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DRAFT AREA OF CONCERN 607 RESOURCE CONSERVATION AND RECOVERY  
CORRECTIVE ACTION MEASURE STUDY VOLUME 1 OF 2 SECTIONS 1 TO 9 AND  
APPENDICES A AND B CNC CHARLESTON SC (DRAFT ACTING AS FINAL)

12/1/1999  
ENSAFE INC.

**DRAFT AOC 607  
RCRA CORRECTIVE MEASURE STUDY**

**CHARLESTON NAVAL COMPLEX  
CHARLESTON, SOUTH CAROLINA**

**CTO-2913**

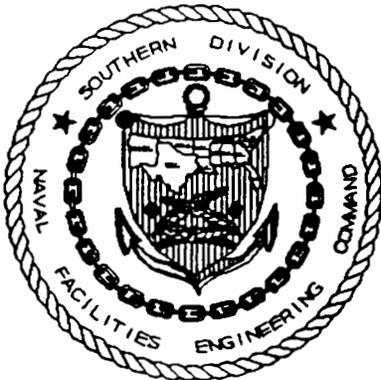
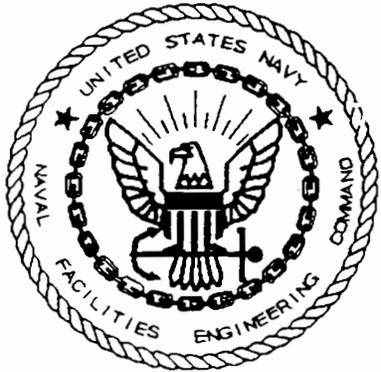
**Volume I of II  
Sections 1-9  
Appendices A & B**

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- Appendix A Aquifer Pumping Test
- Appendix B Dual-Phase Vacuum Extraction Treatability Study Summary
- Appendix C Analytical Data and Chains of Custody
- Appendix D AOC 607 Monitored Natural Attenuation Interim Report

## ACRONYMS

AA	anaerobic-aerobic
bgs	below ground surface
COCs	chemicals of concern
DCE	dichloroethene
DNAPL	dense nonaqueous phase liquid
DPT	direct push technology
DWEL	drinking water equivalent level
MCL	maximum contaminant level
MNA	Monitored Natural Attenuation
NPDES	National Pollutant Discharge Elimination System
O&M	operation and maintenance
OSWER	Office of Solid Waste and Emergency Response
PAHs	polynuclear aromatic hydrocarbons
Pb	lead
PCBs	polychlorinated biphenyls
PCE	perchloroethylene/tetrachloroethene
POTW	publicly owned treatment works
PPE	personal protective equipment
ppm	parts per million
PVC	polyvinyl chloride
RCRA	Resource Conservation and Recovery Act
RBC	risk-based concentration
RFI	RCRA Facility Investigation
SCDHEC	South Carolina Department of Health and Environmental Control
SPH	six-phase electrical heating
SSLs	site screening levels
TCE	trichloroethene
TOC	total organic carbon
USEPA	United States Environmental Protection Agency
VC	vinyl chloride

## 1.0 INTRODUCTION 1

### Purpose and Organization of Report 2

This Corrective Measures Study (CMS) identifies, screens, develops, evaluates, and compares 3  
remedial action alternatives to mitigate hazards and threats to human health and the environment 4  
from soil and groundwater contamination at Area of Concern (AOC) 607 at the Charleston Naval 5  
Complex (CNC), Charleston, South Carolina. 6

The CMS is being performed under the Resource Conservation and Recovery Act of 1976 7  
(RCRA), based on findings reported in the *Zone F RCRA Facility Investigation (RFI), Report,* 8  
*NAVBASE Charleston, North Charleston, South Carolina* (EnSafe, 1998). As required by RCRA, 9  
the CNC Restoration Advisory Board (RAB) provides a focus for community input to the remedial 10  
decision making process. The RAB, which regularly holds open public meetings, consists of 11  
community members, regulators, Navy Southern Division (SOUTHDIV) representatives, and 12  
other CNC project team representatives. 13

When the CMS is complete, a Statement of Basis (SOB) that documents the CMS process and 14  
presents the preferred site alternative will be made available for public comment to ensure that 15  
decision makers are aware of public concerns. The selection of the final remedy for the site could 16  
be affected by public input. The primary CNC decision makers include SOUTHDIV, the 17  
South Carolina Department of Health and Environmental Control (SCDHEC), and the 18  
United States Environmental Protection Agency (USEPA). 19

This CMS report has been organized according to the format in the Office of Solid Waste 20  
and Emergency Response (OSWER) Directive 9902.3-2A, *RCRA Corrective Action Plan* 21  
(Final, May 1994): 22

- **Section 1, Introduction:** This section presents the report’s purpose and summarizes the project. 1  
2
  
- **Section 2, Site Description:** This section presents AOC 607 history and background and the results of previous investigations, including the RCRA Facility Investigation (RFI), baseline risk assessment (BRA), interim stabilization measures (ISM) performed by the Navy Environmental Detachment (DET), and supplemental CMS sampling. 3  
4  
5  
6
  
- **Section 3, Remedial Objectives:** To improve the CMS’s focus, this section summarizes the contaminants of concern (COCs) to be directly addressed by this CMS and their remedial objectives. 7  
8  
9
  
- **Section 4, Identification and Screening of Technologies:** This section outlines general response actions, and identifies and screens remedial technologies that may be used to achieve remedial action objectives. 10  
11  
12
  
- **Section 5, Development and Evaluation of Alternatives:** This section develops and evaluates potential remedial alternatives according to the nine evaluation criteria identified in OSWER Directive 9902.3-2A, *RCRA Corrective Action Plan* (Final, May 1994), presenting strengths and weaknesses to prioritize or rank them relative to the nine evaluation criteria. 13  
14  
15  
16  
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- **Section 6, Recommendations:** This section assesses the relative performance of the alternatives and presents recommendations. 18  
19
  
- **Section 7, Public Involvement Plan:** This section summarizes the public involvement plan as it relates to the CMS. 20  
21

- **Section 8, References:** This section lists applicable references used to prepare the CMS. 1
- **Section 9, Signatory Requirement:** This section provides the applicable signatory requirements for the CMS. 2  
3

**2.0 SITE DESCRIPTION**

**2.1 General**

AOC 607 (Figure 2.1) is located in the southwest part of Zone F, which is one of the 12 RCRA Facility Investigation (RFI) zones designated at the Charleston Naval Complex. The boundary of the former naval facility is approximately 200 feet west of the subject site. The property outside the base boundary in this area is used for residential purposes such as single-family housing. The nearest surface water body is the Cooper River, approximately 2,000 feet northwest of the site.

The subject site is a former dry-cleaning facility in Building 1189 that supported the former local seamen's housing from 1942 to 1986. Toward the end of its operational period, it was used as a general purpose laundry with two industrial washers and dryers. The building also contains office space most recently used for miscellaneous storage. While operating as a dry-cleaning establishment, the facility was classified as a minor emitter of total hydrocarbons. Materials released, stored, or disposed of at the site include perchloroethylene (or tetrachloroethene, PCE) solvent.

PCE, trichloroethene (TCE), 1,2-dichloroethene (DCE), and vinyl chloride have been detected in the soil and groundwater beneath AOC 607. These VOCs are components of typical dry-cleaning chemicals (PCE and TCE) and their degradation products (DCE and vinyl chloride). VOC-impacted groundwater is infiltrating a nearby sanitary sewer line southwest of Building 1189, creating a depression in the potentiometric surface which appears to have slowed lateral contaminant migration.

## Current and Future Use

The site is not currently in use. Current base reuse plans call for redeveloping Zone F to either a commercial/industrial area or a recreational area.

### 2.2 Interim Stabilization Measures

No interim stabilization measures have been performed at this site.

### 2.3 RFI/CMS Sampling and Testing

During the RFI, 62 shallow DPT points, 10 shallow borings, eight shallow wells, six intermediate wells, and seven deep wells were installed to assess VOC contamination associated with AOC 607. During the CMS, eight additional deep DPT samples, eight additional shallow wells, and three additional deep wells were installed to further characterize the site.

An aquifer characterization test was performed in February 1999 (see Appendix A), and a dual-phase vacuum extraction pilot study was performed from June through September 1999 (see Appendix B).

#### 2.3.1 Soil Stratigraphy

Site stratigraphy near Building 1189 is relatively consistent. Three to 5 feet of primarily silt and clay backfill is underlain by natural silt and clay deposits with lesser amounts of sand, down to a depth of about 8 feet. A thin sand unit with lesser amounts of silt and clay is generally encountered about 8 feet below ground surface (bgs). This sand is generally 1 to 3 feet thick and terminates about 10 feet bgs, where a low- to high-plasticity clay unit is found.

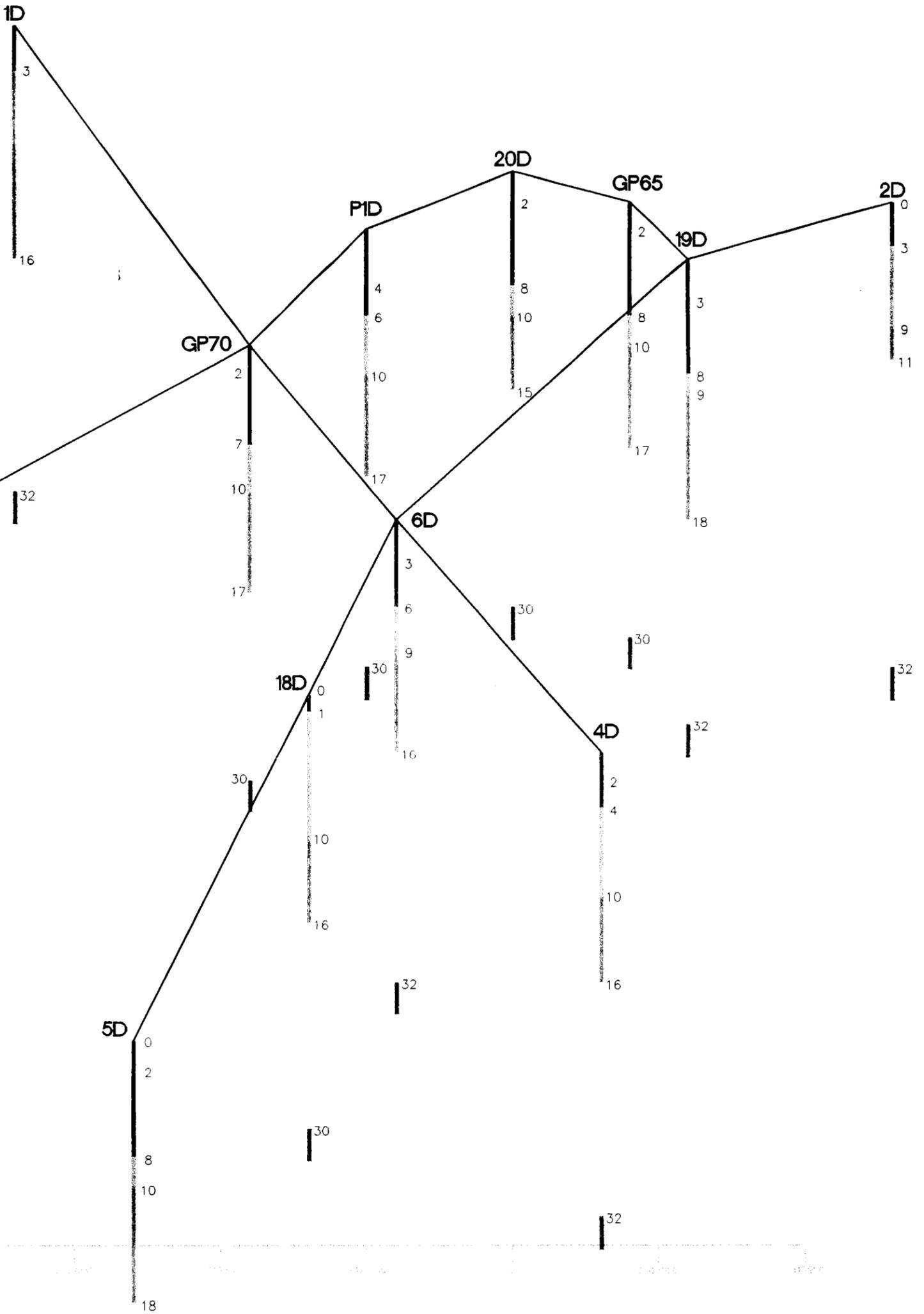
The clay unit, approximately 7 feet thick, retards downward migration of the shallow aquifer. Some samples collected from the clay unit were dry, indicating that the unit is acting as an aquitard, although the clay is moist or saturated in other areas which indicates that some groundwater is migrating vertically, at least in portions of the unit.

About 17 feet bgs, a saturated sand unit with lesser amounts of silt and shell fragments extends to about 30 feet bgs where the Ashley formation is encountered. The Ashley is considered a lower confining unit because it is comprised primarily of silts and clays, and becomes dry only a foot or two below the overlying sand aquifer. Figure 2.2 shows the general distribution of the fill, upper water-bearing sands, the intermediate aquitard, the lower water-bearing sands, and the Ashley formation. Figure 2.3 shows the site and all direct push technology (DPT) sampling points, soil borings, and monitoring wells installed during the RFI and CMS.

### 2.3.2 Groundwater Hydrology

Based on soil stratigraphy, groundwater at the site can be separated into two distinct aquifers – an unconfined upper aquifer above the intermediate aquitard and a confined lower aquifer sandwiched between the intermediate aquitard and the Ashley formation. AOC 607 aquifer surfaces are dominated by a leaking sewer line running northwest, parallel to Building 1189. Depth to water is generally about 4 to 6 feet bgs and depends primarily on recent precipitation, although tidal influence causes about a 0.1-foot daily fluctuation in water levels. Groundwater potentiometric surface maps and vertical gradients from recent water-level monitoring events are shown on Figures 2.3 through 2.9. Potentiometric surface maps from earlier events and additional hydrogeologic information are included in EnSafe's *CMS Work Plan* (July 1998) and *Zone F RFI Report* (April 1998).

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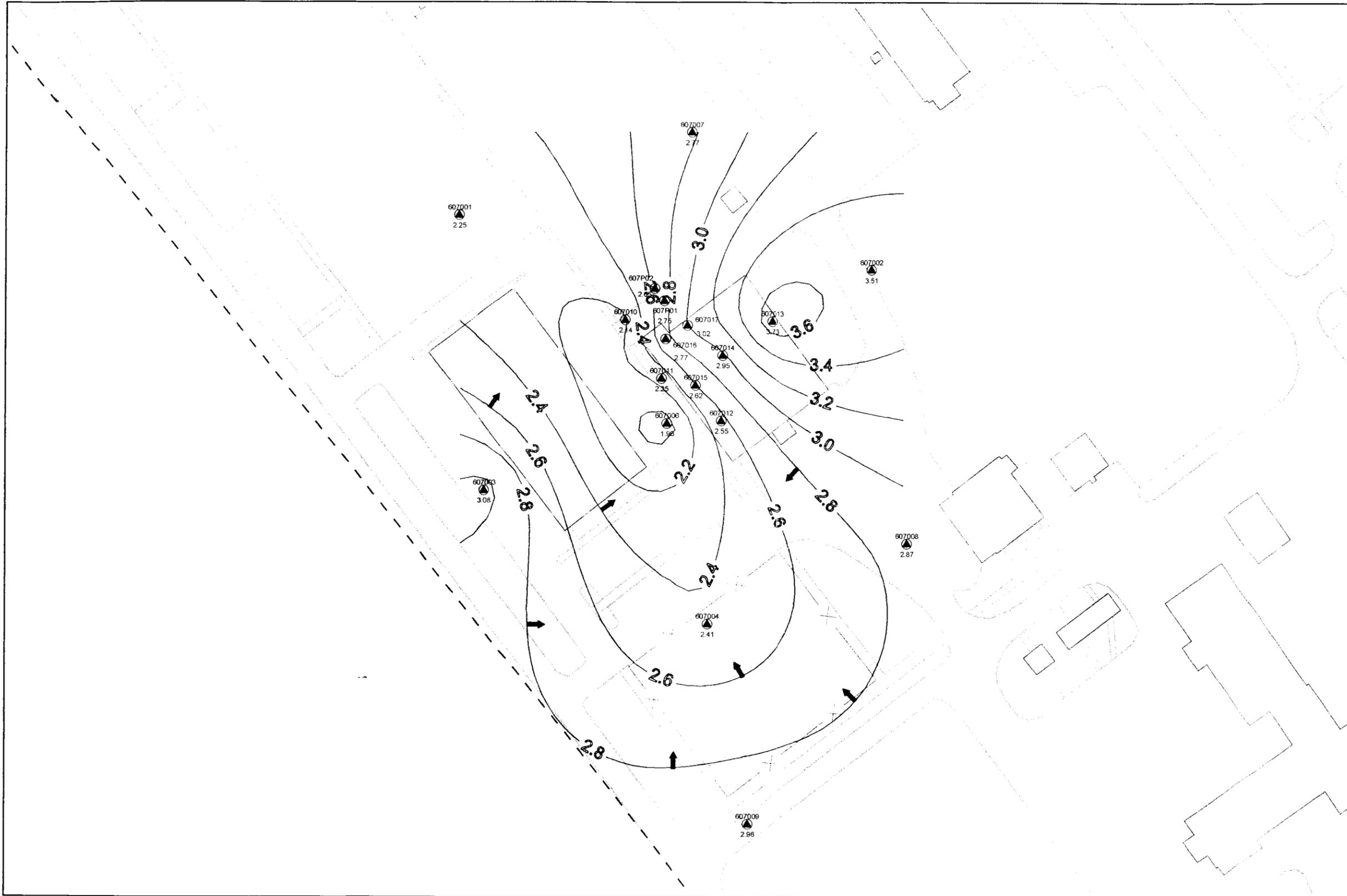


- LEGEND
- FILL
  - SILTY CLAYS AND ORGANIC CLAYS MIXED WITH LESSER AMOUNTS OF SAND DRY TO MOIST
  - UPPER WATER BEARING SANDS
  - INTERMEDIATE AQUITARD
  - LOWER WATER BEARING SANDS
  - ASHLEY FORMATION



AOC 607  
 RCRA CMS REPORT  
 CHARLESTON NAVAL  
 COMPLEX  
 CHARLESTON, S.C.

FIGURE 2.2  
 AOC 607  
 GENERAL STRATIGRAPHY  
 FENCE DIAGRAM



0 75 Feet

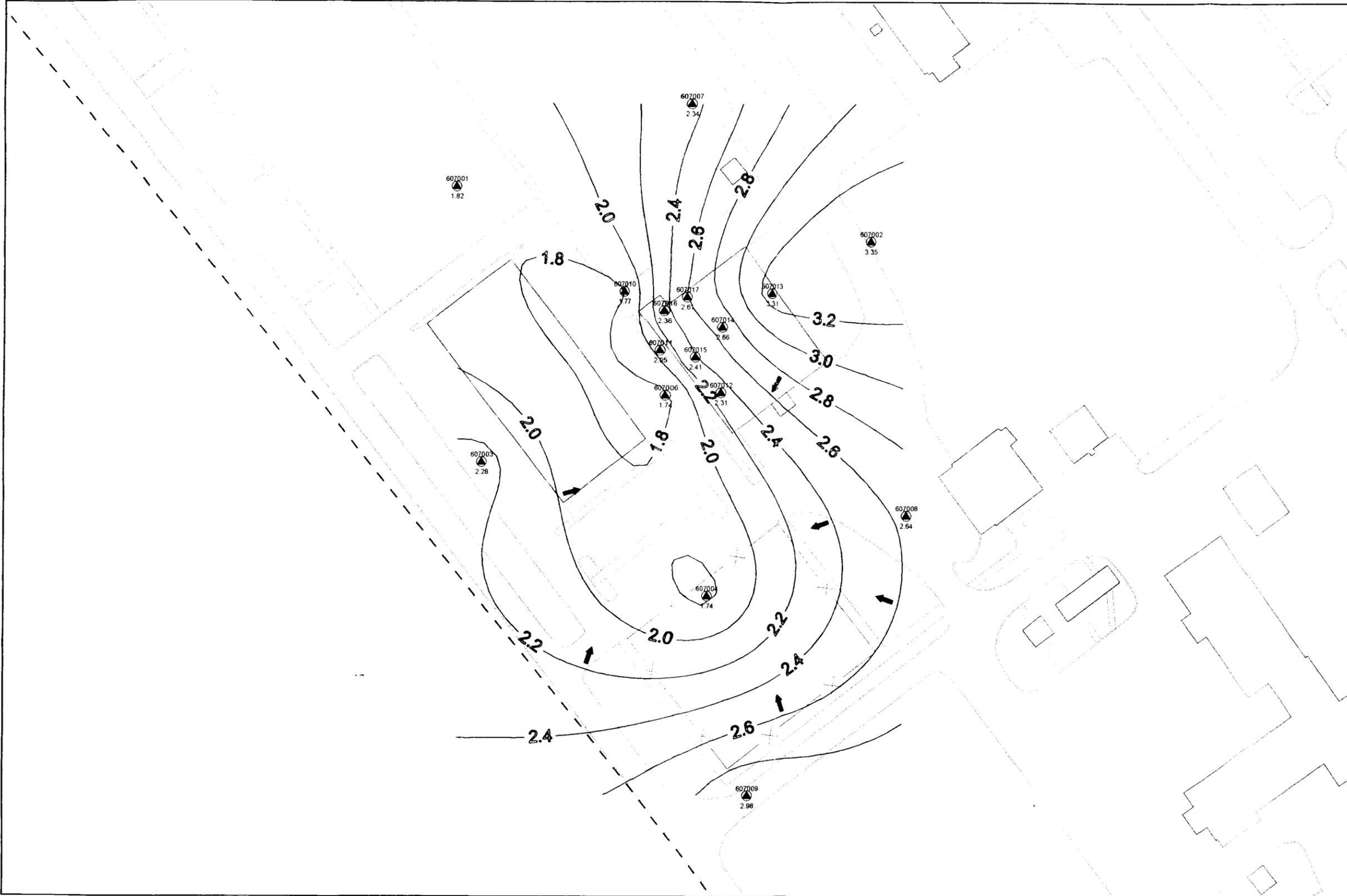
- ▲ MONITORING WELL
- GROUNDWATER ELEVATION CONTOURS
- - - PROPERTY BOUNDARY
- ▭ BUILDING
- - - FENCE
- ▬ ROAD
- - - SIDE-WALK

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Figure 2.4  
AOC 607 - Shallow Groundwater  
Elevation (ft. msl.)  
April 20, 1999



0 75 Feet

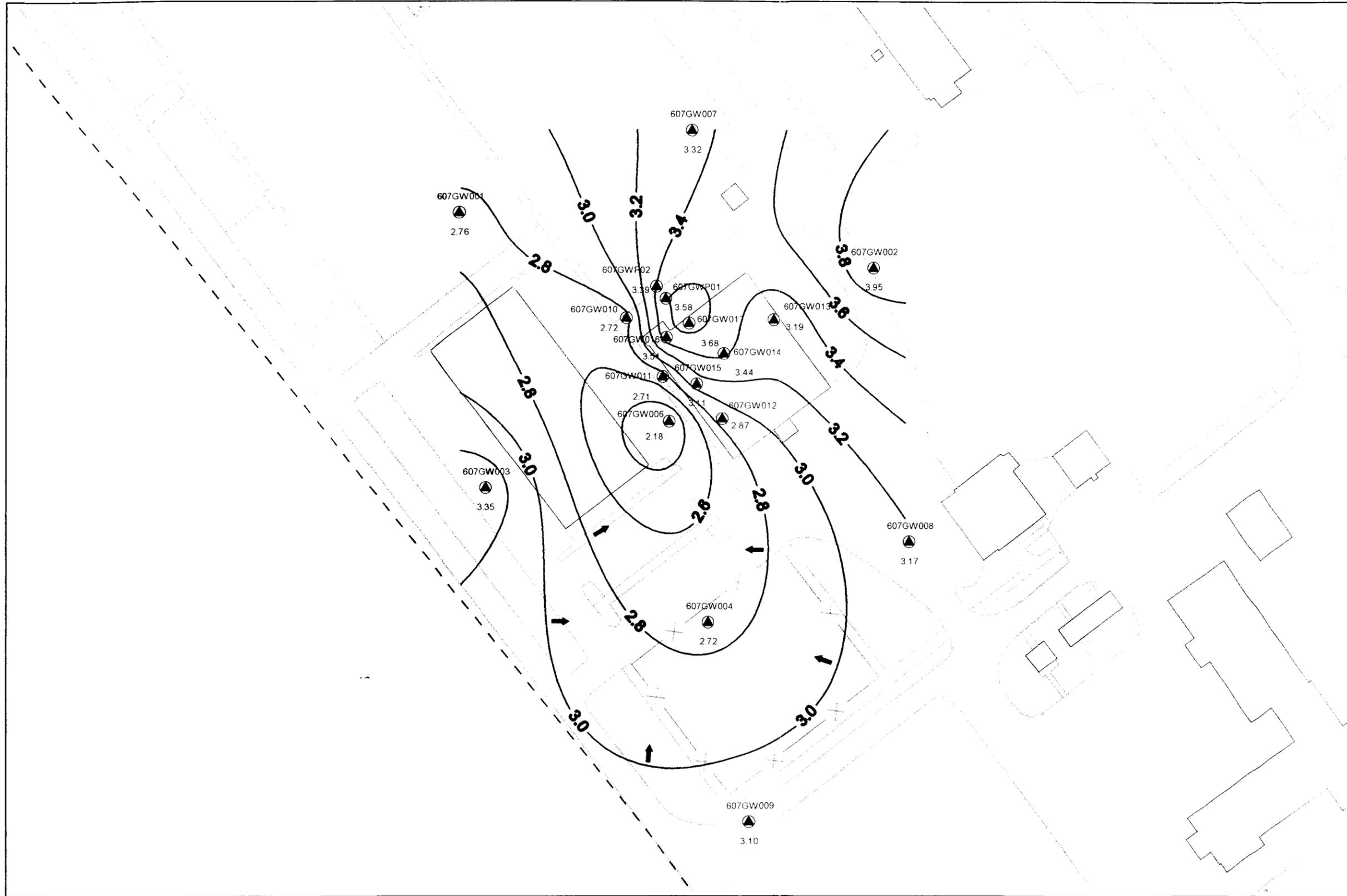
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- GROUNDWATER ELEVATION CONTOURS
- - - PROPERTY BOUNDARY
- ▭ BUILDING
- - - FENCE
- ▭ ROAD
- - - SIDE-WALK

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Figure 2.5  
AOC 607 - Shallow Groundwater  
Elevation (ft. msl.)  
June 22, 1999



0 75 Feet

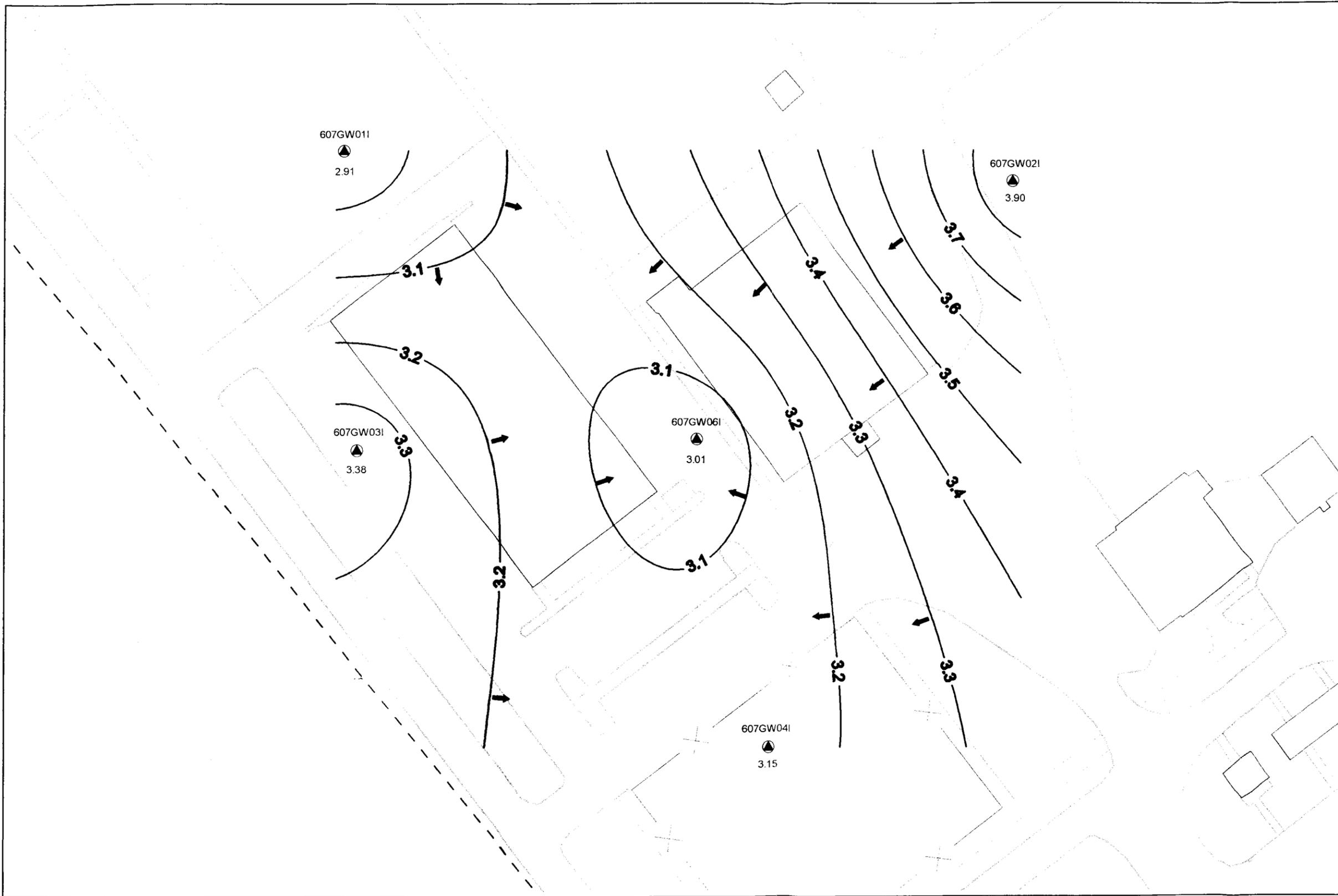
- MONITORING WELL
- GROUNDWATER ELEVATION CONTOURS
- PROPERTY BOUNDARY
- BUILDING
- FENCE
- ROAD
- SIDE-WALK

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Charleston, SC

Figure 2.6  
AOC 607 - Upper Aquifer Potentiometric  
Surface (ft. msl.)  
October 1999



0 50 Feet

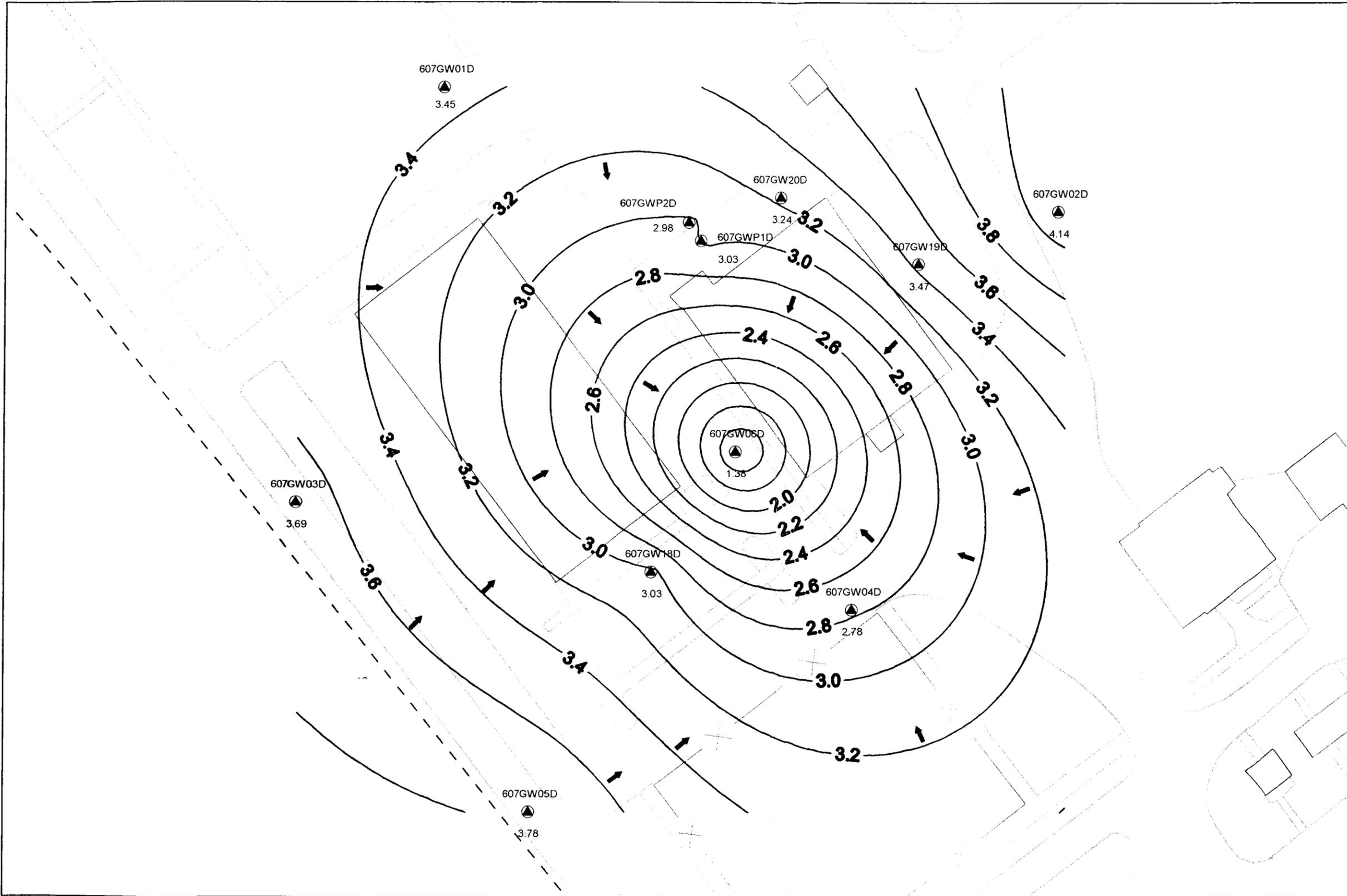
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- GROUNDWATER ELEVATION CONTOURS
- PROPERTY BOUNDARY
- BUILDING
- FENCE
- ROAD
- SIDE-WALK

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Figure 2.7  
AOC 607 - Intermediate Well Lower Aquifer  
Potentiometric Surface (ft. msl.)  
October 1999



0 50 Feet

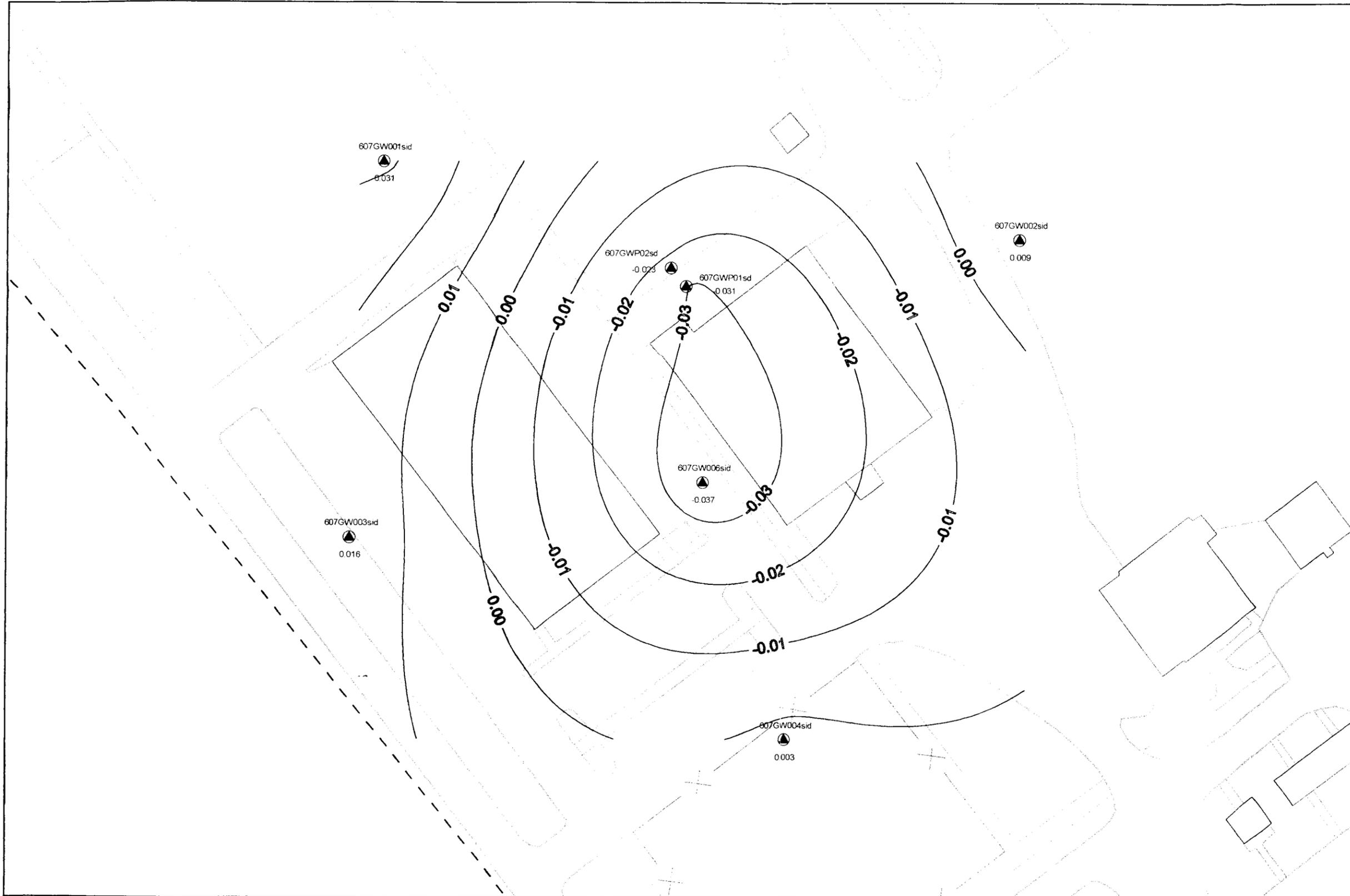
- MONITORING WELL
- GROUNDWATER ELEVATION CONTOURS
- PROPERTY BOUNDARY
- BUILDING
- FENCE
- ROAD
- SIDE-WALK

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Figure 2.8  
AOC 607 - Deep Well Lower Aquifer  
Potentiometric Surface (ft. msl.)  
October 1999



0 50 Feet

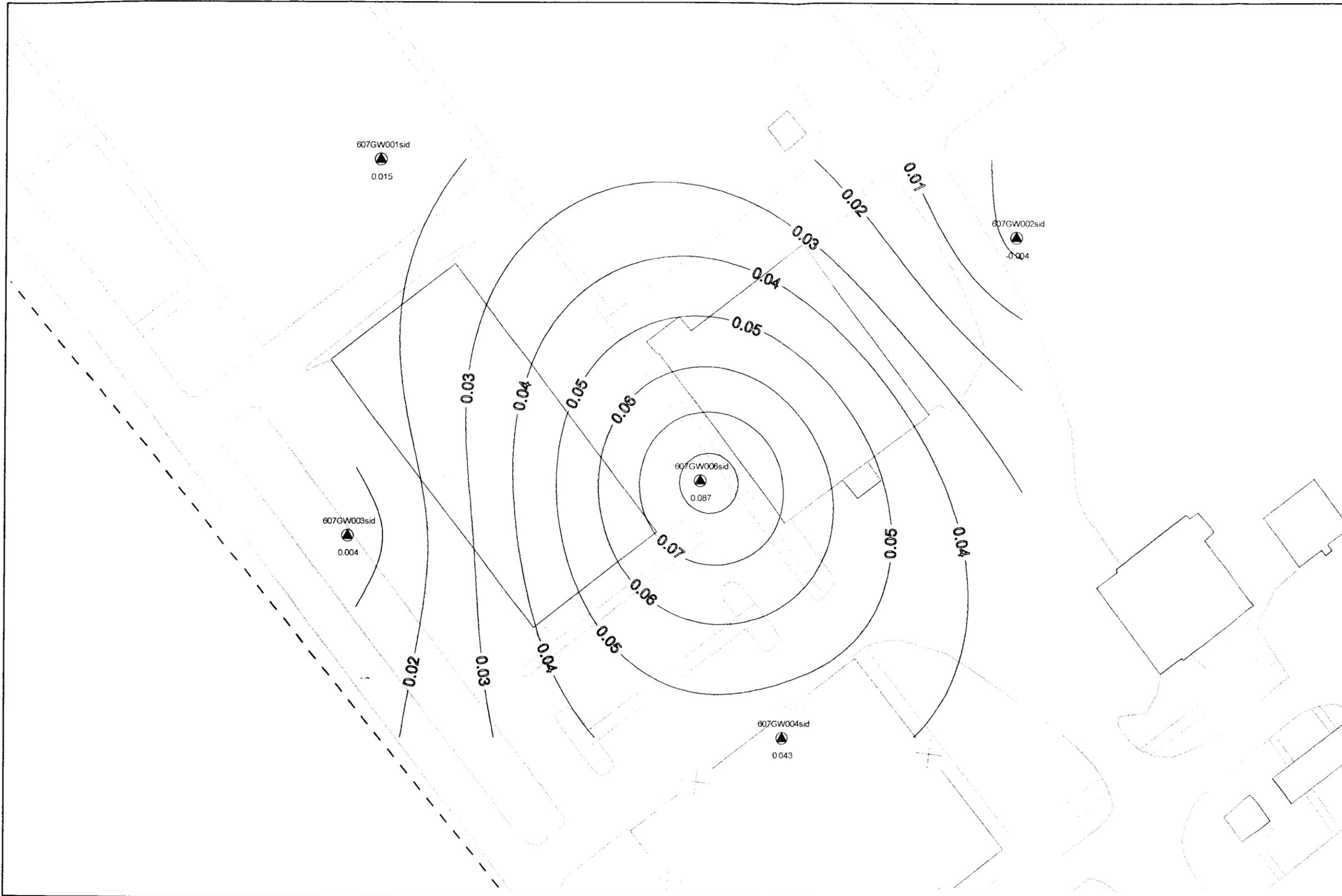
- VERTICAL GRADIENT CONTOUR
- MONITORING WELL
- PROPERTY BOUNDARY
- BUILDING
- FENCE
- ROAD
- SIDE-WALK

Note:  
Negative value represents downward flow.



AOC 607  
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Figure 2.9a  
AOC - 607 - Shallow to Deep  
Vertical Gradient  
October 1999



0 50 Feet

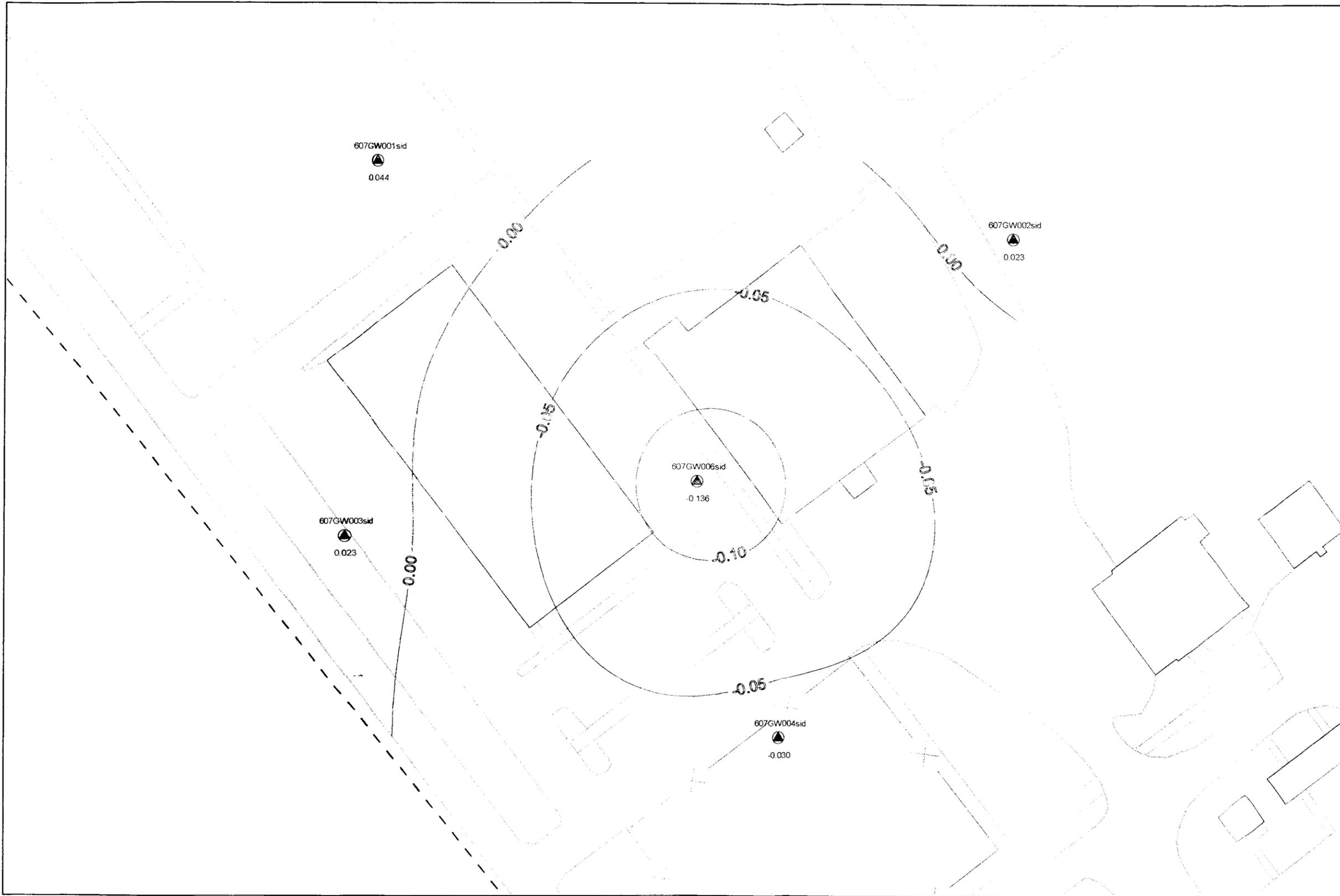
- VERTICAL GRADIENT CONTOUR
- MONITORING WELL
- PROPERTY BOUNDARY
- BUILDING
- FENCE
- ROAD
- SIDE-WALK

Note:  
Positive value represents upward flow.



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Figure 2.9b  
AOC 607 - Shallow to Intermediate  
Vertical Gradients  
October 1999



0 50 Feet

- VERTICAL GRADIENT CONTOUR
- MONITORING WELL
- PROPERTY BOUNDARY
- BUILDING
- FENCE
- ROAD
- SIDE-WALK

Note:  
Negative value represents downward flow.



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Figure 2.9c  
AOC 607 - Intermediate to Deep  
Vertical Gradients  
October 1999

An aquifer pumping test was performed in February 1999 to further characterize aquifer characteristics at the site. Transmissivity and conductivity results for the lower water-bearing zone are listed in Table 2.1, and Appendix A provides complete details of test procedures and results.

**Table 2.1 Aquifer Pumping Test Results for the Lower Water-bearing Zone**

Observation Well I.D.	Horizontal Hydraulic		Storativity (S)
	Transmissivity (T) ft <sup>2</sup> · min <sup>-1</sup>	Conductivity (K) ft · day <sup>-1</sup>	
607-PW1	0.005	0.48	0.05
607-P1D	0.0078	0.75	0.001
607-P2D	0.0094	0.90	0.0005
607-06I	0.017	1.63	0.0003
607-06D	0.0086	0.83	0.0009
Geometric Mean	0.0088 ± .0045	0.87 ± 0.43	0.0009 ± 0.02

A dual-phase vacuum extraction treatability study was performed from July through September 1999 to assess the feasibility of this technology at the site. Results indicate that the shallow aquifer is capable of sustaining a groundwater yield between 1 and 3 gallons per minute. Based on treatability results, shallow aquifer permeability is about 1.7 ft·day<sup>-1</sup>. Complete details of the treatability study are in Appendix B.

### 2.3.3 Sediment

There are no surface water sediment accumulation areas at AOC 607.

### 2.3.4 Surface Water

There are no surface water bodies at AOC 607.

## 2.4 RFI/CMS Analytical Results

The RFI identified arsenic, chloromethane, 1,1-DCE, 1,2-DCE, lead, pentachlorophenol, PCE, TCE, vanadium, and vinyl chloride as chemicals of concern (COCs) in groundwater. Chain of custody forms and analytical and data validation reports for all AOC 607 samples not included in the *Zone F RFI Report* are in Appendix C.

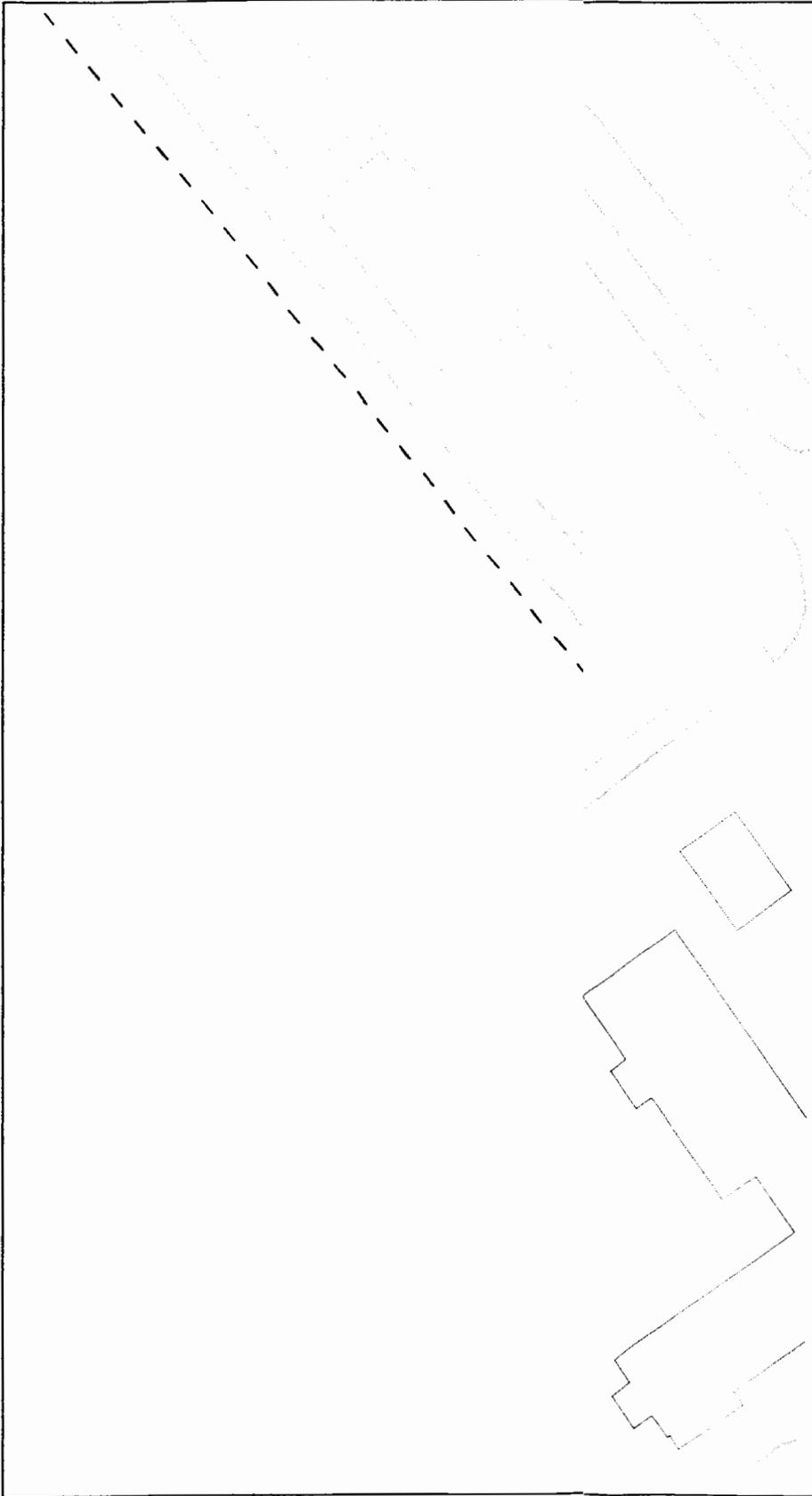
### 2.4.1 Soil Analytical Results

Although the RFI did not identify any COCs for soil, additional soil analytical samples were collected during the CMS to assess the potential for dense non-aqueous phase liquid (DNAPL) source areas in the vadose zone. PCE results for soil samples were mapped (Figures 2.10 and 2.11). No DNAPL was encountered, but results indicate that VOCs are present in shallow soils beneath Building 1189 and have filtered down into the intermediate aquitard below the upper water-bearing sand.

### 2.4.2 Groundwater Analytical Results

Table 2.2 summarizes the groundwater analytical results for most of the AOC 607 COCs identified in the RFI. Pentachlorophenol results are not in the table because it was detected in only one well (607GW003 at 3  $\mu\text{g/L}$ ), and only during the first of four rounds of sampling.

**Arsenic** was not reportedly used during operations at Building 1189, but it appeared sporadically at concentrations below its maximum contaminant level (MCL) in selected site wells. Well 607-004 contained arsenic concentrations slightly above the MCL (50  $\mu\text{g/L}$ ) in three of the four sampling rounds. In all other wells sampled for arsenic, it was either not detected or detected below its MCL. Arsenic concentrations are contoured on Figure 2.12 using the most recent round of data.



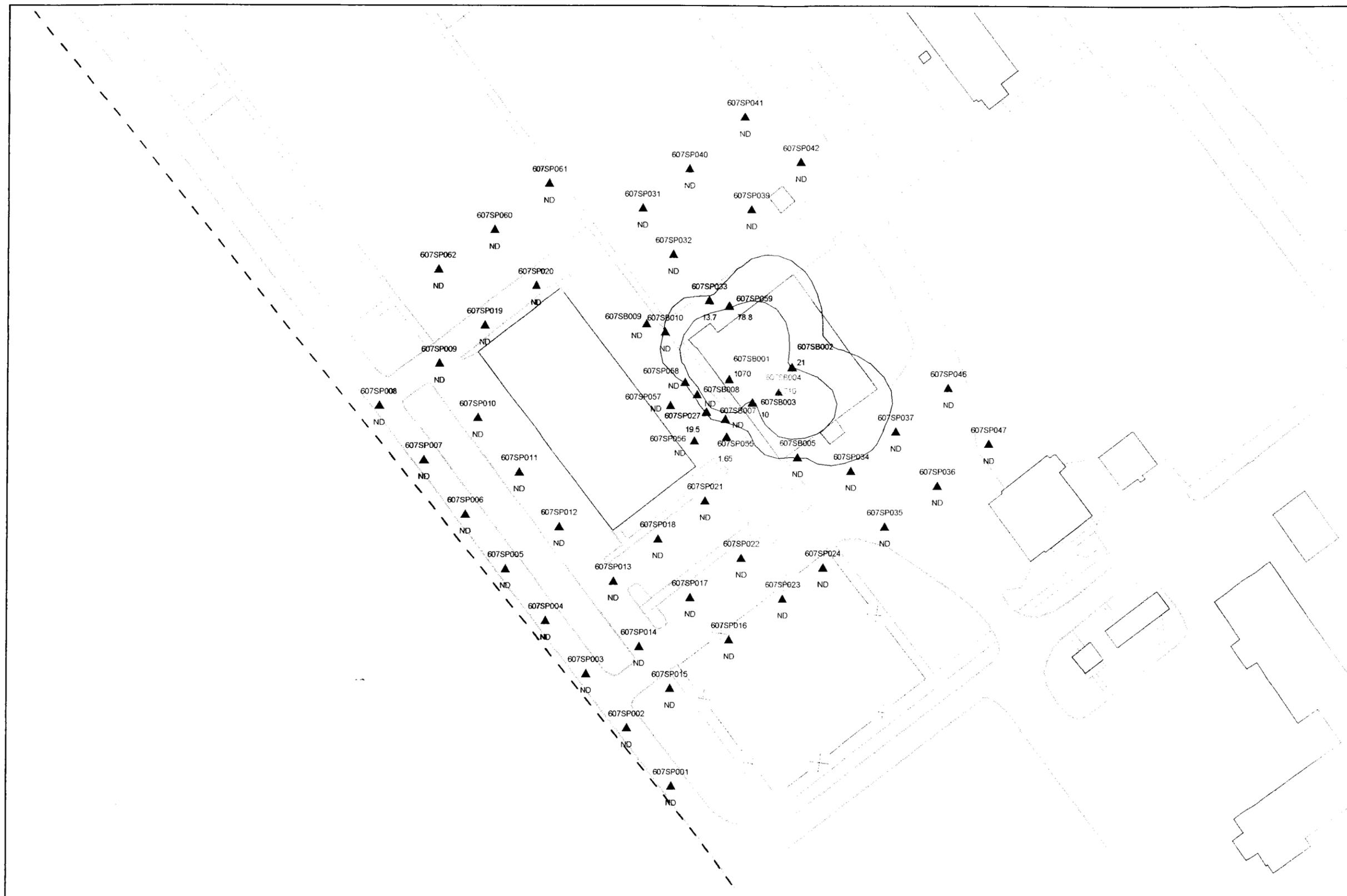
- PCE ( $\mu\text{g}/\text{kg}$ )
- ▲ < 10
  - ▲ 10 - 99
  - ▲ 100 - 999
  - ▲ > 1000
- PCE CONTOUR LINE
  - - - PROPERTY BOUNDARY
  - ▭ BUILDING
  - - - FENCE
  - ▬ ROAD
  - · - · SIDE-WALK

**ENSAFE**



AOC 607  
 CMS REPORT  
 CHARLESTON NAVAL COMPLEX  
 Charleston, SC

Figure 2.10  
 AOC 607 - PCE in Upper Soil  
 Sampling Interval ( $\mu\text{g}/\text{kg}$ )  
 (0-2 Ft. BGS)



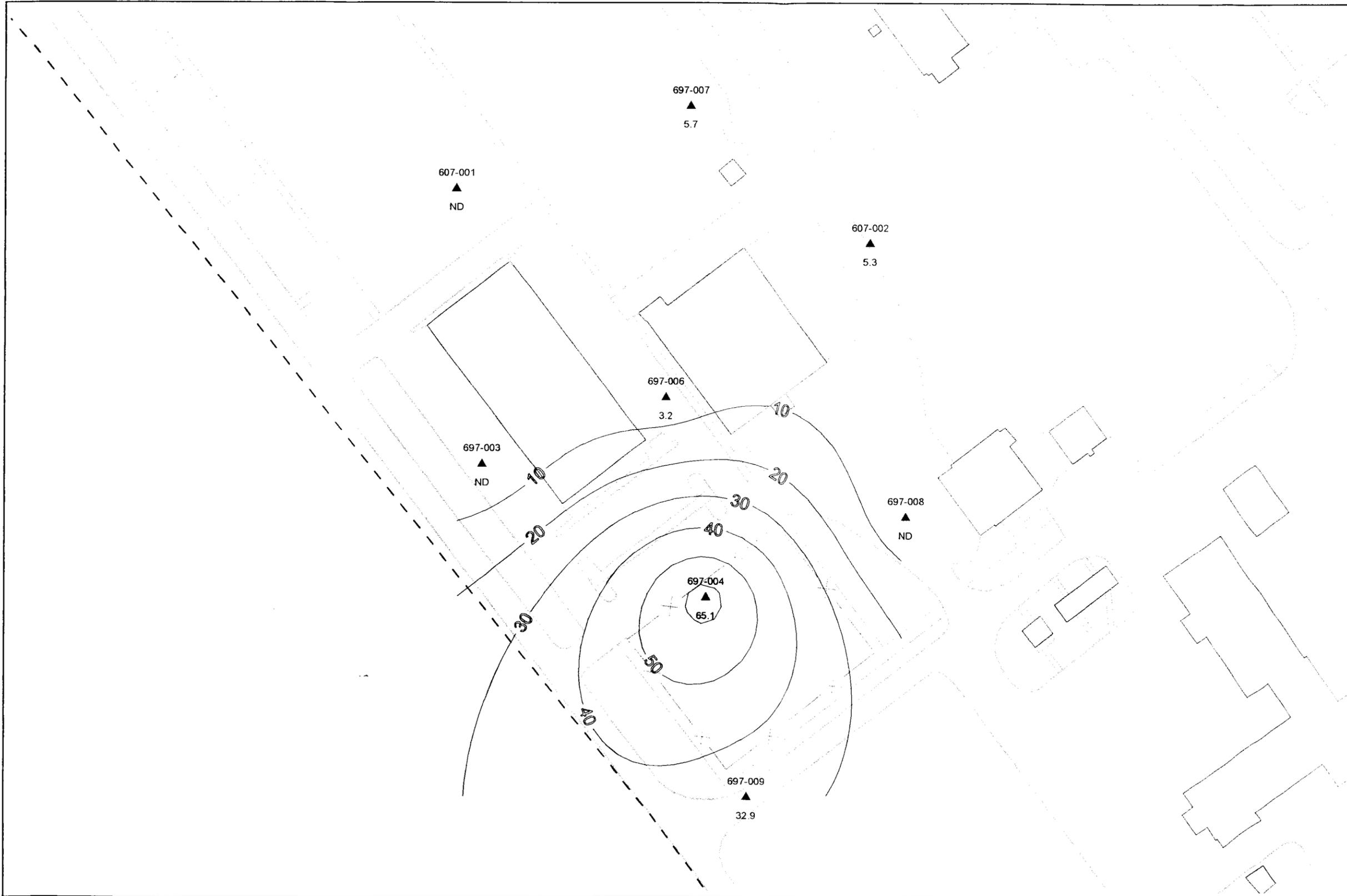
0 75 Feet

- PCE ( $\mu\text{g}/\text{kg}$ )
- ▲ < 10
  - ▲ 10 - 99
  - ▲ 100 - 999
  - ▲ > 1000
- PCE CONTOUR LINE
  - - - PROPERTY BOUNDARY
  - ▭ BUILDING
  - ▭ FENCE
  - ▭ ROAD
  - ▭ SIDE-WALK



AOC 607  
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 CHARLESTON NAVAL COMPLEX  
 Charleston, SC

Figure 2.11  
 ACO 607 - PCE in Lower Soil  
 Sampling Interval ( $\mu\text{g}/\text{kg}$ )  
 (2 to 5 Ft. BGS)



0 75 Feet

- ARSENIC (µg/L)
- ▲ X < 50
  - ▲ X > 50 (> MCL)
  - ARSENIC CONTOUR LINE
  - - - PROPERTY BOUNDARY
  - ▭ BUILDING
  - - - FENCE
  - ROAD
  - - - SIDE-WALK

**ENSAFE**



AOC 607  
CMS REPORT  
CHARLESTON NAVAL COMPLEX  
Charleston, SC

Figure 2.12  
AOC 607 - Arsenic in Shallow  
Groundwater (µg/L)  
October/November 1997

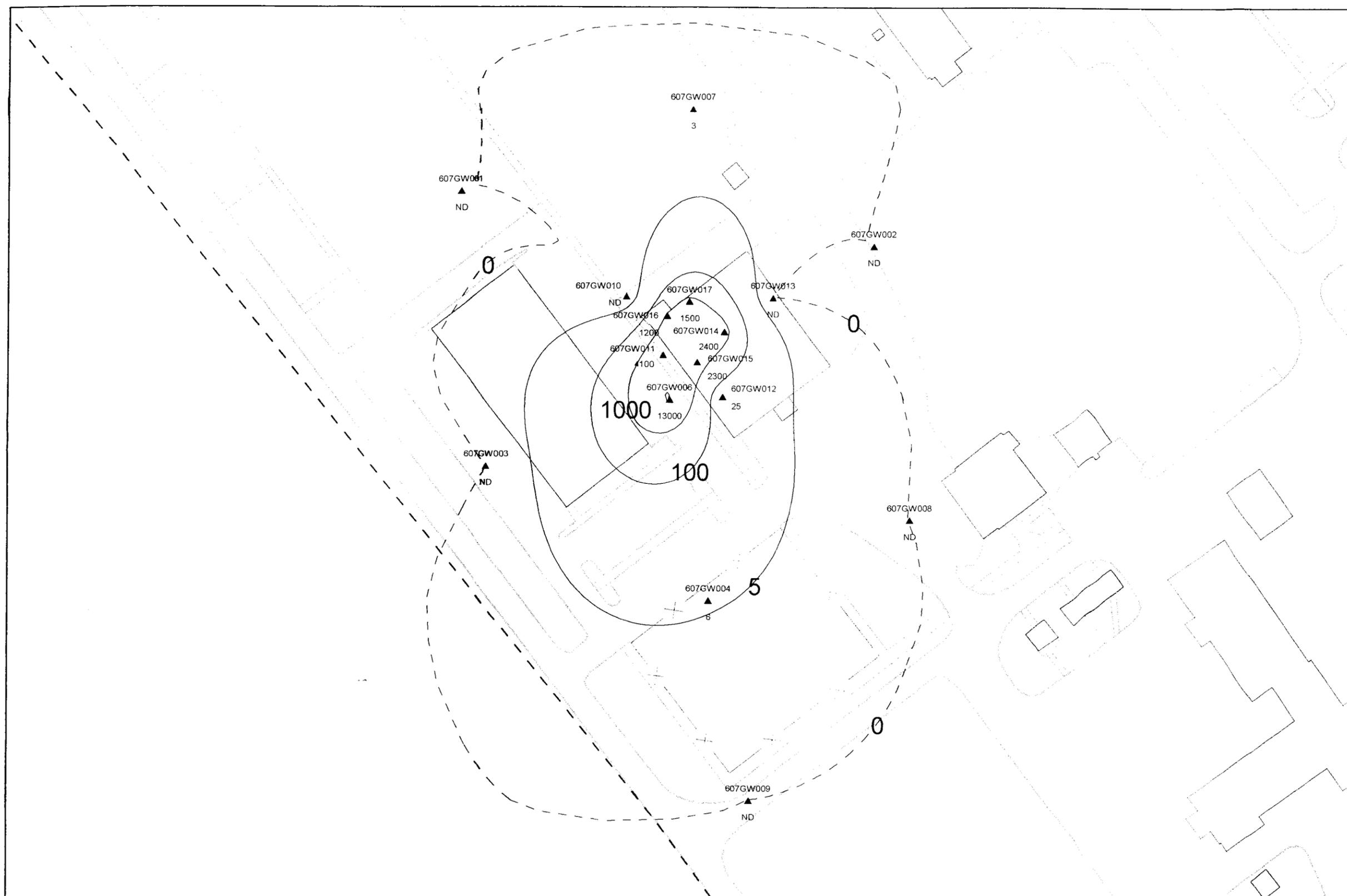
**Lead (Pb)** samples were collected in all four rounds in all shallow wells (607-001 through 607-009). Results indicate that lead was not present above action level concentrations (15 mg/L) except in well 607-002 in the fourth round and well 607-009 in the first round. Well 607-002 was nondetect for lead (less than 1.7 mg/L) prior to the fourth-round event, when the concentration increased to 245 mg/L. Data validation could not find an explanation for the sudden increase, although the reading appears to be statistically anomalous. Lead was not detected (less than 2.1 mg/L) when the well was resampled for a fifth time in October 1999.

Deep wells 607-01D, -02D, -03D, and -05D all contained lead above the action level (15 mg/L) during first round sampling. However, lead was not detected above the action level during the three subsequent rounds in any of these wells. First-round samples were collected with bailers, which increased suspended sediments by agitating the water column. These suspended sediments contained trace amounts of lead which increased the reported lead concentration in the water sample. Subsequent rounds were sampled using low-flow peristaltic pumps which did not increase suspended sediment concentrations, and produced a more accurate reflection of actual groundwater quality.

**Pentachlorophenol** was detected in only one well (607GW003 at 3  $\mu\text{g/L}$ ) during the first of four sampling rounds. Pentachlorophenol was never detected in any other well, and was not detected again in well 607GW003 after the first round.

**Vanadium** did not exceed its risk-based concentration (RBC) of 26 mg/L in any well except 607-007. Concentrations remained fairly steady in this well through four rounds of sampling, ranging from 90 to 102 mg/L.

**Chloromethane, 1,1-DCE, 1,2-DCE, perchloroethene (PCE), trichloroethene (TCE), and vinyl chloride** are all components or daughter products of solvents used in dry cleaning. Chloromethane, 1,1-DCE and vinyl chloride were not detected in most wells, and exceeded their MCLs only in wells where very high concentrations of parent compounds such as PCE and TCE were found. PCE, TCE, 1,2-DCE (total), and vinyl chloride concentrations are contoured on Figures 2.13 through 2.20 using the most recent site data.

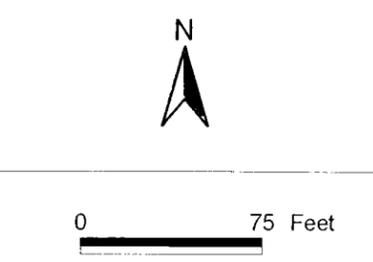
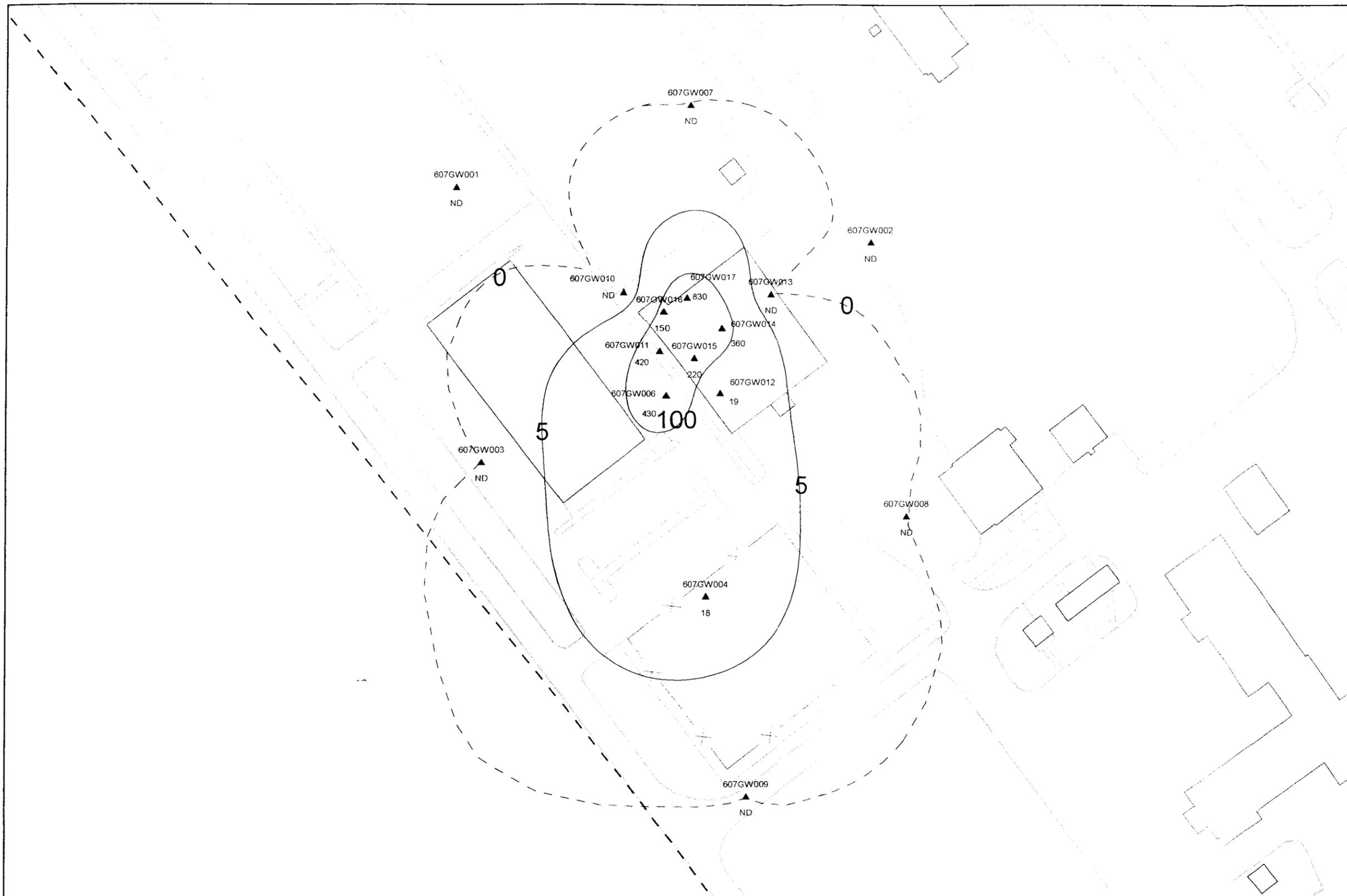


- PCE (µg/L)
- ▲ NONDETECT
  - ▲ DETECT (< 5 (MCL))
  - ▲ DETECT (>= 5 (MCL))
  - CONTOUR LINES
  - - - PROPERTY BOUNDARY
  - ▭ BUILDING
  - ▭ FENCE
  - ▭ ROAD
  - ▭ SIDE-WALK



AOC 607  
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Figure 2.13  
 Upper Water Bearing Zone  
 PCE Concentration (µg/L)  
 October 1999



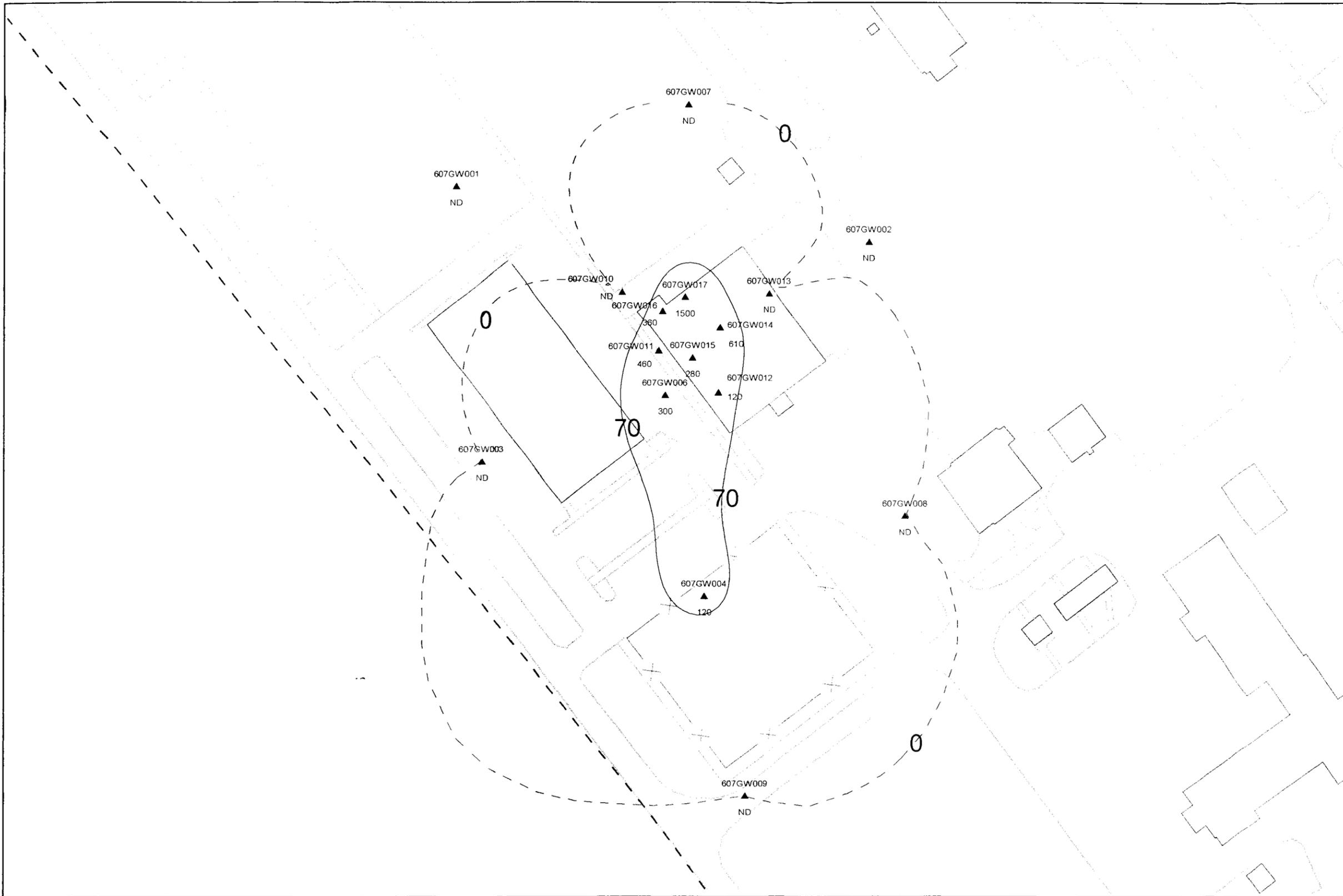
- TCE (µg/L)
- ▲ DETECT (> 5 (MCL))
  - ▲ NONDETECT
  - CONTOUR LINES
  - - - PROPERTY BOUNDARY
  - ▭ BUILDING
  - ▭ FENCE
  - ▭ ROAD
  - ▭ SIDE-WALK

**ENSAFE**



AOC 607  
CMS REPORT  
CHARLESTON NAVAL COMPLEX  
CHARLESTON, SC

Figure 2.14  
Upper Water Bearing Zone  
TCE Concentration (µg/L)  
October 1999



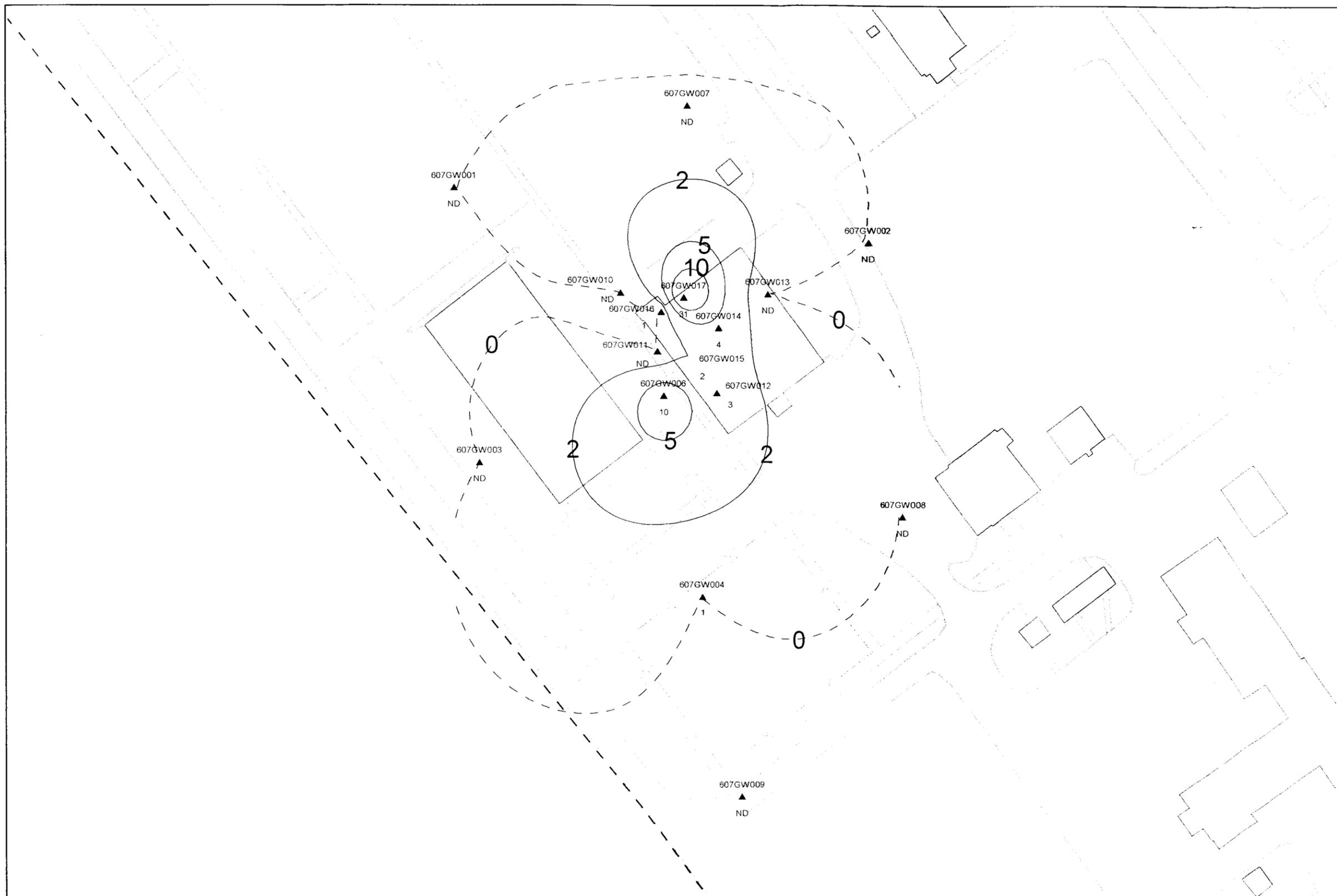
- 12DCE (µg/L)
- ▲ DETECT (> 70 (MCL))
  - ▲ NONDETECT
  - CONTOUR LINES
  - PROPERTY BOUNDARY
  - BUILDING
  - FENCE
  - ROAD
  - SIDE-WALK

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AOC 607  
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CHARLESTON NAVAL COMPLEX  
CHARLESTON, SC

Figure 2.15  
Upper Water Bearing Zone  
1,2-DCE Concentration (µg/L)  
October 1999

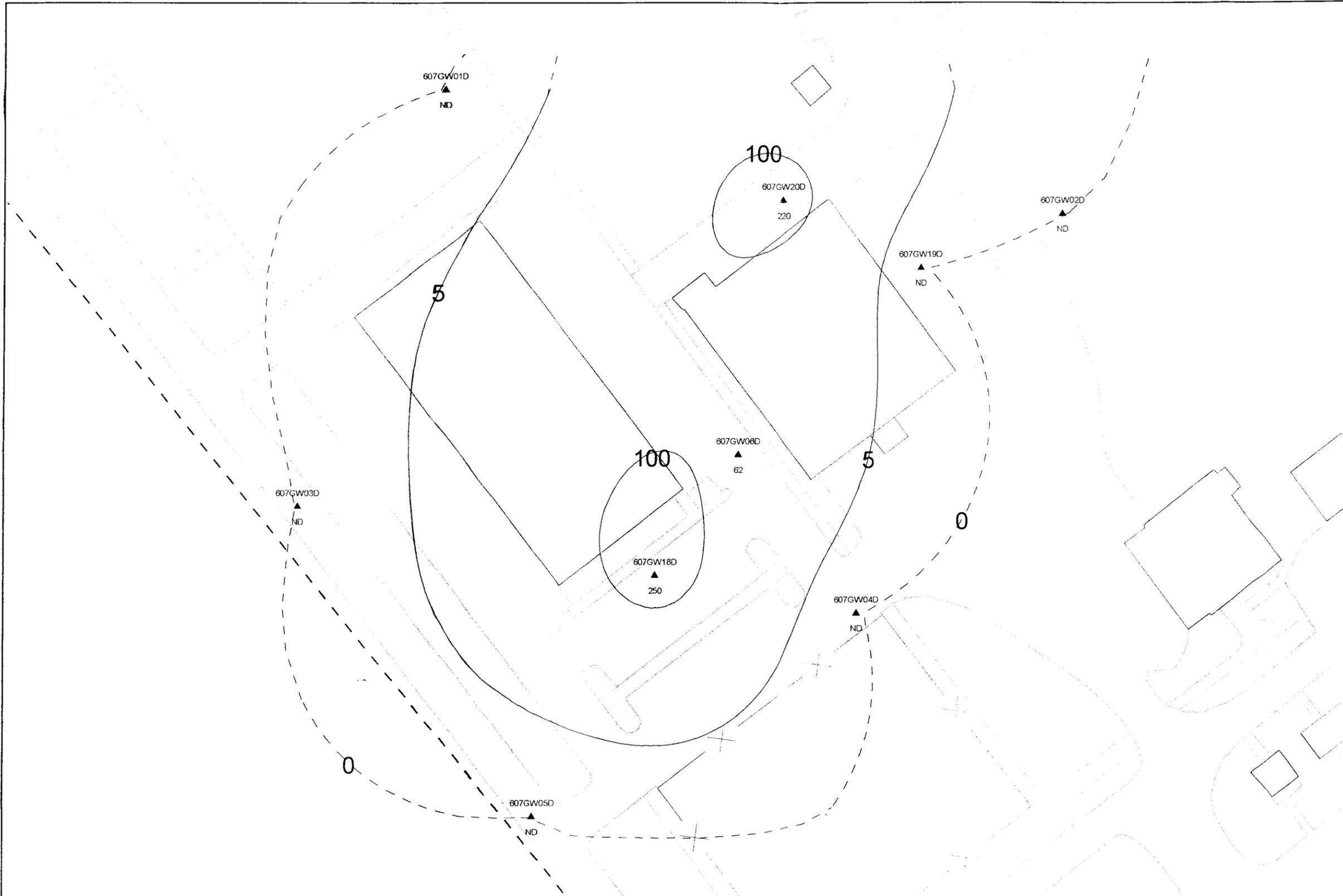


- VINYL CHLORIDE (µg/L)
- ▲ NONDETECT
  - ▲ DETECT (< 2 (MCL))
  - ▲ DETECT (>= 2 (MCL))
- CONTOUR LINES
  - - - PROPERTY BOUNDARY
  - ▭ BUILDING
  - - - FENCE
  - ROAD
  - - - SIDE-WALK



AOC 607  
 CMS REPORT  
 CHARLESTON NAVAL COMPLEX  
 CHARLESTON, SC

Figure 2.16  
 Upper Water Bearing Zone  
 Vinyl Chloride Concentration (µg/L)  
 October 1999



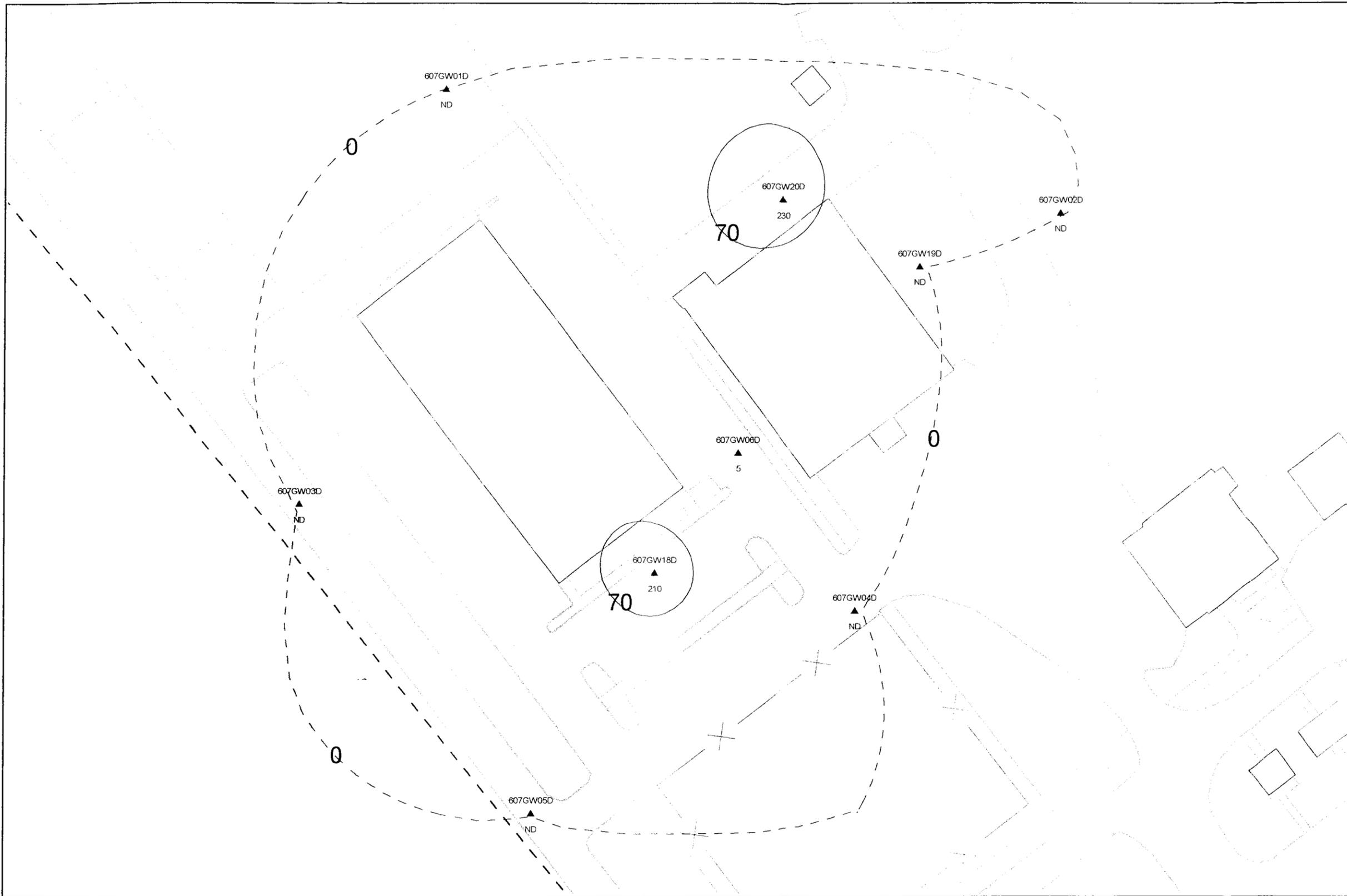
- TCE (µg/L)
- ▲ DETECT (>5 (MCL))
  - ▲ NONDETECT
  - CONTOUR LINES
  - - - PROPERTY BOUNDARY
  - ▭ BUILDING
  - ▭ FENCE
  - ▭ ROAD
  - ▭ SIDE-WALK

**ENSAFE**



AOC 607  
 CMS REPORT  
 CHARLESTON NAVAL COMPLEX  
 CHARLESTON, SC

Figure 2.18  
 Lower Water Bearing Zone  
 TCE Concentration (µg/L)  
 October 1999

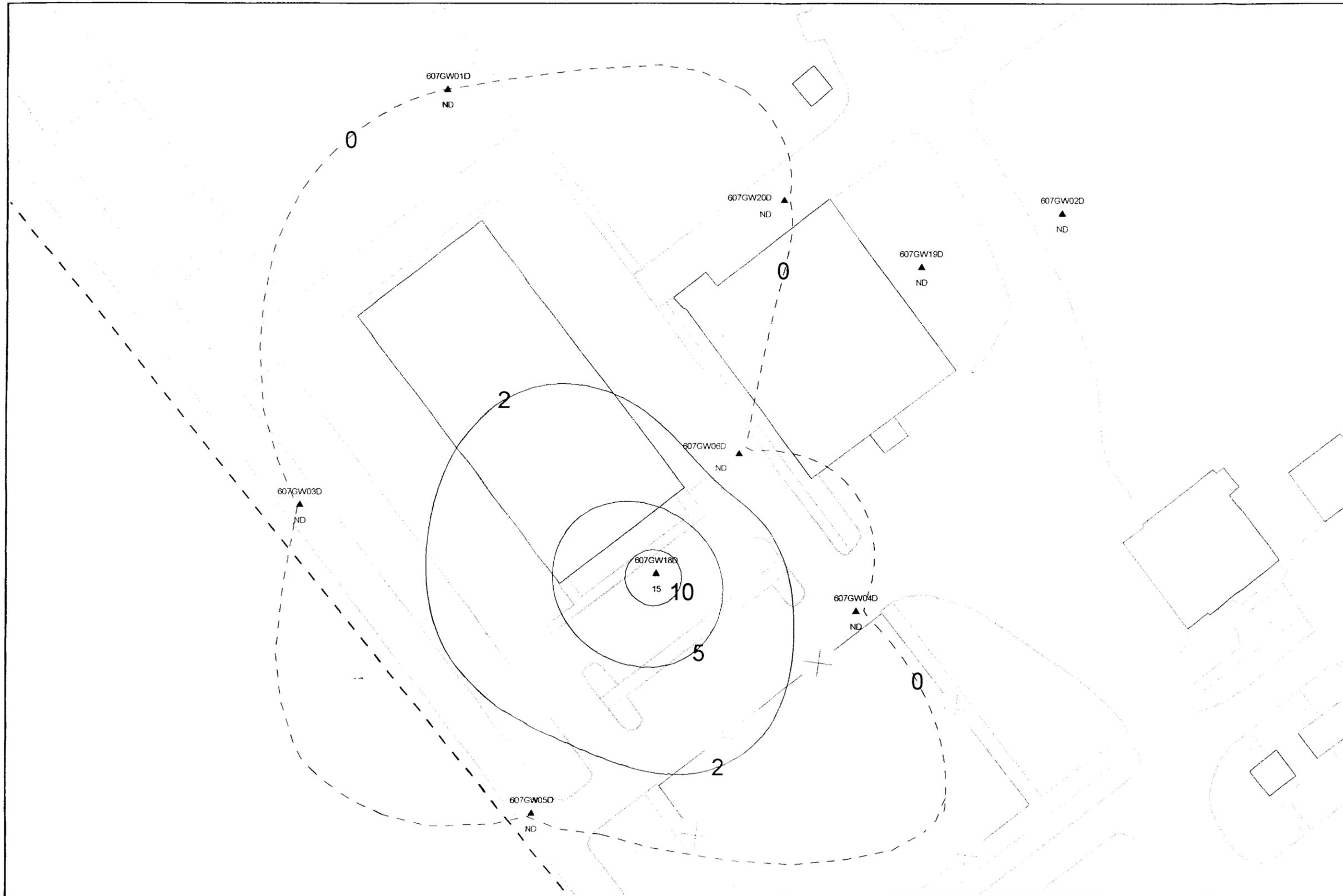


- 12DCE (µg/L)
- ▲ DETECT
  - ▲ NONDETECT
  - CONTOUR LINES
  - - - PROPERTY BOUNDARY
  - ▭ BUILDING
  - - - FENCE
  - ▬ ROAD
  - - - SIDE-WALK



AOC 607  
 CMS REPORT  
 CHARLESTON NAVAL COMPLEX  
 CHARLESTON, SC

Figure 2.19  
 Lower Water Bearing Zone  
 1,2-DCE Concentration (µg/L)  
 October 1999



0 50 Feet

- VINYL CHLORIDE (µg/L)
- ▲ DETECT
  - ▲ NONDETECT
  - CONTOUR LINES
  - - - PROPERTY BOUNDARY
  - ▭ BUILDING
  - ▭ FENCE
  - ▭ ROAD
  - ▭ SIDE-WALK



AOC 607  
 CMS REPORT  
 CHARLESTON NAVAL COMPLEX  
 CHARLESTON, SC

Figure 2.20  
 Lower Water Bearing Zone  
 Vinyl Chloride Concentration (µg/L)  
 October 1999

### 3.0 REMEDIAL OBJECTIVES

To improve the focus of this CMS, this section summarizes the COCs to be directly addressed and their remedial objectives. In some cases, this section justifies the inclusion or removal of COCs identified in the RFI based on the compound's contribution, or lack of contribution, to significant risks, hazards, or other regulatory standards applicable to this site. In other cases, remedial objectives have been based on calculated Zone F background risk and hazard.

#### 3.1 Soil Chemicals of Concern

The RFI did not identify and COCs for soils at this site. However, this CMS will address potential corrective actions for chlorinated VOCs above SSLs in soil to reduce the risk of long term diffusion from the vadose zone into the saturated zone.

#### 3.2 Groundwater Chemicals of Concern

During the RFI, identification of COCs was based on detections exceeding screening values. The South Carolina Department of Health and Environmental Control (SCDHEC) Bureau of Solid Waste Management Assessment and Remediation Criteria has identified groundwater MCLs as the goals for corrective measures. Where MCLs have not been developed for specific COCs at AOC 607, RBCs are the corrective measure goals.

##### *Arsenic*

Arsenic was present at concentrations slightly above its MCL (50  $\mu\text{g/L}$ ) in well 607-004 during 3 of 4 rounds of sampling. Because AOC 607 was a dry cleaning operation that did not use arsenic-containing compounds, and the distance from the facility to well 607-004 is about 100 feet upgradient, the arsenic in well 607-004 does not appear related to AOC 607 activities. Of the primary anthropogenic sources of arsenic, only insecticide or herbicide use unrelated to AOC 607 operations stands as a possible anthropogenic source at this site.

Arsenic is a naturally occurring element in the earth's crust. Natural arsenic is usually found combined with one or more other elements such as oxygen, chlorine, and sulfur. In combination, such arsenic is referred to as inorganic arsenic. Arsenic combined with carbon and hydrogen is referred to as organic arsenic. The organic forms are usually less toxic than the inorganic forms. The inorganic arsenic compounds are solids at normal temperatures and are not likely to volatilize. In water, they range from quite soluble (sodium arsenite and arsenic acid) to practically insoluble (arsenic trisulfide).

Cycling of arsenic between pyrite, iron oxide, and groundwater has been studied in a variety of geologic, hydrologic, and climatic settings within the United States. Within the United States, the most prevalent causes of widespread, high arsenic concentrations are release from iron oxide and sulfide minerals (Welch, 1999).

Arsenic can be released from iron oxide by desorption and dissolution during chemical reduction. Many aquifers contain iron oxide with arsenic as an impurity due to co-precipitation or adsorption. Desorption of arsenic can be promoted by either an increase in pH or the concentration of a competing ion, such as phosphorous. Dissolution occurs where deposition of Fe-coated sediment along with organic matter leads to the dissolution of arsenic-containing iron oxide with a consequent release of arsenic to groundwater.

Because high arsenic concentrations at AOC 607 coincide with high total iron concentrations, evidence supports that the arsenic found in well 607-009 can be attributed to dissolution from naturally occurring iron oxides. Therefore, arsenic will not be further addressed by this CMS.

**Lead**

Lead will not be further addressed by this CMS for the following reasons:

- Lead was detected above action levels in wells screened in the deepest portion of the lower aquifer during the first round of sampling. The first round sampling was performed using bailers which can agitate the aquifer and increase suspended sediment loads in samples. Lead was detected either below action levels or not at all during 3 subsequent rounds of sampling which were performed using low-flow sampling techniques. Therefore, the lead in the first round sample could be attributed to the agitating sampling method which either increased lead-containing suspended solids in the sample or helped dissolve lead that was otherwise not in solution prior to sampling.
- Lead was also detected in the upper aquifer in the fourth round of sampling of well 607-001. Lead did not appear above the action level of 15 mg/L in any other round of sampling in this well or any other upper aquifer well at AOC 607. Therefore, this detection appears to be anomalous and may be due to data transposition errors, laboratory cross contamination, or other error which could cause lead to suddenly appear in sample results from this well after 3 previous rounds and 1 subsequent round of non-detection.

**Vanadium** was detected in most wells at AOC 607 at concentrations below its RBC of 26  $\mu\text{g/L}$  (there is no MCL for vanadium). However, well 607-009 contained concentrations ranging from 90 to 102  $\mu\text{g/L}$  in all four rounds of sampling. Even at these concentrations, vanadium does not drive any incremental lifetime cancer risk, and its contribution to site hazard is only 0.8. In contrast, the primary site hazard contributor - tetrachloroethene - drives a site hazard of 157. Because there is no historic source of vanadium at this AOC, and the concentration and distribution of vanadium does not contribute significantly to site hazard, corrective actions do not appear warranted for vanadium. Therefore, this CMS will no longer address vanadium in groundwater.

*Pentachlorophenol* was detected only in well 607GW003 at a concentration of 3  $\mu\text{g/L}$  and only during the first of 4 rounds of sampling. Pentachlorophenol was never detected in any other well at AOC 607. Because recent repeatable site data indicate that concentrations of pentachlorophenol in AOC 607 groundwater are below its MCL (1  $\mu\text{g/L}$ ), corrective actions do not appear warranted for pentachlorophenol in groundwater at this site. Therefore, this CMS will no longer address pentachlorophenol in groundwater.

*Chloromethane* can be a naturally occurring compound and was detected in only a few wells and at low concentrations. It occurs naturally in large amounts in the oceans and is produced by some plants and rotting wood and when grass, wood, charcoal, and coal burn. It is manufactured in the production of chemicals such as silicone, agricultural chemicals, and butyl rubber.

Chloromethane was detected in only 1 of 10 rounds of sampling in well 607-001 (1  $\mu\text{g/L}$ ), in only 1 of 12 rounds of sampling in well 607-006 (6  $\mu\text{g/L}$ ), and 1 of 6 rounds in well 607-01D (10  $\mu\text{g/L}$ ). Because recent repeatable site data did not detect concentrations of chloromethane in AOC 607 groundwater, and corrective actions will address the more significant VOCs located in the same areas as the sparse detections of chloromethane, corrective actions do not appear warranted for chloromethane at this site. Therefore, this CMS will no longer address chloromethane in groundwater.

*Tetrachloroethylene (PCE)* was detected in several wells at concentrations in excess of its MCL (5  $\mu\text{g/L}$ ) and 1/10th its solubility limit in water. This data indicates that PCE is likely present in NAPL form.

PCE is a man-made substance widely used for dry cleaning fabrics and textiles and for metal-degreasing operations. It is also used as a starting material (building block) for the production of other man-made chemicals. Other names that may be used for tetrachloroethylene include perchloroethylene, perc, PCE, perclene, and perchlor. Although tetrachloroethylene is a

liquid at room temperature, some of the liquid can be expected to evaporate into the air producing 1  
an ether-like odor; evaporation increases as temperature increases. 2

3  
The U.S. Department of Health and Human Services has determined that tetrachloroethylene may 4  
reasonably be anticipated to be a carcinogen. Based on evidence from animal studies, 5  
tetrachloroethylene is thought to be capable of causing cancer in humans. It should be emphasized, 6  
however, that currently available information is not sufficient to determine whether 7  
tetrachloroethylene causes cancer in humans. 8

9  
The USEPA estimates that if people consume 1.0 mg tetrachloroethylene/kg/day in food and water 10  
every day for 70 years, there would be at the most a risk of 510 additional cases of cancer in a 11  
population of 10,000, or 510,000 additional cases in a population of 10,000,000. It should be 12  
noted that these risk values are plausible upper-limit estimates. Actual risk levels are unlikely to 13  
be higher and may be lower. 14

15  
The Environmental Protection Agency (EPA) has developed the following health advisories to 16  
describe concentrations of tetrachloroethylene in drinking water at which no adverse effects are 17  
anticipated to occur: 2.0 milligrams per liter of water (mg/L) for short-term exposure of children, 18  
1.4 mg/L for longer term exposure of children, and 5.0 mg/L for long-term exposure of adults. 19  
In addition, a drinking water equivalent level (DWEL) of 0.5 mg/L has been established. 20

21  
***Trichloroethene (TCE)*** was detected at concentrations in excess of its MCL (5  $\mu\text{g/L}$ ) in multiple 22  
wells. Manufactured TCE is also known as Triclene and Vitran and by other trade names in 23  
industry. It is a nonflammable, colorless liquid at room temperature with a somewhat sweet odor 24  
and a sweet, burning taste. TCE does not occur naturally in the environment but can be present 25  
as a breakdown product of tetrachloroethylene. 26

27

Trichloroethene is mainly used as a solvent to remove grease from metal parts. It is also used as a solvent in other ways and is used to make other chemicals including some household products such as typewriter correction fluid, paint removers, adhesives, and spot removers. Most people begin to smell trichloroethene in air when there are around 100 parts of trichloroethene per a million parts of air (ppm).

**1,1-Dichloroethene (1,1-DCE)** was detected above its MCL in a few wells with sparse frequency. The concentration, frequency and distribution of detections indicate that 1,1-DCE is a daughter product of PCE and TCE at this site.

1,1-DCE was detected above its MCL ( $7 \mu\text{g/L}$ ) in only 1 of 5 rounds of sampling in well 607-015 ( $56 \mu\text{g/L}$ ), in only 1 of 5 rounds of sampling in well 607-017 ( $39 \mu\text{g/L}$ ), and the only round in well 607-18D ( $9 \mu\text{g/L}$ ). I was not detected above its MCL in any other wells in any other round. Because recent repeatable site data did not detect concentrations of chloromethane in AOC 607 groundwater, and corrective actions will address the more significant VOCs located in the same areas as the sparse detections of chloromethane, this CMS will no longer address chloromethane in groundwater.

**1,2-Dichloroethene (1,2-DCE)** was detected at concentrations in excess of its MCL ( $70 \mu\text{g/L}$ ) in multiple wells. The concentration, frequency and distribution of detections indicate that 1,1-DCE is a daughter product of PCE and TCE at this site.

**Vinyl chloride (VC)** was detected above its MCL ( $2 \mu\text{g/L}$ ) in several wells. VC is a colorless gas at normal temperatures. It is also known as chloroethene, chloroethylene, ethylene monochloride, or monochloroethylene. It is flammable (easily capable of burning) as a gas and is not stable at high temperatures or pressure. Vinyl chloride will exist in liquid form if it is kept under high pressure. Vinyl chloride has a mild, sweet odor. Most people begin to smell vinyl chloride in the air at 3,000 parts vinyl chloride per million parts (ppm) of air. Most people begin to taste vinyl

chloride in water at 3.4 ppm. All vinyl chloride is man-made or results from the breakdown of other compounds found in groundwater at this site such as PCE, TCE, and 1,2-DCE.

Production of vinyl chloride in the United States has grown an average of 7 percent from the early 1980s to the early 1990s, with an additional increase of approximately 22 percent between the years of 1992 and 1993. Most of the vinyl chloride produced in the United States is used to make polyvinyl chloride (PVC). PVC is used to make a variety of plastic products including pipes, wire and cable coatings, and packaging materials. Other uses include furniture and automobile upholstery, wall coverings, housewares, and automotive parts. At one time, vinyl chloride was also used as a coolant, as a propellant in spray cans, and in some cosmetics. Since the mid 1970s, it has not been used for these purposes.

**Chloromethane, 1,1-DCE, 1,2-DCE, tetrachloroethylene, trichloroethene, and vinyl chloride** are all present in groundwater at concentrations above their respective MCLs. Table 3.1 summarizes the MCLs for these and other COCs.

**Table 3-1  
AOC 607 CMS Groundwater COCs and MCLs**

COC	MCL (ug/L)
Chloromethane	NA
1,1-Dichloroethene	7
1,2 Dichlorethene (total)	70
Tetrachloroethylene	5
Trichloroethene	5
Vinyl Chloride	2

**Notes:**

NA - Chloromethane does not have an MCL. Its tap-water RBC is 1.4 ug/L.

## 4.0 IDENTIFICATION AND SCREENING OF TECHNOLOGIES

This section describes the initial steps toward remedy selection: identification and screening of applicable technologies. After technologies are identified, they are reviewed based on site-specific conditions and waste constraints. Screening occurs when technologies are either eliminated from further consideration or retained for it. From the technologies retained, alternatives for remedial action at AOC 607 will be developed and further evaluated in Section 5.

### 4.1 Potential Response Actions

Remedial action technologies can be broadly categorized into general response actions for consideration in the CMS. From these generalized categories, potentially applicable technologies will be selected. The general categories of response actions are summarized below.

- **Institutional controls:** Institutional controls often supplement engineering controls as appropriate for short- and long-term management to prevent or limit exposure to hazardous substances, pollutants, or contaminants. Institutional controls should not supplant active response measures as the sole remedy, unless active measures are determined to be impractical. Institutional controls are required for industrial reuse scenarios and typically include:

- Site access controls
- Public awareness, education
- Groundwater use restrictions
- Long-term monitoring
- Deed restrictions
- Warning against excavation, soil use

- **Containment:** This engineering control would protect human health and the environment by preventing or controlling exposure to site contaminants for waste that poses a relatively low long-term threat, or where treatment is impractical.
- **Monitored Natural Attenuation:** This term refers to dilution, dispersion, advection, and biotic degradation of contaminants in the environment. Monitoring must be conducted throughout the process to confirm that degradation is proceeding at rates consistent with remediation objectives and to ensure that receptors are not threatened.
- **Treatment:** Treatment can be used to reduce the toxicity, mobility, or volume of the principal threats posed by a site, where practical.
- **Combination:** Appropriate methods can be combined to protect human health and the environment.

## 4.2 Soil Technology Screening

AOC 607 soil contamination is primarily confined to VOCs in the area beneath Building 1189 in the silty and sandy clay above the upper aquifer and the clay aquitard between the upper and lower water bearing zones. Table 4.1 summarizes technology screening results for each specific technology screened. The following subsections provide general background on the types of technology groups evaluated in terms of their applicability to this site.

### 4.2.1 Institutional Controls - Soil

Institutional controls use site access controls to limit exposure pathways to potential receptors. Site access controls include legal controls such deed restrictions and physical controls such as fencing. None of these options were eliminated from further consideration.

Table 4.1  
 Soil Technology Screening for AOC 607

Technology	Description	Site Constraints	Waste Constraints	Retained
<b>INSTITUTIONAL CONTROLS - SOIL</b>				
Institutional Controls	Leaves contaminated soil in place. Site access would be controlled by site access controls, public awareness, education, deed restrictions, etc.	Does not remove the source — plans for future site use may be impacted.	None.	Yes.
<b>CONTAINMENT TECHNOLOGIES - SOIL</b>				
Surface Cap	Capping is a containment technology that will limit human contact with soil and reduce infiltration of rainwater through contaminated soil. Capping materials include soil, asphalt, and concrete.	Plans for future site use may be impacted by capping technology.	None.	No. Exposure to surface soil and soil to groundwater transport via percolation are not concerns at the site.
<b>IN SITU BIOLOGICAL TREATMENT TECHNOLOGIES - SOIL</b>				
Enhanced Biodegradation	Enhanced biodegradation involves injecting materials into the vadose zone to promote microbial growth and accelerate natural processes. Some common additives are hydrogen peroxide, air, oxygen, and methane.	Soil geochemistry should be compatible with microbial amendments. Oxygen enhancement could be limited by the potential for iron and microbial fouling due to the addition of oxygen and increase in pH. The ability to rectify fouling, should it occur, must be considered. Injection permits are required if liquids are used.	This technology primarily applies to organic hydrocarbons. Very high concentrations of hydrocarbons can be toxic to or inhibit microbial growth.	Yes.
Bioventing	Soils are exposed to air via either passive venting, low pressure injection, or low pressure extraction to stimulate aerobic biological activity. Flow rates are much lower than for soil-vapor extraction, minimizing volatilization and release of contaminants to the atmosphere.	Bioventing is applicable to contaminants in the vadose zone. High permeability soils are preferred and low moisture contents are required.	Bioventing is applicable for any contaminant that more readily degrades aerobically than anaerobically.	Yes.
Electrokinetically Enhanced Bioremediation	One form of enhanced biodegradation, electric fields are applied to the contaminated zone to encourage migration of nutrients into the zone and enhance microbial growth within the zone. Bench scale tests have achieved greater than 75% TCE removal from low permeability clay soils.	The effectiveness of an electric field can be reduced by the presence of buried metallic conductors, and pH and reduction-oxidation changes induced by the process electrode reactions. Low permeability soils are preferred over sands and some moisture is required.	This technology treats soil contaminated with organic compounds easily biodegraded under anaerobic conditions. Bench scale tests have achieved greater than 75% TCE removal from low permeability clay soils.	No. Waste constraint - This technology is in laboratory bench-scale development and is not likely to meet clean up goals.

Table 4.1  
 Soil Technology Screening for AOC 607

Technology	Description	Site Constraints	Waste Constraints	Retained
Landfarming	Contaminated soil is cultivated to enhance aerobic contaminant biodegradation.	In situ landfarming can only be performed on soils in the upper 2 feet.	In situ landfarming works best with non-chlorinated petroleum hydrocarbons.	No. Site constraint - The contaminated soil at this site is too deep for in situ landfarming.
Monitored Natural Attenuation (MNA)	Natural subsurface processes such as dilution, volatilization, biodegradation, adsorption, and chemical reactions with subsurface materials are allowed to reduce contaminants to acceptable concentrations.	MNA may not be a good remediation choice for locations where site conditions make it difficult to predict contaminant movement.	Some inorganics can be immobilized through MNA, but they will not be degraded.	Yes.
Phytoremediation	Phytoremediation is the use of plants to remove, contain, and/or degrade contaminants. Examples include: enhanced rhizosphere biodegradation, phytoaccumulation, phytodegradation, and phytostabilization.	Climatic or hydrologic conditions may restrict the remediation plants' rate of growth, and treatment is generally limited to within 3 feet of the soil surface. Due to time required for remediation, plans for future site use may be impacted by phytoremediation.	High concentrations of hazardous materials can be toxic to plants.	No. Site constraint - Soil contamination at this site is too deep for this technology.

**IN SITU PHYSICAL/CHEMICAL TREATMENT TECHNOLOGIES - SOIL**

Chemical Oxidation	Chemical oxidation is a process in which the oxidation state of a contaminant is increased while the oxidation state of the reactant is decreased. The reactant can be another element, including the oxygen molecule, or it may be a chemical species containing oxygen, such as hydrogen peroxide or chlorine dioxide.	Iron and manganese in the soil will compete with contaminants for oxygen. Delivery of the oxidants are limited in low permeability soil, and uniform application can be difficult in heterogeneous soil.	This technology is effective in treating media contaminated with low concentrations of halogenated and non-halogenated volatiles and semivolatiles, PCBs, pesticides, cyanides, and volatile and nonvolatile metals.	No. Site constraint - Low permeability and high heterogeneity soil and high VOC concentrations at this site preclude the use of this technology.
Electrokinetic Separation	Low intensity direct electrical current is applied across electrode pairs that have been implanted in the ground on either side of the contaminated zone. Contaminants desorbed from the soil surface are transported toward cathodes or anodes, depending on their charge.	Effectiveness is reduced by buried metallic conductors, immobilization of metal ions by undesirable chemical reactions with naturally occurring and co-disposed chemicals, and pH and reduction-oxidation changes induced by the process electrode reactions. Low moisture content also reduces the effectiveness.	This technology can be used to treat soil contaminated with heavy metals, radionuclides, and organic contaminants.	No. Waste constraint - This technology is not very effective with VOCs, or with heterogeneous soils, or in the presence of nearby underground utilities.

Table 4.1  
 Soil Technology Screening for AOC 607

Technology	Description	Site Constraints	Waste Constraints	Retained
Fracturing	Fractures are created in low permeability and over-consolidated sediments to open new passageways to increase the effectiveness of many in situ processes and enhance extraction efficiencies. Fracturing must be used with a treatment technology such as soil vapor extraction or in situ bioremediation. Fracture technologies include blast-, pneumatic-, and hydraulic-fracturing.	Cemented sediment limits fracturing effectiveness and fractures will close in non-clayey soil. The technology should not be used in areas of high seismic activity. Fracturing can potentially interfere with utilities and site activities.	The potential exists for opening new pathways, which could spread contaminants such as dense nonaqueous phase liquids (DNAPLs).	No. Site constraint. Site geology is not conducive to fracturing.
Pressure Dewatering	Air is injected into the soil at a rate that increases groundwater pressure, resulting in groundwater flow away from the air injection site. This technique increases the amount of soil that can be biodegraded through bioventing.	Pressure dewatering applies for remediating contaminants in the vadose zone.	Pressure dewatering applies for any contaminant that is more readily degraded aerobically than anaerobically.	No. Waste constraint. PCE and TCE degrade more rapidly under anaerobic conditions.
Soil Flushing	Soil flushing uses water or a solvent to leach contaminants from the soil. Groundwater extraction must be included to prevent spreading contamination in groundwater.	Low-permeability soil is difficult to treat with soil flushing. Soil flushing should only be used where flushed contaminants and flushing fluid can be contained and recaptured.	Mobilization of NAPLs in response to cosolvent flooding can worsen the extent of site contamination.	No. Site constraint. Low permeability soils at this site prohibit use of this technology.
Soil-Vapor Extraction	SVE uses extraction wells and vacuum pumps to create a pressure gradient to remove water and contaminant vapors from the vadose zone. SVE is often used in conjunction with other technologies.	This technology can be used at sites where areas of contamination are large and deep and/or underneath a structure. Soil should be fairly homogeneous and have high permeability, porosity, and uniform particle size distribution.	SVE applies to soil contaminated with VOCs and some SVOCs.	Yes.
Solidification/Stabilization	In situ solidification/stabilization immobilizes contaminants by using large augers to mix portland cement, lime, or a chemical reagent into the soil to reduce the mobility of the contaminant.	This technology will likely leave a solid mass, similar to concrete, which may impact future use of the site.	This technology works well for inorganics, including radionuclides. Some VOCs can delay or inhibit reactions necessary for solidification.	No. Waste constraint. The high concentrations of VOCs at this site may cause long-term leaching even after stabilization

Table 4.1  
 Soil Technology Screening for AOC 607

Technology	Description	Site Constraints	Waste Constraints	Retained
<b>IN SITU THERMAL TREATMENT TECHNOLOGIES - SOIL</b>				
In Situ Vitrification	Electrical heating is used to melt contaminated soil, producing an in situ matrix with very low leaching characteristics.	Existing structures and utilities may impede or restrict excavation. Large glass mass is left in place.	This technology is primarily used for radioactive contaminants.	No. Waste constraint - Not applicable to VOCs.
Electrical Resistance Heating	Electrical current is applied to the water table to heat groundwater to temperatures up to the boiling point of water. The increased temperature improves volatilization, recovery, and long-term in situ degradation of organic compounds. In situ vapor extraction is required as a co-treatment technology.	This technology is very effective for small areas of very high VOC concentration. However, compared to other technologies, this technology can become very expensive when applied over areas greater than 1 acre. The technology is most effective in saturated or high moisture content silt and clay soils.	This technology addresses primarily organic contamination. However, some metals can be reduced to less toxic states [e.g. Cr(VI) to Cr(III)]	Yes.
Steam Injection	Steam generated above or below ground is used to heat the subsurface to improve volatilization, mobility, recovery, and long-term in situ degradation of organic compounds. In situ vapor extraction is required as a co-treatment technology.	The technology is most effective in low moisture content or dewatered sandy soils. Injection permit required.	This technology addresses primarily organic contamination. However, some metals can be reduced to less toxic states [e.g. Cr(VI) to Cr(III)]	No. Site constraint - This technology can be ineffective in low permeability and/or high moisture content zones.
Hot Water Injection	Hot water is generated above ground and injected into the subsurface to improve mobility, recovery, and long-term in situ degradation of organic compounds. Groundwater extraction is required as a co-treatment technology.	The technology is most effective in sandy soils. It is more effective than steam below the water table. Injection permit required.	This technology addresses primarily organic contamination. However, some metals can be reduced to less toxic states [e.g. Cr(VI) to Cr(III)]	No. Site constraint - This technology can be ineffective in low permeability zones.
<b>EXCAVATION AND OFFSITE DISPOSAL</b>				
Excavation and Offsite Disposal	Contaminated soil is excavated and disposed of offsite at a licensed waste disposal facility.	Existing structures and utilities may impede or restrict excavation. Transportation of the soil through populated areas may affect community acceptance. Dewatering or other controls will be needed for excavating below the water table.	Land disposal restrictions (LDRs) apply. Soil may be disposed of at non-hazardous waste landfill per 40 CFR 268.49, which generally requires ex situ treatment to reduce concentrations to 90% of the mass present at excavation or 10 times the universal treatment standard.	Yes, but co-treatment is required.

Table 4.1  
 Soil Technology Screening for AOC 607

Technology	Description	Site Constraints	Waste Constraints	Retained
<b>EX SITU BIOLOGICAL TREATMENT TECHNOLOGIES - SOIL</b>				
Biopiles	Excavated soil is mixed with amendments, nutrients, and fillers and placed in aboveground enclosures. In an aerated static pile, excavated soil is formed into piles and aerated with blowers or vacuum pumps. Compost piles and static piles are examples of biopiles.	Existing structures and utilities may impede or restrict excavation. A large amount of space is required for biopiles. Dewatering or other controls will be needed for excavating below the water table.	Treats nonhalogenated VOCs and fuel hydrocarbons. Halogenated VOCs, SVOCs, and pesticides also can be treated, but effectiveness varies. Heavy metals cannot be degraded by biopiles and can be toxic to the microorganisms. LDRs apply.	Yes.
Biosorption	Biosorption is the sorptive removal of toxic metals from solution by a specially prepared biomass.	Existing structures and utilities may impede or restrict excavation. This technology may not be effective for clayey soil. Dewatering or other controls will be needed for excavating below the water table.	Biosorption removes toxic metals from solution. Not proven effective at concentrations above 30 ppm. LDRs apply.	No. Waste constraint - This technology is inapplicable to VOCs.
Fungal Biodegradation	Fungal biodegradation refers to the degradation of a wide variety of organopollutants by using the lignin-degrading or wood-rotting enzyme system of white rot fungus.	Existing structures and utilities may impede or restrict excavation. Dewatering or other controls will be needed for excavating below the water table.	White rot fungus can degrade and mineralize organic compounds, including predominant conventional explosives (TNT, RDX, and HMX) and other recalcitrant materials (DDT, PAHs, and PCBs). LDRs apply.	No. Site and waste constraint - Area re-use may prohibit stockpiling of soil on site. High concentrations of VOCs may be toxic to microorganisms.
Landfarming	Contaminated soil is excavated, applied into lined beds and periodically turned over or tilled to aerate and enhance contaminant biodegradation.	Existing structures and utilities may impede or restrict excavation. A large amount of space is required for landfarming. Dewatering or other controls will be needed for excavating below the water table.	Inorganic contaminants will not be biodegraded and volatile contaminants may need pretreatment to prevent polluting the air. LDRs apply.	Yes.
Slurry Phase Biological Treatment	An aqueous slurry is created by combining soil with water and other additives to degrade organic contaminants. Upon completion of the process, the slurry is dewatered and the treated soil is disposed of.	Existing structures and utilities may impede or restrict excavation. Nonhomogeneous soil and clayey soil can create material handling problems. Dewatering or other controls will be needed for excavating below the water table.	Slurry-phase bioreactors primarily treat nonhalogenated SVOCs and VOCs in excavated soil or dredged sediment. Specially adapted microorganisms and co-metabolites can be used to treat halogenated VOCs and SVOCs, pesticides, and PCBs. LDRs apply.	No. Site constraint - Most of the contaminated soil is a saturated high plasticity clay which minimizes the effectiveness of this technology.

Table 4.1  
 Soil Technology Screening for AOC 607

Technology	Description	Site Constraints	Waste Constraints	Retained
<b>EX SITU PHYSICAL/CHEMICAL TREATMENT TECHNOLOGIES - SOIL</b>				
Chemical Extraction	Excavated soil is washed with aqueous-based solutions to separate contaminants sorbed onto fine particles from the rest of the soil matrix. The fractions of soil to be treated are processed in a slurry with specific leachant mixtures to ionize target metals. The treated mixture is further treated to develop an enriched leaching solution, which is then treated to remove the target metals.	Existing structures and utilities may impede or restrict excavation. Soil with higher clay content may reduce extraction efficiency and require longer contact times. Dewatering or other controls will be needed for excavating below the water table.	Acid extraction is suitable for treating soil contaminated by heavy metals.  Solvent extraction has been shown to be effective in treating soil containing primarily organic contaminants, but is generally least effective on very high molecular weight organics and very hydrophilic substances.  Liquid waste stream is generated and must be treated and disposed of. LDRs apply.	No. Site constraint. Most of the contaminated soil is a saturated high plasticity clay which minimizes the effectiveness of this technology.
Chemical Oxidation	Chemical oxidation is a process in which the oxidation state of a contaminant is increased while the oxidation state of the reactant is decreased. The reactant can be another element, including the oxygen molecule, or it may be a chemical species containing oxygen, such as hydrogen peroxide or chlorine dioxide.	Existing structures and utilities may impede or restrict excavation. Iron and manganese in the soil will compete with contaminants for oxygen. Dewatering or other controls will be needed for excavating below the water table.	This technology is effective in treating media contaminated with low concentrations of halogenated and non-halogenated volatiles and semivolatiles, PCBs, pesticides, cyanides, and volatile and nonvolatile metals.	No. Site constraint. Most of the contaminated soil is a saturated high plasticity clay which minimizes the effectiveness of this technology.
Dehalogenation	Reagents are added to soil contaminated with halogenated organics. The dehalogenation process is achieved by either replacing the halogen molecules or decomposing and partially volatilizing the contaminants. Examples of dehalogenation include base-catalyzed decomposition and glycolate/alkaline polyethylene glycol (A/PEG).	Existing structures and utilities may impede or restrict excavation. High clay and moisture content will increase treatment costs. Capture and treatment of residuals from the process will be especially difficult for soil containing high levels of fines and moisture. Dewatering or other controls will be needed for excavating below the water table.	The target contaminant groups for dehalogenation treatment are halogenated SVOCs and pesticides. The technology can be used, but may be less effective against selected halogenated VOCs. LDRs apply.	No. Site constraint. Most of the contaminated soil is a saturated high plasticity clay which minimizes the effectiveness of this technology.

Table 4.1  
 Soil Technology Screening for AOC 607

Technology	Description	Site Constraints	Waste Constraints	Retained
Physical Separation	Separation techniques concentrate contaminated solids through physical means. These processes seek to detach contaminants from their medium (e.g., soil, sand, or other binding material). Gravity separation, magnetic separation, and sieving/physical separation are examples of this technology.	Existing structures and utilities may impede or restrict excavation. Specific gravity of particles will affect settling rates and process efficiency. Dewatering or other controls will be needed for excavating below the water table.	The target contaminant groups are SVOCs, fuels, and inorganics (including radionuclides). The technologies can be used on selected VOCs and pesticides. Magnetic separation is specifically used on heavy metals, radionuclides, and magnetic radioactive particles, such as uranium and plutonium compounds.	No. Waste constraint - This technology is not applicable to absorbed phase VOCs.
Soil Washing	Excavated soil is washed with aqueous-based solutions to separate contaminants sorbed onto fine particles from the rest of the soil matrix. This technology only separates the contaminants and does not destroy them. Further treatment or disposal of the process water is required.	Existing structures and utilities may impede or restrict excavation. High humic content in soil may require pretreatment. It may be difficult to remove organics adsorbed to clay-size particles. Dewatering or other controls will be needed for excavating below the water table.	This technology is effective at removing SVOCs and inorganics. It is less effective at treating VOCs. LDRs apply.	No. Site constraint - Most of the contaminated soil is a saturated high plasticity clay which minimizes the effectiveness of this technology.
Solidification/ Stabilization	Contaminants are physically bound or encased within a stabilized mass, or chemical reactions are induced with stabilizing agents. The contaminants are not removed or destroyed, but their mobility is reduced. Examples of S/S technologies include bituminization, emulsified asphalt, modified sulfur cement, polyethylene extrusion, Pozzolan/portland cement, radioactive waste solidification, sludge stabilization, and soluble phosphates.	Existing structures and utilities may impede or restrict excavation. Dewatering or other controls will be needed for excavating below the water table.	This technology works well for inorganics, including radionuclides. Although organic contaminated soil may be treated with solidification/stabilization, some organics can inhibit reactions necessary for solidification or continue to leach from stabilized material even after treatment. LDRs apply.	No. Waste constraint - This technology is not applicable to high concentrations of VOCs.
Supercritical Carbon Dioxide Extraction (SCDE)	This process employs supercritical carbon dioxide as a solvent to remove normally insoluble organic compounds. It does not destroy target contaminants.	Existing structures and utilities may impede or restrict excavation. Elevated water content can have a negative impact on SCDE performance. Dewatering or other controls will be needed for excavating below the water table.	This technology can remove normally insoluble organics from soil. LDRs apply.	No. Waste constraint - This technology is not applicable to chlorinated VOCs.
<b>EX SITU THERMAL TREATMENT TECHNOLOGIES - SOIL</b>				
Distillation	Hydrocarbons and water are volatilized from contaminated media using either heat or vacuum.	Existing structures and utilities may impede or restrict excavation. Dewatering or other controls will be needed for excavating below the	This process is generally used where it is necessary to recover and collect organic contaminants for re-use or to decrease the	No. Waste constraint - The estimated volume (< 1 ft <sup>3</sup> )

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Table 4.1  
 Soil Technology Screening for AOC 607

Technology	Description	Site Constraints	Waste Constraints	Retained
High-Pressure Oxidation	Wet air oxidation and supercritical water oxidation belong to this technology category. Both processes use high pressure and temperature to treat organic contaminants.	Existing structures and utilities may impede or restrict excavation. Dewatering or other controls will be needed for excavating below the water table.	Wet air oxidation can treat hydrocarbons and other organic compounds.  Supercritical water oxidation applies to PCBs and other stable compounds. LDRs apply.	No. Waste constraint - VOCs at this site do not require high pressure systems for removal.
Hot Gas Decontamination	This process involves raising the temperature of the contaminated material for a specified period of time. The gas effluent from the material is treated in an afterburner system to destroy all volatilized contaminants.	Existing structures and utilities may impede or restrict excavation. Dewatering or other controls will be needed for excavating below the water table.	This process was developed to treat demilitarizing explosive items, such as mines and shells (after removal of explosives), or scrap material contaminated with explosives. LDRs apply.	No. Waste constraint - VOCs do not require destruction.
Incineration/ Pyrolysis	Incineration burns contaminated sediment at high temperatures (1,600° - 2,200°F) to volatilize and combust organic contaminants. A gas treatment system must be included with the incinerator. Units include circulating bed combustors, fluidized bed reactors, infrared combustors, and rotary kilns.  Pyrolysis chemically changes contaminated sediment by heating it in the absence of air. Pyrolysis can be achieved by limiting oxygen supply to rotary kilns and fluidized bed reactors. Molten salt destruction is another example of pyrolysis.	Existing structures and utilities may impede or restrict excavation. Highly abrasive feed can damage the processor unit. The technology requires drying the soil to achieve less than 1% moisture content. Dewatering or other controls will be needed for excavating below the water table.	Incineration is not effective in treating heavy metals contaminated soil. The target contaminant groups for pyrolysis are SVOCs and pesticides. Volatile metals may be removed by the higher temperatures, but are not destroyed. LDRs apply.	No. Waste constraint - VOCs do not require incineration or pyrolysis for removal.
Open Burn/Open Detonation	In open burn operations, explosives or munitions are destroyed by self-sustained combustion, which is ignited by an external source, such as flame, heat, or a detonatable wave. Open detonation destroys detonatable explosives and munitions by detonating with an energetic charge.	Existing structures and utilities may impede or restrict excavation. Substantial space is required for open processes. Open burn/open detonation requires a RCRA Subpart X permit. Dewatering or other controls will be needed for excavating below the water table.	Open burn/open detonation can be used to destroy excess, obsolete, or unserviceable munitions, components, and energetic materials, as well as media contaminated with energetics. LDRs apply.	No. Waste constraint - Not applicable to chlorinated VOCs

Table 4.1  
 Soil Technology Screening for AOC 607

Technology	Description	Site Constraints	Waste Constraints	Retained
Solar Detoxification	Solar detoxification is a process that destroys contaminants by photochemical and thermal reactions using the ultraviolet energy in sunlight. Large mirrors (heliostats) are used to focus sunlight. Reagents such as TiO <sub>2</sub> , hydrogen peroxide, or Fe(III) are sometimes required to act as catalysts.	Existing structures and utilities may impede or restrict excavation. Adequate sunlight and large amounts of area are required. Reagent application and mixing can be inhibited by excessive clay soils. Dewatering or other controls will be needed for excavating below the water table.	The target contaminant groups for solar detoxification are VOCs, SVOCs, solvents, pesticides, and dyes. The process may also remove some heavy metals from water. This technology is more desirable where contaminant destruction is required. LDRs apply.	No. Site constraint and waste constraint - Clay soils may inhibit reagent mixing and photochemical contact time. VOC destruction will not likely be required.
Thermal Desorption	Soil is heated to between 200° and 1,000°F depending on the volatility of the target compound to separate VOCs, water, and some SVOCs from the solids into a gas stream. Organics in the gas stream must be treated or captured.	Existing structures and utilities may impede or restrict excavation. Highly abrasive feed can damage the processor unit. Clay and silty soil and soil with high humic content increase reaction time due to contaminant binding. Dewatering or other controls will be needed for excavating below the water table.	Inorganic contaminants or metals that are not particularly volatile will not be effectively removed by thermal desorption. LDRs apply.	Yes.
Vitrification	Electrical heating is used to melt contaminated soil, producing a glass-like matrix with very low leaching characteristics.	Existing structures and utilities may impede or restrict excavation. Dewatering or other controls will be needed for excavating below the water table.	This technology is primarily used for radioactive contaminants. LDRs apply.	No. Waste constraint - Not applicable to VOCs.

#### 4.2.2 Containment Technologies - Soil

Containment options are generally used to prevent contact with surface soils and to prevent COCs from entering the aquifer via percolation. For this site, all containment options were eliminated from further consideration because (1) there are no surface soil COCs threatening potential receptors via dermal contact, inhalation, or ingestion pathways, and (2) seasonal and tidal fluctuations in the groundwater table elevation cause COCs in the vadose zone to come into contact with the aquifer, and percolation does not play a major role in soil to groundwater transport.

#### 4.2.3 In Situ Biological Treatment Technologies - Soil

In general, in situ biological treatment technologies are used to reduce organic contamination from medium to low concentrations. Some in situ biotechnologies are more effective than others based on the type and concentration of organic contaminant and the type of soil present at the site.

#### *Eliminated*

**Electrokinetically enhanced biodegradation** uses electric fields to encourage the migration of nutrients into a contaminated zone and to stimulate microbial growth within the zone. This technology was eliminated because it is still under development and early laboratory bench-scale results indicate that it may not be effective enough to prevent long term residual leaching of VOCs to groundwater at this site.

Two other technologies - **in situ landfarming** and **phytoremediation** - use cultivation of soil and plants to enhance degradation of contaminants. These technologies were eliminated specifically because they are not capable of treating soils at depths greater than 2 or 3 feet, while contaminated soils at this site extend up to 17 feet below ground surface.

***Retained***

**Enhanced biodegradation and bioventing** were retained. These technologies rely on small amendments (oxygen, nutrients, and/or substrate) added to the soil to stimulate biodegradation of organic compounds. While neither of these technologies could likely meet clean-up goals on their own, they could be needed as a polishing step following more aggressive corrective measures.

**Monitored Natural Attenuation (MNA)** was retained in the event more aggressive corrective measures are able to remove large amounts of contaminant mass from the site, but are unable to significantly further reduce VOC residual mass after the system has been operating for a long period of time (usually greater than 1-year). In such an event, MNA would be implemented to assess whether natural processes are able to reduce residual contamination to a level below clean-up goals.

**4.2.4 In Situ Physical/Chemical Treatment Technologies - Soil**

In general, in situ physical/chemical treatment technologies are used to reduce organic contamination from high to low concentrations. Similar to other technology groups, some in situ physical/chemical technologies are more effective than others based on the contaminant type and concentration and the soil type and heterogeneity present at the site.

***Eliminated***

**Chemical oxidation** is a process where chemical oxidizing agents such as hydrogen peroxide are injected into the contaminated soil in order to increase the oxidation state of the contaminant. This process is very effective in sandy soils where the mass of contamination is relatively low and is confined to a well defined area. Unlike some biological amendments, the cost of oxidizing agent is usually a very significant portion of the total cost of implementing the technology. Because the mass and location of VOC contamination is relatively large and distributed in a non-uniform

manner within a heterogeneous mix of fine grained soil, estimating the mass of oxidizer required and successfully targeting delivery zone would be very difficult to accomplish at this site. Therefore, this technology was screened from further consideration in this CMS.

**Electrokinetic separation** is used to assemble into small areas contaminants spread over large areas in order to facilitate extraction. This technology was designed primarily for metals removal and works best in homogeneous, moist, fine-grained soils that conduct electricity well. Underground utilities or significant soil heterogeneities can reduce this technology's effectiveness. Because (1) the COCs at this site chlorinated VOCs which do not respond as well to electrokinetics as do metals, (2) soil at the site is very heterogeneous with varying degrees of moisture content, and (3) there are several underground utility lines likely to interfere with electrokinetic efficiency, this technology was removed from further consideration in this CMS.

**Fracturing** is performed to increase the removal efficiency of venting or vacuum extraction technologies where contaminants have moved into low permeability soils or complex fractured bedrock formations. This technology does not work well in plastic clays in which fractures close within a short period of time or where potential damage to existing infrastructure such as buildings and sewer lines is likely to occur. Because much of the soil contamination at this site is tied up in plastic clays, this technology was removed from further consideration in this CMS.

**Pressure Dewatering** injects air under high pressure into the subsurface in order to depress the water table. This technology causes groundwater to flow away from the zone of injection so that the newly dewatered zone can be aerobically biodegraded. Because this could cause considerable contaminant migration into previous uncontaminated areas, and because higher-end chlorinated VOCs such as PCE and TCE degrade better under anaerobic conditions, this technology was removed from further consideration in this CMS.

**Soil flushing** uses water or diluted chemical mixtures to flush contaminants from the soil. A groundwater collection system is needed to collect contaminant-containing liquids. This technology works well in homogeneous, medium to coarse grained soils. One drawback to this technology is that mobilization of NAPLs previously bound in the soil column can worsen the extent of contamination if the groundwater collection system fails to collect all of the flushing agent. Because this site contains heterogeneous fine grained soils, this technology was removed from further consideration in this CMS.

**Solidification/Stabilization** uses portland cement, lime, or other chemical reagent to immobilize contaminants in situ. This technology was removed from further consideration in this CMS because it leaves a large mass of contaminant-containing concrete or other impermeable solid in the ground resulting in some long-term liability, and very high concentrations of VOCs could possibly continue to leach from the solid even after stabilization activities are complete.

***Retained***

**Soil Vapor Extraction** uses vacuum extraction wells to strip VOCs from the vadose zone. This is a proven technology for VOC removal and can be used in conjunction with groundwater extraction, thermal technologies, or other treatments where vapors are generated in the subsurface as a result of in situ groundwater treatment. However, its zone of influence per extraction well is limited in very low permeability soils. Because SVE is required for some groundwater treatment technologies, and because it is a reliable method of removing VOCs from soil, it has been retained for further evaluation in this CMS.

#### 4.2.5 In Situ Thermal Treatment Technologies - Soil

In general, in situ thermal treatment technologies are used to reduce organic contamination from free-phase or very high concentrations to lower levels where natural processes can be left to degrade the residual mass. The primary effect of thermal technologies is the volatilization and destruction of VOCs. Because soil has good insulation properties, thermal treatment zones retain much of their heat for long periods after active treatment has stopped. This heat has a secondary effect of enhancing biological activity.

Nearly all in situ thermal technologies require some type of co-treatment vacuum vapor extraction system to collect VOC gases as they are created in situ.

#### *Eliminated*

**In situ vitrification** is a process by which soil and rock temperatures are raised until the soil is glassified in order to stabilize the waste that they contain. It was developed to contain radioactive wastes. VOCs like those found at AOC 607 will volatilize or be destroyed long before temperatures reach the point of glassifying soil and rock. This technology was removed from consideration in this CMS because other thermal technologies are available which require less heat and are more cost effective.

**Steam Injection** uses high or low pressure steam generated above ground to heat the contaminated zone. Steam is very effective in dry, high permeability zones. However, high moisture content or saturated zones can act as condensers, and low permeability zones can resist steam penetration. Because this site contains high moisture content and many low permeability zones, this technology was eliminated from further consideration.

**Hot water injection** uses high temperature water (200 to 500 F°) generated above ground to heat the contaminated zone. Hot water is more effective than steam in high moisture zones, however it still requires relatively high soil permeabilities to accommodate injection. Because this site contains many low permeability zones, this technology was eliminated from further consideration.

*Retained*

**Electrical Resistance Heating** heats soil in-situ using an array of charged and neutral probes. This technology is more energy intensive than either steam or hot water, but it is capable of creating both hot water zones and steam zones in high moisture content, low permeability environment. In situ vacuum extraction is required as a co-treatment.

**4.2.6 Ex-situ Biological Treatment Technologies - Soil**

All ex-situ soil treatment technologies require excavation. Because much of the contaminated soil at this site is located within the aquitard beneath the upper water bearing sands and immediately above the confined lower water bearing sands, any excavation activities in the aquitard will require dewatering of the upper and lower water bearing sands or the installation of sheet piles to isolate the area of excavation and prevent groundwater intrusion.

Because the VOCs at this site are a listed waste, all excavated soil containing these VOCs must comply with land disposal restrictions as described in 40 CFR 268.49. In general, this portion of the CFR states that contamination must be decreased by 90% of the amount present when excavated or 10 times the universal treatment standard prior to disposal of the soil at a non-hazardous waste landfill.

***Eliminated***

In general, biological treatments are not effective in treating very high concentrations of VOCs where the contaminants may have a toxic effect on the organisms attempting to degrade the VOCs. Moreover, heterogeneous soil mixtures of plastic clays and medium to coarse grained sands like those found at this site make uniform application of biological treatments difficult.

**Biosorption** removes toxic metals from solution using specially prepared biomass. It was eliminated from further consideration because it does not treat VOCs.

**Fungal biodegradation** uses white rot fungus to degrade and mineralize organic compounds. The technology was designed for conventional explosives and other recalcitrant materials (PCBs, Pesticides, and PAHs). Because this technology is not designed for chlorinated VOC treatment, it was not retained for further consideration.

**Slurry phase biological treatment** mixes soil into an aqueous slurry to improve contact with biological degradation agents. This technology does not work well with high plasticity clays, therefore it was not retained for further consideration.

***Retained***

Similar to the compost piles found in many backyards, **Biopile** technology mixes excavated soil with nutrients, substrate, and/or fillers to enhance anaerobic biological degradation of organic contaminants. Mixed soil is sometimes aerated using blowers or vacuum pumps where volatilization is a primary concentration reduction mechanism or where aerobic degradation environments are preferred.

**Landfarming** differs from biopiles mainly in the intensity of soil of preparation and mixing. In landfarming, soils are placed in lifts generally less than 2 feet thick where they are periodically tilled. Landfarming is not typically as effective in reducing chlorinated VOCs as biopiles, but it is less complex and could provide adequate remediation pending disposal requirements.

#### 4.2.7 Ex-situ Physical/Chemical Treatment Technologies - Soil

As with ex-situ biological treatments, all ex-situ physical/chemical soil treatment technologies require excavation and will require dewatering or installation of sheet piles to prevent groundwater intrusion.

#### *Eliminated*

Because physical/chemical treatments generally rely more heavily on adequate mixing than biological treatments, cohesive soils can seriously inhibit physical/chemical treatment implementation. For this reason, **chemical extraction, chemical oxidation, chemical dehalogenation, and soil washing** were not retained for further consideration.

**Physical separation** is limited by cohesive soils and is also not applicable to absorbed phase VOCs. Therefore, it was removed from further consideration.

**Solidification/stabilization** mixes chemical agents, asphalt, or low permeability materials with contaminated soil in order to limit contaminant mobility. However, high concentrations or free-phase VOCs can limit the ability of this technology to adequately bind contaminants. Therefore, it has been removed from further consideration.

**Supercritical carbon dioxide extraction** employs supercritical carbon dioxide as a solvent to remove normally insoluble organic compounds. The technology was developed to target primarily

PCBs and pesticides, but would also work with lighter hydrocarbons such as PCE and TCE. However, the technology is more complex than other available technologies, may not work well with high plasticity soils, and is not commercially available. Therefore, it was not retained.

#### 4.2.8 Ex Situ Thermal Treatment Technologies - Soil

Like other ex situ technologies, ex situ thermal soil treatment technologies require excavation and will require dewatering or installation of sheet piles to prevent groundwater intrusion.

##### *Eliminated*

**Distillation** removes contaminant vapors using heat or vacuum and then condenses them for recovery and collection. This process is generally used where it is necessary to recover and collect organic contaminants for re-use and/or to decrease the volume of hazardous waste requiring disposal. This technology was not retained because the estimated volume of absorbed and free-phase VOCs in any excavated soil from this site would be less than 10 gallons, which does not warrant the added expense and complexity of using this technology over one that would vent or destroy VOCs.

**High-pressure Oxidation, Hot Gas Decontamination, Incineration/Pyrolysis, and Vitrification** are all high-energy intensive processes that apply more heat and/or energy than other available thermal technologies to treat the concentration and type of VOCs at this site. Therefore, these technologies were not retained.

**Open Burn/Open Detonation** is used in disposing of explosives and other energetic materials. Therefore, it was not retained.

**Solar detoxification** is a process that destroys contaminants by photochemical and thermal reactions using the ultraviolet energy in sunlight. Large mirrors (heliostats) are used to focus sunlight. Reagents such as TiO<sub>2</sub>, hydrogen peroxide, or Fe(III) are sometimes required to act as catalysts for the photochemical reactions. Thermal processes require no fuel and are therefore advantageous where long periods of operation and maintenance are expected. However, this technology is still in the developmental stages, capital costs of constructing the system can be very high, and no local solar detoxification facility was found during this study to which waste soil could be shipped for treatment. Therefore, this technology was not retained.

#### *Retained*

**Thermal desorption** is a commercially available demonstrated technology that heats soil to between 200° and 1,000° F to remove chlorinated VOCs from all types of soil down to concentrations below detection limits. This may be necessary pending land disposal restrictions based on sampling results from excavated soil. Therefore, it was retained for further evaluation.

### **4.3 Technology Screening Results for Groundwater Remediation**

Table 4.2 summarizes the results of groundwater technology screening for AOC 607.

#### **4.3.1 Containment Technologies - Groundwater**

In general, containment technologies were eliminated from further consideration because the groundwater plume does not appear to be migrating offsite and potentiometric maps do not indicate a potential for such migration in the immediate future. Furthermore, containment barrier technologies would alter current groundwater flow paths and could cause the plume to expand into previously non-contaminated areas without aide of hydraulic controls such as groundwater extraction wells. For these and additional reasons specific to each containment technology cited below, no containment technologies were retained for further evaluation.

Table 4.2  
 Groundwater Technology Screening for AOC 607

Technology	Description	Site Constraints	Waste Constraints	Retained
<b>CONTAINMENT TECHNOLOGIES - GROUNDWATER</b>				
Biobarrier	Biobarrier technologies use in situ bacterial growth to reduce the hydraulic conductivity within an aquifer in order to slow or stop plume migration. Microbes and nutrients may require frequent supplementation to maintain low hydraulic conductivity.	The long-term impact of this technology on sites and aquifers is unknown. Aquifer depth, the ability to uniformly deliver nutrients and microbes, and site size could limit this technology.	Containment technologies are typically effective for all types of contaminants. However, this technology requires in situ co-treatment if COC reduction is required.	No. Site and waste constraints - Site hydraulic conductivity is already low and the plume does not appear to be migrating offsite.
Hydraulic Controls	Passive groundwater extraction and/or injection is used to control groundwater flow and prevent contaminant plume migration. Wells or interceptor trenches are typically used to collect groundwater. Wells, drain fields, or spray irrigation can be used to re-inject extracted groundwater. Extracted groundwater may require treatment prior to discharge.	Hydrogeology must be modeled and monitored to ensure plume capture. High hydraulic conductivity or poorly connected aquifers may limit this technology's ability to contain a plume.	Containment technologies are typically effective for all types of contaminants. Hydraulic controls may not be effective in high COC-concentration, low-permeability environments where diffusion can be more significant than advection.	No. Site and waste constraints - Despite hydraulic control via infiltration into a nearby sewer line for at least 6 years, the plume has expanded via diffusion.
Sheet Piling	Sheet pilings are used to form interlocking underground walls to control groundwater flow and/or prevent contaminant plume migration.	Keying the barrier into an aquitard is required to provide adequate containment. In general, the aquitard must be within 40 feet of the ground surface. Utilities and other subsurface obstacles can prevent implementation of this technology. Extensive monitoring is generally required to ensure wall integrity.	Containment technologies are typically effective for all types of contaminants. Corrosive aquifer environments may degrade the sheet piles.	No. Site and waste constraints - The plume is expanding slowly but does not appear to be migrating offsite. Tidally influenced, brackish groundwater may corrode sheet piles over time.
Slurry Wall	Slurry walls are constructed of a low-permeability material such as bentonite slurry and are used to control groundwater flow and/or prevent contaminant plume migration.	Keying the barrier into an aquitard is required to provide adequate containment. In general, the aquitard must be within 40 feet of the ground surface. Utilities and other subsurface obstacles can prevent implementation of this technology. Extensive monitoring is generally required to ensure wall integrity.	Containment technologies are typically effective for all types of contaminants. High concentrations of organic compounds can breach slurry walls via diffusion.	No. Site and waste constraints - The plume is expanding slowly but does not appear to be migrating offsite. Source area concentrations may be able to breach a slurry wall.

Table 4.2  
 Groundwater Technology Screening for AOC 607

Technology	Description	Site Constraints	Waste Constraints	Retained
<b>IN SITU BIOLOGICAL TREATMENT TECHNOLOGIES - GROUNDWATER</b>				
Anaerobic-Aerobic Sequential Bioremediation	Anaerobic-aerobic sequential bioremediation introduces nutrients, substrates, and/or exogenous bacteria into the aquifer to drive reductive biological dechlorination of PCE and TCE to DCE and VC. Aerobic biodegradation via air sparging is used to aerobically degrade DCE and VC to ethene.	This technology is limited by physical, chemical, hydrogeologic, and biological factors. The aquifer should be compatible in terms of nutrients, pH, Eh, DO, conductivity, porosity, and microbes for this technology to be effective. Injection permits are required.	This treatment technology primarily applies to chlorinated VOCs and possibly chlorinated pesticides.	No. Site constraint - Aquifer heterogeneity makes it highly difficult to implement this technology.
Co-Metabolic Treatment	Methane and/or toluene is injected into the contaminated groundwater to support the co-metabolic breakdown of chlorinated VOCs.	With a heterogeneous subsurface it may be difficult to circulate the solution through every portion of the contaminated zone. Co-metabolic treatment may take over 10 years to achieve cleanup goals. Injection permits are required.	This technology has been demonstrated to degrade chlorinated solvents such as vinyl chloride and TCE.	No. Site and waste constraint - Aquifer heterogeneity inhibits cometabolite distribution, injection permits for toluene may be difficult to obtain, and methane is an explosion hazard.
Enhanced Biodegradation	Enhanced biodegradation involves injecting materials into the aquifer to promote microbial growth and accelerate natural processes. Some common additives are hydrogen peroxide, air, oxygen, sugar, and nitrates.	Groundwater geochemistry should be non-toxic to and compatible with microbial amendments. Treatment may take over 10 years to achieve cleanup goals.  Oxygen enhancement could be limited by the potential for iron and microbial fouling due to the addition of oxygen and increase in pH. The ability to rectify fouling, should it occur, must be considered. Injection permits are required.	This technology primarily applies to organic compounds.	Yes.

**Table 4.2**  
**Groundwater Technology Screening for AOC 607**

Technology	Description	Site Constraints	Waste Constraints	Retained
Natural Attenuation	Natural attenuation involves documentation and modeling of natural subsurface processes such as dilution, volatilization, biodegradation, adsorption, and chemical reactions with subsurface materials to reduce contaminants to acceptable concentrations. Site conditions are managed to protect human health and the environment.	Protection of potentially impacted receptors such as drinking wells or bodies of water should be demonstrated through modeling and monitoring. Cleanup times can last over 30 years.	Non-aqueous phase liquids and/or high concentrations limit the effectiveness of natural attenuation.	Yes.
Phyto-remediation	Phytoremediation refers to all biological, chemical, and physical processes that are influenced by plants that assist in the cleanup of contaminated substances.  Phytoremediation for water includes three processes: rhizofiltration, phytotransformation, and phytostimulation. In addition, groundwater migration can be affected through the use of deep-rooted trees such as poplars to capture groundwater and retard contaminant migration.	Climatic or hydrologic conditions may restrict the rate of growth of the remediation plants. Adequate space is required to grow and treat waste onsite. Phytoremediation requires more time than most technologies, and therefore may not be appropriate when an immediate response is required. The technology is depth limited.	High concentrations of hazardous materials can be toxic to plants. Phytoremediation is believed to be capable of treating a wide range of contaminants, from organics to metals.	No. Site constraint - Aquifer depths are too deep for this technology to be effective.
<b>IN SITU CHEMICAL AND PHYSICAL TREATMENT TECHNOLOGIES - GROUNDWATER</b>				
Air Sparging	Air is injected into the aquifer to strip contaminants from the water through volatilization. Air sparging is usually operated in conjunction with an SVE system to capture gases stripped from the water. Gases may require treatment before being released into the atmosphere.	Air sparging is less effective in low-permeability soil, creating preferential pathways. The water table should be deeper than 5 feet below ground surface.	Air sparging is primarily used to strip VOCs in groundwater. This technology is not effective for inorganics.	Yes.
Blast Fracturing	The technique involves controlled use of explosives to create localized areas of highly fractured rubble (a "fracture trench"). Groundwater can then be extracted from the fracture trench at higher rates, and with greater effectiveness, by recovery wells. Extracted contaminated groundwater is then treated.	Subsurface structures such as buried water mains or pipelines, overburden thickness, and buildings may limit the use of blast fracturing technology.	Blast fracturing has no waste constraints since it does not treat or destroy contaminants.	No. Site constraint - This technology is not efficient in plastic clays and could likely damage existing area infrastructure.

Table 4.2  
 Groundwater Technology Screening for AOC 607

Technology	Description	Site Constraints	Waste Constraints	Retained
Chemical Flushing	Chemical flushing enhances recovery of contaminated groundwater by injecting a cosolvent (e.g., ethanol, methanol, and isopropanol) or a surfactant into a contaminated area. The cosolvent causes both an increase in aqueous contaminant solubility and a decrease in the NAPL-water interfacial tension. Surfactants can increase the mobility and solubility of otherwise hydrophobic contaminants.	Injection is limited by soil permeability and permits will be required. This technology should not be used at sites where migration of mobilized contaminants would increase the threat to human health or the environment.	Mobilization of NAPL may worsen the extent of site contamination. In the case of DNAPL, any lowering of interfacial tension has the potential to vertically remobilize contaminants. Research has shown that an organic cosolvent can also accelerate the movement of metals through an aquifer matrix.	No. Site constraint - This technology may cause substantial COC migration into the clay aquitard below the upper water bearing sands thereby making COC recovery much more difficult.
Chemical Oxidation	Hydrogen peroxide, potassium permanganate, or other oxidizing agent is injected into the aquifer to oxidize and transform contaminants into nonhazardous end products.	Subsurface heterogeneity, low-permeability, or poorly sorted contaminant distributions limit the effectiveness of this technology. Injection permits will be required.	This technology is limited to organic compounds.	Yes.
Dual Phase Vacuum Extraction	Dual phase extraction accelerates site remediation by simultaneously extracting contaminated liquid and soil vapor from the subsurface. Dual phase extraction is generally combined with bioremediation, air sparging, or bioventing when the target contaminants include long-chain hydrocarbons. Bioslurping, two-phase vacuum extraction, dual vacuum extraction, and vacuum-enhanced extraction are examples of dual phase extraction.	Dual phase extraction is most effective in fine-to-medium textured soil or fractured rock in areas with a low water table.	Dual phase extraction cannot remediate heavy chlorinated compounds, pesticides, or heavy hydrocarbons including PCBs, dioxin, fuel oil No. 6, or metals (with the possible exception of mercury) without the aid of other technologies to decrease the viscosity and/or solubility of the target COC.	Yes.
Electrokinetic Remediation	Electrokinetic remediation is done using a low-intensity direct electrical current applied across electrode pairs implanted in the ground on each side of the contaminated zone. The electrical current causes electro-osmosis and ion migration. Contaminants in the aqueous phase move toward respective electrodes depending on their charge. The contaminants may then be extracted and directed to a recovery system or deposited at the electrode.	The presence of buried metallic conductors, chemical reactions with naturally occurring contaminants, and pH and reduction-oxidation changes induced by the process electrode reactions can reduce this technology's effectiveness. Very low permeabilities can also hinder process effectiveness.	Electrokinetic remediation is an in situ treatment for groundwater contaminated with heavy metals, radionuclides, and organics. Removal of nonpolar compounds such as hexachlorobutadiene is possible only if aqueous surfactant solutions are used.	No. Site constraint - Subsurface heterogeneity and buried utility lines would significantly reduce this technology's effectiveness.

**Table 4.2**  
**Groundwater Technology Screening for AOC 607**

Technology	Description	Site Constraints	Waste Constraints	Retained
Horizontal Wells	Horizontal drilling can be used instead of vertical wells to access contaminated materials and minimize the number of wells needed. Horizontal wells allow for recovery where overlying access is limited and well surface area is maximized.	Both horizontal and vertical wells are limited in low-transmissivity zones. Horizontal wells are at a geometric disadvantage in areas where the contaminated zones cover a very small area or are vertically oriented.	Horizontal drilling is not applicable to LNAPL extraction in areas with high water table fluctuations.	Yes.
In-Well Aeration	In-well aeration circulates water in a dual-screened well to aerate it for contaminant stripping and/or bioremediation. Wells are typically installed in the highest contaminated area for in situ bulk-contaminant treatment. Off-gas is collected from the well and typically treated before discharge.	Low-permeability soil limits in-well aeration's zone of influence and ability to circulate groundwater. Groundwater geochemistry should also be evaluated for potential fouling. The presence of nearby receptors that require immediate protection may inhibit the use of this in situ treatment.	In-well aeration is used primarily for VOCs and possibly SVOCs.	No. Site constraint - This technology is not effective in low-permeability soils.
Passive Treatment/Reactive Walls	Passive treatment walls are installed, usually in trenches, across the flow path of a contaminant plume. The treatment walls are constructed of a permeable material that reacts with or acts as a catalyst, such as iron filings. Contaminant reactions involve transforming the contaminants into a less toxic or less mobile form.	Keying the barrier into a low-permeability layer may be required to provide adequate containment. The aquitard must be within 40 feet of the ground surface. Utilities and other subsurface obstacles limit this technology. Groundwater geochemistry should be evaluated to avoid fouling problems.	Walls are potentially available for a wide range of contaminants, but are used primarily for chlorinated VOCs.	No. Site constraint - There is not a well defined flow gradient or plume migration path which could be used to design placement of a passive flow through system.
<b>IN SITU THERMAL TREATMENT TECHNOLOGIES - GROUNDWATER</b>				
Electrical Resistance Heating	Electrical current is applied to the water table to heat groundwater to temperatures up to the boiling point of water. The increased temperature improves volatilization, recovery, and long-term in situ degradation of organic compounds. In situ vapor extraction is required as a co-treatment technology.	This technology is very effective for small areas of very high VOC concentration. However, compared to other technologies, this technology can become very expensive when applied over areas greater than 1 acre. The technology is most effective in saturated or high moisture content silt and clay soils.	This technology addresses primarily organic contamination. However, some metals can be reduced to less toxic states [e.g. Cr(VI) to Cr(III)].	Yes.

**Table 4.2**  
**Groundwater Technology Screening for AOC 607**

Technology	Description	Site Constraints	Waste Constraints	Retained
Steam Stripping	Steam generated above or below ground is used to heat the subsurface to improve volatilization, mobility, recovery, and long-term in situ degradation of organic compounds. In situ vapor extraction is required as a co-treatment technology.	The technology is most effective in low moisture content or dewatered sandy soils. Injection permit is required.	This technology addresses primarily organic contamination. However, some metals can be reduced to less toxic states [e.g. Cr(VI) to Cr(III)].	Yes.
Hot Water Injection	Hot water is generated above ground and injected into the subsurface to improve mobility, recovery, and long-term in situ degradation of organic compounds. Groundwater extraction is required as a co-treatment technology.	The technology is most effective in sandy soils. It is more effective than steam below the water table. Injection permit is required.	This technology addresses primarily organic contamination. However, some metals can be reduced to less toxic states [e.g. Cr(VI) to Cr(III)].	Yes.
<b>EX SITU BIOLOGICAL TREATMENT TECHNOLOGIES - GROUNDWATER</b>				
Bioreactors	The bioreactor contains attached or suspended biological systems and vary in size from small kettle-like containers to lagoons. In suspended growth systems, such as activated sludge, contaminated groundwater circulates in an aeration basin, where a microbial population aerobically degrades organic matter. In attached growth systems, such as trickling filters, microorganisms are established on an inert support matrix to aerobically degrade groundwater contaminants.	Space may limit implementation of lagoons. Wastewater treatment and water discharge permits are required.	This technology is limited to organics.	No. Waste constraint - This technology is not well suited to treating very low to very high COC concentration variability expected in extracted groundwater at this site.
Biosorption	Biosorption is the sorptive removal of toxic metals and radionuclides from solution by specially prepared biomass. Many microorganisms, including certain strains of bacteria, yeasts, filamentous fungi, algae, and plant cells, can accumulate metallic cations from the environment via biosorption.	The binding capacity of biomass may be significantly decreased by low pH (below 3.5), competition between cation species, metal sequestration with organic molecules in solution, and/or the physical form of the biosorbent matrix. Wastewater treatment and water discharge permits are required.	This technology is being tested for treatment of heavy metals and radionuclides.	No. Waste constraint - This technology is more applicable for metals than VOCs found at this site.

Table 4.2  
 Groundwater Technology Screening for AOC 607

Technology	Description	Site Constraints	Waste Constraints	Retained
Constructed Wetlands	Natural geochemical and biological processes inherent in a wetland ecosystem are used to accumulate and remove contaminants from extracted groundwater. The artificial wetland may use filtration as well as degradation to treat contaminants.	Constructed wetlands require large areas (1 or more acres) and must be adjusted to account for site geology, terrain, and climate. Wastewater treatment and water discharge permits are required.	Constructed wetlands have been used to treat organics, nutrients, and metals.	No. Site constraint - Area re-use and space limitations prohibit construction of a wetland treatment system.
Spray Irrigation	Groundwater is sprayed over land for treatment using biological, physical, and natural processes. This technology is also known as land application.	A large area of open land is required to apply groundwater. The spray area should have limited or no human activity. Wastewater treatment and water discharge permits are required.	Some waste may be considered too toxic for land application.	No. Site constraint - Area re-use and space limitations prohibit spray irrigation.
<b>EX SITU CHEMICAL AND PHYSICAL TREATMENT TECHNOLOGIES - GROUNDWATER</b>				
Air Stripping	Volatile organics are partitioned from water by greatly increasing the surface area exposed to air. Types of aeration methods include packed towers, diffused aeration, tray aeration, and spray aeration.	A minimum of about 12' x 12' is required to install a system. Noise reduction equipment may be required. Wastewater treatment, water discharge, and air discharge permits are required.	Air stripping is limited to VOCs.	Yes.
Carbon Adsorption	Carbon adsorption treats extracted groundwater by pumping it through canisters containing activated carbon. The dissolved contaminants adsorb to the carbon.	A minimum of about 12' x 12' is required to install a system. Wastewater treatment and water discharge permits are required.	This technology is primarily used for organic contaminant treatment.	Yes.
Coagulation/Pre-cipitation and Solids Separation	Chemicals are added to extracted groundwater to form insoluble, agglomerated solids, with separation by settling or mechanical filtration.	A large building area is generally required to install a system. Wastewater treatment and water discharge permits are required.	Metals and organics can be removed with this technology.	No. Waste constraint - This technology would produce an additional solid waste stream and is not as efficient as other technologies available for above ground treatment of VOCs.

Table 4.2  
 Groundwater Technology Screening for AOC 607

Technology	Description	Site Constraints	Waste Constraints	Retained
Distillation	Distillation is a chemical separation process using vaporization and condensation to separate components of varying vapor pressures.	Space is required to install a system. Wastewater treatment and water discharge permits are required.	Distillation is used to separate organic components.	No. Waste constraint - The low volume of distillable compounds does not warrant the use of this technology.
Evaporation	Evaporation is the physical separation of water from dissolved solids. Evaporation units are operated either at atmospheric pressure or under vacuum.	Large ponds are required for non-vacuum systems. Wastewater treatment and water discharge permits required.	Evaporation is used primarily to treat inorganic-contaminated waste streams.	No. Waste constraint - This technology is more applicable for metals than VOCs found at this site.
Ion Exchange	Ion exchange removes ions from groundwater by exchanging cations or anions between the contaminants and exchange resins. After their sorption capacity is reached, resins can be regenerated for reuse.	Oxidants in groundwater may damage the resin. Wastewater treatment and water discharge permits are required.	Ion exchange can remove dissolved metals and radionuclides from aqueous solutions. Other compounds that have been treated include nitrate, ammonia, nitrogen, and silicate.	No. Waste constraint - This technology is more applicable for metals than VOCs found at this site.
Modified Natural Clay Adsorption	Naturally occurring clays measuring less than 2 micrometers ( $\mu\text{m}$ ) in diameter are chemically modified to produce a hydrophobic material. The modification process entails mixing the clay with a quaternary amine, isopropyl alcohol, and water to adsorb organic contaminants.  Pretreatment applications include remediation of gasoline spills, mixed solvents and coal gasification wastes. In post-treatment applications, the technology often follows oil-water separators, ultrafiltration units, or biotreatment units to assure discharge quality.	Space onsite must be available. Wastewater treatment and water discharge permits are required.	This technology can only treat organics with low water solubility such as PCBs, pentachlorophenol, or pesticides.	No. Waste constraint - This technology is more applicable for lower solubility organic compounds than the VOCs found at this site.

Table 4.2  
 Groundwater Technology Screening for AOC 607

Technology	Description	Site Constraints	Waste Constraints	Retained
Reverse Osmosis	Clean water is separated from contaminants through membranes under pressure. Water will pass through the membrane walls, but contaminants will not.	Space onsite must be available. Wastewater treatment and water discharge permits are required.	This technology is used to remove organics and inorganics from waste streams.	No. Waste constraint - This technology is more applicable for metals than VOCs found at this site.
Ultrafiltration	Ultrafiltration is a separation technology based on particle size. Contaminants are separated by forcing the fluid through a semipermeable filters. Only particles smaller than the filter openings can flow through.	Space onsite must be available. Wastewater treatment and water discharge permits are required.	This technology is used primarily to remove inorganics from waste streams, but can also be used to remove some organics.	No. Waste constraint - This technology is more applicable for metals than VOCs found at this site.
UV Oxidation	UV oxidation is a destruction process that oxidizes organic contaminants in groundwater using UV light. Hydrogen peroxide is sometimes used as a catalyst.	The UV light must be transmitted to the contaminants. Groundwater with high turbidity, insoluble oil or grease may require pretreatment. Wastewater treatment and water discharge are permits required.	This technology is appropriate for organic contaminants.	Yes.

**DISPOSAL OPTIONS AND PERMITTING REQUIREMENTS**

POTW Discharge Agreement	POTW use agreements are needed to discharge to local sanitary sewer. The North Charleston Sewer District issues sewer use agreements.	The treatment system must be piped to a nearby sanitary sewer line or drop inlet in a way as to not interfere with traffic flow.	In general, a limit of 1 mg/L can be expected on all VOC discharges. Other water quality requirements may also be imposed.	Yes.
NPDES Discharge Permit	NPDES permits are needed to discharge to a surface water body or storm sewer.	The treatment system must be piped to a nearby surface water body storm sewer line or drop inlet in a way as to not interfere with traffic flow.	In general, MCLs can be expected limits for NPDES discharges.	No. Site constraint. The need for an NPDES permit is not likely due to the proximity of the site to a sanitary sewer line.

Table 4.2  
 Groundwater Technology Screening for AOC 607

Technology	Description	Site Constraints	Waste Constraints	Retained
Injection or re-injection	Injection permits are needed to inject or re-inject anything into the aquifer. Injection permits can be obtained from SCDHEC.	Injection or re-injection is limited by low-permeability soils or shallow vadose zones.	In general, MCLs can be expected limits for injection or re-injection.	No. Site constraint. Low-permeability and a shallow vadose zone prohibit injection at this site.
Collection and Offsite Disposal	Groundwater can be collected onsite in large ASTs for transport to an approved offsite disposal or treatment facility.	Long-term collection onsite may trigger hazardous waste accumulation restrictions.	Offsite disposal facilities can typically be found to accept any non-radioactive hazardous waste. Volumes in excess of 5,000 gallons usually make this option cost prohibitive.	No. Waste constraint. Long-term operation of any extraction system would likely accumulate greater than 3,000 gallons per day and 100,000 gallons per month.
Air Discharge	Air discharge permits or exemptions are needed to operate an air stripping or other treatment resulting in emissions of VOCs. Air permits and exemptions can be obtained from SCDHEC.	Emissions must be discharged at a safe height and out of doors to allow adequate dispersion and protect the breathing zone.	In general, exemptions can be obtained for discharges of less than 1,000 lbs. per month.	Yes.
Wastewater Treatment Construction (WWTC) Permit	WWTC permits are required to construct and operate any above ground groundwater treatment or amendment system. Permits can be obtained from SCDHEC.	Treatment system layout and process flow diagram must be submitted to SCDHEC.	None.	Yes.

**Biobarriers** use nutrients and substrate to enhance in situ bacterial growth in order to clog and reduce the conductivity of the contaminated aquifer zone. Because site hydraulic conductivity is already low, and the plume is not currently migrating offsite, this technology was not retained for further evaluation.

**Hydraulic controls** use groundwater extraction and/or injection to control groundwater flow (advection) in effort to prevent plume migration. However, the nearby sewer line has been acting as a hydraulic control for at least the past 6 years, and the plume has still expanded. This indicates that diffusion, rather than advection, is a the more dominant process in the aquifer. This is not unusual in low permeability environments like the one at this site. Therefore, this technology was not retained for further evaluation.

**Sheet pilings** are steel piles used to form an interlocking subsurface barrier capable of preventing groundwater migration. In some cases, sheet pilings have been used to completely encircle a plume in order to prevent its migration. Sheet piles are also required to provide shoring when excavating below the water table. However, in a tidally influenced, brackish environment like the one at this site, sheet piles can corrode over long periods of time. Therefore, while sheet piles will be retained as part of evaluating soil excavation alternatives, it will not be retained as part of groundwater technology evaluations.

**Slurry walls** are subsurface barriers constructed of low permeability material capable of preventing groundwater migration. While slurry walls do not corrode like sheet piles, their in situ construction can leave gaps in the wall which are hard to confirm or refute. Moreover, very high concentrations of VOCs can diffuse through a slurry wall over time. Therefore, slurry walls were not retained for further evaluation.

#### 4.3.2 In situ Biological Treatment Technologies - Groundwater

In general, in situ biological treatments are not effective where COCs exist in concentrations toxic to microorganisms. Such toxic concentrations exist at AOC 607. However, in situ biological treatments may be effective as part of a polishing step following another technology better suited to addressing high concentrations but not as efficient in addressing low concentrations.

##### *Eliminated*

**Anaerobic-aerobic (AA) sequential bioremediation** is a bioenhancement technology that uses nutrients, substrate, and oxygen to form sequential zones of anaerobic and aerobic conditions. These conditions are ideal for anaerobically reducing PCE to TCE to DCE and then aerobically reducing DCE to Vinyl Chloride to Ethene. However, this technology relies heavily on controlling the direction of flow to ensure the anaerobically reduced materials flow through the aerobic zone. Because aquifer heterogeneity at this site makes controlling flow very difficult and apt for failure, this technology was not retained for further consideration.

**Phytoremediation** uses plants to absorb and detoxify contaminants. This technology is limited to the root zone of the plants used. Because groundwater contamination at this site is greater than 17 feet in some areas, this technology was not retained for further evaluation.

In **Co-metabolic Treatment**, methane and/or toluene is injected into the contaminated groundwater to support the co-metabolic breakdown of chlorinated VOCs. However, heterogeneous soils make it difficult to circulate the solution through every portion of the contaminated zone, methane is an explosion hazard, and it would likely be difficult to obtain injection permits for toluene. Therefore, this technology was not retained for further consideration.

***Retained***

**Enhanced biodegradation** uses injected materials such as air, nutrients, primary substrates, or co-metabolites to stimulate natural degradation of contaminants within the aquifer. Unlike AA sequencing, this technology does not rely on flow into separate zones. Rather, injectate is generally applied in a grid covering the entire zone targeted for remediation. In this manner, many of the problems associated with aquifer heterogeneity can be overcome. Applications can be scheduled at different intervals using different injectate if both anaerobic and aerobic environments are required, and this technology is generally capable of reducing medium to low concentrations of VOCs to below clean up goals. Therefore, this technology was retained for further evaluation.

**Natural attenuation** relies on natural processes to reduce contamination to below clean up goals. This technology involves extensive monitoring of site conditions to assess whether and how well natural processes are proceeding towards clean up goals. This technology can be applied alone or as a polishing step accompanying more aggressive technologies. It is capable of reducing VOCs to concentrations below detection limits. Therefore, it was retained for further evaluation.

**4.3.3 In situ Chemical, Physical, and Thermal Treatment Technologies - Groundwater**

Chemical, physical, and thermal treatment technologies are capable of addressing a wide range of contaminant concentrations, however most are best suited for reducing high concentrations to a level somewhere in excess of MCLs. This is due to long term diffusion of COCs adsorbed to soil within the aquifer. Therefore, in situ biodegradation is often required as a follow-up to physicochemical treatments in order to achieve treatment goals.

***Eliminated***

**Blast fracturing** uses explosives to improve groundwater flow through an aquifer and is used in conjunction with groundwater extraction technologies. Because this technology does not work well in plastic clays, could damage local infrastructure, and may leave residual hazardous explosive compounds in the aquifer, it was not retained for further evaluation.

**Chemical flushing** uses cosolvents to improve the mobility and solubility of VOCs to enhance their recovery using other groundwater extraction technologies. Because this technology does not work well in clay and could mobilize contaminants into previously uncontaminated areas, it was not retained for further evaluation.

**Electrokinetic remediation** uses low intensity electric fields to move contaminants into a more centralized area where they can then be extracted using other groundwater extraction technologies. This technology works best with metals and radionuclides, but can be used to some extent with organic compounds. However, this technology does not work well in heterogeneous soils or in close proximity with buried utilities. Because both these inhibiting factors are present at this site, this technology was not retained for further evaluation.

**In-well aeration** circulates and aerates water within a dual-screened well in attempt to create a circulation current and treat the water in the surrounding aquifer zone. These wells have shown moderate success in homogeneous sands, but do not work well in heterogeneous finer grained environments. Therefore, this technology was not retained for further evaluation.

**Passive Treatment/Reactive Walls** use reactive material (Fe(III) for example) placed within a subsurface flow-through wall to treat contaminants within the aquifer. This technology requires a well defined gradient or groundwater flow direction in order to be placed where it can intercept the groundwater plume. Moreover, relatively high groundwater flow rates are required in order

to meet clean up goals in a reasonable time frame, although hydraulic controls can be installed to increase groundwater flow rates. These walls may also require replacement prior to attaining clean up goals based on the amount of reactive material needed to completely reduce all the contaminant mass in the plume, or if fouling due to reaction with natural substances reduces the effectiveness of the reactive wall. Because groundwater flow at this site is complex, and naturally occurring chemicals within the aquifer.

**In-situ chemical oxidation (ISO)** injects hydrogen peroxide, potassium permanganate, or other oxidant to break down chlorinated VOCs in-situ. Because oxidation requires contact between the oxidants and the CVOCs, complex hydrogeology can result in extensive untreated pockets of contamination. Oxidizing agents can also be depleted by non-target natural organic compounds or dissolved iron. Moreover, an accurate estimate of the mass of oxidizing agent requires an accurate estimate of the mass of contaminant.

While this technology could be effective in treating the more homogeneous lower water bearing zone, it would be difficult to apply at this site because:

- The upper water bearing zone is very heterogeneous.
- Aquifer testing and plume mapping indicate that poorly defined preferential flow pathways exist at the site.

- The original source and volume of contamination is not known, so estimating the mass present at the site would need to be based on observed dissolved phase concentrations in monitoring wells which do not take into account the likely presence of scattered areas of DNAPL.
- Of 42 ISO case studies reviewed in a DOD survey (DOD, 1999), about 2 in 3 site results found that the technology failed to meet expectations, and very little data was available to judge the potential at "successful" sites for long-term rebounding of in groundwater concentrations from residual pockets of DNAPL missed by the oxidant application.

*Retained*

**Air sparging** injects air into the aquifer to encourage in situ stripping of VOCs. Some aerobic biological reduction activity may also be enhanced. Vapor extraction technology is required as a co-treatment.

**Dual phase vacuum extraction** uses high vacuum pumps to extract both water and soil vapor from the subsurface simultaneously. Extraction well type and spacing can be designed to account for low soil permeabilities.

**Horizontal wells** are used in lieu of vertical wells where access to the subsurface is limited by building areas or where extraction or injection is designed to extract fluids or vapors from large areas which are relatively thin in depth.

**Electrical resistance heating** is used in low permeability, high moisture content or saturated soils to raise soil and groundwater temperatures to near or above the boiling point of water. **Steam stripping** uses steam generated above or below ground in drier, high permeability soils to improve

volatilization of VOCs. **Hot water injection** is used in high permeability, saturated soils to improve mobility of VOCs and NAPLs. The temperature increase results in volatilization of VOCs in the treatment zone which can be collected by a vapor extraction system. Secondary effects include increased long-term biodegradation due to residual heat once the system is shut down. In situ vapor extraction is required as co-treatment for all 3 technologies.

#### 4.3.4 Ex-Situ Biological Treatment Technologies

Like in situ biological methods, these technologies are not well suited to treating high concentrations of VOCs. Because physical methods such as air stripping are proven efficient means of achieving discharge requirements where treatment of high concentrations of VOCs is required, ex-situ biological treatment systems were generally eliminated from further consideration. Additional technology-specific reasons for elimination are given in Table 4-2.

#### 4.3.5 Ex-situ Physicochemical Treatment Technologies

Ex-situ physicochemical technologies include some of the most reliable technologies for removing VOCs from groundwater. Based on the anticipated waste stream characteristics, a technology from this group of systems typically can be selected and designed to economically achieve discharge requirements for any extracted groundwater. For the high concentrations of VOCs and low flow rates expected, three technologies - **air stripping, carbon adsorption, and UV oxidation** - were retained for further evaluation. In general, technologies not retained in this group were excluded due to their inapplicability to treating VOCs.

**4.4 Disposal Options and Permitting Requirements**

Disposal options and permitting requirements are summarized in Table 4.2. Three options - **NPDES discharge, Re-injection, and Onsite collection for offsite disposal** - have not been retained for further evaluation in this CMS based on the reasons cited in the table. Specific requirements for the different options and permits retained - **POTW discharge, Air Discharge, and Waste Water Treatment System Construction** - will need to be negotiated with SCDHEC once a remedial alternative is selected and approved.

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## **5.0 DEVELOPMENT AND EVALUATION OF ALTERNATIVES**

The purpose of the detailed analysis of alternatives is to provide decision makers with adequate information to select an appropriate site remedy. During the detailed analysis, each alternative is assessed against the evaluation criteria described in the Office of Solid Waste and Emergency Response (OSWER) Directive Number 9902.3-2A. Assessment results are then arrayed to compare the alternatives and identify key tradeoffs among them.

### **5.1 Evaluation Process**

The evaluation process is designed to provide decision-makers with sufficient information to compare the alternatives, select an appropriate remedy for a site, and satisfy RCRA requirements for selecting the remedial action.

#### **Primary Criteria**

Four evaluation criteria have been developed to address the RCRA requirements and considerations and their additional technical and policy considerations. The evaluation criteria with the associated statutory considerations that must be met are:

- Primary Criterion 1 — Protection of human health and the environment
- Primary Criterion 2 — Attainment of cleanup standards
- Primary Criterion 3 — Source control
- Primary Criterion 4 — Compliance with applicable waste management standards

#### **Secondary Criteria**

The alternatives are scored on their abilities to meet the four primary criteria as well as five secondary criteria. These secondary criteria can help rank remedial alternatives that have met all of the primary criteria.

- Secondary Criterion 1 — Long-term reliability and effectiveness 1
- Secondary Criterion 2 — Reduction of toxicity, mobility, or volume 2
- Secondary Criterion 3 — Short-term effectiveness 3
- Secondary Criterion 4 — Implementability 4
- Secondary Criterion 5 — Cost 5

### **5.1.1 Protection of Human Health and the Environment** 7

Corrective action remedies must be protective of human health and the environment, and 8  
evaluation of this criterion provides a final measure to assess whether each alternative is eligible 9  
for selection. The overall assessment of protection draws on assessments conducted under other 10  
evaluation criteria, especially long-term reliability and effectiveness, short-term effectiveness, and 11  
compliance with applicable waste management standards. 12

Evaluation of overall protectiveness should gauge whether an alternative eliminates, reduces, or 14  
controls the risks and hazards posed by each pathway through treatment, engineering, or 15  
institutional controls. This evaluation considers whether an alternative poses any unacceptable 16  
short-term or cross-media impacts. 17

### **5.1.2 Attainment of Cleanup Standards** 19

Remedies must attain media cleanup standards set by the implementing agency, which may be 20  
derived from existing state or federal regulations (e.g., groundwater standards) or other standards. 21  
In some cases, certain technical aspects of the remedy, such as the practical capabilities of 22  
remedial technologies, may influence to some degree the media cleanup standards that are 23  
established. 24

### **5.1.3 Source Control**

A critical objective of any remedy must be to stop further environmental degradation by controlling or eliminating further releases that may threaten human health and the environment. Unless source control measures are taken, efforts to clean up releases may be ineffective or, at best, will essentially involve a perpetual effort. Therefore, an effective source control program is essential to ensure the long-term effectiveness and protectiveness of the corrective action program.

The source control standard is not intended to mandate a specific remedy or class of remedies. Instead, the CMS will examine a wide range of options. This standard should not be interpreted to preclude equal consideration of using other protective remedies to control the source, such as partial waste removal, capping, slurry walls, in situ treatment/stabilization, and consolidation.

This CMS report will also evaluate whether source control measures are necessary, and if so, what actions would be appropriate. For any proposed source control measure, estimated effectiveness will be discussed based onsite conditions and the history of the specific technology.

### **5.1.4 Compliance with Applicable Waste Management Standards**

To be eligible for selection, each alternative must satisfy this criterion which is used to evaluate whether the alternative will meet federal and state waste management standards identified in previous stages of the remedial process.

### **5.1.5 Long-Term Reliability and Effectiveness**

This criterion evaluates the results of a remedial action in terms of the risk and hazard remaining at the site after response objectives have been met. The primary focus is the extent and effectiveness of controls that may be required to manage the risk posed by treatment residuals and/or untreated wastes. The following should be addressed for each alternative:

- **Magnitude of Residual Risk and Hazard:** This factor assesses the residual risk and hazard from untreated waste or treatment residuals at the conclusion of remedial activities. This risk or hazard may be measured by numerical standards such as cancer risk levels, noncancer hazard levels, or the volume or concentration of constituents in waste, media, or treatment residuals remaining onsite.
- **Adequacy and Reliability of Controls:** This factor assesses the adequacy and suitability of any controls used to manage treatment residuals or untreated wastes remaining onsite. It may include an assessment of containment systems and institutional controls to determine if they are sufficient to protect human and environmental receptors from significant exposure.

#### 5.1.6 Reduction of Toxicity, Mobility, or Volume

This criterion addresses the preference for remedial actions using treatment technologies that permanently and significantly reduce the toxicity, mobility, or volume of hazardous substances.

The evaluation should consider the following specific factors:

- Treatment processes, the remedies they will employ, and the materials they will treat.
- Amount of hazardous materials that will be destroyed or treated, including how principal threat(s) will be addressed.
- Degree of expected reduction in toxicity, mobility, or volume, measured as a percentage of reduction (or order of magnitude), when possible.
- Degree to which the treatment will be irreversible.
- Type and quantity of treatment residuals that will remain following treatment.

**5.1.7 Short-Term Effectiveness**

The short-term effectiveness of a remedial alternative is evaluated according to its effect on human health and the environment during implementation of the remedy. Short-term effectiveness is based on four key factors:

- Risks to the community during implementation.
- Risks to workers during implementation.
- Potential for adverse environmental impact as a result of implementation.
- Time until remedial response objectives are achieved.

**5.1.8 Implementability**

This criterion addresses the technical and administrative feasibility of implementing an alternative and the availability of various services and materials required to do so. It involves analysis of the following factors:

**Technical Feasibility**

- Technical difficulties and unknowns associated with construction and operation.
- Potential technical problems during implementation that may lead to schedule delays.
- Ease of using remedial action based on technology performance.
- Feasibility of monitoring the remedy's effectiveness, including an evaluation of exposure risks if monitoring is insufficient to detect a system failure.

**Administrative Feasibility**

Activities needed to coordinate with other offices and agencies.

**Availability of Services and Materials**

- Availability of adequate offsite treatment, storage capacity, and disposal services.

- Availability of necessary equipment and specialists, and provisions to ensure any necessary additional resources. 1  
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- Availability of services and materials, plus the potential to obtain competitive bids, which may be particularly important for innovative technologies. 3  
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- Availability of prospective technologies. 5  
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### 5.1.9 Cost 7

Detailed cost estimates for each remedial alternative are based on engineering analyses, service and equipment suppliers' estimates, and costs for similar actions at other environmental corrective actionsites. The cost estimate for a remedial alternative typically consists of four principal elements: capital cost, annual operation and maintenance (O&M) costs, costs for evaluation reports, and present-worth analysis. Costs are expressed in 1999 dollars. 8  
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#### Capital Costs 13 14

- *Direct costs* for equipment, labor, and materials used to develop, construct, and implement a remedial action. 15  
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- *Indirect costs* for engineering, financial, and other services that are not actually part of construction, but are required to implement a remedial alternative. The percentage applied to the direct cost varies with the degree of difficulty associated with construction and/or implementation of the alternative. In this CMS, the indirect costs include health and safety items, permitting and legal fees, bid and scope contingencies, engineering design and services, and miscellaneous supplies or costs. 17  
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#### Annual O&M Costs 23 24

O&M costs refer to post-construction costs necessary to ensure the continued effectiveness of a remedial action. They typically refer to long-term power and material costs (such as the 25  
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operational cost of a water treatment facility), equipment replacement costs, and long-term monitoring costs. 1  
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### Evaluation Reports 3

These costs are associated with reports prepared to evaluate the results of the selected alternative. 4  
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### Present-Worth Analysis 7

This analysis makes it possible to compare remedial alternatives on the basis of a single comprehensive cost representing a sufficient amount to cover all costs associated with the remedial action during its planned life, if invested in the base year and disbursed as needed. A performance period appropriate to each alternative is assumed for present-worth analyses. Present-worth calculations were completed using a geometric series (P/A, i, j, n) with an interest rate (i) of 7%, an inflation rate (j) of 3%, and a period (n) of 30 years. An increase in the interest rate or decrease in the inflation rate decreases the present-worth of the alternative. 8  
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Specific cost elements are summarized in the cost analysis section for each remedial alternative. Study estimate costs are intended to reflect actual costs with an accuracy of minus 30% to plus 50%, in accordance with USEPA guidelines. 16  
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## 5.2 Development and Evaluation of Remedial Alternatives 20

With the exception of Alternative 1, the following alternatives have been developed from the technologies retained from the screening described in Section 4: 21  
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- Alternative 1: No Further Remedial Action 23
- Alternative 2: Long-Term Monitored Natural Attenuation (MNA) with Carbon-Enhanced Biodegradation 24  
25
- Alternative 3: Soil and Source Area Excavation with Offsite Treatment and Disposal with MNA and Carbon-enhanced Biodegradation 26  
27

- Alternative 4: In Situ Dual-phase Vacuum Extraction and MNA with Enhanced Biodegradation 1  
2
- Alternative 5: In Situ Integrated Thermal Treatment, Dual-phase Vacuum Extraction, and MNA with Enhanced Biodegradation 3  
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### 5.2.1 Alternative 1: No Further Remedial Action 6

No remedial actions would be taken to monitor, contain, remove, or treat soil and groundwater contamination at this site. 7  
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#### *Primary Criteria* 10

##### **Protection of Human Health and the Environment** 11

No further remedial action provides no additional protection of human health and the environment. 12  
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##### **Attainment of Cleanup Standards** 14

No further action would not attain cleanup standards. Groundwater VOC concentrations orders of magnitude greater than MCLs would remain in place. 15  
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##### **Source Control** 18

This alternative provides no source control. 19  
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##### **Compliance with Applicable Waste Management Standards** 21

No waste is managed under this alternative, and no waste management standards apply. 22  
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#### *Secondary Criteria* 24

##### **Long-Term Reliability and Effectiveness** 25

Long-term leaching would occur from soil and suspected DNAPL areas. The plume would eventually migrate offsite either by diffusion or advection. 26  
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### **Reduction of Toxicity, Mobility, or Volume**

This alternative would not reduce the toxicity, mobility, or volume of contaminants.

### **Short-Term Effectiveness**

There are no short-term effects resulting from this alternative.

### **Implementability**

This alternative is technically feasible and easily implemented. No construction, operation, or reliability issues are associated with the no-action alternative. Administrative coordination, offsite services, materials, specialists, or innovative technologies would not be required. No implementation risks are associated with this alternative.

### **Cost**

No costs are associated with this alternative.

### **5.2.2 Alternative 2: Long-Term MNA with Carbon Substrate-Enhanced Biodegradation**

Monitored natural attenuation is defined by OSWER as natural processes in soil and groundwater that act to reduce the mass, toxicity, mobility, volume, or concentration of contaminants. These processes include biodegradation, dispersion, dilution, adsorption, volatilization, and chemical or biological stabilization or destruction. The biodegradation process can be enhanced by the addition of carbon substrate. The National Contingency Plan permits the use of monitored natural attenuation as a remedy or portion of a remedy for corrective actions, and several states, including South Carolina, have developed guidance for evaluating and implementing monitored natural attenuation.

The main processes that contribute to monitored natural attenuation of chlorinated solvents include:

- **Biodegradation** occurs by oxidation-reduction reactions carried out by bacteria. 1
- **Dispersion** and subsequent dilution is caused by advective flow and mixing of 2  
contaminated groundwater with non-contaminated groundwater. 3
- **Diffusion** from areas of high concentration to areas of low or no concentration. 4
- **Volatilization** from liquid or dissolved phase into vapor phase. 5
- **Sorption or stabilization** where VOCs become less mobile through binding to clay or 6  
humic materials. 7

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Monitored natural attenuation requires intensive monitoring of the alternative's effectiveness or 9  
potential effectiveness which can be documented by: 10

- Observed reduction of contaminant mass by comparison of site groundwater analytical data 11  
over time (Tier I Evidence). 12
- Presence of biogeochemical indicators in soil and groundwater related to specific 13  
monitored natural attenuation processes (Tier II Evidence). 14
- Direct microbial evidence from laboratory microcosm studies, where observed reduction 15  
in contaminant mass or presence of biogeochemical indicators is insufficient to adequately 16  
support monitored natural attenuation (Tier III Evidence). 17

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Evaluating the effectiveness of monitored natural attenuation generally includes seven steps: 19

- 1 Review of available site data 20
- 2 Development of a preliminary site conceptual model 21
- 3 Screening site data for evidence of monitored natural attenuation 22
- 4 Identifying and collecting additional data where necessary 23
- 5 Refining, interpreting, and testing the site conceptual model 24
- 6 Conducting an exposure pathway analysis 25
- 7 Implementing a long-term site management strategy 26

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MNA's potential effectiveness (Steps 1 through 3) was evaluated using geochemical data obtained during sampling events in March and September 1998 and chlorinated solvent data collected between November 1996 and February 1998. USEPA protocol (EPA/600/R-98/128, September 1998) was used to judge the adequacy or weight of evidence in support of MNA at this site. Steps 4 through 7 would need to be completed to fully evaluate MNA at this site, but screening results show limited to adequate evidence that MNA would be effective at this site. Screening results also indicate MNA could be enhanced if additional carbon substrate were available to support microbial growth which in turn would lower the redox potential and improve other pro-MNA conditions in the aquifer. The MNA screening summary report is included as Appendix D.

To enhance MNA, dilute concentrations of soluble organic carbon (molasses, for example) would be injected into areas of the plume to correct carbon deficiencies. To reduce capital and long-term O&M costs, carbon injection would be done using batch injections into temporary wells or well points.

In general, 20 gallons of 10% carbon solution can raise total organic carbon (TOC) concentrations in 100,000 gallons of groundwater to the desired minimum level of 20 mg/L. The estimated volume of contaminated water at this site is less than 2,000,000 gallons, so only about 400 gallons 10% carbon solution would need to be injected. However, additional carbon would be injected to provide a residual carbon source capable of sustaining concentrations above 20 mg/L.

Temporary well points would be installed to grid the plume using direct push technology (DPT) and/or hand augers on 25-foot centers. It would require about one week to install the well points needed to distribute the carbon to the plume, after which well points would be pulled and properly abandoned.

*Primary Criteria*

**Protection of Human Health and the Environment**

Enhanced MNA is able to protect human health and the environment by allowing natural processes to reduce contamination to levels below MCLs. MNA without carbon enhancement may eventually drop VOC concentrations below MCLs, but the high concentrations in the source area and the lack of organic carbon in the aquifer may cause VOCs to remain above MCLs for more than 30 years. Injections of organic carbon would aid the biodegradation process, but would not aid in degradation of DNAPLs and other areas of very high concentrations of VOCs in the source area. Under this scenario, COCs would probably migrate offsite into residential areas.

**Attainment of Cleanup Standards**

Carbon-enhanced MNA would eventually lower groundwater concentrations below MCLs.

**Source Control**

This alternative does not provide any source control.

**Compliance with Applicable Waste Management Standards**

No wastes would be managed, and no waste management standards are applicable.

*Secondary Criteria*

**Long-Term Reliability and Effectiveness**

Enhanced MNA would be effective at reducing concentrations of dissolved-phase VOCs less than about 10 mg/L, but would be ineffective at reducing DNAPLs and VOC areas of very high concentration.

**Reduction of Toxicity, Mobility, or Volume**

This alternative would reduce the toxicity and volume of the contaminants through biodegradation, and mobility may be restricted by increased adsorption to injected carbon particles or bioclogging of the aquifer due to increased biological activity. The plume is also expected to dissipate via dilution and natural degradation processes over time and distance.

**Short-Term Effectiveness**

There are no short-term risks associated with this alternative.

**Implementability**

This alternative is technically and administratively feasible. Minimal construction, operation, and maintenance is required. Water-use restrictions would be required until concentrations in the plume fall below MCLs. Regulatory and community acceptance would be required before implementation. An injection permit or exclusion agreement would be required from SCDHEC.

**Cost**

Costs for MNA and enhanced biodegradation at this site include long-term monitoring, reporting, and institutional control expenses. Table 5.1 summarizes the costs for this alternative.

**Table 5.1 Cost Estimate for Alternative 2:  
 Monitored Natural Attenuation with Carbon Substrate Injection**

Monitoring Plan	Quantity	Units	Unit Rate	Cost	Subtotal
Sr Engineer	80	hr.	\$94	\$7,520	
Geologist	24	hr.	\$74	\$1,776	
Chemist	16	hr.	\$74	\$1,184	
Drafting/GIS	8	hr.	\$48	\$384	
Report production and revisions	25% of Monitoring Plan Labor	ea.	-	\$2,716	
<b>Monitoring Plan Subtotal</b>					<b>\$13,580</b>

**Table 5.1 Cost Estimate for Alternative 2:  
 Monitored Natural Attenuation with Carbon Substrate Injection**

<b>Annual Monitoring Labor</b>					1
Sr Engineer	10	hr.	\$94	\$940	2
Geologist	80	hr.	\$74	\$5,920	3
Technician	80	hr.	\$48	\$3,840	4
				\$10,700	5
<b>Travel</b>					6
Airfare	2	ea.	\$1,000	\$2,000	7
Per Diem	12	days	\$152	\$1,824	8
Rental Vehicle	2	weeks	\$300	\$600	9
				\$4,424	10
<b>Offsite Lab Analysis</b>					11
VOCs (SW8260A)	24	ea.	\$124	\$2,976	12
NO3, NO2, SO4, Br, Cl, F, PO4, Sulfide (IC E300)	13	ea.	\$120	\$1,560	13 14
Total Organic Carbon	13	ea.	\$35	\$455	15
Shipping and Handling	15% of Analytical Costs	ea.	-	\$749	16
				\$5,740	17
<b>Onsite Field Lab Analysis</b>					18
Mobilization	1	ea.	\$2,000	\$2,000	19
Dissolved Oxygen	13	ea.	\$30	\$390	20
Iron (II)	13	ea.	\$50	\$650	21
Alkalinity	13	ea.	\$20	\$260	22
Oxidation Reduction Potential	13	ea.	\$20	\$260	23
pH, temperature, conductivity	13	ea.	\$30	\$390	24
Methane, ethane, ethene (SW3810)	13	ea.	\$50	\$650	25
Hydrogen	13	ea.	\$100	\$1,300	26
				\$5,900	27

*Draft Zone F, AOC 607 Corrective Measures Study Report  
Charleston Naval Complex  
Section 5: Development and Evaluation of Alternatives  
December 1999*

**Table 5.1 Cost Estimate for Alternative 2:  
Monitored Natural Attenuation with Carbon Substrate Injection**

<b>Annual Reporting</b>					1
Sr Engineer	40	hr.	\$94	\$3,760	2
Chemist	16	hr.	\$74	\$1,184	3
Geologist	8	hr.	\$74	\$592	4
Drafting	8	hr.	\$48	\$384	5
Report production and revisions	25% of Annual Reporting Labor	ea.	-	\$1,480	6
				\$7,400	7
Contingency	25% of Annual Monitoring and Reporting Subtotal	ea.	-	\$8,541	8
<b>Annual Monitoring Present-worth, n = 30 years. inflation = 3%, interest = 7%</b>					9
				<b>\$727,192</b>	
<b>Injection and Well Permitting</b>	20	hr	\$74	\$1,480	10
<b>DPT Temporary Well Point Installation</b>					11
					12
DPT Rig and Crew	10	days	\$1,200	\$12,000	13
Engineering/Geologist Oversight	80	hrs.	\$74	\$5,920	14
Well and well abandonment materials	ea.	NA	\$400	\$400	15
					16
Substrate (food-grade molasses, vegetable oil or other low-cost soluble carbon source)	ea.	NA	\$400	\$400	17
					18
					19
				\$18,720	20
<b>Building Interior manual well installation</b>					21
					22
Technician	24	hr.	\$48	\$1,152	23
Engineer/Geologist	24	hr.	\$74	\$1,776	24
				\$2,928	25
Contingency	30% permitting and well installation cost	ea.	-	\$5,782	26
<b>Carbon Injection Subtotal</b>					27
				<b>\$28,910</b>	
<b>Alternative 2: MNA and Carbon Injection Total</b>					28
				<b>\$769,682</b>	

**5.2.3 Alternative 3: Soil and Source Area Excavation with (a) Offsite Disposal to a Hazardous Waste Landfill or (b) Onsite Treatment and Backfilling of Excavated Soils followed by MNA with Carbon-Enhanced Biodegradation**

This alternative proposes to excavate all soil with COC concentrations greater than SSLs. This activity would remove long-term leaching threats to groundwater and enable enhanced monitored natural attenuation to more rapidly reach cleanup goals.

Based on RFI and CMS data, the total depth of excavation would reach up to 17 feet and cover an area about 40 feet wide and 70 feet long (about 1,700 cubic yards).

Because much of the contaminated soil is within the aquitard between the upper and lower water bearing sands, the excavation area would need to be dewatered and isolated using sheet piles. For purposes of this CMS, sheet piling isolation to a depth of 30 feet is recommended. Sheet piles to this depth would key into the Ashley Formation and should prevent heaving or groundwater inflow from the lower water-bearing sands.

Following excavation, enhanced MNA would be implemented to assess the degradation of COCs and progress toward MCLs in groundwater.

In Alternative 3a, soil would be transported offsite to a Subtitle C landfill. In Alternative 3b, soil would be treated onsite using a portable thermal desorption unit and backfilled into the pit after treatment.

**Primary Criteria**

**Protection of Human Health and the Environment**

Both excavation alternatives protect human health and the environment by removing contaminated soil and other residual sources above remedial goals. Short-term risks and hazards from inhalation and dermal contact during implementation would be minimal and would be controlled with common engineering techniques and appropriate personal protection equipment (PPE). This alternative must comply with land disposal restrictions and other applicable waste management standards.

Enhanced MNA protects human health and the environment by allowing natural processes to reduce contamination to levels below MCLs.

**Attainment of Cleanup Standards**

The enhanced MNA portion of this alternative would eventually lower groundwater concentrations below MCLs. With removal of the source material by excavation, groundwater concentrations would progress more rapidly toward MCLs than if the source material were allowed to remain in place.

**Source Control**

This alternative would eliminate all source areas and other long-term VOC leaching threats to groundwater.

**Compliance with Applicable Waste Management Standards**

Excavation requires compliance with federal, state, and local air emissions and storm water control regulations. Alternative 3a, transportation offsite, would trigger U.S. Department of Transportation regulations. Land disposal restrictions require all U-listed waste to be disposed of at a Subtitle C hazardous waste landfill unless treated in accordance with 40 CFR 268.49.

**Secondary Criteria**

**Long-Term Reliability and Effectiveness**

Both Alternative 3a and 3b would remove from the site all soil in which contaminant concentrations exceed SSLs. Alternative 3a, disposal at a landfill, is an established and reliable option because onsite risks and hazards are eliminated. Alternative 3b, onsite treatment and backfilling, eliminates risks and hazard through treating excavated soils to nondetect COC concentrations.

In less than 15 years, enhanced MNA would be expected to effectively reduce VOCs remaining after source removal activities are complete.

**Reduction of Toxicity, Mobility, or Volume**

Alternative 3a would only remove contaminated soil from the site. Mobility would be reduced at a Subtitle C landfill where liners and other controls help to limit contaminant migration. Alternative 3b would reduce toxicity, mobility, and volume of the COCs in soil at this site. Under both 3a and 3b, MNA would reduce toxicity and volume of COCs in groundwater, but would not reduce mobility.

**Short-Term Effectiveness**

Excavation would produce a large open pit, about 70 by 40 feet in area and up to 17 feet in depth. Excavation workers would be exposed to increased VOC emissions and increased potential for dermal contact with hazardous constituents. The open pit is a fall hazard, a potential collapse and suffocation hazard, and a potential drowning hazard. Risks would be reduced using site controls such as fencing and adherence to a site-specific health and safety plan during all construction activities. Excavation activities would require about two months to complete.

## **Implementability**

Excavation would require the installation of sheet piling in order to maintain wall stability and control groundwater inflow during excavation and while the pit remains open awaiting backfilling. Installation of sheet piles may not be possible in some areas with underground utility lines. These areas would continue to leak while the pit remains open and would need to be stabilized to prevent collapse. Underground utilities, including storm and sanitary sewers running through the proposed area of excavation, would need to be re-routed.

Site controls would be necessary to restrict access to the construction area until the pit is backfilled and all equipment is demobilized from the site. Water generated from pit dewatering would need to be treated using a portable air stripping tower and discharged to the local POTW via the local sanitary sewer.

**Alternative 3a**, excavation with offsite disposal, would not require any extraordinary services or materials. The Safety-Kleen (Pinewood) Inc. Landfill is a Class C facility in Pinewood, South Carolina, that would accept the soil as hazardous waste pending characterization. **Alternative 3b**, excavation with onsite treatment, would require a commercially available portable thermal unit at the site for about two weeks. Treated soil would be backfilled into the excavated area.

Construction activities may interfere with daily operation of the housing facility west of the site. Water-use restrictions and administrative coordination are required to implement institutional controls. Regulatory and community acceptance would be necessary before implementation.

## **Cost**

The total costs for Alternative 3 are summarized in Table 5.2.

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**Table 5.2 Cost Estimate for Alternative 3:  
 Source Area Excavation and Enhanced MNA**

<i>Excavation Activities</i>						
Excavation	Quantity	Units	Rate	Cost	Subtotal	
Sheet Piling/Shoring	220	LF	\$90	\$19,800		5
Rerouting of underground utilities	ea.	-	-	\$50,000		6
Excavation	1,700	Yd <sup>3</sup>	\$20	\$34,000		7
3a - Transportation to and Disposal at Subtitle C Landfill and Backfill with Clean Soil	2,550	tons	\$135	\$344,250		8 9 10
Engineering Oversight	120	hrs	\$74	\$8,880		11
Contingency	30% of excavation, transportation, and disposal costs		ea.	\$137,079		12
					<b>3a) \$490,209</b>	13
3b - Onsite Treatment via Thermal Desorption and Backfill with Treated Soil	2,550	tons	\$90	\$229,500		14 15 16
Engineering Oversight	160	hr.	\$74	\$11,840		17
Contingency	30% of excavation and treatment costs			\$103,542		18
					<b>3b) \$448,682</b>	19
<b>Monitoring Plan Subtotal (from Alternative 2)</b>					<b>\$13,580</b>	20
<b>MNA Annual Monitoring Present-worth, n=15 years, inflation=3%, interest=7%</b>					<b>\$464,755</b>	21
<b>Carbon Injection Subtotal (from Alternative 2)</b>					<b>\$28,910</b>	22 23
<b>Total</b>					<b>3a) \$997,454</b>	24
					<b>3b) \$955,927</b>	25 26

**5.2.4 Alternative 4: Dual-Phase Vacuum Extraction and Air Sparging with MNA and Enhanced Biodegradation**

This alternative proposes to treat contaminated soil in situ and extract groundwater for ex situ treatment using a dual-phase vacuum recovery system for about six months. Vacuum recovery will be followed by carbon injection and MNA similar to that described in Alternative 3.

This extraction system uses liquid-ring vacuum pumps to strip VOCs from the vadose zone and extract contaminated groundwater more effectively than traditional pump-and-treat systems. Air sparging or passive vent wells would be used to stimulate air flow through the vadose zone and encourage in situ stripping of dissolved-phased VOCs in groundwater.

Vacuum extraction typically removes large amounts of VOCs during the initial few months of operation. Because vacuum recovery becomes inefficient when only COCs in the adsorbed phase remain in the subsurface, systems can be cycled on and off over weeks or months to save operating costs and allow adsorbed-phase contaminants to naturally diffuse into the aquifer or vapor phase where they are more easily recovered. Once concentrations fall below 80% or more of their original amount, enhanced MNA can be used as an effective means of lowering residual concentrations below MCLs.

Soil borings installed during the RFI and CMS indicate that the subsurface at this site is heterogeneous. Extraction wells and well points used during treatability and aquifer testing yielded 0 to 3 gpm within 10 feet of each other, indicating that a robust extraction system would need to be designed to allow for heterogeneities. Vacuum extraction/ air sparging system well points should be installed so that they can be used as either extraction or passive vent points. For cost estimating purposes, well point spacings of 20 feet on center were applied to the suspected source area. This distribution yielded a total of 24 shallow wells (screened from 3 to 11 feet) and 6 deep wells (screened from 17 to 30 feet).

**Primary Criteria**

**Protection of Human Health and the Environment**

Vacuum extraction would significantly reduce risk to human health and the environment in a relatively short period of time (up to 80% recovery of the contaminant mass in three to six months). Enhanced MNA protects human health and the environment by allowing natural processes to reduce contamination below MCLs.

**Attainment of Cleanup Standards**

The enhanced MNA portion of this alternative would eventually lower groundwater concentrations below MCLs. With removal of the source material by vacuum extraction and air sparging, groundwater concentrations would progress more rapidly toward MCLs than if the source material were allowed to remain in place.

**Source Control**

Similar to excavation, this alternative would eliminate all source areas and other long-term VOC leaching threats to groundwater.

**Compliance with Applicable Waste Management Standards**

Aboveground wastewater treatment permits, wastewater discharge permits, air discharge permits, and extraction well permits may all be required for system operation.

**Secondary Criteria**

**Long-Term Reliability and Effectiveness**

This technology would be expected to effectively remove or treat all VOCs within 15 years.

**Reduction of Toxicity, Mobility, or Volume**

Vacuum extraction would remove the VOCs from the subsurface and discharge them to the atmosphere either directly or via air stripping of groundwater. This alternative does not reduce the toxicity or volume of the contaminant, but merely transfers it from aqueous to gaseous phase. This alternative increases its mobility by discharging COCs in dilute form into the atmosphere. MNA would reduce COC toxicity and volume, but would not reduce mobility.

**Short-term Effectiveness**

Risks to onsite workers would be minimal during construction and operation of this system. Mild noise pollution may occur during air stripping.

**Implementability**

This alternative is a commercially available, easily implementable technology. Water generated from vacuum dewatering would need to be treated using a portable air stripping tower and discharged to the local POTW via the local sanitary sewer. Evacuated vapors may require an air discharge permit. However, an exemption may be granted where less than 1,000 lbs. VOCs are generated per month.

**Cost**

The total estimated cost for this alternative is \$788,495 and is summarized in Table 5.3.

**Table 5.3 Alternative 4: Dual-Phase Vacuum Extraction, Air Sparging, and Carbon-Enhanced MNA**

Action	Amount	Units	Rate	Cost
<b>Dual-phase System Construction</b>				
Mobilization/Demobilization	1	ea.	\$3,000	\$3,000
2-inch Shallow Extraction/Sparging/Vent Wells	24	ea.	\$4,000	\$96,000
2-inch Deep Extraction/Sparging Wells	6	ea.	\$7,000	\$42,000

**Table 5.3 Alternative 4: Dual-Phase Vacuum Extraction, Air Sparging, and Carbon-Enhanced MNA**

Action	Amount	Units	Rate	Cost	
Vacuum/Sparging Pumps, Portable Air Stripper, and Above-ground Plumbing Lease	6	months	\$7,000	\$42,000	1
Well Installation, System Construction, And Start-up Oversight	120	hr.	\$74	\$8,880	2
				\$191,880	3
<b>System Monitoring, Permit Sampling Requirements, and Dual-Phase Evaluation</b>					4
Weekly System Monitoring (24 weeks, 4 hours per week)	96	hr.	\$74	\$7,104	5
Sampling Labor (2 events, 24 wells each event)	160	hr.	\$48	\$7,680	6
VOC samples (SW8260) - Water	48	ea.	\$120	\$5,760	7
VOC samples (SW8260) - Air	12	ea.	\$120	\$1,440	8
Engineering Evaluation	48	hr.	\$94	\$4,512	9
Vacuum System Shut-Down Interim Reporting and Revisions	25% Monitoring and Sampling Costs	NA		\$6,624	10
Contingency	25% System Construction, Monitoring and Sampling Costs	NA		\$56,250	11
				\$89,370	12
<b>Dual-phase Vacuum Extraction Subtotal</b>				<b>\$281,250</b>	13
<b>Monitoring Plan Subtotal (from Alternative 2)</b>				<b>\$13,580</b>	14
<b>MNA, Annual Monitoring Present-worth, n=15 years, inflation=3%, interest=7%</b>				<b>\$464,755</b>	15
<b>Carbon Injection Subtotal (from Alternative 2)</b>				<b>\$28,910</b>	16
<b>Alternative 4 Total</b>				<b>\$788,495</b>	17

**5.2.5 Alternative 5: Thermally Enhanced Dual-phase Extraction with Enhanced MNA**

This alternative proposes to treat contaminated soil and groundwater in situ using thermal, physical, and biological systems in combination with one another.

In Situ six-phase electrical heating (SPH) was selected as the thermal technology based on its ability to provide relatively uniform heating in heterogeneous, low-permeability environments. Heated soil and groundwater would reach temperatures near the boiling point of water. The increased temperature would rapidly volatilize and vaporize dissolved-phase VOCs and any DNAPLs that may be present. These VOCs would be collected by vacuum extraction wells in the heated matrix. Air sparging or vent wells would provide air flow through the heated area if needed. The thermal/vacuum system would operate for three to six months, after which over 95% of the VOCs originally present in the source area would likely be removed. After this period, the thermal/vacuum system would demobilize from the site.

Based onsite lithology and aquifer testing, five to ten SPH arrays would be needed to address the source area. Each array would be capable of treating a 15 to 30-foot radius and would be installed so these areas slightly overlap.

Following thermal/vacuum treatment, biodegradation would be enhanced by two mechanisms. First, the soil and groundwater would likely remain heated for weeks or months after the thermal system is shut down. The increased temperature would increase biological activity and subsequent degradation of COCs. Second, a carbon source would be injected in the form of dilute molasses, vegetable oil, or other low-cost substrate to stimulate biological activity by providing a food source for the microorganisms. Carbon injections have been shown to reduce redox potentials to levels well below those required for reductive dechlorination.

### ***Primary Criteria***

#### **Protection of Human Health and the Environment**

Alternative 5 would significantly reduce risk to human health and the environment in a relatively short period of time (three to six months). Enhanced biodegradation further protects human health

and the environment by stimulating natural processes to reduce contamination to levels below MCLs over the next few years.

#### **Attainment of Cleanup Standards**

This alternative would eliminate over 95% of the contaminant mass in the suspected source area and be expected to lower groundwater concentrations below MCLs within five years.

#### **Source Control**

This alternative would eliminate all known source areas and other long-term VOC leaching threats to groundwater.

#### **Compliance with Applicable Waste Management Standards**

Aboveground wastewater treatment permits, wastewater discharge permits, air discharge permits, and extraction well permits may all be required for system operation.

#### ***Secondary Criteria***

##### **Long-Term Reliability and Effectiveness**

This alternative would effectively remove or treat all VOCs.

##### **Reduction of Toxicity, Mobility, or Volume**

Vacuum extraction would remove VOCs from the subsurface and discharge them to the atmosphere. The thermal portion of this alternative does not reduce the toxicity or volume of the contaminant, but merely transfers it from aqueous to gaseous phase. SPH increases mobility by discharging COCs in dilute form into the atmosphere. Enhanced biodegradation would reduce COC toxicity and volume, but would not reduce mobility.

**Short-Term Effectiveness**

Risks to onsite workers would be minimal during construction and operation of this system.

**Implementability**

This alternative is a commercially available, easily implementable technology. Any water extracted would need to be treated using a portable air stripping tower and discharged to the local POTW via the local sanitary sewer. Evacuated vapors may require an air discharge permit, but an exemption may be granted where less than 1,000 lbs. of VOCs are generated per month.

**Cost**

The total cost for this alternative is \$947,671, summarized in Table 5.4. Costs for six-phase heating are based on an approximate treatment area of 90 feet x 180 feet to a depth of 30 feet, which corresponds to a volume of 18,000 cubic yards. Because this is a relatively new technology, large amounts of historic costs are not available for comparison. However, a similar site in Skokie, Illinois was treated for \$32 per yard. This cost included installation, operation, monitoring, permitting, electrical use, and waste disposal.

**Table 5.4 Alternative 5: Thermal Treatment**

Action	Amount	Units	Rate	Cost
<b>Six-Phase Electrical Heating System Construction, Operation, and Reporting</b>				
Treatment of suspected source area	18,000	yd <sup>3</sup>	\$32	\$576,000
Contingency	25% of Treatment costs		NA	\$144,000
<b>SPH Subtotal</b>				<b>\$720,000</b>
<b>MNA Monitoring Plan Subtotal</b>				<b>\$13,580</b>
<b>Annual Monitoring Present-worth, n=5 years, inflation=3%, interest=7%</b>				<b>\$185,182</b>
<b>Carbon Injection Subtotal</b>				<b>\$28,910</b>
<b>Alternative 5 Total</b>				<b>\$947,671</b>

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**5.3 Comparison of Alternatives**

The purpose of the comparative analysis is to identify the advantages and disadvantages of each alternative relative to one another. This section highlights differences between alternatives as they meet each of the criteria, especially the secondary criteria since the primary criteria must be met for an alternative to be considered. The focus should help determine which options are cost-effective and which remedy uses permanent solutions and treatment to the maximum extent practicable. State and community acceptance are required before any proposed alternative is selected. Primary and secondary criteria are detailed below.

*Primary Criteria*

**Protection of Human Health and the Environment**

Alternative 1, *No Further Remedial Action*, provides no additional protection to potential receptors. Contamination would remain onsite and would eventually migrate offsite.

Alternative 2, *Enhanced Monitored Natural Attenuation*, protects potential receptors by enhancing natural processes to improve in situ reduction of contaminant mass. Injections of organic carbon will aid the biodegradation process, but concentrations above MCLs may persist for up to 30 years due to DNAPL and high concentrations of VOCs in the source area. Under this alternative, COCs would probably migrate offsite into residential areas.

Alternative 3, *Source Excavation with (a) offsite disposal or (b) onsite treatment*, protects human health and the environment by removing and/or treating the source of VOC contamination. Enhanced MNA would lower dissolved-phase VOC contamination outside the suspected source zone.

Alternative 4, *Dual-phase vacuum extraction*, also protects human health and the environment by removing and/or treating the source of VOC contamination. Similar to Alternative 3, enhanced MNA would lower dissolved-phase VOC contamination outside the suspected source zone.

Alternative 5, *Six-phase heating and vacuum extraction*, also protects human health and the environment by removing and/or treating the source of VOC contamination. Similar to Alternatives 3 and 4, enhanced MNA would be used to lower dissolved-phase VOC contamination in areas outside the suspected source zone.

#### **Attainment of Cleanup Standards**

Alternative 1, *No Further Remedial Action*, would not attain cleanup standards (MCLs).

Alternative 2, *Enhanced Monitored Natural Attenuation*, would require 30 or more years to reduce contaminants below MCLs and contamination would likely migrate offsite.

Alternative 3, *Source Excavation with (a) offsite disposal or (b) onsite treatment*, and Alternative 4, *Dual-phase vacuum extraction*, would quickly reduce source area contaminants, but enhanced MNA would still require up to 15 years to achieve MCLs.

Alternative 5, *Six-phase heating and vacuum extraction*, would also quickly reduce source area contaminants, but enhanced MNA would require less than five years to achieve MCLs.

**Table 5.5**  
**Alternatives' Ability to Meet Cleanup Standards**

Alternative	Attain MCLs (Yes/No)	Estimated Time Required to Achieve MCLs (years)
1	No	30 +
2	Yes	30 +
3	Yes	< 15
4	Yes	< 15
5	Yes	< 5

**Source Control**

Alternative 1, *No Further Remedial Action*, and Alternative 2, *Enhanced Monitored Natural Attenuation*, would not provide source control.

Alternative 3, *Source Excavation with (a) offsite disposal or (b) onsite treatment*, Alternative 4, *Dual-phase vacuum extraction*, and Alternative 5, *Six-phase heating and vacuum extraction* would all quickly reduce source area contaminants.

**Compliance with Applicable Waste Management Standards**

No waste would be managed under Alternatives 1 and 2, and waste management standards do not apply.

Alternative 3, *Source Excavation with (a) disposal or (b) onsite treatment*, may require compliance with federal, state, and local air emission and storm water control regulations. Transportation and land disposal restrictions would be triggered by disposal of contaminated soil offsite. Due to the presence of U-listed contamination, it is anticipated that excavated soil will be classified as hazardous.

Alternative 4, *Dual-phase vacuum extraction*, and Alternative 5, *Six-phase heating and vacuum extraction* would generate groundwater requiring treatment prior to disposal. Permits would be needed to dispose of treated groundwater to the North Charleston POTW.

### *Secondary Criteria*

#### **Long-term Reliability and Effectiveness**

Alternative 1, *No Further Remedial Action*, provides no long-term reliability or effectiveness.

Alternative 2, *Enhanced Monitored Natural Attenuation*, would not likely prevent contaminant migration offsite and would require at least 30 years to attain cleanup standards, if ever.

Alternative 3, *Source Excavation with (a) offsite disposal or (b) onsite treatment*, and Alternative 4, *Dual-phase vacuum extraction*, would both reduce source area concentrations to levels that would be further reduced using enhanced MNA to meet cleanup goals. Both alternatives use demonstrated technologies likely capable of reducing contaminant mass by over 80% within 6 to 12 months and meeting cleanup criteria within 15 years.

Alternative 5, *Six-phase Heating and vacuum extraction* would reduce source area concentrations to levels which would need to be further reduced to meet cleanup goals using enhanced MNA. This is an innovative technology likely capable of reducing contaminant mass by over 95% within 3 to 6 months, and meeting cleanup criteria within 5 years.

#### **Reduction of Toxicity, Mobility, or Volume**

Alternative 1, *No Further Remedial Action*, provides no reduction of toxicity, mobility, or volume.

Alternative 2, *Enhanced Monitored Natural Attenuation*, would eventually reduce the toxicity and volume of VOCs in the subsurface. However, some intermediate breakdown products such as

vinyl chloride would form temporarily, which are more toxic than their parent compounds. These more toxic compounds would eventually reduce to relatively harmless products such as chloride. Alternative 2 would not likely slow mobility, although some clogging may occur in the aquifer due to biofouling.

Alternative 3, *Source Excavation with (a) offsite disposal or (b) onsite treatment*, Alternative 4, *Dual-phase vacuum extraction*, and Alternative 5, *Six-phase heating and vacuum extraction* would all reduce toxicity, mobility and volume by first removing large amounts of source material from the site and then reducing residual contamination via enhanced MNA processes. With appropriate monitoring and maintenance, these processes would be irreversible.

### Short-Term Effectiveness

Alternative 1, *No Further Remedial Action*, and Alternative 2, *Enhanced Monitored Natural Attenuation*, pose no significant or unusual short-term risks to site workers.

Alternative 3, *Source Excavation with (a) offstie disposal or (b) onsite treatment*, includes exposure to workers, which can be effectively controlled using engineering controls and appropriate PPE during excavating or treatment activities.

Alternative 4, *Dual-phase vacuum extraction*, and Alternative 5, *Six-phase Heating and vacuum extraction*, require installation of additional well points and aboveground treatment systems. However, adherence to an appropriate site health and safety plan would minimize the risks to workers during installation and operation activities.

### Implementability

Alternative 1, *No Further Remedial Action*, requires no action and is therefore implementable.

Alternative 2, *Enhanced Monitored Natural Attenuation*, is easily implemented but would require over 30 years of annual or semi-annual monitoring and reporting.

Alternative 3, *Source Excavation with (a) offsite disposal or (b) onsite treatment*, is likely implementable, but requires the most intensive site work of the five alternatives. However, this alternative may encounter unusual difficulties if significant rerouting of subsurface utilities is required.

Alternative 4, *Dual-phase vacuum extraction*, and Alternative 5, *Six-phase heating and vacuum extraction*, are both in situ technologies that can be implemented without unusual difficulty. Both would require the construction and operation of aboveground systems that would remain onsite for up to 12 months, and both would require discharge agreements with the local POTW.

### Cost

Alternative 1, *No Further Remedial Action*, would incur no costs.

Alternative 2, *Enhanced Monitored Natural Attenuation*, is the least costly (\$770,000) of Alternatives 2 through 5. Reduced costs associated with enhanced MNA for Alternatives 3, 4, and 5 are due to reductions in the anticipated time required to achieve cleanup goals under these scenarios.

Alternatives 3a and 3b, *Source Excavation with (a) offsite disposal or (b) onsite treatment*, are similar in cost (\$997,000 vs. \$956,000). Costs for Alternative 3 are the highest of Alternatives 2 through 5, due in part to a slightly greater contingency rate (30%). Largely unknown costs are associated with the potential need to reroute poorly mapped or unidentified subsurface utilities.

Alternative 4, *Dual-phase vacuum extraction*, costs (\$788,000) are similar to Alternative 2. The higher capital costs in Alternative 4 were offset by a 50% reduction in the anticipated enhanced MNA monitoring.

Alternative 5, *Six-phase heating and vacuum extraction*, is similar in cost (\$947,000) to Alternative 3. Although this cost is about 20% greater than Alternatives 2 and 4, Alternative 5 uses an innovative technology which is expected to become more efficient and economical as experience is gained in its application. Therefore, actual costs may be somewhat lower when the technology is implemented at this site.

Estimated costs among the four action alternatives (Alternatives 2 through 5) are similar, ranging from \$770,000 to \$997,000. Costs within this range are similar given the RCRA CMS guidance requirement that cost estimates be accurate within -30% to +50% of actual implementation costs.

Table 5.6  
 Alternatives Cost Comparison

Alternative	Installation and Start-up Costs	Annual O&M	Net Present-worth
1 No Further Action	\$0	\$0	\$0
2 Enhanced MNA	\$42,290	\$42,705 (annually for 30 years)	\$769,682
3a Excavation with Offsite Disposal	\$532,499	\$42,705 (annually for 15 years)	\$997,454
3b Excavation with Onsite Treatment and Replacement	\$490,972	\$42,705 (annually for 15 years)	\$955,927
4 Dual-phase Extraction with Enhanced MNA	\$323,740	\$42,705 (annually for 15 years)	\$788,495
5 Six-Phase Heating and Dual-phase Extraction with Enhanced MNA	\$923,740	\$42,705 (annually for 5 years)	\$947,671

**5.4 Summary and Ranking of Alternatives**

Per the projects team's request, each soil alternative was scored for each of the primary and secondary criteria based on the comparative analysis of alternatives in Section 5.3. Primary and secondary criteria scoring methodologies are presented as:

**Primary Criteria**

**Secondary Criteria**

<b>0</b> — criteria not met	<b>2</b> — criteria met	<b>0</b> — poor	<b>2</b> — average
<b>1</b> — criteria may be met	<b>3</b> — criteria exceeded	<b>1</b> — below average	<b>3</b> — above average

The scores are multiplied by a weighting factor to emphasize their importance - primary criteria are weighted more than the secondary criteria. Scores are summed to develop an overall score for each alternative, which is used to rank them and provide a tool for selecting the final site remedy. Scoring and ranking results are in Tables 5.7 through 5.12, and the recommended final site remedy is discussed in Section 6.

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**Table 5.7**  
**Summary of Evaluation of Alternative 1:**  
**No Further Remedial Action**

Evaluation Criteria	Weighting Factor <sup>1</sup>	Comments	Score <sup>2</sup>	Score x WF
<b>Primary Criteria</b>				
Protection of Human Health and the Environment	2	No protection.	0	0
Attainment of Cleanup Standards	2	Does not attain cleanup standard (MCLs)	0	0
Source Control	2	Does not provide source control.	0	0
Compliance with Applicable Waste Management Standards	2	No waste is generated, so waste management standards do not apply.	3	6
<b>Secondary Criteria</b>				
Long-term Reliability and Effectiveness	1	Ineffective.	0	0
Reduction of Toxicity, Mobility, or Volume	1	No reduction.	0	0
Short-term Effectiveness	1	No risk to site workers.	3	3
Implementability	1	No action required to implement.	3	3
Cost	1	No costs.	3	3
<b>Ranking Score</b>				<b>15</b>

**Notes:**

- 1 — Weighting factor (WF) assigned by project team consensus.
- 2 — Primary criteria-specific evaluation score: 0 — criteria not met; 1 — criteria may be met; 2 — criteria met; 3 — criteria exceeded. Secondary criteria-specific evaluation score: 0 — poor; 1 — below average; 2 — average; 3 — above average

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**Table 5.8**  
**Summary of Evaluation of Alternative 2:**  
**Enhanced MNA**

Evaluation Criteria	Weighting Factor <sup>1</sup>	Comments	Score <sup>2</sup>	Score x WF	
<b>Primary Criteria</b>					
Protection of Human Health and the Environment	2	Contaminant plume will eventually migrate offsite into residential area.	1	2	
Attainment of Cleanup Standards	2	May not be capable of reducing VOC concentrations to MCLs.	1	2	
Source Control	2	No source control.	0	0	
Compliance with Applicable Waste Management Standards	2	Small amounts of waste water generated during well sampling will require characterization and disposal.	2	4	
<b>Secondary Criteria</b>					
Long-term Reliability and Effectiveness	1	30 or more years may be required for bioreduction of VOCs to acceptable concentrations.	1	1	
Reduction of Toxicity, Mobility, or Volume	1	Bioprocesses will slowly reduce toxicity, mobility, and volume.	1	1	
Short-term Effectiveness	1	Little to no risk to site workers during monitoring activities.	3	3	
Implementability	1	Monitoring guidance available and easily implementable.	3	3	
Cost	1	Lowest capital cost and present-worth among the 4 action alternatives.	3	3	
<b>Ranking Score</b>				<b>20</b>	

**Notes:**

**Notes:**

- 1 — Weighting factor (WF) assigned by project team consensus.
- 2 — Primary criteria-specific evaluation score: 0 — criteria not met; 1 — criteria may be met; 2 — criteria met; 3 — criteria exceeded. Secondary criteria-specific evaluation score: 0 — poor; 1 — below average; 2 — average; 3 — above average

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**Table 5.9**  
**Summary of Evaluation of Alternative 3a:**  
**Source Area Excavation and Offsite Disposal with Enhanced MNA**

Evaluation Criteria	Weighting Factor <sup>1</sup>	Comments	Score <sup>2</sup>	Score x WF	
<b>Primary Criteria</b>					
Protection of Human Health and the Environment	2	Removes source area and may prevent plume from migrating offsite.	2	4	
Attainment of Media Cleanup Standards	2	Likely capable of achieving clean up standards.	2	4	
Source Control	2	Source would be removed.	3	6	
Compliance with Applicable Waste Management Standards	2	Large volumes of contaminated soil would need to be characterized for disposal. Groundwater produced during dewatering would need to be treated prior to discharge under agreement with the local POTW.	1	2	
<b>Secondary Criteria</b>					
Long-term Reliability and Effectiveness	1	Up to 15 years may be required for enhanced MNA processes to reduce VOC concentrations to MCLs.	2	2	
Reduction of Toxicity, Mobility, or Volume	1	Source material will be disposed of offsite. Bioprocesses will reduce toxicity, mobility, and volume of residual contamination.	2	2	
Short-term Effectiveness	1	Risk to site workers is greatest among the alternatives due to the presence of a large open excavation and heavy machinery.	1	1	
Implementability	1	Implementability is most difficult among the alternatives due to surrounding site uses and underground utility concerns.	1	1	
Cost	1	Most expensive among all alternatives.	1	1	
<b>Ranking Score</b>				<b>23</b>	

**Notes:**

- 1 — Weighting factor (WF) assigned by project team consensus.
- 2 — Primary criteria-specific evaluation score: 0 — criteria not met; 1 — criteria may be met; 2 — criteria met; 3 — criteria exceeded. Secondary criteria-specific evaluation score: 0 — poor; 1 — below average; 2 — average; 3 — above average

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**Table 5.10**  
**Summary of Evaluation of Alternative 3b:**  
**Source Area Excavation, Onsite Treatment, and Replacement with Enhanced MNA**

Evaluation Criteria	Weighting Factor <sup>1</sup>	Comments	Score <sup>2</sup>	Score x WF	
<b>Primary Criteria</b>					
Protection of Human Health and the Environment	2	Removes source area and may prevent plume from migrating offsite.	2	4	
Attainment of Media Cleanup Standards	2	Likely capable of achieving clean up standards.	2	4	
Source Control	2	Source would be removed.	3	6	
Compliance with Applicable Waste Management Standards	2	Soil would be treated via thermal desorption and backfilled into the excavation. Groundwater produced during dewatering would need to be treated prior to discharge under agreement with the local POTW.	2	4	
<b>Secondary Criteria</b>					
Long-term Reliability and Effectiveness	1	Up to 15 years may be required for enhanced MNA processes to reduce VOC concentrations to MCLs.	1	1	
Reduction of Toxicity, Mobility, or Volume	1	Source material will be treated onsite. Bioprocesses will reduce toxicity, mobility, and volume of residual contamination.	3	3	
Short-term Effectiveness	1	Risk to site workers is greatest among the alternatives due to the presence of a large open excavation and heavy machinery.	1	1	
Implementability	1	Similar to 3a, implementability is very difficult due to surrounding site uses and underground utility concerns.	1	1	
Cost	1	Less expensive than alternative 3a, but still more expensive than Alternatives 2, 4, and 5.	1	1	
<b>Ranking Score</b>				<b>25</b>	

**Notes:**

- 1 — Weighting factor (WF) assigned by project team consensus.
- 2 — Primary criteria-specific evaluation score: 0 — criteria not met; 1 — criteria may be met; 2 — criteria met; 3 — criteria exceeded. Secondary criteria-specific evaluation score: 0 — poor; 1 — below average; 2 — average; 3 — above average

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 Section 5: Development and Evaluation of Alternatives  
 December 1999

**Table 5.11**  
**Summary of Evaluation of Soil Alternative 4:**  
**Dual-phase Vacuum Extraction with Enhanced MNA**

Evaluation Criteria	Weighting Factor <sup>1</sup>	Comments	Score <sup>2</sup>	Score x WF	
<b>Primary Criteria</b>					
Protection of Human Health and the Environment	2	Reduces source area concentrations to biodegradable concentrations and may prevent plume migration offsite.	2	4	
Attainment of Cleanup Standards	2	Likely capable of achieving clean up standards.	2	4	
Source Control	2	Over 80% of source would likely be removed.	3	6	
Compliance with Applicable Waste Management Standards	2	Extracted groundwater would need to be treated prior to discharge under agreement with the local POTW.	3	6	
<b>Secondary Criteria</b>					
Long-term Reliability and Effectiveness	1	Up to 15 years may be required for enhanced MNA processes to reduce VOC concentrations to MCLs.	2	2	
Reduction of Toxicity, Mobility, or Volume	1	Source material will be treated onsite. Bioprocesses will reduce toxicity, mobility, and volume of residual contamination.	2	2	
Short-term Effectiveness	1	Risk to site workers is minimal.	2	2	
Implementability	1	Technology is easily implementable.	2	2	
Cost	1	Only slightly more expensive than Alternative 2..	2	2	
<b>Ranking Score</b>				<b>30</b>	

**Notes:**

- 1 — Weighting factor (WF) assigned by project team consensus.
- 2 — Primary criteria-specific evaluation score: 0 — criteria not met; 1 — criteria may be met; 2 — criteria met; 3 — criteria exceeded. Secondary criteria-specific evaluation score: 0 — poor; 1 — below average; 2 — average; 3 — above average

Table 5.12  
 Summary of Evaluation of Alternative 5:  
 Six Phase Heating and Dual-phase Vacuum Extraction with Enhanced MNA

Evaluation Criteria	Weighting Factor <sup>1</sup>	Comments	Score <sup>2</sup>	Score x WF	
<b>Primary Criteria</b>					
Protection of Human Health and the Environment	2	Reduces source area concentrations to biodegradable concentrations and would likely prevent plume migration offsite.	3	6	
Attainment of Cleanup Standards	2	Highly likely capable of achieving clean up standards.	3	6	
Source Control	2	Over 95% of source would be removed.	3	6	
Compliance with Applicable Waste Management Standards	2	Extracted groundwater would need to be treated prior to discharge under agreement with the local POTW.	3	6	
<b>Secondary Criteria</b>					
Long-term Reliability and Effectiveness	1	Up to 5 years may be required for enhanced MNA processes to reduce VOC concentrations to MCLs.	3	3	
Reduction of Toxicity, Mobility, or Volume	1	Source material will be treated onsite. Bioprocesses will reduce toxicity, mobility, and volume of residual contamination.	3	3	
Short-term Effectiveness	1	Risk to site workers is minimal.	2	2	
Implementability	1	Technology is easily implementable.	2	2	
Cost	1	Costs slightly less than Alternative 3, and about 15% more than Alternatives 2 and 4.	2	2	
<b>Ranking Score</b>				<b>36</b>	

**Notes:**

- 1 — Weighting factor (WF) assigned by project team consensus.  
 2 — Primary criteria-specific evaluation score: 0 — criteria not met; 1 — criteria may be met; 2 — criteria met; 3 — criteria exceeded. Secondary criteria-specific evaluation score: 0 — poor; 1 — below average; 2 — average; 3 — above average

Table 5.13  
 Soil Alternative Evaluation Results

Evaluation Criteria	Alt. 1: No Further Action	Alt. 2: Enhanced MNA	Alt. 3a: Excavation with Offsite Disposal	Alt. 3b: Excavation, Onsite Thermal Desorption, and Replacement	Alt. 4: Dual-phase Vacuum Extraction with Enhanced MNA	Alt. 5: Six Phase Heating and Dual-phase Vacuum Extraction with Enhanced MNA
Primary Criteria	Score x WF	Score x WF	Score x WF	Score x WF	Score x WF	Score x WF
Protection of Human Health and the Environment	0	2	4	4	4	6
Attainment of Cleanup Standards	0	2	4	4	4	6
Source Control	0	0	6	6	6	6
Compliance with Applicable Waste Management Standards	6	4	2	4	6	6
<b>Secondary Criteria</b>						
Long-term Reliability and Effectiveness	0	1	2	2	2	3
Reduction of Toxicity, Mobility, or Volume	0	1	2	3	2	3
Short-term Effectiveness	3	3	1	1	2	2
Implementability	3	3	1	1	2	2
Cost	3	3	1	1	2	2
<b>Ranking Score</b>	<b>15</b>	<b>19</b>	<b>23</b>	<b>26</b>	<b>30</b>	<b>36</b>

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## 6.0 RECOMMENDATIONS

Selection of the recommended alternative was based on primary and secondary criteria evaluation, remedial alternative comparative analysis, and professional judgment. Based on the rationale and decision factors in the previous sections, Alternative 5, Six Phase Heating (SPH) and Dual Phase Vacuum Extraction with Enhanced MNA was selected for several key reasons:

- Alternative 5 achieved the highest score on the *Project Team Evaluation Table* and is the alternative most likely capable of achieving the cleanup goal of MCLs in groundwater.
- Alternative 5 satisfies all 4 of the primary evaluation criteria. Alternatives 1 and 2 did not.
- Alternative 5 would be the most requiring the least amount of time (likely less than 5 years) to achieve cleanup goals.
- Alternative 5 is more easily implemented than Alternative 3, which would result in a temporary large excavation which could present a physical hazard to nearby residents or high school students.
- Although this alternative requires the most substantial capital investment, present worth is comparable with the other alternatives due to reductions in long-term operation and maintenance costs.
- Alternative 5 allows for unrestricted reuse and redevelopment of the site following completion of remedial actions.

**7.0 PUBLIC INVOLVEMENT PLAN**

**7.1 General**

The following Public Involvement Plan (PIP) is included as part of this report in accordance with the USEPA's guidance on RCRA CMS. This PIP reflects and summarizes information prepared and presented in the U.S. Navy's Community Relations Plan (CRP), prepared for CNC in 1995.

Under RCRA, there is no required interaction with the community during the Corrective Measures Study process. Public input is required to be solicited only at the beginning of the permitting process, or during certain permit modifications. Therefore, the U.S. Navy has outlined a voluntary program of informing local communities throughout the entire RCRA Corrective Action process. Activities are detailed in the 1995 CRP for the CNC.

However, because the CMS process results in a modification to the facility's RCRA permit, certain provisions are made to solicit the public's input on the preferred alternative (as the reason for the modification). The requirements are identical to those required for a draft permit. As described in Section 7.4, the request for public input is typically made during the Statement of Basis process.

Two primary objectives are stated in the CRP:

- To initiate and sustain community involvement.
- To provide a mechanism for communicating to the public.

**7.2 RFI Public Involvement Plan**

To achieve these objectives, the CRP identifies public involvement and outreach activities at each step of the Corrective Action process. For example, the following activities have been designated for the completion of the RFI. All have been accomplished.

- Update and publicize the information repository. 1
  - Continue to publicize the point of contact. 2
  - Update the mailing list. 3
  - Distribute fact sheets and/or write articles to explain RFI findings. 4
  - Inform community leaders of the completion and results of the RFI. 5
  - Update and continue to provide, whenever possible, presentations for informal community groups. 6  
7
  - Update the community on results of the RFI through public Restoration Advisory Board meetings. 8  
9
- 7.3 CMS Public Involvement Plan** 10
- During the Corrective Measures Study, the following activities will be carried out as part of the U.S. Navy’s current and ongoing community involvement program. 11  
12
- Distribute a fact sheet and/or write articles for publication that report CMS recommendations. 13  
14
  - Continue to update the mailing list. 15
  - Continue to respond to requests for speaking engagements. 16

- Update the community on CMS status through public Restoration Advisory Board meetings. 1  
2

**7.4 Statement of Basis Public Involvement Plan** 3

Upon completion of the Corrective Measures Study (when the preferred alternative has been proposed) the following activities are required: 4  
5

- A Statement of Basis will be prepared, explaining the proposed remedy and the method by which it was chosen. 6  
7
- A 45-day comment period will be provided to allow community members the opportunity to review and comment on the preferred alternative. 8  
9
- The availability of the comment period and Statement of Basis will be announced in a public notice. 10  
11
- The community will be provided an update on the preferred remedy through the informal and publicized Restoration Advisory Board meetings. 12  
13

In addition, the following activities will be carried out, as identified in the CRP: 14

- Update and publicize the information repository. 15
- Publicize the environmental point of contact. 16
- Continue to update the mailing list. 17

**7.5 Restoration Advisory Board**

The RAB is a key component of this community outreach program. It is through the RAB that the U.S. Navy has a regular, scheduled, and publicized forum for interfacing with community members on the progress of the environmental program, including the CMS. In addition, RAB members are key instruments in measuring community interest in specific issues and knowledge of them. A Community Relations Subcommittee to the RAB has been tasked with identifying issues and information to be addressed by the U.S. Navy.

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**9.0 SIGNATORY REQUIREMENT**

Condition I.E. of the Hazardous and Solid Waste Amendments (HSWA) portion of the RCRA Part B Permit (EPA SCO 170 022 560) states: All applications, reports, or information submitted to the Regional Administrator shall be signed and certified in accordance with Section 40 CFR 270.11. The certification reads as follows:

*I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fines and imprisonment for knowing violations.*

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Henry N. Sheppard II, P.E.  
Caretaker Site Office, Charleston

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Date

**APPENDIX A**  
**AQUIFER PUMPING TEST**

## **A.1 INTRODUCTION**

During the week of February 1, 1999, aquifer characterization testing was conducted at AOC 607 in Area F to enhance estimates of aquifer characteristics and investigate the feasibility of a groundwater extraction/dewatering remedial alternative. This aquifer characterization test was comprised of several separate phases that are listed below and described in Section A.2.

### **Aquifer Test Phases:**

Phase 1 Ambient condition monitoring

Phase 2 Step drawdown testing

Phase 3 Constant-rate pumping test

Phase 4 Recovery monitoring

The aquifer characterization tests were designed to achieve the following objectives:

### **Objectives:**

- To determine the optimal pumping rate for potential extraction/dewatering wells.
- To refine present estimates of the aquifer parameters.
- To determine the areal extent or radius of influence for a pumping/dewatering well.
- To determine if groundwater pumping/dewatering is a feasible remedial alternative.

## **A.2 AQUIFER CHARACTERIZATION TEST**

After an initial round of water levels were collected, the pump, transducers, data loggers, rain gauge, and any other necessary equipment were installed and set up. Next, operation of the pump and data loggers was tested, the data loggers were programmed, and transducers and water level indicators were calibrated.

### **A.2.1 Monitoring Equipment and Observation Wells**

To improve measurement accuracy and reduce manpower requirements, water levels in the pumping well and six nearby observation wells were measured using pressure transducers and automatic data loggers. Clocks on the data loggers were synchronized with each other before testing began. Water levels in most of the other site wells were monitored intermittently by hand.

**Table A.1**  
**Observation wells monitored with data loggers**

607-PW1 (pumping well)  
607-P01  
607-P1D  
607-P02  
607-P2D  
607-04I  
607-009

The effects of barometric pressure change on the aquifer were investigated during each phase of the test. Pressure changes were monitored with a barometric pressure transducer connected to a data logger.

### **A.2.2 Phase 1, Ambient Condition Monitoring**

Ambient monitoring parameters including barometric pressure and static water level changes were monitored for several days prior to the first test and during each phase of testing. Ambient water level monitoring was conducted to identify potential tidal influences, precipitation recharge, an/or pumping influences of any unidentified area groundwater production wells. Barometric pressure was also monitored continuously during the ambient phases of the test to assess its potential influence on water levels.

Monitoring wells 607-009 and -04I were selected as representative of ambient conditions because its distance from the pumping well was likely sufficient to preclude any effects related to the groundwater extraction being performed as part of this test. Ambient monitoring indicated both

tidal influence and steady drop in water levels throughout the aquifer testing period. Ambient monitoring did not indicate the presence of any operating production wells near the site.

### A.2.3 Phase 2, Step Drawdown Testing

Step drawdown testing involves pumping a well at increasingly greater discharge rates (steps) while monitoring drawdown in the well. By comparing each discharge rate with the corresponding drawdown, the optimum pumping rate for the tested well can be estimated.

A step drawdown test on PW-1 was started at 12 noon on January 27, 1999 with a flow rate of approximately 0.64 gallons per minute (gpm). Groundwater from the pumping well was routed through two 55-gallon activated carbon tanks and then to the sanitary sewer. Influent and effluent samples were collected and analyzed for VOC concentrations on approximately 12 hour intervals during pumping periods.

During the test, the pumping rate was stepped up 4 times. The pumping rate, stabilized drawdown, and duration of each step is presented in Table A.2. Figure A.1 is a graph of the drawdown curve from the step test.

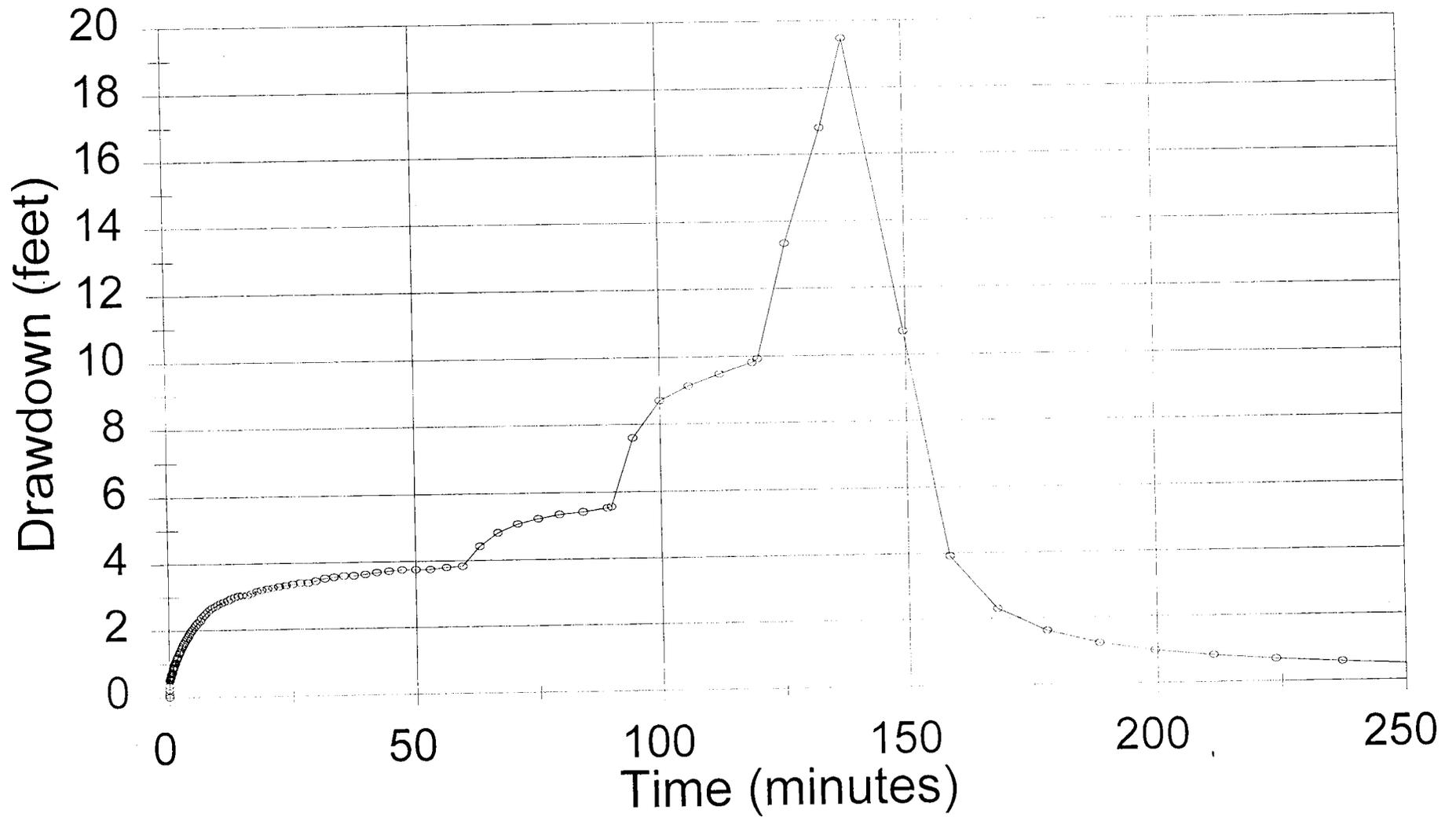
**Table A.2**  
**PW-1 Step Test Data**

<b>Step</b>	<b>Pumping Rate (gpm)</b>	<b>Drawdown (feet)</b>	<b>Duration (minutes)</b>
1	0.64	3.85	60
2	0.79	5.56	30
3	1.20	9.92	30
4 <sup>a</sup>	1.65	19.48	18

Note: a - Step 4 never stabilized and was approaching total drawdown.

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## PW-1 Step Test



#### **A.2.4 Phase 3, Constant-Rate Aquifer Test**

a constant-rate pumping test involves pumping a well at a constant discharge rate while simultaneously recording water levels in pumping and observation wells and the time elapsed from the start of pumping. The water level/elapsed-time measurements are used to estimate aquifer characteristics (hydraulic conductivity, storativity, etc.)

Two constant-rate pumping tests were conducted on PW-1 at different pumping rates. Test 1 started at 12 noon on February 3, 1999 and was conducted for 31 hours. The pumping rate for this test was 1 gpm. Data from this test were used to calculate the aquifer parameters presented in this report.

Test 2 started at 0800 on February 6 with a pumping rate of 1.3 gpm. This test was conducted to provide greater stressing of the aquifer and investigate whether the higher pumping rate could be sustained. This test lasted 8.38 hours before excessive drawdown caused the pump to break suction and shut down. No aquifer parameters were calculated from this test.

At 13:45 on February 7, a third test was conducted at AOC 607 on well P-01 to investigate the recharge potential of the shallow aquifer. This test only lasted 39 minutes because the well went dry at 0.18 gpm. Due to the short duration and total drawdown, no aquifer parameters were obtained from this test.

#### **A.2.5 Phase 4, Recovery Monitoring**

Recovery tests involve monitoring the rise of water levels back to static conditions after pumping has stopped. Recovering water levels are recorded with the time elapsed after pump shutoff and the relationships between pumping rate, pumping duration, and recovery time are used to estimate aquifer characteristics. Generally, recovery data provide a means to double-check the results obtained during the constant-rate test.

After testing, the transducers were removed and decontaminated. The data loggers were taken to the office and the data was downloaded to a PC.

#### **A.2.6 Equipment Decontamination**

To prevent cross-contamination, water level indicators, pressure transducers, and other equipment that came in contact with contaminated groundwater was decontaminated before and after each use.

#### **Decontamination Steps:**

1. Equipment was washed with soap and water.
2. Equipment was rinsed with potable water.
3. Equipment was rinsed with deionized water.

### **A.3 DATA MANAGEMENT AND MANIPULATION**

#### **A.3.1 Drawdown Corrections**

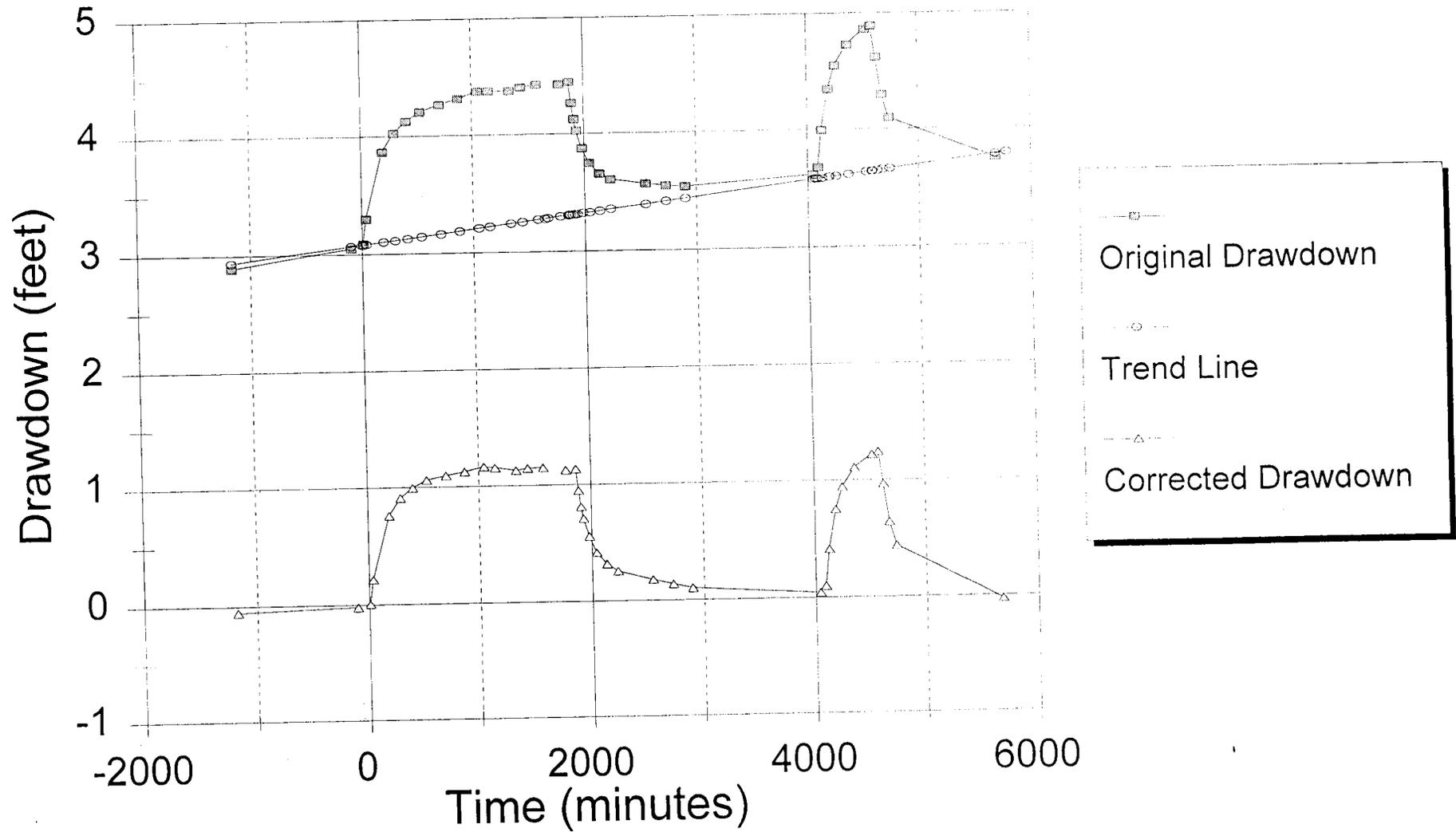
Drawdown data were evaluated for correlation with barometric pressure and ambient water level trends. Barometric pressure was determined to have a negligible effect on water levels, and therefore, was not corrected for. Throughout the first constant-rate test, ambient water levels steadily dropped between 0.27 (at 05D) and 1.21 (at P-01) feet across the site. In order to have representative drawdown data, this ambient trend had to be subtracted from each well's drawdown curve.

#### *Water Level Trend Correction*

First a linear regression line is calculated for the trend using water level points from before and after the test. Then the y-axis value (drawdown) of the trend line is subtracted from each data point on the original drawdown curve. These new corrected y-axis values are then plotted with their corresponding x-axis values (time) to produce the corrected drawdown curve. Figure 2 shows an example of this correction procedure conducted on 06I. The raw drawdown curves for all the observation wells are presented in Attachment 1 along with the corrected drawdown curves for wells that were corrected.

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## 06I Trend Correction



### A.3.2 Data Reduction and Compilation

Trend-corrected data from the pumping tests were compiled using the computer program Aquifer Test Solver (AQTESOLV) for Windows by HydroSOLVE, Inc. (1998). AQTESOLV has several widely published and accepted analytical solutions for many different kinds of aquifer tests. Specifically, a drawdown model associated with leaky confined aquifers was used to estimate aquifer characteristics.

#### *Pumping Test Results*

Data from the constant-rate tests were entered in AQTESOLV and plotted using a leaky confined solution developed by Hantush and Jacob (1955). This method uses time (elapsed) plotted against displacement (drawdown) on logarithmic graph paper to calculate aquifer transmissivity (T) and storativity (S). The AQTESOLV graphs are presented in Attachment 2 of this report.

Table 2 presents the transmissivity (T), hydraulic conductivity (K) and storativity (S) results of the first constant-rate test.

**Table 2**  
**Constant-Rate Test Results**

Observation Well	T (ft <sup>2</sup> /min)	K (ft/day)	S (unitless)
PW-1	0.005	0.48	0.05
P-1D	0.0078	0.75	0.001
P-2D	0.0094	0.9	0.0005
06I	0.017	1.63	0.0003
06D	0.0086	0.83	0.0009
Geometric Mean	0.0088	0.87	0.0015

Notes:  $T = K*b$ ; where  $b = 15$  feet at this site.

Because these aquifer parameters are lognormally distributed, the geometric mean is the best measure of central tendency. Therefore, the average for the site is presented as the geometric mean of all five wells combined.

Recovery data from the first test was analyzed to double-check the results obtained from the pumping phase. As Table 3 indicates, the recovery data had virtually the same geometric mean for each parameter as the pumping phase.

**Table 3**  
**Constant-Rate Test Recovery Results**

Observation Well	T (ft <sup>2</sup> /min)	K (ft/day)	S (unitless)
PW-1	0.005	0.48	0.03
P-1D	0.0087	0.84	0.0009
P-2D	0.011	1.1	0.0005
06I	0.03	2.88	0.0001
06D	0.005	0.48	0.001
Geometric Mean	0.009	0.86	0.0011

Notes: T = K\*b; where b = 15 feet at this site.

During the constant-rate test, only the five observation wells of Table 2 exhibited drawdown levels sufficient for analysis. However, many of the other observation wells were influenced by pumping. Test results indicate that the maximum radius of influence is about 240 feet in each aquifer zone. Table 4 lists the other observation wells that had measurable drawdowns, their corrected drawdown estimates, and their distance from the pumping.

**Table 4**  
**Observation Wells With Measurable Drawdown**

Observation Well	Drawdown (feet)	Distance (feet)
006	0.44	79
007	0.34	135
008	0.2	243
011	0.51	47
012	0.21	86
014	0.33	49
015	0.34	55
016	0.3	18

**Table 4**  
**Observation Wells With Measurable Drawdown**

017	0.52	15
01I	0.25	181
02I	0.52	165
03I	0.22	189
04I	0.27	240
01D	0.28	159
02D	0.34	172
03D	0.06	239
04D	0.23	185

Notes:  $T = K \cdot b$ ; where  $b = 15$  feet at this site.

Observation wells 001, 002, 003, 004, 009, 010, 013, P-01, P-02, and 05D either had negligible drawdown during the test or none at all.

#### A.4 REFERENCES

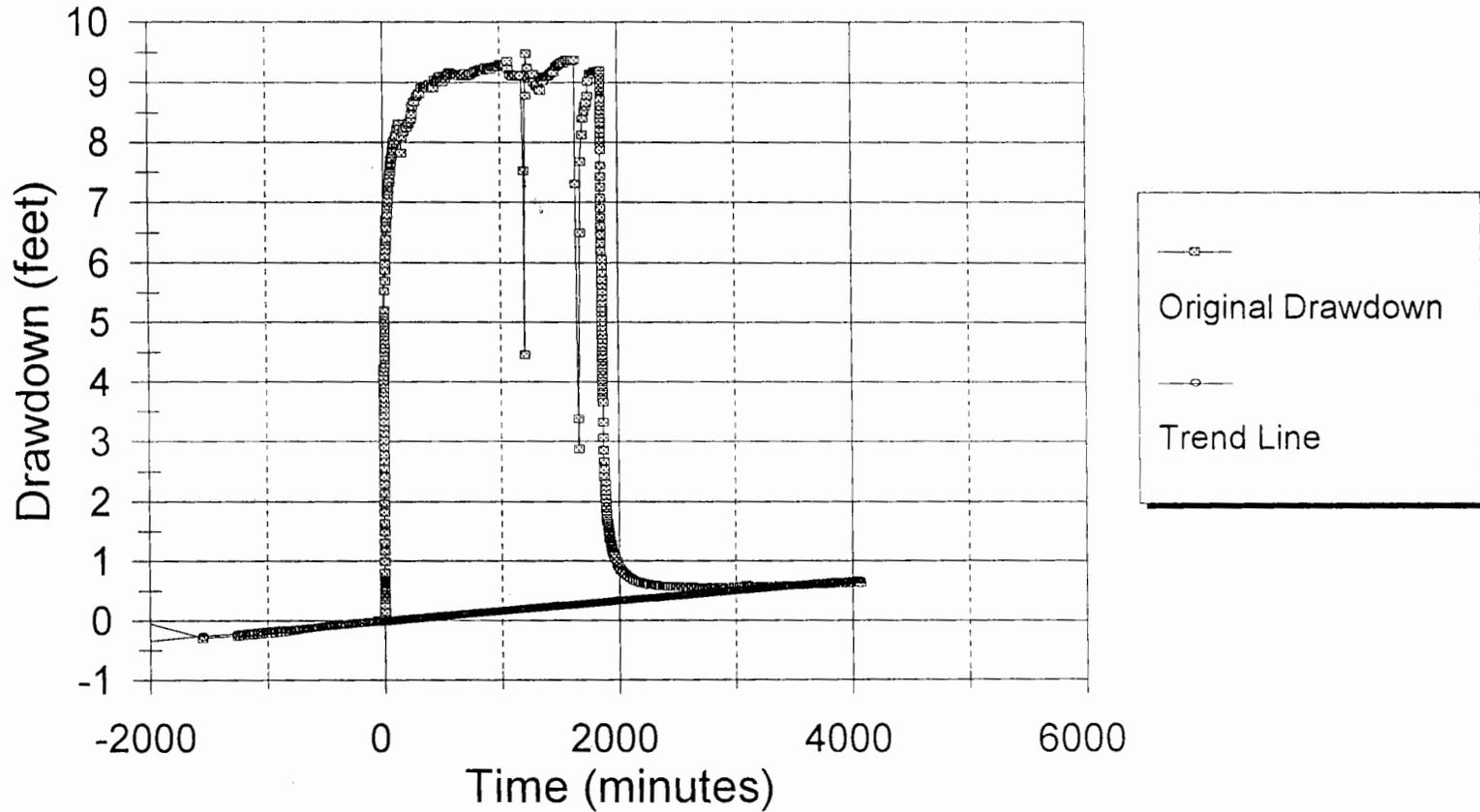
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**Attachment 1**  
**Corrected Drawdown Curves**

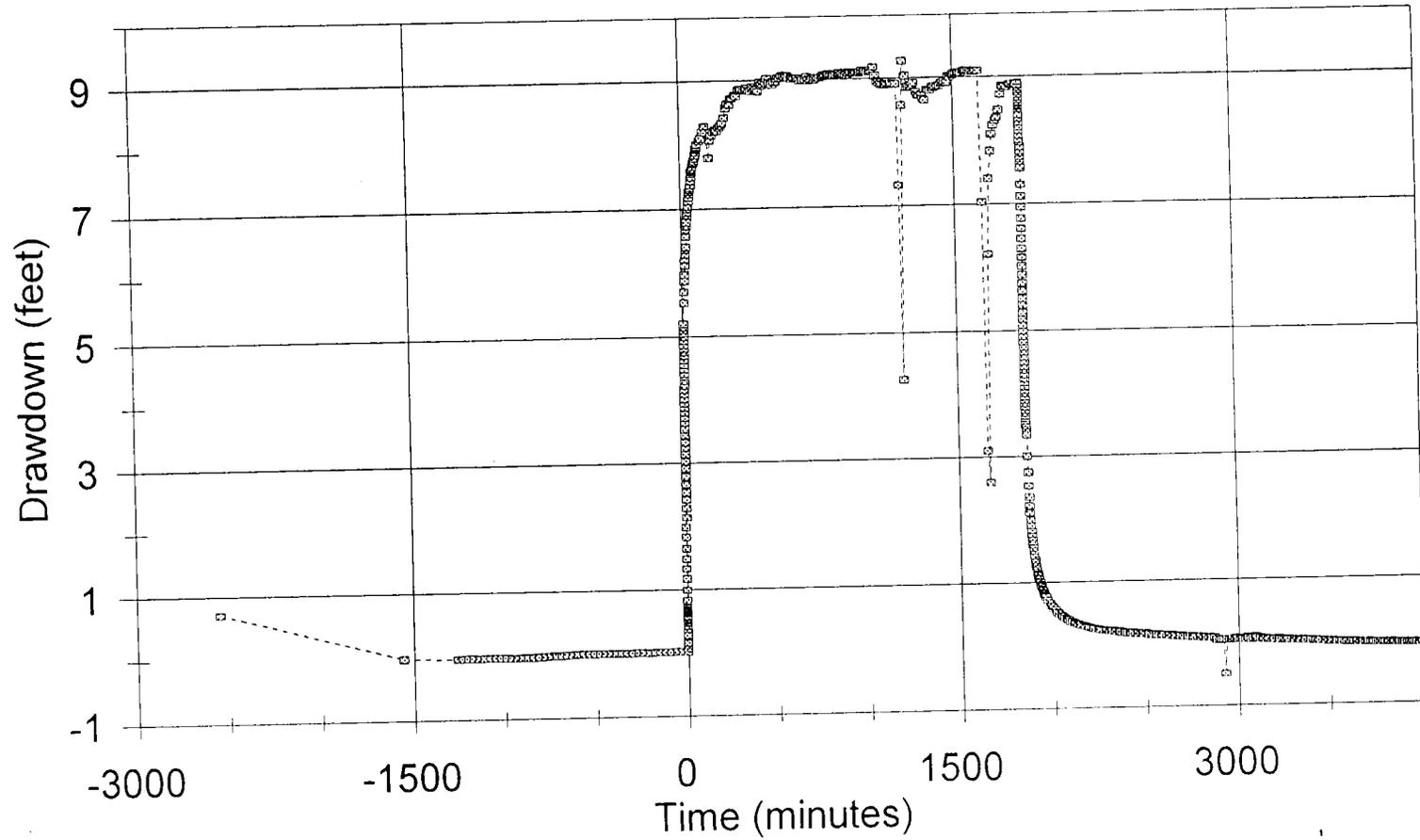
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## PW-1 Raw Data and Trend Line



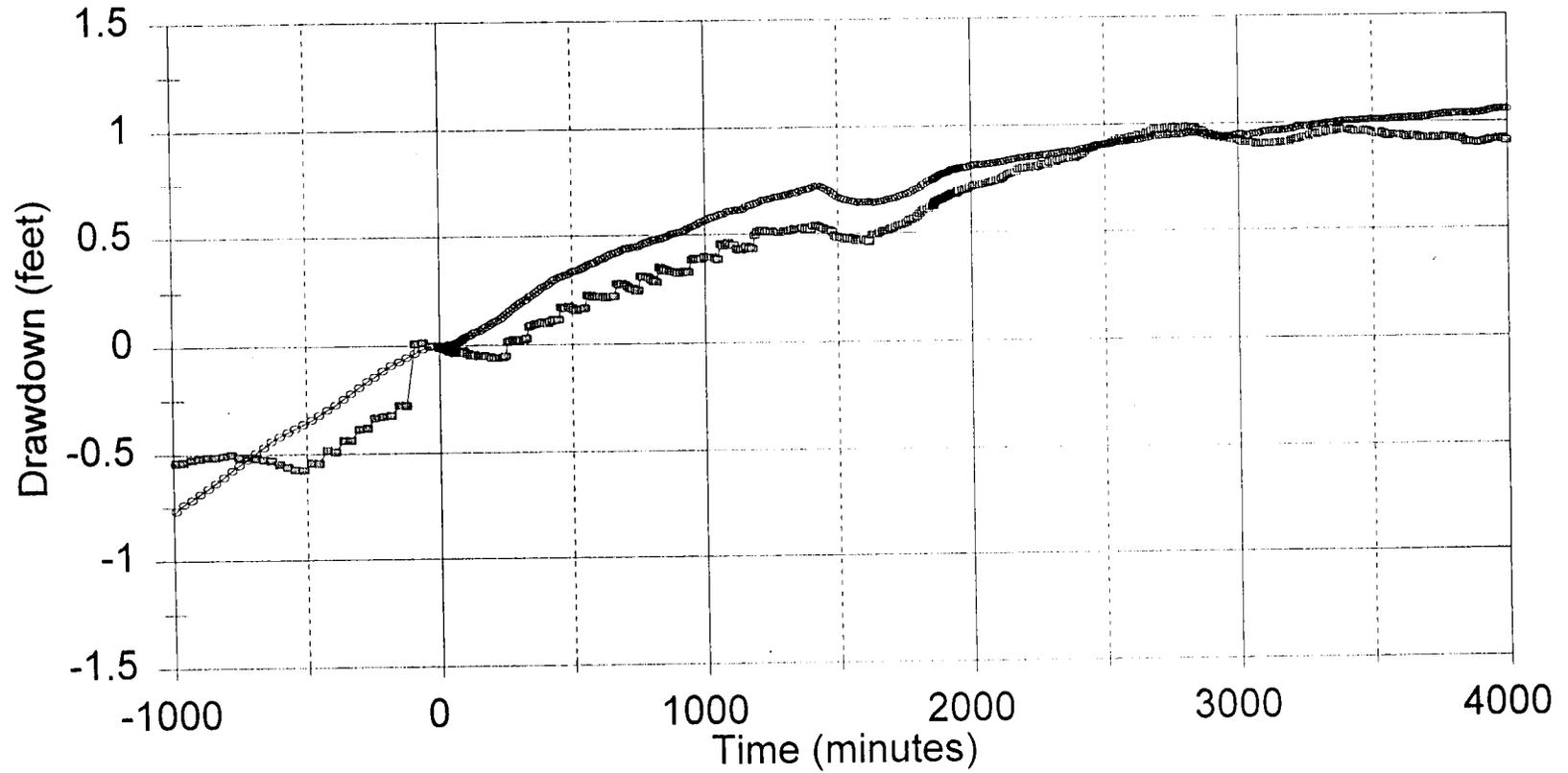
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## PW-1 Trend Corrected



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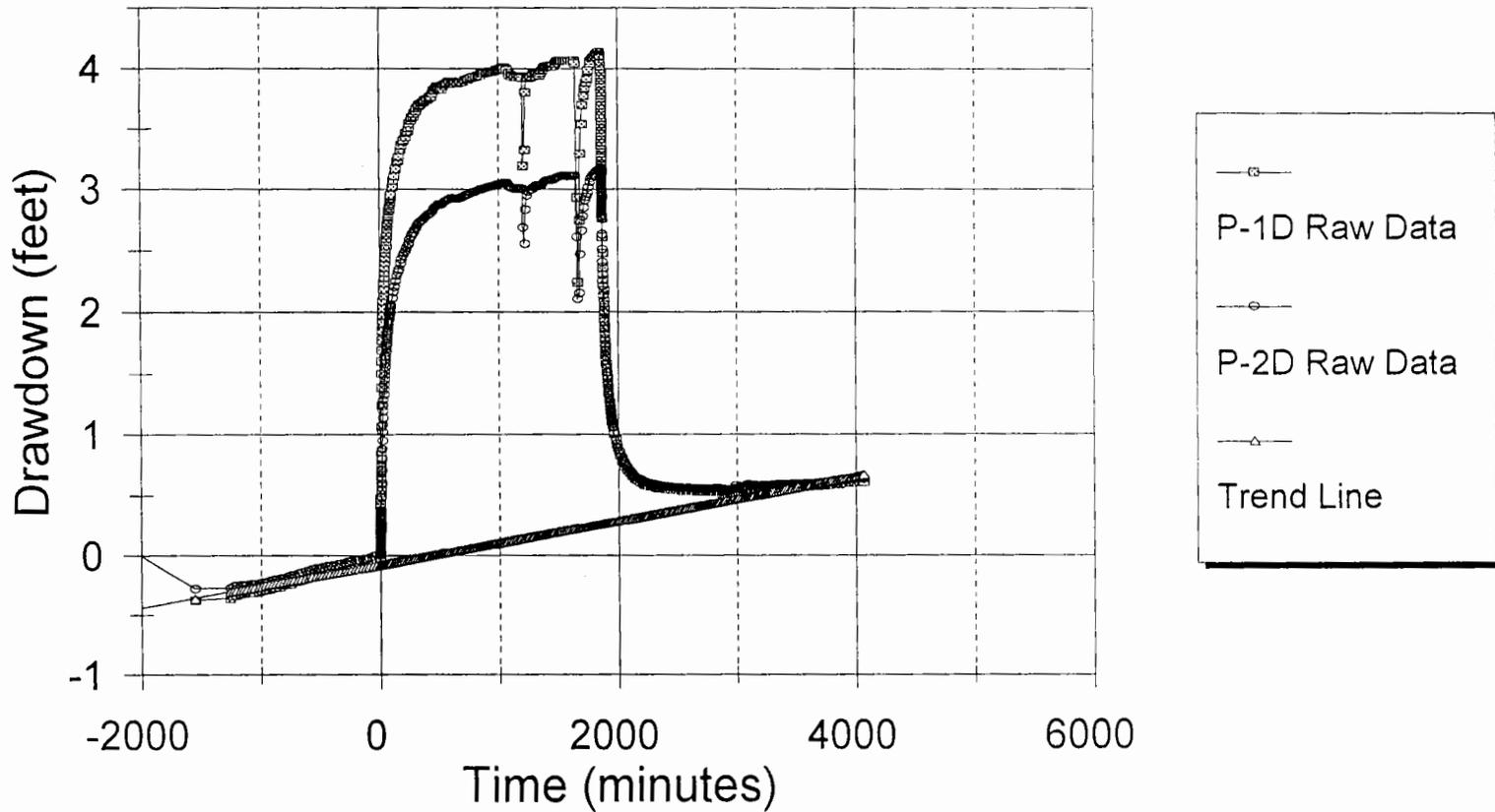
P-01 and P-02



—■— P-01    - - - ○ - - - P-02

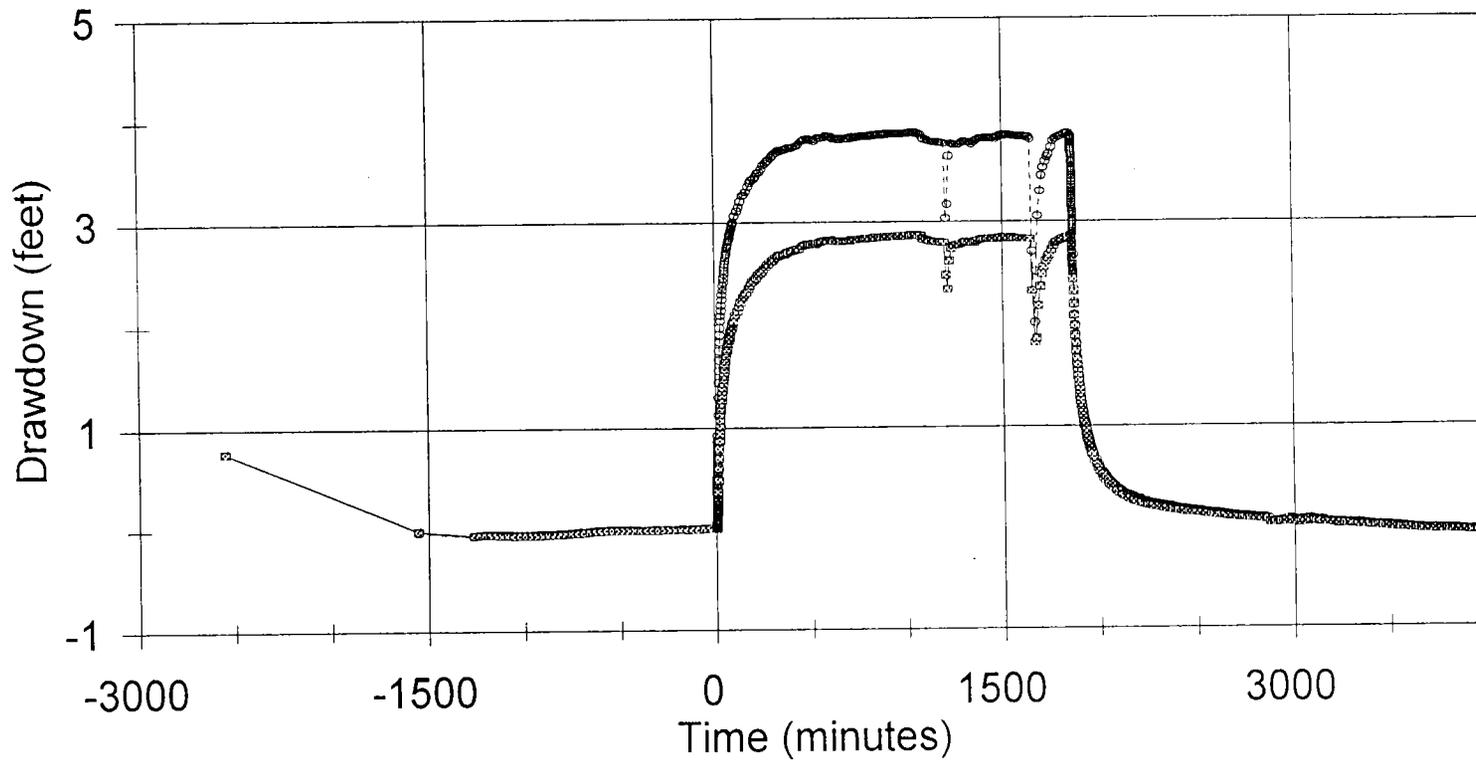
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## P-1D and P-2D Raw Data and Trend Line



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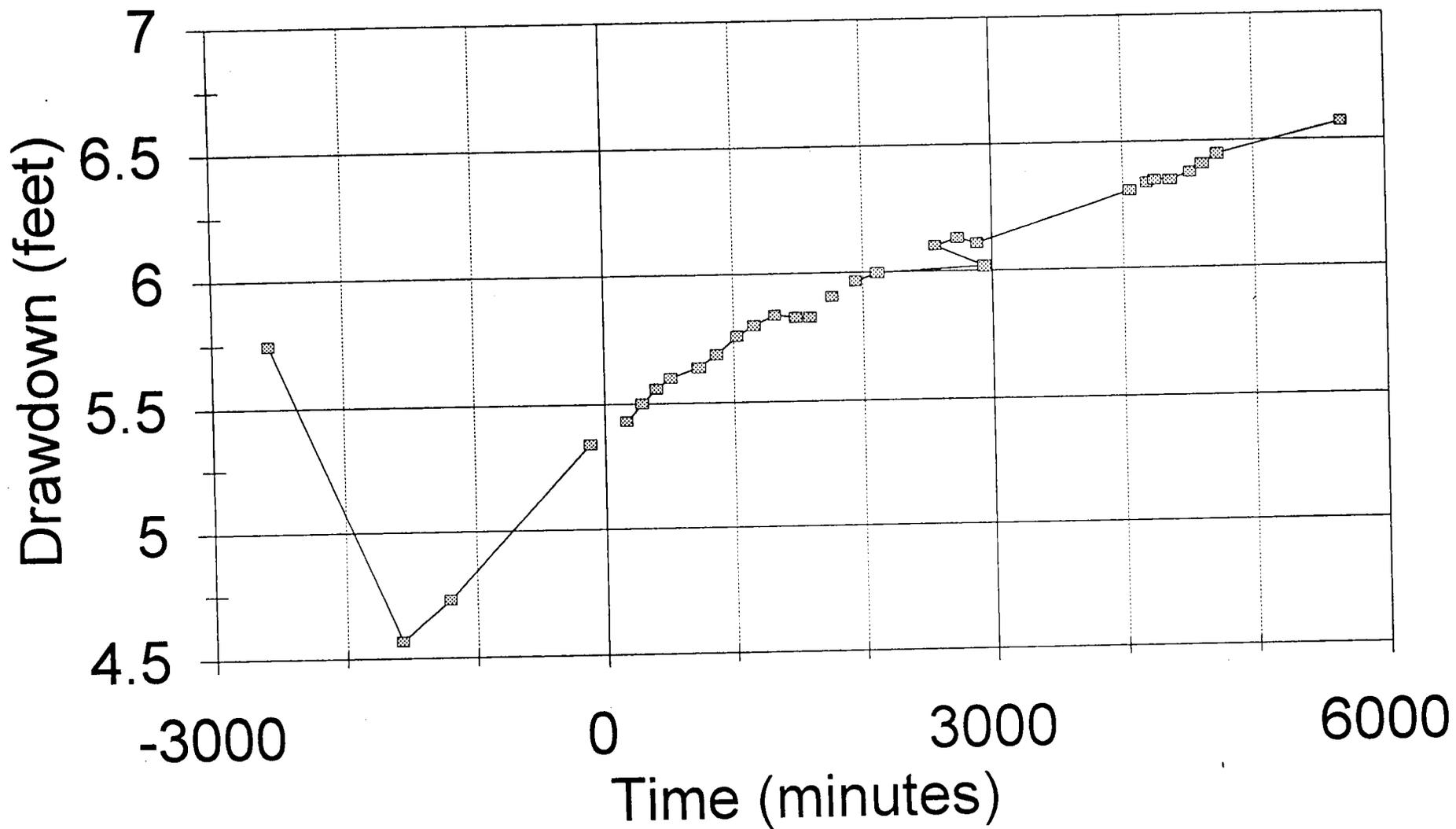
P-1D and P-2D Trend Corrected



---○--- P1D    —○— P2D

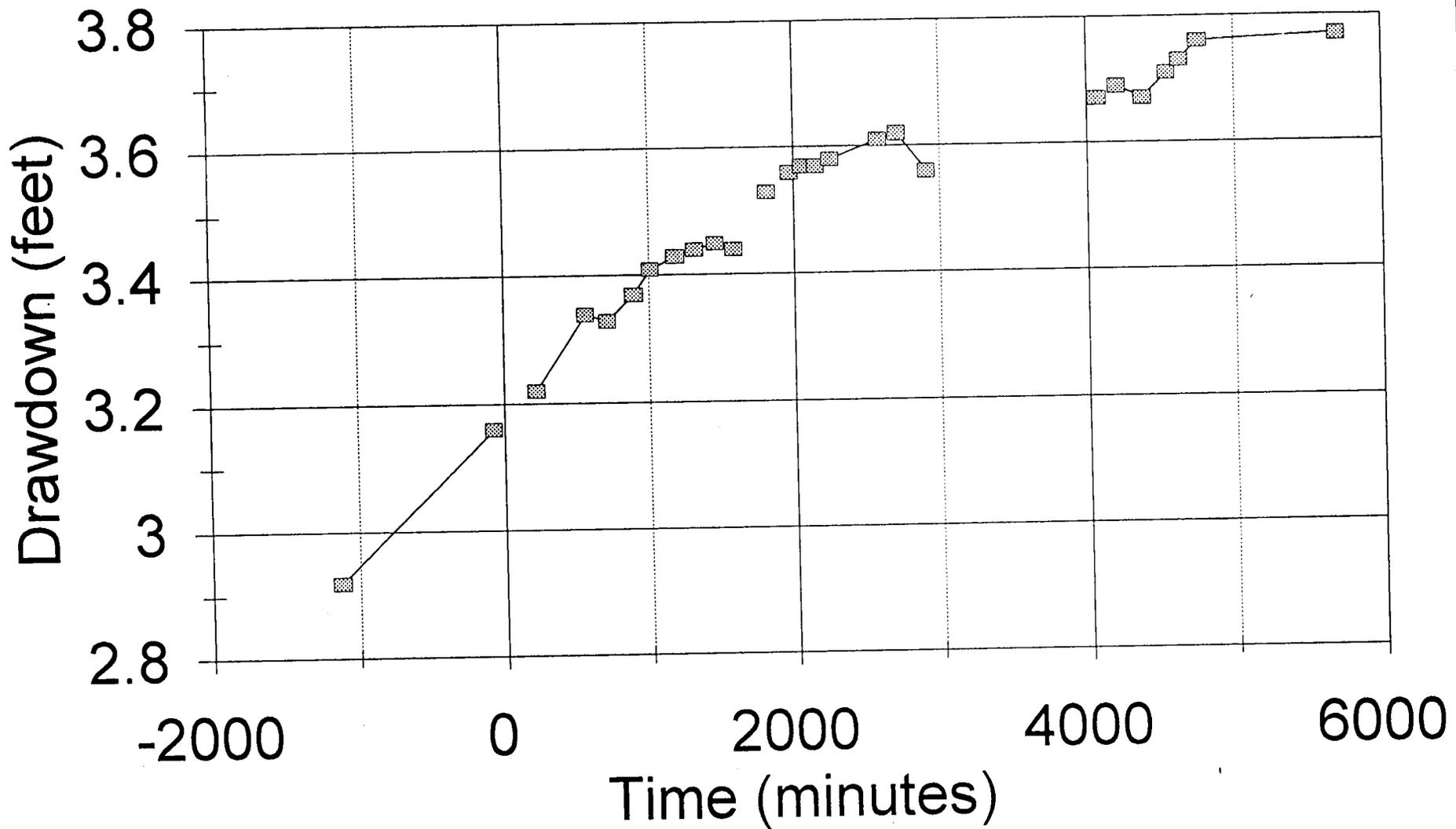
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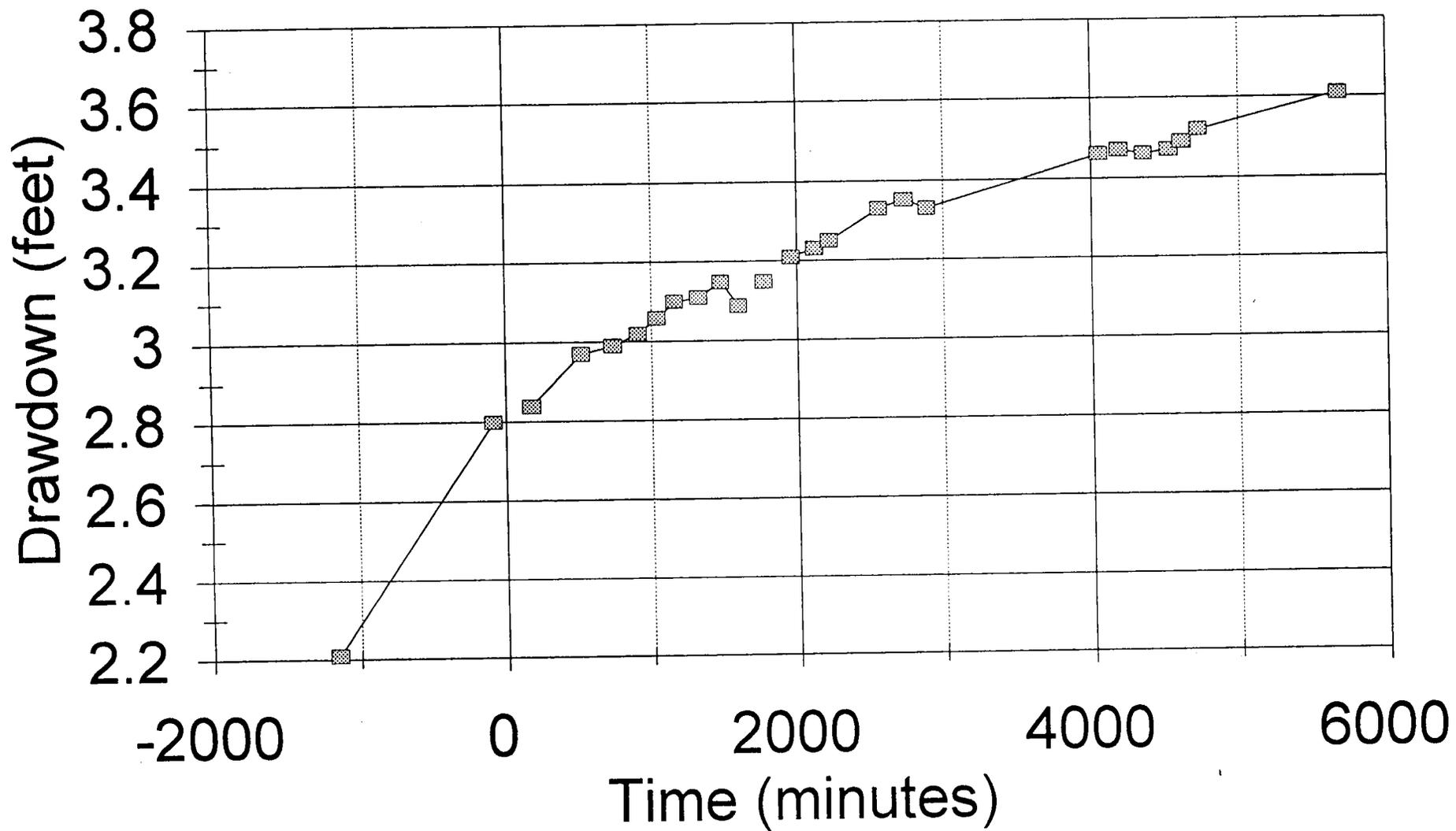
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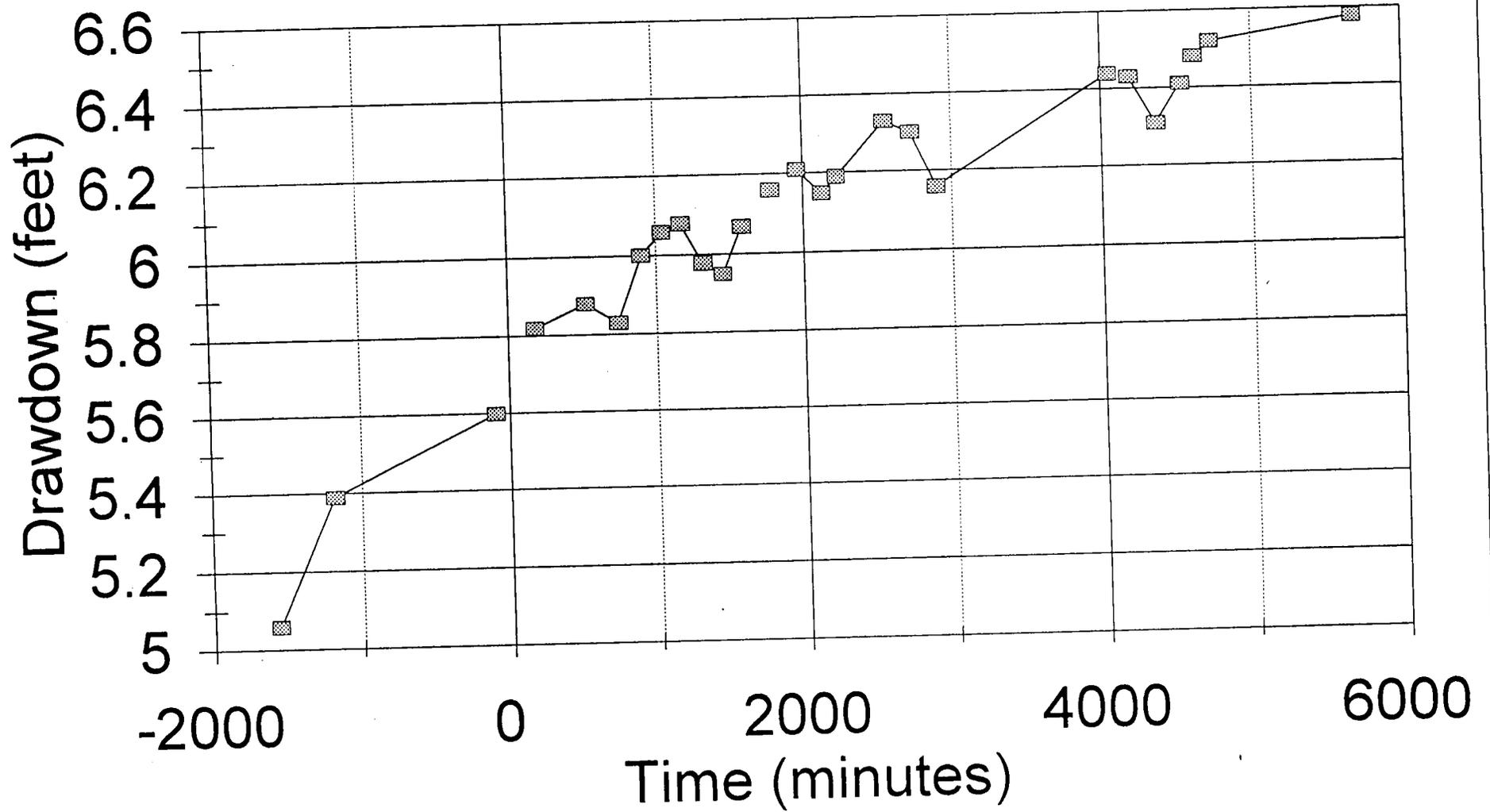
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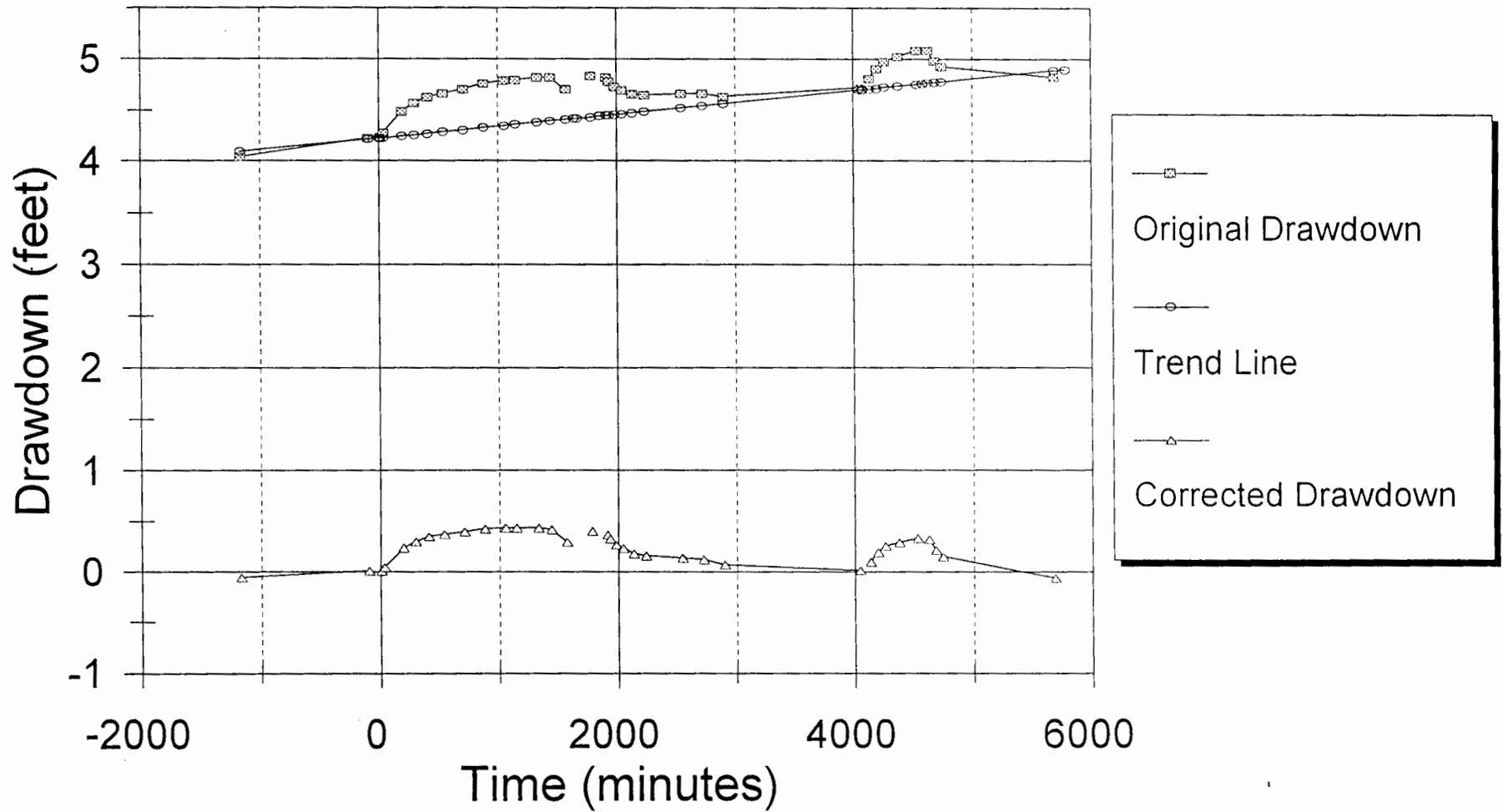
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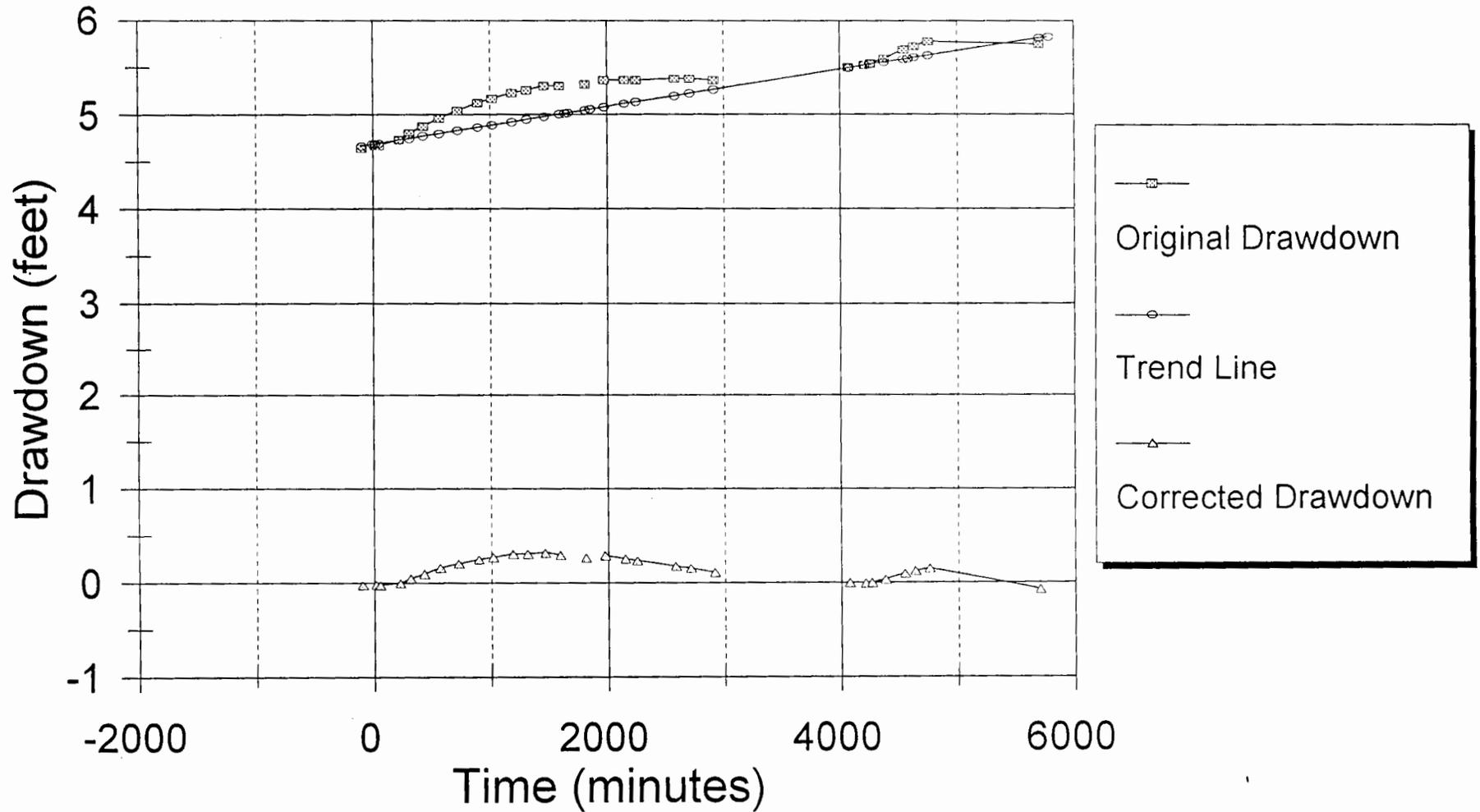
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## 006 Trend Correction



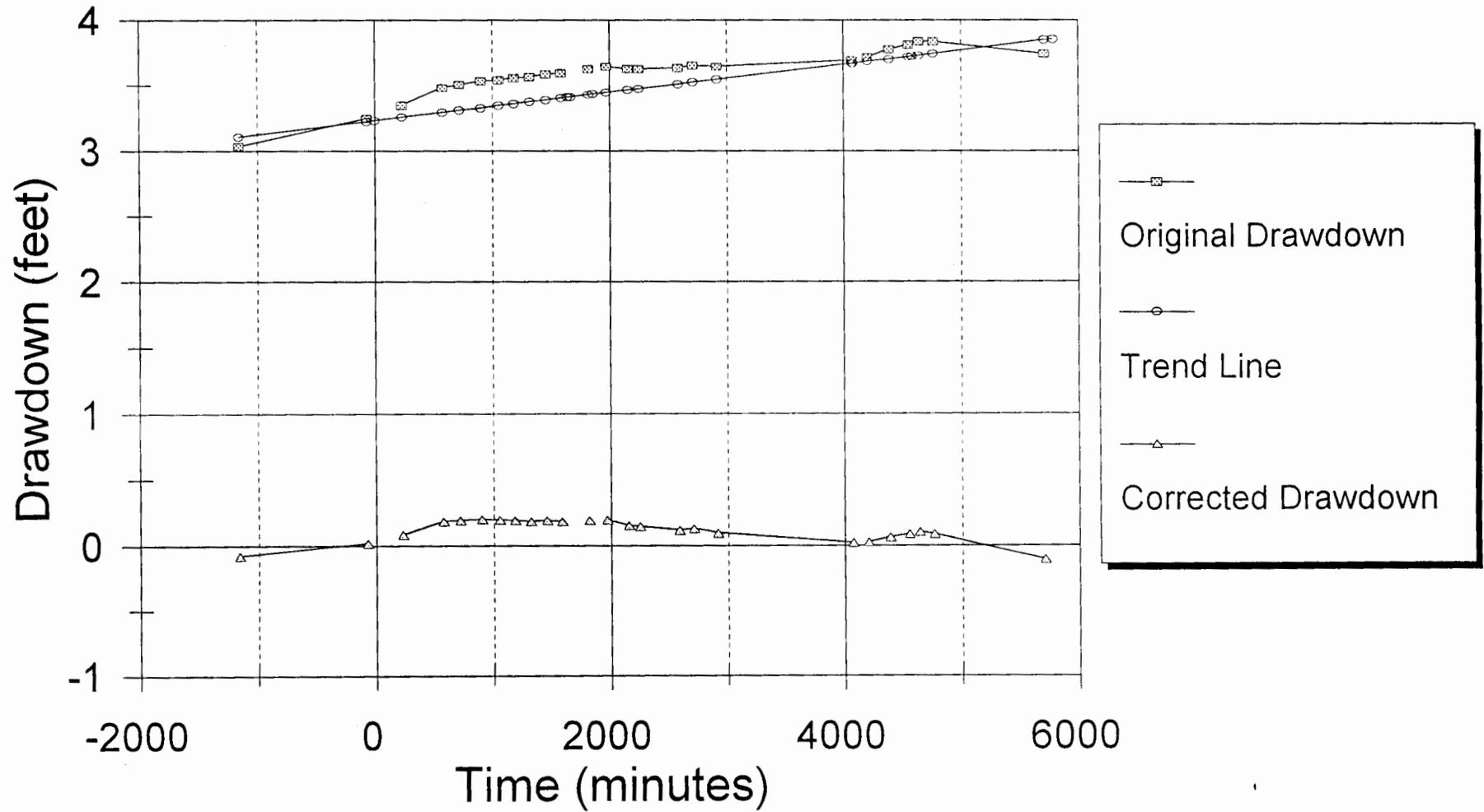
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## 007 Trend Correction



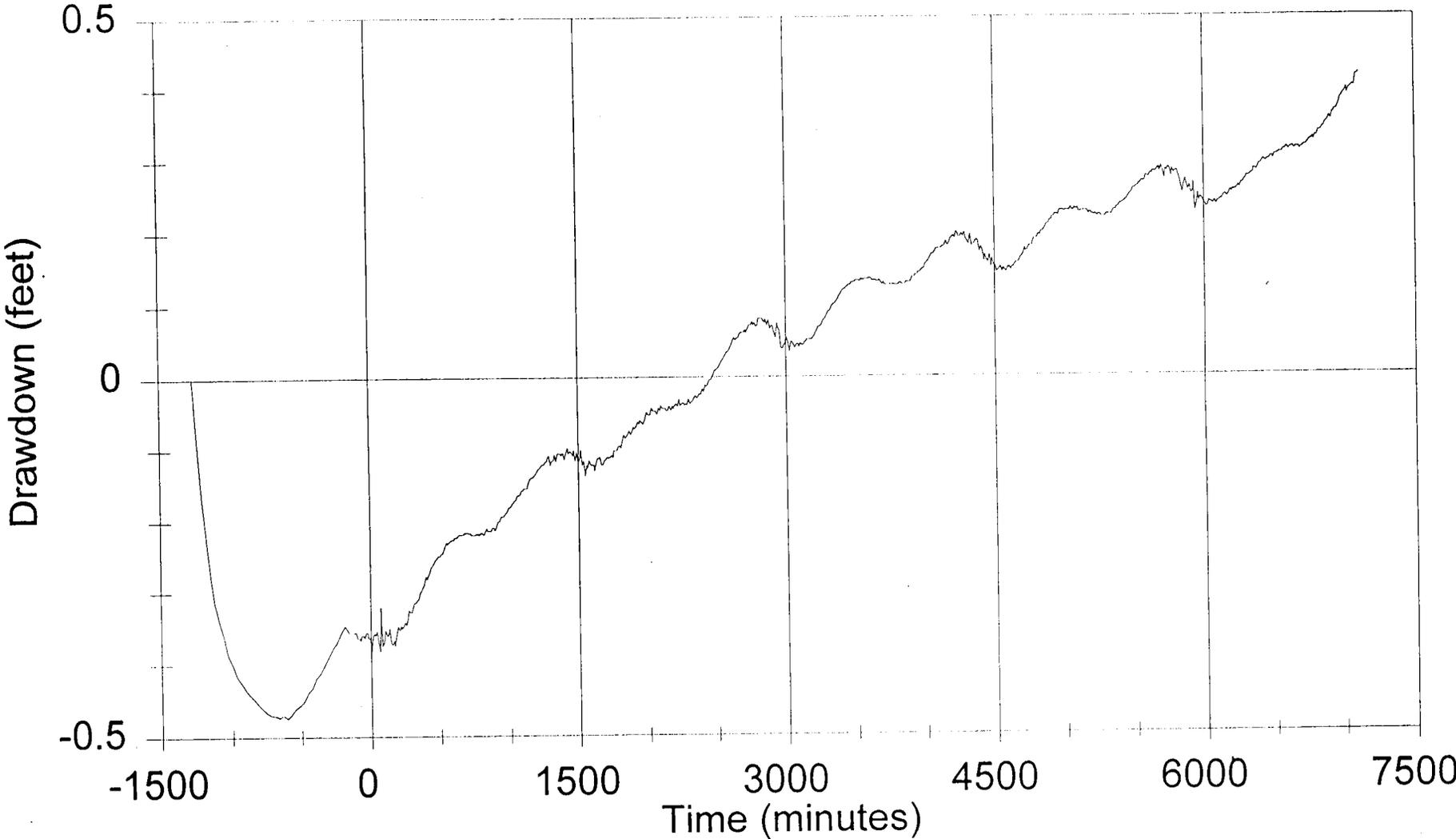
# ZONE F 607

## 008 Trend Correction



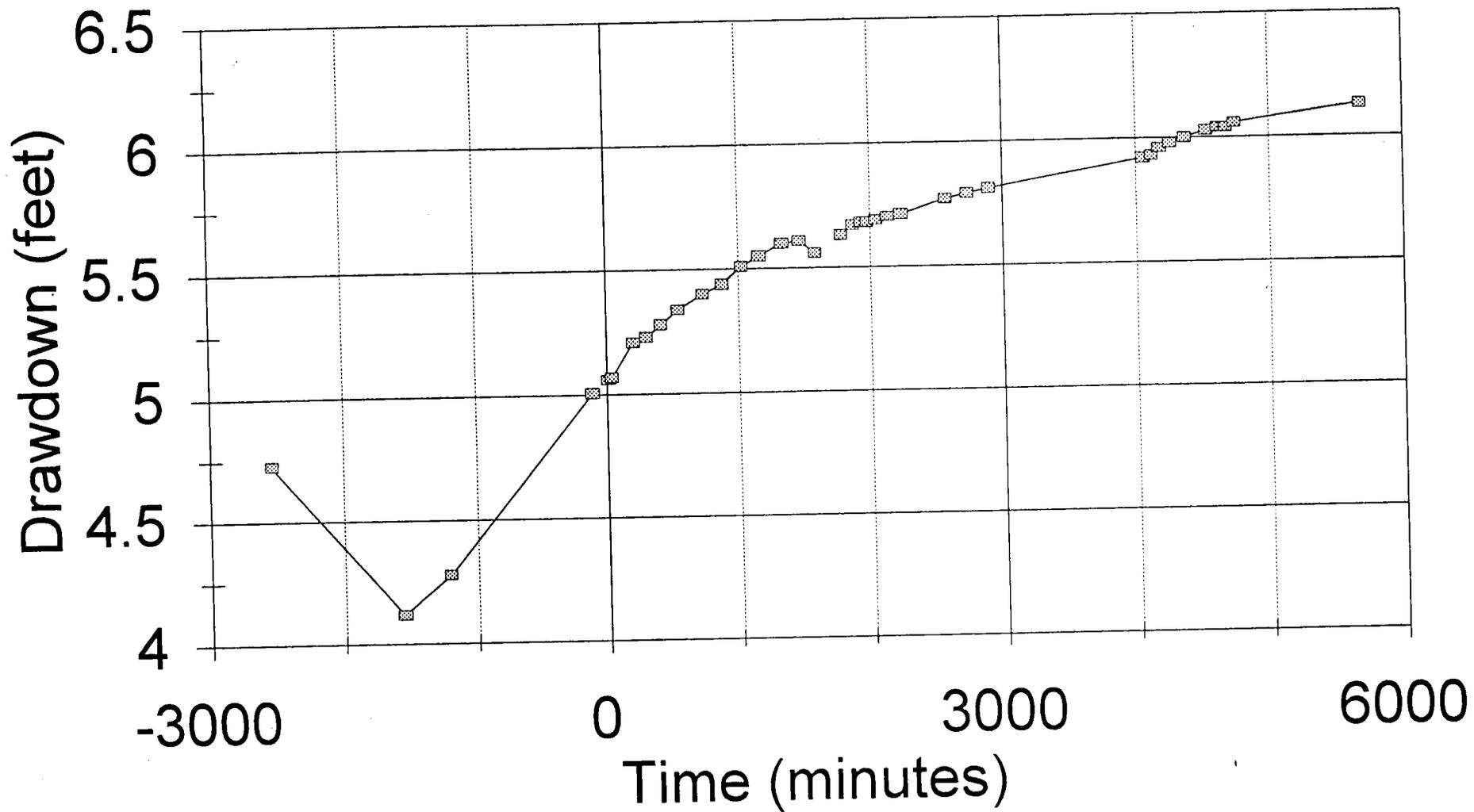
# ZONE F 607

009



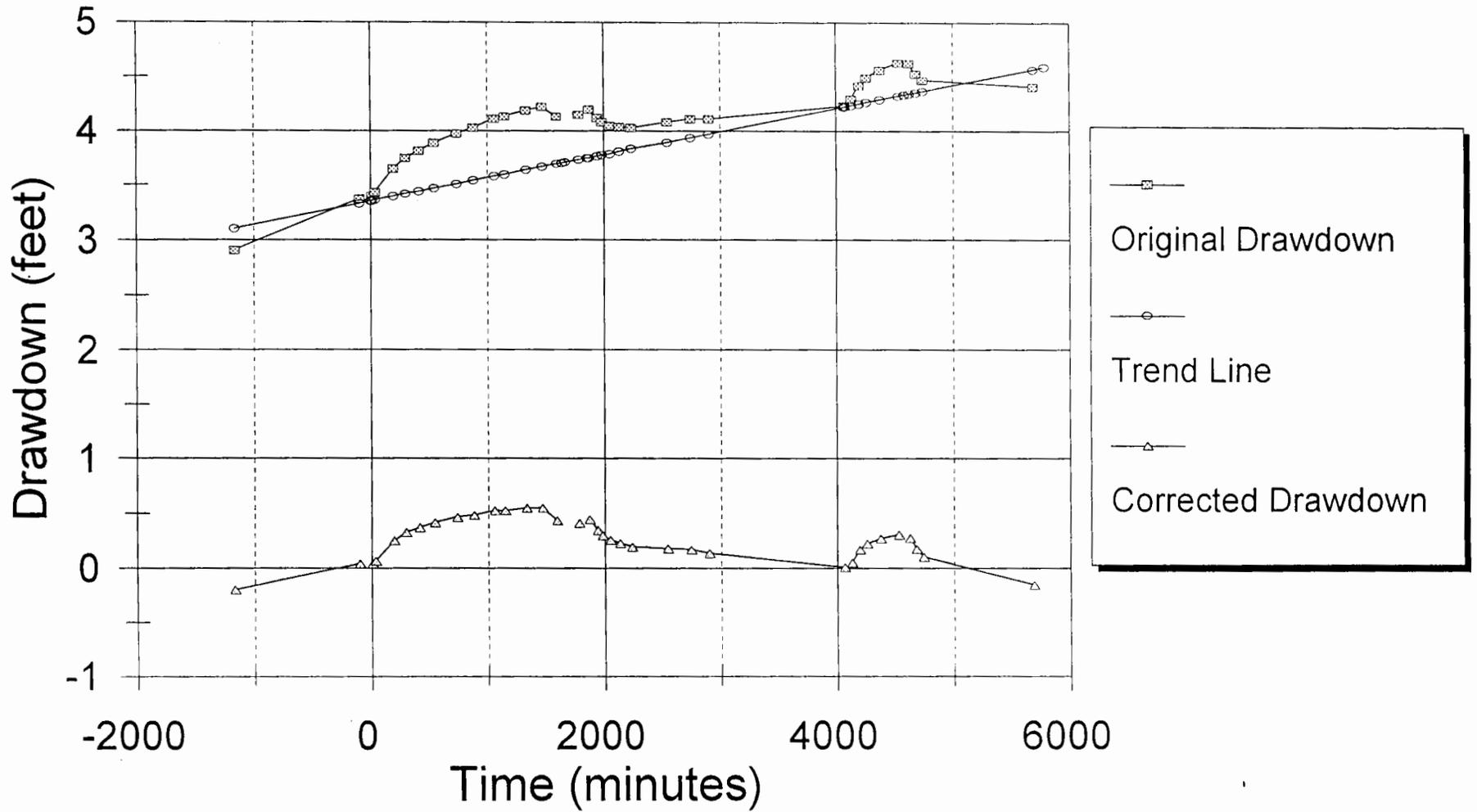
# ZONE F 607

010



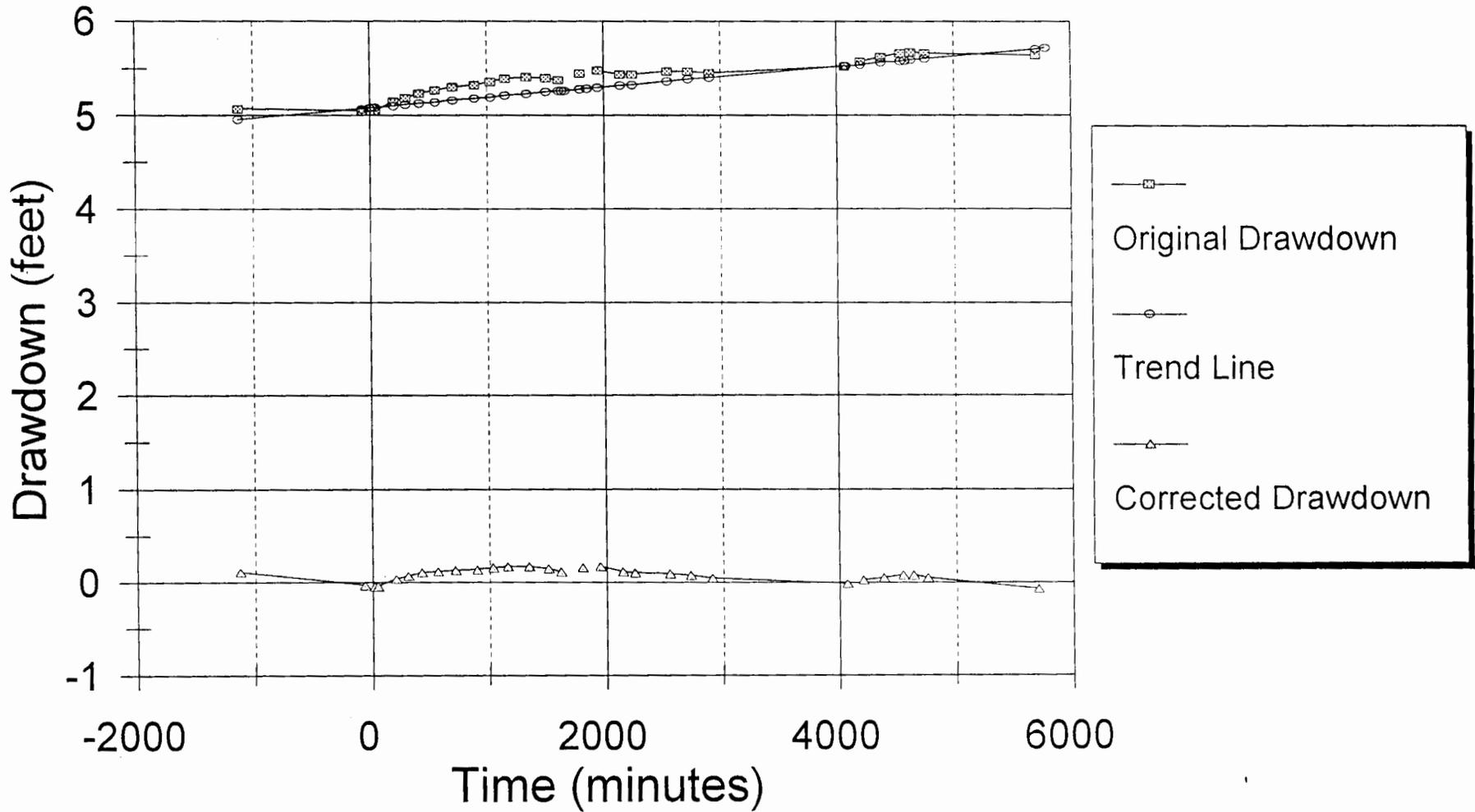
# ZONE F 607

## 011 Trend Correction



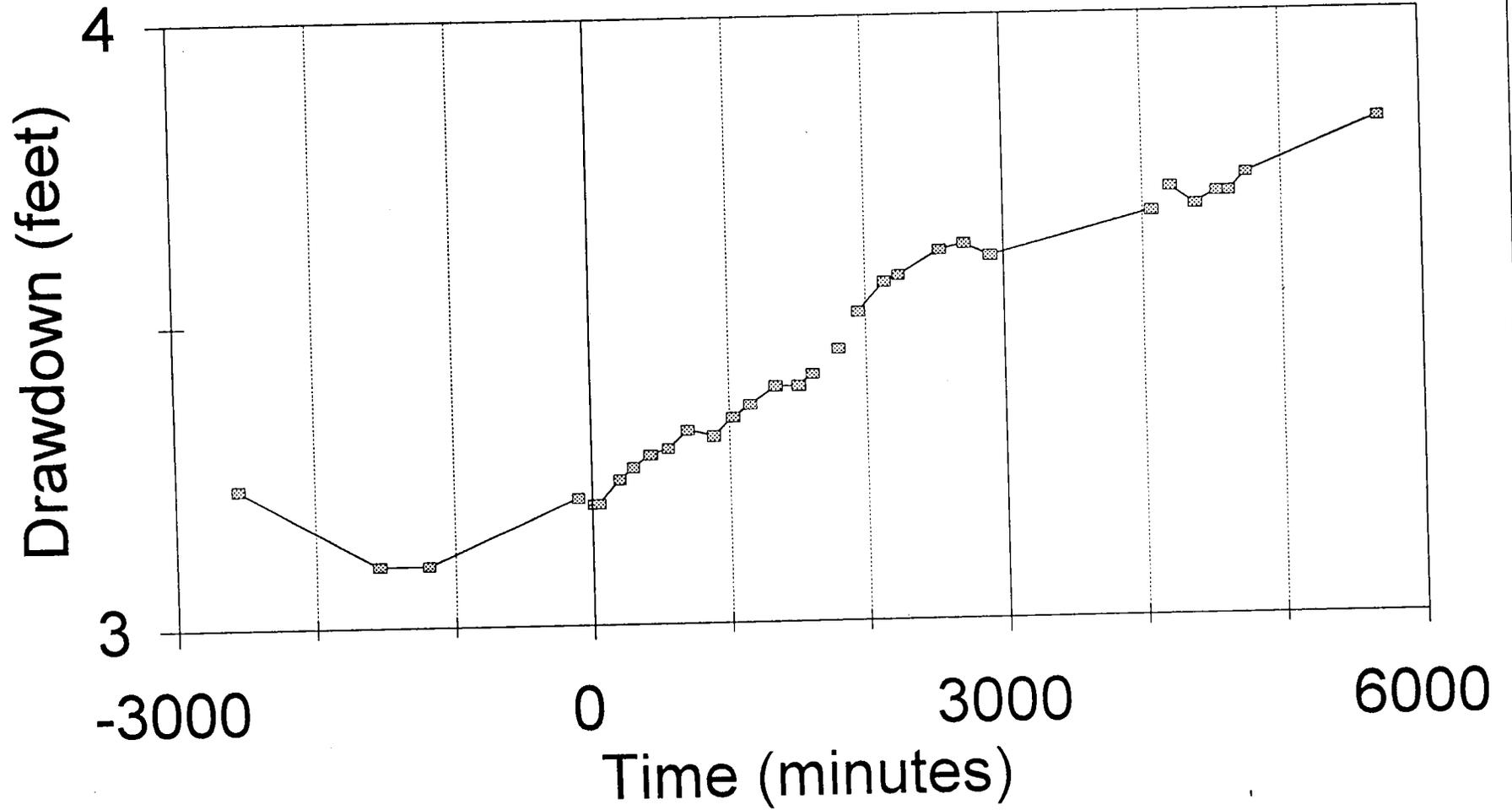
# ZONE F 607

## 012 Trend Correction



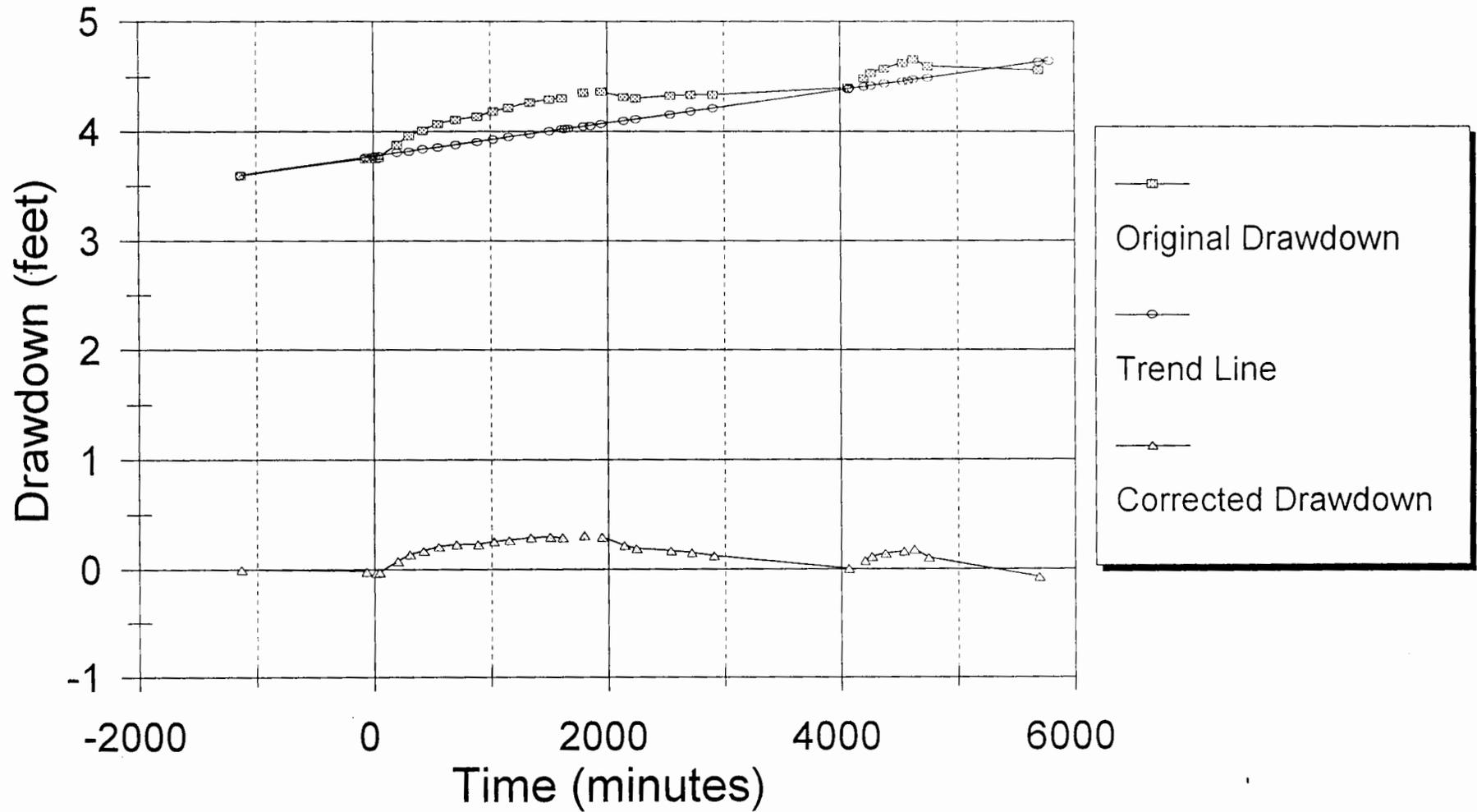
# ZONE F 607

013



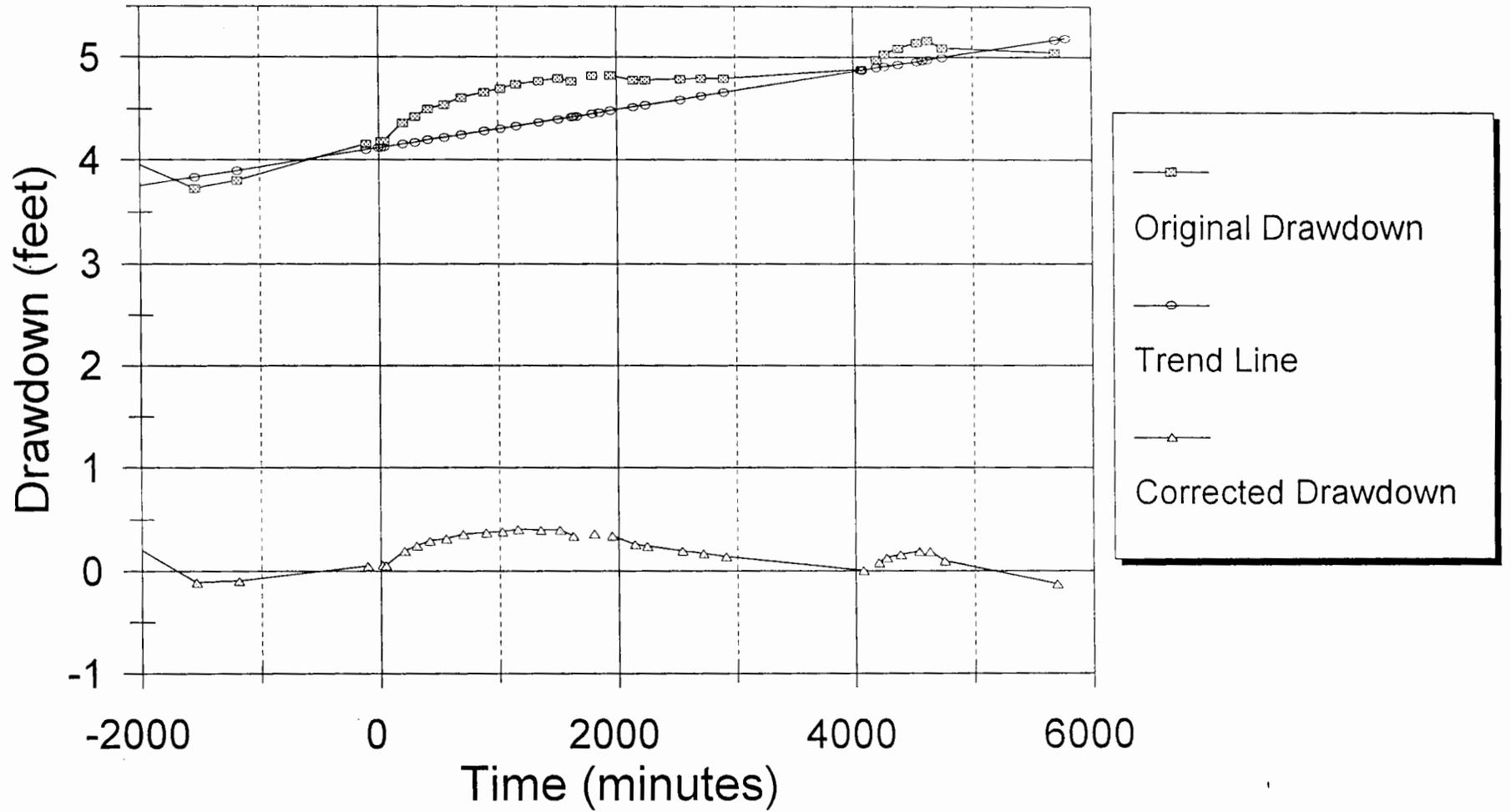
# ZONE F 607

## 014 Trend Correction



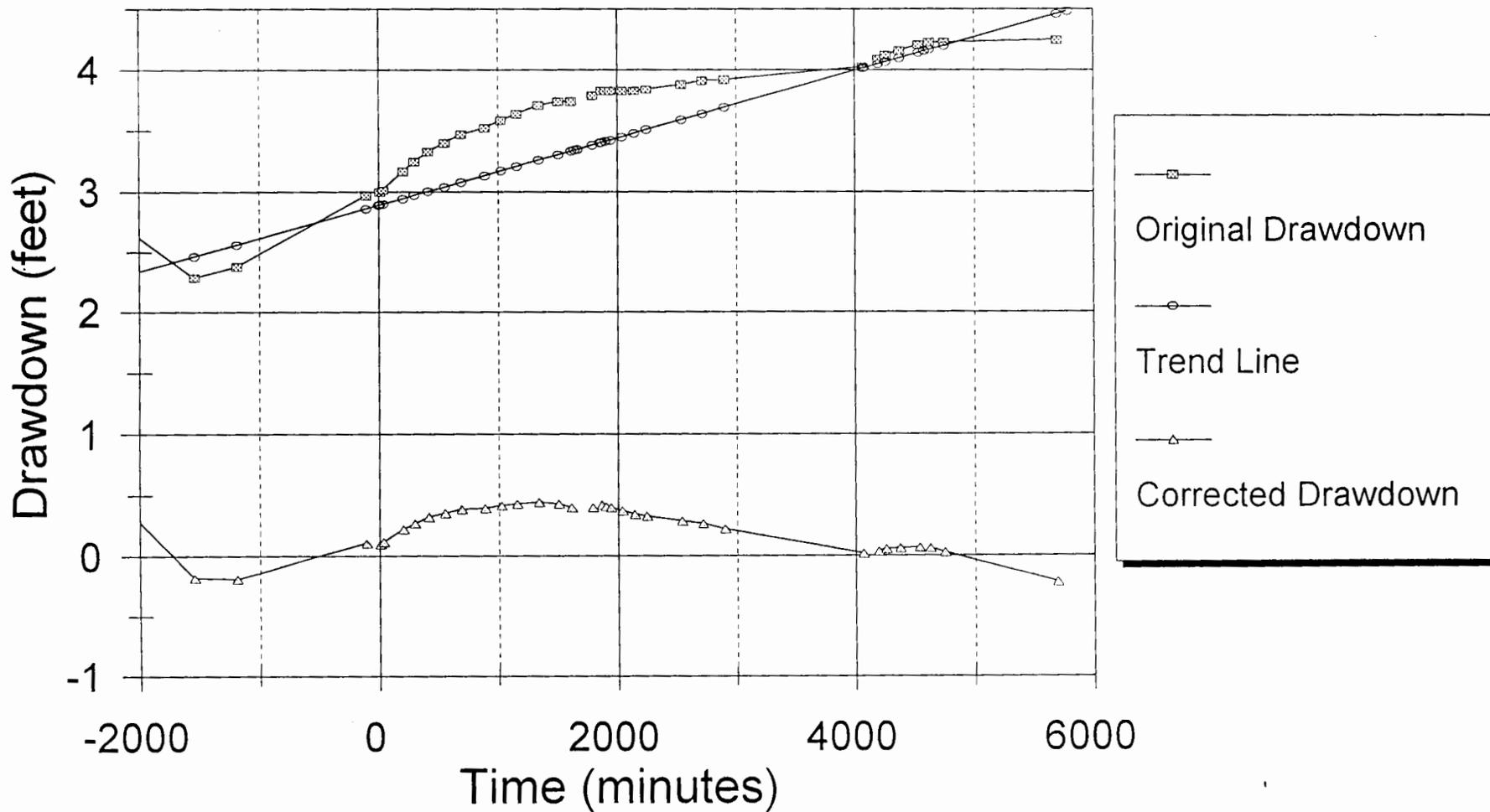
# ZONE F 607

## 015 Trend Correction



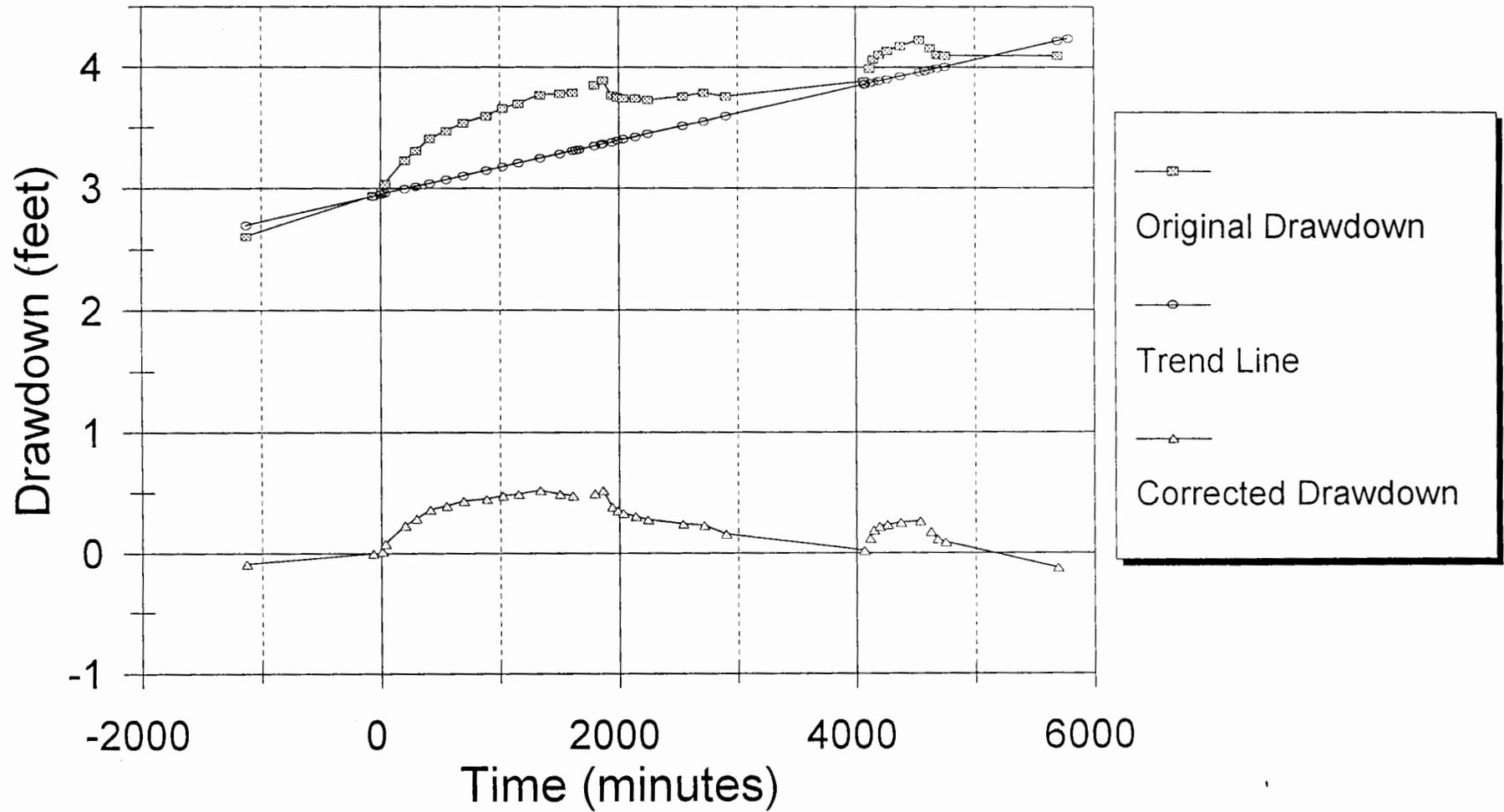
# ZONE F 607

## 016 Trend Correction



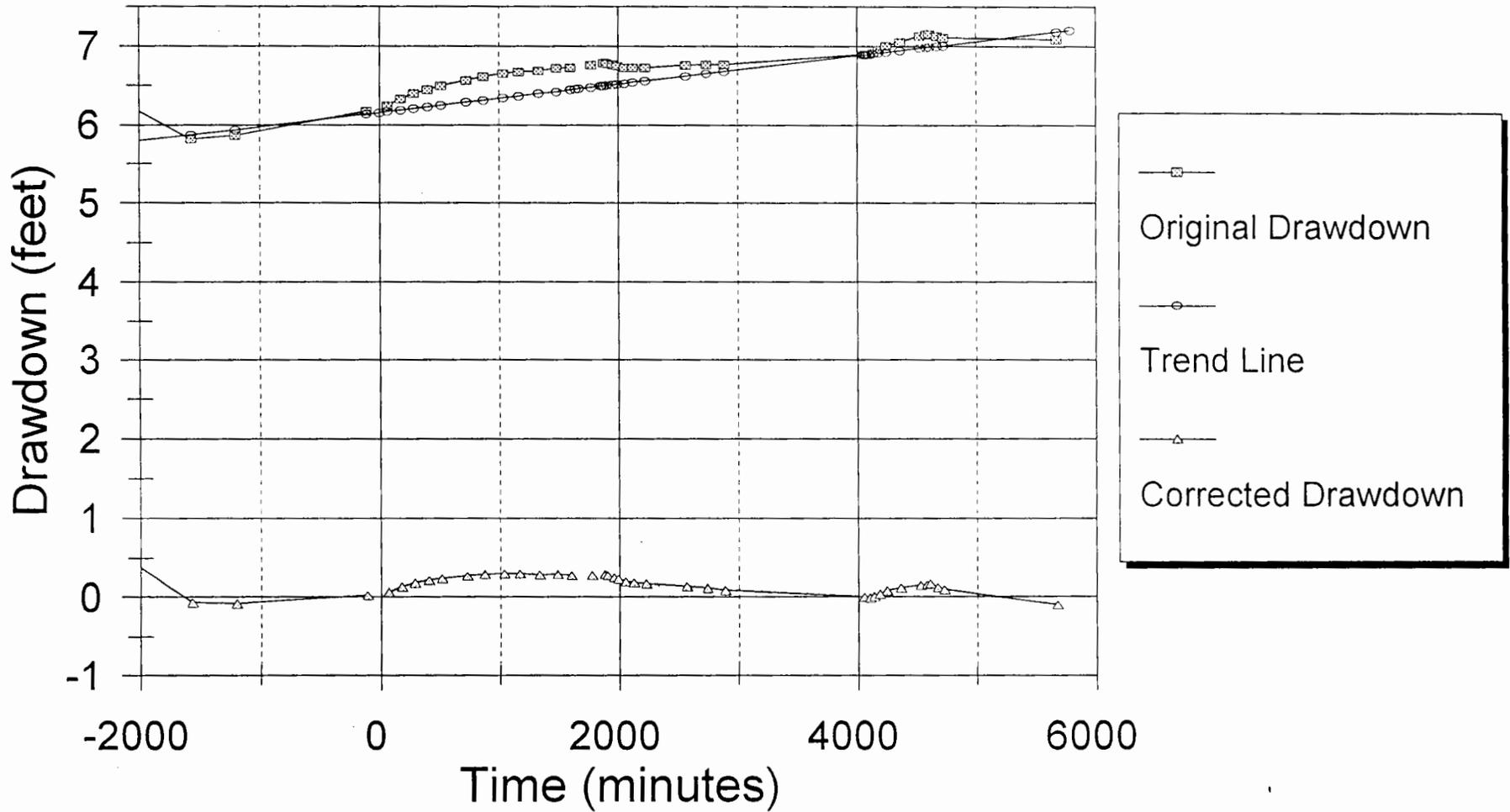
# ZONE F 607

## 017 Trend Correction



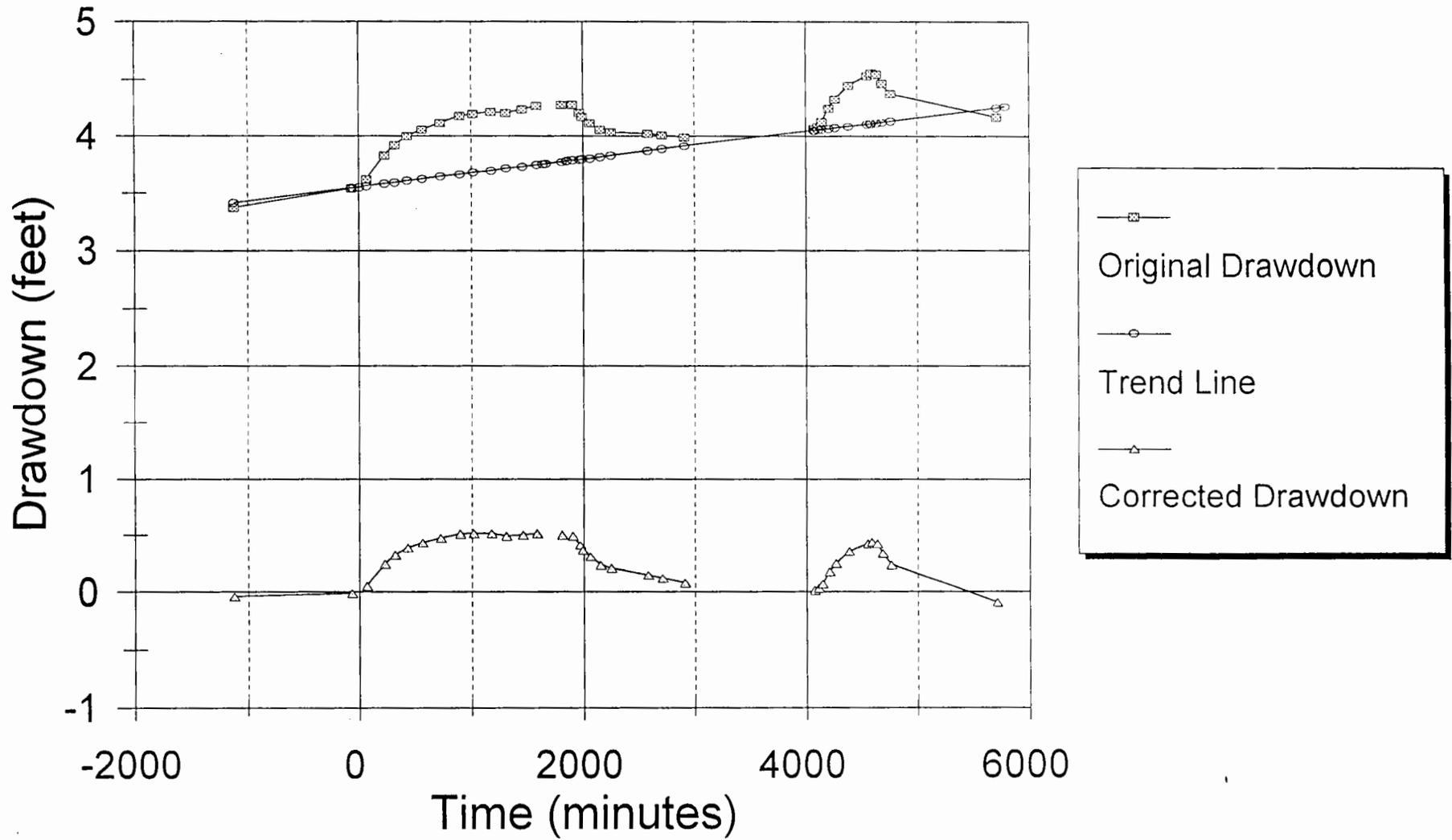
# ZONE F 607

## 01I Trend Correction



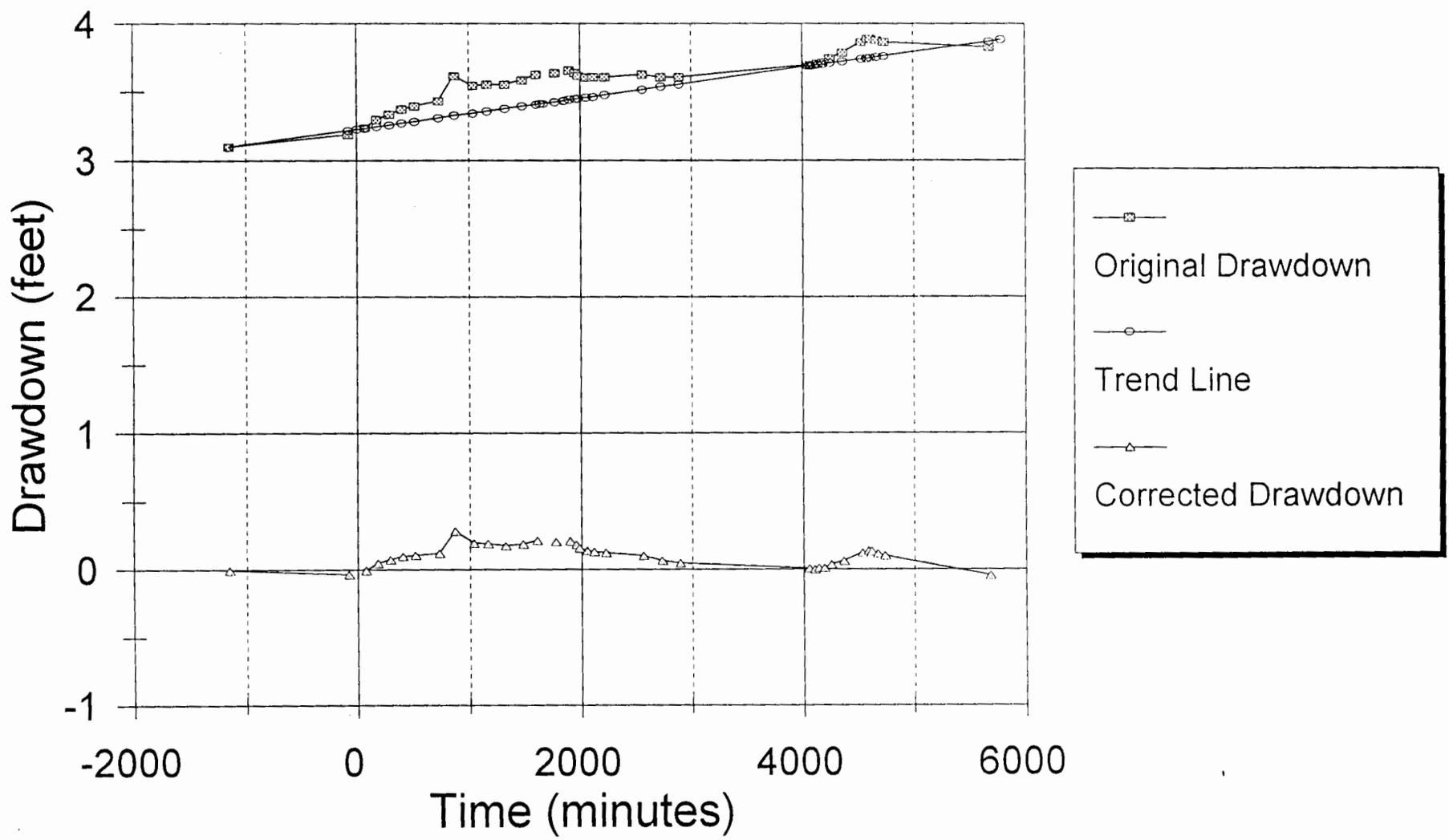
# ZONE F 607

## 02I Trend Correction



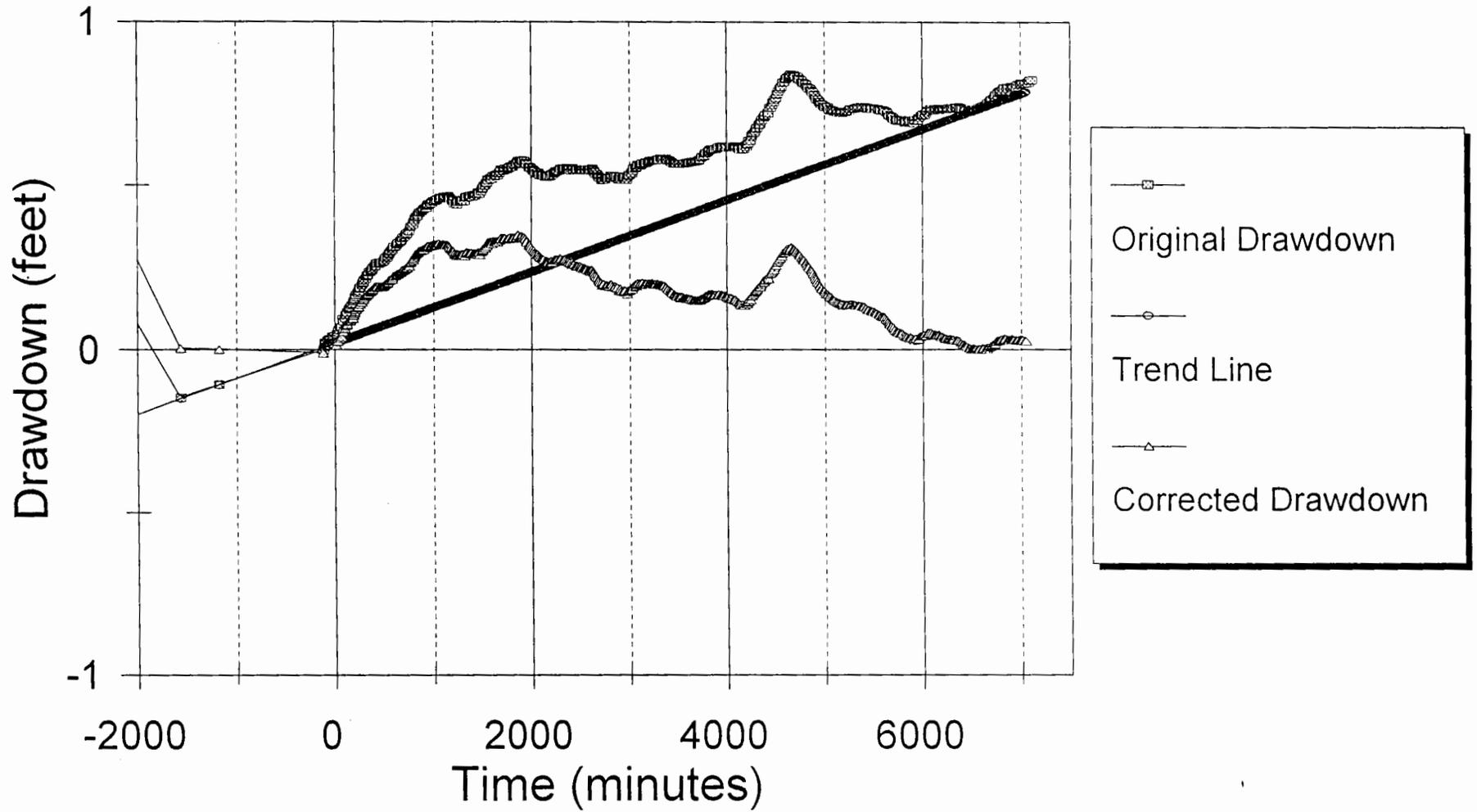
# ZONE F 607

## 03I Trend Correction



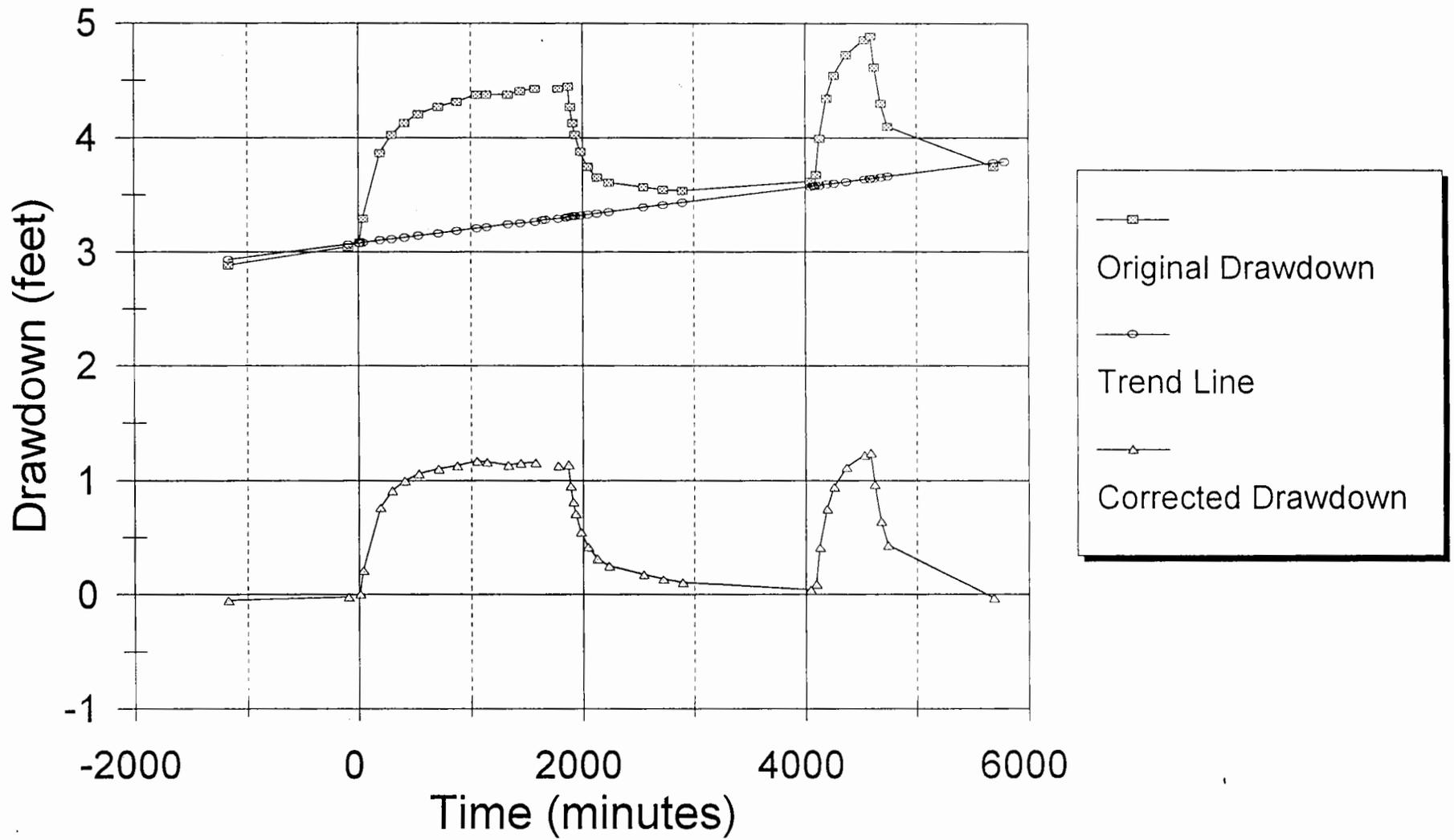
# ZONE F 607

## 04I Trend Correction



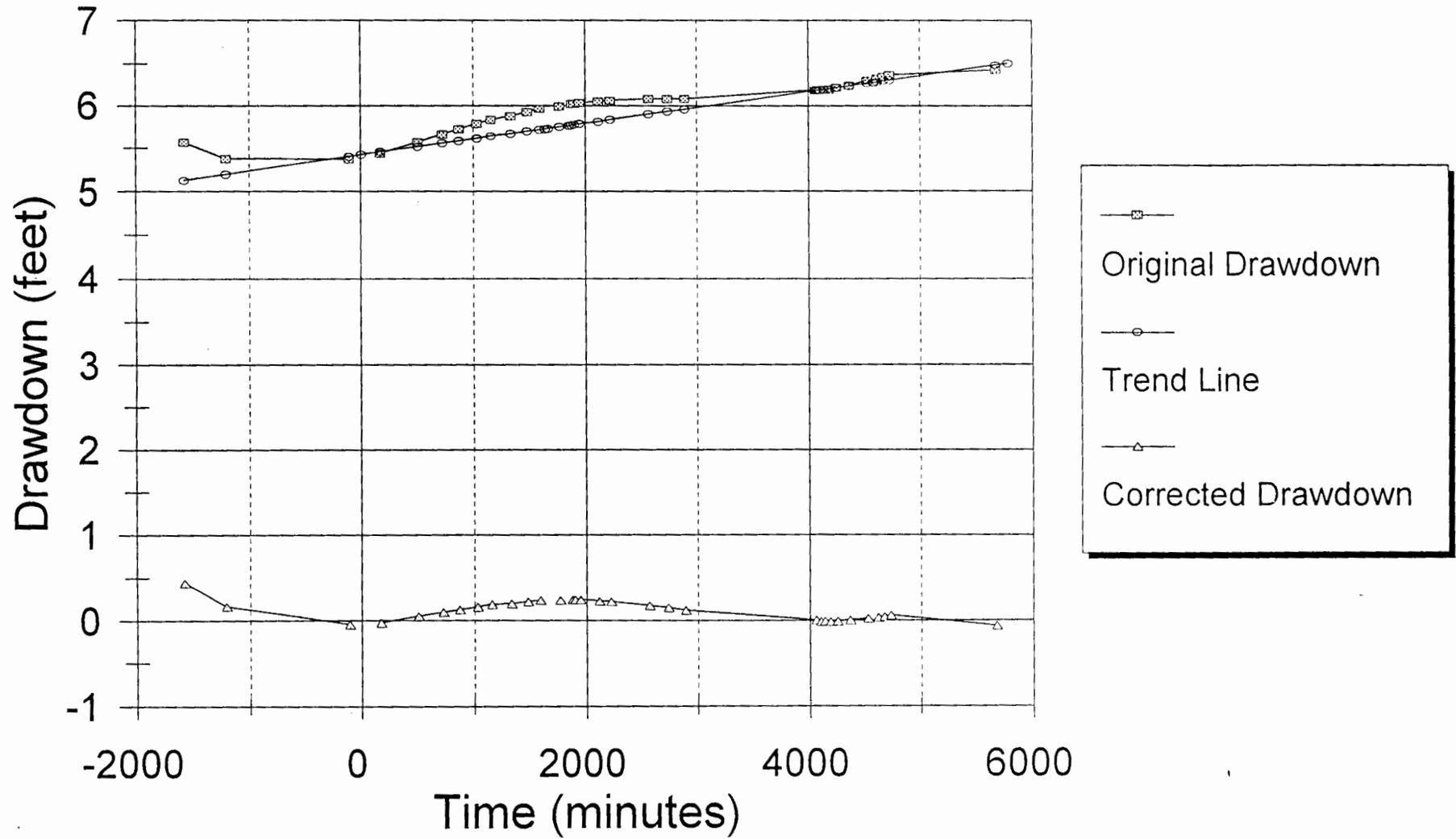
# ZONE F 607

## 06I Trend Correction



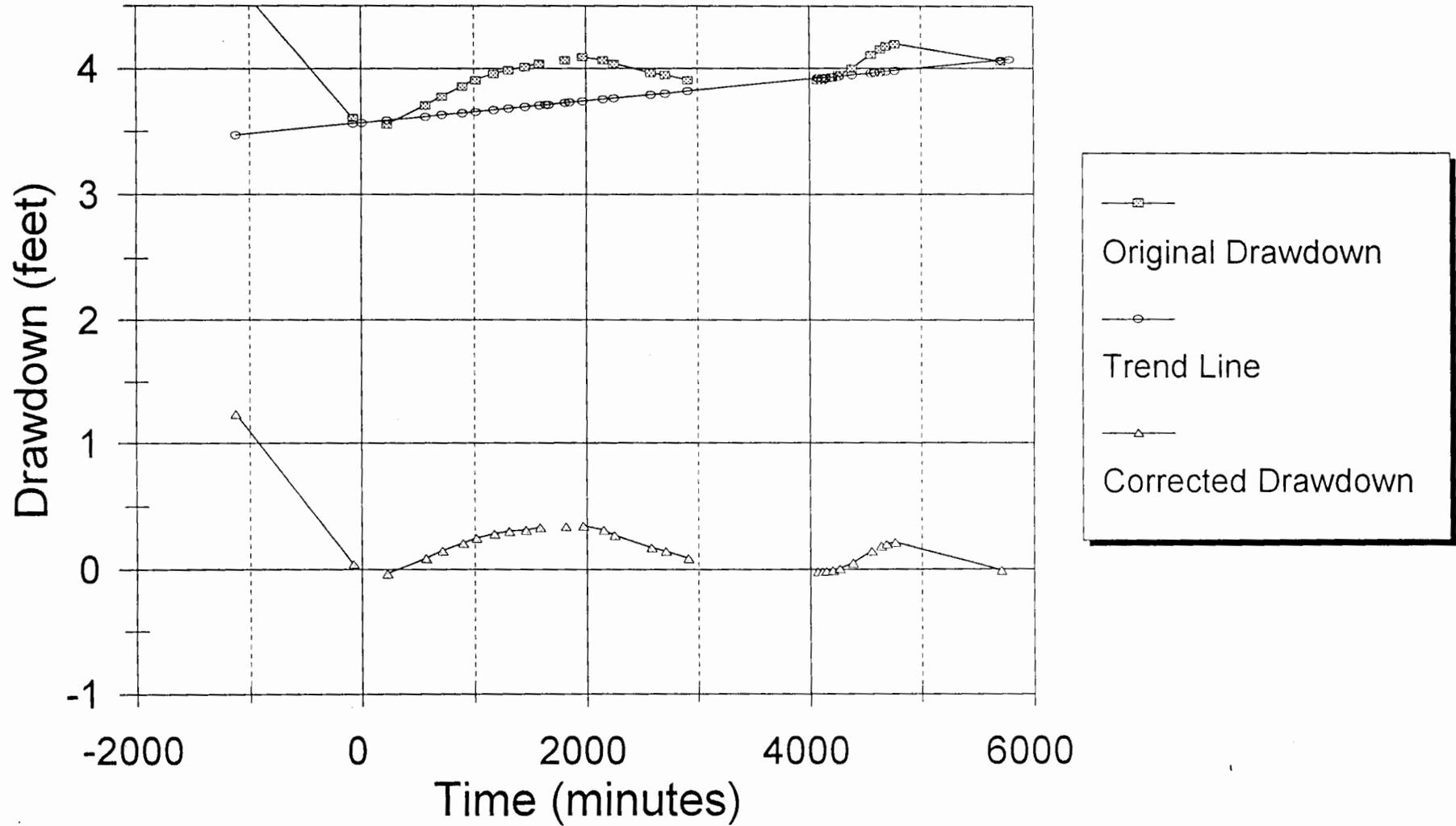
# ZONE F 607

## 01D Trend Correction



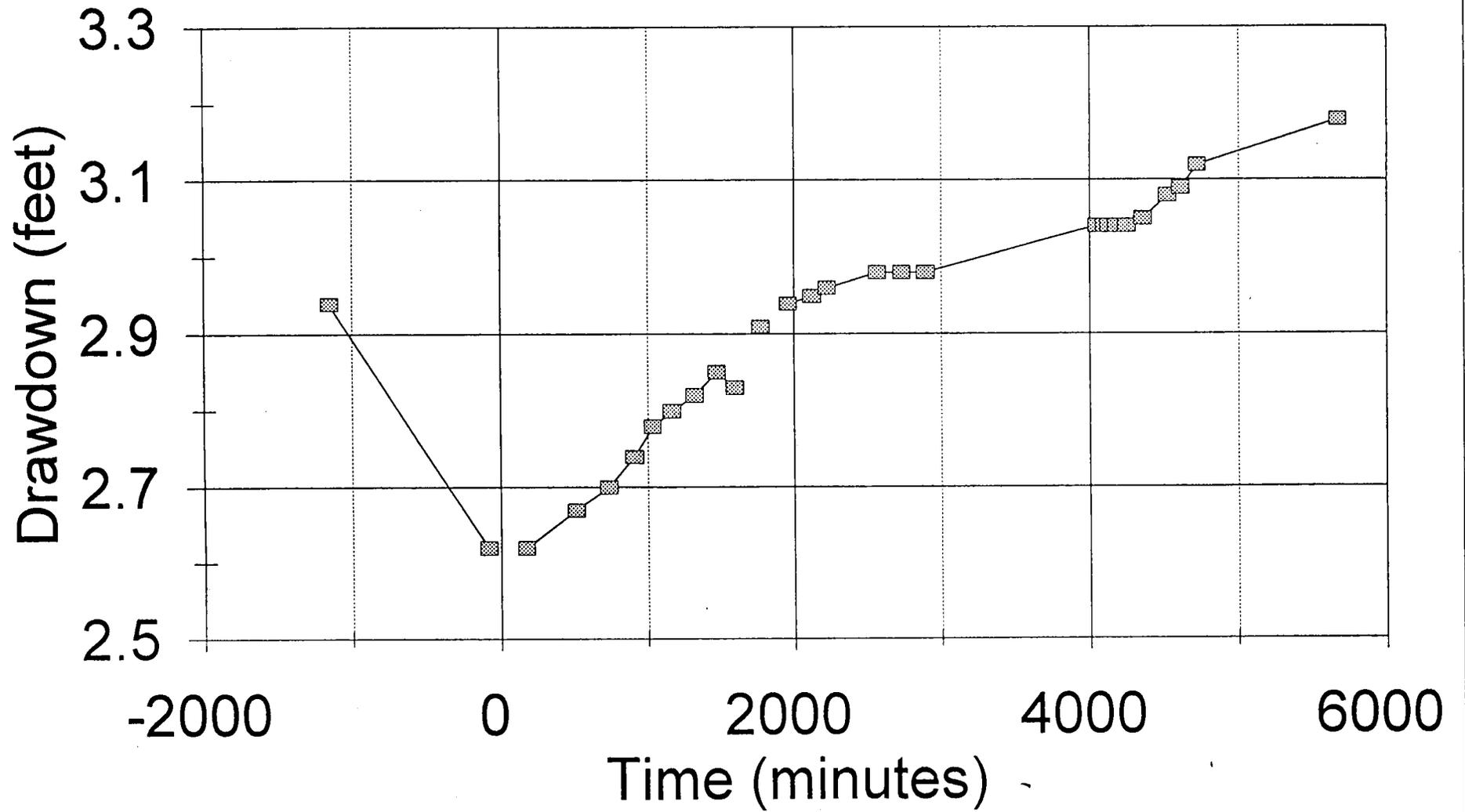
# ZONE F 607

## 02D Trend Correction



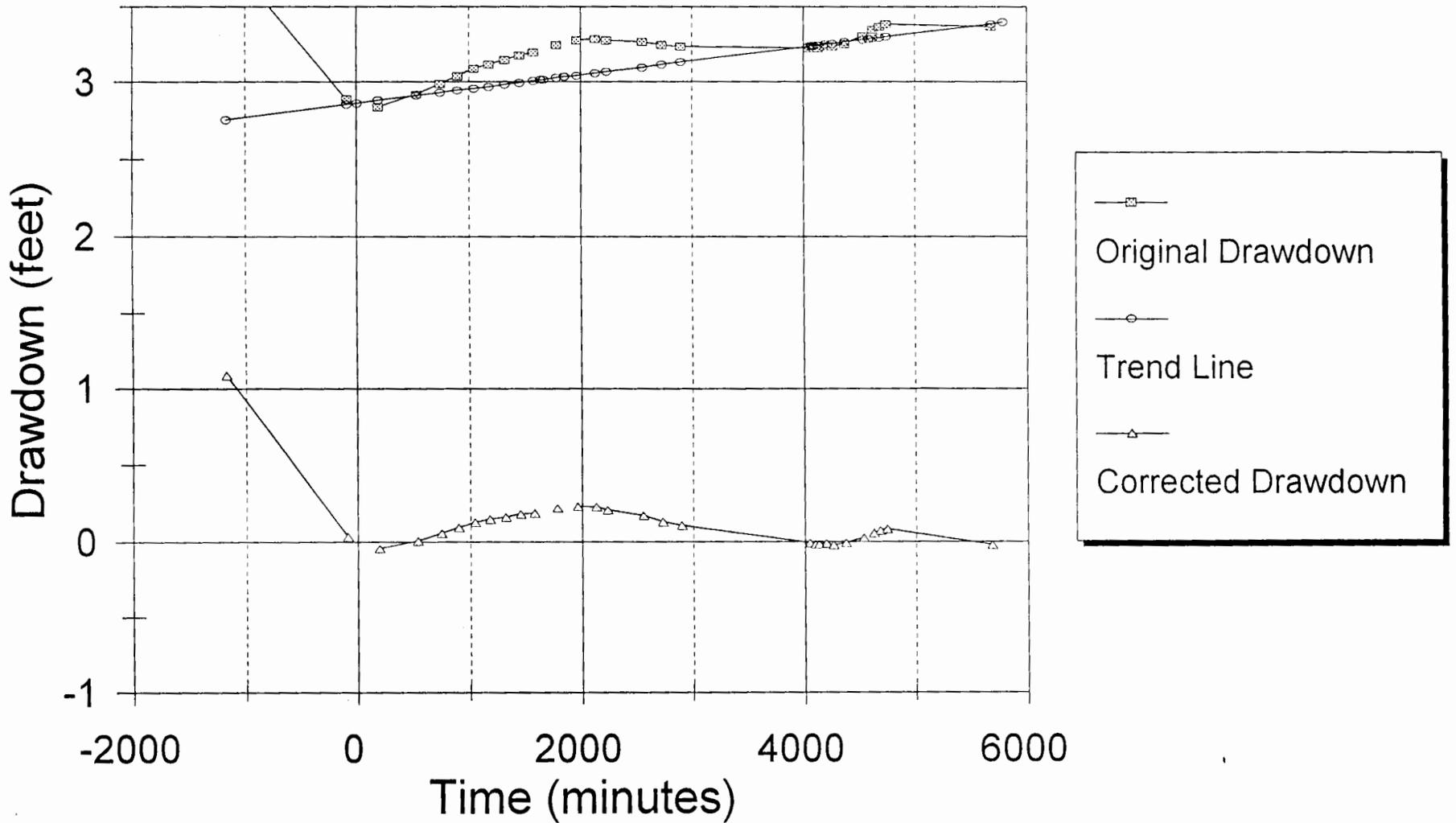
# ZONE F 607

03D



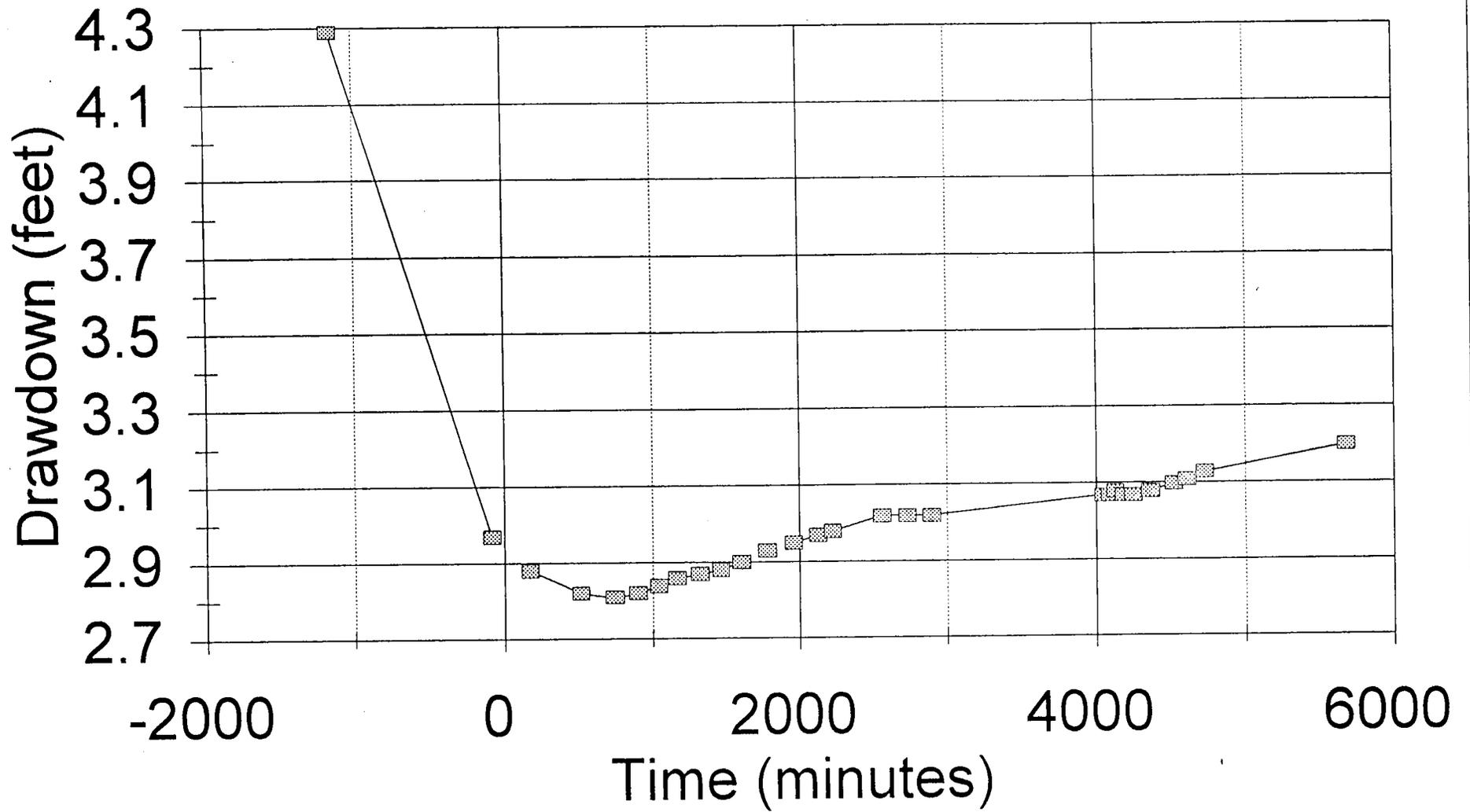
# ZONE F 607

## 04D Trend Correction



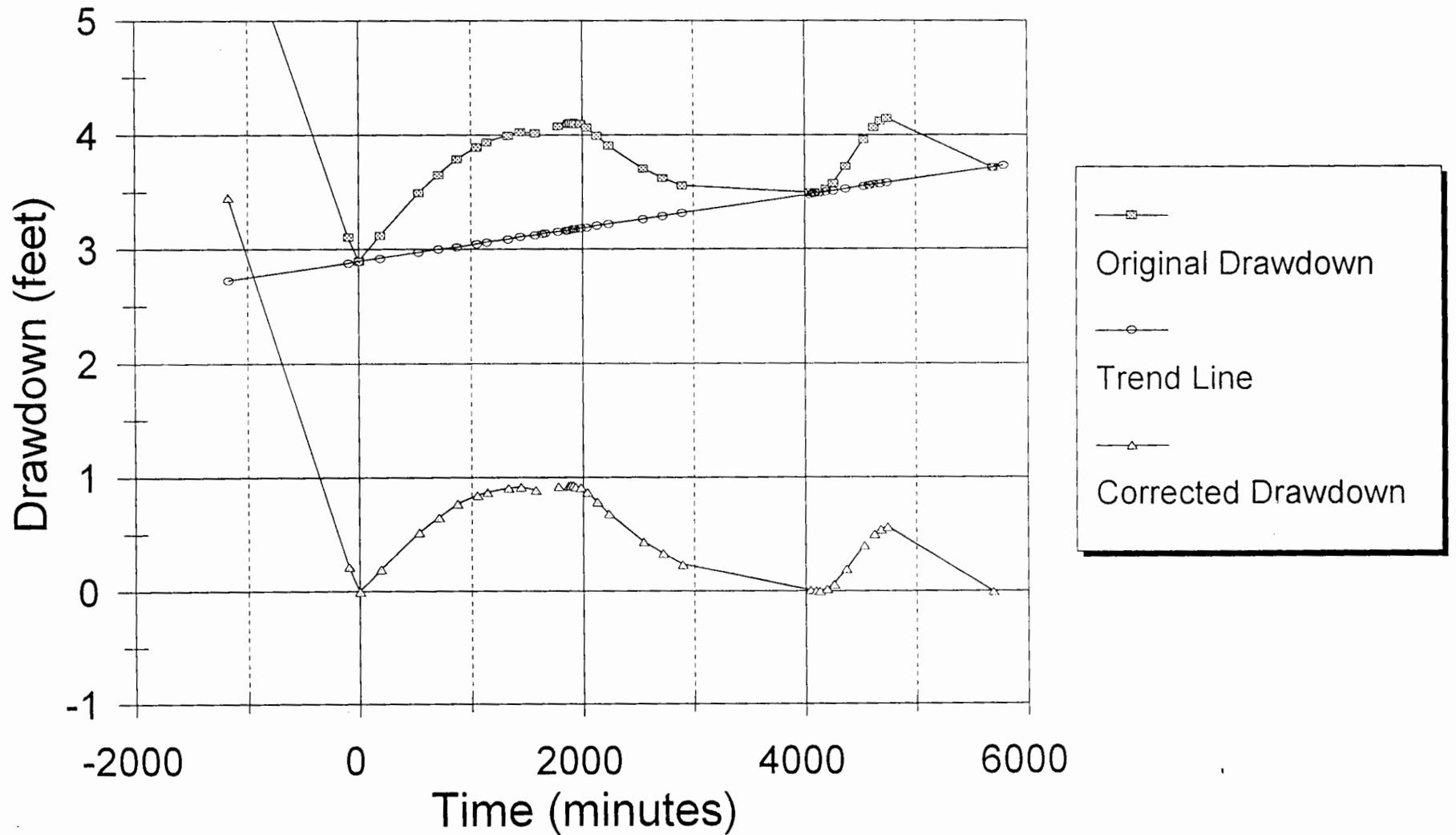
# ZONE F 607

05D



# ZONE F 607

## 06D Trend Correction



**Attachment 2**  
**AQTESOLV Plots**

CONSTANT RATE PUMPING TEST ON PW-1

Data Set: G:\BDOUGLAS\NASCHAR\ZONE\_F~1\PW-1.AQT

Date: 02/26/99

Time: 09:03:01

PROJECT INFORMATION

Company: EnSafe Inc.

Client: Navy Clean

Project: 2906-001-08-014-00

Test Location: Zone F 607

Test Well: PW-1

Test Date: 2/3/99

SOLUTION

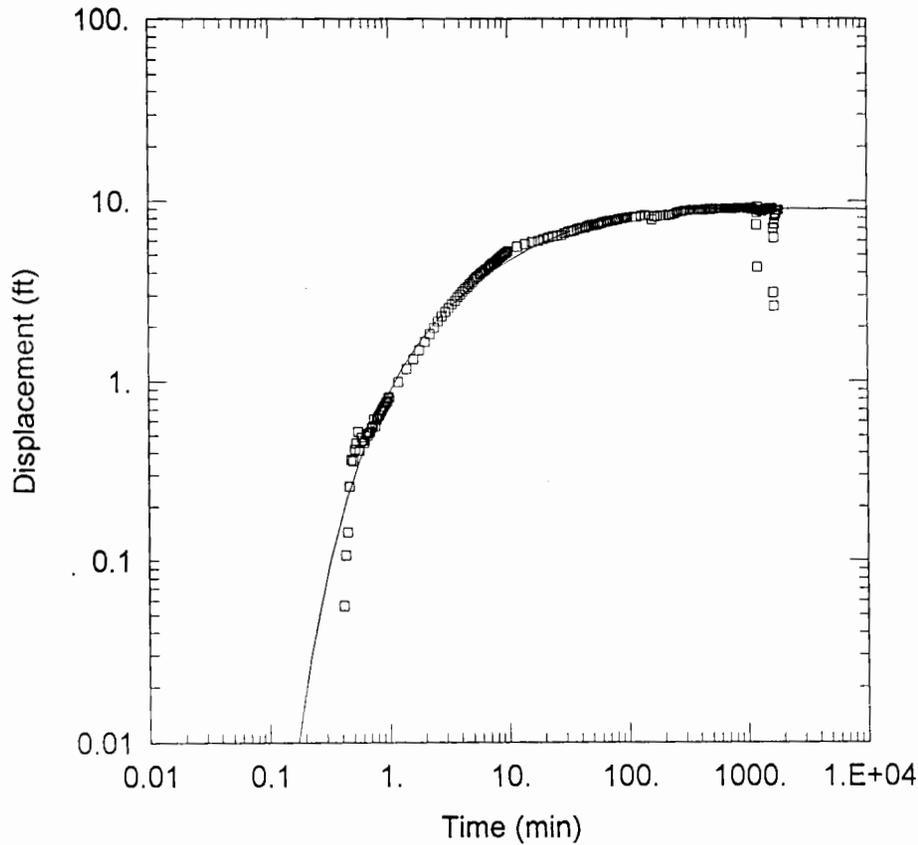
Aquifer Model: Leaky

Solution Method: Hantush-Jacob

T = 0.004998 ft<sup>2</sup>/min

S = 0.0521

r/B = 0.1365



AQUIFER DATA

Saturated Thickness: 15. ft

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
PW 1	0	0

Observation Wells

Well Name	X (ft)	Y (ft)
□ PW-1	0.5	0

CONSTANT RATE PUMPING TEST ON PW-1

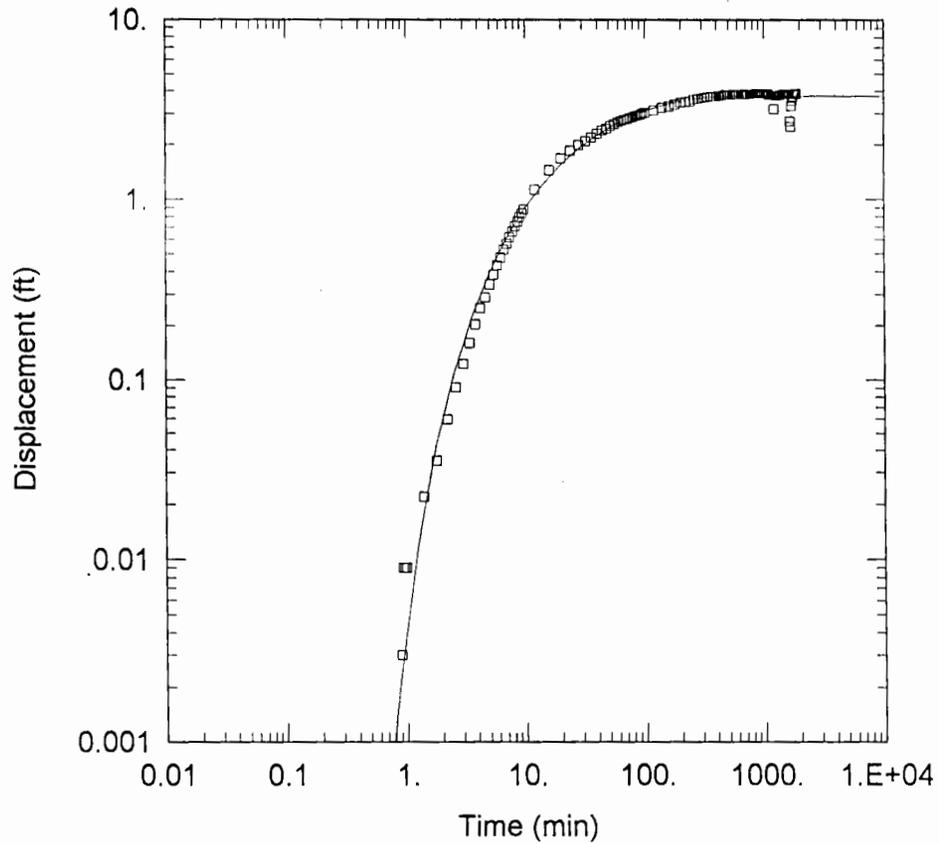
Data Set: G:\BDOUGLAS\NASCHAR\ZONE\_F~1\P-1D.AQT  
 Date: 02/25/99 Time: 14:53:35

PROJECT INFORMATION

Company: EnSafe Inc.  
 Client: Navy Clean  
 Project: 2906-001-08-014-00  
 Test Location: Zone F 607  
 Test Well: PW-1  
 Test Date: 2/3/99

SOLUTION

Aquifer Model: Leaky  
 Solution Method: Hantush-Jacob  
 $T = 0.007822 \text{ ft}^2/\text{min}$   
 $S = 0.000997$   
 $r/B = 0.2953$



AQUIFER DATA

Saturated Thickness: 15. ft

Anisotropy Ratio ( $K_z/K_r$ ): 1.

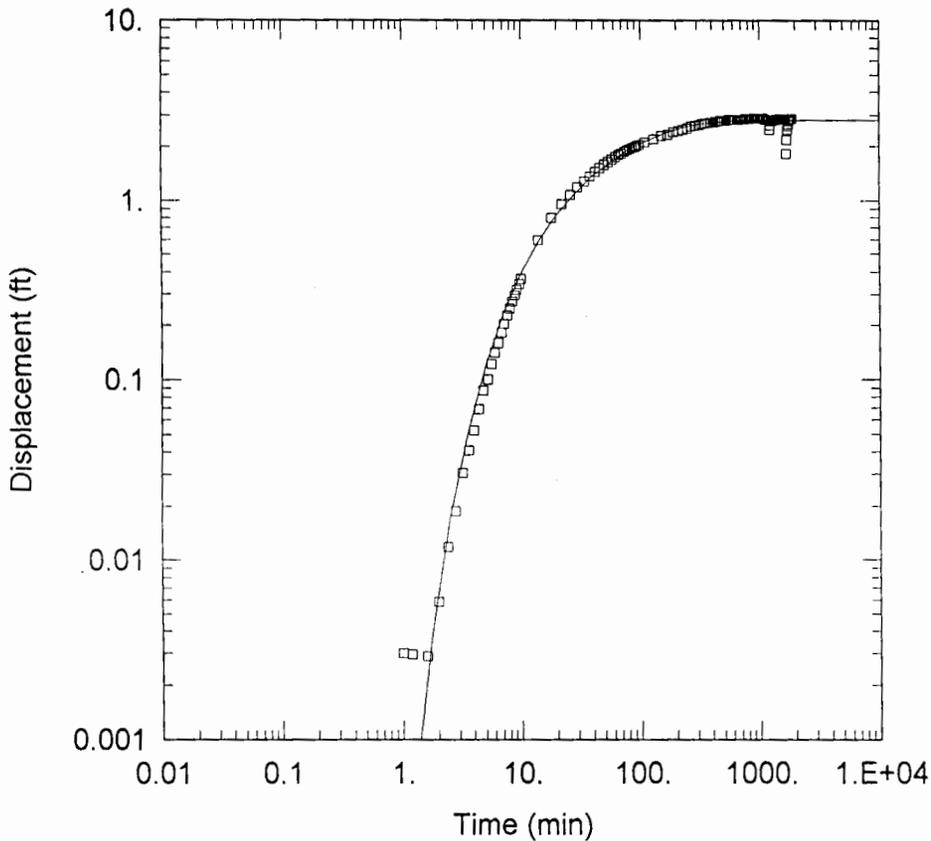
WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
PW 1	0	0

Observation Wells

Well Name	X (ft)	Y (ft)
□ P-1D	11.42	0



CONSTANT RATE PUMPING TEST ON PW-1

Data Set: G:\BDOUGLAS\NASCHARL\ZONE\_F~1\P-2D.AQT  
 Date: 02/25/99 Time: 15:39:50

PROJECT INFORMATION

Company: EnSafe Inc.  
 Client: Navy Clean  
 Project: 2906-001-08-014-00  
 Test Location: Zone F 607  
 Test Well: PW-1  
 Test Date: 2/3/99

SOLUTION

Aquifer Model: Leaky  
 Solution Method: Hantush-Jacob  
 $T = 0.009453 \text{ ft}^2/\text{min}$   
 $S = 0.0005416$   
 $r/B = 0.3443$

AQUIFER DATA

Saturated Thickness: 15. ft

Anisotropy Ratio ( $K_z/K_r$ ): 1.

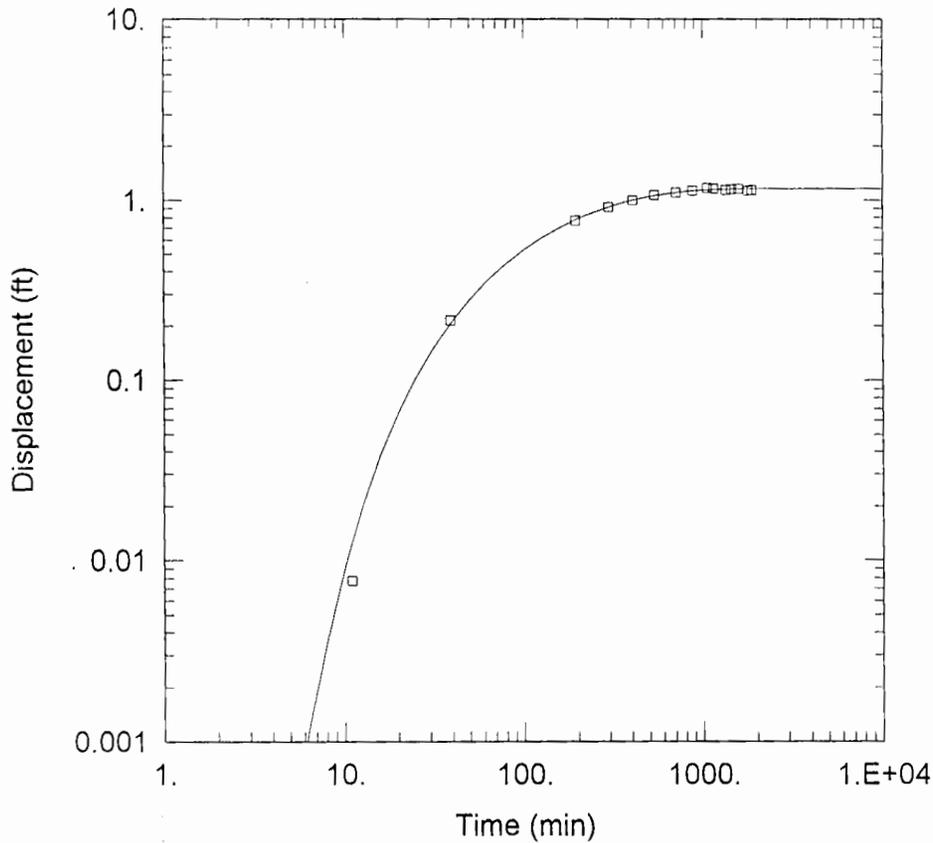
WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
PW 1	0	0

Observation Wells

Well Name	X (ft)	Y (ft)
□ P-2D	22.5	0



CONSTANT RATE PUMPING TEST ON PW-1

Data Set: G:\BDOUGLAS\NASCHARL\ZONE\_F~1\0612.AQT  
 Date: 09/22/99 Time: 09:47:25

PROJECT INFORMATION

Company: EnSafe Inc.  
 Client: Navy Clean  
 Project: 2906-001-08-014-00  
 Test Location: Zone F 607  
 Test Well: PW-1  
 Test Date: 2/3/99

SOLUTION

Aquifer Model: Leaky  
 Solution Method: Hantush-Jacob  
 $T = 0.01668 \text{ ft}^2/\text{min}$   
 $S = 0.0002655$   
 $r/B = 0.511$

AQUIFER DATA

Saturated Thickness: 15. ft

Anisotropy Ratio ( $K_z/K_r$ ): 1.

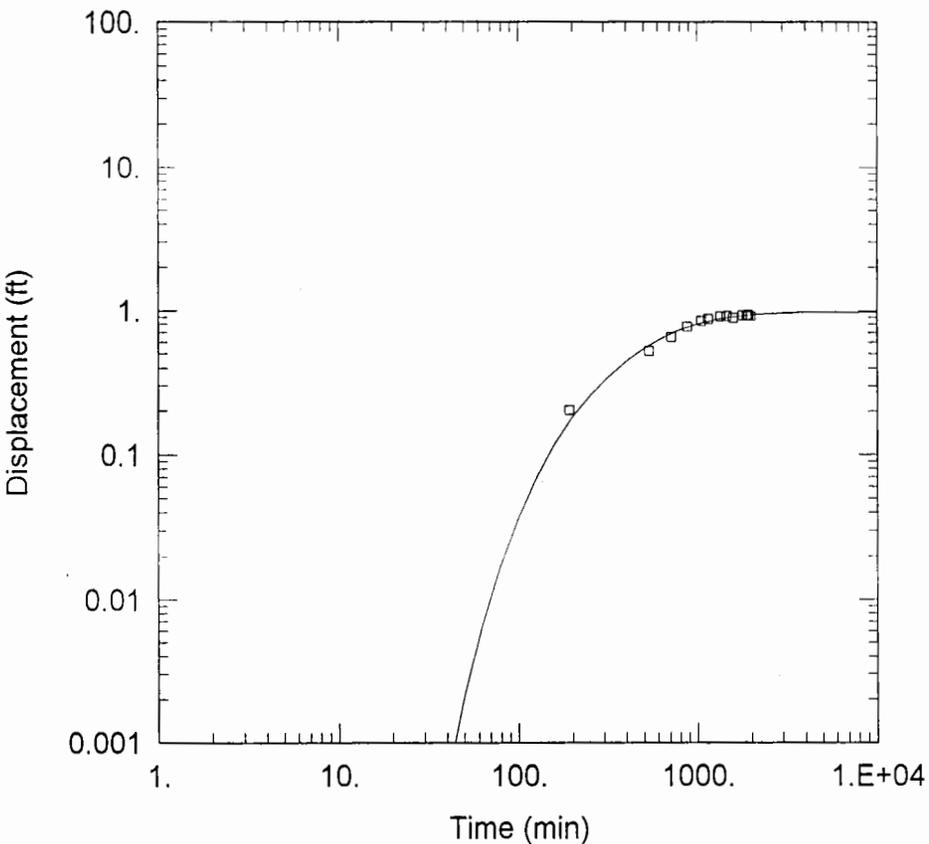
WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
PW 1	0	0

Observation Wells

Well Name	X (ft)	Y (ft)
061	85.6	0



CONSTANT RATE PUMPING TEST ON PW-1

Data Set: G:\BDOUGLAS\NASCHAR\ZONE\_F~1\06D2.AQT  
 Date: 09/21/99 Time: 16:19:15

PROJECT INFORMATION

Company: EnSafe Inc.  
 Client: Navy Clean  
 Project: 2906-001-08-014-00  
 Test Location: Zone F 607  
 Test Well: PW-1  
 Test Date: 2/3/99

SOLUTION

Aquifer Model: Leaky  
 Solution Method: Hantush-Jacob  
 $T = 0.008579 \text{ ft}^2/\text{min}$   
 $S = 0.0008775$   
 $r/B = 1.051$

AQUIFER DATA

Saturated Thickness: 15. ft

Anisotropy Ratio ( $K_z/K_r$ ): 1.

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
PW 1	0	0

Observation Wells

Well Name	X (ft)	Y (ft)
06D	94.9	0

CONSTANT RATE PUMPING TEST ON PW-1

Data Set: G:\BDOUGLAS\NASCHAR\ZONE\_F~1\PW-1REC.AQT

Date: 09/27/99

Time: 10:57:20

PROJECT INFORMATION

Company: EnSafe Inc.

Client: Navy Clean

Project: 2906-001-08-014-00

Test Location: Zone F 607

Test Well: PW-1

Test Date: 2/3/99

SOLUTION

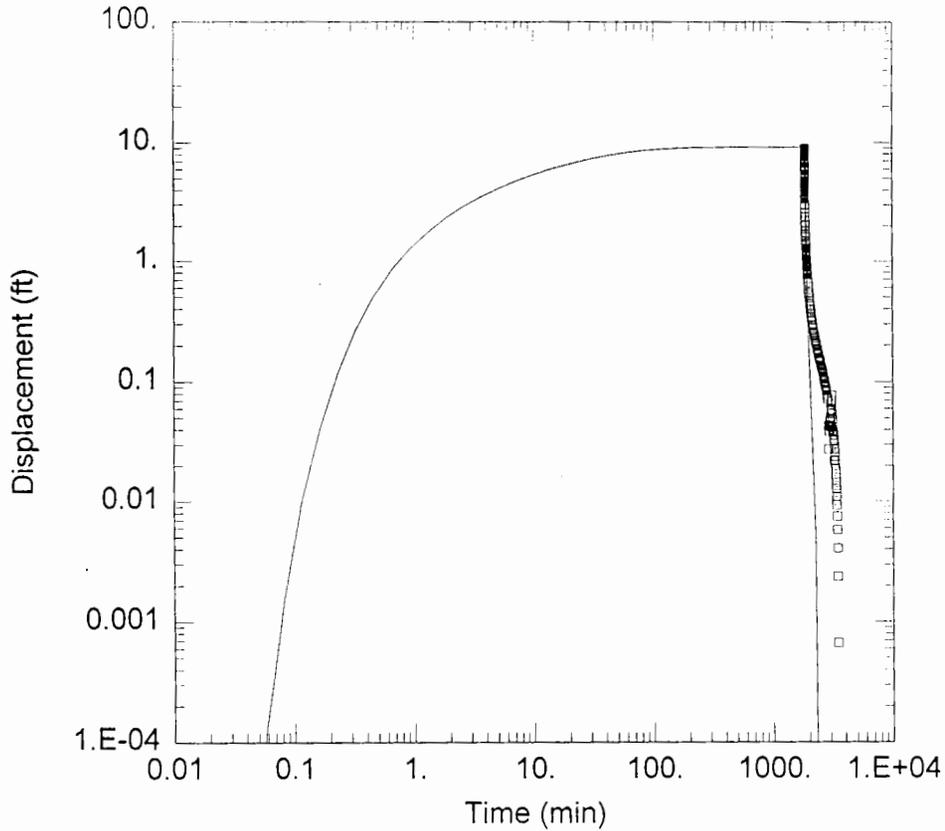
Aquifer Model: Leaky

Solution Method: Hantush-Jacob

$T = 0.004905 \text{ ft}^2/\text{min}$

$S = 0.03482$

$r/B = 0.1407$



AQUIFER DATA

Saturated Thickness: 15. ft

Anisotropy Ratio ( $K_z/K_r$ ): 1.

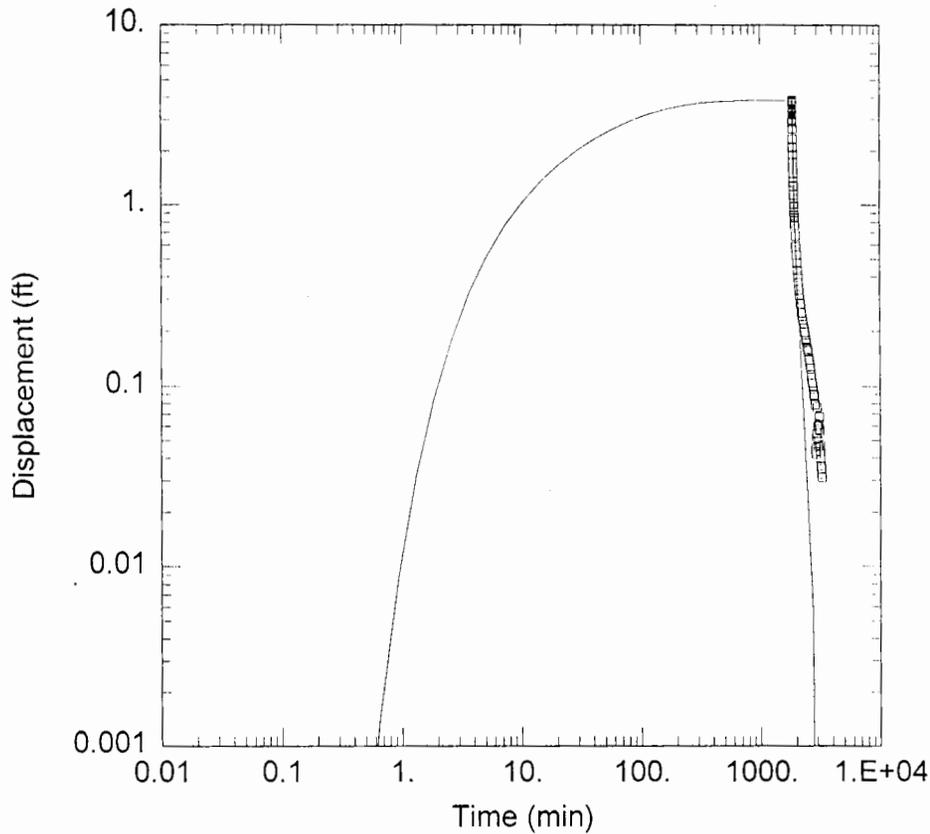
WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
PW 1	0	0

Observation Wells

Well Name	X (ft)	Y (ft)
□ PW-1	0.5	0



CONSTANT RATE PUMPING TEST ON PW-1

Data Set: G:\BDOUGLAS\NASCHAR\ZONE\_F~1\P-1DREC.AQT  
 Date: 09/27/99 Time: 11:30:42

PROJECT INFORMATION

Company: EnSafe Inc.  
 Client: Navy Clean  
 Project: 2906-001-08-014-00  
 Test Location: Zone F 607  
 Test Well: PW-1  
 Test Date: 2/3/99

SOLUTION

Aquifer Model: Leaky  
 Solution Method: Hantush-Jacob  
 $T = 0.008737 \text{ ft}^2/\text{min}$   
 $S = 0.0008699$   
 $r/B = 0.2384$

AQUIFER DATA

Saturated Thickness: 15. ft

Anisotropy Ratio ( $K_z/K_r$ ): 1.

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
PW 1	0	0

Observation Wells

Well Name	X (ft)	Y (ft)
P-1D	11.42	0

CONSTANT RATE PUMPING TEST ON PW-1

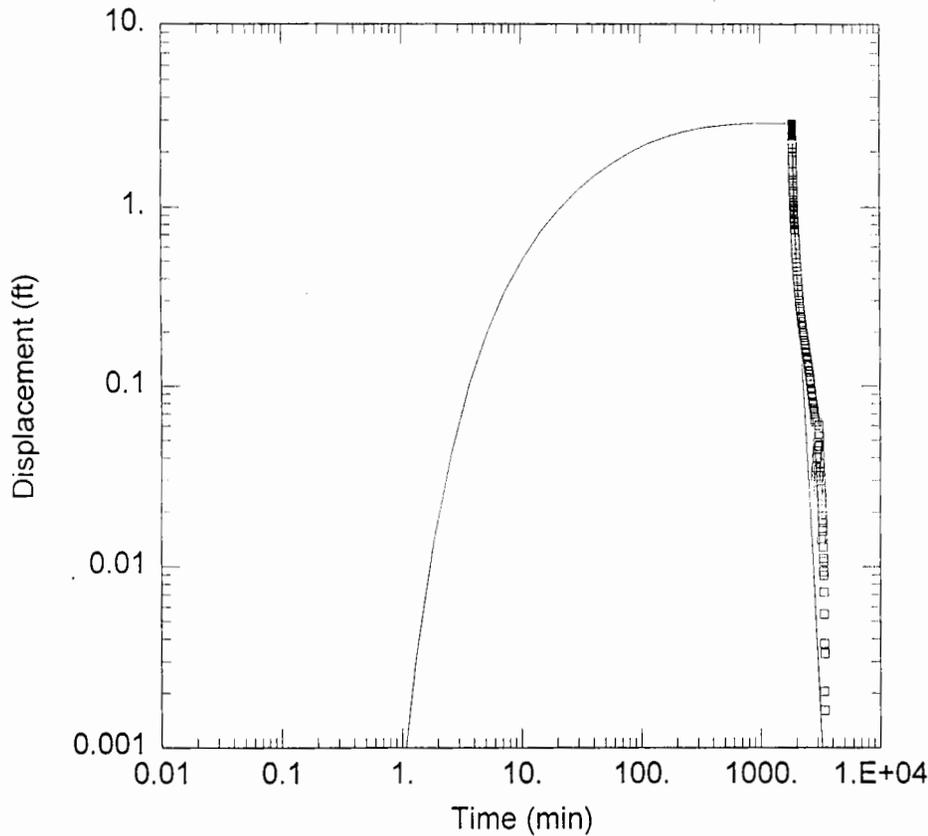
Data Set: G:\BDOUGLAS\NASCHARL\ZONE\_F~1\P-2DREC.AQT  
 Date: 09/27/99 Time: 11:35:52

PROJECT INFORMATION

Company: EnSafe Inc.  
 Client: Navy Clean  
 Project: 2906-001-08-014-00  
 Test Location: Zone F 607  
 Test Well: PW-1  
 Test Date: 2/3/99

SOLUTION

Aquifer Model: Leaky  
 Solution Method: Hantush-Jacob  
 $T = 0.01068 \text{ ft}^2/\text{min}$   
 $S = 0.0004603$   
 $r/B = 0.279$



AQUIFER DATA

Saturated Thickness: 15. ft

Anisotropy Ratio ( $K_z/K_r$ ): 1.

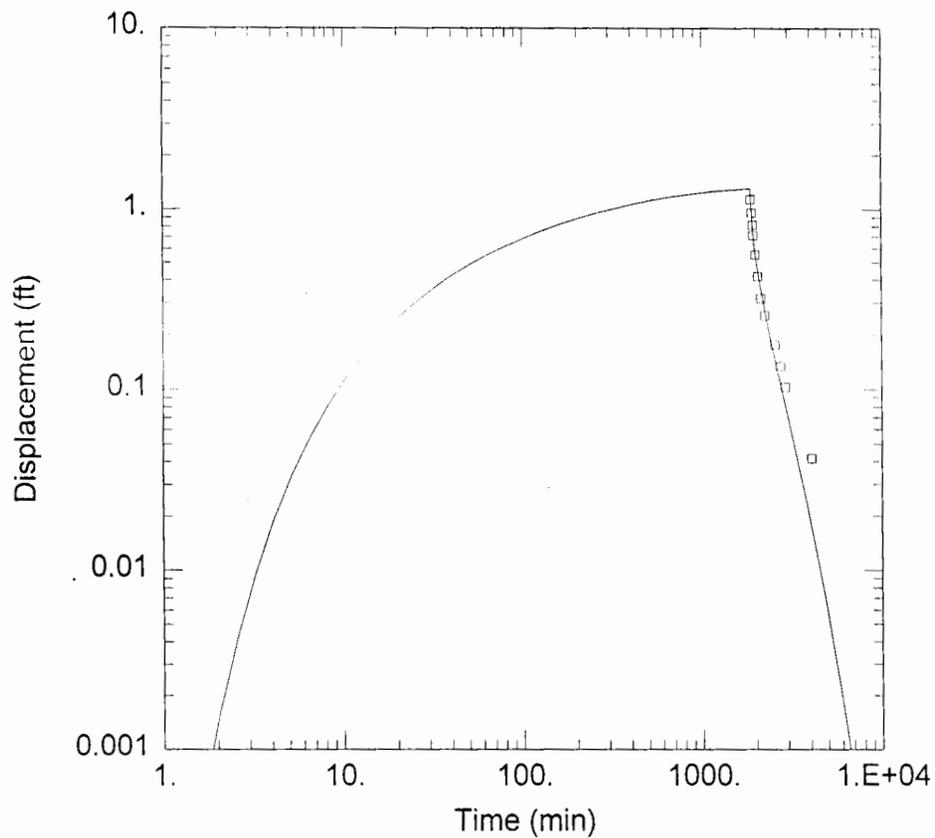
WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
PW 1	0	0

Observation Wells

Well Name	X (ft)	Y (ft)
P-2D	22.5	0



CONSTANT RATE PUMPING TEST ON PW-1

Data Set: G:\BDOUGLAS\NASCHARL\ZONE\_F~1\06I\REC.AQT

Date: 09/27/99

Time: 10:49:50

PROJECT INFORMATION

Company: EnSafe Inc.

Client: Navy Clean

Project: 2906-001-08-014-00

Test Location: Zone F 607

Test Well: PW-1

Test Date: 2/3/99

SOLUTION

Aquifer Model: Leaky

Solution Method: Hantush-Jacob

T = 0.03098 ft<sup>2</sup>/min

S = 0.0001317

r/B = 0.1637

AQUIFER DATA

Saturated Thickness: 15. ft

Anisotropy Ratio (Kz/Kr): 1.

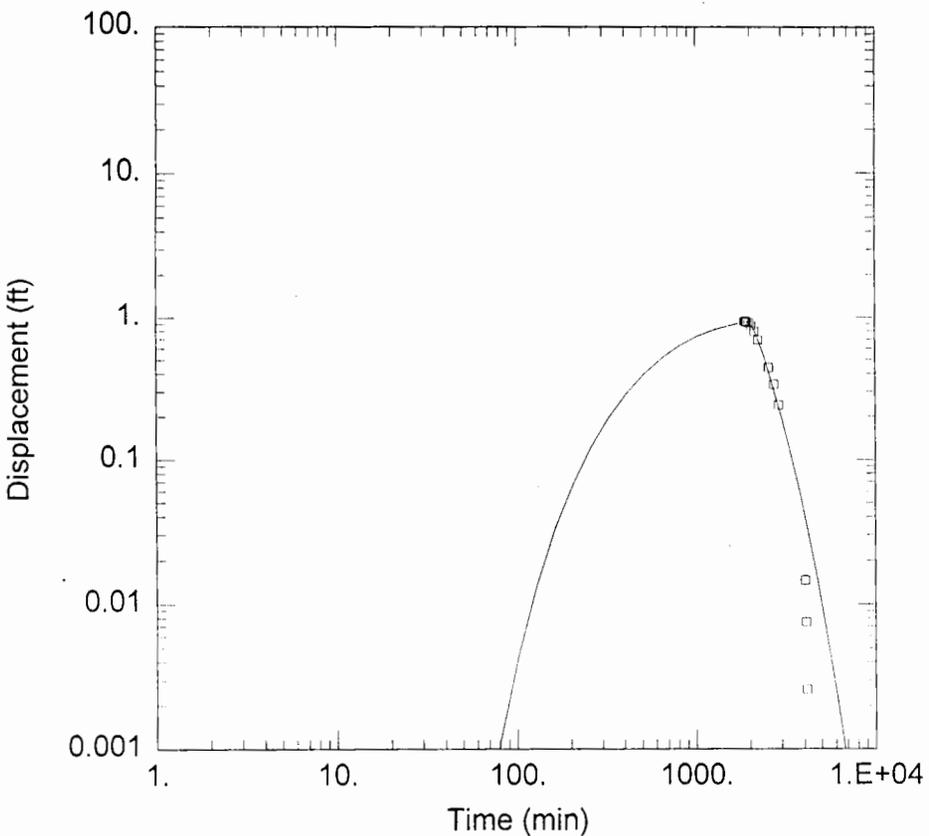
WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
PW 1	0	0

Observation Wells

Well Name	X (ft)	Y (ft)
06I	85.6	0



CONSTANT RATE PUMPING TEST ON PW-1

Data Set: G:\BDOUGLAS\NASCHARL\ZONE\_F~1\06DREC.AQT  
 Date: 09/27/99 Time: 10:32:35

PROJECT INFORMATION

Company: EnSafe Inc.  
 Client: Navy Clean  
 Project: 2906-001-08-014-00  
 Test Location: Zone F 607  
 Test Well: PW-1  
 Test Date: 2/3/99

SOLUTION

Aquifer Model: Leaky  
 Solution Method: Hantush-Jacob  
 $T = 0.004959 \text{ ft}^2/\text{min}$   
 $S = 0.0009921$   
 $r/B = 1.442$

AQUIFER DATA

Saturated Thickness: 15. ft

Anisotropy Ratio ( $K_z/K_r$ ): 1.

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
PW 1	0	0

Observation Wells

Well Name	X (ft)	Y (ft)
06D	94.9	0

**APPENDIX B**  
**DUAL-PHASE VACUUM EXTRACTION**  
**TREATABILITY STUDY SUMMARY**

## EXECUTIVE SUMMARY

From June 26 through September 20, 1999, a dual-phase vacuum extraction treatability study was conducted at AOC 607 in Area F to enhance estimates of aquifer characteristics and investigate the feasibility of vacuum groundwater and soil vapor extraction/dewatering. This study included first a dewatering step, followed by a monitored vacuum test step. The study was designed to:

- Estimate potential groundwater extraction flow rates to a full scale system.
- Estimate vacuum well spacings and expected mass removal rates for a full scale system.
- Assess the capability of dual-phase vacuum extraction in reducing groundwater concentrations to MCLS.

Before vacuum extraction and potential vapor flow could be monitored, the shallow aquifer needed to be dewatered to the underlying clay aquitard located about 11 feet below ground surface (bgs). To dewater the site, 35 temporary well points were installed around the perimeter of Building 1189 to a depth at the top of the aquitard. The well points were connected above ground to a central liquid ring vacuum pump. After a round of water levels was collected, the vacuum pump was turned on June 26.

Water levels were monitored in the surrounding groundwater wells to assess dewatering progress (Attachment B-1). By June 27, water levels in wells inside Building 1189 had dropped to 7 to 9 feet bgs, indicating that the site was dewatering faster than the surrounding aquifer could recharge the study area. Groundwater extraction rates were monitored via a totalizer located at the system header. The dewatering system continued to run until Step 2 vacuum testing activities began in August. By the time Step 2 began, over 200,000 gallons of water had been extracted from the study area. Totalizer readings are summarized in Attachment B-2.

Extracted groundwater was treated via air stripping prior to discharge. Influent and effluent samples were collected and analyzed at the treatment system to assess mass extraction rates and treatment system effectiveness. VOC concentrations dropped off quickly within the first week of

dewatering then stabilized until the system was temporarily shut down prior to vacuum testing. Concentrations rebounded during the few days of vacuum testing set-up in late August. Attachment B-3 summarizes the influent groundwater data. Effluent analytical results were non-detect for VOCs throughout the study.

Extracted soil vapor was also sampled at the system header. Vapor VOC concentrations also dropped off quickly within the first week of dewatering, however vapor VOCs did not rebound as significantly as groundwater VOCs during the few days of vacuum testing set-up. Attachment B-4 summarizes vapor VOC data. Water and vapor laboratory analytical reports are included as Attachment B-5.

Soil vapor vacuum testing was performed in two steps - a short term step test and a long-term parameter evaluation test. The short term step test was performed to estimate what rate would be used during the long term test. Details of test procedures are included in Attachment B-6.

## **Conclusions**

Dewatering results indicate that the shallow aquifer can be dewatered in less than one week using conventional vacuum dewatering techniques. The surrounding aquifer seems capable of recharging the study area at a rate of about 100,000 gallons per month.

During vacuum testing, vacuum influence was seen as far as 12 feet from the vacuum extraction test well indicating that extraction well spacings of 12 feet or less could be used to capture VOCs within a gridded area.

Air flow rates averaged 28 scfm throughout the test. These flow rates indicate reasonable air flow through the vadose zone but could be increased through the use of passive vent or air injection wells.

Analytical results showed a quick drop-off in VOC concentrations to a steady level of about 50 to 100  $\mu\text{g/L}$  in groundwater and soil vapor. Groundwater VOC concentrations also showed a significant rebound effect during the few days the system was shut down for vacuum test set up.

In contrast, soil vapor concentrations did not show as significant a rebound effect. Taken together, these observations indicate the presence of a continuing VOC source (DNAPL) below the water table surface. In order for dual-phase vacuum extraction to be effective in meeting clean-up goals in a timely manner, this DNAPL must be first removed by other means.

**Attachment B-1**

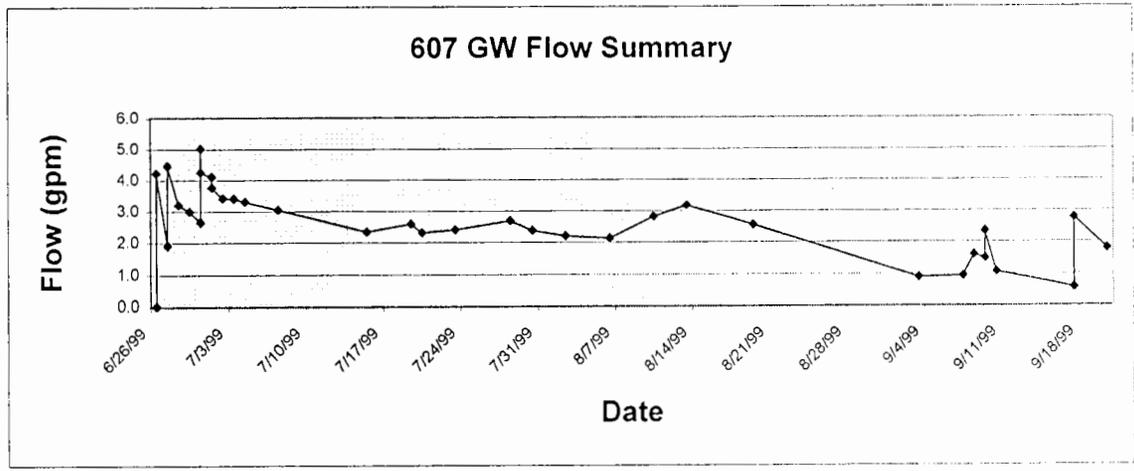
ATTACHMENT B-1 AOC 607 WATER LEVEL SUMMARY

Well	Depth to Water Reading (ft)																			
	22-Jun-99	25-Jun-99	26-Jun-99	26-Jun-99	27-Jun-99	28-Jun-99	29-Jun-99	30-Jun-99	01-Jul-99	02-Jul-99	07-Jul-99	15-Jul-99	15-Jul-99	23-Jul-99	02-Aug-99	12-Aug-99	13-Aug-99	19-Aug-99	17-Sep-99	20-Sep-99
607001	8.96	8.98	8.98	8.99	9.04	9.09	9.11	9.02	8.95	8.91	8.91	8.33	NT	NT	8.40	NT	NT	8.24	NT	NT
607002	5.03	4.96	4.97	4.98	5.05	5.11	5.18	4.89	4.71	4.75	4.81	4.76	4.24	NT	4.58	NT	NT	4.45	3.95	NT
607003	5.71	5.87	5.80	5.84	5.87	5.90	5.91	5.59	5.31	5.28	5.46	4.91	4.84	NT	5.42	NT	NT	5.16	NT	NT
607004	8.41	NT	8.35	8.49	8.52	8.54	8.58	8.32	8.28	8.25	8.42	7.81	NT	NT	8.26	NT	NT	8.10	NT	NT
607006	5.75	5.93	5.60	6.21	6.70	7.05	4.15	7.15	7.08	7.01	6.62	6.12	6.04	5.19	6.28	NT	6.25	6.23	5.67	5.87
607061	5.10	NT	NT	NT	NT	NT	NT	6.51	NT	NT	4.85	NT								
60706D	4.96	NT	NT	NT	NT	NT	NT	5.81	NT	NT	6.19	NT								
607007	8.32	8.21	8.28	8.35	8.45	8.59	8.65	8.55	9.56	8.47	8.45	7.62	NT	NT	7.79	NT	NT	7.43	NT	NT
607008	5.01	5.16	5.13	5.16	5.21	5.24	5.30	5.11	4.85	4.85	4.73	4.28	4.27	NT	4.86	NT	NT	4.72	NT	NT
607009	4.21	4.49	4.45	4.50	4.49	4.46	4.45	4.21	NT	4.20	NT	3.91	3.50	NT						
607010	8.57	8.72	7.89	8.45	9.22	9.39	9.48	8.67	8.45	8.74	NT	7.29	7.29	NT	8.89	NT	7.89	8.62	5.98	7.83
607011	5.85	7.00	5.60	7.09	8.10	8.73	8.66	8.51	8.06	8.00	7.45	6.89	6.49	5.85	6.71	NT	7.15	6.89	7.85	7.98
607012	6.67	6.64	6.40	5.20	7.84	7.97	7.70	7.11	8.33	8.30	7.86	7.18	6.68	6.02	7.83	NT	7.68	7.60	6.63	6.68
607013	5.62	1.48	4.20	4.50	5.06	5.38	2.98	1.57	4.66	5.15	4.76	3.33	4.13	4.40	5.48	7.75	NT	5.21	3.71	4.29
607014	6.34	6.28	8.04	6.45	7.42	7.47	8.09	7.85	7.99	8.04	7.72	7.17	7.04	6.41	7.36	6.90	NT	7.07	5.80	6.17
607015	6.56	7.10	6.40	7.64	8.55	9.06	9.27	8.87	9.20	9.10	8.37	7.90	7.29	6.62	7.81	7.51	NT	7.61	7.06	7.06
607016	6.54	7.05	6.09	6.99	8.54	9.00	9.25	9.32	9.09	8.96	8.85	8.16	7.83	7.67	8.25	7.05	NT	8.03	NT	6.60
607017	6.35	6.99	5.85	6.99	9.01	8.61	9.03	8.91	8.94	8.95	8.68	8.37	7.96	7.89	8.43	7.43	NT	7.71	5.38	6.13
	Change in Water Level from Initial Reading (ft)																			
607001	-0.02	-0.02	-0.03	-0.08	-0.13	-0.15	-0.15	-0.06	0.01	0.05	0.05	0.63	NT	NT	0.56	NT	NT	0.72	NT	NT
607002	0.07	0.06	0.05	-0.02	-0.09	-0.15	-0.15	0.14	0.32	0.28	0.22	0.27	0.79	NT	0.45	NT	NT	0.58	1.08	NT
607003	-0.16	-0.09	-0.13	-0.16	-0.19	-0.20	-0.19	0.12	0.40	0.43	0.25	0.80	0.87	NT	0.29	NT	NT	0.55	NT	NT
607004	NT	0.06	-0.08	-0.11	-0.13	-0.17	-0.17	0.09	0.13	0.16	-0.01	0.60	NT	NT	0.15	NT	NT	0.31	NT	NT
607006	-0.18	0.15	-0.46	-0.95	-1.30	1.60	-1.40	-1.33	-1.28	-0.87	-0.37	-0.29	-0.29	0.58	-0.53	NT	-0.50	-0.48	0.08	-0.12
607061	NT	NT	NT	NT	NT	NT	NT	-1.41	NT	NT	0.25	NT								
60706D	NT	NT	NT	NT	NT	NT	NT	-0.85	NT	NT	-1.23	NT								
607007	0.11	0.06	-0.03	-0.13	-0.27	-0.33	-0.23	-1.24	-0.15	-0.15	-0.13	0.70	NT	NT	0.53	NT	NT	0.89	NT	NT
607008	-0.15	-0.12	-0.15	-0.20	-0.23	-0.29	-0.10	0.16	0.16	0.28	0.73	0.74	0.74	NT	0.15	NT	NT	0.29	NT	NT
607009	-0.28	-0.24	-0.29	-0.28	-0.25	-0.24	0.00	NT	0.01	NT	0.30	0.71	NT							
607010	-0.15	0.68	0.12	-0.65	-0.82	-0.91	-0.10	0.12	-0.17	NT	1.28	1.28	NT	-0.32	NT	0.68	-0.05	2.59	0.74	0.74
607011	-1.15	0.25	-1.24	-2.25	-2.88	-2.81	-2.66	-2.21	-2.15	-1.60	-1.04	-0.64	0.00	-0.86	NT	-1.30	-1.04	-2.00	-2.13	-2.13
607012	0.03	0.27	1.47	-1.17	-1.30	-1.03	-0.44	-1.66	-1.63	-1.19	-0.51	-0.01	0.65	-1.16	NT	-1.01	-0.93	0.04	-0.01	-0.01
607013	4.14	1.42	1.12	0.58	0.26	2.68	4.05	0.96	0.47	0.86	2.29	1.49	1.22	0.14	-2.13	NT	0.41	1.91	1.33	1.33
607014	0.08	0.30	-0.11	-1.08	-1.13	-1.75	-1.51	-1.65	-1.70	-1.38	-0.83	-0.70	-0.07	-1.02	-0.56	NT	-0.73	0.54	0.17	0.17
607015	-0.54	0.16	-1.08	-1.99	-2.50	-2.71	-2.31	-2.64	-2.54	-1.81	-1.34	-0.73	-0.06	-1.25	-0.95	NT	-1.05	-0.50	-0.50	-0.50
607016	-0.51	0.45	-0.45	-2.00	-2.46	-2.71	-2.78	-2.55	-2.42	-2.31	-1.62	-1.29	-1.13	-1.71	-0.51	NT	-1.49	NT	-0.06	-0.06
607017	-0.64	0.50	-0.64	-2.66	-2.26	-2.68	-2.56	-2.59	-2.60	-2.33	-2.02	-1.61	-1.54	-2.08	-1.08	NT	-1.36	0.97	0.22	0.22

**Attachment B-2**

**ATTACHMENT B-2 AOC 607 Groundwater Flow Summary**

Date/Time	Totalizer (gal)	Incr. Flow (gpm)	Running Flow (gpm)	Total Gallons	Totalizer (m3)	Incr. Flow (m3)
6/26/99 10:25	1269430	0.00	0.00	0	4805	
6/26/99 12:45	1270020	4.21	4.21	590	4808	2.2
6/27/99 8:25	1272276	1.91	2.16	2846	4816	8.5
6/27/99 13:20	1273590	4.45	2.58	4160	4821	5.0
6/28/99 8:30	1277268	3.20	2.83	7838	4835	13.9
6/29/99 7:40	1281410	2.98	2.88	11980	4851	15.7
6/30/99 9:00	1285435	2.65	2.82	16005	4866	15.2
6/30/99 13:40	1286840	5.02	2.92	17410	4871	5.3
6/30/99 16:00	1287435	4.25	2.95	18005	4873	2.3
7/1/99 8:00	1291375	4.10	3.11	21945	4888	14.9
7/1/99 16:25	1293275	3.76	3.15	23845	4896	7.2
7/2/99 9:15	1296728	3.42	3.19	27298	4909	13.1
7/3/99 9:00	1301586	3.41	3.22	32156	4927	18.4
7/4/99 10:35	1306659	3.30	3.23	37229	4946	19.2
7/7/99 10:35	1319755	3.03	3.18	50325	4996	49.6
7/15/99 14:20	1347218	2.34	2.82	77788	5100	104.0
7/19/99 11:10	1361589	2.58	2.78	92159	5154	54.4
7/20/99 13:45	1365265	2.30	2.76	95835	5168	13.9
7/23/99 15:30	1375870	2.40	2.72	106440	5208	40.1
7/28/99 16:20	1395289	2.68	2.71	125859	5282	73.5
7/30/99 18:00	1402361	2.37	2.69	132931	5308	26.8
8/2/99 10:10	1410809	2.19	2.65	141379	5340	32.0
8/6/99 14:00	1423539	2.13	2.60	154109	5389	48.2
8/10/99 17:10	1440201	2.80	2.62	170771	5452	63.1
8/13/99 12:20	1452981	3.17	2.65	183551	5500	48.4
8/19/99 13:00	1475098	2.55	2.64	205668	5584	83.7
9/3/99 16:30	1494375	0.88	2.26	224945	5657	73.0
9/7/99 17:00	1499724	0.92	2.18	230294	5677	20.2
9/8/99 8:50	1501234	1.59	2.18	231804	5683	5.7
9/9/99 15:00	1503902	1.47	2.17	234472	5693	10.1
9/9/99 16:10	1504065	2.33	2.17	234635	5693	0.6
9/10/99 18:25	1505729	1.06	2.15	236299	5700	6.3
9/17/99 9:30	1511085	0.56	2.02	241655	5720	20.3
9/17/99 16:05	1512176	2.76	2.03	242746	5724	4.1
9/20/99 11:10	1519355	1.78	2.02	249925	5751	27.2

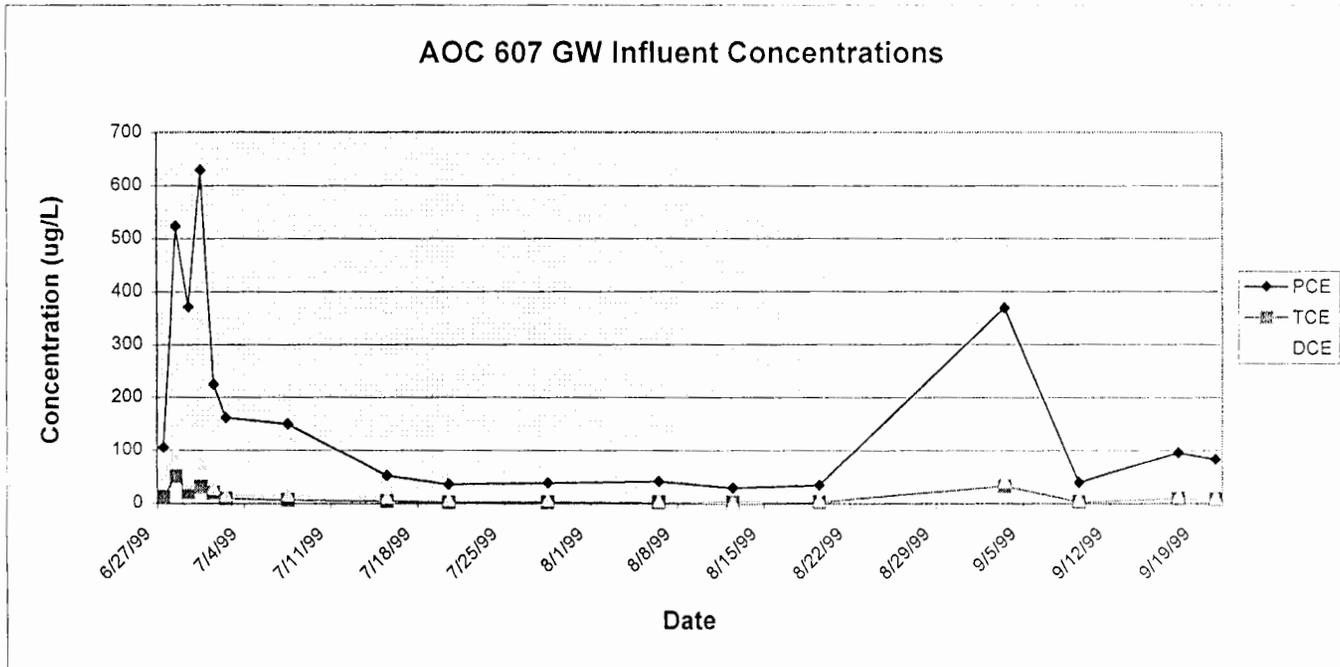


**Attachment B-3**

ATTACHMENT B-3

EXTRACTED GROUNDWATER CONCENTRATIONS AND INCREMENTAL FLOW AT SYSTEM HEADER

Sample ID	Date	Concentration (ug/L)				Incremental Flow		Est. Cumulative Mass Removed (kg)
		PCE	TCE	1,2-DCE	VC	GALLONS	LITERS	
607IN00001	6/26/99	21.1	6.3	31.9	ND			0.0E+00
607IN00002	6/27/99	105.0	11.6	45.3	ND	2846	10773	1.7E-03
607IN00003	6/28/99	523.0	50.9	94.9	1.3	4992	18897	1.4E-02
607IN00004	6/29/99	371.0	20.8	38.0	ND	4142	15679	2.1E-02
607IN00005	6/30/99	629.0	31.0	73.4	ND	4025	15236	3.2E-02
607IN00006	7/1/99	225.0	19.1	27.0	ND	5940	22485	3.8E-02
607IN00007	7/2/99	161.0	8.3	14.2	ND	5353	20263	4.2E-02
607IN00008	7/7/99	149.0	6.4	14.7	ND	23027	87166	5.7E-02
607IN00009	7/15/99	51.3	3.5	10.7	ND	27463	103958	6.4E-02
607IN00010	7/20/99	34.9	1.9	5.3	ND	18047	68315	6.7E-02
607IN00011	7/28/99	37.7	2.1	5.3	ND	30024	113653	7.2E-02
607IN00012	8/6/99	40.4	1.6	3.8	ND	28250	106938	7.7E-02
607IN00013	8/12/99	27.8	2.1	ND	ND	29442	111450	8.0E-02
607IN00014	8/19/99	33.5	1.9	4.5	ND	22117	83722	8.3E-02
607IN00015	9/3/99	369.0	32.1	40.3	ND	19277	72971	1.2E-01
607IN00016	9/9/99	39.0	2.5	5.1	ND	9527	36064	1.2E-01
607IN00017	9/17/99	95.3	8.9	11.7	ND	7183	27191	1.2E-01
607IN00018	9/20/99	82.6	7.6	8.4	ND	8270	31305	1.2E-01



**Attachment B-4**

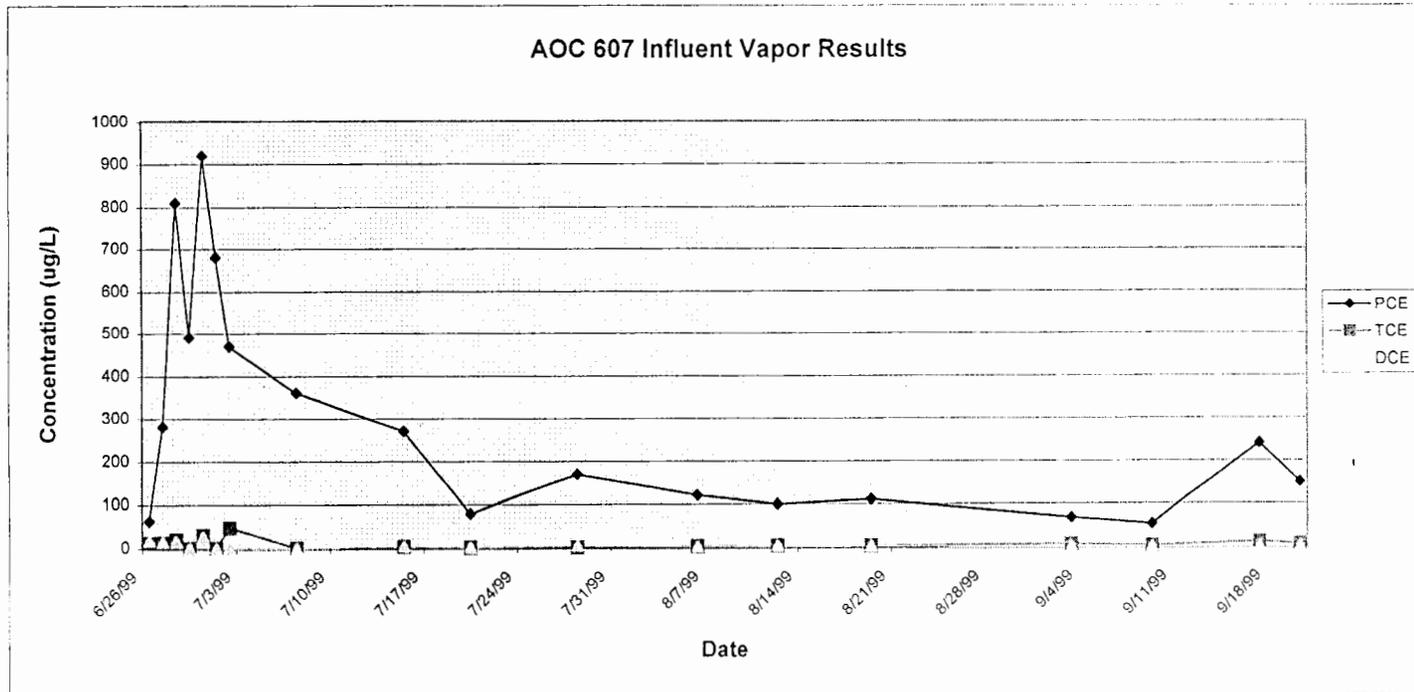
ATTACHMENT B-4

EXTRACTED VAPOR CONCENTRATIONS AND FLOWRATES AT SYSTEM HEADER

Est. Avg. Daily Flowrate =

1142 m<sup>3</sup>

Sample ID	Date	Concentration (mg/m <sup>3</sup> )					TOTAL VOCs	Est. Incremental Flow (m <sup>3</sup> )	Est. Cumulative Mass Removed (kg)
		PCE	TCE	1,2-DCE	VC				
607INVAP01	6/26/99	63.0	12.0	18.0	3.7	96.7	0	0.0	
607INVAP02	6/27/99	280.0	12.0	15.0	3.9	310.9	1142	0.4	
607INVAP03	6/28/99	810.0	20.0	17.0	ND	847.0	1142	1.3	
607INVAP04	6/29/99	490.0	ND	ND	ND	490.0	1142	1.9	
607INVAP05	6/30/99	920.0	30.0	26.0	ND	976.0	1142	3.0	
607INVAP06	7/1/99	680.0	ND	ND	ND	680.0	1142	3.8	
607INVAP07	7/2/99	470.0	48.0	ND	ND	518.0	1142	4.4	
607INVAP08	7/7/99	360.0	ND	ND	ND	360.0	5709	6.4	
607INVAP09	7/15/99	270.0	3.9	4.6	ND	278.5	9134	9.0	
607INVAP10	7/20/99	79.0	1.7	1.7	ND	82.4	5709	9.4	
607INVAP11	7/28/99	170.0	1.5	5.0	ND	176.5	9134	11.0	
607INVAP12	8/6/99	120.0	3.0	2.4	ND	125.4	10276	12.3	
607INVAP13	8/12/99	99.0	4.6	4.2	ND	107.8	6850	13.1	
607INVAP14	8/19/99	110.0	4.0	3.2	ND	117.2	7992	14.0	
607INVAP15	9/3/99	68.0	6.8	ND	ND	74.8	17126	15.3	
607INVAP16	9/9/99	54.0	3.2	ND	ND	57.2	6850	15.7	
607INVAP17	9/17/99	240.0	12.0	ND	ND	252.0	9134	18.0	
607INVAP18	9/20/99	150.0	6.9	ND	ND	156.9	3425	18.5	

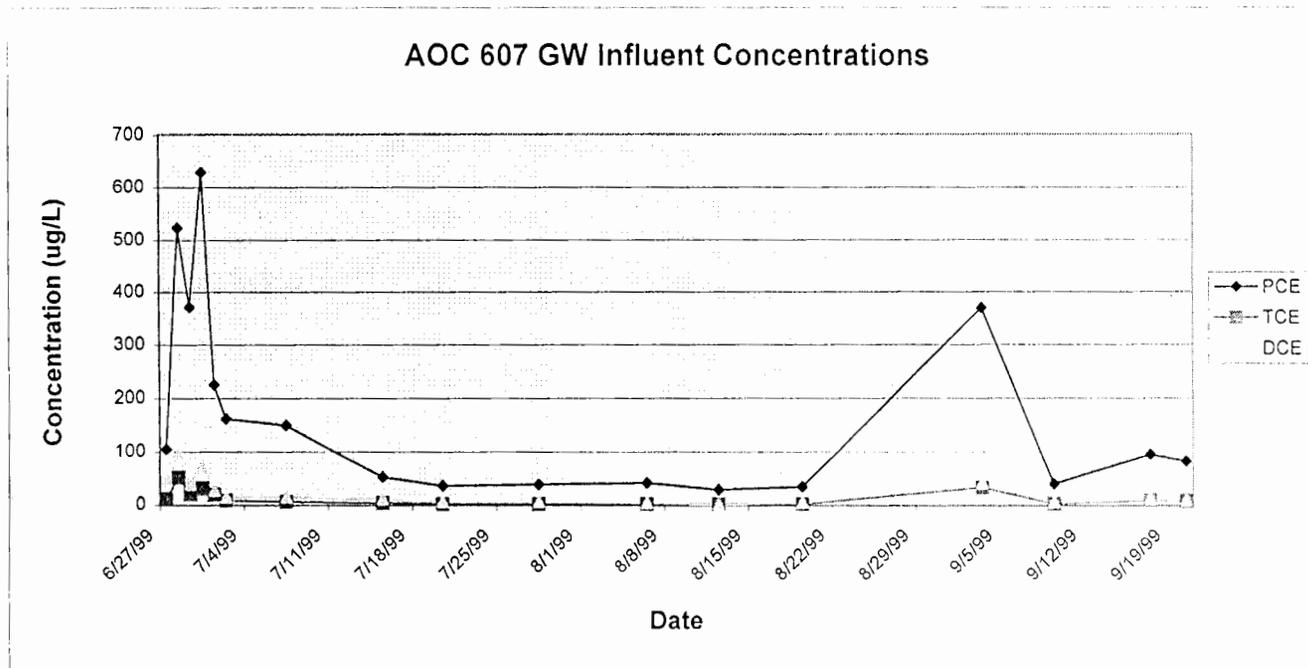


**Attachment B-5**

ATTACHMENT D-1

EXTRACTED GROUNDWATER CONCENTRATIONS AND FLOWRATES AT SYSTEM HEADER

Sample ID	Date	Concentration (ug/L)				VC	Est. Cumulative Mass Removed (kg)
		PCE	TCE	1,2-DCE			
607IN00001	6/26/99	21.1	6.3	31.9	ND	0.0E+00	
607IN00002	6/27/99	105.0	11.6	45.3	ND	2.8E-03	
607IN00003	6/28/99	523.0	50.9	94.9	1.3	1.5E-02	
607IN00004	6/29/99	371.0	20.8	38.0	ND	2.2E-02	
607IN00005	6/30/99	629.0	31.0	73.4	ND	3.5E-02	
607IN00006	7/1/99	225.0	19.1	27.0	ND	4.4E-02	
607IN00007	7/2/99	161.0	8.3	14.2	ND	4.8E-02	
607IN00008	7/7/99	149.0	6.4	14.7	ND	6.2E-02	
607IN00009	7/15/99	51.3	3.5	10.7	ND	7.2E-02	
607IN00010	7/20/99	34.9	1.9	5.3	ND	7.5E-02	
607IN00011	7/28/99	37.7	2.1	5.3	ND	8.2E-02	
607IN00012	8/6/99	40.4	1.6	3.8	ND	8.9E-02	
607IN00013	8/12/99	27.8	2.1	ND	ND	9.2E-02	
607IN00014	8/19/99	33.5	1.9	4.5	ND	9.6E-02	
607IN00015	9/3/99	369.0	32.1	40.3	ND	1.4E-01	
607IN00016	9/9/99	39.0	2.5	5.1	ND	1.5E-01	
607IN00017	9/17/99	95.3	8.9	11.7	ND	1.6E-01	
607IN00018	9/20/99	82.6	7.6	8.4	ND	1.7E-01	

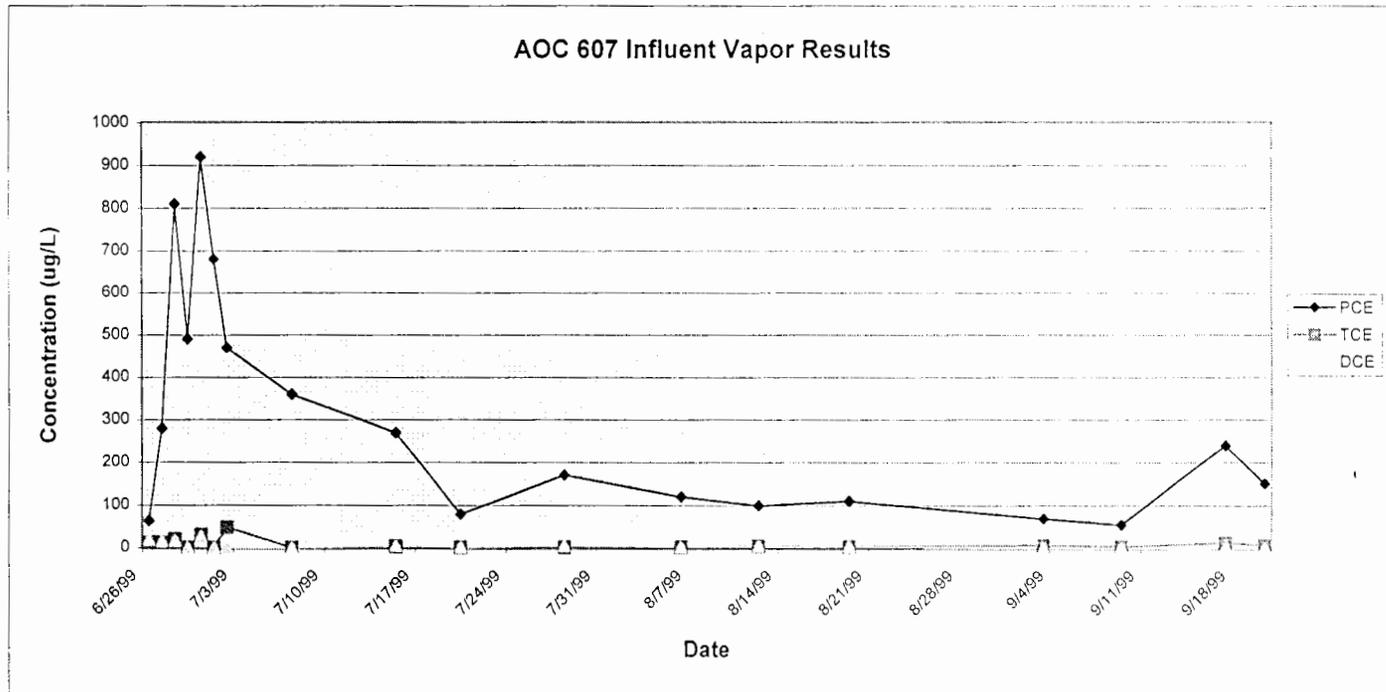


ATTACHMENT D-2

EXTRACTED VAPOR CONCENTRATIONS AND FLOWRATES AT SYSTEM HEADER

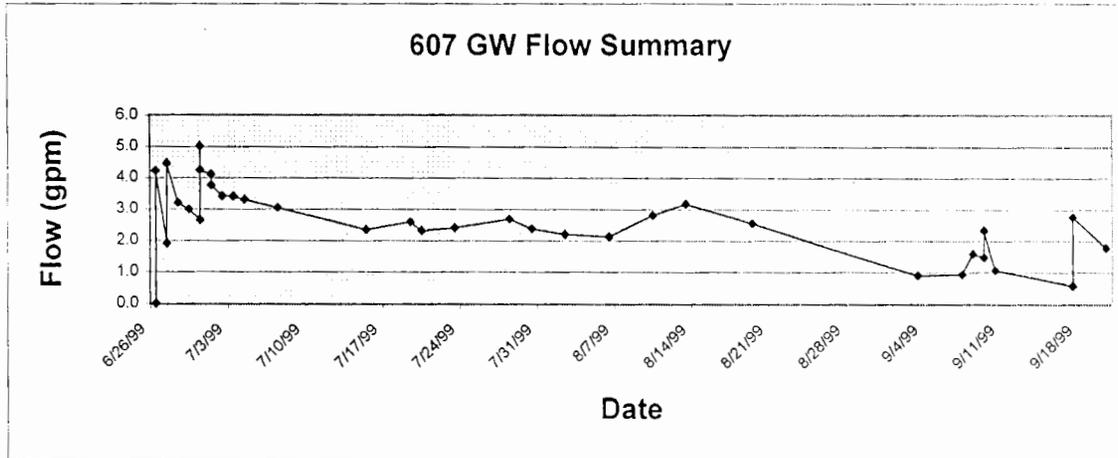
Average Daily Flowrate = 1.1E+03 m<sup>3</sup>

Sample ID	Date	Concentration (mg/m <sup>3</sup> )					TOTAL VOCs	Est. Incremental Days	Est. Cumulative Mass Removed (kg)
		PCE	TCE	1,2-DCE	VC				
607INVAP01	6/26/99	63.0	12.0	18.0	3.7	96.7	0	0.0	
607INVAP02	6/27/99	280.0	12.0	15.0	3.9	310.9	1	0.4	
607INVAP03	6/28/99	810.0	20.0	17.0	ND	847.0	1	1.3	
607INVAP04	6/29/99	490.0	ND	ND	ND	490.0	1	1.9	
607INVAP05	6/30/99	920.0	30.0	26.0	ND	976.0	1	3.0	
607INVAP06	7/1/99	680.0	ND	ND	ND	680.0	1	3.8	
607INVAP07	7/2/99	470.0	48.0	ND	ND	518.0	1	4.4	
607INVAP08	7/7/99	360.0	ND	ND	ND	360.0	5	6.4	
607INVAP09	7/15/99	270.0	3.9	4.6	ND	278.5	8	9.0	
607INVAP10	7/20/99	79.0	1.7	1.7	ND	82.4	5	9.4	
607INVAP11	7/28/99	170.0	1.5	5.0	ND	176.5	8	11.0	
607INVAP12	8/6/99	120.0	3.0	2.4	ND	125.4	9	12.3	
607INVAP13	8/12/99	99.0	4.6	4.2	ND	107.8	6	13.1	
607INVAP14	8/19/99	110.0	4.0	3.2	ND	117.2	7	14.0	
607INVAP15	9/3/99	68.0	6.8	ND	ND	74.8	15	15.3	
607INVAP16	9/9/99	54.0	3.2	ND	ND	57.2	6	15.7	
607INVAP17	9/17/99	240.0	12.0	ND	ND	252.0	8	18.0	
607INVAP18	9/20/99	150.0	6.9	ND	ND	156.9	3	18.5	



ATTACHMENT D-3 AOC 607 Groundwater Flow Summary

Date/Time	Totalizer (gal)	Incr. Flow (gpm)	Running Flow (gpm)	Total Gallons	Totalizer (m3)	Incr. Flow (m3)
6/26/99 10:25	1269430	0.00	0.00	0	4805	
6/26/99 12:45	1270020	4.21	4.21	590	4808	2.2
6/27/99 8:25	1272276	1.91	2.16	2846	4816	8.5
6/27/99 13:20	1273590	4.45	2.58	4160	4821	5.0
6/28/99 8:30	1277268	3.20	2.83	7838	4835	13.9
6/29/99 7:40	1281410	2.98	2.88	11980	4851	15.7
6/30/99 9:00	1285435	2.65	2.82	16005	4866	15.2
6/30/99 13:40	1286840	5.02	2.92	17410	4871	5.3
6/30/99 16:00	1287435	4.25	2.95	18005	4873	2.3
7/1/99 8:00	1291375	4.10	3.11	21945	4888	14.9
7/1/99 16:25	1293275	3.76	3.15	23845	4896	7.2
7/2/99 9:15	1296728	3.42	3.19	27298	4909	13.1
7/3/99 9:00	1301586	3.41	3.22	32156	4927	18.4
7/4/99 10:35	1306659	3.30	3.23	37229	4946	19.2
7/7/99 10:35	1319755	3.03	3.18	50325	4996	49.6
7/15/99 14:20	1347218	2.34	2.82	77788	5100	104.0
7/19/99 11:10	1361589	2.58	2.78	92159	5154	54.4
7/20/99 13:45	1365265	2.30	2.76	95835	5168	13.9
7/23/99 15:30	1375870	2.40	2.72	106440	5208	40.1
7/28/99 16:20	1395289	2.68	2.71	125859	5282	73.5
7/30/99 18:00	1402361	2.37	2.69	132931	5308	26.8
8/2/99 10:10	1410809	2.19	2.65	141379	5340	32.0
8/6/99 14:00	1423539	2.13	2.60	154109	5389	48.2
8/10/99 17:10	1440201	2.80	2.62	170771	5452	63.1
8/13/99 12:20	1452981	3.17	2.65	183551	5500	48.4
8/19/99 13:00	1475098	2.55	2.64	205668	5584	83.7
9/3/99 16:30	1494375	0.88	2.26	224945	5657	73.0
9/7/99 17:00	1499724	0.92	2.18	230294	5677	20.2
9/8/99 8:50	1501234	1.59	2.18	231804	5683	5.7
9/9/99 15:00	1503902	1.47	2.17	234472	5693	10.1
9/9/99 16:10	1504065	2.33	2.17	234635	5693	0.6
9/10/99 18:25	1505729	1.06	2.15	236299	5700	6.3
9/17/99 9:30	1511085	0.56	2.02	241655	5720	20.3
9/17/99 16:05	1512176	2.76	2.03	242746	5724	4.1
9/20/99 11:10	1519355	1.78	2.02	249925	5751	27.2



ATTACHMENT D-4 AOC 607 WATER LEVEL SUMMARY

Well	Depth to Water Reading (ft)																			
	22-Jun-99	25-Jun-99	26-Jun-99	26-Jun-99	27-Jun-99	28-Jun-99	29-Jun-99	30-Jun-99	01-Jul-99	02-Jul-99	07-Jul-99	15-Jul-99	15-Jul-99	23-Jul-99	02-Aug-99	12-Aug-99	13-Aug-99	19-Aug-99	17-Sep-99	20-Sep-99
607001	8.96	8.98	8.98	8.99	9.04	9.09	9.11	9.02	8.95	8.91	8.91	8.33	NT	NT	8.40	NT	NT	8.24	NT	NT
607002	5.03	4.96	4.97	4.98	5.05	5.11	5.18	4.89	4.71	4.75	4.81	4.76	4.24	NT	4.58	NT	NT	4.45	3.95	NT
607003	5.71	5.87	5.80	5.84	5.87	5.90	5.91	5.59	5.31	5.28	5.46	4.91	4.84	NT	5.42	NT	NT	5.16	NT	NT
607004	8.41	NT	8.35	8.49	8.52	8.54	8.58	8.32	8.28	8.25	8.42	7.81	NT	NT	8.26	NT	NT	8.10	NT	NT
607006	5.75	5.93	5.60	6.21	6.70	7.05	4.15	7.15	7.08	7.01	6.62	6.12	6.04	5.19	6.28	NT	6.25	6.23	5.67	5.87
607061	5.10	NT	NT	NT	NT	NT	NT	6.51	NT	NT	4.85	NT								
60706D	4.96	NT	NT	NT	NT	NT	NT	5.81	NT	NT	6.19	NT								
607007	8.32	8.21	8.26	8.35	8.45	8.59	8.65	8.55	9.56	8.47	8.45	7.62	NT	NT	7.79	NT	NT	7.43	NT	NT
607008	5.01	5.16	5.13	5.16	5.21	5.24	5.30	5.11	4.85	4.85	4.73	4.28	4.27	NT	4.86	NT	NT	4.72	NT	NT
607009	4.21	4.49	4.45	4.50	4.49	4.46	4.45	4.21	NT	4.20	NT	3.91	3.50	NT						
607010	8.57	8.72	7.89	8.45	9.22	9.39	9.48	8.67	8.45	8.74	NT	7.29	7.29	NT	8.89	NT	7.89	8.62	5.98	7.83
607011	5.85	7.00	5.60	7.09	8.10	8.73	8.66	8.51	8.06	8.00	7.45	6.89	6.49	5.65	6.71	NT	7.15	6.89	7.85	7.98
607012	6.67	6.64	6.40	5.20	7.84	7.97	7.70	7.11	8.33	8.30	7.86	7.18	6.68	6.02	7.83	NT	7.68	7.60	6.63	6.68
607013	5.62	1.48	4.20	4.50	5.06	5.36	2.96	1.57	4.66	5.15	4.76	3.33	4.13	4.40	5.48	7.75	NT	5.21	3.71	4.29
607014	6.34	6.28	6.04	6.45	7.42	7.47	8.09	7.85	7.99	8.04	7.72	7.17	7.04	6.41	7.36	6.90	NT	7.07	5.80	6.17
607015	6.56	7.10	6.40	7.84	8.55	9.06	9.27	8.87	9.20	8.37	7.90	7.29	6.62	7.81	7.51	NT	7.61	7.06	7.06	7.06
607016	6.54	7.05	6.09	6.99	8.54	9.00	9.25	9.32	9.09	8.96	8.85	8.16	7.83	7.67	8.25	7.05	NT	8.03	NT	6.60
607017	6.35	6.99	5.85	6.99	9.01	8.61	9.03	8.91	8.94	8.95	8.68	8.37	7.96	7.89	8.43	7.43	NT	7.71	5.38	6.13
	Change in Water Level from Initial Reading (ft)																			
607001	-0.02	-0.02	-0.03	-0.08	-0.13	-0.15	-0.06	0.01	0.05	0.05	0.63	NT	NT	0.56	NT	NT	0.72	NT	NT	NT
607002	0.07	0.06	0.05	-0.02	-0.08	-0.15	0.14	0.32	0.28	0.22	0.27	0.79	NT	0.45	NT	NT	0.58	1.08	NT	NT
607003	-0.16	-0.09	-0.13	-0.16	-0.19	-0.20	0.12	0.40	0.43	0.25	0.80	0.87	NT	0.29	NT	NT	0.55	NT	NT	NT
607004	NT	0.06	-0.08	-0.11	-0.13	-0.17	0.09	0.13	0.16	-0.01	0.60	NT	NT	0.15	NT	NT	0.31	NT	NT	NT
607006	-0.18	0.15	-0.46	-0.95	-1.30	1.60	-1.40	-1.33	-1.26	-0.87	-0.37	-0.29	0.56	-0.53	NT	-0.50	-0.48	0.08	-0.12	-0.12
607061	NT	NT	NT	NT	NT	NT	-1.41	NT	NT	0.25	NT									
60706D	NT	NT	NT	NT	NT	NT	-0.85	NT	NT	-1.23	NT									
607007	0.11	0.06	-0.03	-0.13	-0.27	-0.33	-0.23	-1.24	-0.15	-0.13	0.70	NT	NT	0.53	NT	NT	0.89	NT	NT	NT
607008	-0.15	-0.12	-0.15	-0.20	-0.23	-0.29	-0.10	0.16	0.16	0.28	0.73	0.74	NT	0.15	NT	NT	0.29	NT	NT	NT
607009	-0.28	-0.24	-0.29	-0.28	-0.25	-0.24	0.00	NT	0.01	NT	0.30	0.71	NT							
607010	-0.15	0.68	0.12	-0.65	-0.82	-0.91	-0.10	0.12	-0.17	NT	1.28	1.28	NT	-0.32	NT	0.68	-0.05	2.59	0.74	0.74
607011	-1.15	0.25	-1.24	-2.25	-2.88	-2.81	-2.66	-2.21	-2.15	-1.60	-1.04	-0.64	0.00	-0.86	NT	-1.30	-1.04	-2.00	-2.13	-2.13
607012	0.03	0.27	1.47	-1.17	-1.30	-1.03	-0.44	-1.68	-1.63	-1.19	-0.51	-0.01	0.65	-1.16	NT	-1.01	-0.93	0.04	-0.01	-0.01
607013	4.14	1.42	1.12	0.58	0.26	2.66	4.05	0.96	0.47	0.86	2.29	1.49	1.22	0.14	-2.13	NT	0.41	1.91	1.33	1.33
607014	0.06	0.30	-0.11	-1.08	-1.13	-1.75	-1.51	-1.65	-1.70	-1.38	-0.83	-0.70	-0.07	-1.02	-0.56	NT	-0.73	0.54	0.17	0.17
607015	-0.54	0.16	-1.08	-1.99	-2.50	-2.71	-2.31	-2.64	-2.54	-1.81	-1.34	-0.73	-0.06	-1.25	-0.95	NT	-1.05	-0.50	-0.50	-0.50
607016	-0.51	0.45	-0.45	-2.00	-2.46	-2.71	-2.78	-2.55	-2.42	-2.31	-1.62	-1.29	-1.13	-1.71	-0.51	NT	-1.49	NT	-0.08	-0.08
607017	-0.64	0.50	-0.64	-2.66	-2.26	-2.68	-2.56	-2.59	-2.60	-2.33	-2.02	-1.61	-1.54	-2.08	-1.08	NT	-1.36	0.97	0.22	0.22



# GENERAL ENGINEERING LABORATORIES

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## Laboratory Certifications

STATE	GEL	EPI
FL	E87156/87294	E87472/87458
NC	233	
NJ	79002	79002
SC	10120	10582
TN	02934	02934

Client: Ensafe/Allen & Hoshall  
 935 Houston Northcutt Blvd.  
 Mt. Pleasant, South Carolina 29464

Contact: Mr. Charles Vernoy

cc: ENSF00199

Report Date: June 28, 1999

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Sample ID : NBCF/607IN00001  
 Lab ID : 9906890-02  
 Matrix : GroundH2O  
 Date Collected : 06/26/99  
 Date Received : 06/28/99  
 Priority : Urgent  
 Collector : Client

Parameter	Qualifier	Result	DL	RL	Units	DF	Analyst	Date	Time	Batch	M
<b>Volatile Organics</b>											
GCMS Library Search-VOA						TCL	06/28/99	1222	152220	1	
<i>Target Compound List Volatiles - 35 items</i>											
1,1,1-Trichloroethane	U	ND	0.200	1.00	ug/l	1.0	TCL	06/28/99	1222	152220	2
1,1,2,2-Tetrachloroethane	U	ND	0.500	1.00	ug/l	1.0					
1,1,2-Trichloroethane	U	ND	0.400	1.00	ug/l	1.0					
1,1-Dichloroethane	U	ND	0.400	1.00	ug/l	1.0					
1,1-Dichloroethylene	U	ND	0.700	1.00	ug/l	1.0					
1,2-Dichloroethane	U	ND	0.200	1.00	ug/l	1.0					
1,2-Dichloropropane	U	ND	0.200	1.00	ug/l	1.0					
1,2-cis-Dichloroethylene		31.9	0.700	1.00	ug/l	1.0					
1,2-trans-Dichloroethylene	U	ND	0.700	1.00	ug/l	1.0					
2-Butanone		30.0	5.90	10.0	ug/l	1.0					
2-Hexanone	U	ND	3.20	5.00	ug/l	1.0					
4-Methyl-2-pentanone	U	ND	1.60	5.00	ug/l	1.0					
Acetone	U	ND	3.70	5.00	ug/l	1.0					
Benzene	U	ND	0.300	1.00	ug/l	1.0					
Bromoform	J	0.840	0.400	1.00	ug/l	1.0					
Carbon Disulfide	U	ND	1.80	5.00	ug/l	1.0					
Carbon Tetrachloride	U	ND	0.200	1.00	ug/l	1.0					
Chlorobenzene	U	ND	0.300	1.00	ug/l	1.0					
Chlorodibromomethane		2.33	0.300	1.00	ug/l	1.0					
Chloroethane	U	ND	0.300	1.00	ug/l	1.0					
Chloroform		1.06	0.700	1.00	ug/l	1.0					
Dichlorobromomethane		1.40	0.400	1.00	ug/l	1.0					
Ethylbenzene	U	ND	0.300	1.00	ug/l	1.0					
Methyl Bromide	U	ND	0.300	1.00	ug/l	1.0					
Methyl Chloride	U	ND	0.200	1.00	ug/l	1.0					
Methylene Chloride	U	ND	1.20	5.00	ug/l	1.0					
Styrene	U	ND	0.200	1.00	ug/l	1.0					





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### Laboratory Certifications

STATE	GEL	EPI
FL	E87156/87294	E87472/87458
NC	233	
NJ	79002	79002
SC	10120	10582
TN	02934	02934

Client: Ensafe/Allen & Hoshall  
 935 Houston Northcutt Blvd.  
 Mt. Pleasant, South Carolina 29464

Contact: Mr. Charles Vernoy

cc: ENSF00199

Report Date: June 28, 1999

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Sample ID : NBCF/6071N00001

Parameter	Qualifier	Result	DL	RL	Units	DF	Analyst	Date	Time	Batch	M
Tetrachloroethylene		21.1	0.700	1.00	ug/l	1.0					
Toluene	U	ND	0.500	1.00	ug/l	1.0	TCL	06/28/99	1222	152220	2
Trichloroethylene		6.32	0.600	1.00	ug/l	1.0					
Vinyl Acetate	U	ND	1.80	5.00	ug/l	1.0					
Vinyl chloride	U	ND	0.400	1.00	ug/l	1.0					
Xylenes (TOTAL)	U	ND	1.10	2.00	ug/l	1.0					
cis-1,3-Dichloropropylene	U	ND	0.300	1.00	ug/l	1.0					
trans-1,3-Dichloropropylene	U	ND	0.300	1.00	ug/l	1.0					

Surrogate Recovery	Test	Percent%	Acceptable Limits
Bromofluorobenzene	TCL VOLATILES-8260	83.9	(73.0 - 129.)
Dibromofluoromethane	TCL VOLATILES-8260	92.6	(66.0 - 117.)
Toluene-d8	TCL VOLATILES-8260	82.3	(73.0 - 122.)

M = Method	Method-Description
M 1	EPA 8260B
M 2	EPA 8260A

Notes:

The qualifiers in this report are defined as follows:

ND indicates that the analyte was not detected at a concentration greater than the detection limit.

J indicates presence of analyte at a concentration less than the reporting limit (RL) and greater than the detection limit (DL).

U indicates that the analyte was not detected at a concentration greater than the detection limit.

\* indicates that a quality control analyte recovery is outside of specified acceptance criteria.



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## Laboratory Certifications

STATE	GEL	EPI
FL	E87156/S7294	E87472/87458
NC	233	
NJ	79002	79002
SC	10120	10582
TN	02934	02934

Client: Ensafe/Allen & Hoshall  
935 Houston Northcutt Blvd.  
Mt. Pleasant, South Carolina 29464  
Contact: Mr. Charles Vernoy

cc: ENSF00199

Report Date: June 28, 1999

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Sample ID : NBCF/607IN00001

### M = Method

### Method-Description

This data report has been prepared and reviewed in accordance with General Engineering Laboratories standard operating procedures. Please direct any questions to your Project Manager, Jack Spitz at (843) 769-7390.

Reviewed By





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### Laboratory Certifications

STATE	GEL	EPI
FL	E87156/87294	E87472/87458
NC	233	
NJ	79002	79002
SC	10120	10582
TN	02934	02934

Client: Ensafe/Allen & Hoshall  
 935 Houston Northcutt Blvd.  
 Mt. Pleasant, South Carolina 29464  
 Contact: Mr. Charles Vernoy

cc: ENSF00199

Report Date: June 28, 1999

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Sample ID : NBCF/607IN00002  
 Lab ID : 9906890-03  
 Matrix : GroundH2O  
 Date Collected : 06/27/99  
 Date Received : 06/28/99  
 Priority : Urgent  
 Collector : Client

Parameter	Qualifier	Result	DL	RL	Units	DF	Analyst	Date	Time	Batch	M	
<b>Volatile Organics</b>												
GCMS Library Search-VOA							TCL	06/28/99	1252	152220	1	
<i>Target Compound List Volatiles - 35 items</i>												
'1,1,1-Trichloroethane	U	ND	0.200	1.00	ug/l	1.0	TCL	06/28/99	1252	152220	2	
1,1,2,2-Tetrachloroethane	U	ND	0.500	1.00	ug/l	1.0						
1,1,2-Trichloroethane	U	ND	0.400	1.00	ug/l	1.0						
1,1-Dichloroethane	U	ND	0.400	1.00	ug/l	1.0						
1,1-Dichloroethylene	U	ND	0.700	1.00	ug/l	1.0						
1,2-Dichloroethane	U	ND	0.200	1.00	ug/l	1.0						
1,2-Dichloropropane	U	ND	0.200	1.00	ug/l	1.0						
1,2-cis-Dichloroethylene		45.3	0.700	1.00	ug/l	1.0						
1,2-trans-Dichloroethylene	U	ND	0.700	1.00	ug/l	1.0						
2-Butanone	U	ND	5.90	10.0	ug/l	1.0						
2-Hexanone	U	ND	3.20	5.00	ug/l	1.0						
4-Methyl-2-pentanone	U	ND	1.60	5.00	ug/l	1.0						
Acetone	U	ND	3.70	5.00	ug/l	1.0						
Benzene	U	ND	0.300	1.00	ug/l	1.0						
Bromoform	J	0.940	0.400	1.00	ug/l	1.0						
Carbon Disulfide	U	ND	1.80	5.00	ug/l	1.0						
Carbon Tetrachloride	U	ND	0.200	1.00	ug/l	1.0						
Chlorobenzene	U	ND	0.300	1.00	ug/l	1.0						
Chlorodibromomethane		3.82	0.300	1.00	ug/l	1.0						
Chloroethane	U	ND	0.300	1.00	ug/l	1.0						
Chloroform		1.97	0.700	1.00	ug/l	1.0						
Dichlorobromomethane		2.39	0.400	1.00	ug/l	1.0						
Ethylbenzene	U	ND	0.300	1.00	ug/l	1.0						
Methyl Bromide	U	ND	0.300	1.00	ug/l	1.0						
Methyl Chloride	U	ND	0.200	1.00	ug/l	1.0						
Methylene Chloride	U	ND	1.20	5.00	ug/l	1.0						
Styrene	U	ND	0.200	1.00	ug/l	1.0						





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## Laboratory Certifications

STATE	GEL	EPI
FL	E87156/87294	E87472/87458
NC	233	
NJ	79002	79002
SC	10120	10582
TN	02934	02934

Client: Ensafe/Allen & Hoshall  
 935 Houston Northcutt Blvd.  
 Mt. Pleasant, South Carolina 29464  
 Contact: Mr. Charles Vernoy

cc: ENSF00199

Report Date: June 28, 1999

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Sample ID : NBCF/607IN00002

Parameter	Qualifier	Result	DL	RL	Units	DF	Analyst	Date	Time	Batch	M
Tetrachloroethylene		105	1.40	2.00	ug/l	2.0	TCL	06/28/99	1353	152220	2
Toluene	U	ND	0.500	1.00	ug/l	1.0	TCL	06/28/99	1252	152220	2
Trichloroethylene		11.6	0.600	1.00	ug/l	1.0					
Vinyl Acetate	U	ND	1.80	5.00	ug/l	1.0					
Vinyl chloride	U	ND	0.400	1.00	ug/l	1.0					
Xylenes (TOTAL)	U	ND	1.10	2.00	ug/l	1.0					
cis-1,3-Dichloropropylene	U	ND	0.300	1.00	ug/l	1.0					
trans-1,3-Dichloropropylene	U	ND	0.300	1.00	ug/l	1.0					

Surrogate Recovery	Test	Percent%	Acceptable Limits
Bromofluorobenzene	TCL VOLATILES-8260	80.6	(73.0 - 129.)
Dibromofluoromethane	TCL VOLATILES-8260	90.5	(66.0 - 117.)
Toluene-d8	TCL VOLATILES-8260	81.2	(73.0 - 122.)

M = Method	Method-Description
M 1	EPA 8260B
M 2	EPA 8260A

**Notes:**

The qualifiers in this report are defined as follows:

ND indicates that the analyte was not detected at a concentration greater than the detection limit.

J indicates presence of analyte at a concentration less than the reporting limit (RL) and greater than the detection limit (DL).

U indicates that the analyte was not detected at a concentration greater than the detection limit.

\* indicates that a quality control analyte recovery is outside of specified acceptance criteria.



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## Laboratory Certifications

STATE	GEL	EPI
FL	E87156/87294	E87472/87458
NC	233	
NJ	79002	79002
SC	10120	10582
TN	02934	02934

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Report Date: June 28, 1999

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Sample ID : NBCF/607IN00002

M = Method

Method-Description

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## Laboratory Certifications

STATE	GEL	EPI
FL	E87156/87294	E87472/87458
NC	233	
NJ	79002	79002
SC	10120	10582
TN	02934	02934

Client: Ensafe/Allen & Hoshall  
 935 Houston Northcutt Blvd.  
 Mt. Pleasant, South Carolina 29464

Contact: Mr. Charles Vernoy

cc: ENSF00199

Report Date: June 30, 1999

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Sample ID : NBCF/607IN00003  
 Lab ID : 9906911-01  
 Matrix : GroundH2O  
 Date Collected : 06/28/99  
 Date Received : 06/28/99  
 Priority : Routine  
 Collector : Client

Parameter	Qualifier	Result	DL	RL	Units	DF	Analyst	Date	Time	Batch	M
<b>Volatile Organics</b>											
GCMS Library Search-VOA							TCL	06/29/99	1319	152220	1
<i>Target Compound List Volatiles - 35 items</i>											
1,1,1-Trichloroethane	U	ND	0.200	1.00	ug/l	1.0	TCL	06/29/99	1319	152220	2
1,1,2,2-Tetrachloroethane	U	ND	0.500	1.00	ug/l	1.0					
1,1,2-Trichloroethane	U	ND	0.400	1.00	ug/l	1.0					
1,1-Dichloroethane	U	ND	0.400	1.00	ug/l	1.0					
1,1-Dichloroethylene	U	ND	0.700	1.00	ug/l	1.0					
1,2-Dichloroethane	U	ND	0.200	1.00	ug/l	1.0					
1,2-Dichloropropane	U	ND	0.200	1.00	ug/l	1.0					
1,2-cis-Dichloroethylene		90.5	7.00	10.0	ug/l	10.	TCL	06/29/99	1620	152220	2
1,2-trans-Dichloroethylene		4.35	0.700	1.00	ug/l	1.0	TCL	06/29/99	1319	152220	2
2-Butanone	U	ND	5.90	10.0	ug/l	1.0					
2-Hexanone	U	ND	3.20	5.00	ug/l	1.0					
4-Methyl-2-pentanone	U	ND	1.60	5.00	ug/l	1.0					
Acetone	U	ND	3.70	5.00	ug/l	1.0					
Benzene	U	ND	0.300	1.00	ug/l	1.0					
Bromoform	J	0.760	0.400	1.00	ug/l	1.0					
Carbon Disulfide	U	ND	1.80	5.00	ug/l	1.0					
Carbon Tetrachloride	U	ND	0.200	1.00	ug/l	1.0					
Chlorobenzene	U	ND	0.300	1.00	ug/l	1.0					
Chlorodibromomethane		2.23	0.300	1.00	ug/l	1.0					
Chloroethane	U	ND	0.300	1.00	ug/l	1.0					
Chloroform		1.04	0.700	1.00	ug/l	1.0					
Dichlorobromomethane		1.33	0.400	1.00	ug/l	1.0					
Ethylbenzene	U	ND	0.300	1.00	ug/l	1.0					
Methyl Bromide	U	ND	0.300	1.00	ug/l	1.0					
Methyl Chloride	U	ND	0.200	1.00	ug/l	1.0					
Methylene Chloride	U	ND	1.20	5.00	ug/l	1.0					
Styrene	U	ND	0.200	1.00	ug/l	1.0					





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## Laboratory Certifications

STATE	GEL	EPI
FL	E87156/87294	E87472/87458
NC	233	
NJ	79002	79002
SC	10120	10582
TN	02934	02934

Client: Ensafe/Allen & Hoshall  
 935 Houston Northcutt Blvd.  
 Mt. Pleasant, South Carolina 29464

Contact: Mr. Charles Vernoy

cc: ENSF00199

Report Date: June 30, 1999

Page 2 of 3

Sample ID : NBCF/607IN00003

Parameter	Qualifier	Result	DL	RL	Units	DF	Analyst	Date	Time	Batch	M
Tetrachloroethylene		523	7.00	10.0	ug/l	10.	TCL	06/29/99	1620	152220	2
Toluene	U	ND	0.500	1.00	ug/l	1.0	TCL	06/29/99	1319	152220	2
Trichloroethylene		50.9	0.600	1.00	ug/l	1.0					
Vinyl Acetate	U	ND	1.80	5.00	ug/l	1.0					
Vinyl chloride		1.29	0.400	1.00	ug/l	1.0					
Xylenes (TOTAL)	U	ND	1.10	2.00	ug/l	1.0					
cis-1,3-Dichloropropylene	U	ND	0.300	1.00	ug/l	1.0					
trans-1,3-Dichloropropylene	U	ND	0.300	1.00	ug/l	1.0					

Surrogate Recovery	Test	Percent %	Acceptable Limits
Bromofluorobenzene	TCL VOLATILES-8260	81.0	(73.0 - 129.)
Dibromofluoromethane	TCL VOLATILES-8260	91.0	(66.0 - 117.)
Toluene-d8	TCL VOLATILES-8260	85.3	(73.0 - 122.)

M = Method	Method-Description
M 1	EPA 8260 extended
M 2	EPA 8260A

Notes:

The qualifiers in this report are defined as follows:

ND indicates that the analyte was not detected at a concentration greater than the detection limit.

J indicates presence of analyte at a concentration less than the reporting limit (RL) and greater than the detection limit (DL).

U indicates that the analyte was not detected at a concentration greater than the detection limit.

\* indicates that a quality control analyte recovery is outside of specified acceptance criteria.



# GENERAL ENGINEERING LABORATORIES

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## Laboratory Certifications

STATE	GEL	EPI
FL	E87156/87294	E87472/87458
NC	233	
NJ	79002	79002
SC	10120	10582
TN	02934	02934

Client: Ensafe/Allen & Hoshall  
935 Houston Northcutt Blvd.  
Mt. Pleasant, South Carolina 29464  
Contact: Mr. Charles Vernoy

cc: ENSF00199

Report Date: June 30, 1999

Page 3 of 3

Sample ID : NBCF/607IN00003

### M = Method

### Method-Description

This data report has been prepared and reviewed in accordance with General Engineering Laboratories standard operating procedures. Please direct any questions to your Project Manager, Jack Spitz at (843) 769-7390.

Reviewed By

GENERAL ENGINEERING LABORATORY  
VOLATILE ORGANICS ANALYSIS DATA SHEET  
TENTATIVELY IDENTIFIED COMPOUNDS

Sample ID: 9906911-01

Date of Analysis: 29 Jun 99

Number TICs found: 0

Concentration Units:  
(ug/L or ug/Kg)

CAS Number	Compound Name	Estimated Conc.	C
	<i>none found</i>		

Reviewed by: JEB

Date: 6/30/99



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## Laboratory Certifications

STATE	GEL	EPI
FL	E87156/87294	E87472/87458
NC	233	
NJ	79002	79002
SC	10120	10582
TN	02934	02934

Client: Ensafe/Allen & Hoshall  
 935 Houston Northcutt Blvd.  
 Mt. Pleasant, South Carolina 29464

Contact: Mr. Charles Vernoy

cc: ENSF00199

Report Date: July 06, 1999

Page 1 of 3

Sample ID : NBCF/607IN00004  
 Lab ID : 9906932-01  
 Matrix : GroundH2O  
 Date Collected : 06/29/99  
 Date Received : 06/29/99  
 Priority : Routine  
 Collector : Client

Parameter	Qualifier	Result	DL	RL	Units	DF	Analyst	Date	Time	Batch	M
<b>Volatile Organics</b>											
GCMS Library Search-VOA						TCL	07/01/99	0952	152458	1	
<i>Target Compound List Volatiles - 35 items</i>											
1,1,1-Trichloroethane	U	ND	0.200	1.00	ug/l	1.0	TCL	07/01/99	0952	152458	2
1,1,1,2-Tetrachloroethane	U	ND	0.500	1.00	ug/l	1.0					
1,1,2-Trichloroethane	U	ND	0.400	1.00	ug/l	1.0					
1,1-Dichloroethane	U	ND	0.400	1.00	ug/l	1.0					
1,1-Dichloroethylene	U	ND	0.700	1.00	ug/l	1.0					
1,2-Dichloroethane	U	ND	0.200	1.00	ug/l	1.0					
1,2-Dichloropropane	U	ND	0.200	1.00	ug/l	1.0					
1,2-cis-Dichloroethylene		38.0	0.700	1.00	ug/l	1.0					
1,2-trans-Dichloroethylene	U	ND	0.700	1.00	ug/l	1.0					
2-Butanone	U	ND	5.90	10.0	ug/l	1.0					
2-Hexanone	U	ND	3.20	5.00	ug/l	1.0					
4-Methyl-2-pentanone	U	ND	1.60	5.00	ug/l	1.0					
Acetone	U	ND	3.70	5.00	ug/l	1.0					
Benzene	U	ND	0.300	1.00	ug/l	1.0					
Bromoform		2.43	0.400	1.00	ug/l	1.0					
Carbon Disulfide	U	ND	1.80	5.00	ug/l	1.0					
Carbon Tetrachloride	U	ND	0.200	1.00	ug/l	1.0					
Chlorobenzene	U	ND	0.300	1.00	ug/l	1.0					
Chlorodibromomethane		7.58	0.300	1.00	ug/l	1.0					
Chloroethane	U	ND	0.300	1.00	ug/l	1.0					
Chloroform		3.24	0.700	1.00	ug/l	1.0					
Dichlorobromomethane		4.75	0.400	1.00	ug/l	1.0					
Ethylbenzene	U	ND	0.300	1.00	ug/l	1.0					
Methyl Bromide	U	ND	0.300	1.00	ug/l	1.0					
Methyl Chloride	U	ND	0.200	1.00	ug/l	1.0					
Methylene Chloride	U	ND	1.20	5.00	ug/l	1.0					
Styrene	U	ND	0.200	1.00	ug/l	1.0					





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### Laboratory Certifications

STATE	GEL	EPI
FL	E87156/87294	E87472/87458
NC	233	
NJ	79002	79002
SC	10120	10582
TN	02934	02934

Client: Ensafe/Allen & Hoshall  
 935 Houston Northcutt Blvd.  
 Mt. Pleasant, South Carolina 29464

Contact: Mr. Charles Vernoy

cc: ENSF00199

Report Date: July 06, 1999

Page 2 of 3

Sample ID : NBCF/607IN00004

Parameter	Qualifier	Result	DL	RL	Units	DF	Analyst	Date	Time	Batch	M
Tetrachloroethylene		371	7.00	10.0	ug/l	10.	TCL	07/02/99	1403	152458	2
Toluene	U	ND	0.500	1.00	ug/l	1.0	TCL	07/01/99	0952	152458	2
Trichloroethylene		20.8	0.600	1.00	ug/l	1.0					
Vinyl Acetate	U	ND	1.80	5.00	ug/l	1.0					
Vinyl chloride	U	ND	0.400	1.00	ug/l	1.0					
Xylenes (TOTAL)	U	ND	1.10	2.00	ug/l	1.0					
cis-1,3-Dichloropropylene	U	ND	0.300	1.00	ug/l	1.0					
trans-1,3-Dichloropropylene	U	ND	0.300	1.00	ug/l	1.0					

Surrogate Recovery	Test	Percent %	Acceptable Limits
Bromofluorobenzene	TCL VOLATILES-8260	80.7	(73.0 - 129.)
Dibromofluoromethane	TCL VOLATILES-8260	90.6	(66.0 - 117.)
Toluene-d8	TCL VOLATILES-8260	82.6	(73.0 - 122.)

M = Method	Method-Description
M 1	EPA 8260 extended
M 2	EPA 8260A

**Notes:**

The qualifiers in this report are defined as follows:

ND indicates that the analyte was not detected at a concentration greater than the detection limit.

J indicates presence of analyte at a concentration less than the reporting limit (RL) and greater than the detection limit (DL).

U indicates that the analyte was not detected at a concentration greater than the detection limit.

\* indicates that a quality control analyte recovery is outside of specified acceptance criteria.



# GENERAL ENGINEERING LABORATORIES

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## Laboratory Certifications

STATE	GEL	EPI
FL	E87156/87294	E87472/87458
NC	233	
NJ	79002	79002
SC	10120	10582
TN	02934	02934

Client: Ensafe/Allen & Hoshall  
935 Houston Northcutt Blvd.  
Mt. Pleasant, South Carolina 29464  
Contact: Mr. Charles Vernoy

cc: ENSF00199

Report Date: July 06, 1999

Page 3 of 3

Sample ID : NBCF/607IN00004

### M = Method

### Method-Description

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Reviewed By





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## Laboratory Certifications

STATE	GEL	EPI
FL	E87156/87294	E87472/87458
NC	233	
NJ	79002	79002
SC	10120	10582
TN	02934	02934

Client: Ensafe/Allen & Hoshall  
 935 Houston Northcutt Blvd.  
 Mt. Pleasant, South Carolina 29464

Contact: Mr. Charles Vernoy

cc: ENSF00199

Report Date: July 07, 1999

Page 1 of 3

Sample ID : NBCF/607IN00005  
 Lab ID : 9906DFA-01  
 Matrix : GroundH2O  
 Date Collected : 06/30/99  
 Date Received : 06/30/99  
 Priority : Routine  
 Collector : Client

Parameter	Qualifier	Result	DL	RL	Units	DF	Analyst	Date	Time	Batch	M	
<b>Volatile Organics</b>												
GCMS Library Search-VOA							TCL	07/02/99	0403	152458	1	
<i>Target Compound List Volatiles - 35 items</i>												
1,1,1-Trichloroethane	U	ND	0.200	1.00	ug/l	1.0	TCL	07/02/99	0403	152458	2	
1,1,2,2-Tetrachloroethane	U	ND	0.500	1.00	ug/l	1.0						
1,1,2-Trichloroethane	U	ND	0.400	1.00	ug/l	1.0						
1,1-Dichloroethane	U	ND	0.400	1.00	ug/l	1.0						
1,1-Dichloroethylene	U	ND	0.700	1.00	ug/l	1.0						
1,2-Dichloroethane	U	ND	0.200	1.00	ug/l	1.0						
1,2-Dichloropropane	U	ND	0.200	1.00	ug/l	1.0						
1,2-cis-Dichloroethylene		68.3	0.700	1.00	ug/l	1.0						
1,2-trans-Dichloroethylene		5.14	0.700	1.00	ug/l	1.0						
2-Butanone	U	ND	5.90	10.0	ug/l	1.0						
2-Hexanone	U	ND	3.20	5.00	ug/l	1.0						
4-Methyl-2-pentanone	U	ND	1.60	5.00	ug/l	1.0						
Acetone	U	ND	3.70	5.00	ug/l	1.0						
Benzene	U	ND	0.300	1.00	ug/l	1.0						
Bromoform		2.94	0.400	1.00	ug/l	1.0						
Carbon Disulfide	U	ND	1.80	5.00	ug/l	1.0						
Carbon Tetrachloride	U	ND	0.200	1.00	ug/l	1.0						
Chlorobenzene	U	ND	0.300	1.00	ug/l	1.0						
Chlorodibromomethane		6.65	0.300	1.00	ug/l	1.0						
Chloroethane	U	ND	0.300	1.00	ug/l	1.0						
Chloroform		3.91	0.700	1.00	ug/l	1.0						
Dichlorobromomethane		4.85	0.400	1.00	ug/l	1.0						
Ethylbenzene	U	ND	0.300	1.00	ug/l	1.0						
Methyl Bromide	U	ND	0.300	1.00	ug/l	1.0						
Methyl Chloride	U	ND	0.200	1.00	ug/l	1.0						
Methylene Chloride	U	ND	1.20	5.00	ug/l	1.0						
Styrene	U	ND	0.200	1.00	ug/l	1.0						





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STATE	GEL	EPI
FL	E87156/87294	E87472/87458
NC	233	
NJ	79002	79002
SC	10120	10582
TN	02934	02934

Client: Ensafe/Allen & Hoshall  
 935 Houston Northcutt Blvd.  
 Mt. Pleasant, South Carolina 29464

Contact: Mr. Charles Vernoy

cc: ENSF00199

Report Date: July 07, 1999

Page 2 of 3

Sample ID : NBCF/6071N00005

Parameter	Qualifier	Result	DL	RL	Units	DF	Analyst	Date	Time	Batch	M
Tetrachloroethylene		629	7.00	10.0	ug/l	10.	TCL	07/02/99	1433	152458	2
Toluene	U	ND	0.500	1.00	ug/l	1.0	TCL	07/02/99	0403	152458	2
Trichloroethylene		31.0	0.600	1.00	ug/l	1.0					
Vinyl Acetate	U	ND	1.80	5.00	ug/l	1.0					
Vinyl chloride	U	ND	0.400	1.00	ug/l	1.0					
Xylenes (TOTAL)	U	ND	1.10	2.00	ug/l	1.0					
cis-1,3-Dichloropropylene	U	ND	0.300	1.00	ug/l	1.0					
trans-1,3-Dichloropropylene	U	ND	0.300	1.00	ug/l	1.0					

Surrogate Recovery	Test	Percent %	Acceptable Limits
Bromofluorobenzene	TCL VOLATILES-8260	85.5	(73.0 - 129.)
Dibromofluoromethane	TCL VOLATILES-8260	99.8	(66.0 - 117.)
Toluene-d8	TCL VOLATILES-8260	89.2	(73.0 - 122.)

M = Method	Method-Description
M 1	EPA 8260 extended
M 2	EPA 8260A

**Notes:**

The qualifiers in this report are defined as follows:

ND indicates that the analyte was not detected at a concentration greater than the detection limit.

J indicates presence of analyte at a concentration less than the reporting limit (RL) and greater than the detection limit (DL).

U indicates that the analyte was not detected at a concentration greater than the detection limit.

\* indicates that a quality control analyte recovery is outside of specified acceptance criteria.





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## Laboratory Certifications

STATE	GEL	EPI
FL	E87156/87294	E87472/87458
NC	233	
NJ	79002	79002
SC	10120	10582
TN	02934	02934

Client: Ensafe/Allen & Hoshall  
935 Houston Northcutt Blvd.  
Mt. Pleasant, South Carolina 29464  
Contact: Mr. Charles Vernoy

cc: ENSF00199

Report Date: July 07, 1999

Page 3 of 3

Sample ID : NBCF/607IN00005

**M = Method**

**Method-Description**

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Reviewed By





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## Laboratory Certifications

STATE	GEL	EPI
FL	E87156/87294	E87472/87458
NC	233	
NJ	79002	79002
SC	10120	10582
TN	02934	02934

Client: Ensafe/Allen & Hoshall  
 935 Houston Northcutt Blvd.  
 Mt. Pleasant, South Carolina 29464  
 Contact: Mr. Charles Vernoy

cc: ENSF00199

Report Date: July 08, 1999

Page 1 of 3

Sample ID : NBCF1607IN00006  
 Lab ID : 9907019-01  
 Matrix : GroundH2O  
 Date Collected : 07/01/99  
 Date Received : 07/01/99  
 Priority : Routine  
 Collector : Client

Parameter	Qualifier	Result	DL	RL	Units	DF	Analyst	Date	Time	Batch	M
<b>Volatile Organics</b>											
GCMS Library Search-VOA						TCL		07/06/99	1509	152699	1
<i>Target Compound List Volatiles - 35 items</i>											
1,1,1-Trichloroethane	U	ND	0.200	1.00	ug/l	1.0	TCL	07/06/99	1509	152699	2
1,1,2,2-Tetrachloroethane	U	ND	0.500	1.00	ug/l	1.0					
1,1,2-Trichloroethane	U	ND	0.400	1.00	ug/l	1.0					
1,1-Dichloroethane	U	ND	0.400	1.00	ug/l	1.0					
1,1-Dichloroethylene	U	ND	0.700	1.00	ug/l	1.0					
1,2-Dichloroethane	U	ND	0.200	1.00	ug/l	1.0					
1,2-Dichloropropane	U	ND	0.200	1.00	ug/l	1.0					
1,2-cis-Dichloroethylene		27.0	0.700	1.00	ug/l	1.0					
1,2-trans-Dichloroethylene	U	ND	0.700	1.00	ug/l	1.0					
2-Butanone	U	ND	5.90	10.0	ug/l	1.0					
2-Hexanone	U	ND	3.20	5.00	ug/l	1.0					
4-Methyl-2-pentanone	U	ND	1.60	5.00	ug/l	1.0					
Acetone	U	ND	3.70	5.00	ug/l	1.0					
Benzene	U	ND	0.300	1.00	ug/l	1.0					
Bromoform		2.04	0.400	1.00	ug/l	1.0					
Carbon Disulfide	U	ND	1.80	5.00	ug/l	1.0					
Carbon Tetrachloride	U	ND	0.200	1.00	ug/l	1.0					
Chlorobenzene	U	ND	0.300	1.00	ug/l	1.0					
Chlorodibromomethane		5.23	0.300	1.00	ug/l	1.0					
Chloroethane	U	ND	0.300	1.00	ug/l	1.0					
Chloroform		2.94	0.700	1.00	ug/l	1.0					
Dichlorobromomethane		3.86	0.400	1.00	ug/l	1.0					
Ethylbenzene	U	ND	0.300	1.00	ug/l	1.0					
Methyl Bromide	U	ND	0.300	1.00	ug/l	1.0					
Methyl Chloride	U	ND	0.200	1.00	ug/l	1.0					
Methylene Chloride	U	ND	1.20	5.00	ug/l	1.0					
styrene	U	ND	0.200	1.00	ug/l	1.0					





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## Laboratory Certifications

STATE	GEL	EPI
FL	E87156/87294	E87472/87458
NC	233	
NJ	79002	79002
SC	10120	10582
TN	02934	02934

Client: Ensafe/Allen & Hoshall  
 935 Houston Northcutt Blvd.  
 Mt. Pleasant, South Carolina 29464  
 Contact: Mr. Charles Vernoy

cc: ENSF00199

Report Date: July 08, 1999

Page 2 of 3

Sample ID : NBCF1607IN00006

Parameter	Qualifier	Result	DL	RL	Units	DF	Analyst	Date	Time	Batch	M
Tetrachloroethylene		225	7.00	10.0	ug/l	10.	TCL	07/06/99	1945	152699	2
Toluene	U	ND	0.500	1.00	ug/l	1.0	TCL	07/06/99	1509	152699	2
Trichloroethylene		19.1	0.600	1.00	ug/l	1.0					
Vinyl Acetate	U	ND	1.80	5.00	ug/l	1.0					
Vinyl chloride	U	ND	0.400	1.00	ug/l	1.0					
Xylenes (TOTAL)	U	ND	1.10	2.00	ug/l	1.0					
cis-1,3-Dichloropropylene	U	ND	0.300	1.00	ug/l	1.0					
trans-1,3-Dichloropropylene	U	ND	0.300	1.00	ug/l	1.0					

Surrogate Recovery	Test	Percent %	Acceptable Limits
Bromofluorobenzene	TCL VOLATILES-8260	115.	(73.0 - 129.)
Dibromofluoromethane	TCL VOLATILES-8260	107.	(66.0 - 117.)
Toluene-d8	TCL VOLATILES-8260	114.	(73.0 - 122.)

M = Method	Method-Description
M 1	EPA 8260 extended
M 2	EPA 8260A

Notes:

The qualifiers in this report are defined as follows:

ND indicates that the analyte was not detected at a concentration greater than the detection limit.

J indicates presence of analyte at a concentration less than the reporting limit (RL) and greater than the detection limit (DL).

U indicates that the analyte was not detected at a concentration greater than the detection limit.

\* indicates that a quality control analyte recovery is outside of specified acceptance criteria.



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## Laboratory Certifications

STATE	GEL	EPI
FL	E87156/87294	E87472/87458
NC	233	
NJ	79002	79002
SC	10120	10582
TN	02934	02934

Client: Ensafe/Allen & Hoshall  
935 Houston Northcutt Blvd.  
Mt. Pleasant, South Carolina 29464  
Contact: Mr. Charles Vernoy

cc: ENSF00199

Report Date: July 08, 1999

Page 3 of 3

Sample ID : NBCF1607IN00006

### M = Method

### Method-Description

This data report has been prepared and reviewed in accordance with General Engineering Laboratories standard operating procedures. Please direct any questions to your Project Manager, Jack Spitz at (843) 769-7390.

Reviewed By 





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## Laboratory Certifications

STATE	GEL	EPI
FL	E87156/87294	E87472/87458
NC	233	
NJ	79002	79002
SC	10120	10582
TN	02934	02934

Client: Ensafe/Allen & Hoshall  
 935 Houston Northcutt Blvd.  
 Mt. Pleasant, South Carolina 29464

Contact: Mr. Charles Vernoy

cc: ENSF00199

Report Date: July 09, 1999

Page 1 of 3

Sample ID : NBCF/6071N00007  
 Lab ID : 9907063-01  
 Matrix : GroundH2O  
 Date Collected : 07/02/99  
 Date Received : 07/02/99  
 Priority : Routine  
 Collector : Client

Parameter	Qualifier	Result	DL	RL	Units	DF	Analyst	Date	Time	Batch	M
<b>Volatile Organics</b>											
GCMS Library Search-VOA							TCL	07/06/99	1918	152699	1
<i>Target Compound List Volatiles - 35 items</i>											
1,1-Trichloroethane	U	ND	0.200	1.00	ug/l	1.0	TCL	07/06/99	1918	152699	2
1,1,2,2-Tetrachloroethane	U	ND	0.500	1.00	ug/l	1.0					
1,1,2-Trichloroethane	U	ND	0.400	1.00	ug/l	1.0					
1,1-Dichloroethane	U	ND	0.400	1.00	ug/l	1.0					
1,1-Dichloroethylene	U	ND	0.700	1.00	ug/l	1.0					
1,2-Dichloroethane	U	ND	0.200	1.00	ug/l	1.0					
1,2-Dichloropropane	U	ND	0.200	1.00	ug/l	1.0					
1,2-cis-Dichloroethylene		14.2	0.700	1.00	ug/l	1.0					
1,2-trans-Dichloroethylene	U	ND	0.700	1.00	ug/l	1.0					
2-Butanone	U	ND	5.90	10.0	ug/l	1.0					
2-Hexanone	U	ND	3.20	5.00	ug/l	1.0					
4-Methyl-2-pentanone	U	ND	1.60	5.00	ug/l	1.0					
Acetone	U	ND	3.70	5.00	ug/l	1.0					
Benzene	U	ND	0.300	1.00	ug/l	1.0					
Bromoform		1.70	0.400	1.00	ug/l	1.0					
Carbon Disulfide	U	ND	1.80	5.00	ug/l	1.0					
Carbon Tetrachloride	U	ND	0.200	1.00	ug/l	1.0					
Chlorobenzene	U	ND	0.300	1.00	ug/l	1.0					
Chlorodibromomethane		5.57	0.300	1.00	ug/l	1.0					
Chloroethane	U	ND	0.300	1.00	ug/l	1.0					
Chloroform		2.99	0.700	1.00	ug/l	1.0					
Dichlorobromomethane		4.14	0.400	1.00	ug/l	1.0					
Ethylbenzene	U	ND	0.300	1.00	ug/l	1.0					
Methyl Bromide	U	ND	0.300	1.00	ug/l	1.0					
Methyl Chloride	U	ND	0.200	1.00	ug/l	1.0					
Methylene Chloride	U	ND	1.20	5.00	ug/l	1.0					
styrene	U	ND	0.200	1.00	ug/l	1.0					





# GENERAL ENGINEERING LABORATORIES

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### Laboratory Certifications

STATE	GEL	EPI
FL	E87156/87294	E87472/87458
NC	233	
NJ	79002	79002
SC	10120	10582
TN	02934	02934

Client: Ensafe/Allen & Hoshall  
 935 Houston Northcutt Blvd.  
 Mt. Pleasant, South Carolina 29464  
 Contact: Mr. Charles Vernoy

cc: ENSF00199

Report Date: July 09, 1999

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Sample ID : NBCF/607IN00007

Parameter	Qualifier	Result	DL	RL	Units	DF	Analyst	Date	Time	Batch	M
Tetrachloroethylene		161	7.00	10.0	ug/l	10.	TCL	07/06/99	2013	152699	2
Toluene	U	ND	0.500	1.00	ug/l	1.0	TCL	07/06/99	1918	152699	2
Trichloroethylene		8.34	0.600	1.00	ug/l	1.0					
Vinyl Acetate	U	ND	1.80	5.00	ug/l	1.0					
Vinyl chloride	U	ND	0.400	1.00	ug/l	1.0					
Xylenes (TOTAL)	U	ND	1.10	2.00	ug/l	1.0					
cis-1,3-Dichloropropylene	U	ND	0.300	1.00	ug/l	1.0					
trans-1,3-Dichloropropylene	U	ND	0.300	1.00	ug/l	1.0					

Surrogate Recovery	Test	Percent %	Acceptable Limits
Bromofluorobenzene	TCL VOLATILES-8260	117.	(73.0 - 129.)
Dibromofluoromethane	TCL VOLATILES-8260	107.	(66.0 - 117.)
Toluene-d8	TCL VOLATILES-8260	117.	(73.0 - 122.)

M = Method	Method-Description
M 1	EPA 8260 extended
M 2	EPA 8260A

Notes:  
 The qualifiers in this report are defined as follows:  
 ND indicates that the analyte was not detected at a concentration greater than the detection limit.  
 J indicates presence of analyte at a concentration less than the reporting limit (RL) and greater than the detection limit (DL).  
 U indicates that the analyte was not detected at a concentration greater than the detection limit.  
 \* indicates that a quality control analyte recovery is outside of specified acceptance criteria.



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## Laboratory Certifications

STATE	GEL	EPI
FL	E87156/87294	E87472/87458
NC	233	
NJ	79002	79002
SC	10120	10582
TN	02934	02934

Client: Ensafe/Allen & Hoshall  
935 Houston Northcutt Blvd.  
Mt. Pleasant, South Carolina 29464  
Contact: Mr. Charles Vernoy

cc: ENSF00199

Report Date: July 09, 1999

Page 3 of 3

Sample ID : NBCF/607IN00007

### M = Method

### Method-Description

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STATE	GEL	EPI
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NC	233	
NJ	79002	79002
SC	10120	10582
TN	02934	02934

Client: Ensafe/Allen & Hoshall  
 935 Houston Northcutt Blvd.  
 Mt. Pleasant, South Carolina 29464

Contact: Mr. Charles Vernoy

cc: ENSF00199

Report Date: July 14, 1999

Page 1 of 3

Sample ID : NBCF/6071N00008  
 Lab ID : 9907157-01  
 Matrix : GroundH2O  
 Date Collected : 07/07/99  
 Date Received : 07/07/99  
 Priority : Routine  
 Collector : Client

Parameter	Qualifier	Result	DL	RL	Units	DF	Analyst	Date	Time	Batch	M	
<b>Volatile Organics</b>												
GCMS Library Search-VOA							TCL	07/14/99	1016	152918	1	
<i>Target Compound List Volatiles - 35 items</i>												
1,1,1-Trichloroethane	U	ND	0.200	1.00	ug/l	1.0	TCL	07/14/99	1016	152918	2	
1,1,1,2-Tetrachloroethane	U	ND	0.500	1.00	ug/l	1.0						
1,1,2-Trichloroethane	U	ND	0.400	1.00	ug/l	1.0						
1,1-Dichloroethane	U	ND	0.400	1.00	ug/l	1.0						
1,1-Dichloroethylene	U	ND	0.700	1.00	ug/l	1.0						
1,2-Dichloroethane	U	ND	0.200	1.00	ug/l	1.0						
1,2-Dichloropropane	U	ND	0.200	1.00	ug/l	1.0						
1,2-cis-Dichloroethylene		14.7	0.700	1.00	ug/l	1.0						
1,2-trans-Dichloroethylene	U	ND	0.700	1.00	ug/l	1.0						
2-Butanone	U	ND	5.90	10.0	ug/l	1.0						
2-Hexanone	U	ND	3.20	5.00	ug/l	1.0						
4-Methyl-2-pentanone	U	ND	1.60	5.00	ug/l	1.0						
Acetone	U	ND	3.70	5.00	ug/l	1.0						
Benzene	U	ND	0.300	1.00	ug/l	1.0						
Bromoform		1.62	0.400	1.00	ug/l	1.0						
Carbon Disulfide	U	ND	1.80	5.00	ug/l	1.0						
Carbon Tetrachloride	U	ND	0.200	1.00	ug/l	1.0						
Chlorobenzene	U	ND	0.300	1.00	ug/l	1.0						
Chlorodibromomethane		7.10	0.300	1.00	ug/l	1.0						
Chloroethane	U	ND	0.300	1.00	ug/l	1.0						
Chloroform		4.88	0.700	1.00	ug/l	1.0						
Dichlorobromomethane		5.81	0.400	1.00	ug/l	1.0						
Ethylbenzene	U	ND	0.300	1.00	ug/l	1.0						
Methyl Bromide	U	ND	0.300	1.00	ug/l	1.0						
Methyl Chloride	U	ND	0.200	1.00	ug/l	1.0						
Methylene Chloride	U	ND	1.20	5.00	ug/l	1.0						
styrene	U	ND	0.200	1.00	ug/l	1.0						





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FL	E87156/87294	E87472/87458
NC	233	
NJ	79002	79002
SC	10120	10582
TN	02934	02934

Client: Ensafe/Allen & Hoshall  
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 Mt. Pleasant, South Carolina 29464  
 Contact: Mr. Charles Vernoy

cc: ENSF00199

Report Date: July 14, 1999

Page 2 of 3

Sample ID : NBCF/607IN00008

Parameter	Qualifier	Result	DL	RL	Units	DF	Analyst	Date	Time	Batch	M
Tetrachloroethylene		149	7.00	10.0	ug/l	10.	TCL	07/14/99	1115	152918	2
Toluene	U	ND	0.500	1.00	ug/l	1.0	TCL	07/14/99	1016	152918	2
Trichloroethylene		6.36	0.600	1.00	ug/l	1.0					
Vinyl Acetate	U	ND	1.80	5.00	ug/l	1.0					
Vinyl chloride	U	ND	0.400	1.00	ug/l	1.0					
Xylenes (TOTAL)	U	ND	1.10	2.00	ug/l	1.0					
cis-1,3-Dichloropropylene	U	ND	0.300	1.00	ug/l	1.0					
trans-1,3-Dichloropropylene	U	ND	0.300	1.00	ug/l	1.0					

Surrogate Recovery	Test	Percent %	Acceptable Limits
Bromofluorobenzene	TCL VOLATILES-8260	83.0	(73.0 - 129.)
Dibromofluoromethane	TCL VOLATILES-8260	92.4	(66.0 - 117.)
Toluene-d8	TCL VOLATILES-8260	96.0	(73.0 - 122.)

M = Method	Method-Description
M 1	EPA 8260 extended
M 2	EPA 8260A

Notes:

The qualifiers in this report are defined as follows:

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\* indicates that a quality control analyte recovery is outside of specified acceptance criteria.





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## Laboratory Certifications

STATE	GEL	EPI
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NC	233	
NJ	79002	79002
SC	10120	10582
TN	02934	02934

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Contact: Mr. Charles Vernoy

cc: ENSF00199

Report Date: July 14, 1999

Page 3 of 3

Sample ID : NBCF/607IN00008

### M = Method

### Method-Description

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cc: ENSF00199

Report Date: July 26, 1999

Page 1 of 3

Sample ID : NBCF/607IN00009  
 Lab ID : 9907590-01  
 Matrix : GroundH2O  
 Date Collected : 07/15/99  
 Date Received : 07/15/99  
 Priority : Routine  
 Collector : Client

Parameter	Qualifier	Result	DL	RL	Units	DF	Analyst	Date	Time	Batch	M	
<b>Volatile Organics</b>												
GCMS Library Search-VOA							JEB	07/22/99	1345	154106	1	
<i>Target Compound List Volatiles - 35 items</i>												
1,1,1-Trichloroethane	U	ND	0.200	1.00	ug/l	1.0	JEB	07/22/99	1345	154106	2	
1,1,2,2-Tetrachloroethane	U	ND	0.500	1.00	ug/l	1.0						
1,1,2-Trichloroethane	U	ND	0.400	1.00	ug/l	1.0						
1,1-Dichloroethane	U	ND	0.400	1.00	ug/l	1.0						
1,1-Dichloroethylene	U	ND	0.700	1.00	ug/l	1.0						
1,2-Dichloroethane	U	ND	0.200	1.00	ug/l	1.0						
1,2-Dichloropropane	U	ND	0.200	1.00	ug/l	1.0						
1,2-cis-Dichloroethylene		10.7	0.700	1.00	ug/l	1.0						
1,2-trans-Dichloroethylene	U	ND	0.700	1.00	ug/l	1.0						
2-Butanone	U	ND	5.90	10.0	ug/l	1.0						
2-Hexanone	U	ND	3.20	5.00	ug/l	1.0						
4-Methyl-2-pentanone	U	ND	1.60	5.00	ug/l	1.0						
Acetone	U	ND	3.70	5.00	ug/l	1.0						
Benzene	U	ND	0.300	1.00	ug/l	1.0						
Bromoform	U	ND	0.400	1.00	ug/l	1.0						
Carbon Disulfide	U	ND	1.80	5.00	ug/l	1.0						
Carbon Tetrachloride	U	ND	0.200	1.00	ug/l	1.0						
Chlorobenzene	U	ND	0.300	1.00	ug/l	1.0						
Chlorodibromomethane	U	ND	0.300	1.00	ug/l	1.0						
Chloroethane	U	ND	0.300	1.00	ug/l	1.0						
Chloroform	J	0.950	0.700	1.00	ug/l	1.0						
Dichlorobromomethane	J	0.660	0.400	1.00	ug/l	1.0						
Ethylbenzene	U	ND	0.300	1.00	ug/l	1.0						
Methyl Bromide	U	ND	0.300	1.00	ug/l	1.0						
Methyl Chloride	U	ND	0.200	1.00	ug/l	1.0						
Methylene Chloride	J	1.92	1.20	5.00	ug/l	1.0						
Styrene	U	ND	0.200	1.00	ug/l	1.0						





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Page 2 of 3

Sample ID : NBCF/6071N00009

Parameter	Qualifier	Result	DL	RL	Units	DF	Analyst	Date	Time	Batch	M
Tetrachloroethylene		51.3	0.700	1.00	ug/l	1.0					
Toluene	U	ND	0.500	1.00	ug/l	1.0	JEB	07/22/99	1345	154106	2
Trichloroethylene		3.52	0.600	1.00	ug/l	1.0					
Vinyl Acetate	U	ND	1.80	5.00	ug/l	1.0					
Vinyl chloride	U	ND	0.400	1.00	ug/l	1.0					
Xylenes (TOTAL)	U	ND	1.10	2.00	ug/l	1.0					
cis-1,3-Dichloropropylene	U	ND	0.300	1.00	ug/l	1.0					
trans-1,3-Dichloropropylene	U	ND	0.300	1.00	ug/l	1.0					

Surrogate Recovery	Test	Percent %	Acceptable Limits
Bromofluorobenzene	TCL VOLATILES-8260	124.	(73.0 - 129.)
Dibromofluoromethane	TCL VOLATILES-8260	106.	(66.0 - 117.)
Toluene-d8	TCL VOLATILES-8260	117.	(73.0 - 122.)

M = Method	Method-Description
M 1	EPA 8260 extended
M 2	EPA 8260A

**Notes:**

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J indicates presence of analyte at a concentration less than the reporting limit (RL) and greater than the detection limit (DL).

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Report Date: July 26, 1999

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Sample ID : NBCF/607IN00009

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**M = Method**

**Method-Description**

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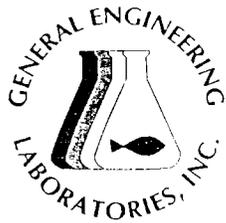
Report Date: July 27, 1999

Page 1 of 3

Sample ID : NBCF/607IN00010  
 Lab ID : 9907662-01  
 Matrix : GroundH2O  
 Date Collected : 07/20/99  
 Date Received : 07/20/99  
 Priority : Routine  
 Collector : Client

Parameter	Qualifier	Result	DL	RL	Units	DF	Analyst	Date	Time	Batch	M
<b>Volatile Organics</b>											
GCMS Library Search-VOA						TCL	07/23/99	1320	154113	1	
<i>Target Compound List Volatiles - 35 items</i>											
1,1,1-Trichloroethane	U	ND	0.200	1.00	ug/l	1.0	TCL	07/23/99	1320	154113	2
1,1,2,2-Tetrachloroethane	U	ND	0.500	1.00	ug/l	1.0					
1,1,2-Trichloroethane	U	ND	0.400	1.00	ug/l	1.0					
1,1-Dichloroethane	U	ND	0.400	1.00	ug/l	1.0					
1,1-Dichloroethylene	U	ND	0.700	1.00	ug/l	1.0					
1,2-Dichloroethane	U	ND	0.200	1.00	ug/l	1.0					
1,2-Dichloropropane	U	ND	0.200	1.00	ug/l	1.0					
1,2-cis-Dichloroethylene		5.28	0.700	1.00	ug/l	1.0					
1,2-trans-Dichloroethylene	U	ND	0.700	1.00	ug/l	1.0					
2-Butanone	U	ND	5.90	10.0	ug/l	1.0					
2-Hexanone	U	ND	3.20	5.00	ug/l	1.0					
4-Methyl-2-pentanone	U	ND	1.60	5.00	ug/l	1.0					
Acetone	U	ND	3.70	5.00	ug/l	1.0					
Benzene	U	ND	0.300	1.00	ug/l	1.0					
Bromoform	U	ND	0.400	1.00	ug/l	1.0					
Carbon Disulfide	U	ND	1.80	5.00	ug/l	1.0					
Carbon Tetrachloride	U	ND	0.200	1.00	ug/l	1.0					
Chlorobenzene	U	ND	0.300	1.00	ug/l	1.0					
Chlorodibromomethane	J	0.670	0.300	1.00	ug/l	1.0					
Chloroethane	U	ND	0.300	1.00	ug/l	1.0					
Chloroform		6.23	0.700	1.00	ug/l	1.0					
Dichlorobromomethane		2.18	0.400	1.00	ug/l	1.0					
Ethylbenzene	U	ND	0.300	1.00	ug/l	1.0					
Methyl Bromide	U	ND	0.300	1.00	ug/l	1.0					
Methyl Chloride	U	ND	0.200	1.00	ug/l	1.0					
Methylene Chloride	J	2.65	1.20	5.00	ug/l	1.0					
Styrene	U	ND	0.200	1.00	ug/l	1.0					





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cc: ENSF00199

Report Date: July 27, 1999

Page 2 of 3

Sample ID : NBCF/607IN00010

Parameter	Qualifier	Result	DL	RL	Units	DF	Analyst	Date	Time	Batch	M
Tetrachloroethylene		34.9	0.700	1.00	ug/l	1.0					
Toluene	U	ND	0.500	1.00	ug/l	1.0	TCL	07/23/99	1320	154113	2
Trichloroethylene		1.88	0.600	1.00	ug/l	1.0					
Vinyl Acetate	U	ND	1.80	5.00	ug/l	1.0					
Vinyl chloride	U	ND	0.400	1.00	ug/l	1.0					
Xylenes (TOTAL)	U	ND	1.10	2.00	ug/l	1.0					
cis-1,3-Dichloropropylene	U	ND	0.300	1.00	ug/l	1.0					
trans-1,3-Dichloropropylene	U	ND	0.300	1.00	ug/l	1.0					

Surrogate Recovery	Test	Percent %	Acceptable Limits
Bromofluorobenzene	TCL VOLATILES-8260	90.7	(73.0 - 129.)
Dibromofluoromethane	TCL VOLATILES-8260	96.5	(66.0 - 117.)
Toluene-d8	TCL VOLATILES-8260	94.5	(73.0 - 122.)

M = Method	Method-Description
M 1	EPA 8260 extended
M 2	EPA 8260A

Notes:

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J indicates presence of analyte at a concentration less than the reporting limit (RL) and greater than the detection limit (DL).

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Report Date: July 27, 1999

Page 3 of 3

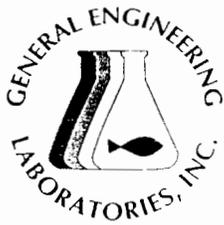
Sample ID : NBCF/607IN00010

**M = Method**

**Method-Description**

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 Contact: Mr. Charles Vernoy

cc: ENSF00199

Report Date: August 04, 1999

Page 1 of 3

Sample ID : NBCF/607IN00011  
 Lab ID : 9907978-01  
 Matrix : GroundH2O  
 Date Collected : 07/28/99  
 Date Received : 07/28/99  
 Priority : Routine  
 Collector : Client

Parameter	Qualifier	Result	DL	RL	Units	DF	Analyst	Date	Time	Batch	M
<b>Volatile Organics</b>											
GCMS Library Search-VOA							JEB	08/02/99	1306	154965	1
<i>Target Compound List Volatiles - 35 items</i>											
1,1,1-Trichloroethane	U	ND	0.200	1.00	ug/l	1.0	JEB	08/02/99	1306	154965	2
1,1,2,2-Tetrachloroethane	U	ND	0.500	1.00	ug/l	1.0					
1,1,2-Trichloroethane	U	ND	0.400	1.00	ug/l	1.0					
1,1-Dichloroethane	U	ND	0.400	1.00	ug/l	1.0					
1,1-Dichloroethylene	U	ND	0.700	1.00	ug/l	1.0					
1,2-Dichloroethane	U	ND	0.200	1.00	ug/l	1.0					
1,2-Dichloropropane	U	ND	0.200	1.00	ug/l	1.0					
1,2-cis-Dichloroethylene		5.29	0.700	1.00	ug/l	1.0					
1,2-trans-Dichloroethylene	U	ND	0.700	1.00	ug/l	1.0					
2-Butanone	U	ND	5.90	10.0	ug/l	1.0					
2-Hexanone	U	ND	3.20	5.00	ug/l	1.0					
4-Methyl-2-pentanone	U	ND	1.60	5.00	ug/l	1.0					
Acetone	U	ND	3.70	5.00	ug/l	1.0					
Benzene	U	ND	0.300	1.00	ug/l	1.0					
Bromoform	U	ND	0.400	1.00	ug/l	1.0					
Carbon Disulfide	U	ND	1.80	5.00	ug/l	1.0					
Carbon Tetrachloride	U	ND	0.200	1.00	ug/l	1.0					
Chlorobenzene	U	ND	0.300	1.00	ug/l	1.0					
Chlorodibromomethane	U	ND	0.300	1.00	ug/l	1.0					
Chloroethane	U	ND	0.300	1.00	ug/l	1.0					
Chloroform		3.93	0.700	1.00	ug/l	1.0					
Dichlorobromomethane		1.34	0.400	1.00	ug/l	1.0					
Ethylbenzene	U	ND	0.300	1.00	ug/l	1.0					
Methyl Bromide	U	ND	0.300	1.00	ug/l	1.0					
Methyl Chloride	U	ND	0.200	1.00	ug/l	1.0					
Methylene Chloride	J	2.65	1.20	5.00	ug/l	1.0					
Styrene	U	ND	0.200	1.00	ug/l	1.0					





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 Mt. Pleasant, South Carolina 29464  
 Contact: Mr. Charles Vernoy

cc: ENSF00199

Report Date: August 04, 1999

Page 2 of 3

Sample ID : NBCF/6071N00011

Parameter	Qualifier	Result	DL	RL	Units	DF	Analyst	Date	Time	Batch	M
Tetrachloroethylene		37.7	0.700	1.00	ug/l	1.0					
Toluene	U	ND	0.500	1.00	ug/l	1.0	JEB	08/02/99	1306	154965	2
Trichloroethylene		2.10	0.600	1.00	ug/l	1.0					
Vinyl Acetate	U	ND	1.80	5.00	ug/l	1.0					
Vinyl chloride	U	ND	0.400	1.00	ug/l	1.0					
Xylenes (TOTAL)	U	ND	1.10	2.00	ug/l	1.0					
cis-1,3-Dichloropropylene	U	ND	0.300	1.00	ug/l	1.0					
trans-1,3-Dichloropropylene	U	ND	0.300	1.00	ug/l	1.0					

Surrogate Recovery	Test	Percent %	Acceptable Limits
Bromofluorobenzene	TCL VOLATILES-8260	85.9	(73.0 - 129.)
Dibromofluoromethane	TCL VOLATILES-8260	95.2	(66.0 - 117.)
Toluene-d8	TCL VOLATILES-8260	92.7	(73.0 - 122.)

M = Method	Method-Description
M 1	EPA 8260 extended
M 2	EPA 8260A

**Notes:**

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ND indicates that the analyte was not detected at a concentration greater than the detection limit.

J indicates presence of analyte at a concentration less than the reporting limit (RL) and greater than the detection limit (DL).

U indicates that the analyte was not detected at a concentration greater than the detection limit.

\* indicates that a quality control analyte recovery is outside of specified acceptance criteria.



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cc: ENSF00199

Report Date: August 04, 1999

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Sample ID : NBCF/6071N00011

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**M = Method****Method-Description**

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 Contact: Mr. Charles Vernoy

cc: ENSF00199

Report Date: August 12, 1999

Page 1 of 3

Sample ID : NBCF/607IN00012  
 Lab ID : 9908231-01  
 Matrix : GroundH2O  
 Date Collected : 08/06/99  
 Date Received : 08/06/99  
 Priority : Routine  
 Collector : Client

Parameter	Qualifier	Result	DL	RL	Units	DF	Analyst	Date	Time	Batch	M
<b>Volatile Organics</b>											
GCMS Library Search-VOA							JEB	08/09/99	1238	155555	1
<i>Target Compound List Volatiles - 35 items</i>											
.1,1-Trichloroethane	U	ND	0.200	1.00	ug/l	1.0	JEB	08/09/99	1238	155555	2
.1,1,2,2-Tetrachloroethane	U	ND	0.500	1.00	ug/l	1.0					
1,1,2-Trichloroethane	U	ND	0.400	1.00	ug/l	1.0					
1,1-Dichloroethane	U	ND	0.400	1.00	ug/l	1.0					
1,1-Dichloroethylene	U	ND	0.700	1.00	ug/l	1.0					
1,2-Dichloroethane	U	ND	0.200	1.00	ug/l	1.0					
1,2-Dichloropropane	U	ND	0.200	1.00	ug/l	1.0					
1,2-cis-Dichloroethylene		3.79	0.700	1.00	ug/l	1.0					
1,2-trans-Dichloroethylene	U	ND	0.700	1.00	ug/l	1.0					
2-Butanone	U	ND	5.90	10.0	ug/l	1.0					
2-Hexanone	U	ND	3.20	5.00	ug/l	1.0					
4-Methyl-2-pentanone	U	ND	1.60	5.00	ug/l	1.0					
Acetone	U	ND	3.70	5.00	ug/l	1.0					
Benzene	U	ND	0.300	1.00	ug/l	1.0					
Bromoform	U	ND	0.400	1.00	ug/l	1.0					
Carbon Disulfide	U	ND	1.80	5.00	ug/l	1.0					
Carbon Tetrachloride	U	ND	0.200	1.00	ug/l	1.0					
Chlorobenzene	U	ND	0.300	1.00	ug/l	1.0					
Chlorodibromomethane	J	0.580	0.300	1.00	ug/l	1.0					
Chloroethane	U	ND	0.300	1.00	ug/l	1.0					
Chloroform		1.10	0.700	1.00	ug/l	1.0					
Dichlorobromomethane	J	0.690	0.400	1.00	ug/l	1.0					
Ethylbenzene	U	ND	0.300	1.00	ug/l	1.0					
Methyl Bromide	U	ND	0.300	1.00	ug/l	1.0					
Methyl Chloride	U	ND	0.200	1.00	ug/l	1.0					
Methylene Chloride	J	1.26	1.20	5.00	ug/l	1.0					
styrene	U	ND	0.200	1.00	ug/l	1.0					





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Sample ID : NBCF/607IN00012

Parameter	Qualifier	Result	DL	RL	Units	DF	Analyst	Date	Time	Batch	M
Tetrachloroethylene		40.4	0.700	1.00	ug/l	1.0					
Toluene	U	ND	0.500	1.00	ug/l	1.0	JEB	08/09/99	1238	155555	2
Trichloroethylene		1.63	0.600	1.00	ug/l	1.0					
Vinyl Acetate	U	ND	1.80	5.00	ug/l	1.0					
Vinyl chloride	U	ND	0.400	1.00	ug/l	1.0					
Xylenes (TOTAL)	U	ND	1.10	2.00	ug/l	1.0					
cis-1,3-Dichloropropylene	U	ND	0.300	1.00	ug/l	1.0					
trans-1,3-Dichloropropylene	U	ND	0.300	1.00	ug/l	1.0					

Surrogate Recovery	Test	Percent%	Acceptable Limits
Bromofluorobenzene	TCL VOLATILES-8260	82.0	(73.0 - 129.)
Dibromofluoromethane	TCL VOLATILES-8260	97.7	(66.0 - 117.)
Toluene-d8	TCL VOLATILES-8260	88.1	(73.0 - 122.)

M = Method	Method-Description
M 1	EPA 8260 extended
M 2	EPA 8260A

Notes:

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Sample ID : NBCF/607IN00012

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**Method-Description**

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Sample ID : NBCF/607IN00013  
 Lab ID : 9908429-01  
 Matrix : GroundH2O  
 Date Collected : 08/12/99  
 Date Received : 08/12/99  
 Priority : Routine  
 Collector : Client

Parameter	Qualifier	Result	DL	RL	Units	DF	Analyst	Date	Time	Batch	M
<b>Volatile Organics</b>											
GCMS Library Search-VOA						TCL		08/16/99	1830	156110	1
<i>Target Compound List Volatiles - 35 items</i>											
1,1,1-Trichloroethane	U	ND	0.200	1.00	ug/l	1.0	TCL	08/16/99	1830	156110	2
1,1,2,2-Tetrachloroethane	U	ND	0.500	1.00	ug/l	1.0					
1,1,2-Trichloroethane	U	ND	0.400	1.00	ug/l	1.0					
1,1-Dichloroethane	U	ND	0.400	1.00	ug/l	1.0					
1,1-Dichloroethylene	U	ND	0.700	1.00	ug/l	1.0					
1,2-Dichloroethane	U	ND	0.200	1.00	ug/l	1.0					
1,2-Dichloropropane	U	ND	0.200	1.00	ug/l	1.0					
1,2-cis-Dichloroethylene	U	ND	0.700	1.00	ug/l	1.0					
1,2-trans-Dichloroethylene	U	ND	0.700	1.00	ug/l	1.0					
2-Butanone	U	ND	5.90	10.0	ug/l	1.0					
2-Hexanone	U	ND	3.20	5.00	ug/l	1.0					
4-Methyl-2-pentanone	U	ND	1.60	5.00	ug/l	1.0					
Acetone	U	ND	3.70	5.00	ug/l	1.0					
Benzene	U	ND	0.300	1.00	ug/l	1.0					
Bromoform	U	ND	0.400	1.00	ug/l	1.0					
Carbon Disulfide	U	ND	1.80	5.00	ug/l	1.0					
Carbon Tetrachloride	U	ND	0.200	1.00	ug/l	1.0					
Chlorobenzene	U	ND	0.300	1.00	ug/l	1.0					
Chlorodibromomethane		2.07	0.300	1.00	ug/l	1.0					
Chloroethane	U	ND	0.300	1.00	ug/l	1.0					
Chloroform		3.64	0.700	1.00	ug/l	1.0					
Dichlorobromomethane	U	ND	0.400	1.00	ug/l	1.0					
Ethylbenzene	U	ND	0.300	1.00	ug/l	1.0					
Methyl Bromide	U	ND	0.300	1.00	ug/l	1.0					
Methyl Chloride	U	ND	0.200	1.00	ug/l	1.0					
Methylene Chloride	U	ND	1.20	5.00	ug/l	1.0					
styrene	U	ND	0.200	1.00	ug/l	1.0					





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Sample ID : NBCF/607IN00013

Parameter	Qualifier	Result	DL	RL	Units	DF	Analyst	Date	Time	Batch	M
Tetrachloroethylene		27.8	0.700	1.00	ug/l	1.0					
Toluene	U	ND	0.500	1.00	ug/l	1.0	TCL	08/16/99	1830	156110	2
Trichloroethylene		2.06	0.600	1.00	ug/l	1.0					
Vinyl Acetate	U	ND	1.80	5.00	ug/l	1.0					
Vinyl chloride	U	ND	0.400	1.00	ug/l	1.0					
Xylenes (TOTAL)	U	ND	1.10	2.00	ug/l	1.0					
cis-1,3-Dichloropropylene	U	ND	0.300	1.00	ug/l	1.0					
trans-1,3-Dichloropropylene	U	ND	0.300	1.00	ug/l	1.0					

surrogate Recovery	Test	Percent %	Acceptable Limits
Bromofluorobenzene	TCL VOLATILES-8260	73.9	(73.0 - 129.)
Dibromofluoromethane	TCL VOLATILES-8260	95.5	(66.0 - 117.)
Toluene-d8	TCL VOLATILES-8260	89.5	(73.0 - 122.)

M = Method	Method-Description
M 1	EPA 8260 extended
M 2	EPA 8260A

**Notes:**

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Sample ID : NBCF/607IN00013

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**Method-Description**

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Sample ID : NBCF/607IN00014  
 Lab ID : 9908696-01  
 Matrix : GroundH2O  
 Date Collected : 08/19/99  
 Date Received : 08/19/99  
 Priority : Routine  
 Collector : Client

Parameter	Qualifier	Result	DL	RL	Units	DF	Analyst	Date	Time	Batch	M
<b>Volatile Organics</b>											
GCMS Library Search-VOA						TCL		08/24/99	1207	156634	1
<i>Target Compound List Volatiles - 35 items</i>											
1,1-Trichloroethane	U	ND	0.200	1.00	ug/l	1.0	TCL	08/24/99	1207	156634	2
1,1,2,2-Tetrachloroethane	U	ND	0.500	1.00	ug/l	1.0					
1,1,2-Trichloroethane	U	ND	0.400	1.00	ug/l	1.0					
1,1-Dichloroethane	U	ND	0.400	1.00	ug/l	1.0					
1,1-Dichloroethylene	U	ND	0.700	1.00	ug/l	1.0					
1,2-Dichloroethane	U	ND	0.200	1.00	ug/l	1.0					
1,2-Dichloropropane	U	ND	0.200	1.00	ug/l	1.0					
1,2-cis-Dichloroethylene		4.53	0.700	1.00	ug/l	1.0					
1,2-trans-Dichloroethylene	U	ND	0.700	1.00	ug/l	1.0					
2-Butanone	U	ND	5.90	10.0	ug/l	1.0					
2-Hexanone	U	ND	3.20	5.00	ug/l	1.0					
4-Methyl-2-pentanone	U	ND	1.60	5.00	ug/l	1.0					
Acetone	U	ND	3.70	5.00	ug/l	1.0					
Benzene	U	ND	0.300	1.00	ug/l	1.0					
Bromoform	U	ND	0.400	1.00	ug/l	1.0					
Carbon Disulfide	U	ND	1.80	5.00	ug/l	1.0					
Carbon Tetrachloride	U	ND	0.200	1.00	ug/l	1.0					
Chlorobenzene	U	ND	0.300	1.00	ug/l	1.0					
Chlorodibromomethane		2.34	0.300	1.00	ug/l	1.0					
Chloroethane	U	ND	0.300	1.00	ug/l	1.0					
Chloroform		3.27	0.700	1.00	ug/l	1.0					
Dichlorobromomethane		2.36	0.400	1.00	ug/l	1.0					
Ethylbenzene	U	ND	0.300	1.00	ug/l	1.0					
Methyl Bromide	U	ND	0.300	1.00	ug/l	1.0					
Methyl Chloride	U	ND	0.200	1.00	ug/l	1.0					
Methylene Chloride	U	ND	1.20	5.00	ug/l	1.0					
styrene	U	ND	0.200	1.00	ug/l	1.0					





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Sample ID : NBCF/607IN00014

Parameter	Qualifier	Result	DL	RL	Units	DF	Analyst Date	Time	Batch	M
Tetrachloroethylene		33.5	0.700	1.00	ug/l	1.0				
Toluene	U	ND	0.500	1.00	ug/l	1.0	TCL 08/24/99	1207	156634	2
Trichloroethylene		1.91	0.600	1.00	ug/l	1.0				
Vinyl Acetate	U	ND	1.80	5.00	ug/l	1.0				
Vinyl chloride	U	ND	0.400	1.00	ug/l	1.0				
Xylenes (TOTAL)	U	ND	1.10	2.00	ug/l	1.0				
cis-1,3-Dichloropropylene	U	ND	0.300	1.00	ug/l	1.0				
trans-1,3-Dichloropropylene	U	ND	0.300	1.00	ug/l	1.0				

Surrogate Recovery	Test	Percent %	Acceptable Limits
Bromofluorobenzene	TCL VOLATILES-8260	83.3	(73.0 - 129.)
Dibromofluoromethane	TCL VOLATILES-8260	101.	(66.0 - 117.)
Toluene-d8	TCL VOLATILES-8260	95.1	(73.0 - 122.)

M = Method	Method-Description
M 1	EPA 8260 extended
M 2	EPA 8260A

**Notes:**

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Sample ID : NBCF/607IN00014

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**M = Method**

**Method-Description**

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Report Date: September 10, 1999

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Sample ID : NBCF/607IN00015  
 Lab ID : 9909160-01  
 Matrix : GroundH2O  
 Date Collected : 09/03/99  
 Date Received : 09/03/99  
 Priority : Routine  
 Collector : Client

Parameter	Qualifier	Result	DL	RL	Units	DF	Analyst	Date	Time	Batch	M
<b>Volatile Organics</b>											
GCMS Library Search-VOA						TCL	09/08/99	1054	157798	1	
<i>Target Compound List Volatiles - 35 items</i>											
1,1,1-Trichloroethane	U	ND	0.200	1.00	ug/l	1.0	TCL	09/08/99	1054	157798	2
1,1,2,2-Tetrachloroethane	U	ND	0.500	1.00	ug/l	1.0					
1,1,2-Trichloroethane	U	ND	0.400	1.00	ug/l	1.0					
1,1-Dichloroethane	U	ND	0.400	1.00	ug/l	1.0					
1,1-Dichloroethylene	U	ND	0.700	1.00	ug/l	1.0					
1,2-Dichloroethane	U	ND	0.200	1.00	ug/l	1.0					
1,2-Dichloropropane	U	ND	0.200	1.00	ug/l	1.0					
1,2-cis-Dichloroethylene		40.3	0.700	1.00	ug/l	1.0					
1,2-trans-Dichloroethylene	U	ND	0.700	1.00	ug/l	1.0					
2-Butanone		31.4	5.90	10.0	ug/l	1.0					
2-Hexanone	U	ND	3.20	5.00	ug/l	1.0					
4-Methyl-2-pentanone	U	ND	1.60	5.00	ug/l	1.0					
Acetone	U	ND	3.70	5.00	ug/l	1.0					
Benzene	U	ND	0.300	1.00	ug/l	1.0					
Bromoform	U	ND	0.400	1.00	ug/l	1.0					
Carbon Disulfide	U	ND	1.80	5.00	ug/l	1.0					
Carbon Tetrachloride	U	ND	0.200	1.00	ug/l	1.0					
Chlorobenzene	U	ND	0.300	1.00	ug/l	1.0					
Chlorodibromomethane	U	ND	0.300	1.00	ug/l	1.0					
Chloroethane	U	ND	0.300	1.00	ug/l	1.0					
Chloroform		1.36	0.700	1.00	ug/l	1.0					
Dichlorobromomethane	U	ND	0.400	1.00	ug/l	1.0					
Ethylbenzene	U	ND	0.300	1.00	ug/l	1.0					
Methyl Bromide	U	ND	0.300	1.00	ug/l	1.0					
Methyl Chloride	U	ND	0.200	1.00	ug/l	1.0					
Methylene Chloride	U	ND	1.20	5.00	ug/l	1.0					
Styrene	U	ND	0.200	1.00	ug/l	1.0					





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Sample ID : NBCF/607IN00015

Parameter	Qualifier	Result	DL	RL	Units	DF	Analyst	Date	Time	Batch	M
Tetrachloroethylene		369	7.00	10.0	ug/l	10.	TCL	09/09/99	1041	157798	2
Toluene	U	ND	0.500	1.00	ug/l	1.0	TCL	09/08/99	1054	157798	2
Trichloroethylene		32.1	0.600	1.00	ug/l	1.0					
Vinyl Acetate	U	ND	1.80	5.00	ug/l	1.0					
Vinyl chloride	U	ND	0.400	1.00	ug/l	1.0					
Xylenes (TOTAL)	U	ND	1.10	2.00	ug/l	1.0					
cis-1,3-Dichloropropylene	U	ND	0.300	1.00	ug/l	1.0					
trans-1,3-Dichloropropylene	U	ND	0.300	1.00	ug/l	1.0					

Surrogate Recovery	Test	Percent %	Acceptable Limits
Bromofluorobenzene	TCL VOLATILES-8260	88.3	(73.0 - 129.)
Dibromofluoromethane	TCL VOLATILES-8260	109.	(66.0 - 117.)
Toluene-d8	TCL VOLATILES-8260	118.	(73.0 - 122.)

M = Method	Method-Description
M 1	EPA 8260 extended
M 2	EPA 8260A

**Notes:**

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cc: ENSF00199

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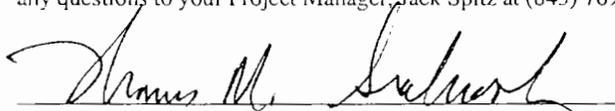
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Sample ID : NBCF/6071N00015

**M = Method**

**Method-Description**

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# GENERAL ENGINEERING LABORATORIES

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## Laboratory Certifications

STATE	GEL	EPI
FL	E87156/87294	E87472/87458
NC	233	
NJ	79002	79002
SC	10120	10582
TN	02934	02934

Client: Ensafe/Allen & Hoshall  
 935 Houston Northcutt Blvd.  
 Mt. Pleasant, South Carolina 29464

Contact: Mr. Charles Vernoy

cc: ENSF00199

Report Date: September 20, 1999

Page 1 of 3

Sample ID : NBCF/607IN00016  
 Lab ID : 9909293-01  
 Matrix : GroundH2O  
 Date Collected : 09/09/99  
 Date Received : 09/09/99  
 Priority : Routine  
 Collector : Client

Parameter	Qualifier	Result	DL	RL	Units	DF	Analyst	Date	Time	Batch	M	
<b>Volatile Organics</b>												
GCMS Library Search-VOA							JEB	09/10/99	1027	158132	1	
<i>Target Compound List Volatiles - 35 items</i>												
1,1,1-Trichloroethane	U	ND	0.200	1.00	ug/l	1.0	JEB	09/10/99	1027	158132	2	
1,1,2,2-Tetrachloroethane	U	ND	0.500	1.00	ug/l	1.0						
1,1,2-Trichloroethane	U	ND	0.400	1.00	ug/l	1.0						
1,1-Dichloroethane	U	ND	0.400	1.00	ug/l	1.0						
1,1-Dichloroethylene	U	ND	0.700	1.00	ug/l	1.0						
1,2-Dichloroethane	U	ND	0.200	1.00	ug/l	1.0						
1,2-Dichloropropane	U	ND	0.200	1.00	ug/l	1.0						
1,2-cis-Dichloroethylene		5.13	0.700	1.00	ug/l	1.0						
1,2-trans-Dichloroethylene	U	ND	0.700	1.00	ug/l	1.0						
2-Butanone	U	ND	5.90	10.0	ug/l	1.0						
2-Hexanone	U	ND	3.20	5.00	ug/l	1.0						
4-Methyl-2-pentanone	U	ND	1.60	5.00	ug/l	1.0						
Acetone	U	ND	3.70	5.00	ug/l	1.0						
Benzene	U	ND	0.300	1.00	ug/l	1.0						
Bromoform	U	ND	0.400	1.00	ug/l	1.0						
Carbon Disulfide	U	ND	1.80	5.00	ug/l	1.0						
Carbon Tetrachloride	U	ND	0.200	1.00	ug/l	1.0						
Chlorobenzene	U	ND	0.300	1.00	ug/l	1.0						
Chlorodibromomethane	J	0.850	0.300	1.00	ug/l	1.0						
Chloroethane	U	ND	0.300	1.00	ug/l	1.0						
Chloroform		1.39	0.700	1.00	ug/l	1.0						
Dichlorobromomethane		1.02	0.400	1.00	ug/l	1.0						
Ethylbenzene	U	ND	0.300	1.00	ug/l	1.0						
Methyl Bromide	U	ND	0.300	1.00	ug/l	1.0						
Methyl Chloride	U	ND	0.200	1.00	ug/l	1.0						
Methylene Chloride	U	ND	1.20	5.00	ug/l	1.0						
Styrene	U	ND	0.200	1.00	ug/l	1.0						





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NC	233	
NJ	79002	79002
SC	10120	10582
TN	02934	02934

Client: Ensafe/Allen & Hoshall  
 935 Houston Northcutt Blvd.  
 Mt. Pleasant, South Carolina 29464  
 Contact: Mr. Charles Vernoy

cc: ENSF00199

Report Date: September 20, 1999

Page 2 of 3

Sample ID : NBCF/607IN00016

Parameter	Qualifier	Result	DL	RL	Units	DF	Analyst	Date	Time	Batch	M
Tetrachloroethylene		39.0	0.700	1.00	ug/l	1.0					
Toluene	U	ND	0.500	1.00	ug/l	1.0	JEB	09/10/99	1027	158132	2
Trichloroethylene		2.48	0.600	1.00	ug/l	1.0					
Vinyl Acetate	U	ND	1.80	5.00	ug/l	1.0					
Vinyl chloride	U	ND	0.400	1.00	ug/l	1.0					
Xylenes (TOTAL)	U	ND	1.10	2.00	ug/l	1.0					
cis-1,3-Dichloropropylene	U	ND	0.300	1.00	ug/l	1.0					
trans-1,3-Dichloropropylene	U	ND	0.300	1.00	ug/l	1.0					

Surrogate Recovery	Test	Percent %	Acceptable Limits
Bromofluorobenzene	TCL VOLATILES-8260	92.7	(73.0 - 129.)
Dibromofluoromethane	TCL VOLATILES-8260	95.2	(66.0 - 117.)
Toluene-d8	TCL VOLATILES-8260	84.3	(73.0 - 122.)

M = Method	Method-Description
M 1	EPA 8260 extended
M 2	EPA 8260A

### Notes:

The qualifiers in this report are defined as follows:

ND indicates that the analyte was not detected at a concentration greater than the detection limit.

J indicates presence of analyte at a concentration less than the reporting limit (RL) and greater than the detection limit (DL).

U indicates that the analyte was not detected at a concentration greater than the detection limit.

\* indicates that a quality control analyte recovery is outside of specified acceptance criteria.





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## Laboratory Certifications

STATE	GEL	EPI
FL	E87156/87294	E87472/87458
NC	233	
NJ	79002	79002
SC	10120	10582
TN	02934	02934

Client: Ensafe/Allen & Hoshall  
935 Houston Northcutt Blvd.  
Mt. Pleasant, South Carolina 29464  
Contact: Mr. Charles Vernoy

cc: ENSF00199

Report Date: September 20, 1999

Page 3 of 3

Sample ID : NBCF/607IN00016

### M = Method

### Method-Description

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## Laboratory Certifications

STATE	GEL	EPI
FL	E87156/87294	E87472/87458
NC	233	
NJ	79002	79002
SC	10120	10582
TN	02934	02934

Client: Ensafe/Allen & Hoshall  
 935 Houston Northcutt Blvd.  
 Mt. Pleasant, South Carolina 29464

Contact: Mr. Charles Vernoy

cc: ENSF00199

Report Date: September 22, 1999

Page 1 of 3

Sample ID : NBCF/6071N00017  
 Lab ID : 9909449-01  
 Matrix : GroundH2O  
 Date Collected : 09/17/99  
 Date Received : 09/17/99  
 Priority : Routine  
 Collector : Client

Parameter	Qualifier	Result	DL	RL	Units	DF	Analyst	Date	Time	Batch	M
<b>Volatile Organics</b>											
GCMS Library Search-VOA						TCL	09/20/99	1659	158448	1	
<i>Target Compound List Volatiles - 35 items</i>											
1,1,1-Trichloroethane	U	ND	0.200	1.00	ug/l	1.0	TCL	09/20/99	1659	158448	2
1,1,2,2-Tetrachloroethane	U	ND	0.500	1.00	ug/l	1.0					
1,1,2-Trichloroethane	U	ND	0.400	1.00	ug/l	1.0					
1,1-Dichloroethane	U	ND	0.400	1.00	ug/l	1.0					
1,1-Dichloroethylene	U	ND	0.700	1.00	ug/l	1.0					
1,2-Dichloroethane	U	ND	0.200	1.00	ug/l	1.0					
1,2-Dichloropropane	U	ND	0.200	1.00	ug/l	1.0					
1,2-cis-Dichloroethylene		11.7	0.700	1.00	ug/l	1.0					
1,2-trans-Dichloroethylene	U	ND	0.700	1.00	ug/l	1.0					
2-Butanone	U	ND	5.90	10.0	ug/l	1.0					
2-Hexanone	U	ND	3.20	5.00	ug/l	1.0					
4-Methyl-2-pentanone	U	ND	1.60	5.00	ug/l	1.0					
Acetone	U	ND	3.70	5.00	ug/l	1.0					
Benzene	U	ND	0.300	1.00	ug/l	1.0					
Bromoform	U	ND	0.400	1.00	ug/l	1.0					
Carbon Disulfide	U	ND	1.80	5.00	ug/l	1.0					
Carbon Tetrachloride	U	ND	0.200	1.00	ug/l	1.0					
Chlorobenzene	U	ND	0.300	1.00	ug/l	1.0					
Chlorodibromomethane	U	ND	0.300	1.00	ug/l	1.0					
Chloroethane	U	ND	0.300	1.00	ug/l	1.0					
Chloroform	U	ND	0.700	1.00	ug/l	1.0					
Dichlorobromomethane	U	ND	0.400	1.00	ug/l	1.0					
Ethylbenzene	U	ND	0.300	1.00	ug/l	1.0					
Methyl Bromide	U	ND	0.300	1.00	ug/l	1.0					
Methyl Chloride	U	ND	0.200	1.00	ug/l	1.0					
Methylene Chloride	U	ND	1.20	5.00	ug/l	1.0					
Styrene	U	ND	0.200	1.00	ug/l	1.0					





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## Laboratory Certifications

STATE	GEL	EPI
FL	E87156/87294	E87472/87458
NC	233	
NJ	79002	79002
SC	10120	10582
TN	02934	02934

Client: Ensafe/Allen & Hoshall  
 935 Houston Northcutt Blvd.  
 Mt. Pleasant, South Carolina 29464  
 Contact: Mr. Charles Vernoy

cc: ENSF00199

Report Date: September 22, 1999

Page 2 of 3

Sample ID : NBCF/6071N00017

Parameter	Qualifier	Result	DL	RL	Units	DF	Analyst Date	Time	Batch	M
Tetrachloroethylene		95.3	0.700	1.00	ug/l	1.0				
Toluene	U	ND	0.500	1.00	ug/l	1.0	TCL 09/20/99	1659	158448	2
Trichloroethylene		8.88	0.600	1.00	ug/l	1.0				
Vinyl Acetate	U	ND	1.80	5.00	ug/l	1.0				
Vinyl chloride	U	ND	0.400	1.00	ug/l	1.0				
Xylenes (TOTAL)	U	ND	1.10	2.00	ug/l	1.0				
cis-1,3-Dichloropropylene	U	ND	0.300	1.00	ug/l	1.0				
trans-1,3-Dichloropropylene	U	ND	0.300	1.00	ug/l	1.0				

Surrogate Recovery	Test	Percent%	Acceptable Limits
Bromofluorobenzene	TCL VOLATILES-8260	81.6	(73.0 - 129.)
Dibromofluoromethane	TCL VOLATILES-8260	107.	(66.0 - 117.)
Toluene-d8	TCL VOLATILES-8260	104.	(73.0 - 122.)

M = Method	Method-Description
M 1	EPA 8260 extended
M 2	EPA 8260A

Notes:

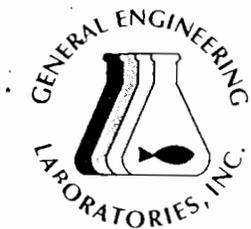
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Mt. Pleasant, South Carolina 29464  
Contact: Mr. Charles Vernoy

cc: ENSF00199

Report Date: September 22, 1999

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Sample ID : NBCF/607IN00017

### M = Method

### Method-Description

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STATE	GEL	EPI
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NC	233	
NJ	79002	79002
SC	10120	10582
TN	02934	02934

Client: Ensafe/Allen & Hoshall  
 935 Houston Northcutt Blvd.  
 Mt. Pleasant, South Carolina 29464  
 Contact: Mr. Charles Vernoy

cc: ENSF00199

Report Date: September 27, 1999

Page 1 of 3

Sample ID : NBCF/6071N00018  
 Lab ID : 9909493-01  
 Matrix : GroundH2O  
 Date Collected : 09/20/99  
 Date Received : 09/20/99  
 Priority : Routine  
 Collector : Client

Parameter	Qualifier	Result	DL	RL	Units	DF	Analyst	Date	Time	Batch	M	
<b>Volatile Organics</b>												
GCMS Library Search-VOA						TCL		09/22/99	1128	158750	1	
<i>Target Compound List Volatiles - 35 items</i>												
1,1,1-Trichloroethane	U	ND	0.200	1.00	ug/l	1.0	TCL	09/22/99	1128	158750	2	
1,1,2,2-Tetrachloroethane	U	ND	0.500	1.00	ug/l	1.0						
1,1,2-Trichloroethane	U	ND	0.400	1.00	ug/l	1.0						
1,1-Dichloroethane	U	ND	0.400	1.00	ug/l	1.0						
1,1-Dichloroethylene	U	ND	0.700	1.00	ug/l	1.0						
1,2-Dichloroethane	U	ND	0.200	1.00	ug/l	1.0						
1,2-Dichloropropane	U	ND	0.200	1.00	ug/l	1.0						
1,2-cis-Dichloroethylene		8.40	0.700	1.00	ug/l	1.0						
1,2-trans-Dichloroethylene	U	ND	0.700	1.00	ug/l	1.0						
2-Butanone	U	ND	5.90	10.0	ug/l	1.0						
2-Hexanone	U	ND	3.20	5.00	ug/l	1.0						
4-Methyl-2-pentanone	U	ND	1.60	5.00	ug/l	1.0						
Acetone	U	ND	3.70	5.00	ug/l	1.0						
Benzene	U	ND	0.300	1.00	ug/l	1.0						
Bromoform	U	ND	0.400	1.00	ug/l	1.0						
Carbon Disulfide	U	ND	1.80	5.00	ug/l	1.0						
Carbon Tetrachloride	U	ND	0.200	1.00	ug/l	1.0						
Chlorobenzene	U	ND	0.300	1.00	ug/l	1.0						
Chlorodibromomethane	U	ND	0.300	1.00	ug/l	1.0						
Chloroethane	U	ND	0.300	1.00	ug/l	1.0						
Chloroform	U	ND	0.700	1.00	ug/l	1.0						
Dichlorobromomethane	U	ND	0.400	1.00	ug/l	1.0						
Ethylbenzene	U	ND	0.300	1.00	ug/l	1.0						
Methyl Bromide	U	ND	0.300	1.00	ug/l	1.0						
Methyl Chloride	U	ND	0.200	1.00	ug/l	1.0						
Methylene Chloride	U	ND	1.20	5.00	ug/l	1.0						
Styrene	U	ND	0.200	1.00	ug/l	1.0						





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STATE	GEL	EPI
FL	E87156/87294	E87472/87458
NC	233	
NJ	79002	79002
SC	10120	10582
TN	02934	02934

Client: Ensafe/Allen & Hoshall  
 935 Houston Northcutt Blvd.  
 Mt. Pleasant, South Carolina 29464  
 Contact: Mr. Charles Vernoy

cc: ENSF00199

Report Date: September 27, 1999

Page 2 of 3

Sample ID : NBCF/6071N00018

Parameter	Qualifier	Result	DL	RL	Units	DF	Analyst	Date	Time	Batch	M
Tetrachloroethylene		82.6	0.700	1.00	ug/l	1.0					
Toluene	U	ND	0.500	1.00	ug/l	1.0	TCL	09/22/99	1128	158750	2
Trichloroethylene		7.60	0.600	1.00	ug/l	1.0					
Vinyl Acetate	U	ND	1.80	5.00	ug/l	1.0					
Vinyl chloride	U	ND	0.400	1.00	ug/l	1.0					
Xylenes (TOTAL)	U	ND	1.10	2.00	ug/l	1.0					
cis-1,3-Dichloropropylene	U	ND	0.300	1.00	ug/l	1.0					
trans-1,3-Dichloropropylene	U	ND	0.300	1.00	ug/l	1.0					

Surrogate Recovery	Test	Percent %	Acceptable Limits
Bromofluorobenzene	TCL VOLATILES-8260	84.5	(73.0 - 129.)
Dibromofluoromethane	TCL VOLATILES-8260	105.	(66.0 - 117.)
Toluene-d8	TCL VOLATILES-8260	105.	(73.0 - 122.)

M = Method	Method-Description
M 1	EPA 8260 extended
M 2	EPA 8260A

**Notes:**

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ND indicates that the analyte was not detected at a concentration greater than the detection limit.

J indicates presence of analyte at a concentration less than the reporting limit (RL) and greater than the detection limit (DL).

U indicates that the analyte was not detected at a concentration greater than the detection limit.

\* indicates that a quality control analyte recovery is outside of specified acceptance criteria.



# GENERAL ENGINEERING LABORATORIES

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## Laboratory Certifications

STATE	GEL	EPI
FL	E87156/87294	E87472/87458
NC	233	
NJ	79002	79002
SC	10120	10582
TN	02934	02934

Client: Ensafe/Allen & Hoshall  
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cc: ENSF00199

Report Date: September 27, 1999

Page 3 of 3

Sample ID : NBCF/6071N00018

### M = Method

### Method-Description

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FL	E87156/87294	E87472/87458
NC	233	
NJ	79002	79002
SC	10120	10582
TN	02934	02934

Client: Ensafe/Allen & Hoshall  
 935 Houston Northcutt Blvd.  
 Mt. Pleasant, South Carolina 29464  
 Contact: Mr. Charles Vernoy

cc: ENSF00199

Report Date: June 28, 1999

Page 1 of 3

Sample ID : NBCF/607EF00001  
 Lab ID : 9906890-01  
 Matrix : GroundH2O  
 Date Collected : 06/26/99  
 Date Received : 06/28/99  
 Priority : Urgent  
 Collector : Client

Parameter	Qualifier	Result	DL	RL	Units	DF	Analyst	Date	Time	Batch	M
<b>Volatile Organics</b>											
GCMS Library Search-VOA						TCL	06/28/99	1152	152220	1	
<i>Target Compound List Volatiles - 35 items</i>											
1,1,1-Trichloroethane	U	ND	0.200	1.00	ug/l	1.0	TCL	06/28/99	1152	152220	2
1,1,2,2-Tetrachloroethane	U	ND	0.500	1.00	ug/l	1.0					
1,1,2-Trichloroethane	U	ND	0.400	1.00	ug/l	1.0					
1,1-Dichloroethane	U	ND	0.400	1.00	ug/l	1.0					
1,1-Dichloroethylene	U	ND	0.700	1.00	ug/l	1.0					
1,2-Dichloroethane	U	ND	0.200	1.00	ug/l	1.0					
1,2-Dichloropropane	U	ND	0.200	1.00	ug/l	1.0					
1,2-cis-Dichloroethylene	U	ND	0.700	1.00	ug/l	1.0					
1,2-trans-Dichloroethylene	U	ND	0.700	1.00	ug/l	1.0					
2-Butanone		19.4	5.90	10.0	ug/l	1.0					
2-Hexanone	U	ND	3.20	5.00	ug/l	1.0					
4-Methyl-2-pentanone	U	ND	1.60	5.00	ug/l	1.0					
Acetone	U	ND	3.70	5.00	ug/l	1.0					
Benzene	U	ND	0.300	1.00	ug/l	1.0					
Bromoform	U	ND	0.400	1.00	ug/l	1.0					
Carbon Disulfide	U	ND	1.80	5.00	ug/l	1.0					
Carbon Tetrachloride	U	ND	0.200	1.00	ug/l	1.0					
Chlorobenzene	U	ND	0.300	1.00	ug/l	1.0					
Chlorodibromomethane	U	ND	0.300	1.00	ug/l	1.0					
Chloroethane	U	ND	0.300	1.00	ug/l	1.0					
Chloroform	U	ND	0.700	1.00	ug/l	1.0					
Dichlorobromomethane	U	ND	0.400	1.00	ug/l	1.0					
Ethylbenzene	U	ND	0.300	1.00	ug/l	1.0					
Methyl Bromide	U	ND	0.300	1.00	ug/l	1.0					
Methyl Chloride	U	ND	0.200	1.00	ug/l	1.0					
Methylene Chloride	U	ND	1.20	5.00	ug/l	1.0					
Styrene	U	ND	0.200	1.00	ug/l	1.0					





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## Laboratory Certifications

STATE	GEL	EPI
FL	E87156/87294	E87472/87458
NC	233	
NJ	79002	79002
SC	10120	10582
TN	02934	02934

Client: Ensafe/Allen & Hoshall  
935 Houston Northcutt Blvd.  
Mt. Pleasant, South Carolina 29464  
Contact: Mr. Charles Vernoy

cc: ENSF00199

Report Date: June 28, 1999

Page 2 of 3

Sample ID : NBCF/607EF00001

Parameter	Qualifier	Result	DL	RL	Units	DF	Analyst	Date	Time	Batch	M
Tetrachloroethylene	J	0.760	0.700	1.00	ug/l	1.0					
Toluene	U	ND	0.500	1.00	ug/l	1.0	TCL	06/28/99	1152	152220	2
Trichloroethylene	U	ND	0.600	1.00	ug/l	1.0					
Vinyl Acetate	U	ND	1.80	5.00	ug/l	1.0					
Vinyl chloride	U	ND	0.400	1.00	ug/l	1.0					
Xylenes (TOTAL)	U	ND	1.10	2.00	ug/l	1.0					
cis-1,3-Dichloropropylene	U	ND	0.300	1.00	ug/l	1.0					
trans-1,3-Dichloropropylene	U	ND	0.300	1.00	ug/l	1.0					

Surrogate Recovery	Test	Percent %	Acceptable Limits
Bromofluorobenzene	TCL VOLATILES-8260	82.7	(73.0 - 129.)
Dibromofluoromethane	TCL VOLATILES-8260	91.4	(66.0 - 117.)
Toluene-d8	TCL VOLATILES-8260	82.0	(73.0 - 122.)

M = Method	Method-Description
M 1	EPA 8260B
M 2	EPA 8260A

### Notes:

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J indicates presence of analyte at a concentration less than the reporting limit (RL) and greater than the detection limit (DL).

U indicates that the analyte was not detected at a concentration greater than the detection limit.

\* indicates that a quality control analyte recovery is outside of specified acceptance criteria.





# GENERAL ENGINEERING LABORATORIES

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## Laboratory Certifications

STATE	GEL	EPI
FL	E87156/87294	E87472/87458
NC	233	
NJ	79002	79002
SC	10120	10582
TN	02934	02934

Client: Ensafe/Allen & Hoshall  
935 Houston Northcutt Blvd.  
Mt. Pleasant, South Carolina 29464  
Contact: Mr. Charles Vernoy

cc: ENSF00199

Report Date: June 28, 1999

Page 3 of 3

Sample ID : NBCF/607EF00001

### M = Method

### Method-Description

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## Laboratory Certifications

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NC	233	
NJ	79002	79002
SC	10120	10582
TN	02934	02934

Client: Ensafe/Allen & Hoshall  
 935 Houston Northcutt Blvd.  
 Mt. Pleasant, South Carolina 29464

Contact: Mr. Charles Vernoy

cc: ENSF00199

Report Date: June 28, 1999

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Sample ID : NBCF/607EF00002  
 Lab ID : 9906890-04  
 Matrix : GroundH2O  
 Date Collected : 06/27/99  
 Date Received : 06/28/99  
 Priority : Urgent  
 Collector : Client

Parameter	Qualifier	Result	DL	RL	Units	DF	Analyst Date	Time	Batch	M	
<b>Volatile Organics</b>											
GCMS Library Search-VOA							TCL	06/28/99	1322	152220	1
<i>Target Compound List Volatiles - 35 items</i>											
1,1,1-Trichloroethane	U	ND	0.200	1.00	ug/l	1.0	TCL	06/28/99	1322	152220	2
1,1,2,2-Tetrachloroethane	U	ND	0.500	1.00	ug/l	1.0					
1,1,2-Trichloroethane	U	ND	0.400	1.00	ug/l	1.0					
1,1-Dichloroethane	U	ND	0.400	1.00	ug/l	1.0					
1,1-Dichloroethylene	U	ND	0.700	1.00	ug/l	1.0					
1,2-Dichloroethane	U	ND	0.200	1.00	ug/l	1.0					
1,2-Dichloropropane	U	ND	0.200	1.00	ug/l	1.0					
1,2-cis-Dichloroethylene	U	ND	0.700	1.00	ug/l	1.0					
1,2-trans-Dichloroethylene	U	ND	0.700	1.00	ug/l	1.0					
2-Butanone	U	ND	5.90	10.0	ug/l	1.0					
2-Hexanone	U	ND	3.20	5.00	ug/l	1.0					
4-Methyl-2-pentanone	U	ND	1.60	5.00	ug/l	1.0					
Acetone	U	ND	3.70	5.00	ug/l	1.0					
Benzene	U	ND	0.300	1.00	ug/l	1.0					
Bromoform	U	ND	0.400	1.00	ug/l	1.0					
Carbon Disulfide	U	ND	1.80	5.00	ug/l	1.0					
Carbon Tetrachloride	U	ND	0.200	1.00	ug/l	1.0					
Chlorobenzene	U	ND	0.300	1.00	ug/l	1.0					
Chlorodibromomethane	U	ND	0.300	1.00	ug/l	1.0					
Chloroethane	U	ND	0.300	1.00	ug/l	1.0					
Chloroform	U	ND	0.700	1.00	ug/l	1.0					
Dichlorobromomethane	U	ND	0.400	1.00	ug/l	1.0					
Ethylbenzene	U	ND	0.300	1.00	ug/l	1.0					
Methyl Bromide	U	ND	0.300	1.00	ug/l	1.0					
Methyl Chloride	U	ND	0.200	1.00	ug/l	1.0					
Methylene Chloride	U	ND	1.20	5.00	ug/l	1.0					
Styrene	U	ND	0.200	1.00	ug/l	1.0					





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NJ	79002	79002
SC	10120	10582
TN	02934	02934

Client: Ensafe/Allen & Hoshall  
 935 Houston Northcutt Blvd.  
 Mt. Pleasant, South Carolina 29464

Contact: Mr. Charles Vernoy

cc: ENSF00199

Report Date: June 28, 1999

Page 2 of 3

Sample ID : NBCF/607EF00002

Parameter	Qualifier	Result	DL	RL	Units	DF	Analyst	Date	Time	Batch	M
Tetrachloroethylene	U	ND	0.700	1.00	ug/l	1.0					
Toluene	U	ND	0.500	1.00	ug/l	1.0	TCL	06/28/99	1322	152220	2
Trichloroethylene	U	ND	0.600	1.00	ug/l	1.0					
Vinyl Acetate	U	ND	1.80	5.00	ug/l	1.0					
Vinyl chloride	U	ND	0.400	1.00	ug/l	1.0					
Xylenes (TOTAL)	U	ND	1.10	2.00	ug/l	1.0					
cis-1,3-Dichloropropylene	U	ND	0.300	1.00	ug/l	1.0					
trans-1,3-Dichloropropylene	U	ND	0.300	1.00	ug/l	1.0					

Surrogate Recovery	Test	Percent %	Acceptable Limits
Bromofluorobenzene	TCL VOLATILES-8260	82.5	(73.0 - 129.)
Dibromofluoromethane	TCL VOLATILES-8260	93.4	(66.0 - 117.)
Toluene-d8	TCL VOLATILES-8260	82.4	(73.0 - 122.)

M = Method	Method-Description
M 1	EPA 8260B
M 2	EPA 8260A

**Notes:**

The qualifiers in this report are defined as follows:

ND indicates that the analyte was not detected at a concentration greater than the detection limit.

J indicates presence of analyte at a concentration less than the reporting limit (RL) and greater than the detection limit (DL).

U indicates that the analyte was not detected at a concentration greater than the detection limit.

\* indicates that a quality control analyte recovery is outside of specified acceptance criteria.



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## Laboratory Certifications

STATE	GEL	EPI
FL	E87156/87294	E87472/87458
NC	233	
NJ	79002	79002
SC	10120	10582
TN	02934	02934

Client: Ensafe/Allen & Hoshall  
935 Houston Northcutt Blvd.  
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Contact: Mr. Charles Vernoy

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Report Date: June 28, 1999

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Sample ID : NBCF/607EF00002

### M = Method

### Method-Description

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 Contact: Mr. Charles Vernoy

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Report Date: August 12, 1999

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Sample ID : NBCF/607EF00003  
 Lab ID : 9908231-02  
 Matrix : GroundH2O  
 Date Collected : 08/06/99  
 Date Received : 08/06/99  
 Priority : Routine  
 Collector : Client

Parameter	Qualifier	Result	DL	RL	Units	DF	Analyst	Date	Time	Batch	M
<b>Volatile Organics</b>											
GCMS Library Search-VOA							JEB	08/09/99	1311	155555	1
<i>Target Compound List Volatiles - 35 items</i>											
1,1,1-Trichloroethane	U	ND	0.200	1.00	ug/l	1.0	JEB	08/09/99	1311	155555	2
1,1,1,2-Tetrachloroethane	U	ND	0.500	1.00	ug/l	1.0					
1,1,2-Trichloroethane	U	ND	0.400	1.00	ug/l	1.0					
1,1-Dichloroethane	U	ND	0.400	1.00	ug/l	1.0					
1,1-Dichloroethylene	U	ND	0.700	1.00	ug/l	1.0					
1,2-Dichloroethane	U	ND	0.200	1.00	ug/l	1.0					
1,2-Dichloropropane	U	ND	0.200	1.00	ug/l	1.0					
1,2-cis-Dichloroethylene	U	ND	0.700	1.00	ug/l	1.0					
1,2-trans-Dichloroethylene	U	ND	0.700	1.00	ug/l	1.0					
2-Butanone	U	ND	5.90	10.0	ug/l	1.0					
2-Hexanone	U	ND	3.20	5.00	ug/l	1.0					
4-Methyl-2-pentanone	U	ND	1.60	5.00	ug/l	1.0					
Acetone	U	ND	3.70	5.00	ug/l	1.0					
Benzene	U	ND	0.300	1.00	ug/l	1.0					
Bromoform	U	ND	0.400	1.00	ug/l	1.0					
Carbon Disulfide	U	ND	1.80	5.00	ug/l	1.0					
Carbon Tetrachloride	U	ND	0.200	1.00	ug/l	1.0					
Chlorobenzene	U	ND	0.300	1.00	ug/l	1.0					
Chlorodibromomethane	U	ND	0.300	1.00	ug/l	1.0					
Chloroethane	U	ND	0.300	1.00	ug/l	1.0					
Chloroform	U	ND	0.700	1.00	ug/l	1.0					
Dichlorobromomethane	U	ND	0.400	1.00	ug/l	1.0					
Ethylbenzene	U	ND	0.300	1.00	ug/l	1.0					
Methyl Bromide	U	ND	0.300	1.00	ug/l	1.0					
Methyl Chloride	U	ND	0.200	1.00	ug/l	1.0					
Methylene Chloride	U	ND	1.20	5.00	ug/l	1.0					
Styrene	U	ND	0.200	1.00	ug/l	1.0					





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Report Date: August 12, 1999

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Sample ID : NBCF/607EF00003

Parameter	Qualifier	Result	DL	RL	Units	DF	Analyst	Date	Time	Batch	M
Tetrachloroethylene	U	ND	0.700	1.00	ug/l	1.0					
Toluene	U	ND	0.500	1.00	ug/l	1.0	JEB	08/09/99	1311	155555	2
Trichloroethylene	U	ND	0.600	1.00	ug/l	1.0					
Vinyl Acetate	U	ND	1.80	5.00	ug/l	1.0					
Vinyl chloride	U	ND	0.400	1.00	ug/l	1.0					
Xylenes (TOTAL)	U	ND	1.10	2.00	ug/l	1.0					
cis-1,3-Dichloropropylene	U	ND	0.300	1.00	ug/l	1.0					
trans-1,3-Dichloropropylene	U	ND	0.300	1.00	ug/l	1.0					

Surrogate Recovery	Test	Percent %	Acceptable Limits
Bromofluorobenzene	TCL VOLATILES-8260	81.6	(73.0 - 129.)
Dibromofluoromethane	TCL VOLATILES-8260	97.0	(66.0 - 117.)
Toluene-d8	TCL VOLATILES-8260	88.0	(73.0 - 122.)

M = Method	Method-Description
M 1	EPA 8260 extended
M 2	EPA 8260A

**Notes:**

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Report Date: August 12, 1999

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Sample ID : NBCF/607EF00003

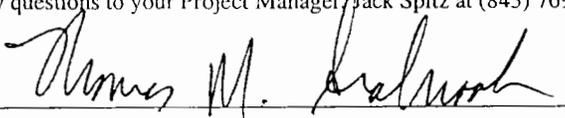
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**M = Method**

**Method-Description**

---

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FL	E87156/87294	E87472/87458
NC	233	
NJ	79002	79002
SC	10120	10582
TN	02934	02934

Client: Ensafe/Allen & Hoshall  
 935 Houston Northcutt Blvd.  
 Mt. Pleasant, South Carolina 29464  
 Contact: Mr. Charles Vernoy

cc: ENSF00199

Report Date: September 20, 1999

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Sample ID : NBCF/607EF00004  
 Lab ID : 9909293-02  
 Matrix : GroundH2O  
 Date Collected : 09/09/99  
 Date Received : 09/09/99  
 Priority : Routine  
 Collector : Client

Parameter	Qualifier	Result	DL	RL	Units	DF	Analyst	Date	Time	Batch	M
<b>Volatile Organics</b>											
GCMS Library Search-VOA							JEB	09/10/99	1056	158132	1
<i>Target Compound List Volatiles - 35 items</i>											
1,1,1-Trichloroethane	U	ND	0.200	1.00	ug/l	1.0	JEB	09/10/99	1056	158132	2
1,1,2,2-Tetrachloroethane	U	ND	0.500	1.00	ug/l	1.0					
1,1,2-Trichloroethane	U	ND	0.400	1.00	ug/l	1.0					
1,1-Dichloroethane	U	ND	0.400	1.00	ug/l	1.0					
1,1-Dichloroethylene	U	ND	0.700	1.00	ug/l	1.0					
1,2-Dichloroethane	U	ND	0.200	1.00	ug/l	1.0					
1,2-Dichloropropane	U	ND	0.200	1.00	ug/l	1.0					
1,2-cis-Dichloroethylene	U	ND	0.700	1.00	ug/l	1.0					
1,2-trans-Dichloroethylene	U	ND	0.700	1.00	ug/l	1.0					
2-Butanone	U	ND	5.90	10.0	ug/l	1.0					
2-Hexanone	U	ND	3.20	5.00	ug/l	1.0					
4-Methyl-2-pentanone	U	ND	1.60	5.00	ug/l	1.0					
Acetone	U	ND	3.70	5.00	ug/l	1.0					
Benzene	U	ND	0.300	1.00	ug/l	1.0					
Bromoform	U	ND	0.400	1.00	ug/l	1.0					
Carbon Disulfide	U	ND	1.80	5.00	ug/l	1.0					
Carbon Tetrachloride	U	ND	0.200	1.00	ug/l	1.0					
Chlorobenzene	U	ND	0.300	1.00	ug/l	1.0					
Chlorodibromomethane	U	ND	0.300	1.00	ug/l	1.0					
Chloroethane	U	ND	0.300	1.00	ug/l	1.0					
Chloroform	U	ND	0.700	1.00	ug/l	1.0					
Dichlorobromomethane	U	ND	0.400	1.00	ug/l	1.0					
Ethylbenzene	U	ND	0.300	1.00	ug/l	1.0					
Methyl Bromide	U	ND	0.300	1.00	ug/l	1.0					
Methyl Chloride	U	ND	0.200	1.00	ug/l	1.0					
Methylene Chloride	U	ND	1.20	5.00	ug/l	1.0					
Styrene	U	ND	0.200	1.00	ug/l	1.0					





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NC	233	
NJ	79002	79002
SC	10120	10582
TN	02934	02934

Client: Ensafe/Allen & Hoshall  
 935 Houston Northcutt Blvd.  
 Mt. Pleasant, South Carolina 29464  
 Contact: Mr. Charles Vernoy

cc: ENSF00199

Report Date: September 20, 1999

Page 2 of 3

Sample ID : NBCF/607EF00004

Parameter	Qualifier	Result	DL	RL	Units	DF	Analyst	Date	Time	Batch	M
Tetrachloroethylene	U	ND	0.700	1.00	ug/l	1.0					
Toluene	U	ND	0.500	1.00	ug/l	1.0	JEB	09/10/99	1056	158132	2
Trichloroethylene	U	ND	0.600	1.00	ug/l	1.0					
Vinyl Acetate	U	ND	1.80	5.00	ug/l	1.0					
Vinyl chloride	U	ND	0.400	1.00	ug/l	1.0					
Xylenes (TOTAL)	U	ND	1.10	2.00	ug/l	1.0					
cis-1,3-Dichloropropylene	U	ND	0.300	1.00	ug/l	1.0					
trans-1,3-Dichloropropylene	U	ND	0.300	1.00	ug/l	1.0					

Surrogate Recovery	Test	Percent %	Acceptable Limits
Bromofluorobenzene	TCL VOLATILES-8260	106.	(73.0 - 129.)
Dibromofluoromethane	TCL VOLATILES-8260	98.3	(66.0 - 117.)
Toluene-d8	TCL VOLATILES-8260	87.6	(73.0 - 122.)

M = Method	Method-Description
M 1	EPA 8260 extended
M 2	EPA 8260A

Notes:

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J indicates presence of analyte at a concentration less than the reporting limit (RL) and greater than the detection limit (DL).

U indicates that the analyte was not detected at a concentration greater than the detection limit.

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## Laboratory Certifications

STATE	GEL	EPI
FL	E87156/87294	E87472/87458
NC	233	
NJ	79002	79002
SC	10120	10582
TN	02934	02934

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935 Houston Northcutt Blvd.  
Mt. Pleasant, South Carolina 29464  
Contact: Mr. Charles Vernoy

cc: ENSF00199

Report Date: September 20, 1999

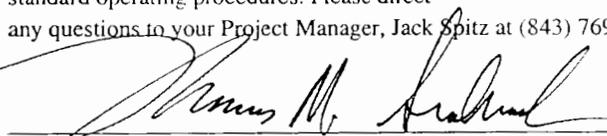
Page 3 of 3

Sample ID : NBCF/607EF00004

### M = Method

### Method-Description

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FL	E87156/87294	E87472/87458
NC	233	
NJ	79002	79002
SC	10120	10582
TN	02934	02934

Client: Ensafe/Allen & Hoshall  
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 Contact: Mr. Charles Vernoy

cc: ENSF00199

Report Date: September 22, 1999

Page 1 of 3

Sample ID : NBCF/607EF00005  
 Lab ID : 9909449-02  
 Matrix : GroundH2O  
 Date Collected : 09/17/99  
 Date Received : 09/17/99  
 Priority : Routine  
 Collector : Client

Parameter	Qualifier	Result	DL	RL	Units	DF	Analyst	Date	Time	Batch	M	
<b>Volatile Organics</b>												
GCMS Library Search-VOA							TCL	09/20/99	1728	158448	1	
<i>Target Compound List Volatiles - 35 items</i>												
1,1,1-Trichloroethane	U	ND	0.200	1.00	ug/l	1.0	TCL	09/20/99	1728	158448	2	
1,1,2,2-Tetrachloroethane	U	ND	0.500	1.00	ug/l	1.0						
1,1,2-Trichloroethane	U	ND	0.400	1.00	ug/l	1.0						
1,1-Dichloroethane	U	ND	0.400	1.00	ug/l	1.0						
1,1-Dichloroethylene	U	ND	0.700	1.00	ug/l	1.0						
1,2-Dichloroethane	U	ND	0.200	1.00	ug/l	1.0						
1,2-Dichloropropane	U	ND	0.200	1.00	ug/l	1.0						
1,2-cis-Dichloroethylene	U	ND	0.700	1.00	ug/l	1.0						
1,2-trans-Dichloroethylene	U	ND	0.700	1.00	ug/l	1.0						
2-Butanone	U	ND	5.90	10.0	ug/l	1.0						
2-Hexanone	U	ND	3.20	5.00	ug/l	1.0						
4-Methyl-2-pentanone	U	ND	1.60	5.00	ug/l	1.0						
Acetone	U	ND	3.70	5.00	ug/l	1.0						
Benzene	U	ND	0.300	1.00	ug/l	1.0						
Bromoform	U	ND	0.400	1.00	ug/l	1.0						
Carbon Disulfide	U	ND	1.80	5.00	ug/l	1.0						
Carbon Tetrachloride	U	ND	0.200	1.00	ug/l	1.0						
Chlorobenzene	U	ND	0.300	1.00	ug/l	1.0						
Chlorodibromomethane	U	ND	0.300	1.00	ug/l	1.0						
Chloroethane	U	ND	0.300	1.00	ug/l	1.0						
Chloroform	U	ND	0.700	1.00	ug/l	1.0						
Dichlorobromomethane	U	ND	0.400	1.00	ug/l	1.0						
Ethylbenzene	U	ND	0.300	1.00	ug/l	1.0						
Methyl Bromide	U	ND	0.300	1.00	ug/l	1.0						
Methyl Chloride	U	ND	0.200	1.00	ug/l	1.0						
Methylene Chloride	U	ND	1.20	5.00	ug/l	1.0						
Styrene	U	ND	0.200	1.00	ug/l	1.0						





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## Laboratory Certifications

STATE	GEL	EPI
FL	E87156/87294	E87472/87458
NC	233	
NJ	79002	79002
SC	10120	10582
TN	02934	02934

Client: Ensafe/Allen & Hoshall  
 935 Houston Northcutt Blvd.  
 Mt. Pleasant, South Carolina 29464  
 Contact: Mr. Charles Vernoy

cc: ENSF00199

Report Date: September 22, 1999

Page 2 of 3

Sample ID : NBCF/607EF00005

Parameter	Qualifier	Result	DL	RL	Units	DF	Analyst	Date	Time	Batch	M
Tetrachloroethylene	U	ND	0.700	1.00	ug/l	1.0					
Toluene	U	ND	0.500	1.00	ug/l	1.0	TCL	09/20/99	1728	158448	2
Trichloroethylene	U	ND	0.600	1.00	ug/l	1.0					
Vinyl Acetate	U	ND	1.80	5.00	ug/l	1.0					
Vinyl chloride	U	ND	0.400	1.00	ug/l	1.0					
Xylenes (TOTAL)	U	ND	1.10	2.00	ug/l	1.0					
cis-1,3-Dichloropropylene	U	ND	0.300	1.00	ug/l	1.0					
trans-1,3-Dichloropropylene	U	ND	0.300	1.00	ug/l	1.0					

Surrogate Recovery	Test	Percent %	Acceptable Limits
Bromofluorobenzene	TCL VOLATILES-8260	77.8	(73.0 - 129.)
Dibromofluoromethane	TCL VOLATILES-8260	106.	(66.0 - 117.)
Toluene-d8	TCL VOLATILES-8260	100.	(73.0 - 122.)

M = Method	Method-Description
M 1	EPA 8260 extended
M 2	EPA 8260A

### Notes:

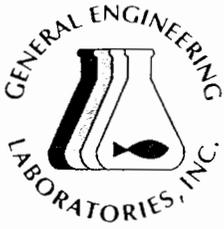
The qualifiers in this report are defined as follows:

ND indicates that the analyte was not detected at a concentration greater than the detection limit.

J indicates presence of analyte at a concentration less than the reporting limit (RL) and greater than the detection limit (DL).

U indicates that the analyte was not detected at a concentration greater than the detection limit.

\* indicates that a quality control analyte recovery is outside of specified acceptance criteria.



# GENERAL ENGINEERING LABORATORIES

*Meeting today's needs with a vision for tomorrow.*

## Laboratory Certifications

STATE	GEL	EPI
FL	E87156/87294	E87472/87458
NC	233	
NJ	79002	79002
SC	10120	10582
TN	02934	02934

Client: Ensafe/Allen & Hoshall  
935 Houston Northcutt Blvd.  
Mt. Pleasant, South Carolina 29464  
Contact: Mr. Charles Vernoy

cc: ENSF00199

Report Date: September 22, 1999

Page 3 of 3

Sample ID : NBCF/607EF00005

M = Method

Method-Description

This data report has been prepared and reviewed in accordance with General Engineering Laboratories standard operating procedures. Please direct any questions to your Project Manager, Jack Spitz at (843) 769-7390.

Reviewed By



LOG NO: S9-14245  
 Received: 28 JUN 99  
 Reported: 29 JUN 99

Mr. Ted Blahnik  
 EnSafe, Inc.  
 935 Houston Northcutt, Suite 113  
 Mt. Pleasant, SC 29464

Client PO. No.: 2/REL71

Requisition: AOC 607  
 Contract No.: 2906-001-13-300-00  
 Project: Navy Base Charleston, Zone F  
 Sampled By: Client  
 Code: 15469071

REPORT OF RESULTS

Page 1

LOG NO	SAMPLE DESCRIPTION , AIR SAMPLES	DATE/ TIME SAMPLED
14245-1	NBCF/607INVAP01	06-26-99/10:25
14245-1-DL	NBCF/607INVAP01	06-26-99/10:25

PARAMETER	14245-1	14245-1-DL
Volatile Organics (EPA-18)		
Vinyl chloride, mg/m3	3.7	4.0U
cis-1,2-Dichloroethene, mg/m3	18	15
trans-1,2-Dichloroethene, mg/m3	1.0U	2.0U
Trichloroethene, mg/m3	12	11
Tetrachloroethene, mg/m3	66E	63D
Analysis Date	06.28.99	06.29.99
Batch ID	1C0628	1C0628
Dilution Factor	1.0	2.0

LOG NO: S9-14245  
 Received: 28 JUN 99  
 Reported: 29 JUN 99

Mr. Ted Blahnik  
 EnSafe, Inc.  
 935 Houston Northcutt, Suite 113  
 Mt. Pleasant, SC 29464

Client PO. No.: 2/REL71

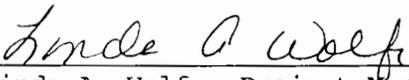
Requisition: AOC 607  
 Contract No.: 2906-001-13-300-00  
 Project: Navy Base Charleston, Zone F  
 Sampled By: Client  
 Code: 15469071

REPORT OF RESULTS

Page 2

LOG NO	SAMPLE DESCRIPTION , QC REPORT FOR AIR SAMPLES	DATE/ TIME SAMPLED
14245-2	Method Blank	
14245-3	Lab Control Standard % Recovery	
PARAMETER	14245-2	14245-3
Volatile Organics (EPA-18)		
Vinyl chloride, mg/m3	2.0U	---
trans-1,2-Dichloroethene, mg/m3	1.0U	---
cis-1,2-Dichloroethene, mg/m3	1.0U	---
Trichloroethene, mg/m3	1.0U	98 %
Tetrachloroethene, mg/m3	1.0U	---
Analysis Date	06.28.99	---
Batch ID	1C0628	---
Dilution Factor	1.0	---

Methods: EPA-18

  
 Linda A. Wolfe, Project Manager

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LOG NO: S9-14281  
 Received: 29 JUN 99  
 Reported: 01 JUL 99

Mr. Ted Blahnik  
 EnSafe, Inc.  
 935 Houston Northcutt, Suite 113  
 Mt. Pleasant, SC 29464

Client PO. No.: 2/REL71

Requisition: AOC 607  
 Contract No.: 2906-001-13-300-00  
 Project: Navy Base Charleston, Zone F  
 Sampled By: Client  
 Code: 15429071

REPORT OF RESULTS

Page 1

LOG NO	SAMPLE DESCRIPTION , AIR SAMPLES	DATE/ TIME SAMPLED
14281-1	NBCF/607INVAP02	06-27-99/10:10
14281-1-DL	NBCF/607INVAP02	06-27-99/10:10

PARAMETER	14281-1	14281-1-DL
Volatile Organics (EPA-18)		
Vinyl chloride, mg/m3	3.9	20U
trans-1,2-Dichloroethene, mg/m3	1.0U	10U
cis-1,2-Dichloroethene, mg/m3	15	21D
Trichloroethene, mg/m3	12	18D
Tetrachloroethene, mg/m3	140E	280D
Analysis Date	06.30.99	07.01.99
Batch ID	1C0630	1C0630
Dilution Factor	1.0	10.0

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LOG NO: S9-14281  
 Received: 29 JUN 99  
 Reported: 01 JUL 99

Mr. Ted Blahnik  
 EnSafe, Inc.  
 935 Houston Northcutt, Suite 113  
 Mt. Pleasant, SC 29464

Client PO. No.: 2/REL71

Requisition: AOC 607  
 Contract No.: 2906-001-13-300-00  
 Project: Navy Base Charleston, Zone F  
 Sampled By: Client  
 Code: 15429071

REPORT OF RESULTS

Page 2

LOG NO	SAMPLE DESCRIPTION , AIR SAMPLES	DATE/ TIME SAMPLED
14281-4	NBCF/607INVAP03	06-28-99/08:30
14281-4-DL	NBCF/607INVAP03	06-28-99/08:30

PARAMETER	14281-4	14281-4-DL
Volatile Organics (EPA-18)		
Vinyl chloride, mg/m3	2.0U	50U
trans-1,2-Dichloroethene, mg/m3	1.0U	25U
cis-1,2-Dichloroethene, mg/m3	17	35D
Trichloroethene, mg/m3	20	36D
Tetrachloroethene, mg/m3	220E	810D
Analysis Date	06.22.99	07.01.99
Batch ID	1C0630	1C0630
Dilution Factor	1.0	25

LOG NO: S9-14281  
Received: 29 JUN 99  
Reported: 01 JUL 99

Mr. Ted Blahnik  
EnSafe, Inc.  
935 Houston Northcutt, Suite 113  
Mt. Pleasant, SC 29464

Client PO. No.: 2/REL71

Requisition: AOC 607  
Contract No.: 2906-001-13-300-00  
Project: Navy Base Charleston, Zone F  
Sampled By: Client  
Code: 15429071

REPORT OF RESULTS

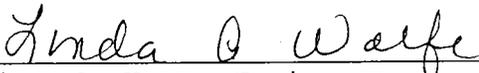
Page 3

LOG NO SAMPLE DESCRIPTION , QC REPORT FOR AIR SAMPLES

14281-2 Method Blank  
14281-3 Lab Control Standard % Recovery

PARAMETER	14281-2	14281-3
Volatile Organics (EPA-18)		
Vinyl chloride, mg/m3	2.0U	---
trans-1,2-Dichloroethene, mg/m3	1.0U	---
cis-1,2-Dichloroethene, mg/m3	1.0U	---
Trichloroethene, mg/m3	1.0U	102 %
Tetrachloroethene, mg/m3	1.0U	---
Analysis Date	06.30.99	06.30.99
Batch ID	1C0630	1C0630
Dilution Factor	1.0	1.0

Methods: EPA-18

  
Linda A. Wolfe, Project Manager

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LOG NO: S9-14287  
Received: 30 JUN 99  
Reported: 13 JUL 99

Mr. Charlie Vernoy  
EnSafe, Inc.  
935 Houston Northcutt, Suite 113  
Mt. Pleasant, SC 29464

Client PO. No.: 2/REL71

Requisition: AOC 607  
Contract No.: 2906-001-13-300-00  
Project: Navy Base Charleston, Zone F  
Sampled By: Client  
Code: 145890713

REPORT OF RESULTS

Page 1

LOG NO	SAMPLE DESCRIPTION , AIR SAMPLES	DATE/ TIME SAMPLED
14287-1	NBCF/607INVAP04	06-29-99/08:10

PARAMETER 14287-1

-----  
Volatile Organics (EPA-18)  
trans-1,2-Dichloroethene, mg/m3 25U  
cis-1,2-Dichloroethene, mg/m3 25U  
Trichloroethene, mg/m3 25U  
Tetrachloroethene, mg/m3 490  
Prep Date 06.30.99  
Analysis Date 06.30.99  
Batch ID 1C0630  
Dilution Factor 25  
-----

LOG NO: S9-14287  
Received: 30 JUN 99  
Reported: 13 JUL 99

Mr. Charlie Vernoy  
EnSafe, Inc.  
935 Houston Northcutt, Suite 113  
Mt. Pleasant, SC 29464

Client PO. No.: 2/REL71

Requisition: AOC 607  
Contract No.: 2906-001-13-300-00  
Project: Navy Base Charleston, Zone F  
Sampled By: Client  
Code: 145890713

REPORT OF RESULTS

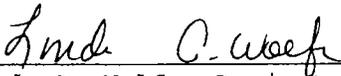
Page 2

LOG NO	SAMPLE DESCRIPTION , QC REPORT FOR AIR SAMPLES	DATE/ TIME SAMPLED
14287-2	Method Blank	
14287-3	Lab Control Standard % Recovery	

PARAMETER	14287-2	14287-3
Volatile Organics (EPA-18)		
trans-1,2-Dichloroethene, mg/m3	1.0U	---
cis-1,2-Dichloroethene, mg/m3	1.0U	---
Trichloroethene, mg/m3	1.0U	102 %
Tetrachloroethene, mg/m3	1.0U	---
Prep Date	06.30.99	06.30.99
Analysis Date	06.30.99	06.30.99
Batch ID	1C0630	1C0630
Dilution Factor	1.0	1.0

Methods: EPA-18

X = Due to the analyte abundance, target compound concentrations are reported from multiple runs to achieve requested detection limits.

  
Linda A. Wolfe, Project Manager

LOG NO: S9-14340  
Received: 01 JUL 99  
Reported: 13 JUL 99

Mr. Charlie Vernoy  
EnSafe, Inc.  
935 Houston Northcutt, Suite 113  
Mt. Pleasant, SC 29464

Client PO. No.: 2/REL71

Requisition: AOC 607  
Contract No.: 2906-001-13-300-00  
Project: Navy Base Charleston, Zone F  
Sampled By: Client  
Code: 145890713

REPORT OF RESULTS

Page 1

LOG NO	SAMPLE DESCRIPTION , AIR SAMPLES	DATE/ TIME SAMPLED
14340-1	NBCF/607INVAP05	06-30-99/09:20
PARAMETER	14340-1	
Volatile Organics (EPA-18)		
trans-1,2-Dichloroethene, mg/m3		25U
cis-1,2-Dichloroethene, mg/m3		26
Trichloroethene, mg/m3		30
Tetrachloroethene, mg/m3		920
Prep Date		06.30.99
Analysis Date		06.30.99
Batch ID		1C0630
Dilution Factor		25

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LOG NO: S9-14340  
Received: 01 JUL 99  
Reported: 13 JUL 99

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935 Houston Northcutt, Suite 113  
Mt. Pleasant, SC 29464

Client PO. No.: 2/REL71

Requisition: AOC 607  
Contract No.: 2906-001-13-300-00  
Project: Navy Base Charleston, Zone F  
Sampled By: Client  
Code: 145890713

## REPORT OF RESULTS

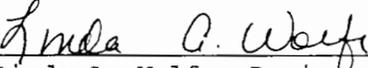
Page 2

LOG NO SAMPLE DESCRIPTION , QC REPORT FOR AIR SAMPLES

14340-2 Method Blank  
14340-3 Lab Control Standard % Recovery

PARAMETER	14340-2	14340-3
Volatile Organics (EPA-18)		
trans-1,2-Dichloroethene, mg/m3	1.0U	---
cis-1,2-Dichloroethene, mg/m3	1.0U	---
Trichloroethene, mg/m3	1.0U	122 %
Tetrachloroethene, mg/m3	1.0U	---
Prep Date	06.30.99	---
Analysis Date	06.30.99	---
Batch ID	1C0630	---
Dilution Factor	1.0	---

Methods: EPA-18

  
Linda A. Wolfe, Project Manager

Final Page Of Report

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LOG NO: S9-14372  
Received: 02 JUL 99  
Reported: 21 JUL 99

Mr. Charlie Vernoy  
EnSafe, Inc.  
935 Houston Northcutt, Suite 113  
Mt. Pleasant, SC 29464

Client PO. No.: 2/REL71

Requisition: AOC 607  
Contract No.: 2906-001-13-300-00  
Project: Navy Base Charleston, Zone F  
Sampled By: Client  
Code: 112590721

REPORT OF RESULTS

Page 1

LOG NO	SAMPLE DESCRIPTION , AIR SAMPLES	DATE/ TIME SAMPLED
14372-1	NBCF/607INVAP06	07-01-99/08:15
PARAMETER	14372-1	
Volatile Organics (EPA-18)		
Vinyl chloride, mg/m3		25U
trans-1,2-Dichloroethene, mg/m3		25U
cis-1,2-Dichloroethene, mg/m3		25U
Trichloroethene, mg/m3		25U
Tetrachloroethene, mg/m3		680
Prep Date		07.02.99
Analysis Date		07.02.99
Batch ID		1C0702
Dilution Factor		25

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LOG NO: S9-14372  
 Received: 02 JUL 99  
 Reported: 21 JUL 99

Mr. Charlie Vernoy  
 EnSafe, Inc.  
 935 Houston Northcutt, Suite 113  
 Mt. Pleasant, SC 29464

Client PO. No.: 2/REL71

Requisition: AOC 607  
 Contract No.: 2906-001-13-300-00  
 Project: Navy Base Charleston, Zone F  
 Sampled By: Client  
 Code: 112590721

REPORT OF RESULTS

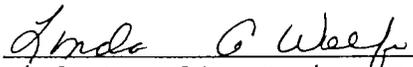
Page 2

LOG NO SAMPLE DESCRIPTION , QC REPORT FOR AIR SAMPLES

14372-2 Method Blank  
 14372-3 Lab Control Standard % Recovery

PARAMETER	14372-2	14372-3
Volatile Organics (EPA-18)		
Vinyl chloride, mg/m3	1.0U	---
trans-1,2-Dichloroethene, mg/m3	1.0U	---
cis-1,2-Dichloroethene, mg/m3	1.0U	---
Trichloroethene, mg/m3	1.0U	123 %
Tetrachloroethene, mg/m3	1.0U	---
Prep Date	07.02.99	07.02.99
Analysis Date	07.02.99	07.02.99
Batch ID	1C0702	1C0702
Dilution Factor	1.0	1.0

Methods: EPA-18

  
 Linda A. Wolfe, Project Manager



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LOG NO: S9-14415  
Received: 03 JUL 99  
Reported: 21 JUL 99

Mr. Charlie Vernoy  
EnSafe, Inc.  
935 Houston Northcutt, Suite 113  
Mt. Pleasant, SC 29464

Client PO. No.: 2/REL71

Requisition: AOC 607  
Contract No.: 2906-001-13-300-00  
Project: Navy Base Charleston, Zone F  
Sampled By: Client  
Code: 112590721

REPORT OF RESULTS

Page 1

LOG NO	SAMPLE DESCRIPTION , AIR SAMPLES	DATE/ TIME SAMPLED
14415-1	NBCF/607INVAP07	07-02-99/10:15
PARAMETER		14415-1
Volatile Organics (EPA-18)		
Vinyl chloride, mg/m3		25U
trans-1,2-Dichloroethene, mg/m3		25U
cis-1,2-Dichloroethene, mg/m3		25U
Trichloroethene, mg/m3		48
Tetrachloroethene, mg/m3		470
Prep Date		07.09.99
Analysis Date		07.09.99
Batch ID		1C0709
Dilution Factor		25

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LOG NO: S9-14415  
 Received: 03 JUL 99  
 Reported: 21 JUL 99

Mr. Charlie Vernoy  
 EnSafe, Inc.  
 935 Houston Northcutt, Suite 113  
 Mt. Pleasant, SC 29464

Client PO. No.: 2/REL71

Requisition: AOC 607  
 Contract No.: 2906-001-13-300-00  
 Project: Navy Base Charleston, Zone F  
 Sampled By: Client  
 Code: 112590721

REPORT OF RESULTS

Page 2

LOG NO SAMPLE DESCRIPTION , QC REPORT FOR AIR SAMPLES

14415-2 Method Blank  
 14415-3 Lab Control Standard % Recovery

PARAMETER	14415-2	14415-3
Volatile Organics (EPA-18)		
Vinyl chloride, mg/m3	1.0U	---
trans-1,2-Dichloroethene, mg/m3	1.0U	---
cis-1,2-Dichloroethene, mg/m3	1.0U	---
Trichloroethene, mg/m3	1.0U	108 %
Tetrachloroethene, mg/m3	1.0U	---
Prep Date	07.09.99	07.09.99
Analysis Date	07.09.99	07.09.99
Batch ID	1C0709	1C0709
Dilution Factor	1.0	1.0

Methods: EPA-18

  
 Linda A. Wolfe, Project Manager

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LOG NO: S9-14481  
Received: 08 JUL 99  
Reported: 21 JUL 99

Mr. Charlie Vernoy  
EnSafe, Inc.  
935 Houston Northcutt, Suite 113  
Mt. Pleasant, SC 29464

Client PO. No.: 2/REL71

Requisition: AOC 607  
Contract No.: 2906-001-13-300-00  
Project: Navy Base Charleston, Zone F  
Sampled By: Client  
Code: 112590721

## REPORT OF RESULTS

Page 1

LOG NO	SAMPLE DESCRIPTION , AIR SAMPLES	DATE/ TIME SAMPLED
14481-1	NBCF/607INVAP08	07-07-99/10:45
PARAMETER	14481-1	
Volatile Organics (EPA-18)		
Vinyl chloride, mg/m3		25U
trans-1,2-Dichloroethene, mg/m3		25U
cis-1,2-Dichloroethene, mg/m3		25U
Trichloroethene, mg/m3		25U
Tetrachloroethene, mg/m3		360
Prep Date		07.09.99
Analysis Date		07.09.99
Batch ID		1C0709
Dilution Factor		25

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LOG NO: S9-14481  
 Received: 08 JUL 99  
 Reported: 21 JUL 99

Mr. Charlie Vernoy  
 EnSafe, Inc.  
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 Mt. Pleasant, SC 29464

Client PO. No.: 2/REL71

Requisition: AOC 607  
 Contract No.: 2906-001-13-300-00  
 Project: Navy Base Charleston, Zone F  
 Sampled By: Client  
 Code: 112590721

REPORT OF RESULTS

Page 2

LOG NO SAMPLE DESCRIPTION , QC REPORT FOR AIR SAMPLES

14481-2 Method Blank  
 14481-3 Lab Control Standard % Recovery

PARAMETER	14481-2	14481-3
Volatile Organics (EPA-18)		
Vinyl chloride, mg/m3	1.0U	---
trans-1,2-Dichloroethene, mg/m3	1.0U	---
cis-1,2-Dichloroethene, mg/m3	1.0U	---
Trichloroethene, mg/m3	1.0U	108 %
Tetrachloroethene, mg/m3	1.0U	---
Prep Date	07.09.99	07.09.99
Analysis Date	07.09.99	07.09.99
Batch ID	1C0709	1C0709
Dilution Factor	1.0	1.0

Methods: EPA-18

*Linda A. Wolfe*  
 Linda A. Wolfe, Project Manager

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Mr. Charlie Vernoy  
EnSafe, Inc.  
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Mt. Pleasant, SC 29464

LOG NO: S9-14709  
Received: 16 JUL 99  
Reported: 30 JUL 99  
Revised: 09 AUG 99 (1)  
Client PO. No.: 2/REL71

Requisition: AOC 607  
Contract No.: 2906-001-13-300-00  
Project: Navy Base Charleston, Zone F  
Sampled By: Client  
Code: 12119089

## REPORT OF RESULTS

Page 1

LOG NO	SAMPLE DESCRIPTION , AIR SAMPLES	DATE/ TIME SAMPLED
14709-1	NBCF/607INVAP09	07-15-99/14:30
14709-1-DL	NBCF/607INVAP09	07-15-99/14:30
PARAMETER	14709-1	14709-1-DL
Volatile Organics (EPA-18)		
Vinyl chloride, mg/m3	<2.0	<50
1,1-Dichloroethene, mg/m3	<1.0	<25
Trichloroethene, mg/m3	3.9	<25
Tetrachloroethene, mg/m3	120E	270
trans-1,2-Dichloroethene, mg/m3	<1.0	<25
cis-1,2-Dichloroethene, mg/m3	4.6	<25
Prep Date	07.16.99	07.16.99
Analysis Date	07.16.99	07.16.99
Batch ID	1C0716	1C0716
Dilution Factor	1.0	25

Mr. Charlie Vernoy  
 EnSafe, Inc.  
 935 Houston Northcutt, Suite 113  
 Mt. Pleasant, SC 29464

LOG NO: S9-14709  
 Received: 16 JUL 99  
 Reported: 30 JUL 99  
 Revised: 09 AUG 99 (1)  
 Client PO. No.: 2/REL71

Requisition: AOC 607  
 Contract No.: 2906-001-13-300-00  
 Project: Navy Base Charleston, Zone F  
 Sampled By: Client  
 Code: 12119089

REPORT OF RESULTS

Page 2

LOG NO SAMPLE DESCRIPTION , QC REPORT FOR AIR SAMPLES

14709-2 Method Blank  
 14709-3 Lab Control Standard % Recovery

PARAMETER	14709-2	14709-3
Volatile Organics (EPA-18)		
Vinyl chloride, mg/m3	<2.0	---
1,1-Dichloroethene, mg/m3	<1.0	94 %
Trichloroethene, mg/m3	<1.0	---
Tetrachloroethene, mg/m3	<1.0	---
trans-1,2-Dichloroethene, mg/m3	<1.0	---
cis-1,2-Dichloroethene, mg/m3	<1.0	---
Prep Date	07.16.99	07.16.99
Analysis Date	07.16.99	07.16.99
Batch ID	1C0716	1C0716
Dilution Factor	1.0	1.0

Methods: EPA-18

Linda A. Wolfe  
 Linda A. Wolfe, Project Manager

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EnSafe, Inc.  
935 Houston Northcutt, Suite 113  
Mt. Pleasant, SC 29464

LOG NO: S9-14792  
Received: 21 JUL 99  
Reported: 30 JUL 99  
Revised: 09 AUG 99 (1)  
Client PO. No.: 2/REL71

Requisition: AOC 607  
Contract No.: 2906-001-13-300-00  
Project: Navy Base Charleston, Zone F  
Sampled By: Client  
Code: 12119089

## REPORT OF RESULTS

Page 1

LOG NO	SAMPLE DESCRIPTION , AIR SAMPLES	DATE/ TIME SAMPLED
14792-1	NBCF/607INVAP10	07-20-99/14:50
14792-1-DL	NBCF/607INVAP10	07-20-99/14:50

PARAMETER	14792-1	14792-1-DL
Volatile Organics (EPA-18)		
Vinyl chloride, mg/m3	<2.0	<4.0
1,1-Dichloroethene, mg/m3	<1.0	<2.0
Trichloroethene, mg/m3	1.7	2.5
Tetrachloroethene, mg/m3	50E	79
trans-1,2-Dichloroethene, mg/m3	<1.0	<2.0
cis-1,2-Dichloroethene, mg/m3	1.7	<2.0
Prep Date	07.22.99	07.22.99
Analysis Date	07.22.99	07.22.99
Batch ID	1C0722	1C0722
Dilution Factor	1.0	2.0

Mr. Charlie Vernoy  
 EnSafe, Inc.  
 935 Houston Northcutt, Suite 113  
 Mt. Pleasant, SC 29464

LOG NO: S9-14792  
 Received: 21 JUL 99  
 Reported: 30 JUL 99  
 Revised: 09 AUG 99 (1)  
 Client PO. No.: 2/REL71

Requisition: AOC 607  
 Contract No.: 2906-001-13-300-00  
 Project: Navy Base Charleston, Zone F  
 Sampled By: Client  
 Code: 12119089

REPORT OF RESULTS

Page 2

LOG NO SAMPLE DESCRIPTION , QC REPORT FOR AIR SAMPLES

14792-2 Method Blank  
 14792-3 Lab Control Standard % Recovery

PARAMETER	14792-2	14792-3
Volatile Organics (EPA-18)		
Vinyl chloride, mg/m3	<2.0	---
1,1-Dichloroethene, mg/m3	<1.0	110 %
Trichloroethene, mg/m3	<1.0	---
Tetrachloroethene, mg/m3	<1.0	---
trans-1,2-Dichloroethene, mg/m3	<1.0	---
cis-1,2-Dichloroethene, mg/m3	<1.0	---
Prep Date	07.22.99	07.22.99
Analysis Date	07.22.99	07.22.99
Batch ID	1C0722	1C0722
Dilution Factor	1.0	1.0

Methods: EPA-18

Linda A. Wolfe  
 Linda A. Wolfe, Project Manager

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LOG NO: S9-15000  
 Received: 29 JUL 99  
 Reported: 11 AUG 99

Mr. Charlie Vernoy  
 EnSafe, Inc.  
 935 Houston Northcutt, Suite 113  
 Mt. Pleasant, SC 29464

Client PO. No.: 2/REL71

Requisition: AOC 607  
 Contract No.: 2906-001-13-300-00  
 Project: Navy Base Charleston, Zone F  
 Sampled By: Client  
 Code: 115190811

REPORT OF RESULTS

Page 1

LOG NO	SAMPLE DESCRIPTION , AIR SAMPLES	DATE/ TIME SAMPLED
15000-1	NBCF/607INVAP11	07-28-99/16:25
15000-1-DL	NBCF/607INVAP11	07-28-99/16:25

PARAMETER	15000-1	15000-1-DL
Volatile Organics (EPA-18)		
Vinyl chloride, mg/m3	2.0U	20U
trans-1,2-Dichloroethene, mg/m3	1.0U	10U
cis-1,2-Dichloroethene, mg/m3	5.0	10U
Trichloroethene, mg/m3	1.5	10U
Tetrachloroethene, mg/m3	87E	170
Prep Date	08.02.99	08.02.99
Analysis Date	08.02.99	08.02.99
Batch ID	1C0802	1C0802
Dilution Factor	1.0	1.0

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LOG NO: S9-15000  
Received: 29 JUL 99  
Reported: 11 AUG 99

Mr. Charlie Vernoy  
EnSafe, Inc.  
935 Houston Northcutt, Suite 113  
Mt. Pleasant, SC 29464

Client PO. No.: 2/REL71

Requisition: AOC 607  
Contract No.: 2906-001-13-300-00  
Project: Navy Base Charleston, Zone F  
Sampled By: Client  
Code: 115190811

## REPORT OF RESULTS

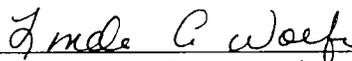
Page 2

LOG NO SAMPLE DESCRIPTION , QC REPORT FOR AIR SAMPLES

15000-2 Method Blank  
15000-3 Lab Control Standard % Recovery

PARAMETER	15000-2	15000-3
Volatile Organics (EPA-18)		
Vinyl chloride, mg/m3	2.0U	---
trans-1,2-Dichloroethene, mg/m3	1.0U	---
cis-1,2-Dichloroethene, mg/m3	1.0U	---
Trichloroethene, mg/m3	1.0U	117 %
Tetrachloroethene, mg/m3	1.0U	---
Prep Date	08.02.99	08.02.99
Analysis Date	08.02.99	08.02.99
Batch ID	1C0802	1C0802
Dilution Factor	1.0	1.0

Methods: EPA-18

  
Linda A. Wolfe, Project Manager

LOG NO: S9-15277  
 Received: 07 AUG 99  
 Reported: 01 SEP 99

Mr. Charlie Vernoy  
 EnSafe, Inc.  
 935 Houston Northcutt, Suite 113  
 Mt. Pleasant, SC 29464

Client PO. No.: 2/REL71

Requisition: AOC 607  
 Contract No.: 2906-001-13-300-00  
 Project: Navy Base Charleston, Zone F  
 Sampled By: Client  
 Code: 16339092

REPORT OF RESULTS

Page 1

LOG NO	SAMPLE DESCRIPTION , AIR SAMPLES	DATE/ TIME SAMPLED
15277-1	NBCF/607INVAP12	08-06-99/14:05
15277-1-DL	NBCF/607INVAP12	08-06-99/14:05

PARAMETER	15277-1	15277-1-DL
Volatile Organics (EPA-18)		
Vinyl chloride, mg/m3	2.0U	10U
trans-1,2-Dichloroethene, mg/m3	1.0U	5.0U
cis-1,2-Dichloroethene, mg/m3	2.4	5.0U
Trichloroethene, mg/m3	3.0	5.0U
Tetrachloroethene, mg/m3	120E	23X
Dilution Factor	1.0	5.0
Analysis Date	08.13.99	08.18.99
Batch ID	1C0813	1C0818

LOG NO: S9-15277  
 Received: 07 AUG 99  
 Reported: 01 SEP 99

Mr. Charlie Vernoy  
 EnSafe, Inc.  
 935 Houston Northcutt, Suite 113  
 Mt. Pleasant, SC 29464

Client PO. No.; 2/REL71

Requisition: AOC 607  
 Contract No.: 2906-001-13-300-00  
 Project: Navy Base Charleston, Zone F  
 Sampled By: Client  
 Code: 16339092

REPORT OF RESULTS

Page 2

LOG NO	SAMPLE DESCRIPTION , QC REPORT FOR AIR SAMPLES	DATE/ TIME SAMPLED
15277-2	Method Blank	
15277-3	Lab Control Standard % Recovery	
PARAMETER	15277-2	15277-3
Volatile Organics (EPA-18)		
Vinyl chloride, mg/m3	2.0U	---
trans-1,2-Dichloroethene, mg/m3	1.0U	---
cis-1,2-Dichloroethene, mg/m3	1.0U	---
Trichloroethene, mg/m3	1.0U	113 %
Tetrachloroethene, mg/m3	1.0U	---
Dilution Factor	1.0	1.0
Analysis Date	08.13.99	08.13.99
Batch ID	1C0813	1C0813

Methods: EPA-18

X = After sampling, the small canisters are returned to STL-SL at ambient pressure. As sample is removed, a vacuum is created in the canister. If the system does not properly seal, ambient air may be drawn into the canister, effectively diluting the sample. Subsequent analyses from this canister would result in lower concentrations than the original analysis. Over a period of time, a leak could cause the contents of the canister to equilibrate with ambient air, which would result in loss of the analytes.

*Linda A. Wolfe*  
 Linda A. Wolfe, Project Manager

LOG NO: S9-15421  
 Received: 13 AUG 99  
 Reported: 01 SEP 99

Mr. Charlie Vernoy  
 EnSafe, Inc.  
 935 Houston Northcutt, Suite 113  
 Mt. Pleasant, SC 29464

Client PO. No.: 2/REL71

Requisition: AOC 607  
 Contract No.: 2906-001-13-300-00  
 Project: Navy Base Charleston, Zone F  
 Sampled By: Client  
 Code: 16419092

REPORT OF RESULTS

Page 1

LOG NO	SAMPLE DESCRIPTION , AIR SAMPLES	DATE/ TIME SAMPLED
15421-1	NBCF/607INVAP13	08-12-99
15421-1-DL	NBCF/607INVAP13	08-12-99

PARAMETER	15421-1	15421-1-DL
Volatile Organics (EPA-18)		
Vinyl chloride, mg/m3	2.0U	10U
trans-1,2-Dichloroethene, mg/m3	1.0U	5.0U
cis-1,2-Dichloroethene, mg/m3	4.2	5.0U
Trichloroethene, mg/m3	4.6	5.0U
Tetrachloroethene, mg/m3	99E	19X
Dilution Factor	1.0	1.0
Analysis Date	08.13.99	08.13.99
Batch ID	1C0813	1C0813

LOG NO: S9-15421  
 Received: 13 AUG 99  
 Reported: 01 SEP 99

Mr. Charlie Vernoy  
 EnSafe, Inc.  
 935 Houston Northcutt, Suite 113  
 Mt. Pleasant, SC 29464

Client PO. No.: 2/REL71

Requisition: AOC 607  
 Contract No.: 2906-001-13-300-00  
 Project: Navy Base Charleston, Zone F  
 Sampled By: Client  
 Code: 16419092

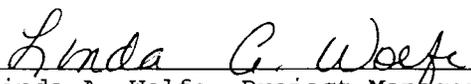
REPORT OF RESULTS

Page 2

LOG NO	SAMPLE DESCRIPTION , QC REPORT FOR AIR SAMPLES	DATE/ TIME SAMPLED
15421-2	Method Blank	
15421-3	Lab Control Standard % Recovery	
PARAMETER	15421-2	15421-3
Volatile Organics (EPA-18)		
Vinyl chloride, mg/m3	2.0U	---
trans-1,2-Dichloroethene, mg/m3	1.0U	---
cis-1,2-Dichloroethene, mg/m3	1.0U	---
Trichloroethene, mg/m3	1.0U	113 %
Tetrachloroethene, mg/m3	1.0U	---
Dilution Factor	1.0	---
Analysis Date	08.13.99	08.13.99
Batch ID	1C0813	1C0813

Methods: EPA 18

X = After sampling, the small canisters are returned to STL-SL at ambient pressure. As sample is removed, a vacuum is created in the canister. If the system does not properly seal, ambient air may be drawn into the canister, effectively diluting the sample. Subsequent analyses from this canister would result in lower concentrations than the original analysis. Over a period of time, a leak could cause the contents of the canister to equilibrate with ambient air, which would result in loss of the analytes.

  
 Linda A. Wolfe, Project Manager

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LOG NO: S9-15601  
Received: 20 AUG 99  
Reported: 02 SEP 99

Mr. Charlie Vernoy  
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935 Houston Northcutt, Suite 113  
Mt. Pleasant, SC 29464

Client PO. No.: 2/REL71

Requisition: AOC 607  
Contract No.: 2906-001-13-300-00  
Project: Navy Base Charleston, Zone F  
Sampled By: Client  
Code: 10039092

REPORT OF RESULTS

Page 1

LOG NO	SAMPLE DESCRIPTION , AIR SAMPLES	DATE/ TIME SAMPLED
15601-1	NBCF/607INVAP14	08-19-99/13:05
15601-1-DL	NBCF/607INVAP14	08-19-99/13:05
PARAMETER	15601-1	15601-1-DL
Volatile Organics (EPA-18)		
Vinyl chloride, mg/m3	2.0U	20U
trans-1,2-Dichloroethene, mg/m3	1.0U	10U
cis-1,2-Dichloroethene, mg/m3	3.2	10U
Trichloroethene, mg/m3	4.0	10U
Tetrachloroethene, mg/m3	110E	110D
Dilution Factor	1.0	10.0
Analysis Date	08.21.99	08.21.99
Batch ID	1C0820	1C0820

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LOG NO: S9-15601  
Received: 20 AUG 99  
Reported: 02 SEP 99

Mr. Charlie Vernoy  
EnSafe, Inc.  
935 Houston Northcutt, Suite 113  
Mt. Pleasant, SC 29464

Client PO. No.: 2/REL71

Requisition: AOC 607  
Contract No.: 2906-001-13-300-00  
Project: Navy Base Charleston, Zone F  
Sampled By: Client  
Code: 10039092

## REPORT OF RESULTS

Page 2

LOG NO SAMPLE DESCRIPTION , QC REPORT FOR AIR SAMPLES

-----  
15601-2 Method Blank  
15601-3 Lab Control Standard % Recovery  
-----

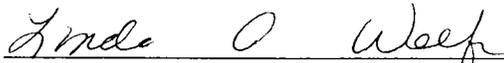
PARAMETER 15601-2 15601-3

-----  
Volatile Organics (EPA-18)

Vinyl chloride, mg/m3	2.0U	---
trans-1,2-Dichloroethene, mg/m3	1.0U	---
cis-1,2-Dichloroethene, mg/m3	1.0U	---
Trichloroethene, mg/m3	1.0U	119 %
Tetrachloroethene, mg/m3	1.0U	---
Dilution Factor	1.0	1.0
Analysis Date	08.20.99	08.20.99
Batch ID	1C0820	1C0820

-----

Methods: EPA-18

  
Linda A. Wolfe, Project Manager

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LOG NO: S9-15862  
 Received: 01 SEP 99  
 Reported: 21 SEP 99

Mr. Charlie Vernoy  
 EnSafe, Inc.  
 935 Houston Northcutt, Suite 113  
 Mt. Pleasant, SC 29464

Client PO. No.: 2/REL71

Requisition: AOC 607  
 Contract No.: 2906-001-13-300-00  
 Project: Navy Base Charleston, Zone F  
 Sampled By: Client  
 Code: 141790921

REPORT OF RESULTS

Page 1

LOG NO	SAMPLE DESCRIPTION , AIR SAMPLES	DATE/ TIME SAMPLED
15862-1	GPVE3	08-26-99/12:35
15862-2	GPVE2	08-26-99/12:45
15862-3	GPVE1	08-26-99/12:50
15862-4	BEGIN30VAC	08-27-99/13:00
15862-4-DL	BEGIN30VAC	08-27-99/13:00

PARAMETER	15862-1	15862-2	15862-3	15862-4	15862-4-DL
Volatile Organics (EPA-18)					
Vinyl chloride, mg/m3	2.0U	2.0U	2.0U	2.0U	20U
trans-1,2-Dichloroethene, mg/m3	1.0U	1.0U	1.0U	1.0U	10U
cis-1,2-Dichloroethene, mg/m3	1.0U	1.0U	1.0U	1.0U	10U
Trichloroethene, mg/m3	1.0U	1.0U	1.0U	18	18D
Tetrachloroethene, mg/m3	1.0U	1.0U	1.0U	260E	240D
Dilution Factor	1.0	1.0	1.0	1.0	10.0
Analysis Date	09.08.99	09.08.99	09.08.99	09.08.99	09.09.99
Batch ID	1C0908	1C0908	1C0908	1C0908	1C0908

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LOG NO: S9-15862  
Received: 01 SEP 99  
Reported: 21 SEP 99

Mr. Charlie Vernoy  
EnSafe, Inc.  
935 Houston Northcutt, Suite 113  
Mt. Pleasant, SC 29464

Client PO. No.: 2/REL71

Requisition: AOC 607  
Contract No.: 2906-001-13-300-00  
Project: Navy Base Charleston, Zone F  
Sampled By: Client  
Code: 141790921

REPORT OF RESULTS

Page 2

LOG NO	SAMPLE DESCRIPTION , AIR SAMPLES	DATE/ TIME SAMPLED
15862-5	MID30VAC	08-27-99/23:00
15862-5-DL	MID30VAC	08-27-99/23:00
15862-6	END30VAC	08-28-99/09:45
15862-7	1ST DRAW	08-28-99/16:15
15862-8	2ND DRAW	09-29-99/09:20

PARAMETER	15862-5	15862-5-DL	15862-6	15862-7	15862-8
Volatile Organics (EPA-18)					
Vinyl chloride, mg/m3	2.0U	20U	50U	2.0U	2.0U
trans-1,2-Dichloroethene, mg/m3	1.0U	10U	25U	1.0U	1.0U
cis-1,2-Dichloroethene, mg/m3	1.0U	10U	25U	1.0U	1.0U
Trichloroethene, mg/m3	20	10D	25U	1.6	1.0U
Tetrachloroethene, mg/m3	290E	210D	480	34	17
Dilution Factor	1.0	10.0	25.0	1.0	1.0
Analysis Date	09.09.99	09.10.99	09.10.99	09.09.99	09.09.99
Batch ID	1C0908	1C0910	1C0910	1C0908	1C0908

LOG NO: S9-15862  
 Received: 01 SEP 99  
 Reported: 21 SEP 99

Mr. Charlie Vernoy  
 EnSafe, Inc.  
 935 Houston Northcutt, Suite 113  
 Mt. Pleasant, SC 29464

Client PO. No.: 2/REL71

Requisition: AOC 607  
 Contract No.: 2906-001-13-300-00  
 Project: Navy Base Charleston, Zone F  
 Sampled By: Client  
 Code: 141790921

REPORT OF RESULTS

Page 3

LOG NO	SAMPLE DESCRIPTION , AIR SAMPLES	DATE/ TIME SAMPLED
15862-9	3RD DRAW	08-29-99/18:25
15862-10	4TH DRAW	08-30-99/09:15
15862-11	5TH DRAW	08-30-99/18:58
15862-11-DL	5TH DRAW	08-30-99/18:58

PARAMETER	15862-9	15862-10	15862-11	15862-11-DL
Volatile Organics (EPA-18)				
Vinyl chloride, mg/m3	2.0U	2.0U	2.4	4.0U
trans-1,2-Dichloroethene, mg/m3	1.0U	1.0U	1.0U	2.0U
cis-1,2-Dichloroethene, mg/m3	1.0U	1.0U	1.0U	2.0U
Trichloroethene, mg/m3	1.0U	1.0U	16	9.3D
Tetrachloroethene, mg/m3	22	29	91E	54D
Dilution Factor	1.0	1.0	1.0	2.0
Analysis Date	09.10.99	09.10.99	09.09.99	09.11.99
Batch ID	1C0910	1C0910	1C0908	1C0910

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LOG NO: S9-15862  
Received: 01 SEP 99  
Reported: 21 SEP 99

Mr. Charlie Vernoy  
EnSafe, Inc.  
935 Houston Northcutt, Suite 113  
Mt. Pleasant, SC 29464

Client PO. No.: 2/REL71

Requisition: AOC 607  
Contract No.: 2906-001-13-300-00  
Project: Navy Base Charleston, Zone F  
Sampled By: Client  
Code: 141790921

REPORT OF RESULTS

Page 4

LOG NO	SAMPLE DESCRIPTION , AIR SAMPLES	DATE/ TIME SAMPLED
15862-12	6TH DRAW	08-31-99/08:20

PARAMETER	15862-12
-----	
Volatile Organics (EPA-18)	
Vinyl chloride, mg/m3	20U
trans-1,2-Dichloroethene, mg/m3	10U
cis-1,2-Dichloroethene, mg/m3	10U
Trichloroethene, mg/m3	10U
Tetrachloroethene, mg/m3	91
Dilution Factor	10.0
Analysis Date	09.11.99
Batch ID	1C0911
-----	

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LOG NO: S9-15862  
Received: 01 SEP 99  
Reported: 21 SEP 99

Mr. Charlie Vernoy  
EnSafe, Inc.  
935 Houston Northcutt, Suite 113  
Mt. Pleasant, SC 29464

Client PO. No.: 2/REL71

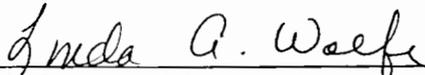
Requisition: AOC 607  
Contract No.: 2906-001-13-300-00  
Project: Navy Base Charleston, Zone F  
Sampled By: Client  
Code: 141790921

REPORT OF RESULTS

Page 5

LOG NO	SAMPLE DESCRIPTION , QC REPORT FOR AIR SAMPLES	DATE/ TIME SAMPLED
15862-13	Method Blank	
15862-14	Lab Control Standard % Recovery	
PARAMETER	15862-13	15862-14
Volatile Organics (EPA-18)		
Vinyl chloride, mg/m3	2.0U	---
trans-1,2-Dichloroethene, mg/m3	1.0U	---
cis-1,2-Dichloroethene, mg/m3	1.0U	---
Trichloroethene, mg/m3	1.0U	97 %
Tetrachloroethene, mg/m3	1.0U	---
Dilution Factor	1.0	1.0
Analysis Date	09.08.99	09.08.99
Batch ID	1C0908	1C0908

Methods: EPA 18

  
Linda A. Wolfe, Project Manager

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LOG NO: S9-15975  
 Received: 04 SEP 99  
 Reported: 21 SEP 99

Mr. Charlie Vernoy  
 EnSafe, Inc.  
 935 Houston Northcutt, Suite 113  
 Mt. Pleasant, SC 29464

Client PO. No.: 2/REL71

Requisition: AOC 607  
 Contract No.: 2906-001-13-300-00  
 Project: Navy Base Charleston, Zone F  
 Sampled By: Client  
 Code: 152290921

REPORT OF RESULTS

Page 1

LOG NO	SAMPLE DESCRIPTION , AIR SAMPLES	DATE/ TIME SAMPLED
15975-1	07THDRAW	08-31-99/18:15
15975-1-DL	07THDRAW	08-31-99/18:15
15975-2	08THDRAW	09-01-99/08:45
15975-2-DL	08THDRAW	09-01-99/08:45
15975-3	09THDRAW	09-01-99/18:35

PARAMETER	15975-1	15975-1-DL	15975-2	15975-2-DL	15975-3
Volatile Organics (EPA-18)					
Vinyl chloride, mg/m3	2.0U	20U	2.0U	20U	2.0U
trans-1,2-Dichloroethene, mg/m3	1.0U	10U	1.0U	10U	1.0U
cis-1,2-Dichloroethene, mg/m3	1.0U	10U	1.0U	10U	1.0U
Trichloroethene, mg/m3	3.5	10U	3.4	10U	2.6
Tetrachloroethene, mg/m3	310E	78	340E	85	260E
Dilution Factor	1.0	10.0	1.0	10.0	1.0
Analysis Date	09.13.99	09.17.99	09.13.99	09.18.99	09.14.99
Batch ID	1C0913	1C0917	1C0913	1C0917	1C0913

LOG NO: S9-15975  
 Received: 04 SEP 99  
 Reported: 21 SEP 99

Mr. Charlie Vernoy  
 EnSafe, Inc.  
 935 Houston Northcutt, Suite 113  
 Mt. Pleasant, SC 29464

Client PO. No.: 2/REL71

Requisition: AOC 607  
 Contract No.: 2906-001-13-300-00  
 Project: Navy Base Charleston, Zone F  
 Sampled By: Client  
 Code: 152290921

REPORT OF RESULTS

Page 2

LOG NO	SAMPLE DESCRIPTION , AIR SAMPLES	DATE/ TIME SAMPLED
15975-3-DL	09THDRAW	09-01-99/18:35
15975-4	10THDRAW	09-02-99/08:15
15975-4-DL	10THDRAW	09-02-99/08:15
15975-5	11THDRAW	09-02-99/19:30
15975-5-DL	11THDRAW	09-02-99/19:30

PARAMETER	15975-3-DL	15975-4	15975-4-DL	15975-5	15975-5-DL
Volatile Organics (EPA-18)					
Vinyl chloride, mg/m3	20U	2.0U	20U	2.0U	20U
trans-1,2-Dichloroethene, mg/m3	10U	1.0U	10U	1.0U	10U
cis-1,2-Dichloroethene, mg/m3	10U	1.0U	10U	1.0U	10U
Trichloroethene, mg/m3	10U	2.0	10U	2.6	10U
Tetrachloroethene, mg/m3	57	210E	110	280E	77
Dilution Factor	10.0	1.0	10.0	1.0	10.0
Analysis Date	09.18.99	09.14.99	09.18.99	09.14.99	09.18.99
Batch ID	1C0917	1C0913	1C0917	1C0913	1C0917

LOG NO: S9-15975  
 Received: 04 SEP 99  
 Reported: 21 SEP 99

Mr. Charlie Vernoy  
 EnSafe, Inc.  
 935 Houston Northcutt, Suite 113  
 Mt. Pleasant, SC 29464

Client PO. No.: 2/REL71

Requisition: AOC 607  
 Contract No.: 2906-001-13-300-00  
 Project: Navy Base Charleston, Zone F  
 Sampled By: Client  
 Code: 152290921

REPORT OF RESULTS

Page 3

LOG NO	SAMPLE DESCRIPTION , AIR SAMPLES	DATE/ TIME SAMPLED
15975-6	12THDRAW	09-03-99/08:15
15975-6-DL	12THDRAW	09-03-99/08:15
15975-7	NBCF607INVAP15	09-03-99/16:30
15975-7-DL	NBCF607INVAP15	09-03-99/16:30

PARAMETER	15975-6	15975-6-DL	15975-7	15975-7-DL
Volatile Organics (EPA-18)				
Vinyl chloride, mg/m3	2.0U	20U	2.0U	20U
trans-1,2-Dichloroethene, mg/m3	1.0U	10U	1.0U	10U
cis-1,2-Dichloroethene, mg/m3	1.0U	10U	1.0U	10U
Trichloroethene, mg/m3	2.9	10U	6.8	10U
Tetrachloroethene, mg/m3	340E	160	180E	68
Dilution Factor	1.0	10.0	1.0	10.0
Analysis Date	09.14.99	09.17.99	09.14.99	09.17.99
Batch ID	1C0913	1C0917	1C0913	1C0917

LOG NO: S9-15975  
 Received: 04 SEP 99  
 Reported: 21 SEP 99

Mr. Charlie Vernoy  
 EnSafe, Inc.  
 935 Houston Northcutt, Suite 113  
 Mt. Pleasant, SC 29464

Client PO. No.: 2/REL71

Requisition: AOC 607  
 Contract No.: 2906-001-13-300-00  
 Project: Navy Base Charleston, Zone F  
 Sampled By: Client  
 Code: 152290921

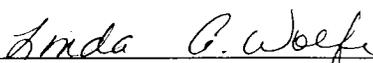
REPORT OF RESULTS

Page 4

LOG NO	SAMPLE DESCRIPTION , QC REPORT FOR AIR SAMPLES	DATE/ TIME SAMPLED
15975-8	Method Blank	
15975-9	Lab Control Standard % Recovery	
PARAMETER	15975-8	15975-9
Volatile Organics (EPA-18)		
Vinyl chloride, mg/m3	2.0U	---
trans-1,2-Dichloroethene, mg/m3	1.0U	---
cis-1,2-Dichloroethene, mg/m3	1.0U	---
Trichloroethene, mg/m3	1.0U	88 %
Tetrachloroethene, mg/m3	1.0U	---
Dilution Factor	1.0	1.0
Analysis Date	09.13.99	09.13.99
Batch ID	1C0913	1C0913

Methods: EPA-18

Note: After sampling, the small canisters are returned to STL-SL at ambient pressure. As sample is removed, a vacuum is created in the canister. If the system does not properly seal, ambient air may be drawn into the canister, effectively diluting the sample. Subsequent analyses from this canister would result in lower concentrations than the original analysis. Over a period of time, a leak could cause the contents of the canister to equilibrate with ambient air, which would result in loss of the analytes.

  
 Linda A. Wolfe, Project Manager

**SL SAVANNAH LABORATORIES**  
 & ENVIRONMENTAL SERVICES, INC.

5102 LaRoche Avenue • Savannah, GA 31404 • (912) 354-7858 • Fax (912) 352-0165 • www.savlabs.com

LOG NO: S9-16089  
 Received: 10 SEP 99  
 Reported: 22 SEP 99

Mr. Charlie Vernoy  
 EnSafe, Inc.  
 935 Houston Northcutt, Suite 113  
 Mt. Pleasant, SC 29464

Client PO. No.: 2/REL71

Requisition: AOC 607  
 Contract No.: 2906-001-13-300-00  
 Project: Navy Base Charleston, Zone F  
 Sampled By: Client  
 Code: 105690922

REPORT OF RESULTS

Page 1

LOG NO	SAMPLE DESCRIPTION , AIR SAMPLES	DATE/ TIME SAMPLED
16089-1	NBCF/607INVAP16	09-09-99/15:10
16089-1-DL	NBCF/607INVAP16	09-09-99/15:10

PARAMETER	16089-1	16089-1-DL
Volatile Organics (EPA-18)		
Vinyl chloride, mg/m3	2.0U	20U
trans-1,2-Dichloroethene, mg/m3	1.0U	10U
cis-1,2-Dichloroethene, mg/m3	1.0U	10U
Trichloroethene, mg/m3	3.2	10U
Tetrachloroethene, mg/m3	170E	54D
Dilution Factor	1.0	10.0
Analysis Date	09.14.99	09.18.99
Batch ID	1C0913	1C0917

LOG NO: S9-16089  
 Received: 10 SEP 99  
 Reported: 22 SEP 99

Mr. Charlie Vernoy  
 EnSafe, Inc.  
 935 Houston Northcutt, Suite 113  
 Mt. Pleasant, SC 29464

Client PO. No.: 2/REL71

Requisition: AOC 607  
 Contract No.: 2906-001-13-300-00  
 Project: Navy Base Charleston, Zone F  
 Sampled By: Client  
 Code: 105690922

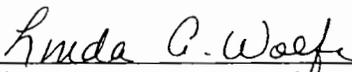
REPORT OF RESULTS

Page 2

LOG NO	SAMPLE DESCRIPTION , QC REPORT FOR AIR SAMPLES	DATE/ TIME SAMPLED
16089-2	Method Blank	
16089-3	Lab Control Standard % Recovery	
PARAMETER	16089-2	16089-3
Volatile Organics (EPA-18)		
Vinyl chloride, mg/m3	2.0U	---
trans-1,2-Dichloroethene, mg/m3	1.0U	---
cis-1,2-Dichloroethene, mg/m3	1.0U	---
Trichloroethene, mg/m3	1.0U	88 %
Tetrachloroethene, mg/m3	1.0U	---
Dilution Factor	1.0	---
Analysis Date	09.13.99	09.13.99
Batch ID	1C0913	1C0913

Methods: EPA-18

Note: After sampling, the small canisters are returned to STL-SL at ambient pressure. As sample is removed, a vacuum is created in the canister. If the system does not properly seal, ambient air may be drawn into the canister, effectively diluting the sample. Subsequent analyses from this canister would result in lower concentrations than the original analysis. Over a period of time, a leak could cause the contents of the canister to equilibrate with ambient air, which would result in loss of the analytes.

  
 Linda A. Wolfe, Project Manager

**SL SAVANNAH LABORATORIES**  
 & ENVIRONMENTAL SERVICES, INC.

5102 LaRoche Avenue • Savannah, GA 31404 • (912) 354-7858 • Fax (912) 352-0165 • www.savlabs.com

LOG NO: S9-16218  
 Received: 18 SEP 99  
 Reported: 04 OCT 99

Mr. Charlie Vernoy  
 EnSafe, Inc.  
 935 Houston Northcutt, Suite 113  
 Mt. Pleasant, SC 29464

Client PO. No.: 2/REL71

Requisition: AOC 607  
 Contract No.: 2906-001-13-300-00  
 Project: Navy Base Charleston, Zone F  
 Sampled By: Client  
 Code: 12009104

REPORT OF RESULTS

Page 1

LOG NO	SAMPLE DESCRIPTION , AIR SAMPLES	DATE/ TIME SAMPLED
16218-1	NBCF/607INVAP17	09-17-99/17:10
16218-1-DL	NBCF/607INVAP17	09-17-99/17:10
PARAMETER	16218-1	16218-1-DL
Volatile Organics (EPA-18)		
Vinyl chloride, mg/m3	1.0U	10U
trans-1,2-Dichloroethene, mg/m3	1.0U	10U
cis-1,2-Dichloroethene, mg/m3	1.0U	10U
Trichloroethene, mg/m3	12	19D
Tetrachloroethene, mg/m3	160E	240D
Dilution Factor	1.0	10
Analysis Date	09.30.99	09.30.99
Batch ID	1C0930	1C0930

# SL SAVANNAH LABORATORIES & ENVIRONMENTAL SERVICES, INC.

5102 LaRoche Avenue • Savannah, GA 31404 • (912) 354-7858 • Fax (912) 352-0165 • www.savlabs.com

LOG NO: S9-16218  
Received: 18 SEP 99  
Reported: 04 OCT 99

Mr. Charlie Vernoy  
EnSafe, Inc.  
935 Houston Northcutt, Suite 113  
Mt. Pleasant, SC 29464

Client PO. No.: 2/REL71

Requisition: AOC 607  
Contract No.: 2906-001-13-300-00  
Project: Navy Base Charleston, Zone F  
Sampled By: Client  
Code: 12009104

## REPORT OF RESULTS

Page 2

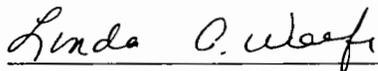
LOG NO SAMPLE DESCRIPTION , QC REPORT FOR AIR SAMPLES

-----  
16218-2 Method Blank  
16218-3 Lab Control Standard % Recovery  
-----

PARAMETER 16218-2 16218-3

-----  
Volatile Organics (EPA-18)  
Vinyl chloride, mg/m3 1.0U ---  
trans-1,2-Dichloroethene, mg/m3 1.0U ---  
cis-1,2-Dichloroethene, mg/m3 1.0U ---  
Trichloroethene, mg/m3 1.0U 84 %  
Tetrachloroethene, mg/m3 1.0U ---  
Dilution Factor 1.0 ---  
Analysis Date 09.30.99 ---  
Batch ID 1C0930 ---  
-----

Methods: EPA-18



Linda A. Wolfe, Project Manager

LOG NO: S9-16237  
 Received: 21 SEP 99  
 Reported: 04 OCT 99

Mr. Charlie Vernoy  
 EnSafe, Inc.  
 935 Houston Northcutt, Suite 113  
 Mt. Pleasant, SC 29464

Client PO. No.: 2/REL71

Requisition: AOC 607  
 Contract No.: 2906-001-13-300-00  
 Project: Navy Base Charleston, Zone F  
 Sampled By: Client  
 Code: 12009104

REPORT OF RESULTS

Page 1

LOG NO	SAMPLE DESCRIPTION , AIR SAMPLES	DATE/ TIME SAMPLED
16237-1	NBCF/607INVAP18	09-20-99/11:00
16237-1-DL	NBCF/607INVAP18	09-20-99/11:00
PARAMETER	16237-1	16237-1-DL
Volatile Organics (EPA-18)		
Vinyl chloride, mg/m3	1.0U	10U
trans-1,2-Dichloroethene, mg/m3	1.0U	10U
cis-1,2-Dichloroethene, mg/m3	1.0U	10U
Trichloroethene, mg/m3	6.9	12D
Tetrachloroethene, mg/m3	100E	150D
Dilution Factor	1.0	10
Analysis Date	09.30.99	09.30.99
Batch ID	1C0930	1C0930

LOG NO: S9-16237  
Received: 21 SEP 99  
Reported: 04 OCT 99

Mr. Charlie Vernoy  
EnSafe, Inc.  
935 Houston Northcutt, Suite 113  
Mt. Pleasant, SC 29464

Client PO. No.: 2/REL71

Requisition: AOC 607  
Contract No.: 2906-001-13-300-00  
Project: Navy Base Charleston, Zone F  
Sampled By: Client  
Code: 12009104

REPORT OF RESULTS

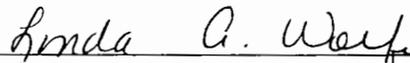
Page 2

LOG NO SAMPLE DESCRIPTION , QC REPORT FOR AIR SAMPLES

-----  
16237-2 Method Blank  
16237-3 Lab Control Standard % Recovery  
-----

PARAMETER	16237-2	16237-3
-----		
Volatile Organics (EPA-18)		
Vinyl chloride, mg/m3	1.0U	---
trans-1,2-Dichloroethene, mg/m3	1.0U	---
cis-1,2-Dichloroethene, mg/m3	1.0U	---
Trichloroethene, mg/m3	1.0U	84 %
Tetrachloroethene, mg/m3	1.0U	---
Dilution Factor	1.0	---
Analysis Date	09.30.99	---
Batch ID	1C0930	---

-----  
Methods: EPA-18

  
-----  
Linda A. Wolfe, Project Manager

**Attachment B-6**

# CROY

ENVIRONMENTAL  
SERVICES, INC.



OEM INSTALLATION  
Site Remediation

October 25, 1999

Mr. Ted Blahnik  
Ensafe, Inc.  
4545 Fuller Drive  
Suite 326  
Irving, Texas 75038

Phone(972)791-3222  
Fax(972)791-0405

RE: Reporting phase of Charleston Navy Base Project

Dear Mr. Blahnik:

This letter report fulfills the final requirement and completes the Croy Environmental Services, Inc. portion of the project at the Navy Base in Charleston, South Carolina. The text summarizes the field portion, and various figures are provided as attachments.

#### Summary of field work

The parameter evaluation testing (PET) phase around Building #1189 occurred during the period Monday, August 23, 1999 through September 20, 1999. Dewatering equipment was modified and the electronic datalogging and telemetry system installed from Monday, August 23<sup>rd</sup> through Thursday, August 26<sup>th</sup>, 1999. A total of eight geoprobes were installed on Thursday, August 26<sup>th</sup>. A 30 hour step test, during which the test well vacuum was increased in 2<sup>nd</sup> Hg increments, was performed on Friday August 27<sup>th</sup> and finished on Saturday, August 28<sup>th</sup>. One of the dewatering points was selected as the extraction well, which was located immediately adjacent to existing monitor well 607-011. The extraction point was 3 feet from the building wall. Geoprobe wells GP-1 and GP-2 were located in a line perpendicular to the wall, extending from on a line from the wall which included the extraction point, monitor well 607-011, GP-1 and GP-2. GP-1 and GP-2 straddled the swale extending from the storm sewer drop inlet, which exists in the parking lot adjacent to the southwest side of the subject building. Samples of the vapor effluent were taken at selected times as prescribed in the scope of work. After the 30-hour test was completed, some of the equipment was relocated and the longer drawdown PET was initiated. The initial well (temporary dewater point #21) was used from 1457 hours on 8/29/99 to 0911 hours on 8/30/99. At that time, the extraction point was moved to the existing 4-inch recovery well due to poor recovery. The 4-inch well was put into operation and continued until 1912 of 8/30/99. Immediately on applying vacuum the 4-inch recovery well did not function normally. Vacuum on the vapor and liquid side was advanced to high initial values on the gauges attached to the wellhead swingarm. Once the initial water from the well annulus was removed, the vacuum remained high and little further water was recovered. After a while the well finally began

to produce. It was thought the well may have been plugged by excessive rotation of the auger on installation, or was installed in a tight clay lens. Several theories could be given for the poor performance, but it was decided that regardless of the reason the well might not suit testing objectives. Therefore the hardware was again switched, this time to dewater point 22, where it remained for the remainder of the testing time. Dewater point 22 was put into operation at 1927 on 8/30/99. Data was recorded during the whole period on the datalogger. Samples of the vapor effluent were taken at prescribed intervals during this test. The long-term PET vapor sampling ended on September 3, 1999. The datalog continued to record and system continued to run until September 20, 1999. Some additional information was acquired on the date using magnahelic vacuum readings, after which all of the equipment was removed.

Additional information gathered on September 20, 1999.

Test well 22 operated with 10" Hg vacuum on the vapor side and 15" vacuum on the waterside. The distance from point 22 and various testing points is as follows:

geoprobe well	GP-3	12' 3"
	GP-6	2' 8"
	GP-5	5' 11"
	GP-8	8' 7"

And direct magnahelic readings in inches of water were GP-6(3.0), GP-5(1.15) and GP-8(1.0). The vacuum was eventually advanced to 20" Hg on the vapor side and 20" Hg on the liquid side, and the readings were GP-6(2.1), GP-5(4.5), GP-8(2.0), and GP-3(0.9)

## HARDWARE SYSTEM

### *Temporary dewater points*

1-1/2 inch PVC well casing, fitted with 9 feet of 0.010inch slotted case. The points have Croy patented 1-inch droptubes inserted into the slotted portion. Points installed had a finished depth of approximately 12 feet, at approximately 5-foot centers along perimeter of building, approximately 3 feet from building edge.

### *Wellpoint connections*

Croy patented CS2400 Dual-Phase vacuum extraction wellhead swingarm

### *Vacuum Manifolds*

6-inch PVC pipe in 20 foot sections, connected with flexible boots.

### *Dual-Phase Vacuum Extraction (DPVE) Unit*

Croy E-series 2 pump unit, w/ transfer pump rate 0-200gpm and vacuum pump 130cfm liquid ring. Skid unit contained Croy 38 gallon knockout tank with flexible valves, make-up water and control box, and a 98 gallon reservoir. Water production monitored by Water Master mechanical totalizer.

### *Treatment (portable stripping tower (DPVE pump mounted onboard))*

Tower height	23 feet w/ TF72C spiral nozzle, 120 degree spray angle
Tower diameter	2.5 feet
Packing height	18 feet
Packing type	2 inch Tri-pack
Blower	1300 cfm American Fan AF-15
Controls	Allen Bradley SLC 150 EEPROM memory module

### *Datalogging*

Sensaphone SCADA 3000, w/ 4-20mA Gem sensors. Vacuum sensor model type 2200BGF1502F3GA 0-15 PSIG and 2200BG3F002F3GA. Dwyer Instruments, Inc. pitot tube Model DS-300 flow sensor, w/ a 604 A-2 4-20mA flow transmitter.

### Probe Calibration

The datalogger/telemetry unit was a Phonetics Sensaphone SCADA 3000. The pressure sensing probes were GEMS transducers, type 2200BG3F002F3GA -15 to 15 PSIG for vacuum pressure and type 2200BGF1502F3GA 0-15 psig for the water levels. The sensors were pre-set for sensitivity range at the factory, and conversion factors for these ranges entered into the software. For both the conversion was supplied by the factory at 14.7psi=30"Hg=34.6'water. Accuracy was checked on arrival at the site using a Solinst water level indicator, and vacuum probes were checked for accuracy compared to an Ashcroft 0-30("Hg) vacuum gauge. All sensors yielded readings consistent with factory applied product labels.

### Geoprobe Installation

In accordance with a request by DHEC, the final depth was finished above (at) the water table. 1 inch geoprobes consisted of a casing of 2.5 feet of solid riser and 3 feet of slotted casing. The probes were advanced only to the lower limit of the vadose zone. After installation, selected probes were sampled by evacuating the casing with a vacuum pump for approximately one minute, and then sampling the for constituents detectable using EPA Method 18. Samples were handled by Ensafe, and analyzed by Savannah Laboratories of Savannah, Georgia.

### Calculation of 'T' and 'K' from drawdown data

The equations used to calculate 'T' and 'K' came from Fetter, Applied Hydrogeology. The figure in Attachment E of drawdown vs. Log of distance from the recovery well was produced using data from Monday August 30, 1999 through Monday, September 20, 1999. The pumprate 'Q' over the period was estimated at 0.57gpm (pumprate over short-term 30 hr test was 1.10gpm, for comparison). Transmissivity 'T' was first calculated from the figure in Attachment E as 11,241.3cm<sup>2</sup>/day (or 12.1 ft<sup>2</sup>/day). The estimate of 'K' was 632.2 cm/day (1.73 ft/day) using an estimated aquifer thickness of 7 feet.

### Calculation of Air Flow

From the equations supplied from Dwyer Instruments, Inc. (manufacturer of the magnahelic and pitot tube used during the tests) , the flow equation for steam or any gas is:

$$Q \text{ (LB/hr)} = 359.1 \times K \times D^2 \times \text{sqrt} (p \times \text{Delta P})$$

Where

- Delta P = differential pressure expressed in inches water column, from direct magnahelic or datalog recorded values
- Q = flow (as shown in equation)
- D = inside diameter of line in inches
- K = flow coefficient (values supplied by Dwyer, in Attachments)
- p = Density in pounds per cubic foot

The readings from the magnahelic were somewhat anomalous for the test period. The first average of the first twenty readings for Delta P from the step test at 2" Hg vacuum was 0.27. The average of the last twenty readings at 24" Hg vacuum was 0.21. The approximate minimum and maximum values were 0.17 and 0.48, respectively. Assuming an average reading between the first and last readings of 0.24, then an approximate average airflow would be

$$\begin{aligned} &= 359.1 \times 0.64 \times 4 \times \text{sqrt} (0.076 \times .24) \\ &= 128.7 \text{ lbs/hr} / 0.076 \text{ lbs/cubic ft} \\ &= 1,693 \text{ cubic feet/hr} \end{aligned}$$

therefore the approximate airflow was 28 cfm. The range would be a minimum of 22 and a maximum of 38cfm.

### *Calculation of mass contaminant removal*

Using the estimate of 28 cfm airflow from the recovery well during the testing period and contaminant values tabulated in the Attachment, estimates were made of the contaminants removed in the vapor stream from the test well during the 30 hour vacuum step test and the long-term groundwater drawdown test. No 1,2 DCE or vinyl chloride was detected in any of the samples taken during the period. The estimated amount of PCE and TCE, removed during the short-term 30-hour test is 0.002 and 0.00008 Lb-mass, and for the long-term test 9.17 and 0.411 Lb-mass, respectively.

Because prior contaminant levels were low, and on the recommendation of Ensafé, the GAC were disconnected and the effluent was exhausted to the atmosphere. Therefore sample results of the effluent of the carbon units are not available.

## ATTACHMENT

DATALOG INPUTS for 30 hr Step-down test

Long-term Drawdown Test Using Dewater Point 21

Long-term Drawdown Test Using Existing 4 inch Well (RW4)

Long-term Drawdown Test Using Dewater Point 22

And

Hard Copy of the Datalog Files

## ATTACHMENTS

Datalogger inputs for short term 30hr PET and Long-term Drawdown PET

Datalogger inputs short term vacuum 30hr PET

Extraction well = 12

Input #	Probe	Distance from	Database Column Location
1(water)	13	0	B
2	12		C
3	11		D
4	3		E
5	22		F
6	23		G
7(vacuum)	607-011		H
8	Gp1		I
9	Gp2		J
10	13	0	K
11	Gp4		L
12	Gp5		M
13	AF13(pitot)		N
14	AF14(pitot)		O

## ATTACHMENTS

Datalogger inputs Long Term Drawdown PET

Extraction well = Ensafe 4" well

Input #	Probe	Distance	Database
1(water)	4"well	0	E
2	12		C
3	11		D
4	3		E
5	22		F
6	23		G
7(vacuum)	607-011		H
8	Gp1		I
9	Gp2		J
10	13	0	K
11	Gp4		L
12	Gp5		M
13	AF13(pitot)		N
14	AF14(pitot)		O

## ATTACHMENTS

Datalogger inputs long-term PET

Extraction well = 21

Input #	Probe	Distance	Database
1(water)	13	0	B
2	12		C
3	11		D
4	3		E
5	22		F
6	23		G
7(vacuum)	607-011		H
8	Gp1		I
9	Gp2		J
10	13	0	K
11	Gp4		L
12	Gp5		M
13	AF13(pitot)		N
14	AF14(pitot)		O

## ATTACHMENT

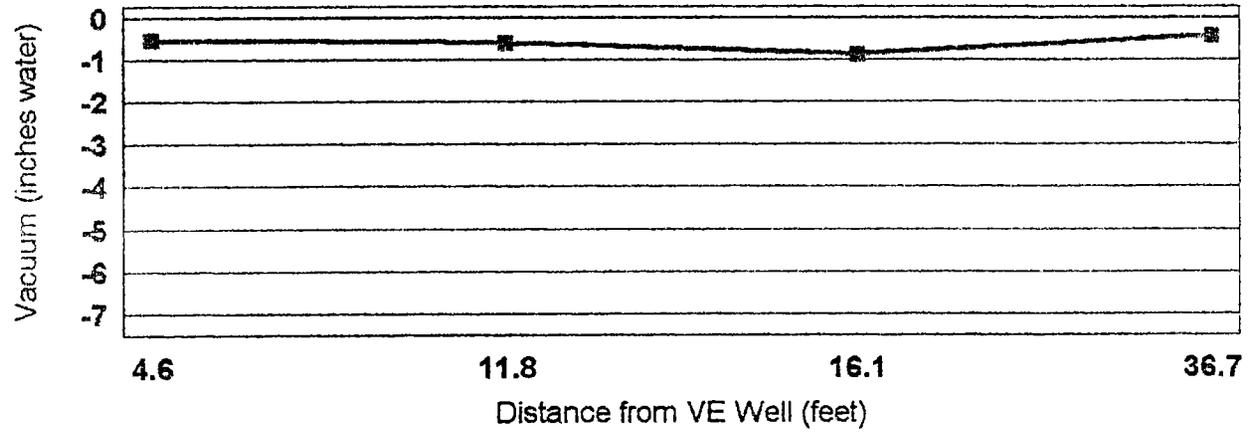
### 30-Hour Test

Wellhead Vacuum (Influence) vs. System Vacuum (2 hour intervals, all monitored wells )

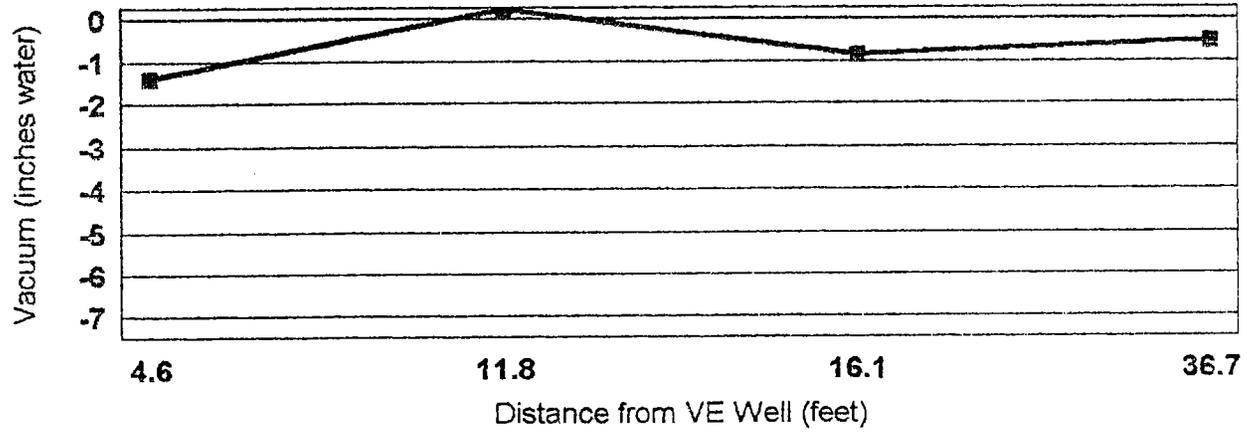
Vacuum Readings vs. Distance from Extraction Well

Vacuum Readings vs. System Vacuum over Time

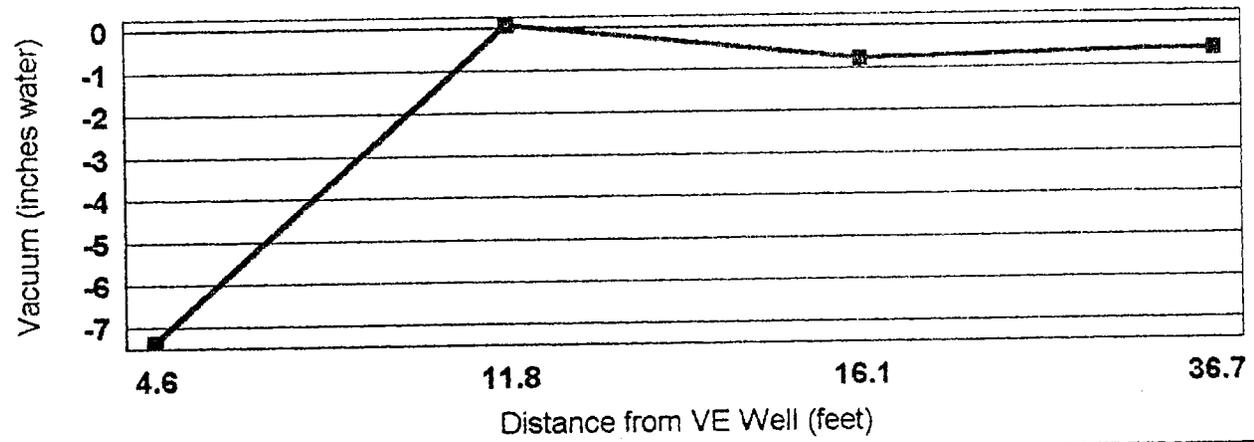
### Vacuum Influence at 6" Hg



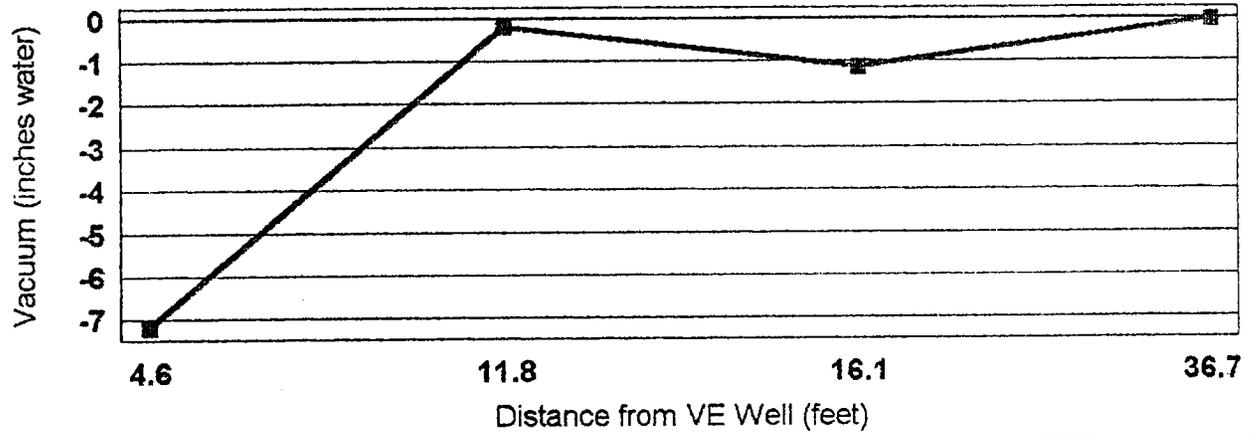
### Vacuum Influence at 10" Hg



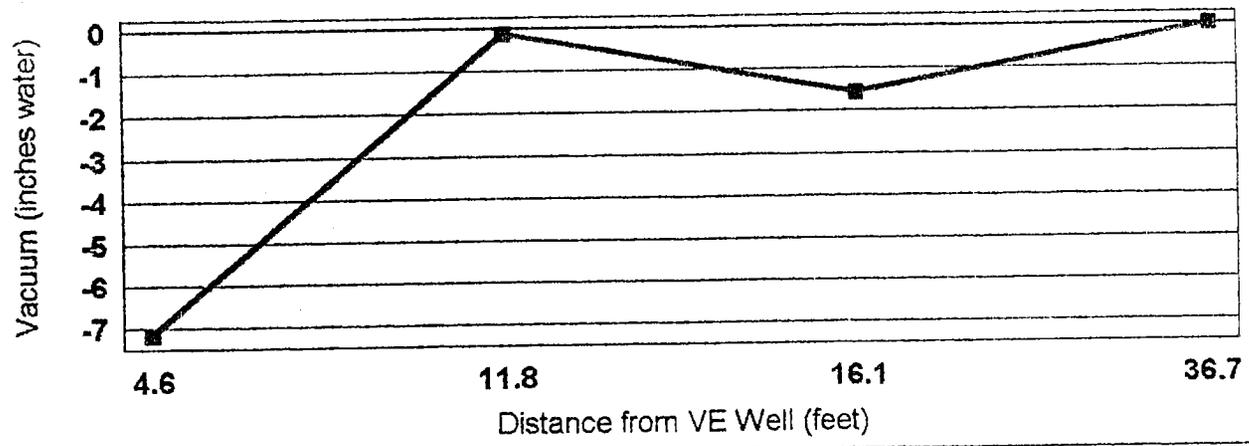
### Vacuum Influence at 14" Hg



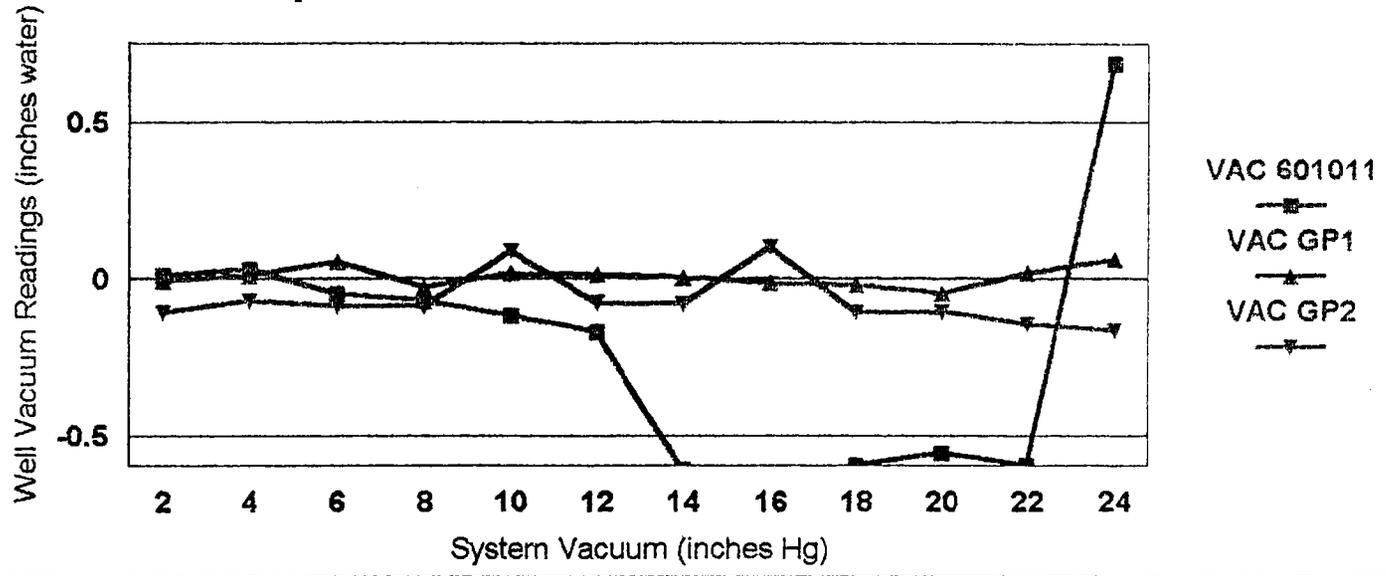
### Vacuum Influence at 18" Hg



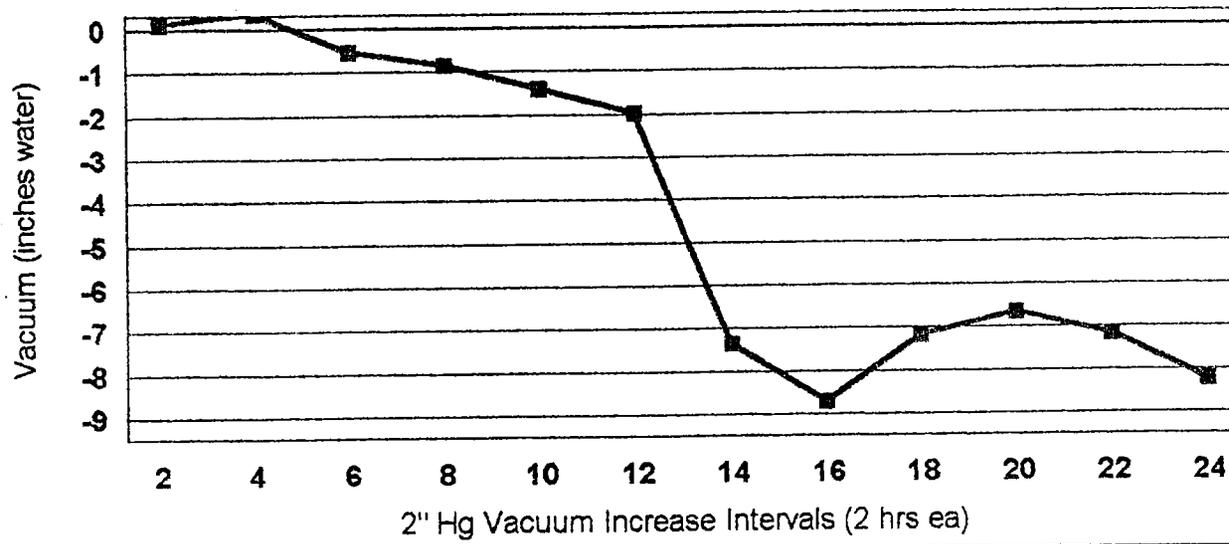
### Vacuum Influence at 22" Hg



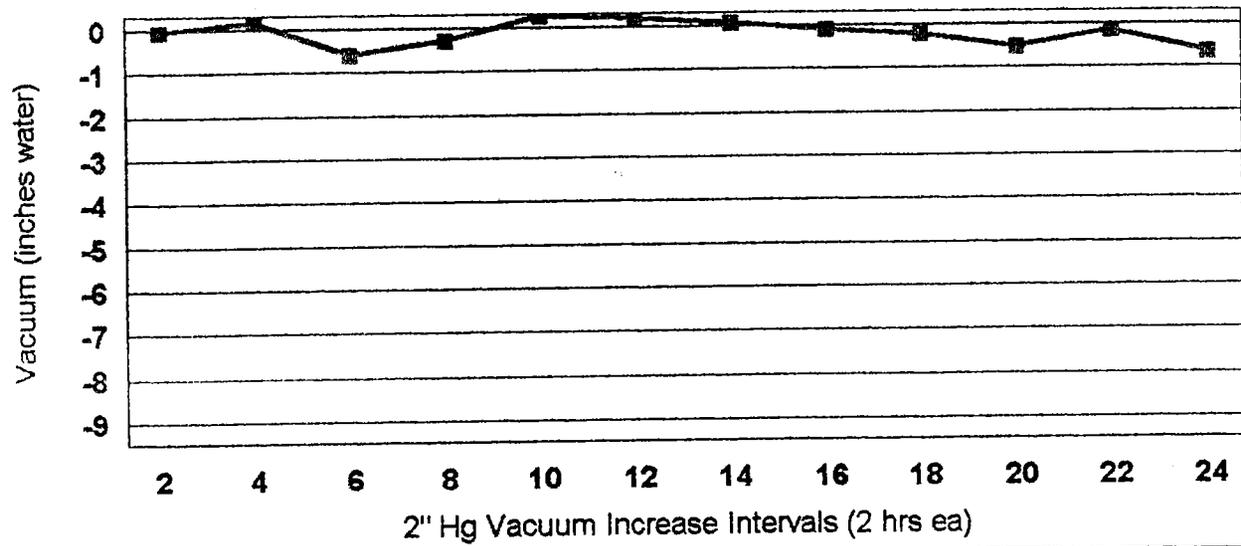
### Step Test - Vacuum Influence at Wells



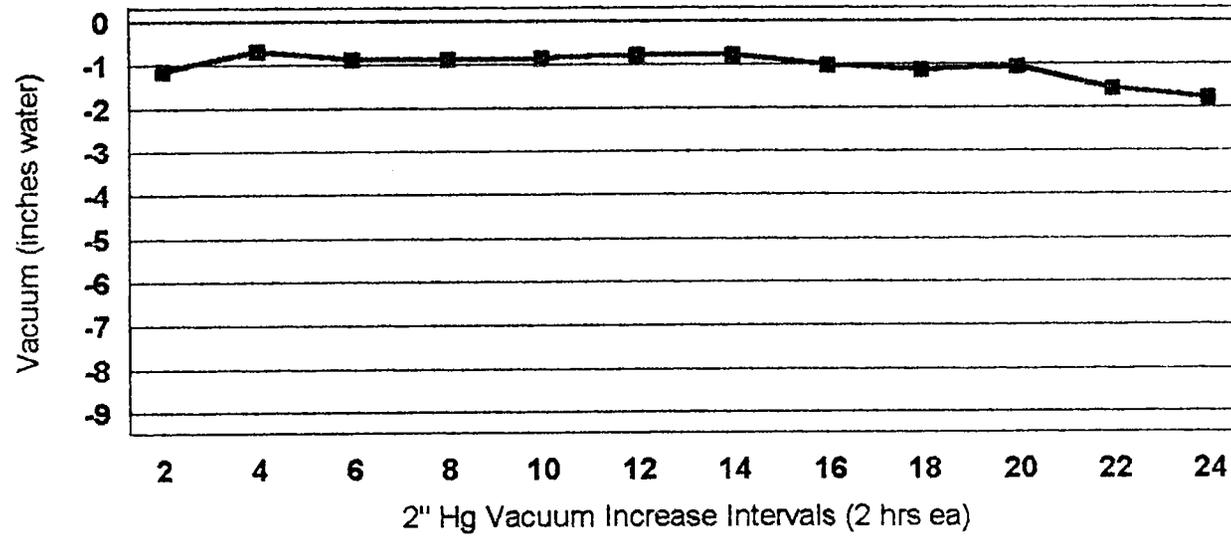
### Well 607-011 Vacuum Influence



### Well GP-1 Vacuum Influence



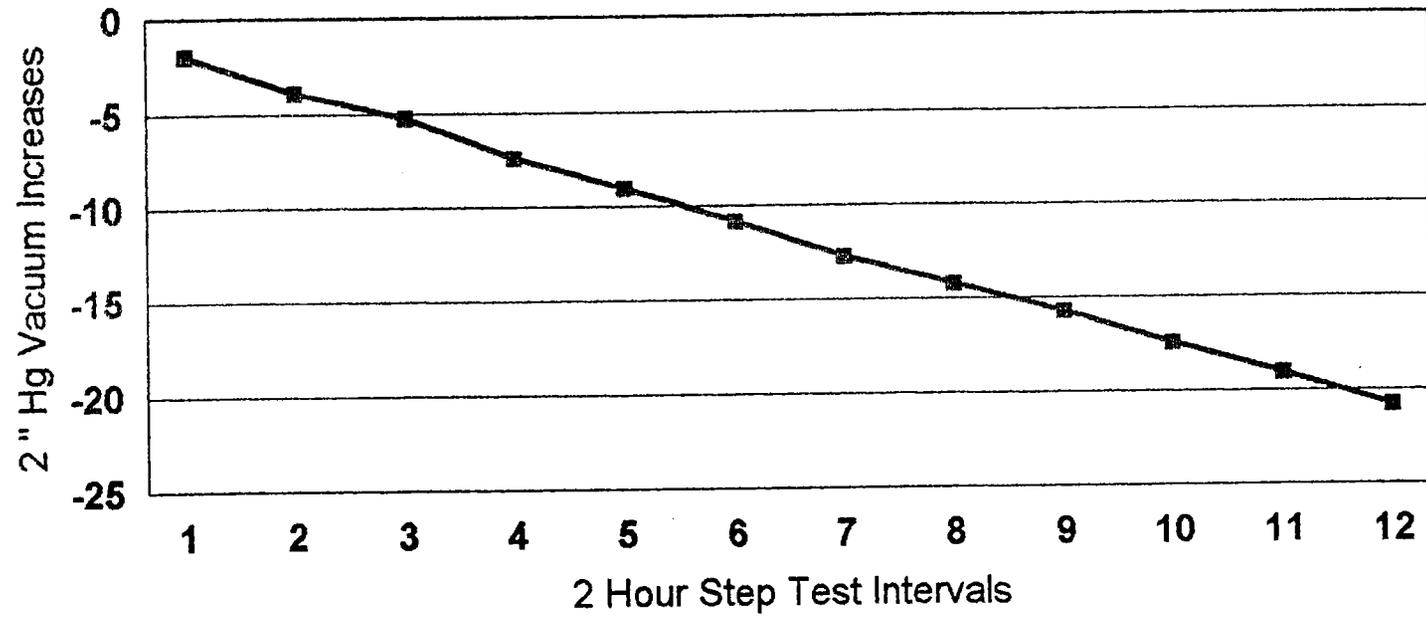
### Well GP-2 Vacuum Influence



## ATTACHMENT

Plot of Wellhead Vacuum vs. time for the DPVE Test Well (30-hour test)

## Recovery Well Vacuum Readings



ATTACHMENT

Table of Air Extraction Rate vs. Time (30-hour Step Test) and Direct Magnahelic Readings

TABLE FOR ATTACHMENT of Mean AIR EXTRACTION RATES (SCFM)

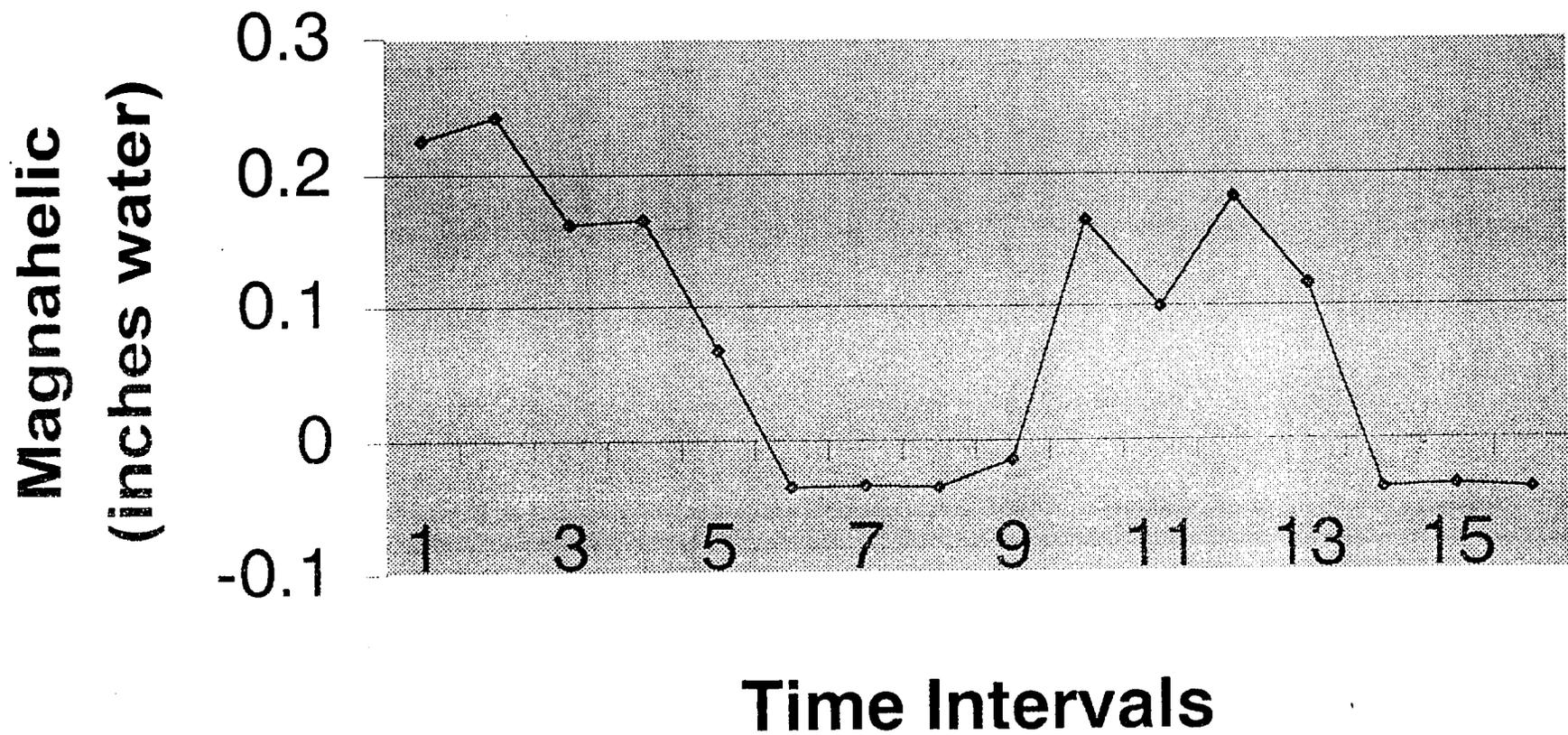
DATE	VACUUM (" Hg)	AVG. DATALO VALUE	EXTRACTIO RATE (CFM)
8/27/99	2	0.087	16.3
	4	-0.050	X
	6	-0.050	X
	8	-0.050	X
	10	-0.050	X
	12	-0.050	X
	14	-0.050	X
	16	-0.050	X
	18	-0.050	X
	20	-0.050	X
	22	-0.037	X
	24	0.270	28.9

X=anomalous reading

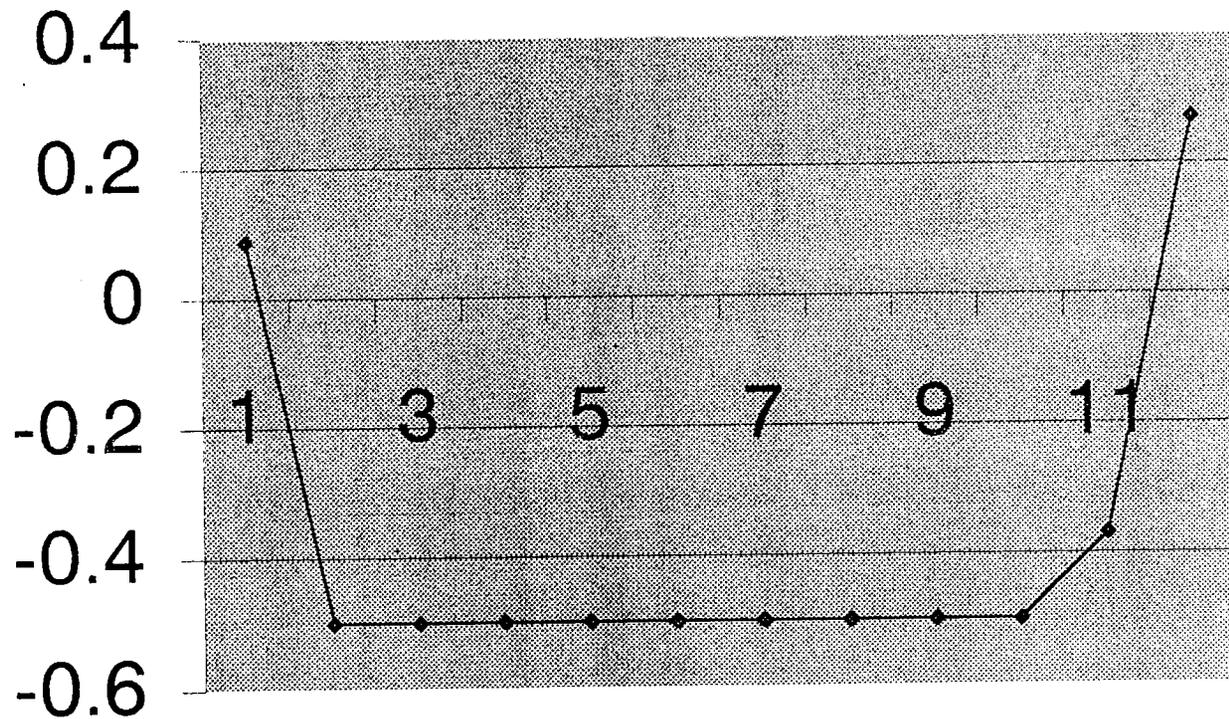
ATTACHMENT

Table of Air Extraction Rate vs. Time

# Magnahelic Value



# 30 HOUR MAGNAHELIC AVERAGES



**FLOW EQUATIONS**

1. Any Liquid

$$Q \text{ (GPM)} = 5.668 \times K \times D^2 \times \sqrt{\Delta P / S_f}$$

2. Steam or Any Gas

$$Q \text{ (lb/Hr)} = 359.1 \times K \times D^2 \times \sqrt{p \times \Delta P}$$

3. Any Gas

$$Q \text{ (SCFM)} = 128.8 \times K \times D^2 \times \sqrt{\frac{P \times \Delta P}{(T+460) \times S_s}}$$

**DIFFERENTIAL PRESSURE EQUATIONS**

1. Any Liquid

$$\Delta P \text{ (in. WC)} = \frac{Q^2 \times S_f}{K^2 \times D^4 \times 32.14}$$

2. Steam or Any Gas

$$\Delta P \text{ (in. WC)} = \frac{Q^2}{K^2 \times D^4 \times p \times 128,900}$$

3. Any Gas

$$\Delta P \text{ (in. WC)} = \frac{Q^2 \times S_s \times (T+460)}{K^2 \times D^4 \times P \times 16,590}$$

**TECHNICAL NOTATIONS**

The following notations apply:

- $\Delta P$  = Differential pressure expressed in inches of water column.
- $Q$  = Flow expressed in GPM, SCFM or PPH as shown in equation.
- $K$  = Flow coefficient — See Values Tabulated on page 3.
- $D$  = Inside diameter of line size expressed in inches. For square

& rectangular ducts use  $D = \sqrt{\frac{4 \times \text{Height} \times \text{Width}}{\pi}}$

- $P$  = Static Line pressure (psia)
- $T$  = Temperature in degrees Fahrenheit (plus 460 = °Rankin)
- $p$  = Density of medium in pounds per cubic foot
- $S_f$  = Sp Gr at flowing conditions
- $S_s$  = Sp Gr at 60°F AIR

**SCFM TO ACFM EQUATION**

$$\text{SCFM} = \text{ACFM} \times \left( \frac{14.7 + \text{PSIG}}{14.7} \right) \left( \frac{520}{460 + ^\circ\text{F}} \right)$$

$$\text{ACFM} = \text{SCFM} \times \left( \frac{14.7}{14.7 + \text{PSIG}} \right) \left( \frac{460 + ^\circ\text{F}}{520} \right)$$

$$\text{POUNDS PER STD. CUBIC FOOT} = \text{POUNDS PER ACT. CUBIC FOOT} \times \left( \frac{14.7}{14.7 + \text{PSIG}} \right) \left( \frac{460 + ^\circ\text{F}}{520} \right)$$

$$\text{POUNDS PER ACT. CUBIC FOOT} = \text{POUNDS PER STD. CUBIC FOOT} \times \left( \frac{14.7 + \text{PSIG}}{14.7} \right) \left( \frac{520}{460 + ^\circ\text{F}} \right)$$

1 CUBIC FOOT OF AIR = 0.076 POUNDS PER CUBIC FOOT AT 60°F AND 14.7 PSIA

(520 = 460 + 60°) Std. Temp. Rankine

Using the appropriate differential pressure equation from page 4, calculate the differential pressure generated by the sensor under **normal** operating conditions of the system. Check the chart below to determine if this value is within the recommended operating range for the sensor. Note that the data in this chart is limited to standard conditions of air at 60°F (15.6°C) and 14.7 psia static line pressure or water at 70°F (21.1°C). To determine recommended operating ranges for other gases, liquids and/or operating conditions, consult the factory.

Note the column on the right side of the chart which defines velocity ranges to avoid. Continuous operation within these can result in damage to the flow sensor caused by excess vibration.

Pipe Size (Schedule 40)	Flow Coefficient "K"	Operating Ranges Air @ 60°F & 14.7 psia (D/P Inches W.C.)	Operating Ranges Water @ 70°F (D/P Inches W.C.)	Velocity Ranges Not Recommended (Feet per Second)
1	0.52	1.10 to 186	4.00 to 675	146 to 220
1½	0.58	1.15 to 157	4.18 to 568	113 to 170
1½	0.58	0.38 to 115	1.36 to 417	96 to 144
2	0.64	0.75 to 75	2.72 to 271	71 to 108
2½	0.62	1.72 to 53	6.22 to 193	56 to 85
3	0.67	0.39 to 35	1.43 to 127	42 to 64
4	0.67	0.28 to 34	1.02 to 123	28 to 43
6	0.71	0.64 to 11	2.31 to 40	15 to 23
8	0.67	0.10 to 10	0.37 to 37	9.5 to 15
10	0.70	0.17 to 22	0.60 to 79	6.4 to 10



DWYER INSTRUMENTS, INC.

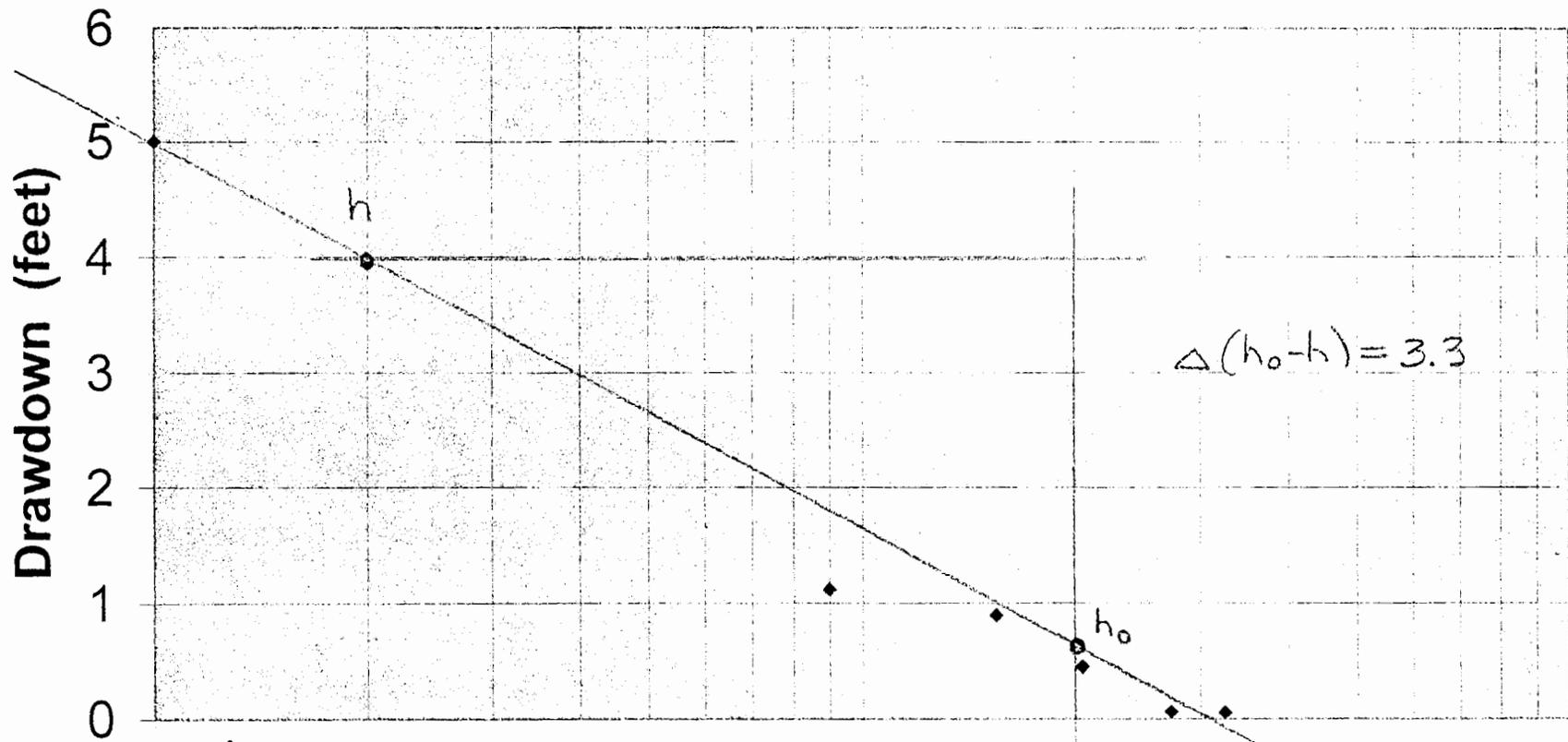
P.O. Box 373, Michigan City, Indiana 46361, U.S.A.

Phone: 219/872-8000 Fax: 219/872-9057

ATTACHMENT

Calculation of Intrinsic Soil Permeability (Long-Term Drawdown Test)

# Drawdown vs. LOG Distance



1 FROM: FETTLER, Applied Hydrogeology

T = TRANSMISSIVITY  
Q = PUMP RATE

Distance (feet)

$$T = \frac{70Q}{\Delta(h_0-h)} = \frac{70(0.5)}{3.3} = 12.1 \text{ ft}^2/\text{day}$$

$$K = \frac{T}{\text{AQUIFER THICKNESS}} = \frac{12.1}{7} = 1.73 \text{ ft/day}$$

## ATTACHMENT

Table of Total Mass (lbs) Removed during Tests

ATTACHMENT

TABLE of TOTAL MASS REMOVED DURING LONG PET TEST

DATE	Sample ID	Vacuum Datalog Value At Sample	PCE (mg/m <sup>3</sup> )	TCE (mg/m <sup>3</sup> )	Lb-mass PCE Per 1/2 day period	Lb-mass TCE Per 1/2 day period
8/28 - pm	1 <sup>st</sup>	0.178	34	1.6	0.357	0.0178
8/29 - am	2 <sup>nd</sup>	0.202	17	ND	0.228	ND
8/29 - pm	3 <sup>rd</sup>	0.232	22	ND	0.313	ND
8/30 - am	4 <sup>th</sup>	0.228	29	ND	0.410	ND
8/30 - pm	5 <sup>th</sup>	0.2250	54	16	0.759	0.225
8/31 - am	6 <sup>th</sup>	0.242	91	ND	1.321	ND
8/31 - pm	7 <sup>th</sup>	0.162	78	3.5	0.784	0.035
9/1 - am	8 <sup>th</sup>	0.1650	85	3.4	0.862	0.034
9/1 - pm	9 <sup>th</sup>	0.067	57	2.6	0.367	0.017
9/2 - am	10 <sup>th</sup>	0.189*	110	2	1.195	0.022
9/2 - pm	11 <sup>th</sup>	0.189*	77	2.6	0.836	0.028
9/3 - am	12 <sup>th</sup>	0.189*	160	2.9	1.738	0.032

\*=anomalous reading, mean of tabled values used

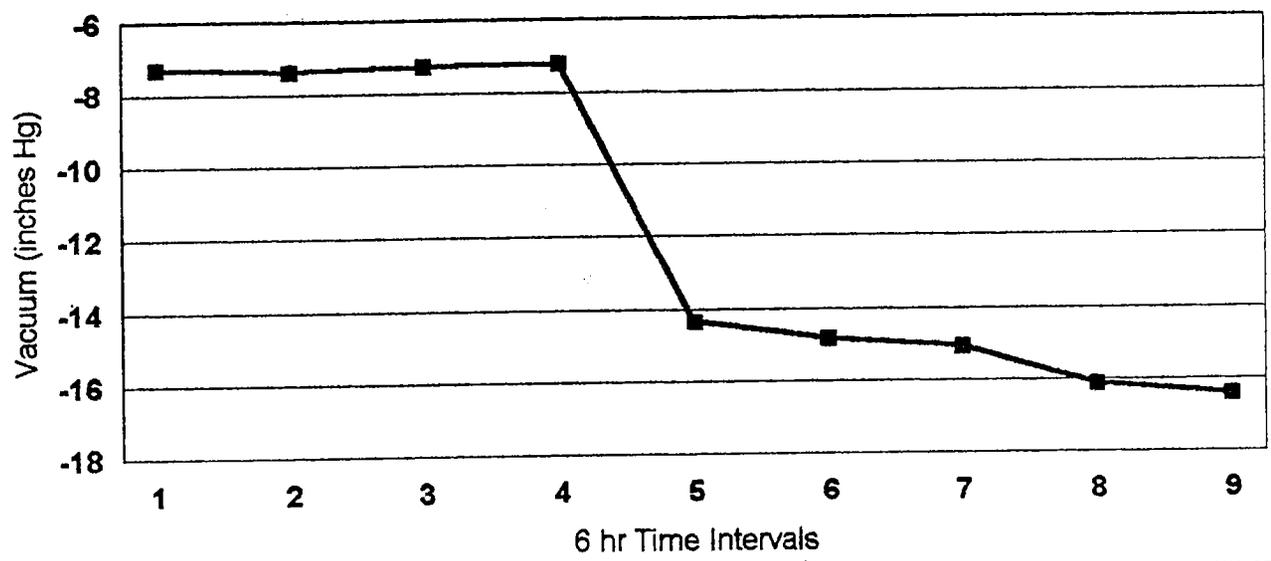
$$\text{Lb-mass} = \text{cfm} * \text{min/day} * \text{mg/m}^3 * \text{m}^3/35.31\text{ft}^3 * \text{Lbmass}/454\text{g} * \text{g}/1000\text{mg} * \text{day}$$

$$\begin{aligned} \text{Short Term 30 hr test} &= 0.002 \text{ Lb-mass PCE} \\ &= 0.00008 \text{ Lb-mass TCE} \end{aligned}$$

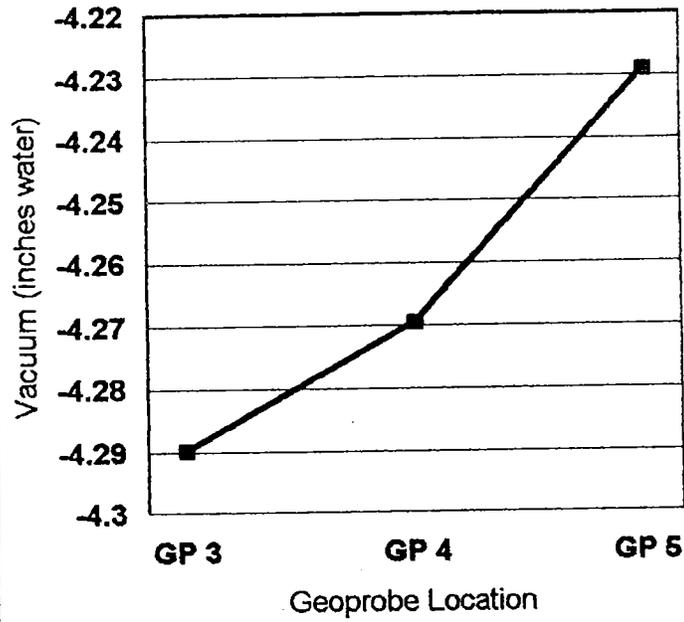
ATTACHMENT

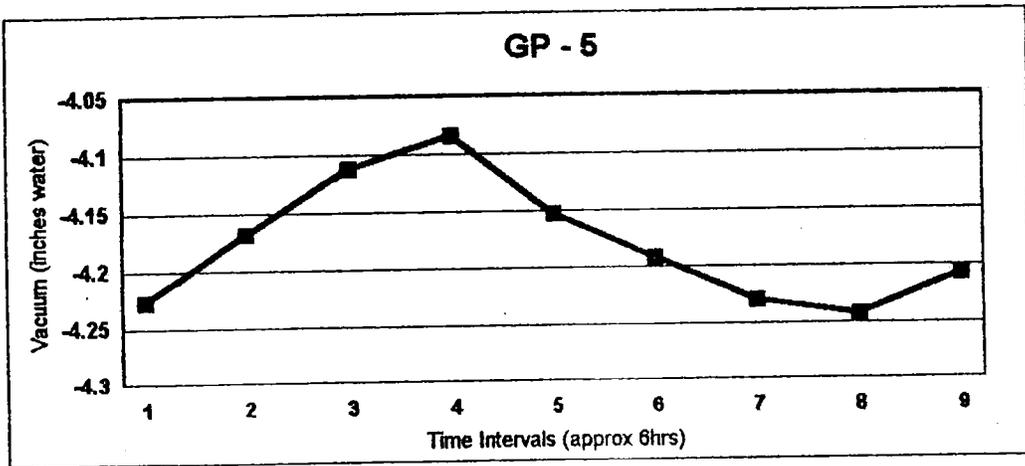
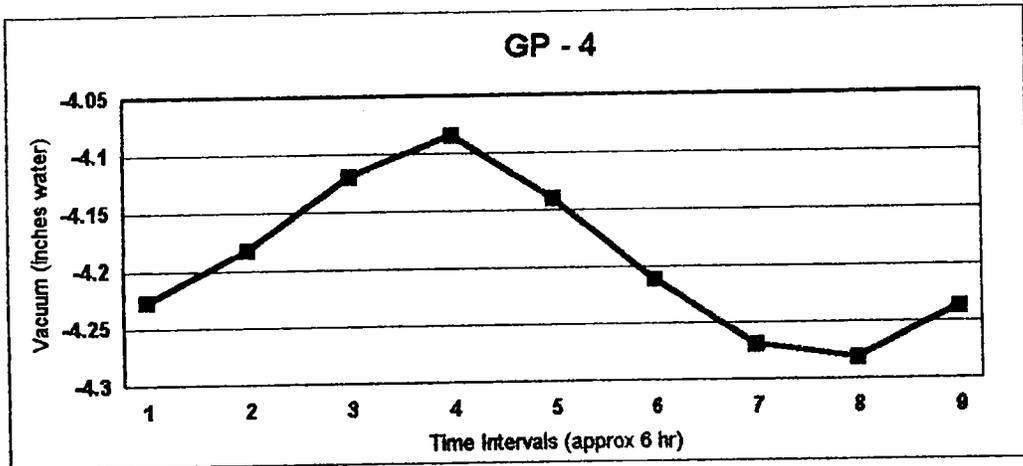
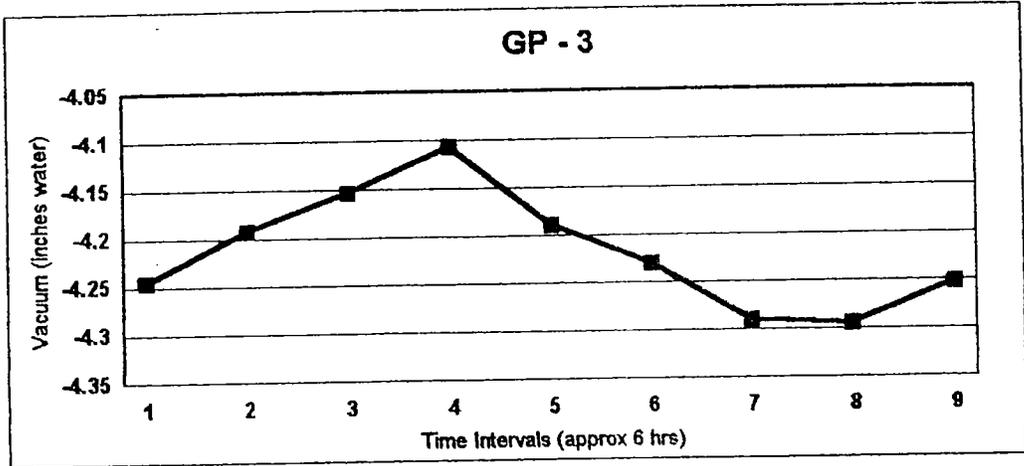
Long-term Drawdown Test - Extraction Well 21 8/28-8/30

### VE Well Vacuum

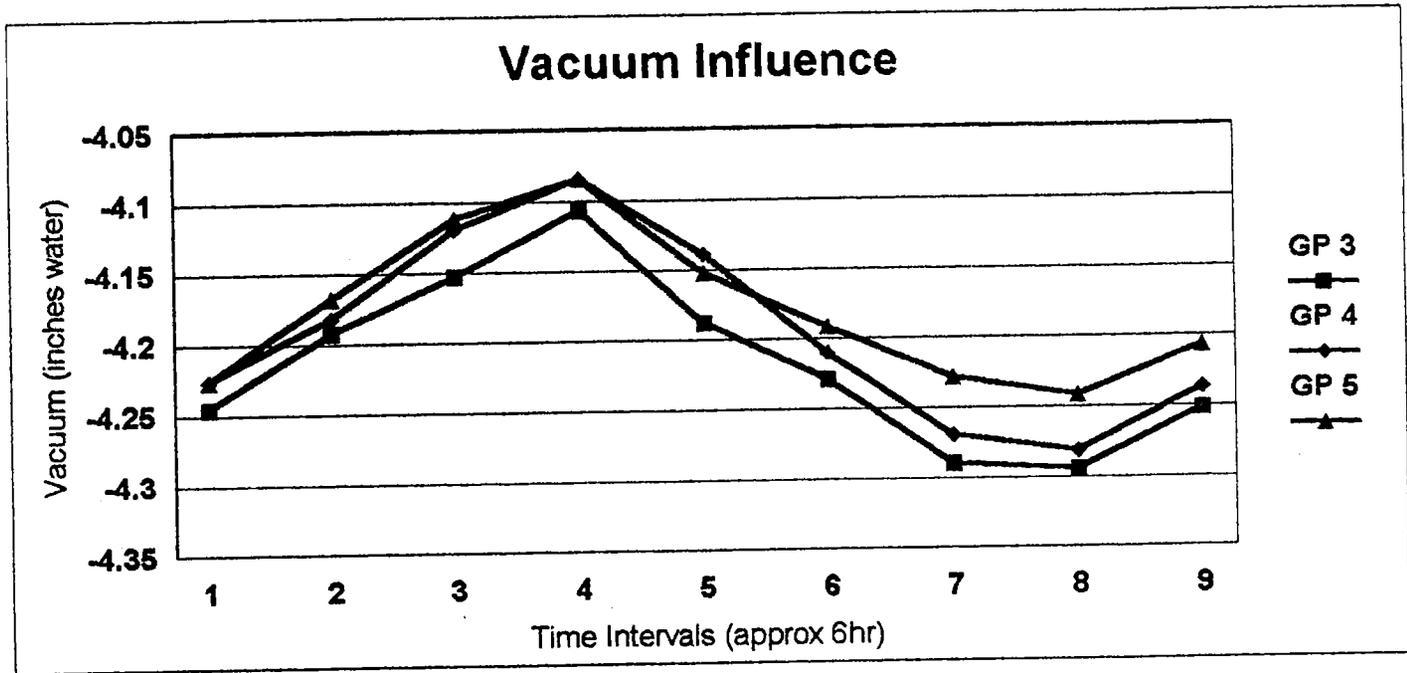


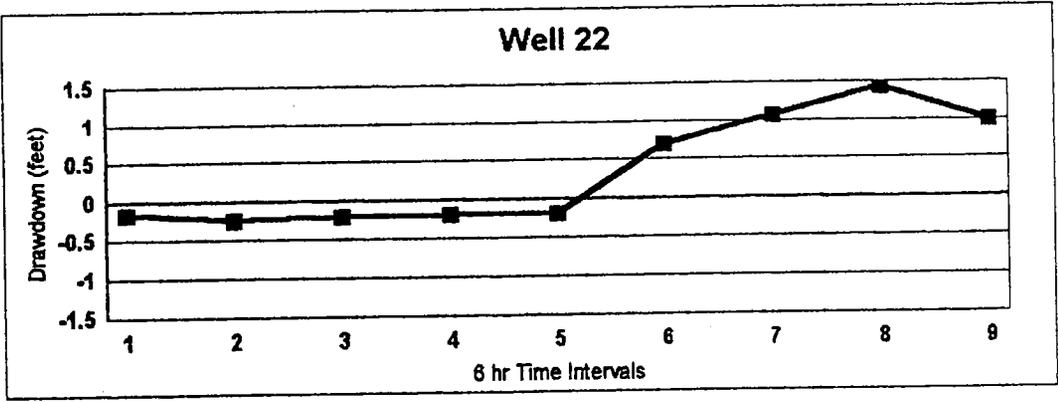
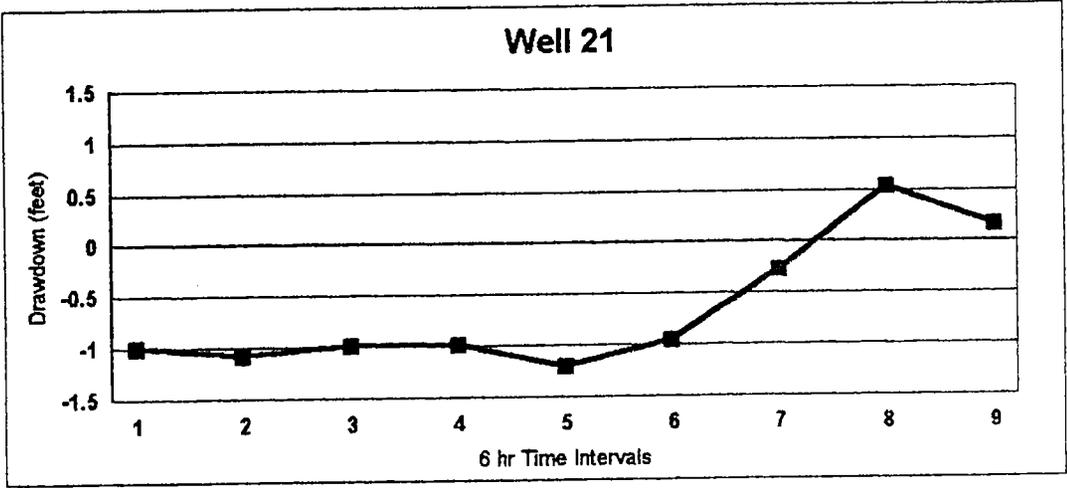
### Vacuum Influence

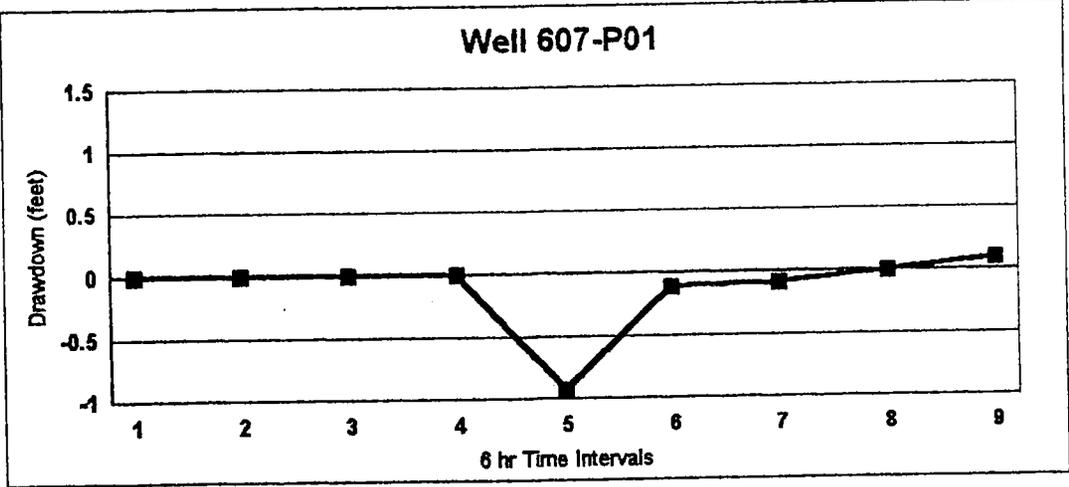


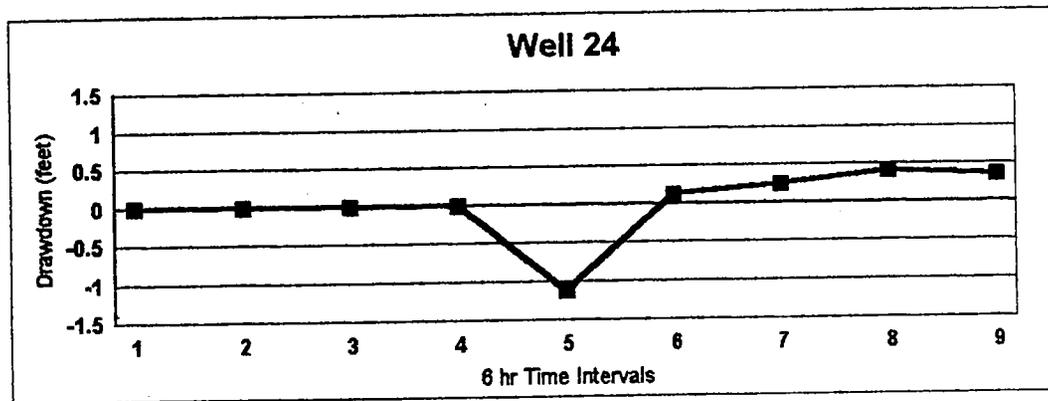
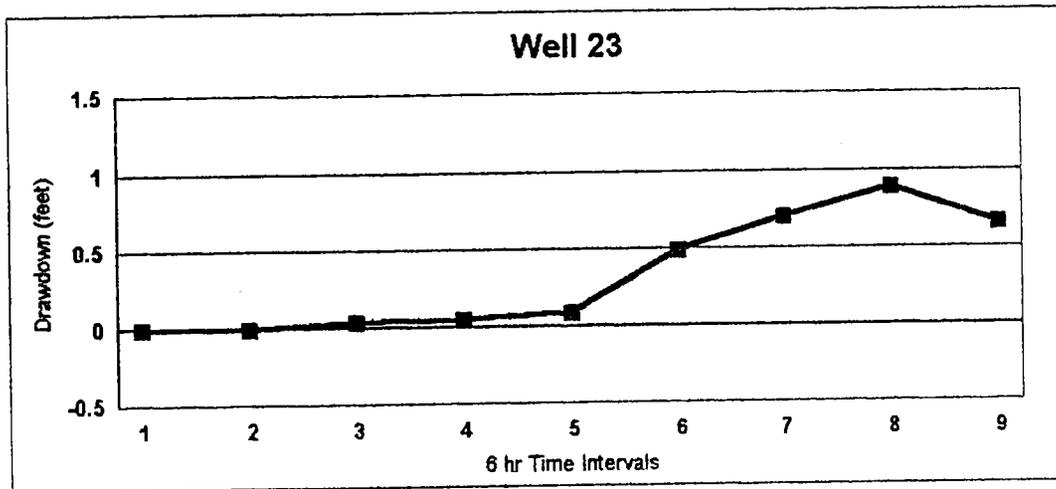


### Vacuum Influence





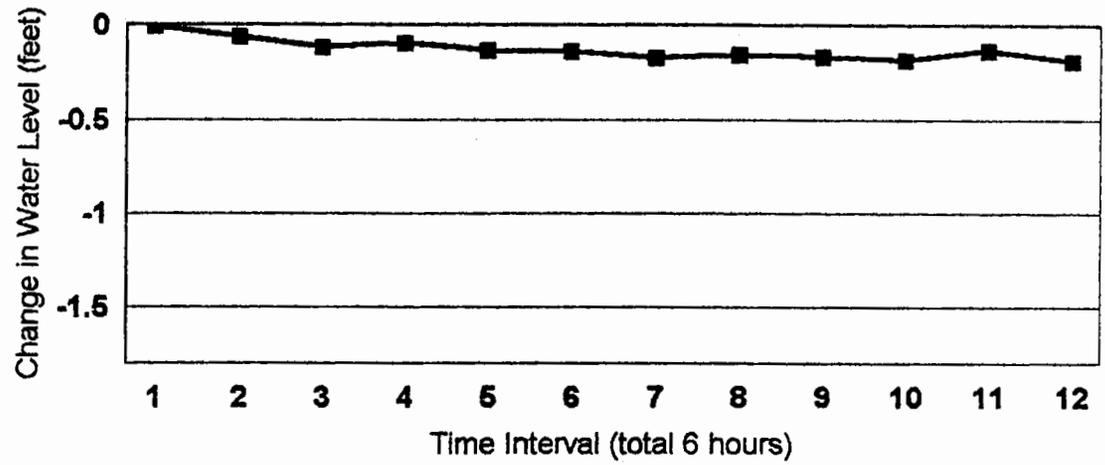




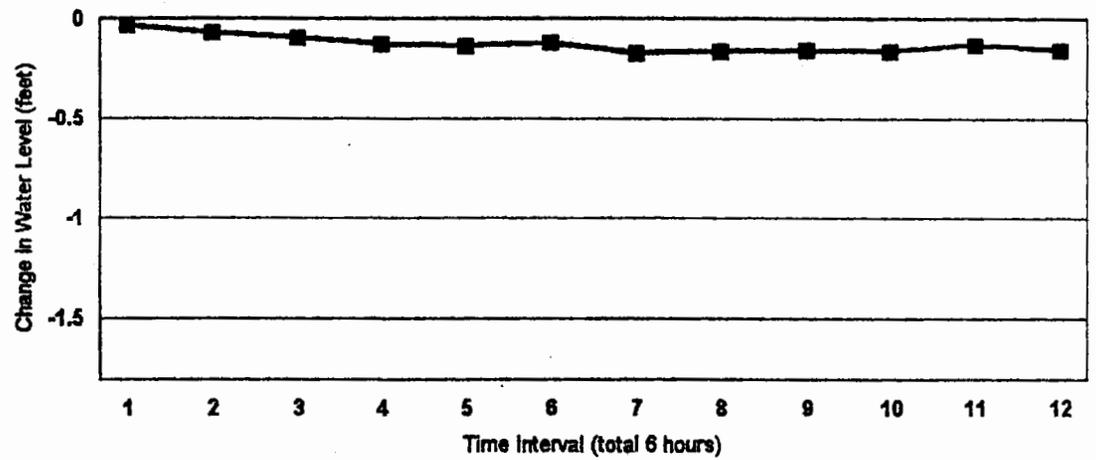
## ATTACHMENT

Long-term Drawdown Test - 4 inch Extraction Well 8/30

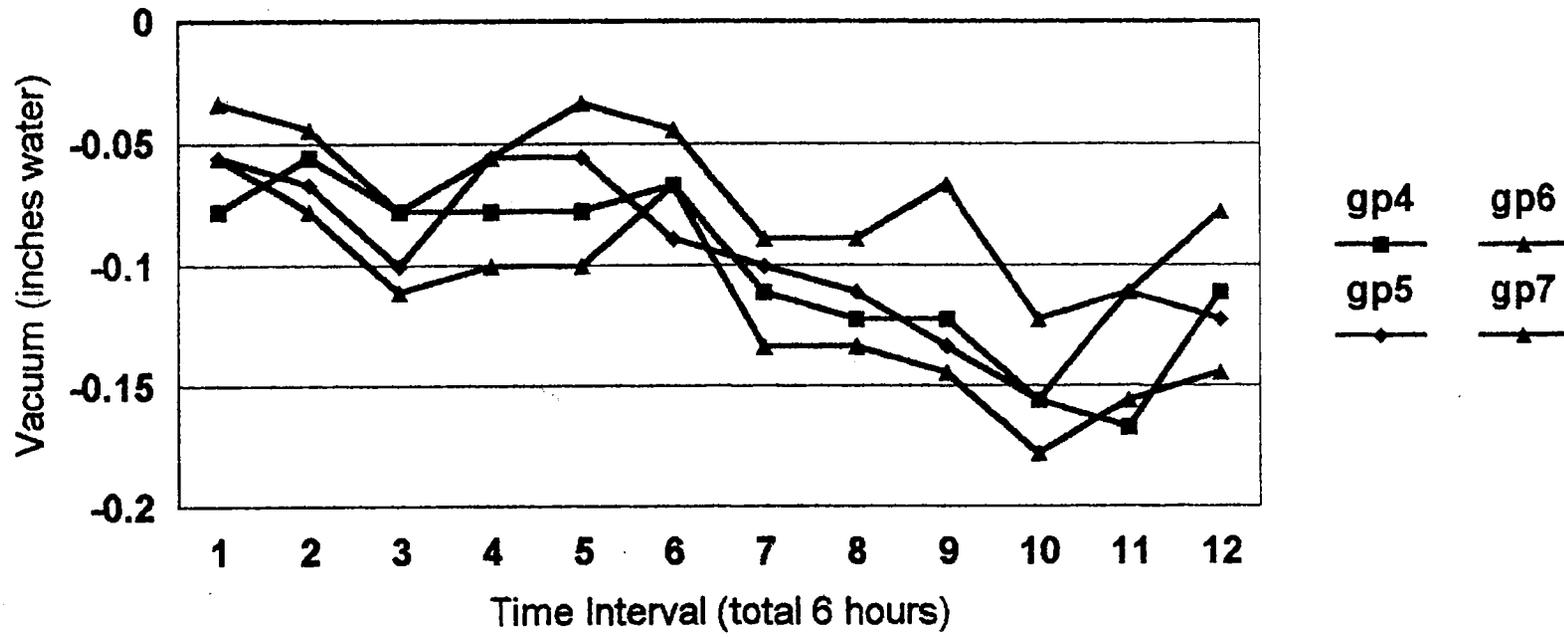
### Drawdown Well 26



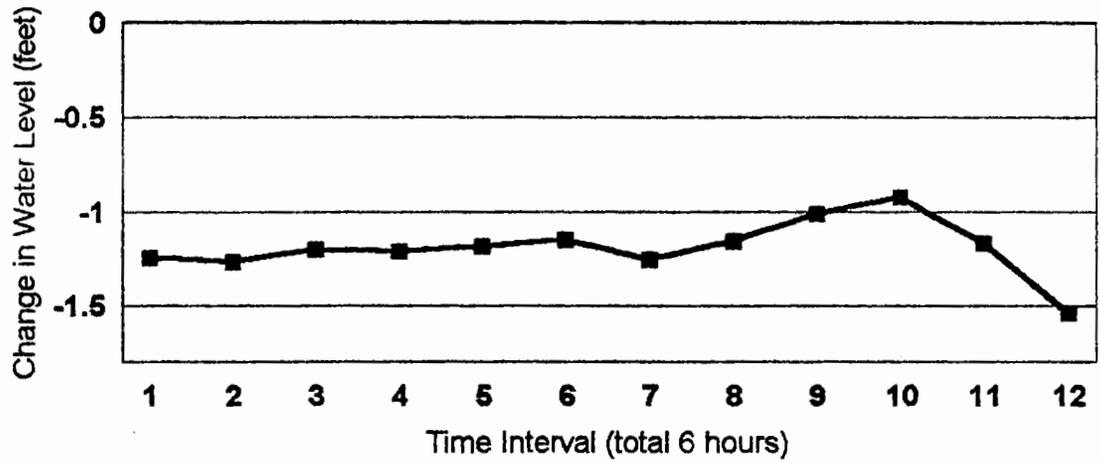
### Drawdown Well 27



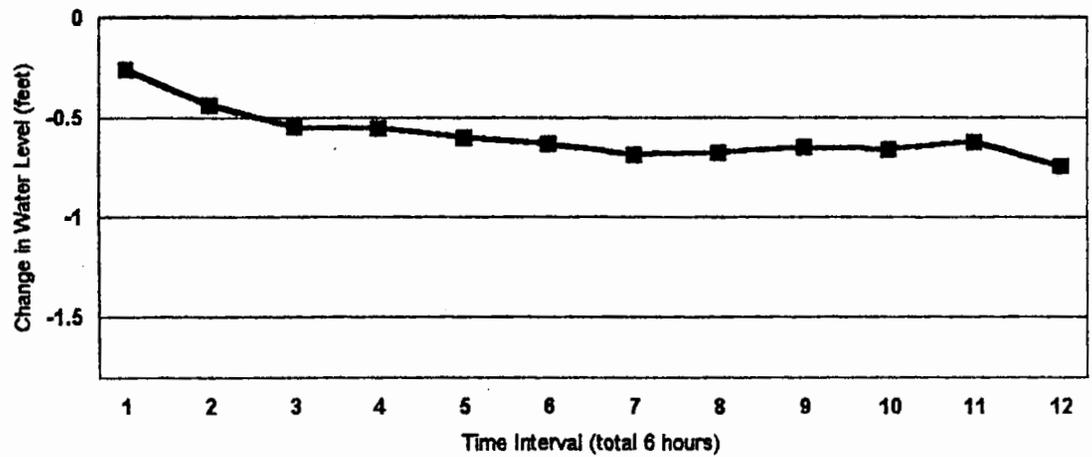
## Vacuum Influence



### Drawdown Well 24



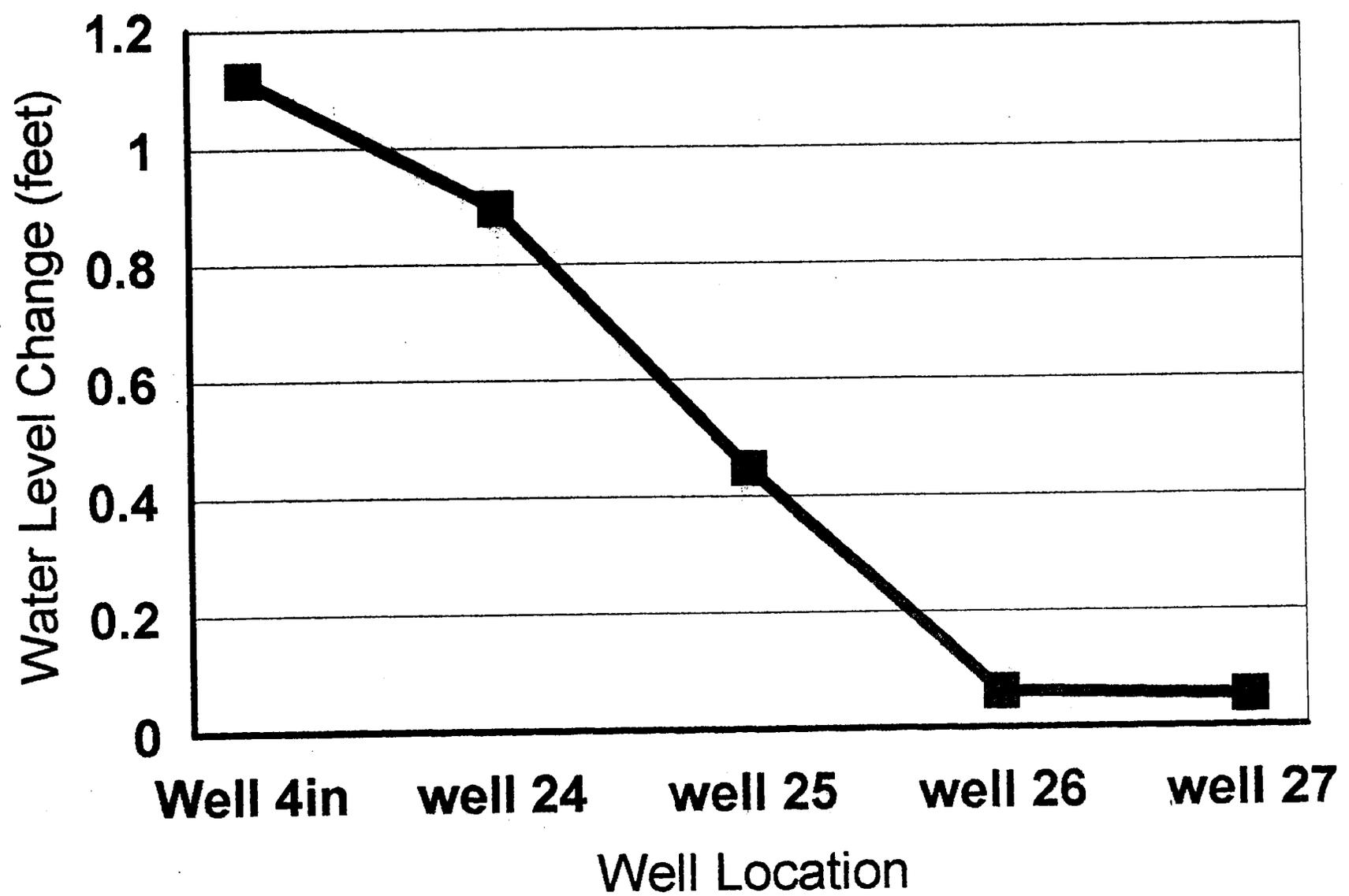
### Drawdown Well 25



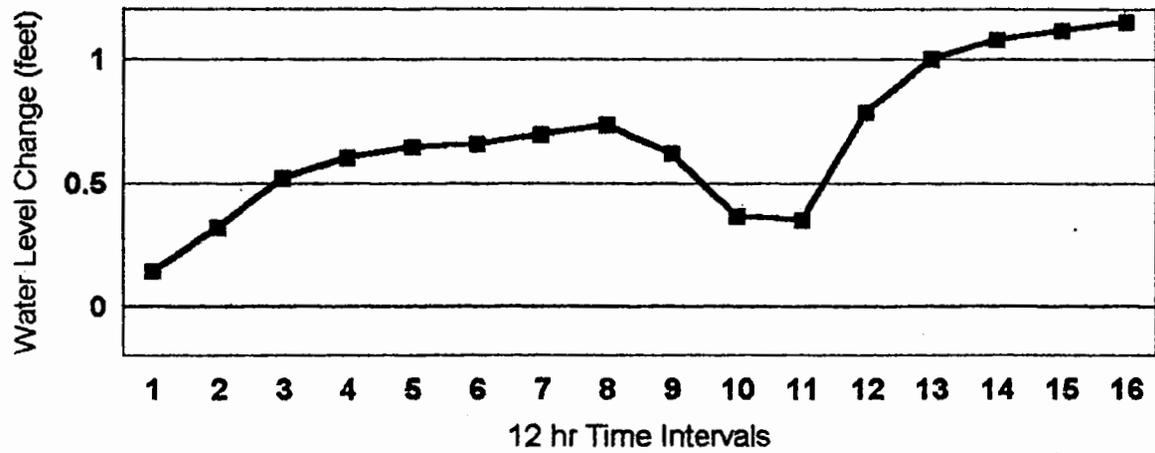
## ATTACHMENT

Long-term Drawdown Test - Extraction Well 22 8/30-9/3..9/20

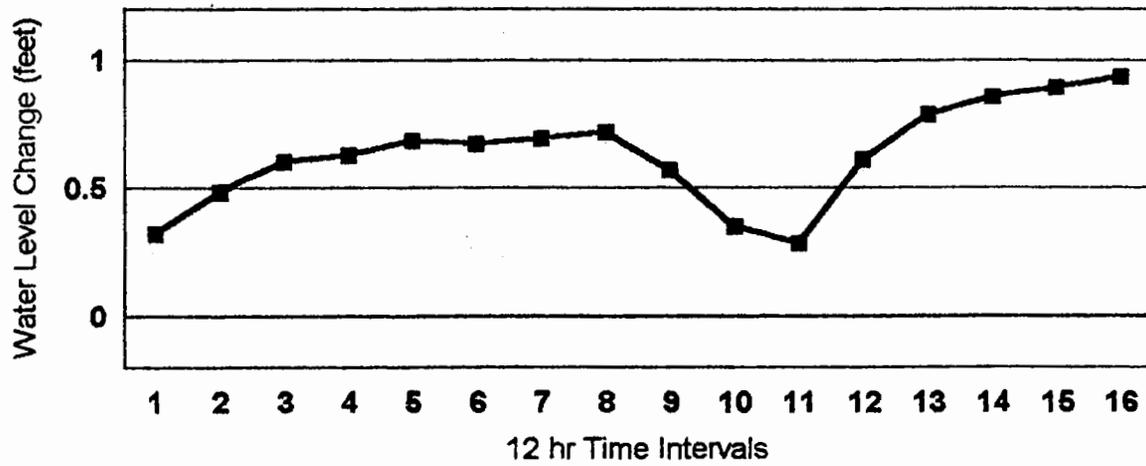
# Drawdown vs Distance



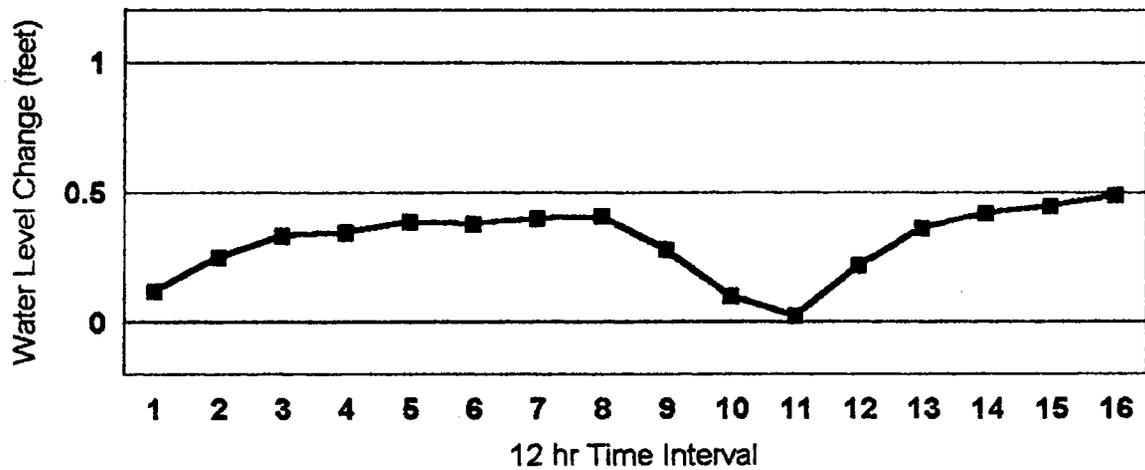
### RW-4



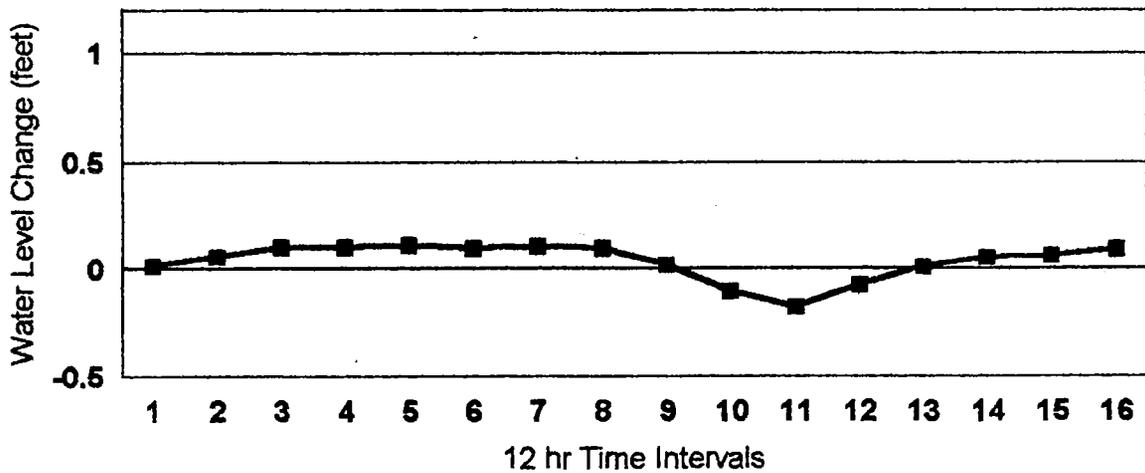
### Well 24



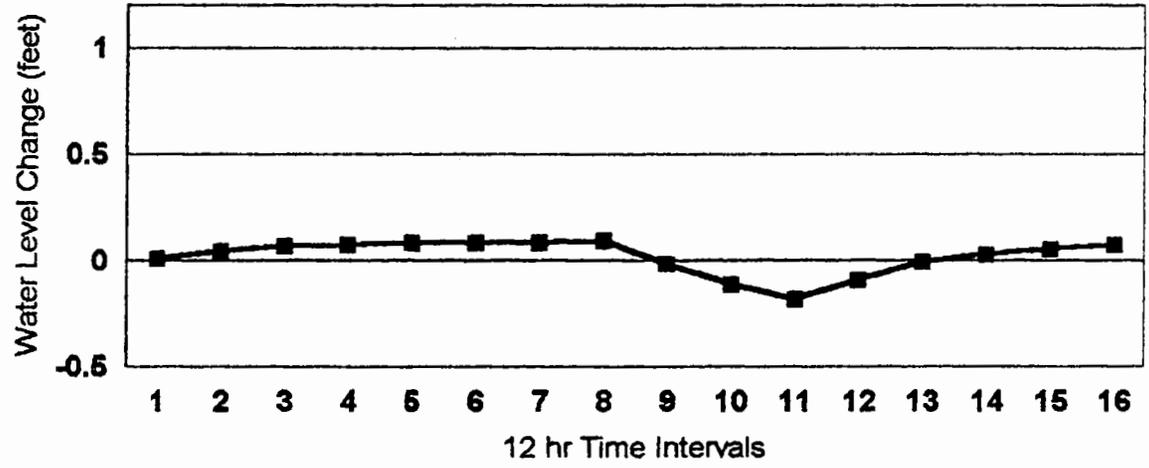
### Well 25



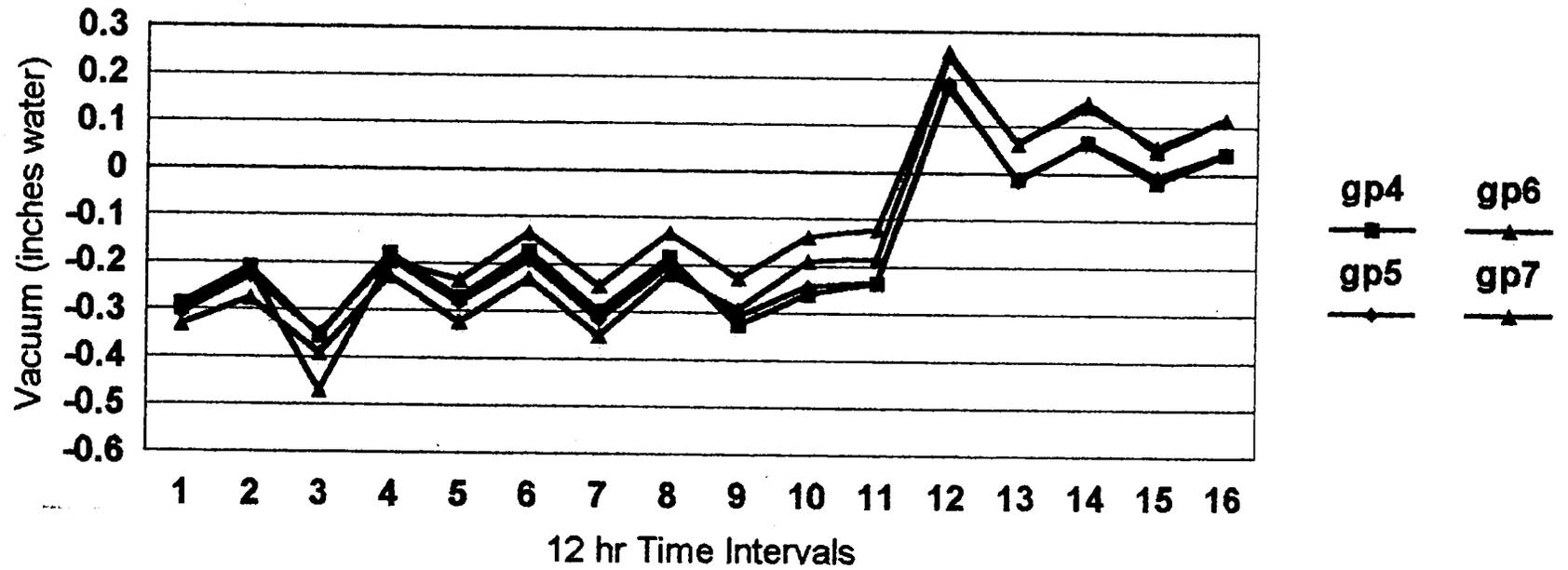
### Well 26



### Well 27



# Vacuum Influence



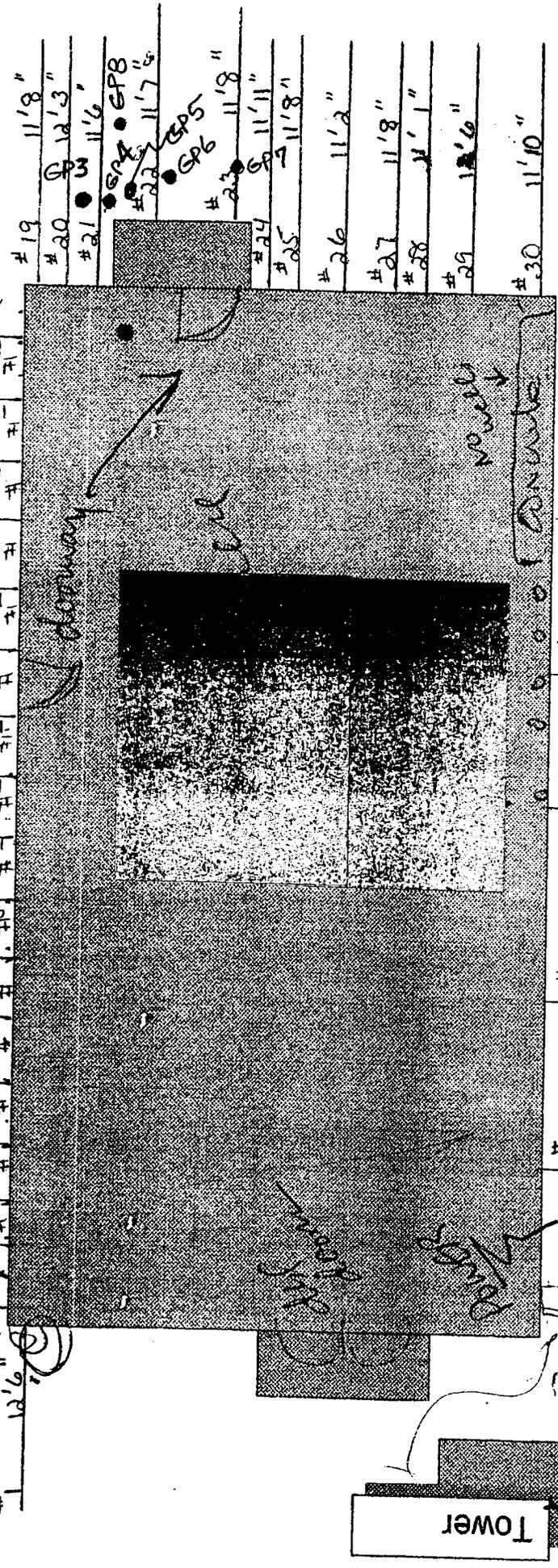
PARKING LOT WELLS (possibly 30' deep)

Approximate total depth of wells

**Bldg. 1189**

side walk

Garage



- #19 11'8"
- #20 12'3"
- #21 11'6"
- GP1 • GP8
- #22 11'7 1/2"
- GP5
- GP6
- #23 11'8"
- #24 11'11"
- #25 11'8"
- #26 11'2"
- #27 11'8"
- #28 11'1"
- #29 12'6"
- #30 11'10"

- #31 12'6"
- #32 12'6"
- #33 12'6"
- #34 12'2"
- #35 12'4"

NOT TO SCALE

Docks 1/2 mile away STREET

Tower

Hydro