: 9,958					
STATE TOTALS: 10,905					

Source: 2014 Camp Ripley Site Development Plan, September 27, 2013

Figure 3: Minnesota National Guard Unit Locations

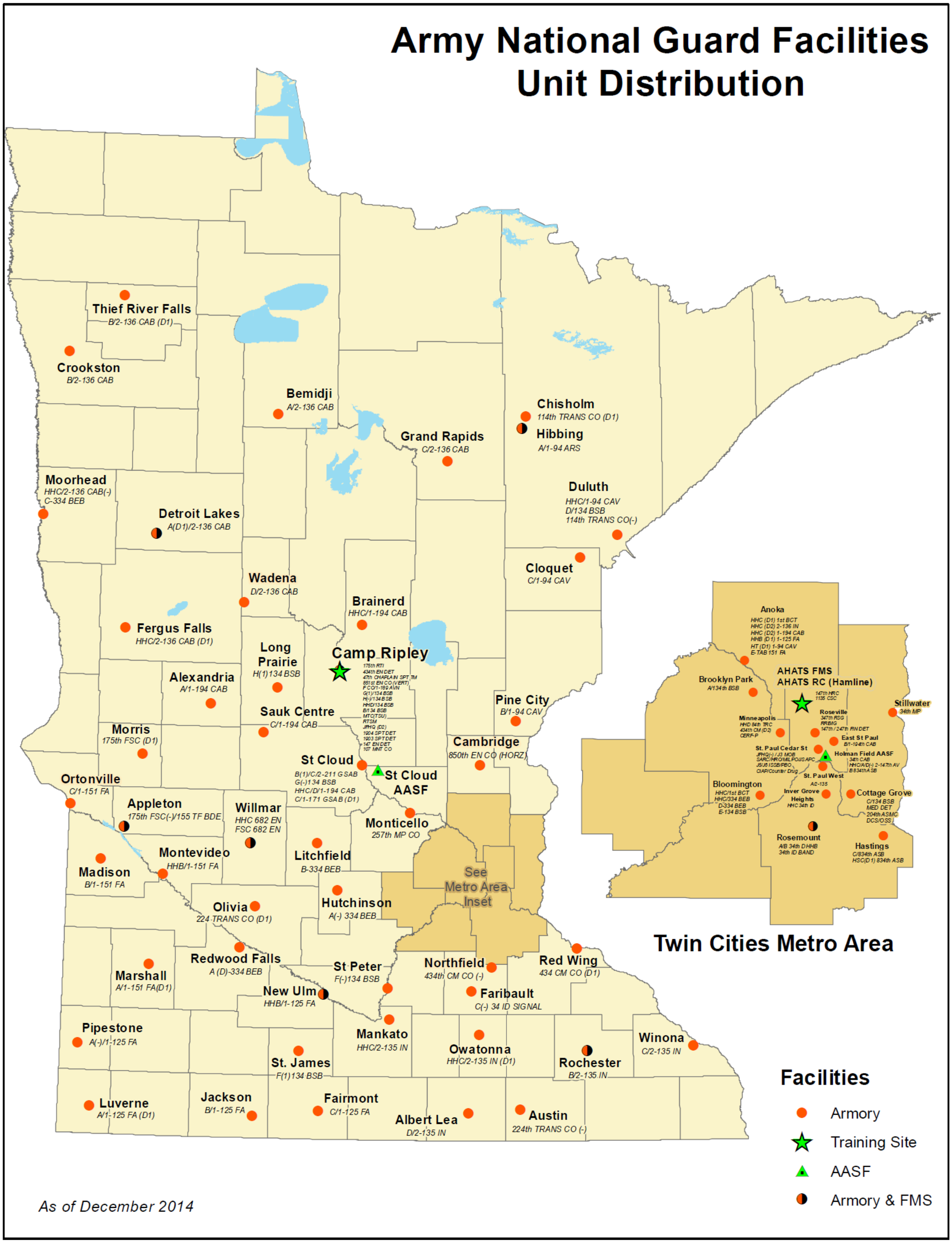


Table 3: Other Military Components That Train at Camp Ripley (Outside MNARNG)

Unit	Component	Assigned	Unit	Component	Assigned
1-108 AVN	KSARNG	69	33rd IBCT	ILARNG	3,000
1-118 FA	GAARNG	253	33rd MP BN	ILARNG	63
1-121 IN BN	GAARNG	695	367 EN BN	MNUSAR	164
1-145 CAB	OHARNG	626	407 CA BN	MN USAR	203
1-147 FA BN	SDARNG	231	48th BSTB	GAARNG	392
1-168 IN BN	IAARNG	694	48th IBCT	GAARNG	3,000
1-178 IN BN	ILARNG	695	4th LE BN	USMC RES	233
106 AVN BN	ILARNG	386	4th Marine Div HQBN	USMC RES	175
108th Sustain BDE	ILARNG	276	634th BSB	ILARNG	829
133 Air Wing	MN AFNG	194	65 TCB	ILARNG	33
136 CSSB	NDARNG	69	934th Air Wing	MN AF RES	225
13th PSYOP	MN USAR	65	MWSS 471	USMC RES	233
141 MAN ENH BDE	NDARNG	192	NMCB25/04	USN RES	25
148 BSB	GAARNG	829	1-133 IN BN	IAARNG	694
181 INF BDE	USA	29	1-188 ADA	NDARNG	362
2-121 IN	GAARNG	491	1/112 AVN BN	NDARNG	286
2-122 FA BN	ILARNG	287	1/113 CAV	IAARNG	401
2-130 IN BN	ILARNG	695	1-147 RTI OHIO	OHARNG	80
2-211 Co C	IAARNG	60	1244 TC	ILARNG	172
2/106 CAV	ILARNG	401	132 QM CO	NDARNG	74
2/34 IBCT	IAARNG	3500	1431 EN SAPPER	MIARNG	49
309 EN Co	MN USAR	89	1437 EN CO	MIARNG	183
319 PSYOP	MN USAR	104	153 EN BN	SDARNG	77
339 PSYOP	MN USAR	104	186 MP Co	IAARNG	170
33rd BSTB	ILARNG	392	192 MP CO Det	NEARNG	45
203RD TC	MN USAR	162	2-211 Co B	IAARNG	26
208th WX Flt	MNAFNG	20	2/34 BSTB	IAARNG	392
211 EN CO Sapper	SDARNG	77	644 RSG HQ	MN USAR	63
232 CSB	ILARNG	69	652ND EN	WI USAR	119
233 MP CO	ILARNG	167	ROTC STJOHN FSB	USA	50
257 BSB	WIARNG	225	ROTC UOFM	USA	50
734 RSG	IAARNG	64	ROTC UND	USA	50
924 EN DET	WIARNG	15	ROTC NDSU	USA	50
933 MP CO	ILARNG	167	ROTC MSU	USA	50
957 EN CO MRBC	NDARNG	185	ROTC SDSU	USA	50

Source: 2014 Camp Ripley Site Development Plan, September 27, 2013

Types of Training:

(1) Camp Ripley supports a wide variety of training as follows:
  - Weapons familiarization and qualification
  - Rifle
  - Pistol
  - Machine gun
  - Grenade launchers, including the MK-19
  - Hand grenade
  - Missile
  - Bradley Fighting Vehicle (BFV) (up to Table XII)
  - Tank (up to Table XII)
  - Artillery
  - Multiple Launch Rocket System (MLRS)
  - Mortar
  - Live Fire Shoot House
  - Aerial Door Gunnery
  - Demolition
  - Convoy Live Fire Tables
  - Infantry Platoon Battle Course
  - Sniper Firing
  - Reflex Firing

(2) Prisoner of War (POW) compounds/Forward Operating Bases (FOBs)

(3) Field training exercises

(4) Live fire exercises
  - Individual/Buddy Team Movement Live Fire Lane

(5) Urban training (MAC, CTF, CACTF, UAC)

(6) Confidence/Obstacle training
  - Rappel Tower and Practice Tower

(7) Land navigation (Mounted and dismounted)

(8) Simulations:
  - ATC Radar
  - ATC Tower
  - Blackhawk UH 60
  - C-GATS
  - Call For Fire Trainer
  - COFT MSA
  - Dfirst/Flextrain
  - EST 2000
  - HMMWV Egress Assistance Trainer (HEAT)
  - IGT .50 Cal
  - LCCATS
  - LMTS
  - M1 CCTT
  - M2A2 CCTT
  - Mini – Rets
  - MGTS
  - MILES
  - MRAP Egress Trainer (MET)
  - MRAP-VVT
  - PGS (M2 precision Gunnery Trainer)

  - PGTS (TOW Gunnery Trainer)
  - STS (Sniper Trainer System)
  - Virtual Convoy Operations Training System (VCOT)
  - VBS2

(9) Biathlon/cross-country skiing
(10) Tracked Vehicle Driver Training Course
(11) NBC Operations
(12) FLRC- Field Leader Reaction Course
(13) EMFB Site- Expert Medical Field Badge Evaluation Site
(14) TUAV
(15) C-130 Training
  - 6100’ Runway
  - Instrument Approach and Landing
  - 3500’ Tactical Assault Strip
  - NVG Capable
  - Three drop zones

Description of Training Site

Cantonment Area

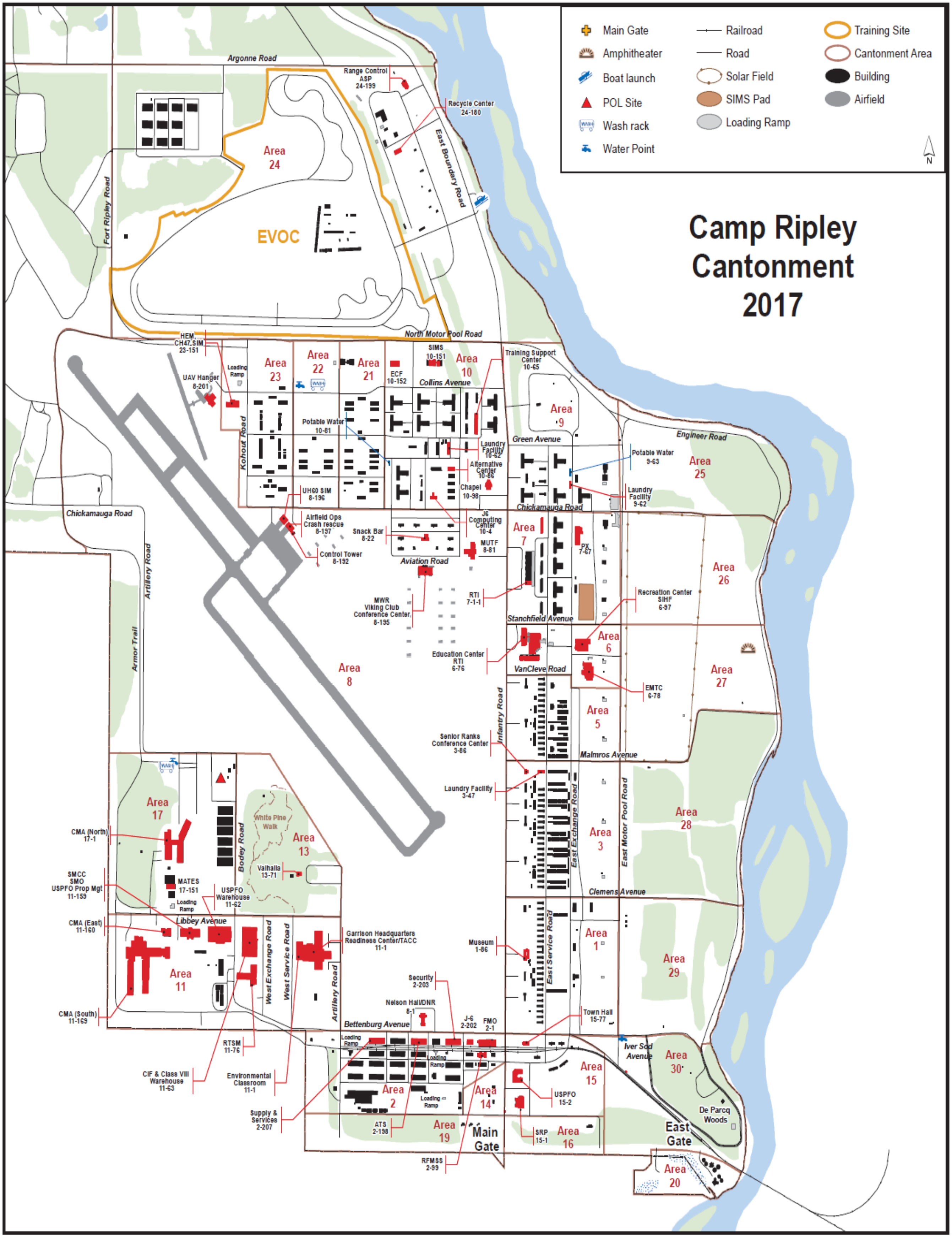
Camp Ripley’s 2,046 acre cantonment area contains the administrative and logistical buildings, troop housing, utilities, and other support facilities for the training site (Figure 4).

The cantonment area utilities have all been upgraded within the past 10 years to accommodate higher demand and ensure compliance with environmental regulations. The utilities include electrical power distribution, heating facilities, drinking water system, natural gas system, wastewater treatment facility, stormwater management system, and communication system.

Logistical support services are provided as part of the cantonment area operational activities. Support facilities include warehouses and buildings that store supplies such as ammunition, food, petroleum, and training equipment. The support facilities also include headquarters buildings, troop housing, museum, Medical Unit Training Facility (MUTF), chapel, airfield, Post Exchange, and Camp Ripley Headquarters buildings. The Training Support Unit personnel assigned to Camp Ripley are essential to the operation and maintenance of these support facilities.

The cantonment area also includes several tenant facilities in support of Camp Ripley: CMA North, CMA South, United States Property and Fiscal Office (USPFO), State Director of Logistics (DOL), Facilities Management Office (FMO), Organizational Maintenance Shop (OMS), Regional Training Site Maintenance (RTSM), Regional Training Institute (RTI) and military units assigned to Camp Ripley. The cantonment area also houses the Enforcement Training Center for the Minnesota Department of Natural Resources.

Figure 4: Cantonment Area



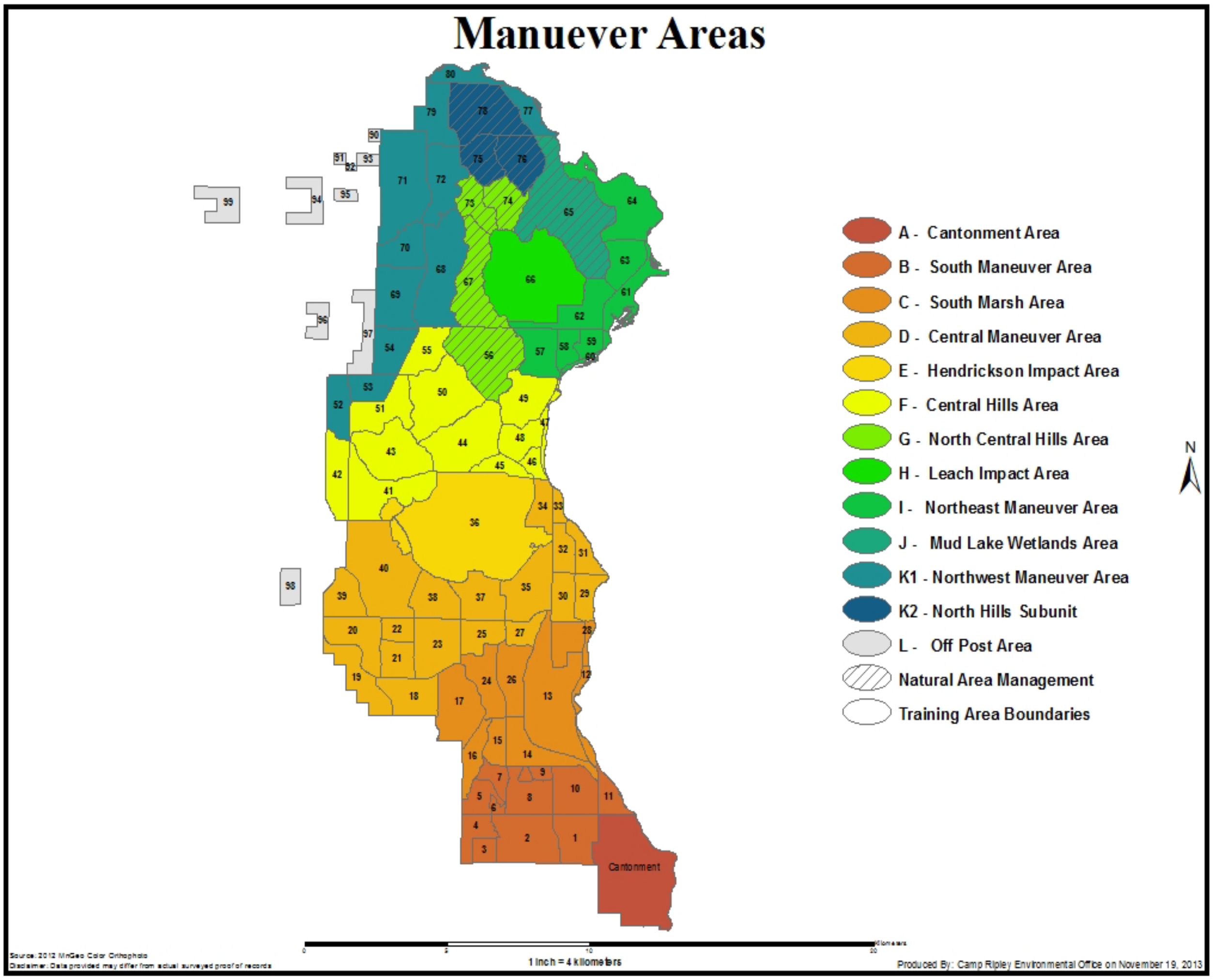
Maneuver Area

Camp Ripley is divided into 12 blocks called maneuver/natural resource management areas (Figure 5 & Table 4). These areas were defined through interpretation of infrared aerial photography, study of maps and databases, and discussions between environmental staff and military operations personnel. They integrated expected military use, natural ecosystems, multiple natural resource potentials, and natural resource policy applications within contiguous land units. This co-process of natural resource planning and site development planning has resulted in defined maneuver area boundaries identical to the larger natural resource management areas. Operational scheduling and control of Camp Ripley for military training is accomplished by dividing these Natural Resource Management Units/Maneuver Areas into numbered subunits called training areas. There are currently 80 training areas established.

Control and scheduling for all uses of Camp Ripley will be accomplished using the Range Facility Management Support System (RFMSS). RFMSS is a computerized scheduling system used to schedule training areas, facilities and ranges.

The scheduling and subsequent land use activities at Camp Ripley will be monitored for each individual training area. Additionally, implementation of this work plan will be monitored for each training area to ensure compatibility of the training mission with sound natural resource management practices. Each training area has a designated training area number.

Figure 5: Maneuver Areas



Source: 2012 MnGeo Color Orthophoto
Disclaimer: Data provided may differ from actual surveyed proof of records

1 inch = 4 kilometers

Produced By: Camp Ripley Environmental Office on November 19, 2013

Table 4: Maneuver Areas/Natural Resource Management Units

Maneuver Area	A	B	C	D	E	F	G	H	I	J	K1	K2
Size (Acres)	2,046	4,001	5,358	9,559	3,478	7,117	3,015	2,123	3,807	2,032	6,391	2,093
MILITARY USE												
Wooded/on-Trail Maneuver	None	Very High	Med.	Very High	None	Low-Med.	Low	None	Med.	Low	High	Med.
Wooded/off-Trail Maneuver	None	Low-Med.	Low	Med.	None	Very Low	None-Low	None	Low	None-Low	Med.	Very Low
Open Field/on-Trail Maneuver	None	High	Low	High	None	Low	None-Low	None	High	None-Low	High	Very Low
Open Field/off-Trail Maneuver	None	High	Low	High	None	Low	None-Low	None	High	None-Low	Very High	Very Low
Assembly/Bivouac	Very High	High	Low	High	None	Low	Very Low	None	High	None-Low	Very High	Med.
# Mortar Points	0	0	0	17	0	7	0	0	12	0	1	2
# Artillery Points	0	11	1	29	0	6	0	0	6	1	41	0
Roads (mi/mi2)	10.2	5.6	3.7	4.9	.9	3.2	2.3	0	5.1	2.1	4.8	2.9
% Area in Ranges	0%	6%	15%	21%	100%	7%	0%	100%	5%	1%	2%	0%
PHYSIOGRAPHY												
Average Slope	2.5%	6.9%	6.0%	7.6%	11.2%	15.1%	20.9%	11.1%	6.4%	4.6%	10.2%	17.8%
Percent of area <8%	97%	71%	54%	72%	44%	26%	5%	35%	73%	40%	52%	11%
VEGETATION												
Open Grass/Brush	--	28%	9%	34%	--	7%	2%	--	28%	2%	18%	3%
Aspen/Birch	--	23%	21%	28%	--	50%	24%	--	23%	22%	46%	17%
Oak/Hardwoods	--	23%	11%	27%	--	34%	60%	--	14%	4%	8%	73%
Jack Pine	--	6%	1%	0%	--	0%	0%	--	14%	1%	14%	0%
Red/White Pine	--	4%	2%	1%	--	2%	0%	--	7%	0%	7%	2%
Misc. Forest	--	1%	0%	0%	--	0%	0%	--	0%	0%	0%	0%
No Data	99%	1%	5%	1%	92%	0%	1%	81%	1%	0%	0%	0%
Wetlands	1%	13%	51%	9%	8%	7%	14%	19%	13%	71%	7%	5%
TOTAL	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

Impact Areas

Approximately 6,380 acres comprise all impact areas on Camp Ripley. The north impact area, known as Leach contains 2,123 acres whereas the south impact area known as Hendrickson contains 3,478 acres. 779 acres of Hole in a Day and A-9 complex make up the remaining dud zone areas. The impact areas are restricted use areas because they may contain unexploded ordinance from weapon systems ranging from 60 mm mortars to 155 mm howitzers.

Ranges

Camp Ripley has 51 ranges; several can be used for small arms and larger caliber weapons. Below Table 5 contains information regarding Camp Ripley's current ranges and training facilities:

Table 5: Current Ranges

Range	Description
A-1	Small Arms Known Distance Range/25m Zero Range-32 Firing Points
A-2	Combat Pistol Qualification Range (CPQR)-15 Firing Points
A-3	Automatic Record Fire (ARF) Range-16 Firing Points
A-4	Automatic Field Fire (AFF) Range-16 Firing Points
A-5	Military Operations on Urbanized Terrain (MOUT) Assault Course
A-6	Confidence Obstacle Site
A-7	Rappel Tower and Practice Tower
A-9	M203/M320 Grenade Launcher Range-5 Firing Points
A-10	Hand Grenade Qualification Course and Practice Lane
A-11	Ferrell Lake Navigation Course
A-12	25 meter Zero Range-32 Firing Points
A-13	EFMB Litter Obstacle Course
A-14	Live Fire Facility (Shoot House)
A-15	Field Leader Reaction Course
ARNO DZ	Air Drop Zone
B-1	25 meter Zero Range-32 Firing Points
B-2	25 meter Zero Range-32 Firing Points
B-2 SHOOTHOUSE	Military Operations on Urbanized Terrain (MOUT) Assault building
B-3	Gettysburg Road Land Navigation Course
B-4	Mounted Land Navigation Course
B-5	Land Navigation Course
B-6	Engineer Dig Site
B-7	Land Navigation Course
B-8	Tactical Mine Lane
BENNET HILL	3 Ski Runs/1 Tubing Run with Tow Rope
BREACH	Live-Fire Exercise Breach Facility
C	NBC Course
CACTF	Combined Arms Collective Training Facility (MOUT)
CENTER (CRG)	Multi-Purpose Training Range (MPTR)/Scout Recce Range (SGRC)
CLF	Convoy Live Fire Exercise
CTF	Collective Training Facility (MOUT)
D	Shotgun/Pistol Marksmanship Range: South Firing Line=40 Firing Points/North Firing Line=20 Firing Points
DEMO-2	OP-2 Field Demolitions Site
DEMO-4	SEAL CABIN Field Demolitions Site
DEMO-5	Light Demolitions Range
DEMO-6	TA75 Field Demolitions Site
DT-1	Vehicle Driver Training Course
DT-2	Vehicle Driver Training Course
DT-3	Vehicle Driver Training Course
EAST (ERG)	Multi-Purpose Training Range (MPTR)
EVOC	Emergency Vehicle Operators Course
F	Biathlon Course-31 Firing Points/25 meter Zero Range-29 Firing Points/Tactical Training Base
FARP	Forward Area Refueling Point
F&M-1	Fire and Movement Range
F&M-2	Fire and Movement Range
HGR	Hand Grenade Range (Live Grenade Familiarization)
IPBC	Infantry Platoon Battle Course
ISBC	Infantry Squad Battle Course

J	Multi-Purpose Field Fire Range (200m Firing Line)
K	Multi-Purpose Field Fire Range
L	Heavy Demolitions Range
M	25m Zero-32 Firing Points
MK-19	MK-19 Multi-Purpose Gunnery Range (40mm TP ONLY)
MSTC	Medical Simulation Training Center
NORTH (NRG)	Multi-Purpose Machine Gun Range(MPMG); 6 Lanes (lanes 2-5 equipped with 1500m targets)
NRG ECP	Entry Control Point (ECP) Trainer Lane
OP-1	Observation Point
OP-1.5	Observation Point
OP-2	Observation Point
OP-16	Observation Point
OP-19	Observation Point
OP-23	Observation Point
R	Vehicle Recovery Site
React to Contact	IED-Defeat Lane
RIPLEY DZ	Air Drop Zone
SEAL Cabin	Non-Standard Small Arms Range
Scaled Range	Scaled Vehicle Mounted Weapon Systems Course
TUAS	Tactical Unmanned Aircraft System Runway
UAC	Urban Assault Course-Station 3 is the Grenadier Gunnery Trainer (40mm TP ONLY)
W-1	Ferrell Lake Pontoon Bridge Site
W-2	Mississippi River Ribbon Bridge Site
WEST (WRG)	Multi-Purpose Machine Gun (MPMG) Range/Heavy Sniper Lane/Sniper Field Fire
Y-1	Tactical Training Base
Y-2 EAST	Tactical Training Base
Y-2 WEST	Tactical Training Base
Y-4	Tactical Training Base

Chapter 2: ITAM Program

The increased operational tempo of military activities has placed more pressure on training lands. Past and continued degradation of natural resources can have a negative effect on the realism of future training exercises.

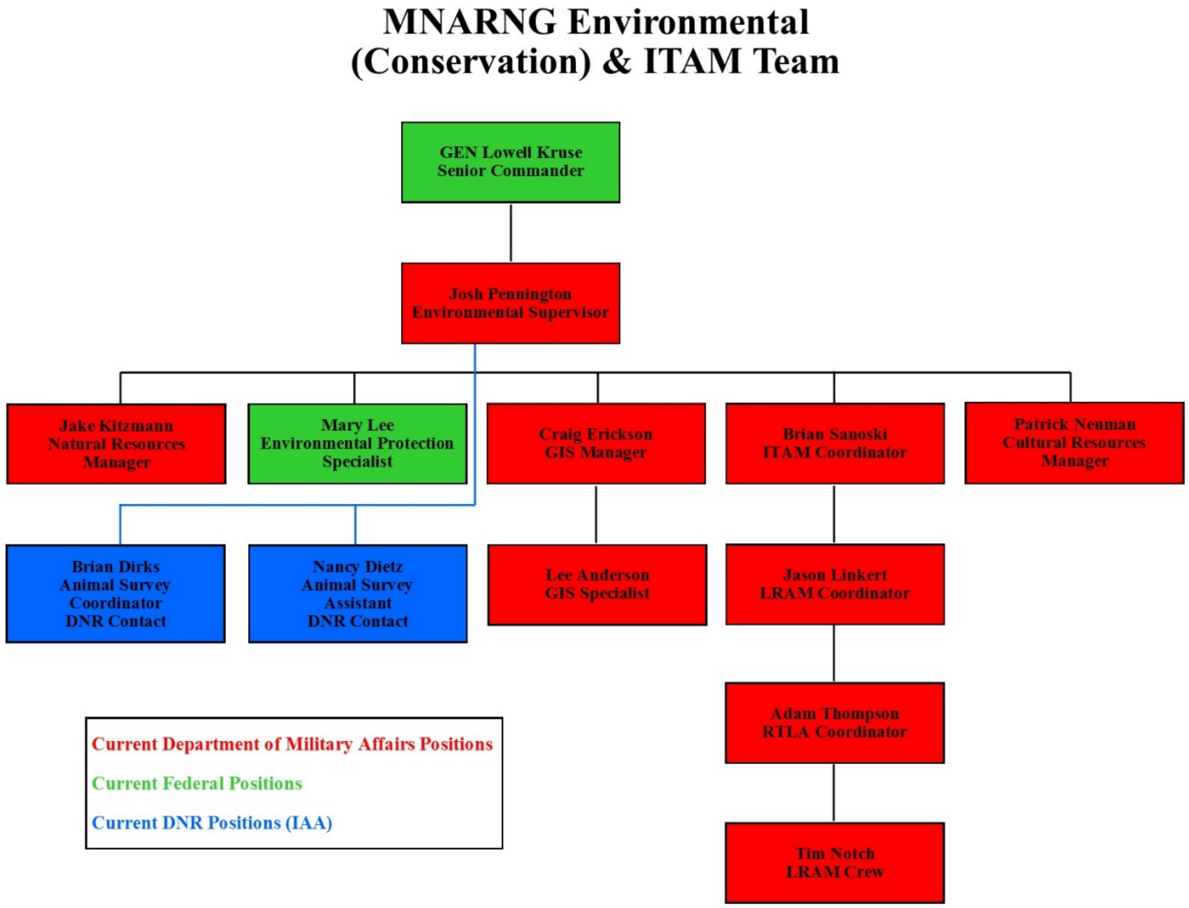
To meet all environmental laws and regulations the U.S. Army Construction Engineering Research Laboratory (USACERL) has developed the ITAM program. The ITAM program is a comprehensive tool that consists of five components necessary to maintain and improve the condition of natural resources. The five components are as follows:

1. **Range and Training Land Assessment (RTLA)**
   Formerly referred to as the Land Condition Trend Analysis (LCTA), the RTLA program is an ongoing program for land inventory and monitoring.
2. **Land Rehabilitation and Maintenance (LRAM)**
   LRAM is an ongoing program whereby erosion control measures and good vegetation management practices are employed to maintain and stabilize the soil.
3. **Training Requirements Integration (TRI)**
   TRI is a program developed to integrate the training mission with the natural resource requirements.
4. **Sustainable Range Awareness (SRA**)
   Formerly referred to as the Environmental Awareness (EA), the SRA program uses educational material to address environmental issues and provide guidelines to the troops in training, commanders and the general public. Educational materials include field cards, handbooks, posters and videotapes.
5. **Geographic Information System (GIS)**
   GIS is a computer-based program developed to assist in resolving complex land management problems. Data depicting a variety of environmental attributes can be prepared, displayed and analyzed to guide land use decisions.

Personnel & Staff:

In 2013 all contract positions with St. Cloud State University (SCSU) were converted to Department of Military Affair (DMA) positions. These changes included all of the following positions: RTLA Coordinator, LRAM Coordinator, GIS Specialist, and Training Area Coordinator. In addition, an ITAM Coordinator was hired to execute the ITAM program.

Figure 6: Environmental Staff



Historical Information of the ITAM Program

The ITAM program was initiated at Camp Ripley in 1991. An initial inventory of the flora and fauna of the installation was completed by the Minnesota Department of Natural Resources (DNR) from 1991-1993 and 81 core and 52 special use plots were established. Since then an additional 62 special use plots have been established. A majority of the special use plots were established in high use areas such as bivouac sites. “LCTA-RTLA” will be used interchangeably throughout the rest of the document.

The GIS program was also initiated in 1991 with the purchase of hardware and software. Two work stations were established, one in the Facility Management Office and the other in the Training Site Environmental Office. In 1992 an individual was hired through the environmental program to manage the GIS system. In 1992 the EA program began with a contract with USACERL. Products produced from the contract included a video tape, soldier field cards, handbooks, and posters. Also during this period a study was conducted to determine black bear population and range on Camp Ripley. In 1994 and 1995 Camp Ripley continued to implement its LCTA program by concentrating its survey efforts on the high use areas on Camp Ripley through a Tactical Vehicle

Study. Efforts in the LCTA, GIS and EA programs were continued through 1995. In 1996 a more intense survey (long-term monitoring) of the LCTA plots was completed for both the flora and fauna.

The LRAM program was implemented in 1997. In 1998 an Erosion Assessment was completed in all 80 training areas on Camp Ripley, which identified 130 sites that needed improvements. In 1998 a new position under our TRI program was established. The position is titled the Training Area Coordinator (TAC). The TAC position serves as a liaison for Camp Ripley Range Control Office and Environmental Office to ensure implementation of the ITAM program for Camp Ripley. In addition, the individual was involved in coordinating training area usage and will assist in the development of training area policies and procedures. The LRAM program continues to do erosion assessments on both Camp Ripley and the Arden Hills Army Training Site (AHATS) annually. Flora and fauna monitoring is done annually with a long term comprehensive monitoring of vegetation in 2000. An LCTA Installation report was completed in July of 2001 which documented the findings of the first 10 years of the LCTA vegetation program. Fauna reports (Animal Survey Reports) have also been produced annually since 1991. Starting in 2001 more funding emphasis was put towards the LRAM program for equipment and land maintenance activities. In 2008 new assessments were added in the RTLA program to better address and identify land capability and condition for the military users of Camp Ripley. Some of these assessments are currently active today and will continue their rotation in the ITAM program as they have been deemed a necessity to support the training needs for Camp Ripley.

Table 6 and Table 7 portray an overview of overall ITAM funding during the years of 1991-2017. From 1991-2017 the MNARNG has obligated approximately $15,593,979 to implement its ITAM Program.

Table 6: ITAM Funding 1991-2017

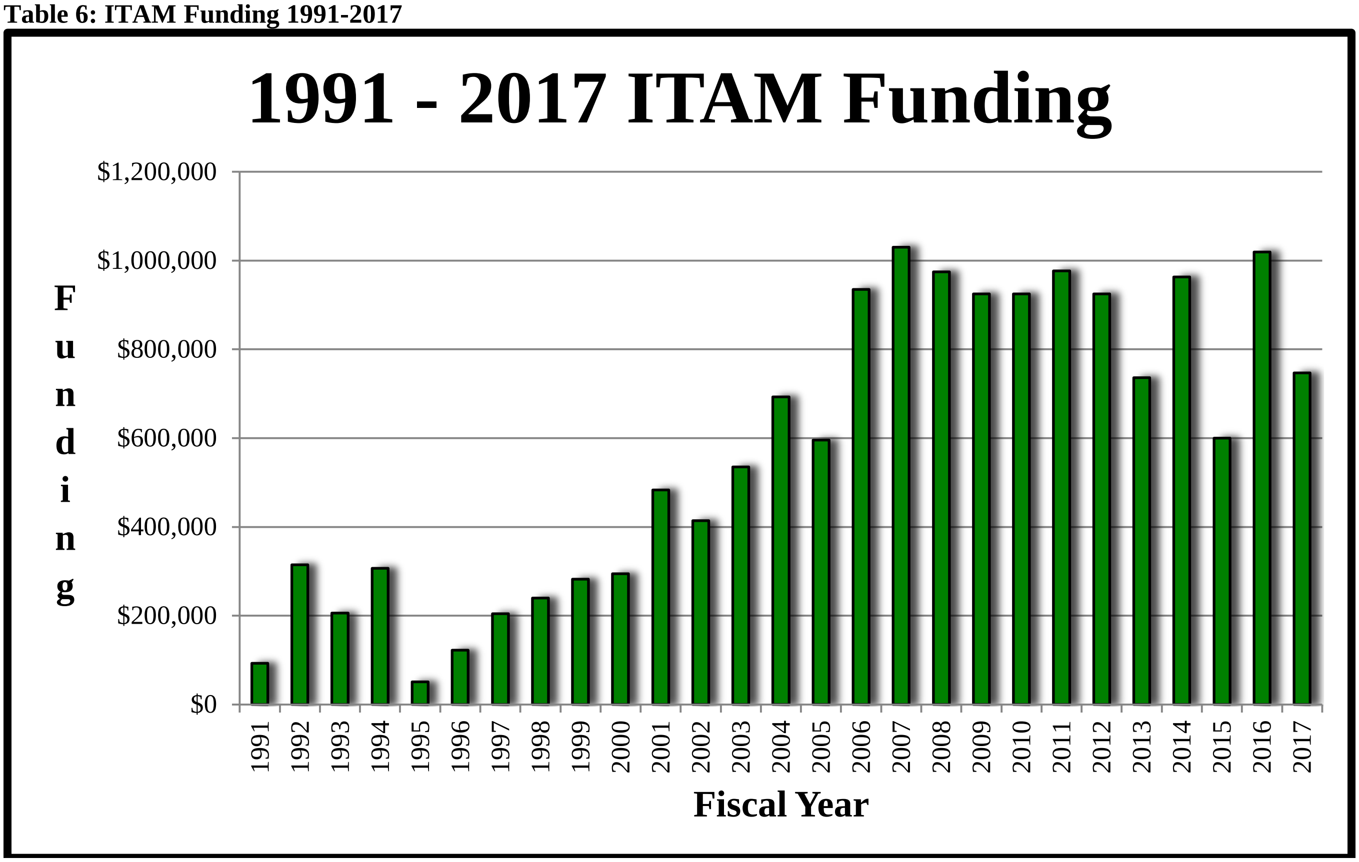
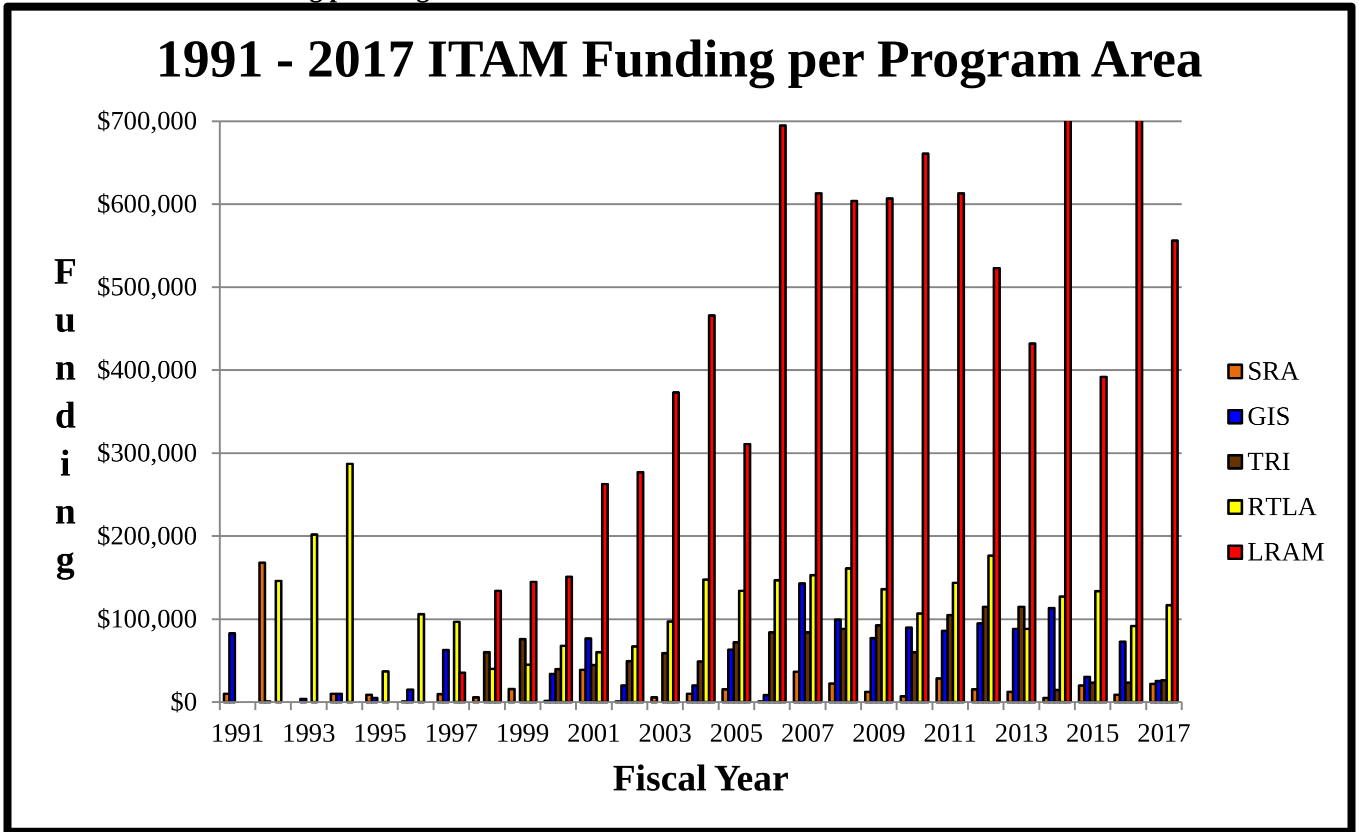


Table 7: 1991-2017 Funding per Program Area



Range and Training Land Assessment (RTLA)

Background

RTLA is the component of the ITAM Program that provides for the collecting, inventorying, monitoring, managing, and analyzing of tabular and spatial data concerning land conditions and capabilities on an installation. RTLA provides data needed to evaluate the capability of training lands to meet multiple use demands on a sustainable basis. It incorporates a relational database and GIS to support land use planning decision processes. RTLA collects physical and biological resources data to relate land capabilities and conditions to training and testing activities. These data are intended to provide information to effectively manage land use and natural and cultural resources.

Camp Ripley entered into a cooperative agreement with Minnesota Department of Natural Resources (MNDNR) in 1989, to institute a comprehensive survey of Camp Ripley’s flora and fauna. The Land Condition Trend Analysis (LCTA) program, a long-term monitoring program was then initiated at Camp Ripley in 1991. The program’s initial function was to evaluate and monitor the impact of military activities on natural resources. Under this system, permanent study plots were established to inventory the flora and fauna of Camp Ripley, and are referred to as core and special use plots.

The initial LCTA program employed a standard method to inventory flora and fauna on permanent field plots. Standard methods are essential for army-wide data comparability. Consequently enables data summarization at Department of the Army (DA) levels, and database system compatibility, which minimizes system development and maintenance costs. Permanent field plots were established to quantify the condition and trends of an installation's natural resources.

The standard size of a plot is six meters by 100 meters with a transect line dividing it in half longitudinally. A total of 195 LCTA plots (81 core & 114 special use) have been established at Camp Ripley. Core plot allocation is based on soil and vegetation cover and represents the land cover distribution occurring on Camp Ripley as a whole.

Special use plots are, as the name implies, for use in special situations. They are not permanent and may only be as long lived as required to collect enough data to make decisions. Special use plots are used to deal with specific issues that cannot be addressed by core plots. The collected data are used to monitor impacts of various types of land uses. This may include determining the success of land rehabilitation efforts, documenting the effects of accidental and prescribed burning, assessing natural recovery of degraded lands, characterizing and monitoring habitat of threatened and endangered species, and wetlands. A majority of the special use plots were established in high use areas (i.e. bivouac sites).

Flora data collection consists of three phases: initial inventory, short-term monitoring, and long-term monitoring. Initial inventory and long-term monitoring provide detailed information on vegetation type, location, height, size and condition; aspect, slope, soil depth, land uses, maintenance activity, wind and water erosion, ground cover, and ground disturbances on the plots of the installation. Short-term monitoring provides similar information, but not as in-depth of detail. After the initial inventory, long-term monitoring was completed every five years. In the interim years, short-term monitoring was being completed. The data is recorded between June and August of each year. Mammal, bird, and reptile and amphibian surveys are also conducted on some of these plots.

Information and results from the LCTA vegetation program can be found in the document titled “Land Condition Trend Analysis 1991-2000 Installation Report”.

RTLA Assessment Development

In 2008 Camp Ripley ITAM staff along with Sound Science and NGB established new assessments to better identify our customers and their requirements. The first step was to work with range control and use the RFMSS data to determine the types and intensity of training that occurs on Camp Ripley. The second step was to coordinate with the Plans, Operations and Training Office (POTO) and range control to identify future training requirements for the MNARNG and to determine whether Camp Ripley has the land capability and condition to meet those requirements. It was determined that the major types of training at Camp Ripley can be broken down into five categories: Field Artillery, Mechanized Maneuver, Engineering, Patrolling/Convoy Operations and Assembly Area or Bivouac Activities. While each of these categories has specific requirements, they all share some common characteristics that help form the Mission-scape for each type of training. Since the start of the Global War on Terrorism, added emphasis was put into training for Patrolling and Convoy operations by all units that utilize Camp Ripley while Bivouac and Assembly Area operations have decreased due to the increased reliance on Forward Operating Bases (FOBs) in the current theater of operations. Mechanized, Engineer and Field Artillery units are still required to conduct branch specific training to maintain Military Occupational Specialty (MOS) skills. The following paragraphs will summarize the five categories of training and the corresponding land requirements. Also reference Table 8 which summaries the common types of military use and their appropriate land requirements.

Field Artillery

Field Artillery training is a major component of the training that occurs at Camp Ripley with two battalions of artillery within Minnesota and another two battalions from South Dakota that habitually train at Camp Ripley. The major weapons systems used are the Multiple Launched Rocket System (MLRS), M109/Paladin self-propelled artillery and the M-155mm towed howitzer system. The MLRS and M109/Paladin systems are more maneuverable than the towed howitzers and therefore have the higher mission-scape requirements.

An analysis of artillery firing points over the last several years using the Range Managers Toolkit (RMTK) and GIS coverage of the vegetation areas showed the following results. Twenty-four unique locations were used for indirect fire training ranging in size from 13 to 180 acres with a mean size of 46 acres and median size of approximately 20 acres. A mathematical analysis of artillery requirements using minimum tube elevation and a platoon of four guns produces a minimum area of approximately 11 acres. Based on this analysis, optimal firing point size would be at least 15 acres of grassland with at least 300 meters between the firing line and woodline in the direction of the impact area. Areas of smaller size would restrict gun placement and firing options; larger open areas will accommodate more guns and allow more options for placement.

The Paladin and MLRS weapons systems incorporate GPS and computer technology to make each system able to operate independently and therefore have additional mission-scape requirements. Due to the minimal set-up time required for these systems, the guns will be in a “hide” position that offers both vertical and horizontal concealment. Once the gun receives a fire-mission, the gun will leave the hide to a suitable firing position, fire the mission then move into a different “hide”. Optimally on the next fire-mission the gun will come out to a different firing position to fire. These two systems therefore require multiple open areas in close proximity, connected by a good trail network and the intervening woods would have a closed canopy with enough underbrush to provide lateral concealment, yet mature tree spacing would also allow enough free maneuvers to allow suitable hide locations. The firing point locations should also have a low percent slope over the entire area to allow maximum use of space.

Mechanized Maneuver

This training pertains mainly to units with the M1 Abrams tank and M2 Bradley fighting vehicles. Areas for mechanized maneuver would offer opportunities for both offensive and defensive operations. An example of the training conducted would be for a platoon of four to six vehicles are in a defensive position with two platoons of 8-12 vehicles maneuvering several kilometers through varying terrain on the attack.

The defended location should be open enough to allow good fields of fire for several hundred meters. Behind the defended area a good trail network should allow concealed movement of forces to cover weak points and counter attacking forces tactics. Forested areas in the vicinity should offer good lateral concealment yet be open enough for vehicle movement between mature trees.

The attacking force will start in an assembly area several kilometers away from their objective. The assembly area should be large enough to accommodate 15 large vehicles and offer both vertical and horizontal concealment. GPS data collected on sites used as assembly areas shows a minimum size of 5 acres. The area should be open enough to allow vehicle maneuver between mature trees. The maneuver lane to the objective should be of varying terrain from flat open spaces at least 300 meters in width to restricted terrain with several choke-points in order to allow maximum leadership challenges. Restricted areas could be limited to one main trail that all forces need to follow or several smaller parallel trails the element could travel on. The last several hundred meters to 1 kilometer from the objective would be a savanna type landscape that allows some concealment as the attacking element closes on the objective.

Engineer

The engineer missions of Mobility, Counter-mobility and Survivability parallel the requirement for Mechanized Maneuver listed above. The greatest difference would be in the Counter-Mobility and Survivability missions that require mechanical digging. Areas designated for defense should be culturally cleared to allow for the digging of anti-tank ditches, vehicle fighting positions and personnel fighting positions. These areas should be planted with native grasses for maximum root depth and soil stabilization. Mechanical digging areas should be relatively flat to minimize erosion potential. Reseeding of disturbed soil should occur quickly after completion of training to further reduce erosion potential at the site.

Patrolling/Convoy Operations

Since the start of the Global War on Terrorism, patrolling and convoy operations have gained ever increasing importance in training units. While training for conventional warfare will continue, learning to fight an unconventional, asymmetrical war will continue to receive increased emphasis in the future. Since 2002, most units training at Camp Ripley have opted to train out of a FOB, using the cantonment area, a Tactical Training Base (Y-1, Y-2, and Y-3) or the Biathlon course as their FOB.

In this training environment squad to platoon sized elements depart the FOB on a mission lasting several hours and covering multiple training areas. Elements will encounter Improvised Explosive Devices (IED), insurgent attack, road blocks and civilians on the battlefield. This training requires several miles of trail network that will provide different command and control challenges. Road conditions should vary from wide, well maintained roads to single vehicle wide trails that constrict maneuver and simulate the urban environment. Ground disturbance for this training is minimal as most training occurs on established trails. Open areas for MEDEVAC training should be interspersed throughout the areas to allow either actual or simulated helicopter evacuation of wounded.

Bivouac/Assembly Areas

Field bivouac sites are being used less and less by units training at CRTC as FOB operations are gaining training emphasis. However; establishing assembly areas is still a necessary requirement to support. GPS data collected in 2001 and 2002 show an average company sized bivouac area is 5 acres. Sites used for bivouac were generally flat areas of mature forest with a good trail network and minimal undergrowth. Forest edges provided enough concealment to make sighting of equipment and personnel difficult. Some hand or mechanical digging does occur in bivouac sites and therefore makes cultural clearances of the areas a high priority.

Mission-Scape Models

Table 8: Mission-Scape Summary

Field Artillery	***Mech Maneuver***	***Engineer Ops***	***Patrolling/Convoy Operations***	***Bivouac***
Good Trail Network				
Min 15 acres open space	Large Open areas	Large Open areas	Interspersed Open areas	Adjacent to other mission-scapes
Adjacent open forest 3-5m tree spacing	Open forest/Savanna type areas	Open forest/Savanna type areas	Various forest conditions	Open forest 3-5m tree spacing
Vertical and lateral concealment				
<10% Slope	Varying Terrain	<10% Slope	Varying Terrain	<10% Slope
Multiple sites in proximity	Varying restricted/unrestricted areas.			

Based on the results of these steps, The RTLA assessment program will use a 3-tiered conceptual model for each type of assessment that Camp Ripley supports. Training land condition and capabilities requirements will be established for each level in the model. The model will then be used as a tool for making management decisions. This tiered model takes advantage of the Red-Amber-Green ranking that is often used by the military. A sample of the three-tiered model is shown below:

Once the categories of training and the corresponding land requirements were identified, the ITAM staff went through an exercise to identify the challenges Camp Ripley faces in providing the proper land requirements for the different types of training. Goals and objectives were then identified to address how we would address the issues pertaining to each training category and assessments were created to better quantify the current capability and condition of the land. A schedule was created for the assessments to address ITAM related goals and objectives (Table 10). Mission-scape models were then created for each assessment. Currently nine RTLA assessments have been created through this process and they are as follows:

Assessment 1: LRAM Assessment

Project Title: Annual assessment of Camp Ripley's maneuver trails to ensure safe travel by all vehicles.

Challenge: Localized erosion events on maneuver trails create both a safety and maintenance challenge. When left unrepaired, these erosion events result in vehicles circling the area and thus widening of the traversed area, creating a growing problem.

Management Goal: All maneuver trails on Camp Ripley will be maintained in a safe and readily traversable condition.

Management Objective: Identify all hazards during a fall survey. All significant safety hazards will be addressed within two weeks of identification. All other identified rehabilitation needs will be completed by October the following year contingent on funding.

Products/Uses: A map of all maneuver trails showing categorized erosion sites and a spreadsheet listing survey data fields and costs tables associated with repairing the sites is created. This will be provided to SRP committee for approval, scheduling, and budgeting.

Monitoring Goal: All trail segments will be surveyed at least biennially.

Methods: Staff will perform annual assessment of maneuver trail condition each fall. Each year, 50% of maneuver trails on Camp Ripley will be assessed. Each event will be individually assessed. The cost of repair will also be estimated for each event based on a standard rubric. In addition to formal surveys, ad hoc reporting by Range and Range Safety Officers is encouraged. Significant hazards are reported directly to Roads and Grounds and are immediately addressed. Other erosion events are reported to the LRAM program manager who follows-up with a site visit and standard assessment.

Data Management: The standard reporting form, supported with photographs of the event will be entered into a database. A word document (maps, summary tables, costs) will be prepared annually which identifies the erosion sites and documents accomplishments.

Assessment 1 Mission-scape Model

Optimal Training

Requires that 100% of all maneuver trails on Camp Ripley are in a safe and readily traversable condition.

Non-Optimal Training

Requires that 75% of all maneuver trails on Camp Ripley are in a safe and readily traversable condition.

Unacceptable Training

Requires less than 50% of all maneuver trails on Camp Ripley are in a safe and readily traversable condition.

This assessment has been part of the Camp Ripley ITAM program since 1998. The first assessment year covered the entire post and recorded 120 sites that required LRAM work. Repair of the combat trails was conducted in 1999 and 2000. Subsequent assessments beginning in 2001 were conducted alternately between the north and south halves of the installation with the south half being assessed during odd years and the northern portion being completed in even years. The dividing boundary distinguishing the north half form the south half is Lake Alott Road represented below in Figure 7. In 2008 the LRAM Assessment officially became part of the RTLA program. Table 9 summarizes the number of sites identified each year per training facility.

Figure 7: Maneuver Trail Condition Schedule

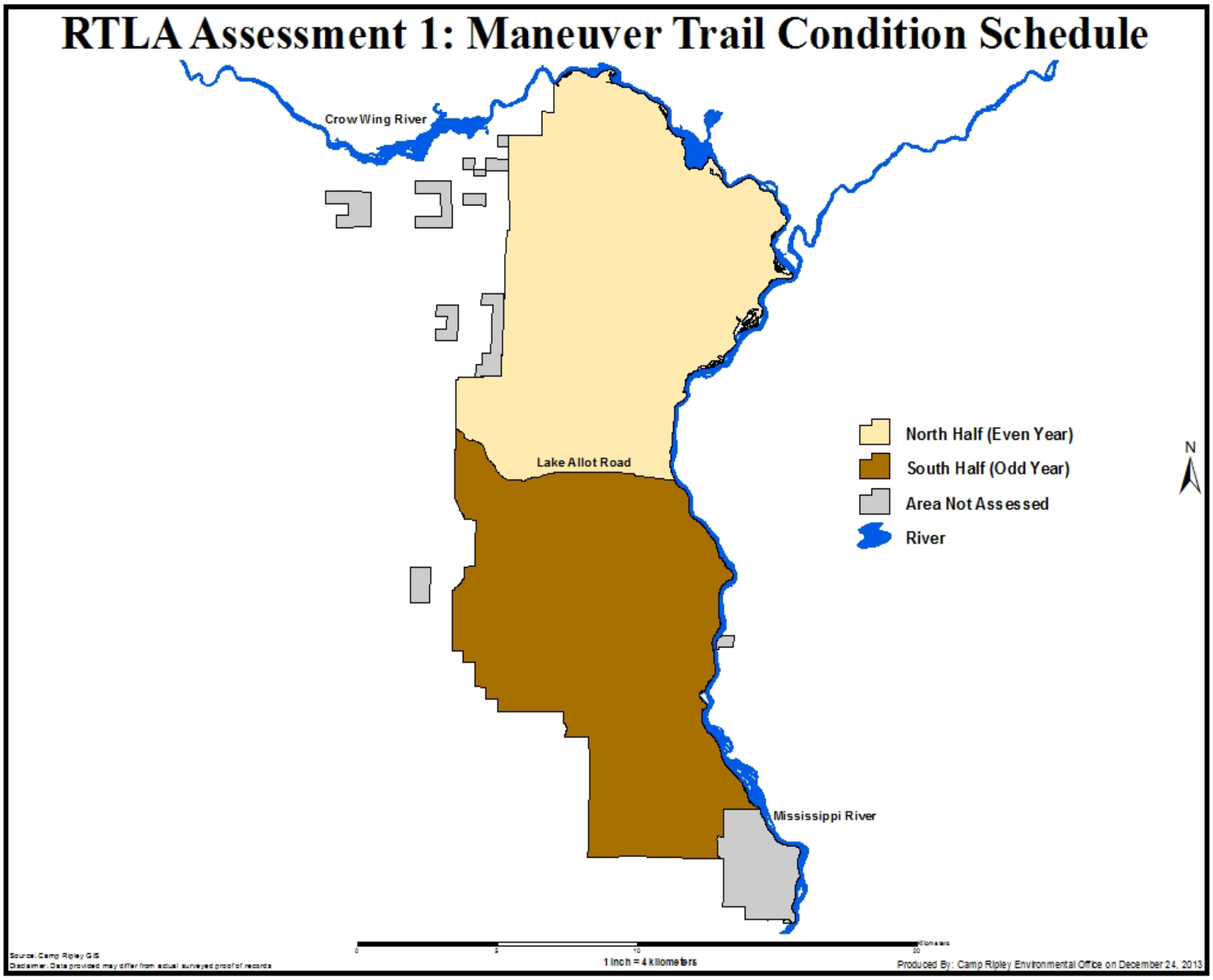
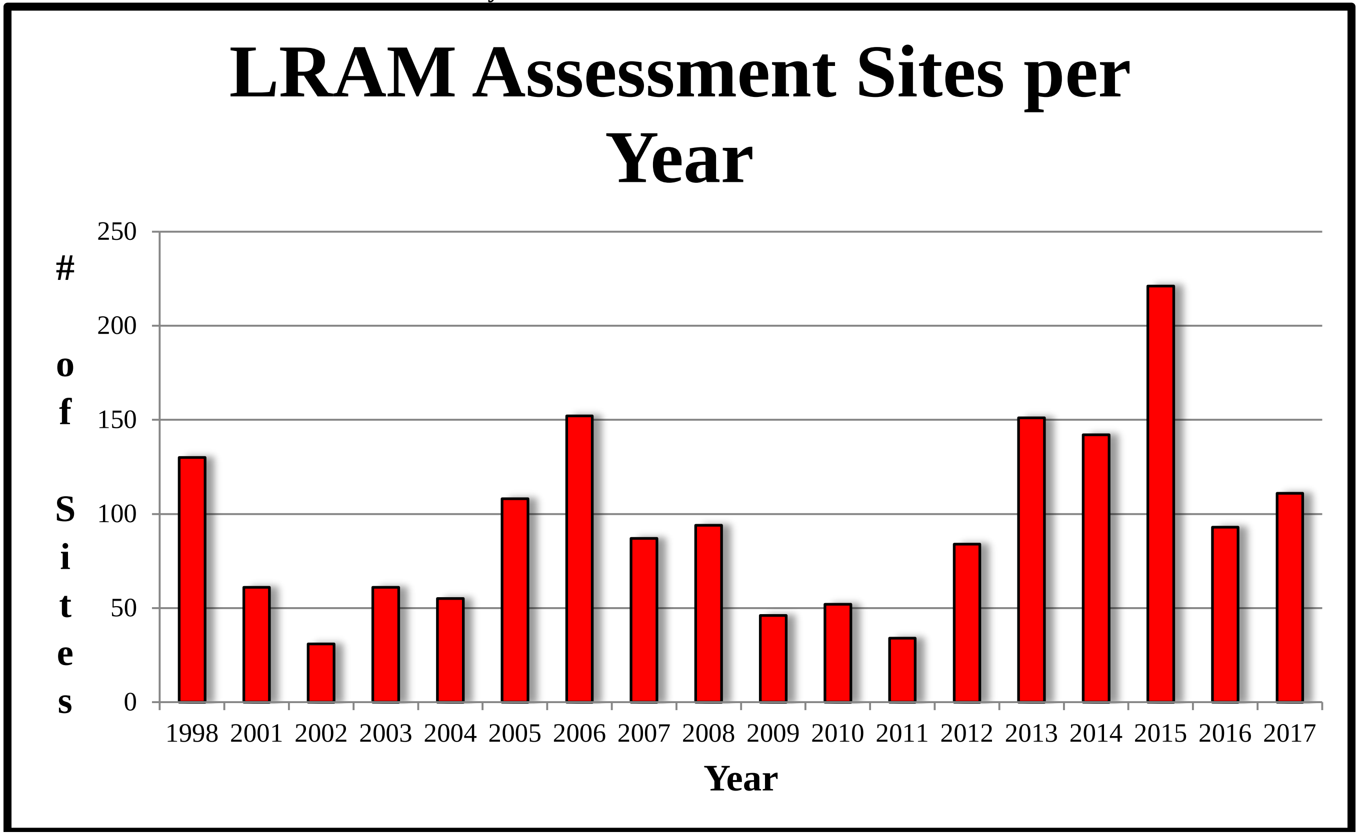


Table 9: Maneuver Trail Condition Sites by Year



Assessment 2: Artillery Firing Point Assessment

Project Title: Assessing the quality and sustainability of artillery firing points.

Challenge: Realistic artillery training requires firing points to be at least 15 acres of open area, each having >300m between the firing point and the tree line, sufficient ingress/egress, and several hides within the adjoining forestland. Natural succession threatens these grasslands by woody encroachment from the edges shrinking the size of the open areas and closing off potential hides.

Management Goal: All grasslands larger than 15 acres in area will be managed to prevent woody vegetation encroachment from the edges. All priority grasslands for artillery use will be actively maintained to meet minimum artillery training criteria.

Management Objectives:

1. There will be no loss of open grasslands larger than 15 acres. Woody encroachment of these areas will be controlled by physical, chemical, mechanical or biological treatment.
2. A minimum of 40 priority grasslands used as artillery firing points will be identified and maintained to ensure:
    1. There is a minimum of 300 meter separation between the firing point and tree line
    2. There is sufficient (more than 2 options) ingress and egress for equipment
    3. The adjoining forest must provide concealed areas, hides that are easily traversable
    4. Each grassland will be connected to others to create clusters of grasslands suitable as firing points

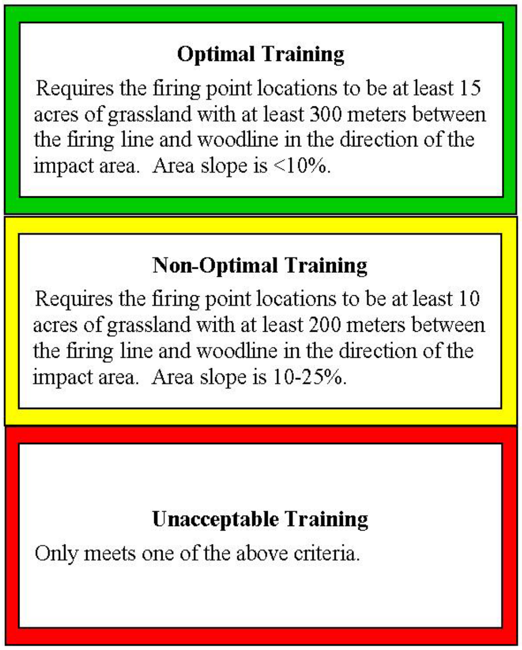
Products/Uses: A map identifying the highest quality/most used sites. This map will be supported by a document identifying the sites, the available targets for each firing point, and capability of each firing point.

Monitoring Goal: All firing points will be assessed on a 3 year basis to detect forest encroachment. We want to be able to detect a loss of >5% loss in area. Each priority firing point will be assessed at least every third year to assess the condition of the grasslands and the adjoining forest.

Methods: The RTLA program identified and updated the GIS layer of all known firing points in 2008. All firing points will be assessed every 3 years utilizing remote sensing imagery. This assessment will include:

1. Size/forest encroachment
2. Number of trails providing ingress/egress (trail condition is assess as part of assessment #1)
3. Distance between firing pad and forest edge
4. Based on this map, identify between 40-50 priority firing points locations. Prioritization based on:
    - A. Maneuverability
    - B. Primary Cover Type
    - C. Woodline Separation
    - D. Ingress/Egress Routes
    - E. Max Slope
    - F. Encroachment
    - G. Undergrowth
    - H. Distance Between Tree Lines
    - I. RFMSS
    - J. Surface Danger Zone (SDZ) Conflict
    - K. Range Conflict
    - L. Weed Density
5. Adjoining forest assessment

Assessment 2 Mission-scape Model



Optimal Training

Requires the firing point locations to be at least 15 acres of grassland with at least 300 meters between the firing line and woodline in the direction of the impact area. Area slope is <10%.

Non-Optimal Training

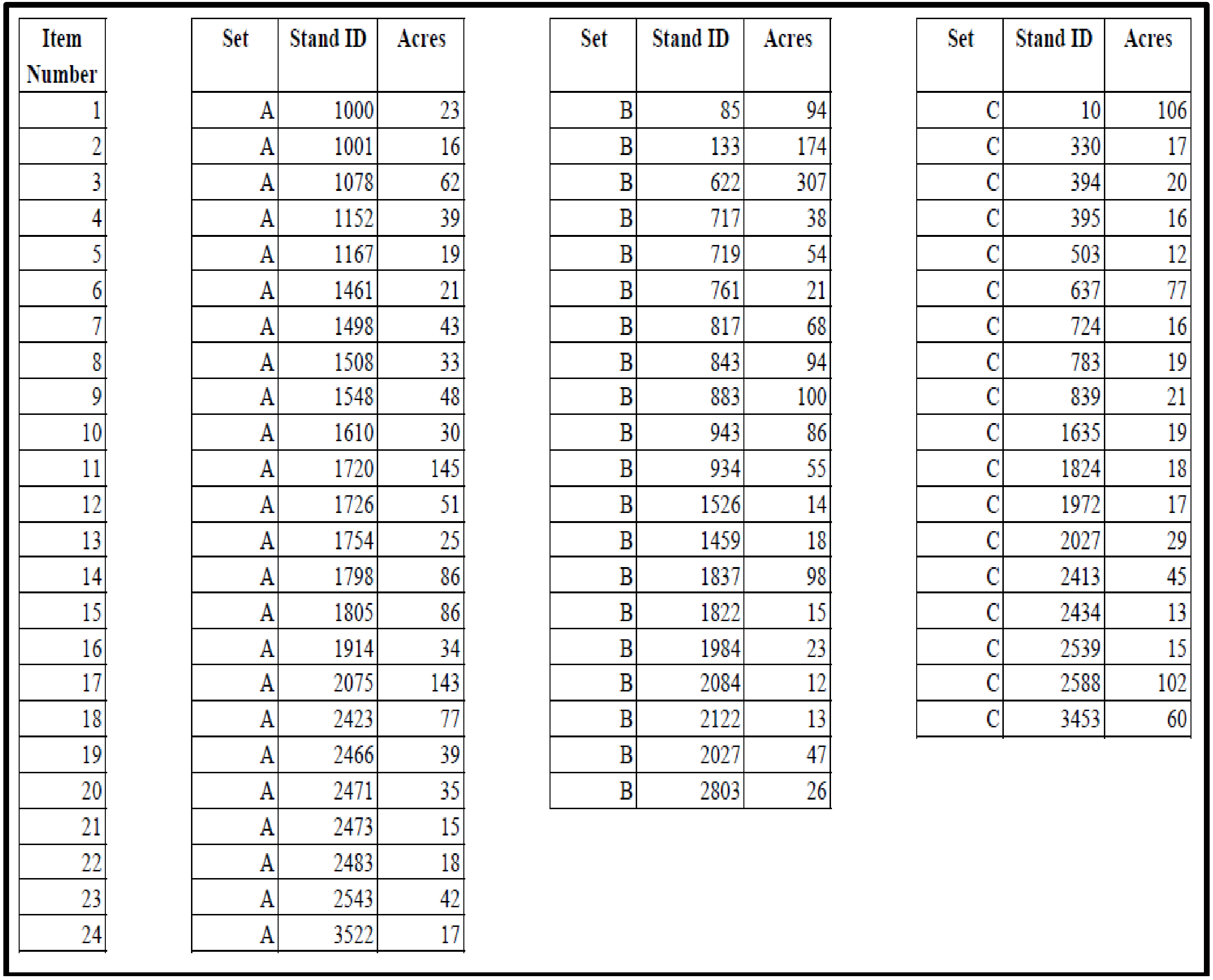
Requires the firing point locations to be at least 10 acres of grassland with at least 200 meters between the firing line and woodline in the direction of the impact area. Area slope is 10-25%.

Unacceptable Training

Only meets one of the above criteria.

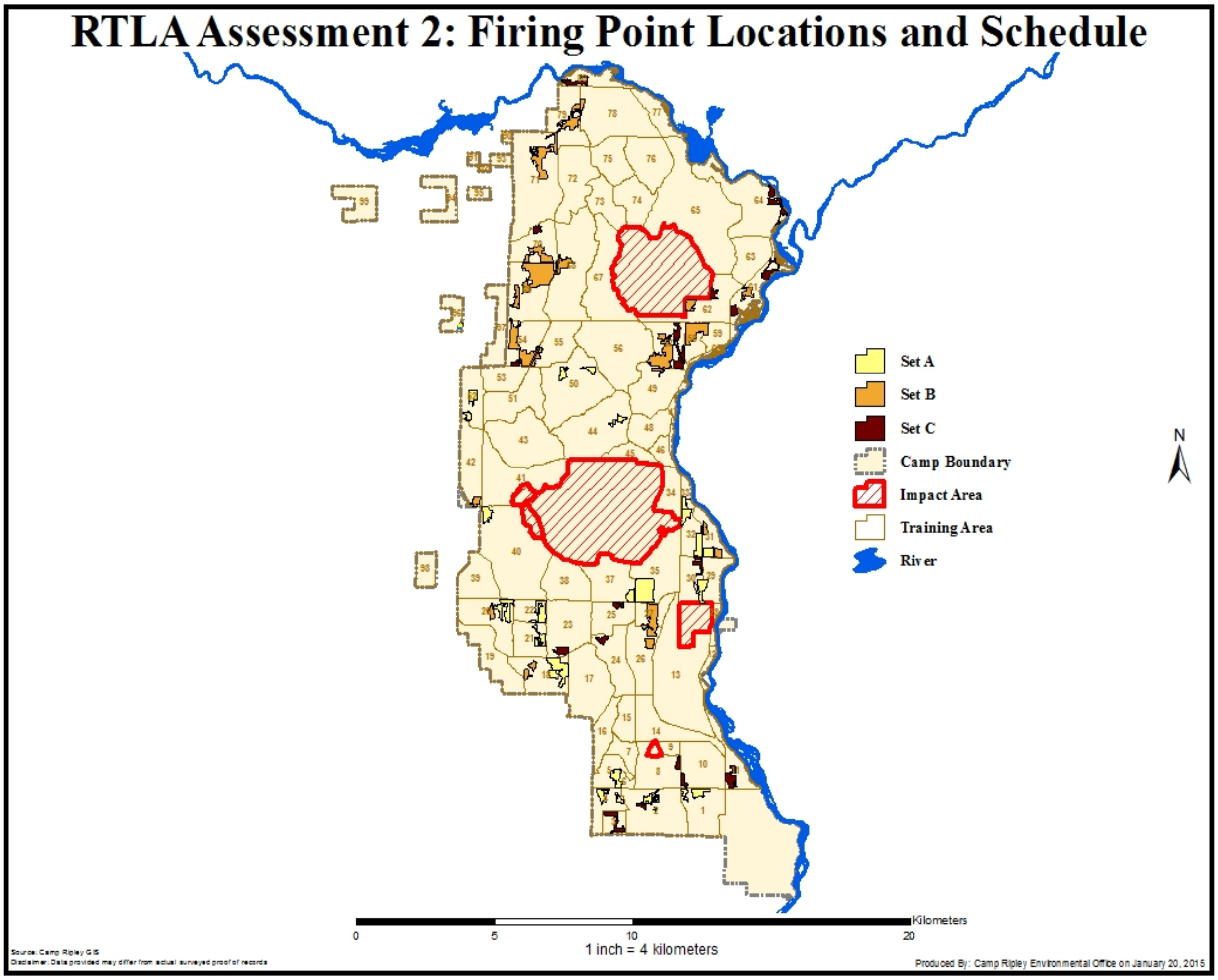
An initial assessment of firing point locations was completed in conjunction with a member of an artillery unit to identify conditions that they believe are appropriate. Initial assessments were done on all 69 priority grasslands during the summers of 2008-2010. The artillery firing point assessment will be based on above criteria and reassessed every 3 years in conjunction with prescribed fire monitoring process. The original total number of sites has decreased from 69 to 61, removing sites that have a high conflict rate with SDZs. The sites were divided in to three groups of 24, 19 and 18 firing points to be assessed on a 3 year rotation and labeled as Set A, Set B and Set C (Figure 8). Re-assessments have been conducted starting in 2012 and assess the effectiveness of the control measures. Additionally, new aerial photography has be flown in 2012 that will allow for more recent analysis of encroachment as well as an additional means of measuring the effectiveness of the remediation work. Prescriptions to maintain firing points involve carbiding, tree shear, chemical, sawyer team, timber sale, reseeding, and prescribed fire. All firing points receive the use of scheduled prescribed fire to control woody encroachment and promote native grasses. Fire is perhaps the best method to establish the preferred vegetation type for military training.

Figure 8: Firing Point Sets



Item Number	Set	Stand ID	Acres	Set	Stand ID	Acres	Set	Stand ID	Acres
1	A	1000	23	B	85	94	C	10	106
2	A	1001	16	B	133	174	C	330	17
3	A	1078	62	B	622	307	C	394	20
4	A	1152	39	B	717	38	C	395	16
5	A	1167	19	B	719	54	C	503	12
6	A	1461	21	B	761	21	C	637	77
7	A	1498	43	B	817	68	C	724	16
8	A	1508	33	B	843	94	C	783	19
9	A	1548	48	B	883	100	C	839	21
10	A	1610	30	B	943	86	C	1635	19
11	A	1720	145	B	934	55	C	1824	18
12	A	1726	51	B	1526	14	C	1972	17
13	A	1754	25	B	1459	18	C	2027	29
14	A	1798	86	B	1837	98	C	2413	45
15	A	1805	86	B	1822	15	C	2434	13
16	A	1914	34	B	1984	23	C	2539	15
17	A	2075	143	B	2084	12	C	2588	102
18	A	2423	77	B	2122	13	C	3453	60
19	A	2466	39	B	2027	47			
20	A	2471	35	B	2803	26			
21	A	2473	15						
22	A	2483	18						
23	A	2543	42						
24	A	3522	17						

Figure 9: Firing Point Assessment Sites



Assessment 3: Open Maneuver Assessment

Project Title: Assessing woody vegetation, vegetation and erosion control in 350 acres of two open maneuver areas.

Challenge: Camp Ripley's largest open grasslands are used for open heavy mechanized maneuver activities. These military uses require areas of at least 100 acres for open maneuver space. These are threatened by woody vegetation, both encroaching from the edge and creating hazards within the center of the grasslands.

Management Goal: All grasslands larger than 100 acres in area will be maintained to eliminate existing woody vegetation and prevent woody encroachment from the edges.

Management Objectives: There will be no loss in spatial extent of open grasslands larger than 100 acres. All safety hazards will be eliminated from these areas.

Products/Uses: All grasslands will be available for training activities.

Monitoring Goal: For each grassland larger than 100 acres, spatial extent will be assessed annually utilizing satellite based imagery. Woody vegetation will be assessed in June following prescribed management techniques. Assess woody vegetation >0.5" diameter & greater than 18" in height.

Methods: Assessments will be done via a time constrained walking survey, stipulating a specified period of search per acre. All safety hazards will be documented and geo-located during these surveys.

Assessment 3 Mission-scape Model

🟩 **Optimal Training**

Requires open areas 100 acres in size, with an interconnected trail network system. No woody vegetation over 18 inches.

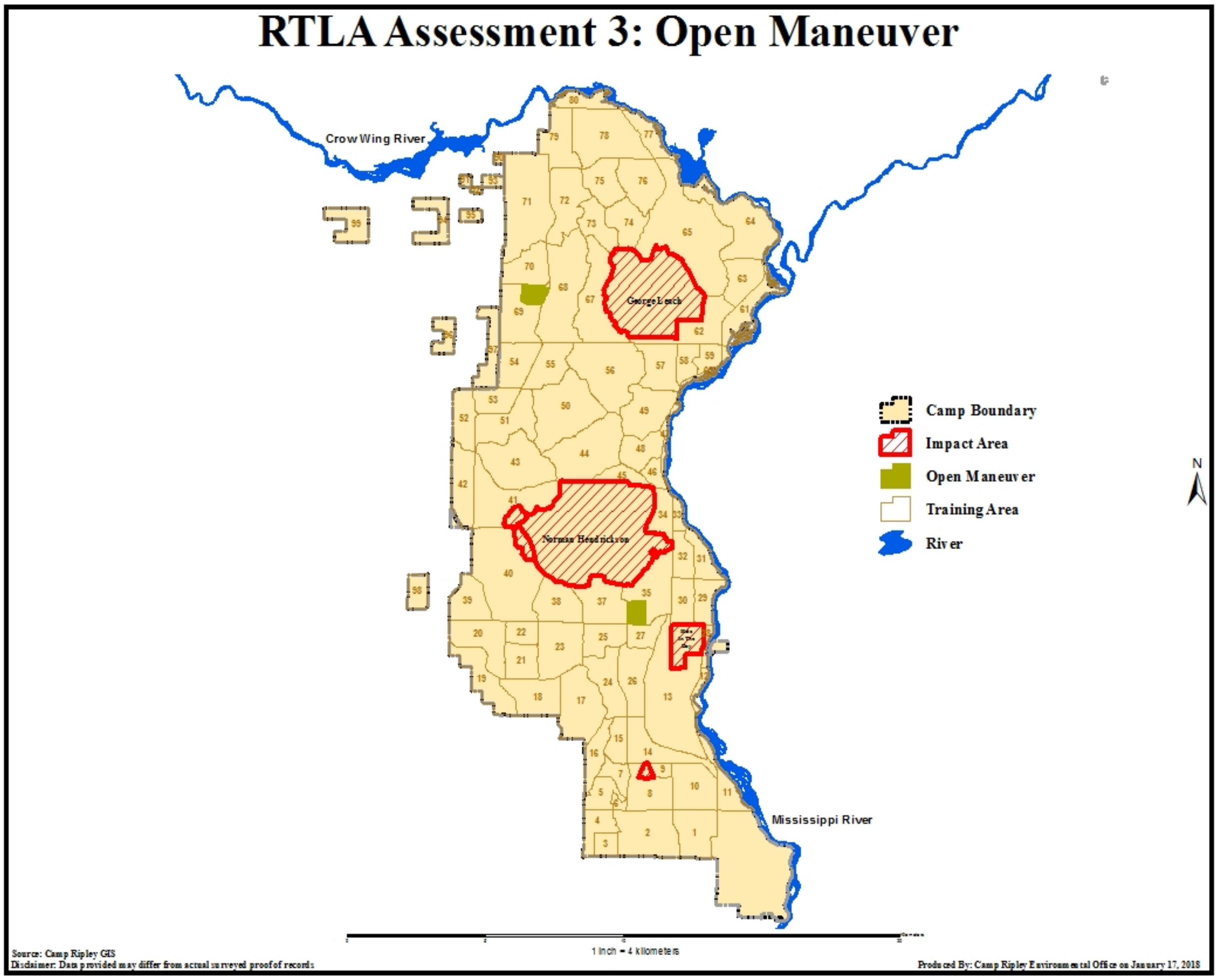
🟨 **Non-Optimal Training**

Requires open areas 100 acres in size, with an interconnected trail network system. Woody vegetation over 18 inches.

🟥 **Unacceptable Training**

Only meets one of the above criteria.

Figure 10: Open Maneuver Assessment Sites



Assessment 4: Maneuver Corridors

Project Title: Monitoring the traversability of Camp Ripley's Maneuver Corridor

Challenge: The ITAM program has been tasked with overseeing the creation and maintenance of five maneuver corridors in maneuver area K1. When completed the approximate total length of these new corridors will be approximately 30 km. These maneuver corridors have be constructed from closed forests surrounding existing trails. This will require forestry management to create acceptable conditions including: stem density, basal area, stem spacing, stump height, horizontal concealment. Monitoring woody encroachment is essential to ensure the width of the maneuver corridors remain at an optimal width of 100m to 300m.

Management Goal: To create wooded maneuver corridors which are easily traversable by track vehicles. This requires patches of dense vegetation providing visual cover embedded in a matrix of park-like stands of trees.

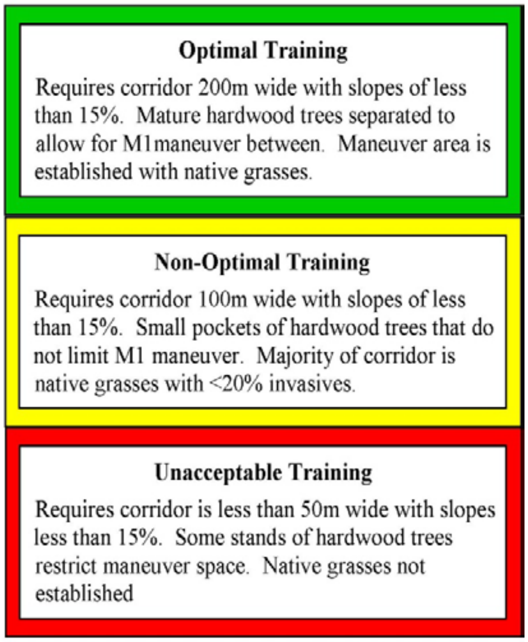
Management Objective: To maintain the traversability of wooded maneuver corridors by track vehicles for mechanized maneuver.

Products/Uses: A subsequent assessment to examine the sustainability of the corridor will be developed after forest thinning is initiated. Subsequent assessments would look at woody encroachment, usage, erosion, stem mortality, and identify areas that are 'unusable' to the training units, and the reason for the limitation. This would be reported to the Sustainable Range Program Action Committee by maneuver lane and training area.

Monitoring Goal: Camp Ripley's Maneuver Corridor will be assessed biannually to ensure adequate safety for units training in these areas.

Methods: The maneuver corridor will be assessed via walking survey. All safety hazards, erosion, snag trees, vegetation encroachment, native vegetation and training impacts will be documented and geo-located during these surveys.

Assessment 4 Mission-scape Model



Optimal Training

Requires corridor 200m wide with slopes of less than 15%. Mature hardwood trees separated to allow for M1maneuver between. Maneuver area is established with native grasses.

Non-Optimal Training

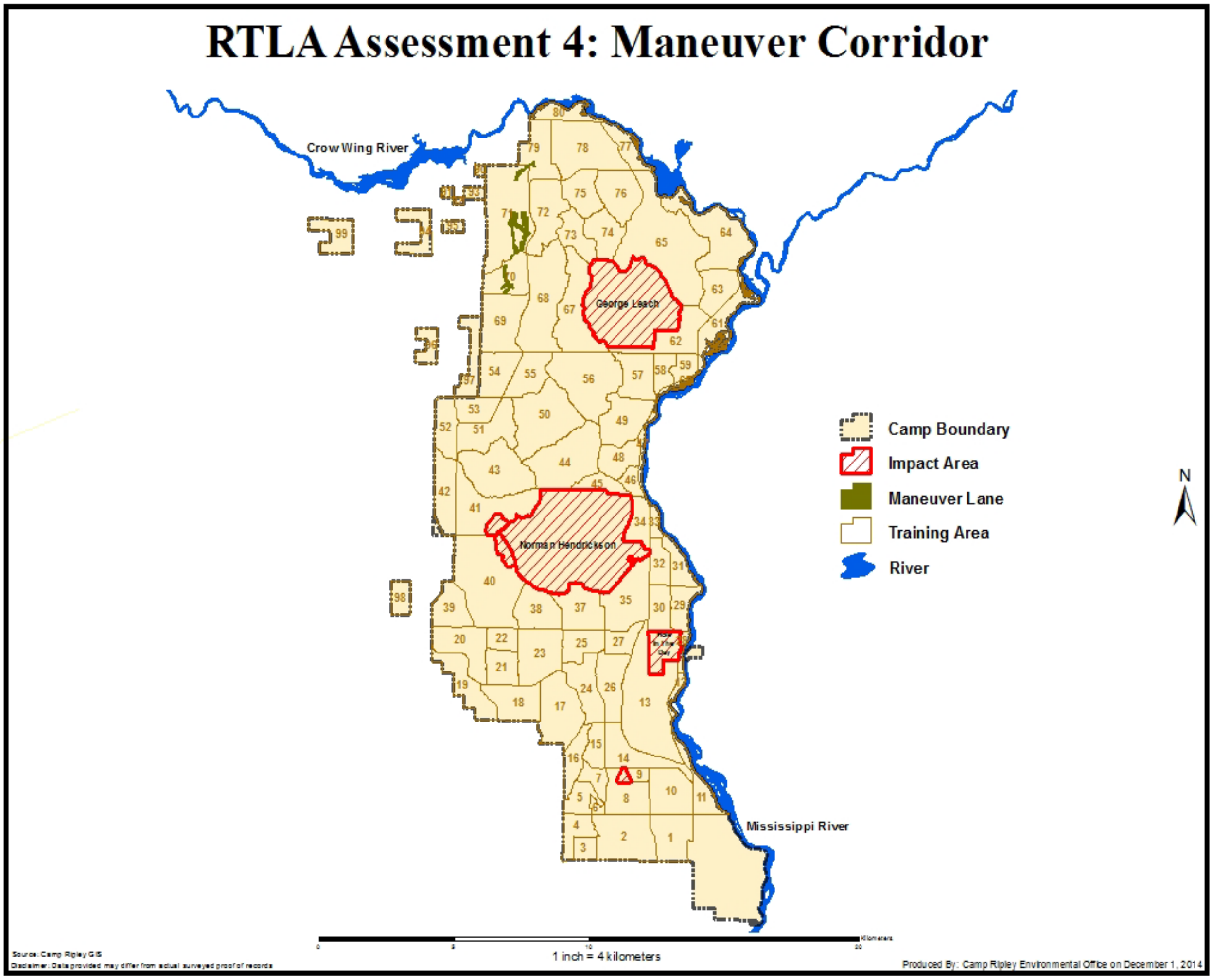
Requires corridor 100m wide with slopes of less than 15%. Small pockets of hardwood trees that do not limit M1 maneuver. Majority of corridor is native grasses with <20% invasives.

Unacceptable Training

Requires corridor is less than 50m wide with slopes less than 15%. Some stands of hardwood trees restrict maneuver space. Native grasses not established

An initial assessment will be completed in conjunction with a member of an artillery unit to identify conditions that they believe are appropriate. Prescriptions to maintain maneuver lanes involve carbide cutting, tree shear, chemical, sawyer team, timber sale, re-seeding, and prescribed fire. Maneuver areas will receive the use of prescribed fire to control woody encroachment and promote native grasses. Fire is perhaps the best method to establish the preferred native grasses for military training.

Figure 11: Maneuver Corridor Assessment



Assessment 5: Observation Point Assessment

Project Title: Assessment of site condition and usage for established and new observation points.

Challenge: The existing observation points have received increased usage over the past several years. Additional troop utilization has resulted in amplified light maneuver damage and vegetation degradation on and surrounding the observation points. Typically site locations are constructed on the highest elevations providing the greatest view, which is associated with steep topography falling away from the observation points. These areas along with the ingress/egress become more susceptible to gully and rill erosion, vegetation degradation and woody encroachment of non-desirable species.

Management Goal: Establish additional or maintain existing observation points to meet the following:

- Approximately 10,000 square feet in size
- Level open grassland
- Maintain line of site and eliminate woody encroachment
- Accessible ingress/egress with no overstory hazards or gully erosion
- Location conducive to maximize viewing of impact areas and meet training requirements

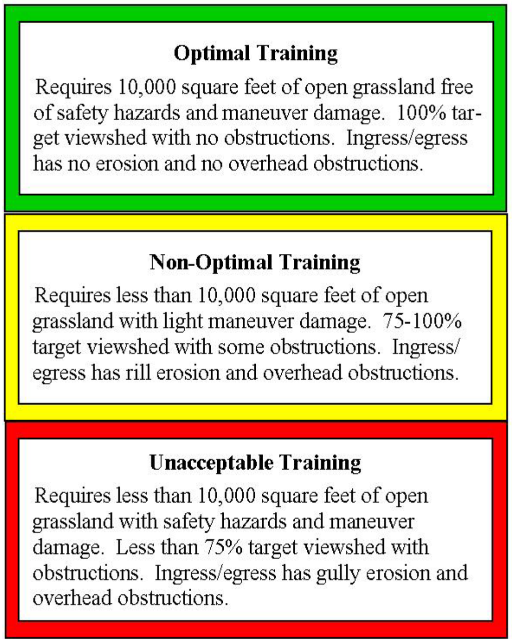
Management Objective: To improve existing sites and create new sites capable of meeting training requirements.

Products/Uses: Sites capable of allowing maximum viewshed of targets through a series of observation points.

Monitoring Goal: The assessment will report on the ingress/egress accessibility, open grasslands, woody encroachment, training hazards, and soil disturbance.

Methods: The assessment will be completed for each observation point annually during the months of May to September. Assessments will be done via a time constrained walking survey, complete coverage of each observation point will be completed. All safety hazards and soil disturbance will be documented and geo-located during these surveys. Areas of woody encroachment will be recognized and evaluated for BMP action to remove encroachment. Sampling intensity should represent 100% of the total area of each site.

Assessment 5 Mission-scape Model



Optimal Training

Requires 10,000 square feet of open grassland free of safety hazards and maneuver damage. 100% target viewshed with no obstructions. Ingress/egress has no erosion and no overhead obstructions.

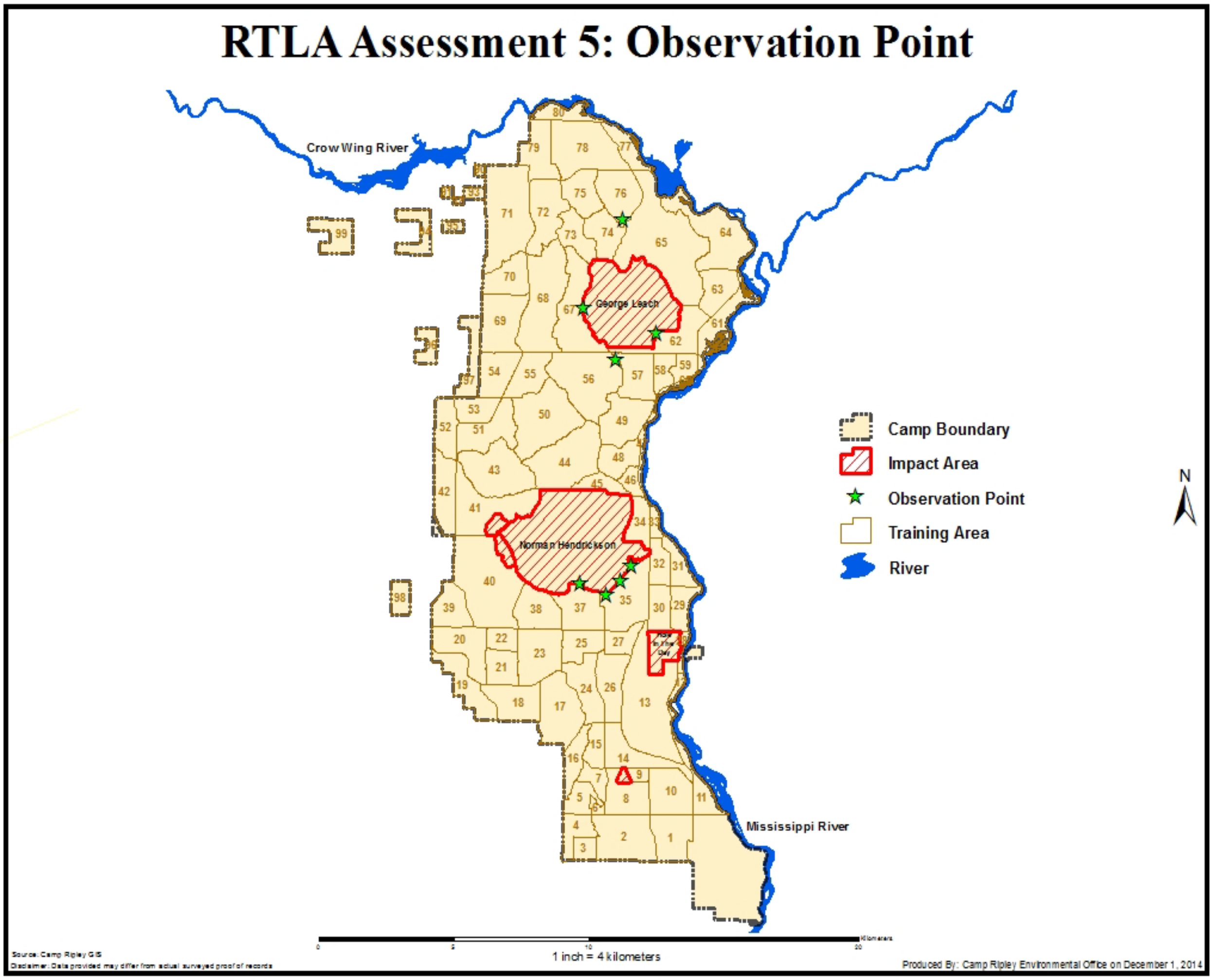
Non-Optimal Training

Requires less than 10,000 square feet of open grassland with light maneuver damage. 75-100% target viewshed with some obstructions. Ingress/egress has rill erosion and overhead obstructions.

Unacceptable Training

Requires less than 10,000 square feet of open grassland with safety hazards and maneuver damage. Less than 75% target viewshed with obstructions. Ingress/egress has gully erosion and overhead obstructions.

Figure 12: Observation Point Assessment



Assessment 6: Land Navigation Courses

Project Title: Monitoring the traversability of Camp Ripley's Land Navigation Courses.

Challenge: Understory vegetation encroachment, primarily hazel, in forested areas results in the forest reaching the point of being impenetrable to foot traffic. Thus, as the shrub layer increases in density and cover, the value of these areas for training is reduced. This encroachment also increases the likelihood of training induced wildfire.

Management Goal: To maintain the vegetation density, and traversability on all land navigation courses to a realistically challenging level.

Management Objective: To maintain the average traversability on all land navigation courses to be traversed at a moderate level of difficulty.

Products/Uses: Guidance on management priorities for Camp Ripley's four land navigation courses.

Monitoring Goal: The assessment will report on the ability to walk through the vegetation. We will use a categorical assessment on the ease of traverse.

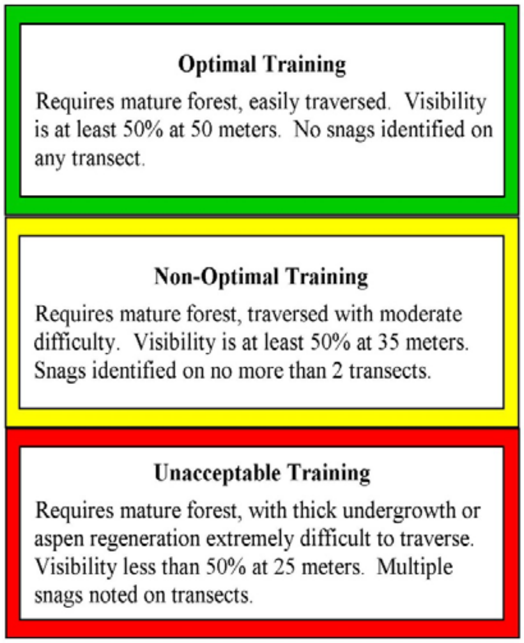
Methods: The assessment will be done along several 200 meter (+/-) transects within each land navigation course. Sampling intensity should represent ~5% of the total area of each course. A categorical assessment of ease of traverse by foot will be defined after consultation with the appropriate Army staff. A possible 3 class scale would be:

1. Easily traversable. No woody vegetation taller than 18"
2. Moderately difficult. Woody vegetation >3' in height common, must press through shrub layer

to traverse
3. Very difficult. Woody vegetation > 3’ abundant. It requires a lot of energy to press through the vegetation

Each transect will be considered an observation. A report of the traversability of the entire land navigation course will be made by reporting average traversability scores.

Assessment 6 Mission-scape Model



Optimal Training

Requires mature forest, easily traversed. Visibility is at least 50% at 50 meters. No snags identified on any transect.

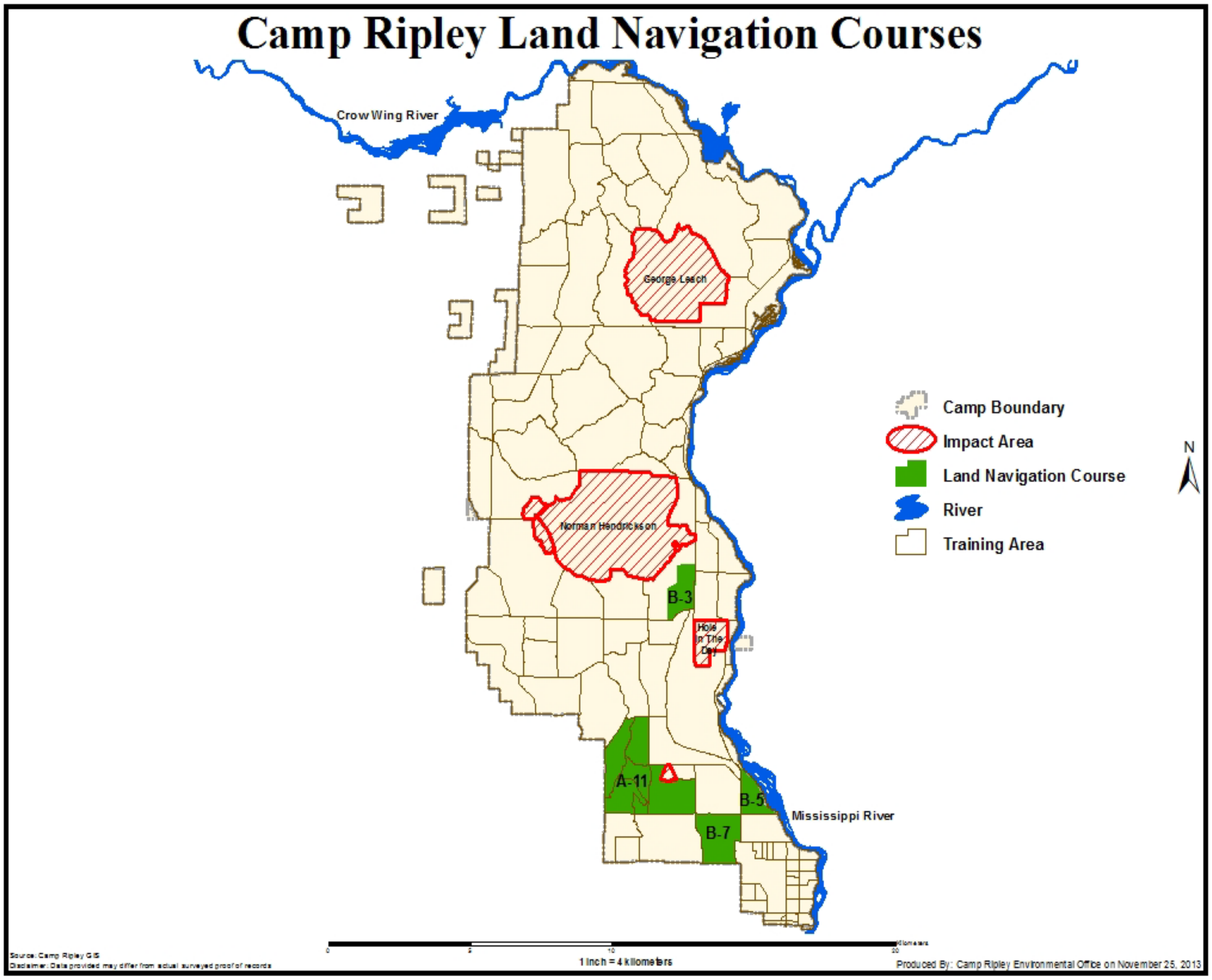
Non-Optimal Training

Requires mature forest, traversed with moderate difficulty. Visibility is at least 50% at 35 meters. Snags identified on no more than 2 transects.

Unacceptable Training

Requires mature forest, with thick undergrowth or aspen regeneration extremely difficult to traverse. Visibility less than 50% at 25 meters. Multiple snags noted on transects.

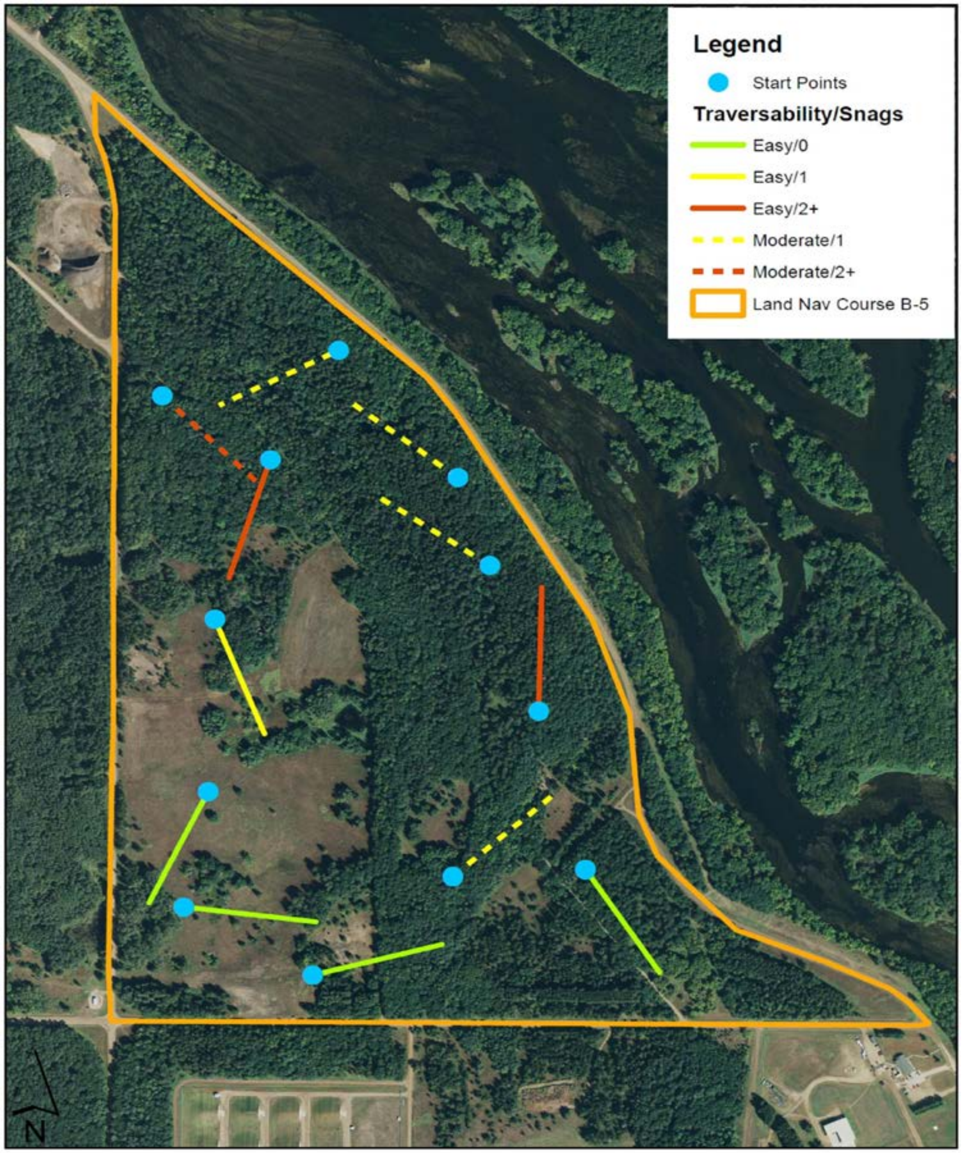
Figure 13: Land Navigation Courses



Source: Camp Ripley GIS
Disclaimer: Data provided may differ from actual surveyed proof of records

Produced By: Camp Ripley Environmental Office on November 25, 2013

Figure 14: Land Navigation Assessment

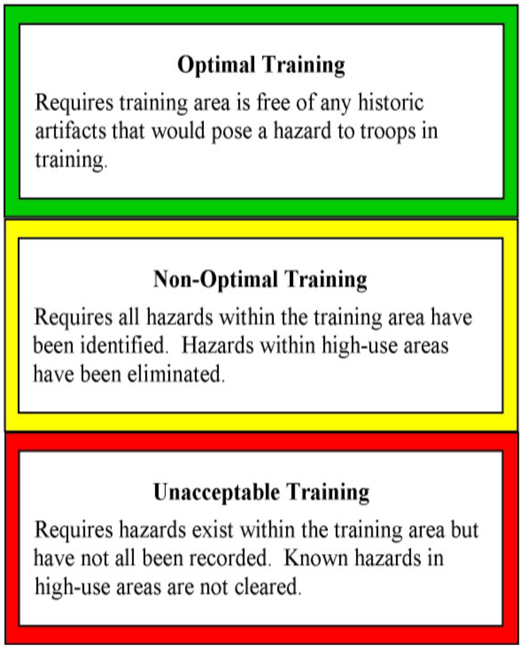


Assessment 7: Hazardous Artifacts

Project Title: Assessment of maneuver training areas for potential hazards.
Challenge: Training at CRTC has not always been as closely monitored as it is today. As a result, various digging activities such as personal and vehicle fighting positions, anti-tank ditches and wire obstacles was not always recorded or recovered at the completion of training. Numerous abandoned fighting positions currently exist within the training areas and pose a potential hazard to soldiers and equipment. Additionally there are artifacts such as barbed-wire fence and cisterns remaining from old farmsteads that also pose a hazard.
Management Goal: To remove all potential hazards from the training areas. Refill old military and civilian excavations, cap with topsoil and reseed with native grasses. Removal of all military and civilian wire obstacles.
Management Objective: To reduce the hazard of operating off-road during periods of limited visibility. Zero damage of equipment caused by training artifacts for units training at CRTC
Products/Uses: A GIS map of all recorded hazards will be produced and given to the LRAM crew leader who will determine method of hazard removal.
Monitoring Goal: The assessment will report on the ability to walk through the vegetation. We will use a categorical assessment of the ease of traverse.

Methods: A review of historic aerial photos will narrow search parameters to areas most conducive to have had this type of training over the past 5 decades. Interviews of Range Control staff will direct survey crews to the most immediate hazards. Crews will record GPS locations of all hazards as well as a description that includes size (square feet) and depth of excavation or length of wire obstacle.

RTLA Assessment 7 Mission-scape Model



Optimal Training

Requires training area is free of any historic artifacts that would pose a hazard to troops in training.

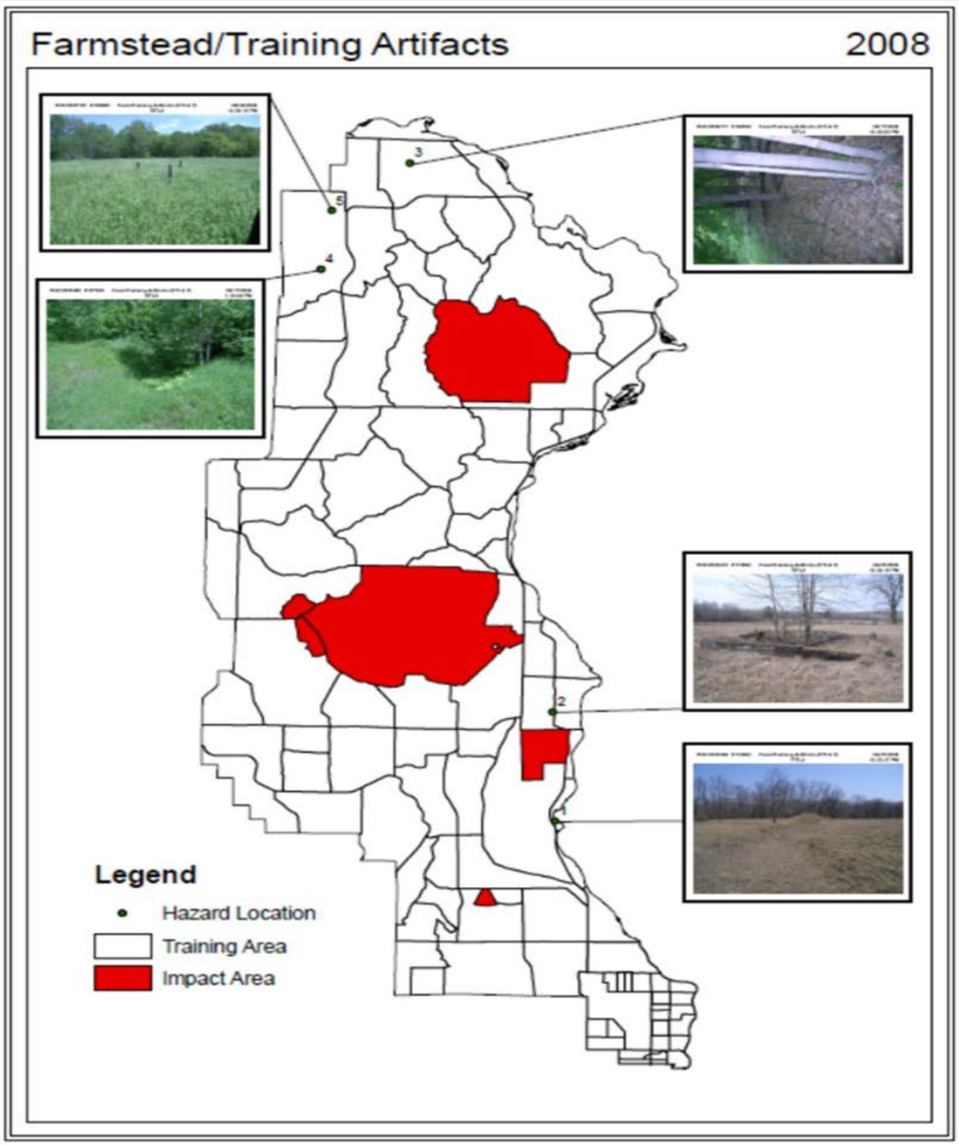
Non-Optimal Training

Requires all hazards within the training area have been identified. Hazards within high-use areas have been eliminated.

Unacceptable Training

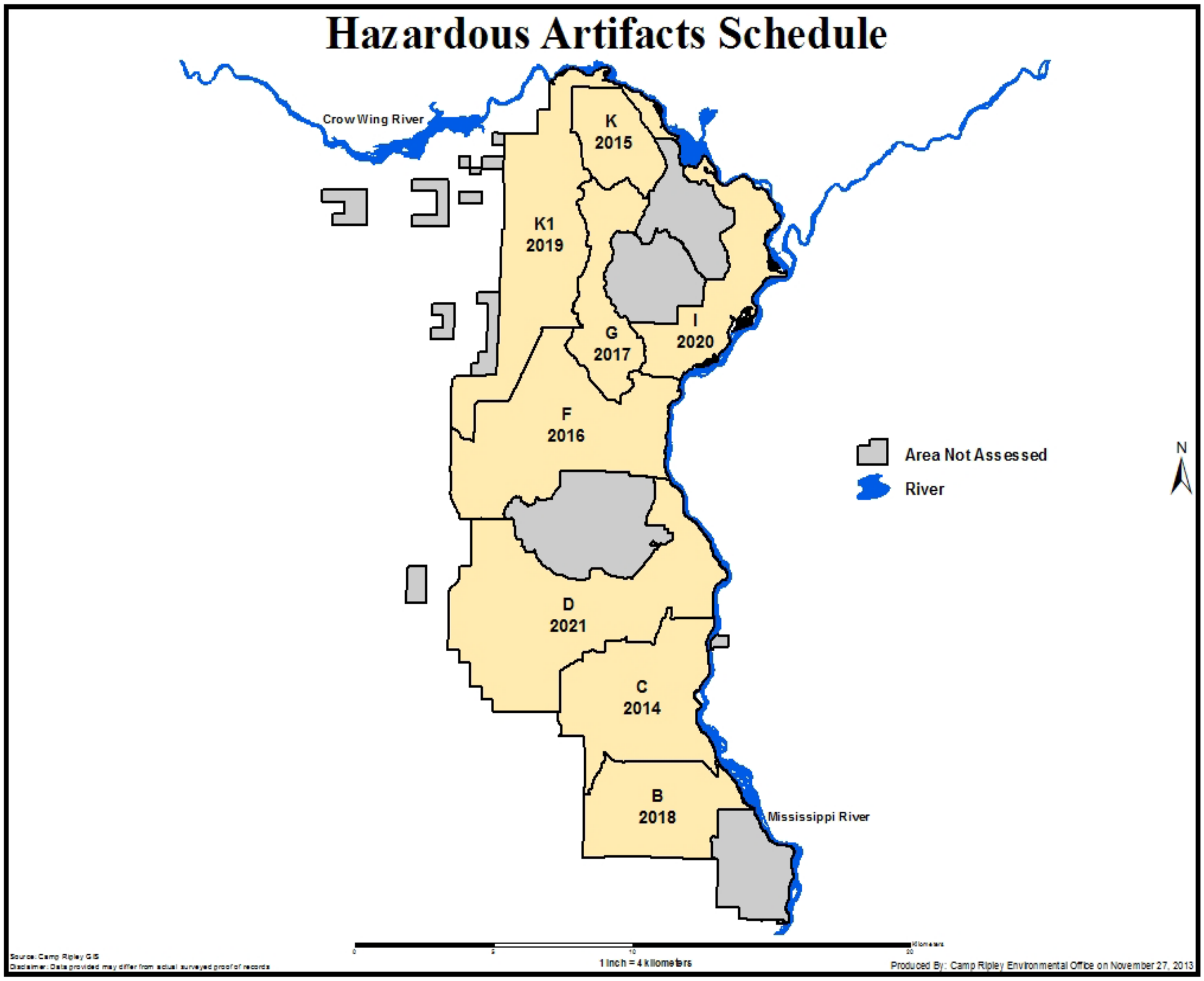
Requires hazards exist within the training area but have not all been recorded. Known hazards in high-use areas are not cleared.

Figure 15: Hazards Artifacts Assessment



Based on the mission-scape model for this assessment, the original intent of recording hazards as they are discovered through other assessments will not allow for any training areas to be in Green status. Starting in 2010, areas have been assessed by maneuver area. Camp Ripley is divided into 13 Maneuver Areas that are similar in ecology and management techniques. Areas not to be included in this assessment are the two impact areas, cantonment, non-contiguous off post lands and a wetland area that is not used for training. The eight remaining maneuver areas will be assessed one per year to ensure thorough documentation of any historic hazards. Each maneuver area varies in size from 2,000 to 9,000 acres with an average size of just over 5,000 acres. Areas developed into ranges will not be included in the assessment. Priority will be established based on training use records in RFMSS.

Figure 16: Hazard Artifacts Assessment Schedule



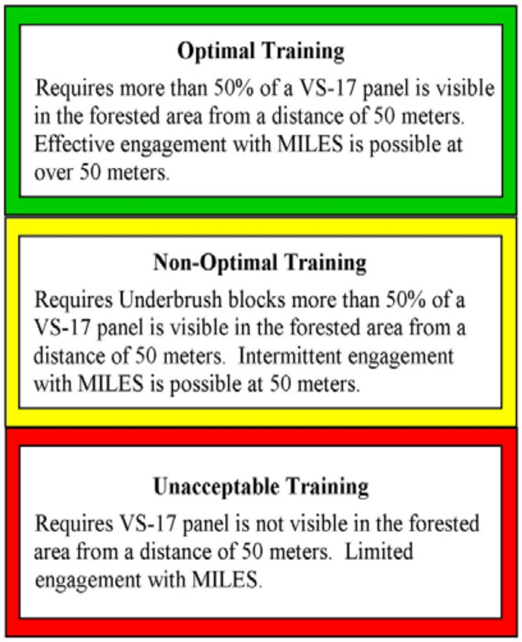
Source: Camp Ripley GIS
Disclaimer: Data provided may differ from actual surveyed proof of records

Produced By: Camp Ripley Environmental Office on November 27, 2013

Assessment 8: Forest Understory

Project Title: Measuring visibility through the underbrush of mature forests.
Challenge: Thick underbrush severely limits the use of mature forest areas by decreasing visibility and relegating the use of MILES equipment ineffective.
Management Goal: To improve visibility in mature forests to a minimum of 50 meters.
Management Objective: Create site specific prescriptions to reduce underbrush in areas adjacent high-use training areas.
Products/Uses: Site specific treatment prescriptions to assist the LRAM crew in improving the usability of training areas.
Monitoring Goal: The assessment will record the lateral visibility through mature forests and the effectiveness of treatments.

Assessment 8 Mission-Scape Model



Optimal Training

Requires more than 50% of a VS-17 panel is visible in the forested area from a distance of 50 meters. Effective engagement with MILES is possible at over 50 meters.

Non-Optimal Training

Requires Underbrush blocks more than 50% of a VS-17 panel is visible in the forested area from a distance of 50 meters. Intermittent engagement with MILES is possible at 50 meters.

Unacceptable Training

Requires VS-17 panel is not visible in the forested area from a distance of 50 meters. Limited engagement with MILES.

Forest understory assessment occurred for the first time in 2010, this initial assessment focuses on method development and testing for full implementation of the assessment in for future use.

Figure 17: VS-17 Panel

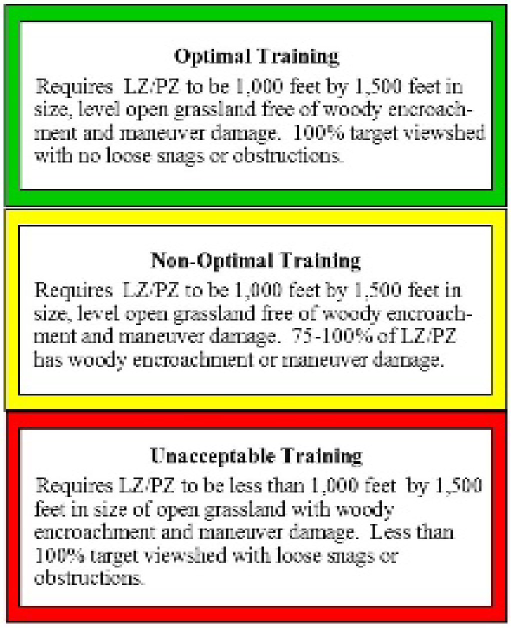
Assessment 9: LZ/PZ

Project Title: Assessment of site condition on 14 LZ/PZ for woody encroachment and maneuver damage.
Challenge: Integrated training of maneuver on grasslands surrounding helipads are often used for open heavy mechanized maneuver activities. Maneuver damage is often encountered around the LZ/PZ from training. These military uses require areas of at least 1,000 x 1,500 feet standoff distance surrounding all helipads for safe and secure landing of aircrafts on helipads. These are threatened by woody vegetation, both encroaching from the edge and creating hazards within the center of the LZ/PZ.
Management Goal: Maintain 14 LZ/PZ to meet the following:

- Approximately 1,000 x 1,500 feet in size
- Level open grassland free of woody encroachment
- Free of maneuver damage
- No loose snag trees surrounding LZ/PZ

Objective: To maintain existing sites capable of meeting 133rd and 934th unit requirements.
Products/Uses: Site capable of allowing access for handling Shinnok or Blackhawk helicopters while supporting additional area for transport vehicles and equipment.
Monitoring Goal: The assessment will report on the ingress/egress accessibility, open grasslands condition, woody encroachment, training hazards, and soil disturbance.
Methods: The assessment will be completed for each LZ/PZ point annually. Assessments will be done via a time constrained walking survey, surrounding the entire LZ/PZ. All safety hazards and soil disturbance will be documented and geo-located during these surveys. Areas of woody encroachment will be recognized and evaluated for BMP action to remove encroachment. Sampling intensity should represent 100% of the total area of each site.

Assessment 9 Mission-scape Model



Optimal Training

Requires LZ/PZ to be 1,000 feet by 1,500 feet in size, level open grassland free of woody encroachment and maneuver damage. 100% target viewshed with no loose snags or obstructions.

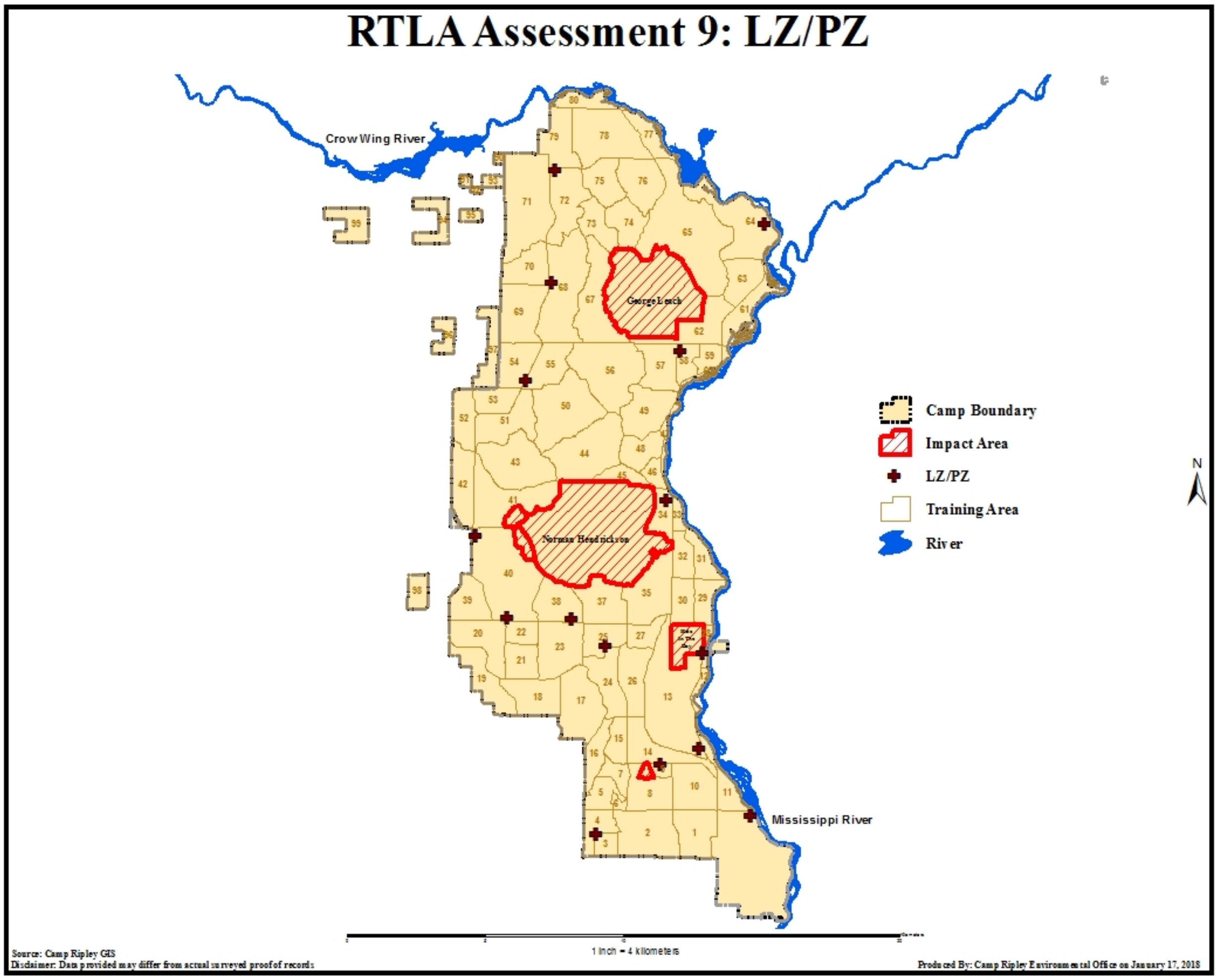
Non-Optimal Training

Requires LZ/PZ to be 1,000 feet by 1,500 feet in size, level open grassland free of woody encroachment and maneuver damage. 75-100% of LZ/PZ has woody encroachment or maneuver damage.

Unacceptable Training

Requires LZ/PZ to be less than 1,000 feet by 1,500 feet in size of open grassland with woody encroachment and maneuver damage. Less than 100% target viewshed with loose snags or obstructions.

Figure 18 LZ/PZ Assessment



RTLA Assessment 9: LZ/PZ

Source: Camp Ripley GIS
Disclaimer: Data provided may differ from actual surveyed proof of records

Produced By: Camp Ripley Environmental Office on January 17, 2018

Assessment Schedule

Table 10: Assessment Schedule

Project Name	2018	2019	2020	2021	2022
Assessment 1 (LRAM)	North Half	South Half	North Half	South Half	North Half
Assessment 2 (Artillery Firing Points)	18 Sites (Set C)	24 Sites (Set A)	20 Sites (Set B)	18 Sites (Set C)	24 Sites (Set A)
Assessment 3 (Open Maneuver)	Open Maneuver	Open Maneuver	Open Maneuver	Open Maneuver	Open Maneuver
Assessment 4 (Maneuver Corridor)	K1	K1	K1	K1	K1
Assessment 5 (Observation Points)	8 OP’s	8 OP’s	8 OP’s	8 OP’s	8 OP’s
Assessment 6 (Land Navigation Course)	B-5	B-7	B-3	A-11	AHATS
Assessment 7 (Hazardous Artifacts)	MA-B	MA-K1	MA-I	MA-D	MA-C
Assessment 8 (Forest Understudy)	TA 16, 24, 26, 25, 27, 35	TA 39, 40, 41, 43	TA 67, 73, 74	TA 44, 45, 46, 48, 49, 50	TA 78
Assessment 9 (LZ/PZ)	14	14	14	14	14

Historic LCTA-RTLA Information

Fauna

Camp Ripley entered into a cooperative agreement with MNDNR in 1989, to institute a comprehensive survey of Camp Ripley's flora and fauna. The Minnesota County Biological Survey (MCBS) conducted baseline flora and fauna surveys within the Camp Ripley Military Installation during 1991 and 1992, which provided an inventory of Camp Ripley's plants, birds, mammals, herpetofauna, fish, butterflies, riverine mussels and aquatic invertebrates. Camp Ripley provides habitat for a variety of wildlife species including approximately 202 birds, 51 mammals, 23 reptiles and amphibians and 56 species of fish. Additional studies have been conducted at Camp Ripley, through partnerships with the University of Minnesota (red-shouldered hawk, black bear, gray wolf), North Dakota State University (Blanding's turtle), and other Minnesota State Colleges and Universities.

Mammals

Since 1991, small mammals have been surveyed every 3-5 years to monitor populations at Camp Ripley. Small mammal surveys are conducted from mid-July through the first week of September, when population levels tend to be higher due to recent reproductive activities. Small mammals are surveyed on 60 LCTA plots according to LCTA methods in Tazik et al. (1992). The traps are set during morning to early afternoon of the first day, checked and reset the morning of the next day, and then checked and removed the third day, resulting in a total of 100 trap-nights per plot. Information and results regarding the ITAM small mammal program are documented in the Annual Conservation Program Report.

Surveys have also been conducted to determine the composition of mammal species utilizing Camp Ripley, and how their populations change over time. Techniques include trapping, den visits, scent post surveys, aerial and satellite telemetry and visual observations. To date there have been 51 species of mammals identified at Camp Ripley.

Birds

Bird surveys began in 1991 with the implementation of the LCTA program and the MCBS base-line research. Since then a total of 202 migratory and resident bird species have been observed at Camp Ripley. Songbirds are monitored on LCTA plots annually, while nesting success of other bird species such as bald eagles are also monitored.

Songbirds are excellent indicators of habitat change because of the large number of species, the relative ease with which they can be detected and identified in the spring breeding season, and the large variety and diversity of habitats they inhabit (Sauer et al. 2000). Songbirds have been surveyed on approximately 90 LCTA plots at Camp Ripley each year since 1991. All species and individuals seen or heard within 100 meters of the midpoint of each LCTA plot during one 10-minute point count are documented. These surveys represent a substantial portion of the summer field activities, lasting from the end of May into July. Starting in 2001, surveys of 30 plots were conducted annually on a rotational basis with a scheduled complete count of all 90 sites every fourth year. Conducting a sample of point counts each year allows detection of fluctuations in the number of species and individuals, but reduces the amount of effort expended in any one year. Songbird counts were conducted on 30 plots in 2001 and 2002. However, recent information concerning West Nile Virus indicates that the impact to birds may be far greater than previously thought. Therefore, songbird surveys will be conducted on all 90 bird plots each year to more closely monitor the impacts of West Nile Virus.

Information and results regarding the birds program are documented in the Annual Conservation Program Report.

Reptiles and Amphibians

Surveys have been conducted to determine the composition of reptile and amphibian species utilizing Camp Ripley, and how their populations change over time. Techniques include trapping, chorus surveys, drift fences and visual observations. To date there have been 23 species of reptiles (12) and amphibians (11) identified at Camp Ripley.

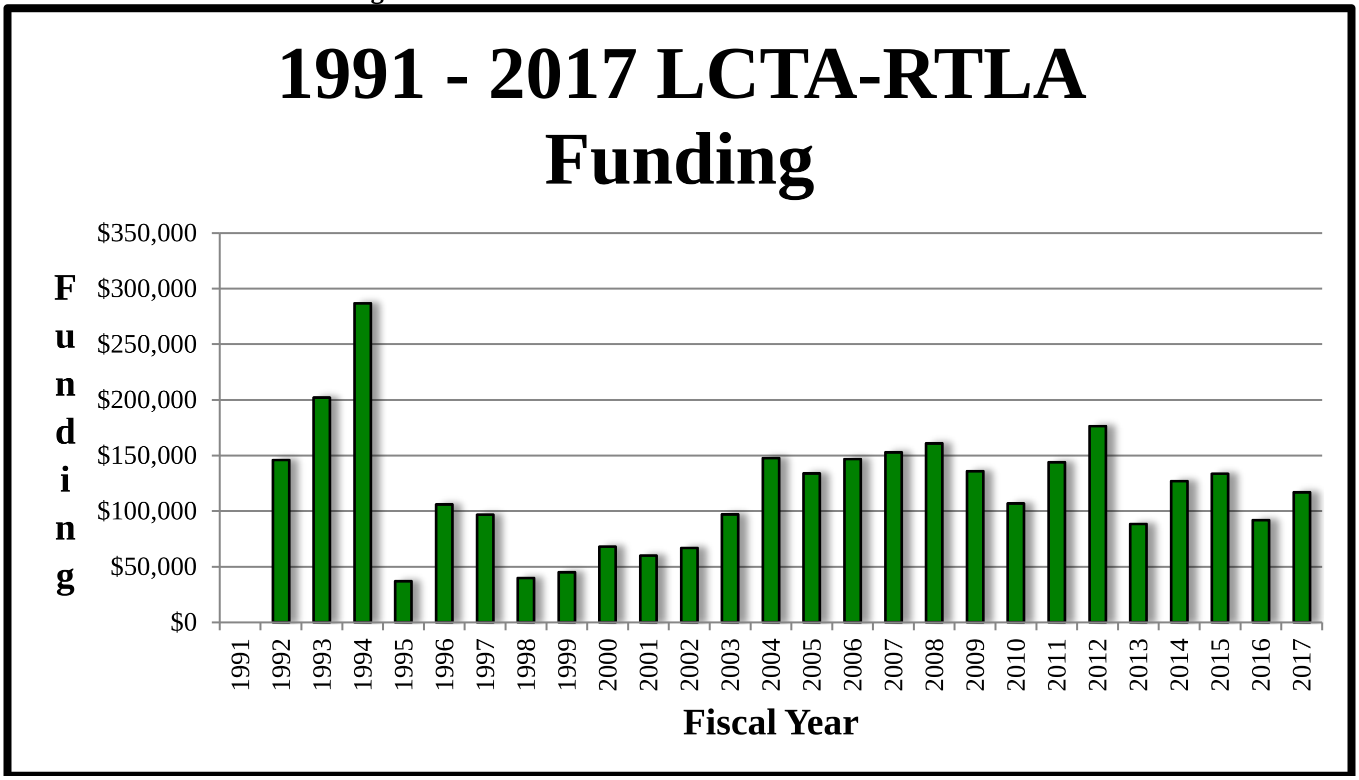
Drift fence surveys have been conducted once every five years at Camp Ripley according to LCTA methods (Tazik et al. (1992)). This method of sampling herpetofauna began in 1991. However, precise locations of the drift fences were not documented at that time. In 1996 drift fences were placed in the same general location, and the precise locations were recorded so that data could be statistically analyzed through quantitative comparisons. Drift fences are placed in five locations representing the different habitats of Camp Ripley; grassland, forest, grassland/forest edge and aquatic edge. One other habitat, floodplain forest, was sampled in 1991 and 1996, but was unavailable for sampling in 2001 due to high water levels. However, an additional forest site was added in 2001. The fences were checked every other day for 12 days in the spring, and then were closed during the summer months when there is typically less amphibian and reptile movement. They were opened again September 5, and checked every other day until September 28.

Information and results regarding the reptiles and amphibians program are documented in the Annual Conservation Program Report.

Funding

Table 11 portrays an historical overview of LCTA-RTLA funding during the years of 1991-2017. From 1991-2017 the MNARNG has obligated approximately $3,111,651 to implement its RTLA Program.

Table 11: LCTA-RTLA Funding 1991-2017



Documents and Accomplishments:

As of 2017 the inventory and survey work on Camp Ripley has identified 565 plant species, 51 mammal species, 232 bird species, 23 reptile and amphibian species, 56 fish species, 65 butterfly species, and 44 dragonfly species. Several documents were produced from the Environmental and RTLA program, they are as follows:

- MN DNR Biological Report No. 40 Animal Surveys at the Minnesota Army National Guard Camp Ripley Training Site 1991-1992.
- MN DNR Biological Report No. 51 Animal Surveys at the Minnesota Army National Guard Camp Ripley Training Site 1993.
- MN DNR Biological Report No. 52 Animal Surveys at the Minnesota Army National Guard Camp Ripley Training Site 1994
- Land Condition-Trend Analysis 1991-1994 Installation Report
- Botanical Survey, which listed the floral species.
- Camp Ripley Military Reservation Fish Survey Results.
- The Aquatic Invertebrate Fauna of Camp Ripley Military Reservation.
- The Butterflies of Camp Ripley.
- Management Recommendations for Bears in Camp Ripley Military Reservation.
- Camp Ripley Series Report No. 5 Animal Surveys at the Minnesota Army National Guard Camp Ripley Training Site 1995.
- Camp Ripley Series Report No. 6 Animal Surveys at the Minnesota Army National Guard Camp Ripley Training Site 1996.
- Camp Ripley Series Report No. 7 Animal Surveys at the Minnesota Army National Guard Camp Ripley Training Site 1997.
- Camp Ripley Series Report No. 8 Animal Surveys at the Minnesota Army National Guard Camp Ripley Training Site 1998.
- Camp Ripley Series Report No. 9 Animal Surveys at the Minnesota Army National Guard Camp Ripley Training Site 1999
- Camp Ripley Series Report No.10 Protected Species Management Plan for Camp Ripley, Minnesota Army
- National Guard Training Site 2000
- Camp Ripley Series Report No. 11 Animal Surveys at the Minnesota Army National Guard Camp Ripley Training Site and Arden Hills Army Training Site 2000
- Camp Ripley Series Report No. 12 Animal Surveys at the Minnesota Army National Guard Camp Ripley Training Site and Arden Hills Army Training Site 2001 Annual Report.
- Land Condition-Trend Analysis 1991-2000 Installation Report 2001
- Camp Ripley Series Report No. 13 Animal Surveys at the Camp Ripley and Arden Hills Minnesota Army
- National Guard Training Sites: 2002 Annual Report
- Camp Ripley Series Report No. 13 Animal Surveys at the Camp Ripley and Arden Hills Minnesota Army
- National Guard Training Sites: 2003 Annual Report
- Camp Ripley Series Report No. 14 Animal Surveys at the Camp Ripley and Arden Hills Minnesota Army National Guard Training Sites: 2004 Annual Report.
- Camp Ripley Series Report No. 15 Animal Surveys at the Camp Ripley and Arden Hills Minnesota Army National Guard Training Sites: 2005 Annual Report.
- Camp Ripley Series Report No. 16 Animal Surveys at the Camp Ripley and Arden Hills Minnesota Army National Guard Training Sites: 2006 Annual Report.
- Camp Ripley Series Report No. 17 Camp Ripley and Arden Hills Minnesota Army National Guard Training Sites, Conservation Program Report, 2007 Annual Report.
- Camp Ripley Series Report No. 18 Camp Ripley and Arden Hills Minnesota Army National Guard Training Sites, Conservation Program Report, 2008 Annual Report.
- Camp Ripley Series Report No. 19 Camp Ripley and Arden Hills Minnesota Army National Guard Training Sites, Conservation Program Report, 2009 Annual Report.
- Camp Ripley Series Report No. 20 Camp Ripley and Arden Hills Minnesota Army National Guard Training Sites, Conservation Program Report, 2010 Annual Report.
- Camp Ripley Series Report No. 21 Camp Ripley Training Center and Arden Hills Army Training Site, Conservation Program Report, 2011 Annual Report.

- Camp Ripley Series Report No. 22 Camp Ripley Training Center and Arden Hills Army Training Site, Conservation Program Report, 2012 Annual Report.
- Camp Ripley Series Report No. 23 Camp Ripley Training Center and Arden Hills Army Training Site, Conservation Program Report, 2013 Annual Report.
- Camp Ripley Series Report No. 24 Camp Ripley Training Center and Arden Hills Army Training Site, Conservation Program Report, 2014 Annual Report.
- Camp Ripley Series Report No. 25 Camp Ripley Training Center and Arden Hills Army Training Site, Conservation Program Report, 2015 Annual Report.
- Camp Ripley Series Report No. 26 Camp Ripley Training Center and Arden Hills Army Training Site, Conservation Program Report, 2016 Annual Report.
- Camp Ripley Series Report No. 27 Camp Ripley Training Center and Arden Hills Army Training Site, Conservation Program Report, 2017 Annual Report.

Land Rehabilitation and Maintenance (LRAM)

LRAM is the component of the ITAM program that provides a preventive and corrective land rehabilitation and maintenance procedure to reduce the long-term impacts of training on Camp Ripley. LRAM uses technologies such as re-vegetation and erosion control techniques to maintain soils and vegetation required to support Camp Ripley's mission. These specifically designed efforts help to maintain Camp Ripley as a quality military training site and subsequently minimize long-term costs associated with land rehabilitation. LRAM includes programming, planning, designing, and executing land rehabilitation, maintenance, and reconfiguration projects based on requirements and priorities identified in the TRI and RTLA components of ITAM.

Site Repairs

The majority of repair work conducted on Camp Ripley falls into two categories: Assessment 1 repairs and Maneuver Damage. The Assessment 1 is conducted each fall after the summer training cycle. A report is completed that includes estimated repair costs for each site identified. The associated LRAM work is completed the following spring and summer. Maneuver damage is that damage to the training lands that occurs during normal military training and is largely comprised of small berms being created as vehicles, especially tracked vehicles execute turns. Maneuver damage is recorded as it happens by Range Control staff when they clear units out of training areas. The damage is immediately reported to the LRAM coordinator who schedules the repair of the area. Generally the repair of maneuver damage consists of simply leveling the area, but occasionally is severe enough to require re-seeding and/or hauling in topsoil.

Training Area Improvements

Improvements to the training areas are the result of the Assessments which help achieve the desirable Mission-scape model outlined in each assessment. As for repairs completed, most of the improvement work is done the year following each assessment.

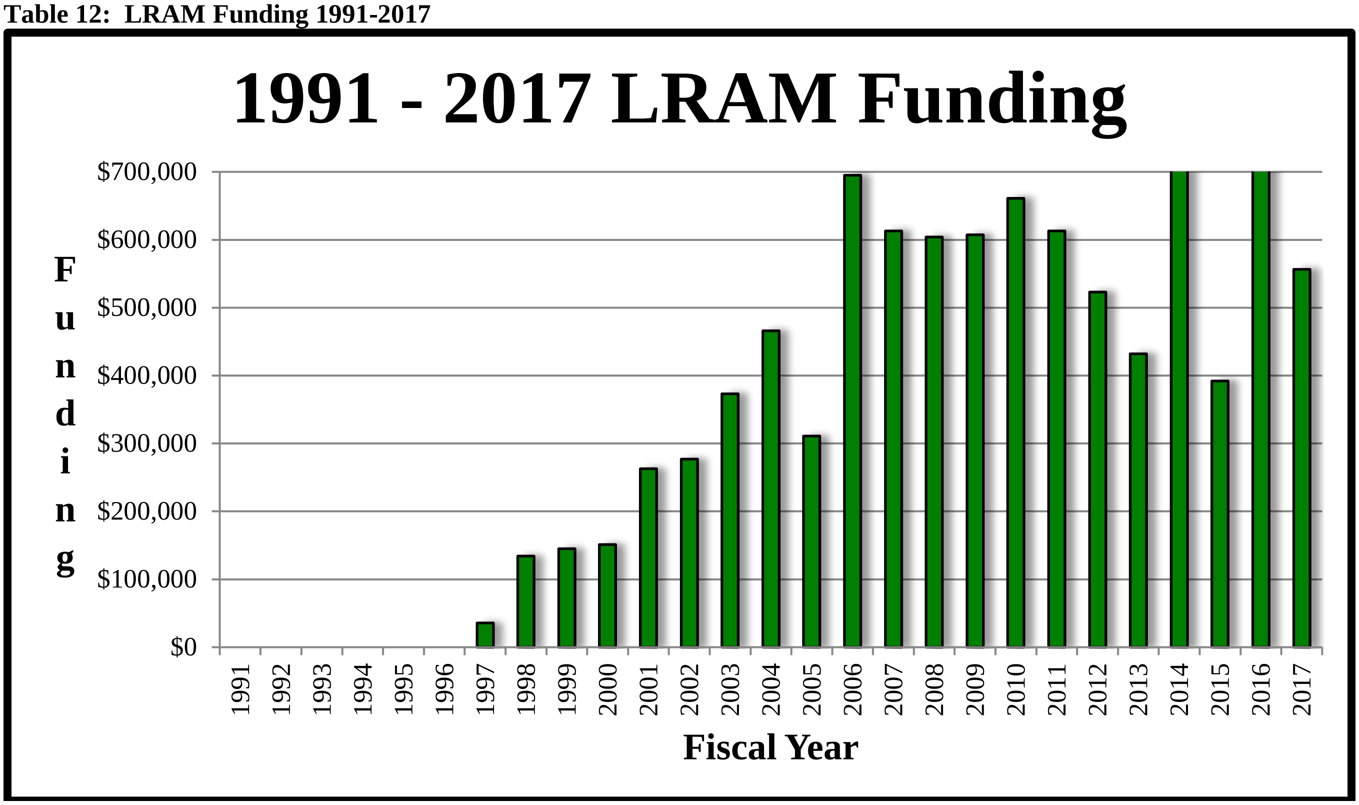
Equipment Procurements

The Camp Ripley LRAM program uses in-house labor for a majority of the work completed. It is therefore fiscally better to purchase equipment that can be used on multiple project types over a number of years. A complete list of ITAM equipment can be found in Chapter 5.

Funding

Table 12 portrays an historical overview of LRAM funding during the years of 1991-2017. From 1991-2017 the MNARNG has obligated approximately $9,376,610 to implement its LRAM Program.

Table 12: LRAM Funding 1991-2017



Training Requirements Integration (TRI)

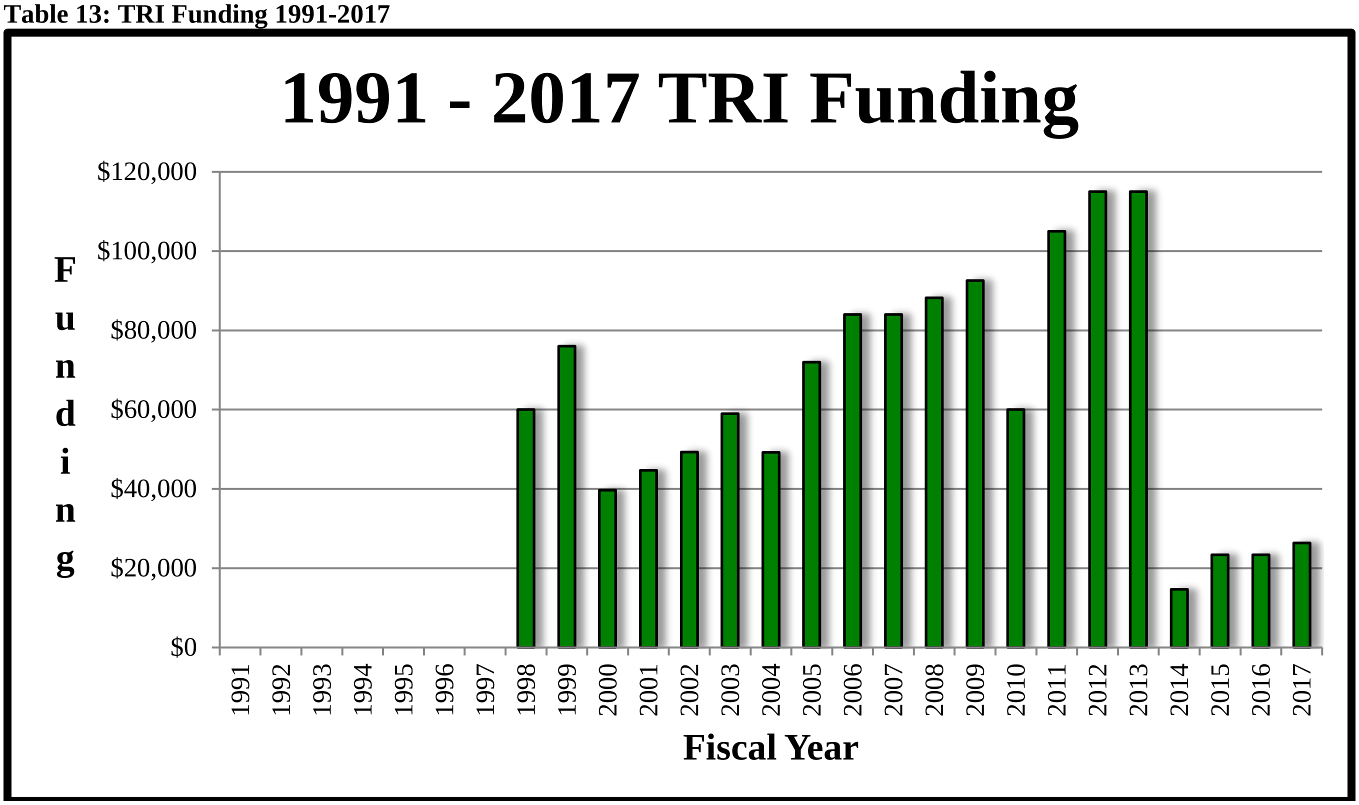
TRI is the component of the ITAM Program that provides a decision support procedure that integrates training requirements with land management, training management, and natural and cultural resources management. The integration of all requirements occurs through continuous consultation between operations, range control, natural and cultural resources managers, and other environmental staff members, as appropriate. The INRMP and ITAM work plan are documents that require TRI input.

TRI improves coordination and facilitates cooperation, decision-making, and allocation by providing information regarding land conditions, capability, and any necessary modification of requirements. TRI achieves the "training-environmental" balance and interface that is critical to land management. To achieve this continuous interaction and coordination between the operations/training staff and natural resource/environmental staff a position has been established. This position is known as the “Training Area Coordinator” (TAC). Major responsibilities of the position include: coordinating and monitoring training area use, coordinating training area activities not directly related to training and gathering use data for the RFMSS and overall implementation of the ITAM program.

Funding

Table 13 portrays an historical overview of TRI funding during the years of 1991-2017. From 1991-2017 the MNARNG has obligated approximately $1,281,566 to implement its TRI Program.

Table 13: TRI Funding 1991-2017



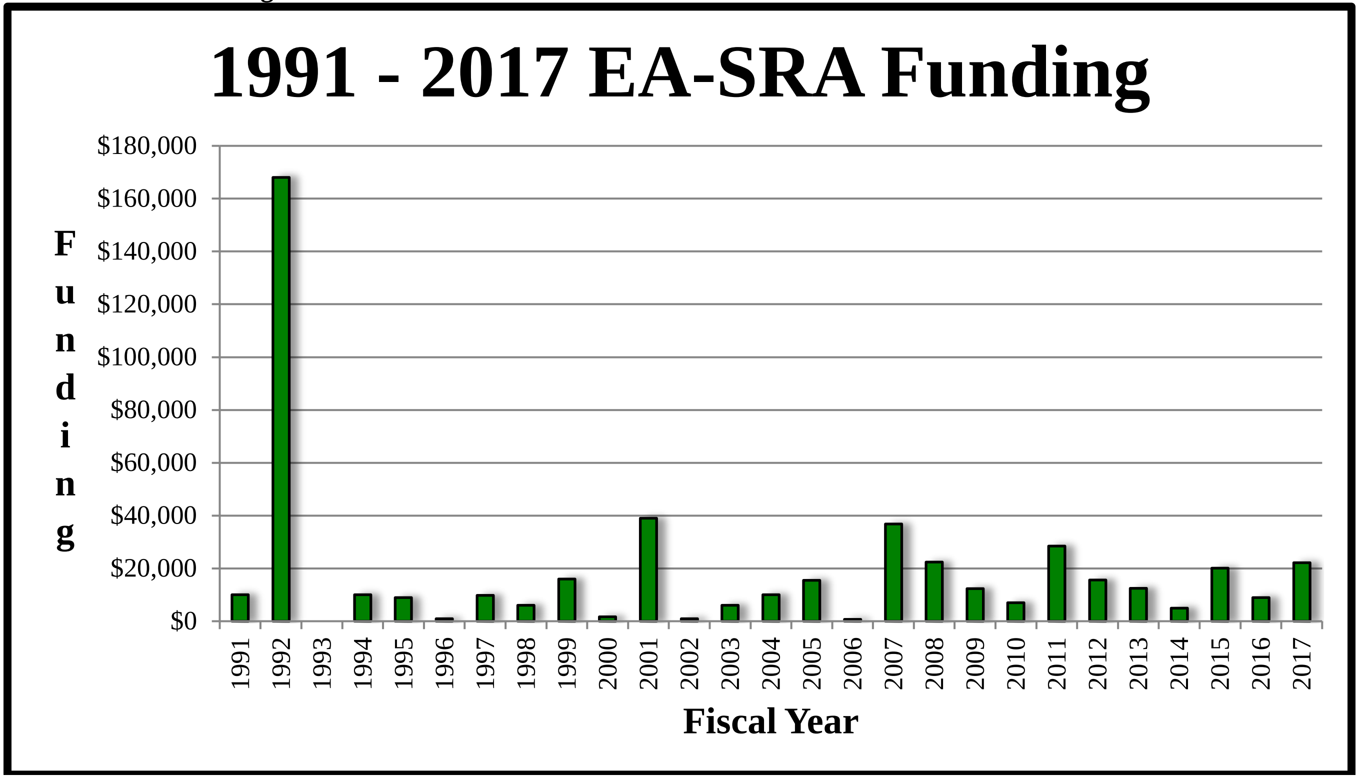
Sustainable Range Awareness (SRA)

Sustainable Range Awareness (SRA) is the component of the ITAM Program that provides a means to develop and distribute educational materials to land users. Materials relate procedures for sound environmental stewardship of natural and cultural resources and reduce the potential for inflicting avoidable impacts. The SRA intent is to inform land users of restrictions and activities, to avoid and to prevent damage to natural and cultural resources. The SRA component applies to soldiers, installation staff, and other land users. The SRA component also includes efforts to inform environmental professionals and the community about Camp Ripley's mission and training activities.

Funding

Table 14 portrays an historical overview of SRA funding during the years of 1991-2017. From 1991-2017 the MNARNG has obligated approximately $495,003.70 to implement its SRA Program.

Table 14: SRA Funding 1991-2017

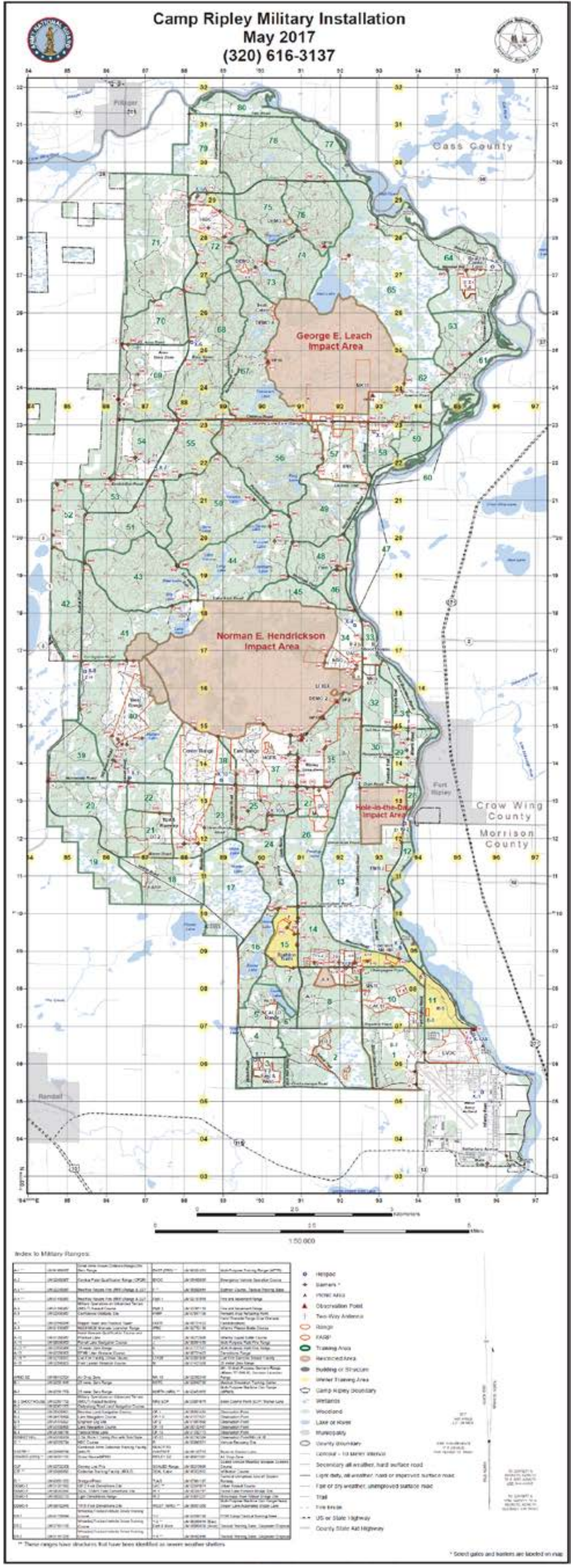


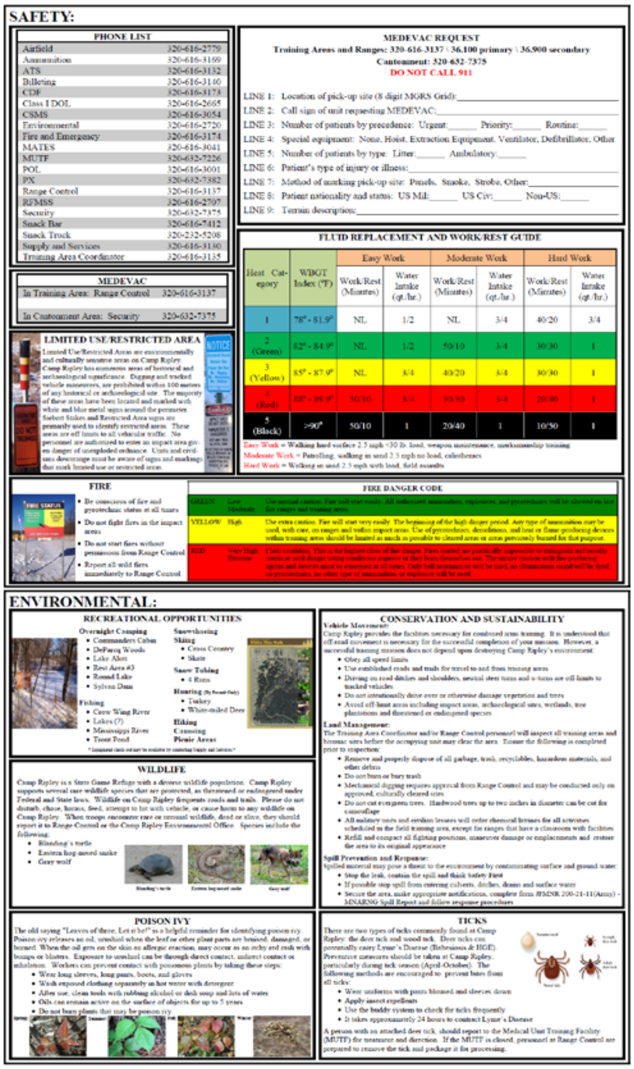
Documents and Accomplishments:

In 1992 a contract was established with the United States Army Corps Engineers Research Laboratory. From this contract SRA has produced and published the following:

- Soldier Field Cards
- Leaders Handbook
- Video
- 1 poster
- 1994 and 1995 additional field cards and handbooks were purchased.
- 1996-2000 based on some military and environmental needs some additional Environmental Awareness posters were created; 1998 Camp Ripley Calendar, Birds of Camp Ripley, Mammals of Camp Ripley, Plants of Camp Ripley, Reptiles and Amphibians of Camp Ripley and UXO
- 2001 Camp Ripley purchased 3 Kiosk stations to inform soldiers about safety, environmental and range regulations, provide GIS products in the form of maps, and allow access to other information about Camp Ripley’s training resources. Other funds were used to purchase the MAP Touch Software License.
- 2002-2004 funds were used to help establish an Educational Classroom where soldiers and the general public can educate themselves about Camp Ripley’s SRA and Land Management Program.
- 2005 an AHATS Training Area map was developed and produced, and exhibits were purchased for the SRA Program.
- 2007 a Camp Ripley Training Area map was developed and produced that was intended to replace previous SRA products.
- 2008 an AHATS Training Area map was developed and produced.
- 2009 The Camp Ripley Solider Field Cards was updated and produced.
- 2010 The Camp Ripley Solider Field Cards was updated and produced.
- 2015 The Camp Ripley Solider Field Cards was updated and produced.
- 2017 The Camp Ripley Solider Field Cards was updated and produced.

Figure 19: Camp Ripley SRA Map




SAFETY:

PHONE LIST	
Airfield	320-616-2779
Ammunition	320-616-3169
ATS	320-616-3132
Billeting	320-616-3140
CDF	320-616-3173
Class I DOL	320-616-2665
CSMS	320-616-3054
Environmental	320-616-2720
Fire and Emergency	320-616-3174
MATES	320-616-3041
MUTF	320-632-7226
POL	320-616-3001
PX	320-632-7382
Range Control	320-616-3137
RFMSS	320-616-2707
Security	320-632-7375
Snack Bar	320-616-7412
Snack Truck	320-232-5208
Supply and Services	320-616-3130
Training Area Coordinator	320-616-3135

MEDEVAC	
In Training Area: Range Control	320-616-3137
In Cantonment Area: Security	320-632-7375

MEDEVAC REQUEST

Training Areas and Ranges: 320-616-3137 \ 36.100 primary \ 36.900 secondary

Cantonment: 320-632-7375

DO NOT CALL 911

LINE 1: Location of pick-up site (8 digit MGRS Grid):______
LINE 2: Call sign of unit requesting MEDEVAC:______
LINE 3: Number of patients by precedence: Urgent:______ Priority:______ Routine:______
LINE 4: Special equipment: None, Hoist, Extraction Equipment, Ventilator, Defibrillator, Other
LINE 5: Number of patients by type: Litter:______ Ambulatory:______
LINE 6: Patient's type of injury or illness:______
LINE 7: Method of marking pick-up site: Panels, Smoke, Strobe, Other:______
LINE 8: Patient nationality and status: US Mil:______ US Civ:______ Non-US:______
LINE 9: Terrain description:______

LIMITED USE/RESTRICTED AREA

Limited Use/Restricted Areas are environmentally and culturally sensitive areas on Camp Ripley. Camp Ripley has numerous areas of historical and archaeological significance. Digging and tracked vehicle maneuvers, are prohibited within 100 meters of any historical or archaeological site. The majority of these areas have been located and marked with white and blue metal signs around the perimeter. Siebert Stakes and Restricted Area signs are primarily used to identify restricted areas. These areas are off limits to all vehicular traffic. No personnel are authorized to enter an impact area given danger of unexploded ordnance. Units and civilians downrange must be aware of signs and markings that mark limited use or restricted areas.

FLUID REPLACEMENT AND WORK/REST GUIDE

Heat Category	WBGT Index (°F)	Easy Work		Moderate Work		Hard Work	
		Work/Rest (Minutes)	Water Intake (qt./hr.)	Work/Rest (Minutes)	Water Intake (qt./hr.)	Work/Rest (Minutes)	Water Intake (qt./hr.)
1	78° - 81.9°	NL	1/2	NL	3/4	40/20	3/4
2 (Green)	82° - 84.9°	NL	1/2	50/10	3/4	30/30	1
3 (Yellow)	85° - 87.9°	NL	3/4	40/20	3/4	30/30	1
4 (Red)	88° - 89.9°	50/10	3/4	30/30	3/4	20/40	1
5 (Black)	>90°	50/10	1	20/40	1	10/50	1

Easy Work = Walking hard surface 2.5 mph <30 lb. load, weapon maintenance, marksmanship training
Moderate Work = Patrolling, walking in sand 2.5 mph no load, calisthenics
Hard Work = Walking in sand 2.5 mph with load, field assaults

FIRE

- Be conscious of fire and pyrotechnic status at all times
- Do not fight fires in the impact areas
- Do not start fires without permission from Range Control
- Report all wild fires immediately to Range Control

FIRE DANGER CODE		
GREEN	Low Moderate	Use normal caution. Fire will start easily. All authorized ammunition, explosives, and pyrotechnics will be allowed on live fire ranges and training areas.
YELLOW	High	Use extra caution. Fire will start very easily. The beginning of the high danger period. Any type of ammunition may be used, with care, on ranges and within impact areas. Use of pyrotechnics, demolitions, and heat or flame producing devices within training areas should be limited as much as possible to cleared areas or areas previously burned for that purpose.
RED	Very High Extreme	Flash condition. This is the highest class of fire danger. Fires started are practically impossible to extinguish and usually continue until danger rating conditions improve or they burn themselves out. The utmost caution with fire producing agents and devices must be exercised at all times. Only ball ammunition will be used, no illumination round will be fired, no pyrotechnics, no other type of ammunition, or explosive will be used.

ENVIRONMENTAL:

RECREATIONAL OPPORTUNITIES

Overnight Camping
- Commanders Cabin
- DeParcq Woods
- Lake Alott
- Rest Area #3
- Round Lake
- Sylvan Dam

Fishing
- Crow Wing River
- Lakes (7)
- Mississippi River
- Trout Pond

Snowshoeing

Skiing
- Cross Country
- Skate

Snow Tubing
- 4 Runs

Hunting (By Permit Only)
- Turkey
- White-tailed Deer

Hiking

Canoeing

Picnic Areas

* Equipment check out may be available by contacting Supply and Services *

WILDLIFE

Camp Ripley is a State Game Refuge with a diverse wildlife population. Camp Ripley supports several rare wildlife species that are protected, as threatened or endangered under Federal and State laws. Wildlife on Camp Ripley frequents roads and trails. Please do not disturb, chase, harass, feed, attempt to hit with vehicle, or cause harm to any wildlife on Camp Ripley. When troops encounter rare or unusual wildlife, dead or alive, they should report it to Range Control or the Camp Ripley Environmental Office. Species include the following:

- Blanding's turtle
- Eastern hog-nosed snake
- Gray wolf

Blanding's turtle
Eastern hog-nosed snake
Gray wolf

POISON IVY

The old saying "Leaves of three, Let it be!" is a helpful reminder for identifying poison ivy. Poison ivy releases an oil, urushiol when the leaf or other plant parts are bruised, damaged, or burned. When the oil gets on the skin an allergic reaction, may occur as an itchy and rash with bumps or blisters. Exposure to urushiol can be through direct contact, indirect contact or inhalation. Workers can prevent contact with poisonous plants by taking these steps:

- Wear long sleeves, long pants, boots, and gloves
- Wash exposed clothing separately in hot water with detergent
- After use, clean tools with rubbing alcohol or dish soap and lots of water
- Oils can remain active on the surface of objects for up to 5 years
- Do not burn plants that may be poison ivy

Spring Summer Fall Winter

CONSERVATION AND SUSTAINABILITY

Vehicle Movement:

Camp Ripley provides the facilities necessary for combined arms training. It is understood that off-road movement is necessary for the successful completion of your mission. However, a successful training mission does not depend upon destroying Camp Ripley's environment:

- Obey all speed limits
- Use established roads and trails for travel to and from training areas
- Driving on road ditches and shoulders, neutral steer turns and u-turns are off limits to tracked vehicles
- Do not intentionally drive over or otherwise damage vegetation and trees
- Avoid off-limit areas including impact areas, archaeological sites, wetlands, tree plantations and threatened or endangered species

Land Management:

The Training Area Coordinator and/or Range Control personnel will inspect all training areas and bivouac sites before the occupying unit may clear the area. Ensure the following is completed prior to inspection:

- Remove and properly dispose of all garbage, trash, recyclables, hazardous materials, and other debris
- Do not burn or bury trash
- Mechanical digging requires approval from Range Control and may be conducted only on approved, culturally cleared sites
- Do not cut evergreen trees. Hardwood trees up to two inches in diameter can be cut for camouflage
- All military units and civilian lessees will order chemical latrines for all activities scheduled in the field training area, except for ranges that have a classroom with facilities
- Refill and compact all fighting positions, maneuver damage or emplacements and restore the area to its original appearance

Spill Prevention and Response:

Spilled material may pose a threat to the environment by contaminating surface and ground water:

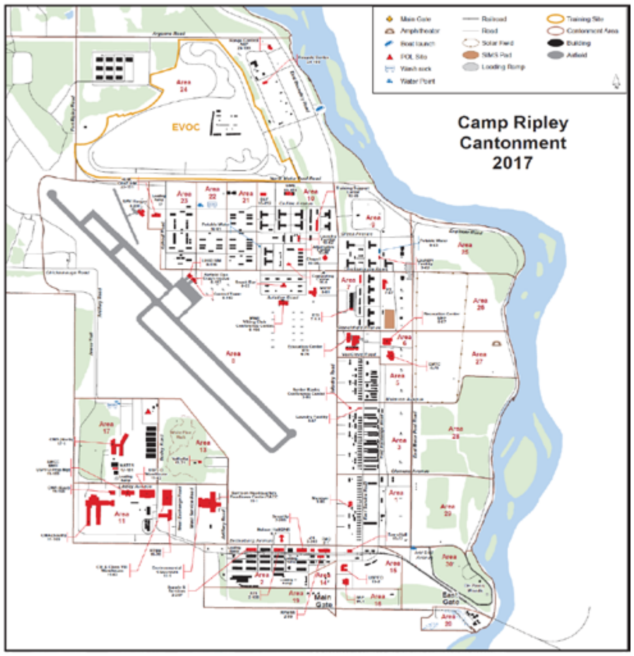
- Stop the leak, contain the spill and think Safety First
- If possible stop spill from entering culverts, ditches, drains and surface water
- Secure the area, make appropriate notifications, complete form JFMNR 200-21-11(Army) - MNARNG Spill Report and follow response procedures

TICKS

There are two types of ticks commonly found at Camp Ripley: the deer tick and wood tick. Deer ticks can potentially carry Lyme's Disease (Babesiosis & HGE). Preventive measures should be taken at Camp Ripley, particularly during tick season (April-October). The following methods are encouraged to prevent bites from all ticks:

- Wear uniforms with pants bloused and sleeves down
- Apply insect repellents
- Use the buddy system to check for ticks frequently
- It takes approximately 24 hours to contract Lyme's Disease

A person with an attached deer tick, should report to the Medical Unit Training Facility (MUTF) for treatment and direction. If the MUTF is closed, personnel at Range Control are prepared to remove the tick and package it for processing.



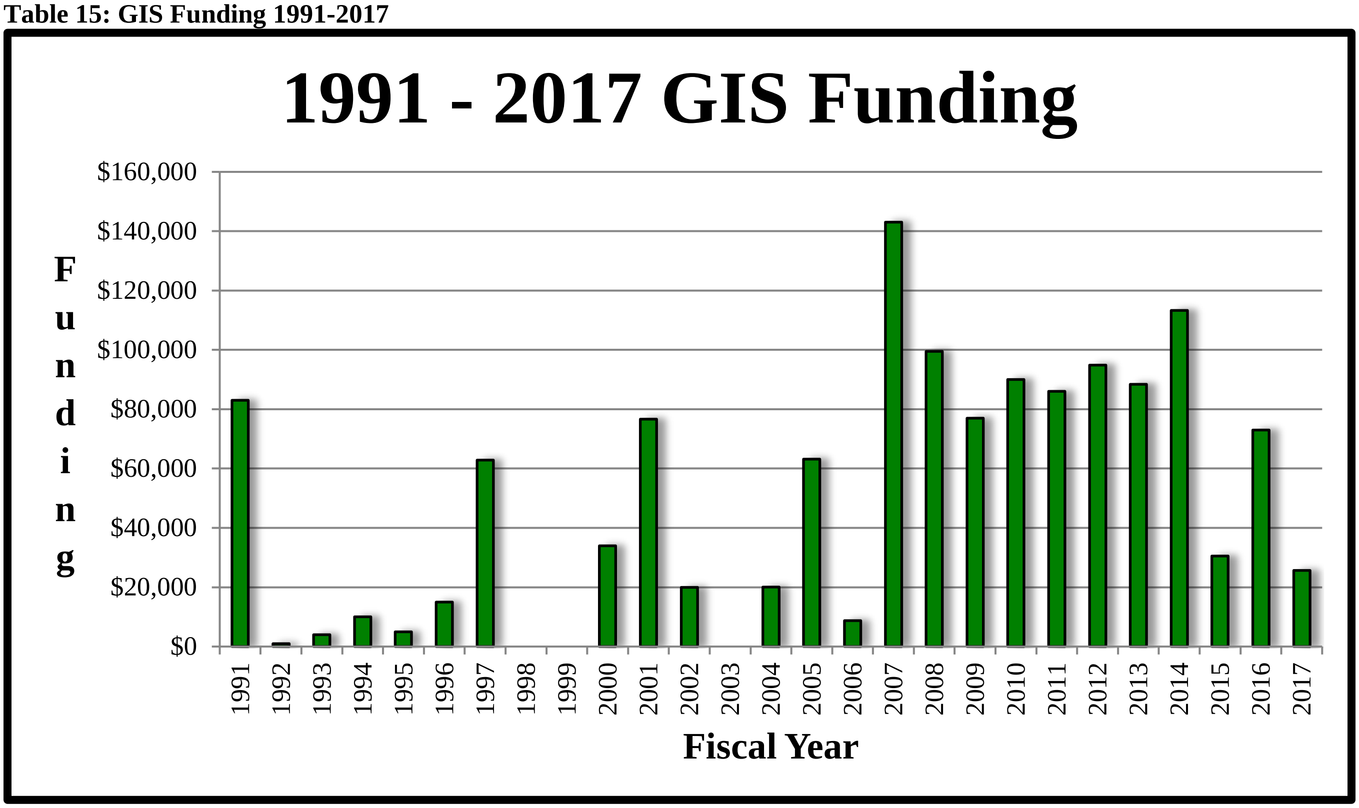
Geographic Information System (GIS)

The success of the Camp Ripley's ITAM program is greatly dependent on a Geographic Information System (GIS). GIS allows for the development and implementation of computer based technology tools whereby spatial/geographic data about Camp Ripley is stored, manipulated, analyzed, and displayed. MNARNG's manages a centralized GIS using the ArcGIS software suite.

Funding

Table 15 portrays an historical overview of GIS funding during the years of 1991-2017. From 1991-2017 the MNARNG has obligated approximately $1,324,648 to implement its GIS Program.

Table 15: GIS Funding 1991-2017



Documents and Accomplishments:

- 1986-1990 Geographic Resources Analysis Support System (GRASS) software was used as part of the Environmental Management Analysis Plan (EMAP). EMAP afforded MNARNG the first opportunity to inventory and provide geographic reference to natural and cultural resources that characterize Camp Ripley.
- 1991 Hardware (Sun Microsystems workstations with UNIX OS) and software (ESRI Arc Info) was purchased, GRASS was abandoned.
- 1992-1995 ArcView was purchased and funds were used to support the ESRI Software Maintenance Contract.
- 1996 a Memorandum of Understanding (MOU) was signed with St. Cloud State University (SCSU) to support development of GIS data. SCSU interns developed data to support the automated range bulletin for range control. ESRI Software Maintenance Contract.

- 1997 the MNARNG Converted GIS systems from UNIX to NT, purchased hardware (3 PC's with Windows OS) and software (Arc Info and ArcView for Windows). Conducted Camp Ripley needs assessment. Contracted for SCSU internships to develop/edit 15 coverage's. Purchased Trimble Pro XR GPS receiver with real time beacon. Trained 24 end users on ArcView. ESRI Software Maintenance Contract.
- 1998-1999 GIS data was made available on the MN-ARNG network.
ArcView software was distributed to environmental and ITAM GIS users. Contracted SCSU internships for data development ESRI Software Maintenance Contract.
- 2000 began converting GIS data structure to comply with the Tri Services Spatial Data Standards (TSSDS). Began drafting FGDC compliant metadata for all GIS layers through the Spatial Metadata Management System (SMMS). ESRI Software Maintenance Contract.
- 2001-2002 a server and software (MS SQL Server) was purchased to establish a centralized GIS data repository. GIS data was converted to the feature class format and stored in a geodatabase on the GIS server. GIS data was restructured to comply with the revised Spatial Data Standards for Facilities, Installations, and Environment (SDSFIE), formally TSSDS. Two replacement workstations were purchased. Acquired a 1m digital terrain model (DTM) for Camp Ripley. Developed policies and procedures for project management.
- 2003-2004 a replacement server and workstation was purchased. Converted the digital Range Bulletin to the new ArcGIS platform. Established use of Range Managers Tool Kit (RMTK) at Range Control for the development of Safety Danger Zones (SDZ).
- 2005-2006 a replacement workstation was purchased. Developed and began implementation of a GIS Management Plan. Contracted SCSU internships for data development in support of the Camp Ripley Army Compatible Use Buffer (ACUB) program.
- 2007 a GIS support contract was put into place to provide GIS staff and Light Detection and Ranging (LIDAR) data was obtained for Camp Ripley.
- 2009 LIDAR data is being field checked to compare with other data sources such as forest inventory and RTLA assessments.
- 2013 High Resolution aerial photography

DATA

Table 16 identifies all spatial data currently maintained for Camp Ripley by the ITAM GIS program:

Table 16: GIS Data

Feature Dataset	Feature Class
common	**coordinate_grid_area**
common	**coordinate_grid_line**
common	**coordinate_grid_point**
flora	**rtla_sample_point**
flora	**rtla_transect_line**
land_status	**land_repair_area**
land_status	**land_repair_line**
land_status	**land_repair_point**
military_operations	**ammunition_storage_area**
military_operations	**firing_line**
military_operations	**firing_point**
military_operations	**forward_arming_refueling_area**
military_operations	**mil_qty_distance_arc_area**

military_operations	**mil_restricted_access_area**
military_operations	**mil_special_use_airspace_area**
military_operations	**mil_surface_danger_zone_area**
military_operations	**military_drop_zone_area**
military_operations	**military_flight_corridor_area**
military_operations	**military_landing_zone_point**
military_operations	**military_range_area**
military_operations	**military_range_feature**
military_operations	**military_safety_marker_point**
military_operations	**military_target_line**
military_operations	**military_target_point**
military_operations	**tank_trail_line**
military_operations	**training_area**
military_operations	**training_point**
military_operations	**training_site_area**
transportation_air	**airspace_obstruct_navaid_point**
transportation_air	**regulated_airspace_area**

Coordination and Partnerships

Essential to plan implementation is a balanced team of trained professional and technical staff. Staffing sources for the ITAM programs include:

- Camp Ripley Environmental Office
- Facilities Management Office
- MNARNG GIS Department
- Camp Ripley Operations Office
- Camp Ripley Range Control Office
- Camp Ripley Department of Public Works Office
- MNDNR personnel associated with Camp Ripley
- Contractors (e.g., University of Minnesota, The Nature Conservancy, St. Cloud State University, Central Lakes College)

The MNARNG currently has a SRP-AC. The primary mission of the SRP-AC is to maximize the capability, availability, and accessibility of ranges and training lands to support doctrinal requirements, mobilization, and deployments under normal and surge conditions. The SRP-AC will provide guidance in planning, integrating, reviewing and implementing the ITAM program within the MNARNG at Camp Ripley.

Data Management, Analysis and Program Reporting

A report or overview of the ITAM program will be documented annually to include all assessments, accomplishments and products purchased or produced from the preceding year.

ITAM Plan Update

The plan will be reviewed annually and revised as mission, accomplishments, or environmental changes warrant. Individual goals, objectives, and policies will be reviewed annually. Major revisions will be formally reviewed every five years to include all assessments, accomplishments and products purchased or produced from the preceding year. The annual ITAM achievements will be introduced annually as annexes to this document. Updates coincide and are represented with annual changes to the Range Complex Master Plan (RCMP).

Chapter 3: Goals and Objectives

Training Lands Objectives

- Maximize the capability, availability and accessibility of ranges and training areas to support unit doctrinal training requirements under normal and surge mobilization conditions.

- Integrate facilities management, environmental program management, the Army Range Safety Program and munitions management with the Sustainable Range Program to optimize mission sustainment of ranges and training lands.

- Ensure the State Master Plan accurately reflects the Camp Ripley Site Development Plan and the installation Range Complex Master Plan.

- Maintain the Sustainable Range Outreach Program with the local community.

- Manage the installation range and training lands for the integration of future force and joint training requirements.

- Continue to maintain and grow the Army Compatible Use Buffer (ACUB) Program.

- Manage the training areas while maintaining a balance between the military and natural resources by incorporating environmentally sustainable infrastructure to all range projects.

- Provide a competent, ready force for the state and nation by maintaining viable ranges that meet the training requirements of utilizing units as a designated Regional Collective Training Capability site.

ITAM Goals and Objectives

Goal 1: Support maneuver training primarily for 34th ID

- Create and maintain 5 maneuver corridors for open maneuver land in area K1 by FY17.

- Assess, improve or maintain 62 artillery firing points across the installation.

- Maintain line of sight on 1,000 acres in heavy maneuver area K1 annually.

- Assess, improve or maintain five dismounted land navigations areas annually.

- Assess, maintain or improve bivouac and maneuver areas

Goal 2: Sustain the training lands to ensure the safe heavy, light and dismounted maneuver training of the 34th ID

- Repair maneuver damage that occurs from routine training activity
- Assess, improve or maintain maneuver trails, corridors and grasslands
- Erosion mitigation
- Reduce training hazards across the installation
- Sustainable Range Awareness

Chapter 4: Funding

Funding required for the implementation of the ITAM plan for Camp Ripley over the next five years will be derived from SRP Program.

NGB-ART is the primary source of funding that supports the ITAM programs for the MNARNG. ITAM funding requirements are identified through an annual ITAM plan. Individual projects are identified in the ITAM plan in the RCMP and submitted to National Guard Bureau for validation and those funded will be documented in the annual report. Refer to Chapter 7 for the total ITAM Budget for the validated projects during the program years of Fiscal Years 2018-2022.

Table 17: 2018 Workplan Summary Report

2018 Workplan Summary Report					
Project ID	**FY**	**Title**	**Description**	**Component**	**Cost**
0572120074	2018	Land Navigation Course Management	Reduce hazards (i.e. snags) reported during the RTLA assessment in AHATS.	LRAM	$11,723.00
0572130162	2018	SRA Products	Produce and distribute awareness materials (maps, posters, handouts, briefing materials)to military units that train on Camp Ripley	SRA	$15,206.80
0572140169	2018	Assessment 1: LRAM Assessment	Assess approximately 217 miles of maneuver trails on northern half of Camp Ripley for maneuver damage and erosion. Record each location and estimate costs associated with rehabilitation for following year management.	RTLA	$33,638.60
0572140172	2018	Assessment 2: Artillery Firing Point	Assess 17 firing points (Set C), totaling 593 acres for forest encroachment, maneuver damage and grassland quality. Assessment results determine which firing points will be improved the following fiscal year.	RTLA	$24,979.40
0572140175	2018	Assessment 3: Open Maneuver Assessment	Annual assessment of 300 acres on two open grasslands primarily used for bivouac and heavy mechanized maneuver training for woody vegetation, both encroaching from the edge and creating hazards within the training areas.	RTLA	$6,032.80
0572140178	2018	Assessment 4: Maneuver Corridors	Assess maneuver lanes in maneuver area K1 to promote an average width of 300m with a slope of less than 15%. Maneuver lane is to be established with native grasses and surrounded by mature trees.	RTLA	$12,071.60
0572140181	2018	Assessment 5: Observation Point Assessment	Assess 8 Observation Points approximately 2 acres total for physical attributes, erosion, and woody encroachment.	RTLA	$3,516.00
0572140187	2018	Assessment 7: Hazardous Artifacts	Assess 7,184 acres of Maneuver Area F for farm and training artifacts that pose a safety issue for training. Assessment details can be found in the ITAM Plan.	RTLA	$28,262.15

0572140190	2018	Assessment 8: Forest Understory Assessment	Assess 2,828 acres for the visibility and MILES compatibility through the forest understory in TAs: 16, 24, 25, 26, 27, and 35. Assessment details can be found in the ITAM Plan.	RTLA	$13,739.10
0572140193	2018	Assessment 9: LZ/PZ Assessment	Assessment of site condition on 14 LZ/PZ for woody encroachment and maneuver damage.	RTLA	$5,918.00
0572140199	2018	ITAM Administration	Attend meetings, coordination, data management, supervise employees, etc...	LRAM	$40,122.00
0572140202	2018	LRAM Administration	Attend meetings, coordination, data management, supervise employees, etc...	LRAM	$26,624.00
0572140205	2018	RTLA Administration	Attend meetings, coordination, and data management, etc...	LRAM	$29,624.00
0572140208	2018	TRI Support	Actively participate in range and land management planning and execution; ensure mission needs are considered in environmental and facilities planning, and environmental constraints are considered in mission planning. Participate in the SRP committee meetings.	TRI	$26,417.60
0572140214	2018	Artillery Firing Point Management	Improve 10 firing points (defined by the 2017 assessment) by reducing woody encroachment into the grassland, promoting native grasses reducing underbrush in surrounding forest and improving trail network.	LRAM	$85,913.75
0572140217	2018	LRAM Management (Maneuver Trail)	Repair sites identified in 2017 Assessment 1. Approximately 150 sites totaling approximately 50 acres in size.	LRAM	$102,441.50
0572140220	2018	Open Maneuver Management	Repair 3 sites totaling approximately 65 acres of maneuver damage caused by military training.	LRAM	$58,329.60
0572140223	2018	Maneuver Corridor Management	Maintain 30km of maneuver lanes in maneuver area K1. Management of lanes includes establishment of native grasses and woody encroachment to maintain a 300m width.	LRAM	$68,430.20
0572140226	2018	Observation Point Management	Stabilize soil and enhance native vegetation on and around 8 OP's annually. Apply gravel and suitable materials as needed to OP's.	LRAM	$9,250.70
0572140233	2018	Forest Understory Management	Improve forest understory on approximately 150 acres of training lands annually.	LRAM	$53,477.20
0572140236	2018	LZ/PZ Management	Provide maintenance to 14 helipads on 2 acres to support military training.	LRAM	$13,414.95
0572140242	2018	Hazardous Artifacts Management	Repair approximately 12 hazardous artifacts or training safety hazards discovered in FY17 Assessment 7.	LRAM	$4,623.70
0572140245	2018	Assessment 6: Land Navigation Course	Assess 222 acres for the traversability of the B-5 Land Navigation Course. Details on the assessment can be found in the ITAM Plan.	RTLA	$14,312.60

0572140253	2018	SRP GIS Administration	GIS Specialist including general administration, TDY/training, coordinating, office supplies, equipment, hardware, software, labor, etc...	GIS	$9,416.28
0572140257	2018	SRP GIS Support to Range Operations	Provides support for RFMSS/GFD, developing SDZs, training range staff, labor, etc...	GIS	$1,208.43
0572140261	2018	SRP GIS Support to Range Modernization/Range Development	Provides support through labor to data and mapping for analysis of alternatives and charrettes.	GIS	$1,208.43
0572140265	2018	SRP GIS Training Support	Provides support to soldiers by supplying with training maps, shot sheets and custom maps as requested.	GIS	$16,918.02
0572140269	2018	SRP GIS Data Development	Provides support through labor to develop, update and manage SRP proponent geospatial data layers (QAPs), MIM Updates and additional data to support SRP Geospatial Data Strategy standards.	GIS	$2,416.86
Cyclic Purchase	2018	CAT 247B Skidsteer with Attachment	Attachments: Bucket, Grapple, Rock, Tree Planter, Sheer, Etc...	LRAM	$80,000.00
Cyclic Purchase	2018	Landpride 72" Overseeder with Roller	Drill Overseeder	LRAM	$6,980.00
Cyclic Purchase	2018	Brushhog Mower Series 286	Mower	LRAM	$2,790.00
Cyclic Purchase	2018	Brushhog Mower Series 286	Mower	LRAM	$2,790.00
Cyclic Purchase	2018	Brushhog Mower Series 306	Mower	LRAM	$2,200.00
Cyclic Purchase	2018	Truax Drill Grass Seeder	Native Grass Drill Seeder	LRAM	$13,010.00
Cyclic Purchase	2018	Bandit Chipper Model 90W	Wood Chipper	LRAM	$15,015.00
					$842,022.27

Table 18: 2019 Workplan Summary Report

2019 Workplan Summary Report

Project ID	FY	Title	Description	Component	Cost
Camp Ripley Project 1	2019	SRA Products	Produce and distribute awareness materials (solider field cards, posters, handouts, briefing materials) to military units that train on Camp Ripley.	SRA	$19,711.20
Camp Ripley Project 2	2019	ITAM Administration	Attend meetings, coordination, data management, supervise employees, etc.…	LRAM	$35,588.00
Camp Ripley Project 3	2019	LRAM Administration	Attend meetings, coordination, data management, supervise employees, etc.…	LRAM	$22,388.00
Camp Ripley Project 4	2019	RTLA Administration	Attend meetings, coordination, data management, supervise employees, etc.…	RTLA	$22,388.00

Camp Ripley Project 5	2019	TRI Support	Actively participate in range and land management planning and execution; ensure mission needs are considered in environmental and facilities planning, and environmental constraints are considered in mission planning. Participate in the SRP committee meetings.	TRI	$30,085.80
Camp Ripley Project 6	2019	SRP GIS Administration	GIS Specialist including general administration, TDY/training, coordinating, office supplies, equipment, hardware, software, labor, etc.…	GIS	$18,388.00
Camp Ripley Project 7	2019	SRP GIS Support to Range Operations	Provides support for RFMSS/GFD, developing SDZs, training range staff, labor, etc.…	GIS	$5,632.80
Camp Ripley Project 8	2019	SRP GIS Support to Range	Provides support through labor to data and mapping for analysis of alternatives and charrettes.	GIS	$3,755.20
Camp Ripley Project 9	2019	SRP GIS Training Support	Provides support to soldiers by supplying with training maps, shot sheets and custom maps as requested.	GIS	$18,766.00
Camp Ripley Project 10	2019	SRP GIS Data Development	Provides support through labor to develop, update and manage SRP proponent geospatial data layers (QAPs), MIM Updates and additional data to support SRP Geospatial Data Strategy standards.	GIS	$4,694.00
Camp Ripley Project 11	2019	Assessment 5: Observation Point	Assess 8 Observation Points approximately 2 acres total for physical attributes, erosion, and woody encroachment.	RTLA	$2,165.80
Camp Ripley Project 12	2019	Assessment 7: Hazardous Artifacts	Assess 6,842 acres of Maneuver Area K1 for farm and training artifacts that pose a safety issue for training. Assessment details can be found in the ITAM Plan.	RTLA	$18,434.60
Camp Ripley Project 13	2019	Assessment 3: Open Maneuver Assessment	Annual assessment of 350 acres on two open grasslands primarily used for bivouac and heavy mechanized maneuver training. Annual assessment of vegetation and erosion control surrounding 14 landing/pickup zones for woody vegetation, both encroaching from the edge and creating hazards within the training areas.	RTLA	$6,813.60
Camp Ripley Project 14	2019	Assessment 4: Maneuver Corridors	Assess maneuver lanes in maneuver area K1 to promote an average width of 300m with a slope of less than 15%. Maneuver lane is to be established with native grasses and surrounded by mature trees.	RTLA	$7,514.00
Camp Ripley Project 15	2019	Assessment 2: Artillery Firing Point	Assess 24 firing points (Set A), totaling 1,147 acres for forest encroachment, maneuver damage and grassland quality. Assessment results determine which firing points will be improved the following fiscal year.	RTLA	$19,170.00

Camp Ripley Project 16	2019	Assessment 8: Forest Understory	Assess 3,849 acres for the visibility and MILES compatibility through the forest understory in TAs: 39, 40, 41 and 43. Assessment details can be found in the ITAM Plan.	RTLA	$12,976.80
Camp Ripley Project 17	2019	Assessment 1: LRAM Assessment	Assess 119 miles of maneuver trails on southern half of Camp Ripley for maneuver damage and erosion. Record each location and estimate costs associated with rehabilitation.	RTLA	$15,903.60
Camp Ripley Project 18	2019	Assessment 6: Land Navigation Area	Stabilize soil and enhance native vegetation on and around 8 OP's annually. Apply gravel and suitable materials as needed to OP's.	RTLA	$8,009.60
Camp Ripley Project 19	2019	Assessment 9: Landing/Pickup Zones	Annual assessment of vegetation and maneuver damage surrounding 14 landing/pickup zones on 21.6 acres for woody vegetation, both encroaching from the edge and creating hazards within the training areas.	RTLA	$1,922.55
Camp Ripley Project 20	2019	Repair: Artillery Firing Points	Improve 10 firing points of 18 sites (Set C) defined by the 2018 assessment by reducing woody encroachment into the grassland, promoting native grasses, reducing underbrush in surrounding forest and improving trail	LRAM	$70,241.00
Camp Ripley Project 21	2019	Reconfigure: Forest Understory	Improve forest understory on 123 acres of training lands. Management will occur within Training Areas 16, 24, 25, 26, 27 and 35.	LRAM	$41,761.50
Camp Ripley Project 22	2019	Repair: Maneuver Trails	Repair sites identified in 2016 Assessment 1 for 71 miles of maneuver trails on the north end of Camp Ripley. Approximately 100 sites totaling approximately 7 acres in size to be repaired.	LRAM	$101,694.50
Camp Ripley Project 23	2019	Repair: Open Maneuver Areas	Repair 2 sites totaling approximately 65 acres of maneuver damage caused by military training.	LRAM	$43,059.80
Camp Ripley Project 24	2019	Maintain: Maneuver Corridor	Maintain 30km of maneuver lanes in maneuver area K1. Management of lanes includes establishment of native grasses and woody encroachment to maintain a 300m width.	LRAM	$49,357.10
Camp Ripley Project 25	2019	Repair: Hazardous Artifacts	Repair 4 hazardous artifacts or training safety hazards discovered in FY16 Assessment 7. 2 tank fighting positions and 2 historic tank ditches need to be filled in.	LRAM	$8,387.60
Camp Ripley Project 26	2019	Repair: Land Navigation Area	Reduce training hazards (i.e. snags) reported during the RTLA assessment in land navigation course B-5 encompassing 223 acres.	LRAM	$13,030.80
Camp Ripley Project 27	2019	Maintain: Observation Points	Stabilize soil and enhance native vegetation on and around 8 OP's annually.	LRAM	$6,840.80

Camp Ripley Project 28	2019	Expand Firing Point 2588 in TA 3	20 acre expansion of firing point to include stumping, grubbing, leveling, seeding and erosion control	LRAM	$45,184.10
Camp Ripley Project 29	2019	Improve Maneuver Trail Network in TA 1	Install 1.33 miles of new maneuver trail, reclaim and restore 0.65 miles of existing maneuver trail back to native grassland expanding firing point 2471 by 111 acres.	LRAM	$104,307.00
Camp Ripley Project 30	2019	Improve Maneuver Trail Network in TA 14	Install 0.07 miles of new maneuver trail, reclaim and restore 0.15 miles of existing maneuver trail back to native grassland.	LRAM	$17,499.40
Camp Ripley Project 31	2019	Maintain LZ/PZ	Repair maneuver damage and maintain native vegetation from woody encroachment surrounding 14 LZ/PZ on 21.6 acres	LRAM	$3,008.15
Cyclic Purchase	2019	3/4 Ton 2500 Chevy Silverado Pick-Up, 4X4	Vehicle replacement as current vehicle has reached its lifespan	LRAM	$30,000.00
Cyclic Purchase	2019	3/4 Ton 2500 Chevy Silverado Pick-Up, 4X4	Vehicle replacement as current vehicle has reached its lifespan	LRAM	$30,000.00
Cyclic Purchase	2019	Diamond Cutter Brush Mower	Maintain maneuver trails and ingress/egress for artillery firing points, maneuver corridors, open maneuver areas, etc...	LRAM	$20,000.00
Cyclic Purchase	2019	Fuel Trailer	Fuel trailer to provide gasoline, diesel and DEF for ITAM equipment working on projects downrange	LRAM	$28,000.00
					$886,679.30

Table 19: 2020 Workplan Summary Report

2020 Workplan Summary Report					
Project ID	**FY**	**Title**	**Description**	**Component**	**Cost**
Camp Ripley Project 1	2020	SRA Products	Produce and distribute awareness materials (solider field cards, posters, handouts, briefing materials) to military units that train on Camp Ripley.	SRA	$19,711.20
Camp Ripley Project 2	2020	ITAM Administration	Attend meetings, coordination, data management, supervise employees, etc.…	LRAM	$35,588.00
Camp Ripley Project 3	2020	LRAM Administration	Attend meetings, coordination, data management, supervise employees, etc.…	LRAM	$22,388.00
Camp Ripley Project 4	2020	RTLA Administration	Attend meetings, coordination, data management, supervise employees, etc.…	RTLA	$22,388.00
Camp Ripley Project 5	2020	TRI Support	Actively participate in range and land management planning and execution; ensure mission needs are considered in environmental and facilities planning, and environmental constraints are considered in mission planning. Participate in the SRP committee meetings.	TRI	$30,085.80
Camp Ripley Project 6	2020	SRP GIS Administration	GIS Specialist including general administration, TDY/training, coordinating, office supplies, equipment, hardware, software, labor, etc.…	GIS	$18,388.00

Camp Ripley Project 7	2020	SRP GIS Support to Range Operations	Provides support for RFMSS/GFD, developing SDZs, training range staff, labor, etc.…	GIS	$5,632.80
Camp Ripley Project 8	2020	SRP GIS Support to Range	Provides support through labor to data and mapping for analysis of alternatives and charrettes.	GIS	$3,755.20
Camp Ripley Project 9	2020	SRP GIS Training Support	Provides support to soldiers by supplying with training maps, shot sheets and custom maps as requested.	GIS	$18,766.00
Camp Ripley Project 10	2020	SRP GIS Data Development	Provides support through labor to develop, update and manage SRP proponent geospatial data layers (QAPs), MIM Updates and additional data to support SRP Geospatial Data Strategy standards.	GIS	$4,694.00
Camp Ripley Project 11	2020	Assessment 5: Observation Point	Assess 8 Observation Points approximately 2 acres total for physical attributes, erosion, and woody encroachment.	RTLA	$2,165.80
Camp Ripley Project 12	2020	Assessment 7: Hazardous Artifacts	Assess 6,842 acres of Maneuver Area K1 for farm and training artifacts that pose a safety issue for training. Assessment details can be found in the ITAM Plan.	RTLA	$18,434.60
Camp Ripley Project 13	2020	Assessment 3: Open Maneuver Assessment	Annual assessment of 350 acres on two open grasslands primarily used for bivouac and heavy mechanized maneuver training. Annual assessment of vegetation and erosion control surrounding 14 landing/pickup zones for woody vegetation, both encroaching from the edge and creating hazards within the training areas.	RTLA	$6,813.60
Camp Ripley Project 14	2020	Assessment 4: Maneuver Corridors	Assess maneuver lanes in maneuver area K1 to promote an average width of 300m with a slope of less than 15%. Maneuver lane is to be established with native grasses and surrounded by mature trees.	RTLA	$7,514.00
Camp Ripley Project 15	2020	Assessment 2: Artillery Firing Point	Assess 24 firing points (Set A), totaling 1,147 acres for forest encroachment, maneuver damage and grassland quality. Assessment results determine which firing points will be improved the following fiscal year.	RTLA	$19,170.00
Camp Ripley Project 16	2020	Assessment 8: Forest Understory	Assess 3,849 acres for the visibility and MILES compatibility through the forest understory in TAs: 39, 40, 41 and 43. Assessment details can be found in the ITAM Plan.	RTLA	$12,976.80
Camp Ripley Project 17	2020	Assessment 1: LRAM Assessment	Assess 119 miles of maneuver trails on southern half of Camp Ripley for maneuver damage and erosion. Record each location and estimate costs associated with rehabilitation.	RTLA	$15,903.60
Camp Ripley Project 18	2020	Assessment 6: Land Navigation Area	Stabilize soil and enhance native vegetation on and around 8 OP's annually. Apply gravel and suitable materials as needed to OP's.	RTLA	$8,009.60

Camp Ripley Project 19	2020	Assessment 9: Landing/Pickup Zones	Annual assessment of vegetation and maneuver damage surrounding 14 landing/pickup zones on 21.6 acres for woody vegetation, both encroaching from the edge and creating hazards within the training areas.	RTLA	$1,922.55
Camp Ripley Project 20	2020	Repair: Artillery Firing Points	Improve 10 firing points of 18 sites (Set C) defined by the 2018 assessment by reducing woody encroachment into the grassland, promoting native grasses, reducing underbrush in surrounding forest and improving trail	LRAM	$70,241.00
Camp Ripley Project 21	2020	Reconfigure: Forest Understory	Improve forest understory on 123 acres of training lands. Management will occur within Training Areas 16, 24, 25, 26, 27 and 35.	LRAM	$41,761.50
Camp Ripley Project 22	2020	Repair: Maneuver Trails	Repair sites identified in 2016 Assessment 1 for 71 miles of maneuver trails on the north end of Camp Ripley. Approximately 100 sites totaling approximately 7 acres in size to be repaired.	LRAM	$101,694.50
Camp Ripley Project 23	2020	Repair: Open Maneuver Areas	Repair 2 sites totaling approximately 65 acres of maneuver damage caused by military training.	LRAM	$43,059.80
Camp Ripley Project 24	2020	Maintain: Maneuver Corridor	Maintain 30km of maneuver lanes in maneuver area K1. Management of lanes includes establishment of native grasses and woody encroachment to maintain a 300m width.	LRAM	$49,357.10
Camp Ripley Project 25	2020	Repair: Hazardous Artifacts	Repair 4 hazardous artifacts or training safety hazards discovered in FY16 Assessment 7. 2 tank fighting positions and 2 historic tank ditches need to be filled in.	LRAM	$8,387.60
Camp Ripley Project 26	2020	Repair: Land Navigation Area	Reduce training hazards (i.e. snags) reported during the RTLA assessment in land navigation course B-5 encompassing 223 acres.	LRAM	$13,030.80
Camp Ripley Project 27	2020	Maintain: Observation Points	Stabilize soil and enhance native vegetation on and around 8 OP's annually.	LRAM	$6,840.80
Camp Ripley Project 28	2020	Expand Firing Point 2588 in TA 3	20 acre expansion of firing point to include stumping, grubbing, leveling, seeding and erosion control	LRAM	$45,184.10
Camp Ripley Project 29	2020	Improve Maneuver Trail Network in TA 1	Install 1.33 miles of new maneuver trail, reclaim and restore 0.65 miles of existing maneuver trail back to native grassland expanding firing point 2471 by 111 acres.	LRAM	$104,307.00
Camp Ripley Project 30	2020	Improve Maneuver Trail Network in TA 14	Install 0.07 miles of new maneuver trail, reclaim and restore 0.15 miles of existing maneuver trail back to native grassland.	LRAM	$17,499.40
Camp Ripley Project 31	2020	Maintain LZ/PZ	Repair maneuver damage and maintain native vegetation from woody encroachment surrounding 14 LZ/PZ on 21.6 acres	LRAM	$3,008.15
Cyclic Purchase	2020	Polaris Sportsman 500 4x4 ATV	All-Terrain Vehicle	LRAM	$5,699.00

Cyclic Purchase	2020	Polaris Ranger 800 6x6, UTV	Utility Task Vehicle	LRAM	$12,700.00
Cyclic Purchase	2020	RICHO CAMERA	Camera	LRAM	$4,750.00
Cyclic Purchase	2020	RICHO CAMERA	Camera	LRAM	$4,750.00
Cyclic Purchase	2020	GARMIN 76CX GPS	GPS	LRAM	$480.00
Cyclic Purchase	2020	GARMIN 76CX GPS	GPS	LRAM	$480.00
Cyclic Purchase	2020	GARMIN 76CX GPS	GPS	LRAM	$480.00
Cyclic Purchase	2020	GARMIN III PLUS GPS	GPS	LRAM	$480.00
Cyclic Purchase	2020	MOTOROLA XTS2500 RADIO	Radio	LRAM	$2,417.79
Cyclic Purchase	2020	MOTOROLA XTS2500 RADIO	Radio	LRAM	$2,417.79
Cyclic Purchase	2020	MOTOROLA XTS2500 RADIO	Radio	LRAM	$2,417.79
Cyclic Purchase	2020	MOTOROLA XTS2500 RADIO	Radio	LRAM	$2,417.79
Cyclic Purchase	2020	MOTOROLA XTS2500 RADIO	Radio	LRAM	$2,417.79
Cyclic Purchase	2020	320 CAT EXCAVATOR	Excavator	LRAM	$246,296.00
Cyclic Purchase	2020	SKIDSTEER 84" GRAPPLE RAKE	Grapple for CAT Skidsteer	LRAM	$3,240.00
Cyclic Purchase	2020	SKIDSTEER 84" MATERIAL BUCKET	Material bucket for CAT Skidsteer	LRAM	$1,230.00
Cyclic Purchase	2020	ALUMA UTILITY TRAILER FOR ATV'S	Aluminum Trailer	LRAM	$4,430.00
Cyclic Purchase	2020	John Deere Gator ATV	All-Terrain Vehicle	LRAM	$10,695.00
Cyclic Purchase	2020	20' Bat Wing Mower	Mower	LRAM	$24,379.60
					$1,110,857.85

Table 20: 2021 Workplan Summary Report

2021 Workplan Summary Report

Project ID	FY	Title	Description	Component	Cost
Camp Ripley Project 1	2021	SRA Products	Produce and distribute awareness materials (solider field cards, posters, handouts, briefing materials) to military units that train on Camp Ripley.	SRA	$19,711.20
Camp Ripley Project 2	2021	ITAM Administration	Attend meetings, coordination, data management, supervise employees, etc.…	LRAM	$35,588.00
Camp Ripley Project 3	2021	LRAM Administration	Attend meetings, coordination, data management, supervise employees, etc.…	LRAM	$22,388.00
Camp Ripley Project 4	2021	RTLA Administration	Attend meetings, coordination, data management, supervise employees, etc.…	RTLA	$22,388.00

Camp Ripley Project 5	2021	TRI Support	Actively participate in range and land management planning and execution; ensure mission needs are considered in environmental and facilities planning, and environmental constraints are considered in mission planning. Participate in the SRP committee meetings.	TRI	$30,085.80
Camp Ripley Project 6	2021	SRP GIS Administration	GIS Specialist including general administration, TDY/training, coordinating, office supplies, equipment, hardware, software, labor, etc.…	GIS	$18,388.00
Camp Ripley Project 7	2021	SRP GIS Support to Range Operations	Provides support for RFMSS/GFD, developing SDZs, training range staff, labor, etc.…	GIS	$5,632.80
Camp Ripley Project 8	2021	SRP GIS Support to Range	Provides support through labor to data and mapping for analysis of alternatives and charrettes.	GIS	$3,755.20
Camp Ripley Project 9	2021	SRP GIS Training Support	Provides support to soldiers by supplying with training maps, shot sheets and custom maps as requested.	GIS	$18,766.00
Camp Ripley Project 10	2021	SRP GIS Data Development	Provides support through labor to develop, update and manage SRP proponent geospatial data layers (QAPs), MIM Updates and additional data to support SRP Geospatial Data Strategy standards.	GIS	$4,694.00
Camp Ripley Project 11	2021	Assessment 5: Observation Point	Assess 8 Observation Points approximately 2 acres total for physical attributes, erosion, and woody encroachment.	RTLA	$2,165.80
Camp Ripley Project 12	2021	Assessment 7: Hazardous Artifacts	Assess 6,842 acres of Maneuver Area K1 for farm and training artifacts that pose a safety issue for training. Assessment details can be found in the ITAM Plan.	RTLA	$18,434.60
Camp Ripley Project 13	2021	Assessment 3: Open Maneuver Assessment	Annual assessment of 350 acres on two open grasslands primarily used for bivouac and heavy mechanized maneuver training. Annual assessment of vegetation and erosion control surrounding 14 landing/pickup zones for woody vegetation, both encroaching from the edge and creating hazards within the training areas.	RTLA	$6,813.60
Camp Ripley Project 14	2021	Assessment 4: Maneuver Corridors	Assess maneuver lanes in maneuver area K1 to promote an average width of 300m with a slope of less than 15%. Maneuver lane is to be established with native grasses and surrounded by mature trees.	RTLA	$7,514.00
Camp Ripley Project 15	2021	Assessment 2: Artillery Firing Point	Assess 24 firing points (Set A), totaling 1,147 acres for forest encroachment, maneuver damage and grassland quality. Assessment results determine which firing points will be improved the following fiscal year.	RTLA	$19,170.00

Camp Ripley Project 16	2021	Assessment 8: Forest Understory	Assess 3,849 acres for the visibility and MILES compatibility through the forest understory in TAs: 39, 40, 41 and 43. Assessment details can be found in the ITAM Plan.	RTLA	$12,976.80
Camp Ripley Project 17	2021	Assessment 1: LRAM Assessment	Assess 119 miles of maneuver trails on southern half of Camp Ripley for maneuver damage and erosion. Record each location and estimate costs associated with rehabilitation.	RTLA	$15,903.60
Camp Ripley Project 18	2021	Assessment 6: Land Navigation Area	Stabilize soil and enhance native vegetation on and around 8 OP's annually. Apply gravel and suitable materials as needed to OP's.	RTLA	$8,009.60
Camp Ripley Project 19	2021	Assessment 9: Landing/Pickup Zones	Annual assessment of vegetation and maneuver damage surrounding 14 landing/pickup zones on 21.6 acres for woody vegetation, both encroaching from the edge and creating hazards within the training areas.	RTLA	$1,922.55
Camp Ripley Project 20	2021	Repair: Artillery Firing Points	Improve 10 firing points of 18 sites (Set C) defined by the 2018 assessment by reducing woody encroachment into the grassland, promoting native grasses, reducing underbrush in surrounding forest and improving trail	LRAM	$70,241.00
Camp Ripley Project 21	2021	Reconfigure: Forest Understory	Improve forest understory on 123 acres of training lands. Management will occur within Training Areas 16, 24, 25, 26, 27 and 35.	LRAM	$41,761.50
Camp Ripley Project 22	2021	Repair: Maneuver Trails	Repair sites identified in 2016 Assessment 1 for 71 miles of maneuver trails on the north end of Camp Ripley. Approximately 100 sites totaling approximately 7 acres in size to be repaired.	LRAM	$101,694.50
Camp Ripley Project 23	2021	Repair: Open Maneuver Areas	Repair 2 sites totaling approximately 65 acres of maneuver damage caused by military training.	LRAM	$43,059.80
Camp Ripley Project 24	2021	Maintain: Maneuver Corridor	Maintain 30km of maneuver lanes in maneuver area K1. Management of lanes includes establishment of native grasses and woody encroachment to maintain a 300m width.	LRAM	$49,357.10
Camp Ripley Project 25	2021	Repair: Hazardous Artifacts	Repair 4 hazardous artifacts or training safety hazards discovered in FY16 Assessment 7. 2 tank fighting positions and 2 historic tank ditches need to be filled in.	LRAM	$8,387.60
Camp Ripley Project 26	2021	Repair: Land Navigation Area	Reduce training hazards (i.e. snags) reported during the RTLA assessment in land navigation course B-5 encompassing 223 acres.	LRAM	$13,030.80
Camp Ripley Project 27	2021	Maintain: Observation Points	Stabilize soil and enhance native vegetation on and around 8 OP's annually.	LRAM	$6,840.80

Camp Ripley Project 28	2021	Expand Firing Point 2588 in TA 3	20 acre expansion of firing point to include stumping, grubbing, leveling, seeding and erosion control	LRAM	$45,184.10
Camp Ripley Project 29	2021	Improve Maneuver Trail Network in TA 1	Install 1.33 miles of new maneuver trail, reclaim and restore 0.65 miles of existing maneuver trail back to native grassland expanding firing point 2471 by 111 acres.	LRAM	$104,307.00
Camp Ripley Project 30	2021	Improve Maneuver Trail Network in TA 14	Install 0.07 miles of new maneuver trail, reclaim and restore 0.15 miles of existing maneuver trail back to native grassland.	LRAM	$17,499.40
Camp Ripley Project 31	2021	Maintain LZ/PZ	Repair maneuver damage and maintain native vegetation from woody encroachment surrounding 14 LZ/PZ on 21.6 acres	LRAM	$3,008.15
Cyclic Purchase	2021	STIHL BRUSHSAW FS 110	Replace existing brushsaw that reached life expectancy	LRAM	$400.00
Cyclic Purchase	2021	STIHL BRUSHSAW FS 110	Replace existing brushsaw that reached life expectancy	LRAM	$400.00
Cyclic Purchase	2021	STIHL CHAINSAW MS361	Replace existing chainsaw that reached life expectancy	LRAM	$729.00
Cyclic Purchase	2021	STIHL CHAINSAW MS361	Replace existing chainsaw that reached life expectancy	LRAM	$729.00
Cyclic Purchase	2021	STIHL CHAINSAW MS361	Replace existing chainsaw that reached life expectancy	LRAM	$729.00
Cyclic Purchase	2021	TANDEM FLATBED TRAILER	Trailer	LRAM	$3,216.00
Cyclic Purchase	2021	STIHL CHAINSAW MS 441	Replace existing chainsaw that reached life expectancy	LRAM	$849.00
Cyclic Purchase	2021	STIHL CHAINSAW MS 441	Replace existing chainsaw that reached life expectancy	LRAM	$849.00
Cyclic Purchase	2021	CAT 279C SKIDSTEER WITH ATTACHMENT	Skidsteer	LRAM	$80,213.00
Cyclic Purchase	2021	MASSEY FERGUSON 1540 TRACTOR	Tractor	LRAM	$14,183.00
Cyclic Purchase	2021	MF 1415 ROTARY BRUSH	Tractor Attachment	LRAM	$2,545.00
Cyclic Purchase	2021	MF 66" SKIDSTEER BUCKET	Tractor Attachment	LRAM	$682.00
Cyclic Purchase	2021	MF 72" SKIDSTEER BUCKET	Tractor Attachment	LRAM	$1,378.00
Cyclic Purchase	2021	MF 63" ROTARY TILLER	Tractor Attachment	LRAM	$2,169.00
Cyclic Purchase	2021	BATWING JOHN DEERE MOWER 20FT	Mower	LRAM	$19,434.00
Cyclic Purchase	2021	FAST BOOM SPRAYER UT3P	Sprayer	LRAM	$4,347.75
Cyclic Purchase	2021	LASER RANGE FINDER TACTICAL KIT	Replace existing range finder that reached life expectancy	LRAM	$4,750.00
					$916,282.05

Table 21: 2022 Workplan Summary Report

2022 Workplan Summary Report					
Project ID	**FY**	**Title**	**Description**	**Component**	**Cost**
Camp Ripley Project 1	2022	SRA Products	Produce and distribute awareness materials (solider field cards, posters, handouts, briefing materials) to military units that train on Camp Ripley.	SRA	$19,711.20
Camp Ripley Project 2	2022	ITAM Administration	Attend meetings, coordination, data management, supervise employees, etc.…	LRAM	$35,588.00
Camp Ripley Project 3	2022	LRAM Administration	Attend meetings, coordination, data management, supervise employees, etc.…	LRAM	$22,388.00
Camp Ripley Project 4	2022	RTLA Administration	Attend meetings, coordination, data management, supervise employees, etc.…	RTLA	$22,388.00
Camp Ripley Project 5	2022	TRI Support	Actively participate in range and land management planning and execution; ensure mission needs are considered in environmental and facilities planning, and environmental constraints are considered in mission planning. Participate in the SRP committee meetings.	TRI	$30,085.80
Camp Ripley Project 6	2022	SRP GIS Administration	GIS Specialist including general administration, TDY/training, coordinating, office supplies, equipment, hardware, software, labor, etc.…	GIS	$18,388.00
Camp Ripley Project 7	2022	SRP GIS Support to Range Operations	Provides support for RFMSS/GFD, developing SDZs, training range staff, labor, etc.…	GIS	$5,632.80
Camp Ripley Project 8	2022	SRP GIS Support to Range	Provides support through labor to data and mapping for analysis of alternatives and charrettes.	GIS	$3,755.20
Camp Ripley Project 9	2022	SRP GIS Training Support	Provides support to soldiers by supplying with training maps, shot sheets and custom maps as requested.	GIS	$18,766.00
Camp Ripley Project 10	2022	SRP GIS Data Development	Provides support through labor to develop, update and manage SRP proponent geospatial data layers (QAPs), MIM Updates and additional data to support SRP Geospatial Data Strategy standards.	GIS	$4,694.00
Camp Ripley Project 11	2022	Assessment 5: Observation Point	Assess 8 Observation Points approximately 2 acres total for physical attributes, erosion, and woody encroachment.	RTLA	$2,165.80
Camp Ripley Project 12	2022	Assessment 7: Hazardous Artifacts	Assess 6,842 acres of Maneuver Area K1 for farm and training artifacts that pose a safety issue for training. Assessment details can be found in the ITAM Plan.	RTLA	$18,434.60

Camp Ripley Project 13	2022	Assessment 3: Open Maneuver Assessment	Annual assessment of 350 acres on two open grasslands primarily used for bivouac and heavy mechanized maneuver training. Annual assessment of vegetation and erosion control surrounding 14 landing/pickup zones for woody vegetation, both encroaching from the edge and creating hazards within the training areas.	RTLA	$6,813.60
Camp Ripley Project 14	2022	Assessment 4: Maneuver Corridors	Assess maneuver lanes in maneuver area K1 to promote an average width of 300m with a slope of less than 15%. Maneuver lane is to be established with native grasses and surrounded by mature trees.	RTLA	$7,514.00
Camp Ripley Project 15	2022	Assessment 2: Artillery Firing Point	Assess 24 firing points (Set A), totaling 1,147 acres for forest encroachment, maneuver damage and grassland quality. Assessment results determine which firing points will be improved the following fiscal year.	RTLA	$19,170.00
Camp Ripley Project 16	2022	Assessment 8: Forest Understory	Assess 3,849 acres for the visibility and MILES compatibility through the forest understory in TAs: 39, 40, 41 and 43. Assessment details can be found in the ITAM Plan.	RTLA	$12,976.80
Camp Ripley Project 17	2022	Assessment 1: LRAM Assessment	Assess 119 miles of maneuver trails on southern half of Camp Ripley for maneuver damage and erosion. Record each location and estimate costs associated with rehabilitation.	RTLA	$15,903.60
Camp Ripley Project 18	2022	Assessment 6: Land Navigation Area	Stabilize soil and enhance native vegetation on and around 8 OP's annually. Apply gravel and suitable materials as needed to OP's.	RTLA	$8,009.60
Camp Ripley Project 19	2022	Assessment 9: Landing/Pickup Zones	Annual assessment of vegetation and maneuver damage surrounding 14 landing/pickup zones on 21.6 acres for woody vegetation, both encroaching from the edge and creating hazards within the training areas.	RTLA	$1,922.55
Camp Ripley Project 20	2022	Repair: Artillery Firing Points	Improve 10 firing points of 18 sites (Set C) defined by the 2018 assessment by reducing woody encroachment into the grassland, promoting native grasses, reducing underbrush in surrounding forest and improving trail	LRAM	$70,241.00
Camp Ripley Project 21	2022	Reconfigure: Forest Understory	Improve forest understory on 123 acres of training lands. Management will occur within Training Areas 16, 24, 25, 26, 27 and 35.	LRAM	$41,761.50
Camp Ripley Project 22	2022	Repair: Maneuver Trails	Repair sites identified in 2016 Assessment 1 for 71 miles of maneuver trails on the north end of Camp Ripley. Approximately 100 sites totaling approximately 7 acres in size to be repaired.	LRAM	$101,694.50

Camp Ripley Project 23	2022	Repair: Open Maneuver Areas	Repair 2 sites totaling approximately 65 acres of maneuver damage caused by military training.	LRAM	$43,059.80
Camp Ripley Project 24	2022	Maintain: Maneuver Corridor	Maintain 30km of maneuver lanes in maneuver area K1. Management of lanes includes establishment of native grasses and woody encroachment to maintain a 300m width.	LRAM	$49,357.10
Camp Ripley Project 25	2022	Repair: Hazardous Artifacts	Repair 4 hazardous artifacts or training safety hazards discovered in FY16 Assessment 7. 2 tank fighting positions and 2 historic tank ditches need to be filled in.	LRAM	$8,387.60
Camp Ripley Project 26	2022	Repair: Land Navigation Area	Reduce training hazards (i.e. snags) reported during the RTLA assessment in land navigation course B-5 encompassing 223 acres.	LRAM	$13,030.80
Camp Ripley Project 27	2022	Maintain: Observation Points	Stabilize soil and enhance native vegetation on and around 8 OP's annually.	LRAM	$6,840.80
Camp Ripley Project 28	2022	Expand Firing Point 2588 in TA 3	20 acre expansion of firing point to include stumping, grubbing, leveling, seeding and erosion control	LRAM	$45,184.10
Camp Ripley Project 29	2022	Improve Maneuver Trail Network in TA 1	Install 1.33 miles of new maneuver trail, reclaim and restore 0.65 miles of existing maneuver trail back to native grassland expanding firing point 2471 by 111 acres.	LRAM	$104,307.00
Camp Ripley Project 30	2022	Improve Maneuver Trail Network in TA 14	Install 0.07 miles of new maneuver trail, reclaim and restore 0.15 miles of existing maneuver trail back to native grassland.	LRAM	$17,499.40
Camp Ripley Project 31	2022	Maintain LZ/PZ	Repair maneuver damage and maintain native vegetation from woody encroachment surrounding 14 LZ/PZ on 21.6 acres	LRAM	$3,008.15
Cyclic Purchase	2022	CAT COMPACTER	Replace existing compacter that has reached lifespan	LRAM	$116,005.00
Cyclic Purchase	2022	TIMBERWOLF TREE SHEAR	Replace existing tree shear that has reached lifespan	LRAM	$8,990.00
Cyclic Purchase	2022	3/4 TON FORD F-350 4X4 PICKUP	Replace existing vehicle that has reached lifespan	LRAM	$35,000.00
					$938,674.30

Chapter 5: ITAM Equipment

Table 22: ITAM Equipment Master List

ITAM Equipment				
Name of ITAM Equipment	**Purchase Year**	**Cost**	**Original Replacement Year**	**Proposed Replacement Year**
POLARIS ATV 500	6/11/2001	$7,668.00	2005	0
JD 5 BOTTOM PLOW	7/29/1998	$10,900.00	2008	0
POLARIS ATV SPORTSMAN 6X6	10/7/2004	$6,750.00	2008	0
POLARIS ATV SPORTSMAN 6X6	10/7/2004	$6,750.00	2008	0
FIRE FIGHTING SLIP-ON 300 GALLON	5/6/2002	$9,660.00	2010	0
FIRE FIGHTING SLIP-ON 250 GALLON (DPW)	12/19/2003	$9,875.00	2013	0
TRUCK TREE PLANTER T-50 WITH INTERNATIONAL TRUCK	6/8/2004	$61,750.00	2014	0
FIRE FIGHTING SLIP-ON UNIT	10/31/2005	$6,650.00	2015	0
GRAVEL SCREENING PLANT	9/14/2006	$67,000.00	2016	0
TRIMBLE GEOXT 6000 SERIES	1/1/2011	$5,200.00	2016	0
STACKING CONVEYOR	9/30/2007	$42,142.00	2017	0
STACKING CONVEYOR	9/30/2007	$42,142.00	2017	0
TOOL BOX AND TOOL SET	10/15/2004	$1,886.00	2019	0
INGERSOL RAND AIR COMPRESSOR	8/1/2009		2019	0
BENCH VISE	8/1/2009		2019	0
SAFETY CABINET	8/1/2009	$1,000.00	2019	0
GEOTRAX 6000 GPS			2020	0
GEOTRAX 6000 GPS			2020	0
RINO 530HCX GPS			2020	0
GARMIN 78S GPS	9/13/2013	$311.49	2023	0
GARMIN 78S GPS	9/13/2013	$311.49	2023	0
GARMIN 78S GPS	9/13/2013	$311.49	2023	0
SNAP ON TOOLS AND BOX	3/15/2007	$17,973.00	2022	0
JAM FOREST ROTO STUMPER	9/17/2012	$50,126.00	2022	0
MILWAUKEE 18VOLT GREASE GUN	8/2/2013	$329.00	2023	0
BATTERY CHARGER AND JUMP STARTER	5/28/2014	$478.46	2024	0
BRILLION P-10 PULVERIZER, SINGLE GANG	9/13/2000	$13,600.00	2010	0
ARCTICCAT SNOWMOBILE			2015	0
ARCTICCAT SNOWMOBILE			2015	0
TRASH PUMP			2010	0
TERRA TORCH			2015	0
KNACK TOOL BOX			2020	0
KNACK TOOL BOX			2020	0
MAX PRO CHAINSAW SHARPENER	9/1/2014	$359.00	2024	0
STIHL LEAF BLOWER		$1,000.00	2017	0
SAFETY CABINET	2/1/2017	$1,000.00	2027	0

CYCLIC COST		$365,172.93		

CAT 247B SKIDSTEER WITH ATTACHMENT	3/16/2004	$80,000.00	2014	2018
OVER SEEDER LANDPRIDE 72" WITH ROLLER	9/25/2000	$6,980.00	2004	2018
BRUSHHOG MOWER SERIES 286	9/11/2002	$2,790.00	2006	2018
BRUSHHOG MOWER SERIES 286	9/11/2002	$2,790.00	2006	2018
BRUSHHOG MOWER SERIES 306	9/11/2002	$2,200.00	2006	2018
TRUAX DRILL GRASS SEEDER	9/26/1997	$13,010.00	2007	2018
BANDIT CHIPPER MODEL 90W	11/30/2004	$15,015.00	2008	2018
CYCLIC COST		$122,785.00		

DIAMOND CUTTER BRUSHMOWER	10/10/2005	$20,000.00	2009	2019
3/4 TON 2500 CHEVY SILVERADO PICKUP 4X4	9/30/2009	$30,000.00	2017	2019
3/4 TON 2500 CHEVY SILVERADO PICKUP 4X4	9/30/2009	$30,000.00	2017	2019
FUEL TRAILER	NEW	$28,000.00	NEW	2019
CYCLIC COST		$108,000.00		

RICHO CAMERA	9/13/2013	$4,750.00	2018	2020
RICHO CAMERA	9/13/2013	$4,750.00	2018	2020
GARMIN 76CX GPS	9/4/2013	$480.00	2018	2020
GARMIN 76CX GPS	9/4/2013	$480.00	2018	2020
GARMIN 76CX GPS	9/4/2013	$480.00	2018	2020
GARMIN III PLUS GPS	9/4/2013	$480.00	2018	2020
MOTOROLA XTS2500 RADIO	7/10/2013	$2,417.79	2018	2020
MOTOROLA XTS2500 RADIO	7/10/2013	$2,417.79	2018	2020
MOTOROLA XTS2500 RADIO	7/10/2013	$2,417.79	2018	2020
MOTOROLA XTS2500 RADIO	7/10/2013	$2,417.79	2018	2020
MOTOROLA XTS2500 RADIO	7/10/2013	$2,417.79	2018	2020
320 CAT EXCAVATOR	8/20/2004	$246,296.00	2014	2020
SKIDSTEER 84" GRAPPLE RAKE	9/1/2009	$3,240.00	2020	2020
SKIDSTEER 84" MATERIAL BUCKET	9/1/2009	$1,230.00	2020	2020
ALUMA UTILITY TRAILER FOR ATV'S	12/20/2004	$4,430.00	2014	2020
POLARIS SPORTSMAN 500 4X4 ATV	5/23/2012	$5,699.00	2020	2020
POLARIS RANGER 800 6X6 UTV	5/23/2012	$12,700.00	2020	2020
JOHN DEERE GATOR ATV	9/15/2005	$10,695.00	2015	2020
WOODS BATWING MOWER	9/16/2013	$23,979.60	2023	2020
CYCLIC COST		$331,778.55		

CAT 279C SKIDSTEER WITH ATTACHMENT	8/20/2009	$80,213.00	2019	2021
MASSEY FERGUSON 1540 TRACTOR	2/21/2008	$14,183.00	2016	2021
MF 1415 ROTARY BRUSH	2/21/2008	$2,545.00	2012	2021

MF 66" SKIDSTEER BUCKET	2/21/2008	$682.00	2016	2021
MF 72" SKIDSTEER BUCKET	2/21/2008	$1,378.00	2014	2021
MF 63" ROTARY TILLER	2/21/2008	$2,169.00	2014	2021
STIHL BRUSHSAW FS 110	5/14/2009	$400.00	2014	2021
STIHL BRUSHSAW FS 110	5/14/2009	$400.00	2014	2021
STIHL CHAINSAW MS361	1/1/2009	$729.00	2014	2021
STIHL CHAINSAW MS361	1/1/2009	$729.00	2014	2021
STIHL CHAINSAW MS361	1/1/2009	$729.00	2014	2021
TANDEM FLATBED TRAILER	7/18/2007	$3,216.00	2017	2021
STIHL CHAINSAW MS 441	8/24/2012	$849.00	2017	2021
STIHL CHAINSAW MS 441	8/24/2012	$849.00	2020	2021
FAST BOOM SPRAYER UT3P	11/8/2013	$4,347.75	2021	2021
BATWING JOHN DEERE MOWER 20FT	12/3/2003	$19,434.00	2013	2021
LASER RANGE FINDER TACTICAL KIT	9/16/2013	$4,750.00	2018	2021
CYCLIC COST		$137,602.75		

CAT COMPACTER	5/9/2007	$116,005.00	2017	2022
TIMBERWOLF TREE SHEAR	5/7/2009	$8,990.00	2018	2022
1 TON FORD F-350 4X4 PICKUP (RED)	4/19/2012	$35,000.00	2022	2022
CYCLIC COST		$159,995.00		

CAT 930H FRONT END LOADER	11/23/2009	$128,000.00	2019	2023
FAST 250 GALLON BOOMLESS SPRAYER	7/26/2010	$6,200.00	2018	2023
ALUMA TRAILER 8X13 W/ SIDE LOAD	10/4/2013	$4,453.48	2023	2023
FELLING TRAILER FT-16 DECK TILT	10/4/2012	$10,254.00	2023	2023
FRONTIER TILLAGE DISKER	9/16/2013	$34,021.00	2023	2023
CYCLIC COST		$182,928.48		

25' FELLING GOOSENECK TRAILER	6/16/2008	$6,570.00	2024	2024
WOODWARD FLAIL VAC SEED STRIPPER	9/8/2014	$15,815.00	2024	2024
FINN T-90 HYDRO SEEDER	9/8/2014	$45,685.00	2024	2024
JOHN DEERE LOADER H360	9/8/2014	$9,200.00	2024	2024
FORD F-550 4X4 CREW CAB WITH FLATBED	11/6/2014	$44,693.59	2024	2024
CYCLIC COST		$121,963.59		

BELLY DUMP TRAILER	8/17/2015	$43,614.15	2025	2025
BATWING MOWER - WOODS SINGLE 10.5' CUT	5/19/2015	$13,646.00	2025	2025
ROLLER PNEU TIRED PULL TYPE	2/1/2000	$16,300.00	2010	2025
TOWMASTER TRAILER 120	9/23/2005	$4,820.00	2015	2025
TOWMASTER TRAILER T5	9/23/2005	$3,770.00	2015	2025
TOWMASTER TRAILER T5	9/23/2005	$3,770.00	2015	2025

TOWMASTER TRAILER T5	9/23/2005	$3,770.00	2015	2025
TOWMASTER TRAILER 12,000 POUND WITH BEAVER TAIL	2/7/2006	$4,876.00	2016	2025
TRAILKINGLOWBOY TRAILER TK 110	11/21/2007	$64,008.00	2017	2025
TRAILKING LOWBOY TRAILER	11/23/2009	$82,823.00	2019	2025
CYCLIC COST		$241,397.15		

CAT 297D2 XHP	3/24/2016	$84,359.00	2026	2026
JOHN DEERE TRACTOR 6155R	10/1/2016	$148,900.00	2026	2026
DOZER FINISH JD 650	9/22/2003	$86,488.00	2013	2026
CYCLIC COST		$319,747.00		

FIMCO 65 GALLON BOOM SPRAYER	9/6/2017	$622.00	2027	2027
FIMCO 65 GALLON BOOM SPRAYER	9/6/2017	$622.00	2027	2027
FIMCO 65 GALLON BOOM SPRAYER	9/6/2017	$622.00	2027	2027
SEPPI CARBIDE HEAD	5/13/2016	$26,500.00	2026	2027
1 TON F-350 PICK-UP, 4X4 (CARIBOU METALLIC)	10/1/2017	$39,631.00	2027	2027
SEMI-TRACTOR	8/23/2006	$72,838.00	2014	2027
CYCLIC COST		$140,835.00		

3/4 TON F-250 PICK-UP, 4X4 (METALLIC GRAY)	10/1/2017	$27,213.00	2027	2028
1 TON F-350 PICK-UP, 4X4 (METALLIC GRAY)	10/1/2017	$39,631.00	2027	2028
JOHN DEERE TRACTOR 7230	9/1/2009	$84,987.00	2019	2028
CYCLIC COST		$151,831.00		

VERMEER STUMP GRINDER	5/24/2017	$45,125.00	2027	2029
FELLING 16 IT-1 DROP DECK TILT TRAILER	9/7/2017	$2,062.00	2027	2029
CASE CX55B MINI EXCAVATOR	9/2/2016	$70,968.00	2026	2029
FAST UT3P BOOMSPRAYER	9/1/2016	$5,548.68	2026	2029
FELLING FT-40-2 LP TRAILER	7/27/2016	$20,184.60	2026	2029
CYCLIC COST		$143,888.28		

Chapter 6: Back Log Requirements

Back log requirements consist of projects that are not included in the fiscal year expense report and projects that exceed ITAM funding requirements. These are projects that have been set aside due to inadequate funding in previous years and exceed the installations ability to accomplish in a single year.

Maneuver Corridor Expansion

The maneuver corridor on Camp Ripley is intended to provide space for platoon level mechanized maneuver in the K-1 maneuver area. The corridor will connect existing open areas and allow force-on-force maneuvers from assembly areas to an objective.

The method used for developing the lanes is a multi-year project. Initially potential corridors were mapped with GIS using 30m digital elevation models to avoid areas of 20% or greater slope. Each year, approximately 75 acres of corridor are field survived and marked using a Trimble GeoXT with ArcPad software installed. The initial two years of markings confirmed the legitimacy of the ArcMap analysis as the actual marked corridors came within 5% of the initial mapped areas. Each corridor section then is placed in the Minnesota Department of Natural Resources (MN DNR) list of timber sales. To minimize aspen regeneration, the harvest is conducted during the summer months.

Timber auctions are held in the fall with the actual harvest happening the following summer. The summer following the sale is when the ground work is conducted. Site preparation includes the removal of all stumps within maneuver lane.

Trees 6 inches in diameter or greater must be protected and left standing. Only the portion of the stump above ground level and the portion up to 12 inches below ground level are to be removed. There should be an effort to retain the stump material and root system below ground to maintain soil stability and avoid potential erosion. The debris may be ground or pulverized and spread out evenly across the ground surface of the maneuver lane as long as the ground or pulverized material does not exceed 1 inch in depth.

Cleared areas to be treated to control weeds and grasses by applying a glyphosate herbicide. Application rates are to be followed per the manufacturer’s directions. Allow a minimum of fourteen (14) days before disturbing the vegetation with other procedures. A complete kill (burn-down) of weeds and scrub must be made prior to seed bed preparation.

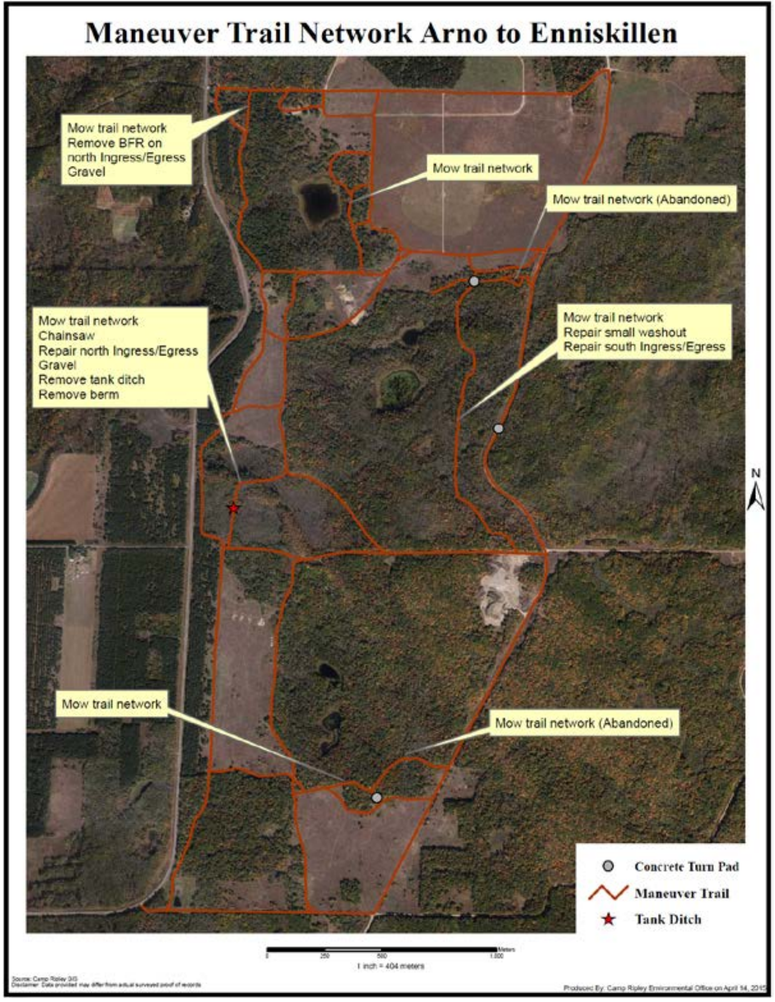
Holes, depressions and rivulets shall be filled in and brought to a smooth finish grade. Do not plant on land that does not have a properly prepared seed bed in accordance with these specifications. Remove stones and clumps over 1 inch diameter which will interfere with the seeding. Methods include hand-raking, mechanical dragging and leveling.

Sow seed with seeding machine, broadcast type, with an interseeding attachment specially designed for seeding native prairie seed species. Broadcast seed uniformly to an average depth of ¼ inch.

The initial corridor was completed 2009. A second corridor was sighted in 2009 and was completed the summer of 2010. Most recently, another corridor was completed in 2014. Additional lanes are proposed pending usage and feedback on completed maneuver corridor. Maintain and establish native prairie by weeding, mowing, trimming, re-planting, and performing other operations as required to establish a healthy, viable native prairie.

Annual maintenance will include hand-weeding once every 60 days for the first year of the prairie growth cycle. Chemical treatment of broadleaf herbicide is utilized on large areas as necessary to control weeds. Prairie plants lost due to erroneous weeding, spraying, or training damage will be replaced. Undesirable woody vegetation and encroachment will be removed by best management practices. Figure 20 shows the anticipated expansion of the Maneuver Corridor to support troop requests.

Figure 20: Maneuver Corridor Project



Source: Camp Ripley GIS
Disclaimer: Data provided may differ from actual surveyed proof of records

Produced By: Camp Ripley Environmental Office on April 14, 2015

Chapter 7: Total Cost by Fiscal Year

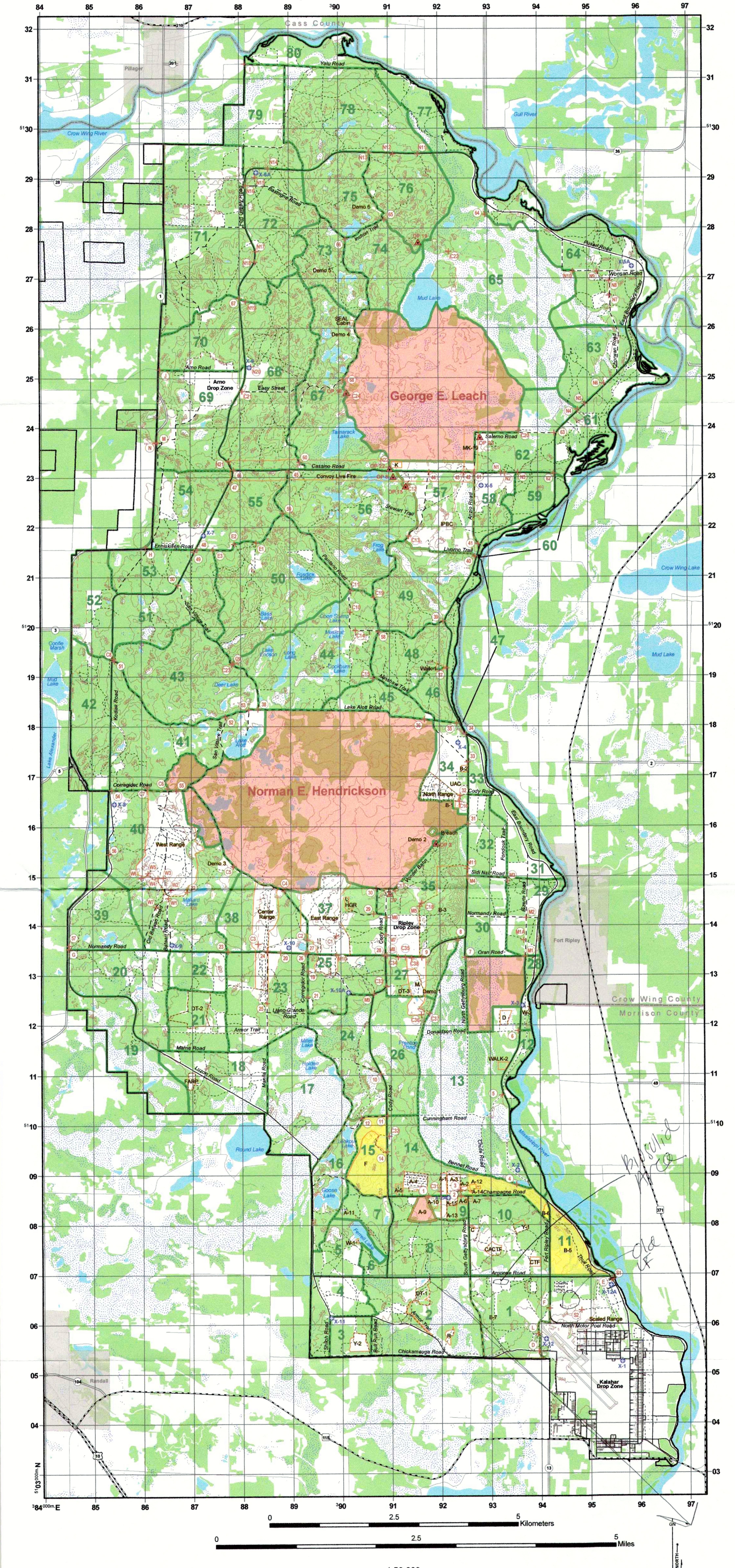
Below is a five-year summary budget table that parallels the budget, showing a roll-up for each Fiscal Year by component and for the complete five years by component (Table 23).

Table 23: Total Cost by Fiscal Year

Fiscal Year	RTLA	LRAM	TRI	SRA	GIS	Total
Budget Year 2018:	$142,470.25	$626,759.60	$26,417.60	$15,206.80	$31,168.02	**$842,022.27**
Budget Year 2019:	$115,298.55	$670,347.75	$30,085.80	$19,711.20	$51,236.00	**$886,679.30**
Budget Year 2020:	$115,298.55	$894,526.30	$30,085.80	$19,711.20	$51,236.00	**$1,110,857.85**
Budget Year 2021:	$115,298.55	$699,950.50	$30,085.80	$19,711.20	$51,236.00	**$916,282.05**
Budget Year 2022:	$115,298.55	$722,342.75	$30,085.80	$19,711.20	$51,236.00	**$938,674.30**
Total:	**$603,664.45**	**$3,613,926.90**	**$146,760.80**	**$94,051.60**	**$146,760.80**	**$4,694,515.77**

DRAFT

Camp Ripley Military Installation
Second Edition - January 2007
(320)-616-3137

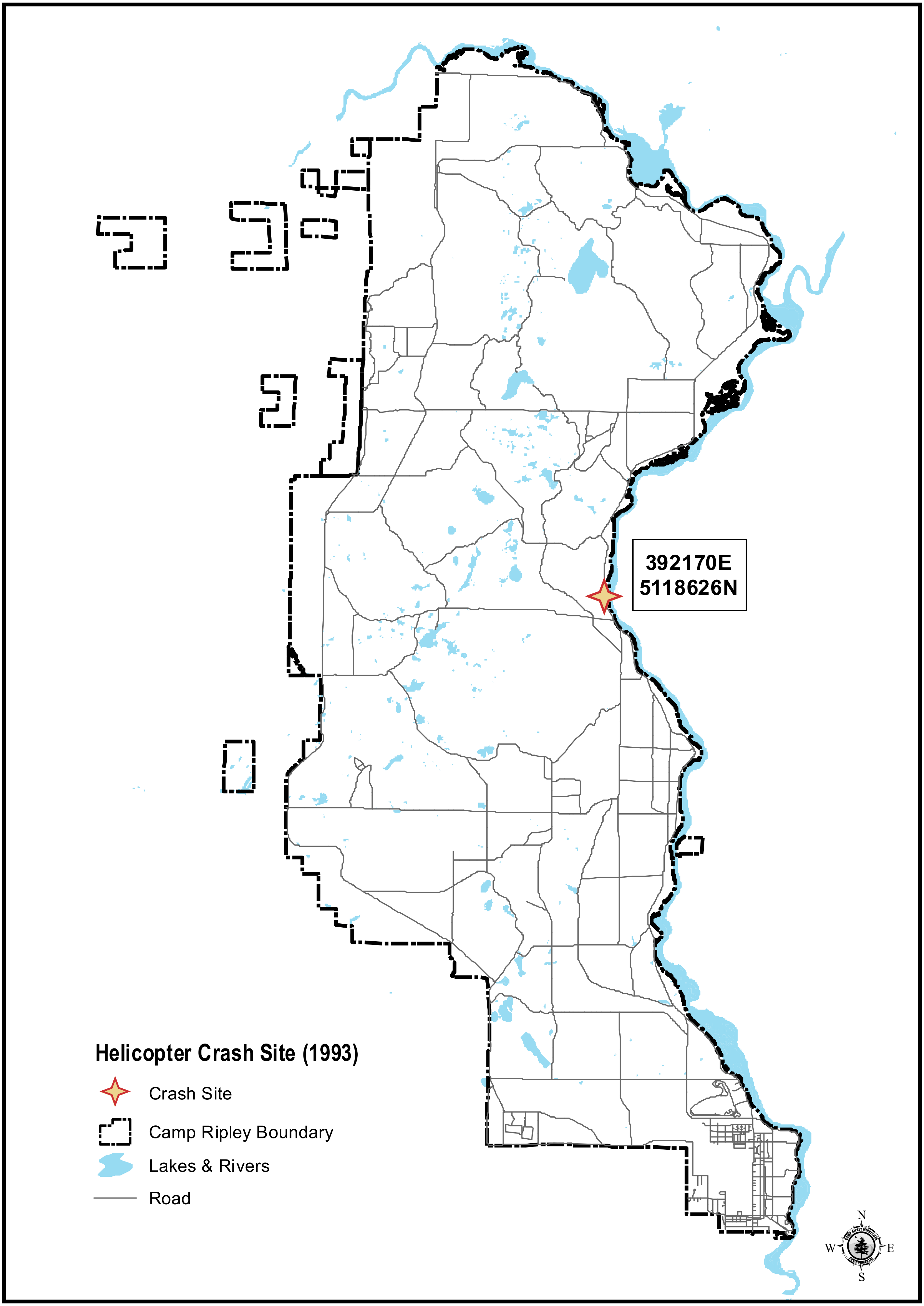


1:50,000

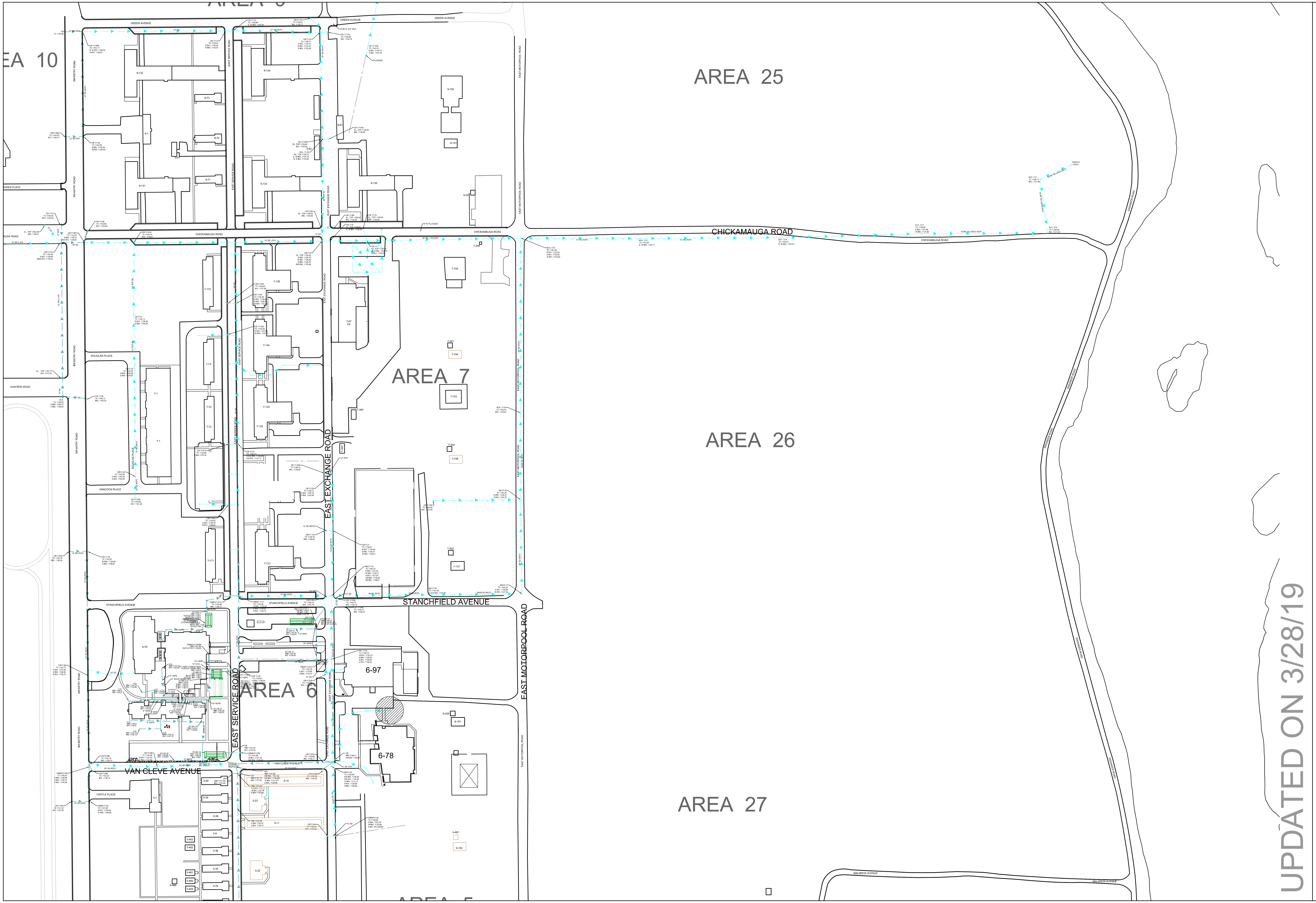
Index to Military Ranges

A-1	Small Arms Known Distance Range (100-1000 yds) and a 25 meter Zero Line with 30 Firing Points (FP)
A-2	Combat Pistol Qualification Range (CPQR), 15 FP
A-3	Automatic Record Fire (ARF) Range, 16 FP
A-4	Automated Field Fire (AFF) Range, 16 FP
A-5	Military Operations on Urbanized Terrain (MOUT) Assault Course, 7 Stations (MILES only)
A-6	Confidence Obstacle Site, 23 Stations
A-7	Rappel Tower and Practice Tower
A-9	M203/M79 Grenade Launcher Range, TP rounds ONLY, 5 FP
A-10	Hand Grenade Qualification Course and Practice Lane (Practice Grenades ONLY)
A-11	Ferrell Lake Navigation Course
A-12	25 meter Zero Range, 30 FP
A-13	EFMB Litter Obstacle Course
A-14	Live Fire Facility (Shoot House)
A-15	Field Leader Reaction Course
ARNO DZ	Air Drop Zone
B-1	25 meter Zero Range, 30 FP
B-2	25 meter Zero Range, 30 FP
B-3	Gettysburg Road Land Navigation Course
B-4	Mounted Land Navigation Course
B-5	Land Navigation Course
B-6	Engineer Dig Site
B-7	Land Navigation Course
BENNET HILL	3 Ski Runs/1 Tubing Run with Tow Rope
BREACH	Live-Fire Exercise Breach Facility
C	NBC Course
CACTF	Combined Arms Collective Training Facility (MOUT)
CENTER (CRG)	MPTR – Tank and BFV Qualification Tables I-V, Machine Gun Qualification, and TOW Missile (Inert Rounds)
CLFX	Convoy Live Fire Exercise
CTF	Collective Training Facility (MOUT)
D	LAW / AT4 Sub-caliber Range, 6 FP
DEMO-1	M Range Demolitions Site
DEMO-2	OP-2 Demolitions Site
DEMO-3	Demolitions Site
DEMO-4	SEAL CABIN Demolitions Site
DEMO-5	TA 73 Demolitions Site
DEMO-6	TA 75 Demolitions Site
DT-1	Tracked Vehicle Driver Training Course
DT-2	Tracked Vehicle Driver Training Course
DT-3	Tracked Vehicle Driver Training Course
EAST (ERG)	Multi-Purpose Training Range (MPTR) - Tank and BFV Qualification Tables I-XII (4 maneuver lanes), Machine Gun Familiarization/Transition (2 FP), Aerial Gunnery Range
F	Biathlon Course, 31FP; 25 meter Zero Range, 29 FP; Forward Operating Base (FOB)
FARP	Forward Area Refueling Point
HGR	Hand Grenade Range (Live Grenade Familiarization)
IPBC	Infantry Platoon Battle Course
J	Multi-Purpose Field Fire Range (200m Firing Line)
K	Dragon, TOW, Javelin Missile Range, 2 FP
L	Engineer Demolition Range
M	Mortar Short Range Training Round (SRTR) Range, 2 FP
MK-19	MK-19 Multi-Purpose Gunnery Range (**40 mm TP ONLY**)
NORTH (NRG)	Machine Gun Multi-Purpose Range (MPR), 8 Lanes (2 Lanes with 1000 meter targets); Targets can only be placed on "BOB".
OP-7	MK-19 40 mm HE
R	Vehicle Recovery Site
RIPLEY DZ	Air Drop Zone
SEAL Cabin	Combat Outpost
Scaled Range	Scaled Vehicle Mounted Weapon Systems Course
UAC	Urban Assault Course
W-1	Ferrell Lake Pontoon Bridge Site
W-2	Mississippi River Ribbon Bridge Site
WALK-1	Individual/Buddy Team Movement Live Fire Lane (I/BTM)
WALK-2	I/BTM Live Fire Lane
WEST (WRG)	MPTR – Tank and BFV qualification Tables I-VIII (4 maneuver lanes), Machine Gun Familiarization/Transition (2FP), MLRS
Y-1	POW Camp/Forward Operating Base
Y-2	POW Camp/Forward Operating Base

⊕	Helipad
+	Barriers
▲	Observation Point
—	Contour - 10 Meter Interval
○	Range
○	Training Area
🟥	Restricted Area
●	Building or Structure
🟨	Winter Training Area
○	Camp Ripley Boundary
⁘	Wetland
🟩	Woodlands
🟦	Lake or River
●	Municipality
○	County Boundary
—•—	US or State Highway
═	County State Aid Highway
-----	Trail
- - -	Fire break
—	Secondary all weather, hard surface road
– – –	Fair or dry weather, unimproved surface road
—	Light duty, all weather, hard or improved surface road



Helicopter Crash Site (1993)



UPDATED ON 3/28/19

STATE OF MINNESOTA
DEPARTMENT OF MILITARY AFFAIRS
FACILITIES MANAGEMENT OFFICE
15000 HWY 115
LITTLE FALLS, MN 56345
320.616.2604 FAX 320.632.7473

NATURAL GAS - UNVERIFIED
NATURAL GAS
NATURAL GAS - ABANDONED
SANITARY WASTE - UNVERIFIED
SANITARY WASTE
SANITARY WASTE - ABANDONED
STORM DRAIN - UNVERIFIED
STORM DRAIN
STORM DRAIN - ABANDONED

DOMESTIC WATER - UNVERIFIED
DOMESTIC WATER
DOMESTIC WATER - ABANDONED
UG ELECTRIC - UNVERIFIED
UG ELECTRIC
UG ELECTRIC - ABANDONED
OVERHD ELECTRIC - UNVERIFIED
OVERHD ELECTRIC

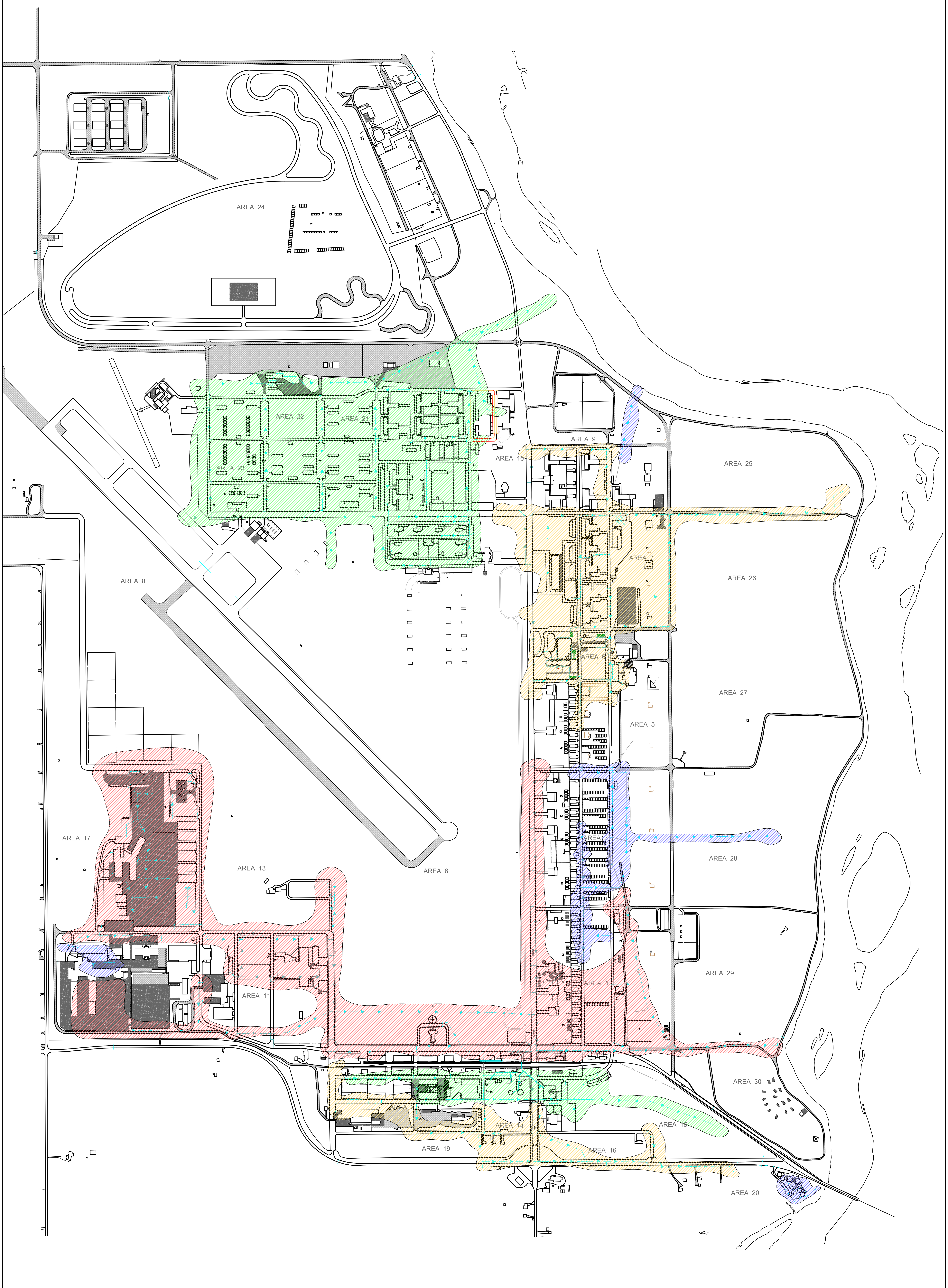
N

SCALE 1" = 150'

CANTONMENT UTILITY MAP
MN ARNG, CAMP RIPLEY
15000 HIGHWAY 115 LITTLE FALLS, MINNESOTA

CANTONEMENT STORM WATER ZONE LAYOUT

SHEET NUMBER
SW-2



UPDATED ON 3/28/19

CANTONMENT UTILITY MAP
MN ARNG, CAMP RIPLEY
15000 HIGHWAY 115 LITTLE FALLS, MINNESOTA

CANTONEMENT STORM WATER ZONE LAYOUT

SHEET NUMBER
SW-1

N
SCALE 1" = 500'

DOMESTIC WATER - UNVERIFIED
DOMESTIC WATER
DOMESTIC WATER - ABANDONED
UG ELECTRIC - UNVERIFIED
UG ELECTRIC
UG ELECTRIC - ABANDONED
OVERHD ELECTRIC - UNVERIFIED
OVERHD ELECTRIC

NATURAL GAS - UNVERIFIED
NATURAL GAS
NATURAL GAS - ABANDONED
SANITARY WASTE - UNVERIFIED
SANITARY WASTE
SANITARY WASTE - ABANDONED
STORM DRAIN - UNVERIFIED
STORM DRAIN
STORM DRAIN - ABANDONED

STATE OF MINNESOTA
DEPARTMENT OF MILITARY AFFAIRS
FACILITIES MANAGEMENT OFFICE
15000 HWY 115
LITTLE FALLS, MN 56345
320.616.2604 FAX 320.632.7473

Appendix B
Preliminary Assessment Documentation

Appendix B.1
Interview Records

PA Interview Questionnaire - Other

Facility: Camp Ripley
Interviewer: [redacted]
Date/Time: 9/26/2018; 14:00

Interviewee: [redacted] **Title: USPFO** **Phone Number:** [redacted] **Email:** [redacted]	Can your name/role be used in the PA Report? [✓ Y] or N Can you recommend anyone we can interview? [✓ Y] or N CMA

Roles or activities with the Facility/Years working at the Facility:

[redacted] works in the USPFO warehouse.

PFAS Use: Identify accidental/intentional release locations, time frame of release, frequency of releases, storage container size (maintenance, fire training, firefighting, buildings with suppression systems (as builts), fueling stations, crash sites, pest management, recreational, dining facilities, metals plating, or waterproofing). How are materials ordered/purchased/disposed/shared with others?

Fire equipment including TriMax fire extinguishers are sent to the USPFO warehouse to discarded as property. Due to the contents of the Tri-Max fire extinguishers being under pressure, they are assigned a DEMIL Code F. This means the equipment must be physically destroyed in some manner by the CMA prior to the item being sent out through DLA, and the USPFO equipment specialist must furnish special DEMIL instructions regarding the degree of physical destruction. At Camp Ripley, the USPFO instructs the CMA to depressurize the system, cut the tops off of the tanks, cut the tanks in half, punch a hole in the bottom of the tanks, and recycle the rubber hoses. However, no instructions are given as to how to dispose of the contents of the tanks if they are full. The mechanics at the CMA indicated AFFF has been dispensed onto the ground outside prior to demilitarization of the TriMax 30 fire extinguishers. The seven TriMax 30 fire extinguishers from the St. Cloud AASF are currently sitting in the USPFO warehouse awaiting demilitarization.	**Known Uses** Use Procurement Disposition Storage (Mixed) Storage (Solution) Inventory, Off-Spec Containment SOP on Filling Leaking Vehicles Nozzle and Suppression System Testing Dining Facilities Vehicle Washing Ramp Washing Fuel Spill Washing and Fueling Stations Chrome Plating or Waterproofing

PA Interview Questionnaire – Fire Station

Facility: Camp Ripley
Interviewer: [redacted]
Date/Time: 9/26/2018; 13:00

Interviewee: Camp Ripley Fire and Emergency Services personnel **Title:** See sign-in sheet **Phone Number:** See sign-in sheet **Email: N/A**	Can your name/role be used in the PA Report? [✓ Y] or N Can you recommend anyone we can interview? Y or [✓ N]

1. Roles or activities with the Facility/years working at the Facility.
In 2007, Camp Ripley Fire and Emergency Services was established with [redacted] and now responds to all fire emergencies on-Post.

2. What can you tell us about the history of AFFF at the Facility? Was it used for any of the following activities, circle all that apply and indicate years of active use, if known? Identify these locations on a facility map. None known

   Maintenance (e.g., ramp washing) – None; no nozzle testing at the facility
   Fire Training Areas – Burn Pit FTA
   Firefighting (Active Fire) - None
   Crash – 13 March 1993; no fire
   Fire Suppression Systems (Hangers/Dining Facilities) - none
   Fire Protection at Fueling Stations – none
   Non-Technical/Recreational/ Pest Management - none

3. Are any current buildings constructed with AFFF dispensing systems or fire suppression systems? What are the AFFF/suppression system test requirements? What is the frequency of testing at the AFFF/suppression systems? No suppression systems

4. Are fire suppression systems currently charged with AFFF or have they been retrofitted for use of high expansion foam? N/A

5. How is AFFF procured? Do you have an inventory/procurement system that tracks use?
AFFF procured by the State Warehouse.

6. What type of AFFF has been/is being used (3%, 6%, Mil Spec Mil-F-24385, High Expansion)? Manufacturer (3M, Dupont, Ansul, National Foam, Angus, Chemguard, Buckeye, Fire Service Plus)?
ChemGuard 363 3 percent x 6 percent, AR-AFFF

7. Is AFFF formulated on base? If so, where is the solution mixed, contained, transferred, etc.?
No

8. Where is the AFFF stored? How is it stored (tanks, 55-gallon drums, 5-gallon buckets)? What size are the storage tanks? Is the AFFF stored as a mixed solution (3% or 6%) or concentrated material?
AFFF stored at the State Warehouse (Building 2-223)

9. How is the AFFF transferred to emergency response vehicles, suppression systems, flightline extinguishers? Is/was there a specified area on the facility where vehicles are filled with AFFF and does this area have secondary containment in case of spills? How and where are vehicles storing AFFF cleaned/decontaminated? Transfer done at the Fire House using a pump

10. Provide a list of vehicles that carried AFFF, now and in the past, and where are/were they located? Three fire trucks and three ATVs currently. Historically, 2 different trucks at Building 2-203 and one truck at Building 8-195.

11. Any vehicles have a history of leaking AFFF? Do you/did you test the vehicles spray patterns to make sure equipment is working properly? How often are/were these spray tests performed and can you provide the locations of these tests, now and in the past? No

12. How many FTAs are/were on this facility and where are they? Locate on a map. How many FTAs are active and inactive? For inactive FTAs, when was the last time that fire training using AFFF was conducted at them? Three FTAs identified – TriMax Emptying, Burn Pit FTA, DHS Demonstration Area

PA Interview Questionnaire – Fire Station

Facility: Camp Ripley
Interviewer: [redacted]
Date/Time: 9/26/2018; 13:00

13. What types of fuels/flammables were used at the FTAs? Fuels, solvents

14. What was the frequency of AFFF use at each location? When a release of AFFF occurs during a fire training exercise, now and in the past, how is/was the AFFF cleaned and disposed of? Were retention ponds built to store discharged AFFF? Was the AFFF trickled to the sanitary sewer or left in the pond to infiltrate?

Most releases were one-time events. The Burn Pit FTA may have been used on multiple occasions.

15. Are there mutual aid/use agreements between county, city, local fire department? Please list, even if informal. If formalized, may we have a copy of the agreement? Can you recall specific times when city, county, state personnel came on-post for training? If so, please state which state/county agency, military entity? Do you have any records, including photographs to share with us?

The Cuyuna Agreement with the Range Fire Chiefs Association and Camp Ripley allows the communities surrounding Camp Ripley to take AFFF from the post in the event of an emergency. This has happened three times:

16. Did individual units come on-post with their own safety personnel, did they also bring their own AFFF? Was training with AFFF part of these exercises? How were emergencies handled under these circumstances? Municipalities were present during the DHS demonstration. AFFF provided by Camp Ripley.

17. Did military routinely or occasionally fire train off-post? List units that you can recall used/trained at various areas. No

18. Are there specific emergency response incident reports (i.e., aircraft or vehicle crash sites and fires)? If so, may we please copy these reports? Who (entity) was the responder? No

19. Do you have records of fuel spill logs? Was it common practice to wash away fuel spills with AFFF? Is/was AFFF used as a precaution in response to fuel releases or emergency runway landings to prevent fires? No

20. Was AFFF used for forest fires or fire management on-post/off-post? If so, please describe what happened and who was involved? No

21. Can you provide any other locations where AFFF has been stored, released, or used (i.e. hangars, buildings, fire stations, firefighting equipment testing and maintenance areas, emergency response sites, storm water/surface water, waste water treatment plants, and AFFF ponds)?

Building 2-166, Building 2-272, Building 8-195, USPFO Warehouse

22. Are you aware of any other creative uses of AFFF? If so, how was AFFF used? What entities were involved? No

23. How is off-spec AFFF disposed (used for training, turned in, or given to a local Fire Station)? If applicable, do you know the name of the vendor that removes off-spec AFFF? Do you have copies of the manifest or B/L? N/A

24. Do you recommend anyone else we can interview? If so, do you have contact information for them? No

PA Interview Questionnaire - Other

Facility: Camp Ripley
Interviewer: [redacted]
Date/Time: 9/26/2018; 08:00

Interviewee: [redacted]
Title: RFMSS
Phone Number: [redacted]
Email: [redacted]

Can your name/role be used in the PA Report? [✓ Y] or N

Can you recommend anyone we can interview?

[✓ Y] or N

Central Lakes College
Fire/EMS Program
501 W College Dr
Brainerd, MN 56401

[redacted]

Roles or activities with the Facility/Years working at the Facility:

[redacted] is from RFMSS.

PFAS Use: Identify accidental/intentional release locations, time frame of release, frequency of releases, storage container size (maintenance, fire training, firefighting, buildings with suppression systems (as builts), fueling stations, crash sites, pest management, recreational, dining facilities, metals plating, or waterproofing). How are materials ordered/purchased/disposed/shared with others?

Fire training by Camp Ripley Fire and Emergency Services and Central Lakes College has occurred on the ranges; however, all fire training by Camp Ripley Fire and Emergency Services is logged as fire break maintenance. It is unknown if training with foam has occurred on the ranges by the Central Lakes College.

Known Uses
Use
Procurement
Disposition
Storage (Mixed)
Storage (Solution)
Inventory, Off-Spec
Containment
SOP on Filling
Leaking Vehicles
Nozzle and Suppression System Testing
Dining Facilities
Vehicle Washing
Ramp Washing
Fuel Spill Washing and Fueling Stations
Chrome Plating or Waterproofing

PA Interview Questionnaire - Other

Facility: Camp Ripley
Interviewer: [redacted]
Date/Time: 9/26/2018; 08:00

Interviewee: [redacted] **Title: Purchasing Supervisor** **Phone Number:** [redacted] **Email:** [redacted]	Can your name/role be used in the PA Report? [✓ Y] or N Can you recommend anyone we can interview? [✓ Y] or N [redacted]

Roles or activities with the Facility/Years working at the Facility:

[redacted] is the purchasing supervisor for Camp Ripley.

PFAS Use: Identify accidental/intentional release locations, time frame of release, frequency of releases, storage container size (maintenance, fire training, firefighting, buildings with suppression systems (as builts), fueling stations, crash sites, pest management, recreational, dining facilities, metals plating, or waterproofing). How are materials ordered/purchased/disposed/shared with others?

When AFFF is purchased for Camp Ripley, [redacted] solicits quotes from vendors and initiates a purchase request. When the purchase is approved and funded, AFFF is ordered and then shipped to the state warehouse for storage (Building 2-223). AFFF was last ordered in 2011. Recommend interviewing [redacted] for information on reclamation of expired or unused AFFF.

Known Uses

- Use
- Procurement
- Disposition
- Storage (Mixed)
- Storage (Solution)
- Inventory, Off-Spec
- Containment
- SOP on Filling
- Leaking Vehicles
- Nozzle and Suppression System Testing
- Dining Facilities
- Vehicle Washing
- Ramp Washing
- Fuel Spill Washing and Fueling Stations
- Chrome Plating or Waterproofing

PA Interview Questionnaire - Other

Facility: Camp Ripley
Interviewer: [redacted]
Date/Time: 9/26/2018; 08:00

Interviewees: [redacted] **Roles: Randall Fire Chief (retired); MNARNG** **Phone Number:** [redacted] **Email:** [redacted]	Can your name/role be used in the PA Report? [✓ Y] or N Can you recommend anyone we can interview? [✓ Y] or N [redacted]

Roles or activities with the Facility/Years working at the Facility:

[redacted] was the fire chief of the Randall Fire Department form 1972-2013. [redacted] was also a member of the MNARNG.

PFAS Use: Identify accidental/intentional release locations, time frame of release, frequency of releases, storage container size (maintenance, fire training, firefighting, buildings with suppression systems (as builts), fueling stations, crash sites, pest management, recreational, dining facilities, metals plating, or waterproofing). How are materials ordered/purchased/disposed/shared with others?

The City of Randall (approximately 8 miles west of Camp Ripley) provided fire emergency response for structural fires in the cantonment area at Camp Ripley starting the 1970s until 2010. Camp Ripley had two fire trucks (a 530 and a 530C) that were stored in building 2-203 and were used by the City of Randall for emergency responses on-Post. No information was available on whether or not the trucks had maintenance issues. Building 2-203 did have floor drains plumbed to an oil-water separator and then to the sanitary sewer. Building 2-203 was renovated in 2009 or 2010. [redacted] did not recall any emergency response events by the City of Randall that required the use of AFFF at Camp Ripley. When fixed wing aircraft started arriving at Camp Ripley (late 1970s, early 1980s), the 133rd (Air Force unit out of Minneapolis) would fly in a crash rescue truck and man the truck during incoming flights. The 133rd conducted winter operations at Camp Ripley and stored the truck in building 2-272. [redacted], the roads and grounds supervisor (47 years) at Building 2-272 recalled the truck being stored in the west bay of the building but did not recall any training with foam, truck washing, or problems with the 133rd truck. [redacted] did recall bulk AFFF in 5-gallon buckets that belonged to Camp Ripley being stored at Building 2-272. [redacted] did not recall nozzle testing events on the trucks owned by Camp Ripley or on the 133rd truck, but did recall one coordinated AFFF fire training in a burn bit with MNARNG and the Air Force's 133rd at the end of runway in the mid to late 1980s. At the end of the training, fuel was lit and extinguished with AFFF. No information was available on the type or amount of AFFF used. The 133rd truck returned to Minneapolis with the unit each spring.

[redacted] indicated AFFF did not start coming into Camp Ripley until the 1980s. Then, AFFF was stored on the trucks and at Building 2-272. The airfield was paved

Known Uses
Use
Procurement
Disposition
Storage (Mixed)
Storage (Solution)
Inventory, Off-Spec
Containment
SOP on Filling
Leaking Vehicles
Nozzle and Suppression System Testing
Dining Facilities
Vehicle Washing

in 1986 or 1987 and had an Airfield Fire Chief, [redacted]. [redacted] brought in a large crash rescue truck (011A) stored at Building 8-197. [redacted] was the lead mechanic and does not recall the truck leaking AFFF. All serious issues were sent to the CSMS for repair. When the 133rd unit was not in town, [redacted] would call up volunteers to standby with the fire truck at the old hangar (Building 8-195) during incoming flights. Building 8-195 was renovated in 2010. On 13 March 1993, two rotary-winged aircraft crashed midflight about 15 miles down range; however, no fire was reported, there was about 3-4 feet of snow on the ground, and AFFF was not reportedly used. In 2007, Camp Ripley Fire and Emergency Services was established with [redacted] and now responds to all fire emergencies on-Post. The 434th headed by [redacted] was established at Camp Ripley in 2010. The 434th trains with Camp Ripley Fire and Emergency Services and assists in fire response. The 434th fire trucks are stored at the old CSMS (Building 2-166).

The Cuyuna Agreement with the Range Fire Chiefs Association and Camp Ripley allows the communities surrounding Camp Ripley to take AFFF from the post in the event of an emergency. This has happened three times:

1. 14 June 1984 – two Burlington Northern coal trains collided head-on near Motley, MN in a wooded area about a mile south of the intersection of Hwy 210 and the Bridgeman Road in May Township. Approximately 100 gallons of AFFF was taken from Camp Ripley for this emergency event. Motley is approximately 30 miles north of Camp Ripley.
2. 1990s – A fuel tanker rolled over on Highway 371 near Brainerd, MN. The fuel tanker did not catch fire, but AFFF was used to keep the vapors down. Approximately 100 gallons of AFFF was taken from Camp Ripley for this emergency event. Brainerd is about 25 miles north of Camp Ripley.
3. 29 October 2007 – wood chips in the gasification silo at the Central Minnesota Ethanol Co-op caught fire, and the buildup of gases caused the roof to explode off the top and fall inside the silo. Approximately 300 gallons of AR-AFFF was taken from Camp Ripley for this emergency event. Central Minnesota Ethanol Co-op is about 5 miles south of Camp Ripley.

PA Interview Questionnaire - Environmental Manager

Facility: Camp Ripley
Interviewer: [redacted]
Date/Time: 9/26/2018 and 9/27/2018

Interviewee: [redacted] **Title: Environmental** **Phone [redacted]** **Email: [redacted]**	Can your name/role be used in the PA Report? [✓ Y] or N Can you recommend anyone we can interview? [✓ Y] or N [redacted] coordinated interviewees for all MNARNG facilities

1. Roles or activities with the Facility/years working at the Facility.

Environmental

2. Where can I find previous facility ownership information?

All of Camp Ripley is state owned. Real property documents will be provided by [redacted]

3. What can you tell us about the history of PFAS including aqueous film forming foam (AFFF) at the Facility? Was it used for any of the following activities, circle all that apply and indicate years of active use, if known? Identify these locations on a facility map.

Maintenance
Fire Training Areas
Firefighting (Active Fire)
Crash
Fire Suppression Systems (Hangers/Dining Facilities)
Fire Protection at Fueling Stations
Non-Technical/Recreational/ Pest Management
Metals Plating Facility
Waterproofing Uniforms (Laundry Facilities)
Other

4. Fill out CSM Information worksheet with the Environmental Manager.

5. Are any current buildings constructed with AFFF dispensing systems or fire suppression systems? What are the AFFF/suppression system test requirements? What is the frequency of testing the AFFF/suppression system? Do you have "As Built" drawings for the buildings?

No, all fire suppression systems at Camp Ripley are Purple K or dry chemical

6. Are fire suppression systems currently charged with AFFF or have they been retrofitted for use of high expansion foam? If retrofitted, when was that done?

N/A

7. How is AFFF procured? Do you have an inventory/procurement system that tracks use?

Procurement through USPFO or state warehouse. [redacted] confirmed purchasing through the state warehouse.

8. What type of AFFF has been/is being used (3%, 6%, Mil Spec Mil-F-24385, High Expansion)? Manufacturer (3M, Dupont, Ansul, National Foam, Angus, Chemguard, Buckeye, Fire Service Plus)?

Ansul 3%

9. Where is the AFFF stored? How is it stored (tanks, 55-gallon drums, 5-gallon buckets)? What size are the storage tanks? Is the AFFF stored as a mixed solution (3% or 6%) or concentrated material?

State Warehouse (Building 2-223)

10. How many FTAs are/were on this facility and where are they? Locate on a map. How many FTAs are active and inactive? For inactive FTAs, when was the last time that fire training using AFFF was conducted at them?

Information provided in [redacted] and Camp Ripley Fire Department interviews.

11. When a release of AFFF occurs during a fire training exercise, now and in the past, how is the AFFF cleaned and disposed of? Were retention ponds built to store discharged AFFF? Was the AFFF trickled to the sanitary sewer or left in the pond to infiltrate?

Information provided in [redacted] and Camp Ripley Fire Department interviews.

12. Can you recall specific times when city, county, and/or state personnel came on-post for training? If so, please state which state/county agency or military entity? Do you have any records, including photographs to share with us?

Information provided in [redacted] and Camp Ripley Fire Department interviews.

13. Did military routinely or occasionally fire train off-post? List the units that you can recall used/trained at various areas.

Information provided in [redacted] and Camp Ripley Fire Department interviews.

14. Did individual units come with their own safety personnel, did they also bring their own AFFF? Was training with AFFF part of these exercises? How were emergencies handled under these circumstances?

Information provided in [redacted] and Camp Ripley Fire Department interviews.

15. Are there specific emergency response incident reports (i.e., aircraft or vehicle crash sites and fires)? If so, may we please copy these reports? Who (entity) was the responder?

AFFF was not dispensed during the 1993 crash. According to all interviewees, no fire was associated with the crash and there was significant snow on the ground.

16. Do you have records of fuel spill logs? Was it common practice to wash away fuel spills with AFFF? Is/was AFFF used as a precaution in response to fuel releases or emergency runway landings to prevent fires?

No

17. Was AFFF used for forest fires or fire management on-post/off-post? If so, please describe what happened and who was involved?

No

18. Are there mutual aid/use agreements between county, city, and local fire department? Please list, even if informal. If formalized, may we have a copy of the agreement?

Cuyuna Agreement

19. Can you provide any other locations where AFFF has been stored, released, or used (i.e. hangars, buildings, fire stations, firefighting equipment testing and maintenance areas, emergency response sites, storm water/surface water, waste treatment plants, and AFFF ponds)?

[redacted] provided the Memorandum for Record dated 8 December 2014 regarding training at the EMTC.

20. Are you aware of any other creative uses of AFFF? If so, how was AFFF used? What entities were involved?

No

21. Are there past studies you are aware of with environmental information on plants/animals/groundwater/soil types, etc., such as Integrated Cultural Resources Management Plans or Integrated Natural Resources Management Plans?

INRMP, CWMPP (both provided on CD)

22. What other records might be helpful to us (environmental compliance, investigation records, admin record) and where can we find them?

CWMPP, historical imagery

23. Do you have or did you have a chrome plating shop on base? What were/are the years of operation of that chrome plating shop?

No

24. Do you know whether the shop has/had a foam blanket mist suppression system or used a fume hood for emissions control? If foam blanket mist suppression was used, where was the foam stored, mixed, applied, etc.?

N/A

25. How is off-spec AFFF disposed (used for training, turned in, or given to a local Fire Station)? If applicable, do you know the name of the vendor that removes off-spec AFFF? Do you have copies of the manifest or B/L?

Information provided in [redacted] and Camp Ripley Fire Department interviews.

26. Do you recommend anyone else we can interview? If so, do you have contact information for them?

[redacted] facilitated several additional interviews throughout the site visit.

PA Interview Questionnaire - Other

Facility: Camp Ripley
Interviewer: [redacted]
Date/Time: 9/26/2018; 08:00

Interviewee: [redacted] **Title: State Asset Federal Usability Officer** **Phone Number: contact through** [redacted] **Email: contact through** [redacted]	Can your name/role be used in the PA Report? [✓ Y] or N Can you recommend anyone we can interview? [✓ Y] or N [redacted] at USPFO

Roles or activities with the Facility/Years working at the Facility:

[redacted] is the State Asset Federal Usability Officer.

PFAS Use: Identify accidental/intentional release locations, time frame of release, frequency of releases, storage container size (maintenance, fire training, firefighting, buildings with suppression systems (as builts), fueling stations, crash sites, pest management, recreational, dining facilities, metals plating, or waterproofing). How are materials ordered/purchased/disposed/shared with others?

	Known Uses
[redacted] provided information on how wastes and excess property are disposed at the USPFO. Hazard wastes are certified, stored separately at the warehouse, then shipped out and disposed by DRMO or DLA. Excess property sits on a shelf as a commodity until someone needs it. If no one wants the item, it is wasted out or disposed of as a property item. Historically, when property was wasted out, it was shipped to Duluth, MN. Currently, on the state side, the item is advertised out of Camp Ripley. Federal items are shipped to various sites throughout the country.	Use Procurement Disposition Storage (Mixed) Storage (Solution) Inventory, Off-Spec Containment SOP on Filling Leaking Vehicles Nozzle and Suppression System Testing Dining Facilities Vehicle Washing Ramp Washing Fuel Spill Washing and Fueling Stations Chrome Plating or Waterproofing

Appendix B.2
Visual Site Inspection Checklists

Visual Site Inspection Checklist

Names(s) of people performing VSI: [redacted]

Recorded by: [redacted]

ARNG Contact: [redacted]

Date and Time: 26 and 27 September 2018, all day

Method of visit (walking, driving, adjacent): walking

Source/Release Information

Site Name / Area Name / Unique ID: Camp Ripley

Site / Area Acreage: 53,000 acres

Historic Site Use (Brief Description): Facility is a training site with multiple vehicle maintenance areas, a runway, and a fire department. AFFF was stored or used at this facility. Release area inferred due to detections in potable wells.

Current Site Use (Brief Description): Same as historic use

Physical barriers or access restrictions: Access to the facility is controlled

1. Was PFAS used (or spilled) at the site/area? **[✓ Y] / N**

1a. If yes, document how PFAS was used and usage time (e.g., fire fighting training 2001 to 2014):
TriMax Discharge Area near Fire Station (Early 2000s), Burn Pit (1980s), EMTC (2014), CMA Release Area (2010)

2. Has usage been documented? **Y / [✓ N]**

2a. If yes, keep a record (place electronic files on a disk):
Information provided through interviews

3. What types of businesses are located near the site? **Industrial / Commercial / Plating / Waterproofing / Residential**

3a. Indicate what businesses are located near the site
N/A

4. Is this site located at an airport/flight line? **[✓ Y] / N**

4a. If yes, provide a description of the airport/flight line tenants:
Ray S. Miller Army Airfield is located at the facility in the northwest cantonment area

Visual Site Inspection Checklist

Other Significant Site Features:

1. Does the facility have a fire suppression system? Y / [✓ N]

1a. If yes, indicate which type of AFFF has been used:

N/A

1b. If yes, describe maintenance schedule/leaks:

N/A

1c. If yes, how often is the AFFF replaced:

N/A

1d. If yes, does the facility have floor drains and where do they lead? Can we obtain an as built drawing?

N/A

Transport / Pathway Information

Migration Potential:

1. Does site/area drainage flow off installation? [✓ Y] / N

1a. If so, note observation and location:

Drainage from Camp Ripley flows towards the Mississippi River

2. Is there channelized flow within the site/area? Y / [✓ N]

2a. If so, please note observation and location:

3. Are monitoring or drinking water wells located near the site? [✓ Y] / N

3a. If so, please note the location:

Three production wells at the facility and several domestic and private wells surrounding the facility.

4. Are surface water intakes located near the site? Y / [✓ N]

4a. If so, please note the location:

5. Can wind dispersion information be obtained? [✓ Y] / N

5a. If so, please note and observe the location.

Wind dispersion information can be obtained from the Ray S. Miller Army Airfield.

6. Does an adjacent non-ARNG PFAS source exist? [✓ Y] / N

6a. If so, please note the source and location.

Motley Train Crash, fuel tanker rollover, Ethanol Co-op fire, Keystone Automotive

6b. Will off-site reconnaissance be conducted? Y / [✓ N]

Visual Site Inspection Checklist

Significant Topographical Features:

1. Has the infrastructure changed at the site/area? **[✓ Y] / N**

1a. If so, please describe change (ex. Structures no longer exist):

Remodeling has occurred at Building 2-203 and Building 8-195.

2. Is the site/area vegetated? **[✓ Y] / N**

2a. If not vegetated, briefly describe the site/area composition:

3. Does the site or area exhibit evidence of erosion? **Y / [✓ N]**

3a. If yes, describe the location and extent of the erosion:

4. Does the site/area exhibit any areas of ponding or standing water? **[✓ Y] / N**

4a. If yes, describe the location and extent of the ponding:

Several wetlands and kettle lakes

Receptor Information

1. Is access to the site restricted? **[✓ Y] / N**

1a. If so, please note to what extent:

The facility is gated and identification must be shown prior to entering the facility.

2. Who can access the site? **[✓ Site Workers] / [✓ Construction Workers] / [✓ Trespassers] / [✓ Residential] / [✓ Recreational Users] / [✓ Ecological]**

2a. Circle all that apply, note any not covered above:

3. Are residential areas located near the site? **[✓ Y] / N**

3a. If so, please note the location/distance:

Residential areas are located within one mile of the facility to the south and west.

4. Are any schools/day care centers located near the site? **Y / [✓ N]**

4a. If so, please note the location/distance/type:

Visual Site Inspection Checklist

5. Are any wetlands located near the site? [✓ Y] / N

5a. If so, please note the location/distance/type:

Several wetlands located within the facility.

Additional Notes

Photographic Log

Photo ID/Name	Date & Location	Photograph Description
Photograph No. 1	26 September 2018, Fire Station (Building 8-197)	Camp Ripley Fire and Emergency Services Fire Truck 1.
Photograph No. 2	26 September 2018, Fire Station (Building 8-197)	Camp Ripley Fire and Emergency Services Fire Truck 2.
Photograph No. 3	26 September 2018, Fire Station (Building 8-197)	Camp Ripley Fire and Emergency Services Fire Truck 3.
Photograph No. 4	27 September 2018, Fire Station (Building 8-197)	AFFF Bulk Storage at the State Warehouse (Building 2-223).
Photograph No. 5	26 September 2018, Fire Station (Building 8-197)	Facing north. TriMax Discharge Area.
Photograph No. 6	26 September 2018, Ray S. Miller Airfield	Facing northwest. Burn Pit Fire Training Area.

Appendix B.3
Conceptual Site Model Information

Preliminary Assessment – Conceptual Site Model Information

Site Name: Camp Ripley

Why has this location been identified as a site? Facility is a training site with multiple vehicle maintenance areas, a runway, and a fire department. AFFF was stored or used at this facility. Release area inferred due to detections in potable wells.

Are there any other activities nearby that could also impact this location?

Keystone Automotive, a chrome plating facility that historically used a PFAS mist suppressant is located in Brainerd, approximately 25 miles north of Camp Ripley. Three additional locations identified by AFFF taken from Camp Ripley under the Cuyuna Agreement.

Training Events

Have any training events with AFFF occurred at this site? Yes

If so, how often? Uncertain; possible multiple fire training events at the Burn Pit FTA

How much material was used? Is it documented? Unknown, no documentation available

Identify Potential Pathways: Do we have enough information to fully understand over land surface water flow, groundwater flow, and geological formations on and around the facility? Any direct pathways to larger water bodies?

Surface Water:

Surface water flow direction? East-southeast

Average rainfall? 29 inches

Any flooding during rainy season? Flooding is uncommon, but a very large flooding event occurred in 1972

Direct or indirect pathway to ditches? No

Direct or indirect pathway to larger bodies of water? Mississippi River borders the facility on the east

Does surface water pond any place on site? Several wetlands and kettle lakes

Any impoundment areas or retention ponds? Several wetlands and kettle lakes

Any NPDES location points near the site? Yes

How does surface water drain on and around the flight line? East-southeast

Preliminary Assessment – Conceptual Site Model Information

Groundwater:

Groundwater flow direction? East-southeast

Depth to groundwater? Depth to water is shallow; Mississippi River captures shallow groundwater

Uses (agricultural, drinking water, irrigation)? Agricultural, drinking water, irrigation

Any groundwater treatment systems? Yes

Any groundwater monitoring well locations near the site? Yes

Is groundwater used for drinking water? Yes

Are there drinking water supply wells on installation? Yes, three drinking water wells present on-site within the Drinking Water Supply Management Area (DWSMA)

Do they serve off-post populations? No

Are there off-post drinking water wells downgradient ? Yes

Waste Water Treatment Plant:

Has the installation ever had a WWTP, past or present? Yes

If so, do we understand the process and which water is/was treated at the plant? Yes

Do we understand the fate of sludge waste? Sludge waste has been land deposited on-Post since 1987

Is surface water from potential contaminated sites treated? Yes

Landfills: All historical landfills on-Post are capped. One large landfill is located in the cantonment area and several small landfills are within the training areas.

Equipment Rinse Water

1. Is firefighting equipment washed? Where does the rinse water go? Yes, to a storm water drain

2. Are nozzles tested? How often are nozzles tested? Where are nozzles tested? Are nozzles cleaned after use? Where does the rinse water flow after cleaning nozzles?

Nozzles have not been tested since certification in 2010-2011

3. Other? Controlled burns are permitted through DNR and occur over 12000 to 15000 acres every year. All controlled burn fires are extinguished with water only.

Preliminary Assessment – Conceptual Site Model Information

Identify Potential Receptors:

Site Worker Yes

Construction Worker Yes

Recreational User Yes

Residential Yes

Child Yes

Ecological Yes

Note what is located near by the site (e.g. daycare, schools, hospitals, churches, agricultural, livestock)?

Documentation

Ask for Engineering drawings (if applicable). N/A

Has there been a reconstruction or changes to the drainage system? When did that occur? None known

Appendix C
Photographic Log

APPENDIX C – Photographic Log

Army National Guard, Preliminary Assessment for PFAS	**Camp Ripley, Minnesota**	**Little Falls, Minnesota**

Photograph No. 1

Description:

Camp Ripley Fire and Emergency Services Fire Truck 1.

Photograph No. 2

Description:

Camp Ripley Fire and Emergency Services Fire Truck 2.

APPENDIX C – Photographic Log

Army National Guard, Preliminary Assessment for PFAS	Camp Ripley, Minnesota	Little Falls, Minnesota

Photograph No. 3

Description:

Camp Ripley Fire and Emergency Services Fire Truck 3.

Photograph No. 4

Description:

AFFF Bulk Storage at the State Warehouse (Building 2-223).

APPENDIX C – Photographic Log

Army National Guard, Preliminary Assessment for PFAS	**Camp Ripley, Minnesota**	**Little Falls, Minnesota**

Photograph No. 5

Description:

Facing north. TriMax Discharge Area.

Photograph No. 6

Description:

Facing northwest. Burn Pit Fire Training Area.

APPENDIX C – Photographic Log

Army National Guard, Preliminary Assessment for PFAS	**Camp Ripley, Minnesota**	**Little Falls, Minnesota**

Photograph No. 7

Description:

Facing southeast. Minnesota Public Safety Division of the Department of Homeland Security Demonstration Area.

Photograph No. 8

Description:

Facing west. Building 2-203.

APPENDIX C – Photographic Log

Army National Guard, Preliminary Assessment for PFAS	Camp Ripley, Minnesota	Little Falls, Minnesota

Photograph No. 9

Description:

Facing east. United States Air Force 133rd Airlift Wing Fire Truck Storage Area.

Photograph No. 10

Description:

Facing southwest. Floor Drain in Building 2-272.

APPENDIX C – Photographic Log

Army National Guard, Preliminary Assessment for PFAS	Camp Ripley, Minnesota	Little Falls, Minnesota

Photograph No. 11

Description:

Facing southwest. Storm Sewer in Building 2-272.

Photograph No. 12

Description:

Facing northeast. Bulk AFFF Storage Area in Building 2-272.

APPENDIX C – Photographic Log

Army National Guard, Preliminary Assessment for PFAS	Camp Ripley, Minnesota	Little Falls, Minnesota

Photograph No. 13

Description:

TriMax Storage in the USPFO Warehouse.

Photograph No. 14

Description:

Facing east. CMA Release Area.