Alternative Feasibility Study
Groundwater Remedial Strategy
Badger Army Ammunition Plant

Prepared for:

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LIST OF ACRONYMS

1,1,1-TCA	1,1,1-Trichloroethane
1,1,2-TCA	1,1,2-Trichloroethane
2,4-DNT	2,4-Dinitrotoluene
2,6-DNT	2,6-Dinitrotoluene
µg/l	Micrograms per liter
AFS	Alternative Feasibility Study
Army	Department of the Army
bgs	Below ground surface
BAAP	Badger Army Ammunition Plant (WDNR designation)
BAAAP	Badger Army Ammunition Plant (Department of Defense designation)
BEST	Biologically Enhanced Subsurface Treatment
BIA	United States Bureau of Indian Affairs
BNA	Base Neutral Acid
BSD	Bluffview Sanitary District
cm/sec	Centimeters per second
COC	Contaminant of Concern
CSM	Conceptual Site Model
CTET	Carbon Tetrachloride
DBG	Deterrent Burning Ground
DNT	Dinitrotoluene
ES	Enforcement Standard
^{o}F	Degrees Fahrenheit
FS	Feasibility Study
ft/ft	Feet per foot
GAC	Granular Activated Carbon
gpm	Gallons per minute
GSM	Groundwater Modeling System
HCC	Human Cancer Criteria
HDPE	High-Density Polyethylene
HCN	Ho-Chunk Nation
HTC	Human Threshold Criteria
HWTTU	Hazardous Waste Thermal Treatment Unit
IFCR	In-Field Conditions Report
IRM	Interim Remedial Measures
MCL	Maximum Contaminant Level
MEC	Munitions and Explosives of Concern
MIRM	Modified Interim Remedial Measures
mg/l	Milligrams per liter
MSL	Mean Sea Level
NC	Nitrocellulose
NG	Nitroglycerin
NPS	National Park Service
NR	Natural Resources
NPWS	Non-Public Water System

O&M	Operation and Maintenance
OSHA	Occupational Safety and Health Administration
PAH	Polycyclic Aromatic Hydrocarbon
PAL	Preventive Action Limit
PBG	Propellant Burning Ground
ppt	Inches of Precipitation
PSTS	Pilot-Scale Treatability Study
RA	Remedial Action
RCRA	Resource Conservation and Recovery Act
RI	Remedial Investigation
SVE	Soil Vapor Extraction
SVOC	Semi-volatile Organic Compounds
TCE	Trichloroethylene or Trichloroethene
USDA	United States Department of Agriculture
VOC	Volatile Organic Compounds
WDNR	Wisconsin Department of Natural Resources
WDOT	Wisconsin Department of Transportation
Wis. Adm. Code	Wisconsin Administrative Code
WPDES	Wisconsin Pollutant Discharge Elimination System
WP&L	Wisconsin Power and Light
WWTP	Wastewater Treatment Plant

1.0 EXECUTIVE SUMMARY

The Badger Army Ammunition Plant (BAAAP), located in south-central Wisconsin within Sumpter and Merrimac Townships in Sauk County, was constructed in 1942 to produce smokeless gunpowder and solid rocket propellant as munitions components for World War II. The installation is located on the Sauk Prairie, between the Baraboo Range and the Wisconsin River. As a result of production and waste disposal practices that were common at the time, soil and groundwater at the BAAAP were impacted.

Numerous site investigations and remedial actions have been conducted at the BAAAP. Groundwater investigation activities at BAAAP began in 1980 and continue today. Site-wide groundwater-related assessment activities include the following: monitoring well installation; water level measurements; pump testing; monitoring well and residential drinking water well sampling; and groundwater modeling. Groundwater impact source-related investigations and remedial actions have been conducted for the three source areas: Propellant Burning Ground (PBG), Central Plume area, and Deterrent Burning Ground (DBG). Groundwater in the PBG and DBG areas are impacted by dinitrotoluene (DNT) and chlorinated solvents. Groundwater in the Central Plume area is impacted by DNT.

An *In-Field Conditions Report* (IFCR), issued by the Wisconsin Department of Natural Resources (WDNR) in 1987, required groundwater monitoring, reporting, and performance-based responses at the BAAAP. The current site-wide groundwater monitoring program follows the IFCR dated August 15, 2005. The interim groundwater remedial action at the PBG began in 1990 and continues today. Groundwater monitoring with the current remedies in place could continue indefinitely (30 years or more).

Groundwater modeling of the contaminant plumes is included as part of this Alternative Feasibility Study (AFS) to better understand fate and transport mechanisms to anticipate plume dynamics into the future. The groundwater model predicts that by 2030 the PBG Plume, containing carbon tetrachloride (CTET) and DNT, will be significantly reduced in size based on continued groundwater remediation by the IRM/MIRM. The concentrations of DNT at the PBG are expected to continue to decrease over time, with the plume narrowing and becoming more confined due to natural biochemical reactions occurring within the plume.

The lack of historical groundwater monitoring data associated with the Central Plume prevented a detailed extrapolation of long-term contaminant trends. The groundwater model predicts that DNT concentrations in the Central Plume would remain stable, with notable decreases in plume size occurring over time, and the plume disappearing in 2040.

Due to the limitations in well placement in the DBG area and the inconsistent layers of fine-grained soil, the model was unable to accurately predict the groundwater flow movement. Due to these limitations, the model predictions for the DBG DNT plume don't accurately represent site conditions. Model simulations do indicate that the mass of DNT at the DBG will decrease over time with the plume disappearing by 2040.

A Conceptual Site Model (CSM) is provided in this AFS to explain the relationship of contaminant sources, environmental media, exposure pathways, and potential human and ecological receptors. All applicable and appropriate regulatory requirements are presented and discussed as they relate to the remediation of the groundwater plumes at BAAAP. These regulations help frame the remedial objective, which is to protect human health by preventing exposure of contaminated groundwater from BAAAP, to restore groundwater to the extent practicable, and minimize the impact of the contaminant plumes on the environment.

The purpose of this AFS is to determine the most appropriate and cost-effective final remedy for the groundwater plumes at BAAAP. A discussion of the three source areas of groundwater impact is included in this AFS and three alternatives are evaluated to address the residual groundwater impacts. Remedial action alternatives were assembled and screened resulting in three alternatives. Each alternative is capable of accomplishing the remedial objective. The final three remedial alternatives evaluated include:

Alternative 1: Interim Remedial Measures/Modified Interim Remedial Measures (IRM/MIRM) Treatment and Monitored Natural Attenuation
This alternative continues IRM/MIRM treatment of the PBG Plume, continued groundwater monitoring, and natural attenuation of the DBG and Central Plumes.

Alternative 2: In-Situ Biochemical Treatment
This alternative would use in-situ groundwater treatment, a modified groundwater monitoring program, and natural attenuation of the PBG, DBG, and Central Plumes.

Alternative 3: Public Water System
This alternative involves the installation of a public water system, a phased shutdown of the IRM and MIRM systems, a modified groundwater monitoring program, and natural attenuation of the PBG, DBG, and Central Plumes.

Each alternative is evaluated using the following nine criteria: overall protection of human health and the environment; compliance with applicable regulations; long-term effectiveness and permanence; reduction of toxicity, mobility, and volume through treatment; short-term effectiveness; implementability; cost; state acceptance; and community acceptance. Based on a thorough evaluation, Alternative 3, Public Water System, is proposed as the final groundwater remedy for the groundwater contaminant plumes at BAAAP.

2.0 INTRODUCTION

This AFS report was prepared to serve as a principal source for decision-making relating to remediation of groundwater impacts from the BAAAP. The AFS provides a summary of historic and current groundwater investigation and remediation efforts by the Department of the Army (Army) and describes the development and re-evaluation of groundwater remedial action alternatives for the BAAAP.

The IFCR, issued by the WDNR in 1987, and subsequent amendments, calls for groundwater monitoring, reporting, and performance-based responses at the BAAAP. The current site-wide

groundwater monitoring program follows the IFCR dated August 15, 2005. On November 23, 2009, additional changes to the northeast area (including the DBG) groundwater monitoring requirements were approved by the WDNR. Investigation of groundwater has been ongoing at the BAAAP from 1980 to the present. The interim groundwater remedial action began in 1990 and continues today. Groundwater monitoring with the current remedies in place would continue indefinitely (30 years or more) until the WDNR approved case closure.

The initial site-wide remedial investigation (RI) and feasibility study (FS) was completed in 1993 and 1994 (ABB-ES, 1993 and 1994). Soil and groundwater remedial alternatives were analyzed, selected, and approved by the Army and state and federal regulators for the PBG and DBG areas, and their associated groundwater contaminant plumes. In addition to the PBG and DBG areas and their associated plumes, the Rocket Paste Area/Central Plume has since been identified through further groundwater investigations.

A re-evaluation of the current groundwater remediation alternative at the BAAAP was warranted because: 1) the current remedial alternative in place is an interim action, which addresses only the PBG Plume, 2) the timeframe required for the IRM/MIRM to meet cleanup standards is indefinite, and 3) recent changes in state groundwater standards make meeting those cleanup standards even more difficult. The revised alternatives were developed and evaluated to achieve the remedial objective. The objective of the groundwater remedial action is to protect human health by preventing exposure of contaminated groundwater from BAAAP, to restore groundwater to the extent practicable, and minimize the impact of the contaminant plumes on the environment.

3.0 SITE BACKGROUND

3.1 Site Description

The BAAAP, located in south-central Wisconsin within Sumpter and Merrimac Townships in Sauk County, was constructed in 1942 to produce smokeless gunpowder and solid rocket propellant as munitions components for World War II. The installation is located on the Sauk Prairie, between the Baraboo Range and the Wisconsin River. The impoundment of the Wisconsin River forms Lake Wisconsin, which borders the southeast side of the BAAAP.

Production of nitric acid, sulfuric acid, Oleum (also known as fuming sulfuric acid), nitrocellulose (NC), and nitroglycerin (NG) occurred in support of munitions components production. Production periods were as follows: World War II (1942 to 1945), Korean War (1951 to 1958), and Vietnam Conflict (1966 to 1975). Disposal of excess hazardous substances occurred at primarily two locations on-site: the PBG and the DBG. As a result of production and waste disposal practices that were common at the time, soil and groundwater at the BAAAP were impacted with several contaminants of concern (COCs).

The primary land uses in the immediate vicinity of the BAAAP are agricultural, recreational, and residential. The agricultural use of the BAAAP (raising crops and cattle grazing), through outlease programs, and the surrounding area, continues to be the primary use of lands within and adjacent to the installation. The United States Department of Agriculture (USDA) has used the

land in and around the southern portion of the installation for grazing and crop development research for many years. The Dairy Forage Research Center Farm was constructed in the 1980s on land transferred from the Army to the USDA.

The primary land use to the north of the installation is for recreation at Devil's Lake State Park, managed by the WDNR. This area is not impacted by past activities at BAAAP as it is located hydrologically upgradient. Lake Wisconsin and the Wisconsin River, to the south and southeast of the BAAAP, are hydraulically connected to the installation. Lake Wisconsin was formed in 1914 by the Wisconsin Power and Light (WP&L) dam on the Wisconsin River, near Prairie du Sac.

The 2000 United States Census estimated the Township of Sumpter population at approximately 1,000 residents and the Township of Merrimac at approximately 400 residents. Approximately 75 of the private residential wells to the south and east of the installation are currently part of the groundwater monitoring program at BAAAP, which began in 1980. Five residential drinking water wells, downgradient of the installation, have been replaced by the Army due to groundwater impacts.

3.2 Site History

Production and Standby Periods

During World War II, BAAAP employed approximately 7,500 workers and produced approximately 271 million pounds of single- and double-base propellant. Oleum and smokeless powder production began in 1943. Rocket paste powder production began in 1945. The solventless extrusion smokeless propellant process was installed in 1944 and 1945. From 1945 to 1951, the installation was in standby status.

BAAAP was reactivated for the Korean War in 1951. Reactivation activities were completed by 1954. Facilities for the manufacture of Ball Powder® propellant were constructed during 1954 and 1955. A facility to recycle old cannon powder as a source of NC for the new propellant was also constructed in 1954 and 1955. BAAAP remained in production until the Korean War ended and the propellant magazines were full (1958). During the Korean War, approximately 286 million pounds of single- and double-base propellant were manufactured with a peak production employment of 5,022 employees. The installation was in standby status again from 1958 to 1966.

BAAAP was reactivated in 1966 for the Vietnam Conflict. The installation manufactured Ball Powder® propellant, rocket propellant, and smokeless propellant from 1966 to 1975. In 1972, construction included new sewage treatment systems, new acid production, and new NG production facilities. During the Vietnam Conflict approximately 487 million pounds of single- and double-base propellant were manufactured with a peak production employment of 5,400 employees. The installation was placed in standby status in 1975 and was declared excess in 1998, which began the dismantling process.

Waste Disposal Practices

The PBG, DBG, and Rocket Paste Area have been identified as the source areas of groundwater contamination. The PBG Plume source area includes Landfill #1, PBG Waste Pits, 1949 Pit, and the Racetrack Area. The DBG Plume source area includes Landfill #3, Landfill #5, and the DBG Waste Pit. The Central Plume source area is near the NG and Rocket Paste areas. The locations of these areas are depicted in Figure 1.

During production periods, the PBG and DBG were used as disposal areas for waste and excess production chemicals, primarily solvents, plasticizers, and explosives. Excess chemicals and munitions components were placed in open pits and burned to dispose of them.

Process wastewater from the Rocket Paste Area and the Nitroglycerin Area was conveyed in open ditches from the north-central to the south side of the installation where it subsequently flowed to the Settling Ponds and Spoils Disposal Areas, and eventually to the Wisconsin River.

Demolition and Restoration

Environmental investigation and restoration activities began at the BAAAP in 1977. Groundwater monitoring and characterization activities began in 1980, with groundwater treatment beginning in 1990. These activities are still in progress today.

Ongoing demolition activities include the following: removal of all process chemicals, equipment, piping, process and storage tanks, munitions and explosives of concern (MEC) that may reasonably be expected to cause an environmental or safety hazard, and the majority of the structures on the installation. Many of the concrete slabs that lay underneath these structures have been removed or are planned for removal and recycling. Current environmental restoration activities include the following: soil investigation and remediation; groundwater monitoring and remediation; impacted process and sanitary sewer removal; friable asbestos removal; and MEC screening, clearance, and certification.

3.3 Environmental Setting

Topography

The land surface at the installation is the result of glaciation. The installation is located on the southern edge of the Baraboo Range, also commonly referred to as the Baraboo Hills. The terminal moraine, deposited by the leading edge of the glacier as it moved from east to west, extends from north to south across the central portion of the installation. The topography in the eastern two-thirds of the installation consists of gently rolling hills with numerous depressions. The northwest third of the installation is an outwash plain that is nearly level to gently sloping towards the southwest.

Climate

The climate of the installation area is typically continental with some influence from the Great Lakes system. Average annual temperatures in the region vary from 39 degrees Fahrenheit (°F) to 50°F. The freeze-free season is typically 80 to 180 days. From 1971 to 2000, the Southwest

Wisconsin Divisional Climate Summary included the following averages: Winter: 19.7°F, 3.44 inches of precipitation (ppt); Spring: 45.8°F, 9.24 ppt; Summer: 69.2°F, 13.14 ppt; Fall: 48.0°F, 8.10 ppt (Wisconsin State Climatology Office Website, 2010). Precipitation for the area averages approximately 30 inches annually. Typically, 70% of this rainfall occurs during the growing season; April through September. The one year and ten year predicted maximum 24-hour rainfall totals for Sauk County are 2.3 and 4.1 inches, respectively.

Surface Water Hydrology

Surface drainage consists of overland flow to the west, south, and east. Much of the run-off collects in isolated depressions on-site and infiltrates or evaporates. The ditches in the northwest portion of the installation drain toward the Ballistics Pond and subsequently to Otter Creek to the west of the installation. The surface water from the NG, Rocket Paste, and Magazine Areas, located in the central and southeast areas of the installation, discharges to the Settling Ponds and Spoils Disposal Areas in the south-central portion of BAAAP. The Settling Ponds are manmade areas that received wastewater from production, but are now almost entirely dry except in severe rain events. The Settling Pond Area drains to the south and east at Gruber's Grove Bay, on Lake Wisconsin. Ponds that contain water throughout most of the year include the Ballistics Pond, Oleum Pond, Wood Duck Pond, Rocket Paste Pond, and NG/Over Flow Ponds.

Geology

A thick sequence of unconsolidated sediments was deposited during the late Wisconsin Stage glaciation, approximately 18,000 years ago. A glacial terminal moraine transects the installation from north to south. West of the terminal moraine, a thick sequence of glacial outwash sand and gravel was deposited. Glacial tills to the east are primarily silty sands. Several feet of clayey silt overlie the glacial sediments on-site, with some loess present.

Bedrock geology at BAAAP is dominated by Cambrian sandstones beneath most of the installation, with some Precambrian metamorphosed granites and rhyolites. The Baraboo Range to the north and west of the installation contain Precambrian quartzite conglomerates and sandstones, which are part of the Baraboo Syncline, rising approximately 500 feet above the installation to the north. The bedrock surface dips steeply toward the south, where soil deposits quickly thicken to a maximum of approximately 250 feet.

Along the northern installation boundary, soil deposits are thin or absent and quartzite and sandstone bedrock outcrops are common. A Precambrian quartzite occurs at the southern base of the hills. South of the Baraboo Range, the quartzite surface dips steeply to the south and is overlain unconformably by Cambrian fine to medium sandstones with minor amounts of shale and dolomite.

Hydrogeology

Two major aquifers are present beneath the installation: the surficial sand and gravel aquifer and the underlying sandstone bedrock aquifer. Both are un-confined to semi-confined and possibly hydraulically connected. The bedrock aquifer varies between 80 to 280 feet below ground surface (bgs). The general direction of groundwater flow is south to southeast. Steep gradients

exist along the northern boundary of the installation. The gradient flattens substantially in the central and southern portions of the installation. Recharge to the sand and gravel aquifer is limited by infiltration through a fine-grained loess unit in some areas. On the north side of the installation, some fine-grained glacio-lacustrine layers occur above the water table. This condition results in a locally elevated groundwater table in this area with downward gradients.

The Lake Wisconsin Reservoir, caused by the hydroelectric dam on the Wisconsin River, influences groundwater flow across the installation. The reservoir is north of the dam where there is an approximate 40-foot surface water drop. The water level in the reservoir is elevated above the water table for much of the southeastern portion of the installation. Subsequently, the Lake Wisconsin Reservoir discharges to the groundwater in the Gruber's Grove Bay area. The net result is groundwater flow parallel to the reservoir with discharge to the Wisconsin River south of the dam. Groundwater in the northeast portion of the installation is higher in elevation than the Lake Wisconsin Reservoir; therefore, the groundwater discharges to the Lake Wisconsin Reservoir.

4.0 SOURCE INVESTIGATIONS AND REMEDIAL MEASURES

Numerous site investigations and remedial actions have been conducted at the BAAAP. Groundwater investigation activities at BAAAP began in 1980 and continue today. Site-wide groundwater related assessment activities, agreed upon by the Army and WDNR, include the following: monitoring well installation; water level measurements; pump testing; monitoring well and residential drinking water well sampling; and groundwater modeling. Groundwater impact source-related investigations and remedial actions, for the PBG, Central Plume Area, and DBG are discussed below. Figure 2 shows the locations of the monitoring wells and Figure 3 shows the locations of the private wells.

4.1 Propellant Burning Ground

The PBG is located in the southwestern portion of the BAAAP. The PBG is comprised of the following areas: Waste Pits, 1949 Pit, Racetrack/Hazardous Waste Thermal Treatment Unit (HWTTU) area, and Landfill #1. The location and layout of the PBG is shown in Figure 4.

DNT and organic solvent-containing materials are known to have been disposed of at the PBG through open burning and burial during production periods. Subsequently, localized impacts to soil consisted of 2,4-dinitrotoluene (2,4-DNT), 2,6-dinitrotoluene (2,6-DNT), polycyclic aromatic hydrocarbons (PAHs), benzene, trichloroethylene (TCE), arsenic, chromium, lead, selenium, and zinc above soil cleanup remedial action objectives.

The PBG Waste Pits consisted of three waste pits and an open burning area. A soil vapor extraction (SVE) system operated at the Waste Pits from 1997 to 1999. Approximately 1,600 pounds of solvent-related Volatile Organic Compounds (VOCs) were successfully removed from within the vadose zone. Approximately 2,280 cubic yards of soil were removed from the PBG Waste Pits, from ground surface to approximately 23 feet bgs in 1999. The soil was transported off-site and incinerated by a licensed hazardous waste contractor. The Waste Pits were filled with clean gravel to grade.

A pilot biotreatment system was installed at Waste Pit 1 in 1999. A Pilot-Scale Treatability Study (PSTS) was conducted in 2000 to evaluate the effectiveness of bacterial degradation of DNT by naturally occurring bacteria in the soil (in-situ). The PSTS extracted groundwater beneath Waste Pit 1, treated the water with phosphate, and reinjected it into the soil column above the waste pit. Oxygen was added to the vadose zone by injecting air through the former SVE system wells, which now served as air sparge wells. Carbohydrate (ethanol) injection wells for the control of nitrate byproduct were installed downgradient, but never used. Monitoring results indicated the indigenous bacteria were aerobically biodegrading DNT in the soil column successfully; therefore, the Army decided to go full-scale with the biotreatment system.

The Biologically Enhanced Subsurface Treatment (BEST) system was installed in 2000 and operated from 2001 to 2005. From 2001 through 2003, additional air sparge wells were installed to aide bacterial degradation of DNT in the groundwater. The air sparge wells were in operation until 2006. Evaluation of the BEST system indicated effective DNT reduction in groundwater occurred during the operation of the system.

A geocomposite cap was installed at the 1949 Pit in 1998 to inhibit the movement of contaminants in the soil. The *1949 Pit Phase One Cap, Final Construction Report* (Olin Corporation, 1999) was submitted and approved by the WDNR in 1999.

The Racetrack/HWTTU area consisted of an oval gravel road, three refuse pits, and burning plates, as well as the HWTTU. The HWTTU was used to destroy propellant residue on metal materials scheduled for maintenance, salvage, or scrap. In 1995, three-fourths of the Racetrack/HWTTU area was closed with a soil cover. The *Final Documentation Report For Soil Cover Construction Racetrack And Thermal Treatment Unit Closure* (Olin Corporation, 1996) was approved by the WDNR. In 1995, three-fourths of the Racetrack/HWTTU area was closed with a soil cover. The remaining portion of the Racetrack area had impacted soil removed in 1997 with no cover required.

Landfill #1 contained structural timbers, asphalt shingles, cardboard, and other office refuse. Landfill #1 was covered with a WDNR-approved geocomposite cap in 1997.

In 2006, a draft AFS was completed to re-evaluate the remedial actions at the PBG. The selected alternative included the previous remedial actions: soil vapor extraction, partial soil excavation and incineration, and full-scale bioremediation. The final remedy chosen included removal of the bioremediation system, installation of an impermeable cap and cover, and continued groundwater monitoring and remediation. On March 17, 2008, the WDNR approved of the final remedy for the PBG subsurface soil.

Removal of the BEST system was completed in 2008. The Waste Pits were then capped with a geosynthetic barrier and compacted clay, according to regulatory requirements. The area was then covered with topsoil, graded, and seeded. The *Construction Documentation Report, PBG Phase 2, Cap and Construction* (SpecPro, Inc., 2009) report was submitted to the WDNR and approved in 2009.

The Waste Pits, 1949 Pit, Racetrack/HWTTU, and Landfill #1 areas are regularly inspected. Signage and fencing are inspected and maintained. Cover areas are inspected annually for erosion, settlement, undesirable vegetation, and other deficiencies. Required repair work to maintain proper grade and drainage is completed. Annual Cap and Cover Reports are submitted to the WDNR.

Interim Remedial Measures/Modified Interim Remedial Measures

The groundwater contamination from the PBG required an immediate response from the Army. Although an exhaustive investigation of groundwater contamination was not completed at the time, proposed interim remedial measures were evaluated in 1989. The goals of the early groundwater remedial action were to: 1) curb the advancement of the plume, 2) reduce contaminants within the plume, and 3) be compliant with local, state, and federal regulations. Options considered included: total plume capture, boundary control extraction, source control extraction, and a combination of boundary and source control extraction. Components of the remedy that were evaluated included: air stripping, activated carbon adsorption, and combined air stripping and carbon adsorption.

A groundwater pump and treat system was installed in 1990. At that time, the extent of groundwater contamination was believed to be within the installation boundaries. The IRM groundwater treatment system originally consisted of two source control wells and liquid phase granular activated carbon (GAC) treatment. The two source control wells (SCW-1 and SCW-2R) extract groundwater from the PBG area at a combined rate of approximately 350 gallons per minute (gpm). Figure 4 shows the locations of the existing IRM extraction wells.

Extracted groundwater is pumped through a GAC system that removes VOCs and DNT from the water by adsorption. The GAC system consists of two units that each contain 20,000 pounds of carbon. The treated water then flows through a 30-inch high-density polyethylene (HDPE) pipeline and discharges into the Lake Wisconsin Reservoir near Gruber's Grove Bay, regulated under a Wisconsin Pollutant Discharge Elimination System (WPDES) permit. A 10-inch pipeline to the Lake Wisconsin Reservoir was the original discharge line, and was used until the 30-inch line was constructed in 1995. The ozone treatment and multi-media filter were removed from the system during BEST System removal in 2008.

An evaluation of the IRM was conducted in 1993 to address new regulatory requirements. This evaluation concluded that the PBG Plume was not being entirely captured by the IRM system. In particular, the plume was extending beneath and east of the three original boundary control wells. A groundwater model was used to evaluate alternative groundwater extraction and treatment options. A groundwater treatment system was designed to augment the existing IRM system.

The MIRM system was installed in 1995. The MIRM groundwater treatment system originally consisted of six boundary extraction wells (EW-161, EW-162, EW-163, EW-164, EW-165, and EW-166), automatic self-cleaning strainers, air strippers, vapor phase GAC treatment, and liquid phase GAC treatment. Four additional extraction wells (EW-167, EW-168, EW-169, and EW-

170) were installed along the axis of the plume in 2005. The currently operating five MIRM extraction wells (EW-163R, EW-167, EW-168, EW-169, and EW-170R) extract groundwater from the PBG Plume at a combined rate of approximately 2,400 gpm. MIRM extraction well EW-164 is currently on standby and not pumping. Figure 4 shows the locations of the existing MIRM extraction wells.

A sulfuric acid tank and pumps are used for descaling the system periodically. A phosphate-based sequestering agent is added to avoid carbonate scaling and fouling of the system.

The water from the MIRM extraction wells flows through three individual air strippers for treatment of VOCs. Each air stripping tower is 27 feet high, eight feet in diameter, and constructed of fiberglass reinforced plastic. A 15.5-foot neoprene packing bed of 3.5-inch media is contained within each tower, which is designed to handle a normal flow of 1,000 gpm and a maximum flow of 1,500 gpm. Each air stripper contains a centrifugal blower capable of supplying 4,600 standard cubic feet per minute of air. The VOCs are thus transferred from water to air.

The air then flows through three GAC vapor phase units, to remove the VOCs through carbon adsorption before being released to the atmosphere. Each GAC unit contains 5,000 pounds of carbon. The MIRM air emissions have been monitored and found to be well below any applicable regulatory limits. The GAC treatment of the air emissions has been discontinued recently following WDNR approval in 2010. After approximately 98 percent of the VOCs have been removed, the water then collects in the air stripper basin.

The water then flows from the air stripper basin into the liquid phase GAC units. The liquid phase GAC treatment system consists of five GAC units arranged in parallel. Each unit has a self-cleaning strainer and two separate beds of GAC adsorbers. The ten liquid phase adsorbers contain 20,000 pounds of carbon each. The treated water is collected in the treated effluent storage basin. Approximately 500 gpm of treated water is used for the BAAAP fire suppression water supply system. The remaining treated water is discharged under a modified WPDES permit to the Lake Wisconsin Reservoir through a 30-inch HDPE pipeline.

The MIRM system was subsequently modified to include two more GAC units to increase the total capacity of the IRM/MIRM system to 4,500 gpm. In 2002, extraction well EW-163 was replaced with EW-163R due to equipment getting stuck in the borehole during maintenance operations. Additional modifications were made to the system in 2004 and 2005 by placing more extraction wells within the body of the plume. This allowed the system to treat water with the highest level of contaminants. MIRM well re-alignment activities in 2006 included the installation of four high-capacity wells, pumps, piping, and control systems. In 2008, one of the original source control wells (SCW-2) was abandoned and replaced with SCW-2R to allow the construction of the PBG cap. In 2010, extraction well EW-170 was replaced with EW-170R due to well bio-fouling and poor well performance.

Bio-fouling is caused by iron-oxidizing bacteria, commonly referred to as “iron bacteria”. The primary form of iron bacteria present at the IRM/MIRM is *Gallionella sp.*. Iron bacteria are

generally aerobic and oxidize iron and manganese to a lesser extent. Dissolved ferrous iron (II) is oxidized to ferric iron (III) or ferric oxide. The result is a mucilaginous slime that contains precipitated ferric oxide. The slime and ferric oxide protect the bacteria, but cause clogging of well screens, pipes, and pumps. Repeated well rehabilitation has been conducted consisting of the following: pre-rehabilitation video logging, wire brushing, bailing debris, adding hydrochloric acid, adding dispersant polymer, surging, acid removal and neutralization, and well sterilization with sodium hypochlorite. The iron bacteria are most likely from an indigenous source.

Total suspended solids cause clogging of the liquid phase GAC units, which subsequently require frequent backwashing. Backwashing currently occurs five to 10 times per month, which reduces the treatment capacity at the MIRM.

Currently, the IRM/MIRM and the wastewater treatment plant (WWTP) have a combined WPDES permit. Bluffview Sanitary District (BSD) is scheduled to take over operations of the WWTP in 2011. It is anticipated this changeover in the WWTP ownership along with the renewal of the WPDES permit by December 2011 will result in the submittal of separate permits by the Army and BSD.

4.2 Central Plume Area

The detection of DNT in groundwater at the Water's Edge Subdivision, south of the central portion of the installation near Gruber's Grove Bay, indicated additional sources of DNT in groundwater, besides the PBG and DBG, were present. In 2004, DNT was first detected within private wells located in the subdivision near Lake Wisconsin. The 2,6-DNT concentration in two private wells exceeded the Chapter NR 140, Wisconsin Administrative Code (Wis. Adm. Code), Enforcement Standard (ES). In 2005, the Army replaced these two private wells.

In 2006, the USDA installed a well (USDA 6) in the southeast portion of BAAAP to water cattle. The USDA 6 well is located approximately 4,300 feet north of the Water's Edge Subdivision. Sampling results indicated 2,6-DNT exceeded the Chapter NR 140, Wis. Adm. Code, ES. Based on the groundwater flow direction and the groundwater contaminant detections, the source of DNT contaminated groundwater is believed to be from the north-central portion of BAAAP where rocket paste and rocket propellant were produced. However, several investigations to date have not determined a specific source of DNT contamination. It is believed that the broad production area may have caused the groundwater impacts. The following is a summary of the DNT source investigations that were conducted in the Central Plume area.

DNT Source Investigation

In 2006, monitoring well sample results north and south of the USDA 6 well indicated the source of the Central Plume groundwater contamination was most likely located north of the Rocket Production Area. A DNT sources investigation followed.

Groundwater data and historical standard operating procedures were reviewed. Based on these reviews, the investigation of the source of DNT contamination focused on the Pre-Mix Houses,

located near the Rocket Paste area. The Pre-Mix Houses supported the production of rocket paste. Barrels of production chemicals, which contained DNT, were transported by rail to each Pre-Mix House from the Bag Loading House. NC and NG were added to the chemical mixture in each Pre-Mix House. The resulting slurry was then pumped to the Final Mix Houses.

In 2007, soil borings to a depth of 20 feet bgs were completed and continuously sampled at locations where releases of DNT may have occurred. Soil samples were analyzed for DNT, base neutral acids (BNAs), and total lead. DNT was not detected in soil samples collected adjacent to the Pre-Mix Houses. In 2008, soil samples were collected to a depth of nine feet bgs in ditches and potential drainage pathways leading from the Rocket Paste and NG Production areas. Only very low concentrations of DNT were detected in several soil samples. In 2010, soil samples were collected to a depth of eight feet bgs near over 20 production buildings located in the NG Production area. Only very low concentrations of DNT were detected in several soil samples.

Eight groundwater monitoring wells were installed in 2007. Five of the wells were constructed so that the screen intersected the water table. The three remaining monitoring wells were constructed so that the screen was centered at approximately two-thirds the depth of the sand and gravel aquifer. The wells ranged in depth from 106 to 207 feet bgs. Groundwater samples from each well were analyzed for VOCs, DNT, and BNAs. 2,4-DNT was detected in several monitoring wells and also the laboratory method blanks. The laboratory equipment may have contaminated the well samples, rendering these results invalid. Subsequent groundwater sampling conducted during June 2008 confirmed that 2,4-DNT was present in three of the eight wells.

4.3 Deterrent Burning Ground

The DBG area consists of seven acres and is located in the northeastern portion of BAAAP. The DBG area was used as a sand borrow pit from the 1940s until the early 1960s, and a waste disposal site from the 1940s to the 1970s. The DBG consisted of three burn areas within a man-made depression, approximately three acres in size and 20 feet deep.

Coal ash from the power plant, construction rubble, trash, and burned garbage were deposited inside the DBG sand borrow pit. The remaining portion of the DBG was used for open burning of deterrent, a liquid organic extract from surplus propellant, composed mostly of DNT and di-n-butyl phthalate, as well as minor amounts of diphenylamine, benzene, and NC. Structural timbers, asphalt shingles, cardboard, paper, and office waste were also burned in the pits. Subsurface soils at the DBG were found to be impacted with DNT, n-nitrosodiphenylamine, arsenic, and chromium. The majority of the impacts were found in the shallowest portion of the pit, with arsenic and chromium in limited areas of the site. Investigations also showed DNT spread laterally in the subsurface soils and reached groundwater.

Landfill #5 is located to the northeast of the DBG. During operations, the landfill reportedly received solid waste, including office waste, demolition debris, laboratory waste, and coal ash from the power plant. No hazardous materials were reported to have been disposed in Landfill #5. The landfill was opened in the early 1940s when operations began and was closed in 1989 with a clay cap.

An interim corrective action consisting of the removal and off-site incineration of DBG waste pit soil occurred in 1999 and 2000. Impacted soil from the three pits was excavated to a depth of approximately 15 feet. The total volume of the excavated and incinerated soil was approximately 4,260 cubic yards. Each pit was backfilled with clean fill to pre-excavation grades. This removed the surface soil contaminated with the highest DNT levels and metals.

In 2001, the backfilled area was temporarily capped and additional soil and groundwater studies were started to better understand the groundwater flow in the area. On May 6, 2002, following submittal of a revised AFS, the Army requested a permit modification to perform the remedial action (RA), including partial excavation and incineration (completed in 2000), resource conservation and recovery act (RCRA) cap/cover, institutional controls, and groundwater monitoring. The final remedy, approved by the WDNR, was installed in 2003.

5.0 GROUNDWATER CHARACTERIZATION

Monitoring well locations are shown on Figure 2. Since 1979, the Army has installed over 400 monitoring wells at BAAAP. Groundwater quality data is collected from monitoring wells to assess contaminant concentrations. The groundwater results are reported to the WDNR.

Between April and July of 2010, the Army installed 40 monitoring wells inside and outside BAAAP to supplement the existing groundwater monitoring network. Eleven of those monitoring wells were installed downgradient from the DBG. The installation and sampling of those eleven wells were documented in the *Northeast Boundary Monitoring Well Installation Report* (SpecPro, Inc., 2010). The other 29 monitoring wells were installed within the DBG, PBG, and Central Plumes. Appendix A contains documentation of the installation of these 29 monitoring wells and a well location map.

5.1 Groundwater Properties

Water Level Elevations and Flow Direction

Water level data collected from monitoring wells across BAAAP indicate groundwater depths ranging from 40 to 130 feet bgs or 765 to 855 feet above mean sea level (MSL). Figure 5 is a representation of the groundwater elevation surface in September 2010. The groundwater flow direction is generally to the south-southeast with more of an eastern component at the northeast boundary. In the southeast corner of BAAAP, groundwater flow is deflected slightly to the south, presumably due to influences from the Lake Wisconsin Reservoir. In the southwest corner of BAAAP, groundwater flow is influenced by the IRM/MIRM extraction wells. Due to the large number of monitoring wells, the elevation measurements for a sampling round are taken within a 30-day period. Direct comparison of water elevations between wells may or may not be valid, depending on precipitation events during a particular 30-day period.

The general groundwater flow direction at the installation is from north to south, but is locally influenced by the Lake Wisconsin Reservoir and the IRM/MIRM pumping wells. The Lake Wisconsin Reservoir, located to the east and southeast of BAAAP, is formed by the WP&L dam, which results in a constant lake elevation of approximately 774 feet MSL. Below the dam, the

water elevation drops abruptly to 736 feet MSL as the lake reverts to the flowing Wisconsin River. The rapid change in water elevations at the dam results in a dramatic hydraulic drop in groundwater elevations around the dam. The pumping of the IRM/MIRM extraction wells located on the western half of the BAAAP southern boundary results in an abrupt elongated groundwater depression zone. Groundwater captured by the depression zone flows toward the IRM/MIRM extraction wells where it is eventually pumped from the sand and gravel aquifer.

Comparison of groundwater and reservoir level elevations indicates water from the Lake Wisconsin Reservoir recharges groundwater or, depending on relation to the WP&L dam, groundwater discharges to the Wisconsin River. Groundwater discharges to the reservoir when adjacent groundwater levels are higher than the reservoir level. Groundwater discharges to the Lake Wisconsin Reservoir in the far northern portion of BAAAP, estimated at an approximate distance of 15,000 feet from the WP&L dam, and continues further upstream. The reservoir discharges to the sand and gravel aquifer when adjacent groundwater levels are lower than the reservoir level. About 15,000 feet north of the WP&L dam, the reservoir transitions from recharging to discharging to the underlying sand and gravel aquifer. Directly south of the WP&L dam, the Wisconsin River resumes with groundwater discharging to the river.

Hydraulic Conductivity

Hydraulic conductivity values were calculated based on aquifer testing at two extraction wells located near the PBG in 2005. The aquifer tests, which were comprised of a pump test followed by a step test, were conducted at extraction well EW-169 in February 2005 and at EW-167 in March 2005. The tests were conducted by continuously pumping the extraction wells over a period of time and measuring the drawdown in nearby observation wells. Observation wells (PBN-8504A, PBM-8505, and PBM-8904C) were monitored for the test at EW-169, which lasted two and one half days. The aquifer test at EW-169 yielded a hydraulic conductivity value between 1.39E-02 to 6.27E-02 centimeters per second (cm/sec). The aquifer test at extraction well EW-167 lasted seven days and drawdown was measured in four nearby observation wells (PBM-8503, PBN-8502A, PBN-8901C, and PBN-8902C). The results of this testing yielded a hydraulic conductivity value between 4.85E-02 and 9.60E-02 cm/sec. Testing methodology is presented in further detail in the *Draft Corrective Measures Implementation Report, MIRM Extraction Well Realignment Project* (Shaw Environmental, Inc., 2006).

Hydraulic conductivity was also estimated based on grain size data from sieve analyses; however, this method is much less accurate than aquifer test results. Eleven sand samples were collected during the pump tests in 2005 and submitted to Johnson Screens in New Brighton, Minnesota, for sieve analysis. The primary purpose of the analysis was to determine the appropriate screen for the well based on grain sizes, but this information was also useful in approximating hydraulic conductivity values. The samples predominantly consisted of fine to medium grained, well sorted sand. No fines (silt and clay) were reported in the samples and only two samples out of the 11 contained gravel size particles. Based on this type of lithology, the hydraulic conductivity value would be in the 10^{-1} to 10^{-3} cm/sec range.

Hydraulic Gradients

As evident from the groundwater elevation map showing the September 2010 data (Figure 5), the northern half of BAAAP has a much steeper horizontal hydraulic gradient than the southern half. Therefore, two data sets were used to calculate horizontal hydraulic gradient for each area. The magnitude and direction of flow for these two areas are represented by the groundwater contours presented in Figure 5. The hydraulic gradient calculated from the northern data set is 0.011 feet per foot (ft/ft). The hydraulic gradient calculated from the southern data set indicated 0.0016 ft/ft.

Horizontal hydraulic gradients were also evaluated over three depth intervals in wells at the DBG (*Groundwater Investigation Report, DBG*, Shaw Environmental, Inc., 2003). Wells are screened at various depths and assigned an alphabetical designation after the number of the well ID. A is the shallow water table interval, and B, C, D, and E are piezometric intervals that increase in depth from B to E. It should be noted that the unconsolidated sand aquifer is unconfined vertically because there may or may not be confining units (clay layers) between these screened intervals. The groundwater horizontal gradient within the water table interval A ranged from 0.0004 ft/ft to 0.0118 ft/ft, with an average of 0.0044 ft/ft. The average gradient within interval B was 0.0009 ft/ft, and interval C was 0.0004 ft/ft. This data indicated that horizontal hydraulic conductivity values in the water table interval were higher than the deeper intervals.

Vertical hydraulic gradients were evaluated for nested well pairs in the PBG and DBG source areas. Vertical groundwater movement is measured by comparing groundwater levels from the different aquifer intervals. Gradients were evaluated from the groundwater elevation data collected during the September 2010 monitoring event. The relative values indicate an essentially flat or slightly upward gradient.

Groundwater Flow Velocities

Groundwater flow velocity is derived from the hydraulic conductivity value, horizontal gradient, and effective porosity. It is a calculated value that provides an estimate of the rate of groundwater flow over time. The mathematical formula for determining groundwater flow velocity (v) is:

$$v = Ki/n_e$$

Where:

K = hydraulic conductivity (feet/day)

i = hydraulic gradient (feet/feet)

n_e = effective porosity

Velocities were calculated based on the two hydraulic conductivity values derived from the aquifer test and the step test in the wells in the PBG area of BAAAP. An effective porosity value of 0.26 was obtained during the recent groundwater modeling effort. Those hydraulic conductivity values ranged from an average of 0.002 cm/sec or 5.7 ft/day to 0.05 cm/sec or 142 ft/day. For the northern portion of BAAAP, the average horizontal gradient of 0.011 ft/ft was used, and for the southern portion of BAAAP, the average horizontal gradient of 0.002 ft/ft was

used. The average linear velocities are between 0.24 and 6.0 ft/day for the northern portion of BAAAP. For the southern portion of BAAAP, the average linear velocities range between 0.04 and 1.1 ft/day. These velocity values equate to 88 to 2,190 ft/year for the northern portion of the site and 15 to 402 ft/year for the southern portion.

5.2 Nature and Extent of Groundwater Contamination

Groundwater investigation activities at BAAAP began in 1980 and continue today. Site-wide groundwater-related assessment activities, agreed upon by the Army and WDNR, include the following: soil vapor surveys; monitoring well drilling, installation, and surveying; water level measurements; pump testing; monitoring well and residential drinking water well sampling; and groundwater modeling. Each year, the Army completes an *Annual Groundwater Narrative Summary Report* that summarizes the groundwater data collected during the previous year.

Historical Groundwater Plume Characterization

An installation RI began at BAAAP in 1988. The draft final (Phase 1) RI report (January 1990) indicated that two plumes of contamination had migrated beyond BAAAP boundaries. From the DBG/Landfill #5 area, a sulfate plume had been detected past the eastern boundary. Concentrations of sulfate at the eastern boundary were reported at 640 milligrams per liter (mg/l), but concentrations in private wells outside the boundary were below the Chapter NR 140, Wis. Adm. Code, PAL of 150 mg/l. From the PBG area, a plume of VOCs with CTET as the primary contaminant had moved past the southern boundary.

An off-site groundwater monitoring program was initiated in January 1990. In late April 1990, results of monitoring residential supply wells south of BAAAP showed that three private potable water wells had been contaminated with CTET and chloroform at levels of 80 µg/l and 9.9 µg/l, respectively. A VOC plume moved south from the PBG waste pits, past the installation's southern boundary, then easterly to the Wisconsin River below the WP&L dam. Two replacement residential wells were installed in December 1990 as a remedial measure. The third resident finalized their agreement with the Army in 1995, and the well replacement was completed in 1996. Prior to well replacement, bottled water had been provided to the affected residences. At the southern boundary of the PBG waste pits, the IRM system was constructed and began operating in May 1990.

The 1993 RI and 1994 FS identified the types, concentrations, and locations of contamination at the installation. This RI/FS looked at the possible ways to treat the contamination and recommended remedies for each site. The regulators agreed with the Army's recommendations for remedies. These were incorporated into the IFCR modifications of June 1995 and the RCRA permit modification of January 6, 1996.

The most recent groundwater data reported to the WDNR included results for 175 monitoring wells and 48 private wells that were sampled during the September and October 2010 rounds. The September and October 2010 groundwater monitoring data is summarized in Tables 1 and 2. See Appendix B for maps displaying groundwater concentrations from the September and

October 2010 groundwater data for CTET, chloroform, total DNT, ethyl ether, 1,1,1-trichloroethane (1,1,1-TCA), 1,1,2-trichloroethane (1,1,2-TCA), and TCE. Appendix B also contains maps of the September and October 2010 groundwater exceedances.

Wisconsin Groundwater Rule Revisions

Effective January 1, 2011, Chapter NR 140, Wis. Adm. Code, groundwater standards were revised. The revision included new standards for DNT (total residues). The ES for DNT (total residues) is 0.05 micrograms per liter (µg/l) and the PAL is 0.005 µg/l. All six DNT isomers (2,3-DNT; 2,4-DNT; 2,5-DNT; 2,6-DNT; 3,4-DNT; and 3,5-DNT) must be added together to determine the DNT (total residues) value, or total DNT. There is no existing federal standard for total DNT.

Propellant Burning Ground Plume

The PBG Plume originates at the PBG and extends southeast beyond the installation boundary. South of BAAAP, the plume turns southeast towards the Wisconsin River due to the influence of the WP&L dam, just north of Prairie du Sac. The PBG groundwater plume shown in Figure 6 represents the area where groundwater concentrations exceed a Chapter NR 140, Wis. Adm. Code, PAL for one or more of the following compounds: CTET, total DNT, ethyl ether, or TCE. All six DNT isomers (2,3-DNT, 2,4-DNT, 2,5-DNT, 2,6-DNT, 3,4-DNT, and 3,5-DNT) have been detected in the PBG Plume, mostly in the PBG Waste Pits. The plume boundary is an interpretation of the September and October 2010 groundwater data collected from both monitoring wells and private wells.

DNT is routinely detected in monitoring wells located both inside and outside of BAAAP. DNT has been detected at varying depths in the sand and gravel aquifer. The highest DNT concentrations are found at the PBG Waste Pits (source area). The IRM extraction wells, SCW-1 and SCW-2R, capture any contaminated groundwater migration from the PBG Waste Pits. The highest total DNT concentration detected during September 2010 was 1,166.1 µg/l in PBM-0002. PBM-0002 is located at the PBG Waste Pits. DNT is occasionally detected in private wells located south of BAAAP, but always at concentrations below the ES.

Elevated levels of CTET (above the ES) are routinely detected in monitoring wells located both inside and outside of BAAAP. CTET has been detected at varying depths in the sand and gravel aquifer. The highest of the CTET detections are found south of the PBG Waste Pits. Elevated concentrations of CTET are found near the MIRM extraction wells, near the BAAAP boundary, and in several wells located off-site towards the Wisconsin River. The highest CTET concentration detected during September 2010 was 75.9 µg/l in SWN-9103C. SWN-9103C is located south of BAAAP along County Road Z. The highest CTET concentration, 23 µg/l, located on BAAAP was detected in PBN-8502A. CTET (below the PAL) is rarely detected in private wells located south of BAAAP.

Elevated levels of TCE (above the ES) are routinely detected in monitoring wells located both inside and outside of BAAAP. TCE has been detected at varying depths in the sand and gravel

aquifer. The highest of the TCE detections are found south of the PBG Waste Pits. Elevated concentrations of TCE are found near the MIRM extraction wells, near the BAAAP boundary, and in several wells located off-site towards the Wisconsin River. The highest TCE concentration detected during September 2010 was 13.1 µg/l in SPN-8904C. SPN-8904C is located near the BAAAP boundary. The highest TCE concentration, 6.82 µg/l, located off-site was detected in PBN-9903C. TCE (below the PAL) is rarely detected in private wells located south of BAAAP.

Elevated concentrations of ethyl ether have only been detected near the BAAAP boundary. Only low concentrations of ethyl ether have been detected off-site. The highest ethyl ether concentration detected during October 2010 was 4,610 µg/l (above the ES) in PBN-1001C, located near an extraction well.

Central Plume

The Central groundwater plume shown in Figure 6 represents the area where groundwater concentrations exceed a Chapter NR 140, Wis. Adm. Code, PAL for total DNT. Only 2,4-DNT and 2,6-DNT have been detected in either monitoring wells or private wells in the Central Plume. The plume boundary is an interpretation of the September and October 2010 groundwater data collected from both monitoring wells and private wells. DNT has been detected at shallow depths in the sand and gravel aquifer. The highest total DNT concentration detected during October 2010 was 0.061 µg/l in RIN-1004B. RIN-1004B is located between the USDA 6 well and the Water's Edge Subdivision.

In 2004, DNT was first detected within private wells located in the Water's Edge Subdivision, along the north shore of Gruber's Grove Bay. The 2,6-DNT concentration in two private wells exceeded the Chapter NR 140, Wis. Adm. Code, ES. In 2005, the Army replaced these private wells. Also in 2005, the Army installed eight monitoring wells in the Water's Edge Subdivision to monitor the groundwater quality. Sampling results indicate that 2,6-DNT is routinely found above the Chapter NR 140, Wis. Adm. Code, ES in two of these monitoring wells.

In 2006, the USDA installed a well (USDA 6) at BAAAP. The well is located approximately 4,300 feet upgradient of the Water's Edge Subdivision. 2,6-DNT is routinely found above the Chapter NR 140, Wis. Adm. Code, ES in the USDA 6 well. The Army has sampled existing monitoring wells at BAAAP and installed additional monitoring wells to define the DNT groundwater plume. Results from these additional wells indicate the source of DNT groundwater contamination is located north of the Rocket Production Area in BAAAP. The source of the Central Plume is not clearly defined.

Deterrent Burning Ground Plume

The DBG groundwater plume shown in Figure 6 represents the area where groundwater concentrations exceed a Chapter NR 140, Wis. Adm. Code, PAL for either total DNT or 1,1,2-TCA. Only five DNT isomers (2,3-DNT, 2,4-DNT, 2,6-DNT, 3,4-DNT, and 3,5-DNT) have been detected in the DBG Plume, mostly in the DBG source area. The plume boundary is an

interpretation of the September and October 2010 groundwater data collected from both monitoring wells and private wells.

DNT is routinely detected in monitoring wells located at BAAAP. DNT has been detected at varying depths in the sand and gravel aquifer. The highest DNT concentrations are found near the DBG (source area). The highest total DNT concentration detected during September 2010 was 5.982 µg/l in ELM-8901. ELM-8901 is located just east of the DBG. DNT has migrated downgradient from the DBG, east and southeast, and has been detected in several monitoring wells located on the BAAAP boundary. In 2003, DNT was first detected in the ELM-9501 well nest. DNT is routinely detected in the ELM-9501 well nest consisting of ELM-9501, ELN-0801B, ELN-0801C, and ELN-0801E.

Detections of DNT have been sporadic in private wells located southeast of BAAAP (Weigand's Bay area). Results from the August 2010 sampling of 21 private wells located in the Weigand's Bay area found that DNT was not detected.

Elevated levels of 1,1,2-TCA, between the PAL and ES, are routinely detected in one monitoring well (ELN-8203B) located east of the DBG. The concentration of 1,1,2-TCA in ELN-8203B was 1.12 µg/l in September 2010. 1,1,2-TCA is detected in several other monitoring wells but below the PAL. 1,1,2-TCA has been detected (below the PAL) in a private well located east of BAAAP.

In 2009, additional investigation work was conducted southeast of the DBG to delineate the downgradient extent of the DBG Plume. Groundwater samples were collected from 12 temporary soil borings. The investigation defined the extent of the DNT and VOC plume. The data indicated that DNT had migrated outside the BAAAP boundary. The results from this investigation were used to determine the best placement of permanent monitoring wells in the area. Further information on this investigation is presented in the *Northeast Boundary Groundwater Investigation Report* (SpecPro, Inc., December 2009).

During 2010, 11 monitoring wells were installed downgradient of the ELM-9501 well nest. These wells were intended to monitor any off-site migration of DNT and VOCs. DNT was not detected in these 11 monitoring wells. The low 1,1,1-TCA concentrations found in ELN-1003B and ELN-1003C are well below the PAL. Because 1,1,1-TCA has also been consistently detected in upgradient wells near the DBG, the DBG is a likely source of these off-site 1,1,1-TCA detections. Further information on the monitoring well installation is presented in the *Northeast Boundary Monitoring Well Installation Report* (SpecPro, Inc., September 2010).

5.3 Groundwater Modeling

A groundwater model was developed to help understand how the groundwater flows beneath BAAAP and help predict the movement of groundwater contamination. A groundwater model is not an exact description of the subsurface but uses mathematical equations to estimate the subsurface conditions. A groundwater model is just a tool to help understand the complicated interaction between soil, bedrock, groundwater, and contaminants.

Groundwater modeling conducted in conjunction with this AFS consisted of reviewing and updating the existing groundwater flow and solute transport models developed previously for the BAAAP. These previous studies included, but were not limited to, the groundwater flow and solute transport models developed by Woodward-Clyde in 1995, T N & Associates and Stone & Webster in 2001 for the PBG, and the subsequent refinement of that effort completed by Shaw Environmental, Inc. (Shaw) in 2006. The current effort entailed: 1) making further adjustments to the site-wide groundwater flow model developed by Shaw; 2) updating the groundwater flow and solute transport models completed by Shaw for the PBG; 3) developing sub-models for the DBG and the Central Plume; and 4) performing model simulations to approximate the migration of the groundwater contaminant plumes over time. Appendix C contains the groundwater modeling technical memorandum prepared by Mr. David Voight (subcontractor to SpecPro).

The Department of Defense Groundwater Modeling System (GMS) (2010) version 7.1 is a comprehensive computer graphical system, which includes modeling tools to facilitate site characterization, model conceptualization, mesh and grid generation, geostatistical computations, and postprocessing. GMS is a state-of-the-art graphical computer interface that is linked with groundwater transport and water quality models to predict the fate and transport of contaminants at a site. Several geostatistical (interpolation/extrapolation) numerical tools are integrated into GMS to help visualize and model the distribution of contaminants in the groundwater.

The latest update of the modular finite-difference groundwater flow model (MODFLOW) was used to calculate the groundwater flow field at BAAAP. MODFLOW is a commonly used groundwater flow model used to solve groundwater flow equations in three dimensions. Solute contaminant transport was evaluated by using MT3DMS, a modular three-dimensional multispecies transport model for the simulation of advection, dispersion, and chemical reactions of dissolved constituents in groundwater.

Site-Wide Groundwater Flow Model

The original groundwater flow model, generated with MODFLOW, consisted of six stratigraphic layers. Layers 1, 3, and 4 were previously determined to consist of sand deposits, whereas layer 2 was a mixture of gravel and sand. Layer 5 was reported to consist of a 30-foot thick gravel deposit sitting above impermeable bedrock (layer 6). Woodward-Clyde reported a combined saturated thickness of 170 feet beneath BAAAP. This information was used along with soil type, soil thickness, and hydraulic conductivity data obtained from the numerous soil borings at BAAAP to update the model. Hydraulic head data was referenced to the screen depth in groundwater monitoring wells and were auto assigned to the appropriate model layers. The boundary conditions used during the development of the Shaw site-wide groundwater model were retained for the current update. The updated site-wide MODFLOW model also consists of six stratigraphic layers. No changes to the overall size of the model domain were made for the site-wide groundwater model. Grid cell dimensions were reset at 150 feet by 150 feet spacing across the entire model domain to provide a framework sufficient for analyzing groundwater flow patterns and for assessing groundwater contaminant plume occurrence and movement. The updated model boundaries are shown on Figure 4 located in Appendix C.

A steady-state calibration was performed and the simulated heads were compared to observed heads at selected locations measured during September 2010. Steady-state is a condition where the flow through the model does not change over time. Model calibration and verification statistics met accepted modeling acceptance criteria. The calibrated model is capable of producing simulated heads that correlate reasonably well with the observed heads within the modeling domain. The most obvious discrepancies between observed and simulated heads occur in areas with the least amount of observation data (near the domain boundaries), with the best agreement occurring within the area of groundwater impacted by the COCs.

Drawdown data from the IRM/MIRM extraction wells were evaluated during the current modeling effort by using MODPATH, a particle tracking computer code that uses MODFLOW output to generate a set of pathlines from particles placed within the model domain. Particle tracking simulations performed during the current modeling effort show that hydraulic control is generally achieved by the IRM/MIRM at the pumping rates used in the model (see Figure 16 in Appendix C). The IRM/MIRM pumping rates used in the model are shown below.

Pumping Well	Flow Rate (gpm)
SCW-1	150
SCW-2R	200
EW-163R	625
EW-167	425
EW-168	425
EW-169	425
EW-170R	575

Groundwater Flow Sub-models

Sub-models representing groundwater flow within each area of interest, DBG, PBG, and Central Plume, were developed from the calibrated site-wide groundwater flow model (see Figure 2 in Appendix C). Boundary conditions, recharge rates, hydraulic conductivity values, and other information associated with each material's layer was retained during sub-model development. Each sub-model also underwent separate calibration and verification steps to confirm model use and acceptability for subsequent solute transport model development.

Solute Transport Sub-models

Solute transport modeling using MT3DMS was performed to provide a preliminary evaluation of transport characteristics of the CTET and DNT (total residues) or total DNT groundwater contaminant plumes at the PBG, and the total DNT plumes at the Central Plume and DBG. The PBG plume was modeled for CTET and DNT because these COCs represent the maximum extent of groundwater contamination. The MT3DMS sub-models developed for each area used MODFLOW groundwater flow output as direct input into MT3DMS, providing the basis for the contaminant transport simulations.

A sensitivity analysis was performed on the DNT sub-model developed for the PBG. The sub-model was most sensitive to porosity. Variations to longitudinal dispersivity and bulk density had little effect on the sub-model.

CTET and total DNT contaminant transport in groundwater was simulated for 30 years using the existing IRM/MIRM pumping conditions. Model development included the use of fate and transport data contained in the prior solute transport model developed by Shaw for the PBG as well as other information obtained from published sources. Active IRM/MIRM extraction wells were simulated as point sinks for contaminants and recharge was simulated as a source of clean water. Each sub-model underwent normal model calibration and verification to verify model performance. This was accomplished by comparing model computed contaminant concentrations to those observed in the field for March 2007 and September 2010.

An update of the existing site-wide groundwater flow and solute transport models developed for BAAAP has provided additional information regarding the likely extent and migration pathways of the CTET and total DNT groundwater contaminant plumes.

Groundwater Model Solute Transport Findings

Contaminant plume occurrence as predicted by the groundwater model is based on reasonable assumptions made during model set-up and execution. The modeling results are not to be considered a representation of the actual site conditions. All simulations assumed the IRM/MIRM extraction wells were continuously operating at the current flow rates.

The model simulated extent of the PBG CTET plume for September 2010 is shown on Figure 19 in Appendix C. Also shown on Figure 19 in Appendix C are the solute transport model simulations from 2010 to 2040. The simulations predict continued migration of the PBG CTET plume that is already located south of BAAAP. Based on the model simulations, the majority of the plume mass will be located south of BAAAP by 2030, with the migrating plume exhibiting concentrations of less than 5 µg/l. The reduction of the PBG CTET plume located on BAAAP is due to continual treatment of groundwater by the IRM/MIRM. The simulations indicate that the CTET plume migrates into the Wisconsin River. Contaminant concentrations with the PBG CTET plume will decrease over time, although the model predicts that the extent of the off-site plume in 2040 will remain similar in size and shape to that observed in 2010.

The model simulated extent of the PBG DNT plume for September 2010 is shown on Figure 21 in Appendix C. Also shown on Figure 21 in Appendix C are the solute transport model simulations from 2010 to 2040. The simulations predict that the PBG DNT plume will remain mostly on BAAAP and be captured by the IRM/MIRM. The concentrations of total DNT at the PBG are expected to continue to decrease over time, with the plume narrowing and becoming more confined due to chemical reactions occurring within the plume, and dilution at the plume edges. Low concentrations of DNT are expected to remain in the PBG area until 2035.

The model simulated extent of DNT in the Central Plume for September 2010 is shown on Figure 26 in Appendix C. Also shown on Figure 26 in Appendix C are the solute transport

model simulations from 2010 to 2040. The lack of historical groundwater monitoring data associated with the Central Plume prevented a detailed extrapolation of long-term contaminant trends. The simulations suggest that the Central Plume is stable and shrinking, with notable decreases in plume size occurring over time and the plume disappearing in 2040.

The model simulated extent of the DBG DNT plume for September 2010 is shown on Figure 31 in Appendix C. Also shown on Figure 31 in Appendix C are the solute transport model simulations from 2010 to 2040. Due to the limited well control downgradient of the DBG area and the inconsistent layers of fine-grained soil, the model was unable to accurately predict the groundwater flow movement. Due to these limitations, the model predictions for the DBG DNT plume don't accurately represent actual site conditions. Model simulations indicate that the mass of DNT at the DBG will decrease over time. Considerable reduction in plume size and DNT concentrations are expected by 2030, with the plume disappearing by 2040.

6.0 CONCEPTUAL SITE MODEL

In order to more fully understand the relationships between contaminants, affected environmental media, exposure pathways, and human and ecological receptors, a CSM was developed. A CSM is a conceptual understanding of a site that identifies suspected sources of hazardous substances, types, and concentrations of hazardous substances, potentially contaminated media, and actual and potential exposure pathways and receptors. Figure 7 shows a CSM based on the known presence and transport of COCs.

6.1 Current and Potential Land Uses

The BAAAP is a former munitions components production facility undergoing demolition, investigation, and remediation activities. The property under Department of Defense ownership has an active security, administration, environmental, maintenance, and demolition workforce. Army staff manage all aspects of ongoing work. Currently, a portion of the installation is off limits to the public and is secured by a security fence.

Future use of the former BAAAP will be divided between the USDA, Wisconsin Department of Transportation (WDOT), United States Bureau of Indian Affairs (BIA) on behalf of the Ho-Chunk Nation (HCN), United States Department of Health Services on behalf of the BSD, Town of Sumpter, and the National Park Service (NPS) on behalf of the WDNR. The installation will serve as agricultural and grazing land (USDA and BIA/HCN), recreational land (NPS/WDNR), cemeteries (Town of Sumpter), and as a wastewater treatment plant (BSD).

6.2 Sources of Contamination

On-Site Sources

Sources of groundwater contamination include the PBG, DBG, and the Central Plume source areas. Figure 1 shows the locations of these source areas and Figure 6 shows groundwater contaminant plumes. DNT and chlorinated solvents are known to have been disposed in the PBG and DBG source areas. WDNR-approved remedial actions relating to soil contamination at

the PBG and DBG source areas have been implemented. The source of the Central Plume contamination is generally located based on groundwater flow direction and the groundwater contaminant detections. DNT contaminated groundwater is believed to be from the north-central portion of BAAAP where rocket paste and rocket propellant were produced. It is believed general production operations in this area caused the groundwater impacts.

Off-Site Sources

Nitrates from non-point sources that are outside of Army control are known to affect groundwater in and around BAAAP. The WDNR has a best management practice program it administers for these agricultural and grazing-related sources.

An unknown source of TCE has been detected in monitoring well BGM-9103, on the west-central boundary of BAAAP. Based on the groundwater flow direction, the source of TCE appears to be located off-site (northwest of BGM-9103).

6.3 Environmental Medium and Exposure Points

Groundwater is the environmental medium of concern at the BAAAP. Both the shallow unconsolidated and deeper bedrock groundwater aquifers are sources of potable water in residential communities downgradient (south and east) of the installation boundaries. In addition, groundwater discharges into the Lake Wisconsin/Lower Wisconsin River area.

6.4 Exposure Pathways and Receptors

Workers involved with groundwater remediation, investigation, actions, and monitoring are subject to some level of risk when working at the BAAAP. Worker safety is currently managed through a health and safety program that complies with all Occupational Safety and Health Administration (OSHA), Department of Defense, and other state and federal health and safety requirements; therefore, this exposure route is not currently a risk or regulatory concern.

The general public are subject to some level of risk through recreational use of the Lake Wisconsin/Lower Wisconsin River. VOCs and Semi-Volatile Organic Compounds (SVOCs) do not bioaccumulate in organisms. For this reason, consumption of fish from Lake Wisconsin or the Lower Wisconsin River way is identified as a pathway of no regulatory concern. In addition, a comparison of National Recommended Water Quality Criteria, developed to protect aquatic life from acute and chronic health effects, shows all surface water criteria are much higher than the groundwater concentrations off-site. Therefore, exposure through surface water is currently not a risk or regulatory concern. For more information on National Recommended Aquatic Life Values, refer to United States Environmental Protection Agency publication *2009 National Recommended Water Quality Criteria* available at http://www.epa.gov/ost/criteria/wqctable/.

Groundwater used for private drinking water has been a concern of residents nearby BAAAP. The Army currently has an environmental monitoring and health protection program in place that is protective of the private water well users. If a Chapter NR 140, Wis. Adm. Code, ES is exceeded in a private well in two consecutive sampling rounds, bottled water is made available

to the occupants and well replacement is offered to the owner. To date, the Army has replaced five shallow private wells with deeper aquifer private wells. However, this exposure route continues to be a potential risk and regulatory concern. It should be noted, per consultation with the WDNR, irrigation wells downgradient of BAAAP are not monitored now and are not considered to be a potential risk or regulatory concern.

7.0 REGULATORY REQUIREMENTS

Under Section NR 722.09(2), Wis. Adm. Code, *Selection of a remedial action*, responsible parties shall select a remedial action...(that shall) comply with all applicable state and federal public health and environmental laws and standards. The following subsections outline the regulations applicable and relevant to the groundwater plumes at BAAAP.

7.1 Wisconsin Groundwater Quality Regulations

Chapter NR 140, Wis. Adm. Code, establishes ESs and PALs for groundwater beneath the State of Wisconsin. The Wisconsin groundwater ES is consistent with federal and state drinking water Maximum Contaminant Levels (MCLs), which applies to public water systems.

Enforcement Standards

The groundwater ESs are protective of public health and welfare on the premise that the groundwater may be ingested through use as drinking water. ESs exist for all the groundwater VOC and SVOC COCs listed in Table 3. All ESs are Public Health Groundwater Quality Standards listed in Table 1 at Section NR 140.10, Wis. Adm. Code, except sulfate, which is a Public Welfare Groundwater Quality Standard listed in Table 2 at Section NR 140.12, Wis. Adm. Code.

Preventive Action Limits

The PALs serve “to inform the WDNR of potential groundwater contamination problems (and to) establish the level of groundwater contamination at which the WDNR is required to commence efforts to control the contamination”. PALs exist for all the groundwater COCs listed in Table 3. All PALs are Public Health Groundwater Quality Standards listed in Table 1 of Section NR 140.10, Wis. Adm. Code, except sulfate, which is a Public Welfare Groundwater Quality Standard listed in Table 2 in Section NR 140.12, Wis. Adm. Code.

Action Required for Exceedance of an ES or a PAL

Actions required by a groundwater ES exceedance are codified in Section NR 140.26, Wis. Adm. Code (Table 6). The regulation lists eight responses appropriate to the detection of an ES exceedance. They are as follows:

1. Require a revision of the operational procedures at a facility, practice or activity.
2. Require a change in the design or construction of the facility, practice or activity.

3. Require an alternate method of waste treatment or disposal.
4. Require prohibition or closure and abandonment of a facility, practice or activity.
5. Require remedial action to renovate or restore groundwater quality.
6. Require remedial action to prevent or minimize the further release of the substance to groundwater.
7. Revise rules or criteria on facility design, location or management practices.
8. Require the collection and evaluation of data to determine whether natural attenuation can be effective to restore groundwater quality within a reasonable period of time, considering applicable criteria specified in ss. NR 140.24, 722.07 and 722.09 or 722.11, and require monitoring to determine whether or not natural attenuation is occurring in compliance with the requirements of s. NR 140.26(2)(a).

The Army has completed or has in place action specific steps 1 through 7 and will evaluate action step 8 more thoroughly during this AFS.

Section NR 140.24, Wis. Adm. Code, (Table 5) lists 12 responses appropriate to the detection of a PAL exceedance. They are as follows:

1. No action pursuant to s. NR 140.24(5) and consistent with s. 160.23, Stats.
2. Require the installation and sampling of groundwater monitoring wells.
3. Require a change in the monitoring program, including increased monitoring.
4. Require an investigation of the extent of groundwater contamination.
5. Require a revision of the operational procedures at the facility, practice or activity.
6. Require a change in the design or construction of the facility, practice or activity.
7. Require an alternate method of waste treatment or disposal.
8. Require prohibition or closure and abandonment of a facility, practice or activity in accordance with sub. (6).
9. Require remedial action to renovate or restore groundwater.
10. Require remedial action to prevent or minimize the further discharge or release of the substance to groundwater.
11. Revise rules or criteria on facility design, location or management practices.
12. Require the collection and evaluation of data to determine whether natural attenuation can be effective to restore groundwater quality within a reasonable period of time, considering applicable criteria specified in ss. NR 140.24, 722.07 and 722.09 or 722.11, and require monitoring to determine whether or not natural attenuation is occurring in compliance with the requirements of s. NR 140.26(2)(a).

The Army has completed or has in place action specific steps 1 through 11 and will evaluate action step 12 more thoroughly during this AFS.

7.2 Wisconsin Water Quality Standards and Criteria

The Wisconsin Water Quality Standards and Criteria requirements are applicable to existing and proposed point source discharges to surface waters of the state that may be associated with the final groundwater remedy. Two downgradient surface water bodies are in the area: the Lake Wisconsin Reservoir (above the WP&L dam) and the Lower Wisconsin River (below the WP&L dam).

The designated use for the Lake Wisconsin Reservoir is defined as "warm water sport fish community" in Section NR 102.13, Wis. Adm. Code. The use classification for the Lower Wisconsin River, below the WP&L dam to Prairie du Chien, is "Exceptional Resource Water" in Section NR 102.11, Wis. Adm. Code.

Water Surface Quality Criteria have been developed in Wisconsin as "Human Threshold Criteria" for 2,4-DNT and 1,1,1-TCA. Wisconsin "Human Cancer Criteria" have been developed for the following: CTET, chloroform, 2,4-DNT, 1,1,2–TCA, and TCE.

Wisconsin Human Threshold Criteria

The human threshold criterion (HTC) is the maximum concentration of a substance established to protect humans from adverse effects resulting from contact with or ingestion of surface waters of the state and from ingestion of aquatic organisms taken from surface waters of the state. Human threshold criteria are derived for those toxic substances for which a threshold dosage or concentration can be estimated below which no adverse effect or response is likely to occur. (Section NR 105.08, Wis. Adm. Code). Currently, HTC-Non-Public Water System (NPWS) have been developed in Wisconsin for two relevant COCs: 2,4-DNT and 1,1,1-TCA.

Chronic exposure to 2,4-DNT at 13 µg/l has been shown to have no adverse effect due to human ingestion of surface water and organisms. The maximum value of 2,4-DNT found in off-site wells (monitoring or residential well) in 2010 was 0.02 µg/l, or less than 1% of the permissible HTC-NPWS criteria.

Chronic exposure to 1,1,1-TCA at 270,000 µg/l has been shown to have no adverse effect due to ingestion of surface water and organisms. 1,1,1-TCA was not found above detectible levels in any off-site wells in 2009.

Wisconsin Human Cancer Criteria

The human cancer criterion (HCC) is the maximum concentration of a substance or mixture of substances established to protect humans from an unreasonable incremental risk of cancer resulting from contact with or ingestion of surface waters of the state and from ingestion of aquatic organisms taken from surface waters of the state over a lifetime of 70 years (Section NR 105.09, Wis. Adm. Code). Currently, HCC- NPWS have been developed in Wisconsin for five relevant COCs: CTET, chloroform, 2,4-DNT, 1,1,2–TCA, and TCE.

Chronic exposure to chloroform at 1,960 µg/l, 2,4-DNT at 13 µg/l, 1,1,2-TCA at 195 µg/l, and TCE at 539 µg/l has been shown to have no unreasonable incremental risk of cancer due to ingestion of surface water and organisms. The maximum value of any of these chemicals found in off-site monitoring wells in 2010 is less than 4% of the permissible HCC-NPWS criteria.

Chronic exposure to CTET at 29 µg/l has been shown to have no unreasonable incremental risk of cancer due to ingestion of surface water and organisms. The maximum value of CTET found in off-site monitoring wells in 2010 is 248% of the permissible HCC-NPWS criteria. This monitoring well (SWN-9103C) in the PBG Plume is located approximately 3,200 feet from the Wisconsin River. Monitoring well PBN-9101C is located further downgradient and only 1,400 feet from the Wisconsin River. The last time PBN-9101C was sampled in 1998, the CTET value was less than 30% of the permissible HCC-NPWS criteria.

Numerous studies or tests have been conducted throughout the years in which surface water samples have been collected and analyzed. Data collected includes Gruber's Grove Bay investigations conducted by Shaw Environmental, Inc. and an April 2007 Weigand's Bay water sample, the December 2007 shallow temporary well water samples (adjacent to Weigand's Bay), and the annual WPDES Whole Effluent Toxicity Monitoring (background samples collected near Inspiration Point and Weigand's Bay) conducted by SpecPro, Inc. Based on the data from these investigations and applicable scientific and regulatory information, the residual contaminant plumes do not adversely affect ecological receptors in the environment.

8.0 REMEDIAL ALTERNATIVES

8.1 Groundwater Remedial Action Objective

The objective of the groundwater remedial action is to protect human health by preventing exposure of contaminated groundwater from BAAAP, to restore groundwater to the extent practicable, and minimize the impact of the contaminant plumes on the environment.

8.2 Remedial Alternatives

Based on site conditions and the screening of cleanup action options, three remedial alternatives were developed to address the presence of contaminants in groundwater at the BAAAP. Each alternative is capable of accomplishing the remedial objective.

Alternative 1: IRM/MIRM Treatment and Monitored Natural Attenuation
This alternative continues IRM/MIRM treatment of the PBG Plume, residential and groundwater monitoring, and natural attenuation of the DBG and Central Plumes.

Alternative 2: In-Situ Biochemical Treatment
This alternative would use in-situ groundwater treatment instead of the current IRM/MIRM treatment, a modified residential and groundwater monitoring program, and natural attenuation of the PBG, DBG, and Central Plumes.

Alternative 3: Public Water System

This alternative involves the installation of a public water system and subsequent elimination of residential wells and IRM/MIRM treatment, a modified groundwater monitoring program, and natural attenuation of the PBG, DBG, and Central Plumes.

8.3 Detailed Analysis of Alternatives

The following describes the conceptual design and criteria for detailed analysis of each alternative. This section provides a description of the criteria for detailed analysis and the detailed analysis of the groundwater alternatives. Each alternative is evaluated against the same criteria established by the WDNR in accordance with Chapter NR 722, Wis. Adm. Code, Standards for Selecting Remedial Actions.

The development of remedial alternatives is evaluated for each contaminated medium or migration or exposure pathway. This evaluation process is to be used to determine which remedial alternative constitutes the most appropriate technology or combination of technologies to restore the environment, to the extent practicable, within a reasonable period of time, and to minimize the harmful effects of the contamination to the air, land, or waters.

Criteria for Detailed Analysis

Relative performance of each alternative is evaluated using the following nine criteria:

1. Overall protection of human health and the environment
   The remedy should be protective of human health and minimize the harmful effects to the environment.

2. Compliance with applicable regulations
   This shall include federal and state regulations.

3. Long-term effectiveness and permanence
   This shall consider the risks remaining after completion of the remedial action and the adequacy and suitability of controls, if any, that are used to manage untreated contaminants remaining at the site.

4. Reduction of toxicity, mobility, and volume through treatment
   This shall include the expected reduction in toxicity, mobility, and volume measured as a percentage or order of magnitude, and the type and quantity of treatment residuals that will remain following treatment.

5. Short-term effectiveness
   This shall include protection of the community during the remedial action, protection of workers during remedial action, environmental impacts to natural resources, and time until remedial response objectives are achieved.

6. Implementability
   This shall consider the feasibility of the remedy including: construction and operation; reliability of technology; ease of undertaking additional remediation, if necessary; and monitoring considerations, addressing the ability to adequately monitor the effectiveness of the remedy and the risks should monitoring be insufficient to detect a system failure.

7. Cost
   This shall consider capital costs, both direct and indirect; annual operations and maintenance (O&M) costs; and present worth analysis (or net present value) of costs.

8. State Acceptance
   This shall consider the issues and concerns that the state may have regarding each alternative. This criterion will be evaluated throughout the development, screening, and evaluation of alternatives based on comments and input received from the WDNR.

9. Community Acceptance
   This involves an evaluation of issues and concerns the public may have regarding each alternative. This criterion will be evaluated throughout the development, screening, and evaluation of alternatives based on comments and input received from the public.

8.4 Alternative 1 – IRM/MIRM Treatment and Monitored Natural Attenuation

Under this alternative, groundwater extraction and treatment of the PBG plume inside the BAAAP boundaries would continue as currently operating.

The current practice of monitored natural attenuation would continue for the other areas of groundwater concern, including the DBG and Central Plumes. Long-term monitoring of the groundwater and residential wells to ensure that remediation and natural attenuation are progressing toward regulatory standards would continue.

Periodic analysis of groundwater (monitoring wells and private wells) would measure the status of the contaminated groundwater plumes, determining when concentrations have decreased below Chapter NR 140, Wis. Adm. Code, standards. After state standards are met the IRM/MIRM would be shut down. Groundwater monitoring would continue for several years, monitoring the PBG plume to ensure stable or receding conditions.

Overall Protection of Human Health and the Environment

This alternative would control and limit the migration of the PBG Plume. Monitoring of private wells would continue, and private wells would be replaced if a Chapter NR 140, Wis. Adm. Code, ES is confirmed. Contaminant concentrations are predicted to decrease through natural attenuation processes. Based on the applicable scientific and regulatory information, the residual contaminant plumes do not adversely affect ecological receptors in the environment.

Compliance with Applicable Regulations

This alternative currently complies with applicable regulations.

Long-Term Effectiveness and Permanence

In this alternative, contaminant concentrations would continue to decrease below regulatory standards through recovery, treatment, and natural processes (dilution, dispersion, and sorption). Monitoring of the plumes would continue for several years after the plumes attenuate to ensure that all areas remain below regulatory standards. Monitoring of residential wells would continue until WDNR concurrence the plumes are in stable or receding conditions.

Reduction of Toxicity, Mobility, and Volume through Treatment

Reductions in toxicity, mobility, and volume would occur through treatment and natural processes. The groundwater contamination would continue to decrease due to natural attenuation processes.

Short-Term Effectiveness

The short-term impacts of alternatives shall be assessed considering the following: short-term risks that might be posed to the community during implementation of an alternative; potential impacts on workers during remedial action and the effectiveness and reliability of protective measures; potential environmental impacts of the remedial action and the effectiveness and reliability of mitigative measures during implementation; and time until protection is achieved.

For this alternative, short-term risks to the community and workers could include those due to potential human or ecological exposure to contaminants. However, there would be no additional short-term risk as this WDNR-approved alternative is already in place and operating on-site.

Implementability

This alternative has already been implemented.

Cost

The estimated present worth costs for Alternative 1 are shown below. See Appendix D for a summary of the costs for Alternative 1.

Engineering design:	$	0
Capital cost:	$	0
Annual O&M:	$	76,911,000
Monitoring and closeout plan/report:	$	55,000
Total present worth:	**$**	**76,966,000**

* Present worth costs use current rates and do not include inflation

State Acceptance

This alternative is a continuation of the current interim groundwater remedy accepted by the WDNR; therefore, it is likely that the WDNR would continue to accept this remedy. However, this criterion would be evaluated throughout the development, screening, and analysis of alternatives based on comments and input received from the WDNR.

Community Acceptance

This alternative is a continuation of the current interim groundwater remedy; therefore, it is likely that the community would continue to accept it. However, this criterion would be evaluated throughout the development, screening, and analysis of alternatives based on comments and input received from the public.

8.5 Alternative 2 – In-Situ Biochemical Treatment

This alternative would involve the in-situ biochemical treatment of each of the three plumes (PBG, DBG, and Central), with groundwater monitoring. Only the portions of the plumes that are located on BAAAP would be treated. Natural attenuation would continue for other areas outside the installation boundaries.

The treatment of chlorinated solvent contaminated groundwater has been well studied, but DNT has not. The one known effective in-situ treatment for both types of contamination would consist of injecting a consortium of naturally-occurring microbes selected for their ability to degrade specific chemicals into harmless by-products through aerobic co-metabolism. This bioremediation product, known as CL-Out®, is marketed by CL Solutions, LLC of Cincinnati, Ohio.

This bio-augmentation treatment by CL-Out® introduces a high population of effective degrading organisms, called pseudomonas, into the treatment zone. The population delivered into the treatment zone is 100 to 1,000 times higher than the native bacterial population. While there may be indigenous organisms capable of degrading the contaminants, the benefit of bio-augmentation is that the added population more effectively degrades the contaminants over a shorter amount of time. CL-Out® has been proven at sites across the United States to be capable of remediating chlorinated VOC compounds in the groundwater.

A treatability study was conducted at BAAAP using CL-Out® in 2008. The study consisted of treating two identical groundwater samples as microcosms and a third identical untreated sample maintained under the same conditions as a standard for comparison. One of the microcosms received just a dosage of CL-Out® and the other microcosm was treated with CL-Out® and dextrose. The dextrose was added to determine whether a carbon source was necessary to support microbial growth because the concentration of DNT and other organics in the groundwater were very low. Samples were collected from each microcosm at intervals following treatment. The results of the treatability study showed that the CL-Out® was very effective in degrading the DNT isomers with most of the contaminant reduction complete within seven days of treatment. For further information, see *Sustainable Remediation Alternative Evaluation –*

Treatability Study of DNT Bio-augmentation at the Badger Army Ammunition Plant presentation poster found at http://symposiumarchive.serdp-estcp.org/symposium2008/posters/upload/t204-saul.pdf.

The groundwater conditions at BAAAP appear to be favorable to allow bio-augmentation to succeed. Pilot tests in the field would be required to prove this is effective on a larger scale.

The CL-Out® mixture would be pumped into a combination of approximately 1,950 temporary wells and existing monitoring wells in the three plumes.

The injection points would need to be spaced approximately 50 feet by 500 feet apart throughout each plume. The existing wells would have their monitoring apparatus removed for the injection. A truck carrying a water/CL-Out® mixture and a pump would be used to bring the treatment to the wells. Approximately 16 pounds of CL-Out® mixture would be pumped into each injection point. The treatment would spread out through the groundwater and take approximately nine months at each plume to show effectiveness. It is assumed that a single round of injections of the CL-Out® mixture would be sufficient to treat each plume. Upon completion of active treatment, each plume would be monitored for contaminant reduction or stabilization.

This alternative would include monitoring of the plume for several years following treatment to ensure the effectiveness of the bioremediation and confirm that concentrations have decreased below regulatory standards. This alternative also involves shutting down the IRM/MIRM upon concurrence from the WDNR that the in-situ biochemical treatment has been effective.

Overall Protection of Human Health and the Environment

This alternative meets the requirements of the remedial action objective because it would effectively degrade the contaminants in groundwater on the installation, thereby minimizing the risk of future contaminant migration to human receptors and the environment. Groundwater monitoring at private wells would continue to provide assurance to the residents that their water is safe to drink. Based on the applicable scientific and regulatory information, the residual contaminant plumes do not adversely affect ecological receptors in the environment.

Compliance with Applicable Regulations

This alternative would be designed to comply with applicable regulations.

Long-Term Effectiveness and Permanence

Both active treatment and natural attenuation components of the alternative would be permanent. Groundwater treatment would permanently remove the majority of DNT and the chlorinated solvents from the groundwater. The remaining contamination would continue to decrease due to natural attenuation processes. This alternative may require supplemental post-treatment applications and would require a groundwater monitoring program to verify the efficacy of the remedial action. This alternative is expected to be effective over the long-term.

Reduction of Toxicity, Mobility, and Volume through Treatment

In-situ bioremediation of groundwater would reduce the toxicity, mobility, and volume of DNT and chlorinated solvents in the treated area. The groundwater contamination would also continue to decrease due to natural attenuation processes and no receptors would be at a significant risk.

Short-Term Effectiveness

The short-term impacts of alternatives shall be assessed considering the following: short-term risks that might be posed to the community during implementation of an alternative; potential impacts on workers during remedial action and the effectiveness and reliability of protective measures; potential environmental impacts of the remedial action and the effectiveness and reliability of mitigative measures during implementation; and time until protection is achieved.

For this alternative, short-term risks to the community and workers could include those due to potential human or ecological exposure to contaminants. Because monitoring well and private well sampling would continue, no significant increase in risk is anticipated for potential receptors with the implementation of this alternative. In addition, there would be little effect on the community as most of the field activity associated with the injection would be conducted by qualified personnel on-site. As observed in the treatability study, the bioremediation occurs very quickly upon introduction of the CL-Out®.

Implementability

CL-Out® has been demonstrated in a drum test to be effective in treating DNT and chlorinated solvents without the production of lasting intermediates or daughter products.

Cost

The estimated present worth costs for Alternative 2 are shown below. See Appendix D for a summary of the costs for Alternative 2.

Engineering design:	$ 45,000
Capital cost:	$ 41,200,000
Post-treatment monitoring:	$ 20,047,000
Monitoring and closeout plan/report:	$ 55,000
Total present worth:	**$ 61,347,000**

* Present worth costs use current rates and do not include inflation

State Acceptance

This criterion would be evaluated throughout the development, screening, and analysis of alternatives based on comments and input received from the WDNR.

Community Acceptance

This criterion would be evaluated throughout the development, screening, and analysis of alternatives based on comments and input received from the public.

8.6 Alternative 3 – Public Water System

This alternative consists of the installation of a public water system that would provide a safe, clean, reliable water source for all the potentially affected well owners downgradient of BAAAP. Two public wells would be installed in an area outside the limits of the BAAAP groundwater plumes and draw water from a deep sandstone aquifer. This alternative would eliminate the need to monitor private wells once homeowners are changed over to public water. The Army proposes that all potable (drinking water) wells be abandoned preventing exposure by ingestion so that receptor would be eliminated. The Army has drafted a proposed remedy area for the public water system (see Figure 8). Cooperation of the affected municipalities in the formation of a water district are envisioned for the development and long-term management of the system. Details on the Army's proposal are being developed and are available at www.cleanwaterwelldone.com.

This alternative also involves preparing a phased shutdown plan for the IRM and MIRM systems and a groundwater monitoring and closure plan to outline the path to case closure, which would be submitted to the WDNR for review and approval. This plan would include a systematic procedure to provide the WDNR the necessary information required to make a closure decision. This procedure would include monitoring steady-state conditions in the PBG Plume to determine contaminant trends following active treatment system shutdown.

Overall Protection of Human Health and the Environment

This alternative would be the most protective of human health because it completely eliminates the exposure pathway to humans by providing an alternative source of water. Based on the applicable scientific and regulatory information, the residual contaminant plumes do not adversely affect ecological receptors in the environment.

Compliance with Applicable Regulations

This alternative would comply with applicable regulations.

Long-Term Effectiveness and Permanence

This alternative provides a permanent, long-term solution to the groundwater threat from BAAAP. The groundwater contamination would continue to decrease due to natural attenuation processes and no receptors would be at a significant risk.

Reduction of Toxicity, Mobility, and Volume through Treatment

This alternative reduces the toxicity, mobility, and volume of the contamination in the groundwater through natural attenuation and eliminates the human exposure pathway by closing the private water wells.

Short-Term Effectiveness

The short-term impacts of this alternative considers the following: short-term risks that might be posed to the community during implementation of an alternative; potential impacts on workers during remedial action and the effectiveness and reliability of protective measures; potential environmental impacts of the remedial action and the effectiveness and reliability of mitigative measures during implementation; and time until protection is achieved.

For this alternative, short-term risks to the community and workers would not include those due to potential human or ecological exposure to contaminants, as all of the proposed work does not come in contact with impacted groundwater. There would be some effect (road/lane closures, increased worker traffic, equipment noise, etc.) on the community due to construction of the wells, water tower, and underground piping. The construction of the public water system is estimated to take approximately three years.

Implementability

This alternative would be feasible, with the consent and approval of the community and community leaders. The towns of Sumpter, Merrimac, and Prairie du Sac must all work effectively together and coordinate efforts for the public water supply alternative to move forward.

Cost

The estimated present worth costs for Alternative 3 are shown below. See Appendix D for a summary of the costs for Alternative 3.

Engineering design:	$ 2,900,000
Capital cost:	$ 24,746,000
Annual O&M:	$ 12,218,000
Monitoring and closeout plan/report:	$ 55,000
Total present worth:	**$ 39,919,000**

* Present worth costs use current rates and do not include inflation

State Acceptance

This criterion will be evaluated throughout the development, screening, and analysis of alternatives based on comments and input received from the WDNR.

Community Acceptance

This criterion will be evaluated throughout the development, screening, and analysis of alternatives based on comments and input received from local governments and the public.

9.0 COMPARISON OF ALTERNATIVES

Through the analysis and evaluation of alternatives using the specified criteria, all three of the presented alternatives are capable of remediating the groundwater contaminant plumes in accordance with WDNR requirements. In addition, all the alternatives provide a reduction in risk to drinking water receptors downgradient of the BAAAP. Alternative 3 provides this reduction of risk in a shorter period of time. All three alternatives carry a measure of uncertainty; Alternative 1 relates to the timeframe necessary to complete the pump and treat phase; Alternative 2 relates to the effectiveness and implementation of the biochemical phase; and Alternative 3 relates to the natural attenuation phase.

Alternative 1 – IRM/MIRM Treatment involves the continued implementation of the existing IRM/MIRM groundwater pump and treat system and groundwater monitoring program. The PBG Plume would continue to be recovered and treated along with groundwater monitoring. This alternative has the advantage of already being in place. In addition, this alternative is effective in actively treating only the PBG Plume. Total cost for Alternative 1 is approximately $77 million present worth.

Alternative 2 – In-situ Biochemical Treatment involves in-situ biochemical treatment of the three groundwater contaminant plumes and the implementation of a modified groundwater monitoring program. This alternative is effective in actively treating all three groundwater contaminant plumes located on BAAAP. Total cost for Alternative 2 is approximately $61 million present worth.

Alternative 3 – Public Water System involves installation of a public water system for potentially affected private well owners downgradient of the BAAAP, a phased shutdown of the IRM and MIRM systems, and the implementation of a modified groundwater monitoring program. Overall, Alternative 3 ultimately relies on natural attenuation to address residual contamination in all three groundwater contaminant plumes. This alternative completely eliminates the potential human exposure pathway, which is the primary remedial action objective. Total cost for Alternative 3 is approximately $40 million present worth.

10.0 REMEDY SELECTION

Considering all the evaluation criteria and comparative aspects associated with the three proposed alternatives, Alternative 3 – Public Water System has been identified as the preferred final remedy for the BAAAP groundwater plumes. Alternative 3 meets the remedial action objective and regulatory requirements because it is protective of human health and the environment; involves a reasonable implementation and restoration time frame; is feasible; and eliminates downgradient drinking water receptors.

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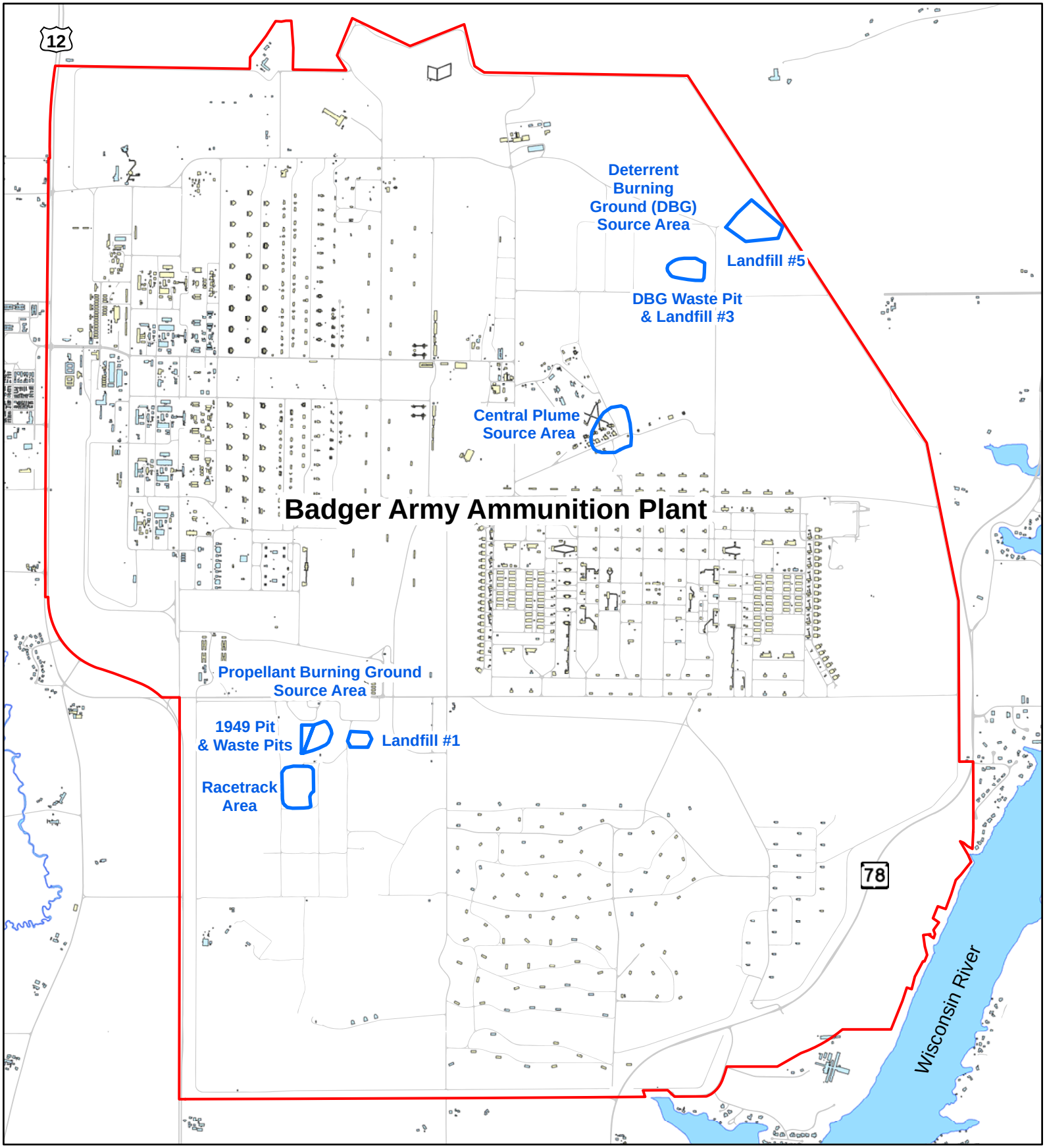
Figures



Legend

- Badger Army Ammunition Plant Boundary
- Source Area
- Paved Road
- Existing Building
- Former Building Footprint

Figure 1

Site Location Map
Alternative Feasibility Study
Groundwater Remedial Strategy
Badger Army Ammunition Plant

1 inch = 2,500 feet

0 3,900 7,800 Feet

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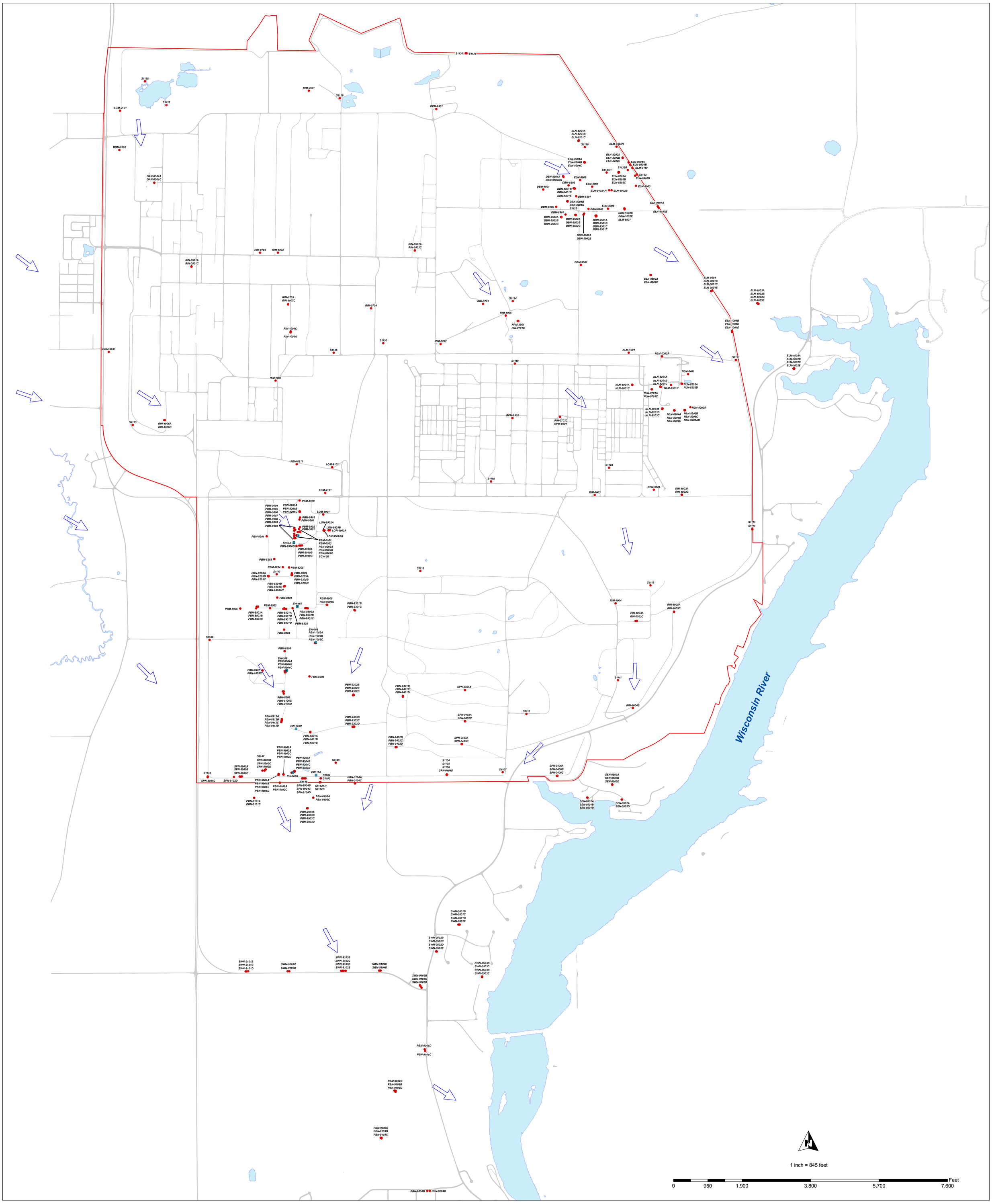

Legend

- Badger Army Ammunition Plant Boundary
- Existing Extraction Well
- Monitoring Well
- Groundwater Flow
- Paved Road
- Wisconsin River/Pond/Reservoir

Figure 2

Monitoring Well Locations
Alternative Feasibility Study Groundwater Remedial Strategy
Badger Army Ammunition Plant

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Plot Date: 2/14/2011

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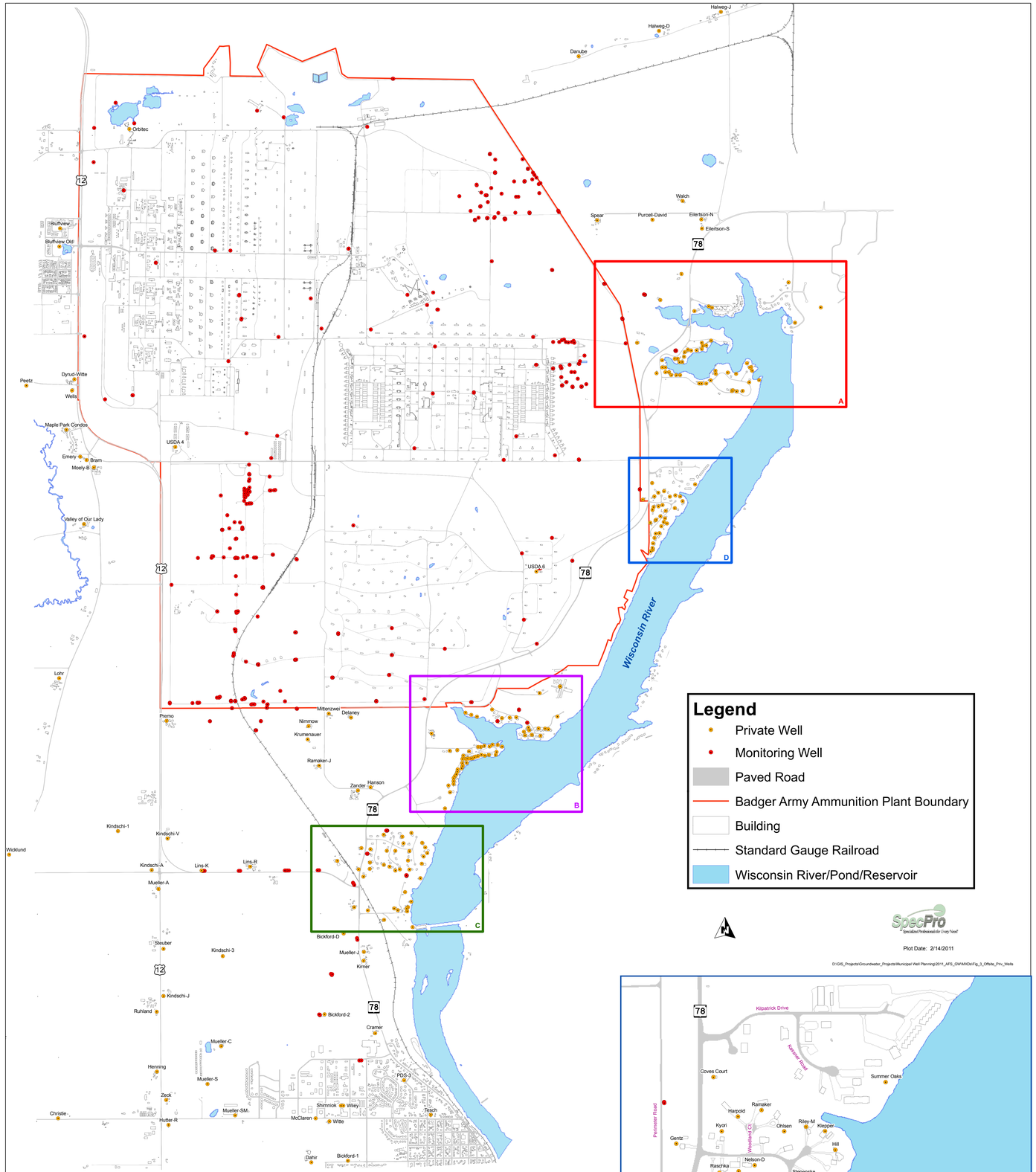
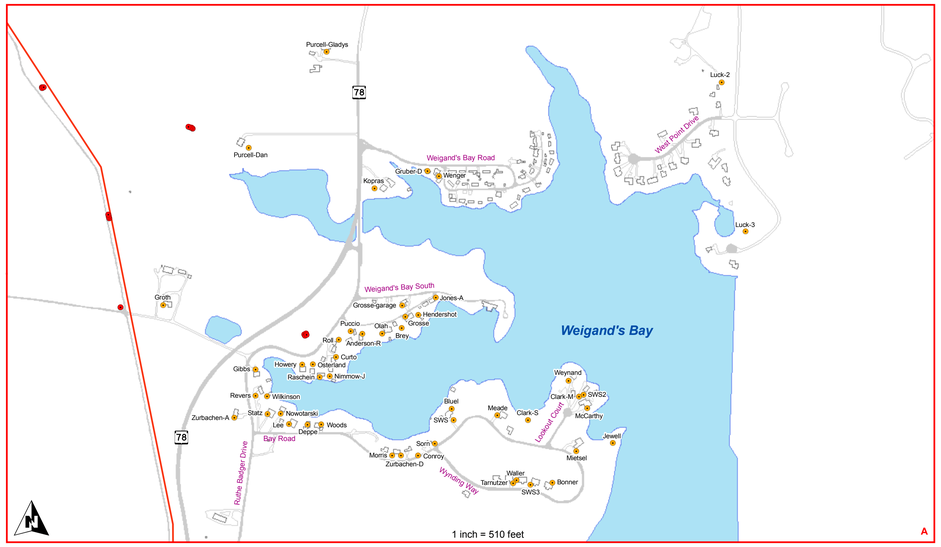
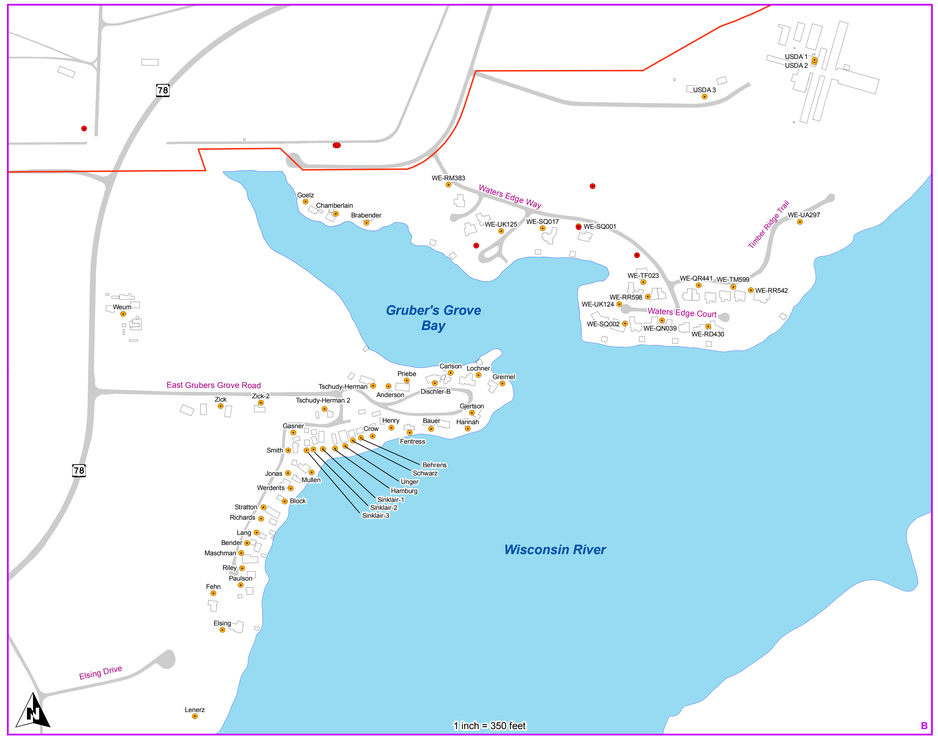
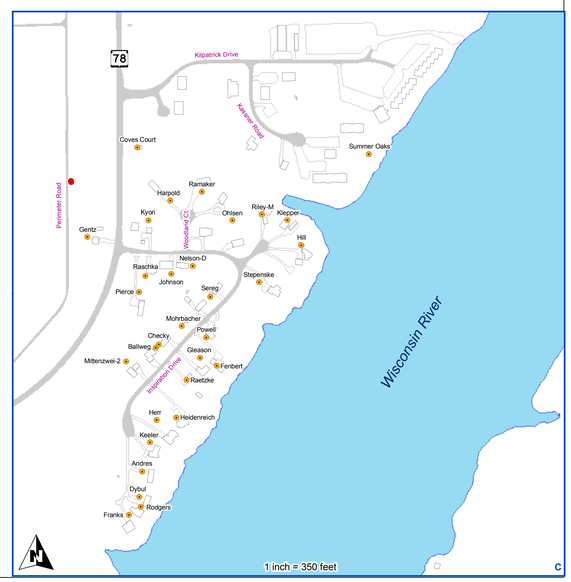


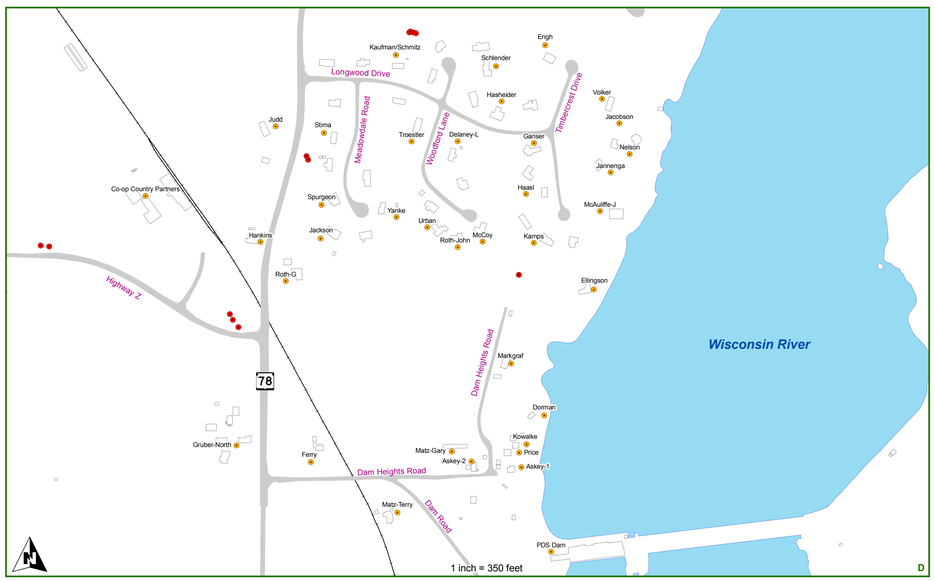
Figure 3

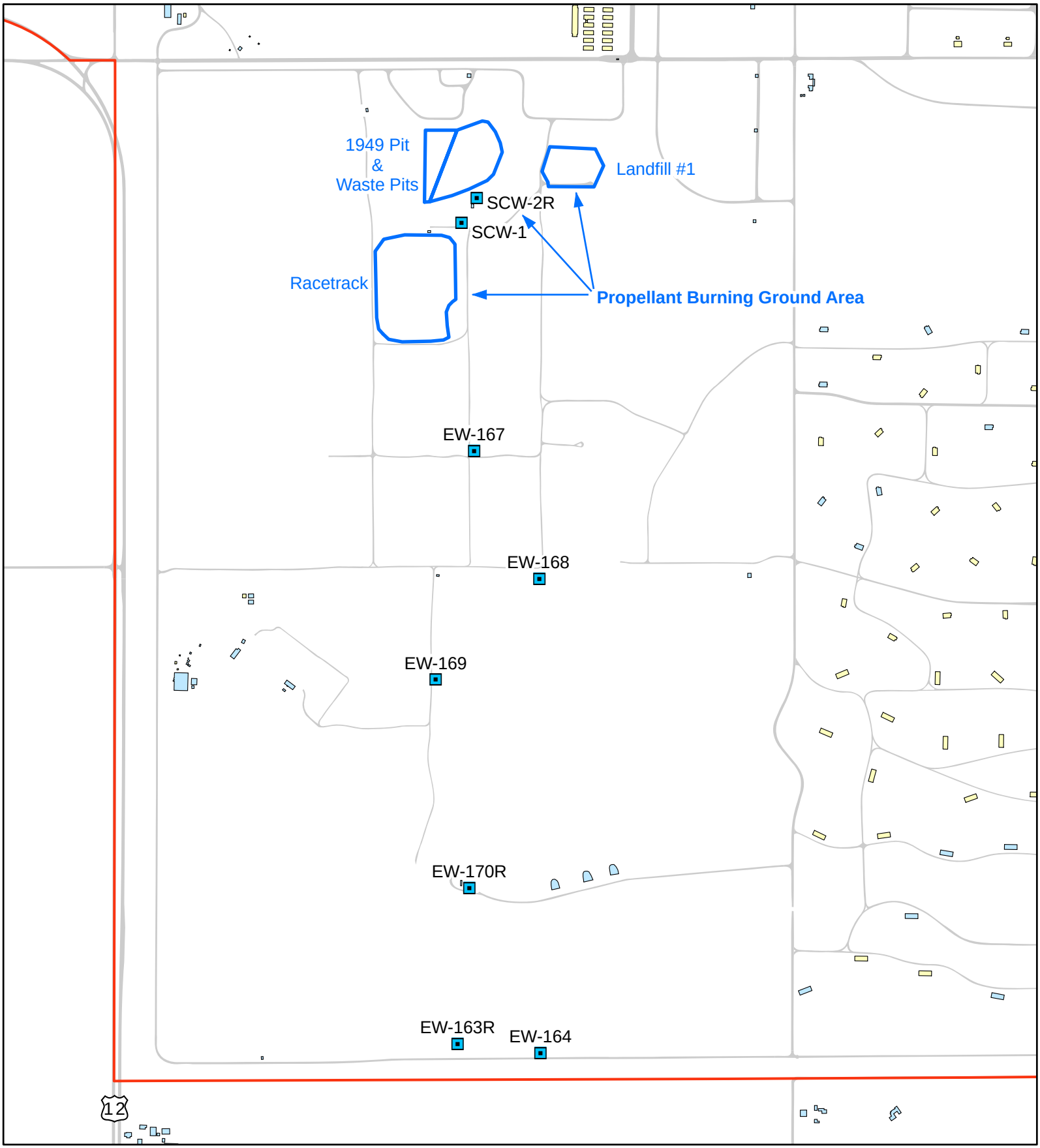
Off-Site Plume Area, Southeast Area, and Private Well Locations
Alternative Feasibility Study Groundwater Remedial Strategy
Badger Army Ammunition Plant











Legend

- Badger Army Ammunition Plant Boundary
- Existing Extraction Well
- Source Area
- Paved Road
- Existing Building
- Former Building Footprint

Figure 4

Interim Remedial Measures (IRM) and Modified Interim Remedial Measures (MIRM) Extraction Wells
Alternative Feasibility Study
Groundwater Remedial Strategy
Badger Army Ammunition Plant

1 inch = 975 feet

0 1,500 3,000 Feet

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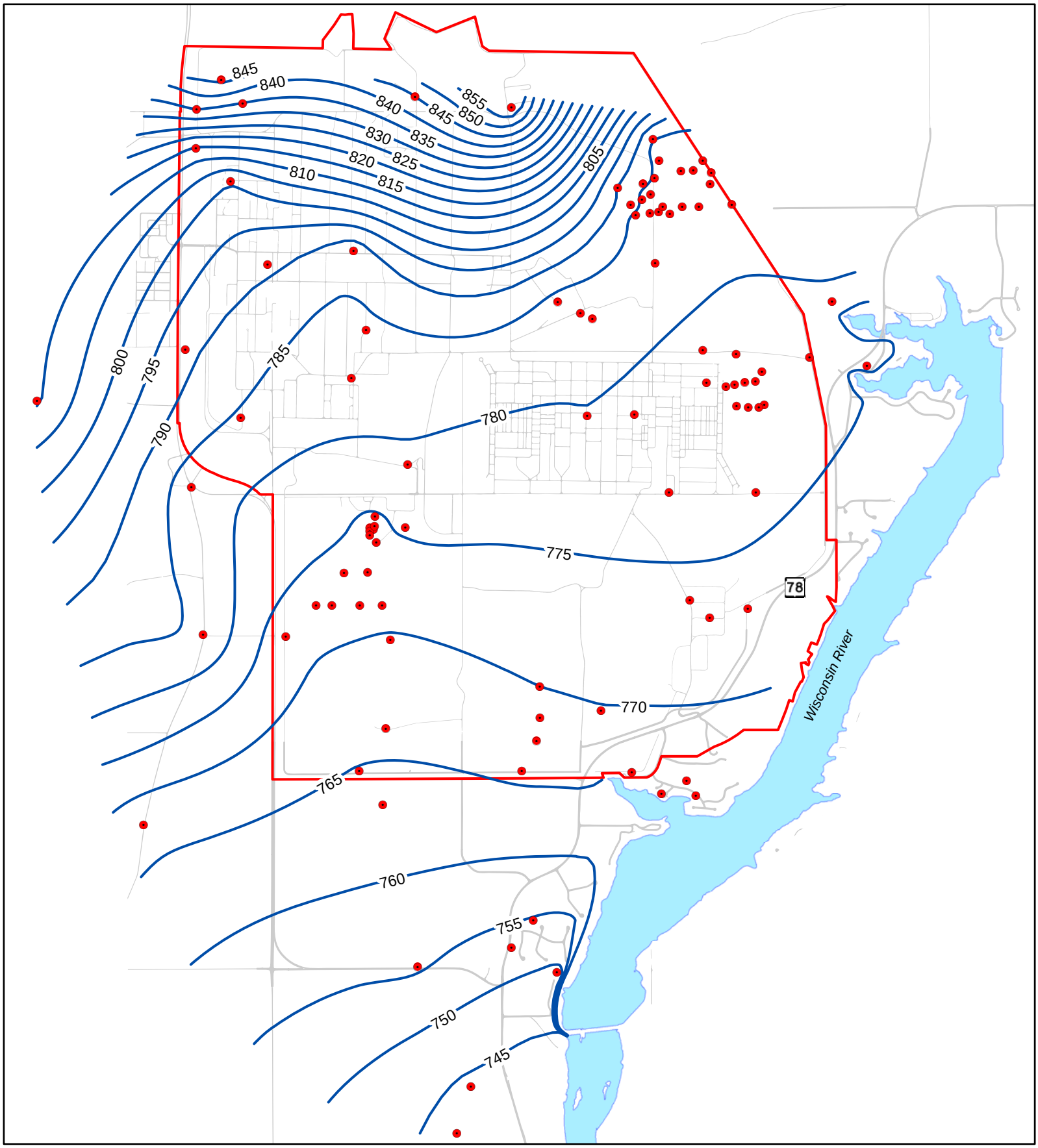

Legend

- Badger Army Ammunition Plant Boundary
- Monitoring Well (used to draw contours)
- Wisconsin River
- Paved Road
- Groundwater Contour

Contour Interval = 5 feet

Figure 5

September 2010 Groundwater Contours
Alternative Feasibility Study
Groundwater Remedial Strategy
Badger Army Ammunition Plant

1 inch = 3,475 feet

0 — 5,250 — 10,500 Feet

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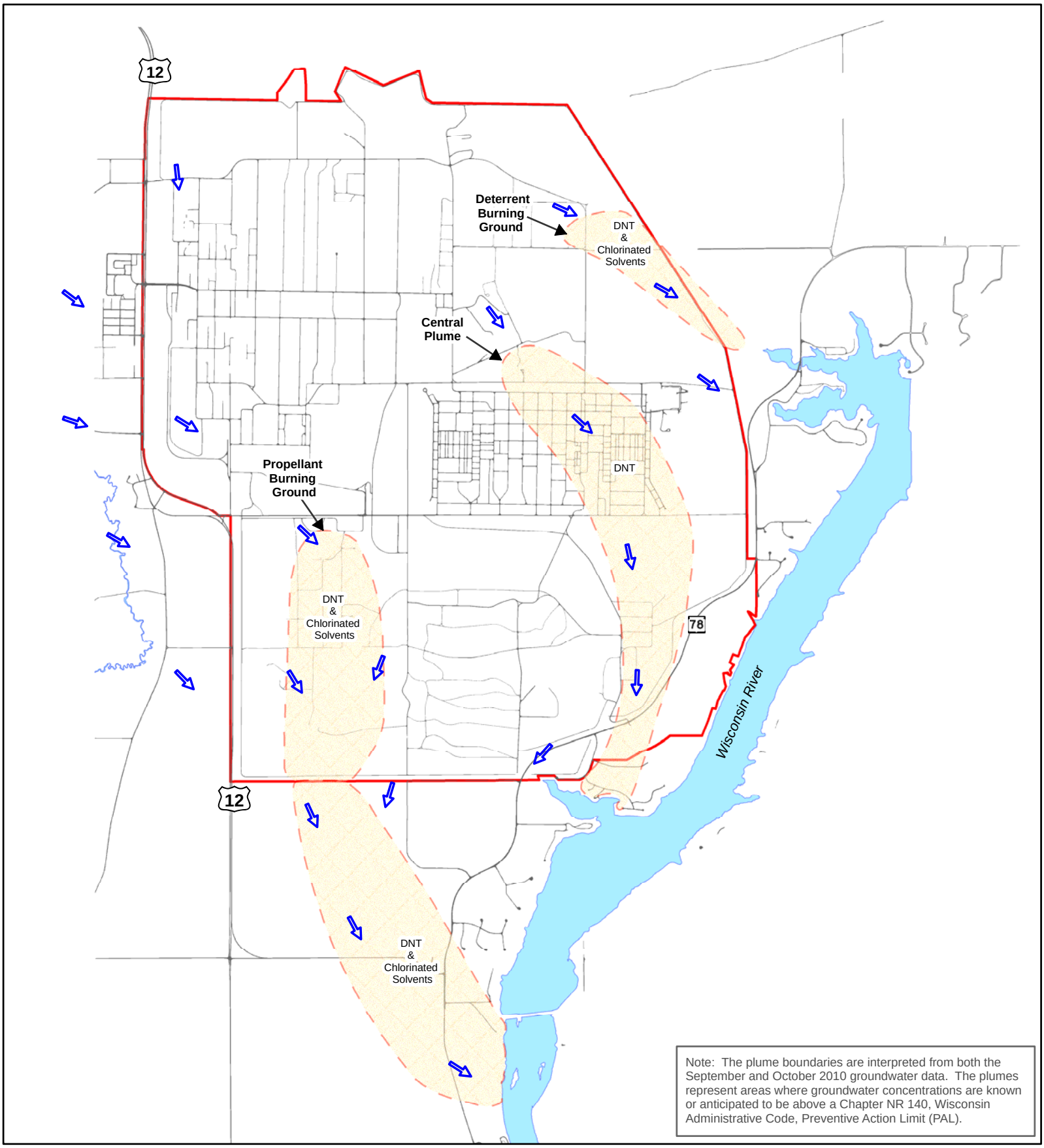

Note: The plume boundaries are interpreted from both the September and October 2010 groundwater data. The plumes represent areas where groundwater concentrations are known or anticipated to be above a Chapter NR 140, Wisconsin Administrative Code, Preventive Action Limit (PAL).

Legend

- Badger Army Ammunition Plant Boundary
- Paved Road
- Groundwater Flow
- Groundwater Plume
- Wisconsin River
- DNT Dinitrotoluene

Figure 6

Groundwater Plumes
Alternative Feasibility Study
Groundwater Remedial Strategy
Badger Army Ammunition Plant

1 inch = 3,750 feet

0 2,800 5,600 11,200 Feet

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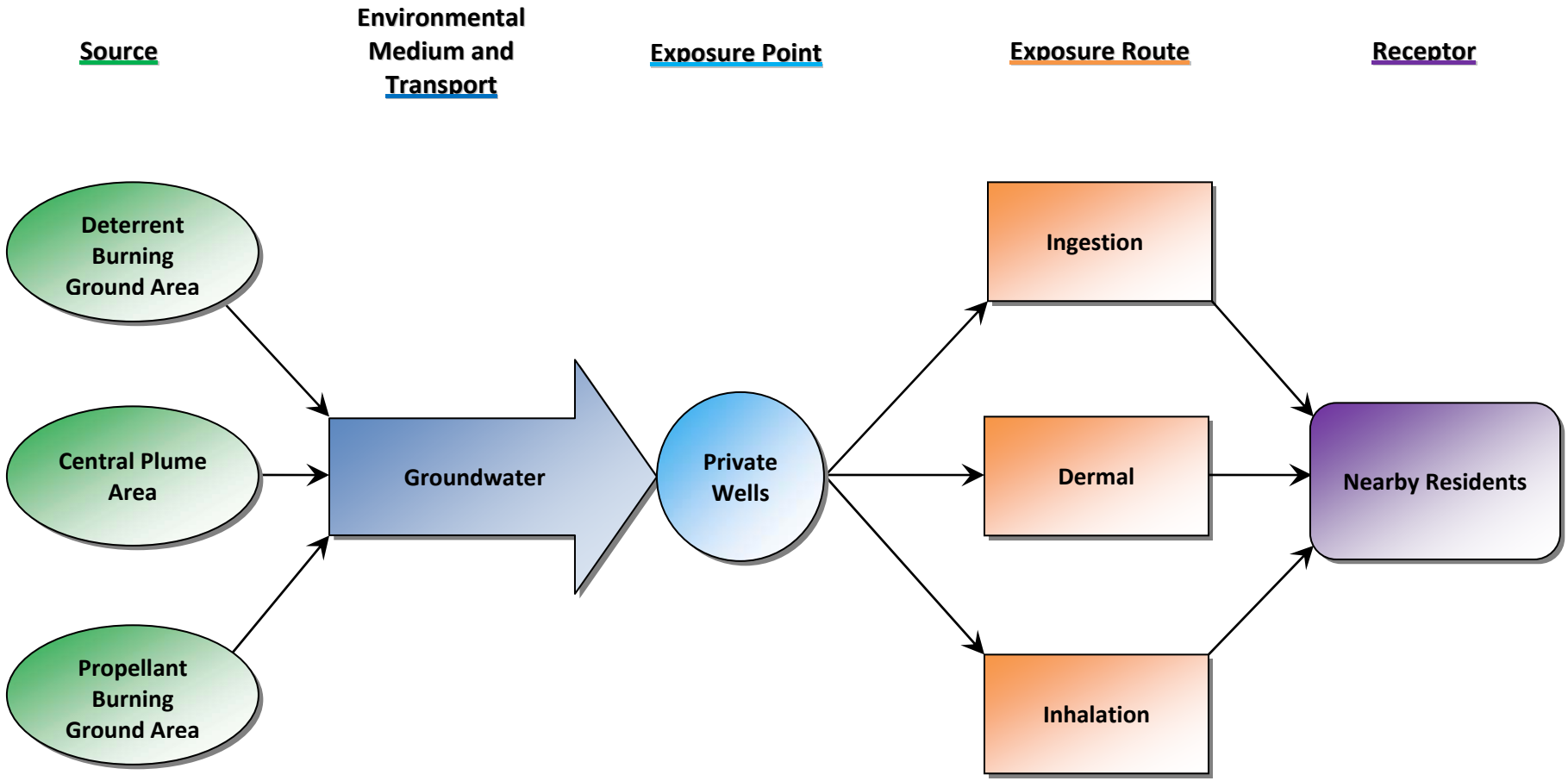
Figure 7
Conceptual Site Model
Alternative Feasibility Study
Groundwater Remedial Strategy



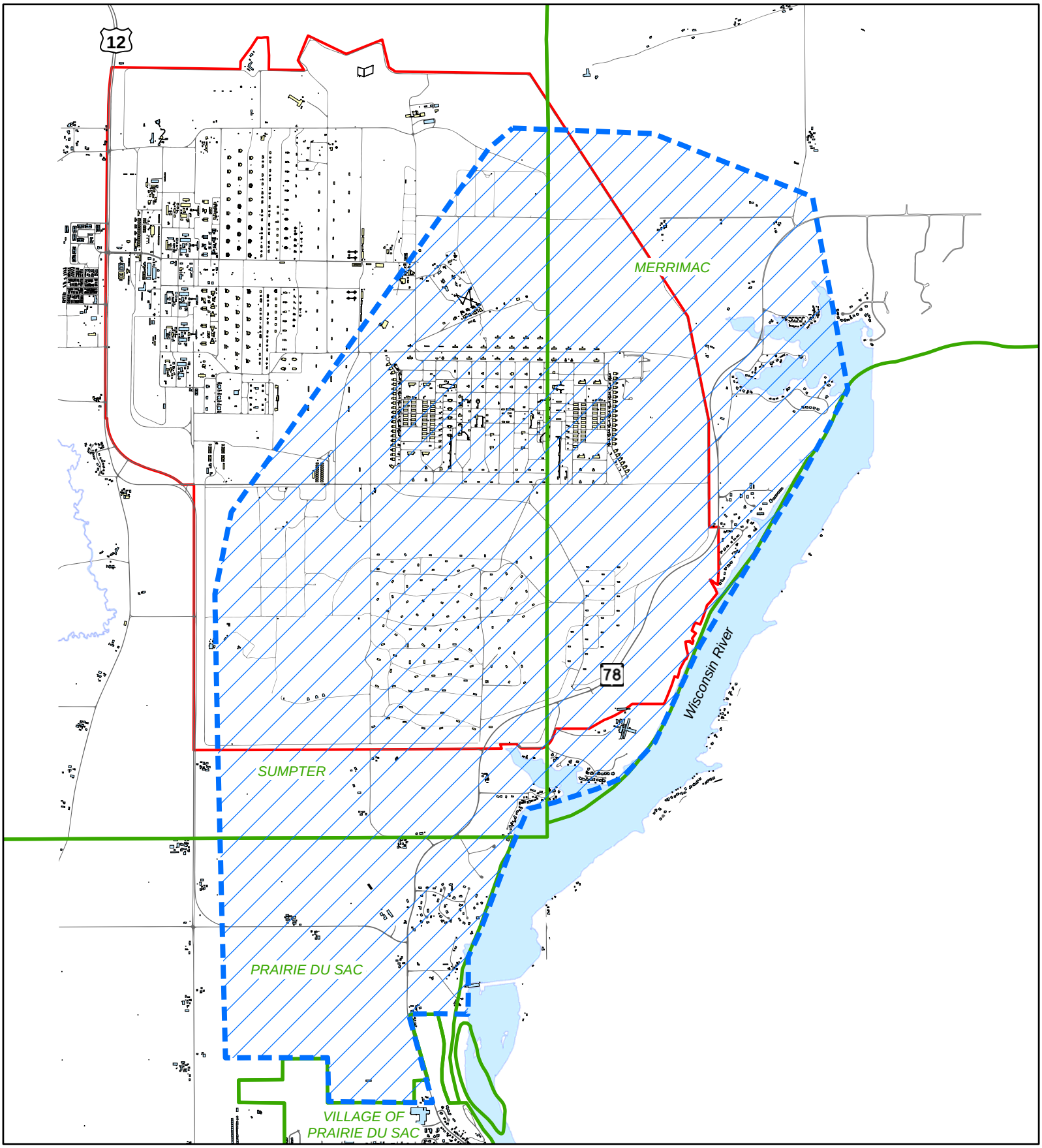


Figure 8

Proposed Remedy Area
Alternative Feasibility Study
Groundwater Remedial Strategy
Badger Army Ammunition Plant

Legend

- Badger Army Ammunition Plant Boundary
- Proposed Remedy Area
- Township Boundary
- Paved Road
- Existing Building
- Former Building Footprint

1 inch = 3,750 feet

0 5,500 11,000 Feet

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Tables

Table 1
Groundwater Analytical Results
September 2010 Round
Badger Army Ammunition Plant

						VOCs - SW8260B								
Well	**Well ID**	**Sample Level**	**Sample Depth (feet)**	**Sample Date**	**Dinitrotoluene, Total**	**1,1-Dichloroethylene**	**1,2-Dichloropropane**	**1,1,1-Trichloroethane**	**1,1,2-Trichloroethane**	**Bromodichloromethane**	**Carbon Tetrachloride**	**Chloroform**	**Ethyl Ether**	**Trichloroethylene**
BGM-9101	350	A	68-78	09/16/10	<0.015	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
BGM-9102	351	A	77-87	09/16/10	<0.015	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
BGM-9103	352	A	90-100	09/16/10	<0.015	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	**7.4**
BGM-9103 (dup)	352	A	90-100	09/16/10	<0.015	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	**7.94**
DBM-8201	301	A	154.6-174.6	09/21/10	**2.2**	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
DBM-8202	302	A	137.3-157.3	09/21/10	**0.972**	<0.10	<0.10	**2.11**	**0.27**	<0.10	<0.10	<0.10	<0.10	<0.10
DBM-8903	306	A	113-133	09/30/10	<0.015	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
DBM-8905	307	A	107-127	09/30/10	<0.015	<0.10	<0.10	**0.83**	<0.10	<0.10	**0.22**	<0.10	<0.10	<0.10
DBM-8905 (dup)	307	A	107-127	09/30/10	<0.015	<0.10	<0.10	**0.82**	<0.10	<0.10	**0.22**	<0.10	<0.10	<0.10
DBM-9501	313	A	92-107	10/05/10	<0.015	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
DBN-8201B	303	B	157.5-159.5	09/30/10	<0.015	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
DBN-8201C	304	C	167.5-169.5	09/30/10	<0.015	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
DBN-8902A	308	A	99.5-119.5	09/30/10	<0.015	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
DBN-8902B	309	B	145-150	09/30/10	<0.015	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
DBN-9501A	314	A	110-120	10/05/10	<0.015	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
DBN-9501B	315	B	162.5-172.5	10/05/10	<0.015	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
DBN-9501C	316	C	218.5-228.5	10/05/10	<0.015	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
DBN-9501E	317	E	245.2-255.5	10/05/10	<0.015	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
DBN-9502A	318	A	103-113	10/05/10	<0.015	<0.10	<0.10	**0.17**	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
DBN-9502B	319	B	155.2-165.5	10/05/10	<0.015	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
DBN-9502C	320	C	210-220.3	10/05/10	<0.015	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	**0.19**	<0.10	<0.10
DBN-9502C (dup)	320	C	210-220.3	10/05/10	<0.015	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	**0.16**	<0.10	<0.10
ELM-8901	216	A	145.5-165	09/22/10	**5.982**	**0.17**	<0.10	**2.46**	**0.3**	<0.10	<0.10	<0.10	<0.10	<0.10
ELM-8903	217	A	130-150	09/16/10	<0.015	<0.10	<0.10	<0.10	**0.11**	<0.10	<0.10	<0.10	<0.10	<0.10
ELM-8907	220	A	130.3-150.3	09/16/10	**2.356**	<0.10	<0.10	**0.16**	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
ELM-8908	221	A	125-145	09/23/10	**1.466**	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
ELM-8909	222	A	135-155	09/16/10	<0.015	<0.10	<0.10	**1.61**	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
ELM-9110	229	A	139-154	09/22/10	<0.015	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
ELM-9501	234	A	54-69	09/22/10	**0.071**	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
ELN-0801B	455	B	100-105	09/22/10	**0.116**	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
ELN-0801C	456	C	145.5-150.5	09/22/10	**0.24**	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
ELN-0801E	457	E	202.6-207.6	09/22/10	<0.015	<0.10	<0.10	**0.18**	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
ELN-0801E (dup)	457	E	202.6-207.6	09/22/10	<0.015	<0.10	<0.10	**0.15**	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
ELN-0802A	458	A	122.4-107.4	09/22/10	<0.015	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
ELN-0802C	459	C	185.7-180.7	09/22/10	<0.015	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
ELN-8203A	210	A	147.5-157.5	09/23/10	<0.015	<0.10	**0.49**	<0.10	**0.62**	<0.10	<0.10	<0.10	**2.29**	<0.10
ELN-8203B	211	B	164-166	09/23/10	<0.015	<0.10	**0.42**	<0.10	**1.11**	<0.10	<0.10	<0.10	**0.14**	<0.10
ELN-8203B (dup)	211	B	164-166	09/23/10	<0.015	<0.10	**0.46**	<0.10	**1.12**	<0.10	<0.10	<0.10	**0.12**	<0.10
ELN-8203C	212	C	174-176	09/23/10	<0.015	<0.10	<0.10	<0.10	**0.58**	<0.10	<0.10	<0.10	<0.10	<0.10
ELN-8204A	213	A	141-151	09/23/10	<0.015	<0.10	<0.10	**0.26**	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
ELN-8204B	214	B	163-165	09/23/10	<0.015	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
ELN-8204C	215	C	171-173	09/23/10	<0.015	<0.10	<0.10	**0.2**	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
ELN-8902B	224	B	173.5-178.5	09/22/10	**0.02**	<0.10	<0.10	**0.26**	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
ELN-8904A	225	A	142-162	09/23/10	<0.015	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
ELN-8904B	226	B	194-199	09/23/10	<0.015	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
ELN-9107A	227	A	116-126	09/16/10	<0.015	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10

Table 1
Groundwater Analytical Results
September 2010 Round
Badger Army Ammunition Plant

						VOCs - SW8260B								
Well	**Well ID**	**Sample Level**	**Sample Depth (feet)**	**Sample Date**	**Dinitrotoluene, Total**	**1,1-Dichloroethylene**	**1,2-Dichloropropane**	**1,1,1-Trichloroethane**	**1,1,2-Trichloroethane**	**Bromodichloromethane**	**Carbon Tetrachloride**	**Chloroform**	**Ethyl Ether**	**Trichloroethylene**
ELN-9107B	228	B	135-145	09/16/10	<0.015	<0.10	<0.10	<0.10	**0.29**	<0.10	<0.10	<0.10	<0.10	<0.10
ELN-9402AR	231	A	130-145	09/22/10	**0.186**	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
LON-8903A	659	A	138-158	09/28/10	<0.015	<0.10	<0.10	**0.19**	<0.10	**0.11**	**1.76**	**0.9**	<0.10	**0.87**
LON-8903B	660	B	193-198	09/28/10	**0.048**	<0.10	<0.10	**0.23**	<0.10	**0.19**	**0.34**	**1.32**	<0.10	**0.21**
NLM-0302R	272	A	112-127	09/15/10	<0.015	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
PBM-0001	367	A	102-127	09/21/10	**1.561**	<0.10	<0.10	<0.10	<0.10	<0.10	**0.55**	**0.39**	<0.10	**1.32**
PBM-0001 (dup)	367	A	102-127	09/21/10	**1.885**	<0.10	<0.10	<0.10	<0.10	<0.10	**0.52**	**0.39**	<0.10	**1.38**
PBM-0002	368	A	100-125	09/21/10	**1166.1**	<0.10	<0.10	<0.10	<0.10	<0.10	**0.26**	**0.19**	<0.10	**1.26**
PBM-0005	371	A	95-120	09/21/10	**1.806**	<0.10	<0.10	**0.11**	<0.10	<0.10	**0.37**	**0.26**	<0.10	**0.91**
PBM-0008	374	A	97-122	09/21/10	**1.546**	<0.10	<0.10	<0.10	<0.10	<0.10	**0.46**	<0.10	<0.10	**2.73**
PBM-8905	635	A	78.05-98.05	10/07/10	<0.015	<0.10	<0.10	<0.10	<0.10	<0.10	**0.19**	<0.10	<0.10	<0.10
PBM-9001D	981	D	200.5-210.5	09/14/10	**0.019**	<0.10	<0.10	<0.10	<0.10	<0.10	**20.8**	**3.08**	<0.10	**3.96**
PBM-9001D (dup)	981	D	200.5-210.5	09/14/10	**0.023**	<0.10	<0.10	<0.10	<0.10	<0.10	**17.7**	**2.78**	<0.10	**3.46**
PBM-9002D	982	D	194.5-204.5	09/15/10	<0.015	<0.10	<0.10	<0.10	<0.10	<0.10	**0.43**	**0.38**	<0.10	<0.10
PBM-9003D	983	D	189.5-199.5	09/15/10	<0.015	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
PBM-9801	360	A	102.5-117.5	09/21/10	**1.613**	<0.10	<0.10	<0.10	<0.10	<0.10	**0.42**	**0.28**	<0.10	**0.44**
PBN-8202C	615	C	139.2-141.2	09/21/10	**1.701**	<0.10	<0.10	<0.10	<0.10	<0.10	**0.4**	**0.49**	<0.10	**1.13**
PBN-8203A	616	A	86.5-96.5	10/04/10	**0.017**	<0.10	<0.10	**0.53**	<0.10	<0.10	**3.86**	**0.13**	<0.10	**0.31**
PBN-8203C	618	C	115.5-117.5	10/04/10	<0.015	<0.10	<0.10	**0.25**	<0.10	<0.10	**1.98**	**0.13**	<0.10	**0.2**
PBN-8205A	622	A	102.5-112.5	10/04/10	**3.018**	<0.10	<0.10	**1.19**	<0.10	<0.10	**6.76**	**0.76**	<0.10	**1.69**
PBN-8205A (dup)	622	A	102.5-112.5	10/04/10	**3.559**	<0.10	<0.10	**1.18**	<0.10	<0.10	**6.39**	**0.71**	<0.10	**1.67**
PBN-8205B	623	B	122.2-124.2	10/06/10	<0.015	<0.10	<0.10	**0.55**	<0.10	<0.10	**3.33**	**0.71**	<0.10	**1.73**
PBN-8205C	624	C	131.5-133.5	10/04/10	**0.342**	<0.10	<0.10	<0.10	<0.10	<0.10	**0.14**	**0.12**	<0.10	**0.8**
PBN-8501A	631	A	112.9-121.9	10/07/10	<0.015	<0.10	<0.10	**1.12**	<0.10	<0.10	**6.4**	**0.62**	<0.10	**1.92**
PBN-8501A (dup)	631	A	112.9-121.9	10/07/10	<0.015	<0.10	<0.10	**1.08**	<0.10	<0.10	**5.95**	**0.6**	<0.10	**1.82**
PBN-8502A	632	A	129-138	10/07/10	<0.015	<0.10	<0.10	**1.07**	<0.10	<0.10	**23**	**0.3**	<0.10	**1.33**
PBN-8503A	633	A	85.82-94.82	10/07/10	<0.015	<0.10	<0.10	**0.29**	<0.10	<0.10	**3.48**	<0.10	<0.10	<0.10
PBN-8901C	642	C	193.1-198.1	10/07/10	<0.015	<0.10	<0.10	**0.3**	<0.10	<0.10	**1.6**	**0.7**	<0.10	**0.68**
PBN-8901D	643	D	233.2-238.2	10/07/10	<0.015	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	**1.21**	<0.10	<0.10
PBN-8902B	644	B	155-160	10/07/10	<0.015	<0.10	<0.10	**0.75**	<0.10	**0.11**	**10.3**	**0.9**	<0.10	**5.46**
PBN-8902C	645	C	188.1-193.3	10/07/10	**0.015**	<0.10	<0.10	**0.85**	<0.10	**0.15**	**8.06**	**1.1**	<0.10	**3.29**
PBN-8903B	646	B	120-125	10/07/10	<0.015	<0.10	<0.10	<0.10	<0.10	**0.16**	**0.27**	**0.76**	<0.10	<0.10
PBN-8903C	647	C	155-160	10/07/10	<0.015	<0.10	<0.10	<0.10	<0.10	**0.14**	<0.10	**0.61**	<0.10	<0.10
PBN-8910A	650	A	108-128	10/04/10	<0.015	<0.10	<0.10	<0.10	<0.10	<0.10	**1.11**	**0.6**	<0.10	**2**
PBN-8910C	652	C	187-192	10/04/10	<0.015	<0.10	<0.10	**0.31**	<0.10	**0.14**	**0.28**	**1.29**	<0.10	<0.10
PBN-9102B	562	B	105-115	09/15/10	<0.015	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
PBN-9102C	563	C	151.3-161.3	09/15/10	<0.015	<0.10	<0.10	<0.10	<0.10	<0.10	**0.14**	**0.21**	<0.10	<0.10
PBN-9102C (dup)	563	C	151.3-161.3	09/15/10	<0.015	<0.10	<0.10	<0.10	<0.10	<0.10	**0.14**	**0.17**	<0.10	<0.10
PBN-9103B	564	B	96.1-106.1	09/15/10	**0.018**	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
PBN-9103C	565	C	142.3-152.3	09/15/10	**0.025**	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
PBN-9112C	665	C	173.4-183.4	09/28/10	<0.015	<0.10	<0.10	**0.6**	<0.10	**0.24**	**5.26**	**1.41**	<0.10	**7.36**
PBN-9112D	666	D	221-231	09/28/10	<0.015	**0.27**	<0.10	**0.16**	<0.10	<0.10	<0.10	<0.10	**0.23**	<0.10
PBN-9301B	668	B	150.5-160.5	10/06/10	<0.015	<0.10	<0.10	**0.88**	<0.10	<0.10	**2.12**	**0.43**	<0.10	**0.18**
PBN-9301C	669	C	217.5-227.5	10/06/10	**0.031**	**0.16**	<0.10	**1.69**	<0.10	<0.10	**2.13**	**0.87**	<0.10	**0.24**
PBN-9303B	673	B	83.5-93.5	10/06/10	<0.015	**0.1**	<0.10	**0.94**	<0.10	<0.10	**3.04**	**0.67**	<0.10	<0.10
PBN-9303C	674	C	154.5-164.5	10/06/10	<0.015	<0.10	<0.10	**0.46**	<0.10	<0.10	**6.12**	**1.62**	<0.10	<0.10

Table 1
Groundwater Analytical Results
September 2010 Round
Badger Army Ammunition Plant

						VOCs - SW8260B								
Well	**Well ID**	**Sample Level**	**Sample Depth (feet)**	**Sample Date**	**Dinitrotoluene, Total**	**1,1-Dichloroethylene**	**1,2-Dichloropropane**	**1,1,1-Trichloroethane**	**1,1,2-Trichloroethane**	**Bromodichloromethane**	**Carbon Tetrachloride**	**Chloroform**	**Ethyl Ether**	**Trichloroethylene**
PBN-9303D	675	D	214.5-224.5	10/06/10	<0.015	**0.14**	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
PBN-9402B	680	B	85.5-95.5	10/06/10	<0.015	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	**0.22**	<0.10	<0.10
PBN-9402C	681	C	125-135	10/06/10	<0.015	<0.10	<0.10	<0.10	<0.10	<0.10	**0.13**	**0.23**	<0.10	<0.10
PBN-9402C (dup)	681	C	125-135	10/06/10	<0.015	<0.10	<0.10	<0.10	<0.10	<0.10	**0.14**	**0.27**	<0.10	<0.10
PBN-9402D	682	D	215-225	10/06/10	<0.015	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
PBN-9902A	688	A	45-60	10/06/10	**0.018**	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
PBN-9902B	689	B	106-111	10/06/10	<0.015	<0.10	<0.10	**0.57**	<0.10	<0.10	**7.53**	**0.74**	<0.10	**1.28**
PBN-9902C	691	C	217.5-222.5	10/06/10	**4.443**	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
PBN-9902D	690	D	217.5-222.5	09/28/10	<0.015	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	**13.3**	<0.10
PBN-9902D (dup)	690	D	217.5-222.5	09/28/10	<0.015	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	**13.4**	<0.10
PBN-9903A	692	A	61-76	09/28/10	<0.015	<0.10	<0.10	<0.10	<0.10	<0.10	**0.93**	<0.10	<0.10	**0.1**
PBN-9903B	693	B	107-112	09/28/10	**0.019**	<0.10	<0.10	**0.5**	<0.10	<0.10	**11.5**	**1.18**	<0.10	**5.8**
PBN-9903C	694	C	158-163	09/28/10	**0.017**	<0.10	<0.10	**0.26**	<0.10	<0.10	**23.8**	**2.07**	<0.10	**6.82**
PBN-9903D	695	D	203-208	09/28/10	<0.015	<0.10	<0.10	**0.12**	<0.10	<0.10	**9.92**	**1.48**	**11.4**	**3.98**
S1103	702	C	115.0-120.1	09/09/10	<0.015	<0.10	<0.10	**0.25**	<0.10	<0.10	**6.99**	**0.8**	<0.10	<0.10
S1103 (dup)	702	C	115.0-120.1	09/09/10	<0.015	<0.10	<0.10	**0.29**	<0.10	<0.10	**7.31**	**0.85**	<0.10	<0.10
S1104	703	A	73.28-93.5	09/09/10	<0.015	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
S1105	704	B	104.4-109.5	09/09/10	<0.015	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
S1106	705	C	130.7-135.7	09/09/10	**0.026**	<0.10	<0.10	<0.10	<0.10	<0.10	**0.34**	**0.24**	<0.10	<0.10
S1121	755	A	39.11-59.3	09/13/10	<0.015	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
S1122	300	A	123.8-144	09/30/10	<0.015	<0.10	<0.10	**0.38**	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
S1134R	236	A	136-151	09/23/10	<0.015	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
SEN-0501A	580	A	17-32	09/08/10	<0.015	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	**0.27**	<0.10	<0.10
SEN-0501B	581	B	77-87	09/08/10	**0.024**	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	**0.68**	<0.10	<0.10
SEN-0501D	582	D	180-190	09/08/10	<0.015	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	**0.82**	<0.10	<0.10
SEN-0502A	583	A	18-33	09/08/10	<0.015	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
SEN-0502B	588	B	592-692	09/08/10	**0.035**	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	**0.47**	<0.10	<0.10
SEN-0502B (dup)	588	B	592-692	09/08/10	**0.039**	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	**0.47**	<0.10	<0.10
SEN-0502D	584	D	177-187	09/08/10	<0.015	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	**0.5**	<0.10	<0.10
SEN-0503A	585	A	40.5-55.5	09/08/10	<0.015	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
SEN-0503B	586	B	100-110	09/08/10	**0.049**	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	**0.41**	<0.10	<0.10
SEN-0503D	587	D	203-213	09/08/10	<0.015	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	**0.35**	<0.10	<0.10
SPN-0401A	728	A	77-92	09/09/10	<0.015	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
SPN-0402A	729	A	30-45	09/13/10	<0.015	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
SPN-0402C	730	C	143.7-148.7	09/13/10	<0.015	<0.10	<0.10	<0.10	<0.10	<0.10	**0.76**	**0.83**	<0.10	<0.10
SPN-0403A	731	A	40.8-55.8	09/13/10	<0.015	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
SPN-0403C	732	C	160-165	09/13/10	<0.015	<0.10	<0.10	<0.10	<0.10	<0.10	**0.6**	**0.81**	<0.10	<0.10
SPN-0404D	733	D	237-242	09/13/10	<0.015	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
SPN-0406A	736	A	28.4-43.4	09/13/10	<0.015	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
SPN-0406B	737	B	93.5-98.5	09/13/10	<0.015	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	**0.48**	<0.10	<0.10
SPN-0406B (dup)	737	B	93.5-98.5	09/13/10	<0.015	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	**0.48**	<0.10	<0.10
SPN-0406C	738	C	144.4-149.4	09/13/10	<0.015	<0.10	<0.10	<0.10	<0.10	<0.10	**0.19**	**1.54**	<0.10	<0.10
SPN-8902B	716	B	93.8-98.8	09/09/10	<0.015	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
SPN-8902C	717	C	124-129	09/09/10	<0.015	<0.10	<0.10	**0.22**	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
SPN-8904B	720	B	70-75	09/09/10	**0.078**	<0.10	<0.10	**0.45**	<0.10	<0.10	**9.5**	**0.97**	<0.10	**6.1**
SPN-8904C	721	C	101.5-106.5	09/09/10	**0.096**	**0.12**	<0.10	**1.03**	<0.10	**0.17**	**17.2**	**1.94**	<0.10	**13.1**

Table 1
Groundwater Analytical Results
September 2010 Round
Badger Army Ammunition Plant

						VOCs - SW8260B								
Well	**Well ID**	**Sample Level**	**Sample Depth (feet)**	**Sample Date**	**Dinitrotoluene, Total**	**1,1-Dichloroethylene**	**1,2-Dichloropropane**	**1,1,1-Trichloroethane**	**1,1,2-Trichloroethane**	**Bromodichloromethane**	**Carbon Tetrachloride**	**Chloroform**	**Ethyl Ether**	**Trichloroethylene**
SWN-0501B	237	B	145.6-155.6	09/07/10	<0.015	<0.10	<0.10	<0.10	<0.10	<0.10	**0.2**	**0.43**	<0.10	<0.10
SWN-0501C	238	C	196.6-206.6	09/07/10	<0.015	<0.10	<0.10	<0.10	<0.10	<0.10	**0.46**	**1.43**	<0.10	<0.10
SWN-0501D	239	D	252.9-262.9	09/07/10	<0.015	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	**0.25**	<0.10
SWN-0501E	240	E	280.3-290.3	09/07/10	<0.015	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	**10.5**	<0.10
SWN-0502B	241	B	145.8-155.8	09/07/10	<0.015	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	**0.87**	<0.10	<0.10
SWN-0502B (dup)	241	B	145.8-155.8	09/07/10	<0.015	<0.10	<0.10	<0.10	<0.10	<0.10	**0.12**	**0.94**	<0.10	<0.10
SWN-0502C	242	C	191.5-201.5	09/07/10	<0.015	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	**1**	<0.10	<0.10
SWN-0502D	243	D	234.9-244.9	09/07/10	<0.015	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
SWN-0502E	244	E	250-260	09/07/10	<0.015	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
SWN-0503B	245	B	144.3-154.3	09/07/10	<0.015	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	**0.54**	<0.10	<0.10
SWN-0503C	246	C	190.6-200.6	09/07/10	<0.015	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	**0.94**	<0.10	<0.10
SWN-0503D	247	D	230.5-240.5	09/07/10	<0.015	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
SWN-0503E	248	E	255.2-265.2	09/07/10	<0.015	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	**4.59**	<0.10
SWN-9102C	569	C	142.5-152.5	09/14/10	**0.052**	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
SWN-9102D	570	D	175-185	09/14/10	<0.015	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	**0.23**	<0.10	<0.10
SWN-9103B	571	B	103.4-113.4	09/14/10	**0.052**	<0.10	<0.10	<0.10	<0.10	<0.10	**14.1**	**1.65**	<0.10	**1.38**
SWN-9103B (dup)	571	B	103.4-113.4	09/14/10	**0.044**	<0.10	<0.10	<0.10	<0.10	<0.10	**14.2**	**1.58**	<0.10	**1.48**
SWN-9103C	572	C	152.8-162.8	09/14/10	<0.015	<0.10	<0.10	<0.10	<0.10	<0.10	**75.9**	**5.82**	<0.10	**0.98**
SWN-9103D	573	D	199.1-209.1	09/14/10	<0.015	<0.10	<0.10	<0.10	<0.10	<0.10	**8.45**	**1.76**	<0.10	**0.29**
SWN-9103E	574	E	227.9-237.9	09/14/10	**0.016**	<0.10	<0.10	<0.10	<0.10	<0.10	**0.22**	<0.10	<0.10	<0.10
SWN-9104C	575	C	154-164	09/14/10	**0.02**	<0.10	<0.10	<0.10	<0.10	<0.10	**1.5**	**0.44**	<0.10	<0.10
SWN-9104D	576	D	187-197	09/14/10	<0.015	<0.10	<0.10	<0.10	<0.10	<0.10	**0.51**	**0.42**	<0.10	<0.10
SWN-9105B	577	B	102.5-112.5	09/15/10	<0.015	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	**0.52**	<0.10	<0.10
SWN-9105C	578	C	137-147	09/15/10	<0.015	<0.10	<0.10	<0.10	<0.10	<0.10	**0.11**	**2.74**	<0.10	<0.10
SWN-9105D	579	D	190.5-200.5	09/15/10	<0.015	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	**0.61**	<0.10	<0.10
Chapter NR 140 PAL					0.005	0.7	0.5	40	0.5	0.06	0.5	0.6	100	0.5
Chapter NR 140 ES					0.05	7	5.0	200	5.0	0.6	5.0	6.0	1000	5

Notes:
The Sample Level references the typical well depth configuration
All results are expressed in micrograms per liter (µg/l)
Bold values are detected results
Wells listed with (dup) after the name were duplicate samples
Dinitrotoluene, Total results were analyzed by either SW8270C or SW8270CSIM
VOCs = Volatile Organic Compounds
Chapter NR 140 PAL - Chapter NR 140, Wisconsin Administrative Code, Preventive Action Limit
Chapter NR 140 ES - Chapter NR 140, Wisconsin Administrative Code, Enforcement Standard

Table 2
Groundwater Analytical Results
2010 Sitewide Monitoring Well Installation
Badger Army Ammunition Plant

					Dinitrotoluenes - SW8270CSIM							VOCs - SW8260B					
Well	**Well ID**	**Sample Level**	**Sample Depth (feet)**	**Sampled Date**	**2,3-Dinitrotoluene**	**2,4-Dinitrotoluene**	**2,5-Dinitrotoluene**	**2,6-Dinitrotoluene**	**3,4-Dinitrotoluene**	**3,5-Dinitrotoluene**	**Dinitrotoluene, Total**	**1,1,1-Trichloroethane**	**Carbon Tetrachloride**	**Chloroform**	**Ethyl Ether**	**Toluene**	**Trichloroethylene**
DBM-1001	471	A	115-125	10/26/10	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	**1.75**	<0.10	<0.10	<0.10	<0.10	<0.10
DBN-1001B	472	B	154.5-159.5	10/26/10	**0.269 (J)**	<0.015	<0.015	<0.015	**0.611**	**0.026 (J)**	**0.906**	**2.44**	**0.44**	<0.10	<0.10	**0.14 (J)**	<0.10
DBN-1001B (dup)	472	B	154.5-159.5	10/26/10	**0.253 (J)**	<0.015	<0.015	<0.015	**0.607**	**0.026 (J)**	**0.886**	**2.46**	**0.43**	<0.10	<0.10	**0.14 (J)**	<0.10
DBN-1001C	473	C	192-197	10/26/10	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.10	<0.10	<0.10	<0.10	**0.14 (J)**	<0.10
DBN-1001E	474	E	275-280	11/08/10	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
DBN-1002C	476	C	205-210	10/26/10	<0.015	<0.015	<0.015	<0.015	**0.016 (J)**	<0.015	**0.016**	**0.52**	**0.12 (J)**	<0.10	<0.10	**0.1 (J)**	<0.10
DBN-1002E	477	E	275-280	11/08/10	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
PBN-1001A	593	A	69-79	10/27/10	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.10	**0.82**	<0.10	<0.10	<0.10	<0.10
PBN-1001B	594	B	135-140	10/27/10	<0.015	<0.015	<0.015	**0.018 (J)**	<0.015	<0.015	**0.018**	**0.37**	**13.1**	**1.24**	<0.10	<0.10	**5.32**
PBN-1001C	595	C	195-200	10/27/10	<0.015	<0.015	<0.015	**0.04 (J)**	<0.015	<0.015	**0.04**	**0.15 (J)**	**5.06**	**3.85**	**4,610**	**0.16 (J)**	**0.12 (J)**
PBN-1002A	589	A	121-131	10/27/10	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.10	**0.21 (J)**	<0.10	<0.10	<0.10	<0.10
PBN-1002B	590	B	171.5-176.5	10/27/10	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	**0.32**	**6.88**	**0.50**	<0.10	<0.10	**1.23**
PBN-1002C	591	C	212-217	10/27/10	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	**0.65**	**11.5**	**0.8**	<0.10	**0.38**	**3.23**
PBN-1003C	592	C	184.5-189.5	10/27/10	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.10	**0.39**	**0.3 (J)**	<0.10	**0.16 (J)**	**0.26 (J)**
RIM-1001	482	A	89-99	10/26/10	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
RIM-1002	478	A	100-110	10/26/10	<0.015	**0.026 (J)**	<0.015	**0.019 (J)**	<0.015	<0.015	**0.045**	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
RIM-1003	491	A	104-114	10/26/10	<0.015	**0.029 (J)**	<0.015	<0.015	<0.015	<0.015	**0.029**	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
RIM-1004	494	A	60-70	10/28/10	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
RIM-1005	490	A	100-110	10/26/10	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
RIN-1001A	480	A	97-107	10/27/10	<0.015	**0.027 (J)**	<0.015	**0.035 (J)**	<0.015	<0.015	**0.062**	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
RIN-1001A (dup)	480	A	97-107	10/27/10	<0.015	**0.042 (J)**	<0.015	**0.052**	<0.015	<0.015	**0.094**	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
RIN-1001C	481	C	176-181	10/27/10	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	**0.25 (J)**	<0.10	**0.3 (J)**	<0.10	<0.10	<0.10
RIN-1002A	492	A	82-92	10/26/10	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
RIN-1002C	493	C	175-180	10/26/10	<0.015	<0.015	<0.015	**0.023 (J)**	<0.015	<0.015	**0.023**	<0.10	<0.10	**0.26 (J)**	<0.10	<0.10	<0.10
RIN-1003A	495	A	80-90	10/28/10	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
RIN-1004B	498	B	141.5-146.5	10/28/10	<0.015	**0.022 (J)**	<0.015	**0.039 (J)**	<0.015	<0.015	**0.061**	<0.10	<0.10	**0.44**	<0.10	<0.10	<0.10
RIN-1004B (dup)	498	B	141.5-146.5	10/28/10	<0.015	**0.024 (J)**	<0.015	**0.037 (J)**	<0.015	<0.015	**0.061**	<0.10	<0.10	**0.42**	<0.10	<0.10	<0.10
RIN-1005A	496	A	50-60	10/28/10	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
RIN-1005C	497	C	142-147	10/28/10	<0.015	<0.015	<0.015	**0.06**	<0.015	<0.015	**0.06**	<0.10	<0.10	**0.76**	<0.10	<0.10	<0.10
RIN-1006A	483	A	90-100	10/27/10	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.10	<0.10	<0.10	<0.10	<0.10	**0.46**
RIN-1006C	484	C	175-180	10/28/10	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
RIN-1007C	479	C	170-175	10/27/10	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	**0.56**	**0.24 (J)**	**0.31**	<0.10	<0.10	**0.26 (J)**
Chapter NR 140 PAL					NE	0.005	NE	0.005	NE	NE	0.005	40	0.5	0.6	100	160	0.5
Chapter NR 140 ES					NE	0.05	NE	0.05	NE	NE	0.05	200	5.0	6.0	1000	800	5

Notes:
The Sample Level references the typical well depth configuration
All results are expressed in micrograms per liter (µg/l)
Bold values are detected results
Samples DBN-1001B (dup), RIN-1001A (dup), and RIN-1004B (dup) were duplicate samples
J = Analytical result is between the Limit of Detection (LOD) and Limit of Quantitation (LOQ)
NE = Not Established
VOCs = Volatile Organic Compounds
Chapter NR 140 PAL - Chapter NR 140, Wisconsin Administrative Code, Preventive Action Limit
Chapter NR 140 ES - Chapter NR 140, Wisconsin Administrative Code, Enforcement Standard

Table 3
Regulatory Requirements: VOCs ands SVOCs
Badger Army Ammunition Plant

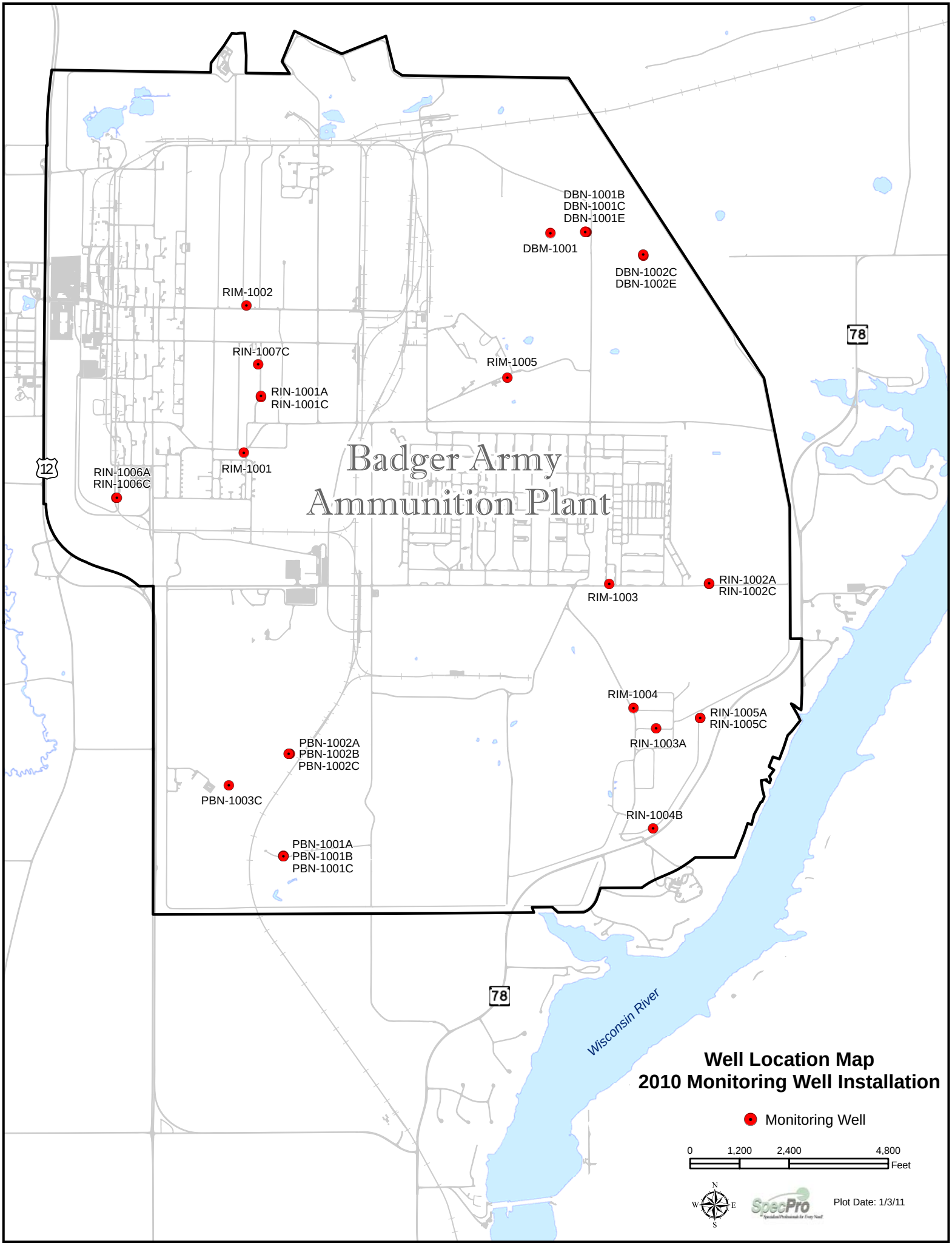
Regulated Media >	Groundwater		Surface Water	
Chemical	Wisconsin - NR 140		Wisconsin - NR 105	
Regulation	Groundwater Standards		WWSF Water Quality Criteria	
Standard	ES	PAL	HTC-NPWS	HCC-NPWS
Unit	µg/l	µg/l	µg/l	µg/l
Bromodichloromethane	0.6	0.06	-----	-----
Carbon Tetrachloride	5	0.5	-----	29
Chloroform	6	0.6	-----	1,960
2,4-Dinitrotoluene	0.05	0.005	13	13
2,6-Dinitrotoluene	0.05	0.005	-----	-----
Dinitrotoluene, Total *	0.05	0.005	-----	-----
1,1,1-Trichloroethane	200	40	270,000	-----
1,1,2-Trichloroethane	5	0.5	-----	195
Trichloroethylene	5	0.5	-----	539

VOC - Volatile Organic Compound
SVOC - Semi-volatile Organic Compound
NR - Natural Resources (Wisconsin Administrative Code)
WWSF - Surface Water Designated Use - Warm Water Sport Fish (Lake Wisconsin) - NR 102
ES - Enforcement Standard - Public Health Groundwater Standard - NR 140.10
PAL - Preventive Action Limit - Public Health Groundwater Quality Guideline - NR 140.10
HTC-NPWS - Human Threshold Criteria - Non Public Water System - NR 105.08
HCC-NPWS - Human Cancer Criteria - Non Public Water System - NR 105.09
µg/l- micrograms per liter
*Total DNT Isomers (2,3 DNT; 2,4 DNT; 2,5 DNT ; 2,6 DNT; 3,4 DNT; 3,5 DNT) - NR 140.10

Appendices

Appendix A

Groundwater Monitoring Well Installation Documentation


Badger Army
Ammunition Plant
DBN-1001B
DBN-1001C
DBN-1001E
DBM-1001
DBN-1002C
DBN-1002E
RIM-1002
RIN-1007C
RIN-1001A
RIN-1001C
RIM-1005
RIM-1001
RIN-1006A
RIN-1006C
RIM-1003
RIN-1002A
RIN-1002C
RIM-1004
RIN-1005A
RIN-1005C
RIN-1003A
PBN-1002A
PBN-1002B
PBN-1002C
PBN-1003C
RIN-1004B
PBN-1001A
PBN-1001B
PBN-1001C
12
78
78
Wisconsin River
Well Location Map
2010 Monitoring Well Installation
Monitoring Well
0
1,200
2,400
4,800
Feet
N
W
E
S
SpecPro
Plot Date: 1/3/11

Monitoring Well Information
2010 Monitoring Well Installation

Well Name	Well ID	License	WI Unique Well ID	Date Installed	Northing	Easting	Well Depth	Top of Casing Elevation	Ground Elevation	Static Water Level (10/26 - 11/8/10) (top of casing)	Groundwater Elevation (10/26 - 11/8/10)	Well Diameter (inches)	Screen Length	Bedrock Depth	Well Type
DBM-1001	471	3037	VM161	05/10/10	501035.03	2042233.38	125.3	911.97	909.21	122.33	789.64	2.5	15	NA	MW
DBN-1001B	472	3037	VM162	05/25/10	501062.19	2043112.65	159.5	912.07	909.77	126.28	785.79	2.5	5	NA	PZ
DBN-1001C	473	3037	VM163	05/27/10	501062.97	2043094.50	197	912.00	909.78	128.34	783.66	2.5	5	NA	PZ
DBN-1001E	474	3037	VM164	06/30/10	501064.75	2043076.32	279.9	912.50	909.95	128.29	784.21	2.5	5	258	PZ
DBN-1002C	476	3037	VM165	06/17/10	500487.21	2044487.97	210.1	916.12	913.72	133.28	782.84	2.5	5	NA	PZ
DBN-1002E	477	3037	VM166	07/12/10	500510.82	2044484.94	280.55	916.24	913.84	133.71	782.53	2.5	5	265	PZ
RIM-1002	478	3487	VM167	04/29/10	499282.00	2034868.80	110.2	891.01	888.51	103.29	787.72	2.5	15	NA	MW
RIN-1007C	479	3487	VM168	06/15/10	497857.57	2035155.19	175.3	883.81	881.41	97.63	786.18	2.5	5	NA	PZ
RIN-1001A	480	3487	VM169	04/28/10	497066.20	2035220.81	106.8	884.38	882.05	99.11	785.27	2.5	15	NA	MW
RIN-1001C	481	3487	VM170	05/24/10	497096.68	2035224.60	181.41	884.02	882.01	98.72	785.3	2.5	5	NA	PZ
RIM-1001	482	3487	VM171	04/27/10	495730.04	2034806.71	98.75	874.90	872.51	90.49	784.41	2.5	15	NA	MW
RIN-1006A	483	3487	VM172	05/18/10	494635.26	2031718.11	100.38	873.48	870.94	87.49	785.99	2.5	15	NA	MW
RIN-1006C	484	3487	VM173	05/18/10	494632.57	2031731.00	180.35	873.39	870.89	87.45	785.45	2.5	5	NA	PZ
RIM-1005	490	3487	VM174	05/06/10	497534.67	2041193.13	110.24	882.69	880.06	100.11	782.58	2.5	15	NA	MW
RIM-1003	491	3487	VM175	05/03/10	492554.74	2043660.80	114.3	885.06	882.78	107.29	777.77	2.5	15	NA	MW
RIN-1002A	492	3487	VM176	05/04/10	492556.37	2046081.69	92.2	862.81	860.46	85.89	776.92	2.5	15	NA	MW
RIN-1002C	493	3487	VM177	06/01/10	492568.67	2046078.50	179.8	862.95	860.86	86.11	776.84	2.5	5	NA	PZ
RIM-1004	494	3487	VM178	05/05/10	489552.08	2044244.43	70.52	836.40	833.60	61.85	774.55	2.5	15	NA	MW
RIN-1003A	495	3487	VM179	05/05/10	489061.45	2044797.07	90.5	857.10	854.66	83.23	773.87	2.5	15	NA	MW
RIN-1005A	496	3487	VM180	05/17/10	489310.71	2045864.38	60.5	828.61	826.74	53.34	775.27	2.5	15	NA	MW
RIN-1005C	497	3487	VM181	05/17/10	489316.84	2045864.92	147	828.75	826.49	54.42	774.33	2.5	5	NA	PZ
RIN-1004B	498	3487	VM182	05/13/10	486645.01	2044721.14	146.7	859.31	856.74	88.76	770.55	2.5	5	NA	PZ
PBN-1002A	589	2814	VM189	05/20/10	488450.52	2035896.71	130.8	893.90	891.70	123.35	770.55	2.5	15	NA	MW
PBN-1002B	590	2814	VM183	05/19/10	488447.03	2035926.71	176.5	894.27	892.27	123.69	770.58	2.5	5	NA	PZ
PBN-1002C	591	2814	VM184	06/09/10	488449.71	2035908.47	216.8	893.48	891.48	122.93	770.55	2.5	5	NA	PZ
PBN-1003C	592	2814	VM185	06/03/10	487681.33	2034447.60	189.6	848.21	846.51	74.47	773.74	2.5	5	NA	PZ
PBN-1001A	593	2814	VM186	05/03/10	485983.78	2035769.90	79.3	840.37	838.17	73.99	766.38	2.5	15	NA	MW
PBN-1001B	594	2814	VM187	06/02/10	485975.99	2035767.53	139.9	839.93	838.23	73.41	766.52	2.5	5	NA	PZ
PBN-1001C	595	2814	VM188	06/08/10	485968.12	2035767.23	199.7	840.01	837.71	73.65	766.36	2.5	5	NA	PZ

Notes:
NA = Bedrock not encountered
PZ = Piezometer
MW = Groundwater Monitoring Well
All measurements are in feet and measured from the ground surface unless otherwise noted.
Northing and Easting coordinates are associated with the State Plane System North American Datum 1983 (NAD83).

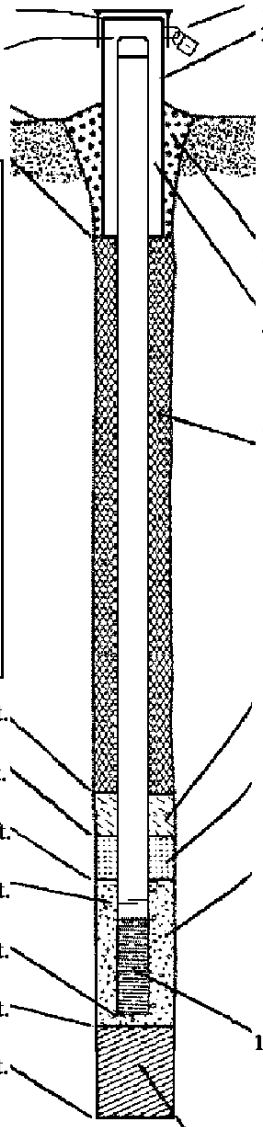
WDNR Monitoring Well Construction Forms

State of Wisconsin
Department of Natural Resources

Route to: Watershed/Wastewater ☐ Waste Management ☐ Remediation/Redevelopment ☑ Other ☐ _____

MONITORING WELL CONSTRUCTION
Form 4400-113A Rev. 7-98

Facility/Project Name: Badger AAP	Local Grid Location of Well: ☐ N. ☐ S. _____ ft. ☐ E. ☐ W. _____ ft.	Well Name: PBN-1002A
Facility License, Permit or Monitoring No.: 2814	Local Grid Origin ☐ (estimated: ☐) or Well Location ☐ Lat. (NAD 83)° ___ " Long. ___ ° ___ ' ___ " or	Wis. Unique Well No.: VM189 / DNR Well ID No.: 589
Facility ID: 157053930	St. Plane 488450.52 ft. N, 2035896.71 ft. E. (S)/C/N	Date Well Installed: 05 / 20 / 2010 (m m d d y y y y)
Type of Well: Well Code 11 / MW	Section Location of Waste/Source: ___ 1/4 of ___ 1/4 of Sec. ___, T. ___ N, R. ___ ☐ E. ☐ W.	Well Installed By: Name (first, last) and Firm: Roy Buckenberger; Layne Christensen Company
Distance from Waste/Source ___ ft. / Enf. Stds. Apply ☑	Location of Well Relative to Waste/Source: u ☐ Upgradient s ☐ Sidegradient d ☑ Downgradient n ☐ Not Known	Gov. Lot Number:



A. Protective pipe, top elevation _____ ft. MSL

B. Well casing, top elevation 893.90 ft. MSL

C. Land surface elevation 891.70 ft. MSL

D. Surface seal, bottom _____ ft. MSL or 4 ft.

12. USCS classification of soil near screen:
GP ☐ GM ☐ GC ☐ GW ☐ SW ☐ SP ☑
SM ☐ SC ☐ ML ☐ MH ☐ CL ☐ CH ☐
Bedrock ☐

13. Sieve analysis performed? ☐ Yes ☑ No

14. Drilling method used: Rotary ☐ 50; Hollow Stem Auger ☐ 41; Other ☑ Rotosonic

15. Drilling fluid used: Water ☑ 02; Air ☐ 01; Drilling Mud ☐ 03; None ☐ 99

16. Drilling additives used? ☐ Yes ☑ No

Describe _____

17. Source of water (attach analysis, if required):

E. Bentonite seal, top _____ ft. MSL or 105.8 ft.

F. Fine sand, top _____ ft. MSL or 110.8 ft.

G. Filter pack, top _____ ft. MSL or 112.8 ft.

H. Screen joint, top _____ ft. MSL or 115.8 ft.

I. Well bottom _____ ft. MSL or 130.8 ft.

J. Filter pack, bottom _____ ft. MSL or 130.8 ft.

K. Borehole, bottom _____ ft. MSL or 130.8 ft.

L. Borehole, diameter 7.0 in.

M. O.D. well casing 2.9 in.

N. I.D. well casing 2.3 in.

1. Cap and lock? ☑ Yes ☐ No

2. Protective cover pipe:
a. Inside diameter: 6.0 in.
b. Length: 7.5 ft.
c. Material: Steel ☑ 04; Other ☐
d. Additional protection? ☑ Yes ☐ No
If yes, describe: Steel Bumper Posts

3. Surface seal: Bentonite ☑ 30; Concrete ☐ 01; Other ☐

4. Material between well casing and protective pipe: Bentonite ☑ 30; Other ☐

5. Annular space seal: a. Granular/Chipped Bentonite ☐ 33
b. ___ Lbs/gal mud weight . . . Bentonite-sand slurry ☐ 35
c. 3.5 Lbs/gal mud weight . . . . . Bentonite slurry ☑ 31
d. ___ % Bentonite . . . . . Bentonite-cement grout ☐ 50
e. 150 gal Ft^3 volume added for any of the above
f. How installed: Tremie ☑ 01; Tremie pumped ☐ 02; Gravity ☐ 08

6. Bentonite seal: a. Bentonite granules ☐ 33
b. ☐ 1/4 in. ☑ 3/8 in. ☐ 1/2 in. Bentonite chips ☑ 32
c. _____ Other ☐

7. Fine sand material: Manufacturer, product name & mesh size
a. Badger Mining, silica sand, 40-60
b. Volume added 1 bag ft^3

8. Filter pack material: Manufacturer, product name & mesh size
a. Red Flint #40
b. Volume added 4 bags ft^3

9. Well casing: Flush threaded PVC schedule 40 ☐ 23; Flush threaded PVC schedule 80 ☑ 24; Other ☐

10. Screen material: same as above
a. Screen type: Factory cut ☑ 11; Continuous slot ☐ 01; Other ☐
b. Manufacturer Campbell Monoflex
c. Slot size: 0.020 in.
d. Slotted length: 15.0 ft.

11. Backfill material (below filter pack): None ☑ 14; Other ☐

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature: Joel Janssen	Firm: SpecPro, Inc.

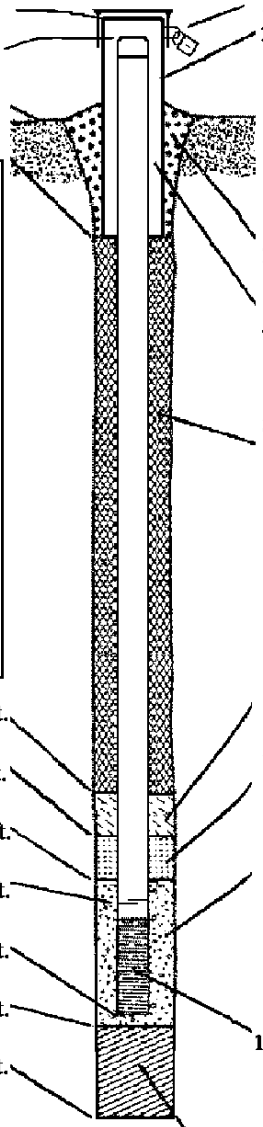
Please complete both Forms 4400-113A and 4400-113B and return them to the appropriate DNR office and bureau. Completion of these reports is required by chs. 160, 281, 283, 289, 291, 292, 293, 295, and 299, Wis. Stats., and ch. NR 141, Wis. Adm. Code. In accordance with chs. 281, 289, 291, 292, 293, 295, and 299, Wis. Stats., failure to file these forms may result in a forfeiture of between $10 and $25,000, or imprisonment for up to one year, depending on the program and conduct involved. Personally identifiable information on these forms is not intended to be used for any other purpose. NOTE: See the instructions for more information, including where the completed forms should be sent.

State of Wisconsin
Department of Natural Resources

Route to: Watershed/Wastewater ☐ Waste Management ☐ Remediation/Redevelopment ☑ Other ☐ _____

MONITORING WELL CONSTRUCTION
Form 4400-113A Rev. 7-98

Facility/Project Name: Badger AAP	Local Grid Location of Well: ☐ N. ☐ S. _____ ft. ☐ E. ☐ W. _____ ft.	Well Name: PBN-1001C
Facility License, Permit or Monitoring No.: 2814	Local Grid Origin ☐ (estimated: ☐) or Well Location ☐ Lat. (NAD 83) ' " Long. ° ' " or	Wis. Unique Well No.: VM188 / DNR Well ID No.: 595
Facility ID: 157053930	St. Plane 485968.12 ft. N, 2035767.23 ft. E. (S)C/N	Date Well Installed: 06 / 08 / 2010 (m m d d y y y y)
Type of Well: Well Code 12 / PZ	Section Location of Waste/Source: ____ 1/4 of ____ 1/4 of Sec. ____, T. ____ N, R. ____ ☐ E. ☐ W.	Well Installed By: Name (first, last) and Firm: Roy Buckenberger; Layne Christensen Company
Distance from Waste/Source ____ ft. / Enf. Stds. Apply ☑	Location of Well Relative to Waste/Source: u ☐ Upgradient s ☐ Sidegradient d ☑ Downgradient n ☐ Not Known; Gov. Lot Number ____	



A. Protective pipe, top elevation _____ ft. MSL

B. Well casing, top elevation 840.01 ft. MSL

C. Land surface elevation 837.71 ft. MSL

D. Surface seal, bottom _____ ft. MSL or 4 ft.

12. USCS classification of soil near screen:
GP ☐ GM ☐ GC ☐ GW ☐ SW ☐ SP ☑
SM ☐ SC ☐ ML ☐ MH ☐ CL ☐ CH ☐
Bedrock ☐

13. Sieve analysis performed? ☐ Yes ☑ No

14. Drilling method used: Rotary ☐ 50; Hollow Stem Auger ☐ 41; Other ☑ Rotosonic

15. Drilling fluid used: Water ☑ 02; Air ☐ 01; Drilling Mud ☐ 03; None ☐ 99

16. Drilling additives used? ☐ Yes ☑ No

Describe _____

17. Source of water (attach analysis, if required):

E. Bentonite seal, top _____ ft. MSL or 184.7 ft.

F. Fine sand, top _____ ft. MSL or 189.7 ft.

G. Filter pack, top _____ ft. MSL or 191.7 ft.

H. Screen joint, top _____ ft. MSL or 194.7 ft.

I. Well bottom _____ ft. MSL or 199.7 ft.

J. Filter pack, bottom _____ ft. MSL or 199.7 ft.

K. Borehole, bottom _____ ft. MSL or 199.7 ft.

L. Borehole, diameter 7.0 in.

M. O.D. well casing 2.9 in.

N. I.D. well casing 2.3 in.

1. Cap and lock? ☑ Yes ☐ No

2. Protective cover pipe:
a. Inside diameter: 6.0 in.
b. Length: 7.5 ft.
c. Material: Steel ☑ 04; Other ☐
d. Additional protection? ☑ Yes ☐ No
If yes, describe: Steel Bumper Posts

3. Surface seal: Bentonite ☑ 30; Concrete ☐ 01; Other ☐

4. Material between well casing and protective pipe: Bentonite ☑ 30; Other ☐

5. Annular space seal: a. Granular/Chipped Bentonite ☐ 33
b. ____ Lbs/gal mud weight . . . Bentonite-sand slurry ☐ 35
c. 3.5 Lbs/gal mud weight . . . . . Bentonite slurry ☑ 31
d. ____ % Bentonite . . . . . Bentonite-cement grout ☐ 50
e. 250 gal Ft^3 volume added for any of the above
f. How installed: Tremie ☑ 01; Tremie pumped ☐ 02; Gravity ☐ 08

6. Bentonite seal: a. Bentonite granules ☐ 33
b. ☐ 1/4 in. ☑ 3/8 in. ☐ 1/2 in. Bentonite chips ☑ 32
c. _____ Other ☐

7. Fine sand material: Manufacturer, product name & mesh size
a. Badger Mining, silica sand, 40-60
b. Volume added 1 bag ft^3

8. Filter pack material: Manufacturer, product name & mesh size
a. Red Flint #40
b. Volume added 4 bags ft^3

9. Well casing: Flush threaded PVC schedule 40 ☐ 23; Flush threaded PVC schedule 80 ☑ 24; Other ☐

10. Screen material: same as above
a. Screen type: Factory cut ☑ 11; Continuous slot ☐ 01; Other ☐
b. Manufacturer Campbell Monoflex
c. Slot size: 0.020 in.
d. Slotted length: 5 ft.

11. Backfill material (below filter pack): None ☑ 14; Other ☐

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature: Joel Janssen	Firm: SpecPro, Inc.

Please complete both Forms 4400-113A and 4400-113B and return them to the appropriate DNR office and bureau. Completion of these reports is required by chs. 160, 281, 283, 289, 291, 292, 293, 295, and 299, Wis. Stats., and ch. NR 141, Wis. Adm. Code. In accordance with chs. 281, 289, 291, 292, 293, 295, and 299, Wis. Stats., failure to file these forms may result in a forfeiture of between $10 and $25,000, or imprisonment for up to one year, depending on the program and conduct involved. Personally identifiable information on these forms is not intended to be used for any other purpose. NOTE: See the instructions for more information, including where the completed forms should be sent.

State of Wisconsin
Department of Natural Resources

Route to: Watershed/Wastewater ☐ Waste Management ☐ Remediation/Redevelopment ☑ Other ☐ _____

MONITORING WELL CONSTRUCTION
Form 4400-113A Rev. 7-98

Facility/Project Name: Badger AAP	Local Grid Location of Well: ☐ N. ☐ S. _____ ft. ☐ E. ☐ W. _____ ft.	Well Name: PBN-1001B
Facility License, Permit or Monitoring No.: 2814	Local Grid Origin ☐ (estimated: ☐) or Well Location ☐ Lat. (NAD 83) ___ ° ___ ' ___ " Long. ___ ° ___ ' ___ " or	Wis. Unique Well No.: VM187 / DNR Well ID No.: 594
Facility ID: 157053930	St. Plane 485975.99 ft. N, 2035767.53 ft. E. (S)C/N	Date Well Installed: 06 / 02 / 2010 (m m d d y y y y)
Type of Well: Well Code 12 / PZ	Section Location of Waste/Source: ___ 1/4 of ___ 1/4 of Sec. ___, T. ___ N, R. ___ ☐ E. ☐ W.	Well Installed By: Name (first, last) and Firm: Roy Buckenberger; Layne Christensen Company
Distance from Waste/Source ___ ft. Enf. Stds. Apply ☑	Location of Well Relative to Waste/Source: u ☐ Upgradient s ☐ Sidegradient d ☑ Downgradient n ☐ Not Known; Gov. Lot Number ___	

A. Protective pipe, top elevation _____ ft. MSL

B. Well casing, top elevation 839.93 ft. MSL

C. Land surface elevation 838.23 ft. MSL

D. Surface seal, bottom _____ ft. MSL or 4 ft.

12. USCS classification of soil near screen:
GP ☐ GM ☐ GC ☐ GW ☐ SW ☐ SP ☑
SM ☐ SC ☐ ML ☐ MH ☐ CL ☐ CH ☐
Bedrock ☐

13. Sieve analysis performed? ☐ Yes ☑ No

14. Drilling method used: Rotary ☐ 50; Hollow Stem Auger ☐ 41; Other ☑ Rotosonic

15. Drilling fluid used: Water ☑ 02; Air ☐ 01; Drilling Mud ☐ 03; None ☐ 99

16. Drilling additives used? ☐ Yes ☑ No

Describe _____

17. Source of water (attach analysis, if required):

E. Bentonite seal, top _____ ft. MSL or 124.9 ft.

F. Fine sand, top _____ ft. MSL or 129.9 ft.

G. Filter pack, top _____ ft. MSL or 131.9 ft.

H. Screen joint, top _____ ft. MSL or 134.9 ft.

I. Well bottom _____ ft. MSL or 139.9 ft.

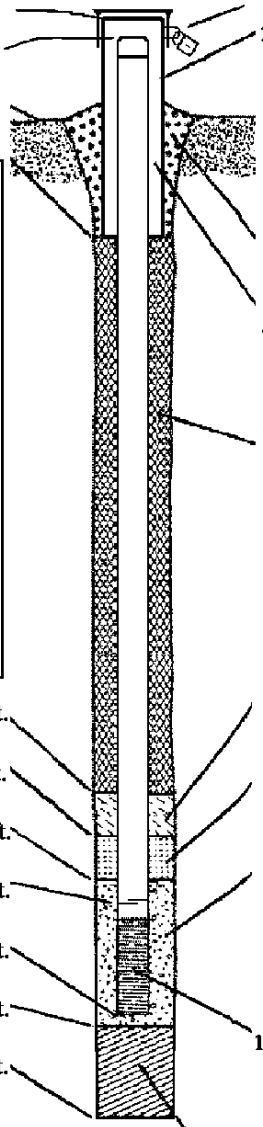
J. Filter pack, bottom _____ ft. MSL or 139.9 ft.

K. Borehole, bottom _____ ft. MSL or 139.9 ft.

L. Borehole, diameter 7.0 in.

M. O.D. well casing 2.9 in.

N. I.D. well casing 2.3 in.



1. Cap and lock? ☑ Yes ☐ No

2. Protective cover pipe:
a. Inside diameter: 6.0 in.
b. Length: 7.5 ft.
c. Material: Steel ☑ 04; Other ☐
d. Additional protection? ☑ Yes ☐ No
If yes, describe: Steel Bumper Posts

3. Surface seal: Bentonite ☑ 30; Concrete ☐ 01; Other ☐

4. Material between well casing and protective pipe: Bentonite ☑ 30; Other ☐

5. Annular space seal: a. Granular/Chipped Bentonite ☐ 33
b. ___ Lbs/gal mud weight . . . Bentonite-sand slurry ☐ 35
c. 3.5 Lbs/gal mud weight . . . . . Bentonite slurry ☑ 31
d. ___ % Bentonite . . . . . Bentonite-cement grout ☐ 50
e. 175 gal Ft^3 volume added for any of the above
f. How installed: Tremie ☑ 01; Tremie pumped ☐ 02; Gravity ☐ 08

6. Bentonite seal: a. Bentonite granules ☐ 33
b. ☐ 1/4 in. ☑ 3/8 in. ☐ 1/2 in. Bentonite chips ☑ 32
c. _____ Other ☐

7. Fine sand material: Manufacturer, product name & mesh size
a. Badger Mining, silica sand, 40-60
b. Volume added 1 bag ft^3

8. Filter pack material: Manufacturer, product name & mesh size
a. Red Flint #40
b. Volume added 4 bags ft^3

9. Well casing: Flush threaded PVC schedule 40 ☐ 23; Flush threaded PVC schedule 80 ☑ 24; Other ☐

10. Screen material: same as above
a. Screen type: Factory cut ☑ 11; Continuous slot ☐ 01; Other ☐
b. Manufacturer Campbell Monoflex
c. Slot size: 0.020 in.
d. Slotted length: 5 ft.

11. Backfill material (below filter pack): None ☑ 14; Other ☐

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature Joel Janssen | Firm SpecPro, Inc.

Please complete both Forms 4400-113A and 4400-113B and return them to the appropriate DNR office and bureau. Completion of these reports is required by chs. 160, 281, 283, 289, 291, 292, 293, 295, and 299, Wis. Stats., and ch. NR 141, Wis. Adm. Code. In accordance with chs. 281, 289, 291, 292, 293, 295, and 299, Wis. Stats., failure to file these forms may result in a forfeiture of between $10 and $25,000, or imprisonment for up to one year, depending on the program and conduct involved. Personally identifiable information on these forms is not intended to be used for any other purpose. NOTE: See the instructions for more information, including where the completed forms should be sent.

State of Wisconsin
Department of Natural Resources

Route to: Watershed/Wastewater ☐ Waste Management ☐ Remediation/Redevelopment ☑ Other ☐ _____

MONITORING WELL CONSTRUCTION
Form 4400-113A Rev. 7-98

Facility/Project Name: Badger AAP	Local Grid Location of Well: ____ ft. ☐ N. ☐ S. ____ ft. ☐ E. ☐ W.	Well Name: PBN-1001A
Facility License, Permit or Monitoring No.: 2814	Local Grid Origin ☐ (estimated: ☐) or Well Location ☐ Lat. (NAD 83)° ____ " Long. ____ ° ____ ' ____ " or	Wis. Unique Well No.: VM186 / DNR Well ID No.: 593
Facility ID: 157053930	St. Plane 485983.78 ft. N, 2035769.90 ft. E. (S)/C/N	Date Well Installed: 05 / 03 / 2010 (m m d d y y y y)
Type of Well: Well Code 11 / MW	Section Location of Waste/Source: ____ 1/4 of ____ 1/4 of Sec. ____, T. ____ N, R. ____ ☐ E. ☐ W.	Well Installed By: Name (first, last) and Firm: Roy Buckenberger; Layne Christensen Company
Distance from Waste/Source ____ ft. Enf. Stds. Apply ☑	Location of Well Relative to Waste/Source: u ☐ Upgradient s ☐ Sidegradient d ☑ Downgradient n ☐ Not Known	Gov. Lot Number: ____

A. Protective pipe, top elevation ____ ft. MSL

B. Well casing, top elevation 840.37 ft. MSL

C. Land surface elevation 838.17 ft. MSL

D. Surface seal, bottom ____ ft. MSL or 4 ft.

12. USCS classification of soil near screen:
GP ☐ GM ☐ GC ☐ GW ☐ SW ☐ SP ☑
SM ☐ SC ☐ ML ☐ MH ☐ CL ☐ CH ☐
Bedrock ☐

13. Sieve analysis performed? ☐ Yes ☑ No

14. Drilling method used: Rotary ☐ 50 Hollow Stem Auger ☐ 41 Other ☑ Rotosonic

15. Drilling fluid used: Water ☑ 02 Air ☐ 01 Drilling Mud ☐ 03 None ☐ 99

16. Drilling additives used? ☐ Yes ☑ No

Describe _____

17. Source of water (attach analysis, if required):

E. Bentonite seal, top ____ ft. MSL or 54.3 ft.

F. Fine sand, top ____ ft. MSL or 59.3 ft.

G. Filter pack, top ____ ft. MSL or 61.3 ft.

H. Screen joint, top ____ ft. MSL or 64.3 ft.

I. Well bottom ____ ft. MSL or 79.3 ft.

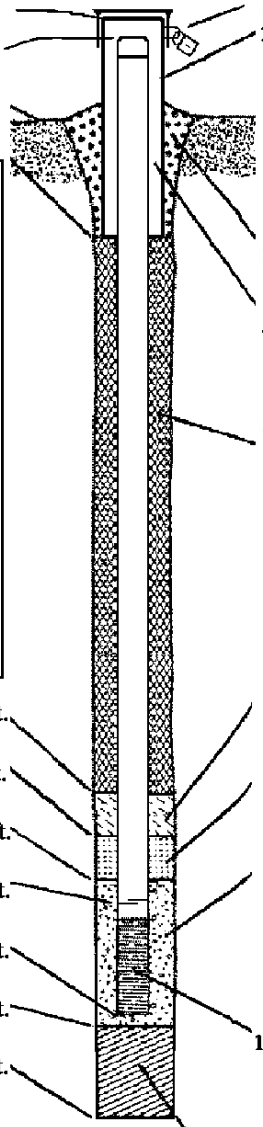
J. Filter pack, bottom ____ ft. MSL or 79.3 ft.

K. Borehole, bottom ____ ft. MSL or 79.3 ft.

L. Borehole, diameter 7.0 in.

M. O.D. well casing 2.9 in.

N. I.D. well casing 2.3 in.



1. Cap and lock? ☑ Yes ☐ No

2. Protective cover pipe:
a. Inside diameter: 6.0 in.
b. Length: 7.5 ft.
c. Material: Steel ☑ 04 Other ☐ ____
d. Additional protection? ☑ Yes ☐ No
If yes, describe: Steel Bumper Posts

3. Surface seal: Bentonite ☑ 30 Concrete ☐ 01 Other ☐ ____

4. Material between well casing and protective pipe: Bentonite ☑ 30 Other ☐ ____

5. Annular space seal: a. Granular/Chipped Bentonite ☐ 33
b. ____ Lbs/gal mud weight . . . Bentonite-sand slurry ☐ 35
c. 3.5 Lbs/gal mud weight . . . . . Bentonite slurry ☑ 31
d. ____ % Bentonite . . . . . Bentonite-cement grout ☐ 50
e. 80 gal Ft^3 volume added for any of the above
f. How installed: Tremie ☑ 01 Tremie pumped ☐ 02 Gravity ☐ 08

6. Bentonite seal: a. Bentonite granules ☐ 33
b. ☐ 1/4 in. ☑ 3/8 in. ☐ 1/2 in. Bentonite chips ☑ 32
c. ____ Other ☐ ____

7. Fine sand material: Manufacturer, product name & mesh size
a. Badger Mining, silica sand, 40-60
b. Volume added 1 bag ft^3

8. Filter pack material: Manufacturer, product name & mesh size
a. Red Flint #40
b. Volume added 4 bags ft^3

9. Well casing: Flush threaded PVC schedule 40 ☐ 23 Flush threaded PVC schedule 80 ☑ 24 Other ☐ ____

10. Screen material: same as above
a. Screen type: Factory cut ☑ 11 Continuous slot ☐ 01 Other ☐ ____
b. Manufacturer Campbell Monoflex
c. Slot size: 0.020 in.
d. Slotted length: 15.0 ft.

11. Backfill material (below filter pack): None ☑ 14 Other ☐ ____

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature: Joel Janssen	Firm: SpecPro, Inc.

Please complete both Forms 4400-113A and 4400-113B and return them to the appropriate DNR office and bureau. Completion of these reports is required by chs. 160, 281, 283, 289, 291, 292, 293, 295, and 299, Wis. Stats., and ch. NR 141, Wis. Adm. Code. In accordance with chs. 281, 289, 291, 292, 293, 295, and 299, Wis. Stats., failure to file these forms may result in a forfeiture of between $10 and $25,000, or imprisonment for up to one year, depending on the program and conduct involved. Personally identifiable information on these forms is not intended to be used for any other purpose. NOTE: See the instructions for more information, including where the completed forms should be sent.

State of Wisconsin
Department of Natural Resources

Route to: Watershed/Wastewater ☐ Waste Management ☐ Remediation/Redevelopment ☑ Other ☐ _____

MONITORING WELL CONSTRUCTION
Form 4400-113A Rev. 7-98

Facility/Project Name: Badger AAP	Local Grid Location of Well: ____ ft. ☐ N. ☐ S. ____ ft. ☐ E. ☐ W.	Well Name: DBN-1002E
Facility License, Permit or Monitoring No.: 3037	Local Grid Origin ☐ (estimated: ☐) or Well Location ☐ Lat. (NAD 83) ____ ° ____ ' ____ " Long. ____ ° ____ ' ____ " or	Wis. Unique Well No.: VM166 / DNR Well ID No.: 477
Facility ID: 157053930	St. Plane 500510.82 ft. N, 2044484.94 ft. E. (S)/C/N	Date Well Installed: 07 / 12 / 2010 (m m d d y y y y)
Type of Well: Well Code 12 / PZ	Section Location of Waste/Source: ____ 1/4 of ____ 1/4 of Sec. ____, T. ____ N, R. ____ ☐ E. ☐ W.	Well Installed By: Name (first, last) and Firm: Vince Meindel; Layne Christensen Company
Distance from Waste/Source ____ ft. Enf. Stds. Apply ☑	Location of Well Relative to Waste/Source: u ☐ Upgradient s ☐ Sidegradient d ☑ Downgradient n ☐ Not Known; Gov. Lot Number ____	

A. Protective pipe, top elevation _____ ft. MSL

B. Well casing, top elevation 916.24 ft. MSL

C. Land surface elevation 913.84 ft. MSL

D. Surface seal, bottom _____ ft. MSL or 4 ft.

12. USCS classification of soil near screen:
GP ☐ GM ☐ GC ☐ GW ☐ SW ☐ SP ☑
SM ☐ SC ☐ ML ☐ MH ☐ CL ☐ CH ☐
Bedrock ☐

13. Sieve analysis performed? ☐ Yes ☑ No

14. Drilling method used: Rotary ☐ 50; Hollow Stem Auger ☐ 41; Other ☑ DWRC

15. Drilling fluid used: Water ☑ 02; Air ☐ 01; Drilling Mud ☐ 03; None ☐ 99

16. Drilling additives used? ☐ Yes ☑ No

Describe _____

17. Source of water (attach analysis, if required):

E. Bentonite seal, top _____ ft. MSL or 265.55 ft.

F. Fine sand, top _____ ft. MSL or 270.55 ft.

G. Filter pack, top _____ ft. MSL or 272.55 ft.

H. Screen joint, top _____ ft. MSL or 275.55 ft.

I. Well bottom _____ ft. MSL or 280.55 ft.

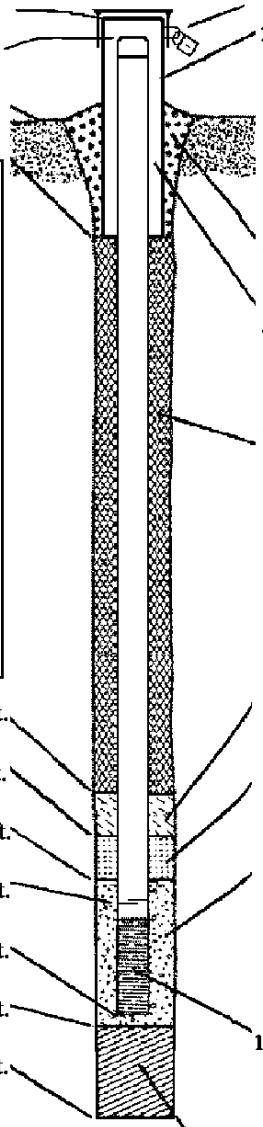
J. Filter pack, bottom _____ ft. MSL or 280.55 ft.

K. Borehole, bottom _____ ft. MSL or 280.55 ft.

L. Borehole, diameter 7.0 in.

M. O.D. well casing 2.9 in.

N. I.D. well casing 2.3 in.



1. Cap and lock? ☑ Yes ☐ No

2. Protective cover pipe:
a. Inside diameter: 6.0 in.
b. Length: 7.5 ft.
c. Material: Steel ☑ 04; Other ☐
d. Additional protection? ☑ Yes ☐ No
If yes, describe: Steel Bumper Posts

3. Surface seal: Bentonite ☑ 30; Concrete ☐ 01; Other ☐

4. Material between well casing and protective pipe: Bentonite ☑ 30; Other ☐

5. Annular space seal: a. Granular/Chipped Bentonite ☐ 33
b. ____ Lbs/gal mud weight . . . Bentonite-sand slurry ☐ 35
c. 3.5 Lbs/gal mud weight . . . . . Bentonite slurry ☑ 31
d. ____ % Bentonite . . . . . Bentonite-cement grout ☐ 50
e. 400 gal Ft^3 volume added for any of the above
f. How installed: Tremie ☑ 01; Tremie pumped ☐ 02; Gravity ☐ 08

6. Bentonite seal: a. Bentonite granules ☐ 33
b. ☐ 1/4 in. ☑ 3/8 in. ☐ 1/2 in. Bentonite chips ☑ 32
c. _____ Other ☐

7. Fine sand material: Manufacturer, product name & mesh size
a. Badger Mining, silica sand, 40-60
b. Volume added 1 bag ft^3

8. Filter pack material: Manufacturer, product name & mesh size
a. Red Flint #40
b. Volume added 4 bags ft^3

9. Well casing: Flush threaded PVC schedule 40 ☐ 23; Flush threaded PVC schedule 80 ☑ 24; Other ☐

10. Screen material: same as above
a. Screen type: Factory cut ☑ 11; Continuous slot ☐ 01; Other ☐
b. Manufacturer Campbell Monoflex
c. Slot size: 0.020 in.
d. Slotted length: 5 ft.

11. Backfill material (below filter pack): None ☑ 14; Other ☐

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature: Joel Janssen	Firm: SpecPro, Inc.

Please complete both Forms 4400-113A and 4400-113B and return them to the appropriate DNR office and bureau. Completion of these reports is required by chs. 160, 281, 283, 289, 291, 292, 293, 295, and 299, Wis. Stats., and ch. NR 141, Wis. Adm. Code. In accordance with chs. 281, 289, 291, 292, 293, 295, and 299, Wis. Stats., failure to file these forms may result in a forfeiture of between $10 and $25,000, or imprisonment for up to one year, depending on the program and conduct involved. Personally identifiable information on these forms is not intended to be used for any other purpose. NOTE: See the instructions for more information, including where the completed forms should be sent.

State of Wisconsin
Department of Natural Resources

Route to: Watershed/Wastewater ☐ Waste Management ☐ Remediation/Redevelopment ☑ Other ☐ _____

MONITORING WELL CONSTRUCTION
Form 4400-113A Rev. 7-98

Facility/Project Name: Badger AAP	Local Grid Location of Well: ____ ft. ☐ N. ☐ S. ____ ft. ☐ E. ☐ W.	Well Name: DBN-1002C
Facility License, Permit or Monitoring No.: 3037	Local Grid Origin ☐ (estimated: ☐) or Well Location ☐ Lat. (NAD 83)° ____ " Long. ____ ° ____ ' ____ " or	Wis. Unique Well No.: VM165 / DNR Well ID No.: 476
Facility ID: 157053930	St. Plane 500487.21 ft. N, 2044487.97 ft. E. (S)/C/N	Date Well Installed: 06 / 17 / 2010 (m m d d y y y y)
Type of Well: Well Code 12 / PZ	Section Location of Waste/Source: ____ 1/4 of ____ 1/4 of Sec. ____, T. ____ N, R. ____ ☐ E. ☐ W.	Well Installed By: Name (first, last) and Firm: Roy Buckenberger; Layne Christensen Company
Distance from Waste/Source ____ ft. / Enf. Stds. Apply ☑	Location of Well Relative to Waste/Source: u ☐ Upgradient s ☐ Sidegradient d ☑ Downgradient n ☐ Not Known	Gov. Lot Number: ____

A. Protective pipe, top elevation ____ ft. MSL

B. Well casing, top elevation 916.12 ft. MSL

C. Land surface elevation 913.72 ft. MSL

D. Surface seal, bottom ____ ft. MSL or 4 ft.

12. USCS classification of soil near screen:
GP ☐ GM ☐ GC ☐ GW ☐ SW ☐ SP ☑
SM ☐ SC ☐ ML ☐ MH ☐ CL ☐ CH ☐
Bedrock ☐

13. Sieve analysis performed? ☐ Yes ☑ No

14. Drilling method used: Rotary ☐ 50; Hollow Stem Auger ☐ 41; Other ☑ Rotosonic

15. Drilling fluid used: Water ☑ 02; Air ☐ 01; Drilling Mud ☐ 03; None ☐ 99

16. Drilling additives used? ☐ Yes ☑ No

Describe _____

17. Source of water (attach analysis, if required):

E. Bentonite seal, top ____ ft. MSL or 195.1 ft.

F. Fine sand, top ____ ft. MSL or 200.1 ft.

G. Filter pack, top ____ ft. MSL or 202.1 ft.

H. Screen joint, top ____ ft. MSL or 205.1 ft.

I. Well bottom ____ ft. MSL or 210.1 ft.

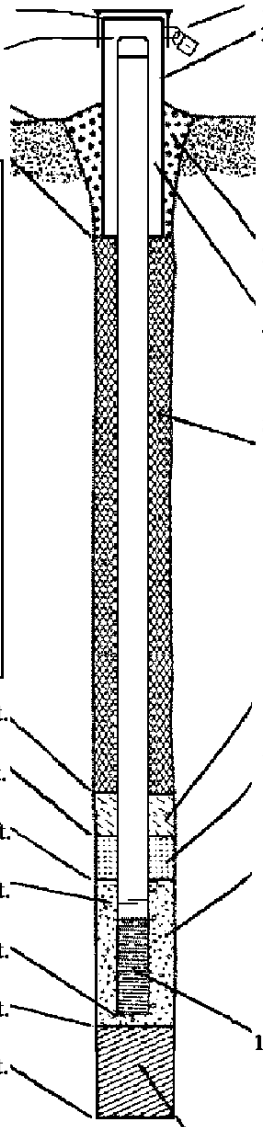
J. Filter pack, bottom ____ ft. MSL or 210.1 ft.

K. Borehole, bottom ____ ft. MSL or 210.1 ft.

L. Borehole, diameter 7.0 in.

M. O.D. well casing 2.9 in.

N. I.D. well casing 2.3 in.



1. Cap and lock? ☑ Yes ☐ No

2. Protective cover pipe:
a. Inside diameter: 6.0 in.
b. Length: 7.5 ft.
c. Material: Steel ☑ 04; Other ☐ ____
d. Additional protection? ☑ Yes ☐ No
If yes, describe: Steel Bumper Posts

3. Surface seal: Bentonite ☑ 30; Concrete ☐ 01; Other ☐ ____

4. Material between well casing and protective pipe: Bentonite ☑ 30; Other ☐ ____

5. Annular space seal: a. Granular/Chipped Bentonite ☐ 33
b. ____ Lbs/gal mud weight . . . Bentonite-sand slurry ☐ 35
c. 3.5 Lbs/gal mud weight . . . . . Bentonite slurry ☑ 31
d. ____ % Bentonite . . . . . Bentonite-cement grout ☐ 50
e. 250 gal Ft^3 volume added for any of the above
f. How installed: Tremie ☑ 01; Tremie pumped ☐ 02; Gravity ☐ 08

6. Bentonite seal: a. Bentonite granules ☐ 33
b. ☐ 1/4 in. ☑ 3/8 in. ☐ 1/2 in. Bentonite chips ☑ 32
c. ____ Other ☐ ____

7. Fine sand material: Manufacturer, product name & mesh size
a. Badger Mining, silica sand, 40-60
b. Volume added 1 bag ft^3

8. Filter pack material: Manufacturer, product name & mesh size
a. Red Flint #40
b. Volume added 4 bags ft^3

9. Well casing: Flush threaded PVC schedule 40 ☐ 23; Flush threaded PVC schedule 80 ☑ 24; Other ☐ ____

10. Screen material: same as above
a. Screen type: Factory cut ☑ 11; Continuous slot ☐ 01; Other ☐ ____
b. Manufacturer Campbell Monoflex
c. Slot size: 0.020 in.
d. Slotted length: 5 ft.

11. Backfill material (below filter pack): None ☑ 14; Other ☐ ____

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature Joel Janssen | Firm SpecPro, Inc.

Please complete both Forms 4400-113A and 4400-113B and return them to the appropriate DNR office and bureau. Completion of these reports is required by chs. 160, 281, 283, 289, 291, 292, 293, 295, and 299, Wis. Stats., and ch. NR 141, Wis. Adm. Code. In accordance with chs. 281, 289, 291, 292, 293, 295, and 299, Wis. Stats., failure to file these forms may result in a forfeiture of between $10 and $25,000, or imprisonment for up to one year, depending on the program and conduct involved. Personally identifiable information on these forms is not intended to be used for any other purpose. NOTE: See the instructions for more information, including where the completed forms should be sent.

State of Wisconsin
Department of Natural Resources

Route to: Watershed/Wastewater ☐ Waste Management ☐ Remediation/Redevelopment ☑ Other ☐ _____

MONITORING WELL CONSTRUCTION
Form 4400-113A Rev. 7-98

Facility/Project Name: Badger AAP	Local Grid Location of Well: ☐ N. ☐ S. _____ ft. ☐ E. ☐ W. _____ ft.	Well Name: DBN-1001E
Facility License, Permit or Monitoring No.: 3037	Local Grid Origin ☐ (estimated: ☐) or Well Location ☐ Lat. (NAD 83)° ____ " Long. ____ ° ____ ' ____ " or	Wis. Unique Well No.: VM164 / DNR Well ID No.: 474
Facility ID: 157053930	St. Plane 501064.75 ft. N, 2043076.32 ft. E. (S)/C/N	Date Well Installed: 06 / 30 / 2010 (m m d d y y y y)
Type of Well: Well Code 12 / PZ	Section Location of Waste/Source: ____ 1/4 of ____ 1/4 of Sec. ____, T. ____ N, R. ____ ☐ E. ☐ W.	Well Installed By: Name (first, last) and Firm: Vince Meindel; Layne Christensen Company
Distance from Waste/Source ____ ft. / Enf. Stds. Apply ☑	Location of Well Relative to Waste/Source: u ☐ Upgradient s ☐ Sidegradient d ☑ Downgradient n ☐ Not Known	Gov. Lot Number: ____

A. Protective pipe, top elevation _____ ft. MSL

B. Well casing, top elevation 912.49 ft. MSL

C. Land surface elevation 910.09 ft. MSL

D. Surface seal, bottom _____ ft. MSL or 4 ft.

12. USCS classification of soil near screen:
GP ☐ GM ☐ GC ☐ GW ☐ SW ☐ SP ☑
SM ☐ SC ☐ ML ☐ MH ☐ CL ☐ CH ☐
Bedrock ☐

13. Sieve analysis performed? ☐ Yes ☑ No

14. Drilling method used: Rotary ☐ 50; Hollow Stem Auger ☐ 41; Other ☑ DWRC

15. Drilling fluid used: Water ☑ 02; Air ☐ 01; Drilling Mud ☐ 03; None ☐ 99

16. Drilling additives used? ☐ Yes ☑ No

Describe _____

17. Source of water (attach analysis, if required):

E. Bentonite seal, top _____ ft. MSL or 264.9 ft.

F. Fine sand, top _____ ft. MSL or 269.9 ft.

G. Filter pack, top _____ ft. MSL or 271.9 ft.

H. Screen joint, top _____ ft. MSL or 274.9 ft.

I. Well bottom _____ ft. MSL or 279.9 ft.

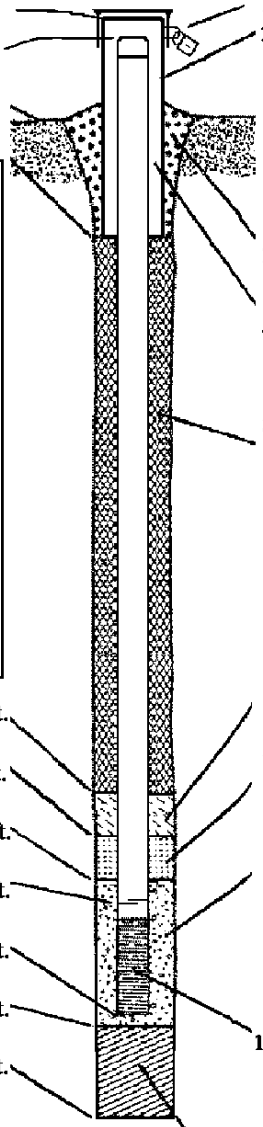
J. Filter pack, bottom _____ ft. MSL or 279.9 ft.

K. Borehole, bottom _____ ft. MSL or 279.9 ft.

L. Borehole, diameter 7.0 in.

M. O.D. well casing 2.9 in.

N. I.D. well casing 2.3 in.



1. Cap and lock? ☑ Yes ☐ No

2. Protective cover pipe:
a. Inside diameter: 6.0 in.
b. Length: 7.5 ft.
c. Material: Steel ☑ 04; Other ☐
d. Additional protection? ☑ Yes ☐ No
If yes, describe: Steel Bumper Posts

3. Surface seal: Bentonite ☑ 30; Concrete ☐ 01; Other ☐

4. Material between well casing and protective pipe: Bentonite ☑ 30; Other ☐

5. Annular space seal: a. Granular/Chipped Bentonite ☐ 33
b. ____ Lbs/gal mud weight . . . Bentonite-sand slurry ☐ 35
c. 3.5 Lbs/gal mud weight . . . . . Bentonite slurry ☑ 31
d. ____ % Bentonite . . . . . Bentonite-cement grout ☐ 50
e. 400 gal Ft^3 volume added for any of the above
f. How installed: Tremie ☑ 01; Tremie pumped ☐ 02; Gravity ☐ 08

6. Bentonite seal: a. Bentonite granules ☐ 33
b. ☐ 1/4 in. ☑ 3/8 in. ☐ 1/2 in. Bentonite chips ☑ 32
c. _____ Other ☐

7. Fine sand material: Manufacturer, product name & mesh size
a. Badger Mining, silica sand, 40-60
b. Volume added 1 bag ft^3

8. Filter pack material: Manufacturer, product name & mesh size
a. Red Flint #40
b. Volume added 4 bags ft^3

9. Well casing: Flush threaded PVC schedule 40 ☐ 23; Flush threaded PVC schedule 80 ☑ 24; Other ☐

10. Screen material: same as above
a. Screen type: Factory cut ☑ 11; Continuous slot ☐ 01; Other ☐
b. Manufacturer Campbell Monoflex
c. Slot size: 0.020 in.
d. Slotted length: 5 ft.

11. Backfill material (below filter pack): None ☑ 14; Other ☐

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature: Joel Janssen	Firm: SpecPro, Inc.

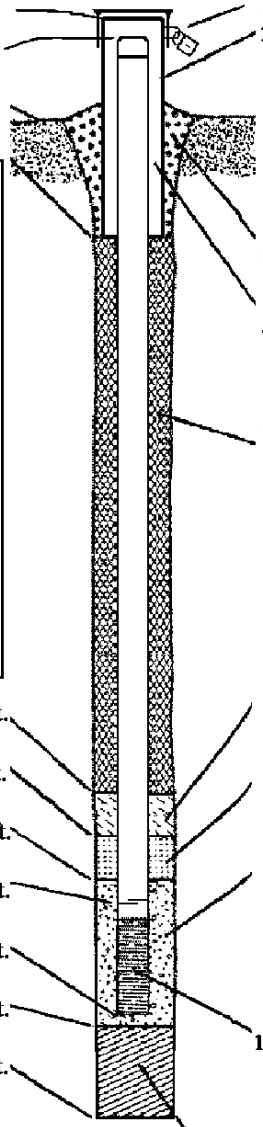
Please complete both Forms 4400-113A and 4400-113B and return them to the appropriate DNR office and bureau. Completion of these reports is required by chs. 160, 281, 283, 289, 291, 292, 293, 295, and 299, Wis. Stats., and ch. NR 141, Wis. Adm. Code. In accordance with chs. 281, 289, 291, 292, 293, 295, and 299, Wis. Stats., failure to file these forms may result in a forfeiture of between $10 and $25,000, or imprisonment for up to one year, depending on the program and conduct involved. Personally identifiable information on these forms is not intended to be used for any other purpose. NOTE: See the instructions for more information, including where the completed forms should be sent.

State of Wisconsin
Department of Natural Resources

Route to: Watershed/Wastewater ☐ Waste Management ☐ Remediation/Redevelopment ☑ Other ☐ _____

MONITORING WELL CONSTRUCTION
Form 4400-113A Rev. 7-98

Facility/Project Name: Badger AAP	Local Grid Location of Well: ☐ N. ☐ S. _____ ft. ☐ E. ☐ W. _____ ft.	Well Name: DBN-1001C
Facility License, Permit or Monitoring No.: 3037	Local Grid Origin ☐ (estimated: ☐) or Well Location ☐ Lat. (NAD 83)° ____ " Long. ____ ° ____ ' ____ " or	Wis. Unique Well No.: VM163 / DNR Well ID No.: 473
Facility ID: 157053930	St. Plane 501062.97 ft. N, 2043094.50 ft. E. (S)C/N	Date Well Installed: 05 / 27 / 2010 (m m d d y y y y)
Type of Well: Well Code 12 / PZ	Section Location of Waste/Source: ____ 1/4 of ____ 1/4 of Sec. ____, T. ____ N, R. ____ ☐ E. ☐ W.	Well Installed By: Name (first, last) and Firm: Roy Buckenberger; Layne Christensen Company
Distance from Waste/Source ____ ft. / Enf. Stds. Apply ☑	Location of Well Relative to Waste/Source: u ☐ Upgradient s ☐ Sidegradient d ☑ Downgradient n ☐ Not Known	Gov. Lot Number: ____



A. Protective pipe, top elevation _____ ft. MSL

B. Well casing, top elevation 912.00 ft. MSL

C. Land surface elevation 909.78 ft. MSL

D. Surface seal, bottom _____ ft. MSL or 4 ft.

12. USCS classification of soil near screen:
GP ☐ GM ☐ GC ☐ GW ☐ SW ☐ SP ☑
SM ☐ SC ☐ ML ☐ MH ☐ CL ☐ CH ☐
Bedrock ☐

13. Sieve analysis performed? ☐ Yes ☑ No

14. Drilling method used: Rotary ☐ 50 Hollow Stem Auger ☐ 41 Other ☑ Rotosonic

15. Drilling fluid used: Water ☑ 02 Air ☐ 01 Drilling Mud ☐ 03 None ☐ 99

16. Drilling additives used? ☐ Yes ☑ No

Describe _____

17. Source of water (attach analysis, if required):

E. Bentonite seal, top _____ ft. MSL or 182 ft.

F. Fine sand, top _____ ft. MSL or 187 ft.

G. Filter pack, top _____ ft. MSL or 189 ft.

H. Screen joint, top _____ ft. MSL or 192 ft.

I. Well bottom _____ ft. MSL or 197 ft.

J. Filter pack, bottom _____ ft. MSL or 197 ft.

K. Borehole, bottom _____ ft. MSL or 197 ft.

L. Borehole, diameter 7.0 in.

M. O.D. well casing 2.9 in.

N. I.D. well casing 2.3 in.

1. Cap and lock? ☑ Yes ☐ No

2. Protective cover pipe:
a. Inside diameter: 6.0 in.
b. Length: 7.5 ft.
c. Material: Steel ☑ 04 Other ☐ ____
d. Additional protection? ☑ Yes ☐ No
If yes, describe: Steel Bumper Posts

3. Surface seal: Bentonite ☑ 30 Concrete ☐ 01 Other ☐ ____

4. Material between well casing and protective pipe: Bentonite ☑ 30 Other ☐ ____

5. Annular space seal: a. Granular/Chipped Bentonite ☐ 33
b. ____ Lbs/gal mud weight . . . Bentonite-sand slurry ☐ 35
c. 3.5 Lbs/gal mud weight . . . . . Bentonite slurry ☑ 31
d. ____ % Bentonite . . . . . Bentonite-cement grout ☐ 50
e. 250 gal Ft^3 volume added for any of the above
f. How installed: Tremie ☑ 01 Tremie pumped ☐ 02 Gravity ☐ 08

6. Bentonite seal: a. Bentonite granules ☐ 33
b. ☐1/4 in. ☑3/8 in. ☐1/2 in. Bentonite chips ☑ 32
c. ____ Other ☐ ____

7. Fine sand material: Manufacturer, product name & mesh size
a. Badger Mining, silica sand, 40-60
b. Volume added 1 bag ft^3

8. Filter pack material: Manufacturer, product name & mesh size
a. Red Flint #40
b. Volume added 4 bags ft^3

9. Well casing: Flush threaded PVC schedule 40 ☐ 23 Flush threaded PVC schedule 80 ☑ 24 Other ☐ ____

10. Screen material: same as above
a. Screen type: Factory cut ☑ 11 Continuous slot ☐ 01 Other ☐ ____
b. Manufacturer Campbell Monoflex
c. Slot size: 0.020 in.
d. Slotted length: 5 ft.

11. Backfill material (below filter pack): None ☑ 14 Other ☐ ____

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature Joel Janssen | Firm SpecPro, Inc.

Please complete both Forms 4400-113A and 4400-113B and return them to the appropriate DNR office and bureau. Completion of these reports is required by chs. 160, 281, 283, 289, 291, 292, 293, 295, and 299, Wis. Stats., and ch. NR 141, Wis. Adm. Code. In accordance with chs. 281, 289, 291, 292, 293, 295, and 299, Wis. Stats., failure to file these forms may result in a forfeiture of between $10 and $25,000, or imprisonment for up to one year, depending on the program and conduct involved. Personally identifiable information on these forms is not intended to be used for any other purpose. NOTE: See the instructions for more information, including where the completed forms should be sent.

State of Wisconsin
Department of Natural Resources

Route to: Watershed/Wastewater ☐ Waste Management ☐ Remediation/Redevelopment ☑ Other ☐ _____

MONITORING WELL CONSTRUCTION
Form 4400-113A Rev. 7-98

Facility/Project Name: Badger AAP	Local Grid Location of Well: ____ ft. ☐ N. ☐ S. ____ ft. ☐ E. ☐ W.	Well Name: DBN-1001B
Facility License, Permit or Monitoring No.: 3037	Local Grid Origin ☐ (estimated: ☐) or Well Location ☐ Lat. (NAD 83)° ____ " Long. ____ ° ____ ' ____ " or	Wis. Unique Well No.: VM162 / DNR Well ID No.: 472
Facility ID: 157053930	St. Plane 501062.19 ft. N, 2043112.65 ft. E. (S)/C/N	Date Well Installed: 05 / 25 / 2010 (m m d d y y y y)
Type of Well: Well Code 12 / PZ	Section Location of Waste/Source: ____ 1/4 of ____ 1/4 of Sec. ____, T. ____ N, R. ____ ☐ E. ☐ W.	Well Installed By: Name (first, last) and Firm: Roy Buckenberger; Layne Christensen Company
Distance from Waste/Source ____ ft. / Enf. Stds. Apply ☑	Location of Well Relative to Waste/Source: u ☐ Upgradient s ☐ Sidegradient d ☑ Downgradient n ☐ Not Known	Gov. Lot Number: ____

A. Protective pipe, top elevation ____ ft. MSL

B. Well casing, top elevation 912.07 ft. MSL

C. Land surface elevation 909.77 ft. MSL

D. Surface seal, bottom ____ ft. MSL or 4 ft.

12. USCS classification of soil near screen:
GP ☐ GM ☐ GC ☐ GW ☐ SW ☐ SP ☑
SM ☐ SC ☐ ML ☐ MH ☐ CL ☐ CH ☐
Bedrock ☐

13. Sieve analysis performed? ☐ Yes ☑ No

14. Drilling method used: Rotary ☐ 50; Hollow Stem Auger ☐ 41; Other ☑ Rotosonic

15. Drilling fluid used: Water ☑ 02; Air ☐ 01; Drilling Mud ☐ 03; None ☐ 99

16. Drilling additives used? ☐ Yes ☑ No

Describe _____

17. Source of water (attach analysis, if required):

E. Bentonite seal, top ____ ft. MSL or 144.5 ft.

F. Fine sand, top ____ ft. MSL or 149.5 ft.

G. Filter pack, top ____ ft. MSL or 151.5 ft.

H. Screen joint, top ____ ft. MSL or 154.5 ft.

I. Well bottom ____ ft. MSL or 159.5 ft.

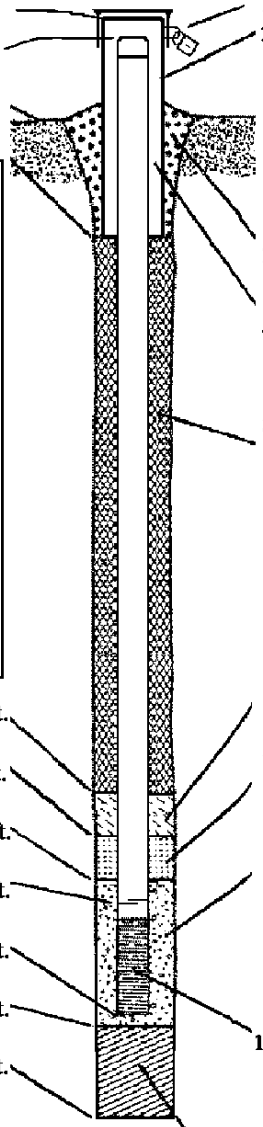
J. Filter pack, bottom ____ ft. MSL or 159.5 ft.

K. Borehole, bottom ____ ft. MSL or 159.5 ft.

L. Borehole, diameter 7.0 in.

M. O.D. well casing 2.9 in.

N. I.D. well casing 2.3 in.



1. Cap and lock? ☑ Yes ☐ No

2. Protective cover pipe:
a. Inside diameter: 6.0 in.
b. Length: 7.5 ft.
c. Material: Steel ☑ 04; Other ☐ ____
d. Additional protection? ☑ Yes ☐ No
If yes, describe: Steel Bumper Posts

3. Surface seal: Bentonite ☑ 30; Concrete ☐ 01; Other ☐ ____

4. Material between well casing and protective pipe: Bentonite ☑ 30; Other ☐ ____

5. Annular space seal: a. Granular/Chipped Bentonite ☐ 33
b. ____ Lbs/gal mud weight . . . Bentonite-sand slurry ☐ 35
c. 3.5 Lbs/gal mud weight . . . . . Bentonite slurry ☑ 31
d. ____ % Bentonite . . . . . Bentonite-cement grout ☐ 50
e. 200 gal Ft^3 volume added for any of the above
f. How installed: Tremie ☑ 01; Tremie pumped ☐ 02; Gravity ☐ 08

6. Bentonite seal: a. Bentonite granules ☐ 33
b. ☐ 1/4 in. ☑ 3/8 in. ☐ 1/2 in. Bentonite chips ☑ 32
c. ____ Other ☐ ____

7. Fine sand material: Manufacturer, product name & mesh size
a. Badger Mining, silica sand, 40-60
b. Volume added 1 bag ft^3

8. Filter pack material: Manufacturer, product name & mesh size
a. Red Flint #40
b. Volume added 4 bags ft^3

9. Well casing: Flush threaded PVC schedule 40 ☐ 23; Flush threaded PVC schedule 80 ☑ 24; Other ☐ ____

10. Screen material: same as above
a. Screen type: Factory cut ☑ 11; Continuous slot ☐ 01; Other ☐ ____
b. Manufacturer Campbell Monoflex
c. Slot size: 0.020 in.
d. Slotted length: 5 ft.

11. Backfill material (below filter pack): None ☑ 14; Other ☐ ____

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature Joel Janssen | Firm SpecPro, Inc.

Please complete both Forms 4400-113A and 4400-113B and return them to the appropriate DNR office and bureau. Completion of these reports is required by chs. 160, 281, 283, 289, 291, 292, 293, 295, and 299, Wis. Stats., and ch. NR 141, Wis. Adm. Code. In accordance with chs. 281, 289, 291, 292, 293, 295, and 299, Wis. Stats., failure to file these forms may result in a forfeiture of between $10 and $25,000, or imprisonment for up to one year, depending on the program and conduct involved. Personally identifiable information on these forms is not intended to be used for any other purpose. NOTE: See the instructions for more information, including where the completed forms should be sent.

State of Wisconsin
Department of Natural Resources

Route to: Watershed/Wastewater ☐ Waste Management ☐ Remediation/Redevelopment ☑ Other ☐ _____

MONITORING WELL CONSTRUCTION
Form 4400-113A Rev. 7-98

Facility/Project Name: Badger AAP	Local Grid Location of Well: ____ ft. ☐ N. ☐ S. ____ ft. ☐ E. ☐ W.	Well Name: DBM-1001
Facility License, Permit or Monitoring No.: 3037	Local Grid Origin ☐ (estimated: ☐) or Well Location ☐ Lat. (NAD 83)° ____ " Long. ____ ° ____ ' ____ " or	Wis. Unique Well No.: VM161 / DNR Well ID No.: 471
Facility ID: 157053930	St. Plane 501035.03 ft. N, 2042233.38 ft. E. (S)C/N	Date Well Installed: 05 / 10 / 2010 (m m d d y y y y)
Type of Well: Well Code 11 / MW	Section Location of Waste/Source: ____ 1/4 of ____ 1/4 of Sec. ____, T. ____ N, R. ____ ☐ E. ☐ W.	Well Installed By: Name (first, last) and Firm: Roy Buckenberger; Layne Christensen Company
Distance from Waste/Source ____ ft. Enf. Stds. Apply ☑	Location of Well Relative to Waste/Source: u ☐ Upgradient s ☐ Sidegradient d ☑ Downgradient n ☐ Not Known; Gov. Lot Number ____	

A. Protective pipe, top elevation ____ ft. MSL

B. Well casing, top elevation 911.97 ft. MSL

C. Land surface elevation 909.21 ft. MSL

D. Surface seal, bottom ____ ft. MSL or 4 ft.

12. USCS classification of soil near screen:
GP ☐ GM ☐ GC ☐ GW ☐ SW ☐ SP ☑
SM ☐ SC ☐ ML ☐ MH ☐ CL ☐ CH ☐
Bedrock ☐

13. Sieve analysis performed? ☐ Yes ☑ No

14. Drilling method used: Rotary ☐ 50; Hollow Stem Auger ☐ 41; Other ☑ Rotosonic

15. Drilling fluid used: Water ☑ 02; Air ☐ 01; Drilling Mud ☐ 03; None ☐ 99

16. Drilling additives used? ☐ Yes ☑ No

Describe ____

17. Source of water (attach analysis, if required): ____

E. Bentonite seal, top ____ ft. MSL or 100.3 ft.

F. Fine sand, top ____ ft. MSL or 105.3 ft.

G. Filter pack, top ____ ft. MSL or 107.3 ft.

H. Screen joint, top ____ ft. MSL or 110.3 ft.

I. Well bottom ____ ft. MSL or 125.3 ft.

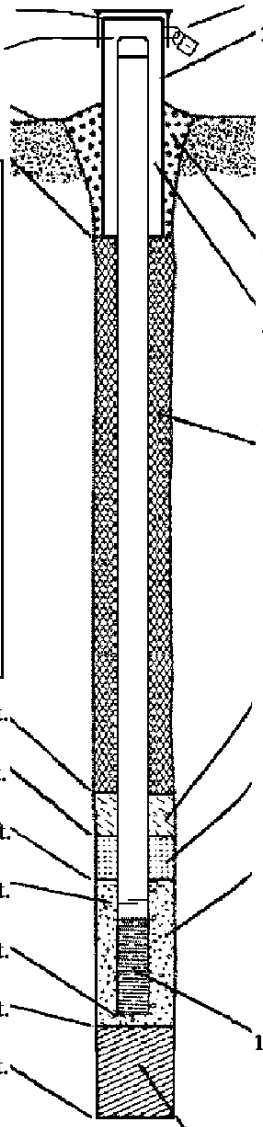
J. Filter pack, bottom ____ ft. MSL or 125.3 ft.

K. Borehole, bottom ____ ft. MSL or 125.3 ft.

L. Borehole, diameter 7.0 in.

M. O.D. well casing 2.9 in.

N. I.D. well casing 2.3 in.



1. Cap and lock? ☑ Yes ☐ No

2. Protective cover pipe:
a. Inside diameter: 6.0 in.
b. Length: 7.5 ft.
c. Material: Steel ☑ 04; Other ☐ ____
d. Additional protection? ☑ Yes ☐ No
If yes, describe: Steel Bumper Posts

3. Surface seal: Bentonite ☑ 30; Concrete ☐ 01; Other ☐ ____

4. Material between well casing and protective pipe: Bentonite ☑ 30; Other ☐ ____

5. Annular space seal: a. Granular/Chipped Bentonite ☐ 33
b. ____ Lbs/gal mud weight . . . Bentonite-sand slurry ☐ 35
c. 3.5 Lbs/gal mud weight . . . . . Bentonite slurry ☑ 31
d. ____ % Bentonite . . . . . Bentonite-cement grout ☐ 50
e. 150 gal Ft^3 volume added for any of the above
f. How installed: Tremie ☑ 01; Tremie pumped ☐ 02; Gravity ☐ 08

6. Bentonite seal: a. Bentonite granules ☐ 33
b. ☐ 1/4 in. ☑ 3/8 in. ☐ 1/2 in. Bentonite chips ☑ 32
c. ____ Other ☐ ____

7. Fine sand material: Manufacturer, product name & mesh size
a. Badger Mining, silica sand, 40-60
b. Volume added 1 bag ft^3

8. Filter pack material: Manufacturer, product name & mesh size
a. Red Flint #40
b. Volume added 4 bags ft^3

9. Well casing: Flush threaded PVC schedule 40 ☐ 23; Flush threaded PVC schedule 80 ☑ 24; Other ☐ ____

10. Screen material: same as above
a. Screen type: Factory cut ☑ 11; Continuous slot ☐ 01; Other ☐ ____
b. Manufacturer Campbell Monoflex
c. Slot size: 0.020 in.
d. Slotted length: 15 ft.

11. Backfill material (below filter pack): None ☑ 14; Other ☐ ____

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature Joel Janssen | Firm SpecPro, Inc.

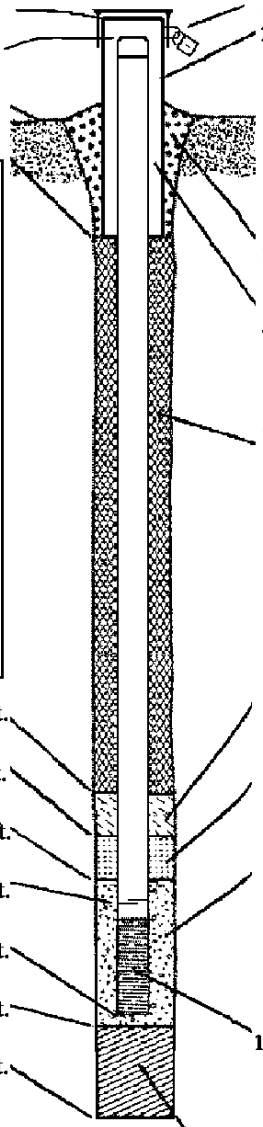
Please complete both Forms 4400-113A and 4400-113B and return them to the appropriate DNR office and bureau. Completion of these reports is required by chs. 160, 281, 283, 289, 291, 292, 293, 295, and 299, Wis. Stats., and ch. NR 141, Wis. Adm. Code. In accordance with chs. 281, 289, 291, 292, 293, 295, and 299, Wis. Stats., failure to file these forms may result in a forfeiture of between $10 and $25,000, or imprisonment for up to one year, depending on the program and conduct involved. Personally identifiable information on these forms is not intended to be used for any other purpose. NOTE: See the instructions for more information, including where the completed forms should be sent.

State of Wisconsin
Department of Natural Resources

Route to: Watershed/Wastewater ☐ Waste Management ☐ Remediation/Redevelopment ☑ Other ☐ _____

MONITORING WELL CONSTRUCTION
Form 4400-113A Rev. 7-98

Facility/Project Name: Badger AAP	Local Grid Location of Well: ____ ft. ☐ N. ☐ S. ____ ft. ☐ E. ☐ W.	Well Name: RIN-1007C
Facility License, Permit or Monitoring No.: 3487	Local Grid Origin ☐ (estimated: ☐) or Well Location ☐ Lat. (NAD 83)° ____ " Long. ____ ° ____ ' ____ " or	Wis. Unique Well No.: VM168 / DNR Well ID No.: 479
Facility ID: 157053930	St. Plane 497857.57 ft. N, 2035155.19 ft. E. (S)/C/N	Date Well Installed: 06 / 15 / 2010 (m m d d y y y y)
Type of Well: Well Code 12 / PZ	Section Location of Waste/Source: ____ 1/4 of ____ 1/4 of Sec. ____, T. ____ N, R. ____ ☐ E. ☐ W.	Well Installed By: Name (first, last) and Firm: Roy Buckenberger; Layne Christensen Company
Distance from Waste/Source ____ ft. / Enf. Stds. Apply ☑	Location of Well Relative to Waste/Source: u ☐ Upgradient s ☐ Sidegradient d ☑ Downgradient n ☐ Not Known	Gov. Lot Number: ____



A. Protective pipe, top elevation ____ ft. MSL

B. Well casing, top elevation 883.81 ft. MSL

C. Land surface elevation 881.41 ft. MSL

D. Surface seal, bottom ____ ft. MSL or 4 ft.

12. USCS classification of soil near screen:
GP ☐ GM ☐ GC ☐ GW ☐ SW ☐ SP ☑
SM ☐ SC ☐ ML ☐ MH ☐ CL ☐ CH ☐
Bedrock ☐

13. Sieve analysis performed? ☐ Yes ☑ No

14. Drilling method used: Rotary ☐ 50; Hollow Stem Auger ☐ 41; Other ☑ Rotosonic

15. Drilling fluid used: Water ☑ 02; Air ☐ 01; Drilling Mud ☐ 03; None ☐ 99

16. Drilling additives used? ☐ Yes ☑ No

Describe _____

17. Source of water (attach analysis, if required):

E. Bentonite seal, top ____ ft. MSL or 160.3 ft.

F. Fine sand, top ____ ft. MSL or 165.3 ft.

G. Filter pack, top ____ ft. MSL or 167.3 ft.

H. Screen joint, top ____ ft. MSL or 170.3 ft.

I. Well bottom ____ ft. MSL or 175.3 ft.

J. Filter pack, bottom ____ ft. MSL or 175.3 ft.

K. Borehole, bottom ____ ft. MSL or 175.3 ft.

L. Borehole, diameter 7.0 in.

M. O.D. well casing 2.9 in.

N. I.D. well casing 2.3 in.

1. Cap and lock? ☑ Yes ☐ No

2. Protective cover pipe:
a. Inside diameter: 6.0 in.
b. Length: 7.5 ft.
c. Material: Steel ☑ 04; Other ☐
d. Additional protection? ☑ Yes ☐ No
If yes, describe: Steel Bumper Posts

3. Surface seal: Bentonite ☑ 30; Concrete ☐ 01; Other ☐

4. Material between well casing and protective pipe: Bentonite ☑ 30; Other ☐

5. Annular space seal: a. Granular/Chipped Bentonite ☐ 33
b. ____ Lbs/gal mud weight . . . Bentonite-sand slurry ☐ 35
c. 3.5 Lbs/gal mud weight . . . . . Bentonite slurry ☑ 31
d. ____ % Bentonite . . . . . Bentonite-cement grout ☐ 50
e. 225 gal Ft^3 volume added for any of the above
f. How installed: Tremie ☑ 01; Tremie pumped ☐ 02; Gravity ☐ 08

6. Bentonite seal: a. Bentonite granules ☐ 33
b. ☐ 1/4 in. ☑ 3/8 in. ☐ 1/2 in. Bentonite chips ☑ 32
c. _____ Other ☐

7. Fine sand material: Manufacturer, product name & mesh size
a. Badger Mining, silica sand, 40-60
b. Volume added 1 bag ft^3

8. Filter pack material: Manufacturer, product name & mesh size
a. Red Flint #40
b. Volume added 4 bags ft^3

9. Well casing: Flush threaded PVC schedule 40 ☐ 23; Flush threaded PVC schedule 80 ☑ 24; Other ☐

10. Screen material: same as above
a. Screen type: Factory cut ☑ 11; Continuous slot ☐ 01; Other ☐
b. Manufacturer Campbell Monoflex
c. Slot size: 0.020 in.
d. Slotted length: 5 ft.

11. Backfill material (below filter pack): None ☑ 14; Other ☐

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature Joel Janssen | Firm SpecPro, Inc.

Please complete both Forms 4400-113A and 4400-113B and return them to the appropriate DNR office and bureau. Completion of these reports is required by chs. 160, 281, 283, 289, 291, 292, 293, 295, and 299, Wis. Stats., and ch. NR 141, Wis. Adm. Code. In accordance with chs. 281, 289, 291, 292, 293, 295, and 299, Wis. Stats., failure to file these forms may result in a forfeiture of between $10 and $25,000, or imprisonment for up to one year, depending on the program and conduct involved. Personally identifiable information on these forms is not intended to be used for any other purpose. NOTE: See the instructions for more information, including where the completed forms should be sent.

State of Wisconsin
Department of Natural Resources

Route to: Watershed/Wastewater ☐ Waste Management ☐ Remediation/Redevelopment ☑ Other ☐ _____

MONITORING WELL CONSTRUCTION
Form 4400-113A Rev. 7-98

Facility/Project Name: Badger AAP - NE Boundary	Local Grid Location of Well: ____ ft. ☐ N. ☐ S. ____ ft. ☐ E. ☐ W.	Well Name: RIN-1006C
Facility License, Permit or Monitoring No.: 3487	Local Grid Origin ☐ (estimated: ☐) or Well Location ☐ Lat. (NAD 83)° ____ " Long. ____ ° ____ ' ____ " or	Wis. Unique Well No.: VM173 / DNR Well ID No.: 484
Facility ID: 157053930	St. Plane 494632.57 ft. N, 2031731.00 ft. E. (S)/C/N	Date Well Installed: 05 / 18 / 2010 (m m d d y y y y)
Type of Well: Well Code 12 / PZ	Section Location of Waste/Source: ____ 1/4 of ____ 1/4 of Sec. ____, T. ____ N, R. ____ ☐ E. ☐ W.	Well Installed By: Name (first, last) and Firm: Roy Buckenberger; Layne Christensen Company
Distance from Waste/Source ____ ft. / Enf. Stds. Apply ☑	Location of Well Relative to Waste/Source: u ☐ Upgradient s ☐ Sidegradient d ☑ Downgradient n ☐ Not Known	Gov. Lot Number: ____

A. Protective pipe, top elevation ____ ft. MSL

B. Well casing, top elevation 873.39 ft. MSL

C. Land surface elevation 870.89 ft. MSL

D. Surface seal, bottom ____ ft. MSL or 4 ft.

12. USCS classification of soil near screen:
GP ☐ GM ☐ GC ☐ GW ☐ SW ☐ SP ☑
SM ☐ SC ☐ ML ☐ MH ☐ CL ☐ CH ☐
Bedrock ☐

13. Sieve analysis performed? ☐ Yes ☑ No

14. Drilling method used: Rotary ☐ 50; Hollow Stem Auger ☐ 41; Other ☑ Rotosonic

15. Drilling fluid used: Water ☑ 02; Air ☐ 01; Drilling Mud ☐ 03; None ☐ 99

16. Drilling additives used? ☐ Yes ☑ No

Describe _____

17. Source of water (attach analysis, if required):

E. Bentonite seal, top ____ ft. MSL or 165.35 ft.

F. Fine sand, top ____ ft. MSL or 170.35 ft.

G. Filter pack, top ____ ft. MSL or 172.35 ft.

H. Screen joint, top ____ ft. MSL or 175.35 ft.

I. Well bottom ____ ft. MSL or 180.35 ft.

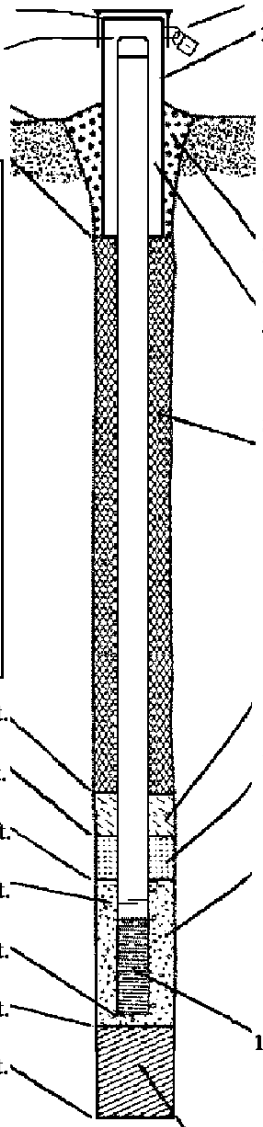
J. Filter pack, bottom ____ ft. MSL or 180.35 ft.

K. Borehole, bottom ____ ft. MSL or 180.35 ft.

L. Borehole, diameter 7.0 in.

M. O.D. well casing 2.9 in.

N. I.D. well casing 2.3 in.



1. Cap and lock? ☑ Yes ☐ No

2. Protective cover pipe:
a. Inside diameter: 6.0 in.
b. Length: 7.5 ft.
c. Material: Steel ☑ 04; Other ☐ ____
d. Additional protection? ☑ Yes ☐ No
If yes, describe: Steel Bumper Posts

3. Surface seal: Bentonite ☑ 30; Concrete ☐ 01; Other ☐ ____

4. Material between well casing and protective pipe: Bentonite ☑ 30; Other ☐ ____

5. Annular space seal: a. Granular/Chipped Bentonite ☐ 33
b. ____ Lbs/gal mud weight . . . Bentonite-sand slurry ☐ 35
c. 3.5 Lbs/gal mud weight . . . . . Bentonite slurry ☑ 31
d. ____ % Bentonite . . . . . Bentonite-cement grout ☐ 50
e. 200 gal Ft^3 volume added for any of the above
f. How installed: Tremie ☑ 01; Tremie pumped ☐ 02; Gravity ☐ 08

6. Bentonite seal: a. Bentonite granules ☐ 33
b. ☐ 1/4 in. ☑ 3/8 in. ☐ 1/2 in. Bentonite chips ☑ 32
c. ____ Other ☐ ____

7. Fine sand material: Manufacturer, product name & mesh size
a. Badger Mining, silica sand, 40-60
b. Volume added 1 bag ft^3

8. Filter pack material: Manufacturer, product name & mesh size
a. Red Flint #40
b. Volume added 4 bags ft^3

9. Well casing: Flush threaded PVC schedule 40 ☐ 23; Flush threaded PVC schedule 80 ☑ 24; Other ☐ ____

10. Screen material: same as above
a. Screen type: Factory cut ☑ 11; Continuous slot ☐ 01; Other ☐ ____
b. Manufacturer Campbell Monoflex
c. Slot size: 0.020 in.
d. Slotted length: 5 ft.

11. Backfill material (below filter pack): None ☑ 14; Other ☐ ____

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature Joel Janssen | Firm SpecPro, Inc.

Please complete both Forms 4400-113A and 4400-113B and return them to the appropriate DNR office and bureau. Completion of these reports is required by chs. 160, 281, 283, 289, 291, 292, 293, 295, and 299, Wis. Stats., and ch. NR 141, Wis. Adm. Code. In accordance with chs. 281, 289, 291, 292, 293, 295, and 299, Wis. Stats., failure to file these forms may result in a forfeiture of between $10 and $25,000, or imprisonment for up to one year, depending on the program and conduct involved. Personally identifiable information on these forms is not intended to be used for any other purpose. NOTE: See the instructions for more information, including where the completed forms should be sent.

State of Wisconsin
Department of Natural Resources

Route to: Watershed/Wastewater ☐ Waste Management ☐ Remediation/Redevelopment ☑ Other ☐ _____

MONITORING WELL CONSTRUCTION
Form 4400-113A Rev. 7-98

Facility/Project Name: Badger AAP - NE Boundary	Local Grid Location of Well: ____ ft. ☐ N. ☐ S. ____ ft. ☐ E. ☐ W.	Well Name: RIN-1006A
Facility License, Permit or Monitoring No.: 3487	Local Grid Origin ☐ (estimated: ☐) or Well Location ☐ Lat. (NAD 83) ____ ° ____ ' ____ " Long. ____ ° ____ ' ____ " or	Wis. Unique Well No.: VM172 / DNR Well ID No.: 483
Facility ID: 157053930	St. Plane 494635.26 ft. N, 2031718.11 ft. E. (S)C/N	Date Well Installed: 05 / 18 / 2010 (m m d d y y y y)
Type of Well: Well Code 11 / MW	Section Location of Waste/Source: ____ 1/4 of ____ 1/4 of Sec. ____, T. ____ N, R. ____ ☐ E. ☐ W.	Well Installed By: Name (first, last) and Firm: Roy Buckenberger; Layne Christensen Company
Distance from Waste/Source ____ ft. Enf. Stds. Apply ☑	Location of Well Relative to Waste/Source: u ☐ Upgradient s ☐ Sidegradient d ☑ Downgradient n ☐ Not Known; Gov. Lot Number ____	

A. Protective pipe, top elevation ____ ft. MSL

B. Well casing, top elevation 873.48 ft. MSL

C. Land surface elevation 870.94 ft. MSL

D. Surface seal, bottom ____ ft. MSL or 4 ft.

12. USCS classification of soil near screen:
GP ☐ GM ☐ GC ☐ GW ☐ SW ☐ SP ☑
SM ☐ SC ☐ ML ☐ MH ☐ CL ☐ CH ☐
Bedrock ☐

13. Sieve analysis performed? ☐ Yes ☑ No

14. Drilling method used: Rotary ☐ 50; Hollow Stem Auger ☐ 41; Other ☑ Rotosonic

15. Drilling fluid used: Water ☑ 02; Air ☐ 01; Drilling Mud ☐ 03; None ☐ 99

16. Drilling additives used? ☐ Yes ☑ No

Describe _____

17. Source of water (attach analysis, if required):

E. Bentonite seal, top ____ ft. MSL or 75.38 ft.

F. Fine sand, top ____ ft. MSL or 80.38 ft.

G. Filter pack, top ____ ft. MSL or 82.38 ft.

H. Screen joint, top ____ ft. MSL or 85.38 ft.

I. Well bottom ____ ft. MSL or 100.38 ft.

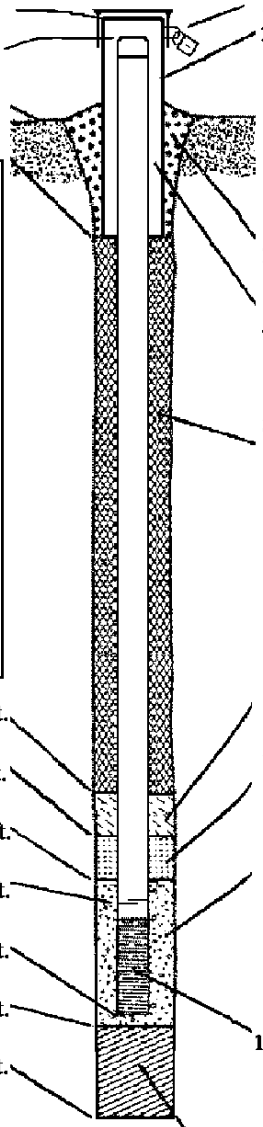
J. Filter pack, bottom ____ ft. MSL or 100.38 ft.

K. Borehole, bottom ____ ft. MSL or 100.38 ft.

L. Borehole, diameter 7.0 in.

M. O.D. well casing 2.9 in.

N. I.D. well casing 2.3 in.



1. Cap and lock? ☑ Yes ☐ No

2. Protective cover pipe:
a. Inside diameter: 6.0 in.
b. Length: 7.5 ft.
c. Material: Steel ☑ 04; Other ☐
d. Additional protection? ☑ Yes ☐ No
If yes, describe: Steel Bumper Posts

3. Surface seal: Bentonite ☑ 30; Concrete ☐ 01; Other ☐

4. Material between well casing and protective pipe: Bentonite ☑ 30; Other ☐

5. Annular space seal: a. Granular/Chipped Bentonite ☐ 33
b. ____ Lbs/gal mud weight . . . Bentonite-sand slurry ☐ 35
c. 3.5 Lbs/gal mud weight . . . . . Bentonite slurry ☑ 31
d. ____ % Bentonite . . . . . Bentonite-cement grout ☐ 50
e. 150 gal Ft^3 volume added for any of the above
f. How installed: Tremie ☑ 01; Tremie pumped ☐ 02; Gravity ☐ 08

6. Bentonite seal: a. Bentonite granules ☐ 33
b. ☐ 1/4 in. ☑ 3/8 in. ☐ 1/2 in. Bentonite chips ☑ 32
c. _____ Other ☐

7. Fine sand material: Manufacturer, product name & mesh size
a. Badger Mining, silica sand, 40-60
b. Volume added 1 bag ft^3

8. Filter pack material: Manufacturer, product name & mesh size
a. Red Flint #40
b. Volume added 4 bags ft^3

9. Well casing: Flush threaded PVC schedule 40 ☐ 23; Flush threaded PVC schedule 80 ☑ 24; Other ☐

10. Screen material: same as above
a. Screen type: Factory cut ☑ 11; Continuous slot ☐ 01; Other ☐
b. Manufacturer Campbell Monoflex
c. Slot size: 0.020 in.
d. Slotted length: 15.0 ft.

11. Backfill material (below filter pack): None ☑ 14; Other ☐

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature: Joel Janssen	Firm: SpecPro, Inc.

Please complete both Forms 4400-113A and 4400-113B and return them to the appropriate DNR office and bureau. Completion of these reports is required by chs. 160, 281, 283, 289, 291, 292, 293, 295, and 299, Wis. Stats., and ch. NR 141, Wis. Adm. Code. In accordance with chs. 281, 289, 291, 292, 293, 295, and 299, Wis. Stats., failure to file these forms may result in a forfeiture of between $10 and $25,000, or imprisonment for up to one year, depending on the program and conduct involved. Personally identifiable information on these forms is not intended to be used for any other purpose. NOTE: See the instructions for more information, including where the completed forms should be sent.

State of Wisconsin
Department of Natural Resources

Route to: Watershed/Wastewater ☐ Waste Management ☐ Remediation/Redevelopment ☑ Other ☐ _____

MONITORING WELL CONSTRUCTION
Form 4400-113A Rev. 7-98

Facility/Project Name: Badger AAP	Local Grid Location of Well: ____ ft. ☐ N. ☐ S. ____ ft. ☐ E. ☐ W.	Well Name: RIN-1005C
Facility License, Permit or Monitoring No.: 3487	Local Grid Origin ☐ (estimated: ☐) or Well Location ☐ Lat. (NAD 83)° ____ " Long. ____ ° ____ ' ____ " or	Wis. Unique Well No.: VM181 / DNR Well ID No.: 497
Facility ID: 157053930	St. Plane 489316.84 ft. N, 2045864.92 ft. E. (S)C/N	Date Well Installed: 05 / 17 / 2010 (m m d d y y y y)
Type of Well: Well Code 12 / PZ	Section Location of Waste/Source: ____ 1/4 of ____ 1/4 of Sec. ____, T. ____ N, R. ____ ☐ E. ☐ W.	Well Installed By: Name (first, last) and Firm: Roy Buckenberger; Layne Christensen Company
Distance from Waste/Source ____ ft. / Enf. Stds. Apply ☑	Location of Well Relative to Waste/Source: u ☐ Upgradient s ☐ Sidegradient d ☑ Downgradient n ☐ Not Known	Gov. Lot Number: ____

A. Protective pipe, top elevation ____ ft. MSL

B. Well casing, top elevation 828.75 ft. MSL

C. Land surface elevation 826.49 ft. MSL

D. Surface seal, bottom ____ ft. MSL or 4 ft.

12. USCS classification of soil near screen:
GP ☐ GM ☐ GC ☐ GW ☐ SW ☐ SP ☑
SM ☐ SC ☐ ML ☐ MH ☐ CL ☐ CH ☐
Bedrock ☐

13. Sieve analysis performed? ☐ Yes ☑ No

14. Drilling method used: Rotary ☐ 50; Hollow Stem Auger ☐ 41; Other ☑ Rotosonic

15. Drilling fluid used: Water ☑ 02; Air ☐ 01; Drilling Mud ☐ 03; None ☐ 99

16. Drilling additives used? ☐ Yes ☑ No

Describe _____

17. Source of water (attach analysis, if required):

E. Bentonite seal, top ____ ft. MSL or 132 ft.

F. Fine sand, top ____ ft. MSL or 137 ft.

G. Filter pack, top ____ ft. MSL or 139 ft.

H. Screen joint, top ____ ft. MSL or 142 ft.

I. Well bottom ____ ft. MSL or 147 ft.

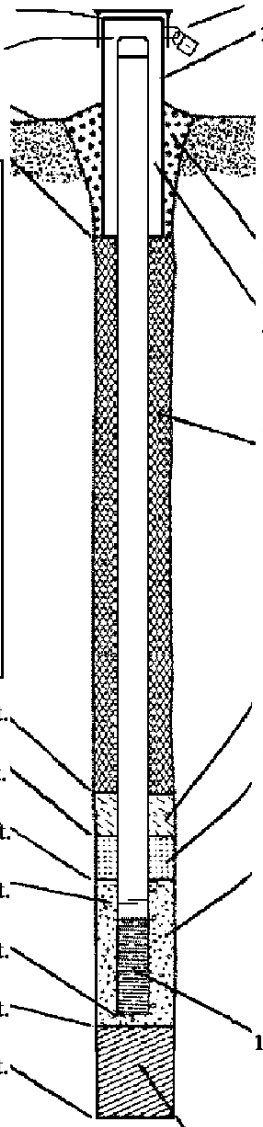
J. Filter pack, bottom ____ ft. MSL or 147 ft.

K. Borehole, bottom ____ ft. MSL or 147 ft.

L. Borehole, diameter 7.0 in.

M. O.D. well casing 2.9 in.

N. I.D. well casing 2.3 in.



1. Cap and lock? ☑ Yes ☐ No

2. Protective cover pipe:
a. Inside diameter: 6.0 in.
b. Length: 7.5 ft.
c. Material: Steel ☑ 04; Other ☐
d. Additional protection? ☑ Yes ☐ No
If yes, describe: Steel Bumper Posts

3. Surface seal: Bentonite ☑ 30; Concrete ☐ 01; Other ☐

4. Material between well casing and protective pipe: Bentonite ☑ 30; Other ☐

5. Annular space seal: a. Granular/Chipped Bentonite ☐ 33
b. ____ Lbs/gal mud weight . . . Bentonite-sand slurry ☐ 35
c. 3.5 Lbs/gal mud weight . . . . . Bentonite slurry ☑ 31
d. ____ % Bentonite . . . . . Bentonite-cement grout ☐ 50
e. 200 gal Ft^3 volume added for any of the above
f. How installed: Tremie ☑ 01; Tremie pumped ☐ 02; Gravity ☐ 08

6. Bentonite seal: a. Bentonite granules ☐ 33
b. ☐ 1/4 in. ☑ 3/8 in. ☐ 1/2 in. Bentonite chips ☑ 32
c. ____ Other ☐

7. Fine sand material: Manufacturer, product name & mesh size
a. Badger Mining, silica sand, 40-60
b. Volume added 1 bag ft^3

8. Filter pack material: Manufacturer, product name & mesh size
a. Red Flint #40
b. Volume added 4 bags ft^3

9. Well casing: Flush threaded PVC schedule 40 ☐ 23; Flush threaded PVC schedule 80 ☑ 24; Other ☐

10. Screen material: same as above
a. Screen type: Factory cut ☑ 11; Continuous slot ☐ 01; Other ☐
b. Manufacturer Campbell Monoflex
c. Slot size: 0.020 in.
d. Slotted length: 5 ft.

11. Backfill material (below filter pack): None ☑ 14; Other ☐

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature: Joel Janssen	Firm: SpecPro, Inc.

Please complete both Forms 4400-113A and 4400-113B and return them to the appropriate DNR office and bureau. Completion of these reports is required by chs. 160, 281, 283, 289, 291, 292, 293, 295, and 299, Wis. Stats., and ch. NR 141, Wis. Adm. Code. In accordance with chs. 281, 289, 291, 292, 293, 295, and 299, Wis. Stats., failure to file these forms may result in a forfeiture of between $10 and $25,000, or imprisonment for up to one year, depending on the program and conduct involved. Personally identifiable information on these forms is not intended to be used for any other purpose. NOTE: See the instructions for more information, including where the completed forms should be sent.

State of Wisconsin
Department of Natural Resources

Route to: Watershed/Wastewater ☐ Waste Management ☐ Remediation/Redevelopment ☑ Other ☐ _____

MONITORING WELL CONSTRUCTION
Form 4400-113A Rev. 7-98

Facility/Project Name: Badger AAP	Local Grid Location of Well: ____ ft. ☐ N. ☐ S. ____ ft. ☐ E. ☐ W.	Well Name: RIN-1005A
Facility License, Permit or Monitoring No.: 3487	Local Grid Origin ☐ (estimated: ☐) or Well Location ☐ Lat. (NAD 83)° ____ " Long. ____ ° ____ ' ____ " or	Wis. Unique Well No.: VM180 / DNR Well ID No.: 496
Facility ID: 157053930	St. Plane 489310.71 ft. N, 2045864.38 ft. E. (S)/C/N	Date Well Installed: 05 / 17 / 2010 (m m d d y y y y)
Type of Well: Well Code 11 / MW	Section Location of Waste/Source: ____ 1/4 of ____ 1/4 of Sec. ____, T. ____ N, R. ____ ☐ E. ☐ W.	Well Installed By: Name (first, last) and Firm: Roy Buckenberger; Layne Christensen Company
Distance from Waste/Source ____ ft. Enf. Stds. Apply ☑	Location of Well Relative to Waste/Source: u ☐ Upgradient s ☐ Sidegradient d ☑ Downgradient n ☐ Not Known	Gov. Lot Number: ____

A. Protective pipe, top elevation _____ ft. MSL

B. Well casing, top elevation 828.61 ft. MSL

C. Land surface elevation 826.74 ft. MSL

D. Surface seal, bottom _____ ft. MSL or 4 ft.

12. USCS classification of soil near screen:
GP ☐ GM ☐ GC ☐ GW ☐ SW ☐ SP ☑
SM ☐ SC ☐ ML ☐ MH ☐ CL ☐ CH ☐
Bedrock ☐

13. Sieve analysis performed? ☐ Yes ☑ No

14. Drilling method used: Rotary ☐ 50; Hollow Stem Auger ☐ 41; Other ☑ Rotosonic

15. Drilling fluid used: Water ☑ 02; Air ☐ 01; Drilling Mud ☐ 03; None ☐ 99

16. Drilling additives used? ☐ Yes ☑ No

Describe _____

17. Source of water (attach analysis, if required):

E. Bentonite seal, top _____ ft. MSL or 35.5 ft.

F. Fine sand, top _____ ft. MSL or 40.5 ft.

G. Filter pack, top _____ ft. MSL or 42.5 ft.

H. Screen joint, top _____ ft. MSL or 45.5 ft.

I. Well bottom _____ ft. MSL or 60.5 ft.

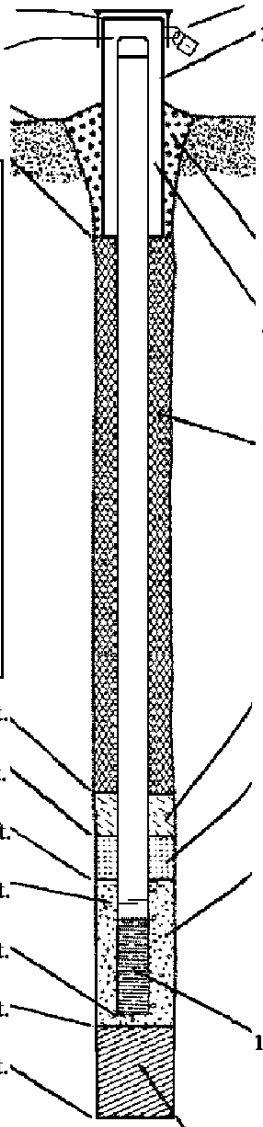
J. Filter pack, bottom _____ ft. MSL or 60.5 ft.

K. Borehole, bottom _____ ft. MSL or 60.5 ft.

L. Borehole, diameter 7.0 in.

M. O.D. well casing 2.9 in.

N. I.D. well casing 2.3 in.



1. Cap and lock? ☑ Yes ☐ No

2. Protective cover pipe:
a. Inside diameter: 6.0 in.
b. Length: 7.5 ft.
c. Material: Steel ☑ 04; Other ☐ ____
d. Additional protection? ☑ Yes ☐ No
If yes, describe: Steel Bumper Posts

3. Surface seal: Bentonite ☑ 30; Concrete ☐ 01; Other ☐ ____

4. Material between well casing and protective pipe: Bentonite ☑ 30; Other ☐ ____

5. Annular space seal: a. Granular/Chipped Bentonite ☐ 33
b. ____ Lbs/gal mud weight . . . Bentonite-sand slurry ☐ 35
c. 3.5 Lbs/gal mud weight . . . . . Bentonite slurry ☑ 31
d. ____ % Bentonite . . . . . Bentonite-cement grout ☐ 50
e. 100 gal Ft^3 volume added for any of the above
f. How installed: Tremie ☑ 01; Tremie pumped ☐ 02; Gravity ☐ 08

6. Bentonite seal: a. Bentonite granules ☐ 33
b. ☐ 1/4 in. ☑ 3/8 in. ☐ 1/2 in. Bentonite chips ☑ 32
c. ____ Other ☐ ____

7. Fine sand material: Manufacturer, product name & mesh size
a. Badger Mining, silica sand, 40-60
b. Volume added 1 bag ft^3

8. Filter pack material: Manufacturer, product name & mesh size
a. Red Flint #40
b. Volume added 4 bags ft^3

9. Well casing: Flush threaded PVC schedule 40 ☐ 23; Flush threaded PVC schedule 80 ☑ 24; Other ☐ ____

10. Screen material: same as above
a. Screen type: Factory cut ☑ 11; Continuous slot ☐ 01; Other ☐ ____
b. Manufacturer Campbell Monoflex
c. Slot size: 0.020 in.
d. Slotted length: 15.0 ft.

11. Backfill material (below filter pack): None ☑ 14; Other ☐ ____

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature Joel Janssen | Firm SpecPro, Inc.

Please complete both Forms 4400-113A and 4400-113B and return them to the appropriate DNR office and bureau. Completion of these reports is required by chs. 160, 281, 283, 289, 291, 292, 293, 295, and 299, Wis. Stats., and ch. NR 141, Wis. Adm. Code. In accordance with chs. 281, 289, 291, 292, 293, 295, and 299, Wis. Stats., failure to file these forms may result in a forfeiture of between $10 and $25,000, or imprisonment for up to one year, depending on the program and conduct involved. Personally identifiable information on these forms is not intended to be used for any other purpose. NOTE: See the instructions for more information, including where the completed forms should be sent.

State of Wisconsin
Department of Natural Resources

Route to: Watershed/Wastewater ☐ Waste Management ☐ Remediation/Redevelopment ☑ Other ☐ _____

MONITORING WELL CONSTRUCTION
Form 4400-113A Rev. 7-98

Facility/Project Name: Badger AAP	Local Grid Location of Well: ☐ N. ☐ S. _____ ft. ☐ E. ☐ W. _____ ft.	Well Name: RIN-1004B
Facility License, Permit or Monitoring No.: 3487	Local Grid Origin ☐ (estimated: ☐) or Well Location ☐ Lat. (NAD 83) ' " Long. ° ' " or	Wis. Unique Well No.: VM182 / DNR Well ID No.: 498
Facility ID: 157053930	St. Plane 486645.01 ft. N, 2044721.14 ft. E. (S)C/N	Date Well Installed: 05 / 13 / 2010 (m m d d y y y y)
Type of Well: Well Code 12 / PZ	Section Location of Waste/Source: ____ 1/4 of ____ 1/4 of Sec. ____, T. ____ N, R. ____ ☐ E. ☐ W.	Well Installed By: Name (first, last) and Firm: Roy Buckenberger; Layne Christensen Company
Distance from Waste/Source ____ ft. / Enf. Stds. Apply ☑	Location of Well Relative to Waste/Source: u ☐ Upgradient s ☐ Sidegradient d ☑ Downgradient n ☐ Not Known; Gov. Lot Number ____	

A. Protective pipe, top elevation _____ ft. MSL

B. Well casing, top elevation 859.31 ft. MSL

C. Land surface elevation 856.74 ft. MSL

D. Surface seal, bottom _____ ft. MSL or 4 ft.

12. USCS classification of soil near screen:
GP ☐ GM ☐ GC ☐ GW ☐ SW ☐ SP ☑
SM ☐ SC ☐ ML ☐ MH ☐ CL ☐ CH ☐
Bedrock ☐

13. Sieve analysis performed? ☐ Yes ☑ No

14. Drilling method used: Rotary ☐ 50; Hollow Stem Auger ☐ 41; Other ☑ Rotosonic

15. Drilling fluid used: Water ☑ 02; Air ☐ 01; Drilling Mud ☐ 03; None ☐ 99

16. Drilling additives used? ☐ Yes ☑ No

Describe _____

17. Source of water (attach analysis, if required):

E. Bentonite seal, top _____ ft. MSL or 131.7 ft.

F. Fine sand, top _____ ft. MSL or 136.7 ft.

G. Filter pack, top _____ ft. MSL or 138.7 ft.

H. Screen joint, top _____ ft. MSL or 141.7 ft.

I. Well bottom _____ ft. MSL or 146.7 ft.

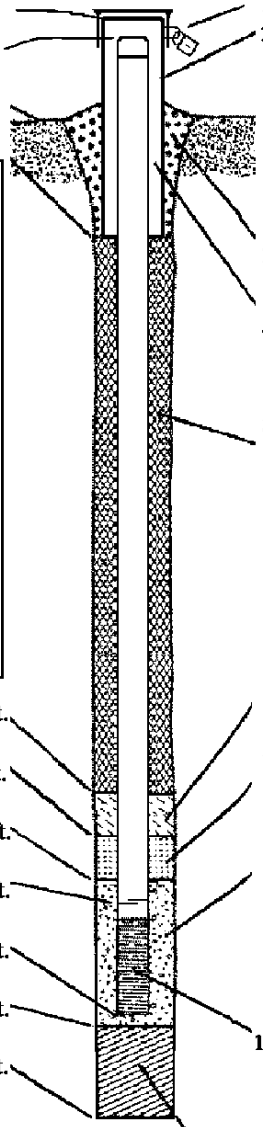
J. Filter pack, bottom _____ ft. MSL or 146.7 ft.

K. Borehole, bottom _____ ft. MSL or 146.7 ft.

L. Borehole, diameter 7.0 in.

M. O.D. well casing 2.9 in.

N. I.D. well casing 2.3 in.



1. Cap and lock? ☑ Yes ☐ No

2. Protective cover pipe:
a. Inside diameter: 6.0 in.
b. Length: 7.5 ft.
c. Material: Steel ☑ 04; Other ☐
d. Additional protection? ☑ Yes ☐ No
If yes, describe: Steel Bumper Posts

3. Surface seal: Bentonite ☑ 30; Concrete ☐ 01; Other ☐

4. Material between well casing and protective pipe: Bentonite ☑ 30; Other ☐

5. Annular space seal: a. Granular/Chipped Bentonite ☐ 33
b. ____ Lbs/gal mud weight . . . Bentonite-sand slurry ☐ 35
c. 3.5 Lbs/gal mud weight . . . . . Bentonite slurry ☑ 31
d. ____ % Bentonite . . . . . Bentonite-cement grout ☐ 50
e. 200 gal Ft^3 volume added for any of the above
f. How installed: Tremie ☑ 01; Tremie pumped ☐ 02; Gravity ☐ 08

6. Bentonite seal: a. Bentonite granules ☐ 33
b. ☐ 1/4 in. ☑ 3/8 in. ☐ 1/2 in. Bentonite chips ☑ 32
c. _____ Other ☐

7. Fine sand material: Manufacturer, product name & mesh size
a. Badger Mining, silica sand, 40-60
b. Volume added 1 bag ft^3

8. Filter pack material: Manufacturer, product name & mesh size
a. Red Flint #40
b. Volume added 4 bags ft^3

9. Well casing: Flush threaded PVC schedule 40 ☐ 23; Flush threaded PVC schedule 80 ☑ 24; Other ☐

10. Screen material: same as above
a. Screen type: Factory cut ☑ 11; Continuous slot ☐ 01; Other ☐
b. Manufacturer Campbell Monoflex
c. Slot size: 0.020 in.
d. Slotted length: 5 ft.

11. Backfill material (below filter pack): None ☑ 14; Other ☐

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature Joel Janssen | Firm SpecPro, Inc.

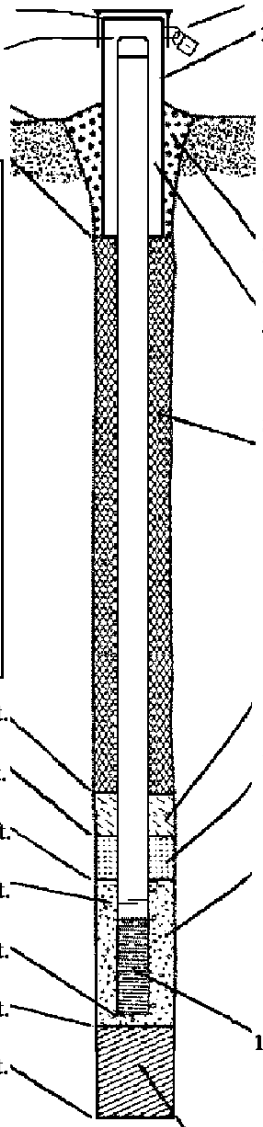
Please complete both Forms 4400-113A and 4400-113B and return them to the appropriate DNR office and bureau. Completion of these reports is required by chs. 160, 281, 283, 289, 291, 292, 293, 295, and 299, Wis. Stats., and ch. NR 141, Wis. Adm. Code. In accordance with chs. 281, 289, 291, 292, 293, 295, and 299, Wis. Stats., failure to file these forms may result in a forfeiture of between $10 and $25,000, or imprisonment for up to one year, depending on the program and conduct involved. Personally identifiable information on these forms is not intended to be used for any other purpose. NOTE: See the instructions for more information, including where the completed forms should be sent.

State of Wisconsin
Department of Natural Resources

Route to: Watershed/Wastewater ☐ Waste Management ☐ Remediation/Redevelopment ☑ Other ☐ _____

MONITORING WELL CONSTRUCTION
Form 4400-113A Rev. 7-98

Facility/Project Name: Badger AAP	Local Grid Location of Well: ____ ft. ☐ N. ☐ S. ____ ft. ☐ E. ☐ W.	Well Name: RIN-1003A
Facility License, Permit or Monitoring No.: 3487	Local Grid Origin ☐ (estimated: ☐) or Well Location ☐ Lat. (NAD 83)° ____ " Long. ____ ° ____ ' ____ " or	Wis. Unique Well No.: VM179 / DNR Well ID No.: 495
Facility ID: 157053930	St. Plane 489061.45 ft. N, 2044797.07 ft. E. (S)/C/N	Date Well Installed: 05 / 05 / 2010 (m m d d y y y y)
Type of Well: Well Code 11 / MW	Section Location of Waste/Source: ____ 1/4 of ____ 1/4 of Sec. ____, T. ____ N, R. ____ ☐ E. ☐ W.	Well Installed By: Name (first, last) and Firm: Roy Buckenberger; Layne Christensen Company
Distance from Waste/Source ____ ft. / Enf. Stds. Apply ☑	Location of Well Relative to Waste/Source: u ☐ Upgradient s ☐ Sidegradient d ☑ Downgradient n ☐ Not Known	Gov. Lot Number: ____



A. Protective pipe, top elevation ____ ft. MSL

B. Well casing, top elevation 857.10 ft. MSL

C. Land surface elevation 854.66 ft. MSL

D. Surface seal, bottom ____ ft. MSL or 4 ft.

12. USCS classification of soil near screen:
GP ☐ GM ☐ GC ☐ GW ☐ SW ☐ SP ☑
SM ☐ SC ☐ ML ☐ MH ☐ CL ☐ CH ☐
Bedrock ☐

13. Sieve analysis performed? ☐ Yes ☑ No

14. Drilling method used: Rotary ☐ 50; Hollow Stem Auger ☐ 41; Other ☑ Rotosonic

15. Drilling fluid used: Water ☑ 02; Air ☐ 01; Drilling Mud ☐ 03; None ☐ 99

16. Drilling additives used? ☐ Yes ☑ No

Describe _____

17. Source of water (attach analysis, if required):

E. Bentonite seal, top ____ ft. MSL or 65.5 ft.

F. Fine sand, top ____ ft. MSL or 70.5 ft.

G. Filter pack, top ____ ft. MSL or 72.5 ft.

H. Screen joint, top ____ ft. MSL or 75.5 ft.

I. Well bottom ____ ft. MSL or 90.5 ft.

J. Filter pack, bottom ____ ft. MSL or 90.5 ft.

K. Borehole, bottom ____ ft. MSL or 90.5 ft.

L. Borehole, diameter 7.0 in.

M. O.D. well casing 2.9 in.

N. I.D. well casing 2.3 in.

1. Cap and lock? ☑ Yes ☐ No

2. Protective cover pipe:
a. Inside diameter: 6.0 in.
b. Length: 7.5 ft.
c. Material: Steel ☑ 04; Other ☐
d. Additional protection? ☑ Yes ☐ No
If yes, describe: Steel Bumper Posts

3. Surface seal: Bentonite ☑ 30; Concrete ☐ 01; Other ☐

4. Material between well casing and protective pipe: Bentonite ☑ 30; Other ☐

5. Annular space seal: a. Granular/Chipped Bentonite ☐ 33
b. ____ Lbs/gal mud weight . . . Bentonite-sand slurry ☐ 35
c. 3.5 Lbs/gal mud weight . . . . . Bentonite slurry ☑ 31
d. ____ % Bentonite . . . . . Bentonite-cement grout ☐ 50
e. 200 gal Ft^3 volume added for any of the above
f. How installed: Tremie ☑ 01; Tremie pumped ☐ 02; Gravity ☐ 08

6. Bentonite seal: a. Bentonite granules ☐ 33
b. ☐ 1/4 in. ☑ 3/8 in. ☐ 1/2 in. Bentonite chips ☑ 32
c. _____ Other ☐

7. Fine sand material: Manufacturer, product name & mesh size
a. Badger Mining, silica sand, 40-60
b. Volume added 1 bag ft^3

8. Filter pack material: Manufacturer, product name & mesh size
a. Red Flint #40
b. Volume added 4 bags ft^3

9. Well casing: Flush threaded PVC schedule 40 ☐ 23; Flush threaded PVC schedule 80 ☑ 24; Other ☐

10. Screen material: same as above
a. Screen type: Factory cut ☑ 11; Continuous slot ☐ 01; Other ☐
b. Manufacturer Campbell Monoflex
c. Slot size: 0.020 in.
d. Slotted length: 15.0 ft.

11. Backfill material (below filter pack): None ☑ 14; Other ☐

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature: Joel Janssen | Firm: SpecPro, Inc.

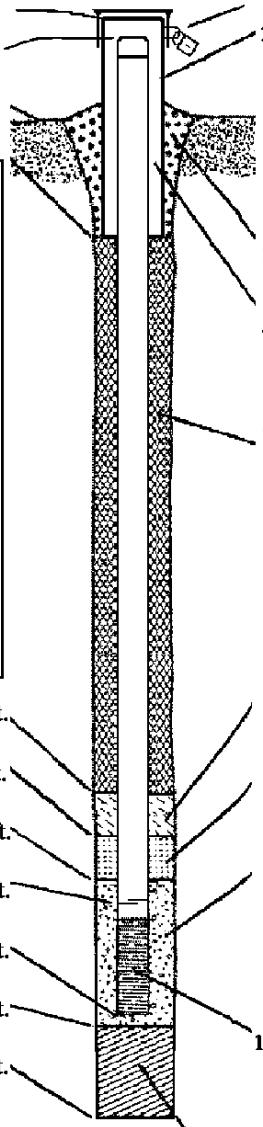
Please complete both Forms 4400-113A and 4400-113B and return them to the appropriate DNR office and bureau. Completion of these reports is required by chs. 160, 281, 283, 289, 291, 292, 293, 295, and 299, Wis. Stats., and ch. NR 141, Wis. Adm. Code. In accordance with chs. 281, 289, 291, 292, 293, 295, and 299, Wis. Stats., failure to file these forms may result in a forfeiture of between $10 and $25,000, or imprisonment for up to one year, depending on the program and conduct involved. Personally identifiable information on these forms is not intended to be used for any other purpose. NOTE: See the instructions for more information, including where the completed forms should be sent.

State of Wisconsin
Department of Natural Resources

Route to: Watershed/Wastewater ☐ Waste Management ☐ Remediation/Redevelopment ☑ Other ☐ _____

MONITORING WELL CONSTRUCTION
Form 4400-113A Rev. 7-98

Facility/Project Name: Badger AAP	Local Grid Location of Well: ____ ft. ☐ N. ☐ S. ____ ft. ☐ E. ☐ W.	Well Name: RIN-1002C
Facility License, Permit or Monitoring No.: 3487	Local Grid Origin ☐ (estimated: ☐) or Well Location ☐ Lat. (NAD 83)° ____ " Long. ____ ° ____ ' ____ " or	Wis. Unique Well No.: VM177 / DNR Well ID No.: 493
Facility ID: 157053930	St. Plane 492568.67 ft. N, 2046078.50 ft. E. (S)C/N	Date Well Installed: 06 / 01 / 2010 (m m d d y y y y)
Type of Well: Well Code 12 / PZ	Section Location of Waste/Source: ____ 1/4 of ____ 1/4 of Sec. ____, T. ____ N, R. ____ ☐ E. ☐ W.	Well Installed By: Name (first, last) and Firm: Roy Buckenberger; Layne Christensen Company
Distance from Waste/Source ____ ft. / Enf. Stds. Apply ☑	Location of Well Relative to Waste/Source: u ☐ Upgradient s ☐ Sidegradient d ☑ Downgradient n ☐ Not Known; Gov. Lot Number ____	



A. Protective pipe, top elevation ____ ft. MSL

B. Well casing, top elevation 862.95 ft. MSL

C. Land surface elevation 860.86 ft. MSL

D. Surface seal, bottom ____ ft. MSL or 4 ft.

12. USCS classification of soil near screen:
GP ☐ GM ☐ GC ☐ GW ☐ SW ☐ SP ☑
SM ☐ SC ☐ ML ☐ MH ☐ CL ☐ CH ☐
Bedrock ☐

13. Sieve analysis performed? ☐ Yes ☑ No

14. Drilling method used: Rotary ☐ 50; Hollow Stem Auger ☐ 41; Other ☑ Rotosonic

15. Drilling fluid used: Water ☑ 02; Air ☐ 01; Drilling Mud ☐ 03; None ☐ 99

16. Drilling additives used? ☐ Yes ☑ No

Describe ____

17. Source of water (attach analysis, if required): ____

E. Bentonite seal, top ____ ft. MSL or 164.8 ft.

F. Fine sand, top ____ ft. MSL or 169.8 ft.

G. Filter pack, top ____ ft. MSL or 171.8 ft.

H. Screen joint, top ____ ft. MSL or 174.8 ft.

I. Well bottom ____ ft. MSL or 179.8 ft.

J. Filter pack, bottom ____ ft. MSL or 179.8 ft.

K. Borehole, bottom ____ ft. MSL or 179.8 ft.

L. Borehole, diameter 7.0 in.

M. O.D. well casing 2.9 in.

N. I.D. well casing 2.3 in.

1. Cap and lock? ☑ Yes ☐ No

2. Protective cover pipe:
a. Inside diameter: 6.0 in.
b. Length: 7.5 ft.
c. Material: Steel ☑ 04; Other ☐ ____
d. Additional protection? ☑ Yes ☐ No
If yes, describe: Steel Bumper Posts

3. Surface seal: Bentonite ☑ 30; Concrete ☐ 01; Other ☐ ____

4. Material between well casing and protective pipe: Bentonite ☑ 30; Other ☐ ____

5. Annular space seal: a. Granular/Chipped Bentonite ☐ 33
b. ____ Lbs/gal mud weight . . . Bentonite-sand slurry ☐ 35
c. 3.5 Lbs/gal mud weight . . . . . Bentonite slurry ☑ 31
d. ____ % Bentonite . . . . . Bentonite-cement grout ☐ 50
e. 200 gal Ft^3 volume added for any of the above
f. How installed: Tremie ☑ 01; Tremie pumped ☐ 02; Gravity ☐ 08

6. Bentonite seal: a. Bentonite granules ☐ 33
b. ☐ 1/4 in. ☑ 3/8 in. ☐ 1/2 in. Bentonite chips ☑ 32
c. ____ Other ☐ ____

7. Fine sand material: Manufacturer, product name & mesh size
a. Badger Mining, silica sand, 40-60
b. Volume added 1 bag ft^3

8. Filter pack material: Manufacturer, product name & mesh size
a. Red Flint #40
b. Volume added 4 bags ft^3

9. Well casing: Flush threaded PVC schedule 40 ☐ 23; Flush threaded PVC schedule 80 ☑ 24; Other ☐ ____

10. Screen material: same as above
a. Screen type: Factory cut ☑ 11; Continuous slot ☐ 01; Other ☐ ____
b. Manufacturer Campbell Monoflex
c. Slot size: 0.020 in.
d. Slotted length: 5 ft.

11. Backfill material (below filter pack): None ☑ 14; Other ☐ ____

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature Joel Janssen | Firm SpecPro, Inc.

Please complete both Forms 4400-113A and 4400-113B and return them to the appropriate DNR office and bureau. Completion of these reports is required by chs. 160, 281, 283, 289, 291, 292, 293, 295, and 299, Wis. Stats., and ch. NR 141, Wis. Adm. Code. In accordance with chs. 281, 289, 291, 292, 293, 295, and 299, Wis. Stats., failure to file these forms may result in a forfeiture of between $10 and $25,000, or imprisonment for up to one year, depending on the program and conduct involved. Personally identifiable information on these forms is not intended to be used for any other purpose. NOTE: See the instructions for more information, including where the completed forms should be sent.

State of Wisconsin
Department of Natural Resources

Route to: Watershed/Wastewater ☐ Waste Management ☐ Remediation/Redevelopment ☑ Other ☐ _____

MONITORING WELL CONSTRUCTION
Form 4400-113A Rev. 7-98

Facility/Project Name: Badger AAP - NE Boundary	Local Grid Location of Well: ____ ft. ☐ N. ☐ S. ____ ft. ☐ E. ☐ W.	Well Name: RIN-1002A
Facility License, Permit or Monitoring No.: 3487	Local Grid Origin ☐ (estimated: ☐) or Well Location ☐ Lat. (NAD 83)° ____ " Long. ____ ° ____ ' ____ " or	Wis. Unique Well No.: VM176 / DNR Well ID No.: 492
Facility ID: 157053930	St. Plane 492556.37 ft. N, 2046081.69 ft. E. (S)/C/N	Date Well Installed: 05 / 04 / 2010 (m m d d y y y y)
Type of Well: Well Code 11 / MW	Section Location of Waste/Source: ____ 1/4 of ____ 1/4 of Sec. ____, T. ____ N, R. ____ ☐ E. ☐ W.	Well Installed By: Name (first, last) and Firm: Roy Buckenberger; Layne Christensen Company
Distance from Waste/Source ____ ft. Enf. Stds. Apply ☑	Location of Well Relative to Waste/Source: u ☐ Upgradient s ☐ Sidegradient d ☑ Downgradient n ☐ Not Known; Gov. Lot Number ____	

A. Protective pipe, top elevation _____ ft. MSL

B. Well casing, top elevation 862.81 ft. MSL

C. Land surface elevation 860.46 ft. MSL

D. Surface seal, bottom _____ ft. MSL or 4 ft.

12. USCS classification of soil near screen:
GP ☐ GM ☐ GC ☐ GW ☐ SW ☐ SP ☑
SM ☐ SC ☐ ML ☐ MH ☐ CL ☐ CH ☐
Bedrock ☐

13. Sieve analysis performed? ☐ Yes ☑ No

14. Drilling method used: Rotary ☐ 50; Hollow Stem Auger ☐ 41; Other ☑ Rotosonic

15. Drilling fluid used: Water ☑ 02; Air ☐ 01; Drilling Mud ☐ 03; None ☐ 99

16. Drilling additives used? ☐ Yes ☑ No

Describe _____

17. Source of water (attach analysis, if required):

E. Bentonite seal, top _____ ft. MSL or 67.2 ft.

F. Fine sand, top _____ ft. MSL or 72.2 ft.

G. Filter pack, top _____ ft. MSL or 74.2 ft.

H. Screen joint, top _____ ft. MSL or 77.2 ft.

I. Well bottom _____ ft. MSL or 92.2 ft.

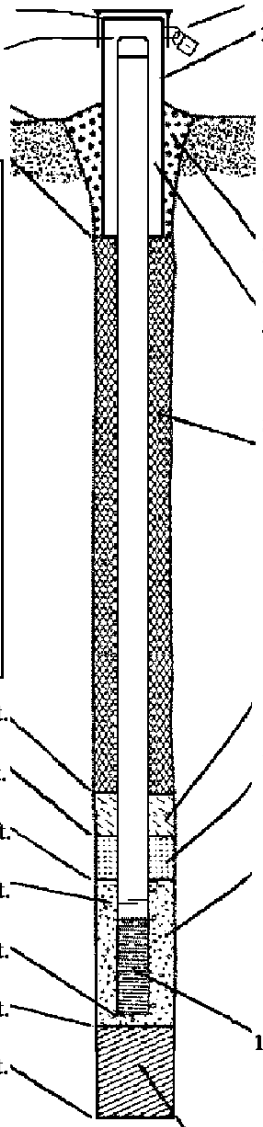
J. Filter pack, bottom _____ ft. MSL or 92.2 ft.

K. Borehole, bottom _____ ft. MSL or 92.2 ft.

L. Borehole, diameter 7.0 in.

M. O.D. well casing 2.9 in.

N. I.D. well casing 2.3 in.



1. Cap and lock? ☑ Yes ☐ No

2. Protective cover pipe:
a. Inside diameter: 6.0 in.
b. Length: 7.5 ft.
c. Material: Steel ☑ 04; Other ☐
d. Additional protection? ☑ Yes ☐ No
If yes, describe: Steel Bumper Posts

3. Surface seal: Bentonite ☑ 30; Concrete ☐ 01; Other ☐

4. Material between well casing and protective pipe: Bentonite ☑ 30; Other ☐

5. Annular space seal: a. Granular/Chipped Bentonite ☐ 33
b. ____ Lbs/gal mud weight . . . Bentonite-sand slurry ☐ 35
c. 3.5 Lbs/gal mud weight . . . . . Bentonite slurry ☑ 31
d. ____ % Bentonite . . . . . Bentonite-cement grout ☐ 50
e. 150 gal Ft^3 volume added for any of the above
f. How installed: Tremie ☑ 01; Tremie pumped ☐ 02; Gravity ☐ 08

6. Bentonite seal: a. Bentonite granules ☐ 33
b. ☐ 1/4 in. ☑ 3/8 in. ☐ 1/2 in. Bentonite chips ☑ 32
c. _____ Other ☐

7. Fine sand material: Manufacturer, product name & mesh size
a. Badger Mining, silica sand, 40-60
b. Volume added 1 bag ft^3

8. Filter pack material: Manufacturer, product name & mesh size
a. Red Flint #40
b. Volume added 4 bags ft^3

9. Well casing: Flush threaded PVC schedule 40 ☐ 23; Flush threaded PVC schedule 80 ☑ 24; Other ☐

10. Screen material: same as above
a. Screen type: Factory cut ☑ 11; Continuous slot ☐ 01; Other ☐
b. Manufacturer Campbell Monoflex
c. Slot size: 0.020 in.
d. Slotted length: 15.0 ft.

11. Backfill material (below filter pack): None ☑ 14; Other ☐

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature Joel Janssen Firm SpecPro, Inc.

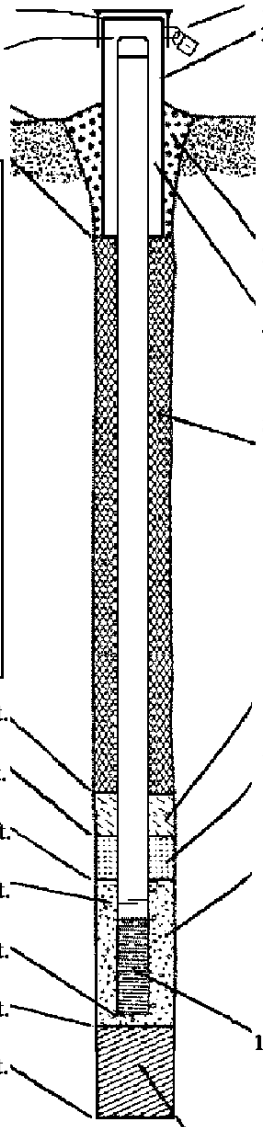
Please complete both Forms 4400-113A and 4400-113B and return them to the appropriate DNR office and bureau. Completion of these reports is required by chs. 160, 281, 283, 289, 291, 292, 293, 295, and 299, Wis. Stats., and ch. NR 141, Wis. Adm. Code. In accordance with chs. 281, 289, 291, 292, 293, 295, and 299, Wis. Stats., failure to file these forms may result in a forfeiture of between $10 and $25,000, or imprisonment for up to one year, depending on the program and conduct involved. Personally identifiable information on these forms is not intended to be used for any other purpose. NOTE: See the instructions for more information, including where the completed forms should be sent.

State of Wisconsin
Department of Natural Resources

Route to: Watershed/Wastewater ☐ Waste Management ☐ Remediation/Redevelopment ☑ Other ☐ _____

MONITORING WELL CONSTRUCTION
Form 4400-113A Rev. 7-98

Facility/Project Name: Badger AAP	Local Grid Location of Well: ____ ft. ☐ N. ☐ S. ____ ft. ☐ E. ☐ W.	Well Name: RIN-1001C
Facility License, Permit or Monitoring No.: 3487	Local Grid Origin ☐ (estimated: ☐) or Well Location ☐ Lat. (NAD 83)° ____ " Long. ____ ° ____ ' ____ " or	Wis. Unique Well No.: VM170 / DNR Well ID No.: 481
Facility ID: 157053930	St. Plane 497096.68 ft. N, 2035224.60 ft. E. (S)/C/N	Date Well Installed: 05 / 24 / 2010 (m m d d y y y y)
Type of Well: Well Code 12 / PZ	Section Location of Waste/Source: ____ 1/4 of ____ 1/4 of Sec. ____, T. ____ N, R. ____ ☐ E. ☐ W.	Well Installed By: Name (first, last) and Firm: Roy Buckenberger; Layne Christensen Company
Distance from Waste/Source ____ ft. / Enf. Stds. Apply ☑	Location of Well Relative to Waste/Source: u ☐ Upgradient s ☐ Sidegradient d ☑ Downgradient n ☐ Not Known	Gov. Lot Number: ____



A. Protective pipe, top elevation ____ ft. MSL

B. Well casing, top elevation 884.02 ft. MSL

C. Land surface elevation 882.01 ft. MSL

D. Surface seal, bottom ____ ft. MSL or 4 ft.

12. USCS classification of soil near screen:
GP ☐ GM ☐ GC ☐ GW ☐ SW ☐ SP ☑
SM ☐ SC ☐ ML ☐ MH ☐ CL ☐ CH ☐
Bedrock ☐

13. Sieve analysis performed? ☐ Yes ☑ No

14. Drilling method used: Rotary ☐ 50; Hollow Stem Auger ☐ 41; Other ☑ Rotosonic

15. Drilling fluid used: Water ☑ 02; Air ☐ 01; Drilling Mud ☐ 03; None ☐ 99

16. Drilling additives used? ☐ Yes ☑ No

Describe _____

17. Source of water (attach analysis, if required): _____

E. Bentonite seal, top ____ ft. MSL or 166.41 ft.

F. Fine sand, top ____ ft. MSL or 171.41 ft.

G. Filter pack, top ____ ft. MSL or 173.41 ft.

H. Screen joint, top ____ ft. MSL or 176.41 ft.

I. Well bottom ____ ft. MSL or 181.41 ft.

J. Filter pack, bottom ____ ft. MSL or 181.41 ft.

K. Borehole, bottom ____ ft. MSL or 181.41 ft.

L. Borehole, diameter 7.0 in.

M. O.D. well casing 2.9 in.

N. I.D. well casing 2.3 in.

1. Cap and lock? ☑ Yes ☐ No

2. Protective cover pipe:
a. Inside diameter: 6.0 in.
b. Length: 7.5 ft.
c. Material: Steel ☑ 04; Other ☐ ____
d. Additional protection? ☑ Yes ☐ No
If yes, describe: Steel Bumper Posts

3. Surface seal: Bentonite ☑ 30; Concrete ☐ 01; Other ☐ ____

4. Material between well casing and protective pipe: Bentonite ☑ 30; Other ☐ ____

5. Annular space seal: a. Granular/Chipped Bentonite ☐ 33
b. ____ Lbs/gal mud weight . . . Bentonite-sand slurry ☐ 35
c. 3.5 Lbs/gal mud weight . . . . . Bentonite slurry ☑ 31
d. ____ % Bentonite . . . . . Bentonite-cement grout ☐ 50
e. 225 gal Ft^3 volume added for any of the above
f. How installed: Tremie ☑ 01; Tremie pumped ☐ 02; Gravity ☐ 08

6. Bentonite seal: a. Bentonite granules ☐ 33
b. ☐ 1/4 in. ☑ 3/8 in. ☐ 1/2 in. Bentonite chips ☑ 32
c. ____ Other ☐ ____

7. Fine sand material: Manufacturer, product name & mesh size
a. Badger Mining, silica sand, 40-60
b. Volume added 1 bag ft^3

8. Filter pack material: Manufacturer, product name & mesh size
a. Red Flint #40
b. Volume added 4 bags ft^3

9. Well casing: Flush threaded PVC schedule 40 ☐ 23; Flush threaded PVC schedule 80 ☑ 24; Other ☐ ____

10. Screen material: same as above
a. Screen type: Factory cut ☑ 11; Continuous slot ☐ 01; Other ☐ ____
b. Manufacturer Campbell Monoflex
c. Slot size: 0.020 in.
d. Slotted length: 5 ft.

11. Backfill material (below filter pack): None ☑ 14; Other ☐ ____

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature Joel Janssen | Firm SpecPro, Inc.

Please complete both Forms 4400-113A and 4400-113B and return them to the appropriate DNR office and bureau. Completion of these reports is required by chs. 160, 281, 283, 289, 291, 292, 293, 295, and 299, Wis. Stats., and ch. NR 141, Wis. Adm. Code. In accordance with chs. 281, 289, 291, 292, 293, 295, and 299, Wis. Stats., failure to file these forms may result in a forfeiture of between $10 and $25,000, or imprisonment for up to one year, depending on the program and conduct involved. Personally identifiable information on these forms is not intended to be used for any other purpose. NOTE: See the instructions for more information, including where the completed forms should be sent.

State of Wisconsin
Department of Natural Resources

Route to: Watershed/Wastewater ☐ Waste Management ☐ Remediation/Redevelopment ☑ Other ☐ _____

MONITORING WELL CONSTRUCTION
Form 4400-113A Rev. 7-98

Facility/Project Name: Badger AAP	Local Grid Location of Well: ☐ N. ☐ S. _____ ft. ☐ E. ☐ W. _____ ft.	Well Name: RIN-1001A
Facility License, Permit or Monitoring No.: 3487	Local Grid Origin ☐ (estimated: ☐) or Well Location ☐ Lat. (NAD 83)° ___ " Long. ___ ° ___ ' ___ " or	Wis. Unique Well No.: VM169 / DNR Well ID No.: 480
Facility ID: 157053930	St. Plane 497066.20 ft. N, 2035220.81 ft. E. (S)/C/N	Date Well Installed: 04 / 28 / 2010 (m m / d d / y y y y)
Type of Well: Well Code 11 / MW	Section Location of Waste/Source: ___ 1/4 of ___ 1/4 of Sec. ___, T. ___ N, R. ___ ☐ E. ☐ W.	Well Installed By: Name (first, last) and Firm: Roy Buckenberger; Layne Christensen Company
Distance from Waste/Source ___ ft. / Enf. Stds. Apply ☑	Location of Well Relative to Waste/Source: u ☐ Upgradient s ☐ Sidegradient d ☑ Downgradient n ☐ Not Known	Gov. Lot Number:

A. Protective pipe, top elevation _____ ft. MSL

B. Well casing, top elevation 884.38 ft. MSL

C. Land surface elevation 882.05 ft. MSL

D. Surface seal, bottom _____ ft. MSL or 4 ft.

12. USCS classification of soil near screen:
GP ☐ GM ☐ GC ☐ GW ☐ SW ☐ SP ☑
SM ☐ SC ☐ ML ☐ MH ☐ CL ☐ CH ☐
Bedrock ☐

13. Sieve analysis performed? ☐ Yes ☑ No

14. Drilling method used: Rotary ☐ 50; Hollow Stem Auger ☐ 41; Other ☑ Rotosonic

15. Drilling fluid used: Water ☑ 02; Air ☐ 01; Drilling Mud ☐ 03; None ☐ 99

16. Drilling additives used? ☐ Yes ☑ No

Describe _____

17. Source of water (attach analysis, if required):

E. Bentonite seal, top _____ ft. MSL or 81.8 ft.

F. Fine sand, top _____ ft. MSL or 86.8 ft.

G. Filter pack, top _____ ft. MSL or 88.8 ft.

H. Screen joint, top _____ ft. MSL or 91.8 ft.

I. Well bottom _____ ft. MSL or 106.8 ft.

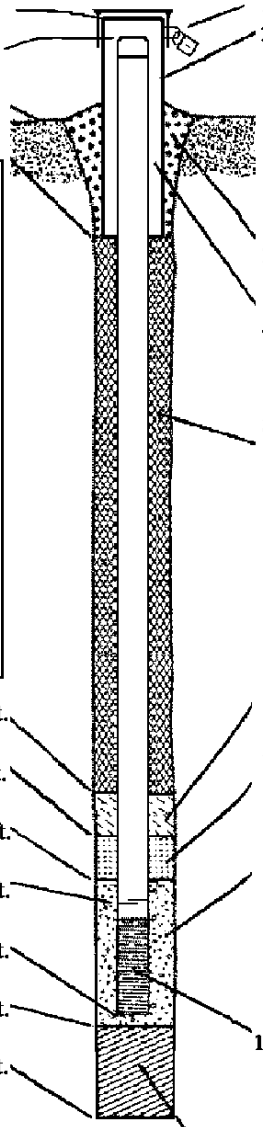
J. Filter pack, bottom _____ ft. MSL or 106.8 ft.

K. Borehole, bottom _____ ft. MSL or 106.8 ft.

L. Borehole, diameter 7.0 in.

M. O.D. well casing 2.9 in.

N. I.D. well casing 2.3 in.



1. Cap and lock? ☑ Yes ☐ No

2. Protective cover pipe:
a. Inside diameter: 6.0 in.
b. Length: 7.5 ft.
c. Material: Steel ☑ 04; Other ☐
d. Additional protection? ☑ Yes ☐ No
If yes, describe: Steel Bumper Posts

3. Surface seal: Bentonite ☑ 30; Concrete ☐ 01; Other ☐

4. Material between well casing and protective pipe: Bentonite ☑ 30; Other ☐

5. Annular space seal: a. Granular/Chipped Bentonite ☐ 33
b. ___ Lbs/gal mud weight . . . Bentonite-sand slurry ☐ 35
c. 3.5 Lbs/gal mud weight . . . . . Bentonite slurry ☑ 31
d. ___ % Bentonite . . . . . Bentonite-cement grout ☐ 50
e. 150 gal Ft^3 volume added for any of the above
f. How installed: Tremie ☑ 01; Tremie pumped ☐ 02; Gravity ☐ 08

6. Bentonite seal: a. Bentonite granules ☐ 33
b. ☐1/4 in. ☑3/8 in. ☐1/2 in. Bentonite chips ☑ 32
c. _____ Other ☐

7. Fine sand material: Manufacturer, product name & mesh size
a. Badger Mining, silica sand, 40-60
b. Volume added 1 bag ft^3

8. Filter pack material: Manufacturer, product name & mesh size
a. Red Flint #40
b. Volume added 4 bags ft^3

9. Well casing: Flush threaded PVC schedule 40 ☐ 23; Flush threaded PVC schedule 80 ☑ 24; Other ☐

10. Screen material: same as above
a. Screen type: Factory cut ☑ 11; Continuous slot ☐ 01; Other ☐
b. Manufacturer Campbell Monoflex
c. Slot size: 0.020 in.
d. Slotted length: 15.0 ft.

11. Backfill material (below filter pack): None ☑ 14; Other ☐

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature: Joel Janssen | Firm: SpecPro, Inc.

Please complete both Forms 4400-113A and 4400-113B and return them to the appropriate DNR office and bureau. Completion of these reports is required by chs. 160, 281, 283, 289, 291, 292, 293, 295, and 299, Wis. Stats., and ch. NR 141, Wis. Adm. Code. In accordance with chs. 281, 289, 291, 292, 293, 295, and 299, Wis. Stats., failure to file these forms may result in a forfeiture of between $10 and $25,000, or imprisonment for up to one year, depending on the program and conduct involved. Personally identifiable information on these forms is not intended to be used for any other purpose. NOTE: See the instructions for more information, including where the completed forms should be sent.

State of Wisconsin
Department of Natural Resources

Route to: Watershed/Wastewater ☐ Waste Management ☐ Remediation/Redevelopment ☑ Other ☐ _____

MONITORING WELL CONSTRUCTION
Form 4400-113A Rev. 7-98

Facility/Project Name: Badger AAP	Local Grid Location of Well: ____ ft. ☐ N. ☐ S. ____ ft. ☐ E. ☐ W.	Well Name: RIM-1005
Facility License, Permit or Monitoring No.: 3487	Local Grid Origin ☐ (estimated: ☐) or Well Location ☐ Lat. (NAD 83)° ____ " Long. ____ ° ____ ' ____ " or	Wis. Unique Well No.: VM174 / DNR Well ID No.: 490
Facility ID: 157053930	St. Plane 497534.67 ft. N, 2041193.13 ft. E. (S)/C/N	Date Well Installed: 05 / 06 / 2010 (m m d d y y y y)
Type of Well: Well Code 11 / MW	Section Location of Waste/Source: ____ 1/4 of ____ 1/4 of Sec. ____, T. ____ N, R. ____ ☐ E. ☐ W.	Well Installed By: Name (first, last) and Firm: Roy Buckenberger; Layne Christensen Company
Distance from Waste/Source ____ ft. / Enf. Stds. Apply ☑	Location of Well Relative to Waste/Source: u ☐ Upgradient s ☐ Sidegradient d ☑ Downgradient n ☐ Not Known	Gov. Lot Number: ____

A. Protective pipe, top elevation ____ ft. MSL

B. Well casing, top elevation 882.69 ft. MSL

C. Land surface elevation 880.06 ft. MSL

D. Surface seal, bottom ____ ft. MSL or 4 ft.

12. USCS classification of soil near screen:
GP ☐ GM ☐ GC ☐ GW ☐ SW ☐ SP ☑
SM ☐ SC ☐ ML ☐ MH ☐ CL ☐ CH ☐
Bedrock ☐

13. Sieve analysis performed? ☐ Yes ☑ No

14. Drilling method used: Rotary ☐ 50; Hollow Stem Auger ☐ 41; Other ☑ Rotosonic

15. Drilling fluid used: Water ☑ 02; Air ☐ 01; Drilling Mud ☐ 03; None ☐ 99

16. Drilling additives used? ☐ Yes ☑ No

Describe _____

17. Source of water (attach analysis, if required):

E. Bentonite seal, top ____ ft. MSL or 85.24 ft.

F. Fine sand, top ____ ft. MSL or 90.24 ft.

G. Filter pack, top ____ ft. MSL or 92.24 ft.

H. Screen joint, top ____ ft. MSL or 95.24 ft.

I. Well bottom ____ ft. MSL or 110.24 ft.

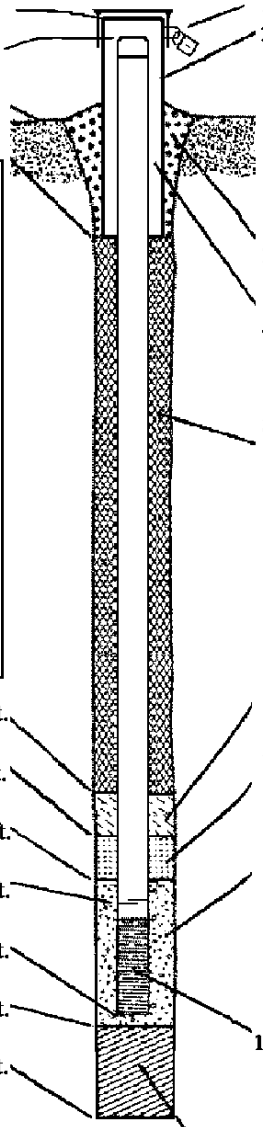
J. Filter pack, bottom ____ ft. MSL or 110.24 ft.

K. Borehole, bottom ____ ft. MSL or 110.24 ft.

L. Borehole, diameter 7.0 in.

M. O.D. well casing 2.9 in.

N. I.D. well casing 2.3 in.



1. Cap and lock? ☑ Yes ☐ No

2. Protective cover pipe:
a. Inside diameter: 6.0 in.
b. Length: 7.5 ft.
c. Material: Steel ☑ 04; Other ☐
d. Additional protection? ☑ Yes ☐ No
If yes, describe: Steel Bumper Posts

3. Surface seal: Bentonite ☑ 30; Concrete ☐ 01; Other ☐

4. Material between well casing and protective pipe: Bentonite ☑ 30; Other ☐

5. Annular space seal: a. Granular/Chipped Bentonite ☐ 33
b. ____ Lbs/gal mud weight . . . Bentonite-sand slurry ☐ 35
c. 3.5 Lbs/gal mud weight . . . . . Bentonite slurry ☑ 31
d. ____ % Bentonite . . . . . Bentonite-cement grout ☐ 50
e. 150 gal Ft^3 volume added for any of the above
f. How installed: Tremie ☑ 01; Tremie pumped ☐ 02; Gravity ☐ 08

6. Bentonite seal: a. Bentonite granules ☐ 33
b. ☐ 1/4 in. ☑ 3/8 in. ☐ 1/2 in. Bentonite chips ☑ 32
c. _____ Other ☐

7. Fine sand material: Manufacturer, product name & mesh size
a. Badger Mining, silica sand, 40-60
b. Volume added 1 bag ft^3

8. Filter pack material: Manufacturer, product name & mesh size
a. Red Flint #40
b. Volume added 4 bags ft^3

9. Well casing: Flush threaded PVC schedule 40 ☐ 23; Flush threaded PVC schedule 80 ☑ 24; Other ☐

10. Screen material: same as above
a. Screen type: Factory cut ☑ 11; Continuous slot ☐ 01; Other ☐
b. Manufacturer Campbell Monoflex
c. Slot size: 0.020 in.
d. Slotted length: 15.0 ft.

11. Backfill material (below filter pack): None ☑ 14; Other ☐

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature Joel Janssen | Firm SpecPro, Inc.

Please complete both Forms 4400-113A and 4400-113B and return them to the appropriate DNR office and bureau. Completion of these reports is required by chs. 160, 281, 283, 289, 291, 292, 293, 295, and 299, Wis. Stats., and ch. NR 141, Wis. Adm. Code. In accordance with chs. 281, 289, 291, 292, 293, 295, and 299, Wis. Stats., failure to file these forms may result in a forfeiture of between $10 and $25,000, or imprisonment for up to one year, depending on the program and conduct involved. Personally identifiable information on these forms is not intended to be used for any other purpose. NOTE: See the instructions for more information, including where the completed forms should be sent.

State of Wisconsin
Department of Natural Resources

Route to: Watershed/Wastewater ☐ Waste Management ☐ Remediation/Redevelopment ☑ Other ☐ _____

MONITORING WELL CONSTRUCTION
Form 4400-113A Rev. 7-98

Facility/Project Name: Badger AAP	Local Grid Location of Well: ____ ft. ☐ N. ☐ S. ____ ft. ☐ E. ☐ W.	Well Name: RIM-1004
Facility License, Permit or Monitoring No.: 3487	Local Grid Origin ☐ (estimated: ☐) or Well Location ☐ Lat. (NAD 83) ____ ° ____ ' ____ " Long. ____ ° ____ ' ____ " or	Wis. Unique Well No.: VM178 / DNR Well ID No.: 494
Facility ID: 157053930	St. Plane 489552.08 ft. N, 2044244.43 ft. E. (S)C/N	Date Well Installed: 05 / 05 / 2010 (m m d d y y y y)
Type of Well: Well Code 11 / MW	Section Location of Waste/Source: ____ 1/4 of ____ 1/4 of Sec. ____, T. ____ N, R. ____ ☐ E. ☐ W.	Well Installed By: Name (first, last) and Firm: Roy Buckenberger; Layne Christensen Company
Distance from Waste/Source ____ ft. Enf. Stds. Apply ☑	Location of Well Relative to Waste/Source: u ☐ Upgradient s ☐ Sidegradient d ☑ Downgradient n ☐ Not Known	Gov. Lot Number: ____

A. Protective pipe, top elevation ____ ft. MSL

B. Well casing, top elevation 836.40 ft. MSL

C. Land surface elevation 833.60 ft. MSL

D. Surface seal, bottom ____ ft. MSL or 4 ft.

12. USCS classification of soil near screen:
GP ☐ GM ☐ GC ☐ GW ☐ SW ☐ SP ☑
SM ☐ SC ☐ ML ☐ MH ☐ CL ☐ CH ☐
Bedrock ☐

13. Sieve analysis performed? ☐ Yes ☑ No

14. Drilling method used: Rotary ☐ 50; Hollow Stem Auger ☐ 41; Other ☑ Rotosonic

15. Drilling fluid used: Water ☑ 02; Air ☐ 01; Drilling Mud ☐ 03; None ☐ 99

16. Drilling additives used? ☐ Yes ☑ No

Describe _____

17. Source of water (attach analysis, if required):

E. Bentonite seal, top ____ ft. MSL or 45.52 ft.

F. Fine sand, top ____ ft. MSL or 50.52 ft.

G. Filter pack, top ____ ft. MSL or 52.52 ft.

H. Screen joint, top ____ ft. MSL or 55.52 ft.

I. Well bottom ____ ft. MSL or 70.52 ft.

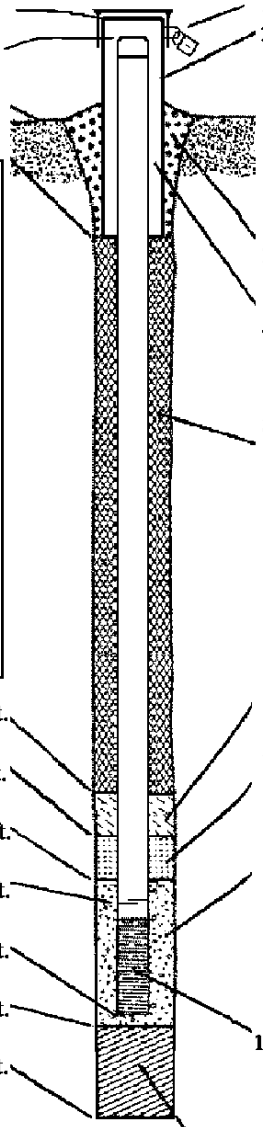
J. Filter pack, bottom ____ ft. MSL or 70.52 ft.

K. Borehole, bottom ____ ft. MSL or 70.52 ft.

L. Borehole, diameter 7.0 in.

M. O.D. well casing 2.9 in.

N. I.D. well casing 2.3 in.



1. Cap and lock? ☑ Yes ☐ No

2. Protective cover pipe:
a. Inside diameter: 6.0 in.
b. Length: 7.5 ft.
c. Material: Steel ☑ 04; Other ☐ ____
d. Additional protection? ☑ Yes ☐ No
If yes, describe: Steel Bumper Posts

3. Surface seal: Bentonite ☑ 30; Concrete ☐ 01; Other ☐ ____

4. Material between well casing and protective pipe: Bentonite ☑ 30; Other ☐ ____

5. Annular space seal: a. Granular/Chipped Bentonite ☐ 33
b. ____ Lbs/gal mud weight . . . Bentonite-sand slurry ☐ 35
c. 3.5 Lbs/gal mud weight . . . . . Bentonite slurry ☑ 31
d. ____ % Bentonite . . . . . Bentonite-cement grout ☐ 50
e. 200 gal Ft^3 volume added for any of the above
f. How installed: Tremie ☑ 01; Tremie pumped ☐ 02; Gravity ☐ 08

6. Bentonite seal: a. Bentonite granules ☐ 33
b. ☐ 1/4 in. ☑ 3/8 in. ☐ 1/2 in. Bentonite chips ☑ 32
c. ____ Other ☐ ____

7. Fine sand material: Manufacturer, product name & mesh size
a. Badger Mining, silica sand, 40-60
b. Volume added 1 bag ft^3

8. Filter pack material: Manufacturer, product name & mesh size
a. Red Flint #40
b. Volume added 4 bags ft^3

9. Well casing: Flush threaded PVC schedule 40 ☐ 23; Flush threaded PVC schedule 80 ☑ 24; Other ☐ ____

10. Screen material: same as above
a. Screen type: Factory cut ☑ 11; Continuous slot ☐ 01; Other ☐ ____
b. Manufacturer Campbell Monoflex
c. Slot size: 0.020 in.
d. Slotted length: 15.0 ft.

11. Backfill material (below filter pack): None ☑ 14; Other ☐ ____

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature: Joel Janssen	Firm: SpecPro, Inc.

Please complete both Forms 4400-113A and 4400-113B and return them to the appropriate DNR office and bureau. Completion of these reports is required by chs. 160, 281, 283, 289, 291, 292, 293, 295, and 299, Wis. Stats., and ch. NR 141, Wis. Adm. Code. In accordance with chs. 281, 289, 291, 292, 293, 295, and 299, Wis. Stats., failure to file these forms may result in a forfeiture of between $10 and $25,000, or imprisonment for up to one year, depending on the program and conduct involved. Personally identifiable information on these forms is not intended to be used for any other purpose. NOTE: See the instructions for more information, including where the completed forms should be sent.

State of Wisconsin
Department of Natural Resources

Route to: Watershed/Wastewater ☐ Waste Management ☐ Remediation/Redevelopment ☑ Other ☐ _____

MONITORING WELL CONSTRUCTION
Form 4400-113A Rev. 7-98

Facility/Project Name: Badger AAP	Local Grid Location of Well: ____ ft. ☐ N. ☐ S. ____ ft. ☐ E. ☐ W.	Well Name: RIM-1003
Facility License, Permit or Monitoring No.: 3487	Local Grid Origin ☐ (estimated: ☐) or Well Location ☐ Lat. (NAD 83)° ____ " Long. ____ ° ____ ' ____ " or	Wis. Unique Well No.: VM175 / DNR Well ID No.: 491
Facility ID: 157053930	St. Plane 492554.74 ft. N, 2043660.80 ft. E. (S)/C/N	Date Well Installed: 05 / 03 / 2010 (m m d d y y y y)
Type of Well: Well Code 11 / MW	Section Location of Waste/Source: ____ 1/4 of ____ 1/4 of Sec. ____, T. ____ N, R. ____ ☐ E. ☐ W.	Well Installed By: Name (first, last) and Firm: Roy Buckenberger; Layne Christensen Company
Distance from Waste/Source ____ ft. / Enf. Stds. Apply ☑	Location of Well Relative to Waste/Source: u ☐ Upgradient s ☐ Sidegradient d ☑ Downgradient n ☐ Not Known	Gov. Lot Number: ____

A. Protective pipe, top elevation ____ ft. MSL

B. Well casing, top elevation 885.06 ft. MSL

C. Land surface elevation 882.78 ft. MSL

D. Surface seal, bottom ____ ft. MSL or 4 ft.

12. USCS classification of soil near screen:
GP ☐ GM ☐ GC ☐ GW ☐ SW ☐ SP ☑
SM ☐ SC ☐ ML ☐ MH ☐ CL ☐ CH ☐
Bedrock ☐

13. Sieve analysis performed? ☐ Yes ☑ No

14. Drilling method used: Rotary ☐ 50; Hollow Stem Auger ☐ 41; Other ☑ Rotosonic

15. Drilling fluid used: Water ☑ 02; Air ☐ 01; Drilling Mud ☐ 03; None ☐ 99

16. Drilling additives used? ☐ Yes ☑ No

Describe _____

17. Source of water (attach analysis, if required):

E. Bentonite seal, top ____ ft. MSL or 89.3 ft.

F. Fine sand, top ____ ft. MSL or 94.3 ft.

G. Filter pack, top ____ ft. MSL or 96.3 ft.

H. Screen joint, top ____ ft. MSL or 99.3 ft.

I. Well bottom ____ ft. MSL or 114.3 ft.

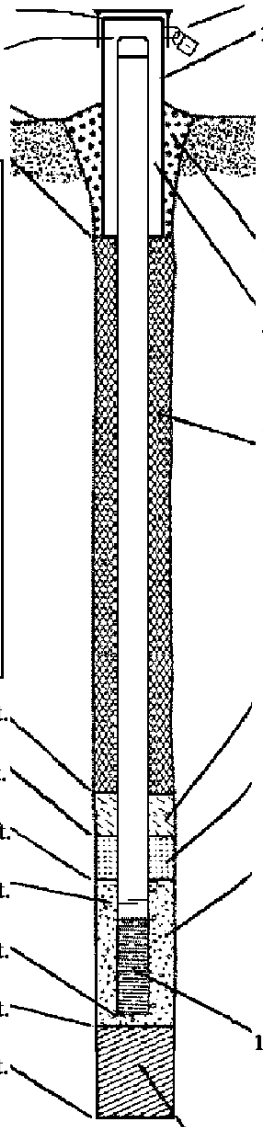
J. Filter pack, bottom ____ ft. MSL or 114.3 ft.

K. Borehole, bottom ____ ft. MSL or 114.3 ft.

L. Borehole, diameter 7.0 in.

M. O.D. well casing 2.9 in.

N. I.D. well casing 2.3 in.



1. Cap and lock? ☑ Yes ☐ No

2. Protective cover pipe:
a. Inside diameter: 6.0 in.
b. Length: 7.5 ft.
c. Material: Steel ☑ 04; Other ☐
d. Additional protection? ☑ Yes ☐ No
If yes, describe: Steel Bumper Posts

3. Surface seal: Bentonite ☑ 30; Concrete ☐ 01; Other ☐

4. Material between well casing and protective pipe: Bentonite ☑ 30; Other ☐

5. Annular space seal: a. Granular/Chipped Bentonite ☐ 33
b. ____ Lbs/gal mud weight . . . Bentonite-sand slurry ☐ 35
c. 3.5 Lbs/gal mud weight . . . . . Bentonite slurry ☑ 31
d. ____ % Bentonite . . . . . Bentonite-cement grout ☐ 50
e. 150 gal Ft^3 volume added for any of the above
f. How installed: Tremie ☑ 01; Tremie pumped ☐ 02; Gravity ☐ 08

6. Bentonite seal: a. Bentonite granules ☐ 33
b. ☐ 1/4 in. ☑ 3/8 in. ☐ 1/2 in. Bentonite chips ☑ 32
c. _____ Other ☐

7. Fine sand material: Manufacturer, product name & mesh size
a. Badger Mining, silica sand, 40-60
b. Volume added 1 bag ft^3

8. Filter pack material: Manufacturer, product name & mesh size
a. Red Flint #40
b. Volume added 4 bags ft^3

9. Well casing: Flush threaded PVC schedule 40 ☐ 23; Flush threaded PVC schedule 80 ☑ 24; Other ☐

10. Screen material: same as above
a. Screen type: Factory cut ☑ 11; Continuous slot ☐ 01; Other ☐
b. Manufacturer Campbell Monoflex
c. Slot size: 0.020 in.
d. Slotted length: 15.0 ft.

11. Backfill material (below filter pack): None ☑ 14; Other ☐

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature: Joel Janssen Firm: SpecPro, Inc.

Please complete both Forms 4400-113A and 4400-113B and return them to the appropriate DNR office and bureau. Completion of these reports is required by chs. 160, 281, 283, 289, 291, 292, 293, 295, and 299, Wis. Stats., and ch. NR 141, Wis. Adm. Code. In accordance with chs. 281, 289, 291, 292, 293, 295, and 299, Wis. Stats., failure to file these forms may result in a forfeiture of between $10 and $25,000, or imprisonment for up to one year, depending on the program and conduct involved. Personally identifiable information on these forms is not intended to be used for any other purpose. NOTE: See the instructions for more information, including where the completed forms should be sent.

State of Wisconsin
Department of Natural Resources

Route to: Watershed/Wastewater ☐ Waste Management ☐ Remediation/Redevelopment ☑ Other ☐ _____

MONITORING WELL CONSTRUCTION
Form 4400-113A Rev. 7-98

Facility/Project Name: Badger AAP	Local Grid Location of Well: ____ ft. ☐ N. ☐ S. ____ ft. ☐ E. ☐ W.	Well Name: RIM-1002
Facility License, Permit or Monitoring No.: 3487	Local Grid Origin ☐ (estimated: ☐) or Well Location ☐ Lat. (NAD 83)° ____ " Long. ____ ° ____ ' ____ " or	Wis. Unique Well No.: VM167 / DNR Well ID No.: 478
Facility ID: 157053930	St. Plane 499282.00 ft. N, 2034868.80 ft. E. (S)C/N	Date Well Installed: 04 / 29 / 2010 (m m d d y y y y)
Type of Well: Well Code 11 / MW	Section Location of Waste/Source: ____ 1/4 of ____ 1/4 of Sec. ____, T. ____ N, R. ____ ☐ E. ☐ W.	Well Installed By: Name (first, last) and Firm: Roy Buckenberger; Layne Christensen Company
Distance from Waste/Source ____ ft. Enf. Stds. Apply ☑	Location of Well Relative to Waste/Source: u ☐ Upgradient s ☐ Sidegradient d ☑ Downgradient n ☐ Not Known; Gov. Lot Number ____	

A. Protective pipe, top elevation ____ ft. MSL

B. Well casing, top elevation 891.01 ft. MSL

C. Land surface elevation 888.51 ft. MSL

D. Surface seal, bottom ____ ft. MSL or 4 ft.

12. USCS classification of soil near screen:
GP ☐ GM ☐ GC ☐ GW ☐ SW ☐ SP ☑
SM ☐ SC ☐ ML ☐ MH ☐ CL ☐ CH ☐
Bedrock ☐

13. Sieve analysis performed? ☐ Yes ☑ No

14. Drilling method used: Rotary ☐ 50; Hollow Stem Auger ☐ 41; Other ☑ Rotosonic

15. Drilling fluid used: Water ☑ 02; Air ☐ 01; Drilling Mud ☐ 03; None ☐ 99

16. Drilling additives used? ☐ Yes ☑ No

Describe _____

17. Source of water (attach analysis, if required):

E. Bentonite seal, top ____ ft. MSL or 85.2 ft.

F. Fine sand, top ____ ft. MSL or 90.2 ft.

G. Filter pack, top ____ ft. MSL or 92.2 ft.

H. Screen joint, top ____ ft. MSL or 95.2 ft.

I. Well bottom ____ ft. MSL or 110.2 ft.

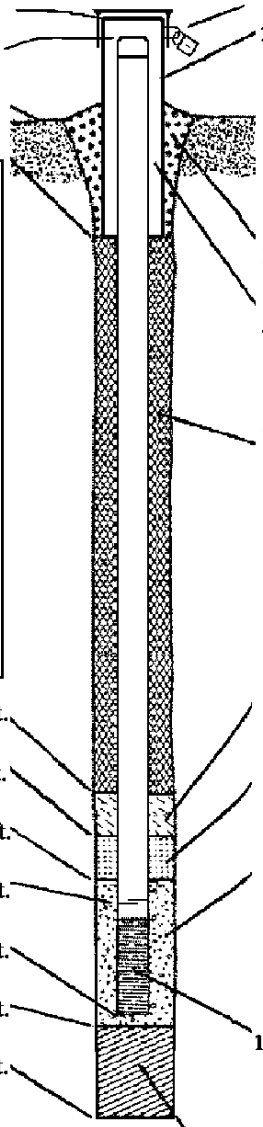
J. Filter pack, bottom ____ ft. MSL or 110.2 ft.

K. Borehole, bottom ____ ft. MSL or 110.2 ft.

L. Borehole, diameter 7.0 in.

M. O.D. well casing 2.9 in.

N. I.D. well casing 2.3 in.



1. Cap and lock? ☑ Yes ☐ No

2. Protective cover pipe:
a. Inside diameter: 6.0 in.
b. Length: 7.5 ft.
c. Material: Steel ☑ 04; Other ☐ ____
d. Additional protection? ☑ Yes ☐ No
If yes, describe: Steel Bumper Posts

3. Surface seal: Bentonite ☑ 30; Concrete ☐ 01; Other ☐ ____

4. Material between well casing and protective pipe: Bentonite ☑ 30; Other ☐ ____

5. Annular space seal: a. Granular/Chipped Bentonite ☐ 33
b. ____ Lbs/gal mud weight . . . Bentonite-sand slurry ☐ 35
c. 3.5 Lbs/gal mud weight . . . . . Bentonite slurry ☑ 31
d. ____ % Bentonite . . . . . Bentonite-cement grout ☐ 50
e. 150 gal Ft^3 volume added for any of the above
f. How installed: Tremie ☑ 01; Tremie pumped ☐ 02; Gravity ☐ 08

6. Bentonite seal: a. Bentonite granules ☐ 33
b. ☐ 1/4 in. ☑ 3/8 in. ☐ 1/2 in. Bentonite chips ☑ 32
c. ____ Other ☐ ____

7. Fine sand material: Manufacturer, product name & mesh size
a. Badger Mining, silica sand, 40-60
b. Volume added 1 bag ft^3

8. Filter pack material: Manufacturer, product name & mesh size
a. Red Flint #40
b. Volume added 4 bags ft^3

9. Well casing: Flush threaded PVC schedule 40 ☐ 23; Flush threaded PVC schedule 80 ☑ 24; Other ☐ ____

10. Screen material: same as above
a. Screen type: Factory cut ☑ 11; Continuous slot ☐ 01; Other ☐ ____
b. Manufacturer Campbell Monoflex
c. Slot size: 0.020 in.
d. Slotted length: 15.0 ft.

11. Backfill material (below filter pack): None ☑ 14; Other ☐ ____

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature Joel Janssen | Firm SpecPro, Inc.

Please complete both Forms 4400-113A and 4400-113B and return them to the appropriate DNR office and bureau. Completion of these reports is required by chs. 160, 281, 283, 289, 291, 292, 293, 295, and 299, Wis. Stats., and ch. NR 141, Wis. Adm. Code. In accordance with chs. 281, 289, 291, 292, 293, 295, and 299, Wis. Stats., failure to file these forms may result in a forfeiture of between $10 and $25,000, or imprisonment for up to one year, depending on the program and conduct involved. Personally identifiable information on these forms is not intended to be used for any other purpose. NOTE: See the instructions for more information, including where the completed forms should be sent.

State of Wisconsin
Department of Natural Resources

Route to: Watershed/Wastewater ☐ Waste Management ☐ Remediation/Redevelopment ☑ Other ☐ _____

MONITORING WELL CONSTRUCTION
Form 4400-113A Rev. 7-98

Facility/Project Name: Badger AAP	Local Grid Location of Well: ☐ N. ☐ S. _____ ft. ☐ E. ☐ W. _____ ft.	Well Name: RIM-1001
Facility License, Permit or Monitoring No.: 3487	Local Grid Origin ☐ (estimated: ☐) or Well Location ☐ Lat. (NAD 83) ___ ° ___ ' ___ " Long. ___ ° ___ ' ___ " or	Wis. Unique Well No.: VM171 / DNR Well ID No.: 482
Facility ID: 157053930	St. Plane 495730.04 ft. N, 2034806.71 ft. E. (S)/C/N	Date Well Installed: 04 / 27 / 2010 (m m d d y y y y)
Type of Well: Well Code 11 / MW	Section Location of Waste/Source: ___ 1/4 of ___ 1/4 of Sec. ___, T. ___ N, R. ___ ☐ E. ☐ W.	Well Installed By: Name (first, last) and Firm: Roy Buckenberger; Layne Christensen Company
Distance from Waste/Source ___ ft. Enf. Stds. Apply ☑	Location of Well Relative to Waste/Source: u ☐ Upgradient s ☐ Sidegradient d ☑ Downgradient n ☐ Not Known; Gov. Lot Number ___	

A. Protective pipe, top elevation _____ ft. MSL

B. Well casing, top elevation 874.90 ft. MSL

C. Land surface elevation 872.51 ft. MSL

D. Surface seal, bottom _____ ft. MSL or 4 ft.

12. USCS classification of soil near screen:
GP ☐ GM ☐ GC ☐ GW ☐ SW ☐ SP ☑
SM ☐ SC ☐ ML ☐ MH ☐ CL ☐ CH ☐
Bedrock ☐

13. Sieve analysis performed? ☐ Yes ☑ No

14. Drilling method used: Rotary ☐ 50; Hollow Stem Auger ☐ 41; Other ☑ Rotosonic

15. Drilling fluid used: Water ☑ 02; Air ☐ 01; Drilling Mud ☐ 03; None ☐ 99

16. Drilling additives used? ☐ Yes ☑ No

Describe _____

17. Source of water (attach analysis, if required):

E. Bentonite seal, top _____ ft. MSL or 73.75 ft.

F. Fine sand, top _____ ft. MSL or 78.75 ft.

G. Filter pack, top _____ ft. MSL or 80.75 ft.

H. Screen joint, top _____ ft. MSL or 83.75 ft.

I. Well bottom _____ ft. MSL or 98.75 ft.

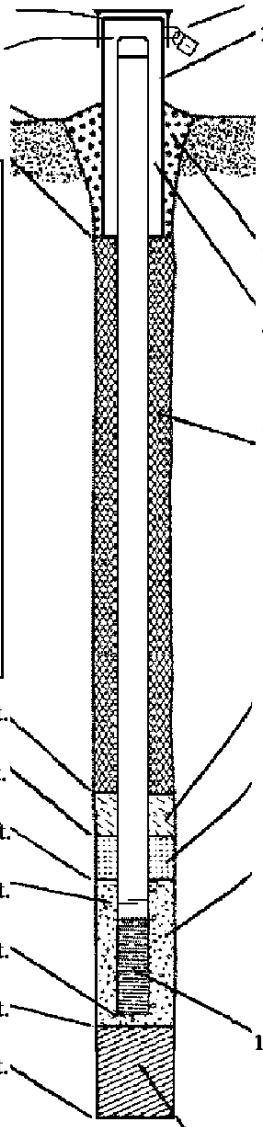
J. Filter pack, bottom _____ ft. MSL or 98.75 ft.

K. Borehole, bottom _____ ft. MSL or 98.75 ft.

L. Borehole, diameter 7.0 in.

M. O.D. well casing 2.9 in.

N. I.D. well casing 2.3 in.



1. Cap and lock? ☑ Yes ☐ No

2. Protective cover pipe:
a. Inside diameter: 6.0 in.
b. Length: 7.5 ft.
c. Material: Steel ☑ 04; Other ☐
d. Additional protection? ☑ Yes ☐ No
If yes, describe: Steel Bumper Posts

3. Surface seal: Bentonite ☑ 30; Concrete ☐ 01; Other ☐

4. Material between well casing and protective pipe: Bentonite ☑ 30; Other ☐

5. Annular space seal: a. Granular/Chipped Bentonite ☐ 33
b. ___ Lbs/gal mud weight . . . Bentonite-sand slurry ☐ 35
c. 3.5 Lbs/gal mud weight . . . . . Bentonite slurry ☑ 31
d. ___ % Bentonite . . . . . Bentonite-cement grout ☐ 50
e. 150 gal Ft^3 volume added for any of the above
f. How installed: Tremie ☑ 01; Tremie pumped ☐ 02; Gravity ☐ 08

6. Bentonite seal: a. Bentonite granules ☐ 33
b. ☐1/4 in. ☑3/8 in. ☐1/2 in. Bentonite chips ☑ 32
c. _____ Other ☐

7. Fine sand material: Manufacturer, product name & mesh size
a. Badger Mining, silica sand, 40-60
b. Volume added 1 bag ft^3

8. Filter pack material: Manufacturer, product name & mesh size
a. Red Flint #40
b. Volume added 4 bags ft^3

9. Well casing: Flush threaded PVC schedule 40 ☐ 23; Flush threaded PVC schedule 80 ☑ 24; Other ☐

10. Screen material: same as above
a. Screen type: Factory cut ☑ 11; Continuous slot ☐ 01; Other ☐
b. Manufacturer Campbell Monoflex
c. Slot size: 0.020 in.
d. Slotted length: 15.0 ft.

11. Backfill material (below filter pack): None ☑ 14; Other ☐

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature: Joel Janssen	Firm: SpecPro, Inc.

Please complete both Forms 4400-113A and 4400-113B and return them to the appropriate DNR office and bureau. Completion of these reports is required by chs. 160, 281, 283, 289, 291, 292, 293, 295, and 299, Wis. Stats., and ch. NR 141, Wis. Adm. Code. In accordance with chs. 281, 289, 291, 292, 293, 295, and 299, Wis. Stats., failure to file these forms may result in a forfeiture of between $10 and $25,000, or imprisonment for up to one year, depending on the program and conduct involved. Personally identifiable information on these forms is not intended to be used for any other purpose. NOTE: See the instructions for more information, including where the completed forms should be sent.

State of Wisconsin
Department of Natural Resources

Route to: Watershed/Wastewater ☐ Waste Management ☐ Remediation/Redevelopment ☑ Other ☐ _____

MONITORING WELL CONSTRUCTION
Form 4400-113A Rev. 7-98

Facility/Project Name: Badger AAP	Local Grid Location of Well: ____ ft. ☐ N. ☐ S. ____ ft. ☐ E. ☐ W.	Well Name: PBN-1003C
Facility License, Permit or Monitoring No.: 2814	Local Grid Origin ☐ (estimated: ☐) or Well Location ☐ Lat. (NAD 83) ____ ° ____ ' ____ " Long. ____ ° ____ ' ____ " or	Wis. Unique Well No.: VM185 / DNR Well ID No.: 592
Facility ID: 157053930	St. Plane 487681.33 ft. N, 2034447.60 ft. E. (S)C/N	Date Well Installed: 06 / 03 / 2010 (m m d d y y y y)
Type of Well: Well Code 12 / PZ	Section Location of Waste/Source: ____ 1/4 of ____ 1/4 of Sec. ____, T. ____ N, R. ____ ☐ E. ☐ W.	Well Installed By: Name (first, last) and Firm: Roy Buckenberger; Layne Christensen Company
Distance from Waste/Source ____ ft. Enf. Stds. Apply ☑	Location of Well Relative to Waste/Source: u ☐ Upgradient s ☐ Sidegradient d ☑ Downgradient n ☐ Not Known; Gov. Lot Number ____	

A. Protective pipe, top elevation ____ ft. MSL

B. Well casing, top elevation 848.21 ft. MSL

C. Land surface elevation 846.51 ft. MSL

D. Surface seal, bottom ____ ft. MSL or 4 ft.

12. USCS classification of soil near screen:
GP ☐ GM ☐ GC ☐ GW ☐ SW ☐ SP ☑
SM ☐ SC ☐ ML ☐ MH ☐ CL ☐ CH ☐
Bedrock ☐

13. Sieve analysis performed? ☐ Yes ☑ No

14. Drilling method used: Rotary ☐ 50; Hollow Stem Auger ☐ 41; Other ☑ Rotosonic

15. Drilling fluid used: Water ☑ 02; Air ☐ 01; Drilling Mud ☐ 03; None ☐ 99

16. Drilling additives used? ☐ Yes ☑ No

Describe _____

17. Source of water (attach analysis, if required):

E. Bentonite seal, top ____ ft. MSL or 174.6 ft.

F. Fine sand, top ____ ft. MSL or 179.6 ft.

G. Filter pack, top ____ ft. MSL or 181.6 ft.

H. Screen joint, top ____ ft. MSL or 184.6 ft.

I. Well bottom ____ ft. MSL or 189.6 ft.

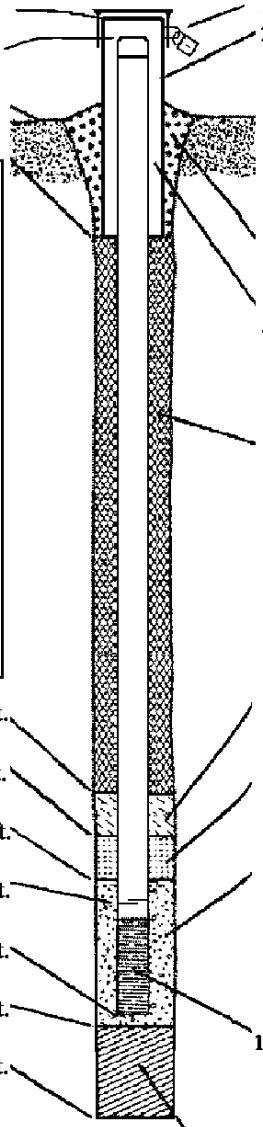
J. Filter pack, bottom ____ ft. MSL or 189.6 ft.

K. Borehole, bottom ____ ft. MSL or 189.6 ft.

L. Borehole, diameter 7.0 in.

M. O.D. well casing 2.9 in.

N. I.D. well casing 2.3 in.



1. Cap and lock? ☑ Yes ☐ No

2. Protective cover pipe:
a. Inside diameter: 6.0 in.
b. Length: 7.5 ft.
c. Material: Steel ☑ 04; Other ☐ ____
d. Additional protection? ☑ Yes ☐ No
If yes, describe: Steel Bumper Posts

3. Surface seal: Bentonite ☑ 30; Concrete ☐ 01; Other ☐ ____

4. Material between well casing and protective pipe: Bentonite ☑ 30; Other ☐ ____

5. Annular space seal: a. Granular/Chipped Bentonite ☐ 33
b. ____ Lbs/gal mud weight . . . Bentonite-sand slurry ☐ 35
c. 3.5 Lbs/gal mud weight . . . . . Bentonite slurry ☑ 31
d. ____ % Bentonite . . . . . Bentonite-cement grout ☐ 50
e. 250 gal Ft^3 volume added for any of the above
f. How installed: Tremie ☑ 01; Tremie pumped ☐ 02; Gravity ☐ 08

6. Bentonite seal: a. Bentonite granules ☐ 33
b. ☐ 1/4 in. ☑ 3/8 in. ☐ 1/2 in. Bentonite chips ☑ 32
c. ____ Other ☐ ____

7. Fine sand material: Manufacturer, product name & mesh size
a. Badger Mining, silica sand, 40-60
b. Volume added 1 bag ft^3

8. Filter pack material: Manufacturer, product name & mesh size
a. Red Flint #40
b. Volume added 4 bags ft^3

9. Well casing: Flush threaded PVC schedule 40 ☐ 23; Flush threaded PVC schedule 80 ☑ 24; Other ☐ ____

10. Screen material: same as above
a. Screen type: Factory cut ☑ 11; Continuous slot ☐ 01; Other ☐ ____
b. Manufacturer Campbell Monoflex
c. Slot size: 0.020 in.
d. Slotted length: 5 ft.

11. Backfill material (below filter pack): None ☑ 14; Other ☐ ____

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature Joel Janssen | Firm SpecPro, Inc.

Please complete both Forms 4400-113A and 4400-113B and return them to the appropriate DNR office and bureau. Completion of these reports is required by chs. 160, 281, 283, 289, 291, 292, 293, 295, and 299, Wis. Stats., and ch. NR 141, Wis. Adm. Code. In accordance with chs. 281, 289, 291, 292, 293, 295, and 299, Wis. Stats., failure to file these forms may result in a forfeiture of between $10 and $25,000, or imprisonment for up to one year, depending on the program and conduct involved. Personally identifiable information on these forms is not intended to be used for any other purpose. NOTE: See the instructions for more information, including where the completed forms should be sent.

State of Wisconsin
Department of Natural Resources

Route to: Watershed/Wastewater ☐ Waste Management ☐ Remediation/Redevelopment ☑ Other ☐ _____

MONITORING WELL CONSTRUCTION
Form 4400-113A Rev. 7-98

Facility/Project Name: Badger AAP	Local Grid Location of Well: ☐ N. ☐ S. _____ ft. ☐ E. ☐ W. _____ ft.	Well Name: PBN-1002C
Facility License, Permit or Monitoring No.: 2814	Local Grid Origin ☐ (estimated: ☐) or Well Location ☐ Lat. (NAD 83) ___ ° ___ ' ___ " Long. ___ ° ___ ' ___ " or	Wis. Unique Well No.: VM184 / DNR Well ID No.: 591
Facility ID: 157053930	St. Plane 488449.71 ft. N, 2035908.47 ft. E. (S)C/N	Date Well Installed: 06 / 09 / 2010 (m m d d y y y y)
Type of Well: Well Code 12 / PZ	Section Location of Waste/Source: ___ 1/4 of ___ 1/4 of Sec. ___, T. ___ N, R. ___ ☐ E. ☐ W.	Well Installed By: Name (first, last) and Firm: Roy Buckenberger; Layne Christensen Company
Distance from Waste/Source ___ ft. / Enf. Stds. Apply ☑	Location of Well Relative to Waste/Source: u ☐ Upgradient s ☐ Sidegradient d ☑ Downgradient n ☐ Not Known	Gov. Lot Number:

A. Protective pipe, top elevation _____ ft. MSL

B. Well casing, top elevation 893.48 ft. MSL

C. Land surface elevation 891.48 ft. MSL

D. Surface seal, bottom _____ ft. MSL or 4 ft.

12. USCS classification of soil near screen:
GP ☐ GM ☐ GC ☐ GW ☐ SW ☐ SP ☑
SM ☐ SC ☐ ML ☐ MH ☐ CL ☐ CH ☐
Bedrock ☐

13. Sieve analysis performed? ☐ Yes ☑ No

14. Drilling method used: Rotary ☐ 50; Hollow Stem Auger ☐ 41; Other ☑ Rotosonic

15. Drilling fluid used: Water ☑ 02; Air ☐ 01; Drilling Mud ☐ 03; None ☐ 99

16. Drilling additives used? ☐ Yes ☑ No

Describe _____

17. Source of water (attach analysis, if required):

E. Bentonite seal, top _____ ft. MSL or 201.8 ft.

F. Fine sand, top _____ ft. MSL or 206.8 ft.

G. Filter pack, top _____ ft. MSL or 208.8 ft.

H. Screen joint, top _____ ft. MSL or 211.8 ft.

I. Well bottom _____ ft. MSL or 216.8 ft.

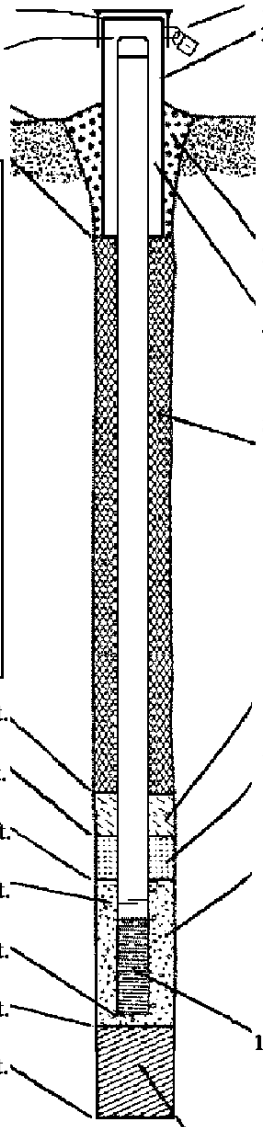
J. Filter pack, bottom _____ ft. MSL or 216.8 ft.

K. Borehole, bottom _____ ft. MSL or 216.8 ft.

L. Borehole, diameter 7.0 in.

M. O.D. well casing 2.9 in.

N. I.D. well casing 2.3 in.



1. Cap and lock? ☑ Yes ☐ No

2. Protective cover pipe:
a. Inside diameter: 6.0 in.
b. Length: 7.5 ft.
c. Material: Steel ☑ 04; Other ☐
d. Additional protection? ☑ Yes ☐ No
If yes, describe: Steel Bumper Posts

3. Surface seal: Bentonite ☑ 30; Concrete ☐ 01; Other ☐

4. Material between well casing and protective pipe: Bentonite ☑ 30; Other ☐

5. Annular space seal: a. Granular/Chipped Bentonite ☐ 33
b. ___ Lbs/gal mud weight . . . Bentonite-sand slurry ☐ 35
c. 3.5 Lbs/gal mud weight . . . . . Bentonite slurry ☑ 31
d. ___ % Bentonite . . . . . Bentonite-cement grout ☐ 50
e. 300 gal Ft^3 volume added for any of the above
f. How installed: Tremie ☑ 01; Tremie pumped ☐ 02; Gravity ☐ 08

6. Bentonite seal: a. Bentonite granules ☐ 33
b. ☐1/4 in. ☑3/8 in. ☐1/2 in. Bentonite chips ☑ 32
c. _____ Other ☐

7. Fine sand material: Manufacturer, product name & mesh size
a. Badger Mining, silica sand, 40-60
b. Volume added 1 bag ft^3

8. Filter pack material: Manufacturer, product name & mesh size
a. Red Flint #40
b. Volume added 4 bags ft^3

9. Well casing: Flush threaded PVC schedule 40 ☐ 23; Flush threaded PVC schedule 80 ☑ 24; Other ☐

10. Screen material: same as above
a. Screen type: Factory cut ☑ 11; Continuous slot ☐ 01; Other ☐
b. Manufacturer Campbell Monoflex
c. Slot size: 0.020 in.
d. Slotted length: 5 ft.

11. Backfill material (below filter pack): None ☑ 14; Other ☐

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature Joel Janssen | Firm SpecPro, Inc.

Please complete both Forms 4400-113A and 4400-113B and return them to the appropriate DNR office and bureau. Completion of these reports is required by chs. 160, 281, 283, 289, 291, 292, 293, 295, and 299, Wis. Stats., and ch. NR 141, Wis. Adm. Code. In accordance with chs. 281, 289, 291, 292, 293, 295, and 299, Wis. Stats., failure to file these forms may result in a forfeiture of between $10 and $25,000, or imprisonment for up to one year, depending on the program and conduct involved. Personally identifiable information on these forms is not intended to be used for any other purpose. NOTE: See the instructions for more information, including where the completed forms should be sent.

State of Wisconsin
Department of Natural Resources

Route to: Watershed/Wastewater ☐ Waste Management ☐ Remediation/Redevelopment ☑ Other ☐ _____

MONITORING WELL CONSTRUCTION
Form 4400-113A Rev. 7-98

Facility/Project Name: Badger AAP	Local Grid Location of Well: ____ ft. ☐ N. ☐ S. ____ ft. ☐ E. ☐ W.	Well Name: PBN-1002B
Facility License, Permit or Monitoring No.: 2814	Local Grid Origin ☐ (estimated: ☐) or Well Location ☐ Lat. (NAD 83) ____ ° ____ ' ____ " Long. ____ ° ____ ' ____ " or	Wis. Unique Well No.: VM183 / DNR Well ID No.: 590
Facility ID: 157053930	St. Plane 488447.03 ft. N, 2035926.71 ft. E. (S)C/N	Date Well Installed: 05 / 19 / 2010 (m m d d y y y y)
Type of Well: Well Code 12 / PZ	Section Location of Waste/Source: ____ 1/4 of ____ 1/4 of Sec. ____, T. ____ N, R. ____ ☐ E. ☐ W.	Well Installed By: Name (first, last) and Firm: Roy Buckenberger; Layne Christensen Company
Distance from Waste/Source ____ ft. / Enf. Stds. Apply ☑	Location of Well Relative to Waste/Source: u ☐ Upgradient s ☐ Sidegradient d ☑ Downgradient n ☐ Not Known; Gov. Lot Number ____	

A. Protective pipe, top elevation ____ ft. MSL

B. Well casing, top elevation 894.27 ft. MSL

C. Land surface elevation 892.27 ft. MSL

D. Surface seal, bottom ____ ft. MSL or 4 ft.

12. USCS classification of soil near screen:
GP ☐ GM ☐ GC ☐ GW ☐ SW ☐ SP ☑
SM ☐ SC ☐ ML ☐ MH ☐ CL ☐ CH ☐
Bedrock ☐

13. Sieve analysis performed? ☐ Yes ☑ No

14. Drilling method used: Rotary ☐ 50; Hollow Stem Auger ☐ 41; Other ☑ Rotosonic

15. Drilling fluid used: Water ☑ 02; Air ☐ 01; Drilling Mud ☐ 03; None ☐ 99

16. Drilling additives used? ☐ Yes ☑ No

Describe _____

17. Source of water (attach analysis, if required):

E. Bentonite seal, top ____ ft. MSL or 161.5 ft.

F. Fine sand, top ____ ft. MSL or 166.5 ft.

G. Filter pack, top ____ ft. MSL or 168.5 ft.

H. Screen joint, top ____ ft. MSL or 171.5 ft.

I. Well bottom ____ ft. MSL or 176.5 ft.

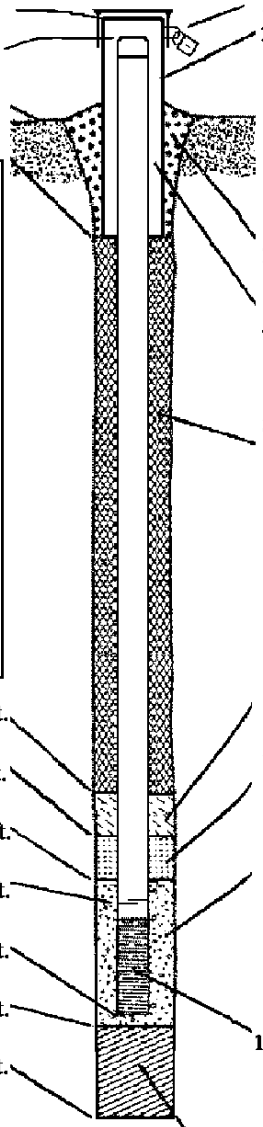
J. Filter pack, bottom ____ ft. MSL or 176.5 ft.

K. Borehole, bottom ____ ft. MSL or 176.5 ft.

L. Borehole, diameter 7.0 in.

M. O.D. well casing 2.9 in.

N. I.D. well casing 2.3 in.



1. Cap and lock? ☑ Yes ☐ No

2. Protective cover pipe:
a. Inside diameter: 6.0 in.
b. Length: 7.5 ft.
c. Material: Steel ☑ 04; Other ☐ ____
d. Additional protection? ☑ Yes ☐ No
If yes, describe: Steel Bumper Posts

3. Surface seal: Bentonite ☑ 30; Concrete ☐ 01; Other ☐ ____

4. Material between well casing and protective pipe: Bentonite ☑ 30; Other ☐ ____

5. Annular space seal: a. Granular/Chipped Bentonite ☐ 33
b. ____ Lbs/gal mud weight . . . Bentonite-sand slurry ☐ 35
c. 3.5 Lbs/gal mud weight . . . . . Bentonite slurry ☑ 31
d. ____ % Bentonite . . . . . Bentonite-cement grout ☐ 50
e. 225 gal Ft^3 volume added for any of the above
f. How installed: Tremie ☑ 01; Tremie pumped ☐ 02; Gravity ☐ 08

6. Bentonite seal: a. Bentonite granules ☐ 33
b. ☐ 1/4 in. ☑ 3/8 in. ☐ 1/2 in. Bentonite chips ☑ 32
c. ____ Other ☐ ____

7. Fine sand material: Manufacturer, product name & mesh size
a. Badger Mining, silica sand, 40-60
b. Volume added 1 bag ft^3

8. Filter pack material: Manufacturer, product name & mesh size
a. Red Flint #40
b. Volume added 4 bags ft^3

9. Well casing: Flush threaded PVC schedule 40 ☐ 23; Flush threaded PVC schedule 80 ☑ 24; Other ☐ ____

10. Screen material: same as above
a. Screen type: Factory cut ☑ 11; Continuous slot ☐ 01; Other ☐ ____
b. Manufacturer Campbell Monoflex
c. Slot size: 0.020 in.
d. Slotted length: 5 ft.

11. Backfill material (below filter pack): None ☑ 14; Other ☐ ____

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature Joel Janssen | Firm SpecPro, Inc.

Please complete both Forms 4400-113A and 4400-113B and return them to the appropriate DNR office and bureau. Completion of these reports is required by chs. 160, 281, 283, 289, 291, 292, 293, 295, and 299, Wis. Stats., and ch. NR 141, Wis. Adm. Code. In accordance with chs. 281, 289, 291, 292, 293, 295, and 299, Wis. Stats., failure to file these forms may result in a forfeiture of between $10 and $25,000, or imprisonment for up to one year, depending on the program and conduct involved. Personally identifiable information on these forms is not intended to be used for any other purpose. NOTE: See the instructions for more information, including where the completed forms should be sent.

WDNR Well Development Forms

State of Wisconsin
Department of Natural Resources

MONITORING WELL DEVELOPMENT

Form 4400-113B Rev. 7-98

Route to: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☑ Other ☐ _____

Facility/Project Name	County Name	Well Name
Badger AAP	Sauk	DBM-1001

Facility License, Permit or Monitoring Number	County Code	Wis. Unique Well Number	DNR Well ID Number
3037	57	VM 161	471

1. Can this well be purged dry? ☐ Yes ☑ No

2. Well development method
   - surged with bailer and bailed ☐ 41
   - surged with bailer and pumped ☑ 61
   - surged with block and bailed ☐ 42
   - surged with block and pumped ☐ 62
   - surged with block, bailed and pumped ☐ 70
   - compressed air ☐ 20
   - bailed only ☐ 10
   - pumped only ☐ 51
   - pumped slowly ☐ 50
   - Other _____ ☐

3. Time spent developing well 60 min.

4. Depth of well (from top of well casisng) 127.6 ft.

5. Inside diameter of well 2.30 in.

6. Volume of water in filter pack and well casing 20.0 gal.

7. Volume of water removed from well 150.0 gal.

8. Volume of water added (if any) 0.0 gal.

9. Source of water added None

10. Analysis performed on water added? ☐ Yes ☑ No
(If yes, attach results)

	Before Development	After Development
11. Depth to Water (from top of well casing)	a. 122.6 ft.	122.6 ft.
Date	b. 05/11/2010 (m m / d d / y y y y)	05/11/2010 (m m / d d / y y y y)
Time	c. : ☐ a.m. ☐ p.m.	: ☐ a.m. ☐ p.m.
12. Sediment in well bottom	inches	inches
13. Water clarity	Clear ☐ 10 / Turbid ☑ 15 (Describe) light brown	Clear ☑ 20 / Turbid ☐ 25 (Describe)

Fill in if drilling fluids were used and well is at solid waste facility:

14. Total suspended solids	mg/l	mg/l
15. COD	mg/l	mg/l

16. Well developed by: Name (first, last) and Firm
First Name: Roy Last Name: Buckenberger
Firm: Layne Christensen Company

17. Additional comments on development:

Name and Address of Facility Contact /Owner/Responsible Party
First Name: Joan Last Name: Kenney
Facility/Firm: Department of the Army
Street: 2 Badger Road
City/State/Zip: Baraboo, Wisconsin 53913-5000

I hereby certify that the above information is true and correct to the best of my knowledge.
Signature: Joel Janssen
Print Name: Joel Janssen
Firm: SpecPro, Inc.

NOTE: See instructions for more information including a list of county codes and well type codes.

State of Wisconsin
Department of Natural Resources

MONITORING WELL DEVELOPMENT

Form 4400-113B Rev. 7-98

Route to: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☑ Other ☐ _____

Facility/Project Name	County Name	Well Name
Badger AAP	Sauk	DBN-1001B

Facility License, Permit or Monitoring Number	County Code	Wis. Unique Well Number	DNR Well ID Number
3037	57	VM162	472

1. Can this well be purged dry? ☐ Yes ☑ No

2. Well development method
   - surged with bailer and bailed ☐ 41
   - surged with bailer and pumped ☑ 61
   - surged with block and bailed ☐ 42
   - surged with block and pumped ☐ 62
   - surged with block, bailed and pumped ☐ 70
   - compressed air ☐ 20
   - bailed only ☐ 10
   - pumped only ☐ 51
   - pumped slowly ☐ 50
   - Other _____ ☐

3. Time spent developing well 60 min.

4. Depth of well (from top of well casisng) 161.8 ft.

5. Inside diameter of well 2.30 in.

6. Volume of water in filter pack and well casing 200.0 gal.

7. Volume of water removed from well 150.0 gal.

8. Volume of water added (if any) 0.0 gal.

9. Source of water added None

10. Analysis performed on water added? ☐ Yes ☑ No
(If yes, attach results)

	Before Development	After Development
11. Depth to Water (from top of well casing)	a. 127.27 ft.	127.27 ft.
Date	b. 05/26/2010 (m m / d d / y y y y)	05/26/2010 (m m / d d / y y y y)
Time	c. : ☐ a.m. ☐ p.m.	: ☐ a.m. ☐ p.m.
12. Sediment in well bottom	inches	inches
13. Water clarity	Clear ☐ 10 Turbid ☑ 15 (Describe)	Clear ☑ 20 Turbid ☐ 25 (Describe)
14. Total suspended solids	mg/l	mg/l
15. COD	mg/l	mg/l

Fill in if drilling fluids were used and well is at solid waste facility:

16. Well developed by: Name (first, last) and Firm
First Name: Roy Last Name: Buckenberger
Firm: Layne Christensen Company

17. Additional comments on development:

Name and Address of Facility Contact/Owner/Responsible Party
First Name: Joan Last Name: Kenney
Facility/Firm: Department of the Army
Street: 2 Badger Road
City/State/Zip: Baraboo, Wisconsin 53913-5000

I hereby certify that the above information is true and correct to the best of my knowledge.
Signature: Joel Janssen
Print Name: Joel Janssen
Firm: SpecPro, Inc.

NOTE: See instructions for more information including a list of county codes and well type codes.

State of Wisconsin
Department of Natural Resources

MONITORING WELL DEVELOPMENT

Form 4400-113B Rev. 7-98

Route to: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☑ Other ☐ _____

Facility/Project Name	County Name	Well Name
Badger AAP	Sauk	DBN-1001C

Facility License, Permit or Monitoring Number	County Code	Wis. Unique Well Number	DNR Well ID Number
3037	57	VM163	473

1. Can this well be purged dry? ☐ Yes ☑ No

2. Well development method
   - surged with bailer and bailed ☐ 41
   - surged with bailer and pumped ☑ 61
   - surged with block and bailed ☐ 42
   - surged with block and pumped ☐ 62
   - surged with block, bailed and pumped ☐ 70
   - compressed air ☐ 20
   - bailed only ☐ 10
   - pumped only ☐ 51
   - pumped slowly ☐ 50
   - Other _____ ☐

3. Time spent developing well 60 min.

4. Depth of well (from top of well casisng) 199.0 ft.

5. Inside diameter of well 2.30 in.

6. Volume of water in filter pack and well casing 200.0 gal.

7. Volume of water removed from well 150.0 gal.

8. Volume of water added (if any) 0.0 gal.

9. Source of water added None

10. Analysis performed on water added? ☐ Yes ☑ No
(If yes, attach results)

	Before Development	After Development
11. Depth to Water (from top of well casing)	a. 129.90 ft.	129.90 ft.
Date	b. 06/01/2010 (mm/dd/yyyy)	06/01/2010 (mm/dd/yyyy)
Time	c. ___:___ ☐ a.m. ☐ p.m.	___:___ ☐ a.m. ☐ p.m.
12. Sediment in well bottom	___.___ inches	___.___ inches
13. Water clarity	Clear ☐ 10 Turbid ☑ 15 (Describe)	Clear ☑ 20 Turbid ☐ 25 (Describe)
14. Total suspended solids	____.___ mg/l	____.___ mg/l
15. COD	____.___ mg/l	____.___ mg/l

Fill in if drilling fluids were used and well is at solid waste facility:

16. Well developed by: Name (first, last) and Firm
First Name: Roy Last Name: Buckenberger
Firm: Layne Christensen Company

17. Additional comments on development:

Name and Address of Facility Contact /Owner/Responsible Party
First Name: Joan Last Name: Kenney
Facility/Firm: Department of the Army
Street: 2 Badger Road
City/State/Zip: Baraboo, Wisconsin 53913-5000

I hereby certify that the above information is true and correct to the best of my knowledge.
Signature: Joel Janssen
Print Name: Joel Janssen
Firm: SpecPro, Inc.

NOTE: See instructions for more information including a list of county codes and well type codes.

State of Wisconsin
Department of Natural Resources

MONITORING WELL DEVELOPMENT

Form 4400-113B Rev. 7-98

Route to: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☑ Other ☐ _____

Facility/Project Name	County Name	Well Name
Badger AAP	Sauk	DBN-1001E

Facility License, Permit or Monitoring Number	County Code	Wis. Unique Well Number	DNR Well ID Number
3037	57	VM164	474

1. Can this well be purged dry? ☐ Yes ☑ No

2. Well development method
   - surged with bailer and bailed ☐ 41
   - surged with bailer and pumped ☑ 61
   - surged with block and bailed ☐ 42
   - surged with block and pumped ☐ 62
   - surged with block, bailed and pumped ☐ 70
   - compressed air ☐ 20
   - bailed only ☐ 10
   - pumped only ☐ 51
   - pumped slowly ☐ 50
   - Other _____ ☐

3. Time spent developing well 60 min.

4. Depth of well (from top of well casisng) 282.3 ft.

5. Inside diameter of well 2.30 in.

6. Volume of water in filter pack and well casing 200.0 gal.

7. Volume of water removed from well 150.0 gal.

8. Volume of water added (if any) 0.0 gal.

9. Source of water added None

10. Analysis performed on water added? ☐ Yes ☑ No
(If yes, attach results)

	Before Development	After Development
11. Depth to Water (from top of well casing)	a. 130.10 ft.	130.10 ft.
Date	b. 07/01/2010 (mm/dd/yyyy)	07/01/2010 (mm/dd/yyyy)
Time	c. ☐ a.m. ☐ p.m.	☐ a.m. ☐ p.m.
12. Sediment in well bottom	inches	inches
13. Water clarity	Clear ☐ 10 Turbid ☑ 15 (Describe)	Clear ☑ 20 Turbid ☐ 25 (Describe)

Fill in if drilling fluids were used and well is at solid waste facility:

14. Total suspended solids	mg/l	mg/l
15. COD	mg/l	mg/l

16. Well developed by: Name (first, last) and Firm
First Name: Vince Last Name: Meindel
Firm: Layne Christensen Company

17. Additional comments on development:

Name and Address of Facility Contact/Owner/Responsible Party
First Name: Joan Last Name: Kenney
Facility/Firm: Department of the Army
Street: 2 Badger Road
City/State/Zip: Baraboo, Wisconsin 53913-5000

I hereby certify that the above information is true and correct to the best of my knowledge.
Signature: Joel Janssen
Print Name: Joel Janssen
Firm: SpecPro, Inc.

NOTE: See instructions for more information including a list of county codes and well type codes.

State of Wisconsin
Department of Natural Resources

MONITORING WELL DEVELOPMENT

Form 4400-113B Rev. 7-98

Route to: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☑ Other ☐ _____

Facility/Project Name	County Name	Well Name
Badger AAP	Sauk	DBN-1002C

Facility License, Permit or Monitoring Number	County Code	Wis. Unique Well Number	DNR Well ID Number
3037	57	VM165	476

1. Can this well be purged dry? ☐ Yes ☑ No

2. Well development method
   - surged with bailer and bailed ☐ 41
   - surged with bailer and pumped ☑ 61
   - surged with block and bailed ☐ 42
   - surged with block and pumped ☐ 62
   - surged with block, bailed and pumped ☐ 70
   - compressed air ☐ 20
   - bailed only ☐ 10
   - pumped only ☐ 51
   - pumped slowly ☐ 50
   - Other _____ ☐

3. Time spent developing well 60 min.

4. Depth of well (from top of well casisng) 212.5 ft.

5. Inside diameter of well 2.30 in.

6. Volume of water in filter pack and well casing 200.0 gal.

7. Volume of water removed from well 150.0 gal.

8. Volume of water added (if any) 0.0 gal.

9. Source of water added None

10. Analysis performed on water added? ☐ Yes ☑ No
(If yes, attach results)

	Before Development	After Development
11. Depth to Water (from top of well casing)	a. 134.74 ft.	134.74 ft.
Date	b. 06/21/2010 (m m / d d / y y y y)	06/21/2010 (m m / d d / y y y y)
Time	c. : ☐ a.m. ☐ p.m.	: ☐ a.m. ☐ p.m.
12. Sediment in well bottom	inches	inches
13. Water clarity	Clear ☐ 10 Turbid ☑ 15 (Describe)	Clear ☑ 20 Turbid ☐ 25 (Describe)
14. Total suspended solids	mg/l	mg/l
15. COD	mg/l	mg/l

Fill in if drilling fluids were used and well is at solid waste facility:

16. Well developed by: Name (first, last) and Firm
First Name: Roy Last Name: Buckenberger
Firm: Layne Christensen Company

17. Additional comments on development:

Name and Address of Facility Contact/Owner/Responsible Party
First Name: Joan Last Name: Kenney
Facility/Firm: Department of the Army
Street: 2 Badger Road
City/State/Zip: Baraboo, Wisconsin 53913-5000

I hereby certify that the above information is true and correct to the best of my knowledge.
Signature: Joel Janssen
Print Name: Joel Janssen
Firm: SpecPro, Inc.

NOTE: See instructions for more information including a list of county codes and well type codes.

State of Wisconsin
Department of Natural Resources

MONITORING WELL DEVELOPMENT

Form 4400-113B Rev. 7-98

Route to: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☑ Other ☐ _____

Facility/Project Name	County Name	Well Name
Badger AAP	Sauk	DBN-1002E

Facility License, Permit or Monitoring Number	County Code	Wis. Unique Well Number	DNR Well ID Number
3037	57	VM166	477

1. Can this well be purged dry? ☐ Yes ☑ No

2. Well development method
   - surged with bailer and bailed ☐ 41
   - surged with bailer and pumped ☑ 61
   - surged with block and bailed ☐ 42
   - surged with block and pumped ☐ 62
   - surged with block, bailed and pumped ☐ 70
   - compressed air ☐ 20
   - bailed only ☐ 10
   - pumped only ☐ 51
   - pumped slowly ☐ 50
   - Other _____ ☐

3. Time spent developing well 60 min.

4. Depth of well (from top of well casisng) 282.95 ft.

5. Inside diameter of well 2.30 in.

6. Volume of water in filter pack and well casing 200.0 gal.

7. Volume of water removed from well 150.0 gal.

8. Volume of water added (if any) 0.0 gal.

9. Source of water added None

10. Analysis performed on water added? ☐ Yes ☑ No
(If yes, attach results)

	Before Development	After Development
11. Depth to Water (from top of well casing)	a. 135.12 ft.	135.12 ft.
Date	b. 07/13/2010 (mm/dd/yyyy)	07/13/2010 (mm/dd/yyyy)
Time	c. : ☐ a.m. ☐ p.m.	: ☐ a.m. ☐ p.m.
12. Sediment in well bottom	. inches	. inches
13. Water clarity	Clear ☐ 10 Turbid ☑ 15 (Describe)	Clear ☑ 20 Turbid ☐ 25 (Describe)

Fill in if drilling fluids were used and well is at solid waste facility:

14. Total suspended solids	. mg/l	. mg/l
15. COD	. mg/l	. mg/l

16. Well developed by: Name (first, last) and Firm
First Name: Vince Last Name: Meindel
Firm: Layne Christensen Company

17. Additional comments on development:

Name and Address of Facility Contact/Owner/Responsible Party
First Name: Joan Last Name: Kenney
Facility/Firm: Department of the Army
Street: 2 Badger Road
City/State/Zip: Baraboo, Wisconsin 53913-5000

I hereby certify that the above information is true and correct to the best of my knowledge.
Signature: Joel Janssen
Print Name: Joel Janssen
Firm: SpecPro, Inc.

NOTE: See instructions for more information including a list of county codes and well type codes.

State of Wisconsin
Department of Natural Resources

MONITORING WELL DEVELOPMENT

Form 4400-113B Rev. 7-98

Route to: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☑ Other ☐ _____

Facility/Project Name	County Name	Well Name
Badger AAP	Sauk	PBN-1001A

Facility License, Permit or Monitoring Number	County Code	Wis. Unique Well Number	DNR Well ID Number
2814	57	VM186	593

1. Can this well be purged dry? ☐ Yes ☑ No

2. Well development method
   - surged with bailer and bailed ☐ 41
   - surged with bailer and pumped ☑ 61
   - surged with block and bailed ☐ 42
   - surged with block and pumped ☐ 62
   - surged with block, bailed and pumped ☐ 70
   - compressed air ☐ 20
   - bailed only ☐ 10
   - pumped only ☐ 51
   - pumped slowly ☐ 50
   - Other _____ ☐

3. Time spent developing well 60 min.

4. Depth of well (from top of well casisng) 815 ft.

5. Inside diameter of well 2.30 in.

6. Volume of water in filter pack and well casing 200.0 gal.

7. Volume of water removed from well 150.0 gal.

8. Volume of water added (if any) 0.0 gal.

9. Source of water added None

10. Analysis performed on water added? ☐ Yes ☑ No
(If yes, attach results)

	Before Development	After Development
11. Depth to Water (from top of well casing)	a. 74.35 ft.	74.35 ft.
Date	b. 05/04/2010 (m m d d y y y y)	05/04/2010 (m m d d y y y y)
Time	c. : ☐ a.m. ☐ p.m.	: ☐ a.m. ☐ p.m.
12. Sediment in well bottom	inches	inches
13. Water clarity	Clear ☐ 10 Turbid ☑ 15 (Describe)	Clear ☑ 20 Turbid ☐ 25 (Describe)
Fill in if drilling fluids were used and well is at solid waste facility:		
14. Total suspended solids	mg/l	mg/l
15. COD	mg/l	mg/l

16. Well developed by: Name (first, last) and Firm
First Name: Roy Last Name: Buckenberger
Firm: Layne Christensen Company

17. Additional comments on development:

Name and Address of Facility Contact /Owner/Responsible Party
First Name: Joan Last Name: Kenney
Facility/Firm: Department of the Army
Street: 2 Badger Road
City/State/Zip: Baraboo, Wisconsin 53913-5000

I hereby certify that the above information is true and correct to the best of my knowledge.
Signature: Joel Janssen
Print Name: Joel Janssen
Firm: SpecPro, Inc.

NOTE: See instructions for more information including a list of county codes and well type codes.

State of Wisconsin
Department of Natural Resources

MONITORING WELL DEVELOPMENT

Form 4400-113B Rev. 7-98

Route to: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☑ Other ☐ _____

Facility/Project Name	County Name	Well Name
Badger AAP	Sauk	PBN-1001B

Facility License, Permit or Monitoring Number	County Code	Wis. Unique Well Number	DNR Well ID Number
2814	57	VM187	594

1. Can this well be purged dry? ☐ Yes ☑ No

2. Well development method
   - surged with bailer and bailed ☐ 41
   - surged with bailer and pumped ☑ 61
   - surged with block and bailed ☐ 42
   - surged with block and pumped ☐ 62
   - surged with block, bailed and pumped ☐ 70
   - compressed air ☐ 20
   - bailed only ☐ 10
   - pumped only ☐ 51
   - pumped slowly ☐ 50
   - Other _____ ☐

3. Time spent developing well 60 min.

4. Depth of well (from top of well casisng) 141.6 ft.

5. Inside diameter of well 2.30 in.

6. Volume of water in filter pack and well casing 200.0 gal.

7. Volume of water removed from well 150.0 gal.

8. Volume of water added (if any) 0.0 gal.

9. Source of water added None

10. Analysis performed on water added? ☐ Yes ☑ No
(If yes, attach results)

	Before Development	After Development
11. Depth to Water (from top of well casing)	a. 74.20 ft.	74.20 ft.
Date	b. 06/03/2010 (m m / d d / y y y y)	06/03/2010 (m m / d d / y y y y)
Time	c. ___:___ ☐ a.m. ☐ p.m.	___:___ ☐ a.m. ☐ p.m.
12. Sediment in well bottom	___.___ inches	___.___ inches
13. Water clarity	Clear ☐ 10 Turbid ☑ 15 (Describe)	Clear ☑ 20 Turbid ☐ 25 (Describe)

Fill in if drilling fluids were used and well is at solid waste facility:

14. Total suspended solids	____.___ mg/l	____.___ mg/l
15. COD	____.___ mg/l	____.___ mg/l

16. Well developed by: Name (first, last) and Firm
First Name: Roy Last Name: Buckenberger
Firm: Layne Christensen Company

17. Additional comments on development:

Name and Address of Facility Contact /Owner/Responsible Party
First Name: Joan Last Name: Kenney
Facility/Firm: Department of the Army
Street: 2 Badger Road
City/State/Zip: Baraboo, Wisconsin 53913-5000

I hereby certify that the above information is true and correct to the best of my knowledge.
Signature: Joel Janssen
Print Name: Joel Janssen
Firm: SpecPro, Inc.

NOTE: See instructions for more information including a list of county codes and well type codes.

State of Wisconsin
Department of Natural Resources

MONITORING WELL DEVELOPMENT

Form 4400-113B Rev. 7-98

Route to: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☑ Other ☐ _____

Facility/Project Name	County Name	Well Name
Badger AAP	Sauk	PBN-1001C

Facility License, Permit or Monitoring Number	County Code	Wis. Unique Well Number	DNR Well ID Number
2814	57	VM188	595

1. Can this well be purged dry? ☐ Yes ☑ No

2. Well development method
   - surged with bailer and bailed ☐ 41
   - surged with bailer and pumped ☑ 61
   - surged with block and bailed ☐ 42
   - surged with block and pumped ☐ 62
   - surged with block, bailed and pumped ☐ 70
   - compressed air ☐ 20
   - bailed only ☐ 10
   - pumped only ☐ 51
   - pumped slowly ☐ 50
   - Other _____ ☐

3. Time spent developing well 60 min.

4. Depth of well (from top of well casisng) 202.0 ft.

5. Inside diameter of well 2.30 in.

6. Volume of water in filter pack and well casing 200.0 gal.

7. Volume of water removed from well 150.0 gal.

8. Volume of water added (if any) 0.0 gal.

9. Source of water added None

10. Analysis performed on water added? ☐ Yes ☑ No
(If yes, attach results)

	Before Development	After Development
11. Depth to Water (from top of well casing)	a. 74.60 ft.	74.60 ft.
Date	b. 06/09/2010 (m m d d y y y y)	06/09/2010 (m m d d y y y y)
Time	c. : ☐ a.m. ☐ p.m.	: ☐ a.m. ☐ p.m.
12. Sediment in well bottom	. inches	. inches
13. Water clarity	Clear ☐ 10 Turbid ☑ 15 (Describe)	Clear ☑ 20 Turbid ☐ 25 (Describe)

Fill in if drilling fluids were used and well is at solid waste facility:

14. Total suspended solids	. mg/l	. mg/l
15. COD	. mg/l	. mg/l

16. Well developed by: Name (first, last) and Firm
First Name: Roy Last Name: Buckenberger
Firm: Layne Christensen Company

17. Additional comments on development:

Name and Address of Facility Contact /Owner/Responsible Party
First Name: Joan Last Name: Kenney
Facility/Firm: Department of the Army
Street: 2 Badger Road
City/State/Zip: Baraboo, Wisconsin 53913-5000

I hereby certify that the above information is true and correct to the best of my knowledge.
Signature: Joel Janssen
Print Name: Joel Janssen
Firm: SpecPro, Inc.

NOTE: See instructions for more information including a list of county codes and well type codes.

State of Wisconsin
Department of Natural Resources

MONITORING WELL DEVELOPMENT

Form 4400-113B Rev. 7-98

Route to: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☑ Other ☐ _____

Facility/Project Name	County Name	Well Name
Badger AAP	Sauk	PBN-1002A

Facility License, Permit or Monitoring Number	County Code	Wis. Unique Well Number	DNR Well ID Number
2814	57	VM189	589

1. Can this well be purged dry? ☐ Yes ☑ No

2. Well development method
   - surged with bailer and bailed ☐ 41
   - surged with bailer and pumped ☑ 61
   - surged with block and bailed ☐ 42
   - surged with block and pumped ☐ 62
   - surged with block, bailed and pumped ☐ 70
   - compressed air ☐ 20
   - bailed only ☐ 10
   - pumped only ☐ 51
   - pumped slowly ☐ 50
   - Other _____ ☐

3. Time spent developing well 60 min.

4. Depth of well (from top of well casisng) 1330 ft.

5. Inside diameter of well 2.30 in.

6. Volume of water in filter pack and well casing 200.0 gal.

7. Volume of water removed from well 150.0 gal.

8. Volume of water added (if any) 0.0 gal.

9. Source of water added None

10. Analysis performed on water added? ☐ Yes ☑ No
(If yes, attach results)

	Before Development	After Development
11. Depth to Water (from top of well casing)	a. 124.32 ft.	124.32 ft.
Date	b. 05/24/2010 (m m / d d / y y y y)	05/24/2010 (m m / d d / y y y y)
Time	c. : ☐ a.m. ☐ p.m.	: ☐ a.m. ☐ p.m.
12. Sediment in well bottom	inches	inches
13. Water clarity	Clear ☐ 10 Turbid ☑ 15 (Describe)	Clear ☑ 20 Turbid ☐ 25 (Describe)

Fill in if drilling fluids were used and well is at solid waste facility:

14. Total suspended solids	mg/l	mg/l
15. COD	mg/l	mg/l

16. Well developed by: Name (first, last) and Firm
First Name: Roy Last Name: Buckenberger
Firm: Layne Christensen Company

17. Additional comments on development:

Name and Address of Facility Contact /Owner/Responsible Party
First Name: Joan Last Name: Kenney
Facility/Firm: Department of the Army
Street: 2 Badger Road
City/State/Zip: Baraboo, Wisconsin 53913-5000

I hereby certify that the above information is true and correct to the best of my knowledge.
Signature: Joel Janssen
Print Name: Joel Janssen
Firm: SpecPro, Inc.

NOTE: See instructions for more information including a list of county codes and well type codes.

State of Wisconsin
Department of Natural Resources

MONITORING WELL DEVELOPMENT

Form 4400-113B Rev. 7-98

Route to: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☑ Other ☐ _____

Facility/Project Name	County Name	Well Name
Badger AAP	Sauk	PBN-1002B

Facility License, Permit or Monitoring Number	County Code	Wis. Unique Well Number	DNR Well ID Number
2814	57	VM183	590

1. Can this well be purged dry? ☐ Yes ☑ No

2. Well development method
   - surged with bailer and bailed ☐ 41
   - surged with bailer and pumped ☑ 61
   - surged with block and bailed ☐ 42
   - surged with block and pumped ☐ 62
   - surged with block, bailed and pumped ☐ 70
   - compressed air ☐ 20
   - bailed only ☐ 10
   - pumped only ☐ 51
   - pumped slowly ☐ 50
   - Other _____ ☐

3. Time spent developing well 60 min.

4. Depth of well (from top of well casisng) 178.5 ft.

5. Inside diameter of well 2.30 in.

6. Volume of water in filter pack and well casing 200.0 gal.

7. Volume of water removed from well 150.0 gal.

8. Volume of water added (if any) 0.0 gal.

9. Source of water added None

10. Analysis performed on water added? ☐ Yes ☑ No
(If yes, attach results)

	Before Development	After Development
11. Depth to Water (from top of well casing)	a. 124.48 ft.	124.48 ft.
Date	b. 05/20/2010 (m m / d d / y y y y)	05/20/2010 (m m / d d / y y y y)
Time	c. : ☐ a.m. ☐ p.m.	: ☐ a.m. ☐ p.m.
12. Sediment in well bottom	inches	inches
13. Water clarity	Clear ☐ 10 Turbid ☑ 15 (Describe)	Clear ☑ 20 Turbid ☐ 25 (Describe)
14. Total suspended solids	mg/l	mg/l
15. COD	mg/l	mg/l

Fill in if drilling fluids were used and well is at solid waste facility:

16. Well developed by: Name (first, last) and Firm
First Name: Roy Last Name: Buckenberger
Firm: Layne Christensen Company

17. Additional comments on development:

Name and Address of Facility Contact/Owner/Responsible Party
First Name: Joan Last Name: Kenney
Facility/Firm: Department of the Army
Street: 2 Badger Road
City/State/Zip: Baraboo, Wisconsin 53913-5000

I hereby certify that the above information is true and correct to the best of my knowledge.
Signature: Joel Janssen
Print Name: Joel Janssen
Firm: SpecPro, Inc.

NOTE: See instructions for more information including a list of county codes and well type codes.

State of Wisconsin
Department of Natural Resources

MONITORING WELL DEVELOPMENT

Form 4400-113B Rev. 7-98

Route to: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☑ Other ☐ _____

Facility/Project Name	County Name	Well Name
Badger AAP	Sauk	PBN-1002C

Facility License, Permit or Monitoring Number	County Code	Wis. Unique Well Number	DNR Well ID Number
2814	57	VM184	591

1. Can this well be purged dry? ☐ Yes ☑ No

2. Well development method
   - surged with bailer and bailed ☐ 41
   - surged with bailer and pumped ☑ 61
   - surged with block and bailed ☐ 42
   - surged with block and pumped ☐ 62
   - surged with block, bailed and pumped ☐ 70
   - compressed air ☐ 20
   - bailed only ☐ 10
   - pumped only ☐ 51
   - pumped slowly ☐ 50
   - Other _____ ☐

3. Time spent developing well 60 min.

4. Depth of well (from top of well casisng) 218.8 ft.

5. Inside diameter of well 2.30 in.

6. Volume of water in filter pack and well casing 200.0 gal.

7. Volume of water removed from well 150.0 gal.

8. Volume of water added (if any) 0.0 gal.

9. Source of water added None

10. Analysis performed on water added? ☐ Yes ☑ No
(If yes, attach results)

	Before Development	After Development
11. Depth to Water (from top of well casing)	a. 124.64 ft.	124.64 ft.
Date	b. 06/10/2010 (m m d d y y y y)	06/10/2010 (m m d d y y y y)
Time	c. ___:___ ☐ a.m. ☐ p.m.	___:___ ☐ a.m. ☐ p.m.
12. Sediment in well bottom	___.___ inches	___.___ inches
13. Water clarity	Clear ☐ 10 Turbid ☑ 15 (Describe)	Clear ☑ 20 Turbid ☐ 25 (Describe)

Fill in if drilling fluids were used and well is at solid waste facility:

14. Total suspended solids	____.___ mg/l	____.___ mg/l
15. COD	____.___ mg/l	____.___ mg/l

16. Well developed by: Name (first, last) and Firm
First Name: Roy Last Name: Buckenberger
Firm: Layne Christensen Company

17. Additional comments on development:

Name and Address of Facility Contact /Owner/Responsible Party
First Name: Joan Last Name: Kenney
Facility/Firm: Department of the Army
Street: 2 Badger Road
City/State/Zip: Baraboo, Wisconsin 53913-5000

I hereby certify that the above information is true and correct to the best of my knowledge.
Signature: Joel Janssen
Print Name: Joel Janssen
Firm: SpecPro, Inc.

NOTE: See instructions for more information including a list of county codes and well type codes.

State of Wisconsin
Department of Natural Resources

MONITORING WELL DEVELOPMENT

Form 4400-113B Rev. 7-98

Route to: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☑ Other ☐ _____

Facility/Project Name	County Name	Well Name
Badger AAP	Sauk	PBN-1003C

Facility License, Permit or Monitoring Number	County Code	Wis. Unique Well Number	DNR Well ID Number
2814	57	VM185	592

1. Can this well be purged dry? ☐ Yes ☑ No

2. Well development method
   - surged with bailer and bailed ☐ 41
   - surged with bailer and pumped ☑ 61
   - surged with block and bailed ☐ 42
   - surged with block and pumped ☐ 62
   - surged with block, bailed and pumped ☐ 70
   - compressed air ☐ 20
   - bailed only ☐ 10
   - pumped only ☐ 51
   - pumped slowly ☐ 50
   - Other _____ ☐

3. Time spent developing well 60 min.

4. Depth of well (from top of well casisng) 191.3 ft.

5. Inside diameter of well 2.30 in.

6. Volume of water in filter pack and well casing 200.0 gal.

7. Volume of water removed from well 150.0 gal.

8. Volume of water added (if any) 0.0 gal.

9. Source of water added None

10. Analysis performed on water added? ☐ Yes ☑ No
(If yes, attach results)

	Before Development	After Development
11. Depth to Water (from top of well casing)	a. 79.15 ft.	79.15 ft.
Date	b. 06/07/2010 (m m / d d / y y y y)	06/07/2010 (m m / d d / y y y y)
Time	c. ___:___ ☐ a.m. ☐ p.m.	___:___ ☐ a.m. ☐ p.m.
12. Sediment in well bottom	___.___ inches	___.___ inches
13. Water clarity	Clear ☐ 10 Turbid ☑ 15 (Describe)	Clear ☑ 20 Turbid ☐ 25 (Describe)

Fill in if drilling fluids were used and well is at solid waste facility:

14. Total suspended solids	____.___ mg/l	____.___ mg/l
15. COD	____.___ mg/l	____.___ mg/l

16. Well developed by: Name (first, last) and Firm
First Name: Roy Last Name: Buckenberger
Firm: Layne Christensen Company

17. Additional comments on development:

Name and Address of Facility Contact /Owner/Responsible Party
First Name: Joan Last Name: Kenney
Facility/Firm: Department of the Army
Street: 2 Badger Road
City/State/Zip: Baraboo, Wisconsin 53913-5000

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Signature: Joel Janssen
Print Name: Joel Janssen
Firm: SpecPro, Inc.

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State of Wisconsin
Department of Natural Resources

MONITORING WELL DEVELOPMENT

Form 4400-113B Rev. 7-98

Route to: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☑ Other ☐ _____

Facility/Project Name	County Name	Well Name
Badger AAP	Sauk	RIM-1001

Facility License, Permit or Monitoring Number	County Code	Wis. Unique Well Number	DNR Well ID Number
3487	57	VM171	482

1. Can this well be purged dry? ☐ Yes ☑ No

2. Well development method
   - surged with bailer and bailed ☐ 41
   - surged with bailer and pumped ☑ 61
   - surged with block and bailed ☐ 42
   - surged with block and pumped ☐ 62
   - surged with block, bailed and pumped ☐ 70
   - compressed air ☐ 20
   - bailed only ☐ 10
   - pumped only ☐ 51
   - pumped slowly ☐ 50
   - Other _____ ☐

3. Time spent developing well 60 min.

4. Depth of well (from top of well casisng) 101.15 ft.

5. Inside diameter of well 2.30 in.

6. Volume of water in filter pack and well casing 200.0 gal.

7. Volume of water removed from well 150.0 gal.

8. Volume of water added (if any) 0.0 gal.

9. Source of water added None

10. Analysis performed on water added? ☐ Yes ☑ No
(If yes, attach results)

	Before Development	After Development
11. Depth to Water (from top of well casing)	a. 92.09 ft.	92.09 ft.
Date	b. 04/28/2010 (mm/dd/yyyy)	04/28/2010 (mm/dd/yyyy)
Time	c. ___:___ ☐ a.m. ☐ p.m.	___:___ ☐ a.m. ☐ p.m.
12. Sediment in well bottom	___.___ inches	___.___ inches
13. Water clarity	Clear ☐ 10 Turbid ☑ 15 (Describe)	Clear ☑ 20 Turbid ☐ 25 (Describe)

Fill in if drilling fluids were used and well is at solid waste facility:

14. Total suspended solids	____.___ mg/l	____.___ mg/l
15. COD	____.___ mg/l	____.___ mg/l

16. Well developed by: Name (first, last) and Firm
First Name: Roy Last Name: Buckenberger
Firm: Layne Christensen Company

17. Additional comments on development:

Name and Address of Facility Contact/Owner/Responsible Party
First Name: Joan Last Name: Kenney
Facility/Firm: Department of the Army
Street: 2 Badger Road
City/State/Zip: Baraboo, Wisconsin 53913-5000

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Signature: Joel Janssen
Print Name: Joel Janssen
Firm: SpecPro, Inc.

NOTE: See instructions for more information including a list of county codes and well type codes.

State of Wisconsin
Department of Natural Resources

MONITORING WELL DEVELOPMENT

Form 4400-113B Rev. 7-98

Route to: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☑ Other ☐ _____

Facility/Project Name	County Name	Well Name
Badger AAP	Sauk	RIM-1002

Facility License, Permit or Monitoring Number	County Code	Wis. Unique Well Number	DNR Well ID Number
3487	57	VM167	478

1. Can this well be purged dry? ☐ Yes ☑ No

2. Well development method
   - surged with bailer and bailed ☐ 41
   - surged with bailer and pumped ☑ 61
   - surged with block and bailed ☐ 42
   - surged with block and pumped ☐ 62
   - surged with block, bailed and pumped ☐ 70
   - compressed air ☐ 20
   - bailed only ☐ 10
   - pumped only ☐ 51
   - pumped slowly ☐ 50
   - Other _____ ☐

3. Time spent developing well 60 min.

4. Depth of well (from top of well casisng) 112.4 ft.

5. Inside diameter of well 2.30 in.

6. Volume of water in filter pack and well casing 200.0 gal.

7. Volume of water removed from well 150.0 gal.

8. Volume of water added (if any) 0.0 gal.

9. Source of water added None

10. Analysis performed on water added? ☐ Yes ☑ No
(If yes, attach results)

	Before Development	After Development
11. Depth to Water (from top of well casing)	a. 104.38 ft.	104.38 ft.
Date	b. 05/03/2010 (m m / d d / y y y y)	05/03/2010 (m m / d d / y y y y)
Time	c. : ☐ a.m. ☐ p.m.	: ☐ a.m. ☐ p.m.
12. Sediment in well bottom	inches	inches
13. Water clarity	Clear ☐ 10 Turbid ☑ 15 (Describe)	Clear ☑ 20 Turbid ☐ 25 (Describe)
14. Total suspended solids	mg/l	mg/l
15. COD	mg/l	mg/l

Fill in if drilling fluids were used and well is at solid waste facility:

16. Well developed by: Name (first, last) and Firm
First Name: Roy Last Name: Buckenberger
Firm: Layne Christensen Company

17. Additional comments on development:

Name and Address of Facility Contact /Owner/Responsible Party
First Name: Joan Last Name: Kenney
Facility/Firm: Department of the Army
Street: 2 Badger Road
City/State/Zip: Baraboo, Wisconsin 53913-5000

I hereby certify that the above information is true and correct to the best of my knowledge.
Signature: Joel Janssen
Print Name: Joel Janssen
Firm: SpecPro, Inc.

NOTE: See instructions for more information including a list of county codes and well type codes.

State of Wisconsin
Department of Natural Resources

MONITORING WELL DEVELOPMENT

Form 4400-113B Rev. 7-98

Route to: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☑ Other ☐ _____

Facility/Project Name	County Name	Well Name
Badger AAP	Sauk	RIM-1003

Facility License, Permit or Monitoring Number	County Code	Wis. Unique Well Number	DNR Well ID Number
3487	57	VM175	491

1. Can this well be purged dry? ☐ Yes ☑ No

2. Well development method
   - surged with bailer and bailed ☐ 41
   - surged with bailer and pumped ☑ 61
   - surged with block and bailed ☐ 42
   - surged with block and pumped ☐ 62
   - surged with block, bailed and pumped ☐ 70
   - compressed air ☐ 20
   - bailed only ☐ 10
   - pumped only ☐ 51
   - pumped slowly ☐ 50
   - Other _____ ☐

3. Time spent developing well 60 min.

4. Depth of well (from top of well casisng) 116.3 ft.

5. Inside diameter of well 2.30 in.

6. Volume of water in filter pack and well casing 200.0 gal.

7. Volume of water removed from well 150.0 gal.

8. Volume of water added (if any) 0.0 gal.

9. Source of water added None

10. Analysis performed on water added? ☐ Yes ☑ No
(If yes, attach results)

	Before Development	After Development
11. Depth to Water (from top of well casing)	a. 108.18 ft.	108.18 ft.
Date	b. 05/04/2010 (m m / d d / y y y y)	05/04/2010 (m m / d d / y y y y)
Time	c. : ☐ a.m. ☐ p.m.	: ☐ a.m. ☐ p.m.
12. Sediment in well bottom	inches	inches
13. Water clarity	Clear ☐ 10 Turbid ☑ 15 (Describe)	Clear ☑ 20 Turbid ☐ 25 (Describe)

Fill in if drilling fluids were used and well is at solid waste facility:

14. Total suspended solids	mg/l	mg/l
15. COD	mg/l	mg/l

16. Well developed by: Name (first, last) and Firm
First Name: Roy Last Name: Buckenberger
Firm: Layne Christensen Company

17. Additional comments on development:

Name and Address of Facility Contact /Owner/Responsible Party
First Name: Joan Last Name: Kenney
Facility/Firm: Department of the Army
Street: 2 Badger Road
City/State/Zip: Baraboo, Wisconsin 53913-5000

I hereby certify that the above information is true and correct to the best of my knowledge.
Signature: Joel Janssen
Print Name: Joel Janssen
Firm: SpecPro, Inc.

NOTE: See instructions for more information including a list of county codes and well type codes.

State of Wisconsin
Department of Natural Resources

MONITORING WELL DEVELOPMENT

Form 4400-113B Rev. 7-98

Route to: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☑ Other ☐ _____

Facility/Project Name	County Name	Well Name
Badger AAP	Sauk	RIM-1004

Facility License, Permit or Monitoring Number	County Code	Wis. Unique Well Number	DNR Well ID Number
3487	57	VM178	494

1. Can this well be purged dry? ☐ Yes ☑ No

2. Well development method
   - surged with bailer and bailed ☐ 41
   - surged with bailer and pumped ☑ 61
   - surged with block and bailed ☐ 42
   - surged with block and pumped ☐ 62
   - surged with block, bailed and pumped ☐ 70
   - compressed air ☐ 20
   - bailed only ☐ 10
   - pumped only ☐ 51
   - pumped slowly ☐ 50
   - Other _____ ☐

3. Time spent developing well 60 min.

4. Depth of well (from top of well casisng) 73.12 ft.

5. Inside diameter of well 2.30 in.

6. Volume of water in filter pack and well casing 200.0 gal.

7. Volume of water removed from well 150.0 gal.

8. Volume of water added (if any) 0.0 gal.

9. Source of water added None

10. Analysis performed on water added? ☐ Yes ☑ No
(If yes, attach results)

	Before Development	After Development
11. Depth to Water (from top of well casing)	a. 62.45 ft.	62.45 ft.
Date	b. 05/06/2010 (m m / d d / y y y y)	05/06/2010 (m m / d d / y y y y)
Time	c. ___:___ ☐ a.m. ☐ p.m.	___:___ ☐ a.m. ☐ p.m.
12. Sediment in well bottom	___.___ inches	___.___ inches
13. Water clarity	Clear ☐ 10 Turbid ☑ 15 (Describe)	Clear ☑ 20 Turbid ☐ 25 (Describe)
14. Total suspended solids	____.___ mg/l	____.___ mg/l
15. COD	____.___ mg/l	____.___ mg/l

Fill in if drilling fluids were used and well is at solid waste facility:

16. Well developed by: Name (first, last) and Firm
First Name: Roy Last Name: Buckenberger
Firm: Layne Christensen Company

17. Additional comments on development:

Name and Address of Facility Contact/Owner/Responsible Party
First Name: Joan Last Name: Kenney
Facility/Firm: Department of the Army
Street: 2 Badger Road
City/State/Zip: Baraboo, Wisconsin 53913-5000

I hereby certify that the above information is true and correct to the best of my knowledge.
Signature: Joel Janssen
Print Name: Joel Janssen
Firm: SpecPro, Inc.

NOTE: See instructions for more information including a list of county codes and well type codes.

State of Wisconsin
Department of Natural Resources

MONITORING WELL DEVELOPMENT

Form 4400-113B Rev. 7-98

Route to: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☑ Other ☐ _____

Facility/Project Name	County Name	Well Name
Badger AAP	Sauk	RIM-1005

Facility License, Permit or Monitoring Number	County Code	Wis. Unique Well Number	DNR Well ID Number
3487	57	VM174	490

1. Can this well be purged dry? ☐ Yes ☑ No

2. Well development method
   - surged with bailer and bailed ☐ 41
   - surged with bailer and pumped ☑ 61
   - surged with block and bailed ☐ 42
   - surged with block and pumped ☐ 62
   - surged with block, bailed and pumped ☐ 70
   - compressed air ☐ 20
   - bailed only ☐ 10
   - pumped only ☐ 51
   - pumped slowly ☐ 50
   - Other _____ ☐

3. Time spent developing well 60 min.

4. Depth of well (from top of well casisng) 112.64 ft.

5. Inside diameter of well 2.30 in.

6. Volume of water in filter pack and well casing 200.0 gal.

7. Volume of water removed from well 150.0 gal.

8. Volume of water added (if any) 0.0 gal.

9. Source of water added None

10. Analysis performed on water added? ☐ Yes ☑ No
(If yes, attach results)

	Before Development	After Development
11. Depth to Water (from top of well casing)	a. 101.67 ft.	101.67 ft.
Date	b. 05/10/2010 (mm/dd/yyyy)	05/10/2010 (mm/dd/yyyy)
Time	c. ___:___ ☐ a.m. ☐ p.m.	___:___ ☐ a.m. ☐ p.m.
12. Sediment in well bottom	___.___ inches	___.___ inches
13. Water clarity	Clear ☐ 10 Turbid ☑ 15 (Describe)	Clear ☑ 20 Turbid ☐ 25 (Describe)
14. Total suspended solids	____.___ mg/l	____.___ mg/l
15. COD	____.___ mg/l	____.___ mg/l

Fill in if drilling fluids were used and well is at solid waste facility:

16. Well developed by: Name (first, last) and Firm
First Name: Roy Last Name: Buckenberger
Firm: Layne Christensen Company

17. Additional comments on development:

Name and Address of Facility Contact/Owner/Responsible Party
First Name: Joan Last Name: Kenney
Facility/Firm: Department of the Army
Street: 2 Badger Road
City/State/Zip: Baraboo, Wisconsin 53913-5000

I hereby certify that the above information is true and correct to the best of my knowledge.
Signature: Joel Janssen
Print Name: Joel Janssen
Firm: SpecPro, Inc.

NOTE: See instructions for more information including a list of county codes and well type codes.

State of Wisconsin
Department of Natural Resources

MONITORING WELL DEVELOPMENT

Form 4400-113B Rev. 7-98

Route to: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☑ Other ☐ _____

Facility/Project Name	County Name	Well Name
Badger AAP	Sauk	RIN-1001A

Facility License, Permit or Monitoring Number	County Code	Wis. Unique Well Number	DNR Well ID Number
3487	57	VM169	480

1. Can this well be purged dry? ☐ Yes ☑ No

2. Well development method
   - surged with bailer and bailed ☐ 41
   - surged with bailer and pumped ☑ 61
   - surged with block and bailed ☐ 42
   - surged with block and pumped ☐ 62
   - surged with block, bailed and pumped ☐ 70
   - compressed air ☐ 20
   - bailed only ☐ 10
   - pumped only ☐ 51
   - pumped slowly ☐ 50
   - Other _____ ☐

3. Time spent developing well 60 min.

4. Depth of well (from top of well casisng) 108.80 ft.

5. Inside diameter of well 2.30 in.

6. Volume of water in filter pack and well casing 200.0 gal.

7. Volume of water removed from well 150.0 gal.

8. Volume of water added (if any) 0.0 gal.

9. Source of water added None

10. Analysis performed on water added? ☐ Yes ☑ No
(If yes, attach results)

	Before Development	After Development
11. Depth to Water (from top of well casing)	a. 100.04 ft.	100.04 ft.
Date	b. 04/29/2010 (m m d d y y y y)	04/29/2010 (m m d d y y y y)
Time	c. ☐ a.m. ☐ p.m.	☐ a.m. ☐ p.m.
12. Sediment in well bottom	inches	inches
13. Water clarity	Clear ☐ 10 Turbid ☑ 15 (Describe)	Clear ☑ 20 Turbid ☐ 25 (Describe)
14. Total suspended solids	mg/l	mg/l
15. COD	mg/l	mg/l

Fill in if drilling fluids were used and well is at solid waste facility:

16. Well developed by: Name (first, last) and Firm
First Name: Roy Last Name: Buckenberger
Firm: Layne Christensen Company

17. Additional comments on development:

Name and Address of Facility Contact/Owner/Responsible Party
First Name: Joan Last Name: Kenney
Facility/Firm: Department of the Army
Street: 2 Badger Road
City/State/Zip: Baraboo, Wisconsin 53913-5000

I hereby certify that the above information is true and correct to the best of my knowledge.
Signature: Joel Janssen
Print Name: Joel Janssen
Firm: SpecPro, Inc.

NOTE: See instructions for more information including a list of county codes and well type codes.

State of Wisconsin
Department of Natural Resources

MONITORING WELL DEVELOPMENT

Form 4400-113B Rev. 7-98

Route to: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☑ Other ☐ _____

Facility/Project Name	County Name	Well Name
Badger AAP	Sauk	RIN-1001C

Facility License, Permit or Monitoring Number	County Code	Wis. Unique Well Number	DNR Well ID Number
3487	57	VM170	481

1. Can this well be purged dry? ☐ Yes ☑ No

2. Well development method
   - surged with bailer and bailed ☐ 41
   - surged with bailer and pumped ☑ 61
   - surged with block and bailed ☐ 42
   - surged with block and pumped ☐ 62
   - surged with block, bailed and pumped ☐ 70
   - compressed air ☐ 20
   - bailed only ☐ 10
   - pumped only ☐ 51
   - pumped slowly ☐ 50
   - Other _____ ☐

3. Time spent developing well 60 min.

4. Depth of well (from top of well casisng) 183.40 ft.

5. Inside diameter of well 2.30 in.

6. Volume of water in filter pack and well casing 200.0 gal.

7. Volume of water removed from well 150.0 gal.

8. Volume of water added (if any) 0.0 gal.

9. Source of water added None

10. Analysis performed on water added? ☐ Yes ☑ No
(If yes, attach results)

	Before Development	After Development
11. Depth to Water (from top of well casing)	a. 99.68 ft.	99.68 ft.
Date	b. 05/25/2010 (m m d d y y y y)	05/25/2010 (m m d d y y y y)
Time	c. : ☐ a.m. ☐ p.m.	: ☐ a.m. ☐ p.m.
12. Sediment in well bottom	inches	inches
13. Water clarity	Clear ☐ 10 Turbid ☑ 15 (Describe)	Clear ☑ 20 Turbid ☐ 25 (Describe)

Fill in if drilling fluids were used and well is at solid waste facility:

14. Total suspended solids	mg/l	mg/l
15. COD	mg/l	mg/l

16. Well developed by: Name (first, last) and Firm
First Name: Roy Last Name: Buckenberger
Firm: Layne Christensen Company

17. Additional comments on development:

Name and Address of Facility Contact/Owner/Responsible Party
First Name: Joan Last Name: Kenney
Facility/Firm: Department of the Army
Street: 2 Badger Road
City/State/Zip: Baraboo, Wisconsin 53913-5000

I hereby certify that the above information is true and correct to the best of my knowledge.
Signature: Joel Janssen
Print Name: Joel Janssen
Firm: SpecPro, Inc.

NOTE: See instructions for more information including a list of county codes and well type codes.

State of Wisconsin
Department of Natural Resources

MONITORING WELL DEVELOPMENT

Form 4400-113B Rev. 7-98

Route to: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☑ Other ☐ _____

Facility/Project Name	County Name	Well Name
Badger AAP	Sauk	RIN-1002A

Facility License, Permit or Monitoring Number	County Code	Wis. Unique Well Number	DNR Well ID Number
3487	57	VM176	492

1. Can this well be purged dry? ☐ Yes ☑ No

2. Well development method
   - surged with bailer and bailed ☐ 41
   - surged with bailer and pumped ☑ 61
   - surged with block and bailed ☐ 42
   - surged with block and pumped ☐ 62
   - surged with block, bailed and pumped ☐ 70
   - compressed air ☐ 20
   - bailed only ☐ 10
   - pumped only ☐ 51
   - pumped slowly ☐ 50
   - Other _____ ☐

3. Time spent developing well 60 min.

4. Depth of well (from top of well casisng) 941 ft.

5. Inside diameter of well 2.30 in.

6. Volume of water in filter pack and well casing 200.0 gal.

7. Volume of water removed from well 150.0 gal.

8. Volume of water added (if any) 0.0 gal.

9. Source of water added None

10. Analysis performed on water added? ☐ Yes ☑ No
(If yes, attach results)

	Before Development	After Development
11. Depth to Water (from top of well casing)	a. 86.70 ft.	86.70 ft.
Date	b. 05/05/2010 (m m d d y y y y)	05/05/2010 (m m d d y y y y)
Time	c. ☐ a.m. ☐ p.m.	☐ a.m. ☐ p.m.
12. Sediment in well bottom	inches	inches
13. Water clarity	Clear ☐ 10 Turbid ☑ 15 (Describe)	Clear ☑ 20 Turbid ☐ 25 (Describe)
14. Total suspended solids	mg/l	mg/l
15. COD	mg/l	mg/l

Fill in if drilling fluids were used and well is at solid waste facility:

16. Well developed by: Name (first, last) and Firm
First Name: Roy Last Name: Buckenberger
Firm: Layne Christensen Company

17. Additional comments on development:

Name and Address of Facility Contact/Owner/Responsible Party
First Name: Joan Last Name: Kenney
Facility/Firm: Department of the Army
Street: 2 Badger Road
City/State/Zip: Baraboo, Wisconsin 53913-5000

I hereby certify that the above information is true and correct to the best of my knowledge.
Signature: Joel Janssen
Print Name: Joel Janssen
Firm: SpecPro, Inc.

NOTE: See instructions for more information including a list of county codes and well type codes.

State of Wisconsin
Department of Natural Resources

MONITORING WELL DEVELOPMENT

Form 4400-113B Rev. 7-98

Route to: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☑ Other ☐ _____

Facility/Project Name	County Name	Well Name
Badger AAP	Sauk	RIN-1002C

Facility License, Permit or Monitoring Number	County Code	Wis. Unique Well Number	DNR Well ID Number
3487	57	VM177	493

1. Can this well be purged dry? ☐ Yes ☑ No

2. Well development method
   - surged with bailer and bailed ☐ 41
   - surged with bailer and pumped ☑ 61
   - surged with block and bailed ☐ 42
   - surged with block and pumped ☐ 62
   - surged with block, bailed and pumped ☐ 70
   - compressed air ☐ 20
   - bailed only ☐ 10
   - pumped only ☐ 51
   - pumped slowly ☐ 50
   - Other _____ ☐

3. Time spent developing well 60 min.

4. Depth of well (from top of well casisng) 181.5 ft.

5. Inside diameter of well 2.30 in.

6. Volume of water in filter pack and well casing 200.0 gal.

7. Volume of water removed from well 150.0 gal.

8. Volume of water added (if any) 0.0 gal.

9. Source of water added None

10. Analysis performed on water added? ☐ Yes ☑ No
(If yes, attach results)

	Before Development	After Development
11. Depth to Water (from top of well casing)	a. 86.88 ft.	86.88 ft.
Date	b. 06/02/2010 (m m / d d / y y y y)	06/02/2010 (m m / d d / y y y y)
Time	c. : ☐ a.m. ☐ p.m.	: ☐ a.m. ☐ p.m.
12. Sediment in well bottom	inches	inches
13. Water clarity	Clear ☐ 10 Turbid ☑ 15 (Describe)	Clear ☑ 20 Turbid ☐ 25 (Describe)
Fill in if drilling fluids were used and well is at solid waste facility:		
14. Total suspended solids	mg/l	mg/l
15. COD	mg/l	mg/l

16. Well developed by: Name (first, last) and Firm
First Name: Roy Last Name: Buckenberger
Firm: Layne Christensen Company

17. Additional comments on development:

Name and Address of Facility Contact /Owner/Responsible Party
First Name: Joan Last Name: Kenney
Facility/Firm: Department of the Army
Street: 2 Badger Road
City/State/Zip: Baraboo, Wisconsin 53913-5000

I hereby certify that the above information is true and correct to the best of my knowledge.
Signature: Joel Janssen
Print Name: Joel Janssen
Firm: SpecPro, Inc.

NOTE: See instructions for more information including a list of county codes and well type codes.

State of Wisconsin
Department of Natural Resources

MONITORING WELL DEVELOPMENT

Form 4400-113B Rev. 7-98

Route to: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☑ Other ☐ _____

Facility/Project Name	County Name	Well Name
Badger AAP	Sauk	RIN-1003A

Facility License, Permit or Monitoring Number	County Code	Wis. Unique Well Number	DNR Well ID Number
3487	57	VM179	495

1. Can this well be purged dry? ☐ Yes ☑ No

2. Well development method
   - surged with bailer and bailed ☐ 41
   - surged with bailer and pumped ☑ 61
   - surged with block and bailed ☐ 42
   - surged with block and pumped ☐ 62
   - surged with block, bailed and pumped ☐ 70
   - compressed air ☐ 20
   - bailed only ☐ 10
   - pumped only ☐ 51
   - pumped slowly ☐ 50
   - Other _____ ☐

3. Time spent developing well 60 min.

4. Depth of well (from top of well casisng) 92.8 ft.

5. Inside diameter of well 2.30 in.

6. Volume of water in filter pack and well casing 200.0 gal.

7. Volume of water removed from well 150.0 gal.

8. Volume of water added (if any) 0.0 gal.

9. Source of water added None

10. Analysis performed on water added? ☐ Yes ☑ No
(If yes, attach results)

	Before Development	After Development
11. Depth to Water (from top of well casing)	a. 83.76 ft.	83.76 ft.
Date	b. 05/06/2010 (m m / d d / y y y y)	05/06/2010 (m m / d d / y y y y)
Time	c. : ☐ a.m. ☐ p.m.	: ☐ a.m. ☐ p.m.
12. Sediment in well bottom	inches	inches
13. Water clarity	Clear ☐ 10 Turbid ☑ 15 (Describe)	Clear ☑ 20 Turbid ☐ 25 (Describe)

Fill in if drilling fluids were used and well is at solid waste facility:

14. Total suspended solids	mg/l	mg/l
15. COD	mg/l	mg/l

16. Well developed by: Name (first, last) and Firm
First Name: Roy Last Name: Buckenberger
Firm: Layne Christensen Company

17. Additional comments on development:

Name and Address of Facility Contact/Owner/Responsible Party
First Name: Joan Last Name: Kenney
Facility/Firm: Department of the Army
Street: 2 Badger Road
City/State/Zip: Baraboo, Wisconsin 53913-5000

I hereby certify that the above information is true and correct to the best of my knowledge.
Signature: Joel Janssen
Print Name: Joel Janssen
Firm: SpecPro, Inc.

NOTE: See instructions for more information including a list of county codes and well type codes.

State of Wisconsin
Department of Natural Resources

MONITORING WELL DEVELOPMENT

Form 4400-113B Rev. 7-98

Route to: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☑ Other ☐ _____

Facility/Project Name	County Name	Well Name
Badger AAP	Sauk	RIN-1004B

Facility License, Permit or Monitoring Number	County Code	Wis. Unique Well Number	DNR Well ID Number
3487	57	VM182	498

1. Can this well be purged dry? ☐ Yes ☑ No

2. Well development method
   - surged with bailer and bailed ☐ 41
   - surged with bailer and pumped ☑ 61
   - surged with block and bailed ☐ 42
   - surged with block and pumped ☐ 62
   - surged with block, bailed and pumped ☐ 70
   - compressed air ☐ 20
   - bailed only ☐ 10
   - pumped only ☐ 51
   - pumped slowly ☐ 50
   - Other _____ ☐

3. Time spent developing well 60 min.

4. Depth of well (from top of well casisng) 149.0 ft.

5. Inside diameter of well 2.30 in.

6. Volume of water in filter pack and well casing 200.0 gal.

7. Volume of water removed from well 150.0 gal.

8. Volume of water added (if any) 0.0 gal.

9. Source of water added None

10. Analysis performed on water added? ☐ Yes ☑ No
(If yes, attach results)

	Before Development	After Development
11. Depth to Water (from top of well casing)	a. 89.10 ft.	89.10 ft.
Date	b. 05/17/2010 (mm/dd/yyyy)	05/17/2010 (mm/dd/yyyy)
Time	c. : ☐ a.m. ☐ p.m.	: ☐ a.m. ☐ p.m.
12. Sediment in well bottom	inches	inches
13. Water clarity	Clear ☐ 10 Turbid ☑ 15 (Describe)	Clear ☑ 20 Turbid ☐ 25 (Describe)
14. Total suspended solids	mg/l	mg/l
15. COD	mg/l	mg/l

Fill in if drilling fluids were used and well is at solid waste facility:

16. Well developed by: Name (first, last) and Firm
First Name: Roy Last Name: Buckenberger
Firm: Layne Christensen Company

17. Additional comments on development:

Name and Address of Facility Contact/Owner/Responsible Party
First Name: Joan Last Name: Kenney
Facility/Firm: Department of the Army
Street: 2 Badger Road
City/State/Zip: Baraboo, Wisconsin 53913-5000

I hereby certify that the above information is true and correct to the best of my knowledge.
Signature: Joel Janssen
Print Name: Joel Janssen
Firm: SpecPro, Inc.

NOTE: See instructions for more information including a list of county codes and well type codes.

State of Wisconsin
Department of Natural Resources

MONITORING WELL DEVELOPMENT

Form 4400-113B Rev. 7-98

Route to: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☑ Other ☐ _____

Facility/Project Name	County Name	Well Name
Badger AAP	Sauk	RIN-1005A

Facility License, Permit or Monitoring Number	County Code	Wis. Unique Well Number	DNR Well ID Number
3487	57	VM180	496

1. Can this well be purged dry? ☐ Yes ☑ No

2. Well development method
   - surged with bailer and bailed ☐ 41
   - surged with bailer and pumped ☑ 61
   - surged with block and bailed ☐ 42
   - surged with block and pumped ☐ 62
   - surged with block, bailed and pumped ☐ 70
   - compressed air ☐ 20
   - bailed only ☐ 10
   - pumped only ☐ 51
   - pumped slowly ☐ 50
   - Other _____ ☐

3. Time spent developing well 60 min.

4. Depth of well (from top of well casisng) 628 ft.

5. Inside diameter of well 2.30 in.

6. Volume of water in filter pack and well casing 200.0 gal.

7. Volume of water removed from well 150.0 gal.

8. Volume of water added (if any) 0.0 gal.

9. Source of water added None

10. Analysis performed on water added? ☐ Yes ☑ No
(If yes, attach results)

	Before Development	After Development
11. Depth to Water (from top of well casing)	a. 55.34 ft.	55.34 ft.
Date	b. 05/18/2010 (m m d d y y y y)	05/18/2010 (m m d d y y y y)
Time	c. __:__ ☐ a.m. ☐ p.m.	__:__ ☐ a.m. ☐ p.m.
12. Sediment in well bottom	___.__ inches	___.__ inches
13. Water clarity	Clear ☐ 10 Turbid ☑ 15 (Describe)	Clear ☑ 20 Turbid ☐ 25 (Describe)
14. Total suspended solids	____.__ mg/l	____.__ mg/l
15. COD	____.__ mg/l	____.__ mg/l

Fill in if drilling fluids were used and well is at solid waste facility:

16. Well developed by: Name (first, last) and Firm
First Name: Roy Last Name: Buckenberger
Firm: Layne Christensen Company

17. Additional comments on development:

Name and Address of Facility Contact /Owner/Responsible Party
First Name: Joan Last Name: Kenney
Facility/Firm: Department of the Army
Street: 2 Badger Road
City/State/Zip: Baraboo, Wisconsin 53913-5000

I hereby certify that the above information is true and correct to the best of my knowledge.
Signature: Joel Janssen
Print Name: Joel Janssen
Firm: SpecPro, Inc.

NOTE: See instructions for more information including a list of county codes and well type codes.

State of Wisconsin
Department of Natural Resources

MONITORING WELL DEVELOPMENT

Form 4400-113B Rev. 7-98

Route to: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☑ Other ☐ _____

Facility/Project Name	County Name	Well Name
Badger AAP	Sauk	RIN-1005C

Facility License, Permit or Monitoring Number	County Code	Wis. Unique Well Number	DNR Well ID Number
3487	57	VM181	497

1. Can this well be purged dry? ☐ Yes ☑ No

2. Well development method
   - surged with bailer and bailed ☐ 41
   - surged with bailer and pumped ☑ 61
   - surged with block and bailed ☐ 42
   - surged with block and pumped ☐ 62
   - surged with block, bailed and pumped ☐ 70
   - compressed air ☐ 20
   - bailed only ☐ 10
   - pumped only ☐ 51
   - pumped slowly ☐ 50
   - Other _____ ☐

3. Time spent developing well 60 min.

4. Depth of well (from top of well casisng) 149.0 ft.

5. Inside diameter of well 2.30 in.

6. Volume of water in filter pack and well casing 200.0 gal.

7. Volume of water removed from well 150.0 gal.

8. Volume of water added (if any) 0.0 gal.

9. Source of water added None

10. Analysis performed on water added? ☐ Yes ☑ No
(If yes, attach results)

	Before Development	After Development
11. Depth to Water (from top of well casing)	a. 54.90 ft.	54.90 ft.
Date	b. 05/18/2010 (mm/dd/yyyy)	05/18/2010 (mm/dd/yyyy)
Time	c. : ☐ a.m. ☐ p.m.	: ☐ a.m. ☐ p.m.
12. Sediment in well bottom	inches	inches
13. Water clarity	Clear ☐ 10 Turbid ☑ 15 (Describe)	Clear ☑ 20 Turbid ☐ 25 (Describe)

Fill in if drilling fluids were used and well is at solid waste facility:

14. Total suspended solids	mg/l	mg/l
15. COD	mg/l	mg/l

16. Well developed by: Name (first, last) and Firm
First Name: Roy Last Name: Buckenberger
Firm: Layne Christensen Company

17. Additional comments on development:

Name and Address of Facility Contact/Owner/Responsible Party
First Name: Joan Last Name: Kenney
Facility/Firm: Department of the Army
Street: 2 Badger Road
City/State/Zip: Baraboo, Wisconsin 53913-5000

I hereby certify that the above information is true and correct to the best of my knowledge.
Signature: Joel Janssen
Print Name: Joel Janssen
Firm: SpecPro, Inc.

NOTE: See instructions for more information including a list of county codes and well type codes.

State of Wisconsin
Department of Natural Resources

MONITORING WELL DEVELOPMENT

Form 4400-113B Rev. 7-98

Route to: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☑ Other ☐ _____

Facility/Project Name	County Name	Well Name
Badger AAP	Sauk	RIN-1006A

Facility License, Permit or Monitoring Number	County Code	Wis. Unique Well Number	DNR Well ID Number
3487	57	VM172	483

1. Can this well be purged dry? ☐ Yes ☑ No

2. Well development method
   - surged with bailer and bailed ☐ 41
   - surged with bailer and pumped ☑ 61
   - surged with block and bailed ☐ 42
   - surged with block and pumped ☐ 62
   - surged with block, bailed and pumped ☐ 70
   - compressed air ☐ 20
   - bailed only ☐ 10
   - pumped only ☐ 51
   - pumped slowly ☐ 50
   - Other _____ ☐

3. Time spent developing well 60 min.

4. Depth of well (from top of well casisng) 102.68 ft.

5. Inside diameter of well 2.30 in.

6. Volume of water in filter pack and well casing 200.0 gal.

7. Volume of water removed from well 150.0 gal.

8. Volume of water added (if any) 0.0 gal.

9. Source of water added None

10. Analysis performed on water added? ☐ Yes ☑ No
(If yes, attach results)

	Before Development	After Development
11. Depth to Water (from top of well casing)	a. 88.94 ft.	88.94 ft.
Date	b. 05/19/2010 (mm/dd/yyyy)	05/19/2010 (mm/dd/yyyy)
Time	c. : ☐ a.m. ☐ p.m.	: ☐ a.m. ☐ p.m.
12. Sediment in well bottom	inches	inches
13. Water clarity	Clear ☐ 10 Turbid ☑ 15 (Describe)	Clear ☑ 20 Turbid ☐ 25 (Describe)

Fill in if drilling fluids were used and well is at solid waste facility:

14. Total suspended solids	mg/l	mg/l
15. COD	mg/l	mg/l

16. Well developed by: Name (first, last) and Firm
First Name: Roy Last Name: Buckenberger
Firm: Layne Christensen Company

17. Additional comments on development:

Name and Address of Facility Contact/Owner/Responsible Party
First Name: Joan Last Name: Kenney
Facility/Firm: Department of the Army
Street: 2 Badger Road
City/State/Zip: Baraboo, Wisconsin 53913-5000

I hereby certify that the above information is true and correct to the best of my knowledge.
Signature: Joel Janssen
Print Name: Joel Janssen
Firm: SpecPro, Inc.

NOTE: See instructions for more information including a list of county codes and well type codes.

State of Wisconsin
Department of Natural Resources

MONITORING WELL DEVELOPMENT

Form 4400-113B Rev. 7-98

Route to: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☑ Other ☐ _____

Facility/Project Name	County Name	Well Name
Badger AAP	Sauk	RIN-1006C

Facility License, Permit or Monitoring Number	County Code	Wis. Unique Well Number	DNR Well ID Number
3487	57	VM173	484

1. Can this well be purged dry? ☐ Yes ☑ No

2. Well development method
   - surged with bailer and bailed ☐ 41
   - surged with bailer and pumped ☑ 61
   - surged with block and bailed ☐ 42
   - surged with block and pumped ☐ 62
   - surged with block, bailed and pumped ☐ 70
   - compressed air ☐ 20
   - bailed only ☐ 10
   - pumped only ☐ 51
   - pumped slowly ☐ 50
   - Other _____ ☐

3. Time spent developing well 60 min.

4. Depth of well (from top of well casisng) 182.85 ft.

5. Inside diameter of well 2.30 in.

6. Volume of water in filter pack and well casing 200.0 gal.

7. Volume of water removed from well 150.0 gal.

8. Volume of water added (if any) 0.0 gal.

9. Source of water added None

10. Analysis performed on water added? ☐ Yes ☑ No
(If yes, attach results)

	Before Development	After Development
11. Depth to Water (from top of well casing)	a. 89.28 ft.	89.28 ft.
Date	b. 05/19/2010 (m m d d y y y y)	05/19/2010 (m m d d y y y y)
Time	c. : ☐ a.m. ☐ p.m.	: ☐ a.m. ☐ p.m.
12. Sediment in well bottom	inches	inches
13. Water clarity	Clear ☐ 10 Turbid ☑ 15 (Describe)	Clear ☑ 20 Turbid ☐ 25 (Describe)

Fill in if drilling fluids were used and well is at solid waste facility:

14. Total suspended solids	mg/l	mg/l
15. COD	mg/l	mg/l

16. Well developed by: Name (first, last) and Firm
First Name: Roy Last Name: Buckenberger
Firm: Layne Christensen Company

17. Additional comments on development:

Name and Address of Facility Contact/Owner/Responsible Party
First Name: Joan Last Name: Kenney
Facility/Firm: Department of the Army
Street: 2 Badger Road
City/State/Zip: Baraboo, Wisconsin 53913-5000

I hereby certify that the above information is true and correct to the best of my knowledge.
Signature: Joel Janssen
Print Name: Joel Janssen
Firm: SpecPro, Inc.

NOTE: See instructions for more information including a list of county codes and well type codes.

State of Wisconsin
Department of Natural Resources

MONITORING WELL DEVELOPMENT

Form 4400-113B Rev. 7-98

Route to: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☑ Other ☐ _____

Facility/Project Name	County Name	Well Name
Badger AAP	Sauk	RIN-1007C

Facility License, Permit or Monitoring Number	County Code	Wis. Unique Well Number	DNR Well ID Number
3487	57	VM168	479

1. Can this well be purged dry? ☐ Yes ☑ No

2. Well development method
   - surged with bailer and bailed ☐ 41
   - surged with bailer and pumped ☑ 61
   - surged with block and bailed ☐ 42
   - surged with block and pumped ☐ 62
   - surged with block, bailed and pumped ☐ 70
   - compressed air ☐ 20
   - bailed only ☐ 10
   - pumped only ☐ 51
   - pumped slowly ☐ 50
   - Other _____ ☐

3. Time spent developing well 60 min.

4. Depth of well (from top of well casisng) 177.70 ft.

5. Inside diameter of well 2.30 in.

6. Volume of water in filter pack and well casing 200.0 gal.

7. Volume of water removed from well 150.0 gal.

8. Volume of water added (if any) 0.0 gal.

9. Source of water added None

10. Analysis performed on water added? ☐ Yes ☑ No
(If yes, attach results)

	Before Development	After Development
11. Depth to Water (from top of well casing)	a. 98.83 ft.	98.83 ft.
Date	b. 06/16/2010 (mm/dd/yyyy)	06/16/2010 (mm/dd/yyyy)
Time	c. : ☐ a.m. ☐ p.m.	: ☐ a.m. ☐ p.m.
12. Sediment in well bottom	inches	inches
13. Water clarity	Clear ☐ 10 Turbid ☑ 15 (Describe)	Clear ☑ 20 Turbid ☐ 25 (Describe)
Fill in if drilling fluids were used and well is at solid waste facility:		
14. Total suspended solids	mg/l	mg/l
15. COD	mg/l	mg/l

16. Well developed by: Name (first, last) and Firm
First Name: Roy Last Name: Buckenberger
Firm: Layne Christensen Company

17. Additional comments on development:

Name and Address of Facility Contact/Owner/Responsible Party
First Name: Joan Last Name: Kenney
Facility/Firm: Department of the Army
Street: 2 Badger Road
City/State/Zip: Baraboo, Wisconsin 53913-5000

I hereby certify that the above information is true and correct to the best of my knowledge.
Signature: Joel Janssen
Print Name: Joel Janssen
Firm: SpecPro, Inc.

NOTE: See instructions for more information including a list of county codes and well type codes.

Soil Boring Logs

State of Wisconsin
Department of Natural Resources

SOIL BORING LOG INFORMATION
Form 4400-122

Route To: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☒ Other ☐ _____

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
Badger Army Ammunition Plant	3037	DBM-1001

Boring Drilled by: Name of crew chief (first, last) and Firm	Date Drilling Started	Date Drilling Completed	Drilling Method
First Name: Roy Last Name: Buckenberger Firm: Layne Christensen Company	5/10/10	5/10/10	Rotosonic

WI Unique Well No	DNR Well ID No.	Well Name	Final Static Water	Surface Elevation	Borehole Diameter
VM161	471	DBM-1001	789.64 Feet MSL	909.21 Feet MSL	7.0 inches

Local Grid Origin (estimated:) or Boring Location	Local Grid Location
State Plane 501035.03 N 2042233.38 E ¼ of ¼ of Section T R	_____ Feet N S _____ Feet E W

Facility ID	County	County Code	Civil Town/City/ or Village
157053930	Sauk	57	Town of Merrimac

Sample: Number and Type	Sample: Length Att. & Recovered (in)	Blow Counts	Depth in Feet (Below ground surface)	SOIL ROCK DESCRIPTION	USCS	Graphic Log	Well Diagram	PID/FID	Soil Properties: Compressive Strength	Soil Properties: Moisture Content	Soil Properties: Liquid Limit	Soil Properties: Plasticity Index	Soil Properties: P 200	RQD/Comments
				Blind drilled to 125.3 feet No soil samples were collected Set well screen from 110.3–125.3 feet End of boring at 125.3 feet										

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature: *Joel Janssen* Firm: SpecPro, Inc.

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State of Wisconsin
Department of Natural Resources

SOIL BORING LOG INFORMATION
Form 4400-122

Route To: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☒ Other ☐ _____

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
Badger Army Ammunition Plant	3037	DBN-1001B

Boring Drilled by: Name of crew chief (first, last) and Firm	Date Drilling Started	Date Drilling Completed	Drilling Method
First Name: Roy Last Name: Buckenberger Firm: Layne Christensen Company	5/25/10	5/25/10	Rotosonic

WI Unique Well No	DNR Well ID No.	Well Name	Final Static Water	Surface Elevation	Borehole Diameter
VM162	472	DBN-1001B	785.79 Feet MSL	909.77 Feet MSL	7.0 inches

Local Grid Origin (estimated:) or Boring Location	Local Grid Location
State Plane 501062.19 N 2043112.65 E ¼ of ¼ of Section T R	N S _____ Feet E W _____ Feet

Facility ID	County	County Code	Civil Town/City/ or Village
157053930	Sauk	57	Town of Merrimac

Sample: Number and Type	Sample: Length Att. & Recovered (in)	Blow Counts	Depth in Feet (Below ground surface)	SOIL ROCK DESCRIPTION	USCS	Graphic Log	Well Diagram	PID/FID	Soil Properties: Compressive Strength	Soil Properties: Moisture Content	Soil Properties: Liquid Limit	Soil Properties: Plasticity Index	Soil Properties: P 200	RQD/Comments
				Blind drilled to 159.5 feet No soil samples were collected Set well screen from 154.5–159.5 feet End of boring at 159.5 feet										

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State of Wisconsin
Department of Natural Resources

SOIL BORING LOG INFORMATION
Form 4400-122

Route To: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☒ Other ☐ _____

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
Badger Army Ammunition Plant	3037	DBN-1001C

Boring Drilled by: Name of crew chief (first, last) and Firm	Date Drilling Started	Date Drilling Completed	Drilling Method
First Name: Roy Last Name: Buckenberger Firm: Layne Christensen Company	5/26/10	5/27/10	Rotosonic

WI Unique Well No	DNR Well ID No.	Well Name	Final Static Water	Surface Elevation	Borehole Diameter
VM163	473	DBN-1001C	783.66 Feet MSL	909.78 Feet MSL	7.0 inches

Local Grid Origin (estimated:) or Boring Location	Local Grid Location
State Plane 501062.97 N 2043094.50 E ¼ of ¼ of Section T R	_____ Feet N S _____ Feet E W

Facility ID	County	County Code	Civil Town/City/ or Village
157053930	Sauk	57	Town of Merrimac

Sample: Number and Type	Sample: Length Att. & Recovered (in)	Blow Counts	Depth in Feet (Below ground surface)	SOIL ROCK DESCRIPTION	USCS	Graphic Log	Well Diagram	PID/FID	Soil Properties: Compressive Strength	Soil Properties: Moisture Content	Soil Properties: Liquid Limit	Soil Properties: Plasticity Index	Soil Properties: P 200	RQD/Comments
				Blind drilled to 197 feet No soil samples were collected See DBN-1001E soil boring log for soil descriptions Set well screen from 192 –197 feet End of boring at 197 feet										

I hereby certify that the information on this form is true and correct to the best of my knowledge.

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State of Wisconsin
Department of Natural Resources

SOIL BORING LOG INFORMATION
Form 4400-122

Route To: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☒ Other ☐ _____

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
Badger Army Ammunition Plant	3037	DBN-1001E

Boring Drilled by: Name of crew chief (first, last) and Firm	Date Drilling Started	Date Drilling Completed	Drilling Method
First Name: Vince Last Name: Meindel Firm: Layne Christensen Company	6/21/10	6/30/10	DWRC

WI Unique Well No	DNR Well ID No.	Well Name	Final Static Water	Surface Elevation	Borehole Diameter
VM164	474	DBN-1001E	784.21 Feet MSL	909.95 Feet MSL	7.0 inches

Local Grid Origin (estimated:) or Boring Location	Local Grid Location
State Plane 501064.75 N 2043076.32 E ¼ of ¼ of Section T R	_____ Feet N S _____ Feet E W

Facility ID	County	County Code	Civil Town/City/ or Village
157053930	Sauk	57	Town of Merrimac

Sample: Number and Type	Sample: Length Att. & Recovered (in)	Blow Counts	Depth in Feet (Below ground surface)	SOIL ROCK DESCRIPTION	USCS	Graphic Log	Well Diagram	PID/FID	Soil Properties: Compressive Strength	Soil Properties: Moisture Content	Soil Properties: Liquid Limit	Soil Properties: Plasticity Index	Soil Properties: P 200	RQD/Comments
				Blind drilled to 60 feet										
			60-85	Sand, fine-medium, trace gravel	SW									
			85-135	Sand, fine-medium-coarse, some gravel	SW									
			135-140	Sand, fine	SP									
			140-160	Clay, brown, high plasticity	CH									
			160-170	Gravel, medium-coarse sand	GW									
			170-180	Sand, fine-medium, some gravel	SW									
			180-240	Sand, fine-medium, trace gravel	SP									
			240-258	Sand, medium-coarse	SW									
			258-279.9	Shale, gray, 1-2 inch sandstone stringers	Bed-rock									
				Set well screen from 274.9 –279.9 feet End of boring at 279.9 feet										

I hereby certify that the information on this form is true and correct to the best of my knowledge.

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State of Wisconsin
Department of Natural Resources

SOIL BORING LOG INFORMATION
Form 4400-122

Route To: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☒ Other ☐ _____

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
Badger Army Ammunition Plant	3037	DBN-1002C

Boring Drilled by: Name of crew chief (first, last) and Firm	Date Drilling Started	Date Drilling Completed	Drilling Method
First Name: Roy Last Name: Buckenberger Firm: Layne Christensen Company	6/16/10	6/17/10	Rotosonic

WI Unique Well No	DNR Well ID No.	Well Name	Final Static Water	Surface Elevation	Borehole Diameter
VM165	476	DBN-1002C	782.84 Feet MSL	913.72 Feet MSL	7.0 inches

Local Grid Origin (estimated:) or Boring Location	Local Grid Location
State Plane 500487.21 N 2044487.97 E ¼ of ¼ of Section T R	_____ Feet N S _____ Feet E W

Facility ID	County	County Code	Civil Town/City/ or Village
157053930	Sauk	57	Town of Merrimac

Sample: Number and Type	Sample: Length Att. & Recovered (in)	Blow Counts	Depth in Feet (Below ground surface)	SOIL ROCK DESCRIPTION	USCS	Graphic Log	Well Diagram	PID/FID	Soil Properties: Compressive Strength	Soil Properties: Moisture Content	Soil Properties: Liquid Limit	Soil Properties: Plasticity Index	Soil Properties: P 200	RQD/Comments
				Blind drilled to 210.1 feet No soil samples were collected See DBN-1002E soil boring log for soil descriptions Set well screen from 205.1–210.1 feet End of boring at 210.1 feet										

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature: *Joel Janssen* Firm: SpecPro, Inc.

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State of Wisconsin
Department of Natural Resources

SOIL BORING LOG INFORMATION
Form 4400-122

Route To: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☒ Other ☐ _____

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
Badger Army Ammunition Plant	3037	DBN-1002E

Boring Drilled by: Name of crew chief (first, last) and Firm	Date Drilling Started	Date Drilling Completed	Drilling Method
First Name: Vince Last Name: Meindel Firm: Layne Christensen Company	7/01/10	7/12/10	DWRC

WI Unique Well No	DNR Well ID No.	Well Name	Final Static Water	Surface Elevation	Borehole Diameter
VM166	477	DBN-1002E	782.53 Feet MSL	913.84 Feet MSL	7.0 inches

Local Grid Origin (estimated:) or Boring Location	Local Grid Location
State Plane 500510.82 N 2044484.94 E ¼ of ¼ of Section T R	N E _____ Feet S _____ Feet W

Facility ID	County	County Code	Civil Town/City/ or Village
157053930	Sauk	57	Town of Merrimac

Sample: Number and Type	Sample: Length Att. & Recovered (in)	Blow Counts	Depth in Feet (Below ground surface)	SOIL ROCK DESCRIPTION	USCS	Graphic Log	Well Diagram	PID/FID	Soil Properties: Compressive Strength	Soil Properties: Moisture Content	Soil Properties: Liquid Limit	Soil Properties: Plasticity Index	Soil Properties: P 200	RQD/Comments
				Blind drilled to 60 feet										
			60-105	Sand, fine-medium, trace gravel/cobbles	SW									
			105-115	Sand, fine-medium-coarse, trace cobbles, granite boulder at 111 feet	SW									
			115-145	Gravel, some sand	GW									
			145-150	Sand, fine-medium-coarse, trace gravel	SW									
			150-160	Gravel, medium-coarse sand	GW									
			160-235	Sand, fine-medium, trace gravel	SP									
			235-260	Sand, fine-medium-coarse, trace gravel	SW									
			260-265	Sand, silty, fine-medium	SM									
			265-280.55	Sandstone and siltstone, gray, interbedded	Bed-rock									
				Set well screen from 280.55 –280.55 feet End of boring at 280.55 feet										

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State of Wisconsin
Department of Natural Resources

SOIL BORING LOG INFORMATION
Form 4400-122

Route To: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☒ Other ☐ _____

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
Badger Army Ammunition Plant	2814	PBN-1001A

Boring Drilled by: Name of crew chief (first, last) and Firm	Date Drilling Started	Date Drilling Completed	Drilling Method
First Name: Roy Last Name: Buckenberger Firm: Layne Christensen Company	5/03/10	5/03/10	Rotosonic

WI Unique Well No	DNR Well ID No.	Well Name	Final Static Water	Surface Elevation	Borehole Diameter
VM186	593	PBN-1001A	766.38 Feet MSL	838.17 Feet MSL	7.0 inches

Local Grid Origin (estimated:) or Boring Location	Local Grid Location
State Plane 485983.78 N 2035769.90 E ¼ of ¼ of Section T R	N E _____ Feet S _____ Feet W

Facility ID	County	County Code	Civil Town/City/ or Village
157053930	Sauk	57	Town of Merrimac

Sample: Number and Type	Sample: Length Att. & Recovered (in)	Blow Counts	Depth in Feet (Below ground surface)	SOIL ROCK DESCRIPTION	USCS	Graphic Log	Well Diagram	PID/FID	Soil Properties: Compressive Strength	Soil Properties: Moisture Content	Soil Properties: Liquid Limit	Soil Properties: Plasticity Index	Soil Properties: P 200	RQD/Comments
				Blind drilled to 79.3 feet No soil samples were collected Set well screen from 64.3-79.3 feet End of boring at 79.3 feet										

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature: *Joel Janssen* Firm: SpecPro, Inc.

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State of Wisconsin
Department of Natural Resources

SOIL BORING LOG INFORMATION
Form 4400-122

Route To: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☒ Other ☐ _____

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
Badger Army Ammunition Plant	2814	PBN-1001B

Boring Drilled by: Name of crew chief (first, last) and Firm	Date Drilling Started	Date Drilling Completed	Drilling Method
First Name: Roy Last Name: Buckenberger Firm: Layne Christensen Company	6/02/10	6/02/10	Rotosonic

WI Unique Well No	DNR Well ID No.	Well Name	Final Static Water	Surface Elevation	Borehole Diameter
VM187	594	PBN-1001B	766.52 Feet MSL	838.23 Feet MSL	7.0 inches

Local Grid Origin (estimated:) or Boring Location	Local Grid Location
State Plane 485975.99 N 2035767.53 E ¼ of ¼ of Section T R	_____ Feet N S _____ Feet E W

Facility ID	County	County Code	Civil Town/City/ or Village
157053930	Sauk	57	Town of Merrimac

Sample: Number and Type	Sample: Length Att. & Recovered (in)	Blow Counts	Depth in Feet (Below ground surface)	SOIL ROCK DESCRIPTION	USCS	Graphic Log	Well Diagram	PID/FID	Soil Properties: Compressive Strength	Soil Properties: Moisture Content	Soil Properties: Liquid Limit	Soil Properties: Plasticity Index	Soil Properties: P 200	RQD/Comments
				Blind drilled to 139.9 feet No soil samples were collected Set well screen from 134.9-139.9 feet End of boring at 139.9 feet										

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature: *Joel Janssen* Firm: SpecPro, Inc.

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State of Wisconsin
Department of Natural Resources

SOIL BORING LOG INFORMATION
Form 4400-122

Route To: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☒ Other ☐ _____

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
Badger Army Ammunition Plant	2814	PBN-1001C

Boring Drilled by: Name of crew chief (first, last) and Firm	Date Drilling Started	Date Drilling Completed	Drilling Method
First Name: Roy Last Name: Buckenberger Firm: Layne Christensen Company	6/07/10	6/08/10	Rotosonic

WI Unique Well No	DNR Well ID No.	Well Name	Final Static Water	Surface Elevation	Borehole Diameter
VM188	595	PBN-1001C	766.36 Feet MSL	837.71 Feet MSL	7.0 inches

Local Grid Origin (estimated:) or Boring Location	Local Grid Location
State Plane 485968.12 N 2035767.23 E ¼ of ¼ of Section T R	N E _____ Feet S _____ Feet W

Facility ID	County	County Code	Civil Town/City/ or Village
157053930	Sauk	57	Town of Merrimac

Sample: Number and Type	Sample: Length Att. & Recovered (in)	Blow Counts	Depth in Feet (Below ground surface)	SOIL ROCK DESCRIPTION	USCS	Graphic Log	Well Diagram	PID/FID	Soil Properties: Compressive Strength	Soil Properties: Moisture Content	Soil Properties: Liquid Limit	Soil Properties: Plasticity Index	Soil Properties: P 200	RQD/Comments
				Blind drilled to 199.7 feet No soil samples were collected Set well screen from 194.7-199.7 feet End of boring at 199.7 feet										

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature: *Joel Janssen* Firm: SpecPro, Inc.

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State of Wisconsin
Department of Natural Resources

SOIL BORING LOG INFORMATION
Form 4400-122

Route To: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☒ Other ☐ _____

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
Badger Army Ammunition Plant	2814	PBN-1002A

Boring Drilled by: Name of crew chief (first, last) and Firm	Date Drilling Started	Date Drilling Completed	Drilling Method
First Name: Roy Last Name: Buckenberger Firm: Layne Christensen Company	5/20/10	5/20/10	Rotosonic

WI Unique Well No	DNR Well ID No.	Well Name	Final Static Water	Surface Elevation	Borehole Diameter
VM189	589	PBN-1002A	770.55 Feet MSL	891.70 Feet MSL	7.0 inches

Local Grid Origin (estimated:) or Boring Location	Local Grid Location
State Plane 488450.52 N 2035896.71 E ¼ of ¼ of Section T R	N E _____ Feet S _____ Feet W

Facility ID	County	County Code	Civil Town/City/ or Village
157053930	Sauk	57	Town of Merrimac

Sample: Number and Type	Sample: Length Att. & Recovered (in)	Blow Counts	Depth in Feet (Below ground surface)	SOIL ROCK DESCRIPTION	USCS	Graphic Log	Well Diagram	PID/FID	Soil Properties: Compressive Strength	Soil Properties: Moisture Content	Soil Properties: Liquid Limit	Soil Properties: Plasticity Index	Soil Properties: P 200	RQD/Comments
				Blind drilled to 130.8 feet No soil samples were collected Set well screen from 115.8-130.8 feet End of boring at 130.8 feet										

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature: *Joel Janssen* Firm: SpecPro, Inc.

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State of Wisconsin
Department of Natural Resources

SOIL BORING LOG INFORMATION
Form 4400-122

Route To: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☒ Other ☐ _____

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
Badger Army Ammunition Plant	2814	PBN-1002B

Boring Drilled by: Name of crew chief (first, last) and Firm	Date Drilling Started	Date Drilling Completed	Drilling Method
First Name: Roy Last Name: Buckenberger Firm: Layne Christensen Company	5/19/10	5/19/10	Rotosonic

WI Unique Well No	DNR Well ID No.	Well Name	Final Static Water	Surface Elevation	Borehole Diameter
VM183	590	PBN-1002B	770.58 Feet MSL	892.27 Feet MSL	7.0 inches

Local Grid Origin (estimated:) or Boring Location	Local Grid Location
State Plane 488447.03 N 2035926.71 E ¼ of ¼ of Section T R	_____ Feet N S _____ Feet E W

Facility ID	County	County Code	Civil Town/City/ or Village
157053930	Sauk	57	Town of Merrimac

Sample: Number and Type	Sample: Length Att. & Recovered (in)	Blow Counts	Depth in Feet (Below ground surface)	SOIL ROCK DESCRIPTION	USCS	Graphic Log	Well Diagram	PID/FID	Soil Properties: Compressive Strength	Soil Properties: Moisture Content	Soil Properties: Liquid Limit	Soil Properties: Plasticity Index	Soil Properties: P 200	RQD/Comments
				Blind drilled to 176.5 feet No soil samples were collected Set well screen from 171.5-176.5 feet End of boring at 176.5 feet										

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature: *Joel Janssen* Firm: SpecPro, Inc.

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Department of Natural Resources

SOIL BORING LOG INFORMATION
Form 4400-122

Route To: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☒ Other ☐ _____

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
Badger Army Ammunition Plant	2814	PBN-1002C

Boring Drilled by: Name of crew chief (first, last) and Firm	Date Drilling Started	Date Drilling Completed	Drilling Method
First Name: Roy Last Name: Buckenberger Firm: Layne Christensen Company	6/08/10	6/09/10	Rotosonic

WI Unique Well No	DNR Well ID No.	Well Name	Final Static Water	Surface Elevation	Borehole Diameter
VM184	591	PBN-1002C	770.55 Feet MSL	891.48 Feet MSL	7.0 inches

Local Grid Origin (estimated:) or Boring Location	Local Grid Location
State Plane 488449.71 N 2035908.47 E ¼ of ¼ of Section T R	_____ Feet N S _____ Feet E W

Facility ID	County	County Code	Civil Town/City/ or Village
157053930	Sauk	57	Town of Merrimac

Sample: Number and Type	Sample: Length Att. & Recovered (in)	Blow Counts	Depth in Feet (Below ground surface)	SOIL ROCK DESCRIPTION	USCS	Graphic Log	Well Diagram	PID/FID	Soil Properties: Compressive Strength	Soil Properties: Moisture Content	Soil Properties: Liquid Limit	Soil Properties: Plasticity Index	Soil Properties: P 200	RQD/Comments
				Blind drilled to 216.8 feet No soil samples were collected Set well screen from 211.8-216.8 feet End of boring at 216.8 feet										

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature: *Joel Janssen* Firm: SpecPro, Inc.

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State of Wisconsin
Department of Natural Resources

SOIL BORING LOG INFORMATION
Form 4400-122

Route To: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☒ Other ☐ _____

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
Badger Army Ammunition Plant	2814	PBN-1003C

Boring Drilled by: Name of crew chief (first, last) and Firm	Date Drilling Started	Date Drilling Completed	Drilling Method
First Name: Roy Last Name: Buckenberger Firm: Layne Christensen Company	6/03/10	6/03/10	Rotosonic

WI Unique Well No	DNR Well ID No.	Well Name	Final Static Water	Surface Elevation	Borehole Diameter
VM185	592	PBN-1003C	773.74 Feet MSL	846.51 Feet MSL	7.0 inches

Local Grid Origin (estimated:) or Boring Location	Local Grid Location
State Plane 487681.33 N 2034447.60 E ¼ of ¼ of Section T R	_____ Feet N S _____ Feet E W

Facility ID	County	County Code	Civil Town/City/ or Village
157053930	Sauk	57	Town of Merrimac

Sample: Number and Type	Sample: Length Att. & Recovered (in)	Blow Counts	Depth in Feet (Below ground surface)	SOIL ROCK DESCRIPTION	USCS	Graphic Log	Well Diagram	PID/FID	Soil Properties: Compressive Strength	Soil Properties: Moisture Content	Soil Properties: Liquid Limit	Soil Properties: Plasticity Index	Soil Properties: P 200	RQD/Comments
				Blind drilled to 189.6 feet No soil samples were collected Set well screen from 184.6-189.6 feet End of boring at 189.6 feet										

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Department of Natural Resources

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Form 4400-122

Route To: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☒ Other ☐ _____

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
Badger Army Ammunition Plant	3487	RIM-1001

Boring Drilled by: Name of crew chief (first, last) and Firm	Date Drilling Started	Date Drilling Completed	Drilling Method
First Name: Roy Last Name: Buckenberger Firm: Layne Christensen Company	4/27/10	4/27/10	Rotosonic

WI Unique Well No	DNR Well ID No.	Well Name	Final Static Water	Surface Elevation	Borehole Diameter
VM171	482	RIM-1001	784.41 Feet MSL	872.51 Feet MSL	7.0 inches

Local Grid Origin (estimated:) or Boring Location	Local Grid Location
State Plane 495730.04 N 2034806.71 E ¼ of ¼ of Section T R	N _____ Feet S E _____ Feet W

Facility ID	County	County Code	Civil Town/City/ or Village
157053930	Sauk	57	Town of Merrimac

Sample: Number and Type	Sample: Length Att. & Recovered (in)	Blow Counts	Depth in Feet (Below ground surface)	SOIL ROCK DESCRIPTION	USCS	Graphic Log	Well Diagram	PID/FID	Soil Properties: Compressive Strength	Soil Properties: Moisture Content	Soil Properties: Liquid Limit	Soil Properties: Plasticity Index	Soil Properties: P 200	RQD/Comments
				Blind drilled to 98.75 feet No soil samples were collected Set well screen from 83.75-98.75 feet End of boring at 98.75 feet										

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Department of Natural Resources

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Form 4400-122

Route To: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☒ Other ☐ _____

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
Badger Army Ammunition Plant	3487	RIM-1002

Boring Drilled by: Name of crew chief (first, last) and Firm	Date Drilling Started	Date Drilling Completed	Drilling Method
First Name: Roy Last Name: Buckenberger Firm: Layne Christensen Company	4/29/10	4/29/10	Rotosonic

WI Unique Well No	DNR Well ID No.	Well Name	Final Static Water	Surface Elevation	Borehole Diameter
VM167	478	RIM-1002	787.72 Feet MSL	888.51 Feet MSL	7.0 inches

Local Grid Origin (estimated:) or Boring Location	Local Grid Location
State Plane 499282.00 N 2034868.80 E ¼ of ¼ of Section T R	_____ Feet N S _____ Feet E W

Facility ID	County	County Code	Civil Town/City/ or Village
157053930	Sauk	57	Town of Merrimac

Sample: Number and Type	Sample: Length Att. & Recovered (in)	Blow Counts	Depth in Feet (Below ground surface)	SOIL ROCK DESCRIPTION	USCS	Graphic Log	Well Diagram	PID/FID	Soil Properties: Compressive Strength	Soil Properties: Moisture Content	Soil Properties: Liquid Limit	Soil Properties: Plasticity Index	Soil Properties: P 200	RQD/Comments
				Blind drilled to 110.2 feet No soil samples were collected Set well screen from 95.2-110.2 feet End of boring at 110.2 feet										

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Form 4400-122

Route To: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☒ Other ☐ _____

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
Badger Army Ammunition Plant	3487	RIM-1003

Boring Drilled by: Name of crew chief (first, last) and Firm	Date Drilling Started	Date Drilling Completed	Drilling Method
First Name: Roy Last Name: Buckenberger Firm: Layne Christensen Company	5/03/10	5/03/10	Rotosonic

WI Unique Well No	DNR Well ID No.	Well Name	Final Static Water	Surface Elevation	Borehole Diameter
VM175	491	RIM-1003	777.77 Feet MSL	882.78 Feet MSL	7.0 inches

Local Grid Origin (estimated:) or Boring Location	Local Grid Location
State Plane 492554.74 N 2043660.80 E ¼ of ¼ of Section T R	_____ Feet N S _____ Feet E W

Facility ID	County	County Code	Civil Town/City/ or Village
157053930	Sauk	57	Town of Merrimac

Sample: Number and Type	Sample: Length Att. & Recovered (in)	Blow Counts	Depth in Feet (Below ground surface)	SOIL ROCK DESCRIPTION	USCS	Graphic Log	Well Diagram	PID/FID	Soil Properties: Compressive Strength	Soil Properties: Moisture Content	Soil Properties: Liquid Limit	Soil Properties: Plasticity Index	Soil Properties: P 200	RQD/Comments
				Blind drilled to 114.3 feet No soil samples were collected Set well screen from 99.3-114.3 feet End of boring at 114.3 feet										

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Route To: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☒ Other ☐ _____

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
Badger Army Ammunition Plant	3487	RIM-1004

Boring Drilled by: Name of crew chief (first, last) and Firm	Date Drilling Started	Date Drilling Completed	Drilling Method
First Name: Roy Last Name: Buckenberger Firm: Layne Christensen Company	5/05/10	5/05/10	Rotosonic

WI Unique Well No	DNR Well ID No.	Well Name	Final Static Water	Surface Elevation	Borehole Diameter
VM178	494	RIM-1004	774.55 Feet MSL	833.60 Feet MSL	7.0 inches

Local Grid Origin (estimated:) or Boring Location	Local Grid Location
State Plane 489552.08 N 2044244.43 E ¼ of ¼ of Section T R	N E _____ Feet S _____ Feet W

Facility ID	County	County Code	Civil Town/City/ or Village
157053930	Sauk	57	Town of Merrimac

Sample: Number and Type	Sample: Length Att. & Recovered (in)	Blow Counts	Depth in Feet (Below ground surface)	SOIL ROCK DESCRIPTION	USCS	Graphic Log	Well Diagram	PID/FID	Soil Properties: Compressive Strength	Soil Properties: Moisture Content	Soil Properties: Liquid Limit	Soil Properties: Plasticity Index	Soil Properties: P 200	RQD/Comments
				Blind drilled to 70.52 feet No soil samples were collected Set well screen from 55.52-70.52 feet End of boring at 70.52 feet										

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Department of Natural Resources

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Route To: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☒ Other ☐ _____

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
Badger Army Ammunition Plant	3487	RIM-1005

Boring Drilled by: Name of crew chief (first, last) and Firm	Date Drilling Started	Date Drilling Completed	Drilling Method
First Name: Roy Last Name: Buckenberger Firm: Layne Christensen Company	5/06/10	5/06/10	Rotosonic

WI Unique Well No	DNR Well ID No.	Well Name	Final Static Water	Surface Elevation	Borehole Diameter
VM174	490	RIM-1005	782.58 Feet MSL	880.06 Feet MSL	7.0 inches

Local Grid Origin (estimated:) or Boring Location	Local Grid Location
State Plane 497534.67 N 2041193.13 E ¼ of ¼ of Section T R	N E _____ Feet S _____ Feet W

Facility ID	County	County Code	Civil Town/City/ or Village
157053930	Sauk	57	Town of Merrimac

Sample: Number and Type	Sample: Length Att. & Recovered (in)	Blow Counts	Depth in Feet (Below ground surface)	SOIL ROCK DESCRIPTION	USCS	Graphic Log	Well Diagram	PID/FID	Soil Properties: Compressive Strength	Soil Properties: Moisture Content	Soil Properties: Liquid Limit	Soil Properties: Plasticity Index	Soil Properties: P 200	RQD/Comments
				Blind drilled to 110.24 feet No soil samples were collected Set well screen from 95.24-110.24 feet End of boring at 110.24 feet										

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Department of Natural Resources

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Route To: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☒ Other ☐ _____

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
Badger Army Ammunition Plant	3487	RIN-1001A

Boring Drilled by: Name of crew chief (first, last) and Firm	Date Drilling Started	Date Drilling Completed	Drilling Method
First Name: Roy Last Name: Buckenberger Firm: Layne Christensen Company	4/28/10	4/28/10	Rotosonic

WI Unique Well No	DNR Well ID No.	Well Name	Final Static Water	Surface Elevation	Borehole Diameter
VM169	480	RIN-1001A	785.27 Feet MSL	882.05 Feet MSL	7.0 inches

Local Grid Origin (estimated:) or Boring Location	Local Grid Location
State Plane 497066.20 N 2035220.81 E ¼ of ¼ of Section T R	_____ Feet N S _____ Feet E W

Facility ID	County	County Code	Civil Town/City/ or Village
157053930	Sauk	57	Town of Merrimac

Sample: Number and Type	Sample: Length Att. & Recovered (in)	Blow Counts	Depth in Feet (Below ground surface)	SOIL ROCK DESCRIPTION	USCS	Graphic Log	Well Diagram	PID/FID	Soil Properties: Compressive Strength	Soil Properties: Moisture Content	Soil Properties: Liquid Limit	Soil Properties: Plasticity Index	Soil Properties: P 200	RQD/Comments
				Blind drilled to 106.8 feet No soil samples were collected Set well screen from 91.8-106.8 feet End of boring at 106.8 feet										

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Department of Natural Resources

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Form 4400-122

Route To: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☒ Other ☐ _____

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
Badger Army Ammunition Plant	3487	RIN-1001C

Boring Drilled by: Name of crew chief (first, last) and Firm	Date Drilling Started	Date Drilling Completed	Drilling Method
First Name: Roy Last Name: Buckenberger Firm: Layne Christensen Company	5/24/10	5/24/10	Rotosonic

WI Unique Well No	DNR Well ID No.	Well Name	Final Static Water	Surface Elevation	Borehole Diameter
VM170	481	RIN-1001C	785.30 Feet MSL	882.01 Feet MSL	7.0 inches

Local Grid Origin (estimated:) or Boring Location	Local Grid Location
State Plane 497096.68 N 2035224.60 E ¼ of ¼ of Section T R	N E _____ Feet S _____ Feet W

Facility ID	County	County Code	Civil Town/City/ or Village
157053930	Sauk	57	Town of Merrimac

Sample: Number and Type	Sample: Length Att. & Recovered (in)	Blow Counts	Depth in Feet (Below ground surface)	SOIL ROCK DESCRIPTION	USCS	Graphic Log	Well Diagram	PID/FID	Soil Properties: Compressive Strength	Soil Properties: Moisture Content	Soil Properties: Liquid Limit	Soil Properties: Plasticity Index	Soil Properties: P 200	RQD/Comments
				Blind drilled to 181.41 feet No soil samples were collected Set well screen from 176.41-181.41 feet End of boring at 181.41 feet										

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Department of Natural Resources

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Form 4400-122

Route To: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☒ Other ☐ _____

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
Badger Army Ammunition Plant	3487	RIN-1002A

Boring Drilled by: Name of crew chief (first, last) and Firm	Date Drilling Started	Date Drilling Completed	Drilling Method
First Name: Roy Last Name: Buckenberger Firm: Layne Christensen Company	5/4/10	5/4/10	Rotosonic

WI Unique Well No	DNR Well ID No.	Well Name	Final Static Water	Surface Elevation	Borehole Diameter
VM176	492	RIN-1002A	776.92 Feet MSL	860.46 Feet MSL	7.0 inches

Local Grid Origin (estimated:) or Boring Location	Local Grid Location
State Plane 492556.37 N 2046081.69 E ¼ of ¼ of Section T R	_____ Feet N S _____ Feet E W

Facility ID	County	County Code	Civil Town/City/ or Village
157053930	Sauk	57	Town of Merrimac

Sample: Number and Type	Sample: Length Att. & Recovered (in)	Blow Counts	Depth in Feet (Below ground surface)	SOIL ROCK DESCRIPTION	USCS	Graphic Log	Well Diagram	PID/FID	Soil Properties: Compressive Strength	Soil Properties: Moisture Content	Soil Properties: Liquid Limit	Soil Properties: Plasticity Index	Soil Properties: P 200	RQD/Comments
				Blind drilled to 92.2 feet No soil samples were collected Set well screen from 77.2- 92.2 feet End of boring at 92.2 feet										

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Department of Natural Resources

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Form 4400-122

Route To: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☒ Other ☐ _____

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
Badger Army Ammunition Plant	3487	RIN-1002C

Boring Drilled by: Name of crew chief (first, last) and Firm	Date Drilling Started	Date Drilling Completed	Drilling Method
First Name: Roy Last Name: Buckenberger Firm: Layne Christensen Company	6/1/10	6/1/10	Rotosonic

WI Unique Well No	DNR Well ID No.	Well Name	Final Static Water	Surface Elevation	Borehole Diameter
VM177	493	RIN-1002C	776.84 Feet MSL	860.86 Feet MSL	7.0 inches

Local Grid Origin (estimated:) or Boring Location	Local Grid Location
State Plane 492568.67 N 2046078.50 E ¼ of ¼ of Section T R	N S _____ Feet E W _____ Feet

Facility ID	County	County Code	Civil Town/City/ or Village
157053930	Sauk	57	Town of Merrimac

Sample: Number and Type	Sample: Length Att. & Recovered (in)	Blow Counts	Depth in Feet (Below ground surface)	SOIL ROCK DESCRIPTION	USCS	Graphic Log	Well Diagram	PID/FID	Soil Properties: Compressive Strength	Soil Properties: Moisture Content	Soil Properties: Liquid Limit	Soil Properties: Plasticity Index	Soil Properties: P 200	RQD/Comments
				Blind drilled to 179.8 feet No soil samples were collected Set well screen from 174.8- 179.8 feet End of boring at 179.8 feet										

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Route To: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☒ Other ☐ _____

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
Badger Army Ammunition Plant	3487	RIN-1003A

Boring Drilled by: Name of crew chief (first, last) and Firm	Date Drilling Started	Date Drilling Completed	Drilling Method
First Name: Roy Last Name: Buckenberger Firm: Layne Christensen Company	5/5/10	5/5/10	Rotosonic

WI Unique Well No	DNR Well ID No.	Well Name	Final Static Water	Surface Elevation	Borehole Diameter
VM179	495	RIN-1003A	773.87 Feet MSL	854.66 Feet MSL	7.0 inches

Local Grid Origin (estimated:) or Boring Location	Local Grid Location
State Plane 489061.45 N 2044797.07 E ¼ of ¼ of Section T R	_____ Feet N S _____ Feet E W

Facility ID	County	County Code	Civil Town/City/ or Village
157053930	Sauk	57	Town of Merrimac

Sample: Number and Type	Sample: Length Att. & Recovered (in)	Blow Counts	Depth in Feet (Below ground surface)	SOIL ROCK DESCRIPTION	USCS	Graphic Log	Well Diagram	PID/FID	Soil Properties: Compressive Strength	Soil Properties: Moisture Content	Soil Properties: Liquid Limit	Soil Properties: Plasticity Index	Soil Properties: P 200	RQD/Comments
				Blind drilled to 90.5 feet No soil samples were collected Set well screen from 75.5- 90.5 feet End of boring at 90.5 feet										

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Route To: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☒ Other ☐ _____

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
Badger Army Ammunition Plant	3487	RIN-1004B

Boring Drilled by: Name of crew chief (first, last) and Firm	Date Drilling Started	Date Drilling Completed	Drilling Method
First Name: Roy Last Name: Buckenberger Firm: Layne Christensen Company	5/13/10	5/13/10	Rotosonic

WI Unique Well No	DNR Well ID No.	Well Name	Final Static Water	Surface Elevation	Borehole Diameter
VM182	498	RIN-1004B	770.55 Feet MSL	856.74 Feet MSL	7.0 inches

Local Grid Origin (estimated:) or Boring Location	Local Grid Location
State Plane 486645.01 N 2044721.14 E ¼ of ¼ of Section T R	_____ Feet N S _____ Feet E W

Facility ID	County	County Code	Civil Town/City/ or Village
157053930	Sauk	57	Town of Merrimac

Sample: Number and Type	Sample: Length Att. & Recovered (in)	Blow Counts	Depth in Feet (Below ground surface)	SOIL ROCK DESCRIPTION	USCS	Graphic Log	Well Diagram	PID/FID	Soil Properties: Compressive Strength	Soil Properties: Moisture Content	Soil Properties: Liquid Limit	Soil Properties: Plasticity Index	Soil Properties: P 200	RQD/Comments
				Blind drilled to 146.7 feet No soil samples were collected Set well screen from 141.7-146.7 feet End of boring at 146.7 feet										

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Remediation/Redevelopment ☒ Other ☐ _____

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
Badger Army Ammunition Plant	3487	RIN-1005A

Boring Drilled by: Name of crew chief (first, last) and Firm	Date Drilling Started	Date Drilling Completed	Drilling Method
First Name: Roy Last Name: Buckenberger Firm: Layne Christensen Company	5/17/10	5/17/10	Rotosonic

WI Unique Well No	DNR Well ID No.	Well Name	Final Static Water	Surface Elevation	Borehole Diameter
VM180	496	RIN-1005A	775.27 Feet MSL	826.74 Feet MSL	7.0 inches

Local Grid Origin (estimated:) or Boring Location	Local Grid Location
State Plane 489310.71 N 2045864.38 E ¼ of ¼ of Section T R	_____ Feet N S _____ Feet E W

Facility ID	County	County Code	Civil Town/City/ or Village
157053930	Sauk	57	Town of Merrimac

Sample: Number and Type	Sample: Length Att. & Recovered (in)	Blow Counts	Depth in Feet (Below ground surface)	SOIL ROCK DESCRIPTION	USCS	Graphic Log	Well Diagram	PID/FID	Soil Properties: Compressive Strength	Soil Properties: Moisture Content	Soil Properties: Liquid Limit	Soil Properties: Plasticity Index	Soil Properties: P 200	RQD/Comments
				Blind drilled to 60.5 feet No soil samples were collected Set well screen from 45.5- 60.5 feet End of boring at 60.5 feet										

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature: *Joel Janssen* Firm: SpecPro, Inc.

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State of Wisconsin
Department of Natural Resources

SOIL BORING LOG INFORMATION
Form 4400-122

Route To: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☒ Other ☐ _____

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
Badger Army Ammunition Plant	3487	RIN-1005C

Boring Drilled by: Name of crew chief (first, last) and Firm	Date Drilling Started	Date Drilling Completed	Drilling Method
First Name: Roy Last Name: Buckenberger Firm: Layne Christensen Company	5/17/10	5/17/10	Rotosonic

WI Unique Well No	DNR Well ID No.	Well Name	Final Static Water	Surface Elevation	Borehole Diameter
VM181	497	RIN-1005C	774.33 Feet MSL	826.49 Feet MSL	7.0 inches

Local Grid Origin (estimated:) or Boring Location	Local Grid Location
State Plane 489316.84 N 2045864.92 E ¼ of ¼ of Section T R	_____ Feet N S _____ Feet E W

Facility ID	County	County Code	Civil Town/City/ or Village
157053930	Sauk	57	Town of Merrimac

Sample: Number and Type	Sample: Length Att. & Recovered (in)	Blow Counts	Depth in Feet (Below ground surface)	SOIL ROCK DESCRIPTION	USCS	Graphic Log	Well Diagram	PID/FID	Soil Properties: Compressive Strength	Soil Properties: Moisture Content	Soil Properties: Liquid Limit	Soil Properties: Plasticity Index	Soil Properties: P 200	RQD/Comments
				Blind drilled to 147 feet No soil samples were collected Set well screen from 142-147 feet End of boring at 147 feet										

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature: *Joel Janssen* Firm: SpecPro, Inc.

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State of Wisconsin
Department of Natural Resources

SOIL BORING LOG INFORMATION
Form 4400-122

Route To: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☒ Other ☐ _____

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
Badger Army Ammunition Plant	3487	RIN-1006A

Boring Drilled by: Name of crew chief (first, last) and Firm	Date Drilling Started	Date Drilling Completed	Drilling Method
First Name: Roy Last Name: Buckenberger Firm: Layne Christensen Company	5/18/10	5/18/10	Rotosonic

WI Unique Well No	DNR Well ID No.	Well Name	Final Static Water	Surface Elevation	Borehole Diameter
VM172	483	RIN-1006A	785.99 Feet MSL	870.94 Feet MSL	7.0 inches

Local Grid Origin (estimated:) or Boring Location	Local Grid Location
State Plane 494635.26 N 2031718.11 E ¼ of ¼ of Section T R	_____ Feet N S _____ Feet E W

Facility ID	County	County Code	Civil Town/City/ or Village
157053930	Sauk	57	Town of Merrimac

Sample: Number and Type	Sample: Length Att. & Recovered (in)	Blow Counts	Depth in Feet (Below ground surface)	SOIL ROCK DESCRIPTION	USCS	Graphic Log	Well Diagram	PID/FID	Soil Properties: Compressive Strength	Soil Properties: Moisture Content	Soil Properties: Liquid Limit	Soil Properties: Plasticity Index	Soil Properties: P 200	RQD/Comments
				Blind drilled to 100.38 feet No soil samples were collected Set well screen from 85.38-100.38 feet End of boring at 100.38 feet										

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature: *Joel Janssen* Firm: SpecPro, Inc.

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State of Wisconsin
Department of Natural Resources

SOIL BORING LOG INFORMATION
Form 4400-122

Route To: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☒ Other ☐ _____

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
Badger Army Ammunition Plant	3487	RIN-1006C

Boring Drilled by: Name of crew chief (first, last) and Firm	Date Drilling Started	Date Drilling Completed	Drilling Method
First Name: Roy Last Name: Buckenberger Firm: Layne Christensen Company	5/18/10	5/18/10	Rotosonic

WI Unique Well No	DNR Well ID No.	Well Name	Final Static Water	Surface Elevation	Borehole Diameter
VM173	484	RIN-1006C	785.45 Feet MSL	870.89 Feet MSL	7.0 inches

Local Grid Origin (estimated:) or Boring Location	Local Grid Location
State Plane 494632.57 N 2031731.00 E ¼ of ¼ of Section T R	_____ Feet N S _____ Feet E W

Facility ID	County	County Code	Civil Town/City/ or Village
157053930	Sauk	57	Town of Merrimac

Sample: Number and Type	Sample: Length Att. & Recovered (in)	Blow Counts	Depth in Feet (Below ground surface)	SOIL ROCK DESCRIPTION	USCS	Graphic Log	Well Diagram	PID/FID	Soil Properties: Compressive Strength	Soil Properties: Moisture Content	Soil Properties: Liquid Limit	Soil Properties: Plasticity Index	Soil Properties: P 200	RQD/Comments
				Blind drilled to 180.35 feet No soil samples were collected Set well screen from 175.35-180.35 feet End of boring at 180.35 feet										

I hereby certify that the information on this form is true and correct to the best of my knowledge.

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State of Wisconsin
Department of Natural Resources

SOIL BORING LOG INFORMATION
Form 4400-122

Route To: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☒ Other ☐ _____

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
Badger Army Ammunition Plant	3487	RIN-1007C

Boring Drilled by: Name of crew chief (first, last) and Firm	Date Drilling Started	Date Drilling Completed	Drilling Method
First Name: Roy Last Name: Buckenberger Firm: Layne Christensen Company	6/14/10	6/15/10	Rotosonic

WI Unique Well No	DNR Well ID No.	Well Name	Final Static Water	Surface Elevation	Borehole Diameter
VM168	479	RIN-1007C	786.18 Feet MSL	881.41 Feet MSL	7.0 inches

Local Grid Origin (estimated:) or Boring Location	Local Grid Location
State Plane 497857.57 N 2035155.19 E ¼ of ¼ of Section T R	_____ Feet N S _____ Feet E W

Facility ID	County	County Code	Civil Town/City/ or Village
157053930	Sauk	57	Town of Merrimac

Sample: Number and Type	Sample: Length Att. & Recovered (in)	Blow Counts	Depth in Feet (Below ground surface)	SOIL ROCK DESCRIPTION	USCS	Graphic Log	Well Diagram	PID/FID	Soil Properties: Compressive Strength	Soil Properties: Moisture Content	Soil Properties: Liquid Limit	Soil Properties: Plasticity Index	Soil Properties: P 200	RQD/Comments
				Blind drilled to 175.3 feet No soil samples were collected Set well screen from 170.3-175.3 feet End of boring at 175.3 feet										

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature: *Joel Janssen* Firm: SpecPro, Inc.

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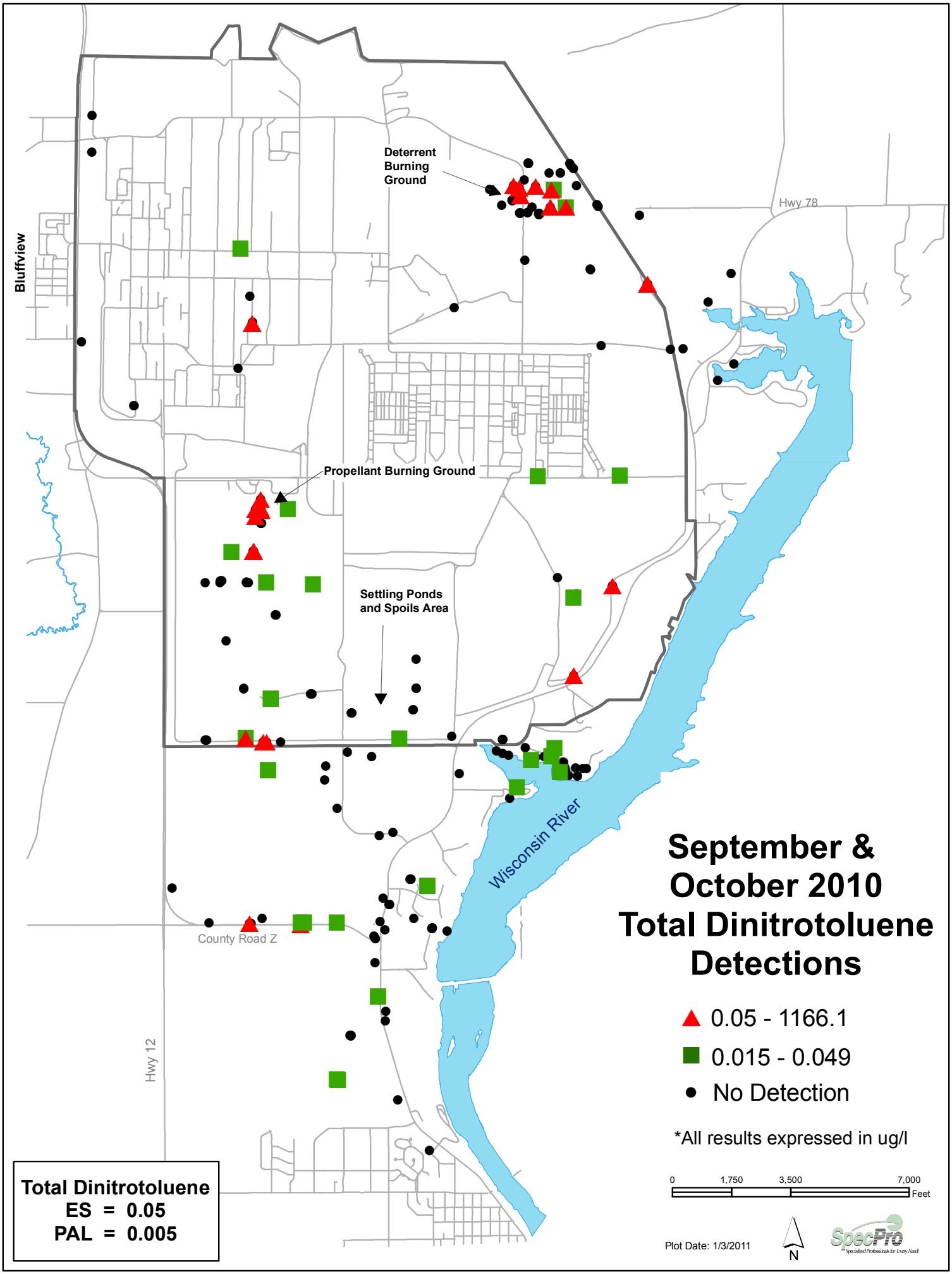
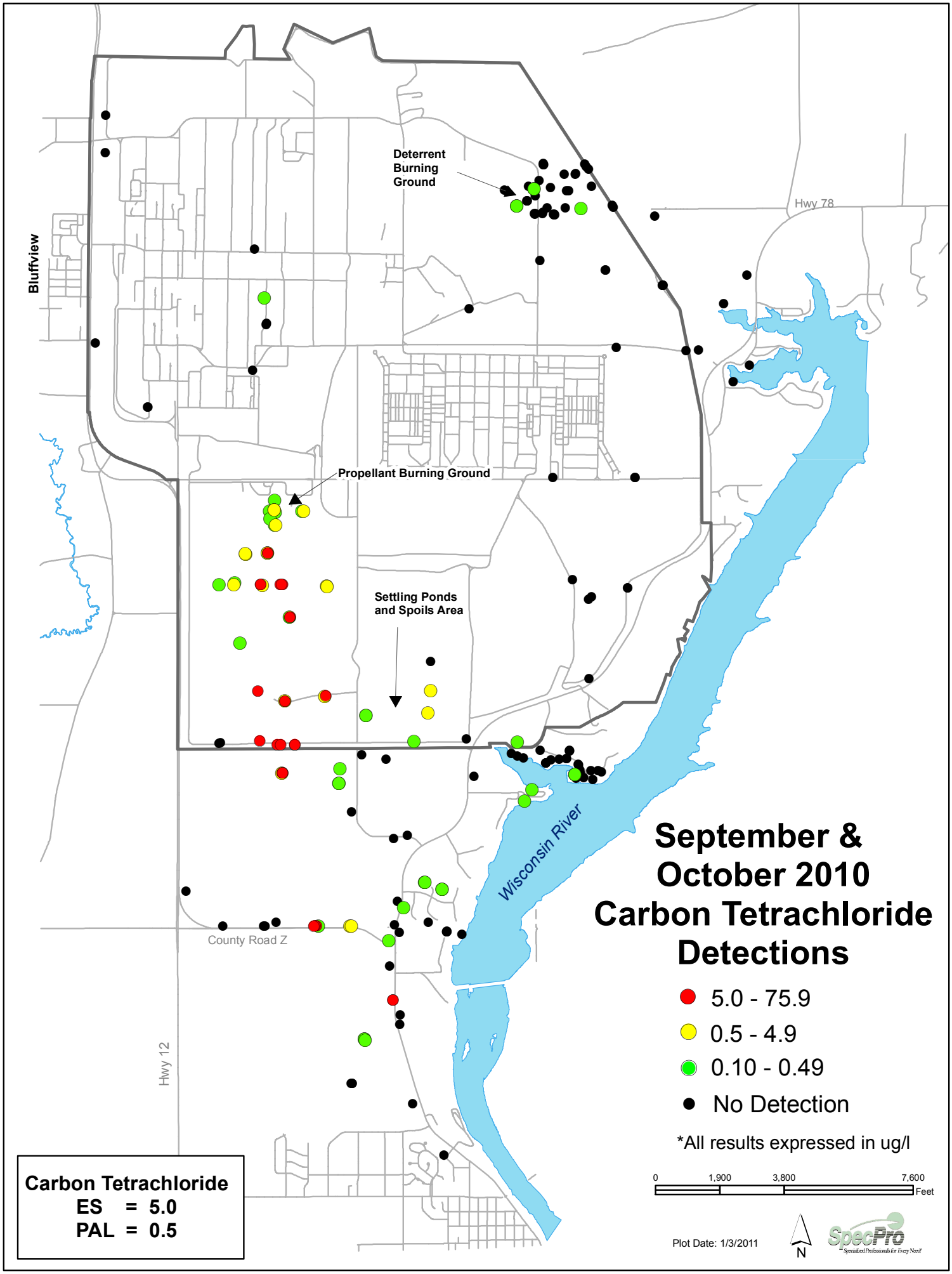
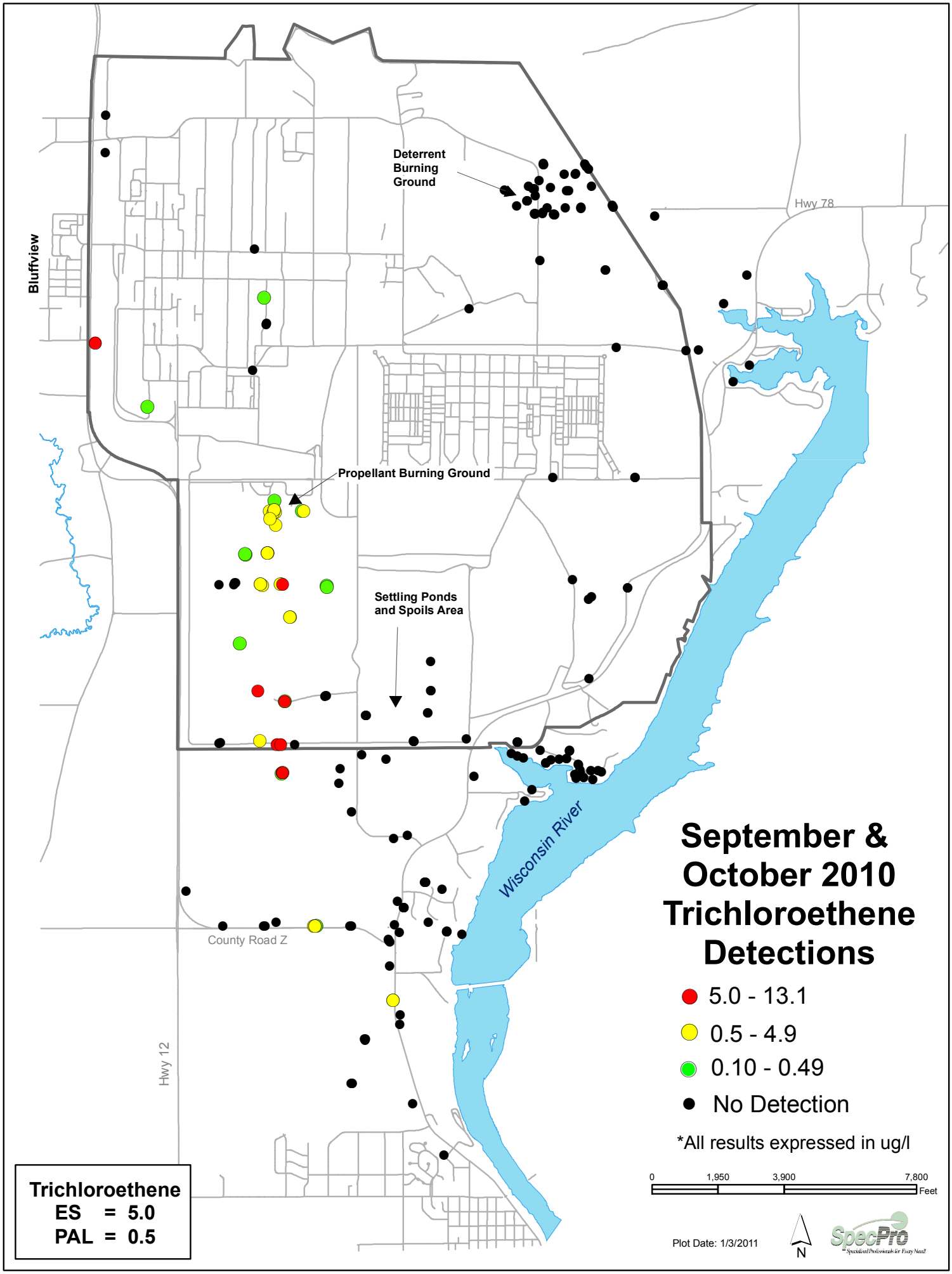
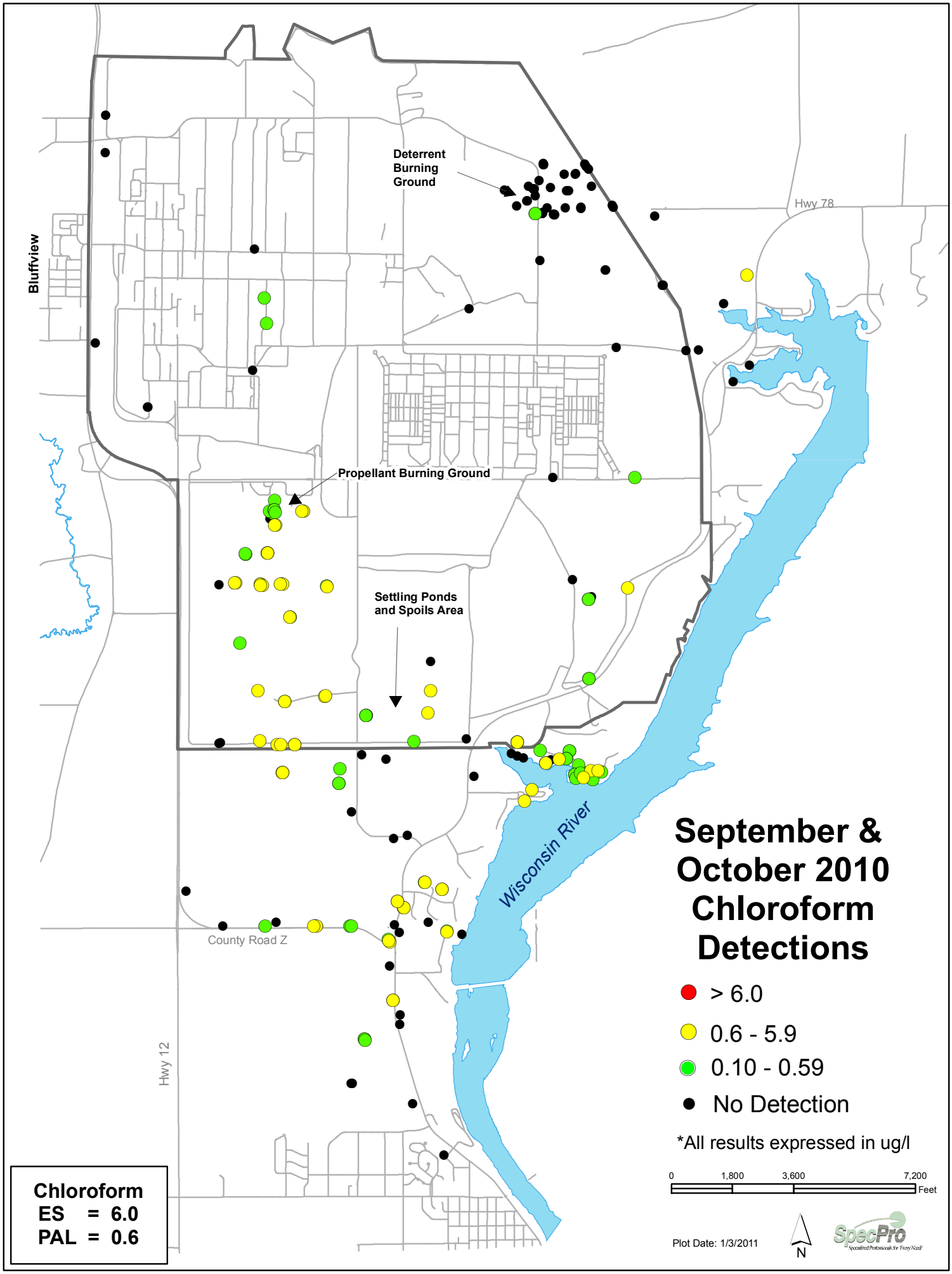
Appendix B

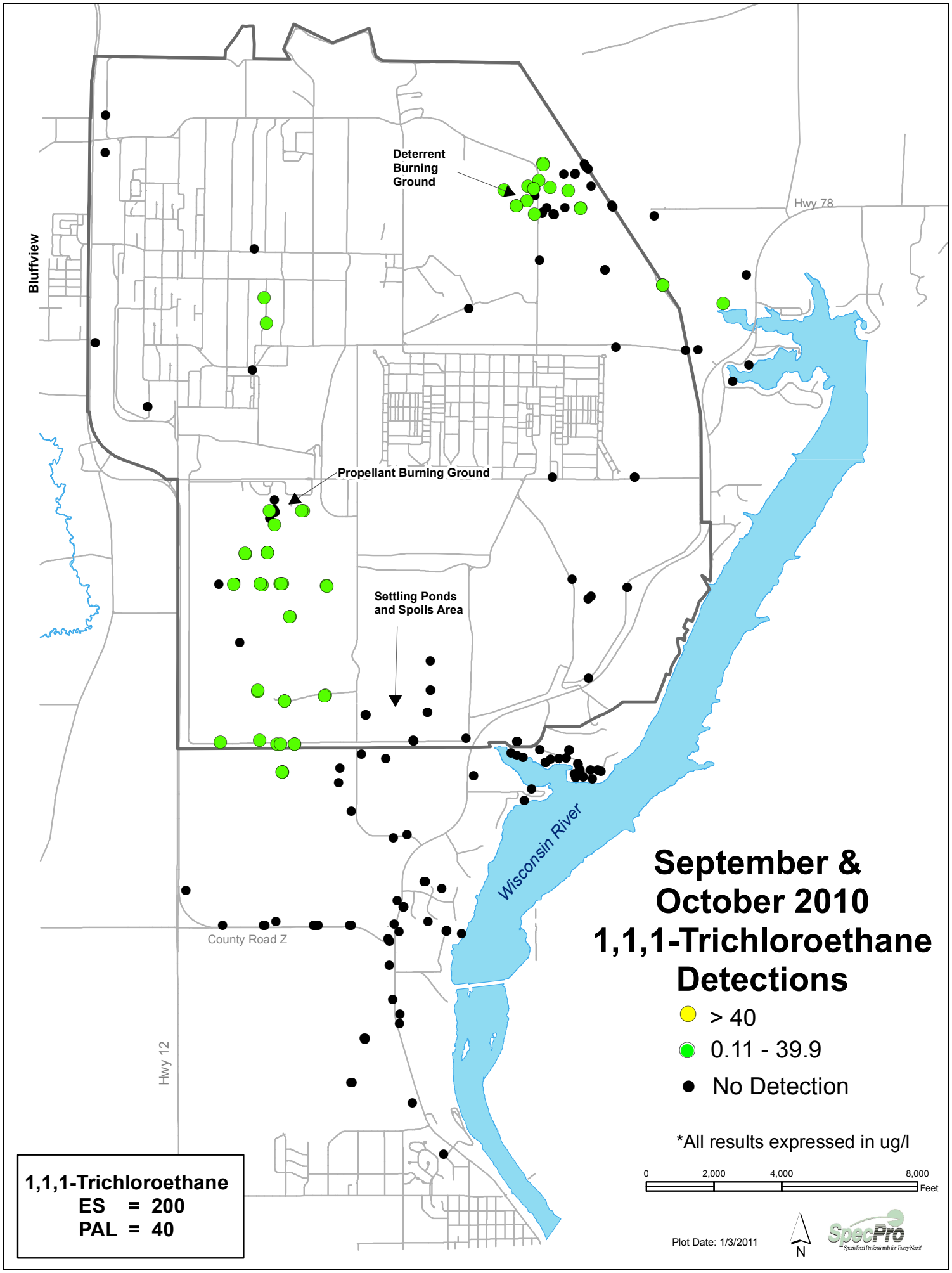
September and October 2010 Contaminant Concentration Maps

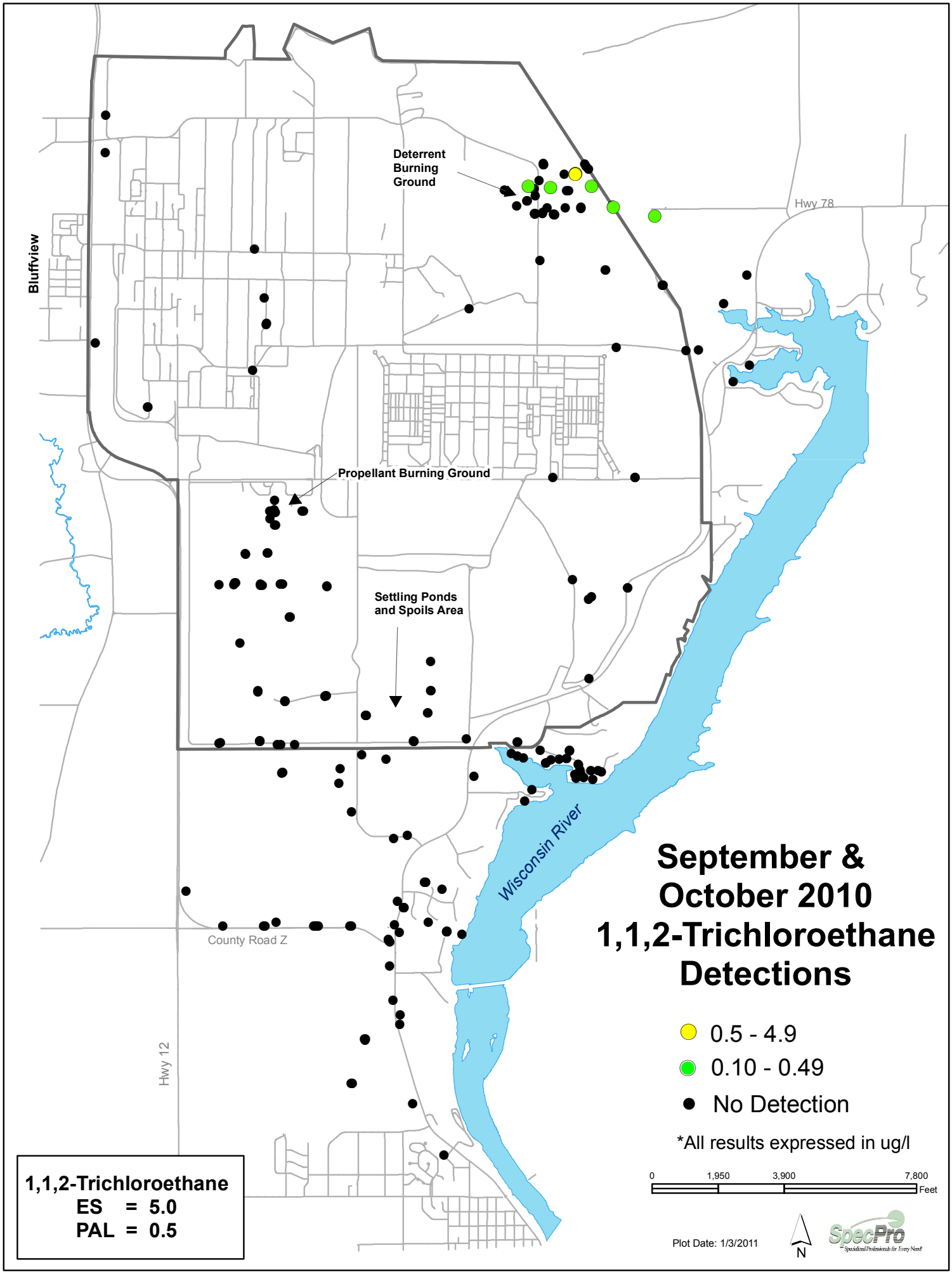

Deterrent Burning Ground
Propellant Burning Ground
Settling Ponds and Spoils Area
Bluffview
Hwy 78
Hwy 12
County Road Z
Wisconsin River
September & October 2010 Total Dinitrotoluene Detections
0.05 - 1166.1
0.015 - 0.049
No Detection
*All results expressed in ug/l
0
1,750
3,500
7,000
Feet
Plot Date: 1/3/2011
N
SpecPro
Specialized Professionals for Every Need!
Total Dinitrotoluene
ES = 0.05
PAL = 0.005

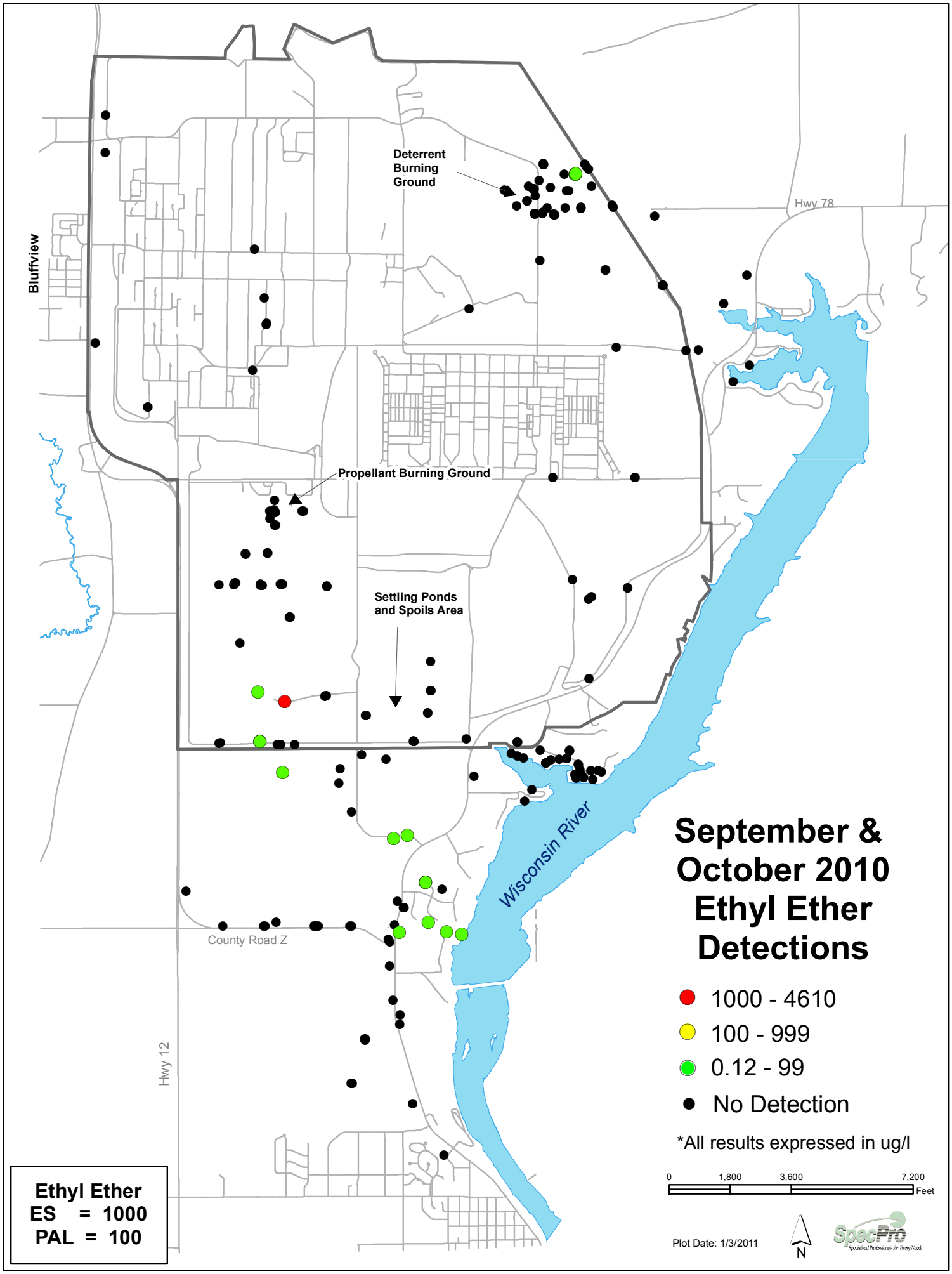

Deterrent Burning Ground
Hwy 78
Bluffview
Propellant Burning Ground
Settling Ponds and Spoils Area
Wisconsin River
County Road Z
Hwy 12
September & October 2010 Carbon Tetrachloride Detections
5.0 - 75.9
0.5 - 4.9
0.10 - 0.49
No Detection
*All results expressed in ug/l
0
1,900
3,800
7,600
Feet
Plot Date: 1/3/2011
N
SpecPro
Carbon Tetrachloride
ES = 5.0
PAL = 0.5

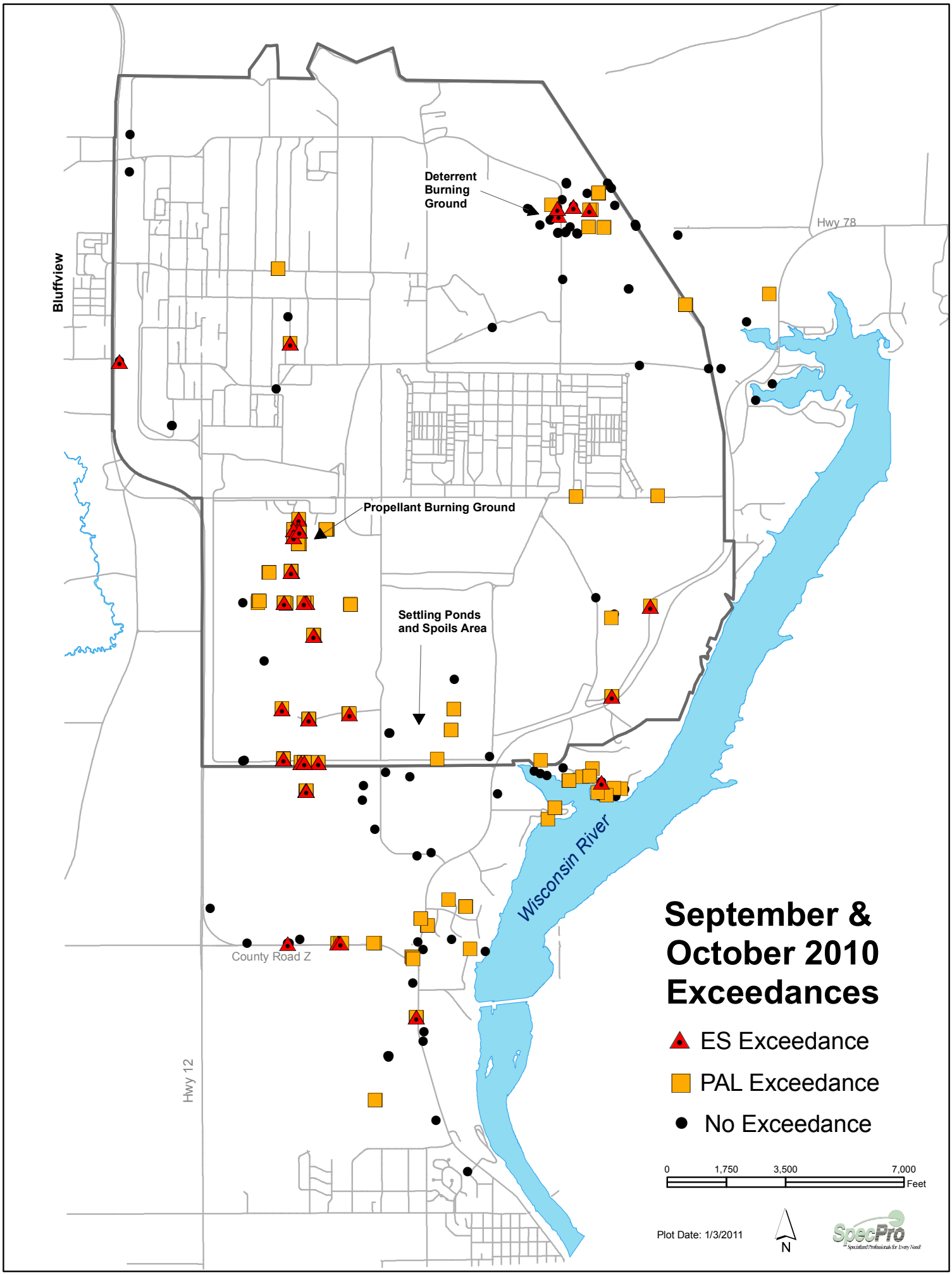

Deterrent Burning Ground
Hwy 78
Bluffview
Propellant Burning Ground
Settling Ponds and Spoils Area
Wisconsin River
County Road Z
Hwy 12
September & October 2010 Trichloroethene Detections
5.0 - 13.1
0.5 - 4.9
0.10 - 0.49
No Detection
*All results expressed in ug/l
0
1,950
3,900
7,800
Feet
Trichloroethene
ES = 5.0
PAL = 0.5
Plot Date: 1/3/2011
N
SpecPro


Deterrent Burning Ground
Propellant Burning Ground
Settling Ponds and Spoils Area
Bluffview
Hwy 78
Hwy 12
County Road Z
Wisconsin River
September & October 2010 Chloroform Detections
> 6.0
0.6 - 5.9
0.10 - 0.59
No Detection
*All results expressed in ug/l
0
1,800
3,600
7,200
Feet
Plot Date: 1/3/2011
N
SpecPro
Specialized Professionals for Every Need!
Chloroform
ES = 6.0
PAL = 0.6


Deterrent Burning Ground
Propellant Burning Ground
Settling Ponds and Spoils Area
Bluffview
Hwy 78
Hwy 12
County Road Z
Wisconsin River
September & October 2010 1,1,1-Trichloroethane Detections
> 40
0.11 - 39.9
No Detection
*All results expressed in ug/l
0
2,000
4,000
8,000
Feet
Plot Date: 1/3/2011
N
SpecPro
Specialized Professionals for Every Need!
1,1,1-Trichloroethane
ES = 200
PAL = 40


Deterrent Burning Ground
Hwy 78
Bluffview
Propellant Burning Ground
Settling Ponds and Spoils Area
Wisconsin River
County Road Z
Hwy 12
September & October 2010 1,1,2-Trichloroethane Detections
0.5 - 4.9
0.10 - 0.49
No Detection
*All results expressed in ug/l
0
1,950
3,900
7,800
Feet
Plot Date: 1/3/2011
N
SpecPro
Specialized Professionals for Every Need!
1,1,2-Trichloroethane
ES = 5.0
PAL = 0.5


Deterrent Burning Ground
Propellant Burning Ground
Settling Ponds and Spoils Area
Bluffview
Hwy 78
Wisconsin River
County Road Z
Hwy 12
September & October 2010 Ethyl Ether Detections
1000 - 4610
100 - 999
0.12 - 99
No Detection
*All results expressed in ug/l
0
1,800
3,600
7,200
Feet
Plot Date: 1/3/2011
N
SpecPro
Specialized Professionals for Every Need!
Ethyl Ether
ES = 1000
PAL = 100


Deterrent Burning Ground
Hwy 78
Bluffview
Propellant Burning Ground
Settling Ponds and Spoils Area
Wisconsin River
County Road Z
Hwy 12
September & October 2010 Exceedances
ES Exceedance
PAL Exceedance
No Exceedance
0
1,750
3,500
7,000
Feet
Plot Date: 1/3/2011
N
SpecPro

Badger Army Ammunition Plant

September 2010 Sampled Wells

Sampled Well

N
W E
S

Map Scale 1:10,000

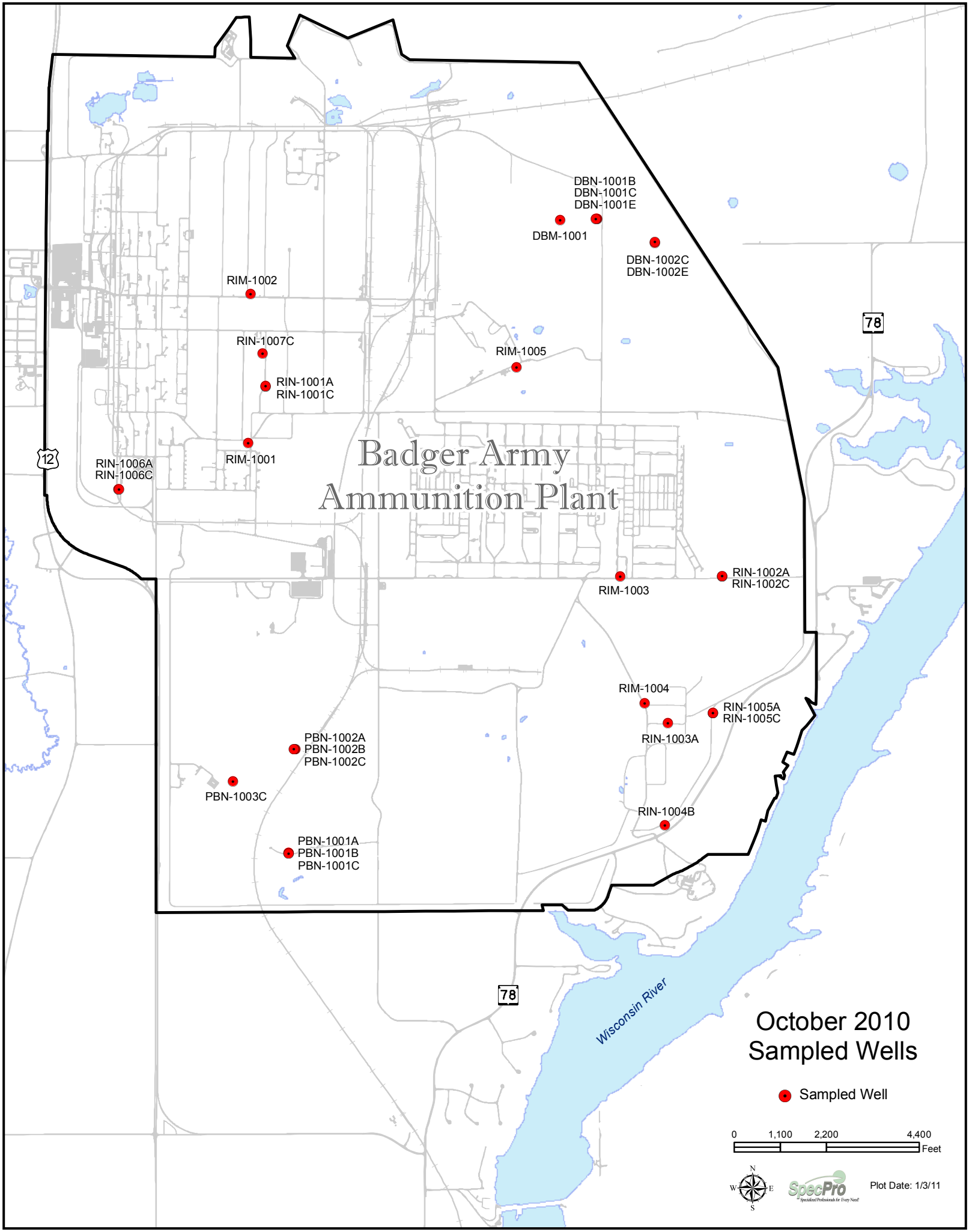
0 850 1,700 3,400 5,100 6,800 Feet

SpecPro
Specialized Professionals for Every Need!

Plot Date: 12/7/10

Wisconsin River

BGM-9101
Orbitec
BGM-9102
BGM-9103
ELN-8204A
ELN-8204B
ELN-8204C
ELN-8904A
ELN-8904B
ELM-9110
S1134R
ELM-8909
DBM-8202
ELN-8203A
ELN-8203B
ELN-8203C
ELM-8901
ELM-8903
DBN-8201B
DBN-8201C
DBM-8201
ELN-9402AR
ELN-8902B
S1122
DBM-8905
DBM-8903
ELM-8907
ELN-9107A
ELN-9107B
ELM-8908
DBN-9502A
DBN-9502B
DBN-9502C
DBN-8902A
DBN-8902B
DBN-9501A
DBN-9501B
DBN-9501C
DBN-9501E
Spear
DBM-9501
ELN-0802A
ELN-0802C
ELM-9501
ELN-0801B
ELN-0801C
ELN-0801E
Purcell-G
Purcell-Dan
NLM-0302R
S1121
Groth
Curto
Nowotarski
PBM-9801
PBM-0005
PBM-0001
LON-8903A
LON-8903B
PBM-0002
PBN-8202C
PBM-0008
PBN-8910A
PBN-8910C
PBN-8203A
PBN-8203C
PBN-8205A
PBN-8205B
PBN-8205C
PBN-8501A
PBN-8901C
PBN-8901D
PBM-8905
PBN-9301B
PBN-9301C
PBN-8503A
PBN-8903B
PBN-8903C
PBN-8502A
PBN-8902B
PBN-8902C
USDA 6
SPN-0401A
PBN-9112C
PBN-9112D
PBN-9303B
PBN-9303C
PBN-9303D
SPN-0402A
SPN-0402C
PBN-9402B
PBN-9402C
PBN-9402D
SPN-0403A
SPN-0403C
PBN-9902A
PBN-9902B
PBN-9902C
PBN-9902D
S1104
S1105
S1106
SPN-0404D
SPN-8902B
SPN-8902C
S1103
SPN-8904B
SPN-8904C
SPN-0406A
SPN-0406B
SPN-0406C
SEN-0503A
SEN-0503B
SEN-0503D
WE-RM383
WE-SQ001
SEN-0502B
Mittenzwei
Delaney
Goelz
Chamberlain
Brabender
WE-UK125
SEN-0502A
SEN-0502D
WE-QR441
WE-SQ017
WE-TM599
PBN-9903A
PBN-9903B
PBN-9903C
PBN-9903D
Nimmow
SEN-0501A
SEN-0501B
SEN-0501D
WE-TF023
WE-RR542
Weum
WE-RR598
Krumenauer
WE-UK124
WE-SQ002
Priebe
WE-QN039
WE-RD430
Crow
Ramaker-J
Hanson
Zander
SWN-0501B
SWN-0501C
SWN-0501D
SWN-0501E
Schlender
Kindschi-V
Judd
SWN-0502B
SWN-0502C
SWN-0502D
SWN-0502E
SWN-9103B
SWN-9103C
SWN-9103D
SWN-9103E
SWN-9104C
SWN-9104D
Lins-R
Urban
Lins-K
Hankins
SWN-9102C
SWN-9102D
Roth-G
Ellingson
SWN-9105B
SWN-9105C
SWN-9105D
SWN-0503B
SWN-0503C
SWN-0503D
SWN-0503E
Gruber-North
PBM-9001D
Mueller-J
Kirner
PBN-9102B
PBN-9102C
PBM-9002D
PBN-9103B
PBN-9103C
PBM-9003D
Cramer
PDS-3


Badger Army
Ammunition Plant
DBN-1001B
DBN-1001C
DBN-1001E
DBM-1001
DBN-1002C
DBN-1002E
RIM-1002
RIN-1007C
RIN-1001A
RIN-1001C
RIM-1005
RIM-1001
RIN-1006A
RIN-1006C
RIM-1003
RIN-1002A
RIN-1002C
RIM-1004
RIN-1005A
RIN-1005C
RIN-1003A
PBN-1002A
PBN-1002B
PBN-1002C
PBN-1003C
RIN-1004B
PBN-1001A
PBN-1001B
PBN-1001C
12
78
78
Wisconsin River
October 2010
Sampled Wells
Sampled Well
0
1,100
2,200
4,400
Feet
N
W
E
S
SpecPro
Plot Date: 1/3/11

Appendix C

Technical Memorandum – Groundwater Flow and Solute Transport Modeling

Technical Memorandum

Groundwater Flow and Solute Transport Modeling

Badger Army Ammunition Plant, Baraboo, Wisconsin

March, 2011

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PLATES

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1.0 Introduction

The Badger Army Ammunition Plant (BAAAP) is a 7,354 acre military installation located near Baraboo (Sauk County), in south central Wisconsin. Built in 1942 to manufacture gunpowders and propellants for the U.S. Army (Army), BAAAP ceased operations in 1975. Remedial investigation activities began at the site in the 1980's in response to several federal and state initiatives. Site restoration activities commenced soon afterward. The intent of the Army is to remediate, mitigate, restore or contain contamination so that the BAAAP property can be transferred from the Army to various public and private organizations. Remediation efforts at BAAAP have been successful, with over 1,900 acres of land already having been transferred.

The purpose of this memorandum is to present the technical approach, methodology and results associated with updating the existing site-wide groundwater flow model prepared for the BAAAP installation. The current project included the development of groundwater flow and solute transport sub-models to allow further evaluation of groundwater contaminant plumes identified at BAAAP. This work, performed in support of site restoration activities, was completed under contract to SpecPro Inc. (SpecPro). SpecPro is the contractor in charge of overseeing the various remediation efforts at BAAAP.

2.0 Background

2.1 Description of the Areas of Concern

BAAAP was used for the manufacture of various propellants for the military. The three areas of concern identified at BAAAP consist of the Propellant Burning Ground (PBG), the Central Plume Area, and the Deterrent Burning Ground (DBG), see **Figures 1 and 2.** Each is discussed further below.

<u>Propellant Burning Ground</u>

Previous subsurface investigations conducted during 1991 by ABB-ES, RUST during 1995 Predesign Activities, and Stone & Webster during 1997 Field Sampling Activities identified soil and groundwater contamination at and around the PBG. The PBG area, located within the southern portion of the BAAAP, covers approximately six (6) acres of land. Locations of concern within the PBG area include former waste disposal pits and an open area used for burning organic solvents, propellant contaminated wastes and lumber, as well as other process chemicals, including explosives and trichloroethylene (TCE).

Groundwater contaminants of concern at the PBG include 2,3-dinitrotoluene (2,3-DNT), 2,4-dinitrotoluene (2,4-DNT), 2,5-dinitrotoluene (2,5-DNT), 2,6-dinitrotoluene (2,6-DNT), 3,4-

dinitrotoluene (3,4-DNT), 3,5-dinitrotoluene (3,5-DNT), carbon tetrachloride (CTET), chloroform, 1,1,2-trichloroethylene (1,1,2-TCA), and TCE. In 1990, an interim remedial measure (IRM) groundwater treatment system was installed at the PBG. The system currently consisted of two groundwater extraction wells located hydraulically downgradient of the PBG and the greatest soil impacts. A modified IRM (MIRM) consisting of six extraction wells was subsequently installed along the southern boundary in a position hydraulically downgradient from the source. The MIRM system was installed in 1995 and then modified in 2005 by placing more extraction wells within the body of the plume.

Central Plume Area

The Central Plume does not have a specific source of contamination. It is believed that the broad area including the Rocket Paste and Rocket Production areas may have caused the groundwater impacts. Groundwater contaminants of concern in the Central Plume include 2,4-dinitrotoluene (2,4-DNT) and 2,6-dinitrotoluene (2,6-DNT).

Deterrent Burning Ground

The DBG is approximately seven acres in size and is located in the northeastern corner of BAAAP. It is an inactive disposal site, previously used for the open burning of deterrent, structural timbers, asphalt shingles, cardboard, papers, and office waste. The site had consisted of a two-acre, 20-feet deep, man-made depression consisting of two or three separate burn areas. It was used as a borrow pit and disposal site from the 1940s through the 1970s. Liquid waste, which included deterrent, was poured into the pits and ignited during the 1970s. Deterrent is a liquid extract of organic material used to modify the burning characteristics of nitrocellulose. Soil beneath the DBG was shown to be a source of groundwater contamination and is currently in the long-term monitoring phase of remediation. The DBG was capped in 2003 to restrict the remaining soil contamination from further contaminating the groundwater. Groundwater contaminants of concern at the DBG include 2,3-dinitrotoluene (2,3-DNT), 2,4-dinitrotoluene (2,4-DNT), 2,6-dinitrotoluene (2,6-DNT), 3,4-dinitrotoluene (3,4-DNT), 3,5-dinitrotoluene (3,5-DNT), and 1,1,2-trichloroethylene (1,1,2-TCA).

3.0 Project Objectives and Approach

The overall objectives of this groundwater modeling effort were to: (1) update the existing site-wide groundwater flow model developed for BAAAP, (2) develop contaminant (solute) transport models for the identified areas of groundwater contamination concern over specified time periods, and (3) use the information obtained from predictive modeling to guide efforts to evaluate and optimize site remediation and restoration activities. This work included:

(1) evaluating site geology and hydrogeology, including recent and current groundwater flow pathways across the BAAAP site,

(2) inputting representative site characterization data into a site-wide groundwater flow model for subsequent evaluation of groundwater flow patterns at the PBG, DBG and Central Plume areas;

(3) developing solute transport sub-models for the PBG, DBG and Central Plume areas, for the purpose of assessing present day groundwater contamination occurrence, and

(4) performing predictive model simulations to approximate the travel paths of the groundwater contaminant plumes over time.

The relative location of each sub-model area is shown on **Figure 2**. The work process flow for this project is also provided as **Figure 3**.

As shown, the project involved a review of historical and more recent site characterization data as it pertained to gaining an understanding of existing site conditions and the results of prior modeling efforts. Such data review was necessary to gain the perspective needed to identify the steps to be taken to (1) update the existing site-wide flow model, (2) update the groundwater flow and solute transport models developed for the PBG, and (3) develop sub-models for other areas of concern. The current project approach included reviewing the existing models for reasonableness, as well as reviewing prior modeling report recommendations and for the purpose of assessing model adjustments that would likely enhance the understanding of current and future contaminant trends at BAAAP. Finally, as with prior modeling efforts, the current project included looking at the effect that changes in the Interim Remedial Measures/Modified Interim Remedial Measures (IRM/MIRM) well configuration and pumping rates would exert on plume capture, and identifying potential strategies for optimizing existing remediation efforts.

4.0 Summary of Previous Models

4.1 ABB-ES

The original groundwater flow model for BAAAP consists of a two-dimensional (2D) regional groundwater flow model developed by ABB-ES in 1992. The 2D regional groundwater flow model developed by ABB-ES simulated an unconfined groundwater flow system in which the regional flow was assumed to be primarily horizontal.

The ABB ES model was constructed using the 1991 version of MODFLOW, developed by the U.S. Geological Survey (USGS). MODFLOW is a commonly used groundwater flow model which uses the finite difference methods to solve flow equations in three dimensions. The computer code consists of a structured package of independent modules that address features associated with a hydrologic system, including rivers, drains, wells, recharge and

evapotranspiration, as well as constant-head, general head and no-flow boundaries. Layers may be simulated as unconfined, confined, or a combination of both.

Solute transport was evaluated by using MT3DMS. MT3D is a modular 3D transport model used for the simulation of advection, dispersion and chemical reactions of dissolved constituents in groundwater (Zheng, 1990). In addition, groundwater flow patterns were evaluated using MODPATH, a particle tracking computer code that uses MODFLOW output to generate a set of pathlines from particles placed within the model domain.

Steady state simulations were performed on the ABB-ES model, and the model calibrated by using the data from a 1993 aquifer performance test. Based on the model results, ABB-ES estimated an average horizontal hydraulic conductivity (Kh) of 300 feet per day (ft/day) for the regional aquifer system at BAAAP. ABB-ES further suggested that the regional aquifer received water from the Wisconsin River, the eastern model boundary. While the ABB-ES model provided a general interpretive view of the groundwater flow pattern at the PBG, its use was limited due to uncertainties resulting from the lack of groundwater elevation data from the Wisconsin River streambed.

4.2 Woodward-Clyde

Woodward-Clyde (W-C) used data from the ABB-ES model to develop an embedded three dimensional (3D) model for the PBG. In 1994, W-C modified and recalibrated the ABB-ES flow model. The W-C model used revised aquifer parameters obtained from an aquifer test conducted along the southern boundary in 1993. PBG model revisions included extending the model domain further south and east so that the full extent of the groundwater contamination plume within the PBG was located within the model. The model grid was also extended to encompass the locations of proposed (additional) boundary control wells south of the PBG.

The W-C groundwater flow model was comprised of five model layers with a combined saturated thickness of 170 feet. Layers 1, 3, and 4 consisted of sand, whereas layer 2 was a mixture of sand and gravel. The bottom layer (layer 5) was reported to consist of a-30 foot gravel deposit sitting above impermeable bedrock. No intervening permeable layers separated the model layers, and the lateral extent of each stacked layer was assigned the same dimensions.

The W-C model was also constructed using the 1991 version of MODFLOW. The W-C PBG model was constructed using October 1989 water level data. Model calibration was based on steady state conditions. Twenty-seven (27) wells were selected as calibration points, and an average 0.57 foot difference between simulated and measured heads was reported. Following

model calibration, the W-C PBG flow model was verified using 1991 and 1993 water level data.

The W-C model simulated a 3D flow field centered at the known PBG contaminant source area. Boundary conditions were assigned based on the 2D regional flow model. Specifically, non-flow boundary conditions were assigned to both the east and west sides of the model domain. A fixed head boundary was assigned to the north and south sides of the model domain, representing uniform southward groundwater flow. W-C extended the PBG model domain south of the BAAAP boundary to minimize model boundary effects, and so groundwater flow observations could be evaluated in the area where additional extraction wells were planned. A steady-state, nonpumping calibration was performed, and the simulated heads were compared to observed heads at select locations measured on October 1989. The calibrated model indicated an average absolute error of 0.57 for the model domain. A Kh value of 325 ft/day was used, with the resulting model simulations showing a water balance of 0.23% greater inflow vs. outflow for Layers 1, 2, 3 and 4. Layer 5 was assigned a Kh of 340 ft/day.

The W-C flow model was calibrated to a steady-state condition and was verified against the water levels measured in 1991 and 1993, as well as the 1993 aquifer performance tests results. Verification indicated that the W-C model was capable of reproducing measured water level data after adjusting constant heads along the north and south boundaries of the model domain. The model predicted drawdown of 0.22 to 0.65 feet reasonably matched the actual drawdown of 0.1 to 0.51 feet observed during the 1993 aquifer performance test.

Following the completion of model calibration and verification, W-C performed capture zone analysis to assess potential strategies to exert further hydraulic control over the groundwater contaminant plume migrating from the PBG. Based on modeling results and recommendations, six (6) additional groundwater extraction wells were installed along the southern BAAAP boundary in 1996. Each extraction well was installed using a 135-foot screen length and was set to recover 500 gallons per minute (gpm). This action was undertaken as a modified interim remedial measure.

The W-C model did not evaluate the long-term effect that the pumping from the additional six extraction wells would exert on the model (or changes to the groundwater flow patterns).

4.3 The Shaw Group, Inc. (Shaw)

Information from the ABB-ES and W-C models was reviewed by the Shaw Group, Inc (Shaw), and its subcontractor, T N & Associates, Inc. (TN&A) prior to the completion of updated groundwater flow and solute transport models for the PBG. For this effort, Shaw used GMS – Ground Water Modeling System (version 3.1), a dynamic groundwater modeling system that

provides applications for site characterization, model development, model calibration, post-processing, and visualization. The version used by Shaw supported both finite-difference and finite-element models in 2D and 3D, including MODFLOW 2000, MODPATH and MT3DMS/RT3D.

The Shaw/TN&A model was considered valid to the stress and boundary conditions on which the model was developed. Shaw concluded however that model suitability needed to be re-evaluated to account for changes that may have occurred after the addition of the six MIRM wells. In 2006, Shaw completed a revised groundwater flow and solute transport model for the PBG. The regional (site-wide) groundwater flow model was also updated at this time. The Shaw 2006 models served as the basis for the current model update.

5.0 Current Model Scope of Work

The historical data used to develop the existing models at BAAAP was considered adequate to proceed with the development of an updated site-wide groundwater flow model for BAAAP and the PBG. The conceptual model and model domain in the current (updated) model were essentially the same as those used by Shaw, with a few modifications. No attempt was made to reconstruct the flow model for the purpose of verifying model input parameters.

Scope of work elements completed under the current modeling effort included:

- **Task 1. Background Data Review and Analysis** that included reviewing prior site characterization data as well as the previously developed models. Included the design and analysis of hydrogeological data for conceptual site model development.
- **Task 2. Site-Wide Groundwater Flow Model** refinement and update. This effort included completing a pre-model assessment; model flow assessment; model calibration and verification; water balance evaluation; model sensitivity analysis; and groundwater flow model deliverables.
- **Task 3. PBG Groundwater Flow Model** approach development and refinement that included PBG sub-model setup; model calibration and verification; water balance evaluation; model sensitivity analysis; and PBG flow sub-model deliverables.
- **Task 4. PBG Solute Transport Model** development that required an approach to refine the existing solute transport model. This task included PBG sub-model setup; sub-model calibration and verification; predictive model simulations; concentration sensitivity analysis; and PBG solute transport sub-model deliverables.
- **Task 5. Optimization Modeling for the PBG MIRM** that included performing MODPATH particle tracking and optimization modeling simulations for current and future out-years.

- **Task 6. Central Plume Area Groundwater Flow Model** development that included pre-model assessment; sub-model assessment; sub-model calibration and verification; water balance evaluation; sub-model sensitivity analysis; and groundwater flow sub-model deliverables.
- **Task 7. Central Plume Area Solute Transport Model** to include sub-model setup; sub-model calibration and verification; predictive model simulations; concentration sensitivity analysis; and solute transport sub-model deliverables.
- **Task 8. DBG Groundwater Flow Model** development that included pre-model assessment; DBG sub-model flow assessment; sub-model calibration and verification; water balance evaluation; sensitivity analysis; and DBG groundwater flow sub-model deliverables.
- **Task 9. DBG Solute Transport Model** development that consisted of developing an approach to refine the existing solute transport model. This task included DBG sub-model setup; sub-model calibration and verification; predictive model simulations; concentration sensitivity analysis; and DBG solute transport sub-model deliverables.

Information regarding the completion of each task is provided in the following sections of the report.

6.0 Background Data Review and Pre-Model Assessment

The model domain employed for the current site-wide groundwater model update is the same as used by Shaw. The grid spacing has been adjusted from the variable grid spacing used by Shaw, which ranged from 150 by 150 feet within the PBG, to 500 by 500 feet elsewhere. For the model update, a constant grid spacing of 150 by 150 feet has been used to provide more refinement across the model domain, and an acceptable framework for sub-model development. The model domain, grid distribution and well locations associated with the model update are shown on **Figure 4.** Monitoring wells, extraction wells and piezometers located within the model domain and used during the model update are provided on **Table 1**. Non-flow boundary conditions were assigned by Shaw for the east and west sides of the model domain, and a fixed head boundary was assigned to the north and south sides of the model domain, representing uniform southward groundwater flow. The boundary conditions used by Shaw were retained for the model update (with slight exceptions as noted later in this report). The flow model boundary and initial conditions are shown on **Figure 5**. A map of the BAAAP site showing the wells in the modeling domain is provided in the Draft Alternative Feasibility Study Report.

6.1 Site-Wide Groundwater Flow Model (Shaw)

Comparison of head contours generated by the Shaw regional groundwater flow model (PEST03) indicates that the qualitative distribution of error is reasonable. In general, good

spatial distribution of calibration and verification points is observed within and adjacent to the presumed area of groundwater contamination. A more quantitative analysis of the distribution of error confirms this opinion although there are a few items worth mentioning:

- Higher calibration errors occur in the northwest portion of the model domain, in the vicinity of BGM-9101, BGM-9102 and BGM-9103, where the residual error ranged from -8.04 feet to -25.4 feet. Re-examination (and necessary adjustments) of the input parameter values and boundary conditions will be performed during the model update. Due to the steepening hydraulic gradient between BGM-9101 and BGM-9102, the model update included a relook at the distribution of soil types, well construction data, and the long-term water level data collected from these wells.
- The majority of the calibration errors were noted along the east side of the modeling domain, including the DBG Area. It is expected that the observed error is largely due to inherent uncertainties regarding local geology and hydrogeology, including how realistically the model establishes the interconnection between the local groundwater flow system and the adjacent Wisconsin River. Further review of the input parameters and boundary conditions specified in the regional groundwater flow model was performed in the model update to determine whether model calibration can be improved. Additionally, further review of the soil types observed at the DBG was performed during the model update to assess whether the number of layers and grid spacing used in the current model is appropriate or in need of readjustment.

6.2 PBG Area (Shaw, TN&A)

Fairly good spatial distribution of calibration and verification points was noted in the model that Shaw developed for the PBG area. Control points are located both within and adjacent to the presumed area of groundwater contamination, although additional data points in the center of the contamination plume area may have assisted with solute transport model development. Twenty-seven (27) calibration wells and 69 verification wells were used during the development of TN&A's PBG groundwater flow model. In general, good spatial distribution and occurrence of control points is noted. Several of the wells used during the development of the Shaw model were not sampled during March and/or September 2010 however, restricting opportunity to compare data trends in the model update.

The site-wide groundwater flow model developed by Shaw (PEST03) used 116 wells for model calibration at the PBG Area. Adjustments to the model parameters and boundary conditions have been performed during preparation of the updated model to evaluate whether the residual head error can be reduced in the area of Weigand's Bay and along the Wisconsin River.

6.3 DBG Area (Shaw)

The spatial distribution of calibration/verification targets used by Shaw for the development of its DBG groundwater flow model is adequate. Thirty-six (36) wells located within and adjacent to the presumed area of groundwater contamination were sampled during March 2010 and/or September 2010, providing information for the model update. The inclusion of groundwater elevation data from other (additional) wells within the DBG area has also been considered during the model update.

Based on prior information, the groundwater contaminant plume within the DBG area trends roughly east and southeast, moving off-site in the vicinity of well ELM-9501, and well nest ELN-0801B,C,E. Review of previously reported groundwater trends shows that variations in hydraulic gradients occur in the area of wells DBN-8201, DBN-8201B,C, and DBN-9502A,B,C. The higher residual error reported by Shaw in this area was evaluated during the model update by reviewing the distribution of soil types in this area to noting whether changes in local geology exist.

6.4 Central Plume Area

No site-specific groundwater flow or solute transport model has been developed for the Central Plume area. Review of well locations and sampling history in this area indicates relatively poor spatial distribution of calibration and verification points. Such a condition requires that the model update rely on a combined well set for model calibration and verification.

7.0 Current Groundwater Flow and Solute Transport Model Approach

7.1 Background Data Review

The primary focus of the background data review completed as part of the model update was to: (1) become familiar with existing data trends and groundwater flow and transport models for the areas of interest, (2) identify the need to accommodate revised aquifer parameters into the model updates, (3) evaluate boundary conditions over time, and (4) verify assumptions for use in subsequent, area-specific modeling. The information reviewed included, but was not limited to, the groundwater flow and solute transport models developed for the PBG by Shaw (Stone & Webster) in 2002, and the subsequent refinement of that effort completed by Shaw in 2006. The project approach developed for the current model update included looking for opportunities to: (1) make further adjustments to the site-wide groundwater flow model developed by Shaw; (2) update the groundwater flow and solute transport models completed by Shaw for the PBG; and (3) develop sub-models for the PBG, DBG and the Central Plume Area.

7.2 Analysis of Hydrogeological Data for Model Development

A considerable number of soil boring logs were created at the BAAAP since the late 1970s. Many of these logs were used to create a series of hydrogeologic cross-sections across the areas of interest – information needed to better understand the alluvial sequences present in the subsurface, as well as relationship to groundwater and contaminant movement across the site.

Seven geologic cross-sections were prepared to depict site geology, hydrogeology, contaminant plume locations and other similar information at the PBG, Central Plume Area and DBG. Their locations are shown on Plate 1 (following page). Representative cross-sections, B-B' and G-G', from the PBG and DBG have been included (**Figures 6 and 7)**. Due to technical limitations, the other five cross-sections were not included in this report. Key observations made from this effort are noted below.

The soil materials underlying BAAAP can be characterized as glaciofluvial outwash deposits. In general, a relatively thin surface deposit of fine grained alluvium, consisting of silt, clayey silt and silty sand is present. The underlying soil type is dominated by a sandy alluvium that locally contains interbedded coarse gravel lenses. Occasional boulder deposits occur within some of the gravelly units. In general, the boulder deposits appear to be more frequent at depth.

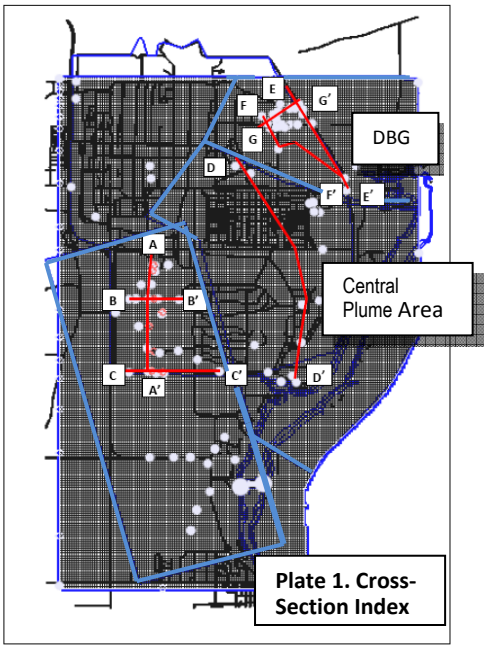
Geologic Cross-Sections – PBG Area

During cross-section preparation, considerable effort was undertaken to compile and review hydraulic conductivity data, water elevation data, hydraulic gradient information and contaminant concentration data. This information was included on the developed cross-sections in an effort to correlate soil types and their characteristics for inclusion into the site-wide groundwater model. Such efforts were affected however by the quality of the data obtained. For instance, the soil boring logs were prepared by several investigators over time, resulting in differences in interpretation. Review of the soil boring logs revealed several instances where the incorrect soil classification was used and/or soil characteristic data was lacking.

Section A-A' (not included) is oriented north-south, along the central axis of the PBG. This section intersects source control wells SCW-1 and SCW-2R as well as extraction well EW-169. In general, the surficial deposits in this area were observed to contain some finer grained silty alluvium (classified as ML under the Unified Soil Classification System). The underlying soil encountered at the north end of this section were reported to generally consist of poorly-graded sand (SP), giving way to predominantly well-graded sand (SW) further south. Occasional coarser grained gravel lenses were encountered, and locally boulder and cobble

layers were observed. Sandstone bedrock was encountered at an elevation of approximately 590 feet AMSL. A zone of cobbles was noted above bedrock. Horizontal hydraulic conductivities ranged from 1 x 10^{-2} cm/sec to 5 x 10^{-2} cm/sec, values consistent with well-sorted sand or sand and gravel.

Many of the soil borings along Section A-A' were completed as well nests consisting of both water table observation wells and piezometers. Recent groundwater elevation data (March 2010) identified groundwater at an elevation of 774.4 feet AMSL in the northernmost wells, decreasing to an elevation of 763 feet AMSL further south. Predominantly south-directed groundwater flow has been reported to occur at the PBG, recognizing that flow patterns are locally affected by pumping induced by the IRM/MIRM groundwater extraction wells. Slightly upward and downward hydraulic gradients have been reported, indicating that the horizontal component of groundwater flow is dominant within the local aquifer system.



Section B-B' is oriented east-west within the PBG area **(Figure 6)**. In general, the soil types encountered along this line appear similar to those observed for Section A-A'. The surface layer varies from silt, clayey silt, organic silt and silty sand (ML, ML-CL, OH, SM). A gravel layer at an elevation around 750 ft AMSL was noted. While a fine-grained soil layer was noted to occur locally at depth, the soil types in this area are dominated by well-graded and poorly-graded sand (SW and SP). The horizontal hydraulic conductivities reported within these sand units ranged from 1 x 10^{-2} cm/sec to 5 x 10^{-2} cm/sec. The water table is fairly uniform across this section, occurring at an elevation of 773 feet AMSL. Slightly upward and downward hydraulic gradients have been reported, indicating predominantly horizontal groundwater flow in this area.

Section C-C' (not included) is oriented east-west, south of B-B', near the BAAAP southern property boundary (PBG area). The surface soils along this section are generally represented by an approximately 15-foot layer of fine-grained alluvium consisting of silt, clayey silt, clay, and silty sand (ML, CL-ML, CL, SM). At greater depths, the boring logs encountered sand with occasional gravel lenses. Sandstone bedrock was encountered in a few borings, at

elevations ranging from 580 feet AMSL to 590 feet AMSL. Wells were installed at various depths across the PBG. The soil types encountered over the screened interval in these wells ranged from poorly- graded and well-graded sands (SP, SW), silty sand (SM) and well-graded gravel (GW). Reported horizontal hydraulic conductivities over the screen intervals in these wells ranged from 1 x 10^{-2} cm/sec (SM) to 4 x 10^{-2} cm/sec (SP).

As noted for Section B-B', the water table surface is fairly uniform. Slightly upward and downward hydraulic gradients were reported, indicating that horizontal groundwater flow dominates.

Geologic Cross-Sections – Central Plume Area

Section D-D' (not included) is oriented roughly north-south, along the axis of the DNT plume observed in the Central Plume Area.

The water table is observed to slope southward along this section, from an elevation of 779.8 feet AMSL at the northernmost well (S1124) to an elevation of 769.55 feet AMSL further south (S1111). All wells completed along this section were screened within (or slightly below) the water table.

The soil types encountered at the north end of this section consist primarily of silty sand (SM) containing various amounts of poorly-graded sand (SP) and minor well-graded sand (SP). An approximate 15 to 30 foot gravel layer (GW) was observed to occur at an elevation of around 800 feet AMSL in this area. The gravel gives way to well-graded sand (SW) with minor gravel further south. Minor amounts of silt and silty sand (ML, SM), including a surficial layer of fine-grained alluvium comprised of clay, clayey silt (ML, CL-ML) were noted further south. The underlying soils encountered in this area were reported to consist of well-graded silty sand (SW-SM) and poorly-graded silty sand (SP-SM). Occasional cobbles and boulders were also reported to occur at various depths.

Geologic Cross-Sections – DBG Area

Section E-E' (not included) is oriented northwest-southeast, extending for some distance along the BAAAP property boundary. Surficial soils range from fine-grained alluvium that consists primarily of silt and silty clay (ML, ML-CL). At other locations the alluvium is absent, and the surficial soil consists of poorly-graded sand (SP), well-graded sand (SW) and/or silty sand (SM). Fairly thick layers of sand occur between the ground surface and the water table. Well-graded gravel deposits (GW) are present at several locations, although the lateral extent of such occurrences appears limited. Most of the wells installed along this section were screened at or just below the water table, which occurs at elevations ranging from 766.0 to 799.8 feet AMSL. The soils occurring at and below the water table consist of sand and gravel layers (GW, GP,

SW), and show an overall trend of coarsening with depth.

Section F-F' (not included) is oriented northwest-southeast across the DBG. Several deeper borings were completed along this section, encountering bedrock at elevations ranging from 653.0 feet AMSL to 658.9 feet AMSL. The soils encountered in borings completed along this section are generally similar – consisting of varying thicknesses of well-graded to poorly-graded sands (SW, SP). Local deposits of well-graded gravel (GW) are present in many of the borings at elevations above the water table (observed to range from 784.2 feet AMSL at the northwest end of this section to 779.8 feet AMSL at the southeast end). The soil types observed at and just below the water table along this section consist primarily of well-graded to poorly-graded sands (SW, SP). Overall, a general coarsening of the soil occurs with depth. Several borings encountered well-graded gravel (GW), poorly-graded gravel (GP) and/or silty gravel (GM) at elevations ranging from around 750 to 790 feet AMSL.

Locally changes in soil types are noted. For instance, several borings completed at the west end of Section F-F' encountered fine-grained soils. Such occurrences were observed below the water table, at elevations ranging from around 750 to 780 feet AMSL. One to two feet of silt (ML) was noted in a few borings, and an approximate 23 foot thick section of clay (CL) was observed.

Section G-G' is oriented west-southwest to east-northeast, extending through the middle of the DBG **(Figure 7)**. A relatively thin layer of fine-grained alluvium was observed at the ground surface in several boring locations. This material was reported to consist of clay (CL) and clayey silt (CL-ML). For the most part, the soils encountered above the water table consist of well-graded sand (SW), poorly-graded sand (SP) and a mixture of well-graded sand and silty sand (SW-SM). Gravel occurs as discontinuous layers and gravel that is intermixed with sand.

The elevation of the water table along Section G-G' has been reported to range from 785.9 to 770.5 feet AMSL. Water table fluctuations of several feet were noted over relatively short distances. In certain instances, the top of the water table appears to be associated with fine grained soils (ML, CL) that occur over a 30 foot interval (750 to 780 feet AMSL).

In summary, preparation of the described cross-sections has led to the following observations:

- The geology of the region is dominated by a thick sequence of primarily well-sorted (poorly-graded) sand (SP). Gravel lenses are occasionally reported in the logs primarily below about 820 feet AMSL.
- Boring log information from across the site tends to show that the glaciofluvial alluvium generally coarsens with depth. The occurrence of gravel lenses and boulders also appears to increase with depth.

- The borings in the DBG area encountered a persistent fine-grained silty deposit at about 750 to 780 feet AMSL. The deposit may be a relict buried abandoned channel composed of fine-grained alluvium. It is possible that this material may exert some influence on local groundwater flow and contaminant transport.
- Soil boring logs have been prepared by several investigators. Differences in detail were noted, and in certain instances, the soil types were not classified correctly. Accordingly, some re-evaluation and re-interpretation of the soil boring log data was conducted.
- Except for a fine-grained silty deposit at the DBG, and a coarser, gravelly zone near the bedrock surface, the soil types at BAAAP are fairly similar – comprised of a heterogeneous mixture of well-sorted to poorly-sorted sand. No effort was made to subdivide the sand sequence into several individual layers.
- Local hydrogeology indicates that groundwater flow is directed generally south and southeast across the model domain. Horizontal groundwater flow dominates.

7.3 Refine the Existing Solute Transport Model for the PBG

Review of the model calibration and verification performed for the PBG solute transport models indicated that such models reasonably represented site conditions and could be used for future assessment of site conditions, including MIRM extraction system optimization studies. Updating of the existing PBG model included reviewing site groundwater monitoring data. Primary emphasis was placed on reviewing the data obtained during 2010, and using representative data from this time period to assess the likely sources and contaminant plume distribution within the PBG area.

One of the primary objectives of the current modeling effort was to assess changes in contaminant concentration and distribution over time. Minor revisions were made to the existing groundwater flow model to better describe the hydrogeological regime in the area of the MIRM wells, and address the incongruities between the MODFLOW output and the transport model observed just north of the MIRM extraction wells. Such conditions were attributed to abrupt changes in hydraulic conductivity, requiring recalibration of horizontal and vertical hydraulic conductivity within each model layer. The current model effort made further refinements to the Shaw model by:

- Providing further refinements to model grid spacing
- Developing groundwater flow and solute transport models specific to each area of concern
- Incorporating additional (more recent) water level and groundwater quality data

- Incorporating more recent hydraulic conductivity (slug test) data
- Reviewing and updating physical and chemical characteristics data for the identified contaminants of concern
- Using updated navigation and solution schemes offered by the GMS modeling platform

While Shaw suggested that the model domain did not extend far enough south to determine the extent of plume capture downgradient of the MIRM wells, information obtained during the current study indicated that the model domain was sufficient to assess the overall effectiveness of the MIRM wells.

7.4 Model Setup

The latest updates to the groundwater modeling platform (GMS, v. 7.1.7 – 7.1.9) were obtained from Aquaveo during the project. The most recent versions of GMS include the 2002 version of MODFLOW, as well as integrated MT3DMS and MODPATH modeling platforms.

Refinements to the groundwater flow model developed by Shaw for the PBG site were made to account for changed conditions identified during the present modeling effort. Modifications made to the Shaw model included making minor changes to boundary conditions along the northeast side of the model, as well as adjusting select key and input parameters for the respective model layers. Further details regarding changes made during the development of the updated site-wide groundwater flow model are provided in the following sections of this report.

7.5 Site-Wide Groundwater Flow Model

The updated site-wide MODFLOW model consists of 168 columns, 239 rows and 6 layers. No changes to the overall size of the model domain were made for the site-wide model. Grid cell dimensions were reset at 150 x 150 foot spacing across the entire model domain to provide a framework sufficient for analyzing groundwater flow patterns and assessing groundwater contaminant plume occurrence and movement.

Initial model input parameters used by Shaw and used during the current modeling effort are summarized in **Table 2**. Layers 1, 3 and 4 were determined previously to consist of sand deposits, whereas Layer 2 was a mixture of gravel and sand (Woodward-Clyde, 1995). Layer 5 was reported to consist of a 30-foot thick gravel deposit sitting above impermeable bedrock (Layer 6). Woodward-Clyde reported a combined saturated thickness of 170 feet at BAAAP – information that was used by Shaw during the preparation of its model. This information was used along with soil type, soil thickness and hydraulic conductivity data obtained from the numerous soil borings at BAAAP for the model update. As noted previously, additional

information regarding soil types and soil characteristics is provided on geologic cross-sections prepared for the PBG and DBG (**Figures 6 and 7**).

A comparison of the terminology and modeling thicknesses used by Woodward Clyde relative to that used by Shaw and this update is provided in Figure 8. As shown, Woodward Clyde identified five (5) units of differing soils types and thicknesses (alluvium), overlying impermeable bedrock. This information was adapted by Shaw, who also used six (6) layers during development of its models. Review of the lithologic and hydrogeochemical information provided for this study did not indicate distinct hydrostratigraphic units extending across the model domain. Rather than rely upon gaps in soil classification data (and inconsistencies in well nomenclature terminology), all hydrogeologic data input into the current models were referenced to elevations rather than layers. This approach allowed site conditions to be viewed without introducing arbitrary reference information.

The layer convention used for the current modeling effort is compared to those used by Woodward Clyde and Shaw in **Figure 8**. As shown, the current model the following naming conventions, which are tied to elevations:

Layer 1. Sand, occurring at a topographic elevation greater than 820 feet AMSL
Layer 2. Sand with minor gravel lenses, occurring between 780-820 feet AMSL
Layer 3. Sand with minor gravel lenses, occurring between 740-780 feet AMSL
Layer 4. Sand with minor gravel lenses, occurring between 700-740 feet AMSL
Layer 5. Sand with minor gravel lenses, occurring between 660-700 feet AMSL
Layer 6. Bedrock and altered bedrock, occurring below 660 feet AMSL

An oblique view of the model domain is provided as **Figure 9**. As shown, the area is topographically higher in the northwest portion of the model domain. Layers 1 and 2 are only present in this area. The changes in the elevation of the Wisconsin River below the dam is also shown, with the river cutting down through Layer 3. As shown, the calibration of the site-wide groundwater model was quite good, with the larger discrepancies between observed vs. predicted head occurring along the boundaries of the model where data was lacking.

The model interpolated distribution of horizontal hydraulic conductivity (Kh) across the model domain is shown on **Figure 10.** To achieve better results and sufficient heterogeneity for hydraulic conductivity distribution, numerous control ("pilot") points were inserted at locations within the model domain. Pilot points were placed: (1) between observation points adding greater density in those areas where more observations points were located; (2) in areas where the observed head gradient was steep; (3) between observation wells and head-dependent boundaries; and (4) at other locations as considered necessary to fill in gaps.

Inverse modeling employing PEST, the automated parameter estimation code within MODFLOW was used for model calibration. Regularization was applied as a homogeneity constraint during each PEST simulation to improve pilot point matching and add extra stability to the inversion process.

Hydraulic head data were referenced to the screen depth in site groundwater monitoring wells, and auto-assigned to the appropriate model layers. The boundary conditions used during the development of the Shaw site-wide groundwater model served as the basis for the current update. After initial runs were performed with the updated model, specified head nodes were added to the east and west boundaries of the model to better represent field observed head data. No flow conditions were also assigned to a portion of the north boundary (east of the DBG), where observation well data is lacking. To assist with model interpolation, pseudo-wells were added to the model domain at a few locations in this area and at other locations where data gaps in head information existed.

The distribution of observed (actual) groundwater isopotentials vs. model predicted groundwater isopotentials for September 2010 is illustrated on **Figure 11**. The most obvious discrepancies between observed and simulated heads were noted in areas with the least amount of observation data (near the domain boundaries), with best agreement occurring within the area of groundwater impacted by the contaminants of concern.

Groundwater flow model calibration was performed by adjusting model input parameters such as Kh, Kv, recharge, and porosity on a "trial and error" basis until a combination of these parameters produced simulated results exhibiting the least amount of error when comparing actual concentrations to those predicted by the model for September 2010. Each parameter was adjusted independently within ranges based on site-specific values determined during previous studies performed at BAAAP or within acceptable ranges from published literature. Calibration target wells were chosen based on prior model setup and existing site data – selecting those wells exhibiting the best spatial coverage for each constituent and layer. Inverse modeling using PEST was performed following each adjustment in input parameters, and the results documented. Continued model simulations were executed until the magnitude and distribution of residual error was determined to fall within acceptable ranges. At that point, forward modeling was performed to obtain final model statistics and output data.

Model verification consists of evaluating the suitability of the calibrated model to independently reproduce a set of field data. In this case, model verification was accomplished by using an independent observation well set from September 2010, and in instances, wells used in the initial model calibration. Simulated head elevations generated for September 2010 were compared to the observed head elevations to assess reasonableness.

Model calibration and verification results are presented on **Figures 12 and 13**. Model calibration and verification statistics are provided on **Tables 3 and 4**. Model calibration statistics reported for each area of interest consist of the residual difference in head elevations, the residual mean, the residual standard deviation, and the maximum and minimum residuals. The residual sum of the squared error and the ratio of the residual standard deviation were also obtained.

Goodness of fit plots (computed vs. observed head values) show acceptable correlation, with the amount and distribution of residual error meeting modeling acceptance criteria. The calibrated model indicated an average absolute error of 0.713 feet between simulated and measured heads, and a water balance of 0.08 percent greater outflow than inflow to the model domain. Based on this information, the calibrated model is capable of producing simulated heads that correlate reasonably well with the observed heads within the modeling domain. This includes providing observed groundwater isopotential contour lines that represent the same overall trend in groundwater flow direction in critical areas of the model domain, including in the vicinity of the IRM/MIRM wells.

A sensitivity analysis was performed to obtain information for assessing the quantitative relationship between the model results and the uncertainties associated with model input parameters and boundary conditions. For the site-wide groundwater flow model, recharge, horizontal hydraulic conductivity and the horizontal anisotropy were systematically varied and the resultant changes in computed head elevations documented.

Results from the sensitivity analysis are provided on **Table 5**. As demonstrated by Shaw, the model is more sensitive to variations in Kh than the other varied parameters. Increasing and decreasing the Kh was accompanied by a relative increase and decrease in the model predicted heads respectively. A 25 percent change in Kh was typically observed to increase or decrease the simulated head by 0.5 feet, with a 50 percent change increasing or decreasing the simulated head values by a foot. A 10 percent change in the recharge was observed to increase or decrease the simulated head by around 0.4 feet. Slight variations in simulated head were observed with changes in anisotropy.

Drawdown data from the IRM/MIRM wells were evaluated during the current modeling effort by using MODPATH, a particle tracking computer code that uses MODFLOW output to generate a set of pathlines from particles placed within the model domain. Particle tracking simulations performed during the current modeling effort shows that hydraulic control is generally achieved by the IRM/MIRM at the pumping rates used in the model. MODPATH particle tracking scenarios indicate that adjustments in well configuration and pumping rates may optimize hydraulic control. Further information regarding the observations resulting from the particle tracking scenarios is provided in the following sections.

8.0 Overview of Groundwater Flow and Solute Transport Sub-models

8.1 Groundwater Flow Sub-models

Sub-models representing groundwater flow within each area of interest was developed from the calibrated site-wide groundwater flow model. Boundary conditions, recharge rates, hydraulic conductivity values and other information associated with each materials layer were retained during sub-model development. Each also underwent separate calibration and verification steps to confirm model use and acceptability for subsequent solute transport model development.

8.1.1 Groundwater Flow Sub-model Calibration

Groundwater flow sub-model calibration was conducted by assigning the September 2010 calibration targets to each sub-model. The observation well calibration subset was the same as that used for site-wide groundwater flow model calibration for all sub-models. Such an approach was considered appropriate since fairly good spatial distribution among the sub-model calibration targets was noted. Sub-model development included comparing the sub-model input parameters and boundary conditions against those used in the site-wide groundwater flow model for consistency.

Initially, an inverse modeling (PEST) simulation was conducted on each newly-developed sub-model and the results documented. Forward modeling was then performed, noting the error associated with the simulation. Model calibration statistics reported for each area of interest consist of the residual difference in head elevations, the residual mean, the residual standard deviation, and the maximum and minimum residuals. The residual sum of the squared error and the ratio of the residual standard deviation over the range of the head values were also determined for each sub-model.

8.1.2 Groundwater Flow Sub-model Verification

In general, model verification consisted of using the calibrated transport model to simulate two separate sets of field data reproducing a data set independent of that used for model calibration. Total independent data sets were not possible however for the sub-model areas due to the limited amount of historical groundwater quality data obtained. Therefore, both an independent subset of observation wells was used for model verification, as well as a subset comprised of observation wells used for model calibration. In both cases, the simulated head elevations generated for September 2010 were compared to observed concentrations to assess reasonableness.

8.1.3 Groundwater Flow Sub-model Sensitivity Analysis

As reported earlier, a sensitivity analysis was completed for the site-wide groundwater flow model. Since each sub-model was constructed from the site-wide groundwater flow model (with few changes), no sensitivity analysis was performed for the groundwater flow sub-models.

8.2 Solute Transport Sub-models

As has been the case with prior studies, the Modular Transport in 3-Dimensions, Multiple Species (MT3DMS) Code was used to evaluate solute fate and transport at the areas of interest. This methodology allowed the transport of multiple mobile and/or immobile species to be evaluated.

MT3DMS was used to provide a preliminary evaluation of transport characteristics of the primary contaminants of concern (COCs): CTET and total DNT in groundwater at the PBG, and total DNT in groundwater at the Central Plume and DBG areas. The MT3DMS sub-models developed for each area used MODFLOW groundwater flow output as direct input into MT3DMS, providing the basis for the contaminant transport simulations.

CTET and total DNT transport in groundwater was simulated under transient conditions ranging up to 30-year simulations. In general, contaminant fate and transport data contained in the prior solute transport model developed by Shaw was used for model update. Information obtained from published sources was also reviewed, and incorporated as appropriate (USACE, 2008).

Based on the known characteristics, the MT3DMS model for CTET was constructed to simulate primarily advective flow with dispersion and mixing. MT3DMS models developed for total DNT included these processes along with chemical reactions (sorption and degradation). Active pumping wells were simulated as point sinks for contaminants and recharge was simulated as a source of clean water.

The observed 3D contaminant plumes developed for each area of concern have been constructed using conventional data interpolation methods (e.g., inverse distance weighting). In instances, additional scatter points with an assigned contaminant concentration of 0.0 ppb were added to the original data set to provide data control where needed and otherwise constrain the interpolation so the generated contaminant plume reasonably depicted historical and recent contaminant trends. The accepted interpolations were subsequently used to define starting concentrations for subsequent solute transport simulations.

Each solute transport sub-model underwent normal model calibration and verification to verify model performance and provide the basis for assessing contaminant sources and pathways in

the future. Model development included performing a sensitivity analysis to assess how the model responded to changes in certain key input parameters.

The mass balance budget for each sub-model area has been evaluated. This assessment, which compares the constituent mass released into the model domain to that removed from the model domain is presented in Section 12.0. The difference between the total mass released into the system and the mass leaving the system will be reported as an error percentage.

8.2.1 Model Approach and Setup

Key assumptions associated with model approach and setup included:

- **Concentration Plumes:** The shape and concentrations of the COC plumes were refined using a "trial and error" method to improve the accuracy of the models; the aqueous concentrations in select areas of the initial plumes were refined for each COC to compensate for factors not explicitly addressed by the solute transport models (e.g. transient groundwater flow effects and basic temporal and spatial variability); and the assignment of initial concentration plumes to the upper three layers of the model domain is appropriate.
- **Sources/Sinks:** Estimated contaminant concentrations entering groundwater were determined by groundwater analytical data from one or more proximal monitoring wells and comparing model predicted vs. actual concentrations during model calibration and verification. Assignment of source loading concentrations also considered reported soil source COCs concentrations for reasonableness.
- **Advection Parameters:** To be consistent with prior model efforts, the solute model setup initially employed the Modified Method of Characteristics (MMOC) solution scheme for all compounds in all simulations. The solution scheme was later changed to third-order total-variation-diminishing (TVD) solution scheme since this method is capable of conserving mass while limiting numerical dispersion and artificial oscillation.
- **Dispersion Parameters:** Dispersion within MT3DMS model simulations employed a dispersion coefficient that considered longitudinal and transverse dispersion values (to account for spreading along and horizontal/vertical to the advective front), as well as values for the corresponding groundwater velocity vector. Longitudinal dispersion was set at 20 feet, latitudinal dispersion at 2 feet and vertical dispersion at 0.5 feet. Downward adjustments were made in the value used for the dispersion parameters at the PBG area however since this is a pump-stressed system where advection dominates. Molecular diffusion was disregarded entirely in all sub-models.

8.2.2 Solute Sub-Model Setup Calibration

Solute transport model calibration was performed by adjusting model input parameters such as partitioning coefficient, reaction rates, source area concentration, initial plume characteristics, and solver packages on a "trial and error" basis until a combination of these parameters produced simulated results exhibiting the least amount of error when comparing actual concentrations to those predicted by the model during a five year period (2002-2007). Each parameter was adjusted independently within ranges based on site-specific values determined during previous studies performed at BAAAP or within acceptable ranges from published literature. Calibration target wells were selected based on prior model setup and existing site data – selecting those wells exhibiting the best spatial coverage for each constituent and layer.

Model calibration statistics reported for each area of interest consist of the residual difference in COC concentrations, the residual mean, the residual standard deviation, and the maximum and minimum residuals. The residual sum of the squared error and the ratio of the residual standard deviation over the range of the concentration values were also determined for each sub-model.

8.2.3 Model Verification

In general, model verification consisted of using the calibrated transport model to simulate two separate sets of field data reproducing a data set independent of that used for model calibration. Total independent data sets were not possible however for all of the sub-model areas due to the limited amount of historical groundwater quality data obtained. Simulated compound concentrations generated over the 2007-2010 time period were compared to observed concentrations associated with the model verification targets to assess reasonableness.

8.2.4 Model Sensitivity Analysis

The sensitivity analysis conducted for each solute transport sub-model consisted of systematically varying select calibrated parameters and documenting the resultant changes in computed concentrations. The following input parameters were included: porosity, longitudinal dispersivity, bulk density, mass transfer coefficient, partitioning coefficient, degradation rate, sorption constant, and reaction constant.

Information regarding the sub-models developed for the PBG, Central Plume Area and DBG follows.

9.0 Propellant Burning Ground Sub-model

9.1 PBG Pre-Model Assessment

9.1.1 Groundwater Flow Sub-model

An imbedded groundwater flow sub-model was developed for the PBG area. Prior to model set-up and development, a site conceptual model was developed. This effort included compiling recent geologic and hydrogeologic data to create three (3) geologic cross-sections / flownets depicting subsurface conditions and contaminant occurrence.

Preliminary modeling activities included verifying that the previously constructed model domain was adequate for the model update. No adjustments were considered necessary to account for the groundwater contaminant plume distribution and the proposed placement of additional wells (i.e., potential boundary wells).

Model setup included evaluating the soil layers (hydrostratigraphic units) identified in the Shaw model. Based on the current review of the boring log information obtained for the alluvium (Layers 1-5), few significant differences were noted to differentiate one layer from another. Regardless, no compelling reason was identified to revise the current five layer model used during prior modeling efforts.

The construction and location of wells used for prior modeling efforts were reviewed during this assessment. As appropriate, new well control was incorporated into the updated model. Hydraulic gradient trends and water balance data were reviewed to assess comparability and reasonableness with prior models. The monitoring wells, extraction wells and piezometers incorporated within the PBG groundwater flow sub-model are listed in **Table 6**.

9.1.2 Solute Transport Sub-models

The modeling completed for the PBG consisted of developing separate solute transport sub-models for the two contaminants of concern present in this area – CTET and DNT. Initially, information from the Shaw model was reviewed to assess reasonableness during conceptual site model development. Water quality data obtained at BAAAP over the last few years were reviewed to assess general contaminant plume occurrence. Data from the March and September 2010 sampling events were further evaluated to assess current water quality. This effort included identifying those wells that could be included in the calibration and/or verification well sets, and provide the information necessary for assessing the ability of the model to predict contaminant concentrations over time.

Model calibration for all solute transport sub-models was performed by observing the difference between actual contaminant concentrations reported for 2007 vs. the concentrations predicted by the model for 2007 (model simulation performed from 2003-2007). Model verification was accomplished by comparing the actual contaminant concentrations reported for September 2010 relative to the model predicted contaminant concentrations (model simulation performed from 2007-2010).

The model calibration/verification process followed during solute transport sub-model development not only considered the residual error statistical results for reasonableness, but also a relook at the model predicted contaminant migration trends relative to observed patterns of contaminant movement as presented in prior studies and as reported by current staff at BAAAP. Based on this evaluation, and "trial and error" adjustments in model input parameters, it was determined reasonable to include source loading for CTET and DNT at the PBG. This assumption is supported by the likely possibility that residual contamination from unknown sources is still occurring at the BAAAP site.

Information obtained during model calibration and verification included the residual difference in COC concentrations, the residual mean, the residual standard deviation, maximum and minimum residuals, the residual sum of the squared error and the ratio of the residual standard deviation over the range of the concentration values. Results from sub-model calibration and verification are presented in the following sections.

9.2 PBG Sub-model Development

9.2.1 PBG Groundwater Flow Sub-model

The PBG groundwater flow sub-model was developed from the site-wide groundwater flow model. Existing geologic and hydrogeologic data was used to create the PBG site conceptual model.

A steady-state calibration was performed, and the simulated heads were compared to observed heads at selection locations measured during September, 2010. Model calibration locations and goodness-of-fit plots are shown on **Figure 14**. Model verification locations and a goodness-of-fit plot are provided on **Figure 15**. Additional details regarding the residual error associated with model calibration and verification are provided in **Tables 7 and 8** respectively.

The calibrated PBG groundwater flow sub-model exhibits an average absolute error of 0.56 feet between simulated and measured heads, and a root mean square error of 0.703 feet. The calibrated sub-model exhibits a water balance of 0.07 percent greater outflow than inflow to the model domain. The PBG sub-model verification has an average absolute error of 0.811 feet and a root mean square error of 0.972 feet. Based on this information, the calibrated model has

satisfied the modeling acceptance criteria established for this project, and is capable of producing simulated heads that correlate reasonably well with the observed heads within the modeling domain.

9.2.2 PBG Solute Transport Sub-model

The physical and chemical data used as initial input parameters during development of the PBG (and other) solute transport sub-models are summarized in **Table 9.** Model calibration and verification statistics reported for the PBG CTET transport sub-model are provided on **Tables 10 and 11**. Model calibration and verification statistics for the PBG DNT transport sub-model are provided in **Tables 12 and 13.**

As noted previously, source loading was included in the solute transport model simulations. Source loading for CTET consisted of introducing 50-100 ppb of CTET at five (5) locations during the 2002-2007 model simulation, and from 50-100 ppb of CTET at three (3) locations during the 2007-2010 time period. The CTET was introduced into model Layers 3 and 4 at locations near the apparent source area. Source loading for DNT consisted of introducing 1.0 ppb DNT at three (3) locations near the present source area over the 2002-2010 time period. A DNT source loading concentration of 1.0 ppb was introduced into the sub-model for the 2010-2015, 2015-2020 and 2020-2030 model simulations. The source loading was assigned to model Layers 3 and 4.

The Modified Method of Characteristics (MMOC) solution was used for the estimation of advection within the CTET PBG sub-model. Other solute transport model input parameters for the CTET simulations included sorption via linear isotherm (for the 2002-2010 period only) and an effective porosity of 26%. Dispersion was assigned using a ratio of horizontal transverse dispersivity to longitudinal dispersivity (TRPT) of 0.1 and a ratio of vertical transverse dispersivity to longitudinal dispersivity (TRVT) of 0.05 to 0.10. Longitudinal dispersion values of 0.0 to 1.0 were used.

The advection solution used for the DNT sub-model at the PBG included MMOC (2002-5 and 2007-10). A third-order total-variation-diminishing (TVD) scheme was used for the 2005-2007 simulation and for the predictive model simulations (2010-2040) to evaluate the effect that this mass conservative method exerts on the model results. Other solute transport model input parameters for the DNT simulations included sorption via linear isotherm, an effective porosity of 26%, a TRPT of 0.1 and a TRVT of 0.001. A longitudinal dispersion of 10 was assigned to all model layers.

9.2.3 PBG Particle Tracking

Particle tracking simulations were performed on the calibrated groundwater flow sub-model to assess the likely hydraulic control exerted by source control wells SCW-1 and SCW-2R, and the existing MIRM extraction wells. Forward and reverse particle tracking simulations were performed at the PBG by using the USGS particle tracking computer code MODPATH. Particles were released along a portion of the PBG sub-model boundary. One and five particle scenarios were employed for the current IRM/MIRM pumping scenario and for an alternative pumping scenario where MIRM well EW-169 is turned off, and well EW-164 is turned on.

Shown on **Figure 16** is the PBG sub-model boundary, as well as the location of existing source control wells SCW-1 and SCW-2R and MIRM extraction wells EW-163R, EW-167, EW-168, EW-169, and EW-170R. Groundwater flows south and southeast across the PBG area, with the MIRM wells being located along the axis of the CTET and DNT groundwater contaminant plumes. EW-163R is located hydraulically downgradient of the other IRM/MIRM wells. Contamination moving beyond EW-163R can be expected to migrate towards the south and southeast.

The particles released from each IRM/MIRM extraction well during the MODPATH simulation show the area of capture exerted by each IRM/MIRM well. In general, the particle tracking simulation generally shows overlap of the capture zones associated with each well. In certain instances relatively long flowpath lines are noted, indicating that groundwater contamination may move southward until it reaches the nose of the capture zone where EW-163R is located. Based on the current MODPATH simulation, it appears that capture of any migrating contaminant plumes within the PBG area will be effective. Minor adjustments to the groundwater flow model indicate however that particle tracks could potentially bypass EW-163R.

While the present effort focused on evaluating the hydraulic control exerted at this time, it is expected that additional MODPATH simulations will be completed to assess hydraulic control at varying pumping rates and configurations for the next several out-years (2015, 2020, 2025, 2030). As a start, the effect that turning off well EW-169 and turning on EW-164 (currently inactive) might exert on particle tracks was evaluated. This simulation, shown on **Figure 17**, results in a broader capture zone along the south property boundary.

Comparison of 3D data interpolation plots vs. model predicted concentrations for CTET are shown on **Figure 18**. The model simulation plots represent the observations made in Layer 3 or Layer 4. Overall, good agreement was noted between the observed vs. predicted CTET plots indicating that the PBG sub-model is capable of generating results that are reasonable and representative.

Predictive model simulations for CTET, over the period from 2010-2040, are provided on **Figure 19**. As shown, the solute transport model simulations predict continued southward movement of the CTET plume south of the PBG (assumes current IRM/MIRM groundwater extraction scenario). Based on the model simulations, the majority of the plume mass will be located off-site by 2030, with the plume exhibiting concentrations within the 1-5 ppb range. The sub-model further predicts that the CTET plume will remain mostly on-site and be captured by the IRM/MIRM during the 2030-2040 timeframe. The residual CTET plume(s) not captured by the IRM/MIRM will continue to narrow and become more limited in extent due primarily to dilution occurring at the plume margin. Based on the model results, it is possible that low concentrations of CTET will remain in the PBG area until 2040.

Comparison of 3D data interpolation plots vs. model predicted concentrations for DNT show that the model is capable of predicting overall contaminant plume distribution (**Figure 20**). Source loading was used over the 2002-2010 time period to produce the observed results. This consisted of introducing 0.5-1.0 ppb DNT at 4-5 locations (Layers 3 and 4) at the existing source area.

Predictive model simulations for DNT, over the period from 2010-2040, are provided on **Figure 21**. The predictive model simulations performed for DNT at the PBG area indicate that the IRM/MIRM extraction system will continue to reduce contaminant mass and plume extent at the PBG. In addition, chemical reactions occurring within the plume and dilution along the plume margins will reduce the mass of DNT present. By 2030, the DNT groundwater contaminant plume can be expected to undergo a substantial reduction in contaminant mass and plume size. The model simulation for 2040 indicates that only low levels of DNT contamination will remain near the center of the IRM/MIRM system.

10.0 Central Plume Area Sub-model

10.1 Central Area Pre-Model Assessment

A site conceptual model was developed prior to set-up and development of the Central Plume Area sub-model. The sub-model was derived from the site-wide groundwater flow model. No adjustments were considered necessary to account for groundwater contaminant plume distribution. Model layer thicknesses and boundary conditions were retained from the site-wide groundwater flow model. Monitoring wells and piezometers used for the development of the Central Plume Area sub-model are listed on **Table 14**.

10.2 Central Area Sub-model Development

10.2.1 Central Plume Area – Groundwater Flow Sub-model

Initially hydraulic gradient trends and water balance data resulting from computer simulations performed during sub-model development were compared against those obtained during site-wide groundwater flow model development to assess reasonableness. After this initial assessment, model calibration and verification was performed. The observation well set used for model calibration and verification contained data from September, 2010.

Calibration and verification targets used during the development of the Central Plume Area groundwater flow sub-model are listed in **Tables 15 and 16,** respectively. Both the locations and the resulting statistics associated with model calibration and verification are provided on **Figures 22 and 23**. An average absolute error of 0.647 and a root mean square of 0.752 are associated with the calibrated model, and an average absolute error of 0.453 and a root mean square of 0.525 were observed during model verification. These results indicate that the flow model will produce results that correlate well with observed head data.

10.2.2 Central Plume Area – PBG Particle Tracking

Particle tracking simulations using MODPATH were performed on the calibrated groundwater flow sub-model to assess likely groundwater flow and contaminant migration pathways. For this simulation, one particle was released from the middle of each cell selected along portions of the north and west sub-model boundaries.

The MODPATH particle tracking simulation completed for the Central Plume Area sub-model is shown on **Figure 24**. The results obtained indicate that southeast and southward directed flow is dominant in this area.

10.2.3 Central Plume Area – Solute Transport Sub-model

Observed data interpolation plots and the corresponding model predicted results for DNT are provided on **Figure 25 and 26**. The model simulation plots represent the observations made in Layer 3 or Layer 4. Comparison of the 3D interpolation plots generated using observed concentration data vs. the model predicted concentrations reasonably match for the 2007 and 2010 time periods.

Source loading was not used for model simulations. The MMOC solution scheme was used to estimate advection. Other input parameters used for the DNT model simulations included an effective porosity of 26%, a TRPT of 0.1 and a TRVT of 0.001. A longitudinal dispersion of 20 was assigned to all model layers.

The statistical data associated with performing calibration and verification of the Central Plume Area solute transport submodel are presented on **Tables 17** and **18**. The information provided includes residual COC concentrations, the residual mean, the residual standard deviation, maximum/ minimum residuals and other related information. Due to the limited amount of groundwater quality data available for this area, model calibration and verification consisted of using two different observation well sets for the 2007-2010 time period.

Notable gaps in groundwater monitoring data are associated with the Central Plume Area, preventing a detailed extrapolation of long-term contaminant trends. In general, the model simulations suggest that the DNT plume is stable and shrinking, with notable decreases in contaminant plume size occurring over time and little (if any) groundwater contamination present in 2040. While the results provided are considered conservative (no chemical reactions assumed during model simulation), additional groundwater sampling data is recommended to help determine likely contaminant trends in this area.

11.0 Deterrent Burning Ground Sub-model

11.1 Pre-Model Assessment

The pre-model assessment performed for the DBG consisted of reviewing information compiled by Shaw, as well as that obtained by reviewing reports and other data that provided an understanding of site and contaminant characteristics. A site conceptual model was developed prior to model set-up and development. As was the case for the PBG, this included developing three (3) geologic cross-sections / flownets to depict subsurface conditions and contaminant occurrence.

The groundwater flow sub-model developed for the DBG was extracted from the site-wide groundwater flow model update. No adjustments were considered necessary to account for the groundwater contaminant plume distribution. Model layer thicknesses and boundary conditions were retained from the site-wide groundwater flow model. Existing groundwater monitoring well control and groundwater quality data was reviewed to assess possible inclusion into the DBG sub-model. The monitoring wells and piezometers incorporated into the DBG sub-model are listed on **Table 19**.

11.2 DBG Model Development

11.2.1 DBG Groundwater Flow Sub-model

Information obtained during the site-wide groundwater flow model assessment was used to further evaluate local groundwater flow patterns. Review of potentiometric maps made by

others for this area indicated that further adjustment of the groundwater flow submodel should be considered during the model update. More specifically, the limited well control in the northeast portion of the site affected the ability of the model to predict the hydraulic gradient trends observed in this area. Unexpected northward directed flow from the DBG sub-model, possibly due the fine-grained material present at depth within the DBG) required that a portion of the northern model boundary in this area be changed from constant head to no flow conditions. Once this adjustment was made, the sub-model underwent inverse modeling using PEST, followed by forward modeling with MODFLOW. Reduced total residual error and water balance data generated during the model simulations indicated that the adjustment in boundary conditions in this area was appropriate.

A steady-state calibration was performed for the DBG groundwater flow sub-model. This was accomplished by comparing the model predicted heads to observed heads at selection locations measured during September, 2010. Model calibration locations and goodness-of-fit plots are shown on **Figure 27**. Model verification locations and a goodness-of-fit plot are provided on **Figure 28**. Additional details regarding the residual error associated with calibration and verification of the DBG groundwater flow sub-model are provided in **Tables 20 and 21** respectively.

The average absolute error and root mean square error associated with the calibrated DBG groundwater flow sub-model are 0.648 and 0.820 respectively. The calibrated sub-model exhibits a water balance of 0.07 percent greater outflow than inflow to the model domain. The During flow sub-model verification an average absolute error of 0.836 and a root mean square error of 0.974 was observed. Such results demonstrate that the model is capable of producing simulated heads that correlate reasonably well with the observed heads.

11.2.2 DBG Solute Transport Sub-model

Source loading was included in the DBG solute transport model simulations. Source loading consisted of introducing 2-25 ppb DNT at five (5) locations (Layers 3, 4, 5) for the 2003-2010 model simulation. The same source loading conditions were employed during the 2010-2020 and 2020-2030 predictive runs.

The Third-order TVD solution scheme was used to model advection. Sorption via linear isotherm and first-order kinetics (dissolved sorption) were used for the DBG. Other input parameters used for the DNT model simulations included an effective porosity of 26%, a TRPT of 1.0 and a TRVT of 0.2. A longitudinal dispersion of 40 was assigned to all model layers.

Calibration and verification results for the DBG solute transport submodel are presented on **Tables 22 and 23**, respectively. The model calibration statistics showed a maximum residual

error of 0.5, a residual mean error of 0.018, and a mean square error of 0.079. The sum of the standard deviation over the observed concentration is 0.149, showing good agreement.

11.2.3 DBG Particle Tracking

MODPATH particle tracking simulations were performed on the calibrated groundwater flow sub-model. For this simulation, one particle was released from the middle of each cell selected along portions of the north and west sub-model boundaries.

The particle tracking simulation completed for the DBG area is shown as **Figure 29**. As shown, the MODPATH simulation shows that groundwater will flow in a general northwest to southeast direction across the sub-model domain. Based on this information, it is expected that contaminants in groundwater at the DBG area will also move towards the south and southeast.

Comparison of 3D data interpolation plots vs. model predicted concentrations for DNT are shown on **Figure 30**. Predictive model simulations for DNT, over the period from 2010-2040, are provided on **Figure 31**. The model simulation plots represent the observations made in Layer 3 or Layer 4.

Comparison of the observed DNT groundwater concentrations for September 2010 vs. the model predicted contaminant concentrations show good agreement. Predictive model simulations indicate that the mass of DNT at the DBG will decrease over time. Corresponding decreases in contaminant concentrations are also expected between 2015 and 2020, when stabilization of the plume occurs. Considerable reduction in plume size and DNT concentrations are expected by 2030, with the plume disappearing by 2040. This interpretation is likely conservative since the future lateral spreading predicted by the model does not appear to be consistent with the existing DNT plume configuration or the expected plume migration pathway.

12.0 Mass Balance Evaluation

12.1 General Information Regarding MT3D

One of the notable aspects of the MT3D solute transport modeling package is its reporting of mass budget information. The governing equation for solute transport is a mathematical statement of mass conservation for a groundwater system that states that the change in mass stored is equal to the net mass flux, plus the difference between the mass contributed by sources and withdrawn by sinks. The net mass flux represents the sum of advective and dispersive fluxes. Sources may include injection wells, recharge, losing rivers and first-order production reactions. Sinks include extraction wells, drains, gaining rivers and decay

reactions. In MT3D models, mass inflows and outflows from specified head and concentration cells are also treated as source and sinks.

There are several different methods to determine mass budget information and estimate mass balance error. The finite difference method is based on an expression of mass balance for each cell in the model, whereas the finite element method minimizes the global mass balance error. The MMOC solution used by Shaw during the development of its models is based on an entirely different concept that relates solute transport and moving particles, and departs from a strict adherence to mass conservation. A small mass balance error is necessary with MMOC, but even then, a small mass balance error is no guarantee that the solution is correct. Transport simulations that are too coarsely discretized may report accurate mass balance but yet be overwhelmed by numerical dispersion.

MT3D calculates a mass budget summary at the end of each transport step. The standard output file provides a detailed account of the cumulative mass terms at the time steps specified in the basic transport package. The output includes total mass in – total mass out, the mass attributable to specified sources and sinks, the total mass in the aquifer, and the discrepancy percentage. For sources, the cumulative mass is defined as the integral through time of the product of volumetric flow rate and the source loading concentration. For sinks, the cumulative mass is the integral of the product of the flow rate and the concentration in the cell containing the sink. In the case of extraction wells, the cumulative mass added and withdrawn up to the specified transport time end step is calculated.

The mass storage term in the budget accounts for the changes in dissolved and sorbed-phase concentrations, with the changes accumulated from one transport step to the next. Change in mass storage terms are defined for the dissolved and sorbed phases, with the storage (out) term compiling the mass in those cells in which the concentrations increase between two transport steps; and the storage (in) term accumulates the mass in those cells in which the concentrations decrease (the sign convention used in MT3D is the same as used in MODFLOW). It should be noted that the storage terms cannot be used to calculate either the total mass in the plume at a particular time, or the change in the total mass between transport steps. For example, while non-reactive solute concentrations will decrease in upstream cells over time, there will be an increase in the solute concentrations in downstream cells as the plume moves through the system. Such increases and decreases will be recorded in the mass budget as ever-increasing outputs and inputs to mass storage, although the total mass in the system may remain constant through time.

12.2 BAAAP Model Mass Balance Estimates

Cumulative mass balance calculations for each contaminant of concern (COC) were completed by evaluating the constituent mass values calculated by the model during several time steps within the model domain. The design of the developed solute transport models included an overestimation of contaminant loading to account for inherent uncertainties, which may include, but are not limited to other possible source areas. In addition, while first order irreversible kinetic reaction rate constants exist for 2,4-DNT, this option was not used during the MT3D simulations. Similarly, the chemical reaction package was not used for the CTET MT3D simulations.

The mass budget was determined in MT3DMS by comparing the constituent mass released into the model domain (through features such as constant concentration sources) to that removed from the model domain (through extraction wells or at model boundaries, for example). The difference between the total mass released into the system versus the mass leaving the system was noted as percent error. Changes in the total mass within the aquifer were noted for each sub-model as a whole.

The mass balance evaluation process included noting the mass balance error, or relative mass discrepancy percentage, as an indicator of the internal consistency of the model simulation. Initial MT3DMS simulations were performed using the MMOC solution to assess consistency with the results obtained by Shaw. In general, the results using in MMOC indicated a discrepancy in the range of about 5%. An alternative for mass balance error was also calculated, based on assumptions regarding the rate of mass loading and the mass leaving the model domain. The TBD solution scheme (3d order ULTIMATE) was used for all mass balance evaluations.

For the MT3D simulations performed during this model update, it was assumed that the injection concentration and rate were constant. This information is consistent with the data entered under wells (in) in the standard output file. The sinks for the PBG sub-model consist of the IRM/MIRM extraction wells and the constant head cells along the Wisconsin River which draw mass out of the system once the plume reaches the boundary. The sinks for the Central Area Plume and DBG sub-models are the constant head cells along the Wisconsin River. The incremental change in cumulative mass leaving each sub-model over time indicates that the model simulations were run over a sufficiently long time period to allow for a reasonable estimation of near-term and long-term contaminant distributions.

PBG Area (CTET)

Mass balance calculations obtained from the 2002-2007 CTET simulation at the PBG show a discrepancy percentage (total in – total out) of -0.04%, well within the established model

acceptance criteria of 1%, indicating that the solute transport sub-model for CTET at the PBG is reliable. The approximate reduction in total mass within the aquifer over the simulation period was estimated to be around 16%. The approximate reduction in total solute mass within the aquifer over the simulation period was estimated to be around 16%. As shown on **Figure 18**, the model predicted concentrations for CTET over this time period decrease especially along the axis of the contaminant plume, from more than 15 ppb in 2002 to generally less than 5 ppb in 2007. Mass balance calculations obtained from the 2007-2010 CTET simulation demonstrated a discrepancy percentage of 0.69%. The reduction in total mass within the aquifer over the 2007-2010 simulation period was estimated to be 8%. A discrepancy percentage of 0.6% was reported for the 2010-2040 period with greater decreases in mass occurring within the aquifer. As shown on **Figure 19**, essentially all of the CTET concentrations are predicted to be below 1.0 ppb by 2020. Plume stabilization is predicted by 2030 and substantial plume reduction is anticipated by 2040.

PBG Area (DNT)

Mass balance calculations obtained for the 2002-2007 DNT simulation at the PBG show a discrepancy percentage (total in – total out) of 0.0%, well below the established model acceptance criteria of 1%, indicating that this solute transport sub-model is reliable. Mass balance calculations obtained from 2007-2010 demonstrated a discrepancy percentage of 0.69%. Increased source loading used during this simulation to introduce more conservatism into the model, resulted in only a minor change in total mass. During this time period, the contaminant plume was observed to increase in size, accompanied by slight upward and downward changes in DNT concentrations **(Figure 20).** A relative error of 0.01% and discrepancy percentage of 1.06% was reported for the 2010-2040 period. As shown on **Figure 21**, the predicted DNT concentrations begin to show reductions in 2020, with substantial decrease in contaminant plume size and DNT concentrations by 2030. Only a small amount of DNT is expected to remain at the end of this simulation period.

Central Plume Area (DNT)

Mass balance calculations obtained from 2007-2010 show the DNT total in – total out equal to 0 (no source loading). The discrepancy percentage of -0.04% indicates that the model was acceptable for assessing contaminant trends. The approximate reduction in total mass within the aquifer over the simulation period was estimated to be around 10%, with the highest DNT concentrations (around 0.1 ppb) being observed along the axis of the contaminant plume **(Figure 25).** Mass balance calculations obtained from 2007-2010 demonstrated a relative discrepancy percentage of 0.7%. Minor reduction in total mass within the aquifer over the 2007-2010 simulation period was noted. A discrepancy percentage of 0.6% was reported for the 2010-2040 period with greater decreases in mass occurring within the aquifer. As shown on

Figure 26, both DNT concentrations and plume size show notable decreases over time, with little if any mass remaining in 2040.

DBG Area (DNT)

Mass balance calculations obtained from the all MT3D simulations completed at the DBG show a discrepancy percentage of 0.0%, meeting established model acceptance criteria. As shown on **Figures 30 and 31**, the model simulations predict spreading of the contaminant plume over time, possibly due to the presence of finer grained soil materials occurring in this area. A reduction in DNT concentrations is indicated by 2020, with the plume showing stabilization in 2020, and a substantial reduction in size by 2030. No residual DNT contamination is anticipated to remain at the DBG in 2040.

12.3 MT3D Limitations

This expression for the MT3D mass discrepancy serves as an indicator of the internal consistency of a simulation, but is not always a reliable indicator of the accuracy of the results. For example, the finite difference advection solution generally yields small mass discrepancies, even for simulations in which there is significant numerical dispersion.

While further model refinements to adjust mass balance error were considered, such action was not taken since the results fell within established model acceptance criteria, contaminant plume distribution is not affected by variations in the mass budget error, the residual statistics for the calibration and predictive runs are favorable, and the model design is purposely conservative. Furthermore, the information provided herein should be considered as a reasonable estimation of mass balance within the model. An absolute mass balance error cannot be quantified.

The magnitude of the mass balance discrepancy that can be accepted depends partly upon the method of the solution. Methods such as finite element and finite difference methods determine the global mass balance error by directly measuring the internal consistency of the solution – requiring the global mass balance error be small to ensure a correct solution (typically less than 1 percent). MMOC (used by Shaw) is not based explicitly on mass balance – but assumes an infinite number of particles and evaluates the analogy between moving particles and migrating solutes. For MMOC, there is no single criterion to judge whether the mass balance discrepancy for a particle-based solution is acceptable – a mass balance discrepancy that increases through time or that consistently exceeds 10-15% is usually indicative of an inaccurate solution. The TVD solution scheme used in this study is also by design mass conservative, so only a relatively small mass discrepancy was accepted.

13.0 Transport Model Sensitivity Analysis

Calibrated model results are not unique, and therefore a sensitivity analysis was performed to assess the effect that changes in model input parameters may exert on model output. To compare the current modeling effort, the sensitivity analysis focused on evaluating the DNT sub-model developed for the PBG area. Calibrated model parameters were systematically varied and the resultant changes in the computed DNT concentrations documented. The following input parameters were included in the analysis: porosity, longitudinal dispersivity and bulk density. Discussion regarding the effect that chemical reactions would be expected to exert on the model computed results is also provided.

For each sensitivity analysis simulation, one parameter was changed from the calibrated value by varying each by a set percentage. A value of 25 percent was considered the most realistic case; however to more fully evaluate model response, parameter adjustments of 50 percent and 75 percent were also evaluated. The resulting changes in the computed DNT concentrations after a three-year simulation (2007-2010) were then documented. Two to three observation points were selected for each model layer. The results of the sensitivity analyses are presented in **Table 24**. Key findings are presented below.

13.1 Porosity

Overall, the model proved to be most sensitive to variations in porosity. A 25 percent change in the porosity (from calibrated values ranging from 0.002 ppb to 0.216 ppb) resulted in an average 12.5 percent change in the DNT computed concentrations (calibration DNT concentrations ranged from 0.002 ppb to 0.216 ppb; a 25 percent change in porosity resulted in computer generated concentrations ranging from 0.001 ppb to 0.215 ppb). The 25 percent change in porosity resulted in a concentration change ranging from 0.001 ppb to 0.059 ppb. These values are similar to those reported by Shaw. A 17 percent change in porosity in the Shaw model produced changes in computed DNT concentrations ranging from 0.1 ppb to 1 ppb. In general, an increase in porosity was observed to produce an increase in DNT concentration.

13.2 Dispersion Parameters

Overall, adjustments of 10 and 25 percent in the longitudinal dispersivity for DNT produced low-order changes (< 0.03 ppb) in the modeled compound concentration at the observation points. Even greater variations in longitudinal dispersivity (to 75 percent) had little effect on the model computed concentrations.

13.3 Sorption and Reaction Parameters

The MT3DMS model for DNT included rate-limited sorption reactions. The parameters that impact sorption reactions include bulk density, mass transfer coefficient, and partitioning coefficient. As reported by Shaw, variations of up to 25 percent in each of these parameters produced no appreciable change in the computed concentrations at the observation points. Rather, order-of-magnitude changes (200 to 300 percent) in the mass transfer coefficient were required to produce substantial changes. Variations of up to 25 percent for bulk density did not produce notable changes in the aqueous concentration at the observation points. This finding is consistent with that reported by Shaw. The MT3DMS model for DNT includes a linear isotherm approximation of sorption. No sensitivity analysis of sorption was performed since Shaw determined that adjustment of this parameter by 25 percent produced no significant change in the modeled concentrations. Shaw determined that a 15 percent adjustment of the first-order irreversible decay rate for DNT (simulates biodegradation) did not produce a significant change in the modeled concentrations. To provide more conservative model outcomes, the current modeling effort did not use first order decay for DNT.

14.0 Modeling Summary

An update of the existing site-wide groundwater flow and solute transport models developed for BAAAP has provided additional information regarding the likely extent and migration of CTET and DNT in groundwater at the PBG, Central Plume Area and DBG over the next several years. Model results indicate that the DNT plumes within all three areas of concern will decrease over time due to processes that normally occur in the natural environment. Contaminant concentrations within the CTET plume at the PBG will also decrease over time, although the model predicts that an off-site CTET plume will still be present in 2040.

Additional subsurface investigation and groundwater sampling is recommended to obtain data to further validate and update the groundwater flow and solute transport models developed during this study. Current analytical data suggests that the model may over predict the benefit of the IRM/MIRM pump and treat system. More detailed flow and transport modeling within the PBG area, to include further evaluation of the MIRM system, would enhance current interpretations and possibly result in a combination of lower pumping rates with natural attenuation to achieve desired results. In addition, more study is needed to better understand the chemical fate and transport processes associated with the DNT isomers present in the groundwater at BAAAP. Such data will serve to enhance future modeling efforts.

Efforts have been made to develop solute transport models that are realistic, but slightly conservative. Latent subsurface conditions, including potentially unknown contaminant sources, may exist at the investigation areas. Such occurrences would result in an

underestimation of the likelihood of contaminant loading to groundwater and overly optimistic contaminant modeling results.

Additional model simulations are recommended to refine model input parameters for both the groundwater flow and solute transport models. As part of this effort, it is recommended that more data be obtained from the PBG, Central Plume and DBG areas to improve model performance, including but not limited to, obtaining soil and hydraulic conductivity data; groundwater elevation and groundwater quality data; as well as aquifer characterization data (i.e., pump tests). Data analysis efforts may include vadose zone modeling in known residual soil source area to generally assess the amount of soil contaminants leaching to groundwater.

15.0 Study Limitations

This report has been prepared for SpecPro. Reliance on the observations, findings, conclusions and recommendations contained herein by others without the expressed approval of SpecPro is prohibited.

The completed solute transport modeling effort should be considered an order-of-magnitude estimate regarding how the primary COCs present within each area of interest vary spatially over time. The model results obtained are directly related to the quality and accuracy of the model input parameters, and may be affected by the inherent variability often associated with investigation data collection and/or laboratory analysis of such data.

The evolving nature of the GMS model package has resulted in the issuance of several upgrades to fix problems associated with the software. It is assumed that such modification did not affect the prior modeling simulations conducted during this study. No effort was made to compare the model results generated using different versions of GMS.

Contaminant plume occurrence as predicted by the current modeling effort is based on reasonable assumptions made during model set-up and execution. As needed, adjustments were made to the model parameters so plume configuration reasonably represented historical and more recent contaminant trends.

All models developed herein should be considered a reasonable depiction of existing site conditions. The results obtained are not to be considered to represent actual site conditions.

16.0 References

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Figures

Technical Memorandum

Groundwater Flow and Solute Transport Modeling

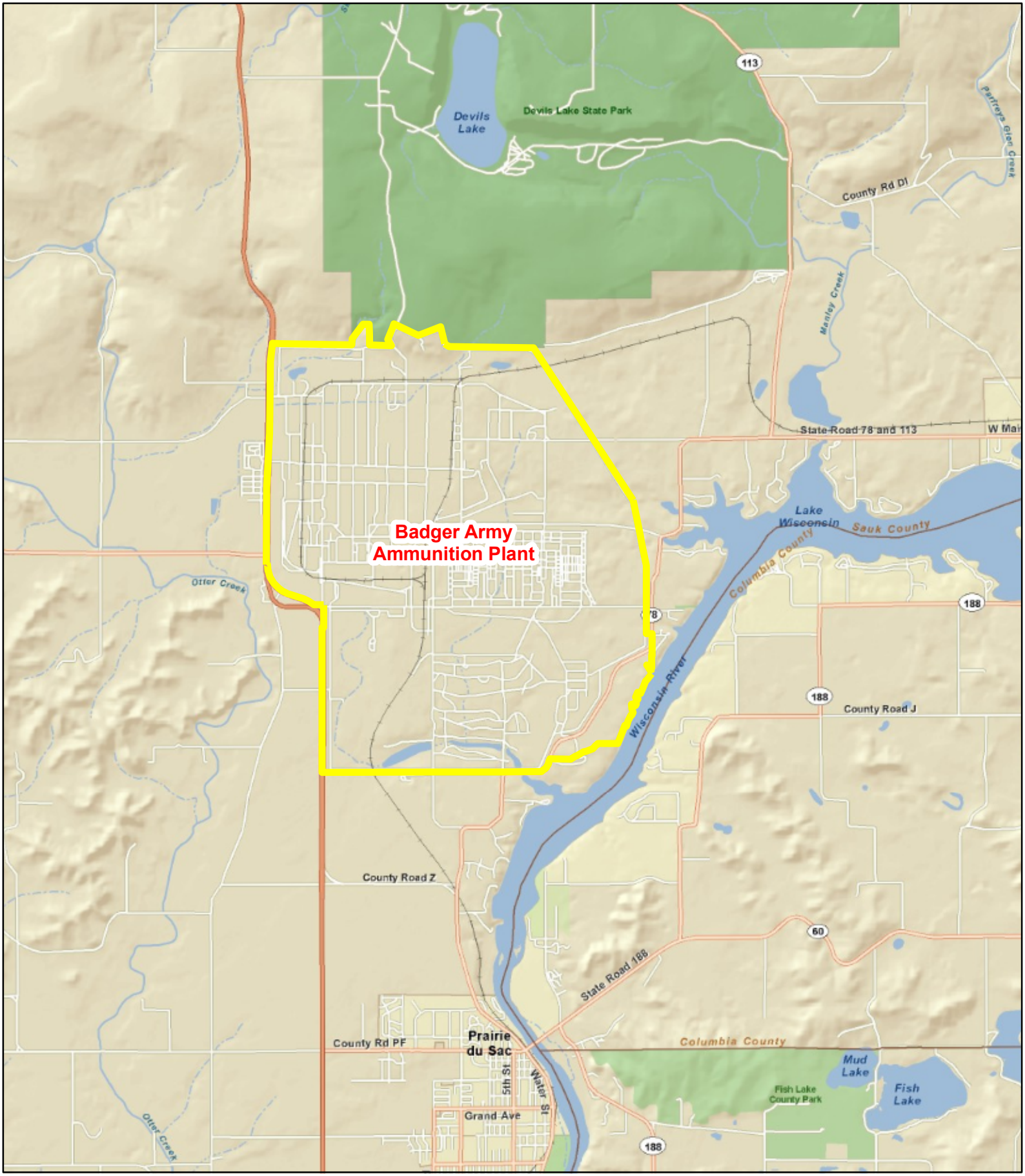


Figure 1

General Site Location
Badger Army Ammunition Plant

0 2 4 Miles

Figure 2. Sub-model Locations
Badger Army Ammunition Plant

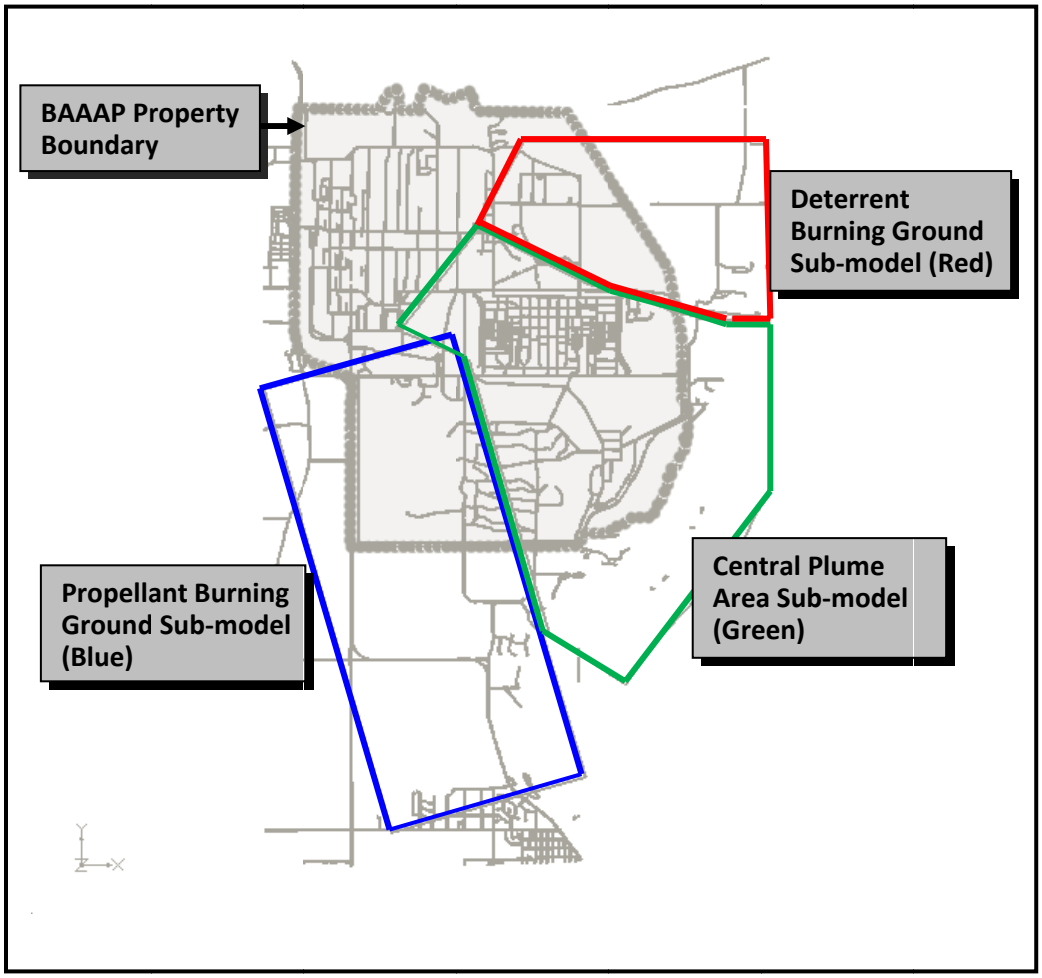


Figure 3. Project Approach Summary

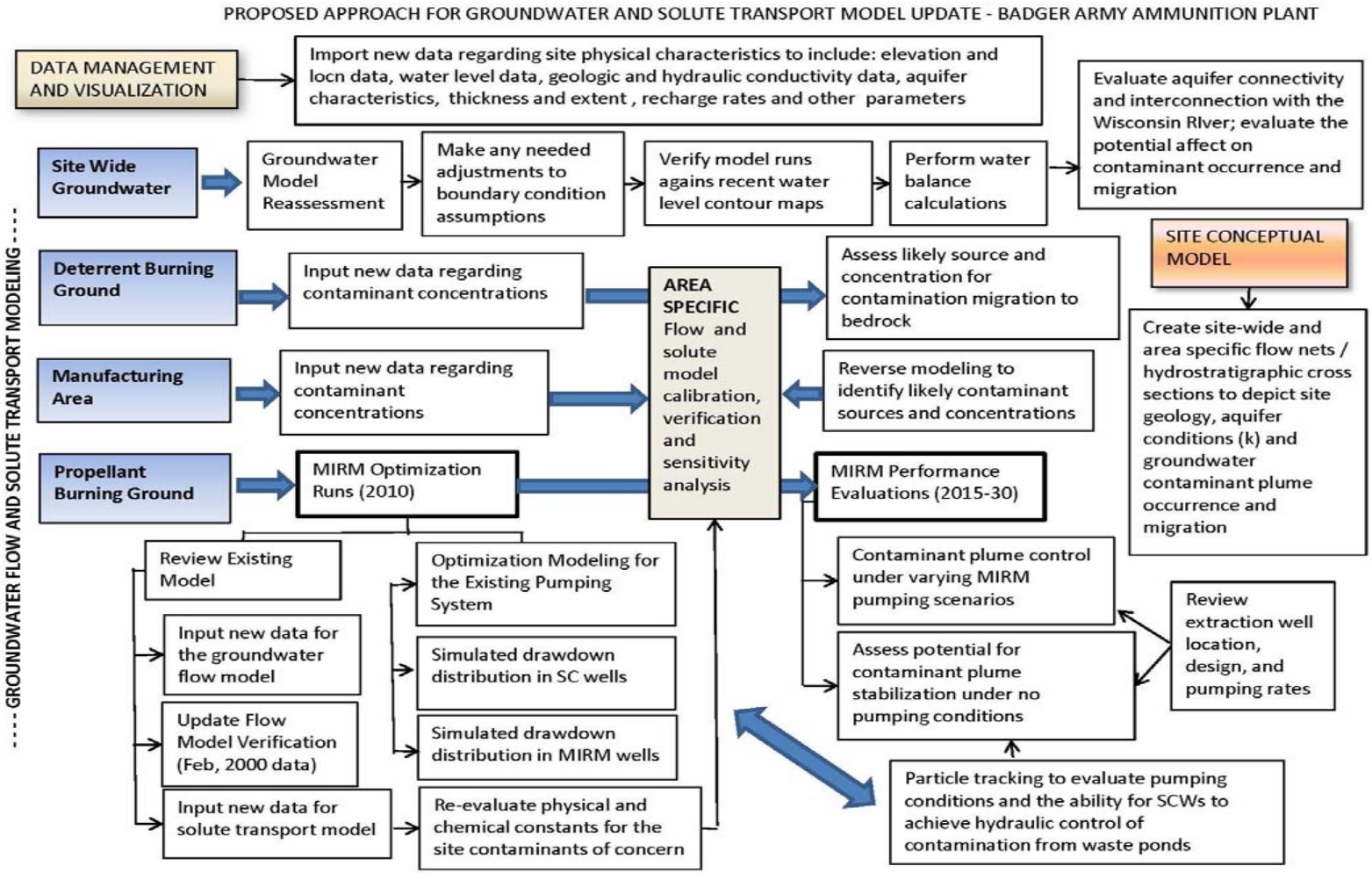


Figure 4. Model Domain, Grid Distribution and Well Locations
Badger Army Ammunition Plant

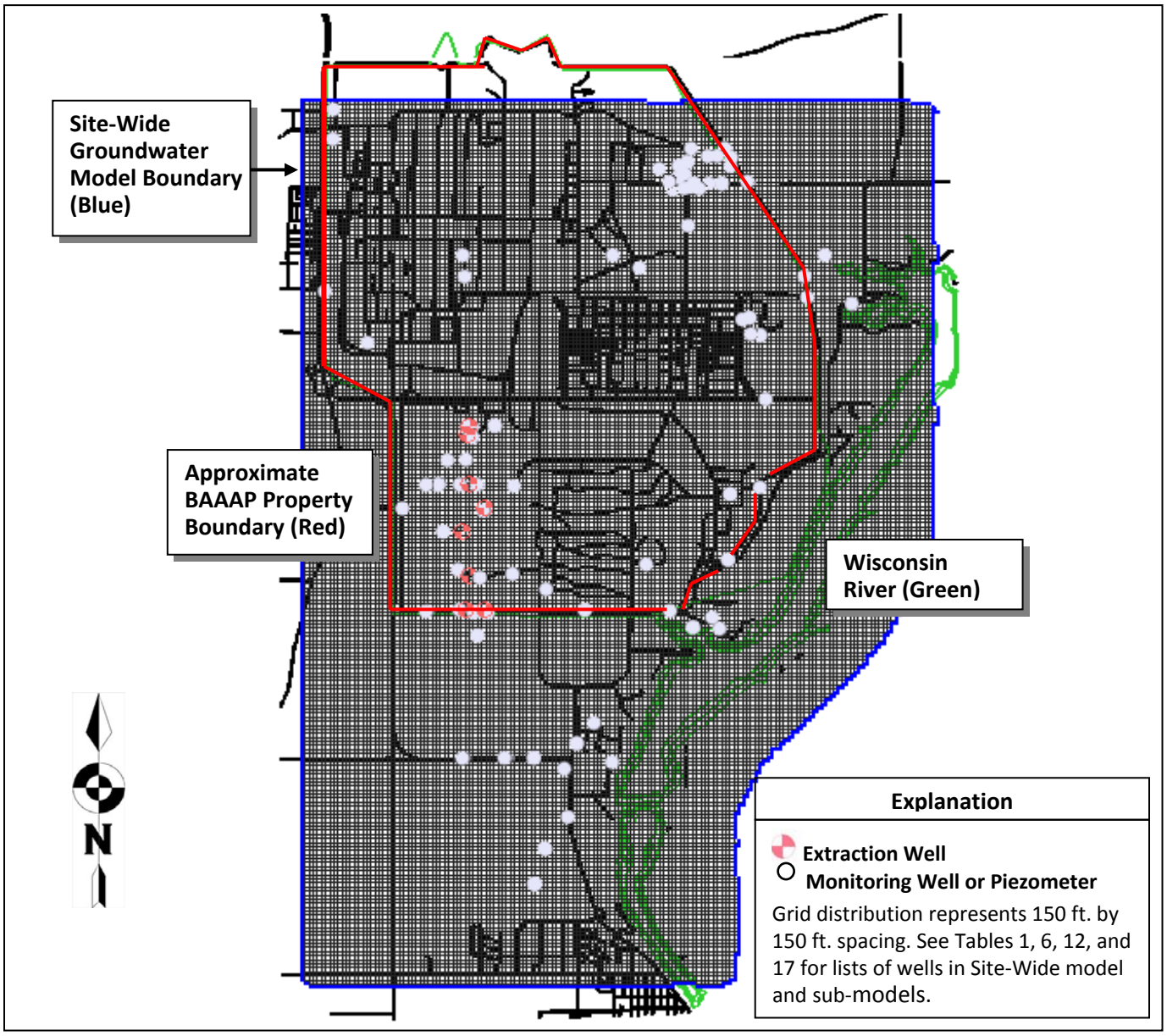
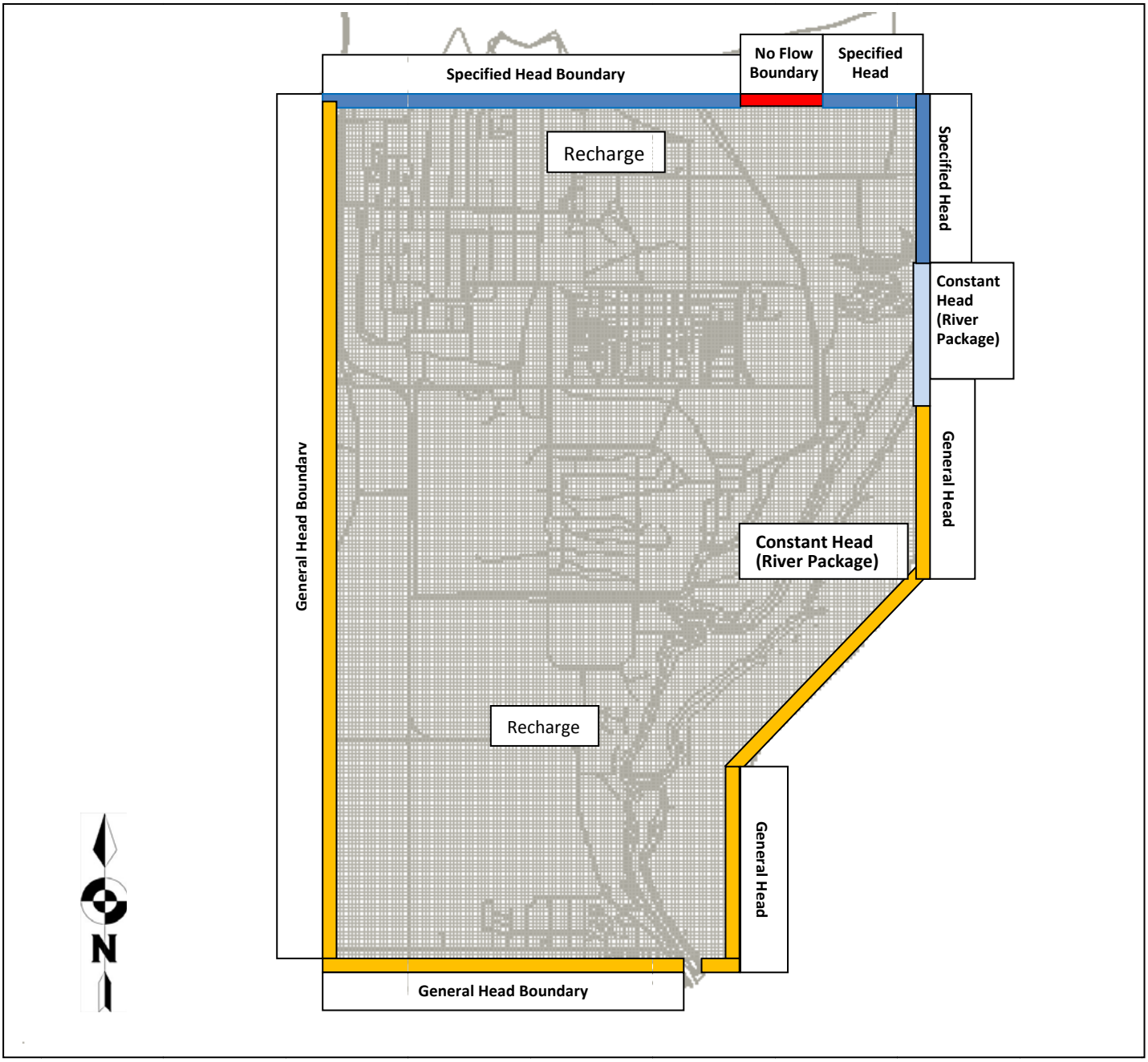


Figure 5. Flow Model Boundary and Initial Conditions
Badger Army Ammunition Plant



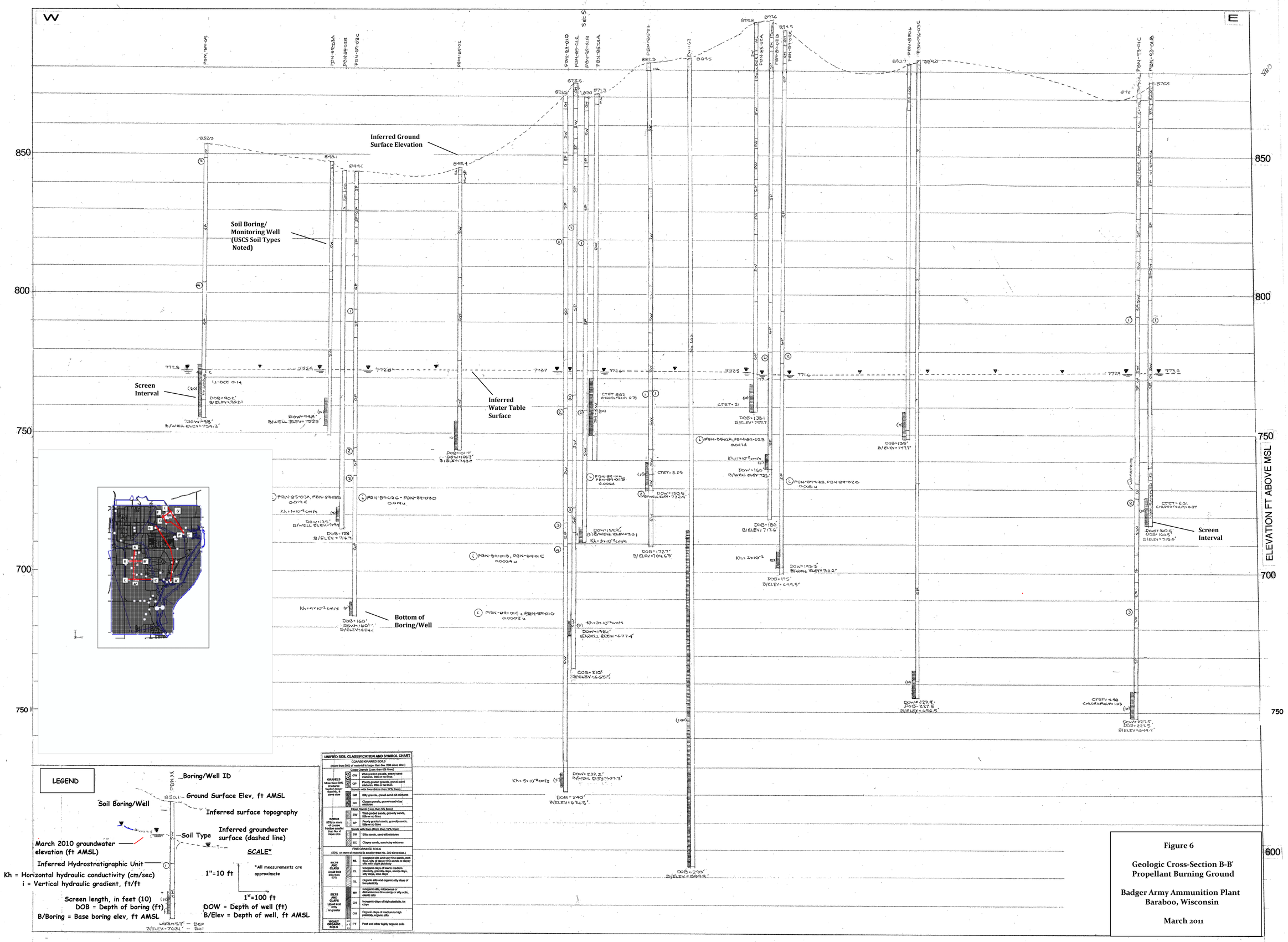


Figure 6

Geologic Cross-Section B-B'
Propellant Burning Ground

Badger Army Ammunition Plant
Baraboo, Wisconsin

March 2011

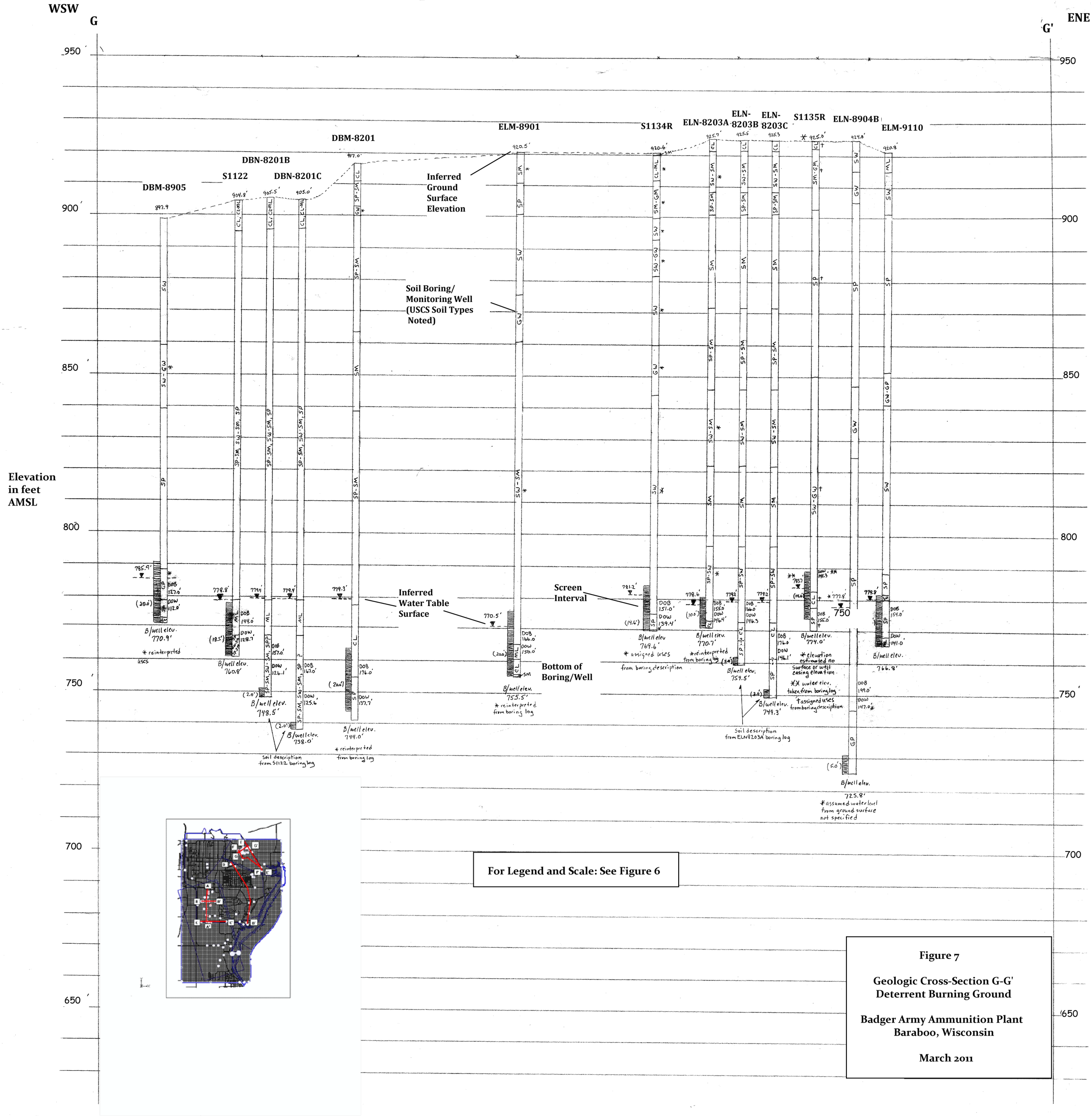


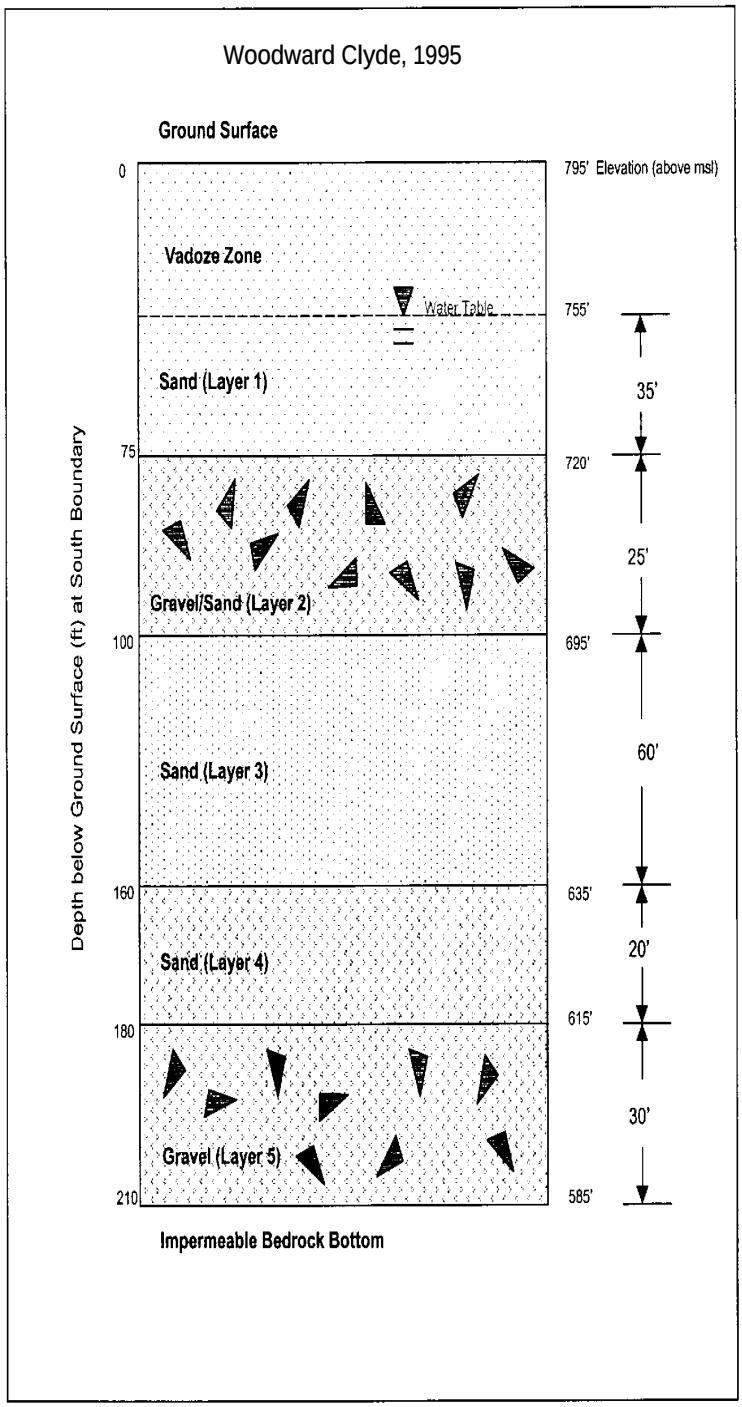
Figure 7

Geologic Cross-Section G-G'
Deterrent Burning Ground

Badger Army Ammunition Plant
Baraboo, Wisconsin

March 2011

Figure 8. Model Layers and Thicknesses



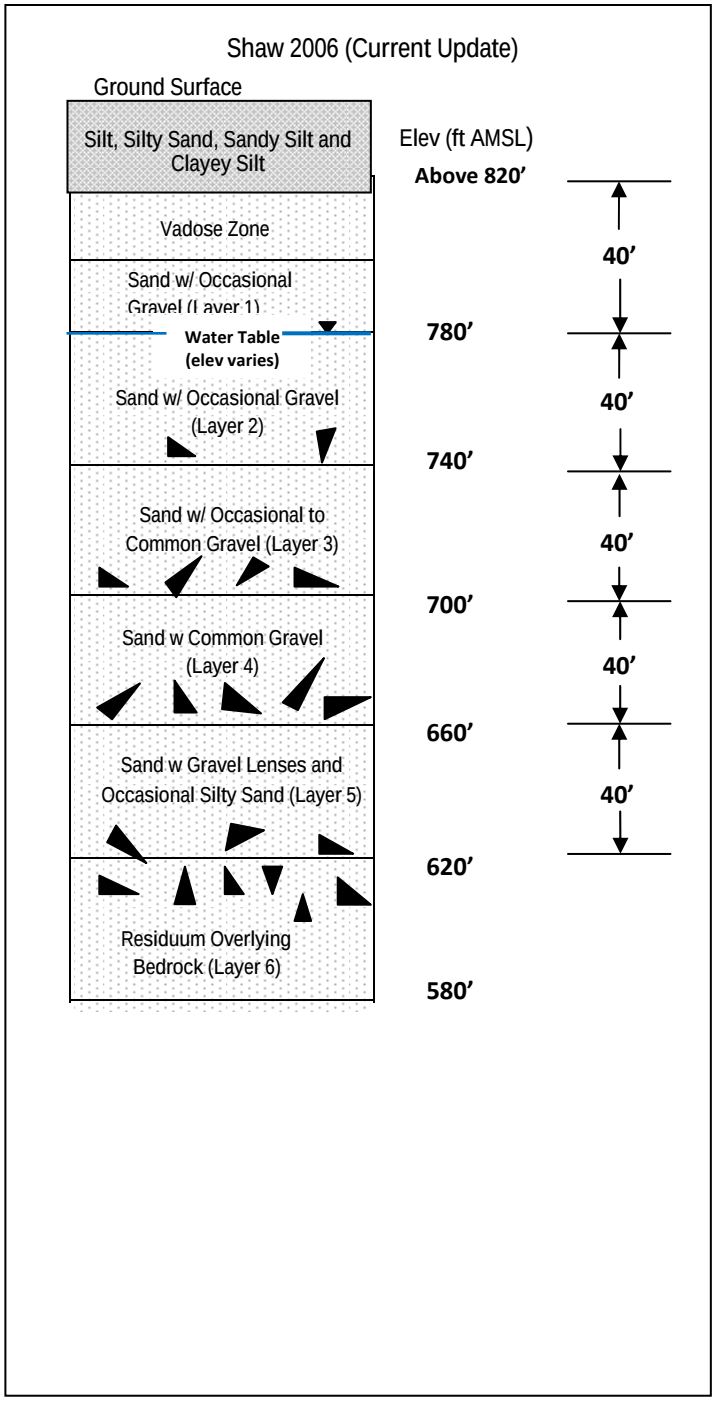
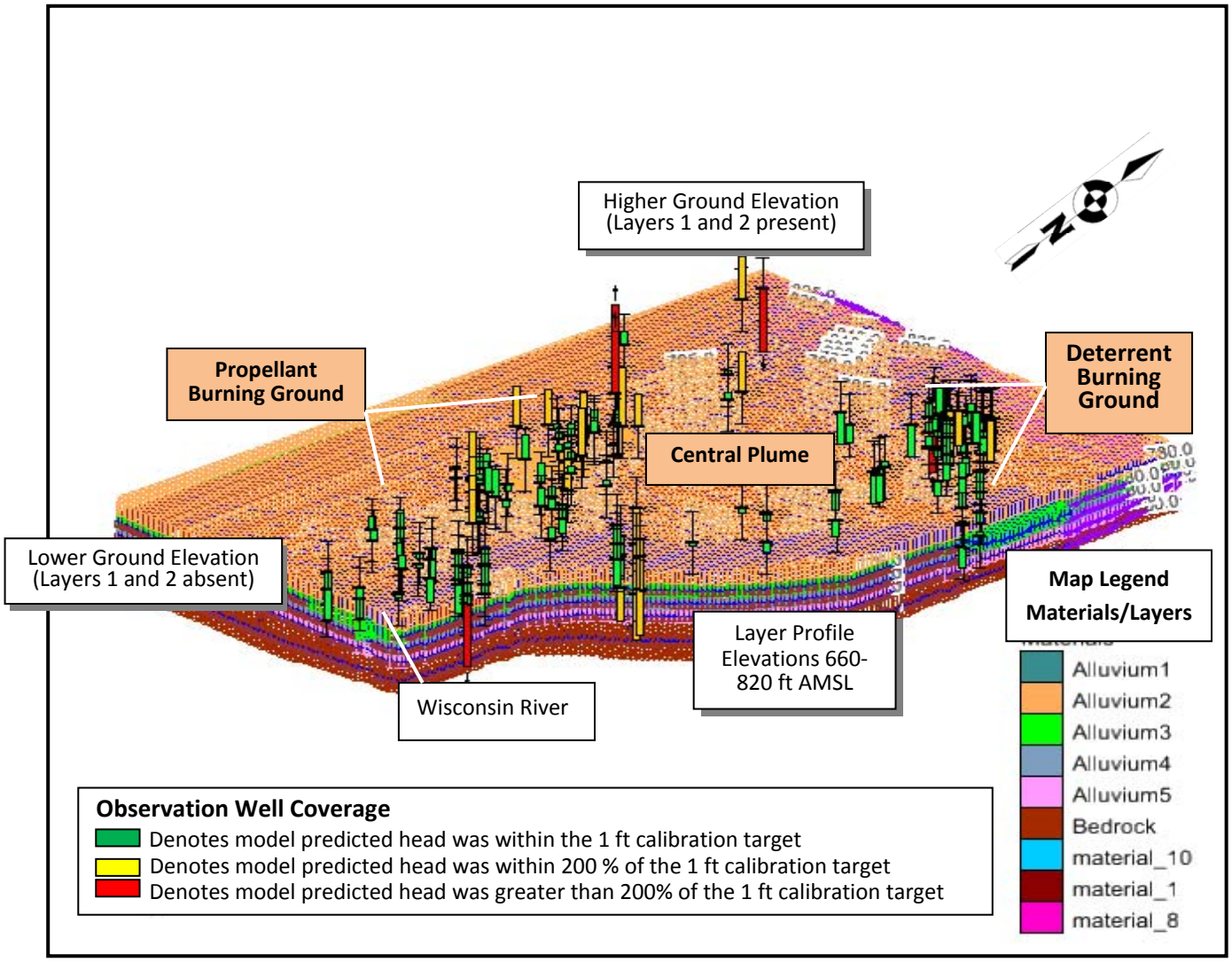
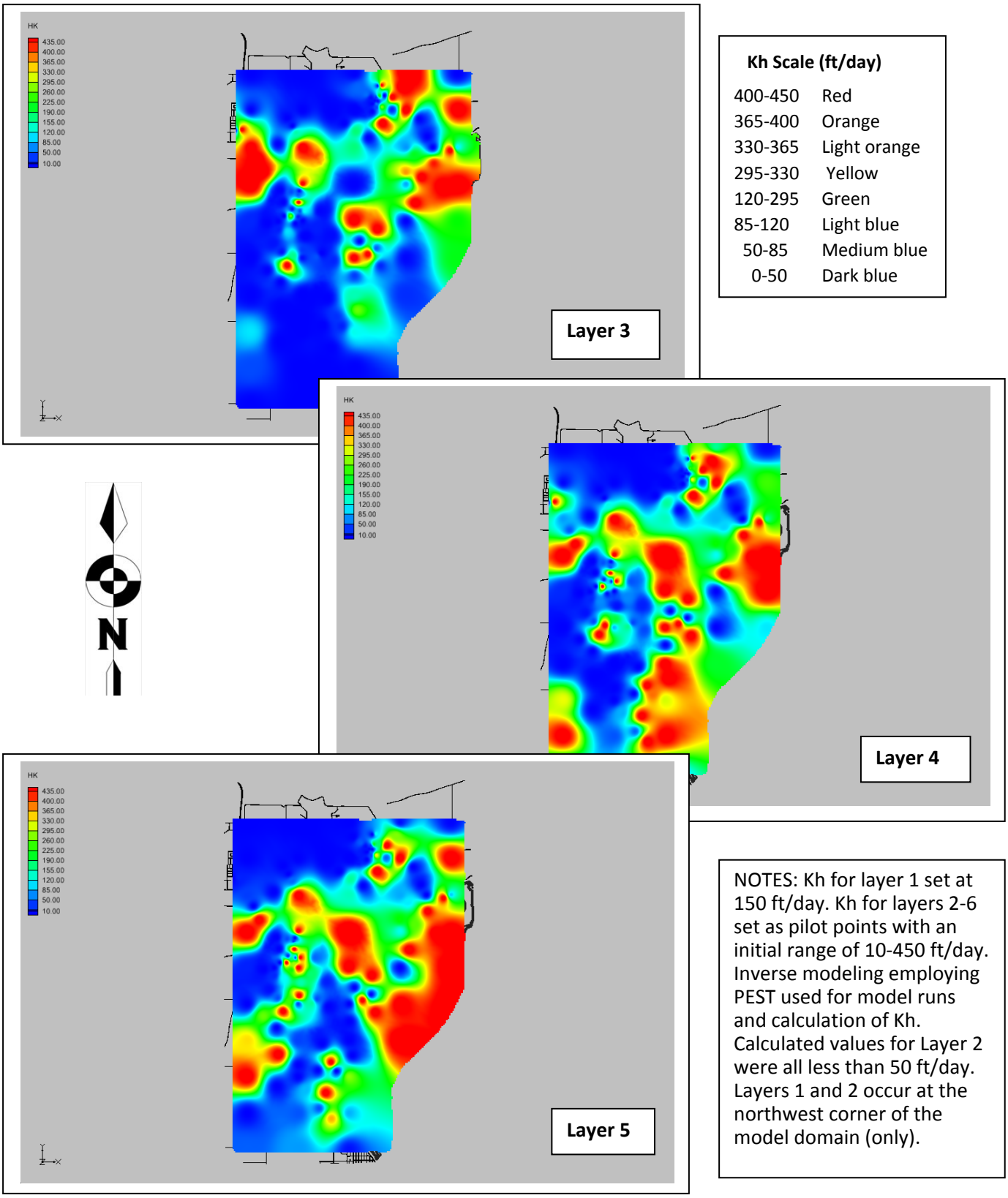


Figure 9. Model Layers and Well Locations



The model is comprised of five layers with a combined saturated thickness of more than 170 feet. Layers 1, 3 and 4 have been reported to consist of sand deposits, whereas Layer 3 was a mixture of gravel and sand (Woodward-Clyde, 1995). The bottom layer (Layer 5) was a 30-foot thick gravel deposit sitting above impermeable bedrock. The current model was constructed on the basis of prior modeling efforts, and includes more than 200 wells. Those shown above were used for model calibration and depict the degree to which model results correspond to field conditions, obtained in September 2010.

Figure 10. Distribution of Horizontal Hydraulic Conductivity

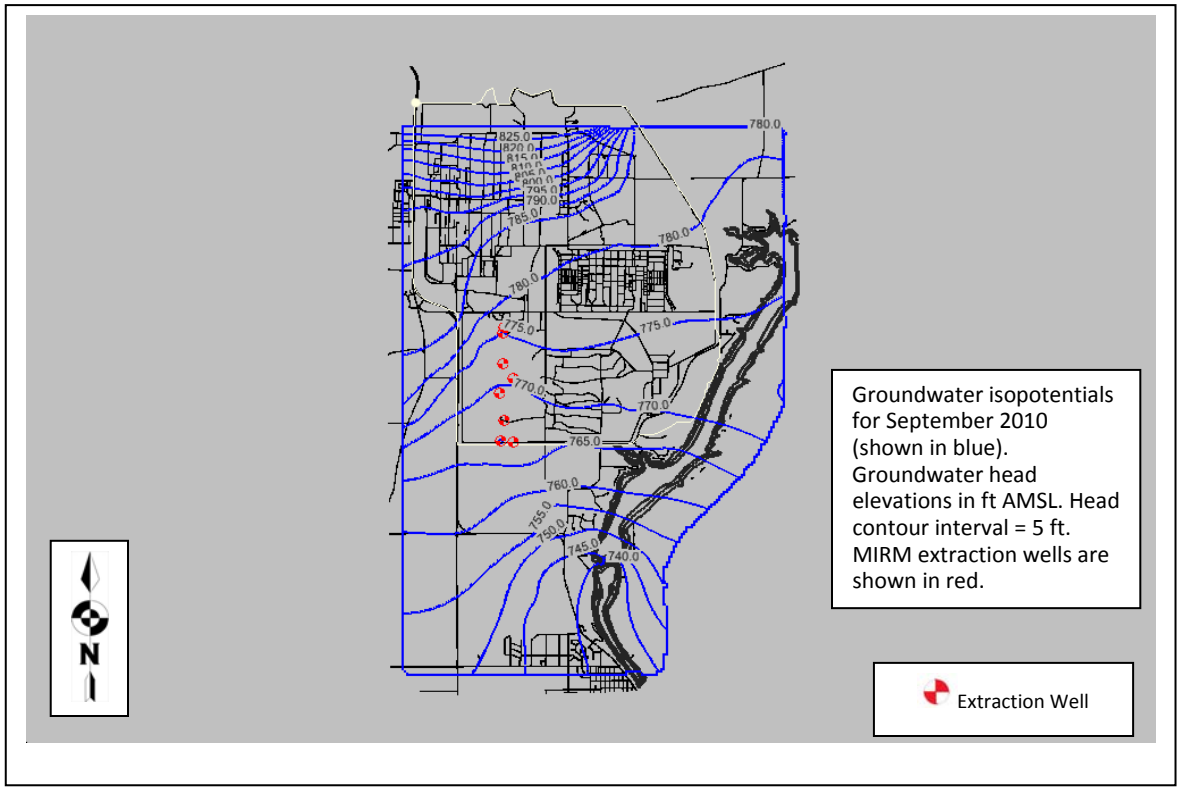


Kh Scale (ft/day)

400-450	Red
365-400	Orange
330-365	Light orange
295-330	Yellow
120-295	Green
85-120	Light blue
50-85	Medium blue
0-50	Dark blue

NOTES: Kh for layer 1 set at 150 ft/day. Kh for layers 2-6 set as pilot points with an initial range of 10-450 ft/day. Inverse modeling employing PEST used for model runs and calculation of Kh. Calculated values for Layer 2 were all less than 50 ft/day. Layers 1 and 2 occur at the northwest corner of the model domain (only).

Figure 11. Calibrated Model Predicted Groundwater Isopotentials



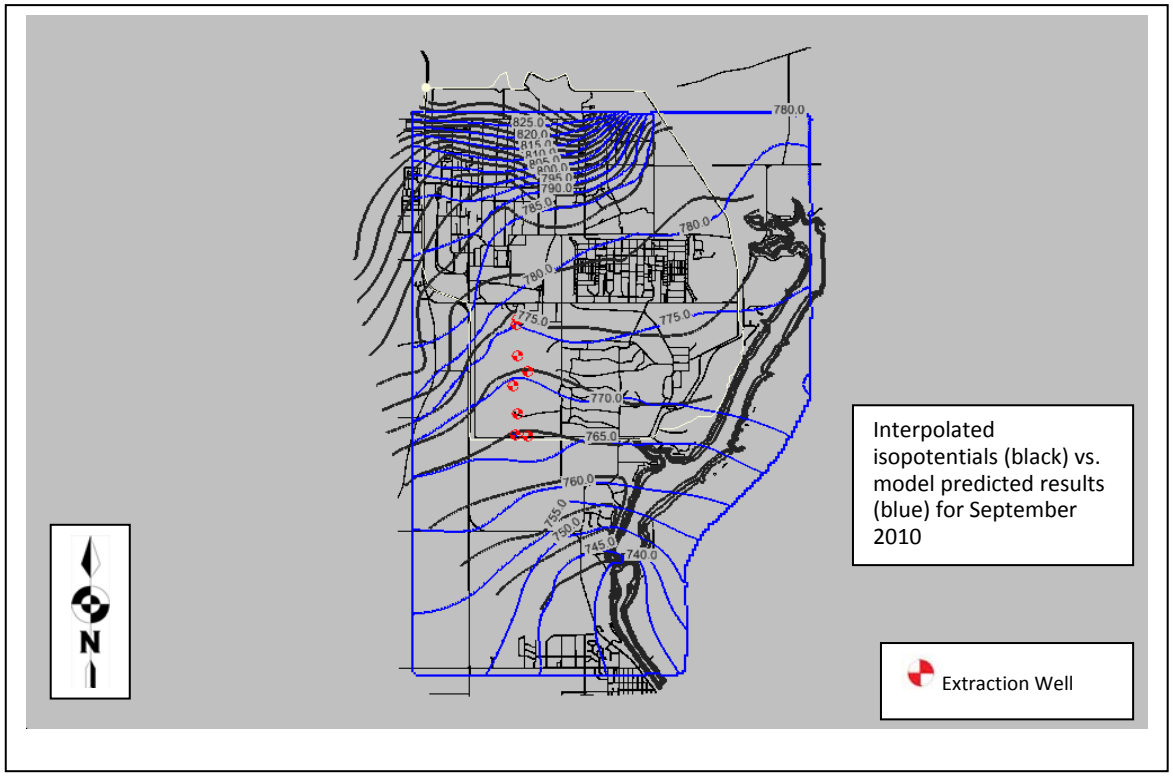
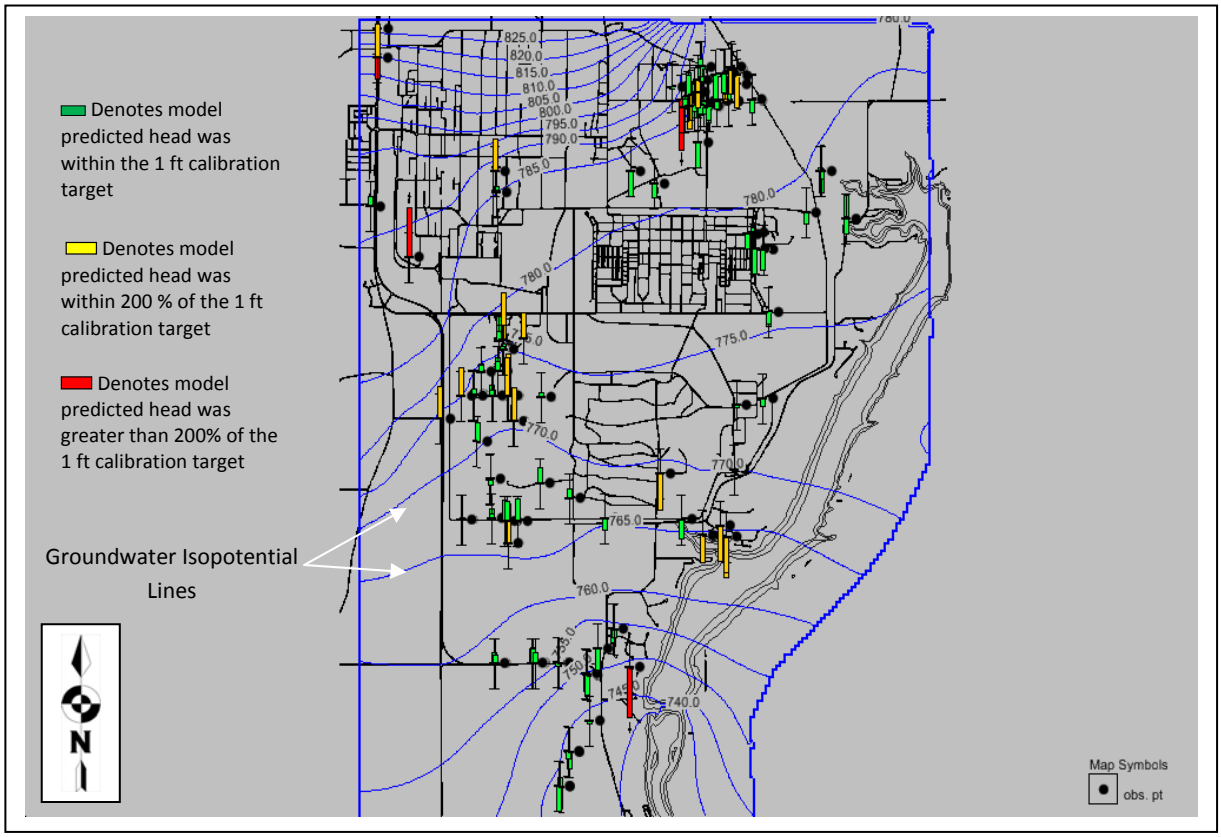


Figure 12
Site-Wide Groundwater Flow Model
Model Calibration Locations and Statistics

Total Wells: 160
Total Residual Error: 1230

Head Error Summary	
Mean Error:	-0.90
Mean Abs. Error:	0.713
Root Mean Sq. Error:	1.062



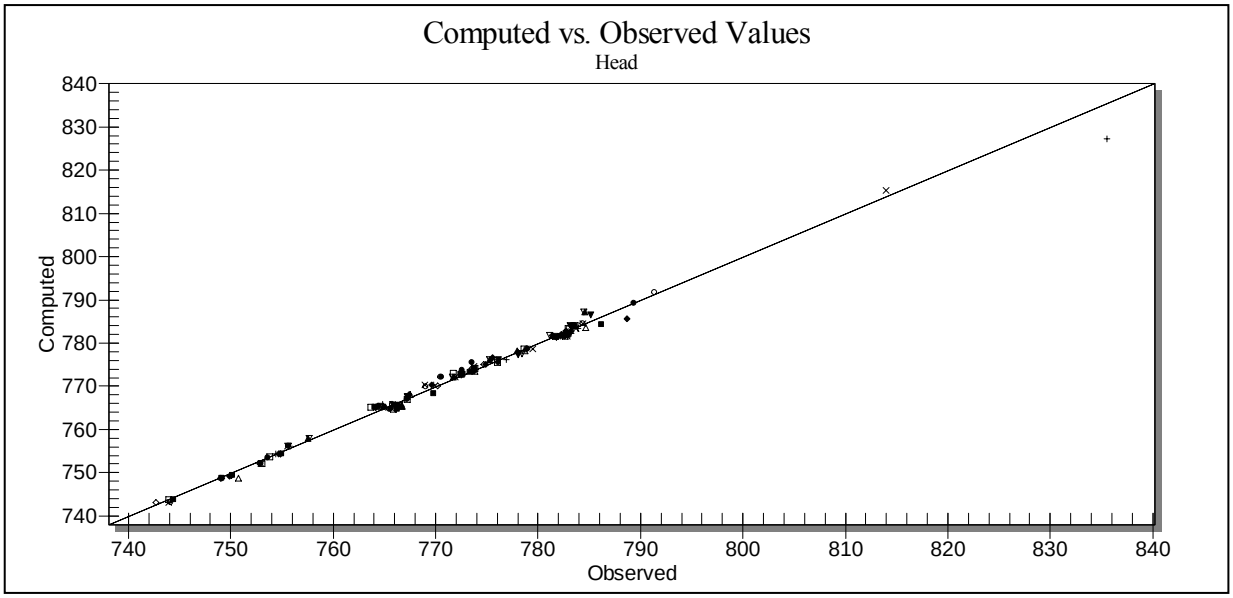
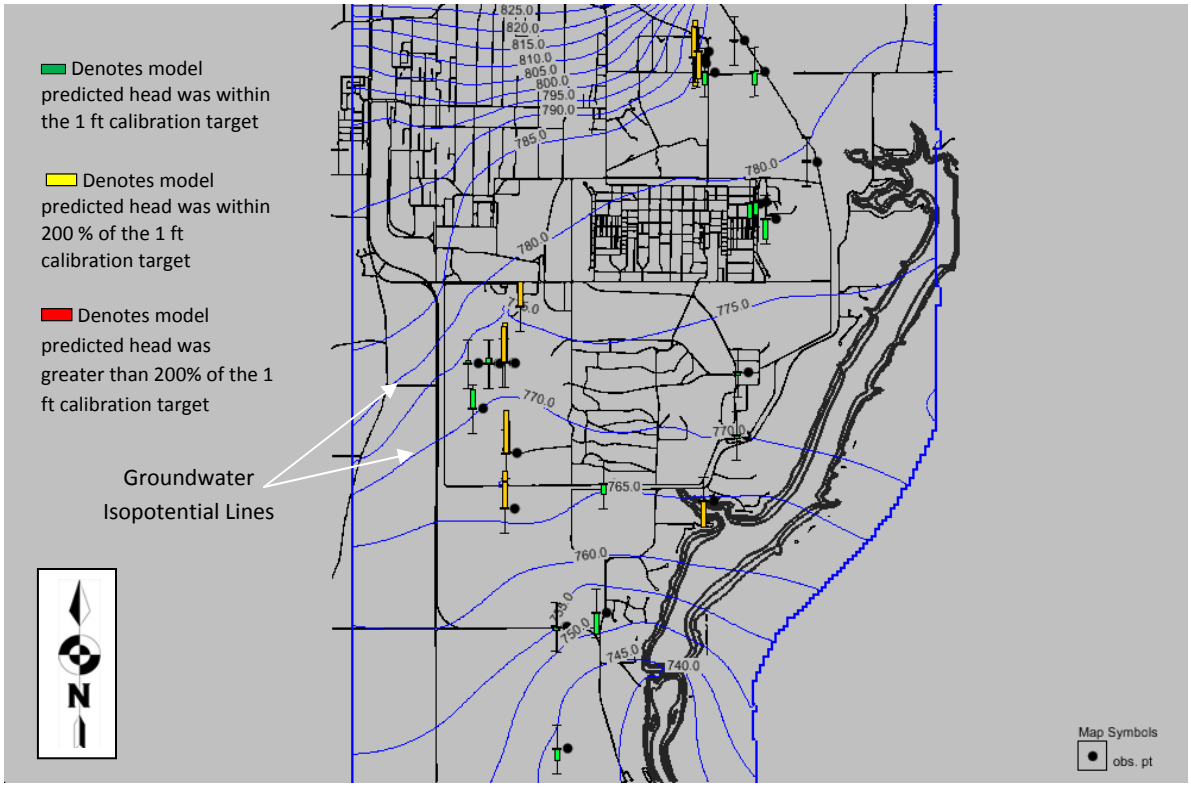


Figure 13
Site-Wide Groundwater Flow Model
Model Verification Locations and Statistics

Total Verification Wells: 40
Total Residual Error: 1230

Head Error Summary	
Mean Error:	0.117
Mean Abs. Error:	0.737
Root Mean Sq. Error:	0.899



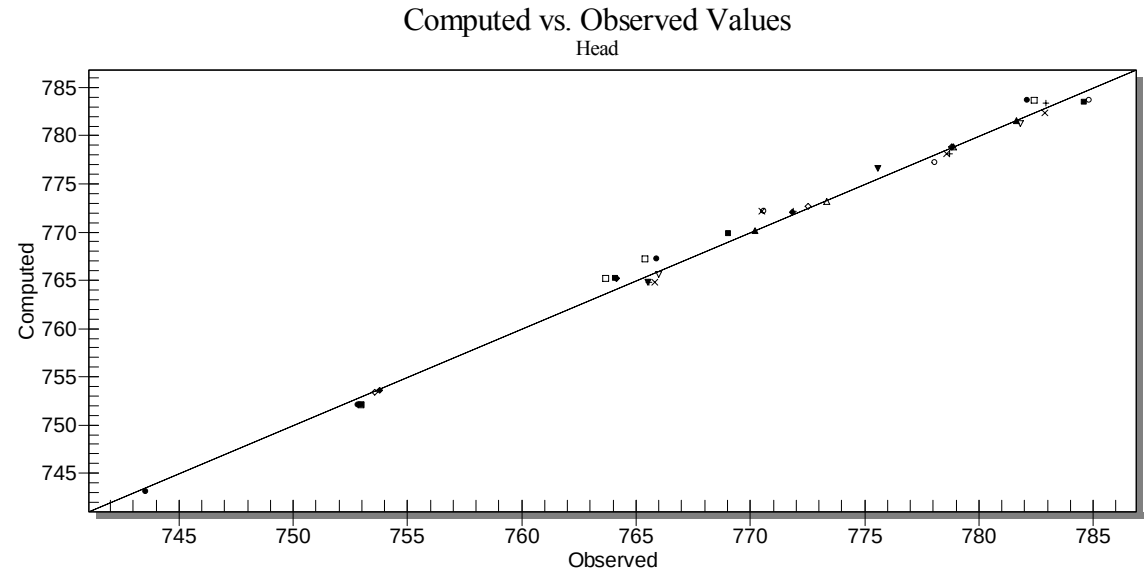
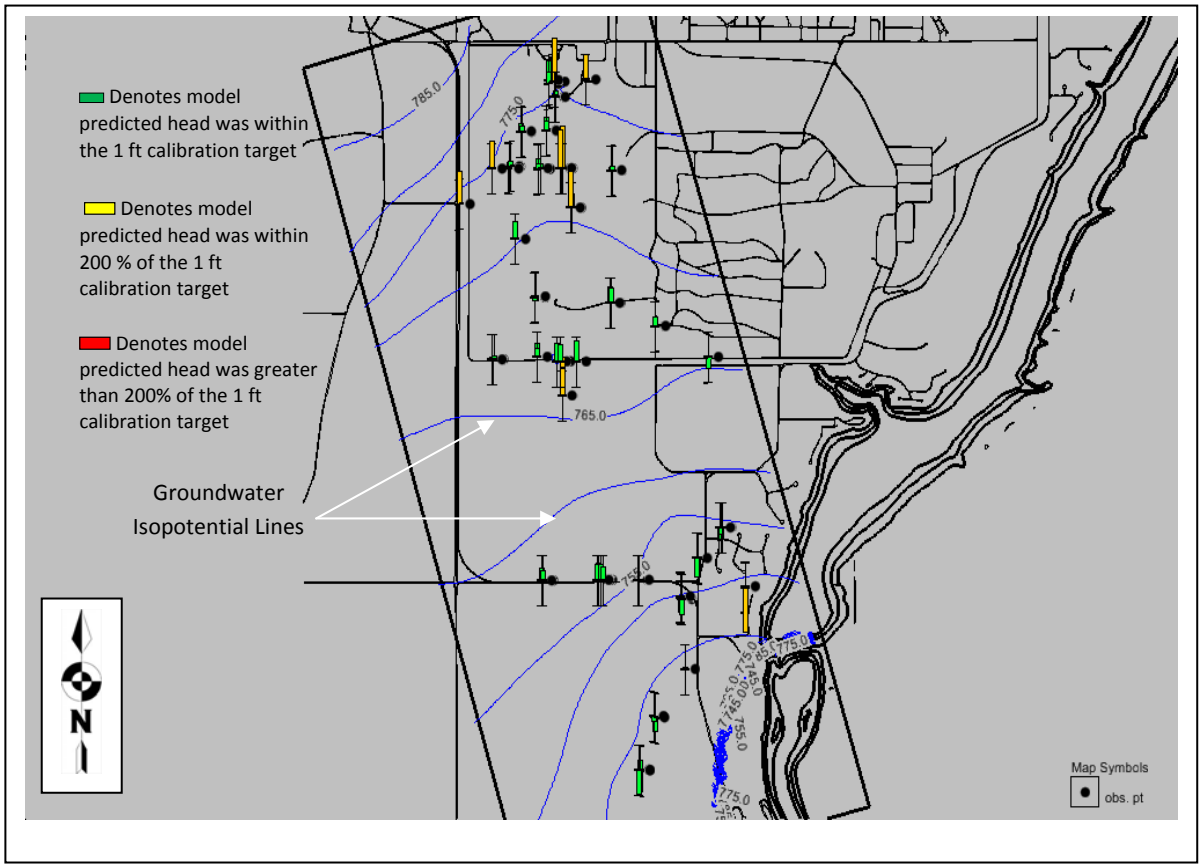


Figure 14
Propellant Burning Ground – Groundwater Flow Sub-Model
Model Calibration Locations and Statistics

Total Wells: 80
Total Residual Error: 228

Head Error Summary	
Mean Error:	0.278
Mean Abs. Error:	0.561
Root Mean Sq. Error:	0.703



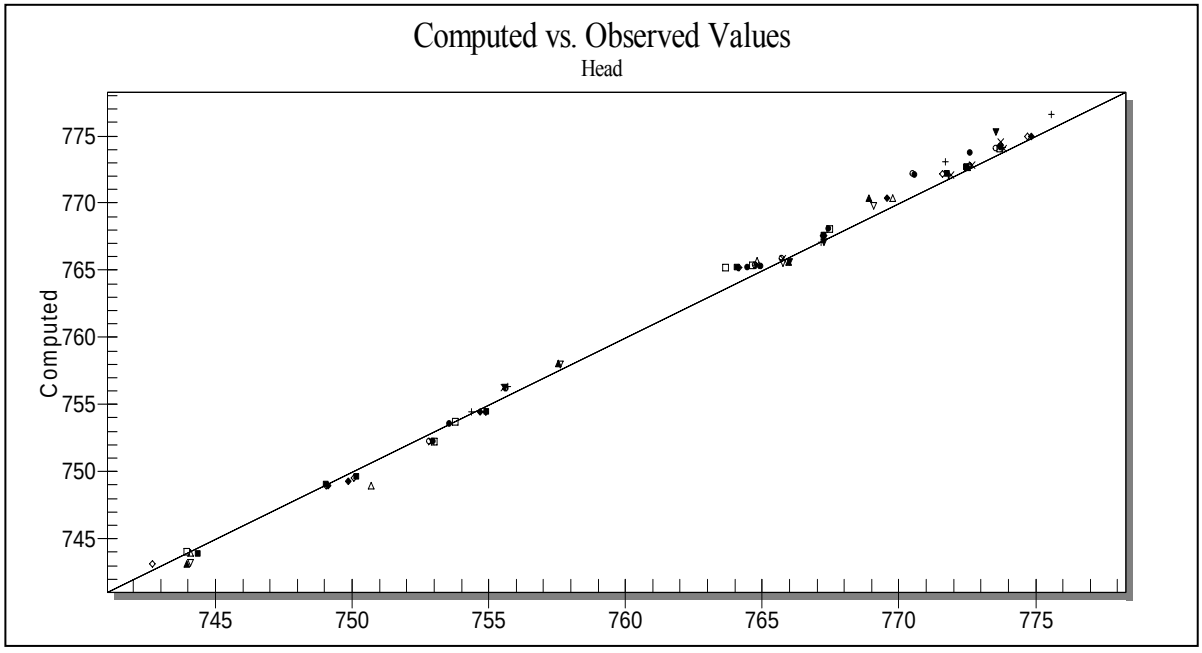
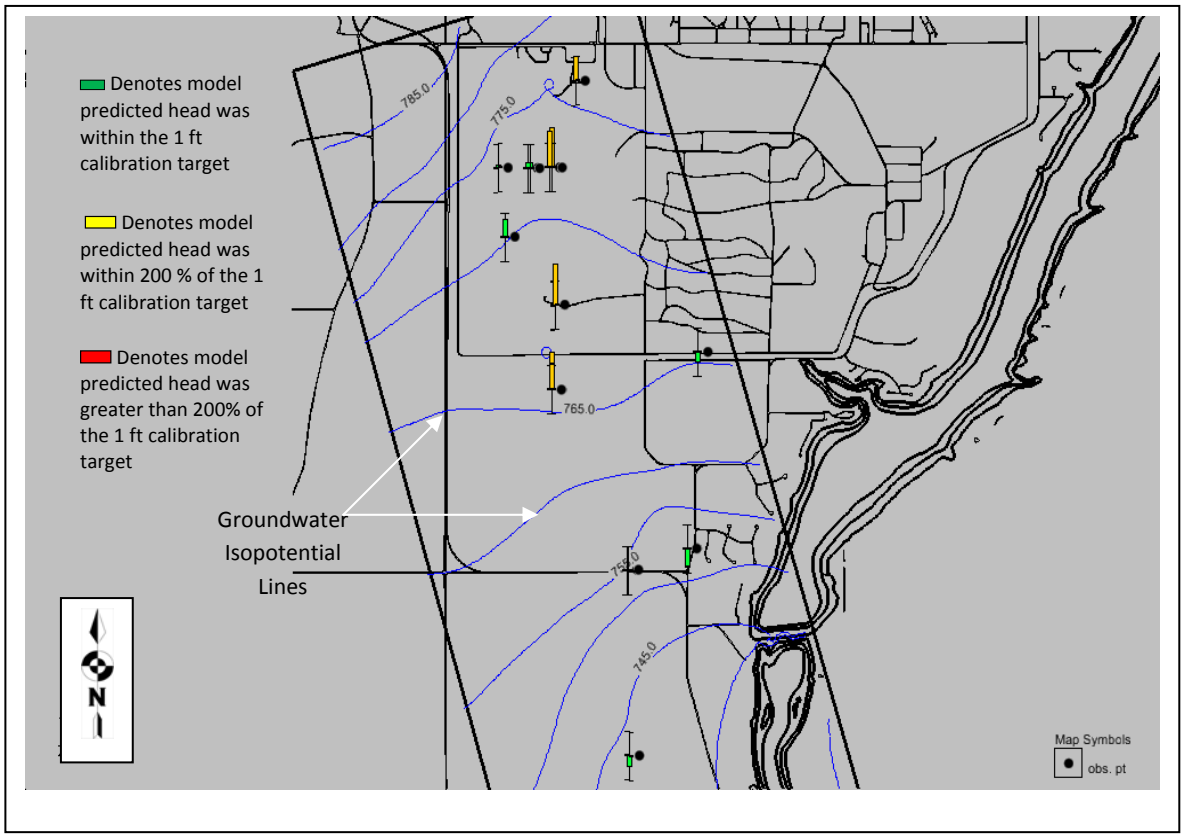


Figure 15
Propellant Burning Ground – Groundwater Flow Sub-Model
Model Verification Locations and Statistics

Total Verification Wells: 21
Total Residual Error: 228

Head Error Summary	
Mean Error:	0.473
Mean Abs. Error:	0.811
Root Mean Sq. Error:	0.972



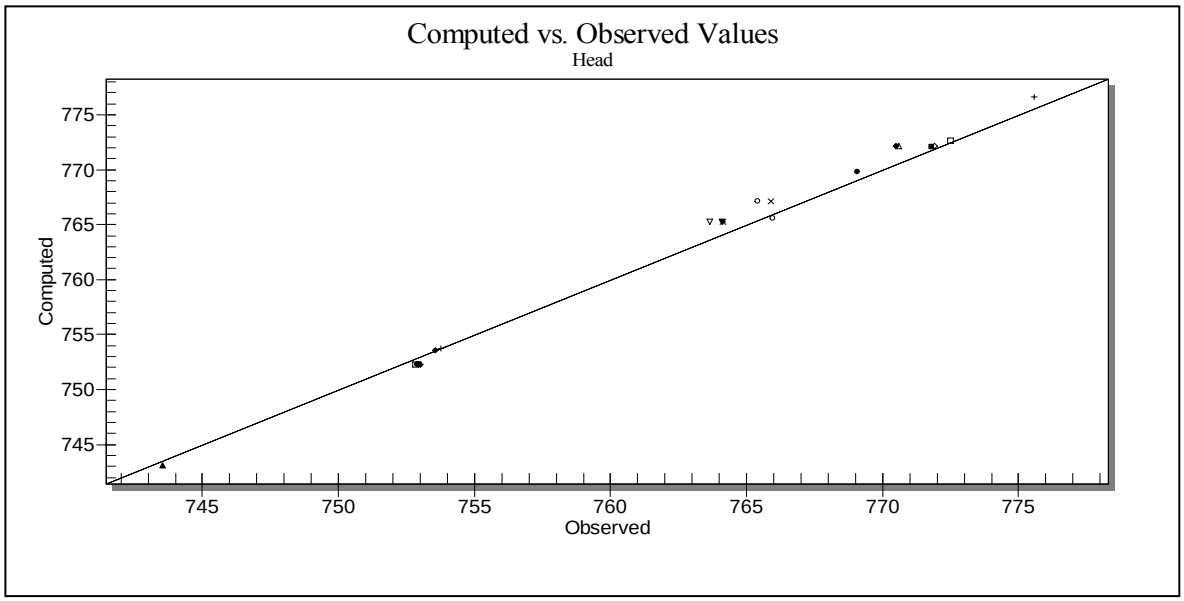
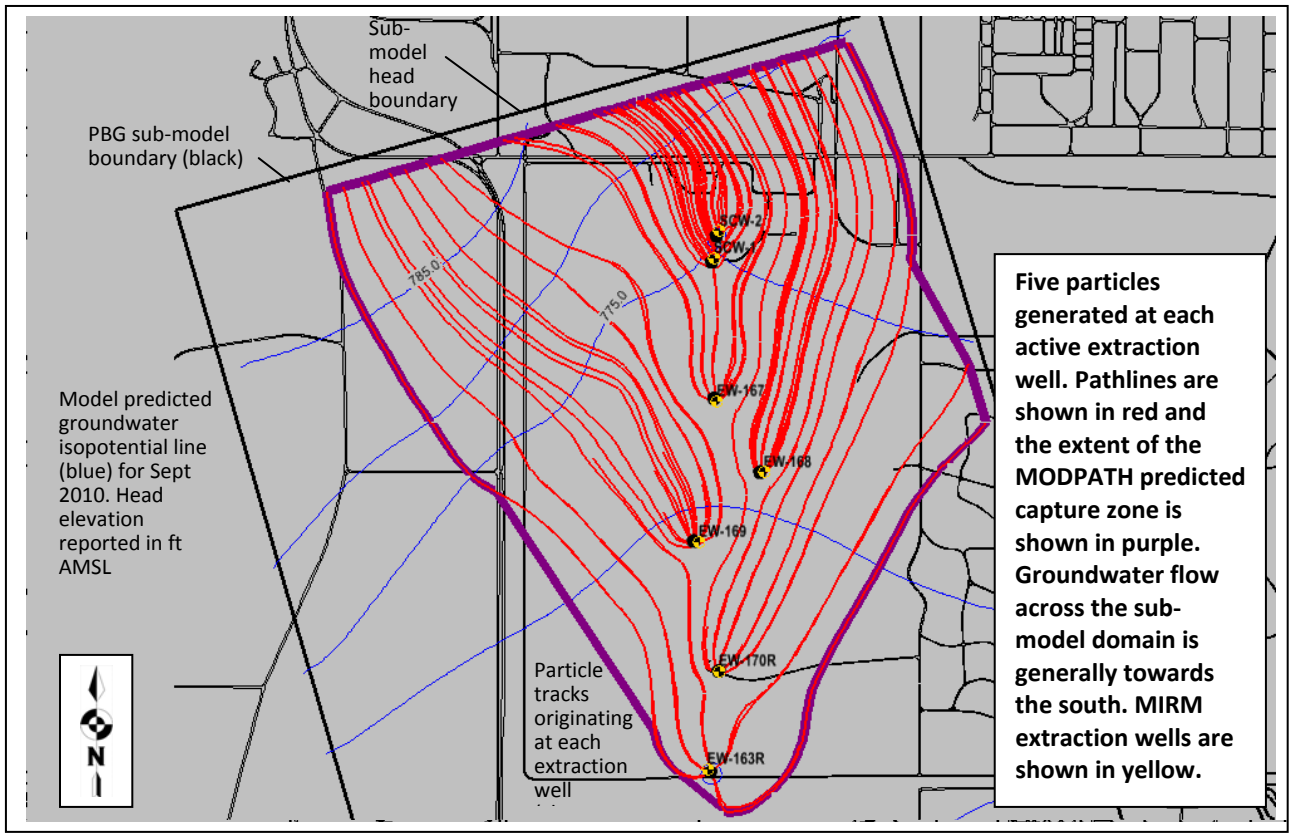


Figure 16
PBG Groundwater Flow Sub-Model
MODPATH Particle Pathlines for the MIRM (current conditions)



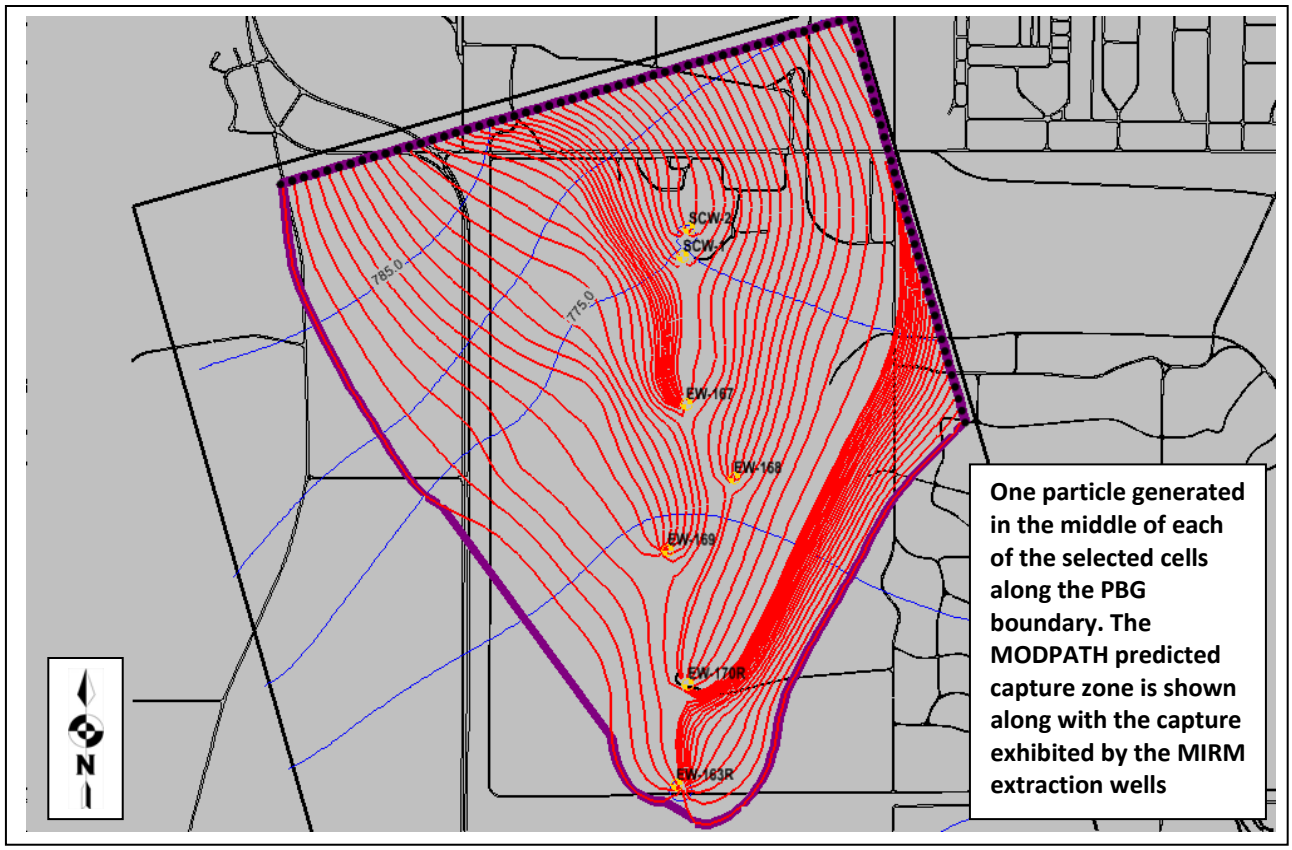
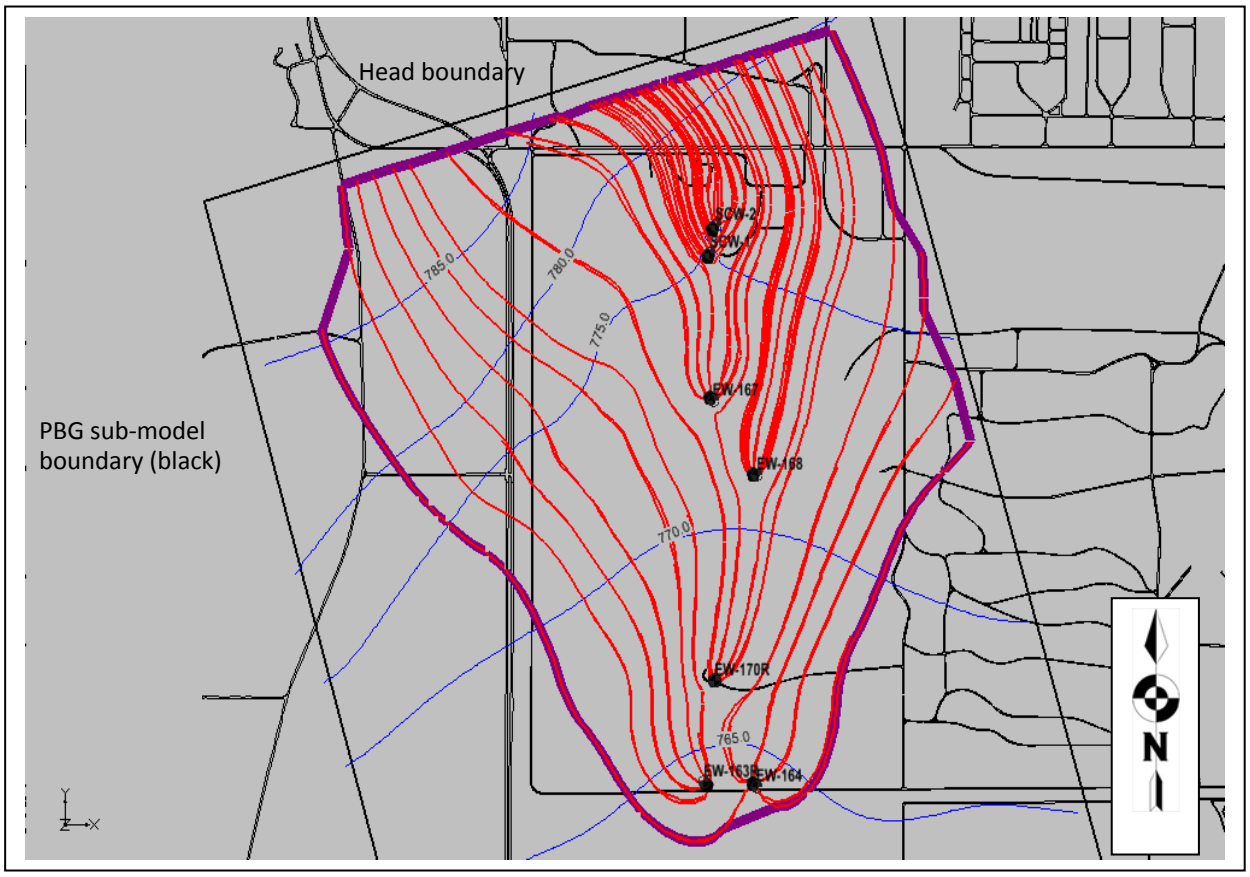


Figure 17
Propellant Burning Ground Sub-Model
MODPATH Particle Pathlines for the MIRM – Revised Pumping Scheme

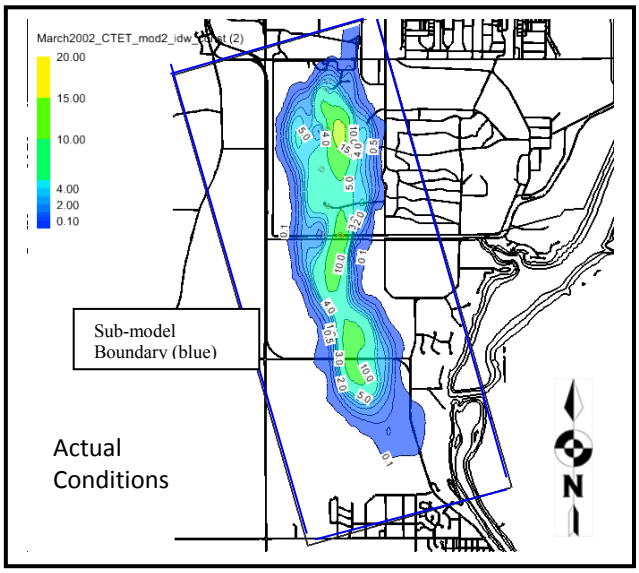


PBG Groundwater Flow Sub-Model; (EW-169 is turned off; EW-164 is turned on).
Five particles generated at each active extraction well (wells are shown in black). Pathlines are shown in red. The MODPATH predicted capture zone is shown in purple. Local groundwater flow is southward.

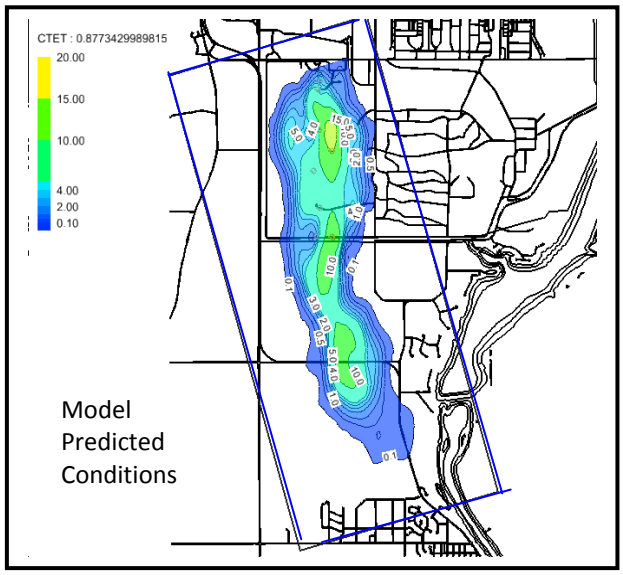
The model predicted groundwater isopotential lines were developed using September 2010 data (shown in blue). Reported head elevations are in feet AMSL. No model calibration was performed after adjustment of the MIRM extraction system. Therefore, the groundwater isopotential lines and particle tracks should only be considered representative.

Figure 18. Propellant Burning Ground Sub-Model
Comparison of Observed vs. Predicted Concentrations of Carbon Tetrachloride

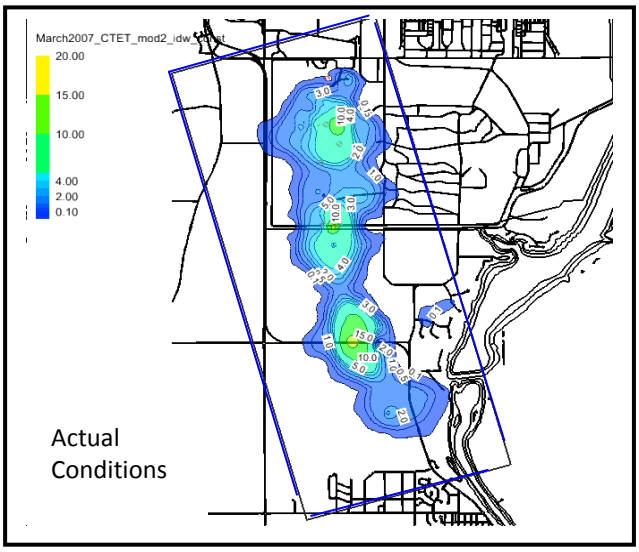
PBG CTET 2002 – 3D DATA INTERPOLATION



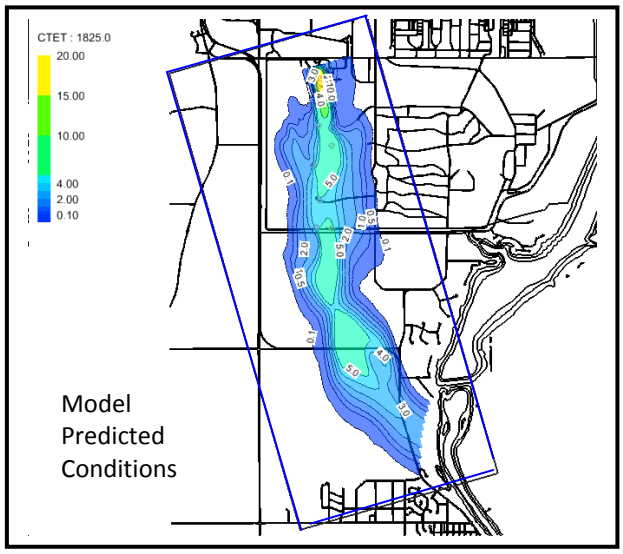
PBG CTET 2002 – MODEL RESULTS



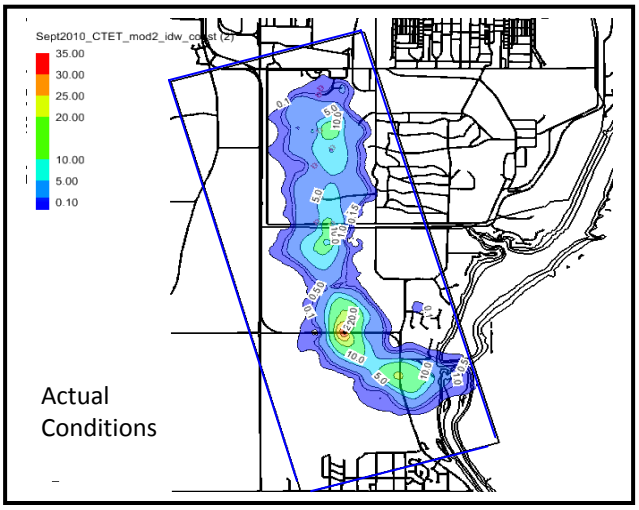
PBG CTET 2007 – 3D DATA INTERPOLATION



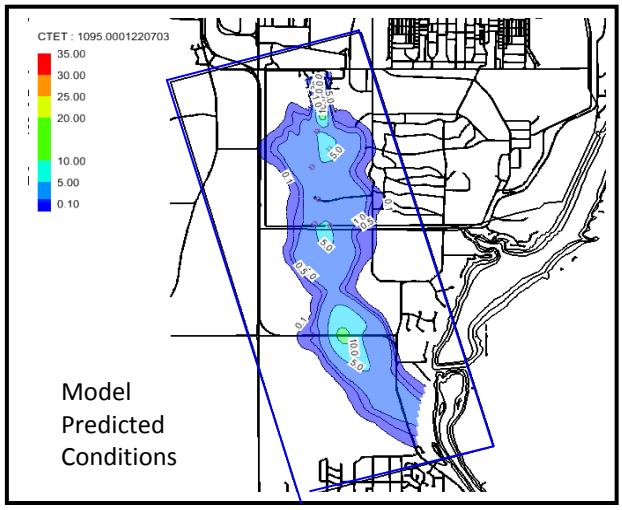
PBG CTET 2007 – MODEL RESULTS



PBG CTET 2010 – 3D DATA INTERPOLATION



PBG CTET 2010– MODEL RESULTS

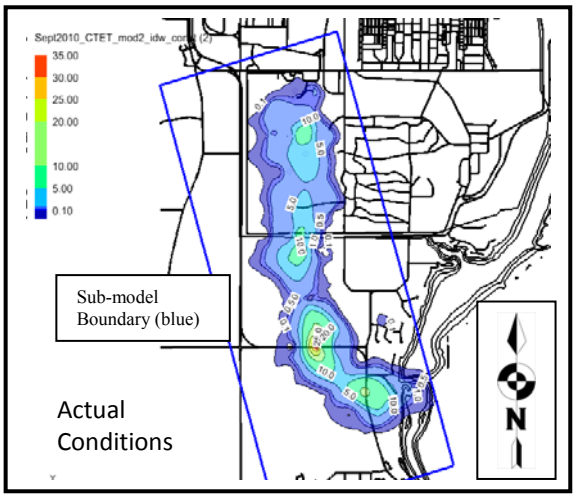


Advection Solution: MMOC (2002-10)
Chemical Reaction: Sorption via linear isotherm
Source Loading Conc: 50-100 ppb, 4 locations, Layers 3, 4.

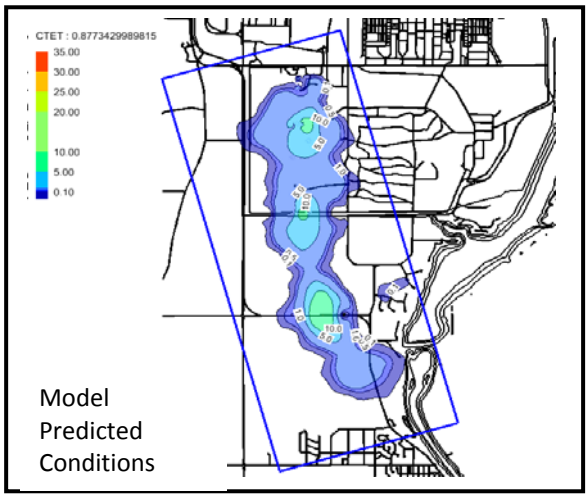
Dispersion Package (TRPT 0.2; TRVT 0.05)
Effective Porosity: 26% (Layers 1-5)
Time Periods for Loading: 2002-2010

Figure 19. Propellant Burning Ground Sub-Model
Predicted Concentrations of Carbon Tetrachloride, 2010-2040

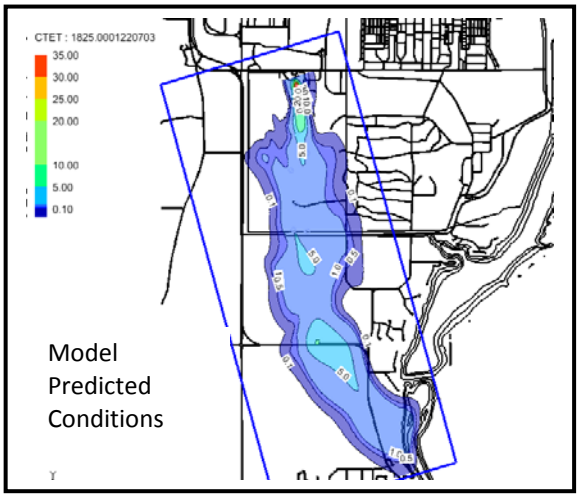
PBG CTET 2010 – DATA INTERPOLATION



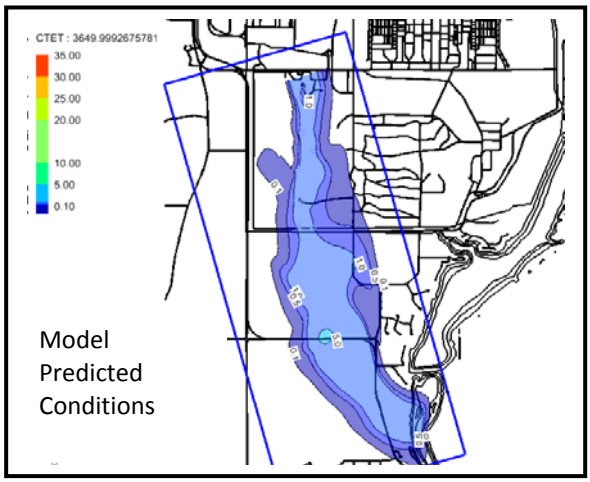
PBG CTET 2010– MODEL SIMULATION



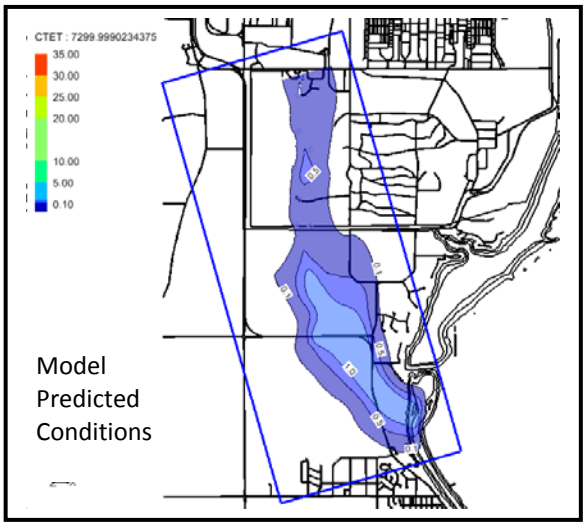
PBG CTET 2015 – MODEL SIMULATION



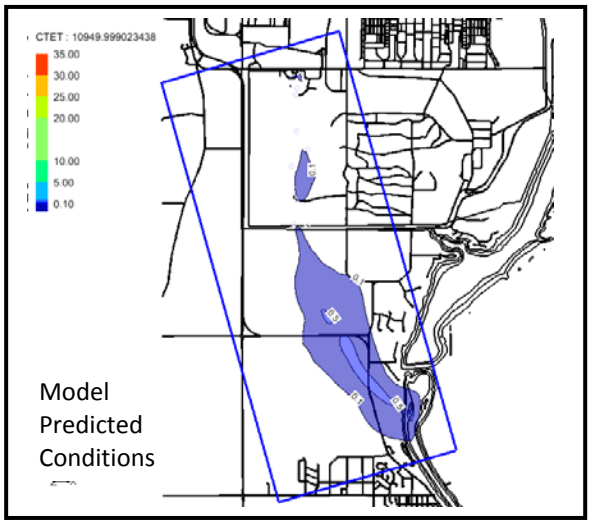
PBG CTET 2020 – MODEL SIMULATION



PBG CTET 2030 – MODEL SIMULATION



PBG CTET 2040 – MODEL SIMULATION

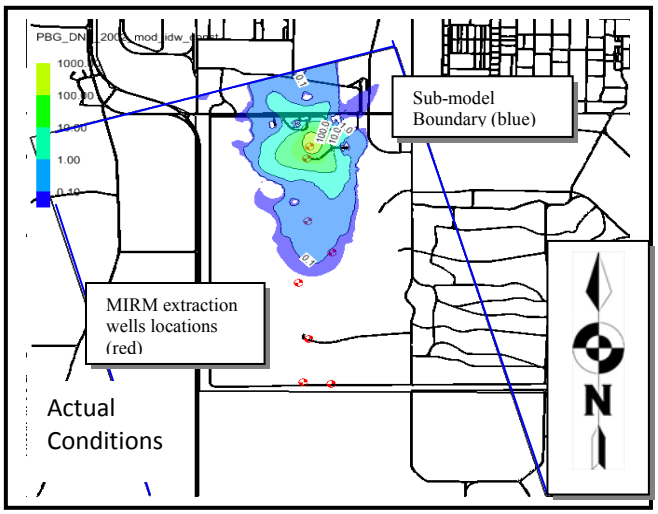


Advection Solution: MMOC (2010-40)
Chemical Reaction: NONE
Source Loading Conc: 40-75 ppb, 4 locations, Layers 3, 4.

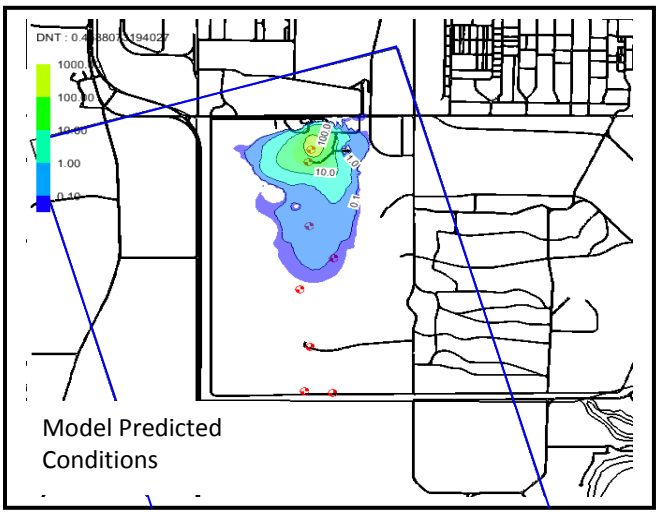
Dispersion Package (TRPT 0.2; TRVT 0.05)
Effective Porosity: 26% (Layers 1-5)
Time Periods for Loading: 2010-2015

Figure 20. Propellant Burning Ground Sub-Model
Comparison of Observed vs. Predicted Concentrations of Total Dinitrotoluene

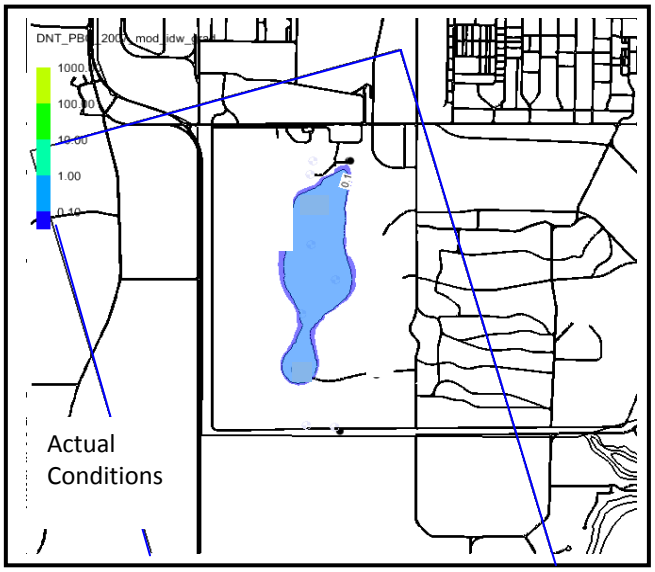
PBG DNT 2002 – 3D DATA INTERPOLATION



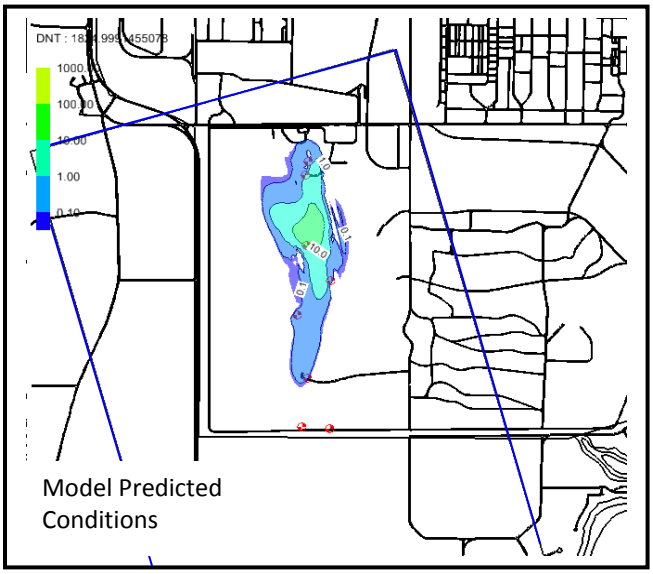
PBG DNT 2002 – MODEL RESULTS



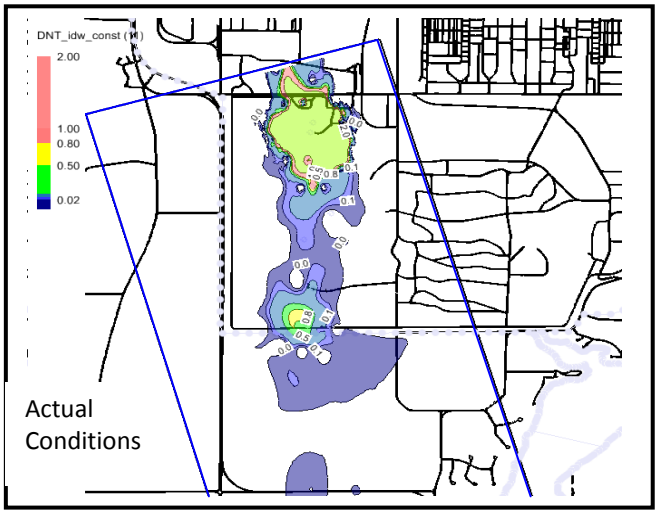
PBG DNT 2007 – 3D DATA INTERPOLATION



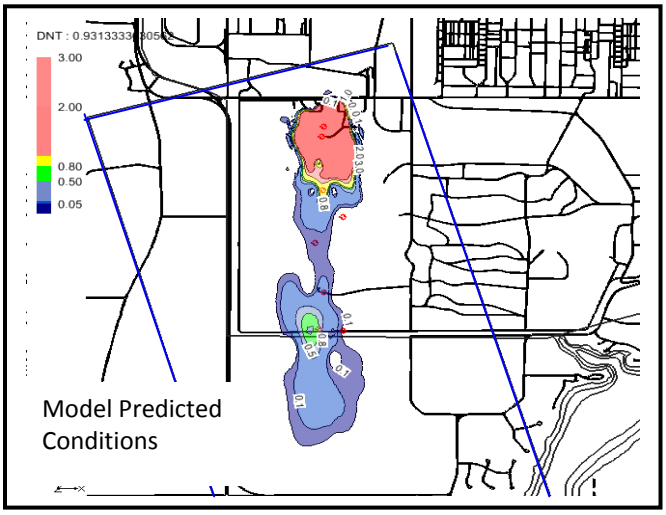
PBG DNT 2007 – MODEL RESULTS



PBG DNT 2010 – 3D DATA INTERPOLATION



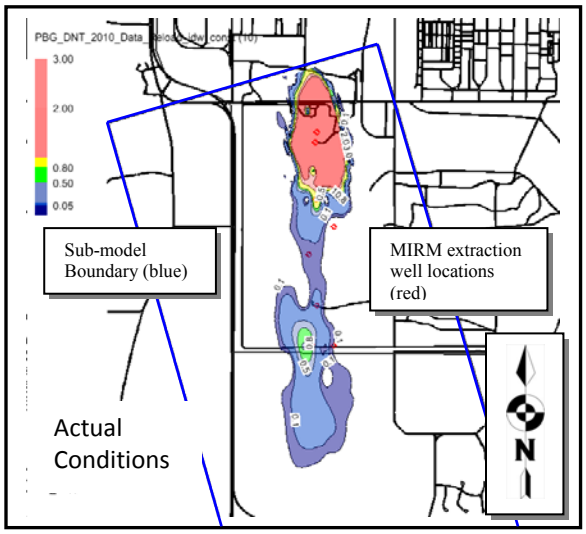
PBG DNT 2010 – MODEL RESULTS



Advection Solution: Third Order TVD (07) MMOC (2002,10)
Chemical Reaction: Sorption via linear isotherm
Source Loading Conc: 0.5 - 1 ppb, 4-5 locations, Layers 3, 4.
Dispersion Package (TRPT 0.2; TRVT 0.05)
Effective Porosity: 26% (Layers 1-5)
Time Periods for Loading: 2002-2010

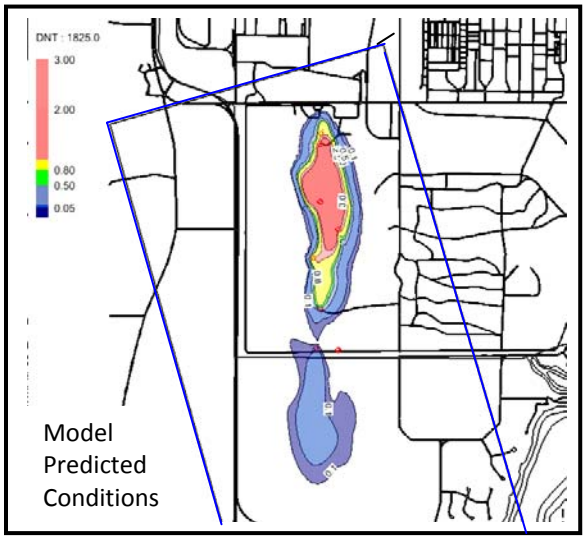
Figure 21. Propellant Burning Ground Sub-Model
Predictive Model Simulations for Total Dinitrotoluene, 2010-2040

PBG DNT 2010 – DATA INTERPOLATION

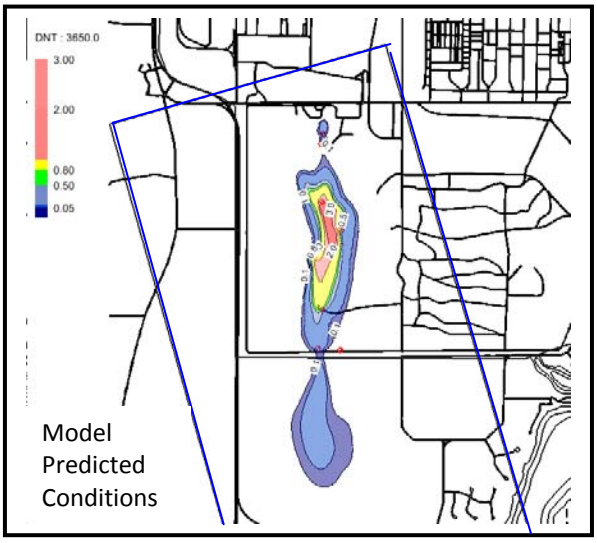


PBG DNT 2010 – MODEL SIMULATION

PBG DNT 2015 – MODEL SIMULATION

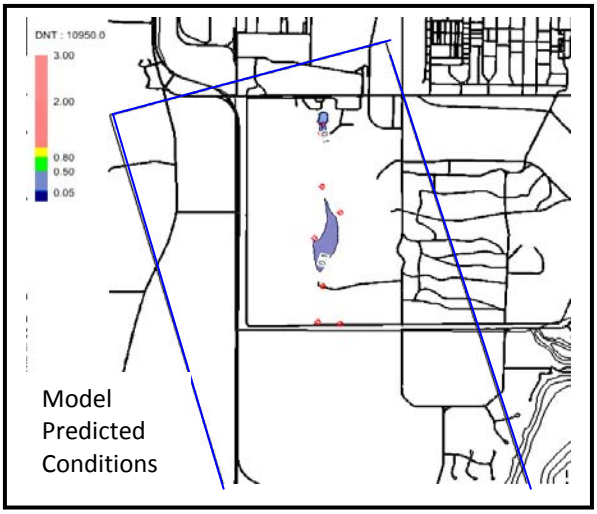


PBG DNT 2020 – MODEL SIMULATION



PBG DNT 2030 – MODEL SIMULATION

PBG DNT 2040 – MODEL SIMULATION



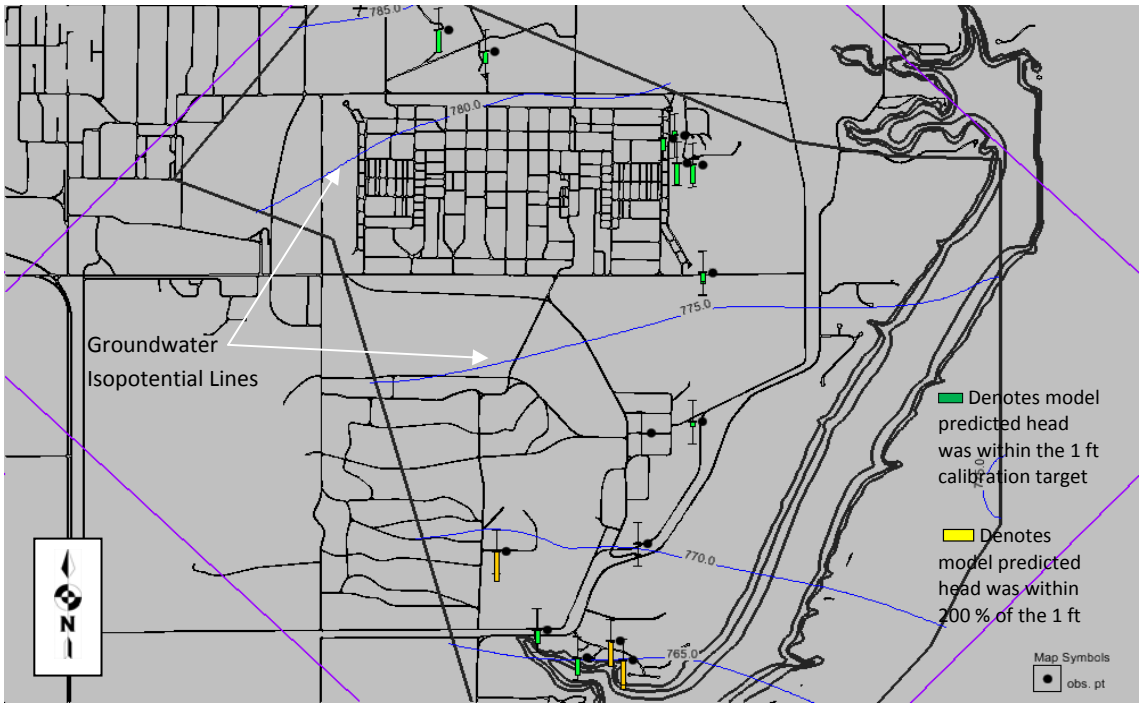
Advection Solution: Third Order TVD
Chemical Reaction: Sorption via linear isotherm
Source Loading Conc: 1 ppb, 3 locations, Layers 3, 4.

Dispersion Package (TRPT 0.2; TRVT 0.05)
Effective Porosity: 26% (Layers 1-5)
Time Periods for Loading: 2010-15, 2015-20, 2020-2025

Figure 22
Central Plume Area – Groundwater Flow Sub-Model
Model Calibration Locations and Statistics

Total Wells: 24
Total Residual Error: 60.5

Head Error Summary	
Mean Error:	-0.621
Mean Abs. Error:	0.647
Root Mean Sq. Error:	0.752



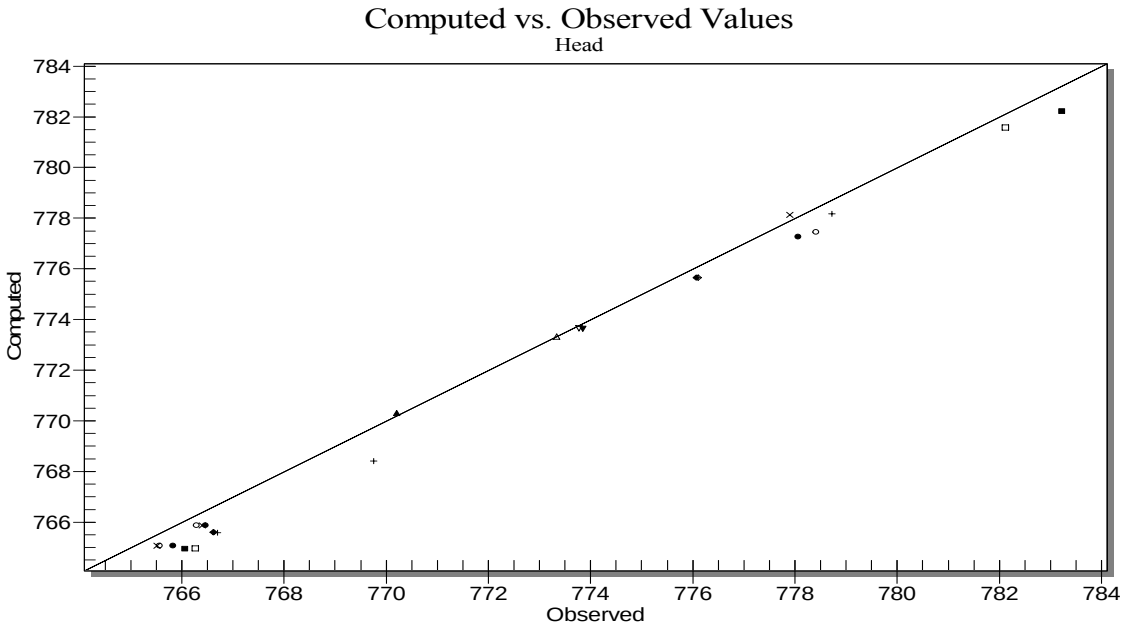
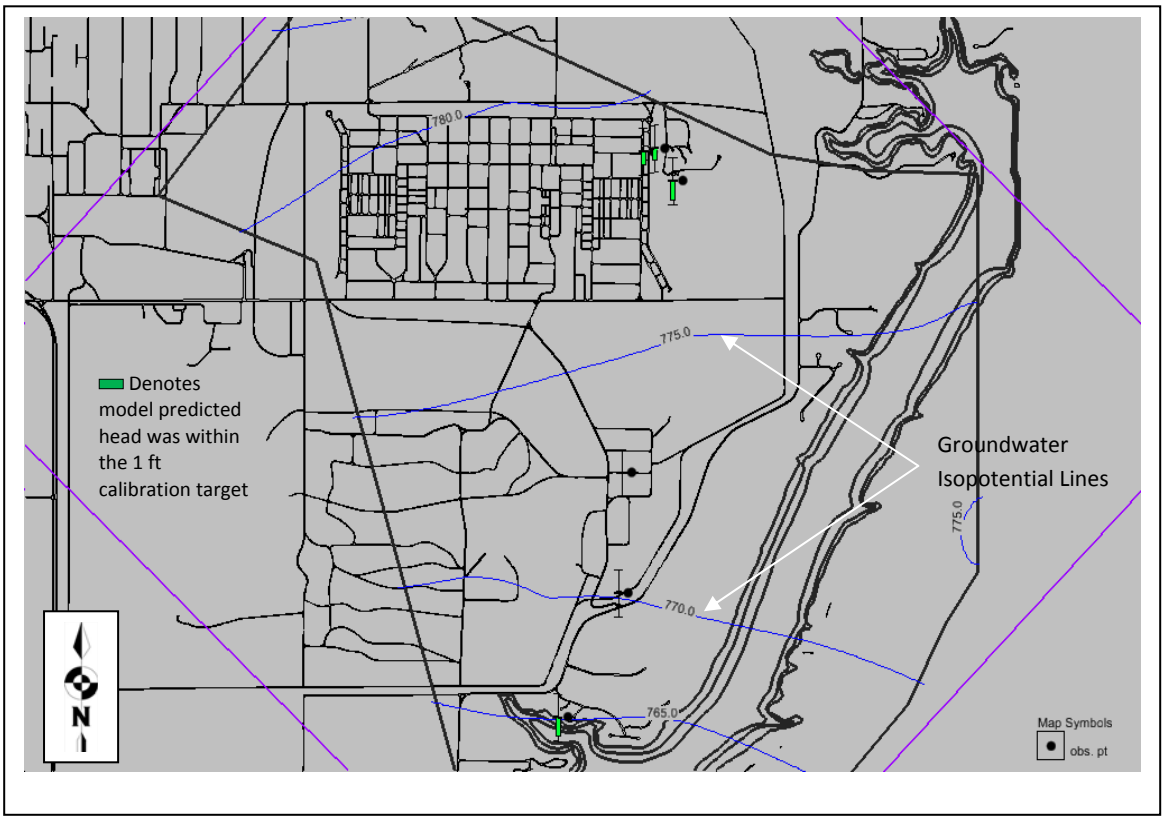


Figure 23
Central Plume Area – Groundwater Flow Sub-Model
Model Verification Locations and Statistics

Total Verification Wells: 8
Total Residual Error: 60.5

Head Error Summary	
Mean Error:	-0.431
Mean Abs. Error:	0.453
Root Mean Sq. Error:	0.525



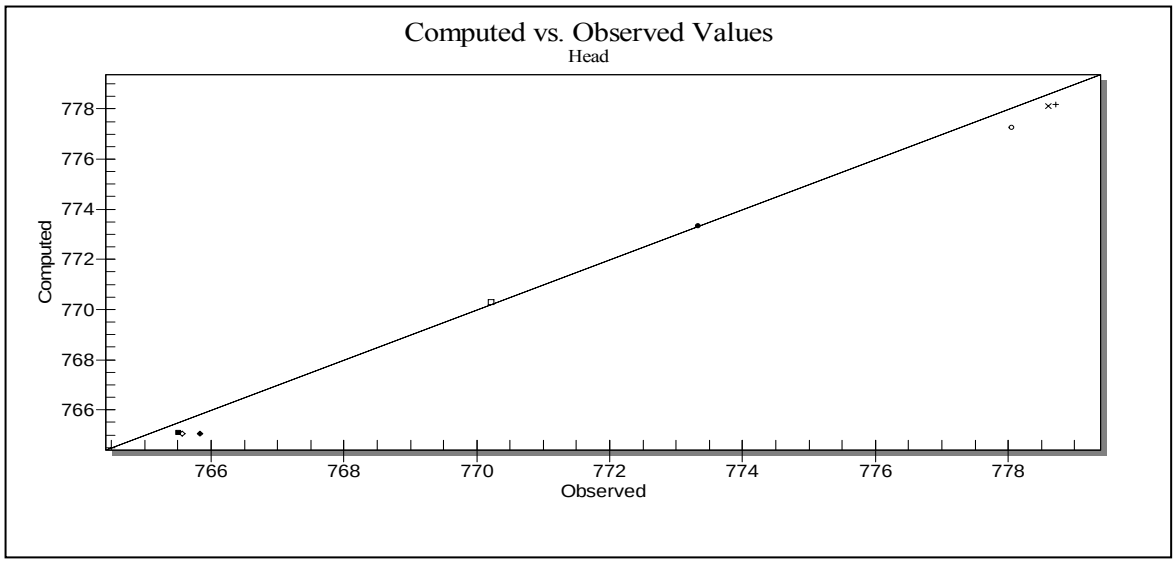


Figure 24
Central Plume Area - Groundwater Flow Sub-Model
Particle Tracking Simulation Plot

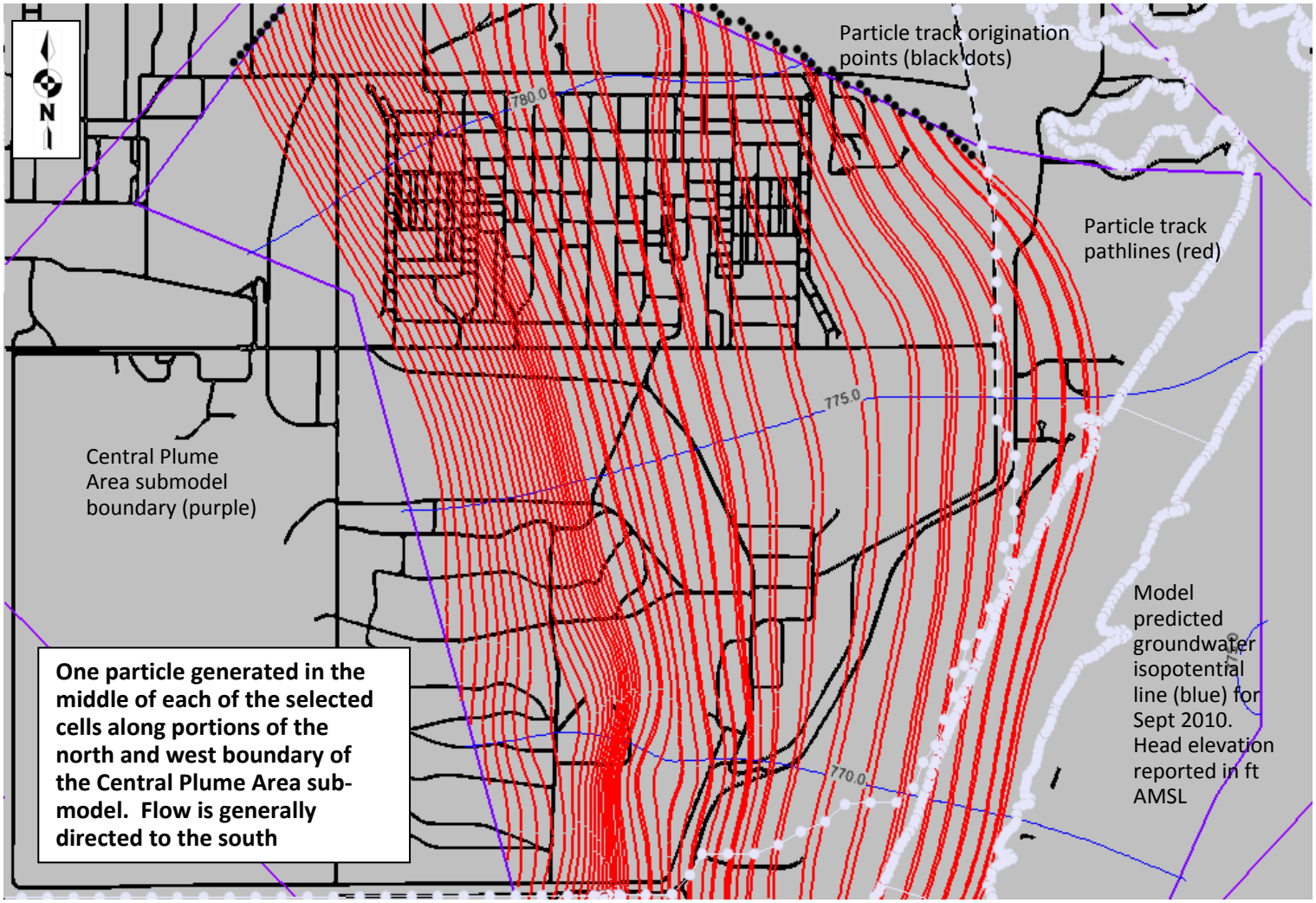
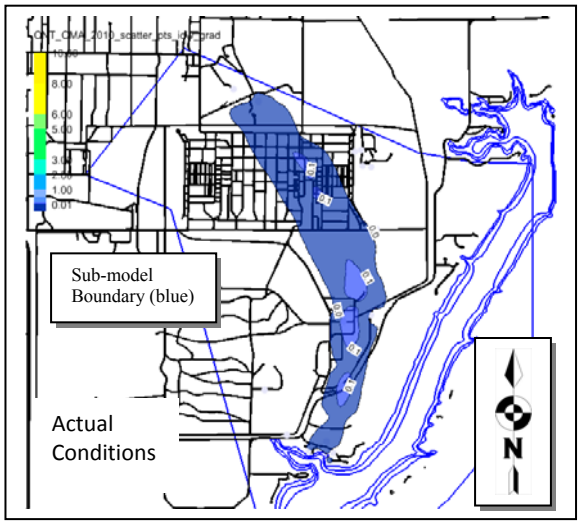
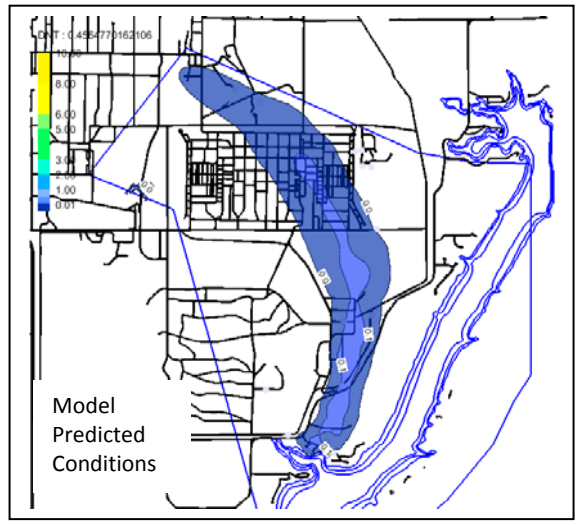


Figure 25. Central Plume Area Sub-Model
Comparison of Observed vs. Predicted Concentrations of Dinitrotoluene

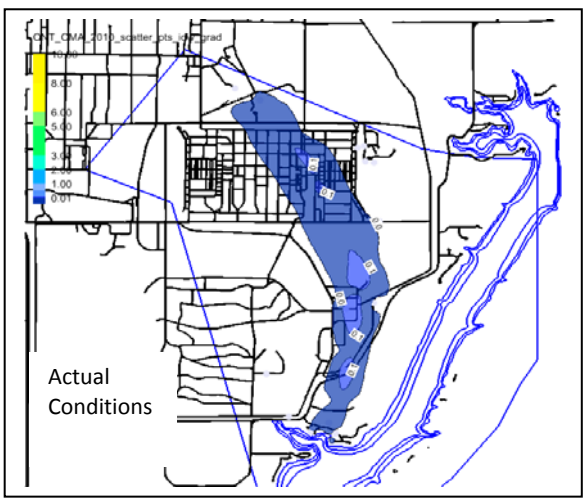
CENTRAL PLUME DNT 2007 – DATA INTERPOLATION



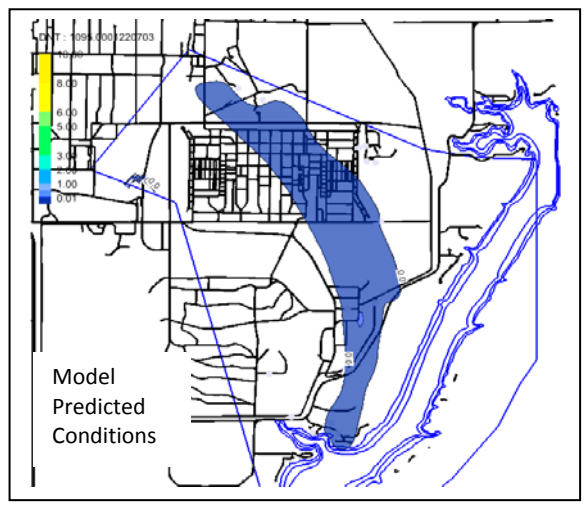
CENTRAL PLUME DNT 2007 – MODEL SIMULATION



CENTRAL PLUME DNT 2010 – DATA INTERPOLATION



CENTRAL PLUME DNT 2010 – MODEL SIMULATION

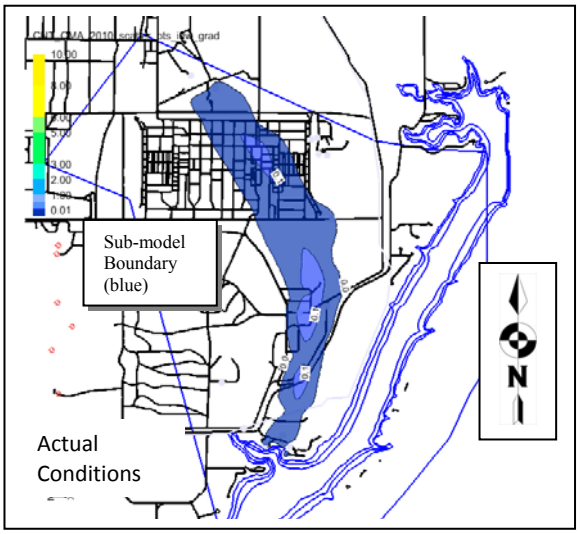


Advection Solution: MMOC (2010-40)
Chemical Reaction: NONE
Source Loading Conc: NONE

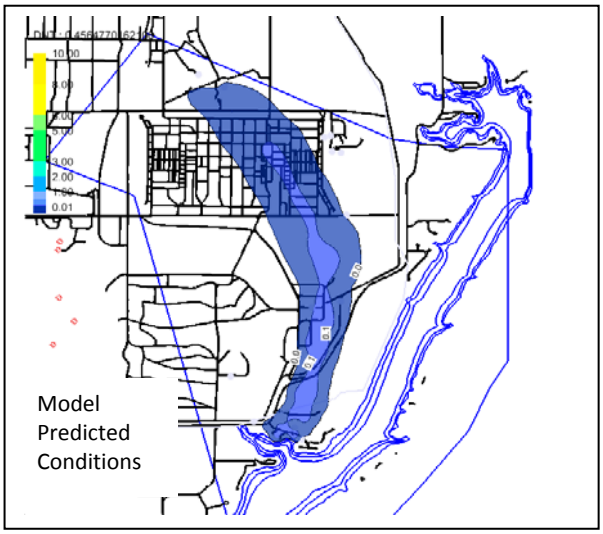
Dispersion Package (TRPT 0.2; TRVT 0.05)
Effective Porosity: 26% (Layers 1-5)
Time Periods for Loading: NONE

Figure 26. Central Plume Area Sub-Model
Predicted Concentrations of Dinitrotoluene, 2010-2040

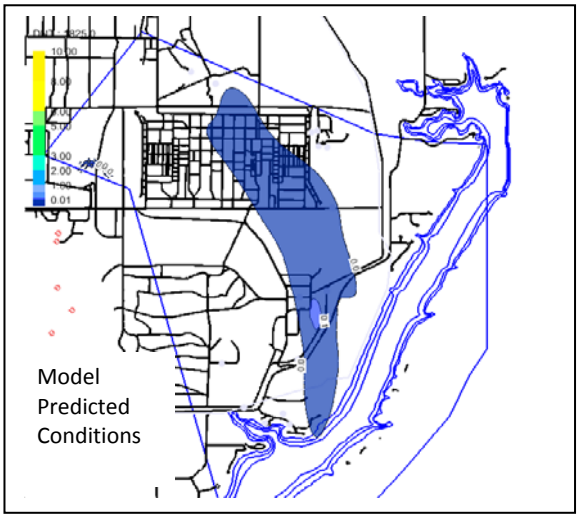
CENTRAL PLUME DNT 2010 – DATA INTERPOLATION



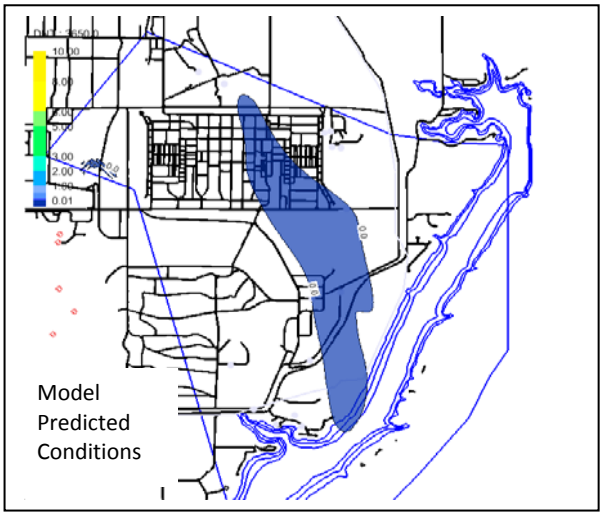
CENTRAL PLUME DNT 2010 – MODEL SIMULATION



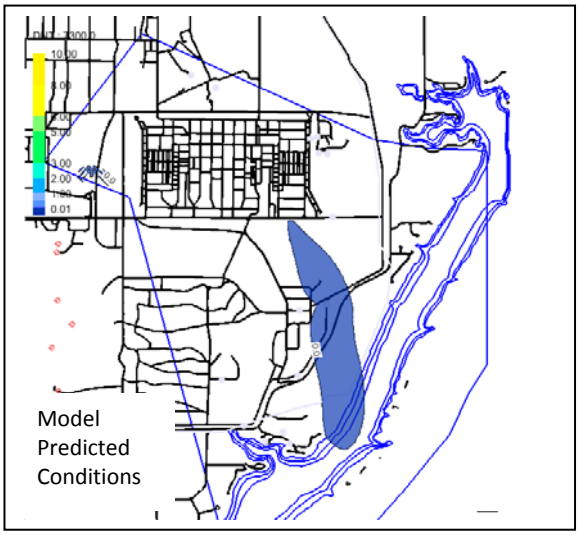
CENTRAL PLUME DNT 2015 – MODEL SIMULATION



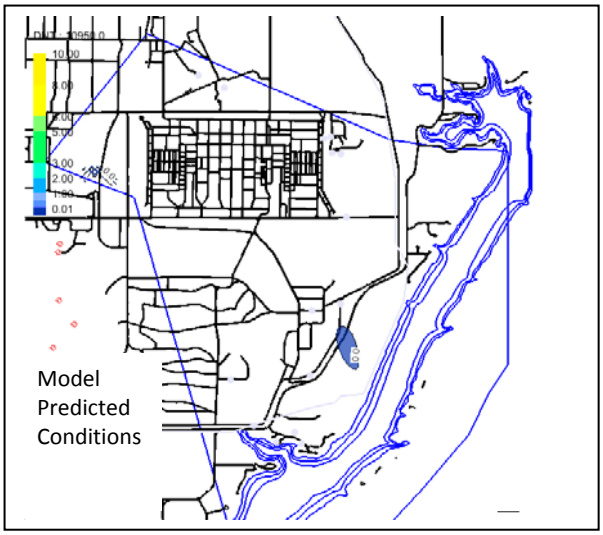
CENTRAL PLUME DNT 2020 – MODEL SIMULATION



CENTRAL PLUME DNT 2030 – MODEL SIMULATION



CENTRAL PLUME DNT 2040 – MODEL SIMULATION



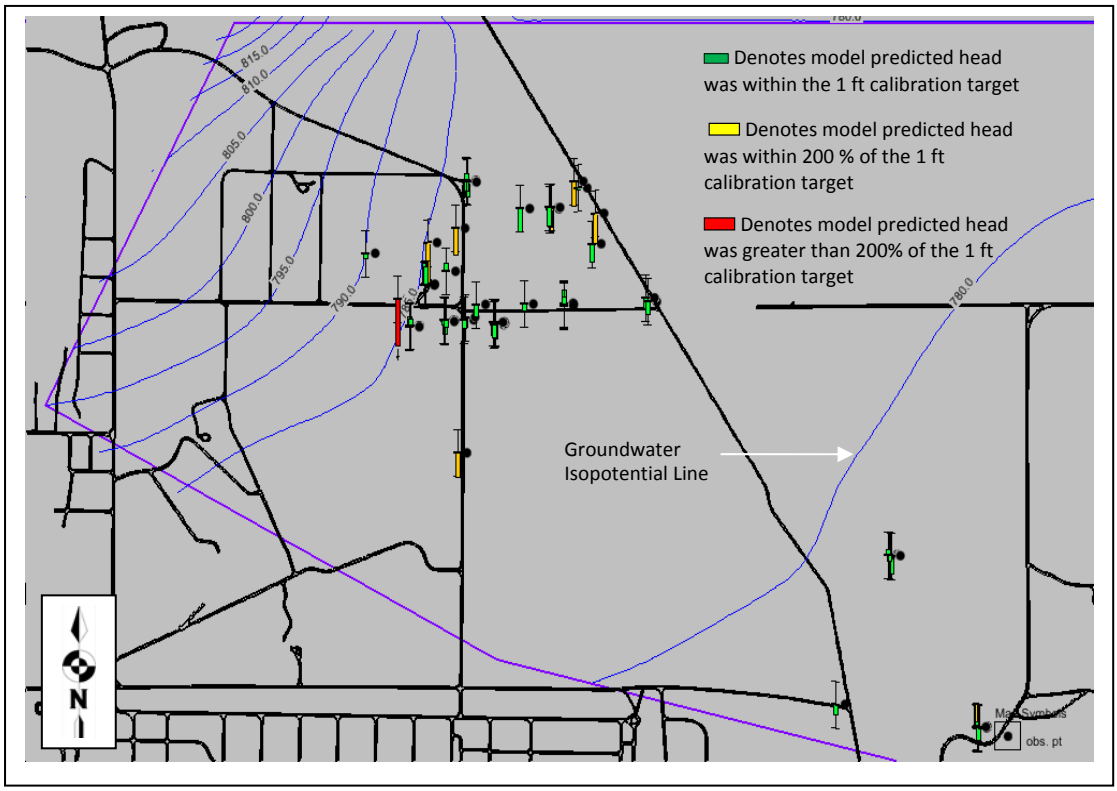
Advection Solution: MMOC (2010-40)
Chemical Reaction: NONE
Source Loading Conc: NONE

Dispersion Package (TRPT 0.2; TRVT 0.05)
Effective Porosity: 26% (Layers 1-5)
Time Periods for Loading: NONE

Figure 27
Deterrent Burning Ground - Groundwater Flow Sub-Model
Model Calibration Locations and Statistics

Total Wells: 48
Total Residual Error: 153

Head Error Summary	
Mean Error:	-0.306
Mean Abs. Error:	0.648
Root Mean Sq. Error:	0.820



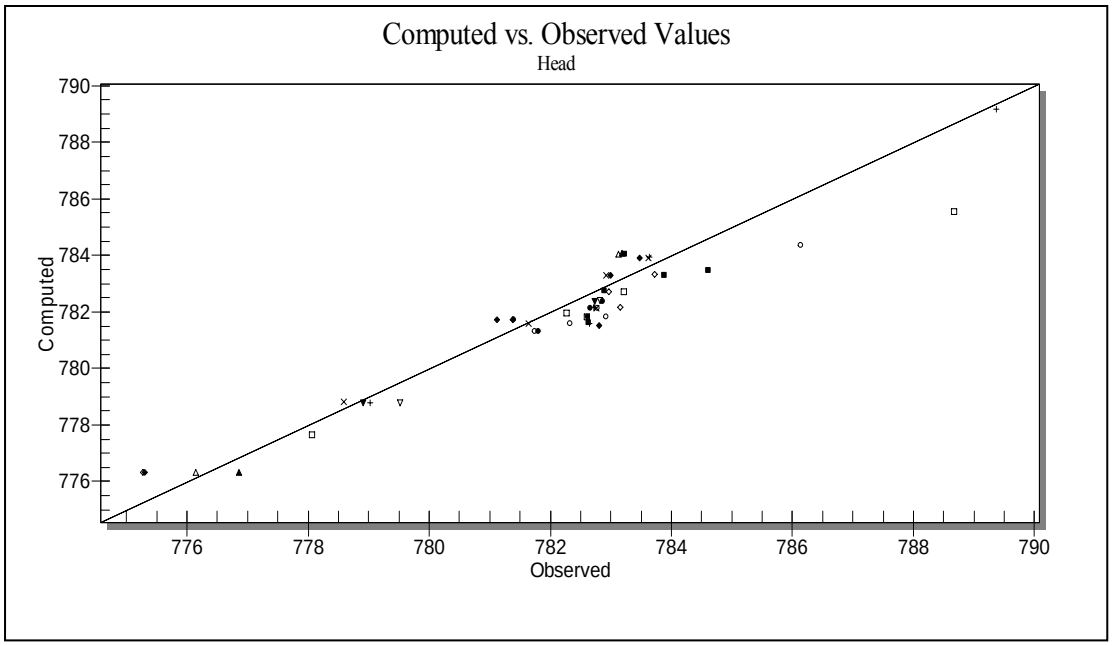
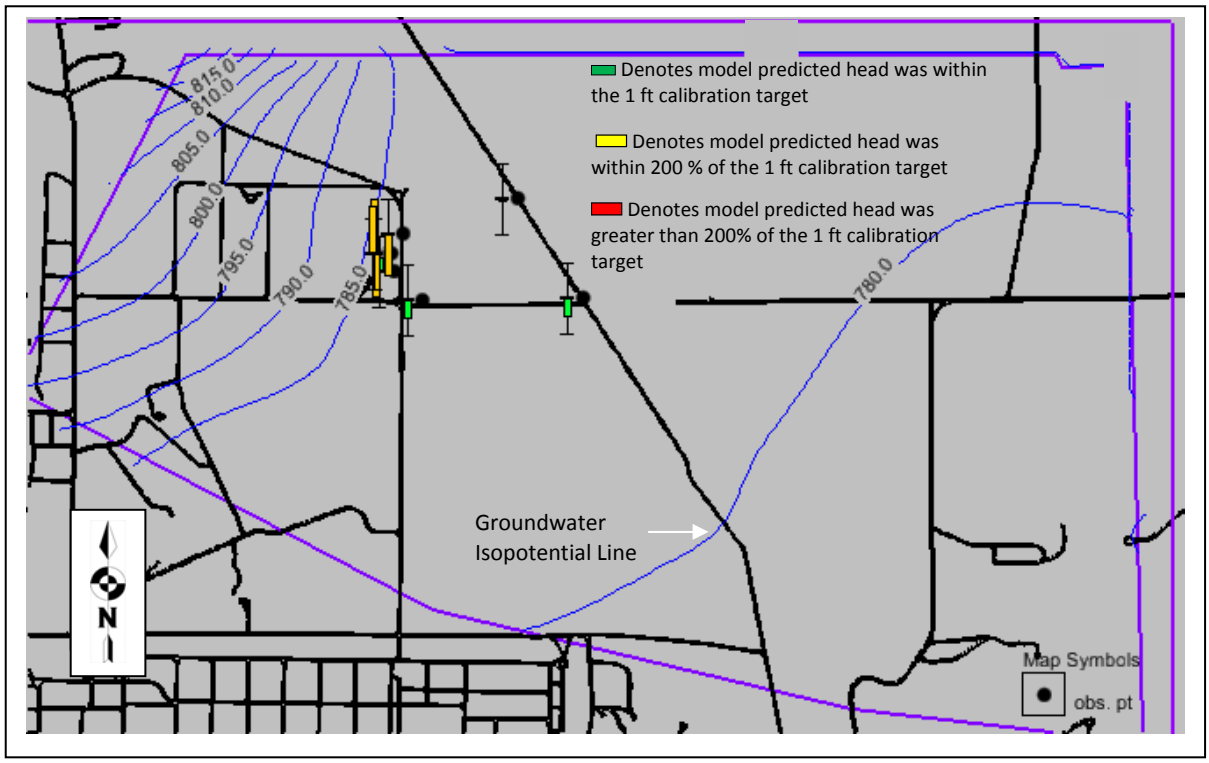


Figure 28
Deterrent Burning Ground – Groundwater Flow Sub-Model
Model Verification Locations and Statistics

Total Verification Wells: 8
Total Residual Error: 153

Head Error Summary	
Mean Error:	-0.20
Mean Abs. Error:	0.836
Root Mean Sq. Error:	0.974



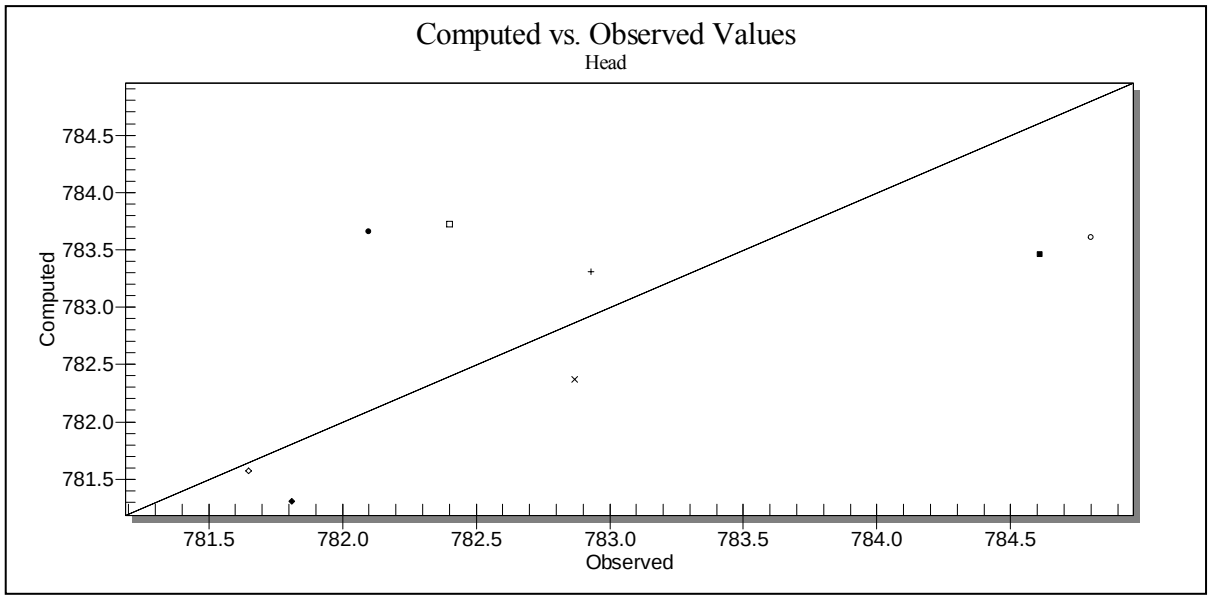


Figure 29
Deterrent Burning Ground - Groundwater Flow Sub-Model
Particle Tracking Simulation Plot

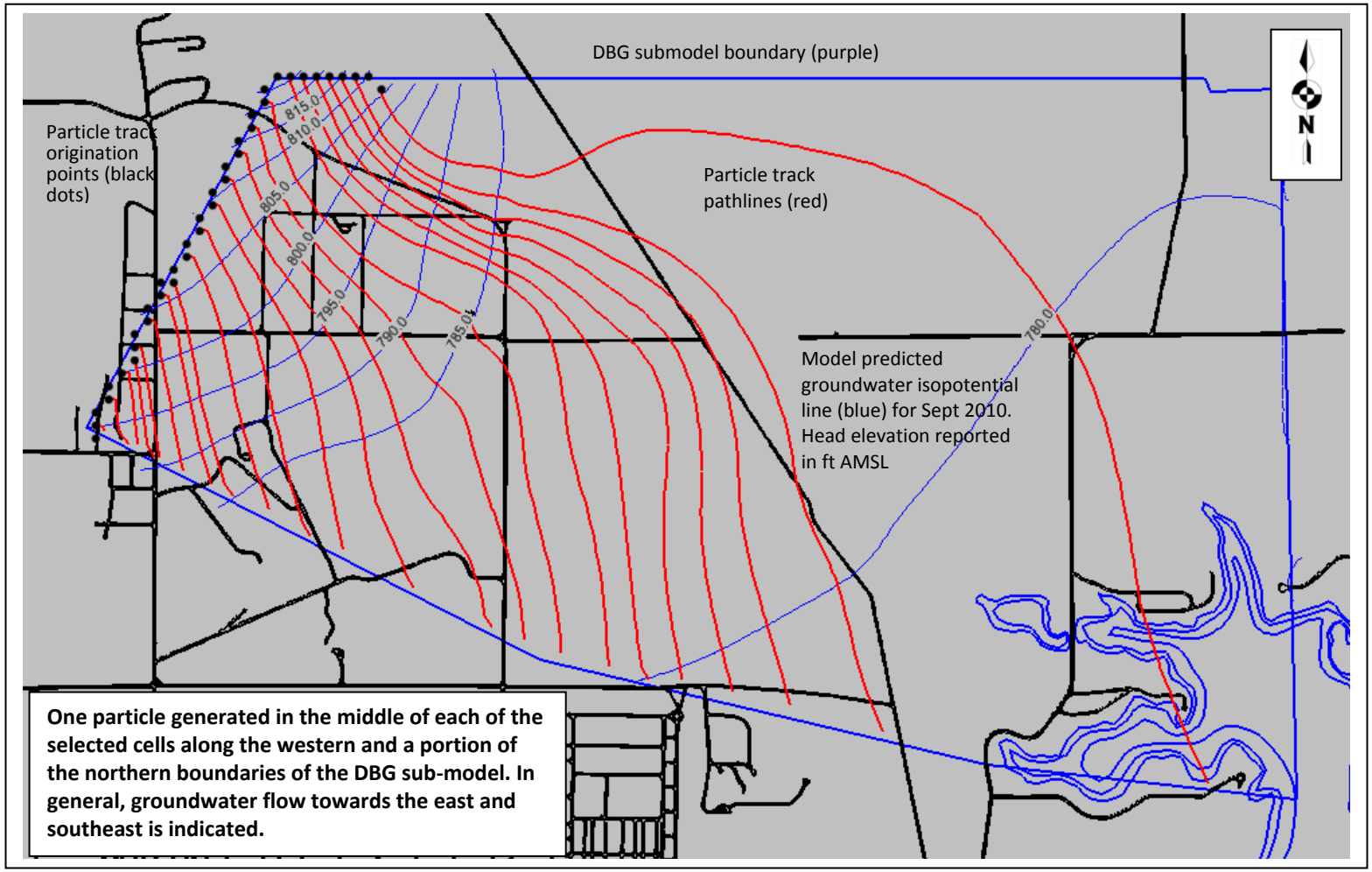
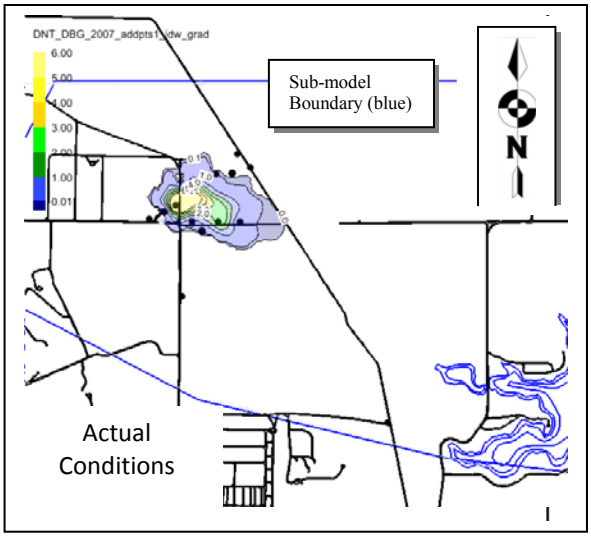
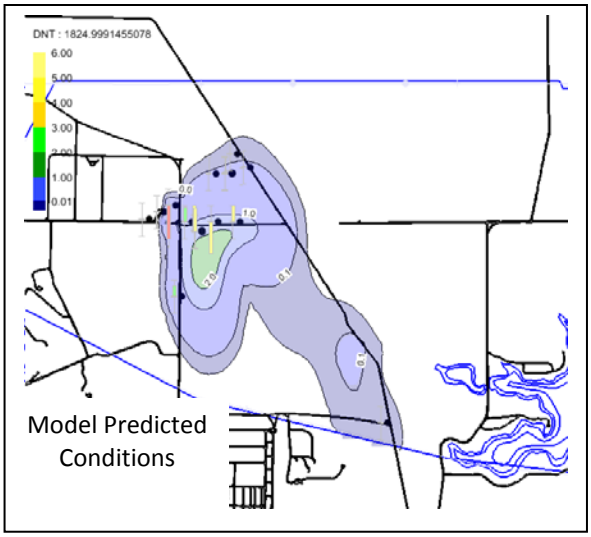


Figure 30. Deterrent Burning Ground Sub-Model
Comparison of Observed vs. Predicted Concentrations of Total Dinitrotoluene

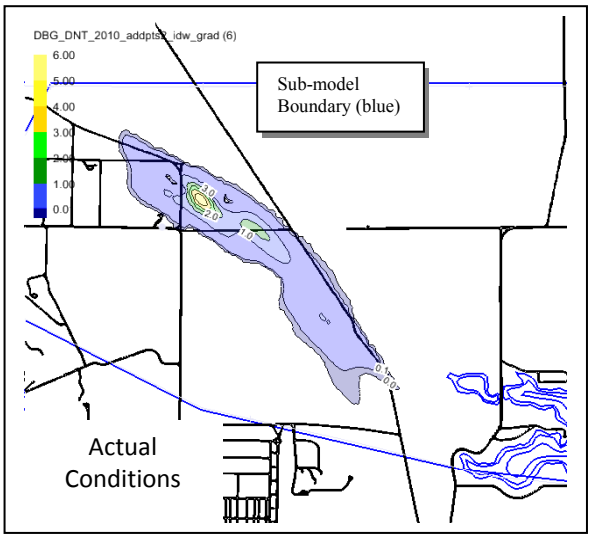
DBG DNT 2007 – DATA INTERPOLATION



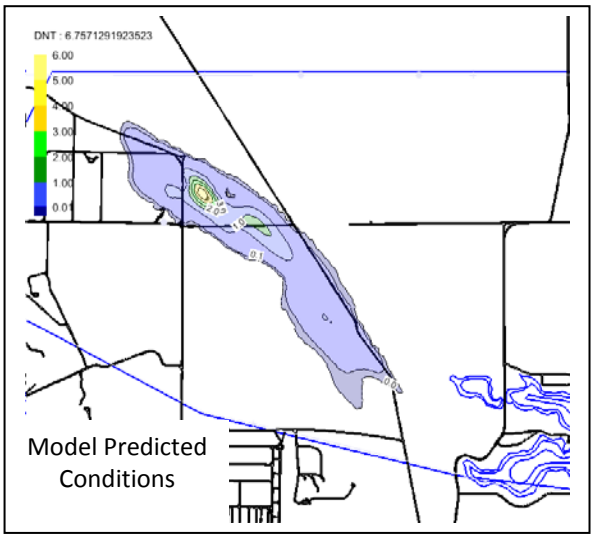
DBG DNT 2007 – MODEL SIMULATION



DBG DNT 2010 – DATA INTERPOLATION



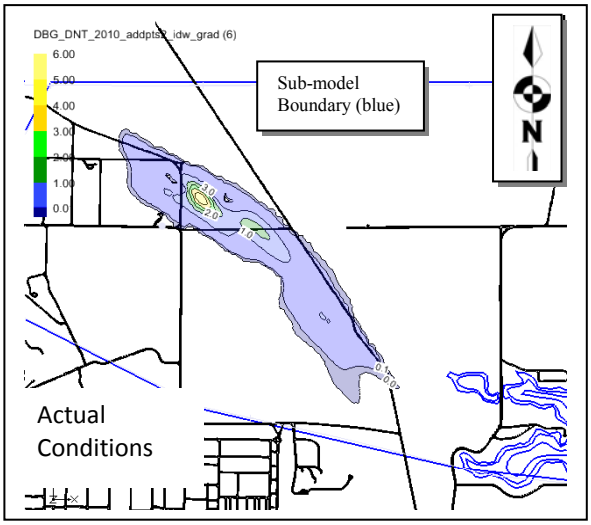
DBG DNT 2010 – MODEL SIMULATION



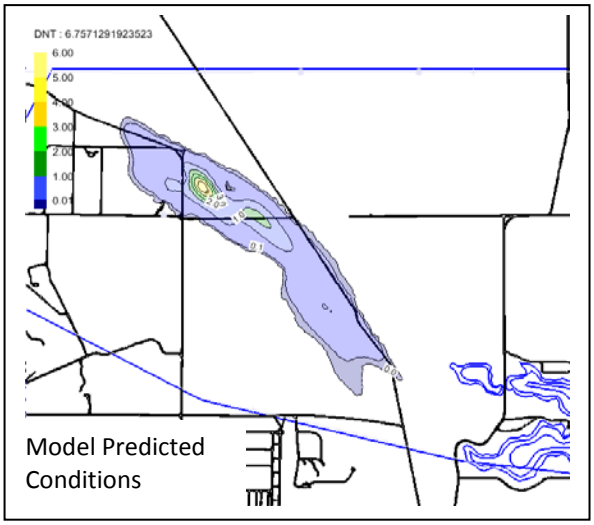
Advection Solution: Third Order TVD	**Dispersion Package** (TRPT 1.0; TRVT 0.2)
Chemical Reaction: Linear Isotherm, 1st Order Kinetics	**Effective Porosity:** 26% (Layers 1-5)
Source Loading Conc:	**Time Periods for Loading:**

Figure 31. Deterrent Burning Ground Sub-Model
Predicted Concentrations of Dinitrotoluene, 2010-2040

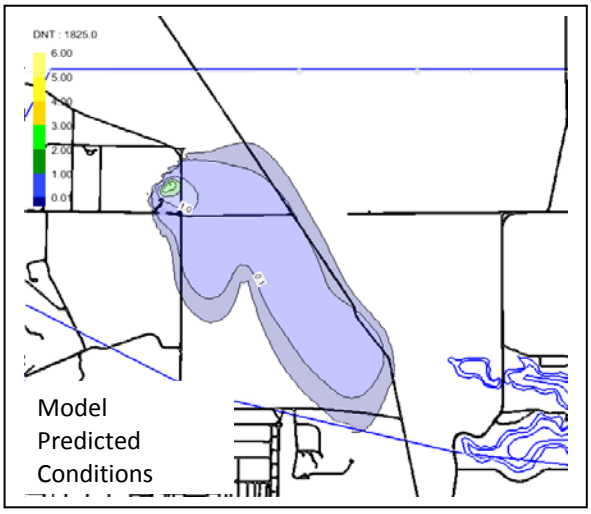
DBG DNT 2010 – DATA INTERPOLATION



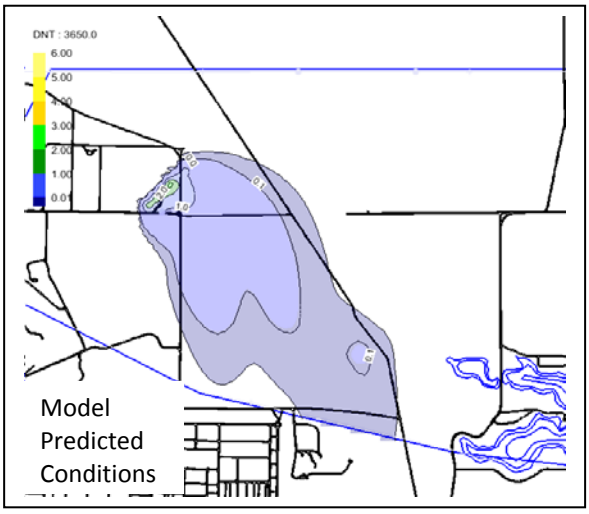
DBG DNT 2010 – MODEL SIMULATION



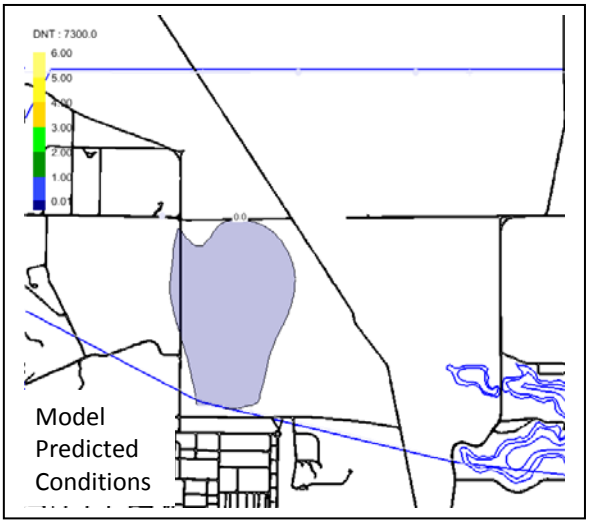
DBG DNT 2015 – MODEL SIMULATION



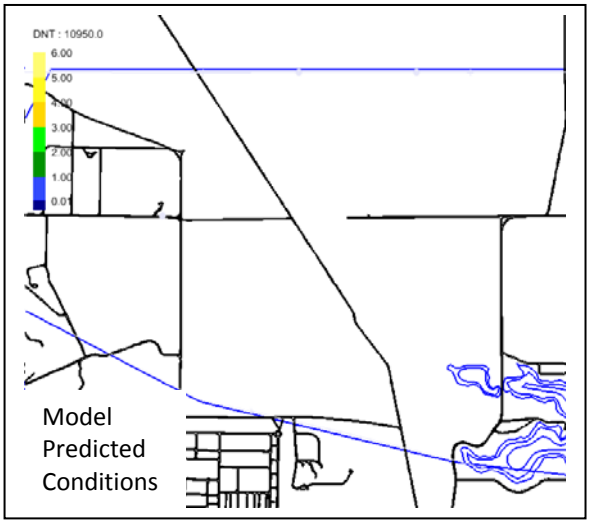
DBG DNT 2020 – MODEL SIMULATION



DBG DNT 2030 – MODEL SIMULATION



DBG DNT 2040 – MODEL SIMULATION



Advection Solution: Third Order TVD (2010-40)
Chemical Reaction: Linear Isotherm, 1st Order Kinetics
Source Loading Conc: 2-25 ppb, 5 locations

Dispersion Package (TRPT 1.0; TRVT 0.2)
Effective Porosity: 26% (Layers 1-5)
Time Periods for Loading: 2010-2020, 2020-2030

Tables

Technical Memorandum

Groundwater Flow and Solute Transport Modeling

Table 1
Site-Wide Groundwater Flow Model
List of Monitoring Wells, Extraction Wells and Piezometers

Well ID	Type	Well ID	Type	Well ID	Type
EW-170R	Extraction	ELN-1002C	Piezometer	PBN-8502A	Monitoring
EW-169	Extraction	ELN-1002E	Piezometer	PBN-8503A	Monitoring
EW-167	Extraction	ELN-1003A	Monitoring	PBN-8901C	Piezometer
EW-168	Extraction	ELN-1003B	Piezometer	PBN-8901D	Piezometer
EW-163R	Extraction	ELN-1003C	Piezometer	PBN-8902B	Piezometer
EW-164	Extraction (off)	ELN-1003E	Piezometer	PBN-8902C	Piezometer
SCW-1	Extraction	ELN-8203A	Monitoring	PBN-8903B	Piezometer
SCW-2R	Extraction	ELN-8203B	Piezometer	PBN-8903C	Piezometer
BGM-9101	Monitoring	ELN-8203C	Piezometer	PBN-8910A	Monitoring
BGM-9102	Monitoring	ELN-8204A	Monitoring	PBN-8910C	Piezometer
BGM-9103	Monitoring	ELN-8204B	Piezometer	PBN-9102C	Piezometer
DBM-1001	Monitoring	ELN-8204C	Piezometer	PBN-9103B	Piezometer
DBM-8201	Monitoring	ELN-8904A	Monitoring	PBN-9103C	Piezometer
DBM-8202	Monitoring	ELN-8904B	Piezometer	PBN-9112C	Piezometer
DBM-8903	Monitoring	ELN-8204A	Monitoring	PBN-9112D	Piezometer
DBM-8905	Monitoring	ELN-8204B	Piezometer	PBN-9301B	Piezometer
DBM-9501	Monitoring	ELN-8204C	Piezometer	PBN-9301C	Piezometer
DBN-1002C	Piezometer	ELN-8904A	Monitoring	PBN-9303B	Piezometer
DBN-1002E	Piezometer	ELN-8904B	Piezometer	PBN-9303C	Piezometer
DBN-8201B	Piezometer	ELN-9107A	Monitoring	PBN-9402B	Piezometer
DBN-8201C	Piezometer	ELN-9107B	Piezometer	PBN-9402C	Piezometer
DBN-8902A	Monitoring	LON-8903A	Monitoring	PBN-9402D	Piezometer
DBN-8902B	Piezometer	NLN-0701A	Monitoring	PBN-9902A	Monitoring
DBN-9501A	Monitoring	NLN-8201A	Monitoring	PBN-9902B	Piezometer
DBN-9501B	Piezometer	NLN-8203A	Monitoring	PBN-9902C	Piezometer
DBN-9501C	Piezometer	NLN-8204A	Monitoring	PBN-9902D	Piezometer
DBN-9501E	Piezometer	NPM-8901	Monitoring	PBN-9903A	Monitoring
DBN-9502A	Monitoring	PBM-0005	Monitoring	PBN-9903B	Piezometer
DBN-9502B	Piezometer	PBM-0006	Monitoring	PBN-9903C	Piezometer
DBN-9502C	Piezometer	PBM-8905	Monitoring	PBN-9903D	Piezometer
DBN-9503A	Monitoring	PBM-9001D	Piezometer	RIM-0701	Monitoring
DBN-9503B	Piezometer	PBM-9002D	Piezometer	RIN-1001A	Monitoring
DBN-9503C	Piezometer	PBM-9003D	Piezometer	RIN-1001C	Piezometer
ELM-8903	Monitoring	PBN-1002A	Monitoring	RIN-1002A	Piezometer
ELM-8907	Monitoring	PBN-1002B	Piezometer	RIN-1002C	Piezometer
ELM-8908	Monitoring	PBN-1002C	Piezometer	RIN-1003A	Monitoring
ELM-8909	Monitoring	PBN-1003C	Piezometer	RIN-1004B	Piezometer
ELN-1002A	Monitoring	PBN-8202C	Piezometer	RIN-1005A	Monitoring
ELN-1002B	Piezometer	PBN-8203A	Monitoring	RIN-1005C	Piezometer
RIN-1001A	Monitoring	PBN-8203C	Piezometer	RIN-1006A	Monitoring
RIN-1001C	Piezometer	PBN-8205A	Monitoring	RIN-1006C	Piezometer
RIN-1002A	Monitoring	PBN-8205B	Piezometer	RIN-1007C	Piezometer

Table 1 (continued)
Site-Wide Groundwater Flow Model
List of Monitoring Wells*, Extraction Wells and Piezometers*

Well ID	Type	Well ID	Type	Well ID	Type
RIN-1002C	Piezometer	SPN-8902C	Piezometer	DBN-1001C	Piezometer
RIN-1003A	Monitoring	SPN-8904B	Piezometer	DBN-1001E	Piezometer
RIN-1004B	Piezometer	SPN-8904C	Piezometer	ELN-1001B	Piezometer
RIN-1005A	Monitoring	SWN-0501B	Piezometer	ELN-1001C	Piezometer
RIN-1005C	Piezometer	SWN-0501C	Piezometer	ELN-1001E	Piezometer
RIN-1006A	Monitoring	SWN-0501D	Piezometer	PBN-1001A	Monitoring
RIN-1006C	Piezometer	SWN-0501E	Piezometer	PBN-1001B	Piezometer
RIN-1007C	Piezometer	SWN-0502B	Piezometer	PBN-1001C	Piezometer
S1103	Monitoring	SWN-0502C	Piezometer	PBN-1003C	Piezometer
S1104	Monitoring	SWN-0502D	Piezometer	PBN-8503A	Monitoring
S1105	Monitoring	SWN-0502E	Piezometer	PBN-9103B	Piezometer
S1106	Monitoring	SWN-0503B	Piezometer	PBN-9903A	Monitoring
S1109	Monitoring	SWN-0503C	Piezometer	SWN-0502B	Piezometer
S1110	Monitoring	SWN-0503D	Piezometer	SWN-0502C	Piezometer
S1121	Monitoring	PBN-8205C	Piezometer	RIM-0701	Monitoring
S1122	Monitoring	PBN-8501A	Monitoring	RIN-1001A	Monitoring
S1134R	Monitoring	SWN-0503E	Piezometer		
S1153	Monitoring	SWN-9102C	Piezometer		
SEN-0501A	Monitoring	SWN-9102C	Piezometer		
SEN-0501B	Piezometer	SWN-9102D	Piezometer		
SEN-0501D	Piezometer	SWN-9103B	Piezometer		
SEN-0502A	Monitoring	SWN-9103C	Piezometer		
SEN-0502D	Piezometer	SWN-9103D	Piezometer		
SEN-0503A	Monitoring	SWN-9103E	Piezometer		
SEN-0503B	Piezometer	SWN-9104C	Piezometer		
SEN-0503D	Piezometer	SWN-9104D	Piezometer		
SPN-0406A	Monitoring	SWN-9105B	Piezometer		
SPN-0406B	Piezometer	SWN-9105C	Piezometer		
SPN-0406C	Piezometer	SWN-9105D	Piezometer		
SPN-8902B	Piezometer	DBN-1001B	Piezometer		

* All single wells and A-series wells are assumed to be water table monitoring wells. All others are assumed to be piezometers.

Table 2. Site-Wide Groundwater Flow Model – Initial Model Input Parameters

Shaw Model	Parameter	Layer 1	Layer 2	Layer 3	Layer 4	Layer 5
PBG flow sub-model	Thickness (ft)	35	25	60	20	30
	Area A (North)					
	Kh (feet/day)	90	90	125	90	160
	Kv (feet/day)	9	9	12.5	9	16
	Area B (South)					
	Kh (feet/day)	120	120	120	120	120
	Kv (feet/day)	25	25	25	25	25
	Area C (EWs)					
	Kh (feet/day)	160	160	160	160	160
	Kv (feet/day)	32	32	32	32	32
	Anisotropy (horiz.)	3	3	3	3	3
	Anisotropy (vert.)	1	1	1	1	1
	Porosity (%)	0.3	0.3	0.3	0.3	0.3
	Recharge (in/yr)	7				

Shaw Model	Parameter	Layer 1	Layer 2	Layer 3	Layer 4	Layer 5
Site-wide flow model	Thickness (ft)	40	40	40	40	40
	Kh (feet/day)	100	200	300	400	500
	Kv (feet/day)	33	66	99	133	167
	Anisotropy (horiz.)	3	3	3	3	3
	Anisotropy (vert.)	1	1	1	1	1
	Porosity (%)	0.3	0.3	0.3	0.3	0.3
	Recharge (in/yr)	10				

Current Model	Parameter	Layer 1	Layer 2	Layer 3	Layer 4	Layer 5
Site-wide flow model	Thickness (ft)	40	40	40	40	40
	Kh (feet/day)	150	PPI*	PPI*	PPI*	PPI*
	Kv (feet/day)	1-10	PPI*	PPI*	PPI*	PPI*
	Anisotropy (horiz.)	1	1	1	1	1
	Anisotropy (vert.)	**	**	**	**	**
	Porosity (%)	0.3	0.3	0.3	0.3	0.3
	Recharge (in/yr)	13				

Current Model	Parameter	Layer 1	Layer 2	Layer 3	Layer 4	Layer 5
Site-wide flow model and the sub-models developed for the PBG, DBG and Central Areas	Thickness (ft)	10	40	40	40	40
	Kh (feet/day)	150	PPI*	PPI*	PPI*	PPI*
	Kv (feet/day)	1-10	PPI*	PPI*	PPI*	PPI*
	Anisotropy	**	**	**	**	**
	Porosity (%)	0.3	0.3	0.3	0.3	0.3
	Recharge (in/yr)	13				

Notes: * Pilot point interpolation (PPI) method and inverse modeling methods employing PEST were used for determining Kh. ** Kv values were determined based on specified anisotropy factors and PPI methods using PEST (values of 1-2 were used for horizontal anisotropy). Recharge values were assigned and optimized during PEST runs.

Table 2. Site-Wide Groundwater Flow Model – Initial Model Input Parameters (con't)

IRM/MIRM Flow – September 2010

Extraction Well	***Extraction Rate Used in Model***	
	gpm	***ft^3/day***
SCW-1	*150*	*28,875*
SCW-2R	*200*	*35,500*
EW-163R	*625*	*120,312*
EW-164	*0*	*0*
EW-165	*0*	*0*
EW-167	*425*	*81,813*
EW-168	*425*	*81,813*
EW-169	*425*	*81,813*
EW-170R	*575*	*110,688*

Table 3
Site-Wide Groundwater Flow Model
Model Calibration Statistics

Well ID	Observed Head (ft)*	Confidence Interval (%)	Computed Head (ft)*	Residual Head (ft)*
BGM-9101	835.53	95	827.2656	-8.2644
BGM-9102	813.94	95	815.3134	1.3734
BGM-9103	791.36	95	791.7911	0.4311
DBM-1001	789.37	95	789.2947	-0.0753
DBM-8201	782.93	95	783.3597	0.4297
DBM-8202	786.14	95	784.3749	-1.7651
DBM-8903	782.87	95	782.3962	-0.4738
DBM-8905	788.67	95	785.6357	-3.0343
DBM-9501	782.64	95	781.6414	-0.9986
DBN-1002C	781.38	95	781.7376	0.3576
DBN-1002E	781.12	95	781.7403	0.6203
DBN-8201B	783.13	95	784.066	0.936
DBN-8201C	783.18	95	784.1166	0.9366
DBN-8902A	782.82	95	782.407	-0.413
DBN-8902B	782.74	95	782.4034	-0.3366
DBN-9501A	782.72	95	782.1711	-0.5489
DBN-9501B	782.76	95	782.1615	-0.5985
DBN-9501C	782.78	95	782.152	-0.628
DBN-9501E	782.66	95	782.1569	-0.5031
DBN-9502A	783.22	95	782.7505	-0.4695
DBN-9502B	782.9	95	782.7812	-0.1188
DBN-9502C	782.97	95	782.7418	-0.2282
DBN-9503A	783.47	95	783.9412	0.4712
DBN-9503B	783.64	95	783.9866	0.3466
DBN-9503C	783.62	95	783.9444	0.3244
ELM-8903	782.32	95	781.5863	-0.7337
ELM-8907	781.4	95	781.7368	0.3368
ELM-8908	782.27	95	781.9862	-0.2838
ELM-8909	784.61	95	783.4933	-1.1167
ELN-1002A	775.27	95	776.2636	0.9936
ELN-1002B	775.3	95	776.2563	0.9563
ELN-1002C	776.14	95	776.2639	0.1239
ELN-1002E	776.86	95	776.2565	-0.6035
ELN-1003A	779.52	95	778.6983	-0.8217
ELN-1003B	778.91	95	778.7109	-0.1991
ELN-1003C	779.03	95	778.7243	-0.3057

* Head elevations are given in feet above mean sea level

Table 3 (continued)
Site-Wide Groundwater Flow Model
Model Calibration Statistics

Well ID	Observed Head (ft)	Confidence Interval (%)	Computed Head (ft)	Residual Head (ft)
ELN-1003E	778.59	95	778.7464	0.1564
ELN-8203A	782.93	95	781.8444	-1.0856
ELN-8203B	782.62	95	781.8539	-0.7661
ELN-8203C	782.6	95	781.8549	-0.7451
ELN-8204A	783.88	95	783.3156	-0.5644
ELN-8204B	783.72	95	783.3413	-0.3787
ELN-8204C	782.99	95	783.3325	0.3425
ELN-8904A	782.65	95	781.5956	-1.0544
ELN-8904B	781.65	95	781.5832	-0.0668
ELN-9107A	781.75	95	781.3226	-0.4274
ELN-9107B	781.81	95	781.311	-0.499
LON-8903A	775.58	95	776.616	1.036
NLN-0701A	778.72	95	778.1552	-0.5648
NLN-8201A	777.9	95	778.1022	0.2022
NLN-8203A	778.41	95	777.4124	-0.9976
NLN-8204A	778.06	95	777.2352	-0.8248
NPM-8901	782.12	95	781.5767	-0.5433
PBM-0005	773.72	95	774.6116	0.8916
PBM-0006	773.74	95	774.1504	0.4104
PBM-8905	772.61	95	773.7473	1.1373
PBM-9001D	743.97	95	743.8608	-0.1092
PBM-9002D	744.37	95	743.7289	-0.6411
PBM-9003D	742.68	95	743.0466	0.3666
PBN-1002A	769.58	95	770.2212	0.6412
PBN-1002B	769.79	95	770.2719	0.4819
PBN-1002C	768.89	95	770.261	1.371
PBN-1003C	769.06	95	769.8519	0.7919
PBN-8202C	773.55	95	775.4532	1.9032
PBN-8203A	773.8	95	774.1489	0.3489
PBN-8203C	773.82	95	774.1126	0.2926
PBN-8205A	773.56	95	774.1188	0.5588
PBN-8205B	773.73	95	774.132	0.402
PBN-8205C	773.69	95	774.1093	0.4193
PBN-8501A	771.76	95	772.1742	0.4142
PBN-8502A	771.61	95	772.1721	0.5621
PBN-8503A	772.51	95	772.6602	0.1502
PBN-8901C	771.82	95	772.0696	0.2496

Table 3 (continued)
Site-Wide Groundwater Flow Model
Model Calibration Statistics

Well ID	Observed Head (ft)	Confidence Interval (%)	Computed Head (ft)	Residual Head (ft)
PBN-8901D	771.9	95	772.1412	0.2412
PBN-8902B	770.5	95	772.1899	1.6899
PBN-8902C	770.59	95	772.1312	1.5412
PBN-8903B	772.51	95	772.7114	0.2014
PBN-8903C	772.46	95	772.6893	0.2293
PBN-8910A	774.72	95	774.968	0.248
PBN-8910C	774.84	95	774.9635	0.1235
PBN-9102C	744.11	95	743.8043	-0.3057
PBN-9103B	743.95	95	743.0664	-0.8836
PBN-9103C	744.11	95	743.1238	-0.9862
PBN-9112C	767.25	95	767.0112	-0.2388
PBN-9112D	767.17	95	766.9734	-0.1966
PBN-9301B	772.68	95	772.794	0.114
PBN-9301C	772.59	95	772.7801	0.1901
PBN-9303B	767.42	95	768.0614	0.6414
PBN-9303C	767.48	95	768.0868	0.6068
PBN-9402B	767.25	95	767.6148	0.3648
PBN-9402C	767.27	95	767.6103	0.3403
PBN-9402D	767.22	95	767.5968	0.3768
PBN-9902A	764.78	95	765.1761	0.3961
PBN-9902B	764.78	95	765.1779	0.3979
PBN-9902C	764.75	95	765.1469	0.3969
PBN-9902D	764.97	95	765.1365	0.1665
PBN-9903A	763.65	95	765.2292	1.5792
PBN-9903B	764.09	95	765.2297	1.1397
PBN-9903C	764.14	95	765.2303	1.0903
PBN-9903D	764.13	95	765.23	1.1
RIM-0701	783.22	95	782.2244	-0.9956
RIN-1001A	784.34	95	784.4899	0.1499
RIN-1001C	784.34	95	784.5533	0.2133
RIN-1002A	776.11	95	775.5776	-0.5324
RIN-1002C	776.07	95	775.5885	-0.4815
RIN-1003A	773.34	95	773.224	-0.116
RIN-1004B	770.21	95	770.1263	-0.0837
RIN-1005A	773.77	95	773.5473	-0.2227
RIN-1005C	773.85	95	773.5296	-0.3204
RIN-1006A	784.54	95	787.1733	2.6333

Table 3 (continued)
Site-Wide Groundwater Flow Model
Model Calibration Statistics

Well ID	Observed Head (ft)	Confidence Interval (%)	Computed Head (ft)	Residual Head (ft)
RIN-1006C	784.47	95	787.1422	2.6722
RIN-1007C	785.17	95	786.4775	1.3075
S1103	764.83	95	765.7492	0.9192
S1104	765.97	95	765.5786	-0.3914
S1105	765.77	95	765.5555	-0.2145
S1106	766	95	765.5576	-0.4424
S1109	771.7	95	773.0359	1.3359
S1110	769.76	95	768.3053	-1.4547
S1121	778.07	95	777.641	-0.429
S1122	783.23	95	784.0754	0.8454
S1134R	783.15	95	782.1966	-0.9534
S1153	782.81	95	781.5276	-1.2824
SEN-0501A	765.51	95	764.7819	-0.7281
SEN-0501B	765.56	95	764.7786	-0.7814
SEN-0501D	765.83	95	764.7751	-1.0549
SEN-0502A	766.26	95	764.6331	-1.6269
SEN-0502D	766.06	95	764.6249	-1.4351
SEN-0503A	766.61	95	765.3141	-1.2959
SEN-0503B	766.62	95	765.3037	-1.3163
SEN-0503D	766.7	95	765.2966	-1.4034
SPN-0406A	766.4	95	765.6675	-0.7325
SPN-0406B	766.29	95	765.6672	-0.6228
SPN-0406C	766.46	95	765.6653	-0.7947
SPN-8902B	765.76	95	765.8331	0.0731
SPN-8902C	765.73	95	765.8223	0.0923
SPN-8904B	764.48	95	765.3541	0.8741
SPN-8904C	764.64	95	765.4393	0.7993
SWN-0501B	754.92	95	754.3531	-0.5669
SWN-0501C	754.9	95	754.3511	-0.5489
SWN-0501D	754.67	95	754.3564	-0.3136
SWN-0501E	754.38	95	754.3594	-0.0206
SWN-0502B	752.91	95	752.1083	-0.8017
SWN-0502C	752.84	95	752.1055	-0.7345
SWN-0502D	752.98	95	752.1122	-0.8678
SWN-0502E	753	95	752.1324	-0.8676
SWN-0503B	749.07	95	748.7948	-0.2752
SWN-0503C	749.04	95	748.7432	-0.2968

Table 3 (continued)
Site-Wide Groundwater Flow Model
Model Calibration Statistics

Well ID	Observed Head (ft)	Confidence Interval (%)	Computed Head (ft)	Residual Head (ft)
SWN-0503D	749.11	95	748.7231	-0.3869
SWN-0503E	750.71	95	748.6959	-2.0141
SWN-9102C	757.55	95	758.0096	0.4596
SWN-9102D	757.61	95	757.9588	0.3488
SWN-9103B	755.58	95	756.1989	0.6189
SWN-9103C	755.7	95	756.2537	0.5537
SWN-9103D	755.57	95	756.1387	0.5687
SWN-9103E	755.61	95	756.0531	0.4431
SWN-9104C	753.56	95	753.419	-0.141
SWN-9104D	753.76	95	753.6141	-0.1459
SWN-9105B	750.17	95	749.4627	-0.7073
SWN-9105C	750.06	95	749.3205	-0.7395
SWN-9105D	749.86	95	749.0916	-0.7684

Table 4
Site-Wide Groundwater Flow Model
Model Verification Statistics

Well ID	Observed Head (ft)	Confidence Interval (%)	Computed Head (ft)*	Residual Head (ft)*
DBM-8201	782.93	95	783.3597	0.4297
DBM-8903	782.87	95	782.3962	-0.4738
DBN-1001B	784.8	95	783.6379	-1.1621
DBN-1001C	782.1	95	783.6807	1.5807
DBN-1001E	782.4	95	783.7305	1.3305
ELM-8909	784.61	95	783.4933	-1.1167
ELN-1001B	778.79	95	778.8371	0.0471
ELN-1001C	778.84	95	778.853	0.013
ELN-1001E	778.9	95	778.8817	-0.0183
ELN-8904B	781.65	95	781.5832	-0.0668
ELN-9107B	781.81	95	781.311	-0.499
LON-8903A	775.58	95	776.616	1.036
NLN-0701A	778.72	95	778.1552	-0.5648
NLN-8201A	778.6	95	778.1023	-0.4977
NLN-8204A	778.06	95	777.2353	-0.8247
PBN-1001B	765.89	95	767.1951	1.3051
PBN-1001C	765.41	95	767.193	1.783
PBN-1003C	769.06	95	769.8519	0.7919
PBN-8503A	772.51	95	772.6602	0.1502
PBN-8901C	771.82	95	772.0697	0.2497
PBN-8901D	771.9	95	772.1411	0.2411
PBN-8902B	770.5	95	772.1899	1.6899
PBN-8902C	770.59	95	772.1312	1.5412
PBN-9103B	743.53	95	743.0664	-0.4636
PBN-9903A	763.65	95	765.2292	1.5792
PBN-9903B	764.09	95	765.2297	1.1397
PBN-9903C	764.14	95	765.2304	1.0904
PBN-9903D	764.13	95	765.23	1.1
RIN-1003A	773.34	95	773.224	-0.116
RIN-1004B	770.21	95	770.1263	-0.0837
S1104	765.97	95	765.5785	-0.3915
SEN-0501A	765.51	95	764.7819	-0.7281
SEN-0501B	765.56	95	764.7786	-0.7814
SEN-0501D	765.83	95	764.7751	-1.0549
SWN-0502B	752.91	95	752.1083	-0.8017

* Head elevations are given in feet above mean sea level

Table 4 (continued)
Site-Wide Groundwater Flow Model
Model Verification Statistics

Well ID	Observed Head (ft)	Confidence Interval (%)	Computed Head (ft)	Residual Head (ft)
SWN-0502C	752.84	95	752.1055	-0.7345
SWN-0502D	752.98	95	752.1122	-0.8678
SWN-0502E	753	95	752.1324	-0.8676
SWN-9104C	753.56	95	753.419	-0.141
SWN-9104D	753.76	95	753.6141	-0.1459

Table 5
Site-Wide Groundwater Flow Model - Sensitivity Analysis

Response Due to Variations in Recharge								
Well Name	**Cell (I, j, k)**	**Simulated Head (feet above mean sea level)**						
PBN-9301B	(105, 59, 2)	769.029	769.965	771.516	772.131	772.751	774.286	775.202
PBN-9103B	(204. 64. 2)	742.268	742.453	742.860	743.043	743.186	743.593	743.838
PBN-9301C	(105, 59, 3)	769.016	769.951	771.502	772.116	772.736	774.270	775.186
SWN-0501C	(164, 79, 3)	752.721	753.155	753.877	754.164	754.453	755.173	755.603
SWN-9102C	(173, 47, 3)	755.653	756.250	757.243	757.639	758.036	759.024	759.617
PBN-9103C	(204, 64, 3)	742.260	742.506	742.916	743.080	743.244	743.654	743.899
RIN-1001C	(54, 47, 3)	781.091	782.079	783.729	784.386	785.049	786.698	787.687
SWN-0501D	(164, 79, 4)	752.728	753.161	753.883	754.170	754.459	755.177	755.607
SWN-9102D	(173, 47, 4)	755.602	756.199	757.192	757.588	757.985	758.974	759.567
PBM-9003D	(204, 64, 4)	742.192	742.436	742.842	743.004	743.166	743.572	743.815
SWN-0501E	(164, 79, 5)	752.733	753.166	753.886	754.173	754.462	755.179	755.609
	Percentage of Calibration Value	**-50%**	**-35%**	**-10%**	******	**+10%**	**+35%**	+50%

Response Due to Variations in Horizontal Hydraulic Conductivity								
Well Name	**Cell (I, j, k)**	**Simulated Head (feet above mean sea level)**						
PBN-9301B	(105, 59, 2)	778.441	774.287	772.085	772.131	773.21	773.03	772.461
PBN-9103B	(204. 64. 2)	748.067	743.919	743.295	743.043	744.293	743.861	743.013
PBN-9301C	(105, 59, 3)	778.498	774.309	772.071	772.116	773.213	773.039	772.444
SWN-0501C	(164, 79, 3)	760.307	753.855	754.601	754.164	753.644	753.237	753.992
SWN-9102C	(173, 47, 3)	763.759	757.531	758.106	757.639	756.207	756.135	757.346
PBN-9103C	(204, 64, 3)	748.125	743.96	743.354	743.08	744.335	743.901	743.067
RIN-1001C	(54, 47, 3)	808.615	790.944	785.965	784.386	786.095	785.954	783.928
SWN-0501D	(164, 79, 4)	760.302	753.851	754.606	754.17	753.643	753.235	753.997
SWN-9102D	(173, 47, 4)	763.717	757.48	758.056	757.588	756.16	756.088	757.297
PBM-9003D	(204, 64, 4)	748.053	743.914	743.273	743.004	744.286	743.855	742.995
SWN-0501E	(164, 79, 5)	760.295	753.846	754.609	754.173	753.64	753.232	753.999
	Calibrated Value Multiplier	**0.25**	**0.5**	**0.75**	******	**1.25**	**1.5**	**1.75**

** Denotes Calibrated Model Value

Table 5 (continued)
Site-Wide Groundwater Flow Model - Sensitivity Analysis

Response Due to Variations in Anisotropy								
Well Name	**Cell (I, j, k)**	**Simulated Head (feet above mean sea level)**						
PBN-9301B	(105, 59, 2)	772.131	772.131	772.131	772.131	772.131	772.131	772.131
PBN-9103B	(204. 64. 2)	743.043	743.043	743.043	743.043	743.043	743.043	743.043
PBN-9301C	(105, 59, 3)	772.116	772.116	772.116	772.116	772.116	772.116	772.116
SWN-0501C	(164, 79, 3)	754.164	754.164	754.164	754.164	754.164	754.164	754.164
SWN-9102C	(173, 47, 3)	757.639	757.639	757.639	757.639	757.639	757.639	757.639
PBN-9103C	(204, 64, 3)	743.08	743.08	743.08	743.08	743.08	743.08	743.08
RIN-1001C	(54, 47, 3)	784.386	784.386	784.386	784.386	784.386	784.386	784.386
SWN-0501D	(164, 79, 4)	754.17	754.17	754.17	754.17	754.17	754.17	754.17
SWN-9102D	(173, 47, 4)	757.588	757.588	757.588	757.588	757.588	757.588	757.588
PBM-9003D	(204, 64, 4)	743.004	743.004	743.004	743.004	743.004	743.004	743.004
SWN-0501E	(164, 79, 5)	754.173	754.173	754.173	754.173	754.173	754.173	754.173
	Calibrated Value Multiplier	**-50%**	**-35%**	**-10%**	******	**+10%**	**+35%**	+50%

** Denotes Calibrated Model Value

Table 6
Propellant Burning Ground Sub-Model
List of Monitoring Wells, Extraction Wells and Piezometers

Well ID	Type	Well ID	Type	Well ID	Type
EW-170R	Extraction	PBN-9112C	Piezometer	SWN-9102C	Piezometer
EW-169	Extraction	PBN-9112D	Piezometer	SWN-9102D	Piezometer
EW-167	Extraction	PBN-9301B	Piezometer	SWN-9103B	Piezometer
EW-168	Extraction	PBN-9301C	Piezometer	SWN-9103C	Piezometer
EW-163R	Extraction	PBN-9303B	Piezometer	SWN-9103D	Piezometer
EW-164	Extraction (off)	PBN-9303C	Piezometer	SWN-9104C	Piezometer
SCW-1	Extraction	PBN-9402B	Piezometer	SWN-9104D	Piezometer
SCW-2	Extraction	PBN-9402C	Piezometer	SWN-9105B	Piezometer
LON-8903A	Monitoring	PBN-9402D	Piezometer	SWN-9105C	Piezometer
PBM-0005	Monitoring	PBN-9902A	Monitoring	SWN-9105D	Piezometer
PBM-0006	Monitoring	PBN-9902B	Piezometer	PBN-1001A	Monitoring
PBM-8905	Monitoring	PBN-9902C	Piezometer	PBN-1001B	Piezometer
PBM-9001D	Piezometer	PBN-9902D	Piezometer	PBN-1001C	Piezometer
PBM-9002D	Piezometer	PBN-9903A	Monitoring	PBN-9103C	Piezometer
PBM-9003D	Piezometer	PBN-9903B	Piezometer	SWN-9103E	Piezometer
PBN-1002A	Monitoring	PBN-9903C	Piezometer		
PBN-1002B	Piezometer	PBN-9903D	Piezometer		
PBN-1002C	Piezometer	S1103	Monitoring		
PBN-1003C	Piezometer	S1104	Monitoring		
PBN-8202C	Piezometer	S1105	Monitoring		
PBN-8203A	Monitoring	S1106	Monitoring		
PBN-8203C	Piezometer	S1109	Monitoring		
PBN-8205A	Monitoring	SPN-8902B	Piezometer		
PBN-8205B	Piezometer	SPN-8902C	Piezometer		
PBN-8205C	Piezometer	SPN-8904B	Piezometer		
PBN-8501A	Monitoring	SPN-8904C	Piezometer		
PBN-8502A	Monitoring	SWN-0501B	Piezometer		
PBN-8503A	Monitoring	SWN-0501C	Piezometer		
PBN-8901C	Piezometer	SWN-0501D	Piezometer		
PBN-8901D	Piezometer	SWN-0501E	Piezometer		
PBN-8902B	Piezometer	SWN-0502B	Piezometer		
PBN-8902C	Piezometer	SWN-0502C	Piezometer		
PBN-8903B	Piezometer	SWN-0502D	Piezometer		
PBN-8903C	Piezometer	SWN-0502E	Piezometer		
PBN-8910A	Monitoring	SWN-0503B	Piezometer		
PBN-8910C	Piezometer	SWN-0503C	Piezometer		
PBN-9102C	Piezometer	SWN-0503D	Piezometer		
PBN-9103B	Piezometer	SWN-0503E	Piezometer		

* All single wells and A-series wells are assumed to be water table monitoring wells. All others are assumed to be piezometers.

Table 7
Propellant Burning Ground - Groundwater Flow Sub-Model
Model Calibration Statistics

Well ID	Observed Head (ft)*	Confidence Interval (%)	Computed Head (ft)*	Residual Head (ft)*
LON-8903A	775.58	95	776.6088	1.0288
PBM-0005	773.72	95	774.522	0.802
PBM-0006	773.74	95	774.2335	0.4935
PBM-8905	772.61	95	773.7066	1.0966
PBM-9001D	743.97	95	744.0403	0.0703
PBM-9002D	744.37	95	743.8503	-0.5197
PBM-9003D	742.68	95	743.0939	0.4139
PBN-1002A	769.58	95	770.3345	0.7545
PBN-1002B	769.79	95	770.3608	0.5708
PBN-1002C	768.89	95	770.3658	1.4758
PBN-1003C	769.06	95	769.7944	0.7344
PBN-8202C	773.55	95	775.3216	1.7716
PBN-8203A	773.8	95	774.1193	0.3193
PBN-8203C	773.82	95	774.0844	0.2644
PBN-8205A	773.56	95	774.0924	0.5324
PBN-8205B	773.73	95	774.1084	0.3784
PBN-8205C	773.69	95	774.0818	0.3918
PBN-8501A	771.76	95	772.1617	0.4017
PBN-8502A	771.61	95	772.1656	0.5556
PBN-8503A	772.51	95	772.6442	0.1342
PBN-8901C	771.82	95	772.0629	0.2429
PBN-8901D	771.9	95	772.1282	0.2282
PBN-8902B	770.5	95	772.1827	1.6827
PBN-8902C	770.59	95	772.1264	1.5364
PBN-8903B	772.51	95	772.6981	0.1881
PBN-8903C	772.46	95	772.6733	0.2133
PBN-8910A	774.72	95	774.9625	0.2425
PBN-8910C	774.84	95	774.954	0.114
PBN-9102C	744.11	95	743.9278	-0.1822
PBN-9103B	743.95	95	743.1154	-0.8346
PBN-9103C	744.11	95	743.1749	-0.9351
PBN-9112C	767.25	95	767.1086	-0.1414
PBN-9112D	767.17	95	767.0695	-0.1005

* Head elevations are given in feet above mean sea level

Table 7 (continued)
Propellant Burning Ground - Groundwater Flow Sub-Model
Model Calibration Statistics

Well ID	Observed Head (ft)	Confidence Interval (%)	Computed Head (ft)	Residual Head (ft)
PBN-9301B	772.68	95	772.7955	0.1155
PBN-9301C	772.59	95	772.781	0.191
PBN-9303B	767.42	95	768.068	0.648
PBN-9303C	767.48	95	768.0937	0.6137
PBN-9402B	767.25	95	767.6153	0.3653
PBN-9402C	767.27	95	767.6106	0.3406
PBN-9402D	767.22	95	767.5974	0.3774
PBN-9902A	764.78	95	765.3371	0.5571
PBN-9902B	764.78	95	765.3392	0.5592
PBN-9902C	764.75	95	765.325	0.575
PBN-9902D	764.97	95	765.3208	0.3508
PBN-9903A	763.65	95	765.219	1.569
PBN-9903B	764.09	95	765.2192	1.1292
PBN-9903C	764.14	95	765.2195	1.0795
PBN-9903D	764.13	95	765.219	1.089
S1103	764.83	95	765.6951	0.8651
S1104	765.97	95	765.5895	-0.3805
S1105	765.77	95	765.5663	-0.2037
S1106	766	95	765.5684	-0.4316
S1109	771.7	95	773.0402	1.3402
SPN-8902B	765.76	95	765.8774	0.1174
SPN-8902C	765.73	95	765.8663	0.1363
SPN-8904B	764.48	95	765.2323	0.7523
SPN-8904C	764.64	95	765.3392	0.6992
SWN-0501B	754.92	95	754.4421	-0.4779
SWN-0501C	754.9	95	754.4402	-0.4598
SWN-0501D	754.67	95	754.4453	-0.2247
SWN-0501E	754.38	95	754.4482	0.0682
SWN-0502B	752.91	95	752.25	-0.66
SWN-0502C	752.84	95	752.2458	-0.5942
SWN-0502D	752.98	95	752.2527	-0.7273
SWN-0502E	753	95	752.273	-0.727
SWN-0503B	749.07	95	749.0251	-0.0449
SWN-0503C	749.04	95	748.9773	-0.0627
SWN-0503D	749.11	95	748.9594	-0.1506

Table 7 (continued)
Propellant Burning Ground - Groundwater Flow Sub-Model
Model Calibration Statistics

Well ID	Observed Head (ft)	Confidence Interval (%)	Computed Head (ft)	Residual Head (ft)
SWN-0503E	750.71	95	748.9344	-1.7756
SWN-9102C	757.55	95	758.061	0.511
SWN-9102D	757.61	95	758.0112	0.4012
SWN-9103B	755.58	95	756.2705	0.6905
SWN-9103C	755.7	95	756.3242	0.6242
SWN-9103D	755.57	95	756.2148	0.6448
SWN-9103E	755.61	95	756.1331	0.5231
SWN-9104C	753.56	95	753.5425	-0.0175
SWN-9104D	753.76	95	753.7347	-0.0253
SWN-9105B	750.17	95	749.6454	-0.5246
SWN-9105C	750.06	95	749.5063	-0.5537
SWN-9105D	749.86	95	749.2828	-0.5772

Table 8
Propellant Burning Ground - Groundwater Flow Sub-Model
Model Verification Statistics

Well ID	Observed Head (ft)*	Confidence Interval (%)	Computed Head (ft)*	Residual Head (ft)*
LON-8903A	775.58	95	776.6088	1.0288
PBN-1001B	765.89	95	767.1627	1.2727
PBN-1001C	765.41	95	767.1608	1.7508
PBN-1003C	769.06	95	769.7944	0.7344
PBN-8503A	772.51	95	772.6442	0.1342
PBN-8901C	771.82	95	772.0629	0.2429
PBN-8901D	771.9	95	772.1281	0.2281
PBN-8902B	770.5	95	772.1826	1.6826
PBN-8902C	770.59	95	772.1263	1.5363
PBN-9103B	743.53	95	743.1154	-0.4146
PBN-9903A	763.65	95	765.2191	1.5691
PBN-9903B	764.09	95	765.2192	1.1292
PBN-9903C	764.14	95	765.2195	1.0795
PBN-9903D	764.13	95	765.2191	1.0891
S1104	765.97	95	765.5895	-0.3805
SWN-0502B	752.91	95	752.25	-0.66
SWN-0502C	752.84	95	752.2458	-0.5942
SWN-0502D	752.98	95	752.2527	-0.7273
SWN-0502E	753	95	752.273	-0.727
SWN-9104C	753.56	95	753.5425	-0.0175
SWN-9104D	753.76	95	753.7347	-0.0253

* Head elevations are given in feet above mean sea level

Table 9
Physical and Chemical Parameters Used for Solute Transport Modeling

Shaw, 2006

Model Package	Parameter Settings	2,3-DNT	2,4-DNT	2,6-DNT	CTET
Advection	Modified method of characteristics	x	x	x	x
Dispersion	Longitudinal (ft)	10 (all layers)	10 (all layers)	10 (all layers)	0.3 (Layers 1-3); 1.0 (Layers 2-4)
	Transverse : Longitudinal	0.1 (all layers)	0.1 (all layers)	0.1 (all layers)	0.1 (all layers)
	Vertical : Longitudinal	0.001 (all layers)	0.001 (all layers)	0.001 (all layers)	0.05 (Layers 2,4); 0.01 (Layers 3, 5)
	Effective Molecular Diffusion Coefficient	0	0	0	0
Source/Sink Mixing	Specified Concentration at Waste Pit 1 (ug/L):	142.5	22260	1441	315000
	Specified Concentration at Waste Pit 2 (ug/L):	130.7	20416	1322	289000
	Specified Concentration at Waste Pit 3 (ug/L):	168.1	26250	1700	272000
Rate Limited Sorption Reactions	Mass Transfer Coefficient	8.00E-10		1.00E-04	9.00E-07
	Partitioning Coefficient	1.00E-02		1.00E-03	1.00E-08
	Porosity	3.00E-01	3.00E-01	3.00E-01	3.00E-01
	Bulk Density (mg/cf)	1.60E+06	1.60E+06	1.60E+06	1.60E+06
Sorption Reactions	First Sorption Constant (Linear isotherm)	- -	1.00E+00	- -	- -
Degradation Rxns	Degradation Constant, dissolved phase (day^{-1})	- -	1.50E-02	- -	- -
	Degradation Constant, sorbed phase (day^{-1})	- -	2.00E-03	- -	- -

Current Study, 2011

Model Package	Parameter Settings	Total DNT	CTET
Advection	Modified method of characteristics	x	x
Dispersion	Longitudinal (ft)	10 (all layers)	0.3 (Layers 1,2,3); 1 (Layers 2,4)
	Transverse : Longitudinal	0.1 (all layers)	0.1 (all layers)
	Vertical : Longitudinal	0.001 (all layers)	0.05 (Layers 2,4), 0.01 (Layers 3,4,5)
	Effective Molecular Diffusion Coefficient	0	0
Source/Sink Mixing	Specified Concentration at the PBG	1 ppb (3 locations)	2-25 ppb (5 locations)
	Specified Concentration at Central Plume	none	NA
	Specified Concentration at the DBG	2-25 ppb (5 locations)	NA
Rate Limited Sorption Reactions	Mass Transfer Coefficient	- -	9.00E-07
	Partitioning Coefficient	- -	1.00E-08
	Porosity	3.00E-01	3.00E-01
	Bulk Density (mg/cf)	1.60E+06	1.60E+06
Sorption Reactions	First Sorption Constant (Linear isotherm)	1.00E+00	- -
Degradation Rxns	Degradation Constant, dissolved phase (day^{-1})	0.015 (optional)	- -
	Degradation Constant, sorbed phase (day^{-1})	0.002 (optional)	- -

Notes:

Dispersion	Consideration of prior assigned dispersivity values, and those reported in literature for sandy soils (transverse dispersivity is typically 0.1 of longitudinal dispersion; vertical dispersivity is typically 0.01 of longitudinal dispersion
Sources/sinks mixing	Information from waste pits used to develop reasonable concentrations for groundwater source loading in the updated model. **DNT** Observed soil concentrations (ppb) for DNT isomers obtained in Jan 2005 (sampling depths of 91 feet, 105 feet and 90 feet, respectively). 2,3-DNT: 700, 45, 230. 2,4 DNT: 2,300, 87, 240. 2,6-DNT: 11,000, 0, 1,700. **CTET**. No elevated concentrations were reported.
Rate Limited Sorption Reactions	Values used in model update are those for 2,4-DNT. For this study, simulations were performed using sorption and degradation reactions for DNT. Given the persistence of select DNT isomers in the natural environment, only those results using linear isotherms are reported.

Table 10
Propellant Burning Ground Solute Transport Sub-Model
Calibration Statistics for CTET (2007)

Well ID	Observed CTET Concentration*	Computed CTET Concentration*	Residual*
LON-8903A	4.22	0	4.220
LON-8903B	0.71	0	0.710
PBN-8203C	0.65	0.013	0.637
PBN-8205A	11.8	0.803	10.997
PBN-8205B	0.57	0.803	-0.233
PBN-8205C	0.49	0.803	-0.313
PBN-8502A	16.3	38.452	-22.152
PBN-8503A	0	32.687	-32.687
PBN-8901C	2.95	10.896	-7.946
PBN-8901D	0	2.79	-2.790
PBN-8902B	12.6	27.207	-14.607
PBN-8902C	5.8	27.207	-21.407
PBN-8903B	2.2	28.395	-26.195
PBN-8903C	0	8.332	-8.332
PBN-8910A	0.89	7.688	-6.798
PBN-8910C	0.51	1.773	-1.263
PBN-9102B	1.79	1.504	0.286
PBN-9102C	1.89	1.538	0.352
PBN-9112C	3.14	3.554	-0.414
PBN-9112D	0	3.615	-3.615
PBN-9301B	2.29	0.417	1.873
PBN-9301C	2.22	0.071	2.149
PBN-9303B	3.57	1.212	2.358
PBN-9303C	5.37	1.073	4.297
PBN-9402B	0	0.234	-0.234
PBN-9402C	0	0.266	-0.266
PBN-9402D	0	0.268	-0.268
PBN-9902A	0	1.938	-1.938
PBN-9902B	9.86	2.153	7.707
PBN-9902C	0	2.195	-2.195
PBN-9902D	0	2.195	-2.195
PBN-9903A	1.49	5.551	-4.061
PBN-9903B	7.75	6.599	1.151
PBN-9903C	12.5	6.841	5.659
PBN-9903D	0	6.561	-6.561
S1103	7.1	3.111	3.989

Table 10
Propellant Burning Ground Solute Transport Sub-Model
Calibration Statistics for CTET (2007)

Well ID	Observed CTET Concentration*	Computed CTET Concentration*	Residual*
SWN-9102C	0	0.139	-0.139
SWN-9102D	1.77	0.116	1.654
SWN-9103B	24.4	6.987	17.413
SWN-9103C	18	2.254	15.746
SWN-9103D	7.74	2.042	5.698
SWN-9103E	3.13	2.042	1.088
SWN-9104C	0	5.676	-5.676
SWN-9105B	0	1.337	-1.337
SWN-9105C	0	1.461	-1.461
SWN-9105D	0	1.528	-1.528
PBN-8501A	10.9	43.474	-32.574
PBM-8905	1.31	0.047	1.263
PBM-9002D	2.94	1.538	1.402
PBN-8202C	0	28.369	-28.369
PBN-8203A	2.75	0.005	2.745
PBN-9303D	0	0.891	-0.891
SPN-8902B	0	0.034	-0.034
SPN-8902C	0	0.035	-0.035
SPN-8904B	10.3	3.968	6.332
SPN-8904C	20.3	4.107	16.193
SWN-0501B	0	0.001	-0.001
SWN-0501C	1.73	0.004	1.726
SWN-0501D	0	0.004	-0.004
SWN-0501E	0	0.004	-0.004
SWN-0502B	0	0.003	-0.003
SWN-0502C	0	0.005	-0.005
SWN-0502D	0	0.005	-0.005
SWN-0502E	0	0.005	-0.005
SWN-0503C	0	0.011	-0.011
SWN-0503D	0	0.011	-0.011
SWN-0503E	0	0.011	-0.011

* All concentrations are in parts per billion (ppb).

Table 10
Propellant Burning Ground Solute Transport Sub-Model
Calibration Statistics for CTET (2007)

Solute Concentration Error Summary	
Maximum Residual	17.413
Minimum Residual	-32.687
Residual Standard Deviation	9.585
Mean Error	-1.805
Mean Absolute Error	5.317
Root Mean Square Error	9.513
Ratio of Standard Deviation/ Observed Concentration Range	0.393

Table 11
Propellant Burning Ground Solute Transport Sub-Model
Model Verification Statistics for CTET (2010)

Well ID	Observed CTET Concentration*	Computed CTET Concentration*	Residual*
LON-8903A	1.76	0.033	1.727
LON-8903B	0.34	0.03	0.310
PBN-8203C	1.98	0.398	1.582
PBN-8502A	23	4.756	18.244
PBN-8901C	1.6	0.946	0.654
PBN-8901D	0	0.689	-0.689
PBN-8910A	1.11	29.533	-28.423
PBN-8910C	0.28	19.015	-18.735
PBN-9102B	0	1.671	-1.671
PBN-9102C	0	1.894	-1.894
PBN-9112C	5.26	3.269	1.991
PBN-9112D	5.26	3.281	1.979
PBN-9301B	2.12	0.474	1.646
PBN-9301C	2.13	0.067	2.063
PBN-9303B	3.04	1.564	1.476
PBN-9402B	0	0.382	-0.382
PBN-9402C	0.13	0.373	-0.243
PBN-9402D	0	0.304	-0.304
PBN-9902A	0	1.331	-1.331
PBN-9902B	7.53	1.452	6.078
PBN-9902C	0	1.514	-1.514
PBN-9902D	0	1.514	-1.514
PBN-9903A	0.93	5.211	-4.281
PBN-9903B	11.5	7.749	3.751
PBN-9903D	0	8.628	-8.628
S1103	6.99	3.656	3.334
SWN-9102C	0	0.244	-0.244
SWN-9102D	0	0.085	-0.085
SWN-9103B	14.1	11.848	2.252
SWN-9103D	8.45	1.489	6.961
SWN-9103E	0	1.489	-1.489
SWN-9104C	1.5	7.834	-6.334
SWN-9105B	0	0.683	-0.683
SWN-9105C	0.11	0.625	-0.515
SWN-9105D	0	0.567	-0.567
PBN-8501A	6.4	2.17	4.230

Table 11 (continued)
Propellant Burning Ground Solute Transport Sub-Model
Model Verification Statistics for CTET (2010)

Well ID	Observed CTET Concentration*	Computed CTET Concentration*	Residual*
PBM-8905	0.19	0.543	-0.353
PBM-9002D	0.43	1.894	-1.464
PBN-8202C	0.4	32.863	-32.463
PBN-8203A	3.86	0.132	3.728
PBN-9303D	0	1.202	-1.202
SPN-8902B	10.3	0.05	10.250
SPN-8902C	0	0.046	-0.046
SWN-0501B	0.2	0.005	0.195
SWN-0501C	0.46	0.022	0.438
SWN-0501D	0	0.022	-0.022
SWN-0501E	0	0.022	-0.022
SWN-0502B	0	0.009	-0.009
SWN-0502C	0	0.019	-0.019
SWN-0502D	0	0.019	-0.019
SWN-0503C	0	0.035	-0.035
SWN-0503D	0	0.035	-0.035
SWN-0503E	0	0.035	-0.035

Solute Concentration Error Summary

Maximum Residual:	18.244
Minimum Residual:	-32.463
Residual Standard Deviation:	7.520
Mean Error:	-0.799
Mean Absolute Error:	3.550
Root Mean Square Error:	7.449
Ratio of Standard Deviation/ Observed Concentration Range:	0.327

*All concentrations in parts per billion (ppb)

Table 12
Propellant Burning Ground Solute Transport Sub-Model
Calibration Statistics for DNT (2007)

Well ID	Observed DNT Concentration*	Computed DNT Concentration*	Residual*
LON-8903A	0.007	0.169	-0.162
LON-8903B	0.000	0.137	-0.137
PBN-8203C	0.012	0.007	0.005
PBN-8205A	0.492	0.555	-0.063
PBN-8205B	0.854	0.555	0.299
PBN-8205C	0.842	0.555	0.287
PBN-8903B	0.022	0.002	0.020
PBN-9112C	0.761	0.000	0.761
PBN-9112D	0.000	0.000	0.000
PBN-9301B	0.007	0.009	-0.002
PBN-9301C	0.038	0.025	0.013
PBN-9303B	0.000	0.000	0.000
PBN-9303C	0.000	0.000	0.000
S1103	0.000	0.015	-0.015
PBM-8905	0.000	0.010	-0.010
PBN-8203A	0.038	0.014	0.024
PBN-9303D	0.000	0.000	0.000

* All concentrations are in parts per billion (ppb).

Solute Concentration Error Summary

Maximum Residual	0.761
Minimum Residual	0.000
Residual Standard Deviation	0.215
Mean Error	0.060
Mean Absolute Error	0.106
Root Mean Square Error	0.209
Ratio of Standard Deviation/ Observed Concentration Range	0.252

Table 13
Propellant Burning Ground Solute Transport Sub-Model
Model Calibration Statistics for DNT (2010)

Well ID	Observed DNT Concentration*	Computed DNT Concentration*	Residual*
PBN-8205A	0.000	0.123	-0.123
PBN-9902A	0.018	0.206	-0.188
PBN-8203A	0.017	0.085	-0.068
PBN-8502A	0.000	0.323	-0.323
PBN-1002A	0.000	0.104	-0.104
SPN-8904B	0.078	0.032	0.046
PBN-9903B	0.019	0.011	0.008
PBN-1001B	0.018	0.127	-0.109
PBN-8205B	0.000	0.123	-0.123
PBN-8902B	0.000	0.272	-0.272
SPN-8902B	0.000	0.006	-0.006
PBN-9303B	0.000	0.004	-0.004
PBN-8903B	0.000	0.016	-0.016
PBN-9301B	0.000	0.009	-0.009
PBN-9902B	0.000	0.216	-0.216
PBN-1002B	0.000	0.086	-0.086
PBN-9902C	4.443	0.224	4.219
PBN-8205C	0.342	0.123	0.219
SPN-8904C	0.096	0.033	0.063
PBN-1001C	0.040	0.044	-0.004
PBN-9301C	0.031	0.002	0.029
PBN-9903C	0.017	0.011	0.006
PBN-8902C	0.015	0.272	-0.257
PBN-8203C	0.000	0.085	-0.085
PBN-1003C	0.000	0.020	-0.020
SPN-8902C	0.000	0.006	-0.006
S1103	0.000	0.019	-0.019
PBN-8903C	0.000	0.013	-0.013
PBN-8901C	0.000	0.146	-0.146
PBN-9112C	0.000	0.217	-0.217
PBN-9303C	0.000	0.005	-0.005
PBN-1002C	0.000	0.078	-0.078
EW-167	1.833	0.133	1.700

Table 13 (continued)
Propellant Burning Ground Solute Transport Sub-Model
Model Calibration Statistics for DNT (2010)

Well ID	Observed DNT Concentration*	Computed DNT Concentration*	Residual*
EW-168	0.025	0.078	-0.053
EW-169	0.058	0.119	-0.061
EW-170R	0.178	0.139	0.039
PBN-8901D	0.000	0.128	-0.128
PBN-9112D	0.000	0.188	-0.188
PBN-9903D	0.000	0.011	-0.011

*All concentrations in parts per billion (ppb)

Solute Concentration Error Summary

Maximum Residual:	4.219
Minimum Residual:	-0.323
Residual Standard Deviation:	0.088
Mean Error:	0.087
Mean Absolute Error:	0.098
Root Mean Square Error:	0.087
Ratio of Standard Deviation/ Observed Concentration Range:	0.019

Table 14
Central Plume Area – Groundwater Flow Sub-Model
List of Monitoring Wells and Piezometers

Well ID	Type	Well ID	Type	Well ID	Type
NLN-0701A	Monitoring	RIN-1003A	Monitoring	SEN-0502A	Monitoring
NLN-8201A	Monitoring	RIN-1004B	Piezometer	SEN-0502D	Piezometer
NLN-8203A	Monitoring	RIN-1005A	Monitoring	SEN-0503A	Monitoring
NLN-8204A	Monitoring	RIN-1005C	Piezometer	SEN-0503B	Piezometer
NPM-8901	Monitoring	S1110	Monitoring	SEN-0503D	Piezometer
RIM-0701	Monitoring	SEN-0501A	Monitoring	SPN-0406A	Monitoring
RIN-1002A	Monitoring	SEN-0501B	Piezometer	SPN-0406B	Piezometer
RIN-1002C	Piezometer	SEN-0501D	Piezometer	SPN-0406C	Piezometer

* All single wells and A-series wells are assumed to be water table monitoring wells. All others are assumed to be piezometers.

Table 15
Central Plume Area – Groundwater Flow Sub-Model
Calibration Statistics

Well ID	Observed Head (ft)*	Confidence Interval (%)	Computed Head (ft)*	Residual Head (ft)*
NLN-0701A	778.72	95	778.1756	-0.5444
NLN-8201A	777.9	95	778.1224	0.2224
NLN-8203A	778.41	95	777.4436	-0.9664
NLN-8204A	778.06	95	777.2656	-0.7944
NPM-8901	782.12	95	781.5841	-0.5359
RIM-0701	783.22	95	782.2265	-0.9935
RIN-1002A	776.11	95	775.6464	-0.4636
RIN-1002C	776.07	95	775.6569	-0.4131
RIN-1003A	773.34	95	773.3258	-0.0142
RIN-1004B	770.21	95	770.3004	0.0904
RIN-1005A	773.77	95	773.655	-0.115
RIN-1005C	773.85	95	773.6373	-0.2127
S1110	769.76	95	768.4044	-1.3556
SEN-0501A	765.51	95	765.0685	-0.4415
SEN-0501B	765.56	95	765.0652	-0.4948
SEN-0501D	765.83	95	765.062	-0.768
SEN-0502A	766.26	95	764.958	-1.302
SEN-0502D	766.06	95	764.95	-1.11
SEN-0503A	766.61	95	765.6028	-1.0072
SEN-0503B	766.62	95	765.5931	-1.0269
SEN-0503D	766.7	95	765.5864	-1.1136
SPN-0406A	766.4	95	765.8675	-0.5325
SPN-0406B	766.29	95	765.8661	-0.4239
SPN-0406C	766.46	95	765.8648	-0.5952

* Head elevations are given in feet above mean sea level

Table 16
Central Plume Area – Groundwater Flow Sub-Model
Verification Statistics

Well ID	Observed Head (ft)*	Confidence Interval (%)	Computed Head (ft)*	Residual Head (ft)*
NLN-0701A	778.72	95	778.1756	-0.5444
NLN-8201A	778.60	95	778.1223	-0.4777
NLN-8204A	778.06	95	777.2656	-0.7944
RIN-1003A	773.34	95	773.3258	-0.0142
RIN-1004B	770.21	95	770.3004	0.0904
SEN-0501A	765.51	95	765.0685	-0.4415
SEN-0501B	765.56	95	765.0652	-0.4948
SEN-0501D	765.83	95	765.062	-0.7680

* Head elevations are given in feet above mean sea level

Table 17
Central Plume Area Solute Transport Sub-Model
Calibration Statistics for DNT (2007)

Well ID	Observed DNT Concentration*	Computed DNT Concentration*	Residual*
SEN-0501A	0.021	0.000	0.021
SEN-0501B	0.078	0.000	0.078
SEN-0501D	0	0.000	0.000
SEN-0502A	0	0.012	-0.012
SEN-0502B	0.118	0.000	0.118
SEN-0502D	0	0.000	0.000
SEN-0503A	0	0.009	-0.009
SEN-0503B	0.053	0.000	0.053
SEN-0503D	0	0.000	0.000
SPN-0406A	0	0.000	0.000
SPN-0406B	0	0.000	0.000
SPN-0406C	0	0.000	0.000
USDA 2	0	0.017	-0.017
WE-RM383	0.015	0.000	0.015
WE-RR598	0	0.000	0.000
WE-SQ002	0	0.000	0.000

* Concentrations are reported in ppb

Solute Concentration Error Summary

Maximum Residual:	0.118
Minimum Residual:	-0.017
Residual Standard Deviation:	0.037
Mean Error:	0.015
Mean Absolute Error:	0.020
Root Mean Square Error:	0.036
Ratio of Standard Deviation/ Observed Concentration Range:	0.311

Table 18
Central Plume Area Solute Transport Sub-Model
Verification Statistics for DNT (2010)

Well ID	Observed DNT Concentration	Computed DNT Concentration	Residual
RIN-1004B	0.060	0.000	0.060
RIN-1005C	0.049	0.000	0.049
SEN-0503B	0.000	0.066	-0.066
SEN-0502B	0.029	0.048	-0.019
RIM-1003	0.029	0.000	0.029
SEN-0501B	0.024	0.039	-0.015
RIN-1002C	0.023	0.000	0.023
WE-UK124	0.016	0.000	0.016
RIM-1005	0.000	0.000	0.000
RIN-1002A	0.000	0.000	0.000
RIN-1005A	0.000	0.000	0.000
RIM-1004	0.000	0.000	0.000
SEN-0503A	0.000	0.024	-0.024
SPN-0406A	0.000	0.002	-0.002
SEN-0502A	0.000	0.003	-0.003
SEN-0501A	0.000	0.021	-0.021
SPN-0406B	0.000	0.002	-0.002
SPN-0406C	0.000	0.003	-0.003
SEN-0502D	0.000	0.004	-0.004
SEN-0503D	0.000	0.037	-0.037
SEN-0501D	0.000	0.027	-0.027
WE-UK125	0.000	0.000	0.000
S1120	0.043	0.000	0.043
RPM-8901	0.030	0.000	0.030
RIN-0702C	0.045	0.000	0.045
RPM-9101	0.130	0.000	0.130
S1112	0.540	0.000	0.540
S1111	0.000	0.000	0.000
USDA 2	0.000	0.000	0.000
WE-RM383	0.000	0.031	-0.031
WE-SQ002	0.000	0.000	0.000
WE-RR598	0.000	0.000	0.000
RPM-8902	0.000	0.000	0.000
NLN-1001A	0.000	0.000	0.000
NLN-1001C	0.000	0.000	0.000
S1119	0.022	0.000	0.022
RIN-0701C	0.000	0.000	0.000

Table 18 (continued)
Central Plume Area Solute Transport Sub-Model
Calibration Statistics for DNT (2010)

Well ID	Observed DNT Concentration	Computed DNT Concentration	Residual
NPM-8901	0.046	0.000	0.046
S1124	0.000	0.000	0.000
RIM-0701	0.000	0.000	0.000
RIM-0702	0.000	0.000	0.000
USDA 6	0.052	0.000	0.052

* Concentrations are reported in ppb

Solute Concentration Error Summary

Maximum Residual:	0.540
Minimum Residual:	-0.066
Residual Standard Deviation:	0.088
Mean Error:	0.020
Mean Absolute Error:	0.032
Root Mean Square Error:	0.871
Ratio of Standard Deviation/ Observed Concentration Range:	0.163

Table 19
Deterrent Burning Ground – Groundwater Flow Sub-Model
List of Monitoring Wells and Piezometers

Well ID	Type	Well ID	Type	Well ID	Type
DBM-8201	Monitoring	DBN-9502C	Piezometer	ELN-8203B	Piezometer
DBM-8202	Monitoring	DBN-9503A	Monitoring	ELN-8203C	Piezometer
DBM-8903	Monitoring	DBN-9503B	Piezometer	ELN-8204A	Monitoring
DBM-8905	Monitoring	DBN-9503C	Piezometer	ELN-8204B	Piezometer
DBM-9501	Monitoring	ELM-8903	Monitoring	ELN-8204C	Piezometer
DBN-1002C	Piezometer	ELM-8907	Monitoring	ELN-8904A	Monitoring
DBN-1002E	Piezometer	ELM-8908	Monitoring	ELN-8904B	Piezometer
DBN-8201B	Piezometer	ELM-8909	Monitoring	ELN-9107A	Monitoring
DBN-8201C	Piezometer	ELN-1002A	Monitoring	ELN-9107B	Piezometer
DBN-8902A	Monitoring	ELN-1002B	Piezometer	S1121	Monitoring
DBN-8902B	Piezometer	ELN-1002C	Piezometer	S1122	Monitoring
DBN-9501A	Monitoring	ELN-1002E	Piezometer	S1134R	Monitoring
DBN-9501B	Piezometer	ELN-1003A	Monitoring	S1153	Monitoring
DBN-9501C	Piezometer	ELN-1003B	Piezometer	DBN-1001B	Piezometer
DBN-9501E	Piezometer	ELN-1003C	Piezometer	DBN-1001C	Piezometer
DBN-9502A	Monitoring	ELN-1003E	Piezometer	DBN-1001E	Piezometer

* All single wells and A-series wells are assumed to be water table monitoring wells. All others are assumed to be piezometers.

Table 20
Deterrent Burning Ground – Groundwater Flow Sub-Model
Model Calibration Statistics

Well ID	Observed Head (ft)*	Confidence Interval (%)	Computed Head (ft)*	Residual Head (ft)*
DBM-1001	789.37	95	789.1779	-0.1921
DBM-8201	782.93	95	783.309	0.379
DBM-8202	786.14	95	784.338	-1.802
DBM-8903	782.87	95	782.3729	-0.4971
DBM-8905	788.67	95	785.5601	-3.1099
DBM-9501	782.64	95	781.625	-1.015
DBN-1002C	781.38	95	781.7268	0.3468
DBN-1002E	781.12	95	781.7295	0.6095
DBN-8201B	783.13	95	784.0502	0.9202
DBN-8201C	783.18	95	784.0909	0.9109
DBN-8902A	782.82	95	782.39	-0.43
DBN-8902B	782.74	95	782.3842	-0.3558
DBN-9501A	782.72	95	782.1535	-0.5665
DBN-9501B	782.76	95	782.144	-0.616
DBN-9501C	782.78	95	782.1345	-0.6455
DBN-9501E	782.66	95	782.139	-0.521
DBN-9502A	783.22	95	782.7139	-0.5061
DBN-9502B	782.9	95	782.7457	-0.1543
DBN-9502C	782.97	95	782.7009	-0.2691
DBN-9503A	783.47	95	783.908	0.438
DBN-9503B	783.64	95	783.9516	0.3116
DBN-9503C	783.62	95	783.9218	0.3018
ELM-8903	782.32	95	781.5782	-0.7418
ELM-8907	781.4	95	781.7261	0.3261
ELM-8908	782.27	95	781.9701	-0.2999
ELM-8909	784.61	95	783.4556	-1.1544
ELN-1002A	775.27	95	776.3341	1.0641
ELN-1002B	775.3	95	776.3259	1.0259
ELN-1002C	776.14	95	776.3361	0.1961
ELN-1002E	776.86	95	776.3274	-0.5326
ELN-1003A	779.52	95	778.7747	-0.7453
ELN-1003B	778.91	95	778.7863	-0.1237
ELN-1003C	779.03	95	778.7992	-0.2308
ELN-1003E	778.59	95	778.821	0.231
ELN-8203A	782.93	95	781.8299	-1.1001
ELN-8203B	782.62	95	781.8403	-0.7797

* Head elevations are given in feet above mean sea level

Table 20 (continued)
Deterrent Burning Ground – Groundwater Flow Sub-Model
Model Calibration Statistics

Well ID	Observed Head (ft)*	Confidence Interval (%)	Computed Head (ft)	Residual Head (ft)
ELN-8203C	782.6	95	781.8414	-0.7586
ELN-8204A	783.88	95	783.2852	-0.5948
ELN-8204B	783.72	95	783.3128	-0.4072
ELN-8204C	782.99	95	783.3029	0.3129
ELN-8904A	782.65	95	781.5878	-1.0622
ELN-8904B	781.65	95	781.5747	-0.0753
ELN-9107A	781.75	95	781.3176	-0.4324
ELN-9107B	781.81	95	781.3069	-0.5031
S1121	778.07	95	777.647	-0.423
S1122	783.23	95	784.0578	0.8278
S1134R	783.15	95	782.1804	-0.9696
S1153	782.81	95	781.5208	-1.2892

Table 21
Deterrent Burning Ground - Groundwater Flow Sub-Model
Verification Statistics

Well ID	Observed Head*	Confidence Interval	Computed Head*	Residual Head*
DBM-8201	782.93	95	783.309	0.379
DBM-8903	782.87	95	782.3728	-0.4972
DBN-1001B	784.8	95	783.6067	-1.1933
DBN-1001C	782.1	95	783.6614	1.5614
DBN-1001E	782.4	95	783.7208	1.3208
ELM-8909	784.61	95	783.4556	-1.1544
ELN-8904B	781.65	95	781.5746	-0.0754
ELN-9107B	781.81	95	781.3069	-0.5031

* Head elevations are given in feet above mean sea level

Table 22
Deterrent Burning Ground - Solute Transport Sub-Model
Model Calibration Statistics (2007)

Well ID	Observed DNT Concentration*	Computed DNT Concentration*	Residual
RIN-1004B	0.060	0.002	0.058
RIN-1005C	0.049	0.029	0.020
SEN-0503B	0.0	0.0	0.000
SEN-0502B	0.029	0.0	0.029
RIM-1003	0.029	0.02	0.009
SEN-0501B	0.024	0.0	0.024
RIN-1002C	0.023	0.014	0.009
WE-UK124	0.016	0.0	0.016
RIM-1005	0.0	0.002	-0.002
RIN-1002A	0.0	0.010	-0.010
RIN-1005A	0.0	0.020	-0.020
RIM-1004	0.0	0.002	-0.002
SEN-0503A	0.0	0.020	-0.020
SPN-0406A	0.0	0.0	0.000
SEN-0502A	0.0	0.023	-0.023
SEN-0501A	0.0	0.0	0.000
SPN-0406B	0.0	0.0	0.000
SPN-0406C	0.0	0.0	0.000
SEN-0502D	0.0	0.0	0.000
SEN-0503D	0.0	0.0	0.000
SEN-0501D	0.0	0.0	0.000
S1120	0.043	0.039	0.004
RPM-8901	0.030	0.028	0.002
RIN-0702C	0.045	0.03	0.015
RPM-9101	0.130	0.025	0.105
S1112	0.540	0.04	0.500
S1111	0.0	0.0	0.000
USDA 2	0.0	0.026	-0.026
WE-RM383	0.0	0.0	0.000
WE-SQ002	0.0	0.0	0.000
WE-RR598	0.0	0.0	0.000
RPM-8902	0.0	0.003	-0.003
NLN-1001A	0.0	0.0	0.000
NLN-1001C	0.0	0.0	0.000
S1119	0.022	0.028	-0.006
RIN-0701C	0.0	0.003	-0.003
NPM-8901	0.046	0.005	0.041

Table 22 (continued)
Deterrent Burning Ground - Solute Transport Sub-Model
Model Calibration Statistics (2007)

Well ID	Observed DNT Concentration*	Computed DNT Concentration*	Residual
S1124	0.0	0.0	0.000
RIM-0701	0.0	0.006	-0.006
RIM-0702	0.0	0.006	-0.006
USDA 6	0.052	0.022	0.030

* All concentrations in parts per billion (ppb)

Solute Concentration Error Summary

Maximum Residual:	0.500
Minimum Residual:	-0.026
Residual Standard Deviation:	0.080
Mean Error:	0.018
Mean Absolute Error:	0.024
Root Mean Square Error:	0.079
Ratio of Standard Deviation/ Observed Concentration Range:	0.149

Table 23
Deterrent Burning Ground Solute Transport Sub-Model
Model Verification Statistics (2010)

Well ID	Observed DNT Concentration*	Computed DNT Concentration*	Residual
RIN-1004B	0.060	0.002	0.058
RIN-1005C	0.049	0.029	0.020
SEN-0503B	0.0	0.0	0.000
SEN-0502B	0.029	0.0	0.029
RIM-1003	0.029	0.02	0.009
SEN-0501B	0.024	0.0	0.024
RIN-1002C	0.023	0.014	0.009
WE-UK124	0.016	0.0	0.016
RIM-1005	0.0	0.002	-0.002
RIN-1002A	0.0	0.010	-0.010
RIN-1005A	0.0	0.020	-0.020
RIM-1004	0.0	0.002	-0.002
SEN-0503A	0.0	0.020	-0.020
SPN-0406A	0.0	0.0	0.000
SEN-0502A	0.0	0.023	-0.023
SEN-0501A	0.0	0.0	0.000
SPN-0406B	0.0	0.0	0.000
SPN-0406C	0.0	0.0	0.000
SEN-0502D	0.0	0.0	0.000
SEN-0503D	0.0	0.0	0.000
SEN-0501D	0.0	0.0	0.000
S1120	0.043	0.039	0.004
RPM-8901	0.030	0.028	0.002
RIN-0702C	0.045	0.03	0.015
RPM-9101	0.130	0.025	0.105
S1112	0.540	0.04	0.500
S1111	0.0	0.0	0.000
USDA 2	0.0	0.026	-0.026
WE-RM383	0.0	0.0	0.000
WE-SQ002	0.0	0.0	0.000
WE-RR598	0.0	0.0	0.000
RPM-8902	0.0	0.003	-0.003
NLN-1001A	0.0	0.0	0.000
NLN-1001C	0.0	0.0	0.000
S1119	0.022	0.028	-0.006
RIN-0701C	0.0	0.003	-0.003
NPM-8901	0.046	0.005	0.041

Table 23 (continued)
Deterrent Burning Ground Solute Transport Sub-Model
Model Verification Statistics (2010)

Well ID	Observed DNT Concentration*	Computed DNT Concentration*	Residual
S1124	0.0	0.0	0.000
RIM-0701	0.0	0.006	-0.006
RIM-0702	0.0	0.006	-0.006
USDA 6	0.052	0.022	0.030

* All concentrations in parts per billion (ppb)

Solute Concentration Error Summary

Maximum Residual:	0.500
Minimum Residual:	-0.026
Residual Standard Deviation:	0.080
Mean Error:	0.018
Mean Absolute Error:	0.024
Root Mean Square Error:	0.079
Ratio of Standard Deviation/ Observed Concentration Range:	0.149

Table 24
Propellant Burning Ground Solute Transport Model
Sensitivity Analysis for DNT (2010)

Response Due to Variations in Effective Porosity								
Well Name	**Cell (I, j, k)**	**Simulated DNT Concentration (ppb)**						
PBN-8203A	(21, 37, 1)	0.005	0.034	0.067	0.085	0.093	0.095	0.093
PBN-1002A	(36, 42, 1)	0.048	0.083	0.098	0.104	0.107	0.108	0.109
SPN-8904B	(59, 33, 2)	0.021	0.028	0.031	0.032	0.031	0.03	0.028
PBN-8903B	(26,33,2)	0.003	0.008	0.013	0.016	0.019	0.02	0.021
PBN-9902B	(58, 29, 2)	0.146	0.194	0.215	0.216	0.206	0.194	0.181
PBN-8205C	(22, 41, 3)	0.026	0.032	0.064	0.123	0.194	0.257	0.316
PBN-1001C	(51, 36, 3)	0.036	0.039	0.041	0.044	0.046	0.048	0.05
PBN-9301C	(32, 51, 3)	0.001	0.001	0.001	0.002	0.002	0.003	0.003
PBN-8901D	(28, 38, 4)	0.056	0.087	0.111	0.128	0.14	0.149	0.155
PBN-9903D	(65, 32, 4)	0.011	0.011	0.011	0.011	0.011	0.011	0.011
	Calibrated Value Multiplier	**0.25**	**0.5**	**0.75**	******	**1.25**	**1.5**	**1.75**

Response Due to Variations in Longitudinal Dispersivity								
Well Name	**Cell (I, j, k)**	**Simulated DNT Concentration (ppb)**						
PBN-8203A	(21, 37, 1)	0.086	0.086	0.085	0.085	0.085	0.085	0.084
PBN-1002A	(36, 42, 1)	0.097	0.099	0.102	0.104	0.107	0.109	0.111
SPN-8904B	(59, 33, 2)	0.031	0.031	0.031	0.032	0.033	0.034	0.035
PBN-8903B	(26,33,2)	0.016	0.016	0.016	0.016	0.016	0.016	0.016
PBN-9902B	(58, 29, 2)	0.225	0.222	0.219	0.216	0.214	0.212	0.210
PBN-8205C	(22, 41, 3)	0.123	0.123	0.123	0.123	0.123	0.123	0.123
PBN-1001C	(51, 36, 3)	0.040	0.042	0.043	0.044	0.045	0.045	0.046
PBN-9301C	(32, 51, 3)	0.001	0.002	0.002	0.002	0.002	0.002	0.002
PBN-8901D	(28, 38, 4)	0.126	0.127	0.127	0.128	0.129	0.129	0.13
PBN-9903D	(65, 32, 4)	0.011	0.011	0.011	0.011	0.011	0.011	0.011
	Calibrated Value Multiplier	**0.25**	**0.5**	**0.75**	******	**1.25**	**1.5**	**1.75**

** Denotes Calibrated Model Value

Table 24 (con't)
Propellant Burning Ground Solute Transport Model
Sensitivity Analysis for DNT (2010)

Response Due to Variations in Bulk Density								
Well Name	**Cell (I, j, k)**							
PBN-8203A	(21, 37, 1)	0.083	0.084	0.084	0.085	0.086	0.087	0.087
PBN-1002A	(36, 42, 1)	0.104	0.103	0.104	0.104	0.105	0.105	0.105
SPN-8904B	(59, 33, 2)	0.032	0.032	0.032	0.032	0.032	0.032	0.032
PBN-8903B	(26,33,2)	0.015	0.016	0.016	0.016	0.016	0.016	0.017
PBN-9902B	(58, 29, 2)	0.217	0.217	0.217	0.216	0.216	0.215	0.215
PBN-8205C	(22, 41, 3)	0.110	0.114	0.118	0.123	0.127	0.131	0.136
PBN-1001C	(51, 36, 3)	0.043	0.043	0.043	0.044	0.044	0.044	0.045
PBN-9301C	(32, 51, 3)	0.002	0.002	0.002	0.002	0.002	0.002	0.002
PBN-8901D	(28, 38, 4)	0.119	0.122	0.125	0.128	0.131	0.134	0.137
PBN-9903D	(65, 32, 4)	0.011	0.011	0.011	0.011	0.011	0.011	0.011
	Calibrated Value Multiplier	**0.25**	**0.5**	**0.75**	******	**1.25**	**1.5**	**1.75**

** Denotes Calibrated Model Value

Appendix D

Remedial Alternative Cost Summary

Alternative 1 Cost Summary
Groundwater Alternative Feasibility Study
Badger Army Ammunition Plant

Alternative	Item Description	Comments		Sub Totals	Total Costs
IRM/MIRM Treatment	**Engineering Design**	No design cost to implement alternative			$0
	Capital Cost	No capital cost to implement alternative			$0
	Annual O&M	- IRM/MIRM Operation	19 years of operation	$ 29,581,000	$76,911,000
		- Groundwater Monitoring	24 years of quarterly sampling; 455 tests from monitoring wells per year; 214 tests from private wells per year	$ 47,330,000	
	Monitoring and Closeout Plan/Report	Prepare final report that requests closure			$55,000
					$76,966,000

Notes:
Costs are based on current monitoring plans and engineering estimates.
IRM/MIRM - Interim Remedial Measures/Modified Interim Remedial Measures
O&M - Operations and Maintenance

Alternative 2 Cost Summary
Groundwater Alternative Feasibility Study
Badger Army Ammunition Plant

Alternative	Item Description	Comments		Sub Totals	Total Costs
In-Situ Biochemical Treatment	**Engineering Design**	Perform field pilot study and design treatment plan			$45,000
	Capital Cost	- Install and Abandon Temporary Wells	1,950 temporary wells installed to appropriate depth and horizontal spacing to treat contaminated groundwater	$ 27,100,000	$41,200,000
		- Inject CL-Out® Mixture	Mix CL-Out® with water and pump mixture into each well to force it into the groundwater aquifer	$ 14,100,000	
	Post-Treatment Monitoring	- IRM/MIRM Operation	5 years of operation to enhance treatment process	$ 6,000,000	$20,047,000
		- Groundwater Monitoring	20 years of sampling to evaluate treatment results and monitor contaminant reduction or stabilization; first 10 years of quarterly sampling: 455 tests from monitoring wells per year and 214 tests from private wells per year; the last 10 years of semiannual sampling: 130 tests from monitoring wells per year and 105 tests from private wells	$ 14,047,000	
	Monitoring and Closeout Plan/Report	Prepare final report that requests closure			$55,000
					$61,347,000

Notes:
Costs are based on current monitoring plans and engineering estimates
IRM/MIRM - Interim Remedial Measures/Modified Interim Remedial Measures

Alternative 3 Cost Summary
Groundwater Alternative Feasibility Study
Badger Army Ammunition Plant

Alternative	Item Description	Comments		Sub Totals	Total Costs
Public Water System	**Engineering Design**	Prepare plans that can be used to construct the water system and oversee the installation of the wells, well houses, reservoir, and underground distribution piping			$2,900,000
	Capital Cost	- Distribution Piping	Install water mains, hydrants, and water laterals to homes, and abandon existing private wells in the proposed remedy area	$ 18,087,000	$24,746,000
		- Well Installation	Install and test 2 high capacity drinking water wells into the sandstone	$ 472,000	
		- Building Construction	Construct 2 well houses and a treatment/administration building	$ 5,446,000	
		- Reservoir	Construct an elevated water reservoir with a capacity of 75,000 gallons	$ 655,000	
		- Equipment	Provide equipment to operate and maintain the water system	$ 86,000	
	Annual O&M	- Water System Operation	5 years of operation	$ 445,000	$12,218,000
		- IRM/MIRM Operation	4 years of operation	$ 4,800,000	
		- Groundwater Monitoring	20 years of sampling to monitor contaminant reduction or stabilization; first 4 years of quarterly sampling: 455 tests from monitoring wells per year and 214 tests from private wells per year; the next 5 years of semiannual sampling: 240 tests from monitoring wells per year and no testing of private wells per year; the last 10 years of semiannual sampling: 110 tests from monitoring wells per year and no testing of private wells per year	$ 6,973,000	
	Monitoring and Closeout Plan/Report	Prepare final report that requests closure			$55,000
					$39,919,000

Notes:
Costs are based on current monitoring plans and engineering estimates.
IRM/MIRM - Interim Remedial Measures/Modified Interim Remedial Measures
O&M - Operations and Maintenance