FINAL

WORK PLAN
FOR THE FORT DRUM PCE REMEDIAL INVESTIGATION
FOR SOLVENT CONTAMINANTS
FORT DRUM, NEW YORK

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Acronyms and Abbreviations

bgs	Below Ground Surface
BTEX	Benzene, Toluene, Ethylbenzene, Xylene
CENAB	United States Corps of Engineers Baltimore District
CFR	Code of Federal Regulations
COPC	Contaminant of Potential Concern
COPEC	Contaminant of Potential Ecological Concern
CRP	Community Relations Plan
CSC	Chlorinated Solvent Compound
CSM	Conceptual Site Model
COC	Chain of Custody
DPT	Direct Push Technology
DNAPL	Dense Non-Aqueous Phase Liquid
ERA	Ecological Risk Assessment
EPC	Exposure Point Concentration
FS	Feasibility Study
FSP	Field Sampling Plan
ft/day	Feet per day
gpm	Gallons per minute
HASP	Health and Safety Plan
HDPE	High Density Polyethylene
HHRA	Human Health Risk Assessment
HRS	Hazard Ranking System Score
HSC	Health and Safety Coordinator
HSO	Health and Safety Officer
IDW	Investigation Derived Waste
LQAM	Laboratory Quality Assurance Manager
MNA	Monitored Natural Attenuation
MPE	Multi-Phase Extraction
NAPL	Non-Aqueous Phase Liquid
NYSDEC	New York State Department of Environmental Conservation

OSHA	Occupational Safety and Health Administration
OSL	Old Sanitary Landfill
PARS	PARS Environmental, Inc.
PCE	Tetrachloroethene
PID	Photoionization Detector
Plexus	Plexus Scientific Corporation
PM	Project Manger
POC	Point of Contact
POL	Petroleum, Oil, Lubricant
PPE	Personal Protection Equipment
PVC	Polyvinyl Chloride
QAPP	Quality Assurance Project Plan
QA/QC	Quality Assurance/Quality Control
RAGS	Risk Assessment Guidance for Superfund
RI	Remedial Investigation
SAP	Sample and Analysis Plan
SLERA	Screening-Level Ecological Risk Assessment
SOP	Standard Operating Procedure
SOW	Scope of Work
SWIM	Surface Water Interface Monitoring
TAT	Turnaround Time
TBD	To Be Determined
TCLP	Toxicity Characteristic Leaching Procedure
TOC	Total Organic Carbon
TRV	Toxicity Reference Values
USAEC	United States Army Environmental Command
USEPA	United States Environmental Protection Agency
UST	Underground Storage Tank
VOC	Volatile Organic Compound

1.0 INTRODUCTION

The U.S. Army Corps of Engineers Baltimore District (CENAB) has selected PARS Environmental, Inc. (PARS) to provide the required personnel, materials, and services to perform a remedial investigation (RI) near Area 3805, hereafter referred to as the Gasoline Alley Areas 1800, 1900, and 3800, located at the Fort Drum Military Installation in Fort Drum, New York. PARS subcontracted Plexus Scientific Corporation (Plexus) to assist with the completion of the CENAB Scope of Work (SOW) dated 10 May 2010. This work will be performed under the Contract No.W912DR-10-R-0099, Delivery Order No. 0001.

The Gasoline Alley Areas 1800, 1900, and 3800 encompasses existing sites Areas 1995, 3805, and the Old Sanitary Landfill (OSL) (Refer to **Figure 1-1**). Dissolved-phase tetrachloroethene (PCE) contamination was discovered during sampling for the Area 3805 investigation and clean-up conducted separately from this RI. A historical review to determine potential sources of chlorinated solvent compounds (CSCs) was conducted in 2009 (Plexus, 2009). The purpose of the RI is to investigate the nature and extent of CSCs (primarily PCE) in the Gasoline Alley Areas 1800, 1900, and 3800.

1.1 Background

1.1.1 Site Description and History

Fort Drum Military Reservation is located in upstate New York approximately 10 miles northeast of Watertown, 80 miles north of Syracuse, and 25 miles southeast of the U.S./Canadian border (refer to **Figure 1-2**). Fort Drum occupies a large portion of northeastern Jefferson County and a portion of western Lewis County. The Reservation encompasses approximately 168 square miles. Fort Drum was established in 1906 as a National Guard training facility. During World War II, the Reservation functioned as an operations base and firing range and provided combat skills training facilities for the 45th Infantry Division and the 4th and 5th Armored Divisions. Additionally, the Reservation conducted small amounts of explosive ordnance disposal. Currently, Fort Drum is the operations headquarters for the 10th Mountain Division (Light Infantry). The Reservation also supports training facilities and services for the US Army National Guard.

Gasoline Alley has been used for fuel storage and dispensing at least since the 1940s when Fort Drum was expanded. Nine fuel dispensing areas were located along Gasoline Alley where kerosene, gasoline, diesel fuel and JP-4 were stored and dispensed from 22 underground storage tanks (USTs) ranging in capacity size from 5,000 to 25,000 gallons. The dispensing areas are referred to as Areas 1195, 1295, 1395, 1495, 1595, 1795, 1895, 1995, and 3805. The USTs, fuel dispensers, and associated piping were removed in 1994 and 1995.

The OSL is an approximately 50-acre closed landfill consisting of 2 cells located on the north side of New York Route 26. Both cells are capped with synthetic covers. The geosynthetic cap for Cell 2 was installed in the summer of 2008. Leachate from the OSL commingles with the dissolved phase fuel constituent plume originating at Area 3805 and discharges to the OSL creek via seeps in the face of the ravine on the north side of the OSL. The primary contaminants in the leachate are benzene, toluene, ethylbenzene, and xylene (BTEX).

The study area includes Areas 1700, 1800, 1900, and 3800; Buildings 1750, 1800, 1943, and 3828; the OSL; and the streams north and northeast of the OSL Refer to **Figure 1-3** for the preliminary boundaries of the study area. The final boundaries will ultimately be dictated by the findings of the RI.

The current source of CSC contamination in the study area is largely unknown, due to the lack of characterization of the deep portion of the unconfined unconsolidated aquifer. Prior to this work plan, a paper study was conducted on the historical data available (Plexus 2009) that highlighted potential source areas for the observed CSC distribution upgradient of Area 3805. The purpose of this RI study is to evaluate the source and characterize CSCs that are currently observed within the study area.

1.2 Project Objectives

The purpose of the Gasoline Alley Areas 1800, 1900, and 3800 RI is to investigate the nature and extent of the CSCs (primarily PCE) within the study area. Based on the results of the RI, remedial alternatives will be evaluated to address the extent of CSC contamination in the Gasoline Alley Areas 1800, 1900, and 3800.

The objectives of the Gasoline Alley Areas 1800, 1900, and 3800 RI are:

- Fully delineate the dissolved phase chlorinated contaminant plume;
- Investigate the impact of CSCs to the bedrock aquifer;
- Investigate and delineate the source area(s) for the chlorinated contaminant plume;
- Evaluate geologic and hydrogeologic properties of the impacted area;
- Assess ecological and human health risks;
- Develop a thorough conceptual site model (CSM); and
- Evaluate potential remedial technologies.

Initial site investigation tasks will be completed and, based on the results, optional tasks may be triggered. The optional tasks will be addressed as a work plan addendum if necessary.

1.2.1 Project Field Approach

The RI will be completed in a phased approach. Refer to Section 3.0 for a detailed discussion of the phased field approach. Between each of the first three phases of the RI, the project team will meet via teleconference to discuss the results and to determine the direction of the field investigation. We expect that each phase of work will require 10 days to complete.

In order to fully characterize the CSC plume, a series of monitoring wells will be installed (refer to **Figure 1-4** and **Figure 1-5**). The monitoring wells will be installed in the overburden and bedrock aquifers. For the purpose of this work plan, wells installed in the unconsolidated aquifer will be referred to as shallow, intermediate, and deep monitoring wells and monitoring wells installed in the bedrock will be referred to as bedrock monitoring wells.

The first phase of work includes installation and sampling of one exploratory bedrock monitoring well and 11 deep monitoring wells within the study area to evaluate the impact of CSCs to the bedrock aquifer and the deep aquifer. The purpose of the exploratory boring is to assess the presence of CSCs in the bedrock aquifer. Boreholes completed during the first phase will be used to define a potential source area and to locate additional monitoring wells to delineate the CSCs.

The second phase of the RI will include deep offset boreholes to evaluate the limits of the CSC plume within the study area. The boreholes will also aid in refining the CSM.

The third phase of the RI will include shallow and intermediate monitoring well installation and sampling. The monitoring wells will be placed and screened based on results of phase 1 and 2 activities.

The fourth phase of the RI will include two rounds of monitoring well sampling. The selected monitoring wells will be sampled for volatile organic compounds (VOCs), including CSCs. Monitored natural attenuation (MNA) and microbial samples will also be collected from a select subset of monitoring wells to support the evaluation of potential remedial alternatives.

1.2.2 Project Tasks

This section provides a brief description of the tasks required to fulfill the SOW. Additionally, optional Tasks 7 through 12 are described below and can be triggered at any time during the RI.

1.2.2.1 Task 1: Project Planning

Task 1 of the SOW includes all planning documents required to complete the RI. The documents included are:

- Site Background Summary;
- Work Plan;
- Community Relations Plan (CRP);
- Sample and Analysis Plan (SAP) to include the Field Sampling Plan (FSP) and an updated version of the Fort Drum Quality Assurance Project Plan (QAPP); and
- Updated version of the Fort Drum Health and Safety Plan (HASP).

Also included in Task 1 is a site visit and meeting with the project team to discuss the RI activities.

1.2.2.2 Task 2: Field Investigation

Task 2 encompasses the field collection of data that will be used for decision-making. The field investigation includes drilling and installation of monitoring wells; soil, groundwater, surface water, sediment, and soil gas sampling; aquifer profiling; aquifer pump testing; and surveying. One exploratory borehole will be advanced into bedrock to assess the presence of PCE contamination in the bedrock aquifer (refer to **Figure 1-4**). A maximum of 21 deep, 18 intermediate and 10 shallow monitoring wells will be installed as part of Task 2. A maximum of five surface water, sediment, and surface water interface monitoring (SWIM) samples will be collected from the creek north of the OSL to evaluate the potential impact to the surface water body (refer to **Figure 1-5**). A maximum of eight soil gas samples will be collected from 3 to 5 feet below ground surface (bgs) to evaluate potential source areas and residual contamination within the vadose zone. The location of the soil gas samples will be determined based on data collected during the field activities.

1.2.2.3 Task 3: Sample Analysis/Validation

Task 3 includes the laboratory analysis and data validation for sampling activities during the RI. The task also includes the development of a data management system to ensure adequate data quality during the project. The data management system will include field logs, sample management and tracking procedures, and document and inventory control measures. The data management system will ensure the quality of the data is sufficient to conduct a Human Health Risk Assessment (HHRA), Ecological Risk Assessment (ERA), and feasibility study (FS).

Field and analytical data will be validated for accuracy. Analytical data validation of the samples collected will be performed by an independent validator. Field and analytical data validation will be completed using the procedures found in Section 9.2 of the Fort Drum QAPP (Plexus, 2010).

1.2.2.4 Task 4: Data Evaluation

Task 4 includes evaluating the data collected, revising the CSM, and using MODFLOW to analyze to fate and transport mechanisms of CSCs at the site. Results from the sampling activities, aquifer profiling, and aquifer pump and slug testing will be included in the model to revise the current CSM. If the optional tasks are completed (Refer to Section 1.3.7), the results will be integrated into the final model. Data will be reduced and summarized in the RI report using the procedures described in Section 9.1 of the Fort Drum QAPP (Plexus, 2010).

1.2.2.5 Task 5: Risk Assessment

Task 5 includes a Baseline HHRA and ERA for the Gasoline Alley Areas 1800, 1900, and 3800. The HHRA and ERA will assess the potential human health and ecological risks associated with the CSCs in the study site. The HHRA and ERA will include four components: contaminant identification, exposure assessment, toxicity assessment, and risk characterization. The HHRA and ERA will be submitted as an attachment to the RI report. Draft and Final versions of the

HHRA and ERA will be submitted and comments will be incorporated prior to the submittal of the Final version.

1.2.2.6 Task 6: Remedial Investigation Report

A Draft and Final Report will be prepared detailing the findings of the RI. The Final version of the RI Report will incorporate comments prior to submittal. The RI Report will include a summary of field activities, data management and analysis, an updated site CSM and fate and transport modeling results, and risk assessments. The RI Report will be produced once the required and optional tasks have been completed, as necessary.

1.2.2.7 Task 7 (Optional): Bedrock Investigation – Well Placement

A bedrock investigation will be triggered if site contamination is found in the bedrock aquifer. An additional 10 bedrock monitoring wells will be installed using the methods from Task 2. A maximum of 10 soil and four groundwater samples per bedrock monitoring well will be collected during drilling and analyzed for VOCs.

1.2.2.8 Task 8 (Optional): Source Area Investigation

Based on results from the data review and field investigation, a source area investigation may be initiated to determine sources of CSC contamination. A maximum of 10 soil borings, ground penetrating radar, and membrane interface probe profiles will be completed to delineate potential source areas.

1.2.2.9 Task 9 (Optional): 72-Hour Pump Test

A 72-hour aquifer pump test may be conducted based on the results of the field investigation. The aquifer pump test will be conducted to determine the interaction of the overburden and bedrock aquifers and to determine preferential flow patterns within the bedrock.

1.2.2.10 Task 10 (Optional): Bench Scale Studies

A maximum of three technologies (biological, enhanced reductive dechlorination, and chemical oxidation) may be evaluated for remedial suitability for the site. The bench scale studies will include removal efficiency testing, reduction kinetics testing, and subsequent stability testing and/or column testing. The results of the bench scale studies will be included in the RI Report.

1.2.2.11 Task 11 (Optional): Pilot Test

Based on the results of the bench scale study, the selected technology will be evaluated in a small scale in-situ pilot test. The pilot study will evaluate the site feasibility of the chosen bench scale study (biological, enhanced reductive dechlorination, or chemical oxidation). We assume that a maximum of two injection points and three monitoring locations will be installed to evaluate the pilot study. Upon completion of the pilot study, a summary and results of the pilot testing will be included in the RI Report.

1.2.2.12 Task 12 (Optional): Infrastructure Evaluation

Based on the results of the data review and field investigation, co-located indoor air and sub-slab vapor samples will be collected at a maximum of 12 locations. The samples will be collected to evaluate the vapor intrusion potential of the source areas to building occupants. Results of the infrastructure evaluation will be included in the RI Report.

1.3 Project Organization and Responsibilities

Project personnel responsibilities are summarized below. The overall project organization is illustrated in **Figure 1-6**.

1.3.1 PARS Key Personnel

The key PARS personnel and their responsibilities are:

Program Manager – Ms. Kiran Gill: The Program Manager is the representative with contract authority. The Program Manager is responsible for the commitment of the resources required for the project's needs.

Project Manager – Mr. John Mihalich: The Project Manager (PM) is accountable to the Program Manager throughout the duration of the project. PM responsibilities include:

- Coordination with United States Army Environmental Command (USAEC), Base personnel, and the CENAB;
- Budget control;
- Subcontractor performance; and
- Review of engineering and interim reports.

Health and Safety Officer – Paul Lawless CIH: The site HSO is responsible for ensuring the field activities are carried out in accordance with the HASP. The HSO will provide technical assistance to the PM and field personnel to help assure site safety. In addition, HSO responsibilities include:

- Monitoring field activities;
- Monitoring personnel exposure to chemical toxins;
- Development of emergency response procedures;
- Monitoring for temperature stress;
- Establishing personnel decontamination procedures; and
- Stopping work in the event unsafe work conditions are encountered.

1.3.2 Plexus Key Personnel

The key Plexus personnel and their responsibilities are:

Program Manager – Mr. Jeffrey Sgambato: The Program Manager is the representative with contract authority. The Program Manager is responsible for the commitment of the resources required for the project's needs.

Project QA/QC Officer – Ms. Heather Sewell: The Project Quality Assurance/Quality Control (QA/QC) Officer provides guidance on technical matters and reviews all technical documents relating to the project. The QA/QC Officer has the responsibility to assess the effectiveness of the QA/QC program, and to recommend modifications to the program when applicable. The QA/QC Officer may delegate technical guidance to specially trained individuals under their direction.

Project Manager – Mr. Gregory Kendall: The PM is accountable to the Program Manager throughout the duration of the project. PM responsibilities include:

- Coordination with PARS and other project team members;
- Budget control;
- Subcontractor performance;
- Project coordination to implement work plans;
- Allocation of resources and staffing to implement the QA/QC program;
- Allocation of resources and staffing to implement the HASP; and
- Review of engineering and interim reports.

Task Manager – Mr. Walter Gee: The Task Manager is accountable to the PM throughout the duration of the project. Task Manager responsibilities include:

- Developing the field program to meet the project objectives.
- Acting as the day-to-day liaison between technical project team and the PM.
- Tracking task costs and schedule.
- Notifying the PM of field changes that may affect the quantity or quality of generated data or costs.
- Reviewing data (including logbooks, chemical data, etc.), to ensure completeness and attainment of data quality objectives.

Project QA/QC Coordinator – Ms. Heather Sewell: The Project QA/QC Coordinator is responsible for project-specific supervision and monitoring of the QA/QC program. These responsibilities include:

- Ensuring field personnel are familiar with and adhere to proper sampling procedures, field measurement techniques, and sample identification, and chain-of-custody procedures;
- Ensuring that updates to the QAPP are distributed;

- Coordination with the analytical laboratory for the receipt of samples, the reporting of analytical results, and recommending corrective actions to correct deficiencies in the analytical protocol or sampling; and
- Preparation of QA reports for management.

Site Manager – Mr. Walter Gee: The Site Manager serves as the on-site contact person for field investigations and tests. The Site Manager is responsible for the logistics of the field activities. Site Manager responsibilities include:

- Inspection and replacement of equipment;
- Preparation of daily and interim reports;
- Preparation of samples for shipment;
- Coordination of field activities; and
- Scheduling sampling and other field activities.

Project Health and Safety Coordinator – Ms. Margaret Mikulich: The Project Health and Safety Coordinator (HSC) will serve as advisor to the PM and Task Manager in matters regarding daily implementation of site health and safety. The Project HSC will have the following responsibilities:

- Interface with the PM and Task Manager about project health and safety-related issues.
- Develop the HASP and site-specific addendums to the HASP.
- Develop new or revised health and safety protocols for site activities.
- In conjunction with the Task Manager and Health and Safety Officer (HSO), ensure all site activities are performed in a manner consistent with this HASP, site-specific addendums, and the Plexus Corporate Health and Safety Program.
- Confirm all Plexus personnel and subcontractors designated to work on this project are qualified for their job assignment in accordance with Occupational Safety and Health Administration (OSHA) 29 Code of Federal Regulations (CFR) 1910.120 training and medical surveillance requirements.
- Recommend personnel disciplinary actions to the PM for health and safety violations.
- Stop site activities if an imminently dangerous situation exists. The emergency situation will be reviewed immediately with the PM.
- Report all incidents, accidents, and near-misses to the Plexus PM.

Laboratory Quality Assurance Manager (Marie Meidhof): The Laboratory Quality Assurance Manager (LQAM) provides technical direction to, and supervision of the QA program within the laboratory. These responsibilities include:

- Monitoring effectiveness of the laboratory QA Program;
- Ensuring maintenance, implementation, and updating of laboratory Standard Operating Procedures (SOPs) and records;

- Performing regular internal facility audits and periodic external (subcontractor) audits;
- Overseeing programs designed to ensure adequate standard traceability, sample chain-of-custody, and corrective action(s);
- Providing regular reports to management addressing the laboratory QA Program status and laboratory certification status;
- Ensuring proper laboratory personnel training; and
- Serving as liaison for the laboratory to federal and state agencies on QA-related issues.

Laboratory Sample Custodian (To Be Determined (TBD)): The Sample Custodian is responsible for the preparation of sample containers and the receipt of collected samples. Sample custodian duties include:

- Preparation of sample containers for shipping to sample collection sites and coordination of shipping/receiving of samples and containers.
- Receiving samples into the laboratory and logging the samples through the laboratory tracking system.
- Tracking samples through analysis, storage, and disposal.

1.3.3 Subcontractors

In order to complete the RI activities, subcontractors must be utilized. The following subcontractors will be used during the Fort Drum RI for Solvent Contaminants:

• Subconsultant	Plexus Scientific Corporation
• Drilling Operations	Boart Longyear
• Analytical Services	Accutest Laboratories
• Waste Transport and Disposal	Eastern Environmental Technologies, Inc.
• Direct Push Services	Zebra Environmental, Inc.
• Data Validation Services	Environmental Data Quality, Inc.
• HHRA and ERA	Avatar Environmental
• Fate and Transport Modeling	GeoTrans, Inc.

1.4 Report Organization

The Work Plan is organized in the following sections:

Section 1: Introduction

Section 2: Summary of Existing Information

Section 3: Phased Field Investigation Approach

Section 4: Project Methodology

Section 5: Human Health and Ecological Risk Assessment and Fate and Transport Model

Section 6: Project Schedules and Deliverables

Section 7: References

PARS ENVIRONMENTAL INC.

2.0 SUMMARY OF EXISTING INFORMATION

2.1 Previous Investigations

The nature and extent of the PCE Contamination Area has yet to be investigated. The information on CSCs generated to date is largely from the investigation and remediation activities of a co-located LNAPL and BTEX site (Areas 1995 and 3805). The focus of the petroleum sites at Area 1995 and 3805 have been in the shallow portion of the surficial aquifer. No regulatory or response actions for CSCs have occurred at the site.

During the investigation of the co-located BTEX site, PCE has been sampled frequently and detected in shallow, intermediate and deep wells since 1995. Time series data of historical PCE is presented in graphical form in **Appendix A**. Detection of historical PCE in the study area show decreasing, increasing and static data trends. The highest recorded concentration of PCE was 2700 µg/L detected in 1999 at 3805-MWI9.

2.2 Geologic Setting

The following section discusses the geologic setting at the Fort Drum Military Reservation. A plume based on the groundwater data collected in Fall 2009 is presented in **Figure 2-1,** which includes a plan view of a geologic cross-section through the study area. The geologic cross-section of the Gasoline Alley Areas 1800, 1900, and 3800 is shown in **Figure 2-2**.

2.2.1 Surficial Geology

The stratigraphic unit present at the ground surface is comprised of unconsolidated, Pleistocene-age, glacially-derived deltaic deposits. These surface deposits are referred to as the Pine Plains Delta. The Pine Plains Delta complex is bordered on the northwest and south by previously deposited till and ground moraine, and on the east by a metamorphic-igneous bedrock complex (EA, 2000).

The upper portions of the delta are characterized by fine- to medium-grained deltaic sands. The lower portions of the delta are generally finer-grained sands with silt and clay content increasing with depth. The deltaic sands are underlain by stratified Pleistocene-age lacustrine deposits of silt and silty clay. These deposits were formed when the ancestral Black River deposited its sediment load into glacial Lake Iroquois during the Wisconsin glaciation. The coarser fraction of the sediment load settled out first to form the delta. Fine clay and silt particles were carried out further into the lake to form the lake-bottom or lacustrine deposits which lie directly atop submerged till or bedrock. A smaller delta was formed by meltwater streams in the vicinity of Natural Bridge during an earlier lake stage and merged with the Pine Plains delta to form a relatively homogenous continuous sand unit which covers much of the southern part of the base (Reynolds, 1986).

The sand delta deposits range in thickness from less than 10 feet along the boundary of the delta to a maximum thickness of about 120 feet near Wheeler Sack Air Field. This thickening is due to an east-west trending bedrock channel just north of the Black River. This valley, in which the limestone units of the Black River Group have been eroded, is probably a former drainage channel of the Black River (Reynolds, 1986).

Based on historical data, the site specific distribution of the deltaic deposits is anticipated to range from 70 to 90 feet bgs that overlie lacustrine deposits from 80 to 110 feet bgs. In some areas, a thin layer of till may be present beneath the lacustrine deposits. The low permeability of the till and clay units creates locally perched groundwater conditions resulting in many swamps, particularly in the northern and eastern part of Fort Drum (EA, 2000).

At the site, these deltaic deposits comprise of two layers of sand and silty sand where heterogeneity is largely controlled by the level of silt content. Generally, the upper portion of the surficial aquifer has a lower silt content than the lower portion, and this is further supported from aquifer hydraulic testing.

2.2.2 Bedrock Geology

Bedrock layers underlie the Pleistocene-age lacustrine deposits. The bedrock units consist of the Cambrian-age Potsdam Sandstone and Theresa Formation (calcareous sandstones and dolomites) and the Ordovician-age Black River Group (carbonates). The sedimentary rocks are underlain by Precambrian-age metamorphic and igneous rocks (Reynolds, 1986).

The oldest and lowermost sedimentary rocks belong to the Cambrian-age Potsdam Sandstone. The Potsdam Sandstone generally consists of tan to white, well sorted sand with siliceous and calcareous cementation. Locally, some of the basal sandstone beds are red from hematite or green from chlorite cementation, and beds of coarse conglomerate are present in some areas. The thickness of Potsdam Sandstone at Fort Drum is estimated to be from 15 to 25 feet (Buddington, 1934).

The Cambrian-age Theresa Formation overlies the Potsdam Sandstone and consists primarily of hard, bluish gray, thinly bedded sandy dolomite with calcareous sandstone layers dominant in the basal part. The upper beds of the formation vary in composition, ranging from calcareous and dolomitic sandstones to sandy dolomite (Johnson, 1971). The thickness of this formation at Fort Drum has been shown to be up to 100 feet. Both the Potsdam Sandstone and Theresa Formation probably underlie most of the Pine Plains delta complex, except for the southeastern and northeastern parts of Fort Drum (Reynolds, 1986).

Overlying the Potsdam Sandstone and Theresa Formation are the Ordovician-age carbonate units of the Black River Group, consisting of the Pamelia, Lowville, and Chaumont Formations, from bottom to top. The Pamelia Formation consists of dolomite with some gray limestone interbeds and basal quartz sand (Johnson, 1971). The Lowville Formation consists of medium-gray, fossiliferous, thick to thinly bedded limestone with shale partings. The Chaumont Formation consists of massive, gray, finely textured, cherty limestone containing abundant fossils.

The Ordovician-age Black River Group has been reported at a thickness of 140 feet in the vicinity of the Black River south of the cantonment area (Reynolds, 1986). In the vicinity of the OSL, where three monitoring wells have been installed in bedrock, the limestone unit was encountered between 100 and 108 feet bgs. Bedrock was encountered at production well FD2 at a depth of 70 feet bgs (EA, 2000).

Within the study area, it is anticipated that the carbonates of the Black River Group will represent the bedrock unit beneath the Pleistocene lacustrine deposits. Current borings at the site show the contact between these two units to range from 100 to 110 feet bgs; however, a high level of variability in elevation of this contact is expected due to the presence of erosional features such as palaeochannels.

2.3 Hydrology

This section describes the hydrology of the shallow and bedrock aquifers at the Fort Drum Military Reservation.

2.3.1 Shallow Aquifer

The surficial, unconfined aquifer at Fort Drum is comprised of the upper portions of the Pine Plains Delta. The aquifer consists of unconsolidated pro-glacial deltaic deposits characterized by fine to medium-grained sand. The aquifer covers the southern one-third of Fort Drum. The sediments in the study area consist of sand and silty sand grading to silt which forms the base of the surficial aquifer. Groundwater from the aquifer discharges into smaller streams that drain northwestward into the Indian River drainage basin.

Depth to the water table at the site ranges from approximately 13 to 18 feet bgs. A potentiometric contour map of the surficial aquifer for Areas 1895/1995/3805 is illustrated in **Figure 2-3**. The potentiometric contours of the surficial aquifer show that the general direction of groundwater flow at the site is to the north and northeast toward the stream that runs between the two cells and along the eastern boundary of the OSL. From review of groundwater elevations within clustered well sets, horizontal flow is dominant in the surficial aquifer; however, there is also a slight downward component to the flow direction across the Gasoline Alley PCE Contamination study area. The Pine Plains Delta aquifer is recharged mainly by snow melt and precipitation. Recharge is low in summer and usually increases in the fall as evapotranspiration is diminished. Generally, recharge deceases in midwinter when precipitation changes over to snow.

The surficial aquifer comprises of two sub layers of sand and silty sand where heterogeneity is largely controlled by the level silt content. From a series of slug tests, geotechnical sampling and aquifer pump tests performed at the site, hydraulic conductivity values range from 0.01 feet per day (ft/day) in the silt layer which forms the aquitard at the base of the surficial aquifer to 21 ft/day in the upper portion of the surficial aquifer. The specific ranges are as follows (USACE, 1997):

- Upper surficial aquifer - 1 to 21 ft/day
- Lower surficial aquifer - 1.05 ft/day
- Aquitard silt layer - 0.01 ft/day

The water quality parameters collected during multiple groundwater sampling events typically exhibit dissolved oxygen and oxygen reduction potential values indicative of aerobic conditions. The ideal conditions for biodegradation (reductive dechlorination) of PCE are anaerobic. This is further supported by the apparent absence of reductive dechlorination daughter constituents.

2.3.2 Bedrock Aquifer

A confined bedrock aquifer containing two major production zones is present at Fort Drum. The upper production zone is comprised of the Ordovician-age Black River Group of limestones and dolomites. This unit is approximately 140 feet thick in the vicinity of the Black River south of the original cantonment area (Reynolds, 1986) and is the unit present beneath Gasoline Alley. This aquifer transmits water in joints, bedding planes, solution cavities, and vertical fractures due to faulting (Waller and Ayer, 1975). Wells completed in the Pamelia and Lowville Formations of the Black River Group have yields of approximately 300 gallons per minute (gpm) (Reynolds, 1986).

The lower production zone is comprised of the Cambrian-age Potsdam Sandstone and overlying Theresa Formation, where present. It consists of fractured and poorly cemented sandstones and sandy dolomites. Little is known about the thickness of the zone in the original cantonment area. Within the Installation, approximately four miles south of Antwerp, the Theresa Formation is up to approximately 100 feet thick, but southeast of the Installation at Herrings, this formation and the underlying Potsdam Sandstone are both absent (Buddington, 1934). The Theresa Formation and Potsdam Sandstone are the primary source of ground water for the Post and probably underlie the Black River Group bedrock aquifer in the area of Gasoline Alley.

Bedrock production wells FD-2 and FD-3 are located approximately 1,900 and 2,300 feet north-northeast of Area 3805 (approximately 200 to 300 feet east of Cell 2 of the OSL). These wells are screened in the sandstone bedrock. Yields from production wells screened in the sandstone bedrock production zone range from 150 to 475 gpm (Reynolds, 1986).

Analysis of groundwater elevations from shallow and bedrock monitoring and production wells in the area shows that the elevation of the water-table aquifer is higher than the bedrock potentiometric surface, indicating a downward groundwater flow gradient. Aquifer tests of bedrock wells near Wheeler Sack Airfield, approximately one mile west of the site, indicated that the bedrock limestone aquifer is at least partially hydraulically connected to the unconsolidated aquifer (Reynolds, 1986). However, the Pleistocene lacustrine deposits of silt and silty clay noted throughout the area may restrict recharge flow in many areas. A dry silt layer was reported during the installation of 3805-MWS19/-MWI20, located north of the OSL (EA, 2000).

3.0 PHASED FIELD INVESTIGATION APPROACH

This section describes the detailed approach that will be implemented during the RI field activities. Each of the first four phases of the field investigation is scheduled to be completed in 10 day shifts. Refer to **Table 3-1** for a chronology of field activities. Each phase of work is described in detail in the following subsections.

After each phase of work, the project team will meet via teleconference to discuss the results of the RI and provide direction for the remainder of the field investigation. Specific details for each activity performed in the field investigation are described in Section 4.0.

3.1 Phase 1 Field Activities

During the first phase of the RI, one exploratory borehole and 11 deep boreholes will be advanced. The exploratory borehole will be drilled adjacent to the monitoring well 3805-PZ2 cluster. Refer to **Figure 3-1** for the flow diagram illustrating the logic flow path that will be used during the completion of the exploratory borehole and **Figure 1-4** for the locations of the initial monitoring wells. The location for the exploratory borehole was chosen based on monitoring well 3805-PZ2 cluster having the highest concentration of PCE during the Fall 2009 Basewide Sampling Event. Continuous soil cores will be collected to provide visual observation of the lithology. The soil cores will be logged based on the procedures described in Section 5.5.6 of the Fort Drum QAPP (Plexus, 2010).

During drilling, boreholes will be double-cased to prevent cross-contamination. It is expected that petroleum hydrocarbons will be encountered in the shallow and intermediate portions of the aquifer. An override isolation casing will be advanced into the upper contact of the bedrock for the bedrock borings, and then a doubled cased hole will be advanced inside the isolation casing.

If Dense Non-Aqueous Phase Liquid (DNAPL) is encountered during the exploratory borehole drilling, the borehole will not be advanced deeper than the silt/clay confining unit at the base of the surficial aquifer. If DNAPL is observed in the exploratory boring, an alternate location will be selected to complete the Phase 1 bedrock boring. Potential DNAPL will be identified using a color changing hydrophobic dye field testing kit. Procedures to identify DNAPL are found in Section 5.8.8 of the Fort Drum QAPP (Plexus, 2010). If DNAPL is not encountered, the borehole will be advanced into the first water bearing unit in bedrock. The target depth of the bedrock monitoring well is approximately 130 feet bgs. The actual final depth will be dependent upon bedrock fracture profiles and the unit's water bearing zones. A discrete groundwater sample will be collected using the Isoflow System™ and submitted to the laboratory for expedited analysis (refer to **Figure 3-2** for a schematic of the Isoflow System™). Discrete groundwater samples will be analyzed for VOCs using United States Environmental Protection Agency (USEPA) Method 8260B. If the concentrations of VOCs in the groundwater samples from the bedrock aquifer are below the New York State Department of Environmental Conservation (NYSDEC) groundwater quality standards for PCE and its breakdown products, the borehole will be grouted to the base of the surficial aquifer and a monitoring well will be installed. If contamination exceeds the NYSDEC criteria, a 2-inch, schedule 40 monitoring well will be installed in bedrock using the procedures found in Section 5.4.1 of the Fort Drum QAPP (Plexus, 2010).

Soil and groundwater samples will be collected from deep boreholes during drilling to determine the vertical extent of contamination and location of both intermediate and shallow monitoring well screens. The installation of shallow and intermediate monitoring wells will be conducted under Phase 3 of the field investigation. Discrete soil and groundwater samples will not be collected from shallow and intermediate boreholes. A maximum of 10 soil and four groundwater samples will be collected from each deep borehole. Discrete soil samples will be collected from each 10-foot core generated. The soil sample will be chosen using photoionization detector (PID) reading, visual observations, odor, and professional judgment. Soil samples will be collected using TerraCore™ samplers based on the procedures found in Section 5.8.5 of the Fort Drum QAPP (Plexus, 2010). The soil samples will be placed on ice in an insulated cooler under strict chain of custody procedures. Soil samples will be submitted to the laboratory for expedited analysis on a daily basis.

Discrete groundwater samples will be collected through the rotosonic drill rods using the Push-Ahead™ Sampler from the surficial aquifer and the Isoflow System™ in bedrock. Refer to **Figure 3-3** for a flow chart describing the discrete groundwater sampling process. Discrete groundwater samples will be collected at specified sample intervals (20, 40, 60, and 90 feet bgs) unless an immediately adjacent monitoring well is screened across the specified sample interval and the monitoring well has been sampled during Fall 2009 or Spring 2010. Deep boreholes will be completed into the base of the surficial aquifer.

Eleven initial deep borehole locations have been determined based on the Fall 2009 sampling event. The initial borehole locations were chosen to address data gaps in the PCE plume. Once drilling activities commence, the investigation will be driven by the results of the analytical and lithologic data generated as part of the RI. Soil cores will be collected in 10 foot intervals during drilling. The soil cores generated during deep drilling will be logged using the procedures found in Section 5.5.6 of the Fort Drum QAPP (Plexus, 2010).

A 4-inch, schedule 40 polyvinyl chloride (PVC) monitoring well will be completed to the base of the surficial aquifer to screen the deep aquifer for contaminants. The 4-inch monitoring well will allow passage for aquifer testing equipment. The aquifer test is described in detail in Section 4.1.7 and will be conducted during Phase 3 of the RI. The remainder of the boreholes will be completed as 2-inch, schedule 40 monitoring wells.

Upon completion of Phase 1 of the field investigation, data collected will be compiled and shared with the project team. A meeting via teleconference will be conducted to discuss the results of Phase 1 and to direct the remainder of the field investigation. Results of the discrete soil and groundwater sampling from the deep boreholes will be used to determine the location of offset monitoring well locations and to determine the screened intervals for shallow and intermediate monitoring wells.

Investigation derived waste (IDW) will be containerized onsite. Water generated from site activities (well development, equipment decontamination, etc.) will be collected into storage tanks and treated using the onsite air stripper. Soil will be containerized in roll-off boxes and disposed of at an offsite location. Toxicity characteristic leaching procedure (TCLP) analysis will be completed prior to disposal of soil waste.

3.2 Phase 2 Field Activities

Results of Phase 1 of monitoring well installation will determine offset locations of additional monitoring wells. A maximum of 10 offset monitoring well clusters (shallow, intermediate, and deep monitoring wells) will be installed to further delineate the PCE plume. Discrete soil and groundwater samples will not be collected from shallow and intermediate boreholes. Preliminary offset boreholes have been located in advance to expedite the dig permit process. The offset boreholes will be based on the data generated from the initial boreholes; not all boreholes may be installed and some boreholes may be relocated to better define the contaminant plume.

Once the analytical data is received, the offset boreholes will be advanced to further define the CSC plume and address data gaps. The offset borehole locations will be driven by data analysis and will be focused on delineating the plume laterally. Once discrete groundwater sample results are at or below regulatory standards for PCE and its breakdown products, the aerial extent will be considered delineated. Refer to **Table 3-2** for USEPA and NYSDEC regulatory standards for groundwater. Once the outer edge of the CSC groundwater plume has been defined, remaining boreholes may be advanced to locate potential source areas and refine the plume’s shape and flow direction.

A maximum of 10 deep, intermediate, and shallow monitoring well clusters will be completed at offset locations. Proposed offset locations are shown in **Figure 1-5**. Screened intervals for the deep, intermediate, and shallow monitoring wells will be determined based on results from groundwater and soil samples and vertical aquifer profiling completed during the deep monitoring well drilling.

Upon completion of Phase 2 of the field investigation, data collected will be compiled and shared with the project team. A meeting via teleconference will be conducted to discuss the results of Phases 1 and 2 and to direct the remainder of the field investigation. Results of the discrete soil and groundwater sampling from the deep boreholes will be used to determine offset monitoring well locations and to determine the screened intervals for shallow and intermediate monitoring wells.

3.3 Phase 3 Field Activities

During Phase 3 of the field investigation, the remaining shallow and intermediate monitoring wells will be installed. Slug testing will be conducted in a maximum of four intermediate and four deep monitoring wells to determine the hydraulic properties of the surficial aquifer. Slug testing will be completed using the procedures found in Section 5.8.6 of the Fort Drum QAPP (Plexus, 2010).

An 8-hour aquifer pumping test will also be completed. The aquifer test will be conducted in the deep, 4-inch monitoring well installed during Phase 1. The aquifer pumping test will be conducted using the procedures found in Section 5.8.7 of the Fort Drum QAPP (Plexus, 2010). Data collected from the aquifer testing will be incorporated into the fate and transport model. Water produced from the aquifer testing will be treated as IDW, containerized, and disposed of at the onsite air stripper.

Five surface water, sediment, and SWIM samples will be collected to determine the impact of CSCs to surface water bodies. Proposed surface water, sediment, and SWIM sample locations are shown in **Figure 1-4**. Surface water samples will be collected using the procedures found in Section 5.7 of the Fort Drum QAPP (Plexus, 2010). Sediment samples will be collected using the procedures found in Section 5.6 of the Fort Drum QAPP (Plexus, 2010). SWIM samples will be collected using the procedures found in Section 5.7.3 of the Fort Drum QAPP (Plexus, 2010). Surface water, sediment, and SWIM samples will be submitted to the laboratory and analyzed for VOCs using USEPA Method 8260B.

A maximum of eight soil gas samples will be collected from three potential source area buildings. The locations of the soil gas samples will be determined based on the results of the groundwater investigation. Samples will be collected using direct push technology (DPT) at 3 to 5 feet bgs into laboratory provided six liter Summa® canisters. The soil gas samples will be analyzed for VOCs using USEPA Method TO15. The soil gas samples will be collected using the procedures found in Section 5.3 in the Fort Drum QAPP (Plexus, 2010). A detailed site survey will be completed during the field investigation. Monitoring wells and additional features such as subsurface infrastructure will be surveyed using a licensed surveyor.

3.4 Phase 4 Field Activities

Two rounds of groundwater samples (up to 130 total samples) will be collected from the newly-installed and existing monitoring wells. The groundwater samples will be collected using low-flow methodology and analyzed for VOCs. Selected groundwater samples will be analyzed for MNA parameters and microbial populations. The USEPA Region II document, "Groundwater Sampling Procedure, Low Stress (Low Flow) Purging and Sampling" (March 1998), will be used as a guidance document during groundwater purging and sampling (located in Appendix F of the Fort Drum QAPP (Plexus, 2010)). Low-flow groundwater sampling procedures can be found in Section 5.4.4 of the Fort Drum QAPP (Plexus, 2010).

4.0 PROJECT METHODOLOGY

This section describes the tasks that will be completed for the Fort Drum RI for Solvent Contaminants.

4.1 Field Investigation Tasks

The objectives of the RI will be completed primarily by field investigation. The field investigation will include: mobilization to and from the site; utility clearance; rotosonic drilling; aquifer profiling; monitoring well installation; soil, groundwater, soil gas, sediment, and surface water sampling; aquifer testing; and surveying. The individual tasks are described in the following sections.

4.1.1 Mobilization

Fieldwork for the RI will be conducted in multiple phases. Activities such as badging, vehicle registration, and utility clearance will be coordinated with the Fort Drum point of contact (POC). The POC will assist in locating equipment staging areas and a water supply for drilling operations.

4.1.2 Utility Clearance

During RI activities, site utilities will be cleared during intrusive operations. To begin the field investigation, dig permits will be submitted for approval by Fort Drum representatives. The dig permits will outline the areas where proposed drilling activities may occur and allow the reservation to mark utilities. Once the dig permits have been approved, a vacuum excavator will be used to ensure utilities are not present at the drilling location. The vacuum excavator will knife to approximately six to 10 feet bgs. The borehole profile will not be logged to the bottom of the vacuum excavator hole. If utilities are encountered during vacuum excavation, the borehole will be relocated and the new borehole will follow the same procedure.

4.1.3 Drilling

The drilling portion of the RI will be completed in a phased approach using rotosonic drilling. Rotosonic drilling advances concentric hollow drill stems using rotation in conjunction with axial vibration of the drill stem. After each stage of drill stem advancement, the inner string is removed with a core of drill cuttings while the outer string remains to hold the borehole open. The cuttings can be removed nearly intact from the inner casing for examination of stratigraphy prior to disposal. Soil Core Log Forms will be used during drilling activities to record the necessary descriptions of the soil cores. The descriptions from the Soil Core Log Form will be transferred to a Borehole Log after drilling is complete. Example Soil Core Log Forms and Borehole Logs are found in **Appendix B**.

Override casing is advanced behind the core barrel to isolate the formation and prevent cross-contamination. The override casing is set a minimum of two feet into the confining unit between aquifers. Drilling fluids (typically potable water) is added to the drill string to remove the soil cuttings from the casing and return the cutting to the surface.

The rotosonic drilling technique allows for greater core recovery during drilling which aids in determining lithologic changes within the borehole. Rotosonic drilling also enhances the protection of the surficial and bedrock aquifers because the borehole is double-cased during drilling to prevent cross-contamination between shallow and deep zone. In addition, rotosonic drilling reduces the amount of IDW produced while greatly increasing the speed of drilling.

IDW will be containerized onsite. Water generated from site activities (drilling, well development, equipment decontamination, etc.) will be collected into storage tanks and treated using the onsite air stripper. Soil will be containerized in roll-off boxes and disposed of at an offsite location. TCLP analysis will be completed prior to disposal of soil waste.

4.1.4 Aquifer Profiling

Up to four groundwater samples from each deep borehole will be collected during drilling operations to define the contaminant zones within the aquifer. Two methods will be used to collect groundwater samples: Isoflow System™ and Push-Ahead System™. Refer to **Figure 3-2** for a schematic of the aquifer profiling systems. Both methods allow the collection of representative groundwater samples during drilling.

The Isoflow System™ method collects groundwater through a temporary well screen placed at the base of the drill string. The override casing is retracted to expose the screen to formation water. The isolated zone is purged via low flow methodology and a groundwater sample is collected once water quality stabilization parameters are achieved. The sampler is removed and the casing advances to the next sampling interval.

The Push-Ahead System™ method collects groundwater through a decontaminated and sealed sampler. The sampler is inserted into the borehole prior to reaching the sample interval (approximately 5 to 15 feet). The sampler is advanced using rotosonic drilling to the desired sample interval. Since the sampler is driven into the formation ahead of the drill string, groundwater is collected directly from the sampler rods without purging. The sampler is removed and the casing advances to the next sampling interval.

Groundwater samples collected during the aquifer profiling will be analyzed by USEPA Method 8260B. The samples will be submitted with an expedited (24-hour) turnaround time (TAT).

4.1.5 Discrete Soil and Groundwater Sampling

During drilling activities for the deep monitoring wells, up to 10 discrete soil samples and four discrete groundwater samples will be collected from the borehole. Soil and groundwater samples will be collected as follows:

- One soil sample will be collected from every 10 foot soil core. Soil samples will be collected if elevated PID readings are observed. In addition, soil samples will be selected using PID readings, odor and visual observation, and professional judgment. Soil samples will not be collected from the exploratory borehole until the silt/clay unit is encountered. Soil samples will be collected using TerraCore® samplers.

- Discrete groundwater samples will be collected at specified sample intervals (20, 40, 60, and 90 feet bgs). Groundwater samples will also be collected from the silt/clay unit and from bedrock (exploratory borehole only).
- Groundwater samples will be collected from each deep borehole using either the Isoflow System™ or Push-Ahead™ method. Each interval will be purged to ensure a representative formation groundwater sample is collected.
- Soil and groundwater samples will be submitted for laboratory analysis on an expedited (24 hour) TAT.

Soil and groundwater samples will be submitted to the laboratory and analyzed using USEPA Method 8260B. Soil samples will be collected using the procedures found in Section 5.8.5 in the Fort Drum QAPP (Plexus, 2010). Groundwater samples will be collected using the procedures found in Section 5.4.8 in the Fort Drum QAPP (Plexus, 2010).

4.1.6 Monitoring Well Installation

Monitoring wells will be installed at each borehole. Screened intervals will be chosen based on the soil and groundwater analytical results. One 4-inch deep monitoring well will be installed. The well design of the 4-inch well screen will be determined based on field data such as grain size distribution and hydraulic conductivity. The primary goal of the 4-inch well is to facilitate an eight-hour aquifer test. To make sure that the 4-inch well is suitable for high anticipated pumping rates (up to 35 gpm), screen length, screen slot size and filter pack material may need to be adjusted. The remaining monitoring wells will be installed using 2-inch schedule 40 PVC with a 10 foot 0.10-inch slotted screen. Each monitoring well will be finished with a two foot by two foot concrete pad with four protective bollards. Refer to **Figure 4-1** for an example of the monitoring well completion diagram. Monitoring wells will be completed using the procedures found in Section 5.4.1 of the Fort Drum QAPP (Plexus, 2010).

After completion of the monitoring well installation, each monitoring well will be developed using the procedures found in Section 5.4.2 of the Fort Drum QAPP (Plexus, 2010).

4.1.7 Aquifer Testing

Two aquifer testing methods will be used to determine hydraulic properties of the surficial aquifer. Slug testing and aquifer pump testing will be performed on newly-installed or existing monitoring wells. The methods are described below.

4.1.7.1 Slug Testing

Rising and falling head slug testing will be conducted on up to four intermediate and four deep monitoring wells. A rising and falling head slug test will be performed at each of the selected monitoring wells. Each test displaces a large amount of groundwater within the monitoring well and measures the time the formation re-equilibrates. Pressure transducers will be deployed in the monitoring wells prior to conducting the slug test. Between tests, the monitoring well will be allowed to return to original conditions before conducting additional tests. Water levels will be collected during the tests and entered on field forms. Example field forms for the slug testing are found in **Appendix B**.

The slug testing will be performed to determine hydraulic properties (primarily hydraulic conductivity) in the surficial aquifer. After collection of the slug test data, the data will be entered into a software program (AQTESOLV) to determine the hydraulic properties of the monitoring wells. Slug testing procedures are found in Section 5.8.6 of the Fort Drum QAPP (Plexus, 2010).

4.1.7.2 Aquifer Testing

An eight-hour aquifer test will be conducted on one newly-installed monitoring well. A four-inch monitoring well will be installed in the deep portion of the aquifer for the eight-hour aquifer test. The test will utilize a submersible pump capable of up to 35 gpm. A maximum of 15 pressure transducers will be deployed two weeks prior to the aquifer pump test in monitoring wells to measure drawdown during the pump test. The pressure transducers will remain in the monitoring wells for two weeks after completion of the aquifer pump test. The pump will be attached to 1 ½ inch high density polyethylene (HDPE) tubing with a flow gauge/totalizer and flow control valve. The water will be transferred to a 21,000 gallon Frac tank, and will be transferred to an onsite stripper for disposal. Monitoring wells will be gauged at specified intervals during the test to confirm the water level measurements made by the pressure transducers. Data collected from the aquifer pump test will be entered on field forms. Example field forms for the aquifer pump test are found in **Appendix B**.

The test will be designed primarily for the inclusion into the numerical groundwater model. The aquifer test will be performed to determine the hydraulic properties (hydraulic conductivity, specific storage, and specific yield) of the surficial aquifer. Water from the monitoring well will be contained in storage tanks and disposed of using the onsite air stripper. After collection of the aquifer test data, the data will be entered into a software program (AQTESOLV) to determine the hydraulic properties of the surficial aquifer. Aquifer testing procedures are found in Section 5.8.7 of the Fort Drum QAPP (Plexus, 2010).

4.1.8 Groundwater Sampling

Two rounds of groundwater sampling will be completed during the RI. Up to 130 groundwater samples will be collected from newly-installed and existing monitoring wells during the two sampling rounds. The monitoring wells will be sampled using low-flow methodology. New, unused polyethylene tubing will be used at each monitoring well. Upon stabilization of the water quality parameters, the samples will be collected in the following order:

1. VOCs;

2. Methane, ethane, and ethene;
3. Total organic carbon (TOC);
4. Sulfate and chloride;
5. Nitrogen, nitrate, and nitrite;
6. Calcium, iron, magnesium, potassium, total silicon, and sodium;
7. Total alkalinity; and
8. Microbial analysis.

The water quality parameters (pH, specific conductivity, dissolved oxygen, temperature, and turbidity) will be recorded prior to the collection of the groundwater sample. A sample of the field data sheet for groundwater sampling is provided in **Appendix B**. The groundwater samples will be analyzed for VOCs using USEPA Method 8260B. A subset of the groundwater samples will be analyzed for MNA parameters and microbial populations. Refer to **Table 4-1** for the complete analytes and analytical methods. Groundwater samples will be collected using the procedures described in Section 5.4.4 of the Fort Drum QAPP (Plexus, 2010).

4.1.9 Direct Push Soil Gas Sampling

A maximum of eight soil gas samples will be collected from three potential source area buildings. The locations of the soil gas samples will be determined based on the results of the groundwater investigation. Samples will be collected using DPT approximately 3 to 5 feet bgs into laboratory provided six liter Summa® canisters. The DPT rods will be driven hydraulically to depth using an expendable point and tubing adapter. The expendable point will be released from the female tubing adapter and the rods will be retracted at least one foot. A male tubing connector with an o-ring will be connected to Teflon®-lined tubing and fed through the rods. The connector will be threaded onto the adapter to form an air tight seal. Modeling clay will be inserted in the borehole and rod annular space to prevent ambient air from entering the rod. A minimum of three tubing volumes will purged from the tubing prior sampling. Prior to sample collection, a tracer test will be performed to determine the collection of formation vapors during the sampling procedure. A regulator set at a flow rate not greater than 200 milliliters per minute will be secured to the tubing. The Summa® canister will be connected to the regulator and the sample will be collected. After the Summa® canister is filled, the canister will be removed and placed in a shipping container under strict chain of custody (COC). The soil gas samples will be analyzed for VOCs using USEPA Method TO15. The soil gas samples will be collected using the procedures found in Section 5.3 in the Fort Drum QAPP (Plexus, 2010). Prior to sample collection a tracer test will be conducted to evaluate whether the sample is being influenced by surface air intrusion at the sampling point. In the event of surface air intrusion the borehole will be re-sealed.

4.1.10 Surface Water, Surface Water Interface Monitoring, and Sediment Sampling

A maximum of five surface water, SWIM, and sediment samples will be collected as part of the RI activities. The samples will be collected from the streams to the north and northeast of the OSL. Surface water samples will be collected from downstream to upstream to prevent cross contamination between samples. Surface water samples will be collected directly from the stream using a decontaminated dipper. After collection of the water, the sample will be transferred into laboratory provided sample containers. The water will be slowly poured over on the side of the bottle to minimize volatilization. Water quality parameters and an estimate of water channel width will be recorded prior to the collection of surface water and sediment samples. A sample of the field data sheet for surface water and sediment sampling is provided in **Appendix B.**

Sediment samples will be collected in areas adjacent to the surface water sample locations. Sediment samples will be collected from downstream to upstream locations to prevent cross-contamination. The sediment sample will be collected from the stream bottom using a decontaminated stainless steel spoon. The sediment sample will be scooped from the bottom of the stream from a downstream to upstream direction. The sediment will be transferred to TerraCore® samplers and placed on ice in an insulated cooler under strict COC.

SWIM samples will be collected to characterize the portion of shallow groundwater discharging to surface water. The SWIM samples will be collected by driving a one-inch PVC pipe a minimum of 2 ½ feet into the hyporheic (mixing) zone adjacent to the stream (refer to **Figure 4-2**). A six-inch screen will be attached to the base of the pipe. The SWIM sample will be collected using a bailer or low-flow methodology from the pipe. The sample will be collected once the water quality parameters are stabilized. Water quality parameters and a sketch of the SWIM sampler will be recorded prior to the collection of the SWIM sample. A sample of the field data sheet for SWIM sampling is provided in **Appendix B.**

The samples will be analyzed for VOCs using USEPA Method 8260B. Proposed surface water, sediment, and SWIM sample locations are shown in **Figure 1-2**. Surface water and sediment samples will be collected using the procedures found in Section 5.6 in the Draft Fort Drum QAPP. SWIM samples will be collected using the procedures found in Section 5.7.3 in the Fort Drum QAPP (Plexus, 2010). Upon collection, the sample will be placed on ice in an insulated cooler under strict COC.

4.1.11 Surveying

Upon completion of the field investigation, a third-order survey will be conducted using a certified land surveyor. The ground surface elevation and horizontal location will be surveyed for each boring location. An xy-coordinate system will be used to describe the horizontal location of each surveyed point, with the x-coordinate as the east-west axis and the y-coordinate as the north-south axis. Horizontal locations will be referenced to the state plane coordinate system currently used by Fort Drum. Ground surface and casing elevation were referenced to mean sea level and measured to the nearest 0.01 foot.

4.2 Sampling and Analysis Activities

The analytical methods that will be performed as part of the RI activities are shown in **Table 4-1**. Borehole soil and groundwater samples will be analyzed for VOCs using USEPA 8260B. Surface water, SWIM, and sediment samples will be analyzed for VOCs using USEPA Method SW8260B. The groundwater samples will be analyzed for VOCs by USEPA Method SW8260B; sulfate and chloride by USEPA Method SW9056; total alkalinity by USEPA Method E310.1; nitrogen and nitrate and nitrite by USEPA Method E353.2; calcium, iron, magnesium, potassium, total silicon, and sodium by USEPA Method SW6010B; total organic carbon by USEPA Method SW9060; methane, ethane, and ethene by USEPA Method RSK-175); and microbial populations. Soil gas samples will be analyzed for VOCs using USEPA Method TO15. All analytical data will undergo a third party validation.

The data generated from this field investigation will be used primarily to fulfill the requirements of the RI. In addition, the data will be of sufficient quality to fulfill the requirements of a FS. The data will be incorporated into a groundwater flow and transport numerical model, a CSM and a baseline risk assessment. The goal of the RI is to evaluate the nature and extent of site related constituents. The data will be used to evaluate the fate and transport, and human health and ecological risks of site related CSCs.

5.0 Human Health Risk Assessment, Ecological Risk Assessment, and Fate and Transport Model

This section describes the HHRA, ERA, and Fate and Transport Model for the Fort Drum RI for Solvent Contaminants.

5.1 Risk Assessments

As part of the RI, a Baseline HHRA and ERA will be performed. The initial task for the HHRA and ERA includes data evaluation. The data evaluation task entails evaluating the available groundwater, surface water, and sediment analytical data associated with the Gasoline Alley Areas 1800, 1900, and 3800, and summarizing the data by exposure medium in tabular format for inclusion in the risk assessments. The summary tables will include the chemicals detected, the range of detections, the frequency of detection, the range of sample quantitation limits, the arithmetic mean, and the standard deviation.

The HHRA report tables will be presented in risk assessment guidance for Superfund (RAGS) Part D format. It is assumed that a maximum of three exposure scenarios will be evaluated for the HHRA (commercial/industrial worker, construction worker, and resident). The HHRA will be evaluated based on all future use scenarios. The site will not be evaluated for current use and the exposure media to be evaluated will consist of groundwater only. It is assumed that the ingestion, dermal absorption, and inhalation of volatiles exposure pathways will be evaluated.

Based on the results of the February 2010 screening, there may be several contaminants of potential concern (COPCs) that do not have available toxicity criteria and will not be able to be evaluated for cancer risks and noncancer health effects. The HHRA and ERA approach is outlined below.

5.1.1 Human Health Risk Assessment

This task will describe the overall approach to the HHRA. The following general categories of information will be provided:

5.1.1.1 Hazard Identification

The hazard identification task describes the available data for use in the risk assessment. The task presents the approach for evaluating the data for use in the risk assessment and presents the summarized data tables that were developed as part of the data evaluation. Hazard identification selects COPCs to be quantitatively evaluated in the risk assessment. This will entail comparing the maximum detected concentrations to health-based screening concentrations (i.e., Oak Ridge National Laboratory Regional Screening Levels).

5.1.1.2 Exposure Assessment

The exposure assessment task presents the exposure setting, including a description of the local land and water uses, and the CSM that describes the source(s) of contamination, the release and transport mechanisms, and the potentially exposed human populations along with the exposure pathways to be evaluated. USEPA's ProUCL software program will be used to calculate the exposure point concentrations (EPCs), where appropriate. EPCs describe the model to estimate exposure doses and present the parameters that will be used to estimate exposure doses along with references to the appropriate guidance.

In addition to those scenarios/pathways presented in the February 2010 screening, a commercial/industrial worker dermal pathway and construction worker ingestion and dermal contact pathways will be evaluated. Additional vapor intrusion pathways will be evaluated for the commercial/industrial worker and residential scenarios.

5.1.1.3 Toxicity Assessment

The toxicity assessment task describes carcinogenic and noncancer effects and toxicity values. This task outlines the approach for determining toxicity values for the COPCs evaluated in the risk assessment.

5.1.1.4 Risk Characterization

Risk characterization describes the approach for estimating cancer risks and noncancer health effects. This task summarizes the cancer risks and noncancer hazard indices.

5.1.1.5 Uncertainty Analysis

Uncertainty analysis identifies the uncertainties inherent in the risk assessment process. It provides the degree of uncertainty as well as indicating if risk is under- or over-estimated as a result.

5.1.1.6 Risk Summary and Conclusions

The risk summary and conclusions provide a perspective on the risk estimates based on the information gathered in the Uncertainty Analysis. It provides an overall summary of the risk estimates and draws conclusions.

5.1.2 Ecological Risk Assessment

This task will describe the overall approach to the screening-level ecological risk assessment (SLERA). The SLERA will be comprised of Steps 1 and 2 of USEPA's *Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments* (EPA, 1997).

The exposure media to be evaluated will consist of surface water and sediment only. A maximum of two receptors will be modeled (one avian and one mammalian piscivore) and that one food item (i.e., fish) will have concentrations modeled. In Level 2 methodology, the surface water concentrations will be compared with aquatic life benchmarks as well as any available herptile benchmarks. Sediment concentrations will be compared with one benchmark (selected based on a hierarchy). The following general categories of information will be provided:

5.1.2.1 Screening-Level Problem Formulation and Ecological Effects Evaluation (Step 1)

Step 1 describes the ecological setting and an evaluation of what receptors may be found in the available habitats. It presents the preliminary CSM. The CSM narrative outlines the contaminant sources, release and migration mechanisms, exposure pathways and routes, potential ecological receptors for each potentially affected habitat, and mechanisms of ecotoxicity associated with the contaminants for potential receptors. Step 1 describes the available data for use in the risk assessment and the screening-level benchmarks to be used to determine contaminants of potential ecological concern (COPECs). It presents the approach for evaluating the data for use in the risk assessment and the summarized data tables that were developed as part of the data evaluation.

5.1.2.2 Screening-Level Preliminary Exposure Estimates and Risk Calculation (Step 2)

Step 2 presents the Level 1 screening methodology by which contaminants COPECs are determined. COPECs will be selected based on their intrinsic toxicological properties and comparisons to available benchmarks. Assuming COPECs are identified in the Level 1 screening, a Level 2 Screening is completed. USEPA's ProUCL software program will be used to calculate the EPCs and an ad-hoc value will be selected as the EPC.

Exposure of one avian and one mammalian piscivore to COPECs will be assessed by quantifying the daily dose ingested of contaminated food items (e.g., fish) and media (e.g., sediments and surface water). Potential ecological effects will be determined by comparing media concentrations (i.e., surface water and sediment) to media-based benchmark and modeled doses to toxicity reference values (TRVs). Critical assumptions will be reviewed and uncertainties presented.

5.1.2.3 Risk Summary and Conclusions

Risk summary and conclusions provide a perspective on the risk estimates based on the information gathered in the Uncertainty Analysis. It provides an overall summary of the risk estimates and draws conclusions.

5.2 Fate and Transport Model

The groundwater modeling task will be broken into three phases of development. These phases will commence once all relevant data has been collected.

5.2.1 Phase 1 – Geologic and Conceptual Model Development

In this task, the geologic model of the subsurface formations to be considered in the groundwater flow and transport analysis will be developed. Existing data and reports pertaining to the geology and hydrogeology of both areas will be reviewed. The review will include, but not be limited to, well construction diagrams, lithologic and stratigraphic logs, geophysical logs, geologic cross-sections, structure/isopach maps, and hydraulic testing data/results. Sources of information include reports and data from the United States Geological Survey, state Geological

Surveys and natural resource agencies, and universities. The results of this task will be a Conceptual Model of the geology/hydrogeology at the site. The conceptual model will be outlined in the final groundwater model report.

5.2.2 Phase 2 – Model Construction and Calibration

Model construction involves the translation of the Conceptual Model developed in Phase 1 into an actual model data files using a consistent framework for accuracy, efficiency, and quality control. Groundwater Vistas will be used as the model pre- and post-processor for model construction and setup, running the model, and post-processing of simulation results. Groundwater Vistas is a commercially-available, Windows based software that is widely used for groundwater model development. MODFLOW will be used as the groundwater flow model for this project. MODFLOW is well-documented, is widely used by consultants, government agencies, and researchers, and is consistently accepted in regulatory and litigation proceedings. The results of Phase 1 will help address basic issues such as how stratigraphy can be simplified into model layers, the extent and thickness of the formations and overlying containment layers, boundary conditions, and initial conditions. The models will be regional in scope to analyze and predict long-term trends of the fate and transport of constituents of interest in the subsurface, but also local in scale (e.g., grid spacing) to assess and predict shorter-term responses and local features. Calibration of the model will be based on both available historic data and data generated as part of the RI investigation. The collected data will be used to calibrate the model (i.e., specification of key hydraulic parameters, such as permeability). If calibration data is not available, specification of hydraulic parameters (e.g., permeability, porosity) will be based on lithologic considerations and literature values.

5.2.3 Phase 3 – Fate and Transport Analysis

In this task, the calibrated model developed in Phase 2 will be used to perform predictive simulations of dissolved constituent fate and transport in the site area. The simulations will include both short-term responses (e.g., expected operational life of potential remedial activities) and long-term responses (e.g., post-operational fate and transport of the plume). In addition, the model will be used to evaluate the long-term effects of natural and man-made stresses to the subsurface that may lead to upward hydraulic gradients and/or migration. A sensitivity analysis will be conducted as part of this task on key hydraulic parameters affecting the fate and transport of dissolved constituents (e.g., permeability, porosity) in order to bracket the expected range in values of these parameters and demonstrate the effects on the long-term fate of dissolved constituents under varying conditions.

6.0 Project Schedule and Deliverables

This section describes the proposed Fort Drum RI for Solvent Contaminants schedule and project deliverables.

6.1 Project Schedule

A detailed schedule of the Fort Drum RI for Solvent Contaminants schedule is shown in **Figure 6-1**. The schedule includes Tasks 1 through 7 from the SOW. If optional tasks are triggered at any point during the RI, an updated schedule will be included in work plan addendums written for the optional tasks. The schedule has been developed to complete Phases 1 through 3 and the first round of Phase 4 of the field investigation prior to the snow season at Fort Drum.

6.2 Deliverables

The project deliverables include:

- Monthly technical and financial progress reports
- Draft and Final Gasoline Alley Areas 1800, 1900, and 3800 Remedial Investigation Work Plan
- Draft and Final Gasoline Alley Areas 1800, 1900, and 3800 Remedial Investigation Field Sampling Plan Addendum
- Draft and Final Gasoline Alley Areas 1800, 1900, and 3800 Remedial Investigation Quality Assurance Project Plan Addendum
- Draft and Final Gasoline Alley Areas 1800, 1900, and 3800 Remedial Investigation Community Relations Plan Addendum
- Draft and Final Gasoline Alley Areas 1800, 1900, and 3800 Remedial Investigation Report

7.0 References

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TABLES

Table 3-1
Chronology of Activities for the Phased Field Program

Phase 1 Activities - September 27 through October 6
Drill Pilot Borehole
Install Bedrock MW or Bentonite Borehole to Top of Confining Unit and Install Bedrock MW
If Bedrock MW is installed, Drill and Install Deep MW
Drill and Install Initial Deep MWs
Phase 1 Activities Project Team Conference Call - October 8
Phase 2 Activities - October 11 through October 20
Drill and Install Initial Deep MWs
Drill and Install Step Out Deep MWs
Phase 2 Activities Project Team Conference Call - October 22
Phase 3 Activities - October 25 through November 3
Drill and Install Shallow MWs
Drill and Install Intermediate MWs
Complete Soil Gas Sampling
Collect Surface Water, Sediment, and SWIM Samples
Conduct Slug Testing
Conduct Aquifer Testing
Complete Site Surveying
Phase 3 Activities Project Team Conference Call - November 5
Phase 4 Activities Round 1 - November 8 through November 17
Collect Groundwater Samples from MWs
Phase 4 Activities Project Team Conference Call - November 19
Phase 4 Activities Round 2 - May 9 through May 18
Collect Groundwater Samples from MWs

Table 3-2
Groundwater Quality Standards for Contaminants of Concern

Contaminant	NYSDEC Groundwater Criteria (µg/L)	USEPA Groundwater MCL (µg/L)
Tetrachloroethene (PCE)	5	5
Trichloroethene (TCE)	5	5
cis-1,2-Dichloroethene (cis-1,2-DCE)	5	70
trans-1,2-Dichloroethene (trans-1,2-DCE)DCE	5	100
1, 1-Dichloroethene (1,2-DCE)	5	7
Vinyl Chloride	2	2

Key:

NYSDEC - New York State Department of Environmental Conservation Surface Water and Groundwater Quality Standards and Groundwater Effluent Limitations

USEPA MCL - United States Environmental Protection Agency National Primary Drinking Water Standard Maximum Contaminant Level

µg/L - Micrograms per Liter

Table 4-1
Sample Analysis Summary

Analyte	Method	Matrix	# Samples	# Equipment Blanks	# Ambient Blanks	# Trip Blanks	# Field Duplicates/ Replicates	# MS/MSD Samples	Total # Samples
Monitoring Well Installation									
VOCs	8260B	SO	189	1	1	20	19	10	250
VOCs	8260B	GW	84	1	1	20	9	5	120
Surface Water, SWIM, and Sediment Sampling									
VOCs	8260B	SW	5	1	1	1	1	1	10
VOCs	8260B	SWIM	5	1	1	1	1	1	10
VOCs	8260B	SD	5	1	1	1	1	1	10
Groundwater Sampling									
VOCs	8260B	GW	120	2	2	10	12	6	152
Sulfate/Chloride	9056	GW	10	0	0	0	1	1	12
Total Alkalinity	E310.1	GW	10	0	0	0	1	1	12
Nitrogen/Nitrate/ Nitrite	E353.2	GW	10	0	0	0	1	1	12
Calcium/Iron/ Magnesium/ Potassium/ Total Silicon/ Sodium	6010B	GW	10	0	0	0	1	1	12
TOC	9060	GW	10	0	0	0	1	1	12
Methane/Ethane/ Ethene	RSK-175	GW	10	0	0	0	1	1	12
Microbial Analysis	qPCR	GW	5	0	0	0	0	0	5
Soil Gas Sampling									
VOCs	TO15	SG	7	0	0	1	1	1	10

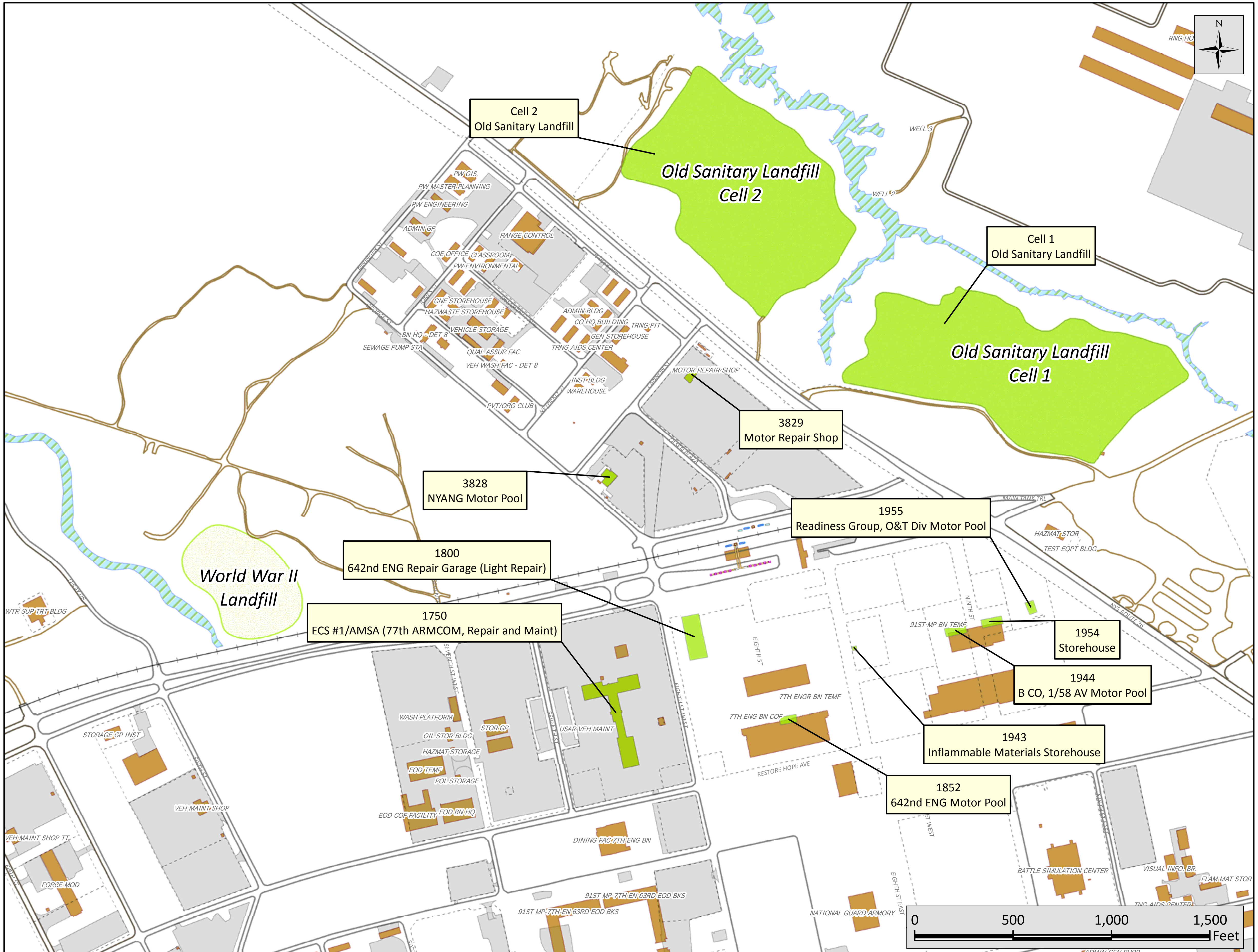
Key:

VOCs = Volatile Organic Compounds
TOC = Total Organic Carbon
SO = Soil Sample
GW = Groundwater Sample
SW = Surface water Sample

SWIM = Surface water interface monitoring sample
SD = Sediment sample
SG = Soil gas Sample
MS/MSD = Matrix Spike/Matrix Spike Duplicate
qPCR = Quantitative Polymerase Chain Reaction

FIGURES

APPENDICES



Legend

- Potential Hazardous Waste Sources

Pump House Features

- Dispenser
- Overhead Truck Dispenser
- Pump House
- UST
- Underground Filling Pipes
- Fence Line
- Rail Road
- Paved Road
- Unpaved Road
- Landfill Site
- Wetlands
- Building
- Parking Lot

ACRONYMS

AMSA	Army Maintenance Support Activity
ARMCOM	Army Command
AV	Aviation
CO	Company
DIV	Division
ECS	Engineer Combat System
ENG	Engineers
NYANG	New York Army National Guard
O & T	Organization and Training

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FIGURE 1-1

Site Location Map

Fort Drum RI for CSC Contaminants Work Plan Fort Drum, NY

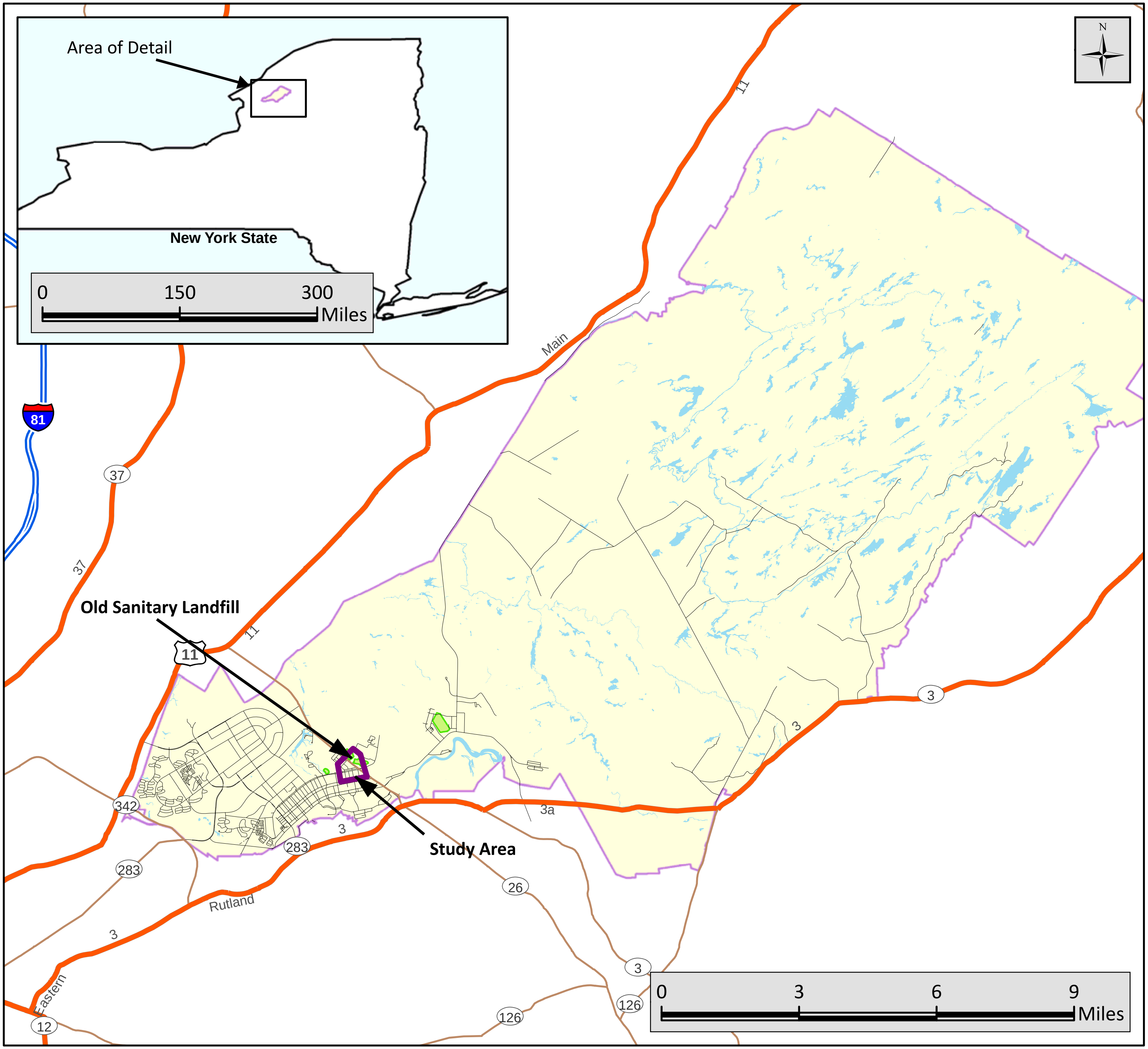

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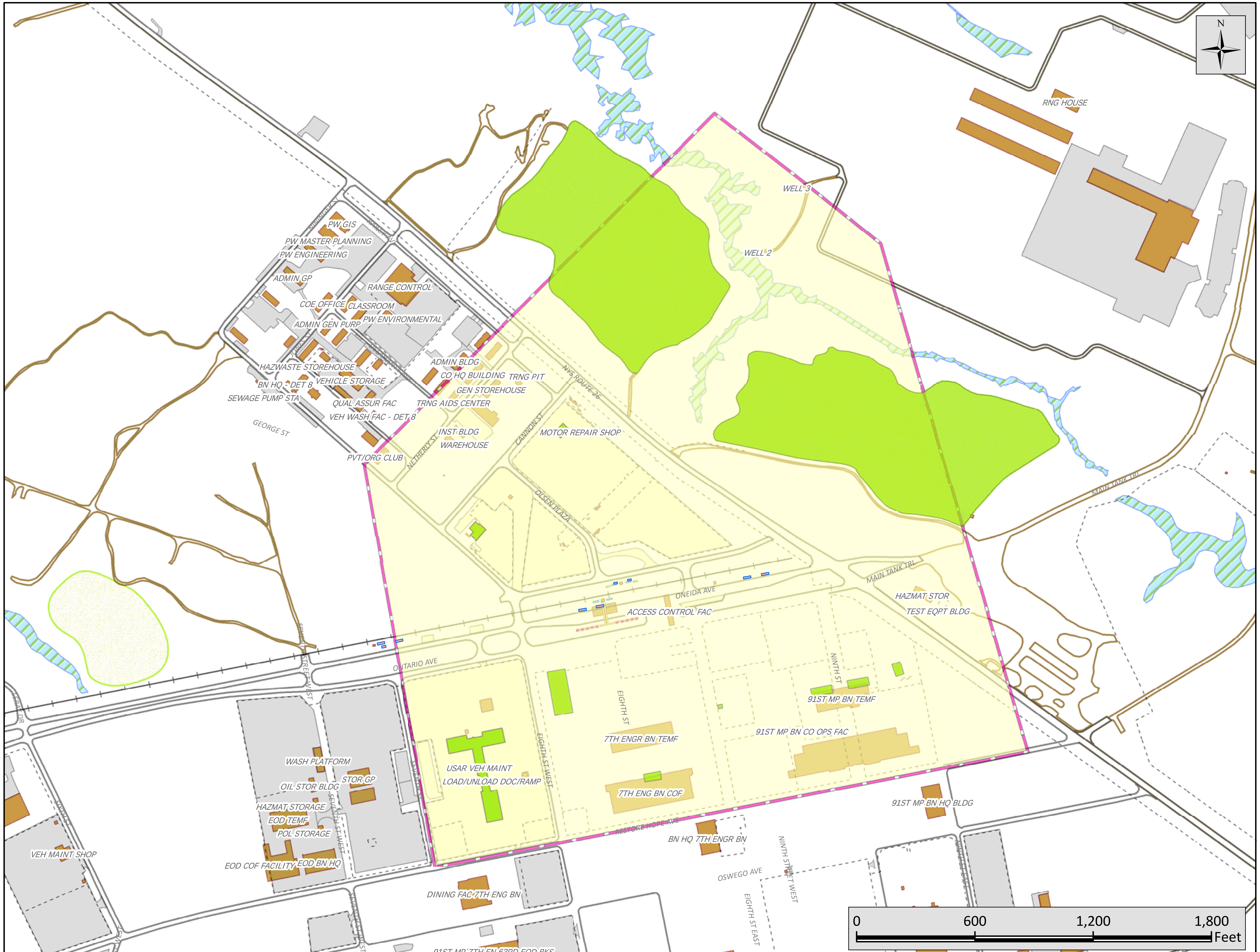
FIGURE 1-2

Regional Location Map

Fort Drum RI for CSC Contaminants Work Plan
Fort Drum, NY



Legend

- Potential Hazardous Waste Sources
- PCE RI Study Area

Pump House Features

- Dispenser
- Overhead Truck Dispenser
- Pump House
- UST
- Underground Filling Pipes
- Fence Line
- Rail Road
- Paved Road
- Unpaved Road
- Landfill Site
- Wetlands
- Building
- Paved Area

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FIGURE 1-3

PCE Remedial Investigation Study Area Location Map

Fort Drum RI for CSC Contaminants Work Plan
Fort Drum, NY

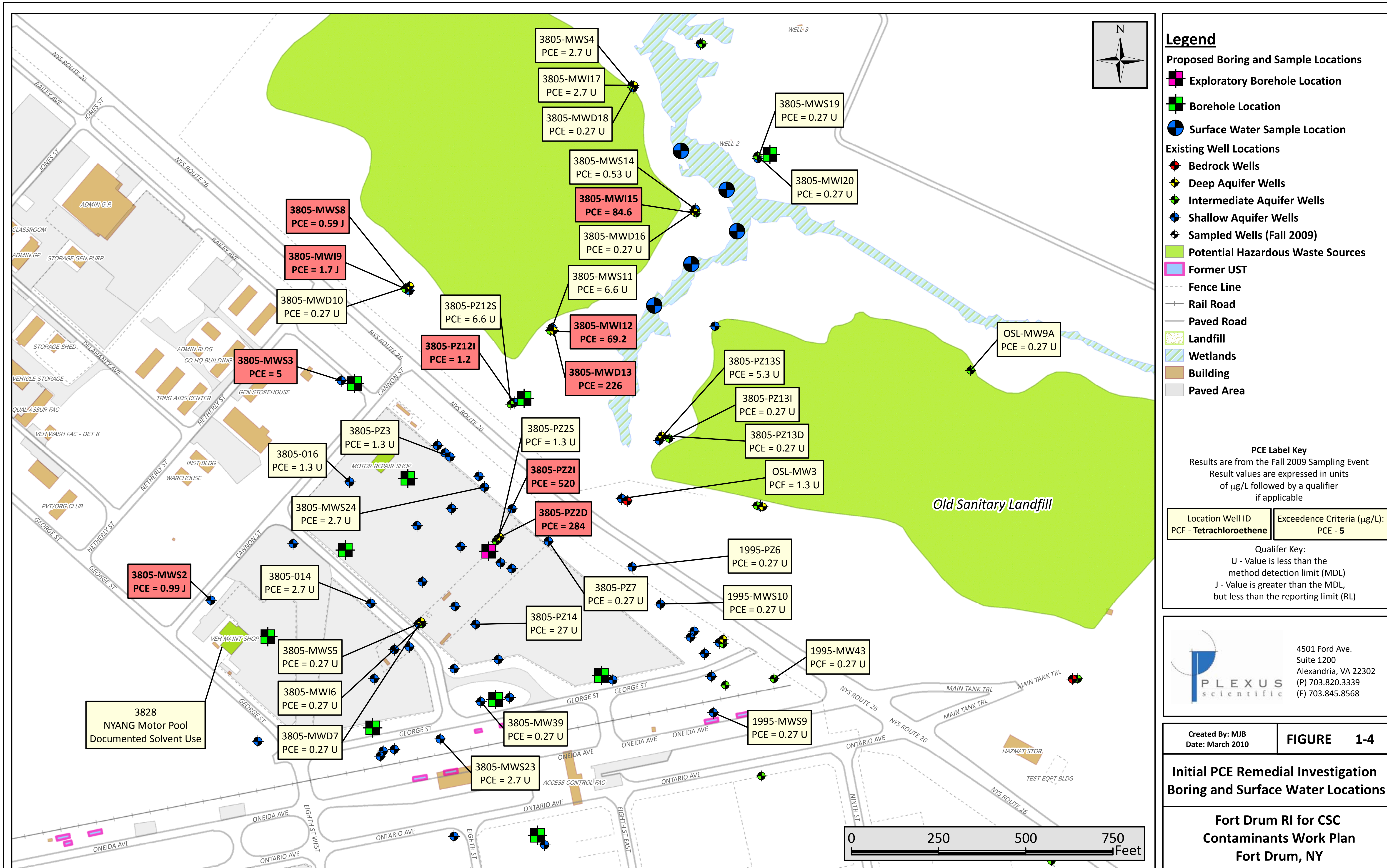
3805-MWS4 PCE = 2.7 U
3805-MWI17 PCE = 2.7 U
3805-MWD18 PCE = 0.27 U
3805-MWS19 PCE = 0.27 U
3805-MWI20 PCE = 0.27 U
3805-MWS14 PCE = 0.53 U
3805-MWI15 PCE = 84.6
3805-MWD16 PCE = 0.27 U
3805-MWS8 PCE = 0.59 J
3805-MWI9 PCE = 1.7 J
3805-MWD10 PCE = 0.27 U
3805-MWS11 PCE = 6.6 U
3805-MWI12 PCE = 69.2
3805-MWD13 PCE = 226
3805-PZ12S PCE = 6.6 U
3805-PZ12I PCE = 1.2
3805-MWS3 PCE = 5
OSL-MW9A PCE = 0.27 U
3805-PZ13S PCE = 5.3 U
3805-PZ13I PCE = 0.27 U
3805-PZ13D PCE = 0.27 U
3805-PZ3 PCE = 1.3 U
3805-PZ2S PCE = 1.3 U
3805-016 PCE = 1.3 U
3805-PZ2I PCE = 520
OSL-MW3 PCE = 1.3 U
3805-MWS24 PCE = 2.7 U
3805-PZ2D PCE = 284
Old Sanitary Landfill
1995-PZ6 PCE = 0.27 U
3805-MWS2 PCE = 0.99 J
3805-014 PCE = 2.7 U
3805-PZ7 PCE = 0.27 U
1995-MWS10 PCE = 0.27 U
3805-PZ14 PCE = 27 U
3805-MWS5 PCE = 0.27 U
1995-MW43 PCE = 0.27 U
3805-MWI6 PCE = 0.27 U
3828 NYANG Motor Pool Documented Solvent Use
3805-MW39 PCE = 0.27 U
1995-MWS9 PCE = 0.27 U
3805-MWD7 PCE = 0.27 U
3805-MWS23 PCE = 2.7 U
N
0 250 500 750 Feet
Legend
Proposed Boring and Sample Locations
Exploratory Borehole Location
Borehole Location
Surface Water Sample Location
Existing Well Locations
Bedrock Wells
Deep Aquifer Wells
Intermediate Aquifer Wells
Shallow Aquifer Wells
Sampled Wells (Fall 2009)
Potential Hazardous Waste Sources
Former UST
Fence Line
Rail Road
Paved Road
Landfill
Wetlands
Building
Paved Area
PCE Label Key
Results are from the Fall 2009 Sampling Event
Result values are expressed in units of µg/L followed by a qualifier if applicable
Location Well ID PCE - Tetrachloroethene
Exceedence Criteria (µg/L): PCE - 5
Qualifier Key:
U - Value is less than the method detection limit (MDL)
J - Value is greater than the MDL, but less than the reporting limit (RL)
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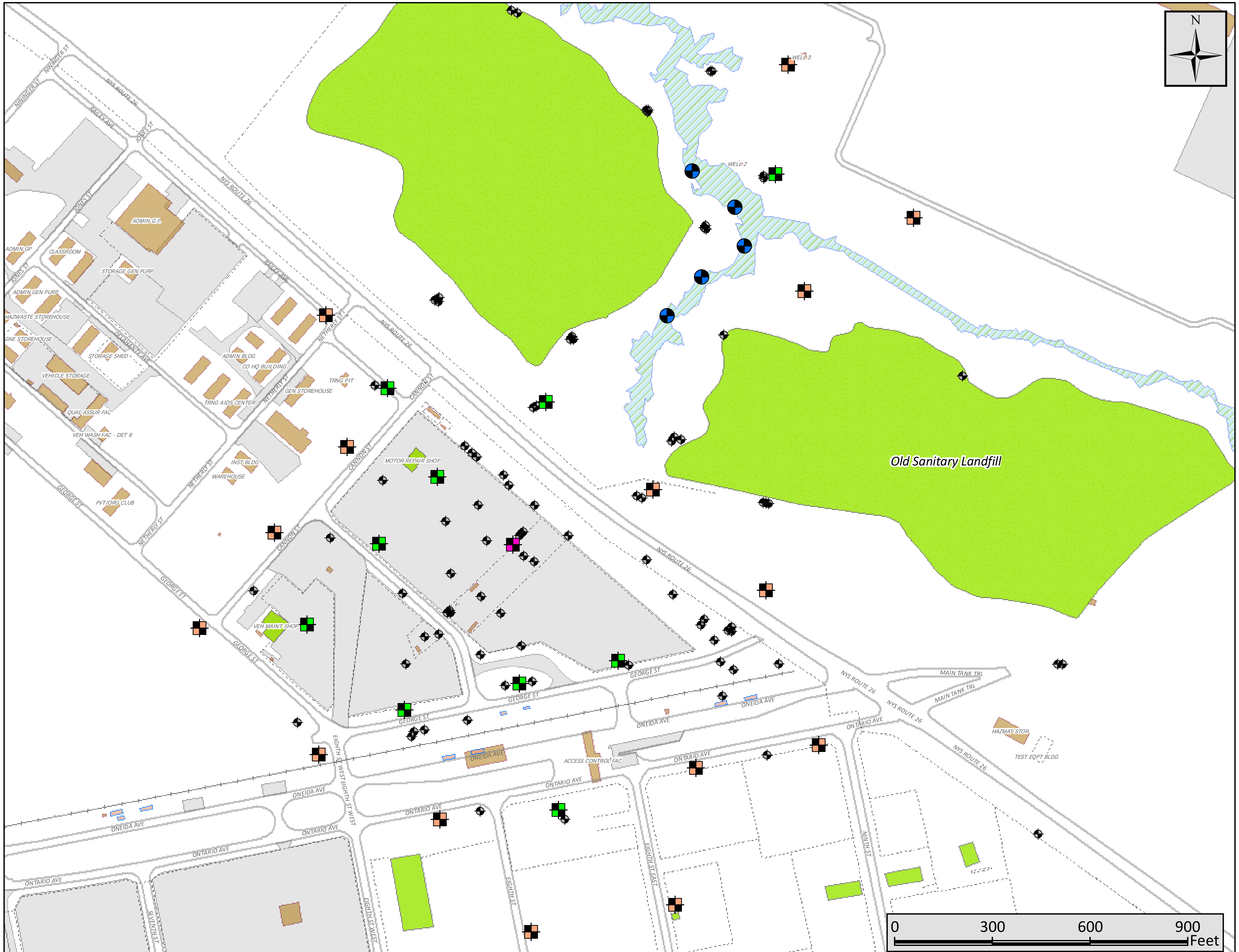
FIGURE 1-4
Initial PCE Remedial Investigation Boring and Surface Water Locations
Fort Drum RI for CSC Contaminants Work Plan
Fort Drum, NY



Legend

Proposed Boring and Sample Locations

- Exploratory Borehole Location
- Borehole Location
- Surface Water Sample Location
- Offset Borehole Location
- Existing Well Locations
- Sampled Wells (Fall 2009)
- Potential Hazardous Waste Sources
- UST
- Fence Line
- Rail Road
- Paved Road
- Landfill
- Wetlands
- Building
- Paved Area

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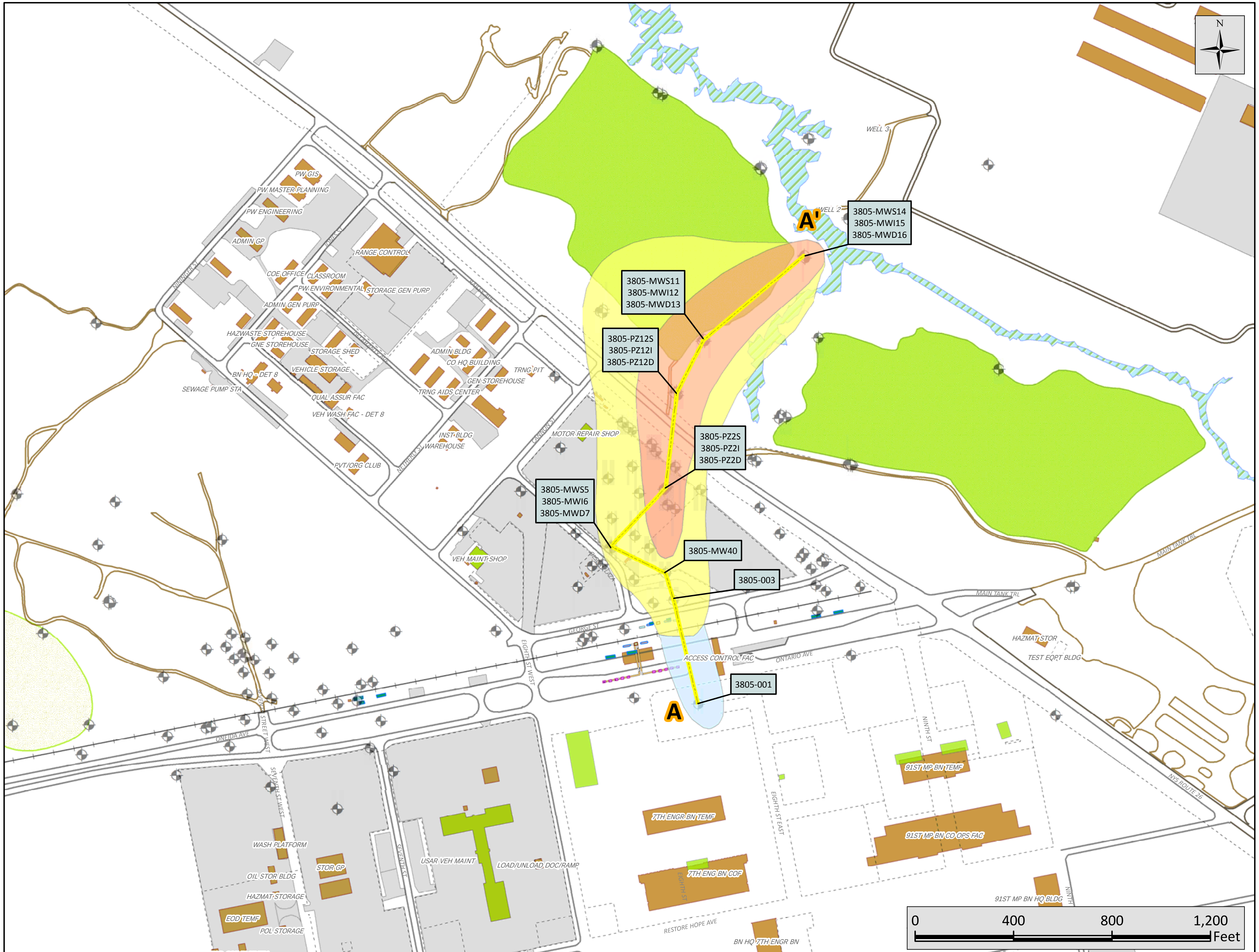
FIGURE 1-5

Proposed Monitoring Well Offset Locations

Fort Drum RI for CSC Contaminants Work Plan Fort Drum, NY



Legend

- Transect
- Depth of PCE Plume
  - Deep & Intermediate
  - Intermediate Only
  - Shallow
- Monitoring Wells
- Former UST Area
- Potential Hazardous Waste Sources
- Pump House Features
  - Dispenser
  - Overhead Truck Dispenser
  - Pump House
  - UST
  - Underground Filling Pipes
- Fence Line
- Rail Road
- Paved Road
- Unpaved Road
- Landfill Site
- Wetlands
- Building
- Paved Area

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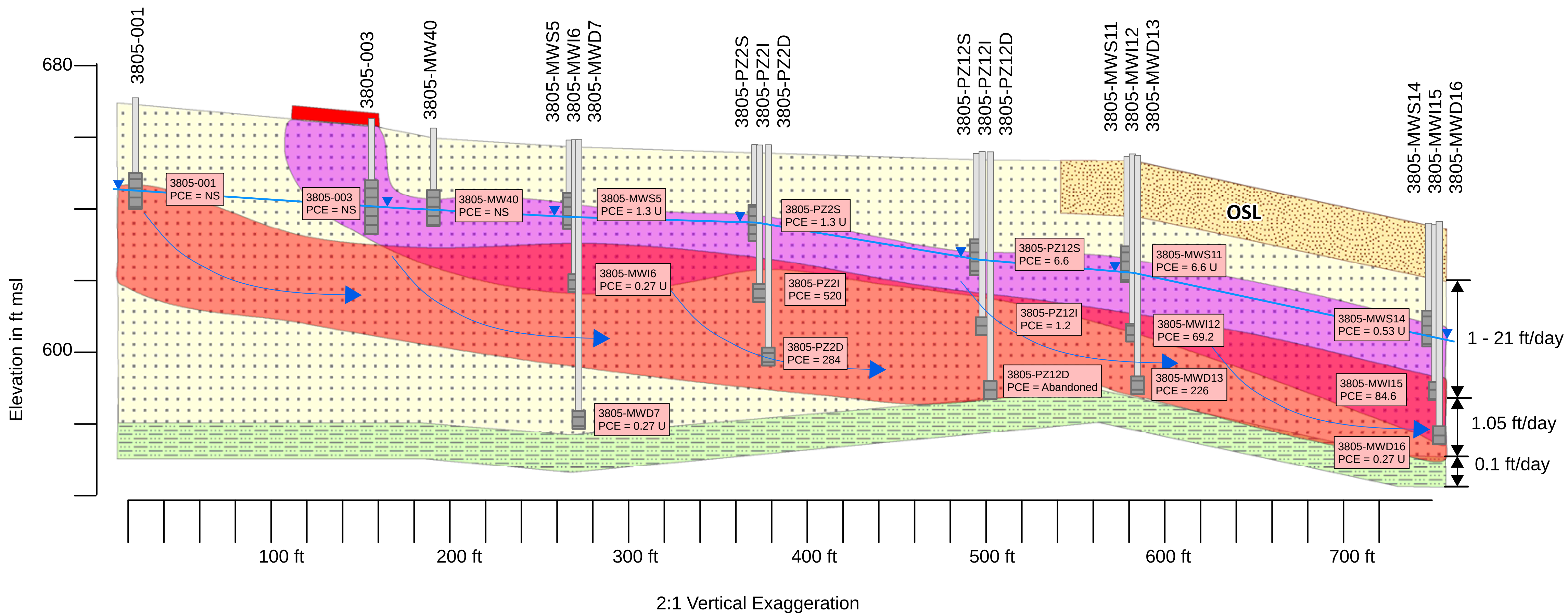
FIGURE 2-1

PCE Plume Depth Distribution and Transect Location Map

Fort Drum RI for CSC Contaminants Work Plan
Fort Drum, NY

Cross-section A to A'



Abreviation Key:
U - Qualifier for when the value is less than the method detection limit (MDL)
NS - Not Sampled
PCE - Tetrachloroethylene
BTEX - Benzene, Toluene, Ethylbenzene, Total Xylenes
µg/L - micrograms per liter
OSL - Old Sanitary Landfill

Legend

- Shallow Groundwater Elevation
- PCE Plume
- BTEX Plume
- BTEX Source Area
- Old Sanitary Landfill
- Sand
- Silt
- PCE/BTEX Mixing Zone
- Groundwater Flow Line
- Monitoring Well: Well ID (3805-001), Well Riser, Well Screen

NOTE:
Analytical results and groundwater elevations from Fall 2009 Basewide Sampling Event

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FIGURE 2-2

PCE & BTEX Plume Distribution Cross Sections

Fort Drum RI for CSC Contaminants Work Plan
Fort Drum, NY

Legend

- Water Level Contour (ft msl)
- Groundwater Flow Direction
- Monitoring Wells
- Former UST Area
- Potential Hazardous Waste Sources

Pump House Features

- Dispenser
- Overhead Truck Dispenser
- Pump House
- UST
- Underground Filling Pipes
- Fence Line
- Rail Road
- Paved Road
- Unpaved Road
- Landfill Site
- Wetlands
- Building
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FIGURE 2-3

Groundwater Elevation Contour and Flowline Map

Fort Drum RI for CSC Contaminants Work Plan Fort Drum, NY

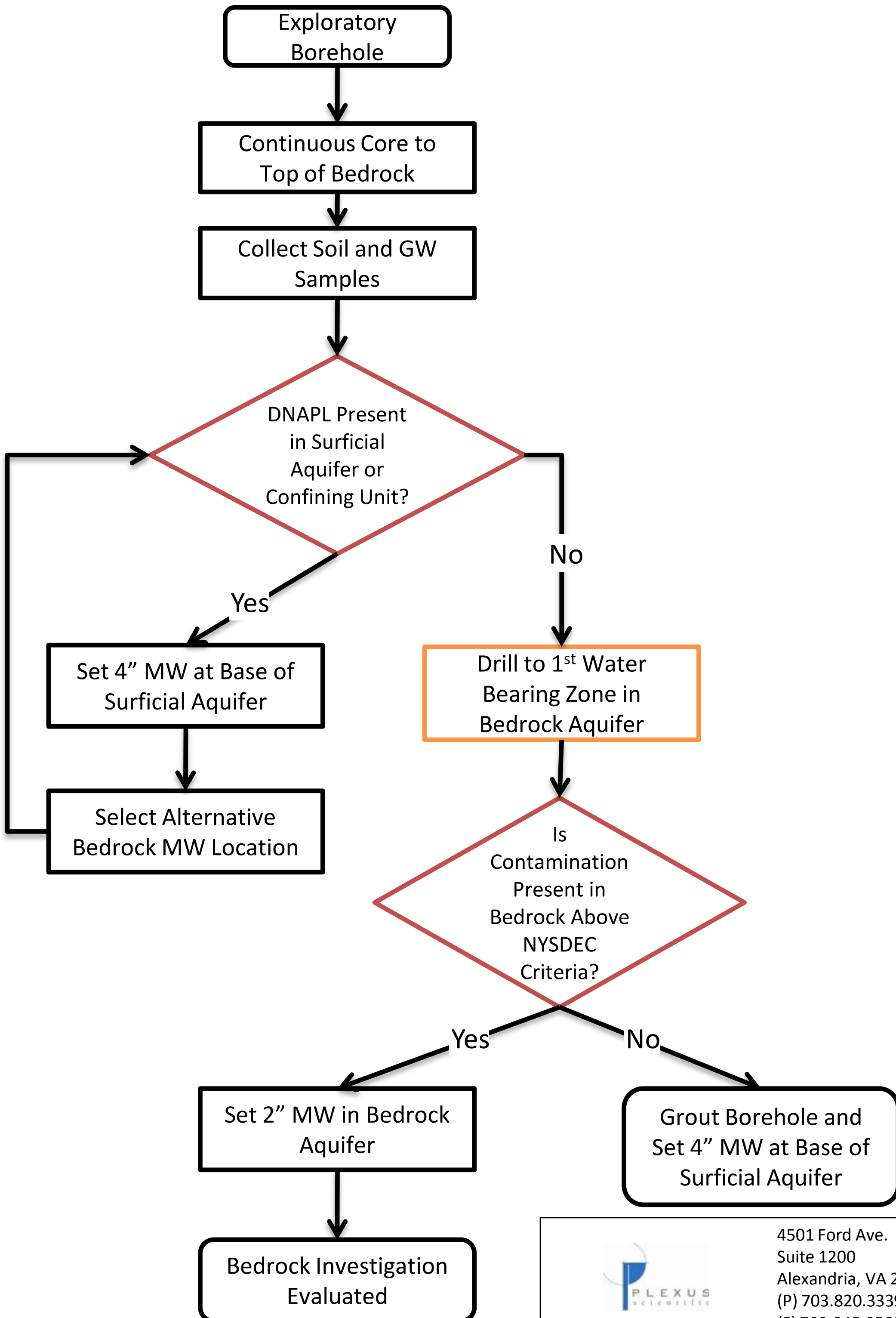

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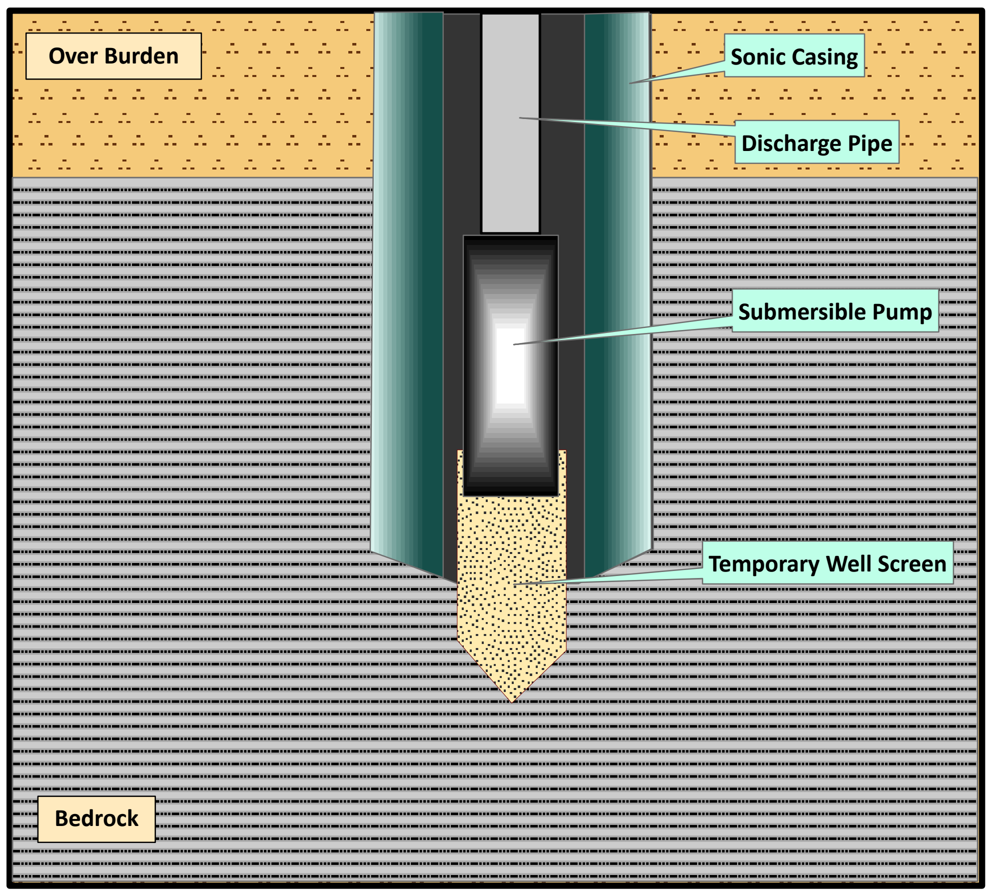
FIGURE 3-1

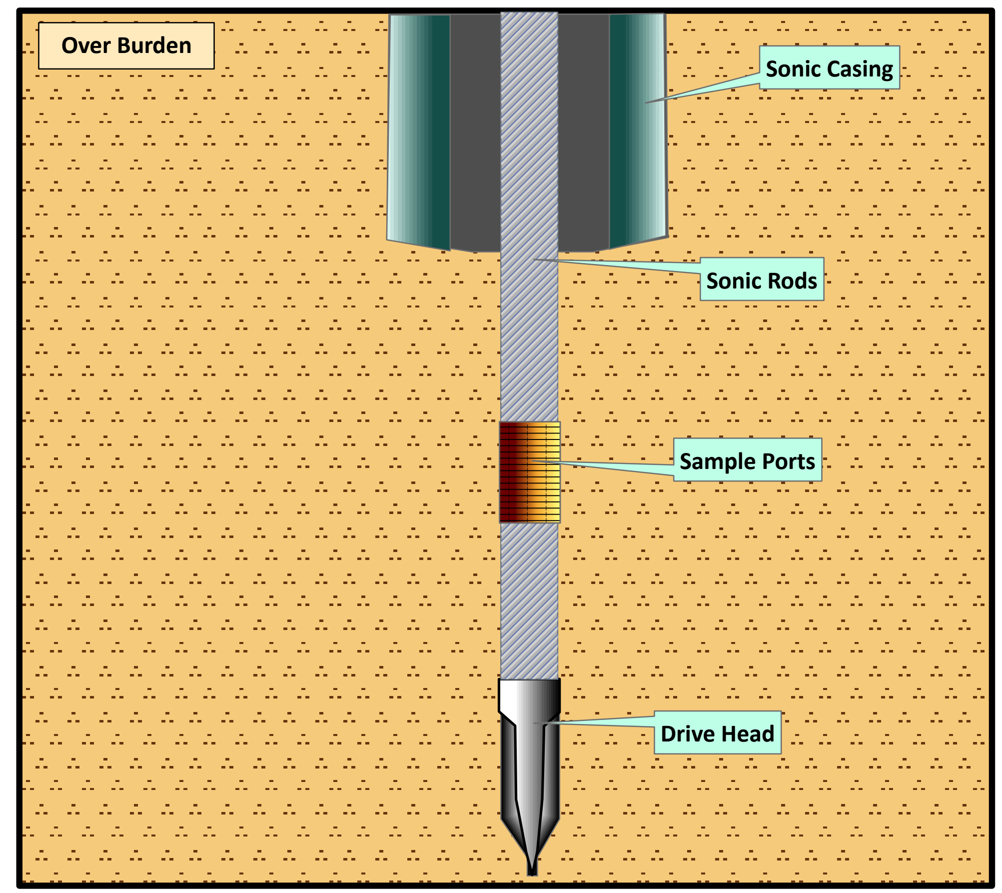
Exploratory Borehole Flowchart

Fort Drum RI for CSC Contaminants Work Plan
Fort Drum, NY

ISOFLOW SYSTEM
For Bedrock Formation Groundwater Sampling



PUSH-AHEAD SYSTEM
For Overburden Formation Groundwater Sampling



Adapted from Boart Longyear's 2009 Water Sampling Brochure.

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FIGURE 3-2

Discrete-Interval Groundwater Sampling Methods

Fort Drum RI for CSC Contaminants Work Plan
Fort Drum, NY

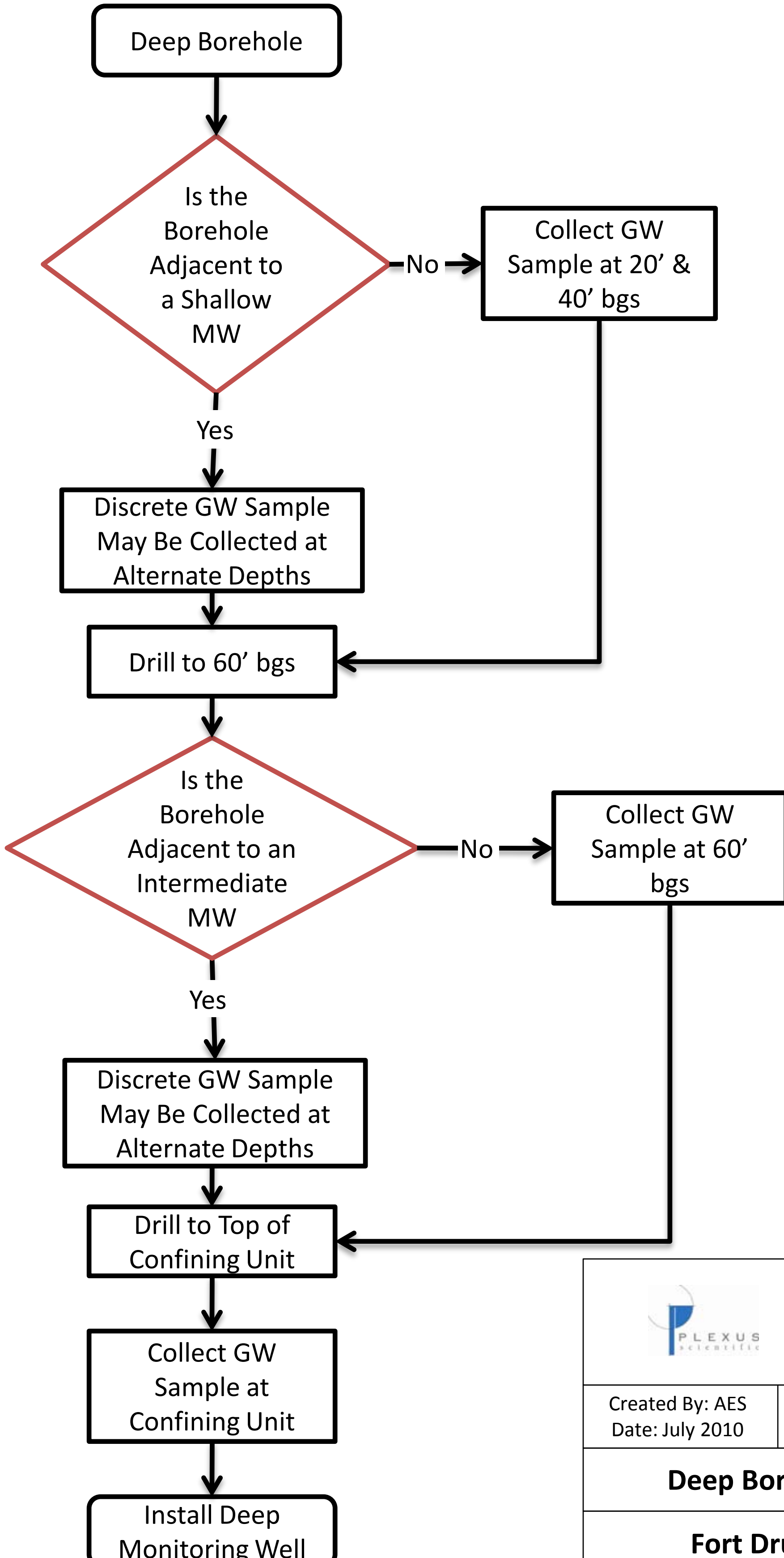

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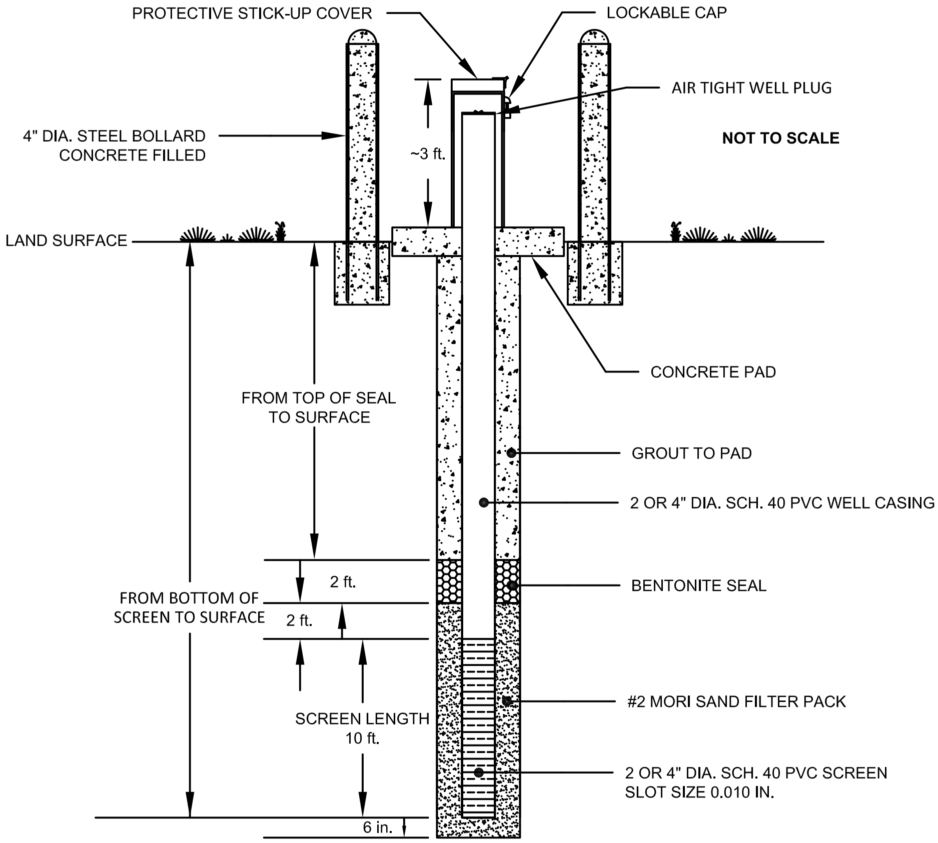
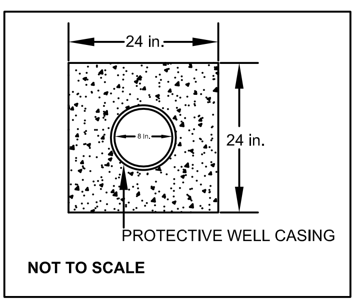
FIGURE 3-3

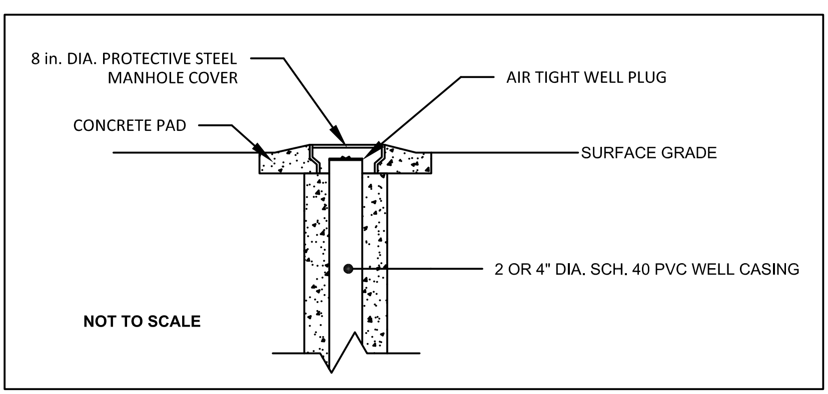
Deep Borehole Flowchart

Fort Drum RI for CSC Contaminants Work Plan
Fort Drum, NY





TOP VIEW OF PAD DETAIL



FLUSH MOUNT CONFIGURATION OF WELL HEAD

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Figure 4-1

Well Construction Diagram

Fort Drum RI for CSC
Contaminants Work Plan
Fort Drum, NY

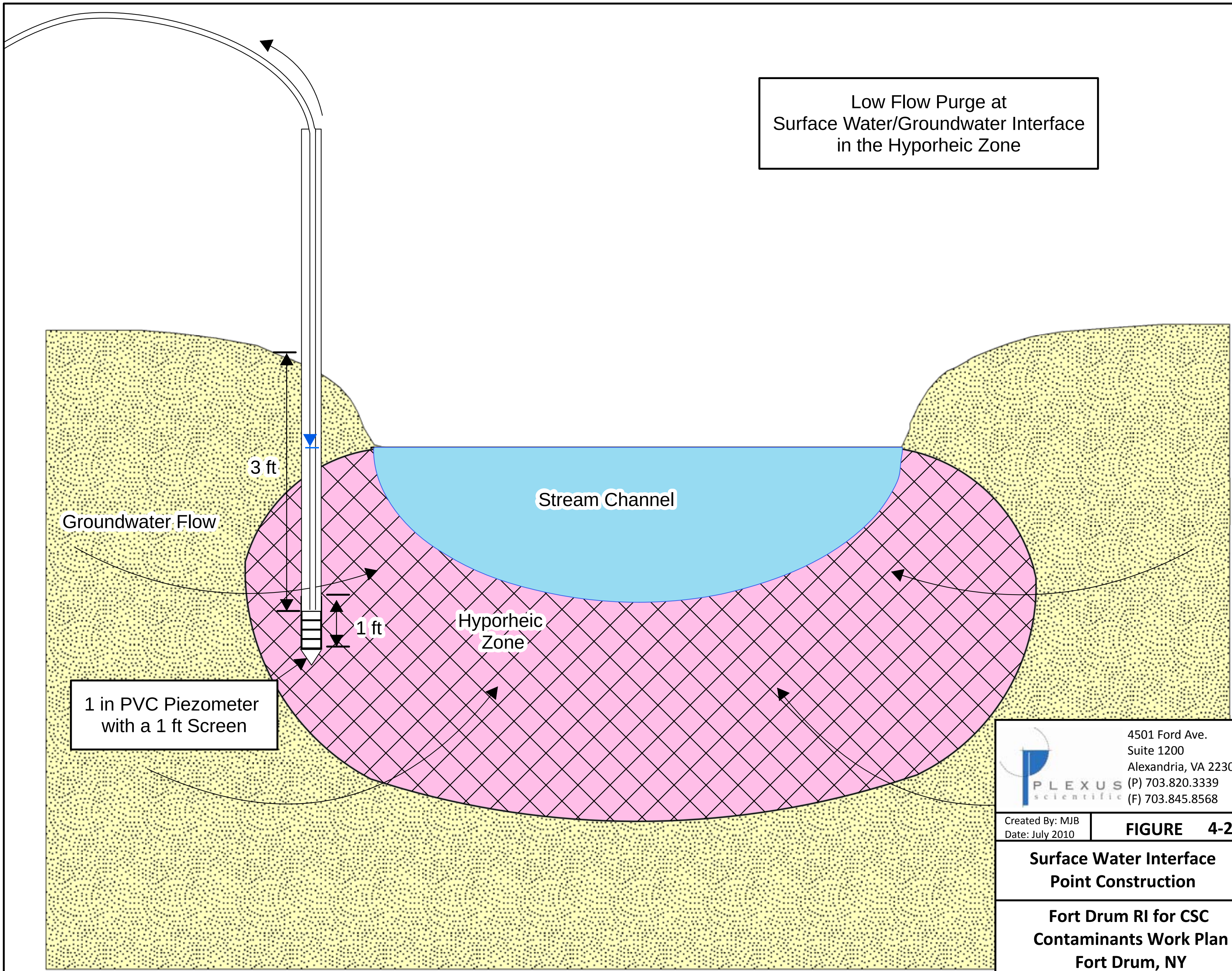

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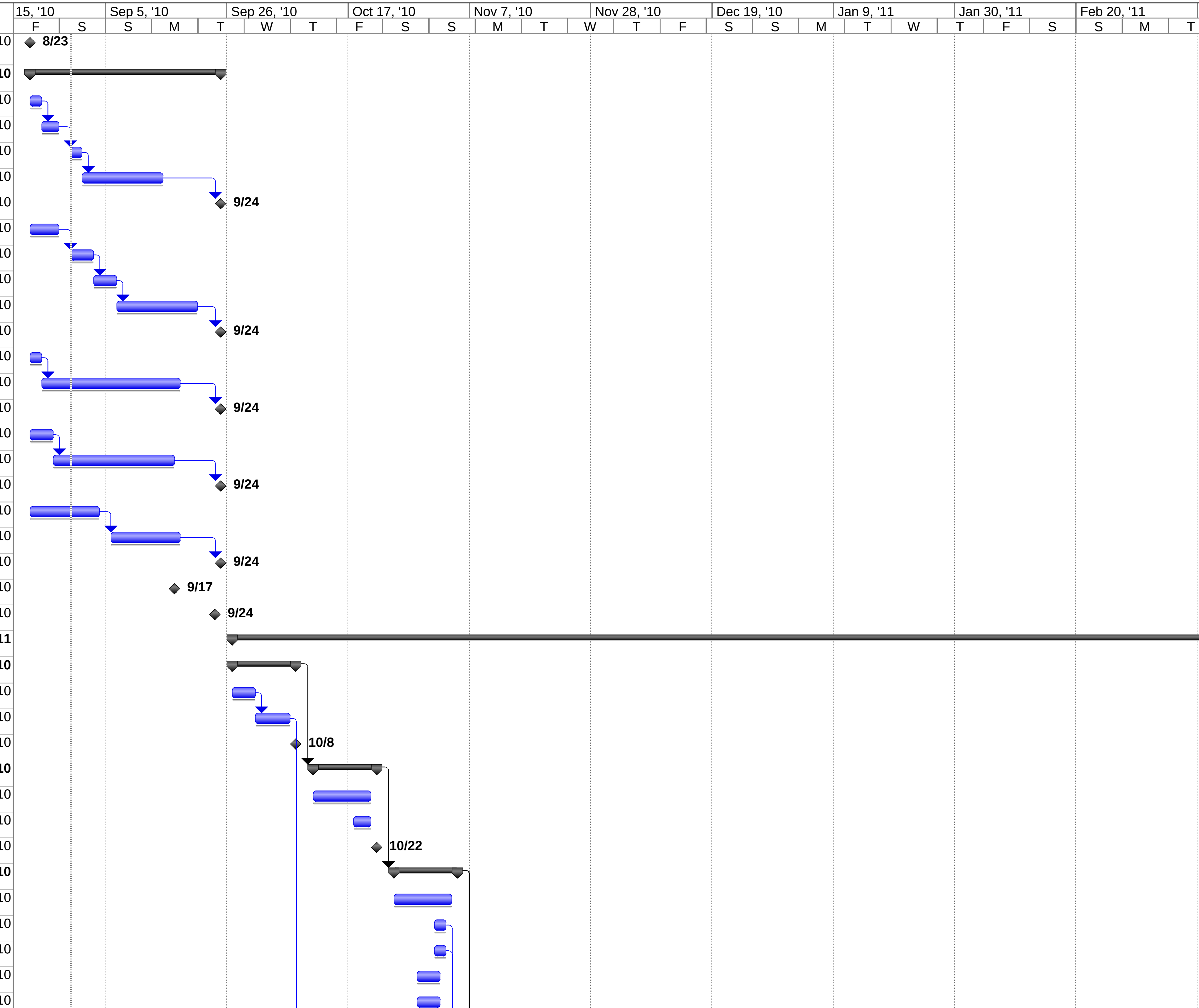
FIGURE 4-2

Surface Water Interface Point Construction

Fort Drum RI for CSC Contaminants Work Plan
Fort Drum, NY

Figure 6-1
Gasoline Alley PCE Remedial Investigation
Draft Work Plan Schedule

ID	Task Name	Duration	Start	Finish
1	**Project Award Date**	0 days	Mon 8/23/10	Mon 8/23/10
2	**Task 1: Project Planning**	**25 days**	**Mon 8/23/10**	**Fri 9/24/10**
3	Army Draft PCE RI Work Plan	2 days	Mon 8/23/10	Tue 8/24/10
4	Internal Army Review of Work Plan	3 days	Wed 8/25/10	Fri 8/27/10
5	Draft PCE RI Work Plan	2 days	Mon 8/30/10	Tue 8/31/10
6	NYSDEC Review of Work Plan	10 days	Wed 9/1/10	Tue 9/14/10
7	Final PCE RI Work Plan	8 days	Wed 9/15/10	Fri 9/24/10
8	Draft PCE RI FSP Updates of QAPP	5 days	Mon 8/23/10	Fri 8/27/10
9	Internal Army Review of FSP Updates of QAPP	4 days	Mon 8/30/10	Thu 9/2/10
10	Draft PCE RI FSP Updates ofQAPP	2 days	Fri 9/3/10	Mon 9/6/10
11	NYSDEC Review of FSP Updates of QAPP	10 days	Tue 9/7/10	Mon 9/20/10
12	Final PCE RI FS Update of QAPP	4 days	Tue 9/21/10	Fri 9/24/10
13	Draft Site Background Summary	2 days	Mon 8/23/10	Tue 8/24/10
14	Army Review of Site Background Summary	18 days	Wed 8/25/10	Fri 9/17/10
15	Final Site Background Summary	5 days	Mon 9/20/10	Fri 9/24/10
16	Draft PCE RI HASP	4 days	Mon 8/23/10	Thu 8/26/10
17	Army Review of HASP	15 days	Fri 8/27/10	Thu 9/16/10
18	Final PCE RI HASP	6 days	Fri 9/17/10	Fri 9/24/10
19	Draft CRP	10 days	Mon 8/23/10	Fri 9/3/10
20	Army Review of CRP	10 days	Mon 9/6/10	Fri 9/17/10
21	Final CRP	5 days	Mon 9/20/10	Fri 9/24/10
22	Project Team Meeting	0 days	Fri 9/17/10	Fri 9/17/10
23	Approval of Planning Documents	0 days	Fri 9/24/10	Fri 9/24/10
24	**Task 2: Field Investigation**	**168 days**	**Mon 9/27/10**	**Wed 5/18/11**
25	**Phase 1 Field Work**	**9 days**	**Mon 9/27/10**	**Fri 10/8/10**
26	Pilot Borehole Advancement	4 days	Mon 9/27/10	Thu 9/30/10
27	Deep Monitoring Well Installation	4 days	Fri 10/1/10	Wed 10/6/10
28	Project Team Meeting - Post Phase 1	0 days	Fri 10/8/10	Fri 10/8/10
29	**Phase 2 Field Work**	**9 days**	**Mon 10/11/10**	**Fri 10/22/10**
30	Deep Monitoring Well Installation	8 days	Mon 10/11/10	Wed 10/20/10
31	Shallow and Intermediate MW Installation	3 days	Mon 10/18/10	Wed 10/20/10
32	Project Team Meeting - Post Phase 2	0 days	Fri 10/22/10	Fri 10/22/10
33	**Phase 3 Field Work**	**9 days**	**Mon 10/25/10**	**Fri 11/5/10**
34	Shallow and Intermediate MW Installation	8 days	Mon 10/25/10	Wed 11/3/10
35	Soil Gas Sampling	2 days	Mon 11/1/10	Tue 11/2/10
36	Surface Water, Sediment, SWIM Sampling	2 days	Mon 11/1/10	Tue 11/2/10
37	Slug Testing	2 days	Fri 10/29/10	Mon 11/1/10
38	Aquifer Testing	2 days	Fri 10/29/10	Mon 11/1/10

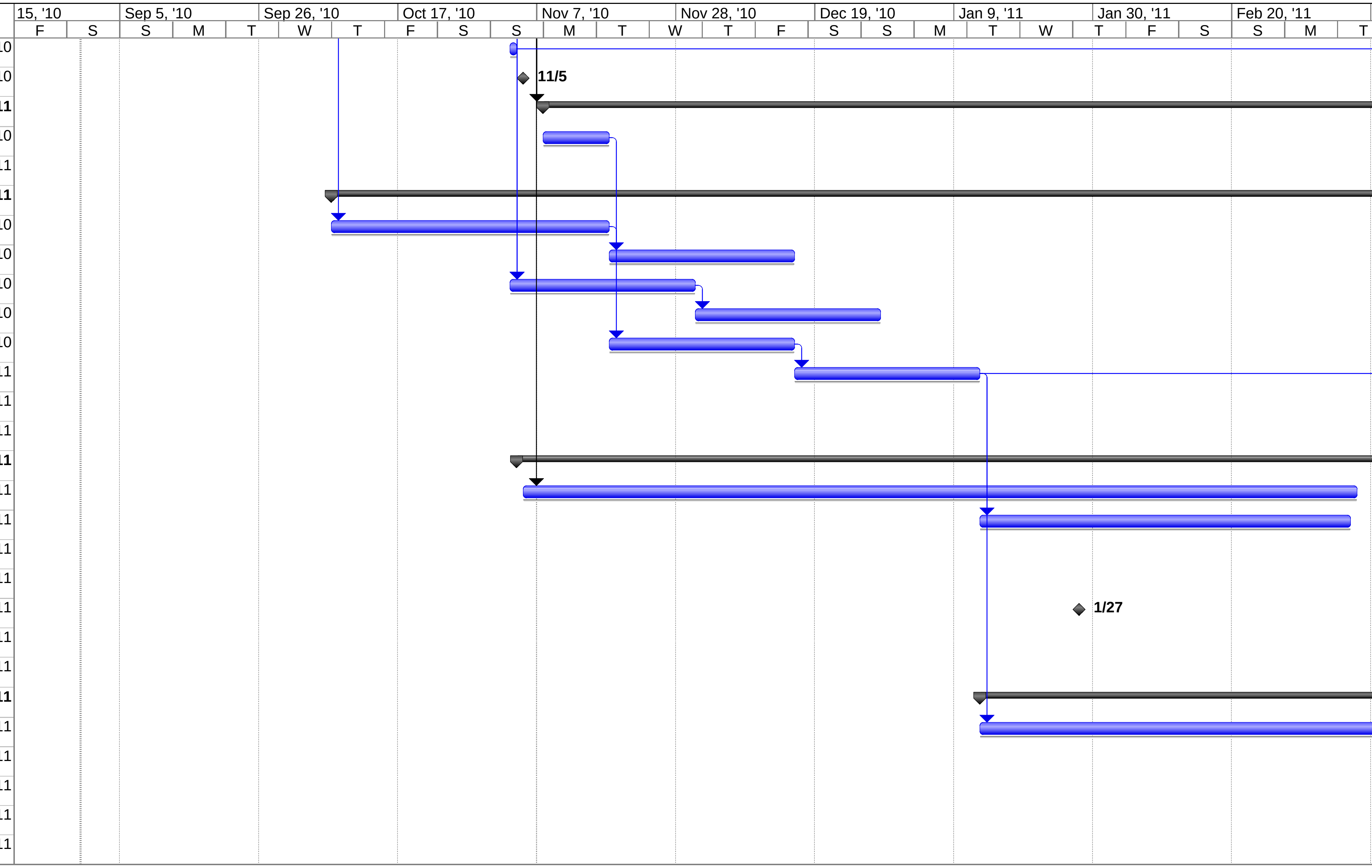


Project: Gasoline Alley PCE RI Schedi
Date: Mon 8/30/10

Task		Progress		Summary		External Tasks		Deadline	
Split		Milestone		Project Summary		External Milestone			

Figure 6-1
Gasoline Alley PCE Remedial Investigation
Draft Work Plan Schedule

ID	Task Name	Duration	Start	Finish
39	Site Survey	1 day	Wed 11/3/10	Wed 11/3/10
40	Project Team Meeting - Post Phase 3	0 days	Fri 11/5/10	Fri 11/5/10
41	**Phase 4 Field Work**	**138 days**	**Mon 11/8/10**	**Wed 5/18/11**
42	Round 1 Groundwater Sampling	8 days	Mon 11/8/10	Wed 11/17/10
43	Round 2 Groundwater Sampling	8 days	Mon 5/9/11	Wed 5/18/11
44	**Task 3: Sample Analysis/Validation**	**200 days**	**Thu 10/7/10**	**Wed 7/13/11**
45	Deep Borehole Laboratory Analysis	30 days	Thu 10/7/10	Wed 11/17/10
46	Deep Borehole Data Validation	20 days	Thu 11/18/10	Wed 12/15/10
47	Soil Gas, SW, SED, SWIM Lab Analysis	20 days	Wed 11/3/10	Tue 11/30/10
48	Soil Gas, SW, SED, SWIM Data Validation	20 days	Wed 12/1/10	Tue 12/28/10
49	Round 1 Groundwater Lab Analysis	20 days	Thu 11/18/10	Wed 12/15/10
50	Round 1 Groundwater Data Validation	20 days	Thu 12/16/10	Wed 1/12/11
51	Round 2 Groundwater Lab Analysis	20 days	Thu 5/19/11	Wed 6/15/11
52	Round 2 Groundwater Lab Validation	20 days	Thu 6/16/11	Wed 7/13/11
53	**Task 4: Data Evaluation**	**220 days**	**Thu 11/4/10**	**Wed 9/7/11**
54	Phase 1-3 Data Reduction and Reporting	90 days	Fri 11/5/10	Thu 3/10/11
55	Phase 4, Round 1 Data Reduction & Reporting	40 days	Thu 1/13/11	Wed 3/9/11
56	Phase 4, Round 2 Data Reduction & Reporting	40 days	Thu 7/14/11	Wed 9/7/11
57	Fate and Transport Modelling	120 days	Thu 11/4/10	Wed 4/20/11
58	Post Field Investigation Meeting	2 days	Wed 1/26/11	Thu 1/27/11
59	RI Report Project Team Meeting	2 days	Wed 8/17/11	Thu 8/18/11
60	**Task 5: Risk Assessment**	90 days	Thu 1/13/11	Wed 5/18/11
61	**Task 6: RI Report**	**202 days**	**Thu 1/13/11**	**Fri 10/21/11**
62	Army Draft PCE RI Report	122 days	Thu 1/13/11	Fri 7/1/11
63	Army Review of RI Report	20 days	Mon 7/4/11	Fri 7/29/11
64	Draft PCE RI Report	10 days	Mon 8/1/11	Fri 8/12/11
65	NYSDEC Review of Draft PCE RI Report	40 days	Mon 8/15/11	Fri 10/7/11
66	Final PCE RI Report	10 days	Mon 10/10/11	Fri 10/21/11



Project: Gasoline Alley PCE RI Sched
Date: Mon 8/30/10

Task | Split | Progress | Milestone | Summary | Project Summary | External Tasks | External Milestone | Deadline

Figure 6-1
Gasoline Alley PCE Remedial Investigation
Draft Work Plan Schedule

ID	Task Name	Duration	Start
1	**Project Award Date**	0 days	Mon 8/23/10
2	**Task 1: Project Planning**	**25 days**	**Mon 8/23/10**
3	Army Draft PCE RI Work Plan	2 days	Mon 8/23/10
4	Internal Army Review of Work Plan	3 days	Wed 8/25/10
5	Draft PCE RI Work Plan	2 days	Mon 8/30/10
6	NYSDEC Review of Work Plan	10 days	Wed 9/1/10
7	Final PCE RI Work Plan	8 days	Wed 9/15/10
8	Draft PCE RI FSP Updates of QAPP	5 days	Mon 8/23/10
9	Internal Army Review of FSP Updates of QAPP	4 days	Mon 8/30/10
10	Draft PCE RI FSP Updates ofQAPP	2 days	Fri 9/3/10
11	NYSDEC Review of FSP Updates of QAPP	10 days	Tue 9/7/10
12	Final PCE RI FS Update of QAPP	4 days	Tue 9/21/10
13	Draft Site Background Summary	2 days	Mon 8/23/10
14	Army Review of Site Background Summary	18 days	Wed 8/25/10
15	Final Site Background Summary	5 days	Mon 9/20/10
16	Draft PCE RI HASP	4 days	Mon 8/23/10
17	Army Review of HASP	15 days	Fri 8/27/10
18	Final PCE RI HASP	6 days	Fri 9/17/10
19	Draft CRP	10 days	Mon 8/23/10
20	Army Review of CRP	10 days	Mon 9/6/10
21	Final CRP	5 days	Mon 9/20/10
22	Project Team Meeting	0 days	Fri 9/17/10
23	Approval of Planning Documents	0 days	Fri 9/24/10
24	**Task 2: Field Investigation**	**168 days**	**Mon 9/27/10**
25	**Phase 1 Field Work**	**9 days**	**Mon 9/27/10**
26	Pilot Borehole Advancement	4 days	Mon 9/27/10
27	Deep Monitoring Well Installation	4 days	Fri 10/1/10
28	Project Team Meeting - Post Phase 1	0 days	Fri 10/8/10
29	**Phase 2 Field Work**	**9 days**	**Mon 10/11/10**
30	Deep Monitoring Well Installation	8 days	Mon 10/11/10
31	Shallow and Intermediate MW Installation	3 days	Mon 10/18/10
32	Project Team Meeting - Post Phase 2	0 days	Fri 10/22/10
33	**Phase 3 Field Work**	**9 days**	**Mon 10/25/10**
34	Shallow and Intermediate MW Installation	8 days	Mon 10/25/10
35	Soil Gas Sampling	2 days	Mon 11/1/10
36	Surface Water, Sediment, SWIM Sampling	2 days	Mon 11/1/10
37	Slug Testing	2 days	Fri 10/29/10
38	Aquifer Testing	2 days	Fri 10/29/10

Timescale: r 13, '11 | Apr 3, '11 | Apr 24, '11 | May 15, '11 | Jun 5, '11 | Jun 26, '11 | Jul 17, '11 | Aug 7, '11 | Aug 28, '11 | Sep 18, '11 | Oct 9, '11
W T F S S M T W T F S S M T W T F S S M T W T F S S M T W

Project: Gasoline Alley PCE RI Sched
Date: Mon 8/30/10

Legend: Task | Split | Progress | Milestone | Summary | Project Summary | External Tasks | External Milestone | Deadline

Figure 6-1
Gasoline Alley PCE Remedial Investigation
Draft Work Plan Schedule

ID	Task Name	Duration	Start
39	Site Survey	1 day	Wed 11/3/10
40	Project Team Meeting - Post Phase 3	0 days	Fri 11/5/10
41	**Phase 4 Field Work**	**138 days**	**Mon 11/8/10**
42	Round 1 Groundwater Sampling	8 days	Mon 11/8/10
43	Round 2 Groundwater Sampling	8 days	Mon 5/9/11
44	**Task 3: Sample Analysis/Validation**	**200 days**	**Thu 10/7/10**
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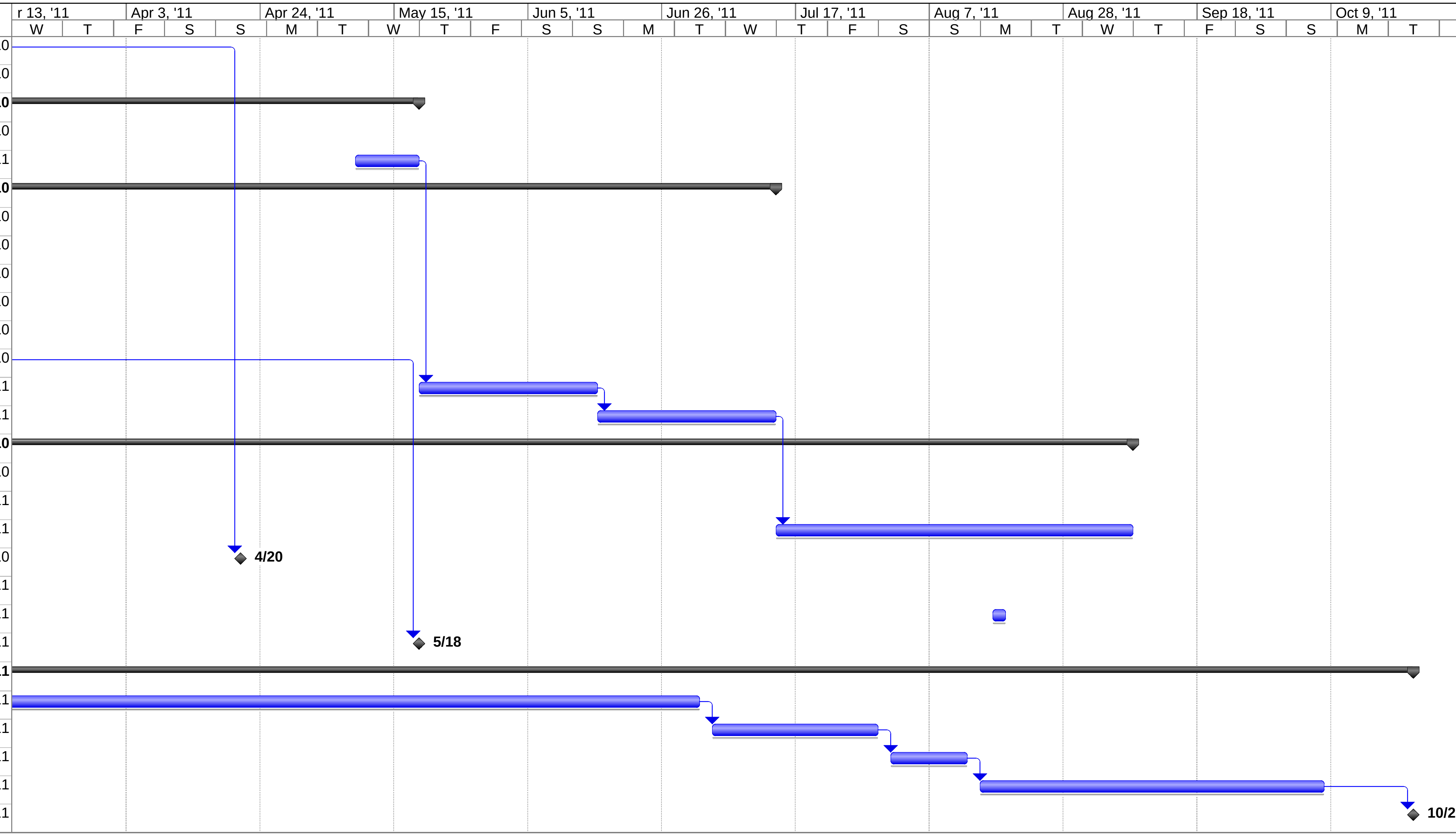
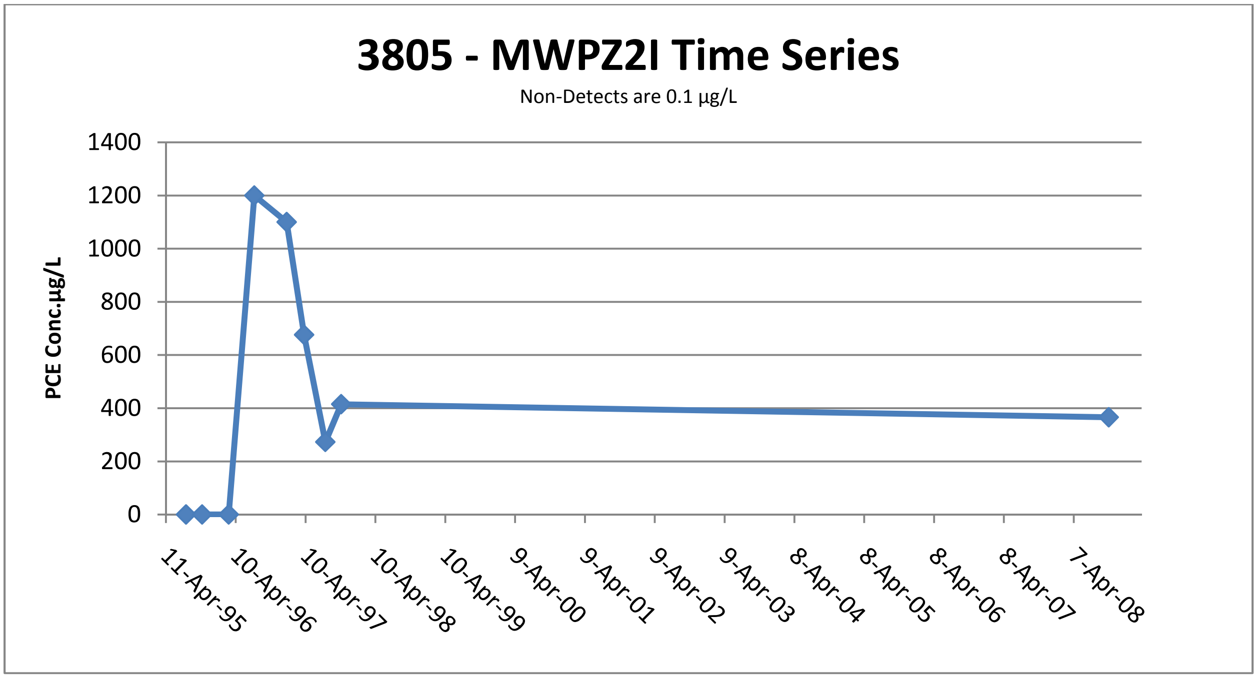
46	Deep Borehole Data Validation	20 days	Thu 11/18/10
47	Soil Gas, SW, SED, SWIM Lab Analysis	20 days	Wed 11/3/10
48	Soil Gas, SW, SED, SWIM Data Validation	20 days	Wed 12/1/10
49	Round 1 Groundwater Lab Analysis	20 days	Thu 11/18/10
50	Round 1 Groundwater Data Validation	20 days	Thu 12/16/10
51	Round 2 Groundwater Lab Analysis	20 days	Thu 5/19/11
52	Round 2 Groundwater Lab Validation	20 days	Thu 6/16/11
53	**Task 4: Data Evaluation**	**220 days**	**Thu 11/4/10**
54	Phase 1-3 Data Reduction and Reporting	90 days	Fri 11/5/10
55	Phase 4, Round 1 Data Reduction & Reporting	40 days	Thu 1/13/11
56	Phase 4, Round 2 Data Reduction & Reporting	40 days	Thu 7/14/11
57	Fate and Transport Modelling	120 days	Thu 11/4/10
58	Post Field Investigation Meeting	2 days	Wed 1/26/11
59	RI Report Project Team Meeting	2 days	Wed 8/17/11
60	**Task 5: Risk Assessment**	90 days	Thu 1/13/11
61	**Task 6: RI Report**	**202 days**	**Thu 1/13/11**
62	Army Draft PCE RI Report	122 days	Thu 1/13/11
63	Army Review of RI Report	20 days	Mon 7/4/11
64	Draft PCE RI Report	10 days	Mon 8/1/11
65	NYSDEC Review of Draft PCE RI Report	40 days	Mon 8/15/11
66	Final PCE RI Report	10 days	Mon 10/10/11

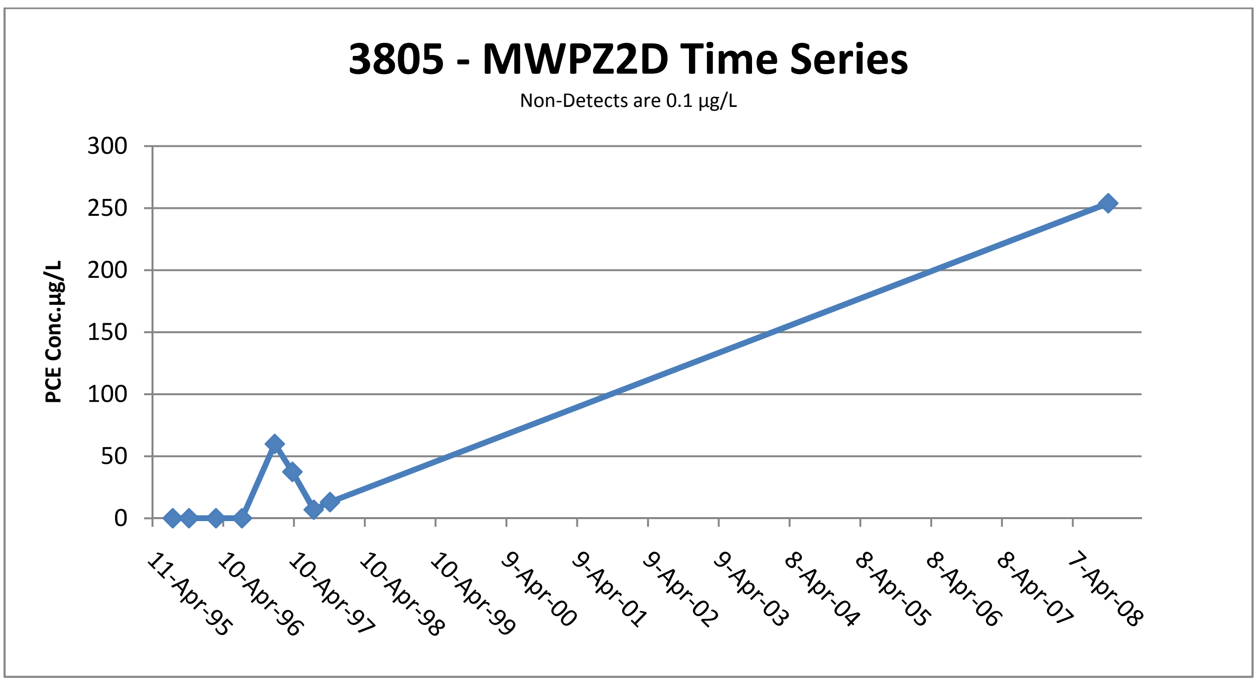


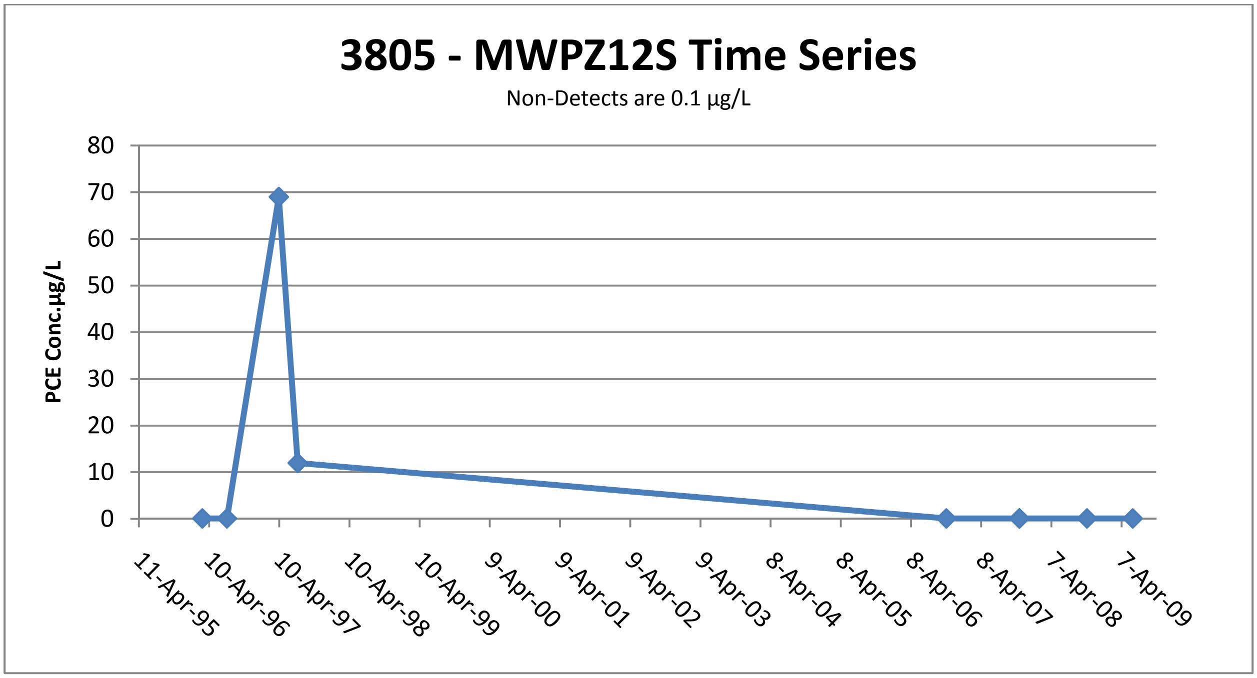
Project: Gasoline Alley PCE RI Sched
Date: Mon 8/30/10

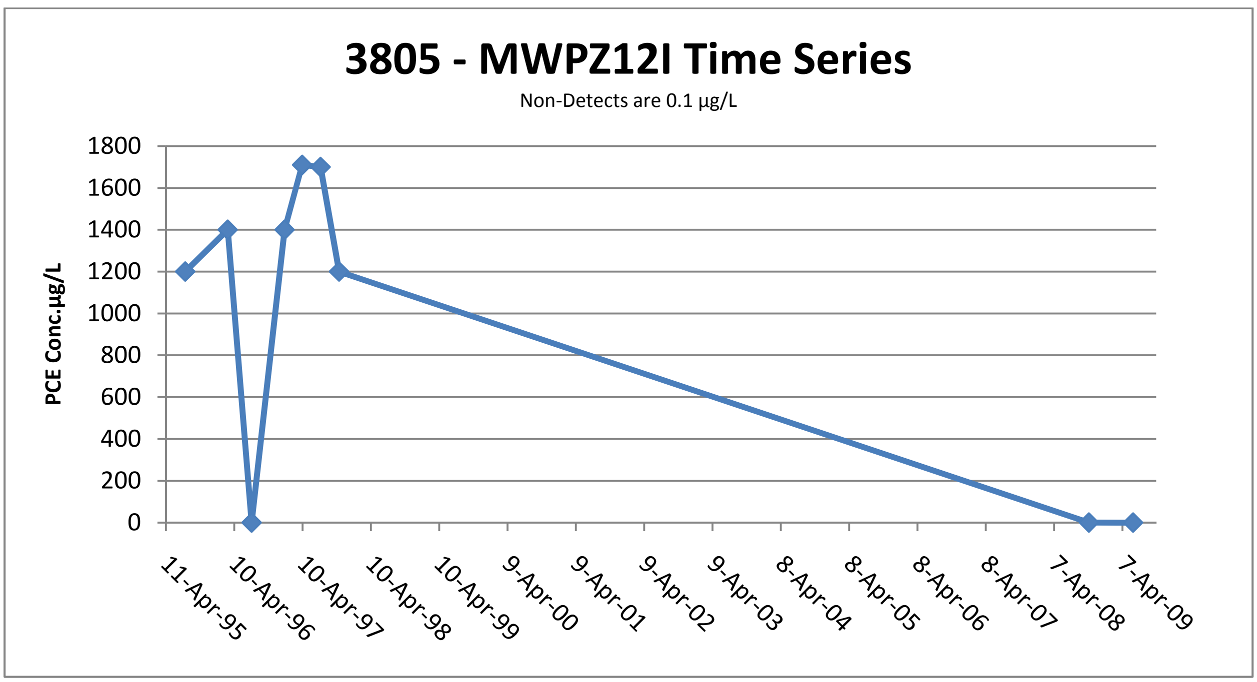
Task	Progress	Summary	External Tasks	Deadline
Split	Milestone	Project Summary	External Milestone	

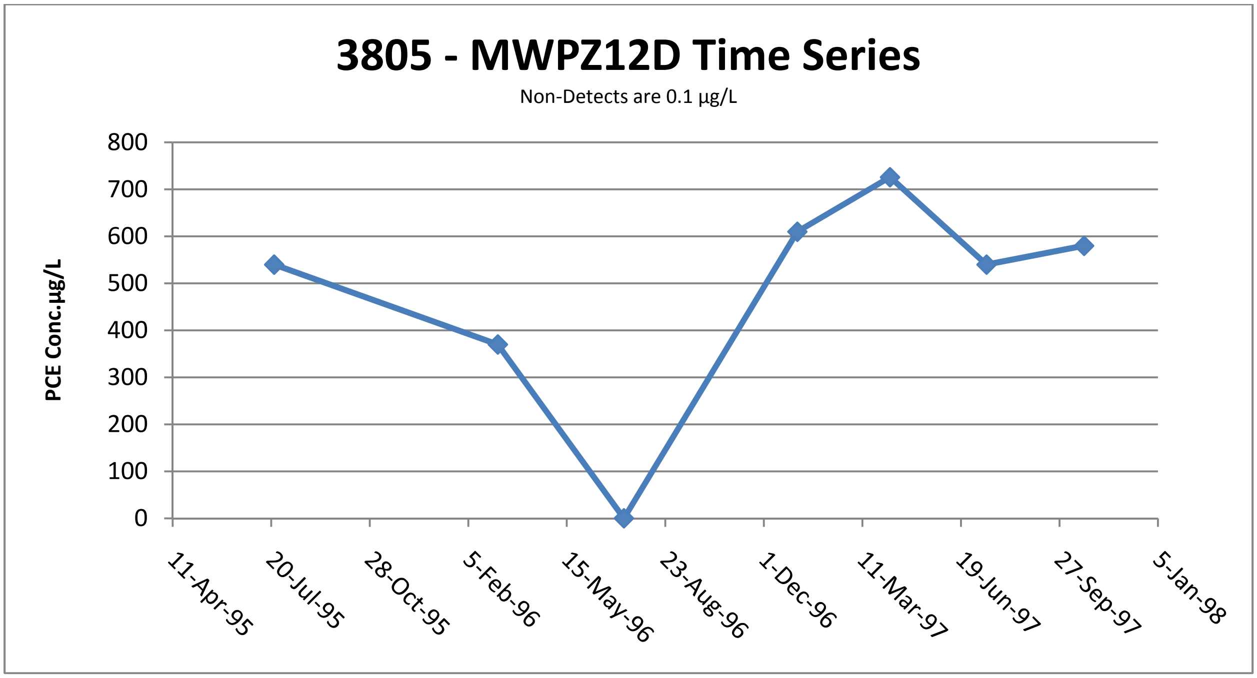
APPENDIX A: PCE Time Series Plots

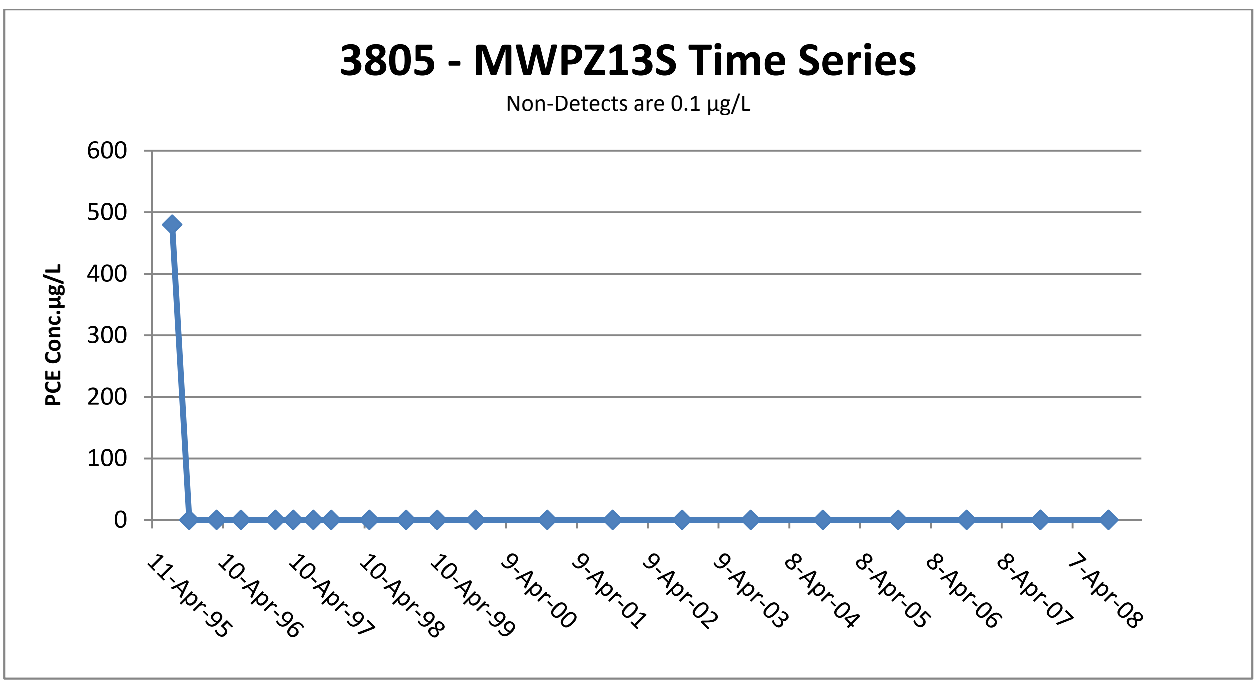

3805 - MWPZ2I Time Series
Non-Detects are 0.1 µg/L
PCE Conc.µg/L
1400
1200
1000
800
600
400
200
0
11-Apr-95
10-Apr-96
10-Apr-97
10-Apr-98
10-Apr-99
9-Apr-00
9-Apr-01
9-Apr-02
9-Apr-03
8-Apr-04
8-Apr-05
8-Apr-06
8-Apr-07
7-Apr-08

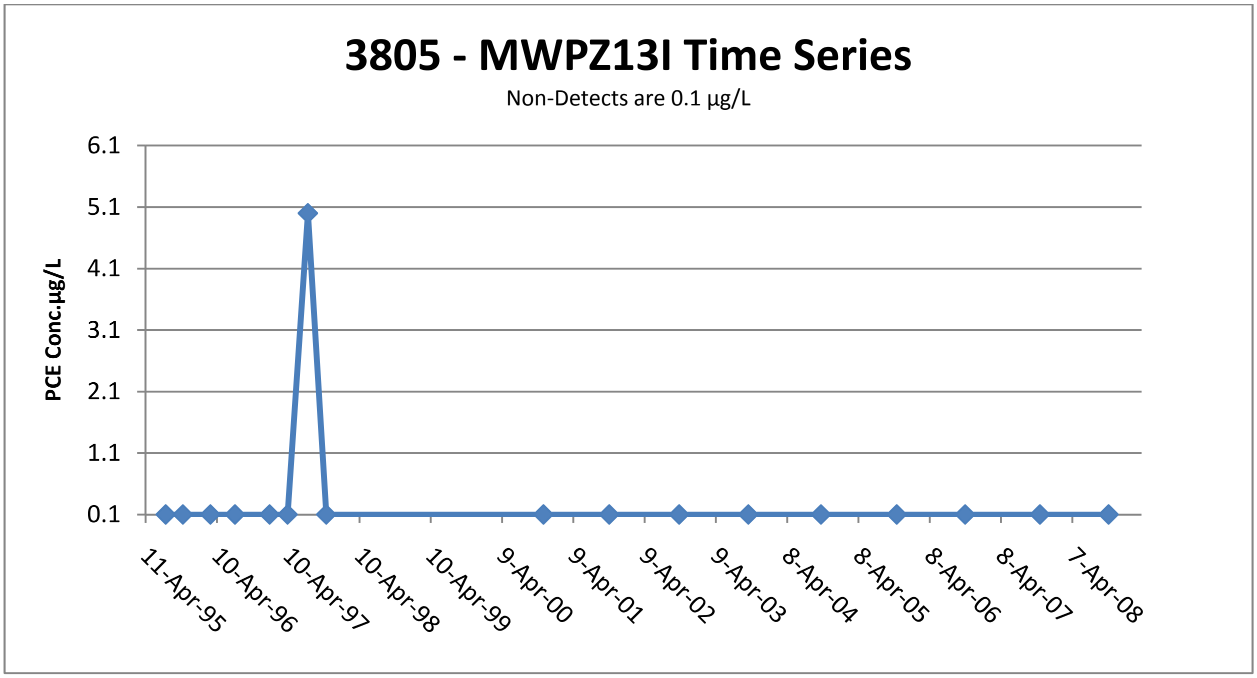

3805 - MWPZ2D Time Series
Non-Detects are 0.1 µg/L
PCE Conc.µg/L
300
250
200
150
100
50
0
11-Apr-95
10-Apr-96
10-Apr-97
10-Apr-98
10-Apr-99
9-Apr-00
9-Apr-01
9-Apr-02
9-Apr-03
8-Apr-04
8-Apr-05
8-Apr-06
8-Apr-07
7-Apr-08

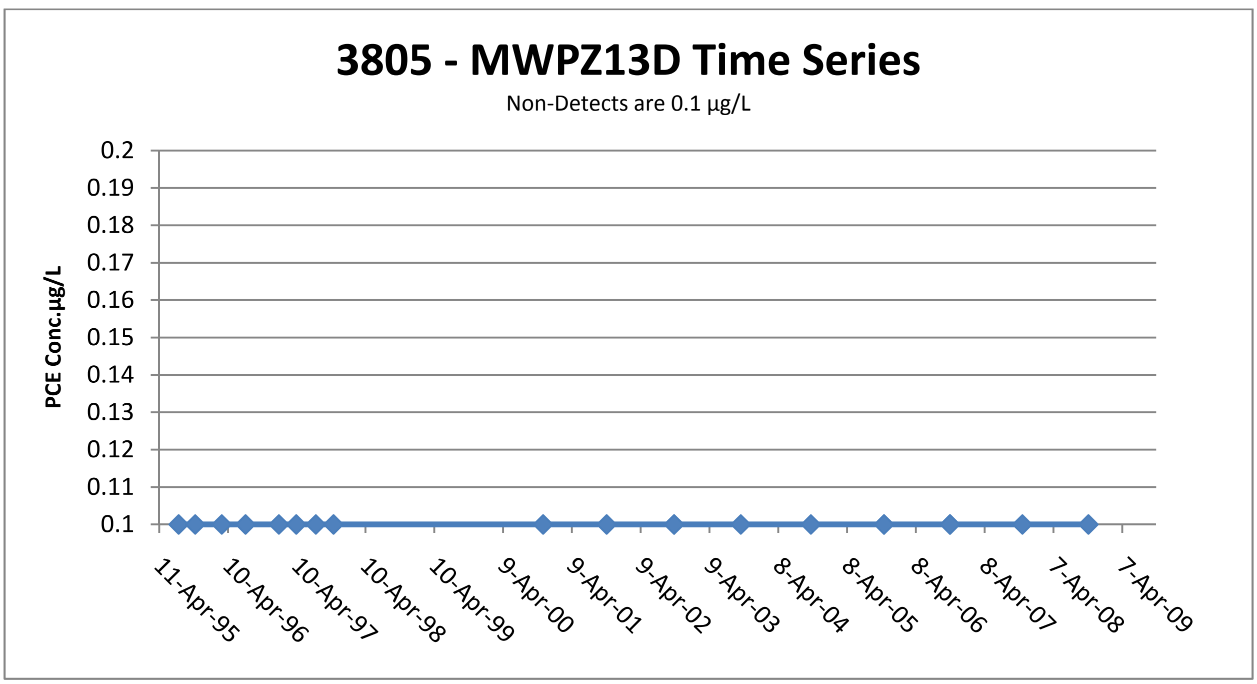

3805 - MWPZ12S Time Series
Non-Detects are 0.1 µg/L
PCE Conc.µg/L
80
70
60
50
40
30
20
10
0
11-Apr-95
10-Apr-96
10-Apr-97
10-Apr-98
10-Apr-99
9-Apr-00
9-Apr-01
9-Apr-02
9-Apr-03
8-Apr-04
8-Apr-05
8-Apr-06
8-Apr-07
7-Apr-08
7-Apr-09

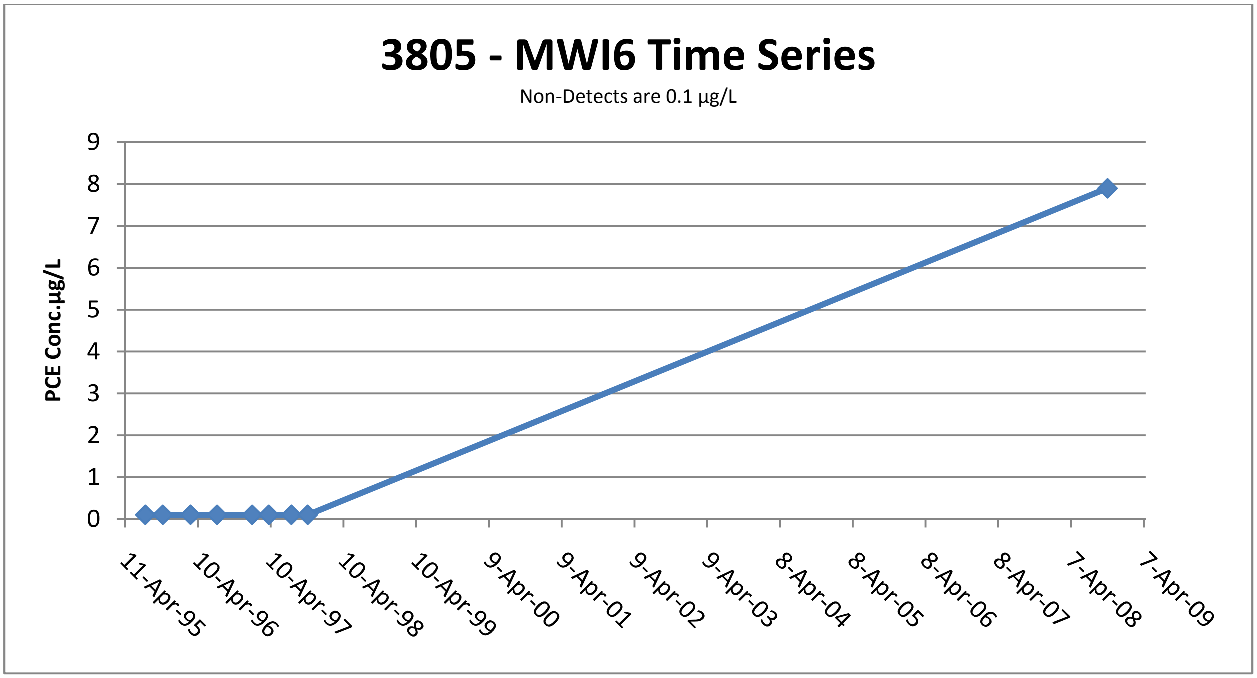

3805 - MWPZ12I Time Series
Non-Detects are 0.1 µg/L
PCE Conc.µg/L
1800
1600
1400
1200
1000
800
600
400
200
0
11-Apr-95
10-Apr-96
10-Apr-97
10-Apr-98
10-Apr-99
9-Apr-00
9-Apr-01
9-Apr-02
9-Apr-03
8-Apr-04
8-Apr-05
8-Apr-06
8-Apr-07
7-Apr-08
7-Apr-09

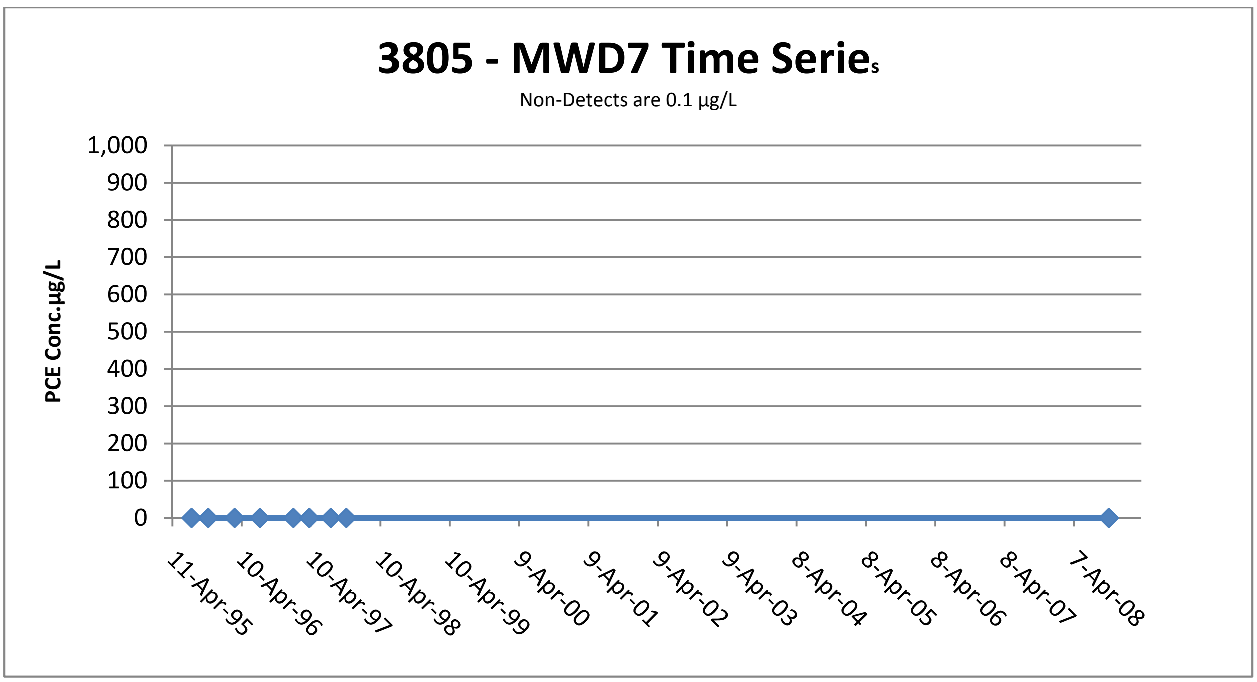

3805 - MWPZ12D Time Series
Non-Detects are 0.1 µg/L
PCE Conc.µg/L
800
700
600
500
400
300
200
100
0
11-Apr-95
20-Jul-95
28-Oct-95
5-Feb-96
15-May-96
23-Aug-96
1-Dec-96
11-Mar-97
19-Jun-97
27-Sep-97
5-Jan-98

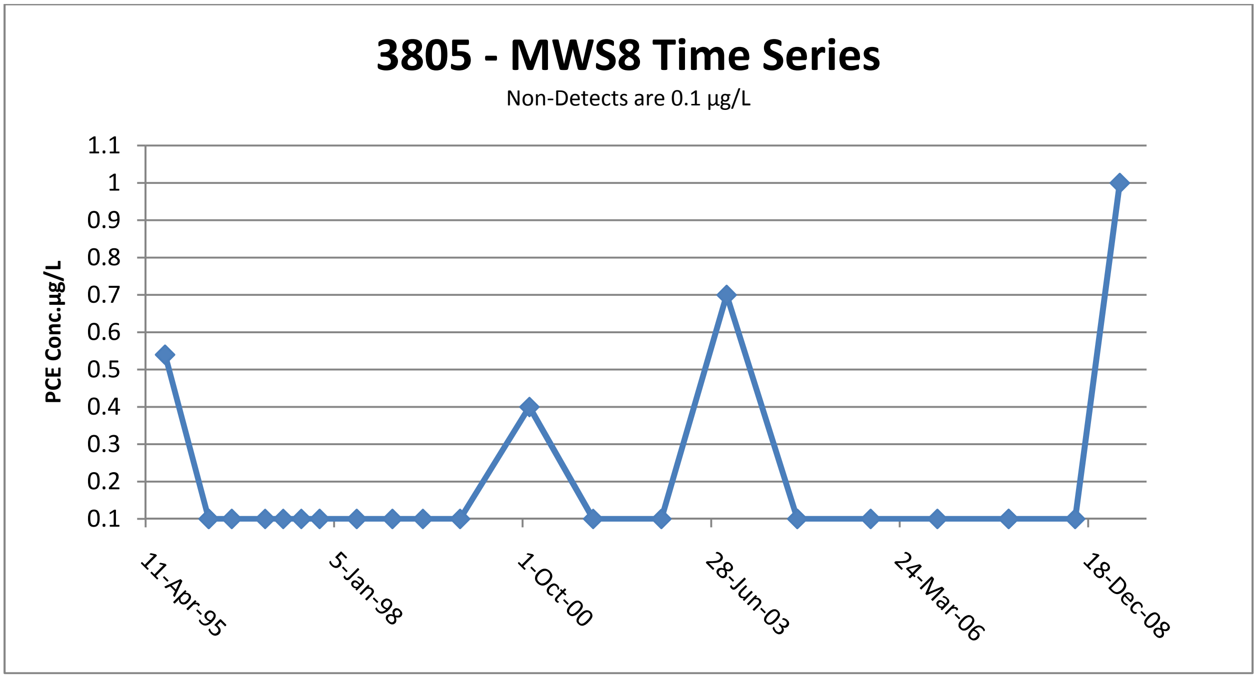

3805 - MWPZ13S Time Series
Non-Detects are 0.1 µg/L
PCE Conc.µg/L
600
500
400
300
200
100
0
11-Apr-95
10-Apr-96
10-Apr-97
10-Apr-98
10-Apr-99
9-Apr-00
9-Apr-01
9-Apr-02
9-Apr-03
8-Apr-04
8-Apr-05
8-Apr-06
8-Apr-07
7-Apr-08

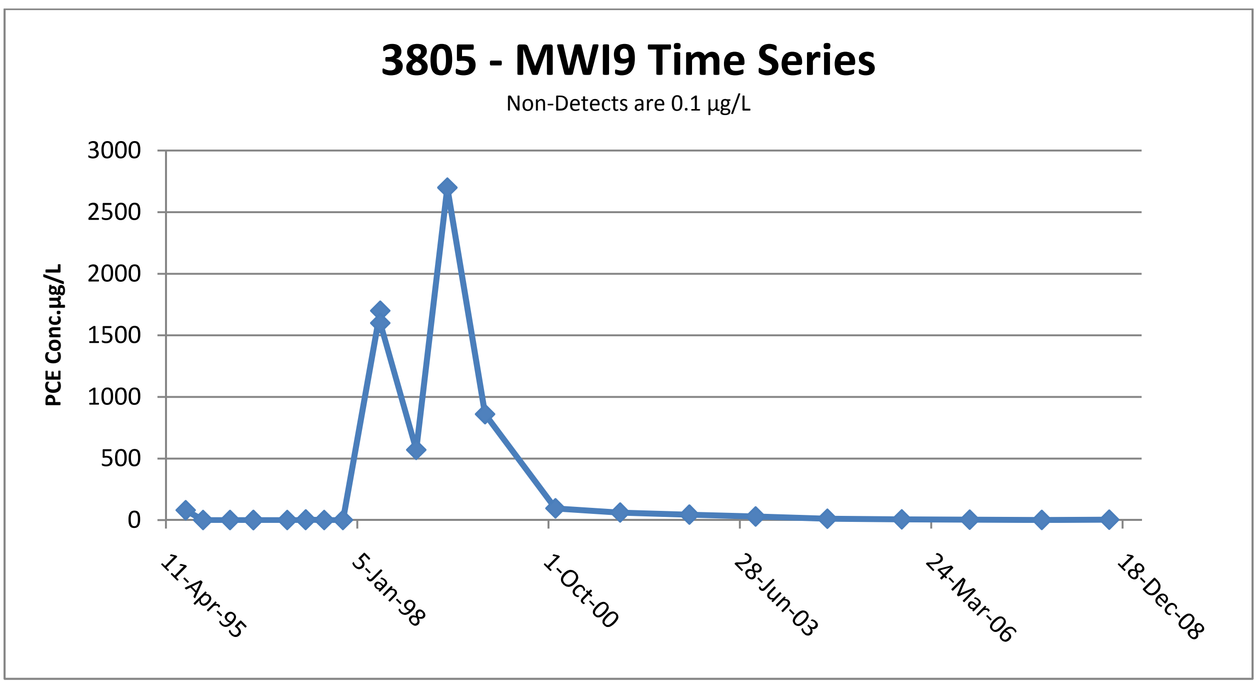

3805 - MWPZ13I Time Series
Non-Detects are 0.1 µg/L
PCE Conc.µg/L
6.1
5.1
4.1
3.1
2.1
1.1
0.1
11-Apr-95
10-Apr-96
10-Apr-97
10-Apr-98
10-Apr-99
9-Apr-00
9-Apr-01
9-Apr-02
9-Apr-03
8-Apr-04
8-Apr-05
8-Apr-06
8-Apr-07
7-Apr-08

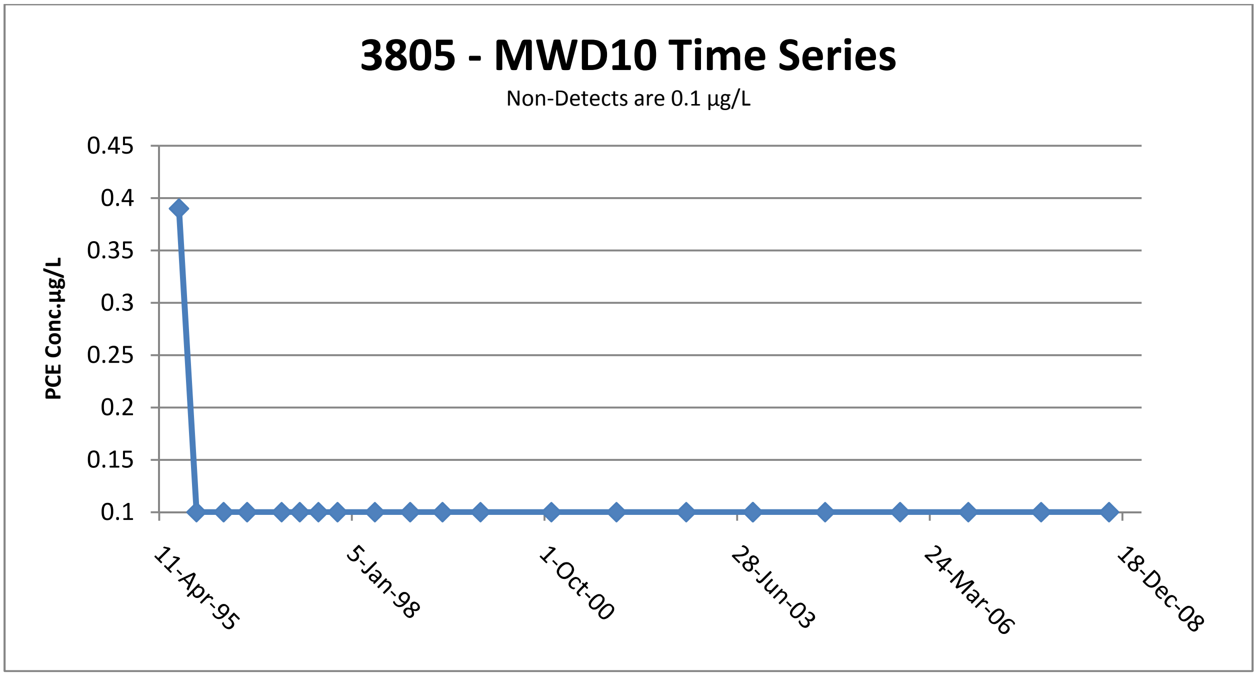

3805 - MWPZ13D Time Series
Non-Detects are 0.1 µg/L
PCE Conc.µg/L
0.2
0.19
0.18
0.17
0.16
0.15
0.14
0.13
0.12
0.11
0.1
11-Apr-95
10-Apr-96
10-Apr-97
10-Apr-98
10-Apr-99
9-Apr-00
9-Apr-01
9-Apr-02
9-Apr-03
8-Apr-04
8-Apr-05
8-Apr-06
8-Apr-07
7-Apr-08
7-Apr-09

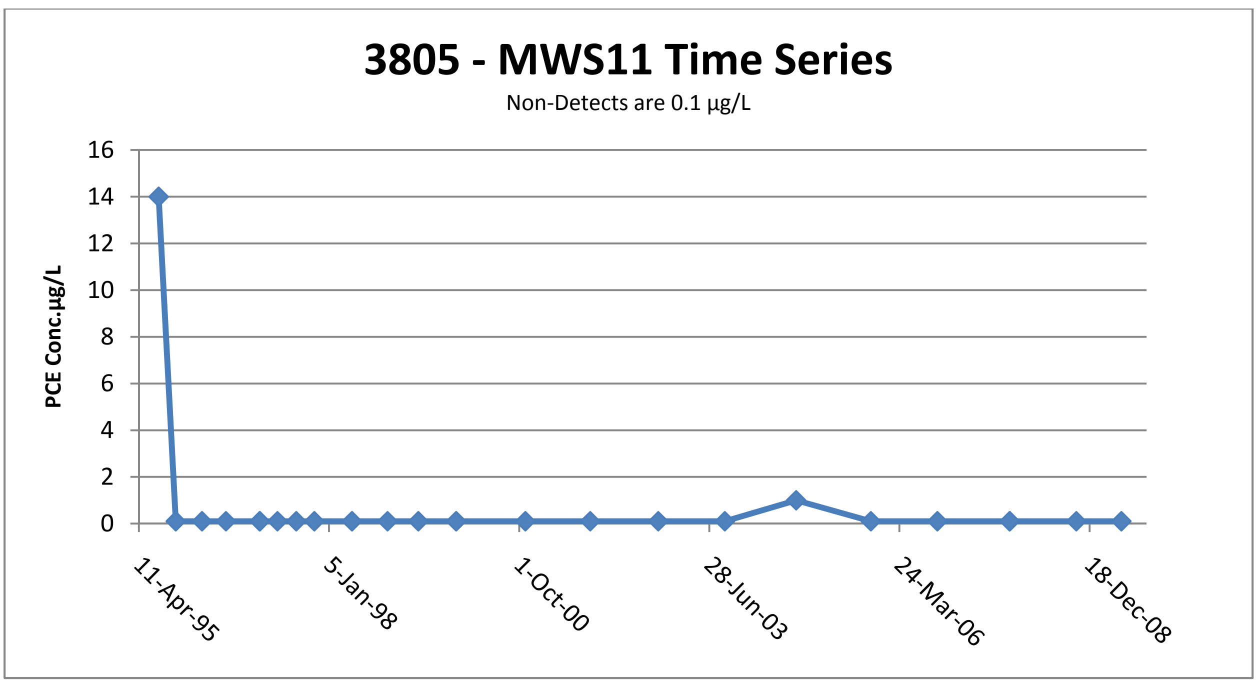

3805 - MWI6 Time Series
Non-Detects are 0.1 µg/L
PCE Conc.µg/L
0
1
2
3
4
5
6
7
8
9
11-Apr-95
10-Apr-96
10-Apr-97
10-Apr-98
10-Apr-99
9-Apr-00
9-Apr-01
9-Apr-02
9-Apr-03
8-Apr-04
8-Apr-05
8-Apr-06
8-Apr-07
7-Apr-08
7-Apr-09

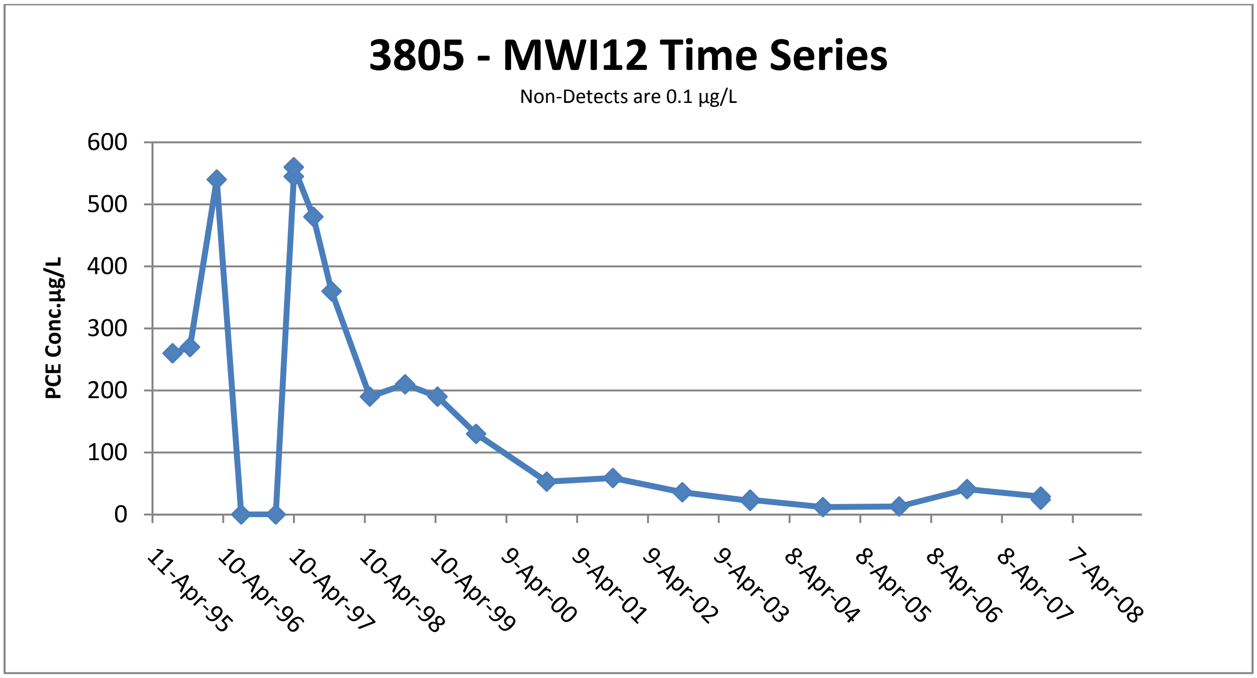

3805 - MWD7 Time Series
Non-Detects are 0.1 µg/L
PCE Conc.µg/L
0
100
200
300
400
500
600
700
800
900
1,000
11-Apr-95
10-Apr-96
10-Apr-97
10-Apr-98
10-Apr-99
9-Apr-00
9-Apr-01
9-Apr-02
9-Apr-03
8-Apr-04
8-Apr-05
8-Apr-06
8-Apr-07
7-Apr-08

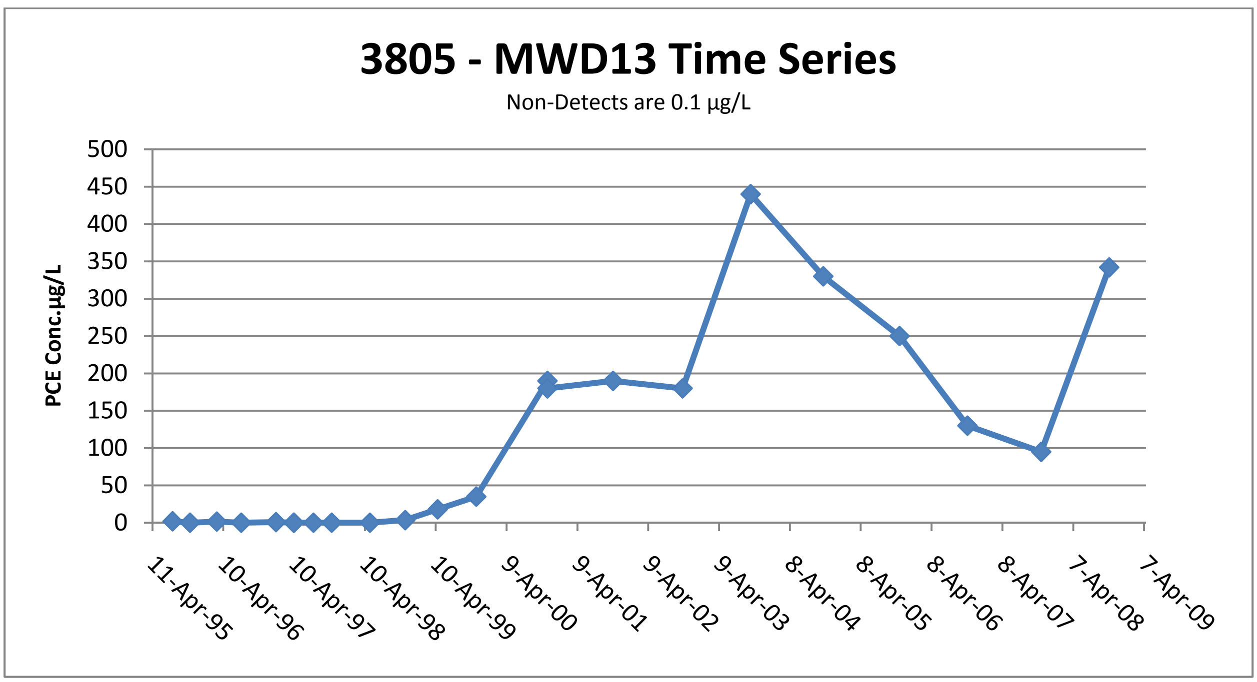

3805 - MWS8 Time Series
Non-Detects are 0.1 µg/L
PCE Conc.µg/L
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
11-Apr-95
5-Jan-98
1-Oct-00
28-Jun-03
24-Mar-06
18-Dec-08


3805 - MWI9 Time Series
Non-Detects are 0.1 µg/L
PCE Conc.µg/L
3000
2500
2000
1500
1000
500
0
11-Apr-95
5-Jan-98
1-Oct-00
28-Jun-03
24-Mar-06
18-Dec-08


3805 - MWD10 Time Series
Non-Detects are 0.1 µg/L
PCE Conc.µg/L
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
11-Apr-95
5-Jan-98
1-Oct-00
28-Jun-03
24-Mar-06
18-Dec-08


3805 - MWS11 Time Series
Non-Detects are 0.1 µg/L
PCE Conc.µg/L
16
14
12
10
8
6
4
2
0
11-Apr-95
5-Jan-98
1-Oct-00
28-Jun-03
24-Mar-06
18-Dec-08


3805 - MWI12 Time Series
Non-Detects are 0.1 µg/L
PCE Conc.µg/L
600
500
400
300
200
100
0
11-Apr-95
10-Apr-96
10-Apr-97
10-Apr-98
10-Apr-99
9-Apr-00
9-Apr-01
9-Apr-02
9-Apr-03
8-Apr-04
8-Apr-05
8-Apr-06
8-Apr-07
7-Apr-08


3805 - MWD13 Time Series
Non-Detects are 0.1 µg/L
PCE Conc.µg/L
500
450
400
350
300
250
200
150
100
50
0
11-Apr-95
10-Apr-96
10-Apr-97
10-Apr-98
10-Apr-99
9-Apr-00
9-Apr-01
9-Apr-02
9-Apr-03
8-Apr-04
8-Apr-05
8-Apr-06
8-Apr-07
7-Apr-08
7-Apr-09

APPENDIX B: Field Forms

Soil Core Section Log Form - Codes

Property	Description	Log Code
ODOR (enter letter and number codes)		
Natural Organic		**O**
Hydrogen Sulfide		**HS**
Solvent		**So**
Petroleum		**P**
Septic		**Se**
Faint		**1**
Moderate		**2**
Strong		**3**
NAPL		
Absent	none observed	**A**
Residual NAPL	NAPL appears immobile	**R**
Mobile NAPL	NAPL appears mobile	**FP**
DOMINANT GRAIN SIZE		
Gravel = **G** / Coarse Sand = **CS** / Medium Sand = **MS** / Fine Sand = **FS** Silt = **Si** / Clay = **C**		
GRADING		
Well Graded	well-graded soil has a wide range of particle sizes and a substantial amount of intermediate sizes	**W**
Poorly Graded	poorly-graded soil consists primarily of 1 size or has missing intermediate grain size fractions	**P**
HCI REACTION		
None	no visible reaction	**N**
Weak	slow bubble formation	**W**
Strong	immediate and vigorous bubble format	**S**
MOISTURE		
Dry	absense of moisture	**D**
Moist	damp but no visible water	**M**
Wet	visible free water	**W**
CEMENTATION		
Weak	crumbles or breaks with handling or little finger pressure	**W**
Moderate	crumbles or breaks with moderate finger pressure	**M**
Strong	will not crumble or break with finger pressure	**S**
ANGULARITY		
Angular	refer to chart	**A**
SubAngular	refer to chart	**SA**
SubRounded	refer to chart	**SR**
Rounded	refer to chart	**R**

Property	Description	Log Code
CONSISTENCY (if cohesive soil)		
Very Soft	thumb will penetrate soil > 1"	**VS**
Soft	thumb will penetrate soil ~ 1"	**So**
Firm	thumb will penetrate soil ~ 1/4"	**F**
Stiff	thumb won't indent soil, but thumbnail will	**St**
Hard	thumbnail will not readily indent soil	**H**
PLASTICITY (if fine-grained)		
Non-plastic	a 1/8" thead can't be rolled at any water content	**NP**
Low	a 1/8" thread can barely be rolled	**L**
Medium	a 1/8" is easy to roll and not much time is required to reach the plastic limit, but the thread can't be rerolled after reaching the plastic limit	**M**
High	a 1/8" thread is easily rolled, takes a long time to reach the plastic limit, and can be rerolled after reaching the plastic limit	**H**
STRUCTURE		
Stratified	alternating layers of varying material color with layers at least 1/4" thick	**S**
Laminated	alternating layers of varying material color with layers <1/4" thick	**La**
Fissured	breaks along defined planes of fracture with little resistance to fracturing	**F**
Slickensided	fracture planes appear polished	**Sl**
Blocky	cohesive soil that can be broken down into small angular fragments	**B**
Lenses	inclusion of small pockets of different soil	**Le**
Homogeneous	same color and appearance throughout	**H**
ORGANIC MATERIAL (typ. dark brown to black color, poss. organic odor, will not have a high toughness or plasticity)		
Peat	> 50% organic matter	**P**
Organic	15-50% organic matter	**O**
Some	5-15% oranic matter	**S**
MATRIX		
Clast Supported		**C**
Matrix Supported		**M**
GRAIN TYPE		
Qtz = quartz, **Sh** = shells, **LS** = limestone fragments, **DF** = dolomite fragments, **PhF** = phosphate rock fragments, **GW** = Groundwater, **So** = Soil		

Soil Section Log Form

Boring ID:	Core Run #:	Depth Interval:	Core Recovery:
Coring Start Time:	Coring End Time:	Time / Date:	Logger:

Core Interval (feet from top)	PID Reading (ppm)	Odor	NAPL	Color, Hue, Chroma (wet)	% Gravel	% Sand	% Silt	% Clay	Grading	Moisture	Cementation	Angularity	Consistency	Plasticity	Structure	Organic Material	Matrix	Soil	Groundwater	Comments

PID
Instrument Calibration Sheet
DAILY LOG

Plexus Scientific
4501 Ford Avenue, Suite 1200
Alexandria, VA 22302

Project Name: ______________________________

Calibrating Personnel: ______________________________

Instrument Name/Model: ______________________________

Date & Time of Calibration	Zero Cal Reading (PPM)	Span Gas Reading (PPM)	Comments (Are readings within 1-2 PPM?)

HEALTH AND SAFETY PLAN (HASP)
SUBCONTRACTOR ACKNOWLEDGEMENT FORM
Remedial Action Operations and Long-Term Management at Designated Sites
Fort Drum, New York

Plexus Scientific Corporation has developed a Health and Safety Plan (HASP) for Remedial Action Operations and Long-Term Management at Designated Sites at Fort Drum, New York. The HASP describes the activities of Plexus personnel, as well as the activities of subcontractor personnel, as they relate to the health and safety hazards associated with the project. The presence of a Plexus project management and the implementation of a HASP developed by Plexus are not intended to relieve the subcontractor of the responsibility for the health and safety of its employees.

The subcontractor may either adopt the Plexus HASP or develop a subcontractor HASP. If the subcontractor chooses to adopt the Plexus HASP, the subcontractor shall review the HASP and ensure that it meets the health and safety requirements of its employees for the operations they are contracted to perform. An Officer of the Subcontractor shall acknowledge their intention to follow the Plexus HASP by signing this form. If the subcontractor chooses to develop its own HASP, this document must be submitted to the Plexus Project Manager at least seven days prior to the start of the project. Plexus will review the subcontractor HASP, and if necessary, direct the subcontractor to correct or revise any health and safety-related deficiencies found in the document. The revised subcontractor HASP shall be available for use on-site prior to the start of the subcontractor's site activities.

The subcontractor shall be responsible for ensuring that its employees are aware of the contents of the approved HASP (either the subcontractor's adoption of the Plexus HASP or the subcontractor's own HASP) and that its employees abide by the provisions of the HASP.

☐ ______________________________ (Name of Subcontractor Company) choose to develop our own HASP.

☐ ______________________________ (Name of Subcontractor Company) choose to adopt the Plexus Scientific Corporation HASP.

______________________________	______________________________
Print Officer Name	Title
______________________________	______________________________
Signature	Date

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PLEXUS SCIENTIFIC CORPORATION
TAILGATE HEALTH & SAFETY MEETING

PROJECT NAME: ______________________ **DATE:** ______________________

PROJECT NUMBER: ______________________ **TIME:** ______________________

CUSTOMER: ______________________ **REPORT NO.:** ______________________

SPECIFIC LOCATION: ______________________

TYPE OF WORK: ______________________ **CHEMICALS USED:** ______________________

HEALTH & SAFETY TOPICS PRESENTED

PROTECTIVE CLOTHING/EQUIPMENT: ______________________

SITE-SPECIFIC CHEMICAL HAZARDS: ______________________

SITE-SPECIFIC PHYSICAL HAZARDS: ______________________

SITE EMERGENCY PROCEDURES: ______________________

EMERGENCY TELEPHONE NUMBERS: ______________________

NEAREST HOSPITAL TO THE SITE: ______________________

TODAY'S WEATHER FORECAST: ______________________

TODAY'S HEALTH & SAFETY TOPIC: ______________________

MEETING ATTENDEES

PRINT YOUR NAME

______________________ ______________________

______________________ ______________________

______________________ ______________________

______________________ ______________________

______________________ ______________________

______________________ ______________________

Ground Water Parameter
Instrument Calibration Sheet
DAILY LOG

Plexus Scientific
4501 Ford Avenue, Suite 1200
Alexandria, VA 22302

Project Name: ______________________________

Calibrating Personnel: ______________________________

Instrument Name/Model: ______________________________

Date of Calibration: ______________ **Time of Calibration:** ______________

Weather Conditions: ______________________________

Barometric Pressure: ______________ **(inches Hg) x 25.4 =** ______________ **mm Hg**

Calibration Event				
Parameter	**Initial Reading**	**Value Entered**	**Calibrated Reading**	**Comment**
pH (4.01)				
Conductivity (mS/m)				
Turbidity (1.0 NTU)				
DO (mg/L)				
ORP (mV)				
Water TEMP (°C)				

Notes: ______________________________

____

____

Ground Water Sampling
Low Flow Data Sheet

Plexus Scientific
4501 Ford Avenue, Suite 1200
Alexandria, VA 22302

Well Casing Volumes (gallon/foot of well)

1-¼" = 0.06	2" = 0.163	3" = 0.37	4" = 0.65
1-½" = 0.09	2-½" = 0.26	3-½" = 0.50	6" = 1.47

Date:
Site Name:
Well ID:
Sampler:

Purge Device:
Static water level:
Well TD: **1X Well Vol.=**
Well Construction:

Time	pH ± 0.1	COND (ms/cm) ± 3%	TURB (NTU) ± 10% or < 10	DO (mg/L) ± 10%	TEMP (°C) ± 3%	SAL (%)	TDS (g/L)	ORP (mv) ± 10 mV	VOL PURG (gal)	Flow Rate (GPM) or (mL/min)	DTW (ft TOPVC) <0.3 ft, drawdown

Comments:

Surface Water Sampling
Data Sheet

Plexus Scientific
4501 Ford Avenue, Suite 1200
Alexandria, VA 22302

Date:
Site Name:
Stream Name
Sampler:

Collection Device:
Collection Method:
Channel Depth (ft)
Channel Wideth (ft)

Time	pH	COND (ms/cm)	TURB (NTU)	DO (mg/L)	ORP (mv)	VOL Collected (gal)

Comments:

Date:
Site Name:
Stream Name
Sampler:

Collection Device:
Collection Method:
Channel Depth (ft)
Channel Wideth (ft)

Time	pH	COND (ms/cm)	TURB (NTU)	DO (mg/L)	ORP (mv)	VOL Collected (gal)

Comments:

Date:
Site Name:
Stream Name
Sampler:

Collection Device:
Collection Method:
Channel Depth (ft)
Channel Wideth (ft)

Time	pH	COND (ms/cm)	TURB (NTU)	DO (mg/L)	ORP (mv)	VOL Collected (gal)

Comments:

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Monitoring Well
Development Data Sheet

Plexus Scientific
4501 Ford Avenue, Suite 1200
Alexandria, VA 22302

Well Casing Volumes (gallon/foot of well)

1-¼" = 0.06	2" = 0.16	3" = 0.37	4" = 0.65
1-½" = 0.09	2-½" = 0.26	3-½" = 0.50	6" = 1.47

Date: ______________________ **Purge Device & Method:** ______________________

Site Name: ______________________ **Static water level:** ______________________

Well ID: ______________________ **Well TD:** __________ **1X Well Vol.=** __________

Developed By: ______________________ **Well Construction:** ______________________

Pump On: ______________________ **Water Column** ______________________

Pump Off: ______________________ **Casing Diameter (inches):** ______________________

Time	pH	COND (ms/cm)	TURB (NTU)	DO (mg/L)	TEMP (°C)	SAL (%)	TDS (g/L)	ORP (mv)	VOL PURG (gal)	Flow Rate (GPM)	DTW (ft TOPVC)

Comments: ____

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Boring Number:

BORING LOG

Site Name & Location	Project Number	Date & Time Started: Date & Time Completed:
Drilling Company	Foreman	Sampler(s) / Sampler Hammer / Drop
Drilling Equipment	Method	Elevation & Datum / Completion Depth / Rock Depth
Bit Size(s)	Core Barrel(s)	Geologist(s)

DEPTH	SAMPLES				SOIL DESCRIPTION	REMARKS
(ft below grade)	Sample Number	Recovery (feet)	FID/ PID (ppm)	Blow Counts		
0						
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						

Page ______ of ______ Signature: ____________________ Date: ______________

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DAILY QUALITY CONTROL REPORT

(1) **SITE:**	
(2) **PROJECT NAME:**	(3) **PROJECT NO.:**
(4) **DATE:**	(5) **FIELD TEAM:**

(6) **WEATHER**

BRIGHT SUN ____
CLEAR ____
OVERCAST ____
RAIN ____
T-STORM ____
SNOW ____

TEMPERATURE (^{0}F)

UP TO 32 _____
32-50 _____
50-70 _____
70-85 _____
85+ _____

WIND

STILL _______
GUSTY ______
MODERATE ______
HIGH ______

DIRECTION __________

HUMIDITY

DRY _______
MODERATE _______
HUMID _______

(7) **SUBCONTRACTORS AND EQUIPMENT ON SITE:**

(8) **HEALTH AND SAFETY LEVELS:**
Summary of Health and Safety Activities:

(9) **INSTRUMENTS USED: ____ CALIBRATED: ___________**
Summary of Work Performed:

(10) **All Samples Were Collected According To Procedures Outlined In The Work Plan: Yes _____ No _____**
Problems Encountered/Corrective Action Taken:

(11) **TOMORROW'S EXPECTATIONS:**

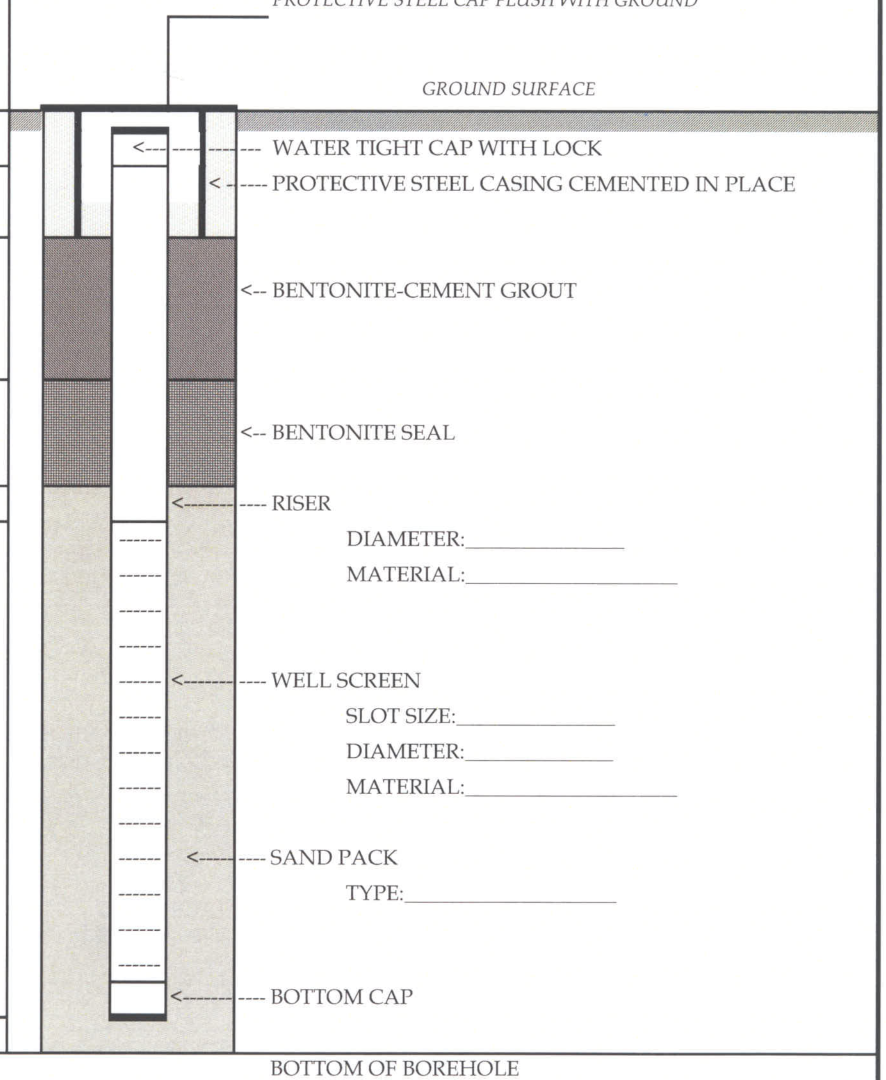
(12) **DATE/TIME PROJECT MANAGER CONTACTED:**

WELL : ____________

MONITORING WELL CONSTRUCTION (FLUSH-MOUNT)

Site Name & Location	Project No.	Water Level(s) (ft below top of casing)			Site Elevation Datum (feet)
Drilling Company	Foreman	Date	Time	Level (feet)	Ground Elevation (feet)
Surveyor					Top of Protective Steel Cap Elevation (feet)
Date and Time of Completion	Geologist				Well Coordinates (Indicate Coordinate System)

Generalized Soil Description	*Elevation	**Depth	CONSTRUCTION DETAILS
		0.0	



REMARKS ____

____

____

* Elevation (feet) above mean sea level unless noted

** Depth in feet below ground surface

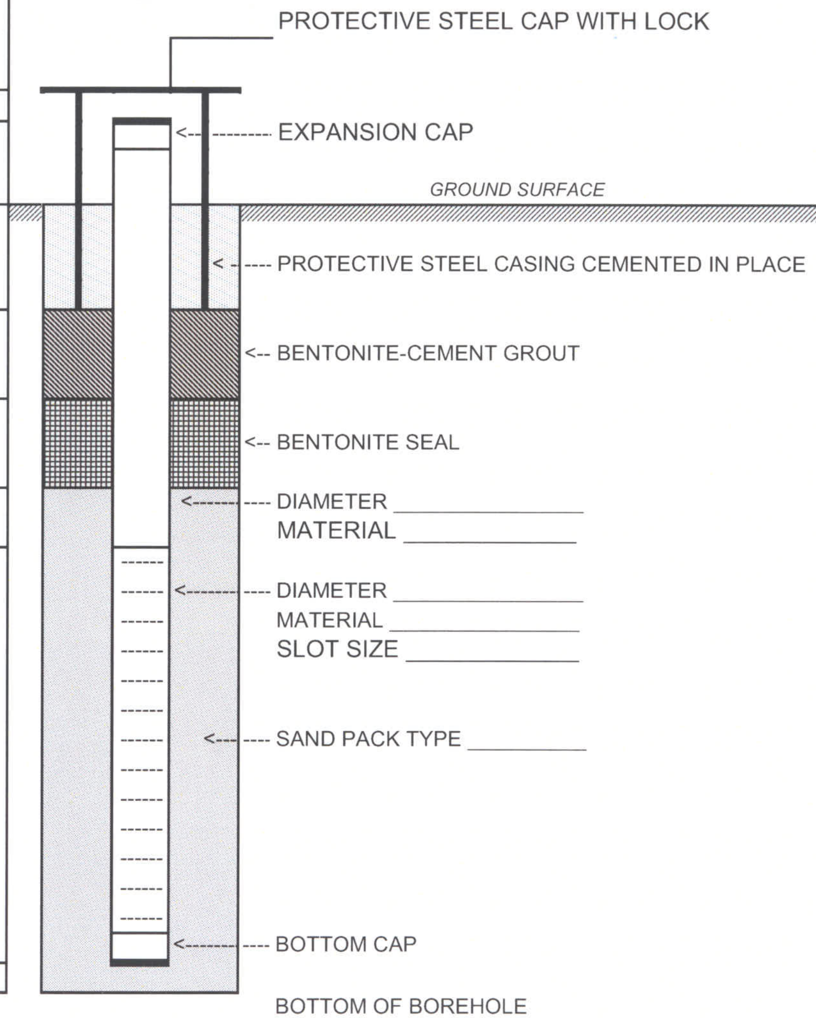
WELL : ____________

MONTORING WELL CONSTRUCTION (STICK-UP)

Site Name & Location	Project No.	Water Level(s) (ft below top of casing)			Site Elevation Datum
Drilling Company	Foreman	Date	Time	Level	Ground Elevation
Surveyor					Top of Protective Steel Cap Elevation
Date and Time of Completion	Inspector				Top of Riser Pipe Elevation

Generalized Soil Description	*Elevation	**Depth
		0.0

CONSTRUCTION DETAILS



REMARKS

* Elevation (feet) above mean sea level unless noted

** Depth in feet below grade

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