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DRAFT WORK PLAN ADDENDUM TREATABILITY STUDY LIGHTER AMPHIBIOUS  
RESUPPLY CARGO (LARC) 60 MAINTENANCE AREA FORT STORY VA  
5/1/2003  
MALCOLM PIRNIE

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***DRAFT***

***WORK PLAN ADDENDUM***

***TREATABILITY STUDY***

***LARC 60 MAINTENANCE AREA  
FORT STORY, VIRGINIA***

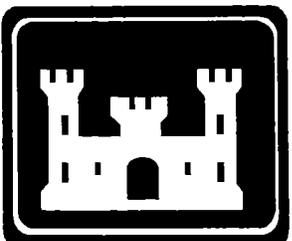
**Installation Restoration Program  
Fort Story, Virginia**

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**U.S. Army Corps of Engineers  
Baltimore District**

**and**

**U. S. Army Transportation Center  
Fort Eustis, Virginia**



**May 2003**

**0285-900-300**

**DRAFT**

# **WORK PLAN ADDENDUM**

**TREATABILITY STUDY**

**LARC 60 MAINTENANCE AREA  
FORT STORY, VIRGINIA**

*PREPARED FOR:*



**U.S. ARMY CORPS OF ENGINEERS  
BALTIMORE DISTRICT  
BALTIMORE, MARYLAND**

**AND**

**U.S. ARMY TRANSPORTATION CENTER  
FORT EUSTIS, VIRGINIA**



**CONTRACT DACA31-00-D-0043  
DELIVERY ORDER No. 15**

**MAY 2003**

**MALCOLM PIRNIE, INC.  
701 Town Center Drive, Suite 600  
Newport News, Virginia 23606**

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## 1.1 INTRODUCTION

Malcolm Pirnie, Inc. was contracted by the U.S. Army Corps of Engineers (USACE), Baltimore District to conduct a Treatability Study (TS) and Feasibility Study (FS) at the LARC 60 Maintenance Area site at Fort Story, Virginia under Contract DACA31-00-D-0043. The purpose of this work plan addendum is to outline the effort and material required to perform the treatability study for the Site. The scope of work provided by USACE is presented in **Appendix A**.

Tetrachloroethene (PCE), trichloroethene (TCE), cis 1,2-dichloroethene (cis 1,2-DCE), naphthalene, 2-methylnaphthalene, and toluene were detected in groundwater above EPA risk screening criteria (EPA RBCs and/or USEPA MCLs), in 2000. The use of in situ chemical oxidation is being considered to reduce the concentrations of these compounds (contaminants of concern [COCs]) in groundwater. To further the evaluation of this remedial technology, a pilot scale (remedy selection) treatability study of in situ chemical oxidation will be conducted at the Site.

This Work Plan Addendum provides the framework for conducting the treatability study. The Work Plan Addendum is comprised of three components: a Field Investigation Plan (FIP), a Quality Assurance Project Plan (QAPP) and a Site Safety and Health Plan (SSHP) which provides information to supplement the data provided in the FIP and generic and site-specific QAPP and SSHP (dated September 2002 and March 2002, respectively) for the LARC 60 Maintenance Area that have been previously submitted to and approved by the USACE and the Virginia Department of Environmental Quality (DEQ). Any revisions or additions to the information or data presented in the generic or site-specific plans that relate to the site will be outlined and discussed in this Addendum.

## 1.2 RI SUMMARY

This section provides a summary of the remedial investigation (RI) results and supplemental investigation results for the LARC 60 Site. The Site is located on Fort Story in Virginia Beach, Virginia. A location view and plan view of the site are presented in **Figures 1-1 and 1-2**, respectively.

- TPH as Heavy Oils were detected in the majority of surface and subsurface soil samples collected at the site with concentrations greater than 100 mg/kg in approximately 50 percent of the samples.
- Numerous metals were detected in soils at this site with concentrations typically decreasing with depth. The lateral extent of metals was not defined. Although typically above background levels, except for arsenic at two soil sample locations (SB-1 and SB-20), metal concentrations were at least one order of magnitude lower than the EPA screening criteria.
- PCE, trichloroethene (TCE), Cis 1,2-dichloroethene, toluene, total lead, total and dissolved manganese, and total and dissolved arsenic were detected in groundwater above EPA risk screening criteria. No compounds were detected in soils or sediment above EPA risk screening criteria, however, TPH as Heavy Oils were detected above the Virginia UST Program action level of 100 milligrams per kilogram.
- Supplemental Investigation  
pH ranged from 5.57 to 7.26 and temperature ranged from 11.4 to 19 deg. C. Conductivity and turbidity ranged from 0.095 to 0.372 (umhos/cm) and 0 to 324 respectively.

Significant concentrations of Site contaminants are presented in **Figures 1-3 through 1-5**. These concentrations are based on the latest concentration data for each constituent. **Table 1-1** presents analytical data from the RI and supplemental investigation.

### Geology/Hydrogeology

The sediments underlying the LARC area consist of sand deposits of the Kennon and Columbia Group that are of Holocene and Pleistocene Age respectively. Drilling penetrated the upper forty feet of sediments and these were described with respect to lithology and sedimentary features by the site geologist. The following table provides a summary of the lithologic units:

DEPTH (BLS)	USCS SOIL TYPE	DESCRIPTION
0 – 2	SP	Asphalt. Fine sand, well sorted, with heavy minerals, moderately sorted.
2 – 18	SM	Medium to fine sand, with heavy minerals, moderately sorted.
18 – 35	SW	Coarse to medium sand, subrounded, with lenses of gravel and medium sand of heavy minerals; with layers of fine to medium sand and sand of heavy minerals.
35 – 46	SC	Fine sand, with heavy minerals, with lenses of cohesive, plastic clay.

- **Figures 1-6 and 1-7** present the traverses and the cross-section views of the site. A Peat lens less than 1 foot in thickness at a relatively shallow depth and a 3- to 4-inch thick buried soil horizon (A1) at approximately 8 to 10 feet below land surface were encountered. The horizon was very organic rich but did not contain any visible vascular plant material. This type of buried soil horizon in coastal plain sediments is typically laterally discontinuous.
- The measured depth to groundwater at the site was approximately 2.5 to 8.0 feet BLS. Water level data from on-site wells indicates that the water table elevation ranges from approximately 2.75 to 7.23 NGVD. **Figure 1-8** presents the water table elevations and flow direction.
- Though locally variable in magnitude and direction, the prevailing hydraulic gradient for the site is in a northward direction toward the coastline as established by the PA/SI. Estimated hydraulic conductivity values range from  $1.99 \times 10^{-3}$  to  $1.84 \times 10^{-2}$  centimeters per second (cm/sec) with an average value of  $7.42 \times 10^{-2}$  cm/sec as established by the PA/SI.
- Data do not indicate any trends in groundwater elevation that are attributable to tidal influence.

Boring logs and well installation diagrams for wells installed by Malcolm

Pirnie are presented in **Appendix B**.

### **Fate and Transport**

- Because of the persistence of TPH as Heavy Oils, its concentrations will only slowly decrease over time in surface soils and groundwater although some migration in groundwater would be expected.
- The chlorinated hydrocarbons detected in groundwater are also associated with the release from the former UST. PCE was present in groundwater at roughly 0.25 percent of its aqueous solubility. In comparison to concentrations established for PCE degradation products in groundwater during past studies, the concentrations of degradation products have increased. PCE concentrations have decreased. The increased concentrations of degradation products and decreasing PCE concentrations indicate that degradation of PCE is occurring as expected.

### **1.3 TREATABILITY STUDY PROGRAM**

The following sections outline the intent of and specific field activities to be performed at the LARC 60 Site at Fort Story. The results of this study will be used to evaluate the use of in situ chemical oxidation as the preferred alternative in the feasibility study.

#### **Study Objectives**

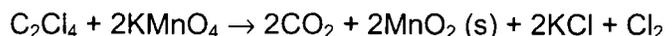
The objectives of the LARC 60 Site Treatability Study are:

- Gather data to evaluate the effectiveness of chemical oxidation using a permanganate compound (sodium or potassium) as a remedial technology at the Site.
- Gather data on contaminant rebound within the study area.
- Gather data to evaluate the effectiveness of chemical oxidant delivery via direct push methods.
- Provide initial steps toward remediating groundwater by reducing levels of COCs in the test area.
- Quantify (via groundwater sampling) post-injection contaminant concentrations including any rebound effects.

- Quantify oxidant quantity for full-scale implementation of chemical oxidation.

### Treatment Technology Description

In situ chemical oxidation via permanganate is driven by the direct reaction of permanganate and the contaminant. The reaction of potassium permanganate with PCE is typical of oxidation/reduction reaction that occurs:



Where:	$\text{C}_2\text{Cl}_4$ :	PCE
	$\text{KMnO}_4$ :	Potassium Permanganate
	$\text{CO}_2$ :	Carbon Dioxide
	$\text{MnO}_2$ :	Manganese Oxide (solid)
	KCl:	Potassium Chloride
	$\text{Cl}_2$ :	Chlorine

The reaction will occur with contaminants sorbed to the soil, dissolved in the groundwater, and existing in a free-phase state. Permanganate has been shown to oxidize a wide range of inorganic and organic compounds including:

- Chlorinated solvents (e.g., PCE)
- Polycyclic aromatic hydrocarbons
- Phenolics
- Cyanides

Organic compounds that contain carbon-carbon double bonds (alkenes) are more readily oxidized by permanganate than compounds having single carbon-carbon bonds (alkanes). Thus, permanganate is more effective at remediating ethene-related compounds, such as PCE and TCE, than ethanes such as trichloroethane (TCA). At this Site, ethane compounds have not been detected at concentrations that indicate a health risk, therefore this shortcoming of permanganate should not be a concern.

Environmental parameters that influence the rate and degree of permanganate oxidation reactions include:

- pH (optimum near 7, but effective over a range of 3 to 12)
- Temperature
- Oxidant contact time with contaminant
- Oxidant concentration

Permanganate is applied in a liquid solution either through a series of wells or direct-push injection points.

### **Treatability Study Activities**

A vendor providing in situ chemical oxidation services will perform the injection of the chemical oxidant, under subcontract to Malcolm Pirnie. In-situ Oxidative Technologies, Inc. and Environmental Business Solutions International, Inc. have been contacted to provide the chemical oxidation services. One of these vendors will be selected to provide services based on a bidding process. Malcolm Pirnie will provide field oversight of the injection and will conduct soil and groundwater sampling activities.

The treatment area is located just north of the Former UST Area. This AOC was chosen due to its relatively high concentrations of COCs, the variety of contaminants detected, and its designation as the probable, former source for Site contamination. The Treatment Area with approximate locations of injection points and monitoring wells are presented on **Figure 1-9**.

#### *Preinjection Activities*

The following activities will be performed in preparation for the oxidant injection:

- Malcolm Pirnie will have the treatment area cleared for utilities.
- The vendor and Malcolm Pirnie will meet on-site to locate and mark injection points relative to existing utilities and proposed upgradient/downgradient groundwater sample locations such as MW-117.
- Malcolm Pirnie and the vendor will meet with Site personnel to coordinate on-going operations at the Site and the oxidant injection.
- A temporary well will be installed using direct push technology. The temporary well will be used for sampling treatment area conditions before, during, and after the oxidant injection. The temporary well will be located in the treatment area as shown on **Figure 1-9**.

#### *Oxidant Injection Activities*

Chemical oxidant, permanganate, will be injected in the test area within a 5-day period, each injection using direct push injection techniques. The injection will target the groundwater table between 10 and 30 feet BLS.

At each location, the chemical oxidant will be introduced into the subsurface at multiple depths, using either gravity feed or low-pressure injection methods. The injection points will be located 10-20 feet upgradient of MW-117 and will be placed along an east-west line at 10-30 feet spacings. The vendor will set the actual spacing depending on their review of existing Site data. Five injection points are anticipated. During the first injection event, 34 lbs of permanganate will be injected per point. Malcolm Pirnie will conduct oversight of the chemical oxidant injection.

Equipment, such as chemical mixing vehicles or storage vessels, used during the injection activities will be mobile or can be placed and removed within the 5-day period.

The vendor will record and provide all operational parameters including but not limited to the following:

- Chemical quantities injected (mass and concentration)
- Rate and periods of injection
- Temperature
- pH
- Vapor concentrations produced, if any

Groundwater samples will be collected at the times and locations noted in **Table 1-2** presented at the end of the FIP. Locations are presented on **Figure 1-9**.

Prior to injection of chemical oxidant, each injection point will be sampled to assess existing conditions at the point of injection. Samples will be collected from 0 to 5 feet below the groundwater table.

Sampling of MW-117 prior to injection is not necessary. The latest analytical (January 2003) data will be used for this well. Once the injection occurs, MW-117 will be sampled weekly to track the fluctuations in field parameters. Once there is no visible permanganate in the well (assumed five weeks after the injection), MW-117 will be sampled to establish final contaminant concentrations. The temporary well will be sampled on a similar schedule, however a pre-injection sample will be collected from the temporary well (see Table 1-2 for schedule). If contaminant levels are reduced by 80% or greater the treatability study will be deemed successful and no further injections will be necessary before full scale implementation of remedy.

If reduction of contaminants levels is below 80%, then another injection

at similar injection points will be performed. The contractor will decide the permanganate quantity based on the new situation. However, no more than 34 lbs of permanganate per point should be used in the second injection. Contractors should bid assuming the use of 34 lbs per point in the second injection. After the second injection, if contaminant reduction is below 80%, then the treatability study fails. Greater than 80% reduction would signify successful and no further injections will be necessary before full scale implementation of remedy.

In addition to the groundwater sampling, one saturated soil sample will be collected during the installation of the temporary well. At the end of the monitoring period, a saturated soil sample will be collected near the temporary well. Each sample will be collected at a depth of approximately 10 feet below the groundwater table. The samples will be analyzed for TCL VOCs, Total petroleum hydrocarbons (TPH), and Total Organic Carbon (TOC) to ascertain the effects of the treatment on the soil matrix.

Malcolm Pirnie will collect samples and analyze or ship to a laboratory as appropriate. Laboratory turnaround time (TAT) for samples will be 21 days. Collection procedures will be in accordance with the methods noted herein and the the Site FIP (Pirnie 1994). Quality control and assurance will be in accordance with the information noted herein and the Generic Quality Assurance Project Plan (Generic QAPP) for Fort Eustis (Pirnie 2002). Although this document was specifically prepared for the Fort Eustis Installation Restoration Program, it contains the most up-to-date sampling and QA/QC protocols and will be referenced and utilized for this project.

## 1.4 INVESTIGATION METHODOLOGIES

The investigation methodologies for decontamination, investigative derived waste management, and site restoration are described in the previously approved FIP dated December 1994 (Pirnie 1994). Procedures for monitoring well sampling and direct push soil and groundwater sampling are provided in the Generic QAPP under Group B: Data Generation and Acquisition Elements. Groundwater samples will be collected using low flow pumps; bailers will not be used.

## 1.5 DATA QUALITY

The data generated from the chemical and physical analysis will be of sufficient quality to evaluate the reduction of contamination from in situ chemical oxidation. To achieve these objectives, this Work Plan

Addendum incorporates procedures defined in the USEPA's document entitled "Data Quality Objectives Process for Superfund", Interim Final Guidance, EPA540-R-93-071, September 1993. To assist in the interpretation of data, the Superfund program has developed the following two descriptive data categories:

- **Screening Data with Definitive Confirmation.** Screening data are generated by rapid, less precise methods of analysis with less rigorous sample preparation. At least 10 percent of the screening data are confirmed using analytical methods and quality assurance/quality control (QA/QC) procedures and criteria associated with definitive data. Screening data QA/QC elements include the following:
  - Sample documentation
  - Chain of Custody
  - Sampling design approach
  - Initial and continuing calibration
  - Determination and documentation of detection limits
  - Analyte identification and quantification
  - Analytical error determination
  - Definitive confirmation
  
- **Definitive Data.** Definitive data are generated using rigorous analytical methods. Data are analyte-specific, with confirmation of analyte identity and concentration. Methods produce tangible raw data (e.g., chromatograms, spectra, digital values) in the form of paper printouts or computer-generated electronic files. For the data to be definitive, either analytical or total measurement error must be determined. Definitive data QA/QC elements include the following:
  - Sample documentation
  - Chain of Custody
  - Sampling design approach
  - Initial and continuing calibration
  - Determination and documentation of detection limits
  - Analyte identification and quantification
  - QC blanks (trip, method, rinse)
  - Matrix spike recoveries
  - Performance Evaluation (PE) samples (when specified)
  - Analytical error determination
  - Total measurement error determination

These data categories replace the references to analytical levels, quality assurance objectives and data use categories discussed in the Generic

QAPP.

The data category for samples collected at the LARC 60 site will include **Definitive Data** for off-site laboratory chemical analysis of groundwater samples collected. Compounds will be analyzed using the following SW-846 or EPA methods:

- TCL Volatile Organics (VOCs) – SW-846 Method 8260

A CLP-equivalent data package will be generated for the analytical data. A description of the standard SW-846 methodology items and the additional items to enhance the package to a CLP-equivalent are provided in **Table 1-3**. The CLP-equivalent data that will be generated will be sufficient for data validation in accordance with the IM1 (inorganic) and M2 (organic) procedures in *the Innovative Approaches to Data Validation*, 1995.

## 1.6 REPORTING

Malcolm Pirnie will prepare a Treatability Study Report after all data has been collected and evaluated. The Report will summarize the field activities, present the analytical results, provide an evaluation of the effectiveness of the technology, and how the treatability study results affect treatment costs for full scale implementation of the technology, if effective. The report will be prepared for review by USACE and will be appended to the Feasibility Report for use in the detailed analysis of remedial technology alternatives. The report will be formatted to include the following sections:

- Field activities
- Analytical results
- Interpretation of the data
- Conclusions on technology effectiveness
- Appendices for supporting data

## 1.7 SCHEDULE

The anticipated schedule for the treatability study is detailed in the table below. The actual start of the field work will be dependent on the approval of this work plan addendum, contracting of a chemical oxidation vendor, and weather.

Treatability Study Schedule	
Task	Date
Pre-injection Activities	Early August 2003
Chemical Oxidant Injection	Mid-August 2003
Post-Injection Groundwater Sampling: 1 week	Late August 2003
Post-Injection Groundwater/Soil Sampling: 1 month	Early October 2003
Treatability Study Report (Preliminary Draft)	Mid-December 2003

## 1.8 REFERENCES

*Final Work Plan, Field Investigation Plan: Remedial Investigation for Fort Story, Virginia.* Malcolm Pirnie, Inc. December 1994.

*Final Generic Quality Assurance Project Plan: Installation Restoration Program, Fort Eustis, Virginia.* Malcolm Pirnie, Inc. September 2002.

*Final Remedial Investigation Report: Firefighter Training Area, LARC 60 Maintenance Area, and Auto Craft Building Area.* Malcolm Pirnie, Inc. May 2002.

TABLE 1-1  
MONITORING WELL GROUNDWATER RESULTS  
LARC 60 MAINTENANCE AREA

Parameters	Well ID and Results for 1995/2000 Sampling Event								Well ID and Results for 2003 Sampling Event												EPA RBC Criteria(1)		
	6MW-1	6MW-2	6MW-3S	6MW-3D	6MW-4	MW-115	MW-117	MW-118	6MW-1	6MW-2	6MW-3S	6MW-3D	6MW-4	6MW-5D	6MW-5S	6MW-6	6MW-7	6MW-8	6MW-9	MW-115		MW-117	MW-118
<b>VOCs (ug/l)</b>																							
Benzene									<5	0.1	<b>0.6J</b>	<5	<5	<5	<5	<5	<5	<5	0.2	<5	<5	<5	0.32
cis 1,2-DCE	<5 / <5	<5	<5 / 2 J	<5	<5 / <5	<5 / <5	<b>20 / 1,900</b>	<5 / <5	<5	<5	<b>1J</b>	<5	<5	<5	<5	<5	<5	<5	<5	<5	<b>22</b>	<5	6.1
Ethylbenzene	<5 / <5	<5	<5 / <5	<5	<5 / <5	<5 / <5	66 / 76	<5 / <5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<b>29</b>	<5	130
MIBK	<5 / <b>50</b>	<5	<b>&lt;5 / 44</b>	<5	<b>&lt;5 / 19</b>	<5 / <5	<5 / <250	<5 / <5	<13	<13	<13	<13	<13	<13	<13	<13	<13	<13	<13	<13	<13	<13	14
Tetrachloroethene	<5 / <5	<5	<5 / <5	<5	<5 / <5	<5 / <5	<b>8.5 / &lt;50</b>	<5 / <5	<5	<5	<b>0.4J</b>	<5	<5	<5	<5	<5	<b>11</b>	<5	<5	<5	<b>2J</b>	<5	1.1
Toluene	<5 / <5	<5	<5 / <5	<5	<5 / <5	<5 / <5	<b>68 / 310</b>	<5 / <5	0.4	0.5	<b>0.8J</b>	<b>0.9JB</b>	<b>0.7J</b>	<b>1JB</b>	<b>1JB</b>	<b>1JB</b>	<b>1JB</b>	<b>0.7J</b>	<b>0.5</b>	<b>0.7J</b>	<b>1JB</b>	<b>1JB</b>	75
Trichloroethene	<5 / <5	<5	<5 / 1.3 J	<5	<5 / <5	<5 / <5	<b>18 / &lt;50</b>	<5 / <5	<5	<5	<b>1J</b>	<5	<5	<5	<5	<5	<5	<b>0.5J</b>	<5	<5	<b>1J</b>	<5	1.6
Vinyl chloride	<10 / <10	<10	<b>&lt;10 / 3.1 J</b>	<10	<10 / <10	<10 / <10	<b>&lt;10 / 8.6 J</b>	<10 / <10	<5	<5	<b>1J</b>	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	0.015
Xylenes	<5 / <10	<5	<5 / <10	<5	<5 / <10	<5 / <10	290 / 450	<5 / <10	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<b>130</b>	<5	1,200
<b>Miscellaneous (mg/l)</b>																							
TSS	NT / <5	NT	NT / <5	NT	NT / <5	NT / <5	NT / 60	NT / <5															-
TDS	NT / 74	NT	NT / 130	NT	NT / 280	NT / 110	NT / 65	NT / 160			187					189					207		-
<b>Total Metals (ug/l)</b>																							
Arsenic	NT / <3	<10	<b>14 / &lt;3</b>	NT	NT / <3	NT / <3	<b>91 / 21</b>	<10 / <3	<3.6	<3.6	<3.7	<3.7	<3.7	<b>3.9B</b>	<3.7	<3.7	<3.7	<3.7	<3.6	<3.7	<b>26.8</b>	<3.7	0.045
Iron	NT / <b>4,600</b>	<b>12,000</b>	<b>16,000 / 2,700</b>	NT	NT / 1,300	NT / <b>6,900</b>	<b>14,000 / 17,000</b>	<b>3,500 / 270</b>	<b>4,020</b>	<b>8,280</b>	<b>7,510</b>	<b>32,000</b>	<b>4,600</b>	<b>26,900</b>	95	720	60B	1,040	<b>3,790</b>	<b>7,291</b>	<b>9,240</b>	<b>2,360</b>	2,200
<b>Dissolved Metals (ug/l)</b>																							
Arsenic	NT / <3	<10	<10 / <3	NT	NT / <3	NT / <3	<b>40 / 14</b>	<10 / <3	<b>3.8B</b>	<b>4.2B</b>	<3.6	<3.6	<3.6	<3.6	<3.6	<3.6	<3.6	<3.6	<3.6	<b>4.2B</b>	<b>27.1</b>	<3.6	0.045
Iron	NT / <b>3,700</b>	<b>9,000</b>	<b>6,900 / 2,500</b>	NT	NT / 1,200	NT / <b>3,600</b>	<b>6,800 / 15,000</b>	<50 / 70	<b>2,200</b>	<b>8,340</b>	<b>8,270</b>	<b>33,300</b>	1,820	<b>19,900</b>	43	705	23	1,150	<b>3,910</b>	<b>7,100</b>	<b>8,840</b>	140	2,200

Notes:

- (1) EPA Region III Risk-based Concentration Criteria for Tap Water
- (2) Virginia Groundwater Standard for Petroleum Hydrocarbons
- (3) NT - Not tested
- (4) USEPA Action Level for Lead in Drinking Water

- K - Reported value may be biased high
- J - Estimated concentration (result between MDL and PQL for organics)
- B - Estimated concentration (result between MDL and PQL for inorganics)
- E - Reported value is estimated because interference detected

Organics detected are bolded and italicized

Concentrations above EPA Region III RBCs for tap water are bolded and shaded.

**Table 1-2 Groundwater/Soil Monitoring Schedule and Parameters**

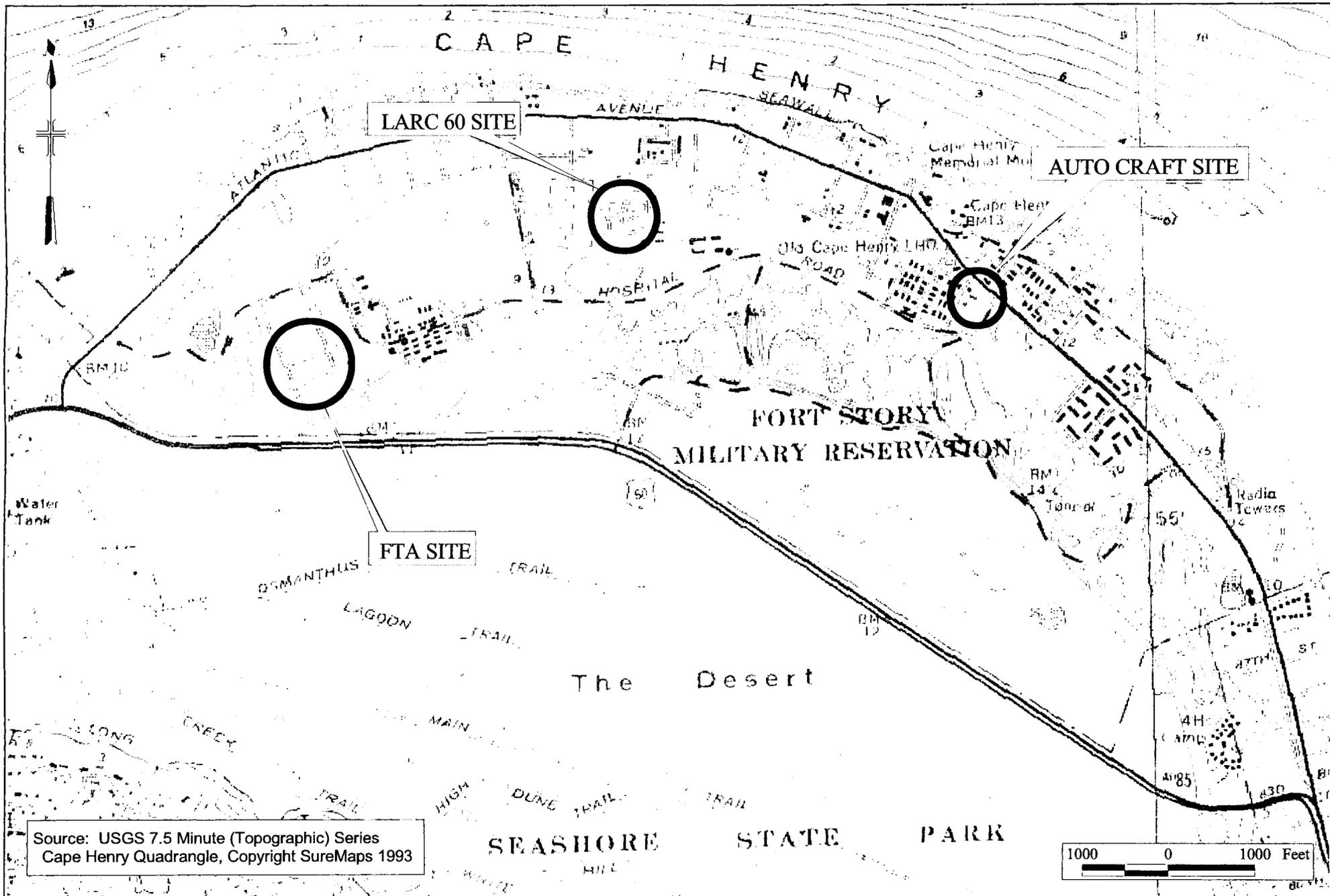
Parameter	Pre-injection		Post-injection: Weekly (until permanganate is not visible)	Post-injection: Approximately 5 weeks out	
	Direct Push @ injection points	Temporary Well and MW-117 <sup>(1)</sup>	Temporary Well and MW- 117	Direct Push Soil Sample <sup>(2)</sup>	Temporary Well and MW-117
VOCs		X		X	X
TPH		X		X	X
Total Organic Carbon		X		X	X
Permanaganate			*		*
Chloride	*	*	*	X	*
Temperature	*	*	*	X	*
Redox Potential	*	*	*	X	*
Ferrous Iron	*	*	*	X	*
Specific Conductivity	*	*	*	X	*
pH	*	*	*	X	*

Notes:

- (1) Sample MW-117 for field parameters only during pre-injection round. Collect saturated soil sample during installation of temporary well.
- (2) Saturated soil sample to be collected near the temporary well.
- X Sample analyzed at off-site lab
- \* Sample analyzed in field with instruments or field test kits. Permanaganate will be monitored by visual observation of purple color.

**TABLE 1-3  
LABORATORY DATA PACKAGE**

ORGANICS PACKAGE	INORGANICS PACKAGE
<b>SW-846 Data Package (CLP-Equivalent)</b>	
<p>Standard Items:</p> <ul style="list-style-type: none"> <li>Envision Forms</li> <li>Title Page</li> <li>Cross Reference Index</li> <li>Case Narratives</li> <li>Form 1 (Sample Results)</li> <li>Form 2 (Surrogate Recoveries)</li> <li>Form 3 (MS/MSD Recoveries)</li> <li>Form 4 (Method Blank Results)</li> <li>Form 5 (GC/MS Performance Check)</li> <li>Form 6 (Initial Calibration)</li> <li>Form 7 (Continuing Calibration)</li> <li>Form 8 (GC/MS IS Area)</li> <li>Form 8 (GC Analytical Sequence)</li> <li>Dry Weight Log</li> <li>Extraction Log</li> <li>Run Logs (GC/MS Only)</li> <li>Internal COC's</li> <li>Sample COC's</li> <li>Analytical Run Logs</li> </ul> <p>Additional Items:</p> <ul style="list-style-type: none"> <li>Raw Data</li> <li>Preparation Logs</li> <li>Data Summary Package</li> <li>TIC's</li> <li>Run Logs</li> <li>pH Logs</li> <li>"J" Values (GC/MS Only)</li> <li>Cross Reference Index</li> </ul>	<p>Standard Items:</p> <ul style="list-style-type: none"> <li>Quattro Forms</li> <li>Case Narratives</li> <li>Sample Results</li> <li>QC Blank Results</li> <li>Spike/Duplicate Results</li> <li>ICV/CCV (Calibration Data)</li> <li>LCSS/LCSW Results</li> <li>ICP Interference Check Data</li> <li>ICP Linear Range</li> <li>Form 5A (Spike Recoveries)</li> <li>ICP Post Spike</li> <li>Dry Weight Logs</li> <li>Internal COC's</li> <li>Sample COC's</li> </ul> <p>Additional Items:</p> <ul style="list-style-type: none"> <li>Raw Data</li> <li>Preparation Logs</li> <li>Data Summary Package</li> <li>Run Logs</li> <li>pH Logs</li> <li>Cross Reference Index</li> </ul>



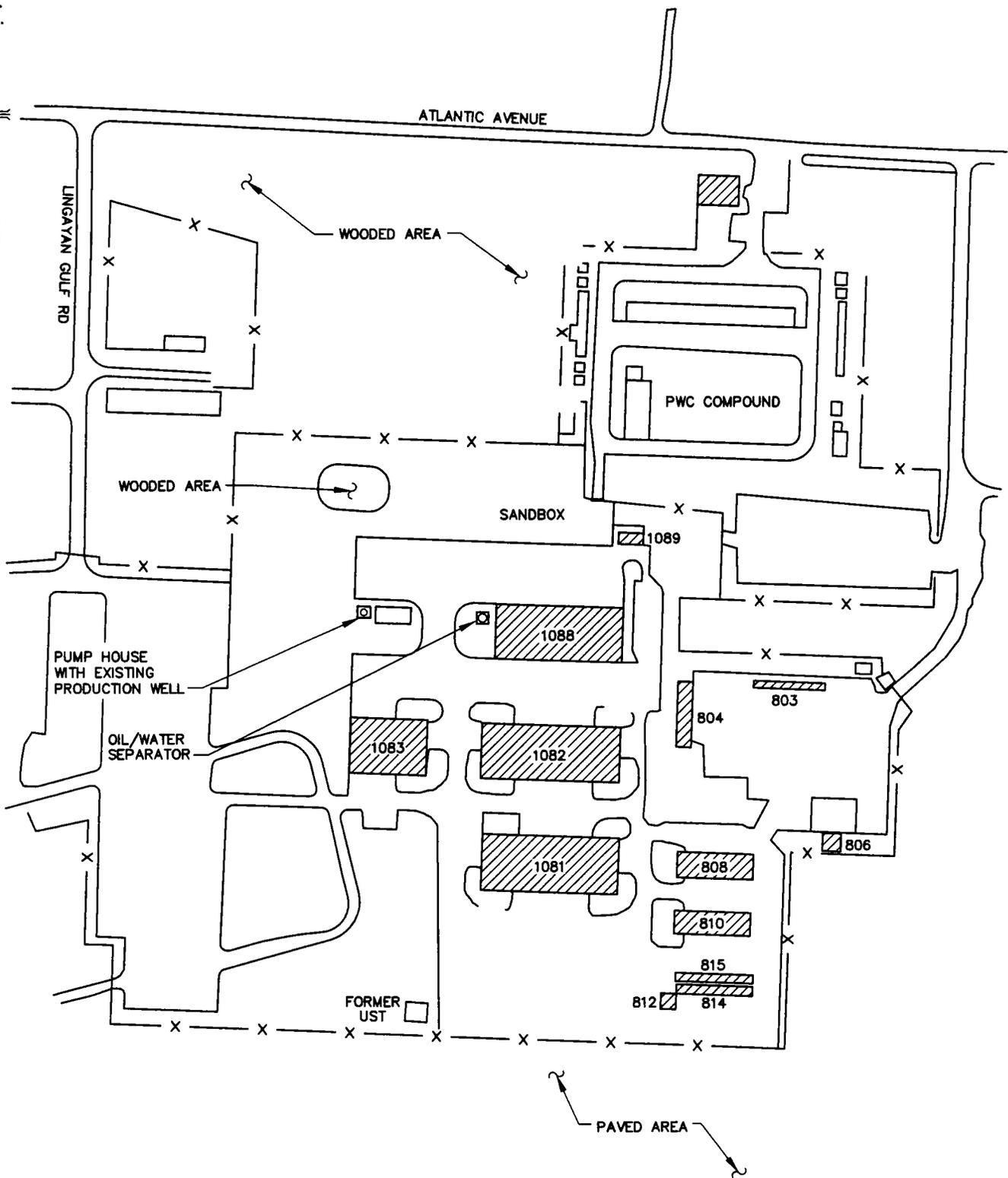
Source: USGS 7.5 Minute (Topographic) Series  
Cape Henry Quadrangle, Copyright SureMaps 1993

**MALCOLM  
PIRNIE**

**FORT STORY, VIRGINIA  
REMEDIAL INVESTIGATION REPORT  
SITE LOCATION MAP**

MAY 2003

FIGURE 1-1

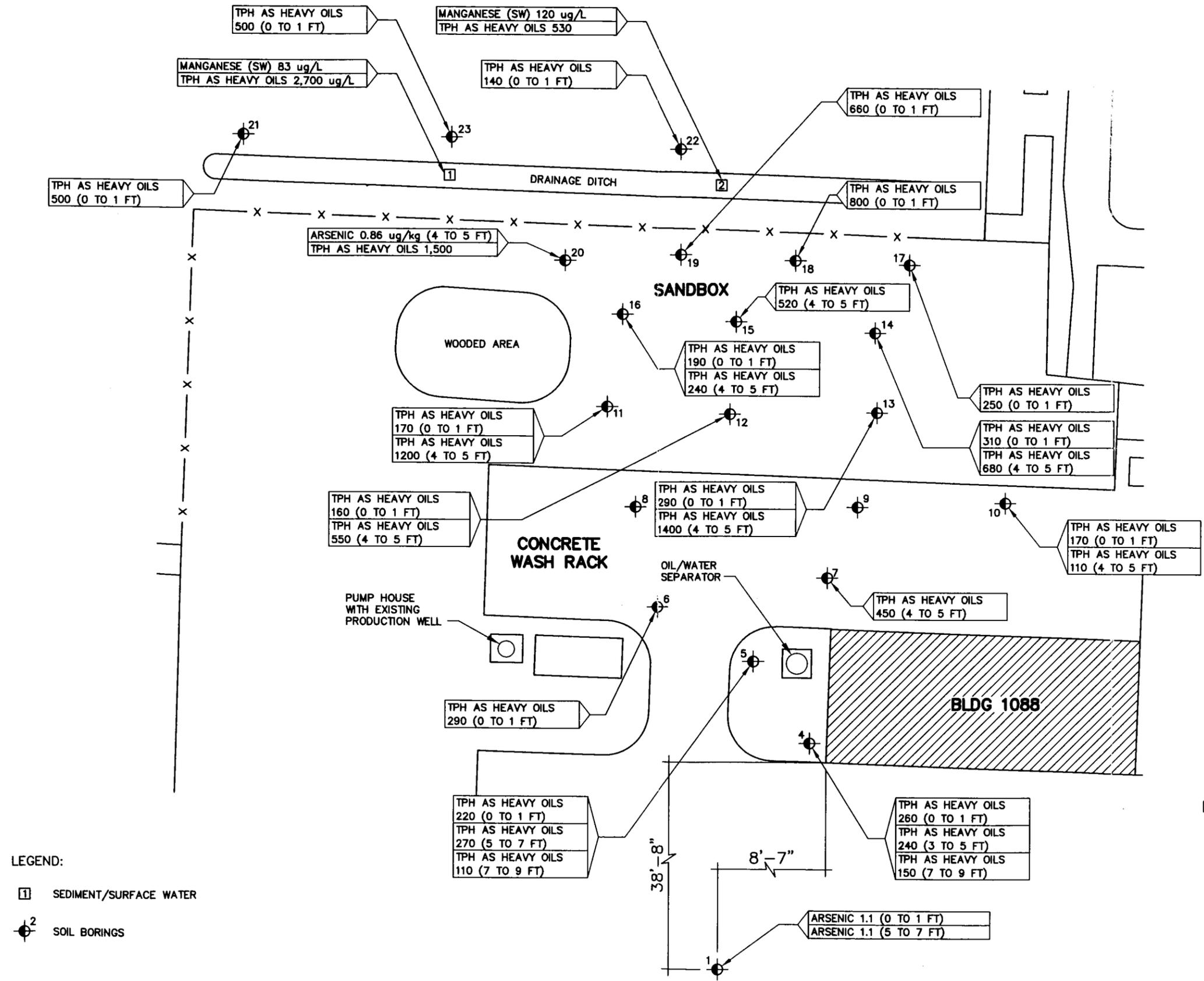


**MALCOLM  
PIRNIE**

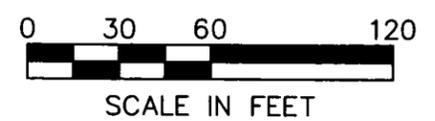
FORT STORY, VIRGINIA  
TREATABILITY STUDY WORK PLAN  
**SITE MAP**

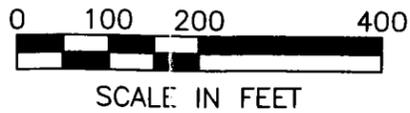
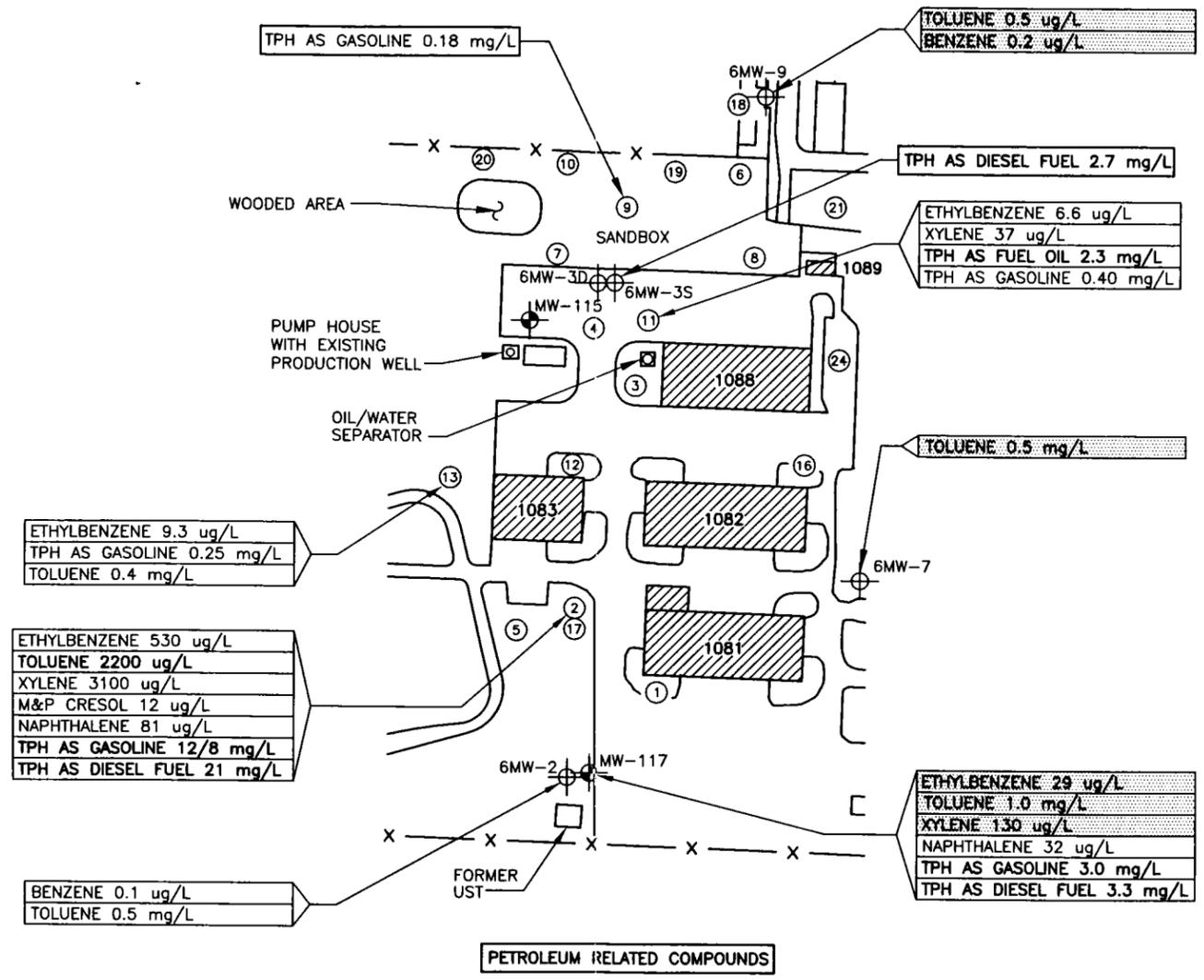
MALCOLM PIRNIE, INC.

MAY 2003  
FIGURE 1-2



NOTE:  
CONCENTRATIONS IN mg/kg UNLESS  
OTHERWISE NOTED.





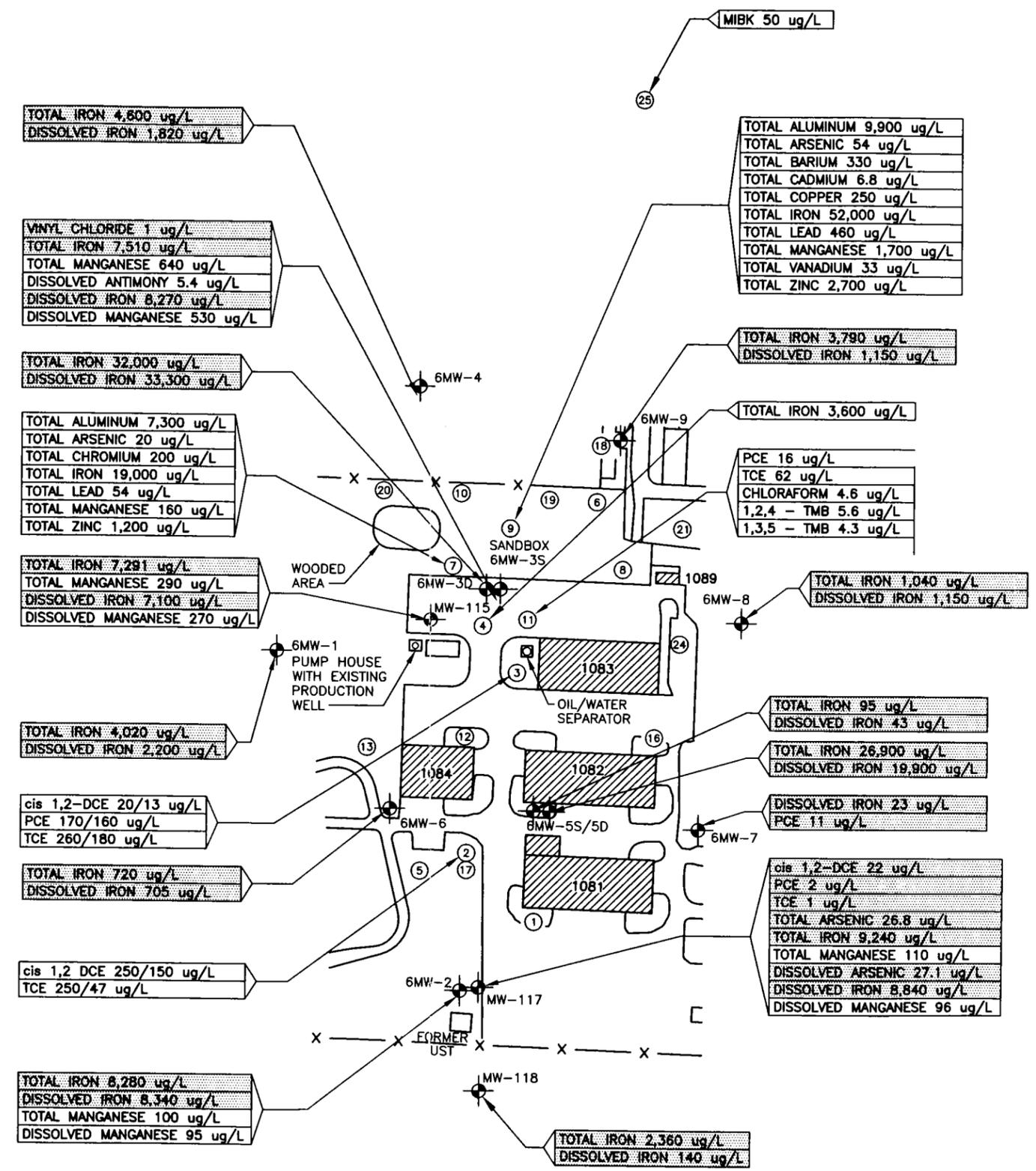
**LEGEND:**

- EXISTING MONITORING WELLS
- NEW WELLS
- DPT GROUNDWATER POINTS
- HIGHLIGHTED DATA FROM 2003
- DATA FROM 1995/2000

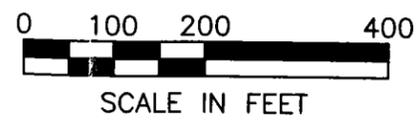


**LEGEND:**

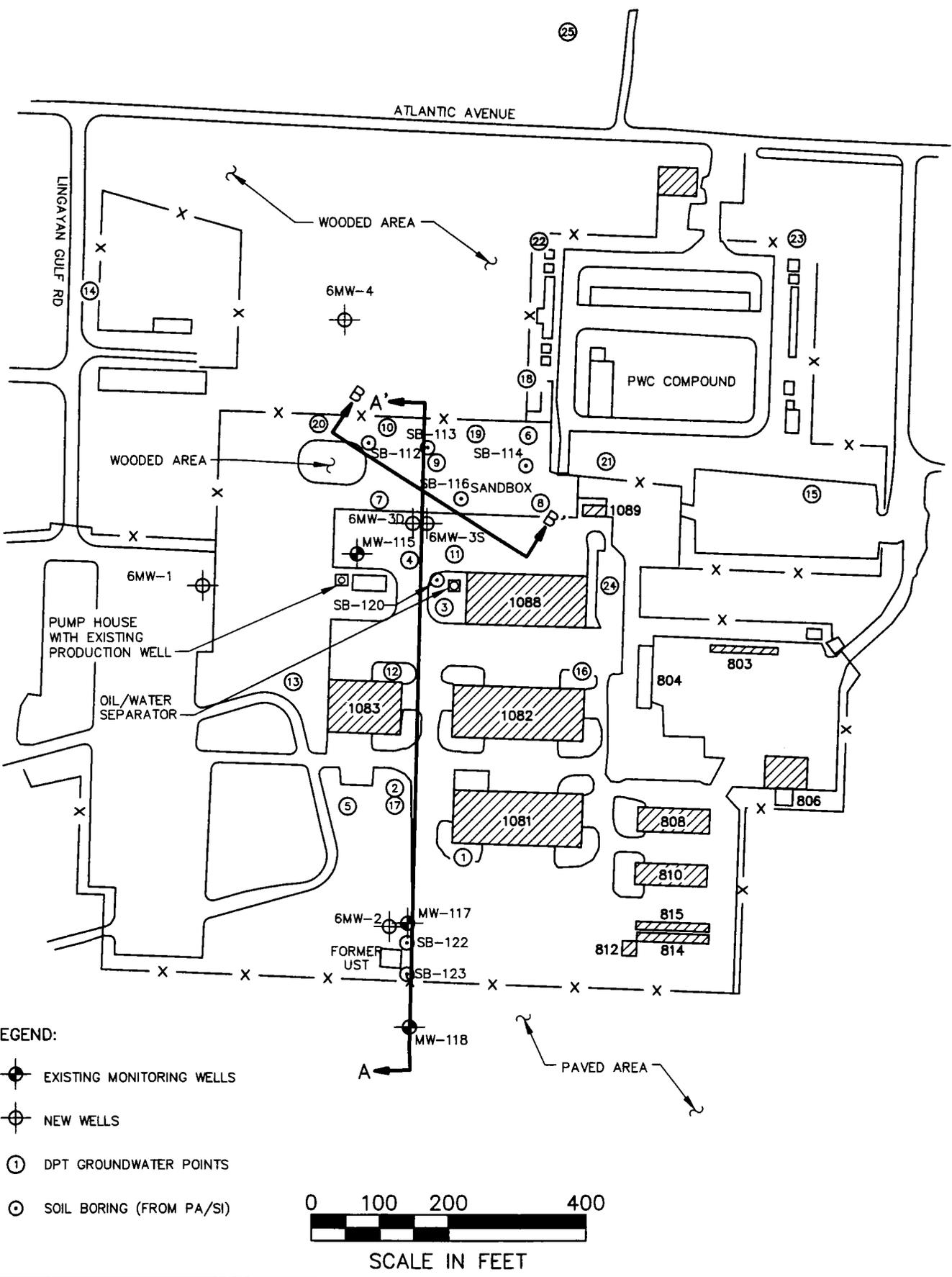
- EXISTING MONITORING WELLS
- DPT GROUNDWATER POINTS
- HIGHLIGHTED DATA FROM 2003
- DATA FROM 1995/2000



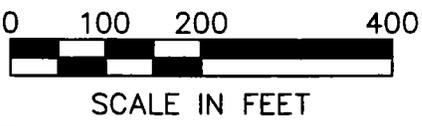
CHLORINATED SOLVENTS/METALS



NOTE: WHEN AVAILABLE BOTH OFF-SITE/ON-SITE ANALYTICAL RESULTS ARE SHOWN. ALL OTHER VALUES SHOWN ARE OFF-SITE LABORATORY ANALYSES.

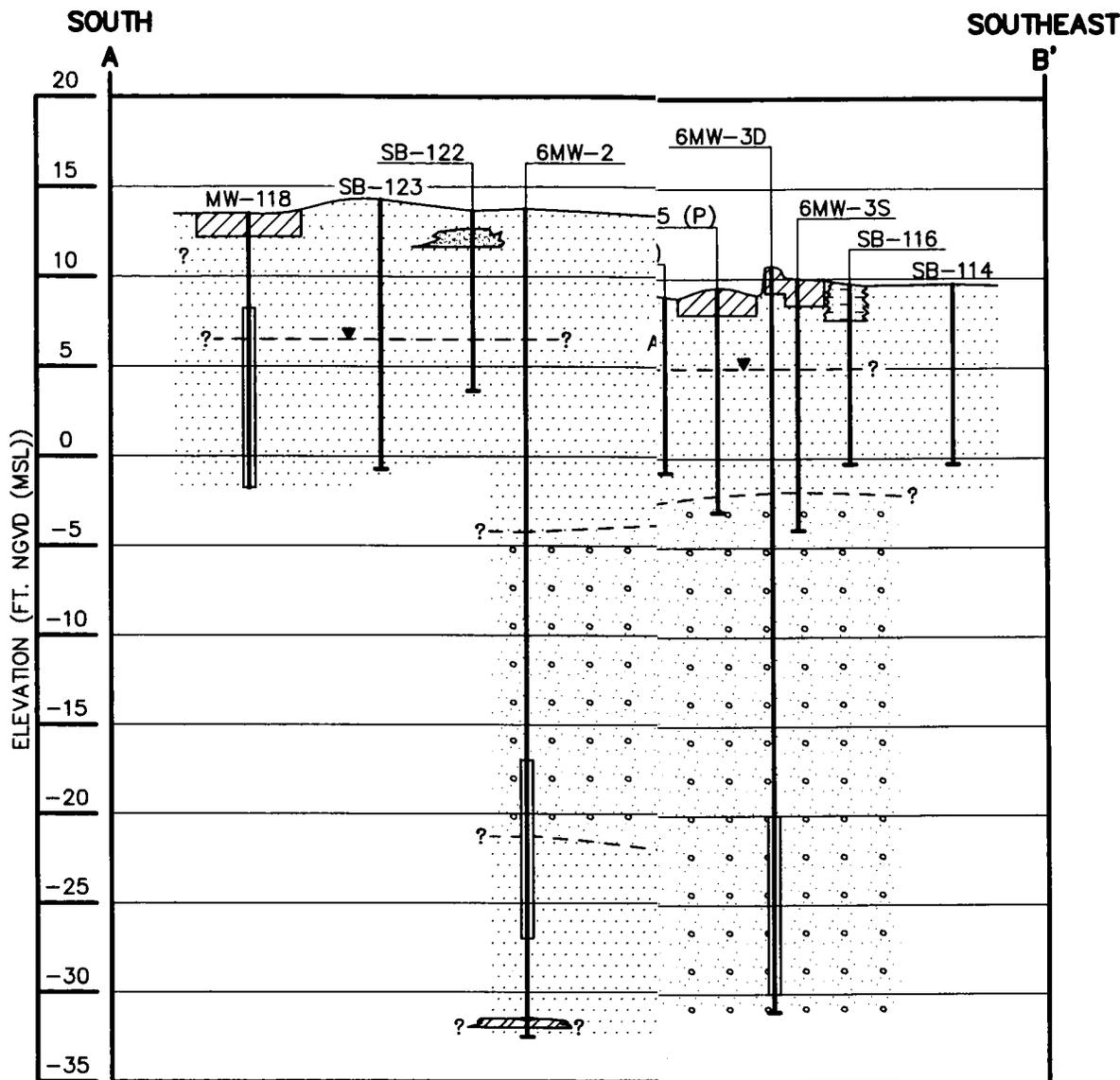


- LEGEND:**
- EXISTING MONITORING WELLS
  - NEW WELLS
  - DPT GROUNDWATER POINTS
  - SOIL BORING (FROM PA/SI)



FORT STORY, VIRGINIA  
 TREATABILITY STUDY WORK PLAN  
**LARC 60 CROSS SECTION TRAVERSES**

MALCOLM PIRNIE, INC.  
 MAY 2003  
 FIGURE 1-6



**LEGEND**

-  SM/SILTY SAND
-  SP/SAND MEDIUM GRAINED
-  1-SW/SAND FINE WITH GRAVEL
-  2-SW/SAND COARSE WITH GRAVEL
-  OL/ORGANIC SILT AND SILTY CLAY
-  SC/INORGANIC CLAY
-  CONCRETE/ASPHALT WITH SAND/GRAVEL

? - ▽

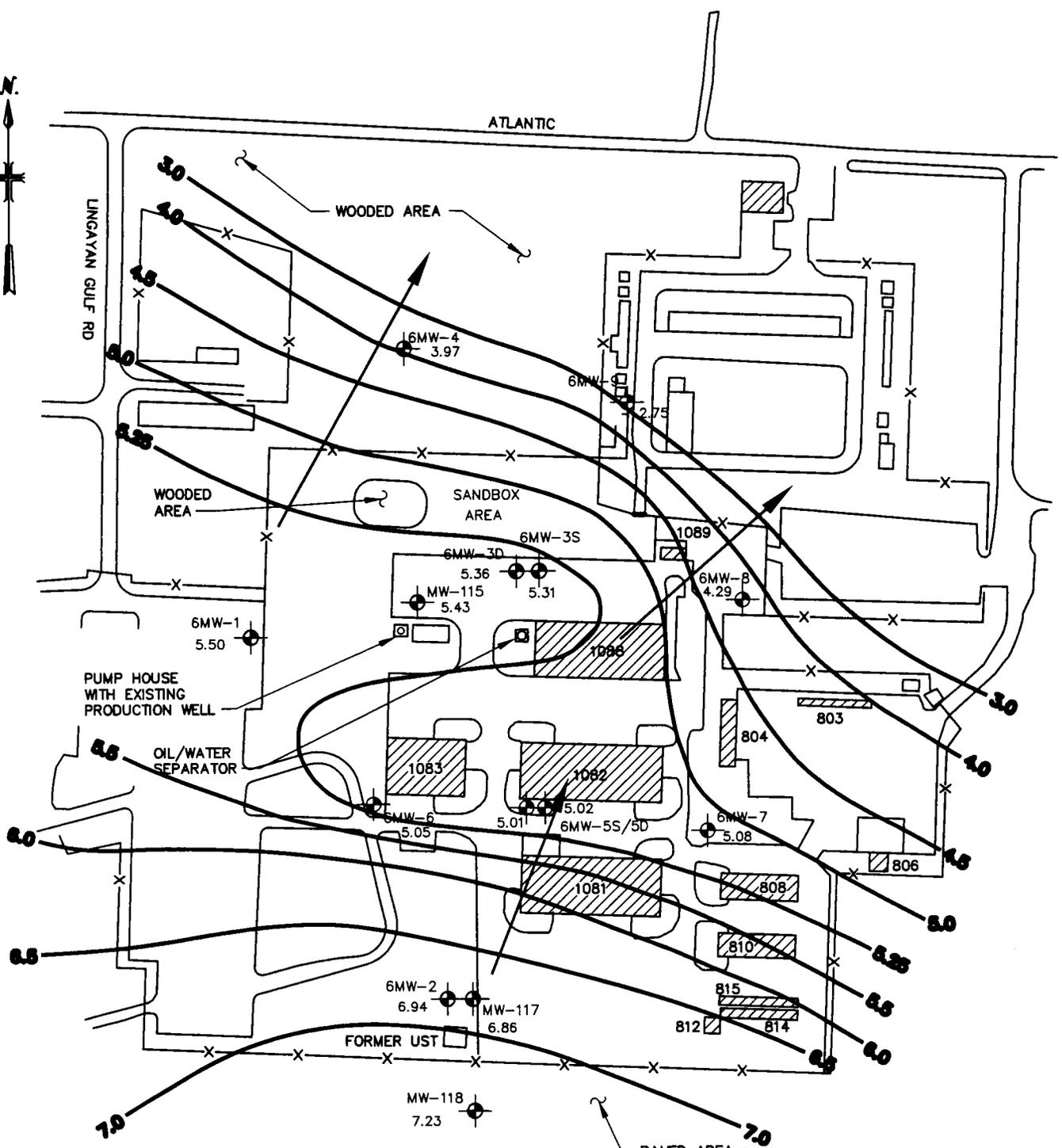
(P)

WELL ELEVATION IS FROM TOP OF MEASURED ON 5/11/95.

ELEVATION FROM TABLE 2-1 OF

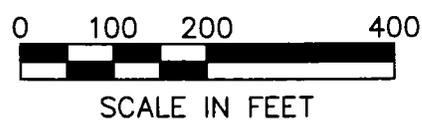
CONDUCTIVITY (K) VALUES ARE NOT REPORTED FOR SM, 1-SW, 2-SW AND SC UNITS. CONDUCTIVITY VALUES FROM TABLE 2-1.

WELL MW-115 INFERRED BASED ON ADJACENT



**LEGEND:**

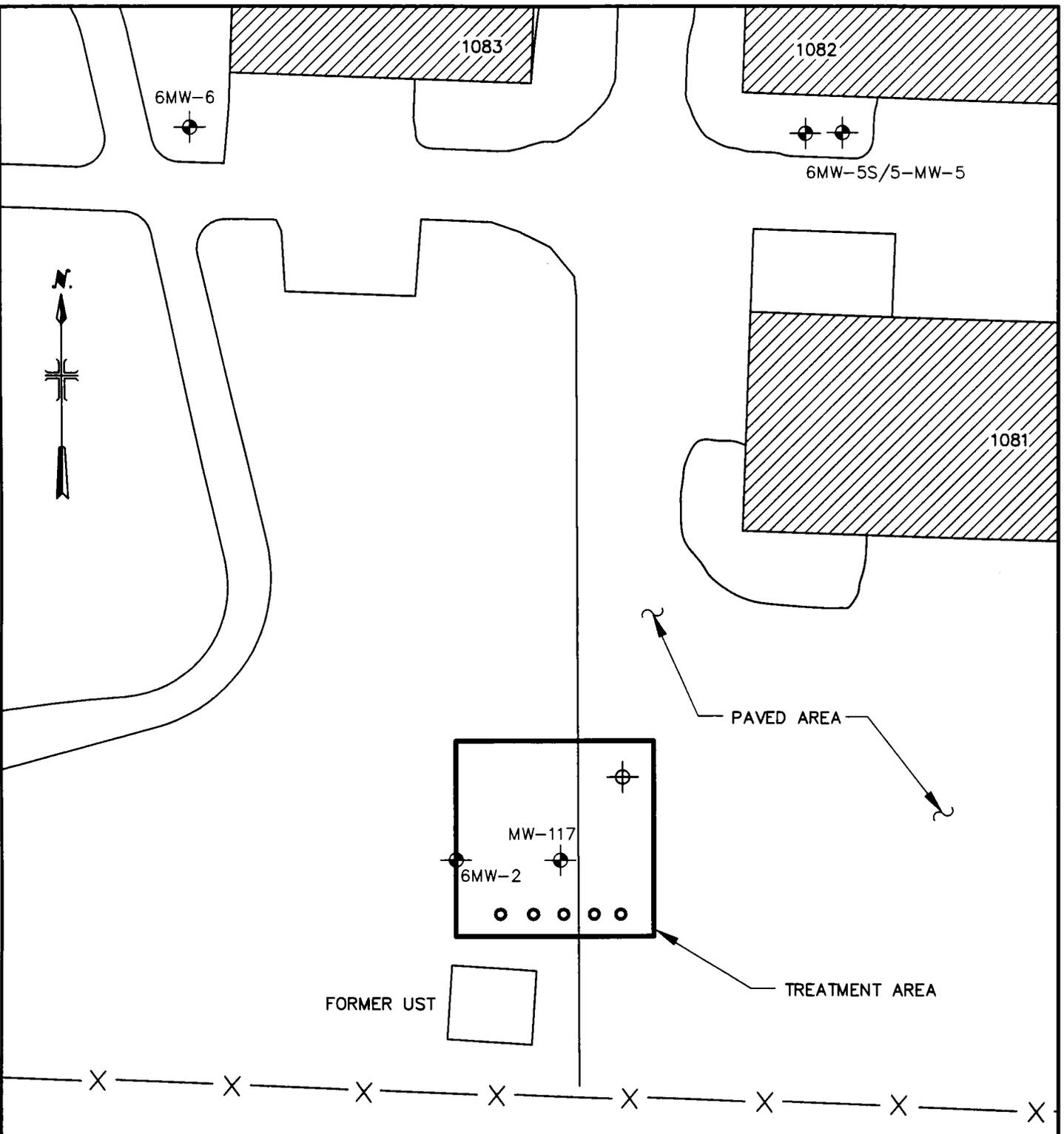
- EXISTING MONITORING WELLS
- GROUNDWATER FLOW DIRECTION  
(GROUNDWATER ELEVATIONS ON 01/29/2003)



**MALCOLM  
PIRNIE**

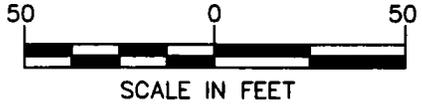
FORT STORY, VIRGINIA  
TREATABILITY STUDY WORK PLAN  
LARC 60 MAINTENANCE AREA  
WATER TABLE ELEVATIONS

MALCOLM PIRNIE, INC.  
MAY 2003  
FIGURE 1-8



LEGEND:

-  EXISTING MONITORING WELL
-  TEMPORARY WELL
-  INJECTION POINTS (DIRECT PUSH)



FORT STORY, VIRGINIA  
TREATABILITY STUDY WORK PLAN  
TREATMENT AREA

MALCOLM PIRNIE, INC.  
MAY 2003  
FIGURE 1-9

## Draft Work Plan Addendum

## 2.1 INTRODUCTION

This section in conjunction with the Generic Quality Assurance Project Plan (Generic QAPP) dated September 2002 and site-specific Chemical Data Acquisition Plan (CDAP) for the LARC 60 Site, dated December 1994, and the Field Investigation Plan (FIP) (Section 1.0 of this Work Plan Addendum) establishes procedures for the collection, analysis and evaluation of data that will be legally and scientifically defensible for the site.

The site description and history as well as the Data Quality Objectives typically discussed in this section were previously described in Section 1 of this Addendum and in the approved December 1994 FIP and CDAP and are not discussed further.

## 2.2 FIELD ACTIVITIES

A discussion of field equipment requirements, sample and analysis program, and sampling and preservation procedures will be provided in this section.

### 2.2.1 Field Equipment

Equipment required to implement the field activities include:

- Field Log
- Photoionization Detector (PID)
- Water Quality Meter (pH, temperature, and conductivity)
- Redox meter
- Hach DR 800 Series Colorimeter
- Portable gas generator/pump control box (provided by the facility)
- Teflon-lined tygon tubing
- Sample collection containers
- Personal protective equipment including latex gloves, nitrile gloves, steel toed boots, and work gloves.

Calibration and maintenance requirements for field instrumentation are provided in Section 6.3 of the December 1994 CDAP.

### 2.2.2 Sampling Program

Numerous groundwater samples will be collected during the study for on-site or off-site analysis. Details on the locations and types of samples are

## Draft Work Plan Addendum

provided in Section 1.3 and **Table 1-2** of this Addendum.

### 2.2.3 Sampling and Preservation Procedures

Procedures for the collection of groundwater samples are provided in Generic QAPP under Group B: Data Generation and Acquisition Elements. Container type and volume, preservation, and holding time requirements for sampling being shipped for off-site analysis are provided in Table 1 of the Generic QAPP.

Sample containers will be preserved by Severn Trent Savannah Laboratories prior to shipment to Malcolm Pirnie.

### 2.2.4 Analytical Program

The total number of field samples and QA/QC samples for off-site analysis are as follows:

Groundwater Samples:	3
Duplicates:	2
Trip Blanks:	2
MS/MSD:	2
Soil Samples:	2
Duplicates:	2
Trip Blanks:	2
MS/MSD:	2

### 2.2.5 Field Documentation

For all sampling events, entries shall be made in a field notebook and logbook as specified in Section 4.4 of the December 1994 CDAP.

Field custody procedures including sample identification and chain-of-custody are specified in Section 5.2 of the December 1994 CDAP.

Sample shipment requirements are provided in Section 5.3 of the December 1994 CDAP.

### **2.3 LABORATORY ANALYTICAL PROCEDURES**

Severn Trent Savannah Laboratories will provide the necessary analysis of the groundwater samples by the following methods:

- VOC: Method 8260 (chlorinated solvents and naphthalene)
- TPH: Method 8015 (DRO/GRO)
- TOC: Method 415.1

### 3.1 INTRODUCTION

This section in conjunction with the generic and site specific Site Safety and Health Plan (SSHP) for the LARC 60 Site, dated December 1994, establishes procedures to protect the health and welfare of both investigative personnel and the surrounding community during the performance of field investigations on and in the immediate vicinity of the LARC 60 Site.

The December 1994 SSHP addresses the issues and concerns of the overall project site and the ubiquitous hazards that are found on the base. The site-specific SSHP supplements the information in the generic SSHP and addresses the chemicals and associated hazards that are unique to the site. The site description and history was previously described in Section 1 of this Addendum and in the previously submitted and approved December 1994 FIP and SSHP and will not be discussed further.

### 3.2 HAZARD ASSESSMENT

#### 3.2.1 Description of Field Activities

Malcolm Pirnie will oversee the installation of a temporary well, the injection of oxidant, and collect soil and groundwater samples to chemically characterize the effects of the permanganate treatment. A site map with proposed treatment area and sampling locations is provided as **Figure 1-9** in this Addendum. A summary of the treatability study activities is provided in Section 1.3 of this Addendum.

#### 3.2.2 Summary of Project Risks

Malcolm Pirnie personnel must be cognizant of the health hazards, chemical, physical and biological, associated with the individual field activities to be conducted and the physical environment in which the work will take place. A hazards analysis of work related tasks is provided in **Table 3-1**. Hazards related to the well installation and sampling tasks are discussed below.

For the oxidant injection, the permanganate vendor will be required to provide their own SSHP for the activities and chemicals used. Malcolm Pirnie personnel will review the vendor's SSHP prior to mobilizing to the field to prepare for overseeing the oxidant injection and to coordinate Malcolm Pirnie's SSHP with the vendors. As part of their SSHP, the vendor will provide MSDS on the specific chemicals used and a summary

## Draft Work Plan Addendum

of the work elements and equipment to be used in the oxidant injection.

**Chemical Hazards**

While conducting sampling, a potential exists for exposure to chemical contaminants through ingestion, inhalation and skin contact. A toxicological summary of chemical contaminants previously detected at the site above EPA Region III RBC values, which are regulated by the Occupational Safety and Health Administration (OSHA), are listed in **Table 3-2**. General chemical, physical, and toxicological data, protective exposure standards, and first aid procedures for each contaminant of concern are given in **Table 3-2**.

During monitoring well installations and sampling, potential inhalation hazards may be present. A Photoionization Detector (PID) will be used to monitor the breathing zones of personnel during the monitoring well sampling activities. Action levels for volatile compounds are provided in Table 10-1 of the December 1994 SSHP. More detailed air monitoring with a flame ionization detector (e.g., Photovac organic vapor analyzer) to ascertain specific compounds and concentrations may be necessary if initial breathing zone levels persist above action levels.

Dermal contact with contaminants can be avoided through the use of proper personal protective equipment as described in Attachment II-4.0 of the December 1994 site-specific SSHP.

**Physical Hazards**

The primary physical hazard which may be encountered during field investigations is injury due to working around heavy equipment. To address this hazard, the following protective equipment shall be used at all times:

- Hard hats
- Steel-toed work boots
- Durable work gloves

This protective clothing shall be utilized in conjunction with the PPE requirements, if any, specified in Attachment II-4.0 in the December 1994 site specific SSHP for protection from chemical hazards. Other potential physical hazards include slip, trip and fall, noise, fire or explosions, dust inhalation, insects, and flying particles.

## Draft Work Plan Addendum

**3.3 SITE CONTROL**

The site control will be required as follows:

**Well Installation:** Provide a zone of 20 feet around the back of the drill rig or direct push rig. Communication with rig operator is essential to maintain a safe work zone. Personal protective equipment, training, communications and decontamination requirements and procedures are specified in the December 1994 generic and site specific SSHPs.

**Oxidant Injection:** Work zone dimensions will be based on vendor's SSHP. Communication with vendor is essential to maintain a safe work zone. Personal protective equipment, training, communications and decontamination requirements and procedures are specified in the December 1994 generic and site specific SSHPs; coordination of between these requirements and those of the vendor are required.

**Groundwater monitoring:** Provide a zone of 20 feet around the monitoring wells during sampling. Only sampling personnel should be within this exclusion zone. Personal protective equipment, training, communications and decontamination requirements and procedures are specified in the December 1994 generic and site specific SSHPs.

**TABLE 3-1  
HAZARDS ANALYSIS**

Work Task	Slip/ Trip/Fall	Noise Exposure	Fire/ Explosions	Dust Inhalation	Vapor/Gas Inhalation	Insects/ Bio Hazards	Exposure to Contaminated Media	Flying Particles
Monitoring Well Installation	X	X	X		X	X	X	X
Oxidant Injection	X	X	X		X	X	X	X
Groundwater/Soil Sampling	X				X	X	X	

**TABLE 3-2  
TOXICOLOGICAL SUMMARY**

Compound	Vapor Pressure (mm Hg)	Ionization Potential (eV)	PEL	Target Organs	Route of Entry	Symptoms and Toxicological Effects	First Aid
<b>Inorganics</b>							
Iron	0	N/A	None	Eyes, skin, liver, respiratory system, and GI tract	Inhalation, Absorption, Ingestion, Skin/eye contact	Diarrhea, vomiting, and possible liver damage	Eye: Irrigate immediately Skin: Wash with soap Breath: Respiratory support Swallow: Immediate medical attention
Manganese	0	N/A	0.2 mg/m <sup>3</sup>	Resp system, CNS, blood, and kidneys	Inhalation, Ingestion	Insomnia, asthenia, dry throat, Parkinson's, chest tightness, kidney damage, and metal fume fever.	Breath: Respiratory support Swallow: Immediate medical attention
<b>Organics</b>							
cis 1,2-DCE	180 - 265	9.65	200 ppm	Eyes, CNS, respiratory system	Inhalation, Absorption, Ingestion, Skin/eye contact	Irritation of eyes, respiratory system, CNS depression	Eye: Irrigate immediately Skin: Wash with soap Breath: Respiratory support Swallow: Immediate medical attention
MIBK	16	9.3	100 ppm	Eyes, skin, resp system, liver, CNS, and kidneys	Inhalation, Absorption, Ingestion, Skin/eye contact	Irritation of eyes, skin, mucous membranes, nausea, dizziness, and liver and kidney damage	Eye: Irrigate immediately Skin: Wash with soap Breath: Respiratory support Swallow: Immediate medical attention
Tetrachloroethene	14	9.32	100 ppm	Eyes, skin, resp system, liver, CNS, and kidneys	Inhalation, Absorption, Ingestion, Skin/eye contact	Irritation of eyes, skin, mucous membranes and resp system, nausea, dizziness, and liver damage	Eye: Irrigate immediately Skin: Wash with soap Breath: Respiratory support Swallow: Immediate medical attention

**TABLE 3-2  
TOXICOLOGICAL SUMMARY**

Compound	Vapor Pressure (mm Hg)	Ionization Potential (eV)	PEL	Target Organs	Route of Entry	Symptoms and Toxicological Effects	First Aid
Toluene	21	8.82	200 ppm	Eyes, skin, resp system, liver, CNS, and kidneys	Inhalation, Absorption, Ingestion, Skin/eye contact	Irritation of eyes, skin, mucous membranes, fatigue, nausea, dizziness, and liver and kidney damage	Eye: Irrigate immediately Skin: Wash with soap Breath: Respiratory support Swallow: Immediate medical attention
Trichloroethene	58	9.45	100 ppm	Eyes, skin, resp system, liver, CNS, and heart	Inhalation, Absorption, Ingestion, Skin/eye contact	Irritation of eyes, skin, vertigo, dizziness, nausea, and liver damage	Eye: Irrigate immediately Skin: Wash with soap Breath: Respiratory support Swallow: Immediate medical attention

Notes: N/A - Data not available.  
 PEL - OSHA Permissible Exposure Limit  
 CNS - Central Nervous System

**LARC**  
**Treatability Study**

**Appendix A**

## **Appendix A: Excerpt from USACE Scope of Work**

### **Treatability Testing**

#### **Treatability Test(s) Work Plan**

The A/E shall prepare a Treatability Test Work Plan which will include the remedial technology descriptions, test objectives, any pilot plant installation and startup procedures, operation and maintenance issues, specialized equipment and materials required, any experimental procedures, the treatability test plan including any variables for the testing, analytical methods required, data management issues, health and safety, and residual management. The plan shall be prepared in preliminary draft, draft, and final versions.

Specifics of the Work Plan will not be known until initial screening of technologies and alternatives have been conducted as part of the FS. However, based on the contaminants at the site (primarily VOCs) some preliminary technologies to be considered for the testing include air sparing/soil vapor extraction (AS/SVE), bioremediation, in-situ chemical oxidation, and reactive iron wall.

#### **Bench-Scale and/or Pilot-Scale Treatability Test**

The A/E shall implement the requirements of the Treatability Test Work Plan. All analytical data for the chemicals of potential concern generated as part of the testing will be validated in accordance with the IM1 (inorganic) and M2 (organic) procedures in the *Innovative Approaches to Data Validation*, 1995.

#### **Data Analysis and Interpretation**

The A/E shall interpret the test data on the technology's effectiveness, implementability, and cost and compare anticipated results versus actual results.

**LARC**  
**Treatability Study**

**Appendix B**



PROJECT: FT STORY - LAGG 60 PROJECT NO: 0285-589  
 DATE: 3/22/95 LOCATION: FOOT STORY - VIRGINIA BEACH, VA  
 ELEVATION: \_\_\_\_\_ DATUM: \_\_\_\_\_

SAMPLE				DEPTH	SPRAT	SOIL DESCRIPTION	WELL CONSTR.	REMARKS
no.	depth	recov ery %	blows per 6"					
S-1	0-2	14	2-16-11-15			2.54 5/3 SAND, FINE,		
S-2	2-4	16	8-9-11-13			10.2 4/3 SAND, FINE TO MEDIUM, SOME HEAVIES, MOIST		
S-3	4-6	12	4-9-6-6			10.2 7/3 SAND, FINE WITH SOME MEDIUM		
S-4	6-8	12	4-4-4-4			2.54 7/3 SAND MEDIUM WITH FINES, WET		HNU @ 10 ODOR
S-5	8-10	4	10-8-5-3			2.54 7/3 SAND AND SOME ROCKS,		HNU @ 30
S-6	10-12	20	3-4-4-7			2.54 7/2 SAND, MEDIUM TO FINE, SOME HEAVIES, WET, ALSO ZONE OF 2.54 6/6 SAND		HNU @ 3-
S-7	12-14	20	2-7-7-2			SAME AS ABOVE		HNU @ 1
S-8	14-16	24	5-4-2-2			2.54 7/2 SAND, MEDIUM, SOME FINES, WET		HNU @ 1
S-9	16-18	24	2-3-3-5			5.4 6/2 SAND, MEDIUM, SOME HEAVIES AND FINES, WET		HNU @ 0 BUT STILL SLIGHT ODR
S-10	18-20	8"	4-6-7-3			5.4 8/1 SAND, COARSE AND MEDIUM, WET, SUB ROUNDED.		HNU @ 0 BUT STILL SLIGHT ODOR
S-11	24-26	18"	7-13-17-20			5.4 8/1 TOP 12" COARSE SAND AND GRAVEL WITH BLACK COARSE SAND ZONE FINE BOTTOM 6" 5.4 7/1 SAND, MEDIUM WITH SOME FINE SAND AND HEAVIES, A FEW COARSE PIECES		HNU @ 0, NO PETROLEUM ODOR
S-12	29-31	14"	7-14-4-38			5.4 7/1 SAND, COARSE TO GRAVEL, GRAVEL UP TO 1 CM IN SIZE		HNU @ 0 NO PET. ODR
S-13	34-36	20	13-7-15-19			TOP 10" SAME AS ABOVE BOTTOM 10" 5.4 6/1 SAND, FINE WITH SOME HEAVIES; NON COHESIVE, FRISBE, WET SAME AS ABOVE		HNU @ 0 NO PET. ODR
S-14	32-41	14"	20-5 1/2			SAME AS ABOVE WITH A CLAY LENSE CLAY IS COHESIVE, PLASTIC		HNU @ 0 NO PET. ODR
S-15	44-46	*	9-4-13-2					

NOTES: HNU @ 0-1 IN BREATHING ZONE CUTTINGS PLACED IN BARREL AT 6"  
 10" SCREEN SAND UP TO 25' BL 4-50 LB BAGS # 2 FINEST GRAVEL  
 30" RISES BENEATH UP TO 22' BL 1-50 LB BAG BENEATH  
 6" WASH SAND  
 BORING TERMINATED AT 44'

\* NOTE: M. COMP. = MAJOR COMPONENT, TEX. = TEXTURE, C. = COLOR,  
 COMP. = COMPONENT, MOIST. = MOISTURE



# MALCOLM PIRNIE

BORING 6MW-30

PROJECT: <u>FT STACY - LOTS 160</u>	PROJECT NO: <u>0285-589</u>
DATE: <u>3/23/45</u>	LOCATION: <u>FOOT STACY - VIRGINIA BEACH VA</u>
ELEVATION:	DATUM:

SAMPLE				DEPTH	STRAT.	SOIL DESCRIPTION	WELL CONST.	REMARKS
no.	depth	recov ery	blows per 6"					
S-1	0-2	4	3-R			TOP 14" CONCRETE BOTTOM 14" SAND AND GRAVEL		HNU @ 10 STRONG PE
S-2	2-4	12"	14-28-44-33			TOP 4" GRAVEL AND SAND BOTTOM 8" 2.5Y 8/0 SAND FINE, SOME HEAVIES, MOIST		HNU @ 5
S-3	4-6	12"	10-4-5			2.5Y 6/0 SAND, MEDIUM, WITH SOME FINE WET.		HNU @ 10 PET. ODCR
S-4	6-8	18"	2-4-7			TOP 12" SAME AS ABOVE BOTTOM 6" 2.5Y 3/2 SAND, MEDIUM TO FINE, ORGANIC MATTER, WET		HNU @ 10 PET. ODCR
S-5	8-10	12"	4-4-4			5Y 6/2 SAND FINE TO MEDIUM AND SOME ORGANIC MATTER		
S-6	10-12	12"	2-2-3-2			SAME AS ABOVE		
S-7	12-14	24"	12-13-23-24			TOP 12" 5Y 6/1 SAND, COARSE TO MEDIUM, HEAVIES BOTTOM 12" 5Y 6/1 SAND FINE WITH SOME MEDIUM SAND, HEAVIES, WET		HNU @ 10
S-8	14-16	18"	5-7-5-4			5Y 6/1 SAND, COARSE GRADING DOWNWARD TO MEDIUM, SOME ROCK FRAGMENTS		HNU @ 10 PET. ODCR
S-9	16-18	20"	4-7-8-9			5Y 6/1 SAND, COARSE WITH SOME MEDIUM SAND, ROCK FRAGMENTS, WET		SLIGHT PE ODCR
S-10	18-20	20"	7-7-6-7			SAME AS ABOVE		
S-11	24-26	12"	11-9-32-32			2.5Y 4/0 SAND, FINE AT TOP THEN BECOMING MEDIUM TO COARSE, SHELL FRAGMENTS		NO ODCR
S-12	29-31	14"	5-4-3-2-4			2.5Y 5/0 SAND MEDIUM TO COARSE, BECOMING MEDIUM TO FINE SAND, AT TIP WET		SLIGHT PET ODCR
S-13	34-36	14"	15-25-35-3			2.5Y 4/0 SAND, FINE, LARGE AMOUNT OF HEAVIES, WET		NO PET. ODCR
S-14	39-41	8"	8-16-24-34			2.5Y 4/0 SAND, COARSE WITH MEDIUM AND FINE SAND, TIP IS FINE SAND WITH SILT		

NOTES: \* AND BATTERY IS LOW HNU IN SPLITTING ZONE C  
 10' SCREEN SAND UP TO 27.5' 2 - 100 LB BAGS AT 116'  
 28.9' RISED BENTONITE UP TO 24.5 1 - 50 LB BAG BENTONITE  
 6" WELL TIP GROUT UP TO 2'  
 INITIAL H<sub>2</sub>O 4.95' WELL DEPTH 39.0'

\* NOTE: M. COMP. = MAJOR COMPONENT, TEX. = TEXTURE, C. = COLOR,  
 COMP. = COMPONENT, MOIST. = MOISTURE

PROJECT: Ft. Story - LARCO  
 DATE: 3/27/95  
 ELEVATION:  
 PROJECT NO: 0285-590  
 LOCATION: Fort Story - Vulture Beach V4  
 DATUM:

SAMPLE				DEPTH	STRAT.	SOIL DESCRIPTION		WELL CONST.	REMARKS
NO.	DEPTH	RECOVER	BLOWS			M. COMP., TEX., C., 2nd COMP., TEX.	C.: 3rd COMP., ETC., MOIST., OTHER		
S-1	0-2	6"	1-27-2			2.57 3/3	WT FOR TO 2.57 6/7, SAND MEDIUM TO FINE WITH SOME HEAVIES, ROOTS, MOIST		
S-2	2-4	8"	2-27-3			2.57 5/4	SAND, MEDIUM WITH SOME COARSE, SOME HEAVIES, WET TO WET		
S-3	4-6	8"	3-37-6				SAME AS ABOVE		HNO @ 0
S-4	6-8	12"	3-47-9			2.57 5/3	SAND, MEDIUM WITH SOME HEAVIES AND FINE SAND, WET		
S-5	8-10	10"	3-47-5			2.57 6/3	SAND, MEDIUM LITTLE FINE SAND, SOME HEAVIES, WET		HNO @ 0
S-6	10-12	12"	3-27-3				SAME AS ABOVE		
S-7	12-14	18"	1-17-2			2.57 6/3	SAND, MEDIUM WITH SOME FINE SAND, SOME HEAVIES, ROOT, WET.		
S-8	14-16	12"	2-47-7			2.57 7/0	SAND, MEDIUM TO FINE, FEW HEAVIES, WET.		

NOTES: HNO IN BREATHING ZONE @ 6' DEPTHS 6' IN

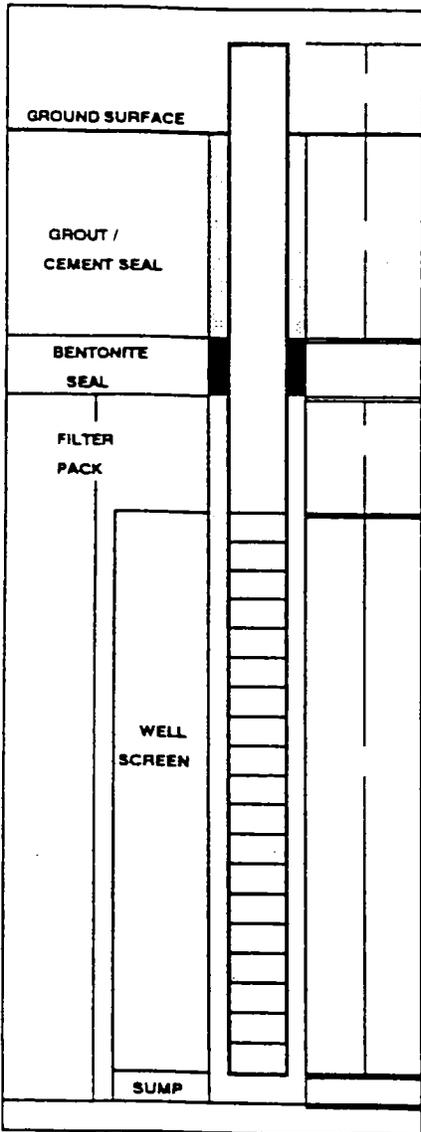
\* NOTE: M. COMP. = MAJOR COMPONENT, TEX. = TEXTURE, C. = COLOR, COMP. = COMPONENT, MOIST. = MOISTURE

WELL ID: GMW-1  
 BORING ID: GMW-1

# MALCOLM PIRNIE

Malcolm Pirnie, Inc. 11832 Rock Landing Drive Suite 400 Newport News, VA 23608

PROJECT NAME: <u>FT STORZ - CAR 60</u>	PROJECT NO: <u>0285-589</u>	GROUND ELEVATION:
DATE STARTED: <u>3/23/95</u>	LOCATION: <u>VA BEACH, VA</u>	CASING ELEVATION:
DATE COMPLETED: <u>3/23/95</u>	DRILLING COMPANY: <u>FISHBURNER</u>	SAMPLE INTERVAL: <u>EVERY 2'</u>
MPI PERSONEL: <u>FRIEDMAN</u>	DRILLING METHOD: <u>HOLLOW STEM</u>	SAMPLE METHOD: <u>SPLIT SPOON</u>



### WELL CONSTRUCTION DATA

**CASING:**  
 Size: NA  
 From: NA

**PROTECTION:**  
 Locking Cap: YES  
 Protective Posts: NO  
 Protective outer casing: 9 1/2" FLUSH MOUNT  
 Material: STEEL

**WELL MATERIALS:**

**Screen**  
 Type: SCHEDULE 40 PVC  
 Diameter: 2"  
 Slot: 0.01"  
 Length: 10'

**Riser**  
 Type: SCHEDULE 40 PVC  
 Diameter: 2"  
 Length: 3' 6"

**TOTAL DEPTH OF WELL:** 14'  
**INITIAL WATER LEVEL:** \_\_\_\_\_  
**FILTER PACK:**  
 Material: # 2 WELL GRAVEL  
 Amount used: 75 200 LBS  
 Total thickness: 11'  
 Supplier: MOBLE

**BENTONITE:**  
 Type: GRAVELAR  
 Size: 3/8"  
 Amount used: 50 LBS

**GROUT:**  
 Type: PORTLAND CEMENT  
 Amount used: \_\_\_\_\_

**WEATHER CONDITIONS:**  
 Temperature: \_\_\_\_\_  
 Precipitation: \_\_\_\_\_

NOTES:

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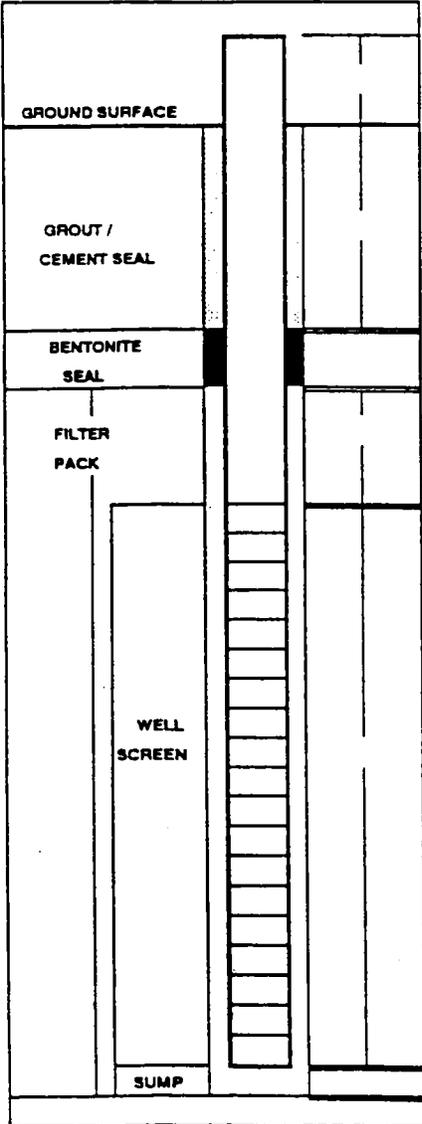
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WELL ID: G MW-2  
 BORING ID: G MW-2



Malcolm Pirnie, Inc. 11832 Rock Landing Drive Suite 400 Newport News, VA 23606

PROJECT NAME: <u>Ft Story - U2C60</u>	PROJECT NO: <u>0285-589</u>	GROUND ELEVATION:
DATE STARTED: <u>3/23/95</u>	LOCATION: <u>VA BEACH, VA</u>	CASING ELEVATION:
DATE COMPLETED: <u>3/23/95</u>	DRILLING COMPANY: <u>FISHBONE</u>	SAMPLE INTERVAL: <u>2' THEN 5' AT 20'</u>
MPI PERSONEL: <u>FRIEDMAN</u>	DRILLING METHOD: <u>HOLLOW STEM</u>	SAMPLE METHOD: <u>SPLIT SPOOLS</u>



**WELL CONSTRUCTION DATA**

**CASING:**  
 Size: NA  
 From: NA

**PROTECTION:**  
 Locking Cap: YES  
 Protective Posts: NO  
 Protective outer casing: 9/2 FLUSH MOUNT  
 Material: STEEL

**WELL MATERIALS:**

**Screen**  
 Type: SCHEDULE 40 PVC  
 Diameter: 2"  
 Slot: 0.01"  
 Length: 10'

**Riser**  
 Type: SCHEDULE 40 PVC  
 Diameter: 2"  
 Length: 30'

**TOTAL DEPTH OF WELL:** 40'6"  
**INITIAL WATER LEVEL:** \_\_\_\_\_  
**FILTER PACK:**  
 Material: #2 WELL GRAVEL  
 Amount used: 200 LBS  
 Total thickness: 15'  
 Supplier: MOBILE

**BENTONITE:**  
 Type: GRANULAR  
 Size: 3/8"  
 Amount used: 50 LBS

**GROUT:**  
 Type: PORTLAND CEMENT AND GUNNELL BENTONITE  
 Amount used: \_\_\_\_\_

**WEATHER CONDITIONS:**  
 Temperature: \_\_\_\_\_  
 Precipitation: \_\_\_\_\_

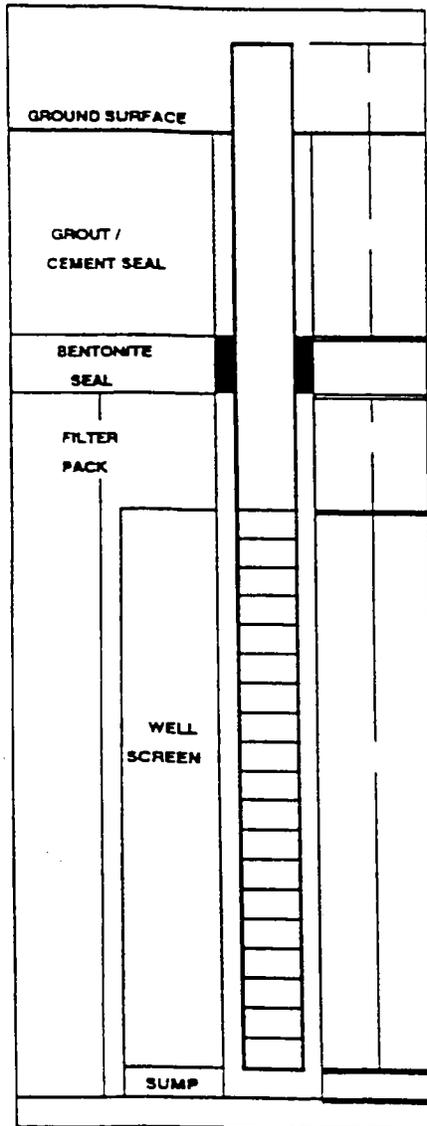
NOTES:  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

WELL ID: 6(MW)-3S  
BORING ID: 6(MW)-3S

**MALCOLM  
PIRNIE**

Malcolm Pirnie, Inc. 11832 Rock Landing Drive Suite 400 Newport News, VA 23608

PROJECT NAME: <u>Ft Story - LAROCK</u>	PROJECT NO: <u>0285-589</u>	GROUND ELEVATION:
DATE STARTED: <u>3/24/95</u>	LOCATION:	CASING ELEVATION:
DATE COMPLETED: <u>3/24/95</u>	DRILLING COMPANY: <u>FISH</u>	SAMPLE INTERVAL: <u>NA</u>
MPI PERSONEL: <u>FRIEDMAN</u>	DRILLING METHOD: <u>HOLLOW STEM</u>	SAMPLE METHOD: <u>NA</u>



WELL CONSTRUCTION DATA	
CASING:	
Size:	<u>NA</u>
From:	<u>NA</u>
PROTECTION:	
Locking Cap:	<u>YES</u>
Protective Pails:	<u>NO</u>
Protective outer casing:	<u>9 1/2" FLUSH MOUNT</u>
Material:	<u>STEEL</u>
WELL MATERIALS:	
Screen	
Type:	<u>SCHEDULE 40 PVC</u>
Diameter:	<u>2"</u>
Slot:	<u>0.01"</u>
Length:	<u>10'</u>
Riser	
Type:	<u>SCHEDULE 40 PVC</u>
Diameter:	<u>2"</u>
Length:	<u>3'9"</u>
TOTAL DEPTH OF WELL:	<u>14'3"</u>
INITIAL WATER LEVEL:	
FILTER PACK:	
Material:	<u>#2 WELL GRAVEL</u>
Amount used:	<u>200 LBS</u>
Total thickness:	<u>11.5</u>
Supplier:	<u>MORIE</u>
BENTONITE:	
Type:	<u>GRANULAR</u>
Size:	<u>3/8"</u>
Amount used:	<u>50 LBS</u>
GROUT:	
Type:	<u>PORTLAND CEMENT</u>
Amount used:	
WEATHER CONDITIONS:	
Temperature:	
Precipitation:	

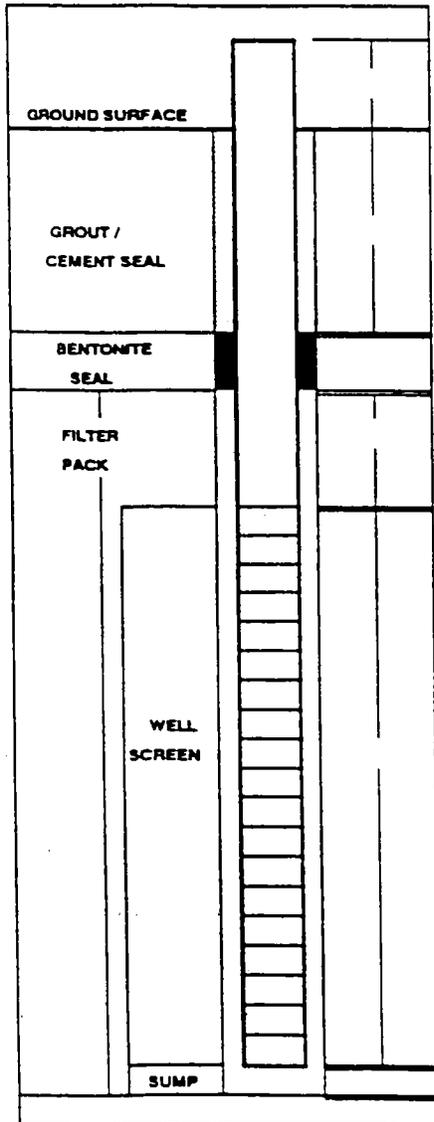
NOTES:

WELL ID: GMW-3D  
 BORING ID: GMW-3D



Malcolm Pirnie, Inc. 11832 Rock Landing Drive Suite 400 Newport News, VA 23608

PROJECT NAME: <u>Ft Story - ARC GO</u>	PROJECT NO: <u>0285-589</u>	GROUND ELEVATION:
DATE STARTED: <u>3/23/95</u>	LOCATION: <u>VA BEACH, VA</u>	CASING ELEVATION:
DATE COMPLETED: <u>3/23/95</u>	DRILLING COMPANY: <u>FISHBUONE</u>	SAMPLE INTERVAL: <u>2' TO 20' THEN 5'</u>
MPI PERSONEL: <u>FRIEDMANN</u>	DRILLING METHOD: <u>HOLLOW STEM</u>	SAMPLE METHOD: <u>SPLIT SPOON</u>



**WELL CONSTRUCTION DATA**

**CASING:**  
 Size: NA  
 From: NA

**PROTECTION:**  
 Locking Cap: YES  
 Protective Pads: NO  
 Protective outer casing: 1 1/2"  
 Material: STEEL

**WELL MATERIALS:**

**Screen**  
 Type: SCHEDULE 40 PVC  
 Diameter: 2"  
 Slot: 0.01"  
 Length: 10'

**Riser**  
 Type: SCHEDULE 40 PVC  
 Diameter: 2"  
 Length: 28'9"

**TOTAL DEPTH OF WELL:** 40'3"  
**INITIAL WATER LEVEL:** \_\_\_\_\_

**FILTER PACK:**  
 Material: # 2 WELL GRAVEL  
 Amount used: 200 LBS  
 Total thickness: 12"  
 Supplier: MORLE

**BENTONITE:**  
 Type: GRANULAR  
 Size: 3/8"  
 Amount used: 50 LBS

**GROUT:**  
 Type: PORTLAND CEMENT AND QUIK GEL BENTONITE  
 Amount used: \_\_\_\_\_

**WEATHER CONDITIONS:**  
 Temperature: \_\_\_\_\_  
 Precipitation: \_\_\_\_\_

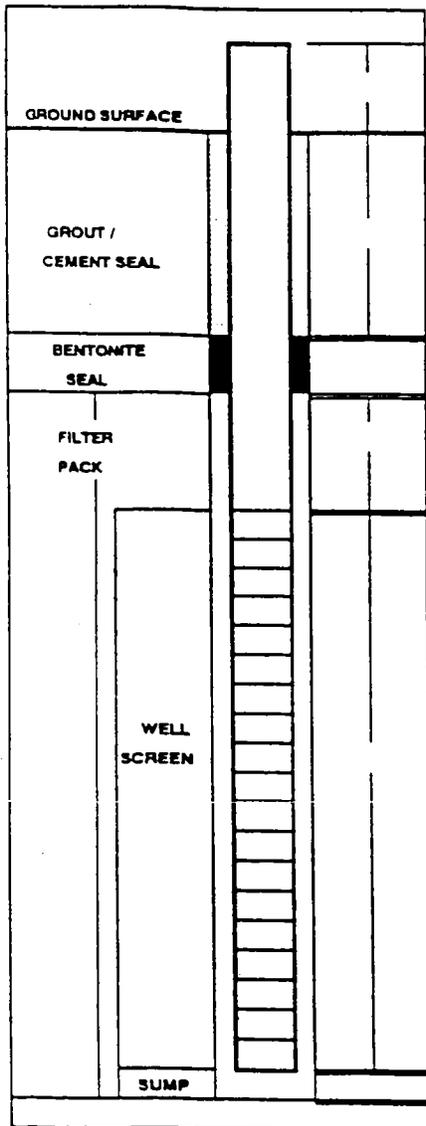
NOTES:

# MALCOLM PIRNIE

Malcolm Pirnie, Inc. 11832 Rock Landing Drive Suite 400 Newport News, VA 23606

WELL ID: G-MW-4  
BORING ID: G-MW-4

PROJECT NAME: <u>FT STORY-LARC 60</u>	PROJECT NO: <u>0285-589</u>	GROUND ELEVATION:
DATE STARTED: <u>3/27/95</u>	LOCATION: <u>VA BEACH, VA</u>	CASING ELEVATION:
DATE COMPLETED: <u>3/27/95</u>	DRILLING COMPANY: <u>FISHBURNE</u>	SAMPLE INTERVAL: <u>EVERY 2'</u>
MPI PERSONEL: <u>FRIEDMANN</u>	DRILLING METHOD: <u>HOLLOW STEM</u>	SAMPLE METHOD: <u>SPLIT SPOON</u>



## WELL CONSTRUCTION DATA

### CASING:

Size: NA  
From: NA

### PROTECTION:

Locking Cap: YES  
Protective Posts: NO  
Protective outer casing: 9/8" FLUSH MOUNT  
Material: STEEL

### WELL MATERIALS:

#### Screen

Type: SCHEDULE 40 PVC  
Diameter: 2"  
Slot: 0.01"  
Length: 10'

#### Riser

Type: SCHEDULE 40 PVC  
Diameter: 2"  
Length: 10' 4"

TOTAL DEPTH OF WELL: 14' 6"

INITIAL WATER LEVEL: \_\_\_\_\_

### FILTER PACK:

Material: #2 WELL GRAVEL  
Amount used: 200 LBS  
Total thickness: 11"  
Supplier: MORIE

### BENTONITE:

Type: GRANULAR  
Size: 3/8"  
Amount used: 50 LBS

### GROUT:

Type: PORTLAND CEMENT  
Amount used: \_\_\_\_\_

### WEATHER CONDITIONS:

Temp perature: \_\_\_\_\_  
Precipitation: \_\_\_\_\_

NOTES:

# MALCOLM PIRNIE

<b>Project:</b> LARC 60 Maintenance Area	<b>Boring:</b> 6MW-5S	Page 1 of 1
<b>Date:</b> 06-Dec-02	<b>Project Number:</b> 0285-900	
<b>Location:</b> Fort Story, VA	<b>Drilling Contractor:</b> Fishburne Drilling	
<b>Inspector:</b> Tina Jung	<b>Driller:</b> Rollen Ross	
<b>Elevation:</b>	<b>Drilling Equipment:</b> Hollow Stem Auger	

Scale	SPT Sample		Sample Type	Sample Depth	Rec.	Sample Description	USCS	Remarks/ P ID
	No.	Blows						
1'		10			70	Top 5": Silty fine sand, roots, 10YR3/2 Remainder: Medium sand, well sorted, loose, 10YR6/6	SP	10:15 0
2'		6 8 10						
3'		6			60	Medium sand, well sorted, clean, 10YR6/6	SP	0
4'		10 13 8						
5'		10			65	Medium sand, well sorted, clean, 10YR6/6 6" from top: Medium sand, well sorted, clean, 10YR4/1, 6" layer	SP	0
6'		6 6 9				Remainder: Medium sand, well sorted, clean, 10YR6/6		
7'		7			75	Top-3": Medium sand, with silty fine sand patches, well sorted, clean, 10YR6/6, pebble	SP	WET (lower half)
8'		5 4 4				Next: Medium sand, well sorted, clean, 10YR6/6 Half point: Medium-coarse sand, well sorted, clean, 10YR6/6, with intermittent stained seams, 7.5YR5/8		0
9'		5			80	Medium-coarse sand, organic matter, brick fragment, 7.5YR6/1	SP	0
10'		6 7 7						
11'		2			45	Medium-coarse sand, 7.5YR6/1	SP	0
12'		2 2 3						
13'		3			80	Medium-coarse sand, organic matter, occasional pebbles, 7.5YR6/1	SP	0
14'		6 10 14				Bottom 6": Medium-coarse sand, organic matter, occasional pebbles, 10YR3/6		
15'		4			80	Medium sand, well sorted, clean, 10YR6/3, some organic matter	SP	0
16'		6 6 7				Bottom 3": Medium-coarse sand, well sorted, clean, 10YR6/3		
17'								
18'								
19'								
20'								

Notes:

# MALCOLM PIRNIE

<b>Project:</b> LARC 60 Maintenance Area	<b>Boring:</b> 6MW-5D	Page 1 of 2
<b>Date:</b> 06-Dec-02	<b>Project Number:</b> 0285-900	
<b>Location:</b> Fort Story, VA	<b>Drilling Contractor:</b> Fishburne Drilling	
<b>Inspector:</b> Tina Jung	<b>Driller:</b> Rollen Ross	
<b>Elevation:</b>	<b>Drilling Equipment:</b> Hollow Stem Auger	

Scale	SPT Sample		Sample Type	Sample Depth	Rec.	Sample Description	USCS	Remarks/ PID
	No.	Blows						
1'		8			50	Top half: Silty fill, dark brown Remainder: Medium sand, well sorted, loose, light brown, 10YR7/4	SP	0
2'		8 8 8						
3'		8			50	Medium sand, well sorted, loose, light brown, 10YR7/4	SP	16
4'		6 7 9						
5'		6			30	Medium sand, well sorted, loose, light brown, 10YR7/4, dark patches	SP	2.7
6'		10 13 14						
7'		17			45	Medium sand, well sorted, loose, light brown, 10YR7/4	SP	11:25AM
8'		12 11 8						11.6
9'		7			40	Medium sand, well sorted, loose, light brown, 10YR6/6 4" from top: Med fine sand, 10YR6/1, 1cm layer Next: organic matter layer Remainder: Medium-coarse sand, well sorted, clean, 10YR6/1	SP	WET (last 6")
10'		5 7 7						22
11'		4			75	Medium-coarse sand, well sorted, clean, 10YR6/1 Lower half: Medium sand, well sorted, clean, 10YR6/1	SP	>300
12'		3 6 4						
13'		7			75	Medium-coarse sand, well sorted, clean, 10YR6/1	SP	>100
14'		7 13 16						
15'		7			85	Medium-coarse sand, well sorted, clean, 10YR5/3, some organic matter, some pebbles	SP	1300
16'		6 8 14						
17'		9			75	Medium-coarse sand, well sorted, clean, 10YR5/3, some organic matter, some pebbles, silty chunks (approx 0.75" diam) at half point Lower 6": Medium sand, well sorted, clean, 10YR5/3	SP	47
18'		13 13 16						
19'		16			50	Coarse sand, poorly sorted, 10YR5/2	SW	
20'		24 19 21						

Notes:

# MALCOLM PIRNIE

<b>Project:</b> LARC 60 Maintenance Area	<b>Boring:</b> 6MW-5D	Page 2 of 2
<b>Date:</b> 06-Dec-02	<b>Project Number:</b> 0285-900	
<b>Location:</b> Fort Story, VA	<b>Drilling Contractor:</b> Fishburne Drilling	
<b>Inspector:</b> Tina Jung	<b>Driller:</b> Rollen Ross	
<b>Elevation:</b>	<b>Drilling Equipment:</b> Hollow Stem Auger	

Scale	SPT Sample		Sample Type	Sample Depth	Rec.	Sample Description	USCS	Remarks
	No.	Blows						
21'		12			?	Coarse to medium sand, poorly sorted, organic matter, 10YR6/2		5.7
22'		17 20 23						
23'		15			80	Coarse to medium sand, poorly sorted, organic matter, 10YR6/2, two large pebbles at bottom		33
24'		15 21 27						
25'		6			25	Medium sand, clean, organic matter, 10YR5/2		12:06PM 130
26'		14 24 26						
27'		14			0	No recovery		
28'		16 19 23						
29'		14			90	Medium sand, becomes progressively more coarse towards bottom, 10YR5/1 Bottom 6": Coarse to medium sand, poorly sorted	SP	<20
30'		26 29 19					SW	
31'		21			40	Medium sand, well sorted, clean, organic matter, Bottom 6": layer colours interspersed, 10YR5/1 and 10YR5/2		>900
32'		30 36 42						
33'		25			70	Medium sand, well sorted, clean, some gravel, 10YR5/2 6" from top: same, but colour change, gley2 5/5PB Last 3": silty fine sand, gley 2 5/5PB		30
34'		32 38 44						
35'		3			75	Medium sand, well sorted, clean, 10YR6/1 10" from bottom: Interspersed layers of silty fine sand and medium sand, gley2 4/5PB		30
36'		2 2 6						
37'		7			70	Medium sand, well sorted, gley2 4/5PB		40
38'		17 24 26						
39'		8			60	Top 6": Medium-fine sand, well sorted, clean, gley2 4/5PB Remainder: Medium sand, well sorted, clean, gley2 4/5PB		40
40'		12 18 21						

Notes:



<b>Project:</b> LARC 60 Maintenance Area	<b>Boring:</b> 6MW-6	Page 1 of 1
<b>Date:</b> 06-Dec-02	<b>Project Number:</b> 0285-900	
<b>Location:</b> Fort Story, VA	<b>Drilling Contractor:</b> Fishburne Drilling	
<b>Inspector:</b> Tina Jung	<b>Driller:</b> Rollen Ross	
<b>Elevation:</b>	<b>Drilling Equipment:</b> Hollow Stem Auger	

Scale	SPT Sample		Sample Type	Sample Depth	Rec.	Sample Description	USCS	Remarks/ PID
	No.	Blows						
1'		7			75	Medium sand, well sorted, roots, 10YR4/3 Half point: silty fine sand, 1" layer, black 10YR3/1 Remainder: Medium sand, well sorted, black staining immediately below silty fine sand layer, 10YR6/4	SP	4.6
2'		7 6						
3'		13			60	Medium sand, well sorted, clean, 10YR7/4	SP	30
4'		11 8						
5'		9			0	Rock stuck in end		
6'		7 6 6						
7'		4			50	Medium sand, well sorted, clean, 10YR7/4 3" from top: medium-fine sand, black staining Remainder: Medium sand, well sorted, clean, 10YR7/2, wet	SP	WET 48
8'		6 5						
9'		4			20	Medium sand, well sorted, clean, 10YR5/3	SP	
10'		3 4 4						
11'		5			55	Medium-coarse sand, well sorted, clean, 10YR6/2, with silty orange small chunks, 7.5YR6/8	SP	0
12'		5 8 8						
13'		8			75	Medium-coarse sand, well sorted, clean, 10YR6/2 Half point: Medium sand, well sorted, clean, 10YR7/1	SP	9:30AM 0
14'		6 4 4						
15'								
16'								
17'								
18'								
19'								
20'								

Notes:



<b>Project:</b> LARC 60 Maintenance Area	<b>Boring:</b> 6MW-7	<b>Page</b> 1 of 1
<b>Date:</b> 06-Dec-02	<b>Project Number:</b> 0285-900	
<b>Location:</b> Fort Story, VA	<b>Drilling Contractor:</b> Fishburne Drilling	
<b>Inspector:</b> Tina Jung	<b>Driller:</b> Rollen Ross	
<b>Elevation:</b>	<b>Drilling Equipment:</b> Hollow Stem Auger	

Scale	SFT Sample		Sample Type	Sample Depth	Rec.	Sample Description	USCS	Remarks/ PID
	No.	Blows						
1'		4			45	Top- 4": Medium sand, roots, pebbles, loose Remainder: Medium sand, well sorted, clean, moist, few pebbles, 10YR6/4	SP	2:20PM 5.4
2'		4						
3'		3			25	Medium sand, well sorted, clean, moist, few pebbles, 10YR6/4	SP	19
4'		3						
5'		1			40	Top 2-4": Medium sand, well sorted, clean, moist, few pebbles, 10YR5/2 Medium sand, well sorted, clean, moist, few pebbles, 10YR6/4	SP	11.7
6'		1						
7'		2			60	Medium sand, well sorted, clean, moist, few pebbles, 10YR6/4 At 5" from top: Same, with mottling, 10YR4/6, 10YR3/6, 10YR6/3 Bottom 6": medium-coarse sand, wet	SP	WET (approx 7.5ft)
8'		2						
9'		3			40	Top-1": Medium sand, with pebbles, roots 1-3": asphalt Remainder: Medium sand, well sorted, clean, 10YR6/3	SP	
10'		3						
11'		2			70	Top-6": Medium sand, roots, asphalt chunks Remainder: Medium sand, well sorted, clean, 10YR6/4	SP	
12'		4						
13'		3			50	Top-4": Medium sand, with coarse sand (<3%), roots Remainder: Medium sand, well sorted, clean, 10YR6/4	SP	
14'		3						
15'		4			75	Medium-coarse sand, occasional coarse sand to gravel (<3%), asphalt bits, 10YR6/4		2:40PM
16'		6						
17'		9						
18'		12						
19'								
20'								

Notes:

# MALCOLM PIRNIE

<b>Project:</b> LARC 60 Maintenance Area	<b>Boring:</b> 6MW-8	Page 1 of 1
<b>Date:</b> 06-Dec-02	<b>Project Number:</b> O285-900	
<b>Location:</b> Fort Story, VA	<b>Drilling Contractor:</b> Fishburne Drilling	
<b>Inspector:</b> Tina Jung	<b>Driller:</b> Rollen Ross	
<b>Elevation:</b>	<b>Drilling Equipment:</b> Hollow Stem Auger	

Scale	SPT Sample		Sample Type	Sample Depth	Rec.	Sample Description	USCS	Remarks/ PID
	No.	Blows						
1'		6			90	Top-2": Medium sand, gravels, roots Next 2": Fine to medium sands, pebbles, roots Next 3-4": Top soil, dry, dark brown Next 3-4": Medium sand, well sorted, clean	SP	3:01PM
2'		8 8 14						
3'		9			55	Top-8": Medium sand, roots, 10YR6/6 Next 1-2": Black stained fine sand Remainder: Medium sand, roots, 10YR6/6	SP	
4'		7 7 7						
5'		5			65	Top-4": Medium sand, roots, 10YR6/6, intermittent black to dark brown staining Remainder: Medium sand, roots, 10YR6/6, with a little 10YR6/8 colour below the black stained area	SP	
6'		6 7 9						
7'		4			60	Medium sand, roots, 10YR6/6, with bits of black staining, occasional 7.5YR5/8 stains	SP	WET at bottom end
8'		6 8 8						
9'		3			50	Medium sand, well sorted, clean	SP	
10'		3 3 5 5						
11'		2			55	Medium sand, clean Top 4" only: With gravels (approx. 10%)	SP	
12'		2 3 3						
13'		4			80	Coarse to medium sand, poorly sorted, 10YR5/2 Half point: Medium sand, well sorted, clean, 10YR7/1	SW SP	
14'		4 4 6 9						
15'		7			80	Medium sand, with coarse to gravels (approx. 15%), 10YR6/2, asphalt bits at bottom	SP	
16'		7 6 9						
17'		4			85	Medium sand, few gravels, 10YR6/2	SP	
18'		4 4 5 6						
19'								
20'								

Notes:

# MALCOLM PIRNIE

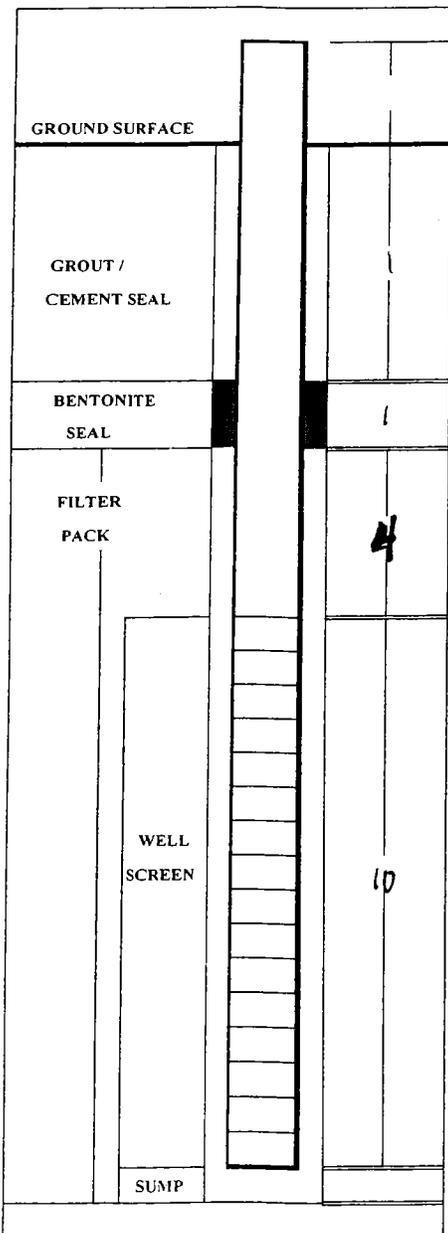
<b>Project:</b> LARC 60 Maintenance Area	<b>Boring:</b> 6MW-9	Page 1 of 1
<b>Date:</b> 05-Dec-02	<b>Project Number:</b> 0285-900	
<b>Location:</b> Fort Story, VA	<b>Drilling Contractor:</b> Fishburne Drilling	
<b>Inspector:</b> Tina Jung	<b>Driller:</b> Rollen Ross	
<b>Elevation:</b>	<b>Drilling Equipment:</b> Hollow Stem Auger	

Scale	SPT Sample		Sample Type	Sample Depth	Rec.	Sample Description	USCS	Remarks/ PID
	No.	Blows						
1'		11			45	Top 5": Silty clay, roots, dry, low plasticity, 10YR4/2 Remainder: Medium-coarse sand, well sorted, brown with orange mottling, 10YR7/3 and 7.5YR6/8	SP	12:41PM 7.9
		11						
		8						
2'		11						
3'		9			75	Medium sand, well sorted, clean, 10YR7/3	SP	9.5
		9						
4'		8 5						
5'		2			25	Medium sand, well sorted, clean, 10YR6/2	SP	WET 11.5
		3						
6'		4 4						
7'		3			75	Medium sand, well sorted, clean, 10YR6/2	SP	11.9
		3						
8'		6 4						
9'		4			45	Medium-coarse sand, well sorted, clean, 10YR6/1, trace roots, odour 4: from top: Silt seams	SP	6
		6						
10'		6 4						
11'		5			55		SP	2.6
		5						
12'		5						
13'		5				Medium-coarse sand, well sorted, clean, 10YR6/1, trace roots	SP	1:02PM 5.8
		6						
14'		7 7						
15'								
16'								
17'								
18'								
19'								
20'								

Notes:

Malcolm Pirnie Inc. 701 Town Center Drive Suite 600 Newport News, VA 23606 757-873-8700 FAX: 757-873-8723

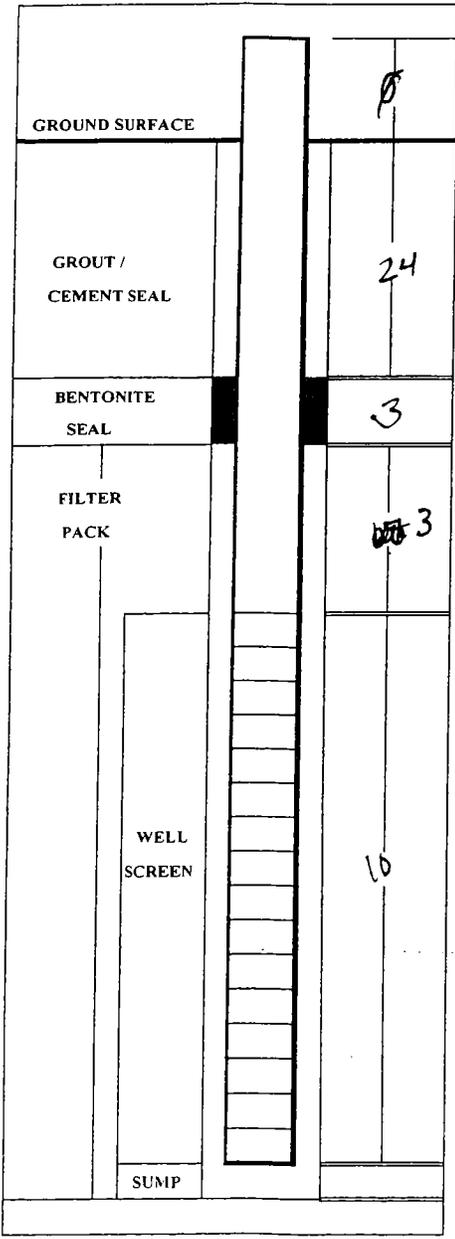
PROJECT NAME: <u>the Division Reserve Site LARC 60</u>			PROJECT NO: <u>0285-917 0285 900</u>		ELEVATIONS
LOCATION: Fort Story, VA			GROUND:		WELL:
NORTHING:			DRILLING INFORMATION		SECURITY CASING:
EASTING:			COMPANY: Fishburne		
INSTALLATION	DATE	TIME	DRILLER: <u>Rollin</u>	FLUIDS:	
STARTED:	<u>12/6/02</u>	<u>1015</u>	EQUIPMENT: <u>Hollow stem auger - pull in</u>	BORE HOLE DIAMETER: <u>4.25'</u>	
COMPLETED:	<u>12/6/02</u>	<u>1100</u>	METHOD: <u>HSA</u>	SAMPLE INTERVAL: <u>CONC</u>	
MPI PERSONNEL: <u>GTP and TYJ</u>			EQUIPMENT DECON.: <u>steam clean</u>		SAMPLE METHOD: <u>SS</u>



WELL CONSTRUCTION DATA	
<b>PROTECTIVE CASING:</b>	
Locking Cap (Y/N):	<input checked="" type="checkbox"/>
Protective Posts (#):	<input checked="" type="checkbox"/>
Protective outer casing:	<u>concrete</u>
Pad:	<u>concrete</u>
<b>WELL MATERIALS:</b>	
Screen	Type: <u>PRC</u>
Diameter:	<u>2"</u> Slot Type: <u>wire wrapped</u> Slot Size: <u>0.01</u>
Joint:	<u>FLUOR D TREAD</u> Length: <u>10'</u>
Riser	Type: <u>N/A</u>
Diameter:	<u>N/A</u> Length: <u>10'</u>
TOTAL DEPTH OF WELL:	<u>16'</u>
INITIAL WATER LEVEL:	<u>6.5'</u>
<b>FILTER PACK:</b>	
Material:	<u>sand</u>
Amount used:	<u>1 bag</u>
Total thickness:	<u>14"</u>
<b>BENTONITE:</b>	
Type:	<u>Bentonite</u>
Size:	<u>3/8"</u>
Amount used:	<u>1 bag</u>
<b>GROUT:</b>	
Type:	<u>Concrete</u>
Amount used:	<u>1 bag</u>
<b>WELL DEVELOPMENT</b>	
Method:	<u>P&amp;S</u>
Development Time:	<u>20 min</u>

NOTES:

PROJECT NAME: <u>Barc 60</u>			PROJECT NO: <u>0285900</u>		ELEVATIONS
LOCATION:					GROUND:
NORTHING:			DRILLING INFORMATION		WELL:
EASTING:			COMPANY: <u>Fishburne</u>		SECURITY CASING:
INSTALLATION	DATE	TIME	DRILLER: <u>Roller</u>	FLUIDS:	
STARTED:	<u>12/6/02</u>	<u>1100</u>	EQUIPMENT: <u>Drill rig</u>	BORE HOLE DIAMETER: <u>4-25"</u>	
COMPLETED:	<u>12/6/02</u>	<u>1400</u>	METHOD: <u>HSA</u>	SAMPLE INTERVAL: <u>Cont</u>	
MPI PERSONNEL:			EQUIPMENT DECON.: <u>Steam</u>	SAMPLE METHOD: <u>SS</u>	



WELL CONSTRUCTION DATA	
<b>PROTECTIVE CASING:</b>	
Locking Cap (Y/N):	<input checked="" type="checkbox"/>
Protective Posts (#):	<input type="checkbox"/>
Protective outer casing:	_____
Pad:	<u>Concrete</u>
<b>WELL MATERIALS:</b>	
Screen	
Type:	<u>PVC</u>
Diameter:	<u>2"</u>
Slot Type:	<u>W-R</u>
Slot Size:	<u>0.01</u>
Joint:	<u>ET</u>
Length:	<u>10'</u>
Riser	
Type:	<u>N/A</u>
Diameter:	<u>N/A</u>
Length:	<u>N/A</u>
TOTAL DEPTH OF WELL:	<u>40'</u>
INITIAL WATER LEVEL:	<u>6.55'</u>
<b>FILTER PACK:</b>	
Material:	_____
Amount used:	<u>2 bags</u>
Total thickness:	_____
<b>BENTONITE:</b>	
Type:	_____
Size:	<u>2 bags</u>
Amount used:	_____
<b>GROUT:</b>	
Type:	<u>QUIKRETE concrete</u>
Amount used:	<u>2 bags</u>
<b>WELL DEVELOPMENT</b>	
Method:	<u>p&amp;s</u>
Development Time:	<u>50 min</u>

NOTES:

PROJECT NAME: <u>80th Division Reserve Site</u> <b>LARC 60</b>			PROJECT NO: 0285-91 <b>X 900</b>		ELEVATIONS
LOCATION: Fort Story, VA			DRILLING INFORMATION		GROUND:
NORTHING:			COMPANY: Fishburne		WELL:
EASTING:			DRILLER: <b>ROLLEN</b>		SECURITY CASING:
INSTALLATION	DATE	TIME	EQUIPMENT: <b>Hollow stem auger</b>		FLUIDS:
STARTED:	12 / 6 / 02	0900	METHOD: <b>HSA</b>		BORE HOLE DIAMETER: <b>4.25"</b>
COMPLETED:	12 / 6 / 02	1000	EQUIPMENT DECON: <b>Steam clean</b>		SAMPLE INTERVAL: <b>CONT</b>
MPI PERSONNEL: <b>GTP and TYJ</b>			SAMPLE METHOD: <b>SS</b>		

**WELL CONSTRUCTION DATA**

**PROTECTIVE CASING:**

Locking Cap (Y/N):  Protective Posts (#):   
 Protective outer casing:   
 Pad: concrete

**WELL MATERIALS:**

**Screen**

Type: PVC  
 Diameter: 2" Slot Type: wire wrapped Slot Size: 01  
 Joint: flush thread Length: 10'

**Riser**

Type: N/A  
 Diameter: N/A Length: N/A

TOTAL DEPTH OF WELL: 14'

INITIAL WATER LEVEL: 5.4'

**FILTER PACK:**

Material: sand  
 Amount used: 1 bag  
 Total thickness: 12"

**BENTONITE:**

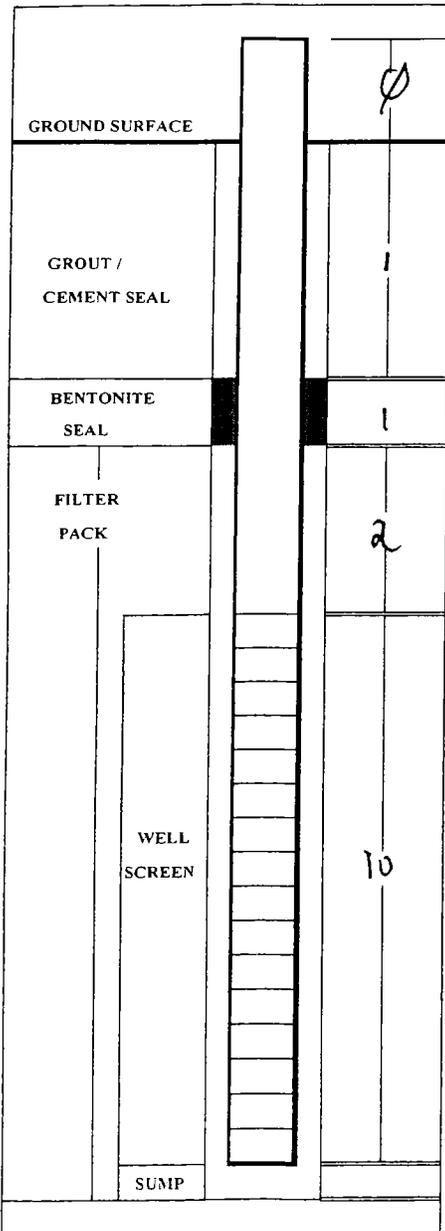
Type: bentonite  
 Size: 3/8"  
 Amount used: 1 bag

**GROUT:**

Type: concrete  
 Amount used: 1 bag

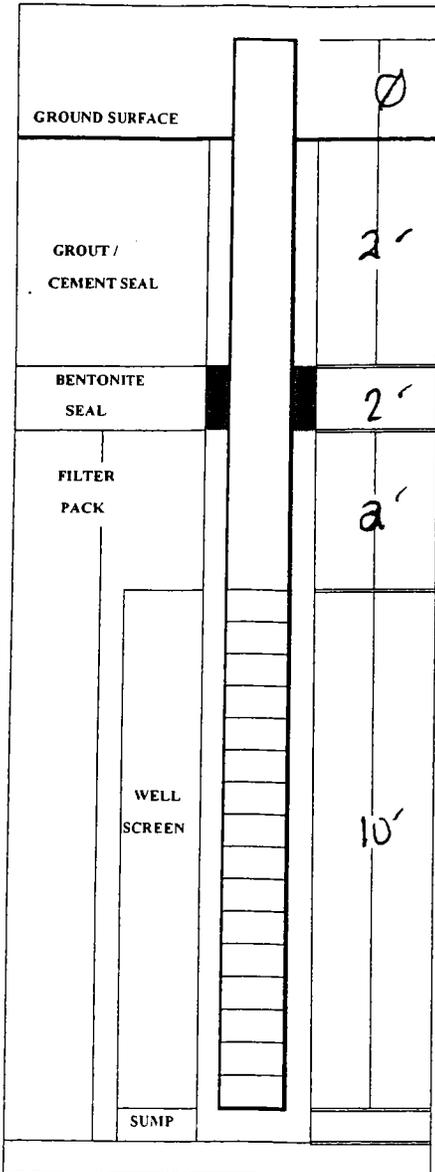
**WELL DEVELOPMENT**

Method: pump & surge  
 Development Time: ~ 25 min



NOTES:

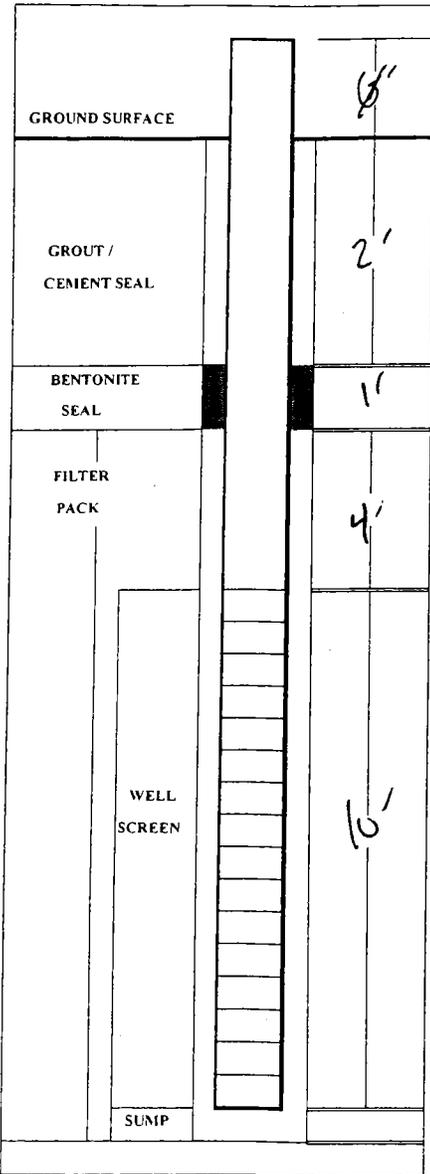
PROJECT NAME: <u>LARC 60</u>			PROJECT NO: <u>028590</u>		ELEVATIONS	
LOCATION: <u>Pt Story</u>					GROUND:	
NORTHING:			DRILLING INFORMATION		WELL:	
EASTING:			COMPANY: <u>Fishburne</u>		SECURITY CASING:	
INSTALLATION	DATE	TIME	DRILLER: <u>Rolen</u>	FLUIDS:		
STARTED:	<u>12/6/02</u>	<u>1405</u>	EQUIPMENT: <u>Drilling rig</u>	BORE HOLE DIAMETER: <u>4.25"</u>		
COMPLETED:	<u>12/6/02</u>	<u>1400</u>	METHOD: <u>HSA</u>	SAMPLE INTERVAL: <u>cont</u>		
MPI PERSONNEL:			EQUIPMENT DECON: <u>steam clean</u>	SAMPLE METHOD: <u>SS</u>		



WELL CONSTRUCTION DATA			
<b>PROTECTIVE CASING:</b>			
Locking Cap (Y/N):	<input checked="" type="checkbox"/>	Protective Posts (H):	<input type="checkbox"/>
Protective outer casing:	-		
Pad:	<u>concrete</u>		
<b>WELL MATERIALS:</b>			
Screen			
Type:	<u>PVC</u>		
Diameter:	<u>2"</u>	Slot Type:	<u>WW</u>
Joint:	<u>PT</u>	Slot Size:	<u>0.01</u>
Length:	<u>10'</u>		
Riser			
Type:	-		
Diameter:	-		
Length:	-		
TOTAL DEPTH OF WELL: <u>16'</u>			
INITIAL WATER LEVEL: <u>7.03</u>			
<b>FILTER PACK:</b>			
Material:	<u>sand</u>		
Amount used:	<u>1 bag</u>		
Total thickness:	<u>12"</u>		
<b>BENTONITE:</b>			
Type:	<u>Bentone</u>		
Size:	<u>318</u>		
Amount used:	<u>1 bag</u>		
<b>GROUT:</b>			
Type:	<u>concrete</u>		
Amount used:	<u>1 bag</u>		
<b>WELL DEVELOPMENT</b>			
Method:	<u>P&amp;S</u>		
Development Time:	<u>20 min</u>		

NOTES:

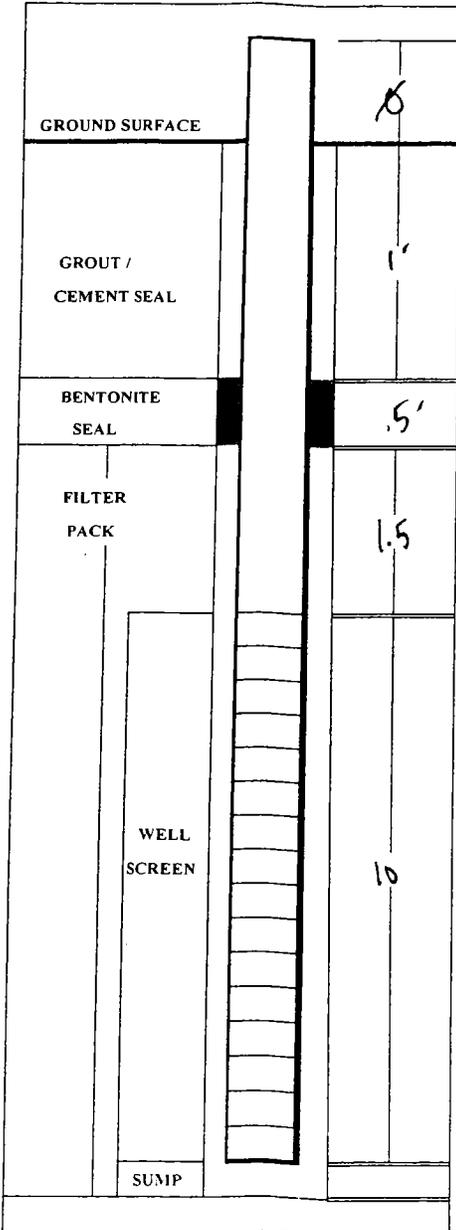
PROJECT NAME: <u>LARC 60</u>			PROJECT NO: <u>0285940</u>		ELEVATIONS	
LOCATION: <u>Pb. Store</u>					GROUND:	
NORTHING:			DRILLING INFORMATION			WELL:
EASTING:			COMPANY: <u>Fishburne</u>			SECURITY CASING:
INSTALLATION	DATE	TIME	DRILLER:	FLUIDS:		
STARTED:	<u>12/6/02</u>	<u>1500</u>	<u>Koller</u>			
COMPLETED:	<u>12/6/02</u>	<u>1545</u>	EQUIPMENT: <u>Drill rig</u>	BORE HOLE DIAMETER: <u>4.25"</u>		
MPI PERSONNEL:			METHOD: <u>HSA</u>	SAMPLE INTERVAL: <u>cont</u>		
			EQUIPMENT DECON.: <u>steam clean</u>	SAMPLE METHOD: <u>SS</u>		



WELL CONSTRUCTION DATA			
<b>PROTECTIVE CASING:</b>			
Locking Cap (Y/N):	<input checked="" type="checkbox"/>	Protective Posts (#):	<input checked="" type="checkbox"/>
Protective outer casing:	_____		
Pud:	<u>concrete</u>		
<b>WELL MATERIALS:</b>			
<b>Screen</b>			
Type:	<u>PVC</u>		
Diameter:	<u>2"</u>	Slot Type:	<u>WW</u>
Joint:	<u>PT</u>	Slot Size:	<u>0.01</u>
Riser	Length: <u>10'</u>		
Type:	_____		
Diameter:	<u>1"</u>	Length:	_____
TOTAL DEPTH OF WELL:	<u>17'</u>		
INITIAL WATER LEVEL:	<u>6.8'</u>		
<b>FILTER PACK:</b>			
Material:	<u>Sand</u>		
Amount used:	<u>1 bag</u>		
Total thickness:	<u>4'</u>		
<b>BENTONITE:</b>			
Type:	<u>Bentonite</u>		
Size:	<u>3/8</u>		
Amount used:	<u>1 bag</u>		
<b>GROUT:</b>			
Type:	<u>concrete</u>		
Amount used:	<u>1 bag</u>		
<b>WELL DEVELOPMENT</b>			
Method:	<u>P&amp;S</u>		
Development Time:	<u>~ 20 min</u>		

NOTES:

PROJECT NAME: <u>the Division Reserve Site</u>		<u>LARC 60</u>		PROJECT NO: <u>0285-900</u>	ELEVATIONS
LOCATION: Fort Story, VA				GROUND:	
NORTHING:		DRILLING INFORMATION			WELL:
EASTING:		COMPANY: Fishburne			SECURITY CASING:
INSTALLATION	DATE	TIME	DRILLER: <u>Rollen</u>	FLUIDS:	
STARTED:	12 / <u>5</u> / 02	<u>1240</u>	EQUIPMENT: <u>Hollow stem auger - drilling</u>	BORE HOLE DIAMETER: <u>4.25</u>	
COMPLETED:	12 / <u>5</u> / 02	<u>1340</u>	METHOD: <u>H&amp;A</u>	SAMPLE INTERVAL: <u>cont</u>	
MPI PERSONNEL: <u>GTP and TYJ</u>			EQUIPMENT DECON: <u>Steam clean</u>	SAMPLE METHOD: <u>SS</u>	



### WELL CONSTRUCTION DATA

**PROTECTIVE CASING:**

Locking Cap (Y/N):  Protective Posts (#):

Protective outer casing: \_\_\_\_\_

Pad: \_\_\_\_\_

**WELL MATERIALS:**

**Screen**

Type: PVC

Diameter: 2" Slot Type: W-W Slot Size: 0.07

Joint: E-T Length: 10'

**Riser**

Type: N/A

Diameter: N/A Length: 0

TOTAL DEPTH OF WELL: 12'

INITIAL WATER LEVEL: 2.5'

**FILTER PACK:**

Material: Sand

Amount used: 1 bag

Total thickness: 11"

**BENTONITE:**

Type: Bentinite

Size: 3/8"

Amount used: 1 bag

**GROUT:**

Type: Concrete

Amount used: 1 bag

**WELL DEVELOPMENT**

Method: p & S

Development Time: 30 min

NOTES: