Attachment XII
Site Specific Sampling and Analysis Plan
Groundwater Remedial Investigation
TNT and Red Water Ponds Areas

Former Plum Brook Ordnance Works, Sandusky, Ohio

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(This SSAP must be used in conjunction with the PBOW SAP, 1996)

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List of Acronyms

bgs	below ground surface
BTEX	benzene, toluene, ethylbenzene and xylenes
°C	degrees Celsius
DERP	Defense Environmental Restoration Program
DNB	dinitrobenzene
DNT	dinitrotoluene
DQO	data quality objective
EPA	U.S. Environmental Protection Agency
FUDS	Formerly Used Defense Site
HPLC	high-performance liquid chromatography
HTF	Hypersonic Tunnel Facility
ICI	International Consultants Incorporated
IDW	investigation-derived waste
IT	IT Corporation
µg/L	micrograms per liter
MCL	maximum contaminant level
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
ml/min	milliliters per minute
Morrison-Knudson	Morrison-Knudson Ferguson Corporation
NASA	National Aeronautics and Space Administration
PAH	polynuclear aromatic hydrocarbons
PBOW	Plum Brook Ordnance Works
PBS	Plum Brook Station
PCB	polychlorinated biphenyls
PRG	preliminary remediation goal
PRRWP	Pentolite Road Red Water Pond
QA	quality assurance
QAPP	quality assurance project plan
QC	quality control
RBC	risk-based concentration
RI	remedial investigation
SAIC	Science Applications International Corporation
SAP	sampling and analysis plan

List of Acronyms (Continued)

SHP	safety and health plan
SMCL	secondary maximum contaminant level
SSAP	site-specific sampling and analysis plan
SU	standard units
SVOC	semivolatile organic compound
TAL	target analyte list
TCL	target compound list
TNB	trinitrobenzene
TNT	trinitrotoluene
TNTA	Area A
TNTB	Area B
TNTC	Area C
TOC	total organic carbon
TSS	total suspended solids
USACE	U.S. Army Corps of Engineers
USCS	unified soil classification system
VOC	volatile organic compound
WARWP	West Area Red Water Pond

1.0 Project Description

The U.S. Army is conducting studies of the environmental impact of suspected hazardous waste sites at previously owned U.S. Department of Defense properties. The former Plum Brook Ordnance Works (PBOW), is located in Sandusky, Erie County, Ohio (Figure 1-1). The PBOW is being investigated under the Defense Environmental Restoration Program (DERP) for Formerly Used Defense Sites (FUDS). The investigation is being managed and technically overseen by the Nashville and Huntington Districts of the U.S. Army Corps of Engineers (USACE). This 9,000-acre facility was used for the manufacture of explosives during World War II. The site is currently owned by the National Aeronautics and Space Administration (NASA) and is operated as the Plum Brook Station of the John Glenn Research Center at Lewis Field.

As an attachment to the PBOW site-wide sampling and analysis plan (SAP) (IT Corporation [IT], 1996a), this site-specific sampling and analysis plan (SSAP) has been prepared for the field work to be carried out in support of the remedial investigations (RI) at two red water pond areas, West Area Red Water Ponds (WARWP) and Pentolite Road Red Water Ponds (PRRWP), and three former trinitrotoluene (TNT) manufacturing areas, Area A (TNTA), Area B (TNTB), and Area C (TNTC). This SSAP must be used in conjunction with the SAP and the quality assurance project plan (QAPP) (IT, 1996b) to ensure that work performed at the subject site will be of the quality required to satisfy the overall and site-specific project objectives. A site-specific safety and health plan has also been prepared separately for this investigation and must be used in conjunction with the site-wide safety and health plan (IT, 1996c).

1.1 Site History

The PBOW site was built in early 1941 and manufactured 2,4,6-TNT, dinitrotoluene (DNT), and pentolite. Production of explosives began in December 1941 and continued until 1945. After the plant was shut down, decontamination of TNT, acid, pentolite, and DNT processing lines began; decontamination was completed during the last quarter of 1945. The property was initially transferred to the Ordnance Department and then to the War Assets Administration after it was certified by the U.S. Army to be decontaminated. In 1949, PBOW was transferred to the General Services Administration. NASA acquired PBOW in 1963 and is presently utilizing the site.

1.2 Summary of Existing Site Data

Numerous investigations have been conducted at PBOW. The discussion of existing site data will focus on the primary areas to be investigated under this RI, which include the three TNT manufacturing areas (Areas A, B, and C) and the Red Water Ponds Areas.

1.2.1 TNT Areas

TNT was manufactured in three areas, designated TNTA, TNTB, and TNTC (Figure 1-2). Each area had production lines consisting of a mono house, a bi-tri house, a fortifier house, and a wash house used in the manufacture of TNT. In addition, other buildings (nailing houses, wastewater settling tanks, DNT sweating and graining houses, etc) were present at each site. Each TNT area is discussed in the following paragraphs.

1.2.1.1 TNT Area A

The former TNTA is located in the northeastern part of PBOW and occupies approximately 114 acres of land. Columbus Avenue bisects the site, as shown in Figures 1-2 and 1-3. NASA constructed its administration building on the east side of Columbus Avenue in the central portion of former TNTA. The NASA Administration Building and associated parking areas cover two of the former TNT process buildings (Buildings 121 and 122) at TNTA. TNTA was used during World War II as a manufacturing facility for TNT and DNT. During PBOW operations, TNTA had four TNT lines, consisting of five buildings each, and two DNT lines, each consisting of one building (Figure 1-3). Wastewater from TNTA was routed to the PRRWP through underground flumes and sewer lines. Significant previous remediation activities have been performed in TNTA. Very little above-ground evidence of the former PBOW structures and features remain in the area, other than abandoned railroad tracks, ditches, and water valves. According to the records review report (Dames and Moore, 1995), TNTA was decontaminated, along with two other TNT areas in 1955 and again in 1966. The decontamination at TNTA was reportedly very thorough. Significant subsurface contamination was removed, including underground flumes and sewer lines. Approximately 16,000 pounds of TNT were removed from TNTA. Previous environmental investigations in this area included a 1993 site inspection by Morrison-Knudsen Ferguson Corporation (Morrison-Knudsen, 1994) and a 1994 TNT Areas site investigation by Dames and Moore (Dames and Moore, 1997). The Morrison-Knudsen inspection of the TNTA site included one soil sample, one co-located sample each of surface water and sediments, and three groundwater samples. No explosives residues were detected in any of these samples.

A total of 36 soil samples were collected from 28 borings in the TNTA site during the 1994 Dames and Moore investigation. Boring locations were placed in and around former buildings that were associated with the TNT production lines. In addition, one soil boring was installed in a ditch north of Maintenance Road. A wide range of nitroaromatic compounds were detected, including concentrations of TNT up to 580 milligrams per kilogram (mg/kg) near the Wastewater Settling Tanks and 53 mg/kg near the Fortifier House. One boring (TNTA-S22-0.0/2.0) near Mono House exhibited 2,4-DNT and 2,6-DNT concentrations of 45 mg/kg and 47 mg/kg, respectively.

IT conducted a site-wide groundwater investigation at PBOW in 1996 (IT, 1997) and again in 1997 (IT, 1998). Both investigations included collection of groundwater samples from wells in TNTA. There are seven existing monitoring wells in TNTA, five overburden wells (MK-MW22, -MW23, -MW24 and PB-TNTA-MW10, -MW11) and two bedrock wells (PB-BED-MW17, -MW18). MK-MW24 is located on the south perimeter of TNTA, hydraulically upgradient of the site, and PB-BED-MW17 and MK-MW23 are located on the north perimeter of TNTA, downgradient of the site. PB-BED-MW18 is located along the east perimeter of TNTA, hydraulically cross-gradient of the site. Three wells, PB-TNTA-MW10, -MW11, and MW-MK22, are located within TNTA. Of the overburden wells, only MK-MW22 groundwater had explosives concentrations exceeding the risk-based concentration (RBC) levels; 4-amino-2,6-DNT was detected above the RBC during both sampling events. All of the overburden wells had concentrations of dissolved manganese exceeding the screening level. In addition, one groundwater sample from MK-MW23, a downgradient well, had a concentration of bis(2-ethylhexyl)phthalate exceeding the RBC. The groundwater sample from PB-BED-MW18 exhibited concentrations of 1,3-dinitrobenzene and nitrobenzene exceeding the screening levels. PB-BED-MW17 and -MW18 had detected concentrations of volatile organic compounds (VOC) and dissolved barium above the respective RBCs.

1.2.1.2 TNT Area B

TNTB comprises an area of approximately 55 acres in the south-central portion of PBOW, immediately north of West Sheid Road, as shown on Figures 1-2 and 1-4. All of the buildings that were present during the TNT manufacturing period have been demolished, and the site has been regraded. Figure 1-4 presents a site map showing the locations of all former buildings. Significant aboveground evidence of former PBOW facilities exists at TNTB in the form of roads, hydrants, and ditches. In addition, aboveground water valves indicate the presence of underground utilities. Two NASA facilities are present at the site and are currently active, the Hypersonic Tunnel Facility (HTF) and the Nitrogen Dewar Tanks (Figure 1-4). The HTF is located in the northwest portion of TNTB and consists of a single building, aboveground and below ground piping and utilities, and paved parking areas. The Nitrogen Dewar Tanks are located in the center of TNTB, with aboveground piping and underground utilities leading to the northwest and to the northeast off site (Dames and Moore, 1997).

In 1993, Morrison-Knudsen collected two surface water, two sediment, and two surface soil samples in the vicinity of TNTB. Each sample was analyzed for VOCs, semivolatile organic compounds (SVOC), nitroaromatics, and dissolved metals. The surface water and sediment locations were called SW07/SD07 and SW08/SD08. SW07 and SD07 were collected near the beginning of Ransom Brook, approximately 250 feet north of Magazine Road near the former red water settling tanks. SW08 and SD08 were collected north of TNTB, approximately 200 feet south of Fox Road and approximately 3,000 feet downgradient of SW07 and SD07 (International Consultants Incorporated [ICI], 1995). The surface water samples had no detections of VOCs or SVOCs. No metals were detected in the surface water at concentrations above the maximum contaminant level (MCL) or the secondary maximum contaminant level (SMCL). The sediment sample collected at SD07 had detections of five VOCs and fourteen SVOCs. The only nitroaromatic compound detected was TNT at a concentration of 25 mg/kg. Eleven organic compounds were detected in sediment sample SD08, all at concentrations of 0.1 mg/kg or less. Detected organic compounds included two VOCs and nine SVOCs, eight of which were polynuclear aromatic hydrocarbons (PAH). The two surface soil sample locations were designated SB09 and SS13. SB09 was collected from the borehole for MK-MW17 shown on Figure 1-4. Sample SS13 was collected in the vicinity of the railroad tracks southwest of the Fortifier House, Building 463 (ICI, 1995). VOCs (toluene and xylenes), SVOCs (bis[2-ethylhexyl]phthalate), and nitroaromatics (TNT and 2,6-DNT) were detected in the surface soil. Nitroaromatics were present at SB09, with TNT detected at a concentration of 12 mg/kg.

Two overburden monitoring wells were installed at TNTB in July 1993 by Morrison-Knudsen. Well MK-MW16 is located upgradient, and well MK-MW17 is located downgradient of TNTB at the locations shown on Figure 1-4. Samples collected from both wells were analyzed for VOCs, SVOCs, nitroaromatics, and dissolved metals. No VOCs or nitroaromatics were detected in either of the wells. Metals were not detected at levels that exceeded MCLs or SMCLs. One SVOC, bis(2-ethylhexyl)phthalate, was detected at a concentration of 12 micrograms per liter (μg/L) in MK-MW17.

In October 1994, as part of the TNT Areas site investigation, Dames and Moore sampled the soil at 26 locations at TNTB. Each sample was analyzed for nitroaromatics and metals. All samples were collected between 0.5 and 3.5 feet below ground surface (bgs). Eighteen of the 26 locations were sampled at one depth, and eight locations were sampled at two depths. Nitroaromatics were detected in eighteen of the 26 locations, and most locations had at least one sample with concentrations greater than 1.0 mg/kg. Concentrations of nitroaromatics in excess of 10,000 mg/kg were present in soils at the Bi-Tri House for Line 5 (Building 452) and the DNT Sweating and Graining House (Building 412).

In December 1994, Dames and Moore sampled both MK-MW16 and MK-MW17 as part of the TNT Areas site investigation. Samples from the wells were analyzed for nitroaromatics, nitrates, and total and dissolved concentrations of 14 metals, which consisted of the 13 priority pollutant metals plus manganese. MK-MW16 did not exhibit any detections of nitroaromatics. The downgradient well MK-MW17 did have TNT at a concentration of 6.5 μg/L and 3-nitrotoluene at a concentration of 5.3 μg/L. Nitrates were detected, but at concentrations below RBCs. Ten metals were detected in overburden groundwater: antimony, arsenic, beryllium, cadmium, copper, lead, manganese, nickel, thallium, and zinc. Six of the metals - copper, lead, manganese, nickel, thallium, and zinc - were detected in both wells. Nickel, manganese, and thallium were the only metals that exceeded RBCs (Dames and Moore, 1997).

In September and October 1996, IT collected groundwater samples from MK-MW16 and MK-MW17 as part of the site-wide groundwater investigation. Both samples from the wells were analyzed for VOCs, SVOCs, metals, pesticides and polychlorinated biphenyls (PCB), cyanide, and nitroaromatics. SVOCs, pesticides, PCBs, and cyanide were not detected, and VOCs were not detected above RBCs. The metals detected above RBCs included aluminum, arsenic, iron, lead, and nickel. Five nitroaromatics were detected above RBCs at MK-MW17. The maximum concentration of any nitroaromatic detected in MK-MW17 was 11 μg/L of 2,6-DNT (IT, 1999).

In 1997, IT installed two bedrock wells near TNTB. TNTB-BED-GW001 was installed northwest of the site to monitor bedrock groundwater downgradient of TNTB, and TNTB-BED-GW002 was installed southeast of TNTB to monitor bedrock groundwater upgradient of the site. In November 1997 and May 1998, as part of the semiannual monitoring investigation portion of the groundwater investigation, overburden wells MK-MW16 and MK-MW17 were sampled by IT (IT, 1999). Overburden groundwater samples were analyzed for VOCs, SVOCs, nitroaromatics, metals (total and dissolved), cyanide, and water quality parameters (alkalinity, chloride, hardness, sulfate, nitrate, total dissolved solids, total organic carbon [TOC], and total suspended solids [TSS]). No VOCs, SVOCs, cyanide, or water quality parameters were detected at concentrations exceeding RBCs. Overburden groundwater samples analyzed for dissolved metals exceeded RBCs for aluminum, arsenic, iron, lead, manganese, and nickel in MK-MW17 and iron, manganese, and nickel in downgradient well MK-MW16. Only one nitroaromatic compound, 4-amino-2,6-DNT, was detected above RBCs. This exceedance occurred only in downgradient well MK-MW17. No SVOCs, cyanide, or water quality parameters were detected at concentrations exceeding RBCs in the bedrock wells (TNTB-BED-GW001 and -GW002). One VOC, benzene, was detected at a concentration above the RBC in well TNTB-BED-GW001. No nitroaromatics were detected in either well. Filtered bedrock groundwater samples analyzed for metals exhibited RBC exceedances for barium, iron, and manganese (IT, 1999).

1.2.1.3 TNT Area C

The former TNTC, located in the southwestern portion of PBOW, occupies approximately 119 acres of land, as shown in Figures 1-2 and 1-5. NASA currently uses some of the remaining structures in the area for storage purposes. TNTC was used during World War II as a manufacturing facility for TNT and DNT. During PBOW operations, TNTC contained five TNT lines consisting of five buildings each (Figure 1-5). Wastewater from TNTC was routed to the PRRWP through underground flumes and sewer lines. Presently, the area is largely overgrown with trees and brush; however, some of the roads, building foundations, and remnants of utilities from former TNT operations are still recognizable. According to the records review report (Dames and Moore, 1995), TNTC was decontaminated, along with two other TNT areas, in 1955 and again in 1966. However, the decontamination at TNTC was reportedly not as thorough as that in TNTA, and significant subsurface contamination associated with underground flumes and sewer lines is probably still present. Previous environmental investigations in this area included a 1993 site inspection by Morrison-Knudsen (Morrison-Knudsen, 1994) and a 1994 TNT Areas site investigation by Dames and Moore (Dames and Moore, 1997). The Morrison-Knudsen inspection of the TNTC site included two surface soil samples and one co-located pair of surface water and sediment samples. Organic compounds were not detected in the surface water sample or the co-located sediment sample. Toluene was detected in both surface soil samples at concentrations below the quantitation limit.

A total of 30 soil samples were collected from 26 borings within the TNTC site during the 1994 Dames and Moore investigation. Boring locations were placed in and around former buildings that were associated with the TNT production lines (Line 12 – Buildings 626, 612, and 604). A wide range of nitroaromatic compounds were detected, including TNT at concentrations up to 2.7 mg/kg (near Building 626) and 2,4-DNT up to 8.7 mg/kg (near Building 626).

IT conducted a site-wide groundwater investigation at PBOW in 1996 (IT, 1997) and again in 1997 (IT, 1998). Both investigations included collection of groundwater samples from six overburden monitoring wells (IT-MW09, MK-MW12, PB-TNTC-MW03, PB-TNTC-MW04, PB-TNTC-MW05, and PB-TNTC-MW06) in TNTC. Chlorobenzene was detected in IT-MW09 below its RBC in 1996. In 1997, benzene and toluene were detected in IT-MW09 at concentrations below RBCs. The SVOC bis(2-ethylhexyl)phthalate was detected above the RBC in MK-MW12 and PB-TNTC-MW06 in 1996. Explosives were not detected during either sampling event.

Manganese was detected in five wells at dissolved-phase concentrations above the RBC in 1996. Iron and nickel exceeded the RBCs in the dissolved phase in PB-TNTC-MW06 and PB-TNTC-MW03, respectively. In 1997, only manganese was found to exceed the RBC in the dissolved phase.

1.2.2 Red Water Pond Areas

1.2.2.1 West Area Red Water Pond

The WARWP is located on the western edge of PBOW, near the intersection of Campbell Street and Fox Road and to the north and west of Pipe Creek, as shown in Figures 1-2 and 1-5. Two former red water pond areas in the WARWP have been identified through the use of aerial photographs, site reconnaissance, and the presence of nitroaromatic compounds in soil and groundwater. Prior to 1985, numerous studies were conducted of the surface water and sediment from the red water pond areas. The Ohio National Guard conducted surface sediment screening for TNT and DNT. The highest values found in the screened sediments were less than 1 mg/kg. IT was contracted in 1989 to conduct near-surface sediment sampling to determine the presence or absence of residual chemical contamination from PBOW operations. Soil sample analysis showed that dinitrobenzene (DNB), trinitrobenzene (TNB), DNT, and TNT were present in the soils at the WARWP. In 1991, Science Applications International Corporation (SAIC) confirmed that hazardous substances had been released into the environment at the WARWP (USACE, 1997).

A site inspection in 1993 by Morrison-Knudsen to determine the potential risk to human health and the environment indicated low levels of VOCs and SVOCs in the sediments around Pipe Creek near the WARWP area but found no contaminant concentrations of VOCs, SVOCs, or nitroaromatics in the surface water. Morrison-Knudsen also installed four groundwater monitoring wells and had the groundwater analyzed for the above contaminants. Laboratory analysis did not indicate the presence of VOCs, SVOCs, or nitroaromatics in the groundwater samples near Pipe Creek.

Additional groundwater investigations were conducted in 1994 by Dames & Moore and again in 1996 and 1997 by IT. Dames and Moore installed overburden and bedrock wells near the WARWP to determine the hydrogeologic conditions and the presence of any VOCs, SVOCs, or nitroaromatics. The investigation indicated that groundwater flow was generally north toward

Lake Erie and exhibited a strong downward vertical component. Significant concentrations of nitroaromatics were also found to be present adjacent to the former red water ponds in both the overburden and bedrock aquifers. VOCs and SVOCs were also present in the bedrock wells. Antimony, manganese, and nickel were detected at concentrations above their maximum contaminant levels (Dames and Moore, 1997). The investigations by IT indicated that the overburden material had been impacted by nitroaromatic compounds in the central portion of the WARWP and that inorganic compounds were present at concentrations exceeding the RBCs throughout the area. IT determined that the bedrock aquifer was impacted by nitroaromatics and other organic and inorganic compounds north of the WARWP, but not in the central portion of the area. IT recommended additional subsurface investigation to determine the nature and extent of contamination in these areas, after background levels were established for metals in groundwater (IT, 1997). Groundwater sampling of the WARWP groundwater wells in November 1997 and May 1998 indicated the continued presence of elevated levels of nitroaromatics (IT, 1999).

1.2.2.2 Pentolite Road Red Water Ponds

The PRRWP are located in the north-central portion of the PBOW facility, north of Maintenance Road, as shown in Figures 1-2 and 1-7, and south-southeast of the Reactor Building Area across Pentolite Road. In 1989, IT conducted an evaluation to determine whether residual chemical contamination was present in the overburden soils and groundwater. Significant concentrations of nitroaromatics (4,4-DNT, 2,6-DNT) and sodium above background levels (ICI, 1995) were detected in the overburden soils in the PRRWP area (IT, 1991).

In 1993, Morrison-Knudsen conducted a site inspection to assess the threat posed to human health and the environment and to determine the need for additional investigation. Surface soil and sediment samples were collected and analyzed from a drainage ditch along Pentolite Road, north of the PRRWP area. No samples from the Pentolite Road ditch showed detectable levels of VOCs, SVOCs, or nitroaromatics (Morrison-Knudsen, 1994).

In 1994, Dames and Moore conducted an investigation of groundwater quality in both the overburden and bedrock aquifers in the PRRWP area. The investigation indicated that groundwater flow in the area was generally north toward Lake Erie and exhibited a strong vertical component. The presence of groundwater in the overburden aquifer was also found to be seasonally dependent. Results of groundwater analysis indicated that greater concentrations of nitroaromatics were present in the overburden wells than in the bedrock wells (Dames and Moore, 1997).

A site-wide groundwater investigation performed by IT in 1996 determined that the overburden aquifer had been impacted by nitroaromatic compounds and that the bedrock aquifer had been impacted by benzene, toluene, ethylbenzene and xylenes (BTEX), SVOCs, and nitroaromatics (IT, 1997). Groundwater sampling events in November 1997 and May 1998 indicated the continued presence of elevated concentrations of nitroaromatic compounds (IT, 1999).

1.3 Site-Wide Hydrogeology

Two hydrolithologic units are known to exist at PBOW. The overburden unit, composed of glacial outwash materials, has a thickness ranging from a few feet in the south to more than 40 feet in some locations in the north. Based on previously collected data, the overburden thickness within the TNT Areas is generally less than 10 feet at TNTA and less than 15 feet at TNTC. The water-producing capacity of the overburden materials is strongly controlled by seasonal changes, and the overburden water-bearing zone is therefore not considered to be a source of water. The bedrock unit consists of Devonian limestone and shale that dip to the southeast at approximately 35 feet per mile.

In general, groundwater flows in a northerly direction, towards Lake Erie, in both the unconsolidated overburden material and the bedrock. However, on the western side of the installation, groundwater in the overburden water-bearing zone flows to the northwest, while groundwater in the bedrock aquifer flows to the northeast. The groundwater flow regime in the overburden unit shows a strong seasonal variation (IT, 1999).

2.0 Scope of Work and Objectives

2.1 Scope of Work

As specified in the scope of work (USACE, 2001), RI activities at the TNT and Red Water Ponds Areas will consist of the following tasks:

- Preparation of this site-specific addendum to the site-wide SAP and safety and health plan
- Monitoring well installation
- Monitoring well development and in-situ permeability determination
- Groundwater sampling
- Soil sampling
- Laboratory analysis of soil and groundwater samples
- Management and disposal of investigation-derived waste
- Preparation and submittal of report of findings.

2.2 Objectives

The primary objective of the RI is to determine the extent of chemical(s) of potential concern in soils and groundwater at the TNT areas (A, B, C) and Red Water Pond areas (WARWP, PRRWP). Specific objectives of the RI are summarized as follows:

- Determine if there are hazardous substances present at the site at levels that constitute an unacceptable risk to human health and the environment.
- Define site physical features and characteristics (aquifer background conditions).
- Evaluate fate and transport pathways (groundwater modeling).
- Determine the nature and extent of source areas.
- Define current and future routes of exposure.
- Determine whether contaminant distribution is consistent with DOD activities.

Sufficient groundwater information will be collected so that a scope of work for groundwater modeling can be completed.

2.3 QAPP Review

The site-wide quality assurance project plan QAPP (IT, 1996b), referenced throughout this work plan, was reviewed for accuracy. Several changes were noted between current analytical methods and sampling procedures and those presented in the QAPP. The following table summarizes outdated sections of the QAPP and sections of the current SSAP that reflect the QAPP modifications.

Subject	1996 QAPP	2001 SSAP
Analytical Methods	Table 1.1 – Analytical methods are not current and are incomplete.	Table 4-1 provides updated analytical methods.
Analytical Lab	Section 2.6 Quanterra is referenced as the laboratory for off-site analysis.	Section 5.0 lists STL Knoxville as the primary laboratory.
Data Validation	Section 2.7 – STEP, Inc. is listed as the subcontractor that will perform data validation.	Data validation will be performed by IT Corporation or a qualified subcontractor.
Decontamination	Section 4.2.4 - Methanol is listed as the solvent for equipment decontamination.	Section 4.3 states that isopropyl alcohol will be used for equipment decontamination.
Sampling ID	Section 4.3 – Designation of SS for soil screening sample type and SO for other soils.	Section 4.1 uses SS for surface soils and SB for soil borings.
Sample Containers	Section 4.9.4 - VOC containers for soil are incorrect.	Section 5.0 and Table 5.1 includes EnCore samplers for VOC analyses.
Split Samples	Section 4.9.6 - The USACE laboratory will not be analyzing QA samples.	Section 5.0 lists Paragon as the QA laboratory.
Container Requirements	Table 5-1 - Container requirements are missing for new methods.	Table 5-1 provides updated sample container requirements for all methods.
Analytical Methods	Tables 7-1 through 7-5 - Analytical methods are outdated or incomplete.	Table 5-1 provides updated analytical methods for all parameters.
Blank Evaluation	Section 8.4 – Indicates that contract Laboratory Program (CLP) functional guidelines are used for blank evaluation.	Reference to blank evaluation is not present in the SSAP. Blank evaluation will be completed in the RI report and will follow Region III guidelines.

2.4 Site-Specific Data Quality Objectives

2.4.1 Overview

The data quality objectives (DQO) process followed during the planning stages of the RI evaluated data requirements needed to support the decision-making process and selected the best action to satisfy these requirements. Incorporated components of the DQO process, described in the U.S. Environmental Protection Agency (EPA) publication 9355.9-01 *Data Quality*

Objectives Process for Superfund (EPA, 1993), are discussed in detail in Section 3.3 of the SAP. Determining factors for procedures necessary to satisfy investigative objectives and to establish the basis of future actions at PBOW are presented in Figure 3-2 of the SAP (IT, 1996a).

2.4.2 Data Users and Available Data

A site-specific conceptual model developed using existing data helped to identify data gaps. During the project planning process, effective methodologies for filling the data gaps were designed and reviewed by the data users with the most efficient data collection design being implemented. The SSAP records the rationale for the design, including the location, number, and type of samples necessary to fill the data gaps and to satisfy the DQOs. The SSAP, along with companion documents, provides the regulatory agencies with sufficient detail so that they can conclude whether the investigative effort is adequate to satisfy the study objectives.

2.4.3 Conceptual Site Model

Four factors considered in defining the conceptual model for the RI are:

- Potential contaminant sources
- Migration pathways
- Potential receptors
- Contaminants of concern.

A source of contamination at PBOW is past TNT manufacturing activities, including the production and storage of raw materials. Sources at the proposed areas of investigation result from TNT and DNT production and associated activities. The migration pathways for potential contaminants include groundwater, soil, sediment, and surface water runoff to creeks. Likely receptors at PBOW are limited to wildlife and aquatic organisms in creeks. Exposure of humans to potential contaminants under current land use at PBOW is unlikely, since the site is a secure NASA research station. Potential receptors near the facility include off-site water users. Chemicals of potential concern, based on past use of the site, should primarily be nitroaromatic explosives, but may also include VOCs, SVOCs, metals, pesticides/PCBs, and cyanide.

2.4.4 Decision-Making Process, Data Uses, and Needs

The decision-making process, presented in detail in Section 3.3.3 of the SAP (IT, 1996a), consists of a seven-step process that will be followed during the RI (IT, 1996a). Data uses and needs are summarized in Table 2-1. Figure 2-1 presents the order in which samples will be collected and organized.

2.4.5 Risk Evaluation

Confirmation of contamination during the RI will be based upon a comparison of detected contaminants in samples from this investigation to the most current preliminary remediation goals (PRGs) developed by EPA, Region IX. EPA definitive data will be used to determine whether the established guidance criteria are exceeded in the media. Definitive data will be adequate for confirming the presence of the contamination and for supporting a risk assessment and feasibility study, if necessary.

2.4.6 Data Quality, Types, and Quantities

Groundwater and soil samples will be collected and analyzed to meet the objectives of the RI. Quality assurance (QA)/quality control (QC) samples will be collected for all sample types as described in Section 3.3 of this SSAP. All samples, except the screening samples, will be analyzed by EPA-approved methods and will comply with EPA definitive data requirements. In addition to meeting the quality needs of the RI, data analyzed at this level of quality are appropriate for all phases of the characterization and risk assessment. Screening samples will be analyzed using a high-performance liquid chromatography (HPLC) screening method. The data will be used to determine the nature and extent of nitroaromatic contamination.

2.4.7 Precision, Accuracy, and Completeness

Laboratory requirements of precision, accuracy, and completeness for confirmation samples generated during the RI are provided in Chapter 12.0 of the QAPP (IT, 1996b).

3.0 Field Activities

Field activities associated with the RI at the PBOW facility include the installation and development of 10 bedrock wells and 15 overburden wells, collection of 135 direct-push groundwater samples, screening analysis for explosives in the direct-push groundwater samples, confirmation analysis for selected samples from 23 (new and existing) overburden monitoring wells and 27 (new and existing) bedrock wells, permeability testing, subsurface soil sampling, land surveying, and investigation-derived waste (IDW) management.

3.1 Investigative Approach

The RI approach will be consistent with work conducted previously at the PBOW facility (IT, 1999). Investigation methods will use an iterative sampling methodology for direct-push groundwater sampling. This approach involves an iterative sampling scheme to screen for VOCs by EPA SW-846 Methods 5030/8260B and nitroaromatic explosives using modified 8330 (HPLC). The screening-level 8330 analytical method is based on the definitive-level SW-846 method, except there is no second-column confirmation analysis. Using this screening method will provide better quality field-screening data than traditional (i.e., colorimetric) screening methods and allow better use of the limited number of direct-push groundwater samples to delineate residuum groundwater contamination. Following this, overburden and bedrock monitoring wells can be accurately placed, based on the nature and extent of the residuum groundwater contamination. In addition, soil samples will be collected at the West Area and PRRWP. Figures 1-2 through 1-7 present the proposed locations of soil sampling associated with two previous sample locations at the red water ponds and the residuum and bedrock monitoring wells.

3.2 Soil Sampling Locations

Soil and rock sampling will be continuous for the entire monitoring well boring. The purpose of the sampling during monitoring well installation is to visually classify the soil and bedrock. The geologist/geotechnical engineer will visually classify and log all borehole material according to the Unified Soil Classification System (USCS) and EM 1110-1-4000. Unless field conditions dictate otherwise, no borehole material will be analyzed for chemical parameters, except for disposal characterization as described in Section 6.0. In addition, direct-push soil samples will be collected from two previous red water ponds sample locations to evaluate the contaminant levels at depth, and from the TNT areas and the red water ponds areas to determine the leaching characteristics of the nitroaromatic contaminants.

3.2.1 TNT Areas

Subsurface soils of the TNT Areas will be investigated during the advancement of 4 of the 10 bedrock and all 15 of the overburden monitoring wells. Monitoring well locations will be spotted in the field based on direct-push groundwater sampling results, discussed in Section 3.4. These locations will be selected with the concurrence of the Army Corps of Engineers and Ohio EPA. Four borings will be completed to collect soil samples from known hot spots at each TNT Area.

3.2.1.1 TNTA

One bedrock and three overburden monitoring wells will be installed in this area. Soil samples will be collected continuously during the drilling of soil borings for monitoring well installations as shown on Figure 1-3. These soil cores will be visually classified. Four direct-push soil samples will be collected to determine nitroaromatic leaching characteristics. These samples will be collected from two known hotspots and will be analyzed for TCL VOCs, nitroaromatics, and TAL metals. A split from each sample will also subjected to the Synthetic Precipitation Leaching Procedure (SPLP) and the leachate analyzed for nitroaromatics.

3.2.1.2 TNTB

Two bedrock and two overburden monitoring wells will be installed in this area. Soil samples will be collected continuously during the installation of soil borings for monitoring well installations as shown on Figure 1-4. These soil cores will be visually classified. Four direct-push soil samples will be collected to determine nitroaromatic leaching characteristics. These samples will be collected from two known hotspots and will be analyzed for TCL VOCs, nitroaromatics, and TAL metals. A split from each sample will also be subjected to the SPLP and the leachate analyzed for nitroaromatics.

3.2.1.3 TNTC

One bedrock and three overburden monitoring wells will be installed in this area. Soil samples will be collected continuously during the installation of soil borings for monitoring well installations as shown on Figure 1-5. These soil cores will be visually classified. Four direct-push soil samples will be collected to determine nitroaromatic leaching characteristics. These samples will be collected from two known hotspots and will be analyzed for TCL VOCs, nitroaromatics, and TAL metals. A split from each sample will also be subjected to the SPLP and the leachate analyzed for nitroaromatics.

3.2.2 Red Water Ponds

Four soil samples will be collected from each of two locations at each Red Water Ponds areas to support feasibility studies for the sites. These samples will be collected from two known hotspots and will be analyzed for TCL VOCs, nitroaromatics, and TAL metals. A split from each sample will also be subjected to the SPLP and the leachate analyzed for nitroaromatics. In addition, as described below, at each Red Water Pond area a 1998 hot spot sample location will be revisited to better define the depth of nitroaromatic contamination at these locations.

3.2.2.1 West Area Ponds

Two soil samples will be collected from one soil boring to be completed near 1998 sample location DP-10, as shown on Figure 1-5. One sample will be collected below 10 ft bgs, and the other will be collected directly above the water table. These samples will be analyzed for nitroaromatics and TAL metals.

3.2.2.2 Pentolite Road Ponds

Two soil samples will be collected from one soil boring to be completed near 1998 sample location DP-13, as shown on Figure 1-7. One sample will be collected below 10 ft bgs, and the other will be collected directly above the water table. These samples will be analyzed for nitroaromatics and TAL metals.

3.3 Soil Sampling Methodology and Procedures

The following sampling methods and operational procedures have been developed to ensure that the data acquired through field sampling will meet the data quality objectives stated in Section 2.4. All soil samples collected by IT field personnel will be documented through the use of sample collection logs and analysis request/chain of custody record forms (Figures 4-16 and 6-2 of the SAP [IT, 1996a]), following field custody procedures specified in Section 5.1 of the QAPP (IT, 1996b). Any changes from the work plans will be recorded in chronological order in the variance log shown in Figure 9-1 of the SAP (IT, 1996a).

An IT geologist will supervise the drilling of each borehole and will maintain a record of the drilling and soil conditions encountered. The geologist will maintain continuous, detailed subsurface logs from examining drill cuttings, recording samples/cores, and noting first-encountered and static groundwater levels for each borehole. Daily field notes will be kept in a Field Activity Daily Log and will include sufficient information to reconstruct the progress of drilling operations, problems encountered, well installation procedures, etc. After completion of database entry, all field forms and documents will be archived in the project files at the IT offices in Knoxville, Tennessee.

3.3.1 Soil Sampling

3.3.1.1 Lithologic Sampling

Subsurface soil and bedrock will be collected during soil boring operations for the installation of monitoring wells and during direct-push advancement. Soil and rock sampling will be continuous for the entire boring/direct-push advance during chemical soil sample collection. The geologist/geotechnical engineer will visually classify and log all borehole material according to the USCS and EM 1110-1-4000. Soil overburden material will be sampled continuously for the purposes of visual geotechnical classification of the borehole material. Soil samples will not be analyzed for chemical parameters, except for disposal characterization as described in Section 6.0

3.3.2 Confirmation Sampling

Subsurface soils will be collected for chemical analysis by direct-push advancement in the Redwater Ponds Areas and the TNT Areas. Soil sampling will be continuous for the entire direct-push advance. The geologist/geotechnical engineer will visually classify and log all borehole material according to the USCS and EM 1110-1-4000. Soil overburden material will be sampled continuously for the purposes of visual geotechnical classification of the borehole material. At each subsurface sample location, an approximately 2.0-inch diameter, 4-foot-long stainless-steel, acetate-lined sampling core will be hydraulically hammered to the required depth. The soil sampler will be driven forward, filling the liner with soil. A portion of the liner will be cut to expose the soil, and three EnCore™ samplers will be used to collect the volatile organic analyte portion of the sample. This portion of the sample will be placed on ice in a cooler as soon as it is collected. The remainder of the soil in the liner will be placed into a stainless-steel bowl, homogenized, and transferred to appropriate sample jars, beginning with the jar(s) for nitroaromatic analysis and SPLP nitroaromatic analysis, then placed on ice. The sampler will assure that the soil samples submitted for nitroaromatic and SPLP nitroaromatic analysis come from the same well homogenized soil material. To obtain a sufficient volume to fill all of the other sample jars, it may be necessary to collect additional soil. If another boring is necessary, it will be immediately adjacent to the original location, to the same depth as the first sample.

All subsurface soil samples will be visually inspected and logged on the hazardous, toxic, and radiologic waste drilling log (Figure 4-11 of the SAP) by the geologist/geotechnical engineer, using the USCS. Upon completion of the boring, the hole will be backfilled with either bentonite/cement or granulated bentonite.

3.4 Groundwater

3.4.1 Direct-Push Groundwater Sampling

Shallow groundwater samples will be collected (provided there is sufficient water) using either hydropunch sampling or by placing temporary piezometers in the borings created during subsurface soil sampling. Hydropunch sampling is the preferred method for collection of the groundwater sample; however, under low yield conditions, a temporary piezometer may be required. Temporary piezometers will be installed inside a 3-inch drive rod borehole. The piezometers will be constructed of two-inch diameter PVC with a 10 foot screen (0.010 slot). A surface seal will be completed using bentonite to prevent surface water from entering the borehole. The temporary piezometer will be allowed to sit a minimum of 24 hours before being sampled to allow for settling of particles disturbed during the installation process, as well as allowing time for the water column to reach its static level. Each location will be staked and the location surveyed for horizontal and vertical data. Each groundwater sample will be collected using a peristaltic pump and PTFE tubing, an inertial pump, or stainless steel bailer. In anticipation of these sample points being low yield the groundwater for field parameter measurements (temperature,pH, dissolved oxygen, redox, turbidity, and conductivity) will be collected after the laboratory samples. This field testing will use an appropriate device and method according to EPA 600/4-79-020: Method for Chemical Analysis of Water and Wastes. The groundwater sampling equipment that contacts the water will be dedicated, or cleaned between each use, to prevent cross-contamination.

3.4.2 Monitoring Well Locations and Rationales

Ten bedrock and fifteen overburden, two-inch diameter monitoring wells will be installed. Three of the bedrock wells will monitor groundwater coming onto Plum Brook Ordnance Works (PBOW) (background wells); two will monitor groundwater leaving PBS at the northern property boundary area; one will monitor groundwater leaving TNT B Area; one will monitor groundwater leaving the Pentolite Red Water Ponds Area and entering the Reactor area; and three will each be paired with an overburden well to monitor groundwater and investigate the vertical connectivity between the overburden and bedrock groundwater within each of the TNT areas. The 15 new overburden wells will be installed as necessary upgradient, within, and downgradient of the TNT Areas, based on existing data and data that will be acquired during the execution of direct-push groundwater sampling. The intent is to adequately characterize the overburden groundwater of each particular TNT area, including background constituent levels. The estimated depths for each new and existing wells are presented in Table 3-1 and the general location illustrated on Figures 1-2 through 1-7. Identification of new monitoring wells will be unique and follow sitewide convention established in previous investigations.

3.4.3 Monitoring Well Installation

New monitoring wells will be installed into both the water table aquifer and the bedrock aquifer. Borings for the installation of the wells will be advanced in the residual soils using rotosonic and/or hollow-stem auger drilling methods or other appropriate drilling method.

After completion of soil borings, well installations will be performed in conformance with USACE geotechnical requirements. Representative samples of graded filter pack material will be evaluated, and the filter sand will be selected before drilling. The well will be constructed by placing a one-foot layer of sand in the borehole below the screen and bringing the filter pack to two feet above the top of screen. Screen lengths for the wells will be a minimum of 10 feet in length. A three- to five-foot thick bentonite pellet seal will be placed above the sand pack, depth permitting, and the remaining annular space between the top of the seal and ground surface will be grouted continuously from the top of the bentonite seal to the ground surface. The type of grout to be used will be bentonite-cement slurry grout with about 5 percent bentonite powder and 95 percent type 1 portland cement, mixed with five to seven gallons of clean water.

A five-foot length of protective, clean steel casing with a locking cap will be installed over the well pipe to a depth of approximately 5 feet bgs. An internal bentonite collar will be placed within the steel protective casing and outside the polyvinyl chloride (PVC) well casing to a height of 0.5 feet above ground surface. A square concrete pad will be constructed around the well, a minimum of 4 feet square and 4 inches thick, sloping away from the well. An internal drainage hole will be drilled through the steel casing just above the mortar collar. After the grout has thoroughly set, the protective steel casing will be painted with fluorescent orange paint and identified by number in white. Three posts will be set radially around the well, close to the edge of the pad. Completed wells will be surveyed by a licensed land surveyor. A typical monitoring well installation and construction diagram is included as Figure 3-1.

A well installation diagram illustrating the depth of the boring, screen location, sand filter pack material, seals, grout, and height above ground surface will be included in the remedial investigation report.

3.4.4 Monitoring Well Development

Each monitoring well will be developed using a submersible pump or bailer as soon as practical, but no sooner than 48 hours nor longer than 7 calendar days after the placement of the internal mortar collar around the well. Prior to development, the static water level will be measured from the top of the casing and recorded. Static water levels will also be measured 24 hours after development. The well will be developed until discharging water is clear to the unaided eye and the sediment thickness remaining in the well is less than 5 percent of the screen length. If yields permit, the standing water volume in the well (calculated as the volume of water in the well screen and casing and saturated annulus) will be removed at least five times. For each well, a sample of the last water removed during development will be captured and retained for visual inspection and photographing. During development, field measurements of pH, specific conductance, and temperature will be made, and descriptions of the development technique and the physical characteristics of the water (clarity, color, turbidity, and odor) will be recorded by the IT geologist. Wells will be developed by pumping or bailing without using acids, flocculants, disinfectants, or dispersing agents. All purged water will be drummed at the well site. Well development will be completed by bailing, pumping, and surging. During development, the pump inlet will be moved through the entire screened interval or the bailer will be lifted from different depths in the well. The development procedure will continue until the following conditions are met:

- Water is clear to the unaided eye, free of sand, and free of drilling fluids.
- Thickness of the accumulated sediment in the well is less than 5 percent of the length of the well screen.
- Temperature, pH, specific conductance values stabilize, and three consecutive turbidity readings are less than 100 NTUs.
- A volume of water has been removed equal to five times standing water in the well, including the well casing and screen, and the saturated annular space assuming 30 percent porosity.

Water will not be added to the well once the well has been grouted and sealed. If heavy or caked sediments must be removed by washing, the water will be from a potable water source and a sample will be submitted for analysis.

If, the groundwater is not clear and free of sand after four hours of well development, the USACE will be contacted for consultation and further instructions. After final development of each well, approximately 1 liter of water from the well will be collected in a clear glass jar, labeled, and photographed (35-mm color print). The photograph will be submitted as part of the well-development log. The photograph will be a suitably back-lit close-up to show the clarity of the water. The development water sample will be archived until receipt of developed prints.

3.4.5 Development Records

The following records will be kept on a well-development log:

- Project name and location
- Well designation and location
- Date and time of well installation
- Date and time of well development
- Static water level from top of well casing before well development and 24 hours after well development
- Quantity of fluid in well prior to development:
  - Standing in well
  - Contained in saturated annulus, based on an assumed 30 percent porosity
- Field measurements of pH, conductivity, and temperature before, twice during, and after development
- Field measurement of turbidity (NTU) until three consecutive measurements are less than 100 NTUs.
- Depth from top of well casing to bottom of well
- Screen length
- Depth from top of well casing to top of sediment inside well, before and after development
- Physical character of removed water, including changes in clarity, color, particulate, and odor
- Type and size/capacity of pump and/or bailer used
- Description of surge technique
- Measured height of well casing above ground surface at time of development
- Typical pumping rate and estimated well yield
- Quantity of water/fluid removed during development, both incremental and total
- Disposal of development water.

3.4.6 Water Level Monitoring

The depth to water will be measured to the nearest 0.01 foot from the highest point on the riser (inner casing) or from a marking on the riser from which the elevation has been surveyed.

3.5 Groundwater Sampling

Groundwater samples will be collected from existing and newly installed monitoring wells (Table 3-1). Proposed and existing groundwater monitoring well locations are shown on Figures 1-2 through 1-7. Groundwater sampling will be conducted in order from the areas assumed to be least contaminated to the areas assumed to be most contaminated. All sampling and purging equipment (pumps, tapes, discharge piping) will be decontaminated prior to use and after each successive use. In addition, the condition of all surface components of the monitoring wells sampled will be documented with the recommendation for repair. The surface components will include the concrete pad, protective posts, protective casing, and well casing. In addition, the condition of the well locks and lock hasps will be documented.

3.5.1 Groundwater Sampling Equipment

The equipment required for groundwater sampling includes:

- Water level indicator
- Low-flow submersible pump with Teflon-lined tubing
- Teflon or stainless steel bailer of appropriate size for the monitoring well fitted with a bottom-emptying device
- Nylon rope
- Oxygen reduction potential (Eh), dissolved oxygen, pH, temperature, turbidity, and specific conductance meters
- Appropriate sample bottles and temperature-controlled container
- Plastic sheeting
- Five-gallon buckets with lids
- Photoionization detector (PID)
- Pump and/or stainless-steel and/or PVC bailers for purging.

3.5.2 Groundwater Sampling Procedures

Sampling of newly installed monitoring wells will take place no sooner than 14 days after well development has been completed. All equipment used to purge wells and collect samples will be protected from ground surface contact and contamination by use of clean plastic sheeting. Two procedures are available for purging and sampling wells. Low-flow (minimal drawdown) is the preferred purging and sampling method in wells where adequate recharge exists. If wells do not recharge adequately to use low-flow (minimal drawdown) sampling, an alternative method will be used depending on the static water level in the well relative to the well screen. Both of these methods are described in the following procedures:

- The well will be checked for proper identification and structural integrity.
- After unlocking the well and removing the well cap, a PID will be used to measure the concentration of organic vapors at the top of casing and in the breathing zone. If readings are above background, safety precautions outlined in the safety and health plan (SHP) will be followed (IT, 1996c).
- The depth to water will be measured using a decontaminated water level indicator, then the volume of water in the well casing and screen and the volume present in the saturated annulus (filter pack) will be calculated.
- Where recharge rates permit, the well will be purged and sampled using a modified low-flow (minimal drawdown) sampling methodology. Either an electric submersible pump or a bladder pump will be used to complete the sampling. The pump will be inserted into the midportion of the well screen and the well pumped at a rate that minimizes drawdown. Typically, purging rates are on the order of 200 milliliters per minute (ml/min) to 500 ml/minute. It is critical that the purge rate be set such that drawdown in the well is never greater than 0.3 ft. Water chemistry parameters (pH, Eh, conductivity, temperature, dissolved oxygen and turbidity) will be monitored for stability.
- If the pre-pumping (static) water level is above the top of the well screen and drawdown exceeds 0.3 ft even at the lowest setting of the pump, low flow sampling cannot be conducted. In this situation, iterative pumping and recovery cycles will be required to remove at least one volume of the standing water in the well casing and saturated annulus. In this instance, the water level must not be allowed to drop below the top of the well screen. It is, however, acceptable to pump out the stagnant water in the well casing at a higher purge rate but pumping must be stopped when the water level in the well reaches the top of the well screen. Once one well volume is removed, the well may be sampled.
- If the pre-pumping (static) water level is below the top of the well screen and drawdown exceeds 0.3 ft even at the lowest setting of the pump, low flow sampling cannot be conducted. In this situation, iterative pumping and recovery cycles will be required to remove at least one volume of the standing water in the well casing and

saturated annulus. However, in some wells, recharge may be so low that adequate purging of the well may not be achieved even over a period of days. In this case, the well may be sampled without purging.

- During purging, field measurement of pH, Eh, temperature, turbidity, dissolved oxygen and conductivity will be performed. When using low-flow sampling, once these parameters are stable, the well may be sampled. If stability is not achieved after 4 hours of purging, the well will be sampled. Stability is defined as follows:

  - pH +/- 0.1 standard units (SU)
  - Eh +/- 10 mV
  - Temperature +/- 3% degrees Celsius
  - Turbidity (three consecutive readings less than 100 NTUs)
  - Dissolved Oxygen +/-1%
  - Conductivity +/-3% of reading.

- For slow recharging wells, field parameters will be recorded after sampling.

- Where possible, groundwater samples will be collected using a submersible sampling pump and in-line sampling. Where the use of in-line sampling is not possible, a bottom-emptying Teflon bailer will be used.

- At the time of sampling, after collection of the sample for chemical analysis, a second sample will be collected for field measurement of temperature, pH, Eh, dissolved oxygen, and conductivity.

- Sample containers will be labeled with appropriate identifying information (location, date, time, condition, added preservatives, etc.). The preprinted labels will be provided by the field sampling crew leader. Each sample will be logged in a field notebook at the time of collection. Sample containers of appropriate volume and composition will be prepared in advance to ensure the collection of sufficient volumes for all specified analyses.

- The samples will be collected so as to minimize aeration as water enters the bottle. Pumping rates will not exceed 100 ml/minute for VOCs. Pumping rates for all other analyses will not exceed 500 ml/minute. Samples collected for VOC analysis will be collected first.

- Samples for volatile analysis will be collected in screw-cap, septum-top glass vials and filled so that there are no air bubbles present to allow volatilization.

- Samples for metals and/or nitroaromatics analysis (as described in the site-specific attachments) will be collected in two separate containers; one will be filtered and the other will not be filtered. Samples will be filtered according to the following procedures:

  - The water sample will be filtered at the well site with portable sample filtering equipment or at the field office.

- A Millipore filtration apparatus (or comparable equipment) equipped with a 0.45-micron filter will be used. The filtering apparatus will be cleaned by rinsing thoroughly with deionized water before filtering each sample.

- All sample containers will be transferred to a cooler chest (kept at 4 degrees Celsius [^{o}C)] and delivered to the laboratory in sufficient time so that specified holding times are not exceeded.

3.6 Land Surveying

Following completion of confirmation soil sampling, monitoring well installation, and groundwater sampling, IT will secure the services of an Ohio-registered professional land surveyor to determine the coordinates and elevations of confirmation soil borings and monitoring well locations. The horizontal coordinates will be to the closest 0.1 foot and referenced to the State Plane Coordinate System. Vertical coordinates (ground elevation and well riser, if applicable) will be to the nearest 0.01 foot and referenced to the 1929 National Geodetic Vertical Datum. If the 1929 Datum is not readily available, the existing local vertical datum will be used. All survey data will be tabulated. Loop closure for survey accuracy will be within the horizontal and vertical limits given above. Once sample survey information is available, it will be entered on approved IT boring logs.

Critical reference points, landmarks, and sample locations will be plotted on appropriate map figures with a scale large enough to show their locations relative to other structures at the site.

Locations of screening samples will be determined based on tape-measuring distances from former process line foundations, and other known site features, to each sample point.

3.7 Field Permeability Testing

Field permeability will be evaluated for new wells installed at the former PBOW by performing a slug test after well development. To avoid altering the groundwater chemistry at the site by the introduction of water, water will be instantaneously displaced by inserting a solid slug. The recovery rate will be recorded, and the data will then be evaluated by the appropriate method to determine in situ hydraulic conductivity. Both falling head and rising head tests will be completed. Pressure transducers and electronic data loggers will be utilized so that several tests can be performed simultaneously.

3.8 Utility Clearances

Prior to beginning any intrusive (i.e., drilling and direct push) investigation, all sites will be cleared by Mr. Don Young, PBS Maintenance Department. Locations for underground utilities will be identified by Mr. Gary Ponikvar, PBS Health and Safety Division. Under no circumstances will investigations begin without written authorization from PBS.

3.9 Site Access

All IT personnel and any subcontracted personnel involved in on-site work will be U.S. citizens. Names of personnel will be provided to Mr. Robert Puzak NASA Environmental Coordinator, at least 72 hours in advance so that site access can be arranged. All personnel entering the site will be appropriately trained and instructed by PBS concerning site safety issues. In addition, each crew will be issued a PBS two-way radio (for emergency use only).

4.0 Sample Analysis and Decontamination Procedures

4.1 Sample Number System

The confirmation sample numbering system to be used during this investigation for fixed-base samples will conform to the USACE-Nashville District's numbering convention. Specifically, each sample will be assigned a unique sample identification number that describes where the sample was collected. Each number consists of a group of letters and numbers, separated by hyphens. The numbering system to be used for the RI is described as follows:

Project Code	Year	Sample Type[a]	Site Identification[b]	Boring Number	Sample Number	Sample Depth[c] (ft)
PBOW	01	XX	XXXX	XXXXX	XXXXXX	XX-XX

[a]Sample types:

- ER – Equipment rinsate sample
- FB – Field blank
- FD – Field duplicate sample
- FS – Field split sample
- GW – Groundwater sample.
- MD – Matrix spike duplicate sample
- MS – Matrix spike sample
- SB – Subsurface soil sample
- SD – Sediment sample
- SS – Surface soil sample
- SW – Surface water sample
- TB – Trip blank.

[b]Site:

- TNTA - TNT Area A
- TNTB - TNT Area B
- TNTC - TNT Area C
- WRWP - West Area Red Water Ponds
- PRWP - Pentolite Road Red Water Ponds.

[c]Depth : Only required for soil samples.

PBOW-00-SB-TNTA-SO001-AB0001-04-06 signifies that this soil sample was collected from a depth of 4 to 6 feet at soil location SO001 in TNTA with a sample number of AB0001. The sample identification number will be recorded by the IT field geologist in the field activity daily log, boring log, and sample collection log as shown respectively in Figures 4-1, 4-11, and 4-16 of the SAP (IT, 1996a).

4.2 Analytical Program

The analytical program has been designed to acquire sufficient and defensible data to determine the extent of contamination in the investigated areas. Table 4-1 summarizes the analytical parameters required and associated laboratory methods to be used during this investigation.

A contract laboratory will analyze samples for nitroaromatics, target compound list (TCL) VOCs, TCL SVOCs, Target Analyte List (TAL) metals, and various water quality parameters. Laboratory QC procedures and data quality requirements are specified in and referenced to appropriate sections of the QAPP (IT, 1996b).

4.3 Decontamination Procedures

Decontamination requirements and procedures are specified in detail in Chapter 5.0 of the SAP (IT, 1996a) and will be followed during the current groundwater investigation. The IT field coordinator must contact Plum Brook Station for access to a potable water source for decontamination use. The following summarizes decontamination procedures for equipment before site entry, between borings, and before site departure:

Nonsampling equipment (augers, drill rod, etc. that does not contact analytical samples):

- Steam-rinse with potable water, or wash and scrub using a brush with nonphosphate detergent and then rinse with potable water.

Confirmation samples:

- Wash and scrub using a brush with nonphosphate detergent.
- Rinse with potable water.
- Rinse with ASTM Type II water.
- Rinse with isopropyl alcohol.
- Final rinse with ASTM Type II water; the volume of water used will be at least five times greater than the volume of isopropyl alcohol used.
- Air dry.
- Wrap in aluminum foil.

5.0 Sample Preservation, Packing, and Shipping

Sample containers and caps will be new, certified as precleaned, and made of materials recommended by the EPA in Title 40, Code of Federal Regulations, Part 136 and SW-846 (3rd Edition). Sample containers and preservatives/preservation methods are summarized in Table 5-1. Sample containers will be supplied and shipped to the job site by the designated primary laboratory.

Each sample container will be bagged before placement in the cooler. Sample holding times will be calculated from the date the sample is collected.

Samples for chemical analysis will be placed in coolers as soon as possible after collection and will be packed to minimize container breakage by using vermiculite, styrofoam peanuts, or bubble wrap to fill void spaces in the cooler. Samples will be cooled to a temperature of approximately 4 ^{o}C and maintained at that temperature by means of double-bagged ice until the cooler is received at the laboratory. Coolers will be shipped to the laboratory by a next-day delivery service. Notification of shipment, including air bill number, will be telephoned or faxed to the laboratory on the day of sample collection. If this is not possible, the laboratory will be notified the following morning.

Completed analytical request/chain of custody records will be secured and included with each shipment of coolers to:

STL Knoxville
Attention: Jamie McKinney
5815 Middlebrook Pike
Knoxville, Tennessee 37923
Telephone: (865) 588-6401

Paragon Analytics
Attention: Debbie Fazio
225 Commerce Drive
Fort Collins, Colorado 80524
Telephone: (970) 490-1511

6.0 Investigation-Derived Waste Management Plan

Anticipated IDW during field activities includes soil (drill cuttings), bedrock cores, purge/development water, decontamination fluid, and disposable personal protective equipment. Detailed procedures for IDW management are provided in Chapter 8.0 of the SAP (IT, 1996a). The following is a brief summary of the procedures for handling IDW.

6.1 Soil and Groundwater

Residual subsurface soil will be placed in 55-gallon drums upon completion of field sampling. IDW drums will be labeled to indicate project name, date collected, and contents and will be stored on pallets in the staging area located east of Building 9201 on Pentolite Road or in a bunker in the Magazine Area.

6.2 Decontamination Fluid

Limited quantities of decontamination fluid, including wash water, nonphosphate soapy water, and final rinse water will be kept in plastic tubs during the decontamination process and will be placed in 55-gallon drums upon completion of field sampling. Decontamination fluid containing small quantities of solvents such as isopropanol will be collected in metal pans for evaporation. IDW drums will be labeled to indicate project name, date collected, and contents and will be stored on pallets in the staging area located east of Building 9201 on Pentolite Road.

6.3 Sampling Equipment and PPE

Limited quantities of PPE and sampling equipment, including Tyvek suits, latex/nitrile gloves, plastic, and disposable tubing used for groundwater sampling, will be generated during sampling. All sampling equipment and PPE will be double-bagged and disposed of in on-site dumpsters. If any of the sampling equipment and PPE appears to be grossly contaminated, it will be decontaminated prior to disposal.

6.4 Laboratory Waste

Laboratory wastes may be generated if an on-site laboratory is used for the screening analysis of soils. These wastes will include solvents used in the analysis of the soils as well as excess soil remaining after sample analysis. All wastes will be containerized in drums, sampled and stored as described in Section 6.5.

6.5 IDW Sampling

All soil and water IDW will be sampled at the completion of fieldwork. For soils, one composite soil sample will be collected from drummed soil for each well. The composite sample will then be submitted to the identified laboratory for a full Toxicity Characteristic Leaching Procedure analysis and nitroaromatics. Seven-day turnaround time will be used, unless otherwise directed by the Project Manager.

When the analytical results are received, IT personnel will evaluate the results and make a determination of off-site disposal methods. Possible disposal facilities will be identified by IT; however, selection of the facility or facilities to receive the IDW will be the responsibility of the USACE.

7.0 References

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TABLES

Table 2-1

Summary of Data Quality Objectives
Remedial Investigation of Groundwater
Former Plum Brook Ordnance Works
Sandusky, Ohio

Potential Data Users	Available Data	Conceptual Model	Media of Concern	Data Uses and Objectives	Data Types	Analytical Level
EPA OEPA DOD USACE NASA IT Corporation Other Contractors Possible Future Land Users	Previous environmental investigations show varying degrees of contamination in the groundwater and soil.	Contaminant Source Production of TNT, DNT, and pentolite. Past DOD operations. Migration Pathways Soil, sediment, surface water, and groundwater Potential receptors Wildlife, human Potential Contaminants of Concern VOCs, SVOCs, metals, and nitroaromatic explosives	Groundwater Soil	Determine if there are hazardous substances present that constitute an unacceptable risk to human health and the environment. Define site physical features and characteristics. Evaluate fate and transport pathways Determine the nature and extent of source areas. Define current and future routes of exposure. Determine whether contaminant distribution is consistent with DOD activities	Groundwater Metals Explosives VOCs SVOCs Water quality parameters Soil Metals Explosives VOCs SVOCs	Field screen Laboratory screen Definitive Definitive

DOD - U.S. Department of Defense.
EPA - U.S. Environmental Protection Agency.
OEPA - Ohio Environmental Protection Agency.
NASA - National Aeronautics and Space Administration.
SVOC - Semivolatile organic compound.
VOC - Volatile organic compound.

Table 3-1

Monitoring Well Construction Details
Groundwater Remedial Investigation of TNT and Red Water Ponds Areas
Former Plum Brook Ordnance Works, Sandusky, Ohio

Wells	Well Depth (feet)	Casing Diameter (inches)	Borehole Diameter (inches)	Screen Interval (feet)
New Bedrock Wells				
Upgradient Boundary, West of West Red Water Ponds	55	2	NA	NA
Upgradient Boundary, West of TNT Area B	45	2	NA	NA
Southeast Upgradient Boundary, Southeast of TNT B	45	2	NA	NA
Bedrock within TNT B	45	2	NA	NA
North of TNT B	25	2	NA	NA
South of Reactor Area and Pentolite Road	75	2	NA	NA
Downgradient Boundary, North of Reactor Area	75	2	NA	NA
Downgradient Boundary, East-Northeast of Reactor Area	75	2	NA	NA
Bedrock within TNT A	85	2	NA	NA
Bedrock within TNT C	100	2	NA	NA
New Overburden Wells				
5 Wells at TNT Area A	15	2	NA	NA
5 Wells at TNT Area B	15	2	NA	NA
5 Wells at TNT Area C	15	2	NA	NA
Existing Bedrock Wells				
AA1-BEDGW-001	65	2	6	15
AA2-BEDGW-001	43	2	6	15
AA3-BEDGW-001	53	2	6	10
ABG-BEDGW-001	21	2	6	15
BG8-BEDGW-001	20	2	6	15
MNTA-BEDGW-001	64	2	6	15
PB-BED-MW13	75.5	4	3 (A)	46 (B)
PB-BED-MW14	52.2	4	3 (A)	29 (B)
PB-BED-MW15	74.4	4	3 (A)	31.5 (B)
PB-BED-MW16	74	4	3 (A)	49.2 (B)
PB-BED-MW17	64.4	4	3 (A)	45 (B)
PB-BED-MW18	75.4	4	3 (A)	51 (B)
PB-BED-MW19	49.5	4	3 (A)	32 (B)
PB-BED-MW20	49.5	4	3 (A)	35 (B)
TNTB-BEDGW-001	24	2	6	15
TNTB-BEDGW-002	24.2	2	6	10
Existing Overburden Wells				
IT-MW01	9.5	2	8	4-9
MK-MW16	8	2	5	10
MK-MW17	6	2	4	10
TNTA-MW10	14	2	10	10
TNTA-MW11	13	2	10	10
TNTC-MW03	14	2	8	5-14
TNTC-MW04	18.8	2	8	8.8-18.8
TNTC-MW05	29.7	2	8	25

A - 3-inch diameter open borehole into bedrock
B - Length of open borehole
NA - Not available Depths for proposed wells are estimated
Depths for proposed wells are estimated

Table 4-1

Summary of Analytical Parameters and Methods
Groundwater Remedial Investigation of TNT and Red Water Ponds Areas
Former Plum Brook Ordnance Works, Sandusky, Ohio

Sample Matrix	Analytical Parameters[a]	Analytical Method[b]
Groundwater	TCL Volatile Organic Compounds	SW-846 5030/8260B
	TCL Semivolatile Organic Compounds	SW-846 3510C/8270C
	Nitroaromatic Compounds	SW-846 8330M
	TAL Metals (T/D)	SW-846 3005A/6010B/7470A
	Turbidity	EPA 180.1
	Alkalinity	EPA 310.1
	Hardness	EPA 130.2
	Total Organic Carbon	SW-846 9060
	Total Dissolved Solids	EPA 160.1
	Total Suspended Solids	EPA 160.2
	Chloride	EPA 325.3
	Cyanide, total	SW-846 9010A/9012
	Nitrate	EPA 350.2
	Sulfate	EPA 375.3
Soil	TCL Volatile Organic Compounds	SW-846 5035/8260B
	Nitroaromatic Compounds	SW-846 8330
	TAL Metals	SW-846 3050B/6010B/7471A
	SPLP Nitroaromatics	SW-846 1312/8330
Soil IDW	TCLP Volatile Organic Compounds	SW-846 1311/8260B
	TCLP Semivolatile Organic Compounds	SW-846 1311/8270C
	TCLP Metals	SW-846 1311/6010B/7471A
	Ignitability	SW-846 1010
	Corrosivity	SW-846 1110
	Reactivity	7.3.3.2/7.3.4.2

[a]Target analyte list (TAL) and target compound list (TCL) are used to designate parameter lists with no requirements for Contract Laboratory Program (CLP) method quality control or data reporting packages

[b] Analyses found in *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods,* USEPA Publication, Third Editio and *Methods for Chemical Analysis of Water and Wastes*, EPA-600/4-79-020, March 1983 and subsequent revisions.

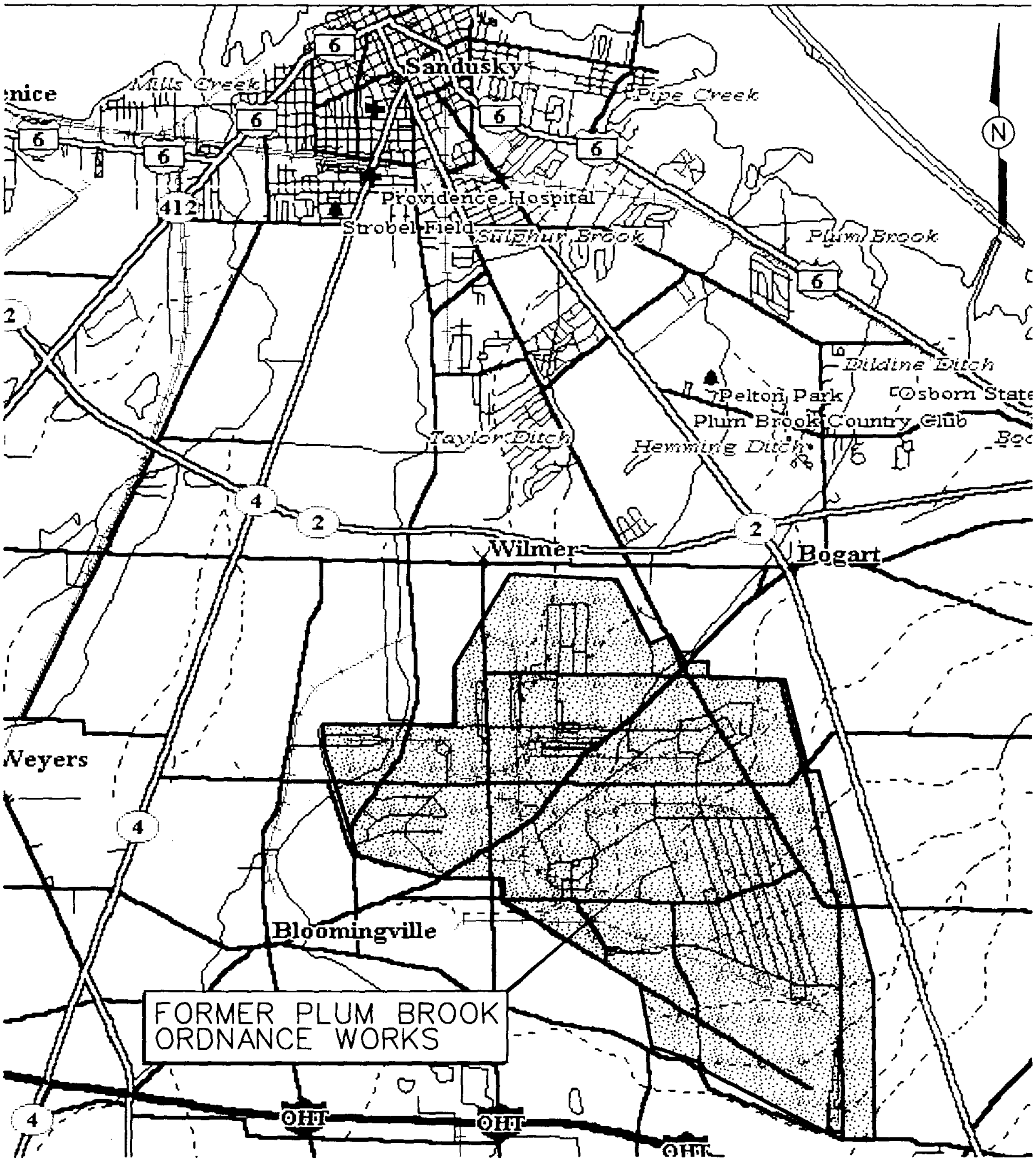
Tab. .-1

Analytical Methods, Containers, Preservatives, and Holding Times
Groundwater Remedial Investigation of TNT and Red Water Ponds Areas
Former Plum Brook Ordnance Works, Sandusky, Ohio

Matrix	Parameter	Analytical Method	Sample Container	Preservation Requirements	Holding Time
Groundwater	TCL VOCs	SW-846 5030/8260B	(3) 40 ml VOA vial	Cool to 4°C, H_2SO_4 to pH <2	14 days
	TCL SVOCs	SW-846 3510C/8270C	(2) 1 L amber glass	Cool to 4°C	7 days extraction/40 days
	Nitroaromatics	SW-846 8330M	(2) 1 L amber glass	Cool to 4°C	7 days extraction/40 days
	TAL Metals (T/D)	SW-846 3005A/6010B/7470A	(2) 500 mL HDPE	Cool to 4°C, HNO_3 to pH <2	6 months (28 days for Hg)
	Turbidity	EPA 180.1	(1) 250 mL HDPE	Cool to 4°C	48 hours
	Alkalinity	EPA 310.1	(1) 250 mL HDPE	Cool to 4°C	14 days
	Hardness	EPA 130.2	(1) 250 mL HDPE	Cool to 4°C, HNO_3 to pH <2	6 months
	TOC	SW-846 9060	(1) 250 mL HDPE	Cool to 4°C, H_2SO_4 to pH <2	28 days
	Total Dissolved Solids	EPA 160.1	(1) 250 mL HDPE	Cool to 4°C	7 days
	Total Suspended Solids	EPA 160.2	(1) 250 mL HDPE	Cool to 4°C	7 days
	Chloride	EPA 325.3	(1) 250 mL HDPE	Cool to 4°C	28 days
	Cyanide, total	SW-846 9010A/9012	(1) 1 L HDPE	Cool to 4°C, NaOH to pH >12	14 days
	Nitrate	EPA 350.2	(1) 250 mL HDPE	Cool to 4°C	48 hours
	Sulfate	EPA 375.3	(1) 250 mL HDPE	Cool to 4°C	28 days
Soil	TCL VOCs	SW-846 5035/8260B	(3) Encore®	Cool to 4°C	48 hours/14 days
	Nitroaromatics	SW-846 8330	4 oz CWM glass with Teflon-lined lid	Cool to 4°C	14 days extraction/40 days
	TAL Metals	SW-846 3050B/6010B/7471A	4 oz CWM glass with Teflon-lined lid	Cool to 4°C	6 months (28 days for Hg)
	SPLP Nitroaromatics	SW-846 1312/8330	4 oz CWM glass with Teflon-lined lid	Cool to 4°C	14 days extraction/7 days/40days
Soil IDW	TCLP VOCs	SW-846 1311/8260B	4 oz CWM glass with Teflon-lined lid	Cool to 4°C	48 hr/14 days
	TCLP SVOCs	SW-846 1311/8270C	4 oz CWM glass with Teflon-lined lid	Cool to 4°C	14 days extraction/40 days
	TCLP Metals	SW-846 1311/6010B/7471A	4 oz CWM glass with Teflon-lined lid	Cool to 4°C	6 months (28 days for Hg)
	Ignitability	SW-846 1010	4 oz CWM glass with Teflon-lined lid	Cool to 4°C	ASAP
	Corrosivity	SW-846 1110	4 oz CWM glass with Teflon-lined lid	Cool to 4°C	ASAP
	Reactivity	7.3.3.2/7.3.4.2	4 oz amber glass with Teflon-lined lid	Cool to 4°C	ASAP

CWM - Clear wide mouth
HDPE - High density polyethylene
SPLP - Synthetic Precipitation Leaching Procedure
SVOC - Semivolatile organic compound.
TAL - Target analyte list.
TCL - Target compound list.
T/D - Total and Dissolved
TOC - Total organic compound.
VOC - Volatile organic compound.

FIGURES



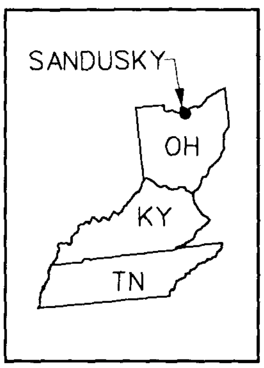


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FIGURE 1-1
VICINITY MAP

FORMER PLUM BROOK ORDNANCE WORKS
SANDUSKY, OHIO

IT CORPORATION
A Member of The IT Group

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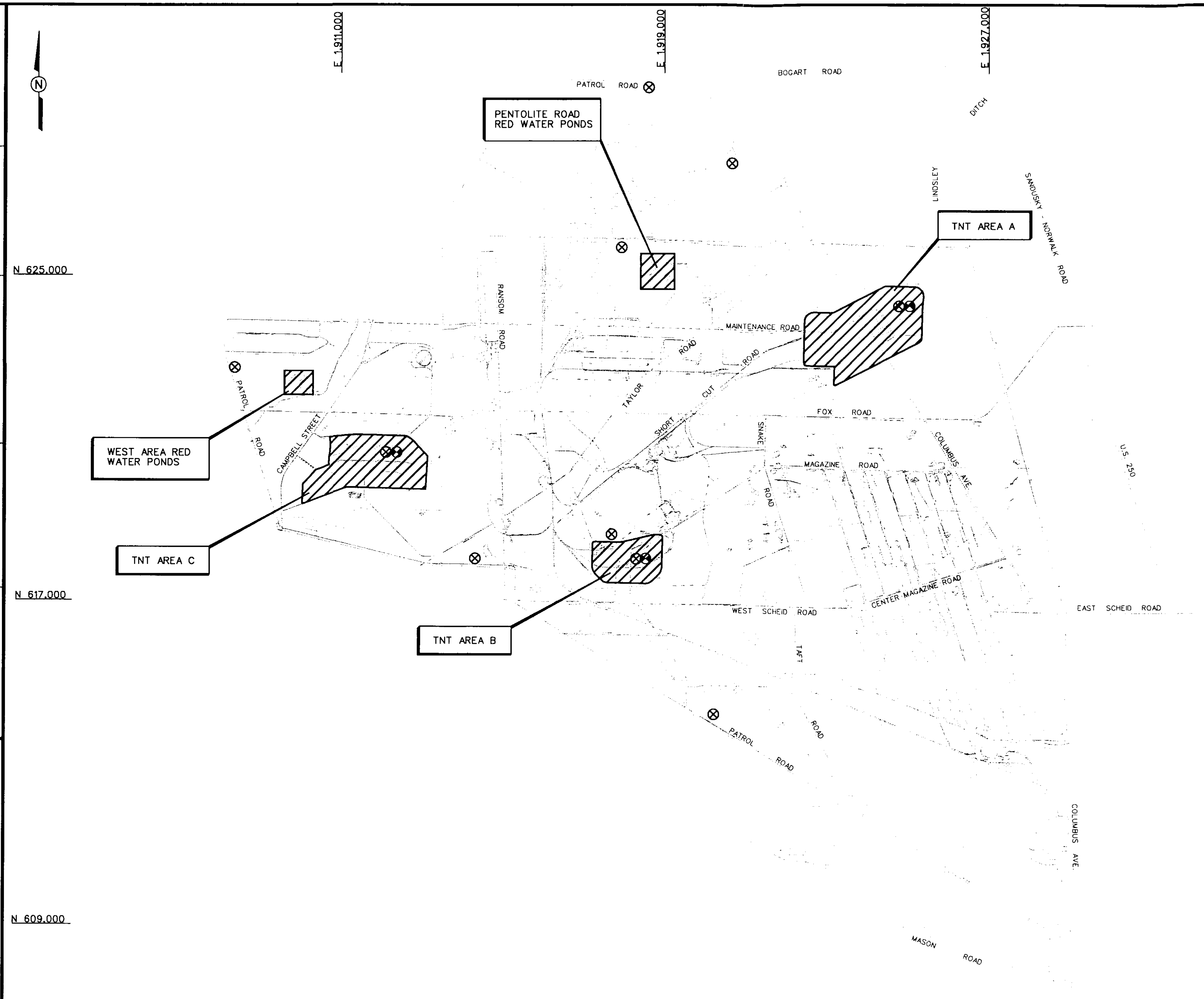

LEGEND:

- AREAS OF CONCERN
- BUILDINGS
- RAILROAD
- SURFACE WATER
- DITCH
- FENCE (PBOW BOUNDARY)
- ⊗ PROPOSED BEDROCK LOCATION
- PROPOSED OVERBURDEN LOCATION

NOTES:

FOUR ADDITIONAL OVERBURDEN WELLS WILL BE INSTALLED BASED ON DIRECT PUSH SAMPLING RESULTS.

SCALE

0 2500 5000 FEET

FIGURE 1-2

LOCATIONS OF AREAS OF CONCERN

FORMER PLUM BROOK ORDNANCE WORKS
NASA PLUM BROOK STATION
SANDUSKY, OHIO

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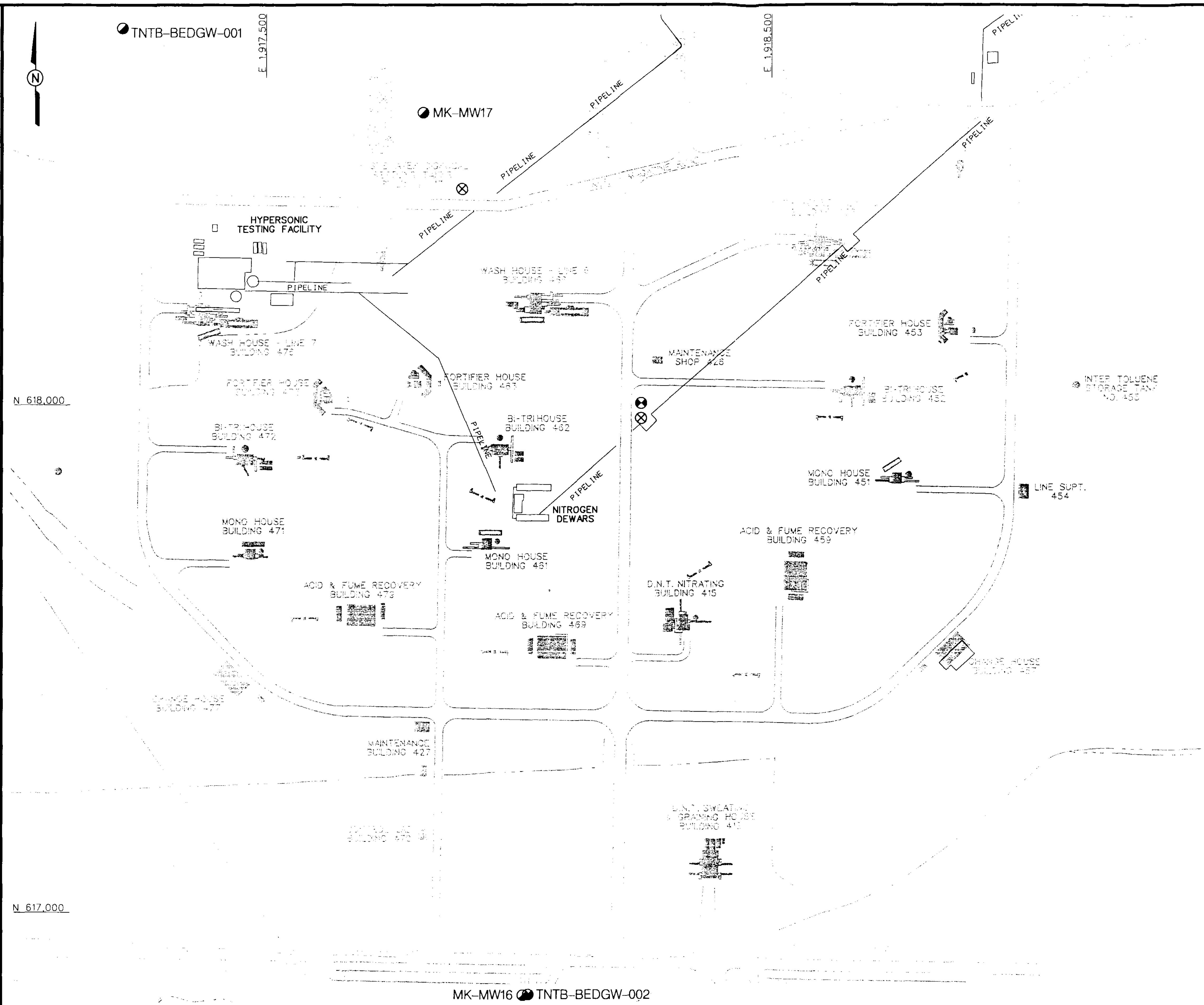

LEGEND:

BUILDINGS

SURFACE DRAINAGE

SURFACE WATER

MONITORING WELL LOCATION

PROPOSED BEDROCK WELL LOCATION

PROPOSED OVERBURDEN WELL LOCATION

NOTES:

FOUR ADDITIONAL OVERBURDEN WELLS WILL BE INSTALLED BASED ON DIRECT PUSH SAMPLING RESULTS.

SCALE

0 200 400 FEET

FIGURE 1-4

TNT AREA B GENERAL SITE FEATURES AND PROPOSED MONITORING WELL LOCATION MAP

FORMER PLUM BROOK ORDNANCE WORKS
NASA PLUM BROOK STATION
SANDUSKY, OHIO

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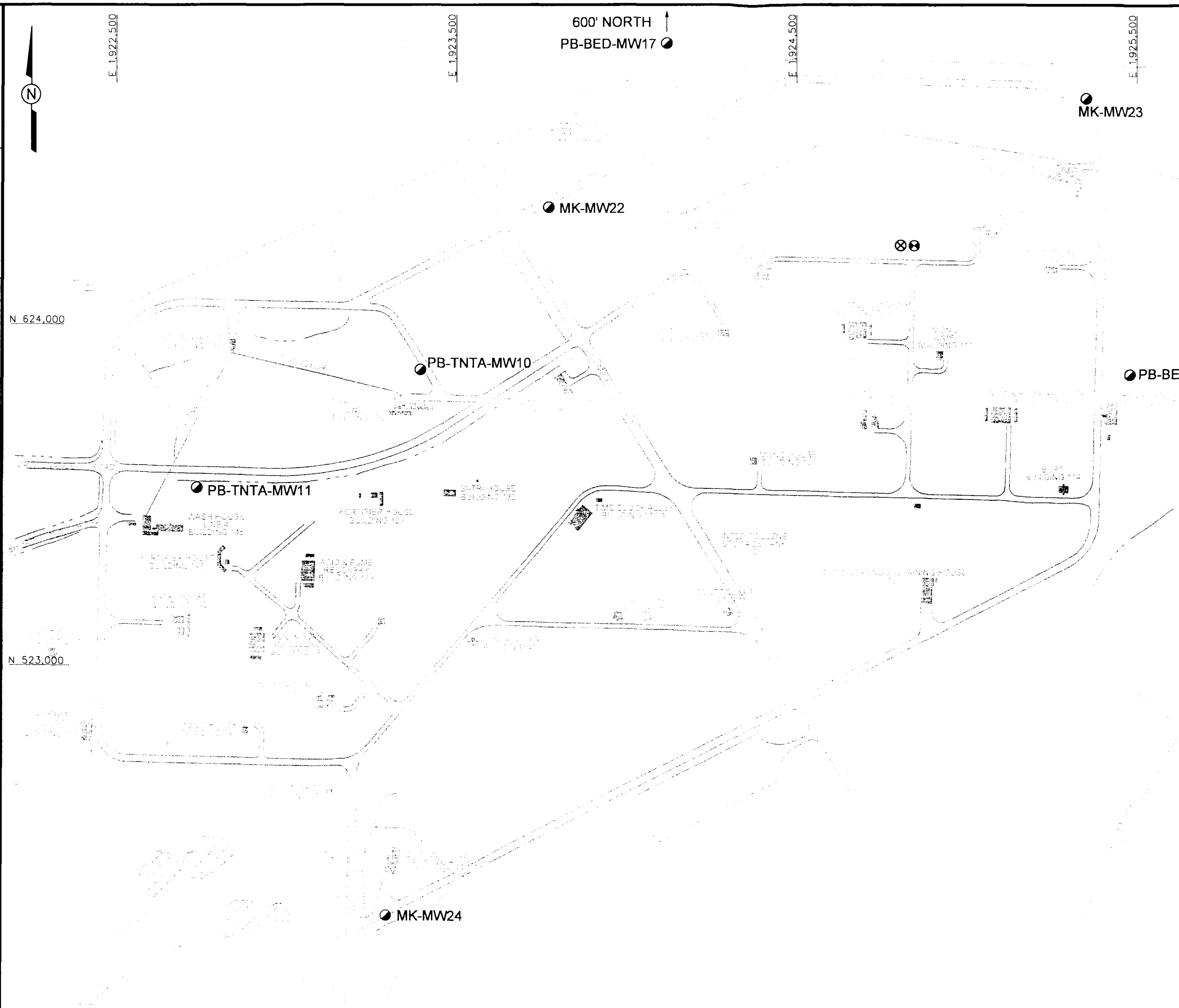

LEGEND:

BUILDINGS

SURFACE DRAINAGE

SURFACE WATER

MONITORING WELL LOCATION

PROPOSED BEDROCK WELL LOCATION

PROPOSED OVERBURDEN WELL LOCATION

NOTES:

FOUR ADDITIONAL OVERBURDEN WELLS WILL BE INSTALLED BASED ON DIRECT PUSH SAMPLING RESULTS.

SCALE

0 300 600 FEET

FIGURE 1-3

TNT AREA A GENERAL SITE FEATURES AND PROPOSED MONITORING WELL LOCATION MAP

FORMER PLUM BROOK ORDNANCE WORKS
NASA PLUM BROOK STATION
SANDUSKY, OHIO

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DWG. NO.: ...\825635es.011 | PROJ. NO.: 825635
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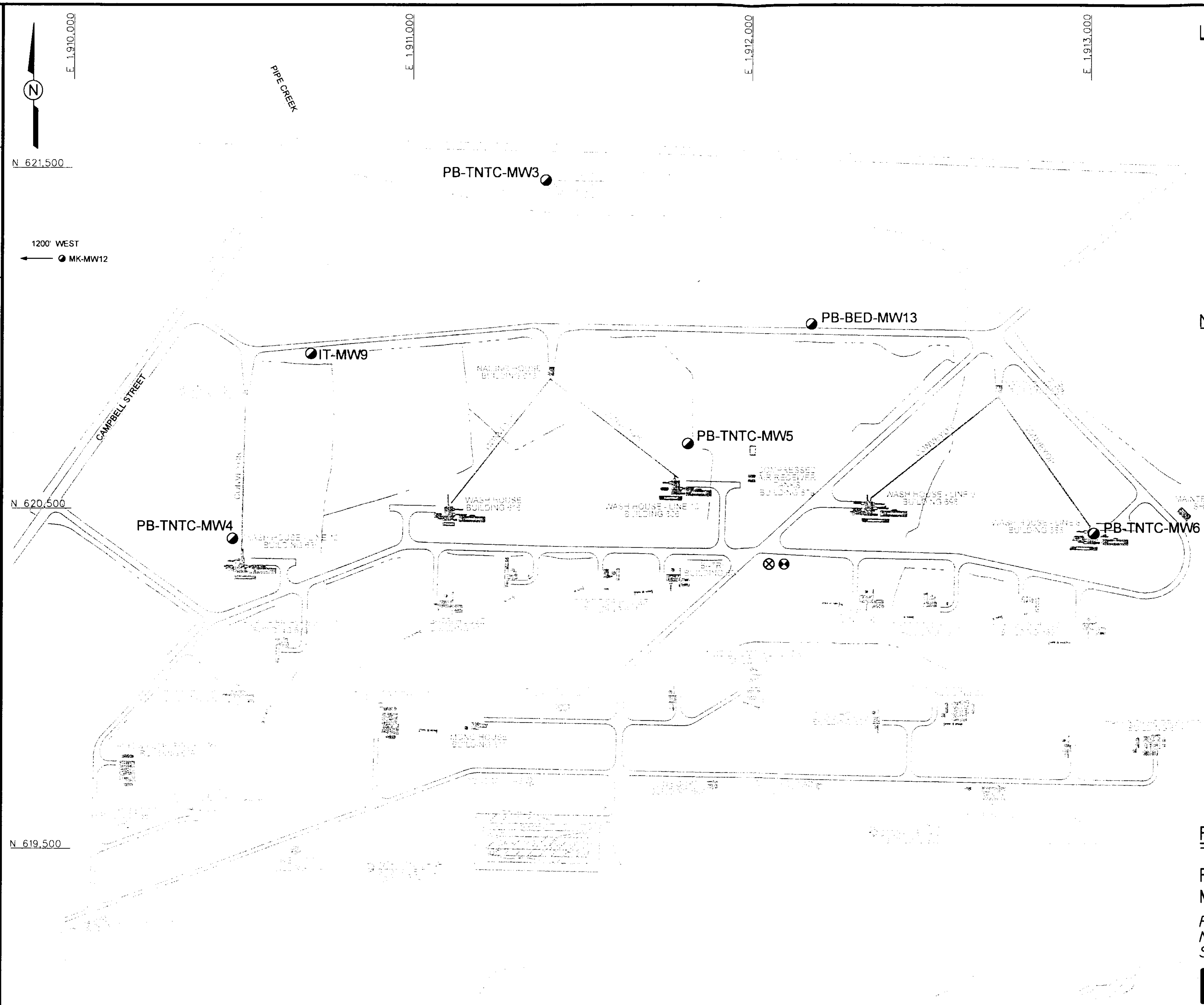

LEGEND:

BUILDINGS

SURFACE DRAINAGE

SURFACE WATER

MONITORING WELL LOCATION

PROPOSED BEDROCK WELL LOCATION

PROPOSED OVERBURDEN WELL LOCATION

NOTES:

FOUR ADDITIONAL OVERBURDEN WELLS WILL BE INSTALLED BASED ON DIRECT PUSH SAMPLING RESULTS.

SCALE

0 300 600 FEET

FIGURE 1-6

TNT AREA C GENERAL SITE FEATURES AND PROPOSED MONITORING WELL LOCATION MAP

FORMER PLUM BROOK ORDNANCE WORKS
NASA PLUM BROOK STATION
SANDUSKY, OHIO

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PROJ. NO.: 825635
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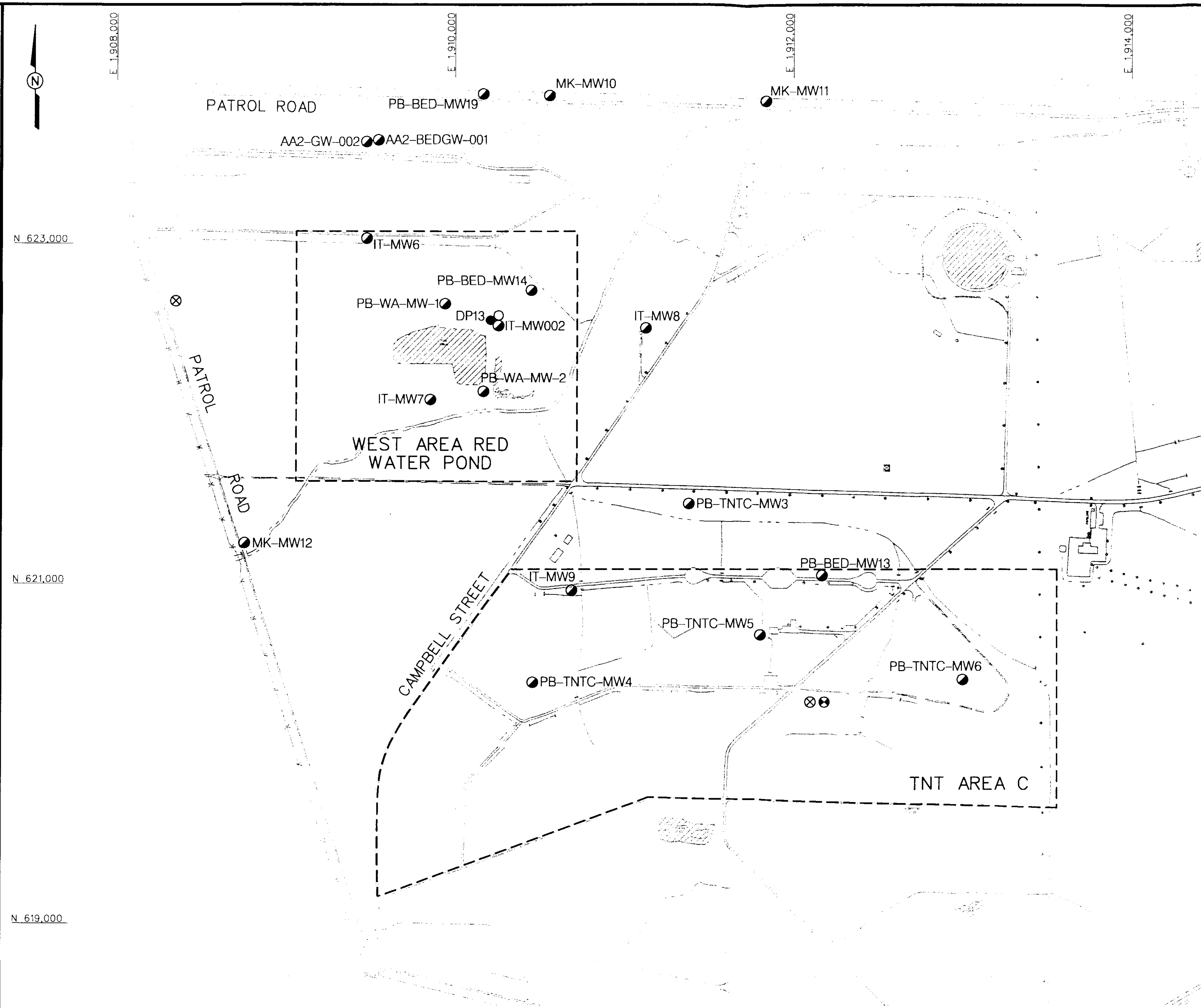

LEGEND:

- BUILDINGS
- FENCE (PBOW BOUNDARY)
- RAILROAD
- DRAINAGE
- EXISTING MONITORING WELL LOCATION
- ⊗ PROPOSED BEDROCK WELL LOCATION
- PROPOSED OVERBURDEN WELL LOCATION
- ● EXISTING DIRECT PUSH LOCATION
- ○ PROPOSED DIRECT PUSH LOCATION

NOTES:

FOUR ADDITIONAL OVERBURDEN WELLS WILL BE INSTALLED BASED ON DIRECT PUSH SAMPLING RESULTS.

SCALE

0 600 1200 FEET

FIGURE 1-5

WEST AREA RED WATER PONDS AND TNT AREA C PROPOSED MONITORING WELL LOCATION MAP

FORMER PLUM BROOK ORDNANCE WORKS
NASA PLUM BROOK STATION
SANDUSKY, OHIO

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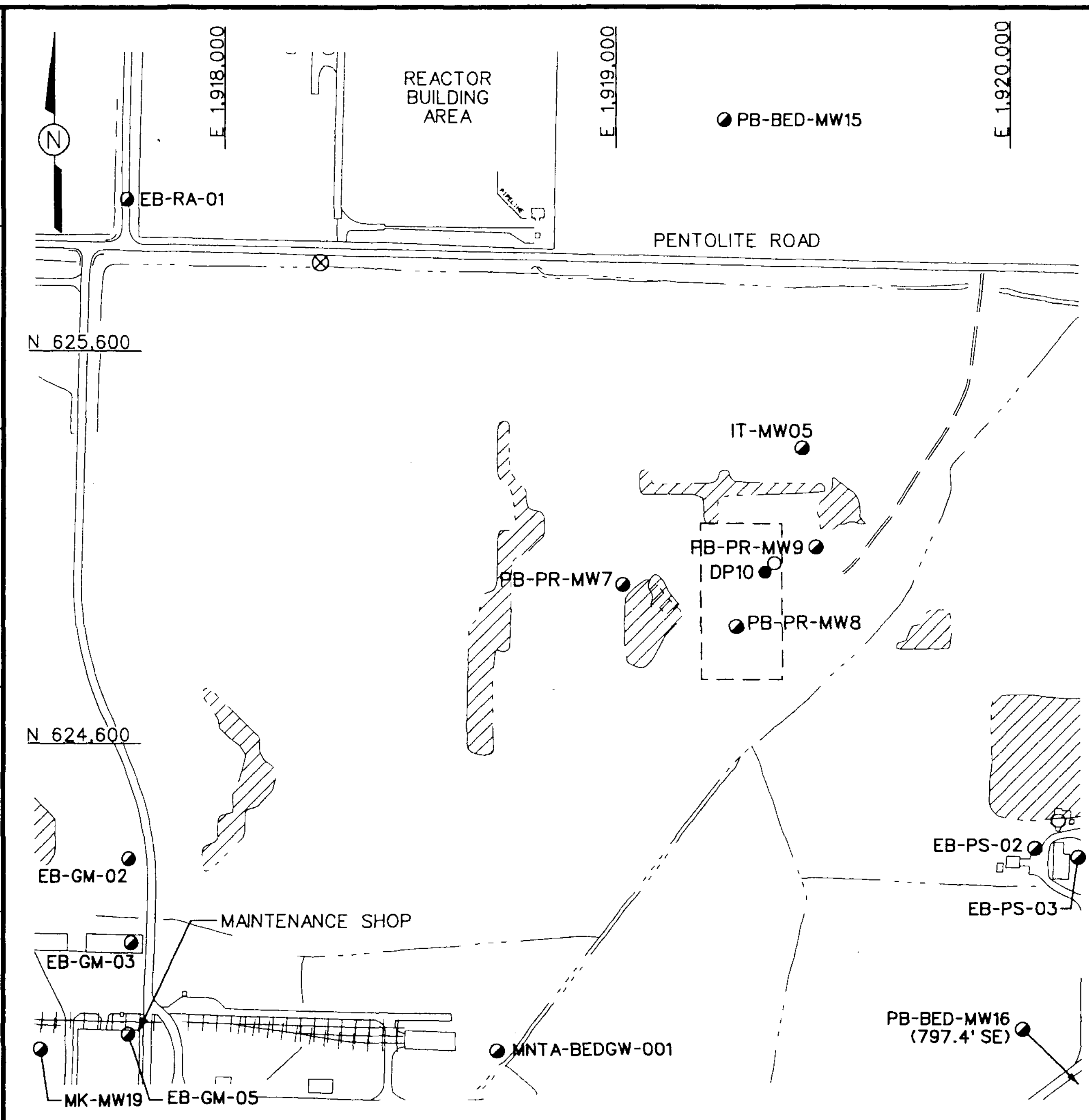

LEGEND:

- BUILDINGS
- RAILROAD
- SURFACE WATER
- SURFACE WATER DRAINAGE
- APPROXIMATE HISTORICAL LOCATION OF PONDS
- FENCE (PBOW BOUNDARY)
- IT-MW02 EXISTING MONITORING WELL LOCATION
- PROPOSED BEDROCK WELL LOCATION
- EXISTING DIRECT PUSH LOCATION
- PRPOSED DIRECT PUSH LOCATION

SCALE

0 400 800 FEET

FIGURE 1-7
PENTOLITE ROAD RED WATER PONDS PROPOSED BEDROCK WELL LOCATION MAP

PLUM BROOK ORDNANCE WORKS
NASA PLUM BROOK STATION
SANDUSKY, OHIO

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STARTING DATE: 07/18/01 | DRAWN BY: B. VANDERGRIFF

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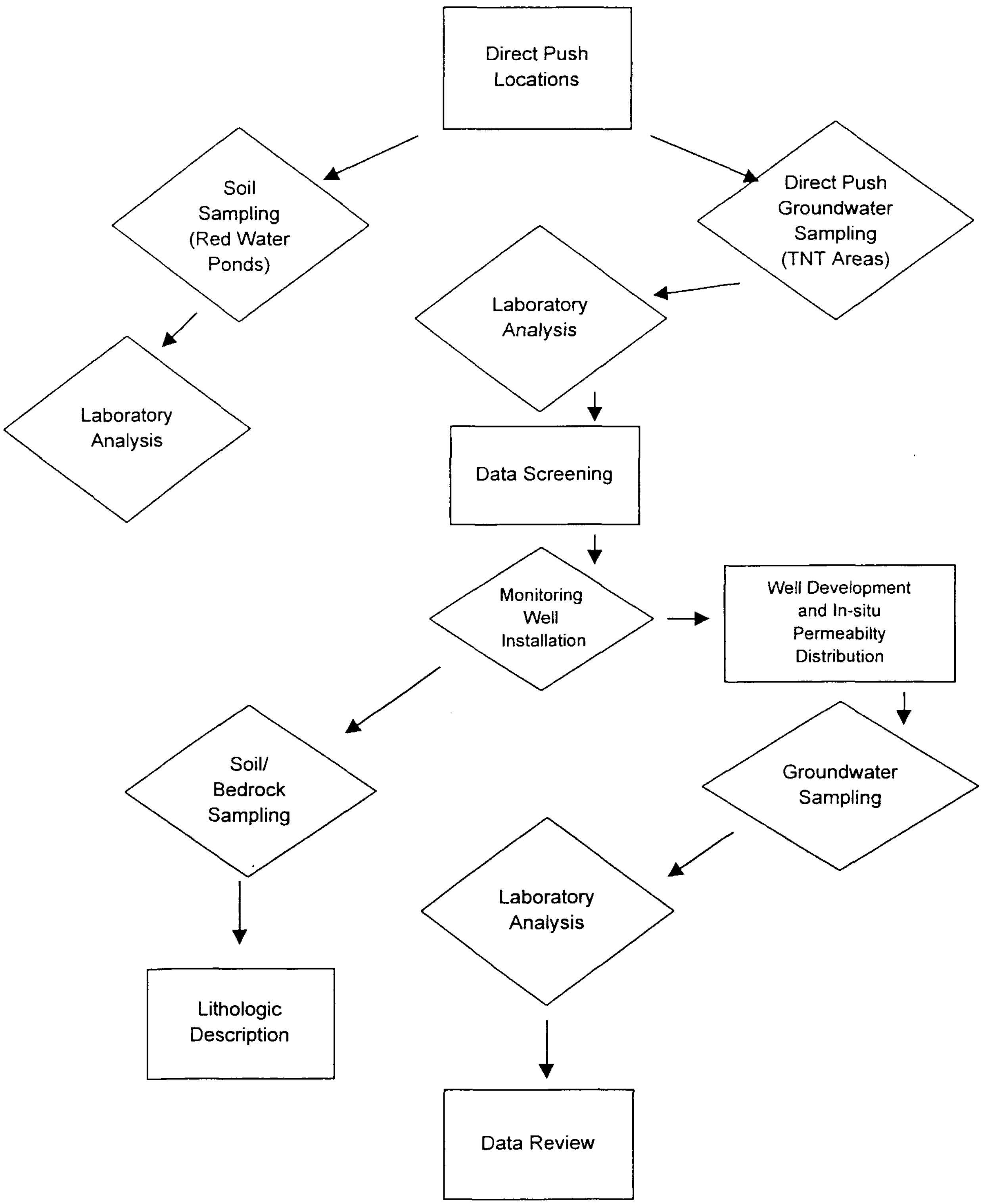
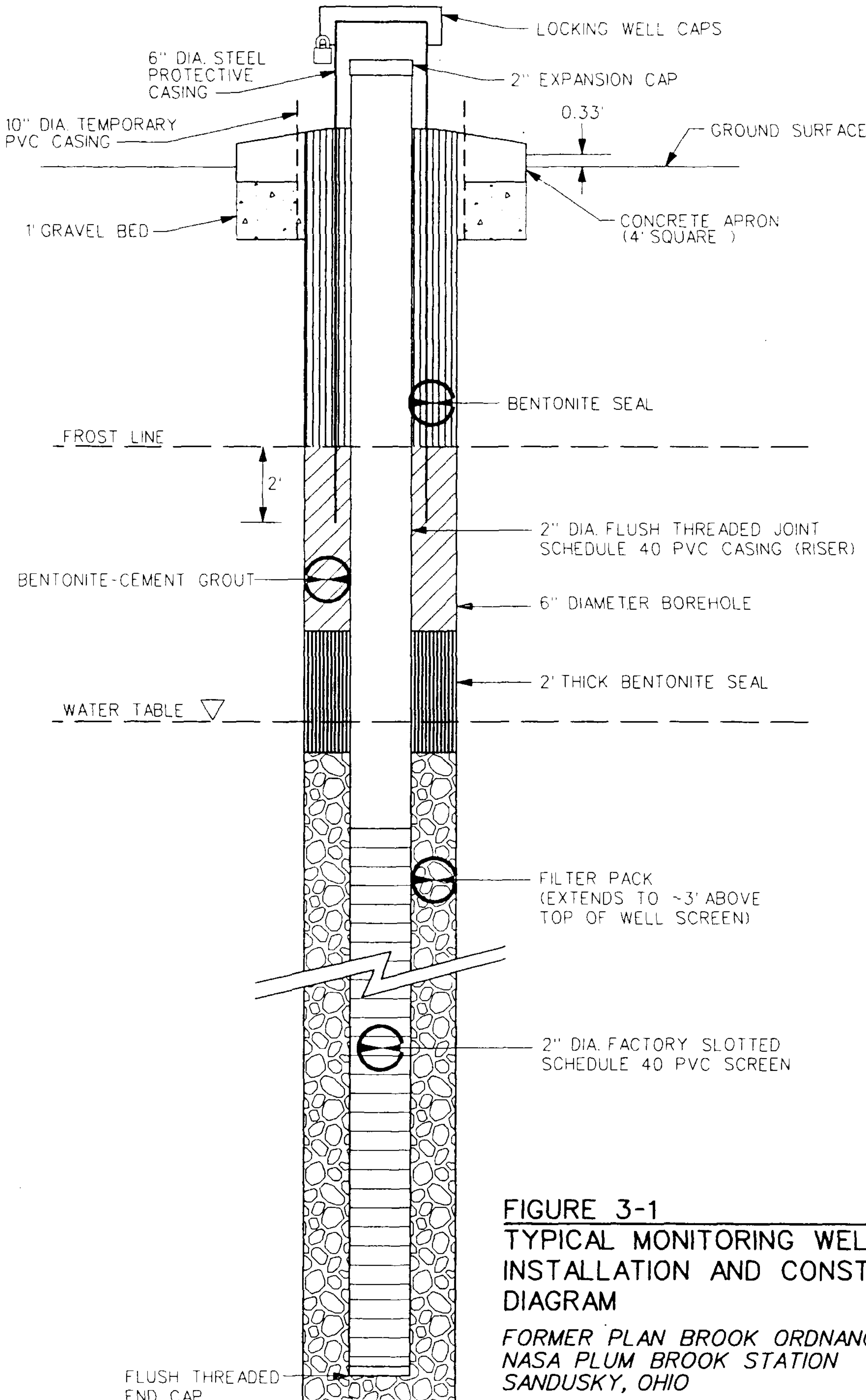
Figure 2-1

Investigation Flow Chart
Remedial Investigation of Groundwater
Former Plum Brook Ordnance Works
Sandusky, Ohio





NOT TO SCALE

FIGURE 3-1

TYPICAL MONITORING WELL INSTALLATION AND CONSTRUCTION DIAGRAM

FORMER PLAN BROOK ORDNANCE WORKS
NASA PLUM BROOK STATION
SANDUSKY, OHIO

IT CORPORATION
A Member of The IT Group

DWG. NO.: \825635ES.008 | PROJ. NO.: 825635
INITIATOR: N. SIREK | PROJ. MGR.: SPANGBERG
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DISCIPLINE SIGN-OFF REVIEW

Client Name: U.S. Army Engineer District, Nashville; CELRN-EC-R-M

Project Description: Groundwater RI, TNT and RWP Areas, Former Plum Brook Ordnance Works, Sandusky, OH

Contract Number: DACA62-00-D-0002 Delivery Order Number: 0010

Project Number: 825635 Task / Phase Number: 02000000

Document Type

Identify specific section or segment covered by this checkprint

- [ ] Technical / Cost Proposal
- [ ] RFP
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- [ ] SAP, SSAP, CDAP, or QAPP
- [x] SHP or SSHP
- [ ] ______ Report
- [ ] Risk Assessment / Evaluation
- [ ] Specifications & Plans
- [ ] Design Calculations
- [ ] Tables
- [ ] Drawings / Figures
- [ ] Other: ______

Document Origin

- [ ] Originator Developed
- [x] Edited Standard
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- [ ] Draft Final
- [x] Final
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	Name, Grade	Discipline	Signature	Date
Originator	W. Hetrick	CIH	W. Hetrick	7/20/01
Checker	S. Smith	Geologist	S. Smith	7/27/01
Peer Review (QC)	D. Unruh	CIH	Don L. Unruh	7/27/01
Project Review	M. Gunderson	Geologist	[signature]	8/2/01
Project Review	M. Spangberg	Engineer	[signature]	7/27/01
Quality Assurance Manager	P. Gray	Quality Assurance	P. L. Gray	7/26/01
Project Manager	M. Spangberg	Engineer	[signature]	7/27/01

Attachment X

Site-Specific Health and Safety Plan
Remedial Investigations and Feasibility Studies
TNT Area A and TNT Area C

Former Plum Brook Ordnance Works
Sandusky, Ohio

Prepared by:

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IT Project Nos. 807111 and 807112

July 2001
Revision 0

This Site-Specific Safety and Health Plan Attachment must be used in conjunction with the Sitewide Safety and Health Plan for Site Investigations and Groundwater Investigations at the former Plum Brook Ordnance Works, dated July 1997.

Reviews and Approvals

August 1, 2001

Project Manager
IT Corporation

Date

August 2, 2001

Health and Safety Manager
IT Corporation

Date

THE AMERICAN BOARD OF INDUSTRIAL HYGIENE
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EXPIRES
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PENNSYLVANIA · 1960
WILLIAM J. HETRICK, CIH

August 1, 2001

Site Coordinator
IT Corporation

Date

August 1, 2001

Site Safety and Health Officer
IT Corporation

Date

Plum Brook Project Emergency Contacts

Note: All field crews will be provided 2-way radios from the Plum Brook Communications Center. In the event of an emergency, contact the Plum Brook Communications Center by radio and they will contact and coordinate emergency response personnel.

Fire Department	(419) 627-5837
Ambulance	911
Police Department	(419) 627-5863
Providence Hospital	(419) 621-7000
National Response Center	(800) 424-8802
Poison Control Center	(800) 462-0800
Ohio EPA Emergency Spill Number	(800) 282-9378
Linda Ingram, USACE Technical Coordinator	(615) 736-5622
Mike Spangberg, IT Project Manager	(860) 688-1151
Dave Kessler, IT Site Manager	2-way radio
William Hetrick, IT H&S Manager	(865) 690-3211
William Hetrick, Pager	(865) 655-9529
Dr. Jerry Berke, IT Occupational Physician	(800) 350-4511

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DNT	dinitrotoluene
NIOSH	National Institute of Occupational Safety and Health
PBOW	Plum Brook Ordnance Works
PPE	personal protective equipment
SHP	safety and health plan
SSHP	site safety and health plan

1.0 Site Work Plan Summary

Project Objective. The objectives of this investigation at the former Plum Brook Ordnance Works (PBOW), Sandusky, Ohio, are summarized as follows:

- Determine if there are hazardous substances present at the site in a manner that constitutes unacceptable risk to human health and the environment.
- Define site physical features and characteristics (aquifer background conditions).
- Evaluate fate and transport pathways (groundwater modeling).
- Determine current and future routes of exposure.

Project Tasks

- Surveying
- Soil boring and sampling
- Decontamination of equipment (high-pressure water jetting operations)
- Sediment/seep and surface water sampling.

Personnel Requirements. Up to 15 employees.

Note: All personnel on this site shall have received training, informational programs, and medical surveillance as outlined in the sitewide safety and health plan (SHP) for site investigations at PBOW, and be familiar with the requirements of this site-specific SHP (SSHP). Figure 1-1 presents PBOW and the hospital location map. Figure 1-2 shows the route from TNT Areas A and C to U.S. Highway 250. The TNT Area A and C work zones will change daily due to the large area to be sampled. Based on the sampling, sufficient work zone boundaries will be established at least 10 feet from surface sampling locations and 30 feet from all boring locations. A site reconnaissance is anticipated to be conducted by the USACE and IT personnel. In addition, visitors from the Restoration Advisory Board may also be present. Because RAB members are unlikely to have the necessary OSHA training, no intrusive work shall be conducted while they are onsite and areas of potential contamination will be avoided.

Project Schedule. Summer 2001.

2.0 Site Characterization and Analysis

2.1 Anticipated Hazards

The activity hazard analysis in Chapter 5.0 contains project-specific practices utilized to reduce or eliminate anticipated site hazards. The activity hazard analysis indicates specific chemical and physical hazards that may be present and encountered during each task from on-site operations. Below each task is a list of hazards and specific actions that will be taken to control the respective hazards. These control measures may include work practice controls, engineering controls, and/or use of appropriate personal protective equipment (PPE).

The potential contaminants of concern include nitroaromatic compounds. Tables 2-1 and 2-2 indicate maximum concentrations of nitroaromatic contaminants detected in soils and groundwater, respectively, during previous investigations at TNT Areas A and C.

Table 2-3 contains chemicals anticipated and chemicals to be used during project activities.

2.2 General Site Information

A description of the site including location, site topography, and site accessibility is presented in Section 1.3 of the site-wide sampling and analysis plan prepared by IT Corporation in September 1996.

Table 2-1

Maximum Concentrations of Nitroaromatic Compounds in Soil Samples Collected Previously Plumb Brook Ordnance Works Sandusky, Ohio

Chemical	Maximum Soil Concentration, TNT Area A (mg/kg)	Maximum Soil Concentration, TNT Area C (mg/kg)
2,4,6-Trinitrotoluene	580	2.7
1,3,5-Trinitrobenzene	2.5	Not Detected
1,3-Dinitrobenzene	0.4	Not Detected
Nitrobenzene	Not Detected	0.3
2,4-Dinitrotoluene	45	8.7
2,6-Dinitrotoluene	47	1.9
3,4-Dinitrotoluene	8.9	1.2
2-Amino-4-Nitrotoluene	Not Detected	0.4
4-Amino-2-Nitrotoluene	0.4	Not Detected
2-Amino-4,6-Dinitrotoluene	7.0	4.7
4-Amino-2,6-Dinitrotoluene	5.6	1.0

Table 2-2

Maximum Concentrations of Nitroaromatic Compounds in Groundwater Samples Collected Previously Plumb Brook Ordnance Works Sandusky, Ohio

Chemical	Maximum Overburden Groundwater Concentration, TNT Area A (µg/L)	Maximum Groundwater Concentration, TNT Area C (µg/L)
2,4,6-Trinitrotoluene	10	Not Detected
1,3,5-Trinitrobenzene	0.43	Not Detected
1,3-Dinitrobenzene	Not Detected	Not Detected
Nitrobenzene	0.26	Not Detected
2,4-Dinitrotoluene	11	Not Detected
2,6-Dinitrotoluene	1.2	Not Detected
3-Nitrotoluene	13	Not Detected
2-Amino-4,6-Dinitrotoluene	31	Not Detected
4-Amino-2,6-Dinitrotoluene	8.7	Not Detected

Table 2-3

Toxicological and Physical Properties of Chemicals
Plum Brook Ordnance Works, Sandusky, Ohio

Substance [CAS]	IP[a] (eV)	Odor Threshold (ppm)	Route[b]	Symptoms of Exposure	Treatment	TWA[c]	STEL[d]	Source[e]	IDLH (NIOSH)[f]
1,3-Dinitrobenzene [99-65-0]	10.43		Inh Abs Ing Con	Anoxia, cyanosis, visual disturbances, central blind spot of vision, bad taste, burning of mouth, dry throat, thirsty; yellowing hair, eyes, and skin; anemia, liver damage.	Eye: Irrigate immediately Skin: Soap wash immediately Breath: Respiratory support Swallow: Immediate medical attention	1 mg/m^3 (skin) 0.15 ppm (skin) 1 mg/m^3 (skin)		PEL TLV REL	50 mg/m^3
Benzene [71-43-2]	9.24	34-119	Inh Abs Ing Con	Irritates eyes, nose, respiratory system; giddiness; headache, nausea, staggered gait; fatigue, anorexia, lassitude; dermatitis; bone-marrow depression. Carcinogenic.	Eye: Irrigate immediately Skin: Soap wash promptly Breath: Respiratory support Swallow: Immediate medical attention	1 ppm (0.5 ppm) 0.1 ppm	5 ppm 2.5 ppm C1 ppm (Ca)	PEL TLV REL	Ca [500 ppm]* *OSHA
Chromium (as Cr) [7440-47-3]	NA	NA	Inh Ing Con	Irritation of eyes, skin, and upper respiratory system; fibrosis of lungs.	Eye: Irrigate immediately Skin: Wash flush Breath: Respiratory support Swallow: Immediate medical attention	1 mg/m^3 0.5 mg/m^3 0,5 mg/m^3	- -	PEL TLV REL	250mg/m^3 (as Cr)
Dinitrotoluene (DNT)	N/A	-	Inh Abs Ing Con	Anoxia, cyanosis, anemia, jaundice; reproductive effects. Animal carcinogen.	Eye: Irrigate immediately Skin: Soap wash immediately Breath: Respiratory support Swallow: Immediate medical attention	1.5 mg/^{3} (skin) 0.2 mg/m^3 (skin) 1.5 mg/m^3 (skin)	- - -	PEL TLV REL	Ca [50 mg/m^3)
Ethyl benzene [100-41-4]	8.76	0.09-0.6	Inh Ing Con	Irritates eyes, mucous membranes; headache; dermatitis; narcosis, coma.	Eye: Irrigate immediately Skin: Water flush promptly Breath: Respiratory support Swallow: Immediate medical attention	100 ppm 100 ppm 100 ppm	125 ppm 125 ppm	PEL TLV REL	800 ppm

Table 2-3

Toxicological and Physical Properties of Chemicals
Plum Brook Ordnance Works, Sandusky, Ohio

Substance [CAS]	IP[a] (eV)	Odor Threshold (ppm)	Route[b]	Symptoms of Exposure	Treatment	TWA[c]	STEL[d]	Source[e]	IDLH (NIOSH)[f]
Gasoline [8006-61-9]	?	0.3	Inh Ing Con	Intoxication, headaches, blurred vision, dizziness, nausea; eye, nose, and throat irritation; potential kidney and other cancers. Carcinogenic.	Eye: Irrigate immediately (15 min) Skin: Soap wash promptly Breath: Respiratory support Swallow: Immediate medical attention	None 300 ppm Ca, lowest feasible conc. (LOQ 15 ppm)	None 500 ppm	PEL TLV REL	1,400 ppm
Methanol	10.85	4.2-5960	Inh Abs Ing Con	Irritated eyes, headache, drowsiness, lightheadedness, nausea, vomiting, disturbance in vision, blindness.	Eye: Irrigate immediately Skin: Water flush promptly Breath: Fresh air Swallow: Immediate medical attention	200 ppm (skin) 200 ppm (skin) 200 ppm (skin)	250 ppm (skin) 250 ppm (skin)	PEL TLV REL	6,000 ppm
Nitric acid [7697-37-2]	11.95	0.3-1	Inh Ing Con	Irritated eyes, mucous membranes, and skin; delayed pulmonary edema, pneumonitis, bronchitis; dental erosion.	Eye: Irrigate immediately Skin: Wash flush promptly Breath: Respiratory support Swallow: Immediate medical attention	2 ppm 2 ppm 2 ppm	4 ppm 4 ppm	PEL TLV REL	25 ppm
Nitrobenzene [98-95-3]	9.92	0.37	Inh Abs Ing Con	Irritation of eyes, skin, anoxia; dermatitis; anemia; methemoglobinemia; testicular effects.	Eye: Irrigate immediately Skin: Wash flush Breath: Respiratory support Swallow: Immediate medical attention	1 ppm (skin) 1 ppm (skin) 1 ppm (skin)		PEL TLV REL	200 ppm
Portland cement			Inh	Fine gray powder that can be irritating if inhaled or in eyes.	Eye: Irrigate immediately Skin: Soap wash flush Breath: Respiratory support Swallow: Immediate medical attention	10 mg/m³ 15 mg/m³ total dust 5 mg/m³ respirable fraction 10 mg/m³/total dust 5 mg/m³ respirable fraction		TLV PEL REL	
Toluene [108-88-3]	8.82	0.16-37	Inh Abs Ing Con	Fatigue, weakness; confusion, euphoria, dizziness, headache; dilated pupils, lacrimation; nervousness, muscular fatigue, insomnia; paralysis; dermatitis.	Eye: Irrigate immediately Skin: Soap wash promptly Breath: Respiratory support Swallow: Immediate medical attention	200 ppm 50 ppm (skin) 100 ppm	300 ppm (c) 150 ppm	PEL TLV REL	500 ppm

Table 2-3

Toxicological and Physical Properties of Chemicals
Plum Brook Ordnance Works, Sandusky, Ohio

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Substance [CAS]	IP[a] (eV)	Odor Threshold (ppm)	Route[b]	Symptoms of Exposure	Treatment	TWA[c]	STEL[d]	Source[e]	IDLH (NIOSH)[f]
1,3,5-Trinitrobenzene [Exposure data provided for nitrobenzene; no exposure data available for 1,3,5-trinitrobenzene)	?	-	Inh Ing Con Abs	Irritating to the skin, mucus membranes, and eyes; nausea, vomiting, diarrhea, and abdominal pain; liver damage.	Eye: Irrigate immediately Skin: Soap wash promptly Breath: Respiratory support Swallow: Immediate medical attention	1 ppm (skin) 1 ppm (skin) 1 ppm (skin)		PEL TLV REL	1800 ppm
Trinitrotoluene (TNT) [118-96-7]	10.59 ev	-	Inh Abs Ing Con	Irritation of skin, mucous membranes; liver damage, jaundice; cyanosis, sore throat; kidney damage; cardio irregularity.	Eye: Irrigate immediately Skin: Soap wash promptly Breath: Respiratory support Swallow: Immediate medical attention	1.5 mg/m^3 (skin) 0.1 mg/m^3 (skin) 0.5 mg/m^3 (skin)		PEL TLV REL	500 mg/m^3

[a]IP = Ionization potential (electron volts).
[b]Route = Inh, Inhalation; Abs, Skin absorption; Ing, Ingestion; Con, Skin and/or eye contact.
[c]TWA = Time-weighted average. The TWA concentration for a normal work day (usually 8 or 10 hours) and a 40-hour work week, to which nearly all workers may be repeatedly exposed, day after day without adverse effect.
[d]STEL = Short-term exposure limit. A 15-minute TWA exposure that should not be exceeded at any time during a work day, even if the TWA is not exceeded.
[e]PEL = Occupational Safety and Health Administration (OSHA) permissible exposure limit (29 CFR 1910.1000, Table Z).
TLV = American Conference of Governmental Industrial Hygiene (ACGIH) threshold limit value—TWA.
REL = National Institute for Occupational Safety and Health (NIOSH) recommended exposure limit.
[f]IDLH (NIOSH)—Immediately dangerous to life or health (NIOSH). Represents the maximum concentration from which, in the event of respirator failure, one could escape within 30 minutes without a respirator and without experiencing any escape-impairing or irreversible health effects.
NE = No evidence could be found for the existence of an IDLH (NIOSH Pocket Guide to Chemical Hazards, Pub. No. 90-117, 1990).
C = Ceiling limit value which should not be exceeded at any time.
Ca = Carcinogen.
NA = Not applicable.
NIC = Notice of intended change (ACGIH).

3.0 Personal Protective Equipment

The work activities will begin in the following levels of protection.

Task	Initial Level of PPE
Staging equipment	Level D
Surveying	Level D
Soil boring and sampling	Modified Level D*
Decontamination of equipment	Modified Level D*
Sediment/seep/surface water sampling	Level D**

* Initial level will be raised to Level C or higher if air monitoring results in the worker's breathing zone are above action levels. Note: If unusual conditions or odors are encountered and air monitoring instruments do not detect volatile organic chemicals or hydrogen sulfide, turn equipment off, evacuate the work area, and contact the Health and Safety Manager for further assistance.

** Nitrile gloves will be worn when conducting sampling operations.

A complete description of Level D, Modified Level D, and Level C follows.

Level D. The following equipment will be used for Level D protection:

- Coveralls or work clothing
- Steel-toed safety boots
- Safety glasses
- Hard hat
- Hearing protection (when working near/adjacent to operating equipment)
- U.S. Coast Guard-approved personal flotation device (where potential for drowning exists).

Modified Level D. The following equipment will be used for Modified Level D protection:

- Permeable Tyvek®, Kleenguard, or its equivalent
- Polyvinyl chloride boot covers
- Nitrile gloves (outer)
- Lightweight nitrile gloves (inner)
- Steel-toed safety boots
- Safety glasses

- Hard hat
- Hearing protection (when working near/adjacent to operating equipment).

Level C. Level C protection will not be used unless air monitoring data indicate the need for upgrade; however, the equipment shall be readily available on site. The following equipment will be used for Level C protection:

- National Institute of Occupational Safety and Health (NIOSH)-approved full face, air purifying respirators equipped with organic vapor/acid gas cartridge in combination with high-efficiency particulate air filter
- Hooded, saran-coated Tyvek®, taped at gloves, boots, and respirator
- Nitrile gloves (outer)
- Lightweight nitrile gloves (inner)
- Neoprene steel-toed boots or polyvinyl chloride overbooties/steel-toed safety boots
- Hard hat
- Hearing protection (when working near/adjacent to operating equipment).

Level B. Level protection will not be used unless air monitoring data indicate the need for upgrade will be used for Level B protection:

- Pressure-demand NIOSH-approved self-contained breathing apparatus
- Hooded, saran-coated Tyvek®, taped at gloves, boots, and respirator
- Nitrile gloves (outer)
- Latex or lightweight nitrile gloves (inner)
- Neoprene steel-toed boots or polyvinyl chloride overbooties/steel-toed safety boots
- Hard hat
- Hearing protection (when working near/adjacent to operating equipment).

Personnel Decontamination: All personnel working in the exclusion zone wearing modified Level D or higher must undergo personnel decontamination prior to entering the support zone. Level D will require no personnel decontamination. The personnel decontamination area shall consist of the following stations:

- ***Station 1.*** Personnel leaving the exclusion zone will remove the gross contamination from their outer clothing and boots by physical means (i.e., dislodging/displacement, rinsing, wiping, brushing etc.).

- ***Station 2.*** Equipment for this station may include plastic-lined waste receptacle, chair, clean damp cloths or paper towels, and plastic bags. At Station 2, personnel will remove their Tyvek® coveralls and gloves and deposit them in the lined waste receptacles. Personnel will wipe their respirators (if used), hard hats, and boots with clean, damp cloths and then remove those items. Those items are then hand-carried to the next station.

- ***Station 3.*** Equipment for this station may include a wash basin with soap and water and a respirator sanitation station. At this station, personnel will thoroughly wash their hands and face before leaving the decontamination zone. Respirators will be sanitized and then placed in a clean, plastic ziplock® bag.

Donning Procedures.

- Put on chemical-resistant boots or boots with boot covers and tape the coveralls over the boots at the ankles.

- Put on gloves.

- Tape the coveralls over the gloves at the wrist.

- If Level C PPE is required, don respirator and check for secure fit.

- Put hood or head covering over the respirator.

- Put on the remaining protective equipment (i.e., hard hat, safety glasses, etc.).

4.0 Site Monitoring

The environmental contaminants of concern are volatile and semivolatile chemicals including 2,4-dinitrotoluene (DNT); 2,6-DNT; 1,3,5-trinitrobenzene; and 2,4,6-trinitrotoluene.

Table 4-1 contains action levels for site monitoring.

Monitoring will be performed by the site safety and health officer initially for the location, then periodically during the performance of boring operations (sampling every 5- to 10-foot soil boring depth). A calibrated photoionization detector with a lamp power of at least 11.2 eV will be utilized to monitor the wells and breathing zones to determine if any organic vapors may be present that would necessitate upgrading of protection level. A calibrated combustible gas/oxygen meter will be utilized to monitor the work sites and breathing zones for explosive or flammable vapors. Benzene detector tubes will be utilized, as needed, to monitor breathing zones for benzene. Table 4-2 describes the air monitoring frequency and location.

No air monitoring is required for operations that do not disturb existing materials (i.e., site setup, surveying, decontamination, and miscellaneous support zone activities).

Table 4-1

Action Levels
Plum Brook Ordnance Works
Sandusky, Ohio

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When in Level B PPE

Analyte	Action Level	Required Action
VOCs	≥ 50 ppm above background	Stop work; evacuate work area; contact H&S Manager
Benzene	≥ 10 ppm in BZ	Stop work; evacuate work area; contact H&S Manager
Dust	≥ 5 mg/cu. meter	Stop work; initiate dust suppression
LEL	≥ 10% of LEL	Stop work; evacuate work area; contact H&S Manager
O2	> 23 % < 20%	Stop work; evacuate work area; contact H&S Manager

When in Level C PPE

Analyte	Action Level	Required Action
VOCs	≥ 25 ppm above background	Stop work; evacuate work area; upgrade to Level B
Benzene	≥ 5 ppm in BZ	Stop work; evacuate work area; upgrade to Level B
Dust	≥ 5 mg/cu. meter	Stop work; initiate dust suppression
LEL	≥ 10% of LEL	Stop work; evacuate work area; contact H&S Manager
O2	> 23 % < 20%	Stop work; evacuate work area; contact H&S Manager

Table 4-1

Action Levels
Plum Brook Ordnance Works
Sandusky, Ohio

When in Modified Level D PPE/Level D PPE

Analyte	Action Level	Required Action
VOCs	≥ 5 ppm above background	Stop work; evacuate work area; upgrade to Level C PPE
Benzene	≥ 1 ppm in BZ	Stop work; evacuate work area; upgrade to Level C PPE
Dust	≥ 0.5 mg/cu. meter	Stop work; initiate dust suppression
LEL	≥ 10% of LEL	Stop work; evacuate work area; contact H&S Manager
O2	> 23 % < 20%	Stop work; evacuate work area; contact H&S Manager

When in Support Zone

Analyte	Action Level	Required Action
Dust	≥ 0. 5 mg/cu. meter	Stop work; initiate dust suppression
VOCs	≥ 1 ppm above background	Stop work; evacuate work area; contact H&S Manager

BZ = Breathing zone.
LEL = Lower explosive limit.
VOCs = Volatile organic compounds.
ppm = parts per million
H&S = health and safety
mg/cu. meter = milligrams per cubic meter

Table 4-2

Air Monitoring Frequency and Location
Plum Brook Ordnance Works
Sandusky, Ohio

Work Activity	Instrument	Frequency	Location
Soil boring and sampling	OV Monitor CGI BDT, as needed	Continuously	BZ of employees and/or work area
Sediment/seep/surface water samples	OV Monitor CGI BDT, as needed	Continuously	BZ of employees and/or work area

OV = Organic vapor.
CGI = Combustible gas monitor.
BDT = Benzene detector tube.

5.0 Activity Hazard Analysis

The attached activity hazard analysis (Table 5-1) is provided for the following activities:

- Setup of equipment and general field activities
- Surveying
- Soil boring and sampling
- Decontamination (high-pressure water jetting operations)
- Sediment/seep and surface water sampling.

Table 5-1

Activity Hazard Analysis
Plum Brook Ordnance Works, Sandusky, Ohio

Activity	Potential Hazards	Recommended Controls
Setup of equipment and general field activities	Slip, trip, and fall hazards	• Determine best access route before transporting equipment. • Practice good housekeeping; keep work area picked up and clean as feasible. • Continually inspect the work area for slip, trip, and fall hazards. • Look before you step; ensure safe and secure footing.
	Heavy lifting	• Use proper lifting techniques. Lifts greater than 60 pounds require assistance or mechanical equipment.
	Falling objects	• Stay alert and clear of materials suspended overhead; wear hard hat and steel-toed boots.
	Flying debris, dirt, dust, etc.	• Wear safety glasses/goggles; ensure that eye wash is in proper working condition.
	Pinch points	• Keep hands, fingers, and feet clear of moving/suspended materials and equipment. • Beware of contact points. • Stay alert at all times!
	Cuts/bruises	• Use cotton or leather work gloves for material handling.
	Bees, spiders, and snakes	• Inspect work area carefully and avoid placing hands and feet into concealed areas.
	Fire	• Fire extinguishers shall be suitably placed, distinctly marked, readily accessible, and maintained in a fully charged and operable condition.
	Hazard communication	• Label all containers as to contents and dispose of properly. • Ensure Material Safety Data Sheets (MSDS) are available for hazardous chemicals used on site.
	Noise	• Sound levels above 85 A-weighted decibels (dBA) mandates hearing protection.
	Lighting	• Adequate lighting will be provided to ensure a safe working environment.
	Cold stress	• Workers should wear insulated clothing when temperatures drop below 40°F. • Drink warm beverages on breaks. Refrain from drinking caffeinated beverages. • Remove wet clothing promptly. • Take breaks in warm areas. • Reduce work periods as necessary. • Layer work clothing.

Table 5-1

Activity Hazard Analysis
Plum Brook Ordnance Works, Sandusky, Ohio

Activity	Potential Hazards	Recommended Controls
Setup of equipment and general field activities (continued)	Frostbite	• Personnel should wear inner cotton gloves and insulating socks to protect extremities from cold weather. • Take breaks in warm areas. • Remove wet gloves and socks promptly.
	Poison ivy/oak/sumac	• Avoid plant areas if possible. • Wear long sleeves and long pants. • Promptly wash clothing that has contacted poisonous plants. • Wash affected areas immediately with soap and water.
	Ticks	• Wear light-colored clothing (can see ticks better). • Mow vegetated and small brush areas. • Wear insect repellant. • Wear long sleeves and long pants. • Visually check oneself promptly and frequently after exiting the work area.
	Heat rash	• Keep the skin clean and dry. • Change perspiration-soaked clothing, as necessary. • Bathe at end of work shift or day. • Apply powder to affected area.
	Heat cramps	• Drink plenty of cool fluids even when not thirsty. • Provide cool fluid for work crews. • Move victim to shaded, cool area.
	Heat exhaustion	• Conduct physiological worker monitoring as needed (i.e., heart rate, oral temperature). • Set up work/rest periods. • Use the buddy system. • Allow workers time to acclimate. • Have ice packs available for use. • Take frequent breaks.
	Heat stroke	• Evaluate possibility of night work. • Perform physiological monitoring on workers during breaks. • Wear body cooling devices.

Table 5-1

Activity Hazard Analysis
Plum Brook Ordnance Works, Sandusky, Ohio

Activity	Potential Hazards	Recommended Controls
Setup of equipment and general field activities (continued)	Contact with moving equipment/vehicles	• Work area will be barricaded/demarcated. • Equipment will be laid out in an area free of traffic flow. • Barricades shall be used on or around work areas when it is necessary to prevent the inadvertent intrusion of pedestrian traffic. • Barriers shall be used to protect workers from vehicular traffic. • Barriers shall be used to guard excavations adjacent to streets or roadways. • Flagging shall be used for the short term (less than 24 hours) to identify hazards until proper barricades or barriers are provided. • Heavy equipment shall have backup alarms.
	Forklift operations	• • Use qualified and trained forklift operators. • The operator shall not exceed the load capacity rating for the forklift. • The load capacity shall be clearly visible on the forklift. • Forklift operators shall inform their supervisor of any prescribed medication that they are taking that would impair their judgement.
	Portable electric tools	• Portable electric tools which are unsafe due to faulty plugs, damaged cords, or other reason, shall be tagged (do not use) and be removed from service. • Portable electric tools and all cord and plug connected equipment shall be protected by a ground-fault circuit interrupter (GFCI) device. • Electrical tools shall be inspected daily prior to use.
	Extension cords	• Extension cords that have faulty plugs, damaged insulation, or are unsafe in any way shall be removed from service. • Cords shall be protected from damage from sharp edges, projections, pinch points (doorways), and vehicular traffic. • Cords shall be suspended with a nonconductive support (rope, plastic ties, etc.). • Cords shall be designed for hard duty. • Cords shall be inspected daily.

Table 5-1

Activity Hazard Analysis
Plum Brook Ordnance Works, Sandusky, Ohio

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Activity	Potential Hazards	Recommended Controls
Setup of equipment and general field activities (continued)	Lightning strikes	• Whenever possible, halt activities and take cover. • If outdoors, stay low to the ground. • Limit the body surface area that is in contact with the ground (i.e., kneeling on one knee is better than laying on the ground). • Seek shelter in a building if possible. • Stay away from windows. • If available, crouch under a group of trees instead of one single tree. • Keep all body parts in contact with the ground as close as possible. • Remain 6 feet away from tree trunk if seeking shelter beneath tree(s). • If in a group, keep 6 feet of distance between people.
	Thunderstorms, tornadoes	• Listen to radio or TV announcements for pending weather information. • Cease field activities during thunderstorm or tornado warnings. • Seek shelter. Do not try to outrun a tornado.
Surveying	Slip, trip, fall	• Site workers will be required to wear hard hat, safety glasses with side shields, work gloves, and steel-toe boots when working in the field. • Provide adequate lighting in all work areas. • Whenever possible, avoid routing cords and hoses across walking pathways. • Flag or cover inconspicuous holes to protect against falls. • Work areas will be kept clean and orderly. • Garbage and trash will be disposed of daily in approved refuse containers. • Tools and accessories will be properly maintained and stored. • Work areas and floors will be kept free of dirt, grease, and slippery materials.
	Traffic accidents	• Place physical barrier (i.e., barricades, fencing) around work areas regularly occupied by pedestrians. • If working adjacent to roadways, have workers wear fluorescent orange vests. • Use warning signs or lights to alert oncoming traffic. • Assign flag person(s) if necessary to direct local traffic. • Set up temporary parking locations outside the immediate work area. • Motor vehicle operators shall obey all posted traffic signs, signals, and speed limits. • Pedestrians have the right-of-way. • Wear seat belts when vehicles are in motion.
	Wildlife hazards	• Workers should be cautious when driving through the site in order to avoid encounters with passing animals.

Table 5-1

Activity Hazard Analysis
Plum Brook Ordnance Works, Sandusky, Ohio

Activity	Potential Hazards	Recommended Controls
Soil Boring and Sampling	Overhead hazards	• Make sure no obstacles are within radius of boom. Always stay a safe distance from power lines.
	Faulty or damaged equipment being utilized to perform work	• All machinery or mechanized equipment will be inspected by a competent mechanic and be certified to be in safe operating condition. • Equipment will be inspected before being put to use and at the beginning of each shift. • Faulty/unsafe equipment will be tagged and if possible locked out. • Drill rigs shall be equipped with reverse signal alarm, backup warning lights, or the vehicle is backed up only when an observer signals it is safe to do so.
	Uneven terrain, poor ground support, inadequate clearances, contact with utilities	• Inspections or determinations of road conditions and structures shall be made in advance to ensure that clearances and load capacities are safe for the passage or placing of any machinery or equipment. • All mobile equipment and areas in which they are operated shall be adequately illuminated. • Aboveground and belowground utilities will be verified with NASA personnel, and delineated or flagged prior to staging equipment. • Whenever the equipment is parked, the parking brake shall be set. • Equipment parked on inclines will have the wheels chocked. • Inspect brakes and tire pressure on drill rig before staging for work.
	Inexperienced operator	• Machinery and mechanized equipment shall be operated only by designated personnel. • Operators shall inform their supervisor(s) of any prescribed medication that they are taking that would impair their judgment.
	Jacks/outriggers	• Ensure proper footing and cribbing.
	Falling objects	• Remove unsecured tools and materials before raising or lowering the derrick. • Stay alert and clear of materials suspended overhead.
	Pinch points	• Keep feet and hands clear of moving/suspended materials and equipment. • Stay alert at all times!
	Fire	• Mechanized equipment shall be shut down prior to and during fueling operations. • Have fire extinguishers inspected and readily available.
	Fall hazards	• Personnel are not allowed to work off of machinery or use machinery as ladders. • Use fall protection when working above 6 feet.

Table 5-1

Activity Hazard Analysis
Plum Brook Ordnance Works, Sandusky, Ohio

Activity	Potential Hazards	Recommended Controls
Soil Boring and Sampling (continued)	Noise	• Hearing protection is mandatory above 85 dBA.
	Contact with rotating or reciprocating machine parts	• Use machine guards; use long-handled shovels to remove auger cuttings. • Use safe lockout procedures for maintenance work.
	Heavy lifting	• Use proper lifting techniques. Lifts greater than 60 pounds require assistance or mechanical equipment; size-up the lift.
	Slip, trip, and fall hazards	• Practice good housekeeping; keep work area picked up and clean as feasible. • Continually inspect the work area for slip, trip, and fall hazards.
	Contact with potentially contaminated materials	• Real-time air monitoring will take place. If necessary, proper personal protective clothing and equipment will be utilized. • Stop immediately at any sign of obstruction. • Do not breathe air surrounding boring unless necessary. • Upgrade to respirator if necessary. • Avoid skin contact with soil cuttings. Wear gloves. • Stay clear of moving parts of drill rig.
	Drum handling	• Be careful not to breathe air from around open drum any more than necessary. Monitor with photoionization detector/flame ionization detector (PID/FID) equipment and upgrade to respirator if necessary. • When filling a drum (with either soil or water), be careful not to make contact with the contained waste. Wear appropriate gloves. Make sure lid or bung of drum is secure. • If moving a drum unassisted, be sure to leverage properly, use proper lifting techniques, and wear safety glasses and steel-toed boots. • When using a drum dolly, make sure straps and lid catch are securely attached. Leverage properly when tilting drum. Be sure toes stay away from drum.
High-Pressure Water Cleaning Operations	Heavy lifting	• Use proper lifting techniques. • Lifts greater than 60 pounds require assistance or mechanical equipment • Size-up the lift.
	Slip, trip, and fall hazards	• Good housekeeping shall be implemented. • The work area shall be kept clean as feasible. • Inspect the work area for slip, trip, and fall hazards.
High-Pressure Water Cleaning Operations (continued)	Fueling	• Only approved safety cans shall be used to store fuel. • Do not refuel equipment while it is operating or still hot to the touch. • Fire extinguishers shall be suitably placed, distinctly marked, readily accessible, and maintained in a fully charged and operable condition.

Table 5-1

Activity Hazard Analysis
Plum Brook Ordnance Works, Sandusky, Ohio

Activity	Potential Hazards	Recommended Controls
	Faulty or damaged equipment	• Equipment shall be inspected before being placed into service and at the beginning of each shift. • Preventive maintenance procedures recommended by the manufacturer shall be followed. • A lockout/tagout procedure shall be used for equipment found to be faulty or undergoing maintenance.
	High-pressure water	• Jetting gun operator must wear appropriate PPE including hard hat, impact-resistant safety glasses with side shields, water-resistant clothing, metatarsal guards for feet and legs, and hearing protection (if appropriate). • One standby person shall be available within the vicinity of the pump during jetting operation. • The work area shall be isolated and adequate barriers will be used to warn other site personnel.
	Unqualified operators	• Only qualified and trained personnel are permitted to operate machinery and mechanized equipment associated with water jet cutting and cleaning.
	Out of control equipment	• No machinery or equipment is permitted to run unattended. • Machinery or equipment will not be operated in a manner that will endanger persons or property nor will the safe operating speeds or loads be exceeded.
	Noise	• Sound levels above 85 dBA mandates hearing protection by nearby site personnel.
	Activation during repairs	• All machinery or equipment will be shut down and positive means taken to prevent its operation while repairs or manual lubrications are being done.
	Pinch points	• Keep feet and hands clear of moving/suspended materials and equipment. • Stay alert and clear of materials suspended
	Falling objects	• Hard hats are required by site personnel. • Stay alert and clear of material suspended overhead.
	Flying debris	• Impact-resistant safety glasses with side shields are required.
	Contact with potentially contaminated materials	• All site personnel will wear the appropriate PPE.
Surface Water/Sediment/ Seep Sampling	Drowning	• Personal flotation devices (PFD) will be provided and worn by workers over or near water where the danger of drowning exists. • PFDs shall be inspected prior to and after each use. • Defective PFDs will be tagged and removed from service. • Ring buoys with at least 90 feet of line shall be provided and readily available at locations where employees are working over or adjacent to water. • Use the "buddy system." • Personnel trained in launching and operating the skiff shall be readily available during work hours.

Table 5-1

Activity Hazard Analysis
Plum Brook Ordnance Works, Sandusky, Ohio

Activity	Potential Hazards	Recommended Controls
	Cross-contamination and contact with potentially contaminated materials	• Sampling technicians will wear proper protective clothing and equipment to safeguard against potential contamination. • Avoid skin contact with water. • Handle samples with care. • Only essential personnel will be in the work area. • Real-time air monitoring will take place before and during sampling activities. • All personnel will follow good hygiene practices. • Proper decontamination procedures will be followed. • All liquids and materials used for decontamination will be contained and disposed of in accordance with federal, state, and local regulations.
	Heat rash	• Keep the skin clean and dry. • Change perspiration-soaked clothing, as necessary. • Comply with IT Procedure HS 400 (July 25, 2000). • Bathe at end of work shift or day. • Apply powder to affected area.
	Heat cramps	• Drink plenty of cool fluids even when not thirsty. • Provide cool fluid for work crews. • Comply with IT Procedure HS 400 (July 25, 2000). • Move victim to shaded, cool area.
	Heat exhaustion	• Conduct physiological worker monitoring as needed (i.e., heart rate, oral temperature). • Set up work/rest periods. • Use the "buddy system." • Comply with IT Procedure HS 400 (July 25, 2000). • Allow workers time to acclimate. • Have ice packs available for use. • Take frequent breaks.
	Heat stroke	• Evaluate possibility of night work. • Perform physiological monitoring on workers during breaks. • Wear body cooling devices. • Comply with IT Procedure HS 400 (July 23, 2000).

RESPONSE TO COMMENTS
U. S. ARMY CORPS OF ENGINEERS
ON ATTACHMENT XII, SITE SPECIFIC SAMPLING AND ANALYSIS PLAN, GROUNDWATER REMEDIAL INVESTIGATION, TNT AND RED WATER PONDS AREAS, FORMER PLUM BROOK ORDNANCE WORKS
SANDUSKY, OHIO
(Draft dated June 2001)

Response to U. S. Army Corps of Engineers on Attachment XII
Comments from CELRN-EC-R-D, June 2001.

SSAP Comments:

Comment 1: **Page 1-6, paragraph at bottom of page: Is the location of MK-MW12 shown on any of the TNT Area C figures? I couldn't find it on Figure 1-5.**

Response 1: MK-MW12 has been included on Figure 1-5.

Comment 2: **Page 2-3, Section 2.4.4, last sentence: The copy of the SSAP I reviewed has no Figure 2-2. Perhaps the reference was intended to refer to the flow chart, Figure 2-1.**

Response 2: Yes, the reference was intended to be to Figure 2-1 and not to Figure 2-2. Corrections have been made to the text.

Comment 3: **Page 3-1, Section 3.0: Isn't the number of new and existing overburden wells to be sampled 23 (18 non-background + 5 background)?**

Response 3: Yes, the number of new and existing wells to be sampled is 23. This has been corrected in the text.

Comment 4: **Page 3-1, Section 3.1, last sentence; page 3-3, Sections 3.2.2.1 and 3.2.2.2: I couldn't find any soil sampling locations proposed on any of the figures.**

Response 4: Proposed soil sampling locations have been added to Figures 1-5 and 1-7.

Comment 5: **Page 3-1, Section 3.2.1: The first sentence implies that there will be 10 bedrock wells installed at the TNT Areas but really only 4 of the 10 are to be associated with particular TNT areas. Please correct the text appropriately.**

Response 5: Noted, the text has been corrected to more accurately reflect that 10 bedrock wells will be installed at PBOW.

Comment 6: **Page 3-4, Section 3.3.2, 3rd sentence: For soil samples it is not necessary to make "a photographic record of the core".**

Response 6: Noted, this step in logging soil cores has been stricken from the work plan.

Comment 7: **Page 3-6, 2nd paragraph, 2nd sentence: The "internal mortar collar ... within the steel protective casing and outside the [PVC] well casing" should be, as shown in Figure 3-1, a bentonite collar. This will allow the surface pad to frost heave without pulling the well with it.**

Response 7: Noted, the text has been corrected to reflect that an internal bentonite collar will be used.

Comment 8: **Page 3-7, Section 3.4.4, 2nd line and bullets; and page 3-8, 5th bullet - turbidity: Relative to development, it is mentioned that turbidity will be described but no mention of measuring it is made aside from the page 3-8 bullet. According to the Scope of Work, Task 4- In addition to the requirements of EM 1110-1-4000, development shall continue until the parameters of pH, temperature, and conductivity have reached equilibrium as described in EM 200-1-3, page C-10 <u>and three consecutive turbidity readings have been less than 100 NTUs</u>. If this criteria can not be met the AE shall propose to CELRN how they intend to proceed. Please make appropriate changes to text.**

Response 8: Noted, the text has been changed indicate that three consecutive turbidity readings less than 100 NTUs are necessary for well development.

Comment 9: **Bottom of page 3-10, turbidity: Scope, Task 5, Section 3.5.1.2- "and three consecutive turbidity readings have been less than 100 NTUs the sample may be collected." This criteria may be more achievable than the +/- 10% criteria proposed. This also removes the chance that highly turbid samples (samples with turbidity above the limits of the meter) will be collected.**

Response 9: Noted, the text has been changed to reflect this comment.

Comment 10: **Table 3-1: One of the planned upgradient wells has been inadvertently omitted but its estimated depth was assigned to**

the first well listed. The omitted well is the "Upgradient Boundary, West of West Red Water Ponds" with an expected depth of 55 feet. The "Upgradient Boundary, West of TNT Area B" well (the first well listed) is expected to go only 45 feet deep.

Response 10: Noted, Table 3-1 has been corrected accordingly.

Comment 11: **Table 3-1: The "South of Reactor Area and Pentolite Road" well is shown as having an expected depth of 25 feet. My estimate says it may go as deep as 75 feet. What is your 25 feet based on?**

Response 11: Estimate was made from inaccurate data in Table 3-1. The table has been corrected to indicate an expected depth of 75 feet for the well "South of Reactor Area and Pentolite Road."

Comment 12: **Table 3-1, Existing Overburden Wells: I assume this list is based on Table 3a of the Scope. However, wells MK-MW22, MK-MW23, and TNTC-MW06 are listed in Table 3-1 but were not listed in the Scope and although TNTC-MW03, TNTC-MW04, and IT-MW01 are listed in the Scope they aren't in Table 3-1. Please explain the discrepancies.**

Response 12: Noted, the tables have been corrected accordingly, removing MK-MW22, MK-MW23, and TNTC-MW06 from the table and adding wells TNTC-MW03, TNTC-MW04, and IT-MW01 to Table 3-1.

Comment 13: **Figure 1-2: The new bedrock well expected to go in on the upgradient boundary southeast of TNT Area B was not displayed.**

Response 13: According to the Scope of Work, Table 2, the additional bedrock well should be installed southwest of the TNT B area. An additional bedrock well has been added to Figure 1-2 to reflect the scope of work.

Comment 14: **Figures 1-2, 1-3, 1-4, 1-5, and 1-6: In the legend, rather than "Proposed Piezometer" use "Proposed Overburden". Also, since we're only showing potential locations for the new overburden wells that will be paired with a bedrock one maybe we should add a "Note" explaining that each TNT Area will also get 4 new overburden wells, their locations to be based on the direct push sampling.**

Response 14: Noted, changes to Figures 1-2 through 1-6 have been made to reflect these comments.

Comment 15: **Figure 1-5: Please add the location of soil boring DP-13 at the WARWP and adjust the legend as necessary.**

Response 15: Noted, the location of soil boring DP-13 has been added to Figure 1-5.

Comment 16: **Figure 1-7: Please add the location of soil boring DP-10 at the PRRWP and adjust the legend as necessary.**

Response 16: Noted, the location of soil boring DP-10 has been added to Figure 1-7.

Comment 17: **General comment. The SPLP is an extraction method, not an analytical method. Please change the text to reflect this and also identify which analyses will be performed on the SPLP extracted samples. I believe the first footnote to Table 6 of the SOW lists that these samples will be analyzed for nitroaromatics only. It is also important that the material be sufficiently mixed because the results from the SPLP extraction/8330 analysis will be compared to the results from the samples analyzed by the 8330 method only. Please add a sentence or two addressing the need for a well mixed sample to the work plan.**

Response 17: Noted, changes have been made to the text to reflect these comments.

Comment 18: <u>Typing and Other Minor Errors</u>

Pg 1-2, Section 1.2.1.1: The reference to "Figure 1-1" on the 8th line should be "Figure 1-3". On the 11th line "features remains" should be "features remain".

Pg 1-7, Section 1.2.2.1, 2nd line: Figure 1-6 is of TNT Area C only, it does not include the WARWP.

Pg 1-8, 3rd line: The term "base/neutral/acid extractable compounds (BNA)" is used while elsewhere the term "semivolatile organic compounds (SVOC)" is used. If these terms refer to the same set of analytes we should probably use only one of them.

In the SSHP, Plum Brook Project Emergency Contacts, Linda Ingram's phone number should be changed to (615) 736-5622 and I believe Mike Gunderson is not expected to be the IT Site Manager.

Response 18: Noted, Typing and other minor errors have been corrected.