PILOT TEST WORK PLAN
Ground Water Monitoring
Well Product Removal
Amoco Superior Terminal
Superior, Wisconsin
WDNR ERRP Case #: 331
Delta Project No. I096-856

Prepared by:

Delta Environmental Consultants, Inc.
2775 South Moorland Road, Suite 300
New Berlin, Wisconsin 53151
(414) 789-0254

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1.0 PURPOSE

The purpose of this work plan is to present general information for conducting free product removal pilot test activities by means of Enhanced Fluid Recovery (EFR) technology at the above referenced site. This work is being conducted to evaluate EFR as an alternative or supplemental remedial technology to the existing interim soil vapor extraction and free phase hydrodrocarbon recovery system. A site map is included as Figure 1.

2.0 TEST OBJECTIVES

The objective of conducting the EFR pilot test is to assess the feasibility of employing EFR, or dual phase vacuum extraction technologies at this site. These technologies have been proven effective, under appropriate site conditions, in removing free phase petroleum product on ground water and adsorbed in vadose zone soils. A detailed description of EFR is presented in Section 3.0 of this text.

Results of the field test will be evaluated and used in determining the overall effectiveness of EFR technology at this site and, if appropriate, to substitute or enhance, the existing intererim remediation system. Because the source-area at the site is widespread a larger more permanent installation may be more cost effective. EFR pilot testing will provide information regarding vacuums, zone of influences, and anticipated flow rates and concentrations to facilitate the design of a full scale dual -phase extraction system, if warranted.

3.0 EFR PROCESS DESCRIPTION

The basic design of the enhanced fluid recovery treatment process involves a point of extraction, coupled to an air stripping/volatilization chamber, followed by a vacuum source and vapor treatment unit. The extraction process removes ground water if present, or vapor if ground water is not available. The distinction for this process is the use of the air stripping/volatilization chamber, which allows treatment of free product on a real time basis, rather than off-site at a later time. The following description addresses details of the front end (extraction point and chamber) of this technology.

Extraction Equipment and Process

Delta will install a vertical pipe onto monitoring and recovery well risers via the appropriate diameter coupling to create a seal on the well. Mounted within the polyvinyl chloride (PVC) coupling is a male-threaded 1 or 1.5 inch

Delta will install a vertical pipe onto monitoring and recovery well risers via the appropriate diameter coupling to create a seal on the well. Mounted within the polyvinyl chloride (PVC) coupling is a male-threaded 1 or 1.5 inch PVC extension (termed a "stinger") installed to extend to approximately one foot below the elevation of free product and ground water in the well. The PVC pipe, coupled to the well riser, is coupled to a manifold joining additional wells prepared as the well described above. Prior to entering the manifold, each PVC line includes a ball valve to allow control of the wells to which the extraction process is applied. When a vacuum is applied to the well, ground water, free product, and, if the draw down is sufficient, soil vapors are extracted from the well under vacuum conditions. Depending on the vacuum source, Delta has observed vacuums as high as 20 inches of mercury in the well and flows as high as 170 cubic feet per minute (cfm) from the well. Note: Vacuums and flow rates obtained are dependent on subsurface conditions and vacuum source and vapor treatment unit capabilities. Vacuum on the system is measured by a vacuum gauge installed into the extraction lines down stream of the monitoring well manifold.

Stripping/Volatilization Tank

All wells are connected to a vacuum truck tank which provides air stripping of petroleum constituents in the ground water and enhanced volatilization of free product into the vapor state. These changes in state are the result of turbulence created by the high air flow rate from these wells and the vacuum which enhances partitioning of free and dissolved product into the vapor state. The stripping and volatilization actions can be further increased by changing the inlet point from the manifold to the vacuum truck tank. The inlet line to the tank is manifolded to allow inflow to enter below the surface of the collected water, increasing the agitation of the liquid. No free product remains following the agitation process. Volatilized petroleum constituents are discharged at the top of the vacuum truck tank into a vapor treatment system before being discharged to the atmosphere. Note: Volumetric air flow is measured using a hot wire anemometer reporting linear flow rate, and is converted to volumetric flow rate based on the cross-sectional area of the vapor discharge line. Water collected during the extraction process is recovered and transported off-site for treatment via wastewater treatment or another approved method as a nonhazardous material. ↳ POTW ?

Vacuum Source and Vapor Treatment

The air stripping and volatilization in the vacuum truck tank requires that a vacuum source be provided which will generate sufficient air flow and vacuum to sufficiently partition petroleum constituents into the vapor state and eliminate all free product extracted from the monitoring wells. The vacuum source will be supplied via an

independent vacuum truck blower and treatment of hydrocarbon emissions is then performed in an internal combustion engine unit. Delta has identified the V.R. Systems "Vapor Combustor™" (Model No. VC500T) internal combustion engine (ICE) as an ideal unit where vapor treatment is required along with extraction rates. This unit includes dual 460 cubic inch displacement (CID) Ford engines which are initially started using propane as an auxiliary fuel. As the vapor concentration in the chamber effluent rises, the ICE gradually introduces the petroleum vapor, eventually shutting off the propane fuel source, provided that petroleum vapors remain at an acceptable level (15,000 to 20,000 parts per million by volume - ppmv). Otherwise, the system will run on a combination of vapor and propane as required for combustion. The ICEs, similar to an automobile engine, are equipped with catalytic converters (to polish the treated discharge) and mufflers. An onboard computer monitors fuel mix ratio and other parameters to ensure efficient operation.

The dual ICE unit can burn up to 110 pounds of vapor per hour (equivalent to approx. 62,000 ppmv under optimal operating conditions). Although site specific conditions will likely limit maximum engine operating conditions, the dual ICEs alone are capable of generating vacuums above 18" Hg an a volumetric flow rate of 500 cfm. Destruction efficiency (DE) percent calculated based on sample analytical results have yielded values no less than 97%, with most DE values exceeding 98%.

System Data

System operation yields information including vacuums and volumetric flow rates, and most importantly, system samples which, when measured with a time-limit value (TLV) organic vapor monitor, provide information including vapor concentration ranges, destruction efficiency, and pounds of petroleum hydrocarbons removed. This last value can be extrapolated to gallons removed, but the resulting quantity is approximate. Vapor concentrations in aggregate, and speciated, are important for evaluating state air permit concerns. Other information collected is compiled and stored on the dual ICE onboard computer. This information includes parameters such as motor shaft revolutions per minute (rpm), % oxygen, etc. A copy of a pilot test data collection sheet is included in Appendix A.

4.0 PILOT TEST INFORMATION

To complete the pilot test, one vacuum truck and one dual ICE unit will be brought on site and connected to selected wells that contain free product. A maximum of four wells will be subjected to EFR at any given time.

The pilot test will be conducted in some or all of these wells for a maximum of two consecutive days. Delta personnel will evaluate site conditions prior to the start of the pilot test and select wells to be tested based on current free product thickness, well accessibility, depth to water table, etc. The pilot test will continue at the selected wells until either the pre-treatment off-gas organic vapor concentrations reach asymtotic levels, or until twenty hours (two operational days) of test operation have been completed.

The EFR event is exempt from air emission limits as it is considered a pilot test under Wisconsin Administrative Code (WAC) Chapter NR 406.04(1)(M)3, which states that the total volume of air flow will not exceed 150,000 cubic feet per day or the emission flow rate will be kept under 250 cfm.

Influent gas emissions and air flow will be routinely measured between the vacuum truck and ICE unit with TLV organic vapor monitor. In addition, air samples will be collected and analyzed for benzene, toluene, ethylbenzene and xylenes (BTEX), and total hydrocarbon content (THC). This data will be used to calculate total pounds of hydrocarbons recovered during each EFR test. The exhaust of the ICE unit will also be monitored to demonstrate complete destruction of hydrocarbon vapors prior to discharge to atmosphere. One influent and one effluent air sample will be collected form the ICE unit and analyzed for BTEX and THC to further document hydrocarbon destruction efficiency. Ground water levels and vacuum readings will be collected from surrounding monitoring wells to provide information regarding the maximum extent of EFR vacuum induced influence at the site.

5.0 WORK PLAN MODIFICATIONS

This work plan has been prepared as a guidance document for a planned pilot test. Situations may arise during the pilot test which may require modifications to the work plan. Should any modifications be necessary, the changes will be documented in the field records. It is not possible to predict the exact duration of the test period. The time will be dependent upon data collected during the test.

6.0 METHODS AND SPECIFICATIONS

Off-Gas Flow Rate

Off-gas flow rate will be calculated using readings from a hot-wire anemometer and pressure differential flow meter.

Organic Vapor Content

Organic vapor content will be monitored in the field using a TLV organic vapor monitor.

Vacuum Readings

Vacuum readings will be obtained from the monitoring points by plugging the top of the well riser with a rubber stopper equipped with a valve. A magnehelic gauge is connected to the valve with flexible tubing. The valve is then opened and the corresponding vacuum is measured.

Water Level Rise

The water table rise will be determined by inserting a conductivity sensor through the vacuum pump connector tee assembly and into the top of water table. Then as the water level rises, in response to the applied pressure, the new water level will be measured.

7.0 EFR FIELD TEST EQUIPMENT

A list of the primary equipment required to conduct an EFR pilot test is included as Appendix B.

8.0 REMARKS

The information contained in this report represent our professional opinions. These opinions are based on currently available information and are arrived at in accordance with currently accepted hydrogeologic and engineering practices at this time and location. Other than this, no warranty is implied or intended.

This report was prepared by **DELTA ENVIRONMENTAL CONSULTANTS, INC.**

Chris Harris
Project Engineer

Date: 10/15/96

Reviewed by:

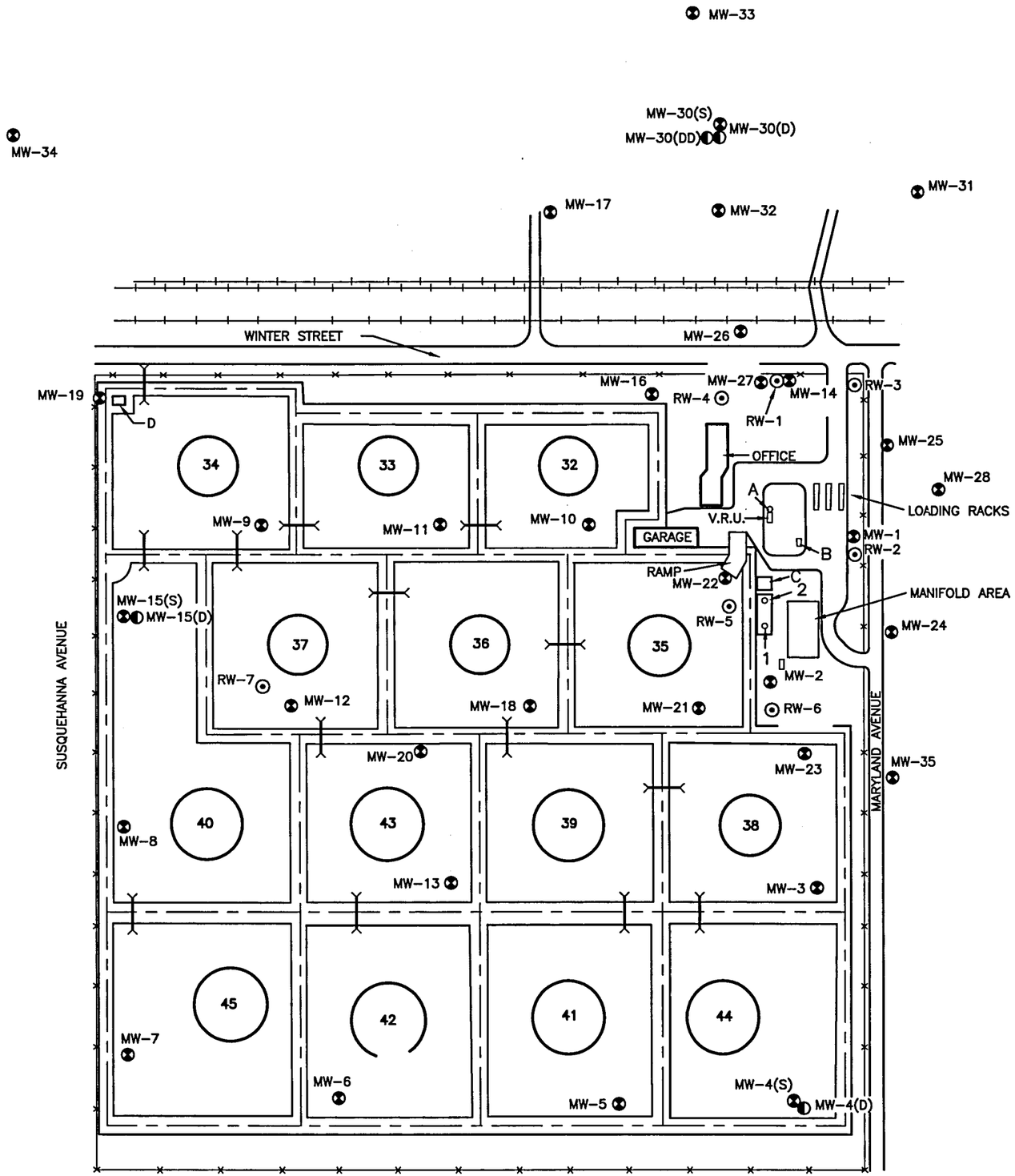
Susan Petrofske
Project Manager

Date: 10/15/96

Joyce Linck, P.E.
Amoco Division Unit Manager

Date: 10/15/96

WISCONSIN
JOYCE A. LINCK
E-23807
RACINE, WI
PROFESSIONAL ENGINEER



LEGEND:

- MONITORING WELL LOCATION
- RECOVERY WELL LOCATION
- RAILROAD TRACKS
- DRAINAGE CULVERT
- FENCE LINE
- A — UNDERGROUND STORAGE TANK LOCATION
- 38 — ABOVE GROUND STORAGE TANK LOCATION
- DEEP MONITORING WELL LOCATIONS

North

0 200

SCALE IN FEET

FIGURE 1.
SITE MAP
SUPERIOR TERMINAL
SUPERIOR, WISCONSIN

PROJECT NO.	PREPARED BY	DRAWN BY
A088--457	JTT	DD/MRA
DATE	REVIEWED BY	FILE NAME
1/16/96		88457-CH

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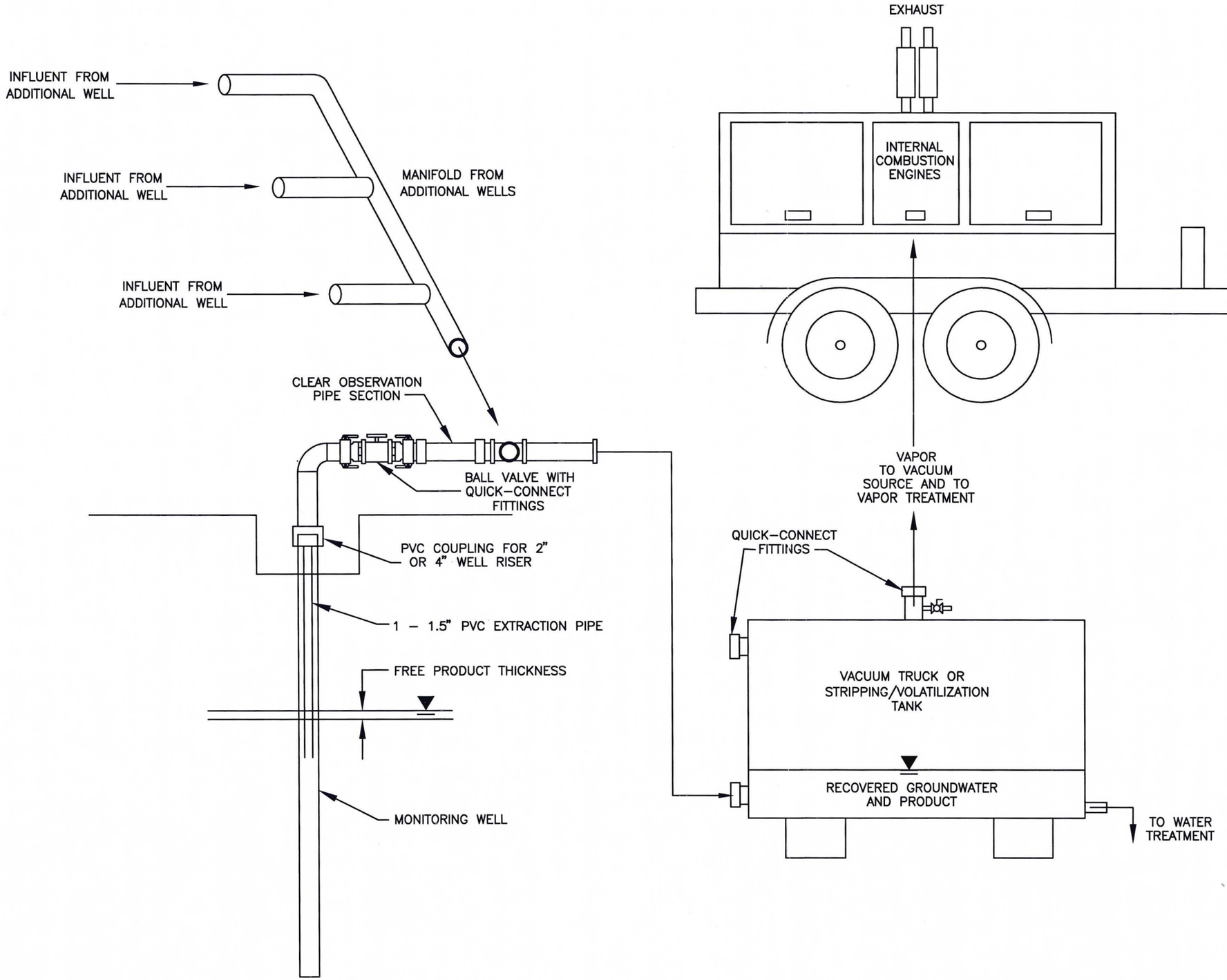

FIGURE 2

ENHANCED FLUID RECOVERY TECHNOLOGY (EFRT) WITH VAPOR

SUPERIOR TERMINAL
AMOCO OIL COMPANY
SUPERIOR, WISCONSIN

PROJECT NO.: 1096-856	DRAWN BY: JTZ
PREPARED BY: CH	DATE: 10/15/96
FILE NAME: 96856EFT	

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Extraction Times			Concentration (ppm)			Recovery Data				
Start Time	End Time	Total Time	Initial ppm	Ending ppm	Average ppm	Vacuum In. Hg	FPM	CFM	lbs/hr	POUNDS

Pounds Per Hour (lb/hr) = ppmv (60 min./hr) x (CFM)(M.W.) / (1×10^{6}) x (379 Ft^3 /lb-mole)

Where: ppmv = parts per million by volume

Flow = CFM = Ft^3 /Min.

M.W. = Molecular Weight (lb/lb-mole)

I.G.C. = Ideal Gas Constant (379 Ft^3 /lb-mole)

Note: For Gasoline Vapors Use M. W. = 75 grams/mole

ENHANCED FLUID RECOVERY TECHNOLOGY

Date: _____

Location: _____

Methods: _____

Stack Diam: _____

Vac. Truck: _____

Vac. Company _____

_____

Operator: _____

Extraction Well(s): _____

_____

Total Pounds Removed: _____

_____

Equiv. Gals. of Product _____

_____

Total Gallons of Water: _____

Bill of Lading: _____

Manifest # Disposal Site: _____

Note: Gasoline is 5.6 lb/gal _____

Note: Diesel is 7.1 lb/gal _____

Client: _____

Project: _____

Project #: _____

System Operator: _____

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C:\FORMS\E-FLUID.FRP

TIME	SUMMARY OF ACTIVITIES

DAILY REPORT

Location: ______________________

Date: ______________________

Contractor: ______________________

Supervisor: ______________________

SSN: ______________________

name: ______________________

SSN: ______________________

name: ______________________

SSN: ______________________

Barriers/Warnings Posted: ______________________

name: ______________________

SSN: ______________________

name: ______________________

SSN: ______________________

Client: ______________________

Project: ______________________

Project #: ______________________

Technician: ______________________

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Appendix B

EFR PILOT TEST EQUIPMENT

Equipment

ICE Unit
Vacuum Truck
EFR vacuum hoses
Organic Vapor Monitor
Interface probe
Magnehelic Gauges
Anemometer
Explosimeter
Water level indicator
250 feet tape measure
100 feet extension cord
Five gallon bucket
Tools
Watch
Duct tape
Keys for locks
Camera and film

General Information

Site map with well locations
Test procedures
Data collection forms
Health and Safety Plan
Site contact information