PRE-DESIGN INVESTIGATION REPORT

FARRAND CONTROLS SITE

Valhalla, New York

Site No. 3-60-046

WORK ASSIGNMENT NO. D004446-19

Prepared For

New York State Department of Environmental Conservation

MAY 2007

DVIRKA AND BARTILUCCI
CONSULTING ENGINEERS
A DIVISION OF WILLIAM F. COSULICH ASSOCIATES, P.C.

PRE-DESIGN INVESTIGATION REPORT

FARRAND CONTROLS SITE
VALHALLA, NEW YORK

SITE NO. 3-60-046

Prepared for:

NEW YORK STATE
DEPARTMENT OF ENVIRONMENTAL CONSERVATION
ALBANY, NEW YORK

Prepared by:

DVIRKA AND BARTILUCCI CONSULTING ENGINEERS
WOODBURY, NEW YORK

MAY 2007

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PRE-DESIGN INVESTIGATION REPORT
FARRAND CONTROLS SITE
VALHALLA, NEW YORK
SITE NO. 3-60-046

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1.0 INTRODUCTION

The Farrand Controls Site, located in Valhalla, New York, is a New York State Class 2 inactive hazardous waste disposal site, Registry Number 3-60-046. The location of the site is shown on Figure 1-1. The New York State Department of Environmental Conservation (NYSDEC) issued a remedial design work assignment to Dvirka and Bartilucci Consulting Engineers (D&B) to address the Farrand Controls Site.

The primary objectives of the Remedial Design Work Assignment for the site is to remediate the known contaminant source in soil, as well as groundwater contamination in the overburden at the site. In accordance with the Record of Decision (ROD) issued by the NYSDEC in March 2002, the remedial alternatives selected for the site and which are components of the remedial program comprise:

- Removal of subsurface soil contaminated with Freon 113,
- In-situ subsurface reductive dechlorination to treat the site groundwater contaminated with chlorinated solvents, and
- Implementation of a short-term groundwater monitoring program to verify the effectiveness of the remedy.

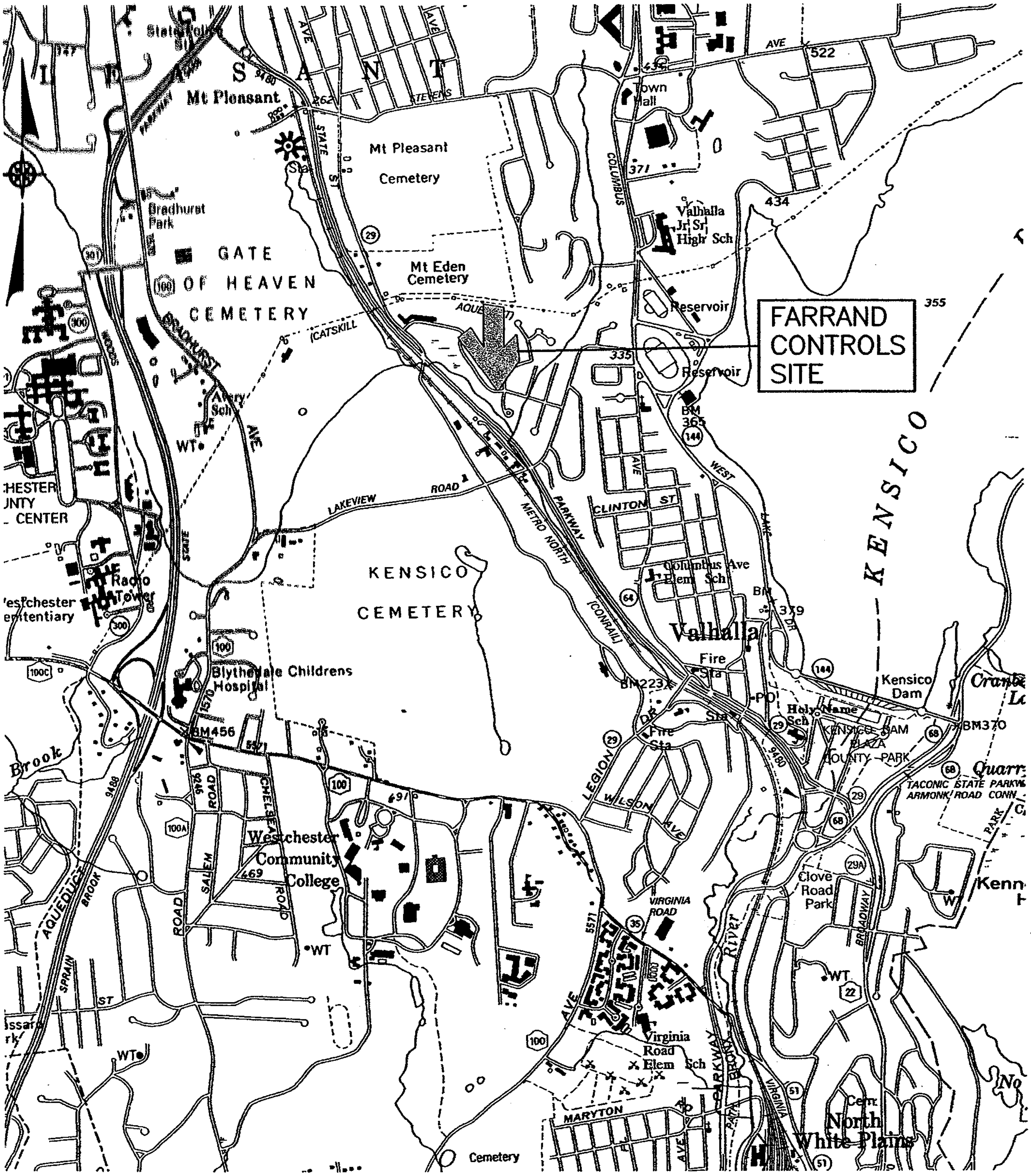
In an effort to optimize the scope and design of the remediation program at the site, a pre-design investigation and a pilot test involving in-situ subsurface reductive chlorination using zero-valent iron injection were conducted. Subsequent to the receipt and evaluation of the pilot test results, a post pilot test investigation was conducted to aid in the interpretation of the pilot test data.

This Pre-Design Investigation Report provides the results of these investigations. The remainder of this report is organized as follows:

- Section 2.0 - presents the scope of work and data collected during the pre-design site investigation;

Figure 1-1

Site Location Map



SOURCE: USGS WHITE PLAINS, QUADRANGLES

0 2000'
SCALE IN FEET

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FARRAND CONTROLS SITE
VALHALLA, NEW YORK

SITE LOCATION MAP

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FIGURE 1-1

- Section 3.0 - provides the findings of the pilot test and presents soil and groundwater data collected during the post pilot test investigation; and

- Section 4.0 - presents a summary of all of the investigation and pilot test findings.

2.0 PRE-DESIGN INVESTIGATION

The pre-design investigation at the Farrand Controls Site was conducted by D&B in December 2004. A map of the site is provided on Figure 2-1. The specific objectives of that investigation were to: locate physical features and property boundaries; locate site utilities; determine the extent of contaminated soil near the storm drain east of the northeast corner of the main site building; update groundwater quality data to define the plume(s); and evaluate indoor air and subslab soil vapor at on-site facility buildings and in nearby residences.

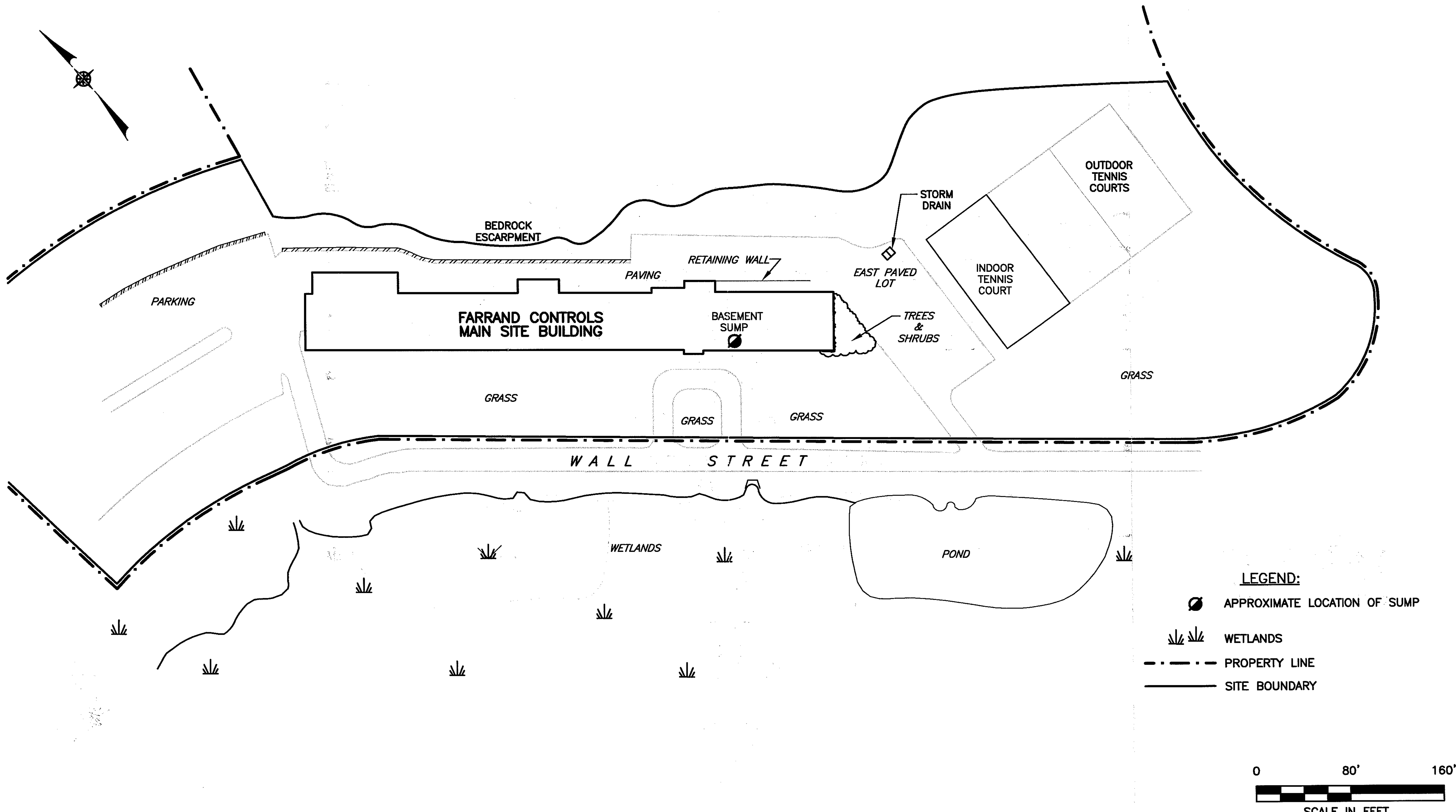
The pre-design investigation activities included: a physical features and property boundary survey; a geophysical survey; on-site soil sampling, on-site groundwater sampling, off-site private well sampling; and facility and off-site indoor air and building subslab soil vapor sampling. The scope and findings of each element of the investigation programs are provided below. These tasks were generally conducted consistent with the Remedial Design Project Work Plan, dated October 2004, with modifications noted in the sections below.

2.1 Physical Features and Property Survey

D&B retained YEC, Inc., of Valley Cottage, New York, a licensed New York State land surveyor, to prepare the physical features and property boundary survey. The survey, completed in March 2005, established property lines for the site, easements and rights-of-way, lot and block numbers, and names and addresses of current adjacent property owners. The survey also mapped identified locations of buried utilities (further described in Section 2.2) and the locations and dimensions of site structures. The map derived from this survey is provided in Appendix A.

2.2 Utility Location Survey

To conduct the utility location survey, D&B retained and supervised Hager-Richter Geophysical Sciences, Inc., (Hager-Richter) Salem, New Hampshire, a geophysical subconsultant. The survey was conducted in December 2004 and January 2005 and while it



SOURCE: GZA GEOENVIRONMENTAL, INC. MAY 1993

F:\2276\Pre-Design Investigation\2276-Fig 2-1.dwg, 03/10/06 12:10:22 PM, FDeVita

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FARRAND CONTROLS SITE
PRE-DESIGN INVESTIGATION REPORT

SITE PLAN

FIGURE 2-1

addressed the overall site, it primarily focused on locating utilities within the areas of pre-design investigation sampling points, and planned soil and groundwater remediation.

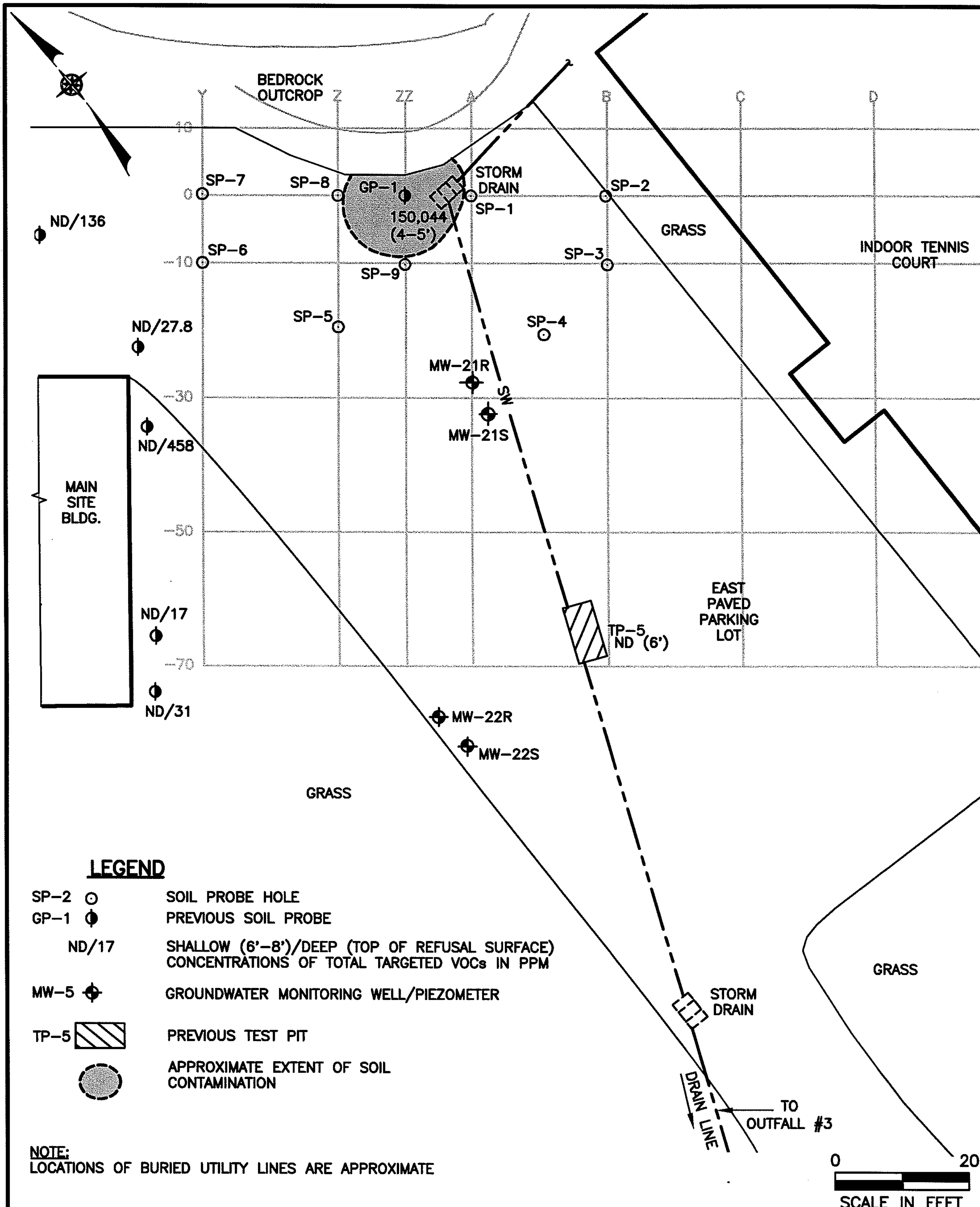
The utility survey was conducted using electromagnetic pipe and cable locating equipment along with ground penetrating radar. The surface traces of buried utilities were marked out in the field and transposed onto a base map of the site. The details of the survey are presented in Hager-Richter's report provided in Appendix B and the findings are depicted on Plate 1 of the report.

To augment the buried utility data collected as part of this task, attempts were also made to uncover utility conduits at specific locations to obtain information regarding conduit type, depth, diameter, and backfill material type. The excavation activities were conducted by Zebra Environmental Corporation, Lynbrook, New York, in January 2004 using a vacuum truck and a portable hand auger. The success of these exploratory excavations was limited due to the depths of the utilities. The information regarding the buried utilities at the site is summarized in Table B1 of Appendix B. Photographs showing utility features, as well as site features and a photographic index, are also presented in Appendix B.

2.3 Extent of Soil Contamination

Elevated levels of contaminants were previously identified in soil in a localized area of the site as part of the Feasibility Study Support Investigation conducted in April 2001. In a Geoprobe test hole (GP-1), located adjacent to the storm drain in the east paved lot, 150,044 ug/kg of 1,1,2-trichloro-1,2,2-trifluoroethane (Freon 113) was detected in the 4 to 5-foot horizon below grade.

In December 2004, in an effort to determine the extent of soil contamination in the vicinity of the storm drain, nine Geoprobe holes were advanced to bedrock in a grid pattern of 10- and 20-foot transects extending outward from GP-1, as shown in Figure 2-2. Soil samples in each probe hole were collected at continuous intervals to determine the lithology and investigate



FARRAND CONTROLS SITE
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LOCATIONS OF SOIL PROBE HOLES IN EAST PAVED LOT

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FIGURE 2-2

potential contaminant impacts (e.g., odor, staining). Each sample was screened with a photoionization detector (PID), examined and logged in detail.

Since none of the soil samples exhibited elevated PID responses or other indications of being impacted (e.g., staining or odor), the 6-inch interval near the water table and directly above the bedrock in each probe hole were collected for laboratory analysis. The samples were analyzed by Mitkem Corporation, Warwick, Rhode Island, for the eight site-specific chlorinated volatile organic compounds (VOCs) and Freon 113 breakdown products[1]. The analytical results of the soil samples are summarized in Table 2-1, and logs of the probe holes are provided in Appendix C.

Based on the soil sample results and assuming an average depth to bedrock of approximately 10 feet, the volume of impacted soil is less than 110 cubic yards.

2.4 Groundwater Occurrence and Flow

A synoptic set of water level measurements was collected from the monitoring wells and piezometers located at the site on December 16, 2004. The depth to water, measuring point elevation and calculated groundwater elevation for each well is provided in Table 2-2. A water table contour map generated from this data is provided as Figure 2-3.

The water levels collected during the pre-design investigation were generally similar to the levels collected from the monitoring network during previous investigations. The levels ranged between approximately 2 and 10 feet below grade, generally being deepest in the vicinity of the main site building and shallowest in the vicinity of the pond/wetland.

The December 16, 2004 water table map depicts a fairly steep gradient to the south across the northwestern area of the site of approximately 5 percent. Across the remainder of the site, the

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[1] 1,1-dichloroethene, 1,1-dichloroethane, cis-1,2-dichloroethene, trans-1,2-dichloroethene, 1,1,1-trichloroethane, trichloroethene, 1,1,2-trichloro-1,2,2-trifluoroethane (Freon 113) and vinyl chloride, and Freon 113 breakdown products 1,2-dichloro-1,1,2-trichloroethane and dichlorodifluoromethane.

Table 2-1

FARRAND CONTROLS SITE
PRE-DESIGN INVESTIGATION REPORT
SOIL PROBE HOLE ANALYTICAL RESULTS

SAMPLE ID	SP-1	SP-1	SP-2	SP-2	SP-3	SP-3	Contract Required Detection Limit	NYSDEC TAGM 4046 Recommended Soil Cleanup Objectives
SAMPLE DEPTH, FT	3.5-4	4-4.5	8-8.5	9-9.5	5.5-6	6.5-7		
DATE OF COLLECTION	12/28/2004	12/28/2004	12/28/2004	12/28/2004	12/28/2004	12/28/2004		
DILUTION FACTOR	1	1	1	1	1	1		
PERCENT SOLIDS	84	87	89	86	88	90		
UNITS	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg
Dichlorodifluoromethane	U	U	U	U	U	U	10	----
Vinyl Chloride	U	U	U	U	U	U	10	200
1,1-Dichloroethene	U	U	U	U	U	U	10	400
1,1,2-Trichloro-1,2,2-trifluoroethane	U	U	U	U	U	U	10	6,000
trans-1,2-Dichloroethene	U	U	U	U	U	U	10	300
1,1-Dichloroethane	U	U	U	U	U	U	10	200
cis-1,2-Dichloroethene	U	U	U	U	U	U	10	----
1,1,1-Trichloroethane	U	U	U	U	U	U	10	800
Trichloroethene	U	10 J	U	U	U	U	10	700
1,2-dichloro-1,1,2-trifluoroethane	U	U	U	U	U	U	10	----
Total	0	10	0	0	0	0		

SAMPLE ID	SP-4	SP-4	SP-5	SP-5	SP-6	SP-6	Contract Required Detection Limit	NYSDEC TAGM 4046 Recommended Soil Cleanup Objectives
SAMPLE DEPTH, FT	8-8.5	18.5-19	7.5-8	21.5-22	9.5-10	16.5-17		
DATE OF COLLECTION	12/28/2004	12/28/2004	12/28/2004	12/28/2004	12/28/2004	12/28/2004		
DILUTION FACTOR	1	1	1	1	1	1		
PERCENT SOLIDS	86	89	90	93	87	88		
UNITS	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg
Dichlorodifluoromethane	U	U	U	U	U	U	10	----
Vinyl Chloride	U	U	U	U	U	U	10	200
1,1-Dichloroethene	U	U	U	U	U	U	10	400
1,1,2-Trichloro-1,2,2-trifluoroethane	U	U	U	U	U	U	10	6,000
trans-1,2-Dichloroethene	U	U	U	U	U	U	10	300
1,1-Dichloroethane	U	U	U	U	U	U	10	200
cis-1,2-Dichloroethene	U	U	U	U	U	U	10	----
1,1,1-Trichloroethane	U	U	U	2 J	U	U	10	800
Trichloroethene	U	U	U	1 J	U	U	10	700
1,2-dichloro-1,1,2-trifluoroethane	U	U	U	U	U	U	10	----
Total	0	0	0	3	0	0		

Qualifiers
U: Compound analyzed for but not detected
J: Compound detected at a concentration below CRDL, value estimate

Notes
----: Not established

Table 2-1

FARRAND CONTROLS SITI
PRE-DESIGN INVESTIGATION REPORI
SOIL PROBE HOLE ANALYTICAL RESULTS

SAMPLE ID	SP-7	SP-7	SP-8	SP-8	SP-9	SP-9	Contract Required Detection Limit	NYSDEC TAGM 4046 Recommended Soil Cleanup Objectives
SAMPLE DEPTH, FT	6-6.5	11-11.5	0.5-1	2.5-3	6.5-7	13.5-14		
DATE OF COLLECTION	12/28/2004	12/28/2004	12/28/2004	12/28/2004	12/28/2004	12/28/2004		
DILUTION FACTOR	1	1	1	1	1	1		
PERCENT SOLIDS	88	83	87	89	85	93		
UNITS	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg
Dichlorodifluoromethane	U	U	U	U	U	U	10	----
Vinyl Chloride	U	U	U	U	U	U	10	200
1,1-Dichloroethene	U	U	U	U	U	U	10	400
1,1,2-Trichloro-1,2,2-trifluoroethane	U	U	U	U	U	U	10	6,000
trans-1,2-Dichloroethene	U	U	U	U	U	U	10	300
1,1-Dichloroethane	U	U	U	U	U	U	10	200
cis-1,2-Dichloroethene	U	U	U	U	U	U	10	----
1,1,1-Trichloroethane	U	U	U	U	U	2 J	10	800
Trichloroethene	U	U	3 J	5 J	U	2 J	10	700
1,2-dichloro-1,1,2-trifluoroethane	U	U	U	U	U	U	10	----
Total	0	0	3	5	0	4		

Qualifiers
U: Compound analyzed for but not detected
J: Compound detected at a concentration below CRDL, value estimate

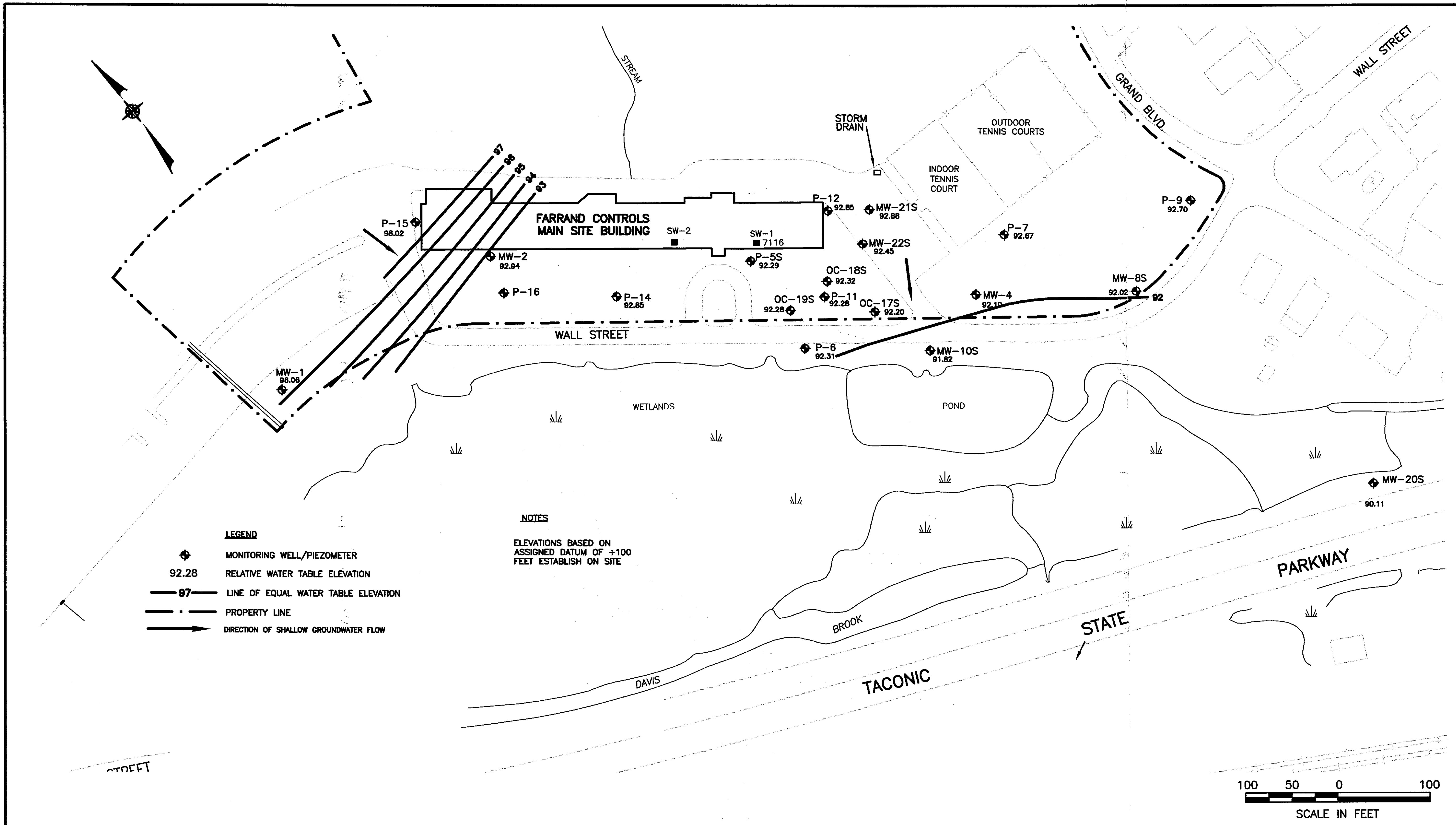
Notes
----: Not established

Table 2-2

FARRAND CONTROLS SITE
PRE-DESIGN INVESTIGATION REPORT
GROUNDWATER ELEVATION DATA

		12/13/2005		
Monitoring Well	**Measuring Point Elevation (feet) (1)**	**Depth To Water (Feet)**	**Groundwater Elevation (Feet)**	**Net Head Difference* (feet)**
MW-1	98.26	2.20	96.06	
MW-2	103.73	10.79	92.94	
MW-3	103.07	Removed	-	
MW-4	97.45	5.35	92.10	
P-5 S	102.65	10.36	92.29	
P-5 I	102.72	10.27	92.45	
P-5 D	102.60	10.39	92.21	+0.08
P-6	95.20	2.89	92.31	
P-7	103.14	10.47	92.67	
MW-8 S	98.96	6.94	92.02	
MW-8 D	97.25	4.81	92.44	
MW-8 R	97.44	5.06	92.38	-0.36
P-9	100.24	7.54	92.70	
MW-10 S	98.19	6.37	91.82	
MW-10 D	95.89	3.54	92.35	
MW-10 R	96.48	4.02	92.46	-0.64
P-11	99.13	6.85	92.28	
P-12	104.10	11.25	92.85	
P-13	100.84	Destroyed	-	
P-14	99.40	6.55	92.85	
P-15	104.18	6.16	98.02	
P-16	100.42	6.88	93.54	
OC-17 S	97.86	5.66	92.20	
OC-17 D	98.07	5.81	92.26	
OC-18 S	100.23	7.91	92.32	
OC-18 D	100.24	7.91	92.33	
OC-19 S	98.48	6.20	92.28	
OC-19 D	98.67	6.31	92.36	
MW-20 S	94.31	4.20	90.11	
MW-20 D	94.40	2.55	91.85	
MW- 20 R	94.19	2.40	91.79	-1.60
MW-21 S	99.49	6.61	92.88	
MW-21 R	99.70	6.75	92.95	-0.07
MW-22 S	98.09	5.64	92.45	
MW-22 R	98.55	6.03	92.52	-0.07

(1): Relative to front lawn hydrant set at level of 100.00'
*:Negative net hydraulic head indicates upwards flow while positive head indicates downward flow between shallow wells, and deep overburden rock wells.
S: Shallow
I: Intermediate
D: Deep
R: Rock



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FARRAND CONTROLS SITE
PRE-DESIGN INVESTIGATION REPORT

WATER TABLE CONTOUR MAP
DECEMBER 16, 2004

FIGURE 2-3

\\N\4\CADwork\2276\Pre-Design Investigation\2276-Fig 2-3.dwg, Layout1, 03/13/06 02:37:20 PM, FDeVita gradient flattens and varies between approximately 0.2 and 0.3 percent. The flow direction over this portion of the property changes from south to southwesterly. In the areas of primary concern (greatest groundwater contamination in the eastern portion of the site), groundwater flow is to the southwest towards the pond/wetland.

Net vertical flow components between shallow overburden, and deep overburden and bedrock wells were also similar to past investigation findings. Net head differences between wells within clusters are included in Table 2-2. A slight net downward component of flow was present in the vicinity of the main site building (+0.08 feet at well cluster 5). A strong net upward component of flow was present near the pond (-0.64 feet at cluster 10). The differential hydraulic heads support previous findings that groundwater flow is slightly downward beneath the vicinity of the on-site building and then proceeds upward towards the southwest indicating ultimate discharge into the pond/wetland.

2.5 Groundwater Quality

To establish updated baseline groundwater quality data, groundwater samples were collected from all site monitoring wells and piezometers, basement sumps located in the on-site building and downgradient private wells in December 2004. The sumps intersect the water table aquifer and consist of a formerly contaminated basement sump (SW-1) in the eastern portion of the facility's building basement, and a sump (SW-2) in an adjoining office to the west. SW-1 received chlorinated VOCs from facility operations and SW-2 is located approximately 50 feet west of SW-1.

The groundwater samples were analyzed for the site-specific VOCs. Specific on-site wells were also sampled and analyzed for selected parameters to evaluate the effectiveness of the pilot test and are discussed in Section 3.3.

2.5.1 Site Groundwater

The site groundwater monitoring network, including 33 wells and piezometers, and the two basement sumps were sampled between December 13 and 15, 2004. The analytical results are provided in Table 2-3.

The distribution of the total site-specific VOCs is provided in the shallow overburden and deep overburden/bedrock units depicted on Figures 2-4 and 2-5, respectively. The presence and extent of contamination in the site groundwater is similar to the previous sampling results from the Feasibility Study Support Investigation.

It is important to note that two wells are no longer in existence on the property. MW-3 was abandoned as part of an interim remedial measure as directed in the ROD because it intersected a site drainage pipe reportedly associated with main building basement sump, and P-13 was destroyed by vehicular traffic.

The plume map depicting total site-specific VOC concentrations in the shallow overburden continues to show two separate plumes (Figure 2-4). A western plume continues to emanate from the vicinity of the eastern basement sump (SW-1) with a maximum total targeted VOC concentration of 7,182 ug/l. The apparent downgradient edge of the plume is near the site boundary at Wall Street. An eastern plume appears to emanate from the storm drain in the paved lot east of the main building (maximum targeted VOC concentration of 2,742 ug/l in MW-21S) and extends to the southern site boundary, similar to the western plume.

As the contamination migrates downward with groundwater in the deep overburden, the groundwater plumes appears to commingle into a single plume that laterally encompasses the eastern end of the building from the eastern basement sump through the paved lot east of the main site building. The plume's maximum detected site-specific total VOC concentration of 60,725 ug/l occurs in bedrock well MW-21R and continues off-site adjacent to the pond where the total VOC concentrations were 1,674 ug/l and 4,025 ug/l at well cluster 10, in the deep overburden and bedrock, respectively.

Table 2-3

FARRAND CONTROLS SITE
PRE-DESIGN INVESTIGATION REPORT
GROUNDWATER SAMPLING PROGRAM RESULTS

SAMPLE ID DATE OF COLLECTION DILUTION FACTOR UNITS	MW-1 12/14/2004 1 ug/l	MW-2 12/14/2004 1 ug/l	MW-4 12/13/2004 1 ug/l	MW-8S 12/13/2004 1 ug/l	MW-08D 12/14/2004 1 ug/l	MW-8R 12/15/2004 1 ug/l	MW-10S 12/14/2004 1 ug/l	Required Detection Limit	Groundwater Standard Guidance Value
Dichlorodifluoromethane	U	U	U	U	U	U	U	10	5 ST
Vinyl Chloride	U	U	U	U	U	U	U	10	2 ST
1,1-Dichloroethene	U	U	U	U	U	U	U	10	5 ST
1,1,2-Trichloro-1,2,2-trifluoroethane	2 J	U	U	U	U	**6 JB**	U	10	5 ST
trans-1,2-Dichloroethene	U	U	U	U	U	U	U	10	5 ST
1,1-Dichloroethane	U	U	U	U	1 J	4 J	U	10	5 ST
cis-1,2-Dichloroethene	U	U	U	U	U	U	U	10	5 ST
1,1,1-Trichloroethane	U	U	U	U	U	U	U	10	5 ST
Trichloroethene	U	U	1 J	U	2 J	1 J	U	10	5 ST
1,2-dichloro-1,1,2-trifluoroethane	U	U	U	U	U	U	U	10	----
Total	**2**	**0**	**1**	**0**	**3**	**11**	**0**		

SAMPLE ID DATE OF COLLECTION DILUTION FACTOR UNITS	MW-10D 12/15/2004 1/10 ug/l	MW-10R 12/15/2004 1/20 ug/l	MW-20S 12/16/2004 1 ug/l	MW-20D 12/16/2004 1 ug/l	MW-20R 12/16/2004 1 ug/l	MW-21S 12/15/2004 1/25 ug/l	MW-21R 12/15/2004 1/200 ug/l	Contract Required Detection Limit	NYSDEC Class GA Groundwater Standard Guidance Value
Dichlorodifluoromethane	**16**	**310 D**	U	U	U	U	U	10	5 ST
Vinyl Chloride	**10**	**9 J**	**12**	U	U	U	**3 J**	10	2 ST
1,1-Dichloroethene	U	U	**6 J**	1 J	U	U	U	10	5 ST
1,1,2-Trichloro-1,2,2-trifluoroethane	**820 DB**	**1,500 DB**	U	U	U	**2,100 DB**	**34,000 DB**	10	5 ST
trans-1,2-Dichloroethene	U	2 J	U	U	U	U	3 J	10	5 ST
1,1-Dichloroethane	**40**	**360 D**	**24**	2 J	U	**9 J**	**370 DJ**	10	5 ST
cis-1,2-Dichloroethene	**100**	**84**	**33**	3 J	U	2 J	**9 J**	10	5 ST
1,1,1-Trichloroethane	**410 D**	**390 D**	U	U	U	**470 DB**	**19,000 D**	10	5 ST
Trichloroethene	**260 D**	**1,000 D**	2 J	**29**	U	**150**	**7,200 D**	10	5 ST
1,2-dichloro-1,1,2-trifluoroethane	18 J	370 J	8 J	U	U	11 J	140 J	10	----
Total	**1,674**	**4,025**	**85**	**35**	**0**	**2,742**	**60,725**		

Qualifiers
U: Compound analyzed for but not detected
J: Compound detected at a concentration below CRDL, value estimated
E: Concentration exceeds instrument calibration range, value estimated
D: Result taken from reanalysis at a secondary dilution

Notes
ST: Standard
----: Not established
[box]: Result exceeds NYSDEC Class GA Groundwater Standard

Table 2-3

FARRAND CONTROLS SITE
PRE-DESIGN INVESTIGATION REPORT
GROUNDWATER SAMPLING PROGRAM RESULTS

SAMPLE ID DATE OF COLLECTION DILUTION FACTOR UNITS	MW-22S 12/15/2004 4 ug/l	MW-22R 12/15/2004 1 ug/l	OC-17S 12/13/2004 1 ug/l	OC-17D 12/13/2004 1 ug/l	OC-18S 12/13/2004 1 ug/l	OC-18D 12/13/2004 1 ug/l	OC-19S 12/13/2004 1 ug/l	Contract Required Detection Limit	NYSDEC Class GA Groundwater Standard Guidance Value
Dichlorodifluoromethane	U	**190 DJ**	U	**20**	U	**43**	U	10	5 ST
Vinyl Chloride	U	**4 J**	U	**10**	U	U	U	10	2 ST
1,1-Dichloroethene	U	U	**28**	**130**	**56**	**190**	2 J	10	5 ST
1,1,2-Trichloro-1,2,2-trifluoroethane	**400**	**13,000 DB**	**39**	**2,100 D**	**370 D**	**4,300 D**	**28**	10	5 ST
trans-1,2-Dichloroethene	U	4 J	U	1 J	U	U	U	10	5 ST
1,1-Dichloroethane	**13 J**	**540 DJ**	**10**	**81**	**18**	**140**	5 J	10	5 ST
cis-1,2-Dichloroethene	U	**22**	**9 J**	**130**	1 J	5 J	**15**	10	5 ST
1,1,1-Trichloroethane	**180**	**8,900 D**	**500 E**	**1,100 D**	**310 D**	**1,800 D**	**7 J**	10	5 ST
Trichloroethene	**110**	**5,200 D**	**110**	**730 D**	**180 D**	**1,100 D**	**11**	10	5 ST
1,2-dichloro-1,1,2-trifluoroethane	U	210 J	U	32 J	U	66 J	U	10	----
Total	**703**	**28,070**	**696**	**4,334**	**935**	**7,644**	**68**		

SAMPLE ID DATE OF COLLECTION DILUTION FACTOR UNITS	OC-19D 12/13/2004 1 ug/l	P-5S 12/14/2004 1 ug/l	P-5I 12/14/2004 1 ug/l	P-5D 12/14/2004 1/20 ug/l	P-6 12/14/2004 1 ug/l	P-7 12/13/2004 1 ug/l	P-9 12/13/2004 1 ug/l	Contract Required Detection Limit	NYSDEC Class GA Groundwater Standard Guidance Value
Dichlorodifluoromethane	U	U	U	**25**	U	U	U	10	5 ST
Vinyl Chloride	U	U	2 J	**3 J**	U	U	U	10	2 ST
1,1-Dichloroethene	U	U	U	U	U	3 J	U	10	5 ST
1,1,2-Trichloro-1,2,2-trifluoroethane	**2,000 D**	U	U	**2,000 D**	U	**17**	U	10	5 ST
trans-1,2-Dichloroethene	U	U	U	U	U	U	U	10	5 ST
1,1-Dichloroethane	**140**	2 J	4 J	**72**	U	**8 J**	U	10	5 ST
cis-1,2-Dichloroethene	**6 J**	**12**	**31**	**47**	U	U	U	10	5 ST
1,1,1-Trichloroethane	**1,500 D**	U	2 J	**760 D**	U	U	U	10	5 ST
Trichloroethene	**830 D**	**17**	**30**	**570 D**	U	**16**	U	10	5 ST
1,2-dichloro-1,1,2-trifluoroethane	58	U	U	37 J	U	U	U	10	----
Total	**4,534**	**31**	**69**	**3,514**	**0**	**44**	**0**		

Qualifiers
U: Compound analyzed for but not detected
J: Compound detected at a concentration below CRDL, value estimated
E: Concentration exceeds instrument calibration range, value estimated
D: Result taken from reanalysis at a secondary dilution

Notes
ST: Standard
----: Not established
[box]: Result exceeds NYSDEC Class GA Groundwater Standard

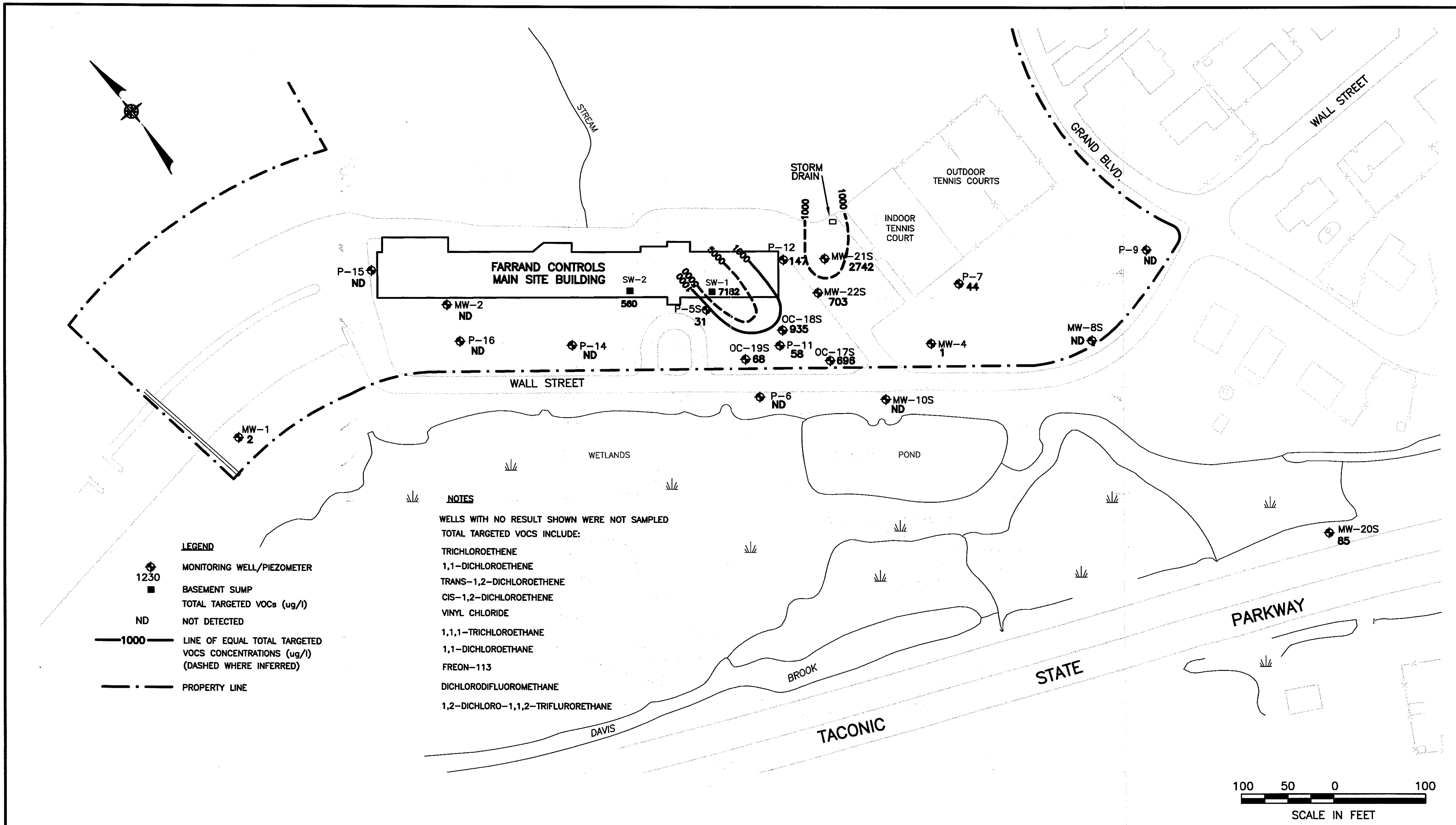
Table 2-3

FARRAND CONTROLS SITE
PRE-DESIGN INVESTIGATION REPORT
GROUNDWATER SAMPLING PROGRAM RESULTS

SAMPLE ID DATE OF COLLECTION DILUTION FACTOR UNITS	P-11 12/13/2004 1 ug/l	P-12 12/13/2004 1 ug/l	P-14 12/14/2004 1 ug/l	P-15 12/14/2004 1 ug/l	P-16 12/14/2004 1 ug/l	SW-1 12/14/2004 1/30 ug/l	SW-2 12/14/2004 1/2 ug/l	Contract Required Detection Limit	NYSDEC Class GA Groundwater Standard Guidance Value
Dichlorodifluoromethane	U	U	U	U	U	U	U	10	5 ST
Vinyl Chloride	U	U	U	U	U	**6 J**	**5 J**	10	2 ST
1,1-Dichloroethene	U	U	U	U	U	**170**	**17**	10	5 ST
1,1,2-Trichloro-1,2,2-trifluoroethane	**15**	**85**	U	U	U	**1,400 D**	**55**	10	5 ST
trans-1,2-Dichloroethene	U	U	U	U	U	U	U	10	5 ST
1,1-Dichloroethane	1 J	2 J	U	U	U	**470 D**	**23**	10	5 ST
cis-1,2-Dichloroethene	U	1 J	U	U	U	**170**	**120**	10	5 ST
1,1,1-Trichloroethane	**23**	**44**	U	U	U	**3,800 D**	**150**	10	5 ST
Trichloroethene	**19**	**15**	U	U	U	**1,100 D**	**190 D**	10	5 ST
1,2-dichloro-1,1,2-trifluoroethane	U	U	U	U	U	**66 J**	U	10	----
Total	**58**	**147**	**0**	**0**	**0**	**7,182**	**560**		

Qualifiers
U: Compound analyzed for but not detected
J: Compound detected at a concentration below CRDL, value estimated
E: Concentration exceeds instrument calibration range, value estimated
D: Result taken from reanalysis at a secondary dilution

Notes
ST: Standard
----: Not established
[box]: Result exceeds NYSDEC Class GA Groundwater Standard



FARRAND CONTROLS SITE
PRE-DESIGN INVESTIGATION REPORT

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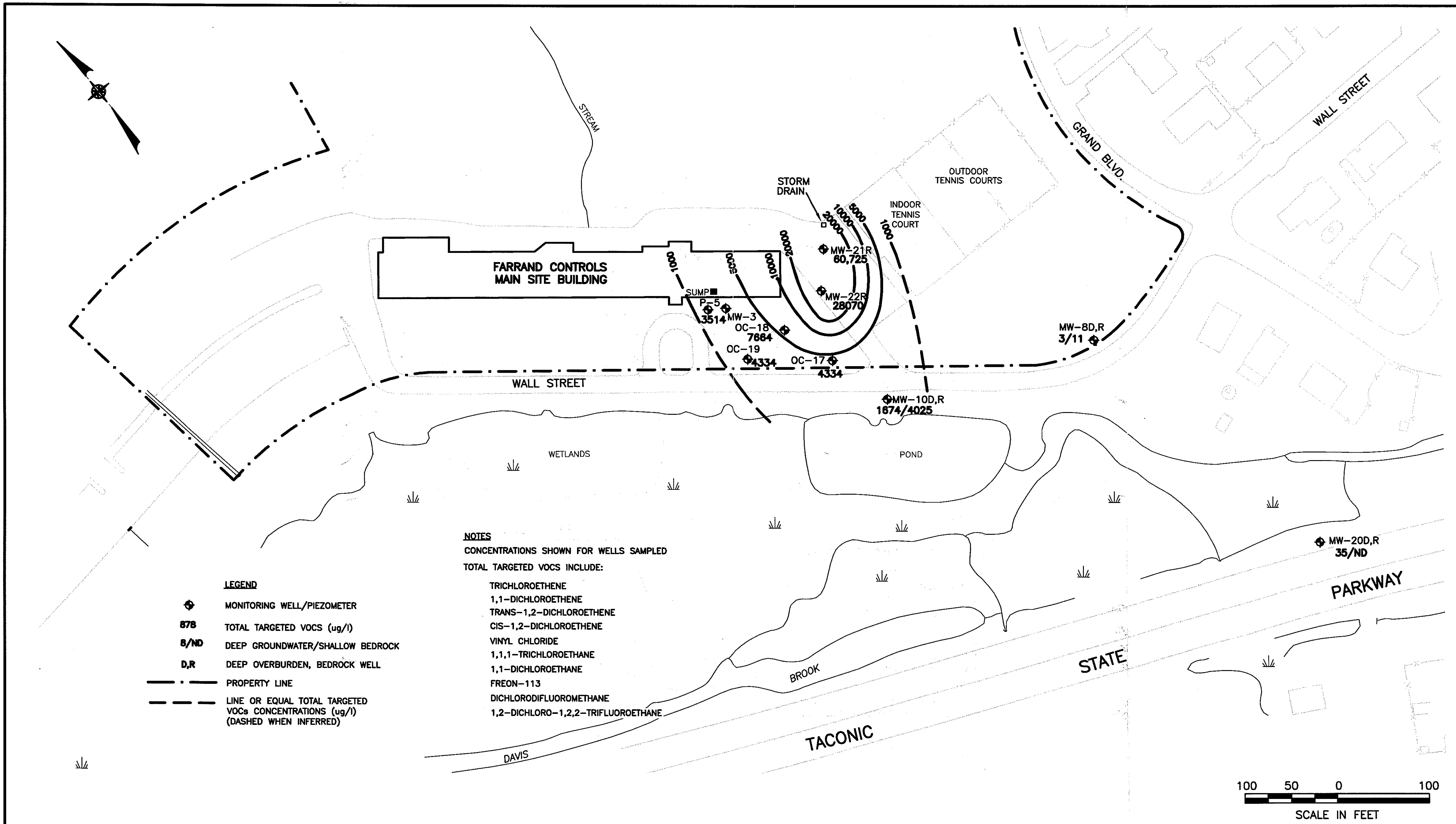
TOTAL TARGETED VOC CONCENTRATIONS IN SHALLOW OVERBURDEN GROUNDWATER

FIGURE 2-4



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FARRAND CONTROLS SITE
PRE-DESIGN INVESTIGATION REPORT

TOTAL TARGETED VOC CONCENTRATIONS IN DEEP OVERBURDEN GROUNDWATER AND BEDROCK

FIGURE 2-5

\\N4\CADwork\2276\Pre-Design Investigation\2276-Fig 2-5.dwg, Layout1, 03/13/06 01:38:07 PM, FDeVita

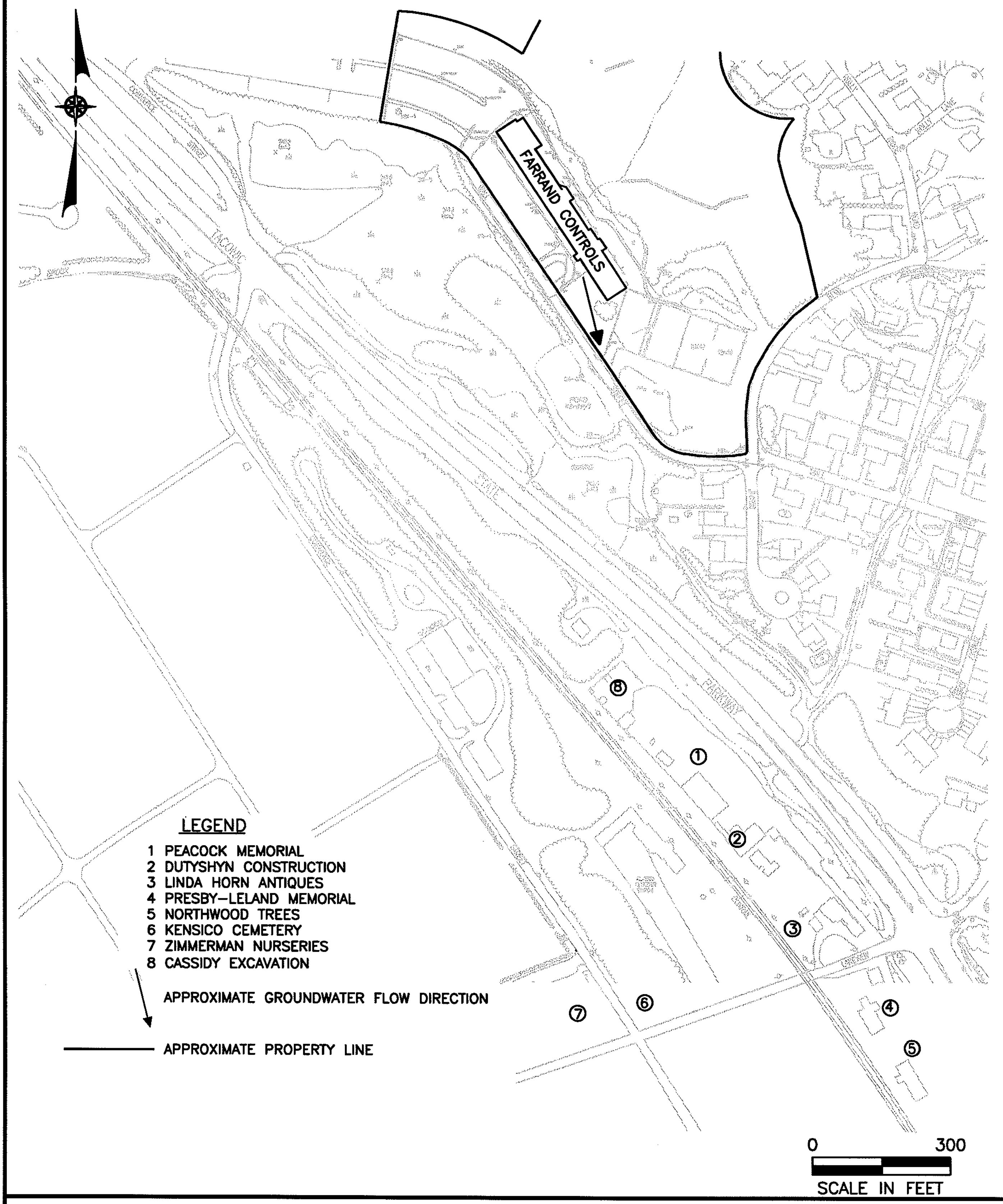
Relative to the previous groundwater results (April, 2001) the shallow VOC plumes are lower in concentrations by between approximately 50 and 90 percent (from 5,520 ug/l to 2,742 ug/l in MW-21S, and from 6,230 ug/l to 703 ug/l in MW-22S). The concentrations of the VOCs in the bedrock wells are approximately twice as high in the latest sampling round.

As Table 2-3 shows, Freon 113 is the primary site-specific VOC in each of the site plumes, accounting for approximately 50 percent of the total VOC concentrations. Two other VOCs (trichloroethene and 1,1,1-trichloroethane) comprise the majority of the remaining site VOC concentrations.

The Freon 113 breakdown products including dichlorofluoromethane and 1,2-dichloro-1,2,2-trichloroethane are present primarily in the deep overburden and bedrock wells at combined concentrations of 62 ug/l in P-5D and 140 ug/l in MW-21R in the wells near the suspected sources areas (the east basement sump and storm drain in the northern portion of the east paved lot, respectively). The combined concentrations of these breakdown products are highest in off-site well cluster 10, adjacent to the pond, where the combined concentration was 680 ug/l in MW-10R. The breakdown product concentrations comprise approximately 15 percent of the total VOC concentration in the downgradient area of cluster 10.

2.5.2 Off-site Private Potable Water Supply Wells

Eight private potable water supply wells, identified as the nearest downgradient private wells from the site, were sampled between December 13 and 16, 2004 and analyzed for the same parameters as the site groundwater monitoring network. The locations of the wells and identified property owners are shown on Figure 2-6, and the analytical results are provided in Table 2-4. Only one compound, Freon 113, was detected and in one sample, Kensico Cemetery, at an estimated concentration of 1 ug/l, below the groundwater standard of 5 ug/l.



FARRAND CONTROLS SITE
PRE-DESIGN INVESTIGATION REPORT

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APPROXIMATE LOCATIONS OF PRIVATE WELLS

FIGURE 2-6

F:\2276\Pre-Design Investigation\2276-Fig 2-6.dwg, 03/10/06 11:26:33 AM, FDeVita

Table 2-4

FARRAND CONTROLS SITE
PRE-DESIGN INVESTIGATION REPORT
PRIVATE WELL SAMPLING PROGRAM RESULTS

SAMPLE ID DATE OF COLLECTION DILUTION FACTOR UNITS	CASSIDY 12/16/04 1 ug/l	DUTYSHYN 12/13/04 1 ug/l	KENSICO 12/14/04 1 ug/l	LINDA HORN 12/16/04 1 ug/l	NORTH TREE 12/14/04 1 ug/l	PEACOCK MEMORIAL 12/13/04 1 ug/l	Contract Required Detection Limit	NYSDEC Class GA Groundwater Standard Guidance Value
Dichlorodifluoromethane	U	U	U	U	U	U	10	5 ST
Vinyl Chloride	U	U	U	U	U	U	10	2 ST
1,1-Dichloroethene	U	U	U	U	U	U	10	5 ST
1,1,2-Trichloro-1,2,2-trifluoroethane	U	U	1 J	U	U	U	10	5 ST
trans-1,2-Dichloroethene	U	U	U	U	U	U	10	5 ST
1,1-Dichloroethane	U	U	U	U	U	U	10	5 ST
cis-1,2-Dichloroethene	U	U	U	U	U	U	10	5 ST
1,1,1-Trichloroethane	U	U	U	U	U	U	10	5 ST
Trichloroethene	U	U	U	U	U	U	10	5 ST
1,2-dichloro-1,1,2-trifluoroethane	U	U	U	U	U	U	10	----
Total	0	0	1	0	0	0		

SAMPLE ID DATE OF COLLECTION DILUTION FACTOR UNITS	PRESBY-LELAND 12/13/04 1 ug/l	ZIMMERMAN 12/14/04 1 ug/l					Contract Required Detection Limit	NYSDEC Class GA Groundwater Standard Guidance Value
Dichlorodifluoromethane	U	U					10	5 ST
Vinyl Chloride	U	U					10	2 ST
1,1-Dichloroethene	U	U					10	5 ST
1,1,2-Trichloro-1,2,2-trifluoroethane	U	U					10	5 ST
trans-1,2-Dichloroethene	U	U					10	5 ST
1,1-Dichloroethane	U	U					10	5 ST
cis-1,2-Dichloroethene	U	U					10	5 ST
1,1,1-Trichloroethane	U	U					10	5 ST
Trichloroethene	U	U					10	5 ST
1,2-dichloro-1,1,2-trifluoroethane	U	U					10	----
Total	0	0						

Qualifiers
U: Compound analyzed for but not detected
J: Compound detected at a concentration below CRDL, value estimated
B: Compound found in method blank as well as the sample
E: Concentration exceeds instrument calibration range, value estimated
D: Result taken from reanalysis at a secondary dilution

Notes
ST: Standard
----: Not established
[ ]: Result exceeds NYSDEC Class GA Groundwater Standard

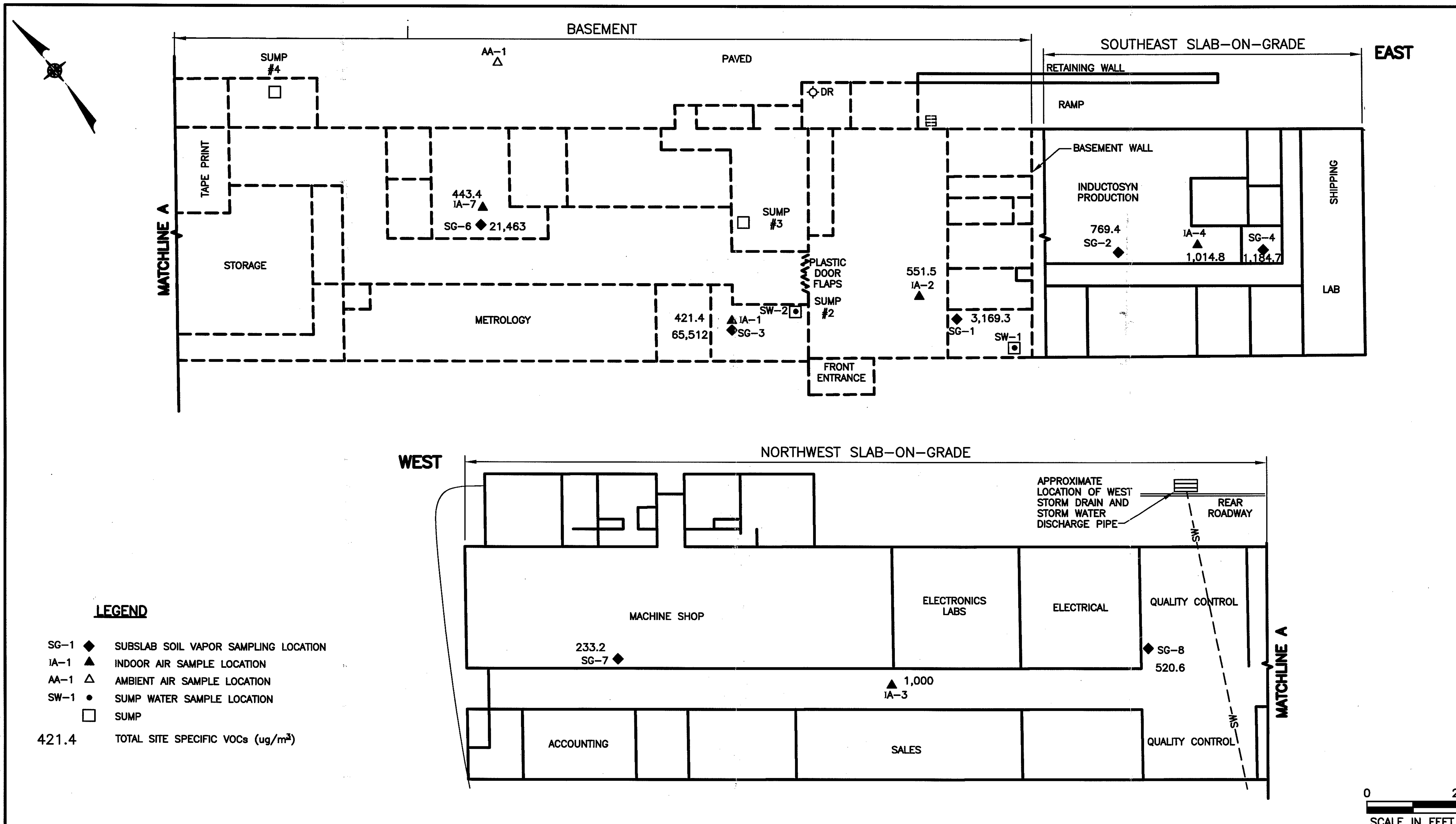
2.6 Indoor Air and Soil Vapor Quality

To investigate the quality of indoor air within buildings and soil vapor beneath building floor slabs, samples were collected at the site buildings and at nearby off-site residences. The samples were analyzed for the site-specific VOCs. The results of these sampling programs are provided below.

2.6.1 Facility Buildings

Eight indoor air and eight soil vapor samples were collected from the main building at the facility and the tennis court building on December 28 and 29, 2004. In addition to the indoor air and sub-slab vapor samples, an outside ambient air sample was collected to help identify any possible outside sources that may have had an impact on sample results. The locations of the sampling points were finalized in consultation with the New York State Department of Health (NYSDOH). The sampling locations for the main building are shown in Figure 2-7. The one pair of tennis court indoor air and subslab soil vapor samples was collected near the mid-point of, and approximately 15 feet from, the front building wall as depicted in Figure 2-8. The ambient air, indoor air and subslab soil vapor analytical results are provided in Table 2-5, and site-specific VOC total concentrations are included on Figure 2-7. The table presents the data in such a manner that the indoor air sample results correspond to the underlying subslab soil vapor sample locations. Inventories of products that were stored in building rooms during the sampling, as provided by facility personnel, are provided in Appendix D.

Of the compounds of concern identified for the site, NYSDOH has established soil vapor intrusion guidance values for only trichloroethene and 1,1,1-trichloroethane. These compounds are not presently used in manufacturing processes at the facility, therefore, the NYSDOH has determined that residential criteria are appropriate to use in the evaluation of potential indoor air impacts.



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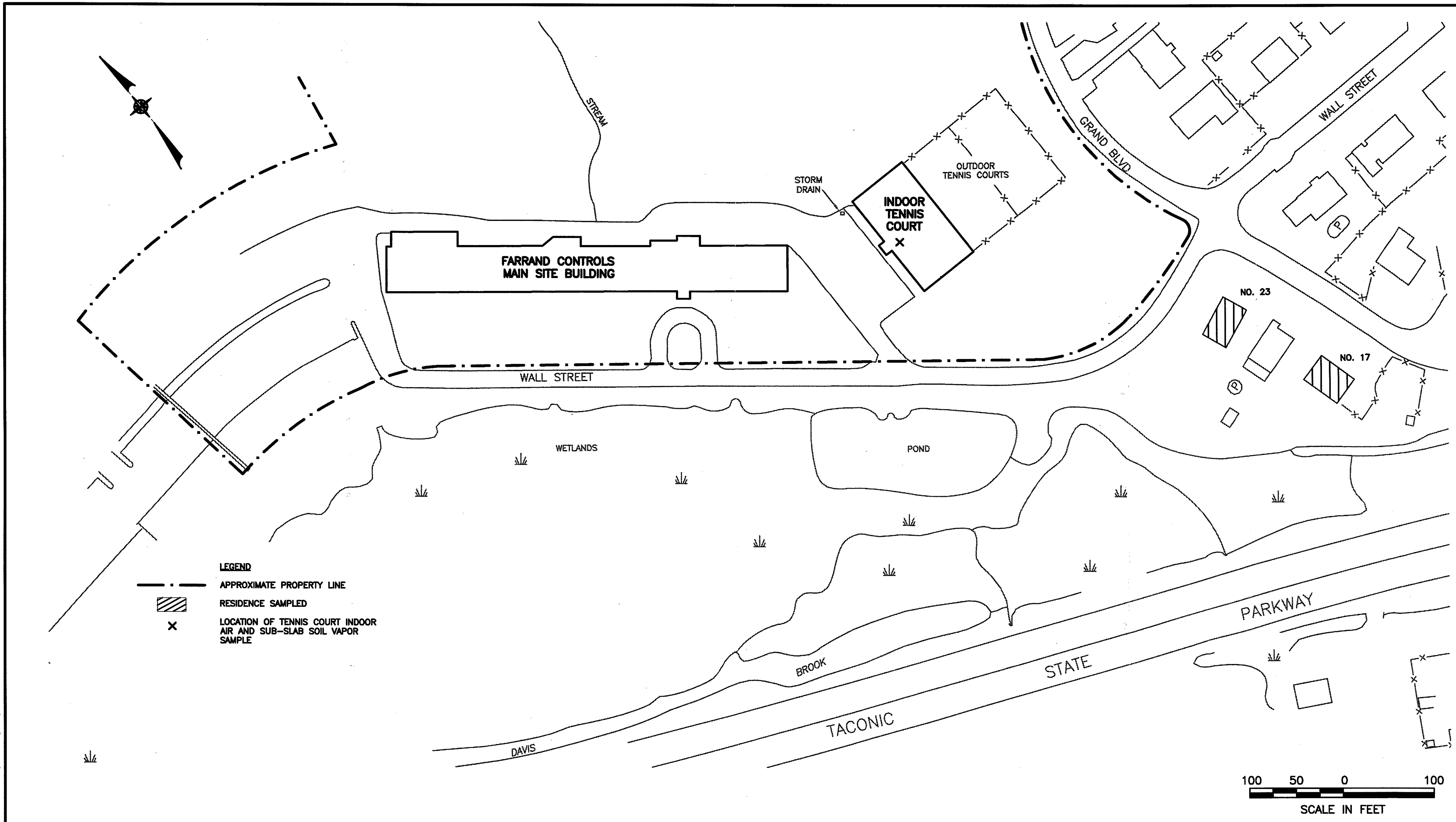
FARRAND CONTROLS SITE
PRE- DESIGN INVESTIGATION REPORT

MAIN BUILDING INDOOR AIR, SUBSLAB SOIL VAPOR AND BASEMENT SUMP SAMPLING RESULTS

FIGURE 2-7

F:\2276\Pre-Design Investigation\2276-Fig 2-7.dwg, Layout2, 03/27/07 10:28:29 AM, CMefford



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FARRAND CONTROLS SITE
PRE-DESIGN INVESTIGATION REPORT

LOCATIONS OF TENNIS COURT AND RESIDENTIAL INDOOR AIR AND SUBSLAB SOIL VAPOR SAMPLING POINTS

FIGURE 2-8

Table 2-5

FARRAND CONTROLS SITE
PRE-DESIGN INVESTIGATION REPORT
FACILITY INDOOR AIR AND SUBSLAB SOIL VAPOR SAMPLING PROGRAM RESULTS

	AMBIENT	MIKE'S OFFICE	MAIN SUMP	WEST 1ST FLOOR	EAST 1ST FLOOR	TENNIS COURT	WEST BASEMENT	
SAMPLE ID	AA-1	IA-1	IA-2	IA-3	IA-4	IA-6	IA-7	Reporting Limit
DATE OF COLLECTION	12/29/2004	12/29/2004	12/29/2004	12/29/2004	12/29/2004	12/28/2004	12/29/2004	
DILUTION FACTOR	1	2.09	1	1	1	1	2.34	
UNITS	ug/m³	ug/m³	ug/m³	ug/m³	ug/m³	ug/m³	ug/m³	ug/m³
Dichlorodifluoromethane	2.4	4.1	5.7	5.4 J	4.4	3.9	4.2	0.99
Vinyl Chloride	U	U	U	U	U	U	U	0.51
1,1-Dichloroethene	U	1.3 J	U	U	U	U	0.79 J	0.79
1,1,2-Trichloro-1,2,2-trifluoroethane	U	11.0	5.1 J	U	4.7 J	0.99 J	11	3.1
trans-1,2-Dichloroethene	6.8	350	500	990	1000	1.7	380	0.79
1,1-Dichloroethane	U	2.3	U	U	U	U	1.5 J	0.81
cis-1,2-Dichloroethene	U	7.7	U	U	U	U	6.9	0.79
1,1,1-Trichloroethane	U	27.0	33	U	U	U	26	1.1
Trichloroethene	U	18	7.7 J	4.6 J	5.7 J	U	13	1.1
1,2-dichloro-1,1,2-trifluoroethane	U	U	U	U	U	U	U	1
Total	**9.2**	**421.4**	**551.5**	**1,000.0**	**1,014.8**	**6.59**	**443.4**	

SAMPLE ID		SG-3	SG-1	SG-7	SG-8	SG-2	SG-4	SG-5	SG-6	Reporting Limit
DATE OF COLLECTION		12/29/2004	12/29/2004	12/29/2004	12/29/2004	12/29/2004	12/29/2004	12/28/2004	12/29/2004	
DILUTION FACTOR		8.38	1	1	1	4.53	1	1	3.36	
UNITS		ug/m³	ug/m³	ug/m³	ug/m³	ug/m³	ug/m³	ug/m³	ug/m³	ug/m³
Dichlorodifluoromethane		U	5.3 J	4.9	2.7	3.8 J	2.8	2.3	U	0.99
Vinyl Chloride		72	U	U	U	U	U	U	53	0.51
1,1-Dichloroethene		2,300	38	U	1.9	U	U	0.5 J	400	0.79
1,1,2-Trichloro-1,2,2-trifluoroethane		30,000	150	1.2 J	30	12 J	810 D	200	3,900	3.1
trans-1,2-Dichloroethene		240	550	220 D	28	670	57	3.3	210	0.79
1,1-Dichloroethane		1,400	270	U	13	U	1.9	U	590	0.81
cis-1,2-Dichloroethene		6,000	69	U	65	1.6 J	U	U	4,500	0.79
1,1,1-Trichloroethane		6,500	1,500	4.4	250	59	180	44	3,900	1.1
Trichloroethene		16,000	520	2.7	130	50	90	0.57 J	7,300	1.1
1,2-dichloro-1,1,2-trifluoroethane		3,000	67	U	U	U	43	210	610	1
Total		**65,512.0**	**3,169.3**	**233.2**	**520.6**	**796.4**	**1,184.7**	**460.67**	**21,463**	

QUALIFIERS
U: Compound analyzed for but not detected
J: Compound detected at a concentration below CRDL, value estimated
B: Compound found in method blank as well as the sample
E: Concentration exceeds instrument calibration range, value estimated
D: Result taken from reanalysis at a secondary dilution

NOTES
Indoor air samples correspond to underlying soil gas samples in table.
IA: Indoor Air
SG: Soil Gas

Soil Vapor

The highest soil vapor VOC concentrations were associated with three basement samples (SG-1 collected in the vicinity of the east sump, SG-3 collected in the facility maintenance manager's office, and SG-6 located approximately 60 feet northwest of the manager's office). The total VOC concentrations in these samples ranged from 3,169.3 ug/m^3 to 65,512 ug/m^3. The highest concentrations were generally associated with Freon 113, trichloroethene and 1,1,1-trichloroethane.

The source for the VOCs in the two eastern basement samples, SG-1 and SG-3, is likely from groundwater contamination in these areas. The source of the elevated VOC concentrations in the western-most subslab soil vapor sample, SG-6, is currently not known. Handling of hazardous materials or subsurface discharges of such materials in areas west of the main building basement sump were not reported to have occurred and not identified in previous investigations as a concern for investigation. The presence of subsurface-related features that may be contributing sources for the VOCs reported in the subslab SG-6 sample are potential past discharges into Sump #4 (located along the rear of the building approximately 60 feet further west from SG-6), and a storm drain and discharge line (located approximately 80 feet further west from SG-6) along the roadway behind the site building. The storm drain reportedly handles runoff from the bedrock outcrop to the north and the swale at its base. The locations of these facilities are included on Figure 2-7.

Indoor Air

Trichloroethene and 1,1,1-trichloroethane concentrations were elevated in indoor air samples collected in the main building and are associated with underlying elevated soil vapor concentrations. There were no detections of either compound in indoor air within the enclosed tennis court building.

Summary

Although the VOC concentrations associated with the indoor air sampling were near or within an order of magnitude of detection levels for most of the analyses, the concentrations were compared to action levels in the Guidance for Evaluating Soil Vapor Intrusion in the State of New York dated October 2006. Based on this comparison, the concentration of TCE in the indoor air and soil vapor at five of the six sampling locations was at a level that would require "mitigation to minimize current potential exposures associated with soil vapor intrusion". In accordance with the guidance, "the most common mitigation methods are sealing preferential pathways in conjunction with installing a sub-slab depressurization system and changing the pressurization of the building in conjunction with monitoring." NYSDEC issued a letter to the property owner in May 2006 stating the NYSDOH has advised NYSDEC that the levels of "compounds are significant enough to warrant mitigation to minimize current or potential exposures to the compounds to workers inside the main building." NYSDEC further indicated that measures should be taken to address these exposures including "seal all cracks and openings in the concrete slab and to seal all open sumps. The installation of a subslab depressurization system should also be considered." According to correspondence from the property owner the following measures were undertaken during a three month period in the summer of 2006:

1. Sealing all significant cracks and openings in the concrete slab.
2. Providing enclosed drainage channels to sumps were open channels existed.
3. Sealing all sumps.
4. Modifications of settings on the HVAC equipment to allow for fresh air intake to the system.

No measures have been undertaken to pursue installation of a subslab depressurization system at this time. The effectiveness of the initial measures will be evaluated through the collection of additional indoor air and subslab soil vapor samples. Further evaluation of the need for a sub-slab depressurization system will be evaluated upon review of the results of the additional sampling. In addition, as discussed in Section 4.0, groundwater remediation is planned for the site and reduction in concentrations of contaminants in the groundwater should also reduce concentrations in the sub-slab soil vapor samples.

2.6.2 Residences

Basement indoor air and subslab soil vapor samples were collected within each of two nearby residences located downgradient of the site at 17 and 23 Grand Boulevard. An ambient sample of outdoor air was also collected in the vicinity of 17 Grand Boulevard. Similar to the facility building locations, the residence sample locations were finalized with NYSDOH input. The sample analytical results are provided in Table 2-6 and the locations of these residences are shown on Figure 2-8. Photographs of the sample locations and materials present in the vicinity of the locations during the sampling are provided in Appendix D.

Dichlorodifluoromethane was the only compound above detection levels in the indoor air and subslab soil vapor and was reported in all of the samples at similar trace concentrations ranging from 2.2 to 2.7 ug/m^3. The indoor air and soil vapor sample results show that these media are not adversely impacted by VOC contamination associated with the site.

Table 2-6

FARRAND CONTROLS SITE
PRE-DESIGN INVESTIGATION REPORT
RESIDENTIAL INDOOR AIR AND SUBSLAB SOIL VAPOR ANALYTICAL RESULTS

	AMBIENT	INDOOR		SOIL VAPOR		
SAMPLE ID	AA-1	23GR-IA	17GR-IA	23GR-SG	17GR-SG	Reporting Limit
DATE OF COLLECTION	12/29/2004	3/15/2005	3/15/2005	12/29/2004	12/29/2004	
DILUTION FACTOR	1	2.09	1	8.38	1	
UNITS	ug/m^3	ug/m^3	ug/m^3	ug/m^3	ug/m^3	ug/m^3
Dichlorodifluoromethane	2.3	2.7	2.8	2.0	2.2	0.99
Vinyl Chloride	U	U	U	U	U	0.51
1,1-Dichloroethene	U	U	U	U	U	0.79
1,1,2-Trichloro-1,2,2-trifluoroethane	U	U	U	U	U	3.1
trans-1,2-Dichloroethene	U	U	U	U	U	0.79
1,1-Dichloroethane	U	U	U	U	U	0.81
cis-1,2-Dichloroethene	U	U	U	U	U	0.79
1,1,1-Trichloroethane	U	0.8 J	U	U	U	1.1
Trichloroethene	U	U	U	U	U	1.1
1,2-Dichloro-1,1,2-trifluoroethane	U	U	U	U	U	1
Total	2.3	3.5	2.8	2.0	2.2	

Qualifiers
U: Compound analyzed for but not detected
J: Compound detected at a concentration below CRDL, value estimated

3.0 ZERO-VALENT IRON INJECTION PILOT STUDY

In order to establish design criteria for full-scale remediation of contaminated overburden groundwater, a pilot study demonstrating the zero-valent iron injection technology was completed at the site in May 2005 by ARS Technologies, Inc. (ARS). In addition, a bench scale treatability study was performed for this technology using groundwater from the site in December 2001. The results of the bench scale treatability study indicated that the technology was applicable to remediation of the contaminants of concern at the site.

The pilot study report is provided in Appendix E. Comments on the final report are also provided in Appendix E. A summary of the pilot test objectives and findings are provided below in Sections 3.1 and 3.2. Baseline data and supplemental soil and groundwater quality data collected after the pilot test was conducted to augment the interpretation of the pilot test results are discussed in Section 3.3.

3.1 Objectives of the Pilot Study

The objectives of the pilot study were to determine:

- The effective zone of influence of injection points and the optimum number and locations for the full-scale system;
- The optimum depth(s) for zero-valent iron injection, including whether injection at multiple depths or a single depth will be required;
- Optimum methods for delivery of the treatment media including optimum pressures to maximize the zone of influence without adverse impacts, such as heaving or daylighting;
- Optimum volume of iron to be injected at each location;
- Optimum soil to iron ratio;
- Whether any unacceptable reaction byproducts or other adverse impacts will result from implementation of the technology at the site;
- Other required site-specific design parameters necessary for full scale design;

- Estimated time period required to achieve groundwater remediation objectives; and
- The capital, operation and maintenance costs for conducting full-scale remediation of the groundwater plume using a commercially available zero-valent iron injection program.

The results of the pilot test with respect to these objectives is presented and discussed below.

3.2 Results of the Pilot Study

3.2.1 Zone of Influence

As discussed in the pilot study report, the effective zone of influence of the injection point was impacted by daylighting in and around the injection point. The daylighting limited the quantity of gas necessary to effectively distribute the zero-valent iron. Although a total of 2,950 pounds of zero-valent iron was injected into the subsurface between 6.5 and 17 feet below ground surface, the distribution of the iron could not be confirmed. The radius of influence from the injection point was inferred to be approximately 15 feet, however, sufficient supporting data from the pilot study was not obtained to confirm this radius. For full-scale implementation a more conservative radius of influence of 10 feet was recommended.

3.2.2 Injection Depths

The pilot test was performed in an area of the site where depth to bedrock was approximately 17 feet below grade and depth to water was approximately 6 feet below grade. This area represents the shallow overburden aquifer at the site. Results from the pilot study would indicate that injection of zero-valent iron at shallow depths (i.e., less than 17 feet below ground surface) could cause daylighting particularly in the geologic formation underlying the site. Therefore, full-scale remediation of the shallow aquifer using this technology could be difficult. ARS provides recommendations in the pilot study report on various modifications to injection methods to minimize daylighting during remediation of the shallow aquifer.

For the remaining portions of the site requiring remediation, aquifer thickness and depths of contamination increase significantly due to the dip of the top of the bedrock surface towards the wetlands. Therefore, daylighting may not occur during injection of zero-valent iron at greater depths, where contamination in the overburden deposits has primarily been identified, and zero-valent iron distribution may be improved. Recommended injection depths are presented in the pilot study report.

3.2.3 Injection Pressures

Injection pressures used during the pilot study indicated soil fluidization and no discernable characteristics of a fracture event. Therefore, pressures used during the pilot study should be sufficient to effectively distribute zero-valent iron in the subsurface. However, as discussed above, at shallow depths, the pressures used during the pilot study did cause significant daylighting and therefore, modifications to the injection method and possibly the injection pressures would need to be undertaken to implement this technology at shallow depths.

3.2.4 Iron Volume and Ratio

Results of the groundwater monitoring performed after the pilot test was conducted are discussed in the following section. Generally, the lack of significant reduced concentrations of VOCs in the groundwater did not indicate significant impacts from zero-valent iron injection. This may be a result of insufficient iron emplacement as well as irregular distribution of iron in the subsurface, and contaminant flow into the system. Due to the inconclusive results obtained during the post injection investigations, including groundwater and iron in soil analytical results, determination of optimum iron volume and ratio from the results pilot test is not possible. However, ARS provides recommendations of iron volumes and ratios based on the results of the treatability study and their experience with this technology.

3.2.5 Reaction By-products

Although no significant change in groundwater quality was noted during the post injection investigations, no adverse "by-products" were noted in the groundwater samples collected.

3.2.6 Full-Scale Implementation

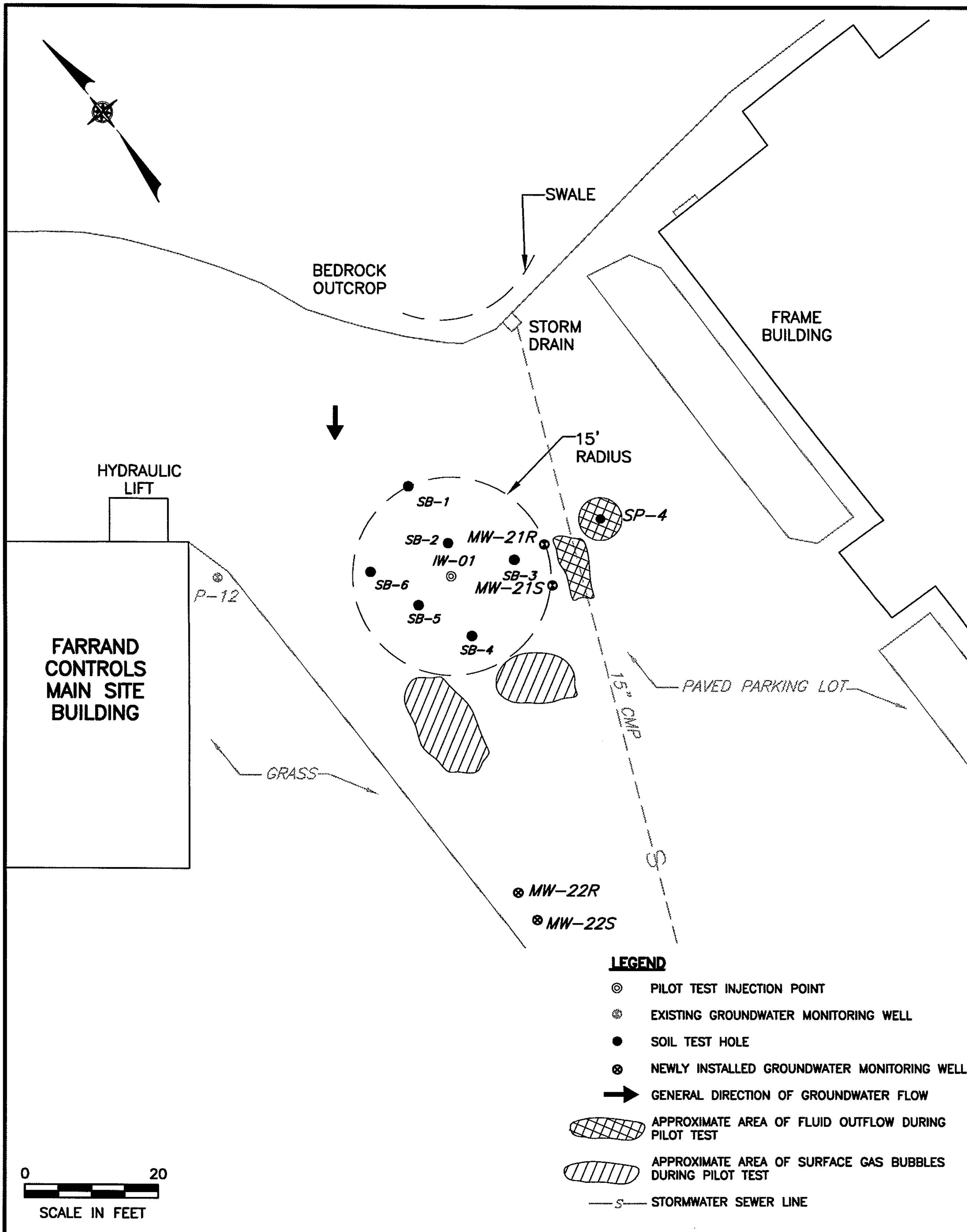
Costs and time frame to implement this technology on a full scale at the site are presented in the pilot study report. The pilot test was conducted at an area of the site with shallow contaminated groundwater and bedrock, and generated important information and design criteria regarding site remediation by zero-valent iron injection. The pilot test was also successful in identifying additional information and design criteria that would help optimize the effectiveness of this remediation technology for the full-scale design. The application of this information to the final site remediation design will likely enhance our understanding of the zero-valent iron delivery technology which, in turn, will impact the cost and time frame presented in the pilot study report.

3.3 Post Pilot Test Investigation

3.3.1 Soil

To investigate the radius of distribution for the zero-valent iron resulting from the pilot test, soil test holes were conducted around the injection point, IN-1, the day after the iron injections were completed (May 26, 2005). Figure 3-1 shows the locations of the injection point, the soil test holes and injection-related field observations, such as the surface gas bubbles and "daylighting," made during the test. The test holes were located radially about the injection point within a 15-foot radius as shown on Figure 3-1.

The soil test holes were advanced to the top of bedrock, between 14 and 18 feet below grade. Soil core samples retrieved at each test hole were exposed to the air overnight to allow



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FARRAND CONTROLS SITE
PRE-DESIGN INVESTIGATION REPORT

POST PILOT TEST INVESTIGATION
SOIL SAMPLING LOCATIONS

FIGURE 3-1

\\Nt4\CADwork\2276\Pre-Design Investigation\2276-fig 3-1.dwg, Layout1, 03/10/06 01:09:17 PM, FDeVita oxidation of iron to facilitate any field evidence of the presence of injected iron. The soil core samples were logged by a D&B geologist and the logs are provided in Appendix F.

The soil logged in the test holes was generally comprised of brown fine and fine to medium grained sand, with silt and some fine to medium grained gravel. A localized silty clay layer, 3 feet thick, was present in soil test hole SB-5 from 13 to 16 feet below grade. Visual examination of the sample cores generally revealed no visible discernable iron in the soil. Small inclusions of possible iron were noted in the 6.5 to 8.5 horizon in SB-5.

Soil samples were selected for total iron analysis by collecting representative samples from three-foot soil zones from each test hole from the water table down to the bedrock. The laboratory analytical results for iron are summarized in Table 3-1. The iron concentrations in the soil samples ranged from 12,200 mg/kg to 33,400 mg/kg with an average concentration of 20,428 mg/kg. These iron concentrations did not appear to reflect elevated levels compared to background iron concentrations in adjacent soil at comparable depths. Background iron concentrations were established by samples collected from Geoprobe probe holes advanced during the remedial investigation at the site and presented in D&B's report dated August 2000. The background soil samples were collected along the east side of the main site building and along the perimeter of the eastern portion of the building. The total iron concentrations in these samples ranged from 9,480 mg/kg to 39,100 mg/kg with an average of 17,799 mg/kg. The iron concentration in the soil samples nearest the injection area, along the eastern building wall, ranged from 9,480 mg/kg to 26,300 mg/kg with an average concentration of 18,424 mg/kg.

3.3.2 Groundwater

In order to aid in evaluating the effectiveness of the zero-valent iron injection, two rounds of groundwater samples were subsequently collected from nearby monitoring wells MW-21S, MW-21R, MW-22S and MW-22D. These wells were sampled in July and September 2005 and were analyzed for the site-specific VOCs in addition to selected degradation indicators and geochemical parameters.

Table 3-1

FARRAND CONTROLS SITE
PRE-DESIGN INVESTIGATION REPORT
POST PILOT TEST SOIL SAMPLING RESULTS

SAMPLE ID	SB-1 (6.5-11)	SB-1 (11-14)	SB-1 (14-17)	SB-2 (6.5-10)	SB-2 (10-13)	SB-2 (13-16)
DATE OF COLLECTION	5/26/05	5/26/05	5/26/05	5/26/05	5/26/05	5/26/05
UNITS	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Iron	13,700	12,200	13,800	13,200	17,300	17,200

SAMPLE ID	SB-3 (6.5-9)	SB-3 (9-11.5)	SB-3 (11.5-14)	SB-4 (6.5-11)	SB-4 (11-14)	SB-4 (14-17)
DATE OF COLLECTION	5/26/05	5/26/05	5/26/05	5/26/05	5/26/05	5/26/05
UNITS	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Iron	22,000	27,200	24,400	33,400	21,000	19,800

SAMPLE ID	SB-5 (6.5-11)	SB-5 (11-14.5)	SB-5 (14.5-18)	SB-6 (6.5-9)	SB-6 (9-11.5)	SB-6D (11.5-14)
DATE OF COLLECTION	5/26/05	5/26/05	5/26/05	5/26/05	5/26/05	5/26/05
UNITS	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Iron	29,200	17,300	23,300	15,600	22,500	24,600

Groundwater analytical results for VOCs in the nearby wells, along with degradation indicators and geochemical parameters are provided in Tables 3-2 and 3-3, respectively. The tables include the results of the initial baseline sampling from December 2004 and the post iron injection sampling results from August and September 2005. VOC concentrations in groundwater were relatively stable or increased in the analytical results for August and September 2005. The concentration of the degradation indicators and geochemical parameters were generally stable. The concentration of chloride increased approximately two to four fold in the two shallow wells and bedrock well nearest the injection point indicating the occurrence of dechlorination. These data did not provide definitive evidence for reduction in contamination from the iron injection.

Due to the inconclusive results obtained from the groundwater sampling program, four paired well clusters of microwells were installed in December 2005 immediately adjacent to the injection point, in consultation with the NYSDEC. Each cluster (MW-PT series) comprised two wells of 3-foot screens; one installed within the upper water table zone and one installed on top of bedrock. Well logs are provided in Appendix F. During the installation of MW-PT2D, a slight odor and a sheen were noted in the 14 to 16 foot horizon on top of a silt layer where the well is screened.

Tables 3-4 and 3-5 include the most recent groundwater sampling results (December 28, 2005) for VOCs, and the degradation indicators and geochemical parameters, respectively, for the nearby existing monitoring wells and the new microwells. The distribution of the total site-specific VOC concentrations in the area of the iron injection is shown on Figure 3-2. This distribution shows the following:

- Contamination in the overburden is predominantly in the deep zone on top of bedrock;
- Significant contamination (total VOC concentration of 93,944 ug/l) at MW-PT2D is emanating from the area of GP-1, to the north, where soil contamination was discovered in the past; and

Table 3-2

FARRAND CONTROLS SITE
PRE-DESIGN INVESTIGATION REPORT
HISTORIC GROUNDWATER ANALYTICAL RESULTS IN VICINITY OF IRON INJECTION

SITE-SPECIFIC VOLATILE ORGANIC COMPOUNDS

SAMPLE ID	MW-21S	MW-21S	MW-21S	MW-21R	MW-21R	MW-21R	Contract	NYSDEC Class GA
DATE OF COLLECTION	12/15/2004	7/14/2005	9/23/2005	12/15/2004	7/14/2005	9/23/2005	Required	Groundwater
DILUTION FACTOR	1/25	1/20	1/20	1/200	1/250	1/1000	Detection	Standard
UNITS	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	Limit	Guidance Value
Dichlorodifluoromethane	U	U	U	U	U	U	10	5 ST
Vinyl Chloride	U	U	U	3 J	U	14	10	2 ST
1,1-Dichloroethene	U	57	U	U	U	U	10	5 ST
1,1,2-Trichloro-1,2,2-trifluoroethane	2,100 DB	2,900 D	2,200 B	34,000 DB	32,000 D	57,000 DB	10	5 ST
trans-1,2-Dichloroethene	U	U	U	3 J	U	U	10	5 ST
1,1-Dichloroethane	9 J	9 J	U	370 DJ	310 DJ	1,100 DJ	10	5 ST
cis-1,2-Dichloroethene	2 J	U	U	9 J	10	90	10	5 ST
1,1,1-Trichloroethane	470 DB	460 D	270	19,000 D	19,000 D	35,000 D	10	5 ST
Trichloroethene	150	130	99 J	7,200 D	5,700 D	13,000 D	10	5 ST
1,2-dichloro-1,1,2-trifluoroethane	11 J	U	U	140 J	U	U	10	----
Total	2,742	3,556	2,569	60,725	57,020	106,204		

SAMPLE ID	MW-22S	MW-22S	MW-22S	MW-22R	MW-22R	MW-22R	Contract	NYSDEC Class GA
DATE OF COLLECTION	12/15/2004	7/14/2005	9/23/2005	12/15/2004	7/14/2005	9/23/2005	Required	Groundwater
DILUTION FACTOR	1/4	1/50	1/50	1/100	1/200	1/200	Detection	Standard
UNITS	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	Limit	Guidance Value
Dichlorodifluoromethane	U	24	U	190 DJ	65	U	10	5 ST
Vinyl Chloride	U	U	U	4 J	2 J	U	10	2 ST
1,1-Dichloroethene	U	U	U	U	U	U	10	5 ST
1,1,2-Trichloro-1,2,2-trifluoroethane	400	3,800 D	4,900 B	13,000 DB	21,000 D	15,000 B	10	5 ST
trans-1,2-Dichloroethene	U	U	U	4 J	U	U	10	5 ST
1,1-Dichloroethane	13 J	170	220 J	540 DJ	650 DJ	580 J	10	5 ST
cis-1,2-Dichloroethene	U	6 J	U	22	21	U	10	5 ST
1,1,1-Trichloroethane	180	1,800 D	2,500	8,900 D	12,000 D	8,800	10	5 ST
Trichloroethene	110	1,100 D	1,900	5,200 D	7,300 D	5,600	10	5 ST
1,2-dichloro-1,1,2-trifluoroethane	U	U	U	210 J	U	U	10	----
Total	703	6,900	9,520	28,070	41,038	29,980		

Qualifiers
U: Compound analyzed for but not detected
J: Compound detected at a concentration below CRDL, value estimated
B: Compound found in method blank as well as the sample
E: Concentration exceeds instrument calibration range, value estimated
D: Result taken from reanalysis at a secondary dilution

Notes
ST: Standard
----: Not established
[box]: Result exceeds NYSDEC Class GA Groundwater Standard

Table 3-3

FARRAND CONTROLS SITE
PRE-DESIGN INVESTIGATION REPORT
HISTORIC GROUNDWATER QUALITY RESULTS IN VICINITY OF IRON INJECTION
DEGRADATION INDICATORS AND GEOCHEMICAL PARAMETERS

SAMPLE ID	MW-21S	MW-21S	MW-21S	MW-21R	MW-21R	MW-21R	Instrument Detection Limit	NYSDEC Class GA Groundwater Standard Guidance Value
DATE OF COLLECTION	12/15/2004	7/14/2005	9/23/2005	12/15/2004	7/14/2005	9/23/2005		
DILUTION FACTOR	1	1	1	1	1	1		
UNITS	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l
Alkalinity	69,000	49,000	53,000	69,000	60,000	67,000	20,000	----
Chloride	52,000	130,000	120,000	45,000	86,000	100,000	2,000	250,000 ST
Nitrate	140	770	870	510	430	400	25	10,000 ST
Silica	13,000	10,000	13,000	18,000	13,000	17,000	50	----
Sulfate	36,000	27,000	29,000	35,000	27,000	30,000	5,000	250,000 ST
Total Dissolved Solids	230,000	410,000	360,000	230,000	290,000	330,000	10,000	----
Total Organic Carbon	8,000	U	U	22,000	U	11,000	5,000	----
Calcium	28,800	47,100	45,300	35,300	40,800	57,700	60	----
Iron	2,770	9,220	3,360	1,990	4,070	4,340	2	300 ST*
Magnesium	8,610	14,600	12,500	4,840 B	6,430	9,500	5	35,000 GV
Manganese	328	468	748	1,300	2,380	2,080	0.9	300 ST*
Potassium	3,300 B	5,190	4,510 B	5,240	5,160	5,870	39	----
Sodium	37,400	47,700	45,600	27,500	35,500	30,700	21	20,000 ST

SAMPLE ID	MW-22S	MW-22S	MW-22S	MW-22R	MW-22R	MW-22R	Instrument Detection Limit	NYSDEC Class GA Groundwater Standard Guidance Value
DATE OF COLLECTION	12/15/2004	7/14/2005	9/23/2005	12/15/2004	7/14/2005	9/23/2005		
DILUTION FACTOR	4	4	4	1	1	1		
UNITS	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l
Alkalinity	95,000	90,000	100,000	75,000	72,000	76,000	20,000	----
Chloride	7,100	38,000	39,000	48,000	52,000	48,000	2,000	250,000 ST
Nitrate	180	300	310	240	270	190	25	10,000 ST
Silica	12,000	13,000	16,000	18,000	14,000	17,000	50	----
Sulfate	33,000	33,000	34,000	36,000	35,000	36,000	5,000	250,000 ST
Total Dissolved Solids	190,000	230,000	280,000	260,000	240,000	240,000	10,000	----
Total Organic Carbon	9,000	U	U	8,000	U	U	5,000	----
Calcium	41,900	43,100	47,900	37,900	35,900	40,500	60	----
Iron	5,840	17,200	3,690	190	363	363	2	300 ST*
Magnesium	7,540	13,800	11,700	11,400	11,000	12,000	5	35,000 GV
Manganese	382	1,140	541	1,070	1,460	1,190	0.9	300 ST*
Potassium	5,600	8,610	4,050 B	3,300 B	2,840 B	2,900 B	39	----
Sodium	6,450	13,300	13,600	15,300	13,600	13,800	21	20,000 ST

Qualifiers
U: Compound analyzed for but not detected
B: Concentration is > IDL but < CRDL.

Notes
ST: Standard
GV: Guidance Value
ST*: Standard for total of iron and manganese is 500 ug/l
----: Not established
[boxed]: Result exceeds NYSDEC Class GA Groundwater Standard
[shaded]: Result exceeds standard of 500 ug/l for iron and manganese

Table 3-4

FARRAND CONTROLS SITE
PRE-DESIGN INVESTIGATION REPORT
SUPPLEMENTAL POST PILOT TEST GROUNDWATER SAMPLING RESULTS

SITE-SPECIFIC VOLATILE ORGANIC COMPOUNDS

SAMPLE ID	MW-21S	MW-21R	MW-22S	MW-22R	MW-PT1S	MW-PT1D	Contract Required Detection Limit	NYSDEC Class GA Groundwater Standard Guidance Value
DATE OF COLLECTION	12/28/05	12/28/05	12/28/05	12/28/05	12/29/05	12/29/05		
DILUTION FACTOR	1	1	1	1	1	1		
UNITS	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l		
Dichlorodifluoromethane	**16**	**210 E**	**140**	**200**	U	**20**	10	5 ST
Vinyl Chloride	U	**5 J**	2 J	**5 J**	U	U	10	2 ST
1,1-Dichloroethene	U	**780 E**	**420 DJ**	**980 DJ**	U	U	10	5 ST
1,1,2-Trichloro-1,2,2-trifluoroethane	**7,400 DB**	**54,000 DB**	**6,600 DB**	**16,000 DB**	**84 DB**	**1,800 DB**	10	5 ST
trans-1,2-Dichloroethene	U	**10**	3 J	U	U	U	10	5 ST
1,1-Dichloroethane	**51**	**790 DJ**	**250 DJ**	**610 DJ**	**19**	**35**	10	5 ST
cis-1,2-Dichloroethene	**7 J**	**34**	**15**	**30**	3 J	**8 J**	10	5 ST
1,1,1-Trichloroethane	**3,900 D**	**27,000 D**	**3,700 D**	**11,000 D**	**570 D**	**310 D**	10	5 ST
Trichloroethene	**880 D**	**9,900 D**	**2,300 D**	**6,600 D**	**410 D**	**230 D**	10	5 ST
1,2-dichloro-1,1,2-trifluoroethane	28	270 E	150	200 DJ	120	44	10	----
Total	**12,282**	**92,999**	**13,580**	**35,625**	**1,206**	**2,447**		

SAMPLE ID	MW-PT2S	MW-PT2D	MW-PT3S	MW-PT3D	MW-PT4S	MW-PT4D	Contract Required Detection Limit	NYSDEC Class GA Groundwater Standard Guidance Value
DATE OF COLLECTION	12/29/05	12/29/05	12/28/05	12/29/05	12/28/05	12/28/05		
DILUTION FACTOR	1	1	1	1	1	1		
UNITS	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l		
Dichlorodifluoromethane	U	**110**	3 J	**53**	**9 J**	**250 E**	10	5 ST
Vinyl Chloride	U	**4 J**	U	U	U	4 J	10	2 ST
1,1-Dichloroethene	U	**1,600 DJ**	**10**	U	U	**730 J**	10	5 ST
1,1,2-Trichloro-1,2,2-trifluoroethane	**100**	**10,000 DB**	**110 B**	**3,000 DB**	**860 DB**	**13,000 DB**	10	5 ST
trans-1,2-Dichloroethene	U	21	U	U	U	**6 J**	10	5 ST
1,1-Dichloroethane	**11**	**2,700 DJ**	**9 J**	**190**	**36**	**430 DJ**	10	5 ST
cis-1,2-Dichloroethene	U	**19**	U	3 J	**9 J**	**28**	10	5 ST
1,1,1-Trichloroethane	**340 D**	**53,000 D**	**100**	**4,000 D**	**470 D**	**6,100 D**	10	5 ST
Trichloroethene	**290 D**	**26,000 D**	**44**	**680 D**	**170 D**	**3,500 D**	10	5 ST
1,2-dichloro-1,1,2-trifluoroethane	7 J	520 DJ	5 J	65	82	280 DJ	10	----
Total	**748**	**93,974**	**281**	**7,991**	**1,636**	**24,328**		

Qualifiers
U: Compound analyzed for but not detected
J: Compound detected at a concentration below CRDL, value estimated
B: Compound found in method blank as well as the sample
E: Concentration exceeds instrument calibration range, value estimated
D: Result taken from reanalysis at a secondary dilution

Notes
ST: Standard
----: Not established
[box]: Result exceeds NYSDEC Class GA Groundwater Standard

Table 3-5

FARRAND CONTROLS SITE
PRE-DESIGN INVESTIGATION REPORT
SUPPLEMENTAL POST PILOT TEST GROUNDWATER SAMPLING RESULTS
DEGRADATION INDICATORS AND GEOCHEMICAL PARAMETERS

SAMPLE ID	MW-21S	MW-21R	MW-22S	MW-22R	MW-PT1S	MW-PT1D	Instrument Detection Limit	NYSDEC Class GA Groundwater Standard Guidance Value
DATE OF COLLECTION	12/28/05	12/28/05	12/28/05	12/28/05	12/29/05	12/29/05		
DILUTION FACTOR	1	1	1	1	1	1		
UNITS	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l
Alkalinity	70,000	80,000	110,000	90,000	50,000	160,000	20,000	----
Chloride	95,000	65,000	39,000	50,000	83,000	54,000	4,000	250,000 ST
Nitrate	180	330	330	160	U	440	25	10,000 ST
Silica	13,000	18,000	18,000	18,000	6,200	18,000	50	----
Sulfate	37,000	34,000	35,000	34,000	6,100	48,000	5,000	250,000 ST
Total Dissolved Solids	300,000	240,000	200,000	250,000	210,000	340,000	10,000	----
Total Organic Carbon	U	U	U	U	U	U	5,000	----
Fluoride	U	U	U	U	250	U	250	1500 ST
Acetate	U	U	U	U	U	U	5,000	----
Ethene	U	U	U	U	U	U	35	----
Ethane	U	U	U	U	U	U	26	----
Ferrous Iron	NA	NA	NA	NA	1.2	U	1,000	----
Ferric Iron	NA	NA	NA	NA	U	U	10,000	----
Calcium	39,700	39,200	43,900	40,000	26,200	51,100	60	----
Iron	2,170	2,530	1,500	521	1,510	127	2	300 ST*
Magnesium	11,200	6,620	11,200	12,200	7,840	17,600	5	35,000 GV
Manganese	544	1,820	341	1,460	1,780	1,440	0.9	300 ST*
Potassium	3,330 B	4,850 B	3,420 B	2,960 B	2,670 B	5,720	39	----
Sodium	46,400	30,700	14,800	14,700	33,100	23,500	21	20,000 ST

Qualifiers
U: Compound analyzed for but not detected
B: Concentration is > IDL but < CRDL.

Notes
ST: Standard
NA: Not Analyzed
GV: Guidance Value
ST*: Standard for total of iron and manganese is 500 ug/l
----: Not established
[boxed]: Result exceeds NYSDEC Class GA Groundwater Standard
[shaded]: Result exceeds standard of 500 ug/l for iron and manganese

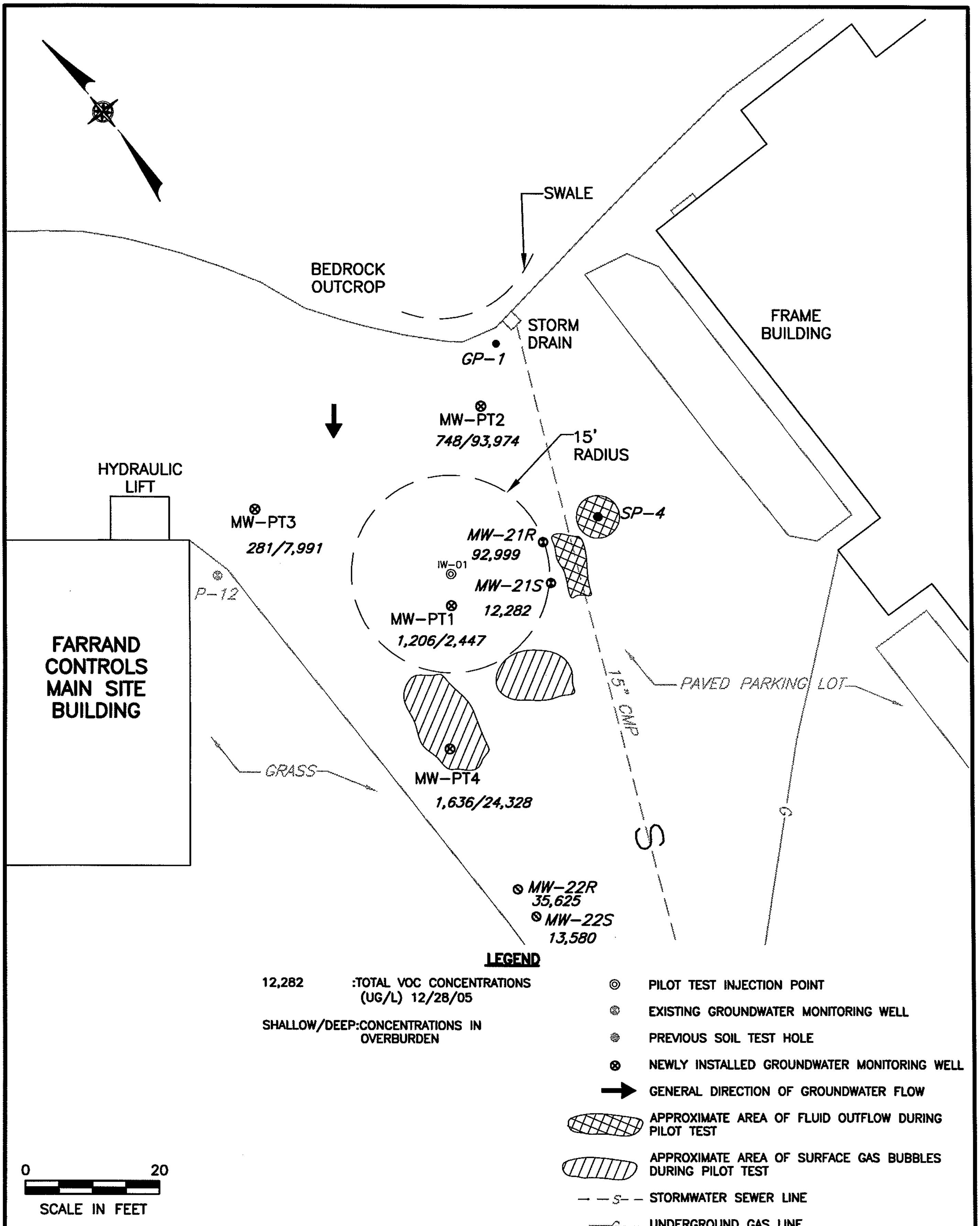
Table 3-5

FARRAND CONTROLS SITE
PRE-DESIGN INVESTIGATION REPORT
SUPPLEMENTAL POST PILOT TEST GROUNDWATER SAMPLING RESULTS
DEGRADATION INDICATORS AND GEOCHEMICAL PARAMETERS

SAMPLE ID DATE OF COLLECTION DILUTION FACTOR UNITS	MW-PT2S 12/29/05 1 ug/l	MW-PT2D 12/29/05 1 ug/l	MW-PT3S 12/28/05 1 ug/l	MW-PT3D 12/29/05 1 ug/l	MW-PT4S 12/28/05 1 ug/l	MW-PT4D 12/28/05 1 ug/l	Instrument Detection Limit ug/l	NYSDEC Class GA Groundwater Standard Guidance Value ug/l
Alkalinity	110,000	100,000	40,000	30,000	150,000	140,000	20,000	----
Chloride	39,000	49,000	12,000	21,000	70,000	62,000	4,000	250,000 ST
Nitrate	1,200	120	1,000	400	190	U	25	10,000 ST
Silica	12,000	19,000	11,000	19,000	16,000	20,000	50	----
Sulfate	55,000	32,000	21,000	31,000	38,000	50,000	5,000	250,000 ST
Total Dissolved Solids	270,000	260,000	98,000	130,000	350,000	370,000	10,000	----
Total Organic Carbon	U	U	U	U	U	U	5,000	----
Fluoride	U	U	U	U	U	U	250	1500 ST
Acetate	U	U	U	U	U	U	5,000	----
Ethene	U	U	U	U	U	U	35	----
Ethane	U	U	U	U	U	U	26	----
Ferrous Iron	1.4	U	U	U	U	U	1,000	----
Ferric Iron	U	U	U	U	U	U	10,000	----
Calcium	29,000	40,100	15,500	17,800	58,700	98,700	60	----
Iron	15.2 B	2,610	449	896	1,700	2,430	2	300 ST*
Magnesium	7,970	10,000	2,720 B	4,850 B	18,000	20,100	5	35,000 GV
Manganese	1,030	3,920	51	695	1,020	3,020	0.9	300 ST*
Potassium	4,860 B	6,010	1,730 B	2,890 B	4,010	5,580	39	----
Sodium	60,500	23,700	9,430	8,410	30,500	17,400	21	20,000 ST

Qualifiers
U: Compound analyzed for but not detected
B: Concentration is > IDL but < CRDL.

Notes
ST: Standard
GV: Guidance Value
ST*: Standard for total of iron and manganese is 500 ug/l
----: Not established
[boxed]: Result exceeds NYSDEC Class GA Groundwater Standard
[shaded]: Result exceeds standard of 500 ug/l for iron and manganese



Dvirka and Bartilucci
CONSULTING ENGINEERS
A DIVISION OF WILLIAM F. COSULICH ASSOCIATES, P.C.

FARRAND CONTROLS SITE
PRE-DESIGN INVESTIGATION REPORT

POST PILOT TEST INVESTIGATION
GROUNDWATER SAMPLING RESULTS

FIGURE 3-2

\\N4\CADwork\2276\Pre-Design Investigation\2276-fig 3-2.dwg, Layout1, 03/13/06 09:56:44 AM, FDeVita

- The total VOC concentration in well MW-PT1D of 2,447 ug/l, which is located approximately 5 feet downgradient of the iron injection point, is lower than the total VOC concentrations in surrounding wells (7,991 ug/l in MW-PT3D and 12,282 ug/l in MW-21S) indicating that the iron injection may be reducing VOC mass. The VOC concentrations detected in the groundwater monitoring wells at the site may not be directly comparable due to the fact that data is likely being impacted by factors such as varying screen lengths in the wells and insufficient historical data to assess any trends in concentrations over time. In addition, sufficient data is not available to allow for a comprehensive understanding of the concentration gradients within each well in the vicinity of the iron injection zone.

The degradation indicators and geochemical parameters (Table 3-5) generally do not show significant variability or definitive relationships between wells, screen zones and VOC concentrations.

4.0 SUMMARY OF FINDINGS

The findings of the pre-design investigation activities, the pilot study and post-pilot test investigation are summarized below.

4.1 Pre-Design Investigation

Utilities

- Numerous buried utilities are present at the site. These include:
  - Electric and storm water lines at the rear of the main building;
  - Gas, sewer, water supply and communication lines along the front wall of the main building;
  - Communication and gas lines along Wall Street; and
  - Storm water and gas lines between the main building and Wall Street.
- The observed depths of the utilities vary between approximately 1 and 8 feet below grade.

Soil Contamination

- Soil contamination previously identified adjacent to the storm drain located in the east paved lot is limited in its vertical and horizontal extent with a volume estimated to be less than 110 cubic yards.

Groundwater Occurrence and Flow

- Depth to groundwater across the site ranges from 2 to 10 feet below grade.
- The shallow groundwater flows south with a steep gradient across the northwestern portion of the site and flows in a southwest direction with a shallow gradient across the remainder of the site.

- Vertical flow components within the overburden, and between the overburden and bedrock are downward under the main building and upward at the downgradient (southern) property boundary where it upwells and discharges to the pond.

Groundwater Quality

- VOCs in the shallow overburden groundwater constitute two separate plumes; a western plume emanating from the formerly contaminated eastern basement sump and an eastern plume emanating from the storm drain located in the eastern portion paved lot.
- As the contamination migrates downward with groundwater, the plumes appear to commingle under the east paved lot.
- Compared to previous 2001 groundwater analytical results, the total targeted VOC concentrations in the shallow plume are between 50 and 90% lower while concentrations of VOCs in the bedrock wells have doubled.
- Freon 113 constitutes approximately 50% of the total targeted VOCs detected, with trichloroethene and 1,1,1-trichloroethane comprising most of the remaining site VOCs.
- Off-site private potable water supply wells continue to show no adverse impacts from site contamination.

Indoor Air and Subslab Soil Gas Quality

- Facility
  - Elevated levels of trans-1,2-dichloroethene (t-DCE) were detected in all facility indoor air samples.
  - t-DCE was not detected at elevated levels in any of the facility subslab soil gas samples and was not historically identified at elevated concentrations in site soil or groundwater samples.
  - Elevated levels of VOCs in soil gas were detected adjacent to the formerly contaminated eastern basement sump, the sump 60 feet to the west and at an area in the basement approximately 80 feet further west.
  - The source of the elevated VOCs in the western soil gas sample is unknown.

- Levels of TCE in indoor air and soil gas were compared to action levels in NYSDOH Guidance for Evaluating Soil Vapor Intrusion. In accordance with the Guidance, mitigation of soil vapor intrusion would be required.
- Property owner has taken measure to mitigate soil vapor intrusion.
- Implementation of more significant measures will be evaluated upon supplemental sampling.

- Residences
  - Elevated VOC concentrations were not detected in any of the indoor air or soil gas samples collected at the two downgradient nearby residences from the Farrand Controls Site.

4.2 Zero-Valent Iron Injection Pilot Study

- The target iron injection zone was between depths of 6 and 17 feet below grade.
- The injection radius of influence was inferred to be approximately 15 feet, however, sufficient supporting data from the pilot study was not generated to confirm this radius. For full-scale implementation, a more conservative radius of 10 feet was recommended in the contractor pilot study report.
- The shallow injection caused "daylighting" that limited injection pressures and iron volumes.
- Interpretation of injection pressures indicated soil fluidization and effective distribution of zero-valent iron.
- Optimum iron volume and ratio was not determined by the pilot test and is recommended by the contractor to be based on the results of the treatability study.
- Based on analytical results obtained during the pilot study and the post-pilot test investigation, no adverse by-products were noted in groundwater.

4.3 Post-Pilot Test Investigation

- Iron concentrations in the pre- and post-pilot test soil samples were not significantly different.

- Low concentrations of VOCs and trends with respect to selected degradation indicators and geochemical parameters in the groundwater showed some indication of the apparent reduction of chlorinated VOC contamination.

- The lack of observed significant contaminant reduction processes may be masked by significant contamination entering the injection area from the north.

4.4 Recommendations for Remedial Measures

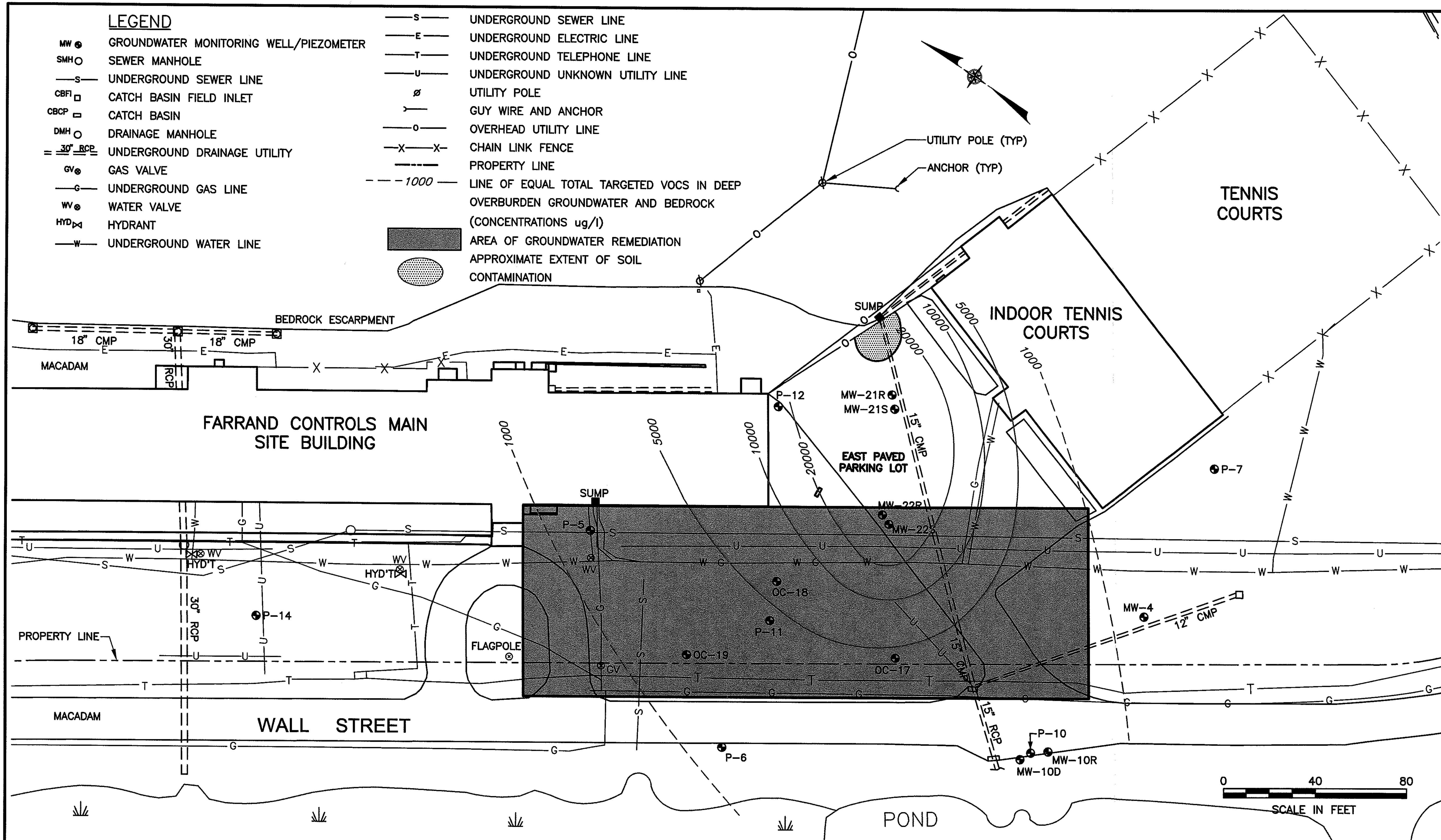
Based on the findings of the pre-design investigation described above, including the zero-valent iron pilot study, the following discussion identifies the remedial measures recommended for implementation at the site. Further details with regard to both the soil and groundwater remediation will be included in the Engineering Design Report.

Soil

As discussed in Section 2.3, it is estimated that approximately 110 cubic yards of soil will require remediation in the area of the storm drain in the eastern paved lot. The area is delineated on Figure 2-2. It is anticipated that the soil will be excavated using standard excavation techniques and that the excavation will cause limited disturbance to daily activities at the facility. As part of the remediation program, replacement of the existing storm drain as well as associated piping in the area of the excavation will likely be required. Further discussion regarding the implementation of this remedial measure will be provided in the Engineering Design Report.

Groundwater

With regard to implementation of remedial measures for groundwater, the remediation will focus on overburden groundwater in the shallow and deep overburden south and southeast of the main facility building, containing elevated levels of total site-specific VOCs at concentrations greater than 1,000 ug/l (see Figure 4-1). Although the zero-valent iron pilot study report included a discussion of a phased approach to remediation that would cover a larger area of the site, this approach will not be pursued in an attempt to minimize daylighting issues and focus on the plume



Dvirka and Bartilucci
CONSULTING ENGINEERS
A DIVISION OF WILLIAM F. COSULICH ASSOCIATES, P.C.

FARRAND CONTROLS SITE
PRE-DESIGN INVESTIGATION REPORT

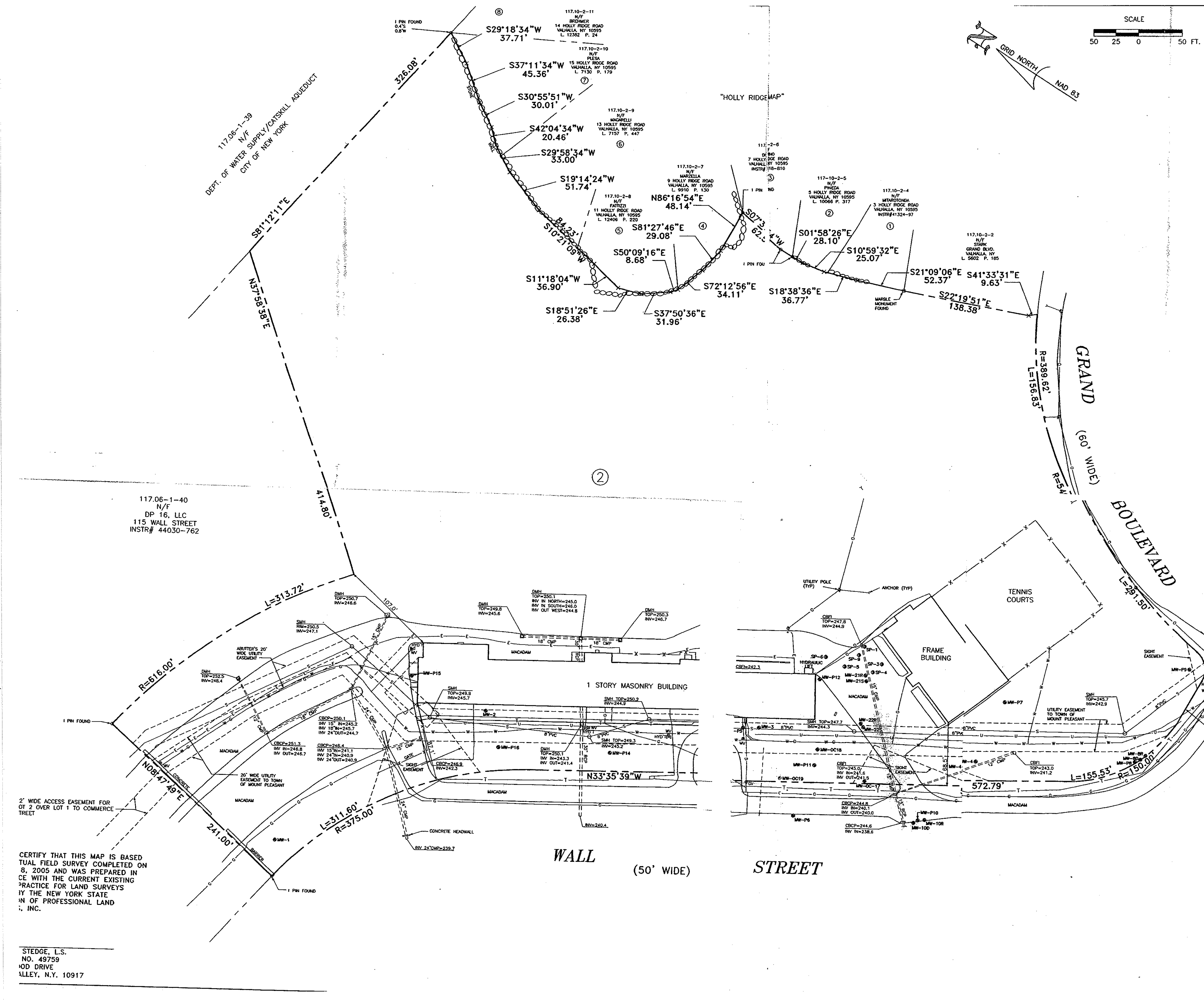
GROUNDWATER REMEDIAL MEASURE

FIGURE 4-1

F:\2587\2587-FIG-1.dwg, FIG 1, 12/21/06 11:40:41 AM, LGiubiak that is impacting the adjacent pond/wetlands remediation area depicted on Figure 4-1. Total VOCs greater than 1,000 ug/l have been detected in this area from the water table (approximately 5.5 to 10 feet below grade) to the underlying bedrock surface at a depth of approximately 50 feet below grade. Shallow groundwater total VOCs concentrations are shown on Figure 2-4. Zero-valent iron will be injected into the subsurface to reduce the concentrations of VOCs in this zone. During development of the Engineering Design Report, to the extent practicable, the results of the pilot study will be used to develop the basis for full-scale design. Data will also be obtained from the other full scale projects that have utilized this technology. Consideration will be given to implementation issues such as daylighting and modification of injection pressures, injection depths and injection point locations to limit the potential for impacts to the structural integrity of the existing building or underground utilities in the area to be remediated. The zone to be remediated may also be modified to address such issues.

APPENDIX A

SURVEY MAP



REVISIONS	VALLEY COTTAGE	YEC, INC.		NEW
	FARRAND CONTROLS PROPERTY SURVE			
	TOWN OF MOUNT PLEASANT			
	WESTCHESTER COUNTY, NEW YORK			
DATE: MARCH 2005	SCALE: 1" = 50'	DRAWN BY: MBW	CHECKED BY: DRS	JOB N A0198

NOTES:

1. TAX LOT: 117.10-2-1
2. RECORD OWNER: RUHLE COMPANIES, INC. 99 WALL STREET, VALHALLA, NY 10595
3. RECORD DEED: LIBER 10074 PAGE 287
4. AREA: 13.572 ACRES
5. HORIZONTAL DATUM: NAD 1983 FROM GPS OBSERVATIONS
6. VERTICAL DATUM: NAVD 88 FROM GPS OBSERVATIONS
7. SUBJECT TO THE FINDINGS OF AN UP TO DATE ABSTRACT OF TITLE.
8. UNAUTHORIZED ALTERATION OR ADDITION TO A SURVEY MAP BEARING A LICENSED LAND SURVEYOR'S EMBOSSED SEAL IS A VIOLATION OF SECTION 7209 SUBDIVISION 2, OF THE NEW YORK STATE EDUCATION LAW.
9. ONLY COPIES FROM THE ORIGINAL TRACING MARKED WITH THE LAND SURVEYOR'S EMBOSSED SEAL SHALL BE CONSIDERED TO BE VALID, TRUE COPIE
10. UTILITIES SHOWN SURVEYED AS MARKED IN FIELD ON DECEMBER 17, 2004
11. LOT 1 APPARENTLY USING DRIVEWAYS ON LOT 2 AS ACCESS.

REFERENCES:

-BEING PARCEL 2 AS SHOWN ON A MAP ENTITLED "SUBDIVISION MAP PREPARED FOR FARRAND REALTY CORP.", FILED IN THE WESTCHESTER COUNTY CLERK'S OFFICE ON DECEMBER 17, 1990 AS MAP NO. 24303

-DEEDS AS NOTED

-MAP ENTITLED "SUBDIVISION MAP, HOLLY RIDGE", FILED IN THE WESTCHESTER COUNTY CLERK'S OFFICE ON JUNE 20, 1972 AS MAP NO. 17748

LEGEND

- GEOPROBE
- SEWER MANHOLE
- UNDERGROUND SEWER LINE
- CATCH BASIN FIELD INLET
- CATCH BASIN
- DRAINAGE MANHOLE
- UNDERGROUND DRAINAGE TILE
- GAS VALVE
- UNDERGROUND GAS LINE
- WATER VALVE
- HYDRANT
- UNDERGROUND WATER LINE
- UNDERGROUND ELECTRIC LINE
- UNDERGROUND TELEPHONE LINE
- UNDERGROUND UNKNOWN UTILITY LINE
- UTILITY POLE
- GUY WIRE AND ANCHOR
- OVERHEAD UTILITY LINE
- CHAIN LINK FENCE
- EASEMENT LINE
- PROPERTY LINE
- SUBDIVISION LOT NUMBER
- 117-10-2-5 N/F PINEDA 5 HOLLY RIDGE ROAD VALHALLA, NY 10595 L. 10066 P. 317 — TAX LOT NUMBER, OWNER, ADDRESS, DEED

APPENDIX B

UTILITY SURVEY AND PHOTOGRAPHS

HAGER-RICHTER
GEOSCIENCE, INC.

UTILITY LOCATION SURVEY
FARRAND CONTROLS SITE
99 WALL STREET
VALHALLA, NEW YORK

Prepared for:

Dvirka & Bartilucci Consulting Engineers
330 Crossways Park Drive
Woodbury, New York 11797-2015

Prepared by:

Hager-Richter Geoscience, Inc.
417 Berkeley Avenue
Orange, New Jersey 07050

File 04MH22
February, 2005

HAGER-RICHTER
GEOSCIENCE, INC.

CONSULTANTS IN GEOLOGY & GEOPHYSICS
417 BERKELEY AVENUE
ORANGE, NEW JERSEY 07050-2106
TELEPHONE (973) 676-3001
FAX (973) 676-4599

February 22, 2005
File 04MH22

David Glass
Dvirka & Bartilucci Consulting Engineers
330 Crossways Park Drive
Woodbury, New York 11797-2015

Tel: (516) 364 - 9890
Fax: (516) 364 - 9045

RE: Utility Location Survey
Farrand Controls Site
99 Wall Street
Valhalla, New York

Dear Mr. Glass:

In this letter, we report the results of a geophysical survey conducted on December 8-10, and 13, 2004, and January 11 and 19 2005, by Hager-Richter Geoscience, Inc. (H-R) at the Farrand Controls Site located at 99 Wall Street in Valhalla, New York for Dvirka & Bartilucci Consulting Engineers (D&B) of Woodbury, New York. The scope of the project and area of interest were specified by D&B. The geophysical survey is part of an environmental investigation by D&B for the New York State Department of Environmental Conservation.

INTRODUCTION

The Site is an active industrial facility, approximately 6-acres in size, located at 99 Wall Street in an industrial section of Valhalla, New York. The general location of the site is shown in Figure 1. The Site consists of a facility building, asphalt paved areas, landscaping, and grass areas.

D&B requested that a subsurface utility location survey be conducted at the site. The area of interest for the geophysical survey was the accessible exterior portions of the site as specified by D&B.

OBJECTIVE

The objective of the geophysical survey was to detect and mark-out, with spray paint or pin flags, the horizontal locations of detectable subsurface utilities and subsurface objects in the accessible exterior portions of the site, as specified by D&B.

THE SURVEY

José Carlos Cambero Calzada of H-R conducted the field operations on December 8-10, and 13, 2004 and January 11 and 19 2005. The project was coordinated with Mr. Albert H. Jaroszewski of D&B, who was present at the site and specified the areas of interest for the geophysical survey.

The utility location survey was conducted using two complementary geophysical methods: Precision Utility Location (PUL) and Ground Penetrating Radar (GPR). The PUL equipment was used primarily in the accessible portions of the area of interest to detect possible utilities. The detected utilities were marked on the ground with spray paint or pin flags. GPR data were acquired along lines oriented perpendicular to utilities detected with PUL with variable line spacing, primarily to confirm the presence of such utilities. In addition, GPR data were acquired along traverses spaced no more than 5 feet apart, and oriented parallel and perpendicular to the building.

EQUIPMENT

PUL. The PUL survey was conducted using a precision electromagnetic pipe and cable locator, Radiodetection RD400 series. The RD400 series consists of separate transmitter and receiver. The system can be used in "passive" and "active" modes to locate buried pipes by detecting electromagnetic signals carried by the pipes. In the "passive" mode, only the receiver unit is used to detect signals carried by the pipe from nearby power lines, live signals transmitted along underground power cables, or very low frequency radio signals resulting from long wave radio transmissions that flow along buried conductors. In the "active" mode of operation, the transmitter is used to induce a signal on a target pipe, and the receiver is used to trace the signal along the length of the pipe

GPR. The GPR survey was conducted using a Sensors & Software Smart Cart Noggin Plus digital subsurface imaging radar system. The system includes a survey wheel that triggers the recording of the data at fixed intervals, thereby increasing the accuracy of the locations of features detected along the survey lines. The GPR system was used with a 500 MHZ antenna and a 75 ns time window[1].

---

[1] A 75 nanosecond (ns) time window corresponds to an approximate *potential* depth of exploration of about 4 meters (m) (12 ft) below grade based on handbook values for the velocity of GPR signals in asphalt pavement (velocity = 0.1 m/ns or 0.328 ft/ns). A nanosecond is 1/1,000,000,000 second. Light and the GPR signal require about 1 ns to travel 1 ft in air. The GPR signal requires about 3.5 ns to travel 1 ft in unsaturated sandy soil.

LIMITATIONS OF THE METHODS

HAGER-RICHTER GEOSCIENCE, INC. MAKES NO GUARANTEE THAT ALL UTILITIES WERE DETECTED IN THIS SURVEY. HAGER-RICHTER GEOSCIENCE, INC. IS NOT RESPONSIBLE FOR DETECTING UTILITIES THAT NORMALLY CANNOT BE DETECTED BY THE METHODS EMPLOYED OR THAT CANNOT BE DETECTED BECAUSE OF SITE CONDITIONS. HAGER-RICHTER IS NOT RESPONSIBLE FOR MAINTAINING MARKOUTS AFTER LEAVING THE WORK AREA. MARKOUTS MADE IN INCLEMENT WEATHER AND, IN PARTICULAR, UNDER WINTER CONDITIONS MAY NOT LAST.

PUL. The PUL equipment cannot detect non-metallic utilities, such as pipes constructed of vitrified clay, plastic, PVC, and unreinforced concrete, when used in passive mode alone. Such pipes can be detected if a wire tracer is installed with access to such tracer for transmission of a signal or where access (such as floor drains and clean-outs) permits insertion of a device on which a signal can be transmitted.

In some, but not all, cases, the subsurface utility designation equipment cannot detect metal utilities reliably under reinforced concrete because the signal couples onto the metal reinforcing in the concrete. Similarly, the method commonly cannot be used adjacent to grounded metal structures such as chain link fences and metal guardrails.

In congested areas, where several utilities are bundled or located within a short distance, the signal transmitted on one utility can couple onto adjacent utilities, and the accuracy of the location indicated by the instrument decreases.

GPR. There are limitations of the GPR technique as used to detect and/or locate targets such as those of the objectives of this survey: (1) surface conditions, (2) electrical conductivity of the ground, (3) contrast of the electrical properties of the target and the surrounding soil, and (4) spacing of the traverses. Of these restrictions, only the last is controllable by us.

The condition of the ground surface can affect the quality of the GPR data and the depth of penetration of the GPR signal. Sites covered with snow piles, high grass, bushes, landscape structures, debris, obstacles, soil mounds, etc. limit the survey access and the coupling of the GPR antenna with the ground. In many cases, the GPR signal will not penetrate below concrete pavement, especially inside buildings, and a target may not be detectable. The GPR method also commonly does not provide useful data under canopies found at some facilities.

The electrical conductivity of the ground determines the attenuation of the GPR signals, and thereby limits the maximum depth of exploration. For example, the GPR signal does not penetrate clay-rich soils, and targets buried in clay might not be detected.

A definite contrast in the electrical conductivities of the surrounding ground and the target material is required to obtain a reflection of the GPR signal. If the contrast is too small then the reflection may be too weak to recognize, possibly due to deeply corroded metal in the target, the target can be missed.

Spacing of the traverses is limited by access at many sites, but where flexibility of traverse spacing is possible, the spacing is adjusted to the size of the target.

RESULTS

General. The geophysical survey consisted of a PUL and GPR survey in the accessible exterior portions of the site. Plate 1 is a site plan showing the results of the geophysical survey. Access was limited in some areas by weeds. Most of the utilities detected by H-R were located using the PUL equipment, or a combination of PUL and GPR equipment. A few unidentified possible utility segments were located with the GPR only.

PUL. In general, the PUL transmitter was attached to known utilities, inside the building as well as in exterior portions of the site, (e.g., water meter, gas meter; light posts, utility poles and electrical conduits), and the resultant signal was traced with the receiver. Utilities detected at the site were marked on the ground with spray paint, and their locations are shown on Plate 1.

Some PVC pipes were also traced by feeding a steel plumbers snake through them and introducing an electrical current on the snake, and marking out the resultant signal. The locations of gas and communication lines detected by H-R, which had been marked out on the ground prior to our field work, were confirmed with PUL. The "inactive" utilities according to Mr. Michael Frenz of the Farrand Controls Site facility, as shown on Plate 1, were detected with the PUL equipment and were later confirmed with the GPR.

GPR. GPR signal penetration in general was good. Reflections were recorded for approximately 30-35 nsec of the 75 nsec time window used for the 250 MHz and 500 MHz antenna. Based on handbook time-to-depth conversions for the GPR signal in average soils, the GPR signal penetration is estimated to have been approximately between 4-5 feet.

The GPR records for the subject site contain reflections typical of utility line segments and their locations are shown on Plate 1. A few unidentified possible utility segments and small unidentified buried objects, roughly 1-1½ feet in diameter, were located with the GPR only, and their locations are shown on Plate 1.

With the exception of utility segments and small unidentified buried objects located by the geophysical survey, no other structures with: (1) electrical properties sufficiently contrasting with the surrounding soils to produce GPR reflections were detected within the effective depth of penetration of the GPR signal (approximately 4-5 feet) in the surveyed area. *Whether utilities are present at depths greater that the effective depth of penetration of the GPR signal or in areas inaccessible to the geophysical survey cannot be determined from the geophysical data.*

CONCLUSION

Based on the utility location survey conducted by H-R at the Farrand Controls Site located at 99 Wall Street in Valhalla, New York, we conclude:

- Utilities, several unidentified utility segments and small unidentified buried objects, roughly 1-1½ feet in diameter, were detected using the PUL and/or GPR equipment.

LIMITATIONS ON USE OF REPORT

This letter report was prepared for the exclusive use of Dvirka & Bartilucci Consulting Engineers (Client). No other party shall be entitled to rely on this Report or any information, documents, records, data, interpretations, advice or opinions given to Client by Hager-Richter Geoscience, Inc. (H-R) in the performance of its work. The Report relates solely to the specific project for which H-R has been retained and shall not be used or relied upon by Client or any third party for any variation or extension of this project, any other project or any other purpose without the express written permission of H-R. Any unpermitted use by Client or any third party shall be at Client's or such third party's own risk and without any liability to H-R.

H-R has used reasonable care, skill, competence and judgment in the performance of its services for this project consistent with professional standards for those providing similar services at the same time, in the same locale, and under like circumstances. Unless otherwise stated, the work performed by H-R should be understood to be exploratory and interpretational in character and any results, findings or recommendations contained in this Report or resulting from the work proposed may include decisions which are judgmental in nature and not necessarily based solely on pure science or engineering. It should be noted that our conclusions might be modified if subsurface conditions were better delineated with additional subsurface exploration including, but not limited to, test pits, soil borings with collection of soil and water samples, and laboratory testing.

Except as expressly provided in this limitations section, H-R makes no other representation or warranty of any kind whatsoever, oral or written, expressed or implied; and all implied warranties of merchantability and fitness for a particular purpose, are hereby disclaimed.

If you have any questions or comments on this letter report, please contact us at your convenience. It has been a pleasure to work with Dvirka & Bartilucci Consulting Engineers on this project. We look forward to working with you again in the future.

Sincerely yours,
HAGER-RICHTER GEOSCIENCE, INC.

Mohamed Hayat
Project Manager

Dorothy Richter, P.G.
President

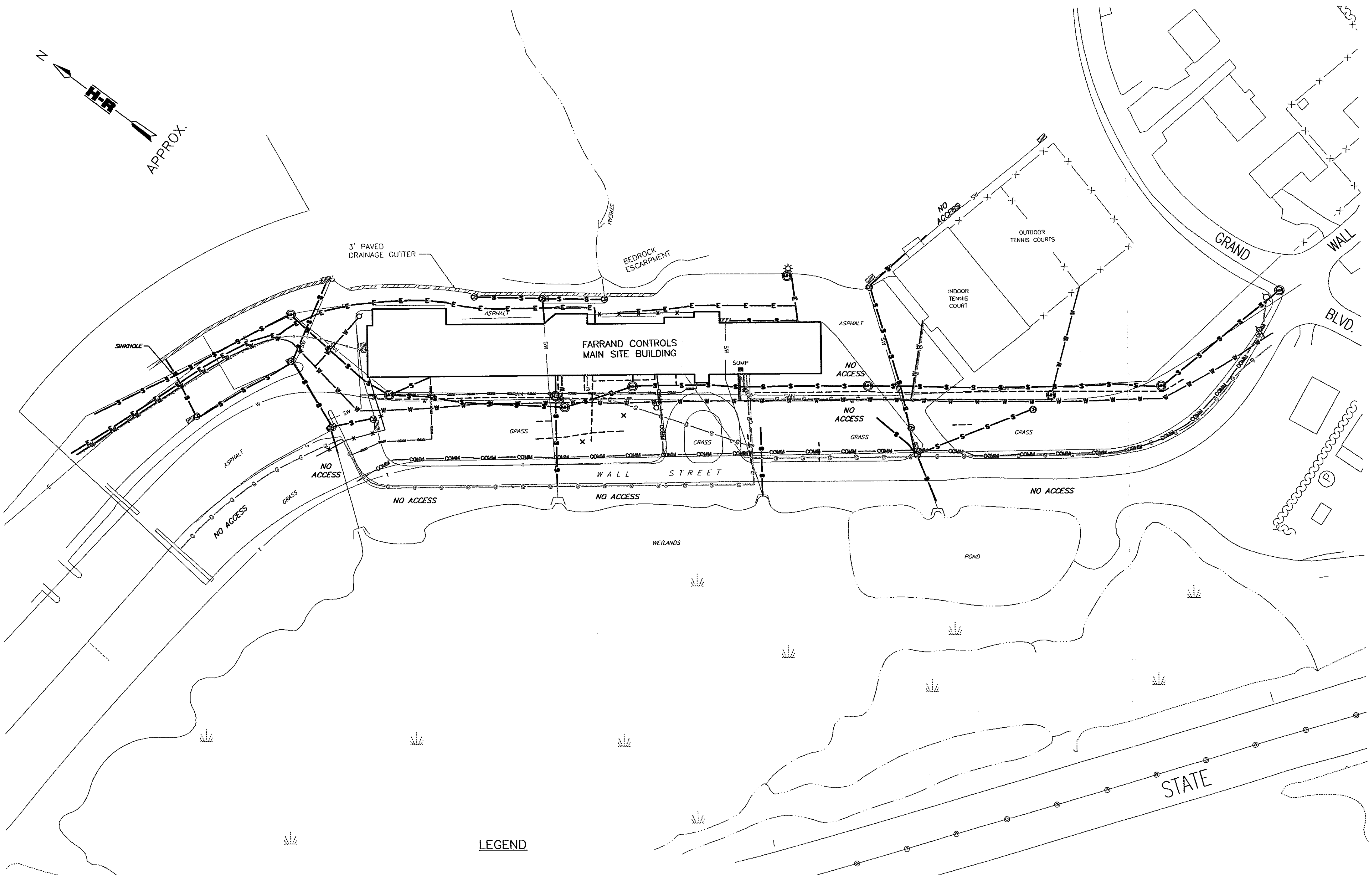
Attachments:

1. Figure 1
2. Plate 1

LOCATION

SCALE (feet)

Figure 1 General Site Location Farrand Controls Site 99 Wall Street Valhalla, New York	
File 04MH22	February, 2005
HAGER–RICHTER GEOSCIENCE, INC. Orange, New Jersey	



LEGEND

GPR TRAVERSE	UNIDENTIFIED BURIED OBJECT
GAS LINE	UTILITY POLE
GAS LINE (INACTIVE)	MANHOLE
ELECTRIC LINE	CATCH BASIN
WATER LINE	HYDRANT
SEWER LINE	WATER VALVE
COMMUNICATION LINE	LIGHT POLE
COMMUNICATION LINE (INACTIVE)	FENCE
POSSIBLE UTILITY	

SCALE (feet)
0 60 120

NOTE:

Modified from site plan provided by Dvirka and Bartilucci Consulting Engineers.

PLATE 1
UTILITY LOCATION SURVEY
FARRAND CONTROLS SITE
99 WALL STREET
VALHALLA, NEW YORK

FILE 04MH22 | DECEMBER, 2004

HAGER-RICHTER GEOSCIENCE, INC.
ORANGE, NEW JERSEY

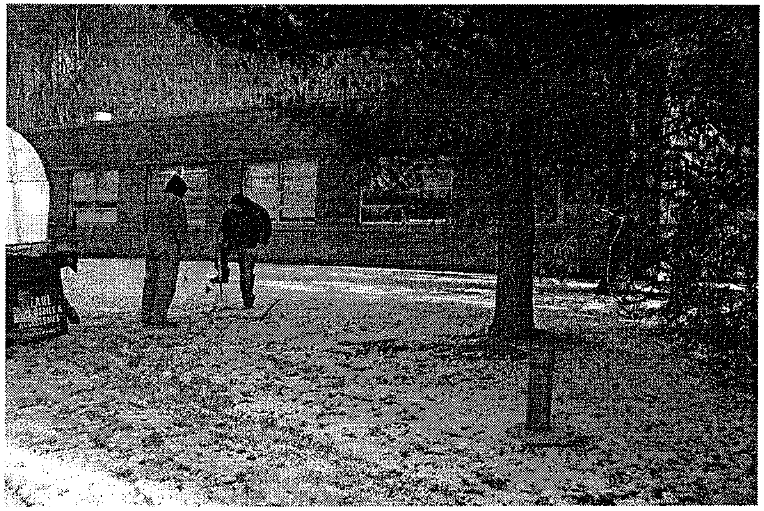
Table B-1

FARRAND CONTROLS SITE
PRE-DESIGN INVESTIGATION REPORT
BURIED UTILITY INFORMATION

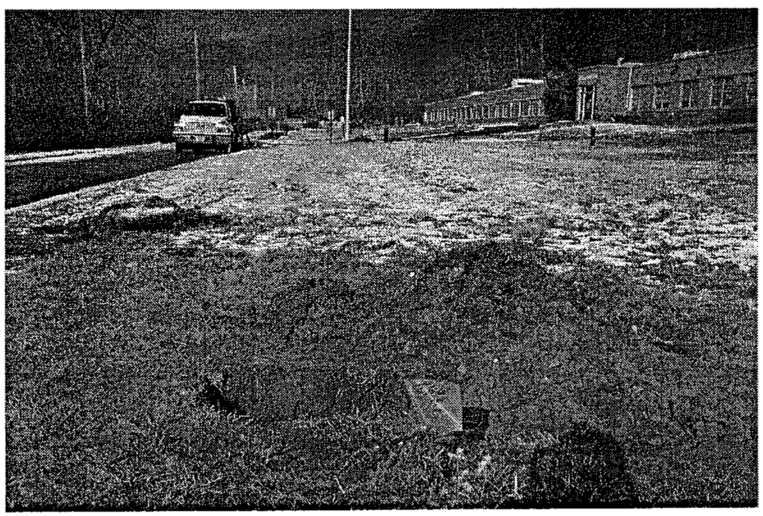
Location	Utility	Conduit Type and Diameter	Depth (feet below grade)	Backfill Type	Photograph No.
Front Main Building Basement Near Entrance	Gas line	1 ½" Steel	4.2	--	10
	Water line (abandoned)	1 ½" Steel	4.6	--	10
	Water line	6" Iron	6.8	--	10
	Sanitary	4" Cast Iron	5	--	10
East Main Building Basement Near Front Wall	Gas Main	2" Steel	3.5	--	8, 9
	Water Main	6" Cast Iron	4.5"	--	8
Front of Main Building Near SE Corner	None	None discerned	5.5	--	1
Along Wall Street	Gas line	2" Steel	3	Gray F-M sand	2
Along Wall Street	Storm water	24" Corrugated metal	1	Brown poorly sorted sand	4, 5, 12
East of Main Building Entrance in Lawn	None	None	5	----	3, 12, 14, 20, 21
Front of Main Building	Storm water	8" Metal	5	--	5, 11, 12
	Storm water	2.5" Concrete	6	--	5, 11, 12
	Sanitary	Open concrete	4	--	5, 11, 12
Main Lawn SE Corner	Catch Basins	1.5" Concrete	3.5"	--	26, 27
Along Wall Street West of Main Building Entrance	Telephone	4" PVC and 1.2" cable	1.2	--	15
East Lawn	Storm water	1 ½' unknown	1		20

FARRAND CONTROLS SITE
ENGINEERING DESIGN REPORT
PHOTOGRAPH INDEX

Photograph #	Description
1	Front of main building near southeast corner looking north showing utility mark-outs.
2	Front lawn of main building near Wall Street looking northwest showing communication and gas line mark-outs.
3	Front lawn of main building looking southeast with central storm water conduit excavation in foreground.
4	Western storm water conduit from outfall looking northeast towards main building.
5	Area of western storm water conduit looking southwest at storm water manhole, hydrant and sanitary system manhole.
6	Communication line splice-box in front of main building.
7	Area of hydrant looking east towards main building front entrance.
8	Water main entering main building basement wall.
9	Gas main entering main building basement wall.
10	Utility conduits through main building basement wall near sump.
11	Western storm water sewer manhole showing conduit from main building.
12	Front lawn of main building looking southeast.
13	Front of main building looking northeast towards front entrance showing communication line splice-box and hydrant.
14	Front lawn adjacent to main building from main entrance looking southeast.
15	Front lawn adjacent to main building from main entrance looking northwest.
16	Wall Street and front lawn of main building looking northwest.
17	Wall Street and front lawn of main building looking southeast.
18	East paved lot looking northeast with storm drain in foreground and tennis court building in background.
19	East paved lot looking east towards tennis court building.
20	Lawn south of tennis court building looking southeast towards Grand Boulevard and site entrance.
21	Wall Street and tennis court building lawn looking southeast towards site entrance.
22	Behind main building looking southeast.
23	Behind main building looking northwest and showing basement ramp.
24	Behind main building looking east at "Farrand Falls" and storm water drains along bedrock outcrop.
25	North storm water drain looking southeast in east paved lot near bedrock outcrop with tennis court building in background.
26	Wall Street and lawn from site entrance.
27	Storm water drains of eastern storm water drainage system at south end of east paved lot.



1. Front of main building near southeast corner looking north showing utility mark-outs.

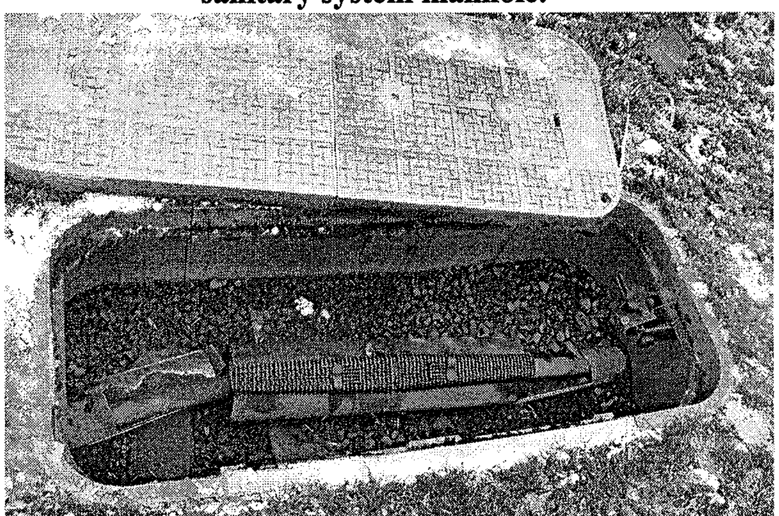


2. Front lawn of main building near Wall Street looking northwest showing mark-outs.

3. Front lawn of main building looking southeast with central storm water conduit excavation in foreground.

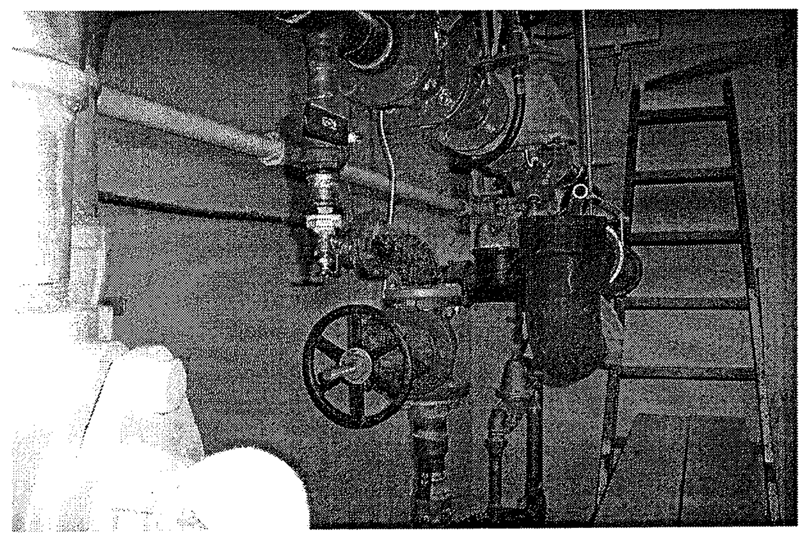
4. Western storm water conduit looking from outfall northeast back to building.

5. Area of western storm water conduit looking south at storm water manhole, hydrant and sanitary system manhole.

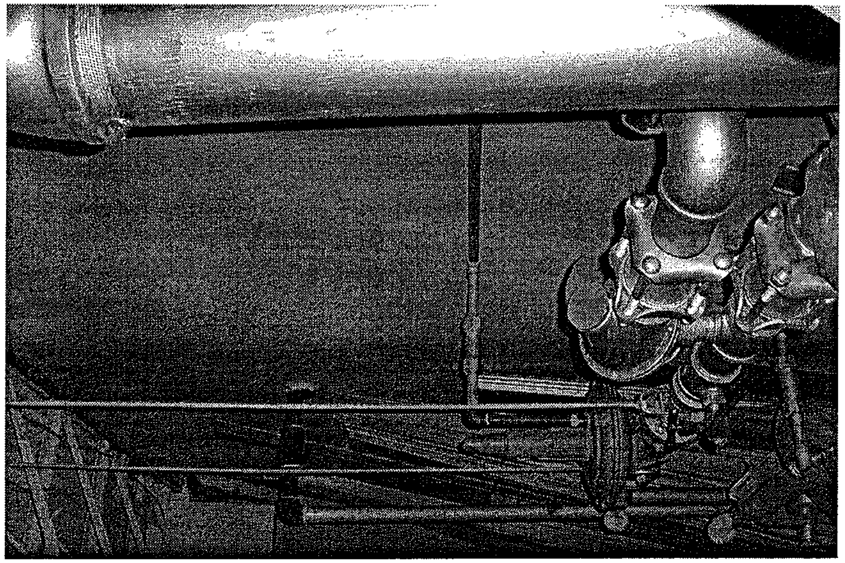


6. Communication line splice-box in front of main building.

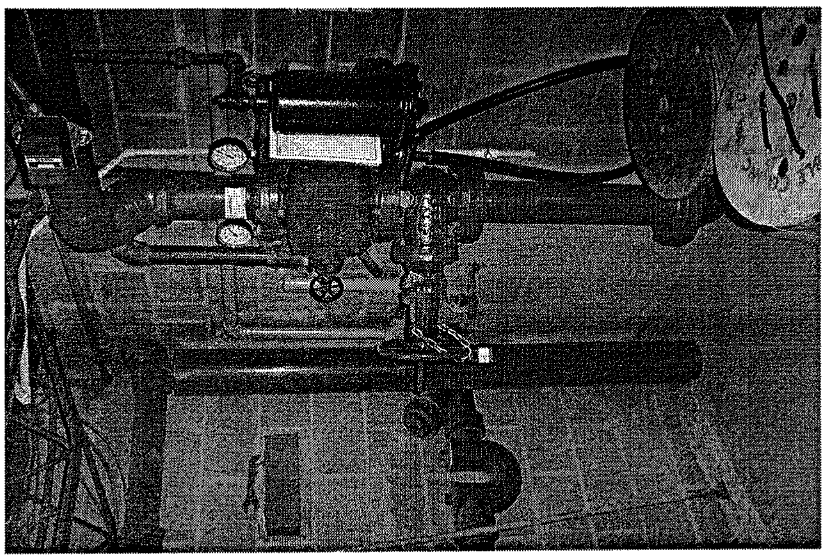
7. Area of hydrant looking east towards main building entrance.



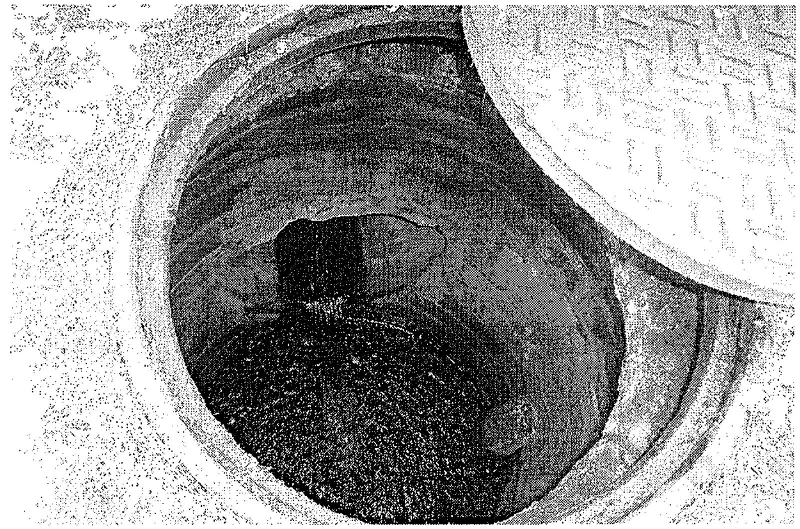
8. Water main entering main building basement wall.



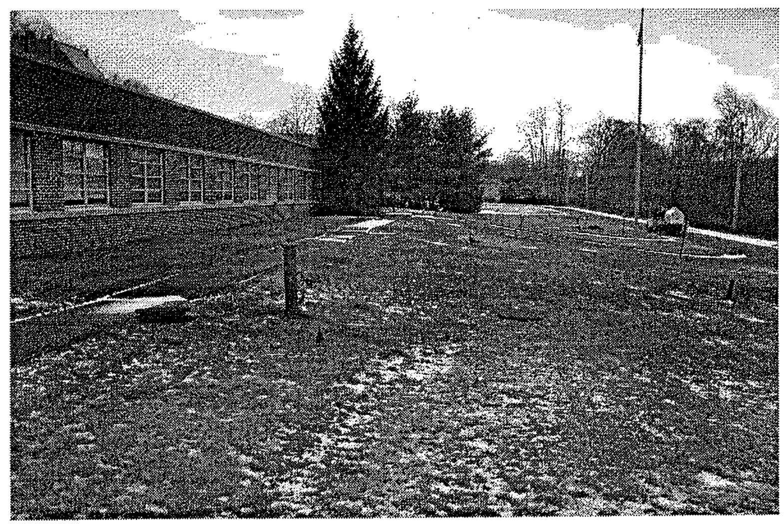
9. Gas main entering main building basement wall.



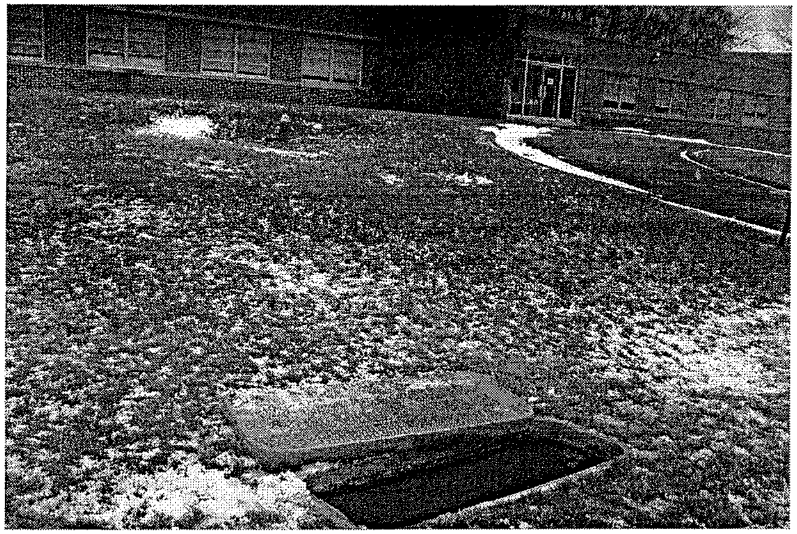
10. Utility conduits through main building basement wall near former main sump.



11. Western storm water sewer manhole showing conduit from main building.



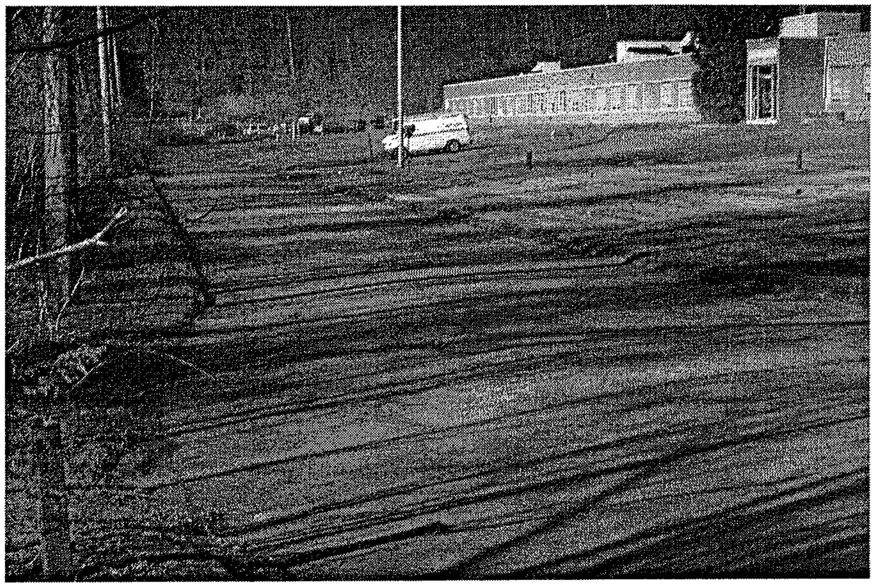
12. Front lawn of main building looking southeast.



13. Front of main building looking northeast towards front entrance showing communication line splice-box and hydrant.

15. Front lawn adjacent to main building from main entrance looking northwest.

14. Front lawn adjacent to main building from main entrance looking southeast.

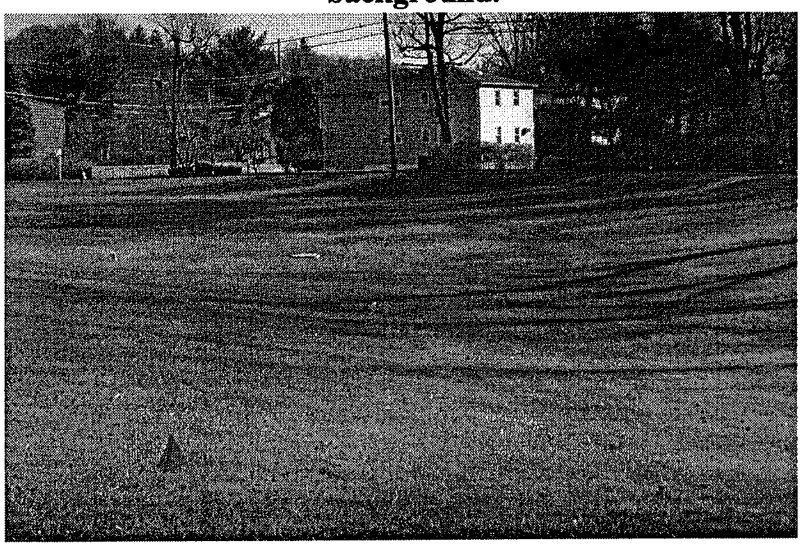


16. Wall Street and main building front lawn looking northwest.

17. Wall Street and front lawn of main building looking southeast.

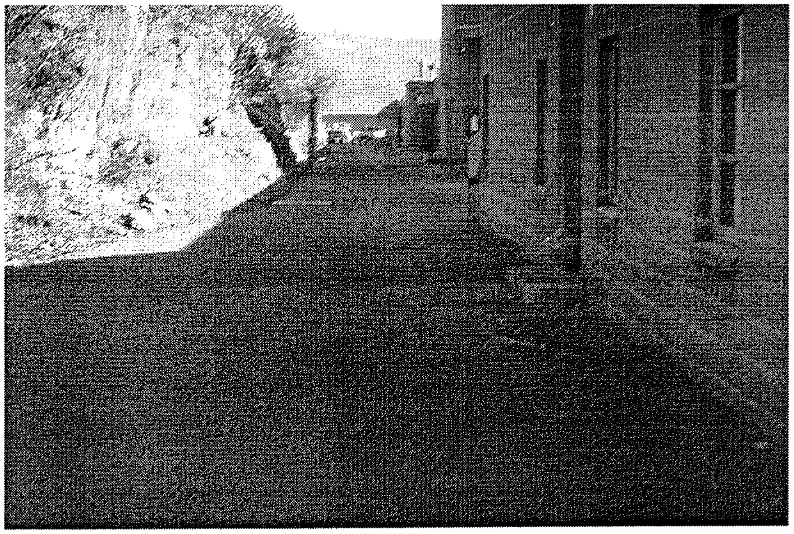
18. East paved lot looking northeast with storm water drain in foreground and tennis court building in background.

19. East paved lot looking east towards tennis court building.

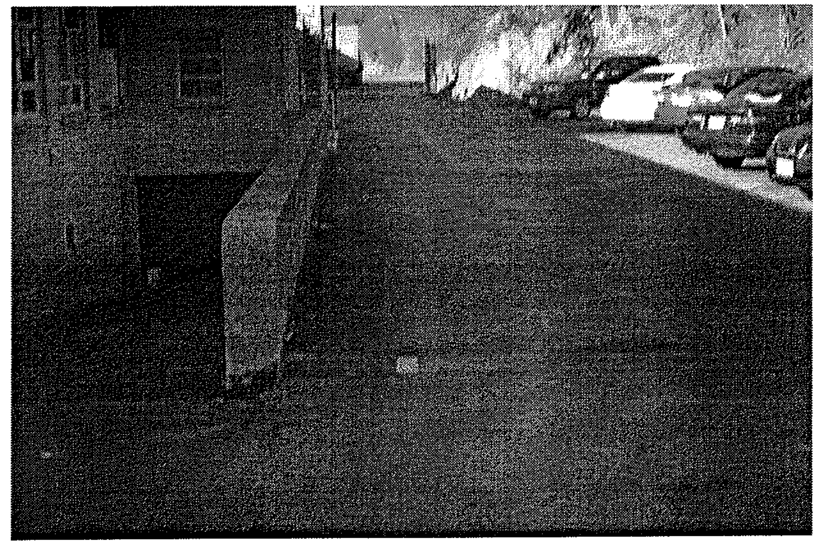


20. Lawn south of tennis court building looking southeast towards site entrance.

21. Wall Street and tennis court building lawn looking southeast towards site entrance.



22. Behindmain building looking southeast.



23. Behind main building looking northwest at ramp.

24. "Farrand Falls" and storm water drains looking east along bedrock outcrop in rear of main building.

25. North storm water drain in east paved lot near bedrock outcrop with tennis court building in background.

26. Wall Street and lawn looking west from site entrance.

27. Storm water drains of eastern storm water drainage system at south end of east paved lot.

APPENDIX C

SOIL PROBE HOLE LOGS

DVIRKA AND BARTILUCCI

DRILLING LOG

DRILLING CONTRACTOR
Driller: Zebra
Inspector: Keith Robins
Rig Type: Geoprobe
Drilling Method: Geoprobe
Drive Hammer Weight: NA

PROJECT NAME: FARRAND CONTROL
PROJECT #: 2276
Location/Address:

BORING NUMBER: SP-1
Sheet 1 of 1
Boring Location:

GROUNDWATER OBSERVATIONS

Water Level			
Time			
Date			
Casing Depth			

Weather: Cold, Chilly 30°F
Date/Time Start: 12/28/04
Date/Time Finish: 12/28/04

Plot Plan: Soil samples collected for lab analysis from (3.5-4') AND (4'-4.5 FT)

Sample Depth	Sample Number	SPT Rec.	PID/FID Reading
0-4	SS-1	36"	0.0
4-6	SS-2	24"	0.0

FIELD IDENTIFICATION OF MATERIAL

(0-2") Asphalt and black stones
(2"-24") Brown-Orange fine Sand, trace fine gravel, trace silt, dry
(24"-36") Crushed gravel and stones, damp
(4'-4.5') Brown-Orange silty fine Sand, wet, well sorted
(4.5-6') Gray-white WEATHERED ROCK, brittle, crushed rock Dry

TOP OF ROCK AT 6 FT

END OF BORING AT 6 FT

WELL SCHEMATIC

COMMENTS

WET @ 3.5 TO 4.0

Geoprobe hit Refusal At 6 (FT)

Soil Stratigraphy Summary

SPT = STANDARD PENETRATION TEST

DVIRKA AND BARTILUCCI

DRILLING LOG

DRILLING CONTRACTOR		
Driller: Zebra	PROJECT NAME: FARRAND CONTROL	BORING NUMBER: SP-2
Inspector: Keith Robins		Sheet 1 of 1
Rig Type: Geoprobe	PROJECT #: 2276	Boring Location:
Drilling Method: Geoprobe	Location/Address:	
Drive Hammer Weight: —		

GROUNDWATER OBSERVATIONS			
Water Level			
Time			
Date			
Casing Depth			

Weather: Cold, chilly 30°F

Date/Time Start: 12/28/04

Date/Time Finish: 12/28/04

Plot Plan: Soil samples collected for Lab analysis from (8-8.5') and (9-9.5')

Sample Depth	Sample Number	SPT Rec=	PID/FID Reading	FIELD IDENTIFICATION OF MATERIAL	WELL SCHEMATIC	COMMENTS
0-4	SS-1	36"	0.0	(0-2") Asphalt and stones (2"-36") Brown-Orange Silty SAND, little gravel, crushed stone, compacted, dry		
4-8	SS-2	48"	0.0	(4'-8') Brown-Orange-Light Red, coarse to fine Sand and fine to coarse white quartz stone, crushed at 7.5 FT (noted red silty clay seam moist at 4.5 FT)		
8-11	SS-3	36"	0.0	(8-9.5') Brown-Orange fine Silty SAND		WET AT 8 FT
				(9.5'-11') Weathered ROCK, crushed, rock fragments, brittle, extremely weathered Rock, DRY		TOP OF WEATHERED Rock
						GEOPROBE Hit REFUSAL AT 11 FT
				XX END OF BORING XXX AT 11 FT		

SPT = STANDARD PENETRATION TEST

Soil Stratigraphy Summary

DVIRKA AND BARTILUCCI

DRILLING CONTRACTOR
Driller: zebra
Inspector: Keith Robins
Rig Type: Geoprobe
Drilling Method: Geoprobe
Drive Hammer Weight: –

DRILLING LOG
PROJECT NAME: Farrand Control
PROJECT #: 2276
Location/Address:

BORING NUMBER SP-3
Sheet 1 of 1
Boring Location:

GROUNDWATER OBSERVATIONS

Water Level			
Time			
Date			
Casing Depth			

Weather: cold, chilly 30°F
Date/Time Start: 12/28/04
Date/Time Finish: 12/28/04

Plot Plan
Soil samples collected for lab analysis from (5.5-6') and (6.5-7')

Sample Depth	Sample Number	SPT Rec:	PID/FID Reading	FIELD IDENTIFICATION OF MATERIAL	WELL SCHEMATIC	COMMENTS
0-4	SS-1	48"	0.0	(0-4") Asphalt and stones (4"-12") Brown - Orange fine to medium Sand, well sorted, trace fine gravel (12"-18") Brown ~~to~~ Orange silty Sand, some fine gravel		
4-7	SS-2	36"	0.0	(18"-36") Gray - Black silt with fine rock fragments, trace fine gravel, compacted. (4-5.5) Black - Gray silt, some fine gravel (5.5'-7') Brown - Gray silty fine Sand, little - trace fine gravel, Gray - white rock pieces and crushed rock, compacted, damp to moist.		Geoprobe Refusal AT 7 FT below grade
				XXX END OF BORING AT 7' XX		

SPT = STANDARD PENETRATION TEST

Soil Stratigraphy Summary

DVIRKA AND BARTILUCCI

DRILLING CONTRACTOR	DRILLING LOG	BORING NUMBER SP-4
Driller: Zebra	PROJECT NAME: Farrand Control	Sheet 1 of 1
Inspector: Keith Robins		Boring Location
Rig Type: Geoprobe	PROJECT #: 2276	
Drilling Method: Geoprobe	Location/Address	
Drive Hammer Weight: —		

GROUNDWATER OBSERVATIONS

Water Level			
Time			
Date			
Casing Depth			

Weather: Cold chilly 30 °F

Date/Time Start: 12/28/04

Date/Time Finish: 12/28/04

Plot Plan: Soil samples collected for lab analysis from (8'-8.5') and (18.5' to 19')

Sample Depth	Sample Number	SPT Rec	PID/FID Reading	FIELD IDENTIFICATION OF MATERIAL	WELL SCHEMATIC	COMMENTS
0-4	SS-1	48"	0.0	(0-4") Asphalt with stones (4"-2') Dark Brown Silty Sand and gravel (2'-4') Dark Gray - Black silty fine Sand, some gravel, trace broken glass fragments and rock pieces, poorly sorted, damp		
4-8	SS-2	36"	0.0	(4'-5') Black - Gray compacted silty sand, subrounded gravel; damp (5'-8') Brown - Orange Silty Sand with fine to medium gravel, rock fragments, well sorted, compacted moist.		
8-12	SS-3	48"	0.0	(8'-12') Brown - Orange silty sand AND fine to coarse gravel, rock pieces, compacted, WET AT 8 FT		▽ WET AT 8 FT.
12-16	SS-4	24"	0.0	(12'-16') Gravel fine to coarse stones 2 inch MAX size, AND rock fragments compacted with some Dark Brown Silty SAND, poorly sorted, WET TO moist		
16-19	SS-5	24"	0.0	(16'-19') Dark Brown to Gray silty Sand, compacted fine gravel with some weathered rock fragments, poorly sorted, WET. HARD Rock Encountered AT 19 FT XXX END OF Boring at 19 FT XX		XXXXX ROCK SURFACE AT ≈ 19 FT

SPT = STANDARD PENETRATION TEST

Soil Stratigraphy Summary

DVIRKA AND BARTILUCCI

DRILLING LOG

DRILLING CONTRACTOR

Driller: Zebra

Inspector: Keith Robins

Rig Type: Geoprobe

Drilling Method: Geoprobe

Drive Hammer Weight: NA

PROJECT NAME: FARRAND CONTROL

PROJECT #: 2276

Location/Address:

BORING NUMBER: SP-5

Sheet 1 of 1

Boring Location:

GROUNDWATER OBSERVATIONS

Water Level			
Time			
Date			
Casing Depth			

Weather: Cold, Chilly 30 °F

Date/Time Start: 12/28/04

Date/Time Finish: 12/28/04

Plot Plan: Soil samples collected for lab analyses from (21.5 to 22) And (7.5 to 8')

Sample Depth	Sample Number	SPT Rec"	PID/FID Reading	FIELD IDENTIFICATION OF MATERIAL	WELL SCHEMATIC	COMMENTS
0-4	SS-1	48"	0.0	(0-2") Asphalt and stones (2"-40") Brown fine Sand, trace fine gravel well sorted (40"-48") Dark Gray-Brown compacted Silty CLAY, trace Brown-Orange fine Sand, damp		
4-8	SS-2	40"	0.0	(4'-6') Brown-Olive Green fine SAND, well sorted (6-8') Brown-Orange compacted medium SAND, some gravel, poorly sorted, loose, broken rock pieces Moist to damp AT Tip of sampler		
8-12	SS-3	40"	0.0	(8-9') Brown-Orange course-medium Sand, WET (9'-11') Brown Silty SAND, some gravel, well sorted, compacted, moist (11-12') Dark Brown Course to Medium SAND, some fine-Course subrounded gravel loose, poorly sorted, WET-Moist		WET AT 8 FT
12-16	SS-4	48"	0.0	(12-16') Brown-Dark Brown Silty SAND, compacted, well sorted, some fine to medium gravel, moist to damp		
16-20	SS-5	48"	0.0	(16-20') Dark Brown-Brown compacted Silty Sand with fm subrnd. gravel, tr. rock fragments, wet to saturated noted AT (17-18') Gravel and C Sand		
20-22	SS-6	24"	0.0	(20-22') Dark Brown to Gray Silty Sand, fm, compacted with crushed weathered gneiss rock AND fine gravel, dry weathered Rock		GEOPROBE HIT REFUSAL AT 22 FT Crushed Rock AT Tip AT 22 FT

Soil Stratigraphy Summary: (END OF BORING AT 22 FT)

SPT = STANDARD PENETRATION TEST

DVIRKA AND BARTILUCCI

DRILLING CONTRACTOR	DRILLING LOG	BORING NUMBER SP-6
Driller: Zebra	PROJECT NAME: FARRAND CONTROL	Sheet 1 of 1
Inspector: Keith Robins		Boring Location:
Rig Type: Geoprobe	PROJECT #: 2276	
Drilling Method: Geoprobe	Location/Address:	
Drive Hammer Weight: NA		

GROUNDWATER OBSERVATIONS

Water Level			
Time			
Date			
Casing Depth			

Weather: Cold, Chilly 30°F

Date/Time Start: 12/28/04

Date/Time Finish: 12/28/04

Plot Plan: Soil samples collected for lab analysis from (9.5-10') and (16.5 to 17').

Sample Depth	Sample Number	SPT Rec"	PID/FID Reading	FIELD IDENTIFICATION OF MATERIAL	WELL SCHEMATIC	COMMENTS
0-4'	SS-1	48"	0.0	(0-2") Asphalt and stones (2"-12") Dark Brown-Orange Sand and gravel		
4-8	SS-2	40"	0.0	(12"-14") Crushed stone (14"-36") Grayish-Black silty SAND, trace gravel		
8-12	SS-3	36"	0.0	(36"-48") Brown-Orange fine to medium Sand, trace gravel, dry to damp		
12-16	SS-4	48"	0.0	(4'-5') Light Tan fine Sand (5'-7') Brown to Orange coarse to fine well sorted sand,		
16-17	SS-5	12"	0.0	some fine to coarse gravel and crushed stone, dry (7'-8') Brown to Orange Coarse to medium Sand, fine to medium gravel, crushed 2" stone, loose, trace silt, moist to wet (7'-8') (8-10') Brown to TAN m-f Qtz Sand well sorted, trace fine subrnd. gravel, tr. silt. moist (10-12') Brown Coarse Sand AND Crushed Rock and coarse gravel, dry rock AT 11.5 FT (12-16') Brown-Tan-light Orange MF Sand, crushed stone, rock fragments, fm gravel (16-17') TAN-Orange fm Sand, f gravel, tr rock		WEATHERED Rock MIXED with trace silt WET 16' REFUSAL AT (17)

SPT = STANDARD PENETRATION TEST

Soil Stratigraphy Summary: pieces, weathered Rock at Tip MOIST TO WET (E.O.B. AT 17')

DVIRKA AND BARTILUCCI

DRILLING LOG

DRILLING CONTRACTOR
Driller: Zebra
Inspector: Keith Robins
Rig Type: Geoprobe
Drilling Method: Geoprobe
Drive Hammer Weight: NA

PROJECT NAME: FARRAND CONTROL
PROJECT #: 2276
Location/Address:

BORING NUMBER: SP-7
Sheet 1 of 1
Boring Location:

GROUNDWATER OBSERVATIONS

Water Level			
Time			
Date			
Casing Depth			

Weather: Cold, chilly 30°F
Date/Time Start: 12/28/04
Date/Time Finish: 12/28/04

Plot Plan: Soil samples collected from (6'-6.5') AND (11-11.5') for lab analysis.

Sample Depth	Sample Number	SPT Rec"	PID/FID Reading
0-4	SS-1	48"	0.0
4-8	SS-2	45"	0.0
8-11.5	SS-3	40"	0.0

FIELD IDENTIFICATION OF MATERIAL

(0-2") Asphalt
(2"-40") Brown-Orange Sand, some fine-medium gravel, dry.
(40"-48") Brown silty sand, compacted with gravel, dry.
(4'-6') Brown-Orange-yellow coarse to medium sand, little fine-gravel, moist
(6'-8') Brown-Orange coarse to medium Sand, some fine to coarse gravel, moist
(8'-11½') Brown medium to fine Sand, trace fine gravel, well sorted, trace decomposed broken bedrock pieces in tip weathered ROCK AT 11½ FT

—— XXX END OF BORING XXX —— AT 11.5 FT

WELL SCHEMATIC

COMMENTS

GEOPROBE HIT REFUSAL AT 11.5 FT

SPT = STANDARD PENETRATION TEST

Soil Stratigraphy Summary

DVIRKA AND BARTILUCCI

DRILLING CONTRACTOR	DRILLING LOG	BORING NUMBER SP-8
Driller: Zebra	PROJECT NAME: FARRAND CONTROL	Sheet 1 of 1
Inspector: Keith Robins		Boring Location
Rig Type: Geoprobe	PROJECT #: 2276	
Drilling Method: Geoprobe	Location/Address	
Drive Hammer Weight: NA		

GROUNDWATER OBSERVATIONS

Water Level			
Time			
Date			
Casing Depth			

Weather: Cold, Chilly 30°F

Date/Time Start: 12/28/04

Date/Time Finish: 12/28/04

Plot Plan: Soil samples collected at (0.5 - 1') and (2.5 to 3') for lab analysis

Sample Depth	Sample Number	SPT Rec=	PID/FID Reading	FIELD IDENTIFICATION OF MATERIAL	WELL SCHEMATIC	COMMENTS
0-3	SS-1	36"	0.0	(0-3") Black asphalt and stones (3"-36") Light Orange fine to medium SAND, some silt, trace to little fine to little subrounded gravel, stones, crushed rock fragments around (3 FT) with Dark Brown moist coarse to medium sand. ——XX END OF BORING ——XX AT 3FT		NO WATER Encountered XXXXX GEOPROBE HIT REFUSAL AT 3FT

SPT = STANDARD PENETRATION TEST

Soil Stratigraphy Summary

DVIRKA AND BARTILUCCI

DRILLING CONTRACTOR	DRILLING LOG	BORING NUMBER SP-9
Driller: Zebra	PROJECT NAME: FARRAND CONTROL	Sheet 1 of 1
Inspector: Keith Robins	PROJECT #: 2276	Boring Location:
Rig Type: Geoprobe	Location/Address:	
Drilling Method: Geoprobe		
Drive Hammer Weight: N-A		

GROUNDWATER OBSERVATIONS			
Water Level			
Time			
Date			
Casing Depth			

Weather: Cold, Chilly 30°F

Date/Time Start: 12/28/07

Date/Time Finish: 12/28/07

Plot Plan: Soil samples collected for lab analysis (6.5 - 7') and (13.5 to 14').

Sample Depth	Sample Number	SPT Rec."	PID/FID Reading	FIELD IDENTIFICATION OF MATERIAL	WELL SCHEMATIC	COMMENTS
0-4'	SS-1	48"	0.0	(0-2") Asphalt and stones (2"-36") Brown - Orange fine to medium Sand, little fine gravel, (36"-48") Dark Gray - Black Silty Sand, compacted, damp		
4-8	SS-2	40"	0.0	(4-5') Brown - Orange course to med Sand AND crushed fine gravel and crushed rock. (5'-6') Brown silty sand, compacted with gravel, moist - WET. (6-6.5') Black - Gray fine Sand, crushed rock (6.5-7') Brown - Orange fine Sand wet at 7 FT (7-8') Dark Brown fine to medium Sand, some silt, trace fine gravel, very moist		WET ≈ 7 FT
8-12	SS-3	48"	0.0	(8'-12') Dark Brown Gray compacted Silty SAND, some gravel, wet		
12-14	SS-4	24"	0.0	(12-13') Dark Brown - Orange medium to course sand, some silt, fine gravel, well sorted, moist to WET (13'-14') Crushed Rock mixed with dry Brown silt, crushed rock in tip of sampler.		Geoprobe Hit refusal AT 14 FT

SPT = STANDARD PENETRATION TEST

Soil Stratigraphy Summary: (END OF BORING AT 14 FT)

APPENDIX D

INVENTORY OF MATERIALS IN VICINITY OF INDOOR AIR SAMPLING LOCATIONS

Table

FARRAND CONTROLS SITE
REMEDIAL DESIGN REPORT
MAINTENANCE AREA MATERIALS

Material	Container Volume/ Type	Quantity
Acrylic adhesive	Pint	1
Cove base cement	Quart	2
Engine start spray	-	1
Epoxy cement	2 Ounce	6
Floor tile adhesive	Gallon	2
Grease	Tube	2
Gun black	½ Gallon	1
Hornet spray	15 ounce	2
Latex caulk	Tube	5
Latex paint	Gallon	10
Lock lube	-	3
Mineral spirits	Gallon	1
Oil-base paint	Gallon	10
Paint stripper	Quart	2
Polycarbonate cement	Pint	1
Polyurethane caulk	Tube	1
Silicone caulk	Tube	4
Spray paint	Can	15
3 in 1 oil	-	1
WD-40	-	1
Wood glue	8 Ounce	3

Notes:
-: Information not available
Inventory date 12/29/04

Table

FARRAND CONTROLS SITE
REMEDIAL DESIGN REPORT
PROCESSING AREA MATERIALS

Material	Container Volume/ Type	Quantity
Acetone	-	-
Epoxy paint (a)	Quart	2
Epoxy paint (b)	Quart	2
Epoxy thinner	Quart	1
Ethenol	Quart	2
Grease	Pound	9
Lacquer cement	Quart	3
Latex caulk	Tube	5
Silicone caulk	Tube	32

Notes:
-: Information not available
Inventory date 12/29/04

APPENDIX E

PILOT STUDY REPORT AND COMMENTS

Report of Results
FEROX^{sm} Injection Pilot Study

FARRAND CONTROLS SITE
VAHALLA, NEW YORK

Prepared for:

Dvirka and Bartilucci
330 Crossways Park Drive
Woodbury, New York
11797-2015

Prepared by:

ARS Technologies, Inc.
98 North Ward Street
New Brunswick, New Jersey 08901

November 2005

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GLOSSARY

BGS	Below Ground Surface
cis-1,2-DCE	*cis*-1,2-Dichloroethene
COC	Contaminant of Concern
CVOC	Chlorinated Volatile Organic Compound
DO	Dissolved Oxygen
GPM	Gallons per Minute
ISCR	*In-Situ* Chemical Reduction
MCL	Minimum Concentration Limit
ND	Not detectable
ORP	Oxygen Reduction Potential
PCE	Tetrachloroethene
PF/LAI	Pneumatic Fracturing and Liquid Atomized Injection
PSI	Pounds Per Square Inch
ROI	Radius of Influence
TCE	Trichloroethene
VC	Vinyl Chloride

1.0 INTRODUCTION

This report summarizes the results of a Ferox^{sm} Pilot Study implemented by ARS Technologies, Inc. (ARS) for Dvirka and Bartilucci Consulting Engineers, Inc. at the Farrand Controls Site (The Site) located in Vahalla, New York. The study was initiated to assess the effectiveness of Pneumatic Fracturing/Liquid Atomized Injection (PF/LAI) and *In-Situ* Chemical Reduction (ISCR) using ARS' patented Ferox^{sm} Technology for the treatment of subsurface Volatile Organic Compounds (VOCs) within a suspected source area. The results generated from the Pilot Study will be used to establish design criteria for full-scale site remediation. Injections within the Pilot Study Test Area were performed within the northern section of the plume representing the thinnest vertical extent of the saturated zone.

The PF/LAI process has been demonstrated to be an effective method for injecting liquids and/or slurries uniformly within all types of geology. The Ferox^{sm} process is a proprietary process developed by ARS involving the use of highly reactive Zero Valent Iron (ZVI) to chemically reduce contaminants *in-situ*. Use of ZVI has become accepted as an effective means of environmental remediation. It is inexpensive, easy to handle and effective in treating a wide range of chlorinated compounds or heavy metals. It has been widely applied *in-situ* or as part of a controlled treatment process in wastewater and/or drinking water applications.

Field operations at the Site were performed from May 24 and May 25, 2005. PF and Ferox^{sm} injections were applied over an 11-foot interval extending from a depth of 6.5 to 17.5 ft bgs resulting in the emplacement of 2,950 pounds of ZVI. The target ZVI dosage of 1.2% (relative to soil mass) was achieved within injection Interval 1 (14 – 17 ft bgs) while 73% of the target was achieved in Interval 2 (16 – 17.5 ft bgs) and Interval 3 (11 – 14 ft bgs). The targeted ZVI dosages within Interval 2, Interval 3 and Interval 4 (6.5 – 9.5 ft bgs) could not be attained as a result of preferential daylighting through an abandoned soil boring (SP-4) located approximately 25 feet from the injection well. Post-injection confirmatory soil cores collected at specific locations (5 – 15 radial feet) around injection boring IW-01 identified a 24% increase in averaged total iron concentrations relative to pre-injection averaged baseline total iron measurements.

All aspects of the Pilot Study were conducted in accordance with Dvirka and Bartilucci's Scope of Work, dated April 28, 2005.

2.0 SITE BACKGROUND

The Site is currently owned and operated by Farrand Controls, Inc and is an active electronic component manufacturing facility. The site is approximately 6 acres in size. Site investigations have revealed the site groundwater to be impacted with elevated levels of volatile organic compounds (VOCs), including trichlorothene (TCE), cis-1, 2-dichloroethene (cis-DCE), trans-1, 2-dichloroethene (trans-DCE), vinyl chloride (VC) and 1,1,2-trichloro-1, 2,2-trifluoroethane (Freon-113).

Most of the Farrand Controls Site is underlain by unconsolidated composites consisting of fine to medium-grained sands containing some gravel and silt. Groundwater has been reported at a depth of 7 to 8 feet bgs.

3.0 TECHNOLOGY BACKGROUND

A critical component of ARS' injection process is ensuring that the reactive media is distributed effectively within the subsurface to facilitate the desired chemical reactions. To accomplish this distribution, ARS incorporates its gas-based PF/LAI technologies for the emplacement of reactive media. LAI relies upon the theory that it is more effective to inject gases or "aerosols" into the subsurface than it is to inject an incompressible liquid into the subsurface. Depending upon the permeability or heterogeneities within the targeted geologic zone, PF may be integrated as a precursor to LAI of a reactive media.

3.1 Pneumatic Fracturing

PF is a patented process in which a gas is injected into the subsurface at pressures that exceed the combined overburden pressure and cohesive soil strength of the geologic matrix, and at flow rates that exceed the effective permeability of the undisturbed soil. The result is the propagation of fractures outward from the injection well to various distances depending upon the geology. Fracture propagation distances of 30 - 60 feet are common in rock formations. Unconsolidated materials such as silts and clays typically exhibit fracture propagation distances of 20 - 40 feet. PF can serve as a critical component for many *in-situ* treatment processes since it allows for an effective permeability enhancement of the geologic matrix while reducing geologic heterogeneities within the subsurface.

3.2 Ferox^{sm} Treatment Technology

The Ferox^{sm} process involves the controlled injection and dispersion of specific quantities of highly reactive ZVI into saturated or unsaturated contaminant zones within individual soil borings. This patented technology represents a significant advancement from the conventional Permeable Reaction Barrier technology since the Ferox^{sm} process relies on a passive, non-disruptive, innovative injection methodology (PF/LAI) in combination with a proprietary ZVI powder product emplaced within the subsurface. Numerous field applications of the technology have been shown to effectively treat halogenated organic compounds, and/or leachable heavy metals in a wide range of geologic formations at any depth.

ARS' ZVI is a proprietary highly reactivity powder exclusively manufactured for ARS. Directly reduced from iron ores, it contains no trace elements at toxic levels that may be found in waste iron stocks from which conventional iron filings used in PRBs originate. As a result of its production process, ARS' ZVI contains internal porosities, which greatly enhance its surface area and, therefore, reactivity. Carbon molecules and other inclusions found within its structural matrix (not as a separate phase), have been theorized to further enhance its reactivity exceeding that of similar sized cast iron powder.

Physical characteristics of a soil will typically govern the emplacement mechanism of the ZVI powder. These mechanisms, which are presented in **Figure 1**, can be characterized into three categories; dispersion, fluidization, or fracture filling. In porous materials such as gravel, the injection of iron powder will result in the dispersion around soil or rock particles, and will travel as far as the gas carrying the particle maintains enough energy to keep it from settling. In loose sand deposits, the injection of high volumes of gas and slurry will result in local fluidization of the formation causing iron particles to get "mixed" within the soil matrix. In more cohesive soils such as clays and silts, the high volume/pressure injections will result in PF of the formation. The emplacement of iron will be governed by the flow of gas in the fractures and the iron particles will settle as the kinetic energy decreases. In field applications of the injection process, iron powder emplacement within a geologic formation will typically exhibit more than one of these mechanisms.

4.0 INJECTION WELL INSTALLATION AND LAYOUT

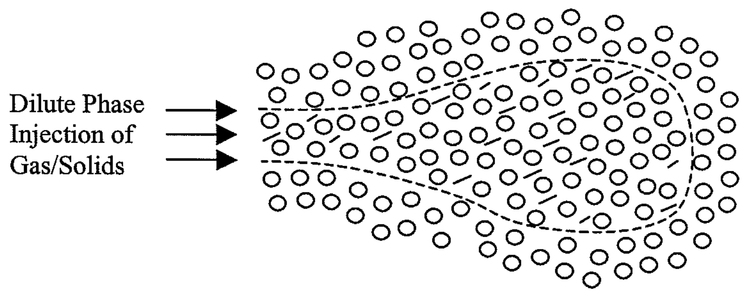
The Pilot Study involved the installation of one injection boring utilizing rota-sonic drilling technology. Precision Sampling from Apopka, Florida was contracted to perform all drilling related activities at the site. The target treatment zones were accessed through the advancement of two types of casing consisting of 3-inch and 4.25-inch drill casing. Initially, difficulties were encountered advancing the 4.25-inch injection casing to the target depths due to the likely presence of cobbles and/or rock fragments within site soils. As a result, a smaller casing (2-inch) had to be pre-advanced through the difficult regions to bedrock (17.5 ft bgs) to provide a pilot hole for the larger injection casing advancement.

5.0 INJECTION PROCEDURES AND PARAMETERS

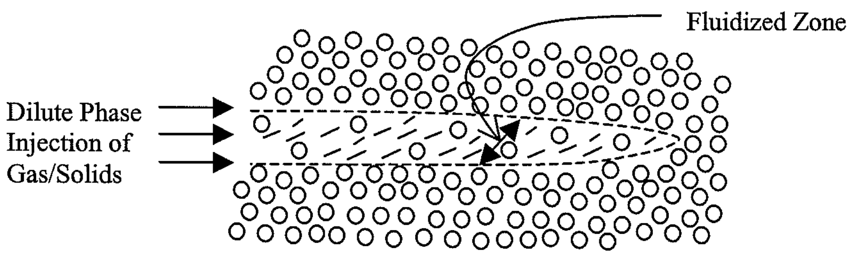
This section summarizes the procedures and parameters monitored during the injection operations. The parameters discussed below can be used as a confirmatory measure on whether fractures and/or ZVI was successfully propagated within the targeted intervals and whether regions of the site have been favorably impacted by the Ferox injections.

In general, the equipment used for the PF process consists of a skid mounted fracture module complete with an injection control manifold and a digital data logger used to monitor various operational parameters. Due to the large quantity of compressed gas needed for fracturing and liquid injections, ARS used pressurized nitrogen as the fracturing fluid. A bulk nitrogen "tube" trailer was mobilized to the site for this operation.

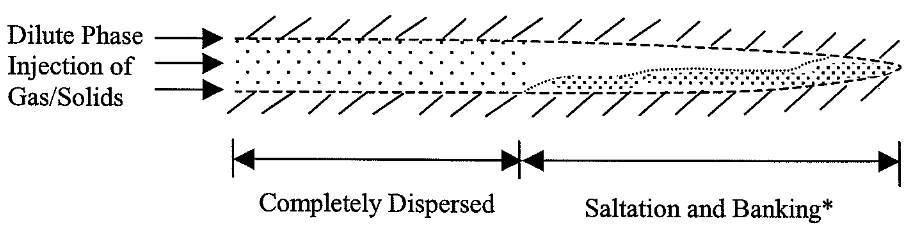
Figure 1 - Emplacement mechanism of the ZVI powder



a) iron slurry travels through formation through the intergranular pore spaces



b) high volumes of gas cause fluidization of formation, causing iron to mix with soil



c) Iron powder is emplaced within the dilated fracture

- Saltation – the leaping or erratic movement of particles as they are transported in a fluid through a pore throat and/or fracture.
- Banking – The temporary deposition and gradual migration of particles as they are transported in a fluid through a pore throat and/or fracture.

or indirectly influenced (i.e. existing pathways such as naturally occurring or induced fractures are dilated). Minimal pressure response in monitoring wells located close to the injection point may indicate that fluidization and significant gas dispersion is occurring.

5.1.3 Ground Surface Heave

Ground surface heave monitoring was conducted for the first two injection interval (Intervals 1 and 2) using surveying transit in conjunction with a heave rod. The heave rod was placed as close as possible to the fracture/injection well. During each injection event, the rod is observed for the maximum amount of upward motion (surface heave). Ground surface heave monitoring data can provide additional information that can be used to assess the distances and orientation of injection fluid propagation. Under circumstances whereby significant daylighting in the form of gas surfacing or leak off is encountered heave measurements are not necessary and may be collected initially to provide a correlation between measured heave and observable daylighting.

5.2 Ferox^{sm} Injection Operations

When applicable, the Ferox^{sm} powder is injected into the subsurface utilizing a nitrogen gas stream integrated with a high-pressure, high-flow injection manifold. The manifold system provides accurate injection pressures, which enables ARS to achieve the optimal dispersion of iron powder.

The ZVI slurry was fed into the gas stream from a proprietary mixing trailer that keeps the iron in suspension by continual circulation of the slurry. The ZVI slurry was delivered into the nitrogen stream through a high-pressure diaphragm pump. Once sufficiently mixed, the ZVI/nitrogen blend is routed through a proprietary injector. Injections were performed in approximately 36-inch intervals.

5.3 Injection Monitoring

During the injection process, ARS personnel monitored the quantity of iron slurry injected as well as the duration of each injection. The quantity of material was recorded after each injection. For the Ferox^{sm} slurry injections, each batch was specifically mixed within the holding tank and subsequently injected, ensuring accurate mass loading rates. Under circumstances where the target mass of ZVI per interval exceeds to mixing capacity of the ARS' mixing/injection trailer, injections are typically performed in a series of batches until the target ZVI mass loading are injected.

As with PF, data parameters including the injection pressure and pressure at adjacent wells were recorded. These parameters are discussed in the previous section.

5.1 Pneumatic Fracturing Operations

Pneumatic fracturing serves as a precursor to the Ferox injections. Fracturing consisted of applying pressurized nitrogen for approximately 15 to 30 seconds within the designated 36-inch injection interval. Selection of the 36-inch injection interval was specifically based on the down-hole assembly configuration and the vertical dispersion patterns of the nozzles utilized for the Pilot Study. Upon completion of the PF injection (15 – 30 seconds), the Ferox injection commenced. This approach was then repeated for each subsequent injection interval prior to the Ferox injections. The compressed nitrogen was routed through the fracture modules' control manifold, which was connected by a high-pressure hose to a proprietary injector.

During each injection, data parameters including pneumatic pressure influence at surrounding monitoring points, ground surface heave measurements and visual field observations are recorded. Additionally, the pressure in the injection interval is logged electronically using a pressure transducer and data logger system for later analysis and evaluation. The following section describes in detail the data parameters that were collected during the PF process at the Site.

5.1.1 Injection Initiation and Maintenance Pressures

For each injection, the pressure in the fracture interval is recorded by a pressure transducer located in-line within the conduit leading to the injection nozzle. These pressures are recorded by a data logging system located on the injection module and accessed using a lap top computer. By comparing the magnitude and shape of the pressure-history curve to previously collected curves in similar geology, an assessment of fracture propagation is made. This information allows one to evaluate if fracturing resulted and two critical measurements; the fracture initiation pressure and the fracture maintenance pressure. The recorded fracture maintenance pressure is an average over the propagation time.

5.1.2 Pressure Influence at Adjacent Wells

Evaluation of pressure influence data collected during PF operations can provide a reasonable assessment on the extent of fracture propagation. During the injections, pressure influence was measured at target wells using calibrated pressure (psi) gauges and pressure transducers. Each pressure gauge is outfitted with a drag arm indicator that records the maximum pressure detected at the monitoring point during the injection. The pressure transducers were setup up to monitor specific wells within the pilot test area and consisted of Hermit data logger fitted with in-line pressure transducers manufactured by In Situ Inc. Model Number PXD-261.

The analysis of pressure response at various locations around an injection point can provide supplemental evidence that fracture and/or material propagation occurred. This data also assists in determining which directions fractures and the subsequent reagent may have propagated. In addition, the degree of pressure response can often help determine whether a monitoring point has been directly influenced (i.e. fractures propagate outward and intersect wells or boreholes),

6.0 SUMMARY OF FIELD IMPLEMENTATION

The Pilot Study field operations were performed within the vicinity (15 feet) of existing monitoring wells MW-21S and MW-21R. Figure 2 shows the approximate locations of injection well IW-01 relative to the monitoring wells. During the implementation of the Pilot Study, ARS closely followed all applicable health and safety-related procedures as described in ARS' "Health and Safety Plan Addendum".

ARS mobilized for the Pilot Study on May 23 and equipment setup was performed on May 23 and 24, 2005. Drilling and the Ferox injections were performed on May 24 and 25. A detailed summary of the field operations is provided below.

6.1 Field Injection Summary

Prior to the Ferox[sm] injections, the subsurface within the pilot study area was pneumatically fractured. This approach was implemented in an attempt to increase the bulk permeability of the site soils through the creation of a fracture network within the targeted treatment zones. The injection intervals where ZVI was emplaced and the sequence of injections corresponding to both PF and the Ferox injections were as follows:

Interval 1(14.0 – 17.0 ft bgs)
Inteval 2 (16.0 - 17.5 ft bgs - beginning of bedrock)
Interval 3 (11.0 – 14.0 ft bgs)
Interval 4 (6.5 – 9.5 ft bgs)

A 1.5 foot portion of the total targeted treatment interval, corresponding to 9.5 – 11.0 ft, could not be addressed due to significant daylighting of gas and formation water from abandoned soil boring SP-4 located approximately 25 ft west of IW-01. Initial injection attempts were made through the injecting of gas only at a nozzle depth of 9.5 ft bgs (8.0 – 11 ft). This was performed to ascertain whether ZVI injections could be successfully completed ultimately resulting in immediate daylighting at SP-4.

At the Farrand Controls Site, injection pressures of 40 to 70 psi were required to initiate gas flow and ZVI injections within the subsurface. In general, once the initial flow of gas into the formation was achieved, gas maintenance pressures matched the initial injection pressure.

Parameters collected during each fracturing event included the discrete injection interval, initiation pressure recorded on the wellhead, pressure influence at surrounding monitoring wells, ground surface heave and visual field observations. These parameters are listed in Tables 1 and 2. The pressure-history curves for each injection are presented in Appendix A of this report. A more detailed description of the pressure-history curves is presented in the "Fracture Initiation and Maintenance Pressure" section below.
The injections were performed in discrete 36-inch intervals. Table 1 summarizes the injection parameters recorded during the injections operations. These parameters represent the actual field

measurements recorded by ARS during the injection operations. It is important to note that fracture curves were collected for the first batch of each interval since a fracture event can only occur once per interval. The relevance of the data presented in Table 1 is discussed in later sections of this report.

A total of four headings are presented in Table 1. The first heading labeled "Batch Data" identifies the date of injection, nozzle depth and corresponding injection interval, batch number, injection start and end times, water and ZVI quantities. The second heading labeled "Module/Injection Point Pressures" identify the module or operators set pressure, peak injection pressure, averaged injection pressure and wellhead pressure recorded at the injection boring. The heading labeled "Nitrogen" identifies the estimated quantities of nitrogen used specific to each injection. The last two headings represent monitoring well pressure influence and general observations made during the injection activities. The term "batch" was derived from the fact that the targeted ZVI dosage designated per interval exceeded the loading capacity of ARS' mixing trailer resulting the targeted mass of ZVI specific to each interval had to be divided in half and represented as "Batch 1" and "Batch 2".

Table 3 presents the quantities of ZVI slurry that was injected into the target treatment zones using a pulsed liquid atomized gas injection. In summary, a total of 2,950 lbs of ZVI were injected over four intervals. The target ZVI dosage (1,100 lbs per interval) was achieved within Interval 1 (14 – 17 ft bgs) while 73% of the target was achieved in Interval 2 (16 – 17.5 ft bgs) and Interval 3 (11 – 14 ft bgs). Injections within Interval 4 (6.5 – 9.5 ft bgs) resulted in the delivery of 18% of the target ZVI.

Injection pressures, ZVI mass, slurry volumes and pressure influence data were collected during the injections and are presented in Table 1 and Appendix B. As discussed above, significant daylighting in the form of formation water was observed around abandoned soil boring location SP-4, located approximately 25 feet west of injection well IW-01. During the injections, field observations suggested that the material emanating from SP-4 consisted of formation water and ZVI. It should be noted that the presence of ZVI at SP-4 was neither physically or chemically confirmed and should therefore be considered speculative solely based on ARS' observation. Nitrogen gas leak off to the surface was also evident during the injections in the form of bubbles penetrating the preexisting cracks in the asphalt. This leak off general was focused within four regions identified in Figure 2. It should be noted that the aspnalt within these regions was wet as a result of the field operations and therefore making it easier to observe bubbling of the injected gas. It should be noted that during the injections, no daylighting of formation water and/or ZVI was observed between the injection well and SP-4 indicating that the formation water and likely ZVI was migrating 25 feet within the subsurface prior to intercepting SP-4.

A total of 1,745 ft^3 of nitrogen was consumed during the injections at IW-01. The nitrogen quantities used were minimal based on the relatively low injection pressures and the pulsed injection technique employed during the Pilot Test. Under circumstances where daylighting around abandoned boring (SP-4) was severe, minimal amounts of gas were applied and the ZVI was hydraulically delivered using a high-pressure pump. In an attempt to minimize daylighting impacts attempts were made on May 24 to re-seal abandoned boring SP-4 by advancing casing to the bedrock and adding grout. Three possible options to mitigate daylighting impacts during the full-scale implementation are discussed in Section 8 of this report.

Two types of down-hole injection assemblies were evaluated during the Pilot Study. The first assembly (Figure 4) was used for Interval 1 (14 – 17 ft bgs), Interval 3 (11 – 14 ft bgs) and Interval 4 (6.5 – 9.5 ft bgs) and consisted of a packer-less setup consisting of a spring-loaded nozzle fitted with four ports to obtain a 360° dispersion. The second injector (Figure 3) was used for Interval 2 (16 – 17.5 ft bgs) and consisted of ARS' standard down-hole injection assembly fitted with two packers fitted with a cone shaped high flow open-port injection nozzle. Schematics of both nozzle configurations are illustrated in Figures 3 and Figures 4. Both nozzle configurations were presented in ARS' "Technical Scope of Work", Dated February 18, 2005.

Fracture Initiation and Maintenance Pressures:

The injection pressures relative to time (Pressure–History Curves) are presented in Appendix A. These graphs represent the real time logging of the nitrogen gas coupled with ZVI injections overtime and is used to evaluate the delivery mechanism of the ZVI within the subsurface. The data presented in Appendix A was recorded with a pressure transducer, which was situated within the nitrogen gas line that is routed to the injection well.

The Pressure-History Curves representing Intervals 1 through 3 and corresponding to Graphs 1A, 2 and 3, represent the fracture event or initial injection of nitrogen prior to the introduction of ZVI. Identifiers are presented on Graph 1A to illustrate the process flow regime and points where the injections were initiated and ended. Graphs 1A, 2 and 3 respectively illustrate a relative flat-lined pressure response typically indicative of a soil fluidization having no discernable characteristics of a fracture event. This is substantiated through the lack of a distinct pressure peak during early times of the injection events. No discernible pressure peak serves as a direct indicator that fractures were not generated and pore space dilation served as the primary delivery mechanism as illustrated in Figure 1. Typically, pressure responses of this nature suggest the presence of sands or non-cohesive materials permeable enough to readily accept the influx of gas. It should be noted that Graph 2 represents the deepest injection with the injection nozzle situated directly on top of the bedrock at a depth of 17.5 feet bgs. The data presented for Graph 2 is indicative of soil fluidization and suggests the presence of non-cohesive soils directly overlying the bedrock interface.

The remaining graphs consisting of 4A through 9 illustrate the pulsed ZVI slurry injections overtime. Identifiers are presented on Graph 4A to illustrate the process flow regime and points where the injections were initiated and ended. The rapid spikes depicted on the curves represent the instantaneous pressuring and pulsing action of the gas as the slurry is dispersed into the target intervals. It is important to note that these pressure spikes during the ZVI injection are not related to the pressure peaks associated with fracture event. Pneumatic fracturing and the subsequent injection of a reagent (ZVI) are two independent events. The pressure spikes observed during the injection of ZVI represent the pulsing pressure of the gas combined with the slurry as both are being injected into the formation.

The pressure curves for Interval 4 were not collected since nitrogen gas was not used to emplace the ZVI; therefore no pressure data existed to record. The overall extent of daylighting around the injection borehole inhibited the use of gas as a delivery mechanism.

Pressure Influence at Adjacent Monitoring Wells:

A total of five wells were monitored for pressure influence consisting of MW-21-R, MW21-S, MW22-R, MW22-S and MW-4. The pressure influence data is summarized in Table 1 and Appendix B. For clarification, it should be noted that the data presented in Table 1 (monitoring well pressures) represent the maximum gauge pressure measurement while the graphs in Appendix B represent pressure at the surrounding monitoring points over the duration of the injection. Comparison of the monitoring well data presented in Table 1 and Appendix A reveal a good correlation between the maximum gauge pressure reading (Table 1) and the maximum value over the duration of the injection (Appendix B) for each interval with the level of sensitivity and/or accuracy favoring the pressure transducer data presented in Appendix B.

During injection operations, significant pressure influence was observed at well MW-21S located approximately 15 ft from the injection well location. Significant pressure influence was not observed at the remaining wells, which were screened either deeper than the injection intervals (MW-21R) or situated outside the targeted 10 foot Radius of Influence (ROI) (MW-22R, MW-22S and MW-4). Very minor pressure increases ranging between 0-0.2 psi were measured at wells MW-21R, MW-22R, MW22-S and MW-4. Pressure increases of this small a magnitude can be considered negligible falling within the acceptable margin of error for the data collection unit employed for the study and may be interpreted as an instrumentation anomaly. Since only one monitoring point (MW-21S) was situated within the anticipated ROI, a firm conclusion regarding the extent of nitrogen gas distribution within the subsurface could not be made. During the injections, visual surface heave in the form of gas venting and daylighting were observed around the injection well. Visual observations during the injections revealed gas propagation emanating from the injection borehole in the form of bubbles penetrating the cracks of the asphalt. The approximate locations of the most significant surface heave and daylighting of gas and formation water are provided in Figure 2. This degree of daylighting (small gas bubbles) is typical of the injection/atomization process and represents a small portion of gas leak off to the atmosphere.

Due to a temporary malfunction on the Hermit Data logger, pressure influence data was not recorded for Interval 1 (batch 2). Pressure data corresponding to injections at Interval 4 (batch 1) were not recorded and therefore not presented since nitrogen gas was not used during injection Interval 4 as a result of significant daylighting around the injection boring.

Surface Heave:

Initial surface heave measurements were recorded during the first three injection intervals. A heave of 0.5 inches was observed adjacent to the wellhead. As the field operations progressed and the injection intervals became more shallower visual heave exceeding 1 inch was observed. The extent of daylighting from and around abandoned soil boring SP-4 prevented further heave measurements from being collected. This resulted in the migration of gas originating from SP-4 under the asphalt causing erratic movement of the heave rod.

Monitoring Well Parameter Data

Geochemical parameters were measured following the completion of each injection interval. These parameters include dissolved oxygen (mg/L), oxidation/reduction potential (mV), temperature (°C), pH, and groundwater elevation (ft. bgs.). Measurements were obtained using a multi-parameter meter at frequencies in accordance with the RFP. Groundwater elevation was measured using a level probe.

Groundwater results pertaining to the geochemical measurements are presented in Table 2 and Table 4. The data identified in Table 2 presents the geochemical parameters, which were collected during the injection operations at the site following the completion of each injection interval. The data provided in Table 4 presents the geochemical data collected by Dvirka and Bartilucci as part of the Groundwater Sampling Program currently being implemented at the site.

The data presented in Table 2 specific to monitoring well MW-21S shows a 98% reduction in post-injection dissolved oxygen concentration and a corresponding increase in pH relative to the pre-injection baseline values. More notably, these favorable changes in groundwater geochemistry provide indirect evidence, coupled with the direct pressure influence, that well MW-21S may have been impacted by the ZVI injections. Dissolved oxygen can serve as the most direct indicator of chemical reduction since it is the most thermodynamically favored electron acceptor and therefore the first to be reduced. An increase in pH results from the initial stages of the iron corrosion in the presence of D.O and water to form hydroxyl ions.

An increase in DO within monitoring well MW-21S was likely caused when water trapped in the well cavity entered the well when the monitoring packer was removed.

The data presented in Table 4 suggests that subsurface contaminant treatment is occurring through reductive dechlorination processes within the vicinity of monitoring well MW-21S. This is substantiated through significant increases in chloride concentration in well MW-21S (relative to baseline concentrations) following the injections. More specifically, post-injection groundwater samples collected from well MW-21S on July 14, 2004 and September 23, 2005 revealed an increase in chloride concentration from a baseline value of 52,000 ug/L to 130,000 ug/L and 120,000 ug/L, respectively. The accumulation of chloride within well MW-21S serves as a direct indicator that reductive dechlorination is occurring whereby the chlorine in the chlorinated compounds (TCE for example) are stripped and replaced by hydrogen.

The volatile organic compound data presented in Table 4 also suggests reductive dechlorination is occurring within the vicinity of MW-21S. This is substantiated through a 34% decrease in TCE and a 43% decrease in 1,1,2 TCA relative to baseline concentrations. Minimal reductions in Freon 113 may be attributed to the influx of higher contaminant concentrations as represented by the July, 14 2005 concentration of 2,900 ug/L or by the slower reaction rates demonstrated during the treatability study between the ZVI and this particular compound.

7.0 PERFORMANCE EVALUATION

A pilot study was implemented at the Farrand Controls Site to assess the effectiveness of PF/LAI and ISCR utilizing ARS' patented Ferox^{sm} technology to treat subsurface VOC contamination in a shallow aquifer of a potential source area. ARS was contracted to implement the pilot scale study, which was performed during May 2005. Daylighting issues in and around abandoned boring SP-4 may have impacted the ZVI distribution by limiting the quantity of gas necessary to effectively distribute the ZVI.

The Ferox^{sm} injections resulted in the injection of 2,950 pounds of ZVI into the targeted treatment zone of 6.5 – 17.5 feet bgs. The subsurface distribution of ZVI was substantiated through increases in average total iron soil concentrations relative to baseline values, notable changes in geochemical parameters in well MW-21S relative to pre-injection baseline values and direct connection with well MW-21S as demonstrated by pressure influence observations during injection operations.

An evaluation of the injected quantities of ZVI within each interval, relative to the estimated 15 foot ROI, indicate elevated total iron concentrations suggesting the presence of reactive ZVI within the Pilot Test area. The data shows total post-injection iron concentration in the soil averaged 20,427 mg/kg while baseline iron concentrations averaged 16,525 mg/kg, representing a 24% increase in iron above baseline values. The averaged baseline total iron concentrations were derived from soil samples collected over the entire site during the remedial investigation within the Pilot Test treatment depth of 6.5 – 17.5 feet bgs. It is important to note that if a larger ROI of 15 feet (relative to 10 ft for the Pilot Study Design) were achieved, it would be expected that the ZVI dosages per unit mass of soil would decrease due the increased ROI and subsequent increases in treatable soil volume. Therefore, assuming a ROI of 15 feet, the calculated dosage per interval based on 1,150 lbs of ZVI would be 0.54%. This calculated dosage correlates reasonably well with the observed 23% increase in post-injection total averaged iron concentration, which equates to a dosage of 0.4%. Due to the inherent variability between soil baseline iron concentrations, as reported in Table G-9 of RFP a detailed comparison/evaluation of each core could not be performed.

The reduced quantities of injected ZVI (2,950 lbs) relative to the targeted quantity (4,600 lbs) may impact the long-term effectiveness of the groundwater treatment resulting in premature depletion of the iron overtime. The short term ZVI reactivity should not be impacted since sufficient ZVI quantities were successfully injected within Interval 2 and Interval 3 to promote reductions in the target contaminants.

An evaluation of PF parameters, which was applied prior to the Ferox injections, showed that fracture generation and propagation did not occur but rather pore space dilation and soil fluidization served as the primary delivery mechanism at the site. Since gas was not applied to the shallowest injection interval (Interval 4; 6.5 – 9.5 ft bgs), pore space dilation and fluidization did not take place within this interval.

The achievable ROI during the PF/LAI injections was identified through an evaluation of injection operational parameters and noted field observations. Operational parameters collected during the PF injections confirmed that a propagation distance of 15 feet could be achieved within the deeper injection intervals as demonstrated by the direct pressure response in monitoring well MW-21S coupled with favorable changes in groundwater geochemistry as measured in well MW-21S immediately following the injections. It is likely that from the geochemical and pressure influence data that a direct impact to Well MW-21S was achieved during the first two or deepest injections corresponding to Interval 1 (14 – 17 ft bgs) and Interval 2 (16 – 17.5 ft bgs). It is unclear whether injection Intervals 3 and 4 had any geochemical impact on well MW-21S since changes in groundwater geochemistry (Suppressed D.O, pH changes) proceed rapidly (minutes) when in sufficient contact with the ZVI.

In conclusion, the ability to safely implement both the PF and LAI process for the delivery of ZVI was proven to applicable at the Farrand Controls Site with minimal disturbances to facility operations. Implementation of the Pilot Study revealed that 73% of the target ZVI dosage could be achieved at or below a treatment depth of 11 ft bgs. As the treatment depths increase towards the center and leading edge of the plume, ZVI daylighting issues should decrease significantly due to an increase in subsurface vertical stress generated from the additional overburden. Based on this, deeper injections extending beyond 11 feet bgs should facilitate a greater percentage of successfully treated intervals.

Implementation of the pilot study identified several site-specific improvements or modifications, which would facilitate and streamline full-scale implementation of the PF/LAI and Ferox[sm] processes. These are discussed below.

8.0 FULL SCALE IMPLEMENTATION AND RECOMMENDATIONS

Injection Boring Design, Spacing and Injection Approach

During the Pilot Study, several attempts were made to optimize the injection boring in an effort to facilitate maximum distribution of the ZVI with the upper two intervals corresponding to Interval 3 and Interval 4. This was accomplished through the use of 2 down-hole injector configurations combined with the use of an outer surface casing integrated with a surface packer. The injection boring optimizations are provided in Figure . These modifications were applied during the injection operations in response to Dvirka and Bartilucci's request that an offset boring not be utilized to inject remaining quantities of ZVI to meet the dosage criteria. As a result, every effort was made to maintain the integrity and seal of the boring for injections through the use of all available tooling present on site. With the exception of the shallowest injection interval, the modifications provided a sufficient annulus seal between the formation and injection casing and/or piping.

The full-scale implementation should incorporate an injection spacing of 20 feet (10 ROI). An assumed 10-foot ROI should be adequate to address the majority of the vertical treatment intervals and provide a sufficient degree of overlap for the deeper injections where a ROI beyond 10 feet is expected.

A total of four modifications and/or technical approaches can be made to minimize daylighting through the abandoned investigative soil borings scattered around the site.

One possible approach would involve utilizing the abandoned borings (where appropriate) as injection locations. To accomplish this, a mini rota-sonic rig or hollow stem auger rig could advance through or over the bentonite and/or grout column to the bedrock. Since it was demonstrated during the Pilot Test that an effective annulus seal could be maintained at the injection boring, this approach would effectively eliminate problematic daylighting points within critical areas requiring treatment.

A second approach would involve advancing an oversized casing over or through the grout seal to effectively seal off the abandoned borehole location from an adjacent injection location. This approach may be appropriate as a responsive measure during injections and may have the potential to eliminate short-circuiting of formation water and/or ZVI along the grout seal.

A third and fourth approach may be implemented to mitigate the difficulties encountered during the shallowest injection intervals and utilize a series of offset injection points within the vicinity of a specific injection boring combined with the injection of a finer sized ZVI. Implementation of this approach would allow the ZVI to be delivered into the subsurface less aggressively with minimal quantities of gas as a result of the buoyant free-flowing characteristics of finer sized micro-scale ZVI. If for example, the target ZVI dosages could not be achieved within the shallowest interval, an offset within five feet of the abandoned (grouted) injection boring could be installed to achieve the target ZVI dosages.

<u>Injection Productivity</u>

Estimates regarding full-scale injection production rates would equate to 24 feet of vertical treatment per ten-hour workday. The deeper injections that will be required towards the midpoint and leading edge of the plume may reduce the production rates due longer injection times and increased drilling time.

Addressing and sealing off potential daylighting locations and using materials compatible with the mini-rota sonic rig to mitigate the breaking of casing during injection boring advancement would minimize delays.

Nitrogen Gas Usage

The daylighting issues combined with the inability to inject within the shallowest interval resulted in low nitrogen consumption corresponding to 1,745 ft^3 of gas for the entire boring. For the full-scale application, pulsing of the gas over the duration of the injection should provide sufficient atomization of the ZVI without compromising the targeted interval. An estimate of nitrogen quantities for the full-scale application will be provided with the cost estimate.

9.0 FULL SCALE FEROX IMPLEMENTATION COST ESTIMATE

Approximate cost estimates have been prepared for treating the Farrand Controls Site with the Ferox^{sm} ZVI Technology. Implementation of the technology will be applied as part of a two-phased remedial approach. Separate costs are provided below for the full-scale implementation of Phase IA, Phase IB and Phase II remediation efforts.

Phase IA remediation will focus on the treatment of a 125 foot by 65 foot area (Identified in Figure 4-1 of the RFP and included as Figure 5 of this report) in the vicinity of wells clusters MW-21 and MW-22 where the highest level of contamination has been reported (source area). Phase IB remediation will focus on a specific region within the vicinity of a sump identified in Figure 5 as the "Sump Treatment Area". Phase II remediation will involve the installation of a reactive ZVI treatment zone down gradient of the source area (See Figure 5) to intercept and treat contaminants currently migrating offsite.

9.1 Phase IA and Phase IB Cost Estimate

The estimated costs associated with the implementation of Phase IA and IB remediation activities in two (2) designated source zones, were based on several key assumptions identified below:

- Treatment Area IA 125 by 65 feet (Figure 5)
- Treatment Area IB 36 by 36 feet (Figure 5)
- Approximate Treatment Interval: 8–20 feet bgs, consisting of fine to medium grained silty sands.
- Porosity of overburden: 0.3 (fine/medium sands).
- Bulk density of overburden: 110 pounds/cubic foot.
- Hydraulic Conductivity: 6.58 x 10^{-7} feet/second[1]
- Maximum CVOC groundwater concentrations in overburden: 6 mg/L.
  Radius of Influence (ROI) of 10 feet.

[1] Hydraulic Conductivity was calculated from groundwater elevations collected on 4/23/01 (Table 3-1 Request for Technical Proposal Document) and slug test data collected on November 1999 (Exhibit A-11 of same document). Distances derived from maps provided in same document.

Based upon these assumptions and the results generated from the treatability study and the Ferox[sm] Pilot Test, the quantity of iron required for full-scale Phase IA and IB source zone treatment was estimated. Table 5 provides the estimated quantity of ZVI required for treatment of the target COCs. Based upon a target 0.86 percent weight of iron in soil for the overburden, approximately 96,000 pounds of iron will be required to effectively treat the targeted compounds in the source area. Selection of a 0.86 percent dosage was based on the Pilot Study results whereby 70% (800 pounds or 0.86%) of the target dosage was met or exceeded within three out of four intervals. The 0.86% dosage was selected based solely on the results generated from the Pilot Study and can be increased if a higher dosage is warranted. Based upon a conservative 10-foot radius of influence, a total of 30 injection wells will be required to treat the overburden for Phase IA and Phase IB from an approximate depth of 8-20 feet bgs. An estimated production rate of 2 borings per day can be anticipated requiring 20 days (1 field crew, 15 injection days plus 5 days setup/breakdown) to complete the Phase IA and IB remediation. In the event and likelihood that daylighting becomes an issue, an additional 6 days of injections may be required to treat the shallowest intervals through amendments to the injection approach.

Table 5: Estimated ZVI for Overburden Treatment (Phase IA and IB) Remediation

Parameter	Value	Comment
Treatment Interval	8-20 feet bgs	Overburden (sands)
Area	9420 ft^2	Both Source Zones
Volume of Soil	113,040 ft^3	
Pounds of Soil	11,304,000 pounds	Based on 100 pounds/ft^3
Iron Required	96,000 pounds	At 0.86% soil weight
Total Cost of Iron	$120,000	Cost at $1.25 per pound
Gallons Injected	26,190 gallons	3.65 pounds/gallon
Gallons per Well	890 gallons	1 injection location

- Based on the above assumptions and parameters, the cost to implement the Ferox technology in the source areas (Phase IA and Phase IB) is estimated to be between **$360,000** and **$390,000**. It is important to note that further cost breakdown would not be prudent at this time until an executable scope has been established. Costs associated with additional injection days for the treatment of the shallowest intervals (offset borings) and rental of electronic monitoring equipment (Hermit Data Logger and Transducers) are not included in this estimate.

9.2 Phase II Cost Estimate

The estimated costs associated with the implementation of Phase II remediation activities have been based on several key assumptions identified below:

- Treatment Area 650 feet long by 45 deep by 25 feet wide (ROI of 12.5 ft).
- Treatment Interval: 37 feet bgs, consisting of fine to medium grained sands.
- Porosity of overburden: 0.3 (fine/medium sands).
- Bulk density of overburden: 100 pounds/cubic foot.
- Maximum total CVOC groundwater concentrations in overburden: 2 mg/L.
- Radius of Influence (ROI) of 12.5 feet.

Since the ZVI injections during the Phase II operations will be applied at deeper depths, a ROI of 12.5 ft was selected to serve as a conservative estimate that will provide a sufficient level of overlap between injection borings and ensure lateral continuity of the treatment cell. Table 6 provides the estimated ZVI required for treatment of the overburden within the plume.

Table 6: Estimated ZVI for Overburden Treatment (Phase II) Remediation

Parameter	Value	Comment
Treatment Interval	8-45 feet bgs	Overburden (sands)
Area	15,000 ft^2	Plume Zone
Volume of Soil	545,000 ft^3	
Pounds of Soil	54,500,000 pounds	Based on 100 pounds/ft^3
Iron Required	410,000 pounds	At 0.75% soil weight
Total Cost of Iron	$512,500	Cost at $1.25 per pound
Gallons Injected	112,000 gallons	3.65 pounds/gallon
Gallons per Well	3700 gallons	1 injection location

As a result of the expanded treatment zone (8 – 45 ft bgs), lower ZVI quantities may be necessary to mitigate borehole instability issues as the injections proceed. A dosage of 0.75 percent iron in soil ratio correlates to approximately 1100 lbs of ZVI per interval, which represents a quantity (based on ARS' experience) that could be injected across most of the treatment interval (8 – 45 ft bgs) without stressing the aquifer to a point where daylighting would occur. As indicated in earlier sections of this report, daylighting will become problematic at the shallower intervals and it is unlikely the entire treatment interval can be completed within one boring; likely requiring offset locations. It is important to note that the 0.75 dosage serves as an estimate on the achievable dosage based on what was observed during the Pilot Study and can be increased if higher dosages are warranted. Based upon a 0.75 percent iron in soil ratio for the overburden, approximately 410,000 pounds of iron will be required to treat the target VOCs migrating from the source area. Based upon a 12.5 foot radius of influence, a total of 30 injection wells will be required to treat the overburden from an approximate depth of 8 – 45 feet bgs. The width of the treatment zone (25 ft) should provide adequate residence time (250 days[2]) to treat all COCs migrating through he treatment zone. An estimated production rate of 1 boring per day can be anticipated requiring 36 days (1 field crew, 30 injection days plus 6 days setup/breakdown) to complete the Phase II remediation effort.

Based on the above assumptions and parameters, the cost to implement the Ferox technology within the plume (Phase II) is estimated to be between **$1,250,000** and **$1,400,000**. Please note that this estimate assumes a maximum treatment depth of 45 ft bgs within the plume and the cost to implement the technology will increase proportionally with depth if injection locations are shifted southwest to intercept the leading edge of the plume.

---

[2] Residence time derived from hydraulic conductivity presented in Phase II summary. Residence time of 250 days should be sufficient to treat Freon 113, which was identified in the treatability study to have the slowest treatment rate.

TABLE - 1

Farrand Controls Site

Injection Data Table

Batch Data								Module/Injection Point Pressures (PSI)				Nitrogen	Monitoring Well Pressures					
Date	Nozzle Depth (ft bgs)	Interval (ft bgs)	Batch	Start Time	End time	Water (gal)	Iron (lbs)	Module Set	Peak	Injection	Wellhead	Volume (cu. Ft.)	MW 21-r	MW 21-s	MW 22-r	MW 22-s	MW 4	Comments
May 24th, 2005	15.5	14 - 17	-	-	-	200	500	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	Nozzle clogged, no injection.
	15.5		1	14:50	14:56	-	-	175	70	70	70	436.3	0	3.1	0	0	0	Successful injection. Visual heave East of injection point.
	15.5		2	15:07	15:13	200	600	60	40	40	40	174.5	0	V+	0	0	0	Heavy DL out of SP-4, visual heave East and South of Injection point
May 25th, 2005	17.5	16 - 17.5	1	8:59	9:05	150	300	75	50	50	50	610.8	0	6.3	0	0	0	Bubbling mw21r, visual heave East, South and West of injection point
	17.5		2	9:14	9:19	200	500	75	50	50	50	261.8	0	0	0	0	0	Massive DL out of SP-4 area, visual heave and DL of Gas East, West and South of Injection point.
	12.5	11- 14.0	1	11:14	11:19	100	300	75	50	50	50	174.5	0	0	0	0	0	No visual heave, DL out of SP-4.
	12.5		2	11:29	11:35	100	500	75	50	50	50	87.3	0	0	0	0	0	Massive DL from SP-4 area
	8	6.5 - 9.5	-	-	-	100	200	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	Nozzle clogged, no injection.
	8		-	-	-	-	-	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	Broken adapter, no injection
	8		1	13:30	13:36	-	-	nd	nd	nd	nd	nd	0	0	0	0	0	Hydraulic injection, no gas, no fracture or injection curves. No heave.

nd signifies "no data"

V+ signifies "prolonged venting of gas"

DL signifies "daylighting"

SP-4 signifies "Soil Probe 4" from Figure 3-1 of Remedial Design Work Plan (D&B)

TABLE - 2

Farrand Controls Site

Groundwater Readings: Horiba U-22

Well	Screened	Sampling Interval	Depth Of Nozzle	Depth to Groundwater (ft)	pH	Redox Potential (mV)	Conductivity (m S/cm)	Temperature (Celsius)	Dissolved Oxygen (mg/L)	Comments
MW 21-r	Depths: 18.8' - 28.8' bgs. Total: 10'	Baseline	-	7.6	7.83	-176	0.408	14.09	1.35	Despite close proximity to injection point, this well did not exhibit any significant pressure influence from injection due to depth of well screen.
		Post Interval 1	15.5	6.62	7.95	-153	0.403	14.29	0.4	
		Post interval 2	17.5	6.67	7.55	-139	0.399	14.26	0.65	
		Post Interval 3	12.5	6.94	7.86	-143	0.401	14.18	0.8	
		End of Pilot Test	8	7.28	7.53	-104	0.4	14.4	1.58	
MW 21-s	Depths: 5' - 15' bgs. Total: 10'	Baseline	-	7.44	6.86	53	0.422	14.05	0.9	Proximity to injection point as well as shallow set of well screen led to good pressure influence at this well.
		Post Interval 1	15.5	6.38	8.4	74	0.48	14.81	0.3	
		Post interval 2	17.5	7.11	7.06	52	0.55	14.69	0.07	
		Post Interval 3	12.5	7.01	8.38	71	0.548	14.42	0.12	
		End of Pilot Test	8	7.16	7.05	81	0.542	14.26	0.02	
MW 22-r	Depths: 25' - 35' bgs. Total: 10'	Baseline	-	6.6	13.31	-55	1.35	14.35	1.48	Consistently high pH readings may be due to presence of bentonite in the well screen.
		Post Interval 1	15.5	6.54	13.24	-58	1.33	14.39	1.36	
		Post interval 2	17.5	6.51	13.35	-60	1.3	13.96	1.2	
		Post Interval 3	12.5	6.51	13.31	-57	1.28	13.99	2.12	
		End of Pilot Test	8	6.55	13.34	1	1.3	14.52	2.74	
MW 22-s	Depths: 5' - 15' bgs. Total: 10'	Baseline	-	6.48	9.09	90	0.374	14.04	0.46	High dissolved oxygen readings in last 3 sampling events due to water which collected in the well cap during injection. When packer was removed this water entered the well.
		Post Interval 1	15.5	6.41	7.25	49	0.351	14.55	0.4	
		Post interval 2	17.5	5.76	9.05	63	0.43	14.07	5.28	
		Post Interval 3	12.5	5.52	7.64	43	0.428	14.14	7.25	
		End of Pilot Test	8	5.48	8.75	90	0.422	14.3	7.18	
MW 4	Depths: 2' - 12' bgs Total:10'	Baseline	-	3.68	7.75	47	0.431	12.28	1.01	Distance from injection point lead to little to no influence on this well.
		Post Interval 1	15.5	3.35	7.24	44	0.427	13.08	1.14	
		Post interval 2	17.5	3.47	7.62	62	0.418	12.93	2.08	
		Post Interval 3	12.5	3.32	7.18	55	0.424	12.56	2.2	
		End of Pilot Test	8	3.47	7.36	94	0.418	13.34	2.38	

Table - 3

Farrand Controls Site

Injection Dosage Summary Table

Date	Nozzle Depth (ft	Interval (ft bgs)	Batch	Target ZVI Dosage (lbs)	Actual ZVI Dosage (lbs)	Percent of Target
May 24th, 2005	15.5	14 - 17	1	1100	1100	100%
	15.5		2			
May 25th, 2005	17.5	16 - 17.5	1	1100	800	73%
	17.5		2			
	12.5	11- 14.0	1	1100	800	73%
	12.5		2			
	8	6.5 - 9.5	1	1100	250	18%
			Totals	**4400**	**2950**	

Iron Dosage

Farrand Controls Site

Monitoring Well Data Collected After Injections

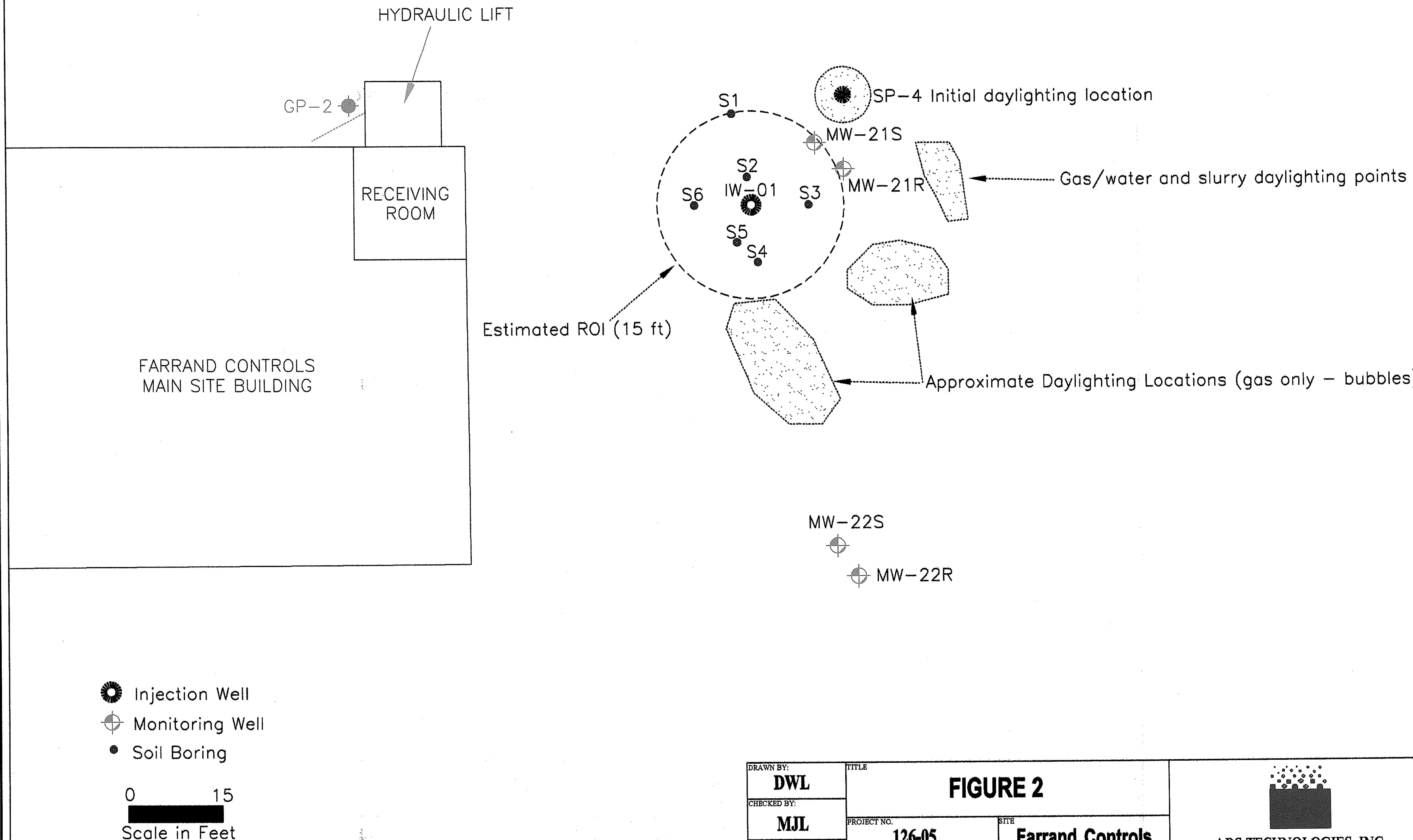
Sample ID	MW-21S	MW-21S	MW-21S
Date of Collection	12/15/2004	7/14/2005	9/23/2005
Dilution Factor	1	1	1
Units	ug/L	ug/L	ug/L
Chloride	52,000	130,000	120,000
1,1,2-Trichloro-1,2,2-Trifluoroethane	2100 DB	2900 D	2200 B
1,1,1-Trichloroethane	470 DB	460 DB	270
Trichloroethene	150	130	99 J

Qualifiers

D : Result taken from reanalysis at a secondary dilution

B : Compound found in the method blank as well as sample

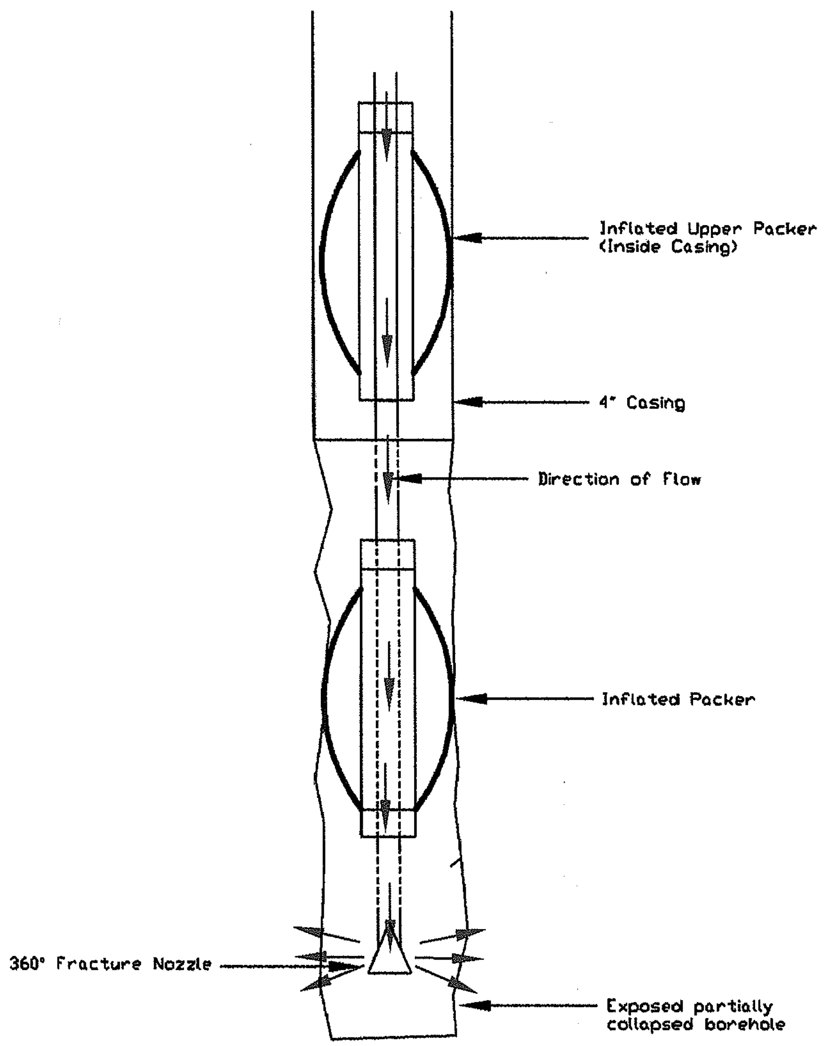
J : Compound detected at a concentration below CRDL, value estimated



DRAWN BY: DWL	TITLE: FIGURE 2	
CHECKED BY: MJL	PROJECT NO. 126-05	SITE Farrand Controls
APP'D BY: MJL	DRAWING NO. 3124-126-05	DATE

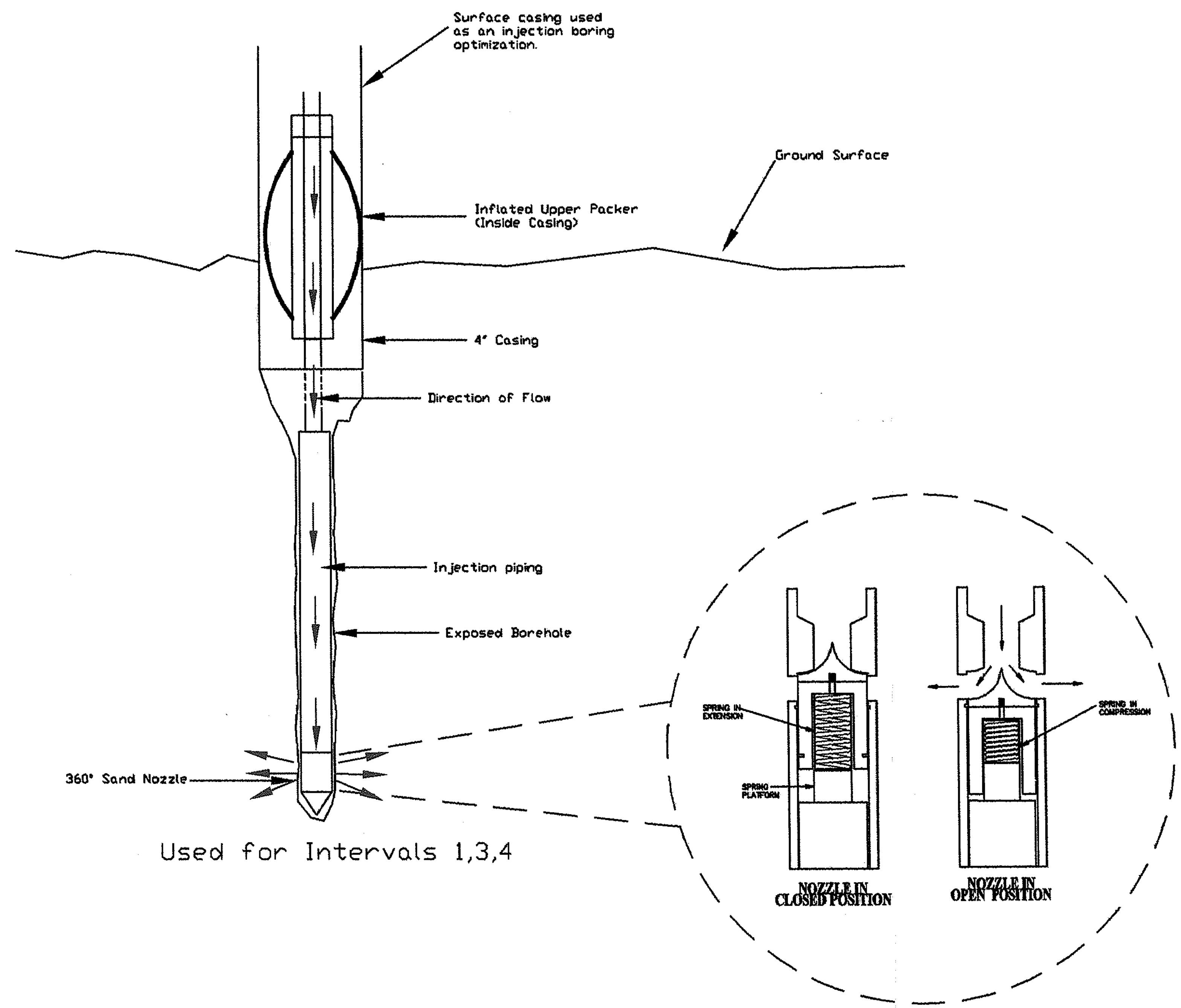
ARS TECHNOLOGIES, INC.
114 North Ward Street
New Brunswick, NJ 08901

FIGURE 3



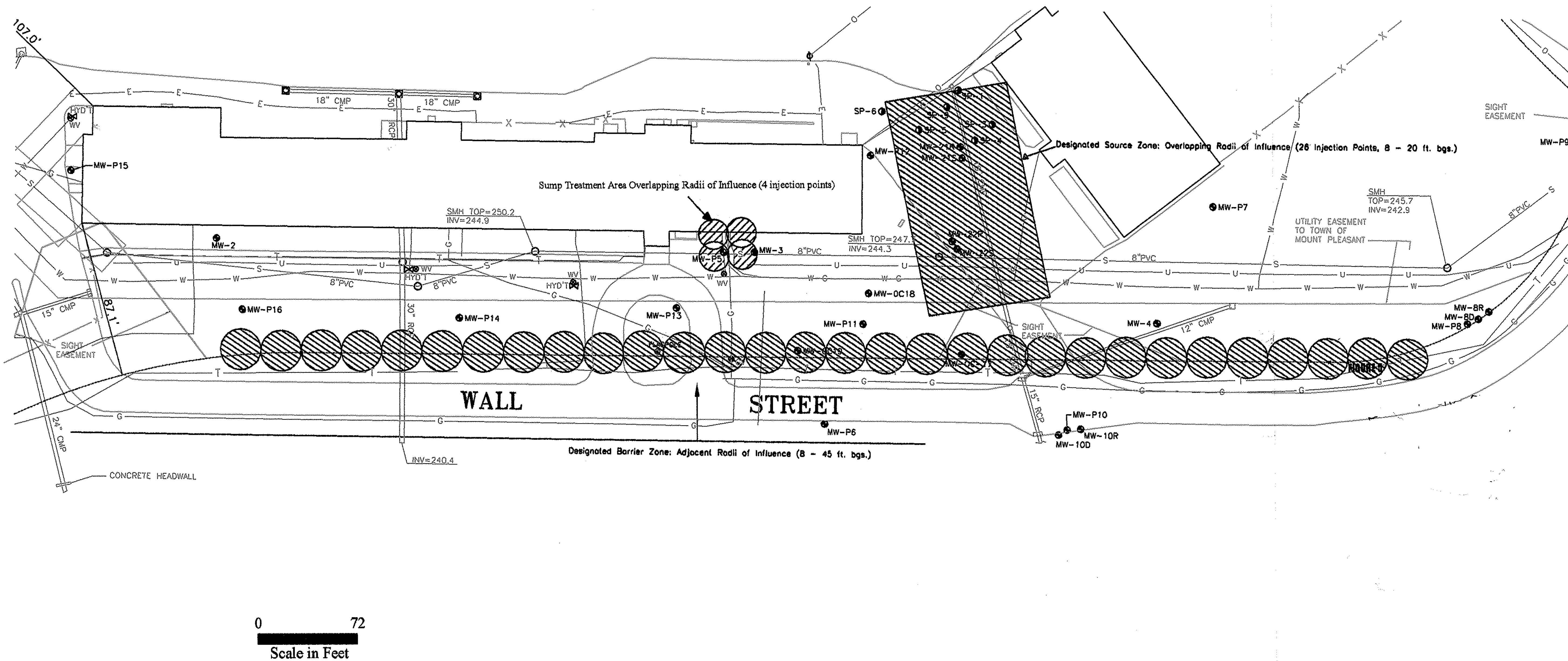
Used for Interval 2 (16-17.5 ft)

FIGURE 4



Used for Intervals 1,3,4

DRAWN BY: DWL	TITLE: FIGURES 3 and 4		ARS TECHNOLOGIES, INC. 114 North Ward Street New Brunswick, NJ 08901
CHECKED BY: MJL	PROJECT NO. 126-05	SITE Farrand Controls	
APP'D BY: MJL	DRAWING NO. 3125-126-05	DATE	

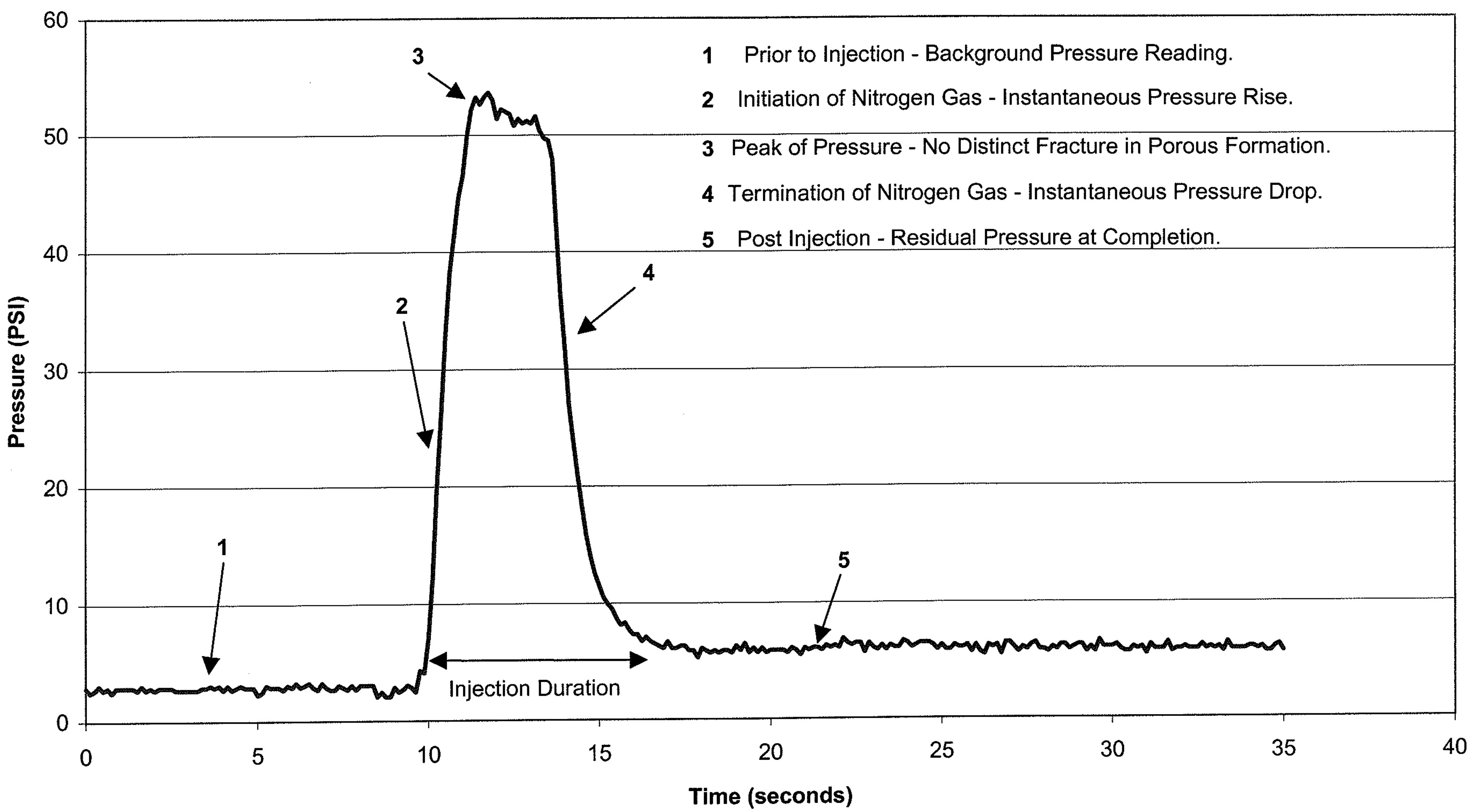


DRAWN BY:	TITLE: **FIGURE 5**	
CHECKED BY:	PROJECT NO. **126-05**	SITE **Farrand Controls**
APPD BY:	DRAWING NO. **3126-126-05**	DATE

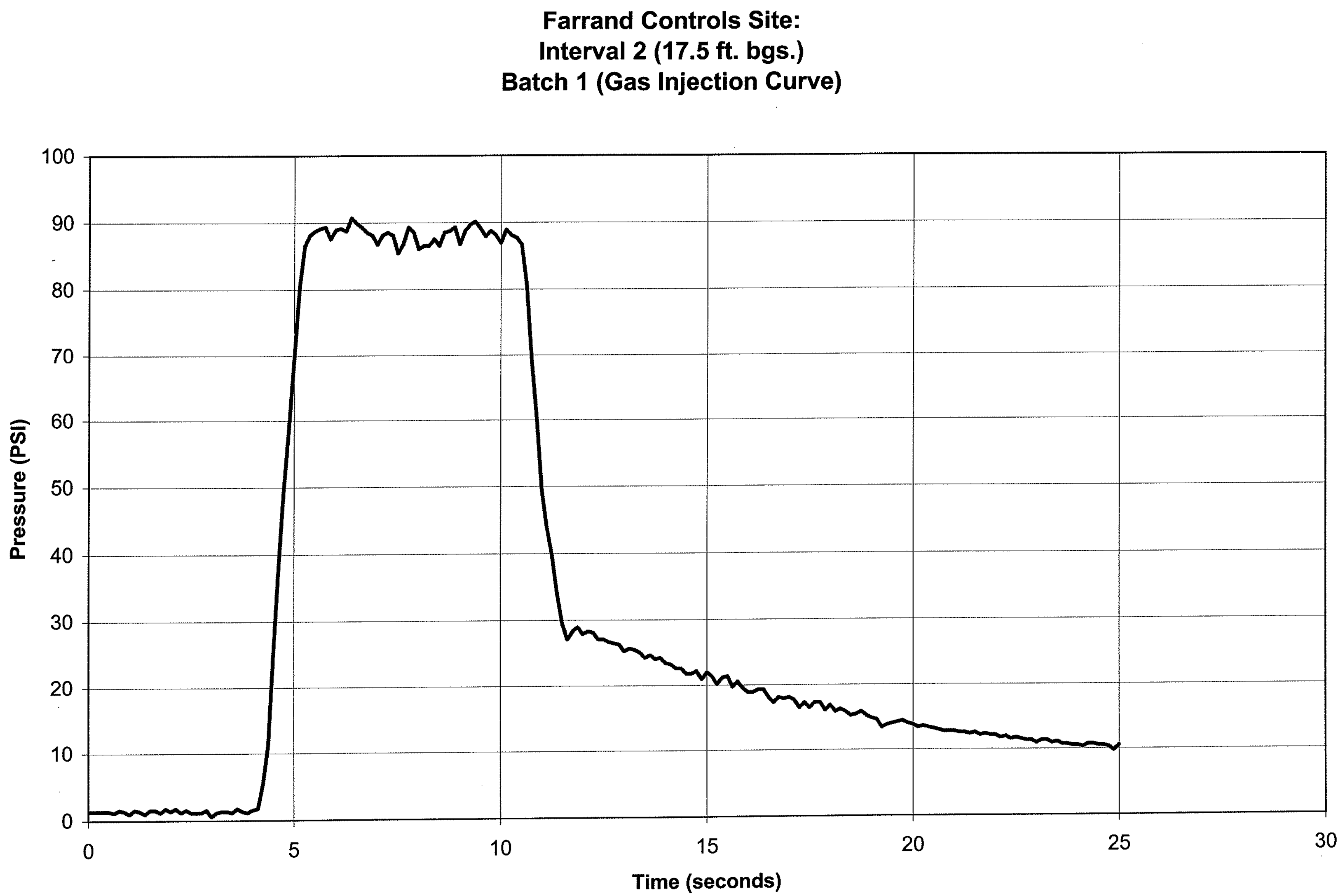
ARS TECHNOLOGIES, INC.
114 North Ward Street
New Brunswick, NJ 08901

GRAPH 1A

Farrand Controls Site:
Interval 1 (15.5 ft. bgs.)
Batch 1 (Gas Injection Curve)



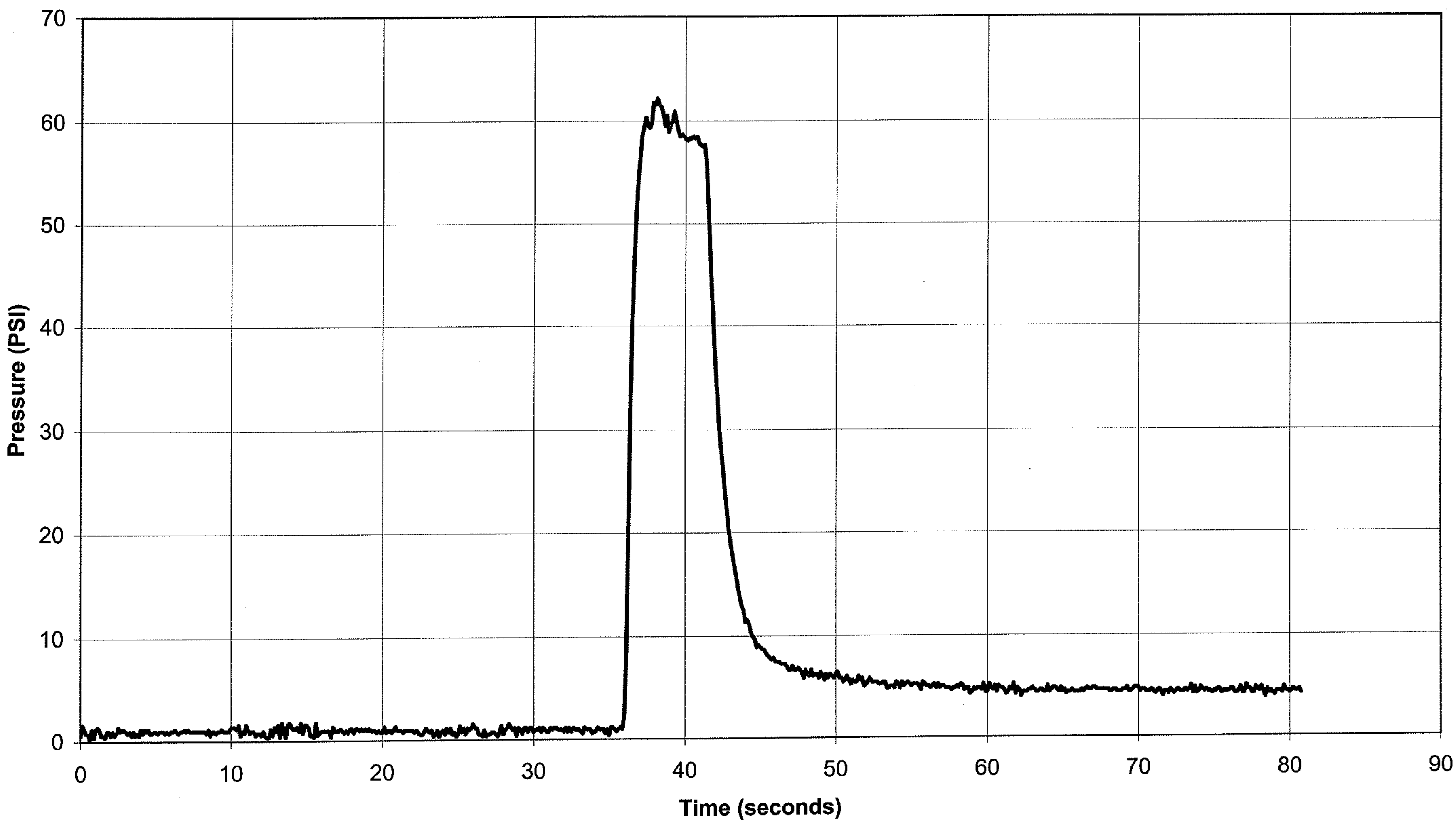
GRAPH 2



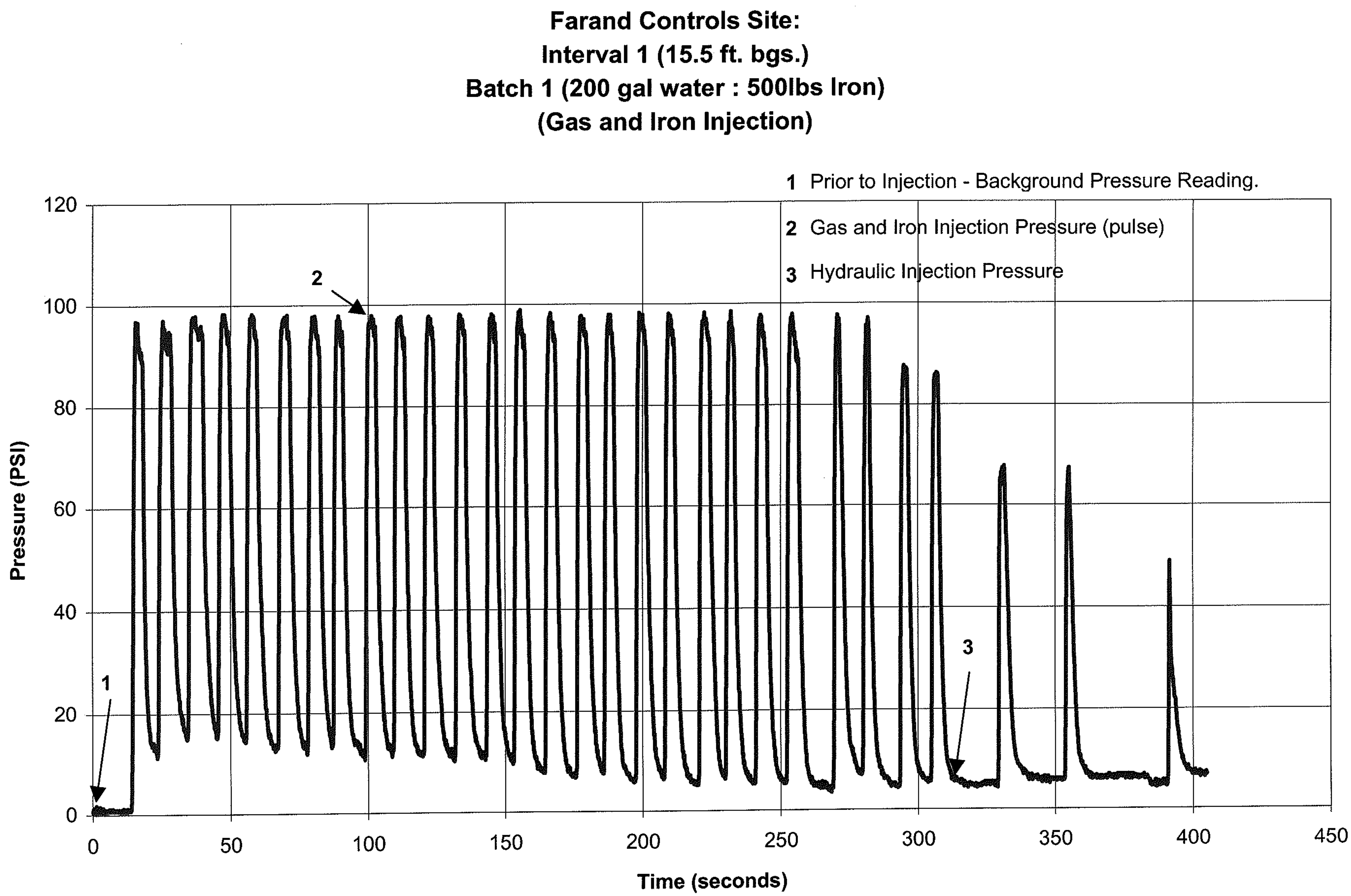
Farrand Controls Site:
Interval 2 (17.5 ft. bgs.)
Batch 1 (Gas Injection Curve)
Pressure (PSI)
100
90
80
70
60
50
40
30
20
10
0
0
5
10
15
20
25
30
Time (seconds)

GRAPH 3

Farrand Controls Site:
Interval 3 (12.5 ft. bgs.)
Batch 1 (Gas Injection Curve)

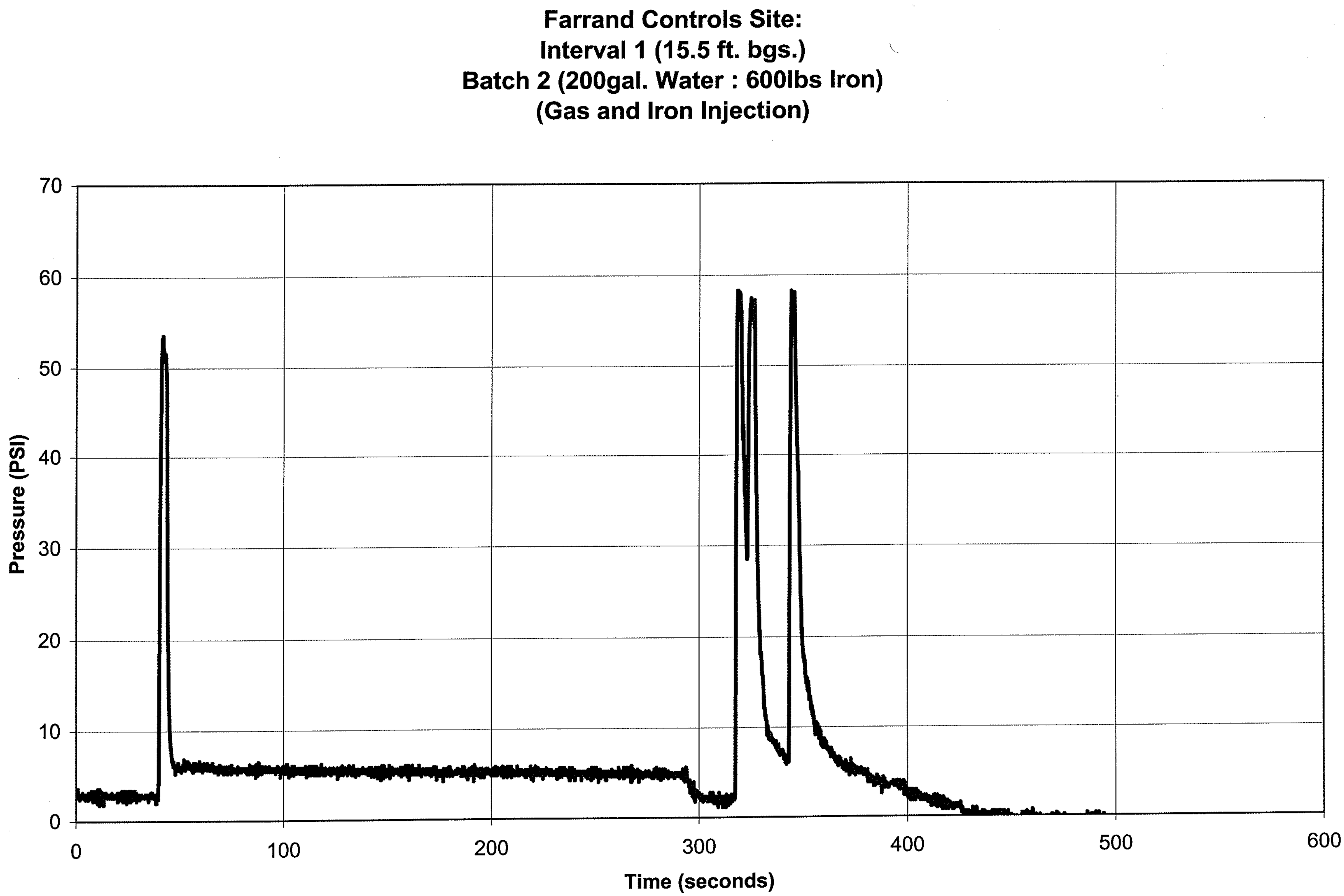


GRAPH 4A



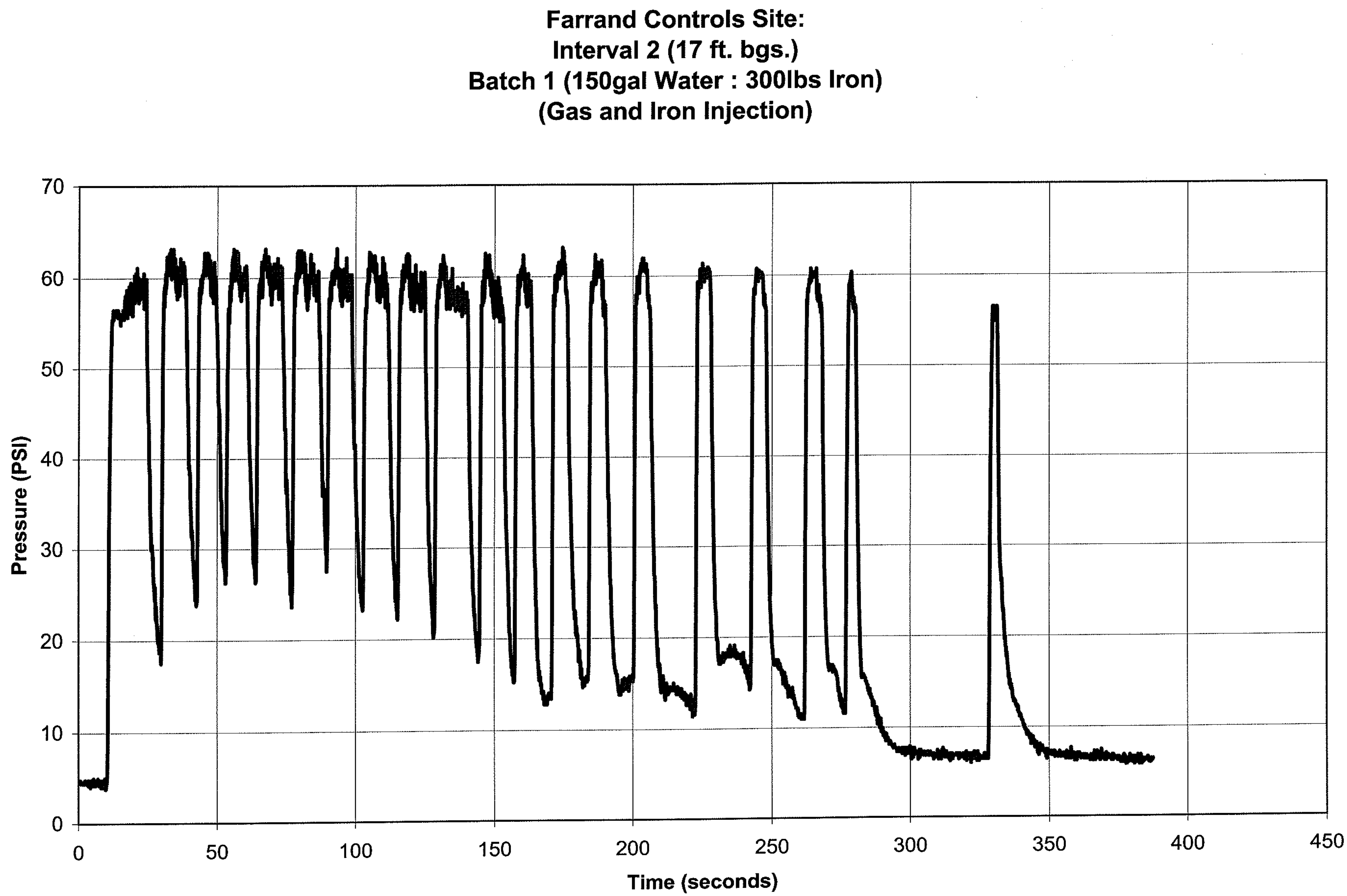
Farand Controls Site:
Interval 1 (15.5 ft. bgs.)
Batch 1 (200 gal water : 500lbs Iron)
(Gas and Iron Injection)
1 Prior to Injection - Background Pressure Reading.
2 Gas and Iron Injection Pressure (pulse)
3 Hydraulic Injection Pressure
Pressure (PSI)
Time (seconds)
0
20
40
60
80
100
120
0
50
100
150
200
250
300
350
400
450
1
2
3

GRAPH 5



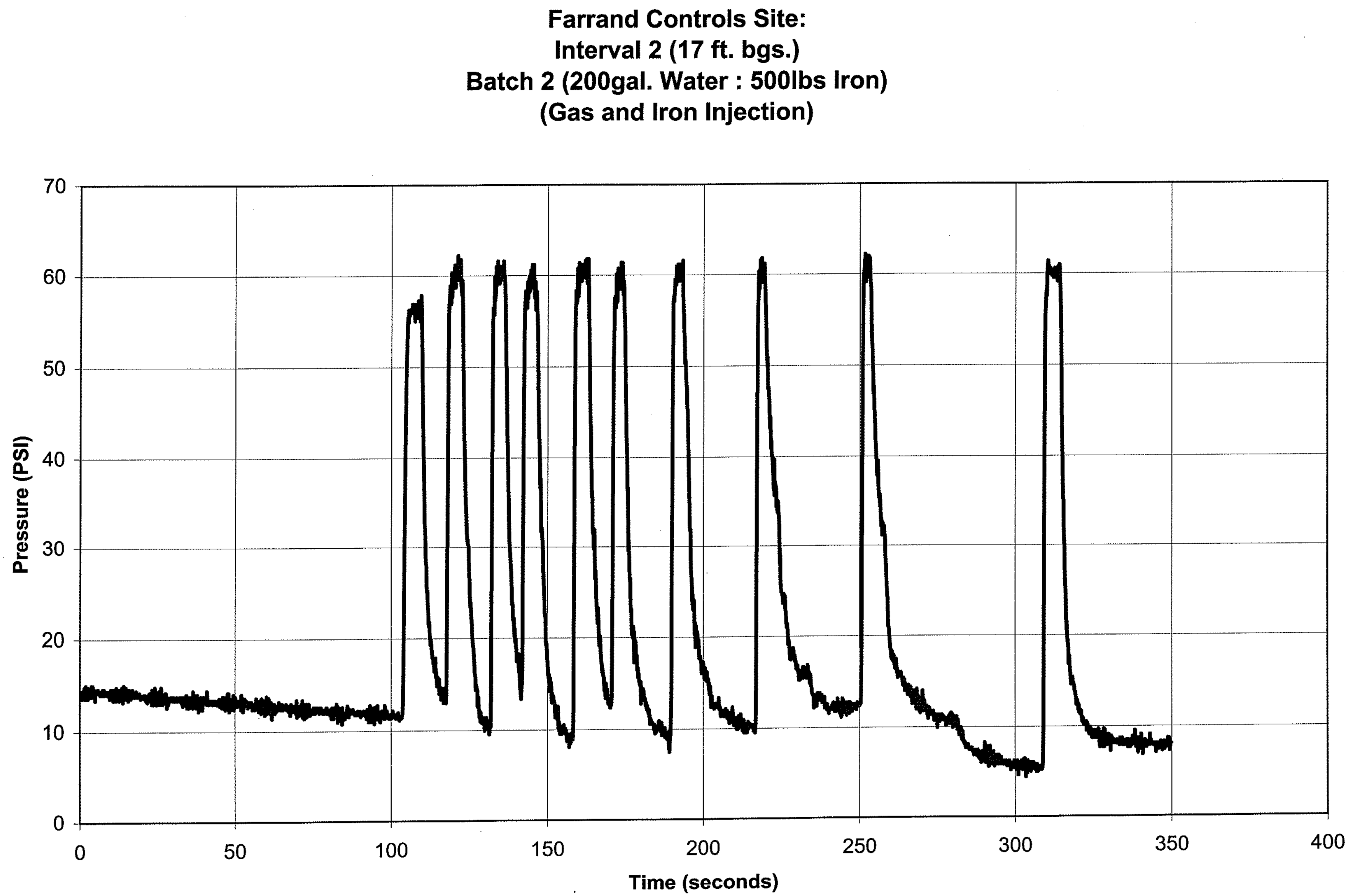
Farrand Controls Site:
Interval 1 (15.5 ft. bgs.)
Batch 2 (200gal. Water : 600lbs Iron)
(Gas and Iron Injection)
Pressure (PSI)
0
10
20
30
40
50
60
70
0
100
200
300
400
500
600
Time (seconds)

GRAPH 6



Farrand Controls Site:
Interval 2 (17 ft. bgs.)
Batch 1 (150gal Water : 300lbs Iron)
(Gas and Iron Injection)
Pressure (PSI)
70
60
50
40
30
20
10
0
0
50
100
150
200
250
300
350
400
450
Time (seconds)

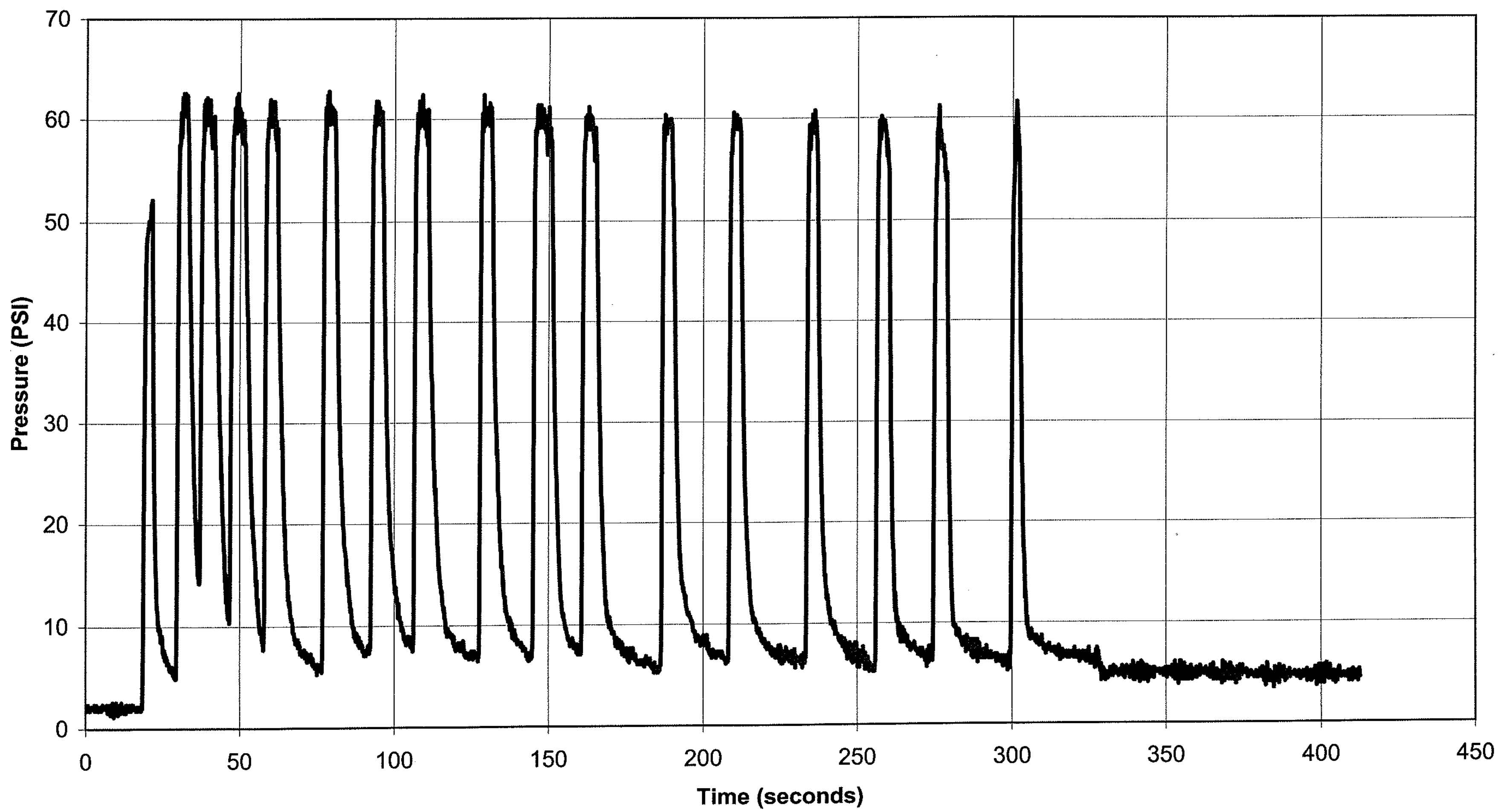
GRAPH 7



Farrand Controls Site:
Interval 2 (17 ft. bgs.)
Batch 2 (200gal. Water : 500lbs Iron)
(Gas and Iron Injection)
Pressure (PSI)
70
60
50
40
30
20
10
0
0
50
100
150
200
250
300
350
400
Time (seconds)

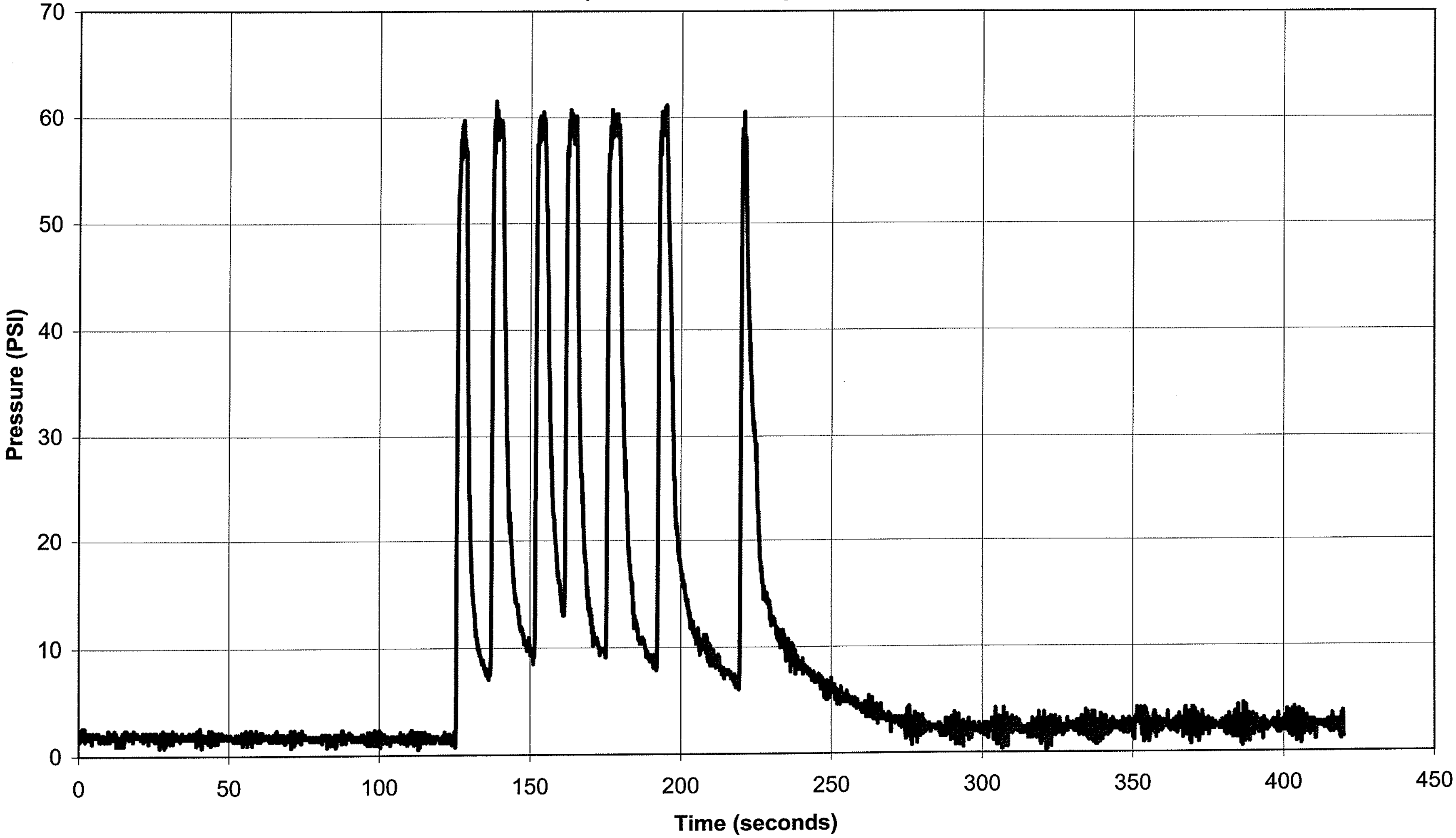
GRAPH 8

Farrand Controls Site:
Interval 3 (12.5 ft. bgs.)
Batch 1 (100gal. Water : 300lbs Iron)
(Gas and Iron Injection)

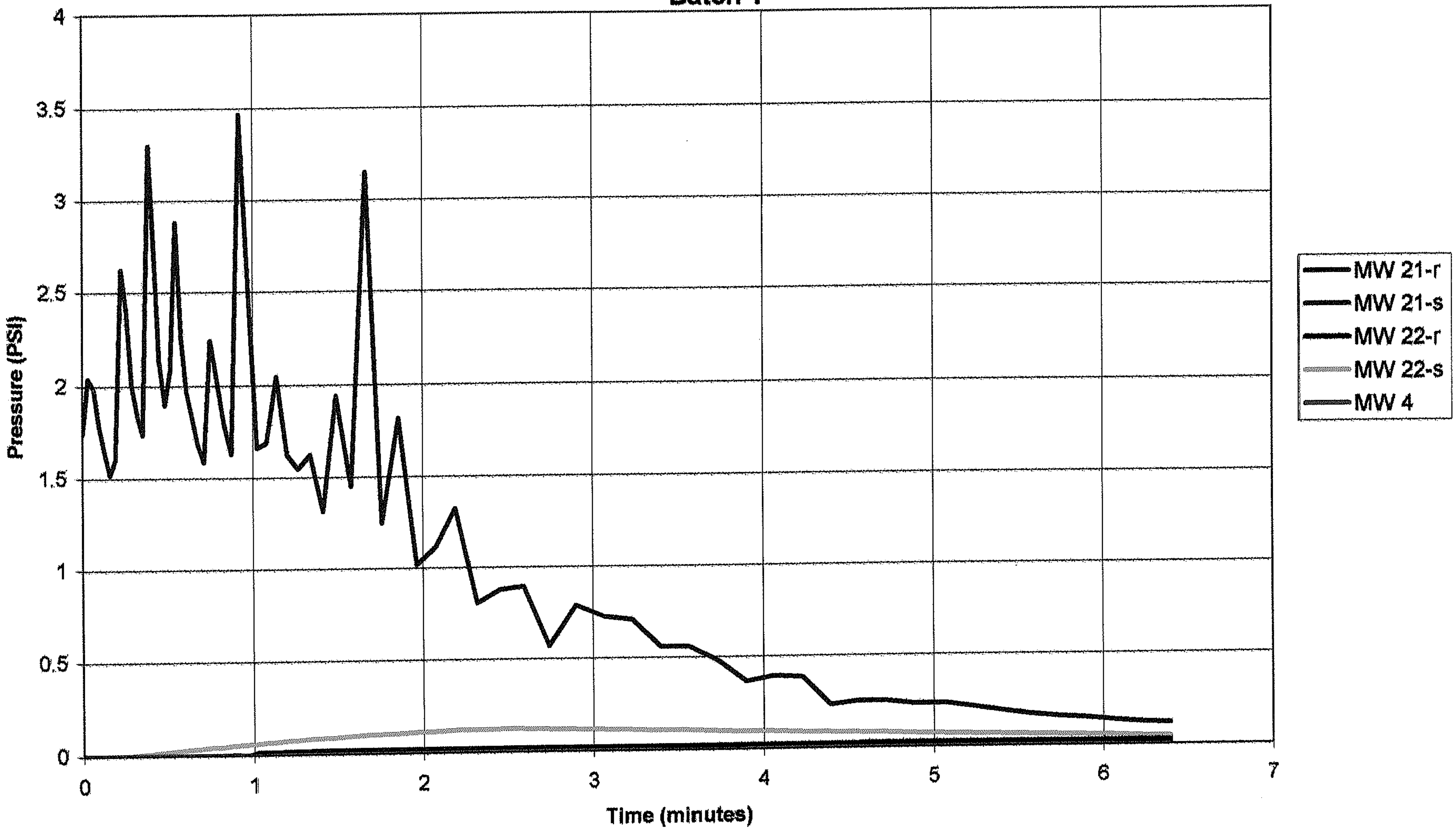


GRAPH 9

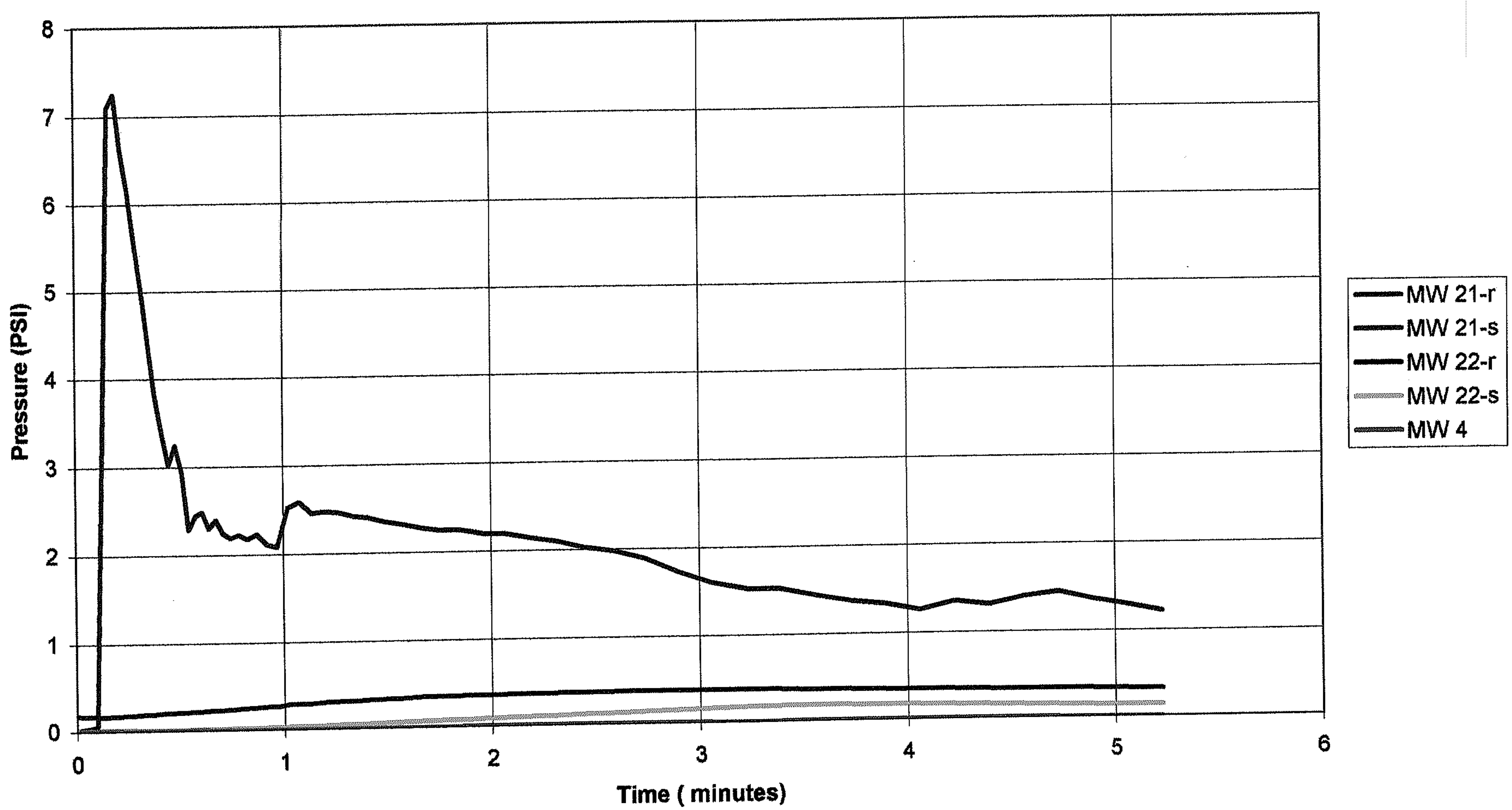
Farrand Controls Site:
Interval 3 (12.5 ft. bgs.)
Batch 2 (100gal. Water : 500lbs Iron)
(Gas and Iron Injection)



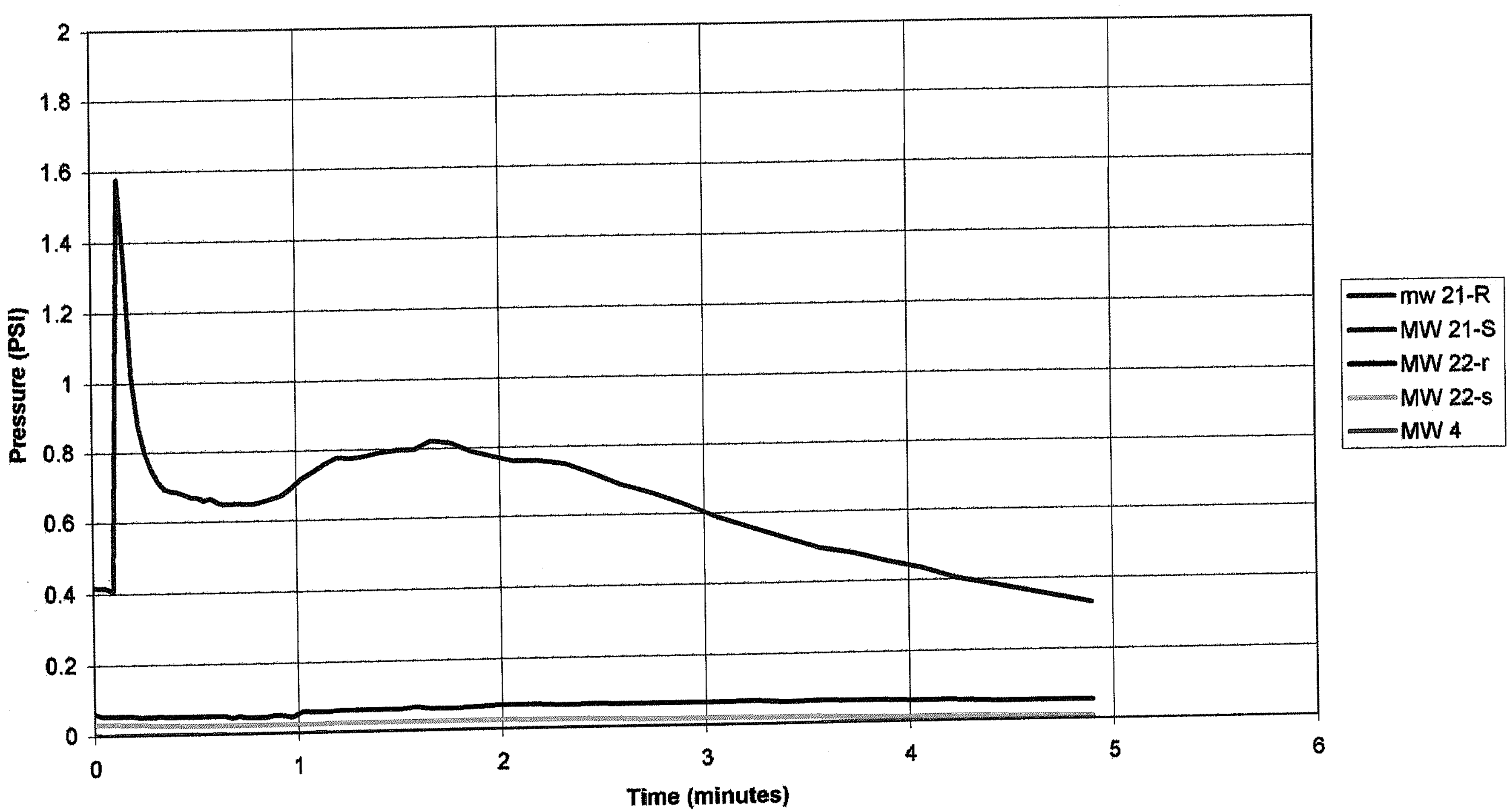
Farrand Controls Site:
Monitoring Well Pressures
Interval 1 (15.5 ft. bgs.)
Batch 1



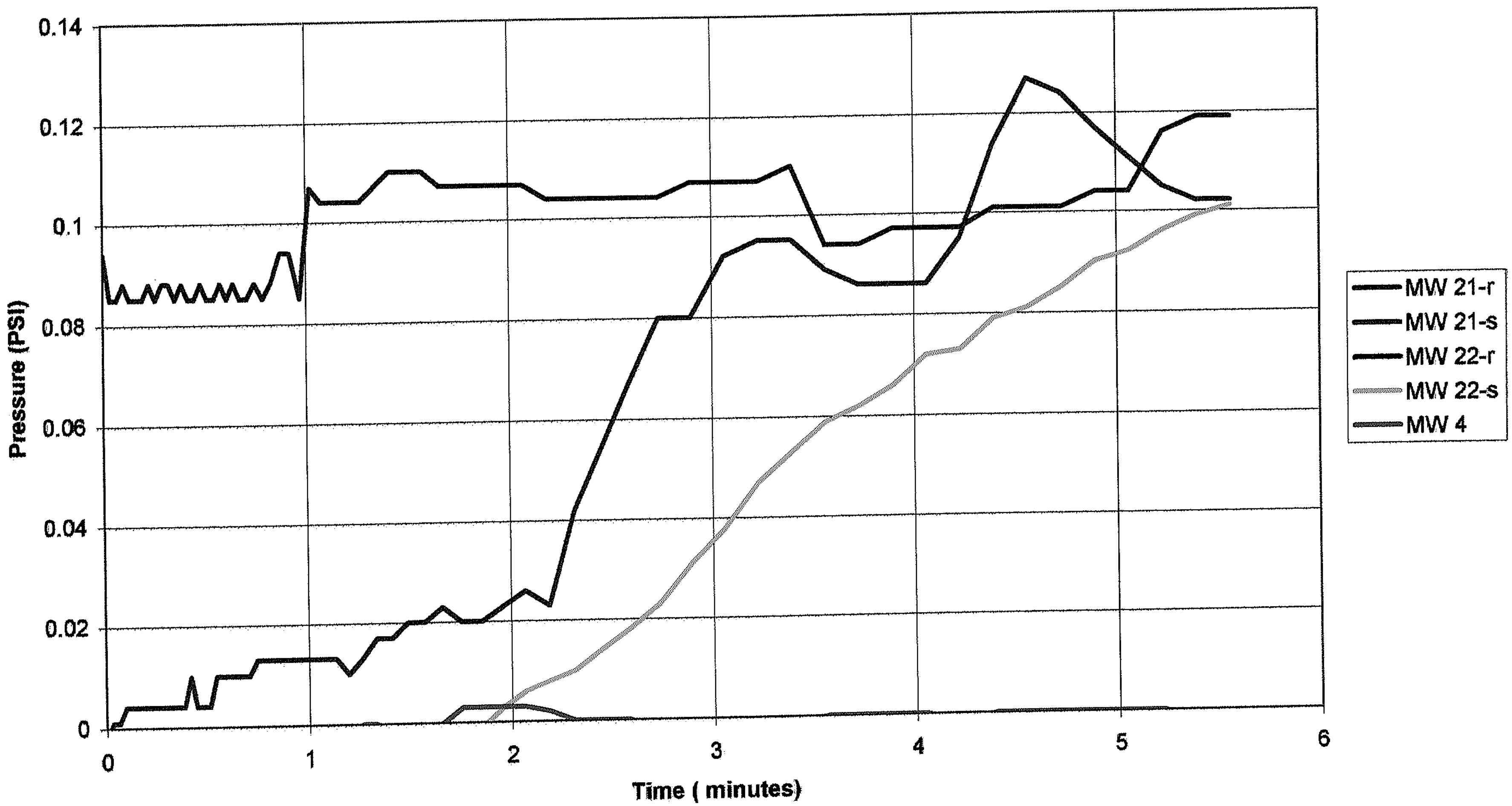
Farrand Controls Site: Monitoring Well Pressures Interval 2 (17 ft. bgs.) Batch 1



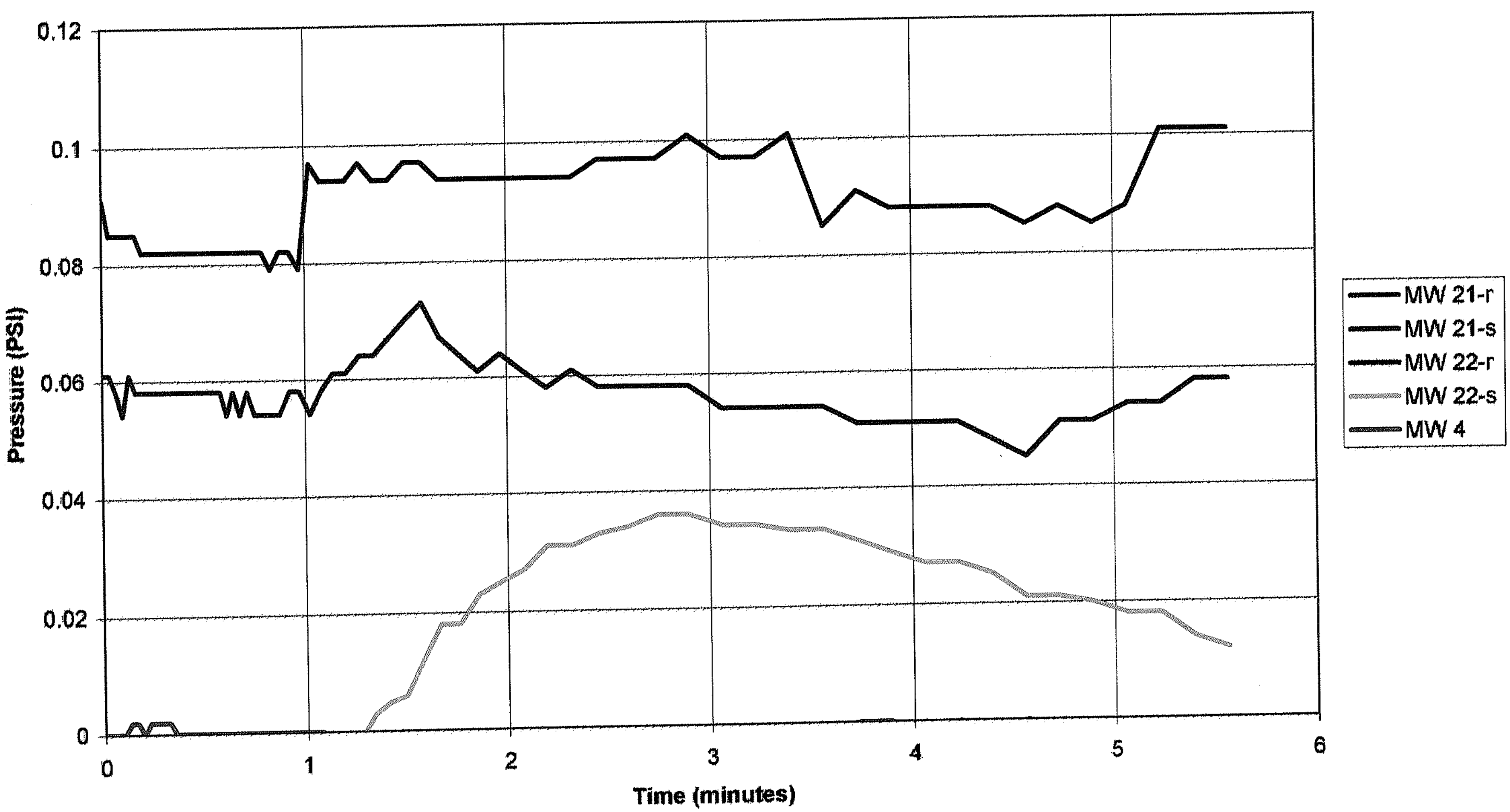
Farrand Controls Site:
Monitoring Well Pressures
Interval 2 (17 ft. bgs.)
Batch 2



Farrand Controls Site:
Monitoring Well Pressures
Interval 3 (12.5 ft. bgs.)
Batch 1



Farrand Controls Site:
Monitoring Well Pressures
Interval 3 (12.5 ft. bgs.)
Batch 2



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e-mail: findingsolutions@db-eng.com

January 13, 2006

Ms. Karen Maiurano
Division of Environmental Remediation
New York State Department of Environmental Conservation
625 Broadway
Albany, NY 12233

Re: Farrand Controls Site
Zero-Valent Iron Pilot Study Report
D&B No. 2276-02

Dear Ms. Maiurano:

The following are our outstanding comments on the final "*Report of Results Ferox Injection Pilot Study,*" as prepared by ARS Technologies dated November 2005.

1. Page 1 – Third paragraph – The percent of target iron for Interval 4 was not included.

2. Pages 1 and 12 - ARS still presents data from the post-injection soil boring sampling as representing an increase in iron concentrations of 24%. As stated on in our letter dated November 10, 2005, iron concentrations in subsurface soil samples collected immediately surrounding the injection point were highly variable and were consistent with iron concentrations detected in subsurface soil samples collected during the remedial investigation. Presenting the results in this manner may be misleading and unfounded.

3. Page 2 - Last paragraph, first sentence - "highly reactivity" should be "highly reactive."

4. Page 6 – Section 5.3, first paragraph, third sentence – The sentence should be revised by replacing "to mixing capacity" with "the mixing capacity."

5. Page 7 - There should be a space between second-to-last and last paragraph.

6. Page 7 – Second-to-last paragraph, second sentence - This sentence indicates that the injection parameters are listed in Tables 1 and 2. The injection parameters are only listed in Table 1.

7. Page 7 – Section 6.1, paragraph 3 – The reference to the range of injection pressures (i.e., 40 to 70 psi) should be consistent with graphs in Appendix A which show a range of 40 to 90 psi.

8. Page 8 -First full paragraph - This paragraph defines each of the different types of pressures monitored and presented in Table 1. Table 1 shows that the peak, injection and wellhead pressures are the same.

9. Page 8 – Second paragraph, last sentence – The word "in" should be placed after the word "resulting."

10. Page 8 - Third full paragraph, middle of paragraph - The statement "should therefore be considered speculative solely based on ARS' observation" is unnecessary.

11. Page 11 - Fifth full paragraph - The noted increase in dissolved oxygen within a monitoring well due to water trapped in the well cavity should refer to MW-22S not MW-21S.

12. Page 12 - Section 7.0 - Performance Evaluation - Third paragraph - This paragraph references a 23% increase in iron concentration, which is inconsistent with the previous value of 24%; please clarify.

13. Page 13 - Second paragraph, second sentence - "Operational parameters collected during the PF injections ***confirmed*** that a propagation distance of 15 feet could be achieved within the deeper injection intervals." Our review of the test data and report does not provide confirmation of this radius.

14. Page 13 – Third paragraph, first sentence – The statement that ZVI injection was *proven to be applicable* should be revised to state that ZVI injection was *proven to be implementable.*

15. Page 13 – Third paragraph, last sentence - "Suppressed" should not be capitalized. Also "D.O." should be revised.

16. Page 13 –Fourth paragraph, first sentence - "ZVI was proven to ***be*** applicable."

17. Page 13 - Last paragraph - This paragraph is missing a figure reference.

18. Page 14 – Injection Productivity, First paragraph, second sentence – "…the production rate due ***to*** longer than..."

19. Page 16 - 1st bullet - "It is important to note that further cost breakdown would not be prudent at this time until an executable scope has been established. Costs associated with additional injection days for the treatment of the shallowest intervals (offset borings) and rental of electronic monitoring equipment (Hermit data logger and transducers) are not included in this estimate." The RFP indicates that the cost estimate "shall include all capital costs associated with system installation and operation and maintenance costs including monitoring for the anticipated duration of remediation. Estimated timeframe for reduction of contaminants to remediation objectives should also be provided as well as costs associated if necessary with additional injections." The cost estimate to should include costs for monitoring equipment as well as a contingency for additional injections.

20. Page 18 – First paragraph – The information presented indicates that all groundwater flowing through the points installed as part of Phase 2 will have a residence time of 250 days. Since the points do not overlap, it does not appear that all groundwater will receive this residence time.

21. Figures 2 and 5 - Scale on Figure 2 is incorrect and scale on Figure 5 should be revised to a more suitable scale. (i.e., 1" = 100'). Also, the scale presented on Figure 5 is inconsistent with area described in text on Page 15, Section 9.

As discussed, these comments will not be forwarded to ARS; however, they will be included as part of the Engineering Report prepared for the Farrand Controls Site. If you have any comments or questions, please contact Albert Jaroszewski or me at (516) 364-9890.

Very truly yours,

Maria Wright

Maria Wright, P.E.

MDWt/jmy
cc: F. Navritil, NYSDOH
R. Walka, D&B
A. Jaroszewski, D&B
♦2276\MDW06LTR.DOC-01

APPENDIX F

POST PILOT TEST MICROWELL LOGS

Dvirka and Bartilucci CONSULTING ENGINEERS A DIVISION OF WILLIAM F. COSULICH ASSOCIATES, P.C.	Project No.: 2204 Project Name: FERRAND CONTROLS REMEDIAL DESIGN	Boring No.: SB-1 Sheet 1 of 1. By: CHRIS MORRIS
Drilling Contractor: PRECISION Driller: Drill Rig: MINI SONIC Date Started: 5/26/05	Geologist: CHRIS MORRIS Drilling Method: PNEUMATIC Drive Hammer Weight: Date Completed: 5/26/05	Boring Completion Depth: " 17.0' Ground Surface Elevation: Boring Diameter: 2"

Depth (ft.)	Soil Sample No.	Type	Blows Per 6"	Rec	Headspace Analysis FID ppm	PID ppm	CH4 ppm	Sample Description	USCS
~~0~~ 7				3.6'				6.5-13' 0-.7' BROWN F SAND WITH LITTLE SILT	
~~1~~ 8								.7-2.25' BROWN F SAND, SOME SILT AND F/M GRAVEL	
~~2~~ 9								2.25-3.5' BROWN F SAND AND F/M GRAVEL, SOME SILT AND PIECES OF WEATHERED BEDROCK	
~~3~~ 10									
~~4~~ 11									
~~5~~ 12									
~~6~~ 13				5.0'				13-17' BROWN M/C SAND, SOME F/M GRAVEL AND SILT	
~~7~~ 14									
~~8~~									
~~9~~									
~~10~~									

Sample Types:
SS =
ST =
D&M =
UC = Undisturbed Core (Dennison Type)

NOTES:

Dvirka and Bartilucci
CONSULTING ENGINEERS
A DIVISION OF WILLIAM F. COSULICH ASSOCIATES, P.C.

Project No.: 2276	**Boring No.:** SB-2	
Project Name: FORRAND CONTROLS REMEDIAL DESIGN	**Sheet** 1 **of** 1. **By:** CHRIS MORRIS	
Drilling Contractor: PRECISION	**Geologist:** CHRIS MORRIS	**Boring Completion Depth:** 16.0'
Driller:	**Drilling Method:** PNEUMATIC	**Ground Surface Elevation:**
Drill Rig: MINI SONIC	**Drive Hammer Weight:**	**Boring Diameter:** 2"
Date Started: 5/26/05	**Date Completed:** 5/26/05	

Depth (ft.)	Soil Sample No.	Type	Blows Per 6"	Rec	Headspace Analysis FID ppm	PID ppm	CH4 ppm	Sample Description	USCS
~~0~~ 6				2.5'				6.5-13' 0-0.5' BROWN AND GRAY ~~CLAY~~ SILT SOME CLAY 0.5-0.6 BN F/M SAND, SOME SILT AND F GRAVEL, LITTLE WEATHERED BEDROCK	
~~1~~ 7									
~~2~~ 8									
~~3~~ 9									
~~4~~ 10									
~~5~~ 11									
~~6~~ 12									
~~7~~ 13				3'				13-16 BN F/M SAND, SOME SILT AND F GRAVEL, LITTLE WEATHERED BEDROCK	
~~8~~ 14									
~~9~~ 15									
~~10~~ 16									

Sample Types:
SS =
ST =
D&M =
UC = Undisturbed Core (Dennison Type)

NOTES:

D&B_BLOG

Dvirka and Bartilucci CONSULTING ENGINEERS A DIVISION OF WILLIAM F. COSULICH ASSOCIATES, P.C.	Project No.: 2276 Project Name: FARRAND CONTROLS REMEDIAL DESIGN	Boring No.: SB-3 Sheet 1 of 1. By: CHRIS MORRIS
Drilling Contractor: PRECISION Driller: Drill Rig: MINI SONIC Date Started: 5/26/05	Geologist: CHRIS MORRIS Drilling Method: PNEUMATIC Drive Hammer Weight: Date Completed: 5/26/05	Boring Completion Depth: 14' Ground Surface Elevation: Boring Diameter: 2"

Depth (ft.)	Soil Sample No.	Type	Blows Per 6"	Rec	Headspace Analysis FID ppm	PID ppm	CH4 ppm	Sample Description	USCS
-~~0~~- 6				4.75'				6.5-13' ~~6.5-9.5~~ BROWN M/C SAND, SOME SILT MF/F GRAVEL AND LITTLE WEATHERED BEDROCK	
-~~1~~- 7									
-~~2~~- 8									
-~~3~~- 9									
-~~4~~- 10									
-~~5~~- 11									
-~~6~~- 12									
-~~7~~- 13				2'				13-14 BROWN F SAND AND SILT, SOME GRAVEL, WET	
-~~8~~-									
-~~9~~-									
-~~10~~-									

Sample Types:	NOTES:
SS = ST = D&M = UC = Undisturbed Core (Dennison Type)	

Dvirka and Bartilucci CONSULTING ENGINEERS
A DIVISION OF WILLIAM F. COSULICH ASSOCIATES, P.C.

Project No.: 2276	**Boring No.:** SB-4
Project Name: FARRAND CONTROLS REMEDIAL DESIGN	**Sheet** 1 **of** 1.	
	By: CHRIS MORRIS	
Drilling Contractor: PRECISION	**Geologist:** CHRIS MORRIS	**Boring Completion Depth:** " 17'
Driller:	**Drilling Method:** PNEUMATIC	**Ground Surface Elevation:**
Drill Rig: MINI SONIC	**Drive Hammer Weight:**	**Boring Diameter:** 2"
Date Started: 5/26/05	**Date Completed:** 5/26/05	

Depth (ft.)	Soil Sample No.	Type	Blows Per 6"	Rec	Headspace Analysis FID ppm	PID ppm	CH4 ppm	Sample Description	USCS
~~0~~ 6				3.5'				6.5 - 13.0' 0.75'. BROWN F SAND, LITTLE SILT 0.75 - 2.25' BROWN F SAND, SOME SILT AND F/M GRAVEL 2.25 - 3.5' BROWN F SAND AND F/M GRAVEL, SOME SILT, FRAGMENTS OF WEATHERED BEDROCK	
~~1~~ 7									
~~2~~ 8									
~~3~~ 9									
~~4~~ 10									
~~5~~ 11									
~~6~~ 12									
~~7~~ 13				5'				13 - 17' ~~13-14'~~ 0-1' BROWN F SAND AND GRAVEL, FRAGMENTS OF WEATHERED BEDROCK ~~14-17'~~ 1-4' BROWN F/M SAND, SOME SILT AND F/M GRAVEL	
~~8~~ 14									
~~9~~									
~~10~~									

Sample Types:
SS =
ST =
D&M =
UC = Undisturbed Core (Dennison Type)

NOTES:

D&B_BLOG

Dvirka and Bartilucci CONSULTING ENGINEERS A DIVISION OF WILLIAM F. COSULICH ASSOCIATES, P.C.	**Project No.:** 2206 **Project Name:** FERRANDO CONTROLS REMEDIAL DESIGN	**Boring No.:** SB-5 **Sheet** 1 **of** 1. **By:** CHRIS MORRIS
Drilling Contractor: PRECISION **Driller:** **Drill Rig:** MINI SONIC **Date Started:** 5/26/05	**Geologist:** CHRIS MORRIS **Drilling Method:** PNEUMATIC **Drive Hammer Weight:** **Date Completed:** 5/26/05	**Boring Completion Depth:** " 18' **Ground Surface Elevation:** **Boring Diameter:** 2"

Depth (ft.)	Soil Sample No.	Type	Blows Per 6"	Rec	Headspace Analysis FID ppm	PID ppm	CH4 ppm	Sample Description	USCS
~~0~~ 6				4'				6.5-13' 6.5-0-2' BROWN MC SAND AND SILT, SOME F/M GRAVEL, SMALL INCLUSIONS OF POSSIBLY IRON. 2-4' BROWN MC SAND AND GRAVEL, WITH COBBLES OF WEATHERED BEDROCK	
~~1~~ 7									
~~2~~ 8									
~~3~~ 9									
~~4~~ 10									
~~5~~ 11									
~~6~~ 12									
~~7~~ 13								13-18' 0-3' BROWN/GREY SILTY CLAY, SOME F/M GRAVEL 3-5' BROWN F SAND AND SILT, SOME GRAVEL	
~~8~~ 14									
~~9~~ 15									
~~10~~ 16									

Sample Types:
SS =
ST =
D&M =
UC = Undisturbed Core (Dennison Type)

NOTES:

Dvirka and Bartilucci CONSULTING ENGINEERS A DIVISION OF WILLIAM F. COSULICH ASSOCIATES, P.C.	Project No.: 2276 Project Name: FARRAND CONTROLS REMEDIAL DESIGN	Boring No.: SB-6 Sheet 1 of 1. By: CHRIS MORRIS
Drilling Contractor: PRECISION Driller: Drill Rig: MINI SONIC Date Started: 5/26/05	Geologist: CHRIS MORRIS Drilling Method: PNEUMATIC Drive Hammer Weight: Date Completed: 5/26/05	Boring Completion Depth: " Ground Surface Elevation: Boring Diameter:

Depth (ft.)	Soil Sample No.	Type	Blows Per 6"	Rec	Headspace Analysis FID ppm	PID ppm	CH4 ppm	Sample Description	USCS
~~-0-~~ 6				4.75'				6.5-13' 0-3' BN M/C SAND AND SILT, SOME F/M GRAVEL, OCCASIONAL ZONES OF SILTY CLAY 3-4.5' BN M/C SAND AND SILT AND FRAGMENTS OF WEATHERED BEDROCK	
~~-1-~~ 7									
~~-2-~~ 8									
~~-3-~~ 9									
~~-4-~~ 10									
~~-5-~~ 11									
~~-6-~~ 12									
~~-7-~~ 13				1'				13-14' BROWN F SAND AND SILT, SOME GRAVEL, WET	
~~-8-~~ 14									
~~-9-~~ 15									
~~-10-~~ 16									

Sample Types:	NOTES:
SS = ST = D&M = UC = Undisturbed Core (Dennison Type)	

D&B_BLOG

BORING LOG

DVIRKA AND BARTILUCCI

Project No.: MW-PT1S
Project Name: FARRAND CONTROLS

Well/Boring No.: MW-PT1S
Sheet 1 of 1
By: K ROBINS Date: 12/19/05
Chk'd: Date:

Drilling Contractor: ZEBRA
Driller: CHARLES
Geologist: K. ROBINS
Drill Rig: GEOPROBE
Drilling Method: PNEUMATIC
Sample Spoon I.D.:
Drive Hammer Wt.:
Date Started: 12/19/05
Date Completed: 12/19/05

Borehole Completion Depth: 10
Borehole Diameter: 2"
Ground Surface El.:
WELL DIA: 3/4" PVC
SCREEN: 0-10'

DEPTH (FT.)	SAMPLE NO.	SAMPLING INTERVAL	RECOVERY/ RQD	BLOWS/6"	HEADSPACE (PPM)	SAMPLE DESCRIPTION
-0-						REFER TO LOG OF MW-PT1D
-1-						
-2-						
-3-						
-4-						
-5-						
-6-						
-7-						
-8-						
-9-						
-10						

Remarks:

Water Level Measurement
______ Date ______
______ Date ______
______ Date ______
______ Date ______

BL

BORING LOG

DVIRKA AND BARTILUCCI

Project No.: 2276
Project Name: FARRAND CONTROLS

Well/Boring No.: MW-PT1D
Sheet 1 **of** 1
By: K. ROBINS **Date:** 12/19/05
Chk'd: ______ **Date:** ______

Drilling Contractor: ZEBRA
Driller: CHARLES **Geologist:** K. ROBINS
Drill Rig: GEOPROBE **Drilling Method:** PNEUMATIC PUSH
Sample Spoon I.D.: ______ **Drive Hammer Wt.:** ______
Date Started: 12/19/05 **Date Completed:** 12/19/05

Borehole Completion Depth: 19'
Borehole Diameter: 2"
Ground Surface El.: –
WELL DIA: 3/4" PVC
SCREEN: 16-19'

DEPTH (FT.)	SAMPLE NO.	SAMPLING INTERVAL	RECOVERY/ RQD	BLOWS/6"	HEADSPACE (PPM)	SAMPLE DESCRIPTION
0		0-4'	40"		0.5	0-4" ASPHALT 4-10" BROWN SILTY SAND 10-14" CONCRETE 14"-4' BROWN TO GREEN FM SAND, TRACE F GRAVEL
2						
4		4-8'			0.7	
6						7-7.2' BROWN SILT 7.2-7.4' BLACK FM SAND, DAMP
8		8-12	48"		0.5	8-9' BROWN FM SAND, F GRAVEL 9-11' BROWN MF SAND, SOME F GRAVEL
10						11-11.5' BLACK SILT, TRACE F GRAVEL 11.5-12 BROWN/LT GRAY SILT, TRACE F GRAVEL
12		12-16	36"		0.5	12-16' BROWN LT GRAY COMPACTED ~~SILT~~ F SAND AND SILT; TRACE FINE GRAVEL
14						
16		16-19	32"		0.3	16-19' BROWN REDDISH SILT, TRACE F SAND, TRACE F GRAVEL
18						
20						

Remarks:

Water Level Measurement

______	Date ______
______	Date ______
______	Date ______
______	Date ______

BL

BORING LOG

DVIRKA AND BARTILUCCI

Project No.: 2206
Project Name: FARRAND CONTROLS

Well/Boring No.: MW-PT2S
Sheet 1 of 1
By: K ROBINS Date: 12/20/05
Chk'd: ______ Date: ______

Drilling Contractor: ZEBRA
Driller: CHARLES
Drill Rig: GEOPROBE
Sample Spoon I.D.: –
Date Started: 12/20/05
Geologist: K. ROBINS
Drilling Method: PNEUMATIC
Drive Hammer Wt.: –
Date Completed: 12/20/05

Borehole Completion Depth: 10'
Borehole Diameter: 2"
Ground Surface El.: –
WELL DIA: 3/4" PVC
SCREEN: 7-10'

DEPTH (FT.)	SAMPLE NO.	SAMPLING INTERVAL	RECOVERY/ RQD	BLOWS/6"	HEADSPACE (PPM)	SAMPLE DESCRIPTION
-0-						REFER TO LOG OF MW-PT2D
-1-						
-2-						
-3-						
-4-						
-5-						
-6-						
-7-						
-8-						
-9-						
-10						

Remarks:

Water Level Measurement ______ Date ______
______ Date ______
______ Date ______
______ Date ______

BL

BORING LOG

DVIRKA AND BARTILUCCI

Project No.: 2276
Project Name: FARRAND CONTROL

Well/Boring No.: MW-PT-2D
Sheet 1 of 1
By: K. ROBINS Date: 12/20/05
Chk'd: Date:

Drilling Contractor: ZEBRA
Driller: CHARLES
Drill Rig: GEOPROBE
Sample Spoon I.D.: –
Date Started: 12/20/05
Geologist: K. ROBINS
Drilling Method: PNEUMATIC
Drive Hammer Wt.: –
Date Completed: 12/20/05
Borehole Completion Depth: 17.5'
Borehole Diameter: 2"
Ground Surface El.: –
WELL DIA. 3/4" PVC
SCREEN @ 14.5–17.5'

DEPTH (FT.)	SAMPLE NO.	SAMPLING INTERVAL	RECOVERY/ RQD	BLOWS/6"	HEADSPACE (PPM)	SAMPLE DESCRIPTION
0		0-4'	36"		0.0	0-2" ASPHALT 2-24" BROWN FM SAND, LITTLE GRAVEL 24-36" DARK GRAY SILT, TRACE GRAVEL
2						
4		4-8'	36"		0.0	BROWN F SAND, SOME SILT, TRACE F GRAVEL, TIGHT
6						
8		8-12'	32"		0.0	BROWN TO DARK BROWN FM SAND, SOME SILT, SOME FC GRAVEL
10						
12		12-16'	24"		13 12-14	BROWN ORANGE SILT AND F SAND, TRACE GRAVEL 14-16' BROWN DARK BROWN SILT, LAYERS OF MC SAND; SLIGHT ODOR FROM WATER WITH SHEEN-LIKE APPEARANCE
14						
16		16-17.5	18"		75	16-17' BROWN GRAY SILT, F GRAVEL 17-17.5' GRAY BUFF SILT; DRY
18						
20						REFUSAL AT 17.5'

Remarks:

Water Level Measurement ______ Date ______
______ Date ______
______ Date ______
______ Date ______

BL

BORING LOG

DVIRKA AND BARTILUCCI

Project No.: 2276	**Well/Boring No.:** MW-PT3S
Project Name: FORRAND COLETRONICS	**Sheet** 1 **of** 1
	By: K. ROBINS **Date:** 12/20/05
	Chk'd: **Date:**

Drilling Contractor: ZEBRA		**Borehole Completion Depth:** 21'
Driller: CHARLES	**Geologist:** K. ROBINS	**Borehole Diameter:** 2"
Drill Rig: GEOPROBE	**Drilling Method:** PNEUMATIC	**Ground Surface El.:** –
Sample Spoon I.D.: –	**Drive Hammer Wt.:** –	WELL DIA.: 3/4 PVC
Date Started: 12/20/05	**Date Completed:** 12/20/05	SCREEN: 8-21'

DEPTH (FT.)	SAMPLE NO.	SAMPLING INTERVAL	RECOVERY/ RQD	BLOWS/6"	HEADSPACE (PPM)	SAMPLE DESCRIPTION
-0-						REFER TO LOG OF MW-PT3D
-1-						
-2-						
-3-						
-4-						
-5-						
-6-						
-7-						
-8-						
-9-						
-10						

Remarks:

Water Level Measurement		
______	Date	______
______	Date	______
______	Date	______
______	Date	______

BL

BORING LOG

DVIRKA AND BARTILUCCI

Project No.: 2276	Well/Boring No.: MW-PT3D
Project Name: FARRAND CONTROLS	Sheet 1 of 1
	By: K.ROBINS Date: 12/20/05
	Chk'd: Date:

Drilling Contractor: GEOPROBE ZEBRA		Borehole Completion Depth: 23'
Driller: CHARLES	Geologist: K. ROBINS	Borehole Diameter: 2"
Drill Rig: GEOPROBE	Drilling Method: PNEUMATIC	Ground Surface El.:
Sample Spoon I.D.: –	Drive Hammer Wt.: –	WELL DIA. 2" PVC
Date Started: 12/20/05	Date Completed: 12/20/05	SCREEN: 19-22'

DEPTH (FT.)	SAMPLE NO.	SAMPLING INTERVAL	RECOVERY/ RQD	BLOWS/6"	HEADSPACE (PPM)	SAMPLE DESCRIPTION
0		0-4'	36"		0.0	0-2" ASPHALT 2-12" BROWN SILT, TRACE GRAVEL 12-16" CONCRETE 16"-36" DARK BROWN F SAND
2						
4		4-8'	40"		0.0	DARK BROWN TO BROWN F SAND, WELL SORTED
6						
8		8-12'	32"		0.0	DARK BROWN TO BROWN F SAND, TRACE SILT, TRACE F GRAVEL
10						
12		12-16'	36"		0.0	SAME
14						
16		16-20'	24"		0.0	DARK BROWN FM SAND, SOME SILT, TRACE M GRAVEL
18						
20		20-23'	32"		0.0	DARK BROWN FM SAND, SOME SILT, TRACE F GRAVEL
22						

Remarks:

Water Level Measurement ______ Date ______
______ Date ______
______ Date ______
______ Date ______

BL

BORING LOG

DVIRKA AND BARTILUCCI

Project No.: 2276
Project Name: FARRAND CONTROLS

Well/Boring No.: MW-PT4D
Sheet 1 of 1
By: K. ROBINS Date: 12/19/05
Chk'd: ______ Date: ______

Drilling Contractor: ZEBRA
Driller: CHARLES
Drill Rig: GEOPROBE
Sample Spoon I.D.: ______
Date Started: 12/19/05

Geologist: K. ROBINS
Drilling Method: PNEUMATIC
Drive Hammer Wt.: —
Date Completed: 12/19/05

Borehole Completion Depth: ~~46~~ 15.5'
Borehole Diameter: 2"
Ground Surface El.: ______
WELL DIA.: 3/4" PVC
SCREEN: ~~6.6-9.6~~' 15.5-18.5'

DEPTH (FT.)	SAMPLE NO.	SAMPLING INTERVAL	RECOVERY/ RQD	BLOWS/6"	HEADSPACE (PPM)	SAMPLE DESCRIPTION
-0-		0-4'	36"		0.0	0-4" ~~NO SAMPLE COLLECTED~~ ASPHALT 4-6" BROWN SILT, TRACE F GRAVEL 6-8" CONCRETE FILL 8-12" BROWN SILT 12-36" DARK GRAY SILT, TRACE GRAVEL
2 ~~-1-~~						
4 ~~-2-~~		4-8'	36"		0.0	4-7' BROWN LT GREEN F SAND 7-7.5' BROWN SILT 7.5-8' DARK GRAY GRAVELLY SILT
6 ~~-3-~~						
8 ~~-4-~~		8-12'	48"		0.0	8-10' BROWN F SAND 10-10.5' BROWN MC SAND, FM GRAVEL 10.5-12 DARK BROWN SILT, TIGHT, TRACE F GRAVEL
10 ~~-5-~~						
12 ~~-6-~~		12-16	24"		0.0	12-16 GRAY SILT, TIGHT, TRACE FM GRAVEL
14 ~~-7-~~						
16 ~~-8-~~		16-19	24"		0.0	SAME
18 ~~-9-~~						
20 ~~-10-~~						19' REFUSAL

Remarks:

Water Level Measurement ______ Date ______
______ Date ______
______ Date ______
______ Date ______

BL

BORING LOG

DVIRKA AND BARTILUCCI

Project No.: 2276
Project Name: FARRAND CONTROL

Well/Boring No.: MW-PT4S
Sheet 1 of 1
By: K. ROBBINS Date: 12/19/05
Chk'd: ______ Date: ______

Drilling Contractor: ZEBRA
Driller: CHARLES Geologist: K. ROBBINS
Drill Rig: GEOPROBE Drilling Method: PNEUMATIC
Sample Spoon I.D.: ______ Drive Hammer Wt.: —
Date Started: 12/19/05 Date Completed: 12/19/05

Borehole Completion Depth: 96'
Borehole Diameter: 2"
Ground Surface El.: —
WELL DIA: 3/4" PVC
SCREEN: 6.6-96'

DEPTH (FT.)	SAMPLE NO.	SAMPLING INTERVAL	RECOVERY/ RQD	BLOWS/6"	HEADSPACE (PPM)	SAMPLE DESCRIPTION
-0-						REFER TO LOG OF MW-PT4D
-1-						
-2-						
-3-						
-4-						
-5-						
-6-						
-7-						
-8-						
-9-						
-10						

Remarks:

Water Level Measurement ______ Date ______
______ Date ______
______ Date ______
______ Date ______

BL