Final
Summary Report
Site-Wide Groundwater Monitoring (1997-1998)
Former Plum Brook Ordnance Works, Sandusky, Ohio

Volume I
Text, Tables, and Figures

Submitted to:

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Project Number 771481

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Revision 1

Draft
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Former Plum Brook Ordnance Works, Sandusky, Ohio

Supplement I
Sample Collection Logs

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List of Acronyms

AA1	Acid Area 1
AA2	Acid Area 2
AA3	Acid Area 3
ABG	Additional Burning Ground
BG8	G-8 Burning Ground
bgs	below ground surface
BNA	base neutral/acid extractable compound
BTEX	benzene, toluene, ethyl benzene, and xylene
COPC	chemical(s) of potential concern
CRQL	contract-required quantitation limit
D&M	Dames and Moore, Inc.
DCE	dichloroethene
DERP	Defense Environmental Restoration Program
DI	dionized water
DNB	dinitrobenzene
DNT	dinitrotoluene
DO	dissolved oxygen
DOD	U.S. Department of Defense
DQE	data quality evaluation
DQO	data quality objective
Eh	oxidation-reduction potential
EPA	U.S. Environmental Protection Agency
ft/day	feet per day
ft/ft	foot per foot
FUDS	Formerly Used Defense Sites
gpm	gallons per minute
GSA	General Services Administration
GWI	groundwater investigation
HI	hazard index
HRS	Hazard Ranking System
HSA	hollow-stem auger
ICI	International Consultants, Inc.
ID	inside diameter
IDL	instrument detection limit

List of Acronyms *(Continued)*

IT	IT Corporation
µg/L	micrograms per liter
µm	micrometer
MK	Morrison Knudsen Group
MNTA	Maintenance Shop Area
msl	mean sea level
NASA	National Aeronautics and Space Administration
NCP	National Contingency Plan
NGVD	National Geodetic Vertical Datum
OD	outside diameter
ODNR	Ohio Department of Natural Resources
OEPA	Ohio Environmental Protection Agency
PBOW	Plum Brook Ordnance Works
PBS	Plum Brook Station
PCB	polychlorinated biphenyl
PID	photoionization detector
PRRWP	Pentolite Road Red Water Ponds
PVC	polyvinyl chloride
QAPP	quality assurance project plan
QA/QC	quality assurance/quality control
RA	risk assessment
RBC	risk-based concentration
RME	reasonable maximum exposure
RRF	relative response factor
SAIC	Science Applications International Corporation
SAP	sampling and analysis plan
SCEM	site conceptual exposure model
SCS	Soil Conservation Service
SVOC	semivolatile organic compound
TCA	trichloroethane
TNB	trinitrobenzene
TNT	trinitrotoluene
TNTA	TNT Area A

List of Acronyms *(Continued)*

TNTB	TNT Area B
TNTC	TNT Area C
TOC	top of casing
VOC	volatile organic compound
USACE	U.S. Army Corps of Engineers
USGS	U.S. Geological Survey
WARWP	West Area Red Water Ponds

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Executive Summary

Site Description. The Former Plum Brook Ordnance Works (PBOW) was built in early 1941 as a manufacturing plant for 2,4,6-trinitrotoluene (TNT), dinitrotoluene (DNT), and pentolite. Production of explosives began in December 1941 and continued until 1945. It is estimated that more than one billion pounds of explosives were manufactured during the 4-year operation period.

After the plant was shut down, decontamination of TNT, acid, pentolite, and DNT processing lines began and were completed during the last quarter of 1945. The property was initially transferred to the 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 (GSA).

The National Aeronautics and Space Administration (NASA) acquired the PBOW on March 15, 1963 and is presently utilizing the site. On April 18, 1978, NASA declared approximately 2,152 acres of land as excess. The Perkins Township Board of Education acquired 46 acres of the excess and uses this area as a bus transportation center. GSA retains the remaining acreage and currently has a use agreement with the Ohio National Guard for 604 acres of the land. NASA presently controls about 6,400 acres and is using the site to conduct space research as a satellite operation of NASA's LERC in Cleveland Ohio. The details of these land transactions are listed in the site management plan and can be found at the NASA PBS.

Historical Activities. Previous investigations of site hydrogeology and groundwater contamination were documented in the Contamination Evaluation Report (IT, 1991), the Site Inspection Report (MK, 1994), the Site Management Plan (ICI, 1995), the Site-Wide Groundwater Investigation Draft Report (D&M, 1996) and the Site-Wide Groundwater Investigation Report (IT, 1996).

In 1989, IT conducted the contamination evaluation focusing on areas associated with past DOD operations at PBOW. As part of the investigation, four groundwater monitoring wells were installed in the overburden water-bearing zone.

A site inspection was conducted at PBOW by MK from June through July 1993. The purpose of the site inspection was to collect information concerning conditions to assess the threat posed to

human health and the environment and to determine the need for any addition investigation. A total of 13 monitoring wells were installed in the overburden water-bearing zone in multiple areas.

From May to June of 1995, D&M conducted a groundwater investigation of the overburden and bedrock water-bearing zones. The objectives of the D&M investigation were as follows:

- Evaluate groundwater occurrence and flow conditions in the overburden and bedrock water-bearing zones;
- Assess the groundwater quality in the overburden water-bearing zone and at the Red Water Ponds and TNT Manufacturing Areas;
- Investigate on a sitewide basis ~~based~~ the baseline groundwater quality of the bedrock water-bearing zone;
- Evaluate the necessity of additional work at PBOW.

A total of 11 monitoring wells were installed in the bedrock water-bearing zone and 8 wells were placed in the bedrock water-bearing zone. Groundwater samples were also collected from 25 wells.

In September 1995, ICI issued a site management plan for PBOW. The objectives were to describe the regulatory framework, site setting, site investigations and results, and management objectives of the PBOW.

IT conducted a site-wide groundwater investigation at the former PBOW from September through October 1996. This work included installation of overburden monitoring wells, redevelopment of the existing monitoring wells, and collection and analysis of groundwater samples to acquire supplementary data of site-wide groundwater levels and contaminants to add to an existing database, and to fill in existing data gaps in groundwater levels and contamination in the western portion of PBOW.

Current Status of Overburden Water-Bearing Zone. The overburden water-bearing zone at PBOW has been impacted by organic and/or explosive contaminants to different extents by past site activities. Nitroaromatic compounds, explosive residues, and SVOCs have significantly impacted the West Area Red Water Pond and the Pentolite Road Red Water Pond areas. Lesser impacts by nitroaromatic compounds are evident at TNTA and TNTB, with bis(2-

ethylhexyl)phthalate also exceeding RBCs at TNTA. Two areas, the Upper Toluene Area and the Maintenance Area, have exhibited impacts by non-explosive organic contaminants at levels well above the RBCs. Lower levels of organic contaminants are evident at TNTC, AA2, the ABG, the Snake Road Burning Grounds, at the Lower Toluene Area. Analytical results from sampled overburden monitoring wells indicated that AA1, AA3 and the Reactor Building do not show organic or explosives contaminants at levels that would pose unacceptable risk to human health.

Five areas, TNTC, AA3, the ABG, the Snake Road Burning Ground and the Upper Toluene Tanks Area, exhibited only dissolved iron, manganese and/or nickel at concentrations exceeding RBCs. Dissolved iron and manganese were detected at concentrations exceeding the RBCs at AA1 and the Lower Toluene Area. Larger suites of inorganic compounds were detected in wells from the West Area Red Water Pond, the Pentolite Road Red Water Pond, TNTA, and TNTB. The overburden water-bearing zone did not exhibit dissolved inorganic compounds exceeding RBCs for three areas; AA2, the Maintenance Area, and the Reactor Facility. Many total metals were determined to exceed RBCs in overburden wells; however, many of these metals were due to suspended solids in the unfiltered sample and were therefore not attributable to site contamination.

Overburden Geologic and Hydrogeological Conclusions. Groundwater flow in the overburden is predominantly to the north-northeast. The general flow direction in the overburden aquifer largely mirrors the surface topography and is strongly correspondent to the topography of the top of the bedrock; thus, groundwater on the western side of the site flows toward a groundwater low. Groundwater elevation fluctuations are very similar among overburden wells which may imply a high degree of connectivity between the site wells. Another possibility is that the overburden water-bearing zone has a higher vertical hydraulic conductivity than assumed and the water levels in the overburden are directly influenced by changes in the bedrock water-bearing zone water levels. Slug test results reveal significant variability in the overburden water-bearing zone hydraulic conductivities across the site, possibly implying the water-bearing zone is not a single hydrogeologic unit.

Current Status of Bedrock Water-Bearing Zone. The bedrock water-bearing zone at PBOW has been impacted by organic and/or explosive contaminants to different extents by past site activities, although to a lesser degree than the overburden. Nitroaromatic compounds and SVOCs have impacted the WARWP, while VOCs have impacted the bedrock wells at the

PRRWP. Lesser impacts by nitroaromatic compounds are evident at TNTA, AA1, AA2 and the Maintenance Area. VOCs have also impacted the bedrock water-bearing zone at TNTC, AA2, and the Upper Toluene Tanks Area; SVOCs also exhibit impacts on water quality at the upper Toluene Tanks Area. Two areas, the ABG and BG8, did not exhibit organics or explosives at concentrations exceeding RBCs.

Dissolved concentrations of barium and manganese were commonly detected at concentrations exceeding RBCs in most areas of PBOW. Other less frequently detected metals exceeding RBCs in the bedrock water -bearing zone include arsenic, iron, thallium, and vanadium. Only two areas, the WARWP and AA3, lacked any detected dissolved inorganic compound at concentrations exceeding RBCs.

Bedrock Geologic and Hydrogelogical Conclusions. Groundwater flow in the bedrock is predominantly to the north-northeast. Little groundwater elevation fluctuation occurred over time in the wells monitoring the Ohio Shale and the Olentangy Shale; however, wells monitoring the Delaware Limestone showed significant variability. There is a similar groundwater elevation fluctuation between wells REACTOR 1, 2, 3, and PB-BED-MW13 located on the west side of PBOW along a bedrock low coming from the Reactor Building Area.

Slug tests revealed that the Ohio Shale had the highest hydraulic conductivity of the three bedrock units tested at approximately 20 ft/day. The Delaware Limestone and Olentangy Shale had hydraulic conductivities of three orders of magnitude lower.

Quarries mining the Delaware Limestone in the vicinity of PBOW have some minor natural hydrocarbon. This is evident in PBOW wells monitoring the bedrock based on drilling notes, H_2S readings, and BTEX compounds detected in the groundwater.

In general, there is a downward vertical gradient from the overburden to the bedrock in the western and northern portions of the site. The greatest groundwater elevation difference was 25 feet in overburden/Delaware Limestone pair IT-AA1-GW002/IT-AA1-BED-GW001 located in the north central portion of the site. In contrast, the central and southern portions of the site showed very similar groundwater elevations in overburden/Ohio Shale pairs. This may indicate a high degree of connectivity between groundwater in the overburden and Ohio Shale.

Peaks in calculated recharge rates appear to correlate with groundwater highs taking into account a lag time. Similarly, lows in recharge rates correspond somewhat (taking into account the lag time) with lows in the groundwater.

Recommendations. The following additional investigations are recommended:

- Determination of the site-specific reference levels for VOC constituents (benzene, toluene, ethyl benzene and xylenes) and background concentrations for metals in the bedrock water-bearing zone.
- Investigation of bedrock water-bearing zone at the Middle Toluene Tank Area.
- Completion of a three-dimensional groundwater fate and transport model utilizing data generated during the site-wide groundwater investigation as well as pertinent historical data to aid in bedrock groundwater monitoring.
- Completion of a human-health risk assessment for site-wide groundwater to define contaminants of concern and to aid in determining whether additional sampling or remedial actions are warranted.
- Complete a residential/agricultural well survey to determine potential off-site receptors; sampling of downgradient off-site wells within proximity of the site should be considered.

1.0 Introduction

The U.S. Army is conducting studies of the environmental impact of suspected hazardous waste sites at properties previously owned by the U.S. Department of Defense (DOD). 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), located in Sandusky, Erie County, Ohio, is an Army DERP FUDS project and is being managed and technically overseen by the USACE-Nashville District Office (CELRN). Figure 1-1 shows the geographical location of the former PBOW site. IT Corporation (IT) was contracted by the CELRN to conduct a Site-Wide Groundwater Investigation (GWI) at PBOW under Delivery Order 0023 of Contract Number DACA62-94-D-0030. Field activities associated with the GWI were conducted between August 1997 and May 1998.

This summary report assimilates data generated during four quarterly monitoring events. Results of the first three quarterly events were previously presented in:

- *First Quarterly Groundwater Level Measurement Report* (October 1997).
- *Second Quarterly Groundwater Level Measurements and First Semi-Annual Groundwater Sampling Event* (May 1998).
- *Third Quarterly Groundwater Level Measurements* (September 1998).

1.1 Objectives and Scope of Work

The objectives of this investigation included the following:

- Determine if there are hazardous substances present at the site at concentrations that may constitute unacceptable risk to human health or the environment.
- Define site physical features and characteristics.
- Collect, evaluate, and tabulate groundwater data to facilitate a scope of work to be written for a groundwater modeling effort at the site.
- Determine current and future routes of exposure.

The scope of the groundwater investigation included a site visit and records review, the preparation of site-specific work plans, monitoring well installations, groundwater sampling, land surveying, analytical work, and report preparation. This report presents the information

presented in three prior quarterly (seasonal) reports, as well as new data obtained as part of the fourth quarterly investigation. This information, in conjunction with recently acquired and interpreted soil, geological, hydrogeological, and climatological information, was then used to more accurately define the site conceptual model.

A major portion of this investigation effort consisted of the collection and interpretation of water level measurements. The purpose for the collection of the quarterly groundwater level measurements was to provide temporal as well as spatial data for evaluating the groundwater flow regime in both overburden and bedrock water-bearing zones. The quarterly water level measurement data help to determine the seasonal fluctuation of groundwater levels and the hydraulic connectivity between the two water-bearing zones.

Another important aspect of this investigation consisted of the collection and interpretation of groundwater samples from a select group of site wells. These two semi-annual groundwater sampling events were conducted to acquire chemical analytical data for constituents such as nitroaromatics, volatile organic compounds (VOC), semivolatile organic compounds (SVOC), metals, etc. and water quality data (sulfate, alkalinity, etc.) on a sitewide basis. Chemical analytical data were collected to determine if there are hazardous substances present at the site in a manner that constitutes unacceptable risk to human health. Ecological risk is addressed at PBOW on a site-specific basis. Ecological risk assessments are currently in progress at TNT Area B (TNTB) and both the Pentolite Road Red Water Ponds (PRRWP) and the West Area Red Water Pond (WARWP) Areas. Risk-based concentrations (RBC) are used to determine human health chemicals of potential concern (COPC) at PBOW as presented in the site-specific sampling and analysis plan (SSAP) approved by the Ohio Environmental Protection Agency (OEPA). Both the chemical analytical data and the water quality data collected as part of this investigation will also support contaminant fate and transport calculations, groundwater modeling efforts, and/or assessment of remedial activities.

1.2 Facility Location and Description

The former PBOW site is currently owned by the National Aeronautics and Space Administration (NASA) and is operated as the Plum Brook Station (PBS) of the NASA John Glenn Research Center at Lewis Field based in Cleveland, Ohio. Most of the aerospace testing facilities built in the 1960s at the site are in standby or inactive status. The site is located approximately 4 miles south of Sandusky, Ohio and 59 miles west of Cleveland (Figure 1-2). Although primarily in Perkins and Oxford Townships, the eastern edge of the site extends into Huron and Milan Townships. PBOW is bounded on the north by Bogart Road, on the south by

Mason Road, on the west by County Road 43, and on the east by U.S Highway 250. The areas surrounding PBOW are mostly agricultural and residential.

Public access is restricted at PBOW except during the annual deer hunting season.

1.3 Site History and Potential for Contamination

The 9,009-acre PBOW site was built in early 1941 as a manufacturing plant for 2,4,6-trinitrotoluene (TNT), dinitrotoluene (DNT), and pentolite. Production of explosives began on December 16, 1941 and continued until 1945. It is estimated that more than one billion pounds of explosives were manufactured during the 4-year operating period.

After the plant was shut down, decontamination of TNT, acid, pentolite, and DNT processing lines began and was completed during the last quarter of 1945. The property was initially transferred to the 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 (GSA).

NASA acquired the PBOW on March 15, 1963 and is presently utilizing the site. On April 18, 1978, NASA declared approximately 2,152 acres of land as excess. The Perkins Township Board of Education acquired 46 acres of the excess and uses this area as a bus transportation center. GSA retains the remaining acreage and currently has a use agreement with the Ohio National Guard for 604 acres of the land. NASA presently controls about 6,400 acres and is using the site to conduct space research as a satellite operation of NASA's John Glenn Research Center at Lewis Field in Cleveland, Ohio. The details of these land transactions are listed in the site management plan and can be found at the NASA PBS.

Potential contaminants in the groundwater at PBOW, based on review of historical use of the site and findings of previous investigations, may include nitroaromatic compounds, VOCs, SVOCs, cyanide, and metals.

2.0 Physical Setting

2.1 Geography, Topography, and Surface Drainage

PBOW is located within the Eastern Lake Region of the Central Lowland Province (Soil Conservation Service [SCS], 1971). Erie County is overlain by lake, glacial outwash, and glacial till sediment. The surface is a plain with a slight slope to the north-northeast toward Lake Erie at approximately 25 feet per mile (Figure 1-2). Elevations at the site range from 680 feet above mean sea level (msl) at the intersection of Taylor Road and Patrol Road on the western side of the site to 625 feet msl at the northern portion of the installation. In general, the topography of PBOW is characterized by a flat ground surface with occasional low hummocks influenced primarily by glacial scouring and deposition. A low escarpment trends from the western to the northeastern portion of the site.

PBOW lies in the eastern region of the Pickeral Creek-Pipe Creek Basin, which is part of the St. Lawrence River drainage basin (Dames and Moore, Inc. [D&M], 1997). Eleven streams exist within the site and flow north-northeast toward Lake Erie, which is located approximately 3.5 miles north of the site. The three main streams at the site, Plum Brook, Ransom Brook, and Pipe Creek, are being monitored by NASA PBS. The site is part of four drainage areas: (1) Sawmill Creek (southern PBOW); (2) Plum Brook (central PBOW); (3) Pipe Creek (western PBOW); and (4) Storrs-Hemminger Ditch, all of which flow into Sandusky Bay (D&M, 1997). The drainage pattern is dendritic where streams are incised into bedrock and poorly developed where they have not yet downcut to the bedrock. In addition to streams seventeen isolated ponds and reservoirs and former red water ponds are located at PBOW (IT, 1996a; D&M, 1997).

2.2 Geology and Soils

2.2.1 Regional Geology

The bedrock in northern Ohio consists of Devonian and Silurian carbonates (limestone and dolomite) and clastics (shale, siltstone, and sandstone). These units unconformably overlie older sedimentary sequences of Ordovician and Cambrian Age rocks which in turn unconformably overlie Pre-Cambrian basement rocks (D&M, 1997). The local bedrock is situated on the eastern flank of the Findlay Arch. Beds in the vicinity of PBOW dip to the southeast at an angle of approximately 10 to 30 feet per mile. In the Devonian and Silurian carbonate of northern and western Erie County weathering of the carbonates has produced cavernous porosity and karst topography.

2.2.2 Local Geology

Three formations, all of Devonian Age, are shown on the regional geologic map (Figure 2-2). Each of the units discussed below were encountered in the upper 100 feet of the bedrock at PBOW along the lines of section presented in Figure 2-2, and on cross-sections shown on Figures 2-3 through 2-7, respectively. The top of bedrock elevation map is presented on Figure 2-8.

The Delaware Limestone is the lowermost formation screened by site wells. It is characterized as a hard, dense, finely crystalline limestone and dolomite. Dissolution of this unit has been described which has produced solution channels along bedding planes and joints, and has even produced caverns in some areas. The unit is typically buff colored and usually is described as fossiliferous. In the vicinity of PBOW, quarries mine limestone from the Delaware. Traces of natural petroleum-derived benzene, toluene, ethyl benzene, and xylene (BTEX) and hydrogen sulfide (H_2S) are common in area quarries (BTEX in Quarry Teleconference, Appendix A). Overlying the Delaware Limestone is the Olentangy Shale. Two members of the Olentangy Shale have been characterized at the site, the Plum Brook Shale and the overlying Prout Limestone. The Plum Brook Shale is interpreted to consist of approximately 35 feet of bluish-gray, soft, fossiliferous shale containing thin layers of dark, hard, fossiliferous limestone. The Prout Limestone has been described as a 15 feet thick unit which occasionally outcrops in a 1,000 to 2,000 foot-wide, northeast striking band across the middle portion of PBOW. It has been described as a dark-gray to blue, very hard, siliceous, fossiliferous limestone or dolomitic mudstone. The uppermost formation at the site is the Ohio Shale. Only one member of the Ohio Shale is present in the PBOW area – the Huron Shale. This unit has been described as black, thinly bedded, with abundant carbonaceous matter. Some large pyrite/carbonate concretions are also present in the Huron Shale with some as large as 6 feet in diameter (D&M, 1997).

2.2.3 Local Soils

The bedrock overburden in Erie County is predominantly glacial till, glacial outwash, or glacial lacustrine (lake) deposits. In the vicinity of PBOW, the soil has been interpreted to be lacustrine. In many areas, the overburden also consists of highly weathered bedrock. The thickness of the overburden ranges from 1 to greater than 25 feet. As shown on Figure 2-9, the overburden is thickest on the northern portion of the site in the vicinity of the Reactor Building Area where it has filled in the bedrock low that is located in the same area.

The 1971 SCS Soil Survey of Erie County mapped four soil associations on PBOW (in the order of areal percentage) as the Prout, Arkport-Galen, Del Rey-Lenawee, and the Lewisburg (SCS,

1971). More recently, the Ohio Department of Natural Resources revised the soil associations in the county which also changed the soil associations at PBOW. The revised survey is not ready for publication, but a document called the Progress Report was issued in 1994 (Ohio Department of Natural Resources [ODNR], 1994). As shown in the 1994 report, the soil in the northwest portion of the site is now placed within the Kibbie-Elnora-Tuscola-Colwood Association which is described as nearly level to gently sloping. The drainage ability of the soil is presented as somewhat poorly drained, moderately well drained, and very poorly drained soils formed in outwash, lacustrine, and deltaic sediments. Along a strip from west to northeast across the site is the Castalia-Millsdale-Milton-Ritchey Association. It is described as a shallow to moderately deep, nearly level to moderately steep, well-drained and very-poorly drained soils formed in glacial till, lacustrine sediments, and limestone residuum. Across much of the central portion of the site is the Hornell-Fries-Colwood Association. It is described as moderately deep to deep, nearly level to gently sloping, somewhat poorly drained to very poorly drained soils formed in glacial till and lacustrine sediments over shale bedrock. At the extreme southeast portion of PBOW is the Pewamo-Bennington Association. It is described as nearly level, to gently sloping, very-poorly drained, and somewhat poorly- drained soils formed from glacial till and lacustrine sediments.

2.2.4 Hydrogeology

2.2.4.1 Current Groundwater Usage

The majority of residents in Erie County receive water from public utilities which receive most of their water from surface water sources. Residences to the north and east of PBOW are connected to city, county, or rural services. Five percent of the county residents obtain groundwater from private wells. Erie County's primary groundwater source is the limestone and dolomite found in the western end of the county. Groundwater wells in the central and eastern portions of the county tap lower yielding shale and sandy zones in the overburden (D&M, 1997). Some wells surrounding PBOW are used for agricultural purposes including irrigation, which could have an effect on drawdown near the site (International Consultants, Inc. [ICI], 1995). A few wells in the vicinity of PBOW were determined to be used for private and public consumption (Science Applications International Corporation [SAIC], 1991); however, none are used within the facility boundary.

2.2.4.2 Regional Hydrogeology

Regional groundwater flow is to the north-northeast towards Lake Erie, although local flow may vary due to local topography. The water in the limestone typically occurs in joints and along bedding planes or in solutionally enlarged openings. Although some limestones in the middle of the county provide well yields of up to 500 gallons per minute (gpm), the overburden and the majority of the other formations can sustain groundwater pumping of only 10 gpm or less (D&M, 1997). A hydrogeological study by the U.S. Geological Survey (USGS) conducted on the glacial deposits in Sandusky in 1990 reported a horizontal hydraulic conductivity of 0.046 foot/day and a vertical hydraulic conductivity of 1.2 feet per day (IT, 1996a).

2.2.4.3 General Site Hydrogeology

At PBOW, the groundwater has been divided into three zones based on location and yield. Zone one occurs in the north and northwestern portion of PBOW. It has been characterized as yielding from 100 to 500 gpm from karst limestone approximately 100 feet below grade. Zone two is in the northern portion of PBOW and has yields of 15 gpm or less from limestone approximately 300 feet below grade. Zone three has the lowest yields and is located in the eastern and southern portion of the site in predominantly shale bedrock. In addition to being found in the shale, groundwater is located in thin sand and gravel horizons interbedded with silt and clay depositions. Most of the Zone three wells are poor yielding with many of them providing less than 3 gpm (D&M, 1997).

The two main water-bearing zones at PBOW are the overburden and the bedrock. The general flow direction in the overburden aquifer is to the north-northeast largely mirroring the surface topography. The flow is also somewhat correspondent to the topography of the top of the bedrock. Some of the groundwater overburden wells become dry at certain times of the year (IT, 1997c). In contrast, the bedrock water-bearing zone is saturated year-round. The conceptual model of the site is that the groundwater flow in the bedrock water-bearing zone migrates and is influenced by the frequency, orientation, density, and connectivity of the fractures. Similar to the overburden flow direction, groundwater in the bedrock flows to the north-northeast. A more detailed discussion of the hydrogeological information obtained as part of the four quarterly investigations is presented in Section 6.0.

2.3 Climatological Setting

The climate for Erie County is continental with cold and cloudy winters and warm, humid summers. The county's first freezing temperature is typically in October, and its last freezing temperature is typically in April. Average annual precipitation for Sandusky from 1961 to 1990

was 34.05 inches. Within that time period, February had the lowest mean monthly rainfall average with 1.65 inches, whereas July had a high of 3.70 inches. The weather changes every few days as cold fronts move through the region. Wind is from the southwest 55 percent of the time (Morrison Knudsen Group [MK], 1994; D&M, 1997). A discussion of more recent climatological data obtained as part of this investigation are presented in Section 6.1.4.

3.0 Summary of Previous Environmental Studies

Previous investigations of site hydrogeology and groundwater contamination were documented in the Contamination Evaluation Report (IT, 1991), the Site Inspection Report (MK, 1994), the Site Management Plan (ICI, 1995), the Site-Wide Groundwater Investigation Draft Report (D&M, 1996), and the Site-Wide Groundwater Investigation Report (IT, 1997c).

In 1989, IT conducted the contamination evaluation focusing on areas associated with past DOD operations at PBOW while under contract for the CELRN. The objective of this preliminary evaluation was to confirm or deny the presence of residual chemical contamination from operational activities conducted at the site during DOD operations. As part of the investigation, four groundwater monitoring wells were installed in the overburden water-bearing zone at locations shown on Figure 2-2. IT-MW01 was placed at the intersection of West Scheid Road and Patrol Road to monitor the quality of groundwater entering the site. IT-MW02 and IT-MW05 were installed in the presumed downgradient locations close to Waste Disposal Areas 2 (also known as West Area Red Water Ponds) and 1 (also known as Pentolite Road Red Water Ponds), respectively. IT-MW06 was located near the northern perimeter of the site and monitors the quality of groundwater exiting the site. Groundwater samples were collected and analyzed for VOCs, SVOCs, nitroaromatic compounds, nitrates, sulfates, and metals. Analytical results indicated that several VOCs, SVOCs, and nitroaromatics were present at concentrations in the low parts per billion range, including acetone, carbon disulfide, 2,6-DNT, and 2,4-DNT. Chromium, manganese, and sulfate were also detected in some groundwater samples at elevated concentrations. The contamination evaluation concluded that these detected organic and inorganic compounds in groundwater represented groundwater contamination from past activities at the facility. The Hazard Ranking System (HRS) score was calculated for the site based on the results of this evaluation. The HRS score was zero because there were no target users of impacted groundwater or surface water within 3 miles of the site.

A site inspection was conducted at PBOW by MK from June through July of 1993 under contract to NASA. The purpose of the site inspection was to collect information concerning conditions at the PBS facility sufficient to assess the threat posed to human health and the environment and to determine the need for any additional investigation. A total of 13 monitoring wells were installed in the overburden water-bearing zone by MK in multiple areas. The MK investigation identified limited contamination by nitroaromatics and metals in groundwater at PBOW. One of

the monitoring wells, the only one slated for the Middle Toluene Tank Area, was unable to be installed.

In 1994 and 1995, D&M conducted a groundwater investigation under contract to the Nashville and Huntington Corps of Engineers districts. The objectives of the D&M investigation were as follows: to evaluate groundwater occurrence and flow conditions in the overburden and bedrock water-bearing zones; to assess the groundwater quality in the overburden water-bearing zone and at the Red Water Ponds and TNT Manufacturing Areas; to investigate on a site-wide basis the baseline groundwater quality of the bedrock water-bearing zone; and to evaluate the necessity of additional work at PBOW. A total of 11 monitoring wells were installed in the overburden water-bearing zone and 8 wells were placed in the limestone bedrock. The general 1997 groundwater flow directions in both water-bearing zones as indicated on the contour maps in the D&M report were to the north, eventually toward Lake Erie. However, the investigation also found that the groundwater flow in the overburden exhibited a strong downward vertical component across most of the site and the presence of groundwater in the overburden water-bearing zone was seasonally dependent. Groundwater samples were collected from 25 wells and analyzed for nitroaromatics, nitrates, and metals. Samples from bedrock wells were also analyzed for VOCs and base neutral/acid extractable compounds (BNA). The analytical results indicated that significant levels of explosive residues (including 1,3,5-trinitrobenzene [TNB], 1,3-dinitrobenzene [DNB], and 2,4-DNT) were present in the groundwater in the overburden aquifer near both Red Water Pond areas. However, away from the ponds, the levels of detected explosives in groundwater decreased. Low levels of explosives were also reported in some overburden wells placed in TNT Area A (TNTA), TNTB, and in several bedrock wells at both Red Water Ponds and TNT Area C (TNTC). Several VOCs and BNAs were detected in the bedrock water-bearing zone, including hydrocarbon compounds with benzene concentrations in seven of the nine bedrock wells at or above the regulatory action level. In addition, eleven metals were detected in groundwater samples in a few limited areas with concentrations of copper, manganese, nickel, and thallium occasionally exceeding their respective regulatory action levels (D&M, 1997).

In September 1995, ICI issued a site management plan under contract with USACE-Huntington District. The objectives were to describe the regulatory framework, site setting, site investigations and results, and management objectives of the PBOW. As part of their site recommendations they stated that at least one additional well should be installed at the G8 Burn Grounds, the Waste Lagoons Area, the Middle Toluene Tank Area, Rail Car Unloading Area, TNT A B, and C, WARWP, and the PRRWP Areas (ICI, 1995).

IT conducted a site-wide GWI at the former PBOW from September through October 1996 under contract to the USACE-Nashville District (IT, 1997c). This work included installation of overburden monitoring wells, redevelopment of existing monitoring wells, and collection and analysis of groundwater samples to acquire supplementary data of site-wide groundwater levels and contaminants to add to an existing database, and to fill in existing data gaps in groundwater levels and contamination in the western portion of PBOW. IT reported that the overburden water-bearing zone had been impacted by nitroaromatic compounds in all areas except at TNTC. Nitroaromatic compounds were also detected in six of the eight bedrock wells sampled, indicating that nitroaromatic contamination is evident in both water-bearing zones. Organic compounds (VOCs and SVOCs) at concentrations exceeding the RBCs were present exclusively in overburden water-bearing zones in the two red water pond areas. At least one BTEX compound was present in all the bedrock wells except BED-MW14 and -MW20. Free product was found in BED-MW16 located near the upper toluene tank area. A variety of metals were present in groundwater samples from both water-bearing zones, with some exceeding RBCs. Hydrogen sulfide (H_2S) gas was encountered in three bedrock wells indicating a possible reducing environment in the bedrock zone. Pesticides/polychlorinated biphenyls (PCB) were not detected in any of the sampled wells. Groundwater samples collected from five overburden wells and one bedrock well contained cyanide. However, the presence of cyanide in water samples was attributed to suspended solids as cyanide was not detected in filtered samples. Based on the GWI, additional sampling efforts were recommended, including additional well installations, quarterly water level measurements, seasonal groundwater sampling, delineation of the lateral extent of contamination in the two Red Water Pond areas, and a geochemical study of bedrock water quality to determine the source of the H_2S.

4.0 Summary of Groundwater Investigation Field Activities

AA1-GW-002, AA2-GW-002, AA3-GW-002, ABG-GW-002

4.1 New Monitoring Well Installation

Four ~~Three~~ new overburden wells and eight bedrock wells were installed as part of the GWI following the first quarterly groundwater level measurement event. In addition, one piezometer was also installed in place of monitoring well IT-AA2-GW-002 because the borehole was dry at the time of well completion. One well cluster consisting of one overburden (piezometer at AA2) and one bedrock well was placed in each of three Acid Areas and in the Additional Burning Ground (ABG).

Monitoring wells were installed in accordance with guidelines specified in the USACE Engineering Manual EM-1110-1-4000 (USACE, 1994) and following procedures established in the site-wide sampling and analysis plan (SAP) (IT, 1996a). Specifically, monitoring wells were installed as described below.

A Dietrich D-50 truck mounted rotary drill rig was used to drill boreholes in the overburden soil for well installation. The boring was advanced by using 8.25-inch outside diameter (OD) (4.25-inch inside diameter [ID]) hollow-stem auger (HSA) to the depth of auger refusal. Soil core samples were collected continuously from the ground surface to the terminating depth using a 2-foot long and 2-inch diameter stainless-steel split spoon. Soil core samples were visually examined by an IT field geologist and documented on the drilling logs (Appendix B). Well completion in each borehole was accomplished using 2-inch-diameter polyvinyl chloride (PVC) Schedule 40 riser pipe and a 10-foot section of factory slotted screen. Three discrete soil samples were collected from each borehole for geotechnical testing. At least one of the three geotechnical samples was collected from the depth interval of the well screen to allow selection of proper size of filter materials. Soil samples were also scanned for the presence of organic vapor using a photoionization detector (PID). The terminating depths for the overburden well boreholes were all at the top of the bedrock with AA1-GW-002 at 22 feet below ground surface (bgs), AA2-GW-002 (piezometer) at 18.5 feet bgs, AA3-GW-002 at 16 feet bgs, and ABG-GW-002 at 6.75 feet bgs, respectively.

A Dietrich D-120 truck mounted rotary drill rig was used to drill boreholes for bedrock well installation. The bedrock wells were installed as double-cased wells. Initially, 14-inch OD (8.25-inch ID) HSA were used to drill through and hold back the overburden materials. Following the overburden drilling, a 10-inch OD roller cone bit was used to cut several feet into

competent bedrock for placement of steel surface casing. The surface casing was made of 10-inch, low carbon steel. The surface casing was placed in the borehole through the augers and pressure grouted into the bedrock. The grout was allowed to cure for at least 48 hours. After the grout was cured and the overburden zone completely sealed, a 3-inch OD, 10-foot long core barrel was used to advance the borehole into the bedrock through the center of the surface casing. Rock cores were visually examined and a lithology description prepared. After the desired depth had been drilled, the core barrel assembly was removed and the borehole was reamed with a 6-inch OD roller cone bit. Bedrock well completion in each borehole was accomplished using 2-inch-diameter, Schedule 40 PVC riser pipe and a 15-foot section of factory slotted screen.

The monitoring well construction details for monitoring wells at the site are summarized in Table 4-1. Drilling logs and monitoring well construction diagrams are included in Appendix B and geotechnical testing results are included in Appendix C.

4.1.1 Monitoring Well Development

All newly constructed monitoring wells were developed after completion of well construction. Well development was performed by surging and bailing or by pumping using a Grundfos™ submersible pump or a Whale™ pump. The method of development chosen depended upon groundwater yield in the well. A well development log was completed for each well to document well development progress, field parameters, and other pertinent information. Photographs of development water and well development logs are included in Appendix B.

In addition to development of new monitoring wells, existing overburden wells that had not been sampled with the previous 12 months at the time of the sampling were redeveloped prior to collecting groundwater samples for chemical analysis, following procedures specified in the SAP (IT, 1996a). Redevelopment was performed to remove the stagnant water column inside the well casing and in the filter pack to allow collection of representative water samples. Redevelopment was performed using a bailer or a submersible pump. During redevelopment, field measurements of pH, oxidation-reduction potential (Eh), temperature, dissolved oxygen (DO), turbidity, and conductivity were collected periodically to monitor changes in water quality and to assess the effectiveness of development.

4.1.2 Hydraulic Conductivity Testing

Rising head slug tests were performed at each newly installed monitoring well to acquire information on the hydraulic conductivity of each water-bearing zone. A slug test was not conducted in the temporary piezometer (AA2-GW-002). Equipment used in the test included:

- Ten pounds per square inch pressure transducer equipped with an atmospheric pressure compensation tube
- HERMIT 1000C Environmental Data Logger
- Five-foot-long, 1.5-inch-diameter PVC slug.

The slug test was set up by lowering the pressure transducer more than 5 feet below the static water level to a point above which the PVC slug could be fully immersed in the well water without interfering with the transducer. The data logger allows water level changes be recorded at desired time intervals. The slug was inserted in the well and the water level allowed to return to static level. The rising test was started by initializing the data logger and removing the slug from the well. The water level recovery versus elapsed time was recorded for later analysis. The test was considered completed when the water column above the pressure transducer had returned to 95 percent of the original level. Following the test, the data recorded by the data logger was recovered and stored on diskette. The raw data were inspected in the field for consistency and completeness. The slug test data were analyzed using the computer program Aquifer Test (Waterloo Hydrogeologic, 1995). The hydraulic conductivity testing data are included in Appendix D, along with a description of the method used in the data analysis.

4.2 Quarterly Groundwater Level Measurements

Four quarterly groundwater level measurement events were completed as part of the GWI. Each groundwater level measurement was completed within one 12-hour period as required by the statement of work. The measurements were collected on August 27 and November 12, 1997, and on February 24, and May 5, 1998.

Reconnaissance of the wells to be measured before each quarterly groundwater level measurement event was performed to determine the accessibility and condition of each well. This included locating wells that were in remote areas, clearing and flagging paths to wells, and identifying any potential health and safety hazards near the wells. All inoperable (rusted) locks were cut off and replaced with special-ordered, keyed-alike padlocks during the first quarterly event. Construction details of each existing well including well identification, well depth, well

diameter, the year of completion, and available survey coordinates as well as previously measured depth to water data were tabulated and provided to each field group. A specially designed water level measurement form was used for data collection.

Upon opening the well cap, real-time air monitoring was conducted using a PID for the overburden wells and a PID and a hydrogen sulfide (H_2S) detector for the bedrock wells. The purpose of the air monitoring was to protect field personnel from organic vapor and H_2S exposure and to document the quality of trapped air in each well for future monitoring and sampling use. Organic vapor had been detected in several overburden wells and H_2S was encountered in bedrock wells during previous groundwater investigations (D&M, 1997; IT, 1997c).

Water level indicators and oil/water interface probes were decontaminated before the first use, between each use, and after the final use in order to prevent possible cross contamination per the procedures outlined in Section 4.2 of the PBOW site-wide quality assurance project plan (QAPP) (IT, 1996b). Field testing and monitoring equipment were inspected and calibrated as specified in Section 6.0 of the PBOW Site-Wide QAPP (IT, 1996b) and according to the manufacturers' specifications. To further minimize the possibility of cross contamination, water level measurements began with the least contaminated well and progressed in sequence to the most contaminated well as determined by the degree of known contaminant concentrations.

The static water level in each well was measured using an electronic water level indicator or an oil/water interface probe to the nearest 0.01 foot. The depth from the marked point on the rim of the inner PVC casing of the well to the water table was recorded. When a marked point was not found, the highest point on the rim of the inner casing was marked as a datum for current and future reference, and depth to water level was measured from that point. A discussion of the results of these four quarterly measurements and a table showing the elevations measured is presented in Section 6.1. Water level measurement forms are included in Appendix B.

4.2.1 First Quarterly Groundwater Level Measurements

On August 27, 1997, groundwater level measurements were completed over a single 11½ hour period (0800 to 1930). No significant precipitation was recorded in the Sandusky area for at least 3 days prior to water level measurements. The first quarterly event measured 73 monitoring wells that were known to exist, including 13 bedrock wells, 59 overburden wells, and 1 temporary overburden piezometer.

4.2.2 Second Quarterly Groundwater Level Measurements

The second quarterly event included 79 monitoring wells/piezometers (19 bedrock wells, 58 overburden wells, and 2 temporary piezometers). Twelve newly installed wells (including one temporary piezometer) were included for the first time in this measurement event. Four overburden wells (PB-MW01, -MW02, -MW03, and -MW04) were eliminated from further measurements due to a lack of adequate well construction and survey data and two bedrock wells (Reactor 4 and 5) were dropped because of their reported connection to sumps within the NASA Reactor Building. Field measurements of static water levels began at 0800 and were completed at 1730 on November 12, 1997. No significant precipitation was recorded in the Sandusky area for at least 3 days prior to the water level measurements.

4.2.3 Third Quarterly Groundwater Level Measurements

The third quarterly event included the same 79 monitoring wells/piezometers as the second quarterly measurements. Two of the wells were dry. Field measurements of static water levels began at 0800 and were completed at 1500 on February 24, 1998. No significant precipitation was recorded in the Sandusky Area for at least 2 days before the water level measurements.

4.2.4 Fourth Quarterly Groundwater Level Measurements

Seventy-nine monitoring wells were measured during the fourth quarterly measurement event on May 5, 1998. Field measurements of static water levels began at 0730 and were completed at 1600. The Sandusky Area had a combined total of 0.16-inches of rain from May 3 through May 5.

4.3 Semi-Annual Groundwater Sampling

Two semi-annual groundwater sampling events were conducted under the GWI at PBOW. The first sampling event was conducted in November 1997 and the second in May/June 1998. Groundwater samples were analyzed for VOCs, SVOCs, nitroaromatic explosives, metals (total and dissolved), cyanide, and water quality parameters alkalinity, chloride, hardness, sulfate, nitrate, total dissolved solids, total organic carbon, and total suspended solids. However, because of an insufficient quantity of water, Reactor 1 was not analyzed for nitrate during the November 1997 event and MK-MW23 was not analyzed for any of the water quality parameters or for PCBs during the May/June 1998 event.

Prior to collecting groundwater samples, monitoring wells were purged to remove standing water in the well casing and screen including water stored in the filter pack voids. The three to five

well volumes requiring removal from the wells were calculated based on the static water level and well construction data, assuming a 30 percent porosity of the filter material. During purging, field measurements of pH, specific conductance, temperature, DO, turbidity, and Eh were made and recorded. Purging was considered completed when the required volume was removed and the field parameters listed above were stabilized for three consecutive readings, following procedures stated in the site-wide QAPP (IT, 1996b). In the case of low yield wells, purging ceased after the well had been purged dry.

The majority of overburden wells were sampled using low-flow techniques with a peristaltic pump equipped with disposable Tygon™ tubing. Sampling tubing was discarded after each use to avoid possible cross-contamination. Dedicated Teflon™ bailers fitted with a bottom-emptying device were used for collection of groundwater samples from bedrock wells. Groundwater samples collected using the peristaltic pump were filtered in the field using in-line 0.45 micrometer (μm) size filters for metal analysis. Samples collected by bailer for metal analysis were filtered using filtration apparatus through 0.45 μm filter paper at the site office as soon as possible following sample collection. All groundwater sample bottles were prelabeled and were placed in coolers packed with ice before being preserved and packed for shipment. Sample filtration, preservation, packing, and shipment were performed in accordance with Section 5.4 of the site-wide QAPP (IT, 1996b).

4.3.1 First Semi-Annual Groundwater Sampling Event

The first semi-annual groundwater sampling event was conducted from November 13 through 24, 1997, following the second quarterly water level measurement event. In the SAP (IT, 1996a), 59 primary groundwater samples were to be collected. Well REACTOR 2 could not be sampled due to the low yield of the well. Well REACTOR 3 could not be sampled because it was dry. Two piezometers, IT-MW07 and AA2-GW-002 were dry. Therefore, samples were collected from 55 wells listed in Table 4-2. Field measurements of groundwater samples are presented in Table 4-3.

4.3.2 Second Semi-Annual Groundwater Sampling Event

The second semi-annual groundwater sampling event was conducted from May 12 through June 1, 1998, following the fourth quarterly water level measurement event. Primary groundwater samples were attempted to be collected from the same group of 57 wells attempted during the first semi-annual event. Two piezometers (IT-MW07 and AA2-GW-002) were dry at the time of

sampling and could not be sampled. Therefore, samples were collected from the 55 wells listed in Table 4-4.

4.4 Land Survey

Newly installed monitoring wells (11 monitoring wells and 1 piezometer installed in October 1997) were surveyed in November 1997 by an Ohio-registered professional land surveyor. In addition, a total of 35 existing monitoring wells were re-surveyed in February 1998 in order to bring the surveyed coordinates of these wells in line with other wells and to collect top-of-casing (TOC) data that were missing from most of these wells. At each well location, the horizontal coordinates (northing and easting) were surveyed in reference to the Ohio State Plane Coordinate system (north zone) while the elevation was surveyed at the ground surface and at the top of the inner casing to the closest 0.01 foot, referenced to the 1927 National Geodetic Vertical Datum (NGVD). The complete land survey data are included in Appendix E.

4.5 Decontamination Procedures

Decontamination of drill rigs, downhole tools, and sampling equipment was performed in accordance with Section 4.4.3 of the SAP (IT, 1996a). Specifically, drill rigs, rods, drill bits, and augers were cleaned at the decontamination pad using high pressure hot water from a steam-cleaner before entering the drilling site, between sites, and after completion of the last borehole. Other equipment, including water level indicators, slug, and transducer were decontaminated by rinsing in sequence with soapy water, deionized (DI) water, methanol, and a final rinse with DI water. Each were then air dried before use. Submersible pumps were decontaminated by running approximately 5 gallons of soapy water and 5 gallons DI water through the pump head and tubing. Equipment rinsate samples were collected and analyzed for the same parameters as the primary sample. The results of the equipment rinsate samples exhibited no detectable chemicals, confirming the effectiveness of the decontamination process.

5.0 Analytical Program

All groundwater samples were analyzed by Quanterra Environmental Services, Knoxville, Tennessee. Analyses for water quality parameters were provided by Quanterra's Tampa laboratory. Data validation was performed by E & I Technologies, an independent third party contractor, located in Oak Ridge, Tennessee. The validation summaries are provided in Appendix F. The analytical results are summarized in Appendix G. Detected hits tables that exclude "B" qualified data are included in Appendix H. The groundwater analytical data were compared to RBCs. A definition of RBC is presented in Section 5.4. The RBC tables (Section 6.2) include only compounds detected above the RBC screening concentrations or those compounds without RBCs. "B" qualified data were not included in the RBC comparison.

5.1 Analytical Program and Methodologies

Chemical analyses for the investigation were performed in accordance with the guidelines detailed in the U.S. Environmental Protection Agency (EPA) *Test Methods for Evaluating Solid Waste* (SW-846), Physical/Chemical Methods, Third Edition, September 1986 (EPA, 1986) and subsequent revisions. The groundwater samples and associated quality assurance/quality control (QA/QC) samples were analyzed for volatile organics, semivolatile organics, PCBs, metals, explosives, and several water quality parameters. Methods used for analysis are summarized in Table 5-1.

All analytical samples collected for the generation of definitive data were reported in EPA Level IV CLP-like data packages. A 100 percent Level III data validation was performed using EPA guidelines presented in the EPA *Contract Laboratory Program National Functional Guidelines for Organic Data Review* (EPA, 1994a) and *USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review* dated February 1994 (EPA, 1994b). After validation, the data were reevaluated for blank contamination and revisions were made to the original validation results. The revisions consisted of assigning "B" qualifiers to the analytical results when necessary. The criteria for blank evaluation were based on those detailed in *Region III Modifications to National Functional Guidelines for Organic Data Review* (September 1994) (EPA, 1994c) and *Region III Modifications to the Laboratory Data Validation Functional Guidelines for Evaluating Inorganics Analyses* (EPA, 1993). The procedure is outlined in Section 5.3.

5.2 Data Quality Evaluation

The reliability of the sampling and analytical procedures used during the investigation was demonstrated by implementing the project-specific QA procedures specified in the site-wide SAP (IT, 1996a) and QAPP (IT, 1996b) and its site-specific attachments. Successful execution of these procedures provides strong supporting evidence that the data are representative of the areas under investigation.

The data quality objectives (DQO) for this project were to produce scientifically valid data of known accuracy and precision, which were complete with respect to identified critical samples, comparable with similar data types and representative of the media sampled so as to be useful for the cited purposes. Evaluation of the data using the DQOs and the data validation process resulted in the determination that most of the data set is valid and of sufficient quality to meet the objectives of the investigation. In both sampling events, acetone, 2-butanone, and 2-hexanone were rejected in several samples due to low relative response factors (RRF) in the initial and continuing calibrations. Only non-detects were rejected. Detects were qualified "J", estimated. In the second sampling event, semivolatile compounds associated with the internal standard perylene-d12 in samples 5685 (WAMW2), 5905R (BEDMW14), 5695 (PRMW7), 5696 (PRMW7), 5705 (PRMW8), and 5715 (PRMW9) were rejected. Compounds associated with acenaphthene-d10 and phenanthrene-d10 in sample 5695 were qualified as "NJ" for detects and"R" for non-detects because of low area counts. The samples were not reanalyzed. A complete evaluation of the procedures implemented in the investigations is discussed in the data quality evaluation (DQE) found in its entirety in Appendix I.

5.3 Blank Evaluation

The purpose of blank analysis is to determine the existence of contamination resulting from laboratory and field activities. Blank evaluation involves qualification of data based on the results of associated field blanks, trip blanks, equipment rinsates, and laboratory method blanks. The criteria for blank evaluation are as follows:

- If a parameter is found in a blank but not detected in the sample, no action is taken.
- For organics, if the sample result is greater than the Contract Required Quantitation Limit (CRQL), but is less than the 5X or 10X multiple of the blank result, the sample result is qualified "B".

- For organics, if the sample result is less than the CRQL and less than the 5X or 10X multiple of the blank result, the sample result is qualified "B". The "J" qualifier is not used.

- For inorganics, if the sample result is greater than the instrument detection limit (IDL) but less than the 5X multiple of the blank result, the sample result is qualified "B".

- If the sample result is greater than the 5X or 10X multiple of the blank result, the sample result is not qualified.

In instances where more than one blank is associated with a given sample, qualification is based upon a comparison with the associated blank having the highest concentration of a contaminant. Blank results are not subtracted from sample concentrations.

5.4 Screening Criteria

The analytical data were screened against RBC screening concentrations derived from the published EPA Region 3 tables (EPA, 1998). RBCs are media-specific contaminant levels used to reduce the list of site-related chemicals carried through all the steps of the COPC selection and quantitative risk assessment. RBCs have been conservatively derived by assuming a residential receptor, applying high-end values for most of the exposure variables, and setting the target cancer risk at 10^{-6} and the target hazard index (HI) at 0.1. The cancer risk of 10^{-6} reflects the lower end of the target risk range as defined in the National Contingency Plan (NCP) (EPA, 1990). The HI of 0.1 provides additional protection from noncancer effects arising from exposure to multiple chemicals. Chemicals present in environmental media at concentrations below the RBCs will not contribute significantly to total site risk.

RBCs were obtained preferentially from the EPA Region III tables compiled for this purpose (EPA, 1998). No attempt was made to develop RBCs for ubiquitous, nutritionally essential elements unlikely to be toxic at concentrations ordinarily found in environmental media and for which toxicity values are unavailable (i.e., calcium, magnesium, potassium, and sodium). RBCs used in the screening of groundwater investigation data are presented in Section 6.0 tables. RBCs for tap water were used to screen contaminants in groundwater. It was assumed that household use of groundwater results in the most restrictive contamination levels.

6.0 Investigation Results

6.1 Geologic and Hydrogeologic Investigation Results

This section presents the geologic and hydrogeologic data and interpretations of the data collected as part of this groundwater investigation. Table 6-1 shows the lithologic units monitored by each of the site wells and headspace in these wells. All the groundwater elevation measurements for site wells measured during the four quarters and those measured since 1994 are shown in Table 6-2. Hydraulic conductivity results for this investigation are shown on Table 6-3. Contours of the water level elevations in the overburden for the four quarters measured are presented in Figures 6-1 through 6-4. Contours of the water level elevations in the bedrock for the four quarters measured are presented in Figures 6-5 through 6-8.

6.1.1 Hydrogeology of Overburden Water-Bearing Zone

Groundwater in the overburden water-bearing zone fluctuated less than 3 feet in the four water level measurements collected as part of this investigation. Groundwater flow in the overburden is predominantly to the north-northeast. The general flow direction in the overburden aquifer largely mirrors the surface topography and is correspondent to the topography of the top of the bedrock. This is demonstrated by comparing the top of the bedrock map (Figure 2-8) with the overburden groundwater elevation contour maps. In the southeastern portion of the site the groundwater has a relatively constant flow to the north-northeast for each of the four dates. However, on the northwest side of the site, the flow is toward a groundwater low located southwest of the Reactor Building Area. Figure 6-9 shows flow in both the overburden and bedrock water-bearing zones in the vicinity of the Reactor Building Area for November 1997 and Figure 6-10 shows the same information for May 1998. A distinct southwestern flow is present in the overburden in that area toward the reactor buildings, possibly as the result of active sump pumps believed to be pumping within and at the base of the overburden there.

Hydraulic gradients were calculated for three transects across the site for the four dates measured. The location of these three transects and the calculations for them are presented in Appendix D. Flow along the western side of the site is toward the north-northwest to a groundwater low at a gradient ranging from 0.0086 foot per foot (ft/ft) to 0.011 ft/ft. Flow at the center of the site was to the north with a very consistent gradient over time ranging from 0.0044 ft/ft to 0.0053 ft/ft. Groundwater on the east-central portion of the site flowed to the northeast at a gradient ranging from 0.0049 ft/ft to 0.0060 ft/ft. Hydraulic conductivities of the overburden water-bearing zone measured by slug tests performed in the site wells range from 0.74 feet per

day (ft/day) to 211.68 ft/day as shown in Table 6-3. All slug test data and hydraulic gradient calculations are presented in Appendix D.

Correspondent seasonal groundwater elevation fluctuations have occurred in the overburden, irrespective of the area of the site. Figure 6-11 demonstrates this similarity between four select overburden wells. Similar fluctuations in overburden wells may imply a significant horizontal connectivity across the overburden water-bearing zone. However, these levels in the overburden may be influenced by changes in water levels in the bedrock water-bearing zone, possibly indicating higher vertical than horizontal hydraulic conductivity in the overburden.

6.1.2 Geology and Hydrogeology of Bedrock Water-Bearing Zone

The bedrock at the site has been largely discussed as one unit in previous reports. In this report, the formations within the bedrock have been differentiated to explain enigmatic groundwater levels and fluctuations over time in many of the site wells. After comparing the geologic plan view map (by the ODNR) with the five cross-sections (discussed in Section 2.0), the bedrock will be discussed as a whole and as three separate units (the Ohio Shale, Olentangy Shale, and the Delaware Limestone) where appropriate.

Horizontal hydraulic gradients were calculated for three transects across the site for the four dates measured. The locations of these three transects and the calculations for them are presented in Appendix D. Flow along the western side of site is toward the north-northeast with a gradient of 0.004 ft/ft to 0.0286 ft/ft. Flow in the center of the site was predominantly to the north-northeast with a gradient ranging from 0.0038 ft/ft to 0.0110 ft/ft. At the east-central portion of the site, flow is to the northeast with a gradient ranging from 0.0023 ft/ft to 0.0038 ft/ft. Groundwater elevation in the bedrock water-bearing zone typically had little fluctuation in the wells monitoring the Ohio Shale and the Olentangy Shale (Figures 6-12 and 6-13, respectively); however, wells monitoring the Delaware Limestone showed significant elevation fluctuations over time (Figure 6-14). Wells constructed in the Delaware Limestone which are located in the Reactor Building Area wells (REACTOR 1, 2, and 3) showed the greatest variation over time with water levels fluctuating as much as 25 feet (Figure 6-15). Another well shown on Figure 6-15, PB-BED-MW13, fluctuated very similarly to those of Reactor Building Area (REACTOR 1, 2, and 3). PB-BED-MW13, which monitors the Delaware Limestone, is located along a bedrock low which trends along the west side of the site to the Reactor Building Area. The very similar extreme fluctuations in these wells indicates that there is a hydraulic connection between these two areas. Eight sump pumps are present in the Reactor Building Area

at the locations shown on Figures 6-9 and 6-10. The frequency and rate that these wells pump is unknown. However, it is possible that these wells may draw a significant amount of water from the top of the bedrock low, causing drawdown as far as PB-BED-MW13 and possibly causing flow from the overburden water-bearing zone to the Reactor Building Area as shown on both Figures 6-9 and 6-10.

Hydraulic conductivities in the bedrock measured by slug tests performed in the site wells shows that the range is from a minimum of 0.03 ft/day to 22.18 ft/day. This range also demonstrates the variability in the hydraulic conductivity of the bedrock across the site. Of the eight wells tested, the Ohio Shale was shown to have the highest hydraulic conductivities at 22.18 ft/day in IT-ABG-BEDGW-001 and 17.9 ft/day in IT-TNTB-BEDGW-002 as shown on Table 6-3. In contrast, the hydraulic conductivities in the other six wells (installed in the Delaware Limestone and the Olentangy Shale) had conductivites two to three orders of magnitude lower.

Some of the lithologic units at the site have had the presence of natural petroleum and H_2S, a byproduct of anaerobic petroleum degradation. After evaluating the boring logs that had petroleum noted during drilling and the wells with H_2S detected by monitoring equipment, it is apparent that petroleum (and H_2S) is naturally occurring at the site to a significant degree only in the Delaware Limestone.

6.1.3 Hydraulic Connection Between Zones

Vertical hydraulic gradients, calculated for five well pairs, revealed two general trends across the site (Table 6-4). Well pairs on the western and northern portions of the site showed a strong downward gradient from the overburden to the bedrock. The greatest difference in water levels occurred in the overburden/Delaware Limestone well pair IT-AA1-GW002/IT-AA1-BED-GW001 with approximately 25 feet of difference in the water levels and an average vertical gradient over time of 0.6 foot/foot downward from the overburden to the bedrock. In contrast, the central and southern portions of the site showed very similar groundwater elevations in the overburden and the bedrock, particularly in well pair ABG-GW002/ABG-BED-GW001. This may indicate that the groundwater in the overburden and the Ohio Shale located on that portion of the site have a high degree of connectivity.

6.1.4 Influence of Precipitation on Water Levels

Although previous investigations have indicated that there is a strong connection between precipitation and water level elevations, no clear correlation exists between monthly precipitation

rates and water level elevations in site wells. Figure 6-16 shows the precipitation rates in Sandusky, Ohio from January 1994 to May 1998. However, when comparing the limited number of seasonal groundwater elevation measurements collected from the site shown in Table 6-2 with aquifer recharge (Figure 6-17), a seasonal correlation appears to be present. Recharge at PBOW was obtained by subtracting potential evapotranspiration rates (from Cleveland, Ohio) and calculated runoff rates from rainfall. Appendix J shows the calculations and reference information required for this calculation.

Figure 6-17 demonstrates that there is a strong correlation between seasons of the year and calculated monthly aquifer recharge rates at PBOW. Recharge to the overburden is calculated to be highest in January for 3 of the 5 years shown. A lag time should, however, occur from the time the rain infiltrates the soil to the time it reaches the water table. This lag time at PBOW should be weeks from the time of precipitation. The lag time depends largely upon the infiltration capacity of the soil, the thickness of the overburden in the areas of recharge, and in the winter, frozen ground. Thus, the groundwater elevations should typically be highest in February or March. Although Figure 6-16 shows that the highest rainfall occurs in summer months, Figure 6-17 shows that recharge rates are actually lower during that season. This is caused by evapotranspiration, which is highest in the mid to late summer in north-central Ohio. Similar to the lag time for the groundwater high, a lag time in the groundwater low should also occur. Thus, groundwater elevations should be lowest in early fall.

Figures 6-16 and 6-17 show that both precipitation and recharge rates were similar for most of the years measured. However, in 1994 the annual precipitation was approximately 25 percent lower than the average annual rate in Sandusky. Correspondingly, the lowest water levels measured in site wells occurred in December 1994. This reveals that significant fluctuation in groundwater wells can occur during drought conditions such as 1994.

6.2 Analytical Results

IT conducted two semi-annual groundwater sampling events of overburden and bedrock monitoring wells as part of the groundwater investigation at PBOW. Specifically, 38 overburden and 17 bedrock wells were sampled in November 1997 and May 1998. The following sections present the blank-corrected results of these two sampling events by monitored water-bearing zone and geographic location within the site. Site-specific RBCs have been used to evaluate the detected constituents. Only analytes exceeding RBCs are shown on figures. Analytes detected

below the RBCs are not discussed in detail or shown on figures but are presented in the referenced data tables. All analytical data is presented in Appendices G and H.

6.2.1 Overburden Water-Bearing Zone

A total of 38 overburden wells were sampled under the GWI. Specific locations of these wells are as follows:

- Five at the WARWP Area
- Four at the PRRWP Area
- Five at TNTA
- Two at TNTB
- Six at TNTC
- Two at Acid Area 1 (AA1)
- Three at Acid Area 2 (AA2)
- One at Acid Area 3 (AA3)
- Five at various Burning Grounds
- Two at the Lower Toluene Tank Area
- One at the Upper Toluene Tank Area
- One at the Reactor Facility
- One upgradient of the PBOW (background).

Note that results from the upgradient background well are included in background wells, Section 6.2.3.

6.2.1.1 West Area Red Water Ponds Area

Five existing overburden monitoring wells were sampled during the two semi-annual sampling events at the WARWP as shown in Figure 6-18. These wells include IT-MW02, IT-MW08, IT-MW10, PB-WA-MW01, and PB-WA-MW02. One of these, PB-WA-MW02, is located south and upgradient of the former Red Water Ponds, while the remaining four wells are located downgradient or sidegradient of the ponds. All wells were analyzed for VOCs, SVOCs, nitroaromatic explosives, PCBs, metals (total and dissolved), cyanide, and water quality parameters as previously discussed.

6.2.1.1.1 First Semi-Annual Sampling Event

One VOC (carbon disulfide) was detected in IT-MW10 in November 1997; however, this constituent did not exceed the RBC (Table 6-5). At least one SVOC was detected in IT-MW02, IT-MW10, and PB-WA-MW01. Four SVOCs exceeded the RBCs in IT-MW02, including 2,4-DNT, 2,6-DNT, 2-nitroaniline, and 4,6-dinitro-2-methylphenol. In IT-MW10, only bis(2-

ethylhexyl)phthalate exceeded the RBC while PB-WA-MW10 exhibited di-n-octyl phthalate at a concentration below the RBC. Of the sampled wells, only IT-MW02 exhibited detectable concentrations of nitroaromatic compounds, consistent with detections under the SVOC analysis. Of the four detected explosives, three (1,3-DNB, 2,4-DNT, and 2,6-DNT) exceeded the respective RBCs; 1,3,5-TNB did not exceed its RBC.

Several metals were detected in each of the five sampled wells at the WARWP in November 1997 (Table 6-5). Manganese exceeded the RBC in each of the sampled wells in both total and dissolved samples. Total iron also exceeded the RBC in IT-MW10, PB-WA-MW01, and PB-WA-MW02, but was not detected in the filtered samples, indicating that the RBC exceedances were due to suspended solids in the unfiltered samples. Similarly, total aluminum and nickel exceeded the RBCs in PB-WA-MW02 but were not detected in the dissolved phase. Cyanide was only detected in PB-WA-MW02 at a concentration of 79 micrograms per liter (µg/L), slightly above the RBC of 73 µg/L.

Water quality parameters are also presented on Table 6-5. Of these, only nitrate has an established RBC, which was exceeded in PB-WA-MW02 at an estimated concentration of 80,000 µg/L.

6.2.1.1.2 Second Semi-Annual Sampling Event

VOCs were not detected in any well during the May 1998 sampling event (Table 6-5). SVOCs were detected in IT-MW02 and PB-WA-MW02, with the largest suite evident in PB-WA-MW02. In IT-MW02, three of four detected SVOCs exceeded RBCs including 2,4-DNT, 2,6-DNT, and 2-nitroaniline. PB-WA-MW02 exhibited six detected SVOCs, of which 2,4-dinitrophenol, 2,4-DNT, 3-nitroaniline, and nitrobenzene exceeded the respective RBCs.

Explosives were detected in IT-MW02 and PB-WA-MW02 during the May 1998 sampling event, consistent with the constituents detected under the SVOC analyses. In IT-MW02, six of seven detected nitroaromatic compounds exceeded the corresponding RBCs, including 1,3-DNB, 2,4-DNT, 2,6-DNT, 3-nitrotoluene, nitrobenzene, and RDX, while PB-WA-MW02 exhibited 1,3-DNB, 2,4-DNT, and 2,6-DNT at concentrations above the RBCs.

Consistent with the November 1997 sampling event, several metals were detected in each of the five sampled wells at the WARWP in May 1998 (Table 6-5). Manganese exceeded the RBC in each of the sampled wells in both total and dissolved samples. Total iron also exceeded the RBC

in IT-MW10 and PB-WA-MW02 but was not detected in the filtered samples, indicating that the RBC exceedances were due to suspended solids in the unfiltered samples. IT-MW10 also exhibited total aluminum, arsenic, barium, chromium, lead, and vanadium at concentrations above the RBCs; however, these metals were not detected in the dissolved phase, indicating that their presence in the unfiltered sample was due to suspended solids. PB-WA-MW02 exhibited total aluminum and nickel at concentrations exceeding the RBCs, of which nickel also exceeded the RBC in the dissolved phase. Cyanide and nitrate again exceeded the respective RBCs in PB-WA-MW02 at levels comparable to those observed in November 1997.

6.2.1.1.3 Summary of Sampling Events

Results from the two sampling events at the WARWP area indicate that the overburden water-bearing zone has been impacted by nitroaromatic explosives and, to a lesser extent, SVOCs in the immediate vicinity of the former Red Water Ponds (IT-MW02 and PB-WA-MW02). Cyanide also appears to have impacted groundwater on the south side of the ponds (PB-WA-MW02), a location also noted for exhibiting red water in the well. Metals have exceeded RBCs, but dissolved RBC exceedances are limited to manganese and nickel. Further evaluation is needed to determine whether these are due to site contamination.

6.2.1.2 Pentolite Road Red Water Ponds Area

Four existing overburden monitoring wells were sampled during the two semi-annual sampling events at the PRRWP at the locations shown on Figure 6-19. These wells include IT-MW05, PB-PR-MW07, PB-PR-MW08, and PB-PR-MW09. All wells were analyzed for VOCs, SVOCs, nitroaromatic explosives, PCBs, metals (total and dissolved), cyanide, and water quality parameters as previously discussed.

6.2.1.2.1 First Semi-Annual Sampling Event

Two VOCs (acetone and carbon disulfide) were detected in IT-MW05 in November 1997; however, neither constituent exceeded the RBCs (Table 6-6). SVOCs were not detected in IT-MW05, but at least three SVOCs were detected in PB-PR-MW07, PB-PR-MW08, and PB-PR-MW09 at concentrations exceeding the RBCs. In PB-PR-MW07, three SVOCs (2,4-DNT, 2,6-DNT, and 4,6-dinitro-2-methylphenol) exceeded the respective RBCs by several orders of magnitude, while five SVOCs (2,4-dinitrophenol, 2,4-DNT, 2,6-DNT, 3-nitroaniline, and 4,6-dinitro-2-methylphenol) were also well above RBCs in PB-PR-MW08. Monitoring well PB-PR-MW09 exhibited 2,4-dinitrophenol, 2,4-DNT, and 3-nitroaniline at concentrations above the RBCs.

Consistent with the SVOC results, the three PB-PR-series wells exhibited detectable concentrations of nitroaromatic explosives that were also well above the respective RBCs. The highest concentrations were observed in PB-PR-MW07 and PB-PR-MW08, where 1,3,5-TNB, 1,3-DNB, and 2,4-DNT exceeded the RBCs. Lesser concentrations were reported for PB-PR-MW09, but 1,3-DNB and 2,4-DNT did exceed the RBCs.

Several metals were detected in each of the four sampled wells at the PRRWP in November 1997 (Table 6-6). Manganese exceeded the RBC in each of the sampled wells in both total and dissolved samples. In IT-MW05, arsenic and iron also exceeded the RBCs, while aluminum exceeded the RBC only in the unfiltered sample. Significantly higher metals concentrations were observed in PB-PR-MW07 and PB-PR-MW08 where total and dissolved cobalt, copper, iron, manganese, and nickel were well above the corresponding RBCs. Cyanide was detected in PB-PR-MW07, PB-PR-MW08, and PB-PR-MW09, exceeding the RBC in each case; reported concentrations of cyanide were highest in PB-PR-MW07 and PB-PR-MW08. Water quality parameters are also presented on Table 6-6. Of these, only nitrate has an established RBC, which was exceeded in PB-PR-MW08 in November 1997.

6.2.1.2.2 Second Semi-Annual Sampling Event

VOCs were detected in each of the four PRRWP wells during the May 1998 sampling event (Table 6-6). However, only bromodichloromethane in PB-PR-MW08 and benzene in PB-PR-MW09 were detected at concentrations exceeding the respective RBCs. SVOCs were not detected in IT-MW05 but were detected in the remaining wells at concentrations above the RBCs, with the highest concentrations evident in PB-PR-MW07 and PB-PR-MW08. PB-PR-MW07 exhibited 2,4-DNT, 4,6-dinitro-2-methylphenol, and nitrobenzene at concentrations well above the RBCs. Similarly, 2,4-dinitrophenol, 2,4-DNT, 4,6-dinitro-2-methylphenol, 4-nitrophenol, dibenzofuran, and nitrobenzene were detected at concentrations well above RBCs in PB-PR-MW08. In PB-PR-MW09, only two SVOCs (2,4-DNT and 4,6-dinitro-2-methylphenol) exceeded the RBCs and at concentrations well below those observed in the other two PB-PR-series wells.

Explosives were detected in the three PB-PR-series wells during the May 1998 sampling event, consistent with the constituents detected under the SVOC analyses and the November sampling event. Three explosives compounds (1,3,5-TNB, 1,3-DNB, and 2,4-DNT) were detected at concentrations several orders of magnitude above the RBCs in PB-PR-MW07 and PB-PR-

MW08, while PB-PR-MW09 exhibited 1,3-DNB and 2,4-DNT at concentrations above the RBCs but well below those observed in the former wells (Table 6-6).

As with the November 1997 sampling event, several metals were detected in each of the four sampled wells at the PRRWP in May 1998 (Table 6-6). Although several total metals exceeded the RBCs in IT-MW05, only manganese exceeded the RBC in the dissolved phase indicating that the remaining RBC exceedances were due to suspended solids in the unfiltered sample. The three PB-PR-series wells exhibited a larger suite of dissolved metals with concentrations well above the RBCs. Dissolved cobalt, copper, iron, manganese, and nickel each surpassed the RBCs in PB-PR-MW07 and PB-PR-MW08. PB-PR-MW09 exhibited dissolved cobalt, copper, manganese, and nickel at concentrations above the RBCs, but these concentrations were well below those observed in PB-PR-MW07 and PB-PR-MW08. Cyanide was again detected at concentrations above the RBC in each of the three PB-PR-series wells.

Water quality parameters are also presented on Table 6-6. Nitrate exceeded the RBC in PB-PR-MW07, PB-PR-MW08, and PB-PR-MW09.

6.2.1.2.3 Summary of Sampling Events

Results from the two sampling events at the PRRWP area indicate that the overburden water-bearing zone has been impacted by VOCs, SVOCs, and nitroaromatic explosives near the former Red Water Ponds. Cyanide has also impacted groundwater in the PB-PR-series wells, two of which (PB-PR-MW07 and –MW08) are also noted for exhibiting red water. Metals have exceeded the RBCs, and detected concentrations in the PB-PR-series wells appear elevated and are considered to be due to site contamination.

6.2.1.3 TNT Manufacturing Area A

Five overburden monitoring wells were sampled during the two semi-annual sampling events at TNT Area A (TNTA) as shown in Figure 6-20. These wells include MK-MW22, MK-MW23, MK-MW24, PB-TNTA-MW10 and PB-TNTA-MW11. All wells were analyzed for VOCs, SVOCs, nitroaromatic explosives, PCBs, metals (total and dissolved), cyanide, and water quality parameters as previously discussed.

6.2.1.3.1 First Semi-Annual Sampling Event

Two VOCs (acetone and carbon disulfide) were detected in MK-MW23 in November 1997 while only acetone was detected in PB-TNTA-MW10; however, none of the detected VOCs

exceeded the RBCs (Table 6-7). One SVOC (di-n-octyl phthalate) was detected in MK-MW23 but at a concentration below the RBC; the remaining four wells did not exhibit detectable concentrations of SVOCs in November 1997.

Only one of the sampled TNTA wells (MK-MW22) exhibited detectable concentrations of nitroaromatic compounds (Table 6-7). Of the five detected explosive constituents in downgradient well MK-MW22, only 4-amino-2,6-DNT exceeded the RBC.
Several metals were detected in each of the five sampled wells at TNTA in November 1997 (Table 6-7). Although up to eight total metals exceeded the respective RBCs, only arsenic, barium, iron, manganese, and vanadium were detected at concentrations above the RBCs in the filtered samples. Dissolved manganese exceeded the RBC in each of the sampled wells, dissolved iron in MK-MW24 and PB-TNTA-MW10, dissolved arsenic in MK-MW23 only, dissolved barium in PB-TNTA-MW10 only, and dissolved vanadium in MK-MW24 only. Cyanide was not detected in any of the overburden wells sampled at TNTA.

Water quality parameters are also presented on Table 6-7; however, none of the detected parameters exceeded RBCs.

6.2.1.3.2 Second Semi-Annual Sampling Event

VOCs, including acetone, carbon disulfide, and toluene, were detected in four of the sampled wells in May 1998; VOCs were not detected in PB-TNTA-MW11. None of the detected VOCs exceeded the RBCs (Table 6-7). One SVOC (bis(2-ethylhexyl)phthalate) was detected in MK-MW23 at a concentration well above the RBC; consistent with the November sampling event, the remaining four wells did not exhibit detectable concentrations of SVOCs in May 1998.

Only one of the sampled TNTA wells (MK-MW22) exhibited detectable concentrations of nitroaromatic compounds (Table 6-7). Of the six detected explosive constituents in MK-MW22, only 4-amino-2,6-DNT exceeded the RBC.

Several metals were detected in each of the five sampled wells at TNTA in May 1998 (Table 6-7). Although up to eleven total metals (MK-MW23) exceeded the respective RBCs, only iron and manganese were detected at concentrations above the RBCs in the filtered samples. Dissolved manganese exceeded the RBC in each of the sampled wells, while dissolved iron exceeded the RBC in MK-MW24 and PB-TNTA-MW10 only. Cyanide was not detected in any of the overburden wells sampled at TNTA in May 1998.

Water quality parameters are also presented on Table 6-7; however, none of the detected parameters exceeded RBCs. Well MK-MW23 was not analyzed for water quality parameters because of an insufficient water volume.

6.2.1.3.3 Summary of Sampling Events

Results from the two sampling events at TNTA indicate that the overburden water-bearing zone has been impacted by nitroaromatic explosives at MK-MW22 and SVOCs at MK-MW23, located downgradient and sidegradient, respectively, of TNTA. Metals have exceeded RBCs, but dissolved RBC exceedances are limited to arsenic, barium, iron, manganese, and vanadium. Further evaluation is needed to determine whether these inorganic constituents are due to site contamination.

6.2.1.4 TNT Manufacturing Area B

Two overburden monitoring wells (MK-MW16 and MK-MW17) were sampled during the two semi-annual sampling events at TNT Area B (TNTB) as shown in Figure 6-21. Each well was analyzed for VOCs, SVOCs, nitroaromatic explosives, PCBs, metals (total and dissolved), cyanide, and water quality parameters as previously discussed.

6.2.1.4.1 First Semi-Annual Sampling Event

VOCs were not detected in the two TNTB overburden wells in November 1997. One SVOC (bis(2-ethylhexyl)phthalate) was detected in MK-MW16 but at a concentration below the RBC; the remaining well did not exhibit detectable concentrations of SVOCs in November 1997 (Table 6-8).

Only one of the sampled TNTB wells (MK-MW17) exhibited detectable concentrations of nitroaromatic compounds (Table 6-8). One nitroaromatic compound, 4-amino-2,6-DNT, was detected and exceeded the RBC. MK-MW17 is located north and downgradient of TNTB.

Of the detected metals in the two TNTB wells, total aluminum, arsenic, iron, manganese, and nickel were present at concentrations above the RBCs in at least one of the two wells. In the dissolved phase, iron and manganese exceeded the RBCs in MK-MW16 and iron, manganese, and nickel exceeded the RBCs in MK-MW17 (Table 6-8). Cyanide was not detected in any of the overburden wells sampled at TNTB.

Water quality parameters are also presented on Table 6-8; however, none of the detected parameters exceeded RBCs.

6.2.1.4.2 Second Semi-Annual Sampling Event

One VOC (acetone) was detected in MK-MW16 in May 1998 but at a concentration below the RBC; VOCs were not detected in MK-MW17 (Table 6-8). One SVOC (2,4-DNT) was detected in MK-MW17 at a concentration below the RBC; MK-MW16 did not exhibit detectable concentrations of SVOCs in May 1998.

Only one of the sampled TNTB wells (MK-MW17) exhibited detectable concentrations of nitroaromatic compounds (Table 6-8). Of the three detected explosive constituents in MK-MW17, only 4-amino-2,6-DNT exceeded the RBC.

Of the detected metals in the two TNTB wells, total aluminum, arsenic, iron, lead, manganese, and nickel were present at concentrations above the RBCs in at least one of the two wells. In the dissolved phase, iron, manganese, and nickel exceeded the RBCs in MK-MW16, while aluminum, arsenic, iron, lead, manganese, and nickel exceeded the RBCs MK-MW17 (Table 6-8). Cyanide was not detected in any of the overburden wells sampled at TNTB.

Water quality parameters are also presented on Table 6-8; however, none of the detected parameters exceeded RBCs.

6.2.1.4.3 Summary of Sampling Events

Results from the two sampling events at TNTB indicate that the overburden water-bearing zone exhibits limited impacts from nitroaromatic explosives at MK-MW17, located north and downgradient of TNTB. Metals have also exceeded RBCs, but further evaluation is needed to determine whether these inorganic constituents are due to site contamination.

6.2.1.5 TNT Manufacturing Area C

Six overburden monitoring wells (IT-MW09, MK-MW12, PB-TNTC-MW03, PB-TNTC-MW04, PB-TNTC-MW05, and PB-TNTC-MW06) were sampled during the two semi-annual sampling events in the vicinity of TNTC as shown on Figure 6-22. Note that MK-MW12 is located several thousand feet northwest and downgradient of TNTC and may be more appropriately considered a background well; however, it is included here due to its geographic

location. Each well was analyzed for VOCs, SVOCs, nitroaromatic explosives, PCBs, metals (total and dissolved), cyanide, and water quality parameters as previously discussed.

6.2.1.5.1 First Semi-Annual Sampling Event

One VOC (chlorobenzene) was detected in IT-MW09 during the November 1997 sampling event at a concentration well below the RBC; VOCs were not detected in the remaining five TNTC wells. One SVOC (bis(2-ethylhexyl)phthalate) was detected in MK-MW12 and PB-TNTC-MW06 at concentrations above the RBC; the remaining wells did not exhibit detectable concentrations of SVOCs in November 1997 (Table 6-9). Explosives were not detected in any of the six TNTC overburden wells in November 1997.

Several total (unfiltered) metals were detected in the five TNTC overburden wells (Table 6-9). Of these, six (aluminum, arsenic, chromium, iron, manganese, and nickel) exceeded the RBC in at least one of the sampled wells. However, in the dissolved phase (filtered samples), manganese exceeded the RBC in each well, nickel exceeded the RBC in PB-TNTC-MW03, and iron exceeded the RBC in PB-TNTC-MW06.

Water quality parameters are also presented on Table 6-9. Nitrate exceeded the RBC in IT-MW09 and PB-TNTC-MW04.

6.2.1.5.2 Second Semi-Annual Sampling Event

Two VOCs (benzene and toluene) were detected at concentrations below the RBC in IT-MW09 during the May 1998 sampling event. Toluene was also detected below the RBC in PB-TNTC-MW06. SVOCs and nitroaromatic compounds were not detected in the five sampled wells in May 1998.

Of the detected metals in the five TNTC wells, total aluminum, arsenic, chromium, iron, lead, and manganese were present at concentrations above the RBCs in at least one of the two wells. However, in the dissolved phase, only manganese exceeded the RBCs; none of the dissolved metals detected in IT-MW09 exceeded RBCs (Table 6-9). Cyanide was not detected in any of the overburden wells sampled at TNTC.

Water quality parameters are also presented on Table 6-9; however, none of the detected parameters exceeded the RBCs during the May 1998 sampling event.

6.2.1.5.3 Summary of Sampling Events

Results from the two sampling events at TNTC indicate that the overburden water-bearing zone has not significantly been impacted by past site activities. Although low levels of VOCs were detected, these detections were limited to two wells and were sporadic in nature. Similarly, only one SVOC (bis[2-ethylhexyl]phthalate) was detected and only in two wells. A limited number of metals exceeded RBCs, but further evaluation is needed to determine whether these inorganic constituents are due to site contamination.

6.2.1.6 Acid Areas and Maintenance Shop Area

Six overburden monitoring wells were sampled during the two semi-annual sampling events in the vicinity of three acid areas. Of these, one (IT-AA1-GW002) is located at AA1 as shown on Figure 6-23, three (MK-MW09, MK-MW10, and MK-MW11) are located at AA2 as shown on Figure 6-24, one (IT-AA3-GW002) is located at AA3 as shown on Figure 6-25, and one (MK-MW19) is located in the Maintenance Shop Area (MNTA) north of AA1 (Figure 6-23). Each well was analyzed for VOCs, SVOCs, nitroaromatic explosives, PCBs, metals (total and dissolved), cyanide, and water quality parameters as previously discussed.

6.2.1.6.1 First Semi-Annual Sampling Event

At AA1 (IT-AA1-GW002), detected parameters were limited to total and dissolved metals (Table 6-10). Of these constituents, only total and dissolved iron, and manganese were detected at concentrations exceeding RBCs. VOCs, SVOCs, cyanide, and explosives were not detected at AA1.

Of the three sampled wells at AA2, only MK-MW10 and MK-MW11 exhibited detected constituents above RBCs. In MK-MW10, one SVOC (bis[2-ethylhexyl]phthalate) and two total metals (iron and manganese) exceeded RBCs; however, dissolved metals did not exceed RBCs indicating that the total metals exceeding RBCs are due to suspended solids. In MK-MW11, one VOC (carbon disulfide) was detected at a concentration below the RBC, while three total metals (aluminum, iron, and manganese) exceeded the RBCs. However, dissolved metals were not detected in MK-MW11, indicating that the total metals were due to suspended solids in the unfiltered sample. Explosives and cyanide were not detected in the three wells at AA2.

VOCs, SVOCs, cyanide, and nitroaromatic compounds were not detected at AA3. Six of eight detected total metals exceeded the respective RBCs in IT-AA3-GW002, including aluminum, arsenic, chromium, iron, lead, and manganese (Table 6-10). However, in the dissolved phase

only manganese exceeded the RBC, indicating that the other total metals were due to suspended solids.

Monitoring well MK-MW19, located at MNTA, exhibited detectable concentrations of VOCs and metals during the November 1997 sampling event. Of these detections, only two VOCs (1,1,1-trichloroethane [TCA]and 1,1-dichloroethene [DCE]) were detected at concentrations exceeding the respective RBCs (Table 6-10).

Water quality parameters for the wells sampled at the three acid areas and the MNTA are also presented on Table 6-10.

6.2.1.6.2 Second Semi-Annual Sampling Event

During the May 1998 sampling event, IT-AA1-GW002 (AA1) exhibited one VOC (carbon disulfide) and metals (Table 6-10). Of these detections, only total and dissolved iron and manganese were detected at concentrations exceeding the respective RBCs. SVOCs, cyanide, and explosives were not detected at AA1.

As with the November 1997 sampling event, only MK-MW10 and MK-MW11 exhibited detected constituents above RBCs at AA2 in May 1998. MK-MW10 exhibited one VOC (chloroform) at a concentration exceeding the RBC; the only other detected constituent (dissolved iron) did not exceed the RBC. In MK-MW11, three total metals (aluminum, iron, and manganese) exceeded the RBCs, but dissolved metals were not detected, indicating that the total metals were due to suspended solids in the unfiltered sample. Explosives, cyanide, and SVOCs were not detected in the three wells at AA2 in May 1998.

Consistent with the first sampling event, VOCs, SVOCs, cyanide, and nitroaromatic compounds were not detected in IT-AA3-GW002 (AA3) in May 1998. One metal (manganese) was detected in the filtered and unfiltered samples at similar concentrations exceeding the RBC (Table 6-10).

At the MNTA, MK-MW19 again exhibited detectable concentrations of VOCs and metals during the May 1998 sampling event. However, only one VOC (1,1-DCE) exceeded the RBC while seven total metals exceeded their respective RBCs. Two dissolved metals were detected (lead and manganese) at concentrations below the respective RBCs (Table 6-10), indicating that the total metals exceeding RBCs were due to suspended solids in the unfiltered sample.

Water quality parameters from the May 1998 sampling event for the wells sampled at the three acid areas and the MNTA are also presented on Table 6-10.

6.2.1.6.3 Summary of Sampling Events

Results from the two sampling events at AA1 suggest that the overburden water-bearing zone has not been significantly impacted by past site activities. Two dissolved metals (iron and manganese) have exceeded the RBCs at concentrations that appear to be elevated in comparison to metals detected in other areas of PBOW. Therefore, metals in the overburden water-bearing zone at AA1 warrant additional evaluation.

Overburden groundwater at AA2 exhibits limited VOC and SVOC contaminants in one well (MK-MW10) located downgradient of the site. However, these detections have been sporadic and further study is needed to determine whether these constituents are site related. While several total metals have exceeded RBCs, the lack of RBC exceedances in the dissolved phase indicates that these metals are due to suspended solids and are not considered site contaminants.

Results from the sampling events at AA3 indicate that the overburden water-bearing zone has not been impacted by past site activities. Only one inorganic constituent (manganese) has exceeded the RBC in the dissolved phase; however, concentrations have been low compared to other PBOW areas and manganese is not believed to be a site-related contaminant.

In the MNTA, the overburden water-bearing zone exhibits impacts from VOCs likely due to past site activities. Dissolved metals have not exceeded RBCs and metals are, therefore, not considered site-related contaminants.

6.2.1.7 Burning Ground Areas

Five overburden monitoring wells were sampled during the two semi-annual sampling events in the vicinity of two former burning grounds areas. Of these, one (IT-ABG-GW002) is located at the ABG (Figure 6-26) and four (GCL-MW01, GCL-MW02A, GCL-MW02B, and GCL-MW03) are located near Snake Road Burning Ground (Figure 6-27). Each well was analyzed for VOCs, SVOCs, nitroaromatic explosives, PCBs, metals (total and dissolved), cyanide, and water quality parameters as previously discussed.

6.2.1.7.1 First Semi-Annual Sampling Event

Groundwater in the overburden water-bearing zone at the ABG exhibited detectable concentrations of VOCs and metals in November 1997; SVOCs, cyanide, and explosives were not detected (Table 6-11). Of the detected VOCs, only benzene was detected at a concentration exceeding the RBC. Although ten total metals exceeded the respective RBCs, only two dissolved metals (iron and manganese) exceeded the RBCs, indicating that the total metals exceedances are due to suspended solids.

At the Snake Road Burning Ground Area, GCL-MW02A exhibited one detected VOC (carbon disulfide) at a concentration well below the RBC (Table 6-11). SVOCs were detected in two wells; bis(2-ethylhexyl)phthalate exceeded the RBC in GCL-MW01 while diethyl phthalate was detected at a concentration well below the RBC in GCL-MW02B. Explosives and cyanide were not detected in any of the four sampled GCL-series wells.

Up to ten total metals were detected in at least one of the four GCL-series wells, of which up to seven exceeded the respective RBCs (Table 6-11). However, only two dissolved (filtered samples) inorganic constituents were detected at concentrations above the RBC indicating that most of the total metals were due to suspended solids. Dissolved manganese exceeded the RBC in each of the four wells while dissolved iron was detected in each well but exceeded the RBC only in GCL-MW01 and GCL-MW02B.

Water quality parameters for the sampled burning grounds wells are also shown on Table 6-11; however, none of these parameters exceeded RBCs.

6.2.1.7.2 Second Semi-Annual Sampling Event

During the May 1998 sampling event, IT-ABG-GW002 (ABG) again exhibited one VOC (benzene) at a concentration exceeding the RBC (Table 6-11); SVOCs, cyanide, and explosives were not detected. Comparable to the November 1997 sampling event, a suite of nine total metals exceeded the RBCs in this well in May 1998. However, only two dissolved metals were detected, indicating that most total metals exceeding the RBCs were due to suspended solids. In the dissolved phase, iron and manganese again exceeded the RBCs during the May 1998 sampling event.

Each of the four GCL-series wells exhibited detectable concentrations of VOCs in May 1998, but none of the detected concentrations exceeded RBCs. SVOCs were detected in only one well

(GCL-MW03); however, the detected concentration of phenol was well below the RBC (Table 6-11). Cyanide and explosives were not detected in any of the Snake Road Burning Ground Area wells in May 1998.

As with the November 1997 sampling event, several total metals were detected at concentrations exceeding the RBCs in the GCL-series wells in May 1998 (Table 6-11). However, filtered samples from these wells indicated the presence of only two dissolved metals at concentrations exceeding the RBCs. Dissolved manganese exceeded the RBC in each of the four wells, and while dissolved iron was detected in each well it exceeded the RBC in only three of the four wells (excluding GCL-MW02A).

Water quality parameters from the May 1998 sampling event for the wells sampled at the burning grounds are also presented on Table 6-11.

6.2.1.7.3 Summary of Sampling Events

Results from the two sampling events at the ABG suggest that the overburden water-bearing zone has been impacted to a limited extent by VOCs (benzene) at concentrations slightly above the RBCs. Two dissolved metals (iron and manganese) have exceeded the RBCs at concentrations that appear to be consistent with those observed in other areas of PBOW. Therefore, these RBC exceedances are suspected to be naturally occurring but will require further evaluation.

Overburden groundwater at the Snake Road Burning Ground Area exhibits limited impacts by VOCs and SVOCs, generally at concentrations below the RBCs. However, these constituents have been detected sporadically over the two sampling events and further study is warranted to determine whether they are due to site contamination. As with the ABG results, only two dissolved metals (iron and manganese) have exceeded RBCs but at concentrations comparable to those in other areas of PBOW.

6.2.1.8 Lower Toluene Tanks Area

Two overburden monitoring wells (MK-MW14 and MK-MW15) were sampled during the two semi-annual sampling events in the vicinity of the lower toluene tanks area (Figure 6-30). Note that these wells were discussed in previous IT reports as part of TNT Area B. Each well was analyzed for VOCs, SVOCs, nitroaromatic explosives, PCBs, metals (total and dissolved), cyanide, and water quality parameters as previously discussed.

6.2.1.8.1 First Semi-Annual Sampling Event

One VOC (carbon disulfide) and one SVOC (bis(2-ethylhexyl)phthalate) were detected in the two overburden water-bearing zone wells sampled at the lower toluene tanks area in November 1997. However, with the exception of bis(2-ethylhexyl)phthalate in MK-MW15, these detections were below the RBCs (Table 6-12). Explosives and cyanide were not detected in either well.

Up to five total metals were detected in the two wells during the November 1997 sampling event, of which two (iron and manganese) exceeded the RBCs in both wells (Table 6-12). These two metals also exceeded the RBCs in the dissolved phase at concentrations similar to those reported for the unfiltered sample, an indication that these metals are present primarily in the dissolved phase in the two wells.

Water quality parameters for the two wells sampled at the lower toluene tank area are also shown on Table 6-12; however, none of these parameters exceeded RBCs.

6.2.1.8.2 Second Semi-Annual Sampling Event

VOCs, SVOCs, and explosive compounds were not detected in the two lower toluene tank area wells during the May 1998 sampling event. Cyanide was detected in MK-MW14 but at a concentration below the RBC (Table 6-12). A suite of three total metals (aluminum, iron, and manganese) exceeded the RBCs in both wells in May 1998. However, only two dissolved metals were detected in the two wells (iron and manganese), and exceeded the RBCs only in MK-MW14. Detected concentrations of these dissolved metals in MK-MW15 were significantly lower than those observed during the November 1997 sampling event.

Water quality parameters from the May 1998 sampling event for the wells sampled at the lower toluene tanks area are also presented on Table 6-12.

6.2.1.8.3 Summary of Sampling Events

Analytical results from the two sampling events at the lower toluene tanks area indicates that the overburden water-bearing zone has not been impacted by past site activities. Two dissolved metals (iron and manganese) have exceeded the RBCs at concentrations that appear to be consistent with those observed in other areas of PBOW. Therefore, these RBC exceedances are suspected to be naturally occurring but will require further evaluation.

6.2.1.9 Upper Toluene Tanks Area

One monitoring well (MK-MW20) has been sampled during the two semi-annual sampling events at the upper toluene tanks area (Figure 6-29). This well was analyzed for VOCs, SVOCs, nitroaromatic explosives, PCBs, metals (total and dissolved), cyanide, and water quality parameters as previously discussed.

6.2.1.9.1 First Semi-Annual Sampling Event

One VOC (toluene) and three SVOCs (2-methylphenol, 4-methylphenol, and bis(2-ethylhexyl)phthalate) were detected at concentrations well above the respective RBCs in the overburden water-bearing zone well at the upper toluene tanks area in November 1997 (Table 6-13). In addition, phenol was detected in MK-MW20 at a concentration well below the RBC. Explosives and cyanide were not detected in the sampled well.

Seven total metals were detected in MK-MW20 at concentrations exceeding the RBCs during the November 1997 sampling event (Table 6-13). However, only two metals (iron and manganese) were detected in the dissolved phase, neither of which exceeded the RBC; this indicates that the total metals exceedances were due to suspended solids in the unfiltered sample.

Water quality parameters for MK-MW20 are also shown on Table 6-13.

6.2.1.9.2 Second Semi-Annual Sampling Event

Confirming results from the November 1997 sampling event, one VOC (toluene) and two SVOCs (2-methylphenol and 4-methylphenol) were detected at concentrations above the RBCs in MK-MW20 during the May 1998 sampling event (Table 6-13). Phenol was also detected, but again at a concentration below the RBC. Explosive compounds and cyanide were not detected. Two total and dissolved metals (iron and manganese) were also detected at concentrations exceeding the RBCs (Table 6-13).

Water quality parameters from the May 1998 sampling event for the well sampled at the upper toluene tanks area are also presented on Table 6-13.

6.2.1.9.3 Summary of Sampling Events

Analytical results from the two sampling events at the upper toluene tanks area indicates that the overburden water-bearing zone has been impacted by toluene and SVOCs from past site activities. Two dissolved metals (iron and manganese) have exceeded the RBCs at

concentrations that appear to be consistent with those observed in other areas of PBOW. It should be noted that although these dissolved metals did not exceed the RBCs in November 1997, the reported concentrations for the two sampling events are comparable and are slightly below or slightly above the RBCs, respectively (Table 6-13). These inorganic RBC exceedances are suspected to be naturally occurring but will require further evaluation.

6.2.1.10 Reactor Building Area

One monitoring well (IT-MW06) has been sampled during the two semi-annual sampling events near the Reactor Building (Figure 6-31). This well was analyzed for VOCs, SVOCs, nitroaromatic explosives, PCBs, metals (total and dissolved), cyanide, and water quality parameters as previously discussed.

6.2.1.10.1 First Semi-Annual Sampling Event

One VOC (toluene) was detected in IT-MW06 in November 1997, but at a concentration well below the RBC (Table 6-14). SVOCs, cyanide, and explosives were not detected.

Two total metals (iron and manganese) were detected at concentrations exceeding the RBCs during the November 1997 sampling event (Table 6-14). However, neither metal was detected in the dissolved phase, indicating that the total metals exceedances were due to suspended solids in the unfiltered sample.

Water quality parameters for IT-MW06 are also shown on Table 6-14.

6.2.1.10.2 Second Semi-Annual Sampling Event

VOCs, SVOCs, explosive compounds, and cyanide were not detected in IT-MW06 during the May 1998 sampling event. Two total metals (iron and manganese) were detected at concentrations exceeding the RBCs (Table 6-14); however, none of the detected dissolved metals exceeded the RBCs.

Water quality parameters from the May 1998 sampling event for IT-MW06 near the Reactor Building are also presented on Table 6-14.

6.2.1.10.3 Summary of Sampling Events

Analytical results from the two sampling events at the Reactor Building indicates that the overburden water-bearing zone in this area has not been impacted by past site activities.

6.2.2 Bedrock Water-Bearing Zone

A total of 17 bedrock wells were sampled under the annual GWI. Specific locations of these wells are as follows:

- One at the WARWP Area 1
- One at the PRRWP Area 1
- Two at TNTA 2
- Two at TNTB 2
- One at TNTC 1
- Two at AA1 11
- Two at AA2 11
- One at AA3 1
- Two at various Burning Grounds 11
- One at the Upper Toluene Tank Area 1
- One at the Reactor Facility
- One upgradient of the PBOW (background). 1

Note that results from sampling of the upgradient background well are included in background wells, Section 6.2.3.

6.2.2.1 West Area Red Water Ponds Area

One bedrock monitoring well (PB-BED-MW14) was sampled during the two semi-annual sampling events at the WARWP at the locations shown on Figure 6-18. This well is located northeast and downgradient of the former Red Water Ponds, and was analyzed for VOCs, SVOCs, nitroaromatic explosives, PCBs, metals (total and dissolved), cyanide, and water quality parameters as previously discussed.

6.2.2.1.1 First Semi-Annual Sampling Event

Four VOCs (benzene, carbon disulfide, ethyl benzene, and total xylenes) were detected in PB-BED-MW14 in November 1997. Of these detected VOCs, only benzene exceeded the RBC (Table 6-15). SVOCs and explosives were not detected in this well in November 1997.

Several metals (total and dissolved) were detected in PB-BED-MW14 but none exceeded the respective RBCs (Table 6-15). Similarly, cyanide was detected but at a concentration below the RBC. Water quality parameters are also presented on Table 6-15.

6.2.2.1.2 Second Semi-Annual Sampling Event

One VOC (carbon disulfide) was detected in PB-BED-MW14 during the May 1998 sampling event, but at a concentration well below the RBC (Table 6-15). However, four SVOCs (2,4-dinitrophenol, 2,4-DNT, 4,6-dinitro-2-methylphenol, and nitrobenzene) were detected at concentrations in excess of calculated RBCs. These explosive compounds were not detected under the nitroaromatic analysis.

As observed during the November 1997 sampling event, several metals (total and dissolved) were detected in PB-BED-MW14 in May 1998 but none exceeded the respective RBCs (Table 6-15). Cyanide was again detected but at a concentration below the RBC. Water quality parameters are also presented on Table 6-15; nitrate exceeded the RBC during the May 1998 sampling event.

6.2.2.1.3 Summary of Sampling Events

Results from the two sampling events at the WARWP area indicate that the bedrock water-bearing zone exhibits impacts from low levels of VOCs, primarily BTEX constituents. Nitroaromatic explosives also appear to have impacted the bedrock water-bearing zone based on the May 1998 SVOC sample results.

6.2.2.2 Pentolite Road Red Water Ponds Area

One bedrock monitoring well (PB-BED-MW15) was sampled during the two semi-annual sampling events at PRRWP (Figure 6-19). This well is located north and downgradient of the former red water ponds and was analyzed for VOCs, SVOCs, nitroaromatic explosives, PCBs, metals (total and dissolved), cyanide, and water quality parameters as previously discussed.

6.2.2.2.1 First Semi-Annual Sampling Event

The four BTEX constituents were detected in PB-BED-MW15 in November 1997, including benzene, ethyl benzene, and toluene at concentrations exceeding the RBCs (Table 6-16). Ten SVOCs were also detected, but only bis(2-ethylhexyl)phthalate exceeded the RBC. Explosives and cyanide were not detected in PB-BED-MW15 in November 1997. Of the detected total and dissolved metals, only barium (total and dissolved) exceeded the RBC (Table 6-16). Water quality parameters are also presented on Table 6-16.

6.2.2.2.2 Second Semi-Annual Sampling Event

VOCs, including BTEX, 1,1,2-TCA, and chlorobenzene, were detected in PB-BED-MW15 during the May 1998 sampling event (Table 6-16). Of these, 1,1,2-TCA, benzene, chlorobenzene, ethyl benzene, and toluene exceeded the respective RBCs. Eight SVOCs were also detected in PB-BED-MW15 in May 1998, but none exceeded the RBCs. Two explosives (2,4-DNT and 2,6-DNT) were detected at concentrations well below the RBCs. Cyanide was not detected in this well in May 1998.

Several total metals, including five (barium, chromium, iron, manganese, and thallium) exceeding RBCs, were detected in PB-BED-MW15 in May 1998 (Table 6-16). However, in the dissolved phase, only barium and thallium were detected at concentrations exceeding the RBCs. Water quality parameters for PB-BED-MW15 are also presented on Table 6-16.

6.2.2.2.3 Summary of Sampling Events

Results from the two sampling events at the PRRWP area indicate that the bedrock water-bearing zone has been impacted by VOCs and bis(2-ethylhexyl)phthalate near the former Red Water Ponds. Metals have also exceeded the RBCs, but detected concentrations require further evaluation to determine whether they are due to site contamination.

6.2.2.3 TNT Manufacturing Area A

Two bedrock monitoring wells (PB-BED-MW17 and PB-BED-MW18) were sampled during the two semi-annual sampling events at TNTA (Figure 6-20). PB-BED-MW17 is located north and downgradient of TNTA, while PB-BED-MW18 east and sidegradient of TNTA. Both wells were analyzed for VOCs, SVOCs, nitroaromatic explosives, PCBs, metals (total and dissolved), cyanide, and water quality parameters as previously discussed.

6.2.2.3.1 First Semi-Annual Sampling Event

VOCs, including BTEX and carbon disulfide, were detected in both PB-BED-MW17 and PB-BED-MW18 in November 1997. Of these detected VOCs, benzene exceeded the RBC in both wells, while toluene exceeded the RBC only in PB-BED-MW17 (Table 6-17). Several SVOCs were detected in PB-BED-MW18 but at concentrations below the RBCs; PB-BED-MW17 did not exhibit detectable concentrations of SVOCs in November 1997.

Both of the sampled TNTA bedrock wells exhibited detectable concentrations of nitroaromatic compounds (Table 6-17). Of the three detected explosive constituents in downgradient well PB-

BED-MW18, only 1,3-DNB and nitrobenzene exceeded the RBCs. In PB-BED-MW17, nitrobenzene was detected but at a concentration below the RBC.

Several metals were detected in each of the TNTA bedrock wells in November 1997 (Table 6-17). Although three total metals exceeded the respective RBCs in PB-BED-MW17, only barium was detected at a concentration above the RBC in the filtered sample. In PB-BED-MW18, RBCs were exceeded only by total and dissolved barium. Cyanide was only detected in PB-BED-MW17 but at a concentration well above the RBC.

Water quality parameters are also presented on Table 6-17; however, none of the detected parameters exceeded RBCs.

6.2.2.3.2 Second Semi-Annual Sampling Event

VOCs, including BTEX, acetone, and carbon disulfide were detected in at least one of the two bedrock wells in May 1998. None of the VOCs detected in PB-BED-MW17 exceeded the RBCs, while benzene exceeded the RBC in PB-BED-MW18 (Table 6-17). Several SVOCs were also detected in the two bedrock wells, but at concentrations below the RBCs. Only one of the sampled TNTA wells (PB-BED-MW18) exhibited detectable concentrations of nitroaromatic compounds (Table 6-17); however, neither detected explosive compound exceeded the RBC.

Several metals were detected in each of the sampled bedrock wells at TNTA in May 1998 (Table 6-17). Three total metals were detected in both wells, with barium exceeding the RBC in each case and manganese exceeding the RBC in PB-BED-MW18. In the dissolved phase, arsenic and barium exceeded the RBC in PB-BED-MW17 while barium and manganese exceeded the RBC in PB-BED-MW18. Cyanide was not detected in either bedrock well sampled at TNTA in May 1998. Water quality parameters are also presented on Table 6-17; however, none of the detected parameters exceeded RBCs.

6.2.2.3.3 Summary of Sampling Events

Based on results from the two sampling events at TNTA, the bedrock water-bearing zone exhibits impacts from VOCs, SVOCs, and nitroaromatic explosives. Metals have exceeded RBCs, but dissolved RBC exceedances are limited to arsenic, barium, and manganese. Further evaluation is needed to determine whether these inorganic constituents are due to site contamination.

6.2.2.4 TNT Manufacturing Area B

Two bedrock monitoring wells (IT-TNTB-BED-GW001 and IT-TNTB-BED-GW002) were sampled during the two semi-annual sampling events at TNTB (Figure 6-21). IT-TNTB-BED-GW001 is located northwest and downgradient of TNTB while IT-TNTB-BED-GW002 is located south and upgradient of the site. Each well was analyzed for VOCs, SVOCs, nitroaromatic explosives, PCBs, metals (total and dissolved), cyanide, and water quality parameters as previously discussed.

6.2.2.4.1 First Semi-Annual Sampling Event

VOCs and SVOCs were detected in both bedrock wells sampled at TNTB in November 1997 (Table 6-18). However, of these detected constituents, only one VOC (benzene) was detected at a concentration above the RBC and only in the upgradient well, IT-TNTB-BED-GW002. Explosives and cyanide were not detected in either well.

IT-TNTB-BED-GW001 exhibited detectable concentrations of seven total metals, of which only iron and manganese exceeded the RBC (Table 6-18). In the dissolved phase, only iron and manganese were detected, exceeding the RBCs for each. Six total metals were detected in IT-TNTB-GW002 of which barium and manganese exceeded the RBCs. The filtered sample exhibited four dissolved metals, of which only barium exceeded the RBC. Water quality parameters are also presented on Table 6-18; however, none of the detected parameters exceeded RBCs.

6.2.2.4.2 Second Semi-Annual Sampling Event

Two VOCs (1,1-dichloroethane [DCA] and carbon disulfide) were detected in IT-TNTB-BED-GW001 in May 1998 but at concentrations below the RBCs; VOCs were not detected in IT-TNTB-BED-GW002 (Table 6-18). SVOCs, explosives, and cyanide were not detected in the two TNTB bedrock wells in May 1998.

IT-TNTB-BED-GW001 exhibited detectable concentrations of eight total metals of which arsenic, barium, iron, and manganese exceeded the RBCs (Table 6-18). However, of three detected dissolved metals, only barium and manganese exceeded the RBCs. Four total metals were detected in IT-TNTB-GW002, of which only barium exceeded the RBCs. The filtered sample exhibited two dissolved metals, of which only barium exceeded the RBC.

Water quality parameters are also presented on Table 6-18; however, none of the detected parameters exceeded RBCs.

6.2.2.4.3 Summary of Sampling Events

Results from the two sampling events at TNTB indicate that the bedrock water-bearing zone exhibits limited impacts from organic constituents at concentrations generally below the RBCs. Metals have also exceeded RBCs, but further evaluation is needed to determine whether these inorganic constituents are due to site contamination.

6.2.2.5 TNT Manufacturing Area C

One bedrock monitoring well (PB-BED-MW13) has been sampled during the two semi-annual sampling events near TNTC (Figure 6-22). PB-BED-MW13 is located on the north side and downgradient of TNTC and was analyzed for VOCs, SVOCs, nitroaromatic explosives, PCBs, metals (total and dissolved), cyanide, and water quality parameters as previously discussed.

6.2.2.5.1 First Semi-Annual Sampling Event

Five VOCs (BTEX and carbon disulfide) were detected in PB-BED-MW13 during the November 1997 sampling event; of these detections, benzene and toluene exceeded the respective RBCs (Table 6-19). A suite of seven SVOCs was also detected in this well, but only one (bis(2-ethylhexyl)phthalate) exceeded the RBCs. Explosives and cyanide were not detected in the TNTC bedrock well in November 1997.

Three total metals (barium, manganese, and zinc) were detected in PB-BED-MW13 in November 1997 (Table 6-19). Of these, only barium exceeded the RBC. In the dissolved phase (filtered samples), barium again exceeded the RBC while zinc was detected at a concentration well below the RBC. Water quality parameters are also presented on Table 6-19.

6.2.2.5.2 Second Semi-Annual Sampling Event

Four VOCs (BTEX) were detected in PB-BED-MW13 during the May 1998 sampling event (Table 6-19). Of these VOCs, benzene and toluene exhibited concentrations above the RBCs. Similar to the November results, eight SVOCs were detected in this bedrock well in May 1998; however, bis(2-ethylhexyl)phthalate was the only SVOC detected at concentrations above the RBCs. Nitroaromatic compounds and cyanide were not detected in PB-BED-MW13 in May 1998.

Two total metals (iron and manganese) and two dissolved metals (barium and manganese) were detected in PB-BED-MW13 in May 1998 (Table 6-19). However, none of these inorganic constituents were present at concentrations exceeding the RBCs. Water quality parameters are also presented on Table 6-19.

6.2.2.5.3 Summary of Sampling Events

Based on results from the two sampling events at TNTC, the bedrock water-bearing zone exhibits impacts by organic constituents, of which benzene, toluene, and bis(2-ethylhexyl)phthalate have exceeded RBCs. One metal (barium) also exceeded the RBC, but further evaluation is needed to determine whether this inorganic constituent is due to site contamination.

6.2.2.6 Acid Areas and Maintenance Shop Area

Five bedrock monitoring wells were sampled during the two semi-annual sampling events in the vicinity of three acid areas. Of these, one (IT-AA1-BED-GW001) is located at AA1 (Figure 6-23), two (IT-AA2-BED-GW001 and PB-BED-MW19) are located at AA2 (Figure 6-24), one (IT-AA3-BED-GW001) is located at AA3 (Figure 6-25), and one (IT-MNTA-BED-GW001) is located in the MNTA north of AA1 (Figure 6-23). Each well was analyzed for VOCs, SVOCs, nitroaromatic explosives, PCBs, metals (total and dissolved), cyanide, and water quality parameters as previously discussed.

6.2.2.6.1 First Semi-Annual Sampling Event

At AA1, IT-AA1-BED-GW001 exhibited detectable concentrations of VOCs and SVOCs during the November 1997 sampling event (Table 6-20). Of the detected organic parameters, benzene and bis(2-ethylhexyl)phthalate exceeded the RBCs. Explosives and cyanide were not detected in this well in November 1997. Several total and dissolved metals were also detected in IT-AA1-BED-GW001. Although four total metals (arsenic, barium, iron, and manganese) exceeded the RBCs, only two dissolved metals (barium and manganese) exceeded the RBCs (Table 6-20).

Both of the two sampled bedrock wells at AA2 exhibited detectable concentrations of VOCs and SVOCs during the November 1997 sampling event. In IT-AA2-BED-GW001, RBCs were exceeded by benzene and chlorobenzene, while PB-BED-MW19 exhibited benzene and bis(2-ethylhexyl)phthalate at concentrations above the RBCs. Nitroaromatic compounds were detected in PB-BED-MW19 but did not exceed the RBCs. Of the detected metals in IT-AA2-BED-GW001, only total iron, total manganese, and dissolved manganese were present at

concentrations above the RBCs. In PB-BED-MW19, inorganic constituents exceeding the RBCs were limited to total and dissolved barium (Table 6-20). Cyanide was detected in PB-BED-MW19 but did not exceed the RBC.

Two VOCs and two SVOCs were detected in IT-AA3-BED-GW001; however, only bis(2-ethylhexyl)phthalate exceeded the RBCs. Explosives and cyanide were not detected in this well in November 1997. Detected inorganic constituents in IT-AA3-BED-GW001 were limited to total and dissolved manganese and zinc; of these, only total manganese exceeded the RBC (Table 6-20).

Monitoring well IT-MNTA-BED-GW001, located at MNTA, exhibited detectable concentrations of VOCs, SVOCs, and metals during the November 1997 sampling event. None of the detected VOCs and SVOCs exceeded RBCs (Table 6-20). Of the detected metals, barium (total and dissolved), iron (total), and manganese (total and dissolved) exceeded the RBCs.

Water quality parameters for the sampled bedrock wells at the three acid areas and the MNTA are also presented on Table 6-20.

6.2.2.6.2 Second Semi-Annual Sampling Event

During the May 1998 sampling event, IT-AA1-BED-GW001 exhibited detectable concentrations of VOCs, SVOCs, and explosives. Of these organic compounds, one VOC (benzene) and one explosive (RDX) exceeded the respective RBCs (Table 6-20). Five total metals and three dissolved metals were also detected in this well; four of the five total metals (arsenic, barium, iron, and manganese) and all of the dissolved metals (arsenic, barium, and manganese) exceeded the RBCs. Cyanide was not detected in IT-AA1-BED-GW001 in May 1998.

Both of the AA2 bedrock wells exhibited VOCs, SVOCs, and explosives during the May 1998 sampling event. In IT-AA2-BED-GW001, benzene and 1,3-DNB exceeded the RBCs, while only benzene exceeded the RBC in PB-BED-MW19 (Table 6-20). A large suite of nine total metals exceeded the RBCs in IT-AA2-BED-GW001 in May 1998; however, only barium and manganese exceeded the RBC in the dissolved phase, indicating that the total metals exceedances were due primarily to suspended solids in the unfiltered sample. In PB-BED-MW19, only total and dissolved barium exceeded the RBC. Cyanide was also detected in PB-BED-MW19 but did not exceed the RBC.

VOCs, SVOCs, cyanide, and nitroaromatic compounds were not detected in IT-AA3-BED-GW001 in May 1998. Three total metals and one dissolved metal were detected in this well, but RBC exceedances were limited to total manganese (Table 6-20).

At the MNTA, IT-MNTA-BED-GW001 again exhibited detectable concentrations of VOCs, SVOCs, and metals during the May 1998 sampling event. One VOC (benzene) exceeded the RBC while total and dissolved barium and manganese exceeded their respective RBCs. In addition, this well exhibited three explosive compounds in May 1998 of which 1,3-DNB exceeded the RBC (Table 6-20). Cyanide was not detected in IT-MNTA-BED-GW001 in May 1998.

Water quality parameters from the May 1998 sampling event for the wells sampled at the three acid areas and the MNTA are also presented on Table 6-20.

6.2.2.6.3 Summary of Sampling Events

Results from the two sampling events at AA1 indicate that the bedrock water-bearing zone has been impacted by low levels of VOCs, SVOCs, and explosives. It is suspected that BTEX constituents there may be related to the Middle Toluene Tanks Area located approximately 2,400 feet upgradient. Monitoring wells have not been installed at the Middle Toluene Tanks Area. Other organic constituents are likely due to past activities at AA1. Three dissolved metals (arsenic, barium, and manganese) have exceeded the RBCs, but at concentrations that appear to be similar to other areas of PBOW.

Bedrock groundwater at AA2 exhibits impacts by VOCs, SVOCs, and explosives, all of which are considered to be site related. While several metals have exceeded RBCs, further study is needed to determine whether these constituents are site related.

Results from the sampling events at AA3 indicate that the bedrock water-bearing zone has not been impacted by past site activities. Sporadic detections of low levels of VOCs and SVOCs are not considered site-related contaminants. None of the inorganic constituents have exceeded the RBCs in the dissolved phase and metals are not considered contaminants of concern at AA3.

In the MNTA, the bedrock water-bearing zone exhibits impacts from low levels of VOCs, SVOCs, and explosives. Two dissolved metals have exceeded RBCs and further study is needed to determine whether these constituents are site-related contaminants.

6.2.2.7 Burning Ground Areas

Two bedrock monitoring wells were sampled during the two semi-annual sampling events in the vicinity of two former burning grounds areas. Of these, one (IT-ABG-BED-GW001) is located at the ABG (Figure 6-26) and one (IT-BG8-BED-GW001) is located at the G-8 Burning Ground (BG8) (Figure 6-27). Each well was analyzed for VOCs, SVOCs, nitroaromatic explosives, PCBs, metals (total and dissolved), cyanide, and water quality parameters as previously discussed.

6.2.2.7.1 First Semi-Annual Sampling Event

Groundwater in the bedrock water-bearing zone at the ABG exhibited detectable concentrations of VOCs and metals in November 1997; SVOCs, cyanide, and explosives were not detected (Table 6-21). The detected VOC (trichloroethene) did not exceed the RBC. Although four total metals exceeded the respective RBCs, only two dissolved metals (iron and manganese) exceeded the RBCs.

At the BG8, bedrock groundwater exhibited detectable levels of VOCs, SVOCs, and metals during the November 1997 sampling event. The detected VOC and SVOC constituents did not exceed RBCs. Explosives and cyanide were not detected in either sampled well. Nine total metals were detected in IT-BG8-BED-GW001 of which seven exceeded the respective RBCs (Table 6-21). However, only two dissolved inorganic constituents (barium and manganese) were detected at concentrations above the RBC, indicating that most of the total metals were due to suspended solids.

Water quality parameters for the sampled burning grounds wells are also shown on Table 6-21; however, none of these parameters exceeded RBCs in November 1997.

6.2.2.7.2 Second Semi-Annual Sampling Event

During the May 1998 sampling event, IT-ABG-BED-GW001 again exhibited one VOC (carbon disulfide) at a concentration below the RBC (Table 6-21); SVOCs, cyanide, and explosives were not detected. Three total metals (iron, lead, and manganese) exceeded the RBCs in this well in May 1998. However, only two dissolved metals exceeded the RBC (iron and manganese).

VOCs, SVOCs, explosives, and cyanide were not detected in IT-BG8-BED-GW001 during the May 1998 sampling event (Table 6-21). Two total metals (iron and manganese) were detected at

concentrations exceeding the RBCs, but the filtered sample indicated the presence of only manganese at a concentration exceeding the RBC.

Water quality parameters from the May 1998 sampling event for the wells sampled at the burning grounds are also presented on Table 6-18. Of these parameters, one (nitrate) exceeded the RBC in IT-BG8-BED-GW001.

6.2.2.7.3 Summary of Sampling Events

Results from the two sampling events at the ABG and BG8 suggest that the bedrock water-bearing zone in these areas has not been impacted by past site activities. Three dissolved metals (barium, iron, and manganese) have exceeded the RBCs at concentrations that appear to be consistent with those observed in other areas of PBOW. Therefore, these RBC exceedances are suspected to be naturally occurring but will require further evaluation.

Because of its location and lack of contaminants, IT-BG8-BED-GW001 appears to be a potential background well.

6.2.2.8 Lower Toluene Tanks Area

Bedrock monitoring wells have not been installed in the lower toluene tanks area and this water-bearing zone has not been monitored under the GWI.

6.2.2.9 Upper Toluene Tanks Area

One bedrock monitoring well (PB-BED-MW16) has been sampled during the two semi-annual sampling events at the upper toluene tanks area (Figure 6-28). This well was analyzed for VOCs, SVOCs, nitroaromatic explosives, PCBs, metals (total and dissolved), cyanide, and water quality parameters as previously discussed.

6.2.2.9.1 First Semi-Annual Sampling Event

Three VOCs (benzene, ethyl benzene, and toluene) and one SVOC (bis[2-ethylhexyl]phthalate) were detected at concentrations well above the respective RBCs in the bedrock water-bearing zone well at the upper toluene tanks area in November 1997 (Table 6-22). In addition, total xylene was detected in PB-BED-MW16 at a concentration slightly below the RBC. Explosives and cyanide were not detected in the sampled well.

Five total metals were detected in PB-BED-MW16 at concentrations exceeding the RBCs during the November 1997 sampling event (Table 6-22). However, only two metals (barium and vanadium) exceeded the RBC in the dissolved phase. Water quality parameters for PB-BED-MW16 are also shown on Table 6-22.

6.2.2.9.2 Second Semi-Annual Sampling Event

Confirming results from the November 1997 sampling event, three VOCs (benzene, ethyl benzene, and toluene) and one SVOC (1,3-dichlorobenzene) were detected at concentrations above the RBCs in PB-BED-MW16 during the May/June 1998 sampling event (Table 6-22). Total xylene was also detected, again at a concentration slightly below the RBC. Explosive compounds and cyanide were not detected. Eight total metals but only three dissolved metals (barium, thallium, and vanadium) exceeded the RBCs, indicating that most of the total metals were due to suspended solids in the unfiltered sample (Table 6-22).

Water quality parameters from the May/June 1998 sampling event for the bedrock well sampled at the upper toluene tanks area are also presented on Table 6-22.

6.2.2.9.3 Summary of Sampling Events

Analytical results from the two sampling events at the upper toluene tanks area indicates that the bedrock water-bearing zone has been impacted by BTEX and SVOCs from past site activities. Three dissolved metals (barium, thallium, and vanadium) have exceeded the RBCs. These inorganic RBC exceedances will require further evaluation to determine whether they are naturally occurring.

6.2.2.10 Reactor Building Area

One bedrock monitoring well (REACTOR 1) has been sampled during the two semi-annual sampling events near the Reactor Building (Figure 6-30). This well was analyzed for VOCs, SVOCs, nitroaromatic explosives, PCBs, metals (total and dissolved), cyanide, and water quality parameters as previously discussed.

6.2.2.10.1 First Semi-Annual Sampling Event

Two VOCs (benzene and total xylene) were detected in REACTOR 1 in November 1997; benzene exceeded the RBC while total xylene was detected at a concentration well below the RBC (Table 6-23). One SVOC, bis(2-ethylhexyl)phthalate, was detected at a concentration well above the RBC. Cyanide and explosives were not detected.

Four total metals (barium, iron, lead, and manganese) were detected at concentrations exceeding the RBCs during the November 1997 sampling event (Table 6-23). However, only barium and manganese exceeded the RBCs in the filtered sample.

Water quality parameters for REACTOR 1 are also shown on Table 6-23.

6.2.2.10.2 Second Semi-Annual Sampling Event

Six VOCs were detected in REACTOR 1 during the May 1998 sampling event, with benzene exhibiting a concentration above the RBC (Table 6-23). SVOCs, explosive compounds, and cyanide were not detected. Two metals (iron and manganese) were detected at concentrations exceeding the RBCs in both total and dissolved phases (Table 6-23).

Water quality parameters from the May 1998 sampling event for REACTOR 1 are also presented on Table 6-23.

6.2.2.10.3 Summary of Sampling Events

Analytical results from the two sampling events at the Reactor Building indicates that the bedrock water-bearing zone in this area exhibits low levels of VOC and SVOC constituents, predominantly below the RBCs. Three dissolved metals (barium, iron, and manganese) have exceeded the RBCs at concentrations that appear to be consistent with those observed in other areas of PBOW. These inorganic RBC exceedances are suspected to be naturally occurring but will require further evaluation.

6.2.3 Background Monitoring Wells

6.2.3.1 Overburden Background Monitoring Wells

One monitoring well (IT-MW01) located near the intersection of West Scheid Road and Patrol Road in the south central portion of PBOW (Figure 6-31) has been sampled during the two semi-annual sampling events. IT-MW01 is located upgradient of PBOW and is considered a background well. This well was analyzed for VOCs, SVOCs, nitroaromatic explosives, PCBs, metals (total and dissolved), cyanide, and water quality parameters as previously discussed.

6.2.3.1.1 First Semi-Annual Sampling Event

VOCs, SVOCs, cyanide, and explosives were not detected in IT-MW01 during the November 1997 sampling event. Four total metals (iron, manganese, mercury, and zinc) were detected, of which iron and manganese exceeded the RBCs (Table 6-24). In the dissolved phase, iron, manganese, and zinc were detected, of which only manganese exceeded the RBC. Water quality parameters for IT-MW01 are also shown on Table 6-24.

6.2.3.1.2 Second Semi-Annual Sampling Event

SVOCs, explosive compounds, and cyanide were not detected in IT-MW01 during the May 1998 sampling event. However, one VOC (toluene) was detected at a concentration below the RBC. Three total metals (iron, manganese, and zinc) were detected of which iron and manganese exceeded the RBCs (Table 6-24). In the dissolved phase, aluminum, iron, and manganese were detected, with manganese and iron exceeding the RBCs. Water quality parameters are also presented on Table 6-24.

6.2.3.1.3 Summary of Sampling Events

Analytical results from IT-MW01 over the two sampling events indicate that this well has not been impacted by past site activities and is suitable for use as a background monitoring well. However, the existing data set is insufficient for the determination of background concentrations in the overburden water-bearing zone.

6.2.3.2 Bedrock Background Monitoring Well

One bedrock monitoring well (PB-BED-MW20) located near the intersection of Taft Road and Patrol Road in the southern portion of PBOW (Figure 6-31) has been sampled during the two semi-annual sampling events; this well is located upgradient of PBOW and is considered a background well. PB-BED-MW20 was analyzed for VOCs, SVOCs, nitroaromatic explosives, PCBs, metals (total and dissolved), cyanide, and water quality parameters as previously discussed.

6.2.3.2.1 First Semi-Annual Sampling Event

Three BTEX constituents and one SVOC were detected in PB-BED-MW20 during the November 1997 sampling event; of these detections, only benzene exhibited a concentration above the RBC (Table 6-24). Explosives and cyanide were not detected. Six total metals (aluminum, barium, copper, iron, manganese, and zinc) were detected, of which barium, iron, and manganese exceeded the RBCs (Table 6-24). In the dissolved phase, barium, iron, and

manganese were detected and exceeded the RBCs. Water quality parameters for PB-BED-MW20 are also shown on Table 6-24.

6.2.3.2.2 Second Semi-Annual Sampling Event

SVOCs, explosive compounds, and cyanide were not detected in PB-BED-MW20 during the May 1998 sampling event. However, three VOCs (benzene, carbon disulfide, and total xylene) were detected, of which only benzene exceeded the RBC. Four total metals (barium, iron, manganese, and mercury) were detected of which barium, iron, and manganese exceeded the RBCs (Table 6-24). In the dissolved phase, barium, iron, manganese, and mercury were detected, with barium and iron exceeding the RBCs. Water quality parameters are also presented on Table 6-24.

6.2.3.2.3 Summary of Sampling Events

Analytical results from PB-BED-MW20 over the two sampling events indicate that the bedrock water-bearing zone in this area exhibits low levels of VOCs and SVOCs which may be naturally occurring; however, further evaluation is necessary to confirm this. Up to three metals have exceeded RBCs in this well; however, the existing data set is insufficient for the determination of background concentrations in the bedrock water-bearing zone.

7.0 Site Conceptual Exposure Model

Exposure is the actual or potential for contact of a receptor with a chemical or physical agent through an identifiable pathway in the environment. An exposure assessment estimates the type and magnitude of potential exposure of a receptor to COPC found at or migrating from a site (EPA, 1989). An exposure assessment includes the following steps:

- Characterize the physical setting.
- Identify the contaminant sources, release mechanisms, and migration pathways.
- Identify the potentially exposed receptors.
- Identify the potential exposure pathways.

The site conceptual exposure model (SCEM) provides the basis for identifying and evaluating the potential risks to human health in a future baseline risk assessment (RA). Two SCEMs are provided for this report. The first is a generalized SCEM which includes the receptors appropriate to all plausible land-use scenarios, and the potential exposure pathways (Figure 7-1). The second is an SCEM limited to groundwater pathways, transport mechanisms, and receptors (Figure 7-2). Figure 7-2 applies to the data contained in this report.

Graphically presenting all possible pathways by which a potential receptor may be exposed, including all sources, release and transport pathways, and exposure routes, facilitates consistent and comprehensive evaluation of risk to human health, and helps ensure that potential pathways are not overlooked. The elements of an SCEM include:

- Source (i.e., initially contaminated environmental media)
- Contaminant release mechanisms
- Contaminant transport pathways
- Intermediate or transport media
- Exposure media
- Receptors
- Routes of exposure.

Contaminant release mechanisms and transport pathways are not required for direct receptor contact with a contaminated source medium.

The receptors and pathways in Figure 7-1 reflect plausible scenarios developed from information regarding site background and history, topography, climate, and site usage as presented in the

scope of work and the site-wide GWI (IT, 1997c). Asterisks identify exposure pathways that are complete and addressed in the RA. Justification for exclusion of other pathways is provided in the footnotes on the figure.

Contaminant Sources, Release Mechanisms, and Migration Pathways. The sources of DOD related groundwater contamination on site are TNT and related nitroaromatic compounds produced as part of the manufacturing process of TNT. Nitroaromatics were released directly to surface water ponds as part of the manufacturing process of TNT. Some of the pond water contaminants were sorbed into pond sediment or were precipitated out of solution and deposited onto the sediment. In addition, above- and below-ground process lines leaked or broke releasing nitroaromatics to the surface and/or subsurface soil. Over-land flow and runoff have spread soil-bound contamination over the surrounding soil, some of which may have reached surface water streams or ponds. Infiltration of contamination from the soil or sediment to the underlying groundwater also occurred. In turn, this contaminated groundwater migrated downgradient, some of which was released into streams, ponds, or marshy areas.

Receptors and Exposure Pathways. Receptors are selected to represent the upper bound on exposure from all plausibly exposed groups of people at the site. Most RA are based on a reasonable maximum exposure (RME) assumption. The intent of the RME assumption is to estimate the highest exposure level that could reasonably be expected to occur, but not necessarily the worst possible case (EPA, 1989, 1991). It is interpreted as reflecting the 90th to 95th percentile on exposure.

Three receptors provide the most plausible potential for human exposure to groundwater:

- On-Site Worker (current and future, including the construction worker and
- trainee)
- Sportsman (current and future, including the hunter and fisherman)
- On-Site Resident (future).

Although Plum Brook is not active, exposure potential exists for workers frequenting contaminated areas particularly, if they drink site groundwater for an extended period of time. A future on-site resident, using an on-site well, is proposed as a plausible scenario under future land use scenarios. Sportsmen may be exposed by direct exposure to site chemicals or by ingestion of

contaminated fish or venison. These animals can bioaccumulate certain chemicals obtained through their food and will be evaluated as potential exposure pathways. The construction worker scenario is included within the on-site worker receptor scenario. However, it is not relevant to Figure 7-2 because its principal exposure is subsurface soil rather than groundwater. Sufficiently frequent access to the site by a trespasser is considered unlikely and this scenario is not included.

8.0 Conclusions

IT has completed two semi-annual groundwater sampling events and four quarterly groundwater level measurement events of overburden and bedrock monitoring wells under the GWI at PBOW. Previous chapters of this report have presented results from these sampling and measurement events as well as hydrogeologic interpretations and conceptual site models developed as part of the site-wide GWI. Figure 8-1 is a compilation of overburden and bedrock monitoring wells that had groundwater samples exhibiting organics above EPA Region 3 RBCs. The following sections present conclusions of the GWI based on the data and interpretations previously presented.

8.1 Overburden Water-Bearing Zone

A total of 38 overburden wells were sampled on a semi-annual basis while groundwater levels were measured in 58 overburden wells on a quarterly basis under the 1997-1998 GWI.

8.1.1 Groundwater Sampling Results

8.1.1.1 Organic and Explosives Constituents

As presented on Table 8-1, analytical results from sampled overburden monitoring wells indicate that several areas of PBOW do not exhibit impacts of organic or explosive compounds from past site activities. Specifically, wells sampled at AA1, AA3, and the Reactor Building do not show organic or explosives contaminants at levels that would be considered to pose unacceptable risk to human health. While not presented on this table, the background well (IT-MW01) shows a similar absence of organic and explosives contaminants consistent with its stated purpose as an overburden background well.

A small suite of organic contaminants exceeding RBCs are evident in wells sampled at TNTC, AA2, the Maintenance Area, the ABG, the Snake Road Burning Ground, and the Lower Toluene Area (Table 8-1). At TNTC, bis(2-ethylhexyl)phthalate was detected in two wells at concentrations of 7.3 µg/L and 28 µg/L, well below the maximum detected concentration of this compound (Table 8-2). One well (MK-MW10) at Acid Area 2 exhibited chloroform (0.45 µg/L) and bis(2-ethylhexyl)phthalate (11 µg/L). The Maintenance Area Well (MK-MW19) exhibited consistent detections of 1,1,1-TCA and 1,1-DCA at concentrations near or above the RBCs; note that these constituents were not detected in other overburden wells (Table 8-2). At the ABG, benzene was detected at concentrations slightly above the RBCs during both sampling events,

while one well (GCL-MW01) at the Snake Road Burning Grounds exhibited bis(2-ethylhexyl)phthalate at 100 µg/L during the second sampling event which is well above the RBC. With the exception of results from the Maintenance Area, these detections have not been consistent over the two sampling events and are not necessarily attributable to site contamination. However, it is concluded that the overburden water-bearing zone at the Maintenance Area has been impacted by VOCs from past site activities.

TNTA exhibited one SVOC (bis(2-ethylhexyl)phthalate) and one nitroaromatic compound (4-amino-2,6-DNT) at concentrations exceeding the RBC. Of these, bis(2-ethylhexyl)phthalate was detected in May 1998 in MK-MW23 at a concentration of 890 µg/L, well above the RBC and is the maximum detected concentration at PBOW over the two sampling events. However, this compound was not detected in November 1997. 4-Amino-2,6-DNT was detected in MK-MW22 at concentrations exceeding the RBC during both sampling events; this well also exhibited other explosives at concentrations below the RBC during both sampling events. These results suggest that while the overburden water-bearing zone has been impacted by low levels of explosives in the north-central portion of TNTA, bis(2-ethylhexyl)phthalate warrants further evaluation to determine whether it is due to site contamination.

TNTB exhibited 4-amino-2,6-DNT at concentrations exceeding the RBC during both sampling events in MK-MW17 (3.6 to 5.7 µg/L). It is concluded that the overburden water-bearing zone on the north side of TNT Area B has been impacted by explosives from past site activities.

The Upper Toluene Area has exhibited a larger suite of organic contaminants than other sites exceeding RBCs, including toluene, 2-methylphenol, 4-methylphenol, and bis(2-ethylhexyl)phthalate (Table 8-1). The detected concentrations of these compounds have been well above the RBCs and have been detected during both sampling events, clearly indicating that the overburden water-bearing zone in this area has been impacted by organic contaminants from past site activities.

Two areas of PBOW have exhibited the largest suites of organic and explosive contaminants in the overburden water-bearing zone; the WARWP, and the PRRWP (Table 8-1). Although a slightly larger set of contaminants have exceeded RBCs at the WARWP, the highest concentrations of contaminants have been documented at the PRRWP. However, both areas exhibit significant impacts from past site activities, primarily because of their role as wastewater

disposal areas. In addition, groundwater from several overburden wells in these areas have been documented to contain red water, consistent with the high levels of nitroaromatic compounds.

In summary, the overburden water-bearing zone at PBOW has been impacted by organic and/or explosive contaminants to different extents by past site activities. Nitroaromatic compounds, explosives residues, and SVOCs have significantly impacted the PRRWP and the WARWP areas. Lesser impacts by nitroaromatic compounds are evident at TNTA and TNTB, with bis(2-ethylhexyl)phthalate also exceeding RBCs at TNTA. Two areas, the Upper Toluene Area and the Maintenance Area, have exhibited impacts by non-explosive organic contaminants at levels well above the RBCs. Lower levels of organic contaminants are evident at TNTC, AA2, the ABG, the Snake Road Burning Grounds, and the Lower Toluene Area. Three areas, AA1, AA3, and the Reactor Building Area, have not been impacted by past site activities.

8.1.1.2 Inorganic Constituents

As presented on Table 8-3, many total metals were determined to exceed the corresponding RBCs in overburden wells sampled across PBOW. However, as discussed in previous sections, many of these total metals were due to suspended solids in the unfiltered sample and were therefore not attributable to site groundwater contamination. Therefore, the following discussion focuses on dissolved metals except for total cyanide and nitrate.

The overburden water-bearing zone within three geographic areas did not exhibit dissolved inorganic compounds at concentrations above the RBCs; AA2, the Maintenance Area, and the Reactor Facility. Five areas (TNTC, AA3, the ABG, the Snake Road Burning Ground, and the Upper Toluene Area) exhibited only dissolved iron, manganese, and/or nickel at concentrations exceeding the RBCs (Table 8-3). Detected concentrations in these five areas were between 684 to 9,240 µg/L for dissolved iron, between 36.4 to 4,020 µg/L for dissolved manganese, and between 56.8 to 77.1 µg/L for dissolved nickel. Comparing these concentrations to site-wide detections (Table 8-4), it is evident that all were at least one order of magnitude below the maximum detected concentration. However, since background concentrations have not been established for metals in groundwater at PBOW, these metals will require further evaluation.

Two dissolved metals (iron and manganese) were detected at concentrations exceeding the RBCs at AA1 and the Lower Toluene Area. Detected concentrations ranged from 226 to 39,100 µg/L for iron and from 30.7 to 5,550 µg/L for manganese. Although dissolved manganese appears to

be well within the range of detected concentrations across PBOW (Table 8-4), the dissolved iron concentrations at the two sites may be elevated and warrant additional evaluation.

Larger suites of inorganic compounds were detected in wells from the WARWP, PRRWP, TNTA, and TNTB (Table 8-3). Although not necessarily attributable to site contamination, many of these metals were detected infrequently in the overburden water-bearing zone across PBOW (Table 8-4). The range in concentration of naturally occurring metals in PBOW overburden and bedrock water-bearing zones is not currently known. Once the range of background metals concentrations has been determined, the metals detected above RBCs should be re-evaluated to determine if they are site-related.

8.1.2 Overburden Geologic and Hydrogeological Conclusions

Groundwater flow in the overburden is predominantly to the north-northeast. The general flow direction in the overburden aquifer largely mirrors the surface topography and is strongly correspondent to the topography of the top of the bedrock; thus, groundwater on the western side of the site flows toward a groundwater low. Groundwater elevation fluctuations are very similar among overburden wells which may imply a high degree of connectivity between the site wells. Another possibility is that the overburden water-bearing zone has a higher vertical hydraulic conductivity than assumed and the water levels in the overburden are directly influenced by changes in the bedrock water-bearing zone water levels. Slug test results reveal significant variability in the overburden water-bearing zone hydraulic conductivities across the site, possibly implying the water-bearing zone is not a single hydrogeologic unit.

8.2 Bedrock Water-Bearing Zone

A total of 17 bedrock wells were sampled on a semi-annual basis while groundwater levels were measured in 19 bedrock wells on a quarterly basis under the 1997-1998 GWI.

8.2.1 Groundwater Sampling Results

8.2.1.1 Organic and Explosives Constituents

As presented on Table 8-5, two of the areas sampled under the site-wide groundwater investigation failed to exhibit any organic or explosive contaminants at levels exceeding RBCs. The bedrock water-bearing zone in these areas (ABG and BG8) along with the background well (PB-BED-MW20) are therefore interpreted to not have been impacted by past site activities. VOCs have impacted the bedrock water-bearing zone in ten areas of the site. The most common

VOC exceeding RBCs was benzene, with detected concentrations ranging from 0.14 µg/L to 780 µg/L (Table 8-6). This constituent was detected in 23 of the 34 samples analyzed for VOCs, and it is known to occur naturally within the Delaware Limestone. However, maximum detected benzene concentrations at the PRRWP (780 µg/L), TNTC (130 µg/L), AA2 (130 µg/L), and Upper Toluene Tanks Area (490 µg/L) are well above levels seen in other areas (including background well PB-BED-MW20) and are considered site-related contaminants (Figure 8-1). Toluene was also detected at concentrations above RBCs in several areas (Table 8-5), with detected concentrations of this VOC ranging from 1.3 to 550 µg/L (Table 8-6). As with benzene, toluene is a naturally occurring BTEX constituent in the Delaware Limestone. However, the maximum detected concentrations at the PRRWP (550 µg/L), TNTA (140 µg/L), TNTC (170 µg/L), and the Upper Toluene Tanks Area (390 µg/L) are well above levels seen in other areas and are considered site-related contaminants (Figure 8-2). Another location which is likely to have site-related BTEX compounds at high concentrations is the area upgradient of AA1. The tanks at the Middle Toluene Tank Area are possible sources for the toluene (50 µg/L) and xylene (500 µg/L) found 2,400 feet downgradient at the AA1 well IT-AA1-BED-GW001. Presently, no wells have been installed in the vicinity of the Middle Toluene Tank Area. Other detected VOCs exceeding RBCs at the PRRWP (1,1,2-TCA, chlorobenzene, and ethylbenzene), AA2 (chlorobenzene), and the Upper Toluene Tank Area (ethyl benzene) are considered to be site-related contaminants.

Several SVOCs have also been detected at levels exceeding the RBCs in the bedrock wells. Of these, bis(2-ethylhexyl)phthalate was detected at concentrations exceeding the RBC most frequently (Table 8-5). Detected concentrations ranged from 1.7 to 920 µg/L (Table 8-6). This compound was detected sporadically and further evaluation will be needed to determine whether it is a site-related contaminant or a sampling artifact in the affected areas. Two areas (WARWP and Upper Toluene Tank Area) exhibited two or more SVOCs at concentrations exceeding the RBCs. At the WARWP, 2,4-dinitrophenol, 2,4-DNT, 4,6-dinitro-2-methylphenol, and nitrobenzene have impacted the bedrock water-bearing zone because of past site activities. The Upper Toluene Tank Area exhibits impacts from 1,3-dichlorobenzene and bis(2-ethylhexyl)phthalate.

Three nitroaromatic compounds (1,3-DNB, nitrobenzene, and RDX) were detected at concentrations exceeding the RBCs at TNTA, AA1, AA2, and/or the Maintenance Area; note that explosives also exceeded RBCs at the WARWP under the SVOC analysis. At TNTA, the bedrock wells have been impacted by low levels of explosives from past site activities. AA1 and

AA2 as well as the Maintenance Area have also been impacted by low levels of nitroaromatic compounds from past site activities.

In summary, the bedrock water-bearing zone at PBOW has been impacted by organic and/or explosive contaminants to different extents by past site activities, although to a lesser degree than the overburden. Nitroaromatic compounds and SVOCs have impacted the WARWP, while VOCs have impacted the bedrock wells at the PRRWP. Lesser impacts by nitroaromatic compounds are evident at TNTA and AA1 and AA2 and the Maintenance Area. VOCs have also impacted the bedrock water-bearing zone at TNTC, AA2, and the Upper Toluene Tanks Area; SVOCs also exhibit impacts on water quality at the Upper Toluene Tanks Area.

8.2.1.2 Inorganic Constituents

As presented on Table 8-7, many total metals were determined to exceed the respective RBCs in bedrock wells sampled across PBOW. However, as discussed in previous sections, many of these total metals were due to suspended solids in the unfiltered sample and were therefore not attributable to site groundwater contamination. Therefore, the following discussion focuses on dissolved metals except for total cyanide.

Only two areas (WARWP and AA3) lacked any detected dissolved inorganic compound at a concentration exceeding the RBC. However, cyanide did exceed the RBC at the WARWP. Two dissolved metals (barium and manganese) were commonly detected in the bedrock wells at concentrations exceeding the RBCs in most areas of PBOW (Table 8-7). Detected concentrations exhibited a wide range (Table 8-8), suggesting that some detections may be due to site contamination. However, these metals will require further evaluation once background has been established.

Other less frequently detected dissolved metals at concentrations exceeding RBCs in the bedrock water-bearing zone include arsenic, iron, thallium, and vanadium (Table 8-7). The frequency of detection, as well as range of concentrations, for these metals is presented on Table 8-8. However, further evaluation of these metals is required once background is established to determine whether they are due to site contamination.

8.2.2 Bedrock Geologic and Hydrogelogical Conclusions

Groundwater flow in the bedrock is predominantly to the north-northeast. Little groundwater elevation fluctuation occurred over time in the wells monitoring the Ohio Shale and the

Olentangy Shale; however, wells monitoring the Delaware Limestone showed significant variability. There is a similar groundwater elevation fluctuation between wells REACTOR 1, 2, 3, and PB-BED-MW13 located on the west side of PBOW along a bedrock low coming from the Reactor Building Area.

Slug tests revealed that the Ohio Shale had the highest hydraulic conductivity of the three bedrock units tested at approximately 20 ft/day. The Delaware Limestone and Olentangy Shale had hydraulic conductivities of three orders of magnitude lower.

Quarries mining the Delaware Limestone in the vicinity of PBOW have some minor natural hydrocarbon. This is evident in PBOW wells monitoring the bedrock based on drilling notes, H_2S readings, and BTEX compounds detected in the groundwater.

In general, there is a downward vertical gradient from the overburden to the bedrock in the western and northern portions of the site. The greatest groundwater elevation difference was 25 feet in overburden/Delaware Limestone pair IT-AA1-GW002/IT-AA1-BED-GW001 located in the north central portion of the site. In contrast, the central and southern portions of the site showed very similar groundwater elevations in overburden/Ohio Shale pairs. This may indicate a high degree of connectivity between groundwater in the overburden and Ohio Shale.

Peaks in calculated recharge rates appear to correlate with groundwater highs taking into account a lag time. Similarly, lows in recharge rates correspond somewhat (taking into account the lag time) with lows in the groundwater.

9.0 Recommendations

- As presented in Section 8.0, Conclusions, the two water-bearing zones at PBOW have exhibited inorganic, organic, and nitroaromatic constituents at concentrations that have exceeded their respective RBCs. It is recommended that additional investigations be performed as follows:

- Determination of site-specific reference levels for VOC constituents and background concentrations for metals in the bedrock water-bearing zone

- Investigation of bedrock groundwater at the Middle Toluene Tank Area

- Completion of a three-dimensional groundwater fate and transport model utilizing data generated during the site-wide groundwater investigation as well as pertinent historical data to aid in bedrock groundwater monitoring

- Completion of a human-health risk assessment for site-wide bedrock groundwater to define contaminants of concern and to aid in determining whether additional sampling or remedial actions are warranted

- Complete a residential/agricultural well survey to determine potential off-site receptors; sampling of downgradient off-site wells within proximity of the site should be considered.

Further investigation and monitoring of the overburden water-bearing zone is not recommended under current and anticipated future land use scenarios for the following reasons:

- There are no identified receptors for groundwater from the overburden water-bearing zone

- The State of Ohio (DERR) has indicated that the overburden water-bearing zone is not considered a potable water source

- The overburden water-bearing zone is not likely to be used as a drinking water source now or in the future due to low permeability.

Contaminant migration issues between the overburden and bedrock water-bearing zones can be addressed through monitoring of bedrock wells. Bedrock monitoring should consist of selected wells within the bedrock contaminant plumes (and/or beneath overburden plumes), bedrock wells downgradient of plumes and near the facility boundary, and any residential/agricultural

wells deemed appropriate for this purpose. The target analytes for future monitoring of bedrock wells should be based on previous analytical results for upgradient areas.

Should facility usage change in the future to allow for public reuse, additional monitoring and/or evaluation of the overburden water-bearing zone may be necessary.

The following paragraphs provide additional detail regarding the scope of recommended actions.

9.1 Background Determination

Site-specific reference levels for VOC constituents and background concentrations for metals should be determined for the bedrock water-bearing zone. Analytical concentrations of site chemicals will be compared with background levels to determine whether their concentrations reflect site-related activities. These background chemicals, assumed to be present from natural conditions, are eliminated from the list of total site chemicals. For PBOW, background chemicals will include metals and naturally occurring organics (i.e., BTEX). The arithmetic mean and the range of the site concentrations of each metal are compared with the arithmetic mean and the range of the background concentration. It is recommended that two existing bedrock wells (PB-BED-MW20 and IT-BG8-BED-GW001) be used for this determination along with three new bedrock wells. Background wells should be sampled on a quarterly basis for 1 year; wells should be analyzed for metals (total and dissolved) and VOCs.

It is recommended that the specific locations of new background wells, sampling frequency, analytical parameters, and statistical approach be developed by CELRN and IT. The specifics of background determination should then be proposed to OEPA and NASA, potentially during a site visit and team meeting at the Plum Brook Station.

9.2 Groundwater Investigation

Additional DOD areas of concern are scheduled for investigation in the near future. These investigations will primarily evaluate soils in each area of concern, but results may suggest that additional wells be installed in order to evaluate potential impacts on the groundwater.

Monitoring wells have not been successfully installed at the Middle Toluene Tanks Area, located approximately 1,500 feet southwest of the intersection of Fox Road and Taylor Road. Based on the results from the Upper and Lower Toluene Tanks Areas, consideration should also be given to the installation of bedrock water-bearing zone wells in this area.

9.3 Groundwater Modeling

A three-dimensional groundwater model should be completed to provide a basis for determining the effectiveness of any chosen remedial actions or groundwater-monitoring program at PBOW. This model should be based largely on the refined conceptual site model developed herein. The groundwater modeling effort should be supported with pump tests or dye trace studies to augment the current understanding of local water-bearing zones. Additional well clusters may also be necessary to understand vertical hydraulic gradients between the overburden and the bedrock. In addition, approximate pumping rates of the sump pumps at the Reactor Area should be obtained and utilized to understand the effect that these wells have on drawdown of local groundwater.

9.4 Risk Assessment

In addition to metals determined to exceed background concentrations, COPC identified herein should be carried forward to appropriate human health risk assessments for the bedrock water-bearing zone:

- WARWP - nitroaromatics, SVOCs, and cyanide
- Pentolite Road Area - BTEX compounds
- TNTA - BTEX and nitroaromatics
- TNTC - BTEX compounds
- AA1 - nitroaromatics
- AA2 - VOCs and nitroaromatics
- Maintenance Area - nitroaromatics
- Upper Toluene Tanks Area - BTEX compounds and SVOCs.

The site-wide bedrock water-bearing zone risk assessments should be conducted following completion of the pending site investigations to ensure that any groundwater concerns identified during these investigations are adequately addressed. If additional wells and groundwater samples are deemed necessary to assess the potential impact of these sites on groundwater quality, then that data should be collected and evaluated prior to the risk assessment.

Results of the risk assessment should then be used to determine (1) the need for additional groundwater monitoring and; (2) the need for remedial action.

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TABLES

Table 4-1

Monitoring Well Construction Details
Former Plumbrook Ordnance Works, Sandusky, Ohio

Well ID	Well Depth (feet bgs)	Date Installed	Casing Type	Casing Diameter (inches)	Borehole Diameter (inches)	Screen Interval (feet bgs)	Top of Filter Pack (feet bgs)	Top of Casing Elevation (feet msl)	Ground Elevation (feet msl)	Well Location
Overburden Monitoring Wells										
AA1-GW-002	22	9/19/97	PVC (40)	2"	8.25"	6.75-21.75	6	640.85	638.6	AA1 area, S of tracks, N of road
AA2-GW-002	18.5	9/22/97	PVC (40)	2"	8.25"	8.25-18.25	5.5	643.95	641.5	N of road at AA2 area
AA3-GW-002	16.0	9/18/97	PVC (40)	2"	8.25"	5.75-15.75	3.0	636.11	634.1	NE of Ransom/Maintenance Rd intersection.
ABG-GW-002	6.75	9/11/97	PVC (40)	2"	8.25"	2.50-6.50	2.0	661.06	658.2	W of Snake/Fox Rd intersection
EB-GM-01	27	1990	NA	NA	NA	NA	NA	640.45	637.70	NE of Bldg.9210
EB-GM-02	29	1990	NA	NA	NA	NA	NA	637.52	634.90	N of Bldg.7131
EB-GM-03	18	1990	NA	NA	NA	NA	NA	638.90	636.20	Behind Bldg.7131
EB-GM-04	16	1990	NA	NA	NA	NA	NA	636.34	633.60	SW of Bldg.7122
EB-GM-05	18	1990	NA	NA	NA	NA	NA	639.70	637.00	NE corner of Bldg.7121
EB-GM-06	18	1990	NA	NA	NA	NA	NA	639.61	637.00	SE corner of Bldg.7121
EB-PS-02	18	1990	NA	NA	NA	NA	NA	638.53	635.70	NW of Bldg.8133
EB-PS-03	18	1990	NA	NA	NA	NA	NA	637.15	634.40	NE of Bldg.8133
EB-PS-04	16	1990	NA	NA	NA	NA	NA	637.87	635.40	N of Bldg.8133
EB-RA-01	16	12/4/90	Stainless	2	8	5.5 - 15.5	4	633.97	631.40	Pentolite Rd at PBRF
EB-RA-02	20	12/13/90	Stainless	2	8	7.75 - 17.75	6	633.95	631.30	NE of Bldg.1134
EB-RA-03	22	12/13/90	Stainless	2	8	6.75 - 21.75	5	633.63	630.90	W of Bldg.1131
EB-RA-04	10	1990	Stainless	2	8	4.75 - 9.75	2.75	633.54	630.70	S W of Bldg.1131
EB-RA-05	10	1990	Stainless	2	8	4.75 - 9.75	2.75	633.34	630.60	S of Bldg.1131
EB-RA-06	10	1990	Stainless	2	8	3.7 - 8.7	3.4	632.64	630.10	S of Bldg.1153
EB-SP-01	9.5	1990	NA	NA	8	NA	NA	655.07	652.30	S of Bldg.9115
EB-SP-03	9.5	1990	NA	NA	8	NA	NA	657.73	655.10	N of Bldg.1461
EB-SP-04	9.5	1990	NA	NA	8	NA	NA	658.02	655.25	W of Bldg.1411 Boiler Room
EB-SP-05	9.5	1990	NA	NA	8	NA	NA	657.00	654.50	SW of Bldg.1411 Boiler Room
EB-SP-06	9	1990	NA	NA	8	NA	NA	658.25	655.40	S of Bldg.1411
GCL-MW01	11.03	3/12/92	Stainless	1	8	5.99 - 10.97	4	674.81	671.4	SE of the Snake Rd burn pit
GCL-MW02A	22.15	3/11/92	Stainless	1	8	12.09 - 22.09	9.9	672.96	669.7	N of the Snake Rd burn pit
GCL-MW02B	9.83	3/12/92	Stainless	1	8	4.82 - 9.82	3.75	673.42	669.6	N of the Snake Rd burn pit
GCL-MW03	10.6	3/12/92	Stainless	1	8	4.56 - 9.45	3	672.57	669.55	W of the Snake Rd burn pit
IT-MW01	9.5	1989	PVC	2	8	4.0 - 9.0	2	678.19	674.5	Scheid Road Burn Ground
IT-MW02	18.3	1989	PVC	2	8	6.0 - 16.0	3.8	639.28	636.37	West Area RWP
IT-MW05	21	1989	PVC	2	8	8.5 - 18.5	6.5	634.67	631.59	Pentolite Road RWP
IT-MW06	18.5	1989	PVC	2	8	6.0 - 16.0	4.4	631.70	628.5	Reactor Facility / PRA
IT-MW07	5.5	1996	PVC	2	4.25	0.5 - 5.5	none	635.03	632.3	West Area RWP, temporary
IT-MW08	13.4	1996	PVC	2	8.25	3.1 - 13.1	3.6	633.16	630.6	West Area RWP
IT-MW09	14.5	1996	PVC	2	8.25	4.1 - 14.1	2	647.45	645.4	TNT Area C
IT-MW10	19.8	1996	PVC	2	8.25	9.3 - 19.3	8.6	644.80	642.2	West Area RWP

Table 4-1

Monitoring Well Construction Details
Former Plumbrook Ordnance Works, Sandusky, Ohio

Well ID	Well Depth (feet bgs)	Date Installed	Casing Type	Casing Diameter (inches)	Borehole Diameter (inches)	Screen Interval (feet bgs)	Top of Filter Pack (feet bgs)	Top of Casing Elevation (feet msl)	Ground Elevation (feet msl)	Well Location
MK-MW09	15	1993	PVC	2	10	5.0 - 15.0	3	645.61	642.95	West Area RWP
MK-MW10	14	1993	PVC	2	10	4.0 - 14.0	2	640.57	637.74	West Area RWP
MK-MW11	13	1993	PVC	2	10	3.0 - 13.0	2	637.36	634.39	West Area RWP
MK-MW12	13	1993	PVC	2	10	3.0 - 13.0	2	640.93	638.1	Pipe Creek
MK-MW14	11.5	1993	PVC	2	10	4.0 - 9.0	2	681.26	678.5	Toluene Tank No. 645
MK-MW15	9	1993	PVC	2	10	4.0 - 9.0	2	680.63	677.8	Toluene Tank No. 655
MK-MW16	8	1993	PVC	2	10	2.0 - 7.0	1	674	671.01	TNT Area B
MK-MW17	6	1993	PVC	2	10	2.0 - 6.0	1	664.32	660.65	TNT Area B
MK-MW19	13	1993	PVC	2	10	3.0 - 13.0	2	639.13	636.2	Garage Maintenance Area
MK-MW20	23	1993	PVC	2	10	5.0 - 20.0	3	637.51	634.3	Toluene Tank No. 265
MK-MW22	9.5	1993	PVC	2	10	2.5 - 7.5	1.5	637.73	635.24	TNT Area A
MK-MW23	16	1993	PVC	2	10	6.0 - 16.0	4	639.11	636.63	TNT Area A
MK-MW24	9.5	1993	PVC	2	10	4.5 - 9.5	2.5	656.80	654.12	TNT Area A
PB-MW01	NA	NA	NA	NA	NA	NA	NA	NA	NA	NE of Bldg.9206
PB-MW02	NA	NA	NA	NA	NA	NA	NA	NA	NA	NW of Bldg.9206
PB-MW03	NA	NA	NA	NA	NA	NA	NA	NA	NA	SE of Bldg.9206
PB-MW04	NA	NA	NA	NA	NA	NA	NA	NA	NA	SW of Bldg.9206
PR-MW07	22.3	1994	PVC	2	8	4.3 - 22.3	3	633.67	631.18	Pentolite Road RWP
PR-MW08	27.5	1994	PVC	2	8	5.0 - 27.5	4	634.7	632.18	Pentolite Road RWP
PR-MW09	19	1994	PVC	2	8	4.0 - 19.0	3	633.38	630.38	Pentolite Road RWP
TNTA-MW10	11	1994	PVC	2	8	3.0 - 11.0	2.5	639.86	637.18	TNT Area A
TNTA-MW11	11.4	1994	PVC	2	8	3.4 - 11.4	2.5	640.18	637.54	TNT Area A
TNTC-MW03	14	1994	PVC	2	8	5.0 - 14.0	3.2	645.09	642.25	TNT Area C
TNTC-MW04	18.8	1994	PVC	2	8	8.8 - 18.8	6	654.11	651.57	TNT Area C
TNTC-MW05	29.7	1994	PVC	2	8	4.7 - 29.7	3.7	651.49	648.75	TNT Area C
TNTC-MW06	12.2	1994	PVC	2	8	3.2 - 12.2	2.5	659.08	656.5	TNT Area C
WA-MW01	22.3	1994	PVC	2	8	4.3 - 22.3	3.7	644.11	642	West Area RWP
WA-MW02	13	1994	PVC	2	8	3.0 - 12.0	2.5	633.33	630.84	West Area RWP
Bedrock Monitoring Wells										
AA1-BEDGW-001	65.0	9/24/97	Steel to 27', PVC (40) to 65'	10" to 27', 2" to 65'	14.25" to 27', 6" to 66'	49.75-64.75	45	641.04	638.8	S of storage yd, N of RR tracks
AA2-BEDGW-001	43.0	10/2/97	Steel to 20', PVC (40) to 43'	10" to 20', 2" to 43'	14.25" to 20', 6" to 44'	27.75-42.75	23	644.06	641.6	AA2 area in woods, 70' N of road
AA3-BEDGW-001	53.0	10/5/97	Steel to 28', PVC (40) to 53'	10" to 28', 2" to 53'	14.25" to 28', 6" to 54'	37.75-52.75	33.0	636.43	634.1	NE of Ransom/Maintenance Rd intersection
ABG-BEDGW-001	21.0	9/10/97	Steel to 7', PVC (40) to 21'	10" to 7', 2" to 21'	14.25" to 7', 6" to 22'	10.75-20.75	9.0	660.59	658.2	SW of Snake/Fox Rd intersection

Table 4-1

Monitoring Well Construction Details
Former Plumbrook Ordnance Works, Sandusky, Ohio

Well ID	Well Depth (feet bgs)	Date Installed	Casing Type	Casing Diameter (inches)	Borehole Diameter (inches)	Screen Interval (feet bgs)	Top of Filter Pack (feet bgs)	Top of Casing Elevation (feet msl)	Ground Elevation (feet msl)	Well Location
BG6-BEDGW-001	20.0	9/20/97	Steel to 4', PVC (40) to 20'	10" to 4', 2" to 20'	14.25" to 4', 6" to 21'	4.75-19.75	4	676.56	673.7	NW of Campbell/ Patrol Rd intersection
MNTA-BEDGW-001	64.0	9/22/97	Steel to 31', PVC (40) to 64'	10" to 31', 2" to 64'	14.25" to 31', 6" to 65'	48.75-63.75	44	638.40	636.05	90 ft E of Bldg 7123, 15 ft west of ditch
PB-BED-MW13	75.5	1994	PVC	4	3 (A)	29.5 (B)	none	647.95	645.49	TNT Area C
PB-BED-MW14	52.2	1994	PVC	4	3 (A)	23.2 (B)	none	645.72	642.73	West Area RWP
PB-BED-MW15	74.4	1994	PVC	4	3 (A)	42.9 (B)	none	631.31	628.76	Pentolite Road RWP
PB-BED-MW16	74	1994	PVC	4	3 (A)	24.8 (B)	none	635.7	633.36	Pentolite Road RWP
PB-BED-MW17	64.4	1994	PVC	4	3 (A)	19.4 (B)	none	629.65	627.02	TNT Area A
PB-BED-MW18	75.4	1994	PVC	4	3 (A)	24.4 (B)	none	651.18	648.51	TNT Area A
PB-BED-MW19	49.5	1994	PVC	4	3 (A)	17.5 (B)	none	642.75	640.19	West Area RWP
PB-BED-MW20	49.5	1994	PVC	4	3 (A)	14.5 (B)	none	676.01	673.25	BG Well - Southern PBS
REACTOR1	80	6/3/60	NA	NA	8	34.5 (B)	none	630.51	630.45	Reactor Facility / PRA
REACTOR2	40	5/24/60	NA	NA	8	33 (B)	none	631.05	631.0	Reactor Facility / PRA
REACTOR3	40	5/16/60	NA	NA	8	32 (B)	none	631.21	631.1	Reactor Facility / PRA
REACTOR4	50	5/19/60	NA	NA	8	32.5 (B)	none	638.83	630.44	Reactor Facility / PRA
REACTOR5	65	9/22/58	NA	NA	5.6	35.5 (B)	none	NA	NA	Reactor Facility / PRA
TNTB-BEDGW-001	24.0	9/31/97	Steel to 9', PVC (40) to 24'	10" to 9', 2" to 24'	14.25" to 9', 6" to 25'	8.75-23.75	7.5	662.43	659.8	48 ft S of Emergency B Rd
TNTB-BEDGW-002	24.2	9/24/97	Steel to 8', PVC (40) to 24.2'	10" to 8', 2" to 24.2'	14.25" to 8', 6" to 25.2'	13.95-23.95	11.2	673.35	670.1	S of Scheid Rd, 40 ft E of MK-MW16

Elevations are with respect to North Geodetic Vertical Datum (NGVD), 1929.

bgs ---- Below ground surface.
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 4-2

Summary of Primary Groundwater Samples Collected
First Semi-Annual Groundwater Sampling Event
Former Plum Brook Ordnance Works, Sandusky, Ohio

(Page 1 of 2)

Well Identification	Sample Identification	Sampling Date	Laboratory Reference Number
IT-AA1-BEDGW-001	PBOW97-IT-AA1-BEDGW-001-GW-5450	11/16/97	5450
IT-AA1-GW-002	PBOW97-IT-AA1-GW-002-GW-5490	11/20/97	5490
IT-AA2-BEDGW-001	PBOW97-IT-AA2-BEDGW-001-GW-5460	11/20/97	5460
IT-AA2-GW-002	DRY (PIEZOMETER)	--	--
IT-AA3-BEDGW-001	PBOW97-IT-AA3-BEDGW-001-GW-5470	11/19/97	5470
IT-AA3-GW-002	PBOW97-IT-AA3-GW-002-GW-5510	11/19/97	5510
IT-ABG-GW-002	PBOW97-IT-ABG-GW-002-GW-5520	11/19/97	5520
IT-ABG-BEDGW-001	PBOW97-IT-ABG-BEDGW-001-GW-5480	11/13/97	5480
BED-MW13	PBOW97-PB-BED-MW13-GW-58990	11/13/97	5890
BED-MW14	PBOW97-PB-BED-MW14-GW-5900	11/18/97	5900
BED-MW15	PBOW97-PB-BED-MW15-GW-5910	11/18/97	5910
BED-MW16	PBOW97-PB-BED-MW16-GW-5920	11/24/97	5920
BED-MW17	PBOW97-PB-BED-MW17-GW-5930	11/20/97	5930
BED-MW18	PBOW97-PB-BED-MW-18-GW-5940	11/19/97	5940
BED-MW19	PBOW97-PB-BED-MW19-GW-5950	11/14/97	5950
BED-MW20	PBOW97-PB-BED-MW20-GW-5960	11/17/97	5960
IT-BG8-BEDGW-001	PBOW97-IT-BG8-BEDGW-001-GW-5410	11/17/97	5410
GCL-MW01	PBOW97-GCL-MW01-GW-5850	11/20/97	5850
GCL-MW02A	PBOW97-GCL-MW02A-GW-5860	11/20/97	5860
GCL-MW02B	PBOW97-GCL-MW02B-GW-5870	11/20/97	5870
GCL-MW03	PBOW97-GCL-MW03-GW-5880	11/20/97	5880
IT-MW01	PBOW97-IT-MW01-GW-5530	11/19/97	5530
IT-MW02	PBOW97-IT-MW02-GW-5540	11/21/97	5540
IT-MW05	PBOW97-IT-MW05-GW-5550	11/19/97	5550
IT-MW06	PBOW97-IT-MW06-GW-5560	11/19/97	5560
IT-MW07	DRY (PIEZOMETER)	--	--
IT-MW08	PBOW97-IT-MW08-GW-5580	11/19/97	5580
IT-MW09	PBOW97-IT-MW09-GW-5590	11/21/97	5590
IT-MW10	PBOW97-IT-MW10-GW-5600	11/14/97	5600
MK-MW09	PBOW97-MK-MW09-GW-5720	11/16/97	5720

Table 4-2

Summary of Primary Groundwater Samples Collected
First Semi-Annual Groundwater Sampling Event
Former Plum Brook Ordnance Works, Sandusky, Ohio

Well Identification	Sample Identification	Sampling Date	Laboratory Reference Number
MK-MW10	PBOW97-MK-MW10-GW-5730	11/14/97	5730
MK-MW11	PBOW97-MK-MW11-GW-5740	11/18/97	5740
MK-MW12	PBOW97-MK-MW12-GW-5750	11/17/97	5750
MK-MW14	PBOW97-MK-MW14-GW-5760	11/16/97	5760
MK-MW15	PBOW97-MK-MW15-GW-5770	11/16/97	5770
MK-MW16	PBOW97-MK-MW16-GW-5780	11/21/97	5780
MK-MW17	PBOW97-MK-MW17-GW-5790	11/21/97	5790
MK-MW19	PBOW97-MK-MK19-GW-5800	11/16/97	5800
MK-MW20	PBOW97-MK-MW20-GW-5810	11/16/97	5810
MK-MW22	PBOW97-MK-MW22-GW-5820	11/14/97	5820
MK-MW23	PBOW97-MK-MW23-GW-5830	11/16/97	5830
MK-MW24	PBOW97-MK-MW24-GW-5840	11/13/97	5840
IT-MNTA-BED-GW001	PBOW97-IT-MNTA-BEDGW-001-5440	11/20/97	5440
PR-MW7	PBOW97-PB-PR-MW7-GW-5690	11/17/97	5690
PR-MW8	PBOW97-PB-PR-MW8-GW-5700	11/17/97	5700
PR-MW9	PBOW97-PB-PR-MW9-GW-5710	11/17/97	5710
REACTOR 1	PBOW97-REACTOR1-GW-5970	11/21/97	5970
REACTOR 2	PURGED DRY	--	--
REACTOR 3	DRY	--	--
TNTA-MW10	PBOW97-PB-TNTA-MW10-GW-5610	11/19/97	5610
TNTA-MW11	PBOW97-PB-TNTA-MW11-GW-5620	11/18/97	5620
IT-TNTB-BED-GW001	PBOW97-IT-TNTB-BEDGW-001-GW-5420	11/17/97	5420
IT-TNTB-BED-GW002	PBOW97-IT-TNTB-BEDGW-002-GW-5430	11/16/97	5430
TNTC-MW3	PBOW97-PB-TNTC-MW3-GW-5630	11/21/97	5630
TNTC-MW4	PBOW97-PB-TNTC-MW4-GW-5640	11/24/97	5640
TNTC-MW5	PBOW97--PB-TNTC-MW5-GW-5650	11/21/97	5650
TNTC-MW6	PBOW97-PB-TNTC-MW6-GW-5660	11/20/97	5660
WA-MW1	PBOW97-PB-WA-MW1-GW-5670	11/21/97	5670
WA-MW2	PBOW97-PB-WA-MW2-GW-5680	11/23/97	5680

Table 4-3

Field Measurements of Groundwater Samples
First and Second Semi-Annual Groundwater Sampling Events
Former Plum Brook Ordnance Works, Sandusky, Ohio

Well Identification	Date	Sample No.	Conductivity (mS/cm)	pH	Eh (mV)	Temperature (°C)	Turbidity (NTU)	Dissolved O_2 (mg/L)	Water Purged (gallons)
Overburden Wells									
GCL-MW01	11/20/97	5850	0.837	6.37	0	12.7	289	0.48	11
	5/17/98	5855	0.50	6.6	25	13	20	8.4	26.29
GCL-MW02A	11/20/97	5860	0.888	7.20	0	11.9	999	7.11	35
	5/17/98	5865	0.74	7.3	-58.6	14	27	7.8	58.66
GCL-MW02B	11/20/97	5870	0.933	6.82	-0.1	12.2	0	1.33	15
	5/17/98	5875	0.65	7.2	98.3	14	8	6.4	25
GCL-MW03	11/20/97	5880	0.524	6.91	118.4	11.9	137	-20	15
	5/17/98	5885	0.40	7.2	-55.8	15	23	7.7	25.82
IT-AA1-GW002	11/20/97	5490	3.34	6.21	-263.8	13.0	628	3.59	15
	5/13/98	5495	3.45	7.16	NM	10.8	624	5.51	9
IT-AA3-GW002	11/19/97	5510	1.02	7.10	-189.6	12.1	999	4.56	25
	5/14/98	5515	0.712	7.01	-2.2	11.5	-10	5.20	1.95
IT-ABG-GW002	11/19/97	5520	1.84	6.70	-15.2	9.5	>1000	10.89	1.5
	5/13/98	5525	1.51	7.22	8.4	14.6	-5	13.62	1
IT-MW01	11/19/97	5530	0.512	6.70	-58.2	9.6	1	10.57	6.5
	5/16/98	5535	0.447	6.23	57.3	14.2	0	13.13	8
IT-MW02	11/21/97	5540	1.25	6.60	NM	11.3	0	11.54	22
	5/15/98	5545	1.51	6.86	5	14	139	13.4	35
IT-MW05	11/19/97	5550	0.962	7.39	-81.9	11.7	78	-0.65	6
	5/28/98	5555	0.76	7.7	61.0	13	380	6.9	9.5
IT-MW06	11/19/97	5560	0.815	7.10	1.7	11.2	40	1.68	10
	5/28/98	5565	0.63	7.1	271.6	13	0	7.3	23
IT-MW08	11/19/97	5580	1.90	7.45	-5.2	10.7	0	9.76	7
	5/13/98	5585	2.17	6.72	NM	11.2	0	14.02	35
IT-MW09	11/21/97	5590	2.10	6.76	121.5	13.8	256	7.32	6
	5/19/98	5595	2.42	6.91	246.7	15.8	154	15.74	8
IT-MW10	11/13/97	5600	1.18	6.78	-155.4	8.6	1	9.59	11
	5/14/98	5605	1.2	7.20	2.87	11.5	999	15.80	9
MK-MW09	11/16/97	5720	0.602	6.96	152	10.0	2	8.84	35
	5/13/98	5725	0.522	7.16	NM	13.0	0	15.78	48

Table 4-3

Field Measurements of Groundwater Samples
First and Second Semi-Annual Groundwater Sampling Events
Former Plum Brook Ordnance Works, Sandusky, Ohio

Well Identification	Date	Sample No.	Conductivity (mS/cm)	pH	Eh (mV)	Temperature (°C)	Turbidity (NTU)	Dissolved O_2 (mg/L)	Water Purged (gallons)
Overburden Wells									
MK-MW10	11/14/97	5730	0.581	6.99	377	11.0	12	8.97	10
	5/12/98	5735	0.485	6.82	NM	12.6	0	13.07	43
MK-MW11	11/18/97	5740	0.785	6.80	71.5	10.8	300	8.03	7
	5/13/98	5745	0.706	7.22	NM	10.5	999	13.98	6
MK-MW12	11/17/97	5750	0.762	6.93	67.4	9.5	2	8.66	10
	5/14/98	5755	0.573	6.24	204.3	13.5	0	13.74	5
MK-MW14	11/16/97	5760	0.946	6.53	-55.9	12.2	0	9.59	11
	5/14/98	5765	0.675	6.68	-39	14.8	0	14.45	25
MK-MW15	11/16/97	5770	0.556	6.81	-89.1	12.0	11	9.01	5.5
	5/14/98	5775	0.096	6.81	87.9	16.7	NM	16.70	25
MK-MW16	11/21/97	5780	NM	NM	NM	NM	NM	NM	1
	5/18/98	5785	1.1	7.40	NM	18.0	1	5.40	34.86
MK-MW17	11/21/97	5790	NM	NM	NM	NM	NM	NM	6
	5/27/98	5795	0.74	6.00	NM	17.0	14	4.90	15
MK-MW19	11/16/97	5800	1.14	7.11	38.5	11.7	223	9.74	25
	6/1/98	5805	0.889	7.54	NM	12.0	467	10.15	45
MK-MW20	11/16/97	5810	3.07	7.31	-251.8	10.5	999	9.87	20
	5/19/98	5815	2.53	7.05	-37.5	18.8	169	10.85	12.5
MK-MW22	11/14/97	5820	885	6.85	4.5	13.6	132	1.85	5
	5/18/98	5825	0.822	8.25	4.6	18.4	988	12.16	3.5
MK-MW23	11/16/97	5830	1.07	6.44	-55.5	14.0	602	0.01	NR
	5/29/98	5835	0.836	7.08	-133.4	15.4	154	13.50	8
MK-MW24	11/13/97	5840	2340	6.83	-53.1	13.8	137	1.70	3
	5/20/98	5845	2.19	7.05	-57.4	16.9	54	12.24	5
PR-MW07	11/17/97	5690	16.0	7.06	81.1	11.3	999	9.50	15
	5/20/98	5695	12.0	6.80	NM	20.0	3	6.40	18
PR-MW08	11/17/97	5700	43.1	7.07	88.5	8.4	999	4.25	25
	5/15/98	5705	3.6	6.80	NM	17.0	99	5.50	21.8
PR-MW09	11/17/97	5710	7.12	7.05	797.6	10.9	170	19.99	4
	5/20/98	5715	7	7.00	NM	21.0	9	6.20	15

Table 4-3

Field Measurements of Groundwater Samples
First and Second Semi-Annual Groundwater Sampling Events
Former Plum Brook Ordnance Works, Sandusky, Ohio

Well Identification	Date	Sample No.	Conductivity (mS/cm)	pH	Eh (mV)	Temperature (°C)	Turbidity (NTU)	Dissolved O_2 (mg/L)	Water Purged (gallons)
Overburden Wells									
TNTA-MW10	11/18/97	5610	1.18	7.29	-170.5	11.2	246	-0.38	6
	5/29/98	5615	1.23	7.36	-109.7	14.8	260	7.17	11
TNTA-MW11	11/18/97	5620	1.54	6.49	-67.2	12.4	77	4.53	5
	5/29/98	5625	1.38	7.16	118.1	14.3	536	7.41	14
TNTC-MW03	11/21/97	5630	3.04	7.31	41.0	11.3	9	9.70	6
	5/18/98	5635	3.35	6.56	NM	13.6	999	15.78	NR
TNTC-MW04	11/20/97	5640	2.24	6.58	109.6	12.0	22	10.27	NM
	5/18/98	5645	2.22	6.80	282.6	14.6	999	14.72	11
TNTC-MW05	11/21/97	5650	1.52	6.97	22.9	10.0	25	11.45	24
	5/18/98	5655	NM	NM	NM	NM	NM	NM	11
TNTC-MW06	11/20/97	5660	1.00	6.71	33.6	11.0	6	11.66	13
	5/16/98	5665	0.983	6.91	179.3	13.5	3.0	14.08	21
WA-MW01	11/21/97	5670	0.96	7.08	4.3	10.0	0	11.65	8
	5/18/98	5675	0.931	8.16	143.8	14.7	0	16.30	16
WA-MW02	11/23/97	5680	5.54	6.52	65.0	10.9	300	10.82	30
	5/15/98	5685	5.42	6.85	168.4	13.7	999	15.19	30.5
Bedrock Wells									
Reactor1	11/21/97	5970	1.02	7.52	-266.8	11.8	90	9.89	243
	6/1/98	5975	0.137	7.86	NM	15.5	81	8.44	113
Reactor2	11/21/97	NS	0.445	8.14	-220.6	11.8	86	7.62	53
	NS	NS	NS	NS	NS	NS	NS	NS	NS
IT-AA1-BED-GW001	11/16/97	5450	5.37	6.99	-340.1	8.7	-10	2.62	49
	5/12/98	5455	7.33	6.91	NM	12.4	107	4.80	20
IT-AA2-BED-GW001	11/20/97	5460	1.28	7.08	-160	8.7	>1000	6.31	25
	5/12/98	5465	1.21	7.06	NM	13.5	999	8.02	20
IT-AA3-BED-GW001	11/19/97	5470	2.93	6.82	-297.2	10.6	595	6.51	42
	5/14/98	5475	2.79	6.81	8.7	13.7	26	NM	30.6
IT-BG8-BED-GW001	11/17/97	5410	3.31	7.21	-245.3	10.5	321	6.83	30
	5/15/98	5415	151	7.80	-36.2	13.0	10	8.00	27.73
IT-MNTA-BED-GW001	11/20/97	5440	9.50	6.78	-329.4	9.8	38	5.38	45
	5/28/98	5445	9.63	4.66	NM	17.2	79	0.74	37.5

Table 4-3

Field Measurements of Groundwater Samples
First and Second Semi-Annual Groundwater Sampling Events
Former Plum Brook Ordnance Works, Sandusky, Ohio

Well Identification	Date	Sample No.	Conductivity (mS/cm)	pH	Eh (mV)	Temperature (°C)	Turbidity (NTU)	Dissolved O_2 (mg/L)	Water Purged (gallons)
Bedrock Wells:									
IT-TNTB-BED-GW001	11/17/97	5420	0.92	7.07	-190.4	9.8	99	4.48	33
	5/18/98	5425	3.2	7.20	NM	14.0	21	6.50	30.12
IT-TNTB-BED-GW002	11/16/97	5430	1.20	7.58	-294.5	10.2	-10	3.75	27
	5/18/98	5435	1.20	7.40	-327.2	13.0	1	6.20	34.59
IT-ABG-BED-GW001	11/13/97	5480	1.09	6.94	15.9	12.9	-10	7.35	25.5
	5/13/98	5485	0.85	7.18	NM	12.0	23	5.37	30
BED-MW13	11/13/97	5890	8.08	6.90	-317.9	9.6	284	4.93	24.5
	5/28/98	5895	0.755	6.98	NM	15.2	173	2.76	15.32
BED-MW14	11/18/97	5900	2.33	7.29	-85.3	8.7	269	4.66	13.5
	5/16/98	5905	2.4	7.70	-10.8	13.0	36	5.50	81.6
BED-MW15	11/18/97	5910	5.08	6.81	-298.3	8.9	71	3.17	15
	5/28/98	5915	6.94	6.91	-20	13.0	79	1.65	23.2
BED-MW16	11/24/97	5920	NM	NM	NM	NM	NM	NM	35
	6/1/98	5925	NM	NM	NM	NM	NM	NM	NR
BED-MW17	11/20/97	5930	4.70	7.00	322.2	8.9	318	7.46	23
	5/29/98	5935	4.21	6.70	NM	15.3	213	1.30	60
BED-MW18	11/19/97	5940	22.3	7.40	-311.6	9.2	109	5.22	27
	5/19/98	5945	2.8	7.20	-297.6	18.0	28	5.40	127.01
BED-MW19	11/14/97	5950	1.30	6.91	-318.1	9.4	108	5.58	14
	5/16/98	5955	1.80	6.70	17.8	16.0	17	6.00	82.5
BED-MW20	11/17/97	5960	48.5	6.74	-24.7	9.4	563	4.14	27
	5/28/98	5965	38.1	6.65	NM	13.0	999	12.80	58

mS/cm - Millisiemens per centimeter.
mV - Millivolts.
NTU - Nephelometric turbidity unit.
NM - Parameter was not measured either to save on limited water volume or because of an instrument malfunction.
NR - Not recorded.
NS - Not sampled.

Table 4-4

Summary of Primary Groundwater Samples
Second Semi-Annual Groundwater Sampling Event
Former Plum Brook Ordnance Works, Sandusky, Ohio

Well Identification	Sample Identification	Sampling Date	Laboratory Reference Number
IT-AA1-BEDGW-001	PBOW-98-GW-AA1-BEDGW-001-5455	5/12/98	5455
IT-AA1-GW-002	PBOW-98-GW-AA1-GW-002-5495	5/13/98	5495
IT-AA2-BEDGW-001	PBOW-98-GW-AA2-BEDGW-001-5465	5/12/98	5465
IT-AA2-GW-002	DRY (PIEZOMETER)	--	--
IT-AA3-BEDGW-001	PBOW-98-GW-AA3-BEDGW-001-5475	5/14/98	5475
IT-AA3-GW-002	PBOW-98-GW-AA3-GW-002-5515	5/14/98	5515
IT-ABG-BEDGW-01	PBOW-98-GW-ABG-BEDGW-001-5485	5/13/98	5485
IT-ABG-GW-002	PBOW-98-GW-ABG-GW-002-5525	5/13/98	5525
BED-MW13	PBOW-98-GW-BEDMW13-5895	5/29/98	5895
BED-MW14	PBOW-98-GW-BEDMW14-5905	5/16/98	5905
BED-MW14	PBOW-98-GW-BEDMW14-5905	5/18/98	5905R
BED-MW15	PBOW-98-GW-BEDMW15-5915	5/28/98	5915
BED-MW16	PBOW-98-GW-BEDMW16-5925	6/1/98	5925
BED-MW17	PBOW-98-GW-BEDMW17-5935	5/29/98	5935
BED-MW18	PBOW-98-GW-BEDMW18-5945	5/19/98	5945
BED-MW19	PBOW-98-GW-BEDMW19-5955	5/16/98	5955
BED-MW20	PBOW-98-GW-BEDMW20-5965	5/28/98	5965
IT-BG8-BEDGW-001	PBOW-98-GW-BG8-BEDGW-001-5415	5/15/98	5415
GCL-MW01	PBOW-98-GW-GCLMW01-5855	5/17/98	5855
GCL-MW02A	PBOW-98-GW-GCLMW02A-5865	5/17/98	5865
GCL-MW02B	PBOW-98-GW-GCLMW02B-5875	5/17/98	5875
GCL-MW03	PBOW-98-GW-GCLMW03-5885	5/17/98	5885
IT-MNTA-BEDGW-001	PBOW-98-GW-MNTA-BEDGW-001-5445	5/28/98	5445
IT-MW01	PBOW-98-GW-ITMW01-5535	5/16/98	5535
IT-MW01	PBOW-98-GW-ITMW01-5535	5/18/98	5535R
IT-MW02	PBOW-98-GW-ITMW02-5545	5/15/98	5545
IT-MW05	PBOW-98-GW-ITMW05-5555	5/28/98	5555
IT-MW06	PBOW-98-GW-ITMW06-5565	5/28/98	5565
IT-MW07	DRY (PIEZOMETER)	--	--
IT-MW08	PBOW-98-GW-ITMW08-5585	5/13/98	5585
IT-MW09	PBOW-98-GW-ITMW09-5595	5/19/98	5595
IT-MW10	PBOW-98-GW-ITMW10-5605	5/14/98	5605
MK-MW09	PBOW-98-GW-MKMW09-5725	5/13/98	5725
MK-MW10	PBOW-98-GW-MKMW10-5735	5/12/98	5735
MK-MW11	PBOW-98-GW-MKMW11-5745	5/13/98	5745
MK-MW12	PBOW-98-GW-MKMW12-5755	5/14/98	5755
MK-MW14	PBOW-98-GW-MKMW14-5765	5/14/98	5765
MK-MW15	PBOW-98-GW-MKMW15-5775	5/14/98	5775
MK-MW16	PBOW-98-GW-MKMW16-5785	5/18/98	5785
MK-MW17	PBOW-98-GW-MKMW17-5795	5/27/98	5795

Table 4-4

Summary of Primary Groundwater Samples
Second Semi-Annual Groundwater Sampling Event
Former Plum Brook Ordnance Works, Sandusky, Ohio

Well Identification	Sample Identification	Sampling Date	Laboratory Reference Number
MK-MW19	PBOW-98-GW-MKMW19-5805	6/1/98	5805
MK-MW20	PBOW-98-GW-MKMW20-5815	5/19/98	5815
MK-MW20	PBOW-98-GW-MKMW20-5815	5/27/98	5815R
MK-MW22	PBOW-98-GW-MKMW22-5825	5/18/98	5825
MK-MW23	PBOW-98-GW-MKMW23-5835	5/29/98	5835
MK-MW24	PBOW-98-GW-MKMW24-5845	5/20/98	5845
PR-MW7	PBOW-98-GW-PRMW7-5695	5/20/98	5695
PR-MW8	PBOW-98-GW-PRMW8-5705	5/20/98	5705
PR-MW9	PBOW-98-GW-PRMW9-5715	5/20/96	5715
REACTOR1	PBOW-98-GW-REACTOR1-5975	6/1/98	5975
REACTOR2	DRY	--	--
REACTOR3	DRY	--	--
REACTOR4	DRY	--	--
TNTA-MW10	PBOW-98-GW-TNTAMW10-5615	5/29/98	5615
TNTA-MW11	PBOW-98-GW-TNTAMW11-5625	5/29/98	5625
IT-TNTB-BEDGW-001	PBOW-98-GW-TNTB-BEDGW-001-5425	5/18/98	5425
IT-TNTB-BEDGW-002	PBOW-98-GW-TNTB-BEDGW-002-5435	5/18/98	5435
TNTC-MW3	PBOW-98-GW-TNTCMW3-5635	5/18/98	5635
TNTC-MW4	PBOW-98-GW-TNTCMW4-5645	5/18/98	5645
TNTC-MW5	PBOW-98-GW-TNTCMW5-5655	5/18/98	5655
TNTC-MW6	PBOW-98-GW-TNTCMW6-5665	5/16/98	5665
TNTC-MW6	PBOW-98-GW-TNTCMW6-5665	5/18/98	5665R
WA-MW1	PBOW-98-GW-WAMW1-5675	5/18/98	5675
WA-MW2	PBOW-98-GW-WAMW2-5685	5/15/98	5685

R - Additional sample volume collected at later date due to slow well recharge, shipping, or laboratory difficulties.

Table 5-1

Summary of Chemical Analyses and Methodologies
First and Second Semi-Annual Groundwater Sampling Events
Former Plum Brook Ordnance Works, Sandusky, Ohio

Matrix	Analytical Parameters	Analytical Method
Water	TCL Volatile Organic Compounds	SW-846 8260A[a]
	TCL Semivolatile Organic Compounds	SW-846 3520B/8270B[a]
	TAL Metals	SW-846 3050A/6010A[b] for Ag, Al, As, Ba, Be, Ca, Cd, Co, Cr, Cu, Fe, K, Mg, Mn, Na, Ni, Pb, Sb, Se, Tl, V, Zn 7470A[a] for Hg
	PCBs	SW-846 3520B/8081[a]
	Nitroaromatic Compounds	SW-846/8330[c] (as modified)
	TOC, Total Cyanide Alkalinity, Chloride, TDS, TSS, Nitrate Sulfate	SW-846 9060, 9010A MCAWW[d] 310.1, 325.2 and 300.0 160.1, 160.2, 353.2 375.4

[a]U.S. Environmental Protection Agency (EPA), *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods*, Third Edition, Update II, September 1994.
[b]U.S. Environmental Protection Agency (EPA), *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods*, Third Edition, Update I, July 1992.
[c]U.S. Environmental Protection Agency (EPA), *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods*, Third Edition, Revision 1, December 1990
[d]U.S. Environmental Protection Agency (EPA), *Methods for Chemical Analysis of Water and Wastes,* EPA- 600/4-79-020, March 1983 and subsequent revisions

TAL - Target analyte list.
TCL - Target compound list.
TDS - Total dissolved solids.
TOC - Total organic carbon.
TSS - Total suspended solids.

Table 6-1

Lithologic Units with Reported H_2S and Petroleum
Former Plum Brook Ordnance Works, Sandusky, Ohio

Well Identification	Ground Elevation (ft msl)	Unit Monitored	Date	HNu Reading During Ground-water Sampling (ppm)	H_2S Reading During Ground-Water Sampling (ppm)	Possible Petroleum Evidence During Well Installation
AA1-BEDGW-001	638.8	Delaware Limestone	5/5/98	6.0	1200	Burnt odor 3-4 ft, Hnu 2.0 ppm; Strong petroleum odor 52-59 ft; Rainbow sheen on surface; Petroleum odor at 61 ft, 2.5-4.2';
			2/24/98	0.0	1600	
			11/12/97	NM	1	
			8/27/97	NP	NP	
AA1-GW-002	638.6	Overburden	5/5/98	0.0	0	Black silt with trace of sand (burnt odor), Hnu = 4.5 ppm
			2/24/98	4.8	NM	
			11/12/97	0.2	NM	
			8/27/97	NP	NP	
AA2-BEDGW-001	641.6	Delaware Limestone	5/5/98	5.0	0	None
			2/24/98	5.0	NM	
			11/12/97	NM	0	
			8/27/97	NP	NP	
AA2-GW002	641.5	Overburden	5/5/98	0.0	0	None
			2/24/98	NM	NM	
			11/12/97	NM	0	
			8/27/97	NP	NP	
AA3-BEDGW-001	634.1	Delaware Limestone	5/5/98	9.0	10	None
			2/24/98	9.0	5	
			11/12/97	NM	0.04	
			8/27/97	NP	NP	
AA3-GW-002	634.1	Overburden	5/5/98	2.0	0	None
			2/24/98	0.8	NM	
			11/12/97	0.2	NM	
			8/27/97	NP	NP	
ABG-BEDGW-001	658.2	Ohio Shale	5/5/98	0.5	0	H_2S = 0.0 ppm at 11 ft.
			2/24/98	0.6	0	
			11/12/97	NM	0	
			8/27/97	NP	NP	
ABG-GW-002	658.2	Overburden	5/5/98	0.0	0	None
			2/24/98	0.7	NM	
			11/12/97	0.0	NM	
			8/27/97	NP	NP	
BED-MW13	645.49	Delaware Limestone	5/5/98	10.0	0	At 27 ft; odor from augers cutting shale - occasionally 3 ppm in breathing zone. At 57 ft; H_2S reading 1 ppm after coring. Oils on augers in Delaware Limestone
			2/24/98	14.0	NM	
			11/12/97	NM	6	
			8/27/97	0.4	0	

Table 6-1

Lithologic Units with Reported H_2S and Petroleum
Former Plum Brook Ordnance Works, Sandusky, Ohio

Well Identification	Ground Elevation (ft msl)	Unit Monitored	Date	HNu Reading During Ground-water Sampling (ppm)	H_2S Reading During Ground-Water Sampling (ppm)	Possible Petroleum Evidence During Well Installation
BED-MW14	642.73	Olentangy Shale/Delaware Limestone	5/5/98	1.0	0	Very slight petroleum odor at 34 ft; small oil sheen on core at 48.5 ft.
			2/24/98	0.2	NM	
			11/12/97	NM	0	
			8/27/97	8.8	0	
BED-MW15	628.76	Delaware Limestone	5/5/98	30.0	150	Slight petroleum odor at 32 ft; black staining on core at 39 ft; 42.5 ft, and 46 ft.
			2/24/98	22.0	203	
			11/12/97	NM	122	
			8/27/97	0.0	0.12	
BED-MW16	633.36	Delaware Limestone	5/5/98	40.0	0	Petroleum odor, discoloration, and small amount of oil (on core) at 56 ft (HNu 16 ppm)
			2/24/98	114.0	0	
			11/12/97	260.0	0	
			8/27/97	220.0	0	
BED-MW17	627.02	Delaware Limestone	5/5/98	45.0	324	Petroleum odor at 45 ft.; black stain on core at 61.3 ft.
			2/24/98	54.0	828	
			11/12/97	NM	0	
			8/27/97	17.2	0	
BED-MW18	648.51	Olentangy Shale/Delaware Limestone	5/5/98	2.0	0	None
			2/24/98	5.4	0	
			11/12/97	NM	0	
			8/27/97	4.2	0	
BED-MW19	640.19	Delaware Limestone	5/5/98	2.0	0	H_2S odor 39.5 - 49.5 ft.
			2/24/98	6.0	NM	
			11/12/97	NM	0	
			8/27/97	9.6	0	
BED-MW20	673.25	Ohio Shale	5/5/98	0.0	0	Black stained shale 47.5 ft.
			2/24/98	0.0	NM	
			11/12/97	NM	0	
			8/27/97	0.3	0	
BG8-BEDGW-001	673.7	Olentangy Shale	5/5/98	0.0	0	None
			2/24/98	0.0	NM	
			11/12/97	NM	0	
			8/27/97			
EB-GM-01	637.70	Overburden	5/5/98	0.0	0	Unknown - borelog not available
			2/24/98	0.0	NM	
			11/12/97	0.2	NM	
			8/27/97	0.0	NM	

Table 6-1

Lithologic Units with Reported H_2S and Petroleum
Former Plum Brook Ordnance Works, Sandusky, Ohio

Well Identification	Ground Elevation (ft msl)	Unit Monitored	Date	HNu Reading During Ground-water Sampling (ppm)	H_2S Reading During Ground-Water Sampling (ppm)	Possible Petroleum Evidence During Well Installation
EB-GM-02	634.90	Overburden	5/5/98	0.0	0	Unknown - borelog not available
			2/24/98	0.0	NM	
			11/12/97	0.2	NM	
			8/27/97	0.0	NM	
EB-GM-03	636.20	Overburden	5/5/98	0.0	0	Unknown - borelog not available
			2/24/98	0.0	NM	
			11/12/97	0.2	NM	
			8/27/97	0.0	NM	
EB-GM-04	633.60	Overburden	5/5/98	0.0	0	Unknown - borelog not available
			2/24/98	0.5	NM	
			11/12/97	0.2	NM	
			8/27/97	0.0	NM	
EB-GM-05	637.00	Overburden	5/5/98	0.0	0	Unknown - borelog not available
			2/24/98	0.0	NM	
			11/12/97	0.2	NM	
			8/27/97	0.0	NM	
EB-GM-06	637.00	Overburden	5/5/98	1.0	0	Unknown - borelog not available
			2/24/98	1.0	NM	
			11/12/97	0.2	NM	
			8/27/97	0.0	NM	
EB-PS-02	635.70	Overburden	5/5/98	0.0	0	None
			2/24/98	0.6	NM	
			11/12/97	0.2	NM	
			8/27/97	0.0	NM	
EB-PS-03	634.40	Overburden	5/5/98	0.0	0	None
			2/24/98	1.7	NM	
			11/12/97	0.2	NM	
			8/27/97	0.0	NM	
EB-PS-04	635.30	Overburden	5/5/98	0.0	0	None
			2/24/98	7.6	NM	
			11/12/97	0.2	NM	
			8/27/97	0.0	NM	
EB-RA-01	631.40	Overburden	5/5/98	0.0	0	None
			2/24/98	0.0	NM	
			11/12/97	NM	NM	
			8/27/97	0.4	0	

Table 6-1

Lithologic Units with Reported H_2S and Petroleum
Former Plum Brook Ordnance Works, Sandusky, Ohio

Well Identification	Ground Elevation (ft msl)	Unit Monitored	Date	HNu Reading During Ground-water Sampling (ppm)	H_2S Reading During Ground-Water Sampling (ppm)	Possible Petroleum Evidence During Well Installation
EB-RA-02	631.30	Overburden	5/5/98	4.3	0	None
			2/24/98	13.8	NM	
			11/12/97	NM	0	
			8/27/97	0.4	0	
EB-RA-03	630.90	Overburden	5/5/98	0.0	0	None
			2/24/98	0.6	NM	
			11/12/97	NM	0	
			8/27/97	0.4	0	
EB-RA-04	630.70	Overburden	5/5/98	0.0	0	None
			2/24/98	0.0	NM	
			11/12/97	NM	0	
			8/27/97	0.4	0	
EB-RA-05	630.60	Overburden	5/5/98	0.0	0	None
			2/24/98	0.0	NM	
			11/12/97	NM	0	
			8/27/97	4.2	0	
EB-RA-06	630.1	Overburden	5/5/98	0.0	0	None
			2/24/98	0.0	NM	
			11/12/97	NM	0	
			8/27/97	0.4	0	
EB-SP-01	652.30	Overburden/Ohio Shale	5/5/98	0.0	0	Unknown - borelog not available
			2/24/98	0.0	NM	
			11/12/97	0.2	NM	
			8/27/97	NM	NM	
EB-SP-03	655.10	Overburden/Ohio Shale	5/5/98	0.0	0	Unknown - borelog not available
			2/24/98	0.0	NM	
			11/12/97	0.2	NM	
			8/27/97	NM	NM	
EB-SP-04	655.25	Overburden/Ohio Shale	5/5/98	0.0	0	Unknown - borelog not available
			2/24/98	0.0	NM	
			11/12/97	0.2	NM	
			8/27/97	NM	NM	
EB-SP-05	654.50	Overburden/Ohio Shale	5/5/98	0.0	0	Unknown - borelog not available
			2/24/98	0.0	NM	
			11/12/97	0.2	NM	
			8/27/97	NM	NM	

Table 6-1

Lithologic Units with Reported H_2S and Petroleum
Former Plum Brook Ordnance Works, Sandusky, Ohio

Well Identification	Ground Elevation (ft msl)	Unit Monitored	Date	HNu Reading During Ground-water Sampling (ppm)	H_2S Reading During Ground-Water Sampling (ppm)	Possible Petroleum Evidence During Well Installation
EB-SP-06	655.40	Overburden/Ohio Shale	5/5/98	0.0	0	Unknown - borelog not available
			2/24/98	0.0	NM	
			11/12/97	0.2	NM	
			8/27/97	NM	NM	
GCL-MW01	671.40	Overburden/Ohio Shale	5/5/98	0.0	0	None
			2/24/98	0.0	NM	
			11/12/97	0.2	NM	
			8/27/97	NM	NM	
GCL-MW02A	669.70	Ohio Shale	5/5/98	0.0	NM	None
			2/24/98	0.0	NM	
			11/12/97	0.3	0	
			8/27/97	0.0	0	
GCL-MW02B	669.60	Overburden/Ohio Shale	5/5/98	0.0	0	None
			2/24/98	0.0	NM	
			11/12/97	0.0	0	
			8/27/97	NM	NM	
GCL-MW03	669.55	Overburden/Ohio Shale	5/5/98	0.0	0	None
			2/24/98	0.0	NM	
			11/12/97	0.2	0	
			8/27/97	NM	NM	
IT-MW01	674.50	Olentangy Shale	5/5/98	4.0	0	None
			2/24/98	0.0	NM	
			11/12/97	0.0	0	
			8/27/97	NM	NM	
IT-MW02	636.37	Overburden	5/5/98	3.0	0	None
			2/24/98	0.0	NM	
			11/12/97	0.3	0	
			8/27/97	0.0	0	
IT-MW05	631.59	Overburden	5/5/98	0.0	0	None
			2/24/98	20.0	NM	
			11/12/97	0.2	NM	
			8/27/97	0.0	NM	
IT-MW06	628.50	Overburden	5/5/98	0.0	0	None
			2/24/98	0.0	NM	
			11/12/97	0.2	NM	
			8/27/97	0.0	NM	

Table 6-1

Lithologic Units with Reported H_2S and Petroleum
Former Plum Brook Ordnance Works, Sandusky, Ohio

Well Identification	Ground Elevation (ft msl)	Unit Monitored	Date	HNu Reading During Ground-water Sampling (ppm)	H_2S Reading During Ground-Water Sampling (ppm)	Possible Petroleum Evidence During Well Installation
IT-MW07	632.30	Overburden	5/5/98	0.0	0	Unknown - borelog not available
			2/24/98	0.0	NM	
			11/12/97	NM	0	
			8/27/97	NM	NM	
IT-MW08	630.60	Overburden/Olentangy Shale	5/5/98	0.0	0	None
			2/24/98	0.0	NM	
			11/12/97	1.1	0	
			8/27/97	0.0	NM	
IT-MW09	645.40	Overburden/Olentangy Shale	5/5/98	0.0	0	None
			2/24/98	0.0	NM	
			11/12/97	0.2	0	
			8/27/97	0.0	NM	
IT-MW10	642.52	Overburden	5/5/98	2.0	0	None
			2/24/98	0.0	NM	
			11/12/97	0.3	0	
			8/27/97	0.0	NM	
MK-MW09	642.95	Overburden	5/5/98	0.0	NM	None
			2/24/98	0.0	NM	
			11/12/97	0.3	0	
			8/27/97	0.0	NM	
MK-MW10	637.74	Overburden	5/5/98	0.0	0	None
			2/24/98	0.0	NM	
			11/12/97	0.3	0	
			8/27/97	0.0	NM	
MK-MW11	634.39	Overburden	5/5/98	0.0	0	None
			2/24/98	0.0	NM	
			11/12/97	0.0	0	
			8/27/97	0.0	NM	
MK-MW12	638.10	Overburden	5/5/98	0.0	0	None
			2/24/98	0.0	NM	
			11/12/97	0.0	0	
			8/27/97	NM	NM	
MK-MW14	678.50	Overburden	5/5/98	0.0	0	None
			2/24/98	0.0	NM	
			11/12/97	0.0	0	
			8/27/97	NM	NM	

Table 6-1

Lithologic Units with Reported H_2S and Petroleum
Former Plum Brook Ordnance Works, Sandusky, Ohio

Well Identification	Ground Elevation (ft msl)	Unit Monitored	Date	HNu Reading During Ground-water Sampling (ppm)	H_2S Reading During Ground-Water Sampling (ppm)	Possible Petroleum Evidence During Well Installation
MK-MW15	677.80	Overburden	5/5/98	0.0	0	None
			2/24/98	0.0	NM	
			11/12/97	0.0	0	
			8/27/97	NM	NM	
MK-MW16	671.01	Overburden/Ohio Shale	5/5/98	0.0	0	None
			2/24/98	0.0	NM	
			11/12/97	0.0	0	
			8/27/97	NM	NM	
MK-MW17	660.65	Overburden	5/5/98	0.0	0	None
			2/24/98	0.0	NM	
			11/12/97	0.0	0	
			8/27/97	60.0	NM	
MK-MW19	636.20	Overburden	5/5/98	0.5	0	None
			2/24/98	0.5	NM	
			11/12/97	0.2	NM	
			8/27/97	0.0	NM	
MK-MW20	634.30	Overburden	5/5/98	50.0	0	Chemical odors encountered at 6 ft. in gravel lens; strong chemical odor (toluene) 6-10 ft (PID = 4,000 ppm in borehole.
			2/24/98	50.0	NM	
			11/12/97	3.0	NM	
			8/27/97	0.2	NM	
MK-MW22	635.24	Overburden	5/5/98	42.0	0	None
			2/24/98	42.0	NM	
			11/12/97	0.2	NM	
			8/27/97	NM	NM	
MK-MW23	636.63	Overburden	5/5/98	47.0	0	None
			2/24/98	47.0	NM	
			11/12/97	0.2	NM	
			8/27/97	NM	0	
MK-MW24	654.12	Overburden	5/5/98	52.0	0	None
			2/24/98	52.0	NM	
			11/12/97	0.2	NM	
			8/27/97	NM	NM	
MNTA-BEDGW-001	636.05	Delaware Limestone	5/5/98	NM	1500	H_2S odor at 50 ft (7 ppm); H_2S 68 ppm at 55 ft; strong petroleum odor at 62 ft
			2/24/98	0.0	>1900	
			11/12/97	NM	1516	
			8/27/97	NM	NM	

Table 6-1

Lithologic Units with Reported H_2S and Petroleum
Former Plum Brook Ordnance Works, Sandusky, Ohio

Well Identification	Ground Elevation (ft msl)	Unit Monitored	Date	HNu Reading During Ground-water Sampling (ppm)	H_2S Reading During Ground-Water Sampling (ppm)	Possible Petroleum Evidence During Well Installation
PR-MW07	631.18	Overburden	5/5/98	0.0	0	None
			2/24/98	43.0	NM	
			11/12/97	0.0	NM	
			8/27/97	0.0	NM	
PR-MW08	632.18	Overburden/ Olentangy Shale	5/5/98	0.0	0	Dark brown stained sandy clay layer 7.8 - 8.0 ft. HNu = 3 ppm
			2/24/98	2.6	NM	
			11/12/97	0.0	NM	
			8/27/97	NM	NM	
PR-MW09	630.38	Overburden	5/5/98	0.0	0	Dark brown streaks in sandy clay 4 - 6 ft; HNu 2 ppm
			2/24/98	24.5	NM	
			11/12/97	0.8	NM	
			8/27/97	NM	NM	
REACTOR1	630.45	Delaware Limestone	5/5/98	0.0	0	None
			2/24/98	0.2	0	
			11/12/97	NM	0	
			8/27/97	0.4	0	
REACTOR2	631.00	Delaware Limestone	5/5/98	0.0	0	None
			2/24/98	0.5	0	
			11/12/97	NM	0	
			8/27/97	3.2	0	
REACTOR3	631.10	Delaware Limestone	5/5/98	0.0	0	None
			2/24/98	1.5	0	
			11/12/97	NM	0	
			8/27/97	0.4	0	
TNTA-MW10	637.18	Overburden/Ohio Shale	5/5/98	1.0	0	None
			2/24/98	52.0	NM	
			11/12/97	0.2	NM	
			8/27/97	0.0	0	
TNTA-MW11	637.54	Overburden/Ohio Shale	5/5/98	0.0	0	None
			2/24/98	0.3	NM	
			11/12/97	0.2	NM	
			8/27/97	0.0	0	
TNTB-BEDGW-001	659.8	Olentangy Shale	5/5/98	0.0	0	H_2S 1 ppm at well head when boring at 20 ft
			2/24/98	0.0	NM	
			11/12/97	NM	0	
			8/27/97	NM	NM	

Table 6-1

Lithologic Units with Reported H_2S and Petroleum
Former Plum Brook Ordnance Works, Sandusky, Ohio

Well Identification	Ground Elevation (ft msl)	Unit Monitored	Date	HNu Reading During Ground-water Sampling (ppm)	H_2S Reading During Ground-Water Sampling (ppm)	Possible Petroleum Evidence During Well Installation
TNTB-BEDGW-002	670.1	Ohio Shale	5/5/98	0.0	0	H_2S odor at 16 ft
			2/24/98	0.0	NM	
			11/12/97	NM	0	
			8/27/97	NM	NM	
TNTC-MW03	642.25	Overburden	5/5/98	0.0	0	None
			2/24/98	0.0	NM	
			11/12/97	0.6	0	
			8/27/97	0.0	NM	
TNTC-MW04	651.57	Overburden	5/5/98	0.0	0	None
			2/24/98	0.0	NM	
			11/12/97	0.0	0	
			8/27/97	0.0	NM	
TNTC-MW05	648.75	Overburden/Olentangy Shale	5/5/98	0.0	NM	None
			2/24/98	0.0	NM	
			11/12/97	0.0	NM	
			8/27/97	0.0	NM	
TNTC-MW06	656.50	Overburden	5/5/98	0.0	0	Black stained sand 4-6; 6.0 - 7.5 ft, PID 1.0 ppm
			2/24/98	0.0	NM	
			11/12/97	0.2	0	
			8/27/97	0.0	NM	
WA-MW01	642.00	Overburden	5/5/98	0.0	0	None
			2/24/98	0.0	NM	
			11/12/97	0.2	0	
			8/27/97	0.0	NM	
WA-MW02	630.84	Overburden	5/5/98	0.0	0	None
			2/24/98	0.0	NM	
			11/12/97	0.2	0	
			8/27/97	0.0	NM	

NM - Not measured.
NP - Not present.

Table 6-2

Summary of Groundwater Elevation Measurements
Former Plum Brook Ordnance Works, Sandusky, Ohio

Well Identification	Coordinates (Ohio Plane)[a] Easting x	Northing y	Top of Casing Elevation[a] (ft msl)	Ground Elevation[a] (ft msl)	Groundwater Elevation Measurements (feet above mean sea level [msl]) 12/1994[b]	03/1995[c]	10/1996[d]	8/27	8/27/1997[e]	11/12	11/12/1997[f]	2/24	02/24/1998[g]	5/5	05/05/1998[h]
IT-AA1-BEDGW-001	1917718	623069	641.04	638.8	--[i]	--	--	--	--	30.52	610.52	30.50	610.54	29.1	611.94
IT-AA1-GW002	1917728	623068	640.85	638.6	--	--	--	--	--	6.22	634.63	3.05	637.80	3.42	637.43
IT-AA2-BEDGW-001	1909553	623600	644.06	641.6	--	--	--	--	--	13.11	630.95	11.58	632.48	9.89	634.17
IT-AA2-GW-002[j]	1909481	623589	643.95	641.5	--	--	--	--	--	--	dry[k]	--	dry	--	dry
IT-AA3-BEDGW-001	1914957	625037	636.43	634.1	--	--	--	--	--	23.22	613.21	21.53	614.90	21.62	614.81
IT-AA3-GW-002	1914956	625028	636.11	634.1	--	--	--	--	--	6.30	629.81	3.88	632.23	3.97	632.14
IT-ABG-BEDGW-001	1921506	621580	660.59	658.2	--	--	--	--	--	6.09	654.50	3.55	657.04	5.60	654.99
IT-ABG-GW-002	1921516	621579	661.06	658.2	--	--	--	--	--	6.55	654.51	3.95	657.11	4.92	656.14
PB-BED-MW13	1912175	621044	~~647.95~~	645.49	607.85	619.29	621.79	27.80	620.15	27.08	620.87	48.47	599.48	41.40	606.55
PB-BED-MW14	1910457	622720	645.72	642.73	621.76	624.39	625.23	18.51	627.21	19.72	626.00	16.44	629.28	15.99	629.73
PB-BED-MW15	1919283	626179	631.31	628.76	603.54	598.91	610.22	29.95	601.36	21.12	610.19	20.34	610.97	19.79	611.52
PB-BED-MW16	1920594	623299	635.70	633.36	571.38	633.68	630.17	11.80	623.90	7.41	628.29	2.28	633.42	2.74	632.96
PB-BED-MW17	1924121	625417	629.65	627.02	602.57	602.90	602.76	26.48	603.17	27.75	601.90	26.85	602.80	26.40	603.25
PB-BED-MW18	1925483	623849	651.18	648.51	625.05	620.39	621.68	30.58	620.60	30.22	620.96	30.55	620.63	30.72	620.46
PB-BED-MW19	1910174	623869	642.75	640.19	621.07	623.52	622.92	19.85	622.90	20.55	622.20	19.00	623.75	18.45	624.30
PB-BED-MW20	1922952	612423	676.01	673.25	661.35	661.28	661.98	14.28	661.73	14.42	661.59	13.98	662.03	13.29	662.72
IT-BG8-BEDGW-001	1909857	618635	676.56	673.7	--	--	--	--	--	6.38	670.18	8.11	668.45	5.86	670.70
EB-GM-01	1918339	623563	640.45	637.70	--	--	--	8.77	631.68	9.29	631.16	7.35	633.10	7.97	632.48
EB-GM-02	1917822	624435	637.52	634.90	--	--	--	10.76	626.76	9.46	628.06	4.91	632.61	5.14	632.38
EB-GM-03	1917775	624131	638.90	636.20	--	--	--	6.28	632.62	7.38	631.52	5.81	633.09	5.99	632.91
EB-GM-04	1917442	624052	636.34	633.60	--	--	--	5.56	630.78	5.55	630.79	3.27	633.07	3.91	632.43
EB-GM-05	1917802	623872	639.70	637.00	--	--	--	6.24	633.46	7.57	632.13	5.80	633.90	dry	dry
EB-GM-06	1917799	623723	639.61	637.00	--	--	--	6.08	633.53	7.36	632.25	5.92	633.69	6.00	633.61
EB-PS-02	1920061	624344	638.53	635.70	--	--	--	5.97	632.56	5.87	632.66	4.81	633.72	4.90	633.63
EB-PS-03	1920187	624324	637.15	634.40	--	--	--	5.65	631.50	6.35	630.80	5.62	631.53	5.52	631.63
EB-PS-04	1920259	624298	637.87	635.30	--	--	--	8.87	629.00	9.00	628.87	7.30	630.57	5.26	632.61
EB-RA-01	1917783	625964	633.97	631.40	--	--	--	6.61	627.36	7.88	626.09	5.63	628.34	5.75	628.22
EB-RA-02	1918282	626944	633.95	631.30	--	--	--	8.10	625.85	8.72	625.43	6.52	627.43	6.72	627.23
EB-RA-03	1918346	626788	633.63	630.90	--	--	--	--	dry	--	dry	9.09	624.54	9.70	623.93
EB-RA-04	1918389	626731	633.54	630.70	--	--	--	8.07	625.47	10.36	623.18	7.12	626.42	7.53	626.01
EB-RA-05	1918492	626717	633.34	630.60	--	--	--	7.95	625.39	8.87	624.47	6.87	626.47	7.07	626.27
EB-RA-06	1918750	626748	632.64	630.10	--	--	--	8.65	623.99	7.86	624.78	5.20	627.44	4.49	628.15
EB-SP-01	1927550	613598	655.07	652.30	--	--	--	6.43	648.64	7.55	647.52	5.54	649.53	5.78	649.29
EB-SP-03	1926836	613398	657.73	655.10	--	--	--	5.26	652.47	6.94	650.79	4.26	653.47	4.21	653.52

Table 6-2

Summary of Groundwater Elevation Measurements
Former Plum Brook Ordnance Works, Sandusky, Ohio

Well Identification	Coordinates (Ohio Plane)[a] Easting x	Northing y	Top of Casing Elevation[a] (ft msl)	Ground Elevation[a] (ft msl)	Groundwater Elevation Measurements (feet above mean sea level [msl]) 12/1994[b]	03/1995[c]	10/1996[d]	8/27	8/27/1997[e]	11/12	11/12/1997[f]	2/24	02/24/1998[g]	5/5	05/05/1998[h]
EB-SP-04	1926937	613162	658.02	655.25	--	--	--	7.20	650.82	8.18	649.84	4.21	653.81	7.20	650.82
EB-SP-05	1926897	613051	657.00	654.50	--	--	--	5.08	651.92	6.17	650.83	4.92	652.08	4.96	652.04
EB-SP-06	1927074	613056	658.25	655.40	--	--	--	6.80	651.45	8.10	650.15	7.04	651.21	7.24	651.01
GCL-MW01	1921255	617560	674.81	671.40	--	--	--	8.32	666.49	8.81	666.00	4.57	670.24	4.98	669.83
GCL-MW02A	1920961	617937	672.96	669.70	--	--	--	7.57	665.39	7.79	665.17	4.65	668.31	4.85	668.11
GCL-MW02B	1920984	617941	673.42	669.60	--	--	--	8.32	665.10	8.41	665.01	4.59	668.83	5.00	668.42
GCL-MW03	1920777	617641	672.57	669.55	--	--	--	6.00	666.57	6.61	665.96	4.20	668.37	4.50	668.07
IT-MW01	1915525	616901	678.19	674.50	--	--	--	5.45	672.74	7.00	671.19	4.66	673.53	4.60	673.59
IT-MW02	1910265	622512	639.28	636.37	627.32	633.75	629.33	8.09	631.19	9.78	629.50	5.68	633.60	5.79	633.49
IT-MW05	1919475	625346	634.67	631.59	620.19	629.62	623.36	9.88	624.79	10.45	624.22	4.42	630.25	4.76	629.91
IT-MW06	1918768	628642	631.70	628.50	--	--	--	8.34	623.36	9.21	622.49	4.01	627.69	4.02	627.68
IT-MW07[j]	1909862	622076	635.03	632.30	--	--	--	--	dry	--	dry	--	dry	--	dry
IT-MW08	1911132	622498	633.16	630.60	--	--	619.96	8.22	624.94	10.72	622.44	2.91	630.25	3.12	630.04
IT-MW09	1910699	620956	647.45	645.40	--	--	dry	6.00	641.45	7.24	640.21	4.72	642.73	5.02	642.43
IT-MW10	1919485	623027	644.80	642.52	--	--	626.41	11.25	633.55	12.12	632.68	8.20	636.60	8.19	636.61
MK-MW09	1908872	623901	645.61	642.95	--	--	--	6.09	639.52	6.49	639.12	5.00	640.61	4.99	640.62
MK-MW10	1910564	623860	640.57	637.74	626.66	--	632.23	7.13	633.44	8.49	632.08	7.15	633.42	5.22	635.35
MK-MW11	1910564	623860	637.36	634.39	625.22	631.36	628.89	7.13	630.23	8.14	629.22	5.92	631.44	6.51	630.85
MK-MW12	1908764	621233	640.93	638.10	--	--	--	9.86	631.07	10.78	630.15	7.45	633.48	8.38	632.55
MK-MW14	1913325	618311	681.26	678.50	--	--	--	8.17	673.09	8.72	672.54	4.62	676.64	4.81	676.45
MK-MW15	1913304	618488	680.63	677.80	--	--	--	8.22	672.41	8.80	671.83	4.92	675.71	4.86	675.77
MK-MW16	1918011	616834	674.00	671.01	667.14	669.36	668.42	5.97	668.03	7.75	666.25	5.14	668.86	5.10	668.90
MK-MW17	1917813	618572	664.32	660.65	659.58	661.10	660.56	4.32	660.00	4.75	659.57	3.68	660.64	3.90	660.42
MK-MW19	1917535	623871	639.13	636.20	--	--	--	7.99	631.14	6.83	632.30	3.67	635.46	4.56	634.57
MK-MW20	1920539	622912	637.51	634.30	--	--	--	4.97	632.54	4.78	632.73	6.61	630.90	5.85	631.66
MK-MW22	1923776	624339	637.73	635.24	628.85	631.55	630.07	8.20	629.53	8.24	629.49	6.94	630.79	7.42	630.31
MK-MW23	1925354	624657	639.11	636.63	620.88	628.12	632.14	8.49	630.62	8.02	631.09	5.61	633.50	6.54	632.57
MK-MW24	1923302	622264	656.80	654.12	648.31	650.77	649.61	7.08	649.72	7.22	649.58	6.25	650.55	6.18	650.62
IT-MNTA-BEDGW-001	1918699	623808	638.40	636.05	--	--	--	--	--	28.04	610.36	27.05	611.35	25.60	612.80
PB-PR-MW07	1919021	624996	633.67	631.18	626.32	631.65	629.64	5.35	628.32	5.06	628.61	2.21	631.46	2.17	631.50
PB-PR-MW08	1919309	624889	634.70	632.18	624.55	629.98	627.56	6.66	628.04	7.72	626.98	4.90	629.80	4.37	630.33
PB-PR-MW09	1919510	625092	633.38	630.38	622.92	630.12	626.57	6.50	626.88	7.85	625.53	3.36	630.02	3.40	629.98
REACTOR1	1917983	626773	630.51	630.45	--	--	--	15.32	615.19	22.06	608.45	33.25	597.26	32.30	598.21
REACTOR2	1918003	626661	631.05	631.00	614.71	601.89	--	15.40	615.65	4.81	626.24	28.53	602.52	27.50	603.55

Table 6-2

Summary of Groundwater Elevation Measurements
Former Plum Brook Ordnance Works, Sandusky, Ohio

Well Identification	Coordinates (Ohio Plane)[a] Easting x	Northing y	Top of Casing Elevation[a] (ft msl)	Ground Elevation[a] (ft msl)	Groundwater Elevation Measurements (feet above mean sea level [msl]) 12/1994[b]	03/1995[c]	10/1996[d]	8/27	8/27/1997[e]	11/12	11/12/1997[f]	2/24	02/24/1998[g]	5/5	05/05/1998[h]
REACTOR3	1918148	626685	631.21	631.10	--	--	--	14.60	616.61	22.17	609.04	37.45	593.76	37.08	594.13
PB-TNTA-MW10	1923399	623864	639.86	637.18	633.71	637.04	635.62	4.16	635.70	4.67	635.19	3.10	636.76	3.24	636.62
PB-TNTA-MW11	1922744	623518	640.18	637.54	630.50	632.82	633.56	5.49	634.69	5.16	635.02	4.78	635.40	4.34	635.84
IT-TNTB-BEDGW-001	1917218	618738	662.43	659.8	--	--	--	--	--	4.11	658.32	5.60	656.83	2.91	659.52
IT-TNTB-BEDGW-002	1918021	616835	673.35	670.1	--	--	--	--	--	6.91	666.44	2.89	670.46	7.67	665.68
PB-TNTC-MW03	1911391	621465	645.09	642.25	dry	639.20	635.01	8.07	637.02	9.27	635.82	3.80	641.29	4.95	640.14
PB-TNTC-MW04	1910470	620413	654.11	651.57	634.87	651.07	648.51	6.15	647.96	7.62	646.49	3.32	650.79	3.21	659.90
PB-TNTC-MW05	1911811	620692	651.49	648.75	628.01	647.62	643.28	5.62	645.87	5.60	645.89	3.02	648.47	3.10	648.39
PB-TNTC-MW06	1913006	620429	659.08	656.50	651.93	655.20	654.56	4.46	654.62	5.71	653.37	3.72	655.36	3.81	655.27
PB-WA-MW01	1909948	622641	644.11	642.00	--	--	--	14.00	630.11	16.15	627.96	4.09	640.02	4.70	639.41
PB-WA-MW02	1910176	622124	633.33	630.84	--	--	--	3.89	629.44	4.46	628.87	1.53	631.80	1.54	631.79

[a] Survey data are scaled to the Ohio State Plane Coordinate System (North Zone).

[b] Data from Dames & Moore, Sitewide Groundwater Investigation Final Report (4/97).

[c] Data from Dames & Moore, Sitewide Groundwater Investigation Final Report (4/97).

[d] Data from IT Corporation, Site-Wide Groundwater Investigation Report (9/97).

[e] Data from IT Corporation, 1st Quarterly Water Level Measurement Event Report (10/97).

[f] Data from IT Corporation, 2nd Quarterly Water Level Measurement and 1st Semi-Annual Groundwater Sampling Event Report (5/98).

[g] Data from IT Corporation, 3rd Quarterly Water Level Measurement Event Report (6/97).

[h] Data from IT Corporation, 4th Quarterly Water Level Measurement and 2nd Semi-Annual Groundwater Sampling Event Report (this volume).

[i] Symbol denotes data are not available.

[j] Temporary piezometer.

[k] Well was dry at the time of the measurement.

Table 6-3

Summary of Hydraulic Conductivity Testing Results
Former Plum Brook Ordnance Works, Sandusky, Ohio

Well ID	Test Type	Hydraulic Conductivities K (ft/min)	Hydraulic Conductivities K (cm/sec)	Hydraulic Conductivities K (ft/day)
Overburden Wells				
IT-MW-08	Rising	3.32E-03	1.69E-03	4.78E+00
	Rising	7.16E-03	3.64E-03	1.03E+01
	Rising	9.57E-03	4.86E-03	1.38E+01
IT-AA1-GW-002	Rising	5.13E-04	2.61E-04	7.39E-01
IT-AA2-GW-002	Dry	---	---	---
IT-AA3-GW-002	Rising	2.94E-03	1.49E-03	4.23E+00
IT-ABG-GW-002	Rising	1.47E-01	7.47E-02	2.12E+02
Maximum (K)		***1.47E-01***	***7.47E-02***	***2.12E+02***
Minimum (K)		***5.13E-04***	***2.61E-04***	***7.39E-01***
Geometric Mean (K)		***6.08E-03***	***3.09E-03***	***8.75E+00***
Standard Deviation (K)		***5.82E-02***	***2.96E-02***	***8.38E+01***
Bedrock Wells				
IT-AA1-BEDGW-001	Rising	5.17E-05	2.63E-05	7.44E-02
IT-AA2-BEDGW-001	Rising	2.26E-05	1.15E-05	3.25E-02
IT-BG8-BEDGW-001	Rising	2.39E-04	1.21E-04	3.44E-01
IT-ABG-BEDGW-001	Rising	1.54E-02	7.83E-03	2.22E+01
IT-TNTB-BEDGW-001	Rising	4.07E-05	2.07E-05	5.86E-02
IT-TNTB-BEDGW-002	Rising	1.24E-02	6.30E-03	1.79E+01
IT-MNTA-BEDGW-001	Rising	2.17E-05	1.10E-05	3.12E-02
IT-AA3-BEDGW-001	Rising	2.58E-04	1.31E-04	3.72E-01
Maximum (K)		***1.54E-02***	***7.83E-03***	***2.22E+01***
Minimum (K)		***2.17E-05***	***1.10E-05***	***3.12E-02***
Geometric Mean (K)		***2.43E-04***	***1.24E-04***	***3.50E-01***
Standard Deviation (K)		***6.44E-03***	***3.27E-03***	***9.27E+00***

Table 6-4

Well Pair Vertical Hydraulic Gradients
Former Plum Brook Ordnance Works, Sandusky, Ohio

	Well Name	Unit Monitored (ft below ground)	Well TD (ft below ground)	Depth of Monitored Zone (ft below ground)	Elevation of Ground Surface (ft)	Elevation of Center of Monitored Zone (ft)	Groundwater Elevation				Average Vertical Gradient (ft/ft)
							8/27/97	11/12/97	2/24/98	5/5/98	
Pair 1	IT-AA1-GW002	OB/OS	22	6.8-21.9	638.6	624.25	NA	634.63	637.80	637.43	
	IT-AA1-BED-GW001	DL	65.0	49.8-64	638.8	581.90	NA	610.52	610.54	611.94	
	Distance Between Center of Monitored Zones					42.35					
	Vertical Gradient						NA	0.563	0.637	0.596	0.599
Pair 2	IT-AA2-GW-002	OB/OLS	18.5	8.3-18.3	641.5	628.20	NA	DRY	DRY	643.95	
	IT-AA2-BED-GW001	DL	54	27.8-42.8	641.6	606.30	NA	630.95	632.48	634.17	
	Distance Between Center of Monitored Zones					21.90					
	Vertical Gradient						NA	NA	NA	0.447	0.447
Pair 3	AA3-GW002	OB	16	5.8-15.8	634.1	623.30	NA	629.81	632.23	622.14	
	AA3-BED-GW001	DL	53	37.8-52.8	634.1	588.80	NA	613.21	614.90	614.81	
	Distance Between Center of Monitored Zones					34.5					
	Vertical Gradient						NA	0.481	0.502	0.212	0.398
Pair 4	ABG-GW002	OB	6.8	2.5-6.5	658.2	653.70	NA	654.51	657.11	657.06	
	ABG-BED-GW001	OS	21	10.8-20.8	658.2	642.40	NA	654.50	657.04	656.99	
	Distance Between Center of Monitored Zones					11.30					
	Vertical Gradient	OB/OS					NA	0.001	0.006	0.006	0.004
Pair 5	MK-MW16	OB/OS	8	2-7	671.01	666.51	668.35	666.25	669.18	669.22	
	TNTB-BED-GW002	OS	24.2	14-24	670.10	651.10	NA	666.44	670.46	665.68	
	Distance Between Center of Monitored Zones					15.41					
	Vertical Gradient						NA	-0.012	-.081	0.223	0.044

OB - Overburden.
OS - Ohio Shale.
OLS - Olentangy Shale.
DL - Delaware Limestone.

Table 6-5

Blank Corrected Constituents in Overburden Monitoring Wells
West Area Red Water Ponds
Former Plum Brook Ordnance Works, Sandusky, Ohio

		Sample Location:	IT-MW02				IT-MW08				IT-MW10			
		Sample No:	5540		5545		5580		5585		5605		5600	
		Sample Date:	21-Nov-97		15-May-98		19-Nov-97		13-May-98		14-Nov-97		14-May-98	
Parameter	Units	RBC	Result	Val Qlfr	Result	Val Qlfr	Result	Val Qlfr	Result	Val Qlfr	Result	Val Qlfr	Result	Val Qlfr
Volatile Organic Compounds														
Carbon disulfide	µg/L	100									0.17	J		
Toluene	µg/L	75												
Total xylenes	µg/L	1200												
Semivolatile Organic Compounds														
2,4-Dinitrophenol	µg/L	7.3												
2,4-Dinitrotoluene	µg/L	7.3	43		43									
2,6-Dinitrotoluene	µg/L	3.7	7.1	J	6.7	J								
2-Nitroaniline	µg/L	0.22	1.5	J	1.3	J								
3-Nitroaniline	µg/L	11			3.3	J								
4,6-Dinitro-2-methylphenol	µg/L	0.37	12	J										
4-Nitrophenol	µg/L	29												
Di-n-octyl phthalate	µg/L	73												
Nitrobenzene	µg/L	0.35												
bis(2-Ethylhexyl)phthalate	µg/L	4.8									6.1	J		
Explosives														
1,3,5-Trinitrobenzene	µg/L	110	14		15									
1,3-Dinitrobenzene	µg/L	0.37	17		19									
2,4,6-Trinitrotoluene	µg/L	1.8												
2,4-Dinitrotoluene	µg/L	7.3	47		47									
2,6-Dinitrotoluene	µg/L	3.7	7.8		8.9									
3-Nitrotoluene	µg/L	12			36									
Nitrobenzene	µg/L	0.35			2.5									
RDX	µg/L	0.61			6.2									
Metals - Unfiltered														
Aluminum	µg/L	3700									1040		11600	
Arsenic	µg/L	0.045											36.8	
Barium	µg/L	260											372	
Chromium	µg/L	18											39.8	
Cobalt	µg/L	220												
Copper	µg/L	150	62.6		30.7								30.8	
Iron	µg/L	1100			595	J	294				3040		41000	
Lead	µg/L	15									4.5		33.6	
Manganese	µg/L	73	896		754		191		361		1670		1460	
Mercury	µg/L	1.1							0.24					
Nickel	µg/L	73												
Selenium	µg/L	18												
Vanadium	µg/L	26											54.4	
Zinc	µg/L	1100							23.4					

Table 6-5

Blank Corrected Constituents in Overburden Monitoring Wells
West Area Red Water Ponds
Former Plum Brook Ordnance Works, Sandusky, Ohio

		Sample Location:	IT-MW02				IT-MW08				IT-MW10			
		Sample No:	5540		5545		5580		5585		5605		5600	
		Sample Date:	21-Nov-97		15-May-98		19-Nov-97		13-May-98		14-Nov-97		14-May-98	
Parameter	Units	RBC	Result	Val Qlfr	Result	Val Qlfr	Result	Val Qlfr	Result	Val Qlfr	Result	Val Qlfr	Result	Val Qlfr
Metals - Filtered														
Chromium	µg/L	18												
Cobalt	µg/L	220												
Copper	µg/L	150	41.6											
Iron	µg/L	1100			509		327							
Manganese	µg/L	73	877		969		238		328		1630		621	
Nickel	µg/L	73												
Vanadium	µg/L	26												
Zinc	µg/L	1100	27.2	J					33.1					
Cyanide														
Cyanide, total	µg/L	73			16									
Water Quality Parameters														
Alkalinity	µg/L	ne	550000		650000		510000		470000		45000		480000	
Chloride	µg/L	ne	97000		23000		18000	J	14000		17000		13000	J
Hardness	µg/L	ne	2E+06		660000		1300000		1600000		760000		820000	
Nitrate	µg/L	5800									100		200	
Sulfate	µg/L	ne	270000		260000		920000	J	780000		300000		270000	J
Total dissolved solids	µg/L	ne	1E+06		1100000		1900000		1700000		930000		1100000	
Total organic carbon	µg/L	ne	41000		28000		6000	J	4400		2700		3000	J
Total suspended solids	µg/L	ne			370000						37000		400000	

Table 6-5

Blank Corrected Constituents in Overburden Monitoring Wells
West Area Red Water Ponds
Former Plum Brook Ordnance Works, Sandusky, Ohio

		Sample Location:	PB-WA-MW01				PB-WA-MW02			
		Sample No:	5670		5675		5680		5685	
		Sample Date:	21-Nov-97		18-May-98		23-Nov-97		15-May-98	
Parameter	Units	RBC	Result	Val Qlfr	Result	Val Qlfr	Result	Val Qlfr	Result	Val Qlfr
Volatile Organic Compounds										
Carbon disulfide	µg/L	100								
Toluene	µg/L	75								
Total xylenes	µg/L	1200								
Semivolatile Organic Compounds										
2,4-Dinitrophenol	µg/L	7.3							7.6	J
2,4-Dinitrotoluene	µg/L	7.3							55	
2,6-Dinitrotoluene	µg/L	3.7							1.8	J
2-Nitroaniline	µg/L	0.22								
3-Nitroaniline	µg/L	11							330	J
4,6-Dinitro-2-methylphenol	µg/L	0.37								
4-Nitrophenol	µg/L	29							1.6	J
Di-n-octyl phthalate	µg/L	73	2.7	J						
Nitrobenzene	µg/L	0.35							3.7	J
bis(2-Ethylhexyl)phthalate	µg/L	4.8								
Explosives										
1,3,5-Trinitrobenzene	µg/L	110							23	
1,3-Dinitrobenzene	µg/L	0.37							23	
2,4,6-Trinitrotoluene	µg/L	1.8								
2,4-Dinitrotoluene	µg/L	7.3							21	
2,6-Dinitrotoluene	µg/L	3.7							4.1	
3-Nitrotoluene	µg/L	12								
Nitrobenzene	µg/L	0.35								
RDX	µg/L	0.61								
Metals - Unfiltered										
Aluminum	µg/L	3700	2710	J			3720	J	4220	
Arsenic	µg/L	0.045								
Barium	µg/L	260								
Chromium	µg/L	18					12.8		11.4	
Cobalt	µg/L	220					142		118	
Copper	µg/L	150					70.2		61.9	
Iron	µg/L	1100	5600		319	J	7930		9390	J
Lead	µg/L	15								
Manganese	µg/L	73	235		303		1660		1510	
Mercury	µg/L	1.1								
Nickel	µg/L	73					228		190	
Selenium	µg/L	18					16.7			
Vanadium	µg/L	26								
Zinc	µg/L	1100					36.7			

Table 6-5

Blank Corrected Constituents in Overburden Monitoring Wells
West Area Red Water Ponds
Former Plum Brook Ordnance Works, Sandusky, Ohio

		Sample Location:	PB-WA-MW01				PB-WA-MW02			
		Sample No:	5670		5675		5680		5685	
		Sample Date:	21-Nov-97		18-May-98		23-Nov-97		15-May-98	
Parameter	Units	RBC	Result	Val Qlfr	Result	Val Qlfr	Result	Val Qlfr	Result	Val Qlfr
Metals - Filtered										
Chromium	µg/L	18							12.4	
Cobalt	µg/L	220							126	
Copper	µg/L	150							66.9	
Iron	µg/L	1100							422	
Manganese	µg/L	73	163		253		1620		2260	
Nickel	µg/L	73							199	
Vanadium	µg/L	26								
Zinc	µg/L	1100								
Cyanide										
Cyanide, total	µg/L	73					79		89	
Water Quality Parameters										
Alkalinity	µg/L	ne	380000		470000		520000		640000	
Chloride	µg/L	ne	7000		7000		2000			
Hardness	µg/L	ne	4900000		940000		3300000		1500000	
Nitrate	µg/L	5800					80000	J	62000	
Sulfate	µg/L	ne	170000		200000		2300000		2000000	
Total dissolved solids	µg/L	ne	650000		630000		7700000		6400000	
Total organic carbon	µg/L	ne	2100		3000		970000		780000	
Total suspended solids	µg/L	ne			8000		40000		160000	

Note: Nutritionally essential elements, including calcium, magnesium, potassium, and sodium, are not presented on this table. Analytical results for these elements may be referenced in Appendix H.

Shaded area indicates concentration above the respective RBC.
ne - Not established.

Table 6-6

Blank Corrected Constituents in Overburden Monitoring Wells
Pentolite Road Red Water Ponds
Former Plum Brook Ordnance Works, Sandusky, Ohio

(Page 1 of 2)

		Sample Location:	IT-MW05				PB-PR-MW7			
		Sample No:	5550		5555		5690		5695	
		Sample Date:	19-Nov-97		28-May-98		17-Nov-97		20-May-98	
Parameter	Units	RBC	Result	Val Qlfr	Result	Val Qlfr	Result	Val Qlfr	Result	Val Qlfr
Volatile Organic Compounds										
2-Butanone	µg/L	190								
2-Hexanone	µg/L	150								
Acetone	µg/L	370	22	J	45	J				
Benzene	µg/L	0.36			0.21	J				
Bromodichloromethane	µg/L	0.17								
Carbon disulfide	µg/L	100	0.21	J						
Ethyl benzene	µg/L	130							0.17	J
Toluene	µg/L	75								
Total xylenes	µg/L	1200							0.82	J
Semivolatile Organic Compounds										
2,4-Dinitrophenol	µg/L	7.3								
2,4-Dinitrotoluene	µg/L	7.3					1800		1800	NJ
2,6-Dinitrotoluene	µg/L	3.7					140	J		
2-Nitrophenol	µg/L	230							6.6	NJ
3-Nitroaniline	µg/L	11								
4,6-Dinitro-2-methylphenol	µg/L	0.37					660	J	12000	NJ
4-Nitrophenol	µg/L	29								
Dibenzofuran	µg/L	15								
Fluorene	µg/L	150								
Nitrobenzene	µg/L	0.35							13	NJ
bis(2-Ethylhexyl)phthalate	µg/L	4.8								
Explosives										
1,3,5-Trinitrobenzene	µg/L	110					2000		2800	
1,3-Dinitrobenzene	µg/L	0.37					1500		2000	
2,4-Dinitrotoluene	µg/L	7.3					1200		1600	
Metals - Unfiltered										
Aluminum	µg/L	3700	3970	J	15800	J	8960	J	10500	J
Arsenic	µg/L	0.045	11.5		14.3					
Barium	µg/L	260			312					
Chromium	µg/L	18	10.6		22.7					
Cobalt	µg/L	220					2320		2350	
Copper	µg/L	150			43.7		887		1060	
Iron	µg/L	1100	14700		26500		21700		32600	
Lead	µg/L	15	6.6		9.4					
Manganese	µg/L	73	302		592		17000		13700	
Mercury	µg/L	1.1	0.3							
Nickel	µg/L	73					1710		1790	
Zinc	µg/L	1100	476							
Metals - Filtered										
Arsenic	µg/L	0.045	12.5							
Cobalt	µg/L	220					2330		2610	
Copper	µg/L	150					911		1050	
Iron	µg/L	1100	3050		185		1360		2110	
Manganese	µg/L	73	114		223		17000		17600	
Nickel	µg/L	73					1710		1900	
Cyanide										
Cyanide, total	µg/L	73					120		200	
Water Quality Parameters										
Alkalinity	µg/L	ne	350000		680000		820000		840000	
Chloride	µg/L	ne	3000		11000				9500000	
Hardness	µg/L	ne	760000		570000		5000000		2300000	
Nitrate	µg/L	5800					400	J	190000	
Sulfate	µg/L	ne	48000		61000		8000000		5400000	
Total dissolved solids	µg/L	ne	420000		650000		17000000		18000000	
Total organic carbon	µg/L	ne	4700		6000		2700000		2900000	
Total suspended solids	µg/L	ne	6000		15000		25000		17000	

Table 6-6

Blank Corrected Constituents in Overburden Monitoring Wells
Pentolite Road Red Water Ponds
Former Plum Brook Ordnance Works, Sandusky, Ohio

		Sample Location:	PB-PR-MW8				PB-PR-MW9			
		Sample No:	5700		5705		5710		5715	
		Sample Date:	17-Nov-97		20-May-98		17-Nov-97		20-May-98	
Parameter	Units	RBC	Result	Val Qlfr	Result	Val Qlfr	Result	Val Qlfr	Result	Val Qlfr
Volatile Organic Compounds										
2-Butanone	µg/L	190			14	J				
2-Hexanone	µg/L	150			2	J				
Acetone	µg/L	370								
Benzene	µg/L	0.36							0.47	J
Bromodichloromethane	µg/L	0.17			0.23	J				
Carbon disulfide	µg/L	100								
Ethyl benzene	µg/L	130							1.5	
Toluene	µg/L	75							1.5	
Total xylenes	µg/L	1200			0.44	J			8	
Semivolatile Organic Compounds										
2,4-Dinitrophenol	µg/L	7.3	6000		3800	NJ	48	J		
2,4-Dinitrotoluene	µg/L	7.3	1500		1700	NJ	110		120	
2,6-Dinitrotoluene	µg/L	3.7	190	J						
2-Nitrophenol	µg/L	230			15					
3-Nitroaniline	µg/L	11	160	J			450	J		
4,6-Dinitro-2-methylphenol	µg/L	0.37	2300	J	20000	NJ			280	NJ
4-Nitrophenol	µg/L	29			42	NJ				
Dibenzofuran	µg/L	15			620	NJ				
Fluorene	µg/L	150			44	NJ				
Nitrobenzene	µg/L	0.35			14					
bis(2-Ethylhexyl)phthalate	µg/L	4.8								
Explosives										
1,3,5-Trinitrobenzene	µg/L	110	1500		2400				71	
1,3-Dinitrobenzene	µg/L	0.37	1500		2100		35		170	
2,4-Dinitrotoluene	µg/L	7.3	1300		2400		28		110	
Metals - Unfiltered										
Aluminum	µg/L	3700								
Arsenic	µg/L	0.045								
Barium	µg/L	260								
Chromium	µg/L	18								
Cobalt	µg/L	220	7270		7150				480	
Copper	µg/L	150	3790		3740				430	
Iron	µg/L	1100	22000		12100				2070	
Lead	µg/L	15								
Manganese	µg/L	73	34100		43900		1900		2300	
Mercury	µg/L	1.1								
Nickel	µg/L	73	7600		6950				466	
Zinc	µg/L	1100								
Metals - Filtered										
Arsenic	µg/L	0.045								
Cobalt	µg/L	220	6770		7450				522	
Copper	µg/L	150	3390		3900				294	
Iron	µg/L	1100	12200		9560					
Manganese	µg/L	73	29700		45500		1890		2500	
Nickel	µg/L	73	6820		7310				460	
Cyanide										
Cyanide, total	µg/L	73	240		1700		36		72	
Water Quality Parameters										
Alkalinity	µg/L	ne	990000		1500000		860000		810000	
Chloride	µg/L	ne	6500000		4700000		7200000		3600000	
Hardness	µg/L	ne	13000000		3100000		2200000		1200000	
Nitrate	µg/L	5800	1600000	J	1500000		200	J	110000	
Sulfate	µg/L	ne	12000000		12000000		3000000		1600000	
Total dissolved solids	µg/L	ne	50000000		49000000		8700000		6400000	
Total organic carbon	µg/L	ne	14000000		11000000		1300000		930000	
Total suspended solids	µg/L	ne	73000		79000		8000		7000	

Note: Nutritionally essential elements, including calcium, magnesium, potassium, and sodium are not presented on this table.
Analytical results for these elements may be referenced in Appendix H.
Shaded area indicates that concentration above the respective RBC.
ne - Not established.

Table 6-7

Blank Corrected Constituents in Overburden Monitoring Wells
TNT Manufacturing Area A
Former Plum Brook Ordnance Works, Sandusky, Ohio

		Sample Location:	MK-MW22				MK-MW23				MK-MW24			
		Sample No:	5820		5825		5830		5835		5840		5845	
		Sample Date:	14-Nov-97		18-May-98		16-Nov-97		29-May-98		13-Nov-97		20-May-98	
Parameter	Units	RBC	Result	Val Qlfr	Result	Val Qlfr	Result	Val Qlfr	Result	Val Qlfr	Result	Val Qlfr	Result	Val Qlfr
Volatile Organic Compounds														
Acetone	µg/L	370					68	J						
Benzene	µg/L	0.36							0.17	J				
Carbon disulfide	µg/L	100					0.37	J						
Toluene	µg/L	75			7.8								10	
Semivolatile Organic Compounds														
Di-n-octyl phthalate	µg/L	73					9.3	J						
bis(2-Ethylhexyl)phthalate	µg/L	4.8							890	D				
Explosives														
1,3,5-Trinitrobenzene	µg/L	110	0.24		0.43									
2,4,6-Trinitrotoluene	µg/L	1.8	0.74		1.7									
2,4-Dinitrotoluene	µg/L	7.3	0.2		0.35									
2,6-Dinitrotoluene	µg/L	3.7	0.53		1.2									
4-Amino-2,6-dinitrotoluene	µg/L	0.22	0.62		0.86									
Nitrobenzene	µg/L	0.35			0.26									
Metals - Unfiltered														
Aluminum	µg/L	3700	7790		6200		27300		143000	J	6620		242	J
Antimony	µg/L	1.5							82					
Arsenic	µg/L	0.045					59.8		113					
Barium	µg/L	260							232					
Beryllium	µg/L	7.3							6.9					
Chromium	µg/L	18	16.6		13.7		57.1		258		25.2			
Cobalt	µg/L	220					50.8		222					
Copper	µg/L	150					47.3		225					
Iron	µg/L	1100	10900		10900	J	68200		304000		13500		1960	
Lead	µg/L	15	6.7		4.3		29.8		108		13.1			
Manganese	µg/L	73	185		142		1370		7550		788		458	
Mercury	µg/L	1.1							0.25					
Nickel	µg/L	73					125		628					
Vanadium	µg/L	26					75.2		244		60.9			
Zinc	µg/L	1100	35.6				167		735		127			

Table 6-7

Blank Corrected Constituents in Overburden Monitoring Wells
TNT Manufacturing Area A
Former Plum Brook Ordnance Works, Sandusky, Ohio

		Sample Location:	MK-MW22				MK-MW23				MK-MW24			
		Sample No:	5820		5825		5830		5835		5840		5845	
		Sample Date:	14-Nov-97		18-May-98		16-Nov-97		29-May-98		13-Nov-97		20-May-98	
Parameter	Units	RBC	Result	Val Qlfr	Result	Val Qlfr	Result	Val Qlfr	Result	Val Qlfr	Result	Val Qlfr	Result	Val Qlfr
Metals - Filtered														
Arsenic	µg/L	0.045					13.8							
Barium	µg/L	260												
Chromium	µg/L	18									14.2			
Iron	µg/L	1100									2920		1440	
Manganese	µg/L	73	149		114		265		134		562		454	
Mercury	µg/L	1.1									0.76			
Vanadium	µg/L	26									53			
Zinc	µg/L	1100												
Water Quality Parameters														
Alkalinity	µg/L	ne	280000		370000		na		na		370000		370000	
Chloride	µg/L	ne	7000		3000		na		na				7000	
Hardness	µg/L	ne	420000		520000		na		na		1900000		1600000	
Sulfate	µg/L	ne	36000		30000		na		na		1200000		1100000	
Total dissolved solids	µg/L	ne	360000		370000		na		na		2400000		2000000	
Total organic carbon	µg/L	ne	11000		2000		na		na		21000		9000	
Total suspended solids	µg/L	ne	150000		130000		na		na		400000		7000	

Table 6-7

Blank Corrected Constituents in Overburden Monitoring Wells
TNT Manufacturing Area A
Former Plum Brook Ordnance Works, Sandusky, Ohio

		Sample Location:	PB-TNTA-MW10				PB-TNTA-MW11			
		Sample No:	5610		5615		5620		5625	
		Sample Date:	18-Nov-97		29-May-98		18-Nov-97		29-May-98	
Parameter	Units	RBC	Result	Val Qlfr	Result	Val Qlfr	Result	Val Qlfr	Result	Val Qlfr
Volatile Organic Compounds										
Acetone	µg/L	370	35	J	7.6	J				
Benzene	µg/L	0.36								
Carbon disulfide	µg/L	100								
Toluene	µg/L	75								
Semivolatile Organic Compounds										
Di-n-octyl phthalate	µg/L	73								
bis(2-Ethylhexyl)phthalate	µg/L	4.8								
Explosives										
1,3,5-Trinitrobenzene	µg/L	110								
2,4,6-Trinitrotoluene	µg/L	1.8								
2,4-Dinitrotoluene	µg/L	7.3								
2,6-Dinitrotoluene	µg/L	3.7								
4-Amino-2,6-dinitrotoluene	µg/L	0.22								
Nitrobenzene	µg/L	0.35								
Metals - Unfiltered										
Aluminum	µg/L	3700	877	J	2280	J	3170	J	2990	J
Antimony	µg/L	1.5								
Arsenic	µg/L	0.045	12.2		14.5		10.5			
Barium	µg/L	260	373							
Beryllium	µg/L	7.3								
Chromium	µg/L	18					15.6		12.2	
Cobalt	µg/L	220								
Copper	µg/L	150								
Iron	µg/L	1100	18200		18700		13300		6610	
Lead	µg/L	15			5.6		10.4		3.2	
Manganese	µg/L	73	1530		1250		1030		444	
Mercury	µg/L	1.1								
Nickel	µg/L	73								
Vanadium	µg/L	26								
Zinc	µg/L	1100	27				47.1			

Table 6-7

Blank Corrected Constituents in Overburden Monitoring Wells
TNT Manufacturing Area A
Former Plum Brook Ordnance Works, Sandusky, Ohio

		Sample Location:	PB-TNTA-MW10				PB-TNTA-MW11			
		Sample No:	5610		5615		5620		5625	
		Sample Date:	18-Nov-97		29-May-98		18-Nov-97		29-May-98	
Parameter	Units	RBC	Result	Val Qlfr	Result	Val Qlfr	Result	Val Qlfr	Result	Val Qlfr
Metals - Filtered										
Arsenic	µg/L	0.045								
Barium	µg/L	260	338							
Chromium	µg/L	18								
Iron	µg/L	1100	7610		9330					
Manganese	µg/L	73	1440		1370		865		355	
Mercury	µg/L	1.1								
Vanadium	µg/L	26								
Zinc	µg/L	1100	25				45.4			
Water Quality Parameters										
Alkalinity	µg/L	ne	490000		410000		450000		460000	
Chloride	µg/L	ne	47000		100000		140000		180000	
Hardness	µg/L	ne	1100000		730000		940000		680000	
Sulfate	µg/L	ne	160000		100000		150000		93000	
Total dissolved solids	µg/L	ne	780000		760000		1000000		1000000	
Total organic carbon	µg/L	ne	4200		2000		4500		3000	
Total suspended solids	µg/L	ne	7000				140000		7000	

Note: Nutritionally essential elements, including calcium, magnesium, potassium, and sodium, are not presented on this table. Analytical results for these elements may be referenced in Appendix H.
Shaded area indicates concentration above the respective RBC.
ne - Not established.
na - Not analyzed.

Table 6-8

Blank Corrected Constituents in Overburden Monitoring Wells
TNT Manufacturing Area B
Former Plum Brook Ordnance Works, Sandusky, Ohio

		Sample Location:	MK-MW16				MK-MW17			
		Sample No:	5780		5785		5790		5795	
		Sample Date:	21-Nov-97		18-May-98		21-Nov-97		27-May-98	
Parameter	Units	RBC	Result	Val Qlfr	Result	Val Qlfr	Result	Val Qlfr	Result	Val Qlfr
Volatile Organic Compounds										
Acetone	µg/L	370			5.2	J				
Carbon disulfide	µg/L	100								
Semivolatile Organic Compounds										
2,4-Dinitrotoluene	µg/L	7.3							1.8	J
bis(2-Ethylhexyl)phthalate	µg/L	4.8	2.4	J						
Explosives										
2,4,6-Trinitrotoluene	µg/L	1.8							0.68	
2,4-Dinitrotoluene	µg/L	7.3							1.7	
4-Amino-2,6-dinitrotoluene	µg/L	0.22					3.6		5.7	
Metals - Unfiltered										
Aluminum	µg/L	3700	4990	J	1180		1830	J	6920	J
Arsenic	µg/L	0.045					12.6		18.7	
Cobalt	µg/L	220			69.8		78.8		54.9	
Copper	µg/L	150							32.9	
Iron	µg/L	1100	19800		20700	J	44300		41900	
Lead	µg/L	15							16.4	
Manganese	µg/L	73	6970		13600		1410		1120	
Nickel	µg/L	73	61.8		108		156		130	
Selenium	µg/L	18	5				5.1			
Zinc	µg/L	1100	75.5		209		137		152	
Metals - Filtered										
Aluminum	µg/L	3700	1080		663				7430	
Arsenic	µg/L	0.045							22	
Cobalt	µg/L	220			51.9		72.9		56.7	
Copper	µg/L	150			39.2				32.2	
Iron	µg/L	1100	2410		5970		34100		41600	
Lead	µg/L	15			7.4				17	
Manganese	µg/L	73	6900		8850		1260		1170	
Mercury	µg/L	1.1					0.3			
Nickel	µg/L	73	47.2		81.7		140		131	
Selenium	µg/L	18	5							
Zinc	µg/L	1100	54.7	J			87.7	J	157	
Cyanide										
Cyanide, total	µg/L	73								
Water Quality Parameters										
Alkalinity	µg/L	ne	36000		320000		38000			
Chloride	µg/L	ne			3000				6000	
Hardness	µg/L	ne	490000		750000		440000		490000	
Sulfate	µg/L	ne	470000		550000		300000		330000	
Total dissolved solids	µg/L	ne	290000		800000		660000		590000	
Total organic carbon	µg/L	ne	2500		2000		3400		3000	
Total suspended solids	µg/L	ne			9000		5000		120000	

Note: Nutritionally essential elements, including calcium, magnesium, potassium, and sodium, are not presented on this table. Analytical results for these elements may be referenced in Appendix H.

Shaded area indicates concentration above the respective RBC.
ne - Not established.

Table 6-9

Blank Corrected Constituents in Overburden Monitoring Wells
TNT Manufacturing Area C
Former Plum Brook Ordnance Works, Sandusky, Ohio

		Sample Location:	IT-MW09				MK-MW12				PB-TNTC-MW03			
		Sample No:	5590		5595		5750		5755		5630		5635	
		Sample Date:	23-Nov-97		19-May-98		17-Nov-97		14-May-98		21-Nov-97		18-May-98	
Parameter	Units	RBC	Result	Val Qlfr	Result	Val Qlfr	Result	Val Qlfr	Result	Val Qlfr	Result	Val Qlfr	Result	Val Qlfr
Volatile Organic Compounds														
Benzene	µg/L	0.36			0.16	J								
Chlorobenzene	µg/L	3.5	0.17	J										
Toluene	µg/L	75			17									
Semivolatile Organic Compounds														
bis(2-Ethylhexyl)phthalate	µg/L	4.8					28							
Metals - Unfiltered														
Aluminum	µg/L	3700	1200	J			310						6030	
Arsenic	µg/L	0.045											18.6	
Chromium	µg/L	18	10.4										30	
Cobalt	µg/L	220									67.5			
Copper	µg/L	150											31.5	
Iron	µg/L	1100	3370		131		830		396		805		23500	J
Lead	µg/L	15											13.8	
Manganese	µg/L	73	249		30.7		1130		1000		2950		973	
Nickel	µg/L	73									120			
Selenium	µg/L	18												
Zinc	µg/L	1100	27.2				25.8				34.5			
Metals - Filtered														
Aluminum	µg/L	3700												
Iron	µg/L	1100												
Lead	µg/L	15			4.1									
Manganese	µg/L	73	372		36.4		1060		1050		2900		617	
Nickel	µg/L	73									77.1			
Selenium	µg/L	18												
Zinc	µg/L	1100	73.3	J							28.5	J		
Water Quality Parameters														
Alkalinity	µg/L	ne	340000		410000		340000		270000		270000		350000	
Chloride	µg/L	ne	28000				6000		1000	J	17000		14000	
Hardness	µg/L	ne	2E+06				540000		450000		13000000		1800000	
Nitrate	µg/L	5800	17000	J	100									
Sulfate	µg/L	ne	2E+06		790000		54000		51000	J	2000000		1300000	
Total dissolved solids	µg/L	ne	3E+06		1600000		410000		400000		3000000		2900000	
Total organic carbon	µg/L	ne	2900		2000		2000		2000	J	2400		3000	
Total suspended solids	µg/L	ne	15000				5000						150000	

Table 6-9

Blank Corrected Constituents in Overburden Monitoring Wells
TNT Manufacturing Area C
Former Plum Brook Ordnance Works, Sandusky, Ohio

		Sample Location:	PB-TNTC-MW04				PB-TNTC-MW05				PB-TNTC-MW06			
		Sample No:	5640		5645		5650		5655		5660		5665 / 5665R	
		Sample Date:	24-Nov-97		18-May-98		21-Nov-97		18-May-98		20-Nov-97		16-May-98	
Parameter	Units	RBC	Result	Val Qlfr	Result	Val Qlfr	Result	Val Qlfr	Result	Val Qlfr	Result	Val Qlfr	Result	Val Qlfr
Volatile Organic Compounds														
Benzene	µg/L	0.36												
Chlorobenzene	µg/L	3.5												
Toluene	µg/L	75											22	
Semivolatile Organic Compounds														
bis(2-Ethylhexyl)phthalate	µg/L	4.8									7.3	J		
Metals - Unfiltered														
Aluminum	µg/L	3700	3820	J	4570	J	3490	J	5230		496	J		
Arsenic	µg/L	0.045	21.5				10.1		21.3					
Chromium	µg/L	18	25.2		11		18.4		28					
Cobalt	µg/L	220												
Copper	µg/L	150							31					
Iron	µg/L	1100	17400		8230		13900		22700	J	2460		2080	J
Lead	µg/L	15	14.5		3.2		13.8		20.1					
Manganese	µg/L	73	800		715		713		616		3700		3830	
Nickel	µg/L	73	52.4											
Selenium	µg/L	18	7.2											
Zinc	µg/L	1100	58.7				53							
Metals - Filtered														
Aluminum	µg/L	3700	432											
Iron	µg/L	1100									1570		684	
Lead	µg/L	15	11				4.2							
Manganese	µg/L	73	1120		582		522		452		4020		3970	
Nickel	µg/L	73	56.8											
Selenium	µg/L	18	11.4											
Zinc	µg/L	1100	52	J										
Water Quality Parameters														
Alkalinity	µg/L	ne	330000		250000		320000		380000		610000		610000	
Chloride	µg/L	ne	23000		27000		50000		26000		3000		180000	
Hardness	µg/L	ne	9200000		720000		500000		850000		920000		790000	
Nitrate	µg/L	5800	91000	J	400				200					
Sulfate	µg/L	ne	1100000		990000		430000		240000					
Total dissolved solids	µg/L	ne	2100000		1600000		1000000		1200000		640000		620000	
Total organic carbon	µg/L	ne	2600		3000		3000		3000		10000		9000	
Total suspended solids	µg/L	ne	5000		280000		7000		240000		130000		4000	

Note: Nutritionally essential elements, including calcium, magnesium, potassium, and sodium, are not presented on this table. Analytical results for these elements may be ref in Appendix H.

Shaded area indicates concentration above the respective RBC.

ne - Not established.

Table 6-10

Blank Corrected Constituents in Overburden Monitoring Wells
Acid Areas and Maintenance Shop Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

		Sample Area:	Acid Area No. 1				Acid Area No. 2							
		Sample Location:	IT-AA1-GW002				MK-MW09				MK-MW10			
		Sample No:	5490		5495		5720		5725		5730		5735	
		Sample Date:	20-Nov-97		13-May-98		16-Nov-97		13-May-98		13-Nov-97		12-May-98	
Parameter	Units	RBC	Result	Val Qlfr	Result	Val Qlfr	Result	Val Qlfr	Result	Val Qlfr	Result	Val Qlfr	Result	Val Qlfr
Volatile Organic Compounds														
1,1,1-Trichloroethane	µg/L	160												
1,1-Dichloroethane	µg/L	80												
1,1-Dichloroethene	µg/L	0.044												
Carbon disulfide	µg/L	100			1.2									
Chloroethane	µg/L	3.6												
Chloroform	µg/L	0.063											0.45	J
Toluene	µg/L	75												
Total xylenes	µg/L	1200												
Semivolatile Organic Compounds														
bis(2-Ethylhexyl)phthalate	µg/L	4.8									11			
Metals - Unfiltered														
Aluminum	µg/L	3700	2020	J							1140			
Arsenic	µg/L	0.045												
Chromium	µg/L	18												
Copper	µg/L	150												
Iron	µg/L	1100	32900		26200						2080			
Lead	µg/L	15					8.5				3.5			
Manganese	µg/L	73	5410		5900						90.9			
Vanadium	µg/L	26												
Zinc	µg/L	1100	67.4								25.5			
Metals - Filtered														
Copper	µg/L	150							50.7					
Iron	µg/L	1100	14400		39100								121	
Lead	µg/L	15												
Manganese	µg/L	73	4740		5550						65.4			
Zinc	µg/L	1100												
Cyanide														
Cyanide, total	µg/L	73												
Water Quality Parameters														
Alkalinity	µg/L	ne	350000		410000		300000		270000		450000		240000	
Chloride	µg/L	ne	9000		9000	J	5000		2000	J	14000		4000	J
Hardness	µg/L	ne	2E+06		2800000		370000		320000		370000		290000	
Nitrate	µg/L	5800					200		200				3200	
Sulfate	µg/L	ne	2E+06		1800000	J	32000		31000	J	270000		21000	J
Total dissolved solids	µg/L	ne	3E+06		3800000		350000		370000		350000		2700000	
Total organic carbon	µg/L	ne	6900		6000	J	1500		1000	J	1400		1000	J
Total suspended solids	µg/L	ne	5000		260000		5000				35000		74000	

Table 6-10

Blank Corrected Constituents in Overburden Monitoring Wells
Acid Areas and Maintenance Shop Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

		Sample Area:	Acid Area No. 2 (continued)				Acid Area No. 3				Maintenance Shop Area			
		Sample Location:	MK-MW11				IT-AA3-GW002				MK-MW19			
		Sample No:	5740		5745		5510		5515		5800		5805	
		Sample Date:	18-Nov-97		13-May-98		19-Nov-97		14-May-98		16-Nov-97		1-Jun-98	
Parameter	Units	RBC	Result	Val Qlfr	Result	Val Qlfr	Result	Val Qlfr	Result	Val Qlfr	Result	Val Qlfr	Result	Val Qlfr
Volatile Organic Compounds														
1,1,1-Trichloroethane	µg/L	160									170		140	
1,1-Dichloroethane	µg/L	80									17		17	
1,1-Dichloroethene	µg/L	0.044									3.4		2.2	J
Carbon disulfide	µg/L	100	0.31	J										
Chloroethane	µg/L	3.6									2.5		1.8	J
Chloroform	µg/L	0.063												
Toluene	µg/L	75									6.1			
Total xylenes	µg/L	1200												
Semivolatile Organic Compounds														
bis(2-Ethylhexyl)phthalate	µg/L	4.8												
Metals - Unfiltered														
Aluminum	µg/L	3700	5080		6810		11600	J					12500	
Arsenic	µg/L	0.045					10.3						12	
Chromium	µg/L	18	12.6		15.4		22.8						24.7	
Copper	µg/L	150					33.6						32.1	
Iron	µg/L	1100	12300		17000		27300						24300	
Lead	µg/L	15	9.4		9.1		16.6						30.6	
Manganese	µg/L	73	344		477		816		123		23.4		418	
Vanadium	µg/L	26											54	
Zinc	µg/L	1100	43.5		163		99.9							
Metals - Filtered														
Copper	µg/L	150												
Iron	µg/L	1100												
Lead	µg/L	15											3	
Manganese	µg/L	73					78.8		139		29.2		22.4	
Zinc	µg/L	1100					49.9							
Cyanide														
Cyanide, total	µg/L	73			38									
Water Quality Parameters														
Alkalinity	µg/L	ne	590000		320000		370000		320000		400000		370000	
Chloride	µg/L	ne	21000		18000	J	4000		4000	J	6000		5000	
Hardness	µg/L	ne	860000		580000		400000		530000		540000		640000	
Nitrate	µg/L	*5800*	*600*		*4700*									
Sulfate	µg/L	ne	54000		53000	J	18000		37000	J	110000		120000	
Total dissolved solids	µg/L	ne	500000		430000		460000		480000		600000		650000	
Total organic carbon	µg/L	ne	3100		2000	J	4500		2000	J	2900		3000	
Total suspended solids	µg/L	ne			58000		290000		150000		12000		10000	

Note: Nutritionally essential elements, including calcium, magnesium, potassium, and sodium, are not presented on this table. Analytical results for these elements may be re
in Appendix H.
Shaded area indicates concentration above the respective RBC.
ne - Not established.

Table 6-11

Blank Corrected Constituents In Overburden Monitoring Wells
Burning Ground Areas
Former Plum Brook Ordnance Works, Sandusky, Ohio

		Sample Area:	Additional Burning Ground				Snake Road Burning Ground							
		Sample Location:	IT-ABG-GW002				GCL-MW01				GCL-MW02A			
		Sample No:	5520		5525		5850		5855		5860		5865	
		Sample Date:	19-Nov-97		13-May-98		20-Nov-97		17-May-98		20-Nov-97		17-May-98	
Parameter	Units	RBC	Result	Val Qlfr	Result	Val Qlfr	Result	Val Qlfr	Result	Val Qlfr	Result	Val Qlfr	Result	Val Qlfr
Volatile Organic Compounds														
Acetone	µg/L	370			6.6	J								
Benzene	µg/L	0.36	0.63	J	0.5	J							0.27	J
Carbon disulfide	µg/L	100	0.24	J	0.35	J					0.64	J	0.2	J
Ethyl benzene	µg/L	130											0.14	J
Methylene chloride	µg/L	4.1												
Toluene	µg/L	75												
Total xylenes	µg/L	1200			0.15	J			0.62	J			0.84	J
Semivolatile Organic Compounds														
Diethyl phthalate	µg/L	2900												
Phenol	µg/L	2200												
bis(2-Ethylhexyl)phthalate	µg/L	4.8					100							
Metals - Unfiltered														
Aluminum	µg/L	3700	34500	J	18600		9410	J	4080		878	J	3350	
Arsenic	µg/L	0.045	66.2		56.8		36.3		13					
Barium	µg/L	260	314		233									
Chromium	µg/L	18	69.8		44.6		44.9		14.6		22.7		33.9	
Cobalt	µg/L	220	72.3		68.4									
Copper	µg/L	150	243		181		48		27.6				27.9	
Iron	µg/L	1100	103000		91100		76600		20300	J	3130		9630	J
Lead	µg/L	15	100		72.2		17.7		6.6				6.1	
Manganese	µg/L	73	3010		2300		432		300		434		548	
Mercury	µg/L	1.1			0.22									
Nickel	µg/L	73	212		142		71.8						48.1	
Selenium	µg/L	18	8.2		6.5		20.4							
Vanadium	µg/L	26	158		109									
Zinc	µg/L	1100	836		685		116							
Metals - Filtered														
Aluminum	µg/L	3700												
Iron	µg/L	1100	4890		9240		4350		3080		806		591	
Lead	µg/L	15												
Manganese	µg/L	73	2500		2010		350		301		421		470	
Zinc	µg/L	1100					22	J						
Water Quality Parameters														
Alkalinity	µg/L	ne	300000		330000		150000		180000		270000		210000	
Chloride	µg/L	ne	4000		5000	J			1000		13000		4000	
Hardness	µg/L	ne	1E+06		1500000		540000		430000		580000		550000	
Nitrate	µg/L	5800			200									
Sulfate	µg/L	ne	710000		660000	J	130000		93000		31000		150000	
Total dissolved solids	µg/L	ne	1E+06		2800000		500000		440000		330000		550000	
Total organic carbon	µg/L	ne	13000		15000	J	5400		3000		4500		3000	
Total suspended solids	*µg/L*	*ne*	*17000*		*2200000*				*50000*		*27000*		*100000*	

Table 6-11

Blank Corrected Constituents in Overburden Monitoring Wells
Burning Ground Areas
Former Plum Brook Ordnance Works, Sandusky, Ohio

		Sample Area:	Snake Road Burning Ground (continued)							
		Sample Location:	*GCL-MW02B*				*GCL-MW03*			
		Sample No:	5870		5875		5880		5885	
		Sample Date:	20-Nov-97		17-May-98		20-Nov-97		17-May-98	
Parameter	Units	RBC	Result	Val Qlfr	Result	Val Qlfr	Result	Val Qlfr	Result	Val Qlfr
Volatile Organic Compounds										
Acetone	µg/L	370								
Benzene	µg/L	0.36							0.28	J
Carbon disulfide	µg/L	100			0.26	J				
Ethyl benzene	µg/L	130							0.19	J
Methylene chloride	µg/L	4.1								
Toluene	µg/L	75								
Total xylenes	µg/L	1200			0.53	J			1.6	
Semivolatile Organic Compounds										
Diethyl phthalate	µg/L	2900	2.7	J						
Phenol	µg/L	2200							10	
bis(2-Ethylhexyl)phthalate	µg/L	4.8								
Metals - Unfiltered										
Aluminum	µg/L	3700	451	J	410		2390	J	1380	
Arsenic	µg/L	0.045					40.2			
Barium	µg/L	260								
Chromium	µg/L	18	11.9							
Cobalt	µg/L	220								
Copper	µg/L	150								
Iron	µg/L	1100	3750		3570	J	26300		5140	J
Lead	µg/L	15								
Manganese	µg/L	73	475		515		493		368	
Mercury	µg/L	1.1								
Nickel	µg/L	73								
Selenium	µg/L	18								
Vanadium	µg/L	26								
Zinc	µg/L	1100								
Metals - Filtered										
Aluminum	µg/L	3700								
Iron	µg/L	1100	1130		1190		892		1270	
Lead	µg/L	15	3.2							
Manganese	µg/L	73	507		532		369		386	
Zinc	µg/L	1100	23.7	J						
Water Quality Parameters										
Alkalinity	µg/L	ne	190000		150000		190000		200000	
Chloride	µg/L	ne	240000		2000				2000	
Hardness	µg/L	ne	380000		480000		200000		360000	
Nitrate	µg/L	5800								
Sulfate	µg/L	ne	130000		200000		29000		23000	
Total dissolved solids	µg/L	ne	440000		570000		250000		280000	
Total organic carbon	µg/L	ne	2700		2000		4200		2000	
Total suspended solids	µg/L	ne			37000		8000		18000	

Note: Nutritionally essential elements, including calcium, magnesium, potassium, and sodium, are not presented on this table. Analytical results for these elements may be referenced in Appendix H.
Shaded area indicates concentration above the respective RBC.
ne - Not established.

Table 6-12

Blank Corrected Constituents in Overburden Monitoring Wells
Lower Toluene Tanks Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

		Sample Location:	MK-MW14				MK-MW15			
		Sample No:	5760		5765		5770		5775	
		Sample Date:	16-Nov-97		14-May-98		16-Nov-97		14-May-98	
Parameter	Units	RBC	Result	Val Qlfr	Result	Val Qlfr	Result	Val Qlfr	Result	Val Qlfr
Volatile Organic Compounds										
Acetone	µg/L	370								
Carbon disulfide	µg/L	100	0.32	J			0.38	J		
Semivolatile Organic Compounds										
2,4-Dinitrotoluene	µg/L	7.3								
bis(2-Ethylhexyl)phthalate	µg/L	4.8	1.7	J			6	J		
Explosives										
2,4,6-Trinitrotoluene	µg/L	1.8								
2,4-Dinitrotoluene	µg/L	7.3								
4-Amino-2,6-dinitrotoluene	µg/L	0.22								
Metals - Unfiltered										
Aluminum	µg/L	3700	520		4550		292		4380	
Arsenic	µg/L	0.045								
Cobalt	µg/L	220								
Copper	µg/L	150							27.2	
Iron	µg/L	1100	19300		19100		12700		10300	
Lead	µg/L	15					7.1		7.2	
Manganese	µg/L	73	370		283		608		101	
Nickel	µg/L	73								
Selenium	µg/L	18								
Zinc	µg/L	1100	25.8				23			
Metals - Filtered										
Aluminum	µg/L	3700								
Arsenic	µg/L	0.045								
Cobalt	µg/L	220								
Copper	µg/L	150								
Iron	µg/L	1100	22900		22400		12700		226	
Lead	µg/L	15					5			
Manganese	µg/L	73	449		373		617		30.7	
Mercury	µg/L	1.1	0.68							
Nickel	µg/L	73								
Selenium	µg/L	18								
Zinc	µg/L	1100								
Cyanide										
Cyanide, total	µg/L	73			11					
Water Quality Parameters										
Alkalinity	µg/L	ne	120000		100000		110000		50000	
Chloride	µg/L	ne	8000		5000	J	3000		1000	J
Hardness	µg/L	ne	560000		370000		300000		380000	
Sulfate	µg/L	ne	280000		320000	J	160000		10000	J
Total dissolved solids	µg/L	ne	670000		560000		350000		92000	
Total organic carbon	µg/L	ne	6100		7000	J	2600		1000	J
Total suspended solids	µg/L	ne	190000		43000		5000		140000	

Note: Nutritionally essential elements, including calcium, magnesium, potassium, and sodium, are not presented on this table. Analytical results for these elements may be referenced in Appendix H.

Shaded area indicates concentration above the respective RBC.
ne - Not established.

Table 6-13

Blank Corrected Constituents in Overburden Monitoring Wells
Upper Toluene Tanks Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

		Sample Location:	MK-MW20			
		Sample No:	5810		5815 / 5815R	
		Sample Date:	16-Nov-97		19-May-98	
Parameter	Units	RBC	Result	Val Qlfr	Result	Val Qlfr
Volatile Organic Compounds						
Chloroform	µg/L	0.063				
Toluene	µg/L	75	13000		63000	
Total xylenes	µg/L	1200				
Semivolatile Organic Compounds						
2-Methylphenol	µg/L	180	1300		240	D
4-Methylphenol	µg/L	18	1200		120	
Phenol	µg/L	2200	6.8	J	12	
bis(2-Ethylhexyl)phthalate	µg/L	4.8	5	J		
Metals - Total						
Aluminum	µg/L	3700	18400		245	J
Arsenic	µg/L	0.045	15.8			
Chromium	µg/L	18	42.7			
Copper	µg/L	150	29.7			
Iron	µg/L	1100	46700		2330	
Lead	µg/L	15	13.1			
Manganese	µg/L	73	994		75.3	
Nickel	µg/L	73	114			
Vanadium	µg/L	26	59.7			
Zinc	µg/L	1100	105			
Metals - Dissolved						
Iron	µg/L	1100	716		1190	
Manganese	µg/L	73	65.3		75.6	
Zinc	µg/L	1100				
Water Quality Parameters						
Alkalinity	µg/L	ne	430000		410000	
Chloride	µg/L	ne	410000		400000	
Hardness	µg/L	ne	900000		2200000	
Sulfate	µg/L	ne	240000		340000	
Total dissolved solids	µg/L	ne	1700000		1700000	
Total organic carbon	µg/L	ne	12000		6000	
Total suspended solids	µg/L	ne	250000			

Note: Nutritionally essential elements, including calcium, magnesium, potassium, results for these elements may be referenced in Appendix H.

Shaded area indicates concentration above the respective RBC.
ne - Not established

Table 6-14

Blank Corrected Constituents in Overburden Monitoring Wells
Reactor Facility Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

		Sample Location:	IT-MW06			
		Sample No:	5560		5565	
		Sample Date:	19-Nov-97		28-May-98	
Parameter	Units	RBC	Result	Val Qlfr	Result	Val Qlfr
Volatile Organic Compounds						
Toluene	µg/L	75	0.2	J		
Metals - Unfiltered						
Aluminum	µg/L	3700			860	J
Iron	µg/L	1100	1620		1810	
Manganese	µg/L	73	340		215	
Mercury	µg/L	1.1	0.3			
Zinc	µg/L	1100	47.4			
Metals - Filtered						
Manganese	µg/L	73			20.7	
Mercury	µg/L	1.1			0.44	
Zinc	µg/L	1100	27.6			
Water Quality Parameters						
Alkalinity	µg/L	ne	320000		290000	
Chloride	µg/L	ne	1000		3000	
Hardness	µg/L	ne	740000		380000	
Sulfate	µg/L	ne	47000			
Total dissolved solids	µg/L	ne	420000		410000	
Total organic carbon	µg/L	ne	3800		3000	
Total suspended solids	µg/L	ne			13000	

Note: Nutritionally essential elements, including calcium, magnesium, potassium, and sodium, are not presented on this table. Analytical results for these elements may be referenced in Appendix H.

Shaded area indicates concentration above the respective RBC.
ne - Not established.

Table 6-15

Blank Corrected Constituents in Bedrock Monitoring Wells
West Area Red Water Ponds
Former Plum Brook Ordnance Works, Sandusky, Ohio

		Sample Location:	PB-BED-MW14			
		Sample No:	5900		5905 / 5905R	
		Sample Date:	18-Nov-97		18-May-98	
Parameter	Units	RBC	Result	Val Qlfr	Result	Val Qlfr
Volatile Organic Compounds						
Benzene	µg/L	0.36	1.1			
Carbon disulfide	µg/L	100	1.3		0.25	J
Ethyl benzene	µg/L	130	0.59	J		
Toluene	µg/L	75				
Total xylenes	µg/L	1200	3.9			
Semivolatile Organic Compounds						
2,4-Dinitrophenol	µg/L	7.3			14	J
2,4-Dinitrotoluene	µg/L	7.3			16	
4,6-Dinitro-2-methylphenol	µg/L	0.37			28	NJ
Nitrobenzene	µg/L	0.35			5.8	J
Metals - Unfiltered						
Aluminum	µg/L	3700	374	J		
Chromium	µg/L	18	10.2			
Iron	µg/L	1100	923		427	J
Manganese	µg/L	73	54		32	
Nickel	µg/L	73	42.3		45.5	
Zinc	µg/L	1100	39.8			
Metals - Filtered						
Cobalt	µg/L	220			65.4	
Iron	µg/L	1100			269	
Manganese	µg/L	73	29.1		32.6	
Nickel	µg/L	73	40.7		71.3	
Zinc	µg/L	1100	32.4			
Cyanide						
Cyanide, total	µg/L	73	16		44	
Water Quality Parameters						
Alkalinity	µg/L	ne	210000		500000	
Chloride	µg/L	ne	79000		3000	
Hardness	µg/L	ne	640000		730000	
Nitrate	µg/L	5800	300		24000	
Sulfate	µg/L	ne	610000		630000	
Total dissolved solids	µg/L	ne	2500000		2300000	
Total organic carbon	µg/L	ne	190000		160000	
Total suspended solids	µg/L	ne	37000		23000	

Note: Nutritionally essential elements, including calcium, magnesium, potassium, and sodium, are not presented on this table. Analytical results for these elements may be referenced in Appendix H.

Shaded area indicates that concentration above the respective RBC.
ne - Not established.

Table 6-16

Blank Corrected Constituents in Bedrock Monitoring Wells
Pentolite Road Red Water Ponds
Former Plum Brook Ordnance Works, Sandusky, Ohio

		Sample Location:	PB-BED-MW15			
		Sample No:	5910		5915	
		Sample Date:	18-Nov-97		28-May-98	
Parameter	Units	RBC	Result	Val Qlfr	Result	Val Qlfr
Volatile Organic Compounds						
1,1,2-Trichloroethane	µg/L	0.19			4.9	J
Benzene	µg/L	0.36	570		780	
Chlorobenzene	µg/L	3.5			5.5	J
Chloroform	µg/L	0.063				
Ethyl benzene	µg/L	130	130		140	
Methylene chloride	µg/L	4.1				
Toluene	µg/L	75	490		550	
Total xylenes	µg/L	1200	920		880	
Semivolatile Organic Compounds						
2,4-Dimethylphenol	µg/L	73	6.7	J	10	
2-Methylnaphthalene	µg/L	150	31		37	
2-Methylphenol	µg/L	180	3	J	6.7	J
4-Methylphenol	µg/L	18	3.9	J	7.7	J
bis(2-Ethylhexyl)phthalate	µg/L	4.8	37			
Fluorene	µg/L	150	1.7	J		
Isophorone	µg/L	70	4.2	J	3.8	J
Naphthalene	µg/L	150	22		31	
Phenanthrene	µg/L	110	2.2	J	2	J
Phenol	µg/L	2200	18		32	
Explosives						
2,4-Dinitrotoluene	µg/L	7.3			0.89	
2,6-Dinitrotoluene	µg/L	3.7			0.89	
Metals - Unfiltered						
Aluminum	µg/L	3700			513	J
Barium	µg/L	260	605		1710	
Chromium	µg/L	18			20.6	
Copper	µg/L	150			39.5	
Iron	µg/L	1100	930		4810	
Manganese	µg/L	73	26.3		139	
Thallium	µg/L	0.23			50.8	
Zinc	µg/L	1100	30.6			
Metals - Filtered						
Barium	µg/L	260	555		1390	
Thallium	µg/L	0.23			62.2	
Zinc	µg/L	1100	30.9			
Water Quality Parameters						
Alkalinity	µg/L	ne	85000		500000	
Chloride	µg/L	ne	1400000		2200000	
Hardness	µg/L	ne	1500000		1800000	
Sulfate	µg/L	ne			82000	
Total dissolved solids	µg/L	ne	3200000		3800000	
Total organic carbon	µg/L	ne	11000		13000	
Total suspended solids	µg/L	ne	7000		13000	

Note: Nutritionally essential elements, including calcium, magnesium, potassium, and sodium, are not presented on this table. Analytical results for these elements may be referenced in Appendix H.
Shaded area indicates concentration above the respective RBC.
ne - Not established.

Table 6-17

Blank Corrected Constituents in Bedrock Monitoring Wells
TNT Manufacturing Area A
Former Plum Brook Ordnance Works, Sandusky, Ohio

		Sample Location:	PB-BED-MW17				PB-BED-MW18			
		Sample No:	5930		5935		5940		5945	
		Sample Date:	20-Nov-97		29-May-98		19-Nov-97		19-May-98	
Parameter	Units	RBC	Result	Val Qlfr	Result	Val Qlfr	Result	Val Qlfr	Result	Val Qlfr
Volatile Organic Compounds										
Acetone	µg/L	370							34	J
Benzene	µg/L	0.36	10	J			11		5.7	
Carbon disulfide	µg/L	100	40	J			32		7.9	
Ethyl benzene	µg/L	130	79		9.9	J	32		88	
Methylene chloride	µg/L	4.1								
Toluene	µg/L	75	140				21		53	
Total xylenes	µg/L	1200	360		46		170		420	
Semivolatile Organic Compounds										
2,4-Dimethylphenol	µg/L	73			2.8	J	5.1	J	11	
2-Methylnaphthalene	µg/L	150			20		2.2	J	5	J
2-Methylphenol	µg/L	180					2.6	J	3.3	J
4-Methylphenol	µg/L	18					2.8	J	4	J
bis(2-Ethylhexyl)phthalate	µg/L	4.8					3.5	J		
Naphthalene	µg/L	150			18		3.8	J	10	
Phenol	µg/L	2200					21	J		
Explosives										
1,3,5-Trinitrobenzene	µg/L	110					1.5			
1,3-Dinitrobenzene	µg/L	0.37					1			
2,4-Dinitrotoluene	µg/L	7.3							0.49	
2,6-Dinitrotoluene	µg/L	3.7							3.6	
Nitrobenzene	µg/L	0.35	0.34				2			
Metals - Unfiltered PRG										
Aluminum 37,000	µg/L	3700					283	J		
Barium 2600	µg/L	260	948		800		893		942	
Iron 11000	µg/L	1100	1580		456				166	
Manganese 880	µg/L	73	124		20.4		36.8		80.8	
Mercury 11	µg/L	1.1					1			
Zinc 15000	µg/L	1100	49.9				31			
Metals - Filtered										
Arsenic 0.045	µg/L	0.045			13.1					
Barium 2600	µg/L	260	1100		871		1010		994	
Lead 0.0036	µg/L	15			6.8					
Manganese 880	µg/L	73					35.9		80.9	
Zinc 15000	µg/L	1100	33.3	J						
Cyanide										
Cyanide, total 6.2	µg/L	73	320							
Water Quality Parameters										
Alkalinity	µg/L	ne	830000		930000		120000		550000	
Chloride	µg/L	ne	1800000		1600000		6900000		1200000	
Hardness	µg/L	ne	1800000		1300000		4000000		10000000	
Sulfate	µg/L	ne	59000		80000		16000		18000	
Total dissolved solids	µg/L	ne	3000000		2900000		12000000		33000000	
Total organic carbon	µg/L	ne	1200		3000		6500		3000	
Total suspended solids	µg/L	ne			4000		61000		100000	

Note: Nutritionally essential elements, including calcium, magnesium, potassium, and sodium, are not presented on this table. Analytical results for these elements may be referenced in Appendix H.

Shaded area indicates concentration above the respective RBC.
ne - Not established.

Table 6-18

Blank Corrected Constituents in Bedrock Monitoring Wells
TNT Manufacturing Area B
Former Plum Brook Ordnance Works, Sandusky, Ohio

		Sample Location:	IT-TNTB-BED-GW001				IT-TNTB-BED-GW002			
		Sample No:	5420		5425		5430		5435	
		Sample Date:	17-Nov-97		18-May-98		16-Nov-97		18-May-98	
Parameter	Units	RBC	Result	Val Qlfr	Result	Val Qlfr	Result	Val Qlfr	Result	Val Qlfr
Volatile Organic Compounds										
1,1-Dichloroethane	µg/L	80			0.19	J				
Benzene	µg/L	0.36	0.14	J			0.91	J		
Carbon disulfide	µg/L	100	0.82	J	7.2		6.4			
Ethyl benzene	µg/L	130					0.85	J		
Total xylenes	µg/L	1200					12			
Semivolatile Organic Compounds										
bis(2-Ethylhexyl)phthalate	µg/L	4.8	3.6	J			3	J		
Phenol	µg/L	2200					2.3	J		
Metals - Unfiltered										
Aluminum	µg/L	3700	654		1130	J	317			
Arsenic	µg/L	0.045			12.9					
Barium	µg/L	260			1100		326		406	
Copper	µg/L	150	33.9		80.9					
Iron	µg/L	1100	41700		13000		1030		168	J
Lead	µg/L	15	3.9		6.2		4.8		7.1	
Manganese	µg/L	73	677		196		85.4		36.6	
Nickel	µg/L	73	42.1							
Zinc	µg/L	1100	48.8		150	J	73.9			
Metals - Filtered										
Barium	µg/L	260			1040		384		414	
Iron	µg/L	1100	16300		302		586			
Lead	µg/L	15					3			
Manganese	µg/L	73	694		278		71		36.5	
Zinc	µg/L	1100								
Water Quality Parameters										
Alkalinity	µg/L	ne	180000		360000		220000		380000	
Chloride	µg/L	ne	90000		600000		91000		74000	
Hardness	µg/L	ne	360000		650000		450000		530000	
Sulfate	µg/L	ne	140000		120000		90000		140000	
Total dissolved solids	µg/L	ne	730000		1200000		760000		7600000	
Total organic carbon	µg/L	ne	12000		5000		5000		4000	
Total suspended solids	µg/L	ne	480000		9000		5000		6000	

Note: Nutritionally essential elements, including calcium, magnesium, potassium, and sodium, are not presented on this table. Analytical results for these elements may be referenced in Appendix H.

Shaded area indicates concentration above the respective RBC.
ne - Not established.

Table 6-19

Blank Corrected Constituents in Bedrock Monitoring Wells
TNT Manufacturing Area C
Former Plum Brook Ordnance Works, Sandusky, Ohio

		Sample Location:	PB-BED-MW13			
		Sample No:	5890		5895	
		Sample Date:	13-Nov-97		29-May-98	
Parameter	Units	RBC	Result	Val Qlfr	Result	Val Qlfr
Volatile Organic Compounds						
Benzene	µg/L	0.36	130		47	
Carbon disulfide	µg/L	100	5.8			
Ethyl benzene	µg/L	130	73		57	
Toluene	µg/L	75	170		120	
Total xylenes	µg/L	1200	520		540	
Semivolatile Organic Compounds						
2,4-Dimethylphenol	µg/L	73	16		13	J
2-Methylnaphthalene	µg/L	150	20		14	J
2-Methylphenol	µg/L	180	4.1	J	3.3	J
4-Methylphenol	µg/L	18	4.7	J	3.3	J
bis(2-Ethylhexyl)phthalate	µg/L	4.8	39		55	J
Isophorone	µg/L	70			2.7	J
Naphthalene	µg/L	150	15		10	J
Phenol	µg/L	2200	62		69	J
Metals - Unfiltered						
Barium	µg/L	260	1550			
Iron	µg/L	1100			207	
Manganese	µg/L	73	17.4		41.9	
Zinc	µg/L	1100	47.2			
Metals - Filtered						
Barium	µg/L	260	1680		208	
Iron	µg/L	1100				
Manganese	µg/L	73			43.8	
Zinc	µg/L	1100	30.1			
Water Quality Parameters						
Alkalinity	µg/L	ne	430000		300000	
Chloride	µg/L	ne	2500000			
Hardness	µg/L	ne	1600000		450000	
Sulfate	µg/L	ne	13000		5000	
Total dissolved solids	µg/L	ne	4800000		510000	
Total organic carbon	µg/L	ne	9600		2000	
Total suspended solids	µg/L	ne	16000			

Note: Nutritionally essential elements, including calcium, magnesium, potassium, and sodium, are not presented on this table. Analytical results for these elements may be referenced in Appendix H.

Shaded area indicates concentration above the respective RBC.
ne - Not established.

Table 6-20

Blank Corrected Constituents in Bedrock Monitoring Wells
Acid Areas and Maintenance Shop Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

		Sample Area:	Acid Area No. 1				Acid Area No. 2							
		Sample Location:	IT-AA1-BED-GW001				IT-AA2-BED-GW001				PB-BED-MW19			
		Sample No:	5450		5455		5460		5465		5950		5955	
		Sample Date:	16-Nov-97		12-May-98		20-Nov-97		12-May-98		14-Nov-97		16-May-98	
Parameter	Units	RBC	Result	Val Qlfr	Result	Val Qlfr	Result	Val Qlfr	Result	Val Qlfr	Result	Val Qlfr	Result	Val Qlfr
Volatile Organic Compounds														
2-Butanone	µg/L	190							18	J				
Acetone	µg/L	370							41	J	68	J		
Benzene	µg/L	0.36	11	J	31		33		130		11		1.9	J
Carbon disulfide	µg/L	100	29	J	63		5.5	J	1.7	J	2		6.9	
Chlorobenzene	µg/L	3.5					21	J						
Chloromethane	µg/L	1.5							10					
Ethylbenzene	µg/L	130	7.7	J	39		23	J	43		5.1		1.2	J
Methylene chloride	µg/L	4.1												
Toluene	µg/L	75			50				20		8.9			
Total xylenes	µg/L	1200	150		500		200		220		38		10	
Semivolatile Organic Compounds														
2,4-Dimethylphenol	µg/L	73			3.6	J	1.3	J	8.6	J				
2,4-Dinitrotoluene	µg/L	7.3												
2-Methylnaphthalene	µg/L	150	28		31		1.3	J	5.6	J	3.3	J	1.5	J
2-Methylphenol	µg/L	180							1.6	J				
4-Methylphenol	µg/L	18							1.6	J				
bis(2-Ethylhexyl)phthalate	µg/L	4.8	28								5.8	J		
Isophorone	µg/L	70	2.9	J										
Naphthalene	µg/L	150	16		18				8.1	J	2.1	J		
Phenanthrene	µg/L	110			2.3	J								
Phenol	µg/L	2200	43		15				74		55			
Explosives														
1,3-Dinitrobenzene	µg/L	0.37							0.81		0.22			
2,4-Dinitrotoluene	µg/L	7.3			0.23				2.5					
2,6-Dinitrotoluene	µg/L	3.7							1.2					
2-Nitrotoluene	µg/L	6.1			1.1									
3-Nitrotoluene	µg/L	12			0.31								0.62	
Nitrobenzene	µg/L	0.35									0.32			
RDX	µg/L	0.61			2.8									
Tetryl	µg/L	37			2.4									

Table 6-20

Blank Corrected Constituents in Bedrock Monitoring Wells
Acid Areas and Maintenance Shop Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

		Sample Area:	Acid Area No. 1				Acid Area No. 2							
		Sample Location:	IT-AA1-BED-GW001				IT-AA2-BED-GW001				PB-BED-MW19			
		Sample No:	5450		5455		5460		5465		5950		5955	
		Sample Date:	16-Nov-97		12-May-98		20-Nov-97		12-May-98		14-Nov-97		16-May-98	
Parameter	Units	RBC	Result	Val Qlfr	Result	Val Qlfr	Result	Val Qlfr	Result	Val Qlfr	Result	Val Qlfr	Result	Val Qlfr
Metals - Unfiltered														
Aluminum	µg/L	3700	637		468		1060	J	10200					
Arsenic	µg/L	0.045	16.5		21.2				34.2					
Barium	µg/L	260	1060		1330		220		645		1520		1800	
Chromium	µg/L	18	12.7						307		10			
Cobalt	µg/L	220							63.3					
Copper	µg/L	150	26.2						62.7		61.7			
Iron	µg/L	1100	1920		2540		5240		51600				141	J
Lead	µg/L	15							38.6		6.8			
Manganese	µg/L	73	575		732		522		5130		30.4			
Nickel	µg/L	73							238					
Vanadium	µg/L	26							108					
Zinc	µg/L	1100	32.8				55				62.3			
Metals - Filtered														
Arsenic	µg/L	0.045			19.6									
Barium	µg/L	260	1260		1490		212		279		1520		1740	
Iron	µg/L	1100												
Manganese	µg/L	73	516		696		351		995				16.3	
Zinc	µg/L	1100	105				66.2	J			57.4			
Cyanide														
Cyanide, total	µg/L	73											16	
Water Quality Parameters														
Alkalinity	µg/L	ne	830000		900000		510000		600000		310000		750000	
Chloride	µg/L	ne	1900000		3000000	J	47000		53000	J	330000		280000	
Hardness	µg/L	ne	1800000		2000000		700000		860000		1700000		750000	
Sulfate	µg/L	ne	7000		40000	J	48000		70000	J	14000		49000	
Total dissolved solids	µg/L	ne	3600000		730000		750000		310000		1200000		590000	
Total organic carbon	µg/L	ne	16000		11000	J	7400		6000	J	16000		9000	
Total suspended solids	µg/L	ne	6000		330000		4000				41000		5000	

Table 6-20

Blank Corrected Constituents in Bedrock Monitoring Wells
Acid Areas and Maintenance Shop Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

		Sample Area:	Acid Area No. 3				Maintenance Shop Area			
		Sample Location:	IT-AA3-BED-GW001				IT-MNTA-BED-GW001			
		Sample No:	5470		5475		5440		5445	
		Sample Date:	19-Nov-97		14-May-98		20-Nov-97		28-May-98	
Parameter	Units	RBC	Result	Val Qlfr	Result	Val Qlfr	Result	Val Qlfr	Result	Val Qlfr
Volatile Organic Compounds										
2-Butanone	µg/L	190								
Acetone	µg/L	370	36	J						
Benzene	µg/L	0.36							19	
Carbon disulfide	µg/L	100	4.2	J			3.7	J	21	
Chlorobenzene	µg/L	3.5								
Chloromethane	µg/L	1.5								
Ethylbenzene	µg/L	130							7.7	
Methylene chloride	µg/L	4.1								
Toluene	µg/L	75							18	
Total xylenes	µg/L	1200							150	
Semivolatile Organic Compounds										
2,4-Dimethylphenol	µg/L	73					1.7	J	1.8	J
2,4-Dinitrotoluene	µg/L	7.3							1.3	J
2-Methylnaphthalene	µg/L	150					1.9	J	1.2	J
2-Methylphenol	µg/L	180								
4-Methylphenol	µg/L	18								
bis(2-Ethylhexyl)phthalate	µg/L	4.8	5.8	J			3.9	J		
Isophorone	µg/L	70								
Naphthalene	µg/L	150					2.3	J		
Phenanthrene	µg/L	110								
Phenol	µg/L	2200	3.1	J			17		11	
Explosives										
1,3-Dinitrobenzene	µg/L	0.37							0.86	
2,4-Dinitrotoluene	µg/L	7.3							2	
2,6-Dinitrotoluene	µg/L	3.7							0.34	
2-Nitrotoluene	µg/L	6.1								
3-Nitrotoluene	µg/L	12								
Nitrobenzene	µg/L	0.35								
RDX	µg/L	0.61								
Tetryl	µg/L	37								

Table 6-20

Blank Corrected Constituents in Bedrock Monitoring Wells
Acid Areas and Maintenance Shop Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

		Sample Area:	Acid Area No. 3				Maintenance Shop Area			
		Sample Location:	IT-AA3-BED-GW001				IT-MNTA-BED-GW001			
		Sample No:	5470		5475		5440		5445	
		Sample Date:	19-Nov-97		14-May-98		20-Nov-97		28-May-98	
Parameter	Units	RBC	Result	Val Qlfr	Result	Val Qlfr	Result	Val Qlfr	Result	Val Qlfr
Metals - Unfiltered										
Aluminum	µg/L	3700			397					
Arsenic	µg/L	0.045								
Barium	µg/L	260					424		457	
Chromium	µg/L	18								
Cobalt	µg/L	220								
Copper	µg/L	150								
Iron	µg/L	1100			450		6400		481	
Lead	µg/L	15								
Manganese	µg/L	73	74.6		83.8		849		181	
Nickel	µg/L	73								
Vanadium	µg/L	26								
Zinc	µg/L	1100	29.2							
Metals - Filtered										
Arsenic	µg/L	0.045								
Barium	µg/L	260					449		596	
Iron	µg/L	1100								
Manganese	µg/L	73	57.6		51.3		899		183	
Zinc	µg/L	1100	23				24.8	J		
Cyanide										
Cyanide, total	µg/L	73								
Water Quality Parameters										
Alkalinity	µg/L	ne	670000		790000		670000			
Chloride	µg/L	ne	790000		860000	J	55000		3800000	
Hardness	µg/L	ne	13000000		860000		2000000		2100000	
Sulfate	µg/L	ne			8000	J	62000		64000	
Total dissolved solids	µg/L	ne	1900000		1800000		5300000		7200000	
Total organic carbon	µg/L	ne	5300	J	2000	J	11000		7000	
Total suspended solids	µg/L	ne	38000		54000		4000		29000	

Note: Nutritionally essential elements, including calcium, magnesium, potassium, and sodium, are not presented on this table. Analytical results for these elements may be referenced in Appendix H.
Shaded area indicates concentration above the respective RBC.
ne - Not established.

Table 6-21

Blank Corrected Constituents in Bedrock Monitoring Wells
Burning Ground Areas
Former Plum Brook Ordnance Works, Sandusky, Ohio

		Sample Area:	Additional Burning Ground				G-8 Burning Ground			
		Sample Location:	IT-ABG-BED-GW001				IT-BG8-BED-GW001			
		Sample No:	5480		5485		5410		5415	
		Sample Date:	13-Nov-97		13-May-98		17-Nov-97		15-May-98	
Parameter	Units	RBC	Result	Val Qlfr	Result	Val Qlfr	Result	Val Qlfr	Result	Val Qlfr
Volatile Organic Compounds										
Carbon disulfide	µg/L	100			0.97	J	0.65	J		
Trichloroethene	µg/L	1.6	0.25	J						
Semivolatile Organic Compounds										
bis(2-Ethylhexyl)phthalate	µg/L	4.8					1.7	J		
Metals - Unfiltered										
Aluminum	µg/L	3700	522				9020		307	
Arsenic	µg/L	0.045	11.7				17.6			
Barium	µg/L	260					520			
Chromium	µg/L	18					18.2			
Copper	µg/L	150					59.5			
Iron	µg/L	1100	8890		5770		22600		1230	J
Lead	µg/L	15	6.9		20.2		26.3		6.8	
Manganese	µg/L	73	912		745		2240		130	
Mercury	µg/L	1.1	3.6							
Zinc	µg/L	1100	27.7				126			
Metals - Filtered										
Aluminum	µg/L	3700			408					
Barium	µg/L	260					366			
Iron	µg/L	1100	7260		5580		563			
Manganese	µg/L	73	990		813		1300		658	
Zinc	µg/L	1100								
Water Quality Parameters										
Alkalinity	µg/L	ne	280000		270000		350000		180000	
Chloride	µg/L	ne			3000	J	780000		34000	
Hardness	µg/L	ne	500000		530000		1000000		340000	
Nitrate	µg/L	5800					200		7300	
Sulfate	µg/L	ne	140000		190000	J	70000		45000	
Total dissolved solids	µg/L	ne	640000		600000		1800000		300000	
Total organic carbon	µg/L	ne	3800		3000	J			1000	
Total suspended solids	µg/L	ne	11000		7000		10000		280000	

Note: Nutritionally essential elements, including calcium, magnesium, potassium, and sodium, are not presented on this table. Analytical results for these elements may be referenced in Appendix H.

Shaded area indicates concentration above the respective RBC.
ne - Not established.

Table 6-22

Blank Corrected Constituents in Bedrock Monitoring Wells
Upper Toluene Tanks Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

		Sample Location:	PB-BED-MW16			
		Sample No:	5920		5925	
		Sample Date:	24-Nov-97		1-Jun-98	
Parameter	Units	RBC	Result		Result	Val Qlfr
Volatile Organic Compounds						
Benzene	µg/L	0.36	490		450	J
Ethyl benzene	µg/L	130	130		140	J
Methylene chloride	µg/L	4.1				
Toluene	µg/L	75	390		350	J
Total xylenes	µg/L	1200	1100		1000	J
Semivolatile Organic Compounds						
1,2,4-Trichlorobenzene	µg/L	19			1.6	J
1,3-Dichlorobenzene	µg/L	1.4			4.4	J
2,4,5-Trichlorophenol	µg/L	370			35	
bis(2-Ethylhexyl)phthalate	µg/L	4.8	920	J		
Metals - Unfiltered						
Aluminum	µg/L	3700	502	J	11000	
Barium	µg/L	260	463		612	
Chromium	µg/L	18	24.4		105	
Copper	µg/L	150			84.9	
Iron	µg/L	1100	1140		45900	
Lead	µg/L	15			40.4	
Manganese	µg/L	73	133		2200	
Nickel	µg/L	73			54.7	
Thallium	µg/L	0.23			101	
Vanadium	µg/L	26	64.7		126	
Zinc	µg/L	1100	30		235	
Metals - Filtered						
Barium	µg/L	260	389		523	
Chromium	µg/L	18	13.6		14.8	
Thallium	µg/L	0.23			53.1	
Vanadium	µg/L	26	58.3		50.6	
Water Quality Parameters						
Alkalinity	µg/L	ne	1600000		1700000	
Chloride	µg/L	ne	88000		140000	
Hardness	µg/L	ne	5300000		2000000	
Sulfate	µg/L	ne	150000		37000	
Total dissolved solids	µg/L	ne	6400000		4000000	
Total organic carbon	µg/L	ne	8400		14000	
Total suspended solids	µg/L	ne	7000		330000	

Note: Nutritionally essential elements, including calcium, magnesium, potassium, and sodium, are not presented on this table. Analytical results for these elements may be referenced in Appendix H.

Shaded area indicates concentration above the respective RBC.
ne - Not established.

Table 6-23

Blank Corrected Constituents in Bedrock Monitoring Wells
Reactor Facility Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

		Sample Location:	REACTOR 1			
		Sample No:	5970		5975	
		Sample Date:	21-Nov-97		1-Jun-98	
Parameter	Units	RBC	Result	Val Qlfr	Result	Val Qlfr
Volatile Organic Compounds						
Acetone	µg/L	370			45	J
Benzene	µg/L	0.36	8.8	J	4.3	J
Carbon disulfide	µg/L	100			2.1	J
Ethyl benzene	µg/L	130			1.6	J
Methylene chloride	µg/L	4.1				
Toluene	µg/L	75			1.3	J
Total xylenes	µg/L	1200	4	J	5.5	
Semivolatile Organic Compounds						
bis(2-Ethylhexyl)phthalate	µg/L	4.8	23	J		
Metals - Unfiltered						
Aluminum	µg/L	3700			298	
Barium	µg/L	260	405			
Chromium	µg/L	18	11.1			
Copper	µg/L	150			29.3	
Iron	µg/L	1100	8000		11100	
Lead	µg/L	15	19.1		12.2	
Manganese	µg/L	73	198		388	
Zinc	µg/L	1100	69.7			
Metals - Filtered						
Barium	µg/L	260	397			
Iron	µg/L	1100			1210	
Lead	µg/L	15	3.5			
Manganese	µg/L	73	144		386	
Zinc	µg/L	1100	22.3	J		
Water Quality Parameters						
Alkalinity	µg/L	ne	487000		67000	
Chloride	µg/L	ne	56900		15000	
Hardness	µg/L	ne	484000		180000	
Nitrate	µg/L	5800	na		300	
Sulfate	µg/L	ne	13900		22000	
Total dissolved solids	µg/L	ne	570000	J	110000	
Total organic carbon	µg/L	ne	2500		5000	
Total suspended solids	µg/L	ne	35000	J	230000	

Note: Nutritionally essential elements, including calcium, magnesium, potassium, and sodium, are not presented on this table. Analytical results for these elements may be referenced in Appendix H.

Shaded area indicates concentration above the respective RBC.
ne - Not established.
na - Not analyzed.

Table 6-24

Blank Corrected Constituents in Monitoring Wells
Background Monitoring Wells
Former Plum Brook Ordnance Works, Sandusky, Ohio

		Sample Location:	IT-MW01			
		Sample No:	5530		5535 / 5535R	
		Sample Date:	19-Nov-97		16-May-98	
Parameter	Units	RBC	Result	Val Qlfr	Result	Val Qlfr
Volatile Organic Compounds						
Toluene	µg/L	75			22	
Metals - Unfiltered						
Iron	µg/L	1100	1320		2200	J
Manganese	µg/L	73	323		348	
Mercury	µg/L	1.1	0.45			
Zinc	µg/L	1100	51.6		149	
Metals - Filtered						
Aluminum	µg/L	3700			276	
Iron	µg/L	1100	1090		1970	
Manganese	µg/L	73	331		395	
Zinc	µg/L	1100	46.9			
Water Quality Parameters						
Alkalinity	µg/L	ne	360000		110000	
Chloride	µg/L	ne	4000		3000	
Hardness	µg/L	ne	420000		200000	
Sulfate	µg/L	ne	79000		140000	
Total dissolved solids	µg/L	ne	310000		400000	
Total organic carbon	µg/L	ne	8600		7000	
Total suspended solids	µg/L	ne	84000		5000	

Note: Nutritionally essential elements, including calcium, magnesium, potassium, and sodium, are not presented on this table. Analytical results for these elements may be referenced in Appendix H.

Shaded area indicates concentration above the respective RBC.
ne - Not established.

		Sample Location:	PB-BED-MW20			
		Sample No:	5960		5965	
		Sample Date:	17-Nov-97		28-May-98	
Parameter	Units	RBC	Result	Val Qlfr	Result	Val Qlfr
Volatile Organic Compounds						
Benzene	µg/L	0.36	0.93	J	1.6	
Carbon disulfide	µg/L	100			0.17	J
Ethylbenzene	µg/L	130	0.15	J		
Total xylenes	µg/L	1200	2.6		0.91	J
Semivolatile Organic Compounds						
2-Methylnaphthalene	µg/L	150	1.1	J		
Metals - Unfiltered						
Aluminum	µg/L	3700	3290		678	J
Barium	µg/L	260	19000		16400	
Copper	µg/L	150	32.8			
Iron	µg/L	1100	13200		6770	
Manganese	µg/L	73	180		153	
Zinc	µg/L	1100	41.6			
Metals - Filtered						
Barium	µg/L	260	21000		4950	
Iron	µg/L	1100	2310		1320	
Manganese	µg/L	73	162		47	
Mercury	µg/L	1.1			0.24	
Water Quality Parameters						
Alkalinity	µg/L	ne	240000		260000	
Chloride	µg/L	ne	19000000		21000000	
Hardness	µg/L	ne	20000000		10000000	
Total dissolved solids	µg/L	ne	32000000		24000000	
Total suspended solids	µg/L	ne	74000		90000	

Table 8-1

Summary of Detected Organic and Explosive Compounds Exceeding RBCs
Site-Wide Overburden Monitoring Wells
Former Plum Brook Ordnance Works, Sandusky, Ohio

Parameter	Units	RBC	WARWP	PRRWP	TNTA	TNTB	TNTC	AA1	AA2	AA3	MNTA	ABG	Snake Rd BG	Lower Toluene	Upper Toluene	Reactor
Volatile Organic Compounds																
1,1,1-Trichloroethane	µg/L	160									◆					
1,1-Dichloroethene	µg/L	0.044									◆					
Benzene	µg/L	0.36										◆				
Chloroform	µg/L	0.063							◆							
Toluene	µg/L	75													◆	
Semivolatile Organic Compounds																
2,4-Dinitrophenol	µg/L	7.3	◆	◆												
2,4-Dinitrotoluene	µg/L	7.3	◆	◆												
2,6-Dinitrotoluene	µg/L	3.7	◆	◆												
2-Methylphenol	µg/L	180													◆	
2-Nitroaniline	µg/L	0.22	◆													
3-Nitroaniline	µg/L	11	◆	◆												
4,6-Dinitro-2-methylphenol	µg/L	0.37	◆	◆												
4-Methylphenol	µg/L	18													◆	
4-Nitrophenol	µg/L	29		◆												
Dibenzofuran	µg/L	15		◆												
Nitrobenzene	µg/L	0.35	◆	◆												
bis(2-Ethylhexyl)phthalate	µg/L	4.8	◆		◆		◆		◆				◆	◆	◆	
Explosives																
1,3,5-Trinitrobenzene	µg/L	110		◆												
1,3-Dinitrobenzene	µg/L	0.37	◆	◆												
2,4-Dinitrotoluene	µg/L	7.3	◆	◆												
2,6-Dinitrotoluene	µg/L	3.7	◆													
3-Nitrotoluene	µg/L	12	◆													
4-Amino-2,6-dinitrotoluene	µg/L	0.22			◆	◆										
Nitrobenzene	µg/L	0.35	◆													
RDX	µg/L	0.61	◆													

Table 8-2

Summary of Detected Organic and Explosive Compounds in Groundwater
Site-Wide Overburden Monitoring Wells
Former Plum Brook Ordnance Works, Sandusky, Ohio

Parameter	Units	RBC	Mean Concentration	Quantity Detected	Percentage	Minimum Concentration	Maximum Concentration
Volatile Organic Compounds							
1,1,1-Trichloroethane	µg/L	160	155	2 / 76	2.63%	140	170
1,1-Dichloroethane	µg/L	80	17	2 / 76	2.63%	17	17
1,1-Dichloroethene	µg/L	0.044	2.8	2 / 76	2.63%	2.2	3.4
2-Butanone	µg/L	190	14	1 / 76	1.32%	14	14
2-Hexanone	µg/L	150	2	1 / 76	1.32%	2	2
Acetone	µg/L	370	27.06	7 / 76	9.21%	5.2	68
Benzene	µg/L	0.36	0.32	8 / 76	10.53%	0.16	0.53
Bromodichloromethane	µg/L	0.17	0.23	1 / 76	1.32%	0.23	0.23
Carbon disulfide	µg/L	100	0.39	12 / 76	15.79%	0.17	1.2
Chlorobenzene	µg/L	3.5	0.17	1 / 76	1.32%	0.17	0.17
Chloroethane	µg/L	3.6	2.15	2 / 76	2.63%	1.8	2.5
Chloroform	µg/L	0.063	0.45	1 / 76	1.32%	0.45	0.45
Ethylbenzene	µg/L	130	0.5	4 / 76	5.26%	0.14	1.5
Toluene	µg/L	75	7608.66	10 / 76	13.16%	0.2	63000
Total xylenes	µg/L	1200	1.63	8 / 76	10.53%	0.15	8
Semivolatile Organic Compounds							
2,4-Dinitrophenol	µg/L	7.3	2463.9	4 / 76	5.26%	7.6	6000
2,4-Dinitrotoluene	µg/L	7.3	717.28	10 / 76	13.16%	1.8	1800
2,6-Dinitrotoluene	µg/L	3.7	69.12	5 / 76	6.58%	1.8	190
2-Methylphenol	µg/L	180	770	2 / 76	2.63%	240	1300
2-Nitroaniline	µg/L	0.22	1.4	2 / 76	2.63%	1.3	1.5
2-Nitrophenol	µg/L	230	10.8	2 / 76	2.63%	6.6	15
3-Nitroaniline	µg/L	11	235.83	4 / 76	5.26%	3.3	450
4,6-Dinitro-2-methylphenol	µg/L	0.37	5875.33	6 / 76	7.89%	12	20000
4-Methylphenol	µg/L	18	660	2 / 76	2.63%	120	1200
4-Nitrophenol	µg/L	29	21.8	2 / 76	2.63%	1.6	42
Dibenzofuran	µg/L	15	620	1 / 76	1.32%	620	620
Di-n-octyl phthalate	µg/L	73	6	2 / 76	2.63%	2.7	9.3
Diethyl phthalate	µg/L	2900	2.7	1 / 76	1.32%	2.7	2.7
Fluorene	µg/L	150	44	1 / 76	1.32%	44	44
Nitrobenzene	µg/L	0.35	10.23	3 / 76	3.95%	3.7	14
Phenol	µg/L	2200	9.6	3 / 76	3.95%	6.8	12
bis(2-Ethylhexyl)phthalate	µg/L	4.8	105.65	10 / 76	13.16%	1.7	890
Explosives							
1,3,5-Trinitrobenzene	µg/L	110	882.37	10 / 76	13.16%	0.24	2800
1,3-Dinitrobenzene	µg/L	0.37	818.22	9 / 76	11.84%	17	2100
2,4,6-Trinitrotoluene	µg/L	1.8	1.04	3 / 76	3.95%	0.68	1.7
2,4-Dinitrotoluene	µg/L	7.3	562.94	12 / 76	15.79%	0.2	2400
2,6-Dinitrotoluene	µg/L	3.7	4.51	5 / 76	6.58%	0.53	8.9
3-Nitrotoluene	µg/L	12	36	1 / 76	1.32%	36	36
4-Amino-2,6-dinitrotoluene	µg/L	0.22	2.7	4 / 76	5.26%	0.62	5.7
Nitrobenzene	µg/L	0.35	1.38	2 / 76	2.63%	0.26	2.5
RDX	µg/L	0.61	6.2	1 / 76	1.32%	6.2	6.2

Table 8-3

Summary of Detected Inorganic Constituents Exceeding RBCs by Site
Site-Wide Overburden Monitoring Wells
Former Plum Brook Ordnance Works, Sandusky, Ohio

Parameter	Units	RBC	WARWP	PRRWP	TNTA	TNTB	TNTC	AA1	AA2	AA3	MNTA	ABG	Snake Rd BG	Lower Toluene	Upper Toluene	Reactor
Metals - Total																
Aluminum	µg/L	3700	◆	◆	◆	◆	◆		◆	◆	◆	◆	◆	◆	◆	
Antimony	µg/L	1.5			◆											
Arsenic	µg/L	0.045	◆	◆	◆	◆	◆			◆	◆	◆	◆		◆	
Barium	µg/L	260	◆	◆	◆							◆				
Chromium	µg/L	18	◆	◆	◆		◆			◆	◆	◆	◆		◆	
Cobalt	µg/L	220		◆	◆											
Copper	µg/L	150		◆	◆							◆				
Iron	µg/L	1100	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆
Lead	µg/L	15	◆		◆	◆	◆			◆	◆	◆	◆			
Manganese	µg/L	73	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆
Nickel	µg/L	73	◆	◆	◆	◆	◆					◆			◆	
Selenium	µg/L	18											◆			
Vanadium	µg/L	26	◆		◆						◆	◆			◆	
Metals - Dissolved																
Aluminum	µg/L	3700				◆										
Arsenic	µg/L	0.045		◆	◆	◆										
Barium	µg/L	260			◆											
Cobalt	µg/L	220		◆												
Copper	µg/L	150		◆												
Iron	µg/L	1100		◆	◆	◆	◆	◆				◆	◆	◆	◆	
Lead	µg/L	15				◆										
Manganese	µg/L	73	◆	◆	◆	◆	◆	◆		◆		◆	◆	◆	◆	
Nickel	µg/L	73		◆		◆	◆									
Vanadium	µg/L	26			◆											
Cyanide																
Cyanide, total	µg/L	73	◆	◆												
Water Quality Parameters																
Nitrate	µg/L	5800	◆	◆												

Table 8-4

Summary of Detected Inorganic Constituents in Groundwater
Site-Wide Overburden Monitoring Wells
Former Plum Brook Ordnance Works, Sandusky, Ohio

Parameter	Units	RBC	Mean Concentration	Frequency of Detection			Percentage	Minimum Concentration	Maximum Concentration	Quantity > RBC
Metals - Total										
Aluminum	µg/L	3700	8274.09	54	/	76	71.05%	242	143000	29
Antimony	µg/L	1.5	82	1	/	76	1.32%	82	82	1
Arsenic	µg/L	0.045	28.41	22	/	76	28.95%	10.1	113	22
Barium	µg/L	260	306	6	/	76	7.89%	232	373	4
Beryllium	µg/L	7.3	6.9	1	/	76	1.32%	6.9	6.9	0
Chromium	µg/L	18	32.64	30	/	76	39.47%	10.4	258	17
Cobalt	µg/L	220	1367.63	15	/	76	19.74%	50.8	7270	6
Copper	µg/L	150	448.99	25	/	76	32.89%	27.2	3790	8
Iron	µg/L	1100	21920.44	68	/	76	89.47%	131	304000	61
Lead	µg/L	15	19.52	32	/	76	42.11%	3.2	108	10
Manganese	µg/L	73	2787.98	73	/	76	96.05%	23.4	43900	71
Mercury	µg/L	1.1	0.29	6	/	76	7.89%	0.22	0.45	0
Nickel	µg/L	73	1045.16	20	/	76	26.32%	48.1	7600	16
Selenium	µg/L	18	9.87	7	/	76	9.21%	5	20.4	1
Vanadium	µg/L	26	101.9	8	/	76	10.53%	54	244	8
Zinc	µg/L	1100	152.68	32	/	76	42.11%	23	836	0
Metals - Dissolved										
Aluminum	µg/L	3700	1976.2	5	/	76	6.58%	276	7430	1
Arsenic	µg/L	0.045	16.1	3	/	76	3.95%	12.5	22	3
Barium	µg/L	260	338	1	/	76	1.32%	338	338	1
Chromium	µg/L	18	13.3	2	/	76	2.63%	12.4	14.2	0
Cobalt	µg/L	220	2221.06	9	/	76	11.84%	51.9	7450	5
Copper	µg/L	150	977.56	10	/	76	13.16%	32.2	3900	5
Iron	µg/L	1100	7040.23	40	/	76	52.63%	121	41600	28
Lead	µg/L	15	6.86	8	/	76	10.53%	3	17	1
Manganese	µg/L	73	2641.48	70	/	76	92.11%	20.7	45500	63
Mercury	µg/L	1.1	0.55	4	/	76	5.26%	0.3	0.76	0
Nickel	µg/L	73	1577.73	12	/	76	15.79%	47.2	7310	10
Selenium	µg/L	18	8.2	2	/	76	2.63%	5	11.4	0
Vanadium	µg/L	26	53	1	/	76	1.32%	53	53	1
Zinc	µg/L	1100	50.27	15	/	76	19.74%	22	157	0
Cyanide										
Cyanide, total	µg/L	73	236.45	11	/	76	14.47%	11	1700	6
Water Quality Parameters										
Alkalinity	µg/L		390397.26	73	/	76	96.05%	36000	1500000	NA
Chloride	µg/L		511969.7	66	/	76	86.84%	1000	9500000	NA
Hardness	µg/L		1491917.81	73	/	76	96.05%	200000	13000000	NA
Nitrate	µg/L	5800	174319.05	21	/	76	27.63%	100	1600000	8
Sulfate	µg/L		993957.75	71	/	76	93.42%	10000	12000000	NA
Total dissolved solids	µg/L		3123270.27	74	/	76	97.37%	92000	50000000	NA
Total organic carbon	µg/L		472170.27	74	/	76	97.37%	1000	14000000	NA
Total suspended solids	µg/L		121050.85	59	/	76	77.63%	4000	2200000	NA

Table 8-5

Summary of Detected Organic and Explosive Compounds Exceeding RBCs
Site-Wide Bedrock Monitoring Wells
Former Plum Brook Ordnance Works, Sandusky, Ohio

Parameter	Units	RBC	WARWP	PRRWP	TNTA	TNTB	TNTC	AA1	AA2	AA3	MNTA	ABG	BG8	Upper Toluene	Reactor
Volatile Organic Compounds															
1,1,2-Trichloroethane	µg/L	0.19		◆											
Benzene	µg/L	0.36	◆	◆	◆	◆	◆	◆	◆		◆			◆	◆
Chlorobenzene	µg/L	3.5		◆					◆						
Ethylbenzene	µg/L	130		◆										◆	
Toluene	µg/L	75		◆	◆		◆							◆	
Semivolatile Organic Compounds															
1,3-Dichlorobenzene	µg/L	1.4												◆	
2,4-Dinitrophenol	µg/L	7.3	◆												
2,4-Dinitrotoluene	µg/L	7.3	◆												
4,6-Dinitro-2-methylphenol	µg/L	0.37	◆												
bis(2-Ethylhexyl)phthalate	µg/L	4.8		◆			◆	◆	◆	◆				◆	◆
Nitrobenzene	µg/L	1.8	◆												
Explosives															
1,3-Dinitrobenzene	µg/L	0.37			◆				◆		◆				
Nitrobenzene	µg/L	0.35			◆										
RDX	µg/L	0.61						◆							

Table 8-6

Summary of Detected Organic and Explosive Compounds in Groundwater
Site-Wide Bedrock Monitoring Wells
Former Plum Brook Ordnance Works, Sandusky, Ohio

Parameter	Units	RBC	Mean Concentration	Quantity Detected	Percentage	Minimum Concentration	Maximum Concentration
Volatile Organic Compounds							
1,1,2-Trichloroethane	µg/L	0.19	4.9	1 / 34	2.94%	4.9	4.9
1,1-Dichloroethane	µg/L	80	0.19	1 / 34	2.94%	0.19	0.19
2-Butanone	µg/L	190	18	1 / 34	2.94%	18	18
Acetone	µg/L	370	44.8	5 / 34	14.71%	34	68
Benzene	µg/L	0.36	119.49	23 / 34	67.65%	0.14	780
Carbon disulfide	µg/L	100	11.03	22 / 34	64.71%	0.17	63
Chlorobenzene	µg/L	3.5	13.25	2 / 34	5.88%	5.5	21
Chloromethane	µg/L	1.5	10	1 / 34	2.94%	10	10
Ethylbenzene	µg/L	130	48.04	21 / 34	61.76%	0.15	140
Toluene	µg/L	75	170.16	14 / 34	41.18%	1.3	550
Total xylenes	µg/L	1200	315.34	23 / 34	67.65%	0.91	1100
Trichloroethene	µg/L	1.6	0.25	1 / 34	2.94%	0.25	0.25
Semivolatile Organic Compounds				/			
1,2,4-Trichlorobenzene	µg/L	19	1.6	1 / 34	2.94%	1.6	1.6
1,3-Dichlorobenzene	µg/L	1.4	4.4	1 / 34	2.94%	4.4	4.4
2,4,5-Trichlorophenol	µg/L	370	35	1 / 34	2.94%	35	35
2,4-Dimethylphenol	µg/L	73	6.8	12 / 34	35.29%	1.3	16
2,4-Dinitrophenol	µg/L	7.3	14	1 / 34	2.94%	14	14
2,4-Dinitrotoluene	µg/L	7.3	8.65	2 / 34	5.88%	1.3	16
2-Methylnaphthalene	µg/L	150	12.76	16 / 34	47.06%	1.1	37
2-Methylphenol	µg/L	180	3.51	7 / 34	20.59%	1.6	6.7
4,6-Dinitro-2-methylphenol	µg/L	0.37	28	1 / 34	2.94%	28	28
4-Methylphenol	µg/L	18	4	7 / 34	20.59%	1.6	7.7
bis(2-Ethylhexyl)phthalate	µg/L	4.8	80.89	14 / 34	41.18%	1.7	920
Fluorene	µg/L	150	1.7	1 / 34	2.94%	1.7	1.7
Isophorone	µg/L	70	3.4	4 / 34	11.76%	2.7	4.2
Naphthalene	µg/L	150	13.03	12 / 34	35.29%	2.1	31
Nitrobenzene	µg/L	1.8	5.8	1 / 34	2.94%	5.8	5.8
Phenanthrene	µg/L	110	2.17	3 / 34	8.82%	2	2.3
Phenol	µg/L	2200	32.49	13 / 34	38.24%	2.3	74
Explosives				/			
1,3,5-Trinitrobenzene	µg/L	110	1.5	1 / 34	2.94%	1.5	1.5
1,3-Dinitrobenzene	µg/L	0.37	0.72	4 / 34	11.76%	0.22	1
2,4-Dinitrotoluene	µg/L	7.3	1.22	5 / 34	14.71%	0.23	2.5
2,6-Dinitrotoluene	µg/L	3.7	1.51	4 / 34	11.76%	0.34	3.6
2-Nitrotoluene	µg/L	6.1	1.1	1 / 34	2.94%	1.1	1.1
3-Nitrotoluene	µg/L	12	0.47	2 / 34	5.88%	0.31	0.62
Nitrobenzene	µg/L	0.35	0.89	3 / 34	8.82%	0.32	2
RDX	µg/L	0.61	2.8	1 / 34	2.94%	2.8	2.8
Tetryl	µg/L	37	2.4	1 / 34	2.94%	2.4	2.4

Table 8-7

Summary of Detected Inorganic Constituents Exceeding RBCs by Site
Site-Wide Bedrock Monitoring Wells
Former Plum Brook Ordnance Works, Sandusky, Ohio

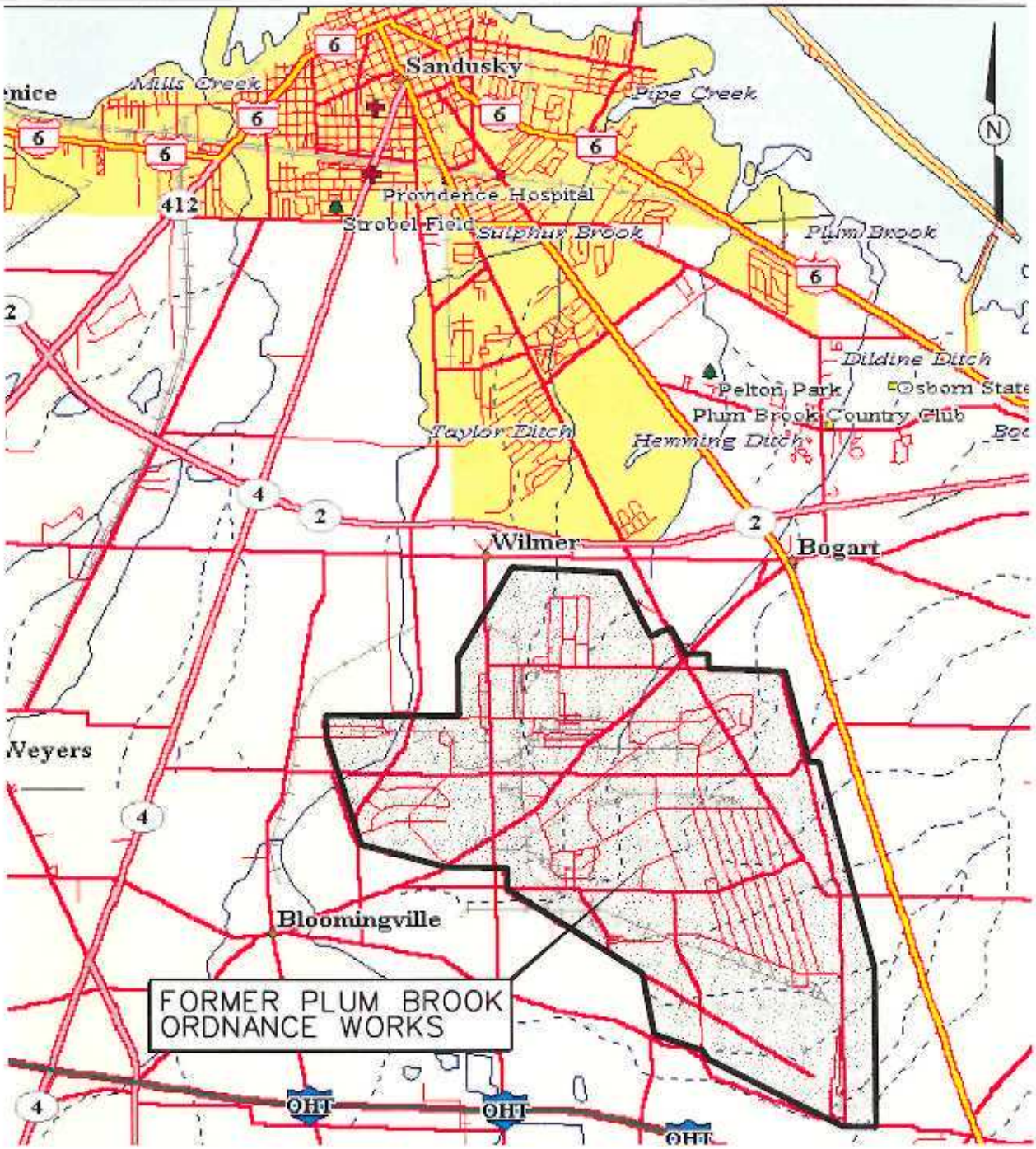
Parameter	Units	RBC	WARWP	PRRWP	TNTA	TNTB	TNTC	AA1	AA2	AA3	MNTA	ABG	BG8	Upper Toluene	Reactor
Metals - Total															
Aluminum	µg/L	3700							◆				◆	◆	
Arsenic	µg/L	0.045				◆		◆	◆			◆	◆		
Barium	µg/L	260		◆	◆	◆	◆	◆	◆		◆		◆	◆	◆
Chromium	µg/L	18		◆					◆				◆	◆	
Iron	µg/L	1100		◆	◆	◆		◆	◆		◆	◆	◆	◆	◆
Lead	µg/L	15							◆			◆	◆	◆	◆
Manganese	µg/L	73		◆	◆	◆		◆	◆	◆	◆	◆	◆	◆	◆
Mercury	µg/L	1.1										◆			
Nickel	µg/L	73							◆						
Thallium	µg/L	0.23		◆										◆	
Vanadium	µg/L	26							◆					◆	
Metals - Filtered															
Arsenic	µg/L	0.045			◆			◆							
Barium	µg/L	260		◆	◆	◆	◆	◆	◆		◆		◆	◆	◆
Iron	µg/L	1100				◆						◆			◆
Manganese	µg/L	73			◆	◆		◆	◆		◆	◆	◆		◆
Thallium	µg/L	0.23		◆										◆	
Vanadium	µg/L	26												◆	
Cyanide															
Cyanide, total	µg/L	73	◆												

Table 8-8

Summary of Detected Inorganic Constituents in Groundwater
Site-Wide Bedrock Monitoring Wells
Former Plum Brook Ordnance Works, Sandusky, Ohio

Parameter	Units	RBC	Mean Concentration	Frequency of Detection			Percentage	Minimum Concentration	Maximum Concentration	Quantity > RBC
Metals - Total										
Aluminum	µg/L	3700	2192.11	19	/	33	57.58%	283	11000	3
Arsenic	µg/L	0.045	19.02	6	/	33	18.18%	11.7	34.2	6
Barium	µg/L	260	2255.67	24	/	33	72.73%	220	19000	23
Chromium	µg/L	18	57.69	9	/	33	27.27%	10	307	5
Cobalt	µg/L	220	63.3	1	/	33	3.03%	63.3	63.3	0
Copper	µg/L	150	51.14	10	/	33	30.30%	26.2	84.9	0
Iron	µg/L	1100	8625.63	30	/	33	90.91%	141	51600	19
Lead	µg/L	15	15.33	13	/	33	39.39%	3.9	40.4	5
Manganese	µg/L	73	515.89	33	/	33	100.00%	17.4	5130	24
Mercury	µg/L	1.1	2.3	2	/	33	6.06%	1	3.6	1
Nickel	µg/L	73	84.52	5	/	33	15.15%	42.1	238	1
Thallium	µg/L	0.23	75.9	2	/	33	6.06%	50.8	101	2
Vanadium	µg/L	26	99.57	3	/	33	9.09%	64.7	126	3
Zinc	µg/L	1100	65.58	18	/	33	54.55%	27.7	235	0
Metals - Filtered										
Aluminum	µg/L	3700	408	1	/	33	3.03%	408	408	0
Arsenic	µg/L	0.045	16.35	2	/	33	6.06%	13.1	19.6	2
Barium	µg/L	260	1792.68	25	/	33	75.76%	208	21000	23
Chromium	µg/L	18	14.2	2	/	33	6.06%	13.6	14.8	0
Cobalt	µg/L	220	65.4	1	/	33	3.03%	65.4	65.4	0
Iron	µg/L	1100	3570	10	/	33	30.30%	269	16300	6
Lead	µg/L	15	4.43	3	/	33	9.09%	3	6.8	0
Manganese	µg/L	73	367.96	26	/	33	78.79%	16.3	1300	16
Mercury	µg/L	1.1	0.24	1	/	33	3.03%	0.24	0.24	0
Nickel	µg/L	73	56	2	/	33	6.06%	40.7	71.3	0
Thallium	µg/L	0.23	57.65	2	/	33	6.06%	53.1	62.2	2
Vanadium	µg/L	26	54.45	2	/	33	6.06%	50.6	58.3	2
Zinc	µg/L	1100	42.54	10	/	33	30.30%	22.3	105	0
Cyanide										
Cyanide, total	µg/L	73	99	4	/	33	12.12%	16	320	1
Water Quality Parameters										
Alkalinity	µg/L		516939.39	33	/	33	100.00%	67000	1700000	NA
Chloride	µg/L		2211528.13	32	/	33	96.97%	3000	21000000	NA
Hardness	µg/L		2703352.94	34	/	33	103.03%	180000	20000000	NA
Nitrate	µg/L	5800	6420	5	/	33	15.15%	200	24000	2
Sulfate	µg/L		101096.67	30	/	33	90.91%	5000	630000	NA
Total dissolved solids	µg/L		5061764.71	34	/	33	103.03%	110000	33000000	NA
Total organic carbon	µg/L		17861.29	31	/	33	93.94%	1000	190000	NA
Total suspended solids	µg/L		75677.42	31	/	33	93.94%	4000	480000	NA

FIGURES



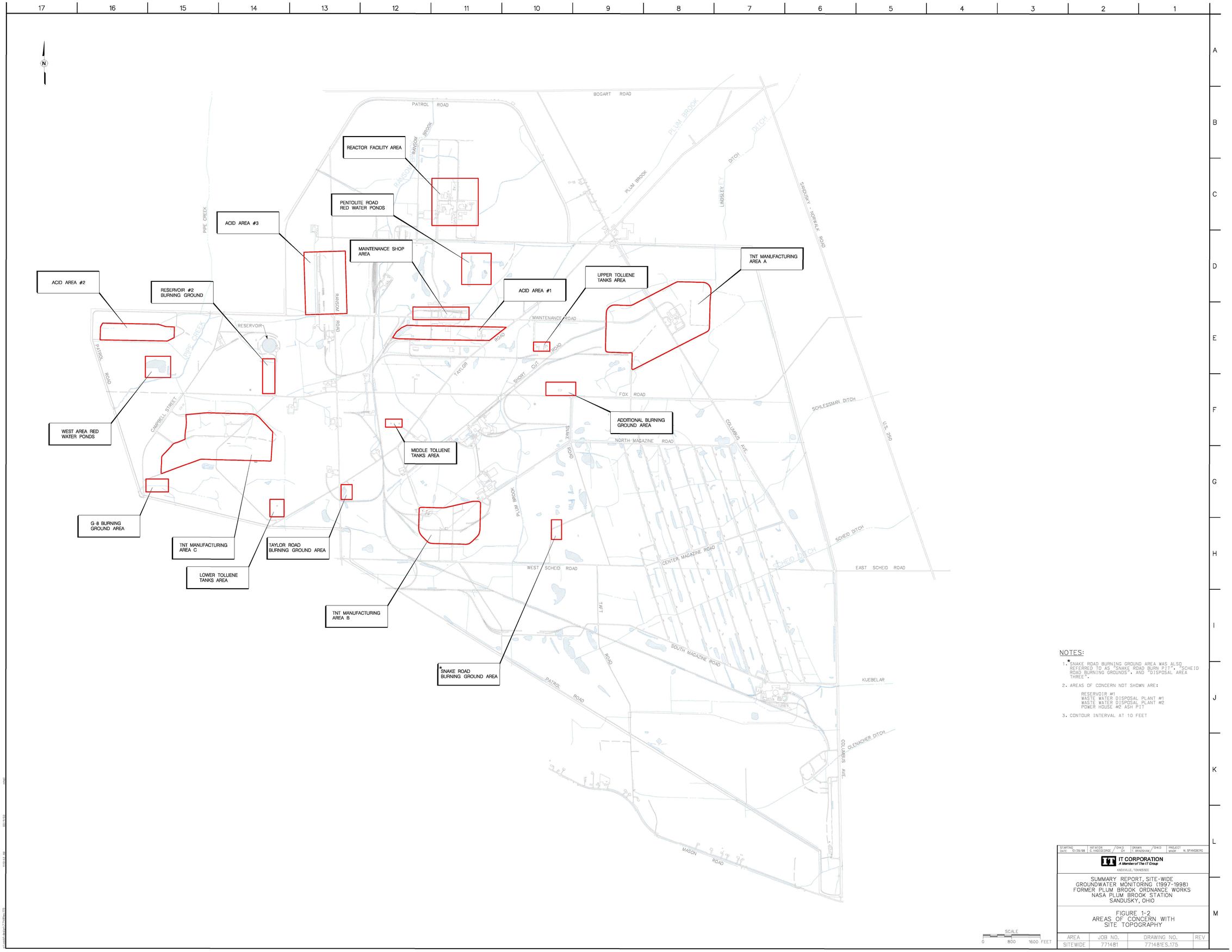
NOT TO SCALE

FIGURE 1-1
VICINITY MAP

FORMER PLUM BROOK ORDNANCE WORKS
SANDUSKY, OHIO

IT CORPORATION
A Member of The IT Group

STARTING DATE: 12/16/97 | DATE LAST REV: 29 JUN 1999 | DRAFT. CHCK. BY: | INITIATOR: D. KESSLER | DWG. NO.: 773701ES.001
DRAWN BY: D. BILLINGSLEY | DRAWN BY: IVANDERG | ENGR. CHCK. BY: D. KESSLER | PROJ. MGR: M. SPANGBERG | PROJ. NO.: 773701
09:20:21 25 JUN 1999 C:\CADD\DESIGN\773701FS.001 IVANDERG



NOTES:

1. *SNAKE ROAD BURNING GROUND AREA WAS ALSO REFERRED TO AS "SNAKE ROAD BURN PIT", "SCHEID ROAD BURNING GROUNDS", AND "DISPOSAL AREA THREE".
2. AREAS OF CONCERN NOT SHOWN ARE:

   RESERVOIR #1
   WASTE WATER DISPOSAL PLANT #1
   WASTE WATER DISPOSAL PLANT #2
   POWER HOUSE #2 ASH PIT

3. CONTOUR INTERVAL AT 10 FEET

STARTING DATE	DWT MODE / CHKD	DRAWN / CHKD	PROJECT
10/29/98	C. HADDECORE / CH	T. BRADSHAW /	MNGR M. SPANGBERG

IT CORPORATION
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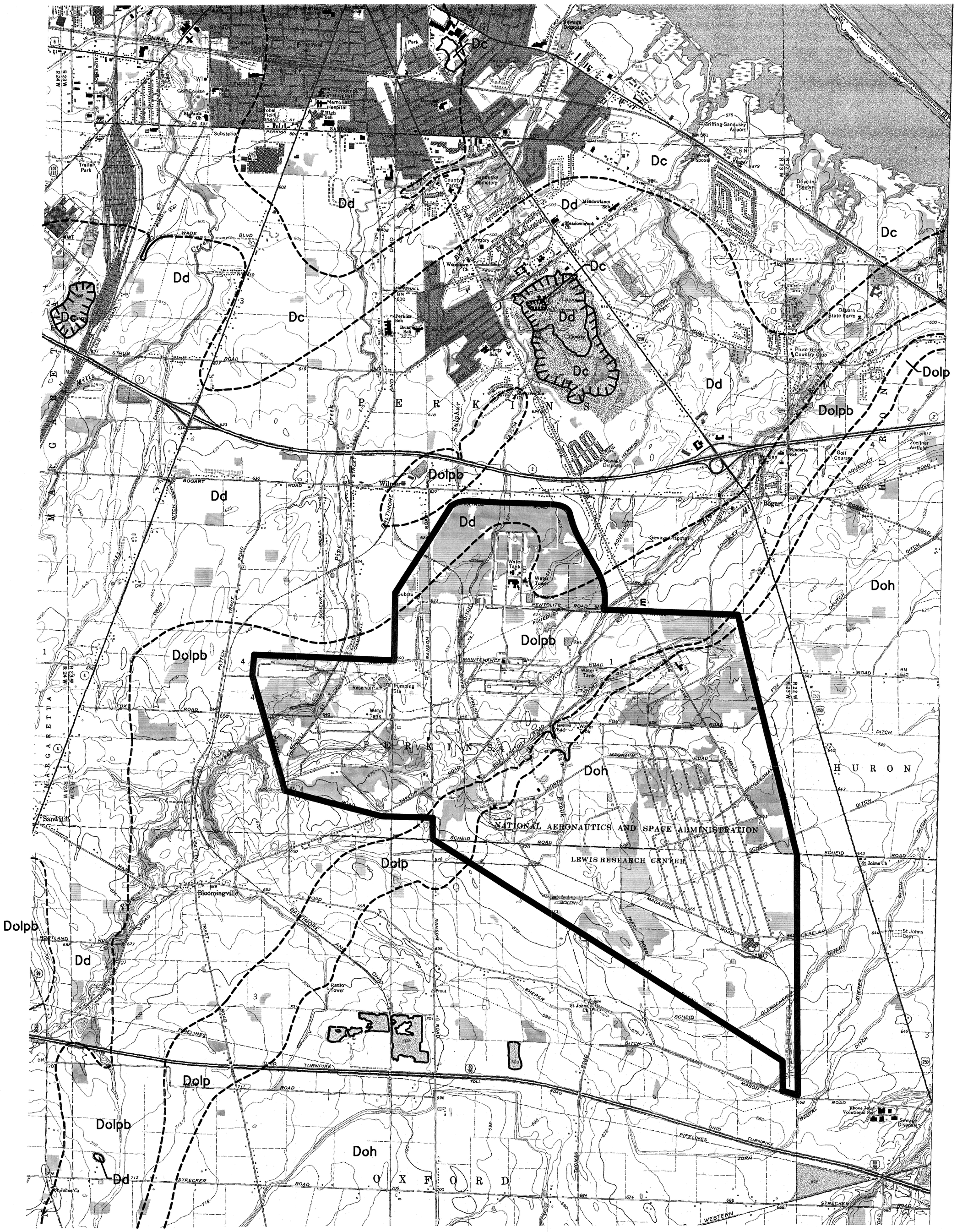
KNOXVILLE, TENNESSEE

SUMMARY REPORT, SITE-WIDE
GROUNDWATER MONITORING (1997-1998)
FORMER PLUM BROOK ORDNANCE WORKS
NASA PLUM BROOK STATION
SANDUSKY, OHIO

FIGURE 1-2
AREAS OF CONCERN WITH
SITE TOPOGRAPHY

AREA	JOB NO.	DRAWING NO.	REV.
SITEWIDE	771481	771481ES.175	



NOTES:

Doh	OHIO SHALE
Dolp	PROUT LIMESTONE MEMEBER (OLENTANGY SHALE)
Dolpb	PLUM BROOK SHALE MEMBER (OLENTANGY SHALE)
Dd	DELAWARE LIMESTONE
Dc	COLUMBUS LIMESTONE
——— — — — .	CONTACT SOLID LINE WHERE EXPOSED; DASHED WHERE CONCEALED BY SEDIMENTS

REFERENCE:

PRELIMINARY BEDROCK GEOLOGY OF THE KIMBALL AND SANDUSKY, OHIO, QUADRANGLES, STATE OF OHIO, DEPARTMENT OF NATURAL RESOURCES, DIVISION OF GEOLOGICAL SURVEY, 1995.

BASE MAPS (COMBINED BY IT) FROM KIMBALL AND SANDUSKY QUADRANGLES, 7.5 MINUTE SERVICES, (TOPOGRAPHIC), 1969. SANDUSKY MAP WAS PHOTOREVISED 1979.

SCALE
0 1250 2500 FEET

NO	DATE	REVISION	BY	CHKD	DSGN ENGR	ENGR	PROJ MGR	APPR

STARTING DATE 07/15/99 | INITIATOR J. KLESSLER | CADD DRAWN VANJURCIC | CHKD | PROJECT MGR M. SPANGELBERG

IT CORPORATION
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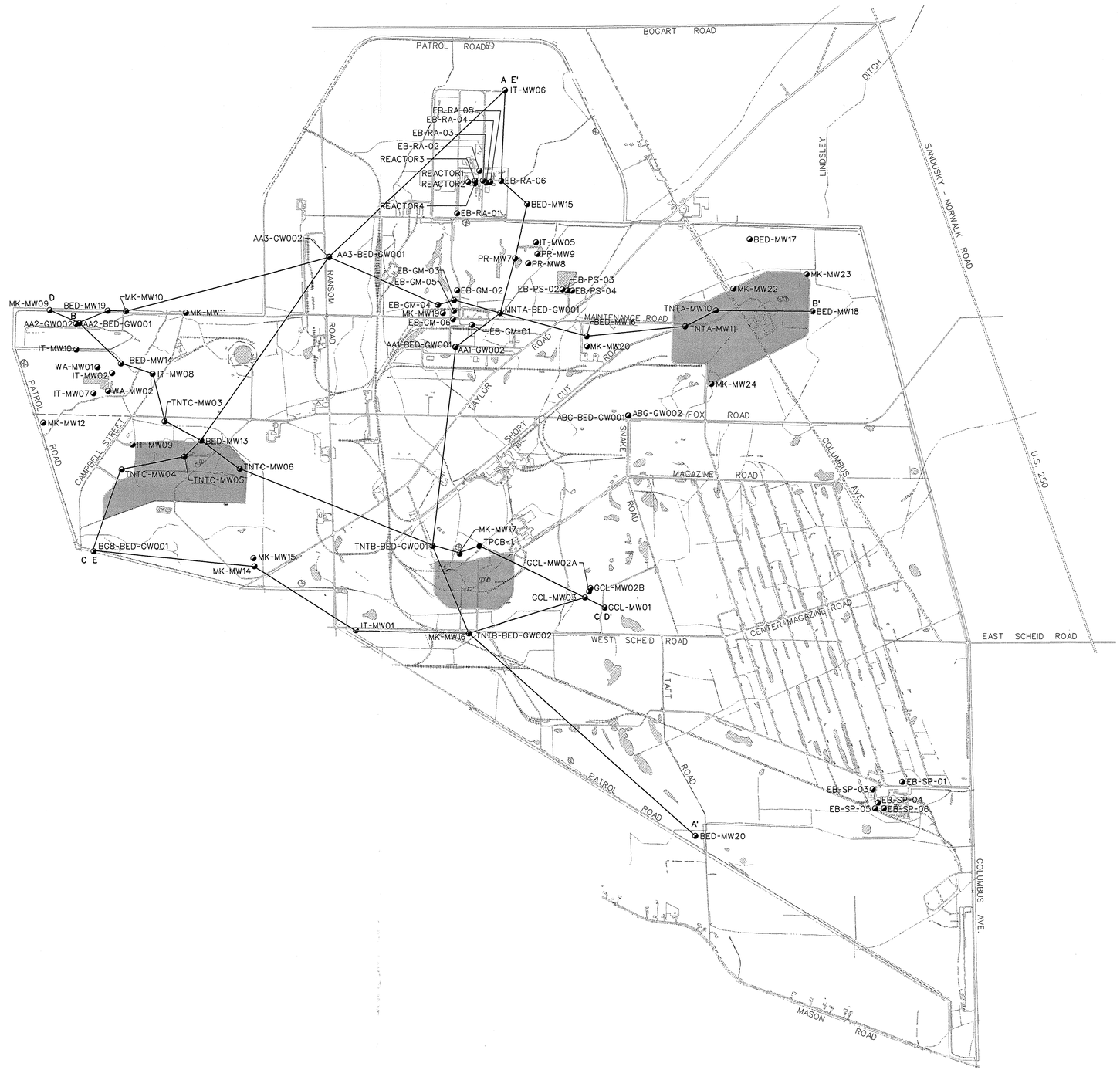
KNOXVILLE, TENNESSEE

SUMMARY REPORT, SITE-WIDE GROUNDWATER MONITORING (1997-1998)
FORMER PLUM BROOK ORDNANCE WORKS
NASA PLUM BROOK STATION
SANDUSKY, OHIO

FIGURE 2-1
REGIONAL GEOLOGIC MAP

AREA	JOB NO.	DRAWING NO.	REV
SITEWIDE	771481	771481ES.152	



LEGEND:

- ABG-BED-GW001 MONITORING WELL LOCATION
- TPCB-1 SOIL BORING LOCATION
- BUILDING
- RAILROAD
- SURFACE WATER
- DITCH
- FENCE (PBOW BOUNDARY)
- A —— A' GEOLOGIC CROSS-SECTION LINE

NOTES:

1. MONITORING WELLS PB-MW01, PB-MW02, PB-MW03, PB-MW04, AND REACTOR 5 ARE NOT SHOWN (SURVEY COORDINATES NOT AVAILABLE).
2. SOIL BORING TPCB-1 NOT SURVEYED. APPROXIMATE LOCATION BASED ON FIELD NOTES. LITHOLOGIC DEPTHS USED ONLY FOR CROSS-SECTION CONSTRUCTION.

NO	DATE	REVISION	BY	CHKD	DSGN ENGR	ENGR	PROJ MGR	APPR

STARTING DATE	INITIATOR	CHKD	DRAWN	CHKD	PROJECT MNGR
12/23/97	R. ELLIS	G. YU	VANDERGRIFF	C. TUMLIN	M. SPANGBERG

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SUMMARY REPORT, SITE-WIDE
GROUNDWATER MONITORING (1997-1998)
FORMER PLUM BROOK ORDNANCE WORKS
NASA PLUM BROOK STATION
SANDUSKY, OHIO

FIGURE 2-2
SITE MAP WITH WELLS AND
LINES OF CROSS-SECTION

AREA	JOB NO.	DRAWING NO.	REV
SITEWIDE	771481	771481ES.129	

SCALE
0 1200 2400 FEET

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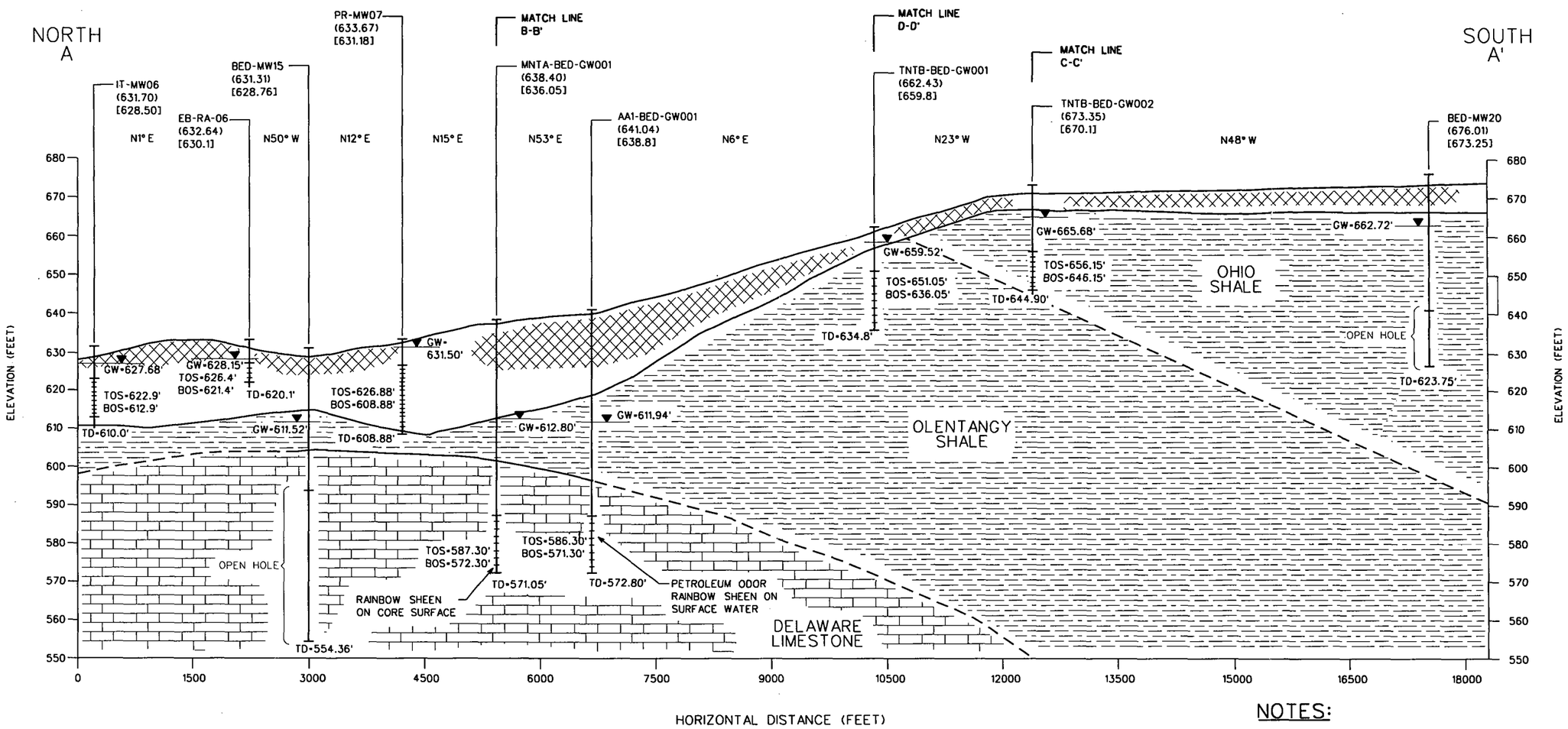

CROSS SECTION A-A'

NOTES:

1. ALL ELEVATIONS ARE REFERENCED TO NORTH AMERICAN VERTICAL DATUM (1983).
2. REFERENCE- PRELIMINARY OHIO, DEPARTMENT OF NATURAL RESOURCES, DIVISION OF GEOLOGICAL SERVICES, OPEN FILE MAP BG-D3DG

LEGEND:

OVERBURDEN	
SHALE	
LIMESTONE	
CONTACT AREA UNCERTAIN	

GW-627.68' ▼	GROUNDWATER ELEVATION (MAY 5, 1998)
BED-MW15	WELL ID
(631.31)	CASING ELEVATION
[628.76]	GROUND SURFACE ELEVATION
TD-610.80'	TOTAL DEPTH OF BOREHOLE
TOS	TOP OF SCREEN
BOS	BOTTOM OF SCREEN
N15° E	BEARING OF CROSS-SECTION SEGMENT

HORIZONTAL SCALE:
0 1500 3000 FEET

VERTICAL SCALE:
0 30 60 FEET

FIGURE 2-3
GEOLOGIC CROSS-SECTION A-A'

SUMMARY REPORT, SITE-WIDE GROUNDWATER MONITORING (1997-1998)
FORMER PLUM BROOK ORDNANCE WORKS
NASA PLUM BROOK STATION
SANDUSKY, OHIO

IT CORPORATION
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STARTING DATE: 1/4/99 | DATE LAST REV.: | DRAFT. CHCK. BY: C. TUMLIN | INITIATOR: D. KESSLER | DWG. NO.: ...\7714 8les.154
DRAWN BY: R. SPIRES | DRAWN BY: | ENGR. CHCK. BY: D. KESSLER | PROJ. MGR.: SPANGBERG | PROJ. NO.: 7714 81
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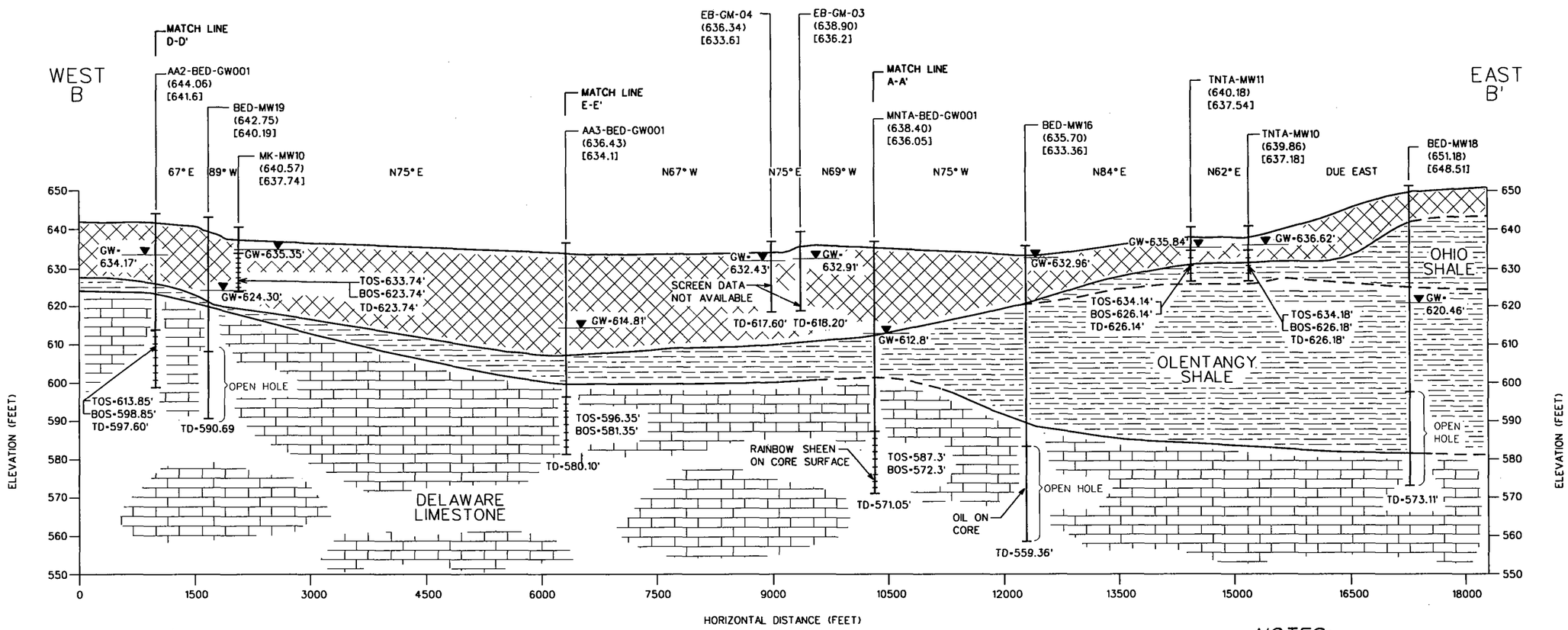
bvanderg



CROSS SECTION B-B'

NOTES:

1. ALL ELEVATIONS ARE REFERENCED TO NORTH AMERICAN VERTICAL DATUM (1983).
2. REFERENCE- PRELIMINARY OHIO, DEPARTMENT OF NATURAL RESOURCES, DIVISION OF GEOLOGICAL SERVICES, OPEN FILE MAP BG-D3DG

LEGEND:

OVERBURDEN	GW-627.68'▼	GROUNDWATER ELEVATION (MAY 5, 1998)
SHALE	BED-MW15	WELL ID
	(631.31)	CASING ELEVATION
LIMESTONE	[628.76]	GROUND SURFACE ELEVATION
	TD-610.80'	TOTAL DEPTH OF BOREHOLE
	TOS	TOP OF SCREEN
CONTACT AREA UNCERTAIN	BOS	BOTTOM OF SCREEN
	N15° E	BEARING OF CROSS-SECTION SEGMENT

HORIZONTAL SCALE:

0 1500 3000 FEET

VERTICAL SCALE:

0 30 60 FEET

FIGURE 2-4
GEOLOGIC CROSS-SECTION B-B'

SUMMARY REPORT, SITE-WIDE GROUNDWATER MONITORING (1997-1998) FORMER PLUM BROOK ORDNANCE WORKS NASA PLUM BROOK STATION SANDUSKY, OHIO

IT CORPORATION
A Member of The IT Group

STARTING DATE: 1/4/99 | DATE LAST REV.: | DRAFT. CHCK. BY: C. TUMLIN | INITIATOR: D. KESSLER | DWG. NO.: ...\771481es.155
DRAWN BY: R. SPIRES | DRAWN BY: | ENGR. CHCK. BY: D. KESSLER | PROJ. MGR.: SPANGBERG | PROJ. NO.: 771481

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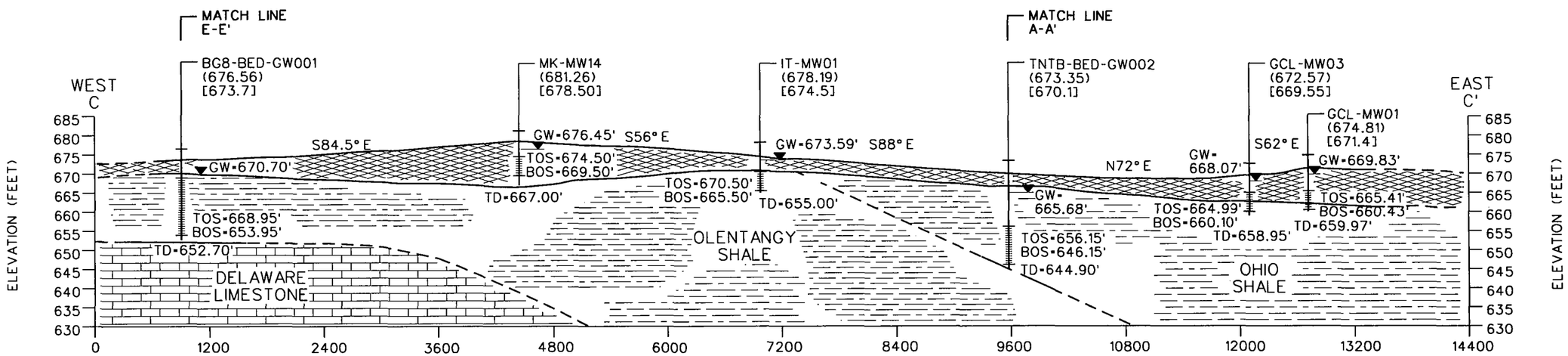

CROSS SECTION C-C'

LEGEND:

OVERBURDEN	GW-627.68'	GROUNDWATER ELEVATION (MAY 5, 1998)
	BED-MW15	WELL ID
SHALE	(631.31)	CASING ELEVATION
	[628.76]	GROUND SURFACE ELEVATION
LIMESTONE	TD-610.80'	TOTAL DEPTH OF BOREHOLE
	TOS	TOP OF SCREEN
CONTACT AREA UNCERTAIN	BOS	BOTTOM OF SCREEN
	N15° E	BEARING OF CROSS-SECTION SEGMENT

HORIZONTAL SCALE:

0 1200 2400 FEET

VERTICAL SCALE:

0 30 60 FEET

NOTES:

1. ALL ELEVATIONS ARE REFERENCED TO NORTH AMERICAN VERTICAL DATUM (1983).
2. REFERENCE- PRELIMINARY OHIO, DEPARTMENT OF NATURAL RESOURCES, DIVISION OF GEOLOGICAL SERVICES, OPEN FILE MAP BG-D3DG

FIGURE 2-5
GEOLOGIC CROSS-SECTION C-C'

SUMMARY REPORT, SITE-WIDE GROUNDWATER MONITORING (1997-1998)
FORMER PLUM BROOK ORDNANCE WORKS
NASA PLUM BROOK STATION
SANDUSKY, OHIO

IT CORPORATION
A Member of The IT Group

DWG. NO.: ...\771481es.156 | PROJ. NO.: 771481
INITIATOR: D. KESSLER | PROJ. MGR.: SPANGBERG
DRAFT. CHCK. BY: C. TUMLIN | ENGR. CHCK. BY: D. KESSLER
STARTING DATE: 05/26/99 | DATE LAST REV.:
DRAWN BY: R. SPIRES | DRAWN BY:
10:37:00 23 JUN 1999
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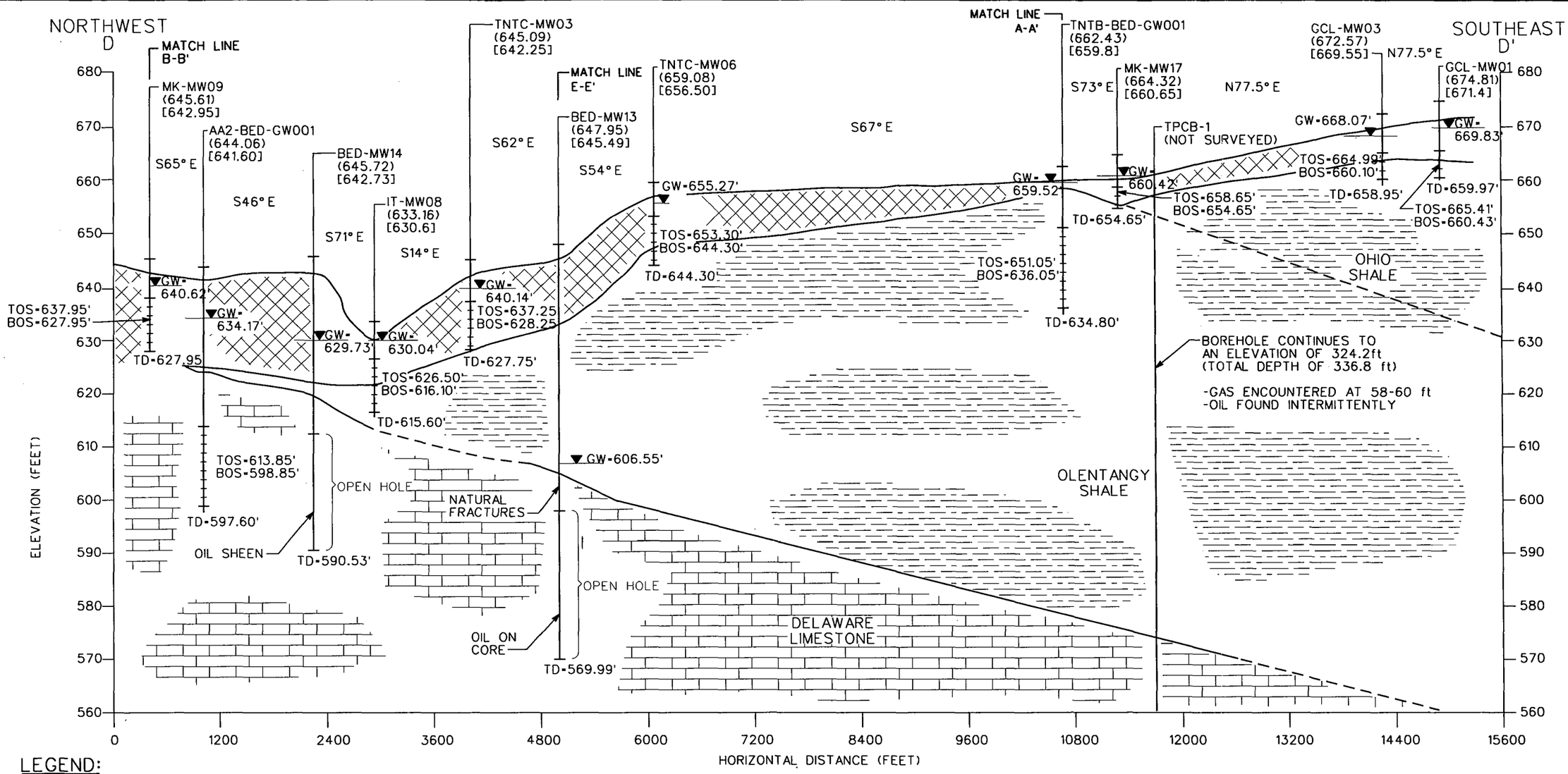

CROSS SECTION D-D'

LEGEND:

OVERBURDEN	GW-627.68' ▼	GROUNDWATER ELEVATION (MAY 5, 1998)
SHALE	BED-MW15	WELL ID
LIMESTONE	(631.31)	CASING ELEVATION
CONTACT AREA UNCERTAIN	[628.76]	GROUND SURFACE ELEVATION
	TD-610.80'	TOTAL DEPTH OF BOREHOLE
	TOS	TOP OF SCREEN
	BOS	BOTTOM OF SCREEN
	N15° E	BEARING OF CROSS-SECTION SEGMENT

NOTES:

1. ALL ELEVATIONS ARE REFERENCED TO NORTH AMERICAN VERTICAL DATUM (1983).
2. REFERENCE- PRELIMINARY OHIO, DEPARTMENT OF NATURAL RESOURCES, DIVISION OF GEOLOGICAL SERVICES, OPEN FILE MAP BG-D3DG

HORIZONTAL SCALE:

0 1200 2400 FEET

VERTICAL SCALE:

0 20 40 FEET

FIGURE 2-6
GEOLOGIC CROSS-SECTION D-D'

SUMMARY REPORT, SITE-WIDE GROUNDWATER MONITORING (1997-1998) FORMER PLUM BROOK ORDNANCE WORKS NASA PLUM BROOK STATION SANDUSKY, OHIO

IT CORPORATION
A Member of The IT Group

STARTING DATE: 05/25/99 | DATE LAST REV.: | DRAFT. CHCK. BY: C. TUMLIN | INITIATOR: HAGEGEORGE | DWG. NO.: ...\771481es.157
DRAWN BY: T. BRADSHAW | DRAWN BY: | ENGR. CHCK. BY: HAGEGEORGE | PROJ. MGR.: SPANGBERG | PROJ. NO.: 771481

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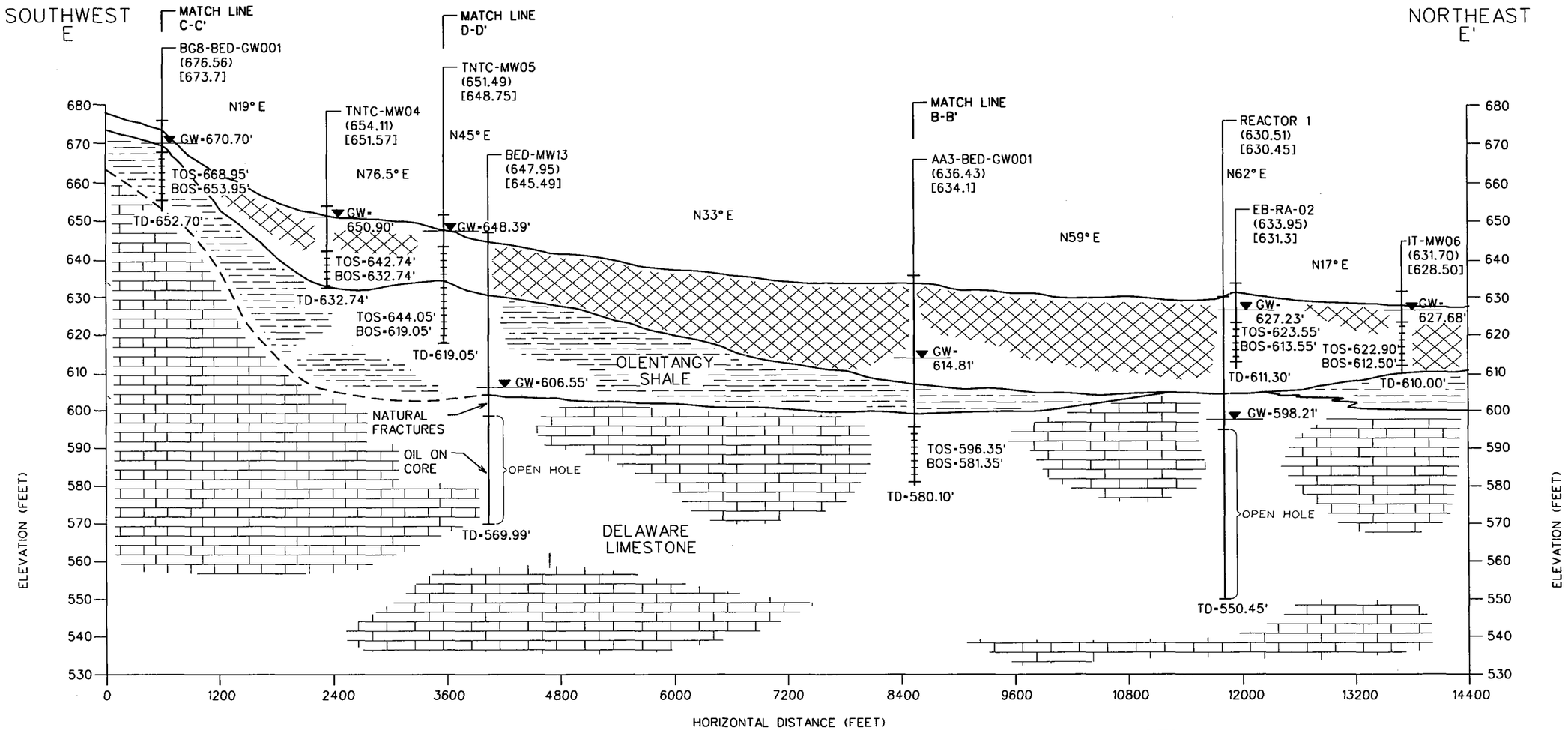

CROSS SECTION E-E'

NOTES:

1. ALL ELEVATIONS ARE REFERENCED TO NORTH AMERICAN VERTICAL DATUM (1983).
2. REFERENCE- PRELIMINARY OHIO, DEPARTMENT OF NATURAL RESOURCES, DIVISION OF GEOLOGICAL SERVICES, OPEN FILE MAP BG-D3DG

LEGEND:

OVERBURDEN	GW-627.68'▼	GROUNDWATER ELEVATION (MAY 5, 1998)
SHALE	BED-MW15	WELL ID
LIMESTONE	(631.31)	CASING ELEVATION
	[628.76]	GROUND SURFACE ELEVATION
CONTACT AREA UNCERTAIN	TD-610.80'	TOTAL DEPTH OF BOREHOLE
	TOS	TOP OF SCREEN
	BOS	BOTTOM OF SCREEN
	N15° E	BEARING OF CROSS-SECTION SEGMENT

HORIZONTAL SCALE:

0 1200 2400 FEET

VERTICAL SCALE:

0 30 60 FEET

FIGURE 2-7
GEOLOGIC CROSS-SECTION E-E'

SUMMARY REPORT, SITE-WIDE GROUNDWATER MONITORING (1997-1998) FORMER PLUM BROOK ORDNANCE WORKS NASA PLUM BROOK STATION SANDUSKY, OHIO

IT CORPORATION
A Member of The IT Group

STARTING DATE:05/26/99 | DATE LAST REV.: | DRAFT. CHCK. BY:C. TUMLIN | INITIATOR:HAGEGEORGE | DWG. NO.: ...\771481es.158
DRAWN BY: T. BRADSHAW | DRAWN BY: | ENGR. CHCK. BY:HAGEGEORGE | PROJ. MGR.:SPANGBERG | PROJ. NO.: 771481

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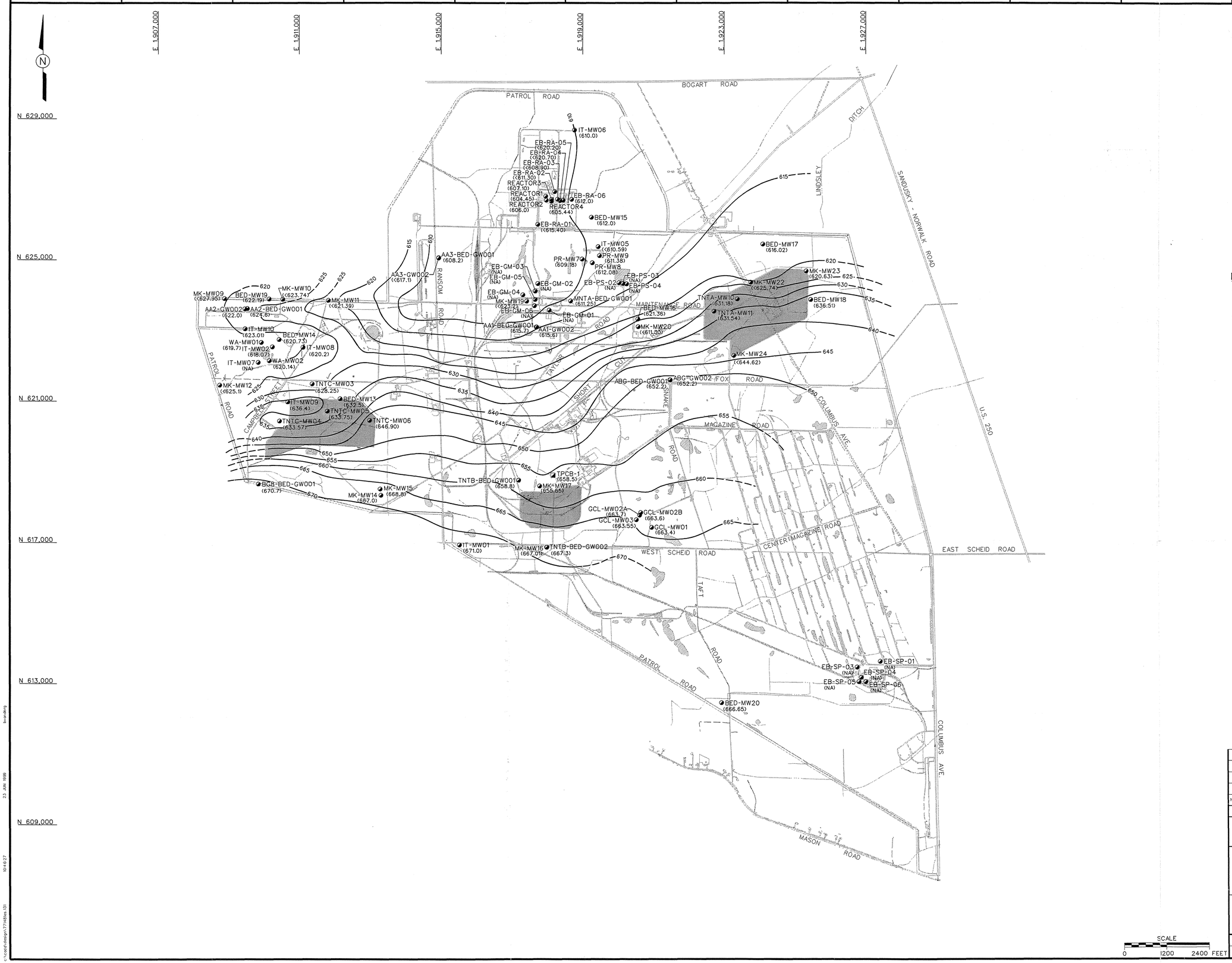
by:anderg



LEGEND:

ABG-BED-GW001	MONITORING WELL LOCATION
TPCB-1	SOIL BORING LOCATION
	BUILDING
	RAILROAD
	SURFACE WATER
	DITCH
	FENCE (PBOW BOUNDARY)
(621.36)	BEDROCK ELEVTION (FT-MSL)
670	BEDROCK ELEVATION CONTOUR (FT-MSL)
(<610.59)	LESS THAN ELEVATION INDICATED . BORING DID NOT ENCOUNTER BEDROCK.
(NA)	DRILL LOG NOT AVAILABLE

NOTES:

1. MONITORING WELLS PB-MW01, PB-MW02, PB-MW03, PB-MW04, AND REACTOR 5 ARE NOT SHOWN (SURVEY COORDINATES NOT AVAILABLE).
2. SOIL BORING TPCB-1 NOT SURVEYED. APPROXIMATE LOCATION BASED ON FIELD NOTES. LITHOLOGIC DEPTHS USED ONLY FOR CROSS-SECTION CONSTRUCTION.

NO	DATE	REVISION	BY	CHKD	DSGN ENGR	ENGR	PROJ MGR	APPR

STARTING DATE	INITIATOR	CHKD	DRAWN	CHKD	PROJECT MNGR
12/11/98	D. KESSLER	KESSLER	VANDERGRIFF	C. TUMLIN	M. SPANOBERG

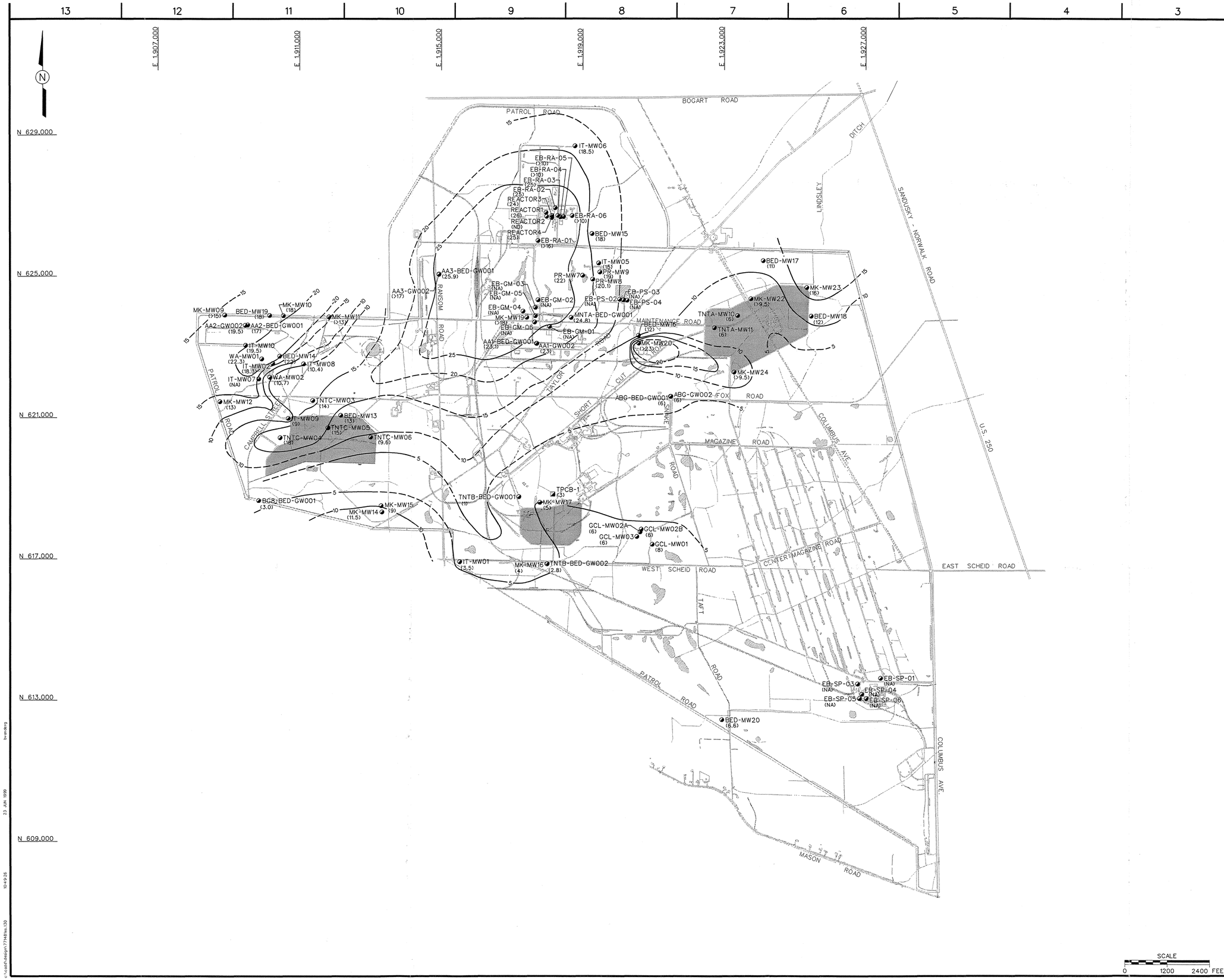
IT CORPORATION
A Member of The IT Group
KNOXVILLE, TENNESSEE

SUMMARY REPORT, SITE-WIDE
GROUNDWATER MONITORING (1997-1998)
FORMER PLUM BROOK ORDNANCE WORKS
NASA PLUM BROOK STATION
SANDUSKY, OHIO

FIGURE 2-8
TOP OF BEDROCK ELEVATION CONTOUR MAP

AREA	JOB NO.	DRAWING NO.	REV
SITEWIDE	771481	771481ES.131	

23 JUN 1999 brandberg 10:46:27 c:\acad\design\771481es.131



LEGEND:

ABG-BED-GW001	MONITORING WELL LOCATION
TPCB-1	SOIL BORING LOCATION
	BUILDING
	RAILROAD
	SURFACE WATER
	DITCH
	FENCE (PBOW BOUNDARY)
(6)	OVERBURDEN THICKNESS (FT)
10	OVERBURDEN THICKNESS CONTOUR (FT)
(>17)	GREATER THAN INDICATED DEPTH
(NA)	DRILL LOG NOT AVAILABLE

NOTES:

1. MONITORING WELLS PB-MW01, PB-MW02, PB-MW03, PB-MW04, AND REACTOR 5 ARE NOT SHOWN (SURVEY COORDINATES NOT AVAILABLE).
2. SOIL BORING TPCB-1 NOT SURVEYED. APPROXIMATE LOCATION BASED ON FIELD NOTES. LITHOLOGIC DEPTHS USED ONLY FOR CROSS-SECTION CONSTRUCTION.

NO	DATE	REVISION	BY	CHKD	DSGN ENGR	ENGR	PROJ MGR	APPR

STARTING DATE	INITIATOR	CHKD	DRAWN	CHKD	PROJECT	
12/11/98	D. KESSLER	KESSLER	VANDERGRIFF	C. TUMLIN	MNGR	M. SPANGBERG

IT CORPORATION
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KNOXVILLE, TENNESSEE

SUMMARY REPORT, SITE-WIDE
GROUNDWATER MONITORING (1997-1998)
FORMER PLUM BROOK ORDNANCE WORKS
NASA PLUM BROOK STATION
SANDUSKY, OHIO

FIGURE 2-9
OVERBURDEN THICKNESS CONTOUR MAP

AREA	JOB NO.	DRAWING NO.	REV
SITEWIDE	771481	771481ES.130	

23 JAN 1999 10:49:26 bvanberg
e:\cad\f\design\771481es.130

LEGEND:

- BUILDING
- FENCE (PBOW BOUNDARY)
- RAILROAD
- DITCH
- SURFACE POND
- MK-MW22 — OVERBURDEN MONITORING WELL
- BED-MW16 — BEDROCK MONITORING WELL
- G.W. FLOW — GROUNDWATER FLOW DIRECTION
- 630 — GROUNDWATER ELEVATION CONTOUR (FT-MSL) (DASHED WHERE INFERED)

NOTES:

1. MONITORING WELLS PB-MW01, PB-MW02, PB-MW03, PB-MW04, AND REACTOR 5 ARE NOT SHOWN (SURVEY COORDINATES NOT AVAILABLE).

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

NO.	DATE	REVISION	BY	CHKD	DSGN ENGR	ENGR	PROJ MGR	APPR

STARTING DATE	INITIATOR	CHKD	DRAWN	CHKD	PROJECT MNGR
05/27/99	HAGEGEORGE	CH	BRADSHAW		M. SPANGBERG

IT CORPORATION
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KNOXVILLE, TENNESSEE

SUMMARY REPORT, SITE-WIDE
GROUNDWATER MONITORING (1997-1998)
FORMER PLUM BROOK ORDNANCE WORKS
NASA PLUM BROOK STATION
SANDUSKY, OHIO

FIGURE 6-1
OVERBURDEN GROUNDWATER ELEVATION
CONTOUR MAP (AUGUST 1997)

AREA	JOB NO.	DRAWING NO.	REV
	771481	771481ES.176	

24 X 36
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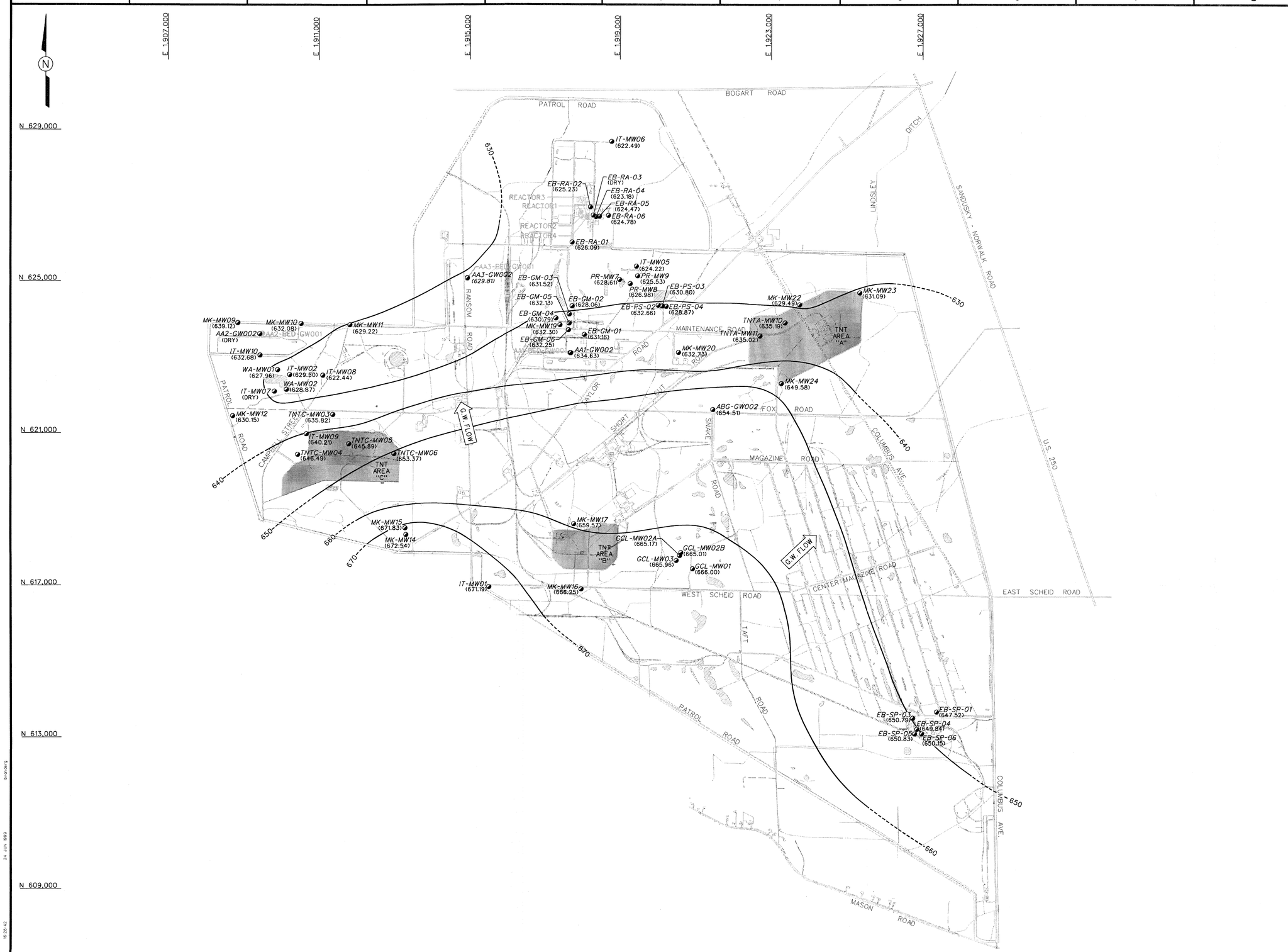
24 JUN 1998
14:57:48
hyandberg



LEGEND:

MK-MW09	OVERBURDEN MONITORING WELL
AA2-BED-GW001	BEDROCK MONITORING WELL
(633.08)	GROUNDWATER ELEVATION (FT-MSL)
G.W. FLOW	GROUNDWATER FLOW DIRECTION
630	GROUNDWATER ELEVATION CONTOUR (FT-MSL) (DASHED WHERE INFERRED)
	BUILDING
	RAILROAD
	SURFACE WATER
	DITCH
	FENCE (PBOW BOUNDARY)

NOTES:

1. MONITORING WELLS PB-MW01, PB-MW02, PB-MW03, PB-MW04, AND REACTOR 5 ARE NOT SHOWN (SURVEY COORDINATES NOT AVAILABLE)

SCALE
0 1200 2400 FEET

NO	DATE	REVISION	BY	CHKD	DSGN ENGR	ENGR	PROJ MGR	APPR

STARTING DATE	INITIATOR	CHKD	DRAWN	CHKD	PROJECT MNGR
01/12/97	D. KESSLER	R. ELLIS	VANDERGRIFF/ C. TUMLIN		M. SPANGBERG

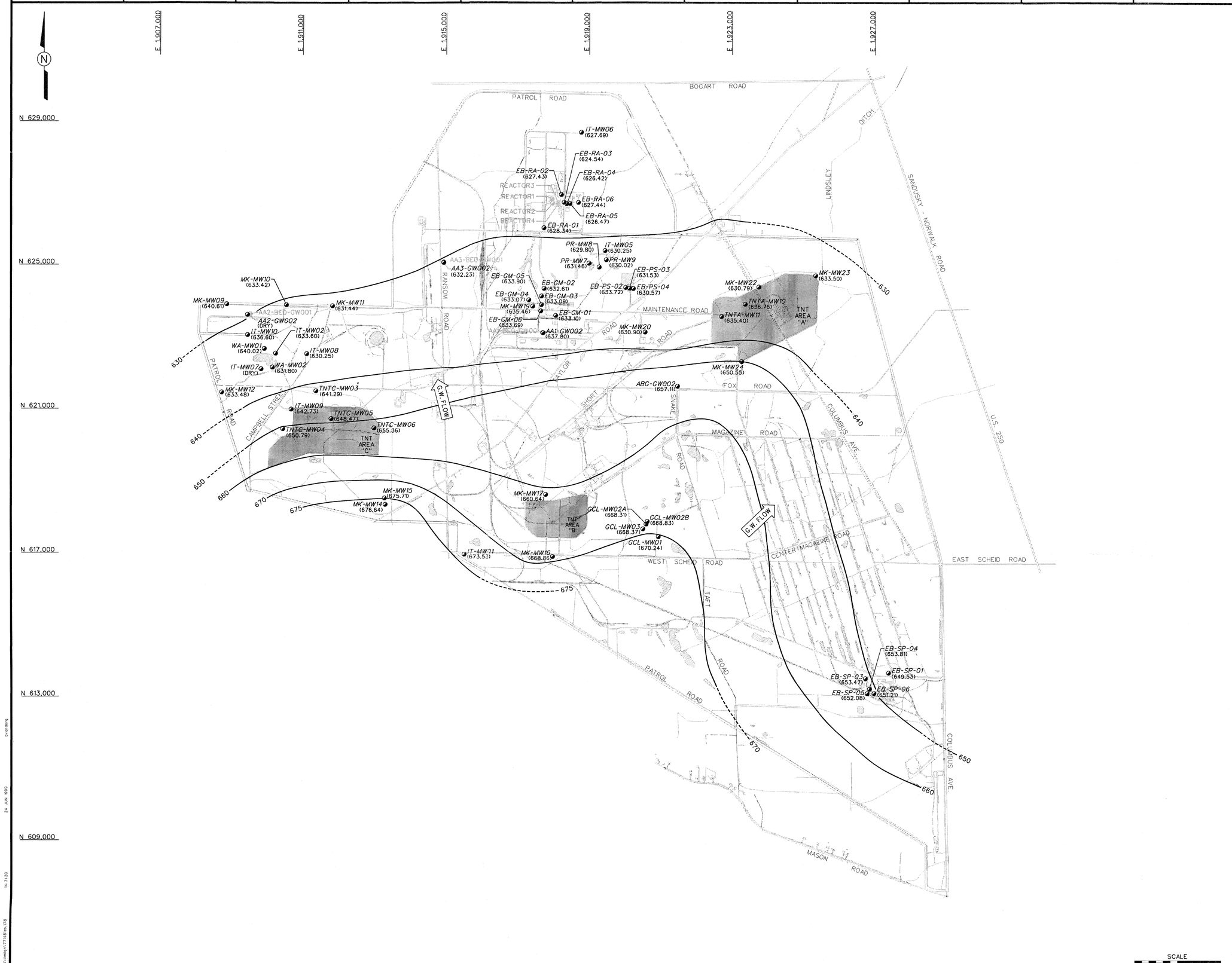
IT CORPORATION
A Member of The IT Group
KNOXVILLE, TENNESSEE

SUMMARY REPORT, SITE-WIDE
GROUNDWATER MONITORING (1997-1998)
FORMER PLUM BROOK ORDNANCE WORKS
NASA PLUM BROOK STATION
SANDUSKY, OHIO

FIGURE 6-2
OVERBURDEN GROUNDWATER ELEVATION
CONTOUR MAP (NOVEMBER 1997)

AREA	JOB NO.	DRAWING NO.	REV
SITEWIDE	771481	771481ES.177	

bvanberg 24 JUN 1999 16:28:42
C:\ACAD5\design\771481es.177



LEGEND:

MK-MW09	OVERBURDEN MONITORING WELL
AA1-BED-GW001	BEDROCK MONITORING WELL
(633.08)	GROUNDWATER ELEVATION (FT-MSL)
G.W. FLOW	GROUNDWATER FLOW DIRECTION
630	GROUNDWATER ELEVATION CONTOUR (FT-MSL) (DASHED WHERE INFERRED)
	BUILDING
	RAILROAD
	SURFACE WATER
	DITCH
	FENCE (PBOW BOUNDARY)

NOTES:

1. MONITORING WELLS PB-MW01, PB-MW02, PB-MW03, PB-MW04, AND REACTOR 5 ARE NOT SHOWN (SURVEY COORDINATES NOT AVAILABLE)

SCALE
0 1200 2400 FEET

NO	DATE	REVISION	BY	CHKD	DSGN ENGR	ENGR	PROJ MGR	APPR

STARTING DATE 05/28/99 | INITIATOR HAGEGEORGE / CHKD CH | DRAWN T. BRADSHAW / CHKD | PROJECT MNGR M. SPANGBERG

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SUMMARY REPORT, SITE-WIDE
GROUNDWATER MONITORING (1997-1998)
FORMER PLUM BROOK ORDNANCE WORKS
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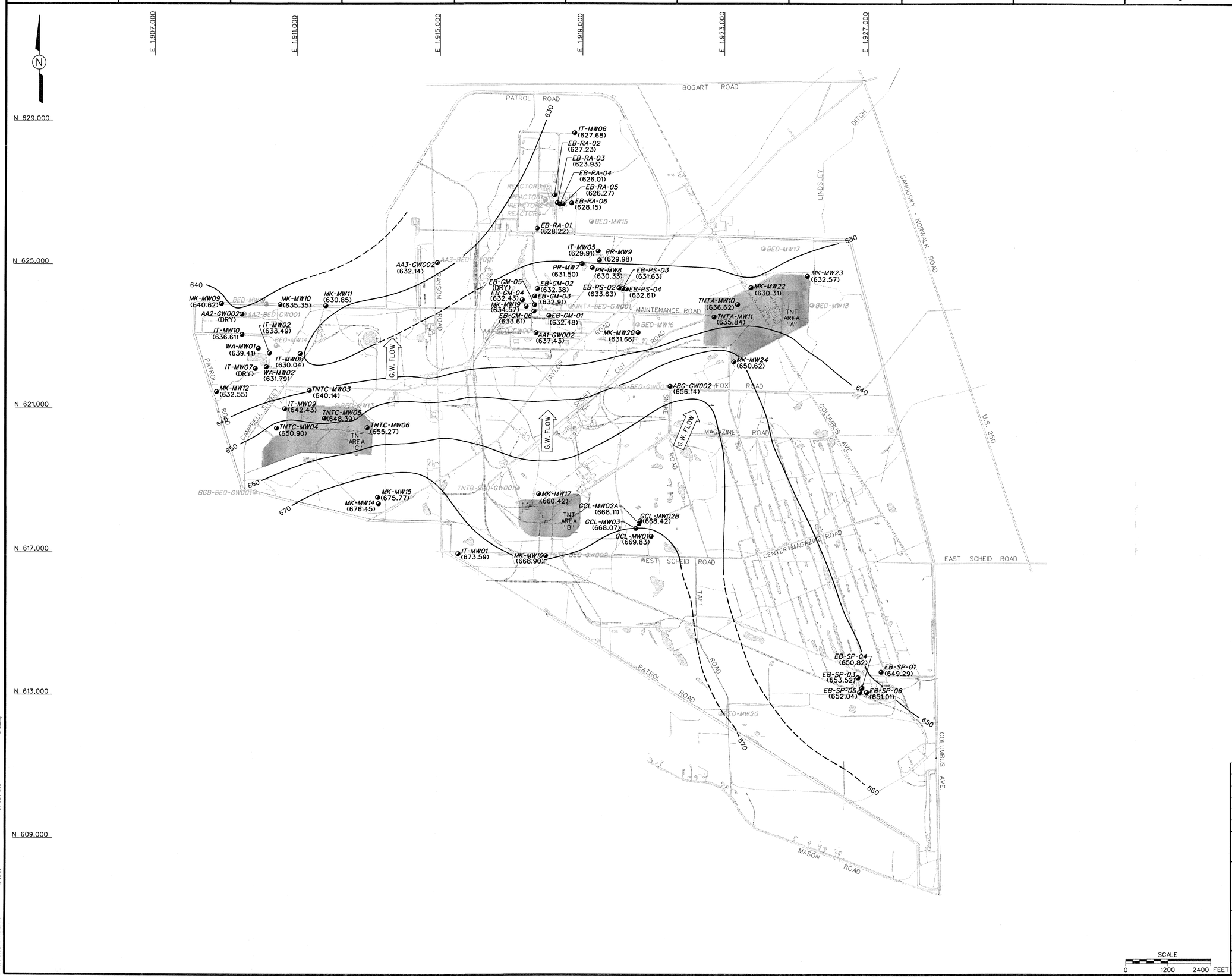
FIGURE 6-3
OVERBURDEN GROUNDWATER ELEVATION
CONTOUR MAP (FEBRUARY 1998)

AREA	JOB NO.	DRAWING NO.	REV
SITEWIDE	771481	771481ES.178	

bvspangberg 24 JUN 1999 14:31:20 c:\cad\design\771481es.178



LEGEND:

ABG-GW002	OVERBURDEN MONITORING WELL
AA2-BED-GW001	BEDROCK MONITORING WELL
	BUILDING
	RAILROAD
	SURFACE WATER
	DITCH
	FENCE (PBOW BOUNDARY)
(630.63)	GROUNDWATER ELEVATION (FT-MSL)
610	GROUNDWATER ELEVATION CONTOUR (FT-MSL) (DASHED WHERE INFERRED)
G.W. FLOW	GROUNDWATER FLOW DIRECTION

NOTES:

1. MONITORING WELLS PB-MW01, PB-MW02, PB-MW03, PB-MW04, AND REACTOR 5 ARE NOT SHOWN (SURVEY COORDINATES NOT AVAILABLE).

SCALE
0 1200 2400 FEET

NO	DATE	REVISION	BY	CHKD	DSGN ENGR	ENGR	PROJ MGR	APPR

STARTING DATE	INITIATOR	CHKD	DRAWN	CHKD	PROJECT MNGR
06/01/99	HAGEGEORGE	CH	BRADSHAW	C. TUMLIN	M. SPANGBERG

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SUMMARY REPORT, SITE-WIDE
GROUNDWATER MONITORING (1997-1998)
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FIGURE 6-4
OVERBURDEN GROUNDWATER ELEVATION
CONTOUR MAP (MAY, 1998)

AREA	JOB NO.	DRAWING NO.	REV
SITEWIDE	771481	771481ES.179	

LEGEND:

- BUILDING
- FENCE (PBOW BOUNDARY)
- RAILROAD
- DITCH
- SURFACE POND
- MK-MW22 / MK-MW22 — OVERBURDEN MONITORING WELL
- BED-MW16 — BEDROCK MONITORING WELL
- G.W. FLOW — GROUNDWATER FLOW DIRECTION
- (620.92) — GROUNDWATER ELEVATION (FT-MSL)
- 630 — GROUNDWATER ELEVATION CONTOUR (FT-MSL) (DASHED WHERE INFERED)

NOTES:

1. MONITORING WELLS PB-MW01, PB-MW02, PB-MW03, PB-MW04, REACTOR 5 ARE NOT SHOWN (SURVEY COORDINATES NOT AVAILABLE)

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

NO	DATE	REVISION	BY	CHKD	DSGN ENGR	ENGR	PROJ MGR	APPR

STARTING DATE 06/01/99 | INITIATOR HAGEGEORGE / CHKD CH | DRAWN BRADSHAW / CHKD CET | PROJECT MNGR M. SPANGBERG

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FORMER PLUM BROOK ORDNANCE WORKS
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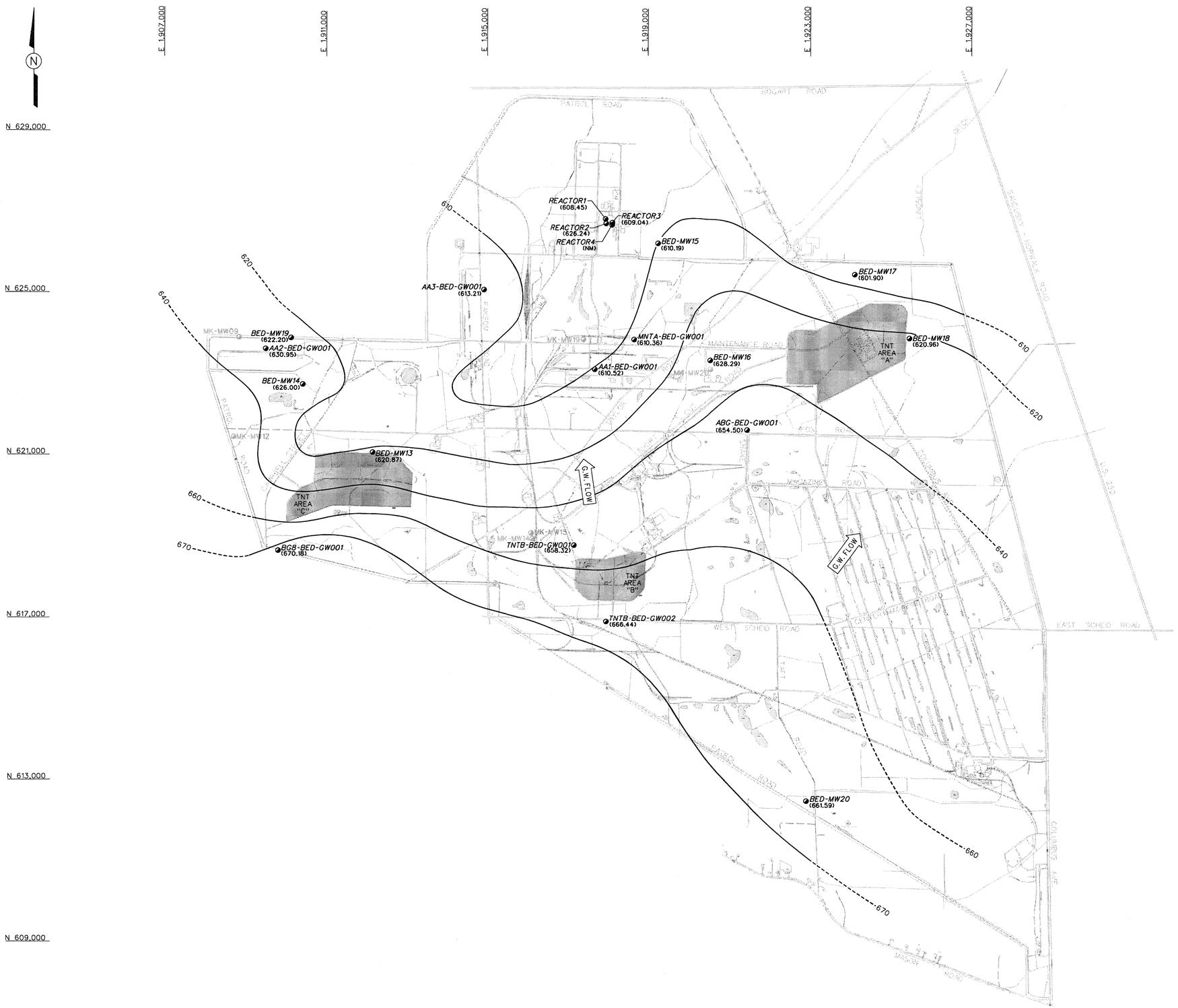
FIGURE 6-5
BEDROCK GROUNDWATER ELEVATION CONTOUR MAP (AUGUST 1997)

AREA	JOB NO.	DRAWING NO.	REV
	771481	771481ES.180	



LEGEND:

MK-MW09	OVERBURDEN MONITORING WELL
BED-MW16	BEDROCK MONITORING WELL
(633.08)	GROUNDWATER ELEVATION (FT-MSL)
(NM)	NOT MEASURED
G.W. FLOW	GROUNDWATER FLOW DIRECTION
630	GROUNDWATER ELEVATION CONTOUR (FT-MSL) (DASHED WHERE INFERRED)
	BUILDING
	RAILROAD
	SURFACE WATER
	DITCH
	FENCE (PBOW BOUNDARY)

NOTES:

1. MONITORING WELLS PB-MW01, PB-MW02, PB-MW03, PB-MW04, AND REACTOR 5 ARE NOT SHOWN (SURVEY COORDINATES NOT AVAILABLE).
2. GROUNDWATER ELEVATION 626.24 FT OF REACTOR WELL NO. 2 NOT USED DURING CONTOURING.

SCALE
0 1200 2400 FEET

NO	DATE	REVISION	BY	CHKD	DSGN ENGR	ENGR	PROJ MGR	APPR

STARTING DATE	INITIATOR	CHKD	DRAWN	CHKD	PROJECT
06/01/99	HAGEGEORGE	CH	BRADSHAW	C. TJMLIN	MNGR M. SPANGBERG

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SUMMARY REPORT, SITE-WIDE
GROUNDWATER MONITORING (1997-1998)
PLUM BROOK ORDNANCE WORKS
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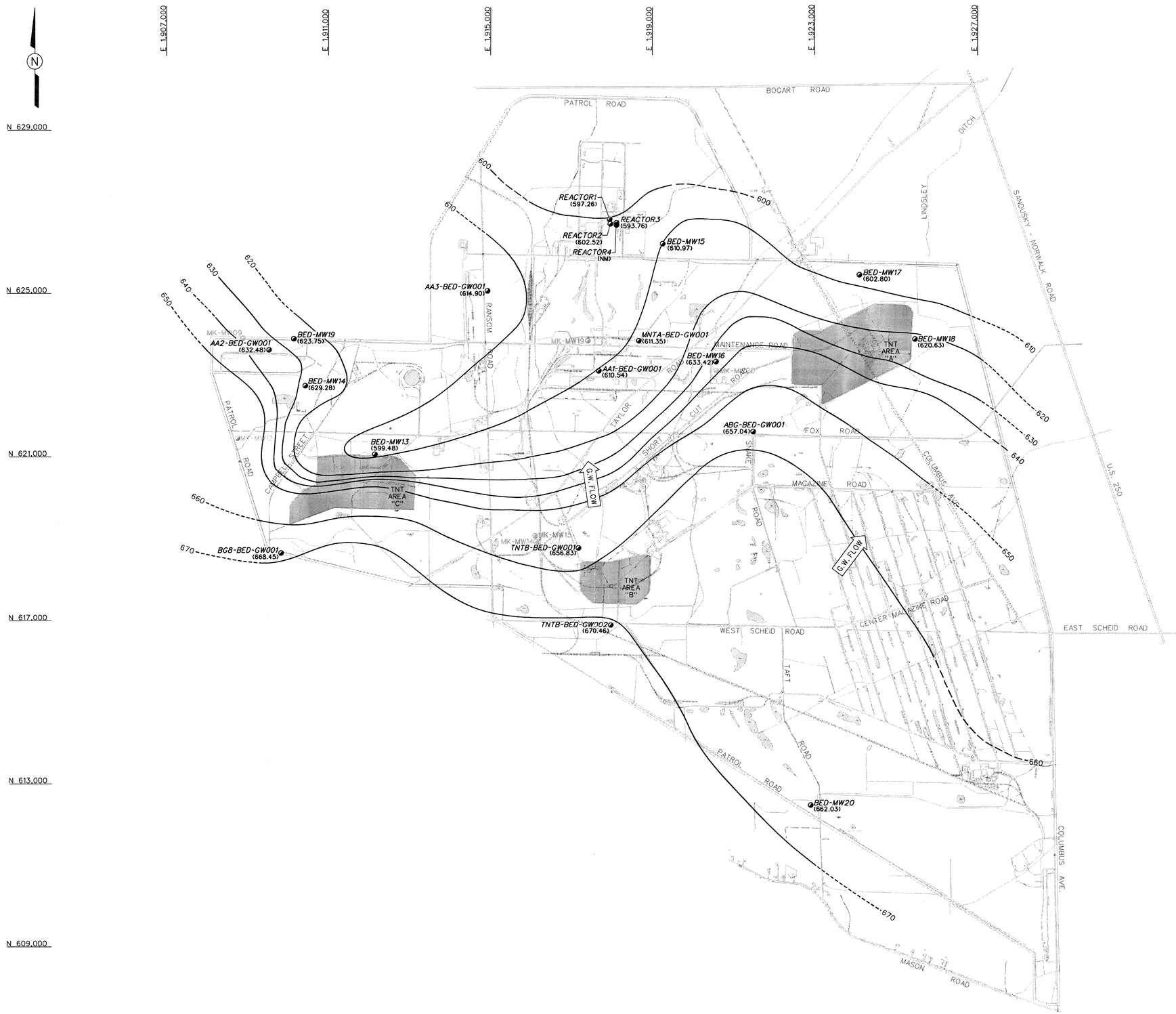
SANDUSKY, OHIO

FIGURE 6-6
BEDROCK GROUNDWATER ELEVATION
CONTOUR MAP (NOVEMBER 1997)

AREA	JOB NO.	DRAWING NO.	REV
SITEWIDE	771481	771481ES.181	

bspangberg 23 JUN 1999 11:32:56 c:\cadd\design\771481es.181



LEGEND:

MK-MW09	OVERBURDEN MONITORING WELL
BED-MW16	BEDROCK MONITORING WELL
(633.08)	GROUNDWATER ELEVATION (FT-MSL)
(NM)	NOT MEASURED
G.W. FLOW	GROUNDWATER FLOW DIRECTION
630	GROUNDWATER ELEVATION CONTOUR (FT-MSL) (DASHED WHERE INFERRED)
	BUILDING
	RAILROAD
	SURFACE WATER
	DITCH
	FENCE (PBOW BOUNDARY)

NOTES:

1. MONITORING WELLS PB-MW01, PB-MW02, PB-MW03, PB-MW04, AND REACTOR 5 ARE NOT SHOWN (SURVEY COORDINATES NOT AVAILABLE).

SCALE
0 1200 2400 FEET

NO	DATE	REVISION	BY	CHKD	DSGN ENGR	ENGR	PROJ MGR	APPR

STARTING DATE	INITIATOR	CHKD	DRAWN	CHKD	PROJECT MNGR
06/01/99	HAGEGEORGE	CH	BRADSHAW	C. TUMLIN	M. SPANGBERG

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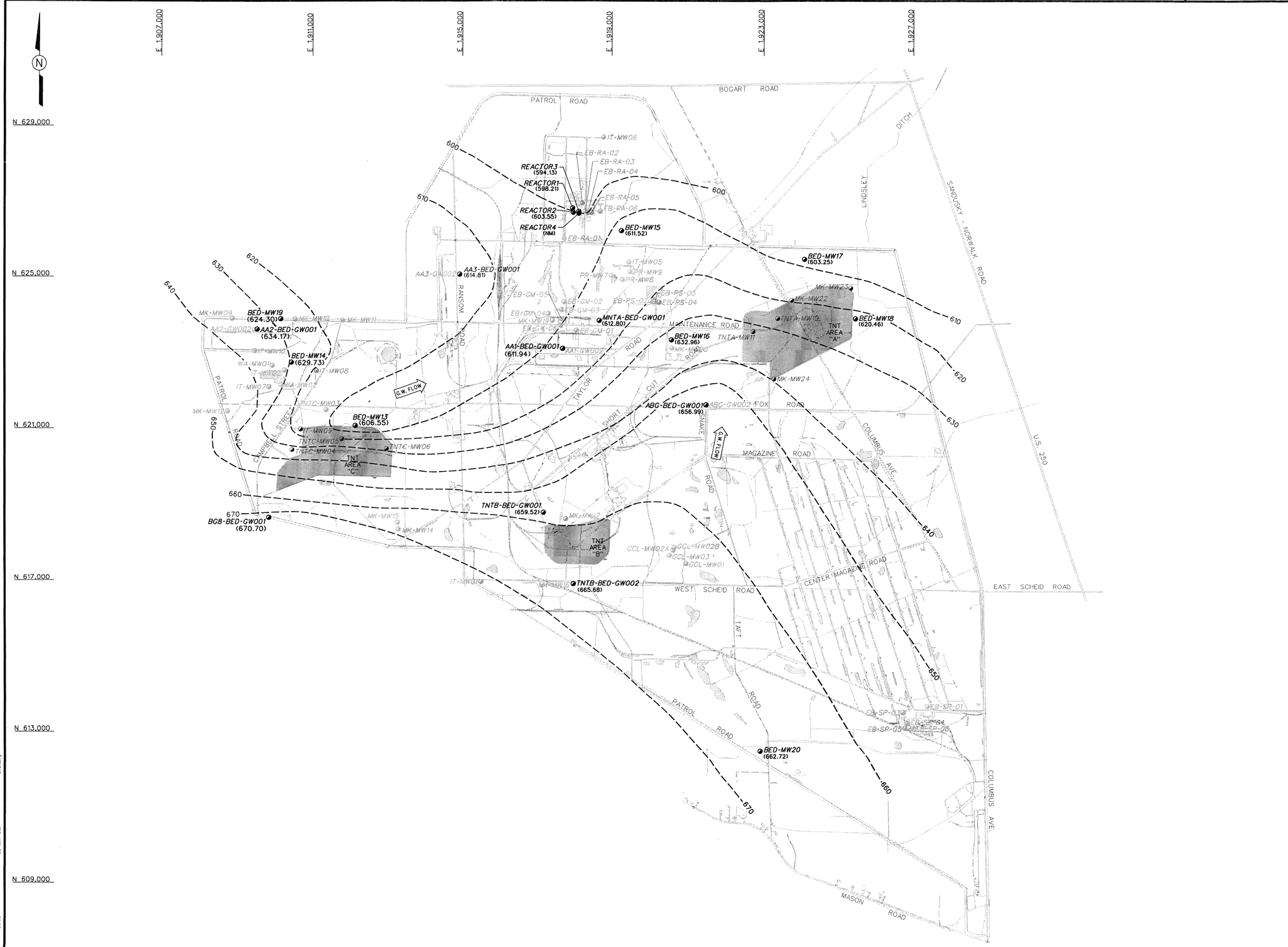
FIGURE 6-7
BEDROCK GROUNDWATER ELEVATION CONTOUR MAP (FEBRUARY 1998)

AREA	JOB NO.	DRAWING NO.	REV
SITEWIDE	771481	771481ES.182	

bradsharg 23 JUN 1999 11:34:29 c:\cad\design\771481es.182



LEGEND:

ABG-BED-GW001	MONITORING WELL LOCATION
MK-MW09 / MK-MW09	OVERBURDEN WELL LOCATION
	BUILDING
	RAILROAD
	SURFACE WATER
	DITCH
	FENCE (PBOW BOUNDARY)
(634.77)	GROUNDWATER ELEVATION (FT-MSL)
(NM)	NOT MEASURED
610	GROUNDWATER ELEVATION CONTOUR
G.W. FLOW	INTERPRETED GROUNDWATER FLOW DIRECTION

NOTES:

1. MONITORING WELLS PB-MW01, PB-MW02, PB-MW03, PB-MW04, AND REACTOR 5 ARE NOT SHOWN (SURVEY COORDINATES NOT AVAILABLE).

SCALE
0 1200 2400 FEET

NO	DATE	REVISION	BY	CHKD	DSGN ENGR	ENGR	PROJ MGR	APPR

STARTING DATE	INITIATOR	CHK'D	DRAWN	CHK'D	PROJECT MNGR
06/01/99	HAGEGEORGE	CH	BRADSHAW	C. TUMLIN	M. SPANGBERG

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SUMMARY REPORT, SITE-WIDE
GROUNDWATER MONITORING (1997-1998)
FORMER PLUM BROOK ORDNANCE WORKS
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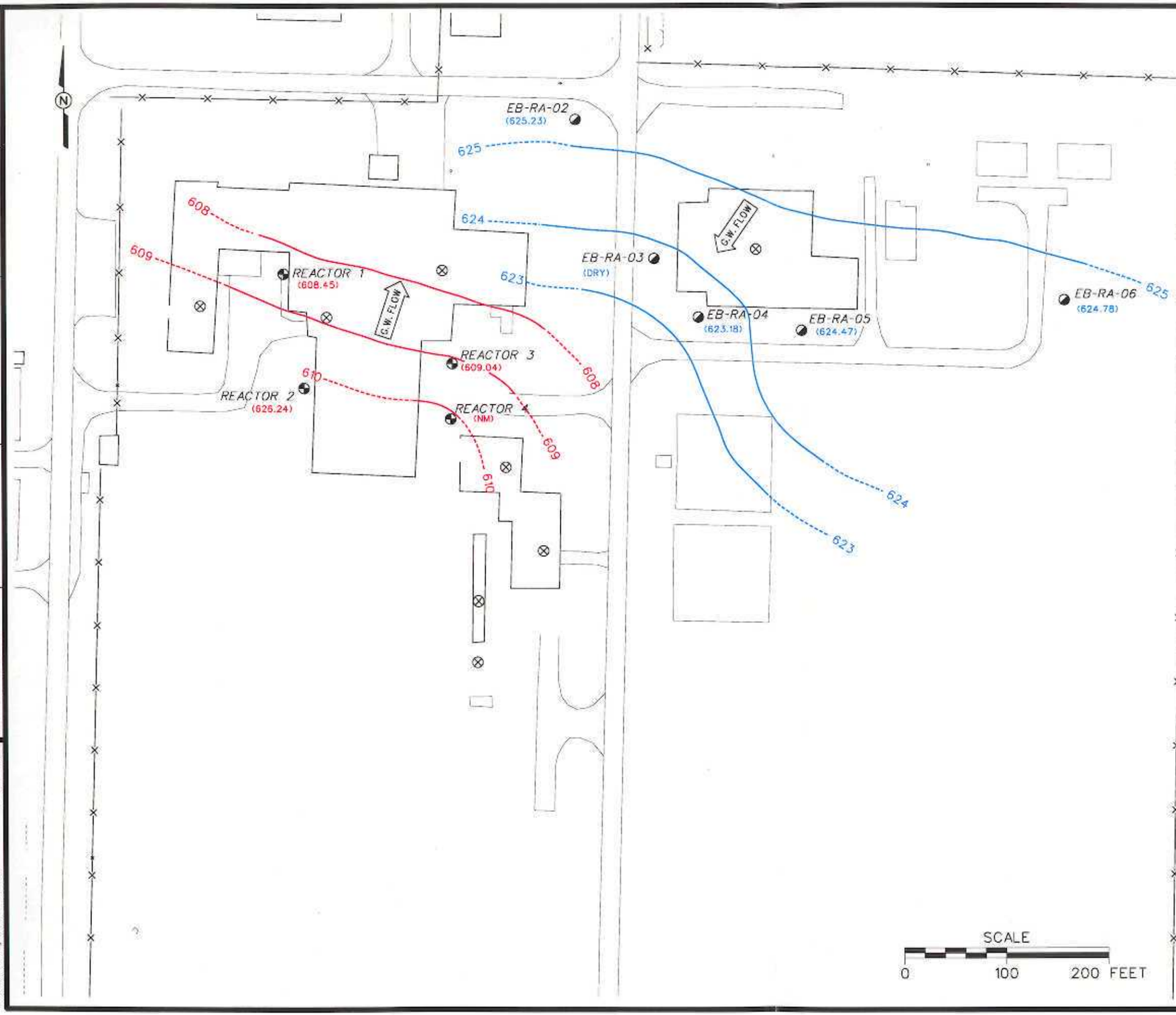
SANDUSKY, OHIO

FIGURE 6-8
BEDROCK GROUNDWATER
ELEVATION CONTOUR MAP
(MAY 1998)

AREA	JOB NO.	DRAWING NO.	REV
SITEWIDE	771481	771481ES.183	

bvanberg 23 JUN 1999 11:35:30 C:\cad\design\771481es.183



LEGEND:

EB-RA-06	OVERBURDEN MONITORING WELL LOCATION
REACTOR 1	BEDROCK MONITORING WELL LOCATION
⊗	SUMP WELL
(608.45)	GROUNDWATER ELEVATION (FT-MSL) IN BEDROCK MONITORING WELLS
610	GROUNDWATER ELEVATION CONTOUR IN BEDROCK MONITORING WELLS
(NM)	NOT MEASURED
(628.18)	GROUNDWATER ELEVATION IN OVERBURDEN MONITORING WELLS (FT-MSL)
623	GROUNDWATER ELEVATION CONTOUR IN OVERBURDEN MONITORING WELLS (FT-MSL)
G.W. FLOW	GROUNDWATER FLOW
	BUILDINGS
	FENCE

NOTES:

1. LOCATIONS OF SUMP WELLS ARE APPROXIMATE. SUMP WELLS HAVE NOT BEEN SURVEYED.
2. GROUNDWATER ELEVATION 626.24 FT OF REACTOR WELL NO. 2 NOT USED DURING CONTOURING.

SCALE

0 100 200 FEET

FIGURE 6-9
GROUNDWATER ELEVATION CONTOUR MAP, REACTOR FACILITY AREA (NOVEMBER 1997)

SUMMARY REPORT, SITE-WIDE GROUNDWATER MONITORING (1997-1998) FORMER PLUM BROOK ORDNANCE WORKS NASA PLUM BROOK STATION SANDUSKY, OHIO

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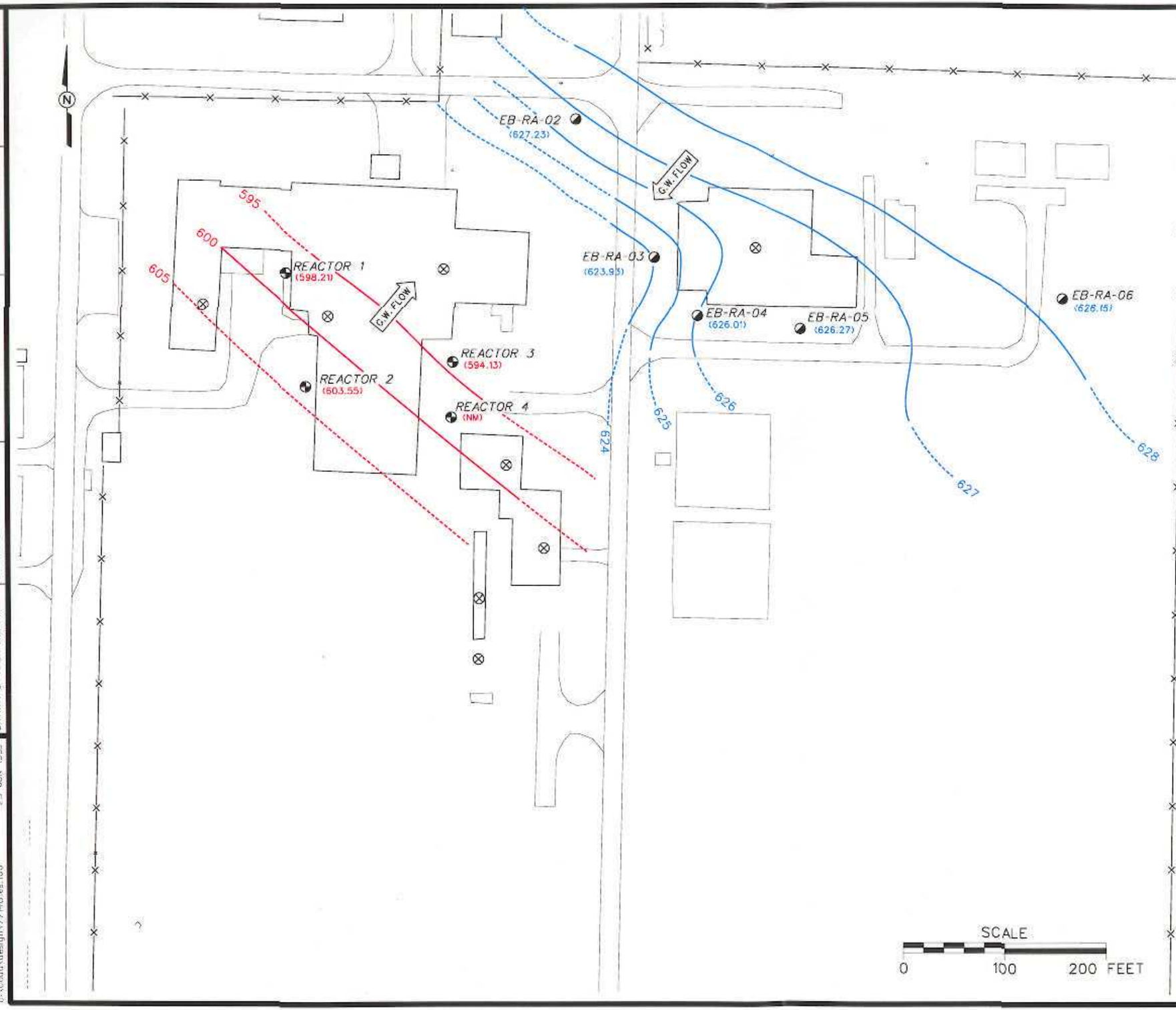
STARTING DATE: 05/26/99 | DATE LAST REV.: | DWG. NO.: 777481ms159
DRAWN BY: B.BADSHAW | DRAWN BY: | PROJ. NO.: 777481
DRAFT. CHCK. BY: C. TUMLIN | INITIAT.GR: HAGEGEORGE
ENGR. CHCK. BY: HAGEGEORGE | PROJ. MGR.: SPANGBERG
23 JUN 1999 11:39:31
by ordering c:\cadd\design\777481ms159



LEGEND:

EB-RA-06	OVERBURDEN MONITORING WELL LOCATION
REACTOR 1	BEDROCK MONITORING WELL LOCATION
⊗	SUMP WELL
(598.21)	GROUNDWATER ELEVATION (FT-MSL) IN BEDROCK MONITORING WELLS
600	GROUNDWATER ELEVATION CONTOUR IN BEDROCK MONITORING WELLS
(NM)	NOT MEASURED
(628.15)	GROUNDWATER ELEVATION IN OVERBURDEN MONITORING WELLS (FT-MSL)
628	GROUNDWATER ELEVATION CONTOUR IN OVERBURDEN MONITORING WELLS (FT-MSL)
C.W. FLOW	GROUNDWATER FLOW
	BUILDINGS
	FENCE

NOTES:

LOCATIONS OF SUMP WELLS ARE APPROXIMATE. SUMP WELLS HAVE NOT BEEN SURVEYED.

FIGURE 6-10
GROUNDWATER ELEVATION CONTOUR MAP, REACTOR FACILITY AREA (MAY 1998)

SUMMARY REPORT, SITE-WIDE GROUNDWATER MONITORING (1997-1998) FORMER PLUM BROOK ORDNANCE WORKS NASA PLUM BROOK STATION SANDUSKY, OHIO

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STARTING DATE: 05/26/99 | DATE LAST REV.:
DRAWN BY: BRADSHAW | DRAWN BY:
DRAFT. CHCK. BY: C. TUMLIN | INITIATOR: HAGEFORDEF | DWG. NO.: 777481es.163
ENGR. CHCK. BY: HAGEFORDEL | PROJ. MGR.: SPANGBERG | PROJ. NO.: 777481
1149-13
23 JUN 1999
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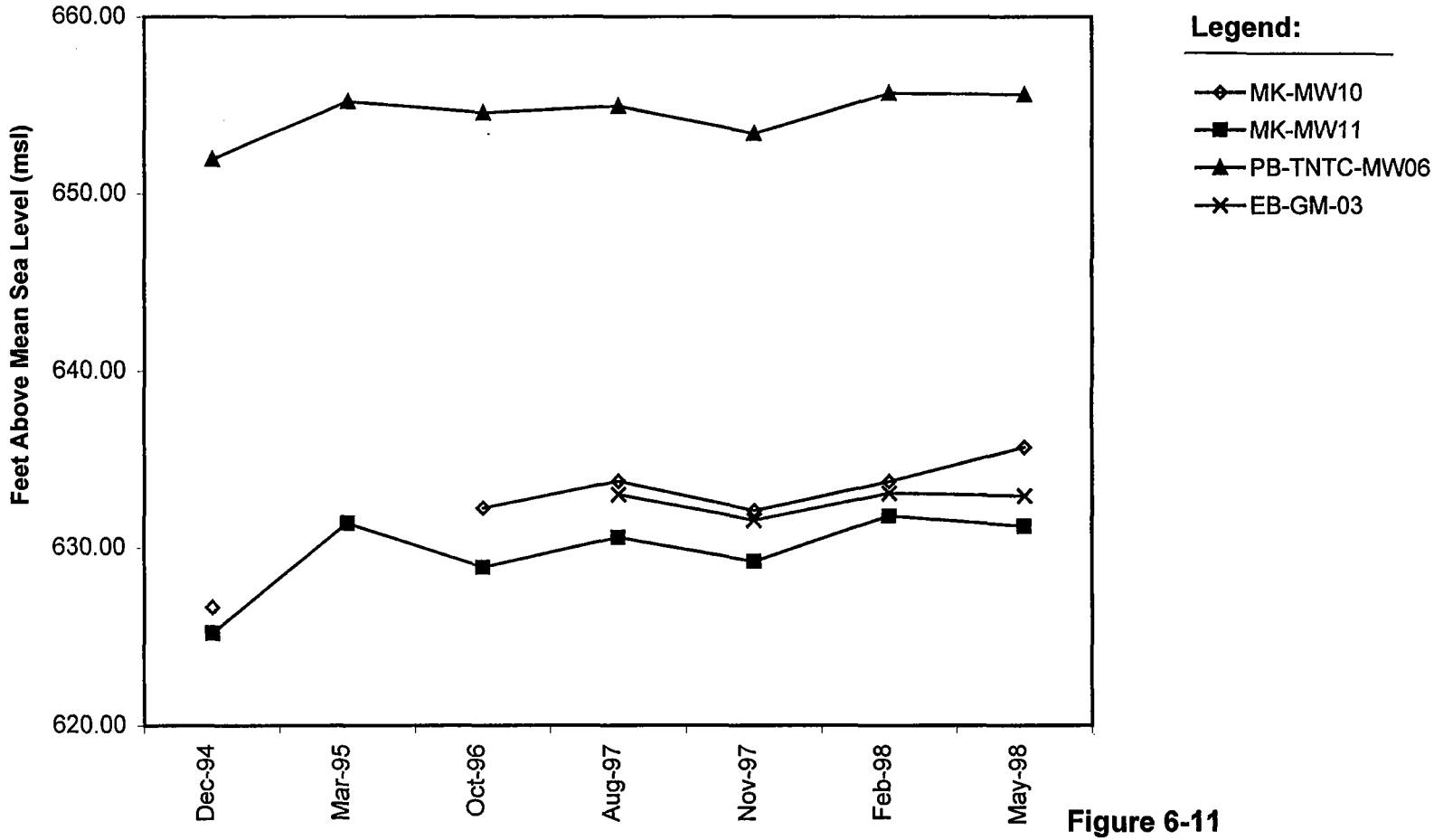

Figure 6-11

Typical Groundwater Elevation Fluctuation, Overburden Wells

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Former Plum Brook Ordnance Works
NASA Plum Brook Station
Sandusky, Ohio

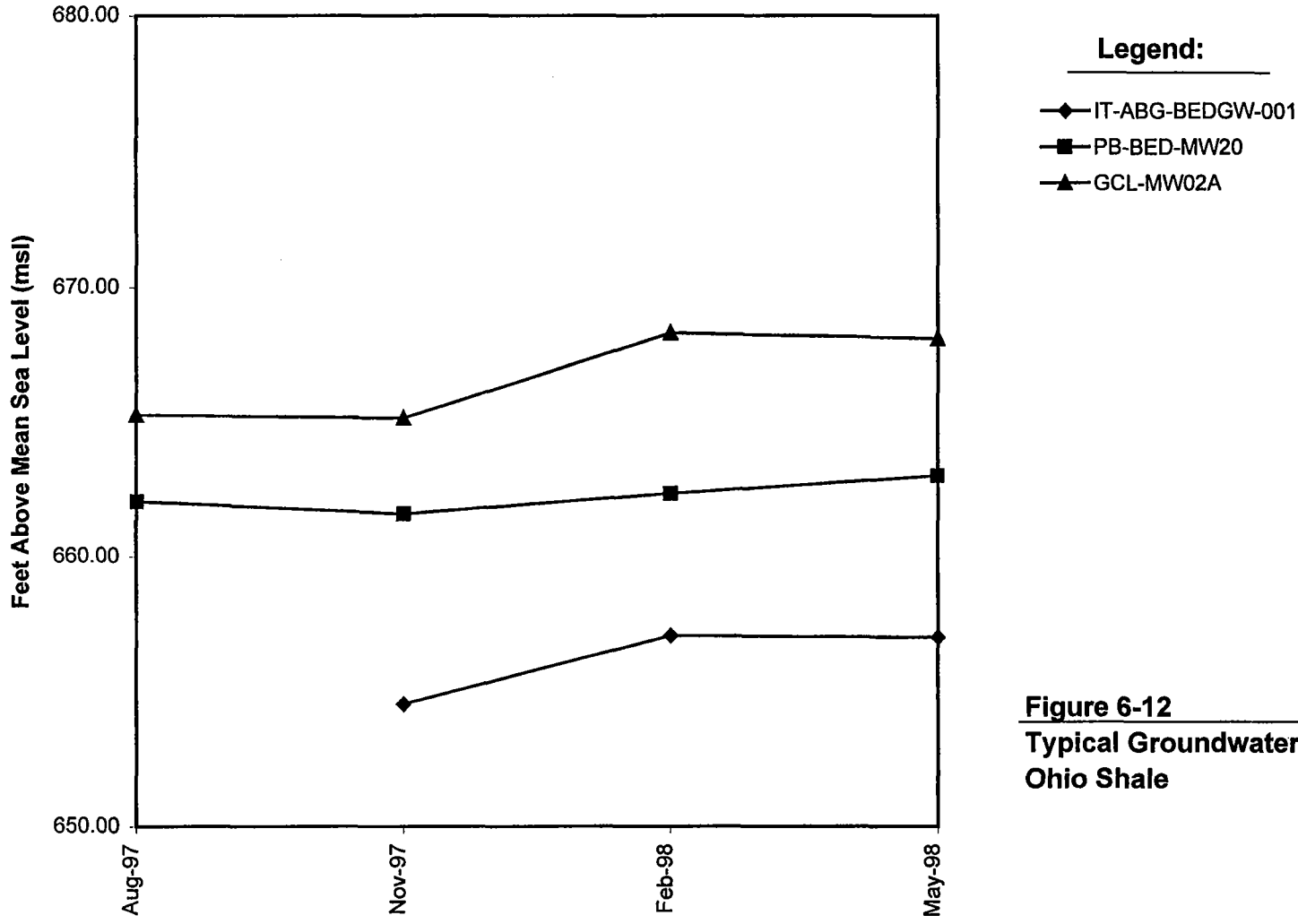

Figure 6-12
Typical Groundwater Fluctuation, Ohio Shale

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Former Plum Brook Ordnance Works
NASA Plum Brook Station
Sandusky, Ohio

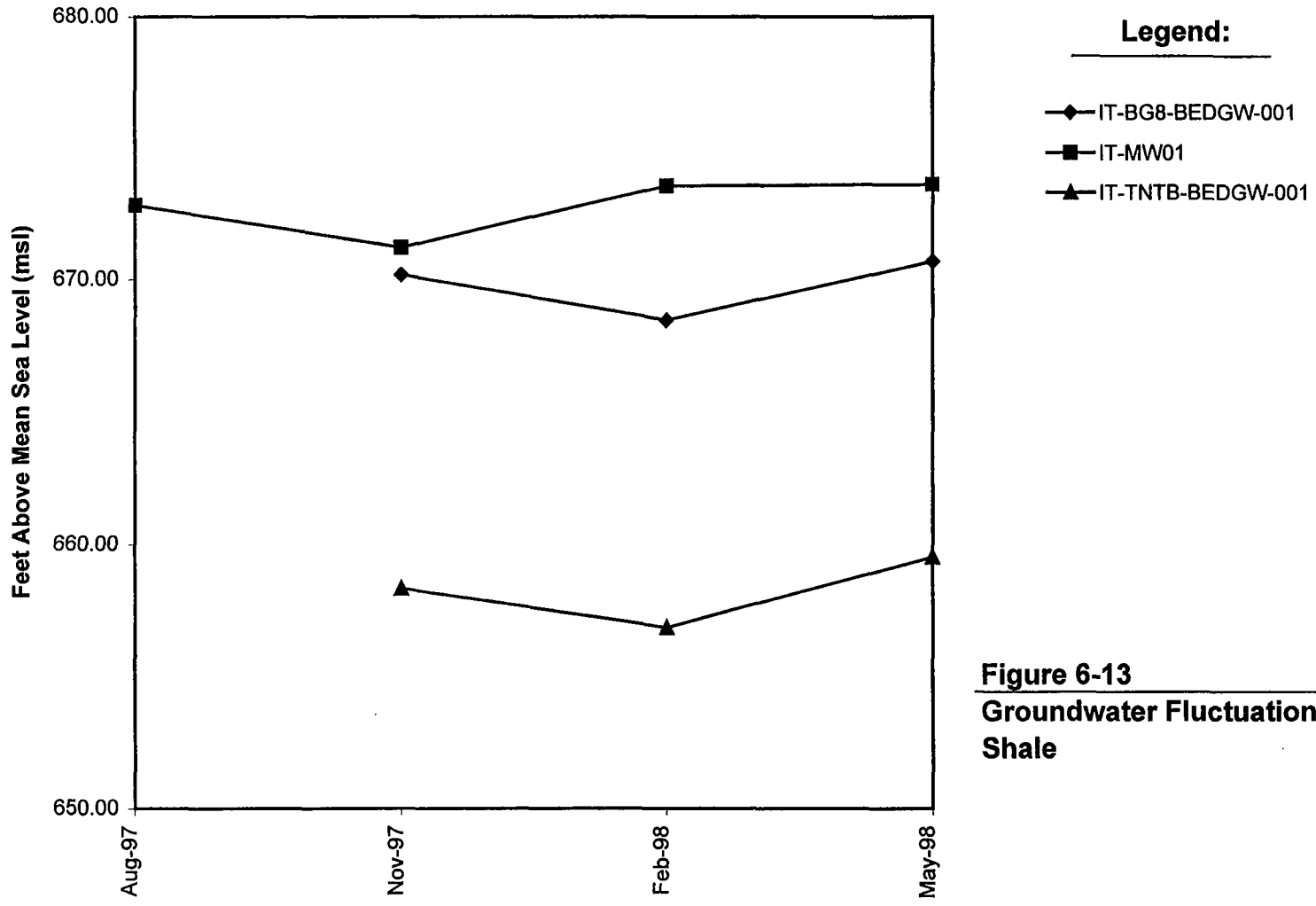

Figure 6-13

Groundwater Fluctuation, Olentangy Shale

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Former Plum Brook Ordnance Works
NASA Plum Brook Station
Sandusky, Ohio

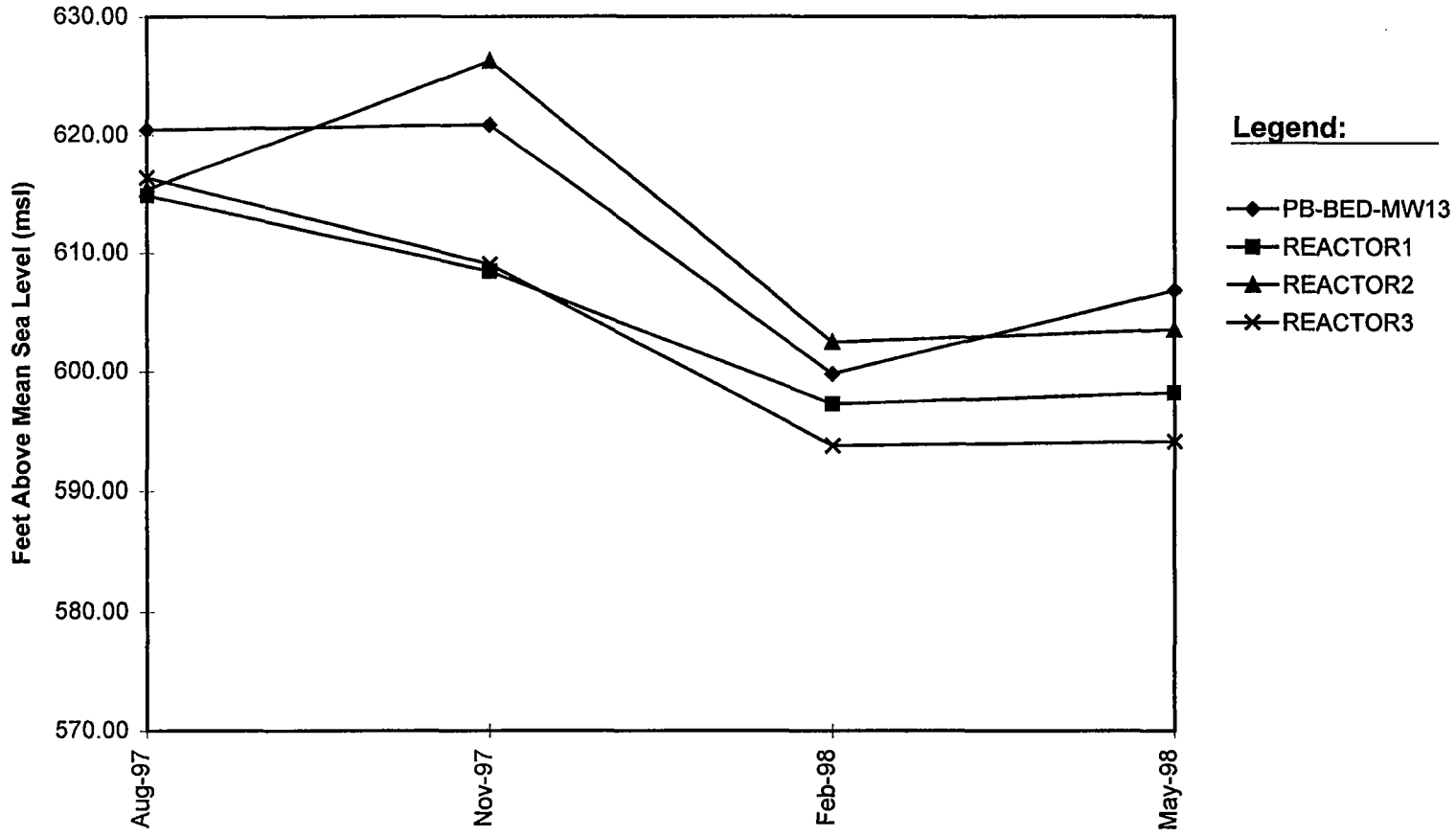

Figure 6-15
Typical Groundwater Fluctuation, Reactor Wells 1, 2, 3 and PB-BED-MW13

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Former Plum Brook Ordnance Works
NASA Plum Brook Station
Sandusky, Ohio

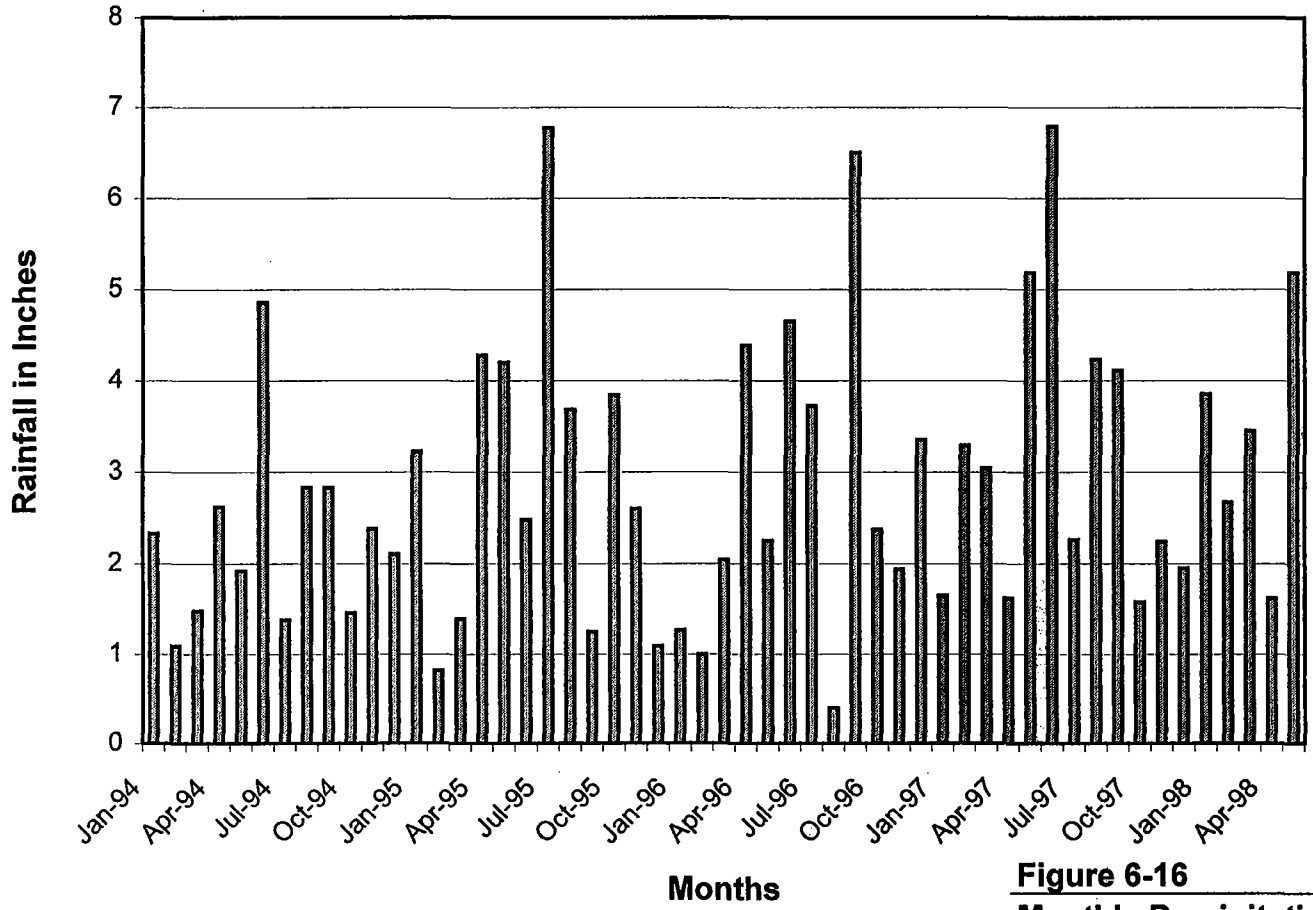

Figure 6-16

Monthly Precipitation Data, January 1994 Through May 1998

IT CORPORATION
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Former Plum Brook Ordnance Works
NASA Plum Brook Station
Sandusky, Ohio

Kn/4379/Mo_rechg(Rainfall)/6/28/99(1:13 PM)

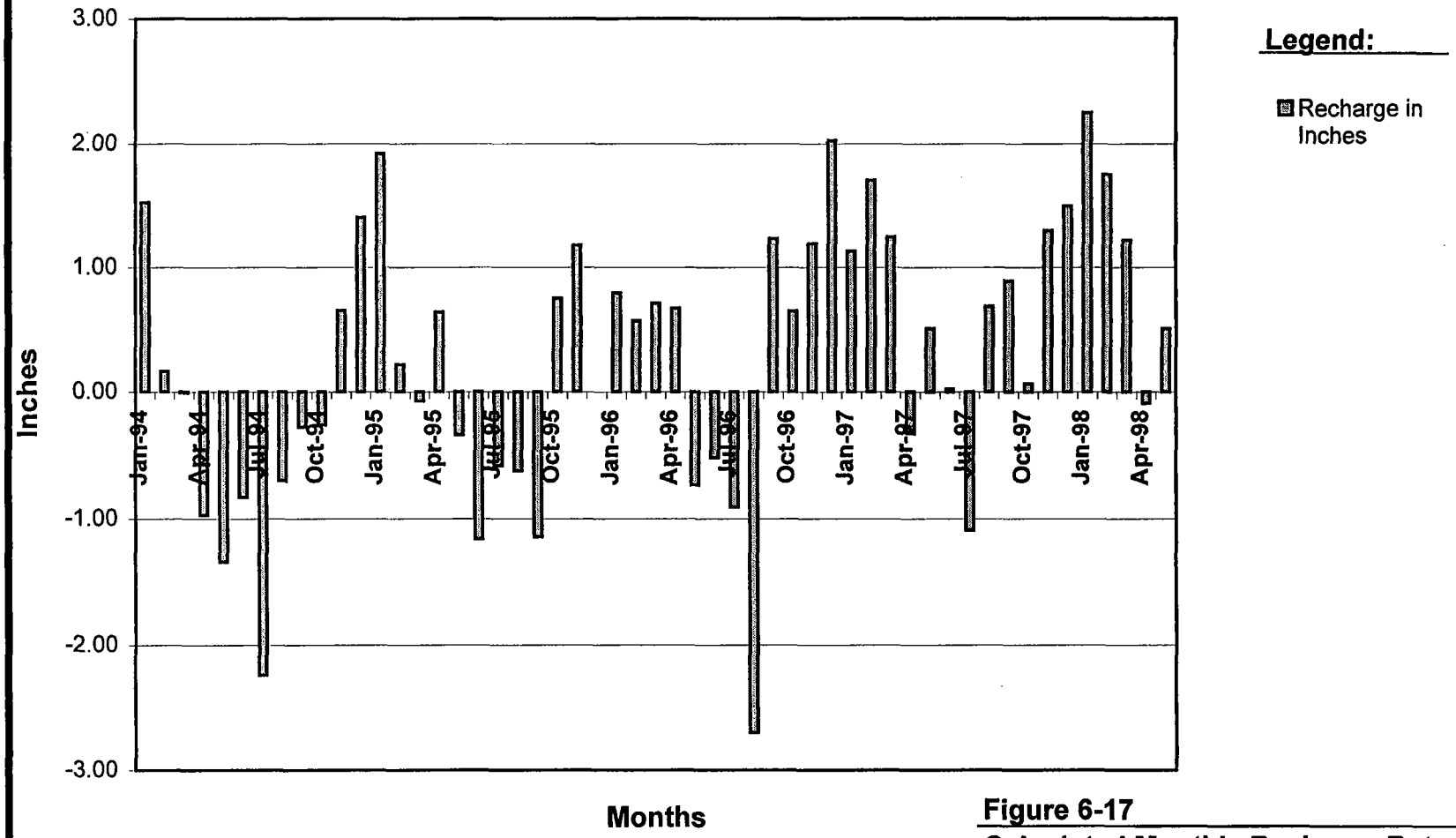

Figure 6-17
Calculated Monthly Recharge Rates at Site

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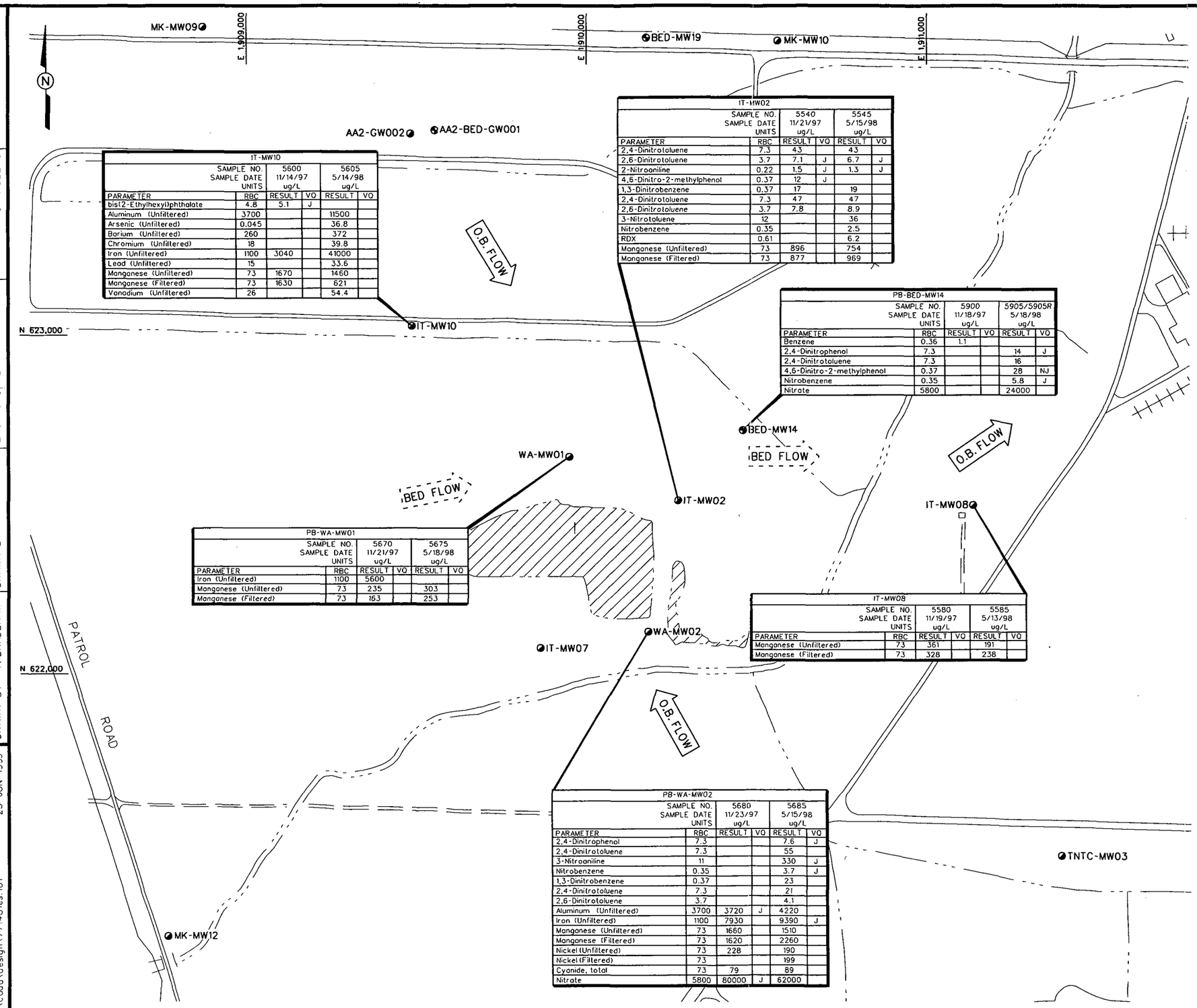
Former Plum Brook Ordnance Works
NASA Plum Brook Station
Sandusky, Ohio

KN/4379/Mo_rechg(Recharge)/6/28/99(1:13 PM)



IT-MW10					
SAMPLE NO.		5600		5605	
SAMPLE DATE		11/14/97		5/14/98	
UNITS		ug/L		ug/L	
PARAMETER	RBC	RESULT	VQ	RESULT	VQ
bis(2-Ethylhexyl)phthalate	4.8	5.1	J		
Aluminum (Unfiltered)	3700			11500	
Arsenic (Unfiltered)	0.045			36.8	
Barium (Unfiltered)	260			372	
Chromium (Unfiltered)	18			39.8	
Iron (Unfiltered)	1100	3040		41000	
Lead (Unfiltered)	15			33.6	
Manganese (Unfiltered)	73	1670		1460	
Manganese (Filtered)	73	1630		621	
Vanadium (Unfiltered)	26			54.4	

IT-MW02					
SAMPLE NO.		5540		5545	
SAMPLE DATE		11/21/97		5/15/98	
UNITS		ug/L		ug/L	
PARAMETER	RBC	RESULT	VQ	RESULT	VQ
2,4-Dinitrotoluene	7.3	43		43	
2,6-Dinitrotoluene	3.7	7.1	J	6.7	J
2-Nitroaniline	0.22	1.5	J	1.3	J
4,6-Dinitro-2-methylphenol	0.37	12	J		
1,3-Dinitrobenzene	0.37	17		19	
2,4-Dinitrotoluene	7.3	47		47	
2,6-Dinitrotoluene	3.7	7.8		8.9	
3-Nitrotoluene	12			36	
Nitrobenzene	0.35			2.5	
RDX	0.61			6.2	
Manganese (Unfiltered)	73	896		754	
Manganese (Filtered)	73	877		969	

PB-BED-MW14					
SAMPLE NO.		5900		5905/5905R	
SAMPLE DATE		11/18/97		5/18/98	
UNITS		ug/L		ug/L	
PARAMETER	RBC	RESULT	VQ	RESULT	VQ
Benzene	0.36	1.1			
2,4-Dinitrophenol	7.3			14	J
2,4-Dinitrotoluene	7.3			16	
4,6-Dinitro-2-methylphenol	0.37			28	NJ
Nitrobenzene	0.35			5.8	J
Nitrate	5800			24000	

PB-WA-MW01					
SAMPLE NO.		5670		5675	
SAMPLE DATE		11/21/97		5/18/98	
UNITS		ug/L		ug/L	
PARAMETER	RBC	RESULT	VQ	RESULT	VQ
Iron (Unfiltered)	1100	5600			
Manganese (Unfiltered)	73	235		303	
Manganese (Filtered)	73	163		253	

IT-MW08					
SAMPLE NO.		5580		5585	
SAMPLE DATE		11/19/97		5/13/98	
UNITS		ug/L		ug/L	
PARAMETER	RBC	RESULT	VQ	RESULT	VQ
Manganese (Unfiltered)	73	361		191	
Manganese (Filtered)	73	328		238	

PB-WA-MW02					
SAMPLE NO.		5680		5685	
SAMPLE DATE		11/23/97		5/15/98	
UNITS		ug/L		ug/L	
PARAMETER	RBC	RESULT	VQ	RESULT	VQ
2,4-Dinitrophenol	7.3			7.6	J
2,4-Dinitrotoluene	7.3			55	
3-Nitroaniline	11			330	J
Nitrobenzene	0.35			3.7	J
1,3-Dinitrobenzene	0.37			23	
2,4-Dinitrotoluene	7.3			21	
2,6-Dinitrotoluene	3.7			4.1	
Aluminum (Unfiltered)	3700	3720	J	4220	
Iron (Unfiltered)	1100	7930		9390	J
Manganese (Unfiltered)	73	1660		1510	
Manganese (Filtered)	73	1620		2260	
Nickel (Unfiltered)	73	228		190	
Nickel (Filtered)	73			199	
Cyanide, total	73	79		89	
Nitrate	5800	80000	J	62000	

LEGEND:

- IT-MW02 — OVERBURDEN MONITORING WELL LOCATION
- BED-MW14 — BEDROCK MONITORING WELL LOCATION
- BUILDINGS
- RAILROAD
- SURFACE WATER
- DITCH
- FENCE
- O.B. FLOW — OVERBURDEN GROUNDWATER FLOW DIRECTION
- BED FLOW — BEDROCK GROUNDWATER FLOW DIRECTION

NOTES:

1. ANALYTICAL RESULTS HAVE BEEN BLANK CORRECTED.
2. GROUNDWATER FLOW DIRECTION ON MAY 5, 1998.

SCALE

0 300 600 FEET

FIGURE 6-18
DETECTED CONSTITUENTS AT WEST AREA RED WATER PONDS ABOVE RBCs IN OVERBURDEN/BEDROCK WELLS
(NOVEMBER 1997 & MAY 1998)

SUMMARY REPORT, SITE-WIDE GROUNDWATER MONITORING (1997-1998)
FORMER PLUM BROOK ORDNANCE WORKS
NASA PLUM BROOK STATION
SANDUSKY, OHIO

IT CORPORATION
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DWG. NO.: ...\771481es.161 | PROJ. NO.: 771481
INITIATOR: HAGEGEORGE | PROJ. MGR.: SPANGBERG
DRAFT. CHCK. BY: C. TUMLIN | ENGR. CHCK. BY: HAGEGEORGE
DATE LAST REV.: | DRAWN BY:
STARTING DATE: 05/26/99 | DRAWN BY: T. BRADSHAW
13:22:23 23 JUN 1999
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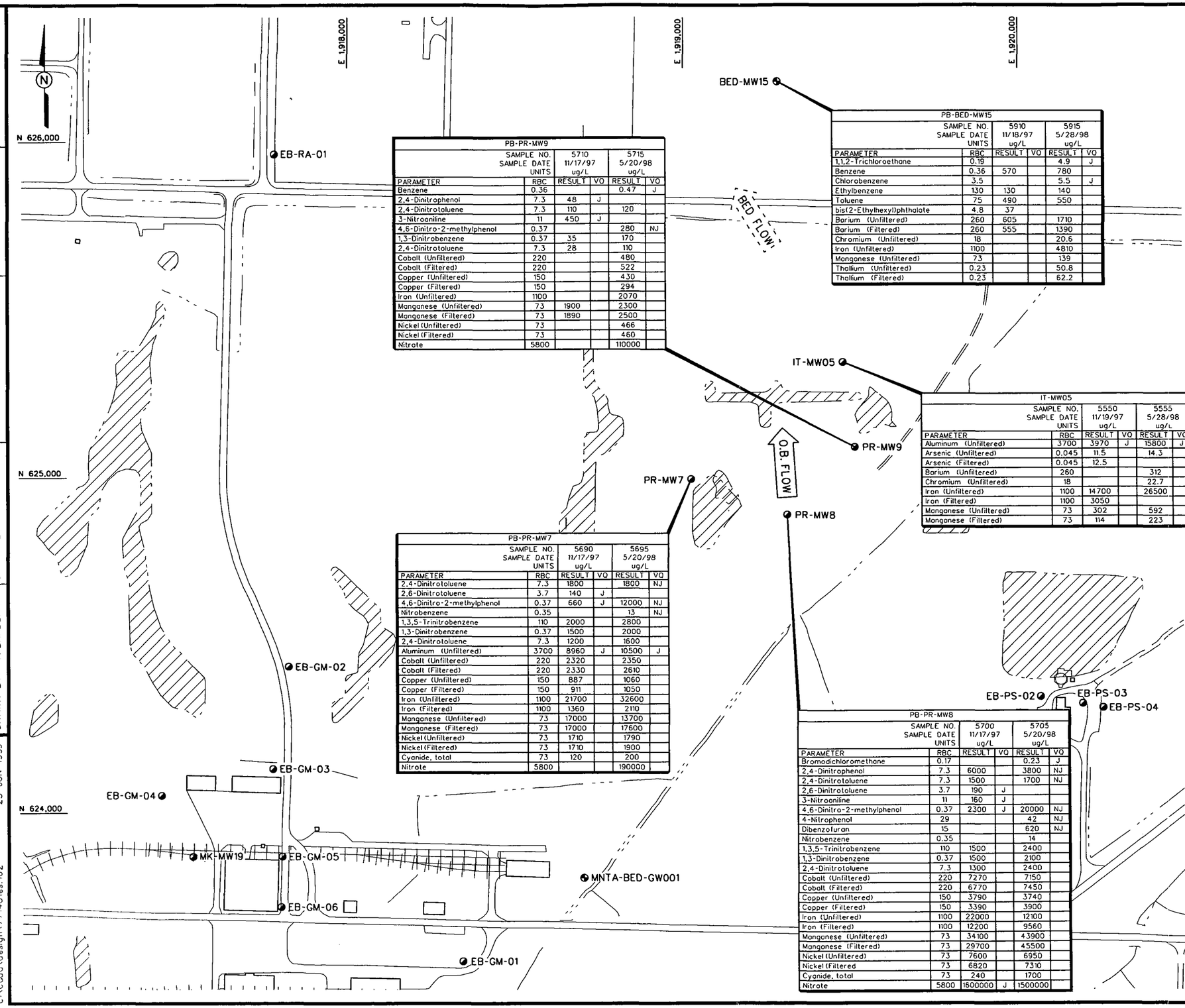


PB-PR-MW9					
SAMPLE NO.		5710		5715	
SAMPLE DATE		11/17/97		5/20/98	
UNITS		ug/L		ug/L	
PARAMETER	RBC	RESULT	VQ	RESULT	VQ
Benzene	0.36			0.47	J
2,4-Dinitrophenol	7.3	48	J		
2,4-Dinitrotoluene	7.3	110		120	
3-Nitroaniline	11	450	J		
4,6-Dinitro-2-methylphenol	0.37			280	NJ
1,3-Dinitrobenzene	0.37	35		170	
2,4-Dinitrotoluene	7.3	28		110	
Cobalt (Unfiltered)	220			480	
Cobalt (Filtered)	220			522	
Copper (Unfiltered)	150			430	
Copper (Filtered)	150			294	
Iron (Unfiltered)	1100			2070	
Manganese (Unfiltered)	73	1900		2300	
Manganese (Filtered)	73	1890		2500	
Nickel (Unfiltered)	73			466	
Nickel (Filtered)	73			460	
Nitrate	5800			110000	

PB-BED-MW15					
SAMPLE NO.		5910		5915	
SAMPLE DATE		11/18/97		5/28/98	
UNITS		ug/L		ug/L	
PARAMETER	RBC	RESULT	VQ	RESULT	VQ
1,1,2-Trichloroethane	0.19			4.9	J
Benzene	0.36	570		780	
Chlorobenzene	3.5			5.5	J
Ethylbenzene	130	130		140	
Toluene	75	490		550	
bis(2-Ethylhexyl)phthalate	4.8	37			
Barium (Unfiltered)	260	605		1710	
Barium (Filtered)	260	555		1390	
Chromium (Unfiltered)	18			20.6	
Iron (Unfiltered)	1100			4610	
Manganese (Unfiltered)	73			139	
Thallium (Unfiltered)	0.23			50.8	
Thallium (Filtered)	0.23			62.2	

IT-MW05					
SAMPLE NO.		5550		5555	
SAMPLE DATE		11/19/97		5/28/98	
UNITS		ug/L		ug/L	
PARAMETER	RBC	RESULT	VQ	RESULT	VQ
Aluminum (Unfiltered)	3700	3970	J	15800	J
Arsenic (Unfiltered)	0.045	11.5		14.3	
Arsenic (Filtered)	0.045	12.5			
Barium (Unfiltered)	260			312	
Chromium (Unfiltered)	18			22.7	
Iron (Unfiltered)	1100	14700		26500	
Iron (Filtered)	1100	3050			
Manganese (Unfiltered)	73	302		592	
Manganese (Filtered)	73	114		223	

PB-PR-MW7					
SAMPLE NO.		5690		5695	
SAMPLE DATE		11/17/97		5/20/98	
UNITS		ug/L		ug/L	
PARAMETER	RBC	RESULT	VQ	RESULT	VQ
2,4-Dinitrotoluene	7.3	1800		1800	NJ
2,6-Dinitrotoluene	3.7	140	J		
4,6-Dinitro-2-methylphenol	0.37	660	J	12000	NJ
Nitrobenzene	0.35			13	NJ
1,3,5-Trinitrobenzene	110	2000		2800	
1,3-Dinitrobenzene	0.37	1500		2000	
2,4-Dinitrotoluene	7.3	1200		1600	
Aluminum (Unfiltered)	3700	8960	J	10500	J
Cobalt (Unfiltered)	220	2320		2350	
Cobalt (Filtered)	220	2330		2610	
Copper (Unfiltered)	150	887		1060	
Copper (Filtered)	150	911		1050	
Iron (Unfiltered)	1100	21700		32600	
Iron (Filtered)	1100	1360		2110	
Manganese (Unfiltered)	73	17000		13700	
Manganese (Filtered)	73	17000		17600	
Nickel (Unfiltered)	73	1710		1790	
Nickel (Filtered)	73	1710		1900	
Cyanide, total	73	120		200	
Nitrate	5800			190000	

PB-PR-MW8					
SAMPLE NO.		5700		5705	
SAMPLE DATE		11/17/97		5/20/98	
UNITS		ug/L		ug/L	
PARAMETER	RBC	RESULT	VQ	RESULT	VQ
Bromodichloromethane	0.17			0.23	J
2,4-Dinitrophenol	7.3	6000		3800	NJ
2,4-Dinitrotoluene	7.3	1500		1700	NJ
2,6-Dinitrotoluene	3.7	190	J		
3-Nitroaniline	11	160	J		
4,6-Dinitro-2-methylphenol	0.37	2300	J	20000	NJ
4-Nitrophenol	29			42	NJ
Dibenzofuran	15			620	NJ
Nitrobenzene	0.35			14	
1,3,5-Trinitrobenzene	110	1500		2400	
1,3-Dinitrobenzene	0.37	1500		2100	
2,4-Dinitrotoluene	7.3	1300		2400	
Cobalt (Unfiltered)	220	7270		7150	
Cobalt (Filtered)	220	6770		7450	
Copper (Unfiltered)	150	3790		3740	
Copper (Filtered)	150	3390		3900	
Iron (Unfiltered)	1100	22000		12100	
Iron (Filtered)	1100	12200		9560	
Manganese (Unfiltered)	73	34100		43900	
Manganese (Filtered)	73	29700		45500	
Nickel (Unfiltered)	73	7600		6950	
Nickel (Filtered	73	6820		7310	
Cyanide, total	73	240		1700	
Nitrate	5800	1600000	J	1500000	

LEGEND:

- IT-MW05 — OVERBURDEN MONITORING WELL LOCATION
- BED-MW15 — BEDROCK MONITORING WELL LOCATION
- BUILDINGS
- RAILROAD
- SURFACE WATER
- DITCH
- FENCE
- O.B. FLOW — OVERBURDEN GROUNDWATER FLOW DIRECTION
- BED FLOW — BEDROCK GROUNDWATER FLOW DIRECTION

NOTES:

1. ANALYTICAL RESULTS HAVE BEEN BLANK CORRECTED.
2. GROUNDWATER FLOW DIRECTION ON MAY 5, 1998.

SCALE

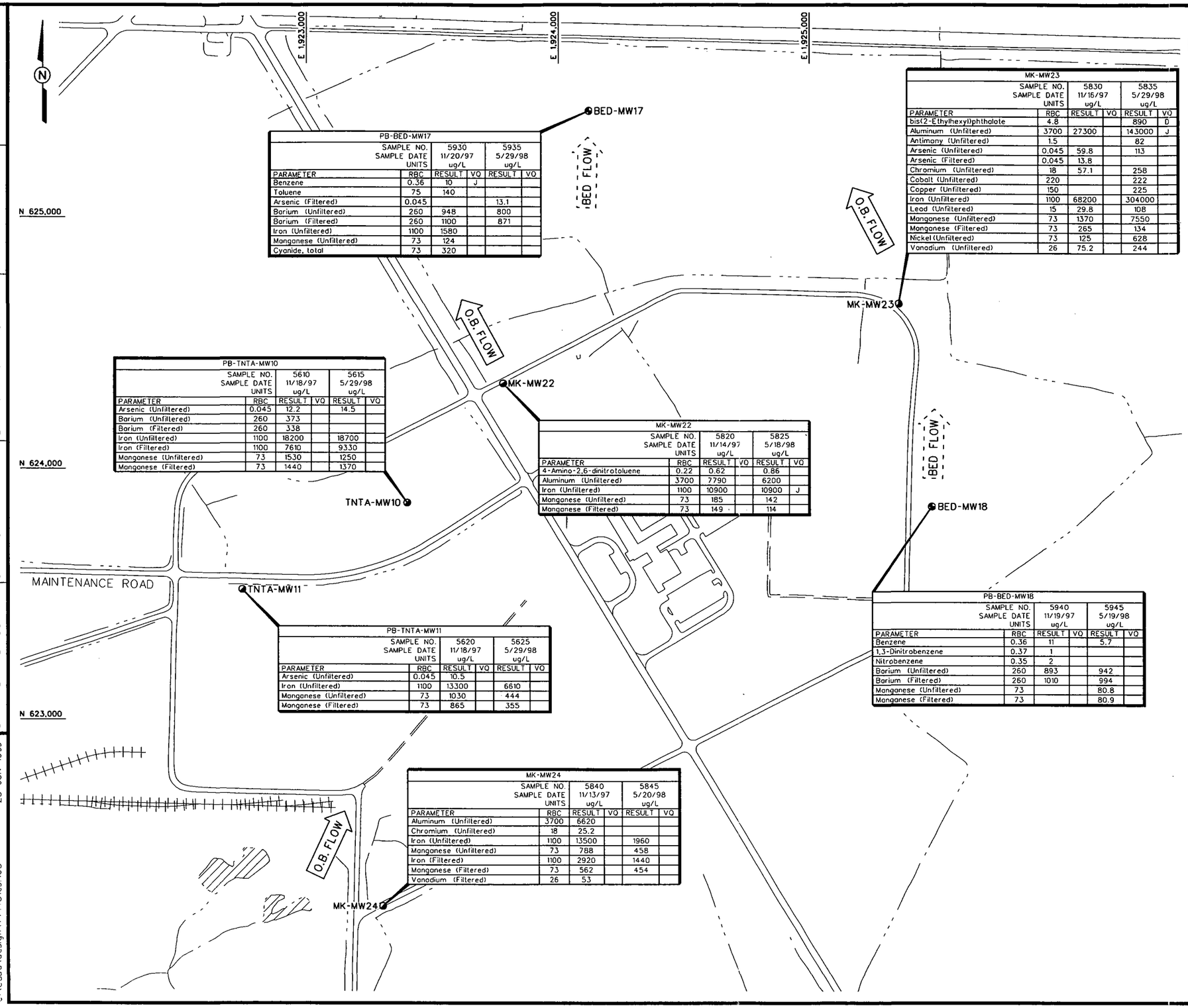
0 300 600 FEET

FIGURE 6-19
DETECTED CONSTITUENTS AT PENTOLITE ROAD RED WATER PONDS ABOVE RBCs IN OVERBURDEN/BEDROCK WELLS (NOVEMBER 1997 & MAY 1998)

SUMMARY REPORT, SITE-WIDE GROUNDWATER MONITORING (1997-1998)
FORMER PLUM BROOK ORDNANCE WORKS
NASA PLUM BROOK STATION
SANDUSKY, OHIO

IT CORPORATION
A Member of The IT Group

DWG. NO.: ...\771481es.162 | PROJ. NO.: 771481
INITIATOR: HAGEGEORGE | PROJ. MGR.: SPANGBERG
DRAFT. CHCK. BY: C. TUMLIN | ENGR. CHCK. BY: HAGEGEORGE
DATE LAST REV.: | DRAWN BY:
STARTING DATE: 05/26/99 | DRAWN BY: T. BRADSHAW
13:23:00 23 JUN 1999
bvanderg c:\cadd\design\771481es.162



PB-BED-MW17					
SAMPLE NO.		5930		5935	
SAMPLE DATE		11/20/97		5/29/98	
UNITS		ug/L		ug/L	
PARAMETER	RBC	RESULT	VQ	RESULT	VQ
Benzene	0.36	10	J		
Toluene	75	140			
Arsenic (Filtered)	0.045			13.1	
Barium (Unfiltered)	260	948		800	
Barium (Filtered)	260	1100		871	
Iron (Unfiltered)	1100	1580			
Manganese (Unfiltered)	73	124			
Cyanide, total	73	320			

MK-MW23					
SAMPLE NO.		5830		5835	
SAMPLE DATE		11/15/97		5/29/98	
UNITS		ug/L		ug/L	
PARAMETER	RBC	RESULT	VQ	RESULT	VQ
bis(2-Ethylhexyl)phthalate	4.8			890	D
Aluminum (Unfiltered)	3700	27300		143000	J
Antimony (Unfiltered)	1.5			82	
Arsenic (Unfiltered)	0.045	59.8		113	
Arsenic (Filtered)	0.045	13.8			
Chromium (Unfiltered)	18	57.1		258	
Cobalt (Unfiltered)	220			222	
Copper (Unfiltered)	150			225	
Iron (Unfiltered)	1100	68200		304000	
Lead (Unfiltered)	15	29.8		108	
Manganese (Unfiltered)	73	1370		7550	
Manganese (Filtered)	73	265		134	
Nickel (Unfiltered)	73	125		628	
Vanadium (Unfiltered)	26	75.2		244	

PB-TNTA-MW10					
SAMPLE NO.		5610		5615	
SAMPLE DATE		11/18/97		5/29/98	
UNITS		ug/L		ug/L	
PARAMETER	RBC	RESULT	VQ	RESULT	VQ
Arsenic (Unfiltered)	0.045	12.2		14.5	
Barium (Unfiltered)	260	373			
Barium (Filtered)	260	338			
Iron (Unfiltered)	1100	18200		18700	
Iron (Filtered)	1100	7610		9330	
Manganese (Unfiltered)	73	1530		1250	
Manganese (Filtered)	73	1440		1370	

MK-MW22					
SAMPLE NO.		5820		5825	
SAMPLE DATE		11/14/97		5/18/98	
UNITS		ug/L		ug/L	
PARAMETER	RBC	RESULT	VQ	RESULT	VQ
4-Amino-2,6-dinitrotoluene	0.22	0.62		0.86	
Aluminum (Unfiltered)	3700	7790		6200	
Iron (Unfiltered)	1100	10900		10900	J
Manganese (Unfiltered)	73	185		142	
Manganese (Filtered)	73	149		114	

PB-TNTA-MW11					
SAMPLE NO.		5620		5625	
SAMPLE DATE		11/18/97		5/29/98	
UNITS		ug/L		ug/L	
PARAMETER	RBC	RESULT	VQ	RESULT	VQ
Arsenic (Unfiltered)	0.045	10.5			
Iron (Unfiltered)	1100	13300		6610	
Manganese (Unfiltered)	73	1030		444	
Manganese (Filtered)	73	865		355	

PB-BED-MW18					
SAMPLE NO.		5940		5945	
SAMPLE DATE		11/19/97		5/19/98	
UNITS		ug/L		ug/L	
PARAMETER	RBC	RESULT	VQ	RESULT	VQ
Benzene	0.36	11		5.7	
1,3-Dinitrobenzene	0.37	1			
Nitrobenzene	0.35	2			
Barium (Unfiltered)	260	893		942	
Barium (Filtered)	260	1010		994	
Manganese (Unfiltered)	73			80.8	
Manganese (Filtered)	73			80.9	

MK-MW24					
SAMPLE NO.		5840		5845	
SAMPLE DATE		11/13/97		5/20/98	
UNITS		ug/L		ug/L	
PARAMETER	RBC	RESULT	VQ	RESULT	VQ
Aluminum (Unfiltered)	3700	6620			
Chromium (Unfiltered)	18	25.2			
Iron (Unfiltered)	1100	13500		1960	
Manganese (Unfiltered)	73	788		458	
Iron (Filtered)	1100	2920		1440	
Manganese (Filtered)	73	562		454	
Vanadium (Filtered)	26	53			

LEGEND:

- MK-MW22 — OVERBURDEN MONITORING WELL LOCATION
- ABG-BED-GW001 — BEDROCK MONITORING WELL LOCATION
- BUILDINGS
- RAILROAD
- SURFACE WATER
- DITCH
- FENCE
- O.B. FLOW — OVERBURDEN GROUNDWATER FLOW DIRECTION
- BED FLOW — BEDROCK GROUNDWATER FLOW DIRECTION

NOTES:

1. ANALYTICAL RESULTS HAVE BEEN BLANK CORRECTED.
2. GROUNDWATER FLOW DIRECTION ON MAY 5, 1998.

SCALE

0 400 800 FEET

FIGURE 6-20
DETECTED CONSTITUENTS AT TNT MANUFACTURING AREA A ABOVE RBCs IN OVERBURDEN/BEDROCK WELLS
(NOVEMBER 1997 & MAY 1998)

SUMMARY REPORT, SITE-WIDE GROUNDWATER MONITORING (1997-1998)
FORMER PLUM BROOK ORDNANCE WORKS
NASA PLUM BROOK STATION
SANDUSKY, OHIO

IT CORPORATION
A Member of The IT Group

DWG. NO.: ...\771481es.163
PROJ. NO.: 771481
INITIATOR: HAGEGEORGE
PROJ. MGR.: SPANGBERG
DRAFT. CHCK. BY: C. TUMLIN
ENGR. CHCK. BY: HAGEGEORGE
DATE LAST REV.:
DRAWN BY:
STARTING DATE: 05/26/99
DRAWN BY: T. BRADSHAW
13:23:37 23 JUN 1999
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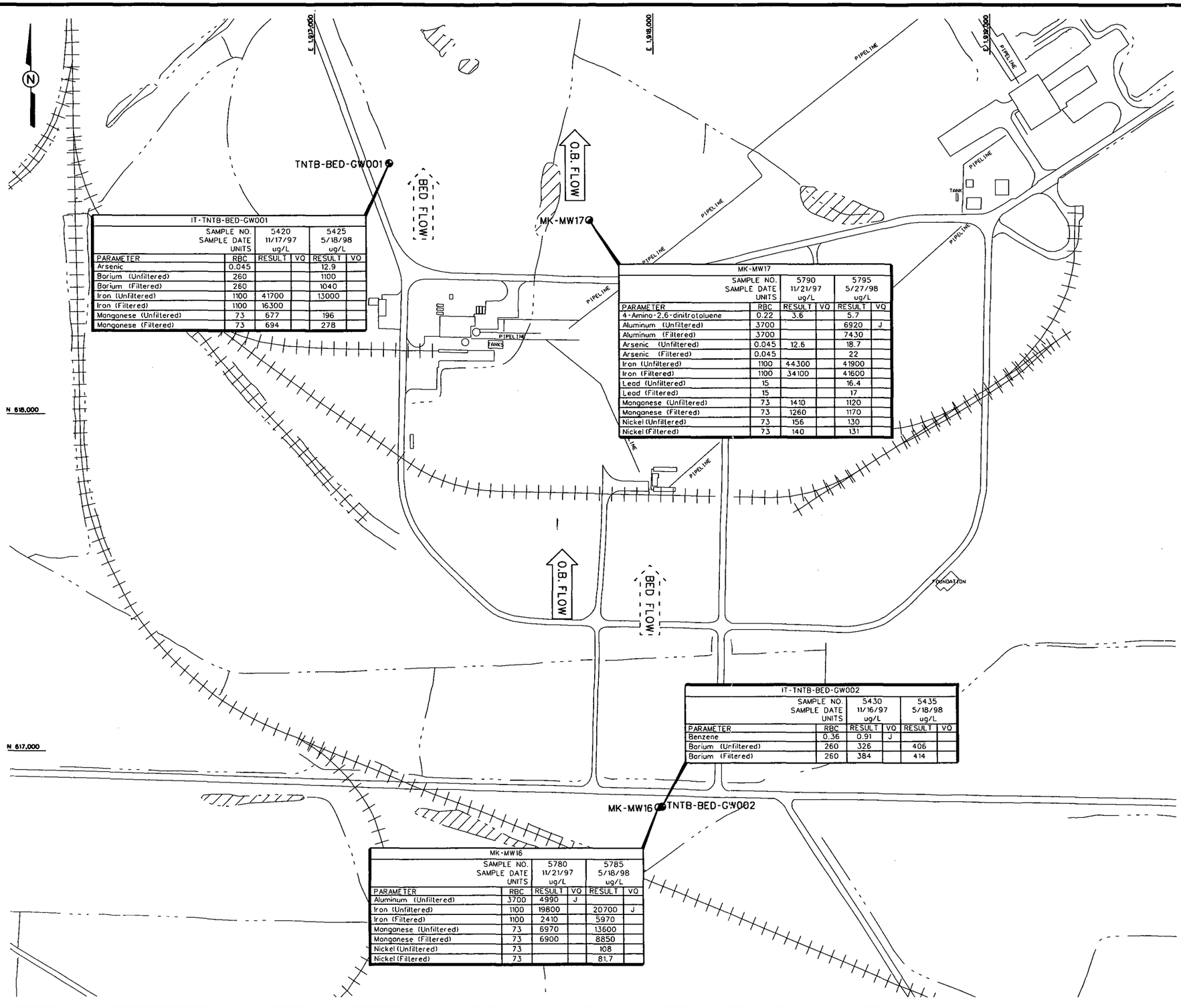

IT-TNTB-BED-GW001					
SAMPLE NO.		5420		5425	
SAMPLE DATE		11/17/97		5/18/98	
UNITS		ug/L		ug/L	
PARAMETER	RBC	RESULT	VQ	RESULT	VQ
Arsenic	0.045			12.9	
Barium (Unfiltered)	260			1100	
Barium (Filtered)	260			1040	
Iron (Unfiltered)	1100	41700		13000	
Iron (Filtered)	1100	16300			
Manganese (Unfiltered)	73	677		196	
Manganese (Filtered)	73	694		278	

MK-MW17					
SAMPLE NO.		5790		5795	
SAMPLE DATE		11/21/97		5/27/98	
UNITS		ug/L		ug/L	
PARAMETER	RBC	RESULT	VQ	RESULT	VQ
4-Amino-2,6-dinitrotoluene	0.22	3.6		5.7	
Aluminum (Unfiltered)	3700			6920	J
Aluminum (Filtered)	3700			7430	
Arsenic (Unfiltered)	0.045	12.6		18.7	
Arsenic (Filtered)	0.045			22	
Iron (Unfiltered)	1100	44300		41900	
Iron (Filtered)	1100	34100		41600	
Lead (Unfiltered)	15			16.4	
Lead (Filtered)	15			17	
Manganese (Unfiltered)	73	1410		1120	
Manganese (Filtered)	73	1260		1170	
Nickel (Unfiltered)	73	156		130	
Nickel (Filtered)	73	140		131	

IT-TNTB-BED-GW002					
SAMPLE NO.		5430		5435	
SAMPLE DATE		11/16/97		5/18/98	
UNITS		ug/L		ug/L	
PARAMETER	RBC	RESULT	VQ	RESULT	VQ
Benzene	0.36	0.91	J		
Barium (Unfiltered)	260	326		406	
Barium (Filtered)	260	384		414	

MK-MW16					
SAMPLE NO.		5780		5785	
SAMPLE DATE		11/21/97		5/18/98	
UNITS		ug/L		ug/L	
PARAMETER	RBC	RESULT	VQ	RESULT	VQ
Aluminum (Unfiltered)	3700	4990	J		
Iron (Unfiltered)	1100	19800		20700	J
Iron (Filtered)	1100	2410		5970	
Manganese (Unfiltered)	73	6970		13600	
Manganese (Filtered)	73	6900		8850	
Nickel (Unfiltered)	73			108	
Nickel (Filtered)	73			81.7	

LEGEND:

- MK-MW16 — OVERBURDEN MONITORING WELL LOCATION
- IT-TNTB-BED-GW002 — BEDROCK MONITORING WELL LOCATION
- BUILDINGS
- RAILROAD
- SURFACE WATER
- DITCH
- O.B. FLOW — OVERBURDEN GROUNDWATER FLOW DIRECTION
- BED FLOW — BEDROCK GROUNDWATER FLOW DIRECTION

NOTES:

1. ANALYTICAL RESULTS HAVE BEEN BLANK CORRECTED.
2. GROUNDWATER FLOW DIRECTION ON MAY 5, 1998.

SCALE

0 300 600 FEET

FIGURE 6-21
DETECTED CONSTITUENTS AT TNT MANUFACTURING AREA B ABOVE RBCs IN OVERBURDEN/BEDROCK WELLS
(NOVEMBER 1997 & MAY 1998)

SUMMARY REPORT, SITE-WIDE GROUNDWATER MONITORING (1997-1998)
FORMER PLUM BROOK ORDNANCE WORKS
NASA PLUM BROOK STATION
SANDUSKY, OHIO

IT CORPORATION
A Member of The IT Group

STARTING DATE: 05/26/99 | DATE LAST REV.: | DRAFT. CHCK. BY: C. TUMLIN | INITIATOR: HAGEGEORGE | DWG. NO.: ...\771481es.164
DRAWN BY: T. BRADSHAW | DRAWN BY: | ENGR. CHCK. BY: HAGEGEORGE | PROJ. MGR.: SPANGBERG | PROJ. NO.: 771481

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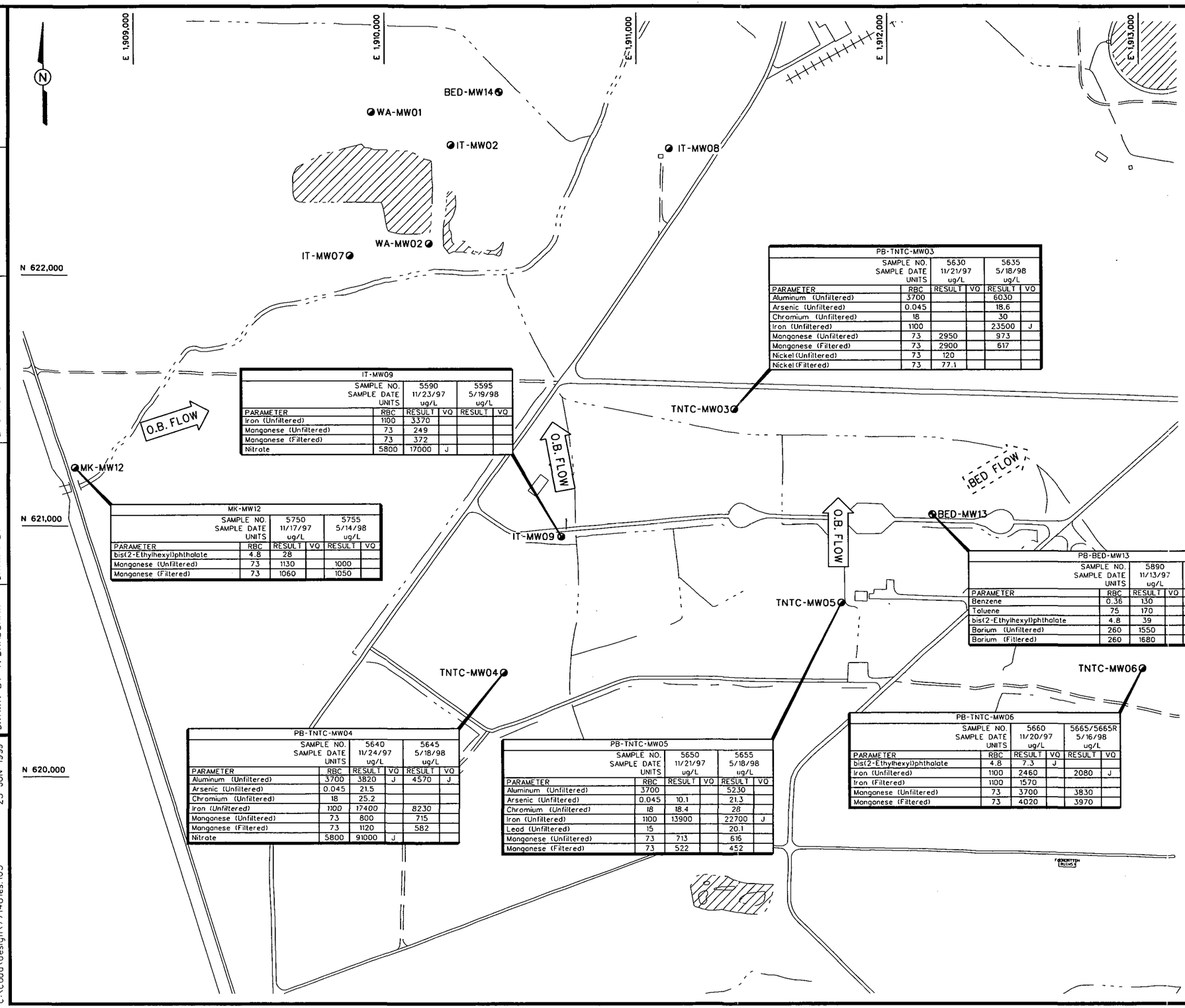

PB-TNTC-MW03					
SAMPLE NO.		5630		5635	
SAMPLE DATE		11/21/97		5/18/98	
UNITS		ug/L		ug/L	
PARAMETER	RBC	RESULT	VQ	RESULT	VQ
Aluminum (Unfiltered)	3700			6030	
Arsenic (Unfiltered)	0.045			18.6	
Chromium (Unfiltered)	18			30	
Iron (Unfiltered)	1100			23500	J
Manganese (Unfiltered)	73	2950		973	
Manganese (Filtered)	73	2900		617	
Nickel (Unfiltered)	73	120			
Nickel (Filtered)	73	77.1			

IT-MW09					
SAMPLE NO.		5590		5595	
SAMPLE DATE		11/23/97		5/19/98	
UNITS		ug/L		ug/L	
PARAMETER	RBC	RESULT	VQ	RESULT	VQ
Iron (Unfiltered)	1100	3370			
Manganese (Unfiltered)	73	249			
Manganese (Filtered)	73	372			
Nitrate	5800	17000	J		

MK-MW12					
SAMPLE NO.		5750		5755	
SAMPLE DATE		11/17/97		5/14/98	
UNITS		ug/L		ug/L	
PARAMETER	RBC	RESULT	VQ	RESULT	VQ
bis(2-Ethylhexyl)phthalate	4.8	28			
Manganese (Unfiltered)	73	1130		1000	
Manganese (Filtered)	73	1060		1050	

PB-BED-MW13					
SAMPLE NO.		5890		5895	
SAMPLE DATE		11/13/97		5/29/98	
UNITS		ug/L		ug/L	
PARAMETER	RBC	RESULT	VQ	RESULT	VQ
Benzene	0.36	130		47	
Toluene	75	170		120	
bis(2-Ethylhexyl)phthalate	4.8	39		55	J
Barium (Unfiltered)	260	1550			
Barium (Filtered)	260	1680			

PB-TNTC-MW04					
SAMPLE NO.		5640		5645	
SAMPLE DATE		11/24/97		5/18/98	
UNITS		ug/L		ug/L	
PARAMETER	RBC	RESULT	VQ	RESULT	VQ
Aluminum (Unfiltered)	3700	3820	J	4570	J
Arsenic (Unfiltered)	0.045	21.5			
Chromium (Unfiltered)	18	25.2			
Iron (Unfiltered)	1100	17400		8230	
Manganese (Unfiltered)	73	800		715	
Manganese (Filtered)	73	1120		582	
Nitrate	5800	91000	J		

PB-TNTC-MW05					
SAMPLE NO.		5650		5655	
SAMPLE DATE		11/21/97		5/18/98	
UNITS		ug/L		ug/L	
PARAMETER	RBC	RESULT	VQ	RESULT	VQ
Aluminum (Unfiltered)	3700			5230	
Arsenic (Unfiltered)	0.045	10.1		21.3	
Chromium (Unfiltered)	18	18.4		28	
Iron (Unfiltered)	1100	13900		22700	J
Lead (Unfiltered)	15			20.1	
Manganese (Unfiltered)	73	713		616	
Manganese (Filtered)	73	522		452	

PB-TNTC-MW06					
SAMPLE NO.		5660		5665/5665R	
SAMPLE DATE		11/20/97		5/16/98	
UNITS		ug/L		ug/L	
PARAMETER	RBC	RESULT	VQ	RESULT	VQ
bis(2-Ethylhexyl)phthalate	4.8	7.3	J		
Iron (Unfiltered)	1100	2460		2080	J
Iron (Filtered)	1100	1570			
Manganese (Unfiltered)	73	3700		3830	
Manganese (Filtered)	73	4020		3970	

LEGEND:

- PB-TNTC-MW03 — OVERBURDEN MONITORING WELL LOCATION
- PB-BED-MW13 — BEDROCK MONITORING WELL LOCATION
- BUILDINGS
- RAILROAD
- SURFACE WATER
- DITCH
- FENCE
- O.B. FLOW — OVERBURDEN GROUNDWATER FLOW DIRECTION
- BED FLOW — BEDROCK GROUNDWATER FLOW DIRECTION

NOTES:

1. ANALYTICAL RESULTS HAVE BEEN BLANK CORRECTED.
2. GROUNDWATER FLOW DIRECTION ON MAY 5, 1998.

SCALE

0 400 800 FEET

FIGURE 6-22
DETECTED CONSTITUENTS AT TNT MANUFACTURING AREA C ABOVE RBCs IN OVERBURDEN/BEDROCK WELLS
(NOVEMBER 1997 & MAY 1998)

SUMMARY REPORT, SITE-WIDE GROUNDWATER MONITORING (1997-1998)
FORMER PLUM BROOK ORDNANCE WORKS
NASA PLUM BROOK STATION
SANDUSKY, OHIO

IT CORPORATION
A Member of The IT Group

DWG. NO.: ...\771481es.165 | PROJ. NO.: 771481
INITIATOR: HAGEGEORGE | PROJ. MGR.: SPANGBERG
DRAFT. CHCK. BY: C. TUMLIN | ENGR. CHCK. BY: HAGEGEORGE
DATE LAST REV.: | DRAWN BY:
STARTING DATE: 05/27/99 | DRAWN BY: T. BRADSHAW
13:25:04 23 JUN 1999
bvanderg
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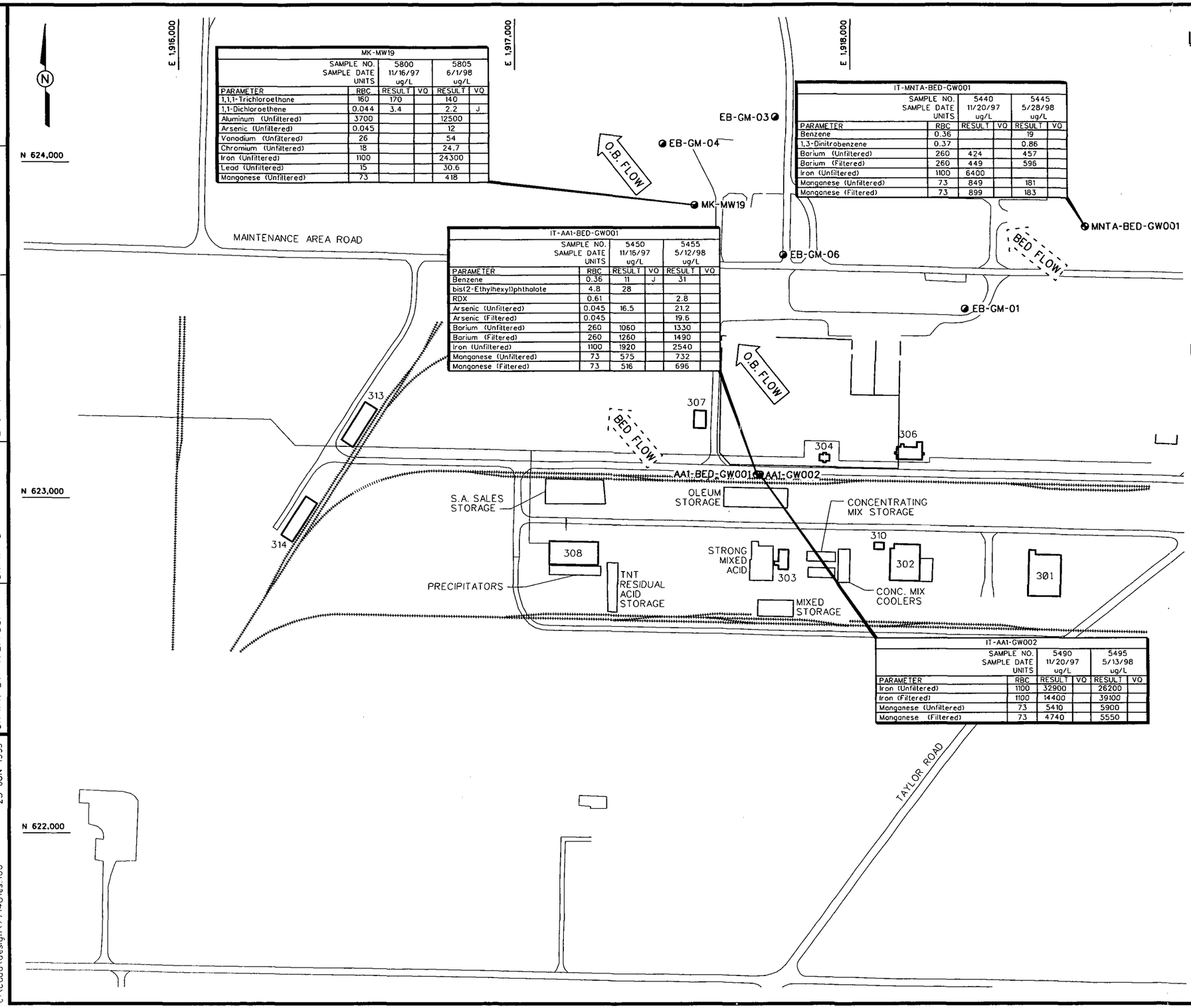

MK-MW19					
SAMPLE NO.		5800		5805	
SAMPLE DATE		11/16/97		6/1/98	
UNITS		ug/L		ug/L	
PARAMETER	RBC	RESULT	VQ	RESULT	VQ
1,1,1-Trichloroethane	160	170		140	
1,1-Dichloroethene	0.044	3.4		2.2	J
Aluminum (Unfiltered)	3700			12500	
Arsenic (Unfiltered)	0.045			12	
Vanadium (Unfiltered)	26			54	
Chromium (Unfiltered)	18			24.7	
Iron (Unfiltered)	1100			24300	
Lead (Unfiltered)	15			30.6	
Manganese (Unfiltered)	73			418	

IT-MNTA-BED-GW001					
SAMPLE NO.		5440		5445	
SAMPLE DATE		11/20/97		5/28/98	
UNITS		ug/L		ug/L	
PARAMETER	RBC	RESULT	VQ	RESULT	VQ
Benzene	0.36			19	
1,3-Dinitrobenzene	0.37			0.86	
Barium (Unfiltered)	260	424		457	
Barium (Filtered)	260	449		596	
Iron (Unfiltered)	1100	6400			
Manganese (Unfiltered)	73	849		181	
Manganese (Filtered)	73	899		183	

IT-AA1-BED-GW001					
SAMPLE NO.		5450		5455	
SAMPLE DATE		11/16/97		5/12/98	
UNITS		ug/L		ug/L	
PARAMETER	RBC	RESULT	VQ	RESULT	VQ
Benzene	0.36	11	J	31	
bis(2-Ethylhexyl)phthalate	4.8	28			
RDX	0.61			2.8	
Arsenic (Unfiltered)	0.045	16.5		21.2	
Arsenic (Filtered)	0.045			19.6	
Barium (Unfiltered)	260	1060		1330	
Barium (Filtered)	260	1260		1490	
Iron (Unfiltered)	1100	1920		2540	
Manganese (Unfiltered)	73	575		732	
Manganese (Filtered)	73	516		696	

IT-AA1-GW002					
SAMPLE NO.		5490		5495	
SAMPLE DATE		11/20/97		5/13/98	
UNITS		ug/L		ug/L	
PARAMETER	RBC	RESULT	VQ	RESULT	VQ
Iron (Unfiltered)	1100	32900		26200	
Iron (Filtered)	1100	14400		39100	
Manganese (Unfiltered)	73	5410		5900	
Manganese (Filtered)	73	4740		5550	

LEGEND:

MK-MW19	OVERBURDEN MONITORING WELL LOCATION
AA1-BED-GW001	BEDROCK MONITORING WELL LOCATION
	BUILDINGS
	RAILROAD
	SURFACE WATER
	DITCH
	FENCE
O.B. FLOW	OVERBURDEN GROUNDWATER FLOW DIRECTION
BED FLOW	BEDROCK GROUNDWATER FLOW DIRECTION

NOTES:

1. ANALYTICAL RESULTS HAVE BEEN BLANK CORRECTED.
2. GROUNDWATER FLOW DIRECTION ON MAY 5, 1998.

SCALE

0 300 600 FEET

FIGURE 6-23
DETECTED CONSTITUENTS AT ACID AREA NO. 1/MAINTENANCE SHOP AREA ABOVE RBCs IN OVERBURDEN/ BEDROCK WELLS (NOVEMBER 1997 & MAY 1998)

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NASA PLUM BROOK STATION
SANDUSKY, OHIO

IT CORPORATION
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STARTING DATE: 05/27/99 | DATE LAST REV.: | DRAFT. CHCK. BY: C. TUMLIN | INITIATOR: HAGEGEORGE | DWG. NO.: ...\771481es.166
DRAWN BY: T. BRADSHAW | DRAWN BY: | ENGR. CHCK. BY: HAGEGEORGE | PROJ. MGR.: SPANGBERG | PROJ. NO.: 771481
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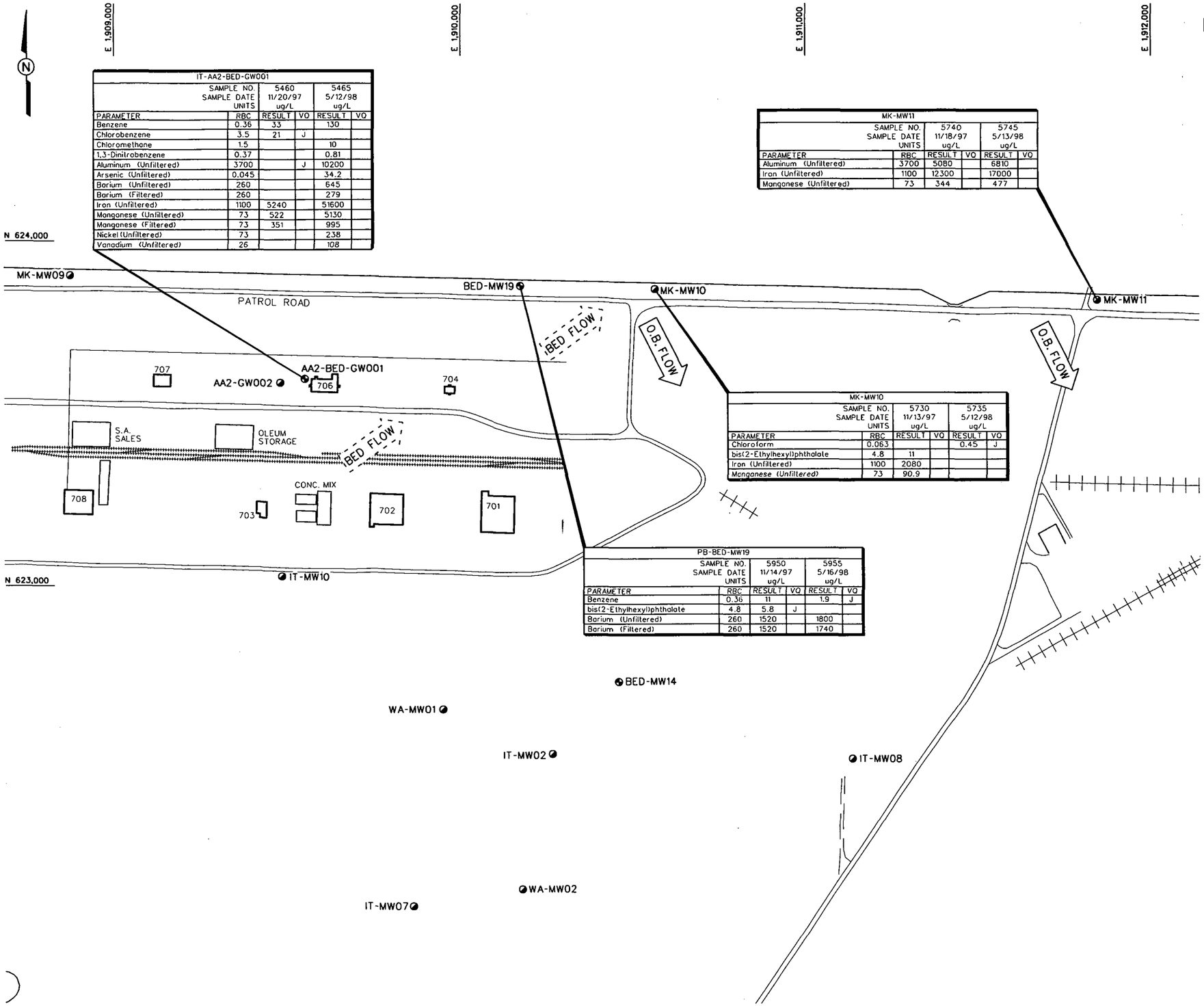

IT-AA2-BED-GW001					
	SAMPLE NO.	5460		5465	
	SAMPLE DATE	11/20/97		5/12/98	
	UNITS	ug/L		ug/L	
PARAMETER	RBC	RESULT	VQ	RESULT	VQ
Benzene	0.36	33		130	
Chlorobenzene	3.5	21	J		
Chloromethane	1.5			10	
1,3-Dinitrobenzene	0.37			0.81	
Aluminum (Unfiltered)	3700		J	10200	
Arsenic (Unfiltered)	0.045			34.2	
Barium (Unfiltered)	260			645	
Barium (Filtered)	260			279	
Iron (Unfiltered)	1100	5240		51600	
Manganese (Unfiltered)	73	522		5130	
Manganese (Filtered)	73	351		995	
Nickel (Unfiltered)	73			238	
Vanadium (Unfiltered)	26			108	

MK-MW11					
	SAMPLE NO.	5740		5745	
	SAMPLE DATE	11/18/97		5/13/98	
	UNITS	ug/L		ug/L	
PARAMETER	RBC	RESULT	VQ	RESULT	VQ
Aluminum (Unfiltered)	3700	5080		6810	
Iron (Unfiltered)	1100	12300		17000	
Manganese (Unfiltered)	73	344		477	

MK-MW10					
	SAMPLE NO.	5730		5735	
	SAMPLE DATE	11/13/97		5/12/98	
	UNITS	ug/L		ug/L	
PARAMETER	RBC	RESULT	VQ	RESULT	VQ
Chloroform	0.063			0.45	J
bis(2-Ethylhexyl)phthalate	4.8	11			
Iron (Unfiltered)	1100	2080			
Manganese (Unfiltered)	73	90.9			

PB-BED-MW19					
	SAMPLE NO.	5950		5955	
	SAMPLE DATE	11/14/97		5/16/98	
	UNITS	ug/L		ug/L	
PARAMETER	RBC	RESULT	VQ	RESULT	VQ
Benzene	0.36	11		1.9	J
bis(2-Ethylhexyl)phthalate	4.8	5.8	J		
Barium (Unfiltered)	260	1520		1800	
Barium (Filtered)	260	1520		1740	

LEGEND:

- MK-MW10 — OVERBURDEN MONITORING WELL LOCATION
- AA2-BED-GW001 — BEDROCK MONITORING WELL LOCATION
- BUILDINGS
- AREA OF STORAGE TANKS
- RAILROAD
- ABANDONED RAILROAD
- SURFACE WATER
- DITCH
- FENCE
- NATURAL GAS
- O.B. FLOW — OVERBURDEN GROUNDWATER FLOW DIRECTION
- BED FLOW — BEDROCK GROUNDWATER FLOW DIRECTION

NOTES:

1. ANALYTICAL RESULTS HAVE BEEN BLANK CORRECTED.
2. GROUNDWATER FLOW DIRECTION ON MAY 5, 1998.

SCALE

0 300 600 FEET

FIGURE 6-24
DETECTED CONSTITUENTS AT ACID AREA NO. 2 ABOVE RBCs IN OVERBURDEN/BEDROCK WELLS (NOVEMBER 1997 & MAY 1998)

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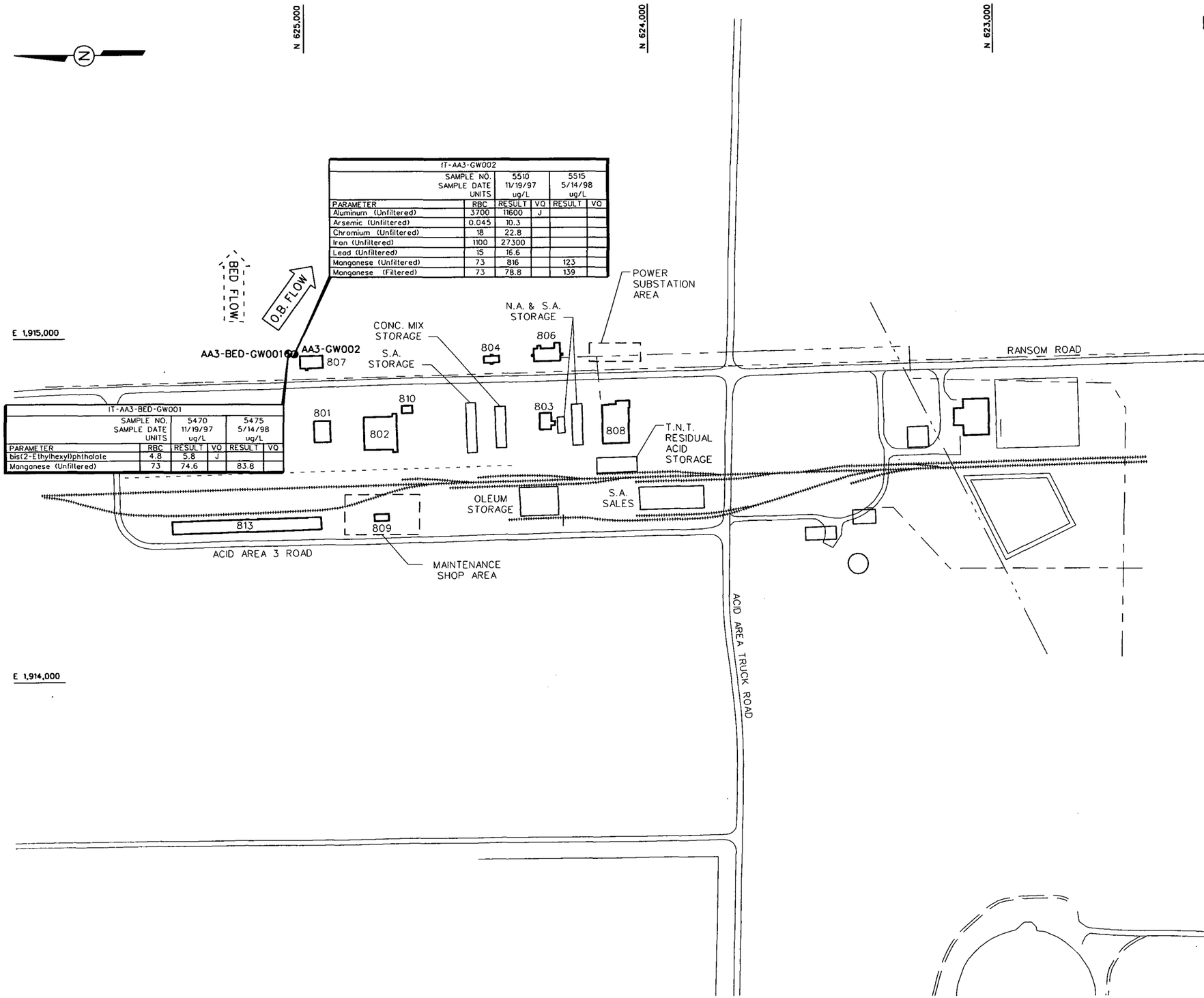

IT-AA3-GW002					
	SAMPLE NO.	5510		5515	
	SAMPLE DATE	11/19/97		5/14/98	
	UNITS	ug/L		ug/L	
PARAMETER	RBC	RESULT	VQ	RESULT	VQ
Aluminum (Unfiltered)	3700	11600	J		
Arsenic (Unfiltered)	0.045	10.3			
Chromium (Unfiltered)	18	22.8			
Iron (Unfiltered)	1100	27300			
Lead (Unfiltered)	15	16.6			
Manganese (Unfiltered)	73	816		123	
Manganese (Filtered)	73	78.8		139	

IT-AA3-BED-GW001					
	SAMPLE NO.	5470		5475	
	SAMPLE DATE	11/19/97		5/14/98	
	UNITS	ug/L		ug/L	
PARAMETER	RBC	RESULT	VQ	RESULT	VQ
bis(2-Ethylhexyl)phthalate	4.8	5.8	J		
Manganese (Unfiltered)	73	74.6		83.8	

LEGEND:

- AA3-GW002 — OVERBURDEN MONITORING WELL LOCATION
- AA3-BED-GW001 — BEDROCK MONITORING WELL LOCATION
- BUILDINGS
- AREA OF STORAGE TANKS
- RAILROAD
- ABANDONED RAILROAD
- SURFACE WATER
- DITCH
- FENCE
- NATURAL GAS
- RAW WATER
- EVAPORATOR LINES
- FORMER SEWER LINE
- O.B. FLOW — OVERBURDEN GROUNDWATER FLOW DIRECTION
- BED FLOW — BEDROCK GROUNDWATER FLOW DIRECTION

NOTES:

1. ANALYTICAL RESULTS HAVE BEEN BLANK CORRECTED.
2. GROUNDWATER FLOW DIRECTION ON MAY 5, 1998.

SCALE

0 300 600 FEET

FIGURE 6-25
DETECTED CONSTITUENTS AT ACID AREA NO. 3 AREA ABOVE RBCs IN OVERBURDEN/BEDROCK WELLS (NOVEMBER 1997 & MAY 1998)

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SANDUSKY, OHIO

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ENGR. CHCK. BY: HAGEGEORGE | PROJ. MGR.: SPANGBERG | PROJ. NO.: 771481
DATE LAST REV.: | STARTING DATE: 05/27/99
DRAWN BY: | DRAWN BY: T. BRADSHAW
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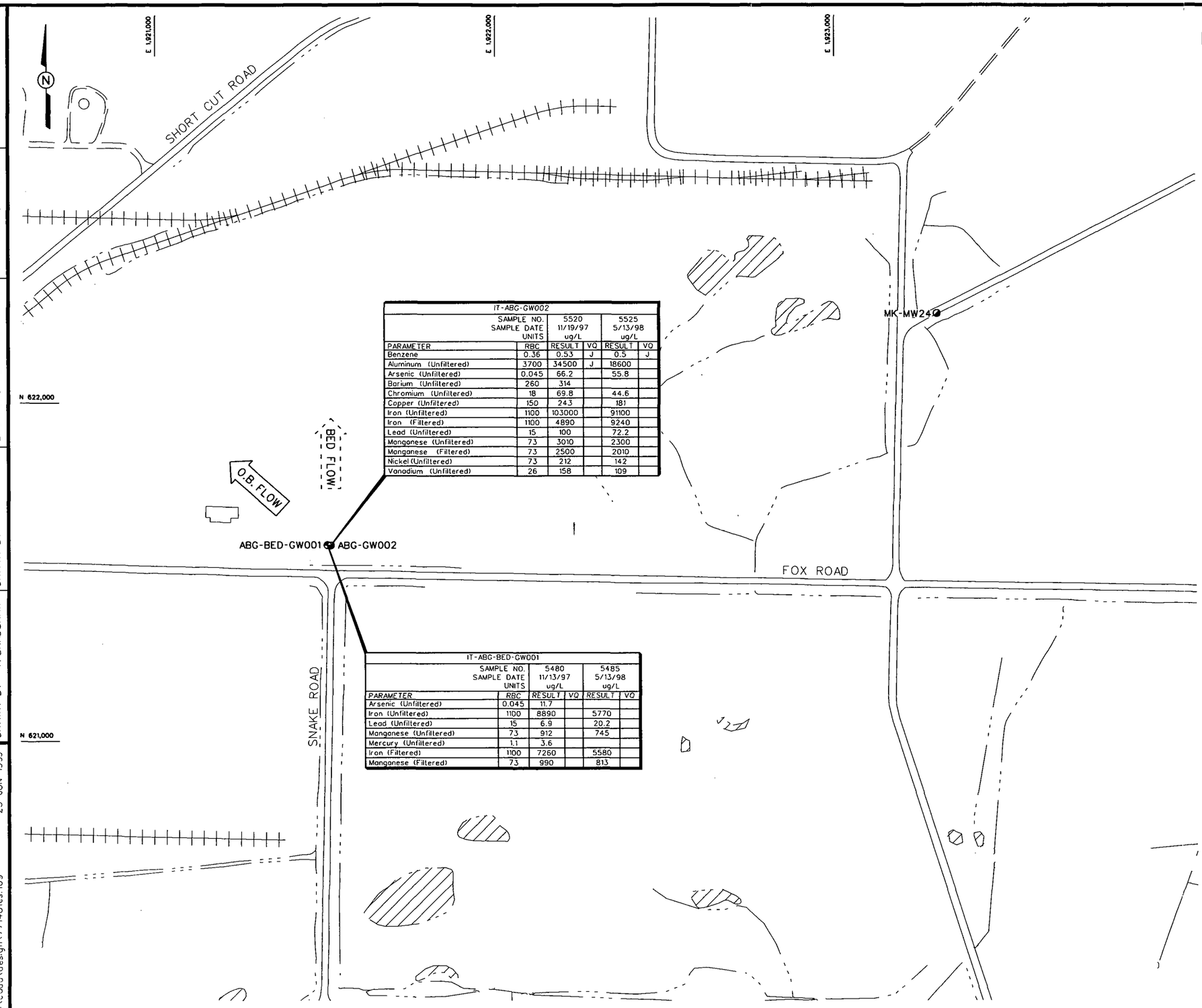

IT-ABG-GW002					
	SAMPLE NO.	5520		5525	
	SAMPLE DATE	11/19/97		5/13/98	
	UNITS	ug/L		ug/L	
PARAMETER	RBC	RESULT	VQ	RESULT	VQ
Benzene	0.36	0.53	J	0.5	J
Aluminum (Unfiltered)	3700	34500	J	18600	
Arsenic (Unfiltered)	0.045	66.2		55.8	
Barium (Unfiltered)	260	314			
Chromium (Unfiltered)	18	69.8		44.6	
Copper (Unfiltered)	150	243		181	
Iron (Unfiltered)	1100	103000		91100	
Iron (Filtered)	1100	4890		9240	
Lead (Unfiltered)	15	100		72.2	
Manganese (Unfiltered)	73	3010		2300	
Manganese (Filtered)	73	2500		2010	
Nickel (Unfiltered)	73	212		142	
Vanadium (Unfiltered)	26	158		109	

IT-ABG-BED-GW001					
	SAMPLE NO.	5480		5485	
	SAMPLE DATE	11/13/97		5/13/98	
	UNITS	ug/L		ug/L	
PARAMETER	RBC	RESULT	VQ	RESULT	VQ
Arsenic (Unfiltered)	0.045	11.7			
Iron (Unfiltered)	1100	8890		5770	
Lead (Unfiltered)	15	6.9		20.2	
Manganese (Unfiltered)	73	912		745	
Mercury (Unfiltered)	1.1	3.6			
Iron (Filtered)	1100	7260		5580	
Manganese (Filtered)	73	990		813	

LEGEND:

ABG-GW002	OVERBURDEN MONITORING WELL LOCATION
ABG-BED-GW001	BEDROCK MONITORING WELL LOCATION
	BUILDINGS
	RAILROAD
	SURFACE WATER
	DITCH
O.B. FLOW	OVERBURDEN GROUNDWATER FLOW DIRECTION
BED FLOW	BEDROCK GROUNDWATER FLOW DIRECTION

NOTES:

1. ANALYTICAL RESULTS HAVE BEEN BLANK CORRECTED.
2. GROUNDWATER FLOW DIRECTION ON MAY 5, 1998.

SCALE

0 300 600 FEET

FIGURE 6-26
DETECTED CONSTITUENTS AT ADDITIONAL BURNING GROUND AREAS ABOVE RBCs IN OVERBURDEN/BEDROCK WELLS (NOVEMBER 1997 & MAY 1998)

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NASA PLUM BROOK STATION
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DRAWN BY: T. BRADSHAW | DRAWN BY: | ENGR. CHCK. BY: HAGEGEORGE | PROJ. MGR.: SPANGBERG | PROJ. NO.: 771481

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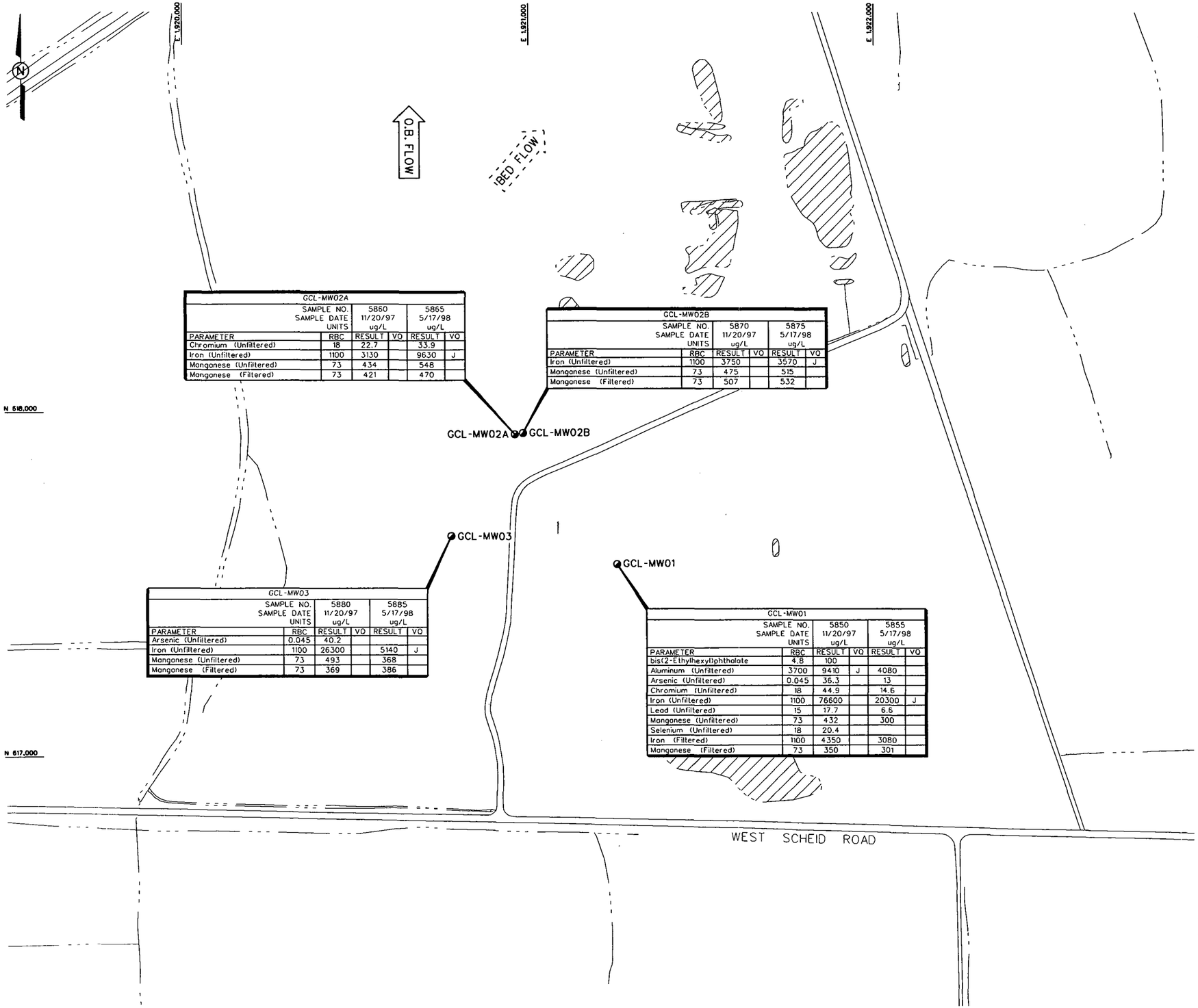

GCL-MW02A					
	SAMPLE NO.	5860		5865	
	SAMPLE DATE	11/20/97		5/17/98	
	UNITS	ug/L		ug/L	
PARAMETER	RBC	RESULT	VO	RESULT	VO
Chromium (Unfiltered)	18	22.7		33.9	
Iron (Unfiltered)	1100	3130		9630	J
Manganese (Unfiltered)	73	434		548	
Manganese (Filtered)	73	421		470	

GCL-MW02B					
	SAMPLE NO.	5870		5875	
	SAMPLE DATE	11/20/97		5/17/98	
	UNITS	ug/L		ug/L	
PARAMETER	RBC	RESULT	VO	RESULT	VO
Iron (Unfiltered)	1100	3750		3570	J
Manganese (Unfiltered)	73	475		515	
Manganese (Filtered)	73	507		532	

GCL-MW03					
	SAMPLE NO.	5880		5885	
	SAMPLE DATE	11/20/97		5/17/98	
	UNITS	ug/L		ug/L	
PARAMETER	RBC	RESULT	VO	RESULT	VO
Arsenic (Unfiltered)	0.045	40.2			
Iron (Unfiltered)	1100	26300		5140	J
Manganese (Unfiltered)	73	493		368	
Manganese (Filtered)	73	369		386	

GCL-MW01					
	SAMPLE NO.	5850		5855	
	SAMPLE DATE	11/20/97		5/17/98	
	UNITS	ug/L		ug/L	
PARAMETER	RBC	RESULT	VO	RESULT	VO
bis(2-Ethylhexyl)phthalate	4.8	100			
Aluminum (Unfiltered)	3700	9410	J	4080	
Arsenic (Unfiltered)	0.045	36.3		13	
Chromium (Unfiltered)	18	44.9		14.6	
Iron (Unfiltered)	1100	76600		20300	J
Lead (Unfiltered)	15	17.7		6.6	
Manganese (Unfiltered)	73	432		300	
Selenium (Unfiltered)	18	20.4			
Iron (Filtered)	1100	4350		3080	
Manganese (Filtered)	73	350		301	

LEGEND:

- GCL-MW02A — OVERBURDEN MONITORING WELL LOCATION
- BUILDINGS
- RAILROAD
- SURFACE WATER
- DITCH
- O.B. FLOW — OVERBURDEN GROUNDWATER FLOW DIRECTION
- BED FLOW — BEDROCK GROUNDWATER FLOW DIRECTION

NOTES:

1. ANALYTICAL RESULTS HAVE BEEN BLANK CORRECTED.
2. GROUNDWATER FLOW DIRECTION ON MAY 5, 1998.

SCALE

0 300 600 FEET

FIGURE 6-27
DETECTED CONSTITUENTS AT SNAKE ROAD BURNING GROUND AREA ABOVE RBCs IN OVERBURDEN WELLS (NOVEMBER 1997 & MAY 1998)

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DRAWN BY: B. VANDERGRIFF | DRAWN BY: | ENGR. CHCK. BY: C. HAGEGEORGE | PROJ. MGR.: SPANGBERG | PROJ. NO.: 771481

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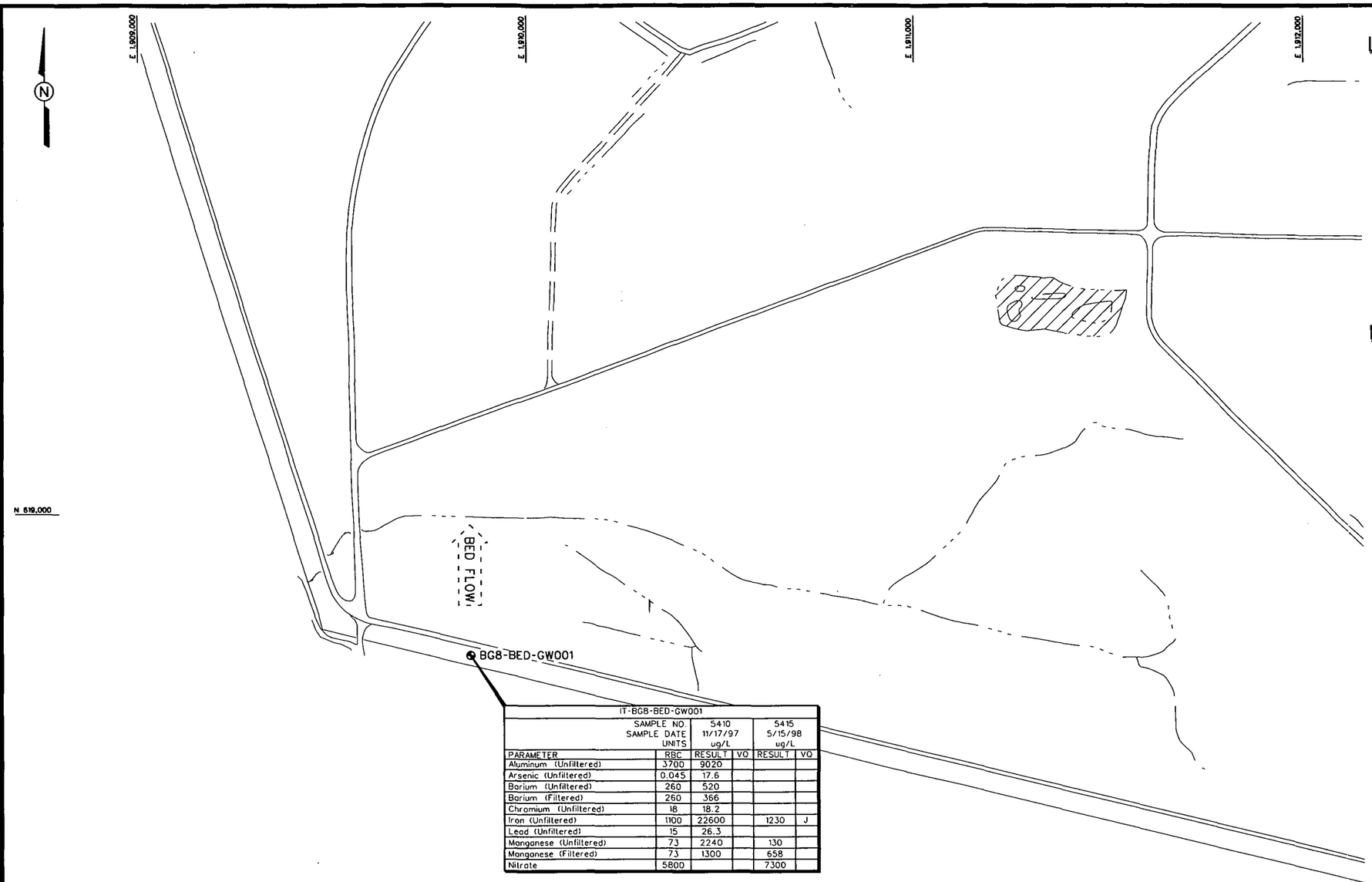

IT-BG8-BED-GW001					
SAMPLE NO.		5410		5415	
SAMPLE DATE		11/17/97		5/15/98	
UNITS		ug/L		ug/L	
PARAMETER	RBC	RESULT	VO	RESULT	VO
Aluminum (Unfiltered)	3700	9020			
Arsenic (Unfiltered)	0.045	17.6			
Barium (Unfiltered)	260	520			
Barium (Filtered)	260	366			
Chromium (Unfiltered)	18	18.2			
Iron (Unfiltered)	1100	22600		1230	J
Lead (Unfiltered)	15	26.3			
Manganese (Unfiltered)	73	2240		130	
Manganese (Filtered)	73	1300		658	
Nitrate	5800			7300	

LEGEND:

- BG8-BED-GW001 — BEDROCK MONITORING WELL LOCATION
- BUILDINGS
- RAILROAD
- SURFACE WATER
- DITCH
- FENCE
- BED FLOW — BEDROCK GROUNDWATER FLOW DIRECTION

NOTES:

1. ANALYTICAL RESULTS HAVE BEEN BLANK CORRECTED.
2. GROUNDWATER FLOW DIRECTION ON MAY 5, 1998.

SCALE

0 300 600 FEET

FIGURE 6-28
DETECTED CONSTITUENTS AT G8 BURNING GROUND ABOVE RBCs IN BEDROCK WELLS (NOVEMBER 1997 & MAY 1998)

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DRAWN BY: T. BRADSHAW | DRAWN BY: | ENGR. CHCK. BY: HAGEGEORGE | PROJ. MGR.: SPANGBERG | PROJ. NO.: 771481

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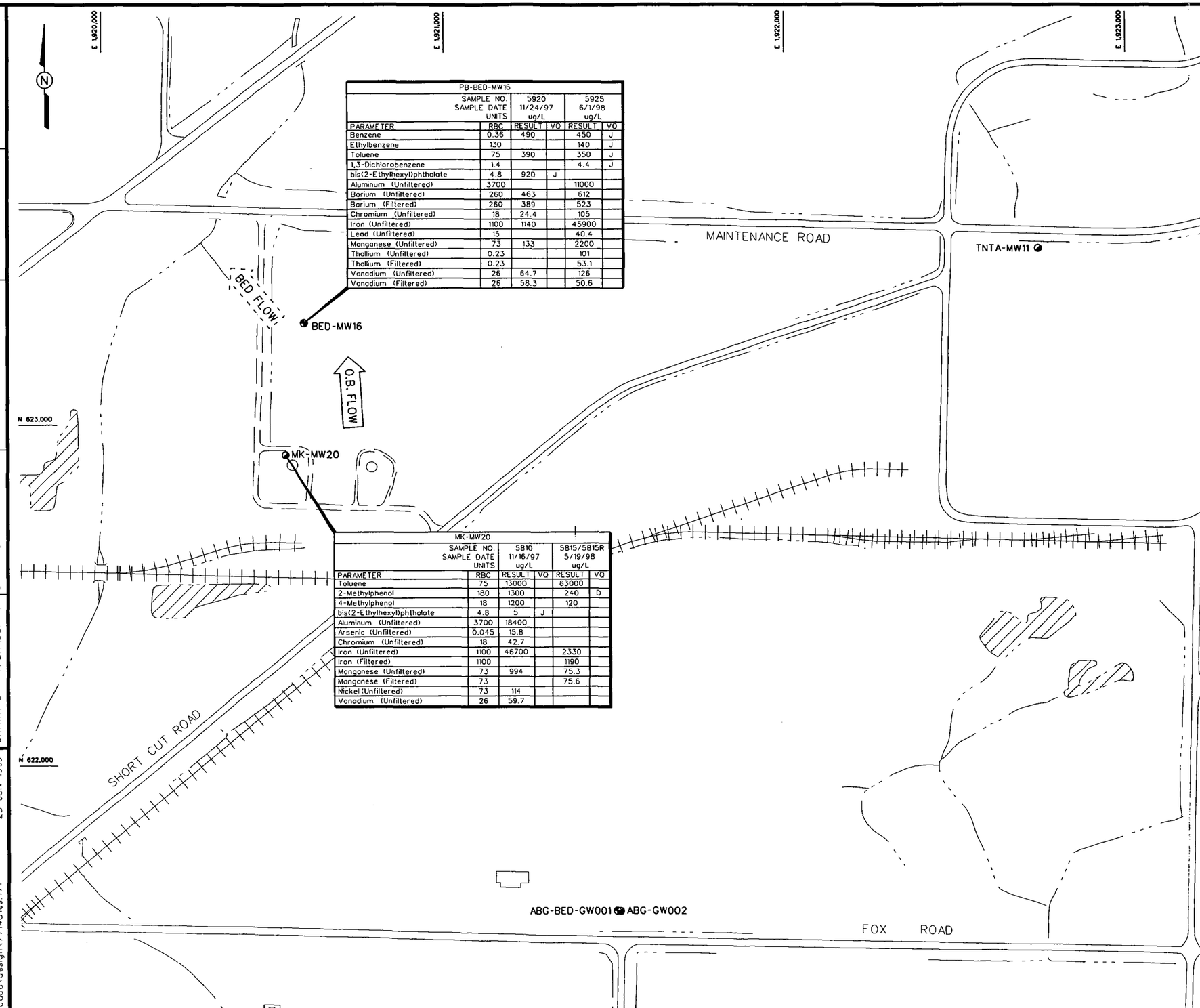

PB-BED-MW16					
	SAMPLE NO.	5920		5925	
	SAMPLE DATE	11/24/97		6/1/98	
	UNITS	ug/L		ug/L	
PARAMETER	RBC	RESULT	VQ	RESULT	VQ
Benzene	0.36	490		450	J
Ethylbenzene	130			140	J
Toluene	75	390		350	J
1,3-Dichlorobenzene	1.4			4.4	J
bis(2-Ethylhexyl)phtholate	4.8	920	J		
Aluminum (Unfiltered)	3700			11000	
Barium (Unfiltered)	260	463		612	
Barium (Filtered)	260	389		523	
Chromium (Unfiltered)	18	24.4		105	
Iron (Unfiltered)	1100	1140		45900	
Lead (Unfiltered)	15			40.4	
Manganese (Unfiltered)	73	133		2200	
Thallium (Unfiltered)	0.23			101	
Thallium (Filtered)	0.23			53.1	
Vanadium (Unfiltered)	26	64.7		126	
Vanadium (Filtered)	26	58.3		50.6	

MK-MW20					
	SAMPLE NO.	5810		5815/5815R	
	SAMPLE DATE	11/16/97		5/19/98	
	UNITS	ug/L		ug/L	
PARAMETER	RBC	RESULT	VQ	RESULT	VQ
Toluene	75	13000		63000	
2-Methylphenol	180	1300		240	D
4-Methylphenol	18	1200		120	
bis(2-Ethylhexyl)phtholate	4.8	5	J		
Aluminum (Unfiltered)	3700	18400			
Arsenic (Unfiltered)	0.045	15.8			
Chromium (Unfiltered)	18	42.7			
Iron (Unfiltered)	1100	46700		2330	
Iron (Filtered)	1100			1190	
Manganese (Unfiltered)	73	994		75.3	
Manganese (Filtered)	73			75.6	
Nickel (Unfiltered)	73	114			
Vanadium (Unfiltered)	26	59.7			

LEGEND:

- MK-MW20 — OVERBURDEN MONITORING WELL LOCATION
- BED-MW16 — BEDROCK MONITORING WELL LOCATION
- BUILDINGS
- RAILROAD
- SURFACE WATER
- DITCH
- O.B. FLOW — OVERBURDEN GROUNDWATER FLOW DIRECTION
- BED FLOW — BEDROCK GROUNDWATER FLOW DIRECTION

NOTES:

1. ANALYTICAL RESULTS HAVE BEEN BLANK CORRECTED.
2. GROUNDWATER FLOW DIRECTION ON MAY 5, 1998.

SCALE

0 300 600 FEET

FIGURE 6-29
DETECTED CONSTITUENTS AT UPPER TOLUENE TANKS AREA ABOVE RBCs IN OVERBURDEN/BEDROCK WELLS (NOVEMBER 1997 & MAY 1998)

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DRAWN BY: T. BRADSHAW | DRAWN BY: | ENGR. CHCK. BY: HAGEGEORGE | PROJ. MGR.: SPANGBERG | PROJ. NO.: 771481

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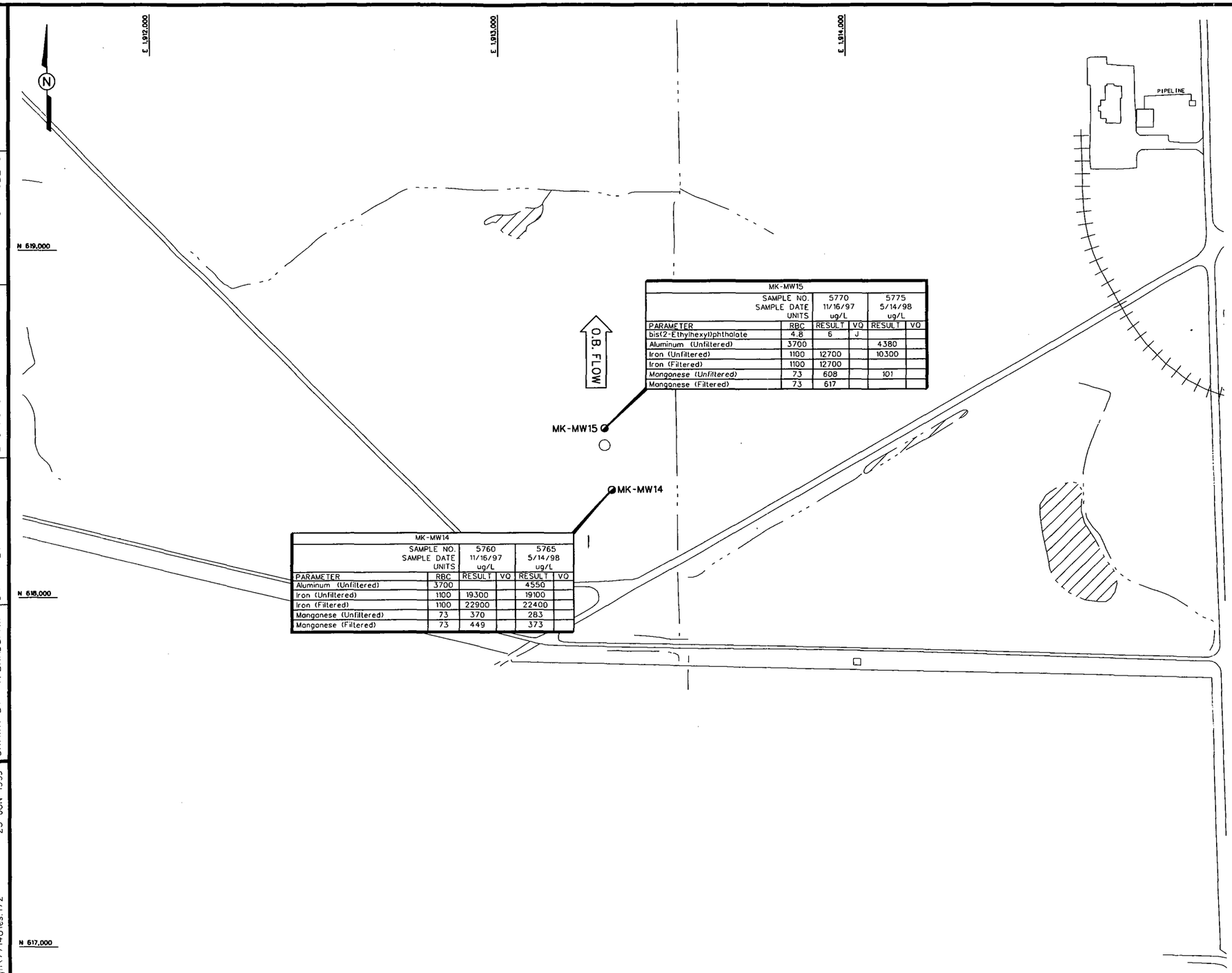

MK-MW15					
SAMPLE NO.		5770		5775	
SAMPLE DATE		11/16/97		5/14/98	
UNITS		ug/L		ug/L	
PARAMETER	RBC	RESULT	VQ	RESULT	VQ
bis(2-Ethylhexyl)phthalate	4.8	6	J		
Aluminum (Unfiltered)	3700			4380	
Iron (Unfiltered)	1100	12700		10300	
Iron (Filtered)	1100	12700			
Manganese (Unfiltered)	73	608		101	
Manganese (Filtered)	73	617			

MK-MW14					
SAMPLE NO.		5760		5765	
SAMPLE DATE		11/16/97		5/14/98	
UNITS		ug/L		ug/L	
PARAMETER	RBC	RESULT	VQ	RESULT	VQ
Aluminum (Unfiltered)	3700			4550	
Iron (Unfiltered)	1100	19300		19100	
Iron (Filtered)	1100	22900		22400	
Manganese (Unfiltered)	73	370		283	
Manganese (Filtered)	73	449		373	

LEGEND:

- MK-MW16 — OVERBURDEN MONITORING WELL LOCATION
- BUILDINGS
- RAILROAD
- SURFACE WATER
- DITCH
- FENCE
- O.B. FLOW — OVERBURDEN GROUNDWATER FLOW DIRECTION

NOTES:

1. ANALYTICAL RESULTS HAVE BEEN BLANK CORRECTED.
2. GROUNDWATER FLOW DIRECTION ON MAY 5, 1998.

SCALE

0 300 600 FEET

FIGURE 6-30
DETECTED CONSTITUENTS AT THE LOWER TOLUENE TANK AREA ABOVE RBCs IN OVERBURDEN WELLS (NOVEMBER 1997 & MAY 1998)

SUMMARY REPORT, SITE-WIDE GROUNDWATER MONITORING (1997-1998)
FORMER PLUM BROOK ORDNANCE WORKS
NASA PLUM BROOK STATION
SANDUSKY, OHIO

IT CORPORATION
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STARTING DATE: 05/27/99 | DATE LAST REV.: | DWG. NO.: ...\771481es.172
DRAWN BY: T. BRADSHAW | DRAWN BY: | PROJ. NO.: 771481
DRAFT. CHCK. BY: C. TUMLIN | INITIATOR: HAGEGEORGE
ENGR. CHCK. BY: HAGEGEORGE | PROJ. MGR.: SPANGBERG
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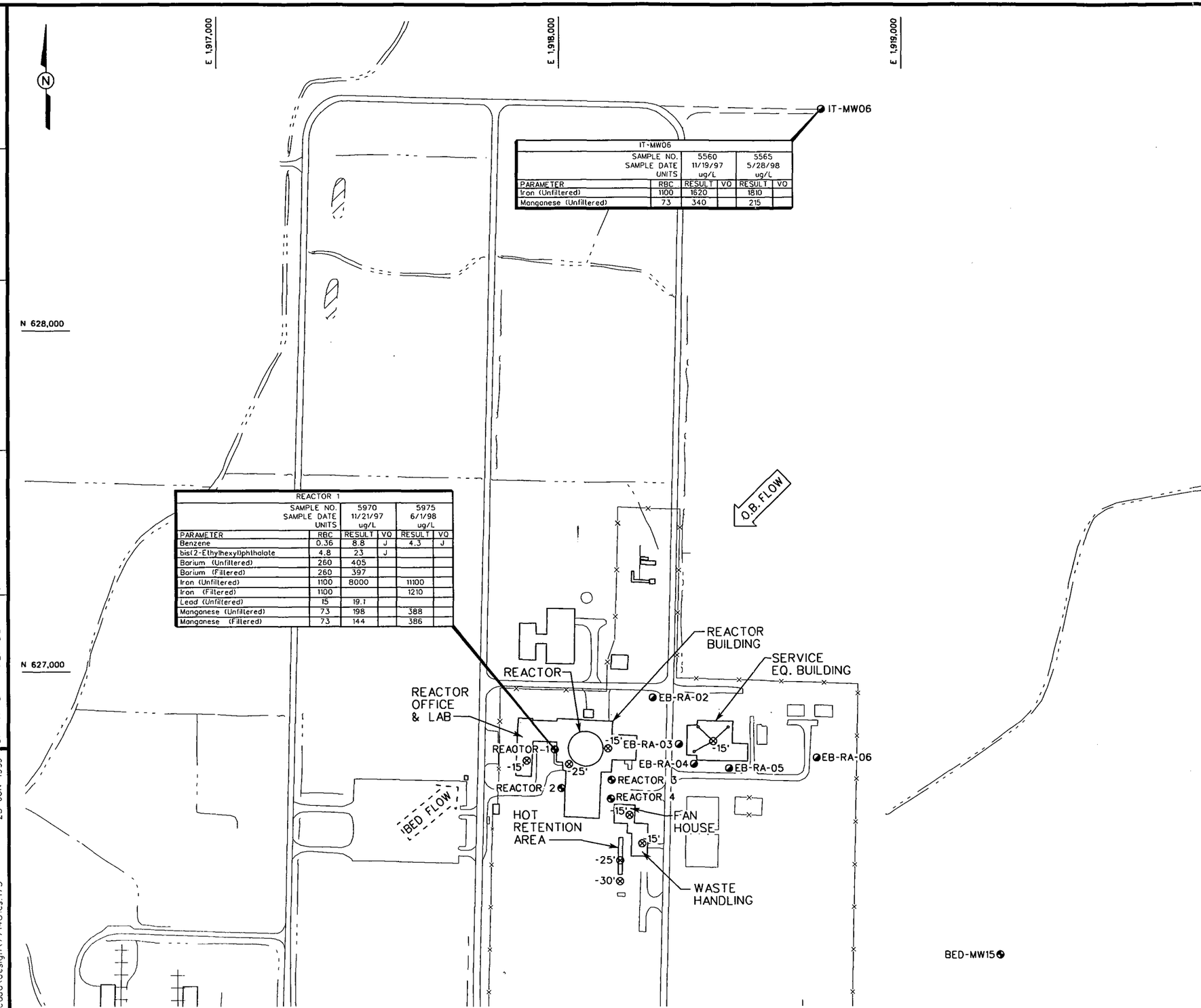

IT-MW06					
	SAMPLE NO.	5560		5565	
	SAMPLE DATE	11/19/97		5/28/98	
	UNITS	ug/L		ug/L	
PARAMETER	RBC	RESULT	VQ	RESULT	VQ
Iron (Unfiltered)	1100	1620		1810	
Manganese (Unfiltered)	73	340		215	

REACTOR 1					
	SAMPLE NO.	5970		5975	
	SAMPLE DATE	11/21/97		6/1/98	
	UNITS	ug/L		ug/L	
PARAMETER	RBC	RESULT	VQ	RESULT	VQ
Benzene	0.36	8.8	J	4.3	J
bis(2-Ethylhexyl)phthalate	4.8	23	J		
Barium (Unfiltered)	260	405			
Barium (Filtered)	260	397			
Iron (Unfiltered)	1100	8000		11100	
Iron (Filtered)	1100			1210	
Lead (Unfiltered)	15	19.1			
Manganese (Unfiltered)	73	198		388	
Manganese (Filtered)	73	144		386	

LEGEND:

IT-MW06	OVERBURDEN MONITORING WELL LOCATION
REACTOR 1	BEDROCK MONITORING WELL LOCATION
-15'	SUMP WELL WITH DEPTH BELOW SUBSURFACE TO TOP OF SUMP PUMP
	BUILDINGS
	RAILROAD
	SURFACE WATER
	DITCH
	FENCE
O.B. FLOW	OVERBURDEN GROUNDWATER FLOW DIRECTION
BED FLOW	BEDROCK GROUNDWATER FLOW DIRECTION

NOTES:

1. ANALYTICAL RESULTS HAVE BEEN BLANK CORRECTED.
2. LOCATIONS OF SUMP WELLS ARE APPROXIMATE. SUMP WELLS HAVE NOT BEEN SURVEYED.
3. GROUNDWATER FLOW DIRECTION ON MAY 5, 1998.

SCALE

0 300 600 FEET

FIGURE 6-31
DETECTED CONSTITUENTS AT THE REACTOR FACILITY AREA ABOVE RBCs IN OVERBURDEN/BEDROCK WELLS
(NOVEMBER 1997 & MAY 1998)

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DRAWN BY: T. BRADSHAW | ENGR. CHCK. BY: HAGEGEORGE | PROJ. MGR.: SPANGBERG | PROJ. NO.: 771481
DATE LAST REV.: | DRAWN BY:
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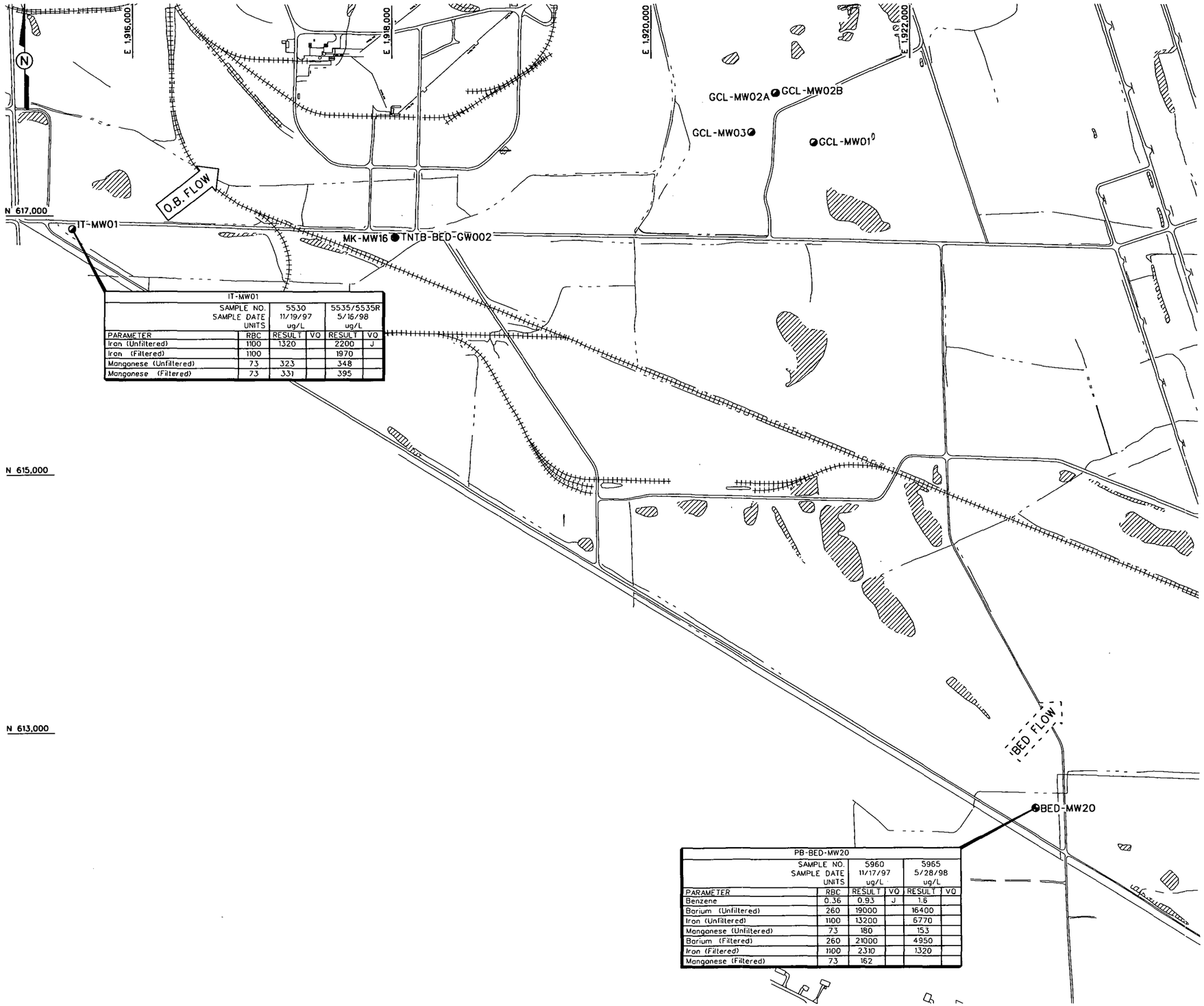

IT-MW01					
SAMPLE NO.		5530		5535/5535R	
SAMPLE DATE		11/19/97		5/16/98	
UNITS		ug/L		ug/L	
PARAMETER	RBC	RESULT	VQ	RESULT	VQ
Iron (Unfiltered)	1100	1320		2200	J
Iron (Filtered)	1100			1970	
Manganese (Unfiltered)	73	323		348	
Manganese (Filtered)	73	331		395	

PB-BED-MW20					
SAMPLE NO.		5960		5965	
SAMPLE DATE		11/17/97		5/28/98	
UNITS		ug/L		ug/L	
PARAMETER	RBC	RESULT	VQ	RESULT	VQ
Benzene	0.36	0.93	J	1.6	
Barium (Unfiltered)	260	19000		16400	
Iron (Unfiltered)	1100	13200		6770	
Manganese (Unfiltered)	73	180		153	
Barium (Filtered)	260	21000		4950	
Iron (Filtered)	1100	2310		1320	
Manganese (Filtered)	73	162			

LEGEND:

- IT-MW01 — OVERBURDEN MONITORING WELL LOCATION
- BED-MW20 — BEDROCK MONITORING WELL LOCATION
- BUILDINGS
- RAILROAD
- SURFACE WATER
- DITCH
- FENCE
- O.B. FLOW — OVERBURDEN GROUNDWATER FLOW DIRECTION
- BED FLOW — BEDROCK GROUNDWATER FLOW DIRECTION

NOTES:

1. ANALYTICAL RESULTS HAVE BEEN BLANK CORRECTED.
2. GROUNDWATER FLOW DIRECTION ON MAY 5, 1998.

SCALE

0 800 1600 FEET

FIGURE 6-32
DETECTED CONSTITUENTS IN BACKGROUND MONITORING WELLS ABOVE RBCs IN OVERBURDEN/ BEDROCK WELLS (NOVEMBER 1997 & MAY 1998)

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DRAWN BY: T. BRADSHAW | DRAWN BY: | ENGR. CHCK. BY: HAGEGEORGE | PROJ. MGR.: SPANGBERG | PROJ. NO.: 771481

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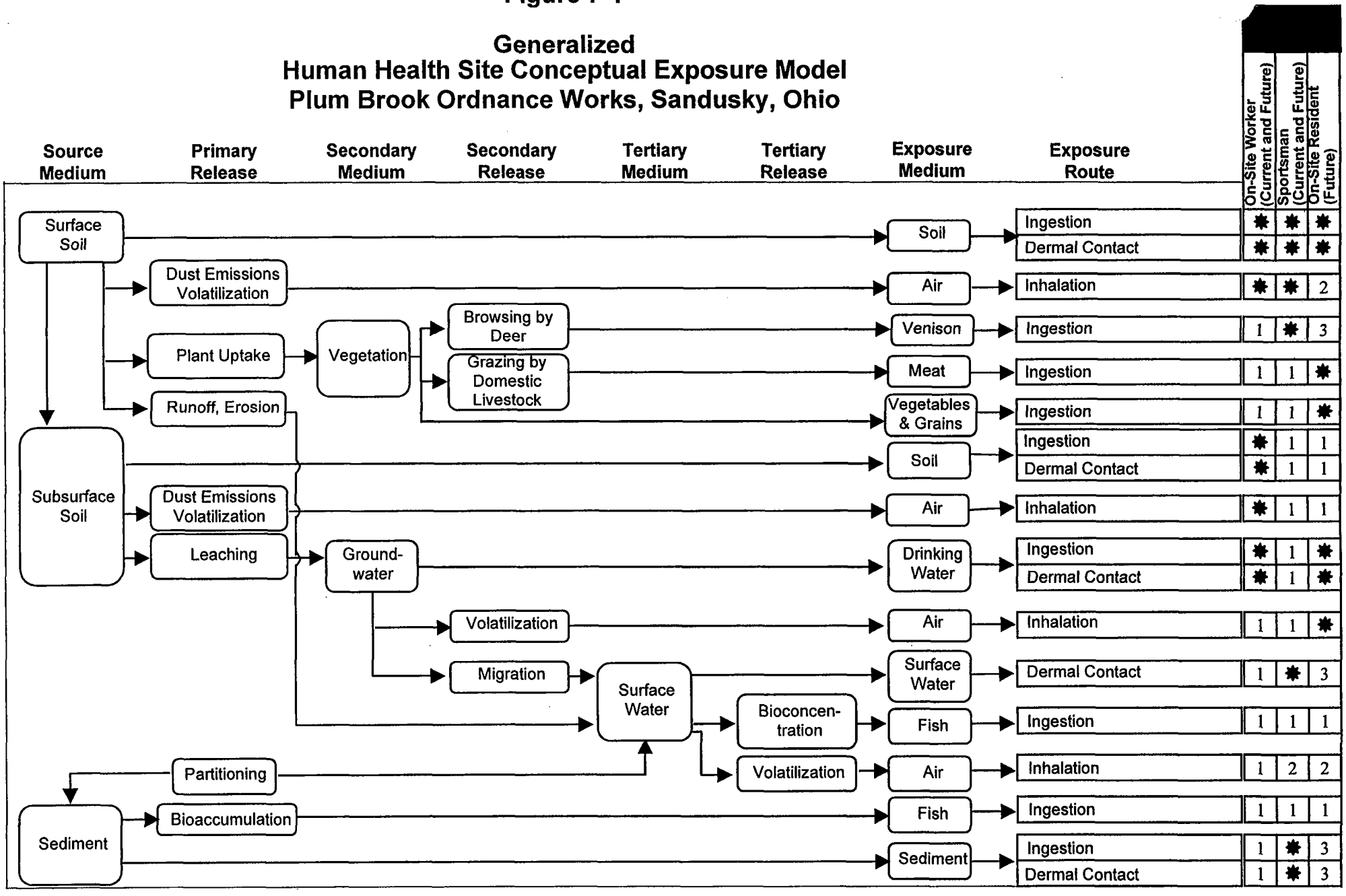
Figure 7-1

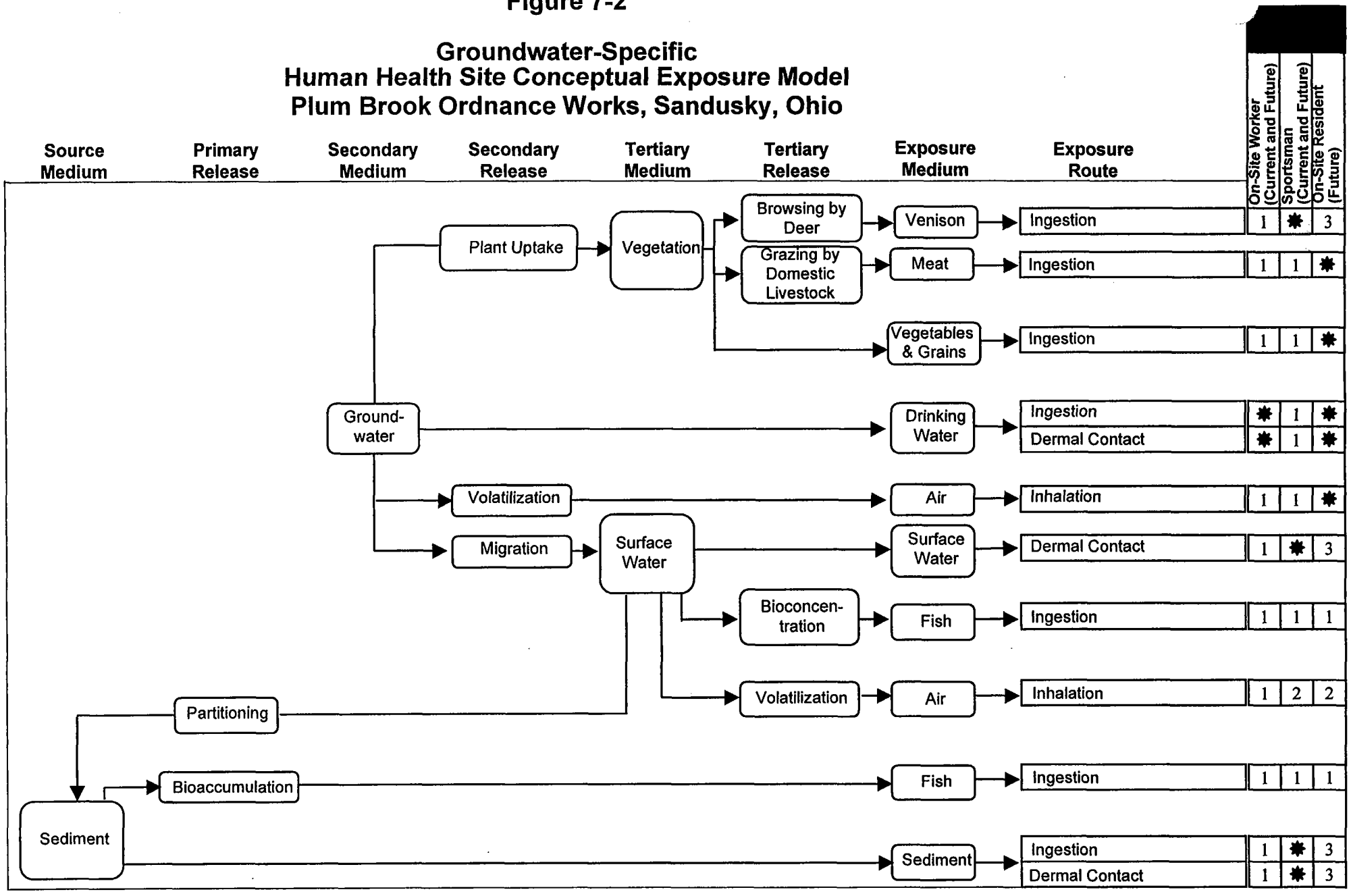
Generalized Human Health Site Conceptual Exposure Model Plum Brook Ordnance Works, Sandusky, Ohio



✸ Complete exposure pathway to be evaluated.
1 = Incomplete exposure pathway.
2 = Although theoretically complete exposure pathway, large dilution factor of outdoor air obviates the need to quantify this pathway.
3 = This pathway is quantified for the sportsman and is not quantified separately for the on-site resident.

Figure 7-2

Groundwater-Specific Human Health Site Conceptual Exposure Model Plum Brook Ordnance Works, Sandusky, Ohio



✸ Complete exposure pathway to be evaluated.
1 = Incomplete exposure pathway.
2 = Although theoretically complete exposure pathway, large dilution factor of outdoor air obviates the need to quantify this pathway.
3 = This pathway is quantified for the sportsman and is not quantified separately for the on-site resident.

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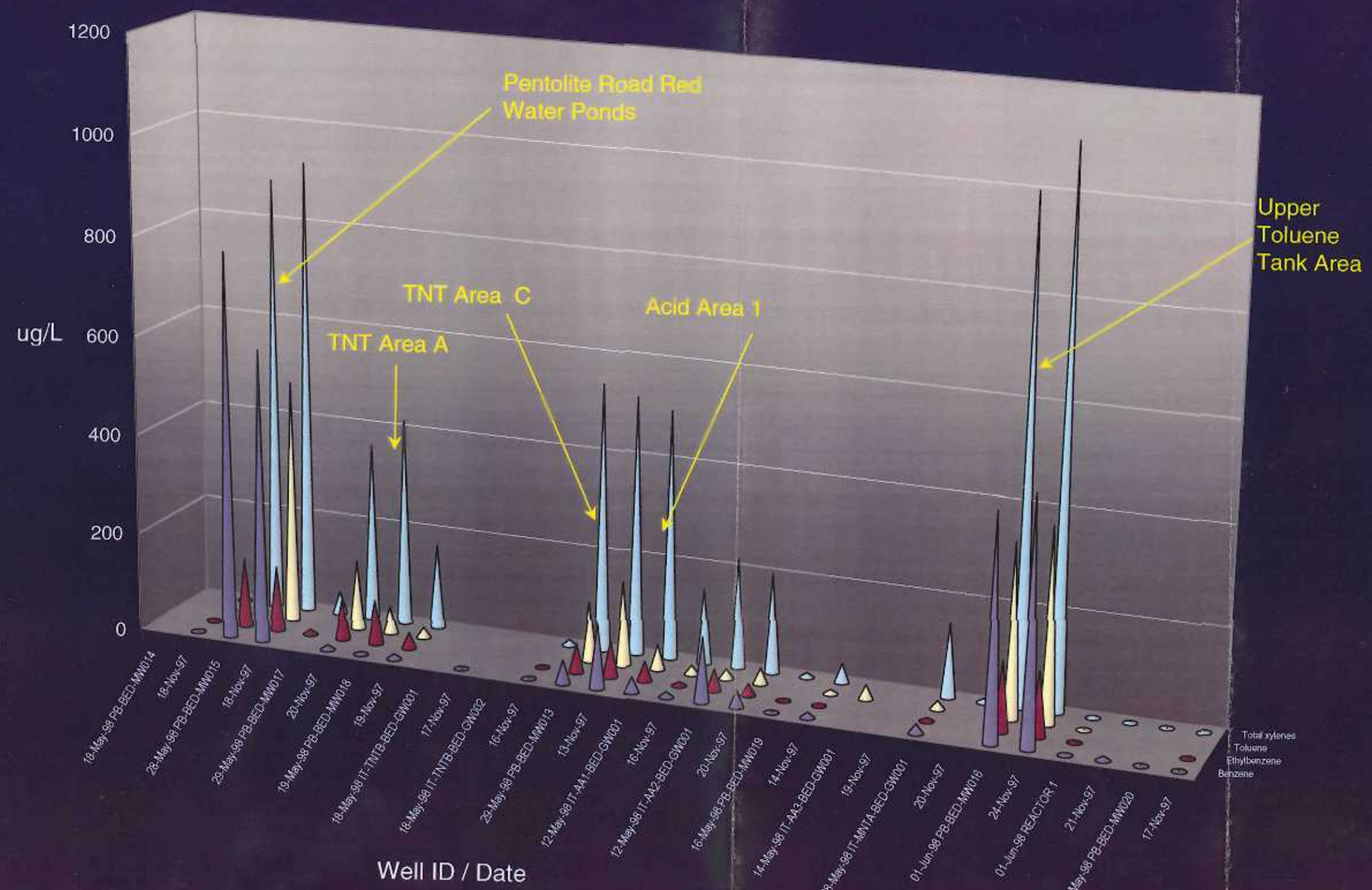
Figure 8-2
Detected BTEX Constituents in Bedrock Monitoring Wells
Plum Brook Ordnance Works, Sandusky, Ohio