Ninth Quarterly (March 2004) Background Groundwater Report
Former Plum Brook Ordnance Works
Sandusky, Ohio

Prepared for:

U.S. Army Corps of Engineers, Nashville District
P. O. Box 1070
Nashville, Tennessee 37202-1070

Prepared by:

Shaw Environmental, Inc.
312 Directors Drive
Knoxville, Tennessee 37923

Shaw Project No. 843656

Revision 0

June 2004

Table of Contents

Page

List of Appendices ii
List of Tables iii
List of Figures iii
List of Acronyms iv
1.0 Introduction 1-1
1.1 Objectives 1-2
1.2 Facility Location and Description 1-3
1.3 Site History and Potential for Contamination 1-4
2.0 Field Activities 2-1
2.1 Investigative Methods 2-1
2.2 Groundwater Sampling 2-1
2.3 Decontamination Procedures 2-2
2.4 IDW Management 2-3
3.0 Analytical Program 3-1
3.1 Analytical Program and Methodologies 3-1
3.2 Data Quality Evaluation 3-2
3.3 Blank Evaluation 3-2
3.4 Comparison to Screening Criteria 3-3
3.4.1 Risk-Based Screening 3-3
3.4.2 Background Screening 3-4
3.4.3 Screening and Risk Evaluation Protocol 3-5
4.0 Analytical Results 4-1
4.1 Groundwater Sampling Events 4-1
4.2 Analytical Results 4-2
4.2.1 Background Monitoring Wells 4-2
4.2.2 Overburden/Shale 4-2
4.2.3 Summary of Overburden/Shale Sampling Events 4-4
4.2.4 Bedrock 4-4
4.2.5 Summary of Bedrock Sampling Events 4-8
5.0 Planned Activities 5-1
6.0 References 6-1

List of Appendices

Appendix A – Teleconference Notes on Natural Petroleum in Bedrock
Appendix B – Sample Collection Logs
Appendix C – Data Validation Summary
Appendix D – Chemical Analytical Data Summary
Appendix E – Detected Hits Summary Excluding "B" Qualifiers
Appendix F – Data Quality Evaluation
Appendix G – Chains-of-Custody

List of Tables

Table	Title	Follows Text
1-1	Summary of Background Investigations	
2-1	Summary of Groundwater Samples Collected	
2-2	Final Field Measurements of Groundwater Samples	
3-1	Summary of Analytical Parameters and Methods	
4-1	Detected Constituents in Background Monitoring Wells	

List of Figures

Figures	Title	Follows Text
1-1	Vicinity Map	
1-2	Locations of Areas of Concern	
1-3	Active/Inactive Natural Oil and Gas Wells of Erie County, Ohio	
2-1	Detected Constituents in Overburden/Bedrock Background Monitoring Wells (November 1997, May 1998, September-October 2001, January, April, July, October 2002, April, September, December 2003, and March 2004)	
3-1	Protocol for Screening and Risk Evaluation	

List of Acronyms

BHHRA	baseline human health risk assessment
BSC	background screening concentration
°C	degrees Celsius
Eh	oxidation-reduction potential
DNT	dinitrotoluene
DQO	data quality objective
EPA	U.S. Environmental Protection Agency
GSA	General Services Administration
HQ	hazard quotient
IDW	investigation-derived waste
ILCR	incremental lifetime cancer risk
IT	IT Corporation
MDC	maximum detected concentration
mV	millivolt
µg/L	micrograms per liter
µmhos/cm	micromhos per centimeter
ml/min	milliliters per minute
NASA	National Aeronautics and Space Administration
NTU	nephelometric turbidity unit
OEPA	Ohio Environmental Protection Agency
PBOW	Plum Brook Ordnance Works
ppm	parts per million
PVC	polyvinyl chloride
QAPP	quality assurance project plan
RBSC	risk-based screening concentration
RDX	cyclotrimethylenetrinitramine
RI	remedial investigation
SAP	sampling and analysis plan
Shaw	Shaw Environmental, Inc.
SSAP	site-specific sampling and analysis plan
SSHP	site-specific health and safety plan
STL	Severn Trent Laboratories, Inc.

List of Acronyms *(Continued)*

SVOC	semivolatile organic compound
TBD	to be determined
TNT	trinitrotoluene
VOC	volatile organic compound
USACE	U.S. Army Corps of Engineers
YSI	Yellow Springs Instrument Company

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. The former Plum Brook Ordnance Works (PBOW), located in Sandusky, Ohio, is currently being investigated under the Defense Environmental Restoration Program for Formerly Used Defense Sites. Figure 1-1 shows the geographical location of the former PBOW site. This 9,000-acre facility was used for the manufacture of explosives during World War II. The site is currently owned by the National Aeronautics and Space Administration (NASA) and is operated as the Plum Brook Station of the John Glenn Research Center with headquarters based out of Lewis Field in Cleveland, Ohio.

The investigation is being managed and technically overseen by the Nashville, Tennessee and Huntington, West Virginia District Offices of the U.S. Army Corps of Engineers (USACE). Shaw Environmental, Inc. (Shaw) (formerly IT Corporation [IT]) was contracted by the USACE Nashville District, to continue a groundwater remedial investigation (RI) at two red water pond areas and three former trinitrotoluene (TNT) manufacturing areas at PBOW. The two red water pond areas are the West Area Red Water Ponds and the Pentolite Road Red Water Ponds. The three former TNT manufacturing areas are TNT Area A, TNT Area B, and TNT Area C (Figure 1-2).

Ninth-quarter sampling activities were conducted pursuant to the following documents: the final site-specific sampling and analysis plan (SSAP) (IT, 2001a), final site-specific safety and health plan (SSHP) (IT, 2001b), the March 2002 letter amendment to the SSAP (IT, 2002a), the site-wide sampling and analysis plan (SAP) (IT, 1996a), the quality assurance project plan (QAPP) (IT, 1996b), and the site-wide safety and health plan (IT, 1996c).

The purpose of the quarterly background sampling is to provide seasonal collection events to evaluate groundwater quality and determine if a trending pattern of organics and inorganics is present in the groundwater of the background monitoring wells. Background (upgradient) groundwater data will be used as part of a groundwater data set for metals in the various groundwater risk assessments. Following completion of the final background sampling event (anticipated June 2004), groundwater screening concentrations will be calculated. The background data values generated will be compared to values from PBOW site wells for

determination of any site-related contamination and may also be used for risk evaluation purposes.

Since minor concentrations of nitroaromatics (less than 0.5 part per million) were detected in three background wells during the month of April 2002 (3rd quarter), a joint decision was made by the USACE, Ohio Environmental Protection Agency (OEPA), NASA, Shaw, and Pacific Environmental Services to continue background groundwater sampling for two additional events. One event was scheduled during the dry season (October 2002) and the other event was scheduled during the wet season (April 2003).

To determine if locations of existing background monitoring wells on PBOW property are truly in "background" locations and to further characterize background groundwater, two additional background monitoring wells (PB-BED-MW28 and PB-BED-MW29) were installed from August 4 through 13, 2003 (Figure 1-2). Well PB-BED-MW28 is located on NASA property outside the security fencing, near the intersection of Taft and Mason Road. It is approximately 2,100 feet upgradient of background well PB-BED-MW20. Monitoring well PB-BED-MW29 is located on private property outside NASA security fencing, approximately 1,100 feet upgradient of background well PB-BED-MW25. With the addition of two new background monitoring wells, a decision was made to continue background groundwater sampling for an additional four quarters (September and December 2003, and March and June 2004). Table 1-1 presents a summary of background groundwater sampling investigations and sampling events conducted to date.

1.1 Objectives

The objectives, as scoped for the quarterly background sampling, are as follows (USACE, 2001, 2003):

1. Determine the quality of bedrock groundwater entering the PBOW site in the upgradient direction (west, south, and southwest).

2. Determine the quality of residuum groundwater upgradient of selected sites at PBOW.

3. Perform trend analysis to determine if any changes in the concentrations of inorganics are seasonally dependent.

4. Establish the range and determine the background concentrations of inorganics in residuum and bedrock groundwater.

Additional background sampling objectives:

5. Evaluate the detection of nitroaromatics reported in April 2002 in background monitoring wells to determine a possible source for this contamination.

6. Determine if groundwater quality of background monitoring wells is adequate for establishing background concentrations.

7. Provide additional groundwater quality data for risk assessment.

Due to drought conditions, establishing background concentrations of inorganics in overburden groundwater was eliminated from the objectives.

This report presents:

- Groundwater sampling procedures
- Results of the background quarterly sampling events (first through ninth quarterly events)
- Laboratory analytical data of the ninth quarter (March 2004) groundwater sampling. Results from previous events are also presented. These sampling events occurred as follows:

  - First quarter results, September 2001 (IT, 2002b)
  - Second quarter results, January 2002 (IT, 2002c)
  - Third quarter results, April 2002 (IT, 2002d)
  - Fourth quarter results, July 2002 (Shaw, 2003a)
  - Fifth quarter results, October 2002 (IT, 2003)
  - Sixth quarter results, April 2003 (Shaw, 2003b)
  - Seventh quarter results, September 2003 (Shaw, 2003c)
  - Eighth quarter results, March 2004 (Shaw, 2004a)

- Handling and disposal of investigation-derived waste (IDW).

1.2 Facility Location and Description

As mentioned above, the former PBOW site is currently owned by NASA. Most of the aerospace testing facilities at PBOW were constructed in the 1960s and are presently in a

standby or inactive status. The site is located approximately 4 miles south of Sandusky, Ohio, and 59 miles west of Cleveland, Ohio. Although primarily in Perkins and Oxford Townships, the eastern edge of the site extends into Huron and Milan Townships. PBOW is bound 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 area immediately surrounding PBOW is mostly agricultural, but residential sections are present along the northern and northeast perimeter. Public access at PBOW is restricted except during the annual deer hunting season.

1.3 Site History and Potential for Contamination

The PBOW site was built in early 1941 as a manufacturing plant for 2,4,6-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. Decontamination was completed during the last quarter of 1945. The property was initially transferred to the Ordnance Department and then to the War Assets Administration after it was certified by the U.S. Army to be decontaminated. In 1949, PBOW was transferred to the General Services Administration (GSA).

NASA acquired 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 for use as a bus transportation center. The 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 its John Glenn Research Center. The details of these land transactions are listed in the site management plan and can be found at the NASA Plum Brook Station.

Based on review of historical use of the site and findings of previous investigations, potential chemicals in the groundwater at PBOW may include nitroaromatic compounds, volatile organic compounds (VOC), semivolatile organic compounds (SVOC), cyanide, and inorganics.

Review of documents (Herdendorf, 1966 and Stout, 1941) and discussions with OEPA and Ohio Department of Natural Resources (Appendix A) personnel indicated that the Columbus and

Delaware bedrock units (the same bedrock units in which one of the PBOW background wells is screened) contain active and abandoned natural gas and petroleum hydrocarbon wells (Figure 1-3). It is therefore important to note that some VOCs (primarily benzene, toluene, ethylbenzene, and total xylenes) and SVOCs may be naturally occurring in site groundwater.

2.0 Field Activities

2.1 Investigative Methods

Ninth quarter groundwater sampling of background monitoring wells was conducted following the same procedures used during the previous eight background groundwater sampling events. Specific sampling procedures are detailed in the approved SSAP/SSHP (IT, 2001a,b).

2.2 Groundwater Sampling

Ninth quarter groundwater sampling was conducted from March 9 to 12, 2004. Background wells sampled included six bedrock wells (PB-BED-MW20, PB-BED-MW24, BG8-BEDGW-001, PB-BED-MW25, PB-BED-MW28, and PB-BED-MW29). Bedrock well PB-BED-MW26 was scheduled for sampling; however, the well was dry, so no groundwater sample could be collected. Background overburden well IT-MW01 was not scheduled to be sampled. Table 2-1 shows a list of the groundwater samples collected. The background monitoring wells sampled are located on the extreme west and southwest portion of PBOW (Figure 2-1). On-site background monitoring wells were selected by the USACE based on the groundwater investigation conducted in 1997 (USACE, 2001).

In August 2003, after review of background analytical data, off-site background monitoring wells PB-BED-MW28 and PB-BED-MW29 were installed farther upgradient of the on-site background monitoring wells. Installation of these two wells was necessary to validate analytical results of on-site background wells, to determine if the present background monitoring wells are truly in "background" locations, and to further characterize the background groundwater.

Groundwater samples were analyzed for nitroaromatics, metals (filtered and unfiltered), VOCs, SVOCs, and water quality parameters (alkalinity, chloride, cyanide, hardness, nitrate, sulfate, total dissolved solids, total organic carbon, total suspended solids, and turbidity). Final field measurements of groundwater samples are presented in Table 2-2. Well locations are shown on Figure 2-1. Sample collection logs are provided in Appendix B.

Six of the seven background bedrock wells were sampled using the low-flow (minimal drawdown) sampling methodology. The following wells were sampled using low-flow methodology: PB-BED-MW24, PB-BED-MW25, PB-BED-MW20, BG8-BEDGW-001, PB-BED-MW28, and PB-BED-MW29. Monitoring well PB-BED-MW26 exhibited a water column

of only 2.13 feet. Based upon groundwater level measurements from previous events, the limited water column, and the known minimal water recharge in the well, a groundwater sample from monitoring well PB-BED-MW26 was not collected. Low-flow minimal drawdown is performed when adequate groundwater recharge is present. Water quality measurements were recorded by use of an inline flow-through cell connected to a Yellow Springs Instrument Company (YSI) meter.

A bladder pump was used for the low-flow minimal drawdown sampling. The pump was inserted into the screened portion of the monitoring well, and the well was pumped at a rate that minimized drawdown. Purging rates in the background monitoring wells ranged from 50 milliliters per minute (ml/min) (PB-BED-MW20) to 400 ml/min (PB-BED-MW25). The purge rate was set so that drawdown in the well was never greater than 6 inches. The following water chemistry parameters were monitored for stability: pH, oxidation-reduction potential, conductivity, temperature, dissolved oxygen, turbidity.

Overburden/shale monitoring well IT-MW01 was not scheduled to be sampled during the ninth quarter groundwater sampling event. An indentation in the polyvinyl chloride (PVC) riser of this well prevents insertion of a bailer or pump. During previous sampling events (July 2002, October 2002, and April 2003), groundwater sampling was performed at this well using a peristaltic pump. With the peristaltic pump, Teflon-lined tubing was inserted into the screened portion of the well. Cyclic compressions on the tubing were made by the peristaltic pump and a vacuum was created removing groundwater from the well. Groundwater recharge rates did not permit low-flow sampling in this well.

When low-flow groundwater sample collection procedures were used, samples that were collected for dissolved metals analysis were filtered in the field through a 0.45-micrometer high-capacity filter attached to the discharge line of the bladder pump. When low-flow sample collection was not possible, the dissolved metals groundwater sample was filtered in the field using a hand held 0.45-micrometer filter. Sample filtration, preservation, packing, and shipment were performed in accordance with Section 5.4 of the site-wide QAPP (IT, 1996b).

2.3 Decontamination Procedures

Decontamination of all sampling equipment was performed in accordance with Section 4.3 of the SSAP (IT, 2001a). Specifically, the water level indicator and low-flow pump were the only instruments that required complete decontamination procedures. Decontamination was

performed in sequence by rinsing with soapy water, deionized water, and isopropyl alcohol, followed with a final rinse of deionized water. The bladder pump was decontaminated by running the decontamination fluids through the pump head. Equipment was then air dried before use. The bladder pump was wrapped in aluminum foil, with the shiny side out, after decontamination. Bailers, if needed, and tubing were not decontaminated because new items were used for each well. To prevent damage to sensitive membranes, the water quality instrument YSI 650, was thoroughly rinsed only with deionized water.

2.4 IDW Management

IDW generated during the March 2004 groundwater sampling event included groundwater, decontamination water, and personal protective equipment. All IDW was managed and handled in accordance with procedures described in the SAP (IT, 1996a).

An estimated total of 30 gallons of decontamination and purge water were generated from the background monitoring wells. All liquid was contained in a labeled 55-gallon drum. Since off-site background well PB-BED-MW29 is located on property not owned by NASA, purge water generated from this well was not permitted to be staged at the NASA facility. Based on historical background analytical results, all purge and decontamination water was disposed of as a nonhazardous liquid at Evergreen Landfill in Northwood, Ohio. Soiled personal protective gear and disposable field equipment generated during the project were double-bagged and placed in an on-site industrial dumpster.

3.0 Analytical Program

Severn Trent Laboratories, Inc. (STL) of Knoxville, Tennessee, analyzed primary and field duplicate project samples. STL's Canton, Ohio laboratory provided analyses for water quality parameters. Accutest Laboratory of Orlando, Florida analyzed the field split. Shaw performed data validation for primary and field duplicate project samples. Datachek validated the field split as part of the preparation of the chemical quality assurance report. The validation summary for the primary and duplicate samples analyzed by Severn Trent is provided in Appendix C. The analytical results are summarized in Appendix D. Tables of detected hits that exclude "B"-qualified data (data that were not detected significantly above method blank or field blank levels) are included in Appendix E. A data quality evaluation is located in Appendix F. Chain-of-custody documentation is provided in Appendix G.

3.1 Analytical Program and Methodologies

Chemical analyses for the investigation were performed in accordance with guidelines detailed in the Environmental Protection Agency's (EPA) *Test Methods for Evaluating Solid Waste (SW-846), Physical/Chemical Methods,* Third Edition (EPA, 1986) and subsequent revisions and EPA 600/4-79-020, *Method for Chemical Analysis of Water and Wastes* (EPA, 1983). The groundwater samples and associated quality assurance/quality control samples were analyzed for VOCs, SVOCs, metals, nitroaromatics, and several water quality parameters. Methods used for analysis of groundwater during the ninth quarterly sampling event are summarized in Table 3-1.

All data analyzed were reviewed for accuracy and completeness. One hundred percent of the data analyzed were subjected to data validation following guidelines in the EPA *Contract Laboratory Program National Functional Guidelines for Organic Data Review*, October 1999 (EPA, 1999) and *Contract Laboratory Program National Functional Guidelines for Inorganic Data Review*, February 2002 (EPA, 2002a). Data were evaluated against specific criteria to verify the achievement of precision, accuracy, representativeness, completeness, and comparability goals established to meet the project data quality objectives (DQO). 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, 1994) and *Region III Modifications to the Laboratory Data Validation Functional Guidelines for Evaluating Inorganics Analyses* (EPA, 1993). The procedure is outlined in Section 3.3.

3.2 Data Quality Evaluation

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

The DQOs for this project were to produce scientifically valid data of known accuracy and precision that 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. A complete evaluation of the analytical results is given in the data quality evaluation found in Appendix F.

3.3 Blank Evaluation

The purpose of blank analysis is to detect 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 practical quantitation limit but is less than 5 times or 10 times the blank result, the sample result is qualified "B." The 10 times limit is applicable only for common laboratory contaminants such as acetone, methylene chloride, 2-butanone, and certain phthalates.
- For organics, if the sample result is less than the practical quantitation limit and less than 5 times or 10 times 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 method detection limit but less than 5 times the blank result, the sample result is qualified "B."
- If the sample result is greater than 5 times or 10 times 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. Sample results are not corrected.

3.4 Comparison to Screening Criteria

This section describes a protocol that will be used in the baseline human health risk assessment (BHHRA) to screen analytical data from site (i.e., non-background) monitoring wells. Site analytical data will be screened in the BHHRA using risk-based screening concentrations (RBSC), and inorganics detected in site samples will be screened against PBOW background screening concentrations (BSC). RBSCs are described in Section 3.4.1 and BSCs are described in Section 3.4.2. The BHHRA protocol for screening is depicted on Figure 3-1. Because only background wells were sampled during the ninth quarterly event, screening values do not apply to this most recent round of sampling.

The Section 4.0 table includes a column for maximum detected concentrations (MDC) and BSCs. The MDC represents the maximum concentration of a particular analyte detected among the background wells. Similar tables will be prepared for each area of concern in the BHHRA. Although "B"-qualified data are identified on the tables, these results are not included in the MDC because all "B"-qualified data will be removed during the BHHRA. Final MDC results for the area of concern will be based on the overall maximum detected concentration for that area, including all quarterly sampling events. BSC values will not be established until quarterly background sampling is complete and a final determination is made as to which wells truly represent background groundwater conditions. True background wells will be determined by further groundwater quality assessment, analytical data comparison with upgradient background wells PB-BED-MW28 and PB-BED-MW29, and additional groundwater flow mapping. Therefore, BSC values for inorganics are denoted by "to be determined" (TBD) in the Section 4.0. One additional background groundwater sampling event is scheduled to be conducted (June 2004) prior to the completion of the RI; the BSCs for inorganics will be based on the resulting data set. These BSC values will be included in the RI and the BHHRA.

3.4.1 Risk-Based Screening

Site groundwater analytical results will be compared to RBSCs in the BHHRA. Groundwater RBSCs are derived from EPA Region 9 preliminary remediation goals tap water criteria, based either on chronic noncancer or cancer effects (EPA, 2002b). For noncancer effects, RBSCs are adjusted to a hazard quotient (HQ) of 0.1. Adjusting the HQ downward accounts for possible

additive effects of multiple chemicals during risk-based screening. For cancer-based effects, both RBSCs and preliminary remediation goals are based on an incremental lifetime cancer risk (ILCR) of 1E-6. Some chemicals exhibit both chronic noncancer and cancer effects. For these chemicals, the RBSC represents either an HQ of 0.1 or an ILCR of 1E-6, whichever results in a lower concentration. The RBSCs are based on a generalized residential drinking water scenario, assumed to be the most restrictive use of groundwater. It is emphasized that RBSCs do not imply a regulatory limit or mandated cleanup level.

In the BHHRA, each chemical with an MDC less than the RBSC will not be considered further. Those chemicals whose MDCs exceed RBSCs will be subject to further evaluation. Risk-based screening is the initial step of the risk screening and evaluation protocol, depicted on Figure 3-1, that will be used in the BHHRA. Based on the findings of the BHHRA, a chemical exceeding its RBSC may or may not be subject to cleanup. No attempt was made to develop RBSCs for ubiquitous, nutritionally essential elements unlikely to be toxic at concentrations ordinarily found in environmental media and for which toxicity values are unavailable (e.g., calcium, magnesium, potassium, and sodium).

3.4.2 Background Screening

Background screening in the BHHRA will apply only to inorganic constituents that exceed RBSCs. Although certain organic compounds in site groundwater (benzene, toluene, ethylbenzene, xylenes, and polynuclear aromatic hydrocarbons) may be attributable to background conditions, these will not be summarily screened out, but rather will be carried through the risk assessment process (i.e., exposure assessment, toxicity assessment, risk characterization), unless screened out on the basis of comparison to RBSCs as described in Section 3.4.1. Final PBOW BSCs will be based on either the 95th upper tolerance limit or the MDC of the background data set (when generated), whichever is less.

BSC values can be finalized only after additional background groundwater samples are collected and a subsequent evaluation of flow direction is performed to determine which wells are truly representative of background conditions. Evaluation of the groundwater flow direction will be made from the March 2004 newly installed wells. Confirmation of the flow direction will be included in a final background summary report anticipated to be submitted in November 2004. Therefore, values for the BSC column on the table in Section 4.0 are left as "TBD." The finalized BSCs will be included in analogous tables in the RI as points of reference, but screening on the basis of background is performed in the BHHRA.

3.4.3 Screening and Risk Evaluation Protocol

Figure 3-1 depicts how risk-based and background screening support the risk assessment decision process that will be applied in the BHHRA. As described in Section 3.4.1 and 3.4.2, the on-site groundwater MDC for a given inorganic analyte that exceeds its RBSC will be screened against its BSC. The "further evaluation" box shown on Figure 3-1, just before the "risk management decision" may include a spatial analysis of site analytical data to determine if elevated concentrations of chemicals that exceed risk criteria are found in small isolated plumes or are evenly distributed throughout the site. This analysis would also examine the potential effect of the distribution on remediation decisions. A geochemical evaluation may be performed for inorganics to further determine whether apparent exceedances in groundwater may be associated with background groundwater conditions.

4.0 Analytical Results

4.1 Groundwater Sampling Events

In March 2004, background groundwater samples representative of high groundwater levels, or wet season conditions, were collected. The background samples were collected from the same monitoring wells sampled in November 1997 and May 1998 (BG8-BEDGW-001 and PB-BED-MW20) as well as from the other background wells (PB-BED-MW24, PB-BED-MW25, PB-BED-MW28, and PB-BED-MW29). A groundwater sample was not collected from background well PB-BED-MW26 due to insufficient water. A quarterly sampling schedule was chosen for these wells to obtain background bedrock groundwater data to determine if similar patterns or trends of chemical constituents are present and thus establish background groundwater constituent concentrations for the bedrock groundwater.

Field measurements of groundwater collected during purge activities of background monitoring wells are shown on page 2 of the sample collection logs in Appendix B. Final measurements representative of the groundwater samples collected are shown on Table 2-2. These results are summarized as follows:

- Temperatures of March 2004 groundwater samples ranged from 9.13 degrees Celsius (°C) (PB-BED-MW29) to 10.91°C (PB-BED-MW20).
- Final turbidity readings in 4 of the 6 wells was 0 nephelometric turbidity units (NTU), with the highest level recorded at 10.2 NTUs in well PB-BED-MW29.
- Conductivity measurements were typically below 2.0 micromhos per centimeter (μmhos/cm). Higher recordings were observed in wells PB-BED-MW29 (9.207 μmhos/cm) and PB-BED-MW20 (48.57 μmhos/cm).
- Oxidation-reduction potential (Eh) measurements of groundwater samples ranged from 42.8 millivolts (mV) (BG8-BEDGW-001) to –310.3 mV (PB-BED-MW24). The positive and negative Eh values are indicative of oxidizing and reducing environments, respectively.
- All of the dissolved oxygen values were found at measurements of 0.0 parts per million (ppm) except for well BG8-BEDGW-001 that exhibited a concentration of 5.51 ppm.

4.2 Analytical Results

The following sections present the blank-evaluated results of the first through the ninth quarterly sampling events. As a comparison tool, the November 1997, May 1998, and previous results are shown on Figure 2-1 with the March 2004 data. Analytical detections for the first through ninth quarters are presented in Table 4-1. All ninth quarter analytical data are presented in Appendices C and D.

4.2.1 Background Monitoring Wells

Due to an indentation in the PVC riser of overburden background well IT-MW01, groundwater was not collected during the September-October 2001 (first quarter), January 2002 (second quarter), or April 2002 (third quarter) sampling events. Groundwater from the well was purged and sampled during the July 2002 (fourth quarter), October 2002 (fifth quarter) and April 2003 (sixth quarter) sampling events using a peristaltic pump. Groundwater for VOC analysis was collected and inserted into the appropriate sample bottle by a pipetting action using the Teflon®-lined tubing for each event. No additional sampling of the well was scheduled following April 2003. Figure 2-1 shows the location of the overburden/shale background well.

Seven bedrock wells were selected to be sampled on a quarterly basis to determine background bedrock groundwater values. These background bedrock monitoring wells are PB-BED-MW20, PB-BED-MW24, PB-BED-MW25, BG8-BEDGW-001, PB-BED-MW26, PB-BED-MW28, and PB-BED-MW29 (Figure 2-1). Groundwater from the background bedrock wells was sample by using either low-flow sampling procedures or by a bailer. Groundwater was analyzed for VOCs, SVOCs, nitroaromatics, metals (total and dissolved), cyanide, and water quality parameters.

Previous and current groundwater sampling results of background overburden/shale and bedrock monitoring wells are described in the following subsections.

4.2.2 Overburden/Shale

September/October 2001, Dry Season Sampling Event (First Quarterly). Due to an indentation of the PVC riser, monitoring well IT-MW01 could not be sampled.

January 2002, Wet Season Sampling Event (Second Quarterly). On January 16, 2002, an attempt was made to repair IT-MW01. As with the September-October 2001 sampling, an indentation of the PVC riser (2 feet below the top of the casing) prevented sampling equipment

(pump and bailer) from reaching groundwater in the well. Review of the IT-MW01 well construction diagram showed that the bottom of the only riser joint (3.2 feet stickup to 4 feet below ground surface) is located within the filter pack. Therefore, this precluded removal of the riser for replacement. Attempts by the sampling personnel were not successful to remove or push back the indentation in the riser.

April 2002, Wet Season Sampling Event (Third Quarterly). Due to an indentation of the PVC riser, monitoring well IT-MW01 could not be sampled.

July 2002, Dry Season Sampling Event (Fourth Quarterly). No nitroaromatics or SVOCs were detected in the overburden background well. Two VOCs, acetone and methylene chloride, were detected and both values were "B" qualified. Several unfiltered and filtered metals were detected. Aluminum, barium, cobalt, copper, iron, manganese, nickel, and zinc were detected in both phases (Table 4-1).

October 2002, Dry Season Sampling Event (Fifth Quarterly). No nitroaromatics or SVOCs were detected in the overburden background well. One VOC, 2-butanone, was detected and it was "B" qualified. Twenty-one unfiltered and 12 filtered metals were detected (Table 4-1).

April 2003, Wet Season Sampling Event (Sixth Quarterly). No nitroaromatics were detected in the overburden background well. Two VOCs, acetone and carbon disulfide, and one SVOC, diethyl phthalate, were detected. Acetone and diethyl phthalate were both "B" qualified. Sixteen unfiltered and 16 filtered metals were detected (Table 4-1).

September 2003, Dry Season Sampling Event (Seventh Quarterly). Overburden/shale monitoring well IT-MW01 was not scheduled to be sampled.

December 2003, Dry Season Sampling Event (Eighth Quarterly). Overburden/shale monitoring well IT-MW01 was not scheduled to be sampled.

March 2004, Wet Season Sampling Event (Ninth Quarterly). Overburden/shale monitoring well IT-MW01 was not scheduled to be sampled.

4.2.3 Summary of Overburden/Shale Sampling Events

No nitroaromatics have been detected in the overburden groundwater from well IT-MW01 during the sampling events from November 1997 to April 2003. Six VOCs have been detected, and all but one detection of toluene (May 1998 - 22 micrograms per liter [µg/L]) and carbon disulfide (April 2003 - 0.1 µg/L) were "B" qualified. One SVOC (diethyl phthalate – April 2003) was detected, but it was "B" qualified. A total of 22 unfiltered and 16 filtered metals have been detected.

4.2.4 Bedrock

September-October 2001, Dry Season Sampling Event (First Quarterly). No nitroaromatic compounds were detected in groundwater samples from the background monitoring wells. Six VOCs (acetone, benzene, ethylbenzene, methylene chloride, toluene, and total xylenes) were detected in well PB-BED-MW24, and 9 VOCs (acetone, benzene, carbon disulfide, chloroform, ethylbenzene, 4-methyl-2-pentanone, methylene chloride, toluene, and total xylenes) were detected in well PB-BED-MW25. SVOC bis(2-ethylhexyl)phthalate was detected in wells PB-BED-MW20 and PB-BED-MW25. Four SVOCs (2,4-dimethylphenol, 2-methylnaphthalene, naphthalene, and phenol) were also detected in well PB-BED-MW24. In the sample from well BG8-BEDGW-001, 9 unfiltered and 8 filtered metals were detected, 13 unfiltered and filtered metals were detected in PB-BED-MW20, 8 unfiltered and 7 filtered metals were detected in PB-BED-MW24, and 9 unfiltered and 9 filtered metals were detected in PB-BED-MW25 (Table 4-1).

January 2002, Wet Season Sampling Event (Second Quarterly). No nitroaromatic compounds were detected in any of the background bedrock monitoring wells. The VOC toluene was detected in the groundwater sample from well PB-BED-MW20; benzene, toluene, ethylbenzene, total xylenes, 2-butanone, carbon disulfide, and chloromethane were detected in well PB-BED-MW24; and carbon disulfide was detected in well PB-BED-MW25. Naphthalene and 2-methylnaphthalene were the only SVOCs detected, and they were found in well PB-BED-MW24. In the groundwater samples from the following wells, the numbers of filtered and unfiltered metals that were detected are listed in parentheses: BG8-BEDGW-001 (11 unfiltered and 11 filtered), PB-BED-MW20 (10 unfiltered and 10 filtered), PB-BED-MW24 (10 unfiltered and 10 filtered), and PB-BED-MW25 (10 unfiltered and 7 filtered). All of the bedrock wells exhibited unfiltered thallium detections that were noted with a "B" validation qualifier. The "B" validation qualifier means that thallium was not detected at a level significantly greater than that

found in the associated method blanks or field blanks. Due to a low water column, only unfiltered metals were sampled in well PB-BED-MW26. Analyte detections in well PB-BED-MW26 included aluminum, arsenic, barium, beryllium, cadmium, chromium, cobalt, copper, iron, lead, manganese, mercury, nickel, vanadium, and zinc. Unfiltered metals detections from monitoring well PB-BED-MW26 were compared with analytical results from the other sampled wells, and the results from PB-BED-MW26 were anomalously high. Therefore, these results were considered to be outliers and will not be used in the determination of BSC values. (Table 4-1).

April 2002, Wet Season Sampling Event (Third Quarterly). Three nitroaromatic compounds were detected in background bedrock wells. Nitrobenzene was detected in wells PB-BED-MW20, PB-BED-MW24, and PB-BED-MW25. Nitroaromatics 2,6-DNT and cyclo-trimethylenetrinitramine (RDX) were detected in PB-BED-MW24. VOCs acetone and total xylenes were detected in well BG8-BEDGW-001, while VOCs acetone, benzene, toluene, ethylbenzene, total xylenes, 2-butanone, and carbon disulfide were detected in well PB-BED-MW24 and carbon disulfide, methylene chloride, and toluene were detected in well PB-BED-MW25. The only SVOCs that were detected were naphthalene and 2-methylnaphthalene in well PB-BED-MW24. The groundwater sample from well BG8-BEDGW-001 contained 11 unfiltered and 9 filtered metals, well PB-BED-MW20 contained 13 unfiltered and 12 filtered metals, well PB-BED-MW24 contained 7 unfiltered and 8 filtered metals, and well PB-BED-MW25 contained 9 unfiltered and 8 filtered metals (Table 4-1).

July 2002, Dry Season Sampling Event (Fourth Quarterly). No nitroaromatic compounds were detected in the groundwater samples of the background monitoring wells. VOCs acetone and 2-butanone were detected in the groundwater sample from well BG8-BEDGW-001; acetone, benzene, bromomethane, 2-butanone, and toluene were detected in well PB-BED-MW20; and acetone, benzene, 2-butanone, ethylbenzene, toluene, and total xylenes were detected in well PB-BED-MW24. Acetone and carbon disulfide were detected in well PB-BED-MW25. SVOC bis(2-ethylhexyl)phthalate was detected in wells BG8-BEDGW-001, PB-BED-MW24, and PB-BED-MW25. The groundwater sample from monitoring well PB-BED-MW24 also exhibited SVOCs 2,4-dimethyphenol, 2-methylnaphthalene, and naphthalene. The groundwater sample from well BG8-BEDGW-001 showed detections of 12 unfiltered and 11 filtered metals; well PB-BED-MW20 contained 10 unfiltered and 10 filtered metals; well PB-BED-MW24 detected 16 unfiltered and 7 filtered metals; and groundwater samples in well PB-BED-MW25 exhibited 8 unfiltered and 9 filtered metals (Table 4-1).

October 2002, Dry Season Sampling Event (Fifth Quarterly). One nitroaromatic compound, nitrobenzene, was detected and it was found in background well PB-BED-MW25. VOCs acetone and carbon disulfide were detected in the groundwater sample from well BG8-BEDGW-001; benzene, carbon disulfide, and toluene were detected in the sample from well PB-BED-MW20; benzene, ethylbenzene, toluene, total xylenes, and carbon disulfide were shown in well PB-BED-MW24; and acetone, benzene, total xylenes, and carbon disulfide were found in the groundwater sample from well PB-BED-MW25. The only SVOC that was detected was 2-methylnaphthalene, and it was from monitoring well PB-BED-MW24. The groundwater sample from well BG8-BEDGW-001 exhibited 9 unfiltered and 9 filtered metals; well PB-BED-MW20 showed 12 unfiltered and 11 filtered metals; well PB-BED-MW24 exhibited 9 unfiltered and 9 filtered metals; and well PB-BED-MW25 showed 9 unfiltered and 9 filtered metals detections (Table 4-1).

April 2003, Wet Season Sampling Event (Sixth Quarterly). One nitroaromatic compound, RDX, was detected in well PB-BED-MW20, and one nitroaromatic compound, 2,4,6-TNT, was detected in well PB-BED-MW24. Although RDX was detected, it was not manufactured at PBOW. VOCs acetone (B qualified) and 2-butanone were detected in the groundwater sample from well BG8-BEDGW-001; benzene, carbon disulfide, and methylene chloride (B qualified) were detected in the sample from well PB-BED-MW20; acetone, benzene, ethylbenzene, methylene chloride, toluene, and total xylenes were detected in well PB-BED-MW24; and carbon disulfide was detected in well PB-BED-MW25. The only SVOCs detected were 2-methylnaphthalene and naphthalene in the groundwater sample from well PB-BED-MW24. The groundwater sample from well BG8-BEDGW-001 showed detections of 10 unfiltered and 11 filtered metals; well PB-BED-MW20 showed detections of 12 unfiltered and 10 filtered metals; well PB-BED-MW24 exhibited 10 unfiltered and 8 filtered metals; and well PB-BED-MW25 showed detections of 9 unfiltered and 11 filtered metals (Table 4-1).

September 2003, Dry Season Sampling Event (Seventh Quarterly). One nitroaromatic compound (4-amino-2,6-dinitrotoluene) was detected and it was found in the groundwater sample from background monitoring well PB-BED-MW20. The compound was "J" qualified, meaning it was detected but it was below the laboratory's reporting limit. VOCs acetone and total xylenes were detected in the groundwater sample from well PB-BED-MW29 and benzene, toluene, and total xylenes were detected in well PB-BED-MW24. No SVOCs were detected in groundwater samples from any well above laboratory reporting limits. The

groundwater sample from well BG8-BEDGW-001 showed detections of 9 unfiltered and 9 filtered metals; well PB-BED-MW20 exhibited 13 unfiltered and 13 filtered metals; well PB-BED-MW24 contained 8 unfiltered and 9 filtered metals; and well PB-BED-MW25 showed detections of 10 unfiltered and 9 filtered metals. The groundwater sample in the newly installed background well PB-BED-MW28 exhibited 11 unfiltered and 11 filtered metals detections, while newly installed well PB-BED-MW29 showed 11 unfiltered and 12 filtered metals detections (Table 4-1).

December 2003, Dry Season Sampling Event (Eighth Quarterly). No nitroaromatic compounds were detected in the groundwater samples of the background monitoring wells. The VOCs carbon disulfide and chloromethane were detected in the groundwater sample from well BG-BEDGW-001; benzene, carbon disulfide, and toluene (B qualified) were detected in well PB-BED-MW20; carbon disulfide, benzene, ethyl benzene, toluene, and total xylenes detected in well PB-BED-MW24; carbon disulfide in well PB-BED-MW25; chloromethane, benzene, ethyl benzene, toluene, and total xylenes in well PB-BED-MW28; and carbon disulfide, chloromethane, benzene, ethyl benzene, and total xylenes in well PB-BED-MW29. The SVOCs 2-methylnaphthalene and naphthalene were detected in the groundwater sample from well PB-BED-MW24. The groundwater sample from well BG8-BEDGW-001 showed detections of 10 unfiltered and 11 filtered metals; well PB-BED-MW20 exhibited 10 unfiltered and 10 filtered metals; well PB-BED-MW24 contained 10 unfiltered and 7 filtered metals; well PB-BED-MW25 showed detections of 10 unfiltered and 8 filtered metals; well PB-BED-MW28 exhibited 10 unfiltered and 10 filtered metals detections; and well PB-BED-MW29 showed 12 unfiltered and 12 filtered metals detections (Table 4-1).

March 2004, Wet Season Sampling Event (Ninth Quarterly). No nitroaromatic compounds were detected in the groundwater samples of the background monitoring wells. VOC carbon disulfide was detected in the groundwater sample from well BG-BEDGW-001; acetone, benzene, carbon disulfide, methylene chloride (B qualified), and toluene were detected in well PB-BED-MW20; benzene, carbon disulfide, ethyl benzene, toluene, and total xylenes detected in well PB-BED-MW24; carbon disulfide and toluene in well PB-BED-MW25; acetone, carbon disulfide, chloromethane, methylene chloride, benzene, and toluene in well PB-BED-MW28; and acetone, carbon disulfide, methylene chloride, benzene, ethyl benzene, and total xylenes in well PB-BED-MW29. No SVOCs were detected in the groundwater samples of the background monitoring wells. The groundwater sample from well BG8-BEDGW-001 showed detections of 9 unfiltered and 10 filtered metals; well PB-BED-MW20 exhibited 11 unfiltered

and 11 filtered metals; well PB-BED-MW24 contained 9 unfiltered and 8 filtered metals; well PB-BED-MW25 showed detections of 8 unfiltered and 7 filtered metals; well PB-BED-MW28 exhibited 11 unfiltered and 11 filtered metals detections; and well PB-BED-MW29 showed 11 unfiltered and 10 filtered metals detections (Table 4-1).

4.2.5 Summary of Bedrock Sampling Events

Four nitroaromatics (2,6-DNT, nitrobenzene, RDX, and 2,4,6-TNT) were detected in the three bedrock wells sampled during the background groundwater sampling events November 1997 to March 2004. Nitrobenzene was found in the groundwater samples from wells PB-BED-MW20 (April 2002), PB-BED-MW24 (April 2002), and PB-BED-MW25 (April and October 2002). Nitroaromatics 2,6-DNT, RDX, and 2,4,6-TNT were detected in groundwater samples from PB-BED-MW24 (April 2002). No nitroaromatics have been detected in groundwater samples from background wells BG8-BEDGW-001, PB-BED-MW28, and PB-BED-MW29. Background well BG8-BEDGW-001 has commonly exhibited VOCs acetone, 2-butanone, carbon disulfide, chloromethane, methylene chloride, and total xylenes. Benzene, ethylbenzene, toluene, total xylenes, carbon disulfide, and methylene chloride have frequently been detected in the groundwater samples from wells PB-BED-MW20, PB-BED-MW24, PB-BED-MW28, and PB-BED-MW29. Acetone, benzene, total xylenes, and carbon disulfide have been detected in the groundwater samples in well PB-BED-MW25. SVOCs naphthalene and 2-methylnaphthalene have frequently been detected but only in well PB-BED-MW24. Twenty-two different unfiltered and 19 filtered metals were detected in groundwater samples from the background wells. Excluding the nutritionally essential compounds (calcium, magnesium, potassium, and sodium), barium, iron, and manganese were the metals most commonly detected in the unfiltered and filtered samples.

5.0 Planned Activities

The following activities are scheduled:

- Continued monitoring and collection of groundwater samples from the seven existing background bedrock monitoring wells. The remaining sampling event is scheduled for June 2004.

- Reporting of the tenth quarterly (June 2004) background groundwater analytical data and field activities in a 2004 Groundwater Data Summary and Evaluation Report. This report will present all background groundwater analytical results, conclusions, and calculated background screening concentrations.

6.0 References

Herdendorf, C. E. 1966, ***Geology of the Vermilion West and Berlin Heights Quadrangles, Ohio,*** Ohio Division of Geological Survey, Report of Investigations 60.

IT Corporation (IT), 2003, ***Fifth Quarterly Background Groundwater Report, Former Plum Brook Ordnance Works, Sandusky, Ohio,*** February.

IT Corporation (IT), 2002a, ***Letter Amendment to Site-Specific Sampling and Analysis Plan, Groundwater Remedial Investigation, TNT and Red Water Ponds Areas, Plum Brook Ordnance Works, Sandusky, Ohio,*** March.

IT Corporation (IT), 2002b, ***2001 Groundwater Remedial Investigation, Former Plum Brook Ordnance Works, Sandusky, Ohio,*** March.

IT Corporation (IT), 2002c, ***Second Quarterly Background Report, Former Plum Brook Ordnance Works, Sandusky, Ohio,*** May.

IT Corporation (IT), 2002d, ***Third Quarterly Background Report, Former Plum Brook Ordnance Works, Sandusky, Ohio,*** July.

IT Corporation (IT), 2001a, ***Site-Specific Sampling and Analysis Plan, Groundwater Remedial Investigation, TNT and Red Water Ponds Areas, Plum Brook Ordnance Works, Sandusky, Ohio,*** July.

IT Corporation (IT), 2001b, ***Site-Specific Safety and Health Plan, Plum Brook Ordnance Works, Sandusky, Ohio***, July.

IT Corporation (IT), 1996a, ***Site-Wide Sampling and Analysis Plan in Site Investigations and Groundwater Investigation, Plum Brook Ordnance Works, Sandusky, Ohio,*** September.

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

IT Corporation (IT), 1996c, ***Site-Wide Safety and Health Plan, Plum Brook Ordnance Works, Sandusky, Ohio,*** September.

Shaw Environmental, Inc. (Shaw), 2004a, ***Eighth Quarterly (December 2003) Background Groundwater Report, Former Plum Brook Ordnance Works, Sandusky, Ohio,*** March.

Shaw Environmental, Inc. (Shaw), 2003a, ***2002 Groundwater Data Summary and Evaluation Report, Former Plum Brook Ordnance Works, Sandusky, Ohio,*** June.

Shaw Environmental, Inc. (Shaw), 2003b, ***Sixth Quarterly Background Groundwater Report, Former Plum Brook Ordnance Works, Sandusky, Ohio,*** July.

Shaw Environmental, Inc. (Shaw), 2003c, ***Seventh Quarterly (September 2003) Background Groundwater Report, Former Plum Brook Ordnance Works, Sandusky, Ohio,*** December.

Stout, Wilbur, 1941, ***Dolomites and Limestones of Western Ohio,*** Geological Survey of Ohio, Bulletin No. 42, p.362-365 and 357-358.

U.S. Army Corps of Engineers (USACE), 2003, ***Scope of Work; Continued Groundwater Remedial Investigation (RI), Background and Off-Site Downgradient Groundwater, Former Plum Brook Ordnance Works, Sandusky, Ohio,*** Nashville, Tennessee, Revised 2 February.

U.S. Army Corps of Engineers (USACE), 2001, ***Scope of Work; Groundwater Remedial Investigation of TNT and Red Water Ponds Areas, Former Plum Brook Ordnance Works, Sandusky, Ohio,*** Nashville, Tennessee, Revised 19 March.

U.S. Environmental Protection Agency (EPA), 2002a, ***Contract Laboratory Program National Functional Guidelines for Inorganic Data Review***, February.

U.S. Environmental Protection Agency (EPA), 2002b, ***Region 9 Preliminary Remediation Goals (PRG),*** 2002 Update, online, 1 October.

U.S. Environmental Protection Agency (EPA), 1999, ***Contract Laboratory Program National Functional Guidelines for Organic Data Review***, October.

U.S. Environmental Protection Agency (EPA), 1994, ***Region III Modifications to National Functional Guidelines for Organic Data Review***, September.

U.S. Environmental Protection Agency (EPA), 1993, ***Region III Modifications to the Laboratory Data Validation Functional Guidelines for Evaluating Inorganic Analyses***, April.

U.S. Environmental Protection Agency (EPA), 1986, ***Test Methods for Evaluating Solid Waste (SW-846), Physical/Chemical Methods***, Third Edition, September.

U.S. Environmental Protection Agency (EPA), 1983, ***Method for Chemical Analysis of Water and Wastes***, EPA 600/4-79-020, March.

TABLES

Table 1-1

Summary of Background Investigations
Ninth Quarterly Background Report
Former Plum Brook Ordnance Works, Sandusky, Ohio

Investigation Conducted By	Date of Activity	Groundwater Level Conditions	Designation	Activity
IT	August 2001	Dry	Groundwater RI	Included installation of 3 background bedrock wells.
IT	September-October 2001	Dry	1st Quarterly Background	Low-flow groundwater sample collection from background wells and selected non-background wells.
IT	January 2002	Wet	2nd Quarterly Background	Low-flow groundwater sample collection from background wells.
IT	April 2002	Wet	3rd Quarterly Background	Low-flow groundwater sample collection from background wells and selected non-background wells.
[a]Shaw	July 2002	Dry	4th Quarterly Background	Low-flow groundwater sample collection from background wells.
Shaw	October 2002	Dry	5th Quarterly Background	Low-flow groundwater sample collection from background wells.
Shaw	April 2003	Wet	6th Quarterly Background	Low-flow groundwater sample collection from background wells.
Shaw	September 2003	Dry	7th Quarterly Background	Low-flow groundwater sample collection from background wells, including new background wells PB-BED-MW28 and PB-BED-MW29.
Shaw	December 2003	Dry	8th Quarterly Background	Low-flow groundwater sample collection from background wells.
Shaw	March 2004	Wet	9th Quarterly Background	Low-flow groundwater sample collection from background wells.

RI - Remedial Investigation.
IT - IT Corporation.
[a]Shaw - IT Corporation was purchased by Shaw Environmental and Infrastructure, Inc. June 6, 2002 and given the name Shaw Environmental, Inc.

Table 2-1

Summary of Groundwater Samples Collected
Ninth Quarterly Background Report
Former Plum Brook Ordnance Works, Sandusky, Ohio

Well Identification	Sample Identification	Sample Date	Number
IT-BG8-BEDGW-001	PBOW-04-IT-BG8-BEDGW-001-DE3000	11-MAR-04	DE3000
PB-BED-MW20	PBOW-04-GW-PB-BED-MW20-DE3001	10-MAR-04	DE3001
PB-BED-MW24	PBOW-04-PB-BED-MW24-DE3002	10-MAR-04	DE3002
PB-BED-MW25	PBOW-04-PB-BED-MW25-DE3003	11-MAR-04	DE3003
PB-BED-MW28	PBOW-04-GW-PB-BED-MW28-DE3004	09-MAR-04	DE3004
PB-BED-MW29	PBOW-04-GW-PB-BED-MW29-DE3005	10-MAR-04	DE3005
PB-BED-MW25	PBOW-04-PB-BED-MW25-DE3006	11-MAR-04	DE3006[a]
PB-BED-MW25	PBOW-04-PB-BED-MW25-DE3007	11-MAR-04	DE3007[b]

[a] Field duplicate.
[b] Field split.

Table 2-2

Final Field Measurements of Groundwater Samples
Ninth Quarterly Background Report
Former Plum Brook Ordnance Works, Sandusky, Ohio

Well Identification	Date	Time	Low-Flow Sampled	PID (ppm)	H_2S (ppm)	Eh (mV)	pH	Conductivity (µmhos/cm)	Turbidity (NTU)	Dissolved O_2 (ppm)	Temperature (°C)	Volume Purged (gal)
Background Overburden Well (1997 through March 2004)												
IT-MW01	11/19/1997	NA	No	0	NM	-58.2	6.7	0.512	1.0	10.57	9.6	6.5
	5/16/1998	NA	No	0	NM	57.3	6.23	0.447	0.0	13.13	14.2	8
	9/27/2001	1040	NA	NM	NM	Not sampled. Riser section dented and prohibited bailer from entering well.						
	1/16/2002	NA	NA	NM	NM	Not sampled. Riser section dented and prohibited bailer from entering well.						
	4/2/2002	NA	NA	NM	NM	Not sampled. Riser section dented and prohibited bailer from entering well.						
	7/10/2002	0900	No	0	0	-8	6.28	0.590	3.7	5.08	17.76	4
	10/16/2002	0925	No	0.0	0.0	-28	6.22	0.765	3.6	3.41	14.4	3.09
	4/9/2003	1040	No	0.0	0.0	134.16	5.22	0.572	45.0	8.08	5.45	6
	9/3/2003	NA	NA	NM	NM	Not sampled.						
	12/10/2003	NA	NA	NA	NA	Not sampled.						
	3/10/2004	NA	NA	NA	NA	Not sampled.						
Background Bedrock Wells (1997 through March 2004)												
O_2 - Oxygen.	11/17/1997	NA	No	0	NM	-245.3	7.21	3.31	321	6.83	10.5	30
	5/15/1998	NA	No	0.1	NM	-36.2	7.80	151	10	8.00	13.0	27.73
	9/27/2001	1220	Yes	0.0	NM	-339	13.03	3.75	0.0	0.00	12.65	2.97
	1/16/2002	1450	Yes	0.0	0.0	-79	7.38	0.856	2.8	0.00	10.69	2.22
	4/3/2002	1127	Yes	0.0	0.0	220	7.25	0.43	4.7	NM	6.7	3
	7/12/2002	0920	Yes	0	0	-258	7.21	3.68	10.3	0.41	13.45	5
	10/18/2002	1050	Yes	0.0	0.0	-307	5.97	3.88	16.5	1.73	14.2	4.0
	4/10/2003	1545	Yes	1.1	0.0	-64.5	7.79	0.656	2.3	NM	8.61	3
	9/18/2003	1550	Yes	0.0	0	-307.9	6.84	3.429	0.0	1.92	15.72	2
	12/10/2003	1620	Yes	0.0	0	-50.8	7.23	0.988	0.0	0.31	11.11	3
	3/11/2004	1405	Yes	0.0	0	42.8	7.16	0.983	0.0	5.51	9.21	2.7
PB-BED-MW20	11/17/1997	NA	No	0	NM	-24.7	6.74	48.5	563	4.14	9.4	27
	5/28/1998	NA	No	0.1	NM	NM	6.65	38.1	999	12.80	13.0	58
	9/26/2001	1415	No	0.0	NM	-73	8.95	53.60	53.5	0.00	10.54	10.33
	1/15/2002	1415	Yes	1.6	0.0	-55	6.83	52.60	15.0	0.00	7.22	1
	4/4/2002	1013	Yes	0.0	NM	51	7.07	53	0.0	0.00	10.37	1.9
	7/10/2002	1600	Yes	0	0	-57	6.73	52.9	NR	0	13.85	3.5
	10/17/2002	1510	No	0.0	0.0	-32	5.69	56.3	10.8	3.38	11.60	24
	4/11/2003	1050	Yes	0.9	0.0	64.3	6.96	49.75	3.7	9.23	10.17	2.8
	9/18/2003	0845	Yes	0.0	0	-9.6	6.43	49.71	0.0	0.38	11.97	1.8
	12/10/2003	1200	Yes	0.0	0	-30.2	6.68	51.46	0.1	0.46	8.86	1.5
	3/10/2004	1525	Yes	0.0	0	-55.7	6.70	48.57	0.0	0.0	10.91	0.75

Table 2-2

Final Field Measurements of Groundwater Samples
Ninth Quarterly Background Report
Former Plum Brook Ordnance Works, Sandusky, Ohio

Well Identification	Date	Time	Low-Flow Sampled	PID (ppm)	H_2S (ppm)	Eh (mV)	pH	Conductivity (µmhos/cm)	Turbidity (NTU)	Dissolved O_2 (ppm)	Temperature (°C)	Volume Purged (gal)
Background Bedrock Wells (1997 through March 2004), continued												
PB-BED-MW24	10/9/2001	0935	Yes	NM	NM	-144	9.38	1.81	73.3	5.32	11.20	2.99
	1/17/2002	1005	Yes	114	0.0	-333	6.82	1.99	2.5	0.00	9.69	2.11
	4/3/2002	1730	Yes	76.0	0.0	-318	7.06	1.98	0.0	NM	10.71	1.8
	7/12/2002	1405	Yes	84.1	>500	-358	6.66	1.88	350	0	12.93	4.5
	10/19/2002	1110	No	58.2	>50	-297	6.30	1.85	22.3	5.52	12.20	4.5
	4/9/2003	1530	Yes	5.6	>200	-337.7	6.64	1.753	0.0	0.0	9.98	3.3
	9/17/2003	1320	Yes	62.9	>500	-323.0	6.14	1.637	0.0	4.88	13.00	3.25
	12/10/2003	1035	Yes	58.3	>50	-331.7	6.61	1.408	0.0	-1.99	10.06	3.2
	3/10/2004	1305	Yes	56.8	156	-310.3	6.54	1.700	3.4	0.0	10.84	2.1
PB-BED-MW25	10/5/2001	0920	Yes	0.0	0.01	-237	10.58	1.89	5.7	2.41	11.90	3.67
	1/16/2002	1030	Yes	0.0	0.0	-291	7.23	2.42	5.8	0.00	10.54	4.44
	4/3/2002	1120	Yes	NM	NM	-333	8.46	2.62	2.7	0.01	10.90	8
	7/11/2002	1115	Yes	0	0	-302	7.19	1.86	1.9	0	12.92	8
	10/17/2002	1035	Yes	0.0	0.0	-290	6.56	2.96	2.1	1.69	12.00	6.0
	4/10/2003	1035	Yes	0.0	0.0	-333.8	7.22	2.817	3.7	NM	10.93	5.5
	9/18/2003	1220	Yes	0.3	0.0	-296.2	6.98	1.707	0.0	0.22	13.91	5.5
	12/11/2003	1355	Yes	0.0	0	-325.6	7.11	1.509	0.0	0.10	10.82	3.6
	3/11/2004	915	Yes	0.0	0.0	-303.4	7.01	1.605	0.0	0.00	10.85	5.2
PB-BED-MW26	10/10/2001	NA	NA	3.6	NM	No sample collected due to insufficient water volume.						
	1/15/02[a]	1030	No	2.2	0.21	-59	6.87	31.0	999	8.04	8.69	0.5
	4/9/2002	NA	NA	NM	NM	No sample collected due to insufficient water volume.						
	7/12/2002	NA	NA	3.1	0	No sample collected due to insufficient water volume.						
	10/16/2002	NA	NA	6.0	0.0	No sample collected due to insufficient water volume.						
	4/8/2003	NA	NA	NM	NM	No sample collected due to insufficient water volume.						
	9/3/2003	NA	NA	NM	NM	No sample collected due to insufficient water volume.						
	12/10/2003	NA	NA	NM	NM	No sample collected due to insufficient water volume.						
	3/10/2004	NA	NA	15.6	0.00	No sample collected due to insufficient water volume.						
PB-BED-MW28	9/17/2003	0915	Yes	0.0	0	-95.2	7.50	1.408	0.0	0.21	13.88	1.50
	12/9/2003	1320	Yes	0.0	0	7.5	7.54	1.391	0.0	0.45	10.28	1.5
	3/9/2004	1410	Yes	0.0	0	75.3	8.50	1.739	0.0	0	10.01	2.5
PB-BED-MW29	9/16/2003	1520	Yes	0.0	0	6.5	6.66	10.30	25.0	0.22	15.80	3.9
	12/9/2003	1535	Yes	8.0	0	3.0	6.82	8.490	1.9	0.39	10.00	1.37
	3/10/2004	1015	Yes	0.0	0	34.4	6.73	9.207	10.2	0.0	9.13	1.8

Table 2-2

Final Field Measurements of Groundwater Samples
Ninth Quarterly Background Report
Former Plum Brook Ordnance Works, Sandusky, Ohio

Notes:

Water quality measurements recorded at time of sample collection. PID and H_2S readings taken as monitoring well lid removed.

°C - Degrees Celsius.
Eh - Oxidation-reduction potential.
H_2S - Hydrogen sulfide.
gal - Gallons.
µmhos/cm - Micromhos per centimeter.
mV - Millivolts.
NA - Not applicable.
NM - Not measured.
NR - Not recorded.
NTU - Nephelometric turbidity unit.
PID - Photoionization detector.
ppm - Parts per million.
O_2 - Oxygen.

[a]Final water quality reading collected from last purged groundwater due to a very limited water volume. Well was purged on 1/15/02 and sample was collected on 1/17/02 at 0820.

Table 3-1

Summary of Analytical Parameters and Methods
Ninth Quarterly Groundwater Report
Former Plum Brook Ordnance Works, Sandusky, Ohio

Sample Matrix	Analytical Parameters[a]	Analytical Method[b]
Groundwater (Monitoring Well)	Nitroaromatic Compounds	SW-846 8330M
	TCL Volatile Organic Compounds	SW-846 5030/8260B
	TCL Semivolatile Organic Compounds	SW-846 3510C/8270C
	TAL Metals (T/D)	SW-846 3005A/6010B/7470A
	Turbidity	EPA 180.1
	Alkalinity	EPA 310.1
	Hardness	EPA 200.7
	Total Organic Carbon	EPA 415.1
	Total Dissolved Solids	EPA 160.1
	Total Suspended Solids	EPA 160.2
	Chloride	EPA 325.2
	Cyanide, total	SW-846 9012A
	Nitrate	EPA 353.2
	Sulfate	EPA 375.4

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

[b] Analyses found in the U.S. Environmental Protection Agency's (EPA), *Test Methods for Evaluating Solid Waste (SW-846), Physical/Chemical Methods,* Third Edition, September 1996, *Methods for Chemical Analysis of Water and Wastes,* March 1983, and their subsequent revisions.

T/D - Total and dissolved (i.e., filtered).

Table 4-1

Detected Constituents in Background Monitoring Wells
Ninth Quarterly Background Report
Former Plum Brook Ordnance Works, Sandusky, Ohio

			Location:	IT-BG8-BEDGW-001																					
			Sample No.:	5410		5415		BD3007		CA3006		CB3007		CC3001		CD3001		DA3001		DC3000		DD3001		DE3000	
			Sample Date:	17-Nov-97		15-May-98		27-Sep-01		16-Jan-02		3-Apr-02		12-Jul-02		18-Oct-02		10-Apr-03		18-Sep-03		10-Dec-03		11-Mar-04	
			Low-Flow Sample:	No		No		Yes		Yes		Yes		Yes		Yes		Yes		Yes		Yes		Yes	
Parameter	Units	MDC	BSC	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ
EXPLOSIVES																									
Amino-2,6-dinitrotoluene, 4-	ug/L	0.19	NE																						
Dinitrotoluene, 2,6-	ug/L	0.43	NE																						
Nitrobenzene	ug/L	0.33	NE																						
RDX	ug/L	0.22	NE																						
Trinitrotoluene, 2,4,6-	ug/L	0.081	NE																						
VOLATILES																									
Acetone	ug/L	170	NE									3.5	J	2.6	B	3.4	J	1.9	B						
Benzene	ug/L	110	NE																						
Bromomethane	ug/L	0.27	NE																						
Butanone, 2-	ug/L	17	NE											3.2	B			0.53	J						
Carbon disulfide	ug/L	29	NE	0.65	J											0.43	J					0.3	J	0.19	J
Chloroform	ug/L	1.1	NE																						
Chloromethane	ug/L	1.3	NE																			0.26	J		
Ethylbenzene	ug/L	38	NE																						
Methyl-2-pentanone, 4-	ug/L	0.3	NE																						
Methylene chloride	ug/L	21	NE	0.37	B																				
Toluene	ug/L	100	NE																						
Trichloroethene	ug/L	0.59	NE																						
Xylenes, total	ug/L	210	NE	0.38	B							1													
SEMIVOLATILES																									
Bis(2-ethylhexyl)phthalate	ug/L	5.4	NE	1.7	J	4	B							4.3	B										
Diethyl phthalate	ug/L	1.5	NE																						
Dimethylphenol, 2,4-	ug/L	1.1	NE																						
Methylnaphthalene, 2-	ug/L	10	NE																						
Naphthalene	ug/L	8.7	NE																						
Phenol	ug/L	1.4	NE																						
METALS-UNFILTERED																									
Aluminum	ug/L	10200	TBD	9020		307		51.6	B	78.7	B	31.5	J	65.2	B	83.6	B	141	B	101	B				
Antimony	ug/L	8	TBD																						
Arsenic	ug/L	52.6	TBD	17.6										3.6	J										
Barium	ug/L	26900	TBD	520				285		68	J	29.9	J	229		279		43.5	J	292		73.2	J	25.8	J
Beryllium	ug/L	4.6	TBD							1.2	B														
Cadmium	ug/L	1.5	TBD																						
Calcium	ug/L	2290000	TBD	161000		57700		124000	J	91300		81500		134000		122000		66600		131000		86200		66800	
Chromium	ug/L	18.2	TBD	18.2				1.4	B																
Cobalt	ug/L	35.8	TBD											12.1	J			1	J						
Copper	ug/L	72.2	TBD	59.5								3.3	J												
Iron	ug/L	52100	TBD	22600		1230	J	204		118	B	38.2	J	1490		74.5	J			218		908			
Lead	ug/L	101	TBD	26.3		6.8																			
Magnesium	ug/L	1040000	TBD	79500		19300		77300		38400		31700		73500		77000		29000		81900		37100		25000	
Manganese	ug/L	2240	TBD	2240		130		71.6		107		29		688		51.1		35		63.8		166		3.6	J
Mercury	ug/L	0.45	TBD																						
Nickel	ug/L	74.9	TBD									6.8	J	8.6	J			8.6	J			4.8	J	3.6	B
Potassium	ug/L	174000	TBD	32900				41100		13300		2530	J	30500		41200	J	5290	J	42700	J	7630		2530	J
Selenium	ug/L	5	TBD																						
Sodium	ug/L	9130000	TBD	399000				459000		93200		23600		395000		462000		48900		471000		86300		21300	
Thallium	ug/L	7.1	TBD							3.3	B									3.8	B	2.5	B	3.1	B
Vanadium	ug/L	35.9	TBD																						
Zinc	ug/L	612	TBD	126		49.7	B			12.6	J	15.6	J	10		0.83	J	2.5	B			30.1		4.3	B

Table 4-1

Detected Constituents in Background Monitoring Wells
Ninth Quarterly Background Report
Former Plum Brook Ordnance Works, Sandusky, Ohio

			Location:	IT-BG8-BEDGW-001																					
			Sample No.:	5410		5415		BD3007		CA3006		CB3007		CC3001		CD3001		DA3001		DC3000		DD3001		DE3000	
			Sample Date:	17-Nov-97		15-May-98		27-Sep-01		16-Jan-02		3-Apr-02		12-Jul-02		18-Oct-02		10-Apr-03		18-Sep-03		10-Dec-03		11-Mar-04	
			Low-Flow Sample:	No		No		Yes		Yes		Yes		Yes		Yes		Yes		Yes		Yes		Yes	
Parameter	Units	MDC	BSC	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ
METALS- FILTERED																									
Aluminum	ug/L	1470	TBD					56.6	B	83.6	B	52	B	113	B	86.7	B	113	B	75	B			61.6	B
Antimony	ug/L	0	TBD																						
Arsenic	ug/L	6.9	TBD																						
Barium	ug/L	26200	TBD	366				279		83.6	J	30.6	J	236		285		47.6	J	292		81.8	J	27.8	J
Beryllium	ug/L	1.5	TBD							1.5	B														
Cadmium	ug/L	1.2	TBD																			1.2	J		
Calcium	ug/L	2570000	TBD	121000	J	92100		125000		98300		82900		133000		127000		70000		131000		89900	J	66100	
Chromium	ug/L	0	TBD																						
Cobalt	ug/L	34.8	TBD											8.2	J			2.5	J						
Copper	ug/L	49.2	TBD																						
Iron	ug/L	6180	TBD	563				169		216				1160		53.4	J			195		856			
Lead	ug/L	8.7	TBD																						
Magnesium	ug/L	1090000	TBD	72400		41000		77600		43300		32300		76000		79800		30400		81900		40000		24800	
Manganese	ug/L	1300	TBD	1300		658		73.5		117		23.6		728		52.2		73.8		64		164		3.6	J
Mercury	ug/L	0.24	TBD																						
Nickel	ug/L	82.9	TBD									7	J	8.5	J			9.8	J			4.8	J	4.8	J
Potassium	ug/L	173000	TBD	32000		14400		40700		16700		2470	J	31000		43200	J	5930	J	42100	J	9690	J	2620	J
Selenium	ug/L	0	TBD																						
Sodium	ug/L	9110000	TBD	398000		139000		459000		121000	J	24400		392000		472000		62800		472000		112000	J	22400	
Thallium	ug/L	7.3	TBD							4.6	B							6.9	B	4.7	B	2.7	B	5.1	J
Vanadium	ug/L	0	TBD																						
Zinc	ug/L	673	TBD			44.9	B			13.5	J	17.3	J	7.3	J	1.2	B	5.8	J			35.9		3.9	B
WATER QUALITY PARAMETERS																									
Alkalinity	ppm	979	NE	350		180		357	J	200		157		367		332		168		355		255		189	
Chloride	ppm	34600	NE	780		34		932		78		63.2	J	896		999		77.7		1000		132		24.5	
Cyanide, total	ppm	0.004	NE																						
Hardness	ppm	20000	NE	1000		340		719		380		314		647		687		320		710		313		340	
Nitrate	ppm	22	NE			7.3				22		10.4						8.6				0.58		16	R
Nitrate-Nitrite	ppm	0.2	NE	0.2																					
Sulfate	ppm	416	NE	70		45		28.3		68		63.3		9.2		11.2		57.5		23.3		54.4		46.4	
Total dissolved solids	ppm	43800	NE	1800		300		1990		500		458		2040		1870		174		1880		584		352	
Total organic carbon	ppm	9.9	NE			1								1.9		1.3				1.2		1.2		1.1	
Total suspended solids	ppm	760	NE	10		280		4				3	J	21				4		7		4			
Turbidity	NTU	742	NE					104	J			0.61		39		44.2		0.56		78.5		5.2	J		

Table 4-1

Detected Constituents in Background Monitoring Wells
Ninth Quarterly Background Report
Former Plum Brook Ordnance Works, Sandusky, Ohio

			Location:	IT-MW01									
			Sample No.:	5530		5535/5535R		CC3009		CD3002		DA3002	
			Sample Date:	19-Nov-97		16-May-98		10-Jul-02		16-Oct-02		9-Apr-03	
			Low-Flow Sample:	No		No		No		No		No	
Parameter	Units	MDC	BSC	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ
EXPLOSIVES													
Amino-2,6-dinitrotoluene, 4-	ug/L	0.19	NE										
Dinitrotoluene, 2,6-	ug/L	0.43	NE										
Nitrobenzene	ug/L	0.33	NE										
RDX	ug/L	0.22	NE										
Trinitrotoluene, 2,4,6-	ug/L	0.081	NE										
VOLATILES													
Acetone	ug/L	170	NE					3.5	B			1.5	B
Benzene	ug/L	110	NE										
Bromomethane	ug/L	0.27	NE										
Butanone, 2-	ug/L	17	NE							0.7	B		
Carbon disulfide	ug/L	29	NE									0.1	J
Chloroform	ug/L	1.1	NE										
Chloromethane	ug/L	1.3	NE										
Ethylbenzene	ug/L	38	NE										
Methyl-2-pentanone, 4-	ug/L	0.3	NE										
Methylene chloride	ug/L	21	NE	0.33	B	0.58	B	0.19	B				
Toluene	ug/L	100	NE			22							
Trichloroethene	ug/L	0.59	NE										
Xylenes, total	ug/L	210	NE	0.31	B								
SEMIVOLATILES													
Bis(2-ethylhexyl)phthalate	ug/L	5.4	NE										
Diethyl phthalate	ug/L	1.5	NE									1.5	B
Dimethylphenol, 2,4-	ug/L	1.1	NE										
Methylnaphthalene, 2-	ug/L	10	NE										
Naphthalene	ug/L	8.7	NE										
Phenol	ug/L	1.4	NE										
METALS-UNFILTERED													
Aluminum	ug/L	10200	TBD					117	J	10200	J	1400	
Antimony	ug/L	8	TBD							8	J		
Arsenic	ug/L	52.6	TBD							52.6			
Barium	ug/L	26900	TBD					75.9	J	139	J	60.7	J
Beryllium	ug/L	4.6	TBD							4.6	J	0.84	B
Cadmium	ug/L	1.5	TBD							1.5	J	0.38	J
Calcium	ug/L	2290000	TBD	46400		47900		39400		56300		44400	
Chromium	ug/L	18.2	TBD							14.1			
Cobalt	ug/L	35.8	TBD					7.5	J	14	J	35.8	J
Copper	ug/L	72.2	TBD					9.1	J	72.2		48.8	
Iron	ug/L	52100	TBD	1320		2200	J	563		52100		3530	
Lead	ug/L	101	TBD							101		8.8	
Magnesium	ug/L	1040000	TBD	17500		16300		15900		19500		19800	
Manganese	ug/L	2240	TBD	323		348		292		490		396	
Mercury	ug/L	0.45	TBD	0.45									
Nickel	ug/L	74.9	TBD					15	J	35	J	74.9	
Potassium	ug/L	174000	TBD	6160		5560		6780	J	6480		7450	J
Selenium	ug/L	5	TBD							5			
Sodium	ug/L	9130000	TBD	22800		22000		19400		17800		19200	
Thallium	ug/L	7.1	TBD							5.7	J	4	B
Vanadium	ug/L	35.9	TBD							35.9	J		
Zinc	ug/L	612	TBD	51.6		149		34.3		124	J	74.8	

Table 4-1

Detected Constituents in Background Monitoring Wells
Ninth Quarterly Background Report
Former Plum Brook Ordnance Works, Sandusky, Ohio

			Location:	IT-MW01									
			Sample No.:	5530		5535/5535R		CC3009		CD3002		DA3002	
			Sample Date:	19-Nov-97		16-May-98		10-Jul-02		16-Oct-02		9-Apr-03	
			Low-Flow Sample:	No		No		No		No		No	
Parameter	Units	MDC	BSC	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ
METALS- FILTERED													
Aluminum	ug/L	1470	TBD			276		62.2	B	71.6	B	1470	
Antimony	ug/L	0	TBD										
Arsenic	ug/L	6.9	TBD										
Barium	ug/L	26200	TBD					82.5	J	89.1	J	52.6	J
Beryllium	ug/L	1.5	TBD									1.2	B
Cadmium	ug/L	1.2	TBD									0.48	J
Calcium	ug/L	2570000	TBD	44900		53100		39300		57700		47400	
Chromium	ug/L	0	TBD										
Cobalt	ug/L	34.8	TBD					10.3	J	4.9	J	34.8	J
Copper	ug/L	49.2	TBD					2.8	J	3.7	J	49.2	
Iron	ug/L	6180	TBD	1090		1970		745		1840		2480	
Lead	ug/L	8.7	TBD									8.7	
Magnesium	ug/L	1090000	TBD	17000		19500		14600		20300		20900	
Manganese	ug/L	1300	TBD	331		395		326		424		360	
Mercury	ug/L	0.24	TBD										
Nickel	ug/L	82.9	TBD					26.2	J	10.5	J	82.9	
Potassium	ug/L	173000	TBD	6180		6390		6390	J	6400	J	7270	J
Selenium	ug/L	0	TBD										
Sodium	ug/L	9110000	TBD	22200		25100		19200		19400		18400	
Thallium	ug/L	7.3	TBD									4.9	B
Vanadium	ug/L	0	TBD										
Zinc	ug/L	673	TBD	46.9		47.5	B	124		13.1	J	73.8	
WATER QUALITY PARAMETERS													
Alkalinity	ppm	979	NE	360		110		90		209		9.9	
Chloride	ppm	34600	NE	4		3		3.4		9.9		3	
Cyanide, total	ppm	0.004	NE										
Hardness	ppm	20000	NE	420		200		144		263		196	
Nitrate	ppm	22	NE					0.19					
Nitrate-Nitrite	ppm	0.2	NE										
Sulfate	ppm	416	NE	79		140		118		67.3		211	
Total dissolved solids	ppm	43800	NE	310		400		279		342		137	
Total organic carbon	ppm	9.9	NE	* 8.6		7		7.1		9.9		3.8	
Total suspended solids	ppm	760	NE	84		5		4		5		21	
Turbidity	NTU	742	NE					1.7		10.6		14	

Table 4-1

Detected Constituents in Background Monitoring Wells
Ninth Quarterly Background Report
Former Plum Brook Ordnance Works, Sandusky, Ohio

			Location:	PB-BED-MW20																					
			Sample No.:	5960		5965		BD3026		CA3005		CB3001		CC3003		CD3003		DA3003		DC3001		DD3002		DE3001	
			Sample Date:	17-Nov-97		28-May-98		26-Sep-01		15-Jan-02		4-Apr-02		10-Jul-02		17-Oct-02		11-Apr-03		18-Sep-03		9-Dec-03		10-Mar-04	
			Low-Flow Sample:	No		No		No		Yes		Yes		Yes		No		Yes		Yes		Yes		Yes	
Parameter	Units	MDC	BSC	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ
EXPLOSIVES																									
Amino-2,6-dinitrotoluene, 4-	ug/L	0.19	NE																	0.19	J				
Dinitrotoluene, 2,6-	ug/L	0.43	NE																						
Nitrobenzene	ug/L	0.33	NE									0.088	J												
RDX	ug/L	0.22	NE															0.17	J						
Trinitrotoluene, 2,4,6-	ug/L	0.081	NE																						
VOLATILES																									
Acetone	ug/L	170	NE					1.2	J			5.3	J	10	B									2.1	J
Benzene	ug/L	110	NE	0.93	J	1.6		0.25	J					3.2		1.3	J	0.23	J	1.4	J	1.2		1.1	
Bromomethane	ug/L	0.27	NE											0.27	J										
Butanone, 2-	ug/L	17	NE											9.8											
Carbon disulfide	ug/L	29	NE			0.17	J									1.1	J	0.21	J			0.16	J	0.21	J
Chloroform	ug/L	1.1	NE																						
Chloromethane	ug/L	1.3	NE																	0.47	B				
Ethylbenzene	ug/L	38	NE	0.15	J																				
Methyl-2-pentanone, 4-	ug/L	0.3	NE																						
Methylene chloride	ug/L	21	NE	0.3	B	0.49	B											0.31	B					0.28	B
Toluene	ug/L	100	NE	0.73	B	0.95	B			2.4	B			0.76	B	0.35	J			0.45	B	0.26	B	0.28	J
Trichloroethene	ug/L	0.59	NE																						
Xylenes, total	ug/L	210	NE	2.6		0.91	J					0.67	J												
SEMIVOLATILES																									
Bis(2-ethylhexyl)phthalate	ug/L	5.4	NE			5.4	B	2.9	J																
Diethyl phthalate	ug/L	1.5	NE																						
Dimethylphenol, 2,4-	ug/L	1.1	NE																						
Methylnaphthalene, 2-	ug/L	10	NE	1.1	J																				
Naphthalene	ug/L	8.7	NE																						
Phenol	ug/L	1.4	NE																						
METALS-UNFILTERED																									
Aluminum	ug/L	10200	TBD	3290		678	J	207	J			48.6	J	83.4	B	155	J	143	B	115	B	57.9	B	63.2	B
Antimony	ug/L	8	TBD																						
Arsenic	ug/L	52.6	TBD																	3.3	J			3.4	B
Barium	ug/L	26900	TBD	19000		16400		23900		22500		23700		24000		25700		26900		25200		26100		25500	
Beryllium	ug/L	4.6	TBD													0.51	B								
Cadmium	ug/L	1.5	TBD																						
Calcium	ug/L	2290000	TBD	2140000		1960000	J	2060000	J	1860000		1890000		2000000		2050000		2180000		2180000		2290000		2100000	
Chromium	ug/L	18.2	TBD					7.6	B			1.7	J					1.3	B						
Cobalt	ug/L	35.8	TBD					7.1	J			6.1	J	8	J	8.1	J	8.5	J	8.6	J	6.8	J	7.1	J
Copper	ug/L	72.2	TBD	32.8				15.8	B	32.8		30.5													
Iron	ug/L	52100	TBD	13200		6770		5920	J	6480		853		4970		5310		257		4120		2030		794	
Lead	ug/L	101	TBD																						
Magnesium	ug/L	1040000	TBD	920000		861000		943000	J	860000		884000		960000		941000		981000		1040000		1040000		992000	
Manganese	ug/L	2240	TBD	180		153		189	J	128		156		190		185		162		192		202		183	
Mercury	ug/L	0.45	TBD																						
Nickel	ug/L	74.9	TBD					3.5	J			3.4	J					7.2	J	4	J				
Potassium	ug/L	174000	TBD	92300		78600		85800	J	165000		86700	J	101000	J	91700	J	81700	J	104000	J	72600	J	174000	J
Selenium	ug/L	5	TBD																						
Sodium	ug/L	9130000	TBD	7660000		7300000		7980000	J	6830000		7770000		8380000		8190000		8430000		8540000		9130000		8600000	
Thallium	ug/L	7.1	TBD							7.1	B					4.1	B			4.6	B				
Vanadium	ug/L	35.9	TBD																						
Zinc	ug/L	612	TBD	41.6		42.1	B	5.3		23.4		64.9		9.7	J	15.6	J	5.3	B	5.7	J	612		43.6	

Table 4-1

Detected Constituents in Background Monitoring Wells
Ninth Quarterly Background Report
Former Plum Brook Ordnance Works, Sandusky, Ohio

			Location:	PB-BED-MW20																					
			Sample No.:	5960		5965		BD3026		CA3005		CB3001		CC3003		CD3003		DA3003		DC3001		DD3002		DE3001	
			Sample Date:	17-Nov-97		28-May-98		26-Sep-01		15-Jan-02		4-Apr-02		10-Jul-02		17-Oct-02		11-Apr-03		18-Sep-03		9-Dec-03		10-Mar-04	
			Low-Flow Sample:	No		No		No		Yes		Yes		Yes		No		Yes		Yes		Yes		Yes	
Parameter	Units	MDC	BSC	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ
METALS- FILTERED																									
Aluminum	ug/L	1470	TBD					40.9	B			55.9	B	63.1	B	69.8	B	109	B	91.4	B			77.8	B
Antimony	ug/L	0	TBD																						
Arsenic	ug/L	6.9	TBD					2.8	J											4.8	J	4.1	J		
Barium	ug/L	26200	TBD	21000		4950		24400		21300		23800		23900		24500		26200		25700		25700		24300	
Beryllium	ug/L	1.5	TBD													0.24	B								
Cadmium	ug/L	1.2	TBD																						
Calcium	ug/L	2570000	TBD	2570000	J	491000	J	2110000		1720000		1910000		2020000		1990000		2120000		2270000		2240000	J	2000000	
Chromium	ug/L	0	TBD																						
Cobalt	ug/L	34.8	TBD					6.4	J			5.9	J	8	J	7.5	J	9.3	J	23.8	J	6.2	J	6.2	J
Copper	ug/L	49.2	TBD					2	B	5.7	J	26.5												5.3	B
Iron	ug/L	6180	TBD	2310		1320		5350		6180		1130		5100		4940				3800		1830		510	
Lead	ug/L	8.7	TBD																						
Magnesium	ug/L	1090000	TBD	1090000		223000	J	965000		829000		888000		969000		911000		953000		1070000		1020000		944000	
Manganese	ug/L	1300	TBD	162		47		188		129		156		193		182		160		220		200		178	
Mercury	ug/L	0.24	TBD			0.24												0.032	J						
Nickel	ug/L	82.9	TBD					2.9	J			3.2	J					6.5	J	6	J				
Potassium	ug/L	173000	TBD	103000		21600		87400	J	170000		86900	J	102000	J	88400	J	79000	J	105000	J	70500	J	173000	J
Selenium	ug/L	0	TBD																						
Sodium	ug/L	9110000	TBD	9110000		1870000		8100000		6870000		7830000		8120000		7750000		8210000		8710000		9000000	J	8220000	
Thallium	ug/L	7.3	TBD							7.3	B									4.1	B				
Vanadium	ug/L	0	TBD																						
Zinc	ug/L	673	TBD					3.3	J	21.6		59.2	J	3.2	J	78.3		4.8	J	6.4	J	673		31.4	
WATER QUALITY PARAMETERS																									
Alkalinity	ppm	979	NE	240		260		255	J	280		229		293		259		246		248		238		248	
Chloride	ppm	34600	NE	19000		21000		22400		18000		17300	J	19000		21100		34600		19100		21300		20800	
Cyanide, total	ppm	0.004	NE																						
Hardness	ppm	20000	NE	20000		10000		9360		8200		8850		8140		9390		9200		9690		9940		9550	
Nitrate	ppm	22	NE																						
Nitrate-Nitrite	ppm	0.2	NE																						
Sulfate	ppm	416	NE							3.2															
Total dissolved solids	ppm	43800	NE	32000		24000		27400	J	26000		27800		35500		43800		32600		42700		33600		28700	
Total organic carbon	ppm	9.9	NE					0.5	J	1.1	J	0.74	J												
Total suspended solids	ppm	760	NE	74		90		125		13		13		33		19		100		112		39		760	
Turbidity	NTU	742	NE					48.4	J	8.8		10.5		7.4		19.2		3.9		6.2		18.4	J	5.7	

Table 4-1

Detected Constituents in Background Monitoring Wells
Ninth Quarterly Background Report
Former Plum Brook Ordnance Works, Sandusky, Ohio

			Location:	PB-BED-MW24																	
			Sample No.:	BD3029		CA3001		CB3008		CC3004		CD3004		DA3004		DC3002		DD3003		DE3002	
			Sample Date:	9-Oct-01		17-Jan-02		3-Apr-02		12-Jul-02		19-Oct-02		9-Apr-03		17-Sep-03		11-Dec-03		10-Mar-04	
			Low-Flow Sample:	Yes		Yes		Yes		Yes		No		Yes		Yes		Yes		Yes	
Parameter	Units	MDC	BSC	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ
EXPLOSIVES																					
Amino-2,6-dinitrotoluene, 4-	ug/L	0.19	NE																		
Dinitrotoluene, 2,6-	ug/L	0.43	NE					0.43													
Nitrobenzene	ug/L	0.33	NE					0.33													
RDX	ug/L	0.22	NE					0.22	J												
Trinitrotoluene, 2,4,6-	ug/L	0.081	NE											0.081	J						
VOLATILES																					
Acetone	ug/L	170	NE	120	J			170	J	60				88	B						
Benzene	ug/L	110	NE	60		91		110		14	J	9.3	J	36	J	32		36		22	
Bromomethane	ug/L	0.27	NE																		
Butanone, 2-	ug/L	17	NE			8.1		17	J	12	B										
Carbon disulfide	ug/L	29	NE			1.2		0.59	J			29						3.4	J	9.1	J
Chloroform	ug/L	1.1	NE																		
Chloromethane	ug/L	1.3	NE			1.3	J														
Ethylbenzene	ug/L	38	NE	19	J	32		38		8	J	4.8	J	15	J	13	J	10		9	J
Methyl-2-pentanone, 4-	ug/L	0.3	NE																		
Methylene chloride	ug/L	21	NE	21	J									14	J						
Toluene	ug/L	100	NE	58		90		100		17	J	14		43	J	37		31		14	
Trichloroethene	ug/L	0.59	NE																		
Xylenes, total	ug/L	210	NE	110		180		210		55		23		82		67		50	J	48	J
SEMIVOLATILES																					
Bis(2-ethylhexyl)phthalate	ug/L	5.4	NE							4.6	B										
Diethyl phthalate	ug/L	1.5	NE																		
Dimethylphenol, 2,4-	ug/L	1.1	NE	1.1	J					0.76	J										
Methylnaphthalene, 2-	ug/L	10	NE	3.6	J	5.6		4.6	J	10	J	1.4	J	5.5	J	4	J	2.9	J		
Naphthalene	ug/L	8.7	NE	2.9	J	7		4	J	8.7	J			4.6	J	3.5	J	2.3	J		
Phenol	ug/L	1.4	NE	1.4	J																
METALS-UNFILTERED																					
Aluminum	ug/L	10200	TBD	37.8	J	77.7	B	35.7	J	1150		115	J	141	B	78	B	194	J	61.5	B
Antimony	ug/L	8	TBD																		
Arsenic	ug/L	52.6	TBD							4.3											
Barium	ug/L	26900	TBD	932		938		1160		680		1080		1140		690		642		489	
Beryllium	ug/L	4.6	TBD			1.2	B														
Cadmium	ug/L	1.5	TBD																		
Calcium	ug/L	2290000	TBD	158000		157000		161000		346000		159000		167000		168000		151000		131000	
Chromium	ug/L	18.2	TBD							9.4											
Cobalt	ug/L	35.8	TBD							2.9				1.2	J			7.7	J		
Copper	ug/L	72.2	TBD							8.6										18.5	J
Iron	ug/L	52100	TBD	48.3	J	72.7	B			13400		403									
Lead	ug/L	101	TBD							5.2	B										
Magnesium	ug/L	1040000	TBD	78500		78900		82900		88800		75400		84500		80600		70800		69500	
Manganese	ug/L	2240	TBD	24.8		19.2		14.8	J	420		23.6		14.1	J	27.4		25.8		26.3	
Mercury	ug/L	0.45	TBD											0.035	J						
Nickel	ug/L	74.9	TBD							7.9											
Potassium	ug/L	174000	TBD	32100		46600		47600	J	41600		22900	J	26400	J	24100	J	24300		23700	J
Selenium	ug/L	5	TBD																		
Sodium	ug/L	9130000	TBD	90800		90600		106000		101000		91800		104000		80400		67000		61800	
Thallium	ug/L	7.1	TBD			4.2	B									3.8	B	2.5	B		
Vanadium	ug/L	35.9	TBD							6.1											
Zinc	ug/L	612	TBD							28.4		3.9	J	1.2	B			9.3	J	6.4	J

Table 4-1

Detected Constituents in Background Monitoring Wells
Ninth Quarterly Background Report
Former Plum Brook Ordnance Works, Sandusky, Ohio

			Location:	PB-BED-MW24																	
			Sample No.:	BD3029		CA3001		CB3008		CC3004		CD3004		DA3004		DC3002		DD3003		DE3002	
			Sample Date:	9-Oct-01		17-Jan-02		3-Apr-02		12-Jul-02		19-Oct-02		9-Apr-03		17-Sep-03		11-Dec-03		10-Mar-04	
			Low-Flow Sample:	Yes		Yes		Yes		Yes		No		Yes		Yes		Yes		Yes	
Parameter	Units	MDC	BSC	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ
METALS- FILTERED																					
Aluminum	ug/L	1470	TBD	55.1	B	89.6	B	74	B	110	B	87	B	128	B	69.9	B	50.8	B	56.9	B
Antimony	ug/L	0	TBD																		
Arsenic	ug/L	6.9	TBD																		
Barium	ug/L	26200	TBD	942		962		1170		670		1140		1160		689		669		489	
Beryllium	ug/L	1.5	TBD			1.5	B														
Cadmium	ug/L	1.2	TBD																		
Calcium	ug/L	2570000	TBD	159000		158000		161000		147000		160000		168000		169000		152000	J	126000	
Chromium	ug/L	0	TBD																		
Cobalt	ug/L	34.8	TBD									1.4	J	1.5	J	3.7	J				
Copper	ug/L	49.2	TBD																		
Iron	ug/L	6180	TBD			40.7	B														
Lead	ug/L	8.7	TBD																		
Magnesium	ug/L	1090000	TBD	78500		78800		82800		79400		77600		83600		79900		71100		67300	
Manganese	ug/L	1300	TBD	22.1		18.7		16.6		44.2		15.5		13.7	J	35		25.5		26	
Mercury	ug/L	0.24	TBD																		
Nickel	ug/L	82.9	TBD																		
Potassium	ug/L	173000	TBD	30700	J	43300		44400	J	38300		24000	J	25800	J	23200	J	24500	J	23900	J
Selenium	ug/L	0	TBD																		
Sodium	ug/L	9110000	TBD	90500		87800	J	105000		98500		92500		105000		79600		67900	J	61200	
Thallium	ug/L	7.3	TBD			4.1	B													2.8	J
Vanadium	ug/L	0	TBD																		
Zinc	ug/L	673	TBD					3.4	J			5.7	B	0.97	J	2.9	B				
WATER QUALITY PARAMETERS																					
Alkalinity	ppm	979	NE	697	J	810		157		979		757		803		846		726		700	
Chloride	ppm	34600	NE	149		140		175	J	155		126		105		98		48.7		79.7	
Cyanide, total	ppm	0.004	NE											0.004	B						
Hardness	ppm	20000	NE	566		710		715		1370		808		820		761		130		670	
Nitrate	ppm	22	NE																		
Nitrate-Nitrite	ppm	0.2	NE																		
Sulfate	ppm	416	NE	21.4		150		23.6		32.3				20.3		24.6		32.6		40.5	
Total dissolved solids	ppm	43800	NE	948		1000		2200		1020		990		949		988		779		755	
Total organic carbon	ppm	9.9	NE	3		1.8		2.4		3.7		3.7		2.4		1.9		1.6		1.5	
Total suspended solids	ppm	760	NE					14		124		62		5				4			
Turbidity	NTU	742	NE	266		61		116		742		49.6		68.8		138		74		23.5	

Table 4-1

Detected Constituents in Background Monitoring Wells
Ninth Quarterly Background Report
Former Plum Brook Ordnance Works, Sandusky, Ohio

			Location:	PB-BED-MW25																	
			Sample No.:	BD3030		CA3002		CB3004		CC3005		CD3005		DA3005		DC3003		DD3004		DE3003	
			Sample Date:	5-Oct-01		16-Jan-02		3-Apr-02		11-Jul-02		17-Oct-02		10-Apr-03		18-Sep-03		11-Dec-03		11-Mar-04	
			Low-Flow Sample:	Yes		Yes		Yes		Yes		Yes		Yes		Yes		Yes		Yes	
Parameter	Units	MDC	BSC	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ
EXPLOSIVES																					
Amino-2,6-dinitrotoluene, 4-	ug/L	0.19	NE																		
Dinitrotoluene, 2,6-	ug/L	0.43	NE																		
Nitrobenzene	ug/L	0.33	NE					0.076	J			0.12	J								
RDX	ug/L	0.22	NE																		
Trinitrotoluene, 2,4,6-	ug/L	0.081	NE																		
VOLATILES																					
Acetone	ug/L	170	NE	1.7	B					1.4	B	1.6	J								
Benzene	ug/L	110	NE	0.37	J							0.15	J								
Bromomethane	ug/L	0.27	NE																		
Butanone, 2-	ug/L	17	NE																		
Carbon disulfide	ug/L	29	NE	0.48	J	1.5		0.36	J	0.17	J	1.3	J	1.5	J			0.77	J	1.2	
Chloroform	ug/L	1.1	NE	1.1																	
Chloromethane	ug/L	1.3	NE																		
Ethylbenzene	ug/L	38	NE	0.22	J																
Methyl-2-pentanone, 4-	ug/L	0.3	NE	0.3	J																
Methylene chloride	ug/L	21	NE	0.3	B			0.21	B												
Toluene	ug/L	100	NE	0.8	J			0.25	J											0.13	J
Trichloroethene	ug/L	0.59	NE																		
Xylenes, total	ug/L	210	NE	1.5								0.37	J								
SEMIVOLATILES																					
Bis(2-ethylhexyl)phthalate	ug/L	5.4	NE	0.86	J					3	B										
Diethyl phthalate	ug/L	1.5	NE																		
Dimethylphenol, 2,4-	ug/L	1.1	NE																		
Methylnaphthalene, 2-	ug/L	10	NE																		
Naphthalene	ug/L	8.7	NE																		
Phenol	ug/L	1.4	NE																		
METALS-UNFILTERED																					
Aluminum	ug/L	10200	TBD	78.2	B	79.8	B	41.3	J	44.6	J	79.7	J	137	B	86.5	B	61.2	B	50.3	B
Antimony	ug/L	8	TBD																		
Arsenic	ug/L	52.6	TBD																		
Barium	ug/L	26900	TBD	226		247		434		164	J	277		558		177	J	187	J	233	
Beryllium	ug/L	4.6	TBD			1.2	B														
Cadmium	ug/L	1.5	TBD																		
Calcium	ug/L	2290000	TBD	134000		158000		173000		183000		200000		194000		159000		141000		107000	
Chromium	ug/L	18.2	TBD																		
Cobalt	ug/L	35.8	TBD																		
Copper	ug/L	72.2	TBD																		
Iron	ug/L	52100	TBD	795		357		91.1	J	103		207		102		156		140		82.1	J
Lead	ug/L	101	TBD																		
Magnesium	ug/L	1040000	TBD	79500		80000		68000		69100		80200		81200		62000		54000		41900	
Manganese	ug/L	2240	TBD	89		56.2		68.8		95.6		86.5		79.8		72.9		58.5		45.1	
Mercury	ug/L	0.45	TBD																		
Nickel	ug/L	74.9	TBD																		
Potassium	ug/L	174000	TBD	17600		21600		14500	J	11400	J	16200	J	19200	J	12100	J	11900		10800	J
Selenium	ug/L	5	TBD																		
Sodium	ug/L	9130000	TBD	112000		115000		196000		92300		187000		223000		120000		122000		114000	
Thallium	ug/L	7.1	TBD			4.7	B									3.1	B	3	B		
Vanadium	ug/L	35.9	TBD																		
Zinc	ug/L	612	TBD	7.7	J			79.5				1.7	J	1.4	B	4.8	J	74.4			

Table 4-1

Detected Constituents in Background Monitoring Wells
Ninth Quarterly Background Report
Former Plum Brook Ordnance Works, Sandusky, Ohio

			Location:	PB-BED-MW25																	
			Sample No.:	BD3030		CA3002		CB3004		CC3005		CD3005		DA3005		DC3003		DD3004		DE3003	
			Sample Date:	5-Oct-01		16-Jan-02		3-Apr-02		11-Jul-02		17-Oct-02		10-Apr-03		18-Sep-03		11-Dec-03		11-Mar-04	
			Low-Flow Sample:	Yes		Yes		Yes		Yes		Yes		Yes		Yes		Yes		Yes	
Parameter	Units	MDC	BSC	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ
METALS- FILTERED																					
Aluminum	ug/L	1470	TBD	68.7	B			52.7	B	97.8	B	69.8	B	135	B	61.8	B			57.7	B
Antimony	ug/L	0	TBD																		
Arsenic	ug/L	6.9	TBD																		
Barium	ug/L	26200	TBD	224		234		452		160	J	270		545		177	J	175	J	239	
Beryllium	ug/L	1.5	TBD																		
Cadmium	ug/L	1.2	TBD																		
Calcium	ug/L	2570000	TBD	128000		146000		176000		187000		198000		188000		158000		135000	J	112000	
Chromium	ug/L	0	TBD																		
Cobalt	ug/L	34.8	TBD											2	J						
Copper	ug/L	49.2	TBD																		
Iron	ug/L	6180	TBD	713		337				59.8	J	157		18.8	J	92.7	J	74.5	J		
Lead	ug/L	8.7	TBD																		
Magnesium	ug/L	1090000	TBD	76800		74400		69700		74100		78600		77900		61400		51400		43800	
Manganese	ug/L	1300	TBD	87		52.2		65.6		94		84.2		75.7		71.5		55.2		46.8	
Mercury	ug/L	0.24	TBD											0.056	J						
Nickel	ug/L	82.9	TBD																		
Potassium	ug/L	173000	TBD	17000		20200		14900	J	12100	J	15900	J	18400	J	11900	J	11100	J	11400	J
Selenium	ug/L	0	TBD																		
Sodium	ug/L	9110000	TBD	109000		114000		196000		97600		180000		217000		118000		115000	J	119000	
Thallium	ug/L	7.3	TBD							6.4	J										
Vanadium	ug/L	0	TBD																		
Zinc	ug/L	673	TBD	3	J			19.9	J			1.5	B	1	J	2.6	B	21.7			
WATER QUALITY PARAMETERS																					
Alkalinity	ppm	979	NE	278	J	320		337		329		314		344		313		316		331	
Chloride	ppm	34600	NE	404		460		558	J	219		631		615		257		221		199	
Cyanide, total	ppm	0.004	NE											0.004	B						
Hardness	ppm	20000	NE	627		720		611		772		848		820		700		540		510	
Nitrate	ppm	22	NE																		
Nitrate-Nitrite	ppm	0.2	NE																		
Sulfate	ppm	416	NE	121		79		36.2		416		79.5		38.6		264		136		142	
Total dissolved solids	ppm	43800	NE	1000		1100		1330		1180		1440		767		1100		834		808	
Total organic carbon	ppm	9.9	NE	4	B	2		3		2.7		2.7		2		2.8		2.4		2.3	
Total suspended solids	ppm	760	NE	4				9		5				4		5		8			
Turbidity	NTU	742	NE	21.7	J	21		112		23.6		35.8		98		22.9		64.4		86.5	

Table 4-1

Detected Constituents in Background Monitoring Wells
Ninth Quarterly Background Report
Former Plum Brook Ordnance Works, Sandusky, Ohio

			Location:	PB-BED-MW26		PB-BED-MW28						PB-BED-MW29					
			Sample No.:	CA3004		DC3004		DD3007		DE3004		DC3005		DD3008		DE3005	
			Sample Date:	17-Jan-02		17-Sep-03		9-Dec-03		9-Mar-04		16-Sep-03		9-Dec-03		10-Mar-04	
			Low-Flow Sample:	No		Yes		Yes		Yes		Yes		Yes		Yes	
Parameter	Units	MDC	BSC	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ
EXPLOSIVES																	
Amino-2,6-dinitrotoluene, 4-	ug/L	0.19	NE														
Dinitrotoluene, 2,6-	ug/L	0.43	NE														
Nitrobenzene	ug/L	0.33	NE														
RDX	ug/L	0.22	NE														
Trinitrotoluene, 2,4,6-	ug/L	0.081	NE														
VOLATILES																	
Acetone	ug/L	170	NE							2.1	J	17				2.1	J
Benzene	ug/L	110	NE			2.4	J	2.2		1.7				0.96	J	0.22	J
Bromomethane	ug/L	0.27	NE														
Butanone, 2-	ug/L	17	NE														
Carbon disulfide	ug/L	29	NE							1.3		0.44	J	13		1.9	
Chloroform	ug/L	1.1	NE									0.25	J				
Chloromethane	ug/L	1.3	NE					0.97	J	0.42	J			0.3	J		
Ethylbenzene	ug/L	38	NE					0.13	J			0.86	J	0.87	J	0.66	J
Methyl-2-pentanone, 4-	ug/L	0.3	NE														
Methylene chloride	ug/L	21	NE							2.1	B					0.59	B
Toluene	ug/L	100	NE			1.7	J	0.62	J	0.18	J	0.12	J				
Trichloroethene	ug/L	0.59	NE			0.59	J										
Xylenes, total	ug/L	210	NE					0.41	J			5.5		5.1	J	4.5	J
SEMIVOLATILES																	
Bis(2-ethylhexyl)phthalate	ug/L	5.4	NE														
Diethyl phthalate	ug/L	1.5	NE														
Dimethylphenol, 2,4-	ug/L	1.1	NE														
Methylnaphthalene, 2-	ug/L	10	NE														
Naphthalene	ug/L	8.7	NE														
Phenol	ug/L	1.4	NE														
METALS-UNFILTERED																	
Aluminum	ug/L	10200	TBD	93200		147	J	42.6	B	54.5	B	309		49.9	B	103	J
Antimony	ug/L	8	TBD														
Arsenic	ug/L	52.6	TBD	56.8		7.4	J	5.4	J	5.5	B			3.3	J	2.6	B
Barium	ug/L	26900	TBD	1970		374		395		342		11300		11800		10800	
Beryllium	ug/L	4.6	TBD	5.2													
Cadmium	ug/L	1.5	TBD	3.3	J												
Calcium	ug/L	2290000	TBD	2180000		20800		20000		17500		316000		295000		274000	
Chromium	ug/L	18.2	TBD	454													
Cobalt	ug/L	35.8	TBD	82.8								3.9	J	3.6	J	3.5	B
Copper	ug/L	72.2	TBD	293													
Iron	ug/L	52100	TBD	232000		235		398		219		932		1550		1480	
Lead	ug/L	101	TBD	79.2													
Magnesium	ug/L	1040000	TBD	958000		8320		7780		7370		217000		198000		189000	
Manganese	ug/L	2240	TBD	7470		20.3		16.6		10.6	J	62.7		50.7		46.4	
Mercury	ug/L	0.45	TBD	0.14	J												
Nickel	ug/L	74.9	TBD	457													
Potassium	ug/L	174000	TBD	334000		7240	J	6050		18300	J	75800	J	67800		112000	J
Selenium	ug/L	5	TBD														
Sodium	ug/L	9130000	TBD	3790000		290000		285000		275000		1390000		1350000		1350000	
Thallium	ug/L	7.1	TBD			4.2	B			6.7	B	5.1	B	2.4	B		
Vanadium	ug/L	35.9	TBD	142													
Zinc	ug/L	612	TBD	789		2.5	B	247		2.8	B	6.9	J	507		9	J

Table 4-1

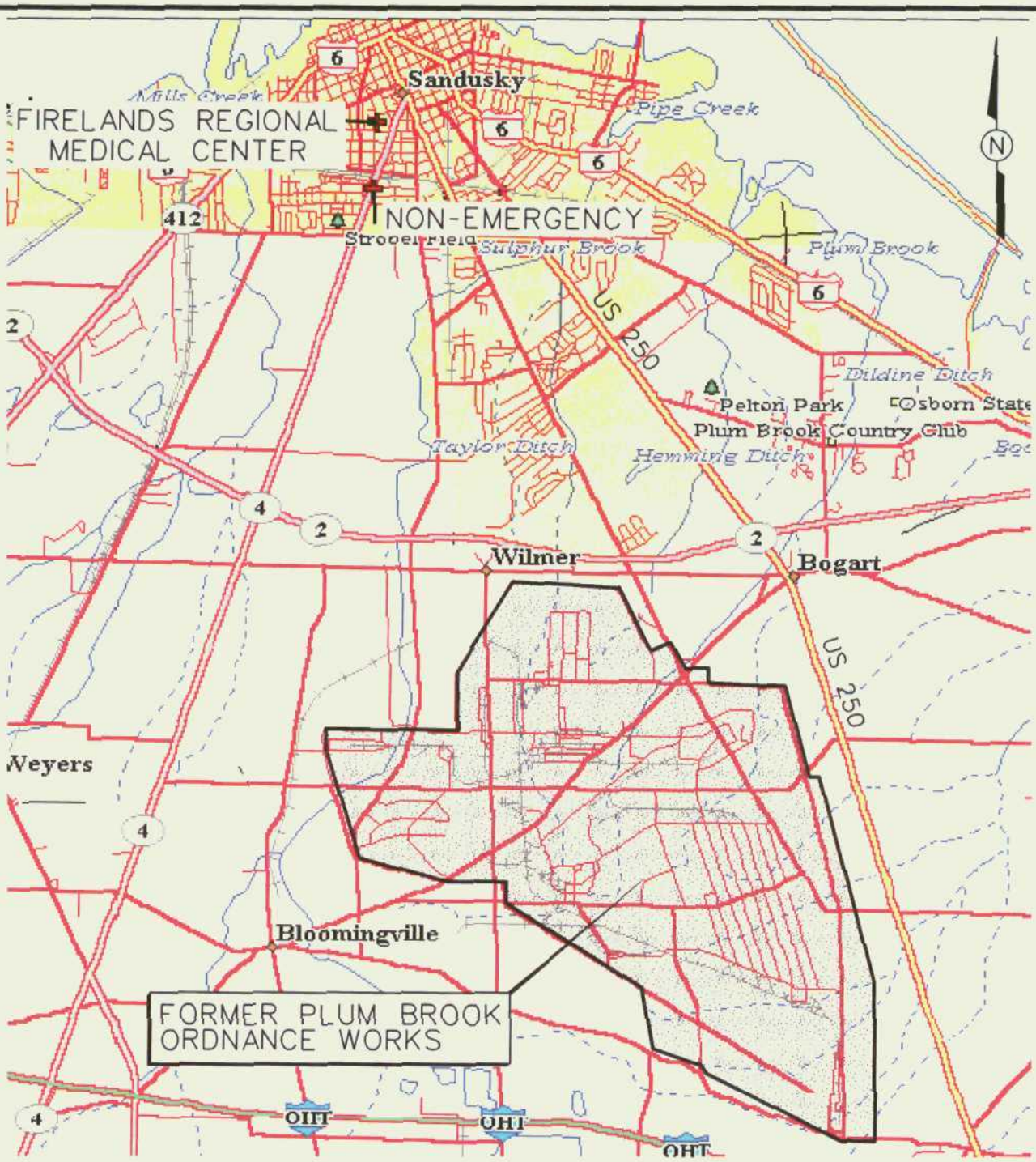
Detected Constituents in Background Monitoring Wells
Ninth Quarterly Background Report
Former Plum Brook Ordnance Works, Sandusky, Ohio

			Location:	PB-BED-MW26		PB-BED-MW28						PB-BED-MW29					
			Sample No.:	CA3004		DC3004		DD3007		DE3004		DC3005		DD3008		DE3005	
			Sample Date:	17-Jan-02		17-Sep-03		9-Dec-03		9-Mar-04		16-Sep-03		9-Dec-03		10-Mar-04	
			Low-Flow Sample:	No		Yes		Yes		Yes		Yes		Yes		Yes	
Parameter	Units	MDC	BSC	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ
METALS: FILTERED																	
Aluminum	ug/L	1470	TBD			152	J			74.6	B	83.1	B	66.9	B	85	B
Antimony	ug/L	0	TBD														
Arsenic	ug/L	6.9	TBD			6.9	J	5.6	J	5	B	2.6	J	3.1	J		
Barium	ug/L	26200	TBD			371		374		354		10500		10800		10800	
Beryllium	ug/L	1.5	TBD														
Cadmium	ug/L	1.2	TBD														
Calcium	ug/L	2570000	TBD			20300		19700	J	17900		316000		283000	J	274000	
Chromium	ug/L	0	TBD														
Cobalt	ug/L	34.8	TBD									6.1	J	3.4	J	3.4	J
Copper	ug/L	49.2	TBD														
Iron	ug/L	6180	TBD			242		354		186		350		1490		1060	
Lead	ug/L	8.7	TBD														
Magnesium	ug/L	1090000	TBD			8120		7670		7540		219000		189000		190000	
Manganese	ug/L	1300	TBD			15.8		16.4		11.8	J	55.1		49.3		45.5	
Mercury	ug/L	0.24	TBD														
Nickel	ug/L	82.9	TBD														
Potassium	ug/L	173000	TBD			7140	J	5920	J	17300	J	76500	J	60700	J	114000	J
Selenium	ug/L	0	TBD														
Sodium	ug/L	9110000	TBD			289000		280000	J	282000		1390000		1250000	J	1360000	
Thallium	ug/L	7.3	TBD			4.1	B	3.8	B	5.2	J	6.2	B	3.8	B		
Vanadium	ug/L	0	TBD														
Zinc	ug/L	673	TBD			3.8	B	247		3	B	8.5	J	528		3.4	B
WATER QUALITY PARAMETERS																	
Alkalinity	ppm	979	NE			474		444		468		443		432		448	
Chloride	ppm	34600	NE			171		148		168		3540		2930		3050	
Cyanide, total	ppm	0.004	NE														
Hardness	ppm	20000	NE			99.5		81.6		78		1750		1500		1540	
Nitrate	ppm	22	NE									0.39					
Nitrate-Nitrite	ppm	0.2	NE														
Sulfate	ppm	416	NE			35.2		13.1				5.7					
Total dissolved solids	ppm	43800	NE			833		697		774		6580		3880		5450	
Total organic carbon	ppm	9.9	NE			5.9		5.3		5.2		2.6		3.9		2.2	
Total suspended solids	ppm	760	NE					4				46		7		105	
Turbidity	NTU	742	NE			3.3		1.6	J	1.4		14.7		7	J	8.1	

BSC - Background screening concentration.
MDC - Maximum detected concentration. Results from PB-BED-MW26 not included.
ug/L - Micrograms per liter.
NE - Not evaluated.
RDX - Cyclotrimethylenetrinitramine.
NTU - Nephelometric turbidity unit.
ppm - Parts per million.
TBD - To be determined.

Validation Qualifiers (VQ)
J - The analyte was positively identified; the reported value is an estimated concentration.
B - The analyte was not detected sigificantly above the levels found in the asseciated blanks.

FIGURES



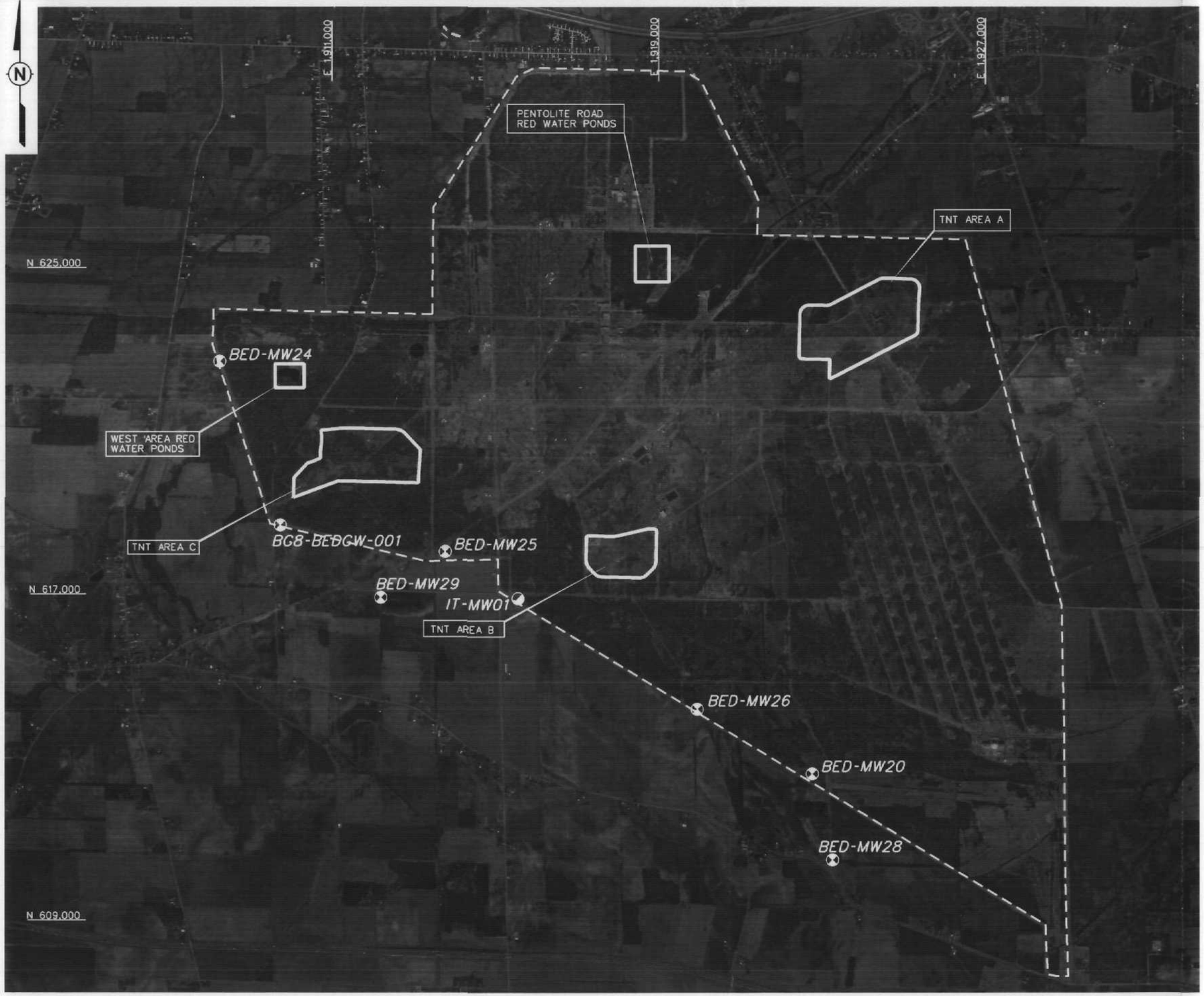
NOT TO SCALE

FIGURE 1-1
VICINITY MAP

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

Shaw® Shaw Environmental, Inc.

STARTING DATE: 12/16/97 | DATE LAST REV.: 5/27/04 | DRAFT. CHCK. BY: | INITIATOR: D. KESSLER | DWG. NO.: 773701ES.001
DRAWN BY: D. BILLINGSLEY | DRAWN BY: dhall | ENGR. CHCK. BY: D. KESSLER | PROJ. MGR.: S. DOWNEY | PROJ. NO.: 773701
8:29:38 AM 5/27/04
dhall 773701es.001



LEGEND

▭	AREAS OF CONCERN
IT-MW01	OVERBURDEN/SHALE MONITORING WELL LOCATION
BED-MW20	BEDROCK MONITORING WELL LOCATION
- - - - -	PBOW PROPERTY BOUNDARY

SCALE

0 2500 5000 FEET

FIGURE 1-2
LOCATIONS OF AREAS OF CONCERN

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

Shaw™ Shaw Environmental, Inc.

DWG. NO.: 843656-pbow-ssap-0002.dgn	PROJ. NO.: 843656
TECH. REVIEW: D.KESSLER	PROJ. MGR.: S.DOWNEY
INITIATOR: D.KESSLER	CADD REVIEW: C.BENTLEY
STARTING DATE: 12MAY03	DRAWN BY: C.TUMLIN

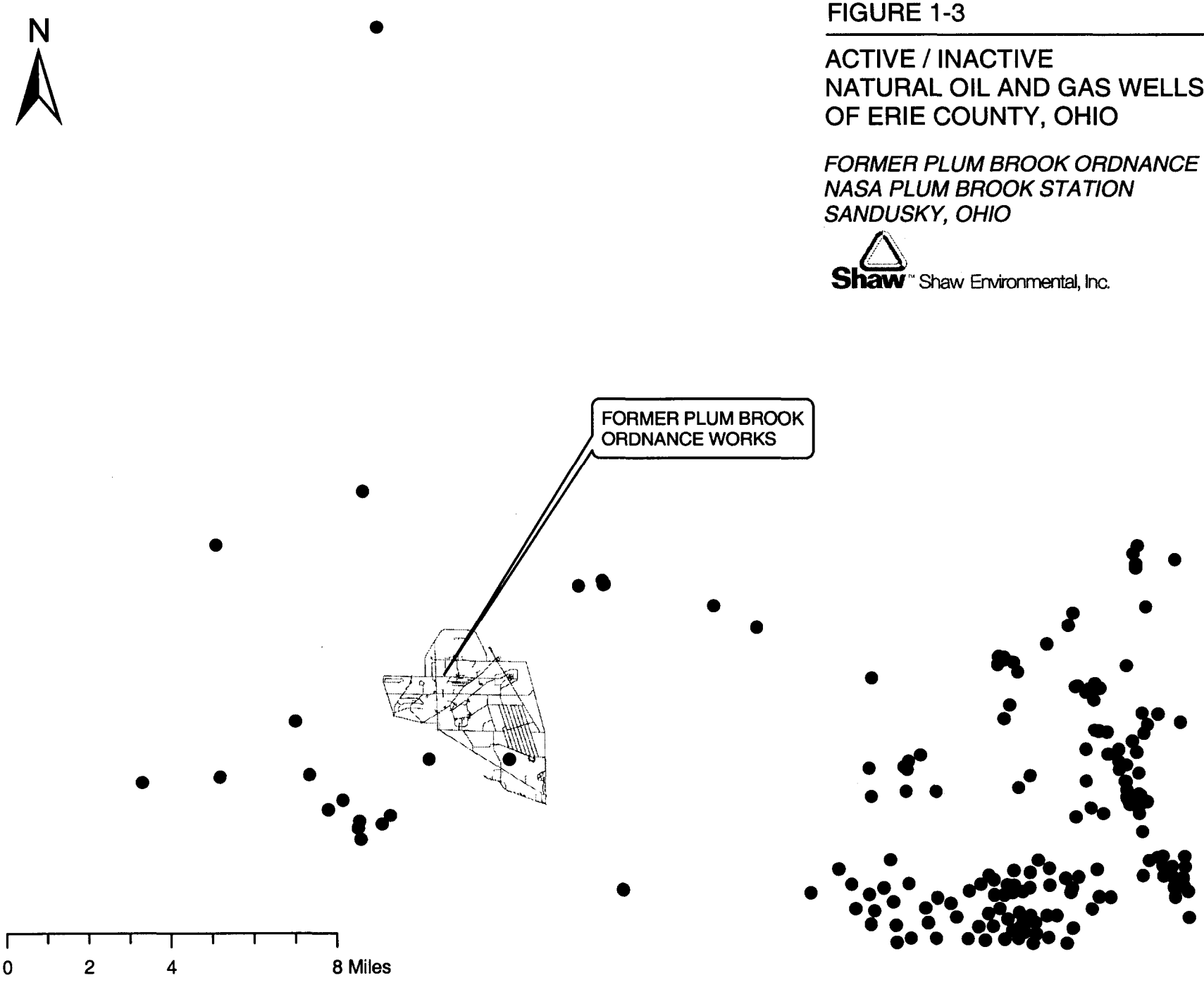
ColorPass_color-tabloid.plt
Standard_Color.tbl
5/27/04 8:07:59 AM
2500.000 FT / IN.
dhall
843656-pbow-ssap-0002.dgn

FIGURE 1-3

ACTIVE / INACTIVE
NATURAL OIL AND GAS WELLS
OF ERIE COUNTY, OHIO

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

Shaw™ Shaw Environmental, Inc.



X:\pbow\gisworkspace\lleonard\output\figure_1_3.pdf (pbow_active_and_inactive_natural_oil_and_gas_wells.mxd)

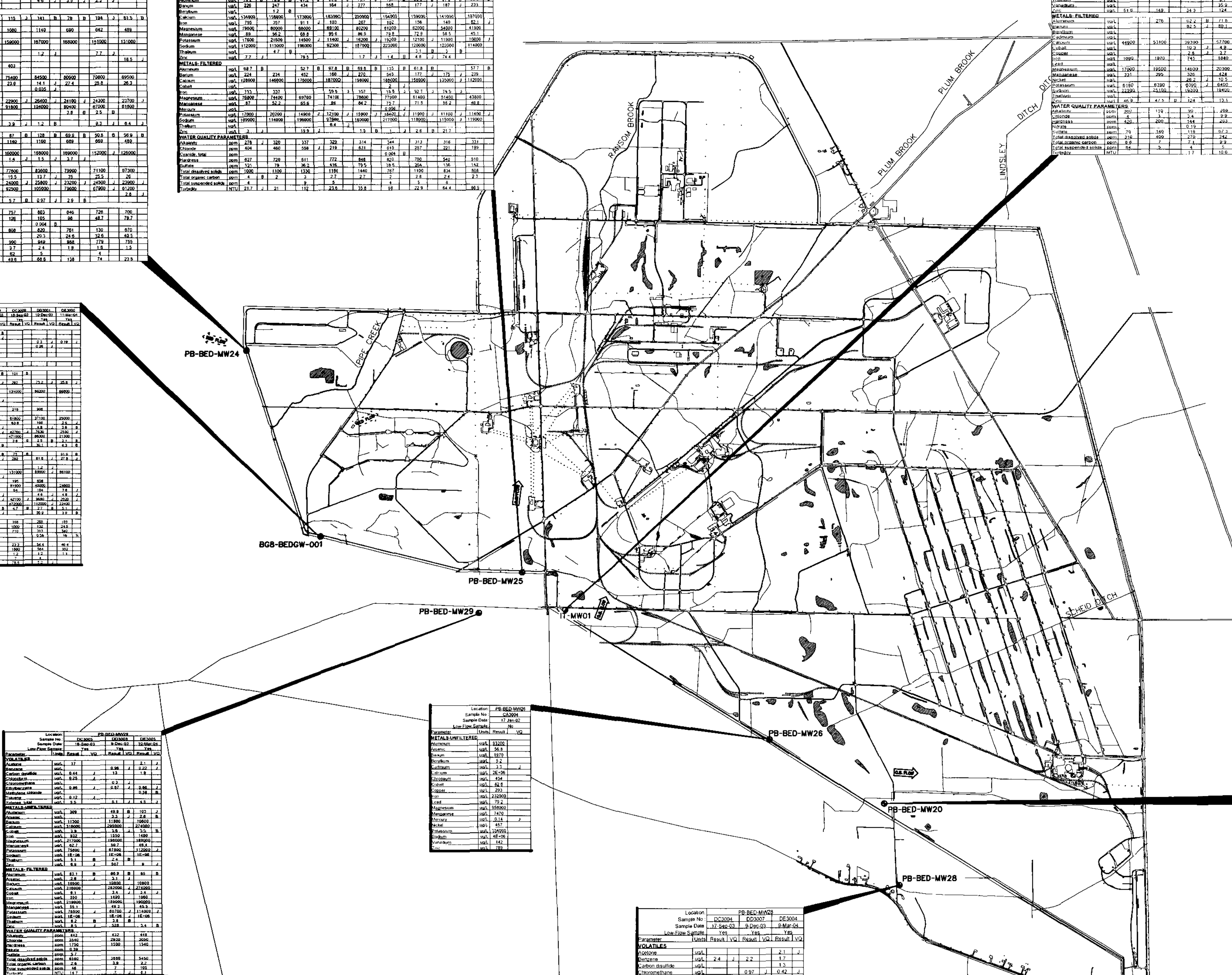
LEGEND:

Symbol	Description
IT-MW01	OVERBURDEN MONITORING WELL LOCATION
PB-BED-MW20	BEDROCK MONITORING WELL LOCATION
	BUILDINGS
	RAILROAD
	SURFACE WATER
	DITCH
	FENCE
O.B. FLOW	OVERBURDEN/SHALE GROUNDWATER FLOW DIRECTION
BED FLOW	BEDROCK GROUNDWATER FLOW DIRECTION

NOTES:

1. GROUNDWATER FLOW DIRECTION ON MAY 4, 2002.
2. UNABLE TO SAMPLE IT-MW01 IN SEPTEMBER 2001, JANUARY OR APRIL 2002. PVC CASING WAS DAMAGED AND PREVENTED ACCESS.
3. MONITORING WELL PB-BED-MW26 HAS NOT BEEN SAMPLED SINCE JANUARY 2002 DUE TO INSUFFICIENT WATER.

NE - NOT ESTABLISHED



Location:		PB-BED-MW20																				
Sample No.:		5960		5965		BD3026		CA3005		CB3001		CC3003		CD3003		DA3003		DC3001		DD3002		DE3001
Sample Date:		17-Nov-97		28-May-98		26-Sep-01		15-Jan-02		4-Apr-02		10-Jul-02		17-Oct-02		11-Apr-03		18-Sep-03		9-Dec-03		10-Mar-04
Low-Flow Sample:		No		No		No		Yes		Yes		Yes		No		Yes		Yes		Yes		Yes
Parameter	Units	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ
EXPLOSIVES																							
Amino-2,6-dinitrotoluene	ug/L																	0.19	J				
Nitrobenzene	ug/L									0.088	J												
RDX	ug/L															0.17	J						
VOLATILES																							
Acetone	ug/L					1.2	J			5.3	J	10	B									2.1	J
Benzene	ug/L	0.93	J	1.6		0.25	J					3.2		1.3	J	0.23	J	1.4	J	1.2		1.1	
Bromomethane	ug/L											0.27	J										
Butanone, 2-	ug/L											9.8											
Carbon disulfide	ug/L			0.17	J									1.1	J	0.21	J			0.16	J	0.21	J
Chloromethane	ug/L																	0.47	B				
Ethylbenzene	ug/L	0.15	J																				
Methylene chloride	ug/L	0.3	B	0.49	B											0.31	B					0.28	B
Toluene	ug/L	0.73	B	0.95	B			2.4	B			0.76	B	0.35	J			0.45	B	0.26	B	0.28	J
Xylenes, total	ug/L	2.6		0.91	J					0.67	J												
SEMIVOLATILES																							
Bis(2-ethylhexyl)phthalate	ug/L			5.4	B	2.9	J																
Methylnaphthalene, 2-	ug/L	1.1	J																				
METALS-UNFILTERED																							
Aluminum	ug/L	3290		678	J	207	J			48.6	J	83.4	B	155	J	143	B	115	B	57.9	B	63.2	B
Arsenic	ug/L																	3.3	J			3.4	B
Barium	ug/L	19000		16400		23900		22500		23700		24000		25700		26900		25200		26100		25500	
Beryllium	ug/L													0.51	B								
Calcium	ug/L	2E+06		2E+06	J	2E+06	J	2E+06		2E+06		2E+06		2E+06		2E+06		2E+06		2E+06		2E+06	
Chromium	ug/L					7.6	B			1.7	J					1.3	B						
Cobalt	ug/L					7.1	J			6.1	J	8	J	8.1	J	8.5	J	8.6	J	6.8	J	7.1	J
Copper	ug/L	32.8				15.8	B	32.8		30.5													
Iron	ug/L	13200		6770		5920	J	6480		853		4970		5310		257		4120		2030		794	
Magnesium	ug/L	920000		861000		943000	J	860000		884000		960000		941000		981000		1E+06		1E+06		992000	
Manganese	ug/L	180		153		189	J	128		156		190		185		162		192		202		183	
Nickel	ug/L					3.5	J			3.4	J					7.2	J	4	J				
Potassium	ug/L	92300		78600		85800	J	165000		86700	J	101000	J	91700	J	81700	J	104000	J	72600	J	174000	J
Sodium	ug/L	8E+06		7E+06		8E+06	J	7E+06		8E+06		8E+06		8E+06		8E+06		9E+06		9E+06		9E+06	
Thallium	ug/L							7.1	B					4.1	B			4.6	B				
Zinc	ug/L	41.6		42.1	B	5.3		23.4		64.9		9.7	J	15.6	J	5.3	B	5.7	J	612		43.6	
METALS- FILTERED																							
Aluminum	ug/L					40.9	B			55.9	B	63.1	B	69.8	B	109	B	91.4	B			77.8	B
Arsenic	ug/L					2.8	J											4.8	J	4.1	J		
Barium	ug/L	21000		4950		24400		21300		23800		23900		24500		26200		25700		25700		24300	
Beryllium	ug/L													0.24	B								
Calcium	ug/L	3E+06	J	491000	J	2E+06		2E+06		2E+06		2E+06		2E+06		2E+06		2E+06		2E+06	J	2E+06	
Cobalt	ug/L					6.4	J			5.9	J	8	J	7.5	J	9.3	J	23.8	J	6.2	J	6.2	J
Copper	ug/L					2	B	5.7	J	26.5												5.3	B
Iron	ug/L	2310		1320		5350		6180		1130		5100		4940				3800		1830		510	
Magnesium	ug/L	1E+06		223000	J	965000		829000		888000		969000		911000		953000		1E+06		1E+06		944000	
Manganese	ug/L	162		47		188		129		156		193		182		160		220		200		178	
Mercury	ug/L			0.24												0.032	J						
Nickel	ug/L					2.9	J			3.2	J					6.5	J	6	J				
Potassium	ug/L	103000		21600		87400	J	170000		86900	J	102000	J	88400	J	79000	J	105000	J	70500	J	173000	J
Selenium	ug/L																						
Sodium	ug/L	9E+06		2E+06		8E+06		7E+06		8E+06		8E+06		8E+06		8E+06		9E+06		9E+06	J	8E+06	
Thallium	ug/L							7.3	B									4.1	B				
Zinc	ug/L					3.3	J	21.6		59.2	J	3.2	J	78.3		4.8	J	6.4	J	673		31.4	
WATER QUALITY PARAMETERS																							
Alkalinity	ppm	240		260		255	J	280		229		293		259		246		248		238		248	
Chloride	ppm	19000		21000		22400		18000		17300	J	19000		21100		34600		19100		21300		20800	
Hardness	ppm	20000		10000		9360		8200		8850		8140		9390		9200		9690		9940		9550	
Sulfate	ppm							3.2															
Total dissolved solids	ppm	32000		24000		27400	J	26000		27800		35500		43800		32600		42700		33600		28700	
Total organic carbon	ppm					0.5	J	1.1	J	0.74	J												
Total suspended solids	ppm	74		90		125		13		13		33		19		100		112		39		760	
Turbidity	NTU					48.4	J	8.8		10.5		7.4		19.2		3.9		6.2		18.4	J	5.7	

Location:		PB-BED-MW26	
Sample No.:		CA3004	
Sample Date:		17-Jan-02	
Low-Flow Sample:		No	
Parameter	Units	Result	VQ
METALS-UNFILTERED			
Aluminum	ug/L	93200	
Arsenic	ug/L	56.8	
Barium	ug/L	1970	
Beryllium	ug/L	5.2	
Cadmium	ug/L	3.3	J
Calcium	ug/L	2E+06	
Chromium	ug/L	454	
Cobalt	ug/L	82.8	
Copper	ug/L	293	
Iron	ug/L	232000	
Lead	ug/L	79.2	
Magnesium	ug/L	958000	
Manganese	ug/L	7470	
Mercury	ug/L	0.14	J
Nickel	ug/L	457	
Potassium	ug/L	234000	
Sodium	ug/L	4E+06	
Vanadium	ug/L	142	
Zinc	ug/L	789	

Location:		PB-BED-MW28					
Sample No.:		DC3004		DD3007		DE3004	
Sample Date:		17-Sep-03		9-Dec-03		9-Mar-04	
Low-Flow Sample:		Yes		Yes		Yes	
Parameter	Units	Result	VQ	Result	VQ	Result	VQ
VOLATILES							
Acetone	ug/L					2.1	J
Benzene	ug/L	2.4	J	2.2		1.7	
Carbon disulfide	ug/L					1.3	
Chloromethane	ug/L			0.97	J	0.42	J
Ethylbenzene	ug/L			0.13	J		
Methylene chloride	ug/L					2.1	B
Toluene	ug/L	1.7	J	0.62	J	0.18	J
Trichloroethene	ug/L	0.59	J				
Xylenes, total	ug/L			0.41	J		
METALS-UNFILTERED							
Aluminum	ug/L	147	J	42.6	B	54.5	B
Arsenic	ug/L	7.4	J	5.4	J	5.5	B
Barium	ug/L	374		395		342	
Calcium	ug/L	20800		20000		17500	
Iron	ug/L	235		398		219	
Magnesium	ug/L	8320		7780		7370	
Manganese	ug/L	20.3		16.6		10.6	J
Potassium	ug/L	7240	J	6050		18300	J
Sodium	ug/L	290000		285000		275000	
Thallium	ug/L	4.2	B			6.7	B
Zinc	ug/L	2.5	B	247		2.8	B
METALS- FILTERED							
Aluminum	ug/L	152	J			74.6	B
Arsenic	ug/L	6.9	J	5.6	J	5	B
Barium	ug/L	371		374		354	
Calcium	ug/L	20300		19700	J	17900	
Iron	ug/L	242		354		186	
Magnesium	ug/L	8120		7670		7540	
Manganese	ug/L	15.8		16.4		11.8	J
Potassium	ug/L	7140	J	5920	J	17300	J
Sodium	ug/L	289000		280000	J	282000	
Thallium	ug/L	4.1	B	3.8	B	5.2	J
Zinc	ug/L	3.8	B	247		3	B
WATER QUALITY PARAMETERS							
Alkalinity	ppm	474		444		468	
Chloride	ppm	171		148		168	
Hardness	ppm	99.5		81.6		78	
Sulfate	ppm	35.2		13.1			
Total dissolved solids	ppm	833		697		774	
Total organic carbon	ppm	5.9		5.3		5.2	
Total suspended solids	ppm			4			
Turbidity	NTU	3.3		1.6	J	1.4	

NO	DATE	REVISION	BY	CHKD	DSGN ENGR	ENGR	PROJ MGR	APPR

STARTING DATE 07/21/02 | INITIATOR D. KESSLER | CHKD | DRAWN VANDERGRIFF | CHKD C. TUMLIN | PROJECT MNGR S. DOWNEY

Shaw Environmental, Inc.
KNOXVILLE, TENNESSEE

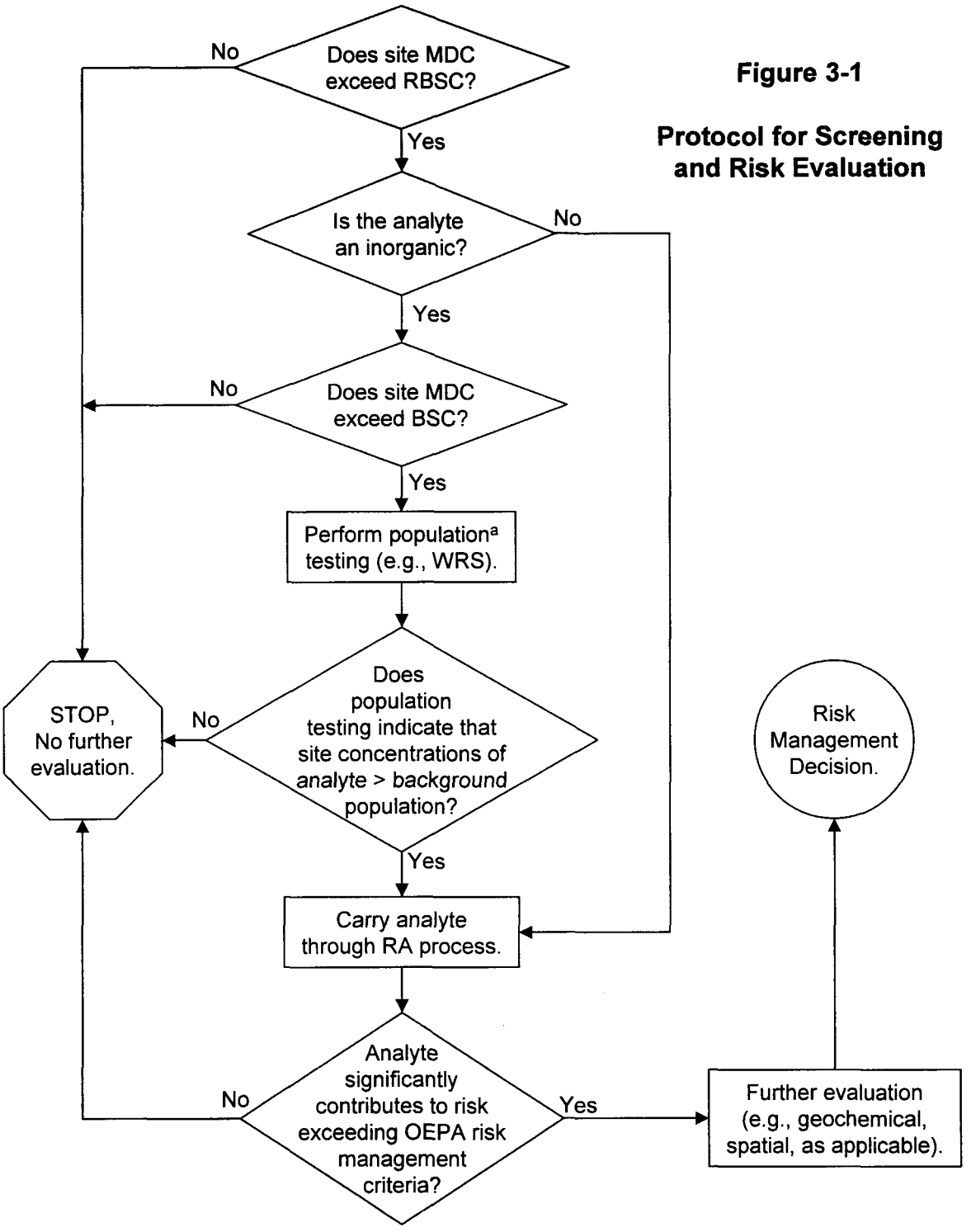
NINTH QUARTERLY BACKGROUND GROUNDWATER REPORT
FORMER PLUM BROOK ORDNANCE WORKS
NASA PLUM BROOK STATION
SANDUSKY, OHIO

FIGURE 2-1
DETECTED CONSTITUENTS IN OVERBURDEN/BEDROCK BACKGROUND MONITORING WELLS
(NOVEMBER 1997, MAY 1998, SEPTEMBER-OCTOBER 2001, JANUARY, APRIL, JULY, OCTOBER 2002, APRIL, SEPTEMBER, DECEMBER 2003, AND MARCH 2004)

AREA	JOB NO.	DRAWING NO.	REV
	843656	843656_002.DGN	

Figure 3-1

Protocol for Screening and Risk Evaluation



Notes:

[a] A judgment may be made at this step to forego or modify population testing if the site data is clearly greater than background and/or individual exceedances suggest the presence of a hot spot. In such cases, the analyte would be carried into the risk assessment process.

BSC - Background screening concentration.
MDC - Maximum detected concentration.
OEPA - Ohio Environmental Protection Agency.
RA - Risk assessment.
RBSC - Risk-based screening concentration.
WRS - Wilcoxon rank sum (test).

Shaw™ Shaw Environmental, Inc.

APPENDIX A

TELECONFERENCE NOTES ON NATURAL PETROLEUM IN BEDROCK

INTERNATIONAL TECHNOLOGY CORPORATION

RECORD OF ☒ TELECON ☐ MEETING

Project Name	Number	Phase	Task	Subtask
PBOW				

Date 11/18/98 Time 1315

CALL FROM ☒ CALL TO ☐ NAME: David Kessler

Other Participants — Name/Location/Representing:

CALL FROM ☐ CALL TO ☒ NAME: Martin Jones (V.P.)

Telephone Number: 419-625-8141

Company Name: Wagner Quarry

Address:

Topic BTEX in Bedrock

City Sandusky

State OH Zip Code

Summary (Decisions & Specific Actions Required by Named Persons):

Inquired about H_2S and BTEX in bedrock.

Martin Jones (VP - mechanical Engineer) said that the BTEX and H_2S in the bedrock is all natural. Very common in the limestone in the area. Hydrogen sulfide is particularly noticed from zones (in the quarry) around depths of ~90-120 ft and 130-160 ft. Oil can be found (in the area) in the limestone at the surface all the way to the base of the limestone. The organics are very common throughout this entire region. LCW levels are seen as far away as Sandusky Rocks Co. (near intersection of Rt 4 and turnpike)

Required Action:

Prepared by (Signature): David Kessler

Distribution:
Original to Project File
Copy to Project Manager
Copy to Preparer

☒ Other Distribution (By Preparer)
Mike Springberg, Rick Ellis
Mike Gunderson

PAGE ___ OF ___

Kessler, Dave

Subject: RE: Erie County limestone

From: "Swinford, Mac" <Mac.Swinford@dnr.state.oh.us>
To: "'djkessler1@juno.com'" <djkessler1@juno.com>
Date: Thu, 29 Aug 2002 09:55:04 -0400
Subject: Erie County limestone
Message-ID:
<83E473D76ECF8240B3F513CE308CA9E8C8156C@nrxchg2.dnr.state.oh.us>

David Kessler:

There is an actively producing oil and gas field producing from the Delaware
Limestone and the underlying Columbus Limestone in Florence and Berlin Townships, Erie County. Information on the individual wells are on file here at the Ohio Geological Survey. We also have maps depicting the general
outline of the fields in this area. Please call Ron Riley 614-265-6573 for
this information.

Regional, the Columbus and to a lesser extent the Delaware Limestone commonly can have a slight to moderate petroleum smell and may have a sulfur odor.

If you require additional information please contact me.

Thank you,
Mac Swinford
Geologist and Supervisor,
Geologic Mapping Group
ODNR, Division of Geological Survey
614-265-6473
e-mail: mac.swinford@dnr.state.oh.us

Shaw™
Shaw Environmental & Infrastructure, Inc.

RECORD OF TELEPHONE CALL

DATE: 2/3/04

TIME: 1000

Project Name: PBOW

Project Number: 843656

Call from: David Kessler

Call to: Mr. Rick Pavey, (614) 265-6599, Ohio Department of Natural Resources (ODNR).

Summary (Decisions/Specific Actions):
Attempted to contact Mr. Mac Swinford of ODNR for information of oil/gas wells found at the DNR website (www.ohiodnr.com/geosurvey/ogcim/petrol/ftpmap, URL: ftp://ftp/dnr.state.oh.us/Geological_Survey/well_db/erie.dbf) but was transferred to DNR representative Mr. Rick Pavey.

Informed Mr. Pavey of above listed website and inquired if he had any information of the wells found on the map. Mr. Pavey said that he would attempt to find specific information and return call. [Shaw faxed the map for his research that was found at the website but had the PBOW coordinates included with the well locations].

Return call from Mr. Pavey to David Kessler ~1300:
From his research into the purpose of the oil/gas wells, he found that the well on PBOW property was not listed in the records (must have been installed before records were kept). The next nearest well to the facility (well immediately to the west, as shown on the map) was drilled in 1957 as a stratigraphic test boring. From his review of the other active/inactive oil and gas wells shown on the figure and his recollection of petroleum hydrocarbon encountered at the Wagnor Quarries, he confirmed that there is "without a doubt petroleum hydrocarbon in the Delaware and Columbus bedrock units". There must not have been sufficient quantities of oil or gas for commercial production in this area (near PBOW), as indicated by the sporadic spacing, but in the southeast corner of the map, a good producing oil field is present. The well locations are very close to one another.

Required Action: Include information in response to Restoration Advisory Board comments received for the Seventh Quarterly Background Groundwater Report.

Prepared By: David Kessler

Distribution: Steve Downey, Mike Gunderson, Tom Siard

APPENDIX B

SAMPLE COLLECTION LOGS

Shaw™
Shaw E & I, Inc.

Sample Collection Log

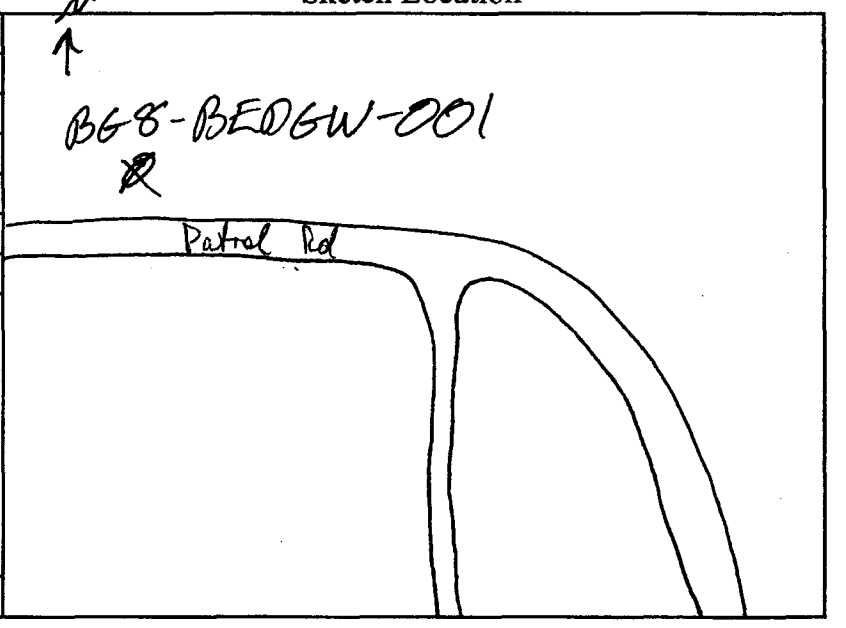
Plum Brook Ordnance Works

Project No: 843656 Project Manager: S. Downey

Location Code:	**IT-BG8-BEDGW-001**	Collection Date:	3.11.04
Sample Number:	**DE3000**	Collection Time:	1405
Sample Name:	**PBOW-04-IT-BG8-BEDGW-001-DE3000**	Start Depth:	14'
Sampling Method:	**Low Flow**	End Depth:	—
Sample Type:	**GW**	Sample Matrix:	**WATER**
Sample Purpose:	**REG**	Sample Team:	**Kessler/Parham**

Analytical Suite	Containers
F[illegible]TRED METALS	1 - 250 mL HDPE
T[illegible]AL METALS	1 - 250 mL HDPE
EXPLOSIVES	1 - 1 L Amb. Glass
VOLATILES	3 - 40 mL Vial
SEMIVOLATILES	2 - 1 L Amb. Glass
TOC	2 - 40 mL Vial
CYANIDE	1 - 1 L HDPE
ALKALINITY	1 - 1 L HDPE
CHLORIDE	
NITRATE	
SULFATE	
TDS	
TSS	
TURBIDITY	
HARDNESS	1 - 250 mL HDPE

Sketch Location



Comments: All samples placed on ice.

[illegible]ed by/Date: Zach Park 3.11.04 Reviewed by/Date: David Kessler 3/11/04

Shaw
Shaw E & I, Inc.

GROUNDWATER PURGE FORM

Location Code: **IT-BG8-BEDGW-001**

Sample Number: **DE3000**

Water Quality Parameter Measurements									
Date/ Time	DTW (ft. BTOC)	Purge Rate (mL/min)	Cumulative Volume Purged (L)	Temp. (degree C)	Conductivity (umhos/cm)	pH (std. units)	Eh (mv)	DO (mg/L)	Turbidity (NTU)
1325	5.55	280	0	—	—	—	—	—	—
1330	5.75	"	1.40	7.94	0.978	7.27	17.3	7.75	0.0
1335	5.78	"	2.80	7.91	0.988	7.15 ~~5.360~~	32.7	5.34	0.0
1340	5.81	"	4.20	8.44	0.982	7.16	39.6	5.50	0.0
1345	5.80	"	5.60	8.45	0.979	7.16	42.1	5.56	0.0
1350	5.80	230	7.0	8.76	0.978	7.18	42.3	5.52	0.0
1355	5.80	"	8.15	8.99	0.978	7.16	42.4	5.52	0.0
1400	5.80	"	9.30	9.15	0.980	7.15	42.6	5.58	0.0
1405	5.80	"	10.45	9.21	0.983	7.16	42.8	5.51	0.0

Purge complete. Began sampling DE3000.

Abbreviations: BTOC - Below top of casing; DTW - Depth to water; mL - milliliter; L - Liter

GROUNDWATER SAMPLING FORM

Shaw®

Project Number: 843635
Project Name: PBOW
Investigation Site: Background
RFA/COC Number: PB03 1104STL-K

Collection Date: 3-11-04
Collection Time: 1405
Sample Filtered (Yes/No): Yes; Metals
Weather/Temp: Cloudy + Cold ~ 37°F

Form Completed By: Z. Parham
Sampler(s): D. Kessler, Z. Parham
Reviewed By: David Kessler

Sample Name: PBOW-04-IT-BG8-BEDGW-001-DE3000

MONITORING WELL INFORMATION [use top of casing (TOC) for all measurements]

Well Number: DEDGW-001	Outside Casing Dia. (in): 2"	Odor:
Well Secure (Yes / No): Yes	Depth to Product (ft): NA	Vapor Monitor Type: PID / LEL
Well Labeled (Yes / No): Yes	Total Well Depth (ft): 20'	Vapor Monitor S/N: /
Well Condition: Good	Depth to Water (ft): 5.55	Reading (ppm): LEL = 0 % O_2 = 20.6 %
Top of Screen: 5'	Water Column: 14.45	PID=0 C = 0 ppm H_2S= 0 ppm
Screen Height: 15'	Top of Filter Pack: 5'	Depth Pump Set: ~~22~~ 14'
Casing Type: PVC	Pump Type: bladder	Pump Settings: psi – 9, Refill – 10, Discharge - 5
		Remarks:

MONITORING WELL PURGE CALCULATIONS

Volume of Water in Casing: Gallons/foot = 0.041 x d^2, where d is casing diameter in inches = (0.041 x (____)^2) = _____gal/ft

Well Volume (gallons) = Water Column (ft) x Gal/ft = _____ft x _____ Gal/ft = _____gallons

Volume of Water in Filter Pack: Gallons/foot = 0.041 x (D^2-d^2), where D is total borehole dia. in inches & d is casing dia. in inches = 0.041 x ((____)^2 – (____)^2) = _____ gal/ft

Filter Pack Volume (gal) = ((Screen Height + Sand Above Set or Water Column) x gal/ft) x porosity (0.3) = ((Screen Height ____ft + ____ ft) x ____gal/ft) x 0.3 = ____gallons

Purge Well Volume: Purge Well Volume – Filter Pack Volume + Well Volume = _____ gal + _____ gal = _____gal

1 x Purge Well Volume (gal.)	2 x Purge Well Volume (gal.)	3 x Purge Well Volume (gal.)	4 x Purge Well Volume (gal.)	5 x Purge Well Volume (gal.)

LOW-FLOW TUBING PURGE CALCULATIONS (3 tubing/pump volumes required for PBOW)

Volume of Water in Tubing: 1/4" ID Tubing = 0.01 Liters/ft. 3/8" ID Tubing = 0.02 Liters/ft. 2" Bladder Pump Volume = 0.3 Liters Tubing Length = ____ft.

Tubing Volume (Liters) = ([Tubing Liters/ft. x Tubing length] + Pump volume) x 3 = ([0.01 L/ft x 16 ft] + 0.3 L) x 3 = 1.38 L

Total Volume Purged: 1.38 L Liters to gallons = L x 0.26gal/L

Shaw™
Shaw E & I, Inc.

Sample Collection Log

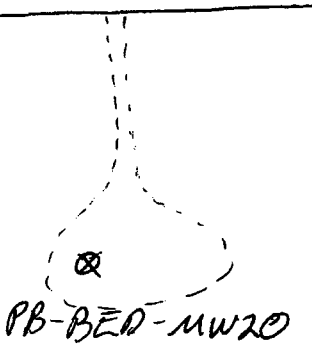
Plum Brook Ordnance Works

Project No: 843656 Project Manager: S. Downey

Location Code:	**PB-BED-MW20**	Collection Date:	3.10.04
Sample Number:	**DE3001**	Collection Time:	1525
Sample Name:	**PBOW-04-PB-BED-MW20-DE3001**	Start Depth:	32'
Sampling Method:	**Low Flow**	End Depth:	—
Sample Type:	**GW**	Sample Matrix:	**WATER**
Sample Purpose:	**REG**	Sample Team:	**Kessler/Parham**

Analytical Suite	Containers
TERED METALS	1 - 250 mL HDPE
TOTAL METALS	1 - 250 mL HDPE
EXPLOSIVES	1 - 1 L Amb. Glass 7/8 Full
VOLATILES	3 - 40 mL Vial
SEMIVOLATILES 1	~~2~~ - 1 L Amb. Glass
TOC	2 - 40 mL Vial
CYANIDE	1 - 1 L HDPE
ALKALINITY	7/8 ~~1~~ - 1 L HDPE DKK
CHLORIDE	
NITRATE	
SULFATE	
TDS	
TSS	
TURBIDITY	
HARDNESS	1 - 250 mL HDPE

Sketch Location



Comments: Samples placed on ice.

gged by/Date: [signature]

Reviewed by/Date: David Kessler 3/10/04

Shaw
Shaw E & I, Inc.

GROUNDWATER PURGE FORM

Location Code: **PB-BED-MW20**

Sample Number: **DE3001**

Water Quality Parameter Measurements									
Date/ Time	DTW (ft. BTOC)	Purge Rate (mL/min)	Cumulative Volume Purged (L)	Temp. (degree C)	Conductivity (umhos/cm)	pH (std. units)	Eh (mv)	DO (mg/L)	Turbidity (NTU)
1450	14.31	190	0.0	11.22	47.33	6.82	-23.1	3.41	8.1
1455	14.29	"	.95	11.26	47.02	6.74	-18.9	0.0	1.8
1500	14.34	50	1.9	11.18	48.15	6.69	-20.9	0.0	0.0
1505	14.51	"	1.15	12.36	48.22	6.70	-45.3	0.0	0.0
1510	14.49	"	1.40	12.59	48.48	6.71	-55.8	0.0	0.0
1515	14.51	"	1.65	10.91	48.56	6.71	-55.9	0.0	0.0
1520	14.51	"	1.90	10.99	48.48	6.70	-55.1	0.0	0.0
1525	14.51	"	2.15	10.91	48.57	6.70	-55.7	0.0	0.0
purge completed. Began sampling DE3001.									

Abbreviations: BTOC - Below top of casing; DTW - Depth to water; mL - milliliter; L - Liter

Tot. Purge Volume: .75 gal

GROUNDWATER SAMPLING FORM

Shaw®

Project Number: 843635
Project Name: PBOW
Investigation Site: Background
RFA/COC Number: PB031004STL-K NL

Collection Date: 3.10.04
Collection Time: 1535
Sample Filtered (Yes/No): Yes; Metals
Weather/Temp: Sunny + Cool

Form Completed By: Z. Parham
Sampler(s): D. Kessler, Z. Parham
Reviewed By: David Kessler

Sample Name: PBOW-04-PB-BED-MW20-GW-DE3001

MONITORING WELL INFORMATION [use top of casing (TOC) for all measurements]

Well Number: MW20	Outside Casing Dia. (in): 2"	Odor: None
Well Secure (Yes / No): Yes	Depth to Product (ft): NA	Vapor Monitor Type: PID / LEL
Well Labeled (Yes / No): Yes	Total Well Depth (ft): 48.6'	Vapor Monitor S/N: /
Well Condition: Good	Depth to Water (ft): 14.28	Reading (ppm): LEL = 1 % O_2 = 20.7 %
Top of Screen: 28'	Water Column: 34.32	PID = 0.0 C = 0 ppm H_2S = 0 ppm
Screen Height: 20'	Top of Filter Pack: 26	Depth Pump Set: 32'
Casing Type: PVC	Pump Type: bladder	Pump Settings: psi – ~~20~~ 15, Refill – ~~10~~ 5, Discharge ~~15~~ 4
		Remarks:

MONITORING WELL PURGE CALCULATIONS

Volume of Water in Casing: Gallons/foot = 0.041 x d^2, where d is casing diameter in inches = (0.041 x (_____)^2) = _____gal/ft

Well Volume (gallons) = Water Column (ft) x Gal/ft = _____ ft x _____ Gal/ft = _____gallons

Volume of Water in Filter Pack: Gallons/foot = 0.041 x (D^2-d^2), ~~where D is total borehole dia.~~ Dow Flow in inches & d is casing dia. in inches = 0.041 x ((_____)^2 – (_____)^2) = _____ gal/ft

Filter Pack Volume (gal) = ((Screen Height + Sand ~~Above Set or Water Column~~) x gal/ft) x porosity (0.3) = ((Screen Height _____ft + _____ ft) x _____gal/ft) x 0.3 = _____gallons

Purge Well Volume: Purge Well Volume = Filter Pack Volume + Well Volume = _____ gal + _____ gal = _____gal

1 x Purge Well Volume (gal.)	2 x Purge Well Volume (gal.)	3 x Purge Well Volume (gal.)	4 x Purge Well Volume (gal.)	5 x Purge Well Volume (gal.)

LOW-FLOW TUBING PURGE CALCULATIONS (3 tubing/pump volumes required for PBOW)

Volume of Water in Tubing: 1/4" ID Tubing = 0.01 Liters/ft. 3/8" ID Tubing = 0.02 Liters/ft. 2" Bladder Pump Volume = 0.3 Liters Tubing Length = ____ft.

Tubing Volume (Liters) = ([Tubing Liters/ft. x Tubing length] + Pump volume) x 3 = ([0.01 L/ft x 35 ft] + 0.3 L) x 3 = 1.95 L

Total Volume Purged: 1.95 L Liters to gallons = L x 0.26gal/L = .507 gal.

Shaw™
Shaw E & I, Inc.

Sample Collection Log

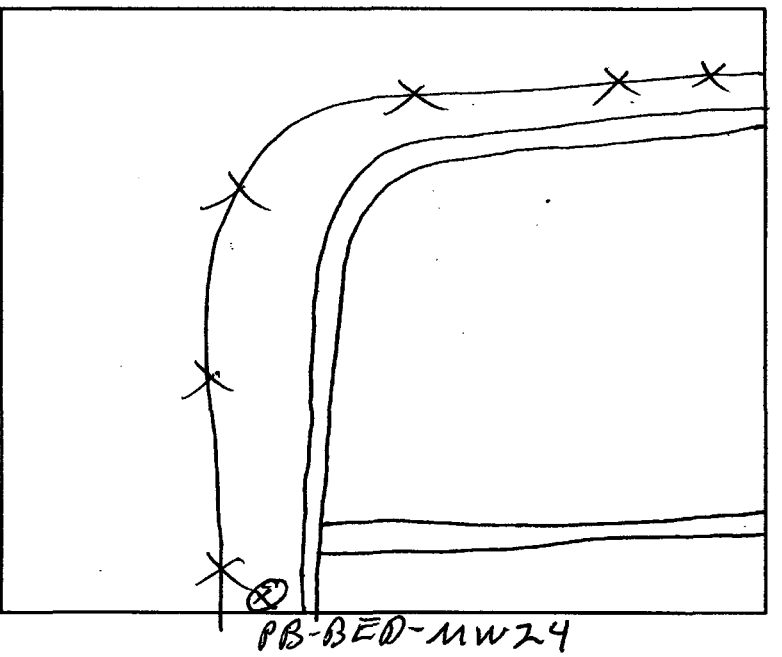
Plum Brook Ordnance Works

Project No: 843656 Project Manager: S. Downey

Location Code:	**PB-BED-MW24**	Collection Date:	3.10.04
Sample Number:	**DE3002**	Collection Time:	1305
Sample Name:	**PBOW-04-PB-BED-MW24-DE3002**	Start Depth:	32'
Sampling Method:	**Low Flow**	End Depth:	—
Sample Type:	**GW**	Sample Matrix:	**WATER**
Sample Purpose:	**REG**	Sample Team:	**Kessler/Parham**

Analytical Suite	Containers
TERED METALS	1 - 250 mL HDPE
TOTAL METALS	1 - 250 mL HDPE
EXPLOSIVES	1 - 1 L Amb. Glass
VOLATILES	3 - 40 mL Vial
SEMIVOLATILES	2 - 1 L Amb. Glass
TOC	2 - 40 mL Vial
CYANIDE	1 - 1 L HDPE
ALKALINITY	1 - 1 L HDPE
CHLORIDE	
NITRATE	
SULFATE	
TDS	
TSS	
TURBIDITY	
HARDNESS	1 - 250 mL HDPE

Sketch Location



Comments: All samples put on ice.

Logged by/Date: [signature] 3.10.04 Reviewed by/Date: David Kessler 3/10/04

Shaw
Shaw E & I, Inc.

GROUNDWATER PURGE FORM

Location Code: **PB-BED-MW24**

Sample Number: **DE3002**

Water Quality Parameter Measurements									
Date/ Time	DTW (ft. BTOC)	Purge Rate (mL/min)	Cumulative Volume Purged (L)	Temp. (degree C)	Conductivity (umhos/cm)	pH (std. units)	Eh (mv)	DO (mg/L)	Turbidity (NTU)
1225	26.10	150	0	—	—	—	—	—	—
1230	26.13	"	.90	9.96	1.798	6.56	-289.4	1.68	22.5
1235	"	"	1.80	10.65	1.782	6.57	-306.6	1.782	7.3
1240	26.09	"	2.70	10.75	1.769	6.57	-310.3	0.0	8.4
1245	26.11	"	3.60	10.74	1.732	6.55	-310.5	0.0	8.6
1250	"	"	4.50	10.80	1.723	6.55	-310.2	0.0	7.0
1255	"	"	5.40	10.78	1.711	6.55	-310.3	0.0	4.9
1300	"	"	6.30	10.81	1.702	6.54	-310.2	0.0	4.2
1305	"	"	7.20	10.84	1.700	6.54	-310.3	0.0	3.4

Purge ended at 1305. Began sampling DE3002

Abbreviations: BTOC - Below top of casing; DTW - Depth to water; mL - milliliter; L - Liter

Total Purge Volume = 2.1 gal.

GROUNDWATER SAMPLING FORM

Shaw®

Project Number: 843635
Project Name: PBOW
Investigation Site: Background NC
RFA/COC Number: PB031004STL-K

Collection Date: 7.10.04
Collection Time: 1305
Sample Filtered (Yes/No): Yes; Metals
Weather/Temp: partly sunny, cool (40°)

Form Completed By: Z. Parham
Sampler(s): D. Kessler, Z. Parham
Reviewed By: David Kessler

Sample Name: PBOW-04-PB-BED-MW24-GW-DE3002

MONITORING WELL INFORMATION [use top of casing (TOC) for all measurements]

Well Number: MW24	Outside Casing Dia. (in): 2"	Odor: Strong H_2S smell
Well Secure (Yes / No): Yes	Depth to Product (ft): NA	Vapor Monitor Type: PID / LEL
Well Labeled (Yes / No): Yes	Total Well Depth (ft): 41'	Vapor Monitor S/N: /
Well Condition: Good	Depth to Water (ft): 25.96	Reading (ppm): LEL 50 % O_2 = 19.8%
Top of Screen: 25.5'	Water Column: 15.04	PID = 56.8 C = 0 ppm H_2S = 156 ppm
Screen Height: 15'	Top of Filter Pack: 19	Depth Pump Set: 32'
Casing Type: PVC	Pump Type: Bladder	Pump Settings: psi – 20, Refill – 10, Discharge - 5
		Remarks:

MONITORING WELL PURGE CALCULATIONS

Volume of Water in Casing: Gallons/foot = 0.041 x d^2, where d is casing diameter in inches = (0.041 x (_____)^2) = _____gal/ft

Well Volume (gallons) = Water Column (ft) x Gal/ft = _____ ft x _____ Gal/ft = _____gallons

Volume of Water in Filter Pack: Gallons/foot = 0.041 x (D^2-d^2), where D is total borehole dia. in inches & d is casing dia. in inches = 0.041 x ((_____)^2 – (_____)^2) = _____ gal/ft

Filter Pack Volume (gal) = ((Screen Height + Sand Above Set of Water Column) x gal/ft) x porosity (0.3) = ((Screen Height _____ft + _____ ft) x _____gal/ft) x 0.3 = _____gallons

Purge Well Volume: Purge Well Volume = Filter Pack Volume + Well Volume = _____ gal + _____ gal = _____gal

1 x Purge Well Volume (gal.)	2 x Purge Well Volume (gal.)	3 x Purge Well Volume (gal.)	4 x Purge Well Volume (gal.)	5 x Purge Well Volume (gal.)

LOW-FLOW TUBING PURGE CALCULATIONS (3 tubing/pump volumes required for PBOW)

Volume of Water in Tubing: 1/4" ID Tubing = 0.01 Liters/ft. 3/8" ID Tubing = 0.02 Liters/ft. 2" Bladder Pump Volume = 0.3 Liters Tubing Length = ____ft.

Tubing Volume (Liters) = ([Tubing Liters/ft. x Tubing length] + Pump volume) x 3 = ([0.01 L/ft x 40 ft] + 0.3 L) x 3 = 2.1 L

Total Volume Purged: 2.1 L Liters to gallons = L x 0.26gal/L = .546 gal

Shaw™
Shaw E & I, Inc.

Sample Collection Log

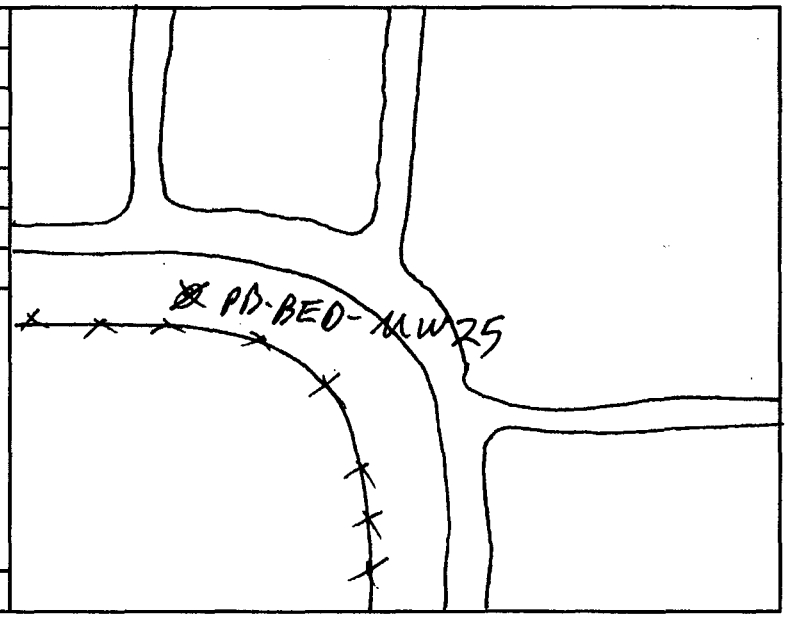
Plum Brook Ordnance Works

Project No: 843656 Project Manager: S. Downey

Location Code:	**PB-BED-MW25**	Collection Date:	3.11.04
Sample Number:	**DE3003**	Collection Time:	0915
Sample Name:	**PBOW-04-PB-BED-MW25-DE3003**	Start Depth:	35'
Sampling Method:	**Low Flow**	End Depth:	—
Sample Type:	**GW**	Sample Matrix:	**WATER**
Sample Purpose:	**REG**	Sample Team:	**Kessler/Parham**

Analytical Suite	Containers
TERED METALS	1 - 250 mL HDPE
TOTAL METALS	1 - 250 mL HDPE
EXPLOSIVES	1 - 1 L Amb. Glass
VOLATILES	3 - 40 mL Vial
SEMIVOLATILES	2 - 1 L Amb. Glass
TOC	2 - 40 mL Vial
CYANIDE	1 - 1 L HDPE
ALKALINITY	1 - 1 L HDPE
CHLORIDE	
NITRATE	
SULFATE	
TDS	
TSS	
TURBIDITY	
HARDNESS	1 - 250 mL HDPE

Sketch Location



Comments: All samples placed on ice

Logged by/Date: [signature] 3.11.04 Reviewed by/Date: David Kessler 3/11/04

Shaw
Shaw E & I, Inc.

GROUNDWATER PURGE FORM

Location Code: **PB-BED-MW25**

Sample Number: **DE3003**

Water Quality Parameter Measurements									
Date/ Time	DTW (ft. BTOC)	Purge Rate (mL/min)	Cumulative Volume Purged (L)	Temp. (degree C)	Conductivity (umhos/cm)	pH (std. units)	Eh (mv)	DO (mg/L)	Turbidity (NTU)
	13.83								
0835	~~14.83~~	~~375~~ 400	0	8.69	2.056	7.26	-120.8	2.68	0.5
0840	13.89	400	2.0 ~~1.975~~	10.36	2.078	7.08	-156.0	2.42	0.0
0845	13.89	"	4.0	10.70	1.716	7.05	-247.7	0.39	0.0
0850	13.89	"	6.0	10.78	1.669	7.03	-281.5	0.14	0.0
0855	13.89	"	8.0	10.84	1.649	7.03	-294.6	0.0	0.0
0902	13.89	"	10.0	10.88	1.621	7.01	-303.1	0.0	0.0
0905	13.89	"	12.0	10.85	1.606	7.01	-303.9	0.0	0.0
0910	13.89	"	14.0	10.86	1.602	7.00	-303.2	0.0	0.0
0915	13.91	"	16.0	10.85	1.605	7.01	-303.4	0.0	0.0
- purge completed. began sampling DE3003 -									

Abbreviations: BTOC - Below top of casing; DTW - Depth to water; mL - milliliter; L - Liter

Total Purge Vol. = 5.2 gal.

GROUNDWATER SAMPLING FORM

Shaw®

Project Number: 843635
Project Name: PBOW
Investigation Site: Background NC
RFA/COC Number: PB031104STL LK

Collection Date: 3.11.04
Collection Time: 0815
Sample Filtered (Yes/No): Yes; Metals
Weather/Temp: Cloudy, cold, windy

Form Completed By: Z. Parham
Sampler(s): D. Kessler, Z. Parham
Reviewed By: D. Kessler

Sample Name: PBOW-04-PB-BED-MW25-GW-DE3003

MONITORING WELL INFORMATION [use top of casing (TOC) for all measurements]

Well Number: MW25	Outside Casing Dia. (in): 2"	Odor:
Well Secure (Yes / No): Yes	Depth to Product (ft): NA	Vapor Monitor Type: PID / LEL
Well Labeled (Yes / No): Yes	Total Well Depth (ft): 40.6'	Vapor Monitor S/N: /
Well Condition: Good	Depth to Water (ft): 13.83	Reading (ppm): LEL = 0 % O_2 = 20.6 %
Top of Screen: 30'	Water Column: 26.77	PID=0 C = 0 ppm H_2S=0 ppm
Screen Height: 10'	Top of Filter Pack: 25	Depth Pump Set: ~~32~~ 35'
Casing Type: PVC	Pump Type: bladder	Pump Settings: psi – 20, Refill – 10, Discharge - 5
		Remarks:

MONITORING WELL PURGE CALCULATIONS

Volume of Water in Casing: Gallons/foot = 0.041 x d^2, where d is casing diameter in inches = (0.041 x (____)^2) = _____ gal/ft

Well Volume (gallons) = Water Column (ft) x Gal/ft = _____ ft x _____ Gal/ft = _____ gallons

Volume of Water in Filter Pack: Gallons/foot = 0.041 x (D^2 - d^2), where D is total borehole dia. in inches & d is casing dia. in inches = 0.041 x ((____)^2 – (____)^2) = _____ gal/ft

Filter Pack Volume (gal) = ((Screen Height + Sand Above Set or Water Column) x gal/ft) x porosity (0.3) = ((Screen Height ____ ft + ____ ft) x ____ gal/ft) x 0.3 = ____ gallons

Purge Well Volume: Purge Well Volume – Filter Pack Volume + Well Volume = _____ gal + _____ gal = _____ gal

1 x Purge Well Volume (gal.)	2 x Purge Well Volume (gal.)	3 x Purge Well Volume (gal.)	4 x Purge Well Volume (gal.)	5 x Purge Well Volume (gal.)

LOW-FLOW TUBING PURGE CALCULATIONS (3 tubing/pump volumes required for PBOW)

Volume of Water in Tubing: 1/4" ID Tubing = 0.01 Liters/ft. 3/8" ID Tubing = 0.02 Liters/ft. 2" Bladder Pump Volume = 0.3 Liters Tubing Length = ____ ft.

Tubing Volume (Liters) = ([Tubing Liters/ft. x Tubing length] + Pump volume) x 3 = ([0.01 L/ft x 40 ft] + 0.3 L) x 3 = 2.1 L

Total Volume Purged: 2.1 L Liters to gallons = L x 0.26gal/L = .546 gal

Shaw™
Shaw E & I, Inc.

Sample Collection Log

Plum Brook Ordnance Works

Project No: 843656 Project Manager: S. Downey

Location Code:	**PB-BED-MW25**	Collection Date:	3.11.04
Sample Number:	**DE3003-MS**	Collection Time:	0915
Sample Name:	**PBOW-04-PB-BED-MW25-DE3003-MS**	Start Depth:	35'
Sampling Method:	**Low Flow**	End Depth:	—
Sample Type:	**GW**	Sample Matrix:	**WATER**
Sample Purpose:	**MS**	Sample Team:	**Kessler/Parham**

Analytical Suite	Containers	Sketch Location
FILTERED METALS	1 - 250 mL HDPE	See sample# DE3003 for location information.
TOTAL METALS	1 - 250 mL HDPE	
EXPLOSIVES	1 - 1 L Amb. Glass	
VOLATILES	3 - 40 mL Vial	
SEMIVOLATILES	2 - 1 L Amb. Glass	
TOC	2 - 40 mL Vial	
CYANIDE	1 - 1 L HDPE	
ALKALINITY	1 - 1 L HDPE	
CHLORIDE		
NITRATE		
SULFATE		
TDS		
TSS		
TURBIDITY		
HARDNESS	1 - 250 mL HDPE	

Comments: See sample# DE3003 for purge and location information.

Logged by/Date: [signature] / 3.11.04

Reviewed by/Date: David Kessler 3/11/04

Shaw™
Shaw E & I, Inc.

Sample Collection Log

Plum Brook Ordnance Works

Project No: 843656 Project Manager: S. Downey

Location Code:	**PB-BED-MW25**	Collection Date:	3.11.04
Sample Number:	**DE3003-MSD**	Collection Time:	0915
Sample Name:	**PBOW-04-PB-BED-MW25-DE3003-MSD**	Start Depth:	35'
Sampling Method:	**Low Flow**	End Depth:	—
Sample Type:	**GW**	Sample Matrix:	**WATER**
Sample Purpose:	**MSD**	Sample Team:	**Kessler/Parham**

Analytical Suite	Containers	Sketch Location
FILTERED METALS	1 - 250 mL HDPE	See sample# DE3003 for location information.
TOTAL METALS	1 - 250 mL HDPE	
EXPLOSIVES	1 - 1 L Amb. Glass	
VOLATILES	3 - 40 mL Vial	
SEMIVOLATILES	2 - 1 L Amb. Glass	
TOC	2 - 40 mL Vial	
CYANIDE	1 - 1 L HDPE	
ALKALINITY	1 - 1 L HDPE	
CHLORIDE		
NITRATE		
SULFATE		
TDS		
TSS		
TURBIDITY		
HARDNESS	1 - 250 mL HDPE	

Comments: See sample# DE3003 for purge and location information.

Logged by/Date: [signature] / 3.11.04

Reviewed by/Date: David Kessler 3/11/04

Shaw™
Shaw E & I, Inc.

Sample Collection Log

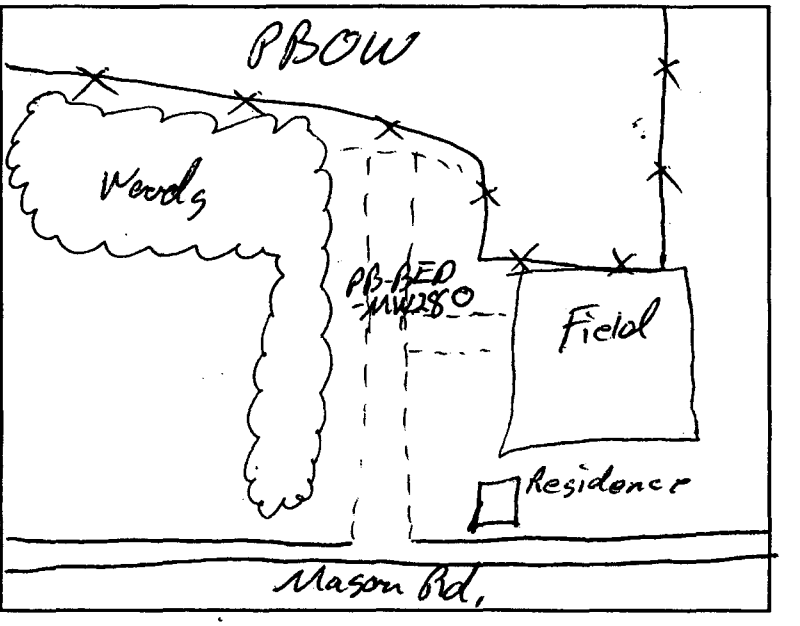
Plum Brook Ordnance Works

Project No: 843656 Project Manager: S. Downey

Location Code:	**PB-BED-MW28**	Collection Date:	3.9.04
Sample Number:	**DE3004**	Collection Time:	1410
Sample Name:	**PBOW-04-PB-BED-MW28-DE3004**	Start Depth:	32'
Sampling Method:	**Low Flow**	End Depth:	—
Sample Type:	**GW**	Sample Matrix:	**WATER**
Sample Purpose:	**REG**	Sample Team:	**Kessler/Parham**

Analytical Suite	Containers
TERED METALS	1 - 250 mL HDPE
TAL METALS	1 - 250 mL HDPE
EXPLOSIVES	1 - 1 L Amb. Glass
VOLATILES	3 - 40 mL Vial
SEMIVOLATILES	2 - 1 L Amb. Glass
TOC	2 - 40 mL Vial
CYANIDE	1 - 1 L HDPE
ALKALINITY	1 - 1 L HDPE
CHLORIDE	
NITRATE	
SULFATE	
TDS	
TSS	
TURBIDITY	
HARDNESS	1 - 250 mL HDPE

Sketch Location



Comments: All samples placed on ice

ged by/Date: [signature] 3.9.04 Reviewed by/Date: David Kessler 3/9/04

Shaw
Shaw E & I, Inc.

GROUNDWATER PURGE FORM

Location Code: **PB-BED-MW28**

Sample Number: **DE3004**

Water Quality Parameter Measurements									
Date/ Time 3.9.04	DTW (ft. BTOC)	Purge Rate (mL/min)	Cumulative Volume Purged (L)	Temp. (degree C)	Conductivity (umhos/cm)	pH (std. units)	Eh (mv)	DO (mg/L)	Turbidity (NTU)
1325	6.26	170	0.0	—	—	—	—	—	—
1330	6.46	"	.85	9.45	1.763	8.46	93.7	1.31	2.1
1335	6.52	"	1.70	9.52	1.756	8.48	76.9	0.44	0.0
1340	6.51	"	2.55	9.80	1.747	8.55	76.6	0.00	0.0
1345	6.51	150	3.40	9.84	1.742	8.54	75.2	0.00	0.0
1350	6.51	"	4.15	10.02	1.730	8.54	76.0	0.00	0.0
1355	6.52	"	4.90	10.02	1.730	8.52	75.8	0.0	0.0
1400	6.51	"	5.65	10.00	1.731	8.51	75.4	0.0	0.0
1405	6.51	"	6.40	10.00	1.735	8.51	75.4	0.0	0.0
1410	6.51	"	7.15	10.01	1.739	8.50	75.3	0.0	0.0
— Purge completed; Began sampling DE3004 —									

Abbreviations: BTOC - Below top of casing; DTW - Depth to water; mL - milliliter; L - Liter

Total Purge Volume = 2.5 gallons

GROUNDWATER SAMPLING FORM

Shaw®

Project Number: 843635
Project Name: PBOW
Investigation Site: Background
RFA/COC Number: PB0304STL NC KN

Collection Date: 3.9.04
Collection Time: 1410
Sample Filtered (Yes/No): Yes; Metals
Weather/Temp: Sunny + Cold / ≈ 35°F

Form Completed By: Z. Parham
Sampler(s): D. Kessler, Z. Parham
Reviewed By: David Kessler

Sample Name: PBOW-04-PB-BED-MW28-GW-DE3004

MONITORING WELL INFORMATION [use top of casing (TOC) for all measurements]

Well Number: MW28	Outside Casing Dia. (in): 2"	Odor: NA
Well Secure (Yes / No): Yes	Depth to Product (ft): NA	Vapor Monitor Type: PID / LEL
Well Labeled (Yes / No): Yes	Total Well Depth (ft): 41.9'	Vapor Monitor S/N: 0.0 1
Well Condition: Good	Depth to Water (ft): 6.26	Reading (ppm): LEL = 0 % O_2 = 20.6 %
Top of Screen: 26.65'	Water Column: 35.64	PID = 0.0 C = 0 ppm H_2S = 0 ppm
Screen Height: 15'	Top of Filter Pack: 17.5'	Depth Pump Set: 32'
Casing Type: PVC	Pump Type: Bladder	Pump Settings: psi – 20, Refill – 10, Discharge - 5
		Remarks:

MONITORING WELL PURGE CALCULATIONS

Volume of Water in Casing: Gallons/foot = 0.041 x d^2, where d is casing diameter in inches = (0.041 x (_____)^2) = _____ gal/ft

Well Volume (gallons) = Water Column (ft) x ~~Gal/ft = 0.041 ft x~~ _____ Gal/ft = _____ gallons

Volume of Water in Filter Pack: Gallons/foot = 0.041 x (D^2 - d^2) where D is total borehole dia. in inches & d is casing dia. in inches = 0.041 x ((_____)^2 – (_____)^2) = _____ gal/ft

Filter Pack Volume (gal) = ((Screen Height + Sand Above Set or Water Column) x gal/ft) x porosity (0.3) = ((Screen Height _____ ft + _____ ft) x _____ gal/ft) x 0.3 = _____ gallons

Purge Well Volume: Purge Well Volume – Filter Pack Volume + Well Volume = _____ gal + _____ gal = _____ gal

1 x Purge Well Volume (gal.)	2 x Purge Well Volume (gal.)	3 x Purge Well Volume (gal.)	4 x Purge Well Volume (gal.)	5 x Purge Well Volume (gal.)

LOW-FLOW TUBING PURGE CALCULATIONS (3 tubing/pump volumes required for PBOW)

Volume of Water in Tubing: 1/4" ID Tubing = 0.01 Liters/ft. 3/8" ID Tubing = 0.02 Liters/ft. 2" Bladder Pump Volume = 0.3 Liters Tubing Length = 39 ft.

Tubing Volume (Liters) = ([Tubing Liters/ft. x Tubing length] + Pump volume) x 3 = ([0.01 L/ft x 39 ft] + 0.3 L) x 3 = 2.07 L

Total Volume Purged: 2.07 L Liters to gallons = L x 0.26gal/L = .547 L

Shaw™
Shaw E & I, Inc.

Sample Collection Log

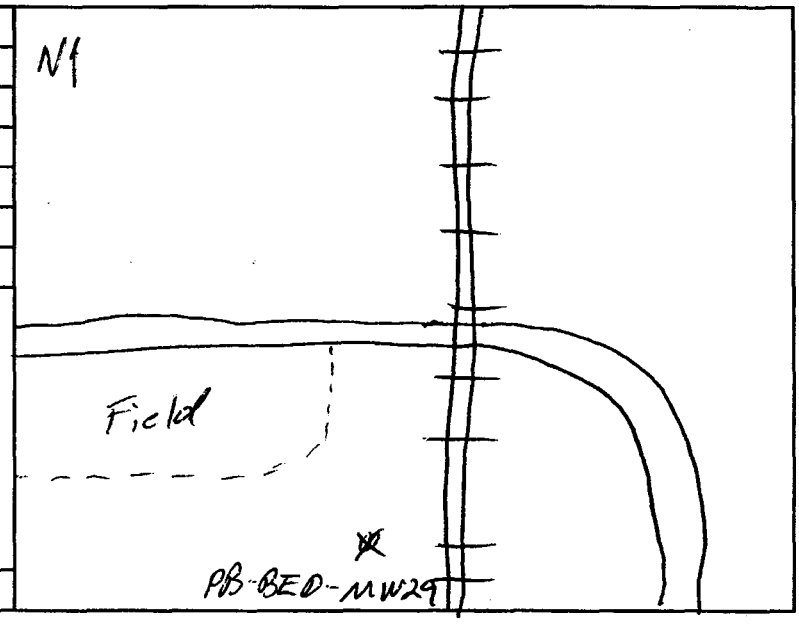
Plum Brook Ordnance Works

Project No: 843656 Project Manager: S. Downey

Location Code:	**PB-BED-MW29**	Collection Date:	3.10.04
Sample Number:	**DE3005**	Collection Time:	1015
Sample Name:	**PBOW-04-PB-BED-MW29-DE3005**	Start Depth:	32'
Sampling Method:	**Low Flow**	End Depth:	—
Sample Type:	**GW**	Sample Matrix:	**WATER**
Sample Purpose:	**REG**	Sample Team:	**Kessler/Parham**

Analytical Suite	Containers
FILTERED METALS	1 - 250 mL HDPE
TOTAL METALS	1 - 250 mL HDPE
EXPLOSIVES	1 - 1 L Amb. Glass
VOLATILES	3 - 40 mL Vial
SEMIVOLATILES	2 - 1 L Amb. Glass
TOC	2 - 40 mL Vial
CYANIDE	1 - 1 L HDPE
ALKALINITY	1 - 1 L HDPE
CHLORIDE	
NITRATE	
SULFATE	
TDS	
TSS	
TURBIDITY	
HARDNESS	1 - 250 mL HDPE

Sketch Location



Comments: All samples placed on ice.

Logged by/Date: Zach Parham / 3.10.04 Reviewed by/Date: David Kessler 3/10/04

Shaw
Shaw E & I, Inc.

GROUNDWATER PURGE FORM

Location Code: **PB-BED-MW29**

Sample Number: **DE3005**

Water Quality Parameter Measurements									
Date/ Time 3.10.04	DTW (ft. BTOC)	Purge Rate (mL/min)	Cumulative Volume Purged (L)	Temp. (degree C)	Conductivity (umhos/cm)	pH (std. units)	Eh (mv)	DO (mg/L)	Turbidity (NTU)
0910	2.73	200	0.0	—	—	—	—	—	—
0915	2.83	"	1.0	6.82	7.369	6.88	68.7	3.66	155.5
0920	2.86	100	2.0	8.93	8.430	6.78	60.7	4.55	141.0
0925	2.89	"	2.5	8.64	8.577	6.77	49.3	6.69	78.2
0930	2.90	120	3.0	9.18	8.771	6.75	42.1	4.44	54.8
0935	2.96	"	3.60	9.47	8.881	6.74	37.6	1.83	44.2
0940	2.96	150	4.20	10.12	8.929	6.75	34.5	1.66	26.9
0945	2.96	"	4.95	9.56	9.301	6.75	34.6	0.58	32.4
0950	2.98	"	5.7	9.12	9.328	6.73	34.6	0.0	22.4
0955	2.99	"	6.45	9.27	9.291	6.74	34.3	0.0	19.3
1000	2.99	"	7.20	9.25	9.219	6.74	34.9	0.0	12.1
1005	3.01	"	7.95	9.26	9.215	6.74	34.7	0.0	10.8
1010	2.99	"		9.17	9.215	6.73	34.6	0.0	10.7
1015	3.00	"		9.13	9.207	6.73	34.4	0.0	10.2
Purge completed. Began sampling DE3005 @ 1015.									

Abbreviations: BTOC - Below top of casing; DTW - Depth to water; mL - milliliter; L - Liter

Total Purge Vol: 1.8 gal

GROUNDWATER SAMPLING FORM

Shaw®

Project Number: 843635
Project Name: PBOW
Investigation Site: Background
RFA/COC Number: PB0310045TL-1 NC

Collection Date: 3.10.04
Collection Time: 1015
Sample Filtered (Yes/No): Yes; Metals
Weather/Temp: Sunny + Cold

Form Completed By: Z. Parham
Sampler(s): D. Kessler, Z. Parham
Reviewed By: David Kessler

Sample Name: PBOW-04-PB-BED-MW29-GW-DE3005

MONITORING WELL INFORMATION [use top of casing (TOC) for all measurements]

Well Number: MW29	Outside Casing Dia. (in): 2"	Odor: NA
Well Secure (Yes / No): Yes	Depth to Product (ft): NA	Vapor Monitor Type: PID / LEL
Well Labeled (Yes / No): Yes	Total Well Depth (ft): 37.9'	Vapor Monitor S/N: /
Well Condition: Good	Depth to Water (ft): 2.73	Reading (ppm): LEL = 18 % O_2 = ~~20.8~~ 20.8 %
Top of Screen: 27.65'	Water Column: 35.17	PID = 0.0 C = 0 ppm H_2S = 0 ppm
Screen Height: 10'	Top of Filter Pack: 25'	Depth Pump Set: 32'
Casing Type: PVC	Pump Type: Bladder	Pump Settings: psi 19.5 – 20, Refill – 10, Discharge - 5
		Remarks:

MONITORING WELL PURGE CALCULATIONS

Volume of Water in Casing: Gallons/foot = 0.041 x d^2, where d is casing diameter in inches = (0.041 x (_____)^2) = _____gal/ft

Well Volume (gallons) = Water Column (ft) x Gal/ft = _____ ft x _____ Gal/ft = _____gallons

Volume of Water in Filter Pack: Gallons/foot = 0.041 x (D^2-d^2), where D is total borehole dia. in inches & d is casing dia. in inches = 0.041 x ((_____)^2 – (_____)^2) = _____ gal/ft

Filter Pack Volume (gal) = ((Screen Height + Sand ~~Above Set~~ or Water Column) x gal/ft) x porosity (0.3) = ((Screen Height _____ft + _____ ft) x _____gal/ft) x 0.3 = _____gallons

Purge Well Volume: Purge Well Volume – Filter Pack Volume + Well Volume = _____ gal + _____ gal = _____gal

1 x Purge Well Volume (gal.)	2 x Purge Well Volume (gal.)	3 x Purge Well Volume (gal.)	4 x Purge Well Volume (gal.)	5 x Purge Well Volume (gal.)

LOW-FLOW TUBING PURGE CALCULATIONS (3 tubing/pump volumes required for PBOW)

Volume of Water in Tubing: 1/4" ID Tubing = 0.01 Liters/ft. 3/8" ID Tubing = 0.02 Liters/ft. 2" Bladder Pump Volume = 0.3 Liters Tubing Length = ____ft.

Tubing Volume (Liters) = ([Tubing Liters/ft. x Tubing length] + Pump volume) x 3 = ([0.01 L/ft x 38 ft] + 0.3 L) x 3 = 2.04 L

Total Volume Purged: 2.04 L Liters to gallons = L x 0.26gal/L = .53 gal

Shaw™
Shaw E & I, Inc.

Sample Collection Log

Plum Brook Ordnance Works

Project No: 843656 Project Manager: S. Downey

Location Code:	**PB-BED-MW25**	Collection Date:	3.11.04
Sample Number:	**DE3006**	Collection Time:	0915
Sample Name:	**PBOW-04-PB-BED-MW25-DE3006**	Start Depth:	35'
Sampling Method:	**Low Flow**	End Depth:	—
Sample Type:	**GW**	Sample Matrix:	**WATER**
Sample Purpose:	**FD**	Sample Team:	**Kessler/Parham**

Analytical Suite	Containers	Sketch Location
TERED METALS	1 - 250 mL HDPE	See sample# DE3003 for location information.
TAL METALS	1 - 250 mL HDPE	
EXPLOSIVES	1 - 1 L Amb. Glass	
VOLATILES	3 - 40 mL Vial	
SEMIVOLATILES	2 - 1 L Amb. Glass	

Comments: See sample# DE3003 for purge and location information.

ged by/Date: Zach Parham / 3.11.04 Reviewed by/Date: David Kessler 3/11/04

Shaw™
Shaw E & I, Inc.

Sample Collection Log

Plum Brook Ordnance Works

Project No: 843656 Project Manager: S. Downey

Location Code:	**PB-BED-MW25**	Collection Date:	3.11.04
Sample Number:	**DE3007**	Collection Time:	0915
Sample Name:	**PBOW-04-PB-BED-MW25-DE3007**	Start Depth:	35'
Sampling Method:	**Low Flow**	End Depth:	—
Sample Type:	**GW**	Sample Matrix:	**WATER**
Sample Purpose:	**FS**	Sample Team:	**Kessler/Parham**

Analytical Suite	Containers	Sketch Location
FILTERED METALS	1 - 250 mL HDPE	See sample# DE3003 for location information.
TOTAL METALS	1 - 250 mL HDPE	
EXPLOSIVES	1 - 1 L Amb. Glass	
VOLATILES	3 - 40 mL Vial	
SEMIVOLATILES	2 - 1 L Amb. Glass	

Comments: See sample# DE3003 for purge and location information.

Logged by/Date: [signature] / 3.11.04 Reviewed by/Date: David Kessler 3/11/04

Shaw™
Shaw E & I, Inc.

Sample Collection Log

Plum Brook Ordnance Works

Project No: 843656 Project Manager: S. Downey

Location Code:	PB-BED-MW26	Collection Date:	~~NA~~ 3.10.04
Sample Number:	DE3008	Collection Time:	NA
Sample Name:	PBOW-04-PB-BED-MW26-DE3008	Start Depth:	NA
Sampling Method:	Low ~~Flow~~	End Depth:	NA
Sample Type:	GW	Sample Matrix:	WATER
Sample Purpose:	REG	Sample Team:	Kessler/Parham

Not Sampled

Analytical Suite	Containers
TERED METALS	1 - 250 mL HDPE
TAL METALS	1 - 250 mL HDPE
EXPLOSIVES	1 - 1 L Amb. Glass
VOLATILES	3 - 40 mL Vial
SEMIVOLATILES	2 - 1 L Amb. Glass
TOC	2 - 40 mL Vial
CYANIDE	1 - 1 L HDPE
ALKALINITY	1 - 1 L HDPE
CHLORIDE	
NITRATE	
SULFATE	
TDS	
TSS	
TURBIDITY	
HARDNESS	1 - 250 mL HDPE

Sketch Location: NA

Comments: PID = 15.6
LEL % = Over O_2 = 20.3 H_2S = 0 C = 175
DTW = 58.22, TD = 60.35, WC = 2.13'

Logged by/Date: [signature] 3.10.04 Reviewed by/Date: David Kessler 3/10/04

APPENDIX C

DATA VALIDATION SUMMARY

Data Validation Summary Report
Plum Brook Ordnance Works
Sandusky, Ohio

1.0 Introduction

Level III data validation was performed on 100 percent of the environmental samples collected for December 2003 sampling event. The analytical data consisted of one sample delivery group (SDG) PB046, which was analyzed by Severn Trent Laboratories (STL). In addition, validation of the field-split data, which were analyzed by Accutest Laboratories, was performed and findings are discussed in section 5.0 of this report. Water matrix was validated.

The following samples were validated for this site investigation:

SDG Number	Sample Number
PB046	DE3000, DE3001, DE3002, DE3003, DE3004, DE3005, DE3007

The chemical parameters for which the samples were analyzed are identified below:

Parameter (Prep/Analytical Method)
Volatile Organics by GC/MS SW846 5030/8260B
Semivolatile Organics by GC/MS SW846 3510C/8270C
Total and Dissolved Metals by SW846 3005A/6010B and 7470A
Nitroaromatic and Nitramine Explosives by SW846 8330M
Wet Chemistry (TOC, Sulfate, Nitrate, Chloride, Alkalinity, Turbidity, TSD, TSS, Hardness, Cyanide)

2.0 Procedures

The sample data were validated following the logic identified in the *EPA Contract Laboratory Program (CLP) National Functional Guidelines for Inorganic Data Review* (July 2002) and the *EPA Contract Laboratory Program National Functional Guidelines for Organic Review* (October 1999) for all areas except blanks. *EPA Region III Modifications to the Laboratory Data Validation Functional Guidelines for Evaluating Inorganic Analyses* (April 1993) and *Region III Modifications to National Functional Guidelines for Organic Data Review, Multi-Media, Multi-Concentration (September 1994)* were applied to the areas associated with blank contamination. Specific quality control (QC) criteria as identified in the quality assurance plan (QAP), analytical methods, and laboratory standard operating procedures (SOP) were applied to

all sample results. As a result of the use of Update III SW846 test methods for the analytical data and the application of the Contract Laboratory Program (CLP) guidelines during the validation process, there were instances where specific QC requirements for all target compounds were not defined. This primarily occurred in the organic, gas chromatography (GC) and GC/mass spectrometry (MS) calibration areas and is due to the fact that the analytical methods are performance-based and allow the use of average calibration responses in lieu of individual responses, which are defined by CLP protocol. In light of applying CLP guidelines to SW846 methods and evaluating the usability of the data during the validation process, specific QC criteria were determined to address all target compounds and are identified in this report for each parameter, as well as in the validation checklists, which function as worksheets. All completed validation checklists are included in attachment A. For those analytical methods not addressed by the CLP and Region III guidelines, the validation was based on the method requirements (i.e., SW846, Code of Federal Regulations, SOPs) and technical judgment, following the logic of the CLP validation guidelines.

3.0 Summary of Data Validation Findings

The overall quality of the data was determined to be acceptable with minimal qualifications. The only rejected data ("R" qualified) was due to "poor performing" volatile compounds (ketones, some halogenated hydrocarbons, etc.), which experienced poor calibration responses in the associated calibration data and samples that were reanalyzed and have more than one set of results reported. The "R" qualifier was assigned to the samples with more than one set of results to indicate that a given result should not be used to characterize a particular constituent or an analysis for a given sample.

Individual validation reports have been prepared for each parameter, and the overall results of the validation findings are summarized in this report. A listing of the validation qualifiers and the reason codes, along with their definitions, is found in Attachment A. The following section highlights the key findings of the data validation for each analysis.

4.0 Analysis-Specific Data Validation Summaries

4.1 Volatile Organics by GC/MS SW846 8260B

Overall, the data are of good quality and are usable as reported by the laboratory with the exceptions noted below. Data were reviewed for the following:

Holding Times

Technical holding time criteria were met for all samples.

Initial and Continuing Calibration

The initial calibration (ICAL) and continuing calibrations (CCAL) associated with the project samples met QC criteria with the following exception(s):

- The following exhibited individual ICAL/CCAL relative response factor (RRF) <0.1:

SDG Number	Samples Affected	Compound(s)	Validation Qualifier
PB046	All	2-Butanone, Acetone, Bromomethane	J/R

- The following exhibited individual ICAL relative standard deviation (%RSD) >30 and/or CCAL percent difference (%D) >20:

SDG Number	Samples Affected	Compound(s)	Validation Qualifier
PB046	DE3000, DE3003, DE3004, DE3006	Bromomethane	R
	DE3000, DE3001, DE3002, DE3003, DE3005, DE3006	Chloromethane	UJ
	DE3001, DE3002, DE3005	Xylenes, Total	J/UJ

Blanks

The 5X/10X rule for contaminants found in the associated equipment rinses, trip blanks, and method blanks was applied to all sample results. All were found to be acceptable with the following exception(s):

SDG Number	Samples Affected	Compound(s)	Blank Contaminant	Validation Qualifier
PB046	DE3001, DE3004, DE3005, DE3006	Methylene Chloride	TB	B

Surrogate Recoveries

All surrogate recoveries were within QC limits.

Matrix Spike / Matrix Spike Duplicate

Matrix Spike/Matrix Spike Duplicate (MS/MSD) analysis was performed for the project samples, and all QC criteria were met.

Laboratory Control Sample

Laboratory Control Sample (LCS) analysis was performed for the project samples and all QC criteria were met.

Field Duplicates

Original and field duplicate results were evaluated and no problems were identified.

Internal Standards

All internal standards met QC criteria.

Quantitation

Results quantitated between the method detection limit (MDL) and the reporting limit (RL), which the lab qualified as "J", were qualified as estimated "J" unless blank contamination was present or the results were rejected.

4.2 Semivolatile Organics by GC/MS SW846 8270C

Overall, the data are of good quality and are usable as reported by the laboratory with the exceptions noted below. Data were reviewed for the following:

Holding Times

Technical holding time criteria were met for all samples, with the exception of the following:

SDG Number	Samples Affected	Compound(s)	Validation Qualifier
PB046	DE3004	All	UJ

- Sample was re-extracted outside of holding time since the original analysis experienced surrogate recovery problems.

Initial and Continuing Calibration

All initial and continuing calibrations associated with the project samples met QC criteria with the following exception(s):

- The following exhibited individual ICAL relative standard deviation (%RSD) >30 and/or CCAL percent difference (%D) >20:

SDG Number	Samples Affected	Compound(s)	Validation Qualifier
PB046	DE3003, DE3006	2,4-Dinitrophenol	UJ

Blanks

The 5X/10X rule for contaminants found in the associated equipment rinses and method blanks was applied to all sample results. All were found to be acceptable.

Surrogate Recoveries

All surrogate recoveries were within QC criteria.

Matrix Spike / Matrix Spike Duplicate

MS/MSD analysis was performed for the project samples, and all QC criteria were met.

Laboratory Control Sample

LCS analysis was performed for the project samples, and all QC criteria were met.

Field Duplicates

Original and field duplicate results were evaluated, and all QC criteria were met.

Internal Standards

All internal standards met QC criteria.

Quantitation

Results quantified between the MDL and the RL, which the lab qualified as "J", were qualified as estimated "J" unless blank contamination was present or the results were rejected.

4.3 Total and Dissolved Metals by SW846 6010B/7470A

Overall, the data are of good quality and are usable as reported by the laboratory with the exceptions noted below. Data were reviewed for the following:

Holding Times

Technical holding time criteria were met for all samples.

Initial and Continuing Calibrations

All initial and continuing calibrations associated with the project samples met QC criteria.

Blanks

The 5X rule for contaminants found in the associated equipment rinse, calibration, and method blanks was applied to all sample results. All criteria were acceptable with the following exception(s):

SDG	Samples Affected	Element(s)	Blank Contaminant	Validation Qualifier
PB046 (Total)	DE3000, DE3004, DE3006	Thallium	Prep	B
	DE3001, DE3002, DE3003, DE3004, DE3006	Aluminum	Calibration	B
	DE3001, DE3004, DE3005	Arsenic	Calibration	B
	DE3000	Nickel	Calibration	B
	DE3005	Cobalt	Calibration	B
	DE3000, DE3004	Zinc	Calibration	B
PB046 (dissolved)	All	Aluminum	Calibration	B
	DE3004	Arsenic	Calibration	B
	DE3001	Copper	Calibration	B
	DE3000, DE3004, DE3005	Zinc	Calibration	B

Matrix Spike / Matrix Spike Duplicate

MS/MSD analysis was performed for the project samples, and all QC criteria were met.

Laboratory Control Sample

LCS analysis was performed for the project samples, and all QC criteria were met.

Interference Check Sample

All Interference Check Sample (ICS) percent recoveries were acceptable. All QC criteria were met.

Inductively Coupled Plasma Serial Dilutions

All QC criteria were met for the serial dilutions associated with the project samples with the following exception(s):

SDG	Samples Affected	Element(s)	Validation Qualifier
PB046 (Total/Dissolved)	All	Potassium	J

Field Duplicates

Original and field duplicate results were evaluated, and no problems were identified.

Quantitation

Results quantified between the MDL and the RL, which the lab qualified as "B", were qualified as estimated "J" unless blank contamination was present or the results were rejected.

4.4 Nitroaromatic and Nitramine Explosives by SW846 8330

Overall, the data are of good quality and are usable as reported by the laboratory with the exceptions noted below. Data were reviewed for the following:

Holding Times

Technical holding time criteria were met for all samples.

Initial and Continuing Calibration

All initial and continuing calibrations associated with the project samples met QC criteria.

Blanks

The 5X rule for contaminants found in the associated equipment rinses and method blanks was applied to all sample results. All were found to be acceptable.

Surrogate Recoveries

All surrogate recoveries were within QC criteria.

Matrix Spike / Matrix Spike Duplicate

MS/MSD analysis was performed for the project samples, and all QC criteria were met with the following exception(s):

SDG Number	Samples Affected	Compound(s)	Validation Qualifier
PB046	All	Tetryl	UJ

Laboratory Control Sample

LCS analysis was performed for the project samples, and all QC criteria were met.

Field Duplicates

Original and field duplicate results were evaluated, and no problems were identified.

Quantitation

Results quantified between the MDL and the RL, which the lab qualified as "J", were qualified as estimated "J" unless blank contamination was present or the results were rejected.

4.5 Wet Chemistry (TOC, Sulfate, Nitrate, Chloride, Alkalinity, Turbidity, TDS, TSS, Hardness, Cyanide)

Overall, the data are of good quality and are usable as reported by the laboratory with the exceptions noted below. Data were reviewed for the following:

Preservation

Preservation criteria were met for all samples.

Holding Times

Technical holding time criteria were met for all samples.

Initial and Continuing Calibration

All initial and continuing calibrations associated with the project samples met QC criteria.

Blanks

The 5X rule for contaminants found in the associated equipment rinses and method blanks was applied to all sample results. All were found to be acceptable.

Matrix Spike / Matrix Spike Duplicate

MS/MSD analysis was performed for the project samples, and all QC criteria were met with the following exception(s):

SDG Number	Samples Affected	Compound(s)	Validation Qualifier
PB046	All	Cyanide	UJ

Laboratory Control Sample

LCS analysis was performed for the project samples, and all QC criteria were met.

Field Duplicates

Original and field duplicate results were evaluated, and no problems were identified.

Quantitation

Results quantified between the MDL and the RL, which the lab qualified as "J", were qualified as estimated "J" unless blank contamination was present or the results were rejected. Results rejected in favor of a preferred result (e.g., due to dilution or reanalysis) were qualified as rejected "R".

5.0 Quality Assurance Field Split Sample Data Evaluation

Data from the quality assurance split sample: SDG F22742 sample DE3007, were validated. The FS sample was analyzed for Volatiles by SW846 8260B, Semivolatiles by SW846 8270C, Explosives by SW846 8330, and Total and Dissolved Metals by SW846 6010B and 7470A. The following section highlights the key findings of the data validation for each analysis.

5.1 Volatile Organics by GC/MS SW846 8260B

Overall, the data are of good quality and are usable as reported by the laboratory with the exceptions noted below. Data were reviewed for the following:

Preservation

Preservation criteria were met for all samples.

Holding Times

Technical holding time criteria were met for all samples.

Initial and Continuing Calibration

The initial calibration (ICAL) and continuing calibrations (CCAL) associated with the project samples met QC criteria with the following exception(s):

- The following exhibited individual ICAL/CCAL relative response factor (RRF) <0.1:

SDG Number	Samples Affected	Compound(s)	Validation Qualifier
F22742	DE3007	Acetone	R

- The following exhibited individual ICAL relative standard deviation (%RSD) >30 and/or CCAL percent difference (%D) >20:

SDG Number	Samples Affected	Compound(s)	Validation Qualifier
F22742	DE3007	Chloroethane	UJ

Blanks

The 5X/10X rule for contaminants found in the associated trip blanks and method blanks was applied to all sample results. All were found to be acceptable.

Surrogate Recoveries

All surrogate recoveries were within QC limits.

Matrix Spike / Matrix Spike Duplicate

Matrix Spike/Matrix Spike Duplicate (MS/MSD) analysis was performed for the project samples, and all QC criteria were met.

Laboratory Control Sample

Laboratory Control Sample (LCS) analysis was performed for the project samples, and all QC criteria were met.

Internal Standards

All internal standards met QC criteria with the following exception:

SDG Number	Samples Affected	Compound(s)	Validation Qualifier
F22742	DE3007	1,1,2,2-Tetrachloroethane	UJ

Field Split/Original Sample Comparison

SDG F22742. DE3003 (original) and DE3007 (FS) results were evaluated. It should be noted that the original sample had positive results for Carbon disulfide above the reporting limits and Toluene below the reporting limits. All results for the field split sample were non-detect.

Quantitation

Results quantitated between the method detection limit (MDL) and the reporting limit (RL), which the lab qualified as "J", were qualified as estimated "J" unless blank contamination was present or the results were rejected.

5.2 Semivolatile Organics by GC/MS SW846 8270C

Overall, the data are of good quality and are usable as reported by the laboratory. Data were reviewed for the following:

Holding Times

Technical holding time criteria were met for all samples.

Initial and Continuing Calibration

The initial calibration and continuing calibrations associated with the project samples met QC criteria.

Blanks

The 5X/10X rule for contaminants found in the associated blanks was applied to all sample results and all were found to be acceptable.

Matrix Spike / Matrix Spike Duplicate

Matrix Spike/Matrix Spike Duplicate (MS/MSD) analysis was performed for the project samples, and all QC criteria were met.

Laboratory Control Sample

LCS analysis was performed for the project samples, and all QC criteria were met.

Surrogate Recoveries

All surrogate recoveries were within QC criteria.

Internal Standards

All internal standards met QC.

Field Split/Original Sample Comparison

SDG F22742. DE3003 (original) and DE3007 (FS) results were evaluated. It should be noted that both samples were non-detect for all compounds.

Quantitation

Results quantified between the MDL and the RL, which the lab qualified as "J", were qualified as estimated "J" unless blank contamination was present or the results were rejected.

5.3 Total and Dissolved Metals by SW846 6010B/7470A

Overall, the data are of good quality and are usable as reported by the laboratory. Data were reviewed for the following:

Holding Times

Technical holding time criteria were met for all samples.

Initial and Continuing Calibration

All initial and continuing calibrations associated with the project samples met QC criteria.

Blanks

The 5X rule for contaminants found in the associated blanks was applied to all sample results and all were found to be acceptable.

Matrix Spike / Matrix Spike Duplicate

Matrix Spike/Matrix Spike Duplicate (MS/MSD) analysis was performed for the project samples, and all QC criteria were met.

Laboratory Control Sample (LCS)

All QC criteria were met for the LCS associated with the project sample analyses.

Interference Check Sample

All Interference Check Sample (ICS) percent recoveries were acceptable. All QC criteria were met.

Inductively Coupled Plasma Serial Dilutions

All QC criteria were met for the serial dilutions associated with the project.

Field Split/Original Sample Comparison

SDG F22742. DE3003 (original) and DE3007 (FS) results were evaluated. All RPD QC criteria for total and dissolved results were met.

Quantitation

Results quantified between the MDL and the RL, which the lab qualified as "J", were qualified as estimated "J" unless blank contamination was present or the results were rejected.

5.4 Nitroaromatic and Nitramine Explosives by SW846 8330

Overall, the data are of good quality and are usable as reported by the laboratory. Data were reviewed for the following:

Holding Times

Technical holding time criteria were met for all samples.

Initial and Continuing Calibration

All initial and continuing calibrations associated with the project samples met QC criteria.

Blanks

The 5X rule for contaminants found in the associated equipment rinses and method blanks was applied to all sample results. All were found to be acceptable.

Surrogate Recoveries

All surrogate recoveries were within QC criteria.

Matrix Spike / Matrix Spike Duplicate

Matrix Spike/Matrix Spike Duplicate (MS/MSD) analysis was performed for the project samples, and all QC criteria were met.

Laboratory Control Sample

LCS analysis was performed for the project samples, and all QC criteria were met.

Field Split/Original Sample Comparison

SDG F22742. DE3003 (original) and DE3007 (FS) results were evaluated. It should be noted that DE3003 (original) and DE3007 (FS) were non-detect for all compounds.

Quantitation

Results quantified between the MDL and the RL, which the lab qualified as "J", were qualified as estimated "J" unless blank contamination was present or the results were rejected. Results rejected in favor of a preferred result (e.g., due to dilution or reanalysis) were qualified as rejected "R".

ATTACHMENT A

VALIDATION QUALIFIERS

Validation Qualifiers

U Not detected. The compound/analyte was analyzed for, but not detected above the associated reporting limit.

J The compound/analyte was positively identified; the reported value is the estimated concentration of the constituent detected in the sample analyzed.

B The concentration reported was detected below the levels reported in the associated equipment rinse samples and/or laboratory method and trip blanks. (5X/10X Rule was applied).

R The reported sample results are rejected due to the following:

1. Severe deficiencies in the supporting quality control data.
2. Anomalies noted in the sampling and/or analysis process, which could affect the validity of the reported data.
3. The presence or absence of the constituent cannot be verified based on the data provided.
4. To indicate not to use a particular result in the event of a reanalysis.

UJ The compound/analyte was analyzed for, but not detected above the established reporting limit. However, review and evaluation of supporting QC data and/or sampling and analysis process have indicated that the "nondetect" may be inaccurate or imprecise. The nondetect result should be estimated.

Validation Reason Code Definitions

Reason Code	Definition
01	Sample received outside of 4+/-2 degrees Celsius
01A	Improper sample preservation
02	Holding time exceeded
02A	Extraction
02B	Analysis
03	Instrument performance – outside criteria
03A	BFB
03B	DFTPP
03C	DDT and/or Endrin % breakdown exceeds criteria
03D	Retention time windows
03E	Resolution
04	Initial calibration results outside specified criteria
04A	Compound mean RRF QC criteria not met
04B	Individual % RSD criteria not met
04C	Correlation coefficient >0.995
05	Continuing calibration results outside specified criteria
05A	Compound mean RRF QC criteria not met
05B	Compound % D QC criteria not met
06	Result qualified as a result of the 5x/10x blank correction
06A	Method or preparation blank
06B	ICB or CCB
06C	ER
06D	TB
06E	FB
07	Surrogate recoveries outside control limits
07A	Sample
07B	Associated method blank or LCS
08	MS/MSD/Duplicate results outside criteria
08A	MS and/or MSD recovery not within control limits (accuracy)
08B	% RPD outside acceptance criteria (precision)
09	Post digestion spike outside criteria (GFAA)
10	Internal standards outside specified control limits
10A	Recovery
10B	Retention time
11	Laboratory control sample recoveries outside specified limits
11A	Recovery
11B	% RPD (if run in duplicate)
12	Interference check standard
13	Serial dilution
14	Tentatively identified compounds
15	Quantitation
16	Multiple results available; alternate analysis preferred
17	Field duplicate RPD criteria is exceeded
18	Percent difference between original and second column exceeds QC criteria
19	Professional judgement was used to qualify the data
20	Pesticide clean-up checks
21	Target compound identification
22	Radiological calibration
23	Radiological quantitation
24	Reported result and/or lab qualifier revised to reflect validation findings

APPENDIX D

CHEMICAL ANALYTICAL DATA SUMMARY

Plum Brook Ordnance Works
Ninth Quarterly Groundwater Monitoring
Chemical Analytical Data Summary

LOCATION_CODE			IT-BG8-BEDGW-001			PB-BED-MW20			PB-BED-MW24			PB-BED-MW25			PB-BED-MW25		
SAMPLE_NO			DE3000			DE3001			DE3002			DE3003			DE3006		
SAMPLE_DATE			11-Mar-04			10-Mar-04			10-Mar-04			11-Mar-04			11-Mar-04		
SAMPLE_PURPOSE			REG			REG			REG			REG			FD		
Parameter	Units	Filtered	Result	Qual	ValQual	Result	Qual	ValQual	Result	Qual	ValQual	Result	Qual	ValQual	Result	Qual	ValQual
Explosives																	
Amino-2,6-dinitrotoluene, 4-	ug/L	N	0.2	U	U	0.2	U	U	0.2	U	U	0.2	U	U	0.2	U	U
Amino-4,6-dinitrotoluene, 2-	ug/L	N	0.2	U	U	0.2	U	U	0.2	U	U	0.2	U	U	0.2	U	U
Dinitrobenzene, 1,3-	ug/L	N	0.2	U	U	0.2	U	U	0.2	U	U	0.2	U	U	0.2	U	U
Dinitrotoluene, 2,4-	mg/kg	N															
Dinitrotoluene, 2,4-	ug/L	N	0.2	U	U	0.2	U	U	0.2	U	U	0.2	U	U	0.2	U	U
Dinitrotoluene, 2,6-	ug/L	N	0.2	U	U	0.2	U	U	0.2	U	U	0.2	U	U	0.2	U	U
HMX	ug/L	N	0.5	U	U	0.5	U	U	0.5	U	U	0.5	U	U	0.5	U	U
Nitrobenzene	ug/L	N	0.2	U	U	0.2	U	U	0.2	U	U	0.2	U	U	0.2	U	U
Nitrotoluene, 2-	ug/L	N	0.2	U	U	0.2	U	U	0.2	U	U	0.2	U	U	0.2	U	U
Nitrotoluene, 3-	ug/L	N	0.2	U	U	0.2	U	U	0.2	U	U	0.2	U	U	0.2	U	U
Nitrotoluene, 4-	ug/L	N	0.2	U	U	0.2	U	U	0.2	U	U	0.2	U	U	0.2	U	U
RDX	ug/L	N	0.5	U	U	0.5	U	U	0.5	U	U	0.5	U	U	0.5	U	U
Tetryl	ug/L	N	0.2	U	UJ	0.2	U	UJ	0.2	U	UJ	0.2	U	UJ	0.2	U	UJ
Trinitrobenzene, 1,3,5-	ug/L	N	0.2	U	U	0.2	U	U	0.2	U	U	0.2	U	U	0.2	U	U
Trinitrotoluene, 2,4,6-	ug/L	N	0.2	U	U	0.2	U	U	0.2	U	U	0.2	U	U	0.2	U	U
General Chemistry																	
Alkalinity	ppm	N	189			248			700			331					
Chloride	ppm	N	24.5			20800			79.7			199					
Cyanide, total	ppm	N	0.01	U	UJ	0.01	U	UJ	0.01	U	UJ	0.01	U	UJ			
Hardness	ppm	N	340			9550			670			510					
Nitrate	ppm	N	13			0.1	U	U	0.1	U	U	0.1	U	U			
Sulfate	ppm	N	46.4			5	U	U	40.5			142					
Total dissolved solids	ppm	N	352			28700			755			808					
Total organic carbon	ppm	N	1.1			1	U	U	1.5			2.3					
Total suspended solids	ppm	N	4	U	U	760			4	U	U	4	U	U			
Turbidity	NTU	N	0.5	U	U	5.7			23.5			86.5					
Metals																	
Aluminum	ug/L	N	200	U	U	63.2	B	B	61.5	B	B	50.3	B	B	50.2	B	B
Aluminum	ug/L	Y	61.6	B	B	77.8	B	B	56.9	B	B	57.7	B	B	87.3	B	B
Antimony	ug/L	N	60	U	U	60	U	U	60	U	U	60	U	U	60	U	U
Antimony	ug/L	Y	60	U	U	60	U	U	60	U	U	60	U	U	60	U	U
Arsenic	ug/L	N	10	U	U	3.4	B	B	10	U	U	10	U	U	10	U	U
Arsenic	ug/L	Y	10	U	U	10	U	U	10	U	U	10	U	U	10	U	U
Barium	ug/L	N	25.8	B	J	25500			489			233			233		
Barium	ug/L	Y	27.8	B	J	24300			489			239			248		
Beryllium	ug/L	N	5	U	U	5	U	U	5	U	U	5	U	U	5	U	U
Beryllium	ug/L	Y	5	U	U	5	U	U	5	U	U	5	U	U	5	U	U
Cadmium	ug/L	N	5	U	U	5	U	U	5	U	U	5	U	U	5	U	U
Cadmium	ug/L	Y	5	U	U	5	U	U	5	U	U	5	U	U	5	U	U
Calcium	ug/L	N	66800			2100000			131000			107000			108000		
Calcium	ug/L	Y	66100			2000000			126000			112000			114000		
Chromium	ug/L	N	10	U	U	10	U	U	10	U	U	10	U	U	10	U	U
Chromium	ug/L	Y	10	U	U	10	U	U	10	U	U	10	U	U	10	U	U
Cobalt	ug/L	N	50	U	U	7.1	B	J	50	U	U	50	U	U	50	U	U
Cobalt	ug/L	Y	50	U	U	6.2	B	J	50	U	U	50	U	U	50	U	U

Plum Brook Ordnance Works
Ninth Quarterly Groundwater Monitoring
Chemical Analytical Data Summary

.OCATION_CODE			IT-BG8-BEDGW-001			PB-BED-MW20			PB-BED-MW24			PB-BED-MW25			PB-BED-MW25		
;AMPLE_NO			DE3000			DE3001			DE3002			DE3003			DE3006		
;AMPLE_DATE			11-Mar-04			10-Mar-04			10-Mar-04			11-Mar-04			11-Mar-04		
;AMPLE_PURPOSE			REG			REG			REG			REG			FD		
?arameter	Units	Filtered	Result	Qual	ValQual	Result	Qual	ValQual	Result	Qual	ValQual	Result	Qual	ValQual	Result	Qual	ValQual
;opper	ug/L	N	25	U	U	25	U	U	18.5	B	J	25	U	U	25	U	U
;opper	ug/L	Y	25	U	U	5.3	B	B	25	U	U	25	U	U	25	U	U
ron	ug/L	N	100	U	U	794			100	U	U	82.1	B	J	82.7	B	J
ron	ug/L	Y	100	U	U	510			100	U	U	100	U	U	100	U	U
.ead	ug/L	N	3	U	U	4.5	G U		3	U	U	3	U	U	3	U	U
.ead	ug/L	Y	3	U	U	4.5	G U		3	U	U	3	U	U	3	U	U
Magnesium	ug/L	N	25000			992000			69500			41900			42000		
Magnesium	ug/L	Y	24800			944000			67300			43800			44900		
Manganese	ug/L	N	3.6	B	J	183			26.3			45.1			45.2		
Manganese	ug/L	Y	3.6	B	J	178			26			46.8			47.7		
Mercury	ug/L	N	0.2	U	U	0.2	U	U	0.2	U	U	0.2	U	U	0.2	U	U
Mercury	ug/L	Y	0.2	U	U	0.2	U	U	0.2	U	U	0.2	U	U	0.2	U	U
Nickel	ug/L	N	3.6	B	B	40	U	U	40	U	U	40	U	U	40	U	U
Nickel	ug/L	Y	4.8	B	J	40	U	U	40	U	U	40	U	U	40	U	U
?otassium	ug/L	N	2530	B	J	174000		J	23700		J	10800		J	10900		J
?otassium	ug/L	Y	2620	B	J	173000		J	23900		J	11400		J	11900		J
Selenium	ug/L	N	5	U	U	5	U	U	5	U	U	5	U	U	5	U	U
Selenium	ug/L	Y	5	U	U	5	U	U	5	U	U	5	U	U	5	U	U
Silver	ug/L	N	10	U	U	10	U	U	10	U	U	10	U	U	10	U	U
Silver	ug/L	Y	10	U	U	10	U	U	10	U	U	10	U	U	10	U	U
Sodium	ug/L	N	21300			8600000			61800			114000			115000		
Sodium	ug/L	Y	22400			8220000			61200			119000			121000		
Thallium	ug/L	N	3.1	B J	B	10	U	U	10	U	U	10	U	U	4.4	B J	B
Thallium	ug/L	Y	5.1	B	J	10	U	U	2.8	B	J	10	U	U	8.4	B	J
Vanadium	ug/L	N	50	U	U	50	U	U	50	U	U	50	U	U	50	U	U
Vanadium	ug/L	Y	50	U	U	50	U	U	50	U	U	50	U	U	50	U	U
Zinc	ug/L	N	4.3	B	B	43.6			6.4	B	J	20	U	U	20	U	U
Zinc	ug/L	Y	3.9	B	B	31.4			20	U	U	20	U	U	20	U	U
Semivolatiles																	
Acenaphthene	ug/L	N	10	U	U	10	U	U	10	U	U	10	U	U	10	U	U
Acenaphthylene	ug/L	N	10	U	U	10	U	U	10	U	U	10	U	U	10	U	U
Anthracene	ug/L	N	10	U	U	10	U	U	10	U	U	10	U	U	10	U	U
Benzo(a)anthracene	ug/L	N	10	U	U	10	U	U	10	U	U	10	U	U	10	U	U
Benzo(a)pyrene	ug/L	N	10	U	U	10	U	U	10	U	U	10	U	U	10	U	U
Benzo(b)fluoranthene	ug/L	N	10	U	U	10	U	U	10	U	U	10	U	U	10	U	U
Benzo(ghi)perylene	ug/L	N	10	U	U	10	U	U	10	U	U	10	U	U	10	U	U
Benzo(k)fluoranthene	ug/L	N	10	U	U	10	U	U	10	U	U	10	U	U	10	U	U
Bis(2-chloroethoxy)methane	ug/L	N	10	U	U	10	U	U	10	U	U	10	U	U	10	U	U
Bis(2-chloroethyl)ether	ug/L	N	10	U	U	10	U	U	10	U	U	10	U	U	10	U	U
Bis(2-chloroisopropyl)ether	ug/L	N	10	U	U	10	U	U	10	U	U	10	U	U	10	U	U
Bis(2-ethylhexyl)phthalate	ug/L	N	10	U	U	10	U	U	10	U	U	10	U	U	10	U	U
Bromophenyl phenyl ether, 4-	ug/L	N	10	U	U	10	U	U	10	U	U	10	U	U	10	U	U
Butyl benzyl phthalate	ug/L	N	10	U	U	10	U	U	10	U	U	10	U	U	10	U	U
Carbazole	ug/L	N	10	U	U	10	U	U	10	U	U	10	U	U	10	U	U
Chloro-3-methylphenol, 4-	ug/L	N	10	U	U	10	U	U	10	U	U	10	U	U	10	U	U
Chloroaniline, 4-	ug/L	N	10	U	U	10	U	U	10	U	U	10	U	U	10	U	U

Plum Brook Ordnance Works
Ninth Quarterly Groundwater Monitoring
Chemical Analytical Data Summary

LOCATION_CODE			IT-BG8-BEDGW-001			PB-BED-MW20			PB-BED-MW24			PB-BED-MW25			PB-BED-MW25		
SAMPLE_NO			DE3000			DE3001			DE3002			DE3003			DE3006		
SAMPLE_DATE			11-Mar-04			10-Mar-04			10-Mar-04			11-Mar-04			11-Mar-04		
SAMPLE_PURPOSE			REG			REG			REG			REG			FD		
Parameter	Units	Filtered	Result	Qual	ValQual	Result	Qual	ValQual	Result	Qual	ValQual	Result	Qual	ValQual	Result	Qual	ValQual
Chloronaphthalene, 2-	ug/L	N	10	U	U	10	U	U	10	U	U	10	U	U	10	U	U
Chlorophenol, 2-	ug/L	N	10	U	U	10	U	U	10	U	U	10	U	U	10	U	U
Chlorophenyl phenyl ether, 4-	ug/L	N	10	U	U	10	U	U	10	U	U	10	U	U	10	U	U
Chrysene	ug/L	N	10	U	U	10	U	U	10	U	U	10	U	U	10	U	U
Dibenz(a,h)anthracene	ug/L	N	10	U	U	10	U	U	10	U	U	10	U	U	10	U	U
Dibenzofuran	ug/L	N	10	U	U	10	U	U	10	U	U	10	U	U	10	U	U
Dichlorobenzene, 1,2-	ug/L	N	10	U	U	10	U	U	10	U	U	10	U	U	10	U	U
Dichlorobenzene, 1,3-	ug/L	N	10	U	U	10	U	U	10	U	U	10	U	U	10	U	U
Dichlorobenzene, 1,4-	ug/L	N	10	U	U	10	U	U	10	U	U	10	U	U	10	U	U
Dichlorobenzidine, 3,3'-	ug/L	N	50	U	U	50	U	U	50	U	U	50	U	U	50	U	U
Dichlorophenol, 2,4-	ug/L	N	10	U	U	10	U	U	10	U	U	10	U	U	10	U	U
Diethyl phthalate	ug/L	N	10	U	U	10	U	U	10	U	U	10	U	U	10	U	U
Dimethyl phthalate	ug/L	N	10	U	U	10	U	U	10	U	U	10	U	U	10	U	U
Dimethylphenol, 2,4-	ug/L	N	10	U	U	10	U	U	10	U	U	10	U	U	10	U	U
Di-n-butyl phthalate	ug/L	N	10	U	U	10	U	U	10	U	U	10	U	U	10	U	U
Dinitro-2-methylphenol, 4,6-	ug/L	N	50	U	U	50	U	U	50	U	U	50	U	U	50	U	U
Dinitrophenol, 2,4-	ug/L	N	50	U	U	50	U	U	50	U	U	50	U	UJ	50	U	UJ
Dinitrotoluene, 2,4-	ug/L	N	10	U	U	10	U	U	10	U	U	10	U	U	10	U	U
Dinitrotoluene, 2,6-	ug/L	N	10	U	U	10	U	U	10	U	U	10	U	U	10	U	U
Di-n-octyl phthalate	ug/L	N	10	U	U	10	U	U	10	U	U	10	U	U	10	U	U
Fluoranthene	ug/L	N	10	U	U	10	U	U	10	U	U	10	U	U	10	U	U
Fluorene	ug/L	N	10	U	U	10	U	U	10	U	U	10	U	U	10	U	U
Hexachlorobenzene	ug/L	N	10	U	U	10	U	U	10	U	U	10	U	U	10	U	U
Hexachlorobutadiene	ug/L	N	10	U	U	10	U	U	10	U	U	10	U	U	10	U	U
Hexachlorocyclopentadiene	ug/L	N	50	U	U	50	U	U	50	U	U	50	U	U	50	U	U
Hexachloroethane	ug/L	N	10	U	U	10	U	U	10	U	U	10	U	U	10	U	U
Indeno(1,2,3-cd)pyrene	ug/L	N	10	U	U	10	U	U	10	U	U	10	U	U	10	U	U
Isophorone	ug/L	N	10	U	U	10	U	U	10	U	U	10	U	U	10	U	U
Methylnaphthalene, 2-	ug/L	N	10	U	U	10	U	U	10	U	U	10	U	U	10	U	U
Methylphenol, 2-	ug/L	N	10	U	U	10	U	U	10	U	U	10	U	U	10	U	U
Methylphenol, 4-	ug/L	N	10	U	U	10	U	U	10	U	U	10	U	U	10	U	U
Naphthalene	ug/L	N	10	U	U	10	U	U	10	U	U	10	U	U	10	U	U
Nitroaniline, 2-	ug/L	N	50	U	U	50	U	U	50	U	U	50	U	U	50	U	U
Nitroaniline, 3-	ug/L	N	50	U	U	50	U	U	50	U	U	50	U	U	50	U	U
Nitroaniline, 4-	ug/L	N	50	U	U	50	U	U	50	U	U	50	U	U	50	U	U
Nitrobenzene	ug/L	N	10	U	U	10	U	U	10	U	U	10	U	U	10	U	U
Nitrophenol, 2-	ug/L	N	10	U	U	10	U	U	10	U	U	10	U	U	10	U	U
Nitrophenol, 4-	ug/L	N	50	U	U	50	U	U	50	U	U	50	U	U	50	U	U
n-Nitroso-di-n-propylamine	ug/L	N	10	U	U	10	U	U	10	U	U	10	U	U	10	U	U
n-Nitrosodiphenylamine	ug/L	N	10	U	U	10	U	U	10	U	U	10	U	U	10	U	U
Pentachlorophenol	ug/L	N	50	U	U	50	U	U	50	U	U	50	U	U	50	U	U
Phenanthrene	ug/L	N	10	U	U	10	U	U	10	U	U	10	U	U	10	U	U
Phenol	ug/L	N	10	U	U	10	U	U	10	U	U	10	U	U	10	U	U
Pyrene	ug/L	N	10	U	U	10	U	U	10	U	U	10	U	U	10	U	U
Trichlorobenzene, 1,2,4-	ug/L	N	10	U	U	10	U	U	10	U	U	10	U	U	10	U	U
Trichlorophenol, 2,4,5-	ug/L	N	10	U	U	10	U	U	10	U	U	10	U	U	10	U	U

Plum Brook Ordnance Works
Ninth Quarterly Groundwater Monitoring
Chemical Analytical Data Summary

LOCATION_CODE			IT-BG8-BEDGW-001			PB-BED-MW20			PB-BED-MW24			PB-BED-MW25			PB-BED-MW25		
SAMPLE_NO			DE3000			DE3001			DE3002			DE3003			DE3006		
SAMPLE_DATE			11-Mar-04			10-Mar-04			10-Mar-04			11-Mar-04			11-Mar-04		
SAMPLE_PURPOSE			REG			REG			REG			REG			FD		
Parameter	Units	Filtered	Result	Qual	ValQual	Result	Qual	ValQual	Result	Qual	ValQual	Result	Qual	ValQual	Result	Qual	ValQual
Trichlorophenol, 2,4,6-	ug/L	N	10	U	U	10	U	U	10	U	U	10	U	U	10	U	U
Volatiles																	
Acetone	ug/L	N	10	U	R	2.1	J	J	100	U	R	10	U	R	10	U	R
Benzene	ug/L	N	1	U	U	1.1			22			1	U	U	1	U	U
Bromodichloromethane	ug/L	N	1	U	U	1	U	U	10	U	U	1	U	U	1	U	U
Bromoform	ug/L	N	1	U	U	1	U	U	10	U	U	1	U	U	1	U	U
Bromomethane	ug/L	N	2	U	R	2	U	R	20	U	R	2	U	R	2	U	R
Butanone, 2-	ug/L	N	5	U	R	5	U	R	50	U	R	5	U	R	5	U	R
Carbon disulfide	ug/L	N	0.19	J	J	0.21	J	J	9.1	J	J	1.2			1.5		
Carbon tetrachloride	ug/L	N	1	U	U	1	U	U	10	U	U	1	U	U	1	U	U
Chlorobenzene	ug/L	N	1	U	U	1	U	U	10	U	U	1	U	U	1	U	U
Chloroethane	ug/L	N	2	U	U	2	U	U	20	U	U	2	U	U	2	U	U
Chloroform	ug/L	N	1	U	U	1	U	U	10	U	U	1	U	U	1	U	U
Chloromethane	ug/L	N	2	U	UJ	2	U	UJ	20	U	UJ	2	U	UJ	2	U	UJ
Dibromochloromethane	ug/L	N	1	U	U	1	U	U	10	U	U	1	U	U	1	U	U
Dichloroethane, 1,1-	ug/L	N	1	U	U	1	U	U	10	U	U	1	U	U	1	U	U
Dichloroethane, 1,2-	ug/L	N	1	U	U	1	U	U	10	U	U	1	U	U	1	U	U
Dichloroethene, 1,1-	ug/L	N	1	U	U	1	U	U	10	U	U	1	U	U	1	U	U
Dichloroethene, 1,2-	ug/L	N	1	U	U	1	U	U	10	U	U	1	U	U	1	U	U
Dichloropropane, 1,2-	ug/L	N	1	U	U	1	U	U	10	U	U	1	U	U	1	U	U
Dichloropropene, cis-1,3-	ug/L	N	1	U	U	1	U	U	10	U	U	1	U	U	1	U	U
Dichloropropene, trans-1,3-	ug/L	N	1	U	U	1	U	U	10	U	U	1	U	U	1	U	U
Ethylbenzene	ug/L	N	1	U	U	1	U	U	9	J	J	1	U	U	1	U	U
Hexanone, 2-	ug/L	N	5	U	U	5	U	U	50	U	U	5	U	U	5	U	U
Methyl-2-pentanone, 4-	ug/L	N	5	U	U	5	U	U	50	U	U	5	U	U	5	U	U
Methylene chloride	ug/L	N	2	U	U	0.28	J	B	20	U	U	2	U	U	1.2	J	B
Styrene	ug/L	N	1	U	U	1	U	U	10	U	U	1	U	U	1	U	U
Tetrachloroethane, 1,1,2,2-	ug/L	N	1	U	U	1	U	U	10	U	U	1	U	U	1	U	U
Tetrachloroethene	ug/L	N	1	U	U	1	U	U	10	U	U	1	U	U	1	U	U
Toluene	ug/L	N	1	U	U	0.28	J	J	14			0.13	J	J	0.12	J	J
Trichloroethane, 1,1,1-	ug/L	N	1	U	U	1	U	U	10	U	U	1	U	U	1	U	U
Trichloroethane, 1,1,2-	ug/L	N	1	U	U	1	U	U	10	U	U	1	U	U	1	U	U
Trichloroethene	ug/L	N	1	U	U	1	U	U	10	U	U	1	U	U	1	U	U
Vinyl chloride	ug/L	N	1	U	U	1	U	U	10	U	U	1	U	U	1	U	U
Xylenes, total	ug/L	N	1	U	U	1	U	UJ	48		J	1	U	U	1	U	U

Plum Brook Ordnance Works
Ninth Quarterly Groundwater Monitoring
Chemical Analytical Data Summary

LOCATION_CODE			PB-BED-MW28			PB-BED-MW29		
SAMPLE_NO			DE3004			DE3005		
SAMPLE_DATE			9-Mar-04			10-Mar-04		
SAMPLE_PURPOSE			REG			REG		
Parameter	Units	Filtered	Result	Qual	ValQual	Result	Qual	ValQual
Explosives								
Amino-2,6-dinitrotoluene, 4-	ug/L	N	0.2	U	U	0.2	U	U
Amino-4,6-dinitrotoluene, 2-	ug/L	N	0.2	U	U	0.2	U	U
Dinitrobenzene, 1,3-	ug/L	N	0.2	U	U	0.2	U	U
Dinitrotoluene, 2,4-	mg/kg	N						
Dinitrotoluene, 2,4-	ug/L	N	0.2	U	U	0.2	U	U
Dinitrotoluene, 2,6-	ug/L	N	0.2	U	U	0.2	U	U
HMX	ug/L	N	0.5	U	U	0.5	U	U
Nitrobenzene	ug/L	N	0.2	U	U	0.2	U	U
Nitrotoluene, 2-	ug/L	N	0.2	U	U	0.2	U	U
Nitrotoluene, 3-	ug/L	N	0.2	U	U	0.2	U	U
Nitrotoluene, 4-	ug/L	N	0.2	U	U	0.2	U	U
RDX	ug/L	N	0.5	U	U	0.5	U	U
Tetryl	ug/L	N	0.2	U	UJ	0.2	U	UJ
Trinitrobenzene, 1,3,5-	ug/L	N	0.2	U	U	0.2	U	U
Trinitrotoluene, 2,4,6-	ug/L	N	0.2	U	U	0.2	U	U
General Chemistry								
Alkalinity	ppm	N	468			448		
Chloride	ppm	N	168			3050		
Cyanide, total	ppm	N	0.01	U	UJ	0.01	U	UJ
Hardness	ppm	N	78			1540		
Nitrate	ppm	N	0.1	U	U	0.1	U	U
Sulfate	ppm	N	5	U	U	5	U	U
Total dissolved solids	ppm	N	774			5450		
Total organic carbon	ppm	N	5.2			2.2		
Total suspended solids	ppm	N	4	U	U	105		
Turbidity	NTU	N	1.4			8.1		
Metals								
Aluminum	ug/L	N	54.5	B	B	103	B	J
Aluminum	ug/L	Y	74.6	B	B	85	B	B
Antimony	ug/L	N	60	U	U	60	U	U
Antimony	ug/L	Y	60	U	U	60	U	U
Arsenic	ug/L	N	5.5	B	B	2.6	B	B
Arsenic	ug/L	Y	5	B	B	10	U	U
Barium	ug/L	N	342			10800		
Barium	ug/L	Y	354			10800		
Beryllium	ug/L	N	5	U	U	5	U	U
Beryllium	ug/L	Y	5	U	U	5	U	U
Cadmium	ug/L	N	5	U	U	5	U	U
Cadmium	ug/L	Y	5	U	U	5	U	U
Calcium	ug/L	N	17500			274000		
Calcium	ug/L	Y	17900			274000		
Chromium	ug/L	N	10	U	U	10	U	U
Chromium	ug/L	Y	10	U	U	10	U	U
Cobalt	ug/L	N	50	U	U	3.5	B	B
Cobalt	ug/L	Y	50	U	U	3.4	B	J

Plum Brook Ordnance Works
Ninth Quarterly Groundwater Monitoring
Chemical Analytical Data Summary

LOCATION_CODE			PB-BED-MW28			PB-BED-MW29		
SAMPLE_NO			DE3004			DE3005		
SAMPLE_DATE			9-Mar-04			10-Mar-04		
SAMPLE_PURPOSE			REG			REG		
Parameter	Units	Filtered	Result	Qual	ValQual	Result	Qual	ValQual
Copper	ug/L	N	25	U	U	25	U	U
Copper	ug/L	Y	25	U	U	25	U	U
Iron	ug/L	N	219			1480		
Iron	ug/L	Y	186			1060		
Lead	ug/L	N	3	U	U	3	U	U
Lead	ug/L	Y	3	U	U	3	U	U
Magnesium	ug/L	N	7370			189000		
Magnesium	ug/L	Y	7540			190000		
Manganese	ug/L	N	10.6	B	J	46.4		
Manganese	ug/L	Y	11.8	B	J	45.5		
Mercury	ug/L	N	0.2	U	U	0.2	U	U
Mercury	ug/L	Y	0.2	U	U	0.2	U	U
Nickel	ug/L	N	40	U	U	40	U	U
Nickel	ug/L	Y	40	U	U	40	U	U
Potassium	ug/L	N	18300		J	112000		J
Potassium	ug/L	Y	17300		J	114000		J
Selenium	ug/L	N	5	U	U	5	U	U
Selenium	ug/L	Y	5	U	U	5	U	U
Silver	ug/L	N	10	U	U	10	U	U
Silver	ug/L	Y	10	U	U	10	U	U
Sodium	ug/L	N	275000			1350000		
Sodium	ug/L	Y	282000			1360000		
Thallium	ug/L	N	6.7	B J	B	10	U	U
Thallium	ug/L	Y	5.2	B	J	10	U	U
Vanadium	ug/L	N	50	U	U	50	U	U
Vanadium	ug/L	Y	50	U	U	50	U	U
Zinc	ug/L	N	2.8	B	B	9	B	J
Zinc	ug/L	Y	3	B	B	3.4	B	B
Semivolatiles								
Acenaphthene	ug/L	N	10	U	UJ	10	U	U
Acenaphthylene	ug/L	N	10	U	UJ	10	U	U
Anthracene	ug/L	N	10	U	UJ	10	U	U
Benzo(a)anthracene	ug/L	N	10	U	UJ	10	U	U
Benzo(a)pyrene	ug/L	N	10	U	UJ	10	U	U
Benzo(b)fluoranthene	ug/L	N	10	U	UJ	10	U	U
Benzo(ghi)perylene	ug/L	N	10	U	UJ	10	U	U
Benzo(k)fluoranthene	ug/L	N	10	U	UJ	10	U	U
Bis(2-chloroethoxy)methane	ug/L	N	10	U	UJ	10	U	U
Bis(2-chloroethyl)ether	ug/L	N	10	U	UJ	10	U	U
Bis(2-chloroisopropyl)ether	ug/L	N	10	U	UJ	10	U	U
Bis(2-ethylhexyl)phthalate	ug/L	N	10	U	UJ	10	U	U
Bromophenyl phenyl ether, 4-	ug/L	N	10	U	UJ	10	U	U
Butyl benzyl phthalate	ug/L	N	10	U	UJ	10	U	U
Carbazole	ug/L	N	10	U	UJ	10	U	U
Chloro-3-methylphenol, 4-	ug/L	N	10	U	UJ	10	U	U
Chloroaniline, 4-	ug/L	N	10	U	UJ	10	U	U

Plum Brook Ordnance Works
Ninth Quarterly Groundwater Monitoring
Chemical Analytical Data Summary

LOCATION_CODE			PB-BED-MW28			PB-BED-MW29		
SAMPLE_NO			DE3004			DE3005		
SAMPLE_DATE			9-Mar-04			10-Mar-04		
SAMPLE_PURPOSE			REG			REG		
Parameter	Units	Filtered	Result	Qual	ValQual	Result	Qual	ValQual
Chloronaphthalene, 2-	ug/L	N	10	U	UJ	10	U	U
Chlorophenol, 2-	ug/L	N	10	U	UJ	10	U	U
Chlorophenyl phenyl ether, 4-	ug/L	N	10	U	UJ	10	U	U
Chrysene	ug/L	N	10	U	UJ	10	U	U
Dibenz(a,h)anthracene	ug/L	N	10	U	UJ	10	U	U
Dibenzofuran	ug/L	N	10	U	UJ	10	U	U
Dichlorobenzene, 1,2-	ug/L	N	10	U	UJ	10	U	U
Dichlorobenzene, 1,3-	ug/L	N	10	U	UJ	10	U	U
Dichlorobenzene, 1,4-	ug/L	N	10	U	UJ	10	U	U
Dichlorobenzidine, 3,3'-	ug/L	N	50	U	UJ	50	U	U
Dichlorophenol, 2,4-	ug/L	N	10	U	UJ	10	U	U
Diethyl phthalate	ug/L	N	10	U	UJ	10	U	U
Dimethyl phthalate	ug/L	N	10	U	UJ	10	U	U
Dimethylphenol, 2,4-	ug/L	N	10	U	UJ	10	U	U
Di-n-butyl phthalate	ug/L	N	10	U	UJ	10	U	U
Dinitro-2-methylphenol, 4,6-	ug/L	N	50	U	UJ	50	U	U
Dinitrophenol, 2,4-	ug/L	N	50	U	UJ	50	U	U
Dinitrotoluene, 2,4-	ug/L	N	10	U	UJ	10	U	U
Dinitrotoluene, 2,6-	ug/L	N	10	U	UJ	10	U	U
Di-n-octyl phthalate	ug/L	N	10	U	UJ	10	U	U
Fluoranthene	ug/L	N	10	U	UJ	10	U	U
Fluorene	ug/L	N	10	U	UJ	10	U	U
Hexachlorobenzene	ug/L	N	10	U	UJ	10	U	U
Hexachlorobutadiene	ug/L	N	10	U	UJ	10	U	U
Hexachlorocyclopentadiene	ug/L	N	50	U	UJ	50	U	U
Hexachloroethane	ug/L	N	10	U	UJ	10	U	U
Indeno(1,2,3-cd)pyrene	ug/L	N	10	U	UJ	10	U	U
Isophorone	ug/L	N	10	U	UJ	10	U	U
Methylnaphthalene, 2-	ug/L	N	10	U	UJ	10	U	U
Methylphenol, 2-	ug/L	N	10	U	UJ	10	U	U
Methylphenol, 4-	ug/L	N	10	U	UJ	10	U	U
Naphthalene	ug/L	N	10	U	UJ	10	U	U
Nitroaniline, 2-	ug/L	N	50	U	UJ	50	U	U
Nitroaniline, 3-	ug/L	N	50	U	UJ	50	U	U
Nitroaniline, 4-	ug/L	N	50	U	UJ	50	U	U
Nitrobenzene	ug/L	N	10	U	UJ	10	U	U
Nitrophenol, 2-	ug/L	N	10	U	UJ	10	U	U
Nitrophenol, 4-	ug/L	N	50	U	UJ	50	U	U
n-Nitroso-di-n-propylamine	ug/L	N	10	U	UJ	10	U	U
n-Nitrosodiphenylamine	ug/L	N	10	U	UJ	10	U	U
Pentachlorophenol	ug/L	N	50	U	UJ	50	U	U
Phenanthrene	ug/L	N	10	U	UJ	10	U	U
Phenol	ug/L	N	10	U	UJ	10	U	U
Pyrene	ug/L	N	10	U	UJ	10	U	U
Trichlorobenzene, 1,2,4-	ug/L	N	10	U	UJ	10	U	U
Trichlorophenol, 2,4,5-	ug/L	N	10	U	UJ	10	U	U

Plum Brook Ordnance Works
Ninth Quarterly Groundwater Monitoring
Chemical Analytical Data Summary

LOCATION_CODE			PB-BED-MW28			PB-BED-MW29		
SAMPLE_NO			DE3004			DE3005		
SAMPLE_DATE			9-Mar-04			10-Mar-04		
SAMPLE_PURPOSE			REG			REG		
Parameter	Units	Filtered	Result	Qual	ValQual	Result	Qual	ValQual
Trichlorophenol, 2,4,6-	ug/L	N	10	U	UJ	10	U	U
Volatiles								
Acetone	ug/L	N	2.1	J	J	2.1	J	J
Benzene	ug/L	N	1.7			0.22	J	J
Bromodichloromethane	ug/L	N	1	U	U	1	U	U
Bromoform	ug/L	N	1	U	U	1	U	U
Bromomethane	ug/L	N	2	U	R	2	U	R
Butanone, 2-	ug/L	N	5	U	R	5	U	R
Carbon disulfide	ug/L	N	1.3			1.9		
Carbon tetrachloride	ug/L	N	1	U	U	1	U	U
Chlorobenzene	ug/L	N	1	U	U	1	U	U
Chloroethane	ug/L	N	2	U	U	2	U	U
Chloroform	ug/L	N	1	U	U	1	U	U
Chloromethane	ug/L	N	0.42	J	J	2	U	UJ
Dibromochloromethane	ug/L	N	1	U	U	1	U	U
Dichloroethane, 1,1-	ug/L	N	1	U	U	1	U	U
Dichloroethane, 1,2-	ug/L	N	1	U	U	1	U	U
Dichloroethene, 1,1-	ug/L	N	1	U	U	1	U	U
Dichloroethene, 1,2-	ug/L	N	1	U	U	1	U	U
Dichloropropane, 1,2-	ug/L	N	1	U	U	1	U	U
Dichloropropene, cis-1,3-	ug/L	N	1	U	U	1	U	U
Dichloropropene, trans-1,3-	ug/L	N	1	U	U	1	U	U
Ethylbenzene	ug/L	N	1	U	U	0.66	J	J
Hexanone, 2-	ug/L	N	5	U	U	5	U	U
Methyl-2-pentanone, 4-	ug/L	N	5	U	U	5	U	U
Methylene chloride	ug/L	N	2.1		B	0.59	J	B
Styrene	ug/L	N	1	U	U	1	U	U
Tetrachloroethane, 1,1,2,2-	ug/L	N	1	U	U	1	U	U
Tetrachloroethene	ug/L	N	1	U	U	1	U	U
Toluene	ug/L	N	0.18	J	J	1	U	U
Trichloroethane, 1,1,1-	ug/L	N	1	U	U	1	U	U
Trichloroethane, 1,1,2-	ug/L	N	1	U	U	1	U	U
Trichloroethene	ug/L	N	1	U	U	1	U	U
Vinyl chloride	ug/L	N	1	U	U	1	U	U
Xylenes, total	ug/L	N	1	U	U	4.5		J

Laboratory Qualifier Definitions (Qual)

B (inorganic) - Analyte detected below the reporting limit. Estimated value

G - Reporting limit is elevated because of matrix interferences

J - Analyte detected below the reporting limit. Estimated value

J - (inorganic) Analyte found in the associated method blank.

U - Not detected

Validation Qualifier Definitions (Val Qual)

B - The analyte was not detected above the value found in an associated blank.

J - The analyte was positively identified; the concentration is estimated.

R - Data was rejected

U - Not detected. The analyte was not detected above the reporting limit.

UJ - Not detected. The associated reporting limit may be inaccurate or imprecise.

APPENDIX E

DETECTED HITS SUMMARY EXCLUDING "B" QUALIFIERS

Plum Brook Ordnance Works
Ninth Quarterly Groundwater Monitoring
Detected Hits Summary Excluding "B" Qualifiers

LOCATION_CODE			IT-BG8-BEDGW-001			PB-BED-MW20			PB-BED-MW24			PB-BED-MW25			PB-BED-MW25		
SAMPLE_NO			DE3000			DE3001			DE3002			DE3003			DE3006		
SAMPLE_DATE			11-Mar-04			10-Mar-04			10-Mar-04			11-Mar-04			11-Mar-04		
SAMPLE_PURPOSE			REG			REG			REG			REG			FD		
Parameter	Units	Filtered	Result	Qual	ValQual	Result	Qual	ValQual	Result	Qual	ValQual	Result	Qual	ValQual	Result	Qual	ValQual
General Chemistry																	
Alkalinity	ppm	N	189			248			700			331					
Chloride	ppm	N	24.5			20800			79.7			199					
Hardness	ppm	N	340			9550			670			510					
Nitrate	ppm	N	13			-	-	-	-	-	-	-	-	-			
Sulfate	ppm	N	46.4			-	-	-	40.5			142					
Total dissolved solids	ppm	N	352			28700			755			808					
Total organic carbon	ppm	N	1.1			-	-	-	1.5			2.3					
Total suspended solids	ppm	N	-	-	-	760			-	-	-	-	-	-			
Turbidity	NTU	N	-	-	-	5.7			23.5			86.5					
Metals																	
Aluminum	ug/L	N	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Barium	ug/L	N	25.8	B	J	25500			489			233			233		
Barium	ug/L	Y	27.8	B	J	24300			489			239			248		
Calcium	ug/L	N	66800			2100000			131000			107000			108000		
Calcium	ug/L	Y	66100			2000000			126000			112000			114000		
Cobalt	ug/L	N	-	-	-	7.1	B	J	-	-	-	-	-	-	-	-	-
Cobalt	ug/L	Y	-	-	-	6.2	B	J	-	-	-	-	-	-	-	-	-
Copper	ug/L	N	-	-	-	-	-	-	18.5	B	J	-	-	-	-	-	-
Iron	ug/L	N	-	-	-	794			-	-	-	82.1	B	J	82.7	B	J
Iron	ug/L	Y	-	-	-	510			-	-	-	-	-	-	-	-	-
Magnesium	ug/L	N	25000			992000			69500			41900			42000		
Magnesium	ug/L	Y	24800			944000			67300			43800			44900		
Manganese	ug/L	N	3.6	B	J	183			26.3			45.1			45.2		
Manganese	ug/L	Y	3.6	B	J	178			26			46.8			47.7		
Nickel	ug/L	Y	4.8	B	J	-	-	-	-	-	-	-	-	-	-	-	-
Potassium	ug/L	N	2530	B	J	174000		J	23700		J	10800		J	10900		J
Potassium	ug/L	Y	2620	B	J	173000		J	23900		J	11400		J	11900		J
Sodium	ug/L	N	21300			8600000			61800			114000			115000		
Sodium	ug/L	Y	22400			8220000			61200			119000			121000		
Thallium	ug/L	Y	5.1	B	J	-	-	-	2.8	B	J	-	-	-	8.4	B	J
Zinc	ug/L	N	-	-	-	43.6			6.4	B	J	-	-	-	-	-	-
Zinc	ug/L	Y	-	-	-	31.4			-	-	-	-	-	-	-	-	-

Plum Brook Ordnance Works
Ninth Quarterly Groundwater Monitoring
Detected Hits Summary Excluding "B" Qualifiers

LOCATION_CODE			IT-BG8-BEDGW-001			PB-BED-MW20			PB-BED-MW24			PB-BED-MW25			PB-BED-MW25		
SAMPLE_NO			DE3000			DE3001			DE3002			DE3003			DE3006		
SAMPLE_DATE			11-Mar-04			10-Mar-04			10-Mar-04			11-Mar-04			11-Mar-04		
SAMPLE_PURPOSE			REG			REG			REG			REG			FD		
Parameter	Units	Filtered	Result	Qual	ValQual	Result	Qual	ValQual	Result	Qual	ValQual	Result	Qual	ValQual	Result	Qual	ValQual
Volatiles																	
Acetone	ug/L	N	-	-	-	2.1	J	J	-	-	-	-	-	-	-	-	-
Benzene	ug/L	N	-	-	-	1.1			22			-	-	-	-	-	-
Carbon disulfide	ug/L	N	0.19	J	J	0.21	J	J	9.1	J	J	1.2			1.5		
Chloromethane	ug/L	N	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ethylbenzene	ug/L	N	-	-	-	-	-	-	9	J	J	-	-	-	-	-	-
Toluene	ug/L	N	-	-	-	0.28	J	J	14			0.13	J	J	0.12	J	J
Xylenes, total	ug/L	N	-	-	-	-	-	-	48		J	-	-	-	-	-	-

Plum Brook Ordnance Works
Ninth Quarterly Groundwater Monitoring
Detected Hits Summary Excluding "B" Qualifiers

LOCATION_CODE			PB-BED-MW28			PB-BED-MW29		
SAMPLE_NO			DE3004			DE3005		
SAMPLE_DATE			9-Mar-04			10-Mar-04		
SAMPLE_PURPOSE			REG			REG		
Parameter	Units	Filtered	Result	Qual	ValQual	Result	Qual	ValQual
General Chemistry								
Alkalinity	ppm	N	468			448		
Chloride	ppm	N	168			3050		
Hardness	ppm	N	78			1540		
Nitrate	ppm	N	-	-	-	-	-	-
Sulfate	ppm	N	-	-	-	-	-	-
Total dissolved solids	ppm	N	774			5450		
Total organic carbon	ppm	N	5.2			2.2		
Total suspended solids	ppm	N	-	-	-	105		
Turbidity	NTU	N	1.4			8.1		
Metals								
Aluminum	ug/L	N	-	-	-	103	B	J
Barium	ug/L	N	342			10800		
Barium	ug/L	Y	354			10800		
Calcium	ug/L	N	17500			274000		
Calcium	ug/L	Y	17900			274000		
Cobalt	ug/L	N	-	-	-	-	-	-
Cobalt	ug/L	Y	-	-	-	3.4	B	J
Copper	ug/L	N	-	-	-	-	-	-
Iron	ug/L	N	219			1480		
Iron	ug/L	Y	186			1060		
Magnesium	ug/L	N	7370			189000		
Magnesium	ug/L	Y	7540			190000		
Manganese	ug/L	N	10.6	B	J	46.4		
Manganese	ug/L	Y	11.8	B	J	45.5		
Nickel	ug/L	Y	-	-	-	-	-	-
Potassium	ug/L	N	18300		J	112000		J
Potassium	ug/L	Y	17300		J	114000		J
Sodium	ug/L	N	275000			1350000		
Sodium	ug/L	Y	282000			1360000		
Thallium	ug/L	Y	5.2	B	J	-	-	-
Zinc	ug/L	N	-	-	-	9	B	J
Zinc	ug/L	Y	-	-	-	-	-	-

Plum Brook Ordnance Works
Ninth Quarterly Groundwater Monitoring
Detected Hits Summary Excluding "B" Qualifiers

LOCATION_CODE			PB-BED-MW28			PB-BED-MW29		
SAMPLE_NO			DE3004			DE3005		
SAMPLE_DATE			9-Mar-04			10-Mar-04		
SAMPLE_PURPOSE			REG			REG		
Parameter	Units	Filtered	Result	Qual	ValQual	Result	Qual	ValQual
Volatiles								
Acetone	ug/L	N	2.1	J	J	2.1	J	J
Benzene	ug/L	N	1.7			0.22	J	J
Carbon disulfide	ug/L	N	1.3			1.9		
Chloromethane	ug/L	N	0.42	J	J	-	-	-
Ethylbenzene	ug/L	N	-	-	-	0.66	J	J
Toluene	ug/L	N	0.18	J	J	-	-	-
Xylenes, total	ug/L	N	-	-	-	4.5		J

Laboratory Qualifier Definitions (Qual)
B (inorganic) - Analyte detected below the reporting limit. Estimated value
J - Analyte detected below the reporting limit. Estimated value

Validation Qualifier Definitions (Val Qual)
J - Estimated value

APPENDIX F

DATA QUALITY EVALUATION

Table of Contents

Page

List of Tables ..... F-ii
List of Acronyms ..... F-iii
F.1.0 Introduction F-1
F.2.0 Field Sampling and QC Activities F-2
F.2.1 Trip Blanks F-2
F.2.2 Field Duplicates F-3
F.2.3 Field Split Samples F-4
F.3.0 Analytical Program and QC Activities F-5
F.3.1 Laboratory QA/QC Procedures F-5
F.3.1.1 Method/Calibration Blanks F-6
F.3.1.2 Matrix Spikes and Laboratory Control Spikes F-6
F.3.1.3 Calibration F-8
F.3.1.4 Column Agreement F-8
F.3.2 Reporting Limits F-8
F.3.3 Holding Times/Preservation F-9
F.4.0 Data Evaluation and Usability F-10
F.4.1 Statement of Data Usability F-12
F.5.0 References F-13

List of Tables

Table	Title
F-1	Sample Cross-reference
F-2	Summary of Analytes Detected in Blanks
F-3	Summary of Original, Field Duplicate, and Field Split Results and RPD Calculations
F-4	Summary of Data Validation Reason Codes
F-5	Summary of Data Validation Qualifiers Assigned and Reason Codes for Qualification
F-6	Laboratory and Validation Qualifier Definitions

List of Acronyms

AR/COC	analysis request/chain of custody
CCAL	continuing calibration
CLP	Contract Laboratory Program
DI	deionized
DQE	data quality evaluation
DQO	data quality objectives
EPA	U.S. Environmental Protection Agency
HPLC	high performance liquid chromatography
ICAL	initial calibration
LCS	laboratory control sample
MDL	method detection limit
MQL	method quantitation limit
MRL	method reporting limit
MS	matrix spike
MSD	matrix spike duplicate
%D	percent difference
%RSD	percent relative standard deviation
PBOW	Plum Brook Ordnance Works
PQL	practical quantitation limit
QA/QC	quality assurance/quality control
RL	reporting limit
RPD	relative percent difference
RRF	relative response factor
SAP	sampling and analysis plan
SOP	standard operating procedures
STL	Severn Trent Laboratory
TDS	total dissolved solids
TOC	total organic compounds
TSS	total suspended solids
USACE	U.S. Army Corps of Engineers
USEPA	U.S. Environmental Protection Agency
VOC	volatile organic compound

F.1.0 Introduction

This appendix of the Ninth Quarterly Background Report presents results of the quality assurance/quality control (QA/QC) measures implemented for the sampling and analysis activities at the Plum Brook Ordnance Works (PBOW) – Sandusky, Ohio. The quality indicators from every aspect of the data collection have been reviewed, and an assessment of the data with regard to project-specific objectives is presented. Successful execution of project-specific objectives and procedures provides strong support for the acceptance of the data generated as adequate for the purpose of evaluating the analytical results from this assessment at PBOW.

Shaw Environmental, Inc. (Formerly IT Corporation) conducted field-sampling activities at PBOW in March 2004. Severn Trent Laboratories (STL) in Knoxville, Tennessee, and Canton, Ohio, analyzed the project samples. Accutest Laboratories of Orlando, Florida, analyzed the field split samples. All data analyzed were reviewed for accuracy and completeness. One hundred percent of the data analyzed were subjected to data validation following Unites States Environmental Protection Agency (USEPA) guidelines in the *USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review*, (EPA, 1999) and *USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review*, (EPA, 2002). The criteria for blank evaluation were based on those detailed in *Region III Modifications to National Functional Guidelines for Organic Data Review* (EPA, 1994) and *Region III Modifications to the Laboratory Data Validation Functional Guidelines for Evaluating Inorganics Analyses* (EPA, 1993). Since these documents specify procedures for Contract Laboratory Program (CLP) data, they are used as guidelines only. Where applicable, method and laboratory quality assurance and quality control requirements supercede these guidelines. Data were evaluated against specific criteria to verify the achievement of precision, accuracy, representativeness, completeness, and comparability goals established to meet the project data quality objectives (DQO). To verify that these DQOs were met, field measurements, sampling and handling procedures, laboratory analysis and reporting, and all nonconformances and discrepancies in the data were examined to determine compliance with the appropriate and applicable procedures defined in the site-wide sampling and analysis plan (SAP). The results of this review are presented in the following sections, with all analytical outliers or nonconformances discussed where they occurred.

F.2.0 Field Sampling and QC Activities

Shaw was retained by the U. S. Army Corps of Engineers (USACE), Nashville District, to conduct investigation and sampling activities at PBOW. Field activities at this site included collection of the background groundwater samples. The collection of these samples along with their associated QA and QC samples are discussed in this section of the Data Quality Evaluation (DQE).

All project and field duplicate samples collected were submitted to STL. Sample shipments from the field were performed under custody and documented using standard Shaw Analysis Request/Chain of Custody (AR/COC) forms. These forms provided project-specific analytical specifications and QC instructions to the laboratory. A formal COC transfer record was prepared and included with these forms to document custody during sample transportation, storage, and disposition by the laboratory. Table F-1 summarizes the field sample number, location, sample type, date of collection, and sample delivery group for each sample collected. Table F-2 summarizes the detected compounds in the method blank and trip blanks associated with the PBOW samples.

F.2.1 Trip Blanks

Aqueous samples designated for volatile organic compound (VOC) analysis may be susceptible to contamination by diffusion of organic compounds into the sample container. Trip blanks are analyzed in order to assess the potential for contamination to be introduced to an aqueous volatile sample during transport and handling procedures. A trip blank is a sample of analyte-free deionized (DI) water that is prepared at the laboratory, shipped to the field with sample containers, and returned to the laboratory with the water matrix samples receiving VOC analysis. A trip blank is then analyzed for volatile organics using the same sample preparation and analysis procedures used for the actual field samples. Three trip blank samples were collected. Three trip blanks contained target analytes and one sample was qualified.

The data validator applied the 5X-10X rule to the samples for the analytes detected. The 10 times limit is applicable only for common laboratory contaminants such as acetone, methylene chloride, and 2-butanone. The following samples were qualified "B" by the data validator, indicating that sample results are indicative of blank contamination:

Lot Number	Sample Affected	Blank Contaminant	Validation Qualifier
PB046	DE3001, DE3002, DE3005, DE3006	Methylene Chloride	B

F.2.2 Field Duplicates

Field duplicate samples are collected and submitted to the laboratory for analysis along with their corresponding original samples. The data generated from the analysis of field duplicate samples are used to evaluate the precision of the sample collection and analysis procedures. High relative percent difference (RPD) between an original sample and its field duplicate may indicate a difference in sample matrix or sample collection rather than true problems with precision of sample analysis. Also, when estimated "J," blank-contaminated "B," or nondetected "U" results are reported, there is a potential for increased variability between the primary and duplicate sample results.

Field duplicate samples were collected at a frequency of approximately one for every ten samples collected (10 percent). One field duplicate sample was collected during this sampling event. Table F-3 compares the original and field duplicate results and shows the RPDs calculated for those detected compounds. Compounds not presented in the table were not detected in either the original or field duplicate samples. In cases where duplicates were performed and one result is less than the reporting limit, but greater than the method detection limit (MDL), the RPD is reported, but should be considered an estimated value.

The acceptance criterion of 30 percent RPD was used to evaluate these sample results. Data was qualified only if the analyte was detected in both samples. Iron and carbon disulfide were qualified "J." In most cases, original and field duplicate data compared well as demonstrated by the RPDs calculated. The instances where they do not compare well involve estimated or blank-contaminated data. RPD is calculated by using the following formula:

$$RPD = \left| \frac{A - B}{(A + B)/2} \right| \quad x \quad 100$$

where:

RPD = relative percent difference
A = original result
B = field duplicate result.

F.2.3 Field Split Samples

Split samples were collected in conjunction with field duplicate samples and sent to Accutest Laboratories. The split samples were submitted to the laboratory for the same analysis as their corresponding field duplicates and original field samples. The split samples are used to determine if data results are reproducible when analyzed by two different laboratories. Results are also evaluated to determine if a contracted laboratory's preparation and analysis procedures are in control and meet the approved method criteria.

Field split samples were collected at a frequency of approximately one for every ten regular samples. One split sample was collected during this sampling event.

Table F-3 compares the original and field split results and shows the RPDs calculated for those detected compounds. Compounds not presented in the table were not detected in either the original or field split samples. The analytes compare well when both labs reported above their reporting limits and there was no blank contamination.

F.3.0 Analytical Program and QC Activities

The project QA/QC program described in the SAP was followed for the collection and laboratory analysis of samples. Each of the analytical methods used require that method-specific QA/QC protocols be followed during sample analysis. These protocols are a critical part of the methods employed and were followed by the laboratory during sample analysis. Specific measures included detailed record keeping procedures, instrument calibrations, and analysis of method blanks, blank spikes, matrix spikes/matrix spike duplicates (MS/MSD), surrogates, and internal standards. The following SW-846 and USEPA methods were used to analyze PBOW samples:

Parameter	Method
Volatiles	SW-846 5030/8260B
Semivolatiles	SW-846 3510/8270C
Nitroaromatic Compounds	SW-846 8330M
Metals	SW-846 3005A/6010B/7470A
Turbidity	EPA 180.1
Alkalinity	EPA 310.1
Total Organic Carbon (TOC)	SW-846 9060
Hardness	EPA 130.2
Total Dissolved Solids (TDS)	EPA 160.1
Total Suspended Solids (TSS)	EPA 160.2
Chloride	EPA 325.2
Total Cyanide	SW-846 9012A
Nitrate	EPA 353.2
Sulfate	EPA 375.4

Appendix D contains validated analytical data summaries for the samples collected during this field investigation. The validator used the QA/QC criteria defined in the SAP to evaluate the data for all parameters for which criteria were provided. If acceptance criteria were not provided in the SAP, the validator used the laboratory-derived acceptance criteria or analytical method criteria to qualify data. Any qualifiers added to these data by the data validator are included in the summaries.

F.3.1 Laboratory QA/QC Procedures

The following sections discuss specific QA/QC protocols required and performed by the laboratory during this investigation.

F.3.1.1 Method/Calibration Blanks

Method blanks are analyzed with each analytical "batch" processed on a per matrix (i.e., soil and water) basis. Method blanks are carried step-wise through the same analytical procedure as their associated field samples, including the addition of solvents, surrogate and standard spikes, and reagents as required in the analysis process. The purpose of a method blank is to identify any possible contaminants that may be introduced to the sample as a result of any part of the analytical process. The data validator evaluated all blank data associated with each sample. When estimated or positive concentrations of compounds/analytes were reported in the corresponding field samples, associated samples were evaluated and qualified using the 5X-10X rule. The 10 times limit is applicable only for common laboratory contaminants such as acetone, methylene chloride, 2-butanone, and certain phthalates. No samples were qualified because of method blank contamination with the exception of total Thallium for samples DE3000, DE3004 and DE3006. Thallium was qualified "B" for these samples.

For some analyses, initial and continuing calibration blanks are performed throughout the run sequence. These blanks verify the presence of carry over contamination for the analytes of interest.

Qualifiers applied to samples based on detects in the calibration blanks are summarized below:

Lot Number	Sample Number Affected	Blank Contaminant	Blank	Validation Qualifier
PB046	DE3000, DE3004, DE3006	Thallium (total)	Calibration	B
	DE3001, DE3002, DE3003, DE3004, DE3005, DE3006	Aluminum (total)	Calibration	B
	DE3001, DE3004, DE3005	Arsenic (total)	Calibration	B
	DE3000	Nickel (total)	Calibration	B
	DE3005	Cobalt (total)	Calibration	B
	DE3000, DE3004	Zinc (total)	Calibration	B
	DE3001, DE3002, DE3003, DE3004, DE3005, DE3006	Aluminum (dissolved)	Calibration	B
	DE3004	Arsenic (dissolved)	Calibration	B
	DE3001	Copper (dissolved)	Calibration	B
	DE3000, DE3004, DE3005	Arsenic (dissolved)	Calibration	B

B - blank contamination

F.3.1.2 Matrix Spikes and Laboratory Control Spikes

Two types of spikes were generally performed for all analyses: MS and laboratory control samples (LCS). MS compounds are spiked into an aliquot of a field sample. LCS compounds are spiked into a blank matrix. The spiked compounds are representative compounds that are

quantified during performance of the method. Recovery of the spiked compound is used as an assessment of analytical accuracy for the sample matrix analyzed. These results are useful in distinguishing sample matrix interferences from analysis interferences through a comparison of MS and LCS recovery data. Often, spikes are performed in duplicate (as an MSD or LCS duplicate). In this manner, the precision of the assessment can be quantified as the RPD of the original and duplicate spike.

Matrix spikes were assigned at a frequency of 1 for every 20 field samples collected. An MS and MSD were assigned in the field to sample DE3003. This sample corresponds to location PB-BED-MW25. Additional sample volume was provided to the laboratory for the MS/MSD analyses. This sampling frequency meets the collection criteria for this program as specified in the SAP. In addition to the overall collection frequency, the analytical method requires that the laboratory analyze 1 set of spikes per analytical batch. To comply with this method requirement, the laboratory may have to analyze batch QC with a work order. The validator evaluated the batch QC. The laboratory statistically determined target acceptance limits were used to assess the spike recovery and RPD.

The MS/MSD criteria were met with a few exceptions. Tetryl was not detected in either the MS or MSD. The MS and MSD recoveries for tetryl were zero. The lab's lower limit is 42 percent. All tetryl results should be considered biased low. The following samples were qualified:

Lot Number	Sample Number Affected	Analyte(s)	Validation Qualifier
Explosives			
PB046	DE3001, DE3002, DE3003, DE3004, DE3005, DE3006	Tetryl	UJ
Wet Chemistry			
PB046	DE3001, DE3002, DE3003, DE3004, DE3005, DE3006	Cyanide	UJ

UJ - undetected, estimated

LCS results are used to evaluate lab method performance in the same manner as the MS/MSD results except the LCS is not performed on an actual field sample matrix. An LCS is prepared for each analytical "batch" for each parameter and matrix analyzed. All LCS recoveries met the established QC criteria.

F.3.1.3 Calibration

A few compounds exhibited unacceptable performances in the calibration standards. The relative response factor (RRF) of bromomethane, acetone, and 2-butanone were less than 0.1. Bromomethane and 2-butanone were rejected in all samples except the field split. Acetone was rejected in samples DE3000, DE3002, DE3003, DE3006, DE3007 and qualified estimated "J" in samples DE3001, DE3004, and DE3005.

The following compounds exhibited individual initial calibration (ICAL) percent relative standard deviation (%RSD) greater than 30 and/or continuing calibration (CCAL) percent differences (%D) greater than 20.

Lot Number	Analysis	Samples	Compounds	Validation Qualifier
PB046	Volatiles	DE3000, DE3003, DE3004, DE3006	Bromomethane	R
		DE3000, DE3001, DE3002, DE3003, DE3005, DE3006	Chloromethane	UJ
		DE3001, DE3002, DE3005	Total Xylenes	J/UJ
F22742	Volatiles	DE3007	Chloroethane	UJ
PB046	Semivolatiles	DE3003, DE3006	2,4 Dinitrophenol	UJ

R- rejected
J - estimated
UJ - undetected, estimated

F.3.1.4 Column Agreement

For high performance liquid chromatography (HPLC) analyses, sample results are confirmed using two dissimilar columns. In order for an analyte to be reported, it must be detected on both columns. Results differing by greater than 40 percent are qualified estimated, "J." All detections were in agreement. No data were qualified.

F.3.2 Reporting Limits

Limits have been established to describe project sensitivity requirements. Each laboratory is required to demonstrate method performance through MDL studies for every method employed. These studies are required to be laboratory-specific so that individual laboratory variables such as equipment brands, reagent suppliers, and chemist technique are factored into the performance study. MDLs are established using controlled matrices (i.e., DI water). Practical quantitation limits (PQL) or method quantitation limits (MQL) used for this project are those statistically determined by the laboratories. The analytical program executed for this project required the use of SW-846 methods, which specify the procedure for calculating the MDLs. The PQL/MQL

calculation adjusts the limit by a predetermined mathematical factor for the analysis of actual environmental sample matrices (i.e., soil, groundwater, etc.). Method reporting limits (MRL) are based on the project action or decision levels.
These limits are generally defined as follows:

- ***MDL.*** The minimum concentration of an analyte that can be measured and reported with 99 percent confidence that the concentration is greater than zero.

- ***MQL/PQL.*** The lowest level that can be reliably achieved within specified limits of precision and accuracy during routine laboratory operating conditions. It is set at the lowest standard used for the calibration curve.

- ***MRL.*** A threshold value below which the laboratory reports a result as non-detected. Ideally, the MRL will be established anywhere between the MDL and half the project action levels.

An MDL is the lower limit at which the laboratory can differentiate a measurement from background. The MDL is determined in accordance with the procedures in 40 CFR Part 136. If project action levels are near or below the MDL, it is unlikely the sensitivity of the method will be achievable. A compromise must be reached. The PQL/MQL is the lower limit at which a measurement becomes meaningful. This measurement (the PQL or the reporting limit [RL] is generally a multiple of three to five times the MDL.

Most samples were handled and analyzed as expected without significant changes to the anticipated project MQLs.

F.3.3 Holding Times/Preservation

All laboratory results submitted for this investigation have been reviewed with respect to laboratory adherence to extraction and analysis holding times. Maximum sample extraction and analysis hold times were those specified in USACE document EM200-1-3. Sample DE3004 semivolatile analysis was re-extracted outside of holding time due to surrogate recovery problems. All semivolatile compounds for DE3004 were qualified estimated "UJ". All other holding time criteria were acceptable for the samples collected.

F.4.0 Data Evaluation and Usability

The analytical data review process identified a few analytical nonconformance issues that were noted during this analytical program. These anomalies have been discussed in the previous sections of this appendix. Table F-5 summarizes all compounds requiring qualifier application due to anomalies discovered during data validation. Table F-4 defines the reason codes for qualification, and Table F-6 defines the data validation qualifiers.

The following definitions are used for defining precision, accuracy, representativeness, completeness, and comparability as they have been applied to this evaluation.

Precision. Precision is a measurement of mutual agreement among individual measurements of the same property, usually under prescribed similar conditions. Precision data were obtained through the analysis and evaluation of duplicate QA samples. Accuracy was determined through the analysis and evaluation of method blanks, LCSs, trip blanks, equipment rinsates, and MS samples.

Accuracy. Accuracy is a measurement of bias in a system and is expressed as a percent recovery. These QA samples were collected and/or analyzed at the frequency established in the SAP, verifying the completeness element of the DQOs along with the evaluation of holding times and reporting limits. Percent recovery is calculated as follows:

$$Percent\ Recovery = \left(\frac{(x-s)}{T}\right) * 100$$

Where:

X = the lab determined concentration of a spiked sample
S = the sample native concentration prior to spike
T = the true concentration of the spike

Relative Percent Difference is calculated as follows:

$$Relative\ Percent\ Difference = \left[\frac{|D1 - D2|}{\frac{D1 + D2}{2}}\right] * 100$$

Where:

D1 and D2 = the results of duplicate measurements

Representativeness. Representativeness is a qualitative parameter that expresses the degree to which sample data actually represent the matrix and site conditions. For example, in conducting groundwater monitoring, representativeness requires proper location of wells and the collection of samples under consistent, documented procedures. Wells are located based upon the results of the hydrological study in progress and are designed to provide maximum coverage of the flow conditions. Requirements and procedures for sample collection and handling are designed to maximize sample representativeness. Representativeness also can be monitored by reviewing field documentation and performing field audits.

The samples were collected using Shaw Standard Operating Procedures (SOP) and were fully documented through the use of standard Shaw field forms. Samples are representative of the matrix and site sampled.

Completeness. Completeness is a measure of the amount of valid data that are obtained during a sampling event as compared to the amount of data expected under optimum conditions. No data points were qualified "R," rejected, in the validation process because of QC criteria as described in the previous sections of this report. Completeness is calculated as follows:

$$Completeness\ \% = \left(\frac{D_r}{D_c}\right) X\ 100$$

Where:

D_r = the number of data points for which valid results are reported

D_c = the number of valid samples/data points that are collected and reach the laboratory for analysis.

During this task, 6 monitoring wells were sampled resulting in approximately 1135 targeted analytical records, including duplicate and split records. Nineteen data points were rejected due to anomalies discovered during the validation process. Using the above calculation, greater than 98% completeness is achieved for the task.

Comparability. Comparability is a qualitative parameter expressing the confidence with which one data set can be compared with another. Comparability ensures that results for the sampling

event can be compared with data from other past and/or future sampling programs. Comparability for this sampling event was achieved through the use of established and recognized techniques and accepted standard USEPA methods. All samples collected and analyzed were subjected to the same sampling, handling, preparation, analysis, reporting, and validation criteria for the purpose of achieving comparability goals within the data set.

F.4.1 Statement of Data Usability

The overall results of the analyses, as discussed in this evaluation, suggest that representative samples were collected and analyzed, and the results are indicative of the media analyzed, with the exception of the few anomalies noted. The data do reflect expected site conditions and are usable for their intended purpose.

Tables F-1 through F-6 summarize the analytical program and the results for the data validation effort for all samples collected by Shaw at PBOW.

F.5.0 References

U.S Environmental Protection Agency (USEPA), 2002, ***USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review***, February.

U.S Environmental Protection Agency (USEPA), 1999, ***USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review***, October.

U.S Environmental Protection Agency (USEPA), 1994, ***Region III Modifications to National Functional Guidelines for Organic Data Review***, September.

U.S Environmental Protection Agency (USEPA), 1993, ***Region III Modifications to the Laboratory Data Validation Functional Guidelines for Evaluating Inorganics Analyses***, April.

Table F-1

Sample Cross-reference
Groundwater Wells
Former Plum Brook Ordnance Works
Sandusky, Ohio

Sample Type	Sample Location	Sample Number	Sample Date	Sample Purpose	Lot Number
GW	IT-BG8-BEDGW-001	DE3000	11-Mar-04	REG	PB046
GW	PB-BED-MW20	DE3001	10-Mar-04	REG	PB046
GW	PB-BED-MW24	DE3002	10-Mar-04	REG	PB046
GW	PB-BED-MW25	DE3003	11-Mar-04	REG	PB046
GW	PB-BED-MW25	DE3006	11-Mar-04	FD	PB046
GW	PB-BED-MW25	DE3007	11-Mar-04	FS	F22742
GW	PB-BED-MW28	DE3004	9-Mar-04	REG	PB046
GW	PB-BED-MW29	DE3005	10-Mar-04	REG	PB046

GW - Groundwater.
REG - Regular.
FD - Field duplicate.
FS - Field split.

Table F-2

Summary of Analytes Detected in Blanks
Former Plum Brook Ordnance Works
Sandusky, Ohio

Lot Number	Sample Number	Analysis Date	Sample Purpose	Parameter	Result	Units	Lab Qualifier
F22742	DE5001	24-Mar-04	TB	Methylene Chloride	1.5	ug/L	J
PB046	DE5002	11-Mar-04	TB	Acetone	1.6	ug/L	J
PB046	DE5002	11-Mar-04	TB	Chlorobenzene	0.19	ug/L	J
PB046	DE5002	11-Mar-04	TB	Methylene Chloride	1.5	ug/L	J
PB046	DE5003	9-Mar-04	TB	Methylene Chloride	1.2	ug/L	J
PB046	DE5004	10-Mar-04	TB	Methylene Chloride	1.2	ug/L	J
PB046	GA8Q0BW	9-Mar-04	BLK	Thallium	3.7	ug/L	B

TB - Trip blank.
BLK - Blank.
ug/L - Micrograms per liter.
J - Estimated value.
B - Analyte in the blank.

Table F-3

Summary of Original, Field Duplicate, and Field Split Results and RPD Calculations
Former Plum Brook Ordnance Works
Sandusky, Ohio

	Location Code	PB-BED-MW25		PB-BED-MW25		PB-BED-MW25		Relative Percent Difference between	Relative Percent Difference between
	Sample Number	DE3003		DE3006		DE3007			
	Sample Date	11-Mar-04		11-Mar-04		11-Mar-04			
	Sample Purpose	REG		FD		FS			
Parameter	Units	Result	ValQual	Result	ValQual	Result	ValQual	REG and FD	REG and FS
Aluminum	ug/L	50.3	B	50.2	B	200	U	0.20	119.62
Barium	ug/L	233		233		227		0.00	2.61
Calcium	ug/L	107000		108000		107000		0.93	0.00
Carbon disulfide	ug/L	1.2		1.5		2	U	22.22	50.00
Iron	ug/L	82.1	J	82.7	J	300	U	0.73	114.05
Magnesium	ug/L	41900		42000		41500		0.24	0.96
Manganese	ug/L	45.1		45.2		42.3		0.22	6.41
Methylene chloride	ug/L	2	U	1.2	B	5	U	50.00	85.71
Potassium	ug/L	10800	J	10900	J	13300		0.92	20.75
Sodium	ug/L	114000		115000		116000		0.87	1.74
Thallium	ug/L	10	U	4.4	B	10		77.78	0.00
Toluene	ug/L	0.13	J	0.12	J	2	U	8.00	175.59

RPD > 30%
ug/L - Micrograms per liter.
REG - Regular.
FD - Field duplicate.
FS - Field split.
J - Estimated value.
U - Undetected.
B - Analyte in blank.
ValQual - Validation qualifer.

Table F-4

Summary of Data Validation Reason Codes
Plum Brook Ordnance Works
Sandusky, Ohio

Reason Code	Description
01	Sample received outside of 4+/-2 degrees Celsius
01A	Improper sample preservation
02	Holding Time Exceeded
02A	Extraction
02B	Analysis
03	Instrument Performance - Outside Criteria
03A	BFB
03B	DFTPP
03C	DDT and/or Endrin % breakdown exceeds criteria
03D	retention time windows
03E	Resolution
04	Initial Calibration results outside specified criteria
04A	Compound mean RRF<0.05
04B	Compound %RSD>30
04C	Correlation Coefficient<0.995
05	Continuing Calibration results outside specified criteria
05A	Compound mean RRF<0.05
05B	Compound %D>25
06	Result qualified as a result of the 5x/10x blank correction
06A	Method or Preparation Blank
06B	ICB or CCB
06C	ER
06D	TB
06E	FB
07	Surrogate Recoveries outside control limits
07A	Sample
07B	Associated method blank or LCS
08	MS/MSD/Duplicate results outside criteria
08A	MS and/or MSD recovery not within control limits (accuracy)
08B	%RPD outside acceptance criteria (precision)
09	Post Digestion Spike outside criteria (GFAA)
10	Internal Standards outside specified control limits
10A	Recovery
10B	Retention Time
11	Laboratory Control Sample recoveries outside specified control limits
11A	Recovery
11B	%RPD (if run in duplicate)
12	Interference Check Standard
13	Serial Dilution
14	Tentatively Identified Compounds
15	Quantitation
16	Multiple results available; alternate analysis preferred
17	Field duplicate RPD criteria exceeded
18	Percent difference between original and second column > 25%
19	Professional judgement was used to qualify the data
20	Pesticide clean-up checks
21	Target compound identification
22	Radiological calibration
23	Radiological quantitation
24	Reported result and/or lab qualifier revised to reflect validation findings
999	See hard copy for details.

Table F-5

Summary of Data Validation Qualifiers Assigned and Reason Codes for Qualification
Former Plum Brook Ordnance Works
Sandusky, Ohio

Lot Number	Sample Number	Analysis	Parameter	VQ	Reason Codes (1,2) R1	R2	R3	R4
F22742	DE3007	VOLATILES	ACETONE	R	04A	05A		
F22742	DE3007	VOLATILES	CHLOROETHANE	UJ	05B			
F22742	DE3007	VOLATILES	1,1,2,2-TETRACHLOROETHANE	UJ	10A			
PB046	DE3000	CYANIDE	CYANIDE	UJ	08A	08B		
PB046	DE3000	EXPLOSIVES	TETRYL	UJ	08A			
PB046	DE3000	TOTAL METALS	THALLIUM	B	06A	15		
PB046	DE3000	TOTAL METALS	NICKEL	B	06B	15		
PB046	DE3000	TOTAL METALS	ZINC	B	06B	15		
PB046	DE3000	DISSOLVED METALS	ALUMINUM	B	06B	15		
PB046	DE3000	DISSOLVED METALS	ZINC	B	06B	15		
PB046	DE3000	TOTAL METALS	POTASSIUM	J	13	15		
PB046	DE3000	DISSOLVED METALS	POTASSIUM	J	13	15		
PB046	DE3000	TOTAL METALS	BARIUM	J	15			
PB046	DE3000	TOTAL METALS	MANGANESE	J	15			
PB046	DE3000	DISSOLVED METALS	BARIUM	J	15			
PB046	DE3000	DISSOLVED METALS	MANGANESE	J	15			
PB046	DE3000	DISSOLVED METALS	NICKEL	J	15			
PB046	DE3000	DISSOLVED METALS	THALLIUM	J	15			
PB046	DE3000	VOLATILES	2-BUTANONE	R	04A	05A		
PB046	DE3000	VOLATILES	ACETONE	R	04A	05A		
PB046	DE3000	VOLATILES	BROMOMETHANE	R	04A	05A	05B	
PB046	DE3000	VOLATILES	CHLOROMETHANE	UJ	05B			
PB046	DE3000	VOLATILES	CARBON DISULFIDE	J	15			
PB046	DE3001	CYANIDE	CYANIDE	UJ	08A	08B		
PB046	DE3001	EXPLOSIVES	TETRYL	UJ	08A			
PB046	DE3001	TOTAL METALS	ALUMINUM	B	06B	15		
PB046	DE3001	TOTAL METALS	ARSENIC	B	06B	15		
PB046	DE3001	DISSOLVED METALS	ALUMINUM	B	06B	15		
PB046	DE3001	DISSOLVED METALS	COPPER	B	06B	15		
PB046	DE3001	TOTAL METALS	POTASSIUM	J	13			
PB046	DE3001	DISSOLVED METALS	POTASSIUM	J	13			
PB046	DE3001	TOTAL METALS	COBALT	J	15			
PB046	DE3001	DISSOLVED METALS	COBALT	J	15			
PB046	DE3001	VOLATILES	ACETONE	J	04A	05A	15	
PB046	DE3001	VOLATILES	2-BUTANONE	R	04A	05A		
PB046	DE3001	VOLATILES	BROMOMETHANE	R	04A	05A		
PB046	DE3001	VOLATILES	CHLOROMETHANE	UJ	05B			
PB046	DE3001	VOLATILES	XYLENES (TOTAL)	UJ	05B			
PB046	DE3001	VOLATILES	METHYLENE CHLORIDE	B	06D	15		
PB046	DE3001	VOLATILES	CARBON DISULFIDE	J	15			
PB046	DE3001	VOLATILES	TOLUENE	J	15			
PB046	DE3002	CYANIDE	CYANIDE	UJ	08A	08B		
PB046	DE3002	EXPLOSIVES	TETRYL	UJ	08A			
PB046	DE3002	TOTAL METALS	ALUMINUM	B	06B	15		
PB046	DE3002	DISSOLVED METALS	ALUMINUM	B	06B	15		
PB046	DE3002	TOTAL METALS	POTASSIUM	J	13			
PB046	DE3002	DISSOLVED METALS	POTASSIUM	J	13			
PB046	DE3002	TOTAL METALS	COPPER	J	15			
PB046	DE3002	TOTAL METALS	ZINC	J	15			
PB046	DE3002	DISSOLVED METALS	THALLIUM	J	15			
PB046	DE3002	VOLATILES	2-BUTANONE	R	04A	05A		

Table F-5

Summary of Data Validation Qualifiers Assigned and Reason Codes for Qualification
Former Plum Brook Ordnance Works
Sandusky, Ohio

Lot Number	Sample Number	Analysis	Parameter	VQ	Reason Codes (1,2) R1	R2	R3	R4
PB046	DE3002	VOLATILES	ACETONE	R	04A	05A		
PB046	DE3002	VOLATILES	BROMOMETHANE	R	04A	05A		
PB046	DE3002	VOLATILES	XYLENES (TOTAL)	J	05B			
PB046	DE3002	VOLATILES	CHLOROMETHANE	UJ	05B			
PB046	DE3002	VOLATILES	CARBON DISULFIDE	J	15			
PB046	DE3002	VOLATILES	ETHYLBENZENE	J	15			
PB046	DE3003	CYANIDE	CYANIDE	UJ	08A	08B		
PB046	DE3003	EXPLOSIVES	TETRYL	UJ	08A			
PB046	DE3003	TOTAL METALS	ALUMINUM	B	06B	15		
PB046	DE3003	DISSOLVED METALS	ALUMINUM	B	06B	15		
PB046	DE3003	TOTAL METALS	POTASSIUM	J	13			
PB046	DE3003	DISSOLVED METALS	POTASSIUM	J	13			
PB046	DE3003	TOTAL METALS	IRON	J	15			
PB046	DE3003	SEMIVOLATILES	2,4-DINITROPHENOL	UJ	05B			
PB046	DE3003	VOLATILES	2-BUTANONE	R	04A	05A		
PB046	DE3003	VOLATILES	ACETONE	R	04A	05A		
PB046	DE3003	VOLATILES	BROMOMETHANE	R	04A	05A	05B	
PB046	DE3003	VOLATILES	CHLOROMETHANE	UJ	05B			
PB046	DE3003	VOLATILES	TOLUENE	J	15			
PB046	DE3004	CYANIDE	CYANIDE	UJ	08A	08B		
PB046	DE3004	EXPLOSIVES	TETRYL	UJ	08A			
PB046	DE3004	TOTAL METALS	THALLIUM	B	06A	15		
PB046	DE3004	TOTAL METALS	ALUMINUM	B	06B	15		
PB046	DE3004	TOTAL METALS	ARSENIC	B	06B	15		
PB046	DE3004	TOTAL METALS	ZINC	B	06B	15		
PB046	DE3004	DISSOLVED METALS	ALUMINUM	B	06B	15		
PB046	DE3004	DISSOLVED METALS	ARSENIC	B	06B	15		
PB046	DE3004	DISSOLVED METALS	ZINC	B	06B	15		
PB046	DE3004	TOTAL METALS	POTASSIUM	J	13			
PB046	DE3004	DISSOLVED METALS	POTASSIUM	J	13			
PB046	DE3004	TOTAL METALS	MANGANESE	J	15			
PB046	DE3004	DISSOLVED METALS	MANGANESE	J	15			
PB046	DE3004	DISSOLVED METALS	THALLIUM	J	15			
PB046	DE3004	SEMIVOLATILES	1,2,4-TRICHLOROBENZENE	UJ	02A			
PB046	DE3004	SEMIVOLATILES	1,2-DICHLOROBENZENE	UJ	02A			
PB046	DE3004	SEMIVOLATILES	1,3-DICHLOROBENZENE	UJ	02A			
PB046	DE3004	SEMIVOLATILES	1,4-DICHLOROBENZENE	UJ	02A			
PB046	DE3004	SEMIVOLATILES	2,2'-OXYBIS(1-CHLOROPROPA	UJ	02A			
PB046	DE3004	SEMIVOLATILES	2,4,5-TRICHLOROPHENOL	UJ	02A			
PB046	DE3004	SEMIVOLATILES	2,4,6-TRICHLOROPHENOL	UJ	02A			
PB046	DE3004	SEMIVOLATILES	2,4-DICHLOROPHENOL	UJ	02A			
PB046	DE3004	SEMIVOLATILES	2,4-DIMETHYLPHENOL	UJ	02A			
PB046	DE3004	SEMIVOLATILES	2,4-DINITROPHENOL	UJ	02A			
PB046	DE3004	SEMIVOLATILES	2,4-DINITROTOLUENE	UJ	02A			
PB046	DE3004	SEMIVOLATILES	2,6-DINITROTOLUENE	UJ	02A			
PB046	DE3004	SEMIVOLATILES	2-CHLORONAPHTHALENE	UJ	02A			
PB046	DE3004	SEMIVOLATILES	2-CHLOROPHENOL	UJ	02A			
PB046	DE3004	SEMIVOLATILES	2-METHYLNAPHTHALENE	UJ	02A			
PB046	DE3004	SEMIVOLATILES	2-METHYLPHENOL	UJ	02A			
PB046	DE3004	SEMIVOLATILES	2-NITROANILINE	UJ	02A			
PB046	DE3004	SEMIVOLATILES	2-NITROPHENOL	UJ	02A			

Table F-5

Summary of Data Validation Qualifiers Assigned and Reason Codes for Qualification
Former Plum Brook Ordnance Works
Sandusky, Ohio

Lot Number	Sample Number	Analysis	Parameter	VQ	Reason Codes (1,2) R1	R2	R3	R4
PB046	DE3004	SEMIVOLATILES	3,3'-DICHLOROBENZIDINE	UJ	02A			
PB046	DE3004	SEMIVOLATILES	3-NITROANILINE	UJ	02A			
PB046	DE3004	SEMIVOLATILES	4,6-DINITRO-2-METHYLPHENO	UJ	02A			
PB046	DE3004	SEMIVOLATILES	4-BROMOPHENYL PHENYL ETHE	UJ	02A			
PB046	DE3004	SEMIVOLATILES	4-CHLORO-3-METHYLPHENOL	UJ	02A			
PB046	DE3004	SEMIVOLATILES	4-CHLOROANILINE	UJ	02A			
PB046	DE3004	SEMIVOLATILES	4-CHLOROPHENYL PHENYL ETH	UJ	02A			
PB046	DE3004	SEMIVOLATILES	4-METHYLPHENOL	UJ	02A			
PB046	DE3004	SEMIVOLATILES	4-NITROANILINE	UJ	02A			
PB046	DE3004	SEMIVOLATILES	4-NITROPHENOL	UJ	02A			
PB046	DE3004	SEMIVOLATILES	ACENAPHTHENE	UJ	02A			
PB046	DE3004	SEMIVOLATILES	ACENAPHTHYLENE	UJ	02A			
PB046	DE3004	SEMIVOLATILES	ANTHRACENE	UJ	02A			
PB046	DE3004	SEMIVOLATILES	BENZO(A)ANTHRACENE	UJ	02A			
PB046	DE3004	SEMIVOLATILES	BENZO(A)PYRENE	UJ	02A			
PB046	DE3004	SEMIVOLATILES	BENZO(B)FLUORANTHENE	UJ	02A			
PB046	DE3004	SEMIVOLATILES	BENZO(GHI)PERYLENE	UJ	02A			
PB046	DE3004	SEMIVOLATILES	BENZO(K)FLUORANTHENE	UJ	02A			
PB046	DE3004	SEMIVOLATILES	BIS(2-CHLOROETHOXY)METHAN	UJ	02A			
PB046	DE3004	SEMIVOLATILES	BIS(2-CHLOROETHYL) ETHER	UJ	02A			
PB046	DE3004	SEMIVOLATILES	BIS(2-ETHYLHEXYL) PHTHALA	UJ	02A			
PB046	DE3004	SEMIVOLATILES	BUTYL BENZYL PHTHALATE	UJ	02A			
PB046	DE3004	SEMIVOLATILES	CARBAZOLE	UJ	02A			
PB046	DE3004	SEMIVOLATILES	CHRYSENE	UJ	02A			
PB046	DE3004	SEMIVOLATILES	DI-N-BUTYL PHTHALATE	UJ	02A			
PB046	DE3004	SEMIVOLATILES	DI-N-OCTYL PHTHALATE	UJ	02A			
PB046	DE3004	SEMIVOLATILES	DIBENZ(A,H)ANTHRACENE	UJ	02A			
PB046	DE3004	SEMIVOLATILES	DIBENZOFURAN	UJ	02A			
PB046	DE3004	SEMIVOLATILES	DIETHYL PHTHALATE	UJ	02A			
PB046	DE3004	SEMIVOLATILES	DIMETHYL PHTHALATE	UJ	02A			
PB046	DE3004	SEMIVOLATILES	FLUORANTHENE	UJ	02A			
PB046	DE3004	SEMIVOLATILES	FLUORENE	UJ	02A			
PB046	DE3004	SEMIVOLATILES	HEXACHLOROBENZENE	UJ	02A			
PB046	DE3004	SEMIVOLATILES	HEXACHLOROBUTADIENE	UJ	02A			
PB046	DE3004	SEMIVOLATILES	HEXACHLOROCYCLOPENTADIENE	UJ	02A			
PB046	DE3004	SEMIVOLATILES	HEXACHLOROETHANE	UJ	02A			
PB046	DE3004	SEMIVOLATILES	INDENO(1,2,3-CD)PYRENE	UJ	02A			
PB046	DE3004	SEMIVOLATILES	ISOPHORONE	UJ	02A			
PB046	DE3004	SEMIVOLATILES	N-NITROSODI-N-PROPYLAMINE	UJ	02A			
PB046	DE3004	SEMIVOLATILES	N-NITROSODIPHENYLAMINE	UJ	02A			
PB046	DE3004	SEMIVOLATILES	NAPHTHALENE	UJ	02A			
PB046	DE3004	SEMIVOLATILES	NITROBENZENE	UJ	02A			
PB046	DE3004	SEMIVOLATILES	PENTACHLOROPHENOL	UJ	02A			
PB046	DE3004	SEMIVOLATILES	PHENANTHRENE	UJ	02A			
PB046	DE3004	SEMIVOLATILES	PHENOL	UJ	02A			
PB046	DE3004	SEMIVOLATILES	PYRENE	UJ	02A			
PB046	DE3004	VOLATILES	ACETONE	J	04A	05A	15	
PB046	DE3004	VOLATILES	2-BUTANONE	R	04A	05A		
PB046	DE3004	VOLATILES	BROMOMETHANE	R	04A	05A	05B	
PB046	DE3004	VOLATILES	METHYLENE CHLORIDE	B	06D			
PB046	DE3004	VOLATILES	TOLUENE	J	15			

Table F-5

Summary of Data Validation Qualifiers Assigned and Reason Codes for Qualification
Former Plum Brook Ordnance Works
Sandusky, Ohio

(Page 4 of 4)

Lot Number	Sample Number	Analysis	Parameter	VQ	Reason Codes (1,2) R1	R2	R3	R4
PB046	DE3005	CYANIDE	CYANIDE	UJ	08A	08B		
PB046	DE3005	EXPLOSIVES	TETRYL	UJ	08A			
PB046	DE3005	TOTAL METALS	ARSENIC	B	06B	15		
PB046	DE3005	TOTAL METALS	COBALT	B	06B	15		
PB046	DE3005	DISSOLVED METALS	ALUMINUM	B	06B	15		
PB046	DE3005	DISSOLVED METALS	ZINC	B	06B	15		
PB046	DE3005	TOTAL METALS	POTASSIUM	J	13			
PB046	DE3005	DISSOLVED METALS	POTASSIUM	J	13			
PB046	DE3005	TOTAL METALS	ALUMINUM	J	15			
PB046	DE3005	TOTAL METALS	ZINC	J	15			
PB046	DE3005	DISSOLVED METALS	COBALT	J	15			
PB046	DE3005	VOLATILES	ACETONE	J	04A	05A	15	
PB046	DE3005	VOLATILES	2-BUTANONE	R	04A	05A		
PB046	DE3005	VOLATILES	BROMOMETHANE	R	04A	05A		
PB046	DE3005	VOLATILES	XYLENES (TOTAL)	J	05B			
PB046	DE3005	VOLATILES	CHLOROMETHANE	UJ	05B			
PB046	DE3005	VOLATILES	METHYLENE CHLORIDE	B	06D	15		
PB046	DE3005	VOLATILES	BENZENE	J	15			
PB046	DE3005	VOLATILES	ETHYLBENZENE	J	15			
PB046	DE3006	EXPLOSIVES	TETRYL	UJ	08A			
PB046	DE3006	TOTAL METALS	THALLIUM	B	06A	15		
PB046	DE3006	TOTAL METALS	ALUMINUM	B	06B	15		
PB046	DE3006	DISSOLVED METALS	ALUMINUM	B	06B	15		
PB046	DE3006	TOTAL METALS	POTASSIUM	J	13			
PB046	DE3006	DISSOLVED METALS	POTASSIUM	J	13			
PB046	DE3006	TOTAL METALS	IRON	J	15			
PB046	DE3006	DISSOLVED METALS	THALLIUM	J	15			
PB046	DE3006	SEMIVOLATILES	2,4-DINITROPHENOL	UJ	05B			
PB046	DE3006	VOLATILES	2-BUTANONE	R	04A	05A		
PB046	DE3006	VOLATILES	ACETONE	R	04A	05A		
PB046	DE3006	VOLATILES	BROMOMETHANE	R	04A	05A	05B	
PB046	DE3006	VOLATILES	CHLOROMETHANE	UJ	05B			
PB046	DE3006	VOLATILES	METHYLENE CHLORIDE	B	06D	15		
PB046	DE3006	VOLATILES	TOLUENE	J	15			

Footnotes:
(1) Table F-4 defines all reason codes.
(2) Reason codes are assigned in order of their importance to the validation qualifiers with R1 being most important.
Definitions:
VQ = validation qualifier

Table F-6

Laboratory and Validation Qualifier Definitions
Former Plum Brook Ordnance Works
Sandusky, Ohio

Qualifier	Definition
Laboratory - Organic	
B	The compound was detected in the sample and in an associated method blank.
J	The compound was positively identified; the reported value is an estimated concentration between the method detection limit and the reporting limit.
U	Not detected. The compound was analyzed for, but not detected above the associated reporting limit.
Laboratory - Inorganic	
B	The analyte was positively identified; the reported value is an estimated concentration between the method detection limit and the reporting limit.
J	The compound was detected in the sample and in an associated method blank.
G	Elevated reporting limit due to matrix interference.
U	Not detected. The analyte was analyzed for, but not detected above the associated reporting limit.
Validation - All	
B	The analyte was not detected significantly above the levels found in the associated method blank or field blanks
J	The compound/analyte was positively identified; the reported value is an estimated concentration.
R	Rejected due to severe deficiencies in the analytical process or supporting quality control data. The presence or absence of the compound/analyte cannot be verified.
U	Not detected. The compound/analyte was analyzed for, but not detected above the associated reporting limit.
UJ	Not detected. The associated reporting limit may be inaccurate or imprecise.

APPENDIX G

CHAINS-OF-CUSTODY

Shaw
Shaw E & I, Inc.

ANALYSIS REQUEST AND CHAIN-OF-CUSTODY RECORD

REFERENCE COC NO.: PB0309 045TL-NC
~~PB03 09 04STL~~

PAGE 1 OF 1

Bill To: Accounting
Shaw E & I
312 Directors Drive
Knoxville, TN 37923

Report To: Maureen McMyler
Shaw E & I
312 Directors Drive
Knoxville, TN 37923

Project Name/No: PBOW/843656
Sample Team Member: David Kessler
Profit Center: Knoxville
Project Manager: Steve Downey
Project No.: 843656
Required Report Date: 21 days

Sample Shipment Date: 3/9/04
Laboratory Destination: STL-North Canton
Laboratory Contact: Ken Kuzior
Project Contact/Phone: Maureen McMyler/865-690-3211
Carrier Waybill No.: ~~8231546624~~ DKK
8270690953 32

Sample Number	Sample Type/ Description	Date/Time Collected	Container Type	Sample Volume	Pre-servative	Requested Testing Program	Condition on Receipt	Disposal Record
DE3004	WATER	3/9/04 1410	2 - Glass	40 mL	H2SO4	TOC by 9060		
			1 - HDPE	1000 mL	Cool	Alkalinity by 310.1; Chloride by 325.2		
						Nitrate by 353.2; Sulfate by 375.4		
						TDS by 160.1; TSS by 160.2		
						Turbidity by 180.1		
			1 - HDPE	250 mL	HNO3	Hardness by 130.2		
	WATER		2 - Glass	40 mL	H2SO4	TOC by 9060		
			1 - HDPE	1000 mL	Cool	Alkalinity by 310.1; Chloride by 325.2		
						Nitrate by 353.2; Sulfate by 375.4	DKK	
						~~TDS by 160.1; TSS by 160.2~~		
						Turbidity by 180.1		
			1 - HDPE	250 mL	HNO3	Hardness by 130.2		
	WATER		2 - Glass	40 mL	H2SO4	TOC by 9060		
			1 - HDPE	1000 mL	Cool	Alkalinity by 310.1; Chloride by 325.2		
						Nitrate by 353.2; Sulfate by 375.4	DKK	
						TDS by 160.1; TSS by 160.2		
						Turbidity by 180.1		
			1 - HDPE	250 mL	HNO3	Hardness by 130.2		
							DKK	

Special Instructions:

Possible Hazard Identification:
Non-haz: X Flammable: ___ Poison B: ___ Unknown: ___

Sample Disposal:
Return to Client: ___ Disposal by Lab: X Archive: ___

Turnaround Time:
Normal: X Rush: ___

Level of QC Required:
Definitive: X Project Specific: ___

1. Relinquished by: David Kessler	Date: 3/9/04 Time: 1800	1. Received by: Anne S Andrews	Date: 3/10/04 Time: 0945
2. Relinquished by:	Date: Time:	2. Received by:	Date: Time:
3. Relinquished by:	Date: Time:	2. Received by:	Date: Time:

Comments:

H4C100133

Shaw™
Shaw E & I, Inc.

ANALYSIS REQUEST AND CHAIN-OF-CUSTODY RECORD

REFERENCE COC NO.: PB03 09 04STL-K

PAGE 1 OF 1

Bill To: Accounting
Shaw E & I
312 Directors Drive
Knoxville, TN 37923

Report To: Maureen McMyler
Shaw E & I
312 Directors Drive
Knoxville, TN 37923

Project Name/No: PBOW
Sample Team Member: David Kessler
Profit Center: Knoxville
Project Manager: Steve Downey
Project No.: 843656
Required Report Date: 21 DAYS

Sample Shipment Date: 3/9/04
Laboratory Destination: STL- Knoxville
Laboratory Contact: Jamie McKinney
Project Contact/Phone: Maureen McMyler/865-690-3211
Carrier Waybill No.: 833154266841

Sample Number	Sample Type/ Description	Date/Time Collected	Container Type	Sample Volume	Pre-servative	Requested Testing Program	Condition on Receipt	Disposal Record
DE3004	WATER	3/9/04 1410	2 - Amber	1 L	Cool	Explosives by 8830		
			1 - HDPE	250 mL	HNO3 pH2	Total TAL Metals by 6010B/7470A		
			1 - HDPE	250 mL	HNO3 pH2	Dissolved TAL Metals by 6010B/7470A		
			2 - Amber	1 L	Cool	TCL SVOCs by 8270C		
			3 - Glass	40 mL	HCL	TCL VOCs by 8260B		
			1 - HDPE	1 L	NaOH pH12	Cyanide by 9010/9012		
	WATER		2 - Amber	1 L	Cool	Explosives by 8830		
			1 - HDPE	250 mL	HNO3	Total TAL Metals by 6010B/7470A		
			1 - HDPE	250 mL	HNO3	Dissolved TAL Metals by 6010B/7470A	DKK	
			2 - Amber	1 L	Cool	TCL SVOCs by 8270C		
			3 - Glass	40 mL	HCL	TCL VOCs by 8260B		
			1 - HDPE	1 L	NaOH	Cyanide by 9010/9012		
	WATER		2 - Amber	1 L	Cool	Explosives by 8830		
			1 - HDPE	250 mL	HNO3	Total TAL Metals by 6010B/7470A		
			1 - HDPE	250 mL	HNO3	Dissolved TAL Metals by 6010B/7470A		
			2 - Amber	1 L	Cool	TCL SVOCs by 8270C	DKK	
			3 - Glass	40 mL	HCL	TCL VOCs by 8260B		
			1 - HDPE	1 L	NaOH	Cyanide by 9010/9012		
DE5003	WATER	3/9/04	2 - Glass	40 mL	HCL	TCL VOCs by 8260B		

Special Instructions:

Possible Hazard Identification:
Non-haz: X Flammable: ___ Poison B: ___ Unknown: ___

Sample Disposal:
Return to Client: ___ Disposal by Lab: X Archive: ___

Turnaround Time:
Normal: X Rush: ___

Level of QC Required:
Definitive: X Project Specific: ___

1. Relinquished by: David Kessler	Date: 3/9/04 Time: 1800	1. Received by: Andrew D. Flores	Date: 03-10-04 Time: 09:00
2. Relinquished by:	Date: Time:	2. Received by:	Date: Time:
3. Relinquished by:	Date: Time:	2. Received by:	Date: Time:

Comments: Custody Seals Intact Received Temp. 2°C 1 COOLER / FEDEX TR# 833154266841 ADF 03-10-04

Shaw
Shaw E & I, Inc.

ANALYSIS REQUEST AND CHAIN-OF-CUSTODY RECORD

REFERENCE COC NO.: PB03 10 04STL-NC

PAGE 1 OF 1

Project Name/No: PBOW/843656
Sample Team Member: David Kessler
Profit Center: Knoxville
Project Manager: Steve Downey
Project No.: 843656
Required Report Date: 21 days

Sample Shipment Date: 3.10.04
Laboratory Destination: STL-North Canton
Laboratory Contact: Ken Kuzior
Project Contact/Phone: Maureen McMyler/865-690-3211
Carrier Waybill No.: 835302112894

Bill To: Accounting
Shaw E & I
312 Directors Drive
Knoxville, TN 37923

Report To: Maureen McMyler
Shaw E & I
312 Directors Drive
Knoxville, TN 37923

Sample Number	Sample Type/ Description	Date/Time Collected	Container Type	Sample Volume	Pre-servative	Requested Testing Program	Condition on Receipt	Disposal Record
DE3005	WATER	3.10.04 1015	2 - Glass	40 mL	H2SO4	TOC by 9060		
			1 - HDPE	1000 mL	Cool	Alkalinity by 310.1; Chloride by 325.2		
						Nitrate by 353.2; Sulfate by 375.4		
						TDS by 160.1; TSS by 160.2		
						Turbidity by 180.1		
			1 - HDPE	250 mL	HNO3	Hardness by 130.2		
DE3002	WATER	3.10.04 1305	2 - Glass	40 mL	H2SO4	TOC by 9060		
			1 - HDPE	1000 mL	Cool	Alkalinity by 310.1; Chloride by 325.2		
						Nitrate by 353.2; Sulfate by 375.4		
						TDS by 160.1; TSS by 160.2		
						Turbidity by 180.1		
			1 - HDPE	250 mL	HNO3	Hardness by 130.2		
DE3001	WATER	3.10.04 1525	2 - Glass	40 mL	H2SO4	TOC by 9060		
			1 - HDPE	1000 mL	Cool	Alkalinity by 310.1; Chloride by 325.2		
						Nitrate by 353.2; Sulfate by 375.4		
						TDS by 160.1; TSS by 160.2		
						Turbidity by 180.1		
			1 - HDPE	250 mL	HNO3	Hardness by 130.2		
						DKK		

Special Instructions:

Possible Hazard Identification:
Non-haz: X Flammable: ___ Poison B: ___ Unknown: ___

Sample Disposal:
Return to Client: ___ Disposal by Lab: X Archive: ___

Turnaround Time:
Normal: X Rush: ___

Level of QC Required:
Definitive: X Project Specific: ___

1. Relinquished by: David Kessler	Date: 3/10/04 Time: 1800	1. Received by: Gary Burns	Date: 3/11/04 Time: 9:50
2. Relinquished by:	Date: Time:	2. Received by:	Date: Time:
3. Relinquished by:	Date: Time:	2. Received by:	Date: Time:

Comments:

HMC110113

Shaw™
Shaw E & I, Inc.

ANALYSIS REQUEST AND CHAIN-OF-CUSTODY RECORD

REFERENCE COC NO.: PB03 10 04STL-K

PAGE 1 OF 1

Project Name/No: PBOW
Sample Team Member: David Kessler
Profit Center: Knoxville
Project Manager: Steve Downey
Project No.: 843656
Required Report Date: 21 DAYS

Sample Shipment Date: 3.10.04
Laboratory Destination: STL- Knoxville
Laboratory Contact: Jamie McKinney
Project Contact/Phone: Maureen McMyler/865-690-3211
Carrier Waybill No.: 835302112909

Bill To: Accounting
Shaw E & I
312 Directors Drive
Knoxville, TN 37923

Report To: Maureen McMyler
Shaw E & I
312 Directors Drive
Knoxville, TN 37923

Sample Number	Sample Type/ Description	Date/Time Collected	Container Type	Sample Volume	Pre-servative	Requested Testing Program	Condition on Receipt	Disposal Record
DE3005	WATER	3.10.04 1015	1 - Amber	1 L	Cool	Explosives by 8830	Custody Seals Intact	
			1 - HDPE	250 mL	HNO3 ph2	Total TAL Metals by 6010B/7470A	Received Temp. 2°C	
			1 - HDPE	250 mL	HNO3 ph2	Dissolved TAL Metals by 6010B/7470A	1 cooler / Fedex	
			2 - Amber	1 L	Cool	TCL SVOCs by 8270C	T#835302112909	
			3 - Glass	40 mL	HCL	TCL VOCs by 8260B	~~[illegible]~~ ADF 03-11-04	
			1 - HDPE	1 L	NaOH ph12	Cyanide by 9010/9012	ADF 03-11-04	
DE3002	WATER	3.10.04 1305	1 - Amber	1 L	Cool	Explosives by 8830		
			1 - HDPE	250 mL	HNO3 ph2	Total TAL Metals by 6010B/7470A		
			1 - HDPE	250 mL	HNO3 ph2	Dissolved TAL Metals by 6010B/7470A		
			2 - Amber	1 L	Cool	TCL SVOCs by 8270C		
			3 - Glass	40 mL	HCL	TCL VOCs by 8260B		
			1 - HDPE	1 L	NaOH ph12	Cyanide by 9010/9012		
DE3001	WATER	3.10.04 1525	1 - Amber	1 L	Cool	Explosives by 8830	7/8 full	
			1 - HDPE	250 mL	HNO3 ph2	Total TAL Metals by 6010B/7470A		
			1 - HDPE	250 mL	HNO3 ph2	Dissolved TAL Metals by 6010B/7470A		
			1 - Amber	1 L	Cool	TCL SVOCs by 8270C		
			3'- Glass	40 mL	HCL	TCL VOCs by 8260B		
			1 - HDPE	1 L	NaOH ph12	Cyanide by 9010/9012	7/8 full	
DE3004	WATER	NA	2 - Glass	40 mL	HCL	TCL VOCs by 8260B		

Special Instructions:

Possible Hazard Identification:
Non-haz: X Flammable: ___ Poison B: ___ Unknown ___

Sample Disposal:
Return to Client: ___ Disposal by Lab: X Archive: ___

Turnaround Time:
Normal: X Rush: ___

Level of QC Required:
Definitive: X Project Specific: ___

1. Relinquished by: David Kessler	Date: 3/10/04 Time: 1800	1. Received by: Andrew D. Flores	Date: 03-11-04 Time: 09:00
2. Relinquished by:	Date: Time:	2. Received by:	Date: Time:
3. Relinquished by:	Date: Time:	2. Received by:	Date: Time:

Comments:

200

Shaw™
Shaw E & I, Inc.

ANALYSIS REQUEST AND CHAIN-OF-CUSTODY RECORD

#4C120129

REFERENCE COC NO.: PB03 11 04STL-K

PAGE 1 OF 2

Bill To: Accounting
Shaw E & I
312 Directors Drive
Knoxville, TN 37923

Report To: Maureen McMyler
Shaw E & I
312 Directors Drive
Knoxville, TN 37923

Project Name/No: PBOW
Sample Team Member: David Kessler
Profit Center: Knoxville
Project Manager: Steve Downey
Project No.: 843656
Required Report Date: 21 DAYS

Sample Shipment Date: 3/11/04
Laboratory Destination: STL- Knoxville
Laboratory Contact: Jamie McKinney
Project Contact/Phone: Maureen McMyler/865-690-3211
Carrier Waybill No.: 835302112861

Sample Number	Sample Type/ Description	Date/Time Collected	Container Type	Sample Volume	Pre-servative	Requested Testing Program	Condition on Receipt	Disposal Record
DE3003	WATER	3.11.04 0915	12 - Amber	1 L	Cool	Explosives by 8330	Custody Seals Intact	
			1 - HDPE	250 mL pH2	HNO3	Total TAL Metals by 6010B/7470A	Received Temp. 2°c	
			1 - HDPE	250 mL pH2	HNO3	Dissolved TAL Metals by 6010B/7470A	3 COOLERS / FEDEX	
			2 - Amber	1 L	Cool	TCL SVOCs by 8270C	T#835302112861	
			3 - Glass	40 mL	HCL	TCL VOCs by 8260B	ADF 03-12-04	
			1 - HDPE	1 L pH12	NaOH	Cyanide by 9010/9012		
DE3003-MS	WATER	3.11.04 0915	12 - Amber	1 L	Cool	Explosives by 8330		
			1 - HDPE	250 mL pH2	HNO3	Total TAL Metals by 6010B/7470A		
			1 - HDPE	250 mL pH2	HNO3	Dissolved TAL Metals by 6010B/7470A		
			2 - Amber	1 L	Cool	TCL SVOCs by 8270C		
			3 - Glass	40 mL	HCL	TCL VOCs by 8260B		
			1 - HDPE	1 L pH12	NaOH	Cyanide by 9010/9012		
~~WATER~~			~~2 - Glass~~	~~40 mL~~	~~HCL~~	~~TCL VOCs by 8260B~~	DEK 3/11/04	
DE3003-MSD	WATER	3/11/04 0915	1 - Amber	1L	Cool	Explosives by 8330		
			1 - HDPE	250 mL pH2	HNO_3	Total TAL Metals by 6010B/7470A		
			1 - HDPE	250 mL pH2	HNO_3	Dissolved TAL Metals by 6010B/7470A		
			2 - Amber	1 L	Cool	TCL SVOCs by 8270C		
			3 - Glass	40 mL	HCL	TCL VOCs by 8260B		
DE5002	TRIP	3/11/04	2 - Glass	40 mL	HCL	TCL VOCs by 8260B		

Special Instructions:

Possible Hazard Identification: DE3003-MSD → 1 - HDPE 1L pH12 NAOH

Cyanide by 9010/9012

Sample Disposal:

Non-haz: X Flammable: ___ Poison B: ___ Unknown: ___

Return to Client: ___ Disposal by Lab: X Archive: ___

Turnaround Time:

Normal: X Rush: ___

Level of QC Required:

Definitive: X Project Specific: ___

1. Relinquished by: David Kessler	Date: 3/11/04 Time: 1800	1. Received by: Andrew D. Flores	Date: 03-12-04 Time: 09:10
2. Relinquished by:	Date: Time:	2. Received by:	Date: Time:
3. Relinquished by:	Date: Time:	2. Received by:	Date: Time:

Comments:

page 2 of 2

~~H4C0~~ H4C120129
MFH 3-12-04

Shaw™
Shaw E & I, Inc.

ANALYSIS REQUEST AND CHAIN-OF-CUSTODY RECORD

REFERENCE COC NO.: PB03 11 04STL-K

PAGE ~~2~~ 3 OF 2

Bill To: Accounting
Shaw E & I
312 Directors Drive
Knoxville, TN 37923

Report To: Maureen McMyler
Shaw E & I
312 Directors Drive
Knoxville, TN 37923

Project Name/No: PBOW
Sample Team Member: David Kessler
Profit Center: Knoxville
Project Manager: Steve Downey
Project No.: 843656
Required Report Date: 21 DAYS

Sample Shipment Date: 3/11/04
Laboratory Destination: STL- Knoxville
Laboratory Contact: Jamie McKinney
Project Contact/Phone: Maureen McMyler/865-690-3211
Carrier Waybill No.: 8353021128 61

Sample Number	Sample Type/ Description	Date/Time Collected	Container Type	Sample Volume	Pre-servative	Requested Testing Program	Condition on Receipt	Disposal Record
DE 3006	WATER	3/11/04 0915	2 - Amber	1 L	Cool	Explosives by 8830		
			1 - HDPE	250 mL pH2	HNO3	Total TAL Metals by 6010B/7470A		
			1 - HDPE	250 mL pH2	HNO3	Dissolved TAL Metals by 6010B/7470A		
			2 - Amber	1 L	Cool	TCL SVOCs by 8270C		
			3 - Glass	40 mL	HCL	TCL VOCs by 8260B		
			1 - HDPE	1 L	NaOH	Cyanide by 9010/9012		
DE 3000	WATER	3/11/04 1405	2 - Amber	1 L	Cool	Explosives by 8830		
			1 - HDPE	250 mL pH2	HNO3	Total TAL Metals by 6010B/7470A		
			1 - HDPE	250 mL pH2	HNO3	Dissolved TAL Metals by 6010B/7470A		
			2 - Amber	1 L	Cool	TCL SVOCs by 8270C		
			3 - Glass	40 mL	HCL	TCL VOCs by 8260B		
			1 - HDPE	1 L pH12	NaOH	Cyanide by 9010/9012		
	WATER		2 - Glass	40 mL	HCL	TCL VOCs by 8260B		
	DKK 3/11/04							

Special Instructions:

Possible Hazard Identification:
Non-haz: X Flammable: ___ Poison B: ___ Unknown: ___

Sample Disposal:
Return to Client: ___ Disposal by Lab: X Archive: ___

Turnaround Time:
Normal: X Rush: ___

Level of QC Required:
Definitive: X Project Specific: ___

1. Relinquished by: David Kessler	Date: 3/11/04 Time: 1600	1. Received by: Andrew D. Flores	Date: 03-12-04 Time: 09:10
2. Relinquished by:	Date: Time:	2. Received by:	Date: Time:
3. Relinquished by:	Date: Time:	2. Received by:	Date: Time:

Comments:

211

page 1 of 2

Shaw
Shaw E & I, Inc.

ANALYSIS REQUEST AND CHAIN-OF-CUSTODY RECORD

REFERENCE COC NO.: PB03 H 04STL-NC

PAGE 1 OF 2

Project Name/No: PBOW/843656
Sample Team Member: David Kessler
Profit Center: Knoxville
Project Manager: Steve Downey
Project No.: 843656
Required Report Date: 21 days

Sample Shipment Date: 3/11/04
Laboratory Destination: STL-North Canton
Laboratory Contact: Ken Kunzior
Project Contact/Phone: Maureen McMyler/865-690-3211
Carrier Waybill No.: 835302412872

Bill To: Accounting, Shaw E & I, 312 Directors Drive, Knoxville, TN 37923
Report To: Maureen McMyler, Shaw E & I, 312 Directors Drive, Knoxville, TN 37923

Sample Number	Sample Type/ Description	Date/Time Collected	Container Type	Sample Volume	Pre-servative	Requested Testing Program	Condition on Receipt	Disposal Record
DE 3003	WATER	3.11.04 0915	2 - Glass	40 mL	H2SO4	TOC by 9060		
			1 - HDPE	1000 mL	Cool	Alkalinity by 310.1; Chloride by 325.2		
						Nitrate by 353.2; Sulfate by 375.4		
						TDS by 160.1; TSS by 160.2		
						Turbidity by 180.1		
			1 - HDPE	250 mL	HNO3	Hardness by 130.2		
DE 3003-MS	WATER	3.11.04 0915	2 - Glass	40 mL	H2SO4	TOC by 9060		
			1 - HDPE	1000 mL	Cool	Alkalinity by 310.1; Chloride by 325.2		
						Nitrate by 353.2; Sulfate by 375.4		
						TDS by 160.1; TSS by 160.2		
						Turbidity by 180.1		
			1 - HDPE	250 mL	HNO3	Hardness by 130.2		
DE 3003-MSD	water	3/11/04 0915	2-Glass	40 ml	H_2SO_4	TOC by 9060		
			1-HDPE	1000ml	Cool	Alkalinity by 310.1; Chloride by 325.2		
						Nitrate by 353.2; Sulfate by 375.4		
						TDS by 160.1; TSS by 160.2		
						Turbidity by 180.1		
			1-HDPE	250 ml	HNO_3	Hardness by 130.2		
							DLR 3/11/04	

Special Instructions:

Possible Hazard Identification:
Non-haz: X Flammable: ___ Poison B: ___ Unknown: ___

Sample Disposal:
Return to Client: ___ Disposal by Lab: X Archive: ___

Turnaround Time:
Normal: X Rush: ___

Level of QC Required:
Definitive: X Project Specific: ___

1. Relinquished by: David Kessler	Date: 3/11/04 Time: 1800	1. Received by: Natalie J Burkhart	Date: 3-12-04 Time: 9:40
2. Relinquished by:	Date: Time:	2. Received by:	Date: Time:
3. Relinquished by:	Date: Time:	2. Received by:	Date: Time:

Comments:

page 2 of 2

Shaw
Shaw E & I, Inc.

ANALYSIS REQUEST AND CHAIN-OF-CUSTODY RECORD

REFERENCE COC NO.: PB03 11 04STL-NC 2

PAGE 2 OF 2

Project Name/No: PBOW/843656
Sample Team Member: David Kessler
Profit Center: Knoxville
Project Manager: Steve Downey
Project No.: 843656
Required Report Date: 21 days

Sample Shipment Date: 3/11/04
Laboratory Destination: STL-North Canton
Laboratory Contact: Ken Kuzior
Project Contact/Phone: Maureen McMyler/865-690-3211
Carrier Waybill No.: 835302112872

Bill To: Accounting
Shaw E & I
312 Directors Drive
Knoxville, TN 37923

Report To: Maureen McMyler
Shaw E & I
312 Directors Drive
Knoxville, TN 37923

Sample Number	Sample Type/ Description	Date/Time Collected	Container Type	Sample Volume	Pre-servative	Requested Testing Program	Condition on Receipt	Disposal Record
DE3006	WATER	3/11/04 0915	2 - Glass	40 mL	H2SO4	TOC by 9060		
			1 - HDPE	1000 mL	Cool	Alkalinity by 310.1; Chloride by 325.2		
						Nitrate by 353.2; Sulfate by 375.4		
						TDS by 160.1; TSS by 160.2		
						Turbidity by 180.1		
			1 - HDPE	250 mL	HNO3	Hardness by 130.2		
DE 3000	WATER	3/11/04 1405	2 - Glass	40 mL	H2SO4	TOC by 9060		
			1 - HDPE	1000 mL	Cool	Alkalinity by 310.1; Chloride by 325.2		
						Nitrate by 353.2; Sulfate by 375.4		
						TDS by 160.1; TSS by 160.2		
						Turbidity by 180.1		
			1 - HDPE	250 mL	HNO3	Hardness by 130.2		
		DKK 3/11/04						

Special Instructions:

Possible Hazard Identification:
Non-haz: X Flammable: ___ Poison B: ___ Unknown: ___

Sample Disposal:
Return to Client: ___ Disposal by Lab: X Archive: ___

Turnaround Time:
Normal: X Rush: ___

Level of QC Required:
Definitive: X Project Specific: ___

1. Relinquished by: David Kessler Date: 3/11/04 Time: 1800
1. Received by: Natalie J. Butler Date: 3-12-04 Time: 9:40
2. Relinquished by: Date: Time:
2. Received by: Date: Time:
3. Relinquished by: Date: Time:
2. Received by: Date: Time:

Comments:

222

F22742

Shaw
Shaw E & I, Inc.

ANALYSIS REQUEST AND CHAIN-OF-CUSTODY RECORD

REFERENCE COC NO.: PB03 11 04ACC

PAGE 1 OF 1

Bill To: Accounting, Shaw E & I, 312 Directors Drive, Knoxville, TN 37923

Report To: Maureen McMyler, Shaw E & I, 312 Directors Drive, Knoxville, TN 37923

Project Name/No: PBOW
Sample Team Member: David Kessler
Profit Center: Knoxville
Project Manager: Steve Downey
Project No.: 843656
Required Report Date: 21 days

Sample Shipment Date: 3-11-04
Laboratory Destination: Accutest
Laboratory Contact: Sue Bell
Project Contact/Phone: Maureen McMyler/865-560-5271
Carrier Waybill No.: 835302112883

Sample Number	Sample Type/ Description	Date/Time Collected	Container Type	Sample Volume	Pre-servative	Requested Testing Program	Condition on Receipt	Disposal Record
(1) DE3007	WATER		1 - Amber	1 L	Cool	Explosives by 8330		
			2 - Amber	1 L	Cool	Semivolatiles by 8270C		
			3 - Vial	40 mL	HCl	Volatiles by 8260B		
			1 - HDPE	250 mL	HNO3	TAL Metals (Total) by 6010B/7471A		
			1 - HDPE	250 mL	HNO3	TAL Metals (Diss) by 6010B/7471A		
(2) DE5001	WATER		2 - Vial	40 mL	HCl	Volatiles by 8260B		

Special Instructions:

Possible Hazard Identification: Non-haz: X Flammable: ___ Poison B: ___ Unknown: ___

Sample Disposal: Return to Client: ___ Disposal by Lab: X Archive: ___

Turnaround Time: Normal: X Rush: ___

Level of QC Required: Definitive: X Project Specific: ___

1. Relinquished by: David Kessler	Date: 3-11-04 Time: 1800	1. Received by: FED-EX	Date: Time:
2. Relinquished by: FED-EX	Date: Time:	2. Received by: Carlos Pz	Date: 3-12-04 Time: 9:00 am
3. Relinquished by:	Date: Time:	3. Received by:	Date: Time:

Comments:

3.1

3.1 3

F22742: Chain of Custody
Page 1 of 2

ACCUTEST Laboratories

Response to Comments
HTRW – Center of Expertise
Eighth Quarterly (December 2003) Background Groundwater Report
Former Plum Brook Ordnance Works, Sandusky, Ohio
(Dated March 2004)

Comments will be incorporated into the Ninth Quarterly Background Groundwater Report.

Comments by Sam Bass (Geologist)

Comment 1: Page 3-3, Section 3.4, second paragraph. The text states "Final maximum detected concentrations (MDC) results for the area of concern will be based on the overall maximum detected concentration for that area, including all quarterly sampling events." This approach would result in the selection of a non-representative value for the MDC. Considering the wells have been sampled for several years, the maximum concentration found in the first sampling round would not be representative of current ground water conditions. Further, from a risk assessment point of view the 95% UCL is typically used as the exposure point concentration, so use of a maximum detected value does not appear appropriate. It is recommended that the value to be screened be determined by statistical evaluation of the data, using the 95% UCL of the mean concentration for each analyte at each well.

Response 1: The statement referenced in Section 3.4 pertains to the reporting of analytical data. To clarify this, the following changes will be made: 1) in the second sentence on the second paragraph "...within an area of concern" will be replaced by "...among the background wells," and 2) a new sentence will be inserted between the current second and third sentences that will state, "Similar tables will be prepared for each area of concern in the BHHRA." Therefore, representativeness of the overall MDC of each analyte with regard to the table is not an issue, but the MDC column simply provides the highest value detected among the background wells or (in the BHHRA) within the area of concern. Please see the response to Comment regarding Well PB-BED-MW26.

Risk-based screening is mentioned in this background groundwater report to give the reader a perspective as to how the background data will be used for screening in the BHHRA. The basic protocol for developing BSC values and their use in the BHHRA was agreed upon by USACE, OEPA, and NASA PBS at a September 11, 2002 meeting in Sandusky, Ohio. Site data are not reported in this background document;

accordingly, neither are particular issues such as site data representativeness nor the BHHRA protocol for determining exposure point concentrations.

Comment 2: **Page 3-3, Section 3.4, second paragraph. Text states "BSC values will not be established until quarterly background sampling is complete and a final determination is made as to which wells truly represent background ground water conditions." The text should explain how it will be determined which wells truly represent background.**

Response 2: A sentence will be included following the 5th sentence in the second paragraph, page 3-3: "True background wells will be determined by further groundwater quality assessment, analytical data comparison with upgradient background wells PB-BED-MW28 and PB-BED-MW29, and additional groundwater flow mapping".

Comment 3: **Page 4-5, Section 4.2.4, January 2002 sampling event. Suggest the last sentence be rephrased. The results of the single sampling round at PB-BED-MW26 are not outliers as much as they are not representative of ground water in the area due to the extremely high turbidity of the samples collected from that well. The high concentrations of unfiltered metals are a direct result of the inordinately high turbidity, therefore the samples are not representative of water in the aquifer and should not be considered in any further analyses.**

Response 3: The following phrase will be added to the last sentence: "... and will not be used in the determination of BSC values." It is acknowledged that high turbidity is certainly a factor in the anomalously high concentrations. However, when the metals analytical results of PB-BED-MW26 are plotted on a bar graph and compared with the same analytical data from the other wells, the results are outliers in comparison, even when accounting for the high turbidity.

Comment 4: **Table 4-1, page 11 of 12. As noted in the previous comment, ground water from PB-BED-MW26 is not representative of site conditions due to the extremely high turbidity of the samples. All but 6 of 22 maximum detected concentrations for metals came from PB-BED-MW26. It would be inappropriate to use results from this well in determination of background screening concentrations.**

Response 4: Agreed. During the September 11, 2002 meeting between the USACE, OEPA, NASA, and Shaw, it was determined to eliminate all groundwater analytical data from well PB-BED-MW26 from the background data set used to develop the BSC values. The MDC values from the well will not be included in the final background screening calculations. In the ninth quarterly report, results from PB-BED-MW26 will be excluded from the MDC column on Table 4-1, although the results for this well will still be presented in Table 4-1.