NASA PLUM BROOK STATION

UNDERGROUND STORAGE TANK
CORRECTIVE ACTIONS REMEDIAL INVESTIGATION/FEASIBILITY STUDY

- PHASE I REPORT -
November 1991

Prepared for:

WARNER/OSBORN/PARDEE
26777 Lorain Road
Suite 500
North Olmsted, Ohio 44070

For Submittal to:

NASA LEWIS RESEARCH CENTER
21000 Brookpark Road
Cleveland, Ohio 44135

Prepared by:

EBASCO ENVIRONMENTAL
A Division of Ebasco Services Incorporated

5000 Bradenton Avenue
Suite 200
Dublin, Ohio 43017

CONTENTS

SECTION		PAGE
	CONTENTS	i
	TABLES	iv
	FIGURES	vi
	APPENDICES	x
1.0	**INTRODUCTION**	1-1
1.1	Objectives	1-1
1.2	Project Background	1-1
1.3	Facility Background Information	1-2
1.4	Previous Investigations	1-3
2.0	**ASSESSMENT METHODOLOGY**	2-1
2.1	Overview of the Phase I Field Investigation Program	2-1
2.1.1	Sample and Sample Location Identifiers	2-1
2.1.2	Soil Borings and Monitoring Well Installations	2-1
2.1.3	Subsurface Soil Sample Collection	2-2
2.1.4	Ground Water Sample Collection	2-2
2.1.5	Sediment/Surface Water Grab Sample Collection	2-3
2.1.6	Sample Shipment and Chain of Custody	2-3
2.1.7	Ground Water Level Measurements	2-3
2.2	Overview of the Data Evaluation Process	2-4
2.2.1	Lab Data QA and QC	2-4
2.2.2	Analytical Results for Organic Compounds	2-5
2.2.3	Analytical Results for Inorganic Compounds	
2.2.4	Ground Water Level Contours	
2.2.5	Boring Logs and Well Logs	
3.0	**SITE CHARACTERIZATION FINDINGS**	3-1
3.1	Garage and Maintenance Area	3-2
3.1.1	Previous Investigations and Results	3-2
3.1.1.1	UST Closure Assessments and Initial Remediation Efforts	3-2

CONTENTS (Cont'd)

SECTION		PAGE
3.1.1.2	Soil Gas Survey	3-5
3.1.2	Current Investigation and Results	3-7
3.1.2.1	Soil Sampling and Analyses	3-7
3.1.2.1.1	Physical and General Stratigraphic Characteristics	3-8
3.1.2.1.2	Nature and Extent of Contamination	3-9
3.1.2.2	Ground Water Sampling and Analysis	3-9
3.1.2.2.1	Nature and Extent of Contamination	3-9
3.1.2.2.2	Ground Water Flow	3-10
3.1.2.3	Sediment Sampling and Analysis	3-11
3.1.2.3.1	Nature and Extent of Contamination	3-11
3.1.3	Conclusions for Garage and Maintenance Area	3-12
3.2	Space Power Facility	3-13
3.2.1	Previous Investigations and Results	3-14
3.2.1.1	UST Closure Assessment	3-14
3.2.1.2	Soil Gas Survey	3-15
3.2.2	Current Investigation and Results	
3.2.2.1	Soil Sampling and Analysis	
3.2.2.1.1	Physical and General Stratigraphic Characteristics	3-17
3.2.2.1.2	Nature and Extent of Contamination	3-18
3.2.2.2	Ground Water Sampling and Analysis	3-19
3.2.2.2.1	Nature and Extent of Contamination	3-19
3.2.2.2.2	Ground Water Flow	
3.2.2.3	Sediment Sampling and Analysis	3-21
3.2.2.3.1	Nature and Extent of Contamination	3-21
3.2.3	Conclusions for Space Power Facility Area	3-22
3.3	Pump Station	3-23
3.3.1	Previous Investigations and Results	3-20
3.3.1.1	UST Closure Assessment	3-20
3.3.1.2	Soil Gas Survey	3-20
3.3.2	Current Investigation and Results	3-22
3.3.2.1	Soil Sampling and Analyses	3-22
3.3.2.1.1	Physical and General Stratigraphic Characteristics	3-22
3.3.2.1.2	Nature and Extent of Contamination	
3.3.2.2	Ground Water Sampling and Analysis	3-23
3.3.2.2.1	Nature and Extent of Contamination	3-23
3.3.2.2.2	Ground Water Flow	3-24
3.3.2.3	Sediment Sampling and Analysis	3-24
3.3.2.3.1	Nature and Extent of Contamination	3-24

CONTENTS (Cont'd)

SECTION			PAGE
3.3.3		Conclusions for Pump Station	3-24
3.4	Reactor Area		3-26
3.4.1		Previous Investigations and Results	3-26
	3.4.1.1	UST Closure Assessment	3-26
	3.4.1.2	Soil Gas Survey	3-26
3.4.2		Current Investigation and Results	3-26
	3.4.2.1	Soil Sampling and Analyses	3-27
	3.4.2.1.1	Physical and General Stratigraphic Characteristics	3-28
	3.4.2.1.2	Nature and Extent of Contamination	3-28
	3.4.2.2	Ground Water Sampling and Analysis	3-29
	3.4.2.2.1	Nature and Extent of Contamination	3-29
	3.4.2.2.2	Ground Water Flow	3-30
	3.4.2.3	Sediment Sampling and Analysis	3-30
3.4.3		Conclusions for Reactor Area	3-30
4.0	**SUMMARY AND RECOMMENDATIONS**		4-1
4.1	Summary		4-1
4.2	Recommendations		4-4
4.2.1		Recommendations Applicable to All Tank Areas	4-5
4.2.2		Recommendations Associated with Specific Tank Areas	4-6
4.2.3		Additional Comments	4-7

TABLES

TABLE	
1-1	Summary of PBS UST Activities and Related Events
1-2	PBS USTs Removed During the 1989 Calendar Year
2-1	Criteria Used for Comparisons of Inorganics in Soils
3-1	Results of Soil Analyses for the Building 7132 Tank Area at the Garage and Maintenance Area
3-2	Results of Surface Water Analyses for the Building 7132 Tank Area at the Garage and Maintenance Area
3-3	Results of Ground Water Analyses for the Building 7132 Tank Area at the Garage and Maintenance Area
3-4	Results of the Soil Analyses During the Additional Soil Excavation at the Building 7132 Tank Area at the Garage and Maintenance Area
3-5	Results of Soil Analyses for the Building 7121 Tank Area at the Garage and Maintenance Area
3-6	Results of Soil Analyses for the Building 7131 Tank Area at the Garage and Maintenance Area
3-7	Soil and Gas Survey Results for the Garage and Maintenance Area
3-8	Summary of Organic Contaminants Detected at the Garage and Maintenance Area
3-9	Results of Soil Analyses for the Building 1141 Tank Area at the Space Power Facility
3-10	Soil and Gas Survey Results for the Space Power Facility Tank Area
3-11	Summary of Organic Contaminants Detected at the Space Power Facility Area

TABLES (Cont'd)

TABLE	
3-12	Results of Soil Analyses for the Building 8133 Tank Area at the Pump Station
3-13	Soil and Gas Survey Results for the Pump Station Tank Area
3-14	Summary of Organic Contaminants Detected at the Pump Station Area
3-15	Results of Soil Analyses for the Building 1131 Tank Area at the Reactor Area
3-16	Summary of Organic Contaminants Detected at the Reactor Area
4-1	Summary of Current Site Characterization Results for the Plum Brook Station Former UST Locations

FIGURES

FIGURE	
1-1	Locations of the Four Former Underground Storage Tank Areas at the NASA Plum Brook Station
3-1	Locations of the Four Former Underground Storage Tank Areas at the NASA Plum Brook Station
3-2	Site Location Map for the USTs at the Garage and Maintenance Area
3-3	Sampling Locations Associated with the Building 7132 USTs at the Garage and Maintenance Area
3-4	Sampling Locations Associated with the Additional Excavation at the Building 7132 USTs at the Garage and Maintenance Area
3-5	Sampling Locations Associated with the Building 7121 USTs at the Garage and Maintenance Area
3-6	Sampling Locations Associated with the Building 7131 USTs at the Garage and Maintenance Area
3-7	Soil Gas Sampling Locations and Results for Benzene, Toluene and Xylene at the Garage and Maintenance Area
3-8	Soil Gas Sampling Locations and Results for DCE, TCE and PCE at the Garage and Maintenance Area
3-9	Locations of Soil Borings and Ground Water Monitoring Wells at the Garage and Maintenance Area
3-10	Generalized Stratigraphic Section at the Garage and Maintenance Area
3-11	Organic Contaminant Concentrations in Soil at the Garage and Maintenance Area
3-12	Organic Contaminant Concentrations in Ground Water at the Garage and Maintenance Area

FIGURES (Cont'd)

FIGURE	
3-13	Ground Water Elevation Contours for 01/09/91 at the Garage and Maintenance Area
3-14	Ground Water Elevation Contours for 05/09/91 at the Garage and Maintenance Area
3-15	Regional Ground Water Elevation Contours for the Plum Brook Station (Based on the 05/09/91 Data)
3-16	Locations of Sediment Samples at the Garage and Maintenance Area
3-17	Organic Contaminant Concentrations in Sediment at the Garage and Maintenance Area
3-18	Sampling Locations Associated with the Building 1411 USTs at the Space Power Facility
3-19	Soil Gas Sampling Locations and Results for Benzene, Toluene and Xylene at the Space Power Facility
3-20	Soil Gas Sampling Locations and Results for DCE, TCE and PCE at the Space Power Facility
3-21	Locations of Soil Borings and Ground Water Monitoring Wells at the Space Power Facility
3-22	Generalized Stratigraphic Section at the Space Power Facility
3-23	Organic Contaminant Concentrations in Soil at the Space Power Facility
3-24	Ground Water Elevation Contours for 01/09/91 at the Space Power Facility
3-25	Ground Water Elevation Contours for 05/09/91 at the Space Power Facility
3-26	Locations of Sediment Samples at the Space Power Facility

FIGURES (Cont'd)

FIGURE	
3-27	Organic Contaminant Concentrations in Sediment at the Space Power Facility
3-28	Sampling Locations Associated with the Building 8133 USTs at the Pump Station
3-29	Soil Gas Sampling Locations and Results for Benzene, Toluene and Xylene at the Pump Station
3-30	Locations of Soil Borings and Ground Water Monitoring Wells at the Pump Station
3-31	Generalized Stratigraphic Section at the Pump Station
3-32	Organic Contaminant Concentrations in Soil at the Pump Station
3-33	Locations of Sediment Samples at the Pump Station
3-34	Organic Contaminant Concentrations in Sediment at the Pump Station
3-35	Sampling Locations Associated With the Building 1131 USTs at the Reactor Area
3-36	Locations of Soil Borings and Ground Water Monitoring Wells at the Reactor Area
3-37	Generalized Stratigraphic Section at the Reactor Area
3-38	Organic Contaminant Concentrations in Soil at the Reactor Area
3-39	Organic Contaminant Concentrations in Ground Water at the Reactor Area
3-40	Ground Water Elevation Contours for 01/09/91 at the Reactor Area

FIGURES (Cont'd)

FIGURE

3-41 Ground Water Elevation Contours for 05/09/91 at the Reactor Area

APPENDICES

APPENDIX	
A	COMPLETE PHASE I SOIL SAMPLING RESULTS
B	COMPLETE PHASE I GROUND WATER SAMPLING RESULTS
C	COMPLETE PHASE I SEDIMENT SAMPLING RESULTS
D	COMPLETE PHASE I RESULTS FOR BLANKS
E	BORING LOGS FOR THE PHASE I INVESTIGATION
F	LOGS FOR THE PHASE I GROUND WATER MONITORING WELLS

1.0 INTRODUCTION

This report summarizes the work performed during the first phase of an underground storage tank (UST) Corrective Actions Remedial Investigation / Feasibility Study (RI/FS) at the NASA Plum Brook Station (PBS). The projected scope of the overall investigation was detailed in the PBS UST Corrective Actions RI/FS Work Plan developed by NASA and Ebasco Environmental (August, 1990 - Final Draft).

1.1 Objectives

The USTs at PBS have been the subject of study since new UST regulations went into effect in 1988. The ultimate objective of the federally and state-mandated UST corrective actions requirements is the cleanup of contaminated soil and ground water associated with leaking USTs. The purpose of the overall Corrective Actions RI/FS project of which the current investigation is an initial element, is to: characterize the nature and extent of any contamination in the soil, ground or surface water which has resulted from leaking UST systems at four (4) separate areas at PBS; evaluate the currently available remedial alternatives for addressing this contamination; and develop a Corrective Actions Plan for the UST sites for managing the associated risks to human health and the environment.

The primary objectives of the current investigation were to compile all the currently available data from the previous and current investigations for each of the four (4) Tank Areas, determine the contaminants present at each Tank Area (and consequently, the contaminants not present), conclude which detected contaminants were logically and physically linked to the reported contents of the former USTs and identify the pathways by which the residual contamination present may spread. A secondary objective of the investigation was to document either the presence or absence of contaminants at each Tank Area so that a more efficient, targeted analytical program could be designed for any future characterization work that may be required.

1.2 Project Background

To comply with the 1988 regulations, twenty (20) USTs at the NASA Lewis Research Center (LeRC) and nineteen (19) USTs at PBS were identified as requiring study under a UST Compliance Program. The tanks were designated for study based on information contained in LeRC and PBS UST inventory listings. In the fall of 1989, three more tanks at LeRC were located, identified, and scheduled for removal. All forty-two tanks contained petroleum products, hazardous spent solvents or unknown products.

A UST Compliance Program was designed by Ebasco Environmental and NASA to assure that the LeRC (which administratively includes PBS) was in compliance with the applicable state and federal regulatory requirements for USTs. As part of implementing

this program, the fourteen (14) tanks at PBS were removed, and UST Closure Assessments were conducted by Ebasco. The locations of these former tank areas are shown in Figure 1-1. Table 1-1 summarizes the principal events of the PBS UST project history. Sampling and monitoring performed during the closure assessments indicated that the tanks had been leaking or that spills had apparently occurred. As a result, a 3-phase Corrective Actions Remedial Investigation / Feasibility Study (RI/FS) for the PBS was developed to characterize the nature and extent of any contamination, and to evaluate the currently available remedial alternatives for addressing the contamination. Phase I was the preliminary characterization effort aimed at describing current conditions at the tank areas. Phase II of the plan was the Remedial Investigation, and Phase III was the Feasibility Study.

Previously, the tank areas were assessed during tank closure activities, and during an initial field program which included limited soil excavation, soil sampling, ground water monitoring well installation, and soil gas surveys. The additional characterization activities performed in this study focus on determining the full nature of the residual contamination, and the potential for off-site migration of contaminants.

1.3 Facility Background Information

The Plum Brook Station is located approximately 4 miles south of Sandusky, Ohio, and covers approximately 6500 acres. Approximately 160 structures, many of them storage facilities, are located at the Plum Brook Station (Environmental Resources Document for NASA Lewis Research Center, May 1983). Much of the facilities at PBS are inactive currently. Activities associated with the four primary areas of investigation during the Phase 1 study are discussed as follows. Building 7131 at the Garage and Maintenance area continues to be used for vehicle and equipment maintenance, and is currently staffed with two to three employees. The remaining buildings in the Garage and Maintenance area, Buildings 7122 and 7121, are not staffed and are not in active use. During the Phase 1 investigation, operations were taking place at the Space Power Facility (SPF) and are expected to continue on an intermittent basis during the near future as various projects are undertaken at the SPF. The pump station, Building 8133, is staffed by two employees currently. The reactor area is inactive currently and no staff is assigned to the area. In total there are approximately 100 people working at the Plum Brook Station, most of whom are not regularly in the four Phase 1 areas of concern.

Acreage within the boundary of the site is primarily unused open space comprised of woodland, brushland and grassland. Approximately 23% of the site is associated with facilities and site operations (Environmental Resources Document for NASA Lewis Research Center, 1990).

The land immediately surrounding the site is used as a rural residential area with homes along the adjacent roadways. Farm fields and open fields with some wooded tracts

account for the remainder of the immediate surrounding properties.

There are 130 ground water well beyond the Plum Brook Station boundary which are within a four mile radius of the site. None of these ground water wells are within 3/4 of a mile of any of the tank areas included in the Phase 1 investigation.

The Plum Brook Station is underlain by lucustrine glacial deposits and consolidated sedimentary rock. The lucustrine deposits are composed of clays and silts. These deposits were settled out of glacial lakes. The lake sediments are approximately 5 to 20 feet thick. Lucustrine deposits are poorly drained (Environmental Resources Document for NASA Lewis Research Center, May 1983).

The bedrock of the area is consolidated sedimentary rock. The regional dip of the strata is easterly, and younger rocks crop out progressively from west to east. The bedrock is limestone in the western part of the facility and shale in the eastern portion. The limestone formations have considerable variation in physical and chemical structure; nevertheless, the limestone has high porosity and makes excellent aquifers. The shale material has little porosity, except for fractures near the surface (Environmental Resources Document for NASA Lewis Research Center, May 1983).

1.4 Previous Investigations

Nineteen (19) USTs at PBS were identified as requiring study under a UST Compliance Program developed by Ebasco in 1989. From late June through December of 1989, fourteen (14) USTs were removed from the PBS in accordance with this program. Table 1-2 identifies the tanks, indicates the areas from which they were removed, and notes the type of material reported to have been stored in each tank given the best available records.

The removal of the USTs included the performance of a closure assessment as required by regulation. In addition, an initial remediation effort was conducted at the Garage and Maintenance Area (Building No. 7132), and soil gas surveys were performed at three of the four tank areas as indicated in Table 1-1. The results of each of these prior investigations is included in the appropriate subsections of Section 3.0.

TABLE 1-1
Summary of PBS UST Activities and Related Events

DATE	ACTIVITY/EVENT
1988, May	New Ohio State UST Regulations Promulgated - O.A.C. 1301:7-7-28 [Ohio Fire Code Article 28, Flammable and Combustible Liquids]
1988, December 22	New Federal UST Regulations Promulgated - 40 CFR Part 280 [Technical Standards and Corrective Action Requirements for Owners and Operators of Underground Storage Tanks]
1989, June 13	NASA Meets with Ohio State Fire Marshal's Office, Bureau of Underground Storage Tank Regulation (BUSTR) to Discuss Compliance with State and Federal UST Regulations
1989, June	NASA Receives Permit from BUSTR to Remove Three USTs at the PBS
1989, June 28 - July 5	Underground Storage Tanks 7132-1 (#33), 7132-2 (#34), 7132-3 (#35) are Removed from the Garage and Maintenance Area - Closure assessment (including soil, ground water and surface water sampling and analysis) performed
1989, July	UST Compliance Program Developed for PBS - Program outlined the UST removal and/or replacement options available to NASA to comply with the new regulations over a 3-year period
1989, August	Monitoring wells installed at the Garage and Maintenance Area
1989, August	Closure Assessment Report for PBS USTs #33, #34 and #35 is Finalized
1989, September	Underground Storage Tanks 7121-1 (#28), 7121-2 (#29), 7121-3 (#30), 7121-4 (#31), 7131-1 (#32) are Removed from the Garage and Maintenance Area - Closure assessment (including soil sampling and analysis) performed

TABLE 1-1 (continued)

DATE	ACTIVITY/EVENT
1989, September	Underground Storage Tank 8133-1 (#39) is Removed from the Pump Station Area - Closure assessment (including soil sampling and analysis) performed
1989, September	Underground Storage Tanks 1411-1 (#24) and 1411-2 (#25) are Removed from the Space Power Facility - Closure assessment (including soil sampling and analysis) performed
1989, September	Preliminary Remediation Effort Undertaken at the Garage and Maintenance Area - 1,320 cubic yards of soil removed
1989, October	BUSTR Directs Further Removal of Soil from the Tank Pit at the Garage and Maintenance Area - 18 additional inches of soil is removed
1989, October 18 - 25	Soil Gas Surveys are Conducted at the Garage and Maintenance Area, the Pump Station Area and the Space Power Facility Area
1989, December	Closure Assessment Report for PBS USTs #24, #25, #28, #29, #30, #31, #32 and #39 is Finalized
1989, December	Underground Storage Tanks 1131-1 (#21), 1131-2 (#22) and 1131-3 (#23) are Removed from the Reactor Building Area - Closure assessment (including soil sampling and analysis) performed
1990, January	Revised NASA UST Compliance Program is Finalized
1990, May	Regulatory Jurisdiction for the PBS USTs is Turned Over to the OEPA Northwest District Office by BUSTR Because of Evidence of Hazardous Waste Contamination From Some of the USTs Removed

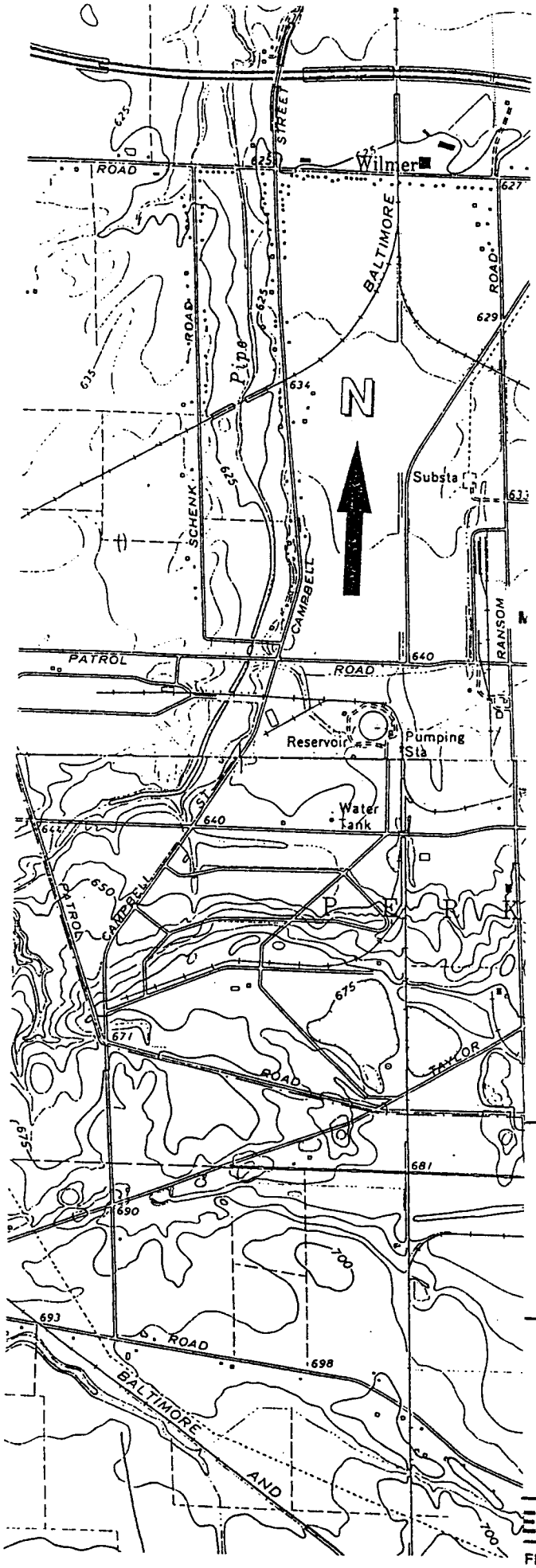
TABLE 1-1 (continued)

DATE	ACTIVITY/EVENT
1990, May	Closure Assessment Report for PBS USTs #21, #22 and #23 is Finalized
1990, June 12	Ebasco Submits Draft Work Plan for the PBS UST Corrective Actions RI/FS to NASA for Review
1990, August 9	Ebasco Submits Final Work Plan for the PBS UST Corrective Actions RI/FS to NASA
1990, September 25	NASA Submits Work Plan for the PBS UST Corrective Actions RI/FS to the Ohio EPA for Review and Concurrence
1990, October 5	Ebasco Begins Work on the First Phase of the Corrective Actions RI/FS Project to Characterize the Current Conditions at the Former UST Areas - Monitoring wells installed at all areas - Soil, ground water and sediment samples analyzed

TABLE 1-2

PBS USTs Removed During the 1989 Calendar Year

Location	No. of Tanks	Capacity (Gallons)	Contents
Garage and Maintenance Area:			
Building 7121	1	3,000	waste oil and solvents
	3	700	acetone, TCE, and TCA, respectively
Building 7131	1	1,500	waste oil
Building 7132	3	9,000	gasoline
Space Power Facility:			
Building 1411	2	1,000	waste oil
Pump Station:			
Building 8133	1	750	gasoline/diesel
Reactor Area:			
Building 1131	2	7,900	gasoline/diesel and fuel
	1	500	waste oil and solvents



NASA PLUM BROOK STATION

UNDERGROUND STORAGE TANK CORRECTIVE ACTIONS REMEDIAL INVESTIGATION/FEASIBILITY STUDY: PHASE I

Locations of the Four Former Underground Storage Tank Areas at the NASA Plum Brook Station

EBASCO ENVIRONMENTAL | SCALE: 1"=2000'

FROM USGS SANDUSKY & KIMBALL, OHIO 7.5 MINUTE QUADRANGLE TOPO MAPS

FIGURE 1-1

2.0 ASSESSMENT METHODOLOGY

2.1 Overview of the Phase I Field Investigation Program

This section details the sampling locations and describes the sampling methods which were used during the Phase I field investigation, which started in November 1990 and continued into May 1991. The following sections outline the procedures which were used and the locations of samples collected during each portion of the field program. The field activities involved in the Phase I field investigation included soil borings and sampling, well installation, ground water sampling, and sediment sampling.

2.1.1 Sample and Sample Location Identifiers

All of the field samples and the sampling locations in the Phase I field investigation are identified by a standard nomenclature. The location identifiers (IDs) have three segments to the character string, while the sample identifiers have the same three segments and a fourth segment indicating the sample medium. Both the location and sample IDs have as the first segment of the identifier PBS, indicating Plum Brook Station. Both also have as the second portion of the identifier an area code, either GM (Garage and Maintenance Area), SP (Space Power Facility), PS (Pump Station), or RA (Reactor Area). During the previous closure assessments the four digit building number, such as 1411 for the Space Power Facility, was used as the location code. Following the area code, the field samples have a segment identifying the sample medium, either SB (soil boring), GW (ground water), or SS (sediment). Both the sample and location identifiers end in the sequential number assigned to each location in each area of concern. An example of a location code would be PBS-GM-06, denoting the sixth boring location at the Garage and Maintenance Area. An example of a sample code would be PBS-RA-SB-04, denoting a soil boring sample at the fourth boring location at the Reactor Area.

2.1.2 Soil Borings and Monitoring Well Installations

Soil borings were completed at 23 locations at the four different UST areas of concern at the Plum Brook Station. Of these 23 soil borings, 20 were completed as ground water monitoring wells. Although it was expected that 22 of the 23 soil boring locations would be completed as wells, two locations were not completed as wells because of a lack of ground water. The boring log for each location can be found in Appendix E.

All of the well casing materials, including screens, risers and bottom caps, was 304 stainless steel. A sand pack of #5 Medium Blast sand was poured around the screened portion of each well. A bentonite seal was then placed above the sand pack to prevent infiltration. All of the wells were then finished with a concrete base and an above ground

aluminum well protector. Well logs with well construction diagrams and elevations can be found in Appendix F. As the final part of the well installation and prior to the ground water sampling, each of the 20 monitoring wells was developed. Well development consisted of removing from 4 to 5 well volumes with a hand bailer.

2.1.3 Subsurface Soil Sample Collection

Hollow stem auger drilling, using 4 1/4" augers, was used to complete all of the soil borings during the Phase I field effort. Continuous split spoon sampling was performed during the drilling at each boring location. The split spoons used were 24" in length and 2" in diameter.

The split spoon samples were scanned with a photoionization detector (PID) and any readings above background levels were noted. The recovery, composition, consistency, and color of the soil samples were recorded in the field log book and are reported in the boring logs in Appendix E.

A portion of each split spoon sample was placed in a stainless steel bowl to be composited and then placed in sample containers for transport to the analytical laboratory. The exception to this routine involved the collection of the volatiles sample. One split spoon was selected between 5 feet and 15 feet below the ground surface to be the volatiles sample. The depth at which the volatiles sample was taken was determined by scanning with the PID for elevated levels of volatiles. The sample containers for the volatiles analysis were immediately filled and sealed after the split spoon was opened and scanned with the PID.

Prior to setting up at each boring location, the split spoons and drilling equipment, including augers, rods, drill bit and tools, were decontaminated. A portable steam washer was used to decontaminate this equipment. Potable water was used for the steam wash. No solvents were used during the decontamination process.

2.1.4 Ground Water Sample Collection

Ground water sampling was conducted at one background location and one contaminated location for each of the four areas for a total of eight unique ground water samples. The schedule below lists the wells that were sampled at each area and also denotes whether the well was considered to be a contaminated location or a background location prior to sampling:

TANK AREA	PRESUMED BACKGROUND LOCATION	PRESUMED CONTAMINATED LOCATION
Garage and Maintenance Area	PBS-GM-02	PBS-GM-06
Space Power Facility	PBS-SP-01	PBS-SP-06
Pump Station	PBS-PS-04	PBS-PS-02
Reactor Area	PBS-RA-01	PBS-RA-04

Each of the eight wells sampled was purged of three well volumes prior to taking the ground water samples. Both the well purging and the sampling was done with a stainless steel bailer which was decontaminated prior to use at each monitoring well. The bailers were disassembled and washed in a solution of distilled water and trisodium phosphate, and then rinsed with distilled water. No solvents were used during the decontamination of the bailers.

2.1.5 Sediment/Surface Water Grab Sample Collection

Five sediment samples were collected as part of the field investigation. Two samples each were collected at the Garage and Maintenance Area and the Space Power Facility, and one was collected at the Pump Station. All of the samples collected were sampled from the drainage channels near the former tank locations. As there were no drainage channels near the former tank locations at the Reactor Area, no sediment sample was collected at that area. The sediment samples from other areas were collected using a stainless steel trowel and were placed in the sample jars for transport to the laboratory.

2.1.6 Sample Shipment and Chain of Custody

All of the field samples collected, including subsurface soils, ground water and sediment, were submitted to Hittman Ebasco for laboratory analysis. Chain of custody forms were submitted to the laboratory with each set of samples submitted. Chain of custody forms included each sample identifier, the sample matrix, the required analyses, and sample collection date. Samples were submitted via an overnight delivery service on a daily basis and were received by the laboratory within 24 hours of shipment. Samples were logged in at the lab and the chain of custody forms were returned. Chain of custody forms are included in Appendix G.

2.1.7 Ground Water Level Measurements

Two rounds of ground water level measurements were taken. The first set of ground water level measurements was taken during well development in January 1991. The

second set of measurements was taken on May 9, 1991 to get a second set of data for determining ground water flow characteristics. An electronic ground water level indicator was used both times to obtain the water levels relative to the top of the well casings. These data along with the surveying information provided by the NASA Facilities Engineering Division were used to assess ground water flow at the four former UST areas.

2.2 Overview of the Data Evaluation Process

2.2.1 Laboratory Data Quality Assurance and Quality Control

All of the samples collected during the Phase I field program were analyzed by Hittman Ebasco Associates. All analytical laboratory data was generated using Data Quality Objective (DQO) Level 4. This level requires full laboratory analytical procedures in accordance with USEPA recognized quality control. Since the primary use of Phase I data, at this time, is to focus Phase II, DQO Level 4 was not employed for independent data validation of data from the laboratory. Data validation was performed by the laboratory in accordance with Contract Laboratory Protocols (CLP) and independent data validation can be completed in the future to qualify the data for use in the risk assessment.

All of the field samples, duplicates and field blanks were analyzed for the Target Compound List (TCL) volatiles, semivolatiles, and pesticides/PCBs and Target Analyte List (TAL) metals and cyanide and Total Petroleum Hydrocarbons (TPH). Trip blanks were analyzed for TCL volatiles. The TCL/TAL analyses were completed following USEPA Contract Laboratory Protocols (CLP) for laboratory data quality standards. The TPH analysis was performed in accordance with EPA method 418.1. The laboratory results for the TCL/TAL analyses were reported following stringent quality requirements for laboratory blanks and laboratory data validation. The laboratory sample data reporting forms (Form 1) are shown in Appendix H for each sample. A number of samples were reanalyzed due to inconsistencies in lab quality control, such as matrix spike recoveries out of the acceptable range. For samples that had more than one sample result both sample results were reported.

Following the TCL volatiles and semivolatiles analysis Hittman Ebasco conducted a library search to identify Tentatively Identified Compounds (TICs). Numerous TICs were identified for various samples and these TICs are shown on the Form 1 for each sample in Appendix H. The TICs were not considered in the analysis of the Phase I data for various reasons, first the very nature of TICs, i.e. compounds that are tentatively identified, makes them very suspect, also according the Hittman Ebasco representatives TICs can often be an indication of natural background hydrocarbons, related to this is the fact that no correlation was found between the TICs and compounds suspected to be

stored in the removed underground storage tanks.

The Contract Required Quantitation Limits (CRQL) for TCL/TAL analyses as set forth in the CLP were met for the field samples and QA samples during the Phase I operations. Soil sample results from Hittman Ebasco were reported on a wet weight basis as CLP requires, because of this the soil samples results have slightly varying quantitation limits due to variations in moisture content of the various soil samples. This is not unusual with soil samples because of the varying soil characteristics and water content of each unique sample. Sample quantitation limits that vary greatly from the CRQL are a result of sample dilution due to elevated levels of contaminants in the sample.

2.2.2 Analytical Results for Organic Compounds

The results of analyses for organic compounds in the soil, ground water and sediment samples taken at the site during past studies and the current investigation have been compiled and presented for each Tank Area in Section 3. In general, the set of organics analyzed for in the past studies varied somewhat between studies and across the Tank Areas. Consistent analyses were performed for all samples taken during the current investigation. In this Report, results for all detected and undetected (but tested for) organics have been presented as they appeared in the earlier original study reports. Contaminant data from the previous investigations were summarized in a manner chosen to best convey the nature and extent of any organics contamination present in a manner consistent with the number of samples taken, the analyses performed on those samples, and the quality of the data.

The organics data from the current investigation related to Volatile Organic Compounds, semivolatile organic compounds (B/N/A extractables), pesticides, polychlorinated biphenyls (PCBs), and Total Petroleum Hydrocarbons (TPH). With very few exceptions, the organic compounds analyzed for in the soil, ground water, and sediment samples are not naturally occurring at levels detectable by standard techniques. As such, finding such a compound in a sample at a concentration above the detection limit is indicative of anthropogenic contamination. All detected organics were, therefore, highlighted in this Report. A notable exception to this generality may be the Total Petroleum Hydrocarbons. Natural oil-bearing shales and limestones are present in the PBS area. The soil borings conducted for the current investigation encountered shale bedrock beneath two of the Tank Areas (areas where the borings were terminated at the bedrock). It is possible that rock samples from these areas may contain some detectable concentration of natural TPH. However, the soil samples taken from the borings made for the current investigation consisted of the overburden material (either naturally occurring or fill) which would not be expected to have detectable TPH content. As such, the TPH detected in the current overburden samples was generally taken to be indicative of UST leakage or spills especially if concentrations exceeded about 40-50 mg/Kg.

The procedure used to compile and review the analytical data generated during the current investigation involved the following:

1. The raw data sheets from the laboratory were examined and the data was compiled into a series of comprehensive data tables. A data table was constructed for each Tank Area/environmental medium combination. This amounted to a total of 15 major tables, representing the results of soil, ground water, and sediment testing at each of the four areas (except for sediments at the Reactor Area), and four tables showing the results of the trip blanks and the soil, ground water, and sediment field blanks. These tables are included as Appendices A (soil results), B (ground water results), C (sediment results), and D (blank results). A separate table was constructed for each Tank Area within Appendices A, B and C, with Table 1 pertaining to the Garage and Maintenance Area, Table 2 to the Space Power Facility, Table 3 to the Pump Station and Table 4 to the Reactor Area. Each appendix table contains the results of each analysis or reanalysis performed for every sample in that Tank Area, and includes all analytes, whether or not they were detected. Undetected results were noted by the appropriate quantitative detection limit and the "U" qualifier. Each appendix table lists the analytical results in the following order: volatile organic compounds, semivolatile organic compounds, pesticides/PCBs, metals, cyanide, and TPH. The identification number, type, depth of collection and date of collection also are noted for each individual sample.

2. The full set of data for each Tank Area was examined with respect to QA/QC, observation of contamination in blanks, and identification of possible laboratory contaminants. This review included direct discussions with the laboratory. Based on this review and analysis, six organic compounds were identified to be probable laboratory contaminants (Methylene Chloride, Acetone, Carbon Disulfide, bis (2-Ethylhexyl)phthalate, Butylbenzylphthalate and Di-n-Octylphthalate) and one pesticide (Endosulfan Sulfate) was determined to be spurious due to its general presence in the blanks. These compounds were not further considered in relation to UST contamination.

3. The reviewed data on organics were summarized in both graphical and tabular form for each Tank Area. Contaminant maps were developed which identified where the various contaminants were detected at each area and at what concentration. A separate contaminant map was developed for the soil, ground water, and sediment data for each area. These are presented and discussed below. The identified laboratory and blank contaminants were not included on these contaminant maps. Secondly, summary tables of the organics detected at each tank area were compiled. These tables list all detected organics and identify the maximum

concentration of each compound detected in each of the three environmental media and at what frequency they were detected (e.g., 3/7 representing detections in 3 out of 7 samples taken in that medium at that Tank Area). These summary tables also are presented and discussed in Section 3.

2.2.3 Analytical Results for Inorganic Compounds

Inorganics were not analyzed in any of the prior investigations, but were analyzed during the current investigation. Metals may have been associated with the USTs, in that metal complexes have historically been added to fuels and lubricating oils, to enhance their performance. Examples include zinc, barium, nickel, lead, and vanadium. Waste solvents may also have become contaminated with metals through physical or chemical reaction mechanisms. These inorganics represent possible contamination from the former fuel, waste oil, and waste solvent USTs.

Unlike the vast majority of the organics tested for, the inorganics are naturally occurring in soils. Many of these inorganics, however, are not associated with significant health risks in connection with a broad range of soil concentrations and plausible exposures, and others are actually required by the body. As such, detection of an inorganic in a soil sample is not automatically a concern. The natural presence of inorganics in soils dictates that some criteria be developed for judging if the level of the inorganic detected is significantly greater than naturally occurring levels. Frequently, the "background" concentration is used as this criterion. As the natural background level of an inorganic typically varies by 2 or 3 orders of magnitude, depending on where in the United States the soil is, a measurement of local background concentration is required for making judgments about possible anthropogenic sources of inorganics contamination.

As was previously noted, a set of the soil borings were located in areas thought not to be influenced by the contamination from the leaking USTs. Two locations were chosen from each of the four Tank Areas. However, upon review of the laboratory results of the soil analyses from these samples, four of the eight samples were found to contain organics contamination (PBS-GM-SB-02, PBS-PS-SB-01, PBS-PS-SB-04, PBS-SP-SB-02). As organics contamination could be linked to inorganics contamination, the four samples showing organics contamination were not considered in calculating the local background inorganics concentration statistics used in this Report. The concentrations measured in the remaining four samples (PBS-GM-SB-01, PBS-RA-SB-01, PBS-RA-SB-06, and PBS-SP-SB-01) were used to characterize the local background inorganics concentrations for this study.

In keeping with the newly established OEPA "How Clean is Clean Policy" (OEPA, July 26,1991), the following equation was used to calculate "Upper Confidence

Limits" (UCLs) as criteria to compare to on-site inorganic concentrations to dtermine if they are statistically greater than background:

$$X + k(a)$$

where, X = mean background concentration of compound
a = relative standard deviation of background data
k = tolerance factor.

These are shown for inorganics in Table 2-1. When available, Table 2-1 also shows two other criteria with regard to the inorganics. The first was published ranges of natural soil inorganics concentrations for the United States. As has been noted, these ranges are characteristically wide, displaying significant regional variability. The second criteria examined was the Soil Clean-Up Criteria being enforced by the State of New Jersey. While these criteria are not enforceable in Ohio, they provide an indication of the cut-off levels of inorganics that have been used as soil remediation targets in other places. The State of Ohio currently has not established criteria for inorganic clean-up in soils.

Taken together, the method used to evaluate the analytical results for inorganics in the soils from the current investigation was to (refer to Table 2-1):

1. Establish the "local background" concentration of each inorganic tested for by averaging the four background samples and calculating their standard deviation.

2. Calculating the OEPA criteria for comparison to background (i.e., the UCLs).

3. Compare the measured inorganics concentrations from each soil sample to the UCL determined in Step 2. If this concentration was not exceeded, determine that no problem was indicated. If this concentration was exceeded, proceed to Step 4.

4. Determine if the inorganic exceeding the UCL is a natural nutrient or element not typically of concern for health reasons. If the inorganic is not typically considered a health risk in soils at these levels, determine that no problem was indicated. If the inorganic did not fall into one of these two categories, proceed to Step 5.

5. Compare the sample concentration to the United States background range and the New Jersey Soil Clean-Up Criteria (when these criteria exist). Determine whether the measured concentration fell outside the United States range or exceeded the New Jersey criteria. If it did neither,

determine that no problem was indicated, otherwise, flag the inorganic and location as a possible concern.

The results of applying this sequential data analysis approach to the information collected during the current investigation is reported for each Tank Area in Section 3.

2.2.4 Ground Water Level Contours

The two sets of monitoring well ground water level measurements, taken in May and January, were combined with the wellhead surveying data to generate ground water contour maps for each Tank Area. Separate contour maps were drawn for May and January for each location. These maps showed the apparent local ground water flow patterns at each Tank Area, including the influence of existing structures and topography.

In addition, the May ground water level measurements from each Tank Area were combined to create an overall PBS ground water contour map. This map depicts the overall site ground water flow direction, when local influences are netted out. The ground water contour maps for each Tank Area and time of year, as well as the overall site contour map, are presented and discussed in Section 3.

2.2.5 Boring Logs and Well Logs

Field measurements and observations during the installation of the boreholes and monitoring wells in the current investigation were used to develop the Boring Logs and Well Logs contained in Appendices E and F, respectively. This information was used to develop a general characterization of the soils and near surface stratigraphy at each of the four Tank Areas. These descriptions are presented and discussed in Section 3.

TABLE 2-1
Criteria Used for Comparisons
of Inorganics in Soils to Background Levels

INORGANICS	Mean Conc. in Bkgd. Samples (n=4) (mg/Kg)	Standard Deviation	k Tolerance Factor	OEPA Criteria Mean + k x s.d.	Range of U.S. Bkgd. Conc.(1) (mg/Kg)	New Jersey Soil Cleanup Criteria(1) (mg/Kg)
Aluminum	9845	3650	5.145	28624.25	NA	NA
Antimony	1.83	0.08	5.145	2.24	NA	NA
Arsenic	6.53	2.65	5.145	20.16	1.1-16.7	20
Barium	79.8	42.6	5.145	298.98	NA	400
Beryllium	0.46	0.04	5.145	0.67	1-7	NA
Cadmium	2.48	0.95	5.145	7.37	0.01-1	3
Calcium (N)	16165	8380	5.145	59280.10	NA	NA
Chromium	16.1	4.51	5.145	39.30	1-1500	100
Cobalt	11.1	6.7	5.145	45.57	NA	NA
Copper	18	5.4	5.145	45.78	2-200	170
Iron (N)	25075	9036	5.145	71565.22	NA	NA
Lead	9.95	3.16	5.145	26.21	2-200	250-1000
Magnesium (N)	5630	1728	5.145	14520.56	NA	NA
Manganese (N)	590	478	5.145	3049.31	NA	NA
Mercury	0.11	0.007	5.145	0.15	0.01-4.8	1
Nickel	33	20.36	5.145	137.75	3-550	100
Potassium	964	597	5.145	4035.57	NA	NA
Selenium	3.82	5.3	5.145	31.09	0.01-6	4
Silver	0.63	0.05	5.145	0.89	0.01-5	5
Sodium (N)	585	270	7.655	2651.85	NA	NA
Thallium	0.86	0.04	5.145	1.07	NA	NA
Vanadium	26.5	12.1	5.145	88.75	NA	NA
Zinc	59	24.4	5.145	184.54	10-3000	350
Cyanide	1.23	0.08	5.145	1.64	NA	NA

NOTES

NA Not Available

(N) Nutrient / Not of Health Concern under These Conditions

(1) NJDEP, Summary of Approaches to Soil Cleanup Levels, Table 1

3.0 SITE CHARACTERIZATION FINDINGS

This section summarizes the studies conducted at each of the four tank areas, presents the results of the studies, describes the contamination observed and the potential pathways for contaminant migration. The locations of the four former PBS UST Areas are shown on Figure 3-1.

For purposes of gaining some perspective on ground water flow, the theoretical Darcy's Law flow velocity was calculated for the overburden aquifer using the measured ground water level gradients and the theoretical hydraulic conductivity values for the soil units encountered at each Tank Area (a maximum of 10^{-5} meters per second for fine sand to a minimum of 10^{-13} for clay, silt, or glacial till). It must be highlighted that the hydraulic conductivities used were characteristic published values reported to correspond to the standard soil types encountered. No Tank Area-specific hydraulic conductivity (aquifer) tests were conducted. As such, the calculational results must be considered to be illustrative at best. Taking the maximum theoretical hydraulic conductivity for the various soil units observed to be present at each Tank Area, the maximum horizontal ground water flow velocities associated with the January and May 1991 were calculated as

$$V_{df} = [K (h_1 - h_2)]/L$$

where,

V_{df}	=	Darcy's Flow Velocity
K	=	Theoritical hydraulic conductivity
$(h_1 - h_2)$	=	Difference in hydraulic head
L	=	Distance along the flow path between the points where h_1 and h_2 were measured.

It must be emphasized that this estimate is based on the theoretical performance of a homogeneous water-bearing layer consisting entirely of the most transmissive soil type. This would generally be expected to be conservative, or leading to flow velocities higher than what might actually be observed. All of the boreholes exhibited multiple soil units, and many of these units are reported to have characteristic hydraulic conductivities many orders of magnitude lower than the value used to scale the maximum flow velocity. These factors would indicate that horizontal flow velocities in undisturbed areas (i.e., areas with no buried utility lines, building foundations, or other preferential pathway structures) would be lower than the calculated values. On the other hand, a coarse gravel utility trench or roadbed would be expected to allow for faster ground water migration along its length. These preferential migration rates typically would be many times larger than the theoretical Darcy Law rates that were calculated.

The ground water flow direction and velocity in the bedrock aquifer have not been investigated.

3.1 Garage and Maintenance Area

A total of eight (8) USTs were removed from the Garage and Maintenance Area. The former UST locations are shown in Figure 3-2.

On July 5, 1989, the permanent closure-by-removal of three 9,000 gallon steel USTs was performed at Building No. 7132. These three tanks (7132-1 (#33), 7132-2 (#34) and 7132-3 (#35)) had previously contained petroleum fuels. Gasoline was stored in Tanks 7132-1 and 7132-2, and diesel fuel was stored in 7132-3. All three tanks were installed in 1942. Tank 7132-2 was in service until the week prior to removal. Tanks 7132-1 and 7132-3 had been taken out of service earlier due to suspected leakage. The tanks were removed in order to comply with a notice from the State Fire Marshall's Office.

Tanks 7121-2 (#29), 7121-3 (#30) and 7121-4 (#31) were removed on September 18, 1989. Each 700-gallon steel tank was installed in 1964 and contained solvents. When inventoried prior to removal, they were all found to contain water.

Tank 7121-1 (#28) had a 3,000 gallon capacity, and was installed in 1942. This steel tank was reported to contain waste oil and solvents until it was removed on September 18, 1989.

Finally, Tank 7131-1 (#32), located north of Building No. 7131, was excavated on September 18, 1989. Prior to its removal, the 1,500 gallon steel tank was used to store waste oil and solvents.

3.1.1 Previous Investigations and Results

The activities conducted at the Garage and Maintenance Area have included UST closure assessments, the installation of ground water monitoring wells, an initial remedial effort, and a soil gas survey. These efforts are reviewed below.

3.1.1.1 UST Closure Assessments and Initial Remediation Efforts

During the UST removal operations, closure assessments were performed. This assessment included a visual site inspection, soil and water sampling, and inspection of the tanks after removal. The tanks were inspected by the Ebasco representative onsite and by John Graves of the Inspection Division of the State Fire Marshall's Office.

Tanks 7132-1 (#33), 7132-2 (#34) and 7132-3 (#35)

The three (3) USTs adjacent to Building No. 7132 were located in a common pit in a

grassy area just west of the large paved area. The visual inspection yielded no evidence of spillage in the grass, and evidence of only minor spillage at the Pump Island and on the surrounding asphalt.

Several areas of corrosion were noted on each tank. Tank 7132-3 (#35) had a hole in it at the seam at the top of the vent end of the tank. A dark area with a sheen was noted in the soil about five feet west of the fill end of Tank 7132-1 (#33).

Soil samples were taken from the bottom of the tank pit, as well as from the piles of excavated soil and from beneath the Pump Island that was adjacent to these tanks. In general, three samples were taken from the bottom of the tank pit for each removed tank: one from the end where the tank's fill connection was; one from the end where the tank's vent was; and one at a point between these two. In the case of Tank 7132-1 (#33), the vent end sample could not be collected as the wall of the excavation had collapsed. One soil sample also was taken from each of the four piles of soil removed from the pit. A soil sample was taken from the area beneath the Pump Island.

Soil samples were also taken during the installation of the four boreholes that were subsequently completed as monitoring wells. Two samples were analyzed from each boring, one from the capillary fringe and another from the saturated layer at the top of the aquifer.

These sampling locations are identified on Figure 3-3. All soil samples were analyzed for the BTEX (Benzene, Toluene, Ethylbenzene and Xylene) compounds and Total Petroleum Hydrocarbons (TPH). The samples taken from the excavated soil piles were also analyzed for ignitability and EP Toxicity lead. The results of these soil analyses are presented in Table 3-1.

Surface water and liquid samples also were taken and analyzed from this area. The first sample was taken of the water collected in the pit on the day of the tank removal. This water exhibited a noticeable oily sheen. The second sample, taken a week later, was of a rust-colored seep mixture of water and soil from the east end of the Tank 7132-3 pit. Shortly thereafter, two additional surface water samples were taken from the pit areas associated with Tanks 7132-1 and 7132-3, as shown on Figure 3-3. The surface water samples were analyzed for the BTEX compounds and TPH. The results of these surface water analyses are presented in Table 3-2.

Ground water samples were taken from the four monitoring wells that were installed. Figure 3-3 also shows the locations of these wells. The ground water samples were analyzed for the BTEX compounds and TPH. The results of these analyses are presented in Table 3-3.

The combined results indicated that contamination was present in the pit bottom, the gathered surface water, and in the soil beneath the Pump Island. Small amounts of

contamination were detected in the soils excavated from the pits. These excavated soils all had EP Toxicity results <500 ug/L Lead and Flashpoints greater than 200°F. Of the samples collected from the soil borings, the results indicated slightly elevated levels of BTEX in Boreholes 1 and 3, and lower concentrations of contaminants in Boreholes 2 and 4. The ground water results showed elevated levels of BTEX only in Monitoring Well 1, no levels above the detection limits for BTEX in the other wells, and <1.0 mg/L TPH in all of the wells.

Based on the soil and ground water sampling associated with the closure assessment, it was determined that additional soil had to be removed from the tank pit, given the level of contamination remaining. Soil in the tank pit was scanned with a photoionization detector to determine how much soil should be removed and from what locations. Additional soil was removed from around the former location of the Pump Island, the tank pit walls and the tank pit floor. The depth of the excavation in the area of the tanks following this soil removal was approximately 13 feet.

Soil samples were again collected from the bottom of the tank pit upon completion of this excavation. Six soil samples were collected in the area beneath the former tanks and six samples were taken from the area east of the tanks in the area of the Pump Island, as shown in Figure 3-4. These samples were analyzed for Benzene, Toluene, Ethylbenzene, Xylene and TPH. The laboratory analysis results are shown in Table 3-4. These samples had undetectable or low levels of these contaminants with the exception of sample 7132-SS-2 which was taken from the center of the tank pit. Sample 7132-SS-2 had a Benzene concentration of 420 ug/Kg. After discussion with the Ohio State Bureau of Underground Storage Tank Regulation it was determined that an additional 1-1.5 feet of soil should be removed from the tank bottom before the excavation was backfilled. This additional excavating was completed and the tank pit was backfilled.

Tanks 7121-1 (#28), 7121-2 (#29), 7121-3 (#30) and 7121-4 (#31)

Three soil samples were taken from the bottom of the pit from which Tank #28 was pulled, and two samples of the excavated soil were analyzed. All five samples were analyzed for Volatile Organic Compounds (VOCs) and TPH. The excavated soil samples also were tested for EP Toxicity lead and ignitability. The sample locations for Tank #28 are shown on Figure 3-5. Two soil samples were taken from the bottom of the pit from which Tanks #29, #30 and #31 were pulled and two samples of the excavated soil from this pit were analyzed. All four soil samples from this area were analyzed for VOCs and TPH, while one sample of the excavated soil and the sample taken from the south wall of the tank pit were also analyzed for EP Toxicity lead and ignitability.

The results of these analyses are shown in Table 3-5. In general, the soils associated with Tank #28 were found to be contaminated with a greater number of compounds and at higher concentrations than the soils at Tanks #29, #30 and #31. The soils from Tanks #29, #30 and #31 showed concentrations of 1,1,1-Trichloroethane and Trichloroethene at

levels of hundreds of ppb, with several other compounds at the tens of ppb level. The soils associated with Tank #28 showed highly elevated levels of a number of compounds. Trichloroethene and Tetrachloroethene were reported at tens of ppm levels; Toluene was at the 1 ppm level; and nine other organics were reported at concentrations of hundreds of ppb. Thirty different organics were detected in the Tank #28 soils while twenty four were detected in the Tank #29, #30 and #31 soils at a lower frequency. The maximum TPH concentrations in the samples for these two areas were nearly identical, at 284 and 287 ppm, respectively. EP Toxicity concentrations for lead were all below the detection limit and no soil sample exhibited a Flashpoint less than 200°F.

Tank 7131-1 (#32)

Three soil samples were taken from the bottom of the pit from which Tank #32 was pulled, and two samples of the excavated soil were analyzed. All five samples were analyzed for VOCs and TPH. The excavated soil samples also were tested for EP Toxicity lead and ignitability. The sample locations for Tank #32 are shown on Figure 3-6. The results of these analyses are shown in Table 3-6.

There were no visible signs of contamination during excavation of the tanks. Laboratory analysis of the soil samples indicated low levels of contamination, at less than ppm levels, were present. Elevated concentrations of trichloroethene were found in each of the five samples. Elevated levels of total petroleum hydrocarbons were found in each sample except for one collected from the excavated soil. Sixteen different compounds were detected at ppb levels in these soils.

3.1.1.2 Soil Gas Survey

In October, 1989, a soil gas survey was conducted at the Garage and Maintenance Area. The survey encompassed the area around Building Nos. 7121, 7122, 7131 and 7132. A total of 76 soil gas samples were collected and analyzed from this area. Numerous underground utilities cross the study area. Underground utilities are often packed in gravel beds or other highly permeable fill beds which can provide a preferential conduit for liquid and vapor migration. As such, the locations of the known underground utilities were considered when determining the soil gas sampling locations. Also considered were the building foundations and surface topography.

Soil gas samples were collected in the following manner. A solid steel probe was advanced 3 to 4 feet into the ground and then withdrawn. A sampling probe with a slightly larger diameter was then advanced 2 feet into the hole. Gas was purged from the sampling probe using a hand-operated vacuum pump. A sample was then collected from the top of the sampling probe upstream of the vacuum pump. A 1.0 ml sample was extracted, injected into a portable gas chromatograph (GC), and analyzed. The GC was calibrated to quantify Dichloroethene (DCE), Benzene, Trichloroethene (TCE), Toluene,

Tetrachlorethene (PCE), and Xylene. All concentrations were reported in microliters of analyte vapor per 1,000 liters of air (parts per billion (ppb)).

The results of the soil gas survey are shown in Table 3-7. Figures 3-7 and 3-8 show the sampling locations, compounds detected and the compound concentrations. Figure 3-7 highlights the relative distribution of the fuel-related compounds while Figure 3-8 focuses on the distribution of detected organic solvent materials. Most of the areas sampled showed measurable levels of one or more of the target compounds. The highest concentrations detected were found near former UST locations, along building foundations, roads, railroad tracks or along buried utility lines. A more area-specific summary is presented below for each Tank Area.

Building No. 7121

Two sampling locations at the southeast corner of Building No. 7121 (7121-7 and 7121-8) contained the highest levels of solvents detected at the Garage and Maintenance Area. These points are near two areas east of Building No. 7121 where four tanks containing waste oil and solvents were removed. The area east of Building No. 7121 exhibited the highest levels of fuel products found at the Garage and Maintenance Area. In general, all sides of Building No. 7121 exhibited some level of contamination from fuel products and solvents. This may be due to migration from one or more sources, or to numerous surface spills.

A pattern of TCE contamination is evident in samples 7121-4,6,7,8 and 11 as seen on Figure 3-8. Sample 7121-4 had the highest concentration of TCE, 9500 ppb. Samples 7121-6,7,8 and 11 also had soil gas concentrations of TCE above 670 ppb. Lower concentrations of contamination, both from fuel products and solvents, were found in the grassy areas east and west of Building No. 7121 and under the parking lots north and south of Building No. 7121, with concentrations ranging from 250 to 5 ppb. Concentrations of this magnitude combined with the sporadic detections and concentrations of any given analyte are indicative of low-level soil or ground water contamination.

The discovery of relatively high levels of both fuel product and waste solvent contamination along the entire east end of Building No. 7121 on either side of the former tank locations suggest a zone of relatively permeable soil in this location or the presence of preferential pathways in the North-South direction. An examination of the underground utilities in this area (refer to NASA Drawing No. PF-65180) reveals the presence of the Garage Road roadbed, an 8" sanitary sewer line, and two 6" fire water supply lines running right through this area. These structures and features could be serving as preferential migration pathways for the movement of these soluble contaminants in ground water. The foundation of Building No. 7121 and the railroad bed north of the Building may be acting to distribute the east side contamination all around the Building.

Building No. 7131

One UST containing waste oil was removed from the north side of Building No. 7131. The results of ten of the twelve soil gas samples taken in the area of the removed tank, showed no target analytes, fuel products or solvent compounds, above the detection limits (see Figures 3-7 and 3-8). Samples 7131-1 and 7131-5 indicated contamination from fuel products, with total hydrocarbon concentrations of 270 ppb and 86 ppb, respectively.

Building No. 7132

Three USTs, containing gasoline and diesel fuel, were removed from the area west of Building No. 7132. Two samples (7132-3 and 7132-4) near the tank pit indicated contamination from fuel products, but no target solvent compounds. In addition, sample A-19 contained detectable levels of fuel products and solvents that may be due to a small, isolated spill in the vicinity of Building Nos. 7132 and 7122 or to ground water contamination migrating from the source at Building No. 7132.

Area Northwest of the Garage and Maintenance Area

Samples collected north and northwest of the Garage and Maintenance Area indicated low level contamination from fuel products, TCE and PCE in concentrations ranging from 23 to 7 ppb. The special distribution of the contaminants detected appears to be sporadic, and indicated that low-level soil or ground water contamination may be present.

3.1.2 Current Investigation and Results

The field activities at the Garage and Maintenance Area associated with the current investigation were conducted on the following dates:

Soil Sampling: 11/27/90, 11/29/90, 11/30/90, 12/4/90 and 12/7/90
Ground Water Sampling: 1/15/91
Sediment Sampling: 1/11/91
Ground Water Level Measurements: 1/9/91, 5/9/91

The results of these sampling and analysis activities, are presented below.

3.1.2.1 Soil Sampling and Analyses

Seven of the 23 borings were completed at the Garage and Maintenance Area (Figure 3-9). Six of these locations were finished as ground water monitoring wells. The seven borings ranged in depth from 16 feet to 29 feet. Soil borings at locations PBS-GM-01 and PBS-GM-02 were advanced to the shale bedrock which was 27 feet and 29 feet

below the ground surface respectively. Prior to drilling it had been assumed that bedrock would be encountered at approximately 15 feet. After the first two borings were completed, it was decided that it was unnecessary to advance the boring to bedrock and subsequent borings were completed at an impermeable layer below the water table that would allow for monitoring the tank pit.

Of the six soil borings completed as monitoring wells, PBS-GM-01 and PBS-GM-02 were intended to be indicative of background conditions. The four remaining boring locations which were completed as monitoring wells, PBS-GM-03 through PBS-GM-06, were placed to help characterize the contamination at the Garage and Maintenance Area. The seventh location which was planned as a boring, but was not to be finished as a well, was located near the sewer line at the southeast corner of Building No. 7121. It was suspected, because of a previous sewer study, that contamination may have traveled along the sewer line and therefore a boring was located near this line. The six monitoring well locations and the soil boring location are shown in Figure 3-9.

3.1.2.1.1 Physical and General Stratigraphic Characteristics

Based on the seven boreholes made at the Garage and Maintenance Area as part of the current investigation, the overburden material at the Garage and Maintenance Area has an average thickness of 28 feet. Figure 3-10 presents a generalized stratigraphic section for the Garage and Maintenance Area showing the types of soils and their orders of occurrence. This section is based only on the seven borings made for this study. The surface soil in this area is predominantly brown fine sand with a mean thickness of 4 feet (In certain locations, this sand is overlain by 1 to 2 feet of gravel fill material.). The brown fine sand is underlain by grey sandy-clayey silt, except at the PBS-GM-02 location. The thickness of this grey sandy-clayey silt unit ranges from 1 to 12 feet. Beneath this unit is a layer of grey clayey silt. Where this unit is present, it ranges in thickness from 2 to 11 feet. The clayey silt is underlain by grey silty clay, with an average thickness of 4 feet. This unit is followed by a layer of grey sand which ranges in thickness from 3 to 8 feet, and is underlain by clayey silt. The clayey silt exhibited an average thickness of 3 to 8 feet. This unit overlies the grey shale bedrock. The top of bedrock is at an elevation of approximately 610 feet at borehole location PBS-GM-01 in the southeast corner of the Tank Area. This corresponds to an overburden thickness of 27 feet at this location. In the northern-most part of this Tank Area, at borehole location PBS-GM-02, the brown fine sand is underlain by grey fine sand, 4 feet in thickness, followed by a grey sandy-silt unit which is 7 feet in thickness. The top of bedrock at this location occurs at an elevation of approximately 607 feet (with a corresponding 29 foot overburden layer thickness).

3.1.2.1.2 Nature and Extent of Contamination

Seven soil borings were made at the Garage and Maintenance Area as part of the current investigation. These samples were composited over the total depth of the boring except for the volatiles samples which were taken at depths ranging from 4 to 12 feet below the ground surface. The complete results of the chemical analyses of these samples are presented in Table A-1 in Appendix A. A summary of the detected organic compounds is presented in Table 3-8. Excluding the probable laboratory contaminants, ten (10) different volatile organic compounds were detected in this set of samples and no semivolatile organics, pesticides or PCBs were found. 2-Butanone and 1,1,1-Trichloroethane were found at low ppm levels. Three of the seven samples contained none of the organics tested for at detectable levels (excluding the lab contaminants.) The distribution of the organics detected in the soils at this tank area is presented in Figure 3-11. Highlighted in this figure are the general presence of solvent compounds on the east side of Building No. 7121, a relative hot spot of solvents off the northeast corner of the building, and some TPH contamination northwest of the former location of Tanks 7132-1 (#33), 7132-2 (#34), and 7132-3 (#35). One unexpected result was the detection of both fuel and solvent related organics at sampling location PBS-GM-SB-02 (north of Building No. 7131 along the Garage Road). This location had originally been chosen as a local background sample. Using the inorganics comparison methodology and criteria described earlier, no inorganics were indicated to be of concern in the soils at the Garage and Maintenance Area. Three inorganics, calcium (72200 mg/Kg), magnesium (20100 mg/Kg) and mercury (0.19 mg/Kg) were detected at levels exceeding the UCL (see Table 2-1) indicating concentrations significantly higher than local background concentration.

3.1.2.2 Ground Water Sampling and Analysis

3.1.2.2.1 Nature and Extent of Contamination

Two ground water samples were taken at the Garage and Maintenance Area as part of the current investigation, one from a well expected to be heavily contaminated (PBS-GM-06) and one from a well expected to be clean (PBS-GM-02). At the time of the ground water sampling the expected ground water flow was unknown and was assumes to follow a northwesterly direction, for this reason PBS-GM-02 was expected to be a background location. Following the determination of ground water flow patterns it was found that PBS-GM-02 was down gradient of the contaminated areas and therefore was not a valid background location. Because ground water from only two wells at each tank area was sampled and the ground water flow direction was not known prior to sampling this result is understandable. The complete results of the chemical analyses of these samples are presented in Table B-1 in Appendix B. A summary of the detected organic compounds is presented in Table 3-8. Four solvent compounds were detected in these samples at concentrations less than 120 ppb. The highest measured concentration was associated

with 1,1,1-Trichloroethane in the well expected to be contaminated, at 120 ppb. Unexpectedly, a trace level of Trichloroethene (7 ppb) was detected in the "background" well (PBS-GM-02). This contamination was detected in both the original and duplicate sample taken at this location. The other background monitoring well was not sampled at this time. For future work PBS-GM-02 should not be considered as representing background conditions. Excluding the probable laboratory contaminants, no semivolatile compounds were detected in the ground water samples. Trace levels of Beta-BHC were detected in both samples at the Garage and Maintenance Area. BHC (Benzene Hexachloride) is a mixture of isomers of 1,2,3,4,5,6-Hexachlorocyclohexane and is a common insecticide. The detection of BHC at this location is not apparently linked to the contents of the former USTs at the focus of the current investigation. The distribution of the organics detected in the ground water at this tank area in January is presented in Figure 3-12. Highlighted in this figure are the presence of solvents in the ground water east of Building No. 7121 and the presence of trace levels of TCE in the intended background well.

3.1.2.2.2 Ground Water Flow

Figures 3-13 and 3-14 present the local ground water elevation contours developed from the January 9, 1991 and May 9, 1991 ground water level measurements, respectively. The ground water flow direction indicated for the January measurements was toward the North-North-West (NNW), whereas in May it was more directly toward the Northwest (NW). As can be seen, there appears to be seasonal fluctuation in both ground water flow direction and elevation given these two sets of measurements. The measured ground water level was approximately 1 foot lower in May, as compared to January, at the Garage and Maintenance Area. These Tank Area-specific ground water contours should also be compared to the ground water level contours developed for the entire Plum Brook Station based on the May 1991 data. This site map is presented in Figure 3-15. This larger scale ground water contour map shows an overall flow direction toward the NNW in this general area of the PBS. At the time of the Phase I investigation all of the locations of the excavated tanks were below the ground water surface.

Theoretical Darcy's Law flow velocity was calculated for the overburden aquifer using the measured ground water level gradients and the theoretical hydraulic conductivity values for the soil units encountered at this Tank Area. Taking the maximum theoretical hydraulic conductivity for the various soil units observed to be present at this Tank Area, the maximum horizontal ground water flow velocities associated with the January and May 1991 were calculated to be 1.9 and 3.4 feet per year, respectively. It must be emphasized that this estimate is based on the theoretical performance of a homogeneous water-bearing layer consisting entirely of the most transmissive soil type. The theoretical horizontal ground water velocities calculated would suggest that horizontal migration of the UST contaminants in the overburden aquifer would be relatively slow and not

significant relative to preferential migration along buried lines or structures.

3.1.2.3 Sediment Sampling and Analysis

Two sediment samples were taken at the Garage and Maintenance Area as part of the current investigation. Sample PBS-GM-SS-01 was collected from a drainage ditch east of the northeast corner of Building No. 7121 and near the former locations of Tank #28 and Tanks #29, #30 and #31. Sample PBS-GM-SS-02 was taken from a drainage ditch north of Building No. 7131 and Tank #32. Both of these drainage ditches channel water from the former UST areas toward the east. The locations of these samples are shown on Figure 3-16. The complete results of the chemical analyses of these samples are presented in Table C-1 in Appendix C. A summary of the detected organic compounds is presented in Table 3-8.

3.1.2.3.1 Nature and Extent of Contamination

Excluding the compounds identified as being probable laboratory contaminants, only one volatile organic compound was detected in the sediment samples at this location: 1,1-Dichloroethane (at 21 ppb). While it is generally not common to find volatile organics in near surface soil or sediment samples, the presence of 1,1-Dichloroethane at these low levels in the one sediment sample is probably due to the unavoidable amount of ice and moisture that was contained in the sediment sample when it was collected and sent to the laboratory in mid-January. As can be seen in Table 3-8, 1,1-Dichloroethane was present in all media at the Garage and Maintenance Area. Table 3-8 also indicates that a broad range of semivolatile polycyclic aromatic hydrocarbons (PAHs) were detected in the ditch sediments at concentrations up to 4 ppm. The distribution of the organics detected in the sediments at this tank area is presented in Figure 3-17.

PAHs comprise a diverse family of substituted and unsubstituted polycyclic and heterocyclic aromatic compounds. PAHs are typically formed as a result of incomplete combustion of organic compounds in the presence of insufficient oxygen. Common sources of PAHs are fossil fuel (coal and oil) derivatives and combustion sources (e.g., automobiles, incinerators, asphalt, fires). PAHs characteristically exhibit a great tendency to adhere to soils and sediments. Given these properties, and the fact that no PAHs were detected in the subsurface soil or ground water at this tank area, the source of the contamination represented in Table 3-8 is indicated to be surface materials containing PAHs (or with PAHs adhering to them) washing into the drainage ditches. As both sediment sampling locations were very near asphalt or macadam road surfaces, it is likely that the detected semivolatile PAHs in the Garage and Maintenance Area ditch sediments are due to roadway run-off and gasoline and diesel vehicle tailpipe emissions, and not to the former USTs or their contents.

3.1.3 Conclusions for Garage and Maintenance Area

Upon examination of the combined results of both the previous and current studies, a fairly consistent picture of the current conditions at the Garage and Maintenance Area can be formed.

The Building No. 7132 USTs clearly had leaked based on the visual inspection of the pulled tanks and the initial soil and ground water sampling performed. Based on the tank pit soil sampling, the initial remediation effort appears to have eliminated the highly contaminated soil and product which would have been a continuing source of contamination. The subsequent soil gas survey indicated low levels of the fuel and solvent target compounds in the undisturbed areas just west and north of the former UST area. The most recent sampling identified an elevated TPH concentration in the soil sample taken in this area. The ground water in this particular location was not sampled under the current investigation.

The Building No. 7131 UST also appear to have leaked, based on the initial soil sampling conducted, despite the fact that no visible evidence of contamination was seen during the removal process. The soil gas survey performed indicated that very little residual fuel or solvent contamination was present at this location. The most recent sampling also indicated no residual soil contamination. The monitoring well at this location was not sampled under the current investigation.

The Building No. 7121 UST location is clearly contaminated with a mixture of fuel product and solvents. The closure assessment shows much greater contamination in association with Tank #28 (which was formerly under the grassy area east of Building No. 7121) than with the three USTs formerly located next to the northeast corner of the building. Significantly elevated concentrations of a number of solvents were measured here. The subsequent soil gas survey reinforced these findings and identified pockets of high contamination just east of Building No. 7121 and apparent migration of lower levels of contamination to the north and south (apparently along buried utilities and pipelines) and to the west (along the building foundation and railroad track roadbed). The most recent sampling confirmed the presence and levels of solvent contamination in the soils in the area east of Building No. 7121. Solvent contamination also was found in the ground water sample taken from this area during the current investigation.

UST contamination at the Garage and Maintenance Area was limited to a range of volatile organic compounds and TPH. The trace levels of semivolatile contamination found in the Garage and Maintenance Area sediment samples would not appear to be associated with the former USTs. No PCBs and no UST related pesticides were detected and no inorganics were highlighted as problematic based on the sampling.

Transport and migration of contamination from the former UST locations at this Tank

Area would appear to be linked to ground water movement. Migration along preferential flow pathways associated with man-made structures would appear to be greater than migration through the undisturbed soil. These preferential pathways appear to have themselves become secondary sources of contamination in some areas.

3.2 Space Power Facility

On September 18 and 19, 1989 two (2) USTs were removed from the Space Power Facility (SPF). The tanks were located in a common pit adjacent to the south foundation wall of Building No. 1411, near the boiler room. Figure 3-1 shows the location of the SPF at the Plum Brook Station. Both of the 1,000 gallon-capacity steel tanks were installed in 1968. Tank 1411-1 (#24) contained waste oil and solvents, and was in use until it was removed. Tank 1411-2 (#25) previously contained fuel oil, but was out of use and contained water when it was removed.

3.2.1 Previous Investigations and Results

The activities conducted at the Space Power Facility have included a closure assessment and a soil gas survey. These activities are reviewed below.

3.2.1.1 UST Closure Assessment

As part of the UST removal operation, a closure assessment was completed. The assessment included a visual site inspection, soil sample collection and analysis, and examination of the tanks after removal. The tanks were inspected by the Ebasco representatives onsite and by John Graves of the Inspection Division of the State Fire Marshall's Office.

Tank 1411-1 (#24) was removed on September 18, 1989 and Tank 1411-2 (#25) was removed on September 19, 1989 from the area south of Building No. 1411 between two driveways. During excavation, shale bedrock was encountered approximately twelve (12) feet below the ground surface. Soil sampling was performed in the excavation on September 19th. A total of nine (9) soil samples were collected. Four (4) samples were taken from the pile of excavated material, and analyzed for VOCs, TPH, EP Toxicity lead and ignitability. The remaining five (5) samples were taken from the walls and bottom of the pit. One of these was analyzed for VOCs, TPH, EP Toxicity lead, and ignitability, and the others were analyzed for VOCs and TPH. These sampling locations are identified on Figure 3-18.

VOC contamination was found in the soils. A total of 35 different compounds were detected in the soil samples analyzed. Table 3-9 shows the highest concentrations

detected for the VOCs analyzed. Also shown are the VOCs not detected in the SPF soil samples. The compounds 1,1,1-Trichloroethane, Trichloroethene, and Naphthalene were detected in all soil samples at maximum concentrations of approximately 1.0 to 1.5 ppm. Trimethylbenzene, both 1,3,5- and 1,2,4-, were detected at 500 ppb levels. All other VOCs detected were at concentrations less than 400 ppb.

Lead concentrations from the EP Toxicity tests were below the detection limit and Flashpoints were greater than 200 °F for all of the samples, indicating that the soils were not hazardous due to their toxicity or ignitability.

There were elevated levels of Total Petroleum Hydrocarbons in all soil samples taken from the former Tank Area, as shown in Table 3-9. The TPH concentrations ranged from a low of 93 mg/kg to a high of 2030 mg/kg. The highest concentrations of TPH were found in samples collected from the north and west walls of the pit (near the Building) and in the excavated soil taken from these areas.

3.2.1.2 Soil Gas Survey

In October, 1989, a soil gas survey was conducted at the Space Power Facility. A total of 22 soil gas samples were collected and analyzed. The locations of the survey points were determined based on several factors, including the distribution of underground utilities. Buried pipelines and conduits are generally packed in gravel or other highly transmissive materials which can affect the rate and direction of contaminant movement by providing a preferential pathway for migration. Contaminants also tend to migrate along building foundations and follow the ground surface topography.

Soil gas samples were collected in the following manner. A solid steel probe was advanced 3 to 4 feet into the ground and then withdrawn. A sampling probe with a slightly larger diameter was then advanced 2 feet into the hole. Gas was purged from the sampling probe using a hand-operated vacuum pump. A sample was then collected from the top of the sampling probe upstream of the vacuum pump. A 1.0 ml sample was extracted, injected into a portable gas chromatograph (GC), and analyzed. The GC was calibrated to quantify Dichloroethene (DCE), Benzene, Trichloroethene (TCE), Toluene, Tetrachlorethene (PCE), and Xylene. All concentrations were reported in microliters of analyte vapor per 1,000 liters of air (parts per billion (ppb)).

The results of the soil gas survey are shown in Table 3-10. Figures 3-19 and 3-20 show the sampling locations, compounds detected and the compound concentrations. Figure 3-19 highlights the relative distribution of the fuel-related compounds while Figure 3-20 focuses on the distribution of detected organic solvent materials. Most of the areas sampled showed measurable levels of one or more of the target compounds. The highest concentrations detected were found near former UST locations, along building foundations, roadbeds, railroad tracks or along buried utility lines.

The majority of the soil gas samples indicated contamination only from fuel products. The highest concentrations of fuel products in the soil gas were found on the west side of the Building. Sample 1411-10 had the highest fuel product concentration at this site, with a total Benzene-Toluene-Xylene concentration of approximately 3,000 ppb. Samples 1411-9, 1411-10 and C-5 showed elevated concentrations of these compounds. These samples are aligned in a northwest direction and have a concentration gradient of 10% to 50% towards the northwest for a distance of several hundred feet. The relative location of these samples and their concentrations indicate the possibility of ground water contamination.

Fuel products also were detected on the southern side of the Building. The highest concentration in this area was at sample point 1411-2, just south of the Tank Area, which had an elevated Toluene and Xylene concentration. The contamination in this area may be due to contaminant migration from the former Tank Area or west side of the Building, or it could be from an independent source. Samples south of the Building, in the vicinity of the removed USTs, showed concentrations of Benzene, Toluene, and Xylene ranging from 10 to 130 ppb. All of the samples south of the Building show similar concentrations with no steep concentration gradient in any direction, which is generally indicative of ground water contamination.

The only location displaying one of the target solvents was 1411-15, on the southeast side of the Building, which showed TCE at 700 ppb. This isolated reading could indicate that a spill may have occurred at this location.

3.2.2 Current Investigation and Results

The field activities at the Space Power Facility Area associated with the current investigation were conducted on the following dates:

Soil Sampling: 12/10/90, 12/11/90 and 12/12/90
Ground Water Sampling: 1/16/91
Sediment Sampling: 1/11/91
Ground Water Level Measurements: 1/9/91, 5/9/91

The results of these sampling and analysis activities, are presented below.

3.2.2.1 Soil Sampling and Analyses

At the Space Power Facility, six borings were completed and five of these locations were finished as ground water monitoring wells. All six borings at the Space Power Facility encountered shale bedrock from 7 feet to 9.5 feet below the ground surface. Location PBS-SP-02 was planned to be finished as a monitoring well but upon completion of the

boring, not enough ground water was present to justify installing a monitoring well. The remaining five borings were completed as monitoring wells. Locations PBS-SP-01 and PBS-SP-02 were intended to be background locations, while locations PBS-SP-03, PBS-SP-04, PBS-SP-05 and PBS-SP-06 were selected to help characterize the extent of contamination associated with this area. The six locations are shown on Figure 3-21.

3.2.2.1.1 Physical and General Stratigraphic Characteristics

Based on the six boreholes made at the Space Power Facility Area as part of the current investigation, the overburden material at the Space Power Facility Area has an average thickness of 8 feet. Figure 3-22 presents the generalized stratigraphic section for the Space Power Facility Area showing the types of soils and the order of occurrence of the soil units encountered. This generalization is based only on the six boreholes made for this study. The surface soil in this area is predominantly grey mottled clayey silt. Gravel with brown sandy silt were found near the surface to a depth of 2 feet at borehole PBS-SP-01 in the northeast corner of the Tank Area. This fill is underlain by the grey mottled clayey silt to a thickness of 4 feet. This unit is then underlain by approximately 2 feet of grey silty clay followed by a 1 foot thick layer of grey fine sand. Bedrock, consisting of grey shale, is encountered at a depth of about 9 feet below the ground surface, corresponding to an elevation of approximately 645 feet.

At the remaining borehole locations, the grey mottled clayey silt varies in thickness from 2.5 to 7 feet. This unit is then immediately underlain by the grey shale bedrock or, in places, the clayey silt grades into the grey shale. At these locations, the bedrock occurs at a depth of about 7 feet below ground surface, at an elevation of approximately 650 feet. With the exception of PBS-SP-01, the silty clay and sand units were not present in the boring samples examined for this Tank Area. At these boreholes, representing most of the site, the overburden lying above the bedrock is a poor water bearing material. The wells installed at these locations would not produce sufficient water to complete the purging operation, as was reported in the description of the well development activities.

3.2.2.1.2 Nature and Extent of Contamination

Six soil borings were made at the Space Power Facility Area as part of the current investigation. The samples were composited over the total depth of the boring except for the volatiles samples which were taken at depths ranging from 4 to 9.5 feet below the ground surface. The complete results of the chemical analyses of these samples are presented in Table A-2 in Appendix A. A summary of the detected organic compounds is presented in Table 3-11. Excluding the probable laboratory contaminants, only one (1) volatile organic compound was detected in this set of samples and three (3) semivolatile organics were found. No pesticides or PCBs were detected in these soil samples. Trichloroethene was found in one of the six samples at a concentration of 2 ppb. 2-

Methylnaphthalene was found at a concentration of 670 ppb (slightly higher than the sample detection limits of 560 ppb) in one of the soil samples. The other two semivolatile organic compounds reported, Naphthalene and Phenanthrene, were estimated by the laboratory to be present at concentrations less than the sample detection limit (at roughly 10% and 60% of the sample detection limits, respectively). No other semivolatile organic compounds were detected or reported by the laboratory. Four of the six samples contained none of the organics tested for at detectable levels excluding the lab contaminants. The distribution of the organics detected in the soils at this Tank Area is presented in Figure 3-23. Highlighted in this figure is the relative lack of detected organics contamination at this former Tank Area. The lone solvent detected (Trichloroethene estimated at 2 ppb at PBS-SP-SB-02) can practically be considered to be below detection levels. No other samples showed solvent compounds. As noted, the three semivolatiles reported for this area were associated with only the soil sample taken directly next to the former UST location, and these compounds were reported at concentrations of 10% to 120% of the sample detection limit. The only significant organics contamination of note appears to be TPH. The highest concentration of TPH measured in this area was again at the borehole made right next to the former tank location (288 ppm). The two nearest other soil samples taken about 100 feet on eigher side of this boring did not show TPH contamination. A near detection level concentration of TPH was reported for the soil sample taken on the west side of Building No. 1411. Again, TPH was not reported in any of the adjacent soil samples. This low concentration may, therefore, be associated with an isolated surface spill or leak. Alternately, TPH at this location may be due to migration of contamination from the former leaking tanks along the Building No. 1411 foundation and backfill. The near detection level TPH concentration detected at PBS-SP-SB-01 was somewhat unexpected, as this boring was selected as a background sample for this Tank Area. This amount of TPH may, again, be attributable to an isolated spill or runoff from the nearby roadway.

Using the inorganics comparison methodology and criteria described earlier, a number of inorganics were measured at levels exceeding the UCL criteria for determining significantly higher than background levels (see Table 2-1). These include arsenic, beryllium, cobalt, copper, mercury and thallium. Two of these are generally of concern with respect to health effects - arsenic and mercury. Arsenic was present in two of the six soil samples at levels (22 and 37 mg/Kg) exceeding the UCL for this element. These two samples were both within 150 feet of the former tank locations. The levels of Arsenic reported at the two locations were outside the range of U.S. soil background levels and higher than the N.J. Soil Clean-up Criterion. A logical relationship of Arsenic to the contents of the former USTs has not been made, and other nearby sources (e.g., the railroad line, combustion stack to the east, etc.) may be the source of this contamination.

Mercury was detected at concentrations exceeding the calculated UCL for mercury (see Table 2-1) in three samples (1.1, 6.8 and 0.2 mg/kg). One measurement (6.8 mg/kg)

exceeded both the published U.S. background range and the N.J. Soil Clean-up Criterion. The isolated nature of this finding in a near surface soil sample may indicate a surface spill.

3.2.2.2 Ground Water Sampling and Analysis

3.2.2.2.1 Nature and Extent of Contamination

Two ground water samples were taken at the Space Power Facility Area as part of the current investigation, one from a well expected to be heavily contaminated (PBS-SP-06) and one from a well expected to be clean (PBS-SP-01). The complete results of the chemical analyses of these samples are presented in Table B-2 in Appendix B. A summary of the detected organic compounds is presented in Table 3-11. As can be seen, no volatile or semivolatile organics, pesticides, PCBs, or TPH were detected in either of these two samples.

3.2.2.2.2 Ground Water Flow

Figures 3-24 and 3-25 present the local ground water elevation contours developed from the January 9, 1991 and May 9, 1991 ground water level measurements, respectively. The ground water flow direction indicated for both the January and May measurements was toward the northeast (NE). As can be seen, the January ground water contours exhibited a pattern of relatively steep gradients such that ground water moves into the area beneath Building Nos. 1411 and 1441 from the northwest and the southeast and then turns toward the northeast. The January contours give the impression of an underground trough draining to the northeast. The ground water contours for May exhibit this same overall pattern, but with gradients which are much less pronounced. These lower gradients result in flows which move toward the north and east, converging on the northeast direction. These Tank Area-specific ground water contours should also be compared to the ground water level contours developed for the entire Plum Brook Station based on the May 1991 data. This site map is presented in Figure 3-15. This larger scale ground water contour map shows an overall flow direction toward the NNW in this general area of the PBS.

The original location of the excavated tanks was at the current level of the ground water table. The tanks were directly above the bedrock and the saturated zone comprises the few feet directly above the bedrock.

Taking the maximum theoretical hydraulic conductivity for the various soil units observed to be present at this Tank Area, the maximum horizontal ground water flow velocities associated with the January and May 1991 were calculated to be 2.0 and 3.1 feet per year,

respectively. It must be emphasized that this estimate is based on the theoretical performance of a homogeneous water-bearing layer consisting entirely of the most transmissive soil type. The theoretical horizontal ground water velocities calculated would suggest that horizontal migration of the UST contaminants in the overburden aquifer would be relatively slow and not significant relative to preferential migration along buried lines or structures.

3.2.2.3 Sediment Sampling and Analysis

Two sediment samples were taken at the Space Power Facility Area as part of the current investigation, both from drainage ditches directly south of the former UST location. The location of these two samples as shown in Figure 3-26. The first location (PBS-SP-SS-01) was approximately 40 feet south of the former USTs on the side of the road nearest Building No. 1411 while the second location (PBS-SP-SS-02) was directly across the road between the road and the railroad tracks. The complete results of the chemical analyses of these samples are presented in Table C-2 in Appendix C. A summary of the detected organic compounds is presented in Table 3-11.

3.2.2.3.1 Nature and Extent of Contamination

Excluding the compounds identified as being probable laboratory contaminants, no volatile organic compounds were detected in the sediment samples at this location. Table 3-11 also indicates that a broad range of semivolatile polycyclic aromatic hydrocarbons (PAHs) were detected in the ditch sediments at concentrations less than 1 ppm. Aroclor-1254, a PCB, also was detected in the ditch nearest the Building at a concentration of 1.6 ppm. Aroclor-1254 contains a mixture of 11% tetra-, 49% penta-, 34% hexa- and 6% heptachlorobiphenyls. Arochlor-1254 was used in heat transfer and hydraulic fluids, lubricants and insecticides. TPH was detected in both sediment samples, at 1320 and 127 ppm on the near-side and far-side of the road, respectively. The distribution of the organics detected in the sediments at this tank area is presented in Figure 3-27.

PAHs, as was previously noted, are typically formed as a result of incomplete combustion of organic compounds in the presence of insufficient oxygen. Common sources of PAHs are fossil fuel (coal and oil) derivatives and combustion sources (e.g., automobiles, incinerators, asphalt, fires). PAHS characteristically exhibit a great tendency to adhere to soils and sediments. Given these properties, and the fact that no PAHs were detected in the subsurface soil or ground water at this Tank Area, the source of the contamination represented in Table 3-11 is indicated to be surface materials containing PAHs or soil particles with PAHs adhering to them which have been washed into the drainage ditches. As both sediment sampling locations were very near asphalt or macadam road surfaces, it is likely that the detected semivolatile PAHs in the Space Power Facility Area ditch

sediments are due to roadway run-off, gasoline and diesel vehicle tailpipe emissions, or the nearby stack emissions, and not to the former USTs or their contents.

The presence of TPH in these sediments at concentrations nearly equal to or greater than in the soil sample taken next to the former UST location, and a lack of TPH in the close-by soil samples of PBS-SP-SB-02 and -05 would tend to indicate that the sediment TPH contamination may not be due to migration of TPH contamination from the former USTs. Instead, surface spillage or leakage and run-off of fuel product might be indicated. Preferential migration of TPH away from Building No. 1411 toward the ditch along buried utility lines and conduits cannot, however, be completely ruled out.

3.2.3 Conclusions for Space Power Facility Area

In combination, the results of the previous and current investigations at the Space Power Facility indicate an area of low level residual fuel product contamination apparently associated with the former USTs and possible pockets of low level solvent contamination possibly due to isolated spills, surface activity or leakage from the waste oil tank.

The Space Power Facility USTs had leaked based on the initial soil sampling performed. Elevated concentrations of both solvent compounds and fuel products (including TPH) were detected in the tank pit soil samples. The follow-up soil gas survey indicated low levels of contamination in the areas surrounding the former UST location on the south and western sides of Building No. 1411. Migration of contaminants with ground water flow along and under the building foundation and along the buried water, natural gas and power lines off the southwestern corner of the building was indicated. No target solvent compounds were detected near the former UST location by the soil gas survey. The lone detection at a point further to the east would appear to be due to migration along and under the Building or to an isolated spill not associated with the former USTs. The most recent sampling also indicated some trace levels of residual volatiles contamination in the soil near the former tank location and the more widespread presence of low levels of TPH. No contamination was detected in the ground water samples taken at this Tank Area during the current investigation. Elevated TPH concentrations also were found in the sediment samples taken from the drainage ditches just south of the former UST location on both sides of the road. Trace levels of semivolatile PAHs and a PCB compound also were found in the drainage ditch closest to the former UST location.

UST contamination at the Space Power Facility was limited to a range of volatile organic compounds and TPH. The trace levels of semivolatile compounds and the PCB found in the Space Power Facility sediment samples would not appear to be associated with the former USTs. Two metals, arsenic and mercury, were highlighted as potentially problematic in the soils at certain locations in this area. However, there is currently no clear linkage of these metals to the contents of the former USTs.

Transport and migration of contamination from the former UST locations at this Tank Area would appear to be linked to ground water movement. Migration along preferential flow pathways associated with man-made structures would appear to dominate migration through the undisturbed soil. These preferential pathways have themselves become secondary sources of contamination in some areas.

3.3 Pump Station

The location of the Pump Station, Building No. 8133 at the Plum Brook Station, is shown on Figure 3-1. One UST, Tank 8133-1 (#39), was removed from the Pump Station, on September 18, 1989. The tank was located on the west side of the Building adjacent to the foundation. The tank location is indicated on Figure 3-28. The 250 gallon capacity steel gasoline tank was installed in 1942. At the time it was removed, it was permanently out of use and contained only water.

3.3.1 Previous Investigations and Results

3.3.1.1 UST Closure Assessment

A UST closure assessment was conducted as part of the removal of Tank 8133-1 (#39). The assessment included: a visual inspection of the excavation to determine whether contamination may be present, the collection of soil samples from the sidewalls and bottom of the pit and from the excavated material, and a visual inspection of the tank after removal to assess its integrity. The tanks were inspected by the Ebasco representative onsite and by John Graves of the Inspection Division of the State Fire Marshall's Office.

Tank 8133-1 (#39) was removed and visually inspected on September 18, 1989. It was found to have holes in it, and the soil in the pit was visibly contaminated. After the tank was removed, water slowly began to seep into the excavation from beneath Building No. 8133 until the water level was approximately 2 feet below the ground surface. The water was pumped out and additional soil was removed. A water main was discovered approximately 7 feet below the ground surface.

A total of three (3) soil samples were collected at this tank location, two from the excavated soil, and one from the bottom of the excavation. All three samples were analyzed for TPH, EP Toxicity lead, ignitability, and Benzene, Toluene, Ethylbenzene, and Total Xylenes (the BTEX compounds). The results of these soil analyses are presented in Table 3-12.

The sample collected from the bottom of the excavation (8133-SS-3) contained very low

levels of BTEX, and TPH was undetected. The two samples taken from the excavated material had elevated levels of BTEX, especially sample 8133-SS-1, which contained concentrations from 1,400 (Benzene) to 16,000 (Total Xylenes) ppb. TPH concentrations ranged from undetected to 655 ppm.

Because the contaminant concentrations in the soil underlying the tank were found to be negligible, it was indicated that the contamination was limited to the soils that had surrounded the tank and had been removed.

3.3.1.2 Soil Gas Survey

The soil gas survey at this area was conducted in October of 1989. Fourteen (14) soil gas samples were collected and analyzed from this area. The study took into consideration both the UST and an above ground petroleum product storage tank located adjacent to the Building and UST. The results of this survey are presented in Table 3-13 and Figure 3-29.

Five of the fourteen soil gas sampling results indicated some level of contamination from petroleum products. The highest concentration was in the sample collected east of the Building (Location 8133-13). The sample had a total Benzene-Toluene-Xylene concentration of 1,070 ppb. Samples collected around this point had no detectable levels of contaminants, indicating that this was probably an isolated source of contamination, such as a spill or leak.

Samples in the vicinity of the Tank Area showed levels of contaminants near or below the detection limits. Four (4) samples indicated the presence of Benzene, Toluene, or Xylene with concentrations ranging from 9 to 33 ppb. Concentrations in this range, combined with the sporadic pattern of detections, is indicative of low-level soil or ground water contamination.

3.3.2 Current Investigation and Results

The field activities at the Pump Station Area associated with the current investigation were conducted on the following dates:

Soil Sampling: 12/5/90, 12/6/90 and 12/7/90
Ground Water Sampling: 1/15/91
Sediment Sampling: 1/11/91
Ground Water Level Measurements: 1/9/91, 5/9/91

The results of these sampling and analysis activities, are presented below.

3.3.2.1 Soil Sampling and Analyses

Four soil borings were located at the Pump Station (Building No. 8133). These four borings were completed to a depth of between 14 feet and 18 feet below ground surface. Three of the four locations were finished as ground water monitoring wells. Location PBS-PS-01 was not completed as a monitoring well because of a lack of ground water.

Locations PBS-PS-01 and PBS-PS-04 were planned as background locations and PBS-PS-02 and PBS-PS-03 were expected to be contaminated locations. The four boring locations are shown on Figure 3-30.

3.3.2.1.1 Physical and General Stratigraphic Characteristics

Based on four boreholes made at the Pump Station Area as part of the current investigation, the overburden material at the Pump Station Area has an average thickness greater than 18 feet. Figure 3-31 presents the generalized stratigraphic section for the Pump Station Area showing the types of soils present and their orders of occurrence. As is noted on Figure 3-31, the borings made at the Pump Station Area were not advanced to bedrock. As such, the full depth of the overburden in this Tank Area has not been established. The surface soil in this area is predominantly brown fine sand with trace silt which is occasionally covered by a layer of sandy-clayey silt. The sandy-clayey silt, when present, occurs to a depth of 3 feet while the fine sand unit ranges from 1 to 8 feet in thickness. The sand unit is underlain by grey sandy-clayey silt. In areas where this unit occurs, its thickness ranges from 2 to greater than 8 feet. The sandy-clayey silt is followed by grey clayey silt with a minimum thickness of 4 feet. At PBS-PS-01, this layer is more than 10 feet thick. The clayey silt is underlain by grey silty clay, with a mean thickness of 2 feet which is followed by more grey clayey silt. The sand unit may be able to bear water while the clayey silt and silty clay units are indicated to be poor water bearing units. These characteristics are evident during the well development activities, as the wells were purged dry after removing only about 10 to 11 gallons of water.

3.3.2.1.2 Nature and Extent of Contamination

The samples from the boreholes in the Pump Station Area were composited over the total depth of the boring except for the volatiles samples which were taken at depths ranging from 4 to 10 feet below the ground surface. The complete results of the chemical analyses of these samples are presented in Table A-3 in Appendix A. A summary of the detected organic compounds is presented in Table 3-14. Excluding the probable laboratory contaminants, only one volatile organic compound was detected in this set of samples, and two semivolatile organics were reported as estimated to be present at less than the sample detection limits. No pesticides or PCBs were found in any of the

samples. Trichloroethene was found at the slightly elevated level of 25 ppb. Three of the four samples contained none of the volatile or semivolatile organics tested for at detectable levels excluding the laboratory contaminants. The distribution of the organics detected in the soils at this Tank Area is presented in Figure 3-32. Highlighted in this figure is the lack of solvent compounds anywhere in the area, with the exception of the 25 ppb measurement of Trichloroethene at PBS-PS-SB-04 east of Building No. 8133. This single occurrence may be indicative of an isolated leak or spill or the preferential migration of contaminants along and under building foundations, roadbeds, or buried utilities and conduits toward the east. Also noteworthy are levels of TPH at concentrations that are three times the sample detection limits, at all four sampling locations. The presence of TPH and the low levels of two PAHs at PBS-SP-01 were somewhat unexpected, as this location had been chosen as a local background sample. The semivolatile PAHs, Fluoranthene and Pyrene, were reported present at this location by the laboratory at concentrations of roughly 30% (130 ppb) and 20% (84 ppb) of the sample detection limit, respectively. Using the inorganics comparison methodology and criteria described earlier, no inorganics are indicated to be of concern in the soils at the Pump Station Area. Only one inorganic, zinc, was detected at a level (236 mg/kg) exceeding its calculated UCL (185 mg/kg, see Table 2-1) indicating significant difference from background. However, the reported concentration was well within the range of U.S. background zinc concentrations in soil and was less than the N.J. Soil Clean-up Criterion.

3.3.2.2 Ground Water Sampling and Analysis

3.3.2.2.1 Nature and Extent of Contamination

Two ground water samples were taken at the Pump Station Area as part of the current investigation, one from a well expected to be heavily contaminated (PBS-PS-02) and one from a well expected to be clean (PBS-PS-04). The complete results of the chemical analyses of these samples are presented in Table B-3 in Appendix B. A summary of the detected organic compounds is presented in Table 3-14. As can be seen, no volatile or semivolatile organics, pesticides, PCBs, or TPH were detected in either of these two samples (excluding the probable laboratory contaminant Acetone.)

3.3.2.2.2 Ground Water Flow

Three of the four boreholes made at the Pump Station Area were completed as monitoring wells. The fourth location, PBS-PS-01, turned out to be a dry hole. Ground water level measurements were made in January and May of 1991 at the three installed monitoring wells, as was done at the other Tank Areas. In this case, however, these three locations turned out to be nearly linear with respect to ground water elevations based on both the January and May measurements. Generally illustrative ground water levels contour maps for this Tank Area could not be constructed. The water level measurements were all

nearly equal (within 0.33 to 0.67 feet of one another). As a result, the information collected could not be justifiably used to estimate a local ground water level gradient. As such, no estimate of the local ground water velocity in the undisturbed portions of the Tank Area was possible.

The data available would indicate, however, that ground water flow in the area between Building No. 8133 and the Reservoir is toward the north (N) or North-North-East (NNE). Again, this indicated local ground water level gradient can be compared to the overall site ground water contours which represent overall flow to the North-North-West (NNW) in this area.

3.3.2.3 Sediment Sampling and Analysis

One sediment sample PBS-PS-SS-01 was taken at the Pump Station Area as part of the current investigation. The location of this sediment sample is shown on Figure 3-33. This sample was taken from a relatively low-lying area northwest of Building No. 8133 near the monitoring well and subsurface soil sampling location PBS-PS-02. The complete results of the chemical analyses of these samples are presented in Table C-3 in Appendix C. A summary of the detected organic compounds is presented in Table 3-14.

3.3.2.3.1 Nature and Extent of Contamination

No volatile organic compounds were detected in the sediment sample at this location. Table 3-14 also indicates that a broad range of semivolatile polycyclic aromatic hydrocarbons (PAHs) were detected in the sediment sample at concentrations up to 500 ppb, and TPH were reported at 90 ppm. The distribution of the organics detected in the sediment at this location is presented in Figure 3-34.

PAHs, as has been noted, are typically formed as a result of incomplete combustion of organic compounds in the presence of insufficient oxygen. Common sources of PAHs are fossil fuel (coal and oil) derivatives and combustion sources (e.g., automobiles, incinerators, fires, asphalt). PAHs characteristically exhibit a great tendency to adhere to soils and sediments. Given these properties, and the fact that no PAHs were detected in the subsurface soil or ground water at this same sampling location, the source of the contamination represented in Table 3-14 and Figure 3-34 is likely to be surface run-off of materials containing PAHs (or with PAHs adhering to them) into the low-lying portions of the site. As this sediment sampling location was very near an asphalt or macadam road surface, it is likely that the detected semivolatile PAHs are due to roadway run-off and gasoline and diesel vehicle tailpipe emissions, and not to the former USTs or their contents. The presence of TPH in the surface sediment is consistent with its presence in the composite sample taken at depths close-by.

3.3.3 Conclusions for Pump Station Area

The former gasoline tank at the Pump Station was found to contain holes and be leaking when it was removed. Visible contamination was present in the tank pit and significantly elevated BTEX concentrations were measured in the tank pit soil samples taken during the removal operation. The subsequent soil gas survey identified very low concentrations of the target fuel compounds in a set of sample locations west of Building No. 8133 along a line from the former UST location toward the North-North-East (NNE). A sample location east of the Building next to the electrical gear at the northeast corner showed evidence of an isolated spill or leak of fuel product not related to the former UST or of contaminant migration under the Building. No target solvent compounds were detected by the soil gas analyses. The most recent sampling indicated trace concentrations of TPH in all soil samples taken at this area. The source of the TPH is currently not clear, as a TPH concentration twice the value found in the samples closest to Building No. 8133 was measured at the boring location anticipated to be a background sample.

No soil or ground water contamination by volatile or semivolatile organic compounds, pesticides or PCBs was found in the samples taken during the current investigation. No inorganics were highlighted as problematic or potentially problematic based on this sampling. The trace levels of semivolatile contamination found in the one Pump Station sediment sample taken would not appear to be associated with the former UST, as trace PAH concentrations were also detected in the background soil boring.

Transport and migration of any residual contamination from the former UST would appear to be linked to ground water movement. Preferential migration may be along the buried raw or potable water lines to the west and northwest of the Building or along and under the Building itself. The media along these preferential migration routes may have become secondary sources of low level TPH contamination.

3.4 Reactor Area

The Reactor Area consists of a number of buildings, roads, tunnels, open areas, structures. Figure 3-1 shows the location of the Reactor Area at the Plum Brook Station. On December 28, 1989, the permanent closure by removal of three (3) USTs was performed.

The USTs were lying adjacent to each other in a north-south direction, south of Building No. 1311. Two (2) of the tanks, 1311-1 (#21) and 1311-2 (#22) were 7,900 gallon steel fuel oil tanks that were not in use at the time of their removal. Tank 1311-3 (#23) was a 500 gallon steel waste oil tank which was in use until its removal. All three tanks were installed in 1961.

3.4.1 Previous Investigations and Results

3.4.1.1 UST Closure Assessment

A UST closure assessment was performed as part of the tank removal operation. The study consisted of a visual inspection of the tanks during and after removal, environmental sampling, and air monitoring. Mr. Edwin Maglott of the State Fire Marshall's Office, and Ms. Pamela Doerner of the Ohio EPA, along with the Ebasco field representative, were onsite to oversee the removal of the USTs, and to inspect the tanks. After the tanks were removed, they were visually inspected and found to be in good condition structurally. There were no apparent holes or cracks in the tanks, and there was very little visible corrosion.

Environmental sampling consisted of the collection of eleven (11) soil samples. Soil samples were screened with an HNu photoionization meter to gain an indication of whether volatile organic compounds were present in the samples. Three (3) samples were taken from the tank cover soil to determine if there had been appreciable surface spillage, overfilling or piping failures. Six (6) samples were taken from the soil underlying the tanks, to detect the presence of any past or ongoing leaks.

Soil samples 1131-SS-1 through 1131-SS-6 were collected from beneath the tanks as shown in Figure 3-35 and were analyzed for TPH, VOCs, EP Toxicity lead, and ignitability. Samples 1131-SS-7, 1131-SS-8 and 1131-SS-9 were taken from the cover soil prior to the removal of the USTs. These samples were taken from the soil containment area which was set up east of Building No. 1131. The cover soil samples were analyzed for TPH, VOCs, EP Toxicity lead, and ignitability.

Due to the apparent contamination, indicated by both the HNu readings and visual inspection of the pit, it was determined that additional soil would be removed before the tank pit was backfilled. However, no additional soil was removed on December 28th, due to a lack of sufficient soil containment capacity. On December 29th, additional containment areas were set up. Approximately 3 to 4 feet of additional soil was removed from the pit bottom. The depth of the excavation was approximately 13 feet after the additional excavation was completed. The soil at this depth was a hard, homogeneous grey clay.

Two additional samples (1131-SS-10 and 1131-SS-11) were taken from the pit bottom after the additional soil was removed. Figure 3-35 shows the sample locations. Sample 1131-SS-10 was taken along the northern side of the pit where it appeared that the excavated soils had been discolored, possibly due to contamination from the excavated USTs. Sample 1131-SS-11 was taken along the eastern side of the pit beneath the previous location of the waste oil tank. Both samples had background readings when screened with the HNu. Both samples were analyzed for TPH and VOCs. The results

of these analyses are summarized in Table 3-15.

Samples 1131-SS-1 through 1131-SS-9 had lead concentrations below the detection limit, and Flashpoints above 200°F. The concentrations of TPH in the excavated cover soil and the pit bottom indicated that contamination of the surrounding soils has occurred. As high concentrations of TPH were found in the soil which covered the tanks, it would seem that at least a portion of the soil contamination was due to piping failures, overfilling or surface spills. Five of the samples from the pit bottom also showed elevated levels of TPH. Samples 1131-SS-10 and 1131-SS-11, taken after an additional 3-4 feet of soil was removed, did not show elevated levels of TPH.

Volatile organics were also detected in the soil samples. They included both possible petroleum degradation products and other compounds such as chlorinated organics which could have been found in the waste oil tank. Thirty-seven (37) organics were detected in various samples and the concentrations ranged as high as 13,388 ug/kg for naphthalene in 1131-SS-8. Ten VOCs were detected at ppm levels.

3.4.1.2 Soil Gas Survey

No soil gas survey was conducted at this location.

3.4.2 Current Investigation and Results

The field activities at the Reactor Area associated with the current investigation were conducted on the following dates:

Soil Sampling: 12/4/90, 12/13/90, 12/14/90 and 12/17/90
Ground Water Sampling: 1/15/91 and 1/16/91
Ground Water Level Measurements: 1/9/91, 5/9/91

The results of these sampling and analysis activities, are presented below.

3.4.2.1 Soil Sampling and Analyses

Six soil borings were completed around the Reactor Area. These borings were completed to depths ranging from 10' to 22'. PBS-RA-01 and PBS-RA-06 were planned to be background locations, while the remaining locations, PBS-RA-02 through PBS-RA-05 had been selected to characterize the contaminated area.

All of the soil borings in the Reactor Area were completed as ground water monitoring wells. These locations are shown on Figure 3-36.

3.4.2.1.1 Physical and General Stratigraphic Characteristics

Based on the six boreholes made at the Reactor Area as part of the current investigation, the overburden material at the Reactor Area has an average thickness greater than 22 feet. Figure 3-37 presents the generalized stratigraphic section for the Reactor Area showing the types of soils and the order of occurrence of the soil units encountered. The surface soil in this area is brown fine sand, with a mean thickness of 6 to 7 feet. In some places, this unit is underlain by grey fine sand which varies in thickness from 2.5 to more than 14 ft. The grey fine sand is followed by grey sandy-clayey silt, which has a maximum thickness of 4 feet and overlies the grey silty clay. At PBS-RA-01, the brown fine sand is underlain by grey sandy-clayey silt with a thickness of 8 feet. This unit was followed by grey clayey silt. The bedrock was not encountered by any boring at this area. The overburden does not appear, to the extent that it has been investigated, to be a water bearing unit. The monitoring wells exhibit low yield as was seen during well the development effort. Following the purging of about 6 gallons of water, the wells were unable to sustain enough water to continue purging.

3.4.2.1.2 Nature and Extent of Contamination

The samples collected from the boreholes at the Reactor Area were composited over the total depth of the boring except for the volatiles samples which were ranging from 4 to 10 feet below the ground surface. The complete results of the chemical analyses of these samples are presented in Table A-4 in Appendix A. A summary of the detected organic compounds is presented in Table 3-16. Excluding the probable laboratory contaminants, four (4) different volatile organic compounds were detected in this set of samples. These four volatiles (1,2-Dichloroethene (Total) at 120 ppb, 1,1,1-Trichloroethane at 22 ppb, Trichloroethene at 760 ppb, and Tetrachloroethene - 19 ppb) were all detected only in one of the six samples, PBS-RA-SB-05. This sample was taken approximately 70 feet east of the former UST location. The distribution of the organics detected in the soils at this Tank Area is presented in Figure 3-38. Table 3-16 and Figure 3-38 also indicate that five or six non-lab contaminant semivolatile organic compounds belonging to the PAH family also were reported by the laboratory for the two samples just south of the Building. As is noted, the laboratory reported estimated concentrations for these compounds at levels associated with 20% to 65% of the sample detection limit. Consequently, the listed semivolatiles may practically be considered not detected. TPH was detected at 3 of the 6 sampling locations. The highest measured value of 159 ppm, was associated with the sampling location due west of Building No. 1131 next to the roadway. The other two concentrations, for the two soil samples taken south of Building No. 1131, were approximately at the detection limit. Using the inorganics comparison methodology and criteria described earlier, no inorganics are indicated to be of concern in the soils at the Reactor Area. Two inorganics (Calcium and Magnesium) were detected at levels

exceeding their calculated UCLs indicating signicant difference from background, but these inorganics are not generally of concern with respect to toxic health hazard.

3.4.2.2 Ground Water Sampling and Analysis

3.4.2.2.1 Nature and Extent of Contamination

Two ground water samples were taken at the Reactor Area as part of the current investigation, one from a well expected to be heavily contaminated (PBS-RA-04) and one from a well expected to be clean (PBS-RA-01). The complete results of the chemical analyses of these samples are presented in Table B-4 in Appendix B. A summary of the detected organic compounds is presented in Table 3-16. As can be seen, no volatile or semivolatile organics, PCBs, or TPH were detected in either of these two samples. A very trace amount (0.097 ppb) of the insecticide Beta-BHC was detected in the presumed background well (see Figure 3-39). Because insecticides were not stored in the USTs, the presence of the Beta-BHC in ground water is not associated with the former USTs.

3.4.2.2.2 Ground Water Flow

Figures 3-40 and 3-41 present the local ground water elevation contours developed from the January 9, 1991 and May 9, 1991 ground water level measurements, respectively. The ground water elevation contours for this area reflect the presence of the underground tunnel which connects Building Nos. 1134, 1131 and 1152 in this area. A dewatering operation is taking place at this tunnel in which ground water draining into the area around the tunnel is collected and pumped out. The dewatering in this area has a pronounced local effect on ground water elevations and flow direction. The dewatering of the tunnel dominates the local ground water flow pattern in the surrounding area, including the former location of the USTs. This local effect diminishes with distance from the dewatering point, and the overall site ground water level contours shown in Figure 3-15 become more representative. In the area of the excavated tanks the ground water table during the Phase I investigation was above the level were the removed tanks had been located.

Taking the maximum theoretical hydraulic conductivity for the various soil units observed to be present at this Tank Area, the maximum horizontal ground water flow velocities associated with the January and May 1991 were calculated to be 72 and 58 feet per year, respectively. These calculated velocities are roughly a factor of 30 to 50 higher than the velocities calculated for the other areas. This calculation also highlighted the relative steepness of the gradients in this area.

3.4.2.3 Sediment Sampling and Analysis

No sediment sampling or analysis was performed at the Reactor Area as part of the current investigation.

3.4.3 Conclusions for Reactor Area

Although the USTs removed at the Reactor Area appeared to be in good condition structurally, with no holes or cracks, initial soil sampling identified significantly elevated levels of a variety of fuel products and solvent compounds in the soil beneath and surrounding the tanks. The most recent sampling confirmed the presence of solvents in the soils from the sampling locations next to the south side of Building No. 1131. Trace or low levels of TPH were found in the three soil samples taken adjacent to the south or west sides of the Building. Trace levels of a number of semivolatile PAH compounds were also found in the samples closest to the former UST location. It is not clear at this time that the source of the PAHs is the former USTs, given the low concentrations of these compounds reported by the laboratory. No inorganics were highlighted to be of possible concern based on the current investigation. No PCBs were detected in any soil or ground water sample and a trace level of an insecticide was detected in the intended "background" location ground water sample for this Tank Area.

Transport and migration of contamination from the former UST locations at the Reactor Area would appear to be dictated by the movement of ground water and the apparent tunnel dewatering operation. This activity, as reflected in the local ground water level contours constructed for this Tank Area, would appear to be drawing the contamination away from the former UST locations toward the northwest. As the collected ground water is not treated before being discharged into Pentolite Ditch, any contaminated ground water collected at the tunnel would be transported directly to the surface water and sediments in the Ditch.

TABLE 3-1
Results of Soil Analyses for the Building 7132 Tank Area
at the Garage and Maintenance Area

	Benzene ug/Kg	Toluene ug/Kg	Ethylbenzene ug/Kg	Xylene ug/Kg	TPH mg/Kg
Ohio EPA standards*	6	4000	6000	28000	40
Pit Bottom Samples					
7132-SS-1F	320	39	200	1100	341.7
7132-SS-1M	14000	8700	3600	19000	48.5
7132-SS-2F	3400	550	420 U	5200	56.6
7132-SS-2V	43000	30000	11000	96000	616.6
7132-SS-2M	2200 U	2900	2200 U	7600	503
7132-SS-3F	120	56	150	1900	186
7132-SS-3V	140 U	1100	280	5100	29
7132-SS-3M	4 U	4 U	4.9	12	253.8
Pump Island Sample					
7132-SSPI-1	2800	54000	47000	400000	2817
Soil Pile Samples**					
7132-SSP-1	0.22 U	0.22 U	0.22 U	0.22 U	76
7132-SSP-2	0.23 U	0.23 U	0.41	1.3	67
7132-SSP-3	1.3	0.47	0.28 U	0.28 U	83
7132-SSP-4	0.23 U	0.23 U	10	5.1	621
Soil Boring Samples					
7132-SB-1CAP	15.03	1.5	1.06	4.74	38 U
7132-SB-1SAT	14.42	1.41	0.69	3.23	39 U
7132-SB-2CAP	0.31	0.56	0.31	0.65	47 U
7132-SB-2SAT	0.26	0.31	0.39	0.39	51
7132-SB-3CAP	0.44	2.37	0.69	1.57	46 U
7132-SB-3SAT	0.26	0.42	0.26	0.3	39 U
7132-SB-4CAP	0.25	0.31	0.25	0.235	38 U
7132-SB-4SAT	0.24	0.35	0.26	0.25	38

U Undetected

* Ohio EPA Document #PP0103200, Interim Final Guidance on Petroleum Contaminated Soil; March 25, 1991

** All soil samples exhibited EP Tox Lead <500 ug/L and Flashpoint >200 F.

TABLE 3-2
Results of Surface Water Analyses for the Building 7132 Tank Area
at the Garage and Maintenance Area

	Benzene ug/L	Toluene ug/L	Ethylbenzene ug/L	Xylene ug/L	TPH mg/L
Standing Water Samples					
7132-SW-1SH	55	18	20	79	35
7132-SW-1A	2 U	2 U	2 U	2 U	1 U
7132-SW-3A	2 U	2 U	2 U	2 U	56.2
Seep Material Sample					
7132-SW-3SE	2 U	2 U	2 U	2 U	1.6 U

U Undetected

TABLE 3-3
Results of Ground Water Analyses for the Building 7132 Tank Area
at the Garage and Maintenance Area

	Benzene ug/L	Toluene ug/L	Ethylbenzene ug/L	Xylene ug/L	TPH mg/L
Monitoring Well Samples					
7132-GW-1	58	1.6	0.4	6.1	1 U
7132-GW-2	0.2 U	0.18	0.2 U	0.2 U	1 U
7132-GW-3	0.2 U	0.2 U	0.2 U	0.2 U	1 U
7132-GW-4	0.2 U	0.2 U	0.2 U	0.2 U	1 U
7132-GW-4DUP	0.2 U	0.2 U	0.2 U	0.2 U	1 U

U Undetected

TABLE 3–4
Results of the Soil Analyses during the Additional Soil Excavation
at the Building 7132 Tank Area at the Garage and Maintenance Area

	Benzene ug/Kg	Toluene ug/Kg	Ethylbenzene ug/Kg	Xylene ug/Kg	TPH mg/Kg
Soil Samples					
7132-SS-1	0.26 U	1.10	0.26 U	0.35	166
7132-SS-2	420.00	8.90	0.79	4.00	132
7132-SS-3	3.10	0.85	0.25 U	0.27	159
7132-SS-4	3.20	3.80	0.59	2.70	190
7132-SS-5	0.25 U	1.60	0.25 U	0.25 U	121
7132-SS-6	0.24 U	1.10	0.24 U	0.24 U	118
7132-PI-1	0.24 U	1.20	0.24 U	1.70	79
7132-PI-2	0.95	9.50	2.30	5.60	39 U
7132-PI-3	0.46	7.70	0.25 U	0.25 U	40 U
7132-PI-4	0.60	3.00	0.37	0.94	40 U
7132-PI-5	1.30	0.64	0.25 U	0.25 U	81
7132-PI-6	0.30	1.80	0.25 U	0.25 U	41 U

U Undetected

TABLE 3-5
Results of Soil Analyses for the Building 7121 Tank Area
at the Garage and Maintenace Area

	Maximum Concentration Detected in Soil			
	Building 7121 Tank #28		Building 7121 Tanks #29, #30, #31	
Volatile Organic Compounds	ug/Kg	Frequency	ug/Kg	Frequency
Dichlorodifluoromethane	ND	-	ND	-
Chloromethane	ND	-	ND	-
Vinyl Chloride	ND	-	3	1 / 4
Bromomethane	ND	-	ND	-
Chloroethane	10	1 / 5	34	1 / 4
Trichlorofluoromethane	28	5 / 5	4	3 / 4
1,1 Dichloroethene	44	3 / 5	13	3 / 4
Methylene Chloride	249	5 / 5	4	3 / 4
trans-1,2-Dichloroethene	2	2 / 4	ND	-
1,1 Dichloroethane	1214	5 / 5	70	4 / 4
cis-1,2 Dichloroethene	188	4 / 4	ND	-
2,2 Dichloropropane	ND	-	ND	-
Chloroform	1	2 / 4	ND	-
Bromochloromethane	ND	-	ND	-
1,1,1-Trichloroethane	7700	5 / 5	610	4 / 4
1,1 Dichloropropene	ND	-	ND	-
Carbon Tetrachloride	431	5 / 5	94	3 / 4
1,2 Dichloroethane	96	3 / 5	3	1 / 4
Benzene	14	2 / 5	ND	-
Trichloroethene	21142	5 / 5	200	4 / 4
1,2 Dichloropropane	ND	-	ND	-
Bromodichloromethane	1	1 / 5	ND	-
Dibromomethane	ND	-	ND	-
Toluene	1101	5 / 5	2	3 / 4
1,1,2-Trichloroethane	212	5 / 5	1	1 / 4
1,3 Dichloropropane	ND	-	ND	-
Tetrachloroethene	10048	5 / 5	8	4 / 4
Dibromochloromethane	ND	-	ND	-
1,2-Dibromomethane-EDB	ND	-	ND	-
Chlorobenzene	ND	-	1	2 / 4
Ethylbenzene	411	4 / 5	1	1 / 4
1,1,1,2-Tetrachloroethane	ND	-	ND	-
m & p -Xylenes	395	4 / 5	2	1 / 4
o-Xylene	137	4 / 5	1	1 / 4
Styrene	ND	-	ND	-
1,1,2,2-Tetrachloroethane	4	2 / 5	ND	-
Isopropylbenzene	10	2 / 4	ND	-
Bromoform	ND	-	ND	-
1,2,3- Trichloropropane	ND	-	ND	-
n-Propylbenzene	31	2 / 4	ND	-
Bromobenzene	ND	-	ND	-
1,3,5 Trimethylbenzene	442	3 / 4	ND	-

ND Not Detected

TABLE 3-5 Continued
Results of Soil Analyses for the Building 7121 Tank Area
at the Garage and Maintenace Area

	Maximum Concentration Detected in Soil			
	Building 7121 Tank #28		Building 7121 Tanks #29, #30, #31	
Volatile Organic Compounds	ug/Kg	Frequency	ug/Kg	Frequency
4-Chlorotoluene	ND	-	ND	-
2-Chlorotoluene	ND	-	ND	-
tert-Butylbenzene	40	2 / 4	ND	-
1,2,4 Trimethylbenzene	479	3 / 4	ND	-
sec-Butylbenzene	8	1 / 4	ND	-
p-Isopropyltoluene	22	1 / 4	ND	-
1,3 Dichlorobenzene	ND	-	2	1 / 4
1,4 Dichlorobenzene	1	1 / 4	2	1 / 4
n-Butylbenzene	ND	-	ND	-
1,2 Dichlorobenzene	ND	-	1	1 / 4
1,2-Dibromo-3-Chloropropane	ND	-	ND	-
1,2,4 Trichlorobenzene	1	1 / 4	ND	-
Hexachlorobutadiene	ND	-	ND	-
Naphthalene	268	4 / 4	ND	-
1,2,3 Trichlorobenzene	55	2 / 4	ND	-
Acetone	28	1 / 1	380	1 / 4
Acrylonitrile	ND	-	ND	-
Acrolein	ND	-	ND	-
Carbon Disulfide	ND	-	2	2 / 4
1,2-Dichloroethene (Total)	19	1 / 1	3	1 / 4
2-Butanone	ND	-	86	1 / 4
Vinyl Acetate	ND	-	ND	-
trans-1,3-Dichloropropene	ND	-	ND	-
cis-1,3-Dichloropropene	ND	-	ND	-
2-Chloroethylvinylether	ND	-	ND	-
4-Methyl-2-Pentanone	ND	-	ND	-
2-Hexanone	ND	-	7	1 / 4
TPH (mg/Kg)	284	3 / 5	287	1 / 3

ND Not Detected

TABLE 3-6
Results of Soil Analyses for the Building 7131 Tank Area
at the Garage and Maintenace Area

	Maximum Concentration Detected in Soil	
	Building 7131 Tank #32	
Volatile Organic Compounds	ug/Kg	Frequency
Dichlorodifluoromethane	ND	-
Chloromethane	ND	-
Vinyl Chloride	ND	-
Bromomethane	ND	-
Chloroethane	ND	-
Trichlorofluoromethane	17	1 / 5
1,1 Dichloroethene	ND	-
Methylene Chloride	70	4 / 5
trans-1,2-Dichloroethene	ND	-
1,1 Dichloroethane	40	1 / 5
cis-1,2 Dichloroethene	ND	-
2,2 Dichloropropane	ND	-
Chloroform	ND	-
Bromochloromethane	ND	-
1,1,1-Trichloroethane	23	5 / 5
1,1 Dichloropropene	ND	-
Carbon Tetrachloride	2	2 / 5
1,2 Dichloroethane	370	1 / 5
Benzene	ND	-
Trichloroethene	728	5 / 5
1,2 Dichloropropane	ND	-
Bromodichloromethane	ND	-
Dibromomethane	ND	-
Toluene	1	2 / 5
1,1,2-Trichloroethane	ND	-
1,3 Dichloropropane	ND	-
Tetrachloroethene	17	1 / 5
Dibromochloromethane	ND	-
1,2-Dibromomethane-EDB	ND	-
Chlorobenzene	ND	-
Ethylbenzene	2	1 / 5
1,1,1,2-Tetrachloroethane	ND	-
m-Xylene	2	1 / 5
o&p-Xylene	ND	-
Styrene	ND	-
1,1,2,2-Tetrachloroethane	ND	-
Isopropylbenzene	ND	-
Bromoform	ND	-
1,2,3- Trichloropropane	ND	-
n-Propylbenzene	ND	-
Bromobenzene	ND	-
1,3,5-Trimethylbenzene	366	1 / 5

ND Not Detected

TABLE 3-6 Continued
Results of Soil Analyses for the Building 7131 Tank Area
at the Garage and Maintenace Area

	Maximum Concentration Detected in Soil	
	Building 7131 Tank #32	
Volatile Organic Compounds	ug/Kg	Frequency
4-Chlorotoluene	ND	-
2-Chlorotoluene	ND	-
tert-Butylbenzene	ND	-
1,2,4-Trimethylbenzene	349	2 / 5
sec-Butylbenzene	ND	-
p-Isopropyltoluene	ND	-
1,3 Dichlorobenzene	ND	-
1,4 Dichlorobenzene	ND	-
n-Butylbenzene	ND	-
1,2 Dichlorobenzene	ND	-
1,2-Dibromo-3-Chloropropane	ND	-
1,2,4-Trichlorobenzene	ND	-
Hexachlorobutadiene	14	1 / 5
Napthalene	159	5 / 5
1,2,3-Trichlorobenzene	18	1 / 5
TPH (mg/Kg)	244	4 / 5

ND Not Detected

TABLE 3-7
Soil Gas Survey Results for
the Garage and Maintenance Tank Area

SAMPLE ID	CONCENTRATIONS (ppb) DCE	BENZENE	TCE	TOLUENE	PCE	XYLENE	NOTES
	dl=5	dl=5	dl=5	dl=5	dl=5	dl=10	
7121-1							
7121-2							*
7121-3			20				
7121-3			22				
7121-4			4600				
7121-4			9500				
7121-5		10		6.7		21	*
7121-6		49	1700				*
7121-7				190		290	*
7121-7		1400	1200	22		22	*
7121-8		26000	4200	730		260	*
7121-9	23	59					*
7121-9	170	110					*
7121-10		5.4	8.2				
7121-11		39000	670			100	*
7121-12		110		5.5			
7121-13							
7121-14		900	120				*
7121-14		120	12				*
7121-15						13	
7121-15						12	
7121-16							
7121-17		260	150	85			*
7121-18							
7121-19							
7121-20						17	
7121-21						27	
7121-22							
7121-23			110				
7121-23			140				
7121-24		2200	54				*
7121-25		22					*
7121-26							
7121-27							

NOTES:

Blank cell indicates below detection limit (<dl)

A sample listed twice is a field duplicate

* indicates multipie peak response commonly associated with a fuel product

TABLE 3-7 (Continued)
Soil Gas Survey Results for
the Garage and Maintenance Tank Area

SAMPLE ID	CONCENTRATIONS (ppb)						
	DCE	BENZENE	TCE	TOLUENE	PCE	XYLENE	NOTES
	dl=5	dl=5	dl=5	dl=5	dl=5	dl=10	
7131-1			11	16		58	*
7131-2							
7131-3							
7131-4							
7131-5		28					*
7131-5							
7131-6							
7131-7							
7131-8							
7131-9							
7131-10							
7131-11							
7131-12							
7132-3		25					*
7132-3		190					*
7132-4		31				28	*
7132-9							*
7132-10	170						*
A1							
A2							
A3		5.6		22		112	*
A3							*
A4		7.1	12	34			*
A5		78					*
A6							
A7				5.9			*
A8							
A9			6.8	4.7			*
A10		9.7	7.4			89	*
A10				53			*
A11			7.7				*
A13							

NOTES:

Blank cell indicates below detection limit (<dl)

A sample listed twice is a field duplicate

* indicates multiple peak response commonly associated with a fuel product

TABLE 3-7 (Continued)
Soil Gas Survey Results for
the Garage and Maintenance Tank Area

SAMPLE ID	CONCENTRATIONS (ppb)						
	DCE	BENZENE	TCE	TOLUENE	PCE	XYLENE	NOTES
	dl=5	dl=5	dl=5	dl=5	dl=5	dl=10	
A17							*
A18							*
A19				8.6			*
A20							
A21							
A22							
D1							
D2							
D4							
D5					12		
D5					6.1		
D26					6.4		
D26					6.8		
D7							
D8				13		12	
D9							
D10							
D11							
D12							
D13							
D14							
D15							
D16							
D17							
D17			21				
D27				9.7			
D28			23				
D29							
E1			42				

NOTES:
Blank cell indicates below detection limit (<dl)
A sample listed twice is a field duplicate
* indicates multiple peak response commonly associated with a fuel product

TABLE 3-8
SUMMARY OF ORGANIC CONTAMINANTS DETECTED AT THE
GARAGE AND MAINTENANCE AREA.

GARAGE AND MAINTENANCE AREA	MAXIMUM CONCENTRATION DETECTED IN					
	SOIL		GROUND WATER		SEDIMENT	
VOLATILE ORGANIC COMPOUNDS	ug/Kg	Freq.	ug/L	Freq.	ug/Kg	Freq.
Methylene Chloride •	120	6/7	ND		21	2/2
Acetone •	110	6/7	ND		94	2/2
Carbon Disulfide •	400 E	6/7	ND		ND	
1,1-Dichloroethene	61	1/7	20	1/2	ND	
1,1-Dichloroethane	50	2/7	24	1/2	21	1/2
2-Butanone	6200	1/7	ND		ND	
1,1,1-Trichloroethane	2000	3/7	120	1/2	ND	
Carbon Tetrachloride	260	1/7	ND		ND	
Bromodichloromethane	6	1/7	ND		ND	
Trichloroethene	55	1/7	7	1/2	ND	
Tetrachloroethene	24	1/7	ND		ND	
1,1,2,2-Tetrachloroethane	35	2/7	ND		ND	
Ethylbenzene	21	1/7	ND		ND	
SEMIVOLATILE ORGANIC COMPOUNDS	ug/Kg	Freq.	ug/L	Freq.	ug/Kg	Freq.
Phenanthrene	ND		ND		1200 J	2/2
Anthracene	ND		ND		220 J	1/2
Fluoranthene	ND		ND		3700	2/2
Pyrene	ND		ND		2200	2/2
Butylbenzylphthalate	ND		6 J	1/2	ND	
Benzo(a)anthracene	ND		ND		1200 J	2/2
Chrysene	ND		ND		1600 J	2/2
bis(2-Ethylhexyl)phthalate •	5400	7/7	7 J	1/2	4300	1/2
Di-n-octyl Phthalate	ND		14	1/2	ND	
Benzo(b)fluoranthene	ND		ND		2400	2/2
Benzo(k)fluoranthene	ND		ND		2200	2/2
Benzo(a)pyrene	ND		ND		850 J	1/2
Indeno(1,2,3-cd)pyrene	ND		ND		850 J	1/2
Dibenzo(a,h)anthracene	ND		ND		280 J	1/2
Benzo(g,h,i)perylene	ND		ND		710 J	1/2
PESTICIDE / PCBs COMPOUNDS	ug/Kg	Freq.	ug/L	Freq.	ug/Kg	Freq.
Beta-BHC	ND		0.19	2/2	82	2/2
Delta-BHC	ND		ND		370	1/2
TOTAL PETROLEUM HYDROCARBONS	mg/Kg	Freq.	mg/L	Freq.	mg/Kg	Freq.
TPH	129	2/7	ND		2620	2/2

NOTES : • Probable Laboratory Contaminants (See Text)
J Estimated, Value Below the Quantitation Limit
E Concentration Exceeds Calibration Range of GC/MS Instrument
ND Not Detected

TABLE 3-9
Results of Soil Analyses for the Building 1411 Tank Area
at the Space Power Facility

	Maximum Concentration Detected in Soil	
	Building 1411 Tanks #24, 25	
Volatile Organic Compounds	ug/Kg	Frequency
Dichlorodifluoromethane	ND	-
Chloromethane	ND	-
Vinyl Chloride	ND	-
Bromomethane	ND	-
Chloroethane	ND	-
Trichlorofluoromethane	93	6 / 9
1,1 Dichloroethene	22	2 / 9
Methylene Chloride	164	9 / 9
trans-1,2-Dichloroethene	17	2 / 6
1,1 Dichloroethane	228	9 / 9
cis-1,2 Dichloroethene	362	3 / 6
2,2 Dichloropropane	ND	-
Chloroform	ND	-
Bromochloromethane	ND	-
1,1,1-Trichloroethane	1254	9 / 9
1,1 Dichloropropene	ND	-
Carbon Tetrachloride	213	5 / 9
1,2 Dichloroethane	5	3 / 9
Benzene	11	5 / 9
Trichloroethene	1432	9 / 9
1,2 Dichloropropane	ND	-
Bromodichloromethane	ND	-
Dibromomethane	ND	-
Toluene	16	5 / 9
1,1,2-Trichloroethane	11	1 / 9
1,3 Dichloropropane	ND	-
Tetrachloroethene	342	4 / 9
Dibromochloromethane	ND	-
1,2-Dibromomethane-EDB	ND	-
Chlorobenzene	ND	-
Ethylbenzene	45	5 / 9
1,1,1,2-Tetrachloroethane	ND	-
m & p -Xylenes	43	5 / 9
o-Xylene	33	5 / 9
Styrene	ND	-
1,1,2,2-Tetrachloroethane	ND	-
Isopropylbenzene	31	3 / 6
Bromoform	ND	-
1,2,3- Trichloropropane	ND	-
n-Propylbenzene	76	3 / 6
Bromobenzene	ND	-
1,3,5 Trimethylbenzene	496	5 / 6

ND Not Detected

TABLE 3-9 Continued
Results of Soil Analyses for the Building 1411 Tank Area
at the Space Power Facility

	Maximum Concentration Detected in Soil	
	Building 1411 Tanks #24, 25	
Volatile Organic Compounds	ug/Kg	Frequency
4-Chlorotoluene	3	1 / 6
2-Chlorotoluene	3	1 / 6
tert-Butylbenzene	70	3 / 6
1,2,4 Trimethylbenzene	541	5 / 6
sec-Butylbenzene	37	3 / 6
p-Isopropyltoluene	74	3 / 6
1,3 Dichlorobenzene	ND	-
1,4 Dichlorobenzene	ND	-
n-Butylbenzene	ND	-
1,2 Dichlorobenzene	8	1 / 9
1,2-Dibromo-3-Chloropropane	ND	-
1,2,4 Trichlorobenzene	10	2 / 6
Hexachlorobutadiene	ND	-
Naphthalene	1094	6 / 6
1,2,3 Trichlorobenzene	40	2 / 6
Acetone	54	3 / 3
Acrylonitrile	ND	-
Acrolein	ND	-
Carbon Disulfide	1	1 / 3
1,2-Dichloroethene (Total)	3	2 / 3
2-Butanone	ND	-
Vinyl Acetate	ND	-
trans-1,3-Dichloropropene	ND	-
cis-1,3-Dichloropropene	ND	-
2-Chloroethylvinylether	ND	-
4-Methyl-2-Pentanone	10	2 / 3
2-Hexanone	39	3 / 3
TPH (mg/Kg)	2030	9 / 9

ND Not Detected

TABLE 3–10
Soil Gas Survey Results for
the Space Power Facility Tank Area

SAMPLE ID	CONCENTRATIONS (ppb) DCE	BENZENE	TCE	TOLUENE	PCE	XYLENE	NOTES
	dl=5	dl=5	dl=5	dl=5	dl=5	dl=5	
1411-1							
1411-2				60		130	*
1411-3						5.1	
1411-4							
1411-5		98		6.7			*
1411-6							
1411-7				35			*
1411-8							
1411-9				210		160	*
1411-9		200		71		16	*
1411-10				470		280	*
1411-10		2000				130	*
1411-11							
1411-12							*
1411-12						9.6	*
1411-13				10		24	*
1411-14				10		5.6	*
1411-15			700	29			*
1411-15		110		26			*
1411-16							
C1				17			*
C2							*
C3							*
C4							*
C5		270		150			*
C6							

NOTES:
Blank cell indicates below detection limit (<dl)
A sample listed twice is a field duplicate
* indicates multiple peak response commonly associated with a fuel product

TABLE 3-11
SUMMARY OF ORGANIC CONTAMINANTS DETECTED AT THE
SPACE POWER FACILITY AREA

SPACE POWER FACILITY AREA	MAXIMUM CONCENTRATION DETECTED IN					
	SOIL		GROUND WATER		SEDIMENT	
VOLATILE ORGANIC COMPOUNDS	ug/Kg	Freq.	ug/L	Freq.	ug/Kg	Freq.
Methylene Chloride *	71	6/6	ND		4 J	1/2
Acetone *	130 B	5/6	ND		ND	
Trichloroethene	2 J	1/6	ND		ND	
SEMIVOLATILE ORGANIC COMPOUNDS	ug/Kg	Freq.	ug/L	Freq.	ug/Kg	Freq.
Naphthalene	56 J	1/6	ND		ND	
2-Methylnaphthalene	670	1/6	ND		ND	
Phenanthrene	330 J	1/6	ND		200 J	1/2
Fluoranthene	ND		ND		890 J	1/2
Pyrene	ND		ND		980	1/2
Benzo(a)anthracene	ND		ND		490 J	1/2
Chrysene	ND		ND		590 J	1/2
bis(2-Ethylhexyl)phthalate *	ND		ND		490 J	1/2
Benzo(b)fluoranthene	ND		ND		680 J	1/2
Benzo(k)fluoranthene	ND		ND		890 J	1/2
Benzo(a)pyrene	ND		ND		680 J	1/2
Indeno(1,2,3-cd)pyrene	ND		ND		490 J	1/2
PESTICIDE / PCBs COMPOUNDS	ug/Kg	Freq.	ug/L	Freq.	ug/Kg	Freq.
Aroclor-1254	ND		ND		1600	1/2
TOTAL PETROLEUM HYDROCARBONS	mg/Kg	Freq.	mg/L	Freq.	mg/Kg	Freq.
TPH	288	3/6	ND		1320	2/2

NOTES : * Probable Laboratory Contaminants (See Text)
J Estimated, Value Below the Quantitation Limit
B Analyte Found in Associated Blank
ND Not Detected

TABLE 3-12
Results of Soil Analyses for the Building 8133 Tank Area
at the Pump Station

	Benzene ug/Kg	Toluene ug/Kg	Ethylbenzene ug/Kg	Xylene ug/Kg	TPH mg/Kg
8133-SS-1	1400	7200	4400	16000	655
8133-SS-2	62	103	15	65	44 U
8133-SS-3	0.19	0.77	0.27	0.94	42 U

U Undetected

TABLE 3-13
Soil Gas Survey Results for
the Pump Station Tank Area

SAMPLE ID	CONCENTRATIONS (ppb)						
	DCE	BENZENE	TCE	TOLUENE	PCE	XYLENE	NOTES
	dl=5	dl=5	dl=5	dl=5	dl=5	dl=5	
8133-1							*
8133-2							*
8133-2							*
8133-3				8.9			*
8133-5				8.8			*
8133-7							*
8133-8							*
8133-9		7.1				33	*
8133-10		8				16	*
8133-11							*
8133-13		550		200		320	*
B1							
B3							
B4							
B5							

NOTES:
Blank cell indicates below detection limit (<dl)
A sample listed twice is a field duplicate
* indicates multiple peak response commonly associated with a fuel product

TABLE 3-14
SUMMARY OF ORGANIC CONTAMINANTS DETECTED AT THE
PUMP STATION AREA

PUMP STATION AREA	MAXIMUM CONCENTRATION DETECTED IN					
	SOIL		GROUND WATER		SEDIMENT	
VOLATILE ORGANIC COMPOUNDS	ug/Kg	Freq.	ug/L	Freq.	ug/Kg	Freq.
Methylene Chloride *	55	4/4	ND		ND	
Acetone *	510 E	3/4	12 B	1/2	ND	
Carbon Disulfide *	12	3/4	ND		ND	
Trichloroethene	25	1/4	ND		ND	
SEMIVOLATILE ORGANIC COMPOUNDS	ug/Kg	Freq.	ug/L	Freq.	ug/Kg	Freq.
Fluoranthene	130 J	1/4	ND		490 J	1/1
Pyrene	84 J	1/4	ND		390 J	1/1
bis(2-Ethylhexyl)phthalate *	1700	3/4	ND		ND	
Benzo(a)anthracene	ND		ND		300 J	1/1
Chrysene	ND		ND		300 J	1/1
Benzo(b)fluoranthene	ND		ND		300 J	1/1
Benzo(k)fluoranthene	ND		ND		490 J	1/1
Benzo(a)pyrene	ND		ND		300 J	1/1
Indeno(1,2,3-cd)pyrene	ND		ND		300 J	1/1
Benzo(g,h,i)perylene	ND		ND		200 J	1/1
PESTICIDE / PCBs COMPOUNDS	ug/Kg	Freq.	ug/L	Freq.	ug/Kg	Freq.
NONE	-		-		-	
TOTAL PETROLEUM HYDROCARBONS	mg/Kg	Freq.	mg/L	Freq.	mg/Kg	Freq.
TPH	125	4/4	ND		90	1/1

NOTES : * Probable Laboratory Contaminants (See Text)
J Estimated, Value Below the Quantitation Limit
E Concentration Exceeds Calibration Range of GC/MS Instrument
B Analyte Found in Associated Blank
ND Not Detected

TABLE 3-15
Results of Soil Analyses for the Building 1131 Tank Area
at the Reactor Area

	Maximum Concentration Detected in Soil	
	Building 1131 Tanks #21, 22, 23	
Volatile Organic Compounds	ug/Kg	Frequency
Dichlorodifluoromethane	61	4 / 11
Chloromethane	ND	-
Vinyl Chloride	ND	-
Bromomethane	ND	-
Chloroethane	990	2 / 11
Trichlorofluoromethane	120	3 / 11
1,1 Dichloroethene	ND	-
Methylene Chloride	503	6 / 11
trans-1,2-Dichloroethene	17	1 / 11
1,1 Dichloroethane	6120	4 / 11
cis-1,2 Dichloroethene	165	1 / 11
2,2 Dichloropropane	ND	-
Chloroform	1	1 / 11
Bromochloromethane	ND	-
1,1,1-Trichloroethane	891	4 / 11
1,1 Dichloropropene	ND	-
Carbon Tetrachloride	91	1 / 11
1,2 Dichloroethane	178	1 / 11
Benzene	32	6 / 11
Trichloroethene	1019	6 / 11
1,2 Dichloropropane	ND	-
Bromodichloromethane	23	1 / 11
Dibromomethane	ND	-
Toluene	41	7 / 11
1,1,2-Trichloroethane	143	1 / 11
1,3 Dichloropropane	ND	-
Tetrachloroethene	1043	2 / 11
Dibromochloromethane	ND	-
1,2-Dibromomethane-EDB	ND	-
Chlorobenzene	ND	-
Ethylbenzene	1093	9 / 11
1,1,1,2-Tetrachloroethane	375	3 / 11
m & p -Xylenes	1115	9 / 11
o-Xylene	703	8 / 11
Styrene	ND	-
1,1,2,2-Tetrachloroethane	463	6 / 11
Isopropylbenzene	380	5 / 11
Bromoform	ND	-
1,2,3- Trichloropropane	9	1 / 11
n-Propylbenzene	612	6 / 11
Bromobenzene	ND	-
1,3,5 Trimethylbenzene	4365	10 / 11

ND Not Detected

TABLE 3-15 Continued
Results of Soil Analyses for the Building 1131 Tank Area
at the Reactor Area

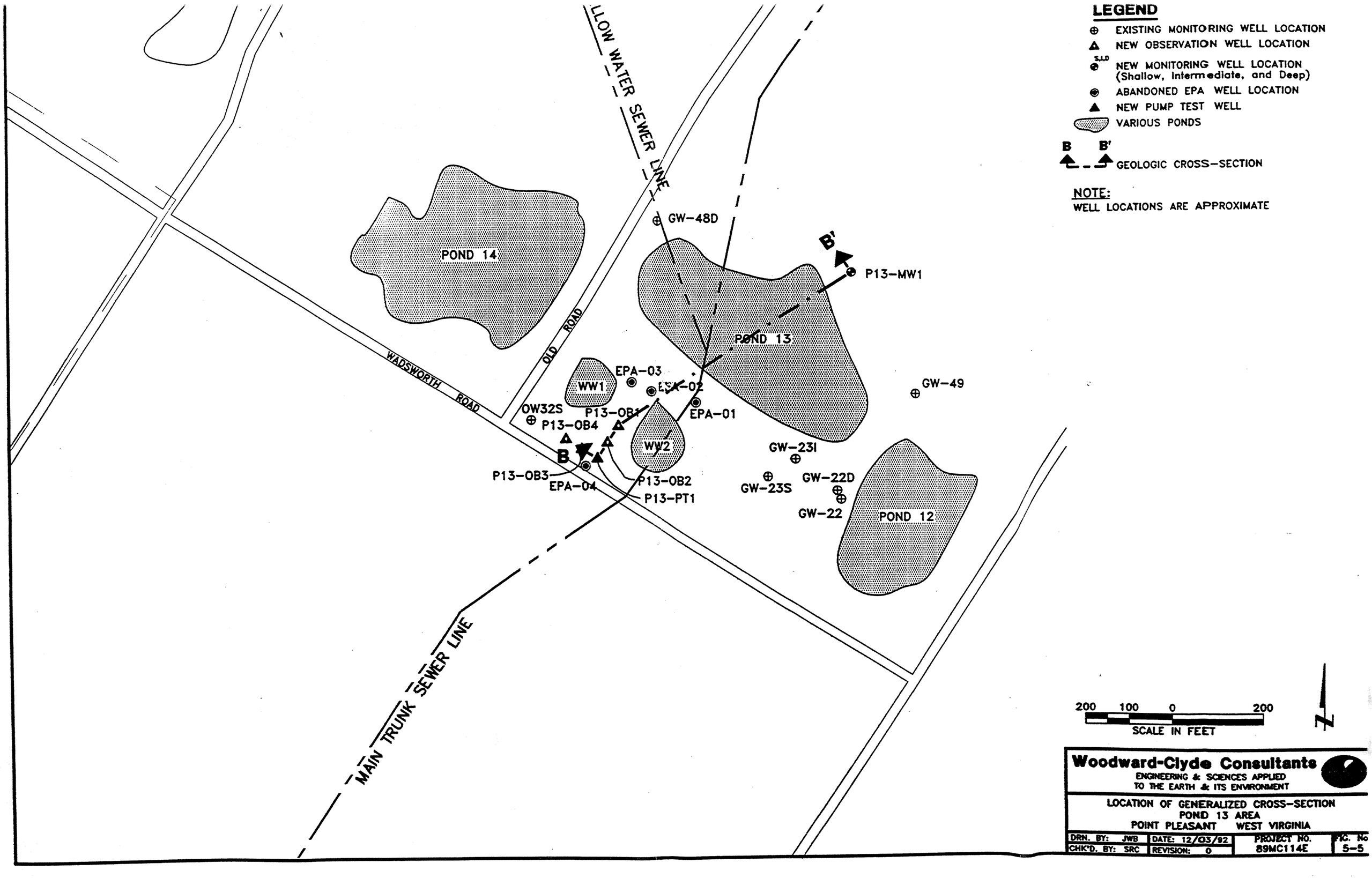
	Maximum Concentration Detected in Soil	
	Building 1131 Tanks #21, 22, 23	
Volatile Organic Compounds	ug/Kg	Frequency
4-Chlorotoluene	ND	-
2-Chlorotoluene	ND	-
tert-Butylbenzene	645	9 / 11
1,2,4 Trimethylbenzene	4413	10 / 11
sec-Butylbenzene	858	7 / 11
p-Isopropyltoluene	1854	6 / 11
1,3 Dichlorobenzene	2	1 / 11
1,4 Dichlorobenzene	2	1 / 11
n-Butylbenzene	ND	-
1,2 Dichlorobenzene	31	1 / 11
Dibromo-3-Chloropropane	ND	-
1,2,4 Trichlorobenzene	575	5 / 11
Hexachlorobutadiene	404	2 / 11
Naphthalene	13388	11 / 11
1,2,3 Trichlorobenzene	1025	10 / 11
TPH (mg/Kg)	3570	9 / 11

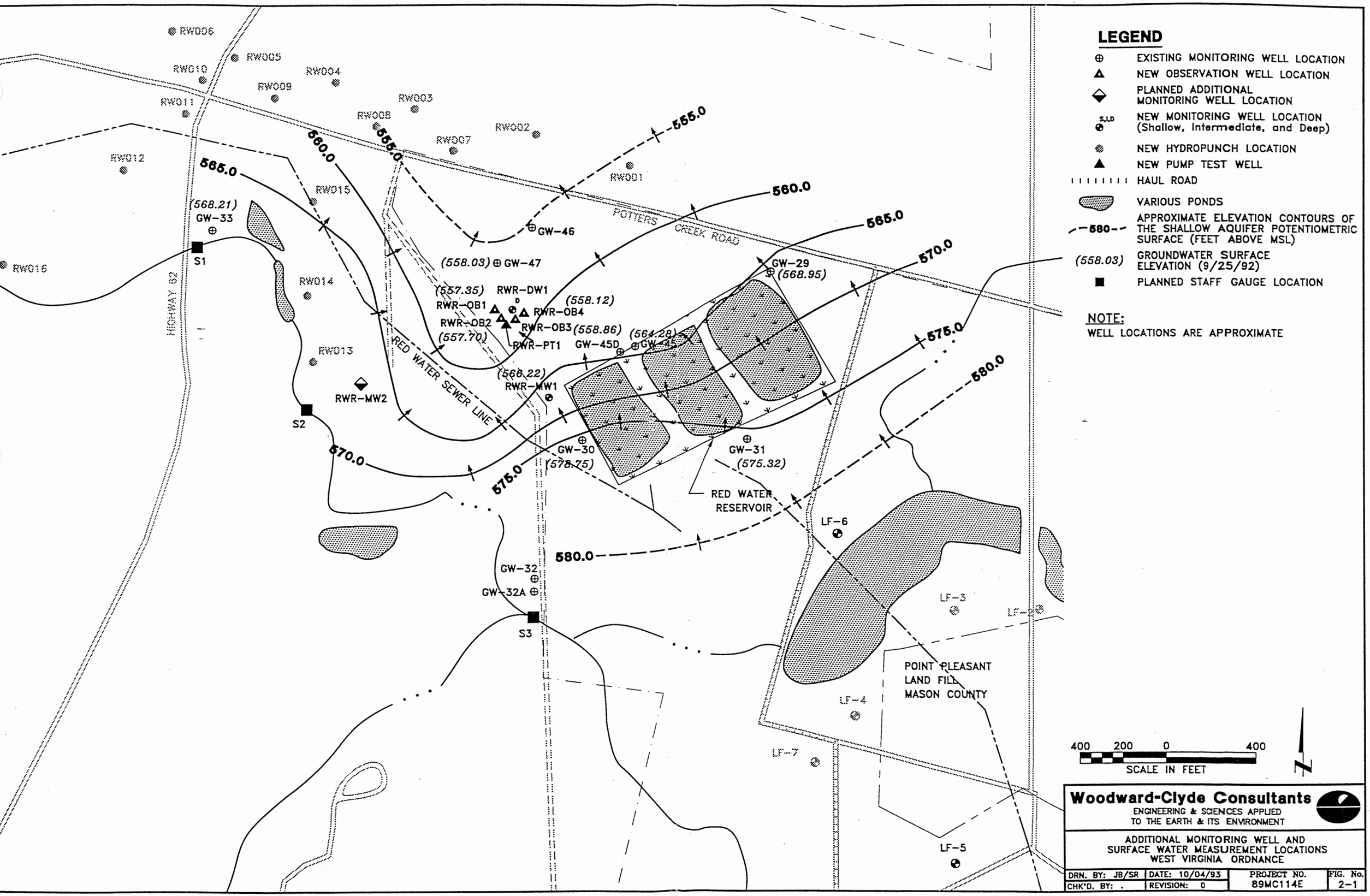
ND Not Detected

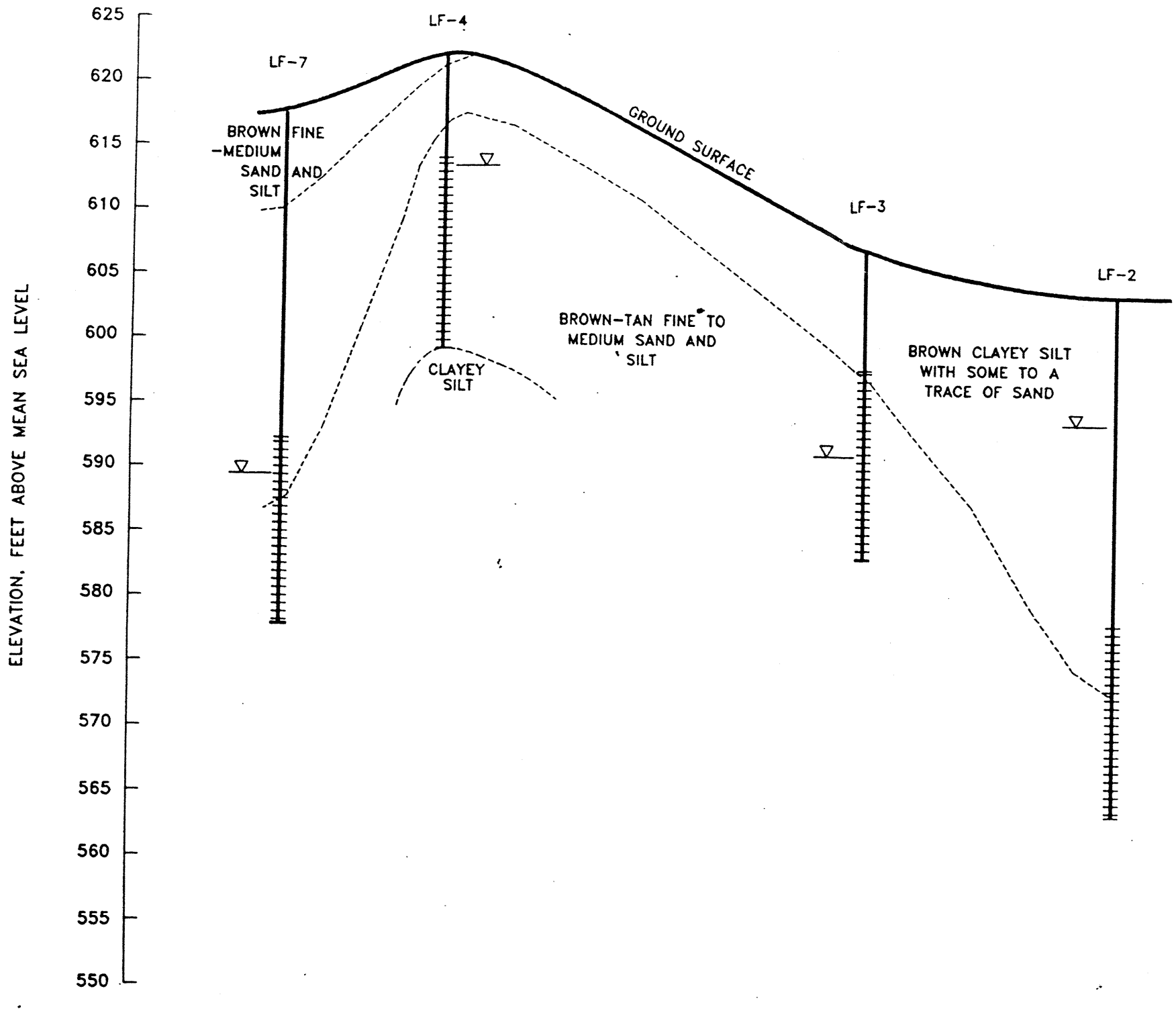
TABLE 3-16
SUMMARY OF ORGANIC CONTAMINANTS DETECTED AT THE REACTOR AREA

REACTOR AREA	MAXIMUM CONCENTRATION DETECTED IN			
	SOIL		GROUND WATER	
VOLATILE ORGANIC COMPOUNDS	ug/Kg	Freq.	ug/L	Freq.
Methylene Chloride •	95	5/6	ND	
Acetone •	320 BE	4/6	ND	
Carbon Disulfide •	31	3/6	ND	
1,2-Dichloroethene (Total)	120	1/6	ND	
1,1,1-Trichloroethane	22	1/6	ND	
Trichloroethene	760 E	1/6	ND	
Tetrachloroethene	19	1/6	ND	
SEMIVOLATILE ORGANIC COMPOUNDS	ug/Kg	Freq.	ug/L	Freq.
Phenanthrene	290 J	2/6	ND	
Anthracene	93 J	1/6	ND	
Fluoranthene	270 J	2/6	ND	
Pyrene	230 J	2/6	ND	
Benzo(a)anthracene	130 J	2/6	ND	
Chrysene	130 J	2/6	ND	
bis(2-Ethylhexyl)phthalate *	590	1/6	ND	
PESTICIDE / PCBs COMPOUNDS	ug/Kg	Freq.	ug/L	Freq.
Beta-BHC	ND		0.097	1/2
TOTAL PETROLEUM HYDROCARBONS	mg/Kg	Freq.	mg/L	Freq.
TPH	159	3/6	ND	

NOTES : • Probable Laboratory Contaminants (See Text)
J Estimated, Value Below the Quantitation Limit
E Concentration Exceeds Calibration Range of GC/MS Instrument
B Analyte Found in Associated Blank
ND Not Detected


LEGEND
EXISTING MONITORING WELL LOCATION
NEW OBSERVATION WELL LOCATION
S,I,D
NEW MONITORING WELL LOCATION (Shallow, Intermediate, and Deep)
ABANDONED EPA WELL LOCATION
NEW PUMP TEST WELL
VARIOUS PONDS
B B'
GEOLOGIC CROSS-SECTION
NOTE:
WELL LOCATIONS ARE APPROXIMATE
LLOW WATER SEWER LINE
GW-48D
POND 14
B'
P13-MW1
POND 13
OLD ROAD
WADSWORTH ROAD
EPA-03
WW1
EPA-02
EPA-01
GW-49
OW32S
P13-OB1
P13-OB4
WW2
GW-23I
B
P13-OB3
EPA-04
P13-OB2
P13-PT1
GW-23S
GW-22D
GW-22
POND 12
MAIN TRUNK SEWER LINE
200 100 0 200
SCALE IN FEET
N
Woodward-Clyde Consultants
ENGINEERING & SCIENCES APPLIED
TO THE EARTH & ITS ENVIRONMENT
LOCATION OF GENERALIZED CROSS-SECTION
POND 13 AREA
POINT PLEASANT WEST VIRGINIA
DRN. BY: JWB
DATE: 12/03/92
PROJECT NO. 89MC114E
FIG. No 5-5
CHK'D. BY: SRC
REVISION: 0


LEGEND
EXISTING MONITORING WELL LOCATION
NEW OBSERVATION WELL LOCATION
PLANNED ADDITIONAL MONITORING WELL LOCATION
S,I,D
NEW MONITORING WELL LOCATION (Shallow, Intermediate, and Deep)
NEW HYDROPUNCH LOCATION
NEW PUMP TEST WELL
HAUL ROAD
VARIOUS PONDS
580
APPROXIMATE ELEVATION CONTOURS OF THE SHALLOW AQUIFER POTENTIOMETRIC SURFACE (FEET ABOVE MSL)
(558.03)
GROUNDWATER SURFACE ELEVATION (9/25/92)
PLANNED STAFF GAUGE LOCATION
NOTE:
WELL LOCATIONS ARE APPROXIMATE
RW006
RW005
RW010
RW004
RW009
RW011
RW003
RW008
RW002
RW007
RW012
RW001
RW015
RW016
RW014
RW013
HIGHWAY 62
POTTERS CREEK ROAD
RED WATER SEWER LINE
RED WATER RESERVOIR
POINT PLEASANT LAND FILL MASON COUNTY
(568.21)
GW-33
S1
GW-46
(558.03) GW-47
(557.35)
RWR-DW1
RWR-OB1
RWR-OB4
RWR-OB2
RWR-OB3
(558.12)
(558.86)
(557.70)
RWR-PT1
GW-45D
(564.28)
GW-45
(568.22)
RWR-MW1
RWR-MW2
S2
GW-29
(568.95)
GW-30
(578.75)
GW-31
(575.32)
LF-6
GW-32
GW-32A
S3
LF-3
LF-4
LF-7
LF-5
555.0
560.0
565.0
570.0
575.0
580.0
400 200 0 400
SCALE IN FEET
N
Woodward-Clyde Consultants
ENGINEERING & SCIENCES APPLIED TO THE EARTH & ITS ENVIRONMENT
ADDITIONAL MONITORING WELL AND SURFACE WATER MEASUREMENT LOCATIONS WEST VIRGINIA ORDNANCE
DRN. BY: JB/SR
DATE: 10/04/93
PROJECT NO. 89MC114E
FIG. No. 2-1
CHK'D. BY: .
REVISION: 0



LEGEND

WELL RISER

WELL SCREEN

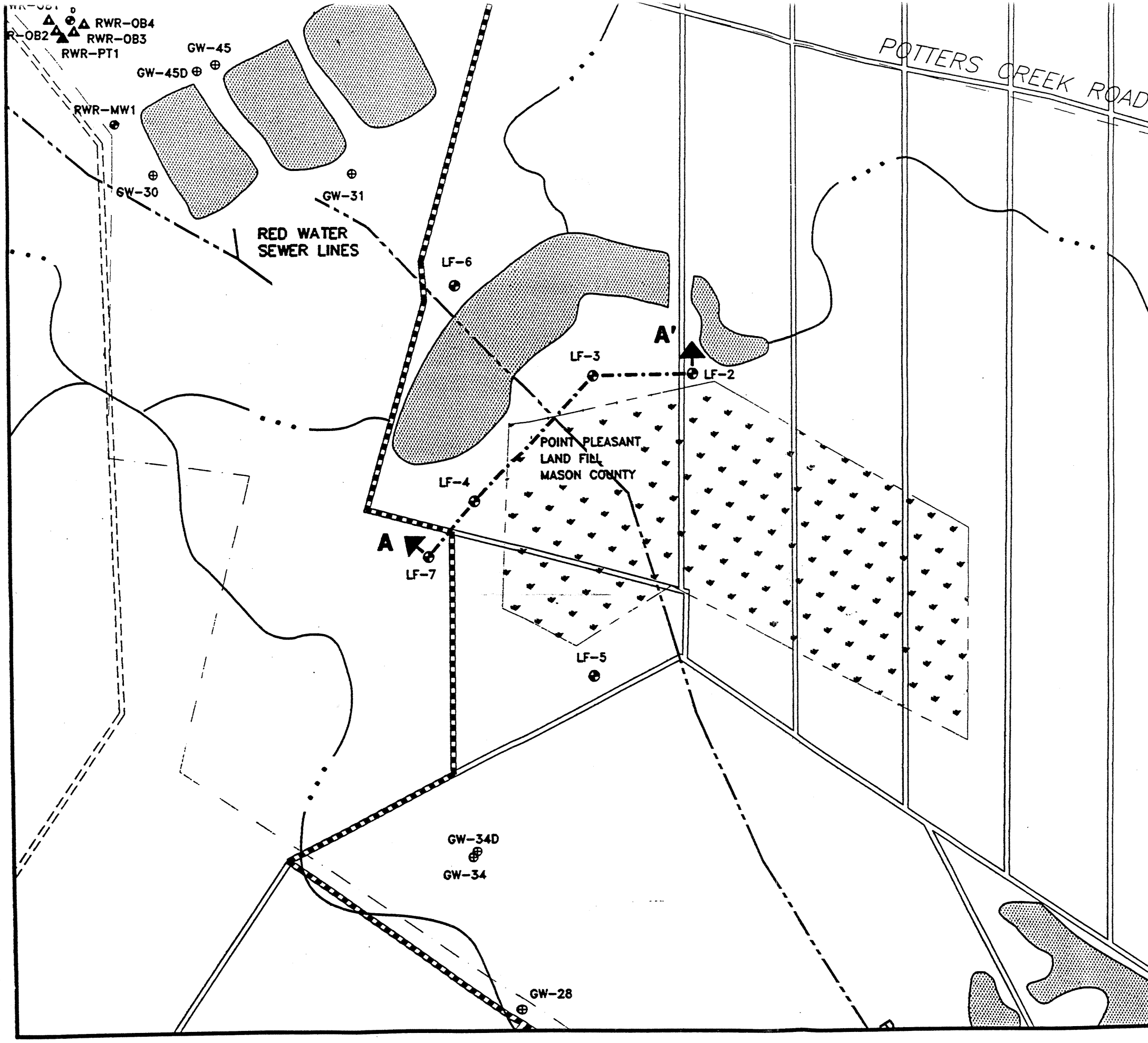
200 100 0

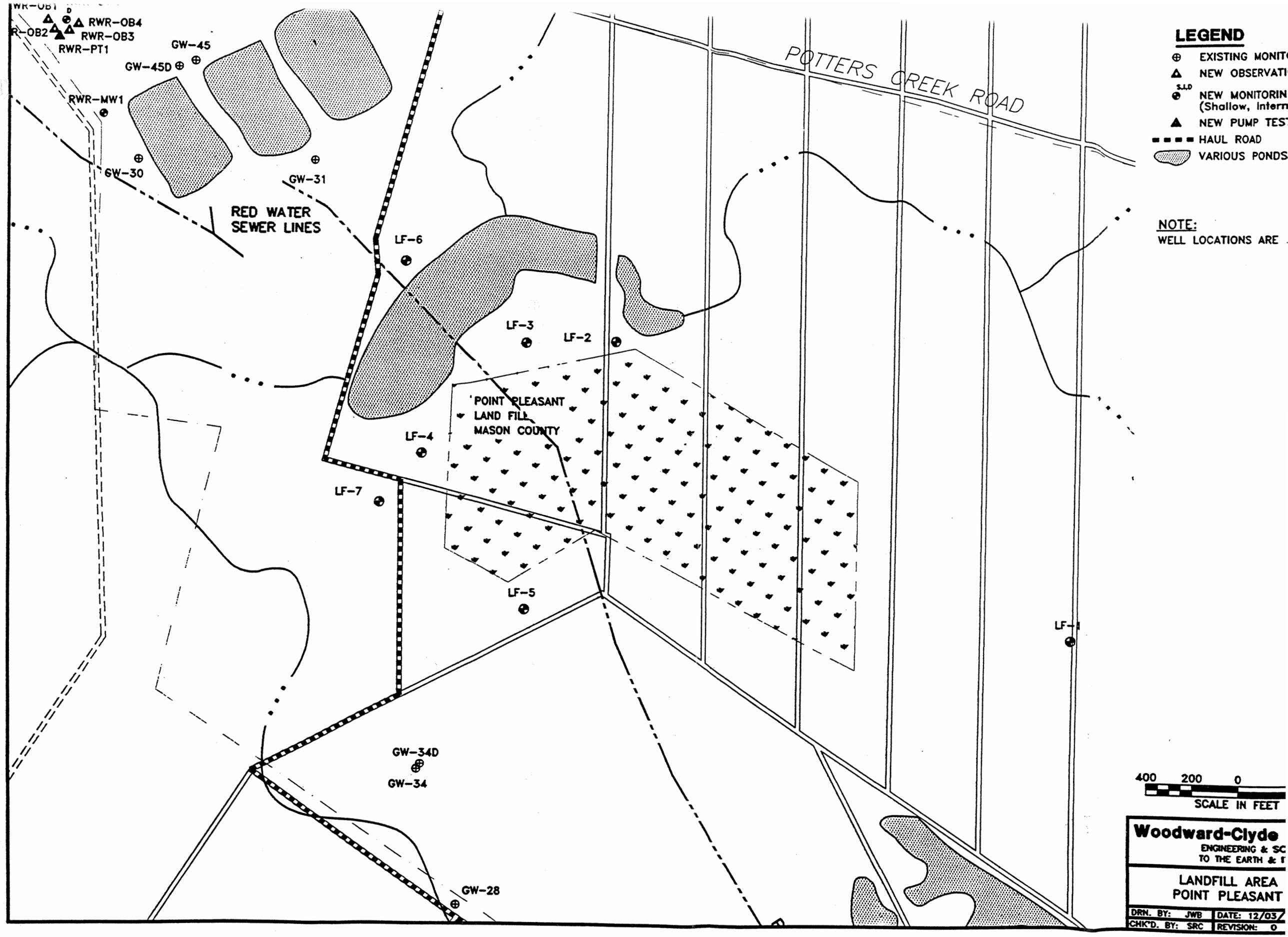
HORIZONTAL SCALE IN

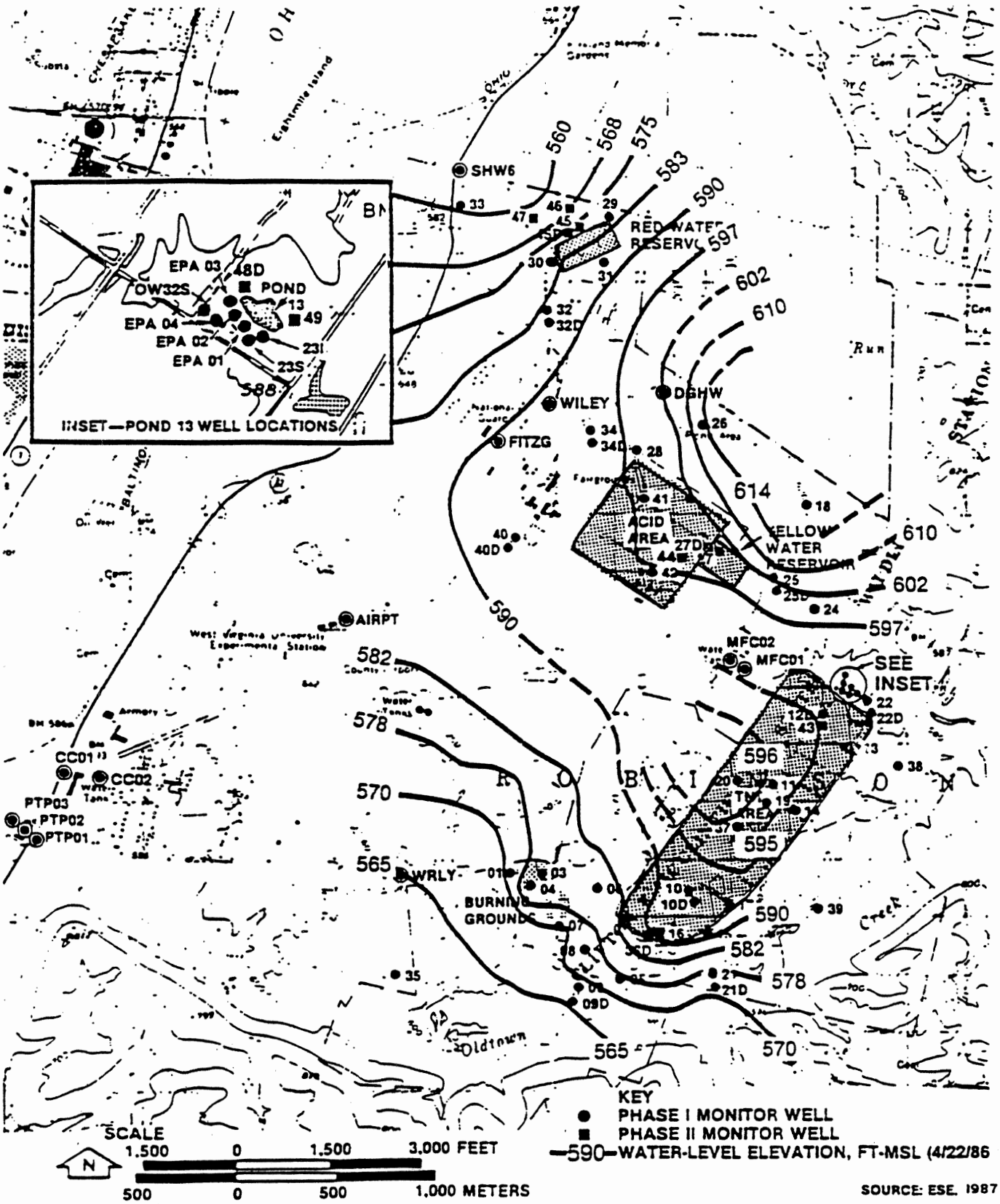
5 4 3 2 1 0

VERTICAL SCALE IN FE

CAD FI 1 VG 08/02/1993 14:16


RWR-OB4
RWR-OB2
RWR-OB3
RWR-PT1
GW-45
GW-45D
RWR-MW1
GW-30
GW-31
RED WATER
SEWER LINES
POTTERS CREEK ROAD
LF-6
A'
LF-3
LF-2
POINT PLEASANT
LAND FILL
MASON COUNTY
LF-4
A
LF-7
LF-5
GW-34D
GW-34
GW-28

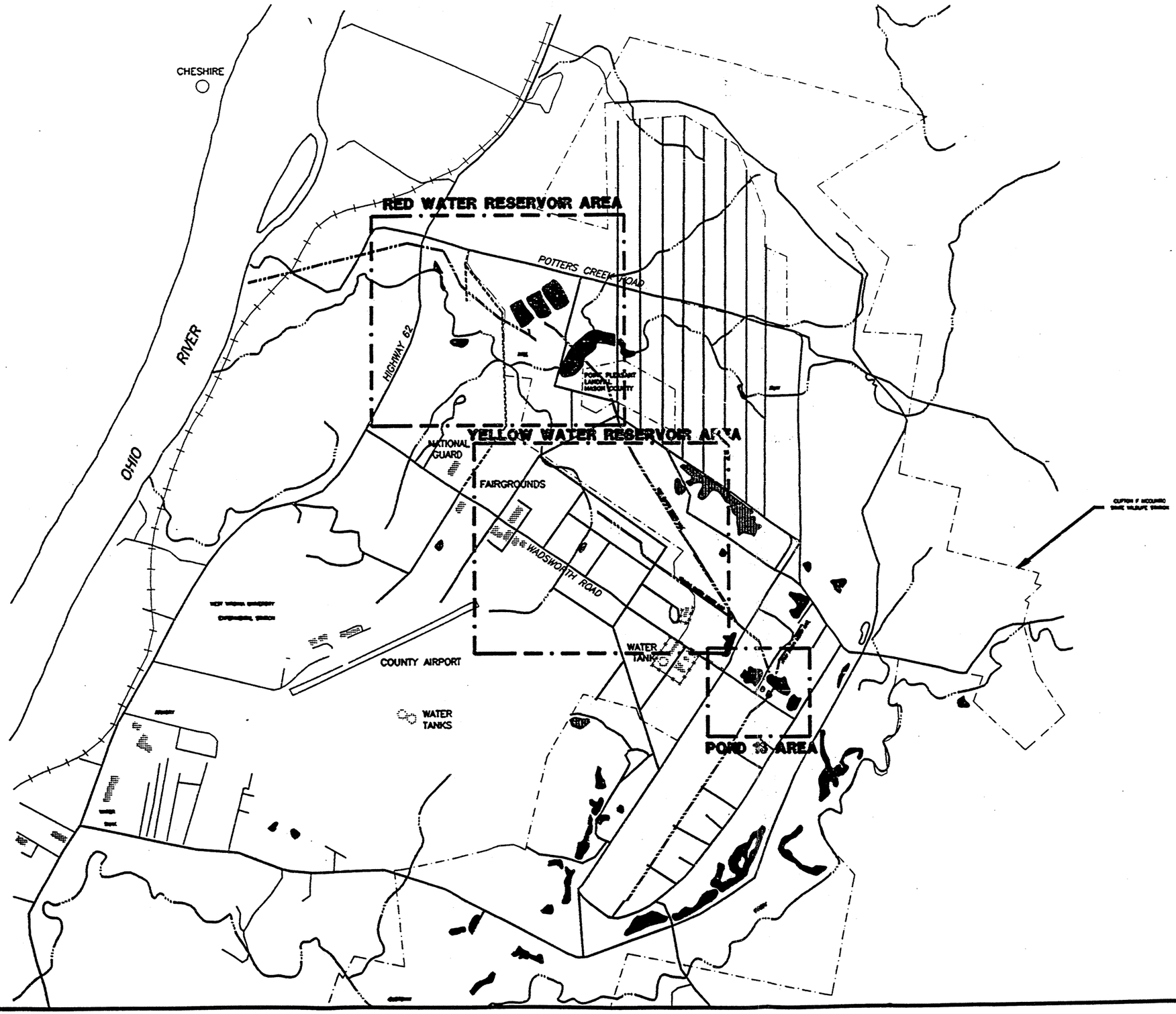

RWR-OB1
RWR-OB4
RWR-OB2
RWR-OB3
RWR-PT1
GW-45
GW-45D
RWR-MW1
GW-30
GW-31
RED WATER
SEWER LINES
POTTERS CREEK ROAD
LF-6
LF-3
LF-2
POINT PLEASANT
LAND FILL
MASON COUNTY
LF-4
LF-7
LF-5
LF-1
GW-34D
GW-34
GW-28
LEGEND
EXISTING MONITO
NEW OBSERVATI
NEW MONITORIN
(Shallow, Intern
NEW PUMP TEST
HAUL ROAD
VARIOUS PONDS
NOTE:
WELL LOCATIONS ARE
400 200 0
SCALE IN FEET
Woodward-Clyde
ENGINEERING & SC
TO THE EARTH & I
LANDFILL AREA
POINT PLEASANT
DRN. BY: JWB
DATE: 12/03/
CHK'D. BY: SRC
REVISION: 0



Woodward-Clyde Consultants
ENGINEERS, GEOLOGISTS, AND ENVIRONMENTAL SCIENTISTS

SITEWIDE GROUNDWATER LEVEL CONTOURS — SHALLOW AQUIFER — APRIL 22, 1986

DRN. BY: SCR	DATE: 12-15-92	PROJECT NO.	FIG. NO.
CHK'D BY:	DATE:	89MC114E	4-[illegible]



LEGEND

VARIOUS PONDS

2000 1000 0 2000

SCALE IN FEET

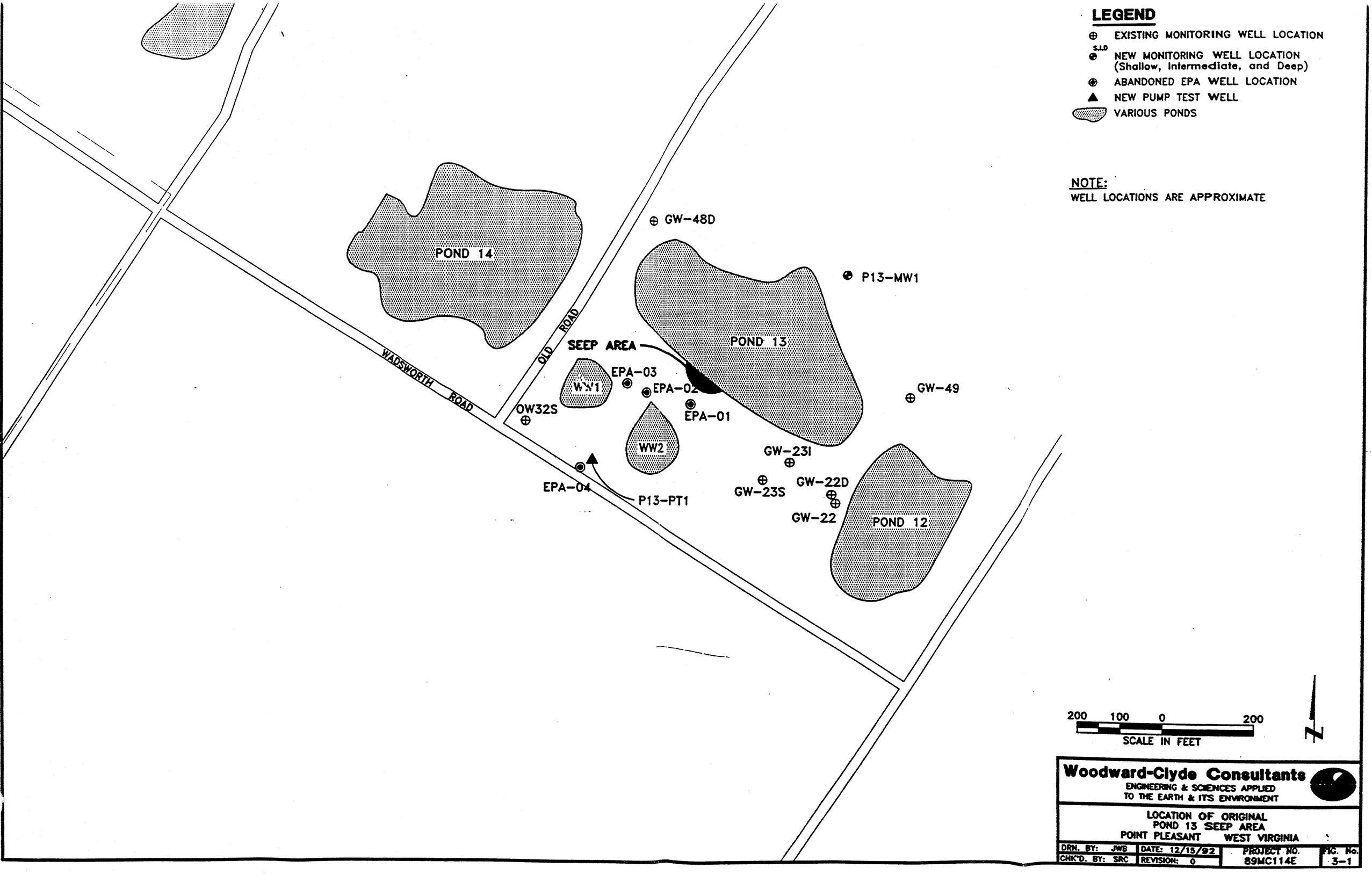
N

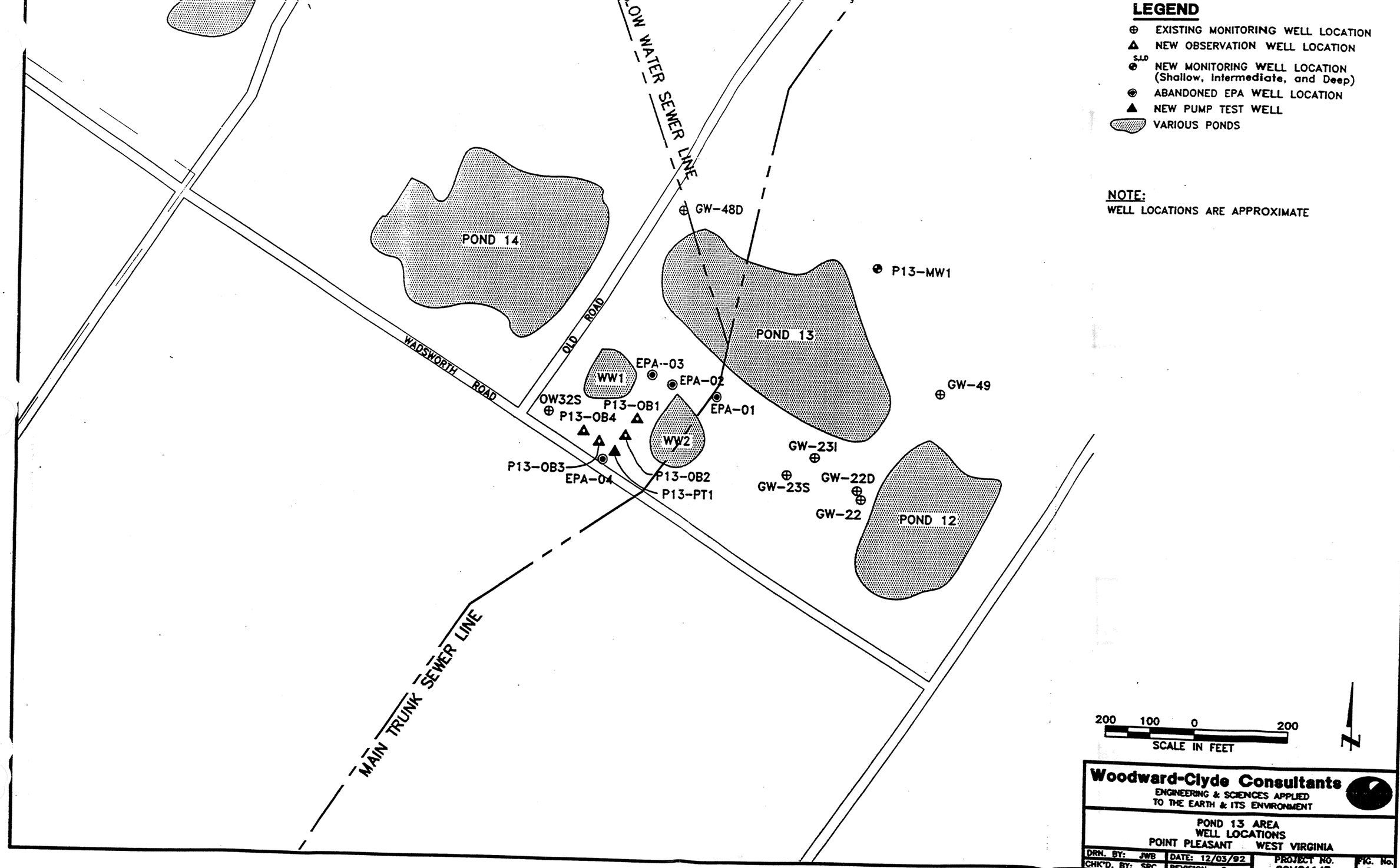
Woodward-Clyde Consultants

ENGINEERING & SCIENCES APPLIED TO THE EARTH & ITS ENVIRONMENT

LOCATION OF INVESTIGATION SITES
POINT PLEASANT WEST VIRGINIA

DRN. BY: CJG	DATE: 12\07\92	PROJECT NO. 89MC114E	FIG. NO. 4-1
CHK'D. BY:	REVISION: 0		


LEGEND
EXISTING MONITORING WELL LOCATION
S,I,D
NEW MONITORING WELL LOCATION (Shallow, Intermediate, and Deep)
ABANDONED EPA WELL LOCATION
NEW PUMP TEST WELL
VARIOUS PONDS
NOTE:
WELL LOCATIONS ARE APPROXIMATE
POND 14
POND 13
POND 12
WW1
WW2
WADSWORTH ROAD
OLD ROAD
SEEP AREA
GW-48D
P13-MW1
GW-49
EPA-03
EPA-02
EPA-01
OW32S
GW-23I
GW-22D
GW-23S
GW-22
EPA-04
P13-PT1
200 100 0 200
SCALE IN FEET
N
Woodward-Clyde Consultants
ENGINEERING & SCIENCES APPLIED
TO THE EARTH & ITS ENVIRONMENT
LOCATION OF ORIGINAL
POND 13 SEEP AREA
POINT PLEASANT WEST VIRGINIA
DRN. BY: JWB
CHK'D. BY: SRC
DATE: 12/15/92
REVISION: 0
PROJECT NO.
89MC114E
FIG. No.
3-1


LEGEND
EXISTING MONITORING WELL LOCATION
NEW OBSERVATION WELL LOCATION
S,I,D
NEW MONITORING WELL LOCATION (Shallow, Intermediate, and Deep)
ABANDONED EPA WELL LOCATION
NEW PUMP TEST WELL
VARIOUS PONDS
NOTE:
WELL LOCATIONS ARE APPROXIMATE
LOW WATER SEWER LINE
MAIN TRUNK SEWER LINE
WADSWORTH ROAD
OLD ROAD
POND 14
POND 13
POND 12
WW1
WW2
GW-48D
P13-MW1
GW-49
EPA--03
EPA-02
EPA-01
OW32S
P13-OB1
P13-OB4
P13-OB3
EPA-04
P13-OB2
P13-PT1
GW-23I
GW-23S
GW-22D
GW-22
200 100 0 200
SCALE IN FEET
N
Woodward-Clyde Consultants
ENGINEERING & SCIENCES APPLIED TO THE EARTH & ITS ENVIRONMENT
POND 13 AREA
WELL LOCATIONS
POINT PLEASANT WEST VIRGINIA
DRN. BY: JWB
CHK'D. BY: SRC
DATE: 12/03/92
REVISION: 0
PROJECT NO. 89MC114E
FIG. No. 5-4

Soil Unit	Range of Unit Thickness at the Tank Area
Brown Fine Sand	6' - 8'
* Grey Fine Sand	2.5' - >14'
* Grey Sandy Clayey Silt	1.5' - 8'
* Grey Clayey Silt	>1.5'
Grey Silty Clay	

OVERBURDEN

* Unit not encountered at all borehole locations

NOTE Bedrock was not reached at this Tank Area; Drilling was completed in the first confining layer encountered

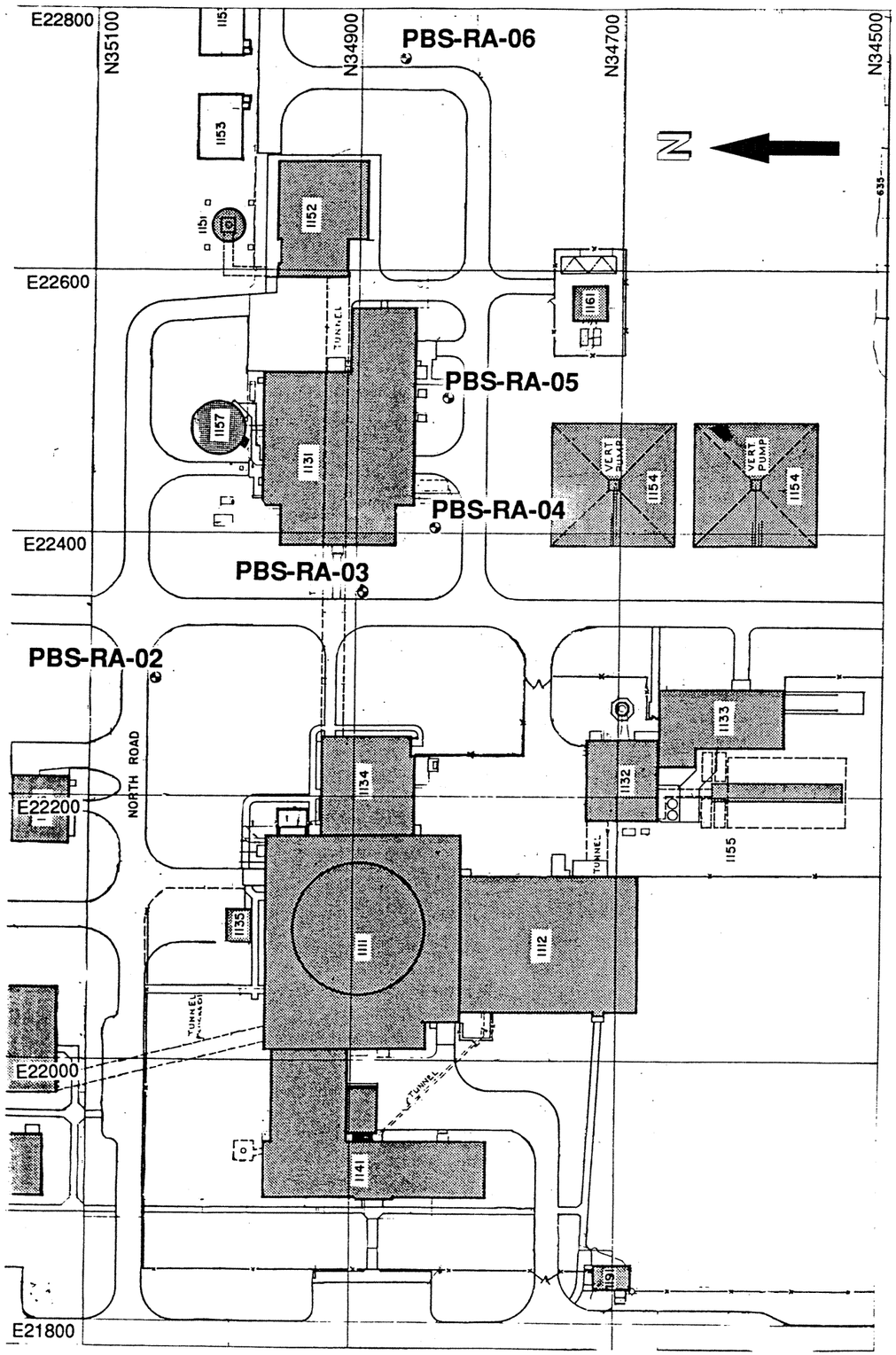
NASA PLUM BROOK STATION
UNDERGROUND STORAGE TANK CORRECTIVE ACTIONS REMEDIAL INVESTIGATION/FEASIBILITY STUDY: PHASE I

Generalized Stratigraphic Section

REACTOR AREA

EBASCO ENVIRONMENTAL | NOT TO SCALE

FIGURE 3-37



LEGEND

Ground Water Monitoring Well Location

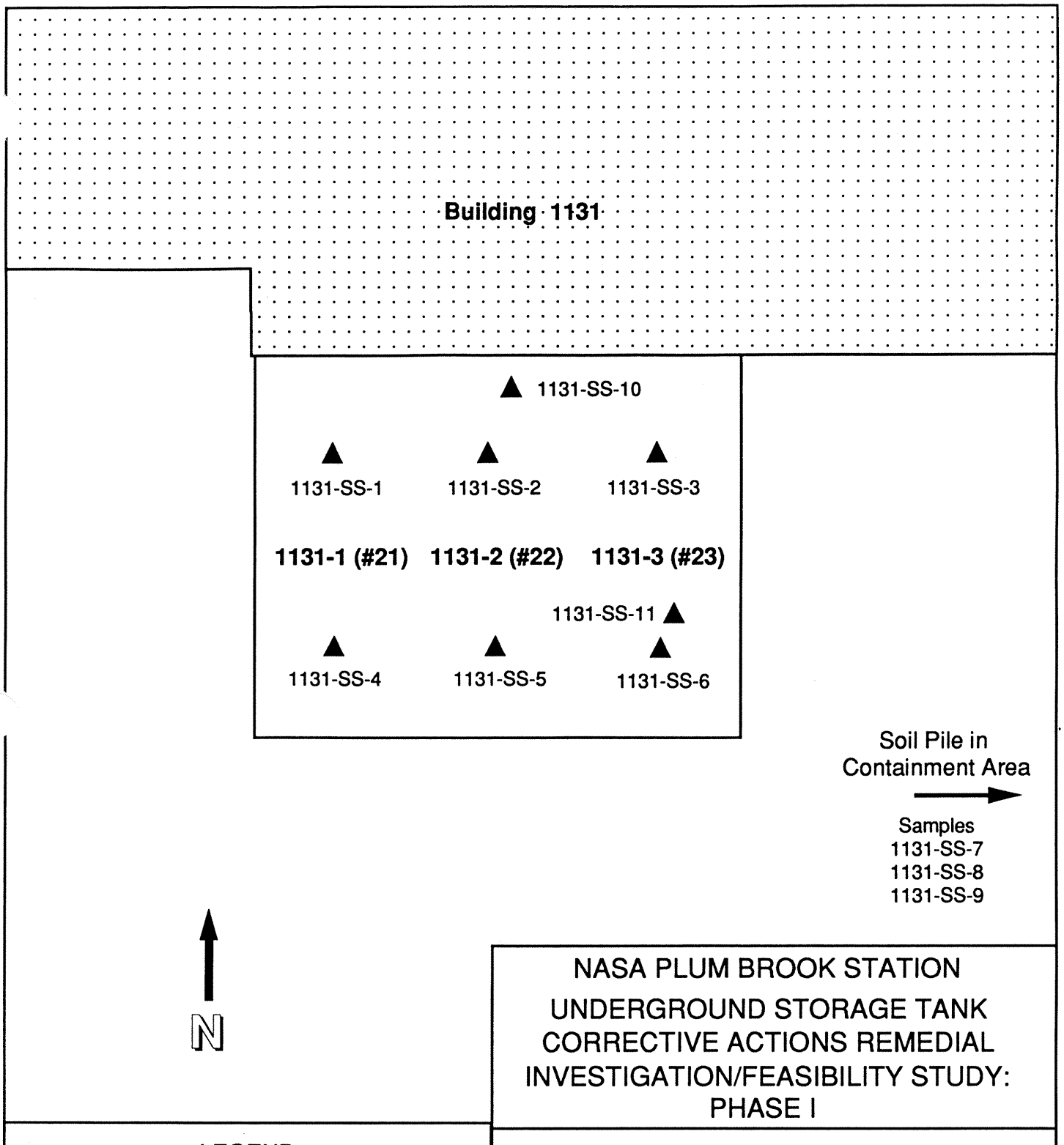
NASA PLUM BROOK STATION
UNDERGROUND STORAGE TANK
CORRECTIVE ACTIONS REMEDIAL
INVESTIGATION/FEASIBILITY STUDY:
PHASE I

Locations of Soil Borings and Ground Water Monitoring Wells

REACTOR AREA

EBASCO ENVIRONMENTAL | SCALE: 1"=100'

FROM NASA DWG. NO. PF-65156 | **FIGURE 3-36**



NASA PLUM BROOK STATION
UNDERGROUND STORAGE TANK
CORRECTIVE ACTIONS REMEDIAL
INVESTIGATION/FEASIBILITY STUDY:
PHASE I

LEGEND

Soil Sample

Tank Pit

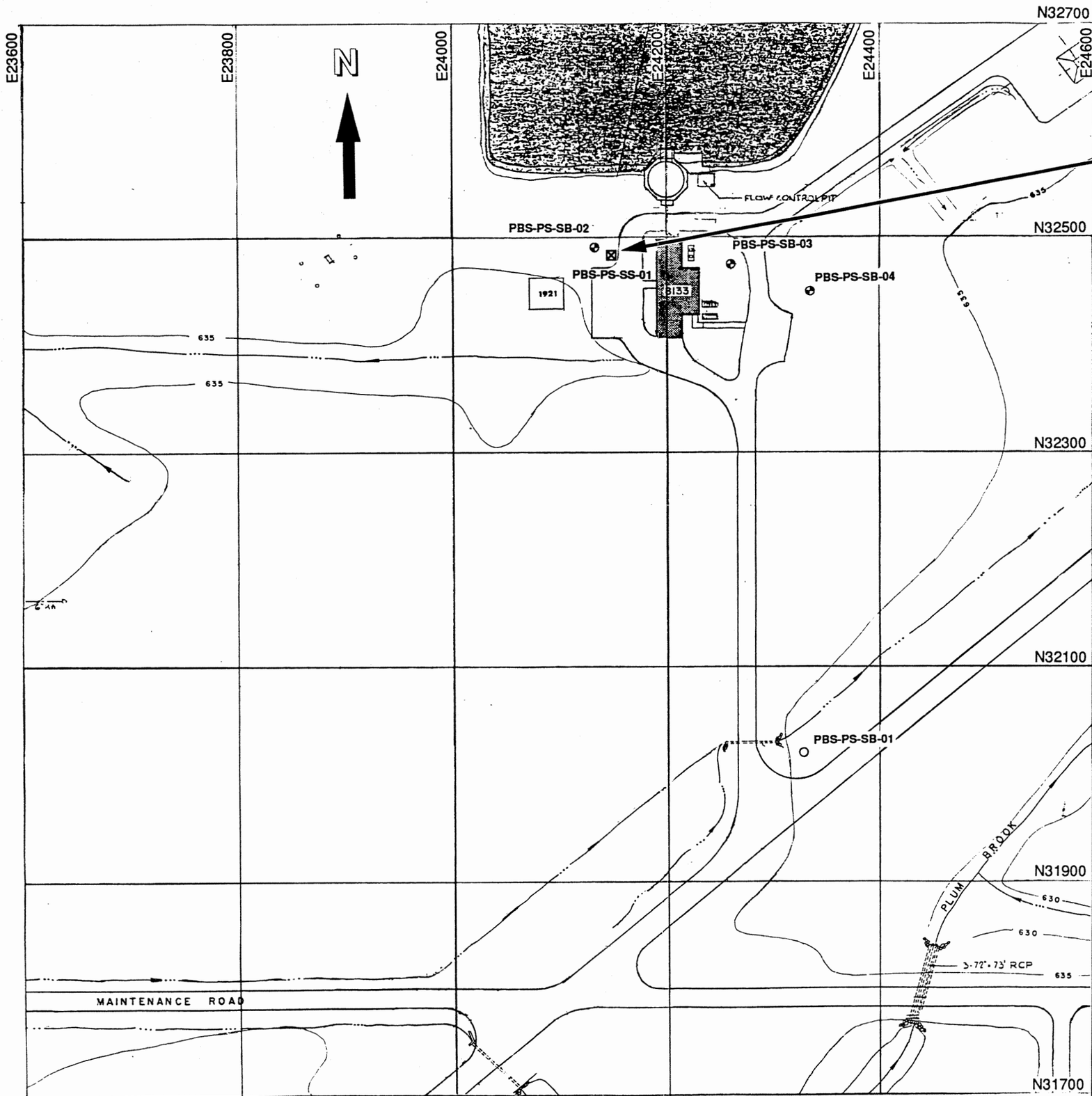
Excavated Soil Pile

Sampling Locations Associated With the Building 1131 USTs

REACTOR AREA

EBASCO ENVIRONMENTAL | NOT TO SCALE

FIGURE 3-35



PBS-PS-SS-01	Conc.
Fluoranthene	490 J ug/Kg
Pyrene	390 J ug/Kg
Benzo(a)anthracene	300 J ug/Kg
Chrysene	300 J ug/Kg
Benzo(b)fluoranthene	300 J ug/Kg
Benzo(k)fluoranthene	490 J ug/Kg
Benzo(a)pyrene	300 J ug/Kg
Indeno(1,2,3-cd)pyrene	300 J ug/Kg
Benzo(g,h,i)perylene	200 J ug/Kg
Total Petroleum Hydrocarbons	90 mg/Kg

J = Estimated

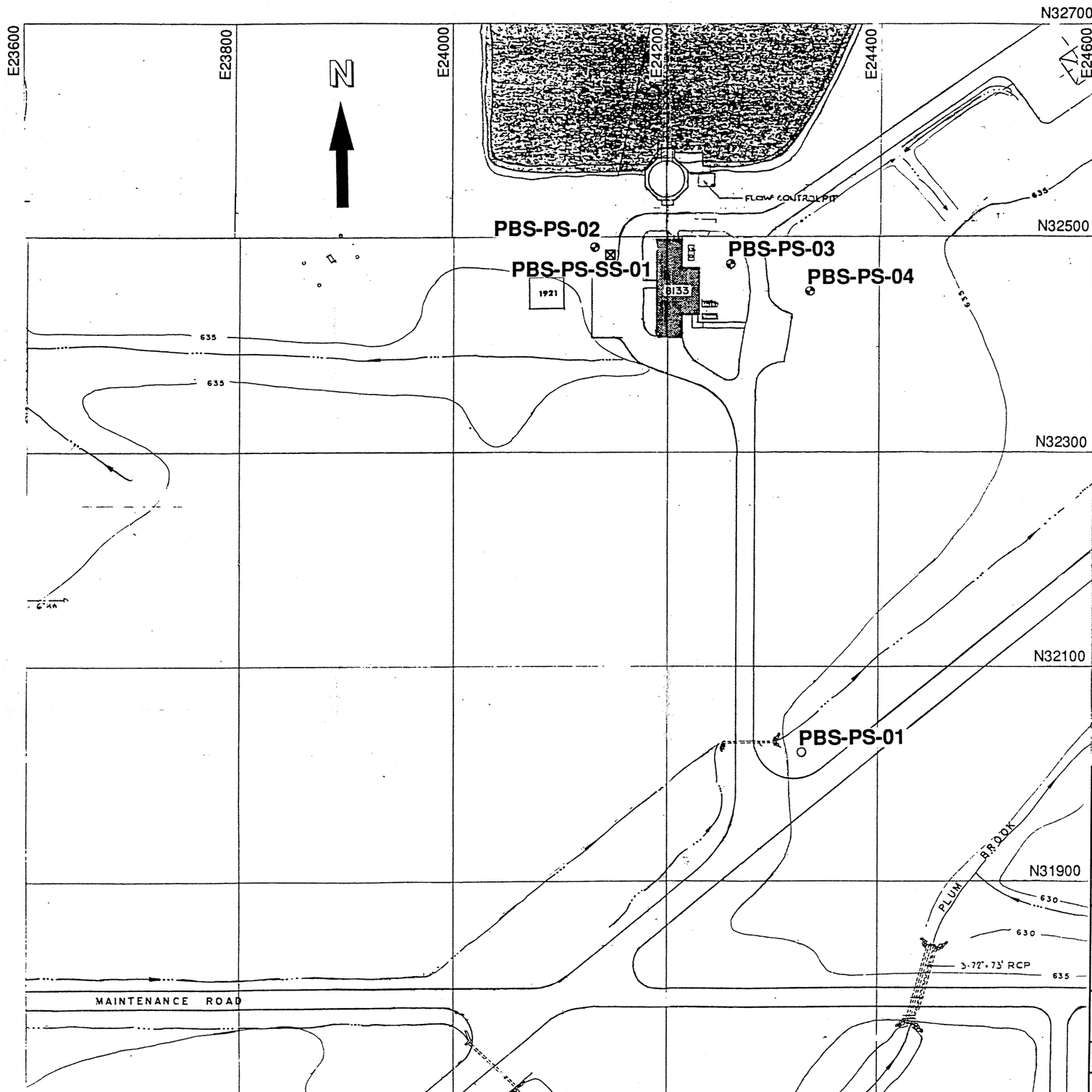
NASA PLUM BROOK STATION
UNDERGROUND STORAGE TANK CORRECTIVE ACTIONS REMEDIAL INVESTIGATIONS/FEASIBILITY STUDY: PHASE I

Organic Contaminant Concentrations in Sediment

PUMP STATION

EBASCO ENVIRONMENTAL | SCALE: 1"=100'

FROM NASA DWG. NOs. PF-65265 & 65273 | **FIGURE 3-34**



LEGEND

- Ground Water Monitoring Well Location
- Soil Boring Location
- Sediment Sample Location

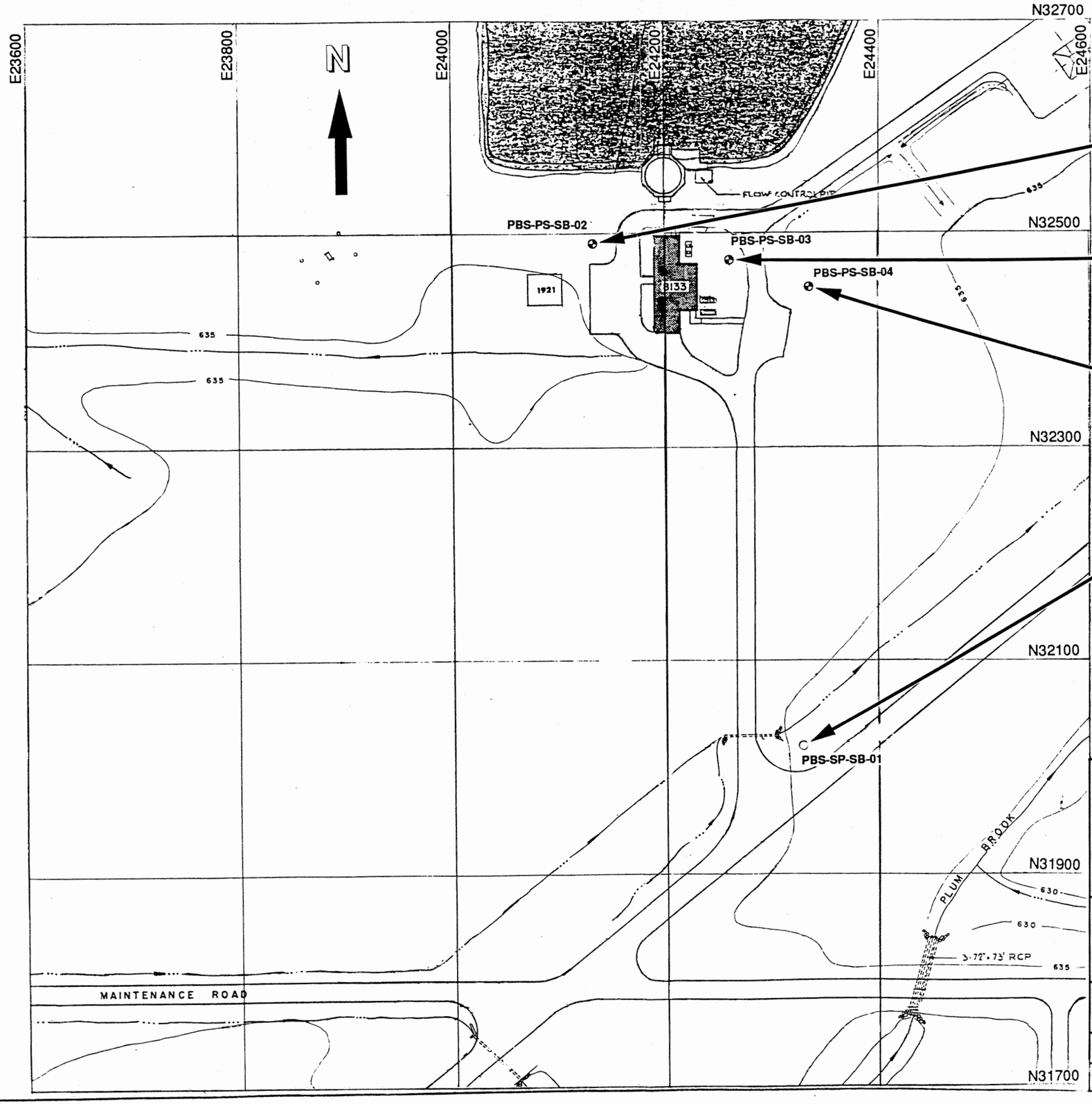
NASA PLUM BROOK STATION
UNDERGROUND STORAGE TANK
CORRECTIVE ACTIONS REMEDIAL
INVESTIGATION/FEASIBILITY STUDY:
PHASE I

Location of Sediment Sample

PUMP STATION

EBASCO ENVIRONMENTAL | SCALE: 1"=100'

FROM NASA DWG. NOs. PF-65265 & 65273 | **FIGURE 3-33**



PBS-PS-SB02	Conc.
Total Petroleum Hydrocarbons	32 mg/Kg

PBS-PS-SB05 (SB03 DUP)	Conc.
Total Petroleum Hydrocarbons	36 mg/Kg

PBS-PS-SB04	Conc.
Trichloroethene	25 ug/Kg
Total Petroleum Hydrocarbons	125 mg/Kg

PBS-PS-SB01	Conc.
Fluoranthene	130 J ug/Kg
Pyrene	84 J ug/Kg
Total Petroleum Hydrocarbons	77 mg/Kg

J = Estimated

NASA PLUM BROOK STATION
UNDERGROUND STORAGE TANK CORRECTIVE ACTIONS REMEDIAL INVESTIGATIONS/FEASIBILITY STUDY: PHASE I

Organic Contaminant Concentrations in Soil

PUMP STATION

EBASCO ENVIRONMENTAL | SCALE: 1"=100'

FROM NASA DWG. NOs. PF-65265 & 65273 | **FIGURE 3-32**

Soil Unit	Range of Unit Thickness at the Tank Area
* Sandy Clayey Silt	3'
Fine Sand with Trace Silt	1' - 8'
* Grey Sandy Clayey Silt	2' - >8'
Grey Clayey Silt	4' - >10'
Grey Silty Clay	2' - 2.5'
Grey Clayey Silt	

OVERBURDEN

* Unit not encountered at all borehole locations

NOTE Bedrock was not reached at this Tank Area; Drilling was completed in the first confining layer encountered

NASA PLUM BROOK STATION

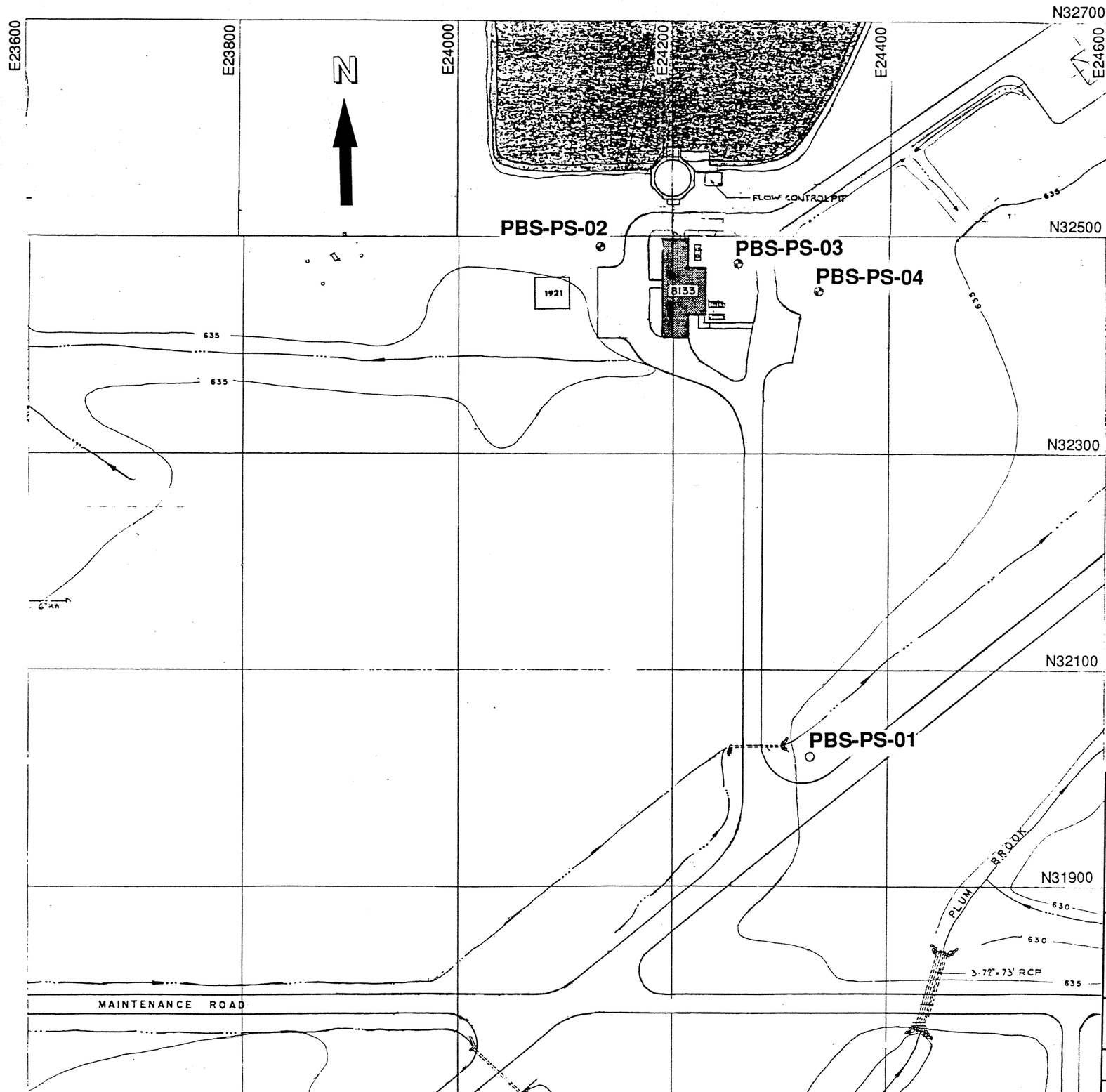
UNDERGROUND STORAGE TANK CORRECTIVE ACTIONS REMEDIAL INVESTIGATION/FEASIBILITY STUDY: PHASE I

Generalized Stratigraphic Section

PUMP STATION

EBASCO ENVIRONMENTAL | NOT TO SCALE

FIGURE 3-31



LEGEND

Ground Water Monitoring Well Location

Soil Boring Location

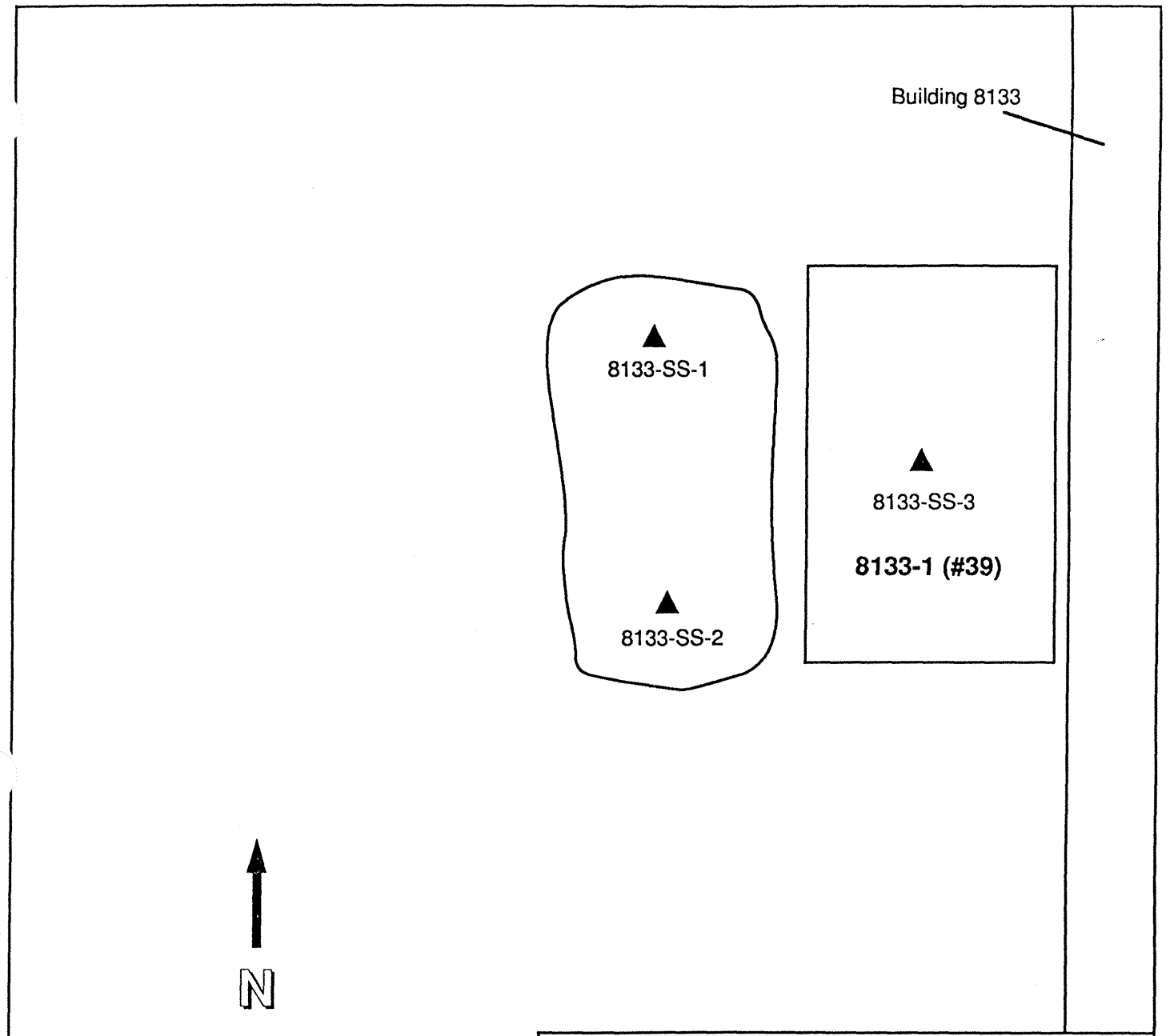
NASA PLUM BROOK STATION
UNDERGROUND STORAGE TANK
CORRECTIVE ACTIONS REMEDIAL
INVESTIGATION/FEASIBILITY STUDY:
PHASE I

Locations of Soil Borings and Ground Water Monitoring Wells

PUMP STATION

EBASCO ENVIRONMENTAL | SCALE: 1"=100'

FROM NASA DWG. NOs. PF-65265 & 65273 | **FIGURE 3-30**



NASA PLUM BROOK STATION
UNDERGROUND STORAGE TANK CORRECTIVE ACTIONS REMEDIAL INVESTIGATION/FEASIBILITY STUDY: PHASE I

LEGEND

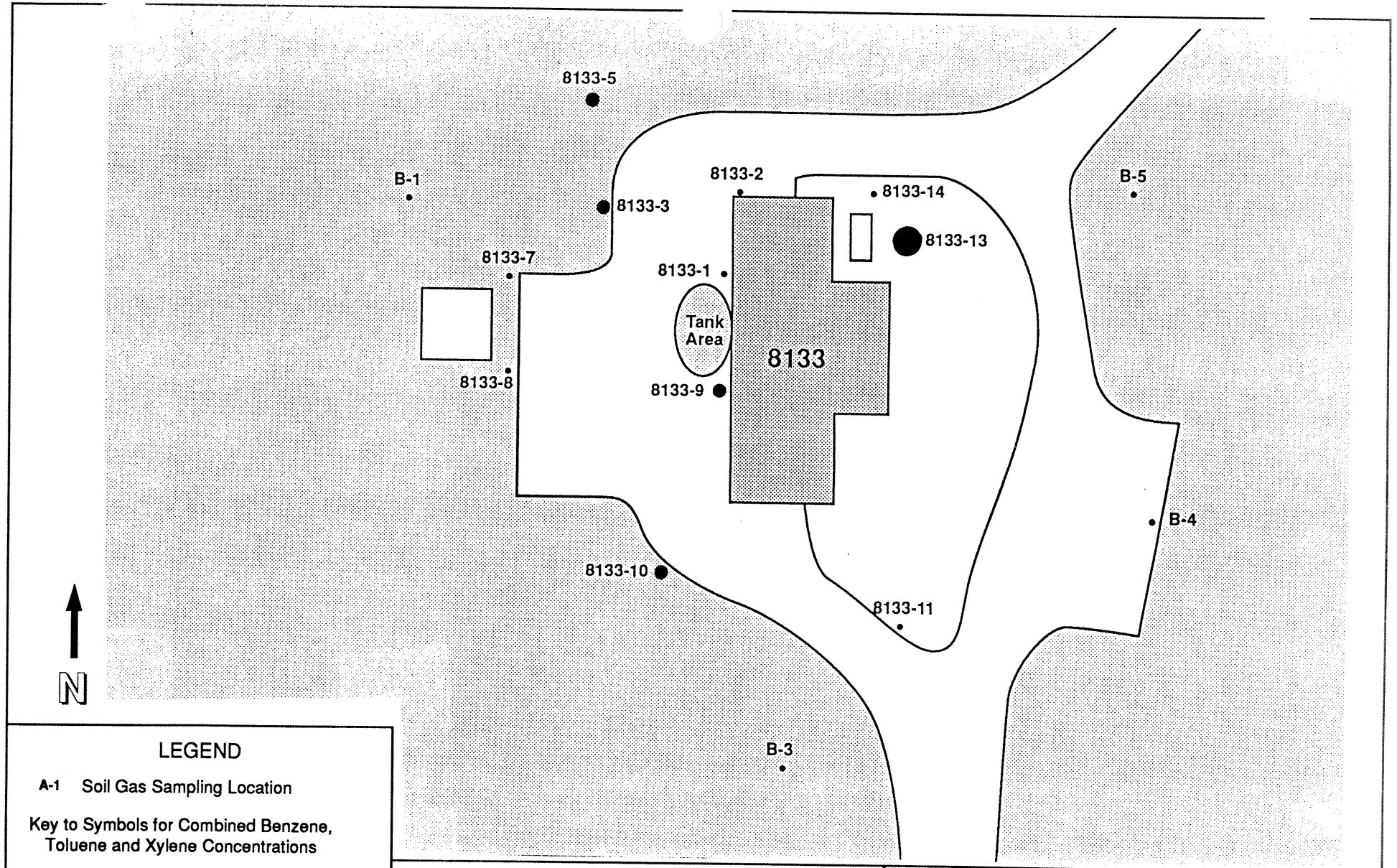
- Soil Sample
- Tank Pit
- Excavated Soil Pile

Sampling Locations Associated With the Building 8133 UST

PUMP STATION

EBASCO ENVIRONMENTAL | NOT TO SCALE

FIGURE 3-28



LEGEND

A-1 Soil Gas Sampling Location

Key to Symbols for Combined Benzene, Toluene and Xylene Concentrations

- Not Detected
- Detected <100 ppb
- 100 - 500 ppb
- 500 - 1000 ppb
- 1000 - 5000 ppb
- >5000 ppb

NASA PLUM BROOK STATION

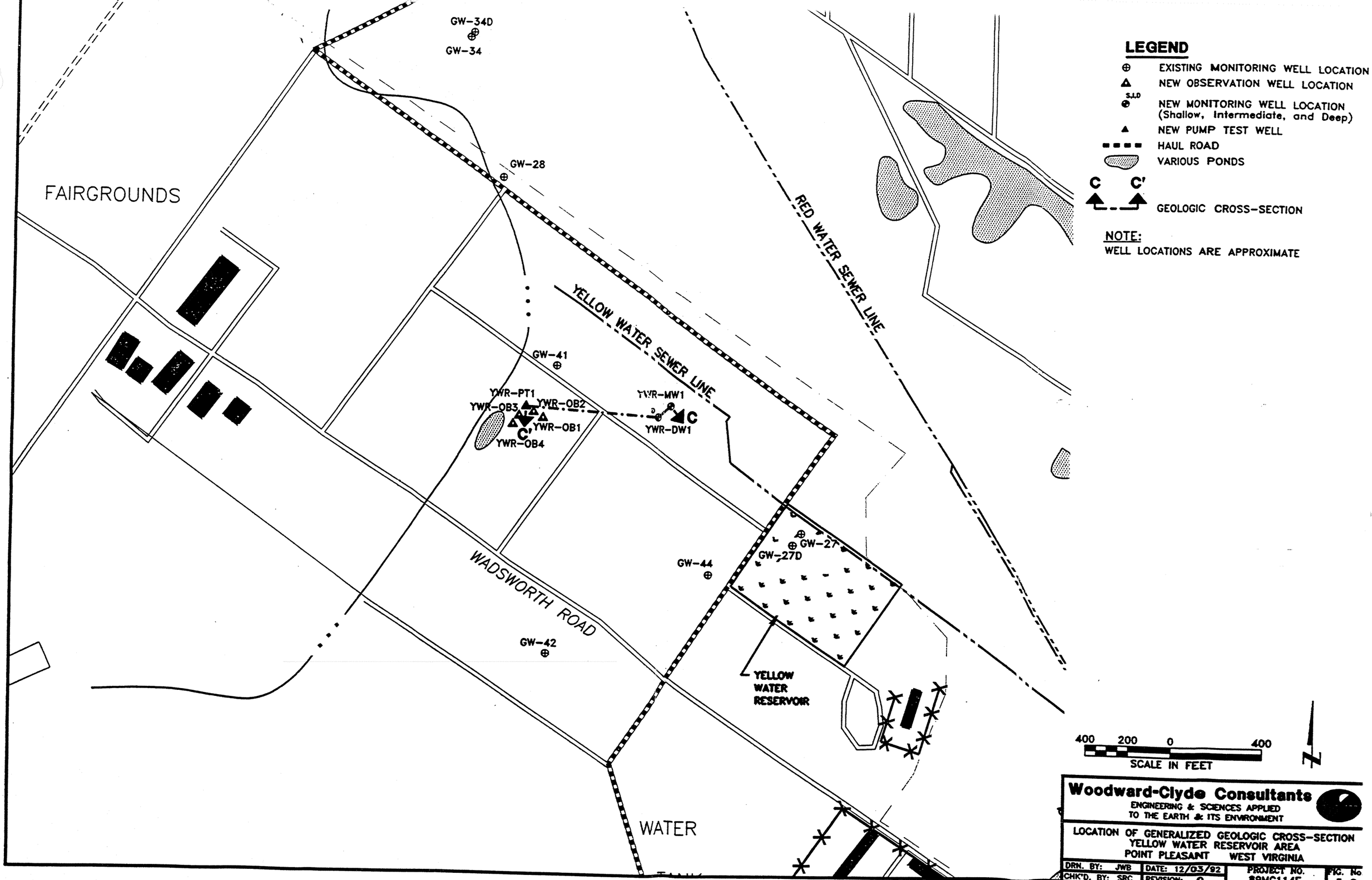
UNDERGROUND STORAGE TANK CORRECTIVE ACTIONS REMEDIAL INVESTIGATION/FEASIBILITY STUDY: PHASE I

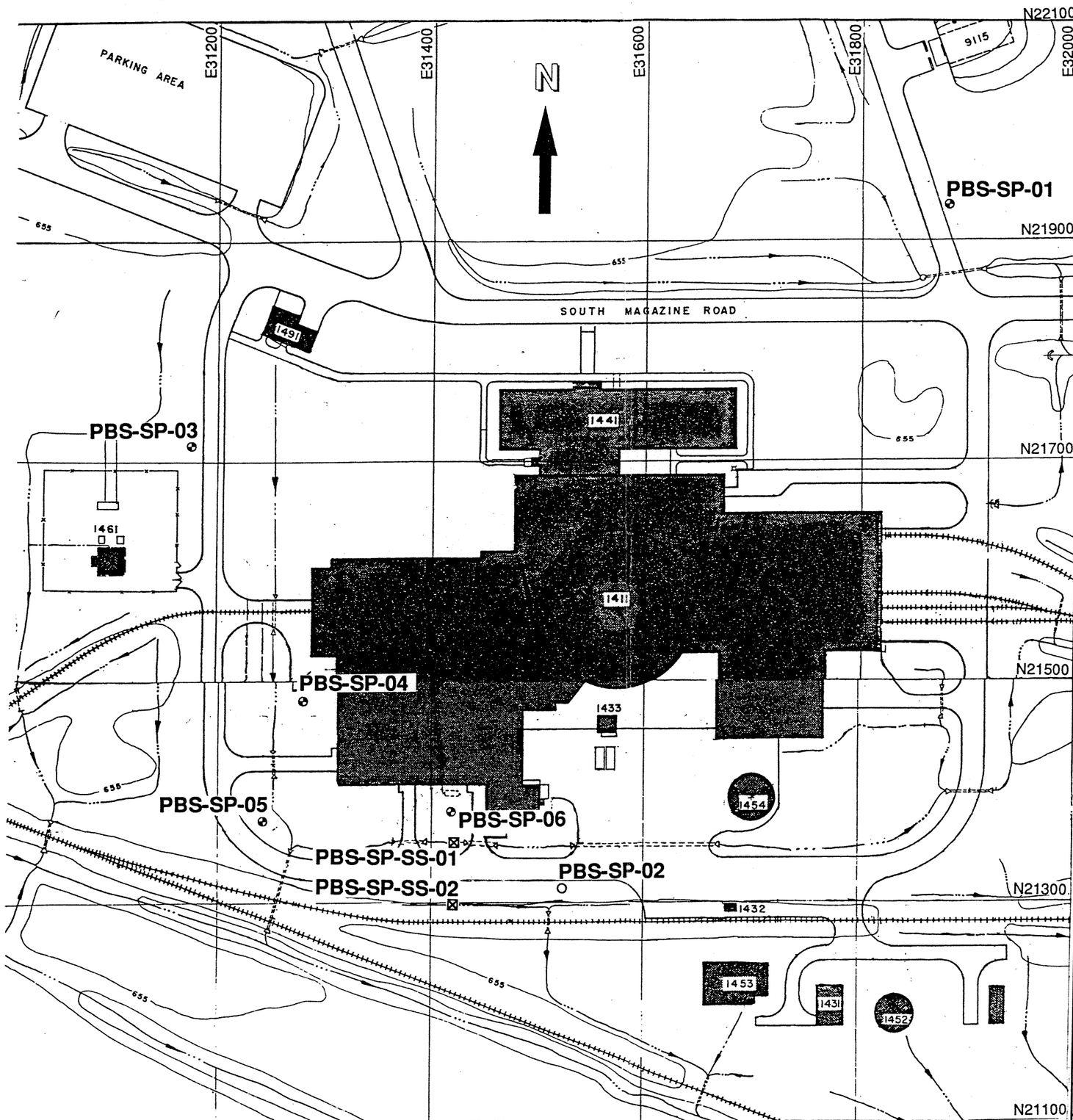
EBASCO ENVIRONMENTAL | NOT TO SCALE

Soil Gas Sampling Locations and Results for Benzene, Toluene and Xylene

PUMP STATION

FIGURE 3-29


GW-34D
GW-34
GW-28
FAIRGROUNDS
RED WATER SEWER LINE
YELLOW WATER SEWER LINE
GW-41
YWR-PT1
YWR-OB3
YWR-OB2
YWR-OB1
YWR-OB4
YWR-MW1
YWR-DW1
C
C'
GW-27
GW-27D
GW-44
WADSWORTH ROAD
GW-42
YELLOW WATER RESERVOIR
WATER
LEGEND
EXISTING MONITORING WELL LOCATION
NEW OBSERVATION WELL LOCATION
S,I,D
NEW MONITORING WELL LOCATION (Shallow, Intermediate, and Deep)
NEW PUMP TEST WELL
HAUL ROAD
VARIOUS PONDS
C C'
GEOLOGIC CROSS-SECTION
NOTE:
WELL LOCATIONS ARE APPROXIMATE
400 200 0 400
SCALE IN FEET
N
Woodward-Clyde Consultants
ENGINEERING & SCIENCES APPLIED TO THE EARTH & ITS ENVIRONMENT
LOCATION OF GENERALIZED GEOLOGIC CROSS-SECTION
YELLOW WATER RESERVOIR AREA
POINT PLEASANT WEST VIRGINIA
DRN. BY: JWB
CHK'D. BY: SRC
DATE: 12/03/92
REVISION: 0
PROJECT NO. 89MC114E
FIG. No 5-8



LEGEND

- Ground Water Monitoring Well Location
- Soil Boring Location
- Sediment Sample Location

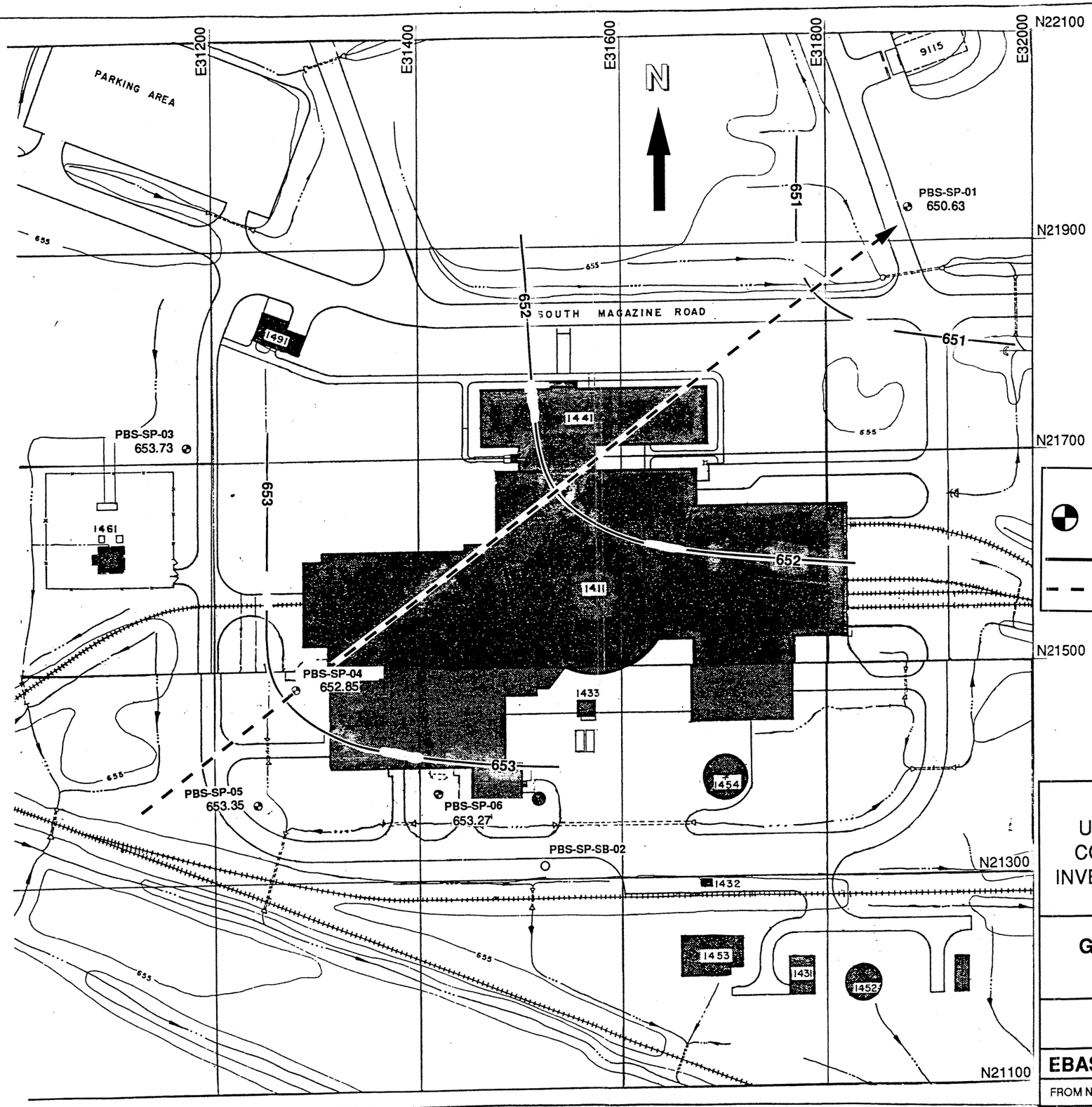
NASA PLUM BROOK STATION
UNDERGROUND STORAGE TANK
CORRECTIVE ACTIONS REMEDIAL
INVESTIGATION/FEASIBILITY STUDY:
PHASE I

Locations of Sediment Samples

SPACE POWER FACILITY

EBASCO ENVIRONMENTAL | SCALE: 1"=100'

FROM NASA DWG. NOs. PF-65530 & 65538 | **FIGURE 3-26**



LEGEND

PBS-SP-01 650.63	Ground Water Monitoring Well Ground Water Elevation
652	Ground Water Elevation Contour
	Direction of Ground Water Flow

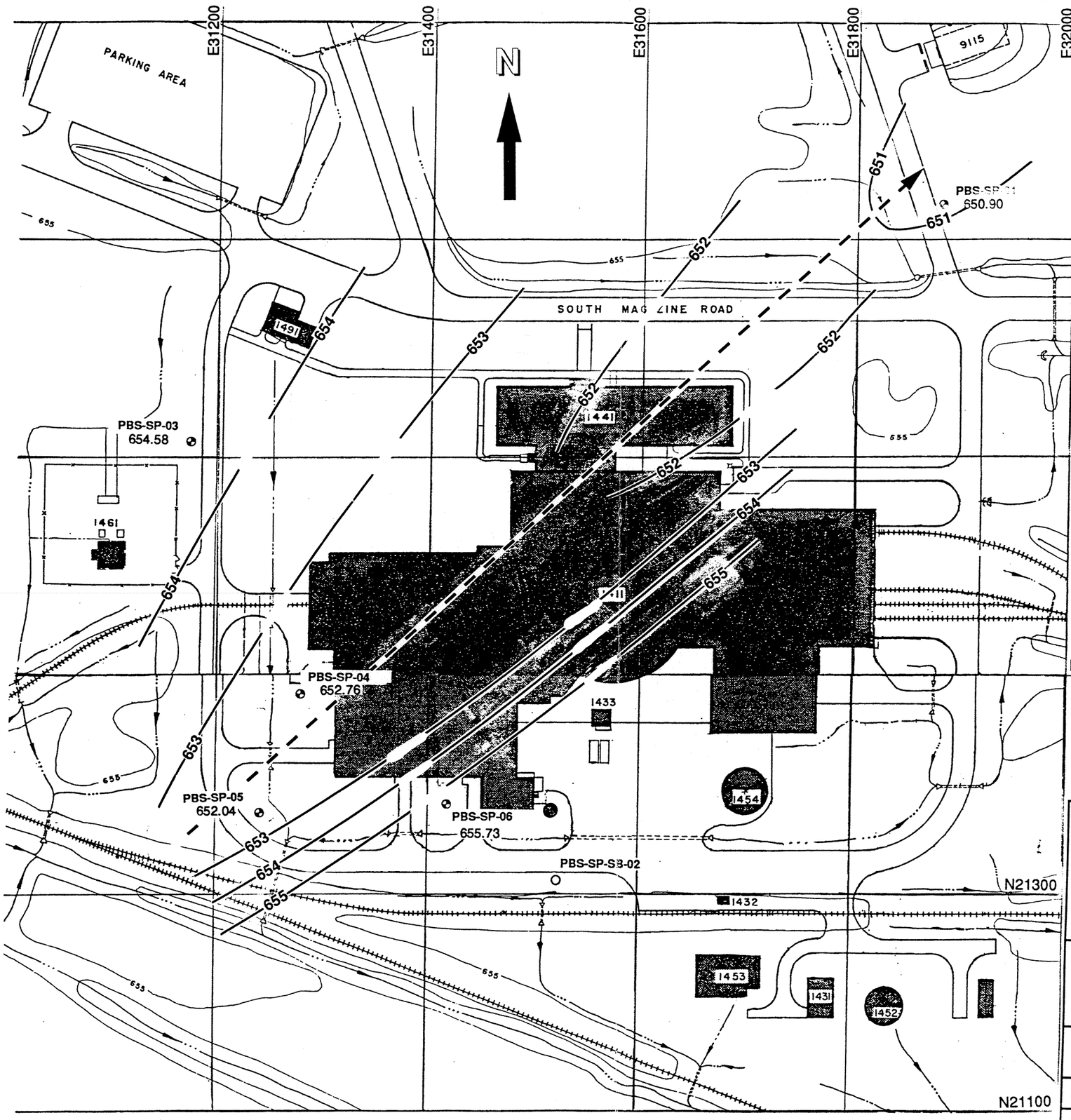
NASA PLUM BROOK STATION
UNDERGROUND STORAGE TANK CORRECTIVE ACTIONS REMEDIAL INVESTIGATIONS/FEASIBILITY STUDY: PHASE I

Ground Water Elevation Contours for 05/09/91

SPACE POWER FACILITY

EBASCO ENVIRONMENTAL | SCALE: 1"=100'

FROM NASA DWG. NOs. PF-65530 & 65538 | **FIGURE 3-25**



LEGEND

PBS-SP-01 650.90	Ground Water Monitoring Well Ground Water Elevation
652	Ground Water Elevation Contour
	Direction of Ground Water Flow

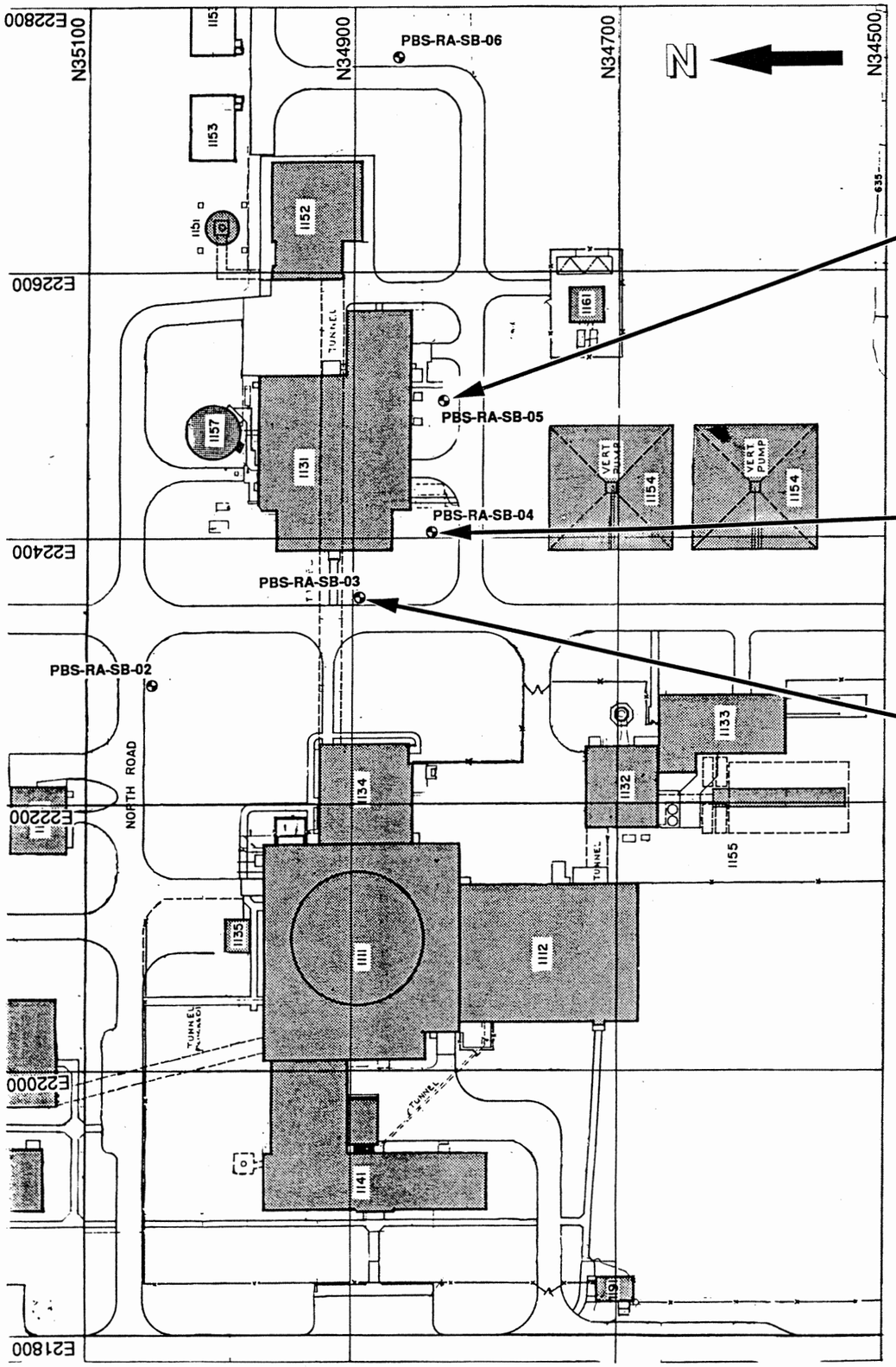
NASA PLUM BROOK STATION
UNDERGROUND STORAGE TANK CORRECTIVE ACTIONS REMEDIAL INVESTIGATIONS/FEASIBILITY STUDY: PHASE I

Ground Water Elevation Contours for 01/09/91

SPACE POWER FACILITY

EBASCO ENVIRONMENTAL | SCALE: 1"=100'

FROM NASA DWG. NOs. PF-65530 & 65538 | **FIGURE 3-24**



PBS-RA-SB05	Conc.
1,2-Dichloroethene (Total)	120 ug/Kg
Trichloroethene	460 ug/Kg
Tetrachloroethene	19 ug/Kg
Phenanthrene	290 J ug/Kg
Anthracene	93 J ug/Kg
Fluoranthene	270 J ug/Kg
Pyrene	230 J ug/Kg
Benzo(a)anthracene	130 J ug/Kg
Chrysene	130 J ug/Kg
Total Petroleum Hydrocarbons	37 mg/Kg

J = Estimated

PBS-RA-SB04	Conc.
1,1,1-Trichloroethane	22 ug/Kg
Phenanthrene	150 J ug/Kg
Fluoranthene	210 J ug/Kg
Pyrene	230 J ug/Kg
Benzo(a)anthracene	110 J ug/Kg
Chrysene	120 J ug/Kg
Total Petroleum Hydrocarbons	36 mg/Kg

J = Estimated

PBS-RA-SB03	Conc.
Total Petroleum Hydrocarbons	159 mg/Kg

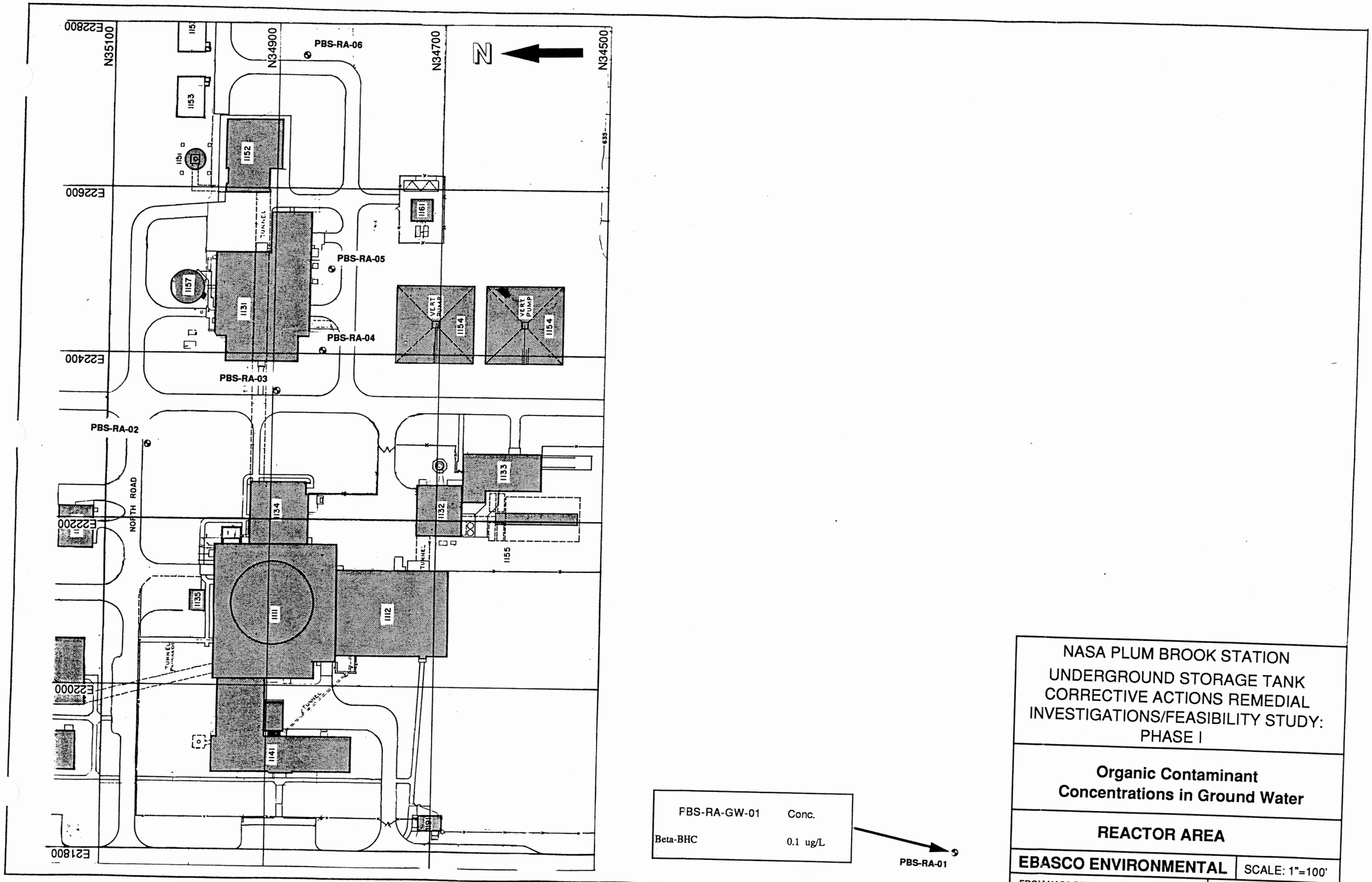
NASA PLUM BROOK STATION
UNDERGROUND STORAGE TANK
CORRECTIVE ACTIONS REMEDIAL
INVESTIGATIONS/FEASIBILITY STUDY:
PHASE I

Organic Contaminant Concentrations in Soil

REACTOR AREA

EBASCO ENVIRONMENTAL | SCALE: 1"=100'

FROM NASA DWG. NO. PF-65156 | **FIGURE 3-38**



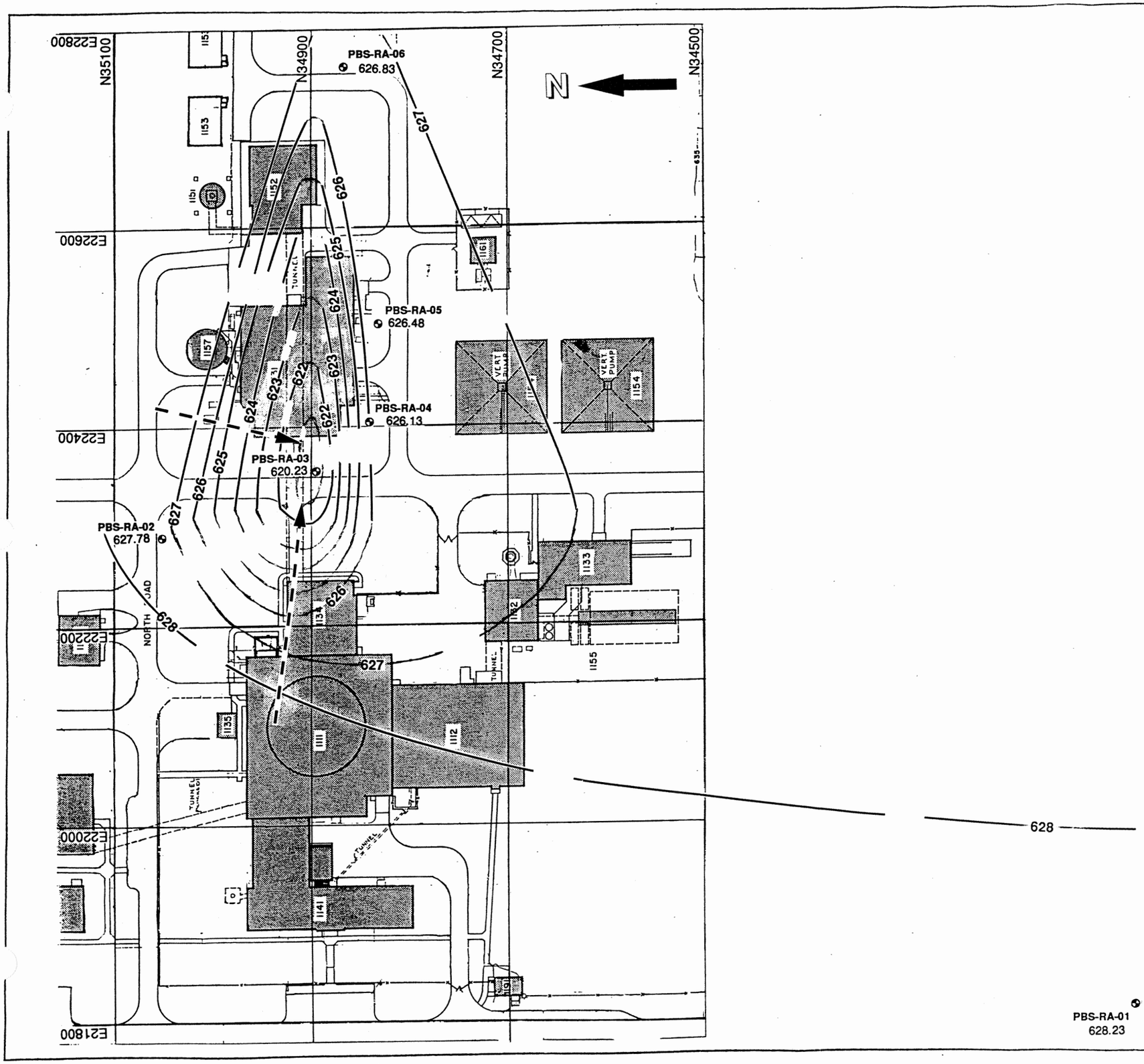
NASA PLUM BROOK STATION
UNDERGROUND STORAGE TANK
CORRECTIVE ACTIONS REMEDIAL
INVESTIGATIONS/FEASIBILITY STUDY:
PHASE I

Organic Contaminant Concentrations in Ground Water

REACTOR AREA

EBASCO ENVIRONMENTAL | SCALE: 1"=100'

FROM NASA DWG. NO. PF-65156 | **FIGURE 3-39**



LEGEND

PBS-RA-01 628.23	Ground Water Monitoring Well Ground Water Elevation
628	Ground Water Elevation Contour
	Direction of Ground Water Flow

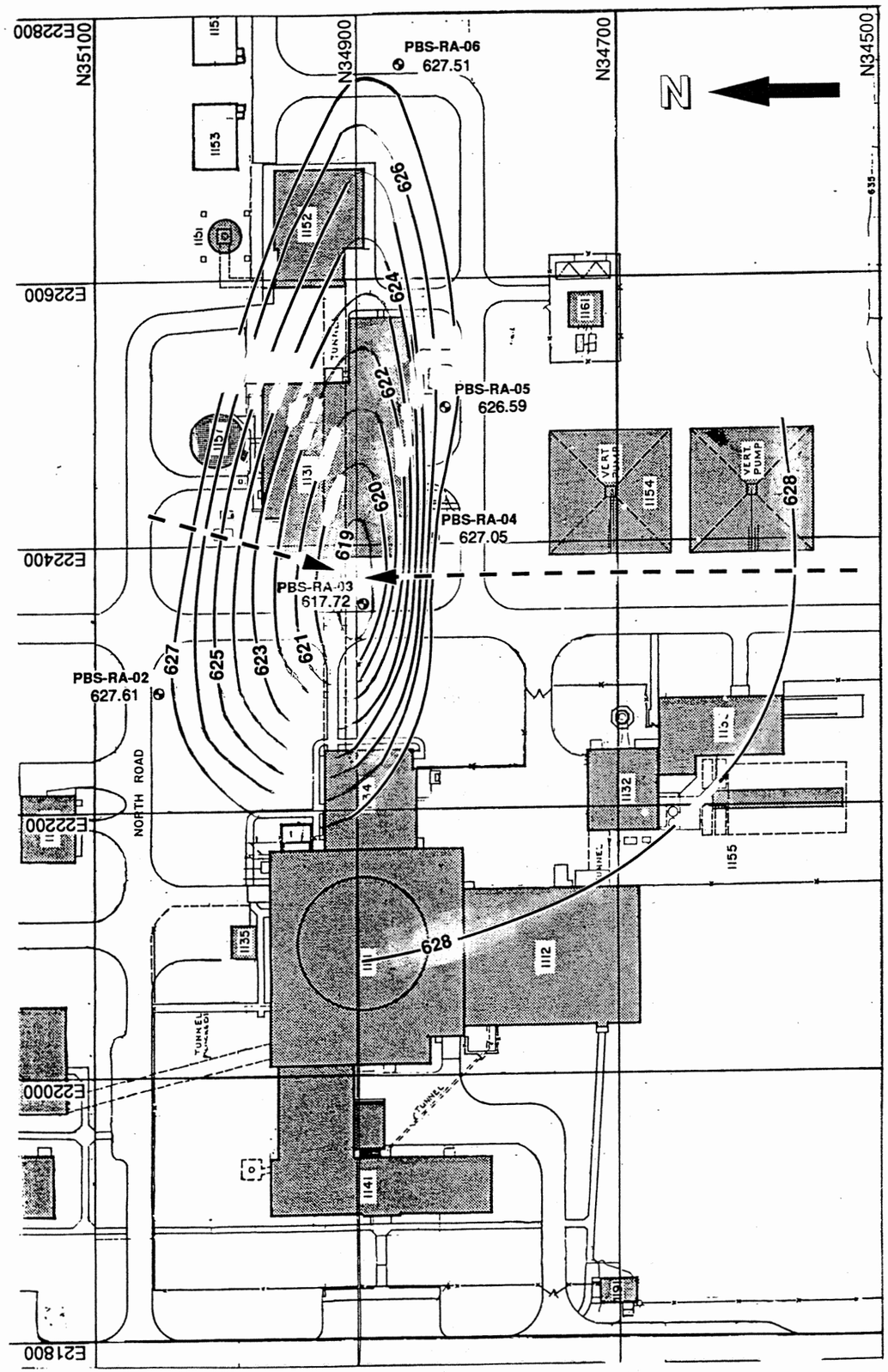
NASA PLUM BROOK STATION
UNDERGROUND STORAGE TANK CORRECTIVE ACTIONS REMEDIAL INVESTIGATIONS/FEASIBILITY STUDY: PHASE I

Ground Water Elevation Contours for 05/09/91

REACTOR AREA

EBASCO ENVIRONMENTAL | SCALE: 1"=100'

FROM NASA DWG. NO. PF-65156 | **FIGURE 3-41**



LEGEND

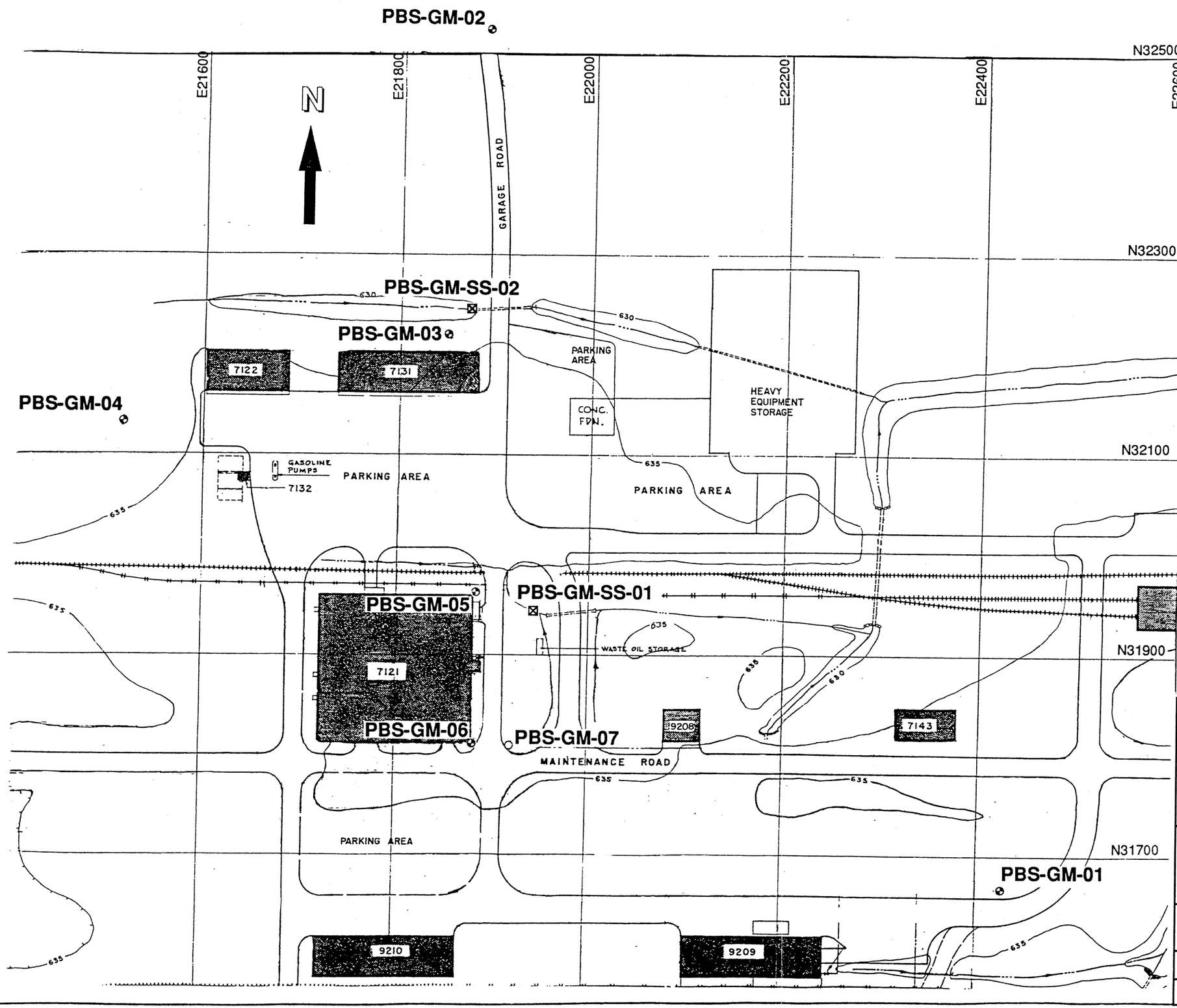
PBS-RA-01 628.88	Ground Water Monitoring Well Ground Water Elevation
628	Ground Water Elevation Contour
→	Direction of Ground Water Flow

NASA PLUM BROOK STATION
UNDERGROUND STORAGE TANK
CORRECTIVE ACTIONS REMEDIAL
INVESTIGATIONS/FEASIBILITY STUDY:
PHASE I

Ground Water Elevation Contours for 01/10/91

REACTOR AREA

EBASCO ENVIRONMENTAL	SCALE: 1"=100'
FROM NASA DWG. NO. PF-65156	**FIGURE 3-40**



LEGEND

- Ground Water Monitoring Well Location
- Soil Boring Location
- Sediment Sample Location

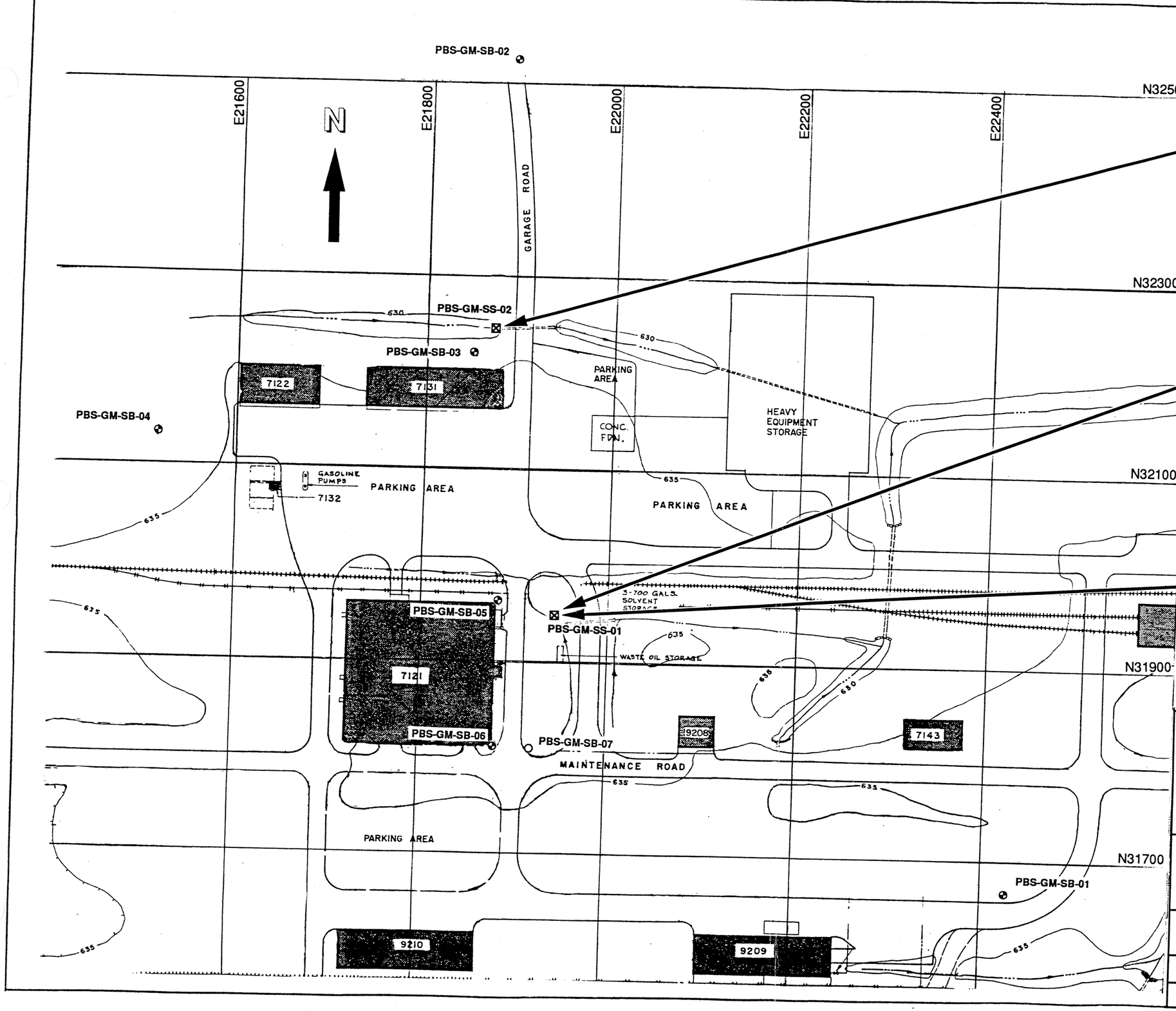
NASA PLUM BROOK STATION
UNDERGROUND STORAGE TANK CORRECTIVE ACTIONS REMEDIAL INVESTIGATION/FEASIBILITY STUDY: PHASE I

Locations of Sediment Samples

GARAGE AND MAINTENANCE AREA

EBASCO ENVIRONMENTAL | SCALE: 1"=100'

FROM NASA DWG. NO. PF-65180 | **FIGURE 3-16**



PBS-GM-SS-02	Conc.
1,1-Dichloroethane	21 ug/Kg
Phenanthrene	1200 J ug/Kg
Anthracene	220 J ug/Kg
Fluoranthene	3700 ug/Kg
Pyrene	2200 ug/Kg
Benzo(a)anthracene	1200 J ug/Kg
Chrysene	1600 J ug/Kg
Benzo(b)fluoranthene	2400 ug/Kg
Benzo(k)fluoranthene	2200 ug/Kg
Beta-BHC	82 ug/Kg
Delta-BHC	370 ug/Kg
Total Petroleum Hydrocarbons	2620 mg/Kg

PBS-GM-SS-01	Conc.
Phenanthrene	570 J ug/Kg
Fluoranthene	1400 ug/Kg
Pyrene	1000 J ug/Kg
Benzo(a)anthracene	570 J ug/Kg
Chrysene	1000 J ug/Kg
Benzo(b)fluoranthene	1400 ug/Kg
Benzo(k)fluoranthene	1600 ug/Kg
Benzo(a)pyrene	850 J ug/Kg
Indeno(1,2,3-cd)pyrene	850 J ug/Kg
Dibenzo(a,h)anthracene	280 J ug/Kg
Benzo(g,h,i)perylene	710 J ug/Kg
Total Petroleum Hydrocarbons	110 mg/Kg

PBS-GM-SS-03 (SS-01 DUP)	Conc.
Phenanthrene	360 J ug/Kg
Fluoranthene	1100 J ug/Kg
Pyrene	590 J ug/Kg
Benzo(a)anthracene	360 J ug/Kg
Chrysene	590 J ug/Kg
Benzo(b)fluoranthene	710 J ug/Kg
Benzo(k)fluoranthene	950 J ug/Kg
Benzo(a)pyrene	590 J ug/Kg
Indeno(1,2,3-cd)pyrene	590 J ug/Kg
Beta-BHC	40 ug/Kg
Total Petroleum Hydrocarbons	181 mg/Kg

J = Estimated

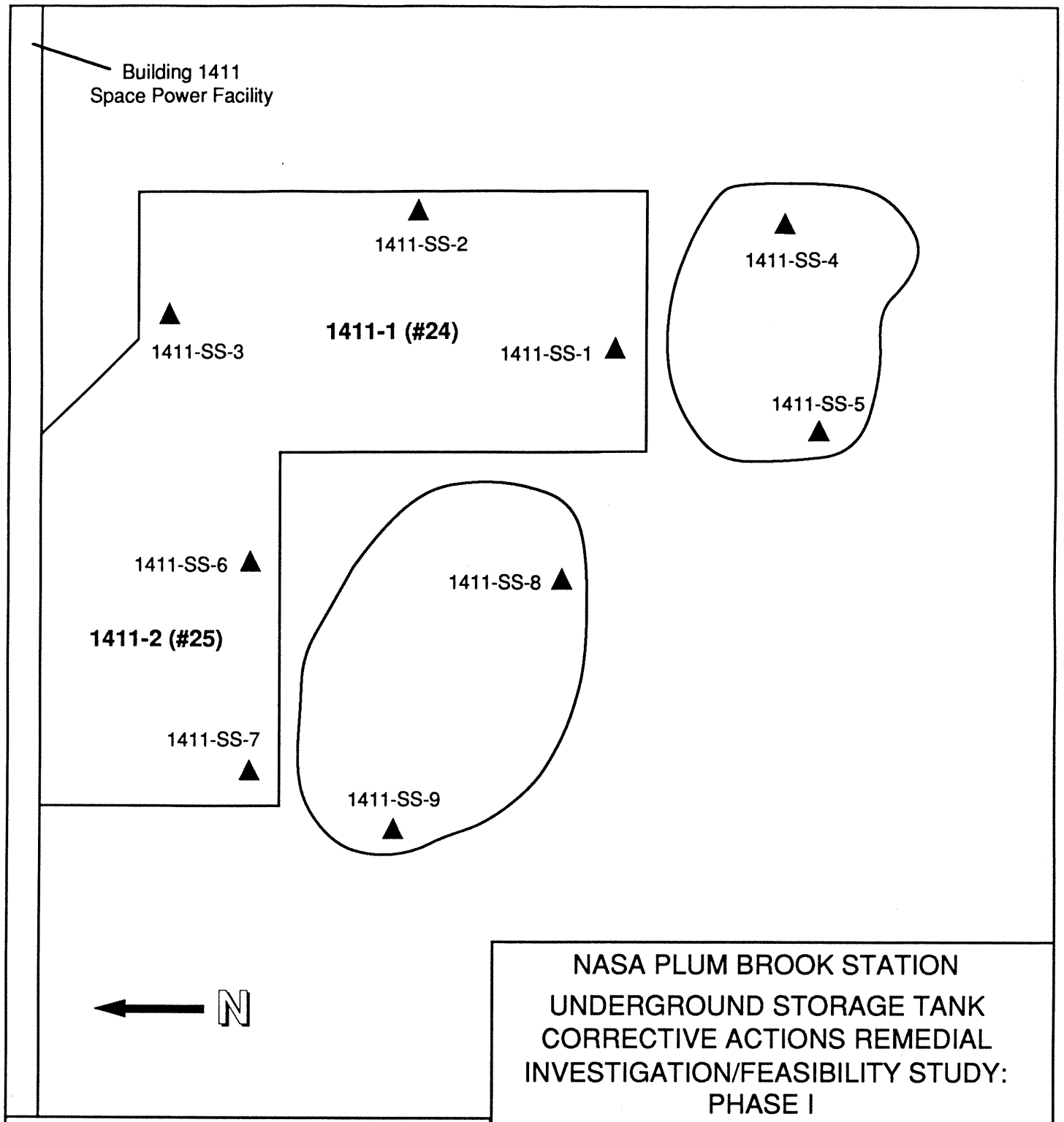
NASA PLUM BROOK STATION
UNDERGROUND STORAGE TANK CORRECTIVE ACTIONS REMEDIAL INVESTIGATIONS/FEASIBILITY STUDY: PHASE I

Organic Contaminant Concentrations in Sediment

GARAGE AND MAINTENANCE AREA

EBASCO ENVIRONMENTAL | SCALE: 1"=100'

FROM NASA DWG. NO. PF-65180 | **FIGURE 3-17**



NASA PLUM BROOK STATION
UNDERGROUND STORAGE TANK CORRECTIVE ACTIONS REMEDIAL INVESTIGATION/FEASIBILITY STUDY: PHASE I

LEGEND

Soil Sample

Tank Pit

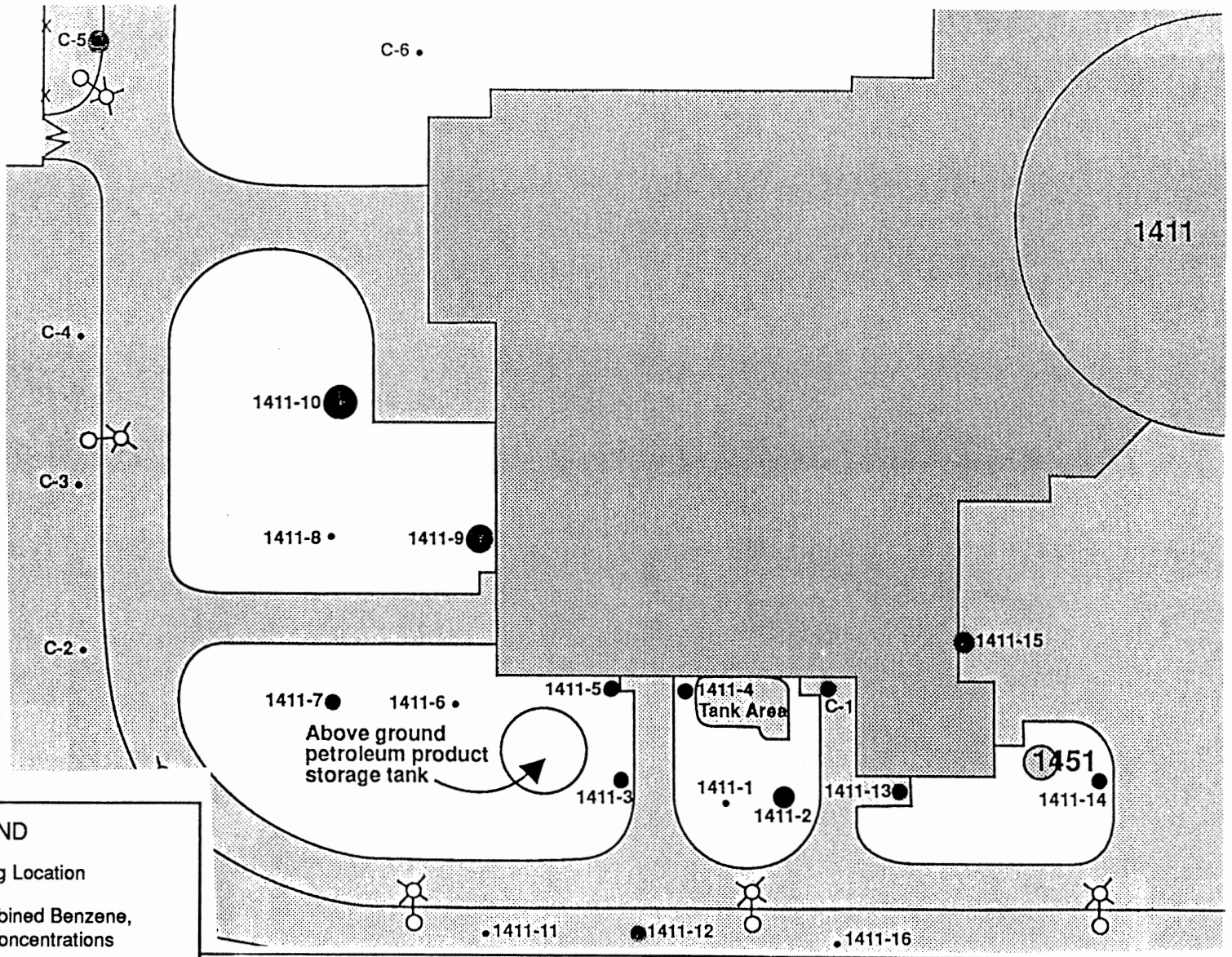
Excavated Soil Pile

Sampling Locations Associated With the Building 1411 USTs

SPACE POWER FACILITY

EBASCO ENVIRONMENTAL | NOT TO SCALE

FIGURE 3-18



LEGEND

A-1 Soil Gas Sampling Location

Key to Symbols for Combined Benzene, Toluene and Xylene Concentrations

- Not Detected
- Detected <100 ppb
- 100 - 500 ppb
- 500 - 1000 ppb
- 1000 - 5000 ppb
- >5000 ppb

NASA PLUM BROOK STATION

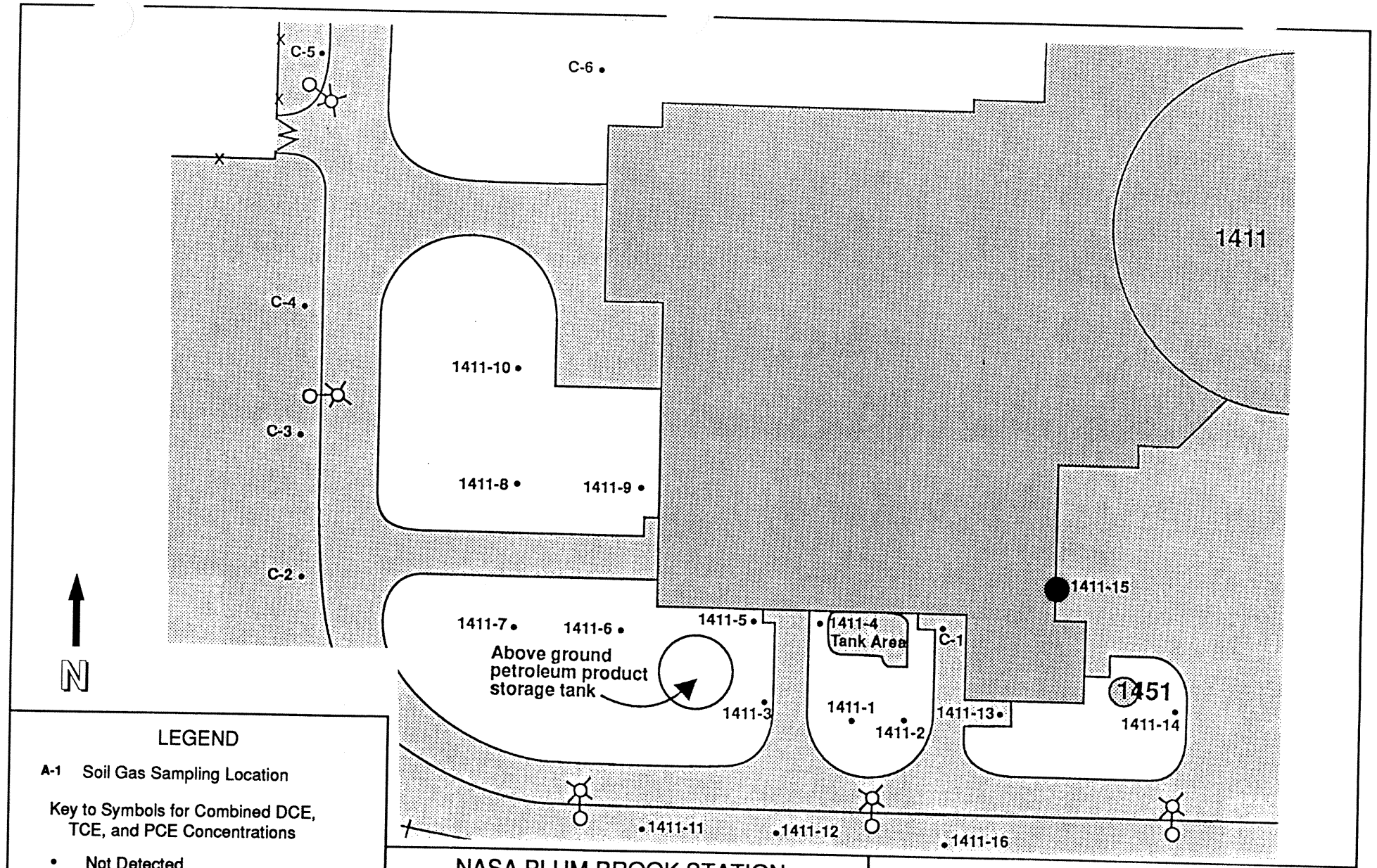
UNDERGROUND STORAGE TANK CORRECTIVE ACTIONS REMEDIAL INVESTIGATION/FEASIBILITY STUDY: PHASE I

EBASCO ENVIRONMENTAL | NOT TO SCALE

Soil Gas Sampling Locations and Results for Benzene, Toluene and Xylene

SPACE POWER FACILITY

FIGURE 3-19



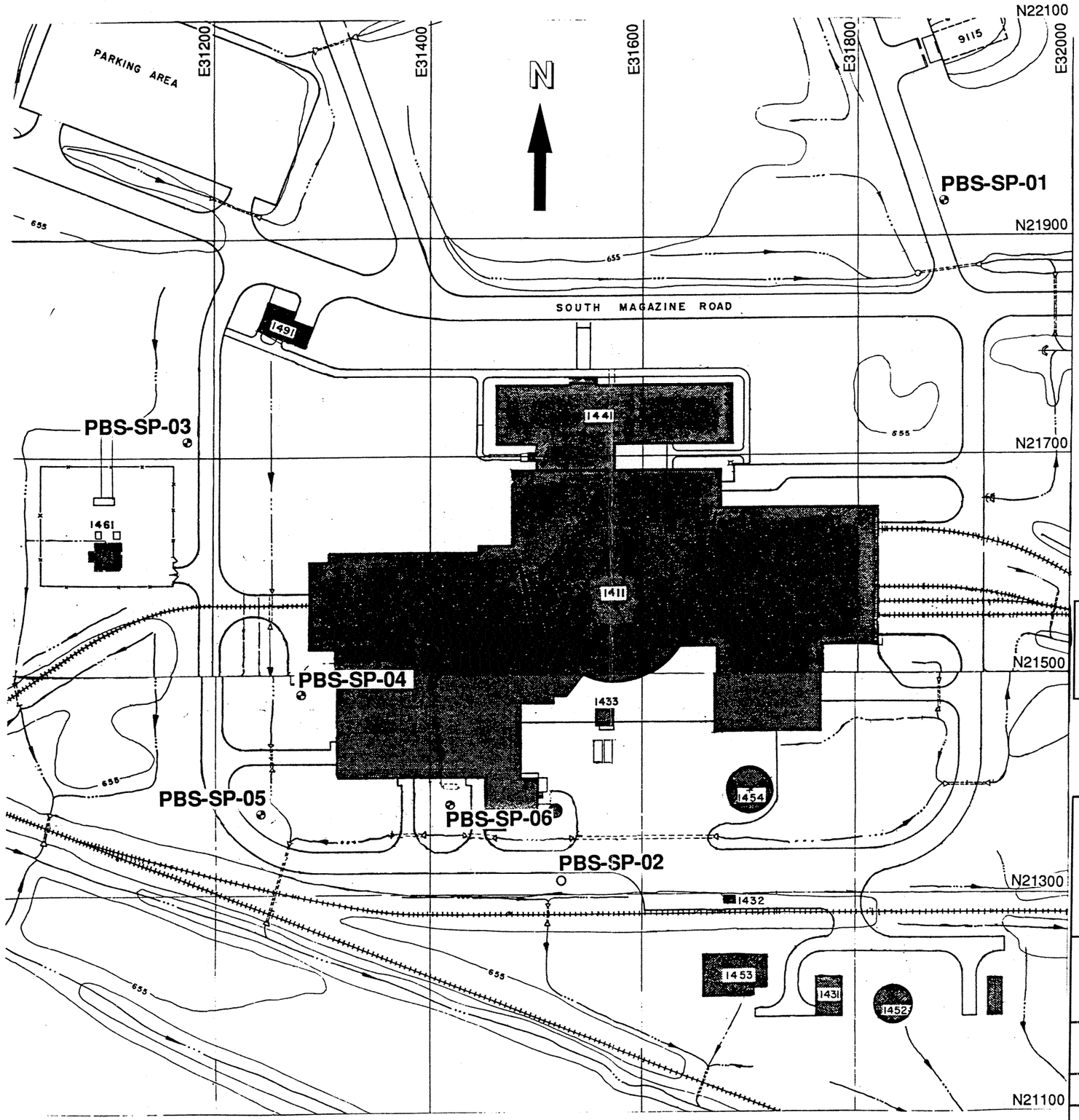
NASA PLUM BROOK STATION
UNDERGROUND STORAGE TANK CORRECTIVE ACTIONS REMEDIAL INVESTIGATION/FEASIBILITY STUDY: PHASE I

EBASCO ENVIRONMENTAL | NOT TO SCALE

Soil Gas Sampling Locations and Results for DCE, TCE and PCE

SPACE POWER FACILITY

FIGURE 3-20



LEGEND

- Ground Water Monitoring Well Location
- Soil Boring Location

NASA PLUM BROOK STATION
UNDERGROUND STORAGE TANK CORRECTIVE ACTIONS REMEDIAL INVESTIGATION/FEASIBILITY STUDY: PHASE I

Locations of Soil Borings and Ground Water Monitoring Wells

SPACE POWER FACILITY

EBASCO ENVIRONMENTAL | SCALE: 1"=100'

FROM NASA DWG. NOs. PF-65530 & 65538 | **FIGURE 3-21**

BEDROCK

Grey Shale

* Unit not encountered at all borehole locations

NASA PLUM BROOK STATION

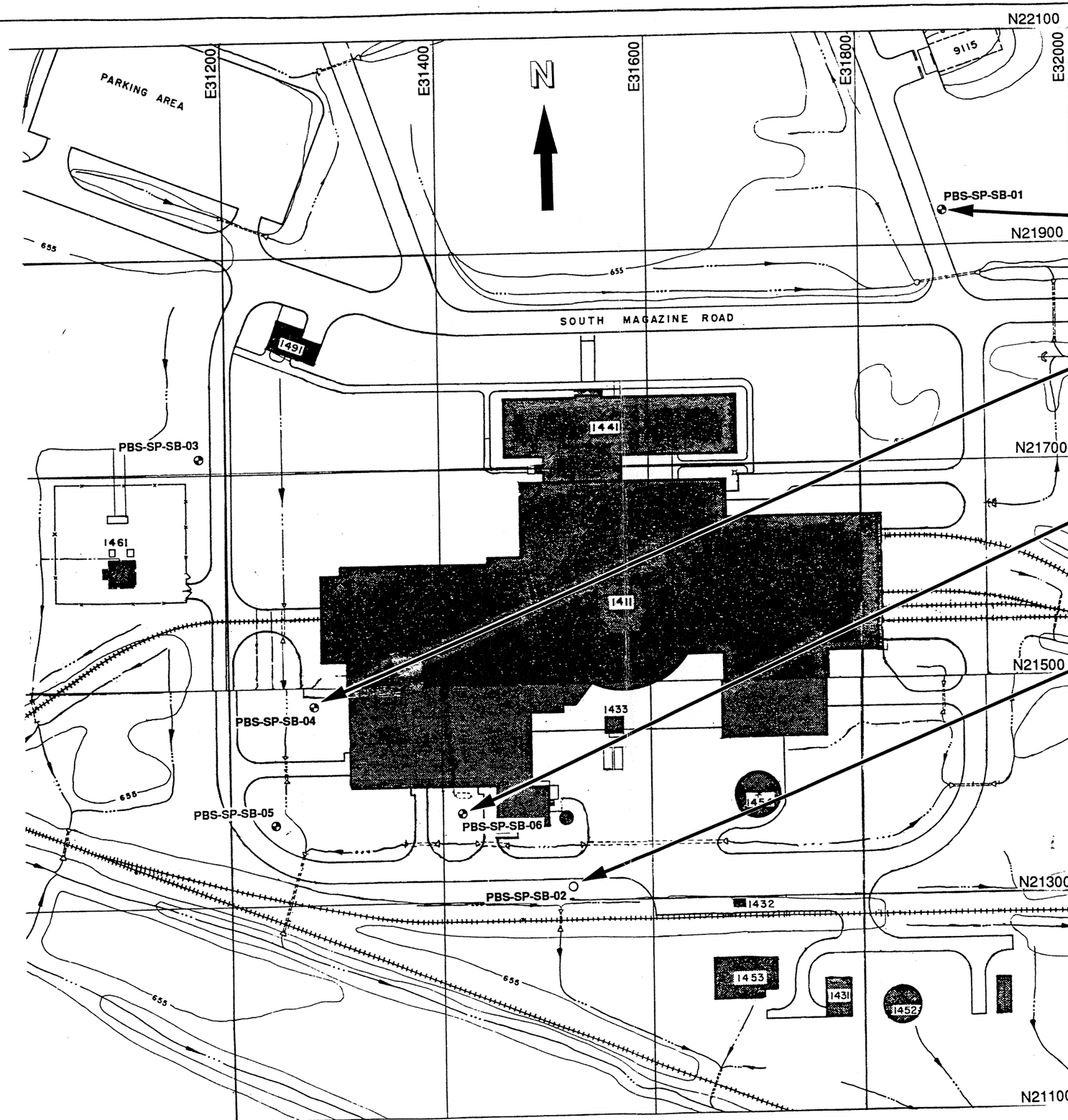
UNDERGROUND STORAGE TANK CORRECTIVE ACTIONS REMEDIAL INVESTIGATION/FEASIBILITY STUDY: PHASE I

Generalized Stratigraphic Section

SPACE POWER FACILITY

EBASCO ENVIRONMENTAL | NOT TO SCALE

FIGURE 3-22



PBS-SP-SB01	Conc.
Total Petroleum Hydrocarbons	44 mg/Kg

PBS-SP-SB04	Conc.
Total Petroleum Hydrocarbons	35 mg/Kg

PBS-SP-SB06	Conc.
Naphthalene	56 J ug/Kg
2-Methylnaphthalene	670 ug/Kg
Phenanthrene	330 J ug/Kg
Total Petroleum Hydrocarbons	288 mg/Kg

J = Estimated

PBS-SP-SBO2	Conc.
Trichloroethene	2 J ug/Kg

J = Estimated

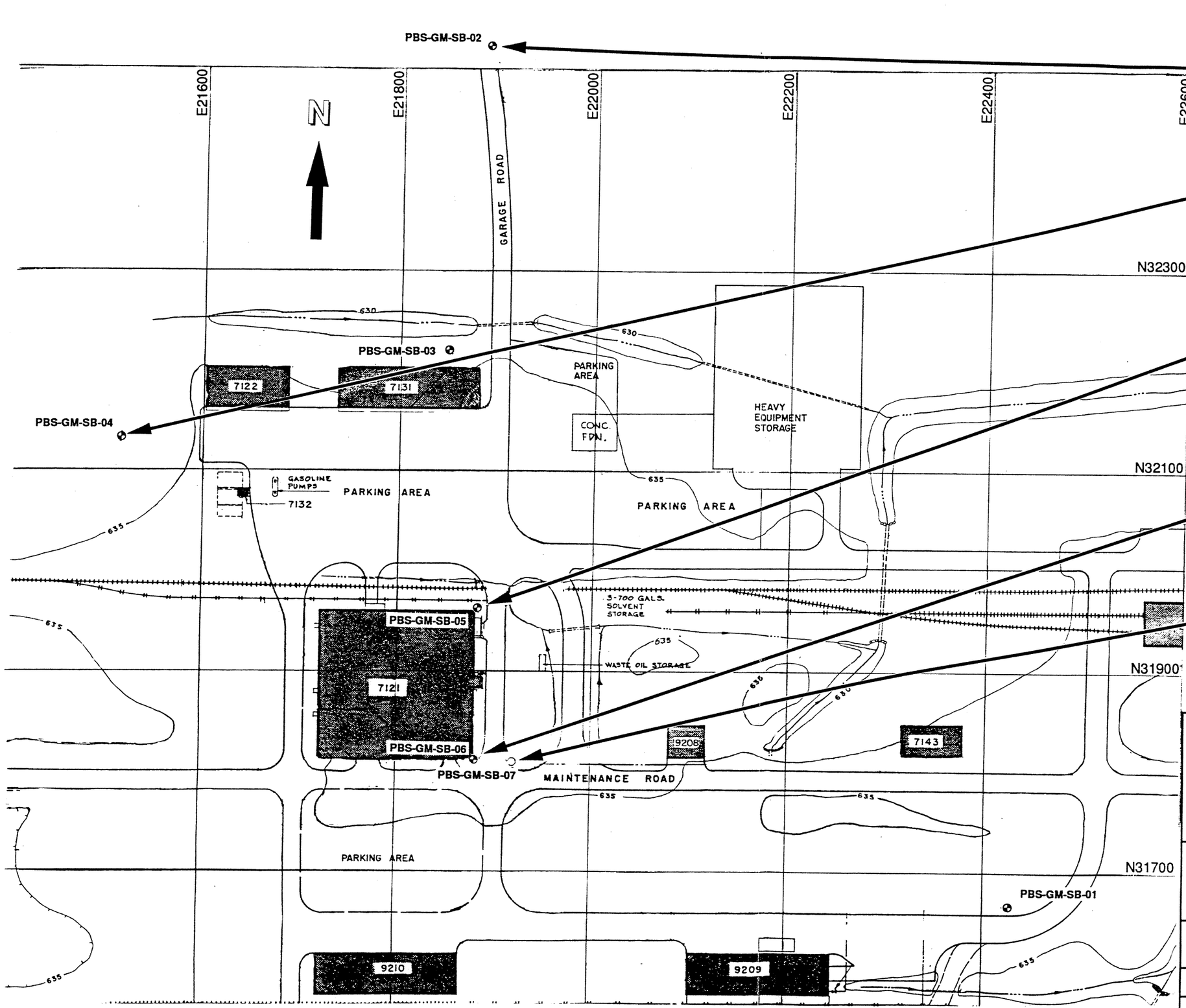
NASA PLUM BROOK STATION
UNDERGROUND STORAGE TANK CORRECTIVE ACTIONS REMEDIAL INVESTIGATIONS/FEASIBILITY STUDY: PHASE I

Organic Contaminant Concentrations in Soil

SPACE POWER FACILITY

EBASCO ENVIRONMENTAL | SCALE: 1"=100'

FROM NASA DWG. NOs. PF-65530 & 65538 | **FIGURE 3-23**



PBS-GM-SB02	Conc.
Bromodichloromethane	6 ug/Kg
1,1,2,2-Tetrachloroethane	35 ug/Kg
Ethylbenzene	21 ug/Kg
Total Petroleum Hydrocarbons	106 mg/Kg

PBS-GM-SB04	Conc.
Total Petroleum Hydrocarbons	129 mg/Kg

PBS-GM-SB05	Conc.
1,1-Dichloroethene	61 ug/Kg
1,1-Dichloroethane	50 ug/Kg
2-Butanone	6200 ug/Kg
1,1,1-Trichloroethane	2000 ug/Kg
Carbon Tetrachloride	260 ug/Kg
Trichloroethene	55 ug/Kg
Tetrachloroethane	24 ug/Kg
1,1,2,2-Tetrachloroethane	18 ug/Kg

PBS-GM-SB06	Conc.
1,1-Dichloroethane	12 ug/Kg
1,1,1-Trichloroethane	25 ug/Kg

PBS-GM-SB07	Conc.
1,1,1-Trichloroethane	20 ug/Kg

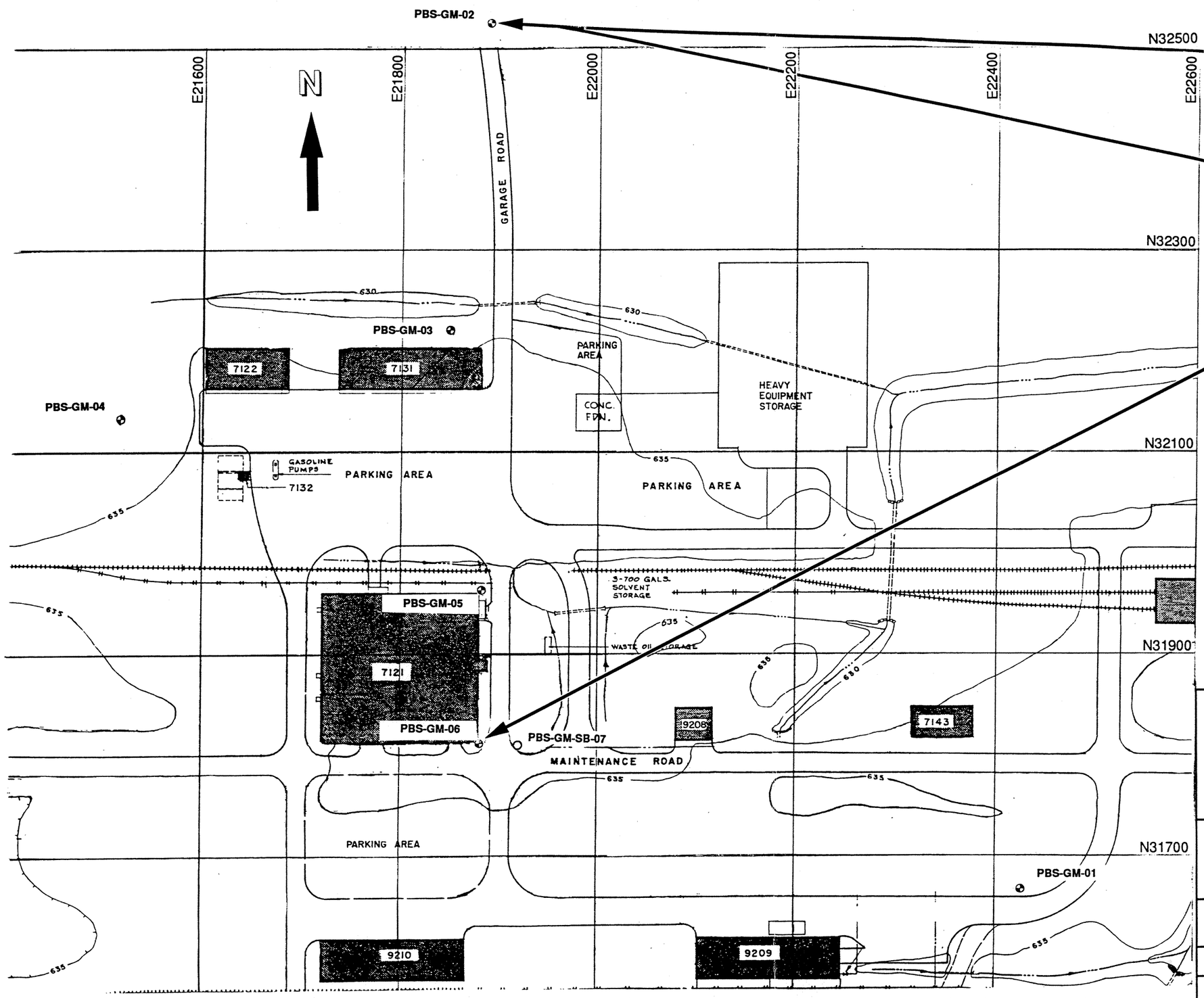
NASA PLUM BROOK STATION
UNDERGROUND STORAGE TANK
CORRECTIVE ACTIONS REMEDIAL
INVESTIGATIONS/FEASIBILITY STUDY:
PHASE I

Organic Contaminant Concentrations in Soil

GARAGE AND MAINTENANCE AREA

EBASCO ENVIRONMENTAL | SCALE: 1"=100'

FROM NASA DWG. NO. PF-65180 | **FIGURE 3-11**



PBS-GM-GW-02	Conc.
Trichloroethene	7 ug/L
Beta-BHC	0.06 ug/L

PBS-GM-GW-08 (GW-02-DUP)	Conc.
Trichloroethene	7 ug/L
Di-n-octyl Phthalate	14 ug/L
Beta-BHC	0.05 ug/L

PBS-GM-GW-06	Conc.
1,1-Dichloroethene	20 ug/L
1,1-Dichloroethane	24 ug/L
1,1,1-Trichloroethane	120 ug/L
Butylbenzylphthalate	6 J ug/L
Beta-BHC	0.19 ug/L

J = Estimated

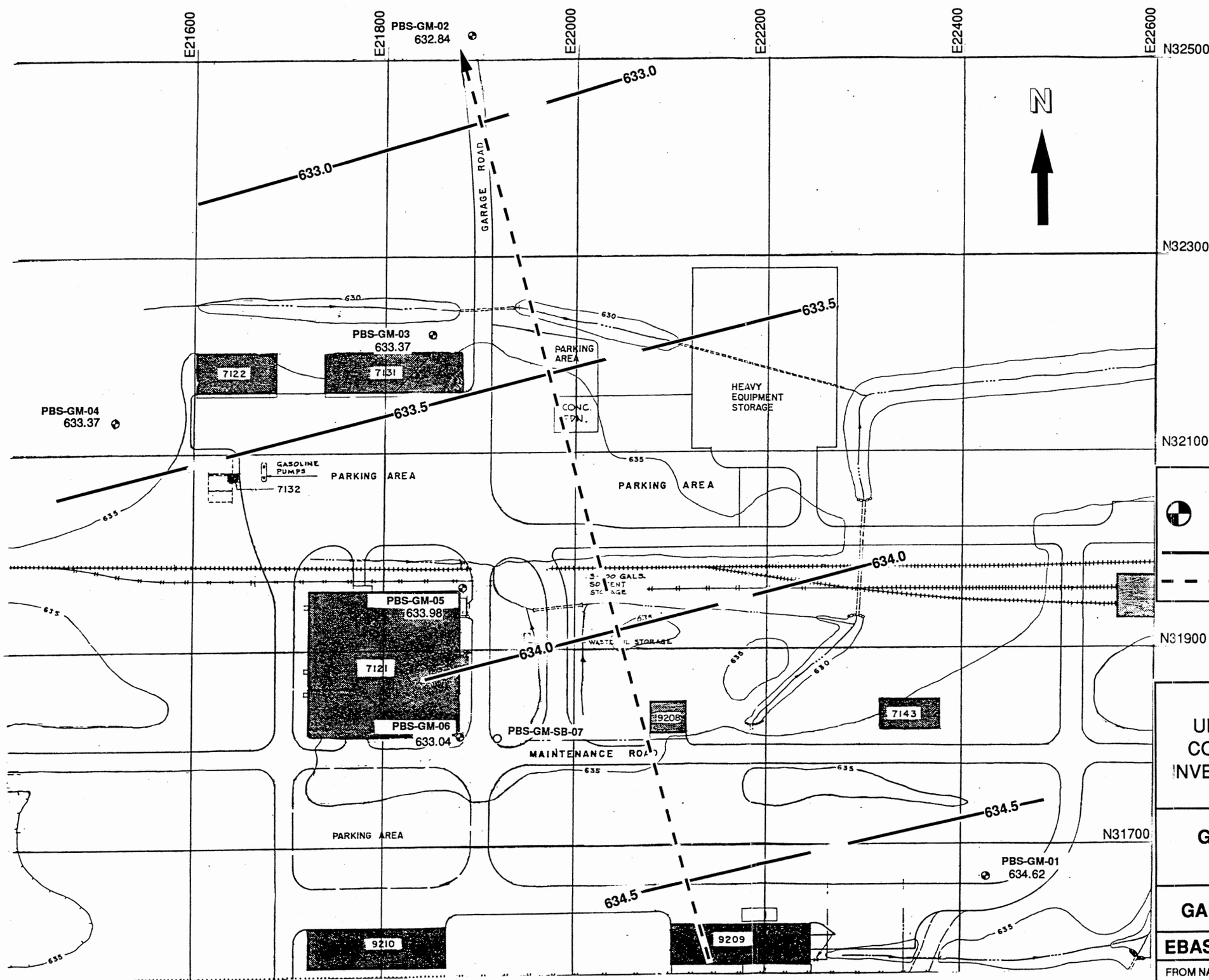
NASA PLUM BROOK STATION
UNDERGROUND STORAGE TANK CORRECTIVE ACTIONS REMEDIAL INVESTIGATIONS/FEASIBILITY STUDY: PHASE I

Organic Contaminant Concentrations in Ground Water

GARAGE AND MAINTENANCE AREA

EBASCO ENVIRONMENTAL | SCALE: 1"=100'

FROM NASA DWG. NO. PF-65180 | **FIGURE 3-12**



LEGEND

PBS-GM-01 634.62	Ground Water Monitoring Well Ground Water Elevation
634.0	Ground Water Elevation Contour
	Direction of Ground Water Flow

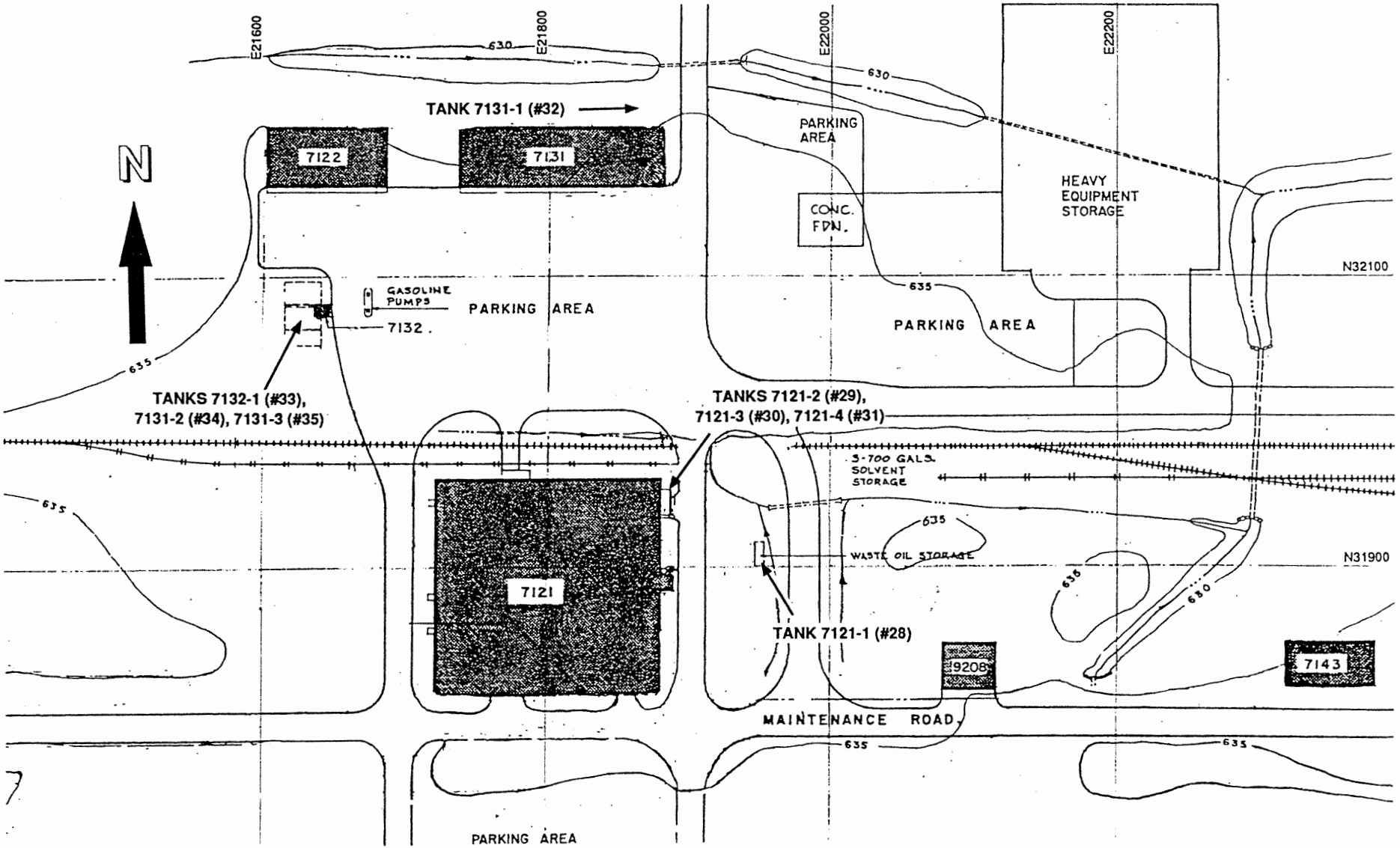
NASA PLUM BROOK STATION
UNDERGROUND STORAGE TANK
CORRECTIVE ACTIONS REMEDIAL
INVESTIGATIONS/FEASIBILITY STUDY:
PHASE I

Ground Water Elevation Contours for 01/09/91

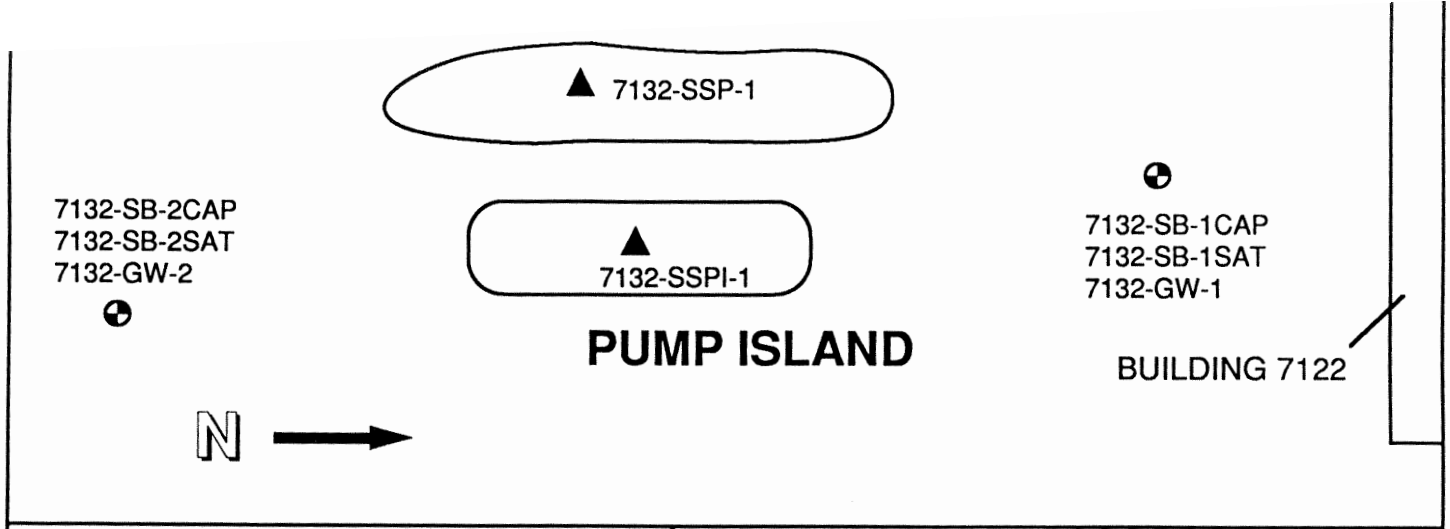
GARAGE AND MAINTENANCE AREA

EBASCO ENVIRONMENTAL | SCALE: 1"=100'

FROM NASA DWG. NO. PF-65180 | **FIGURE 3-13**



NASA PLUM BROOK STATION UNDERGROUND STORAGE TANK CORRECTIVE ACTIONS REMEDIAL INVESTIGATION/FEASIBILITY STUDY: PHASE I	**Site Location Map for the USTs**
	GARAGE AND MAINTENANCE AREA
EBASCO ENVIRONMENTAL SCALE: 1" = 200'	FROM NASA DRAWING PF-65180 **FIGURE 3-2**



LEGEND

- Ground Water Monitoring Well
- Soil Sample
- Surface Water Sample
- CAP — Soil Boring Sample from the Capillary Fringe
- SAT — Soil Boring Sample from the Saturated Zone
- Tank Pit
- Former Excavated Soil Pile

NASA PLUM BROOK STATION

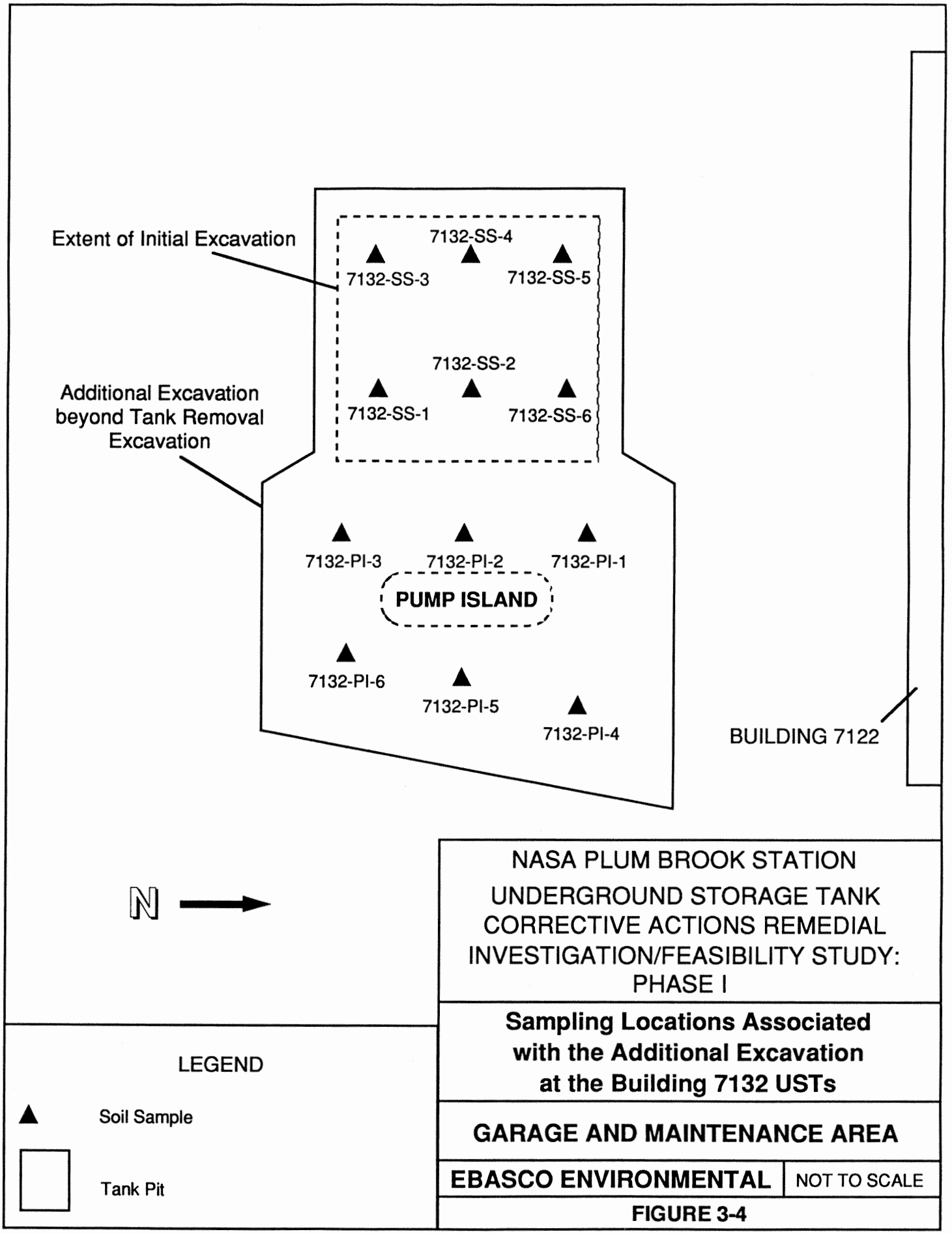
UNDERGROUND STORAGE TANK CORRECTIVE ACTIONS REMEDIAL INVESTIGATION/FEASIBILITY STUDY: PHASE I

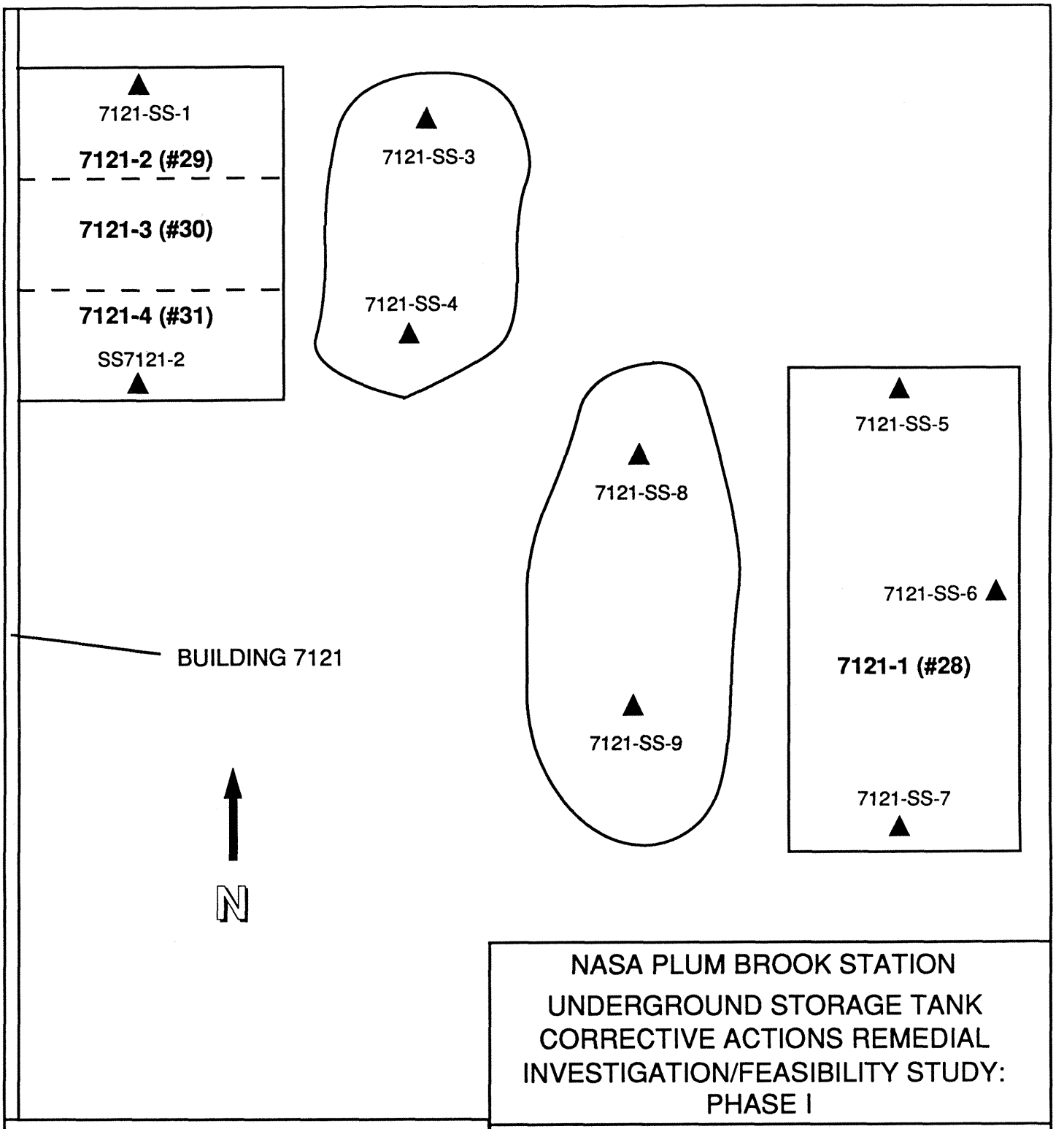
Sampling Locations Associated with the Building 7132 USTs

GARAGE AND MAINTENANCE AREA

EBASCO ENVIRONMENTAL | NOT TO SCALE

FIGURE 3-3


Extent of Initial Excavation
7132-SS-4
7132-SS-3
7132-SS-5
7132-SS-2
Additional Excavation beyond Tank Removal Excavation
7132-SS-1
7132-SS-6
7132-PI-3
7132-PI-2
7132-PI-1
PUMP ISLAND
7132-PI-6
7132-PI-5
7132-PI-4
BUILDING 7122
N
LEGEND
Soil Sample
Tank Pit
NASA PLUM BROOK STATION
UNDERGROUND STORAGE TANK CORRECTIVE ACTIONS REMEDIAL INVESTIGATION/FEASIBILITY STUDY: PHASE I
Sampling Locations Associated with the Additional Excavation at the Building 7132 USTs
GARAGE AND MAINTENANCE AREA
EBASCO ENVIRONMENTAL
NOT TO SCALE
FIGURE 3-4



NASA PLUM BROOK STATION
UNDERGROUND STORAGE TANK CORRECTIVE ACTIONS REMEDIAL INVESTIGATION/FEASIBILITY STUDY: PHASE I

LEGEND

▲ Soil Sample

Tank Pit

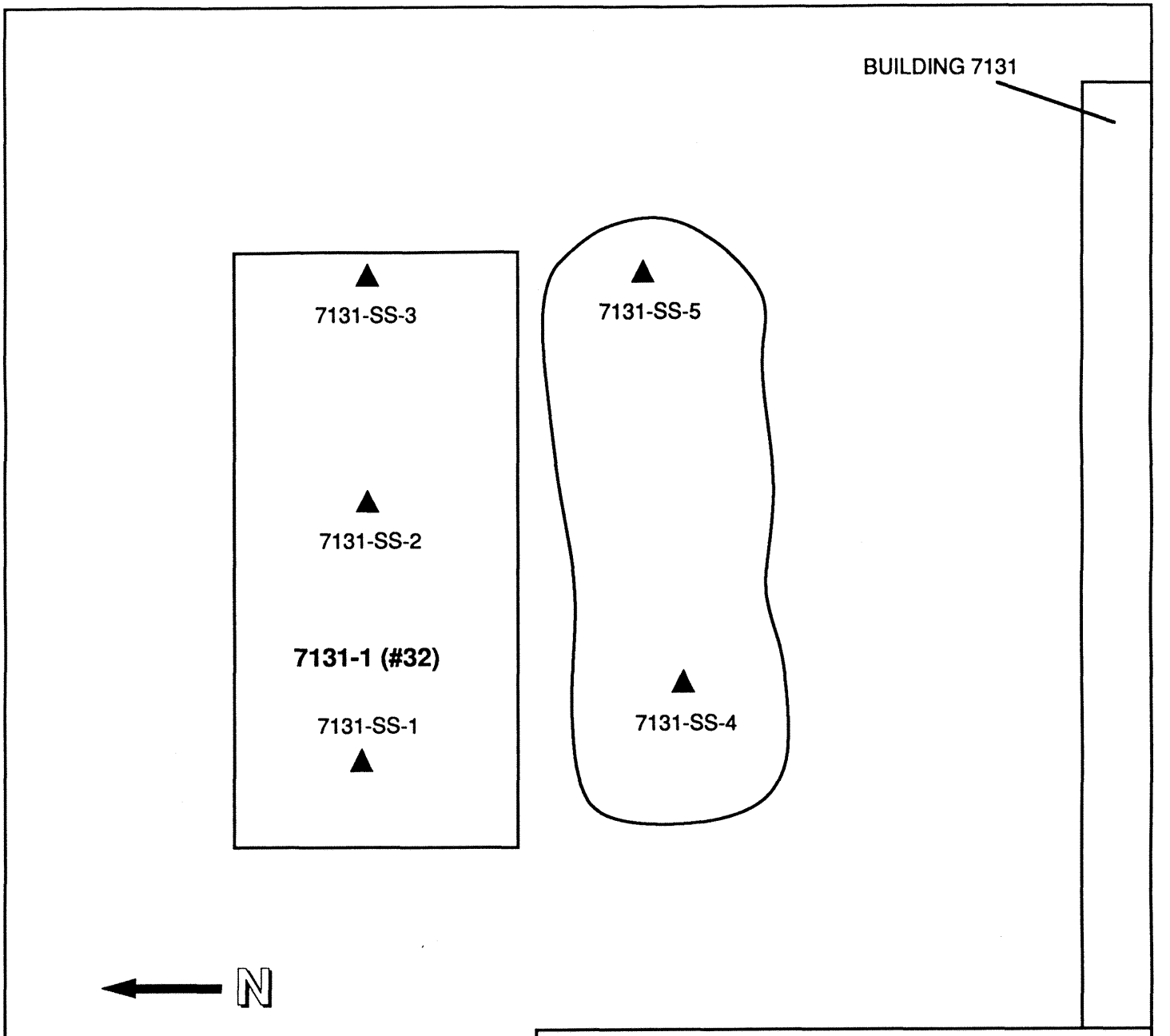
Excavated Soil Pile

Sampling Locations Associated With the Building 7121 USTs

GARAGE AND MAINTENANCE AREA

EBASCO ENVIRONMENTAL | NOT TO SCALE

FIGURE 3-5



NASA PLUM BROOK STATION
UNDERGROUND STORAGE TANK CORRECTIVE ACTIONS REMEDIAL INVESTIGATION/FEASIBILITY STUDY: PHASE I

LEGEND

▲ Soil Sample

Tank Pit

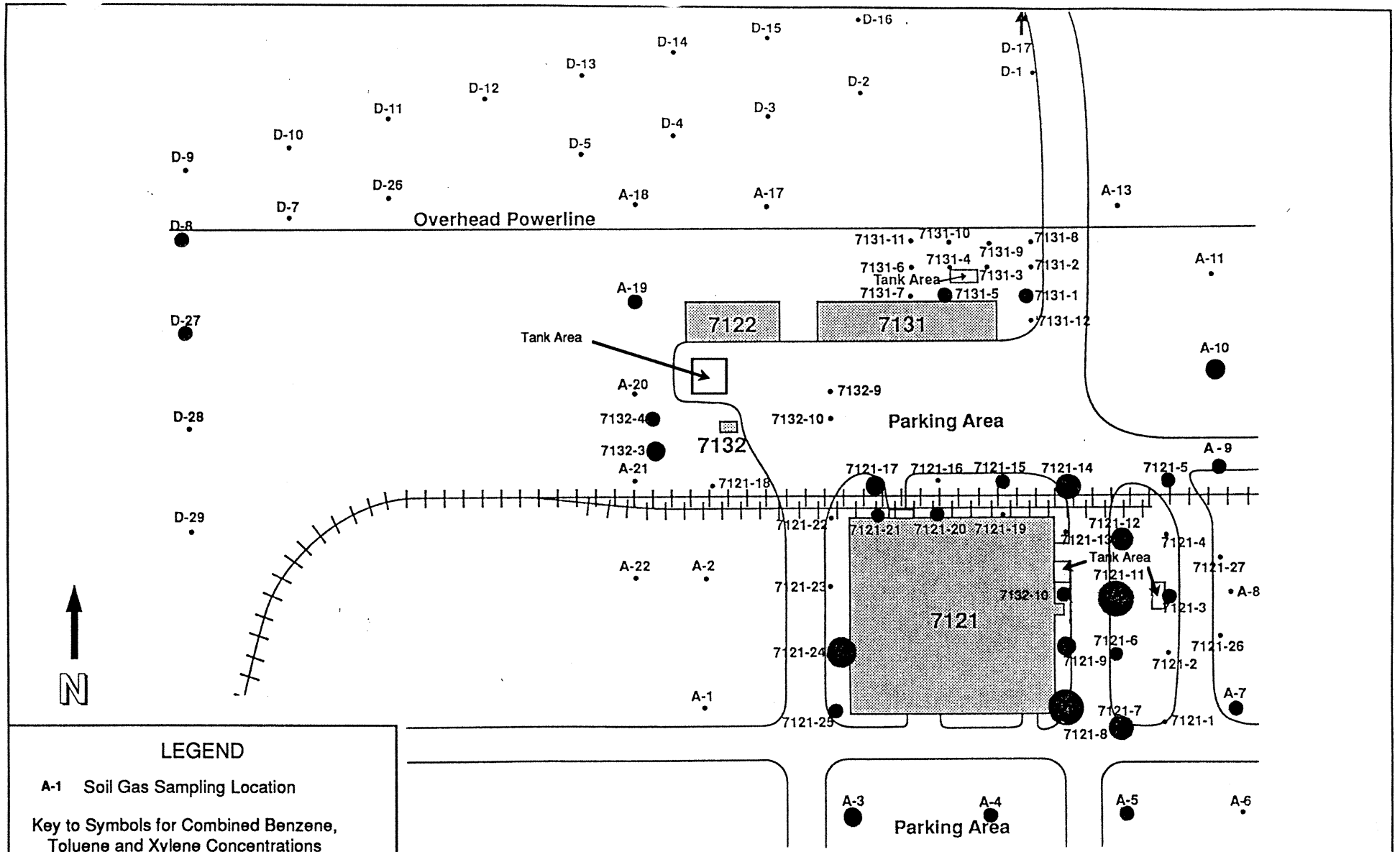
Excavated Soil Pile

Sampling Locations Associated With the Building 7131 UST

GARAGE AND MAINTENANCE AREA

EBASCO ENVIRONMENTAL | NOT TO SCALE

FIGURE 3-6



LEGEND

A-1 Soil Gas Sampling Location

Key to Symbols for Combined Benzene, Toluene and Xylene Concentrations

- Not Detected
- Detected <100 ppb
- 100 - 500 ppb
- 500 - 1000 ppb
- 1000 - 5000 ppb
- >5000 ppb

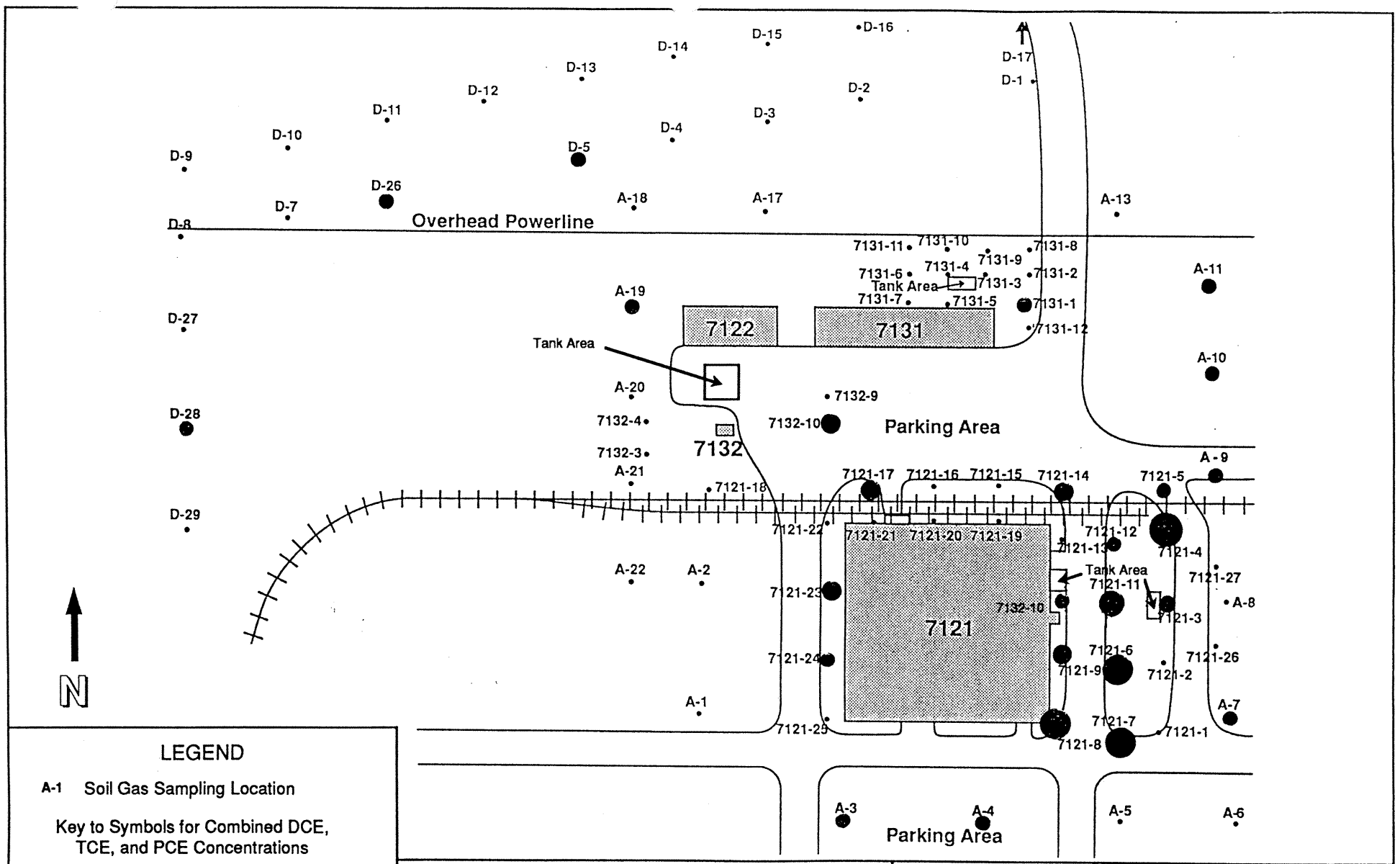
NASA PLUM BROOK STATION
UNDERGROUND STORAGE TANK CORRECTIVE ACTIONS REMEDIAL INVESTIGATION/FEASIBILITY STUDY: PHASE I

EBASCO ENVIRONMENTAL | NOT TO SCALE

Soil Gas Sampling Locations and Results for Benzene, Toluene and Xylene

GARAGE AND MAINTENANCE AREA

FIGURE 3-7



LEGEND

A-1 Soil Gas Sampling Location

Key to Symbols for Combined DCE, TCE, and PCE Concentrations

- Not Detected
- Detected <100 ppb
- 100 - 500 ppb
- 500 - 1000 ppb
- 1000 - 5000 ppb
- >5000 ppb

NASA PLUM BROOK STATION
UNDERGROUND STORAGE TANK CORRECTIVE ACTIONS REMEDIAL INVESTIGATION/FEASIBILITY STUDY: PHASE I

EBASCO ENVIRONMENTAL | NOT TO SCALE

Soil Gas Sampling Locations and Results for DCE, TCE and PCE

GARAGE AND MAINTENANCE AREA

FIGURE 3-8

	Grey Sand	3' - 8'
	Grey Clayey Silt	3' - 8'
BEDROCK	Grey Shale	

* Unit not encountered at all borehole locations

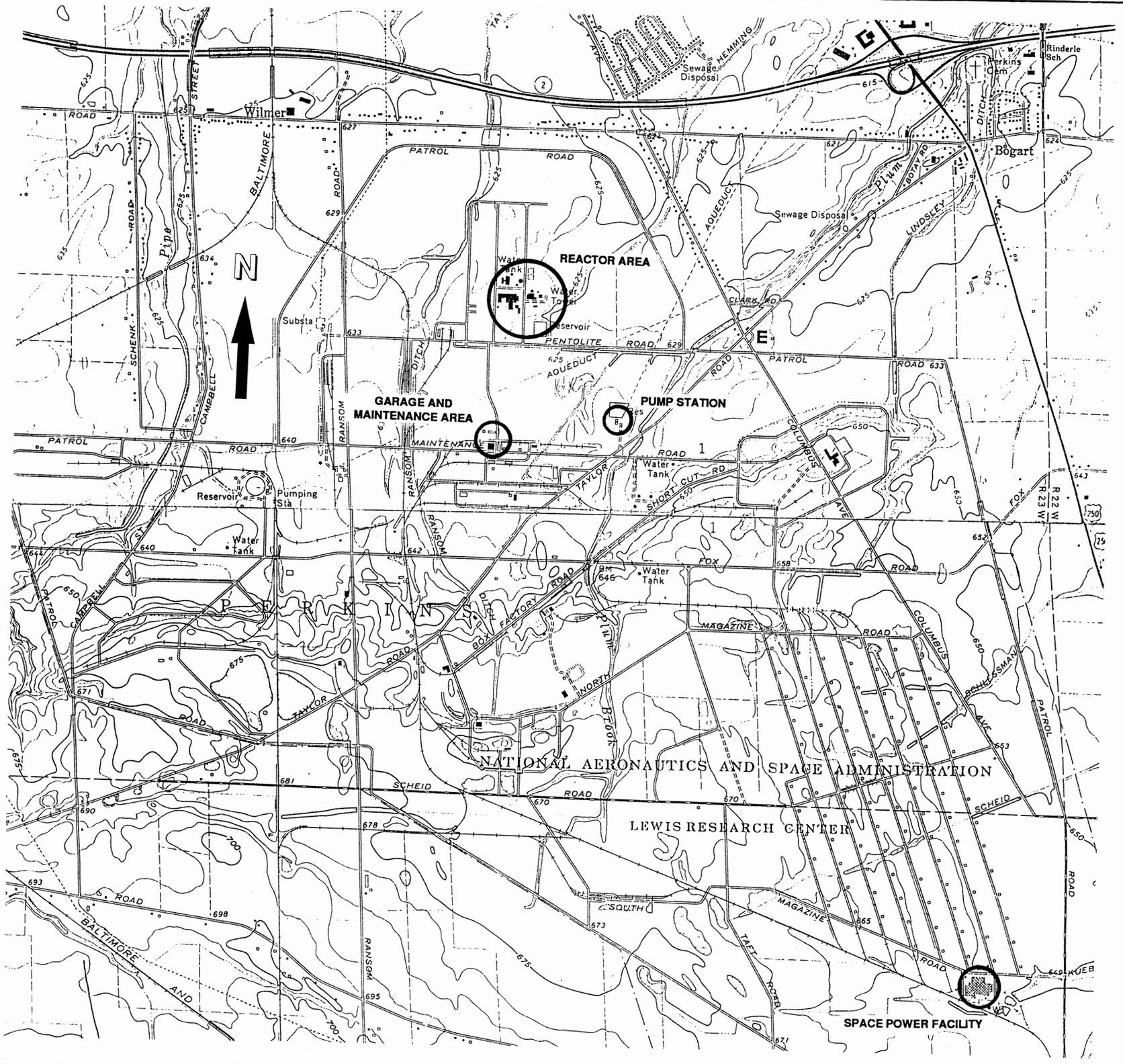
NASA PLUM BROOK STATION
UNDERGROUND STORAGE TANK CORRECTIVE ACTIONS REMEDIAL INVESTIGATION/FEASIBILITY STUDY: PHASE I

Generalized Stratigraphic Section

GARAGE AND MAINTENANCE AREA

EBASCO ENVIRONMENTAL | NOT TO SCALE

FIGURE 3-10



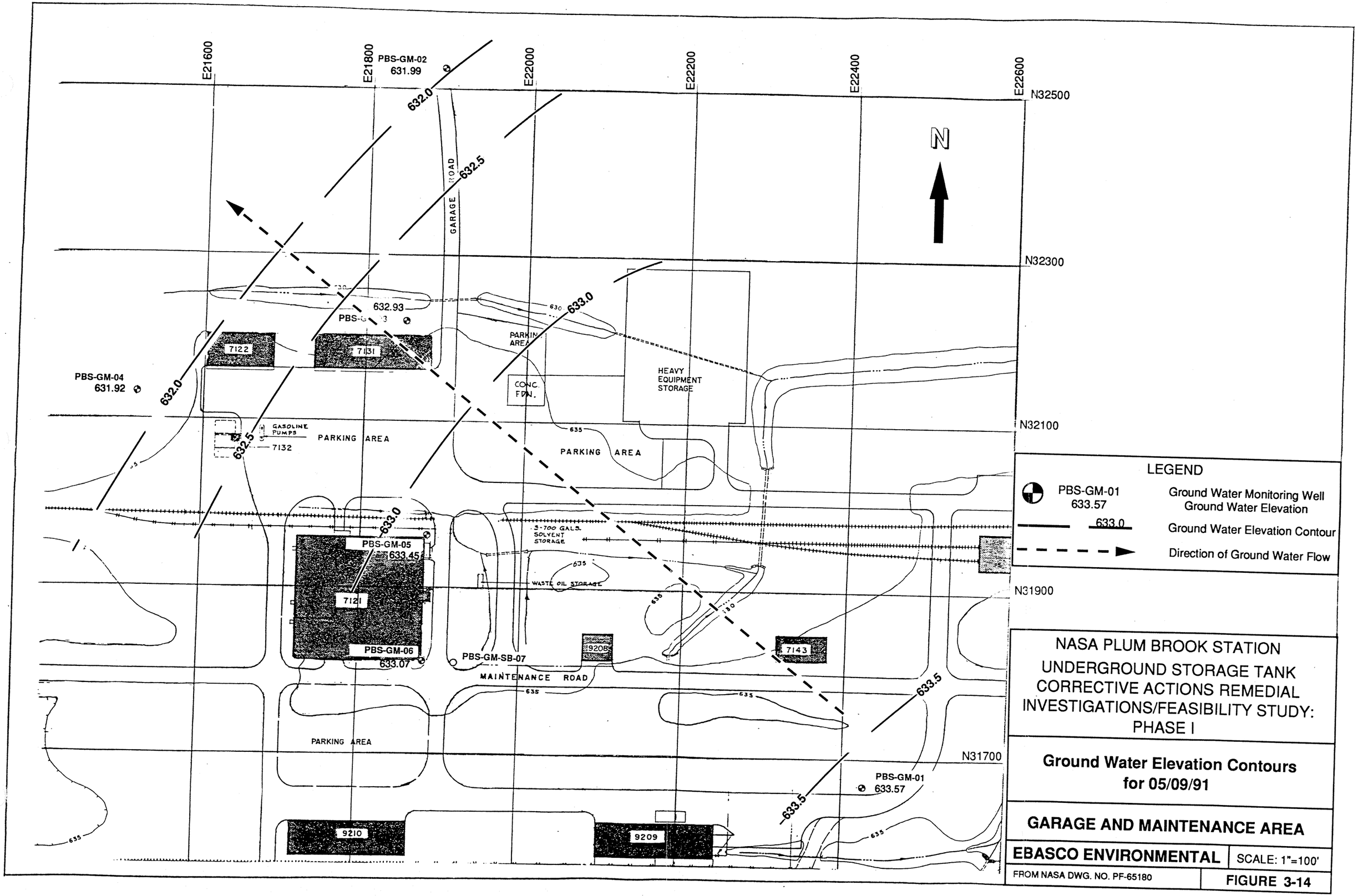
NASA PLUM BROOK STATION
UNDERGROUND STORAGE TANK
CORRECTIVE ACTIONS REMEDIAL
INVESTIGATION/FEASIBILITY STUDY:
PHASE I

Locations of the Four Former Underground Storage Tank Areas at the NASA Plum Brook Station

EBASCO ENVIRONMENTAL | SCALE: 1"=2000'

FROM USGS SANDUSKY & KIMBALL, OHIO 7.5 MINUTE QUADRANGLE TOPO MAPS

FIGURE 3-1



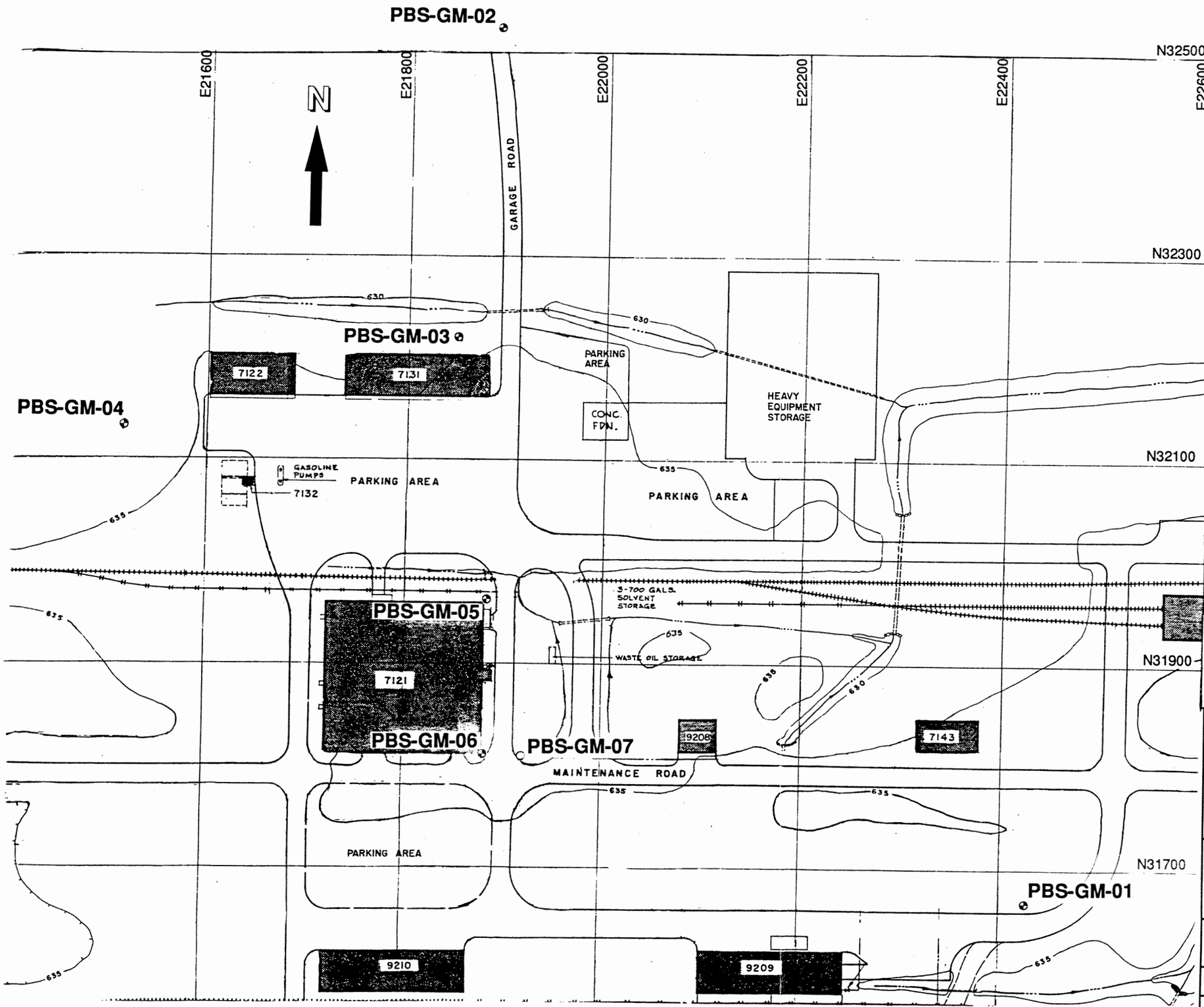
NASA PLUM BROOK STATION
UNDERGROUND STORAGE TANK
CORRECTIVE ACTIONS REMEDIAL
INVESTIGATIONS/FEASIBILITY STUDY:
PHASE I

Ground Water Elevation Contours for 05/09/91

GARAGE AND MAINTENANCE AREA

EBASCO ENVIRONMENTAL | SCALE: 1"=100'

FROM NASA DWG. NO. PF-65180 | **FIGURE 3-14**



LEGEND

Ground Water Monitoring Well Location

Soil Boring Location

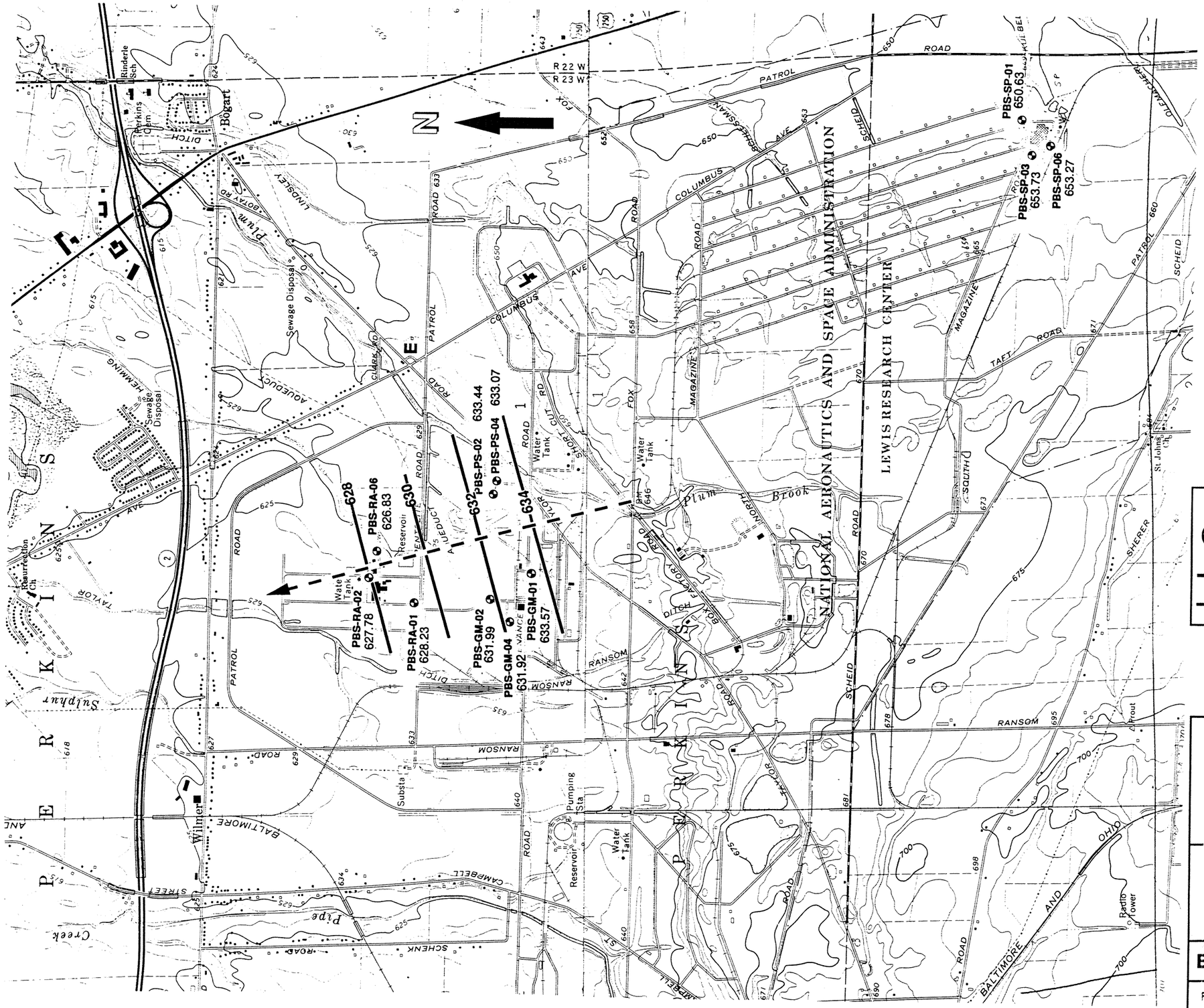
NASA PLUM BROOK STATION
UNDERGROUND STORAGE TANK
CORRECTIVE ACTIONS REMEDIAL
INVESTIGATION/FEASIBILITY STUDY:
PHASE I

Locations of Soil Borings and Ground Water Monitoring Wells

GARAGE AND MAINTENANCE AREA

EBASCO ENVIRONMENTAL | SCALE: 1"=100'

FROM NASA DWG. NO. PF-65180 | **FIGURE 3-9**



LEGEND

PBS-GM-01 633.57	Ground Water Monitoring Well Ground Water Elevation
634.0	Ground Water Elevation Contour
	Direction of Ground Water Flow

NASA PLUM BROOK STATION
UNDERGROUND STORAGE TANK CORRECTIVE ACTIONS REMEDIAL INVESTIGATIONS/FEASIBILITY STUDY: PHASE I

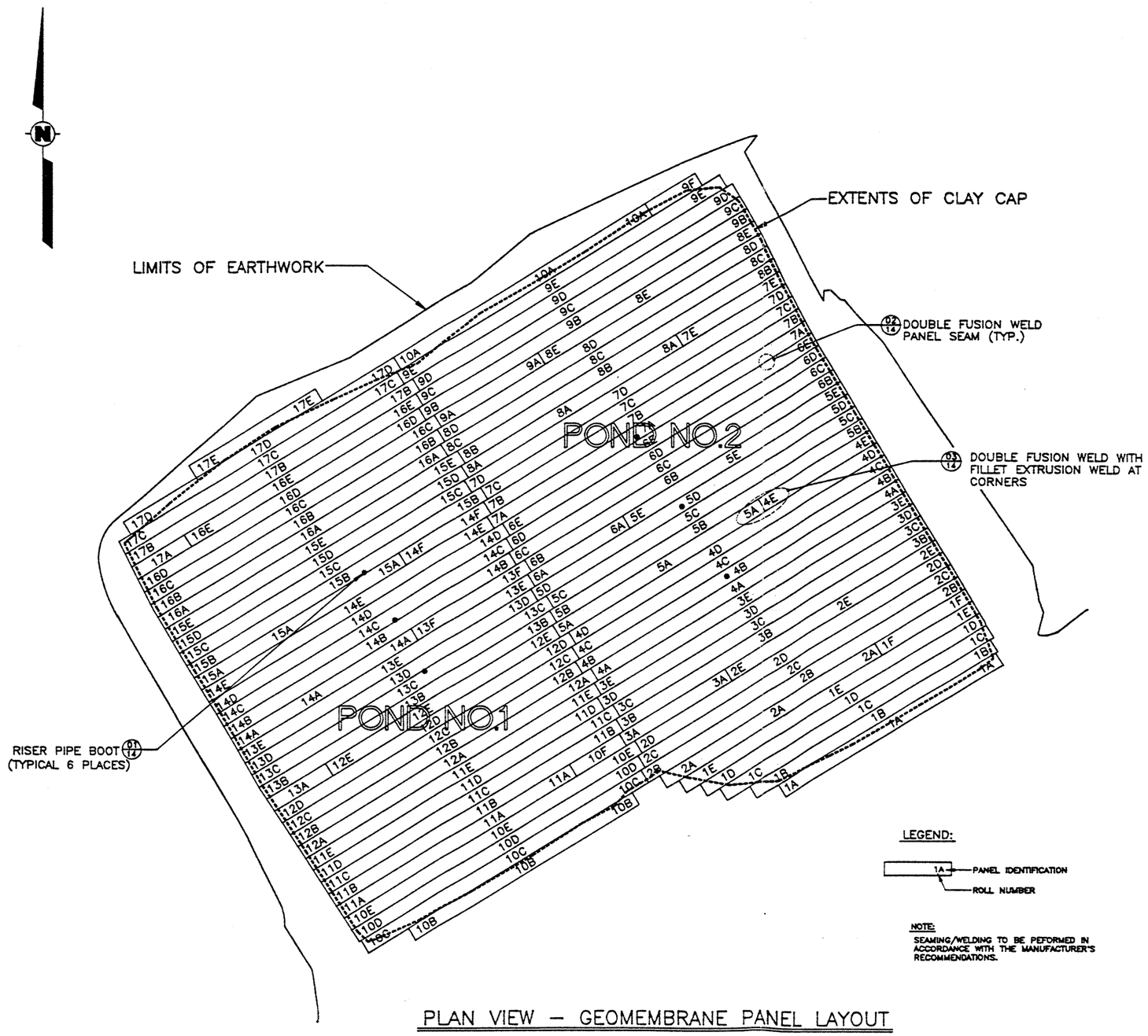
Regional Ground Water Elevation Contours for the Plum Brook Station (Based on the 05/09/91 Data)

EBASCO ENVIRONMENTAL | SCALE: 1"=2000'

FROM USGS SANDUSKY & KIMBELL, OHIO 7.5 MINUTE QUADRANGLE TOPO MAPS

FIGURE 3-15

OHM CORPORATION PITTSBURGH, PA | DRAWING NUMBER 9715-F19



LEGEND:

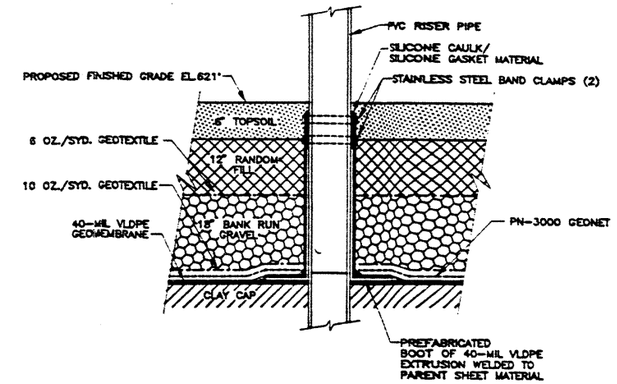
1A — PANEL IDENTIFICATION
— ROLL NUMBER

NOTE:

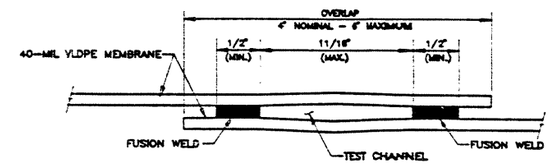
SEAMING/WELDING TO BE PEFORMED IN ACCORDANCE WITH THE MANUFACTURER'S RECOMMENDATIONS.

PLAN VIEW – GEOMEMBRANE PANEL LAYOUT

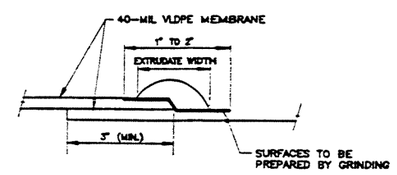
SCALE
50 0 50 100 FEET



DETAIL 01/14
TYPICAL RISER PIPE BOOT
N. T. S.



DETAIL 02/14
DOUBLE FUSION WELD PANEL SEAMS
N. T. S.



DETAIL 03/14
EXTRUSION WELD
N. T. S.

$$ – THINK VALUE ENGINEERING – $$

Revisions			
Symbol	Descriptions	Date	Approved
	GENERAL REVISION BASED ON AGENCY COMMENTS	3-6-92	JWC

OHM Corporation

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
HUNTINGTON, WEST VIRGINIA

RED WATER RESERVOIR CLOSURE CAP
FORMER WEST VIRGINIA ORDNANCE WORKS
POINT PLEASANT, WEST VIRGINIA

RED WATER AREA
PROPOSED GEOMEMBRANE
PANEL LAYOUT

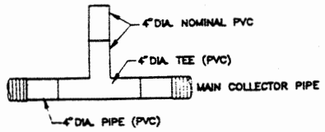
Designed by: N.E.L.			
Drawn by: B. O'Connor			
Checked by: D. Campbell/D. Pringle			
Reviewed by: J. Colella, P.E.	Scale: As Shown	Sheet reference number: 14	Date: NOVEMBER 26, 1991
Submitted by: D. Pringle Architect-Engineer	Spec. No.: DACW45-89-D-0508		Drawing Code:
	Contract No.: DACW45-89-D-0508		

PLOT SCALE: 1 = 50

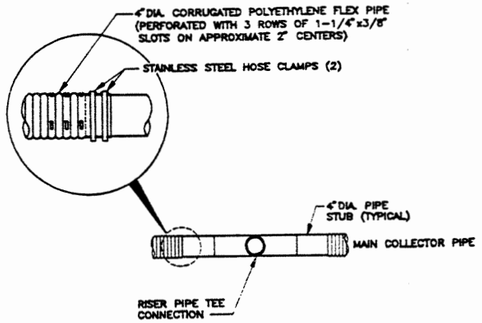
REFERENCES:

1. LIMITS OF CLAY CAP PLOTTED FROM SURVEY DATA PREPARED BY S & S ENGINEERING OF CHARLESTON, W.VA. DATE OF SURVEY: NOVEMBER 8, 1991.
2. PLAN VIEW OF GEOSYNTHETIC PANEL LAYOUT PREPARED BY NEW ENGLAND LINER SYSTEMS INC.

OHM CORPORATION PITTSBURGH, PA | DRAWING NUMBER 9715-F14

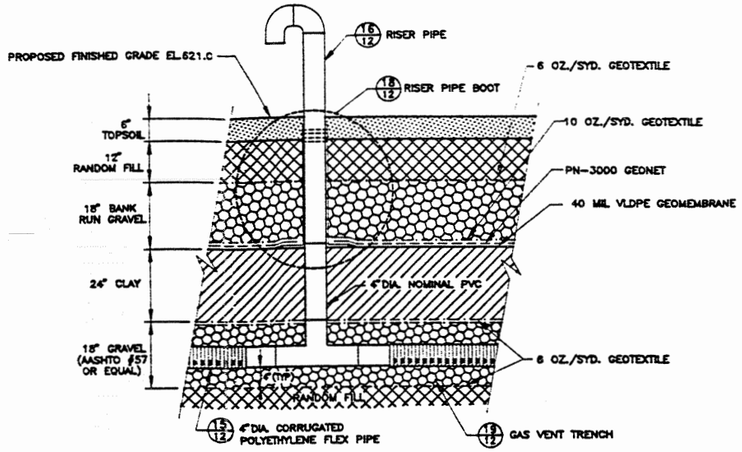


ELEVATION VIEW

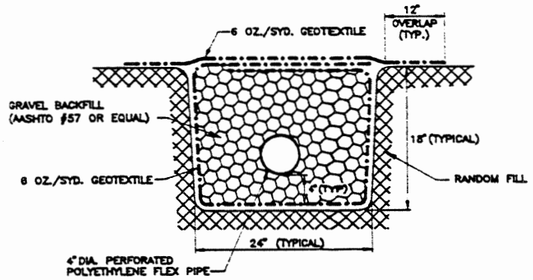


PLAN VIEW

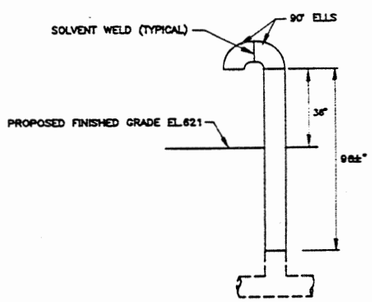
DETAIL 15/12
TYPICAL GAS VENT SYSTEM
RISER PIPE ASSEMBLY
N. T. S.



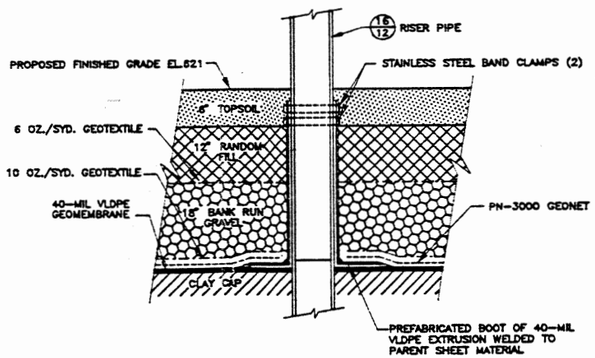
DETAIL 17/08
TYPICAL GAS VENT UNIT INSTALLATION
N. T. S.



DETAIL 19/12
TYPICAL GAS VENT TRENCH
N. T. S.



DETAIL 16/12
TYPICAL RISER PIPE
N. T. S.



DETAIL 18/12
TYPICAL RISER PIPE BOOT
N. T. S.

NOTE:
CARE SHALL BE TAKEN DURING PLACEMENT OF SOIL MATERIALS AROUND GAS VENT PIPE SO AS NOT TO DAMAGE PIPE.

$$ – THINK VALUE ENGINEERING – $$

Revisions

Symbol	Descriptions	Date	Approved
	GENERAL REVISION BASED ON AGENCY COMMENTS	9-27-91	JWC
	GENERAL REVISION BASED ON AGENCY COMMENTS	3-6-92	JWC

OHM Corporation

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
HUNTINGTON, WEST VIRGINIA

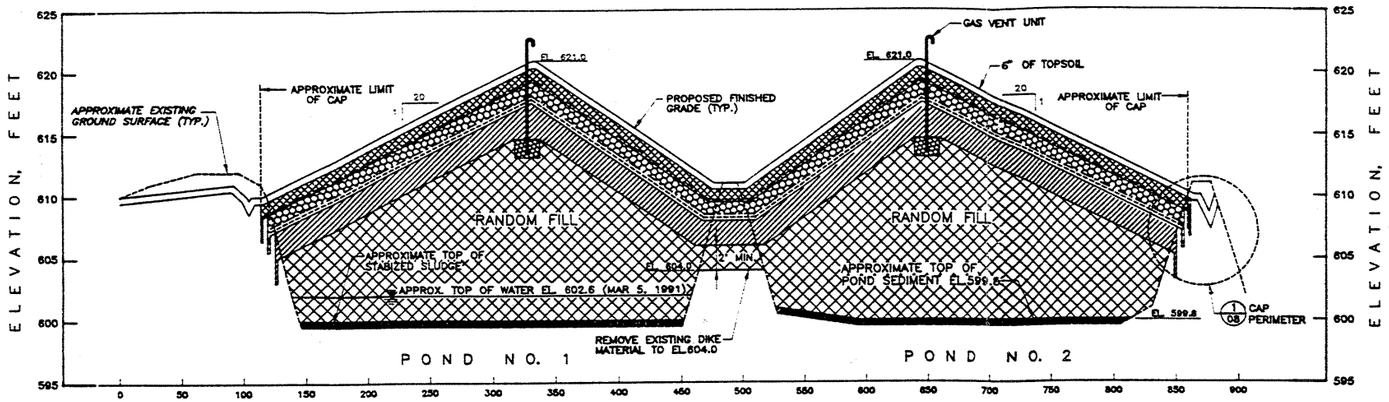
Designed by: D. Pringle/D. Campbell
Drawn by: B. O'Connor
Checked by: D. Campbell/D. Pringle
Reviewed by: J. Colella, P.E.
Submitted by: D. Pringle, Architect-Engineer

RED WATER RESERVOIR CLOSURE CAP
FORMER WEST VIRGINIA ORDNANCE WORKS
POINT PLEASANT, WEST VIRGINIA

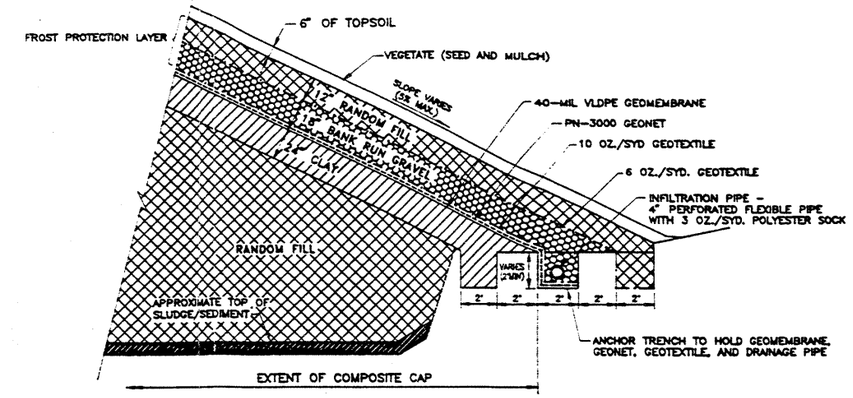
DETAILS
SHEET 3 OF 3

Scale: As Shown
Spec. No.: DACW45-89-D-0508
Contract No.: DACW45-89-D-0508
Sheet reference number: 12
Date: AUGUST 12, 1991
Drawing Code:

PLOT SCALE: 1" = 1"



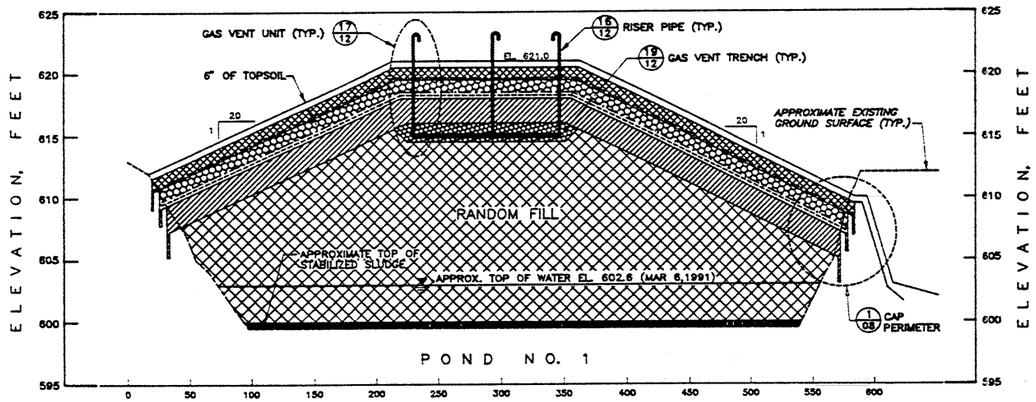
SECTION A/03



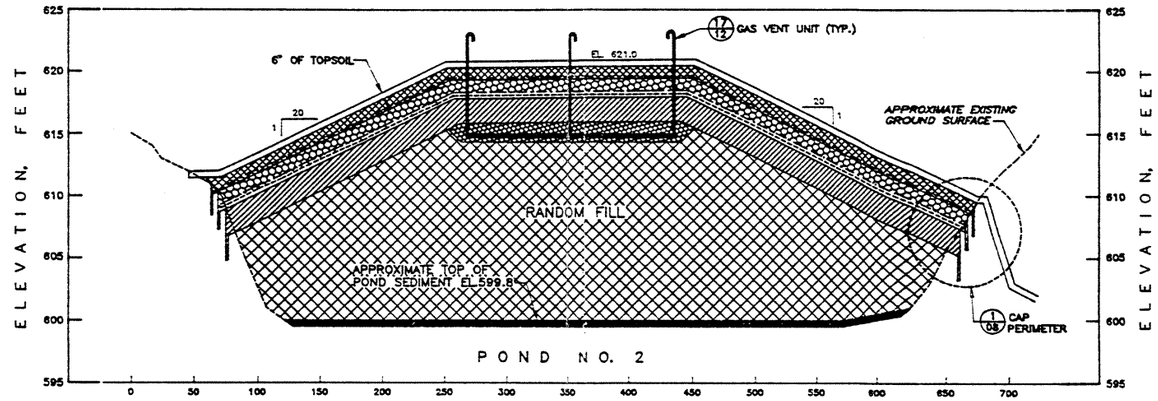
DETAIL 1/08

CAP PERIMETER DETAIL

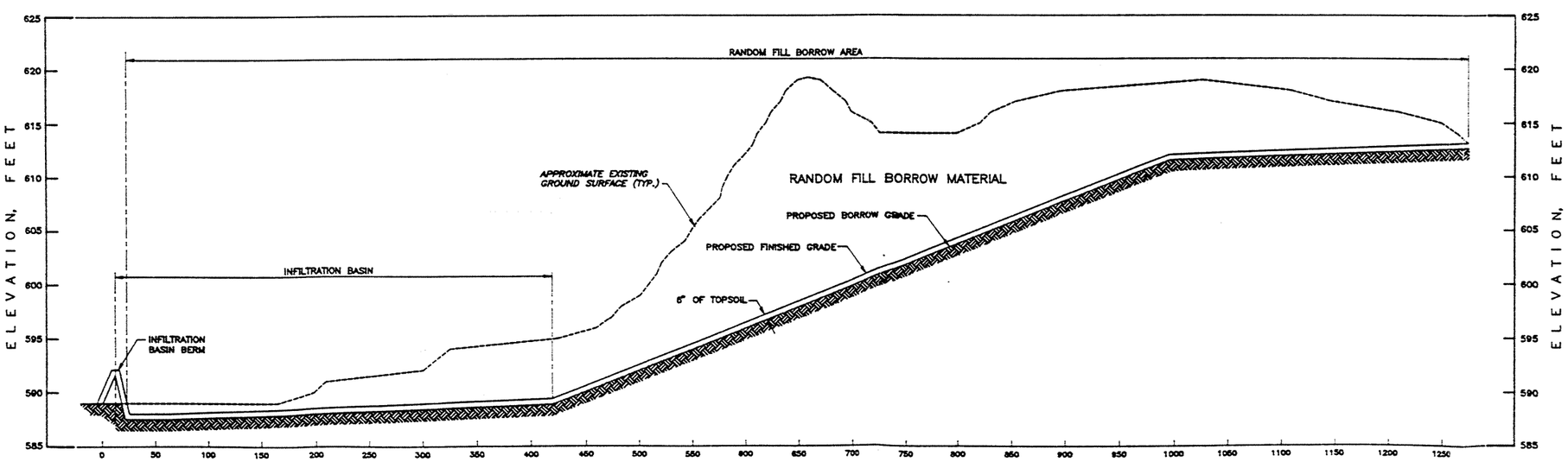
N. T. S.



SECTION B/03



SECTION C/03



SECTION D/03 D/04

HORIZONTAL SCALE 50 0 50 100 FEET

VERTICAL SCALE 5 0 5 10 FEET

LEGEND:

- EXISTING GROUND SURFACE
- GEONET
- GEOTEXTILE
- GEOMEMBRANE
- RANDOM FILL
- STABILIZED SEDIMENT
- POND SEDIMENT
- CLAY
- NATIVE SOIL
- GRAVEL (AASHTO #57 OR EQUAL)

$$ – THINK VALUE ENGINEERING – $$

Revisions

Symbol	Descriptions	Date	Approved
	GENERAL REVISION BASED ON AGENCY COMMENTS	9-27-91	JWC
	GENERAL REVISION BASED ON AGENCY COMMENTS	3-6-92	JWC

OHM Corporation

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
HUNTINGTON, WEST VIRGINIA

Designed by: D. Pringle/D. Campbell
Drawn by: A. Smith
Checked by: D. Campbell/D. Pringle
Reviewed by: J. Colella, P.E.
Submitted by: D. Pringle Architect-Engineer

RED WATER RESERVOIR CLOSURE CAP
FORMER WEST VIRGINIA ORDNANCE WORKS
POINT PLEASANT, WEST VIRGINIA

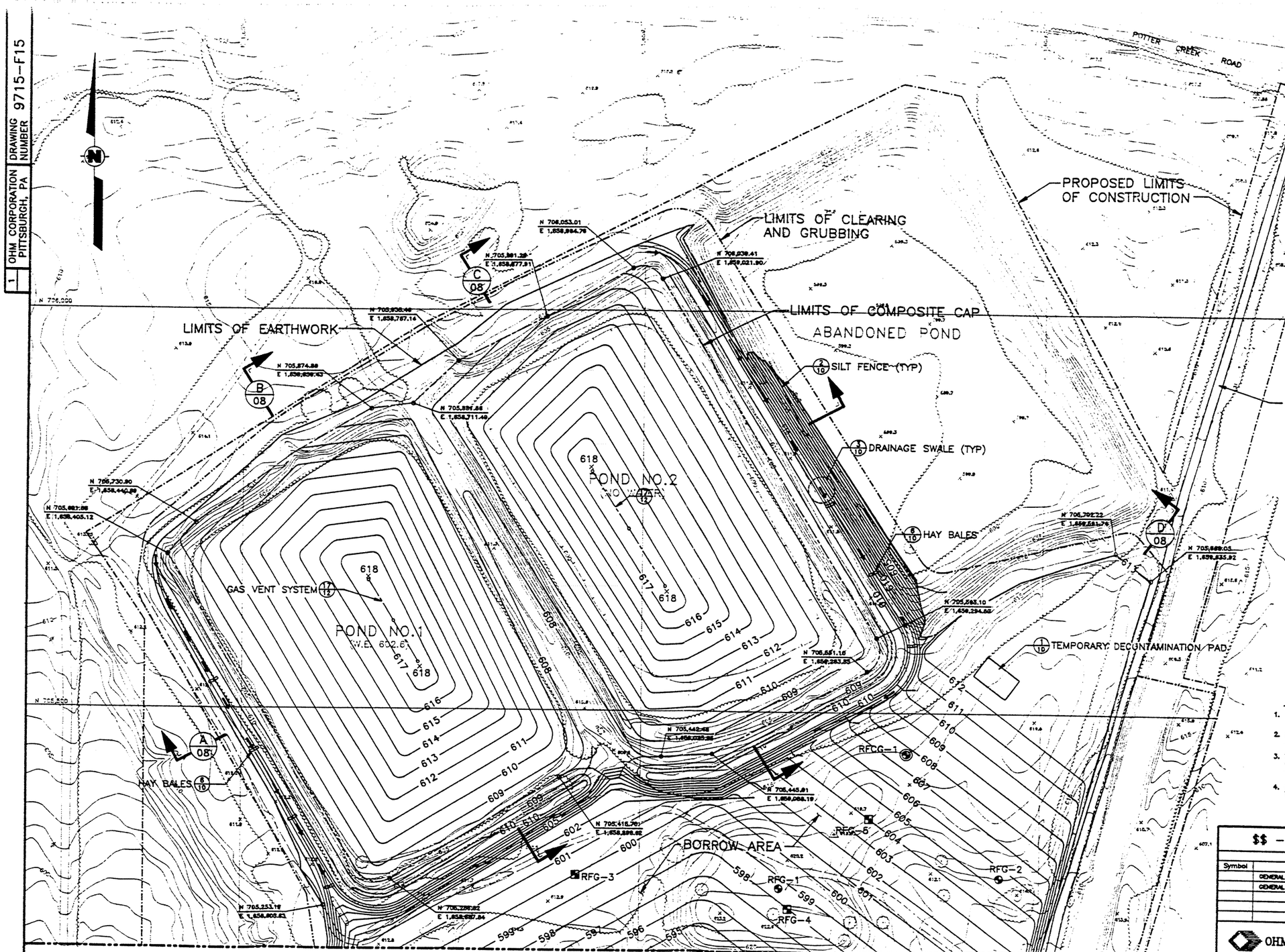
RED WATER AREA
CROSS SECTIONS

Scale: As Shown
Spec. No.: DACW45-89-D-0508
Contract No.: DACW45-89-D-0508
Sheet reference number: 08
Date: SEPT. 16, 1991
Drawing Code:

OHM CORPORATION PITTSBURGH, PA
DRAWING NUMBER 9715-F4

PLOT SCALE: 1" = 1"

1	OHM CORPORATION PITTSBURGH, PA	DRAWING NUMBER 9715-F15



LEGEND:

- RFCG-1 — LOCATION AND IDENTIFICATION NUMBER OF SOIL BORING FOR CHEMICAL AND GEOTECHNICAL ANALYSIS
- RFG-1 — LOCATION AND IDENTIFICATION NUMBER OF SOIL BORING FOR GEOTECHNICAL ANALYSIS
- RFG-3 — LOCATION AND IDENTIFICATION NUMBER OF SOIL TESTPIT FOR GEOTECHNICAL ANALYSIS
- DRAINAGE FLOW DIRECTION
- SILT FENCE
- HAY BALE CHECK DAM
- 1/10 — DETAIL NUMBER OR SECTION LETTER; 08 — SHEET REFERENCE
- 605 — PROPOSED CONTOURS

NOTES:

1. CONTOURS SHOWN WITHIN BORROW AREA ARE PROPOSED FINISHED GRADE (TOP OF TOPSOIL)
2. SILT BARRIER FENCE TO BE REMOVED AFTER SEEDING HAS ACHIEVED TWO MONTHS GROWTH.
3. TEMPORARY EROSION CONTROL WILL BE INSTALLED DURING EXCAVATION AS DIRECTED BY SITE ENGINEER OR USACE ON-SITE REPRESENTATIVE.
4. CONTOURS WITHIN LIMITS OF COMPOSITE CAP REPRESENT TOP OF CLAY.

REFERENCE:
TOPOGRAPHY PREPARED BY AEROCON PHOTOGRAMMETRIC SURVEY, INC. WILLOUGHBY, OHIO. DATE OF PHOTOGRAPHY: MARCH 5, 1991. CONTOUR INTERVAL: 1', SCALE: 1" = 50'.

PLOT SCALE: 1 = 50

SCALE
50 0 50 100 FEET

$$ – THINK VALUE ENGINEERING – $$

Revisions			
Symbol	Descriptions	Date	Approved
	GENERAL REVISION BASED ON AGENCY COMMENTS	9-27-91	JWC
	GENERAL REVISION BASED ON AGENCY COMMENTS	3-6-92	JWC

OHM Corporation

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
HUNTINGTON, WEST VIRGINIA

Designed by: D. Pringle/D. Campbell
Drawn by: A. Smith
Checked by: D. Campbell/D. Pringle
Reviewed by: J. Colella, P.E.
Submitted by: D. Pringle, Architect-Engineer

RED WATER RESERVOIR CLOSURE CAP
FORMER WEST VIRGINIA ORDNANCE WORKS
POINT PLEASANT, WEST VIRGINIA

RED WATER AREA TOP OF CLAY CAP FOR PONDS 1 & 2

Scale: As Shown
Spec. No.: DACW45-89-D-0508
Contract No.: DACW45-89-D-0508
Sheet reference number: 07
Date: AUGUST 18, 1990
Drawing Code:

DRAWING NUMBER 9715-F2

1 OHM CORPORATION PITTSBURGH, PA

POTTER CREEK ROAD

SITE ENTRANCE GATE

PROJECT SIGN

PROPOSED LIMITS OF CONSTRUCTION

LIMITS OF CLEARING AND GRUBBING

ABANDONED POND

SILT FENCE (TYP)

DRAINAGE SWALE (TYP)

INFILTRATION PIPE

HAY BALES

ACCESS ROAD

TEMPORARY DECONTAMINATION PAD

LIMITS OF EARTHWORK

POND NO.2

POND NO.1

GAS VENT SYSTEM

BORROW AREA

LEVEL SPREADER

ROCK LINING

RFG-1 RFG-2 RFG-3 RFG-4 RFG-5 RECG-1

INV. EL.606.00 INV. EL.605.00 INV. EL.605.50 INV. EL.605.44 INV. EL.603.92

N 706,000 N 705,500

MATCH LINE (SEE SHEET 04)

LEGEND:

- RFCG-1 — LOCATION AND IDENTIFICATION NUMBER OF SOIL BORING FOR CHEMICAL AND GEOTECHNICAL ANALYSIS
- RFG-1 — LOCATION AND IDENTIFICATION NUMBER OF SOIL BORING FOR GEOTECHNICAL ANALYSIS
- RFG-3 — LOCATION AND IDENTIFICATION NUMBER OF SOIL TESTPIT FOR GEOTECHNICAL ANALYSIS
- DRAINAGE FLOW DIRECTION
- SILT FENCE
- HAY BALE CHECK DAM
- 1/08 — DETAIL NUMBER OR SECTION LETTER / SHEET REFERENCE
- 605 — PROPOSED CONTOURS
- INFILTRATION PIPE (4" DIA. PERF. CORR. HDPE FLEX. PIPE)

NOTES:

1. CONTOURS SHOWN WITHIN LIMITS OF CLEARING AND GRUBBING ARE PROPOSED FINISHED GRADE (TOP OF TOPSOIL).
2. SILT BARRIER FENCE TO BE REMOVED AFTER SEEDING HAS ACHIEVED TWO MONTHS GROWTH.
3. TEMPORARY EROSION CONTROL WILL BE INSTALLED DURING EXCAVATION AS DIRECTED BY SITE ENGINEER OR USACE ON-SITE REPRESENTATIVE.

$$ — THINK VALUE ENGINEERING — $$

Revisions

Symbol	Descriptions	Date	Approved
	GENERAL REVISION BASED ON AGENCY COMMENTS	9-27-91	JWC
	INCLUDED INFILTRATION PIPE ON DRAWING	3-6-92	JWC

OHM Corporation

U.S. ARMY ENGINEER DISTRICT CORPS OF ENGINEERS HUNTINGTON, WEST VIRGINIA

Designed by: D. Pringle/D. Campbell

Drawn by: A. Smith

Checked by: D. Campbell/D. Pringle

Reviewed by: J. Colella

Submitted by: D. Pringle Architect-Engineer

RED WATER RESERVOIR CLOSURE CAP
FORMER WEST VIRGINIA ORDNANCE WORKS
POINT PLEASANT, WEST VIRGINIA

RED WATER AREA
FINAL GRADING PLAN
SHEET 1 OF 2

Scale: As Shown

Spec. No.: DACW45-89-D-0508

Contract No.: DACW45-89-D-0508

Sheet reference number: 03

Date: JULY 18, 1990

Drawing Code:

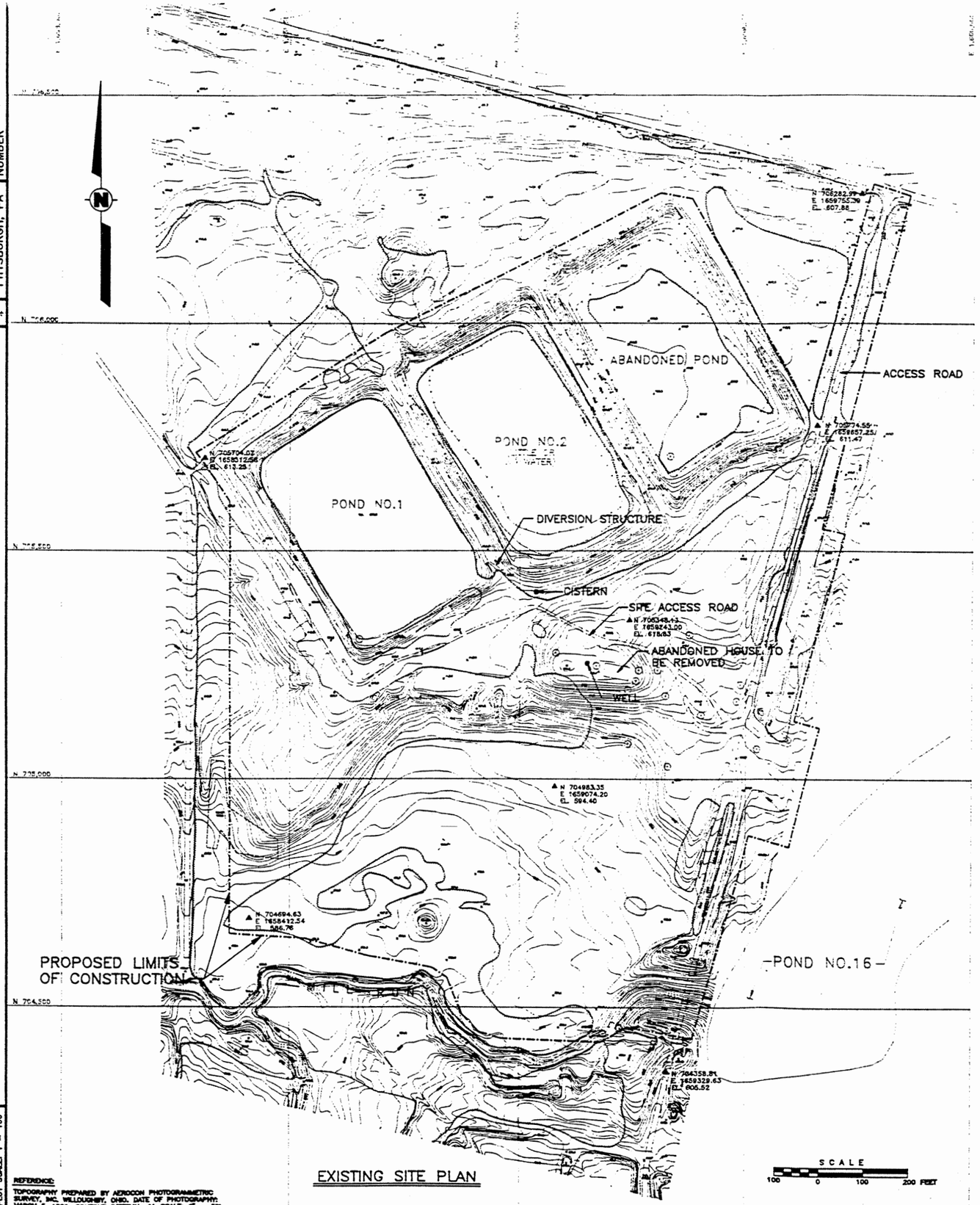
SCALE 50 0 50 100 FEET

PLOT SCALE: 1 = 50

REFERENCE:
TOPOGRAPHY PREPARED BY AEROCON PHOTOGRAMMETRIC SURVEY, INC. WILLOUGHBY, OHIO. DATE OF PHOTOGRAPHY: MARCH 3, 1991, CONTOUR INTERVAL: 1', SCALE: 1" = 50'.

OHM CORPORATION
PITTSBURGH, PA

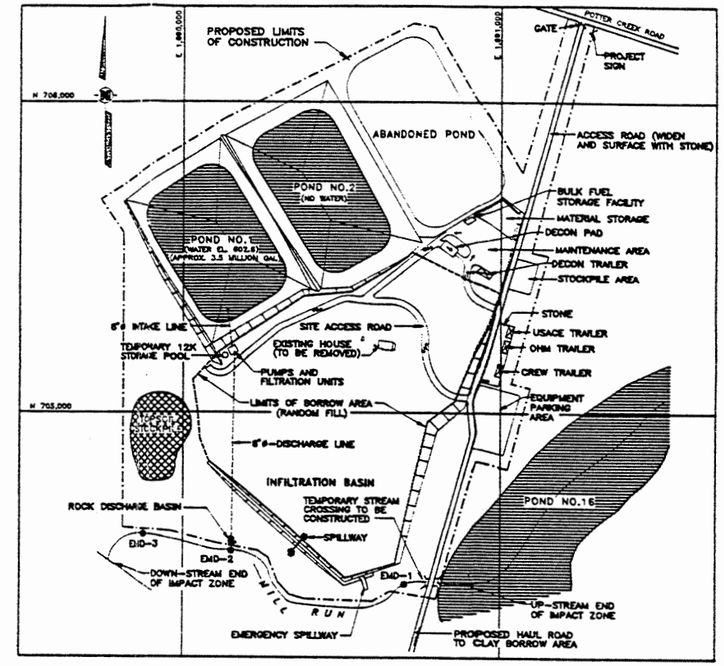
DRAWING NUMBER 9715-F1



EXISTING SITE PLAN

REFERENCE:
TOPOGRAPHY PREPARED BY AEROCON PHOTOGRAMMETRIC SURVEY, INC. WILLOUGHBY, OHIO. DATE OF PHOTOGRAPHY: MARCH 5, 1991. CONTOUR INTERVAL: 1'. SCALE: 1" = 50'.

PLOT SCALE: 1 = 100



OPERATIONAL SITE LAYOUT

SCALE
0 200 400 FEET

LEGEND:

EMD-3 ● LOCATION AND IDENTIFICATION NUMBER OF ENVIRONMENTAL SAMPLING POINT

△ AERIAL GROUND TARGETS AND COORDINATES FOR TOPOGRAPHIC MAPPING
N 704883.35
E 1659074.20
EL 594.40

NOTE:

LOCATION OF PERMANENT SURVEY MONUMENTS TO BE DETERMINED DURING THE CLAY MATERIAL EXCAVATION AND PLACEMENT ACTIVITIES

$$ – THINK VALUE ENGINEERING – $$

Revisions

Symbol	Descriptions	Date	Approved
	GENERAL REVISION BASED ON AGENCY COMMENTS	9-27-91	JWC

OHM Corporation

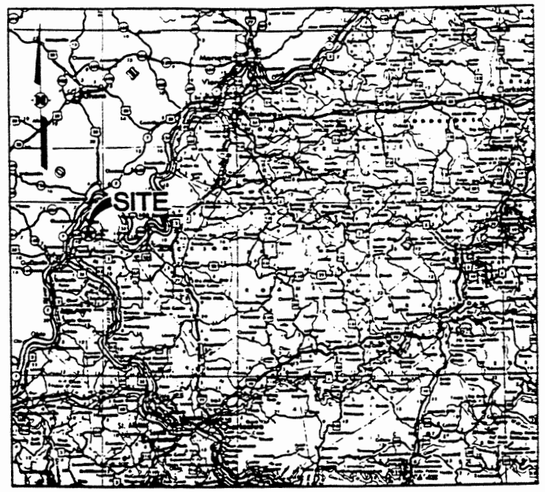
U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
HUNTINGTON, WEST VIRGINIA

RED WATER RESERVOIR CLOSURE CAP
FORMER WEST VIRGINIA ORDNANCE WORKS
POINT PLEASANT, WEST VIRGINIA

RED WATER AREA
EXISTING SITE PLAN AND
OPERATIONAL SITE LAYOUT

Designed by: D. Pringle/D. Campbell			
Drawn by: B. O'Connor			
Checked by: D. Campbell/D. Pringle			
Reviewed by: S. Choirabartl, P.E.	Scale: As Shown	Sheet reference number: 02	Date: JULY 18, 1990
Submitted by: D. Pringle Architect-Engineer	Spec. No.: DACW45-89-D-0508		Drawing Code:
	Contract No.: DACW45-89-D-0508		

OHM CORPORATION PITTSBURGH, PA | DRAWING NUMBER 9715-T1

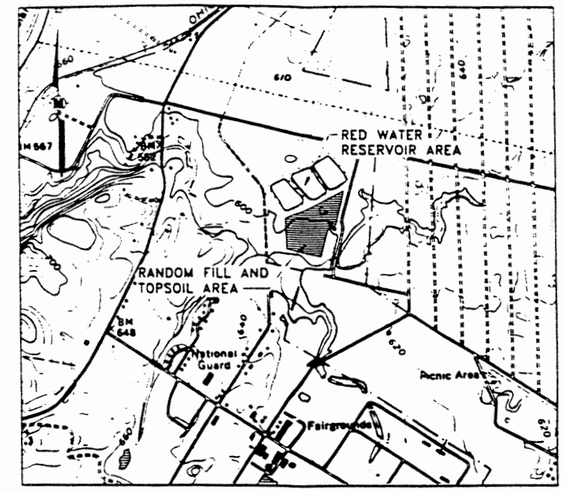


SITE LOCATION MAP

SCALE 0 12 24 MILES

INDEX OF DRAWINGS

PREVIOUSLY APPROVED	INCLUDED WITH THIS SUBMITTAL	OHM DRAWING NUMBER	SHEET REFERENCE NUMBER	DRAWING DESCRIPTION
☒	☒	9715-T1	SHEET 01	TITLE SHEET
☒	☒	9715-F1	SHEET 02	RED WATER AREA – EXISTING SITE PLAN AND OPERATIONAL SITE LAYOUT
☒	☒	9715-F2	SHEET 03	RED WATER AREA – FINAL GRADING PLAN (SHEET 1 OF 2)
☒	☐	9715-F3	SHEET 04	RED WATER AREA – FINAL GRADING PLAN (SHEET 2 OF 2)
☒	☐	9715-F11	SHEET 05	RED WATER AREA – TOP OF RANDOM FILL FOR PONDS 1 & 2 (SHEET 1 OF 2)
☒	☐	9715-F13	SHEET 06	RED WATER AREA – TOP OF RANDOM FILL FOR PONDS 1 & 2 (SHEET 2 OF 2)
☒	☒	9715-F15	SHEET 07	RED WATER AREA – TOP OF CLAY CAP FOR PONDS 1 & 2
☐	☒	9715-F4	SHEET 08	RED WATER AREA – CROSS SECTIONS
☒	☐	9715-F5	SHEET 09	CLAY BORROW AREA – INITIAL GRADING PLAN
☒	☐	9715-F6	SHEET 10	DETAILS – SHEET 1 OF 3
☒	☐	9715-F7	SHEET 11	DETAILS – SHEET 2 OF 3
☐	☒	9715-F14	SHEET 12	DETAILS – SHEET 3 OF 3
☒	☐	9715-F10	SHEET 13	PROPOSED HAUL ROAD – PLAN, SECTIONS, AND DETAILS
☐	☒	9715-F19	SHEET 14	RED WATER AREA – PROPOSED GEOMEMBRANE PANEL LAYOUT



SITE VICINITY MAP

SCALE 0 2000 4000 FEET

RED WATER RESERVOIR CLOSURE CAP

FORMER WEST VIRGINIA ORDNANCE WORKS
POINT PLEASANT, WEST VIRGINIA

PREPARED FOR

U.S. ARMY CORPS OF ENGINEERS
HUNTINGTON DISTRICT
HUNTINGTON, WEST VIRGINIA

COMMONWEALTH OF PENNSYLVANIA
REGISTERED PROFESSIONAL
JOSEPH W. COLELLA
ENGINEER
No. 27115-E

Joseph W. Colella 3-30-92

$$ – THINK VALUE ENGINEERING – $$

Revisions			
Symbol	Descriptions	Date	Approved
	GENERAL REVISION BASED ON AGENCY COMMENTS	9-18-91	JWC
	REVISED INDEX OF DRAWINGS LIST	3-6-92	JWC

OHM Corporation

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
HUNTINGTON, WEST VIRGINIA

Designed by: D. Pringle/D. Campbell
Drawn by: B. O'Connor
Checked by: D. Campbell/D. Pringle
Reviewed by: S. Chakraborti, P.E.
Submitted by: D. Pringle, Engineer

RED WATER RESERVOIR CLOSURE CAP
FORMER WEST VIRGINIA ORDNANCE WORKS
POINT PLEASANT, WEST VIRGINIA

TITLE SHEET

Scale: As Shown
Spec. No.: DACW45-89-D-0506
Contract No.: DACW45-89-D-0506
Sheet reference number: 01
Date: JULY 18, 1991
Drawing Code:

REFERENCE:
VICINITY MAP – 7.5 MIN U.S.G.S. MAP OF CHESHIRE, OHIO–W. VA

PLOT SCALE: 1" = 1"

PALM MEMORIAL GARDENS

20' 10' 0 20' 40'

1" = 20'- 0"

R.D. BAILEY, PALM MEMORIAL GARDENS

COMPOSITE

REV	DESCRIPTION	DATE	APPROVED

LEGEND

- EXTRACTION WELL LOCATION
- STREAMLINE CONTOURS
- GROUNDWATER POTENTIOMETRIC SURFACE CONTOURS (CONTOUR INTERVAL = 8.0 FEET)
- EXISTING WELL LOCATION
- HYDROPUNCH SAMPLE LOCATIONS
- RED WATER SEWER LINE

NOTE:
HYDROPUNCH SAMPLE LOCATIONS ARE APPROXIMATE

RED WATER SEWER LINE LOCATION IS APPROXIMATE

REPORTED LOCATION AND BOUNDARY OF FORMER SEDIMENT BASIN IS APPROXIMATE

N

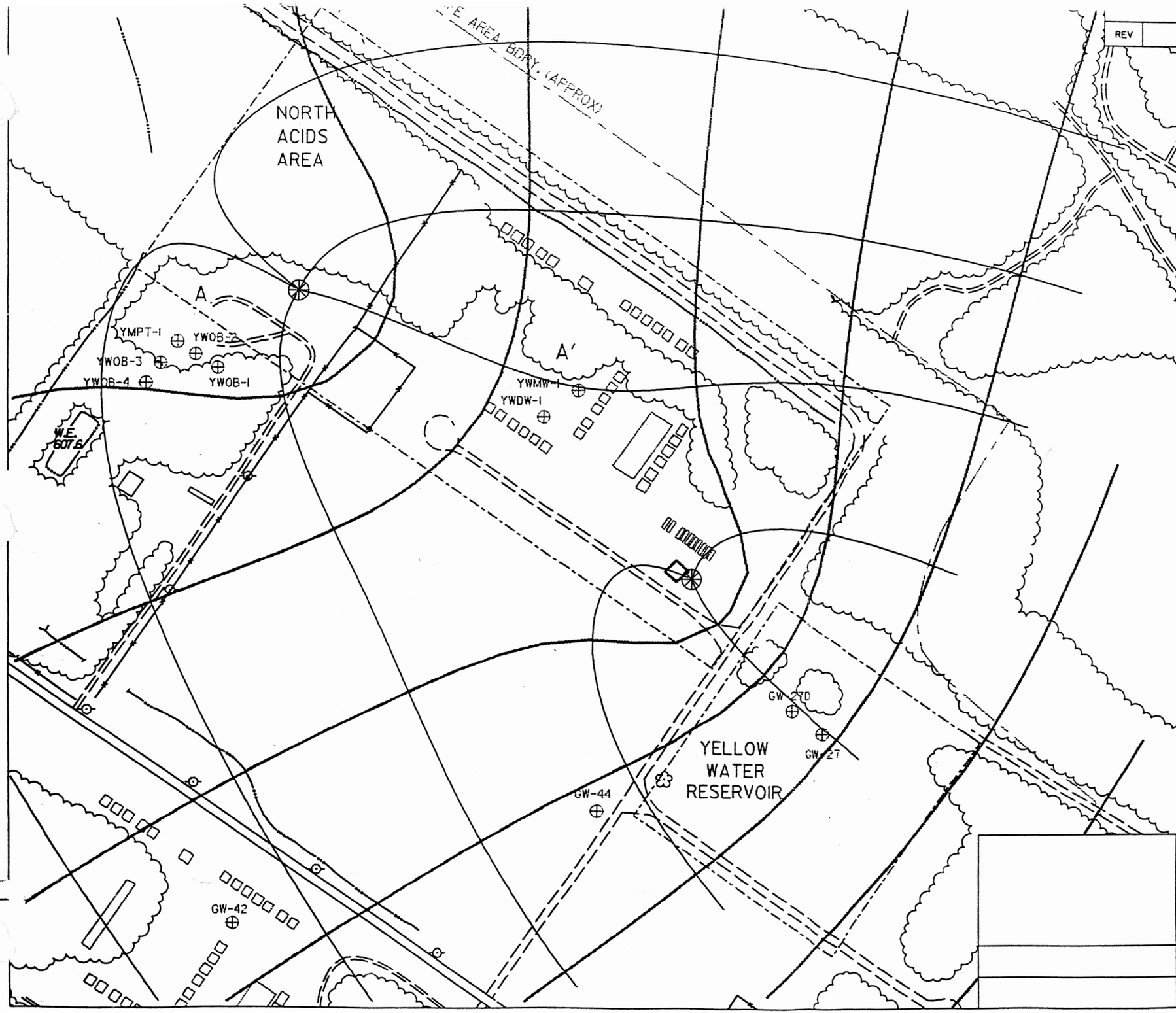
SCALE: 1 INCH = 300 FEET
300' 0 300'

EXTRACTION WELL LOCATION PLAN

RED WATER RESERVOIR
FORMER WEST VIRGINIA ORDNANCE WORKS
POINT PLEASANT WEST VIRGINIA

SIZE	FSCM NO.	DWG. NO.	REV.
B		FIGURE 6-3	0
SCALE: SHOWN		89114E02.DGN	SHEET 1 OF 1

REV	DESCRIPTION	DATE	APPROVED



LEGEND

EXTRACTION WELL LOCATION

STREAMLINE CONTOURS

GROUNDWATER POTENTIOMETRIC SURFACE CONTOURS

MONITORING WELL LOCATION

NOTE:
WELL LOCATIONS ARE APPROXIMATE
CONTOUR INTERVAL = 0.5 FEET

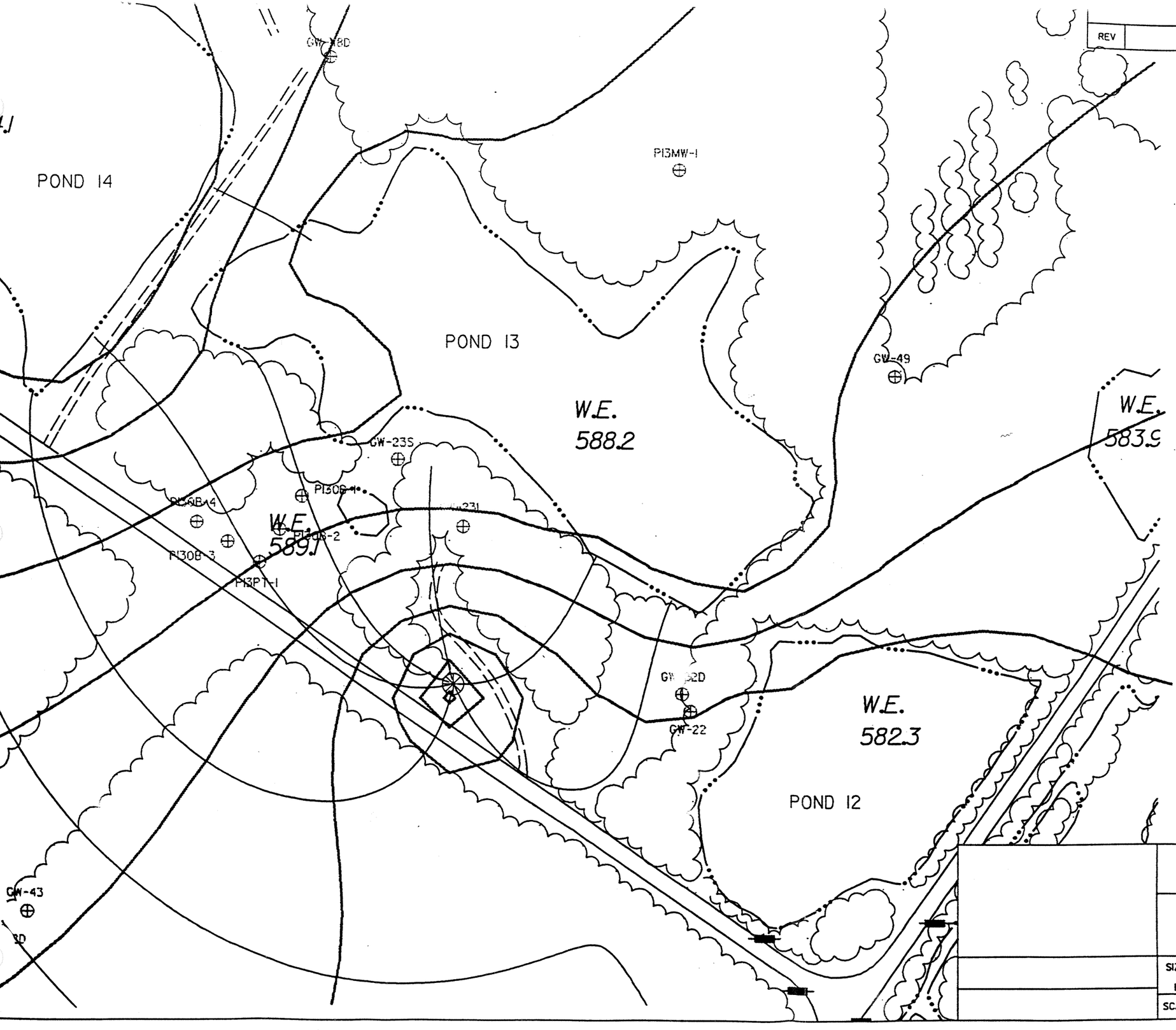
N

SCALE: 1 INCH = 200 FEET
200' 100' 0 200'

EXTRACTION WELL
LOCATION PLAN

YELLOW WATER RESERVOIR/NORTH ACIDS AR
FORMER WEST VIRGINIA ORDNANCE WORKS
POINT PLEASANT WEST VIRGINIA

SIZE	FSCM NO.	DWG. NO.	REV.
B		FIGURE 6-2	0
SCALE: SHOWN	89114E03.DGN	SHEET 1 OF 1	



REVISIONS

REV	DESCRIPTION	DATE	APPROVED

LEGEND

- EXTRACTION WELL LOCATION
- STREAMLINE CONTOURS
- GROUNDWATER POTENTIOMETRIC SURFACE CONTOURS
- MONITORING WELL LOCATION

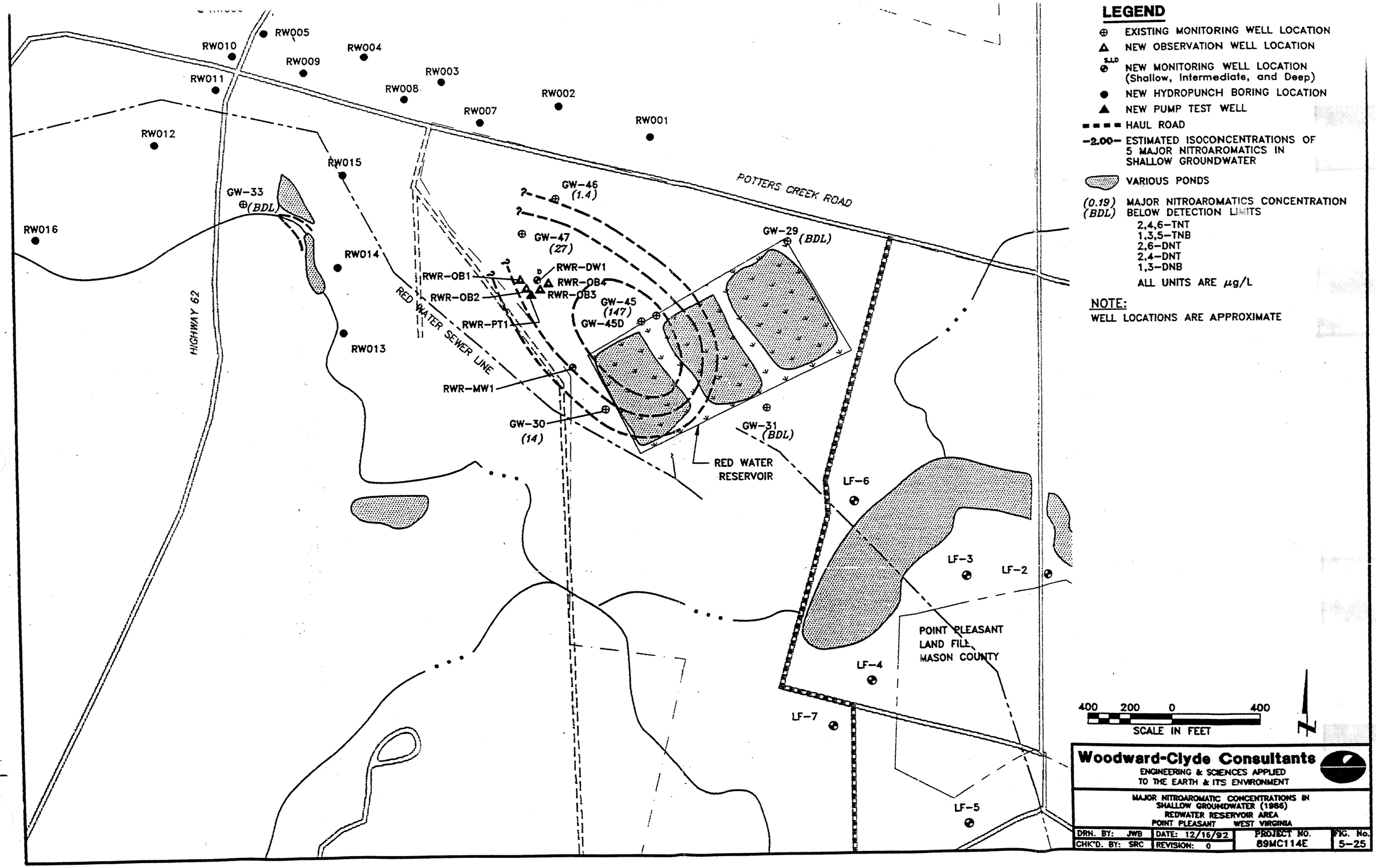
NOTE:
WELL LOCATIONS ARE APPROXIMATE
CONTOUR INTERVAL = 2.0 FEET

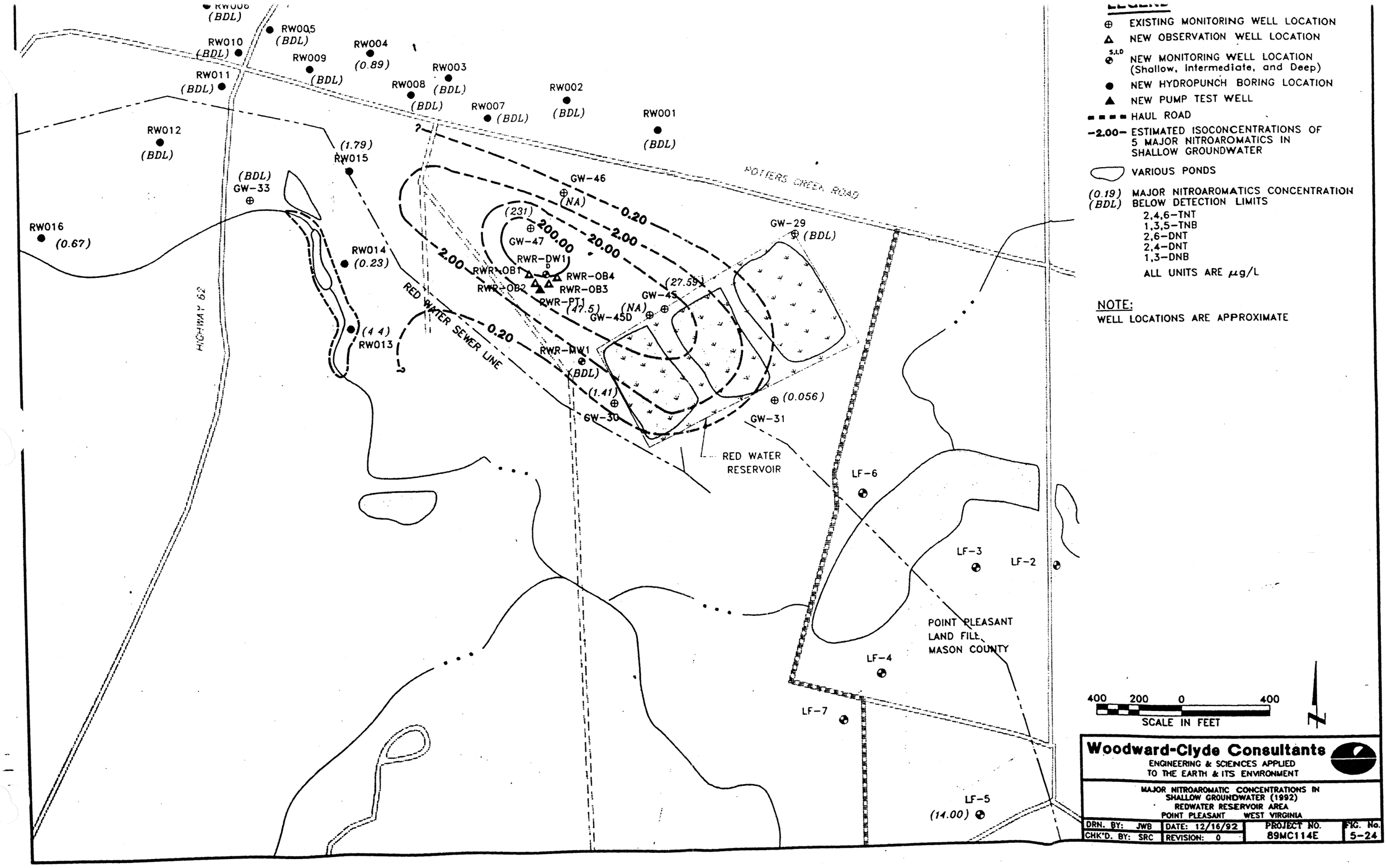
SCALE: 1 INCH = 100 FEET
100' 0 100'

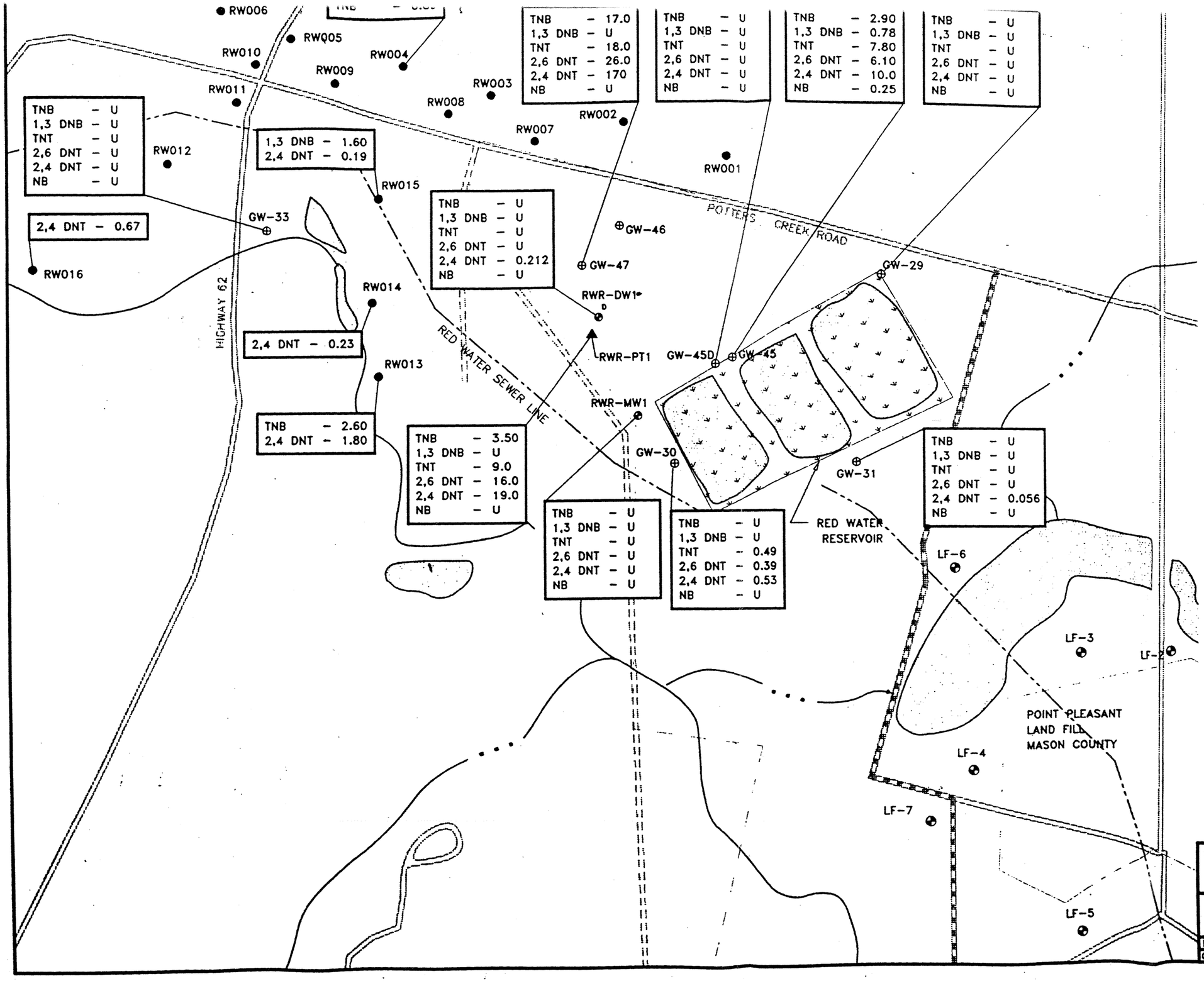
EXTRACTION WELL
LOCATION PLAN

POND 13
FORMER WEST VIRGINIA ORDNANCE WORKS
POINT PLEASANT WEST VIRGINIA

SIZE	FSCM NO.	DWG. NO.	REV.
B		FIGURE 6-1	0
SCALE: SHOWN	8914E04.DGN	SHEET 1 OF 1	


LEGEND
EXISTING MONITORING WELL LOCATION
NEW OBSERVATION WELL LOCATION
NEW MONITORING WELL LOCATION (Shallow, Intermediate, and Deep)
NEW HYDROPUNCH BORING LOCATION
NEW PUMP TEST WELL
HAUL ROAD
-2.00- ESTIMATED ISOCONCENTRATIONS OF 5 MAJOR NITROAROMATICS IN SHALLOW GROUNDWATER
VARIOUS PONDS
(0.19) MAJOR NITROAROMATICS CONCENTRATION
(BDL) BELOW DETECTION LIMITS
2,4,6-TNT
1,3,5-TNB
2,6-DNT
2,4-DNT
1,3-DNB
ALL UNITS ARE μg/L
NOTE:
WELL LOCATIONS ARE APPROXIMATE
RW005
RW010
RW004
RW009
RW003
RW011
RW008
RW002
RW007
RW001
RW012
RW015
RW016
RW014
RW013
GW-33 (BDL)
GW-46 (1.4)
GW-47 (27)
GW-29 (BDL)
RWR-DW1
RWR-OB1
RWR-OB4
RWR-OB2
RWR-OB3
GW-45 (147)
GW-45D
RWR-PT1
RWR-MW1
GW-30 (14)
GW-31 (BDL)
RED WATER SEWER LINE
HIGHWAY 62
POTTERS CREEK ROAD
RED WATER RESERVOIR
LF-6
LF-3
LF-2
LF-4
LF-7
LF-5
POINT PLEASANT LAND FILL MASON COUNTY
400 200 0 400
SCALE IN FEET
N
Woodward-Clyde Consultants
ENGINEERING & SCIENCES APPLIED TO THE EARTH & ITS ENVIRONMENT
MAJOR NITROAROMATIC CONCENTRATIONS IN SHALLOW GROUNDWATER (1986)
REDWATER RESERVOIR AREA
POINT PLEASANT WEST VIRGINIA
DRN. BY: JWB
CHK'D. BY: SRC
DATE: 12/16/92
REVISION: 0
PROJECT NO. 89MC114E
FIG. No. 5-25


LEGEND
EXISTING MONITORING WELL LOCATION
NEW OBSERVATION WELL LOCATION
S,I,D
NEW MONITORING WELL LOCATION (Shallow, Intermediate, and Deep)
NEW HYDROPUNCH BORING LOCATION
NEW PUMP TEST WELL
HAUL ROAD
-2.00- ESTIMATED ISOCONCENTRATIONS OF 5 MAJOR NITROAROMATICS IN SHALLOW GROUNDWATER
VARIOUS PONDS
(0.19) MAJOR NITROAROMATICS CONCENTRATION
(BDL) BELOW DETECTION LIMITS
2,4,6-TNT
1,3,5-TNB
2,6-DNT
2,4-DNT
1,3-DNB
ALL UNITS ARE µg/L
NOTE:
WELL LOCATIONS ARE APPROXIMATE
RW006 (BDL)
RW005 (BDL)
RW010 (BDL)
RW004 (0.89)
RW009 (BDL)
RW003 (BDL)
RW011 (BDL)
RW008 (BDL)
RW002 (BDL)
RW007 (BDL)
RW001 (BDL)
RW012 (BDL)
(1.79) RW015
(BDL) GW-33
RW016 (0.67)
RW014 (0.23)
(4.4) RW013
HIGHWAY 62
POTTERS CREEK ROAD
GW-46 (NA)
(231) GW-47
200.00
20.00
2.00
0.20
RWR-DW1
RWR-OB1
RWR-OB4
RWR-OB2
RWR-OB3
RWR-PT1
(47.5)
GW-45D
(NA)
GW-45
(27.59)
GW-29 (BDL)
RED WATER SEWER LINE
RWR-MW1 (BDL)
(1.41) GW-30
(0.056) GW-31
RED WATER RESERVOIR
LF-6
LF-3
LF-2
POINT PLEASANT LAND FILL MASON COUNTY
LF-4
LF-7
LF-5 (14.00)
400 200 0 400
SCALE IN FEET
N
Woodward-Clyde Consultants
ENGINEERING & SCIENCES APPLIED TO THE EARTH & ITS ENVIRONMENT
MAJOR NITROAROMATIC CONCENTRATIONS IN SHALLOW GROUNDWATER (1992)
REDWATER RESERVOIR AREA
POINT PLEASANT WEST VIRGINIA
DRN. BY: JWB
CHK'D. BY: SRC
DATE: 12/16/92
REVISION: 0
PROJECT NO. 89MC114E
FIG. No. 5-24



LEGEND

- ⊕ EXISTING MONITORING WELL LOCATION
- ▲ NEW OBSERVATION WELL LOCATION
- S.I.D. NEW MONITORING WELL LOCATION (Shallow, Intermediate, and Deep)
- ● NEW HYDROPUNCH LOCATION
- ▲ NEW PUMP TEST WELL
- ■ ■ ■ ■ ■ HAUL ROAD
- VARIOUS PONDS
- -580- APPROXIMATE ELEVATION CONTOURS OF THE SHALLOW AQUIFER POTENTIOMETRIC SURFACE (FEET ABOVE MSL)

TNB	–	TRINITROBENZENE
1,3 DNB	–	1,3 DINITROBENZENE
TNT	–	TRINITROTOLUENE
2,6 DNT	–	2,6 DINITROTOLUENE
2,4 DNT	–	2,4 DINITROTOLUENE
NB	–	NITROBENZENE
U	–	BELOW THE REPORTING LIMITS

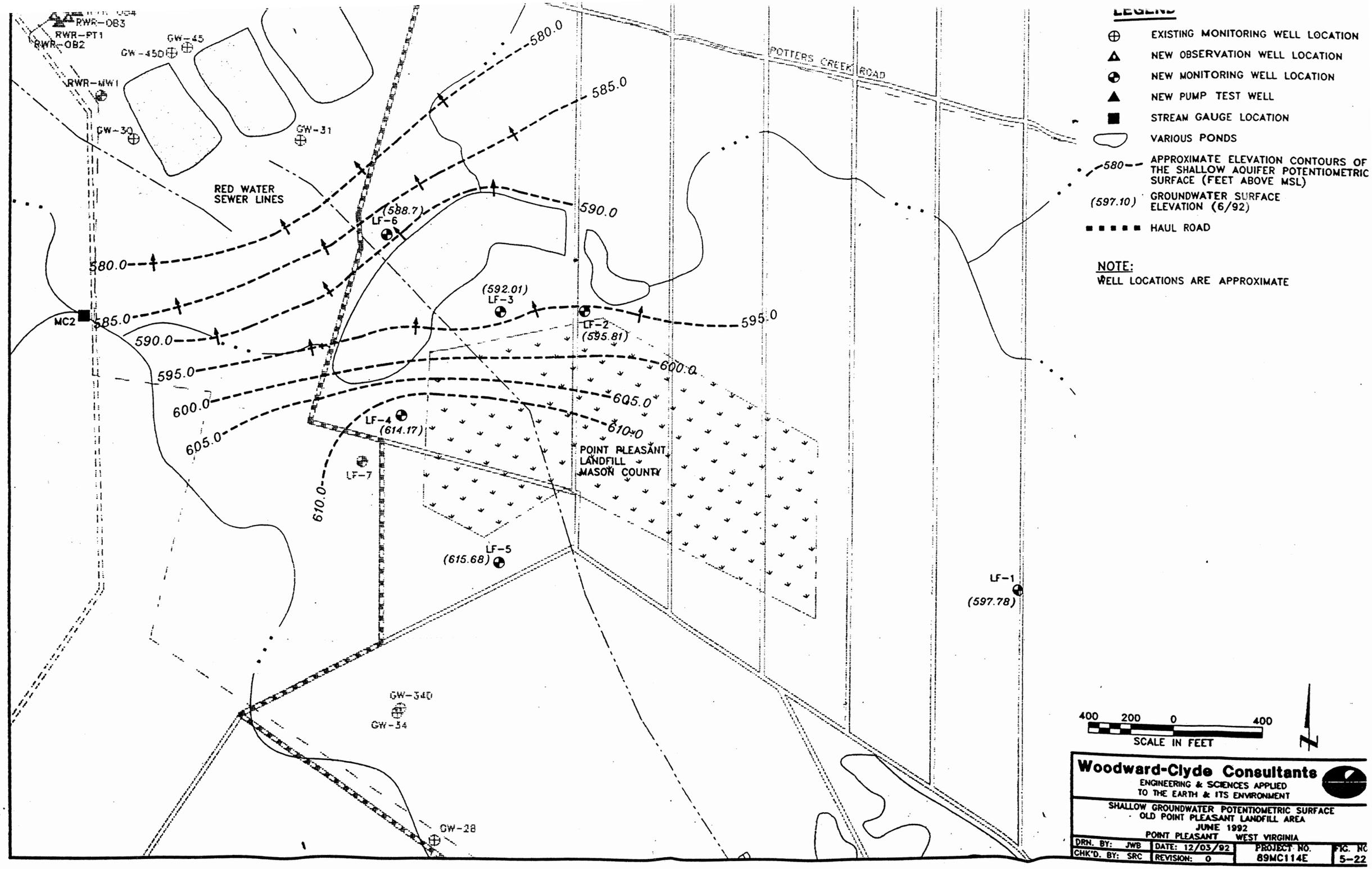
ALL UNITS ARE $\mu g/L$

NOTE:
WELL LOCATIONS ARE APPROXIMATE

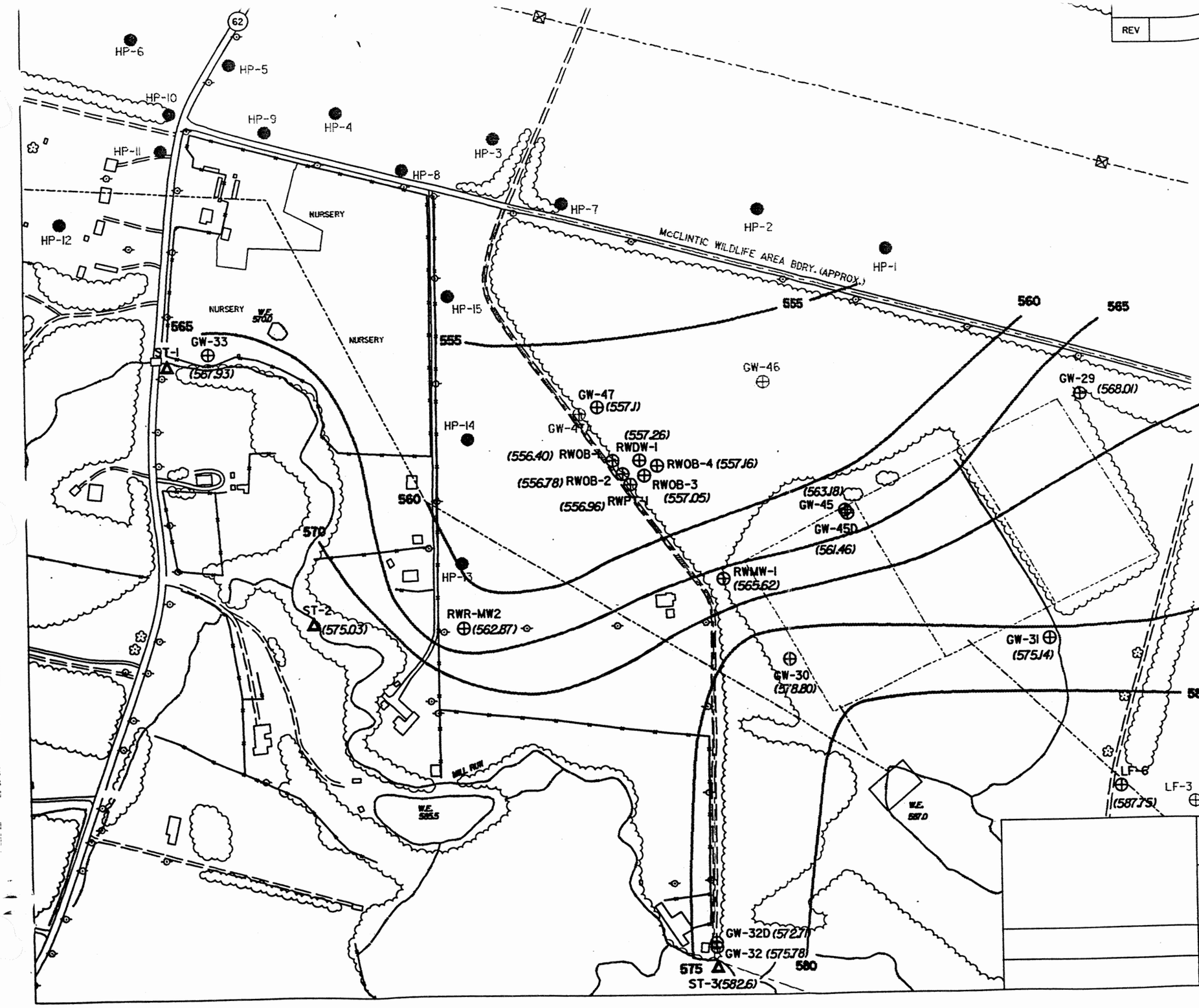
Woodward-Clyde Consultants
ENGINEERING & SCIENCES APPLIED TO THE EARTH & ITS ENVIRONMENT

RED WATER RESERVOIR AREA
1992 MAJOR NITROAROMATICS ANALYTICAL RESULTS OF GROUNDWATER
POINT PLEASANT WEST VIRGINIA

DRN. BY: JWB	DATE: 06/29/93	PROJECT NO.	FIG. No
CHK'D. BY: .	REVISION: 0	89MC114E	5-23


LEGEND
EXISTING MONITORING WELL LOCATION
NEW OBSERVATION WELL LOCATION
NEW MONITORING WELL LOCATION
NEW PUMP TEST WELL
STREAM GAUGE LOCATION
VARIOUS PONDS
580 APPROXIMATE ELEVATION CONTOURS OF THE SHALLOW AQUIFER POTENTIOMETRIC SURFACE (FEET ABOVE MSL)
(597.10) GROUNDWATER SURFACE ELEVATION (6/92)
HAUL ROAD
NOTE:
WELL LOCATIONS ARE APPROXIMATE
POTTERS CREEK ROAD
RWR-OB3
RWR-PT1
RWR-OB2
GW-45
GW-45D
RWR-MW1
GW-30
GW-31
RED WATER SEWER LINES
MC2
LF-6 (588.7)
LF-3 (592.01)
LF-2 (595.81)
LF-4 (614.17)
LF-7
LF-5 (615.68)
LF-1 (597.78)
POINT PLEASANT LANDFILL MASON COUNTY
580.0
585.0
590.0
595.0
600.0
605.0
610.0
GW-34D
GW-34
GW-28
400 200 0 400
SCALE IN FEET
N
Woodward-Clyde Consultants
ENGINEERING & SCIENCES APPLIED TO THE EARTH & ITS ENVIRONMENT
SHALLOW GROUNDWATER POTENTIOMETRIC SURFACE
OLD POINT PLEASANT LANDFILL AREA
JUNE 1992
POINT PLEASANT WEST VIRGINIA
DRN. BY: JWB
CHK'D. BY: SRC
DATE: 12/03/92
REVISION: 0
PROJECT NO. 89MC114E
FIG. NO 5-22

REV	DESCRIPTION	DATE	APPROVED



LEGEND

- ⊕ EXISTING WELL LOCATIONS
- ● HYDROPUNCH SAMPLE LOCATIONS
- —— GROUNDWATER CONTOUR
- ST-1 ▲ STREAM GAGE LOCATIONS
- - - - - RED WATER SEWER LINE

NOTE:
HYDROPUNCH SAMPLE LOCATIONS ARE APPROXIMATE

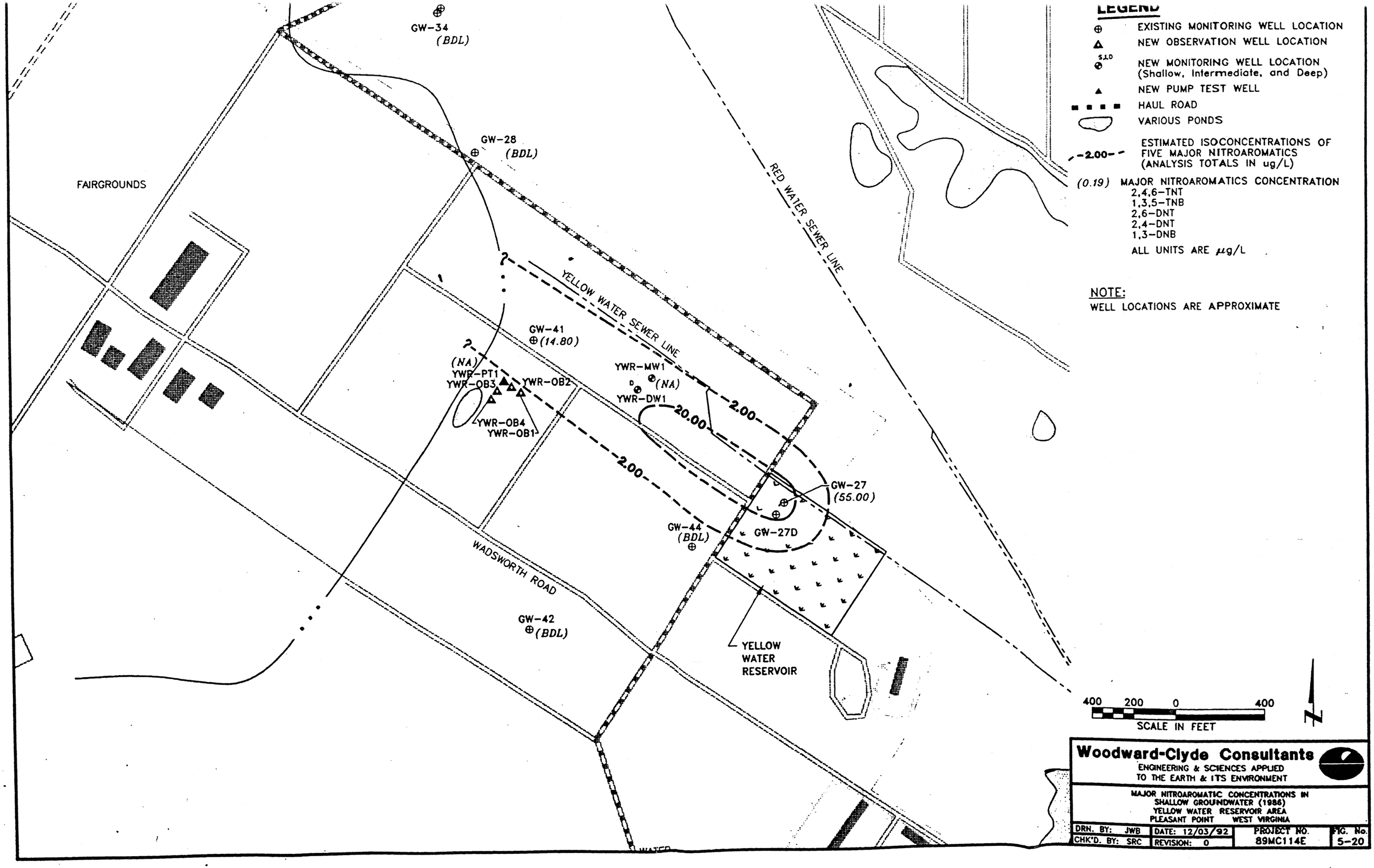
RED WATER SEWER LINE LOCATION IS APPROXIMATE

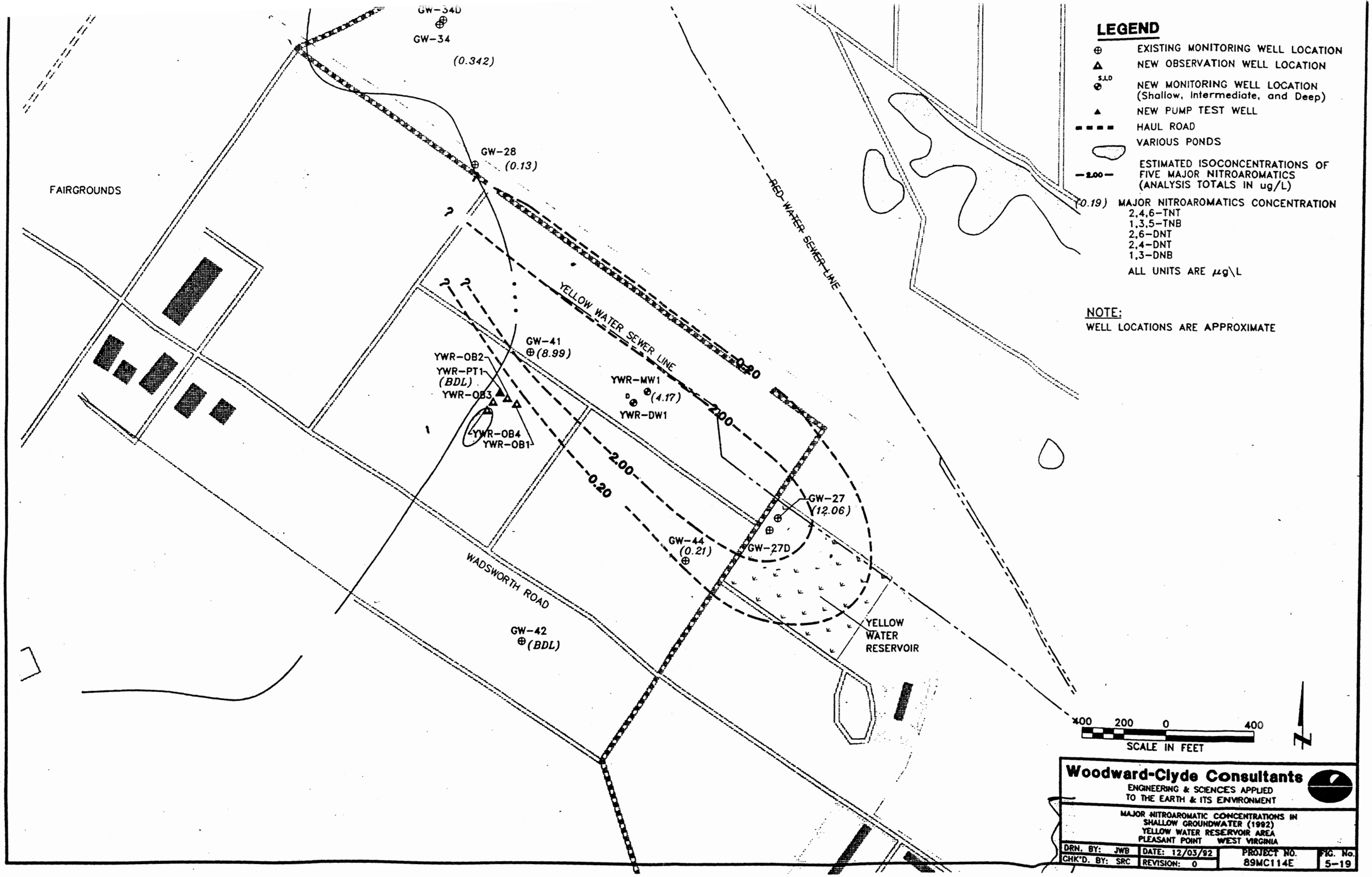
REPORTED LOCATION AND BOUNDARY OF FORMER SEDIMENT BASIN IS APPROXIMATE

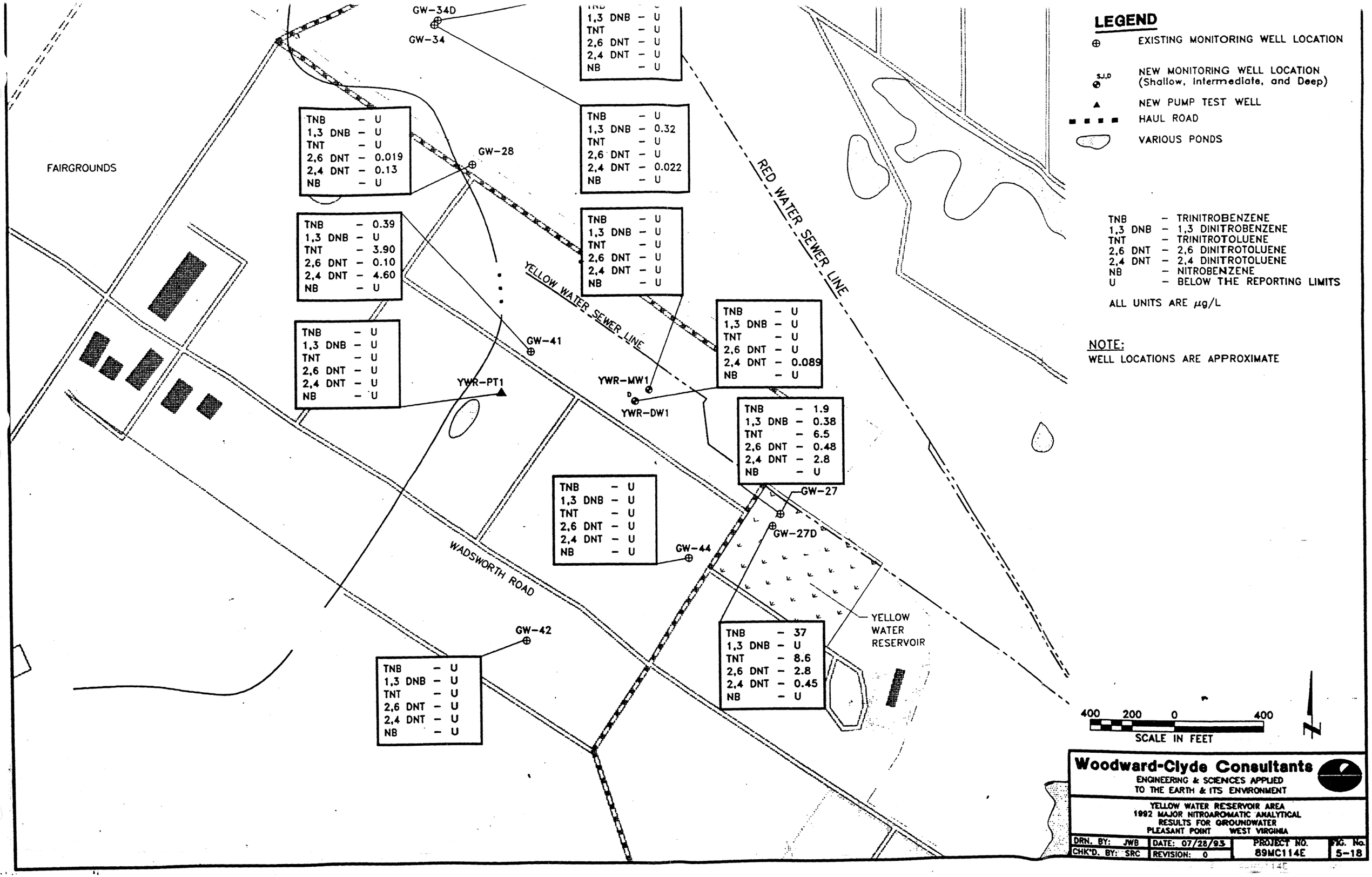
SHALLOW GROUNDWATER POTENTIOMETRIC
(OCTOBER 1993)

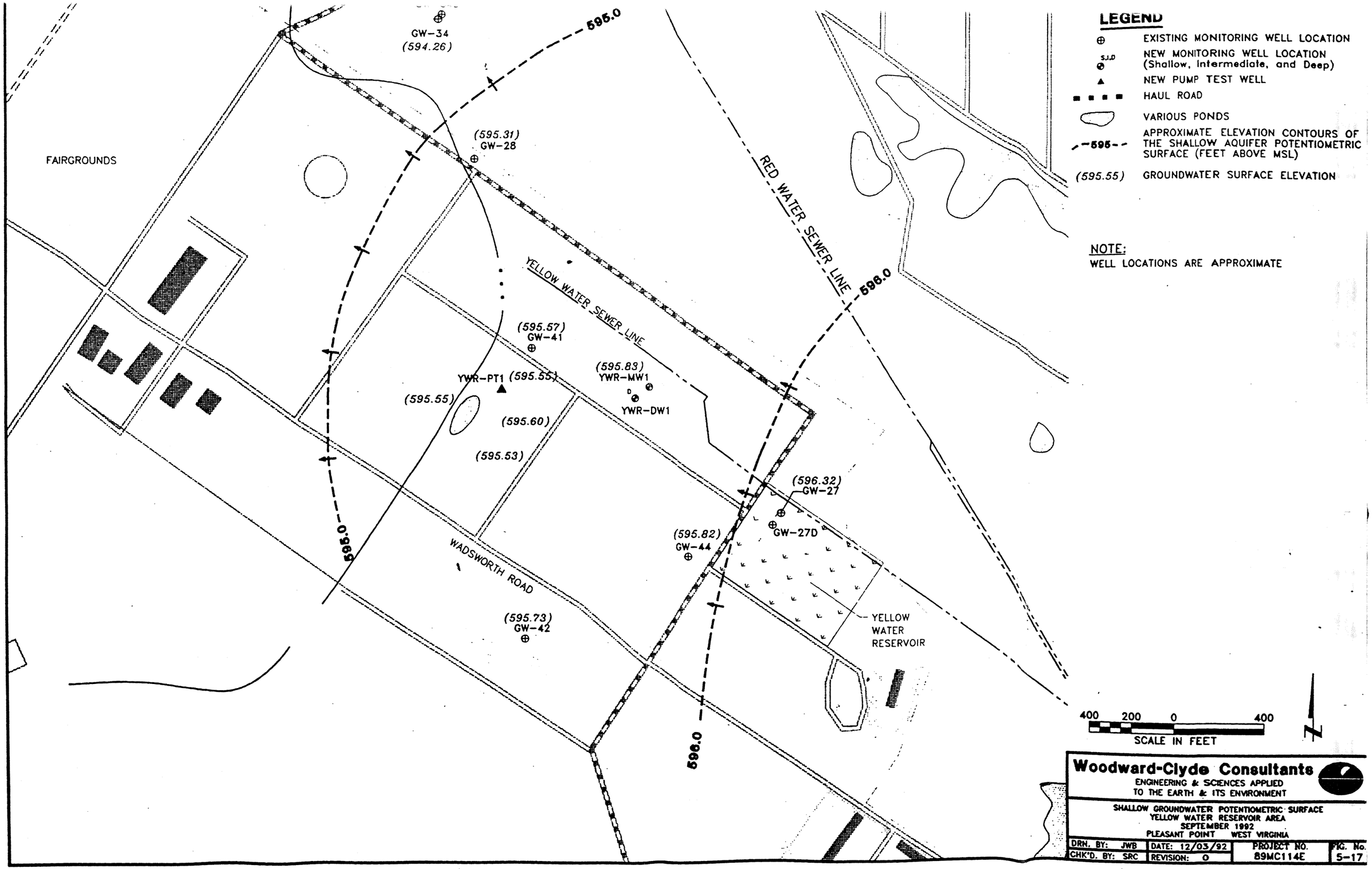
RED WATER RESERVOIR
FORMER WEST VIRGINIA ORDNANCE WORKS
POINT PLEASANT WEST VIRGINIA

SIZE	FSCM NO.	DWG. NO.	REV.
B		FIGURE 5-21	0
SCALE: SHOWN	89114E01.DGN	SHEET 1 OF 1	

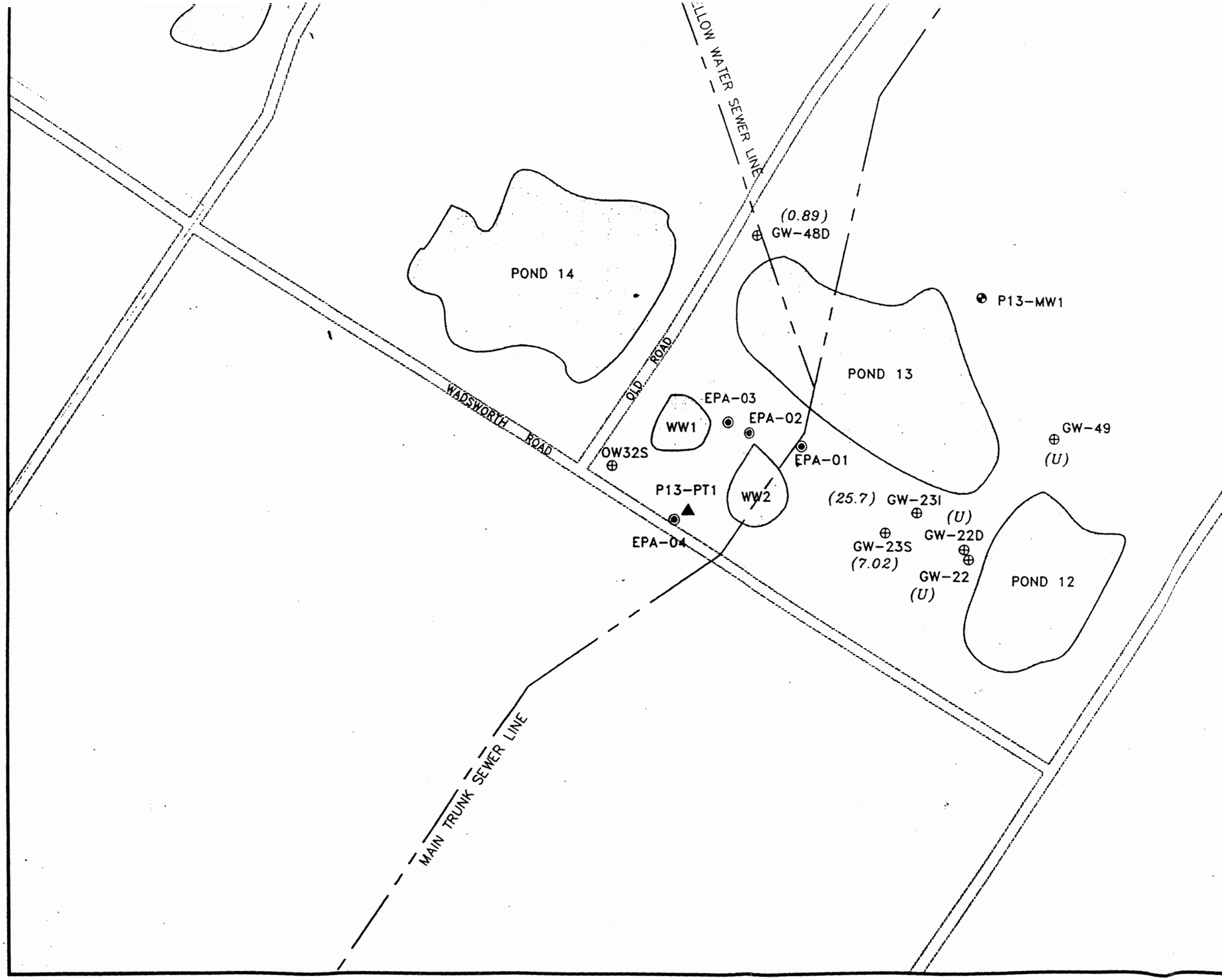

LEGEND
EXISTING MONITORING WELL LOCATION
NEW OBSERVATION WELL LOCATION
S,I,D
NEW MONITORING WELL LOCATION (Shallow, Intermediate, and Deep)
NEW PUMP TEST WELL
HAUL ROAD
VARIOUS PONDS
-2.00-
ESTIMATED ISOCONCENTRATIONS OF FIVE MAJOR NITROAROMATICS (ANALYSIS TOTALS IN ug/L)
(0.19) MAJOR NITROAROMATICS CONCENTRATION
2,4,6-TNT
1,3,5-TNB
2,6-DNT
2,4-DNT
1,3-DNB
ALL UNITS ARE µg/L
NOTE:
WELL LOCATIONS ARE APPROXIMATE
GW-34
(BDL)
GW-28
(BDL)
FAIRGROUNDS
RED WATER SEWER LINE
YELLOW WATER SEWER LINE
GW-41
(14.80)
(NA)
YWR-PT1
YWR-OB3
YWR-OB2
YWR-OB4
YWR-OB1
YWR-MW1
(NA)
D
YWR-DW1
20.00
2.00
2.00
GW-27
(55.00)
GW-44
(BDL)
GW-27D
WADSWORTH ROAD
GW-42
(BDL)
YELLOW WATER RESERVOIR
400 200 0 400
SCALE IN FEET
N
Woodward-Clyde Consultants
ENGINEERING & SCIENCES APPLIED TO THE EARTH & ITS ENVIRONMENT
MAJOR NITROAROMATIC CONCENTRATIONS IN SHALLOW GROUNDWATER (1986)
YELLOW WATER RESERVOIR AREA
PLEASANT POINT WEST VIRGINIA
DRN. BY: JWB
CHK'D. BY: SRC
DATE: 12/03/92
REVISION: 0
PROJECT NO. 89MC114E
FIG. No. 5-20


GW-34D
GW-34
(0.342)
GW-28
(0.13)
FAIRGROUNDS
RED WATER SEWER LINE
YELLOW WATER SEWER LINE
GW-41
(8.99)
YWR-OB2
YWR-PT1
(BDL)
YWR-OB3
YWR-OB4
YWR-OB1
YWR-MW1
(4.17)
YWR-DW1
0.20
2.00
GW-27
(12.06)
GW-27D
GW-44
(0.21)
WADSWORTH ROAD
GW-42
(BDL)
YELLOW
WATER
RESERVOIR
LEGEND
EXISTING MONITORING WELL LOCATION
NEW OBSERVATION WELL LOCATION
S,I,D
NEW MONITORING WELL LOCATION (Shallow, Intermediate, and Deep)
NEW PUMP TEST WELL
HAUL ROAD
VARIOUS PONDS
2.00
ESTIMATED ISOCONCENTRATIONS OF FIVE MAJOR NITROAROMATICS (ANALYSIS TOTALS IN ug/L)
(0.19)
MAJOR NITROAROMATICS CONCENTRATION
2,4,6-TNT
1,3,5-TNB
2,6-DNT
2,4-DNT
1,3-DNB
ALL UNITS ARE μg\L
NOTE:
WELL LOCATIONS ARE APPROXIMATE
400 200 0 400
SCALE IN FEET
N
Woodward-Clyde Consultants
ENGINEERING & SCIENCES APPLIED TO THE EARTH & ITS ENVIRONMENT
MAJOR NITROAROMATIC CONCENTRATIONS IN SHALLOW GROUNDWATER (1992)
YELLOW WATER RESERVOIR AREA
PLEASANT POINT WEST VIRGINIA
DRN. BY: JWB
CHK'D. BY: SRC
DATE: 12/03/92
REVISION: 0
PROJECT NO. 89MC114E
FIG. No. 5-19


LEGEND
EXISTING MONITORING WELL LOCATION
S,I,D
NEW MONITORING WELL LOCATION (Shallow, Intermediate, and Deep)
NEW PUMP TEST WELL
HAUL ROAD
VARIOUS PONDS
TNB - TRINITROBENZENE
1,3 DNB - 1,3 DINITROBENZENE
TNT - TRINITROTOLUENE
2,6 DNT - 2,6 DINITROTOLUENE
2,4 DNT - 2,4 DINITROTOLUENE
NB - NITROBENZENE
U - BELOW THE REPORTING LIMITS
ALL UNITS ARE μg/L
NOTE:
WELL LOCATIONS ARE APPROXIMATE
FAIRGROUNDS
GW-34D
GW-34
TNB - U
1,3 DNB - U
TNT - U
2,6 DNT - U
2,4 DNT - U
NB - U
GW-28
TNB - U
1,3 DNB - U
TNT - U
2,6 DNT - 0.019
2,4 DNT - 0.13
NB - U
TNB - U
1,3 DNB - 0.32
TNT - U
2,6 DNT - U
2,4 DNT - 0.022
NB - U
RED WATER SEWER LINE
YELLOW WATER SEWER LINE
TNB - 0.39
1,3 DNB - U
TNT - 3.90
2,6 DNT - 0.10
2,4 DNT - 4.60
NB - U
TNB - U
1,3 DNB - U
TNT - U
2,6 DNT - U
2,4 DNT - U
NB - U
GW-41
YWR-PT1
YWR-MW1
D
YWR-DW1
TNB - U
1,3 DNB - U
TNT - U
2,6 DNT - U
2,4 DNT - 0.089
NB - U
TNB - 1.9
1,3 DNB - 0.38
TNT - 6.5
2,6 DNT - 0.48
2,4 DNT - 2.8
NB - U
GW-27
GW-27D
TNB - U
1,3 DNB - U
TNT - U
2,6 DNT - U
2,4 DNT - U
NB - U
GW-44
WADSWORTH ROAD
YELLOW WATER RESERVOIR
GW-42
TNB - U
1,3 DNB - U
TNT - U
2,6 DNT - U
2,4 DNT - U
NB - U
TNB - 37
1,3 DNB - U
TNT - 8.6
2,6 DNT - 2.8
2,4 DNT - 0.45
NB - U
400 200 0 400
SCALE IN FEET
N
Woodward-Clyde Consultants
ENGINEERING & SCIENCES APPLIED TO THE EARTH & ITS ENVIRONMENT
YELLOW WATER RESERVOIR AREA
1992 MAJOR NITROAROMATIC ANALYTICAL RESULTS FOR GROUNDWATER
PLEASANT POINT WEST VIRGINIA
DRN. BY: JWB
CHK'D. BY: SRC
DATE: 07/28/93
REVISION: 0
PROJECT NO. 89MC114E
FIG. No. 5-18



AD FILE: 1 -SHALLOW 08/02/1993 14:05

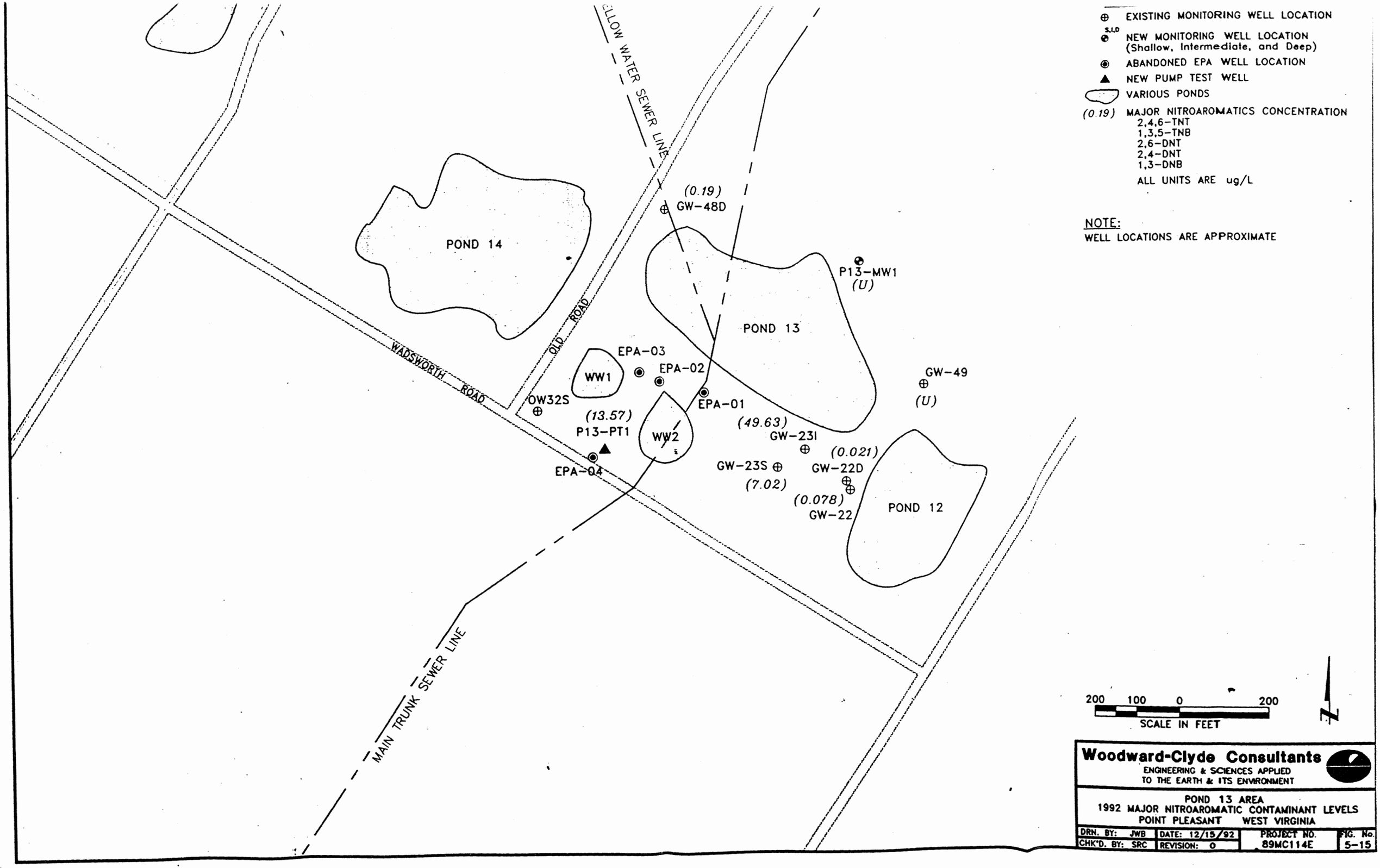


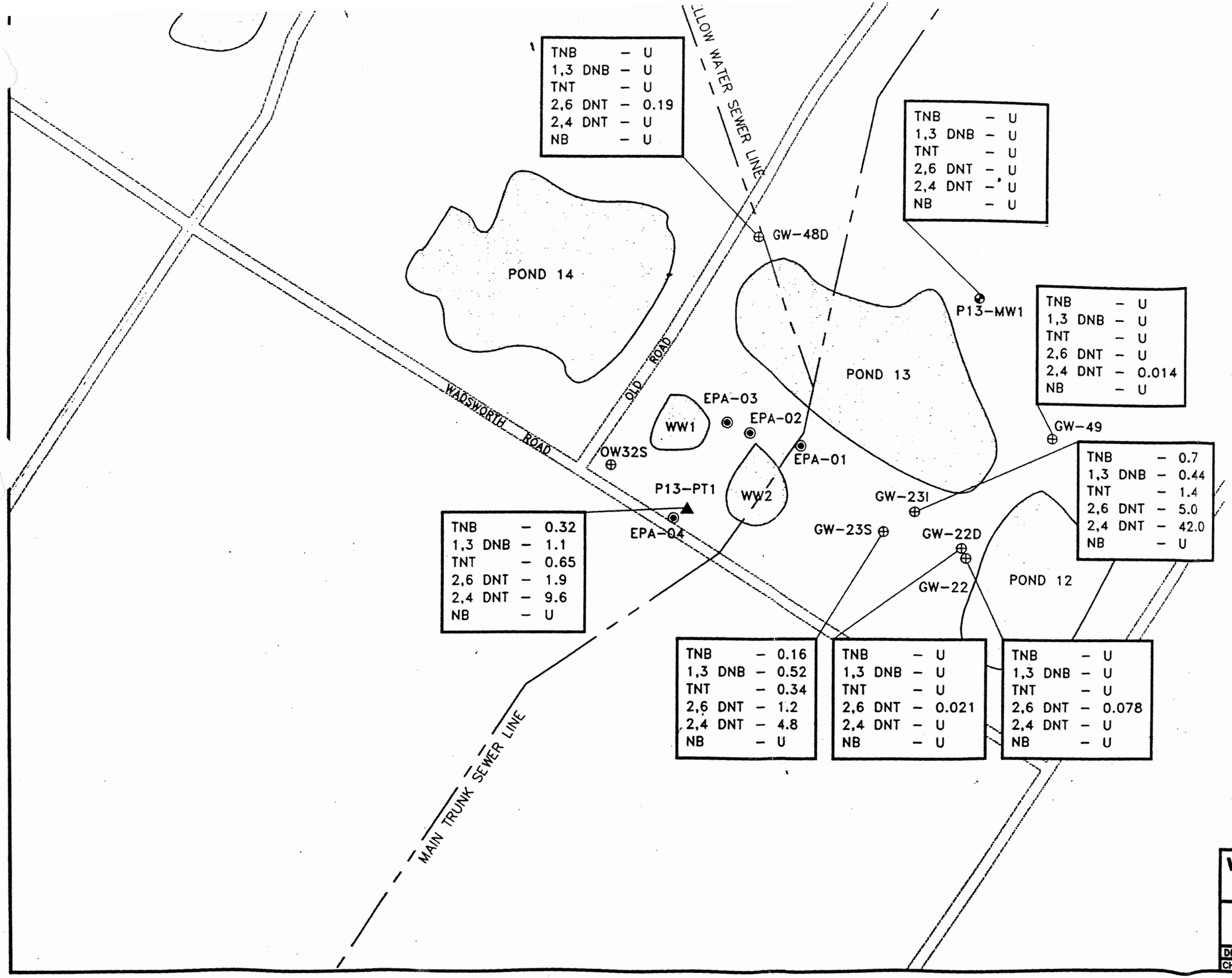
Woodward-Clyde Consultants
ENGINEERING & SCIENCES APPLIED TO THE EARTH & ITS ENVIRONMENT

1986 POND 13 AREA
MAJOR NITROAROMATIC CONTAMINANT LEVELS
POINT PLEASANT WEST VIRGINIA

DRN. BY: JWB	DATE: 12/15/92	PROJECT NO.	FIG. No.
CHK'D. BY: SRC	REVISION: 0	89MC114E	5-16

CAD FILE 08/02/1993 14:26


EXISTING MONITORING WELL LOCATION
S,I,D
NEW MONITORING WELL LOCATION (Shallow, Intermediate, and Deep)
ABANDONED EPA WELL LOCATION
NEW PUMP TEST WELL
VARIOUS PONDS
(0.19) MAJOR NITROAROMATICS CONCENTRATION
2,4,6-TNT
1,3,5-TNB
2,6-DNT
2,4-DNT
1,3-DNB
ALL UNITS ARE ug/L
NOTE:
WELL LOCATIONS ARE APPROXIMATE
POND 14
POND 13
POND 12
WW1
WW2
WADSWORTH ROAD
OLD ROAD
YELLOW WATER SEWER LINE
MAIN TRUNK SEWER LINE
(0.19)
GW-48D
P13-MW1
(U)
EPA-03
EPA-02
EPA-01
OW32S
(13.57)
P13-PT1
EPA-04
(49.63)
GW-23I
GW-49
(U)
(0.021)
GW-22D
GW-23S
(7.02)
(0.078)
GW-22
200 100 0 200
SCALE IN FEET
N
Woodward-Clyde Consultants
ENGINEERING & SCIENCES APPLIED
TO THE EARTH & ITS ENVIRONMENT
POND 13 AREA
1992 MAJOR NITROAROMATIC CONTAMINANT LEVELS
POINT PLEASANT WEST VIRGINIA
DRN. BY: JWB
DATE: 12/15/92
PROJECT NO.
FIG. No.
CHK'D. BY: SRC
REVISION: 0
89MC114E
5-15

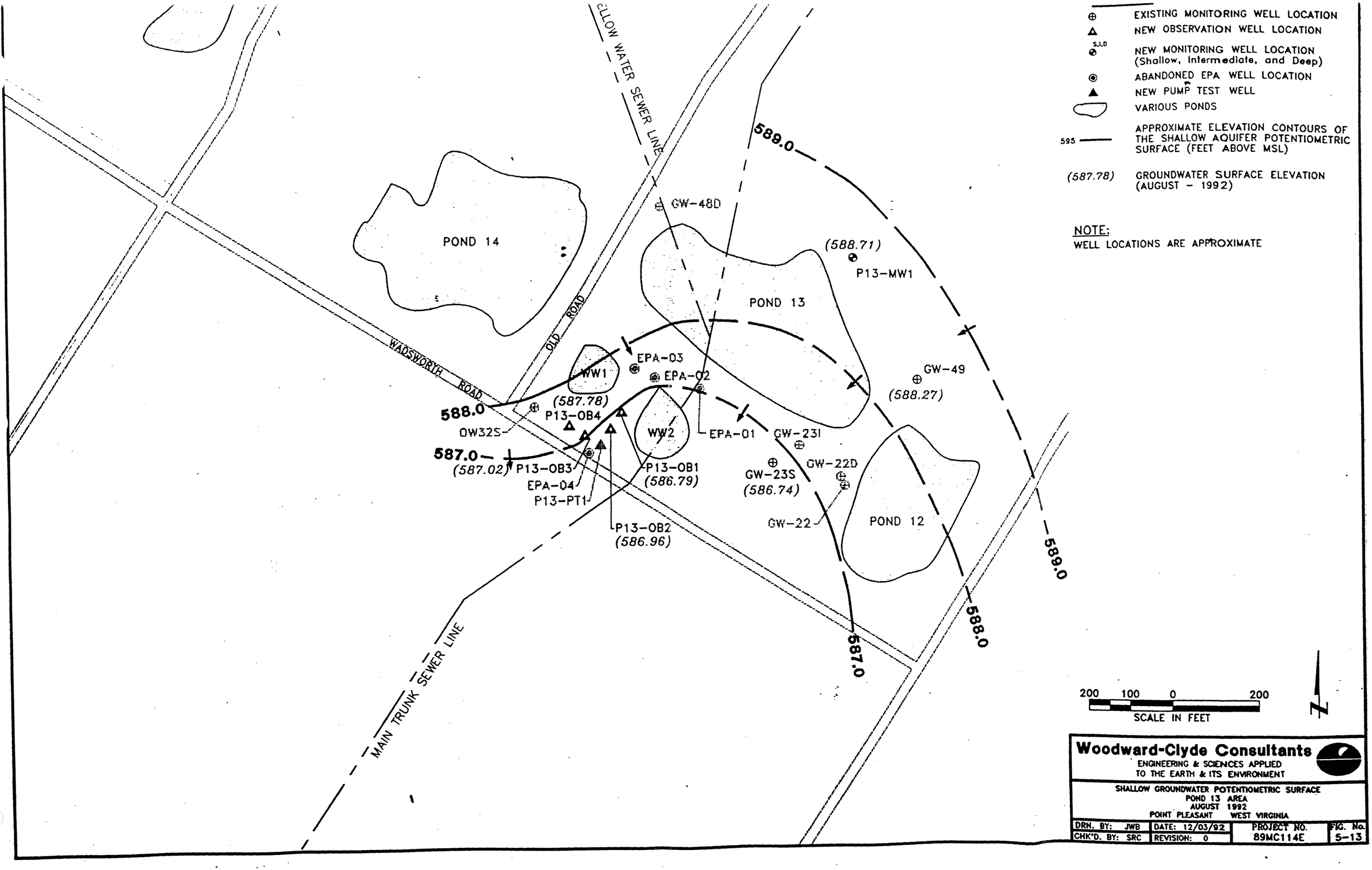


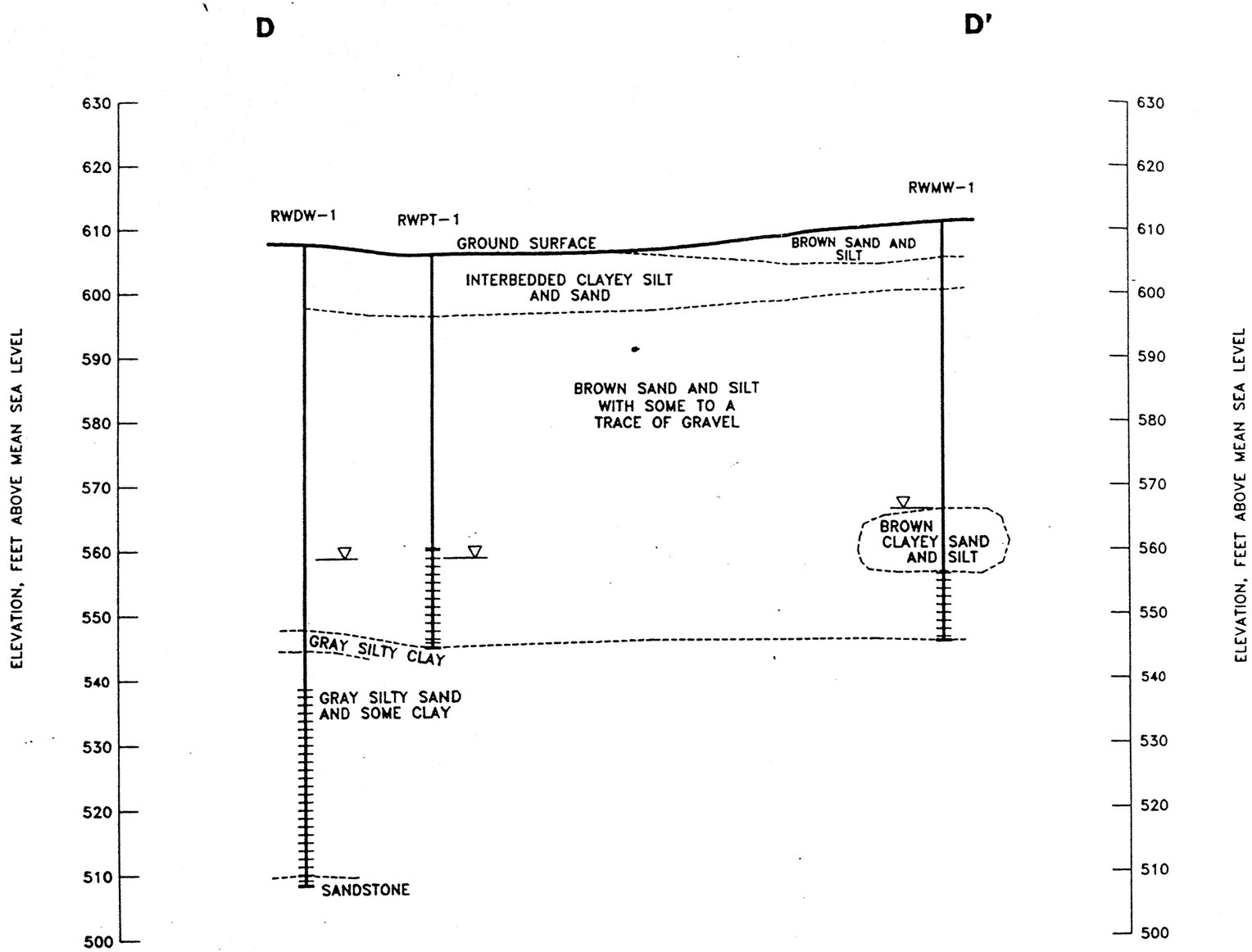
Woodward-Clyde Consultants
ENGINEERING & SCIENCES APPLIED TO THE EARTH & ITS ENVIRONMENT

POND 13 AREA
1992 MAJOR NITROAROMATIC ANALYTICAL RESULTS OF GROUNDWATER
POINT PLEASANT WEST VIRGINIA

DRN. BY: JWB	DATE: 12/15/92	PROJECT NO. 89MC114E	FIG. No. 5-14
CHK'D. BY: SRC	REVISION: 0		

CAD FILE: 4-HITS 08/02/1993 14:15


EXISTING MONITORING WELL LOCATION
NEW OBSERVATION WELL LOCATION
S,I,D
NEW MONITORING WELL LOCATION (Shallow, Intermediate, and Deep)
ABANDONED EPA WELL LOCATION
NEW PUMP TEST WELL
VARIOUS PONDS
595
APPROXIMATE ELEVATION CONTOURS OF THE SHALLOW AQUIFER POTENTIOMETRIC SURFACE (FEET ABOVE MSL)
(587.78)
GROUNDWATER SURFACE ELEVATION (AUGUST - 1992)
NOTE:
WELL LOCATIONS ARE APPROXIMATE
ELLOW WATER SEWER LINE
POND 14
POND 13
POND 12
WADSWORTH ROAD
OLD ROAD
MAIN TRUNK SEWER LINE
589.0
588.0
587.0
GW-48D
(588.71)
P13-MW1
GW-49
(588.27)
EPA-03
EPA-02
WW1
WW2
(587.78)
P13-OB4
OW32S
(587.02)
P13-OB3
EPA-04
P13-PT1
P13-OB1
(586.79)
P13-OB2
(586.96)
EPA-01
GW-23I
GW-23S
(586.74)
GW-22D
GW-22
200 100 0 200
SCALE IN FEET
N
Woodward-Clyde Consultants
ENGINEERING & SCIENCES APPLIED
TO THE EARTH & ITS ENVIRONMENT
SHALLOW GROUNDWATER POTENTIOMETRIC SURFACE
POND 13 AREA
AUGUST 1992
POINT PLEASANT WEST VIRGINIA
DRN. BY: JWB
CHK'D. BY: SRC
DATE: 12/03/92
REVISION: 0
PROJECT NO.
89MC114E
FIG. No.
5-13



LEGEND

WELL RISER

WELL SCREEN

100 50 0 100

HORIZONTAL SCALE IN FEET

20 10 0 20

VERTICAL SCALE IN FEET

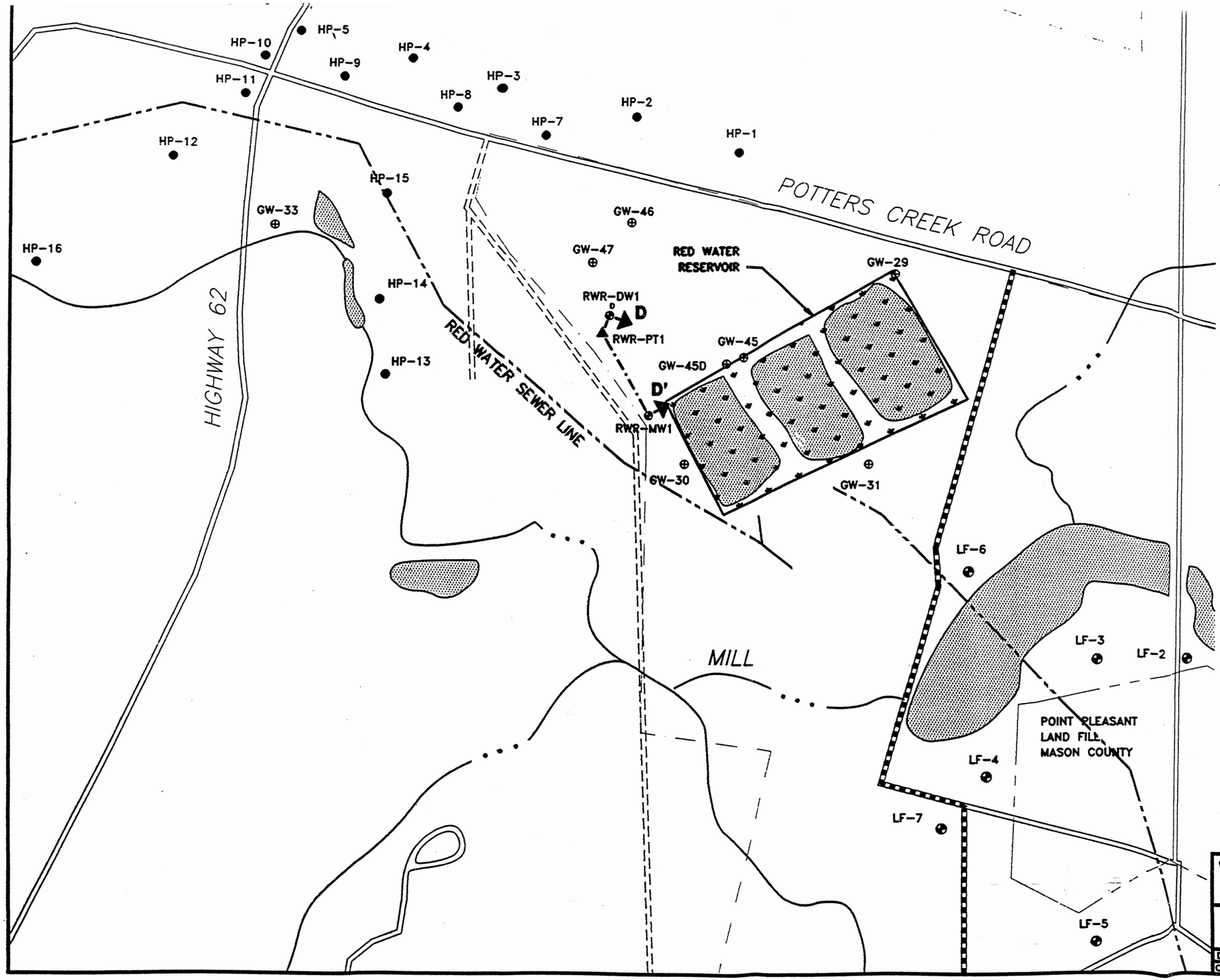
Woodward-Clyde Consultants

ENGINEERING & SCIENCES APPLIED TO THE EARTH & ITS ENVIRONMENT

GENERALIZED GEOLOGIC CROSS-SECTION D – D'
RED WATER AREA
POINT PLEASANT WEST VIRGINIA

DRN. BY: EAB	DATE: 12/15/92	PROJECT No.	FIG. No.
CHK'D. BY:	REVISION: 0	89MC114E	5-12

CAD FILE: 8b...-f21.DWG 08/02/1993 14:18



LEGEND

- EXISTING MONITORING WELL LOCATION
- S,I,D NEW MONITORING WELL LOCATION (Shallow, Intermediate, and Deep)
- NEW HYDROPUNCH BORING LOCATION
- NEW PUMP TEST WELL
- HAUL ROAD
- VARIOUS PONDS
- A A' GEOLOGIC CROSS-SECTION

NOTE:
WELL LOCATIONS ARE APPROXIMATE

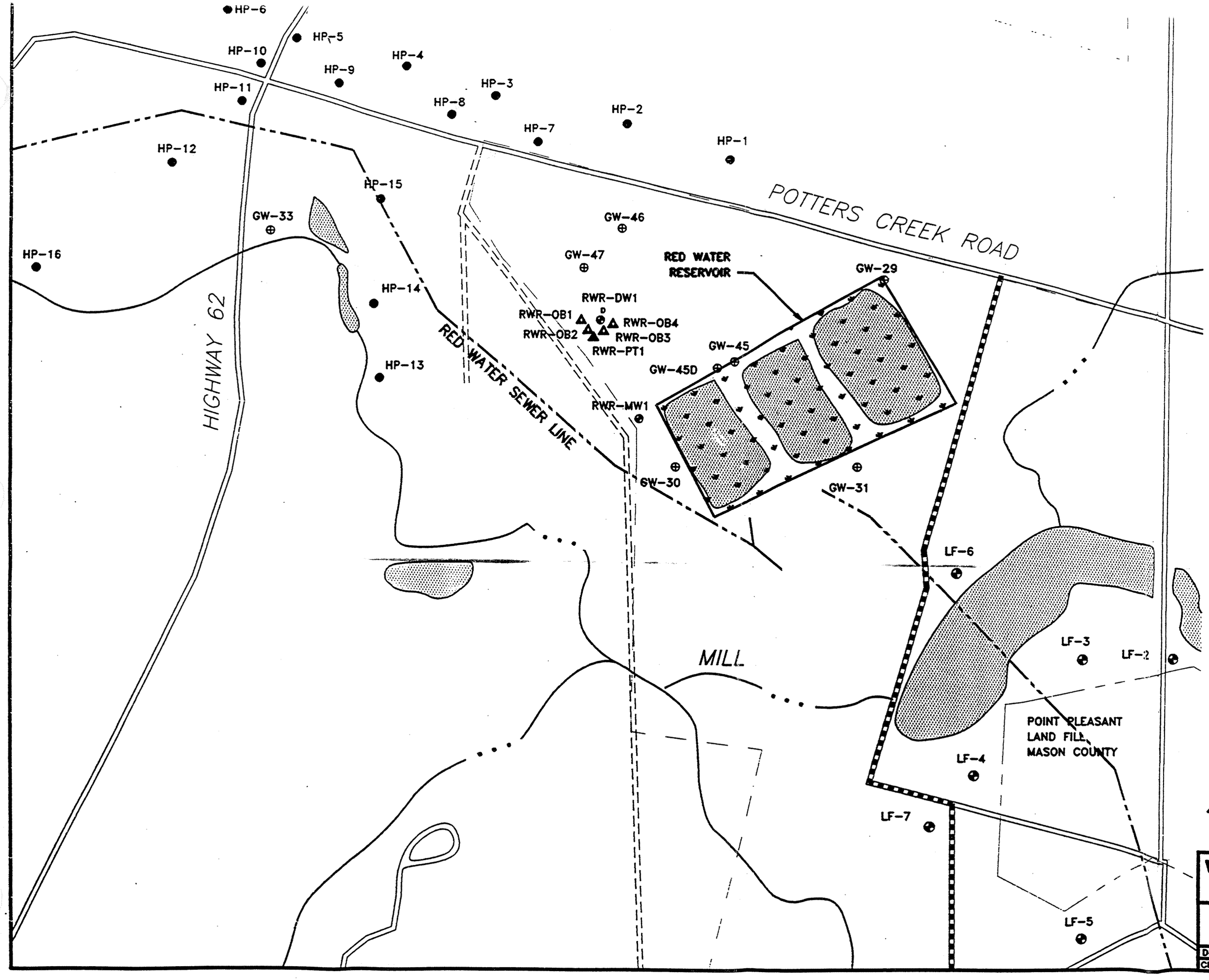
400 200 0 400
SCALE IN FEET

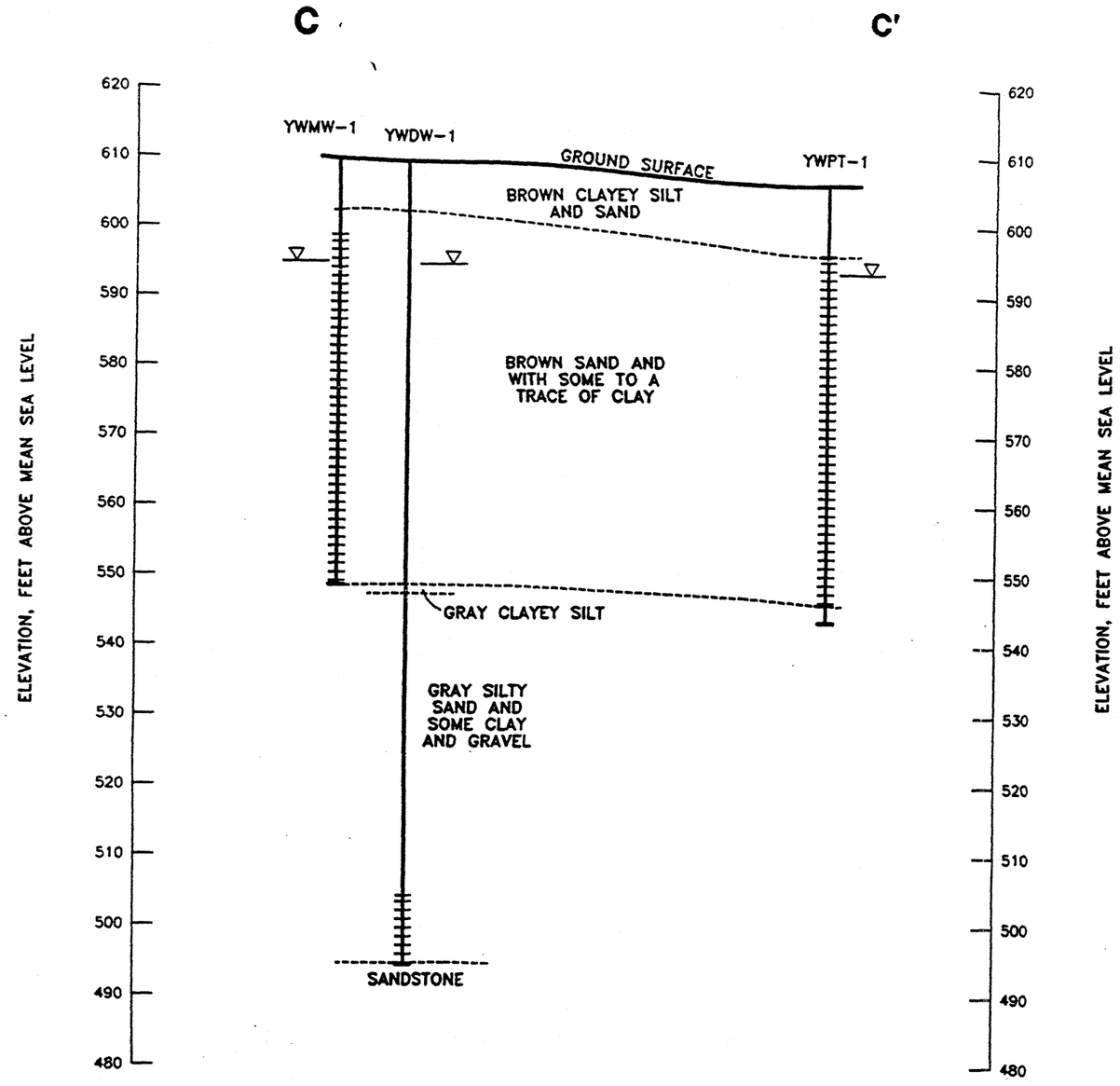
N

Woodward-Clyde Consultants
ENGINEERING & SCIENCES APPLIED TO THE EARTH & ITS ENVIRONMENT

LOCATION OF GENERALIZED GEOLOGIC CROSS SECTION
RED WATER RESERVOIR AREA
POINT PLEASANT WEST VIRGINIA

DRN. BY: JWB	DATE: 12/15/92	PROJECT NO.	FIG. No.
CHK'D. BY: SRC	REVISION: 0	89MC114E	5-11


HP-6
HP-5
HP-10
HP-4
HP-9
HP-3
HP-11
HP-8
HP-2
HP-7
HP-1
HP-12
HP-15
POTTERS CREEK ROAD
GW-33
GW-46
HP-16
GW-47
RED WATER
RESERVOIR
GW-29
HP-14
RWR-DW1
RWR-OB1
RWR-OB4
RWR-OB2
RWR-OB3
RWR-PT1
GW-45
GW-45D
HIGHWAY 62
HP-13
RED WATER SEWER LINE
RWR-MW1
GW-30
GW-31
LF-6
LF-3
LF-2
MILL
POINT PLEASANT
LAND FILL
MASON COUNTY
LF-4
LF-7
LF-5



LEGEND

WELL RISER

WELL SCREEN

200 100 0 200

HORIZONTAL SCALE IN FEET

20 10 0 20

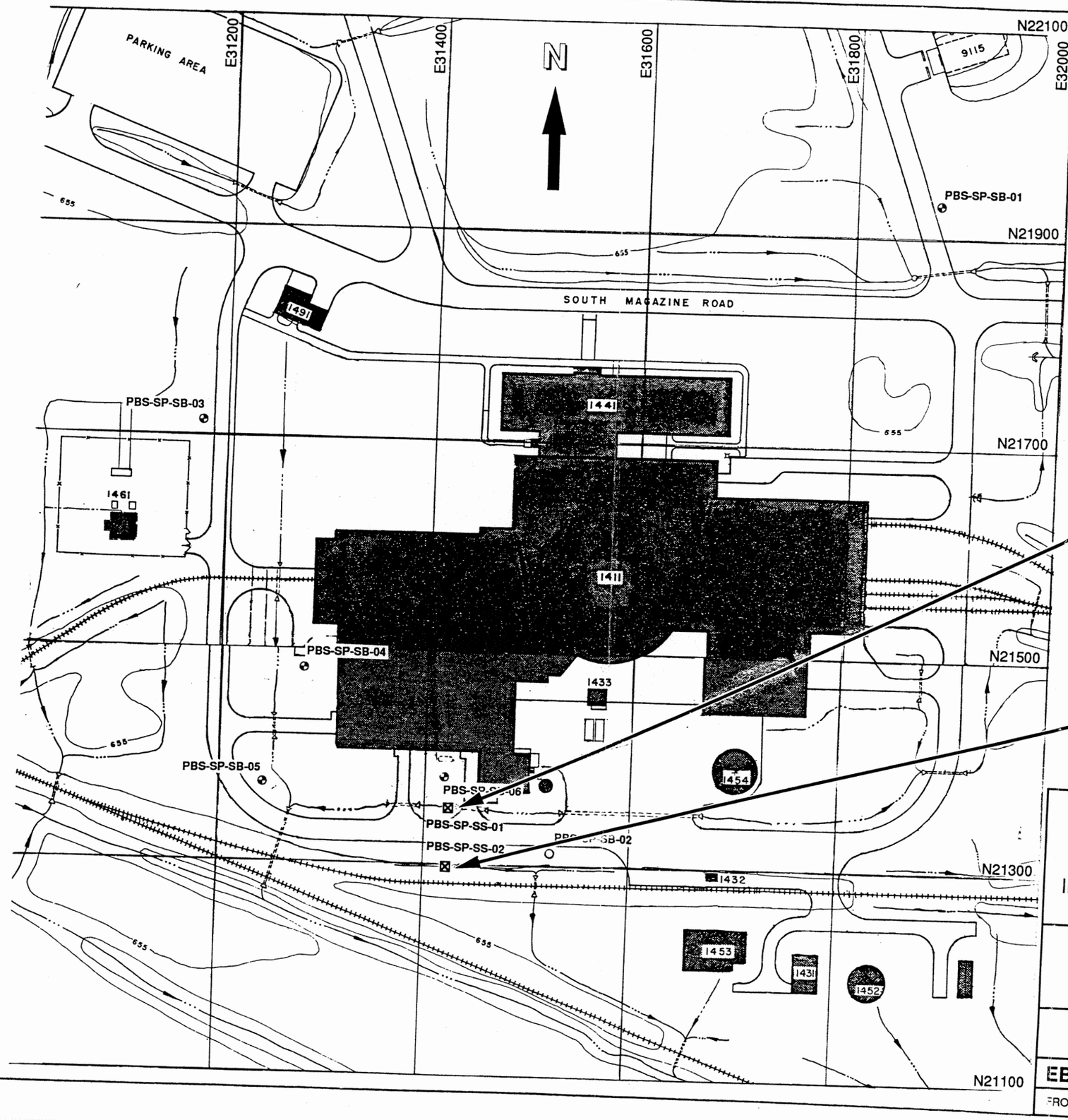
VERTICAL SCALE IN FEET

Woodward-Clyde Consultants

ENGINEERING & SCIENCES APPLIED TO THE EARTH & ITS ENVIRONMENT

GENERALIZED GEOLOGIC CROSS-SECTION C – C'
YELLOW WATER AREA
POINT PLEASANT WEST VIRGINIA

DRN. BY: SCR	DATE: 12/16/92	PROJECT No. 89MC114E	FIG. No. 5-9
CHK'D. BY: SRC	REVISION: 0		



PBS-SP-SS-01	Conc.
Phenanthrene	200 J ug/Kg
Fluoranthene	890 J ug/Kg
Pyrene	980 ug/Kg
Benzo(a)anthracene	490 J ug/Kg
Chrysene	590 J ug/Kg
Benzo(b)fluoranthene	680 J ug/Kg
Benzo(k)fluoranthene	890 J ug/Kg
Benzo(a)pyrene	680 J ug/Kg
Indeno(1,2,3-cd)pyrene	490 J ug/Kg
Aroclor-1254	1600 ug/Kg
Total Petroleum Hydrocarbons	1320 mg/Kg

J = Estimated

PBS-SP-SS-02	Conc.
Total Petroleum Hydrocarbons	127 mg/Kg

NASA PLUM BROOK STATION
UNDERGROUND STORAGE TANK
CORRECTIVE ACTIONS REMEDIAL
INVESTIGATIONS/FEASIBILITY STUDY:
PHASE I

Organic Contaminant Concentrations in Sediment

SPACE POWER FACILITY

EBASCO ENVIRONMENTAL | SCALE: 1"=100'

FROM NASA DWG. NOs. PF-65530 & 65538 | **FIGURE 3-27**

4.0 SUMMARY AND RECOMMENDATIONS

4.1 Summary

Section 1.1 of this Report identified the objectives of the current investigation to be:

1) To compile all the currently available site characterization data from the previous and current UST investigations for each of the four former UST areas at the PBS;

2) To develop a preliminary assessment of the extent of UST-related contamination present at each Tank Area;

3) To identify the pathways by which any contamination present may spread or migrate; and

4) To document the presence or absence of contaminants at each Tank Area so that a more efficient, targeted analytical program can be specified for any future characterization activities that may be required.

Sections 1.0 and 3.0 provide extensive background on the previous activities and investigations conducted at each of the Tank Areas. Table 1-1 presents a summary of the administrative and investigative UST activities that have been conducted at the PBS. Section 3.0 presents a comprehensive compilation of the relevant and pertinent characteristics of the former USTs and their associated environmental media at each Tank Area. The location, age, size, material of construction, and prior contents of each UST are noted (refer to Sections 3.1, 3.2, 3.3 and 3.4 for the four Tank Areas, respectively). Thereafter all analytical and testing results generated during the UST closure assessments, initial remediation efforts, or soil gas surveys conducted prior to the current study are quantitatively summarized and discussed (refer to 3.1.1, 3.2.1, 3.3.1 and 3.4.1 for the four Tank Areas, respectively). The analytical data obtained from the current investigation are then presented, summarized and evaluated (refer to 3.1.2, 3.2.2, 3.3.2 and 3.4.2 for the four Tank Areas, respectively). Finally, the complete set of compiled information for each Tank Area is synthesized and collectively evaluated. The compiled data are presented in both tabular and graphical form, whenever practical, to facilitate their interpretation.

The results from the current and prior investigations presented for each Tank Area were reviewed collectively to gain a "weight-of-evidence" indication of the extent of contamination present at each former UST location. The extent of contamination suggested by these results must be considered preliminary, in that the sampling conducted for the closure assessments and for this Phase I investigation was not designed to define the full extent of the contaminated areas. The closure assessment and initial remediation

effort soil sampling was generally limited to the soil in the area immediately above, adjacent to, and beneath the former USTs. Four additional boreholes and monitoring wells were subsequently installed at the Garage and Maintenance Area which provided information at a somewhat larger radius from the former UST location at Building No. 7132. The soil, groundwater and sediment sampling locations for the current investigation also were not selected with the primary goal of defining the full extent to the contamination at each area. This sampling was designed to allow the contaminants present at each Tank Area (and, consequently, the contaminants not present) to be identified, and a determination to be made of which detected contaminants were logically and physically linked to the reported contents of the former USTS. As such, samples were taken at locations that were anticipated to be contaminated and at locations that were anticipated to be "clean", or unaffected by the former USTs. A small number of the other samples were taken at discretionary locations to check hypotheses about preferential pathway and surface run-off contaminant migration, or to more confidently detect the full range of contaminants present in the area. The soil gas surveys performed at 3 of the 4 Tank Areas were, however, designed to systematically investigate a larger area at each former UST location and provide some qualitative indication of the extent of contamination. As was noted, these soil gas results are not quantitatively specific with respect to particular volatile organic compounds and cannot always be used to distinguish soil contamination from ground water contamination. The soil gas results are qualitative in nature and indicate the general presence or absence of certain types of volatile organic compounds.

Noting these caveats, the compiled data was evaluated. Thereafter, an overall picture of the current nature and extent of the UST contamination present at each of the Tank Areas was developed and potential UST contaminant migration pathways were identified. This synthesized characterization is summarized in Table 4-1. Table 4-1 presents the findings of the completed UST data evaluations in the following areas:

1) The environmental media (i.e., subsurface soil, ground water, or surface sediments)that were found to contain UST-related contaminants;

2) The types of chemical contaminants (i.e., volatile organics, semivolatile organics, pesticides, PCBs, metals, Cyanide or TPH) that were found in the samples analyzed, and which were indicated to be associated with the reported contents of the former USTs;

3) A subjective ranking (e.g., significant, low, or very low) of the level of residual UST contamination indicated to be present at the former UST locations; and

4) The ground water and soluble contaminant migration routes indicated to be influencing the pattern of contamination observed at each Tank Area / former UST location.

A number of points can be highlighted with respect to the summarization presented in Table 4-1. First, the principal contaminated medium is clearly the Tank Area soils. There appears to be at least low level residual soil contamination at, or immediately adjacent to, most of the former UST locations. This soil appears to be now acting as a secondary source of contaminant release. Ground water is indicated to be the principal means by which the volatile organics (fuel or solvent compounds) are migrating horizontally (and possibly vertically) away from the original UST locations. The soluble contaminants appear to be migrating with the ground water in relatively low concentrations at most locations. Some of the more volatile compounds are likely to have been partially released from the ground water into the soil gas over time. These volatilized compounds may then have migrated up through the relatively shallow, and sometimes porous, overburden and been vented into the atmosphere. Alternatively, these migrating free volatiles could have become captured on the surfaces of overlying clay/overburden material and possibly later re-released. However, the VOCs detected in the samples taken during the current investigation would not be expected to exhibit a great tendency to adhere to the site soils or overburden materials.

Because the soil originally covering and surrounding the USTs has been removed and replaced by clean fill, no soil contaminant transport or migration routes are suggested. Any residual UST soil contamination is indicated to be at a depth below the ground surface which would preclude accidental contact by people or vehicles, wind blowing and transport, or disturbance by routine site activities at the surface. Credible subsurface soil contact and movement would only be associated with purposeful re-excavation of the former UST locations. This would expose the residual UST contamination and make it available for possible dispersion or transport.

Plausible theoretical estimates of the ground water flow rate through the undisturbed overburden material indicated that migration of contaminants in the ground water in this manner would be much slower than by ground water movement along more porous and transmissive soil features, such as coarser fill or foundation aggregate. These calculations should be confirmed by site-specific field tests. This more transmissive material would likely be found along the buried utility lines, building foundations, and, possibly, constructed roadbeds. The observed contamination pattern, to the extent relevant data was available, supported this conceptual model of migration.

Volatile organic compounds and TPH were shown to be the only UST contaminants of concern at all four of the Tank Areas. All other organic compounds (e.g., selected PAHs, the insecticide BHC, and Aroclor-1254) and inorganic compounds (e.g., Arsenic and Mercury) detected on a spot basis could not be clearly associated with the reported contents of the former USTs given the available information. TPH was reported at detectable levels at most soil sampling locations, including many selected as the "background" locations. TPH is, therefore, not viewed, in this case, as a reliable indicator of residual UST contamination. Sampling for the standard VOCs would provide a much less ambiguous indication of the extent of migration of the former UST contents.

Varying degrees of residual contamination were seen across the set of Tank Areas and former UST locations. The former UST area on the east side of Building No. 7121 at the Garage and Maintenance Area is clearly the most affected area based on the magnitude of the contaminant concentrations measured, the number of different compounds detected, and the apparent extent of migration of these contaminants.

The next most impacted location would appear to be the Space Power Facility. This ranking is based on the range of contaminants detected at this location (including those that may or may not be related to the former UST contents) and the visual observations and real time air monitoring performed at the site during the closure assessment. These observations and readings suggested the presence of a greater level of contamination than was documented by the limited sampling program conducted for the phase I investigation. The occurrence of a significant spill of an above ground storage tank at this same location on November 17, 1989 also may have contributed to the conditions now present. Based on the available data, the Reactor Area former UST location is indicated to be next most impacted by residual UST contamination. The Building No. 7131 and building No. 7132 locations at the Garage and Maintenance Area and the Pump Station former UST location are all currently indicated to be only slightly impacted by residual UST contamination, given the data available. It is acknowledged that this relative ranking is subjective and based on limited (but all available) data. Additional targeted sampling and analysis is warranted to confirm these findings prior to the commitment of significant remedial resources.

4.2 Recommendations

The recommendations that follow have been developed to ensure that the investigation and remediation of the environmental damage caused by the former USTs at the PBS will progress in a logical, efficient and cost-effective manner. These recommendations relate to suggested tasks aimed at filling data gaps identified by the Phase I investigation. With this information, and the results contained in this Report, NASA will be able to make informed decisions about the actions that must be taken with regard to the USTs at the PBS in the near future to protect human health and the environment.

The proactive activities proposed below represent tasks that can be conducted at minimum cost to characterize certain conditions that could not be unambiguously established by the Phase I effort given its multiple objectives and limited sampling program. These recommended activities are designed to make the fullest use of all the existing ground water monitoring wells that have been installed to more systematically establish the extent of contamination and the site-specific migration potential in ground water. In addition, some follow-up sampling and analysis of environmental media in prescribed locations is called for to investigate possible UST contaminant migration routes brought to light by the Phase I investigation. Establishing this information is necessary and prerequisite to determine if further actions are necessary at the various Tank Areas, and to define the

type and level of activity which should be undertaken. As the cost of systematically defining the nature and extent of soil contamination in the areas highlighted as containing residual UST contamination will be significant (as would be associated with a standard remedial investigation), prudence dictates that all cost-effective information be first collected and evaluated so that this next step in the UST investigation and remediation process be conducted only where reasonable and warranted, and in a manner that will meet all NASA and regulatory requirements. The proposed follow-up activities now recommended will enable the expenditure of resources to be concentrated on testing and laboratory analyses, while field labor, mobilization, documentation and production costs are kept to a minimum.

The recommendations presented below consist of two types: those applicable to each of the Tank Areas and those specific to a particular Tank Area or former UST location. These activities are recommended to be conducted at the earliest possible time so that the collected information may be timely with regard to decision-making about future proactive or mandated steps to be taken with respect to the USTs at the PBS.

4.2.1 Recommendations Applicable to All Tank Areas

1) Sample all existing ground water monitoring wells for VOC contamination, including the 20 wells installed during the Phase I investigation and the 4 wells installed previously during the closure assessment for the USTs at Building No. 7132. This sampling should be conducted quarterly for at least one year. After one year, the need for and frequency of this sampling should be re-evaluated. This work is proposed so that the areal extent and magnitude of ground water contamination at each Tank Area may be more completely assessed. The Phase I sampling was performed to identify which contaminants were of concern at these sites, as well as to measure the general magnitude of the residual contamination present. These recommended analyses will allow NASA to assess the temporal and spatial variations of the concentrations of any VOC contaminants present at each Tank Area.

2) Collect monthly ground water levels at all 24 monitoring wells for one year. After one year, the need for continued water level measurement should be re-evaluated. This information, along with the analytical results from the ground water sampling, will allow for a better determination of the ground water flow paths and, therefore, areal extent of contamination. This information is a basic component of formal site characterizations of this type, and would be expected to be available.

3) Conduct a set of aquifer tests (slug tests) at a limited number of wells so that better values for hydraulic conductivities and ground water flow velocities in the unconsolidated materials at the sites can be determined. At least one aquifer test should be conducted at each Tank Area and two tests should be performed near the former UST areas indicated as having the greatest level of residual UST contamination. A total of about 8 aquifer tests will be necessary. Knowledge of the ground water migration velocities are crucial when considering the assessment of risk to human health and the environment. Actual measurements of aquifer characteristics are a basic component of formal site characterizations of this type, and would be expected to have been made. Use of theoretical values calculated from published ranges for aquifer characteristics for anything other than the gross screening done in this Report would not be acceptable.

4) Conduct one round of air screening in the PBS building basements where preferential ground water migration along foundations was indicated. Permeable zones along building foundations and basement walls have been identified as possible migration routes for contaminants at some locations. This screening is recommended so that the existence of this migration route can be verified and so that the possible impact of the build-up of airborne volatile solvent or fuel products in the buildings can be quantitatively assessed. This assessment would be needed to determine if any potential inhalation risks are associated with these building areas. Based on an initial screening, subsurface building areas are present only at the Reactor Area and the Space Power Facility. However, any such structures should be identified and checked. Follow-up monitoring would be warranted where unusual readings are encountered.

4.2.2 Recommendations Associated with Specific Tank Areas

<u>Garage and Maintenance Area</u>

1) Review of a recent study by Warner/Osborn/Pardee ("Sanitary Sewer and Wastewater Treatment Plant Engineering Evaluation - Requirements for the Year 2000", W/O/P, January 1991) revealed that the USTs in this area are a source of organic contamination into the sanitary sewers, with the sanitary sewers then becoming a secondary (and more rapid) transport mechanism. A study should be done to determine if this is also occurring in the storm sewers. The sewers themselves could be a source of contamination if leaking, or a transport mechanism.

2) Screen the air in the sanitary sewer line adjacent to Building Nos. 7131 and 7121 for VOCs with a photoionization detector or a flame ionization detector. Following the air screening, collect sediment and wastewater samples from these sewers. If possible, assess the structural integrity of these lines. It is expected that access to these sewers will be from the six manholes in the area surrounding Building No. 7121. This testing should establish if there is contamination inside as well as outside the lines, where the contamination may have originated (if it is present), and if contamination may be or may have passed into or out of the sewer line.

Space Power Facility Area

No additional special recommendations have been identified for this Tank Area at this time.

Pump Station Area

1) Install two additional ground water monitoring wells at the Pump Station at locations suggested by the ground water level contours developed under the current investigation. These additional locations for water level measurements are needed to properly define the local ground water flow direction and velocity. These wells should then be sampled during the following quarterly sampling event. The water levels should be measured during the first monthly round of water level measurement after completion of the well development activities.

Reactor Area

1) Periodically, analyze (for VOCs) the water which is being collected from the footer drain along the length of the 1131 tunnel and pumped to the Water Monitoring Station (Building No. 1191) near the Reactor Area. The flow rate and discharge volumes should also be measured.

4.2.3 Additional Comments

After obtaining and evaluating the results of the supplemental investigations associated with the recommendations above, it will be necessary to reassess the need for and scope of any further work. This follow-up activity, such as additional sampling with targeted laboratory analyses, and possible perimeter well installation and monitoring at certain Tank Areas may be called for if a conventional Remedial Investigation-style (RI) study is mandated. The information presented in this Report, coupled with the results of the recommended tasks, would enable the RI study to be properly scoped and focused.

TABLE 4-1

Summary of Current Site Characterization Results for the Plum Brook Station Former UST Locations

Tank Area / Former UST Location	UST Contaminated Media			UST Contamination Detected or Indicated to be Potentially Problematic							Level of Residual UST Contamination Present	Potential Ground Water Migration Routes	
	Sub-surface Soil	Ground Water	Surface Sediment	VOCs	Semi-vols	Pesti-cides	PCBs	Metals	CN	TPH		Through Natural Overburden	Along Prefer-ential Pathways
Garage and Maintenance Area													
/ Tanks #33, #34, and #35 (Building 7132)	X	X	-							X	Very Low	X	Buried Water Line
/ Tanks #28, #29, #30 and #31 (Building 7121)	X	X	(1)	X	(1)	(2)				X	Significant	X	Buried Water and Sewer Lines Roadbed Building Foundation
/ Tank #32 (Building 7131)	-	-	(1)	X	(1)	(2)				X	Very Low	X	Buried Sewer, Water and Natural Gas Lines Roadbed Building Foundation Ground Water Break-out and Run-off
Space Power Facility													
/ Tanks #24 and #25 (Building 1411)	X	-	(1)	X	X(1)		(3)	(4)		X	Low	X	Buried Sewer, Water and Natural Gas Lines Roadbed Building Foundation
Pump Station													
/ Tank #39 (Building 8133)	X	-	(1)	X	(1)					X	Very Low	X	Buried Water Lines Building Foundation
Reactor Area / Tanks #21, #22, and #23 (Building 1131)	X	-		X	(1)	(2)				X	Low	X	Underground Tunnel Dewatering and Discharge Buried Sewer and Water Lines Buried Electrical Conduit Channels

NOTES

- Not detected in current investigation
(1) Detected PAHs in sediment samples are not indicated to be related to the former USTs
(2) Detected Pesticide in ground water samples is not indicated to be related to the former USTs
(3) Detected PCB compound in sediment samples is not indicated to be related to the former USTs
(4) Detected Metals (Arsenic and Mercury) are not current[illegible]ed to former UST contents