Attachment VI

Site-Specific Sampling and Analysis Plan
Sitewide Investigation of Groundwater
Former Plum Brook Ordnance Works
Sandusky, Ohio

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IT Project Number 771481
Control Copy No. 12

Revision 1

July 1997

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

KN/3667/3667.TXT/07-17-97(5:02 pm)/D2/E(5-8-97)

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List of Acronyms

ASTM	American Society for Testing and Materials
bgs	below ground surface
BNA	base/neutral and acid extractables
CFR	Code of Federal Regulations
°C	degrees Celsius
DERP	Defense Environmental Restoration Program
DNT	dinitrotoluene
DOD	U.S. Department of Defense
DQO	data quality objective
EPA	U.S. Environmental Protection Agency
FUDS	Formerly Used Defense Sites
GIS	Geographic Information System
GWI	groundwater investigation
HSA	hollow-stem auger
ID	inside diameter
IDW	investigation-derived waste
IT	IT Corporation
NASA	National Aeronautic and Space Administration
OD	outside diameter
PBOW	Plum Brook Ordnance Works
PCB	polychlorinated biphenyl
PPE	personal protective equipment
psi	pounds per square inch
PVC	polyvinyl chloride
QA/QC	quality assurance/quality control
QAPP	quality assurance project plan
SAP	sampling and analysis plan
SHP	safety and health plan
SI	site investigation
SOW	statement of work
SSAP	site-specific sampling and analysis plan
SSHP	site-specific safety and health plan

List of Acronyms *(Continued)*

SVOC	semivolatile organic compound
TAL	target analyte list
TCL	target compound list
TNT	trinitrotoluene
USACE	U.S. Army Corps of Engineers
USCS	Unified Soil Classification System
VOC	volatile organic compound
WARWP	West Area Red Water Pond

VI.1.0 Project Description

The U. S. Army is conducting studies of environmental impact of suspected hazardous waste sites at previously owned U.S. Department of Defense (DOD) properties. This work is being pursued by the U.S. Army Corps of Engineers (USACE) under the Defense Environmental Restoration Program (DERP) Formerly Used Defense Sites (FUDS). The former Plum Brook Ordnance Works (PBOW) in Sandusky, Ohio (Figure VI-1) is a DERP FUDS project currently being managed and technically overseen by the Nashville District of USACE. IT Corporation (IT) is contracted to provide engineering services to conduct a sitewide groundwater investigation (GWI), including quarterly groundwater level measurements, installation and development of 12 new wells, and two sampling events of new and existing monitoring wells.

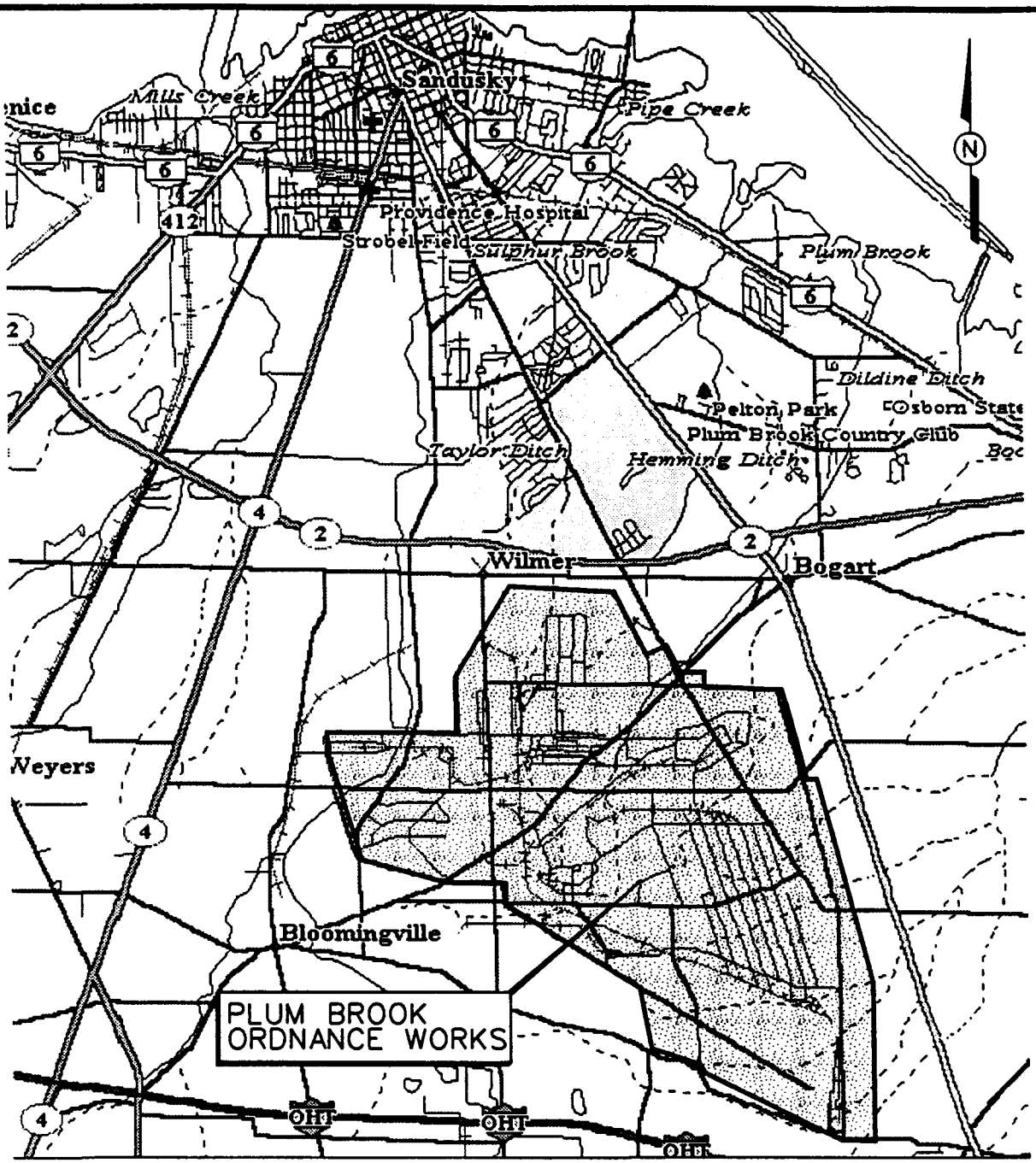
As an attachment to the PBOW sitewide sampling and analysis plan (SAP) (IT, 1996a), this site-specific sampling and analysis plan (SSAP) has been prepared for the work to be carried out in support of the GWI at PBOW. This SSAP must be used in conjunction with the SAP and the quality assurance project plan (QAPP) (IT, 1996b) to ensure that work to be performed at this site will be of the quality required to satisfy the overall and site-specific project objectives. A site-specific safety and health plan (SSHP) has also been prepared separately for this investigation and must be used in conjunction with the sitewide safety and health plan (SHP) (IT, 1996c).

VI.1.1 Site History

The PBOW site, built in early 1941, manufactured 2,4,6-trinitrotoluene (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 Ordnance Department, 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. The National Aeronautics and Space Administration (NASA) acquired the PBOW in 1963 and is presently utilizing the site.

VI.1.2 Summary of Existing Site Data

The western portion of the PBOW generally refers to the area west of Ransom Road. The area is predominantly wooded with some cleared areas covered with grasses and bushes. Several areas identified by previous investigations as potential areas of contamination include Reservoir No. 2



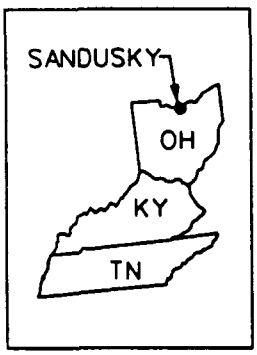


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FIGURE VI-1
VICINITY MAP

PLUM BROOK ORDNANCE WORKS
SANDUSKY, OHIO

INTERNATIONAL TECHNOLOGY CORPORATION

STARTING DATE: 5/8/97	DATE LAST REV.:	DRAFT. CHCK. BY: R. KNIGHT	INITIATOR: D.SEYMORE	DWG. NO.: 77148IES.003
DRAWN BY: R. KNIGHT	DRAWN BY:	ENGR. CHCK. BY: D. SEYMORE	PROJ. MGR.: D. BURTON	PROJ. NO.: 771481

77148IES.003 14:06:48 MAY 08, 1997 RMK

Burning Ground, Waste Water Disposal Plant No. 2, Power House No. 2 Ash Pit, TNT Area C, West Area Red Water Pond (WARWP), and G-8 Burning Ground. According to additional investigations conducted by several government agencies, the chemicals of potential concern within the western portion of PBOW may include volatile organic compounds (VOC), semi-volatile organic compounds (SVOC), polychlorinated biphenyls (PCB), metals, and nitro-aromatics. The findings of these investigations are summarized in Section 1.2.2 of SAP (IT, 1996a).

In 1994, the USACE Nashville District conducted the most recent sitewide groundwater investigation of the overburden and bedrock hydrostratigrahic units at PBOW (Dames & Moore, 1996). Eleven overburden groundwater monitoring wells and eight bedrock wells were installed during the 1994 investigation. Groundwater samples were collected from 16 overburden wells and 8 bedrock wells. All groundwater samples were analyzed for nitroaromatic compounds, nitrates, and total and dissolved metals. Samples from bedrock wells were also analyzed for VOCs and base/neutral and acid extractables (BNA) to acquire baseline groundwater quality information of the bedrock aquifer. The major findings of this investigation are briefly summarized in the following paragraphs to facilitate the GWI planning process and to aid in field operations. Table VI-1 summarizes monitoring well construction details for existing monitoring wells to be sampled during the GWI.

The overburden unit, composed of glacial outwash materials, has a thickness ranging from a few feet in the south to greater than 40 feet in some locations in the north. 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 consolidated bedrock. On the western side of the site groundwater in the overburden water-bearing zone flows to the northwest, while groundwater in the bedrock aquifer flows to the northeast. Table VI-2 presents available historical groundwater level elevation data for selected existing monitoring wells to be sampled during the GWI.

The results of the groundwater quality analyses indicated significant levels of explosive residues in the groundwater in the overburden aquifer in the immediate vicinity of both former Red Water Pond areas. Low levels of explosives, several VOCs, and BNAs were also detected in several bedrock wells. The locations of monitoring wells to be sampled during this GWI are provided on Figure VI-2.

Table VI-1

Existing Monitoring Well Construction Details
Wells to be Sampled During the Groundwater Investigation
Former Plum Brook Ordnance Works, Sandusky, Ohio

Well Identification	Well Depth (feet)	Date Installed	Installed By	Casing Type	Casing Diameter (inches)	Borehole Diameter (inches)	Screen Interval (feet bgs)	Top of Filter Pack (feet bgs)	TOC Elevation (feet msl)	Ground Elevation (feet msl)	Well Location
Overburden Monitoring Wells											
IT-MW01	9.5	1989	IT	PVC	2	8	4.0 - 9.0	2.0	678.24	674.52	Scheid Road Burn Grd
IT-MW02	18.3	1989	IT	PVC	2	8	6.0 - 16.0	3.8	639.63	636.53	West Area RWP
IT-MW05	21.0	1989	IT	PVC	2	8	8.5 - 18.5	6.5	634.99	631.91	Pentolite Road RWP
IT-MW06	18.5	1989	IT	PVC	2	8	6.0 - 16.0	4.4	632.97	628.90	Reactor Facility / PRA
IT-MW07	5.5	1996	IT	PVC	2	4.25	0.5 - 5.5	none	635.03	632.30	West Area RWP, temporary
IT-MW08	13.4	1996	IT	PVC	2	8.25	3.1 - 13.1	3.6	633.16	630.60	West Area RWP
IT-MW09	14.5	1996	IT	PVC	2	8.25	4.1 - 14.1	2.0	647.45	645.40	TNT Area C
IT-MW10	19.8	1996	IT	PVC	2	8.25	9.3 - 19.3	8.6	644.80	642.20	West Area RWP
PB-TNTA-MW10	11.0	1994	D&M	PVC	2	8	3.0 - 11.0	2.5	640.18	637.50	TNT Area A
PB-TNTA-MW11	11.4	1994	D&M	PVC	2	8	3.4 - 11.4	2.5	640.50	637.86	TNT Area A
PB-TNTC-MW03	14.0	1994	D&M	PVC	2	8	5.0 - 14.0	3.2	645.41	642.57	TNT Area C
PB-TNTC-MW04	18.8	1994	D&M	PVC	2	8	8.8 - 18.8	6.0	654.43	651.89	TNT Area C
PB-TNTC-MW05	29.7	1994	D&M	PVC	2	8	4.7 - 29.7	3.7	651.81	649.07	TNT Area C
PB-TNTC-MW06	12.2	1994	D&M	PVC	2	8	3.2 - 12.2	2.5	659.40	656.82	TNT Area C
PB-WA-MW01	22.3	1994	D&M	PVC	2	8	4.3 - 22.3	3.7	644.43	642.32	West Area RWP

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Well Identification	Well Depth (feet)	Date Installed	Installed By	Casing Type	Casing Diameter (inches)	Borehole Diameter (inches)	Screen Interval (feet bgs)	Top of Filter Pack (feet bgs)	TOC Elevation (feet msl)	Ground Elevation (feet msl)	Well Location
PB-WA-MW02	13.0	1994	D&M	PVC	2	8	3.0 - 12.0	2.5	633.65	631.16	West Area RWP
PB-PR-MW07	22.3	1994	D&M	PVC	2	8	4.3 - 22.3	3.0	633.99	631.50	Pentolite Road RWP
PB-PR-MW08	27.5	1994	D&M	PVC	2	8	5.0 - 27.5	4.0	635.02	632.50	Pentolite Road RWP
PB-PR-MW09	19.0	1994	D&M	PVC	2	8	4.0 - 19.0	3.0	633.70	630.70	Pentolite Road RWP
MK-MW09	15.0	1993	MK	PVC	2	10	5.0 - 15.0	3.0	645.91	643.04	West Area RWP
MK-MW10	14.0	1993	MK	PVC	2	10	4.0 - 14.0	2.0	641.25	638.23	West Area RWP
MK-MW11	13.0	1993	MK	PVC	2	10	3.0 - 13.0	2.0	638.00	634.88	West Area RWP
MK-MW12	13.0	1993	MK	PVC	2	10	3.0 - 13.0	2.0	641.73	673.78	Pipe Creek
MK-MW14	11.5	1993	MK	PVC	2	10	4.0 - 9.0	2.0	681.93	679.04	Toluene Tank No. 645
MK-MW15	9.0	1993	MK	PVC	2	10	4.0 - 9.0	2.0	681.45	678.35	Toluene Tank No. 655
MK-MW16	8.0	1993	MK	PVC	2	10	2.0 - 7.0	1.0	674.64	671.45	TNT Area B
MK-MW17	6.0	1993	MK	PVC	2	10	2.0 - 6.0	1.0	661.90	661.43	TNT Area B
MK-MW19	13.0	1993	MK	PVC	2	10	3.0 - 13.0	2.0	639.85	636.82	Garage Maintenance Area
MK-MW20	23.0	1993	MK	PVC	2	10	5.0 - 20.0	3.0	637.86	635.04	Toluene Tank No. 265
MK-MW22	9.5	1993	MK	PVC	2	10	2.5 - 7.5	1.5	638.95	635.84	TNT Area A
MK-MW23	16.0	1993	MK	PVC	2	10	6.0 - 16.0	4.0	640.01	637.01	TNT Area A

Table VI-1

Existing Monitoring Well Construction Details
Wells to be Sampled During the Groundwater Investigation
Former Plum Brook Ordnance Works, Sandusky, Ohio

Well Identification	Well Depth (feet)	Date Installed	Installed By	Casing Type	Casing Diameter (inches)	Borehole Diameter (inches)	Screen Interval (feet bgs)	Top of Filter Pack (feet bgs)	TOC Elevation (feet msl)	Ground Elevation (feet msl)	Well Location
MK-MW24	9.5	1993	MK	PVC	2	10	4.5 - 9.5	2.5	657.59	654.57	TNT Area A
GCL-MW01	NA	1992	H+GLC	NA	NA	NA	NA	NA	674.74	671.31	Snake Rd. Burn Grd (BG)
GCL-MW02A	NA	1992	H+GLC	NA	NA	NA	NA	NA	672.66	669.68	Snake Rd. Burn Grd
GCL-MW02B	NA	1992	H+GLC	NA	NA	NA	NA	NA	673.07	669.60	Snake Rd. Burn Grd
GCL-MW03	NA	1992	H+GLC	NA	NA	NA	NA	NA	671.52	668.67	Snake Rd. Burn Grd
Bedrock Monitoring Wells											
PB-BED-MW13	75.5	1994	D&M	PVC	4	3 (A)	29.5 (B)	none	648.27	645.81	TNT Area C
PB-BED-MW14	52.2	1994	D&M	PVC	4	3 (A)	23.2 (B)	none	646.04	643.05	West Area RWP
PB-BED-MW15	74.4	1994	D&M	PVC	4	3 (A)	42.9 (B)	none	631.64	629.08	Pentolite Road RWP
PB-BED-MW16	74.0	1994	D&M	PVC	4	3 (A)	24.8 (B)	none	636.02	633.68	Pentolite Road RWP
PB-BED-MW17	64.4	1994	D&M	PVC	4	3 (A)	19.4 (B)	none	629.97	627.37	TNT Area A
PB-BED-MW18	75.4	1994	D&M	PVC	4	3 (A)	24.4 (B)	none	651.50	648.83	TNT Area A
PB-BED-MW19	49.5	1994	D&M	PVC	4	3 (A)	17.5 (B)	none	643.07	640.51	West Area RWP
PB-BED-MW20	49.5	1994	D&M	PVC	4	3 (A)	14.5 (B)	none	676.33	673.57	BG Well - Southern PBS
REACTOR1	NA	NA	NA	NA	NA	NA	NA	NA	630.12	630.21	Reactor Facility / PRA
REACTOR2	NA	NA	NA	NA	NA	NA	NA	NA	630.68	630.72	Reactor Facility / PRA

Table VI-1

Existing Monitoring Well Construction Details
Wells to be Sampled During the Groundwater Investigation
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Well Identification	Well Depth (feet)	Date Installed	Installed By	Casing Type	Casing Diameter (inches)	Borehole Diameter (inches)	Screen Interval (feet bgs)	Top of Filter Pack (feet bgs)	TOC Elevation (feet msl)	Ground Elevation (feet msl)	Well Location
REACTOR3	NA	NA	NA	NA	NA	NA	NA	NA	630.88	630.73	Reactor Facility / PRA
REACTOR4	NA	NA	NA	NA	NA	NA	NA	NA	631.15	630.76	Reactor Facility / PRA

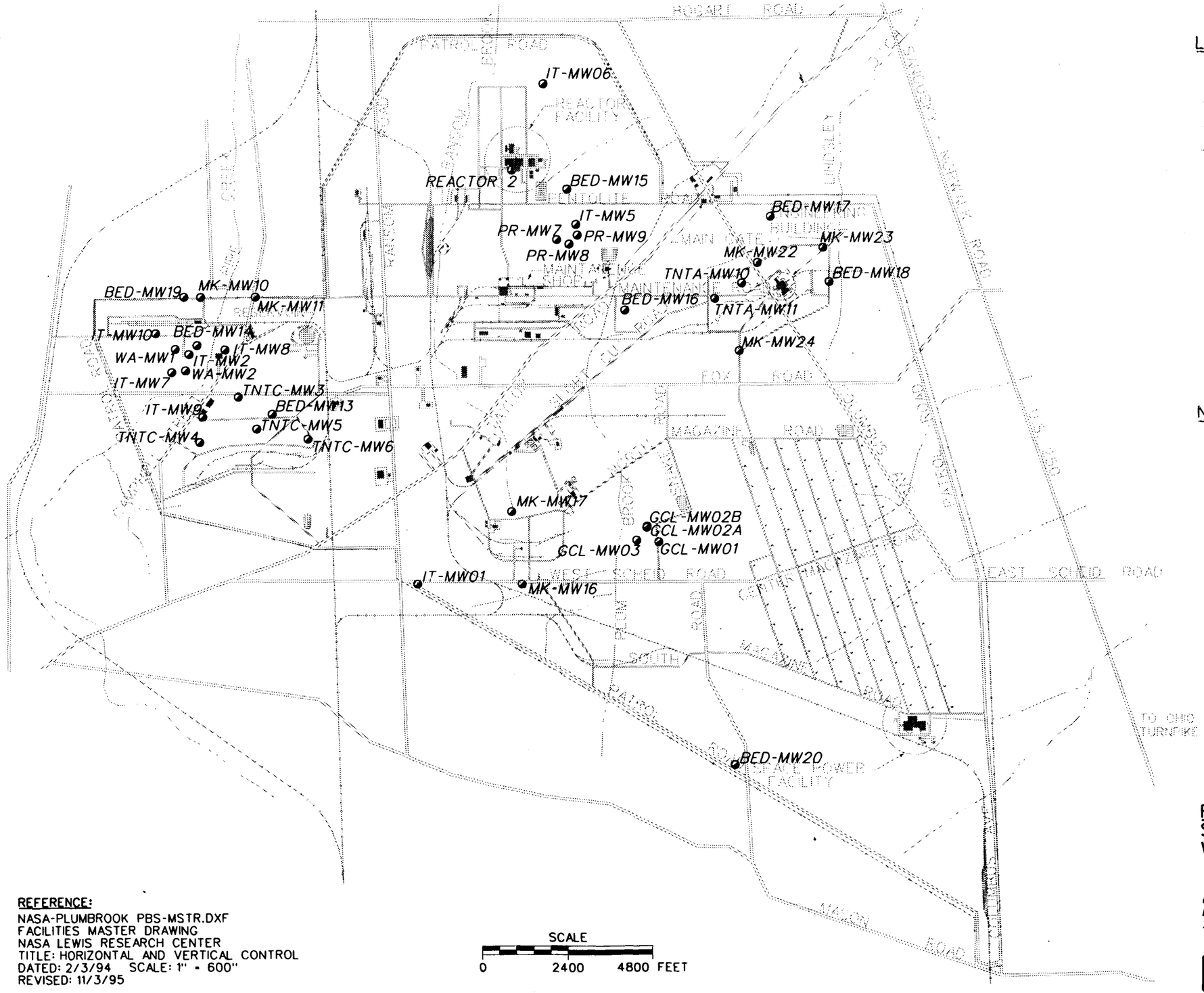
A - 3-inch diameter open borehole into bedrock.
B - Depth at which PVC casing ends; remainder of well is open borehole in bedrock.
RWP - Red Water Ponds
PRA - Pentolite Road Area
BG - Background location
PBS - Plum Brook Station
NA - Information not available

Table VI-2

Groundwater Level Elevations
Former Plum Brook Ordnance Works, Sandusky, Ohio

Well Identification	Top Of Casing Elevation (feet, msl)	Ground Elevation (feet, msl)	Water Level Elevation Dec-94 (feet, msl)	Water Level Elevation Mar-95 (feet, msl)	Water Level Elevation Oct-96 (feet, msl)	Notes
PB-TNTA-MW10	640.18	637.50	633.71	637.04	635.62	
PB-TNTA-MW11	640.50	637.86	630.56	632.82	633.56	
PB-TNTC-MW3	645.41	642.57	Dry, <628.57	639.20	635.01	
PB-TNTC-MW4	654.43	651.89	634.87	651.07	648.51	
PB-TNTC-MW5	651.81	649.07	628.01	647.62	643.28	
PB-TNTC-MW6	659.40	656.82	651.93	655.20	654.56	
PB-WA-MW1	644.43	642.32	619.85	619.45	624.99	
PB-WA-MW2	633.65	631.16	629.59	631.91	628.75	
PB-PR-MW7	633.99	631.50	626.32	631.65	629.64	
PB-PR-MW8	635.02	632.50	624.55	629.98	627.56	
PB-PR-MW9	633.70	630.70	622.92	630.12	626.57	
PB-BED-MW13	648.27	645.81	607.85	619.29	621.79	
PB-BED-MW14	646.04	643.05	621.76	624.39	625.23	
PB-BED-MW15	631.64	629.08	603.54	598.91	610.22	
PB-BED-MW16	636.02	633.68	571.38	633.68	630.17	
PB-BED-MW17	629.97	627.34	602.57	602.90	602.76	
PB-BED-MW18	651.50	648.83	625.05	620.39	621.68	
PB-BED-MW19	643.07	640.50	621.07	623.52	622.92	
PB-BED-MW20	676.33	673.57	661.35	661.28	661.98	
MK-MW10	640.89	638.06	626.66	Not Measured	632.23	
MK-MW11	637.69	634.71	625.22	631.36	628.89	
MK-MW16	674.32	671.33	667.14	669.36	668.42	
MK-MW17	664.64	660.97	659.58	661.10	660.56	
MK-MW22	638.05	635.56	628.85	631.55	630.07	
MK-MW23	639.07	636.95	620.88	628.12	632.14	
MK-MW24	657.12	654.44	648.31	650.77	649.61	
IT-MW002	639.63	636.69	627.32	633.75	629.33	
IT-MW005	634.99	631.91	620.19	629.62	623.36	
IT-MW07	635.03	632.30	-	-	dry, < 627.30	piezometer
IT-MW08	633.16	630.60	-	-	619.96	new well/survey data
IT-MW09	647.45	645.40	-	-	dry, < 632	new well/survey data
IT-MW010	644.80	642.20	-	-	626.41	new well/survey data

Note: TOC and ground surface elevations were reported in Table 5-2 of Dames & Moore Site-Wide Groundwater Investigation report, (Dames & Moore, 1996) unless otherwise indicated.



LEGEND:

- BUILDINGS
- FENCE (PBOW BOUNDARY)
- RAILROAD
- DITCH
- SURFACE POND
- EXISTING WELL

NOTES:

SURVEY COORDINATES ARE NOT AVAILABLE FOR MONITORING WELLS MK-MW09, MK-MW12, MK-MW14, MK-MW15, MK-MW19, MK-MW20, REACTOR-1, REACTOR-3, AND REACTOR-4.

REFERENCE:
NASA-PLUMBROOK PBS-MSTR.DXF
FACILITIES MASTER DRAWING
NASA LEWIS RESEARCH CENTER
TITLE: HORIZONTAL AND VERTICAL CONTROL
DATED: 2/3/94 SCALE: 1" = 600"
REVISED: 11/3/95

SCALE
0 2400 4800 FEET

FIGURE VI-2
SITE WIDE MONITORING
WELL LOCATION MAP

PLUM BROOK ORDNANCE WORKS
NASA PLUM BROOK STATION
SANDUSKY, OHIO

INTERNATIONAL TECHNOLOGY CORPORATION

STARTING DATE: 5/8/97	DATE LAST REV.:	DRAFT. CHCK. BY: R. KNIGHT	INITIATOR: D. SEYMORE	DWG. NO.:7714BIES.001
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A site visit conducted by IT project members on May 15 and 16, 1996 acquired information regarding 28 existing monitoring wells to be sampled and assessed site accessibility for new monitoring well installation. All targeted existing wells were located and appeared to be in good condition. Some wells are off-road and some are in swampy areas that require the use of an all-terrain vehicle.

VI.2.0 Project Organization and Responsibility

The project organization for this sitewide GWI consists of a project manager, a health and safety officer, a principal investigator, an analytical coordinator, field geologists, and technicians. Chapter 2.0 of the SAP (IT, 1996a) presents names of key IT personnel and their respective responsibilities.

VI.3.0 Scopes and Objectives

VI.3.1 Scope

As specified in the statement of work (SOW) (USACE, 1997), the scope for the groundwater investigation at PBOW consists of preparation of site-specific addendums to the sitewide SAP and SHP; completion of field activities, including installation of monitoring wells and collection of soil samples from new monitoring wells and groundwater samples from new and existing monitoring wells for chemical analysis, evaluation of analytical results; periodic sitewide water level measurements; preparation of investigation report of activities, conclusions, and recommendations for future actions, and a Geographic Information System (GIS) deliverable.

VI.3.2 Objectives

Specific objectives of the sitewide groundwater level investigation 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.

Evaluation of fate and transport pathways will not be completely satisfied during this investigation, but sufficient groundwater information will be collected so that a scope of work for groundwater modeling can be completed if required to determine fate and transport of hazardous substances in site groundwater. Additionally, the collected data can be used to conduct a human health and ecological risk assessment, if necessary.

VI.3.3 Site-Specific Data Quality Objectives

Overview. The data quality objectives (DQO) process followed during the planning stages of the investigation 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 sitewide SAP. Determining factors for procedures necessary to satisfy investigative objectives and to establish the basis of future actions at PBOW are presented in Table VI-3 and Figure 3-2 of the sitewide SAP (IT, 1996a).

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 sampling necessary to fill the data gaps and to satisfy the data quality objectives. 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.

Conceptual Site Model. Four factors considered in defining the conceptual model for the sitewide GWI are:

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

A potential source of contamination at PBOW are past TNT manufacturing activities. The migration pathways include groundwater infiltration, soil, and surface water runoff to the creek.

Table VI-3

Summary of Data Quality Objectives for the Groundwater Investigation 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	Data Quantity
EPA OEPA DOD USACE NASA IT Corporation Other Contractors Possible Future Land Users	Overburden Wells: Nitroaromatic compounds exceed RBCs in the overburden water bearing zone in the West Area Red Water Pond Area (WARWP), Pentolite Road Red Water Pond Area (PRRWP), TNT Area A (TNTA), and TNT Area B (TNTB). Metals exceed RBCs in overburden wells in WARWP, PRRWP, TNTA, TNTB, and TNTC. Bedrock Wells: Organic compounds exceed RBCs in PRRWP, TNTA, and TNTC. Nitroaromatics exceed RBCs in PRRWP, TNTA, and TNTC. Metals exceed RBCs in WARWP, PRRWP, TNTA, and TNTC. H_2S in bedrock wells. Data Gaps: 8 bedrock & 4 overburden wells needed to accurately define nature and extent of contamination.	Contaminated Sources: TNT Areas, Burning Grounds, and Wastewater Ponds. Migration Pathways: Soil, sediment, surface water, and groundwater. Potential Receptors: Wildlife and humans. Potential Contaminants of Concern: VOCs, SVOCs, metals, nitroaromatics, and PCBs.	Groundwater	Determine if hazardous substances are present at levels posing a threat to human health and environment. Define physical features and characteristics (aquifer background conditions). Evaluate fate and transport pathways (modeling). Determine current and future routes of exposure.	TAL Total Metals TAL Dissolved Metals Explosives TCL VOCs TCL SVOCs PCBs Water Quality Parameters (hardness, alkalinity, TOC, TDS, TSS, chloride, total cyanide, nitrate, and sulfate)	Definitive Data[a]	118 + QA

a Definitive data as defined in EPA/540/G-93/071, *Data Quality Objectives Process for Superfund* (EPA 1993).

Likely receptors at PBOW are limited to aquatic organisms in creeks and wildlife. 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. Potential contaminants of concern based on past use of the site may include VOCs, SVOCs, metals, pesticides/PCBs, nitroaromatics, and total cyanide.

Decision-Making Process, Data Uses, and Needs. The decision-making process, presented in detail in Section 3.3.3 of the sitewide SAP (IT, 1996a), consists of a seven-step process that will be followed during the sitewide GWI. Data uses and needs are summarized in Table VI-3.

Risk Evaluation. Confirmation of contamination at the additional sitewide GWI will be based upon a comparison of detected contaminants from this and previous investigations to the most current guidance criteria. EPA definitive data will be used to achieve detection limits sufficient to determine whether or not 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.

Data Quality, Types, and Quality. Soil and groundwater samples will be collected and analyzed in order to meet the objectives of the additional sitewide GWI. Quality assurance/ quality control (QA/QC) samples will be collected for all sample types as described in Section VI.4.5 of this SSAP. All 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 SI, data analyzed at this level of quality are appropriate for all phases of the characterization and risk assessment.

Precision, Accuracy, and Completeness. Laboratory requirements of precision, accuracy, and completeness for this are provided in Section 3.3.4.4.3 of the sitewide SAP (IT, 1996a).

VI.4.0 Field Activities

Field activities during the additional groundwater level investigation at PBOW include the installation, development, geotechnical sampling, and groundwater sampling of 8 new bedrock wells (IT-BG8-BEDGW-001, TNTB-BEDGW-001, TNTB-BEDGW-002, MNTA-BEDGW-001,

AA1-BEDGW-001, AA2-BEDGW-001, AA3-BEDGW-001, and ABG-BEDGW-001) and 4 new overburden wells (IT-AA1-GW-002, AA2-GW-002, AA3-GW-002, ABG-GW-002); the groundwater sampling of 12 existing bedrock wells and 35 existing overburden wells, with QA/QC samples, followed by sitewide water level measurements, surveying, and management of investigation-derived waste (IDW).

VI.4.1 Monitoring Well Installation

VI.4.1.1 Monitoring Well Locations and Rationale

Twelve new monitoring wells will be installed during the investigation of groundwater at PBOW. Eight monitoring wells will be installed as bedrock wells, while the remaining four monitoring wells will be installed as overburden wells. Table VI-4 provides a summary of the wells to be installed, including anticipated well depths, locations, construction details, and rationale. Monitoring well installation in the referenced locations will allow for additional characterization of the aquifer conditions, evaluation of fate and transport pathways, determination of whether the hazardous substances pose an unacceptable risk to human health and the environment, and definition of current and future routes of exposure. Additional rationale for placement of monitoring wells comes from previous analytical results/contaminant plumes and the need to fill data gaps.

Tentative locations of these monitoring wells are presented on Figure VI-3. The locations may require adjustment if site conditions warrant. In that event, the IT field coordinator will contact the USACE oversight representative and the project manager prior to changing well locations. 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).

Bedrock monitoring wells will be installed to an assumed total depth of 75 feet below ground surface (bgs), while overburden monitoring wells will be installed to an assumed total depth of 15 feet bgs.

VI.4.1.2 Drilling Methods for Overburden Monitoring Wells

A total of four boreholes for monitoring well installation will be installed in the unconsolidated overburden materials by the hollow-stem auger (HSA) method using nominal 8.25-inch inside diameter (ID) augers as specified in the following text. Continuous soil sampling and rock coring will be conducted in each borehole from the surface to the total depth for lithological

Table VI-4

Construction Details and Location Rationale for Proposed Monitoring Wells Groundwater Investigation Former Plum Brook Ordnance Works, Sandusky, Ohio

Well Identification	Total Depth (feet bgs)	Casing Diameter (inches)	Screen Interval (feet bgs)	Proposed Well Location	Rationale / Purpose
Bedrock Monitoring Wells					
IT-BG8-BEDGW-001	75.0	2	60 - 75	G8 Burning Grounds (corner of Campbell Road and Patrol Road)	Upgradient water quality data, West Area Red Water Ponds and TNT Area C
IT-TNTB-BEDGW-001	75.0	2	60 - 75	TNT Area B near MK-MW16	Upgradient water quality data, TNT Area B
IT-TNTB-BEDGW-002	75.0	2	60 - 75	TNT Area B near MK-MW17	Downgradient water quality data, TNT Area B
IT-MNTA-BEDGW-001	75.0	2	60 - 75	Maintenance Area	Upgradient water quality data, Pentolite Road Red Water Pond Area
Nested Monitoring Well Pairs					
IT-AA1-BEDGW-001	75.0	2	60 - 75	Acids Area 1	Bedrock water quality data, Acids Area 1
IT-AA1-GW-002	15.0	2	5 - 15	Acids Area 1	Overburden water quality data, Acids Area 1
IT-AA2-BEDGW-001	75.0	2	60 - 75	Acids Area 2	Bedrock water quality data, Acids Area 2
IT-AA2-GW-002	15.0	2	5 - 15	Acids Area 2	Overburden water quality data, Acids Area 2
IT-AA3-BEDGW-001	75.0	2	60 - 75	Acids Area 3	Bedrock water quality data, Acids Area 3
IT-AA3-GW-002	15.0	2	5 - 15	Acids Area 3	Overburden water quality data, Acids Area 3
IT-ABG-BEDGW-001	75.0	2	60 - 75	Additional Burning Ground	Bedrock water quality data, Additional Burning Ground
IT-ABG-GW-002	15.0	2	5 - 15	Additional Burning Ground	Overburden water quality data, Additional Burning Ground

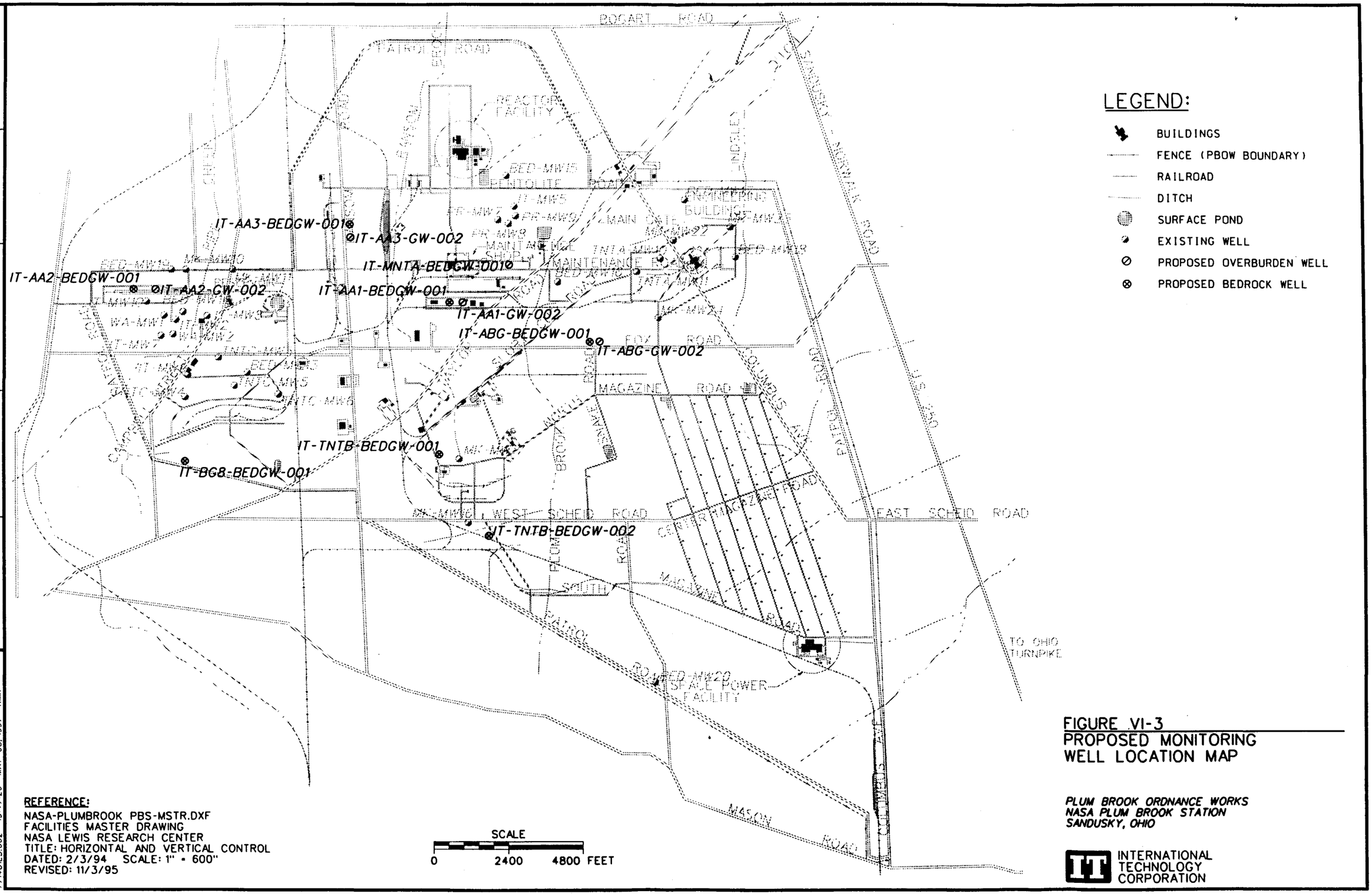


FIGURE VI-3
PROPOSED MONITORING WELL LOCATION MAP

PLUM BROOK ORDNANCE WORKS
NASA PLUM BROOK STATION
SANDUSKY, OHIO

INTERNATIONAL TECHNOLOGY CORPORATION

STARTING DATE: 5/8/97	DATE LAST REV.:	DRAFT. CHCK. BY: R. KNIGHT	INITIATOR: D. SEYMORE
DRAWN BY: R. KNIGHT	DRAWN BY:	ENGR. CHCK. BY: D. SEYMORE	PROJ. MGR.:D. BURTON

DWG. NO.:771481ES.002
PROJ. NO.:771481

771481ES.002 13:47:26 MAY 08, 1997 RMK

description. All soil samples will be visually inspected and logged on the HTRW Drilling Log (Figure 4-11 of the Site-Wide SAP) by an IT field geologist using the Unified Soil Classification System (USCS). Three soil samples will be collected from each borehole and submitted for geotechnical analysis; at least one of the samples will be collected from the aquifer material in the screened interval. Geotechnical samples will be analyzed by a geotechnical testing laboratory for sieve analysis, Atterberg limits, soil density, and moisture content. In addition, one sample will be collected of the filter pack material and submitted for sieve analysis only. The borehole will be advanced to first water with a 10-foot screen section placed 1 foot above the bottom. The estimated depth of each overburden well is 15 feet bgs. If bedrock is encountered at a depth of less than 6 feet bgs, a monitoring well will not be installed and the borehole will be abandoned by grouting from the bottom to the ground surface. A new well location will then be identified and coordinated with the USACE.

VI.4.1.3 Drilling Methods for Bedrock Monitoring Wells

A total of eight new bedrock monitoring wells will be installed during the investigation of groundwater at PBOW. The bedrock monitoring wells will be installed as double-cased wells, drilled using HSA methodology. Initially, 14-inch-diameter HSA will be used to drill through the overburden material to bedrock and 5 feet into bedrock at an assumed depth of 50 feet bgs. A 10-inch ID low-carbon steel surface casing will then be installed into the borehole through the augers and pressure-grouted in place using 3,000 pounds per square inch (psi) concrete to prevent frost damage. The surface casing will be permitted to cure for a minimum of 48 hours, after which the borehole will be advanced through the surface casing to the estimated total depth of 75 feet bgs (25 feet into bedrock) using 6-inch outside diameter (OD) air rotary drilling techniques.

Continuous soil sampling and rock coring will be conducted in each borehole from the surface to the total depth for lithological description. All soil samples will be visually inspected and logged by an IT field geologist using the USCS. Two soil samples will be collected from each borehole and submitted for geotechnical analysis. Geotechnical samples will be analyzed by a geotechnical testing laboratory for sieve analysis, Atterberg limits, soil density, and moisture content. In addition, one sample will be collected of the filter pack material and submitted for sieve analysis only.

Drilling and installation of all monitoring wells will follow the requirements of USACE EM-1110-1-4000, *Monitoring Well Design, Installation, and Documentation at Hazardous and/or Toxic Waste Sites* (USACE, 1994).

VI.4.1.4 Soil Samples for Geologic Logging

The soil and rock sampling shall be continuous for the entire monitoring well boring. Visual classification and logging of borehole material in the field shall be in accordance with USCS nomenclature and procedures described in USACE EM 1110-1-4000 (USACE, 1994), including making a photographic record of the core. Soil overburden material shall be split-spoon sampled for the purpose of visual geotechnical classification of the borehole material.

VI.4.1.5 Soil Samples for Geotechnical Testing

Sample collection for geotechnical analysis according to the USACE scope of work is summarized in Table VI-5.

Two soil samples from each of the eight bedrock wells will be collected. The sieve analysis number includes screened interval samples from overburden wells.

The results of geotechnical analysis will be included in the investigation report along with drilling logs.

VI.4.1.6 Monitoring Well Completion

All monitoring wells will be completed using 2-inch-ID, schedule 40 polyvinyl chloride (PVC) casing (American Society for Testing and Materials [ASTM] F480-81, D1785), and screen for overburden and bedrock wells, using procedures specified in the Resource Conservation and Recovery Act groundwater monitoring technical enforcement guidance document (EPA, 1986), the USACE EM-1110-1-4000 (USACE, 1994), and the State of Ohio requirements.

VI.4.1.7 Materials and Procedures for Overburden Monitoring Wells

A typical overburden monitoring well construction diagram is provided as Figure VI-4. The overburden groundwater monitoring wells will be installed using the following materials and procedures:

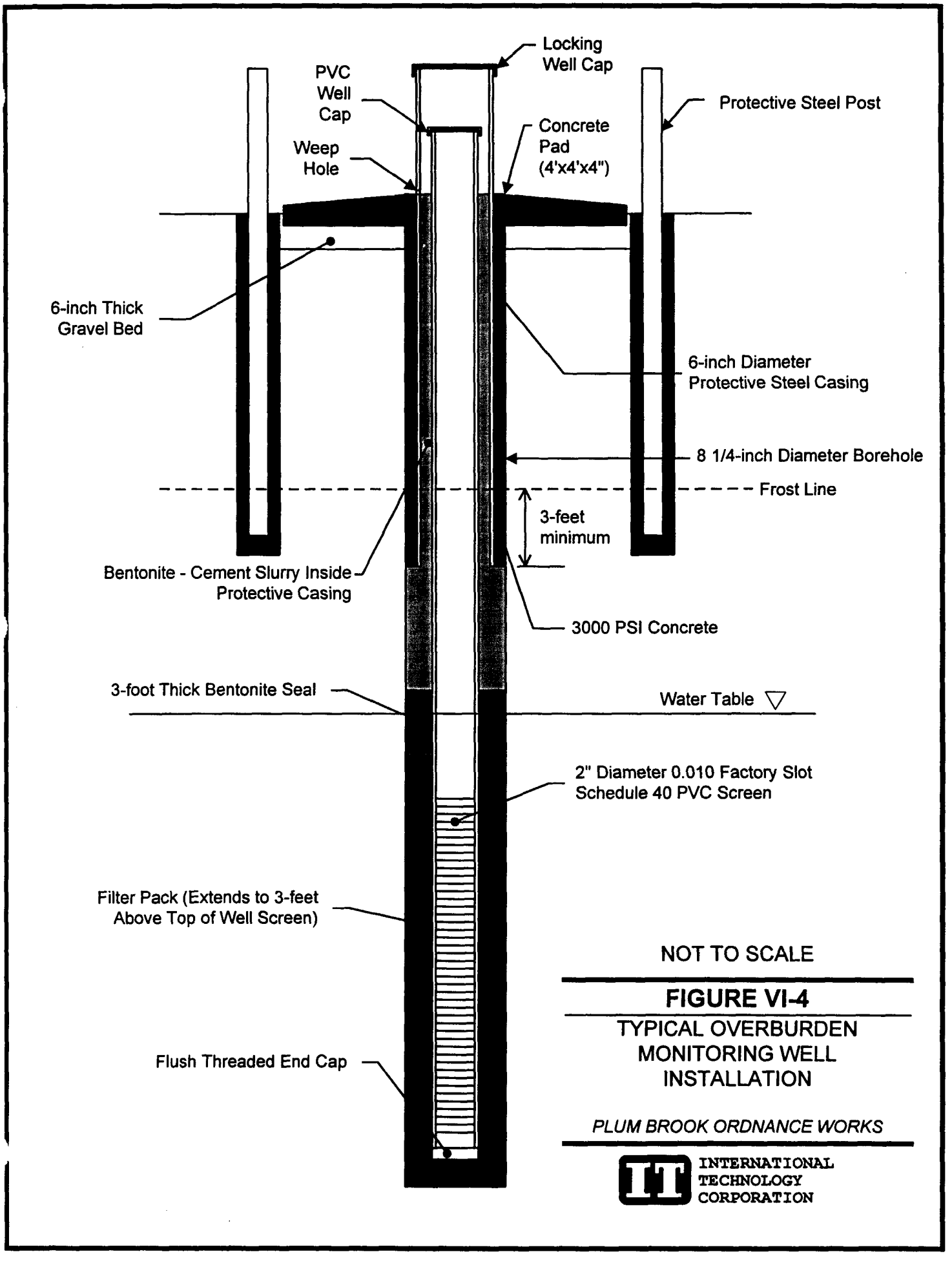
- ***Well Screens.*** A 2-inch ID, flush-jointed threaded schedule 40 PVC factory slot screen. The slot size will be determined based upon historical site data and confirmed through sieve analyses. Ten feet of screen with a PVC end cap will be placed in each overburden well.

- ***Well Casing.*** A 2-inch ID, flush-jointed threaded schedule 40 PVC (ASTM D1875) casing will be attached to the top of the screen. Glues or adhesives will not

Table VI-5

Geotechnical Samples for the New Well Installations
Former Plum Brook Ordnance Works, Sandusky, Ohio

Geotechnical Test	ASTM Method	Number of Samples
Moisture content	D2216	16
Atterberg limits	D4318	16
Sieve analysis	D422	16 + 4
Soil density	D2487	16


Locking Well Cap
PVC Well Cap
Protective Steel Post
Concrete Pad (4'x4'x4")
Weep Hole
6-inch Thick Gravel Bed
6-inch Diameter Protective Steel Casing
8 1/4-inch Diameter Borehole
Frost Line
3-feet minimum
Bentonite - Cement Slurry Inside Protective Casing
3000 PSI Concrete
3-foot Thick Bentonite Seal
Water Table
2" Diameter 0.010 Factory Slot Schedule 40 PVC Screen
Filter Pack (Extends to 3-feet Above Top of Well Screen)
Flush Threaded End Cap
NOT TO SCALE
FIGURE VI-4
TYPICAL OVERBURDEN MONITORING WELL INSTALLATION
PLUM BROOK ORDNANCE WORKS
INTERNATIONAL TECHNOLOGY CORPORATION

be used. The casing string will extend approximately 2.5 feet above grade and will be certified by the manufacturer as being the material specified.

- ***Decontamination.*** All well completion materials, including screen and casing, will be decontaminated by steam, laboratory grade detergent, and distilled water rinse prior to installation.

- ***Filter Pack.*** Clean, inert, noncarbonate materials will be used to construct a uniform and continuous filter pack. The filter pack will be designed to prevent migration of formation fines into the well bore. The filter pack will be placed by pipe from the bottom of the borehole to approximately 36 inches above the top of the well screen. A sieve analysis will be performed on the filter pack material.

- ***Bentonite Seal.*** A 3-foot seal consisting of tamped 1/4-inch bentonite pellets will be tremied into the annular space between the well riser and the borehole wall immediately above the filter pack. If the seal is constructed above the groundwater, it will be sufficiently hydrated with clean, nonchlorinated water to preclude transmission of grout from above into the filter pack or well screen.

- ***Frost Protection.*** All monitoring wells will be constructed to prevent frost damage. The protective steel casing will be installed to a depth of 3 feet below the frost line (7 feet bgs), and 3,000-psi concrete will be placed in the annular space between the protective casing and the borehole wall. Figure VI-4 provides construction details for frost protection.

- ***Grout.*** Neat cement grout consisting of approximately 94 pounds Portland Type II cement (in accordance with ASTM C-150) and not more than 3 pounds powdered bentonite and 7 gallons of water will be used. The grout will be placed using a tremie pipe from the top of the bentonite seal to the ground surface (except where 3,000-psi concrete is used for frost protection).

- ***Surface Protection.*** Surface protection will consist of a 6-inch-OD steel surface casing extending approximately 7 feet into the ground and approximately 2.5 feet above the ground (a maximum of 0.2 feet above the top of the PVC well casing) with a lockable cap set into and surrounded by a concrete pad 4 feet square and approximately 4 inches thick. The pad will be sloped a minimum of 2 inches from the surface casing to the edge of the pad to provide positive drainage and will be placed on a 6-inch-thick gravel bed. USACE specifications to prevent frost heave will be used in well construction. Four 3-inch-diameter, concrete-filled steel posts extending approximately 3 feet above the ground surface will be set in concrete approximately 5 feet into the ground at equal spacing around the concrete pad. All of the locks on the new wells will be keyed alike. A permanent tag will be affixed to the outer protective casing or cap and will clearly identify the well number, the USACE, Nashville District, and the adjusted top of casing elevation.

VI.4.1.8 Materials and Procedures for Bedrock Monitoring Wells

A typical bedrock monitoring well construction diagram is provided as Figure VI-5. The bedrock groundwater monitoring wells will be installed using the following materials and procedures:

- ***Surface Casing.*** A 14-inch-diameter HSA will be used to drill through the overburden material to bedrock and 5 feet into the bedrock. A 10-inch-ID, low-carbon steel surface casing will be installed through the augers 5 feet into the bedrock and pressure grouted into place using 3,000-psi concrete.

- ***Well Screens.*** A 2-inch ID, flush-jointed threaded schedule 40 PVC factory slot screen. The slot size will be determined based upon historical site data and confirmed through sieve analyses. Fifteen feet of screen with a PVC end cap will be placed in each bedrock well.

- ***Well Casing.*** A 2-inch-ID, flush-jointed threaded schedule 40 PVC (ASTM D1875) casing will be attached to the top of the screen. Glues or adhesives will not be used. The casing string will extend approximately 2.5 feet above grade and will be certified by the manufacturer as being the material specified.

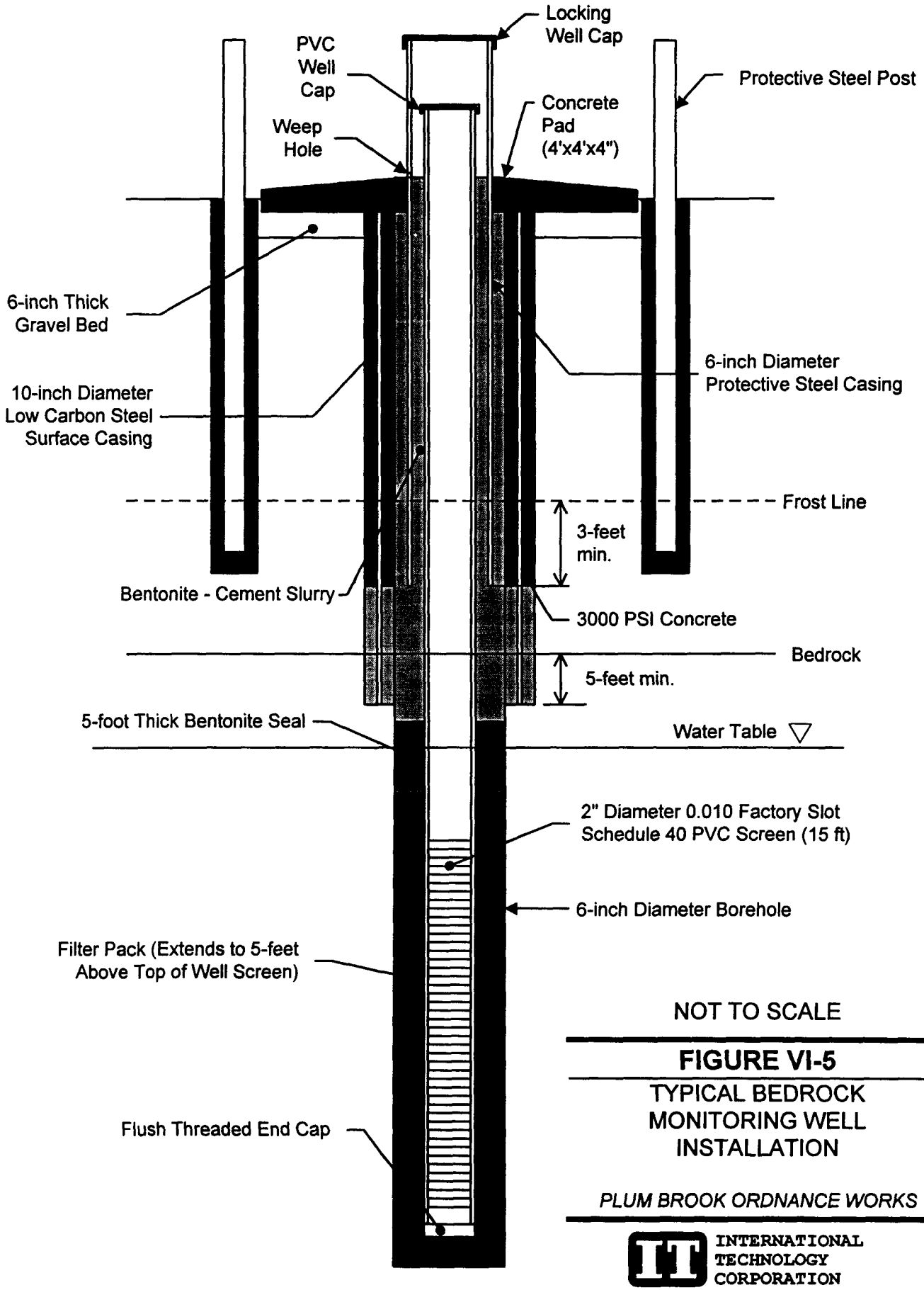
- ***Decontamination.*** All well completion materials, including screen and casing, will be decontaminated by steam, laboratory grade detergent, and distilled water rinse prior to installation.

- ***Filter Pack.*** Clean, inert, noncarbonate materials will be used to construct a uniform and continuous filter pack. The filter pack will be designed to prevent migration of formation fines into the well bore. The filter pack will be placed by pipe from the bottom of the borehole to approximately 60 inches above the top of the well screen. A sieve analysis will be performed on the filter pack material.

- ***Bentonite Seal.*** A 5-foot seal consisting of tamped 1/4-inch bentonite pellets will be tremied into the annular space between the well riser and the borehole wall immediately above the filter pack. If the seal is constructed above the groundwater, it will be sufficiently hydrated with clean, nonchlorinated water to preclude transmission of grout from above into the filter pack or well screen.

- ***Frost Protection.*** All monitoring wells will be constructed to prevent frost damage. For bedrock wells, 3,000-psi concrete will be used to set the surface casing in place. Figure VI-5 provides construction details for frost protection.

- ***Grout.*** Neat cement grout consisting of approximately 94 pounds Portland Type II cement (in accordance with ASTM C-150) and not more than 3 pounds powdered bentonite and 7 gallons of water will be used. The grout will be placed using a tremie pipe from the top of the bentonite seal to the ground surface (except where 3,000-psi concrete is used for frost protection).



NOT TO SCALE

FIGURE VI-5

TYPICAL BEDROCK MONITORING WELL INSTALLATION

PLUM BROOK ORDNANCE WORKS

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- ***Surface Protection.*** Surface protection will consist of a 6-inch-OD steel surface casing extending approximately 3 feet into the ground and approximately 2.5 feet above the ground (a maximum of 0.2 feet above the top of the PVC well casing) with a lockable cap set into and surrounded by a concrete pad 4 feet square and approximately 4 inches thick. The pad will be sloped a minimum of 2 inches from the surface casing to the edge of the pad to provide positive drainage and will be placed on a 6-inch-thick gravel bed. USACE specifications to prevent frost heave will be used in well construction. Four 3-inch-diameter, concrete-filled steel posts extending approximately 3 feet above the ground surface will be set in concrete approximately 5 feet into the ground at equal spacing around the concrete pad. All of the locks on the new wells will be keyed alike. A permanent tag will be affixed to the outer protective casing or cap and will clearly identify the well number, the USACE, Nashville District, and the adjusted top of casing elevation.

VI.4.2 Monitoring Well Development

New monitoring wells will be developed not sooner than 48 hours after installation, but not more than 7 days after internal mortar collar (grout) placement. Existing wells to be sampled, if not sampled in the past 12 months will be redeveloped in the same manner as the new wells, but the development time will be limited to 2 hours. Well development will be conducted in accordance with the procedures and requirements of EM-1100-1-4000, Appendix C of EM 200-1-3, the sitewide SAP, and the SOW. Wells will be developed by raising and lowering a surge block throughout the length of screen, followed by pumping or bailing without using acids, flocculent, or dispersing agents. Water will not be added to a well as part of development once the well has been grouted and sealed. 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.
- The sediment thickness remaining within the well is less than 1 percent to the screen length or less than 0.1 foot for screens equal to or less than 10 feet long.
- Temperature, pH, and specific conductance values stabilize.
- A volume of water equal to at least five times standing water in the well including the well casing and screen, and the saturated annular space assuming 30 percent of porosity has been removed.

Each new well will be developed for a maximum of 6 hours and each existing well will be developed for up to 2 hours. If the well is not satisfactorily developed within this time, the USACE will be contacted for consultation and further instructions.

Color photographs (35-millimeter color prints) will be taken of water from each monitoring well after development. Specifically, a 1-liter water sample will be collected of the last water removed during development and placed in a clear glass jar, labeled, and photographed. 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.

VI.4.3 In Situ Permeability Testing

In situ permeabilities of each newly installed monitoring well will be determined using a "rising head" slug test. Each test will consist of instantaneously extracting a slug from the well and monitoring the subsequent recovery of the groundwater level. Transducers and a data logger will be used to record water level changes in the well during the tests. After completion of the test, data will be downloaded to a computer to generate a "time-drawdown" curve, which will be analyzed by the hydrogeologist to obtain the hydraulic conductivity of the tested aquifer.

VI.4.4 Redevelopment of Existing Wells

Prior to sample collection, up to 20 existing wells will require redevelopment following the procedures described in Section VI.4.2. If wells have not been sampled within the last 12 months, redevelopment will be conducted.

VI.4.5 Groundwater Sampling

Groundwater samples will be collected from each of the 8 newly installed and 12 existing bedrock wells and 4 newly installed and 35 existing overburden wells. Groundwater samples will be collected from all specified wells during two sampling events: once during the wet season and once during the dry season. Groundwater samples to be collected during this investigation and their designated sample numbers, along with required QA/QC sample quantities are listed in Table VI-6.

Existing overburden wells that have not been sampled within the previous 12 months at the time of sampling will be redeveloped for a period of up to 2 hours prior to sampling. In the event that the field parameters have not stabilized at the end of this time, the contracting officer will be contacted for consultation and guidance.

Table VI-6

Summary of Groundwater and QA/QC Samples
Groundwater Investigation
Former Plum Brook Ordnance Works, Sandusky, Ohio

Groundwater Sample ID	Monitoring Well ID	QA/QC Sample Quantity [a]					
		FD/FS[b]		MS/MSD[c]		FB[d]	
		Sampling Round					
		1	2	1	2	1	2
New Bedrock Monitoring Wells							
PBOW-97-GW-BG8-BEDGW-001-5410	IT-BG8-BEDGW-001	X					
PBOW-97-GW-TNTB-BEDGW-001-5420	IT-TNTB-BEDGW-001		X				
PBOW-97-GW-TNTB-BEDGW-002-5430	IT-TNTB-BEDGW-002			X			
PBOW-97-GW-MNTA-BEDGW-001-5440	IT-MNTA-BEDGW-001				X		
PBOW-97-GW-AA1-BEDGW-001-5450	IT-AA1-BEDGW-001	X					
PBOW-97-GW-AA2-BEDGW-001-5460	IT-AA2-BEDGW-001		X				
PBOW-97-GW-AA3-BEDGW-001-5470	IT-AA3-BEDGW-001						
PBOW-97-GW-ABG-BEDGW-001-5480	IT-ABG-BEDGW-001						
New Overburden Monitoring Wells							
PBOW-97-GW-AA1-GW-002-5490	IT-AA1-GW-002						
PBOW-97-GW-AA2-GW-002-5500	IT-AA2-GW-002			X		X	
PBOW-97-GW-AA3-GW-002-5510	IT-AA3-GW-002				X		X
PBOW-97-GW-ABG-GW-002-5520	IT-ABG-GW-002						
Existing Overburden Monitoring Wells							
PBOW-97-GW-ITMW01-5530	IT-MW01						
PBOW-97-GW-ITMW02-5540	IT-MW02	X			X		
PBOW-97-GW-ITMW05-5550	IT-MW05		X	X			
PBOW-97-GW-ITMW06-5560	IT-MW06	X					
PBOW-97-GW-ITMW07-5570	IT-MW07		X	X			
PBOW-97-GW-ITMW08-5580	IT-MW08				X		
PBOW-97-GW-ITMW09-5590	IT-MW09						
PBOW-97-GW-ITMW10-5600	IT-MW10						
PBOW-97-GW-TNTAMW10-5610	PB-TNTA-MW10	X					
PBOW-97-GW-TNTAMW11-5620	PB-TNTA-MW11		X				
PBOW-97-GW-TNTCMW3-5630	PB-TNTC-MW3						
PBOW-97-GW-TNTCMW4-5640	PB-TNTC-MW4	X					
PBOW-97-GW-TNTCMW5-5650	PB-TNTC-MW5		X				
PBOW-97-GW-TNTCMW6-5660	PB-TNTC-MW6						
PBOW-97-GW-WAMW1-5670	PB-WA-MW1	X					
PBOW-97-GW-WAMW2-5680	PB-WA-MW2		X				
PBOW-97-GW-PRMW7-5690	PB-PR-MW7			X		X	
PBOW-97-GW-PRMW8-5700	PB-PR-MW8	X			X		X
PBOW-97-GW-PRMW9-5710	PB-PR-MW9		X				
PBOW-97-GW-MKMW09-5720	MK-MW09						

Table VI-6

Summary of Groundwater and QA/QC Samples
Groundwater Investigation
Former Plum Brook Ordnance Works, Sandusky, Ohio

Groundwater Sample ID	Monitoring Well ID	QA/QC Sample Quantity [a]					
		FD/FS[b]		MS/MSD[c]		FB[d]	
		Sampling Round					
		1	2	1	2	1	2
Existing Overburden Monitoring Wells (con't)							
PBOW-97-GW-MKMW10-5730	MK-MW10	X					
PBOW-97-GW-MKMW11-5740	MK-MW11		X				
PBOW-97-GW-MKMW12-5750	MK-MW12						
PBOW-97-GW-MKMW14-5760	MK-MW14						
PBOW-97-GW-MKMW15-5770	MK-MW15						
PBOW-97-GW-MKMW16-5780	MK-MW16						
PBOW-97-GW-MKMW17-5790	MK-MW17						
PBOW-97-GW-MKMW19-5800	MK-MW19						
PBOW-97-GW-MKMW20-5810	MK-MW20						
PBOW-97-GW-MKMW22-5820	MK-MW22						
PBOW-97-GW-MKMW23-5830	MK-MW23						
PBOW-97-GW-MKMW24-5840	MK-MW24						
PBOW-97-GW-GCLMW01-5850	GCL-MW01		X				
PBOW-97-GW-GCLMW02A-5860	GCL-MW02A	X					
PBOW-97-GW-GCLMW02B-5870	GCL-MW02B						
PBOW-97-GW-GCLMW03-5880	GCL-MW03						
Existing Bedrock Monitoring Wells							
PBOW-97-GW-BEDMW13-5890	PB-BED-MW13						
PBOW-97-GW-BEDMW14-5900	PB-BED-MW14						
PBOW-97-GW-BEDMW15-5910	PB-BED-MW15						
PBOW-97-GW-BEDMW16-5920	PB-BED-MW16	X		X			
PBOW-97-GW-BEDMW17-5930	PB-BED-MW17		X		X		
PBOW-97-GW-BEDMW18-5940	PB-BED-MW18						
PBOW-97-GW-BEDMW19-5950	PB-BED-MW19						
PBOW-97-GW-BEDMW20-5960	PB-BED-MW20						
PBOW-97-GW-REACTOR1-5970	REACTOR1	X					
PBOW-97-GW-REACTOR2-5980	REACTOR2		X				
PBOW-97-GW-REACTOR3-5990	REACTOR3						
PBOW-97-GW-REACTOR4-6000	REACTOR4						

[a]Laboratory prepared trip blanks will be submitted for VOC samples.
[b]Field duplicate/field split.
[c]Matrix spike/matrix spike duplicate.
[d]Field blank.

During groundwater sampling, field measurements of pH, turbidity, specific conductance, dissolved oxygen, reduction-oxidation potential, and temperature will be made. These measurements will be taken prior to purging, periodically during purging, and immediately prior to sample collection.

Sampling of newly installed monitoring wells and existing wells will take place no sooner than 14 days after well development has been completed. Groundwater sampling will be completed using dedicated sampling equipment, including a disposable Teflon® bailer fitted with a bottom-emptying device and a new, clean nylon rope at each well. All equipment used to purge wells and collect samples will be protected from ground surface contact and contamination by use of clean plastic sheeting. The following procedures will be followed when collecting groundwater samples from all monitoring wells:

- The well will be checked for proper identification and structural integrity.
- After unlocking the well and removing the well cap, a photoionization detector and a hydrogen sulfide detector will be used to measure the concentration of organic vapors and hydrogen sulfide at the top of casing and in the breathing zone. If readings exceed action levels specified in Table VI.4-1 of the SSHP, safety precautions outlined in the health and safety plans will be followed.
- 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.
- Either a bailer or an appropriate submersible sampling pump will be used to remove three times the volume of the standing water in the well casing and saturated annulus.
- During purging, field measurement of pH, Eh (oxidation-reduction potential), turbidity, temperature, and conductivity will be performed periodically and logged.
- 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, turbidity, dissolved oxygen, and conductivity and logged.
- Sample containers will be labeled with appropriate identifying information (location, date, time, condition, added preservatives, etc.). 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 sample will be collected so as to minimize aeration as water enters the bottle.
- 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 metal analysis 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:
  - 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 following procedures set forth in Section 5.2 of the sitewide SAP before filtering each sample.
- All sample containers will be transferred to a cooler chest (keep at 4 degrees Celsius [°C]) and delivered to the laboratory in sufficient time so that specified holding times are not exceeded.

VI.5.0 Sample Analysis and Decontamination Procedures

VI.5.1 Sample Number System

Sample numbering system to be used during this investigation will conform to 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 GWI is described as follows:

Project Code	Year	Sample Type[a]	Site Identification[b]	Location (Well ID)	Sample Number	Sample Depth (Feet)
PBOW	97	XX	XXX	XXXX	XXXX	XXX

[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
SO - Soil

[b]Site identification (refer to page 6-3 at the sitewide SAP).

"PBOW-97-GW-BG8-BEDGW01-0235" signifies that this groundwater sample is collected from groundwater well BEDGW-001 in the G-8 Burning Ground with a laboratory number of 0235. 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).

VI.5.2 Analytical Program

All groundwater samples will be collected for target compound list (TCL) VOCs, TCL SVOCs, PCBs, total cyanide, and nitroaromatic compounds. Groundwater samples will also be analyzed for total target analyte list (TAL) metals (unfiltered) and dissolved TAL metals (filtered). In addition, groundwater samples will be analyzed by the laboratory for the water quality parameters specified in Table VI-7. Laboratory QC procedures and data quality requirements are specified in and referenced to appropriate sections of the QAPP (IT, 1996b).

VI.5.3 Decontamination Procedures

Drilling and sampling equipment decontamination will be performed to maintain integrity of the groundwater sample collected. Temporary decontamination pad(s) will be built on site in proximity to new monitoring well locations. The stations will be lined with three layers of at least 6-mil-thick Visqueen and will be bermed on all sides. The following decontamination procedures will be used to decontaminate drilling equipment, including drilling tools, equipment, and monitoring well materials, upon site entrance, between borings, and before site departure:

- Steam rinse.
- Steam wash using a brush with nonphosphate detergent.
- Steam rinse.
- Final rinse with distilled water.
- Air dry.

Groundwater sampling equipment including submersible pump and water level indicator will be decontaminated upon site entry, between wells, and before site departure following the procedures below:

Table VI-7

Summary of Groundwater Analytical Parameters and Methods
Groundwater Investigation
Former Plum Brook Ordnance Works, Sandusky, Ohio

Parameter	Analytical Method	Number of Field Samples	Field Duplicates (10%)	Matrix Spike (5%)	Matrix Spike Duplicate (5%)	Field Blank	Trip Blank	Total Number of Samples
TCL Volatile Organic Compound	8260 A	118	12	6	6	2	15	159
TCL Semivolatile Organic Compound	3520B / 8270B	118	12	6	6	2		144
Total TAL Metals	3005A / 6010A	118	12	6	6	2		144
Dissolved TAL Metals	3005A / 6010A	118	12	6	6	2		144
Nitroaromatic Compounds	Mod. 8330	118	12	6	6	2		144
PCBs	3520B / 8081	118	12	6	6	2		144
Water Quality								
Hardness	EPA 130.1	118						118
Alkalinity	EPA 310.1	118						118
Total Organic Carbon	9060	118						118
Total Dissolved Solids	EPA 160.1	118						118
Total Suspended Solids	EPA 160.2	118						118
Chloride	EPA 325.3	118						118
Total Cyanide	9010A / 9012	118						118
Nitrate	EPA 352.1	118						118
Sulfate	EPA 375.3	118						118
Column Totals		1770	72	36	36	12	15	1941

Notes:

(1) Field parameters to be performed include pH, dissolved oxygen, specific conductance, reduction-oxidation potential, turbidity, and temperature.

(2) Equipment rinsates are not required as groundwater samples will be collected using dedicated/disposable bailers.

- Wash in soapy water.
- Rinse with potable water.
- Rinse with nitric acid (10 percent solution).
- Rinse with a volume of deionized water (ASTM Type II water) five times greater than the volume of nitric acid.
- Rinse with hexane.
- Rinse with deionized water (ASTM Type II water) five times greater than the volume of hexane.
- Rinse with methanol.
- Rinse with deionized water (ASTM Type II water) five times greater than the volume of methanol.
- Air dry.

VI.6.0 Sample Preservation, Packing, and Shipping

Sample containers and caps will be new, certified as being precleaned, containers made of materials recommended by the EPA in Title 40 Code of Federal Regulations (CFR) Part 136 and SW-846 (3rd Edition). Sample containers and preservatives/preservation methods are summarized in Table 5-1 of the QAPP (IT, 1996b). 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, not the date that it is received by the laboratory.

Unless prior arrangements are made, the sample containers will be shipped to the site with necessary preservatives added, except for the bottles to be used for metal analysis. Samples for dissolved metal analysis will be prepared after the water has been filtered.

Samples for geotechnical analysis need not be chemically preserved; however, the samples will be properly sealed to prevent moisture loss and will be packaged so that the material is adequately preserved in its natural state. Samples will be placed in sample containers that will be sealed with three wraps of electrical type or duct tape around the lid lip.

Samples will be placed in coolers as soon as possible after collection and will be packed so as to minimize the possibility of container breakage by using Vermiculite or styrofoam peanuts to fill void spaces in the cooler. Samples will be cooled as promptly as feasible to a temperature of approximately 4°C and maintained at that temperature by means of blue ice from the time the shipping carton is sealed using tape and custody tape until it is received at the laboratory. Coolers will be shipped to the laboratory by a next-day-delivery service. Notification of shipment, including airbill number, will be telephoned or faxed to the laboratory the day of sample collection. If this is not possible, the laboratory will be notified the following morning.

Completed Analysis Request/Chain of Custody records will be secured and included with each shipment of coolers to:

Sample Receiving
Quanterra Environmental Services
5815 Middlebrook Pike
Knoxville, Tennessee 37921
Telephone: (423)-588-6401

or

USACE QA Laboratory - to be determined

VI.7.0 Investigation-Derived Waste Management Plan

IDW during field activities at PBOW includes drill cuttings, development water, purge water, decon water, decon fluid, and disposable personal protective equipment (PPE). IDW will be handled following the EPA guidance document EPA\540\G-\91\009, *Management of Investigation-Derived Wastes During Site Inspection* (EPA, 1991). Specifically, IDW will be managed in the following manner:

- Drill cuttings from 12 wells will be placed separately in 55-gallon sealable drums and stored on site or in the designated IDW staging area. The options of disposal of cuttings will depend on the laboratory results of drill cutting samples.
- Disposable PPE will be double-bagged and disposed of in the on-site dumpster.
- Decontamination water will be stored in 55-gallon drums and stored on site pending analytical results for proper disposal.
- Decontamination fluid as specified in Section 8.5 of the Site-Wide SAP will be kept in a stainless-steel pan and will be allowed to evaporate.
- Well development and purge water from each well will be stored separately in 55-gallon drums and kept on site pending analytical results of the water from each well for proper disposal.

Analytical parameters for drill cuttings from new monitoring wells for IDW disposal are presented in Table VI-8. For monitoring wells installed as clusters, one composite sample will be collected for disposal characteristics.

VI.8.0 Project Schedule

The project schedule is presented in Figure VI-6.

VI.9.0 References

Dames & Moore, 1996, ***Draft Report, Sitewide Groundwater Investigation, Plum Brook Ordnance Works***, May 1996.

IT Corporation (IT), 1996a, ***Sitewide Sampling and Analysis Plan, Plum Brook Ordnance Works, Sandusky, Ohio***, July 1996.

IT Corporation (IT), 1996b, ***Quality Assurance Project Plan, Plum Brook Ordnance Works, Sandusky, Ohio***, July 1996.

IT Corporation (IT), 1996c, ***Sitewide Safety and Health Plan, Plum Brook Ordnance Works, Sandusky, Ohio***, July 1996.

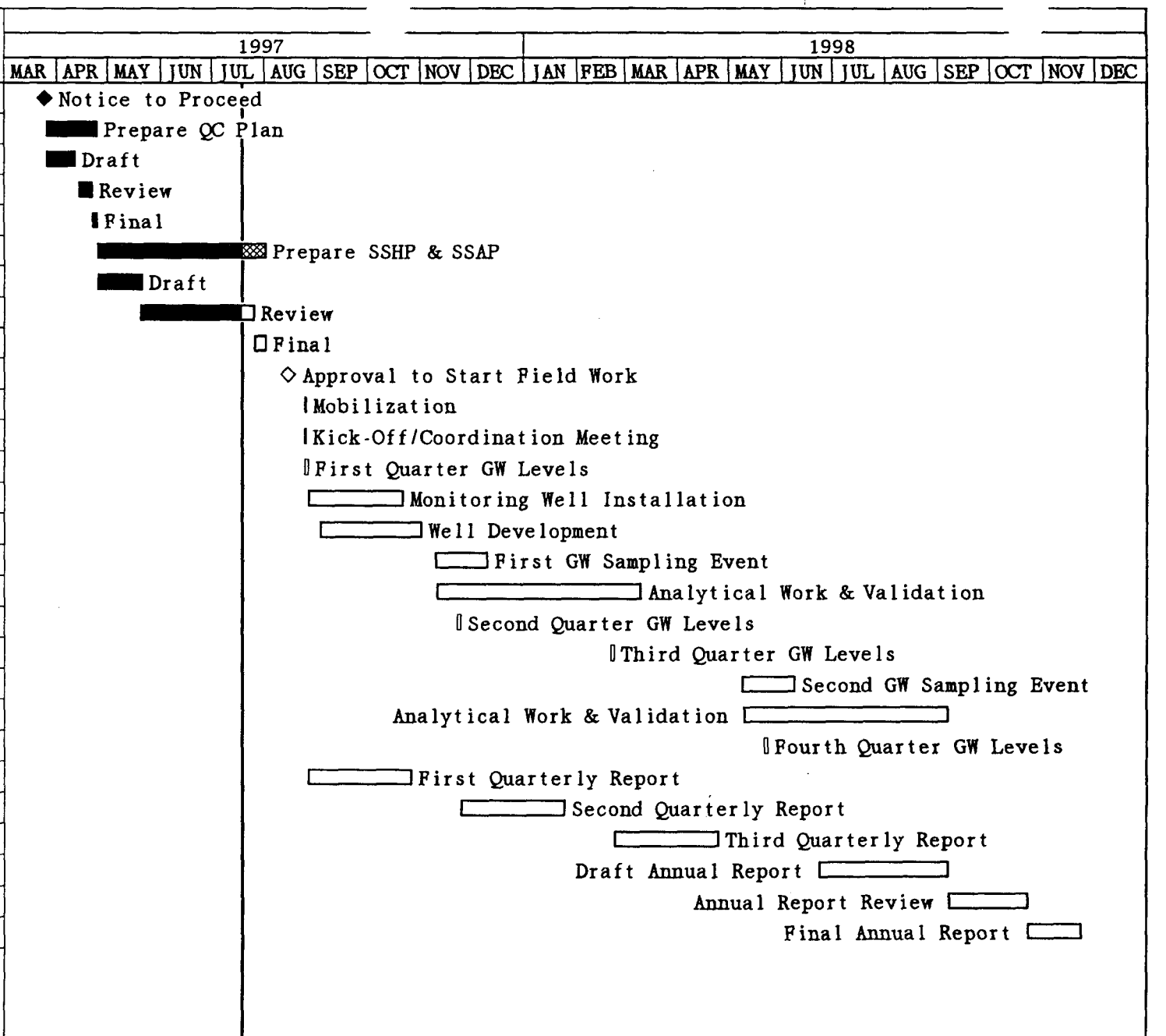
U.S. Army Corps of Engineers (USACE), 1997, ***Statement of Work***, January 1997.

Table VI-8

Analytical Parameters for IDW Disposal Monitoring Well Drill Cuttings, Groundwater Investigation Former Plum Brook Ordnance Works, Sandusky, Ohio

Parameter	Analytical Method	Number of Samples
Hazardous waste characterisitcs (ignitability, corrosivity, and reactivity)	CLP	8
TCLP volatiles	CLP	8
TCLP semivolatiles	CLP	8
TCLP metals	CLP	8

EARLY START	EARLY FINISH	REM DUR
25MAR97A		0
26MAR97A	24APR97A	0
26MAR97A	11APR97A	0
14APR97A	21APR97A	0
22APR97A	24APR97A	0
25APR97A	1AUG97	14
25APR97A	20MAY97A	0
20MAY97A	25JUL97	7
26JUL97	1AUG97	7
15AUG97		0
25AUG97	25AUG97	1
25AUG97	25AUG97	1
25AUG97	26AUG97	2
27AUG97	21OCT97	56
3SEP97	1NOV97	60
10NOV97	10DEC97	31
11NOV97	10MAR98	120
23NOV97	24NOV97	2
21FEB98	22FEB98	2
9MAY98	8JUN98	31
10MAY98	6SEP98	120
22MAY98	23MAY98	2
27AUG97	26OCT97	61
25NOV97	24JAN98	61
23FEB98	24APR98	61
23JUN98	6SEP98	76
7SEP98	22OCT98	46
23OCT98	22NOV98	31



Activity Classification: CONSTRAINT
HAMMOCK

Plot Date 23JUL97
Data Date 19JUL97
Project Start 11MAR97
Project Finish 19DEC98

(c) Primavera Systems, Inc.

Activity Bar/Early Dates
Critical Activity
Progress Bar
Milestone/Flag Activity

NCCB PBG6

Sheet 1 of 1

USACE - Nashville District
PBOW - Groundwater Investigation
Proposed Project Schedule

Date	Revision	Checked	Approved

U.S. Army Corps of Engineers (USACE), 1994, ***Monitoring Well Design, Installation, and Documentation at Hazardous and/or Toxic Waste Sites,*** EM1110-1-4000, August 1994.

U.S. Environmental Protection Agency (EPA), 1993, ***Data Quality Objectives Process for Superfund***, EPA/J40/G-93/071, Publication 9377.9.01, September 1993.

U.S. Environmental Protection Agency (EPA), 1991, ***Management of Investigation-Derived Wastes During Site Investigation***, EPA/540/G-/91/009, May 1991.

U.S. Environmental Protection Agency (EPA), 1986, ***RCRA Groundwater Monitoring Technical Enforcement Guidance Document***, OSWER 9950.1, Washington, DC, September 1986.

INTERNATIONAL TECHNOLOGY CORPORATION

DISCIPLINE SIGN-OFF REVIEW

Client Name: U.S. Army Engineer District, Nashville; CEORN-ER-M

Project Description: Site-Wide Groundwater Investigation, Plum Brook Ordnance Works

Contract Number: DACA62-94-D-0030 Delivery Order Number: 0023

Project Number: 771481 Task / Phase Number: 04000000

Document Type	Identify specific section or segment covered by this checkprint	Document Origin
☐ Technical / Cost Proposal		☐ Originator Developed
☐ RFP		☒ Edited Standard
☐ Contract / Subcontract		☐ Client Furnished
☐ SAP, SSAP, CDAP, or QAPP		
☒ SHP or SSHP	SSHP, Sitewide GWI, Rev. 1, July 1997	**Document Status**
☐ _____ Report		☐ Preliminary
☐ Risk Assessment / Evaluation		☐ Internal Draft
☐ Specifications & Plans		☐ Draft
☐ Design Calculations		☐ Draft Final
☐ Tables		☒ Final
☐ Drawings / Figures		☐ Other: _____
☐ Other: _____		

	Required Person	Signature	Date
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Checker			
Backchecker			
Updater			
Rechecker			
Technical Reviewer	H. Pullum	Jim Bolden	8-5-97
Technical Reviewer			
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Technical Reviewer			
Quality Assurance Officer	T. Smith	[illegible] for T. Smith	8/5/97
Project Manager	M. Spangberg	[illegible]	7/31/97
Program Manager	D. Burton	[illegible]	8/5/97

Attachment VI

Site-Specific Safety And Health Plan
Sitewide Investigation of Groundwater
Former Plum Brook Ordnance Works
Sandusky, Ohio

Prepared By:

IT Corporation
312 Directors Drive
Knoxville, Tennessee 37923

Submitted To:

Commander
U.S. Army Engineer District, Nashville
Post Office Box 1070
Nashville, Tennessee 37202-1070

IT Project No. 771481
Control Copy No. 12

Revision 1

July 1997

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

Reviews and Approvals

Project Manager IT Corporation	7-31-97 Date
Health and Safety Manager IT Corporation	8-5-97 Date
Site Coordinator IT Corporation	8/5/97 Date
Site Safety and Health Officer IT Corporation	Date

Distribution List

Control Copy Nos. 1 through 15	Mrs. Linda Hejazi
Control Copy No. 16	D. Burton
Control Copy No. 17	M. Spangberg
Control Copy No. 18	S. Muffler
Control Copy No. 19	G. Yu
Control Copy No. 20	T. Smith
Control Copy No. 21	D. Seymore
Control Copy No. 22	M. Smith
Control Copy No. 23	K. Arrant
Control Copy Nos. 24 and 25	Field personnel

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
Don Burton, IT Program Manager	(423) 690-3211
Mike Spangberg, IT Project Manager	(423) 690-3211
George Yu, IT Site Manager	(423) 690-3211
Melissa Smith, IT H&S Manager	(423) 690-3211
Dr. Elaine Theriault, IT Occupational Physician	(800) 299-3674

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VI.1.0 Site Work Plan Summary

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

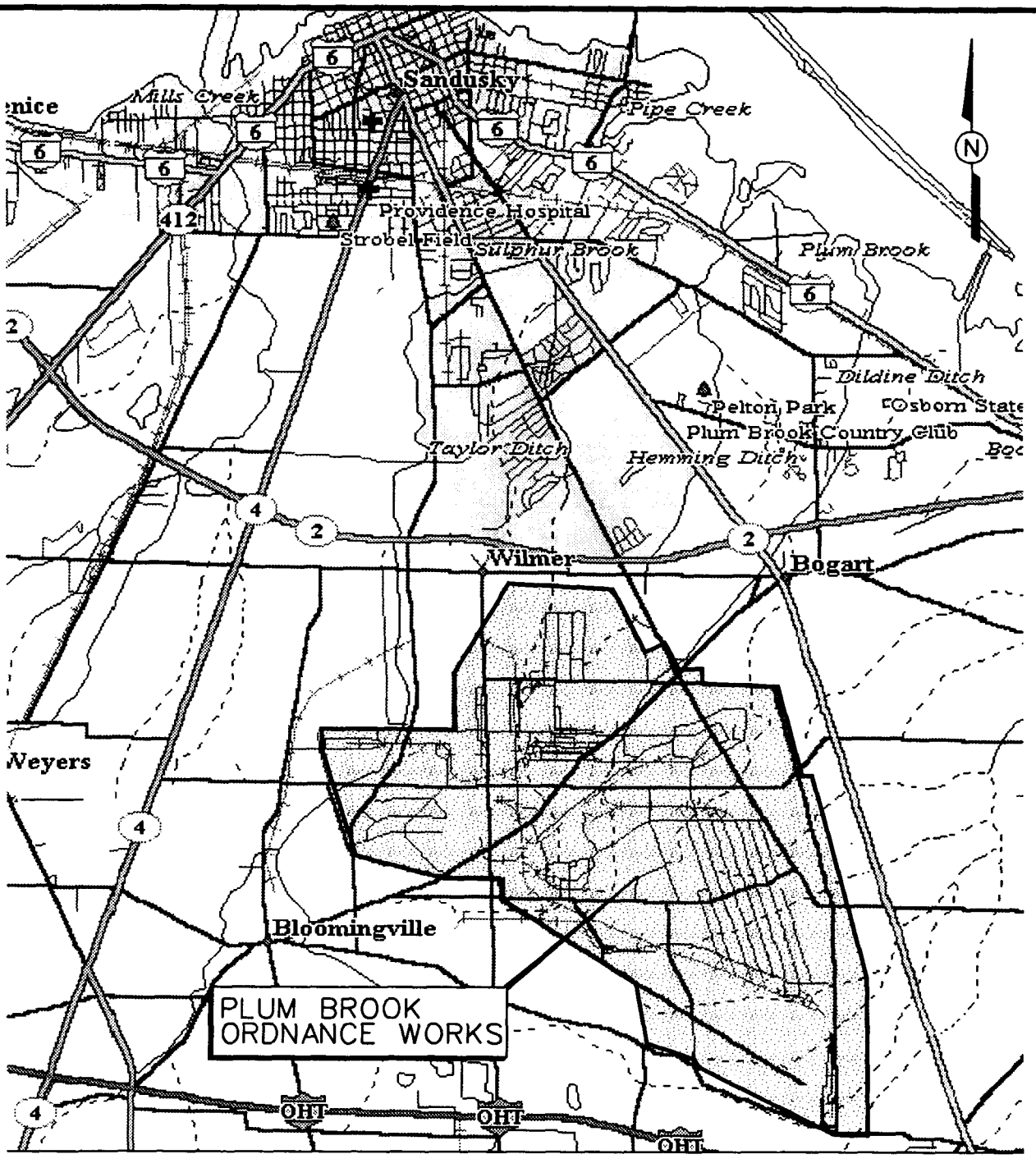
- Determine if there are hazardous substances present at the site in a manner that constitutes unacceptable risk to human health and the environment.
- Define site physical features and characteristics (aquifer background conditions).
- Evaluate fate and transport pathways (groundwater modeling).
- Determine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

Project Tasks

- Installation of monitoring wells
- Well development
- In situ permeability testing
- Monitoring well groundwater sampling
- Disposal of investigation-derived wastes
- Periodic site-wide groundwater 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 site-wide safety and health plan (SHP) for site investigations at Plum Brook, and be familiar with the requirements of this site-specific SHP (SSHP). Figure VI.1-1 presents the site and hospital location map.



NOT TO SCALE

FIGURE VI.1-1
SITE AND HOSPITAL
LOCATION MAP

PLUM BROOK ORDNANCE WORKS
SANDUSKY, OHIO

INTERNATIONAL
TECHNOLOGY
CORPORATION

STARTING DATE: 5/8/97	DATE LAST REV.: 23 JUL 9	DRAFT. CHCK. BY: R. KNIGHT	INITIATOR: M. SPANGBERG	DWG. NO.: \771484ES.004
DRAWN BY: R. KNIGHT	DRAWN BY: RKNIGHT	ENGR. CHCK. BY: M. SPANGBERG	PROJ. MGR.: D. BURTON	PROJ. NO.: 771481

771484ES.004 11:33:19 JULY 23, 1997 RMK

VI.2.0 Site Characterization and Analysis

VI.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 Job 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 chemical contaminants of concern include volatile and semivolatile chemicals listed below. Hydrogen sulfide may also be encountered in bedrock monitoring wells.

Chemical	Highest Concentration Detected in Previous Investigations (µg/L)
Benzene	1,300
Chlorobenzene	1.3
1,3-Dinitrobenzene (DNB)	0.66
2,4-Dinitrotoluene (DNT)	530
2,6-DNT	70
Ethyl benzene	180
Nitrobenzene	0.51
Toluene	800
Xylene	1,300

Table VI.2-1 contains chemicals anticipated and chemicals to be used during project activities.

VI.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 Sitewide Sampling and Analysis Plan prepared by IT Corporation in September 1996.

Table VI.2-1

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]
Acetone [67-64-1]	9.69	13–100	Inh Ing Con	Irritated eyes, nose, and throat; headache, dizziness; dermatitis.	Eye: Irrigate immediately Skin: Soap wash immediately Breath: Respiratory support Swallow: Immediate medical attention	750 ppm 750 ppm 250 ppm	1,000 ppm 1,000 ppm	PEL TLV REL	2,500 ppm
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 (10 ppm) NIC–0.1 skin 0.1 ppm	5 ppm C1 ppm (Ca)	PEL TLV REL	Ca [500 ppm]* *OSHA
Chlorobenzene	9.06	1.3	Inh Ing Con	Irritation of eyes, skin, and nose, drowsiness, incoordination, CNS depression.	Eye: Irrigate immediately Skin: Soap wash immediately Breath: Respiratory support Swallow: Immediate medical attention	75 ppm 10 ppm		PEL OLV	1,000 ppm
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
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) NIC-0.2 mg/m^3 (skin) 1.5 mg/m^3 (skin)	- - -	PEL TLV REL	Ca [50 mg/m^3)

Table VI.2-1

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]
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 125 ppm	PEL TLV REL	2,000 ppm
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	300 ppm 300 ppm Ca, lowest feasible conc. (LOQ 15 ppm)	500 ppm 500 ppm	PEL TLV REL	?
Hydrogen chloride (hydrochloric acid) [74-90-8]	10.16	43-200	Inh Ing Con	Mild irritation of the eyes, nose, and throat; drowsiness, dizziness, headache; dry, cracked skin.	Eye: Irrigate immediately Skin: Water flush promptly Breath: Respiratory support Swallow: Immediate medical attention		C5 ppm C5 ppm C5 ppm	PEL TLV REL	100 ppm
Hydrogen sulfide [7783-06-4]	10.46	0.001-0.13	Inh Con	Irritates eyes, respiratory system; apnea, coma, convulsion; conjunctivitis, eye pain, discharge of tears, visual intolerance to light; dizziness, headache, fatigue, GI disturbances.	Eye: Irrigate immediately Skin: Soap wash promptly Breath: Respiratory support Swallow: Immediate medical attention	10 ppm	C20 pm 15 ppm C10 ppm	PEL TLV REL	100 ppm
Isopropyl alcohol (isopropanol) [67-63-0]	10.16	43-200	Inh Ing Con	Mild irritation of the eyes, nose, and throat; drowsiness, dizziness, headache; dry, cracked skin.	Eye: Irrigate immediately Skin: Wash flush Breath: Respiratory support Swallow: Immediate medical attention	400 ppm 400 ppm 400 ppm	500 ppm 500 ppm 500 ppm	PEL TLV REL	12,000 ppm

Table VI.2-1

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]
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: Wash flush promptly Breath: Fresh air Swallow: Immediate medical attention		200 ppm (skin) 200 ppm (skin) 200 ppm	PEL TLV REL	25,000 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 4 ppm	PEL TLV REL	100 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/m^3 10 mg/m^3/total dust 5 mg/m^3 respirable fraction	TLV PEL/REL	
Sodium hydroxide [1310-73-2]	NA	NA	Inh Ing Con	Irritated nose; pneumonitis; burns eyes and skin; temporary loss of hair.	Eye: Irrigate immediately Skin: Water flush immediately Breath: Respiratory support Swallow: Immediate medical attention		C2 mg/m^3 C2 mg/m^3 C2 mg/m^3	PEL TLV REL	250 mg/m^3

Table VI.2-1

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]
Sulfuric acid [7664-93-9]	?	0.15	Inh Ing Con	Irritated eyes, nose, and throat; pulmonary edema, bronchitis; emphysema; conjunctivitis; stomatitis; dental erosion; tracheobronchitis; skin and eye burns; dermatitis.	Eye: Irrigate immediately Skin: Water flush immediately Breath: Respiratory support Swallow: Immediate medical attention	1 mg/m³ 1 mg/m³ 1 mg/m³	3 mg/m³	PEL TLV REL	80 mg/m³
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	100 ppm 50 ppm (skin) 100 ppm	150 ppm 150 ppm	PEL TLV REL	2,000 ppm
Xylene (o-, m-, and p-isomers) [1330-20-7;95-47-6; 108-38-3;106-42-3]	8.56/ 8.56/ 8.44	1.1–20	Inh Abs Ing Con	Dizziness, excitement, drowsiness, incoordination, staggering gait; irritated eyes, nose, throat; corneal vacuolization; anorexia, nausea, vomiting, abdominal pain; dermatitis.	Eye: Irrigate immediately Skin: Soap wash promptly Breath: Respiratory support Swallow: Immediate medical attention	100 ppm 100 ppm 100 ppm	150 ppm 150 ppm 150 ppm	PEL TLV REL	1,000 ppm

[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).
AEL = Airborne Exposure Limit.
TLV = American Conference of Governmental Industrial Hygiene (ACGIH) threshold limit value—TWA.
REL = National Institute for Occupational Safety and Health (NIOSH) recommended exposure limit.

Table VI.2-1

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

[1]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.
? = Unknown.
LEL = Lower explosive limits.
LC_{50} = Lethal concentration for 50 percent of population tested.
LD_{50} = Lethal dose for 50 percent of population tested.
NIC = Notice of intended change (ACGIH).

VI.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
Installation of monitoring wells	Modified Level D*
Well development, in-situ permeability testing, and groundwater sampling	Modified Level D*
Disposal of IDW	Modified Level D
Periodic groundwater sampling	Modified 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 H&S Manager for further assistance.

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).

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

- Permeable Tyvek, Kleenguard, or its equivalent
- Latex boot covers
- Nitrile gloves (outer)
- Latex or 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/Mine Safety and Health Agency (MSHA)-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)
- 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).

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/MSHA-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).

VI.4.0 Site Monitoring

The environmental contaminants of concern are volatile and semivolatile chemicals including benzene, chlorobenzene, 1,3-DNB, 2,4-DNT, 2,6-DNT, ethyl benzene, nitrobenzene, toluene, and xylene. Additionally, hydrogen sulfide may also be encountered in bedrock monitoring wells.

Table VI.4-1 contains action levels for site monitoring.

Monitoring will be performed by the site safety and health officer (SSHO) during the performance of invasive operations. A calibrated photoionization detector and hydrogen sulfide analyzer will be utilized to monitor the wells and breathing zones, to determine if any organic material and/or hydrogen sulfide may be present that would necessitate upgrading of protection level.

Invasive operations include disturbing existing wells, sampling wells, installation of wells, and collection of samples.

Noninvasive operations that do not disturb existing materials include site setup, decontamination, and miscellaneous support zone activities.

Table VI.4-1

Action Levels
Plum Brook Ordnance Works
Sandusky, Ohio

When in Level B PPE

Analyte	Action Level	Required Action[a,b]
Volatile organic chemicals	≥ 100 ppm above background in breathing zone (BZ)	Stop work, evacuate work area
Hydrogen sulfide	≥ 100 ppm above background in BZ	Stop work, evacuate work area

When in Level C PPE

Analyte	Action Level	Required Action[a,b]
Volatile organic chemicals	≥ 50 ppm above background in BZ	Stop work, suspend work activities for 15 to 30 minutes, if readings are sustained then upgrade to Level B PPE.
Hydrogen sulfide	≥ 10 ppm above background in BZ	Stop work, suspend work activities for 15 to 30 minutes, if readings are sustained then upgrade to Level B PPE.

When in Level D/Modified D PPE

Analyte	Action Level	Required Action[a,b]
Volatile organic chemicals	≥ 5 ppm above background in BZ	Stop activities, suspend work activities for 15 to 30 minutes, if readings are sustained then upgrade to Level C PPE.
Hydrogen sulfide	≥ 5 ppm above background in BZ	Stop activities, suspend work activities for 15 to 30 minutes, if readings are sustained then upgrade to Level C PPE.

Table VI.4-1

Action Levels
Plum Brook Ordnance Works
Sandusky, Ohio

When in Support Zone

Analyte	Action Level	Required Action
Volatile organic chemicals	≥ 1 ppm above background in BZ	Evacuate support zone and re-establish perimeter of EZ.
Hydrogen sulfide	≥ 1 ppm above background in BZ	Evacuate support zone and re-establish perimeter of EZ.

[a]Four instantaneous peaks in any 15-minute period or a sustained reading for 5 minutes in excess of the action level will trigger a response.
[b]Contact with the H&S manager must be made prior to continuance of work. The H&S manager may then initiate perimeter/integrated air sampling along with additional engineering controls.

No one is permitted to downgrade levels of PPE without authorization from the H&S manager.

VI.5.0 Activity Hazard Analysis

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

- Setup of equipment and general field activities
- Installation of monitoring wells
- Well development, in-situ permeability testing, groundwater sampling
- Disposal of IDW
- Periodic groundwater sampling.

Table VI.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.

Table VI.5-1

Activity Hazard Analysis
Plum Brook Ordnance Works
Sandusky, Ohio

Activity	Potential Hazards	Recommended Controls
Setup of equipment and general field activities (continued)	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.
	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.

Table VI.5-1

Activity Hazard Analysis
Plum Brook Ordnance Works
Sandusky, Ohio

Activity	Potential Hazards	Recommended Controls
Setup of equipment and general field activities (continued)	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.
	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.

Table VI.5-1

Activity Hazard Analysis
Plum Brook Ordnance Works
Sandusky, Ohio

Activity	Potential Hazards	Recommended Controls
Setup of equipment and general field activities (continued)	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.
	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, tornados	• 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.
Drilling and installation of monitoring wells	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.

Table VI.5-1

Activity Hazard Analysis
Plum Brook Ordnance Works
Sandusky, Ohio

Activity	Potential Hazards	Recommended Controls
Drilling and installation of monitoring wells (continued)	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 located prior to staging equipment. • Whenever the equipment is parked, the parking brake shall be set. • Equipment parked on inclines will have the wheels choked. • 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 them as ladders. • Use fall protection when working above 6 feet.
	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.

Table VI.5-1

Activity Hazard Analysis
Plum Brook Ordnance Works
Sandusky, Ohio

Activity	Potential Hazards	Recommended Controls
Drilling and installation of monitoring wells (continued)	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.
Well development permeability testing, groundwater sampling	Cross-contamination and contact with potentially contaminated materials	• Stop immediately at any sign of obstruction. • Sampling technicians will wear proper protective clothing and equipment to safeguard against potential contamination. • Only essential personnel will be in the work area. • Initial 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.
	Cut hazards	• Use care when handling glassware. • Wear adequate hand protection.
	Slip, trip, fall	• Site workers will be required to wear hard hat, safety glasses with side shields, work gloves, and steel-toe/shank boots when working in the field. • Whenever possible, avoid routing cords and hoses across walkway pathways. • Flag or cover inconspicuous holes to protect against falls.

Table VI.5-1

Activity Hazard Analysis
Plum Brook Ordnance Works
Sandusky, Ohio

Activity	Potential Hazards	Recommended Controls
Well development permeability testing, groundwater sampling (continued)	Bees, spiders, and snakes	• Workers shall inspect the work area carefully and avoid placing hands and feet into concealed areas. • Evaluate need for sensitive workers to have prescribed antibiotic or medicine to combat of symptoms.
	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.
	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.
	Access/egress hazards	• Use qualified and trained bushhog operator. • Keep employees out of the bushhog work area. • Utilize good housekeeping practices. • Keep aisleways, pathways, and work areas free of obstruction. • Clean ice or snow off of walkways or work stations. • Use appropriate footwear for the task assigned.
	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 areas.

Table VI.5-1

Activity Hazard Analysis
Plum Brook Ordnance Works
Sandusky, Ohio

Activity	Potential Hazards	Recommended Controls
Well development permeability testing, groundwater sampling (continued)	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.
Periodic groundwater sampling	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.
	Cut hazards	• Use care when handling glassware. • Wear adequate hand protection.
	Hazard communication	• MSDSs shall be obtained for chemicals brought on site. • Label all containers as to contents.
	Strains/sprains	• Use the proper tool for the job being performed. • Get assistance if needed. • Avoid twisting/turning while pulling on tools, moving equipment, etc.
	Spills/residual materials	• Absorbent material and containers will be kept available where leaks or spills may occur.
	Lighting	• Adequate lighting will be provided to ensure a safe working environment.
	Unattended worker	• "Buddy System" - visual contact will be maintained with the sampling technician during sampling activities.

Table VI.5-1

Activity Hazard Analysis
Plum Brook Ordnance Works
Sandusky, Ohio

Activity	Potential Hazards	Recommended Controls
Disposal of IDW	Forklift operation	• 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.
	Cuts, punctures, or abrasions	• Work (leather or cotton) gloves shall be worn by personnel. • The proper tool shall be utilized to open/close drums.
	Back injury	• Use mechanical equipment to lift and move items, when necessary. • Get assistance when necessary. • Size up the job. • Lift with your legs, not your back. • Do not lift awkwardly sized items and those items over 60 pounds. • If a worker loses control of item, STAND CLEAR and DO NOT try to prevent its fall.
	Pinch points	• Keep hands and feet clear of moving/suspended materials and equipment. • Wear hard toe/shank safety shoes/boots and hand protection.
	Strains/sprains	• Do not stand on drums. • Use the proper tool for the job being performed. • Get assistance if needed. • Avoid twisting/turning while pulling on tools, moving equipment, etc.
	Unattended worker	• "Buddy System" - visual contact will be maintained with the sampling technician during activities.
	Slip, trip, fall	• Site workers will be required to wear hard hats, safety glasses with side shields, work gloves, and steel-toed/shank boots when working in the field. • Whenever possible, avoid routing cords and hoses across walking pathways. • Flag or cover inconspicuous holes to protect against falls.

RESPONSE TO COMMENTS
DRAFT SITE-SPECIFIC SAMPLING AND ANALYSIS PLAN, SITEWIDE INVESTIGATION OF GROUNDWATER, FORMER PLUM BROOK ORDNANCE WORKS, SANDUSKY, OHIO

Comments of Jim Beaujon dated May 1997

Comment 1: **Pg VI-1, first paragraph: After "(DERP)" add, "Formerly Used Defense Sites (FUDS)." Change appropriate sentence to "The Former Plum Brook Ordnance Works (PBOW) in Sandusky, Ohio is a DERP FUDS project currently being managed and technically overseen by the Nashville District of USACE." Change "groundwater level investigation (GWI)" to "groundwater investigation (GWI)."**

Response 1: The paragraph has been revised as requested.

Comment 2: **Pg VI-1, second paragraph, last line: change "investigation that must be" to "investigation and must be."**

Response 2: The sentence has been revised as requested.

Comment 3: **Figure VI-1: Can Ransom Road be labeled?**

Response 3: Ransom Road is labeled on Figure VI-2, while Figure VI-1 is intended to provide the site location relative to surrounding communities. No changes made.

Comment 4: **Pg VI-2, paragraph beginning with "In 1994:" Rewrite for clarity the second, third, and fourth sentences.**

Response 4: The paragraph has been revised.

Comment 5: **Pg VI-2, paragraph beginning with "In 1994," last sentence, and Table VI-1: clarify whether these are: all the wells at PBOW; only the PBOW wells for which there are construction details; or, details only for the wells to be sampled under this SSAP.**

Response 5: The text has been revised to indicate that Table VI-1 shows existing wells that are to be sampled during the GWI. Table VI-1 has been revised to include all existing wells to be sampled.

Comment 6: **Pg VI-2, paragraph beginning with "General groundwater," last sentence, and Table VI-2: clarify whether these are: all the wells at PBOW; only the**

PBOW wells for which there is groundwater level elevation data; or, groundwater level elevations only for the wells to be sampled under this SSAP.

Response 6: The text has been revised to indicate that Table VI-2 shows available elevation data for selected existing wells that are to be sampled during the GWI. This is a smaller set of wells than the total number of wells to be sampled due to limited historical data.

Comment 7: **Pg VI-12, Section VI.4.4, second line: change "sampled with the last" to "sampled within the last."**

Response 7: The sentence has been changed.

Comment 8: **Pg VI-13, second bullet item, "If readings are above background:" It would be better to state a trigger level rather than "background."**

Response 8: The statement has been revised to "If readings exceed action levels specified in Table VI.4-1 of the SSHP..."

Comment 9: **Table VI-5: This reviewer's copy only had "Page 2 of 2" for this table.**

Response 9: Page 1 of 2 of Table VI-5 was inadvertently omitted from the draft document and has been added.

Comment 10: **Pg VI-17 and 18: the USACE Ohio River Division Lab will be closing in the near future, Please contact the project chemist, Becky Terry, for coordination.**

Response 10: The USACE QA laboratory referenced has been changed to "To be determined"; submittal of QA samples will be coordinated with Becky Terry as suggested.

Comment 11: **Pg VI-18, last sentence on page: Will the "one sample" collected for disposal characteristics be a grab or a composite sample? Composite seems to me to be more appropriate. Please clarify the text.**

RESPONSE TO COMMENTS
DRAFT SITE-SPECIFIC SAMPLING AND ANALYSIS PLAN,
SITEWIDE INVESTIGATION OF GROUNDWATER,
FORMER PLUM BROOK ORDNANCE WORKS,
SANDUSKY, OHIO

Response 11: The text has been revised to state that one composite sample will be collected.

Comments of Doug Mullendore dated May 1997

Comment 1: **Page VI-1, Section VI.1.1, 1st Sentence: change sentence to "The PBOW facility, built in early 1941, manufactured 2,4,6 trinitrotoluene (TNT), dinitrotoluene (DNT), and pentolite.**

Response 1: The sentence has been changed.

Comment 2: **Page VI-1, section VI.1.2, Last Sentence: Change sentence to "Several areas identified by previous investigations as potential areas of contamination are Reservoir Number 2 Burning Ground,...and G-8 Burning Ground.**

Response 2: The sentence has been changed as requested.

Comment 3: **Page VI-2, section VI.1.2, 1st Complete Sentence: If pesticides are a contaminant of concern why aren't we testing for them during the GWI?**

Response 3: The statement has been changed from "pesticides/polychlorinated biphenyls" to "polychlorinated biphenyls."

Comment 4: **Page VI-2, 2nd Complete Paragraph 1st Sentence: Change sentence to "The overburden unit composed of glacial outwash materials has a thickness from a few feet in the south to greater than 40 feet in some locations in the north."**

Response 4: The sentence has been changed as requested.

Comment 5: **Page VI-2, 3rd Complete Paragraph, 1st Sentence: change sentence to "In general groundwater flows in a northerly direction toward Lake Erie, in both the unconsolidated overburden material and consolidated bedrock."**

Response 5: The sentence has been revised.

RESPONSE TO COMMENTS
DRAFT SITE-SPECIFIC SAMPLING AND ANALYSIS PLAN,
SITEWIDE INVESTIGATION OF GROUNDWATER,
FORMER PLUM BROOK ORDNANCE WORKS,
SANDUSKY, OHIO

Comment 6: **Page VI-2, 3rd Complete Paragraph, 2nd Sentence: change sentence to "On the western side of the site groundwater in the overburden water bearing zone flows to the northwest, while groundwater in the bedrock aquifer flows to the northeast."**

Response 6: The sentence has been changed.

Comment 7: **Page VI-3, 1st Complete Paragraph: change paragraph to "A site visit conducted by IT project members on May 15 and 16, 1996 acquired information regarding 28 existing monitoring wells to be sampled and assessed site accessibility for new monitoring well installation. All targeted existing wells were located and appeared to be in good condition. Some wells are off-road and some are in swampy areas that require the use of an all terrain vehicle."**

Response 7: The paragraph has been revised as suggested.

Comment 8: **Page VI-4, 2nd Sentence: change sentence to "Additionally the collected data can be used to conduct a human health and ecological risk assessment, if necessary.**

Response 8: The sentence has been revised.

Comment 9: **Page VI-4, "Overview:" Change paragraph to "The data quality objectives process (DO) followed during the planing stages of the investigation evaluated data requirements needed to support the decision making process and selected the best action to satisfy these requirements. Incorporated components of the DO process, described in 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 sitewide SAP. Determining factors for procedures necessary to satisfy investigative objectives and to establish the basis of future actions at PBOW are presented in Table 3-1 and Figure 3-2 of the sitewide SAP (IT, 1996)."**

Response 9: The paragraph has been changed. See also comment 16.

RESPONSE TO COMMENTS
DRAFT SITE-SPECIFIC SAMPLING AND ANALYSIS PLAN,
SITEWIDE INVESTIGATION OF GROUNDWATER,
FORMER PLUM BROOK ORDNANCE WORKS,
SANDUSKY, OHIO

Comment 10: **Page VI-4, "Data Users and Available Data:" change paragraph to "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 or the design, including the location, number, and type of sampling necessary to "fill" the data gaps and to satisfy the data quality objectives. The SSAP, along with companion documents, provides the regulatory agencies with sufficient detail, so they can conclude whether the investigative effort is adequate to satisfy the study objectives."**

Response 10: The paragraph has been changed.

Comment 11: **page VI-5, "Conceptual Site Model," 1st Sentence: Change sentence to "Four factors considered in defining the conceptual model for the sitewide GWI are:...concern."**

Response 11: The sentence has been changed.

Comment 12: **Page VI-5, "conceptual site Model," 2nd Sentence: change sentence to "a potential source of contamination at PBOW are past TNT manufacturing activities."**

Response 12: The sentence has been changed.

Comment 13: **Page VI-5, "conceptual site Model," 4th Sentence: Change sentence to "Likely receptors at PBOW are limited to aquatic organisms in creeks and wildlife."**

Response 13: The sentence has been changed.

Comment 14: **Page VI-5, "conceptual site Model," 5th Sentence: Is this sentence only concerned with groundwater and the current use scenario" what about possible future use scenarios?**

Response 14: The sentence has been revised to indicate that it relates to the current land use.

Potential future use of the site has not been addressed here due to the proposed language in the draft consent order, but can be addressed at a later date.

Comment 15: **Page VI-5,"Conceptual site Model," 6th Sentence: change sentence to "Potential receptors near the facility include off-site water users.**

Response 15: The sentence has been changed as suggested

Comment 16: **Page VI-5,"Decision Making Process, Data Uses, and Needs:" change paragraph to "The decision making process, presented in detail in Section 3.3.3 of the sitewide SAP, consists of a seven step process which will be followed during the sitewide GWI." How can the data uses and needs for this study be presented in a previously prepared document?**

Response 16: The paragraph has been changed as requested. A table presenting the revised DQOs for the GWI, including data uses and needs, has been added to the SSAP.

Comment 17: **Page VI-5, "Risk Evaluation," Last Sentence: Switch "risk assessment" and "feasibility study."**

Response 17: The sentence has been revised as requested.

Comment 18: **Table VI-3: Include the rationale for locating the wells.**

Response 18: The rationale for well locations have been added to the table, now Table VI-4.

Comments of Becky Terry dated May 1997

Comment 1: **Page VI-iii. List of Acronyms. GWI. Change Groundwater Elevation Investigation to Groundwater Investigation.**

Response 1: The acronym definition has been changed.

Comment 2: **Page VI-4. Section VI.3.3. Second para. Be consistent with usage of EPA. Use Ohio and US EPA.**

Response 2: The sentence has been rewritten (see D. Mullendore Comment 9).

Comment 3: **Page VI-5. Section VI.3.3. Risk Evaluation. Detected contaminants from this investigation or detected contaminants from this study plus all previous investigations will be compared to the most current guidance criteria? Describe the component that make data definitive.**

Response 3: The sentence has been revised to state that detected contaminants from the GWI and previous investigations will be evaluated. Definitive data is defined by the USEPA in EPA 540-R-93-071, Data Quality Objectives Process for Superfund, which is referenced on Table VI.3.

Comment 4: **Page VI-7, Section VI.4.1.2. State the form which will be utilized for the logging of the soil classification system.**

Response 4: The statement has been revised to indicate that the HTRW Drilling Log as presented in the Site-Wide SAP will be used.

Comment 5: **Page VI-7. Section VI.4.21.2. State the section of EM 200-1-3 which lists the requirements for well development. State the criteria for stabilization in EM 200-1-3.**

Response 5: Appendix C of EM 200-1-3 provides general requirements for monitoring well development and the reference is included here as it is specifically identified in the scope of work for the GWI. The sentence has been revised to reference Appendix C of EM 200-1-3.

Comment 6: **Page VI-17. Section VI.6.0 Fourth para. Last sentence. Containers will be sealed with electrical or duct tape?**

Response 6: The referenced paragraph presents packaging requirements for geotechnical samples, which are not subject to the same packaging requirements as chemical samples. Because the geotechnical samples are to be tested for moisture content and other parameters where the natural moisture content of the sample is of importance, these containers will be sealed with electrical tape or duct tape to minimize moisture loss.

RESPONSE TO COMMENTS
DRAFT SITE-SPECIFIC SAMPLING AND ANALYSIS PLAN,
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SANDUSKY, OHIO

Comment 7: **Page VI-18. Section VI.7.0. Fourth bullet. Be specific the decontamination fluid that will be allowed to evaporate.**

Response 7: The bullet has been revised to reference Section 8.5 of the Site-Wide SAP which identifies the types of decontamination fluids that will be permitted to evaporate.

Comments of Angela Levert dated May 1997

Comment 1: **This document provides the elements specified for site-specific addenda in the Site-Wide Safety and Health Plan (September 1996).**

Response 1: No response required.

Comment 2: **Table VI.4-1. Check the application of the footnotes "a" and "b." It appears that both footnotes apply to the *Required Action* heading for Levels B, C, and D. The title block for Level D should be "when in Level D/Modified D PPE."**

Response 2: Both footnotes were added to Level B, C, and D headings as suggested. The title block for Level D was revised as suggested.

Comment 3: **Table VI.5-1. "Contact with moving equipment/vehicles" is repeated under the activity Setup of equipment and general field activities (pages 1 of 9 and 3 of 9). The second entry is more complete. Please delete the first entry.**

Response 3: The text was deleted as suggested.

RESPONSE TO COMMENTS
DRAFT SITE-SPECIFIC SAMPLING AND ANALYSIS PLAN AND HEALTH PLAN FOR THE SITEWIDE INVESTIGATION OF GROUNDWATER (ATTACHMENT VI), DATED MAY 1997
FORMER PLUM BROOK ORDNANCE WORKS, SANDUSKY, OHIO

Comments of USACE Huntington District

Comment 1: **It is noted that this document refers to the PBOW Sampling and Analysis Plan and the Quality Assurance Project Plan. It is not clear at this point whether these documents have been finalized and approved by EPA.**

Response 1: The Ohio EPA has reviewed and commented on the Site-Wide SAP on two occasions (September 5 and November 11, 1996). Comments provided were addressed and incorporated into the SAP, with formal response documents presented as an attachment to the final SAP, dated September 1996.

Comment 2: **Section VI.3.2, Objectives. The statement (...the quality of the collected data will be such that it can be used to support a human health risk assessment.) Could be revised as a bulleted item to clearly show that this is an objective,**

Response 2: The statement is intended to convey that the quality of all data collected will be of sufficient quality to support a risk assessment if necessary. As the current scope does not include conducting such a risk assessment, the stated project objectives have not been changed.

Comment 3: **Section VI.4.5, Groundwater Sampling. Decontamination procedures for the bailer and nylon rope are not clear. Will dedicated equipment be used or will this equipment be taken to the decon pad? Revise this section for clarity.**

Response 3: Disposable bailers and new nylon rope will be used at each well; therefore, decontamination of these items will not be required. The statement has been revised to clarify.

Comment 4: **Table VI-5. Part of this table is missing. Revise to include the entire table in the report.**

Response 4: The second page was inadvertently omitted and has been included.

Comment 5: **Section VI.4.5., Groundwater Sampling. Groundwater samples should be filtered in the field. Waiting until samples are taken back to the field office may alter the analytical results of the samples. Therefore, the statement that indicates that the samples will be filtered at the field office should be deleted.**

Response 5: Samples collected in the field in clean sample containers are immediately placed on ice in coolers until brought to the field office where they are filtered, preserved, and packaged for shipment. The short period of time from sample collection to filtration will have no impact on the sample quality or sample results. Conversely, filtration of samples in the field add other concerns, including power supplies for vacuum pumps used in the filtration and decontamination of filtration equipment. In addition, the use of dedicated bailers for groundwater sampling precludes the use of in-line filtering.

Comment 6: **Section VI.5.2, Analytical Program. This section should address deliverables.**

Response 6: Analytical deliverables are addressed in the QAPP and in the SOW; including them in the SSAP is not consistent with the purpose of the SSAP.

Comment 7: **Section VI.5.3, Decontamination procedures. Further explanation of the decon location is needed. Will this pad be in one fixed location on-site or will it be moved and set up next to each well? If this pad is to be in one fixed location, explain the logistics of having to return to the decon pad during sampling of a well. Will the bailer and nylon rope be returned to the decon station after each well is sampled or will dedicated sampling equipment be used?**

Response 7: The text has been revised to indicate that multiple temporary decon pads will be placed near the drilling locations. These pads will be used primarily for decontamination of drilling equipment. During groundwater sampling, disposable bailers and nylon rope will be used, thus eliminating decontamination requirements for these items. Other items, such as water level indicators and submersible pumps, will be brought to the nearest decon pad for decontamination between wells.

Comment 8: **Section VI.5.4..., Decontamination procedures. Will disassembly be required for the decontamination of any of the equipment?**

Response 8: With the exception of drilling equipment and removal of disposable tubing from the submersible pump(s), disassembly of equipment is not anticipated.

Comment 9: **Table VI-6. Explain the rationale for the number of quality control samples listed in this table. It does not appear that two field blanks are sufficient considering the number of field samples that are to be taken since field blanks should be taken at a frequency of one per day.**

Response 9: Field blanks, as defined in section 4.9.3 of the Site-Wide QAPP, are collected from the source water for the steam cleaner and the final decontamination water. Thus, two samples are normally collected during one sample event; one sample of the potable water source (used for steam cleaner) and one sample of the deionized/distilled water used for decontamination, unless multiple lots of deionized/ditilled water are used. Equipment rinsates are collected from the final decontamination rinse water from sampling equipment at the rate of one per day per sampling team. However, because sampling equipment will be disposable (i.e., used one time for collection of one sample and disposed), equipment rinsates will not be required.

Comment 10: **Table VI-6. Re: Modified Method No. 8330. In reviewing this method, it appears that the procedure does not include the low-level salting out extraction necessary for groundwater samples. This method needs revised to include this extraction procedure.**

Response 10: The reason the method is quoted as 'Modified Method 8330' in all references is due to the omission of the salting out extraction from the procedure performed. The USACE-MRD is aware of this modification and has approved the SOP as written. All USACE-MRD Performance Evaluation samples are performed using the modified method with successful results.

Comment 11: **Section VI.7.0, Investigation Derived Waste Management Plan.**

Comment 11a: **It appears that the drill cuttings will be characterized using the analytical results of water samples. It would be advisable to analyze a sample of the drill cuttings.**

Response 11a: Drill cuttings will be characterized through the collection and analysis of composite soil cutting samples collected from each well or nested well pair. Sample analysis will be as specified in Table VI-8. The text has been revised to clarify.

Comment 11b: **Define decontamination fluids. Specify whether this is water and soap or nitric acid and hexane. The nitric acid and hexane should not be allowed to evaporate.**

Response 11b: Because of the small quantities of these solvents that are to be used, and

considering that most sampling equipment will be disposable and will not require decontamination, decon water containing solvents will be placed in stainless steel pans and allowed to evaporate. This is consistent with the Site-Wide SAP (Section 8.5) which is now referenced in the text.

Comment 11c: **It is noted that purge water from existing wells will be poured onto the ground but purge water and well development water from new wells will be stored and kept on site pending analytical results for proper disposal. Has there been an agreement made to pour water from the existing wells on the ground? Explain the rationale for the difference in procedure for the water form new versus existing wells.**

Response 11c: The provision for pouring purge water from wells onto the ground has been removed. All purge and development water will be placed in 55-gallon drums and stored for characterization and disposal.

Comment 11d: **Clarify the statement (For monitoring wells installed as clusters, only one sample will be collected for disposal characteristics.) What type of sample will be collected for disposal characteristics, soil or groundwater?**

Response 11d: One composite soil sample will be collected from the monitoring well drilling cuttings; for nested well pairs, one composite sample will be collected from the cuttings from both wells. Soil cuttings will be tested for the parameters shown on Table VI-8.

Comment 12: **Table VI-7. It is not clear from Table VI-7 whether eight (8) additional groundwater samples will be taken in addition to the 118 groundwater samples listed in Table VI-6. Please clarify.**

Response 12: The title of Table VI-8 (previously VI-7) has been changed to clarify that the samples are soil cuttings from monitoring wells installed during the GWI.

	Date
ROUTING AND TRANSMITTAL SLIP	26 August 1997

TO: *(Name, office symbol, room number, building, Agency/Post)*	Initials	Date
1. Mr. Rick Meadows CELRH-ED-AE		
2.		
3.		
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5.		

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	Coordination		Justify		

REMARKS

Attached are copies of the following documents for Plum Brook Ordnance Works Delivery Order D.O. 0023, Investigation of Groundwater:

Attachment VI, Site-Specific Sampling and Analysis Plan, Sitewide Investigation of Groundwater, dated July 1997, Control Copy Nos. 12, 13, & 14

Attachment VI, Site-Specific Safety and Health Plan, Sitewide Investigation of Groundwater, dated July 1997, Control Copy Nos. 12, 13, & 14

Response to Comments

DO NOT use this form as a RECORD of approvals, concurrences, disposals, clearances, and similar actions

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Linda S. Ingram LINDA S. INGRAM CELRN-EP-R-M	Phone No. (615) 736-7122

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INTERNATIONAL TECHNOLOGY CORPORATION

DISCIPLINE SIGN-OFF REVIEW

Client Name: U.S. Army Engineer District, Nashville; CEORN-ER-M

Project Description: Site-Wide Groundwater Investigation, Plum Brook Ordnance Works

Contract Number: DACA62-94-D-0030 Delivery Order Number: 0023

Project Number: 771481 Task / Phase Number: 04000000

Document Type	Identify specific section or segment covered by this checkprint	Document Origin
☐ Technical / Cost Proposal		☒ Originator Developed
☐ RFP		☐ Edited Standard
☐ Contract / Subcontract		☐ Client Furnished
☒ SAP, SSAP, CDAP, or QAPP	SSAP, Sitewide GWI, Rev. 1, July 1997	
☐ SHP or SSHP		**Document Status**
☐ _____ Report		☐ Preliminary
☐ Risk Assessment / Evaluation		☐ Internal Draft
☐ Specifications & Plans		☐ Draft
☐ Design Calculations		☐ Draft Final
☐ Tables		☒ Final
☐ Drawings / Figures		☐ Other: _____
☐ Other: _____		

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