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ONE YEAR OPERATIONAL REPORT
FOR
SITE 16 F BIOSLURPER SYSTEMS
AT
NAVAL WEAPONS STATION - EARLE
COLTS NECK, NEW JERSEY

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REMEDIAL ACTION CONTRACT N62472-94-D-0398

NAVAL WEAPONS STATION EARLE
SITE 16 F
BIOSLURPER SYSTEMS OPERATIONAL REPORT

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1.0 INTRODUCTION

Foster Wheeler Environmental Corporation (Foster Wheeler Environmental) has been contracted by the Northern Division, Naval Facilities Engineering Command (NORDIV) to construct, install, and maintain two bioslurping systems and associated groundwater treatment units at Site 16F at Naval Weapons Station (NWS) Earle, located in Colts Neck, NJ. One system was located in the vicinity of Building C-16, and the other system was located northwest of Building C-50. This Summary Report is being submitted to satisfy the post-construction submittal requirements included in paragraph 1.2.1, Pre- and Post-Construction Documentation of the Statement of Services for Delivery Order No. 0017, Modification No. 7 under Remedial Action Contract No. N62472-94-D-0398.

2.0 PROJECT LOCATION AND DESCRIPTION

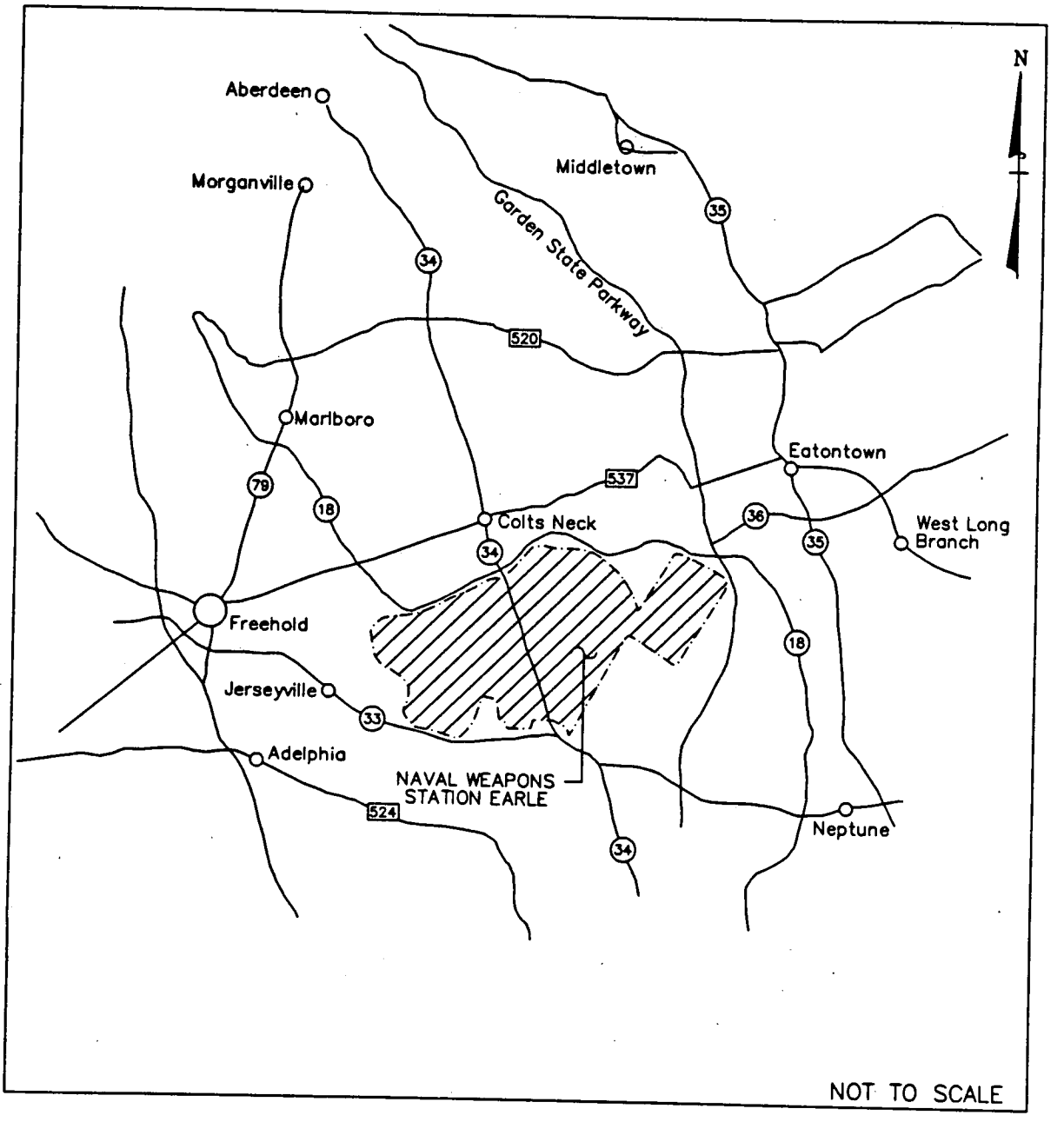
NWS Earle is located in east-central Monmouth County in the town of Colts Neck, NJ, as depicted in Figure 2-1. Site 16/F is located in the north-central portion of NWS Earle as shown in Figure 2-2. The areas addressed with the bioslurping remediation at Site 16/F were the light non-aqueous phase (LNAPL) plume southeast of Building C-16, the LNAPL plume northwest of Building C-50, and a former gas station site near Building C-18.

An underground fuel line located in the area north of Building C-19 was used to transport diesel fuel from an underground storage tank (UST) located at the northeastern corner of Building C-18 to a dispensing station near Building C-50. A leak in the fuel line was discovered in 1977 and use of the pipeline was discontinued after the leak was discovered and excavated. Part or all of the former underground diesel transfer line is still in place.

2.1 PREVIOUS INVESTIGATIONS

Between June and October of 1995, Brown & Root Environmental conducted a Remedial Investigation (RI) at Site 16/F. The RI Report prepared by Brown & Root Environmental subsequent to the 1995 field investigation concluded that hydrocarbons detected in the subsurface have impacted the groundwater. The groundwater contamination (primarily volatile organics and fuel constituents) is associated with a free-product LNAPL layer. This floating product is a source of organics to groundwater. In addition, there is a potential for residual leaching of aromatic volatiles and the lighter PAHs from subsurface soils into groundwater because of the significant concentrations present.

In 1995 the Navy conducted an investigation at Site 16 using a Site Characterization and Analysis Penetrometer System (SCAPS). SCAPS is a field screening technique which detects polynuclear aromatic hydrocarbon (PAHs) compounds using a Laser Induced Fluorescence (LIF) system. The LIF is quantitative in a known matrix with a known contaminant. One soil sample was collected to calibrate the LIF using Diesel Fuel



U.S. Navy RAC
NWS- Earle, Colts Neck, NJ

Figure 2-1
Vicinity Map

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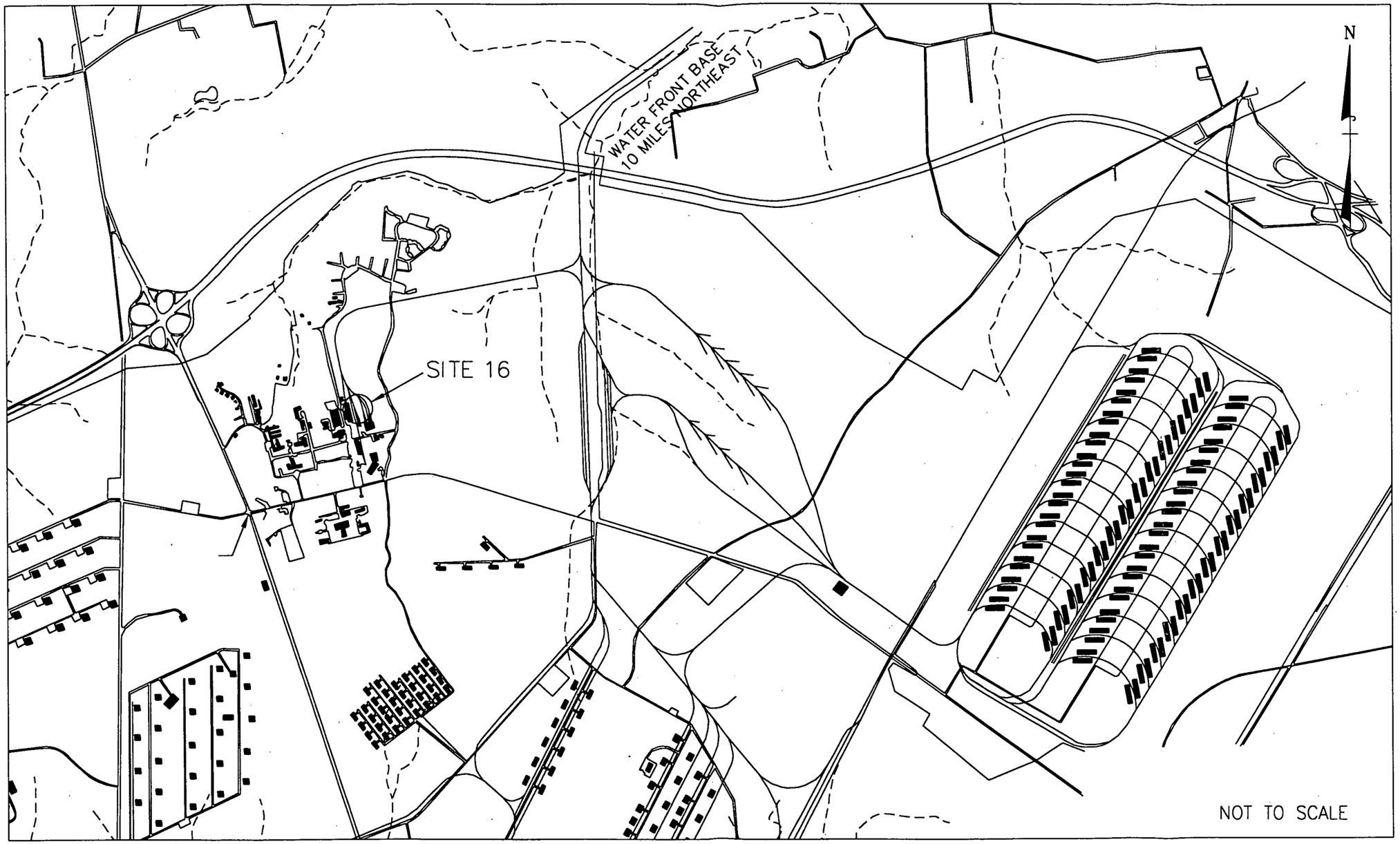

U. S. Navy RAC
NWS – Earle, Colts Neck, NJ

Figure 2-2
Site 16F
Project Location Map

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earle\fig-2-2

Marine. The fluorescent intensity mapping, obtained from the push samples, was used to gain a better understanding of the contaminant distribution. Twenty nine (29) SCAPS borings were completed in the area between Building C-16 and C-50. Figure 2-3 depicts the intensity of the LIF at a depth of 10.5 feet below grade.

2.2 GEOLOGY

Site 16 is located within the Outer Coastal Plain of the Atlantic Coastal Plain Physiographic Province, approximately nine miles inland from the Atlantic Ocean. The site is relatively flat with the most significant topographic relief being the drainage swales located between the railroad tracks. According to regional mapping, the site is located on an outcropping of the Vincentown Formation and upper colluvium. The upper colluvium, where present, is shallow and consists of massive sand and silty sand, which may contain quartz or ironstone pebbles. The Vincentown Formation consists of gray and green, glauconitic, fine to coarse-grained sand with silt.

According to the information obtained from the well installation logs and the SCAPS Investigation, the soil underlying the site is composed of fine to medium sand and silty sand.

2.3 HYDROGEOLOGY

The shallow groundwater at the site occurs within unconfined conditions in the upper colluvium and Vincentown Formation. Static water level measurements, water table elevations, and depths-to-product and depths-to-water measurements are summarized in Appendix A. Based on slug tests conducted during the RI, the hydraulic conductivity of the Vincentown Formation at the site is approximately 3.48×10^{-4} cm/sec (0.99 ft/day). The average hydraulic conductivity calculated for the upper colluvium and Vincentown Formation is 8.69×10^{-4} cm/sec (2.94 ft/day) (Brown and Root).

Water level measurements collected during the RI determined that the groundwater flow direction at the site is to the north (Brown and Root). Based interpretation of groundwater elevations collected during the one year of bioslurper operation, there appears to be localized groundwater flow toward the west/northwest in the vicinity of Building C-16. Figures 2-4, 2-5, and 2-6 depict the potentiometric surface on three different dates, between April 1998 and June 1999.

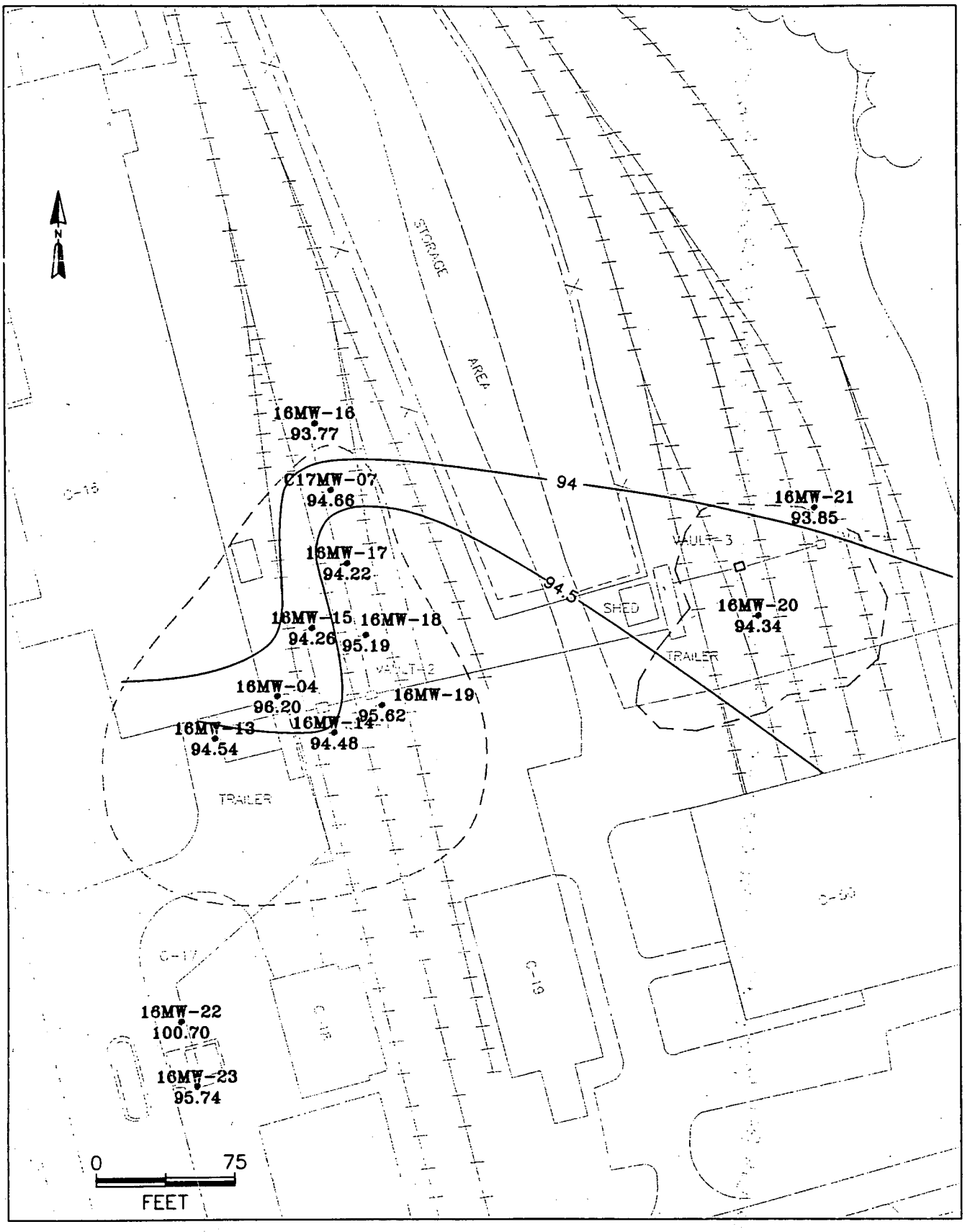
3.0 BIOSLURPER SYSTEM INSTALLATION

3.1 WELL INSTALLATION

Extraction wells were placed in the plume areas based on existing groundwater flow information, the SCAPS data, and product measurements in existing monitoring wells. The general approach was to install the recovery wells, and then determine if additional wells were warranted to further remediate the plumes. Figure 3.1 depicts the locations of the recovery wells. A total of nine additional product recovery wells (16MW13 through

Naval Weapons Station - Earle

Figure 2-3
Navy SCAPS Results



Legend

16MW-22 — Well ID

100.70 — Elevation (Ft AMSL)

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U.S. Navy RAC
NWS- Earle, Colts Neck, NJ

Figure 2-4
Site 16F
Groundwater Potentiometric Surface 4/24/98

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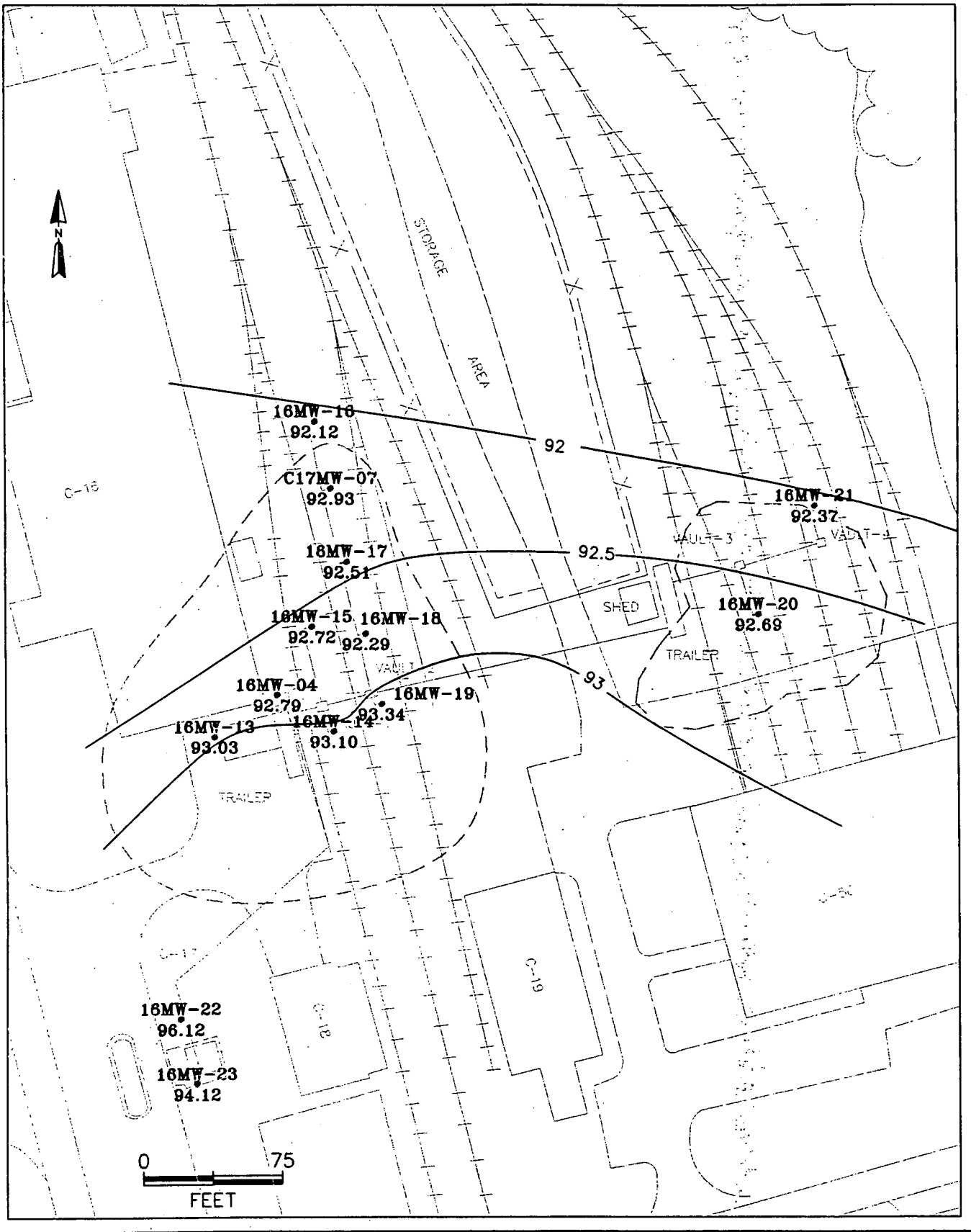

Legend

16MW-22 — Well ID

100.70 — Elevation (Ft AMSL)

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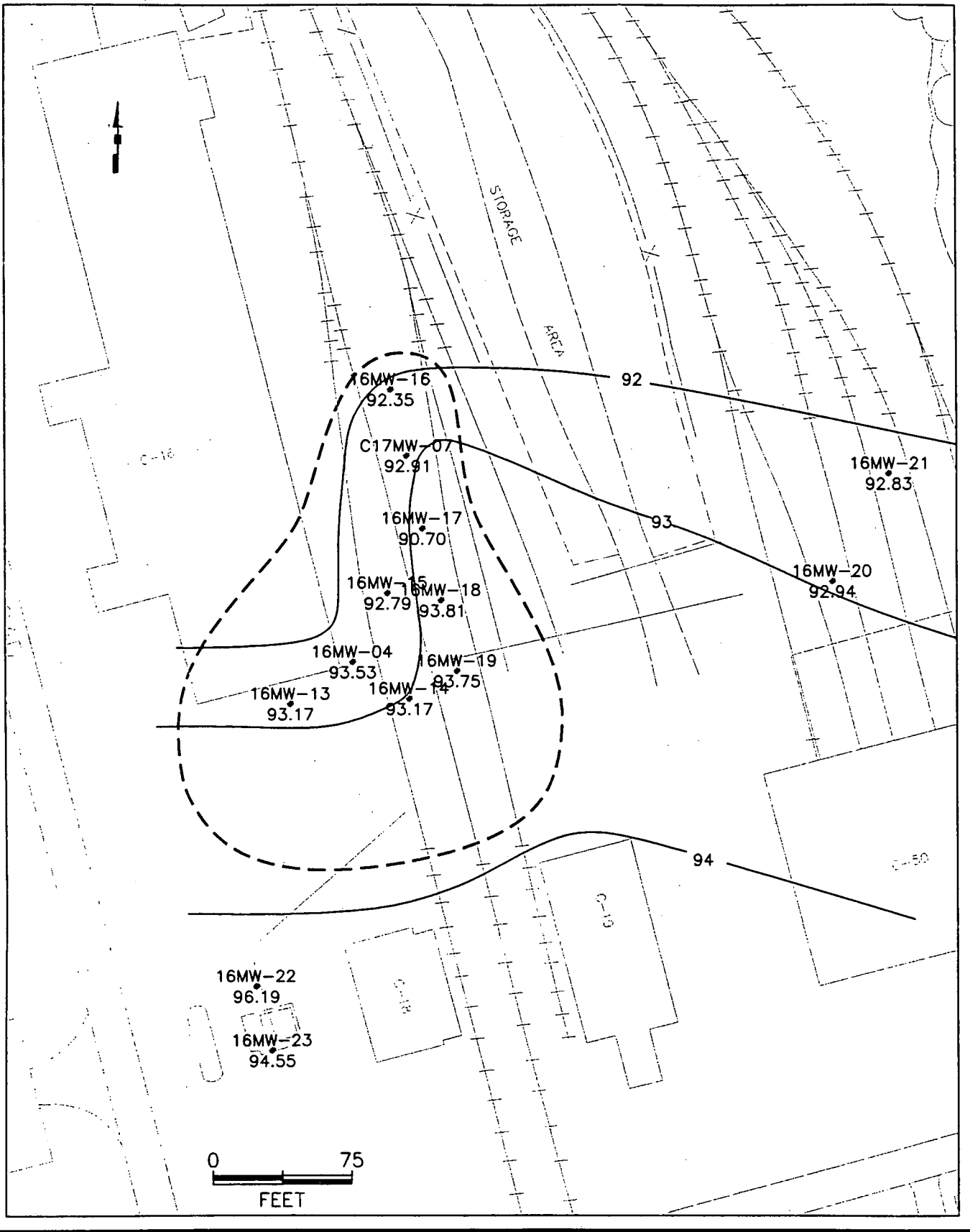
U.S. Navy RAC
NWS- Earle, Colts Neck, NJ

Figure 2-5
Site 16F
Groundwater Potentiometric Surface 8/13/98

FOSTER WHEELER ENVIRONMENTAL CORPORATION



Legend

16MW-22 — Well ID

100.70 —— Elevation (Ft AMSL)

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Figure 2-6

Site 16F

Product Thickness Isopleth 6/9/99

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16MW21) and two bioventing wells (16MW22 and 16MW23) were installed prior to the operation of the bioslurper units. Two existing monitoring wells (16MW04 and C17/20MW07) were also converted to extraction wells.

The extraction wells were installed using a hollow stem auger drilling rig to advance 6¼-inch inside diameter augers to a depth of approximately 20-feet below grade. The wells were constructed of 4-inch diameter PVC. A vault box was placed around each well to allow for the necessary space needed to connect the well to the piping going into the bioslurper system. The tops of the recovery wells were configured with Y pipes to facilitate the one-inch diameter drop tube, valve, vacuum gauge, and a measurement/ sampling port (Figure 3-2). The wells were equipped in a manner that allowed individual adjustments of applied vacuum at each well. The tops of the wells were configured with a compression cap to allow the movement of the one-inch diameter straw to various depths, based upon product depth and thickness.

The extraction wells were connected to 2-inch diameter schedule 40 PVC manifolds, contained inside 4-inch diameter schedule 80 PVC secondary containment pipe. Appendix B contains photos of the piping installation. All the piping was installed in accordance to the approved Work Plan. Valve boxes were installed at the pipe manifolds that branched between the railroad tracks in order to have the capability of switching the operations of extraction wells between Unit #1 and Unit #2.

3.2 SYSTEM INSTALLATION

Two self-contained 8 ft. by 40 ft. by 8 ft high refurbished cargo boxes were used to house the bioslurper pumps, process equipment, and treatment units. The units arrived at the site with all recovery/treatment equipment mounted, plumbed and wired internally to NEMA 7 (explosion-proof) standards. The complete turnkey units were off-loaded with a crane and connected to a power source, water, and the wells upon arrival. Appendix B contains photos of the off-loading and systems connections.

Each bioslurper unit contains specific operational areas constructed from existing skid-mounted units. The following paragraphs describe the process equipment associated with each "skid" inside the units. See Figures 3-3 and 3-4 for process and instrumentation details.

Exhauster Skid

The exhauster skid functions as the source of the vacuum which is placed on the recovery wells, and also functions as a vapor-phase knock-out tank and is equipped with a vapor phase discharge line. The exhauster skid is connected to the Free Product Skid via a 3-inch diameter vacuum line and a 1-inch manual blow-down line. Vapors from the exhauster skid are directed, via a 3-inch diameter pipe, to a vapor-phase knock out tank (moisture separator). The main components of the exhauster skid are presented below:

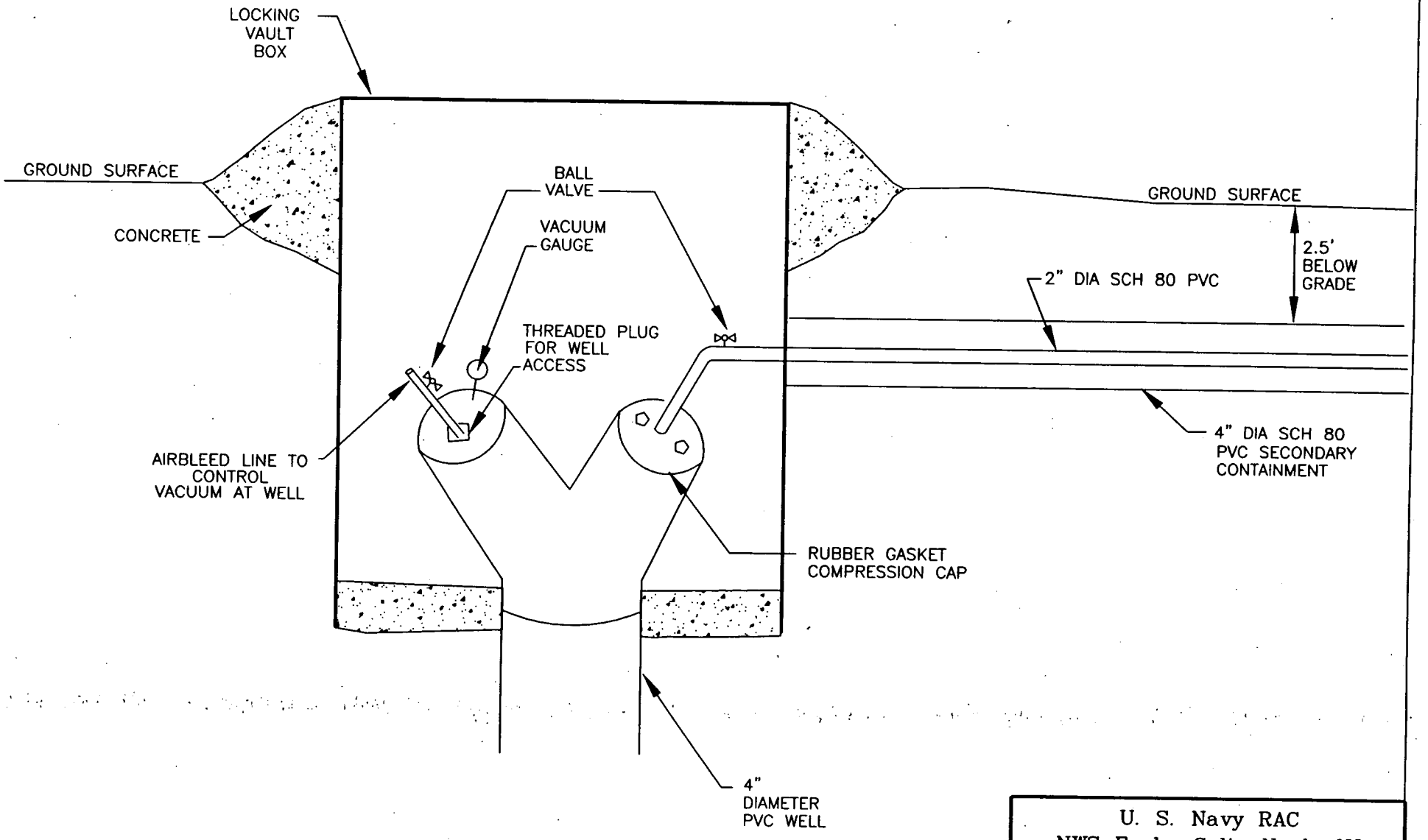

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Figure 3-2

Recovery Well Connection Details

F STER WHEELER ENVIRONMENTAL C RPORATION

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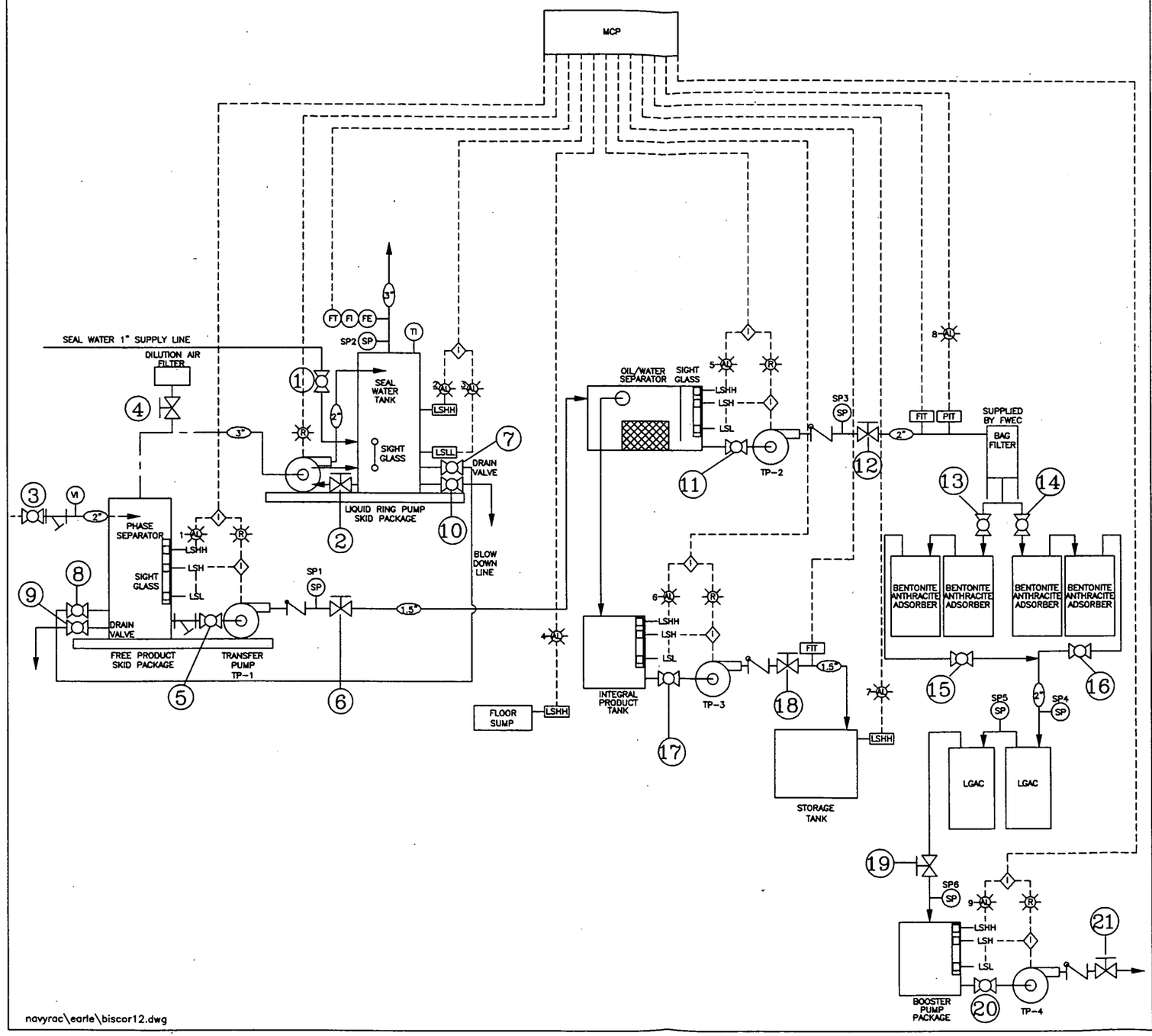

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LEGEND

FE	FLOW ELEMENT
FI	FLOW INDICATOR
FIT	FLOW INDICATOR TRANSMITTER
FT	FLOW TRANSMITTER
LGAC	LIQUID PHASE CARBON
LSH	LEVEL SWITCH HIGH
LSHH	LEVEL SWITCH HIGH HIGH
LSLL	LEVEL SWITCH LOW LOW
LSL	LEVEL SWITCH LOW
MCP	MASTER CONTROL PANEL
PI	PRESSURE INDICATOR
PIT	PRESSURE INDICATOR TRANSMITTER
SP	SAMPLE PORT
TI	TEMPERATURE INDICATOR
VI	VACUUM INDICATOR
I	INTERLOCK
SV	SOLENOID VALVE
	GATE VALVE
	CHECK VALVE
	BUTTERFLY VALVE
	WYE STRAINER
	BALL VALVE
------	CONTROL LINE
———	WATER LINE
———	VAPOR LINE
R	RUN LIGHT
AL	ALARM LIGHT– ALARMS/SYSTEM SHUTDOWN

1 PHASE SEPARATOR TANK HIGH HIGH LEVEL
2 SEAL WATER TANK HIGH HIGH LEVEL
3 SEAL WATER TANK LOW LOW LEVEL
4 FLOOR SUMP HIGH HIGH LEVEL
5 OIL/WATER SEP. EFFLUENT SUMP HIGH HIGH LEVEL
6 OIL/WATER SEP. PRODUCT SUMP HIGH HIGH LEVEL
7 PRODUCT STORAGE TANK HIGH HIGH LEVEL
8 EFFLUENT PUMP HIGH PRESSURE
9 BOOSTER PUMP HIGH HIGH LEVEL

(1) VALVE NUMBER

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Naval Weapons Station – Earle

Figure 3–3
Bioslurper Treatment Unit #1
Process & Instrumentation Diagram

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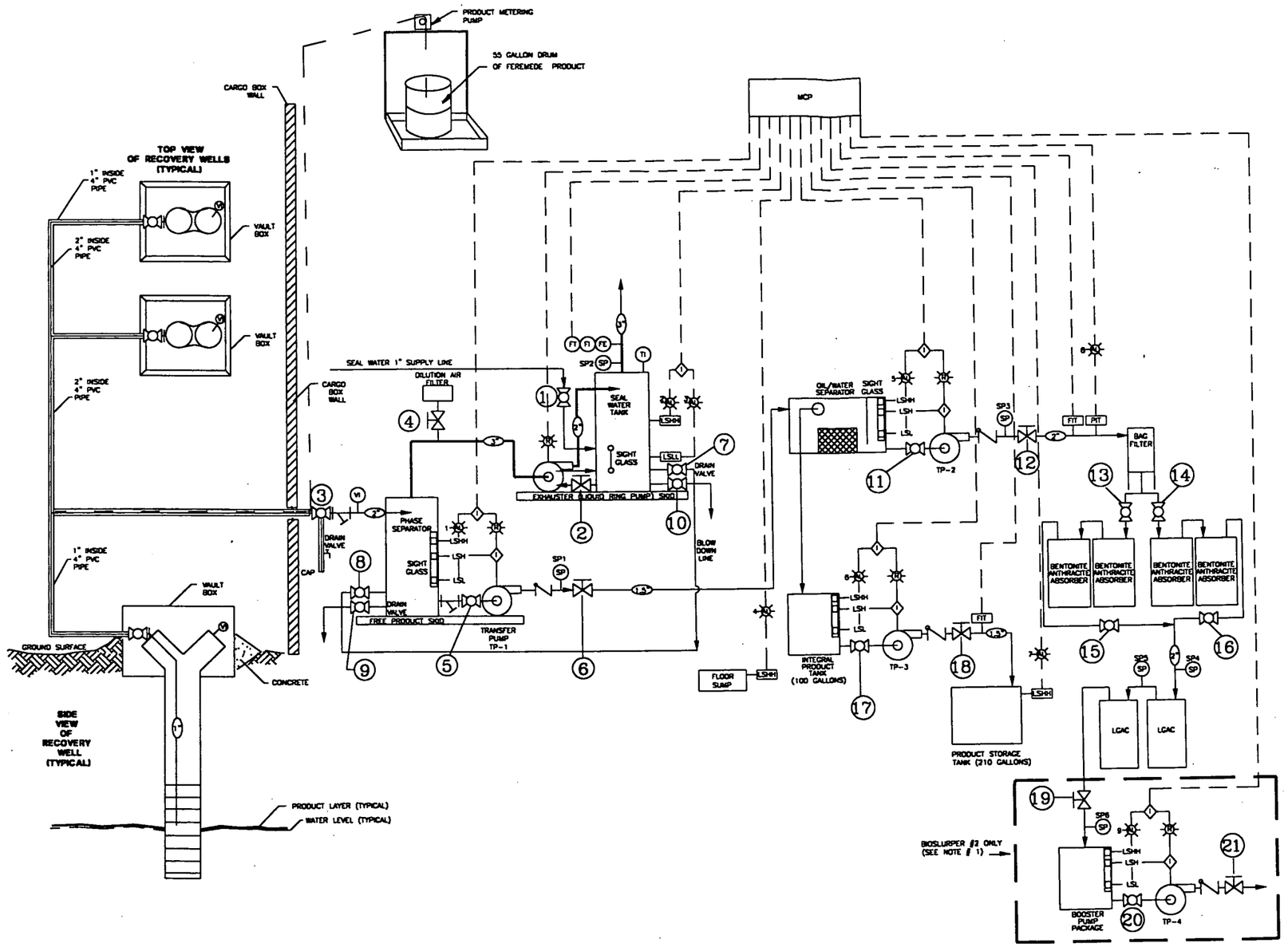

NOTES:

1 - THE 60 GALLON EFFLUENT SUMP TANK AND ASSOCIATED EQUIPMENT/PIPING/FITTINGS/BOOSTER PUMP/ETC. IS NOT PRESENT IN BIOSLURPER #1 BECAUSE THE EFFLUENT LINE CONNECTS DIRECTLY TO THE LINE TO THE SEWER SYSTEM CONNECTION.

LEGEND

FE	FLOW ELEMENT
FI	FLOW INDICATOR
FIT	FLOW INDICATOR TRANSMITTER
FT	FLOW TRANSMITTER
LGAC	LIQUID PHASE CARBON
LSH	LEVEL SWITCH HIGH
LSHH	LEVEL SWITCH HIGH HIGH
LSLL	LEVEL SWITCH LOW LOW
LSL	LEVEL SWITCH LOW
MCP	MASTER CONTROL PANEL
PI	PRESSURE INDICATOR
PIT	PRESSURE INDICATOR TRANSMITTER
SP	SAMPLE PORT
TI	TEMPERATURE INDICATOR
VI	VACUUM INDICATOR
	INTERLOCK
	SOLENOID VALVE
	GATE VALVE
	CHECK VALVE
	BUTTERFLY VALVE
	WYE STRAINER
	BALL VALVE
	CONTROL LINE
	LIQUID LINE
	VAPOR LINE
	CHEMICAL LINE
	DOUBLE WALL LINE
	RUN LIGHT
	ALARM LIGHT- ALARMS/SYSTEM SHUTDOWN

1 PHASE SEPARATOR TANK HIGH HIGH LEVEL
2 SEAL WATER TANK HIGH HIGH LEVEL
3 SEAL WATER TANK LOW LOW LEVEL
4 FLOOR SUMP HIGH HIGH LEVEL
5 OIL/WATER SEP. EFFLUENT SUMP HIGH HIGH LEVEL
6 OIL/WATER SEP. PRODUCT SUMP HIGH HIGH LEVEL
7 PRODUCT STORAGE TANK HIGH HIGH LEVEL
8 EFFLUENT PUMP HIGH PRESSURE
9 BOOSTER PUMP HIGH HIGH LEVEL

(1) VALVE NUMBER

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Figure 3-4
Bioslurper Treatment Unit #2
Process & Instrumentation Diagram

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fig3-4

- Heat exchanger
- 7.5 HP liquid ring vacuum pump
- Liquid level switches in air/liquid separation tank for high-high and low-low override conditions.
- 120 gallon air/liquid separation tank, which also supplies seal water to the liquid ring vacuum pump

Free Product Skid

The free product skid is equipped with a tank to drop-out the oil and water phase of the air/water/oil mixture, which is pulled via a vacuum, from the recovery wells. The vacuum to the wells is controlled at this location by an air bleed valve and measured with a vacuum gauge. The oil and water in this tank is transferred by a pump to the oil/water separator skid. The main components of the free product skid are presented below:

- 120 gallon oil/water drop-out tank equipped with float type level switches
- A progressive cavity transfer pump to transfer the oily water mixture to the oil/water separator

Oil/Water Separator Skid

The oil/water separator skid is equipped with an oversized corrugated parallel plate type coalescing oil/water separator and a product transfer pump. The oil/water separator is rated for process flow rates up to 120 gpm, but the nominal flow rate that is actually processed is typically 8 to 12 gpm. The effluent water from the oil/water separator skid is transferred to the effluent treatment skid. The main components of the oil/water separator are presented below:

- 200 gallon integral sump
- 100 gallon integral product holding compartment
- Sight glass assemblies with level controls
- Internal sludge baffle
- Stainless steel effluent water transfer pump (5 HP)
- Stainless steel product transfer pump (1 HP)
- 275 gallon product holding tank

Effluent Treatment Skid

The effluent treatment skid is used to treat the effluent from the oil/water separator. The treatment train consists of a 100 micron bag filter, clay absorption units and a set of liquid-phase activated carbon adsorption units. The system is configured with a backup series of clay absorption units to be used when the primary set is spent. The treated water from the effluent treatment skid is discharged to the sanitary sewer. The effluent treatment system consists of the following items:

- A 20-gpm 100 micron bag filter unit

- Four high pressure clay absorption units (300 lbs. each) plumbed in a parallel/series configuration.
- Two liquid-phase activated carbon units plumbed in series (300 lbs. each)

Air Treatment System

Vapors from the exhauster skid are processed through the Air Treatment skid on Unit #1 prior to being discharged to the atmosphere. Approximately six months into the operation of the bioslurper systems, laboratory results of an air discharge sample from Unit #1 determined that the air discharge for that period was over the NJDEP air discharge permit limits. In order to ensure that no additional violations occurred, an air treatment system was installed on Unit #1. The air treatment system consists of the following:

- 120-gallon moisture separator with an 8-inch by 12-inch demister tower with manway access.
- Sight glass with level switches (low level, high level, high/high level)
- Drain line from the moisture separator tank to the phase separator tank.
- Explosion-proof solenoid valve on the drain line from the moisture separator tank.
- Intrinsically safe relays on moisture separator switches.
- Two 180-pound vapor-phase activated carbon units plumbed in series.

Master Control Panel

The control panel consists of a Program Logic Control (PLC) based master control panel and telemonitoring/datalogging system. The system is Microsoft® Windows® based operation and configuration software. The master control panel consists of the following:

- LCD local display of all systems functioning
- Internal fax modem
- Control voltage transformer
- Intrinsically safe relays and zenar barriers
- Interactive remote monitoring
- Run lights
- Alarm lights
- Remote viewing of product flow and effluent gauges
- Motor starters with thermal overload protection for all system motors

Automated Instrumentation

The two bioslurper systems were equipped with numerous sensors, switches, and alarms that were connected to the Master Control Panel. The system sensors were configured to ensure that if one or more parts of the system are not functioning properly, the entire system would automatically shut down, and beeper or faxed alarm reports were sent to FWENC's Langhorne, PA office, as well as the Navy's ROICC and Northern Division offices. The following switches were configured to turn off the entire system:

- High/high level sensor on the oil/water drop-out tank (free-product skid)
- High/high level sensor and the low/low sensor on the seal water tank (exhauster skid)
- High/high level sensor on the effluent tank of the oil/water separator (oil/water separator skid)
- High/high level sensor on the integral product tank of the oil/water separator (oil/water separator skid)
- High level sensor on the product storage tank (oil/water separator skid)
- High/high level sensor in the booster pump tank (Booster pump skid inUnit #2 only)
- High/high level sensor in the moisture separator (Air treatment skid inUnit #1 only)
- High pressure switch (effluent treatment skid)
- High level sensor in a floor sump inside the treatment building

4.0 PLUME CHARACTERISTICS

The objectives of the bioslurper systems operations are to conduct remedial operations in three separate areas: 1) the main free-phase plume located south and southeast of Building C-16; 2) a smaller free-phase plume north of Building C-50; and 3) the residual soil contamination associated with the former gas station site west of Building C-18.

The free-phase plume to the south and east of Building C-16 is suspected to have been the result of a leaking former underground fuel line. A former fuel line, located in the area north of Building C-18, was used to transport diesel fuel from a UST located at the northeastern corner of Building C-18 to a dispensing station near Building C-50. As evidenced by laboratory analytical results of air samples from Unit #1, there is also some residual gasoline contamination associated with the plume near Building C-16.

The free-phase plume to the north of Building C-50 is suspected to have been the result of minor spills at a former diesel dispensing station located between the railroad tracks, north of the Building C-50.

The soil contamination associated with the former gas station site was from previously removed USTs. There is no free-phase oil present in the former gas station area. Two bioventing wells are situated in this area to aid in remediating the vadose zone soils.

The diesel fuel spills would have started out as free product or free phase oil. This phase is initially very mobile, and migrates downward through the unsaturated (vadose) zone due to gravitational forces until either the water table or a stratigraphic barrier is encountered. The viscosity of the light non-aqueous phase liquid (LNAPL), the groundwater gradient, and the permeability of the aquifer media control the rate of free product migration. A "smear zone" develops when the mobile LNAPL is smeared vertically through seasonal fluctuations in the water table. Once the smear zone develops, a portion of the LNAPL exists as a discontinuous non-wetting liquid phase (residual) that is relatively immobile except at seasonal low water table (TAB 6). The increased smear zone reduces the volume of the remaining mobile free-phase oil.

Based on the data gathered from water level measurements obtained in the recovery wells, the elevations in the wells vary as much as 3.9 to 7.29-feet below grade, with the average groundwater fluctuation of 5.79-feet in a well. That means that the free-phase product is being smeared vertically across a smear zone of almost 6-feet. Appendix A contains the historical water table elevations collected from the extraction wells. The main free product plume is located to the east of Building C-16. The free-phase plume area is overlain by drainage ditches and railroad tracks. Due to the topographic depressions of the drainage ditches, and the permeability of the ballast associated with the railroad tracks, the localized groundwater table is subject to excessive water table fluctuations from rain events, which cause an increase in the vertical distribution of the oil across the smear zone. According to Peargin, Ireland, and Stephenson (1997), the largest percentage of LNAPL occurs within the smear zone versus the vadose zone.

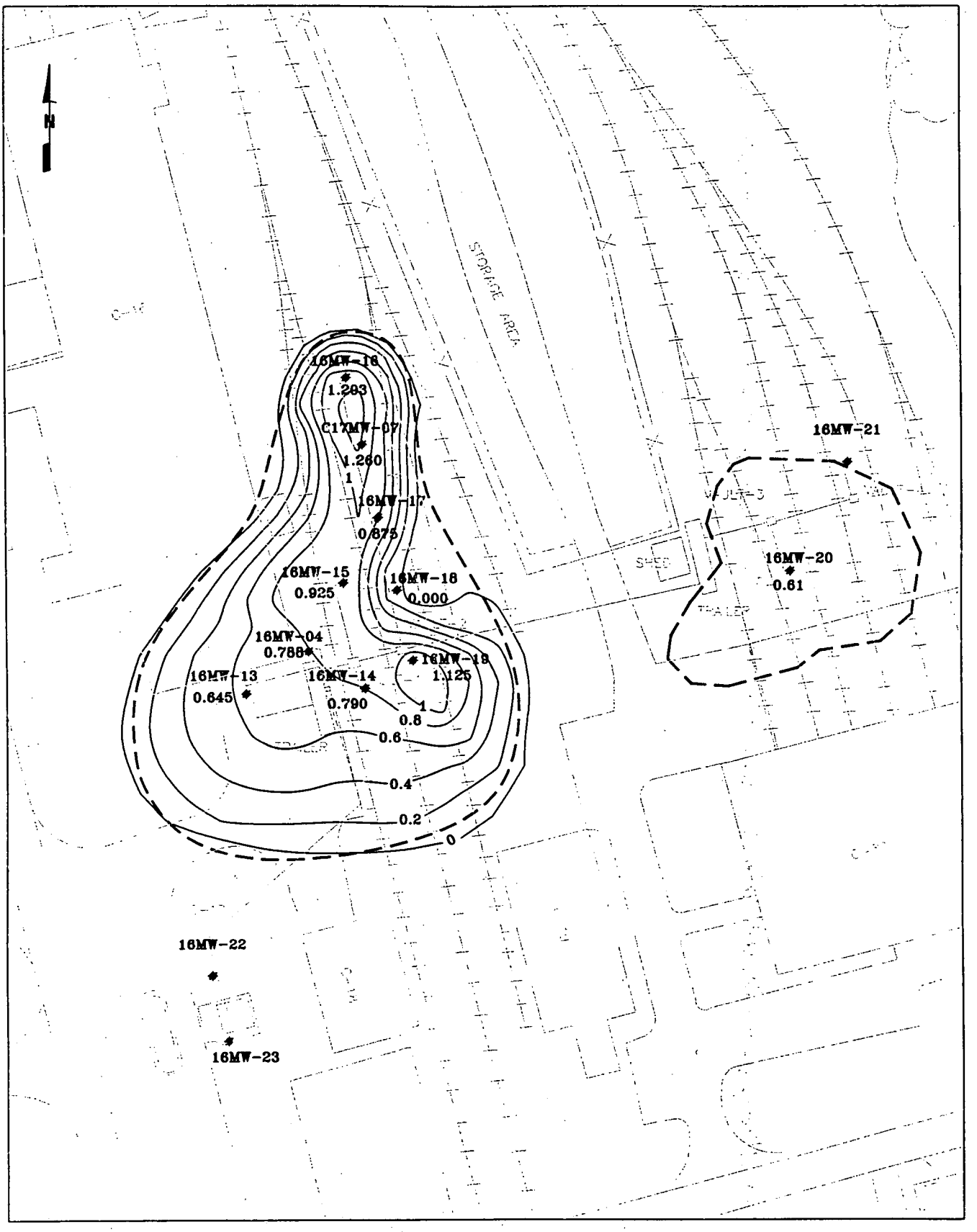
Figures 4-1 through 4-4 depict the product thickness concentrations at Site 16 over the one-year operational period. The product thickness isopleths are based on the corrected thickness, adjusted for exaggeration measured in the well.

As depicted in the latest product thickness map (Figure 4-4), the majority of remaining oil is located in the southwest portion of the free-phase plume near Building C-16. The concentration of the free-phase oil appears to be situated under the southwestern corner of Building C-16. Based on the present location of the wells, the western and southwestern extent of the free-phase plume cannot be completely defined. The estimated boundaries of the free-phase plume generated from the SCAPS Investigation (dashed line) have been used to define the original free-phase plume boundary. Based on the most recent product thickness isopleth, there is an estimated 13,509 gallons of free-phase oil in the vicinity of Building C-16. It is important to note that varying groundwater elevations effect the available, and measurable, free-phase oil. Maximum thicknesses will accumulate during periods of low (depressed) water table conditions.

The extent of the free-phase plume located north of Building C-50 has not been verified with additional wells. The free-phase boundary depicted is based on the SCAPS Investigation. One extraction well (16MW20) is being used to extract product from the central portion of the suspected plume. While extraction well 16MW20 has consistently recovered free-phase oil, the oil thickness in the well is minimal. Appendix A contains specific product thickness information. Measurements from an extraction well located at the hydraulically downgradient edge of the suspected free-phase plume have not detected any free-phase oil.

5.0 BIOSLURPER SYSTEM OPERATION

The bioslurper systems are designed to de-water the smear zone and remove LNAPL through drainage, volatilization, and biodegradation. The high vacuum of the bioslurper system extracts LNAPL from the pore spaces where it was formerly held by capillary tension. Typically, a vacuum pressure of 2.1 to 4.6 inches of Hg is applied to each well. The velocity in the drop tube must be sufficient to lift water as an entrained fluid.



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NWS- Earle, Colts Neck, NJ

Figure 4-1
Site 16F
Product Thickness Isopleth 12/12/97

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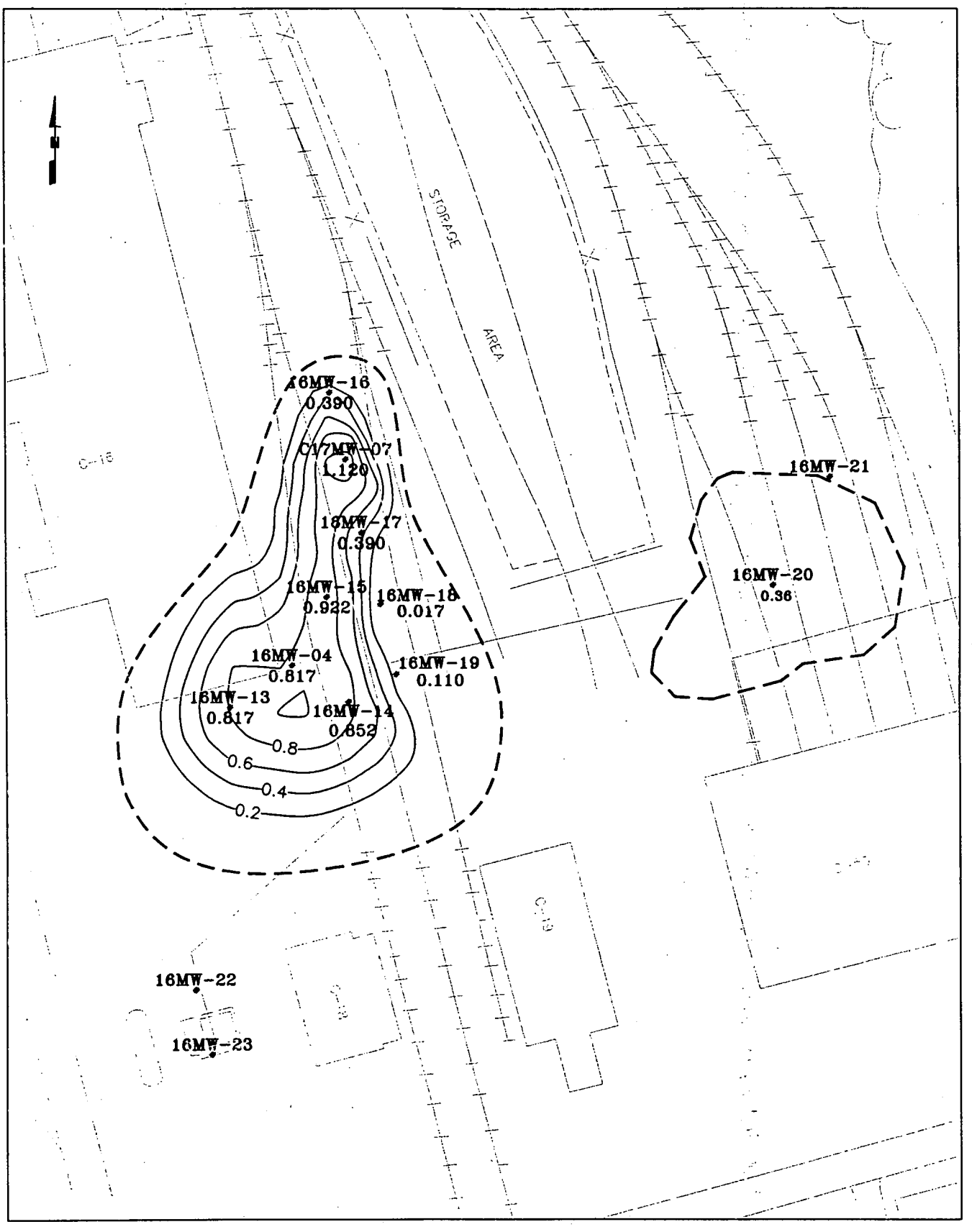

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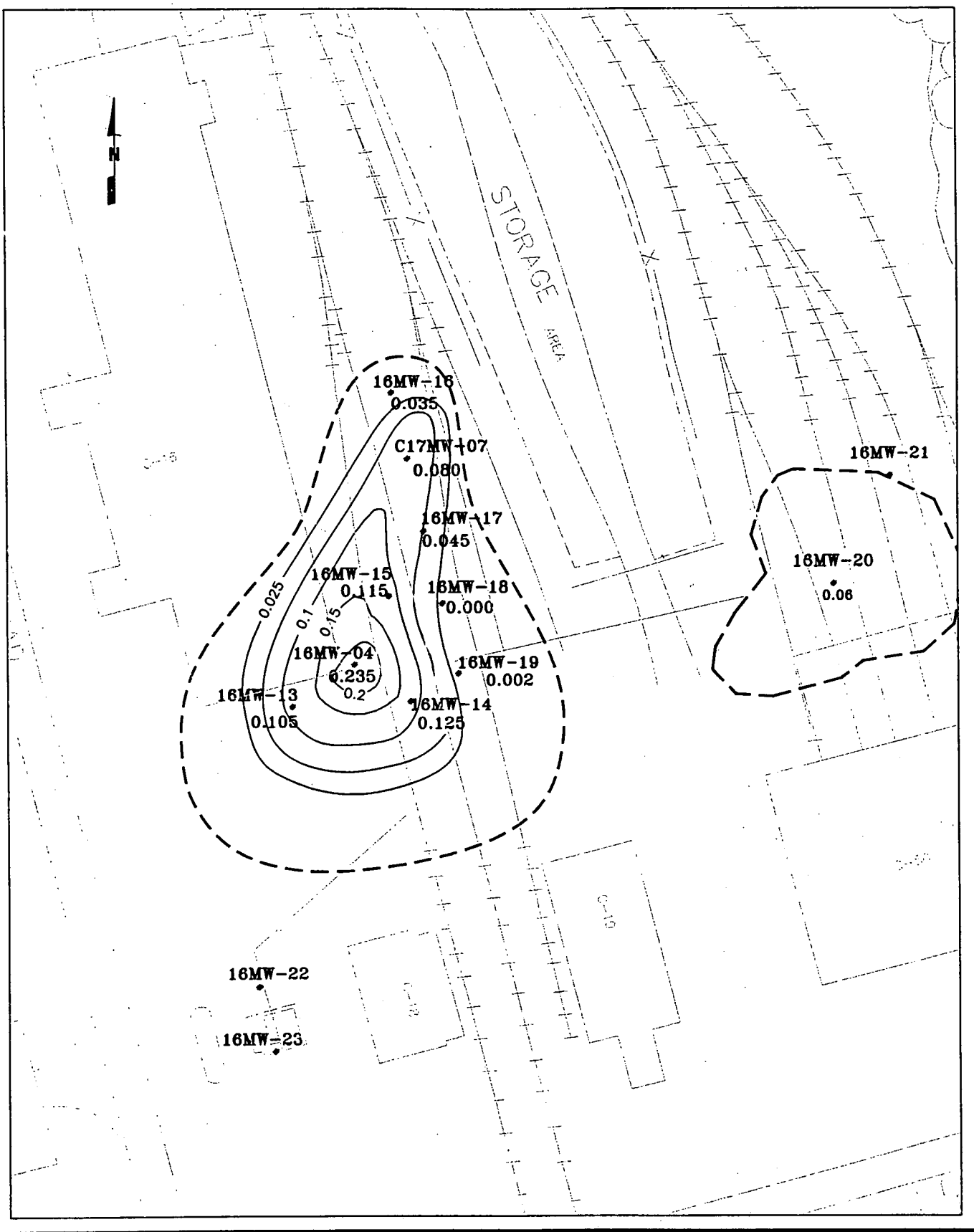
U.S. Navy RAC
NWS- Earle, Colts Neck, NJ

Figure 4-2
Site 16F
Product Thickness Isopleth 7/30/98

FOSTER WHEELER ENVIRONMENTAL CORPORATION



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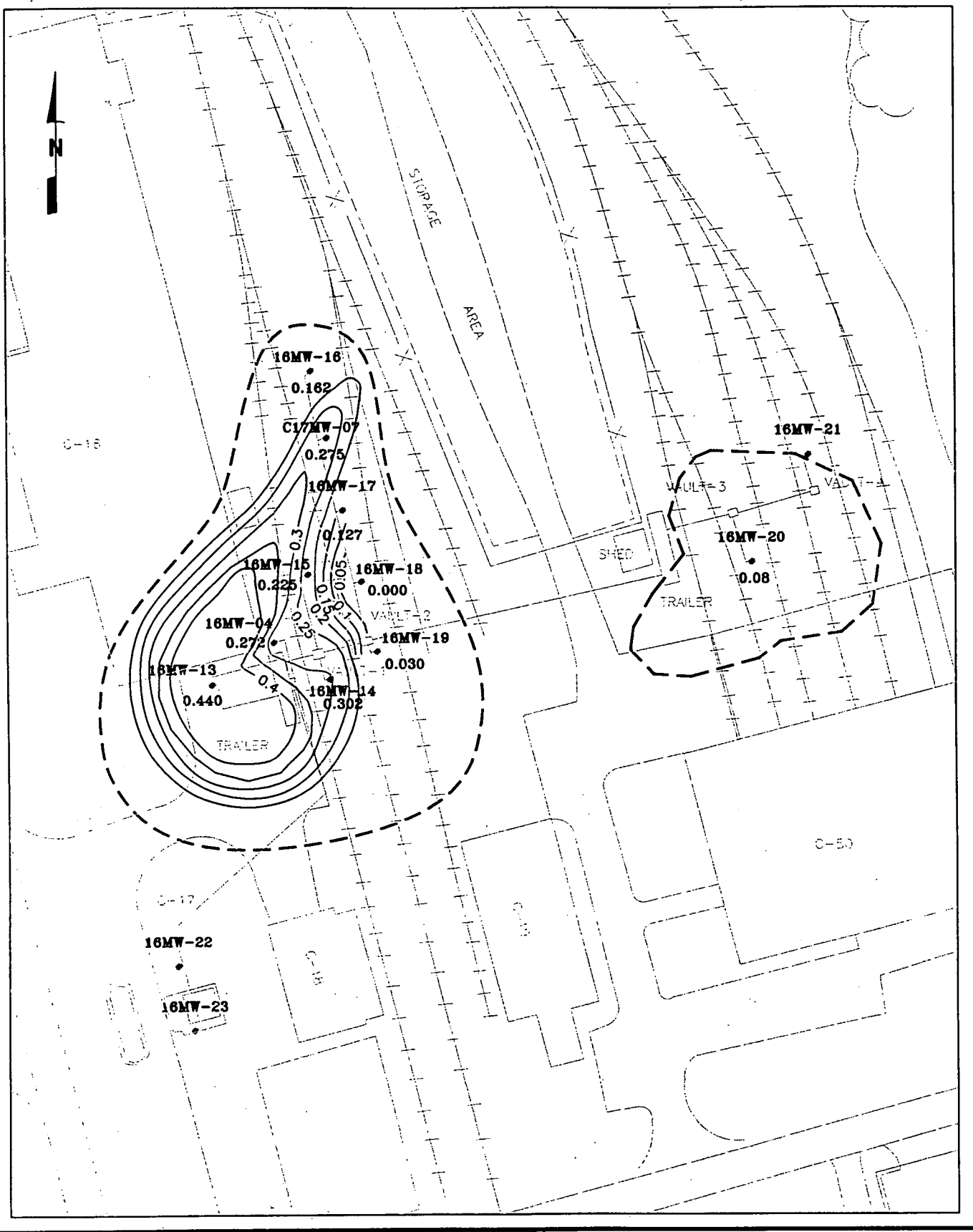
U.S. Navy RAC
NWS- Earle, Colts Neck, NJ

Figure 4-3
Site 16F
Product Thickness Isopleth 12/3/98

FOSTER WHEELER ENVIRONMENTAL CORPORATION



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U.S. Navy RAC
NWS- Earle, Colts Neck, NJ

Figure 4-4
Site 16F
Product Thickness Isopleth 6/9/99

FOSTER WHEELER ENVIRONMENTAL CORPORATION

Unit #1, located adjacent to Building C-16, was operated utilizing four product recovery wells (16MW13, 16MW04, 16MW14, and 16MW15), and two bioventing wells (16MW22 and 16MW23). The product recovery wells were operated at a vacuum of approximately 5 to 8 inches of mercury, with the one-inch diameter drop tube set immediately above the product level in the well. The bioventing wells were operated at a vacuum of 2 to 3 inches of mercury, and the one-inch diameter drop tube was placed several feet above the water table to minimize any water withdraw. On a yearly average, each product extraction well connected to Unit #1 produced approximately 1.67 gallons of water per minute (gpm) or 100.31 gallons per hour (gph) and 0.98 gph of oil. As depicted in the graphs in Appendix C, the product recovery rates were greatest at the start of the system and have decreased over time. Appendix C also contains a monthly breakdown of the average recovery rates of oil and water per well at each bioslurper unit.

Unit #2, located north of Building C-50, was operated utilizing six product recovery wells (16MW16, 16MW17, 16MW19, C17/20MW07, and 16MW20). The product recovery wells were operated at a vacuum of approximately 5 to 8 inches of mercury, with the one-inch diameter drop tube set right above the product level in the well. On a yearly average, each product extraction well connected to Unit #2 produced approximately 1.46 gpm or 87.82 gph of water and 0.25 gph of oil. As depicted in the graphs in Appendix C, the product recovery rates were greatest at the start of the system and has decreased over time. Unit #2 was operated on an average of 1 to 2 hours/ day, 5 days/week. The pipe connections to Unit #2 were configured in order to allow extraction from the wells on the outer edge of the free-phase plume east of Building C-16, and the one recovery well north of Building C-50. The product thickness and product recovery rates of the wells were significantly less than the recovery wells connected to Unit #1, therefore Unit #2 was operated for a lesser amount of time.

6.0 BIOSLURPER SYSTEM MODIFICATIONS

Several modifications were made to the bioslurper units over the past one year of operation. The modifications were completed in order to correct operational problems discovered during the extended operation of the systems.

The following paragraphs summarize the major modifications to the bioslurper systems over the past year of operation:

- Solenoid valves were installed on the potable water lines coming into each of the bioslurper units. As requested by the Navy, the solenoid valves were located on the outside of the units. The potable water lines to the units supply water for the operation of the liquid ring pumps, which produce the vacuum for the product recovery operations.
    - The solenoid valves were installed in the "normally closed" position, such that if power to the systems is interrupted, the solenoid valve would close, cutting off water to the unit.
    - The solenoid valves were wired into the motor relays of the liquid ring pumps. Wiring the solenoid valves in this manner turns off the water supply to the

units any time an alarm condition occurs, and turns off the liquid ring pump. The liquid ring pumps will automatically shut down anytime an alarm condition occurs within the units.

- The upgraded modification allows the water supply to be automatically regulated by a mechanical float assembly inside the seal water tank, however if the mechanism fails, the water level will rise and activate the high water level sensor, which in turn, shuts off the entire unit, including the water supply line.

- A vapor-phase knockout tank (moisture separator), with a demister pad, and two vapor-phase activated carbon drums were installed in the wooden shed adjacent to Bioslurper Unit #1. The air treatment equipment was installed in the shed due to space limitations within the treatment trailer. The vapor-phase knock-out tank was equipped with low level, high level, and high/high level float switches. The high and low level switches activate and deactivate the opening of a solenoid valve to drain the water from the vapor-phase knockout tank. A one-inch diameter PVC line connects the vapor-phase knock out tank to the phase separator tank inside the bioslurper unit. This drain line is equipped with the solenoid valve previously discussed. When the solenoid valve opens, the drain line is subject to the vacuum on the phase separator tank, and the water from the vapor-phase knock out tank is evacuated into the phase separator tank. The water from the phase separator tank is subsequently treated along with the water in the oil/water separator. The high/high level on the phase separator tank was wired into the Master Control Panel to turn off the entire system, in the event of activation, to prevent overflows.

- Two revised New Jersey Department of Environmental Protection (NJDEP) Air Discharge Permit Applications were completed to reflect the following modifications:
  - The air treatment equipment was added to Bioslurper Unit #1.
  - The air discharge limits for both Bioslurper Unit #1 and Unit #2 were elevated to the maximum total volatile organic and total toxic volatile organic compound concentrations allowable by NJDEP.

7.0 OPERATIONAL EVALUATION

The bioslurper systems have been operating in accordance to their design, but there are some operational concerns that have come to light over the past year of operation. The main operational concerns are the costs associated with the operation and maintenance (O&M) of the systems, and the extent of influence of the extraction wells in the free-phase plume area.

7.1 SYSTEM OPERATION CONCERNS

7.1.1 Effluent Treatment

The major operational costs of concern are the groundwater and air treatment costs. The effluent of both bioslurper systems is discharged to the NWS-Earle Sewer Treatment

Plant. Based on agreements with NWS-Earle prior to the start-up of the systems, the effluent discharge from the systems was to meet the NJPDES Discharge Permit criteria for their discharge. The applicable discharge criteria the effluent is to meet is 10 ppm total petroleum hydrocarbons (TPH).

Since the bioslurper systems use a vacuum to recover the oil, the oil is brought into the system in the form of fine oil droplets, air and water. The smaller micron-size oil droplets require a longer retention time in order to rise and separate. The rise of the oil droplet is mainly dependent upon the size of the droplet, the specific gravity, and the temperature. The larger the droplet, the more buoyant and quicker to rise. Since the actual size of the oil droplets being introduced into the oil/water separator are much smaller in size, over-sized oil/water separators were installed in the systems. Each system processes between 8 to 12 gpm, and the oil/water separators were sized to process 120 gpm. Oil/water separators are used to separate free-phase oil, and will not separate emulsified oils (RGF,1996). Some of the oil being recovered is emulsified by the mechanical mixing inherent to this type of system. It is also believed that a portion of the oil being recovered is present in the form of very small diameter oil droplets, which are not being adequately removed by the oil/water separator.

According to historical studies on dual-phase systems, a knockout tank is recommended on the intake side of the vacuum pump in order to limit the emulsification of oil into the water, and remove iron rich water before the vacuum pump (Tab 6). The bioslurper systems at the site were each designed and installed with a series of two knockout tanks on the intake side of the vacuum pump to enhance operational efficiency. The second knockout tank is also supplied with fresh water to supply the vacuum pump instead of utilizing recovered groundwater, which would have increased the emulsification of the oil.

Historical studies of recovery systems in which the LNAPL is a low volatility fuel, such as diesel fuel, treatment for oil/water emulsions are typically required (Kittel, Hincher, et al). Typical treatment of emulsified oil/water include using a holding tank to increase residence time of the water, using large pore bag filters (100 to 200 micron), and using surface-modified clay to reduce the TPH concentrations (Kittel, Hincher, et, al). The construction of the bioslurper systems at NWS-Earle included a larger oil/water separator for increased residence time of the water, a large micron bag filter, and surface modified clay and activated carbon treatment units. The absorption media is a chemically-modified clay and anthracite filtration media, capable of absorbing up to 60% of its weight in oil and grease (CETCO, 1997). The clay absorption units can adsorb the emulsified oil, extending the lifetime of the activated carbon by a factor of 2 to 10 times.

While the groundwater treatment systems operate in accordance with design, and have proven that the discharge requirements of $\leq$ 10 ppm of TPH can be achieved, there is a large O&M cost associated with changing out the clay units. The clay treatment units at Bioslurper Unit #1 required a change out approximately every 2 weeks. Bioslurper Unit #2 required a change out approximately every 5 to 6 weeks. Even with the oversized oil/water separator, the effluent of the oil/water separator in Bioslurper Unit #1 contained elevated concentrations of TPH.

Based on the analytical results of the one-year operation, the average TPH concentration of the effluent of the Bioslurper Unit #1 oil/water separator was 1,262 ppm. While the treatment system of Bioslurper Unit #1 effectively reduced the TPH concentration to an average of 0.33 ppm prior to discharge, the elevated TPH concentrations of the effluent prior to treatment resulted in elevated O&M costs. Based on the analytical results of the one-year operation, the average TPH concentration of the effluent of the Bioslurper Unit #2 oil/water separator was only 108 ppm, and the average discharge concentration was 0.36 ppm. The main difference in the oil/water separator concentration between the two bioslurper systems can be attributed to the operational times of the units, and, in effect, the retention time of the water in the oil/water separator. The analytical results, available literature, as well as visual observations, have indicated that if the recovered groundwater is given a longer retention time, the TPH concentrations of the effluent will decrease.

7.1.3 Iron Fouling

Using a vacuum-enhanced recovery system to recover free product introduces oxygen to the subsurface promoting biodegradation. However, the increased air flow (and oxygen supply) causes the oxidation of iron, which can have a debilitating effect on the groundwater treatment system. Under natural conditions at the site, the groundwater is in a reduced state with a pH of approximately 5, and iron is in the form of Fe^{+2} (Drever, 1997). When the groundwater becomes oxygenated, the stability point of the iron shifts from Fe^{+2} to $Fe(OH)_3$ (Drever, 1997). Elevated concentrations of iron in the groundwater go from a reduced state to an oxidized state because of introduction of additional oxygen, which is inherent to the vacuum recovery process.

The groundwater at the site has naturally occurring iron concentrations averaging 241 mg/l. The majority of the iron in the aquifer is in the soluble form of ferrous iron (Fe^{+2}) which is stable at a pH of 5. While removing the LNAPL, water, and air from a well with a vacuum unit, oxygen is introduced and the ferrous iron is oxidized into less soluble ferric hydroxide [$Fe(OH)_3$]. Ferric hydroxide forms a bulky gelatinous floc that is dependent upon dissolved oxygen (Buton and Tchobanoglous, 1991). As the high concentrations of iron in groundwater are oxidized by the vacuum-enhanced system, small oil droplets are physically entrained with the iron, resulting in a buoyant iron/oil flocculent. The oil/water solution is being oxidized in the well as the vacuum draws air into the well and across the aquifer. The iron is further oxidized in the piping network and the oil/water solution within the air/water separation tank, prior to being discharged to the oil/water separator. The oil and water in the air/water separation tank are continuously subjected to a vacuum, which agitates the solution and increases the iron oxidation, hence increasing flocculation. A study by Tinholt and Wendling (1997) determined that 50 to 100% of the dissolved iron concentration in groundwater precipitates out as iron hydroxide in a typical groundwater treatment system, and that 80% of the precipitation occurs within 5 minutes of aeration.

A deposit control agent known as FeREMEDE® was initially administered to the influent of the bioslurper in an attempt to reduce iron flocculation. FeREMEDE® is a

concentrated blend of sequesterants and polymetric dispersents, designed to keep iron, as well as some other metallic oxides, in solution, and stop the iron already oxidized from flocculating. A small-diameter tube connected to a metering pump was used to dispense the chemical down into the vacuum line in the well. The line used to administer the chemical was placed only part way into the well, to ensure that all the chemical was picked up by the vacuum as the oil/water and air were being pulled from the well. The sequesterent/disspersent was not injected into the aquifer; but only into the vacuum line. After some initial adjustments, the optimal feed concentration for the FeREMEDE® chemical product into the water was approximately 310 ppm.

The injection of the FeREMEDE® was terminated after approximately one month of operation for several reasons. While decreasing the iron flocculation, the chemical did not eliminate the flocculation, and therefore the additional maintenance created by the flocculation was still required for the optimal operation of the oil water separator. By manipulating the oil skimmer in the oil/water separator, it was determined that by increasing the oil thickness in the oil/water separator, the flocculation could be suppressed and held into the top of the coalescing filter pack media. By physically pushing the flocculation down into the coalescing media of the oil/water separator, the carry over of the flocculation to the effluent side of the oil/water separator was all but eliminated. The costs of introducing the FeREMEDE® chemical into the systems were weighted against the costs of periodically cleaning out the oil/water separator and disposing of the wastes off-site. Since the oil/water separators require periodic cleaning anyway, the additional costs of more frequent cleanings was not significant. The cost of the FeREMEDE® chemical was expensive, and when weighted against its benefits, it was not cost effective. Another problem surrounding the use of the FeREMEDE® chemical, included a noticeable increase in the amount of oil being emulsified if the dosage concentration was increased. Because of the variable recovery rate of the bioslurper systems due to rainfall and infiltration, there is not a consistent recovery rate of water into either system, which diminishes the effectiveness of the FeREMEDE® chemical.

A few additional problems occur with respect to the operation of the recovery/treatment units as a result of elevated iron concentrations. The elevated iron concentrations cause iron to precipitate out as scale inside pipelines and pumps. Float switches on the oil/water separator tank of the extraction system became fouled and were a source of problems for system operation. In order to correct the problem of iron fouling of the float switches, a more aggressive O&M procedure was undertaken, and additional buoyancy was added to the float assemblies on the effluent side of the oil/water separator.

7.2 EXTRACTION WELL CONCERNS

The bioslurper systems are continuing to operate within the design capabilities. Free product continues to be recovered, but the product recovery rate has decreased over the duration of the systems operations. The decrease in the volume of oil recovered is a function of the volume of oil available within the radius of influence of the recovery wells, as well as a function of the available oil located at the oil/water interface. It should be noted that while the bioslurpers are removing the available product within the radius of

influence of the recovery wells, the recovery well placements at this point in time do not provide sufficient coverage of the entire free-phase plume. The increase in product thickness' in the recovery wells after the system is turned off indicates that additional free-phase product is migrating, under natural conditions, to those wells while the system is off. The recovery wells were installed in what was (at the time) believed to be the hydraulically downgradient portion of the free-phase plume. By ensuring that recovery wells were installed in the most downgradient portion of the free-phase plume, even though there may not have been complete coverage throughout the free-phase plume, the free-phase oil could eventually be captured with the available recovery wells. The possible addition of extraction wells to the existing system is discussed in Section 8.0.

7.3 PRODUCT RECOVERY

The product recovered from the bioslurper systems was evaluated for all waste streams processed. The waste streams processed and evaluated include: the free-phase oil extracted; the petroleum removed from treating the contaminated groundwater; the petroleum removed from the vapor extraction component of the systems; and, the biodegradation component of the systems, which was calculated based on measurements of the carbon dioxide levels generated during biodegradation. Table 7-1 summarizes the product recovered from each of the system waste streams. Appendix C contains a graphical representation of the data.

Table 7-1: Oil Recovered From All System Components to Date

	Unit #1 (gal.)	**Unit #2 (gal.)**	**Total (gal.)**
Free-Phase Oil	2,900	380	3,280
Biodegradation	1,218.61	536.82	1,755.43
Groundwater Treatment	290.58	59.58	350.16
Vapor Extraction	55.86	16.95	72.81
Total Oil	**4,465**	**993.35**	**5,458.40**

7.3.1 Free Product Recovery

The free product, or free-phase oil, recovered from the bioslurper units was evaluated over the one year period of operation. The free-phase oil was removed from the oil/water mixture recovered from the wells by the oil/water separators inside each bioslurper unit. Appendix C contains both the graphical representation of the oil recovery per month over the operational period, and tabulated data. Approximately 2,900 gallons of free-phase oil were recovered from Bioslurper Unit #1, and approximately 380 gallons from Bioslurper Unit #2, yielding a total of 3,280 gallons of free-phase oil recovered from both units.

7.3.2 Petroleum Recovered From Groundwater Treatment

The bioslurper systems recover contaminated groundwater, air and oil in one waste stream. The free-phase oil and water are separated by an oil/water separator. The contaminated water, which is contains dissolved petroleum hydrocarbons, is treated prior to discharge. The effluent waste stream from the oil/water separator, prior to and after treatment, were routinely laboratory analyzed in order to determine the amount of petroleum hydrocarbons recovered by extracting and treating the groundwater. The total petroleum hydrocarbons recovered from groundwater treatment was 290.58 gallons from Unit #1 and 59.58 gallons from Unit #2 (350.16 gallons total). Appendix C contains the tabulated data, and Appendix D contains the calculations used to determine the volumes recovered.

7.3.3 Petroleum Recovery From Vapor Extraction

Since a vacuum is used to recover the free-phase oil and water from the extraction well, some of the petroleum contaminants in the vadose zone are volatilized and recovered in the extracted air that enters the bioslurpers. The TPH concentrations of air samples collected during the operational period, and actual volumetric flow rates of the vapor stream, were used to determine the amount of hydrocarbons remediated by vapor extraction. Appendix C contains the tabulated data, and Appendix D contains the calculations used to derive the estimated volumes. The total petroleum hydrocarbons recovered from vapor extraction was 55.86 gallons from Unit #1 and 16.95 gallons from Unit #2 (72.81 gallons total).

7.3.4 Petroleum Remediated Through Biodegradation

Bioventing and Bioslurping use the existing contaminants as a carbon energy source, and introduce oxygen to the subsurface via a vacuum on the well to enhance the natural in-situ aerobic biodegradation of the petroleum products using the indigenous soil microbes (Gibbs).

Biodegradation was monitored by analyzing the air in the recovery wells and the vapor discharge stack during operation of the system. The CO_2 levels in the discharge stack and monitoring wells, minus the background CO_2 concentrations, and the vapor flow rate of the system was used to estimate the mass of hydrocarbons degraded during operation of the bioslurper systems using the following stoichiometric equation:

$$C_{13}H_{28} + 15O_2 + NH_3 \rightarrow C_5H_7O_2N + 8CO_2 + 12\,H_2O$$

According to the equation, 1.913 pounds of CO_2 will be produced for each pound of diesel fuel degraded (Damera, 1997). The equation assumes that half the hydrocarbons ($C_{13}H_{28}$) are converted to CO_2 and the other half to biomass ($C_5H_7O_2N$).

Based on the evaluation of petroleum biodegradation at Site 16F, it is estimated that Bioslurper Unit #1 has biodegraded approximately 8,469.36 pounds of petroleum and Bioslurper Unit #2 has biodegraded approximately 3,730.87 pounds of petroleum. Appendix C contains the graphical representation of the data, and Appendix D contains the calculations used to estimate the volume.

8.0 CONCLUSIONS AND RECOMMENDATIONS

Bioslurping, or vacuum-enhanced recovery, can be used successfully to remove the LNAPL at the subject site. System modifications can be performed to lower the operation and maintenance (O&M) costs associated with the bioslurper units. There are several combinations of options that are recommended in order to increase the efficiency of the recovery/treatment system while reducing the O&M costs.

1. The first suggestion would be to lower the water intake into the systems, while maximizing product recovery. During the first year of operation, both systems were operated on an almost daily basis, with Unit #1operating for up to 8 hours a day, and Unit #2 operating 1-2 hours a day. Based on observations over the past year of operation, it would be prudent to operate the extraction wells at a less frequent interval. The outlying extraction wells tend to not recharge very quickly, and should be operated on a less frequent basis. There are several wells that have consistently demonstrated a faster product recharge rate than others. Extraction wells 16MW04, 16MW13, 16MW14, 16MW16, and C17/20MW07 have demonstrated a faster product recovery rate than other wells. The recovery rate of these extraction wells correlate to their location within the main body of the free-phase plume. The suggested frequency would be to operate the extraction wells with a quicker recovery rate four to eight hours/day. Operation of the system at eight hours/day would only be recommended in times of low water table elevation. At times of low water table elevation, the smear zone is exposed providing greater product recovery potential without de-watering. The system should be operated less frequently during the periods of higher groundwater elevations.

2. The vacuum extraction drop tubes in each well could be reconfigured in order to maintain product withdraw while decreasing water recovery. Typically, a vacuum pressure of 2.1 to 4.6 inches of Hg is applied to the well to extract free-product from a well (Peargin et. al.). The product recovery wells at the site were operated at a vacuum of approximately 5 to 8 inches of mercury, with the one-inch diameter drop tube set right above the product level in the well. The higher vacuum rates at the wells were maintained in order to capture and lift the entrained fluids. The required extraction velocity at each well was achieved based on visual inspections utilizing a clear PVC sight-tube at each well. The vacuum on each well was adjusted until visual observations verified extraction of the entrained fluids. The extraction velocity in the well can be increased while lowering the vacuum on the well or by decreasing the diameter of the extraction tube in the wells. There are presently 1-inch diameter drop tubes in the recovery wells. By decreasing the diameter of the extraction tube in the well, the vacuum applied to that well may be lowered, resulting in a reduction in the

amount of water withdrawn from the well. During product recovery, the water table should be maintained as close to static conditions as possible, in order to minimize the smear zone. During the bioslurping operation, the applied vacuum raises the water table, which counteracts draw-down effect caused by liquid extraction.

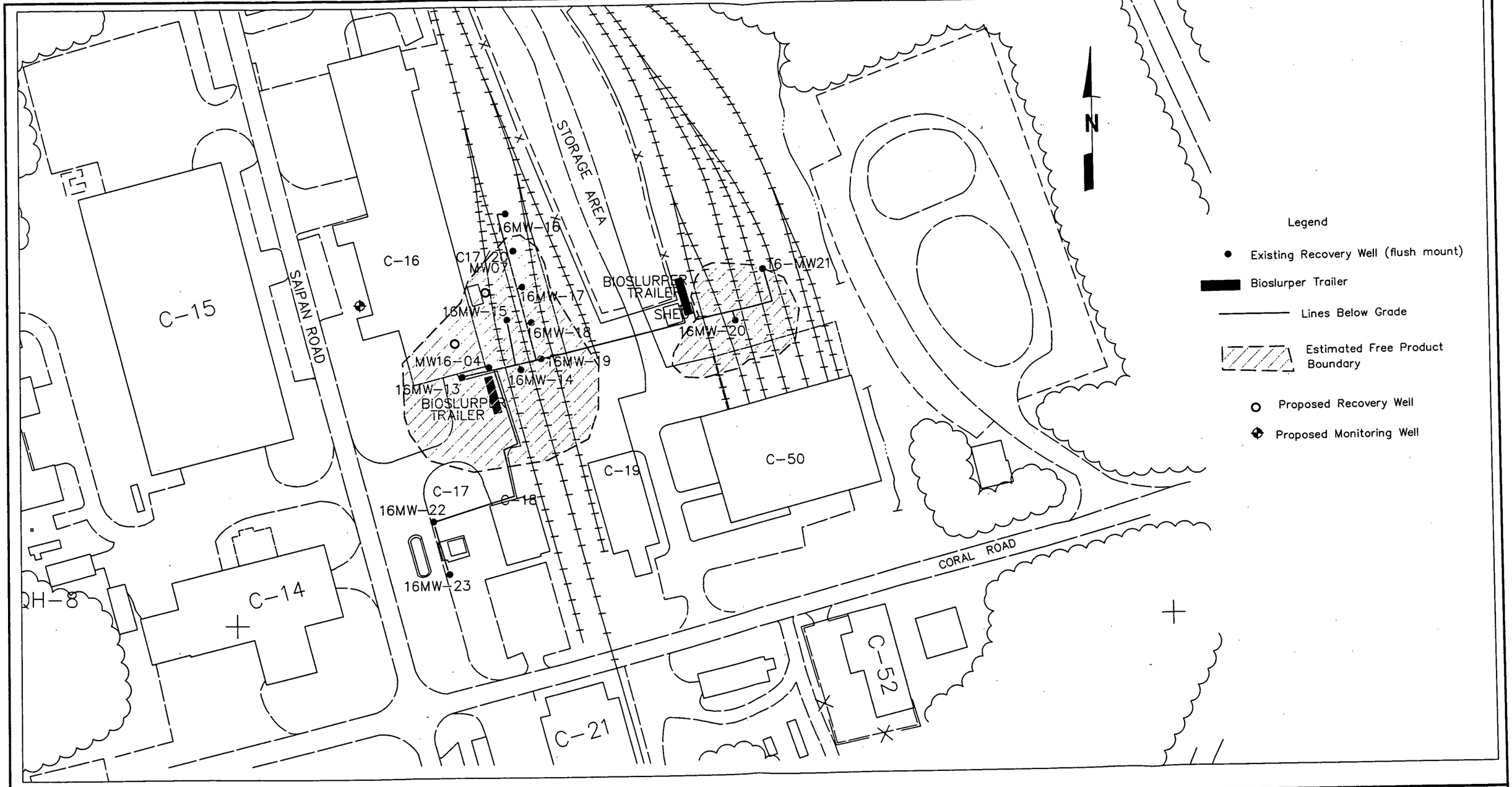
3. The installation of an additional effluent equalization tank to Bioslurper Unit #1 is recommended in order to decrease the O&M costs associated with the treatment of the oil/water separator effluent. By installing a large (3,000 gallon) equalization tank after the oil/water separator, the effluent from the oil/water separator is provided additional retention time prior to treatment, allowing for greater separation of free-phase oil. An equalization tank extends the retention time, thereby reducing TPH concentrations of the effluent; which therefore, extends the life of the modified-clay and carbon treatment media.

1. Installation of additional wells are recommended in order to further delineate the free-phase plume in the western portion of the site, as well as to add additional recovery wells to the system. Based on the existing product thickness maps and groundwater gradient contours, a portion of the thickest part of the free-phase oil lies under the southeastern corner of Building C-16. The installation of additional recovery wells is recommended inside the southeast corner of Building C-16, and along the eastern side of Building C-16, 75 ft. north of 16MW04. The new recovery wells can be connected to the existing underground piping network. It is also recommended that a monitoring well be installed west of Building C-16 (towards the northwest corner) in order to determine if any free-phase product is migrating to the northwest. The additional proposed wells are shown on Figure 8-1.

8.1 EVALUATION OF AN ADDITIONAL PETROLEUM RECOVERY TECHNOLOGY

Studies have proven that vacuum-enhanced oil recovery systems (bioslurping) are more effective in removal of free-phase oil than typical passive skimmer systems and dual pump systems. One of the main problems with vacuum-enhanced oil recovery is that water is withdrawn along with the product. While the amount of water withdrawn with vacuum-enhanced recovery systems is significantly less than dual pump recovery systems, the water still requires processing.

A relatively new technology has been developed using a pneumatic-type skimmer pump in conjunction with a vacuum applied to the well (Appendix E). The inherent problem with skimmer pumps is that they remove the existing free-phase oil available in the well, but do not actively draw additional product into the well. The combination of the skimmer pump technology with the vacuum enhanced recovery could potentially continue the active recovery of free-phase oil, while eliminating the need to recover and treat groundwater. A vacuum applied to the well could draw the oil into the well, and product only would be removed with the skimmer pump.



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Naval Weapons Station – Earle

Figure 8-1
Site 16
Location of Additional Proposed Wells

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fig8-1

Xitech Instruments, Inc. (Xitech) provides the appropriate equipment for the vacuum-enhanced skimmer pump systems. Appendix E contains information on the systems available from Xitech. Foster Wheeler Environmental has contacted Xitech about the potential use of this technology at NWS-Earle. Xitech is willing to supply the equipment and conduct a one-week pilot study at no cost, to determine the effectiveness of this technology as compared to bioslurping.

It is recommended that a pilot study be conducted in order to determine the effectiveness of the vacuum-enhanced skimming system compared to the present bioslurper system operation. The results of the pilot study would be evaluated to determine the effectiveness of the system, and the positive/negative applications as compared to bioslurping. The additional equipment needs and required piping modifications to install the new technology would be evaluated as part of the pilot study. A cost comparison would be completed, weighing the present O&M costs of operating the bioslurper systems, with the additional equipment and operating costs of the vacuum-enhanced skimmer system.

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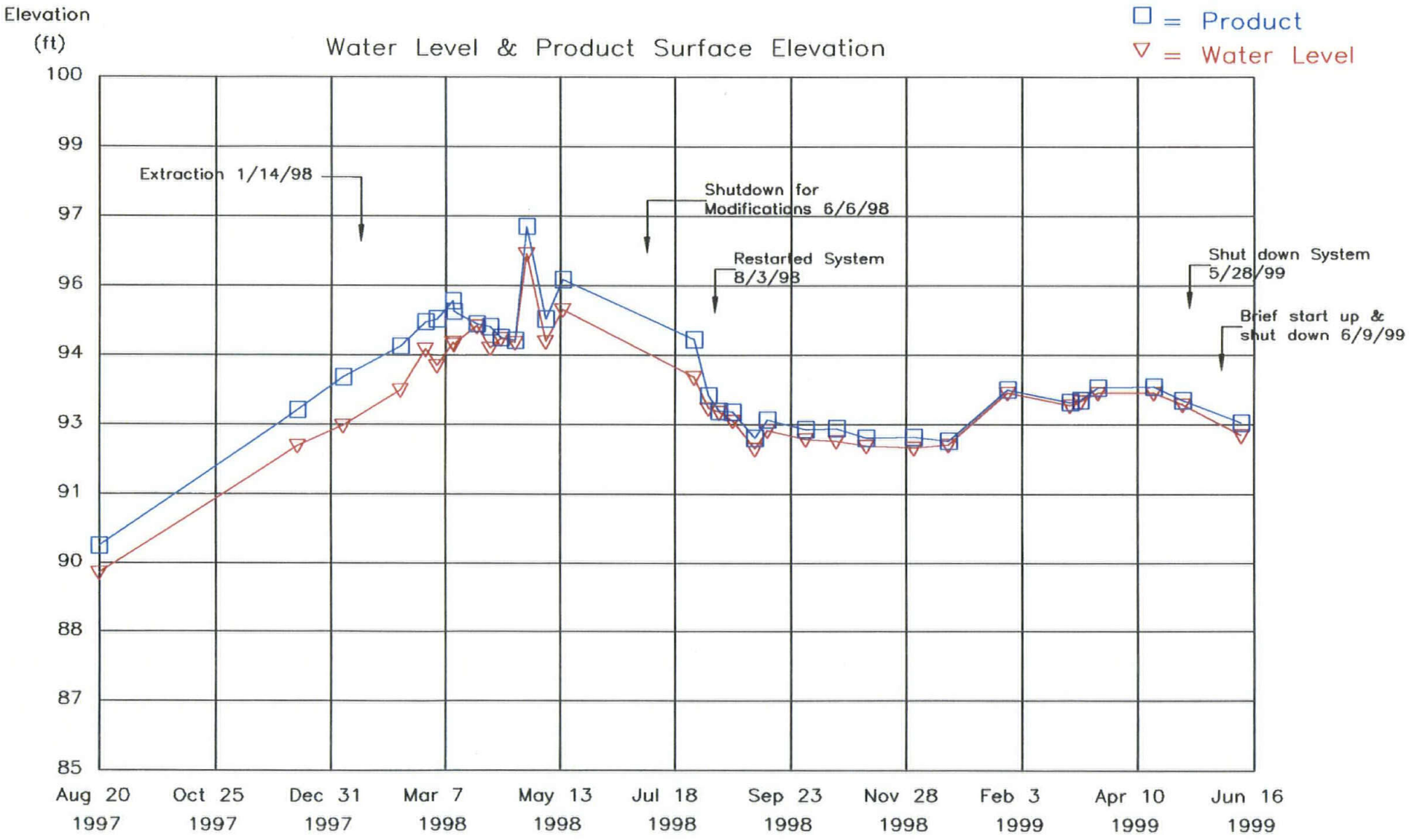
Elevation
(ft)
Water Level & Product Surface Elevation
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▽ = Water Level
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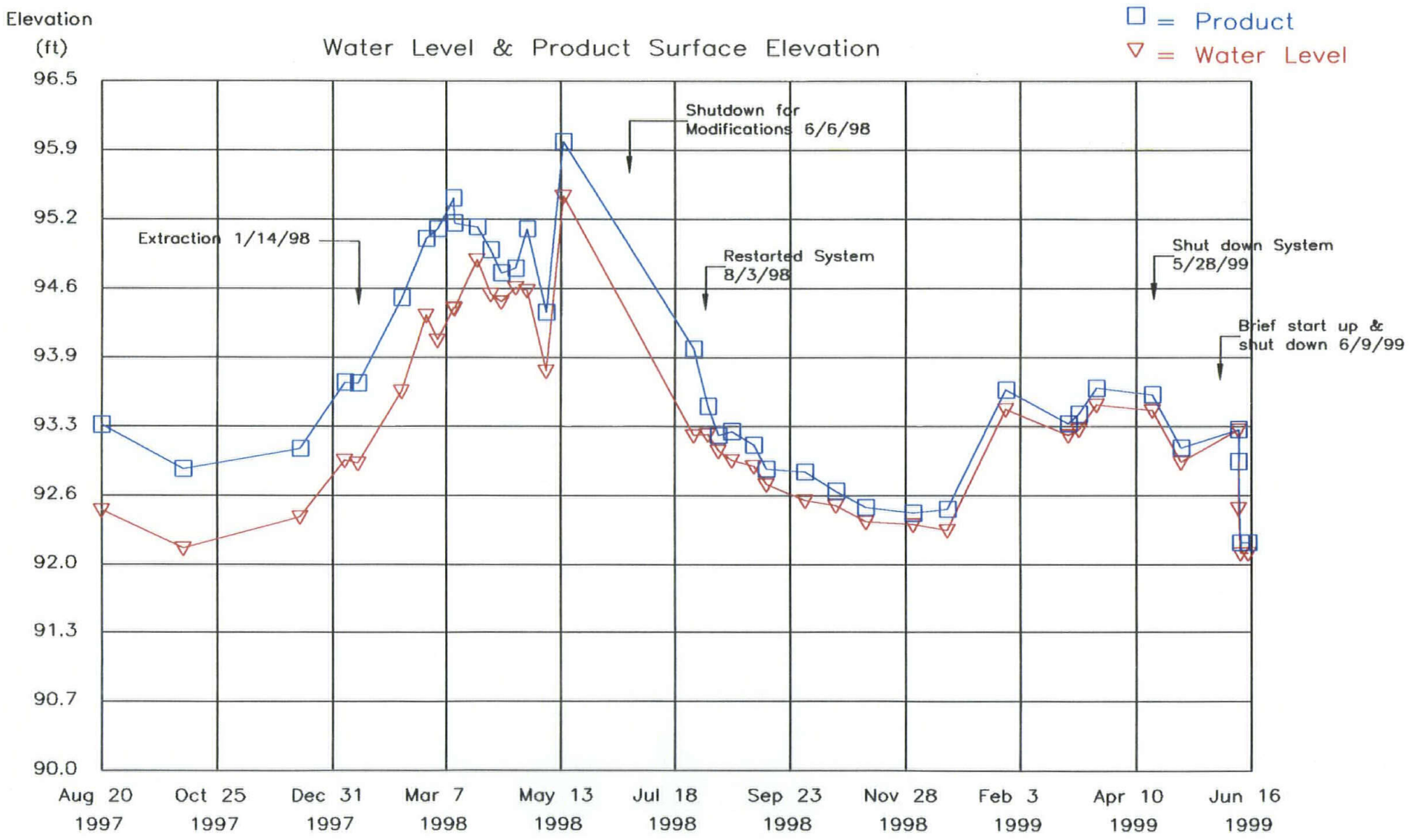
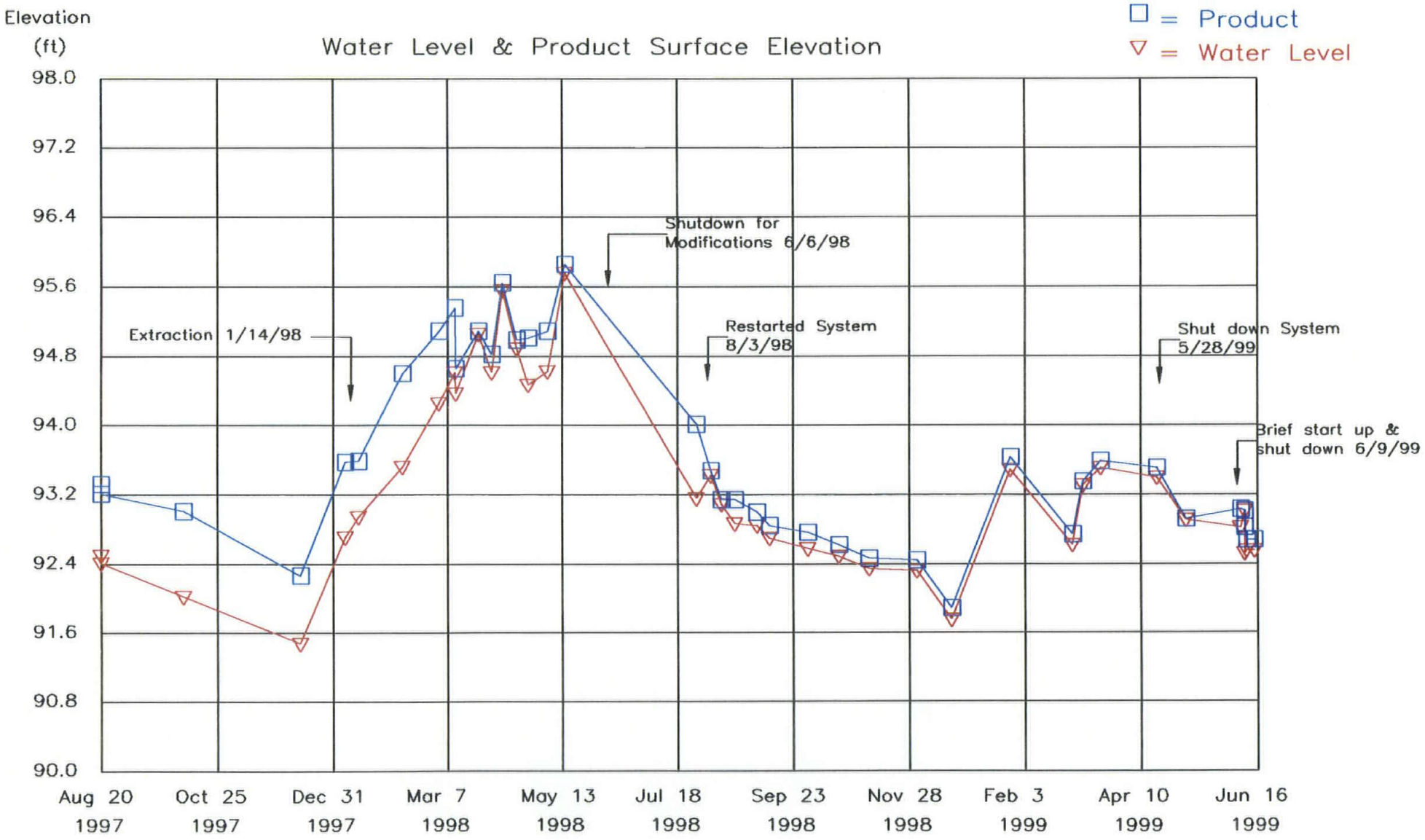
Extraction 1/14/98
Shutdown for
Modifications 6/6/98
Restarted System
8/3/98
Shut down System
5/28/99
Brief start up &
shut down 6/9/99
Aug 20
1997
Oct 25
1997
Dec 31
1997
Mar 7
1998
May 13
1998
Jul 18
1998
Sep 23
1998
Nov 28
1998
Feb 3
1999
Apr 10
1999
Jun 16
1999

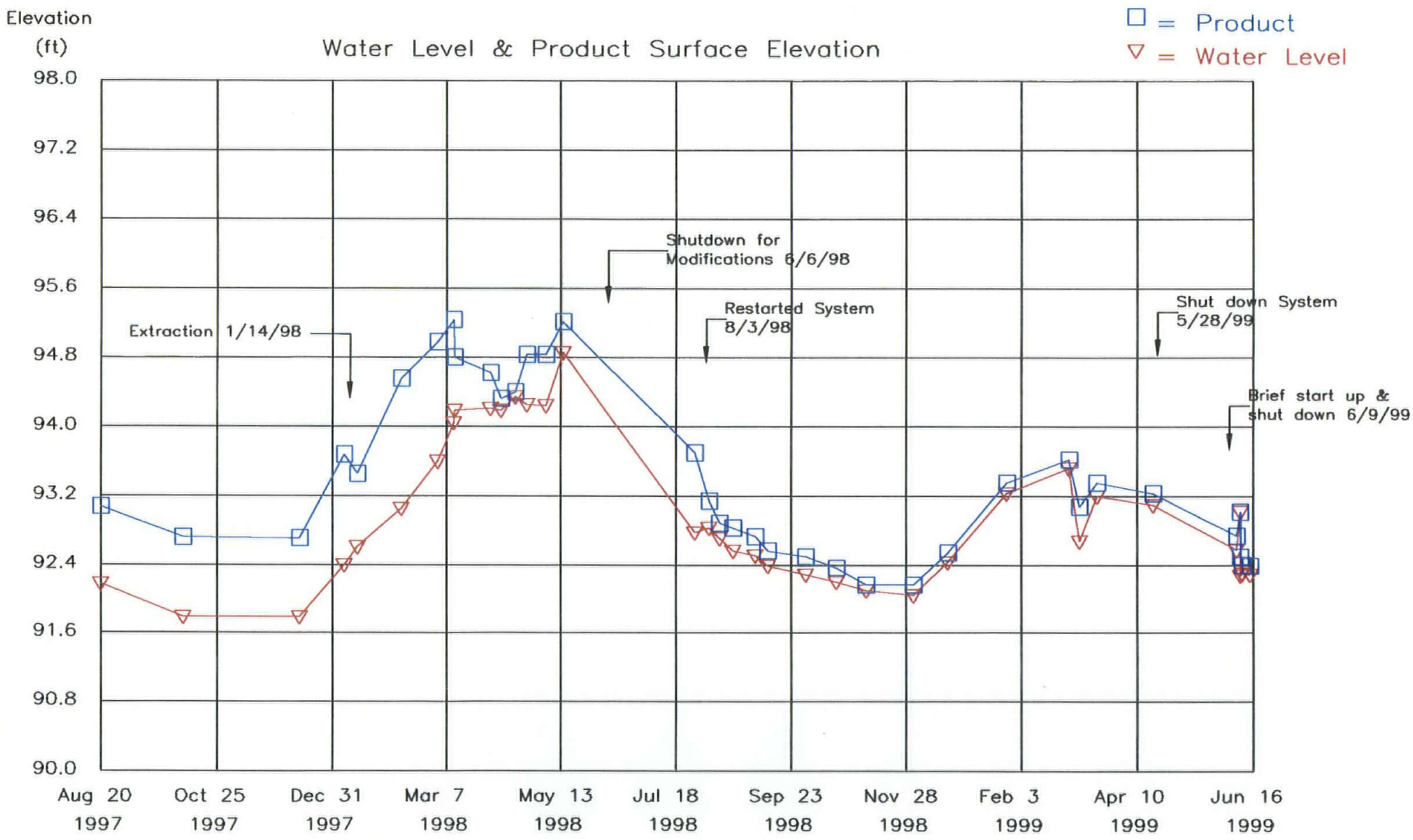
Well: 16MW-13


Elevation
(ft)
Water Level & Product Surface Elevation
□ = Product
▽ = Water Level
96.5
95.9
95.2
94.6
93.9
93.3
92.6
92.0
91.3
90.7
90.0
Shutdown for Modifications 6/6/98
Extraction 1/14/98
Restarted System 8/3/98
Shut down System 5/28/99
Brief start up & shut down 6/9/99
Aug 20 1997
Oct 25 1997
Dec 31 1997
Mar 7 1998
May 13 1998
Jul 18 1998
Sep 23 1998
Nov 28 1998
Feb 3 1999
Apr 10 1999
Jun 16 1999

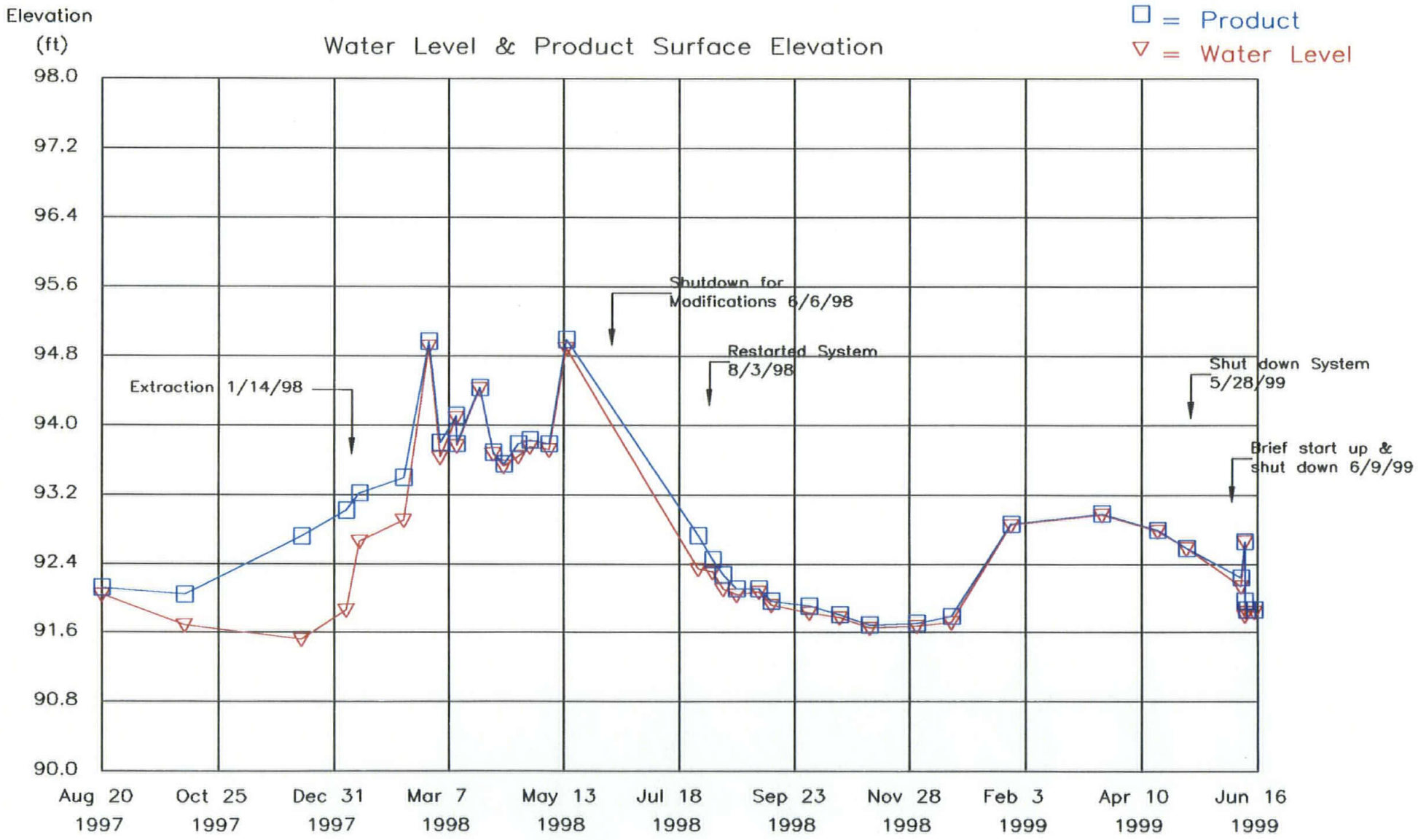
Well: 16MW-14


Elevation
(ft)
Water Level & Product Surface Elevation
□ = Product
▽ = Water Level
98.0
97.2
96.4
95.6
94.8
94.0
93.2
92.4
91.6
90.8
90.0
Extraction 1/14/98
Shutdown for
Modifications 6/6/98
Restarted System
8/3/98
Shut down System
5/28/99
Brief start up &
shut down 6/9/99
Aug 20 1997
Oct 25 1997
Dec 31 1997
Mar 7 1998
May 13 1998
Jul 18 1998
Sep 23 1998
Nov 28 1998
Feb 3 1999
Apr 10 1999
Jun 16 1999

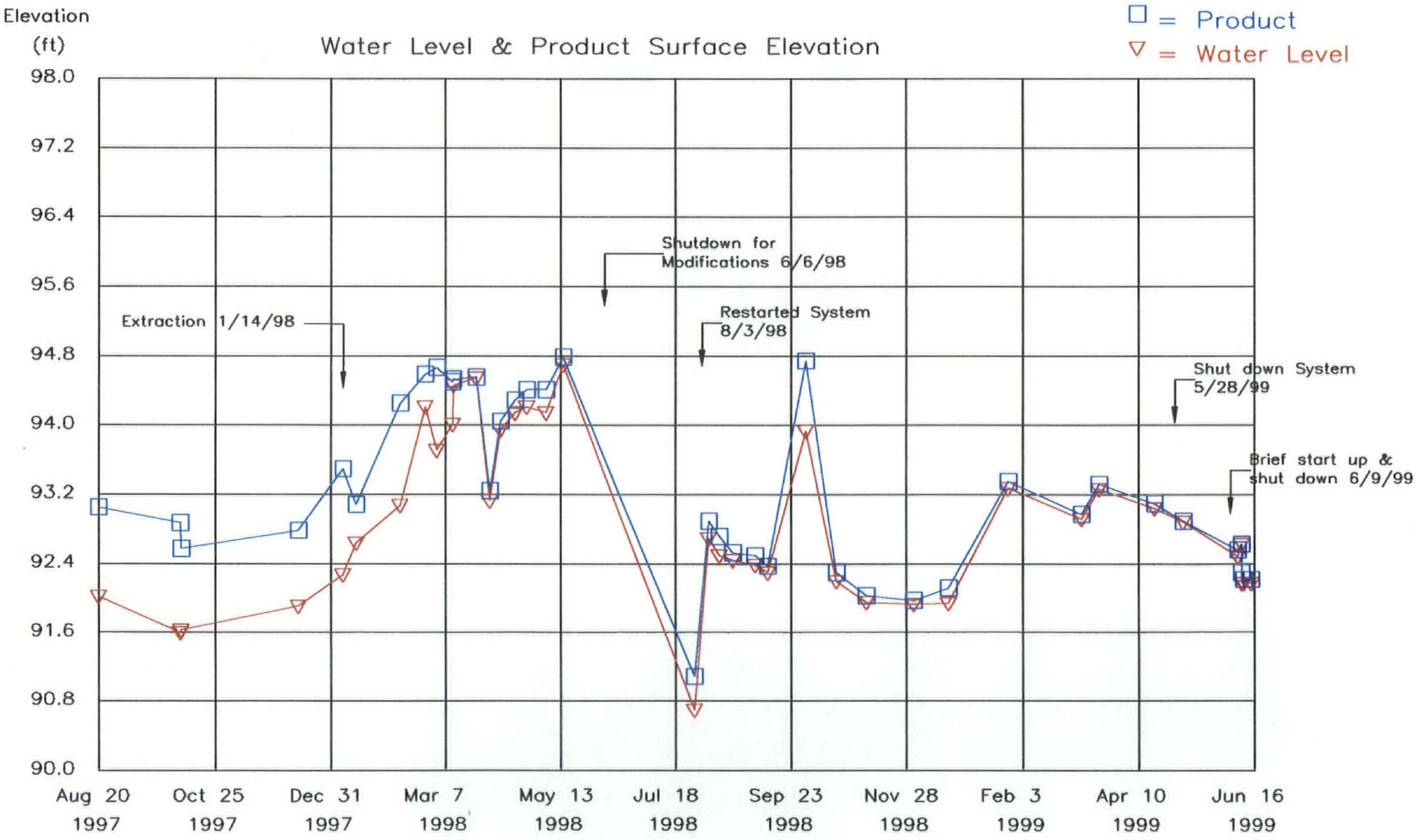
Well: 16MW-15


Elevation
(ft)
Water Level & Product Surface Elevation
□ = Product
▽ = Water Level
98.0
97.2
96.4
95.6
94.8
94.0
93.2
92.4
91.6
90.8
90.0
Extraction 1/14/98
Shutdown for Modifications 6/6/98
Restarted System 8/3/98
Shut down System 5/28/99
Brief start up & shut down 6/9/99
Aug 20 1997
Oct 25 1997
Dec 31 1997
Mar 7 1998
May 13 1998
Jul 18 1998
Sep 23 1998
Nov 28 1998
Feb 3 1999
Apr 10 1999
Jun 16 1999

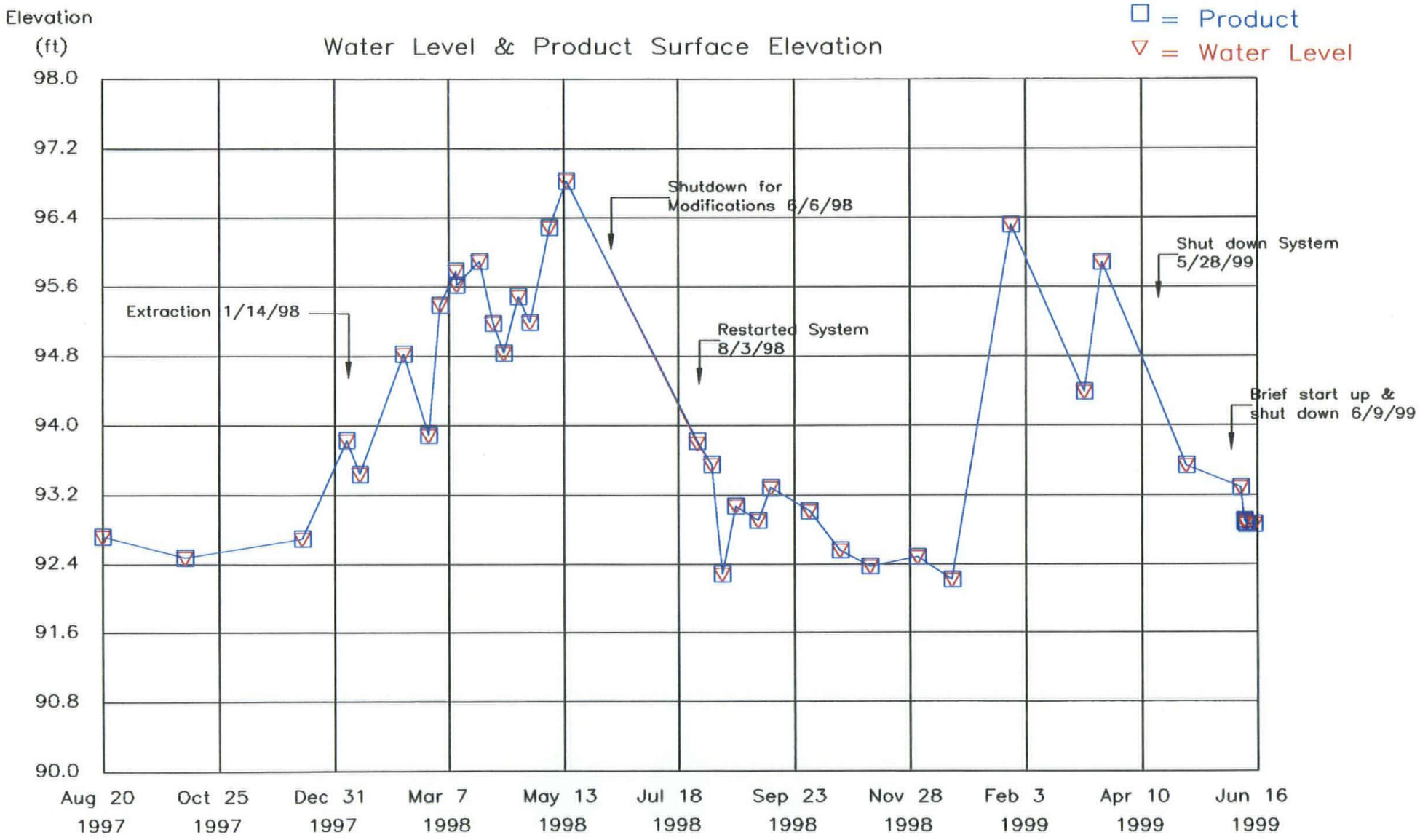
Well: 16MW-16


Elevation
(ft)
Water Level & Product Surface Elevation
□ = Product
▽ = Water Level
98.0
97.2
96.4
95.6
94.8
94.0
93.2
92.4
91.6
90.8
90.0
Extraction 1/14/98
Shutdown for
Modifications 6/6/98
Restarted System
8/3/98
Shut down System
5/28/99
Brief start up &
shut down 6/9/99
Aug 20 1997
Oct 25 1997
Dec 31 1997
Mar 7 1998
May 13 1998
Jul 18 1998
Sep 23 1998
Nov 28 1998
Feb 3 1999
Apr 10 1999
Jun 16 1999

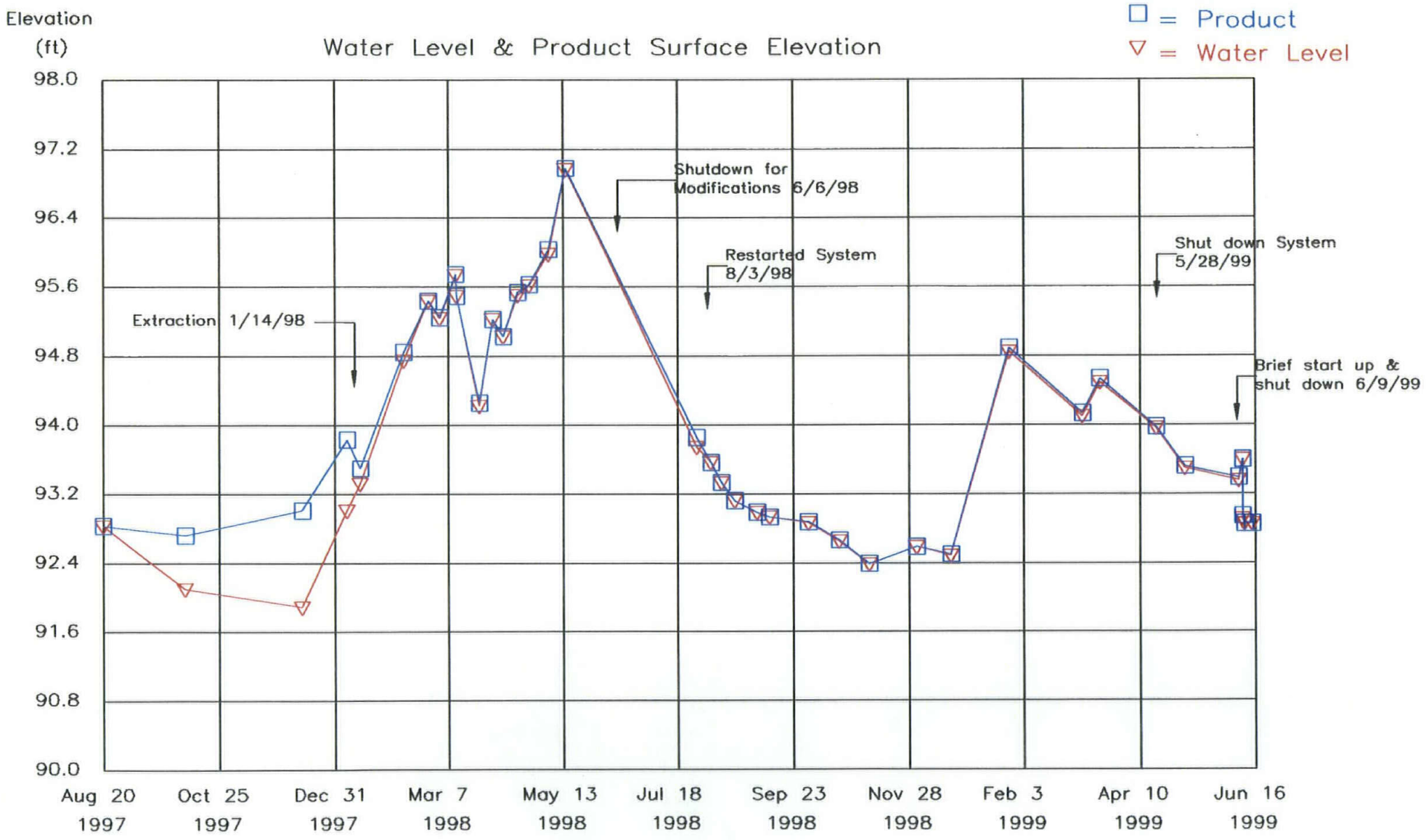
Well: 16MW-17


Elevation
(ft)
Water Level & Product Surface Elevation
□ = Product
▽ = Water Level
98.0
97.2
96.4
95.6
94.8
94.0
93.2
92.4
91.6
90.8
90.0
Extraction 1/14/98
Shutdown for
Modifications 6/6/98
Restarted System
8/3/98
Shut down System
5/28/99
Brief start up &
shut down 6/9/99
Aug 20
1997
Oct 25
1997
Dec 31
1997
Mar 7
1998
May 13
1998
Jul 18
1998
Sep 23
1998
Nov 28
1998
Feb 3
1999
Apr 10
1999
Jun 16
1999

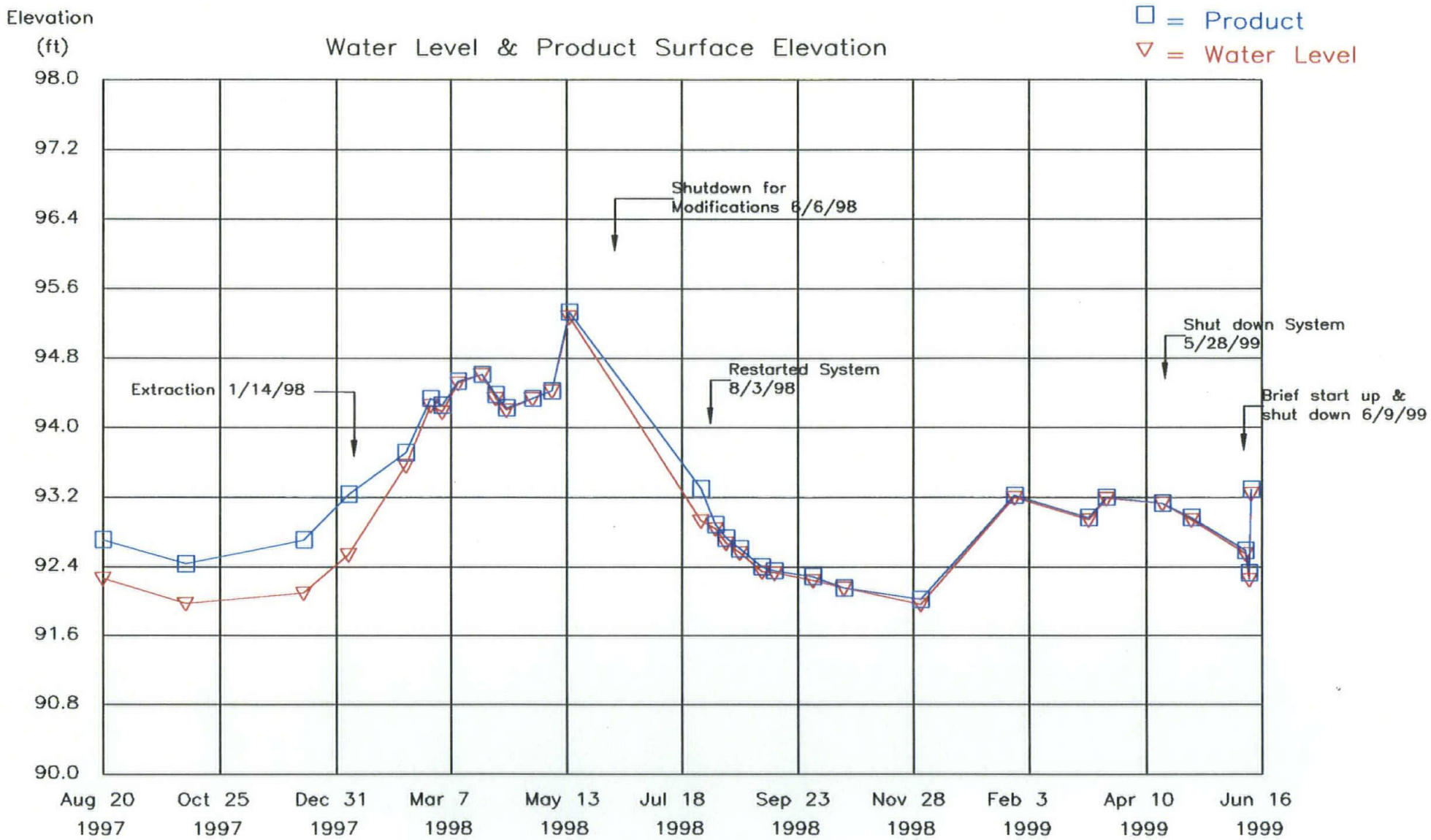
Well: 16MW-18


Elevation
(ft)
Water Level & Product Surface Elevation
□ = Product
▽ = Water Level
98.0
97.2
96.4
95.6
94.8
94.0
93.2
92.4
91.6
90.8
90.0
Extraction 1/14/98
Shutdown for
Modifications 6/6/98
Restarted System
8/3/98
Shut down System
5/28/99
Brief start up &
shut down 6/9/99
Aug 20
1997
Oct 25
1997
Dec 31
1997
Mar 7
1998
May 13
1998
Jul 18
1998
Sep 23
1998
Nov 28
1998
Feb 3
1999
Apr 10
1999
Jun 16
1999

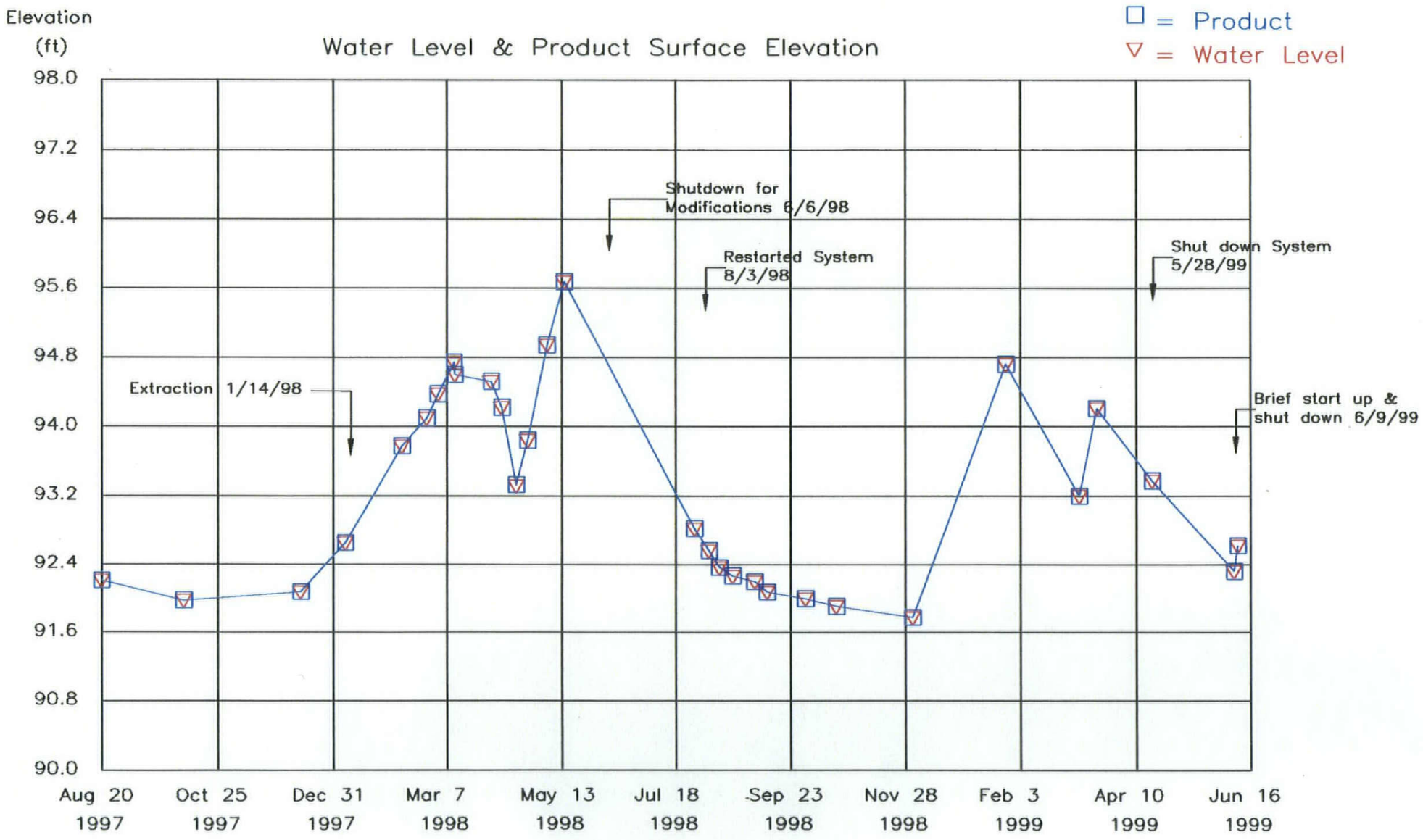
Well: 16MW-19


Elevation
(ft)
Water Level & Product Surface Elevation
□ = Product
▽ = Water Level
98.0
97.2
96.4
95.6
94.8
94.0
93.2
92.4
91.6
90.8
90.0
Extraction 1/14/98
Shutdown for Modifications 6/6/98
Restarted System 8/3/98
Shut down System 5/28/99
Brief start up & shut down 6/9/99
Aug 20 1997
Oct 25 1997
Dec 31 1997
Mar 7 1998
May 13 1998
Jul 18 1998
Sep 23 1998
Nov 28 1998
Feb 3 1999
Apr 10 1999
Jun 16 1999

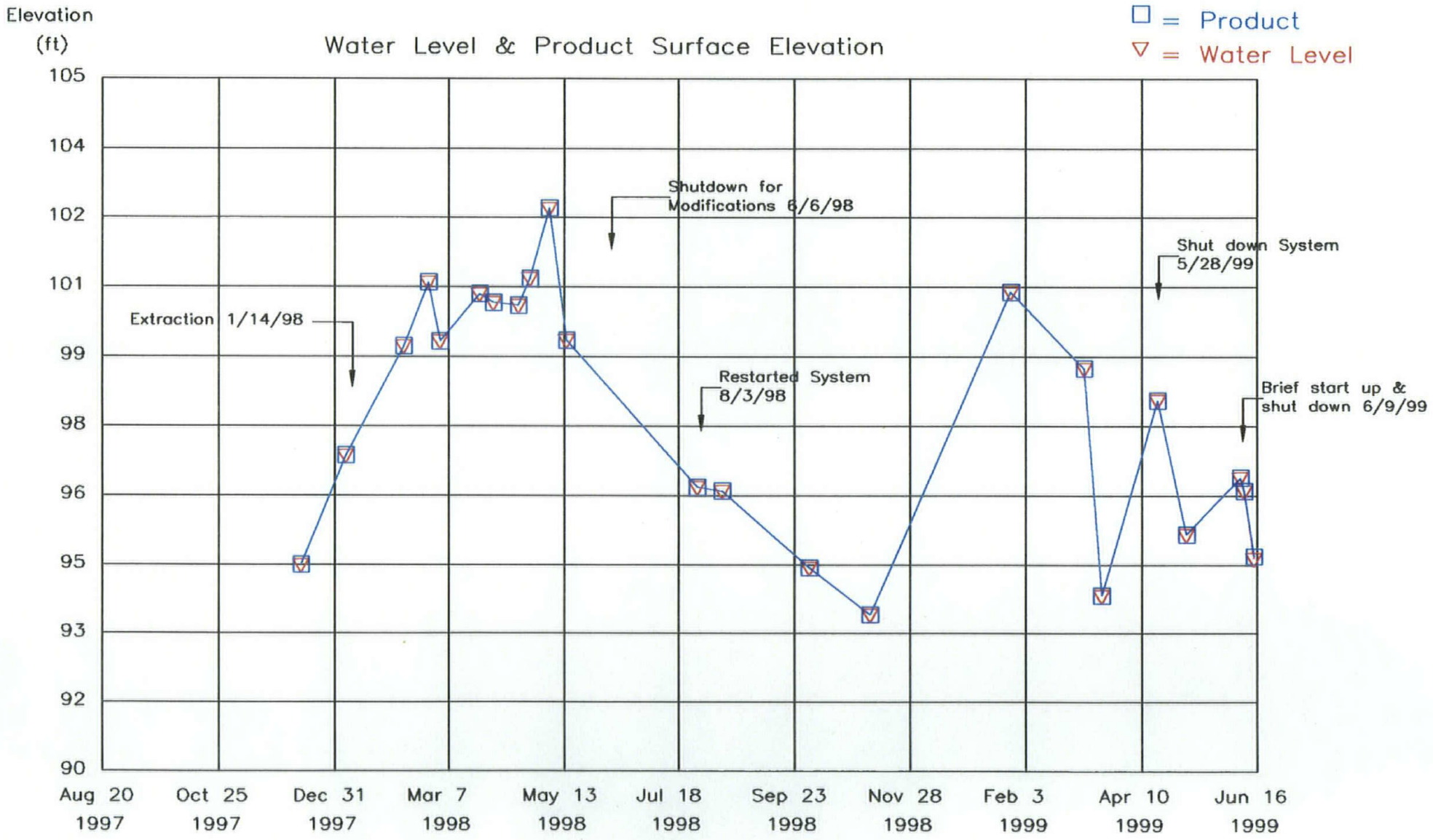
Well: 16MW-20


Elevation
(ft)
Water Level & Product Surface Elevation
□ = Product
▽ = Water Level
98.0
97.2
96.4
95.6
94.8
94.0
93.2
92.4
91.6
90.8
90.0
Shutdown for
Modifications 6/6/98
Extraction 1/14/98
Restarted System
8/3/98
Shut down System
5/28/99
Brief start up &
shut down 6/9/99
Aug 20 1997
Oct 25 1997
Dec 31 1997
Mar 7 1998
May 13 1998
Jul 18 1998
Sep 23 1998
Nov 28 1998
Feb 3 1999
Apr 10 1999
Jun 16 1999

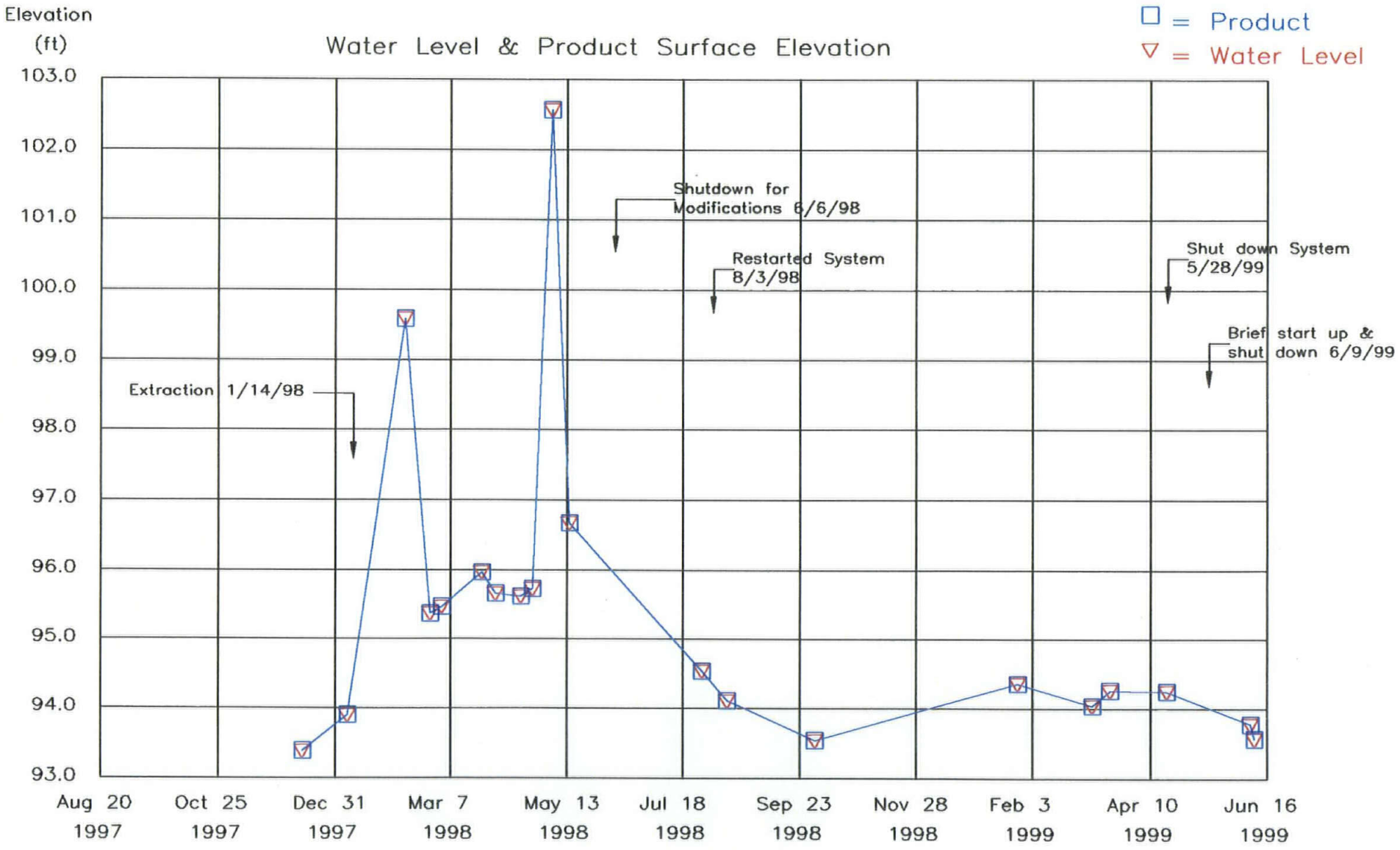
Well: 16MW-21


Elevation
(ft)
Water Level & Product Surface Elevation
□ = Product
▽ = Water Level
98.0
97.2
96.4
95.6
94.8
94.0
93.2
92.4
91.6
90.8
90.0
Shutdown for
Modifications 6/6/98
Restarted System
8/3/98
Shut down System
5/28/99
Extraction 1/14/98
Brief start up &
shut down 6/9/99
Aug 20 1997
Oct 25 1997
Dec 31 1997
Mar 7 1998
May 13 1998
Jul 18 1998
Sep 23 1998
Nov 28 1998
Feb 3 1999
Apr 10 1999
Jun 16 1999

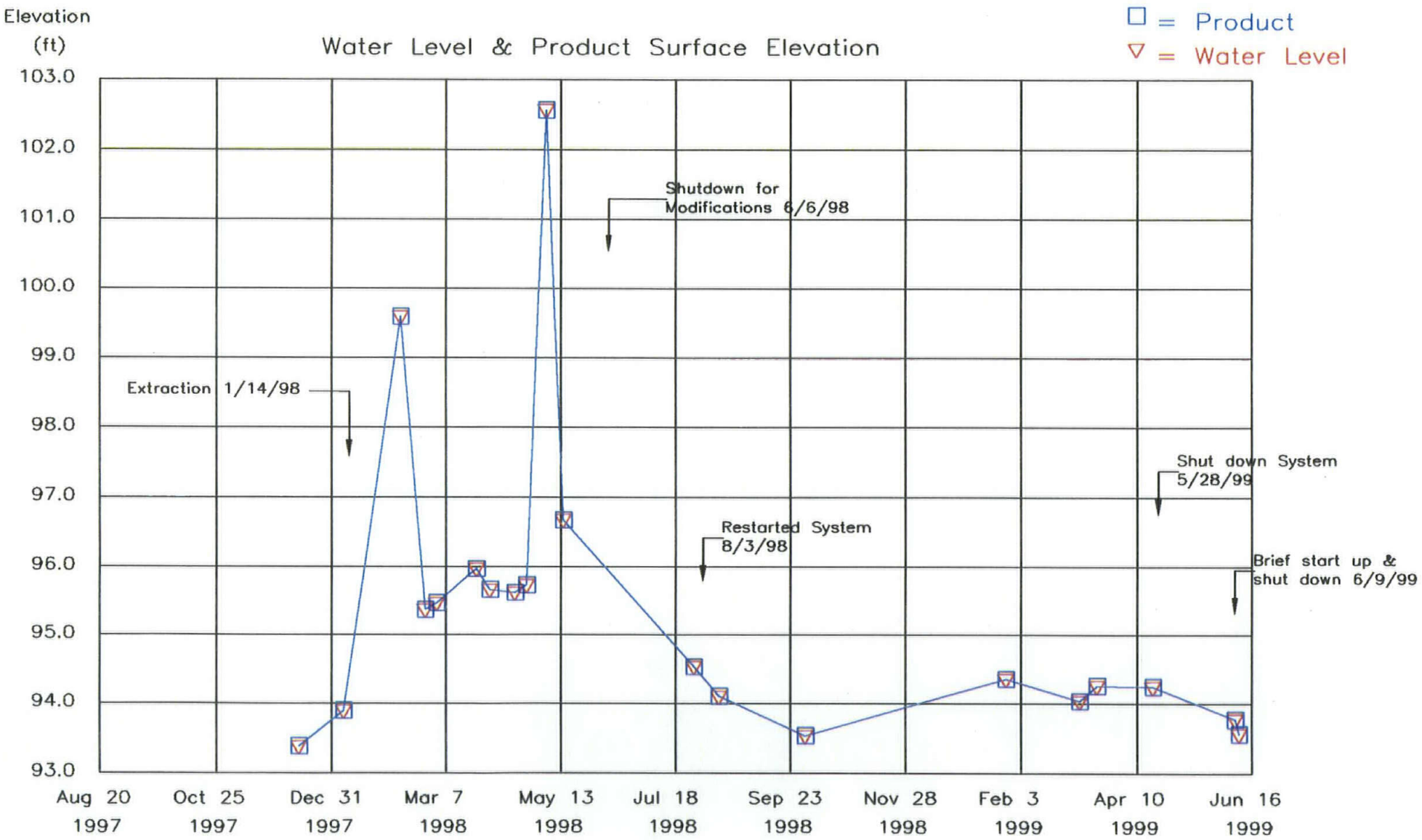
Well: 16MW-22


Elevation
(ft)
Water Level & Product Surface Elevation
□ = Product
▽ = Water Level
105
104
102
101
99
98
96
95
93
92
90
Extraction 1/14/98
Shutdown for
Modifications 6/6/98
Restarted System
8/3/98
Shut down System
5/28/99
Brief start up &
shut down 6/9/99
Aug 20
1997
Oct 25
1997
Dec 31
1997
Mar 7
1998
May 13
1998
Jul 18
1998
Sep 23
1998
Nov 28
1998
Feb 3
1999
Apr 10
1999
Jun 16
1999

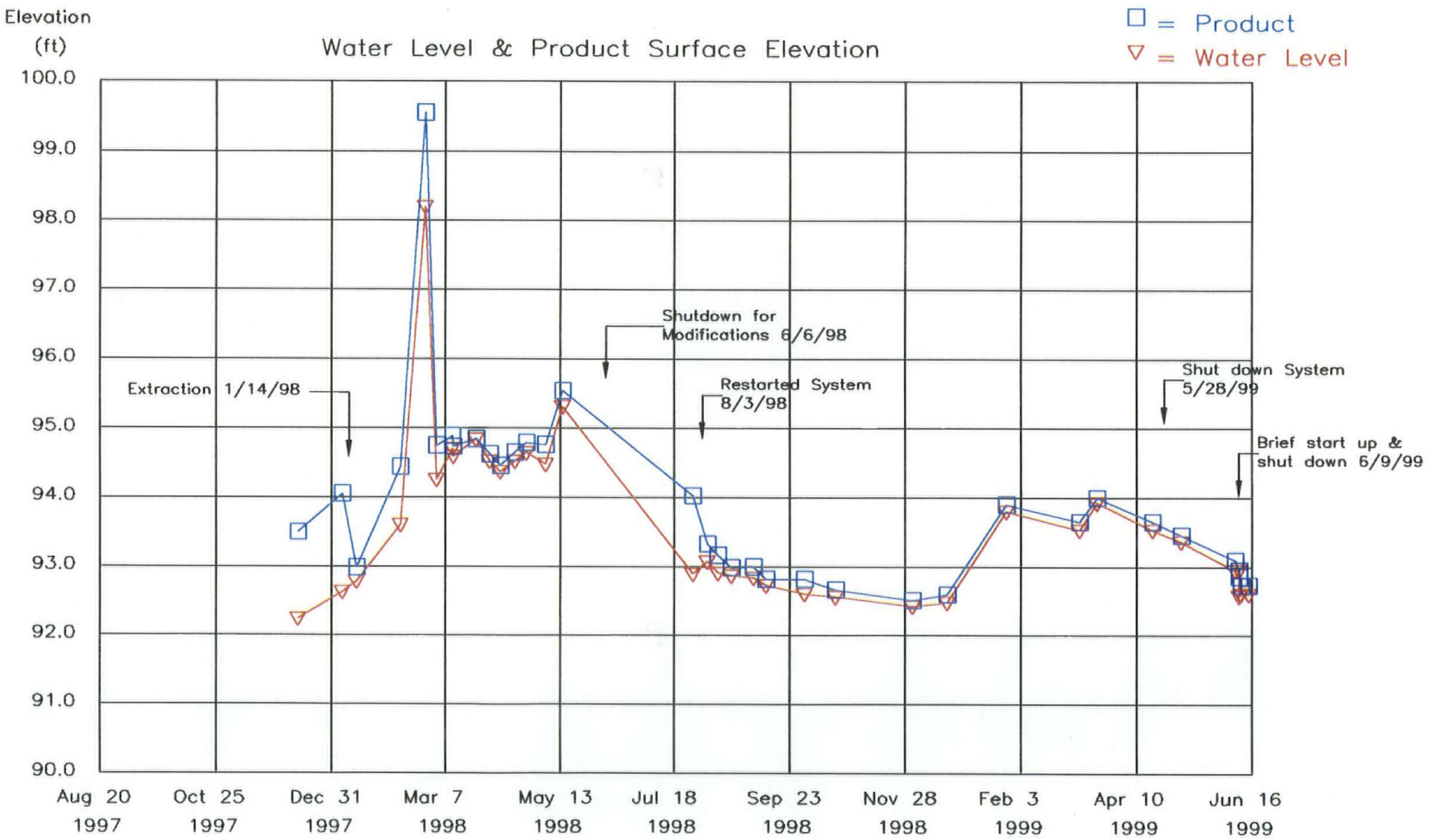
Well: 16MW-23


Elevation
(ft)
Water Level & Product Surface Elevation
□ = Product
▽ = Water Level
103.0
102.0
101.0
100.0
99.0
98.0
97.0
96.0
95.0
94.0
93.0
Shutdown for
Modifications 6/6/98
Restarted System
8/3/98
Shut down System
5/28/99
Brief start up &
shut down 6/9/99
Extraction 1/14/98
Aug 20
1997
Oct 25
1997
Dec 31
1997
Mar 7
1998
May 13
1998
Jul 18
1998
Sep 23
1998
Nov 28
1998
Feb 3
1999
Apr 10
1999
Jun 16
1999

Well: 16MW-23


Elevation
(ft)
Water Level & Product Surface Elevation
□ = Product
▽ = Water Level
103.0
102.0
101.0
100.0
99.0
98.0
97.0
96.0
95.0
94.0
93.0
Shutdown for
Modifications 6/6/98
Extraction 1/14/98
Shut down System
5/28/99
Restarted System
8/3/98
Brief start up &
shut down 6/9/99
Aug 20 1997
Oct 25 1997
Dec 31 1997
Mar 7 1998
May 13 1998
Jul 18 1998
Sep 23 1998
Nov 28 1998
Feb 3 1999
Apr 10 1999
Jun 16 1999

Well: C17MW-07



Water Level Product Thickness Data

SITE	DATE	MP ELEVATION (feet)	TIME	DEPTH TO WATER (feet)	FLOATING PRODUCT THICKNESS (feet)	WATER ELEV. (feet)	△ WATER ELEV.(1) (feet)	EQUIV. FRESH WATER HEAD (feet)
16MW-04	08/20/97	101.23	11:34	11.92	0.57	89.30	NA	89.79
16MW-04	12/12/97	101.23	00:00	9.18	0.78	92.04	2.73	92.71
16MW-04	01/07/98	101.23	11:02	8.73	1.03	92.49	0.45	93.37
16MW-04	02/10/98	101.23	00:00	7.97	0.93	93.25	0.76	94.05
16MW-04	02/24/98	101.23	00:00	7.08	0.56	94.14	0.89	94.62
16MW-04	03/03/98	101.23	00:00	7.45	1.00	93.78	-0.36	94.63
16MW-04	03/12/98	101.23	00:00	6.94	0.88	94.28	0.50	95.03
16MW-04	03/13/98	101.23	00:00	6.99	0.71	94.23	-0.05	94.84
16MW-04	03/26/98	101.23	00:00	6.60	0.05	94.62	0.39	94.67
16MW-04	04/03/98	101.23	00:00	7.06	0.44	94.16	-0.46	94.54
16MW-04	04/09/98	101.23	00:00	6.86	0.01	94.36	0.20	94.37
16MW-04	04/17/98	101.23	00:00	6.94	0.04	94.29	-0.07	94.32
16MW-04	04/24/98	101.23	00:00	5.03	0.57	96.19	1.90	96.68
16MW-04	05/05/98	101.23	00:00	6.93	0.48	94.29	-1.90	94.78
16MW-04	05/15/98	101.23	00:00	6.24	0.65	94.98	0.69	95.54
16MW-04	07/30/98	101.23	00:00	7.69	0.81	93.53	-1.45	94.22
16MW-04	08/07/98	101.23	00:00	8.36	0.27	92.87	-0.66	93.10
16MW-04	08/13/98	101.23	00:00	8.44	0.02	92.79	-0.08	92.80
16MW-04	08/21/98	101.23	00:00	8.63	0.19	92.60	-0.19	92.76
16MW-04	09/03/98	101.23	00:00	9.25	0.23	91.98	-0.62	92.17
16MW-04	09/10/98	101.23	00:00	8.85	0.24	92.38	0.40	92.58
16MW-04	10/02/98	101.23	00:00	9.02	0.20	92.20	-0.17	92.38
16MW-04	10/20/98	101.23	00:00	9.07	0.26	92.16	-0.04	92.38
16MW-04	11/06/98	101.23	00:00	9.17	0.16	92.05	-0.10	92.19
16MW-04	12/03/98	101.23	00:00	9.22	0.23	92.00	-0.05	92.20
16MW-04	12/23/98	101.23	00:00	9.15	0.08	92.07	0.07	92.14
16MW-04	01/26/99	101.23	00:00	8.03	0.07	93.19	1.11	93.25
16MW-04	03/03/99	101.23	00:00	8.31	0.06	92.92	-0.27	92.97
16MW-04	03/09/99	101.23	00:00	8.22	0.02	93.01	0.09	93.02
16MW-04	03/19/99	101.23	00:00	8.04	0.12	93.19	0.18	93.29
16MW-04	04/20/99	101.23	00:00	8.03	0.13	93.19	0.00	93.30
16MW-04	05/07/99	101.23	00:00	8.28	0.08	92.95	-0.24	93.01
16MW-04	06/09/99	101.23	00:00	8.99	0.00	92.24	-0.71	92.24
16MW-04	06/09/99	101.23	00:01	8.95	0.27	92.27	0.03	92.50
16MW-13	08/20/97	100.97	00:00	8.50	0.80	92.47	NA	93.15

(1) Change in Water Elevation since last reported measurement

D = Dry NA = Not Available

(2) Measurements Based on Mean Sea Level

Water Level Product Thickness Data

SITE	DATE	MP ELEVATION (feet)	TIME	DEPTH TO WATER (feet)	FLOATING PRODUCT THICKNESS (feet)	WATER ELEV. (feet)	△ WATER ELEV(1) (feet)	EQUIV. FRESH WATER HEAD (feet)
16MW-13	08/20/97	100.97	08:45	8.50	0.80	92.47	0.00	93.15
16MW-13	10/06/97	100.97	10:45	8.85	0.74	92.11	-0.35	92.74
16MW-13	12/12/97	100.97	08:30	8.56	0.64	92.40	0.29	92.95
16MW-13	01/07/98	100.97	09:35	8.03	0.73	92.94	0.53	93.56
16MW-13	01/15/98	100.97	07:30	8.05	0.74	92.91	-0.02	93.54
16MW-13	02/10/98	100.97	00:00	7.38	0.87	93.58	0.67	94.33
16MW-13	02/24/98	100.97	00:00	6.66	0.71	94.30	0.71	94.91
16MW-13	03/03/98	100.97	00:00	6.90	1.04	94.07	-0.23	94.95
16MW-13	03/12/98	100.97	00:00	6.59	1.02	94.37	0.30	95.24
16MW-13	03/13/98	100.97	00:00	6.60	0.80	94.36	-0.01	95.05
16MW-13	03/26/98	100.97	00:00	6.14	0.30	94.82	0.46	95.08
16MW-13	04/03/98	100.97	00:00	6.46	0.41	94.50	-0.32	94.85
16MW-13	04/09/98	100.97	00:00	6.53	0.26	94.43	-0.07	94.65
16MW-13	04/17/98	100.97	00:00	6.41	0.18	94.56	0.12	94.71
16MW-13	04/24/98	100.97	00:00	6.43	0.57	94.53	-0.02	95.02
16MW-13	05/05/98	100.97	00:00	7.19	0.55	93.77	-0.75	94.33
16MW-13	05/15/98	100.97	00:00	5.54	0.51	95.42	1.64	95.94
16MW-13	07/30/98	100.97	00:00	7.79	0.81	93.17	-2.25	93.86
16MW-13	08/07/98	100.97	00:00	7.78	0.26	93.18	0.01	93.40
16MW-13	08/13/98	100.97	00:00	7.94	0.14	93.03	-0.15	93.14
16MW-13	08/21/98	100.97	00:00	8.03	0.27	92.94	-0.09	93.17
16MW-13	09/03/98	100.97	00:00	8.09	0.20	92.88	-0.06	93.05
16MW-13	09/10/98	100.97	00:00	8.26	0.15	92.71	-0.17	92.83
16MW-13	10/02/98	100.97	00:00	8.41	0.27	92.55	-0.15	92.78
16MW-13	10/20/98	100.97	00:00	8.46	0.14	92.51	-0.04	92.62
16MW-13	11/06/98	100.97	00:00	8.60	0.13	92.36	-0.14	92.48
16MW-13	12/03/98	100.97	00:00	8.63	0.10	92.33	-0.03	92.42
16MW-13	12/23/98	100.97	00:00	8.69	0.20	92.28	-0.05	92.45
16MW-13	01/26/99	100.97	00:00	7.55	0.18	93.41	1.13	93.57
16MW-13	03/03/99	100.97	00:00	7.80	0.11	93.17	-0.24	93.26
16MW-13	03/09/99	100.97	00:00	7.74	0.14	93.22	0.05	93.34
16MW-13	03/19/99	100.97	00:00	7.50	0.15	93.46	0.23	93.59
16MW-13	04/20/99	100.97	00:00	7.56	0.14	93.40	-0.06	93.52
16MW-13	05/07/99	100.97	00:00	8.04	0.13	92.92	-0.48	93.04
16MW-13	06/09/99	100.97	00:00	7.74	0.00	93.22	0.30	93.22
16MW-13	06/09/99	100.97	00:01	8.48	0.44	92.49	-0.73	92.86

(1) Change in Water Elevation since last reported measurement

D = Dry NA = Not Available

(2) Measurements Based on Mean Sea Level

Water Level Product Thickness Data

SITE	DATE	MP ELEVATION (feet)	TIME	DEPTH TO WATER (feet)	FLOATING PRODUCT THICKNESS (feet)	WATER ELEV. (feet)	△ WATER ELEV.(1) (feet)	EQUIV. FRESH WATER HEAD (feet)
16MW-13	06/10/99	100.97	00:00	8.90	0.09	92.06	-0.42	92.14
16MW-13	06/14/99	100.97	13:05	8.90	0.09	92.06	0.00	92.14
16MW-14	08/20/97	100.66	00:00	8.15	0.82	92.50	NA	93.20
16MW-14	08/20/97	100.66	08:48	8.24	0.80	92.42	-0.08	93.10
16MW-14	10/06/97	100.66	10:45	8.63	0.99	92.02	-0.39	92.87
16MW-14	12/12/97	100.66	08:30	9.18	0.79	91.48	-0.54	92.15
16MW-14	01/07/98	100.66	09:49	7.94	0.86	92.72	1.24	93.45
16MW-14	01/07/98	100.66	09:56	7.94	0.86	92.72	0.00	93.45
16MW-14	01/15/98	100.66	07:30	7.70	0.63	92.95	0.23	93.49
16MW-14	02/10/98	100.66	00:00	7.12	1.07	93.53	0.57	94.45
16MW-14	03/03/98	100.66	00:00	6.39	0.83	94.26	0.73	94.97
16MW-14	03/12/98	100.66	00:00	6.04	0.74	94.61	0.34	95.24
16MW-14	03/13/98	100.66	00:00	6.28	0.28	94.37	-0.24	94.61
16MW-14	03/26/98	100.66	00:00	5.60	0.03	95.05	0.68	95.08
16MW-14	04/03/98	100.66	00:00	6.03	0.20	94.62	-0.43	94.79
16MW-14	04/09/98	100.66	00:00	5.10	0.09	95.55	0.93	95.63
16MW-14	04/17/98	100.66	00:00	5.76	0.09	94.89	-0.66	94.97
16MW-14	04/24/98	100.66	00:00	6.18	0.54	94.47	-0.42	94.93
16MW-14	05/05/98	100.66	00:00	6.03	0.46	94.63	0.15	95.02
16MW-14	05/15/98	100.66	00:00	4.90	0.10	95.76	1.13	95.84
16MW-14	07/30/98	100.66	00:00	7.49	0.85	93.16	-2.59	93.89
16MW-14	08/07/98	100.66	00:00	7.22	0.05	93.43	0.26	93.47
16MW-14	08/13/98	100.66	00:00	7.56	0.05	93.10	-0.33	93.14
16MW-14	08/21/98	100.66	00:00	7.78	0.27	92.87	-0.22	93.10
16MW-14	09/03/98	100.66	00:00	7.81	0.16	92.85	-0.02	92.98
16MW-14	09/10/98	100.66	00:00	7.96	0.15	92.70	-0.15	92.82
16MW-14	10/02/98	100.66	00:00	8.07	0.18	92.58	-0.11	92.74
16MW-14	10/20/98	100.66	00:00	8.16	0.13	92.49	-0.09	92.61
16MW-14	11/06/98	100.66	00:00	8.30	0.11	92.35	-0.14	92.45
16MW-14	12/03/98	100.66	00:00	8.33	0.12	92.32	-0.03	92.43
16MW-14	12/23/98	100.66	00:00	8.90	0.14	91.75	-0.56	91.87
16MW-14	01/26/99	100.66	00:00	7.17	0.15	93.49	1.73	93.61
16MW-14	03/03/99	100.66	00:00	8.03	0.12	92.62	-0.86	92.73
16MW-14	03/09/99	100.66	00:00	7.33	0.03	93.32	0.69	93.35
16MW-14	03/19/99	100.66	00:00	7.14	0.08	93.51	0.19	93.58

(1) Change in Water Elevation since last reported measurement

D = Dry NA = Not Available

(2) Measurements Based on Mean Sea Level

Water Level Product Thickness Data

SITE	DATE	MP ELEVATION (feet)	TIME	DEPTH TO WATER (feet)	FLOATING PRODUCT THICKNESS (feet)	WATER ELEV. (feet)	△ WATER ELEV.(1) (feet)	EQUIV. FRESH WATER HEAD (feet)
16MW-14	04/20/99	100.66	00:00	7.25	0.11	93.40	-0.10	93.50
16MW-14	05/07/99	100.66	00:00	7.74	0.01	92.92	-0.48	92.92
16MW-14	06/07/99	100.66	00:00	7.83	0.21	92.82	-0.09	93.00
16MW-14	06/09/99	100.66	00:00	7.64	0.00	93.01	0.19	93.01
16MW-14	06/09/99	100.66	00:01	8.13	0.30	92.52	-0.49	92.78
16MW-14	06/10/99	100.66	00:00	8.10	0.13	92.55	0.03	92.66
16MW-14	06/14/99	100.66	13:10	8.10	0.13	92.55	0.00	92.66
16MW-15	08/20/97	100.98	00:00	8.79	0.89	92.18	NA	92.94
16MW-15	08/20/97	100.98	08:55	8.79	0.89	92.18	0.00	92.94
16MW-15	08/20/97	100.98	09:12	8.79	0.89	92.18	0.00	92.94
16MW-15	10/06/97	100.98	10:45	9.18	0.93	91.79	-0.38	92.59
16MW-15	12/12/97	100.98	08:30	9.18	0.92	91.79	-0.00	92.58
16MW-15	01/07/98	100.98	10:05	8.57	1.27	92.41	0.61	93.49
16MW-15	01/15/98	100.98	07:30	8.36	0.84	92.62	0.21	93.33
16MW-15	02/10/98	100.98	00:00	7.91	1.49	93.06	0.44	94.33
16MW-15	03/03/98	100.98	00:00	7.37	1.37	93.60	0.54	94.77
16MW-15	03/12/98	100.98	00:00	6.93	1.19	94.05	0.44	95.06
16MW-15	03/13/98	100.98	00:00	6.78	0.60	94.19	0.14	94.71
16MW-15	04/03/98	100.98	00:00	6.76	0.41	94.21	0.02	94.56
16MW-15	04/09/98	100.98	00:00	6.78	0.13	94.19	-0.02	94.31
16MW-15	04/17/98	100.98	00:00	6.62	0.05	94.35	0.16	94.40
16MW-15	04/24/98	100.98	00:00	6.71	0.57	94.26	-0.09	94.75
16MW-15	05/05/98	100.98	00:00	6.73	0.59	94.25	-0.01	94.84
16MW-15	05/15/98	100.98	00:00	6.12	0.36	94.86	0.61	95.16
16MW-15	07/30/98	100.98	00:00	8.19	0.92	92.78	-2.07	93.57
16MW-15	08/07/98	100.98	00:00	8.13	0.30	92.84	0.05	93.10
16MW-15	08/13/98	100.98	00:00	8.26	0.17	92.72	-0.12	92.86
16MW-15	08/21/98	100.98	00:00	8.41	0.27	92.57	-0.15	92.80
16MW-15	09/03/98	100.98	00:00	8.46	0.22	92.52	-0.05	92.70
16MW-15	09/10/98	100.98	00:00	8.58	0.17	92.39	-0.12	92.54
16MW-15	10/02/98	100.98	00:00	8.68	0.20	92.29	-0.10	92.46
16MW-15	10/20/98	100.98	00:00	8.77	0.16	92.21	-0.08	92.34
16MW-15	11/06/98	100.98	00:00	8.87	0.06	92.10	-0.10	92.15
16MW-15	12/03/98	100.98	00:00	8.92	0.11	92.05	-0.05	92.15
16MW-15	12/23/98	100.98	00:00	8.54	0.11	92.44	0.38	92.53

(1) Change in Water Elevation since last reported measurement

D = Dry NA = Not Available

(2) Measurements Based on Mean Sea Level

Water Level Product Thickness Data

SITE	DATE	MP ELEVATION (feet)	TIME	DEPTH TO WATER (feet)	FLOATING PRODUCT THICKNESS (feet)	WATER ELEV. (feet)	△ WATER ELEV(1) (feet)	EQUIV. FRESH WATER HEAD (feet)
16MW-15	01/26/99	100.98	00:00	7.74	0.12	93.23	0.79	93.34
16MW-15	03/03/99	100.98	00:00	7.45	0.10	93.52	0.29	93.61
16MW-15	03/09/99	100.98	00:00	8.30	0.40	92.68	-0.84	93.02
16MW-15	03/19/99	100.98	00:00	7.76	0.14	93.21	0.53	93.33
16MW-15	04/20/99	100.98	00:00	7.88	0.14	93.10	-0.11	93.21
16MW-15	06/07/99	100.98	00:00	8.40	0.17	92.58	-0.52	92.72
16MW-15	06/09/99	100.98	00:00	7.95	0.00	93.02	0.44	93.02
16MW-15	06/09/99	100.98	00:01	8.69	0.22	92.28	-0.74	92.47
16MW-15	06/10/99	100.98	00:00	8.67	0.10	92.30	0.01	92.39
16MW-15	06/14/99	100.98	13:15	8.68	0.10	92.29	-0.01	92.38
16MW-16	08/20/97	98.82	00:00	6.77	0.08	92.05	NA	92.11
16MW-16	08/20/97	98.82	09:12	6.77	0.08	92.05	0.00	92.11
16MW-16	10/06/97	98.82	10:45	7.12	0.35	91.69	-0.35	91.99
16MW-16	12/12/97	98.82	08:30	7.29	1.20	91.52	-0.16	92.55
16MW-16	01/07/98	98.82	10:10	6.94	1.15	91.87	0.35	92.85
16MW-16	01/15/98	98.82	07:30	6.15	0.56	92.67	0.79	93.14
16MW-16	02/10/98	98.82	00:00	5.90	0.49	92.91	0.24	93.33
16MW-16	02/24/98	98.82	00:00	3.90	0.05	94.92	2.00	94.96
16MW-16	03/03/98	98.82	00:00	5.18	0.17	93.63	-1.28	93.78
16MW-16	03/12/98	98.82	00:00	4.72	0.02	94.09	0.45	94.11
16MW-16	03/13/98	98.82	00:00	5.05	0.02	93.76	-0.32	93.78
16MW-16	03/26/98	98.82	00:00	4.39	0.01	94.43	0.66	94.43
16MW-16	04/03/98	98.82	00:00	5.13	0.01	93.68	-0.74	93.69
16MW-16	04/09/98	98.82	00:00	5.28	0.02	93.53	-0.14	93.55
16MW-16	04/17/98	98.82	00:00	5.17	0.14	93.64	0.11	93.77
16MW-16	04/24/98	98.82	00:00	5.05	0.07	93.76	0.11	93.82
16MW-16	05/05/98	98.82	00:00	5.09	0.07	93.72	-0.04	93.80
16MW-16	05/15/98	98.82	00:00	3.92	0.10	94.89	1.16	94.98
16MW-16	07/30/98	98.82	00:00	6.47	0.39	92.35	-2.54	92.68
16MW-16	08/07/98	98.82	00:00	6.50	0.14	92.32	-0.03	92.43
16MW-16	08/13/98	98.82	00:00	6.70	0.17	92.11	-0.20	92.26
16MW-16	08/21/98	98.82	00:00	6.77	0.07	92.04	-0.07	92.10
16MW-16	09/03/98	98.82	00:00	6.74	0.04	92.08	0.03	92.11
16MW-16	09/10/98	98.82	00:00	6.89	0.04	91.93	-0.15	91.96
16MW-16	10/02/98	98.82	00:00	6.98	0.08	91.84	-0.09	91.90

(1) Change in Water Elevation since last reported measurement

D = Dry NA = Not Available

(2) Measurements Based on Mean Sea Level

Water Level Product Thickness Data

SITE	DATE	MP ELEVATION (feet)	TIME	DEPTH TO WATER (feet)	FLOATING PRODUCT THICKNESS (feet)	WATER ELEV. (feet)	△ WATER ELEV.(1) (feet)	EQUIV. FRESH WATER HEAD (feet)
16MW-16	10/20/98	98.82	00:00	7.04	0.04	91.78	-0.06	91.81
16MW-16	11/06/98	98.82	00:00	7.15	0.03	91.66	-0.11	91.69
16MW-16	12/03/98	98.82	00:00	7.13	0.03	91.68	0.01	91.71
16MW-16	12/23/98	98.82	00:00	7.09	0.06	91.73	0.04	91.78
16MW-16	01/26/99	98.82	00:00	5.95	0.00	92.86	1.13	92.86
16MW-16	03/19/99	98.82	00:00	5.83	0.00	92.98	0.12	92.98
16MW-16	04/20/99	98.82	00:00	6.02	0.01	92.80	-0.18	92.80
16MW-16	05/07/99	98.82	00:00	6.23	0.01	92.59	-0.21	92.59
16MW-16	06/07/99	98.82	00:00	6.66	0.09	92.15	-0.43	92.23
16MW-16	06/09/99	98.82	00:00	6.15	0.00	92.67	0.51	92.67
16MW-16	06/09/99	98.82	00:01	7.01	0.16	91.80	-0.86	91.94
16MW-16	06/10/99	98.82	00:00	6.97	0.02	91.84	0.03	91.86
16MW-16	06/14/99	98.82	13:40	6.97	0.02	91.84	0.00	91.86
16MW-17	08/20/97	99.79	00:00	7.76	1.03	92.02	NA	92.90
16MW-17	08/20/97	99.79	09:07	7.76	1.03	92.02	0.00	92.90
16MW-17	10/06/97	99.79	00:00	8.19	1.28	91.60	-0.42	92.69
16MW-17	10/06/97	99.79	10:45	8.15	0.94	91.63	0.03	92.44
16MW-17	12/12/97	99.79	08:30	7.87	0.87	91.91	0.27	92.66
16MW-17	01/07/98	99.79	10:23	7.50	1.21	92.28	0.37	93.32
16MW-17	01/15/98	99.79	07:30	7.13	0.43	92.65	0.36	93.02
16MW-17	02/10/98	99.79	00:00	6.70	1.17	93.08	0.43	94.08
16MW-17	02/24/98	99.79	00:00	5.57	0.37	94.21	1.13	94.53
16MW-17	03/03/98	99.79	00:00	6.07	0.95	93.71	-0.50	94.52
16MW-17	03/12/98	99.79	00:00	5.77	0.49	94.01	0.30	94.43
16MW-17	03/13/98	99.79	00:00	5.32	0.07	94.46	0.45	94.52
16MW-17	03/26/98	99.79	00:00	5.24	0.01	94.54	0.08	94.55
16MW-17	04/03/98	99.79	00:00	6.64	0.10	93.14	-1.40	93.23
16MW-17	04/09/98	99.79	00:00	5.83	0.09	93.95	0.81	94.03
16MW-17	04/17/98	99.79	00:00	5.63	0.13	94.15	0.20	94.27
16MW-17	04/24/98	99.79	00:00	5.57	0.20	94.21	0.06	94.38
16MW-17	05/05/98	99.79	00:00	5.64	0.27	94.15	-0.06	94.42
16MW-17	05/15/98	99.79	00:00	5.09	0.09	94.70	0.55	94.77
16MW-17	07/30/98	99.79	00:00	9.09	0.39	90.70	-4.00	91.03
16MW-17	08/07/98	99.79	00:00	7.09	0.21	92.70	2.00	92.87
16MW-17	08/13/98	99.79	00:00	7.28	0.22	92.50	-0.19	92.69

(1) Change in Water Elevation since last reported measurement

D = Dry NA = Not Available

(2) Measurements Based on Mean Sea Level

Water Level Product Thickness Data

SITE	DATE	MP ELEVATION (feet)	TIME	DEPTH TO WATER (feet)	FLOATING PRODUCT THICKNESS (feet)	WATER ELEV. (feet)	△ WATER ELEV(1) (feet)	EQUIV. FRESH WATER HEAD (feet)
16MW-17	08/21/98	99.79	00:00	7.34	0.09	92.44	-0.06	92.52
16MW-17	09/03/98	99.79	00:00	7.40	0.12	92.39	-0.05	92.49
16MW-17	09/10/98	99.79	00:00	7.48	0.07	92.30	-0.08	92.37
16MW-17	10/02/98	99.79	00:00	5.85	0.81	93.94	1.63	94.63
16MW-17	10/20/98	99.79	00:00	7.58	0.09	92.21	-1.73	92.28
16MW-17	11/06/98	99.79	00:00	7.82	0.07	91.96	-0.24	92.02
16MW-17	12/03/98	99.79	00:00	7.85	0.04	91.93	-0.03	91.97
16MW-17	12/23/98	99.79	00:00	7.83	0.17	91.95	0.02	92.10
16MW-17	01/26/99	99.79	00:00	6.50	0.07	93.28	1.33	93.34
16MW-17	03/09/99	99.79	00:00	6.85	0.05	92.93	-0.35	92.97
16MW-17	03/19/99	99.79	00:00	6.51	0.05	93.27	0.34	93.32
16MW-17	04/20/99	99.79	00:00	6.73	0.05	93.05	-0.22	93.10
16MW-17	05/07/99	99.79	00:00	6.90	0.02	92.89	-0.16	92.90
16MW-17	06/07/99	99.79	00:00	7.29	0.07	92.49	-0.39	92.55
16MW-17	06/09/99	99.79	00:00	7.15	0.00	92.63	0.14	92.63
16MW-17	06/09/99	99.79	00:01	7.60	0.12	92.18	-0.45	92.28
16MW-17	06/10/99	99.79	00:00	7.60	0.04	92.18	0.00	92.22
16MW-17	06/14/99	99.79	13:30	7.60	0.04	92.18	0.00	92.22
16MW-18	08/20/97	100.69	00:00	7.96	0.00	92.73	NA	92.73
16MW-18	08/20/97	100.69	09:03	7.96	0.00	92.73	0.00	92.73
16MW-18	10/06/97	100.69	10:45	8.21	0.00	92.48	-0.25	92.48
16MW-18	12/12/97	100.69	08:30	7.98	0.00	92.71	0.23	92.71
16MW-18	01/07/98	100.69	10:30	6.85	0.00	93.84	1.13	93.84
16MW-18	01/15/98	100.69	07:30	7.24	0.00	93.45	-0.39	93.45
16MW-18	02/10/98	100.69	00:00	5.86	0.00	94.83	1.38	94.83
16MW-18	02/24/98	100.69	00:00	6.80	0.00	93.89	-0.94	93.89
16MW-18	03/03/98	100.69	00:00	5.30	0.00	95.39	1.50	95.39
16MW-18	03/12/98	100.69	00:00	4.89	0.00	95.80	0.41	95.80
16MW-18	03/13/98	100.69	00:00	5.06	0.00	95.63	-0.17	95.63
16MW-18	03/26/98	100.69	00:00	4.78	0.00	95.91	0.28	95.91
16MW-18	04/03/98	100.69	00:00	5.51	0.00	95.18	-0.73	95.18
16MW-18	04/09/98	100.69	00:00	5.85	0.00	94.84	-0.34	94.84
16MW-18	04/17/98	100.69	00:00	5.20	0.00	95.49	0.65	95.49
16MW-18	04/24/98	100.69	00:00	5.50	0.00	95.19	-0.30	95.19
16MW-18	05/05/98	100.69	00:00	4.40	0.00	96.29	1.10	96.29

(1) Change in Water Elevation since last reported measurement

D = Dry NA = Not Available

(2) Measurements Based on Mean Sea Level

Water Level Product Thickness Data

SITE	DATE	MP ELEVATION (feet)	TIME	DEPTH TO WATER (feet)	FLOATING PRODUCT THICKNESS (feet)	WATER ELEV. (feet)	△ WATER ELEV.(1) (feet)	EQUIV. FRESH WATER HEAD (feet)
16MW-18	05/15/98	100.69	00:00	3.85	0.00	96.84	0.55	96.84
16MW-18	07/30/98	100.69	00:00	6.87	0.01	93.81	-3.02	93.82
16MW-18	08/07/98	100.69	00:00	7.13	0.00	93.55	-0.25	93.55
16MW-18	08/13/98	100.69	00:00	8.40	0.00	92.29	-1.26	92.29
16MW-18	08/21/98	100.69	00:00	7.61	0.00	93.08	0.79	93.08
16MW-18	09/03/98	100.69	00:00	7.77	0.00	92.91	-0.16	92.91
16MW-18	09/10/98	100.69	00:00	7.39	0.00	93.29	0.38	93.29
16MW-18	10/02/98	100.69	00:00	7.66	0.00	93.03	-0.26	93.03
16MW-18	10/20/98	100.69	00:00	8.12	0.00	92.57	-0.46	92.57
16MW-18	11/06/98	100.69	00:00	8.31	0.00	92.38	-0.19	92.38
16MW-18	12/03/98	100.69	00:00	8.20	0.00	92.49	0.11	92.49
16MW-18	12/23/98	100.69	00:00	8.46	0.00	92.22	-0.26	92.22
16MW-18	01/26/99	100.69	00:00	4.36	0.00	96.33	4.10	96.33
16MW-18	03/09/99	100.69	00:00	6.30	0.00	94.39	-1.94	94.39
16MW-18	03/19/99	100.69	00:00	4.80	0.00	95.89	1.50	95.89
16MW-18	05/07/99	100.69	00:00	7.14	0.00	93.55	-2.34	93.55
16MW-18	06/07/99	100.69	00:00	7.40	0.00	93.29	-0.26	93.29
16MW-18	06/09/99	100.69	00:00	7.79	0.00	92.90	-0.39	92.90
16MW-18	06/09/99	100.69	00:01	7.77	0.00	92.92	0.02	92.92
16MW-18	06/10/99	100.69	00:00	7.82	0.00	92.87	-0.05	92.87
16MW-18	06/14/99	100.69	13:25	7.82	0.00	92.87	0.00	92.87
16MW-19	08/20/97	100.54	08:57	7.70	0.00	92.84	NA	92.84
16MW-19	10/06/97	100.54	10:45	8.43	0.62	92.11	-0.73	92.63
16MW-19	12/12/97	100.54	08:30	8.64	1.12	91.89	-0.21	92.85
16MW-19	01/07/98	100.54	10:37	7.52	0.82	93.01	1.12	93.71
16MW-19	01/15/98	100.54	07:30	7.21	0.18	93.32	0.31	93.48
16MW-19	02/10/98	100.54	00:00	5.78	0.09	94.75	1.42	94.83
16MW-19	02/24/98	100.54	00:00	5.10	0.00	95.44	0.68	95.44
16MW-19	03/03/98	100.54	00:00	5.30	0.01	95.23	-0.20	95.24
16MW-19	03/12/98	100.54	00:00	4.80	0.01	95.73	0.50	95.74
16MW-19	03/13/98	100.54	00:00	5.05	0.00	95.49	-0.24	95.49
16MW-19	03/26/98	100.54	00:00	6.31	0.03	94.23	-1.26	94.25
16MW-19	04/03/98	100.54	00:00	5.31	0.00	95.23	1.00	95.23
16MW-19	04/09/98	100.54	00:00	5.51	0.00	95.02	-0.20	95.03
16MW-19	04/17/98	100.54	00:00	5.03	0.03	95.50	0.48	95.53

(1) Change in Water Elevation since last reported measurement

D = Dry NA = Not Available

(2) Measurements Based on Mean Sea Level

Water Level Product Thickness Data

SITE	DATE	MP ELEVATION (feet)	TIME	DEPTH TO WATER (feet)	FLOATING PRODUCT THICKNESS (feet)	WATER ELEV. (feet)	△ WATER ELEV.(1) (feet)	EQUIV. FRESH WATER HEAD (feet)
16MW-19	04/24/98	100.54	00:00	4.92	0.01	95.62	0.11	95.62
16MW-19	05/05/98	100.54	00:00	4.55	0.05	95.98	0.36	96.04
16MW-19	05/15/98	100.54	00:00	3.56	0.01	96.97	0.99	96.98
16MW-19	07/30/98	100.54	00:00	6.79	0.11	93.75	-3.22	93.84
16MW-19	08/07/98	100.54	00:00	6.97	0.00	93.57	-0.18	93.57
16MW-19	08/13/98	100.54	00:00	7.20	0.00	93.33	-0.23	93.33
16MW-19	08/21/98	100.54	00:00	7.41	0.00	93.13	-0.20	93.13
16MW-19	09/03/98	100.54	00:00	7.54	0.00	92.99	-0.13	92.99
16MW-19	09/10/98	100.54	00:00	7.60	0.00	92.93	-0.06	92.93
16MW-19	10/02/98	100.54	00:00	7.66	0.00	92.87	-0.06	92.87
16MW-19	10/20/98	100.54	00:00	7.87	0.00	92.66	-0.21	92.66
16MW-19	11/06/98	100.54	00:00	8.14	0.00	92.39	-0.27	92.39
16MW-19	12/03/98	100.54	00:00	7.94	0.00	92.59	0.20	92.59
16MW-19	12/23/98	100.54	00:00	8.04	0.01	92.49	-0.10	92.50
16MW-19	01/26/99	100.54	00:00	5.69	0.04	94.85	2.35	94.88
16MW-19	03/09/99	100.54	00:00	6.43	0.03	94.11	-0.74	94.13
16MW-19	03/19/99	100.54	00:00	6.05	0.05	94.49	0.38	94.53
16MW-19	04/20/99	100.54	00:00	6.56	0.01	93.97	-0.51	93.98
16MW-19	05/07/99	100.54	00:00	7.03	0.02	93.50	-0.47	93.52
16MW-19	06/07/99	100.54	00:00	7.17	0.02	93.36	-0.14	93.38
16MW-19	06/09/99	100.54	00:00	6.94	0.00	93.60	0.23	93.60
16MW-19	06/09/99	100.54	00:01	7.62	0.03	92.92	-0.68	92.94
16MW-19	06/10/99	100.54	00:00	7.68	0.00	92.86	-0.06	92.86
16MW-19	06/14/99	100.54	13:20	7.68	0.00	92.86	0.00	92.86
16MW-20	08/20/97	100.82	09:26	8.54	0.44	92.27	NA	92.65
16MW-20	10/06/97	100.82	10:45	8.84	0.46	91.98	-0.29	92.37
16MW-20	12/12/97	100.82	08:30	8.71	0.61	92.10	0.12	92.62
16MW-20	01/07/98	100.82	10:49	8.27	0.69	92.54	0.43	93.13
16MW-20	02/10/98	100.82	00:00	7.25	0.15	93.56	1.02	93.69
16MW-20	02/24/98	100.82	00:00	6.56	0.08	94.26	0.69	94.32
16MW-20	03/03/98	100.82	00:00	6.63	0.07	94.18	-0.07	94.24
16MW-20	03/12/98	100.82	00:00	6.30	0.02	94.51	0.33	94.53
16MW-20	03/26/98	100.82	00:00	6.20	0.00	94.61	0.10	94.61
16MW-20	04/03/98	100.82	00:00	6.48	0.04	94.34	-0.27	94.37
16MW-20	04/09/98	100.82	00:00	6.61	0.02	94.20	-0.13	94.22

(1) Change in Water Elevation since last reported measurement

D = Dry NA = Not Available

(2) Measurements Based on Mean Sea Level

Water Level Product Thickness Data

SITE	DATE	MP ELEVATION (feet)	TIME	DEPTH TO WATER (feet)	FLOATING PRODUCT THICKNESS (feet)	WATER ELEV. (feet)	△ WATER ELEV(1) (feet)	EQUIV. FRESH WATER HEAD (feet)
16MW-20	04/24/98	100.82	00:00	6.48	0.00	94.34	0.13	94.34
16MW-20	05/05/98	100.82	00:00	6.39	0.00	94.42	0.08	94.43
16MW-20	05/15/98	100.82	00:00	5.53	0.05	95.28	0.86	95.33
16MW-20	07/30/98	100.82	00:00	7.87	0.36	92.94	-2.34	93.25
16MW-20	08/07/98	100.82	00:00	7.96	0.04	92.85	-0.09	92.89
16MW-20	08/13/98	100.82	00:00	8.13	0.05	92.68	-0.16	92.73
16MW-20	08/21/98	100.82	00:00	8.25	0.05	92.57	-0.11	92.61
16MW-20	09/03/98	100.82	00:00	8.47	0.06	92.35	-0.22	92.40
16MW-20	09/10/98	100.82	00:00	8.47	0.01	92.34	-0.00	92.35
16MW-20	10/02/98	100.82	00:00	8.57	0.05	92.24	-0.09	92.29
16MW-20	10/20/98	100.82	00:00	8.66	0.00	92.16	-0.08	92.16
16MW-20	12/03/98	100.82	00:00	8.85	0.06	91.97	-0.19	92.02
16MW-20	01/26/99	100.82	00:00	7.61	0.02	93.20	1.23	93.22
16MW-20	03/09/99	100.82	00:00	7.87	0.02	92.94	-0.25	92.96
16MW-20	03/19/99	100.82	00:00	7.63	0.01	93.19	0.24	93.19
16MW-20	04/20/99	100.82	00:00	7.68	0.00	93.13	-0.05	93.13
16MW-20	05/07/99	100.82	00:00	7.86	0.01	92.95	-0.18	92.96
16MW-20	06/07/99	100.82	00:00	8.25	0.03	92.56	-0.39	92.59
16MW-20	06/09/99	100.82	00:01	8.56	0.08	92.26	-0.30	92.32
16MW-20	06/10/99	100.82	00:00	7.57	0.05	93.25	0.99	93.29
16MW-21	08/20/97	99.78	00:00	7.56	0.00	92.21	NA	92.21
16MW-21	08/20/97	99.78	09:35	7.56	0.00	92.21	0.00	92.21
16MW-21	10/06/97	99.78	10:45	7.80	0.00	91.98	-0.23	91.98
16MW-21	12/12/97	99.78	08:30	7.70	0.00	92.08	0.10	92.08
16MW-21	01/07/98	99.78	10:58	7.12	0.00	92.66	0.58	92.66
16MW-21	02/10/98	99.78	00:00	6.00	0.00	93.78	1.12	93.78
16MW-21	02/24/98	99.78	00:00	5.67	0.00	94.11	0.33	94.11
16MW-21	03/03/98	99.78	00:00	5.40	0.00	94.38	0.27	94.38
16MW-21	03/12/98	99.78	00:00	5.03	0.00	94.75	0.37	94.75
16MW-21	03/13/98	99.78	00:00	5.17	0.00	94.61	-0.14	94.61
16MW-21	04/03/98	99.78	00:00	5.25	0.00	94.53	-0.08	94.53
16MW-21	04/09/98	99.78	00:00	5.55	0.00	94.23	-0.30	94.23
16MW-21	04/17/98	99.78	00:00	6.45	0.01	93.32	-0.90	93.34
16MW-21	04/24/98	99.78	00:00	5.93	0.00	93.85	0.52	93.85
16MW-21	05/05/98	99.78	00:00	4.83	0.00	94.95	1.10	94.95

(1) Change in Water Elevation since last reported measurement

D = Dry NA = Not Available

(2) Measurements Based on Mean Sea Level

Water Level Product Thickness Data

SITE	DATE	MP ELEVATION (feet)	TIME	DEPTH TO WATER (feet)	FLOATING PRODUCT THICKNESS (feet)	WATER ELEV. (feet)	△ WATER ELEV.(1) (feet)	EQUIV. FRESH WATER HEAD (feet)
16MW-21	05/15/98	99.78	00:00	4.10	0.00	95.68	0.73	95.68
16MW-21	07/30/98	99.78	00:00	6.95	0.00	92.83	-2.85	92.83
16MW-21	08/07/98	99.78	00:00	7.21	0.00	92.57	-0.26	92.57
16MW-21	08/13/98	99.78	00:00	7.41	0.00	92.37	-0.20	92.37
16MW-21	08/21/98	99.78	00:00	7.51	0.00	92.27	-0.10	92.27
16MW-21	09/03/98	99.78	00:00	7.57	0.00	92.21	-0.06	92.21
16MW-21	09/10/98	99.78	00:00	7.70	0.00	92.08	-0.13	92.08
16MW-21	10/02/98	99.78	00:00	7.77	0.00	92.01	-0.07	92.01
16MW-21	10/20/98	99.78	00:00	7.86	0.00	91.92	-0.09	91.92
16MW-21	12/03/98	99.78	00:00	8.00	0.00	91.78	-0.14	91.78
16MW-21	01/26/99	99.78	00:00	5.05	0.00	94.73	2.95	94.73
16MW-21	03/09/99	99.78	00:00	6.57	0.00	93.21	-1.52	93.21
16MW-21	03/19/99	99.78	00:00	5.56	0.00	94.22	1.01	94.22
16MW-21	04/20/99	99.78	00:00	6.40	0.00	93.38	-0.84	93.38
16MW-21	06/07/99	99.78	00:00	7.45	0.00	92.33	-1.05	92.33
16MW-21	06/09/99	99.78	00:01	7.15	0.00	92.63	0.30	92.63
16MW-22	12/12/97	102.22	00:00	7.70	0.00	94.52	NA	94.52
16MW-22	01/07/98	102.22	00:00	5.34	0.00	96.88	2.36	96.88
16MW-22	02/10/98	102.22	00:00	2.98	0.00	99.24	2.36	99.24
16MW-22	02/24/98	102.22	00:00	1.60	0.00	100.62	1.38	100.62
16MW-22	03/03/98	102.22	00:00	2.87	0.00	99.35	-1.27	99.35
16MW-22	03/26/98	102.22	00:00	1.85	0.00	100.37	1.02	100.37
16MW-22	04/03/98	102.22	00:00	2.05	0.00	100.17	-0.20	100.17
16MW-22	04/17/98	102.22	00:00	2.10	0.00	100.12	-0.05	100.12
16MW-22	04/24/98	102.22	00:00	1.52	0.00	100.70	0.58	100.70
16MW-22	05/05/98	102.22	00:00	0.00	0.00	102.22	1.52	102.22
16MW-22	05/15/98	102.22	00:00	2.86	0.00	99.36	-2.86	99.36
16MW-22	07/30/98	102.22	00:00	6.03	0.00	96.19	-3.17	96.19
16MW-22	08/13/98	102.22	00:00	6.10	0.00	96.12	-0.07	96.12
16MW-22	10/02/98	102.22	00:00	7.78	0.00	94.44	-1.68	94.44
16MW-22	11/06/98	102.22	00:00	8.79	0.00	93.43	-1.01	93.43
16MW-22	01/26/99	102.22	00:00	1.81	0.00	100.41	6.98	100.41
16MW-22	03/09/99	102.22	00:00	3.45	0.00	98.77	-1.64	98.77
16MW-22	03/19/99	102.22	00:00	8.38	0.00	93.84	-4.93	93.84
16MW-22	04/20/99	102.22	00:00	4.15	0.00	98.07	4.23	98.07

(1) Change in Water Elevation since last reported measurement

D = Dry NA = Not Available

(2) Measurements Based on Mean Sea Level

Water Level Product Thickness Data

SITE	DATE	MP ELEVATION (feet)	TIME	DEPTH TO WATER (feet)	FLOATING PRODUCT THICKNESS (feet)	WATER ELEV. (feet)	△ WATER ELEV.(1) (feet)	EQUIV. FRESH WATER HEAD (feet)
16MW-22	05/07/99	102.22	00:00	7.05	0.00	95.17	-2.90	95.17
16MW-22	06/07/99	102.22	00:00	5.81	0.00	96.41	1.24	96.41
16MW-22	06/09/99	102.22	00:01	6.11	0.00	96.11	-0.30	96.11
16MW-22	06/14/99	102.22	13:45	7.57	0.05	94.65	-1.46	94.69
16MW-23	12/12/97	102.58	08:30	9.19	0.00	93.39	NA	93.39
16MW-23	01/07/98	102.58	09:35	8.67	0.00	93.91	0.52	93.91
16MW-23	01/07/98	102.58	09:49	8.67	0.00	93.91	0.00	93.91
16MW-23	02/10/98	102.58	00:00	2.98	0.00	99.60	5.69	99.60
16MW-23	02/24/98	102.58	00:00	7.20	0.00	95.38	-4.22	95.38
16MW-23	03/03/98	102.58	00:00	7.10	0.00	95.48	0.10	95.48
16MW-23	03/26/98	102.58	00:00	6.60	0.00	95.98	0.50	95.98
16MW-23	04/03/98	102.58	00:00	6.90	0.00	95.68	-0.30	95.68
16MW-23	04/17/98	102.58	00:00	6.95	0.00	95.63	-0.05	95.63
16MW-23	04/24/98	102.58	00:00	6.84	0.00	95.74	0.11	95.74
16MW-23	05/05/98	102.58	00:00	0.00	0.00	102.58	6.84	102.58
16MW-23	05/15/98	102.58	00:00	5.89	0.00	96.69	-5.89	96.69
16MW-23	07/30/98	102.58	00:00	8.03	0.00	94.55	-2.14	94.55
16MW-23	08/13/98	102.58	00:00	8.46	0.00	94.12	-0.43	94.12
16MW-23	10/02/98	102.58	00:00	9.03	0.00	93.55	-0.57	93.55
16MW-23	01/26/99	102.58	00:00	8.21	0.00	94.37	0.82	94.37
16MW-23	03/09/99	102.58	00:00	8.53	0.00	94.05	-0.32	94.05
16MW-23	03/19/99	102.58	00:00	8.31	0.00	94.27	0.22	94.27
16MW-23	04/20/99	102.58	00:00	8.32	0.00	94.26	-0.01	94.26
16MW-23	06/07/99	102.58	00:00	8.80	0.00	93.78	-0.48	93.78
16MW-23	06/09/99	102.58	00:01	9.01	0.00	93.57	-0.21	93.57
C17MW-07	12/12/97	100.16	00:00	7.91	1.26	92.25	NA	93.32
C17MW-07	01/07/98	100.16	00:00	7.52	1.42	92.64	0.39	93.84
C17MW-07	01/15/98	100.16	00:00	7.36	0.19	92.79	0.15	92.96
C17MW-07	02/10/98	100.16	00:00	6.54	0.83	93.61	0.82	94.32
C17MW-07	02/24/98	100.16	00:00	1.95	1.35	98.21	4.59	99.36
C17MW-07	03/03/98	100.16	00:00	5.89	0.49	94.27	-3.94	94.68
C17MW-07	03/12/98	100.16	00:00	5.45	0.18	94.71	0.44	94.86
C17MW-07	03/13/98	100.16	00:00	5.55	0.13	94.60	-0.10	94.72
C17MW-07	03/26/98	100.16	00:00	5.31	0.01	94.84	0.24	94.85

(1) Change in Water Elevation since last reported measurement

D = Dry NA = Not Available

(2) Measurements Based on Mean Sea Level

Water Level Product Thickness Data

Date: 07/12/99

SITE	DATE	MP ELEVATION (feet)	TIME	DEPTH TO WATER (feet)	FLOATING PRODUCT THICKNESS (feet)	WATER ELEV. (feet)	△ WATER ELEV.(1) (feet)	EQUIV. FRESH WATER HEAD (feet)
C17MW-07	04/03/98	100.16	00:00	5.62	0.09	94.53	-0.31	94.61
C17MW-07	04/09/98	100.16	00:00	5.77	0.08	94.38	-0.15	94.45
C17MW-07	04/17/98	100.16	00:00	5.62	0.12	94.53	0.15	94.64
C17MW-07	04/24/98	100.16	00:00	5.50	0.13	94.65	0.12	94.77
C17MW-07	05/05/98	100.16	00:00	5.66	0.27	94.49	-0.16	94.77
C17MW-07	05/15/98	100.16	00:00	4.83	0.22	95.32	0.83	95.51
C17MW-07	07/30/98	100.16	00:00	7.25	1.12	92.91	-2.41	93.86
C17MW-07	08/07/98	100.16	00:00	7.06	0.24	93.09	0.18	93.30
C17MW-07	08/13/98	100.16	00:00	7.23	0.25	92.93	-0.16	93.14
C17MW-07	08/21/98	100.16	00:00	7.27	0.11	92.88	-0.04	92.98
C17MW-07	09/03/98	100.16	00:00	7.31	0.15	92.85	-0.03	92.97
C17MW-07	09/10/98	100.16	00:00	7.41	0.08	92.74	-0.10	92.81
C17MW-07	10/02/98	100.16	00:00	7.54	0.20	92.61	-0.13	92.78
C17MW-07	10/20/98	100.16	00:00	7.58	0.10	92.58	-0.03	92.66
C17MW-07	12/03/98	100.16	00:00	7.72	0.08	92.44	-0.14	92.50
C17MW-07	12/23/98	100.16	00:00	7.67	0.12	92.49	0.05	92.59
C17MW-07	01/26/99	100.16	00:00	6.35	0.10	93.81	1.32	93.89
C17MW-07	03/09/99	100.16	00:00	6.61	0.11	93.54	-0.26	93.64
C17MW-07	03/19/99	100.16	00:00	6.22	0.07	93.93	0.38	93.99
C17MW-07	04/20/99	100.16	00:00	6.60	0.10	93.55	-0.37	93.64
C17MW-07	05/07/99	100.16	00:00	6.77	0.07	93.38	-0.17	93.44
C17MW-07	06/07/99	100.16	00:00	7.19	0.13	92.96	-0.42	93.07
C17MW-07	06/09/99	100.16	00:00	7.20	0.00	92.96	-0.00	92.96
C17MW-07	06/09/99	100.16	00:01	7.56	0.27	92.59	-0.36	92.82
C17MW-07	06/10/99	100.16	00:00	7.54	0.13	92.62	0.02	92.73
C17MW-07	06/14/99	100.16	13:35	7.54	0.13	92.62	0.00	92.73

(1) Change in Water Elevation since last reported measurement

D = Dry NA = Not Available

(2) Measurements Based on Mean Sea Level

Figure 1 Preparation for asphalt pad by building C-16, facing north.

Figure 2. Installation of asphalt berm near building C-16.

Figure 3. Construction of asphalt pad north of building C-50

Figure 4. Compaction of asphalt pad north of building C-50

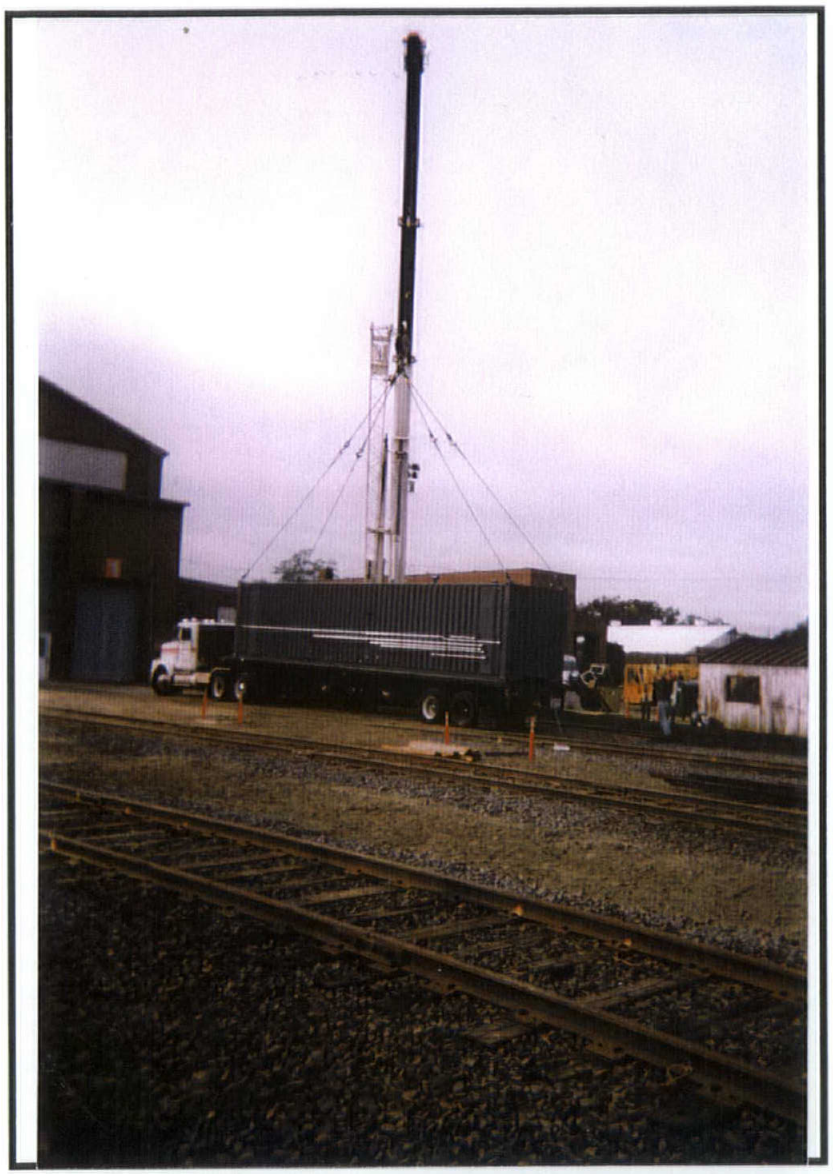


Figure 5. Off loading of bioslurper unit with a hydraulic crane.

Figure 6. Setting of bioslurper unit with hydraulic crane.

Figure 7. Excavation activities adjacent to bioslurper unit #1.

Figure 8. Piping network underlying railroad tracks showing steel outer protective casing.

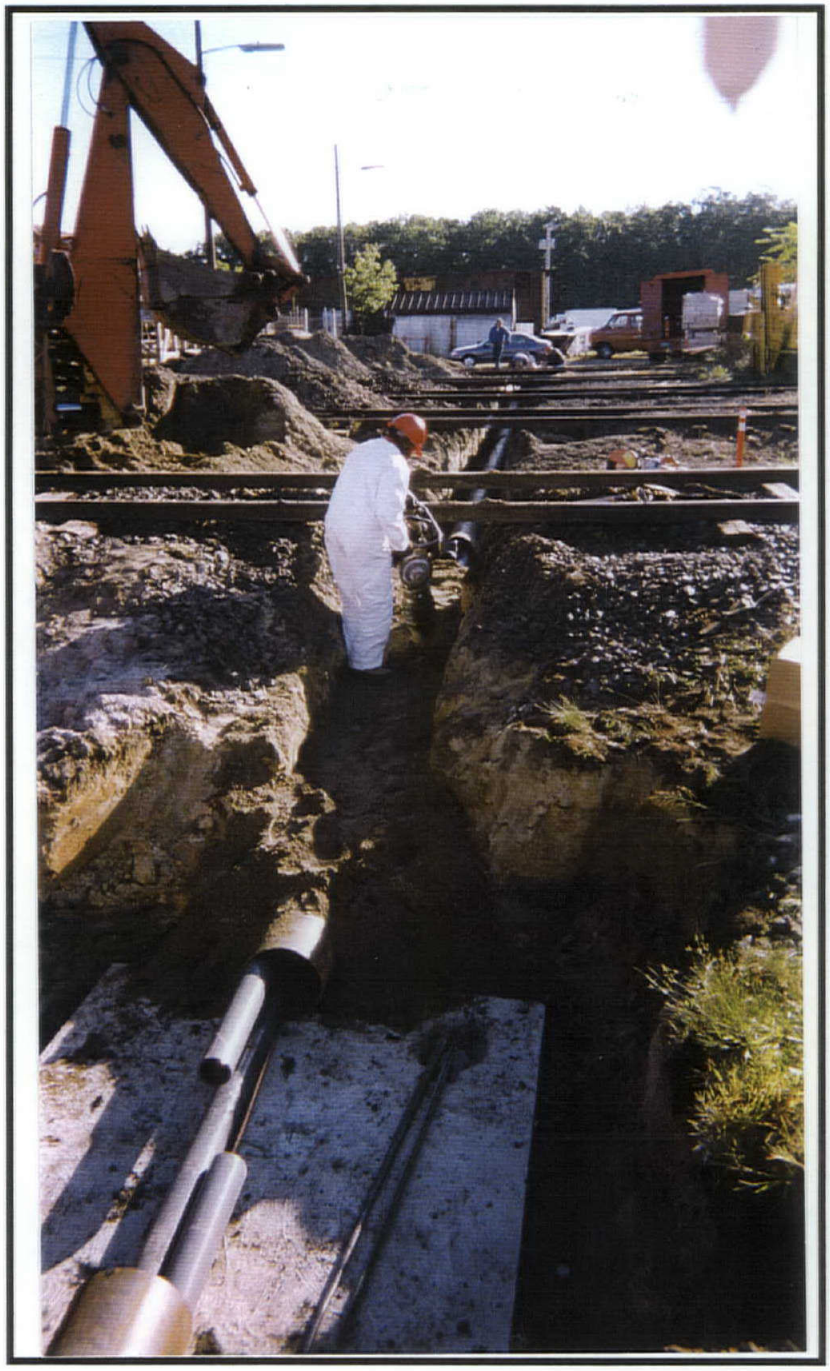


Figure 9. Piping network between bioslurper unit#1 and bioslurper unit #2 facing east.

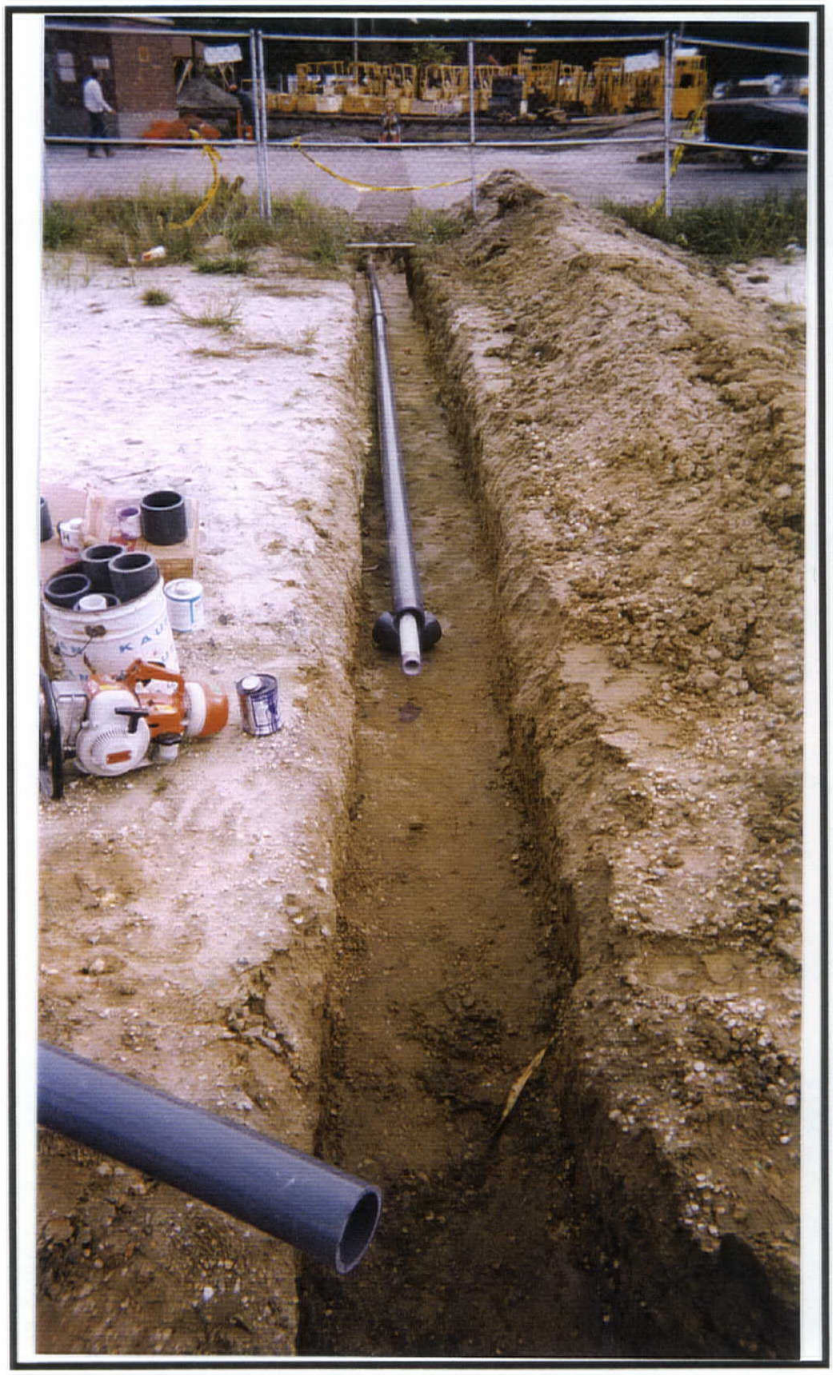


Figure 10. Piping to bioventing wells at gas station facing northeast.

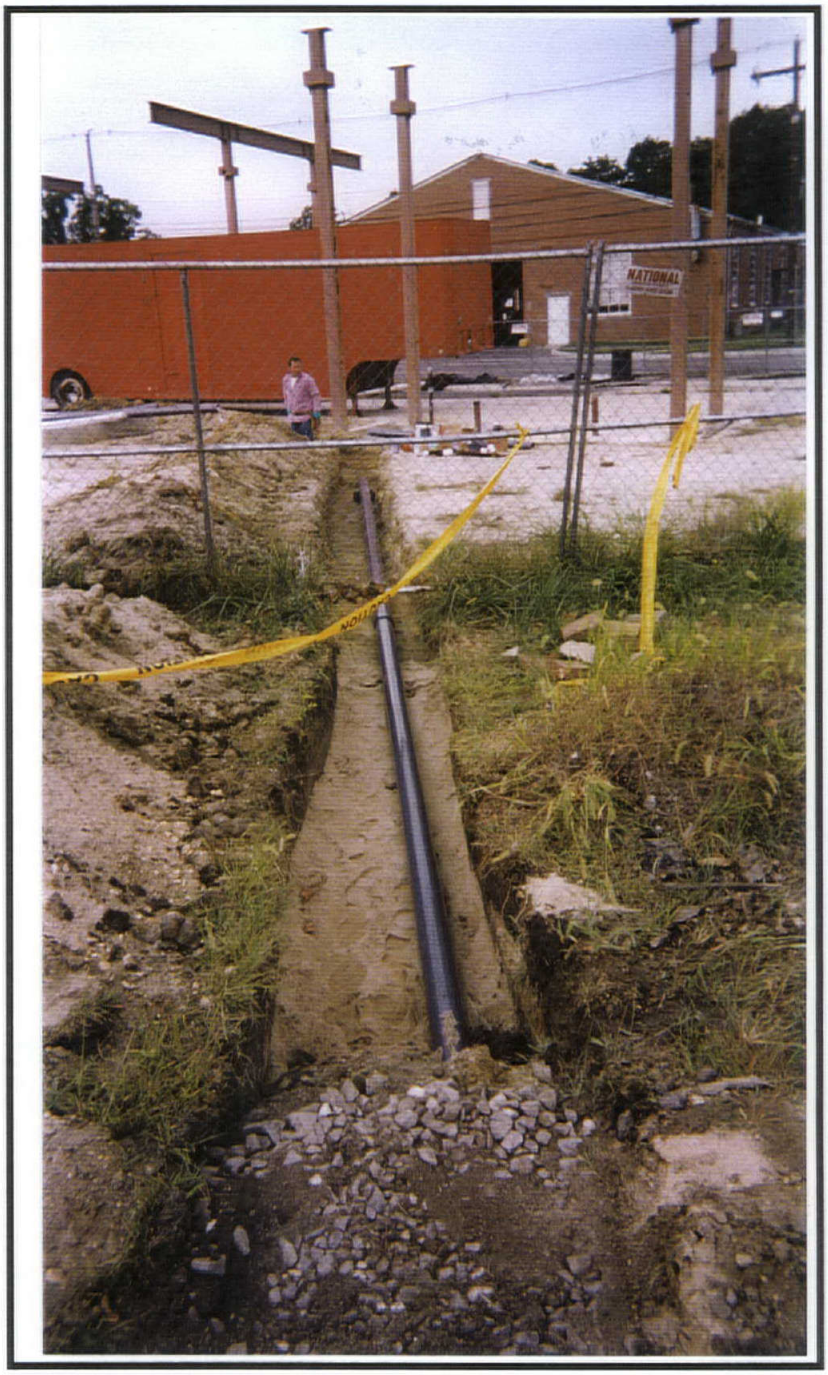


Figure 11. Piping to bioventing wells at gas station sit facing southwest.

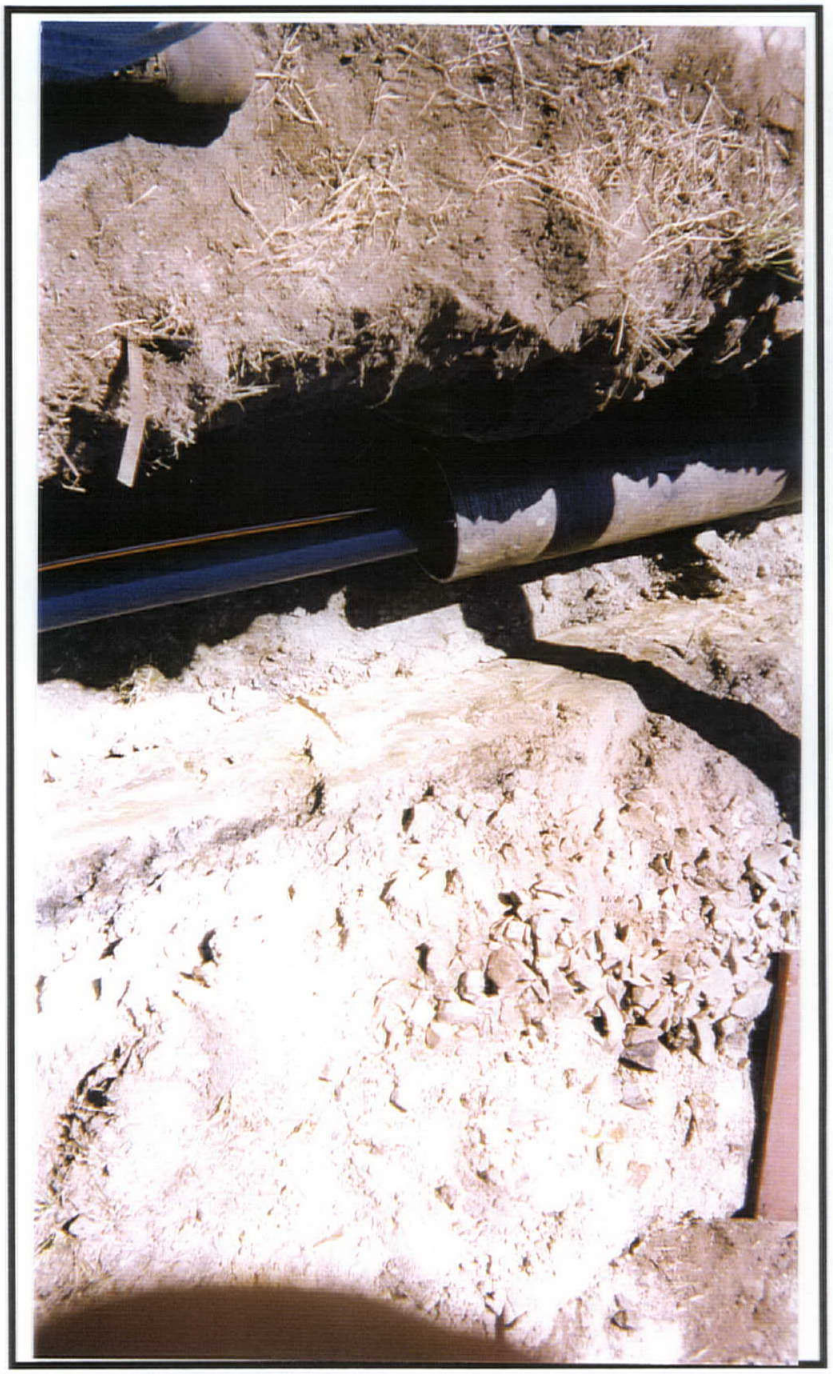


Figure 12. Four inch schedule 80 PVC inside six (6) inch diameter steel casing near building C-50.

Figure 13. Compacting trench from bioventing line to gas station facing north.

Figure 14. Piping run under railroad tracks north of building C-50.

Figure 15. Base of vaults for access to piping network.

Figure 16. Construction of pipe access vault box.

Figure 17. Construction of vault boxes for access to piping network.

Figure 18.Construction of vault box north of building C-50.

Figure 19. Compaction of soils underlying railroad tracks.

Figure 20. Compaction testing using a nuclear density gauge.

Figure 21. Backfilling lateral line to wells 16MW-16 through 16MW-19 facing North.

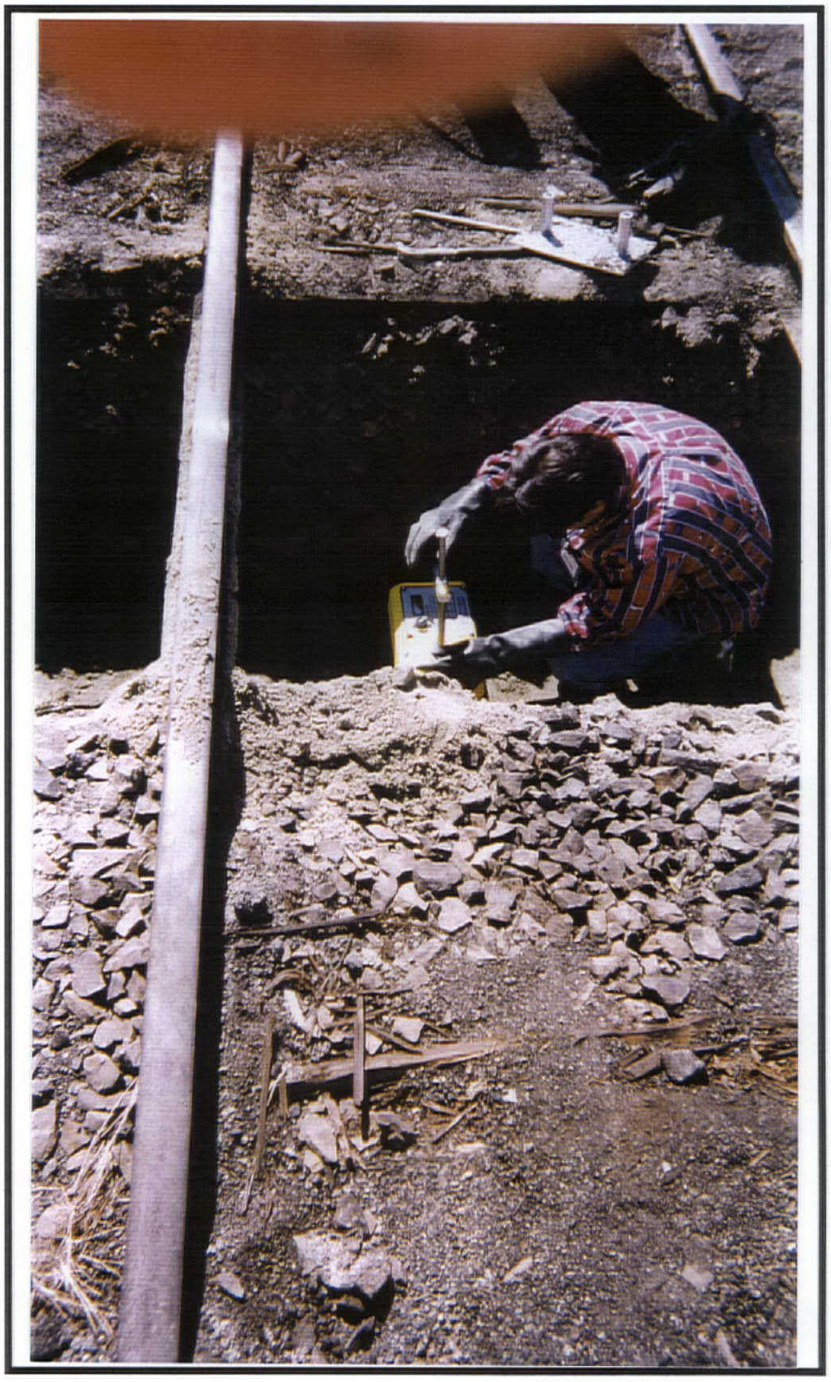


Figure 22. Compaction testing of backfilled soils using a nuclear density gauge.

Figure 23. Placement of marking tape 1 foot below grade.

Figure 24. Placement of pipeline marking tape 1 foot beow grade.

Figure 25. Hydrostatic testing of piping.

Figure 26. Compacting operations of backfilled trench

Figure 27. Placing ballast under and around railroad tracks.

Figure 28. Placement of stone sub-grade prior to asphalt.

Figure 29. Placement of asphalt in parking lot area south of building C-16.

Figure 30. Compacting asphalt in trench..

Figure 31. Piping network from extraction wells entering bioslurper unit #1 facing northwest.

Figure 32. Bioslurper unit #1 facing southeast.

Figure 33. Placing asphalt around 16MW-13.

Figure 34. Regraded piping run from 16 MW-14 to 16 MW-15 facing north.

Figure 35. Regradded area of piping run from 16MW-16 through 16 MW-19 facing north.

Figure 36. Completed trench area east of building C-16 showing well markers.

Figure 37. Water supply line and effluent discharge line connections to building C-16 facing northwest.

Figure 38. Electrician connecting into a transformer northeast of building C-50.

Figure 39. Electrician connecting powerlines to pole adjacent to bioslurper unit #2.

Figure 40.Vacuum truck on-site for removing clay media for tank repairs.

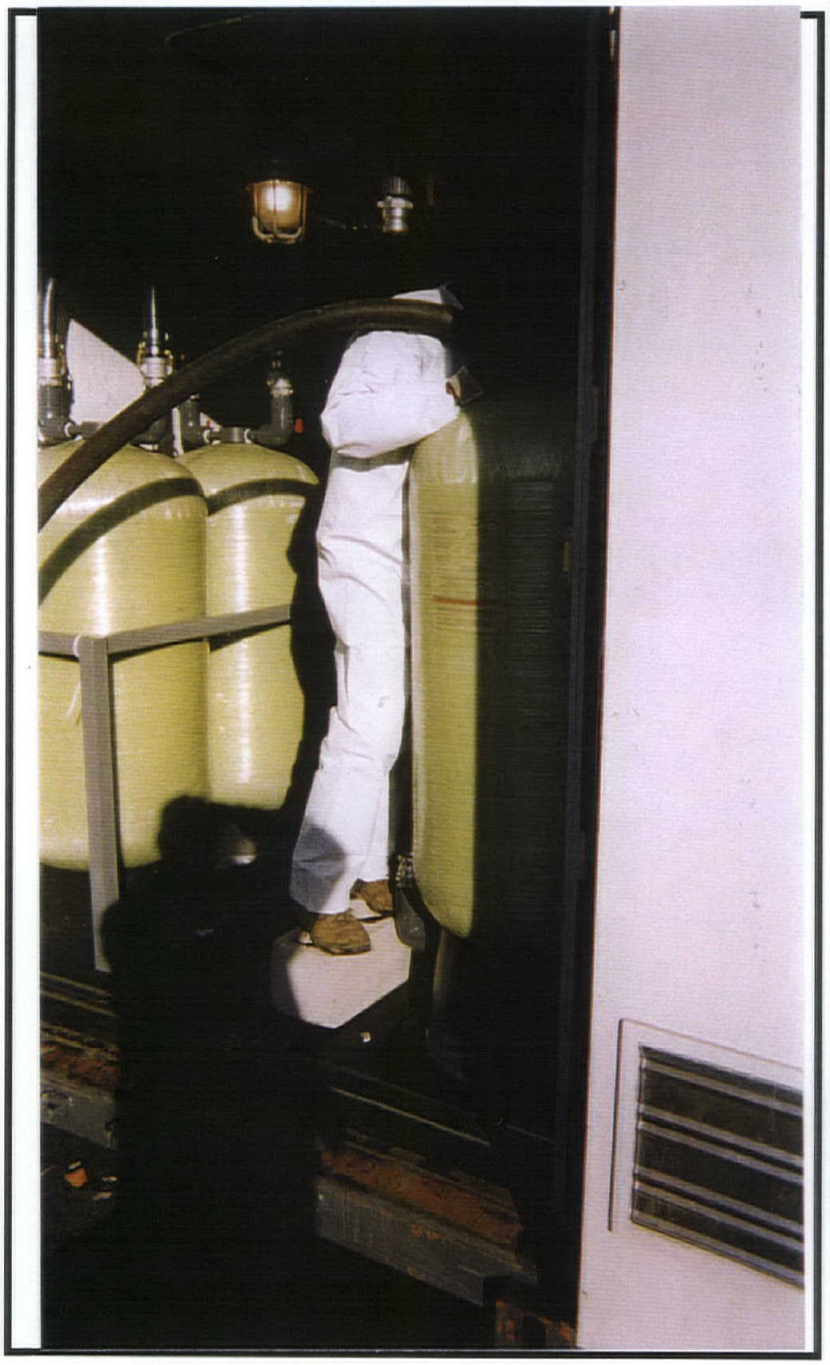


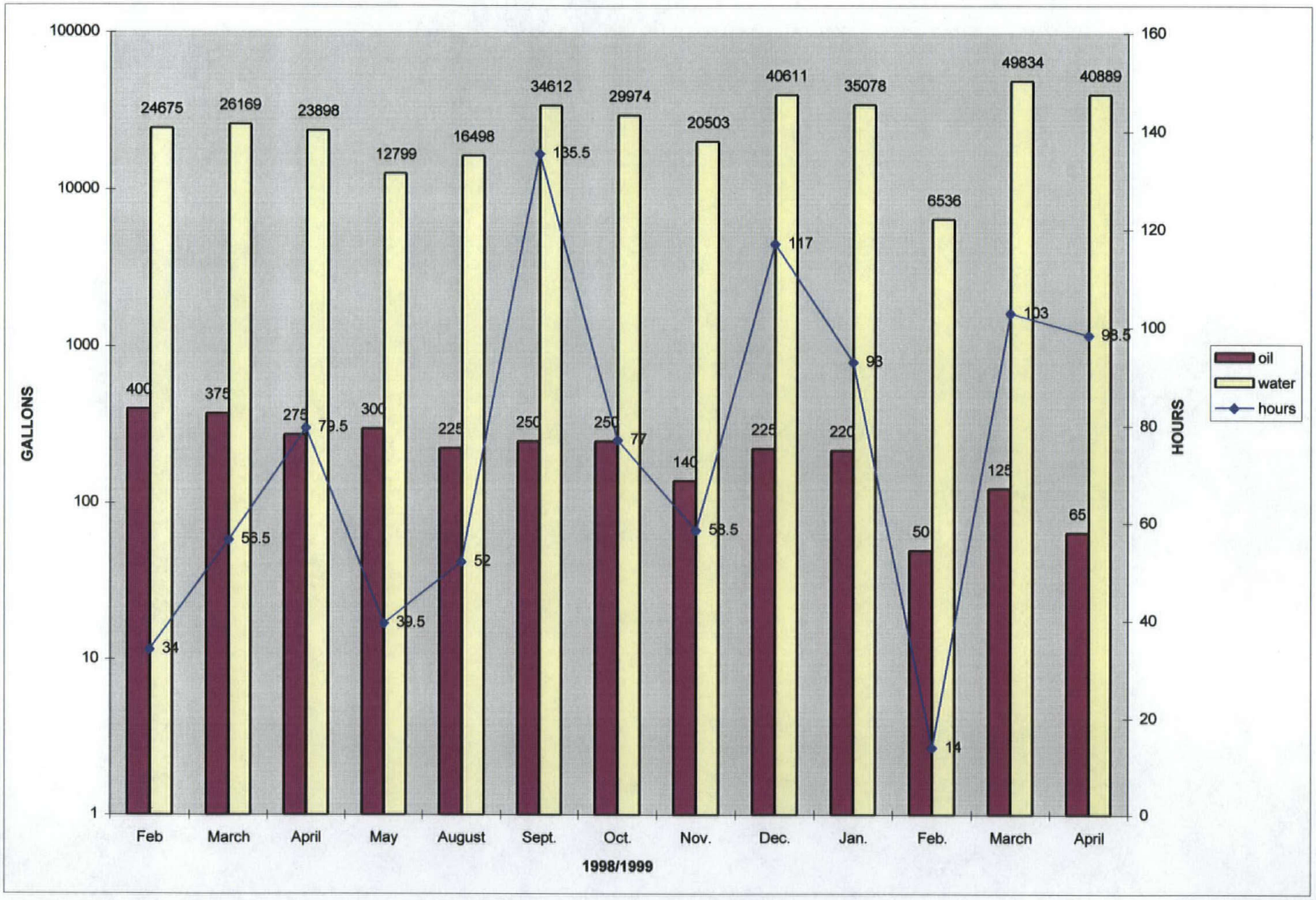
Figure 41.Clay absorption media being vacuumed out of tanks in bioslurper unit.

Figure 42. clay media being placed in drums.

Figure 43. Clay absorption tanks after removal from bioslurper unit

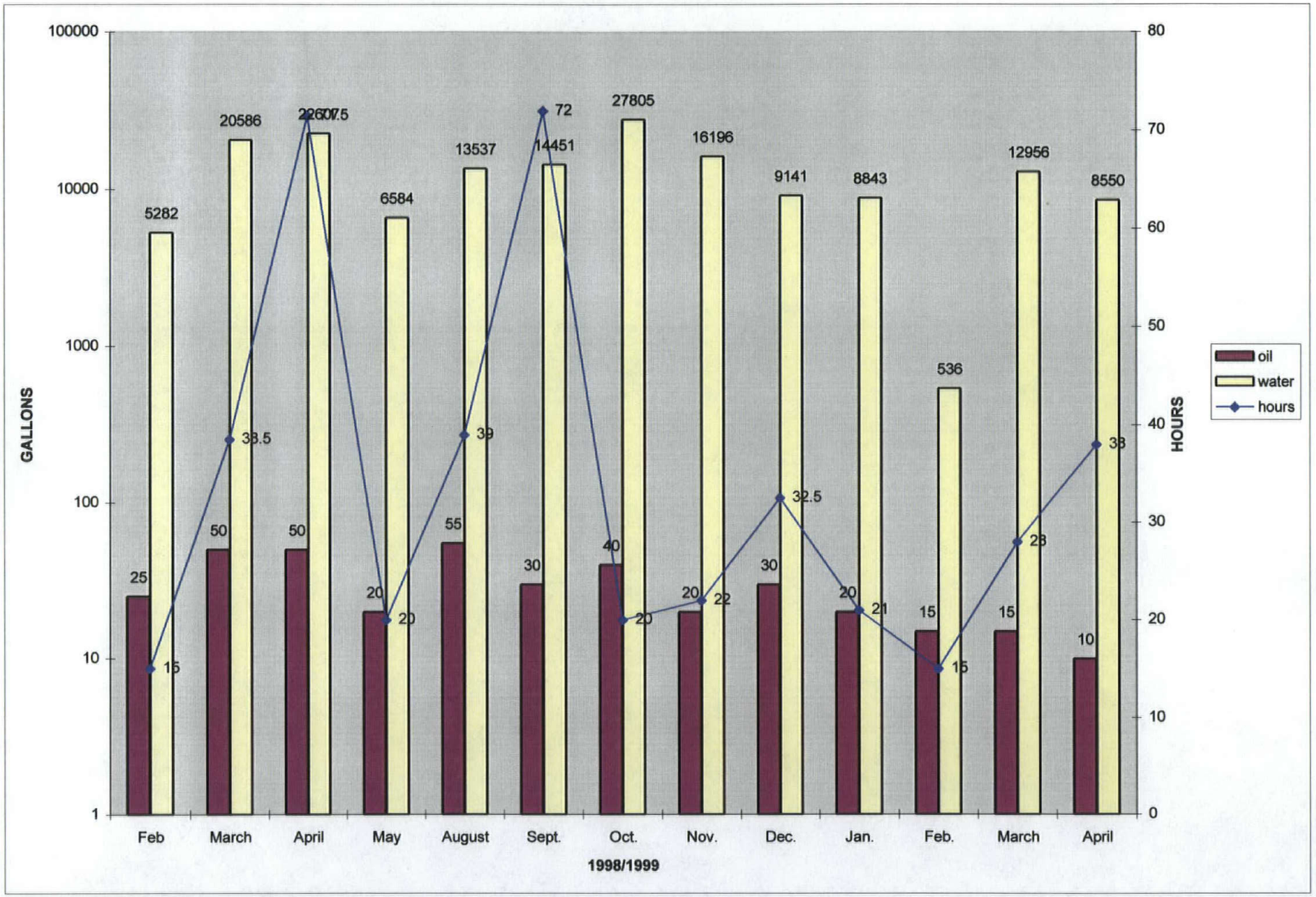
Figure 44. Hydrostatic testing of clay absorption tanks after repairs.

BIOSLURPER UNIT #1: GROUNDWATER/OIL RECOVERY VERSUS OPERATION TIME

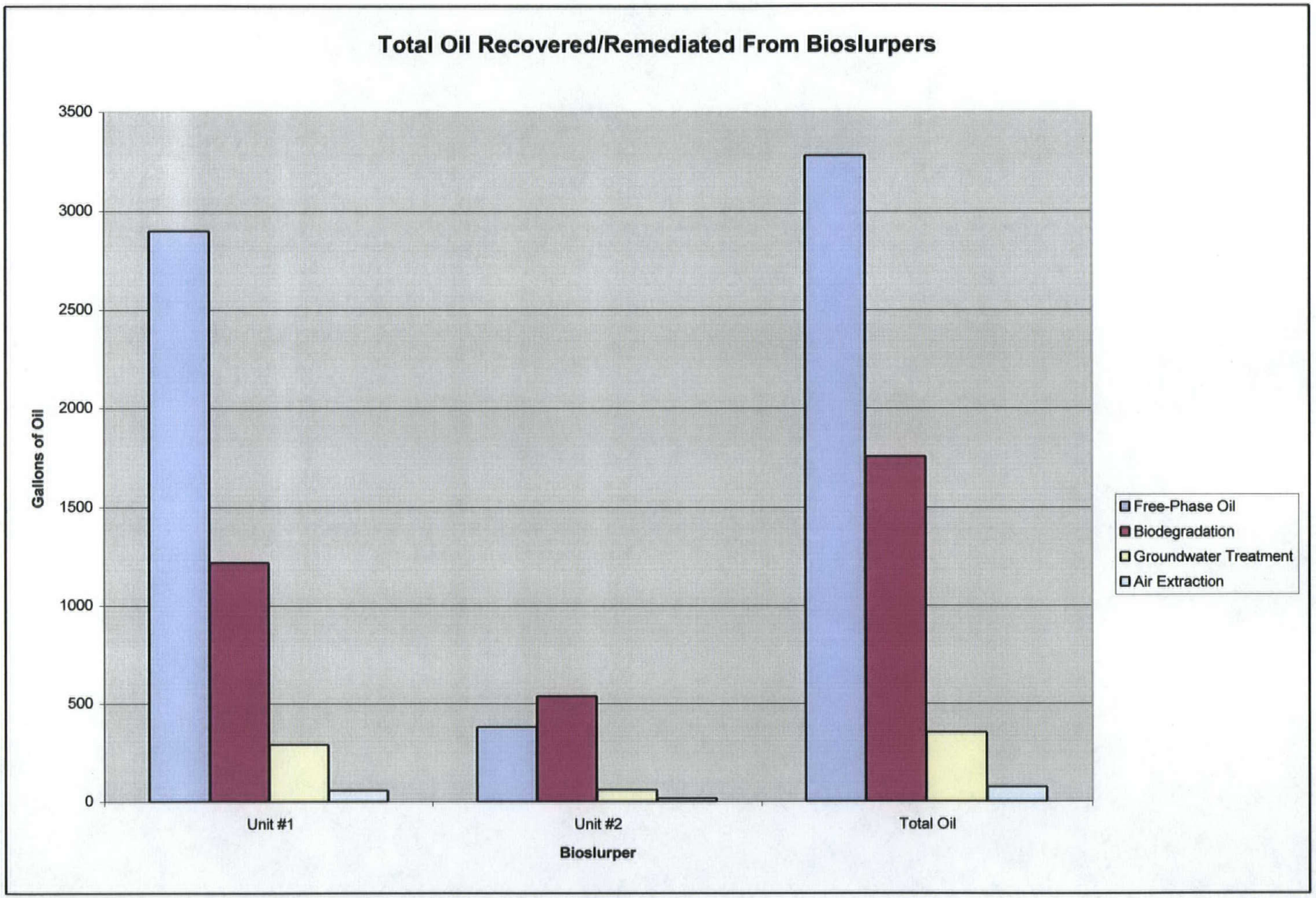


Bios Chart 99.xls
BIOS 1 Chart 4

BIOSLURPER UNIT #2: GROUNDWATER/OIL RECOVERY VERSUS OPERATION TIME



Bios Chart 99.xls
BIOS 2 Chart 4


Total Oil Recovered/Remediated From Bioslurpers
Gallons of Oil
3500
3000
2500
2000
1500
1000
500
0
Unit #1
Unit #2
Total Oil
Bioslurper
Free-Phase Oil
Biodegradation
Groundwater Treatment
Air Extraction

FOSTER WHEELER ENVIRONMENTAL CORPORATION

BY _____ DATE _____ SHEET 1 OF 2

CHKD. BY _____ DATE _____ OFS NO. _____ DEPT. NO. _____

CLIENT _____

PROJECT Naval Weapons Station - Earle

SUBJECT Bioslurper Unit #1 : Biodegradation Calculations

- Background CO_2 concentration in wells : 1% CO_2
- CO_2 concentration in air discharge : 4% CO_2
- 3% CO_2 discharge the result of biodegradation

Unit #1 : 958 hours of operation (Feb 98' - April 99)
76.05 ft^3/min average air discharge

$$76.05 \frac{ft^3}{min} \times 958 \text{ hours} \times 60 \frac{min}{hr} = 4{,}371{,}354.00 \ ft^3$$

$$4{,}371{,}354.00 \times 0.03 (CO_2) = 131{,}140.62 \ ft^3 \text{ of } CO_2$$

$$131{,}140.62 \ ft^3 \times 0.1234 \ lb/ft^3 \ ^* (CO_2) = 16{,}182.75 \text{ lbs. of } CO_2$$

- 1.913 pounds of CO_2 produced for every one pound of petroleum biodegraded

$$16{,}182.75 \times \frac{1 \text{ lb. Petroleum}}{1.913 \text{ lbs } CO_2} \ ^+ = \frac{8{,}459.36 \text{ lbs}}{\text{Biodegraded}} \text{ of Petroleum}$$

* Glover, Thomas J., Pocket Reference, 2nd Edition. 1997.
\+ Damera, 1997

FOSTER WHEELER ENVIRONMENTAL CORPORATION

BY _____ DATE _____ SHEET 2 OF 2

CHKD. BY _____ DATE _____ OFS NO. _____ DEPT. NO. _____

CLIENT _____

PROJECT Naval Weapons Station - Earle

SUBJECT Biosluper Unit #2: Biodegradation Calculations

- Background CO_2 concentration in wells: 1% CO_2
- CO_2 Concentration in air discharge: 3.5% CO_2
- 2.5% CO_2 discharge the result of biodegradation

Unit #2: 435 hours of operation (Feb 98' - April 99')
88.64 ft^3/min Average air discharge

$$88.64 \frac{ft^3}{min} \times 435 \text{ hours} \times \frac{60 \text{ min}}{hr} = 2{,}313{,}504 \ ft^3$$

$$2{,}313{,}504 \ ft^3 \times 0.025 \ (CO_2) = 57{,}837.60 \ ft^3 \text{ of } CO_2$$

$$57{,}837.60 \ ft^3 \times 0.1234 \frac{lb}{ft^3} (CO_2) = 7{,}137.16 \text{ lbs. of } CO_2$$

- 1.913 pounds of CO_2 produced for every one pound of petroleum biodegraded.

$$7{,}137.16 \div 1.913 = \underline{3{,}730.87 \text{ lbs of Petroleum Biodegraded}}$$

FOSTER WHEELER ENVIRONMENTAL CORPORATION

BY _____ DATE _____ SHEET 1 OF 2

CHKD. BY _____ DATE _____ OFS NO. _____ DEPT. NO. _____

CLIENT _____

PROJECT Naval Weapons Station - Earle

SUBJECT Conversion of Pounds to Gallons of Diesel Recovered

Diesel Fuel: Specific Gravity 0.84

$52.1\ lb/ft^3$

$1\ ft^3 = 7.5$ gallons

* Glover, Thomas, J. Pocket Reference, 2nd Edition, 1997

Diesel Fuel $= 52.1 \frac{lb}{ft^3} \times \frac{1\ ft^3}{7.5\ gallons} = 6.95\ lbs/gallon$

Unit #1:

- Air Extraction: $388.24\ lbs \times \frac{1\ gallon}{6.95\ lbs} = 55.86$ gallons
- Groundwater Treatment: $2019.51\ lbs \times \frac{1\ gallon}{6.95\ lbs} = 290.58$ gallons
- Biodegradation: $8{,}469.36\ lbs \times \frac{1\ gallon}{6.95\ lbs} = 1218.61$ gallons

Total Petroleum Removed $= 1{,}565.05$ gallons

FOSTER WHEELER ENVIRONMENTAL CORPORATION

BY _____ DATE _____ SHEET 2 OF 2

CHKD. BY _____ DATE _____ OFS NO. _____ DEPT. NO. _____

CLIENT _____

PROJECT Naval Weapons Station - Earle

SUBJECT Conversion of Pounds to Gallons of Diesel Recovered

Unit #2

- Air Extraction: 117.82 pounds x $\frac{1 \text{ gallon}}{6.95 \text{ lbs}}$ = 16.95 gallons
- Groundwater Treatment: 414.08 pounds x $\frac{1 \text{ gallon}}{6.95}$ = 59.58 gallons
- Biodegradation: 3,730.87 pound x $\frac{1 \text{ gallon}}{6.95}$ = 536.82 gallons

Total Petroleum Removed = 613.35 gallons

	Gallons of Oil		
	Unit #1	Unit #2	Total
Free Phase Oil	2,900	380	3,280
Biodegradation	1,218.61	536.82	1,755.43
Groundwater Treat.	290.58	59.58	350.16
Air Extraction:	55.86	16.95	72.81
Total Oil:	4465.05	993.35	5458.40 gallons

FOSTER WHEELER ENVIRONMENTAL CORPORATION

BY _____ DATE _____ SHEET 1 OF 1

CHKD. BY _____ DATE _____ OFS NO. _____ DEPT. NO. _____

CLIENT _____

PROJECT Naval Weapons Station - Earle

SUBJECT TPH Calcs for Groundwater

Calculation used to determine petroleum recovered from groundwater extraction and treatment:

TPH concentration of oil/water separator prior to treatment minus the TPH concentration of the effluent after treatment to obtain the average TPH concentration of groundwater processed through the system.

Total gallons x 3.785 $\frac{\text{liters}}{\text{gallon}}$ = _____ liters

TPH $\frac{mg}{l}$ x _____ liters = _____ mg of TPH x $\frac{1\ g}{1{,}000\ mg}$ = grams of TPH

_____ grams x 0.002205 $\frac{\text{pounds}}{\text{gram}}$ = _____ pounds of TPH

* The above calculations were used to determine the mass on a monthly basis (Quarterly Reports). Those totals were then averaged for operational report.

FOSTER WHEELER ENVIRONMENTAL CORPORATION

BY _____ DATE _____ SHEET 1 OF _____

CHKD. BY _____ DATE _____ OFS NO. _____ DEPT. NO. _____

CLIENT _____

PROJECT Naval Weapons Station Earle

SUBJECT TPH Calc for Vapor

Calculations used to determine petroleum recovered from Vapor phase extraction.

Monthly TPH concentrations of air discharge are obtained from the laboratory analysis of air samples.

Daily air discharge rates obtained from magnehelic gauge and transmitter are averaged for the month.

$$\underline{\text{TPH}}\ \frac{mg}{m^3} \times \text{Airflow}\ \frac{m^3}{min} = \underline{\text{TPH}}\ \frac{mg}{min}$$

$$\underline{\text{TPH}}\ \frac{mg}{min} \times 0.001\ \frac{grams}{mg} = \underline{\text{TPH}}\ \frac{grams}{min}$$

$$\text{TPH}\ \frac{grams}{min} \times 0.002205\ \frac{lbs}{gram} = \underline{\text{TPH}}\ \frac{lbs}{min}$$

$$\text{TPH}\ \frac{lbs}{min} \times 60\ \frac{min}{hr} = \text{TPH}\ \frac{lbs}{hr} \times \text{Operational Time} = \text{lbs TPH}$$

* The above calculations were used to determine the mass on a monthly basis (Quarterly Reports). These totals were then averaged for operational report

Bioslurper Unit #1 Groundwater/Oil Recovery Versus Operation Time

WATER

MONTH	GALLONS	GALLONS PER WELL	HOURS	MINUTES	GALLONS PER HOUR PER UNIT / PER WELL	GALLONS PER MINUTE PER UNIT / PER WELL
Feb-98	24675	6168.75	34	2040	181.43	3.02
Mar-98	26169	6542.25	56.5	3390	115.79	1.93
Apr-98	23898	5974.50	79.5	4770	75.15	1.25
May-98	12799	3199.75	39.5	2370	81.01	1.35
Aug-98	16498	4124.50	52	3120	79.32	1.32
Sep-98	34612	8653.00	135.5	8130	63.86	1.06
Oct-98	29974	7493.50	77	4620	97.32	1.62
Nov-98	20503	5125.75	58.5	3510	87.62	1.46
Dec-98	40611	10152.75	117	7020	86.78	1.45
Jan-99	35078	8769.50	93	5580	94.30	1.57
Feb-99	6536	1634.00	14	840	116.71	1.95
Mar-99	49834	12458.50	103	6180	120.96	2.02
Apr-99	40889	10222.25	98.5	5910	103.78	1.73

Average Gallons per Hour Per Unit / Per Well = 100.31

Average Gallons per Minute Per Unit / Per Well = 1.67

OIL

MONTH	GALLONS	GALLONS PER WELL	HOURS	MINUTES	GALLONS PER HOUR PER UNIT / PER WELL	GALLONS PER MINUTE PER UNIT / PER WELL
Feb-98	400	100.00	34	2040	2.94	0.0490
Mar-98	375	93.75	56.5	3390	1.66	0.0277
Apr-98	275	68.75	79.5	4770	0.86	0.0144
May-98	300	75.00	39.5	2370	1.90	0.0316
Aug-98	225	56.25	52	3120	1.08	0.0180
Sep-98	250	62.50	135.5	8130	0.46	0.0077
Oct-98	250	62.50	77	4620	0.81	0.0135
Nov-98	140	35.00	58.5	3510	0.60	0.0100
Dec-98	225	56.25	117	7020	0.48	0.0080
Jan-99	220	55.00	93	5580	0.59	0.0099
Feb-99	50	12.50	14	840	0.89	0.0149
Mar-99	125	31.25	103	6180	0.30	0.0051
Apr-99	65	16.25	98.5	5910	0.16	0.0027

Average Gallons per Hour Per Unit / Per Well = 0.98

Average Gallons per Minute Per Unit / Per Well = 0.02

Bioslurper Unit #2 Groundwater/Oil Recovery Versus Operation Time

WATER

MONTH	GALLONS	GALLONS PER WELL	HOURS	MINUTES	GALLONS PER HOUR PER UNIT / PER WELL	GALLONS PER MINUTE PER UNIT / PER WELL
Feb-98	5282	1056.40	15	900	70.43	1.17
Mar-98	20586	4117.20	38.5	2310	106.94	1.78
Apr-98	22607.5	4521.50	71	4260	63.68	1.06
May-98	6584	1316.80	20	1200	65.84	1.10
Aug-98	13537	2707.40	39	2340	69.42	1.16
Sep-98	14451	2890.20	72	4320	40.14	0.67
Oct-98	27805	5561.00	20	1200	278.05	4.63
Nov-98	16196	3239.20	20	1200	161.96	2.70
Dec-98	9141	1828.20	32.5	1950	56.25	0.94
Jan-99	8843	1768.60	21	1260	84.22	1.40
Feb-99	536	107.20	15	900	7.15	0.12
Mar-99	12956	2591.20	28	1680	92.54	1.54
Apr-99	8550	1710.00	38	2280	45.00	0.75

Average Gallons per Hour Per Unit / Per Well = 87.82

Average Gallons per Minute Per Unit / Per Well = 1.46

OIL

MONTH	GALLONS	GALLONS PER WELL	HOURS	MINUTES	GALLONS PER HOUR PER UNIT / PER WELL	GALLONS PER MINUTE PER UNIT / PER WELL
Feb-98	25	6.25	15	900	0.42	0.0069
Mar-98	50	12.50	38.5	2310	0.32	0.0054
Apr-98	50	12.50	71	4260	0.18	0.0029
May-98	20	5.00	20	1200	0.25	0.0042
Aug-98	55	13.75	39	2340	0.35	0.0059
Sep-98	30	7.50	72	4320	0.10	0.0017
Oct-98	40	10.00	20	1200	0.50	0.0083
Nov-98	20	5.00	20	1200	0.25	0.0042
Dec-98	30	7.50	32.5	1950	0.23	0.0038
Jan-99	20	5.00	21	1260	0.24	0.0040
Feb-99	15	3.75	15	900	0.25	0.0042
Mar-99	15	3.75	28	1680	0.13	0.0022
Apr-99	10	2.50	38	2280	0.07	0.0011

Average Gallons per Hour Per Unit / Per Well = 0.25

Average Gallons per Minute Per Unit / Per Well = 0.0042

Average Air Discharge Rates for Bioslurper Unit #2

No Treatment

SAMPLE DATA NUMBER	SAMPLE DATA DATE	Acetone Compound Concentration (ppm(v))	Acetone Output Rate (lbs/hr)	Benzene Compound Concentration (ppm(v))	Benzene Output Rate (lbs/hr)	Toluene Compound Concentration (ppm(v))	Toluene Output Rate (lbs/hr)	Ethylbenzene Compound Concentration (ppm(v))	Ethylbenzene Output Rate (lbs/hr)	m,p-Xylenes Compound Concentration (ppm(v))	m,p-Xylenes Output Rate (lbs/hr)	o-Xylene Compound Concentration (ppm(v))	o-Xylene Output Rate (lbs/hr)	1,3,5-Trimethylbenzene Compound Concentration (ppm(v))	1,3,5-Trimethylbenzene Output Rate (lbs/hr)	1,2,4-Trimethylbenzene Compound Concentration (ppm(v))	1,2,4-Trimethylbenzene Output Rate (lbs/hr)
16(B)VD-05	4/17/98	0.0	0.00E+00	0.0	0.00E+00	0.0	0.00E+00	0.3	4.71E-04	0.8	1.26E-03	0.3	4.71E-04	0.2	3.56E-04	0.0	0.00E+00
16(B)VD-06	5/1/98	0.0	0.00E+00	0.0	0.00E+00	0.0	0.00E+00	0.1	1.56E-04	0.3	4.68E-04	0.1	1.56E-04	0.2	3.53E-04	0.4	7.06E-04
16(B)VD-07	5/21/98	0.0	0.00E+00	0.9	9.74E-04	0.0	0.00E+00	1.4	2.06E-03	3.8	5.59E-03	1.5	2.21E-03	1.5	2.50E-03	3.2	5.33E-03
16(B)VD-08	6/1/98	0.0	0.00E+00	0.8	9.70E-04	0.6	8.58E-04	1.6	2.64E-03	4.9	8.07E-03	1.6	2.64E-03	1.4	2.61E-03	3.7	6.90E-03
16(B)VD-09	8/7/98	0.0	0.00E+00	0.61	5.94E-04	0.16	1.84E-04	2.1	2.78E-03	5.0	6.61E-03	2.0	2.65E-03	1.7	2.55E-03	4.0	5.99E-03
16(B)VD-10	8/14/98	0.0	0.00E+00	0.5	4.87E-04	1.10	1.26E-03	1.7	2.25E-03	4.1	5.42E-03	1.6	2.12E-03	1.6	2.40E-03	3.6	5.39E-03

Sample Data - 16(B)VD-98-2 (3/5/98)	Benzene Concentration in ppm(v) = 1.1	Output Rate (lbs/hr) = 0.0012
	Total Volatile Organics in ppm(v) = 10.9	Output Rate (lbs/hr) = 0.016
Sample Data - 16(B)VD-98-3 (3/28/98)	Benzene Concentration in ppm(v) = 0.5	Output Rate (lbs/hr) = 0.0005
	Total Volatile Organics in ppm(v) = 7.1	Output Rate (lbs/hr) = 0.011

Average Compound Concentration (ppm(v)):

Acetone	0.0
Benzene	0.6
Toluene	0.3
Ethylbenzene	1.2
m,p-Xylenes	3.2
o-Xylene	1.2
1,3,5-Trimethylbenzene	1.1
1,2,4-Trimethylbenzene	2.5

Total Average Concentration (ppm(v)): 9.7

Average Output Rate (lbs/hr):

Acetone	0.00E+00
Benzene	5.91E-04
Toluene	3.84E-04
Ethylbenzene	1.73E-03
m,p-Xylenes	4.57E-03
o-Xylene	1.71E-03
1,3,5-Trimethylbenzene	1.79E-03
1,2,4-Trimethylbenzene	4.05E-03

Total Average Output Rate (lbs/hr): 1.44E-02

Aft r Treatment

SAMPLE DATA NUMBER	SAMPLE DATA DATE	Acetone Compound Concentration (ppm(v))	Acetone Output Rate (lbs/hr)	Benzene Compound Concentration (ppm(v))	Benzene Output Rate (lbs/hr)	Toluene Compound Concentration (ppm(v))	Toluene Output Rate (lbs/hr)	Ethylbenzene Compound Concentration (ppm(v))	Ethylbenzene Output Rate (lbs/hr)	m,p-Xylenes Compound Concentration (ppm(v))	m,p-Xylenes Output Rate (lbs/hr)	o-Xylene Compound Concentration (ppm(v))	o-Xylene Output Rate (lbs/hr)	1,3,5-Trimethylbenzene Compound Concentration (ppm(v))	1,3,5-Trimethylbenzene Output Rate (lbs/hr)	1,2,4-Trimethylbenzene Compound Concentration (ppm(v))	1,2,4-Trimethylbenzene Output Rate (lbs/hr)
16(B)99VD04	4/30/99	0.0	N/A	0.0	N/A	0.0	N/A	0.9	N/A	2.0	N/A	1.1	N/A	1.4	N/A	0.0	N/A
16(B)VD15	12/31/99	0.0	0.00E+00	0.0	0.00E+00	0.0	0.00E+00	0.0	0.00E+00	0.0	0.00E+00	0.0	0.00E+00	0.0	0.00E+00	0.0	0.00E+00
16(B)99VD01	2/1/99	0.023	1.56E-05	0.55	5.02E-04	0.038	4.09E-05	0.0	0.00E+00	0.0	0.00E+00	0.71	8.81E-04	0.3	4.21E-04	0.064	8.99E-05
16(B)99VD02	2/25/99	0.0	0.00E+00	0.28	3.10E-04	0.13	1.70E-04	0.23	3.46E-04	0.33	4.97E-04	0.1	1.50E-04	0.006	9.71E-06	0.02	3.41E-05
16(B)99VD03	3/31/99	0.0	0.00E+00	0.24	2.83E-04	0.0	0.00E+00	0.4	6.42E-04	0.55	8.82E-04	0.34	5.45E-04	0.0	0.00E+00	0.0	0.00E+00
16(B)VD-10	8/14/98	0.0	0.00E+00	0.5	4.87E-04	1.1	1.26E-03	1.7	2.25E-03	4.1	5.42E-03	1.6	2.12E-03	1.600	2.40E-03	3.6	5.39E-03
16(B)VD-12	10/2/98	0.0	0.00E+00	0.0	0.00E+00	0.0	0.00E+00	0.0	0.00E+00	0.0	0.00E+00	0.0	0.00E+00	0.0	0.00E+00	1.2	2.09E-03
16(B)VD-13	10/30/98	0.0	0.00E+00	0.0	0.00E+00	0.0	0.00E+00	0.0	0.00E+00	1.2	1.65E-03	0.0	0.00E+00	0.0	0.00E+00	2.4	3.73E-03
16(B)VD14	11/30/98	0.0	0.00E+00	0.0	0.00E+00	0.0	0.00E+00	0.0	0.00E+00	0.0	0.00E+00	0.0	0.00E+00	0.0	0.00E+00	0.0	0.00E+00

Average Compound Concentration (ppm(v)):

Acetone	0.00256
Benzene	0.174
Toluene	0.1409
Ethylbenzene	0.36
m,p-Xylenes	0.9
o-Xylene	0.428
1,3,5-Trimethylbenzene	0.367
1,2,4-Trimethylbenzene	0.0

Total Average Concentration (ppm(v)): 3.2

Average Output Rate (lbs/hr):

Acetone	1.95E-06
Benzene	1.98E-04
Toluene	1.84E-04
Ethylbenzene	0.00E+00
m,p-Xylenes	1.06E-03
o-Xylene	0.00E+00
1,3,5-Trimethylbenzene	3.54E-04
1,2,4-Trimethylbenzene	0.00E+00

Total Average Output Rate (lbs/hr): 4.08E-03

Average Air Discharge Rates for Bioslurper Unit #1

No Treatment

SAMPLE DATA NUMBER	SAMPLE DATA DATE	Acetone Compound Concentration (ppm(v))	Acetone Output Rate (lbs/hr)	Benzene Compound Concentration (ppm(v))	Benzene Output Rate (lbs/hr)	Toluene Compound Concentration (ppm(v))	Toluene Output Rate (lbs/hr)	Ethylbenzene Compound Concentration (ppm(v))	Ethylbenzene Output Rate (lbs/hr)	m,p-Xylenes Compound Concentration (ppm(v))	m,p-Xylenes Output Rate (lbs/hr)	o-Xylene Compound Concentration (ppm(v))	o-Xylene Output Rate (lbs/hr)	1,3,5-Trimethylbenzene Compound Concentration (ppm(v))	1,3,5-Trimethylbenzene Output Rate (lbs/hr)	1,2,4-Trimethylbenzene Compound Concentration (ppm(v))	1,2,4-Trimethylbenzene Output Rate (lbs/hr)
16(A)VD-04	4/3/98	0.0	0.00E+00	3.4	3.68E-03	1.7	2.17E-03	3.6	5.29E-03	11.0	1.62E-02	3.3	4.85E-03	1.2	2.00E-03	3.1	5.16E-03
16(A)VD-05	4/17/98	0.0	0.00E+00	0.5	5.29E-04	0.2	2.49E-04	0.5	7.19E-04	1.5	2.16E-03	0.5	7.19E-04	0.0	0.00E+00	0.6	9.76E-04
16(A)VD-06	5/1/98	0.0	0.00E+00	0.3	3.38E-04	0.0	0.00E+00	0.2	3.07E-04	0.6	9.20E-04	0.2	3.07E-04	0.0	0.00E+00	0.3	5.21E-04
16(A)VD-07	5/15/98	0.0	0.00E+00	4.5	4.87E-03	1.2	1.53E-03	2.5	3.68E-03	6.3	9.26E-03	2.0	2.94E-03	1.2	2.00E-03	2.6	4.33E-03
16(A)VD-08	6/1/98	0.0	0.00E+00	3.0	3.29E-03	1.5	1.94E-03	2.3	3.43E-03	7.3	1.09E-02	2.6	3.88E-03	1.4	2.36E-03	4.3	7.26E-03
16(A)VD-09	8/7/98	0.0	0.00E+00	0.056	4.09E-05	0.028	2.41E-05	0.0	0.00E+00	0.0	0.00E+00	0.0	0.00E+00	0.0	0.00E+00	0.0	0.00E+00
16(A)VD-10	8/13/98	0.0	0.00E+00	0.002	1.41E-06	0.1	8.32E-05	0.0	0.00E+00	0.001	9.59E-07	0.0	0.00E+00	0.001	1.09E-06	0.0	0.00E+00

Sample Data - 16(A)VD-98-2 (1/29/98)	Benzene Concentration in ppm(v) = 4.2	Output Rate (lbs/hr) = 0.005
	Total Volatile Organics in ppm(v) = 10.3	Output Rate (lbs/hr) = 0.014
Sample Data - 16(A)VD-98-3 (3/27/98)	Benzene Concentration in ppm(v) = 1.9	Output Rate (lbs/hr) = 0.002
	Total Volatile Organics in ppm(v) = 8.7	Output Rate (lbs/hr) = 0.012

Average Compound Concentration (ppm(v)):

Acetone	0.0
Benzene	2.0
Toluene	0.7
Ethylbenzene	1.3
m,p-Xylenes	3.8
o-Xylene	1.2
1,3,5-Trimethylbenzene	0.5
1,2,4-Trimethylbenzene	1.6

Total Average Concentration (ppm(v)): 10.5

Average Output Rate (lbs/hr):

Acetone	0.00E+00
Benzene	2.19E-03
Toluene	8.57E-04
Ethylbenzene	1.92E-03
m,p-Xylenes	5.63E-03
o-Xylene	1.81E-03
1,3,5-Trimethylbenzene	9.09E-04
1,2,4-Trimethylbenzene	2.61E-03

Total Average Output Rate (lbs/hr): 1.50E-02

After Treatment

SAMPLE DATA NUMBER	SAMPLE DATA DATE	Acetone Compound Concentration (ppm(v))	Acetone Output Rate (lbs/hr)	Benzene Compound Concentration (ppm(v))	Benzene Output Rate (lbs/hr)	Toluene Compound Concentration (ppm(v))	Toluene Output Rate (lbs/hr)	Ethylbenzene Compound Concentration (ppm(v))	Ethylbenzene Output Rate (lbs/hr)	m,p-Xylenes Compound Concentration (ppm(v))	m,p-Xylenes Output Rate (lbs/hr)	o-Xylene Compound Concentration (ppm(v))	o-Xylene Output Rate (lbs/hr)	1,3,5-Trimethylbenzene Compound Concentration (ppm(v))	1,3,5-Trimethylbenzene Output Rate (lbs/hr)	1,2,4-Trimethylbenzene Compound Concentration (ppm(v))	1,2,4-Trimethylbenzene Output Rate (lbs/hr)
16(A)99VD04	4/30/99	0.0	N/A	0.0	N/A	3.6	N/A	0.91	N/A	3.3	N/A	1.7	N/A	1.1	N/A	0.0	N/A
16(A)VD15	12/31/99	0.0	0.00E+00	0.0	0.00E+00	0.0	0.00E+00	0.0	0.00E+00	0.0	0.00E+00	0.0	0.00E+00	0.0	0.00E+00	0.0	0.00E+00
16(A)99VD01	2/1/99	0.0	0.00E+00	0.0	0.00E+00	0.0	0.00E+00	0.0	0.00E+00	0.0	0.00E+00	0.0	0.00E+00	0.0	0.00E+00	0.0	0.00E+00
16(A)99VD02	2/25/99	0.0	0.00E+00	0.0	0.00E+00	0.0	0.00E+00	0.0	0.00E+00	0.0	0.00E+00	0.0	0.00E+00	0.0	0.00E+00	0.0	0.00E+00
16(A)99VD03	3/31/99	0.0	0.00E+00	0.0	0.00E+00	0.0	0.00E+00	0.0	0.00E+00	0.0	0.00E+00	0.0	0.00E+00	0.0	0.00E+00	0.0	0.00E+00
16(A)VD-10	8/13/98	0.0	0.00E+00	0.002	1.41E-06	0.100	8.32E-05	0.0	0.00E+00	0.001	9.59E-07	0.0	0.00E+00	0.001	1.09E-06	0.0	0.00E+00
16(A)VD-12	10/2/98	0.0	0.00E+00	0.0	0.00E+00	0.0	0.00E+00	0.0	0.00E+00	0.0	0.00E+00	0.0	0.00E+00	0.0	0.00E+00	0.0	0.00E+00
16(A)VD-13	10/30/98	0.0	0.00E+00	0.0	0.00E+00	0.0	0.00E+00	0.0	0.00E+00	0.0	0.00E+00	0.0	0.00E+00	0.0	0.00E+00	0.0	0.00E+00
16(A)VD14	11/30/98	20.0	1.22E-02	4.600	3.78E-03	1.2	1.16E-03	0.0	0.00E+00	0.0	0.00E+00	0.0	0.00E+00	0.0	0.00E+00	0.0	0.00E+00

Average Compound Concentration (ppm(v)):

Acetone	2.2
Benzene	0.5
Toluene	0.5
Ethylbenzene	0.1
m,p-Xylenes	0.4
o-Xylene	0.2
1,3,5-Trimethylbenzene	0.1
1,2,4-Trimethylbenzene	0.0

Total Average Concentration (ppm(v)): 4.1

Average Output Rate (lbs/hr):

Acetone	1.53E-03
Benzene	4.73E-04
Toluene	1.55E-04
Ethylbenzene	0.00E+00
m,p-Xylenes	1.20E-07
o-Xylene	0.00E+00
1,3,5-Trimethylbenzene	1.36E-07
1,2,4-Trimethylbenzene	0.00E+00

Total Average Output Rate (lbs/hr): 2.15E-03

Bioslurper Unit #1 Groundwater/Oil Recovery Versus Operation Time

WATER

MONTH	GALLONS	GALLONS PER WELL	HOURS	MINUTES	GALLONS PER HOUR PER UNIT / PER WELL	GALLONS PER MINUTE PER UNIT / PER WELL
Feb-98	24675	6168.75	34	2040	181.43	3.02
Mar-98	26169	6542.25	56.5	3390	115.79	1.93
Apr-98	23898	5974.50	79.5	4770	75.15	1.25
May-98	12799	3199.75	39.5	2370	81.01	1.35
Aug-98	16498	4124.50	52	3120	79.32	1.32
Sep-98	34612	8653.00	135.5	8130	63.86	1.06
Oct-98	29974	7493.50	77	4620	97.32	1.62
Nov-98	20503	5125.75	58.5	3510	87.62	1.46
Dec-98	40611	10152.75	117	7020	86.78	1.45
Jan-99	35078	8769.50	93	5580	94.30	1.57
Feb-99	6536	1634.00	14	840	116.71	1.95
Mar-99	49834	12458.50	103	6180	120.96	2.02
Apr-99	40889	10222.25	98.5	5910	103.78	1.73

OIL

MONTH	GALLONS	GALLONS PER WELL	HOURS	MINUTES	GALLONS PER HOUR PER UNIT / PER WELL	GALLONS PER MINUTE PER UNIT / PER WELL
Feb-98	400	100.00	34	2040	2.94	0.0490
Mar-98	375	93.75	56.5	3390	1.66	0.0277
Apr-98	275	68.75	79.5	4770	0.86	0.0144
May-98	300	75.00	39.5	2370	1.90	0.0316
Aug-98	225	56.25	52	3120	1.08	0.0180
Sep-98	250	62.50	135.5	8130	0.46	0.0077
Oct-98	250	62.50	77	4620	0.81	0.0135
Nov-98	140	35.00	58.5	3510	0.60	0.0100
Dec-98	225	56.25	117	7020	0.48	0.0080
Jan-99	220	55.00	93	5580	0.59	0.0099
Feb-99	50	12.50	14	840	0.89	0.0149
Mar-99	125	31.25	103	6180	0.30	0.0051
Apr-99	65	16.25	98.5	5910	0.16	0.0027

Vacuum Enhanced Recovery "VER"

Xitech learned of the Vacuum Enhanced Recovery "**VER**" concept to remediation of Free Product several years ago from a technical paper written by Mr. Steven Blake, Chief Scientist for the Geraghty Miller Corporation. Mr. Blake's paper demonstrated that range of influence and product migration to a well could be dramatically increased by applying a vacuum to a well where LNAPLs were present. Up until recently Mr. Steven Blake's concept had only been implemented as a total fluids recovery system, "Bio-Slurppe". In 1995 Xitech and Tetra Tech Environmental installed its first VER system at a site in New Mexico to recover diesel fuel without any water. When 30 inches of water vacuum was applied to the wells LNAPL thickness went to 7 feet in all wells, and the ADJ1000 Smart Skimmer recovered the LNAPLs without pumping any water. Historically, if high volumes of LNAPL recovery were desired, a Total Fluids pumping approach would be used to increase range of influence, obtain hydraulic containment of the migrating plume and increase LNAPL recovery. Today there is a definite move away from Total Fluids pumping due to the negitive effects of smearing of the free prodoct layer and the cost of operating and maintaining the above ground water treatment systems . VER and the ADJ1000 Smart Skimmer offers up to 25 gallons per hour LNAPL recovery rates without recovering any water.

VER / ADJ 1000 Projects For 1996-98

OHM Remediation is operating a VER/ADJ 1000 system on a US Marine Base in Southern Arizona. With the VER system in operation at 22 inches of water vacuum, our ADJ1000 Smart Skimmer recovery rate doubled.

Tetra Tech is operating a VER/ADJ 1000 system at White Sands WSMR in Southern New Mexico.

Fluor Daniel GTI is operating a VER/ADJ 1000 system at Elmendorf Air Force Base in Anchorage Alaska.

IT Corporation will be operating a large VER/ADJ 1000 system at Dover AFB in Delaware in early 1998.

XITECH ADJ1000 Recovery System

Updates As of August 1998

Military Installation Progress

Fluor Daniel GTI has installed 30 Skimmers at Elmendorf AFB in Anchorage Alaska. **OHM Corporation** has installed 5 skimmers with a VER system at Yuma Marine Air Station in Arizona. **IT Corporation** has installed Skimmers at George Air Force Base in San Bernardino, California that have recovered 50,000 gallons of JP4 to date. **IT Corporation** also installed Skimmers at Edwards AFB, March AFB, Travis AFB, and China Lake Navel Air Station in California. **Tetra Tech Corporation** installed 13 ADJ 1000 Skimmers along with a VER System at White Sands Missile Range in Southern New Mexico to recover diesel fuel. **Dames & Moore** is doing a pilot study at Nellis AFB in Nevada. **IT Corporation** will be installing 13 ADJ1000 and a VER System at Dover AFB in August 98. **Dames & Moore** will be installing 21 ADJ1000 and a VER System at a second location at Dover AFB in September 98. **OHM Corporation** has installed a skimmer at North Island Navel Air Station in California. **Ch2M Hill** will be installing 2 ADJ1000 and a VER System at Travis AFB in California in August 98. **Foster Wheeler** is doing a pilot study at Holloman AFB in New Mexico.

Oil Companies Installation Progress

Dames & Moore installed 20 Skimmers at a Chevron Refinery in Hawaii. **Basin & Range Hydrogeologist** installed 2 Skimmers at a Union 76 station in Arizona. **Harding Lawson Associates** installed 10 Skimmers at the Quaker State Oil Refinery in Pennsylvania which has recovered over 130,000 gallons of product in a two year period. We have 9 Skimmers at the Basis Petroleum Refinery in Texas recovering a mixture of fuel oils. **Fluor Daniel GTI** installed 3 mobile and 3 fixed Skimmer systems at an Exxon bulk terminal in Maryland. **Dames & Moore** installed 17 Skimmers on Spain's largest Oil refinery, Repsol in Cartahana, Spain recovering a mixture of fuel oils. **Dames & Moore** installed three Skimmers at the BP Oil Refinery in Lavera, France. **GES Environmental** has installed 4 Skimmers at the Sun Oil Refinery in Pennsylvania. **Fluor Daniel GTI** is installing several more Skimmers at the Sun Oil Refinery in Pennsylvania in 98. **ERM Southwest** will do a pilot study in August 98 at the Exxon Baytown oil refinery in Texas. **Fluor Daniel GTI** is doing a pilot study at the Exxon refinery in Boston Massachusetts.

XITECH PRODUCT RECOVERY DEMONSTRATION PROGRAM

The Product Recovery Demonstration Program was created for the benefit of all parties involved to determine what method and equipment would be best suited for recovering LNPLS or DNPLS at a site.

PROGRAM BENEFITS

- Faster approvals from responsible parties and regulations
- Guaranteed remediation results
- Consultants get actual site remediation data, system training, and actual cost/performance data for comparison and decision making
- Clients see an actual working solution prior to acquisition
- Regulators see actual cost/performance data for comparison and decision making
- XITECH has the opportunity to compare its technology against other approaches and competitive technologies

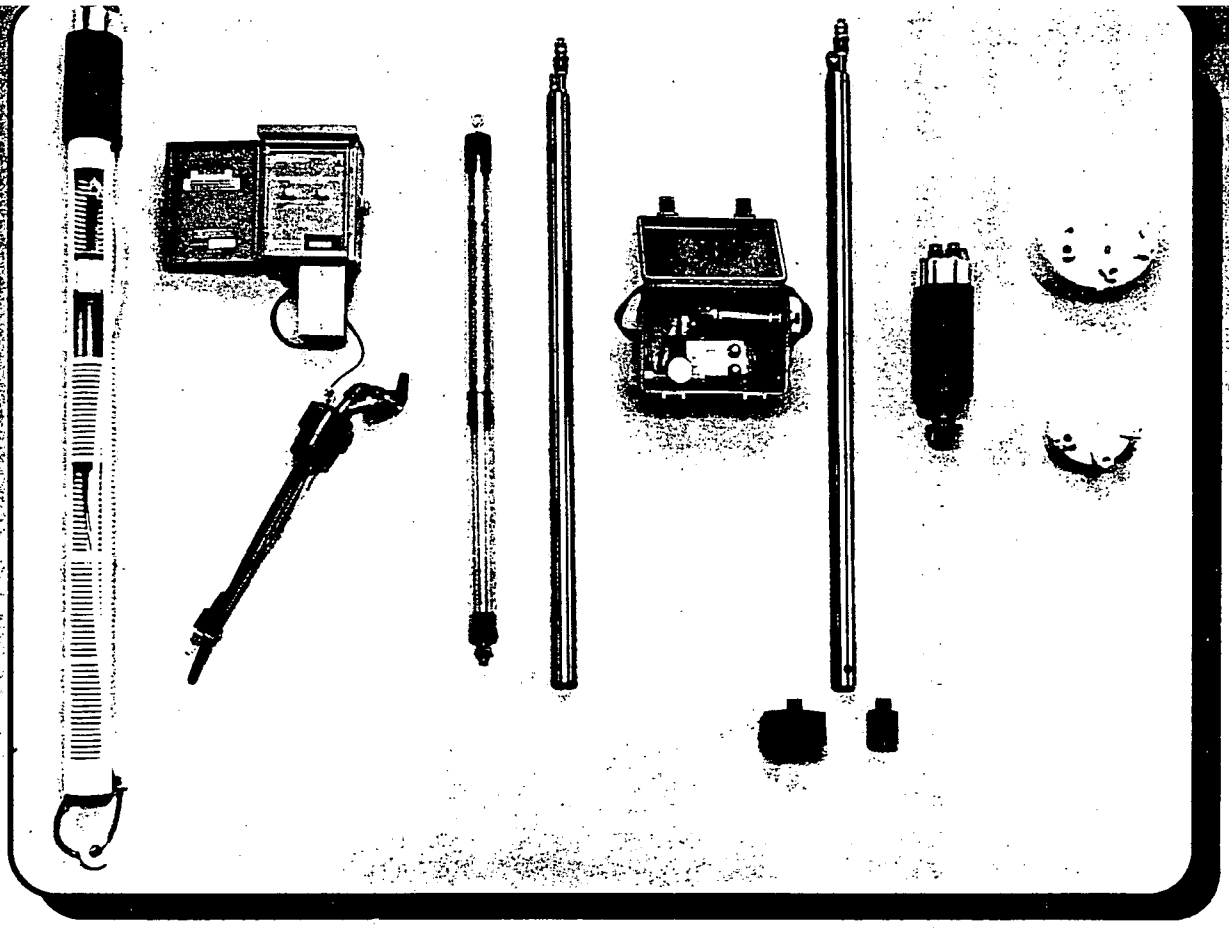
XITECH is happy to provide its ADJ product recovery system free of charge to any environmental professional for a two week pilot study. To participate in this great opportunity, XITECH requires that a XITECH sale representative be present at the time of installation to ensure proper installation and provide operational training of the recovery system. The responsible party requesting this service must assume all liability for the installation and operation during this pilot study, assume responsibility for the security of all XITECH equipment while on the project site, assume the responsibility for decontamination of the equipment and disposal of any contaminated tubing, and assume responsibility for safe transport of the pilot study equipment back to XITECH at the completion of the two week period.

WHAT XITECH PROVIDES: One ADJ Smart Skimmer, 2500 ES Timer with high level tank shutoff sensor assembly, well cap, all necessary tubing for air supply and product discharge, safety rope for skimmer, air supply regulator, operation manual, and a XITECH Sales Technician for one day to oversee installation and provide operational training.

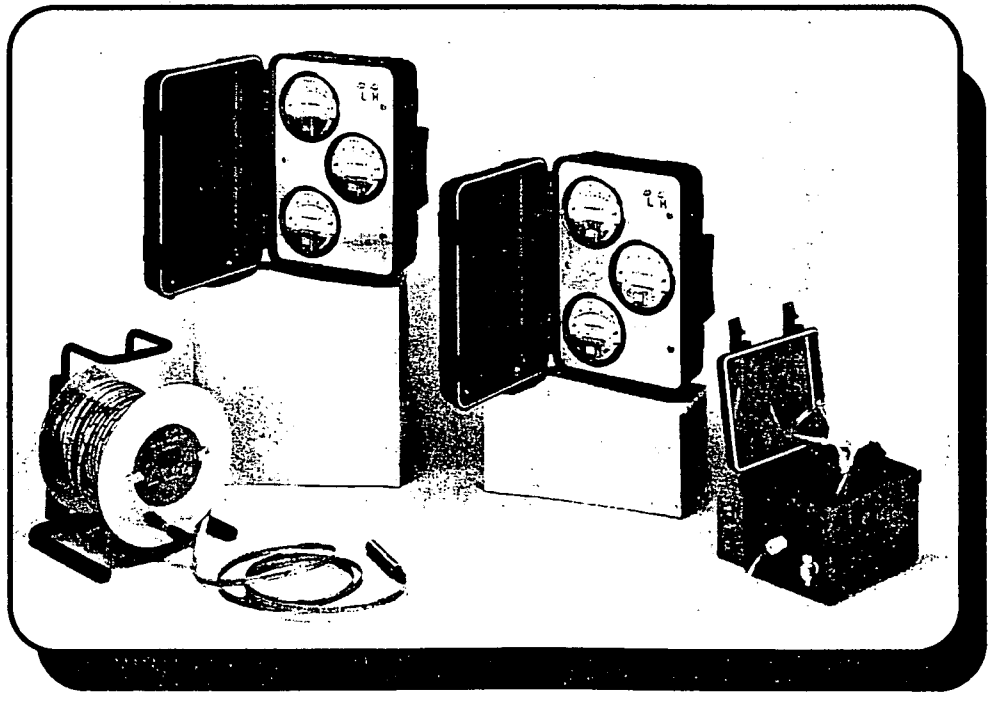
WHAT THE PARTICIPANT PROVIDES: Security of XITECH property, compressed air supply, electrical power (AC or 12 volt DC), holding tank for the product, technician for installing the system and prompt return or purchase of the system at the end of the 2 week pilot study.

HOW TO GET STARTED: Contact your local Xitech Sales Representative or the XITECH main office.

WHAT TO EXPECT: Xitech will be able to ship a complete recovery system within two weeks from completing all necessary site information.



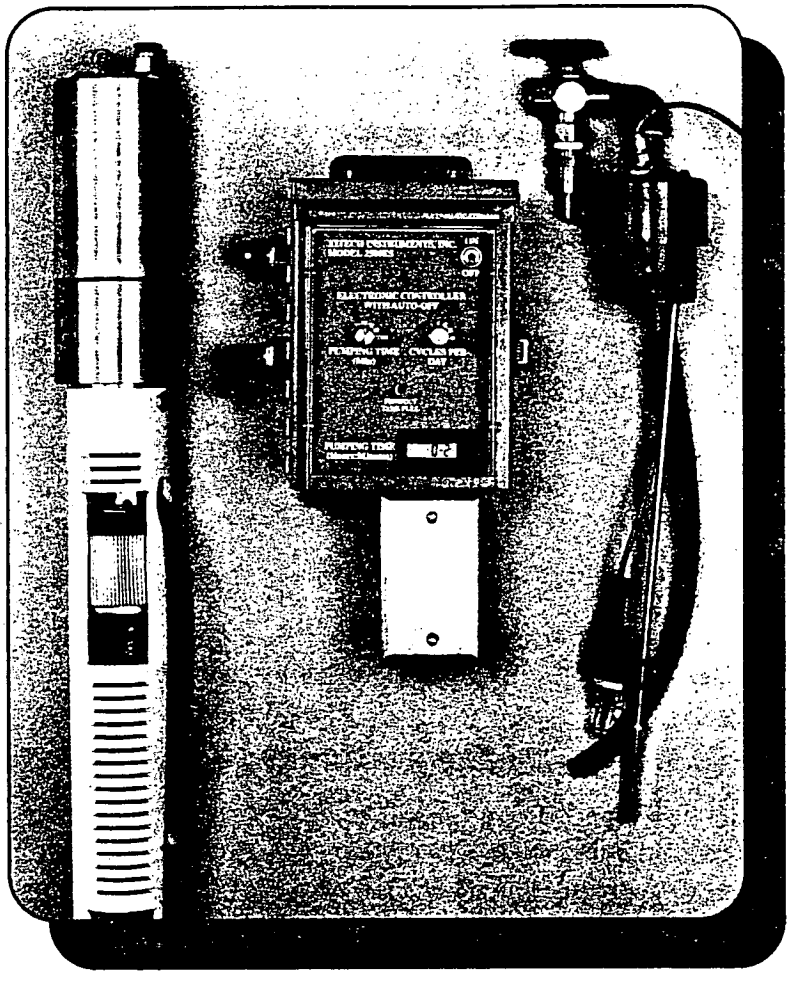
Groundwater Remediation Equipment



Groundwater Remediation Instrumentation

ADJ1000 Free Product Recovery System

The ADJ1000 Free Product Recovery System can operate without the use of AC power, remove product ONLY down to a sheen, operate on bottled gas, and can be installed in less than 1 hour. The ADJ1000 Recovery System consists of the pneumatically operated ADJ 1000 Smart Skimmer, 2500ES Electronic Timer with electronic high level product tank shutoff assembly. The ADJ1000 Smart Skimmer requires no above ground controls to operate, has 30 inches of float travel, uses a high volume hydrophobic filter, pumps over 25GPH, and consumes less than .5CFM of air. The 2500ES Electronic Timer provides intermittent pumping control for several ADJ 1000 Smart Skimmers, provides continuous electronic monitoring of the high level tank shutoff sensor, displays total run time of system, and operates on a 12DC/120AC/220AC power source. The electronic high level shutoff assembly has a three way product inlet switching valve, double wall tubing fitting to double contain the product line, and an infrared electronic liquid level sensor that is intrinsically safe.

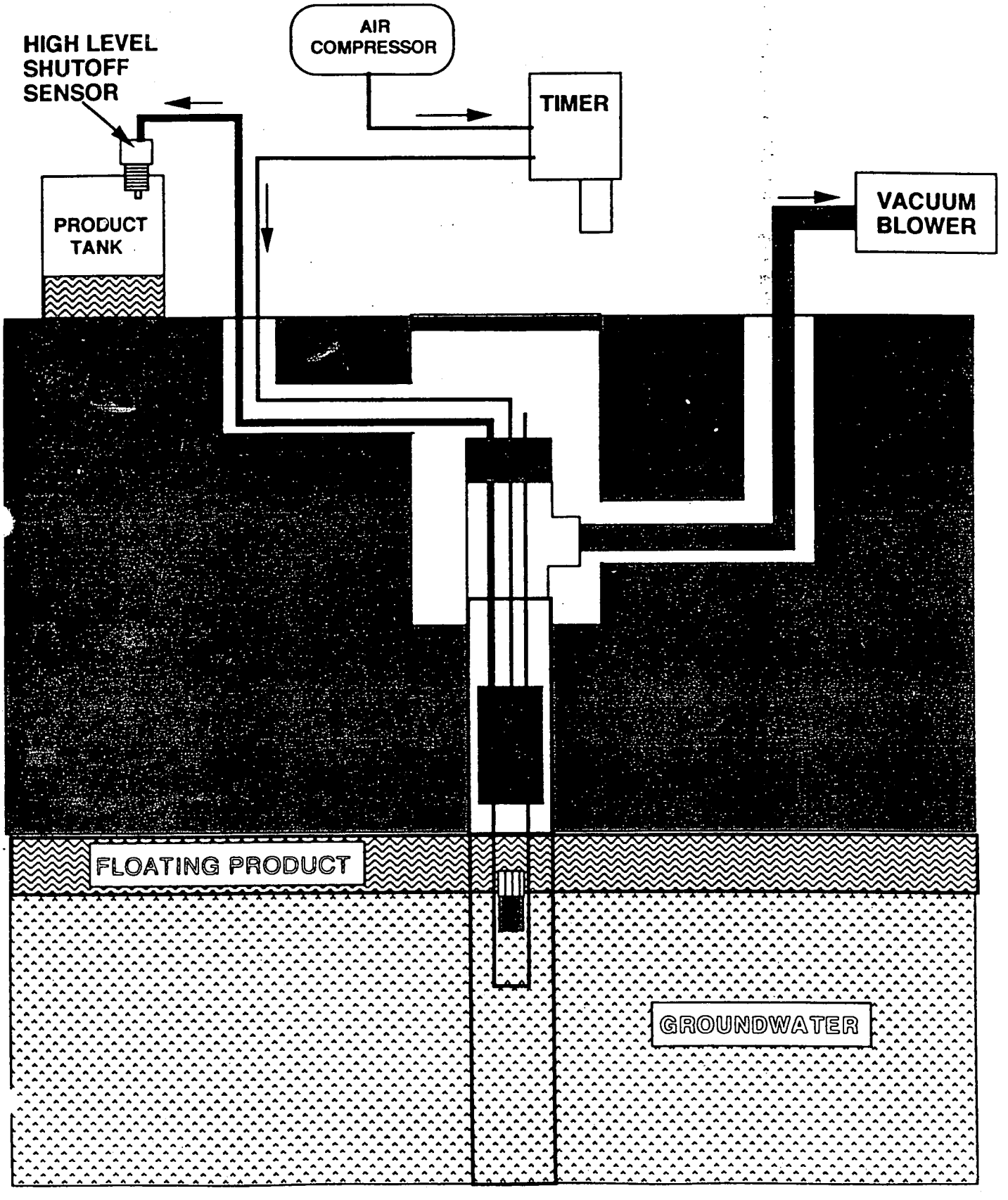


U.S. Patent# 5,326,458

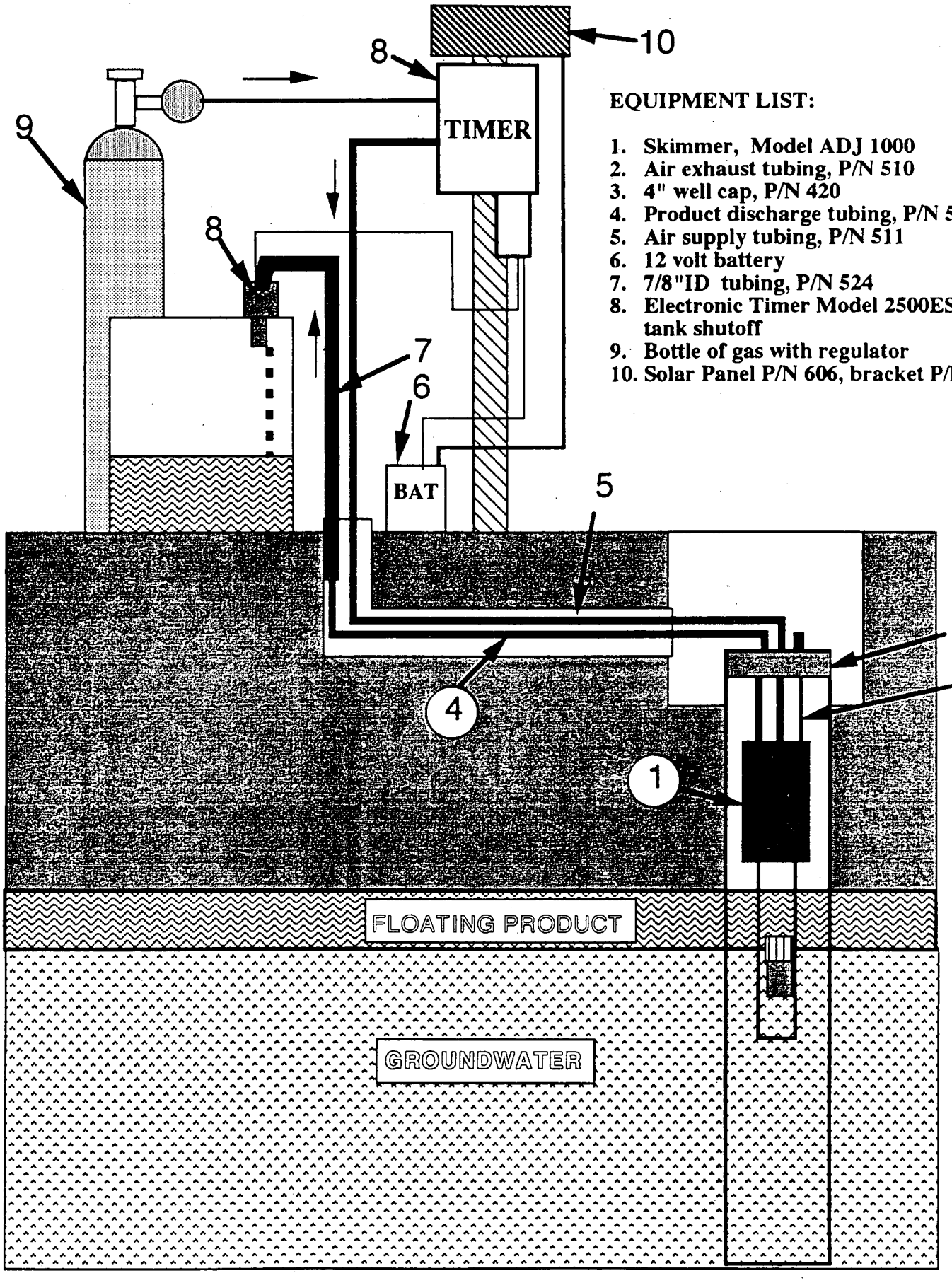
ADJ 1000 Smart Skimmer
Pumping range from 5-25 GPH
Skimmer float travel: 30 inches
Operating pressure range: 35-125 PSIG
Maximum operating well depth: 200 feet
Max air requirements: .5 CFM @ 125 PSIG
Air quality requirements: 5-10 Microns
Weight: 11 LBS
Size: 3-1/2" DIA. X 48" L
Materials : PVC, SST, Viton, Buna, Al
Order No. **ADJ 1000**

2500ES Electronic Timer with Tank Shutoff
Intermittent pumping control
Pumping times (MINS):5,10,20,30,60,CONT.
Pumping cycles per day: 1,3,6,12,24,48
Infrared sensor tank over-fill protection
Visual indicator displays tank full condition
Elapsed pumping timer in hours and minutes
Power supply choices: 12DC,110AC, 220AC
Size: 8" X 6" X 4" NEMA 3R locking enclosure
Order No. **2500ES**

XITECH ADJ 1000 SYSTEM WITH VACUUM ENHANCED RECOVERY "VER"



XITECH LNAPL RECOVERY SYSTEM
Without the use of AC Power



EQUIPMENT LIST:

1. Skimmer, Model ADJ 1000
2. Air exhaust tubing, P/N 510
3. 4" well cap, P/N 420
4. Product discharge tubing, P/N 511
5. Air supply tubing, P/N 511
6. 12 volt battery
7. 7/8"ID tubing, P/N 524
8. Electronic Timer Model 2500ES with tank shutoff
9. Bottle of gas with regulator
10. Solar Panel P/N 606, bracket P/N 613

To Order Call 1-888-867-9483

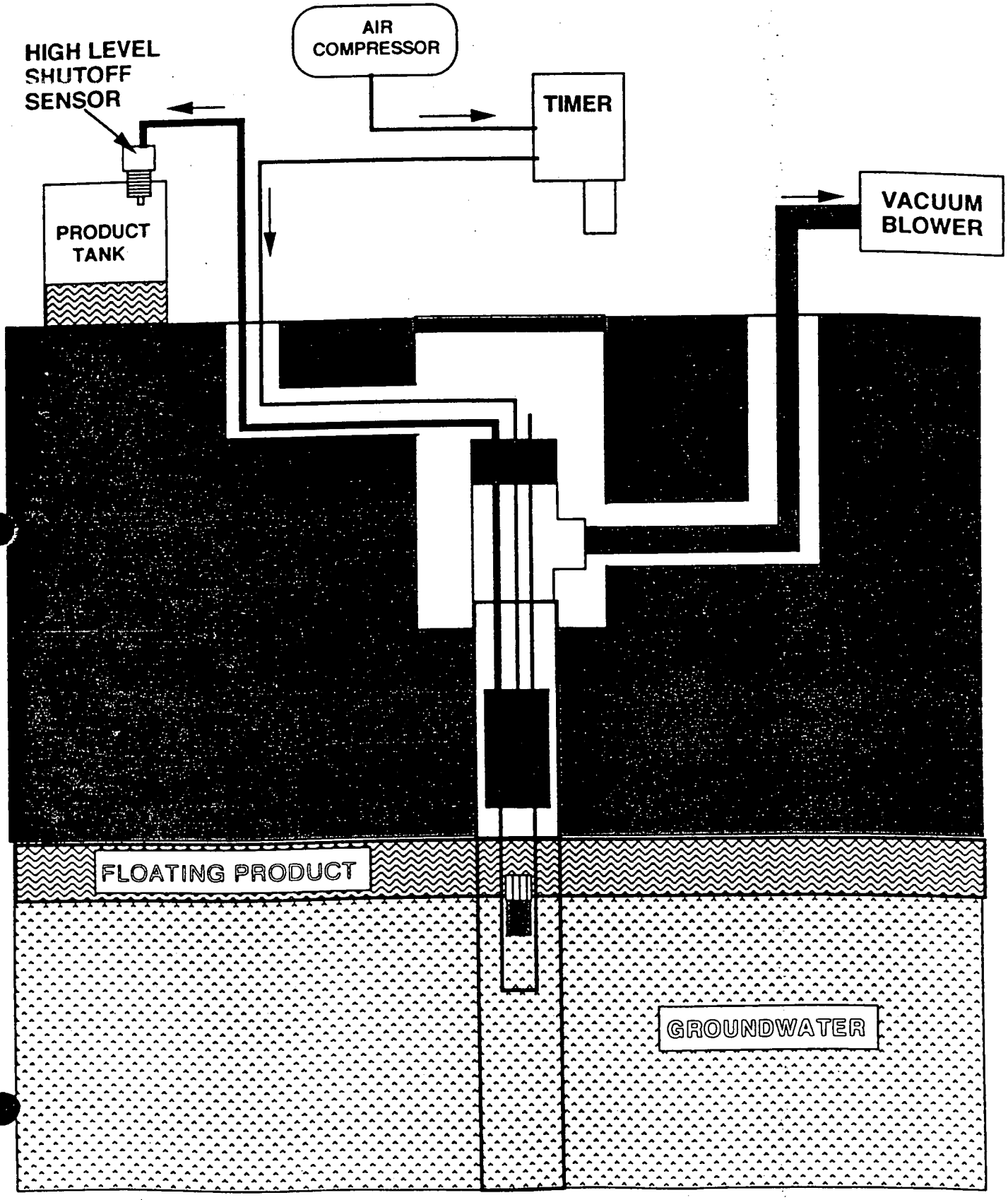
ADJ 1000 Recovery System Applications

Vacuum Enhanced Recovery "VER": This technology combination is the most advanced method for recovering high volumes of free product without recovering any water. Please turn to Page 4 for a more thorough explanation. This recovery approach is very simple. Just apply enough vacuum in the well to create a steady migration of LNAPL's into the well and place a skimmer pump at the water/product interface to recover the LNAPL's. This method requires that the skimmer be able to recover LNAPLs at 20 gallons per hour or greater, operate under 100 inches of water vacuum, and pump zero water to justify the added expense of the vacuum system. The ADJ1000 Smart Skimmer can recover 25 gallons per hour of free product, operate under 160 inches of vacuum, and recover zero water. This technology also provides a cost effective method for hydraulic containment of the free product and can be applied to all types of floating product.

Intermittent LNAPL Recovery: This method of recovering free product has several advantages over traditional continuous recovery systems. We have demonstrated many times that free product recovery is always higher if the recovery pump is operated on an intermittent schedule. The best recovery occurs when you remove all free product quickly, turn off the product pump, allow the free product to return to it's static level in the well, and then pump the free product off again. This method of recovery works best when there is no other technology being applied to the well. The 2500ES Electronic Timer provides multiple choices of intermittent recovery rates, monitors the high level tank condition, and displays total run time of the pumping system. One 2500ES Timer can operate up to 20 Smart Skimmers. This equipment is best utilized when depths to product are between 5 and 200 feet and when free product recovery rates are less than 25 gallons per hour. This system can be operated in CLASS I, Division 1 areas.

Intermittent LNAPL Recovery Without AC Power: This method of recovery is best for remote locations; locations where isolated resources are desired or locations where resources are too costly to provide. In this situation the ADJ 1000 Smart Skimmer can be powered by $20 bottle of air, and the 2500ES Electronic Timer can be powered by a 12 volt battery and solar panel. This system is best applied where steady slow free product recovery is required. The $20 bottle of compressed air will last up to thirty days in most recovery situations. This equipment is best utilized when depths to product are between 5 and 100 feet and the total column of free product removed takes more than two hours to recover.

Mobile LNAPL Recovery : This method of recovery is best for situations that require free product recovery of multiple wells that are remote or in locations that are restricted from using normal recovery equipment. In this situation we have designed a road certified trailer recovery system which includes one ADJ 1000 skimmer, one 2500ES timer with high level tank shutoff sensor, one 200 gallon product tank with secondary containment, a location for two bottles of compressed air, 12 volt battery and solar panel, hose reel rigidly mounted, 100 feet of hose, and a rigid mounted housing for the skimmer. All product discharge tubing is double contained throughout the system.

Low Volume Total Fluids Recovery: The highest concentrations of dissolved hydrocarbons in the groundwater can be recovered by modifying the ADJ 1000 Smart Skimmer's hydrophobic filter to allow water and free product to enter the hydrophobic filter. When the well is **not** disturbed by aggressive pumping actions, the highest concentrations of dissolved hydrocarbons will be located within the top 1 inch of the water surface. The modified ADJ 1000 Smart Skimmer will recover only total fluids within the top 1 inch of the groundwater surface including any free product that may present itself. This application will require some type of above ground water treatment system.

XITECH ADJ 1000 SYSTEM WITH VACUUM ENHANCED RECOVERY "VER"