



**Aquaterra**  
Technologies, Inc.

PI #2

30 January 2003

Mr. James Oppenheim, P.E.  
Sunoco, Inc (R&M)  
3144 Passyunk Avenue,  
Philadelphia, PA 19145


Re: Site Characterization and Remedial Feasibility Testing Report  
Short Pier Area  
80 Second Street  
Point Breeze Refinery  
Philadelphia, Pennsylvania

Dear Jim:

Aquaterra Technologies, Inc. (Aquaterra) is pleased to submit this Site Characterization and Remedial Feasibility Testing Report for the above referenced site. Remedial system design criteria were based upon subsurface investigations and remedial feasibility testing which were performed at the site from January 2002 through the present.

If you have any questions or require additional information regarding this case, please contact the undersigned.

Respectfully submitted,  
AQUATERRA TECHNOLOGIES, INC.

  
Robert M DiFilippo, P.G.  
Principal Hydrogeologist

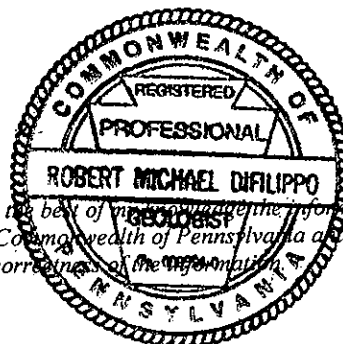
Kevin W Martin  
Remediation Specialist

Enclosure

CC:

Aquaterra Project File

By affixing my seal to this document, I am certifying that to the best of my knowledge the information is true and correct. I further certify that I am licensed to practice in the Commonwealth of Pennsylvania and that it is within my professional expertise to verify the correctness of the information.





## **SITE INVESTIGATION AND REMEDIAL ACTION PLAN**

Short Pier Area- South Yard  
Philadelphia Refinery  
Philadelphia, PA

31 January 2003

Prepared for:

Sunoco, Inc. (R&M)  
Philadelphia Refinery  
3144 Passyunk Avenue  
Philadelphia, PA

Prepared by:

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## INTRODUCTION



Sunoco, Inc. (R&M) is the current owner and operator of a petroleum refinery on 3144 Passyunk Avenue in Philadelphia, PA. Within the South Yard of this refinery, an area of investigation known as the Short Pier as been targeted due to the observance of a petroleum hydrocarbon sheen on the Schuylkill River in 2001. The sheen appeared to emanate from the adjacent bulkhead.

Excavations and pipe integrity tests performed by refinery personnel and subcontractors along River Road indicated that an unused Naphthalene line on the east side of River Road was leaking. This line was taken out of service and the leak in the adjacent excavation stopped in December 2001. Data obtained during this investigation suggested that different degrees of additional characterization and remediation were warranted at the Short Pier Area. This report summarizes the historic and current data obtained from the Short Pier.

### Site Background

The site is located along the east bank of the Schuylkill River in the South Yard of the Sun Philadelphia Refinery (Figure 1). Four, 2-inch diameter monitoring wells (S-106 through S-110): three, 6-inch diameter recovery wells (RW-600, RW-601 and RW-602) were in existence prior to the onset of this study. In the shallow subsurface, proximal to the river, fill materials (sand, clay, and gravel) overlay a decking system of four-inch wooden planks which rest atop pilings driven into the sediments of the Schuylkill River. A schematic of the decking system is included as Figure 3. The decking system occurs at depths ranging from 7 to 17 feet below ground surface. The lateral extent of the deck system is apparently 50 feet from the bulkhead at the river towards the East. The river-crossing box for the Sun Pipe Line (Sunoco Logistics) piping system is located at the northern extent of the study area. Further to the north of the "river-crossing" is an area known as the Case Wharf.

Topography in the study area is variable, with the ground surface above the decking system being relatively flat. Moving eastward towards River Road topographic gradient is steep, rising approximately 10 ft over 75 ft lateral distance. The portion of the site on both sides of River Road is again relatively flat.

## SITE CHARACTERIZATION

Further evaluation of subsurface conditions within the Short Pier area was performed in 2002 by Aquaterra Technologies, Inc. (Aquaterra). This evaluation included monitoring well installation, liquid level monitoring, tidal studies and remedial feasibility testing.

### Monitoring Well Installation

On 14 January 2002, Parratt -Wolff Drilling of East Syracuse, NY was contracted to install a series of four-inch diameter monitoring wells at the site. Supervision of the drilling was performed by Aquaterra personnel. The purpose of these wells was fourfold: 1) delineate the extent of the NAPL plume at the site; 2) delineate the lateral and vertical extent of the decking system; 3) evaluate conditions beneath the decking system, and 4) evaluate an effective NAPL recovery system.

Prior to well installation, the Pennsylvania One Call System was notified to locate and mark any subsurface utilities. In addition, refinery personnel were involved to insure that no known lines were in conflict with the well locations. Due to the uncertain locations of numerous subsurface lines transecting the site, several of the well locations were hydroexcavated by Hydrochem to a depth of 8' BGS prior to well installation.



Eleven groundwater monitoring wells were installed on-site (MW-A through MW-K). Each borehole was advanced by way of hollow stem auger drilling methods. Each of the borings was drilled approximately 10-13' below ground surface (BGS) at the deck area (MW-A, B, C, D, E and J) and 20'-30' BGS east of the decking (MW-F, G, H, and K). Well construction consisted of four-inch diameter solid PVC piping from grade and extends 2-3 feet above the initial zone of saturation. PVC well screen (0.020-slot) extends to the completion depth of the borings. Filter pack material consisting of #2 Morie sand was placed above the PVC screen (approximately 1') and a mixture of bentonite/grout was used as a seal and topped with Portland cement as a fill. All wells with the exception of well MW-I were finished to grade with a manhole cover. MW-I was finished above grade with 2' of steel protective casing.

To evaluate the conditions below the decking system, monitoring well MW-I was constructed with PVC well screen below the decking system. Construction of the well was accomplished by advancing hollow stem augers to the top of the decking and setting 6" diameter steel casing into the decking, grouting the casing in-place with a Portland cement slurry, and split spooning through the decking and unconsolidated sediment beneath. Four-inch well screen and casing were set into this boring so that the screened interval was coincident with the sediments beneath the decking, and sealed with the slurry above the sand pack at the contact of the decking and underlying sediments.

During drilling, Aquaterra collected soil samples for field screening with a Photo-Ionization Detector (PID) to provide preliminary indications of the presence or absence of volatile organic compounds (VOCs). PID readings and the observed lithology were recorded and included in the drill logs (Attachment A).

Upon completion of the installation of the eleven groundwater monitoring wells, each of the wells was surveyed per the site datum from existing monitoring wells. The top of casing elevations (reference elevations in feet) were measured with a Spectra-Physics EL-1, Laser plane Leveling device and stadia rod.

### **Liquid Level Data**

Liquid level measurements were collected on 19 February 2002 from the wells within the Short Pier area. Groundwater occurs within the unconsolidated material above the decking system and is influenced by tidal fluctuations in the Schuylkill River. Liquid level measurements taken on 19 February 2002 indicate that the depth to groundwater ranges from 7.04 feet to 10.54 in the areas of the decking system. This translates into groundwater elevations of approximately 9.39 to 10.77 feet ASML. In the easternmost portion of the site, where the decking does not occur, depths to groundwater ranged from 16.01 to 18.96 feet below ground surface or 15.73 to 12.14 feet ASML, respectively.

The groundwater flow gradient beneath the site, as determined from the 19 February 2002 water level measurements, is to the West. The hydraulic gradient is approximately 0.04 feet/foot. Liquid level data obtained on 19 February 2002 are summarized on Table 1.

Results of the liquid level gauging events suggest that the decking system provides a physical barrier to downward NAPL migration. Liquid level data collected at MW-J, set above the decking system, shows the presence of NAPL; however, data collected to the adjacent MW-I, set below the decking system, show the absence of NAPL.

### **Tidal Influence Study**

The site is proximal to the tidally influenced Schuylkill River. As such, tidal influences such as apparent NAPL masking in certain wells at high tide and NAPL accumulation in wells at low tide have been observed. Specifically, these tidal influences were observed to affect pumping rates and hydrocarbon recovery rates during extraction testing. To quantify the tidal effects on the site, static monitoring was performed on 30 April 2002 in the absence of pumping from four monitoring wells (MW-F, MW-I, MW-J, and S-107).

The effect of daily tidal fluctuations on product thicknesses in the monitoring wells was quantified by gauging select wells for depth to product and depth to water at different stages of the tide. Minor changes in product thickness during the low and high tides were observed in most of the wells; however, a product thickness increase of 1.66 feet was observed at MW-J during low tide, as compared to high tide. In addition, nominal tidal effects were noted in monitoring well, MW-F, which is at River Road, located approximately 135 ft. from the river. Data from the tidal monitoring study are summarized in Table 2.

### **REMEDIAL FEASIBILITY TESTING**

On 7 February 2002, Aquaterra performed High Vacuum Total Phase Extraction Tests on select monitoring wells to determine the feasibility of high vacuum extraction as a remedial technology for this site. Monitoring wells, MW-B, F, J, K and G were selected as vacuum extractions test points.

Tests performed at each of the monitoring wells indicated vacuum influence did occur. Radius of influence ranged from 36 feet from MW-J to 60 feet from MW-G. On average, the greatest vacuum influence of -1.21 to -1.48 inches of water was observed at wells located 13 to 20 feet from the test wells, respectively. Details on this feasibility testing event can be found in Table 3.

The results of the individual well high vacuum test suggest that total phase, high vacuum extraction is a feasible remediation technology; therefore, wells MW-C, S-106, MW-A, MW-H, S-107, MW-B, MW-D, MW-J and MW-E were modified with wellhead seals and downhole extraction tubing to facilitate total phase extraction. An above-ground piping manifold was installed to facilitate operation of multiple wells for the next phase of testing.

Each extraction well was equipped with a section of clear piping for subjective quantification of water and product flow rates; valves for extraction rate adjustment; vacuum gauge and sample port appurtenance at each well head.



On 9 April 2002, Aquaterra performed High Vacuum Total Phase Extraction Tests at High Tide conditions on select monitoring wells to determine the feasibility of high vacuum extraction as a remedial technology for this site. Monitoring wells MW-B, MW-C, MW-D, MW-E, MW-J and S-107 were selected as vacuum extractions test points. Results of this test are summarized in Table 4.

On 16 April 2002, Aquaterra performed High Vacuum Total Phase Extraction Tests at Low Tide conditions on select monitoring wells to determine the feasibility of high vacuum extraction as a remedial technology for this site. Monitoring wells S-107, S-106, MW-B, MW-D, MW-E, and MW-J were selected as vacuum extractions test points. Results of this test are summarized in Table 5.

## **REMEDIAL ACTION PLAN**

In consideration of past site investigations and remedial testing programs performed in 2002, it has been determined a NAPL plume is present within the subsurface in the Short Pier Area. Based upon field observations during well installation and subsequent depth to liquid readings, the horizon of impact corresponds with groundwater elevation which range from 7 to 13 feet below ground surface. As indicated by liquid level data collected from MW-I, the NAPL appears restricted from downward vertical migration by the presence of the decking system. The unconsolidated fill above the decking system consists of sand and clay with some gravel. Site-specific data, including liquid levels, location of the decking system and relative sediment type, are summarized in the attached cross-section (Figure 3).

Following review of data collected during the subsurface investigations conducted on-site, including tidal monitoring and site remedial feasibility testing, it has been determined that Total Phase Extraction (TPE) is the most applicable remedial technology for this site. The objective of this technology is to remove both NAPL, dissolved and vapor phase petroleum hydrocarbons present in the subsurface by dewatering the contaminated zones. The dewatering that occurs through TPE via the application of high vacuum will enhance mass removal (fluid and vapor) in the contaminated zones. The goal of this remedial action is to remove the source of petroleum sheen to the river and prevent the sheen from re-occurring by maintaining hydraulic control for the water table and associated NAPL plume.

A diesel powered Godwin dewatering pump has been used during remedial feasibility testing activities used to recover separate phase product, groundwater and vapor-phase hydrocarbons. A total of nine (9) existing monitoring wells (MW-A, MW-B, MW-C, MW-D, MW-E, MW-H, MW-J, S-106 and S-107) were utilized for the total phase extraction system. The extraction wells are spaced approximately 12 to 36 feet apart to obtain optimal capture zone influence. Extraction well construction consists of



2-inch diameter PVC screen and casing at wells, S-106 and S-107. The construction of the remaining wells consists of 4-inch PVC screen and casing. At these nine locations, drop tubes were installed in the extraction points to facilitate dewatering. Extraction wells are equipped with wellhead seals, pitless adaptors and drop tubes to allow adjustment of the depth of extraction in each well. The wellhead seal facilitates vacuum propagation to the subsurface. Each extraction well has been piped individually to a manifold (Figure 4).

Recovered liquids passed through the dewatering pump and were routed to a nearby process sewer. Liquids in this sewer are sent to the bio-plant for treatment. Vapors are treated with a biofilter prior to exhaust to the atmosphere.

## **PILOT SYSTEM OPERATION**

Pilot System build out and testing occurred throughout the period of 12 July 2002 through 20 August 2002. During that time, the biofilter was installed and monitored for proper temperature and moisture. The pilot system has operated continuously, with the exception of site construction interruptions, until 6 December 2002. At start-up, the system operated from extraction wells S-107 and MW-C. On 8 October 2002, extraction wells MW-B and MW-F were added to the system operation. Throughout October and November, the system extracted from the following wells: MW-A, MW-B, MW-F, MW-J, S-107 and S-109.

From start-up on 20 August 2002 to 6 December 2002, the system operated with an average vacuum of 11" Hg and average airflow of 194 scfm. Since system start-up on 20 August 2002, an estimated total of 142,277 pounds of vapor-phased hydrocarbons have been recovered. No estimate of the total gallons of separate-phase hydrocarbons has been calculated.

Subsequent to system shutdown, liquid levels in all site wells were measured. From this event a noticeable reduction in separate phase hydrocarbon thickness in several wells are evident. These data are provided in Table 7.

## **FUTURE ACTIONS**

The liquid recovery system has been shut down for the winter months. The vapor extraction system will continue to operate at the site through the winter months. Monitoring wells will be gauged twice in March to determine NAPL presence. Based on these gauging events and the status of sheening into the river, a determination will be made on the re-activation of the TPE system. If the monitoring wells contain significant apparent NAPL thickness and the sheening of petroleum based substances re-occurs in the river adjacent to the short pier, the TPE system will be re-deployed. If there is no evidence of significant NAPL accumulation in study area monitoring wells, the vapor extraction system will continue to operate at the site until hydrocarbon removal demonstrates vapor extraction is no longer an effective remedial approach.



## FIGURES

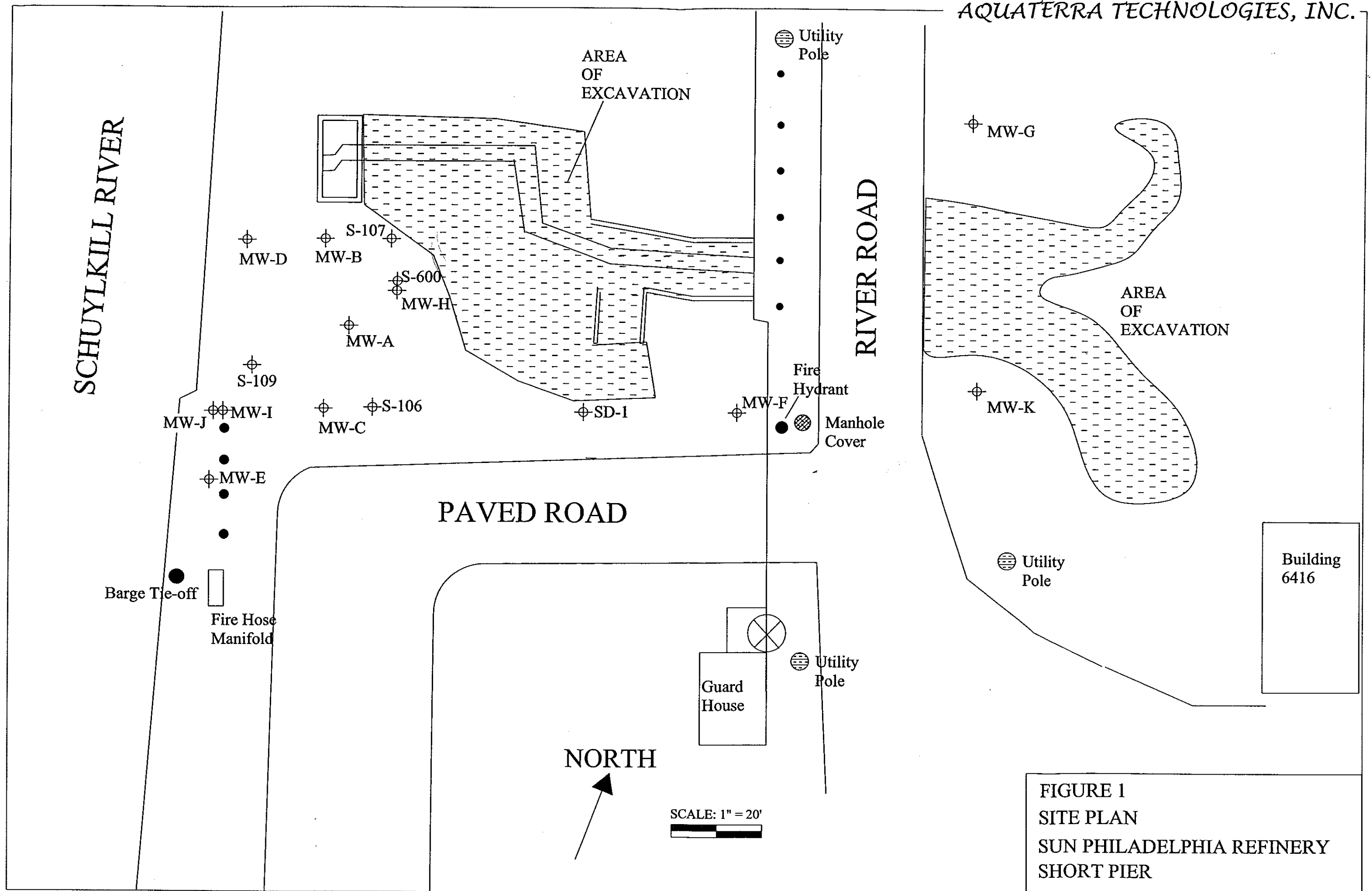


FIGURE 1  
SITE PLAN  
SUN PHILADELPHIA REFINERY  
SHORT PIER

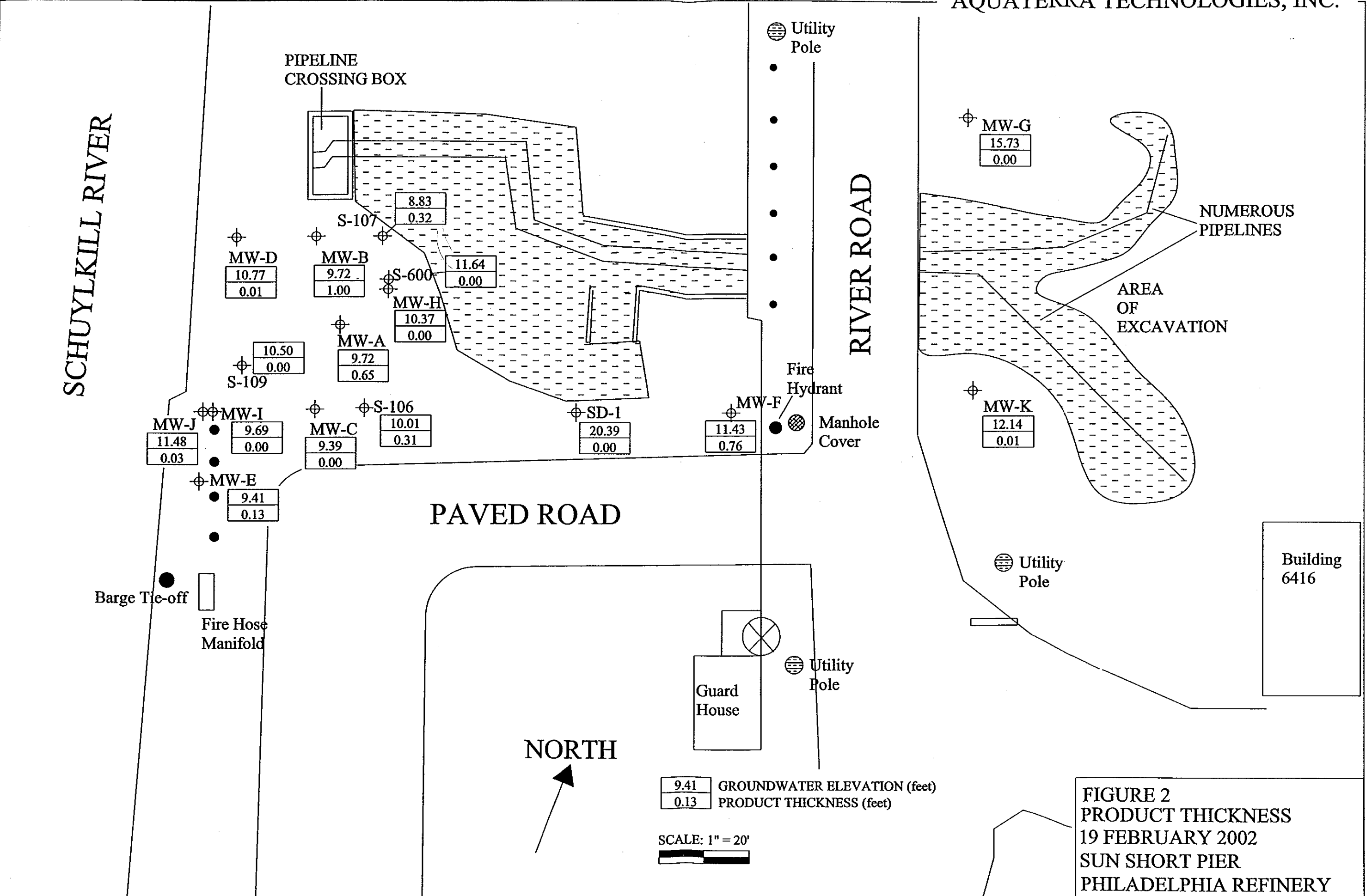
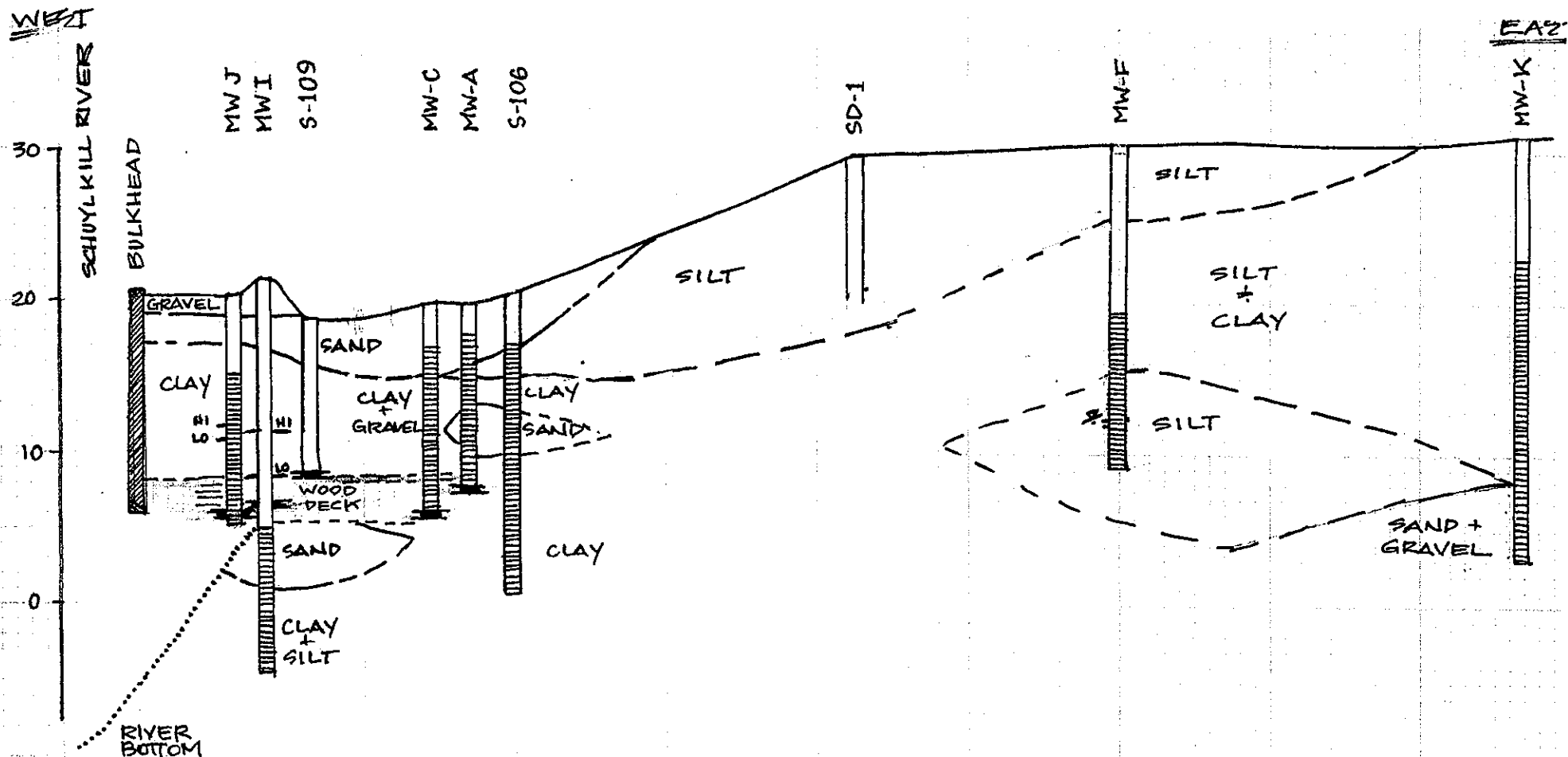


FIGURE 2  
PRODUCT THICKNESS  
19 FEBRUARY 2002  
SUN SHORT PIER  
PHILADELPHIA REFINERY

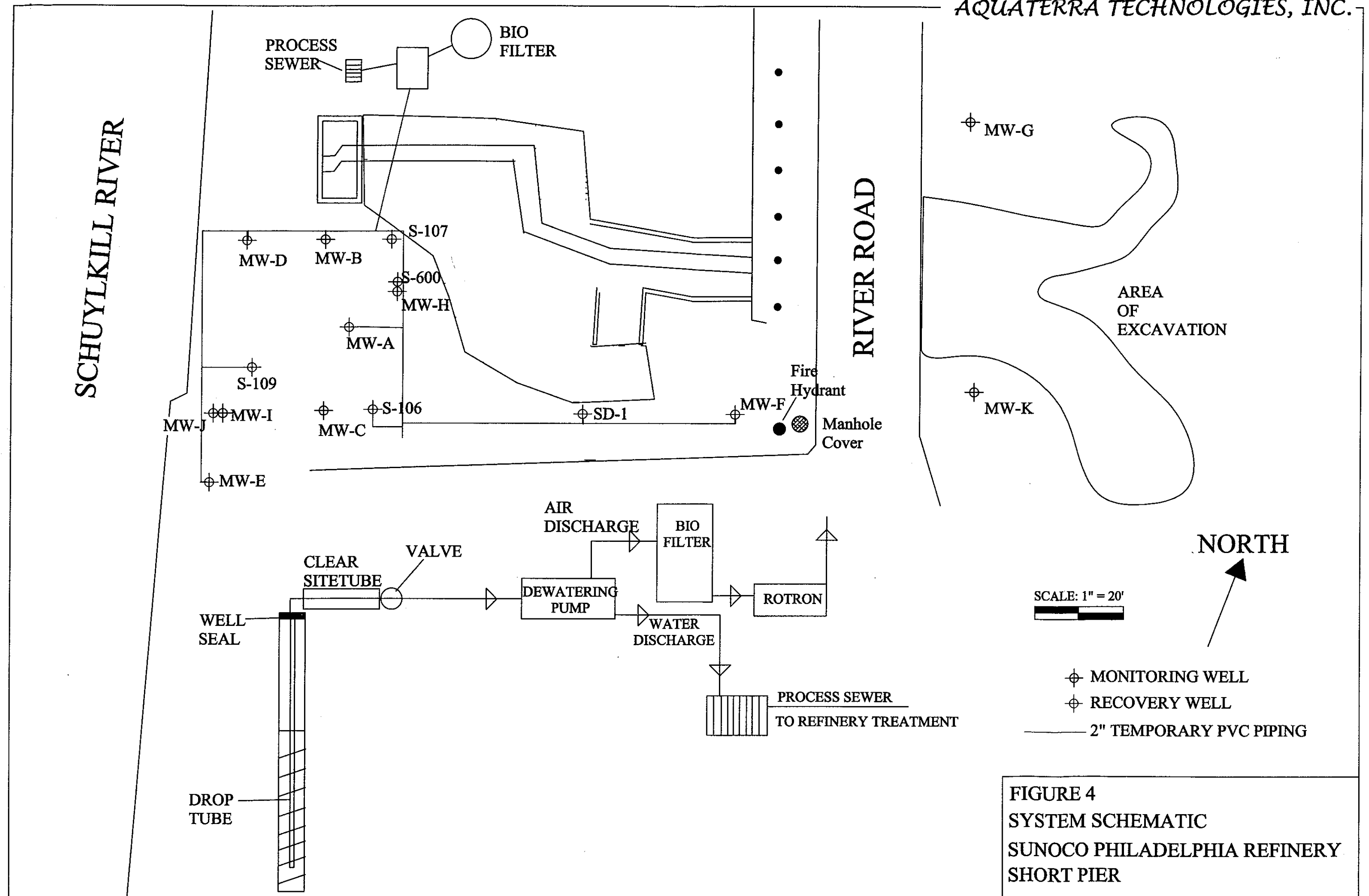


NOTES:

- 1) Depth of bulkhead estimated.
- 2) River bottom estimated.

CROSS SECTION  
SHORT PIER AREA  
PT. BREEZE PROCESSING A  
SUN COMPANY INC.  
PHILADELPHIA REFINERY  
PHILADELPHIA, PA

FIGURE 3



**FIGURE 4**  
**SYSTEM SCHEMATIC**  
**SUNOCO PHILADELPHIA REFINERY**  
**SHORT PIER**

## TABLES

Sunoco, Inc.  
Philadelphia Refinery, Short Pier

**TABLE 1**  
**Liquid Level Data**  
**19 February 2002**

LOCATION	CASING ELEVATION (feet)	DEPTH TO WATER (feet)	DEPTH TO PRODUCT (feet)	PRODUCT THICKNESS (feet)	ADJUSTED GW ELEV. (feet)
MW-A	19.74	10.02	9.37	0.65	9.72
MW-B	18.18	8.46	7.46	1.00	9.72
MW-C	19.93	10.54		0.00	9.39
MW-D	17.81	7.04	7.03	0.01	10.77
MW-E	19.17	9.76	9.63	0.13	9.41
MW-F	30.24	18.81	18.05	0.76	11.43
MW-G	31.74	16.01		0.00	15.73
MW-H	20.08	9.71		0.00	10.37
MW-I	21.44	11.75		0.00	9.69
MW-J	20.41	8.93	8.90	0.03	11.48
MW-K	31.10	18.96	18.95	0.01	12.14
S-106	20.89	10.88	10.57	0.31	10.01
S-107	19.45	10.62	10.30	0.32	8.83
S-109	18.79	8.29		0.00	10.50
SD-1	29.70	9.31		0.00	20.39
S-600	20.08	8.44		0.00	11.64

Sunoco, Inc.  
Philadelphia Refinery, Short Pier

**TABLE 2**  
Tidal Study  
30 April 2002

Monitoring Well	7:00 AM			11:00 AM (low tide)			3:30 PM (approaching high tide)		
	DTP	DTW	PT	DTP	DTW	PT	DTP	DTW	PT
<b>MW-F</b>	17.9	18.63	0.73	17.95	18.85	0.9	17.94	18.81	0.87
<b>MW-I*</b>	NP	10.85	NP	NP	12.8	NP	NP	10.22	NP
<b>MW-J</b>	8.3	8.38	0.08	9.11	9.16	0.05	8.27	8.32	0.05
<b>S-107</b>	10.25	10.82	0.98	10.8	13.3	2.23	10.14	10.61	0.47

Notes:

DTP: Depth to Product

DTW: Depth to Water

PT: Product Thickness

\* Open to river level



Short Pier Area  
Philadelphia Refinery, Short Pier

**TABLE 3**  
High-Vacuum Test on Individual Wells  
7 February 2002

TEST WELL MW-B		Prior Applied Vac at MW-B	During Applied Vac at MW-B	Distance from Test Well
MW-A	DTP	8.65	7.72	20
	DTW	9.08	8.42	
	Vac	NM	-0.01	
MW-C	DTP	NM	NP	38
	DTW	NM	8.33	
	Vac	NM	-0.31	
MW-D	DTP	7.07	6.43	18
	DTW	7.08	6.44	
	Vac	-0.07	-0.98	
MW-H	DTP	NP	-	20
	DTW	9.05	9.05	
	Vac	NM	-1.48	
MW-J	DTP	9.35	NP	46
	DTW	9.5	7.46	
	Vac	NM	0.00	

Vacuum Applied to MW-B= 20

TEST WELL MW-J		During Applied Vac at MW-J	Distance from Test Well
MW-A	DTP	NM	36
	DTW	NM	
	Vac	-0.01	
MW-C	DTP	NP	25
	DTW	8.33	
	Vac	-0.31	
MW-E	DTP	NP	15
	DTW	6.86	
	Vac	-0.98	
MW-I	DTP	NP	10
	DTW	9.01	
	Vac	0.00	
S-109	DTP	6.45	13
	DTW	6.69	
	Vac	-1.21	
RW-602	DTP	NP	50
	DTW	7.65	
	Vac	NM	

TEST WELL MW-F		Prior Applied Vac at MW-F	During Applied Vac at MW-F	Distance from Test Well
MW-G	DTP	NP	NP	84
	DTW	15.13	15.13	
	Vac	NM	0	
MW-K	DTP	17.59	17.6	54
	DTW	17.6	17.61	
	Vac	NM	-0.07	

TEST WELL MW-K		During Applied Vac at MW-K	Distance from Test Well
MW-F	DTP	NM	54
	DTW	NM	
	Vac	-0.54	
MW-G	DTP	NM	60
	DTW	NM	
	Vac	0.00	

TEST WELL MW-G		During Applied Vac at MW-G	Distance from Test Well
MW-K	DTP	NM	60
	DTW	NM	
	Vac	-0.38	

Notes:

Vacuum reported in units of Inches of Water

Distances reported in units of feet

Groundwater experiences tidal influence from adjacent Schuylkill River.

Test performed during a rising tide.

Sunoco, Inc.  
Philadelphia Refinery, Short Pier

**TABLE 4**  
High Vacuum Test-Multiple Wells  
High Tide Conditions  
9 April 2002

Time	10:15 AM				High Tide				
					10:50 AM	12:30 PM	1:00 PM	1:51 PM	2:30 PM
VAC at LRP ("Hg)	5	15							
Vac at Well Head ("Hg)		5.5	10	9			5	9	5
LEL		100%					24%	54%	
Individual Well Observations									
MW-C					-1.10 WC			-2.09 WC	
S-106			shut off well						
MW-A					-0.07 WC				
MW-H									
S-107			no flow						
MW-B	product&water	increased flow		flow	-2.55 psi		-0.12 bar		
MW-D	mist	shut off well				-0.03 WC	-0.057 bar		
MW-J			flow	flow	-3.7 psi		-0.195 bar		
MW-E	light flow		flow	flow	7" Hg		0.19 bar		
2" by crossing box				med flow	-2.71 psi				
2" by road				start	med flow				
2" by river					low flow				
MW-F					0.08 WC			0.20 WC	
Orange well					0.0 WC			0.0 WC	
2" by bulkhead							-0.167 bar		
S by Valve Box							-0.145 bar		

Well Gauging	10:15 AM		11:45	12:30		1:51 PM	2:30 PM
	DTP	DTW	DTW	DTW	DTP	DTW	DTW
MW-A		10.08				7.98	
MW-B	7.42	8.46					
MW-C	11.28	11.29				8.47	
MW-D		7.76		7.71	7.82		
MW-E	10.48	10.58					
MW-F	18	18.88					
MW-G							
MW-H		9.59					
S-107	12.1	13.72					
MW-I		12.78	9.35				
MW-J	9.21	9.25					
Orange well		14.55					14.55
SD-1		9.11					9.08
RW-602		9.65	9.7			8.82	
RW by road		9.65				8.92	
6" by road			9.22				

Shaded boxes indicate wells not under vacuum.

Sunoco, Inc.  
Philadelphia Refinery, Short Pier

**TABLE 5**  
High Vacuum Test-Multiple Wells  
Low Tide Conditions  
16 April 2002

T ime	9:00 AM				10:00 AM		10:30 AM	11:15 AM	12:30 PM	1:00 PM	2:00 PM	3:00 PM
VAC at Pump									11.0		12	
VAC at Manifold				9	9				10			
Vac at Well Head ("Hg)	7	8	10	7	9	9	8	10	10		10	
flow (cfm)	95	116	93	116		93	94		110		91.5	
LEL				100%	>100 %	>100%	>100%	88	78		72	
O2 (ppm)						17.5						
Individual Well Observations												
MW-C	0.0" WC				0.138" WC	1.38" WC			1.43 bar			
MW-A	0.0" WC				0.11" WC	0.12" WC			0.12 bar			
S-107		no flow	no flow	flow	-0.190 bar	-0.190 bar		0.280 bar				flow
S-106	flow	no flow	flow	flow	-0.193 bar	-0.193 bar		-0.280 bar				
S-109	0.00" WC				1.25" WC	1.25" WC			1.44 bar			
MW-B	flow	no flow	flow	flow	-0.195 bar	-0.195 bar		0.283 bar		flow		flow
MW-D												
MW-J	no flow	no flow	flow	flow	-0.260 bar	-0.260 bar	flow	-0.307 bar		flow		
MW-E	flow	no flow	flow	flow			light flow			light flow		
MW-F	0.0" WC				0.04" WC	0.04" WC						0.07
Orange well												0.00

Well Gauging	7:00 AM		9:00 AM	10:00 AM		12:30 PM		2:00 PM		3:00 PM	
	DTP	DTW	DTW	DTP	DTW	DTP	DTW	DTP	DTW	DTP	DTW
MW-A	9.49	10.03		10.06		10.1	10.3				
MW-B	7.58	8.42									
MW-C		10.08			11.33		11.31		10.83		9.39
MW-D	7.47	7.51									
MW-E	10.18	10.2									
MW-F	17.95	18.72									
S-107	10.62	12.29									
S-106	11.32	11.38									
S-109		9.21		9.22			9.23	9.22	9.23	9.1	all product to well btm 9.45
MW-I		11.67	12.95		12.93		12.89		11.74		10.7
MW-J		9.07									
Orange well	14.94	14.95									
RW-602		9.27			9.9		10.97		10.87		9.58
6" by road	9.42				9.96		9.96		9.86		9.68

Shaded boxes indicate wells not under vacuum.

**TABLE 6**  
**Short Pier Area**  
**Philadelphia Refinery**  
**VAPOR HYDROCARBON RECOVERY ESTIMATES**

LBS/day=100GMOLE/29GMOLE X PPM/1,000,000 X SCFM X 0.0749LBS/CUFTx1440min/day

Date	Vacuum (Hg")	Influent conc. (ppm)	scfm	lbs/day	percent operational	TOTAL #s
8/22/2002		841	198	62		0
8/26/2002						
8/30/2002	3	391	198	45	89%	382
9/6/2002	5	501	198	37	100%	335
9/13/2002	7	1204	198	59	50.00%	696
10/8/2002	8	2400	187	339	89%	9182
10/11/2002	15	12000	198	486	70%	923
10/18/2002	15	8280	198	393	64%	2484
11/1/2002	21	7440	198	716	100%	6981
11/6/2002	13	243	197	281	89%	1252
11/19/2002	13	934	198	43	100%	563
11/27/2002	12	1250	198	80	100%	643
AVERAGE LBS/DAY				231		
TOTAL POUNDS REMOVED DURING TEST						23,442

Percent operation based upon hour gauge readings and system operation data.

**TABLE 7. LIQUID LEVELS  
SUNOCO-PHILADELPHIA REFINERY  
SHORT PIER**

**30-Dec-2002**

<b>LOCATION</b>	<b>CASING ELEVATION (feet)</b>	<b>DEPTH TO WATER (feet)</b>	<b>DEPTH TO PRODUCT (feet)</b>	<b>PRODUCT THICKNESS (feet)</b>	<b>ADJUSTED GW ELEV. (feet)</b>
<b>MW-A</b>	19.74	7.21	7.19	0.02	12.53
<b>MW-B</b>	18.18	6.68	6.66	0.02	11.50
<b>MW-C</b>	19.93	7.44		0.00	12.49
<b>MW-D</b>	17.81	6.56	6.55	0.01	11.25
<b>MW-E</b>	19.17	6.48		0.00	12.69
<b>MW-F</b>	30.24	17.64	17.63	0.01	12.60
<b>MW-G</b>	31.74		ng	0.00	
<b>MW-H</b>	20.08	7.66		0.00	12.42
<b>MW-I</b>	21.44	8.76		0.00	12.68
<b>MW-J</b>	20.41	7.18		0.00	13.23
<b>MW-K</b>	31.10	18.33	18.09	0.24	12.77
<b>S-106</b>	20.89	8.82	8.39	0.43	12.07
<b>S-107</b>	19.45	9.40		0.00	10.05
<b>S-109</b>	18.79	7.17		0.00	11.62
<b>S-600</b>	20.08		ng	0.00	

**ATTACHMENT A**  
**Drill Logs**

**Aquaterra Technologies, Inc.**  
**Subsurface Log: MW-A**

**Project Name:** Philadelphia Refinery

**Location:** Case Wharf

**Boring Number:** MW-A

**Casing Elevation:** 19.74

**Screen Diameter:** 4 inch      **Length:** 10

**Casing Diameter:** 4 inch      **Length:** 2

**Drilling Method:** Hollow Stem Auger

**Owner:** Sunoco, Inc. (R&M)

**Permit No.:** N/A

**Log By:** Kevin Martin

**Driller:** Parratt - Wolff

**Slot Size:** 0.020"

**Type:** PVC

**Sample Method:** Split-Spoon/Grab

**Date:** 14-Jan-02

**Borehole Dia:** 6-inch

**Water Level (Init):** NA

**Construction Details**

**Total Well Depth:** 12

**Screen Interval:** 2-12

**Sand Pack Interval:** 2-12

**Completion Details:** Completed with 8-inch manhole cover and locking cap

**Bentonite Interval:** 1-2

**Cement/Grout Interval:** 0-1

**Sand Pack Type:** No. 2 sand

	Backfill
	Cement/Grout
	Bentonite
	Sand

Depth (ft)	Sample Depth (ft)	OVM (ppm)	Lithology	Well Schematic
2			Green-brown, fine SAND. (dry)	
4	0-4	7.5		
	5	5	Dark gray SAND and GRAVEL (dry)	
6	6	4	Black CLAY and SILT (dry)	
	7	0	(moist)	
8			Black clayey SAND, some gravel (moist)	
	9	110		
10				
12			Encountered wood	
			Bottom of boring at 12 feet below ground surface	

**Aquaterra Technologies, Inc.**  
**Subsurface Log: MW-B**

**Project Name:** Philadelphia Refinery  
**Location:** Short Pier  
**Boring Number:** MW-B  
**Casing Elevation:** 18.18  
**Screen Diameter:** 4-inch    **Length:** 9  
**Casing Diameter:** 4-inch    **Length:** 1  
**Drilling Method:** Hollow Stem Auger

**Owner:** Sunoco, Inc. (R&M)  
**Permit No.:** N/A  
**Log By:** Kevin Martin  
**Driller:** Parratt - Wolff  
**Slot Size:** 0.020"  
**Type:** PVC  
**Sample Method:** Split-Spoon/Grab

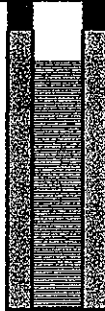
**Date:** 15-Jan-02  
**Borehole Dia:** 6-inch  
**Water Level (Init):** NA

**Construction Details**

**Total Well Depth:** 9.5  
**Screen Interval:** 0.5-9  
**Sand Pack Interval:** 0.5-9  
**Completion Details:** Completed with 8-inch manhole cover and locking cap

**Bentonite Interval:**  
**Cement/Grout Interval:** 0-0.5  
**Sand Pack Type:** No. 2 sand

	Backfill
	Cement/Grout
	Bentonite
	Sand

Depth (ft)	Sample Depth (ft)	OV (ppm)	Lithology	Well Schematic
2	0-2	0	Black, clayey SAND and GRAVEL.	
4			Dark gray, SAND and GRAVEL (dry).	
6	3-5	100		
8	6-8	262		
10	9	610		
10	9.5	134	Clayey SAND, little gravel (moist). Wood.	
12				
			Bottom of boring at 9.5 feet below ground surface	



**Aquaterra Technologies, Inc.**  
**Subsurface Log: MW-C**

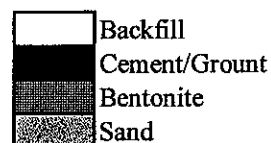
**Project Name:** Philadelphia Refinery  
**Location:** Short Pier  
**Boring Number:** MW-C  
**Casing Elevation:** 19.93  
**Screen Diameter:** 4 inch      **Length:** 10  
**Casing Diameter:** 4 inch      **Length:** 3.5  
**Drilling Method:** Hollow Stem Auger

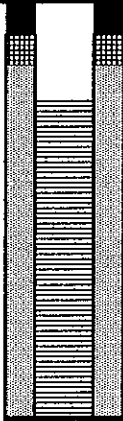
**Owner:** Sunoco, Inc. (R&M)  
**Permit No.:** N/A  
**Log By:** Kevin Martin  
**Driller:** Parratt - Wolff  
**Slot Size:** 0.020"  
**Type:** PVC  
**Sample Method:** Split-Spoon/Grab

**Date:** 15-Jan-02  
**Borehole Dia:** 6-inch  
**Water Level (Init):** NA

**Total Well Depth:** 13.5  
**Screen Interval:** 3.5-13.5  
**Sand Pack Interval:** 3-13.5  
**Completion Details:** Completed with 8-inch manhole cover and locking cap

**Construction Details**  
**Bentonite Interval:** 2-3  
**Cement/Grout Interval:** 0-2  
**Sand Pack Type:** No. 2 sand



Depth (ft)	Sample Depth (ft)	OVM (ppm)	Lithology	Well Schematic
2	0-5	17	Green-brown fine SAND. (dry)	
4				
6				
6	6-7	59	Black, rounded GRAVEL and sandy CLAY.	
8	7.5	75		
10				
12	12	30	Black, plastic sandy CLAY, some wood fragments (moist)	
	13	107		
14			Encounter wood deck at 13.5 feet	
			Bottom of boring at 13.5 feet below ground surface	

**Aquaterra Technologies, Inc.**  
**Subsurface Log: MW-D**

**Project Name:** Philadelphia Refinery  
**Location:** Short Pier  
**Boring Number:** MW-D  
**Casing Elevation:** 17.81  
**Screen Diameter:** 4 inch    **Length:** 7'  
**Casing Diameter:** 4 inch    **Length:** 2'  
**Drilling Method:** Hollow Stem Auger

**Owner:** Sunoco, Inc. (R&M)  
**Permit No.:** N/A  
**Log By:** Kevin Martin  
**Driller:** Parratt - Wolff  
**Slot Size:** 0.020"  
**Type:** PVC  
**Sample Method:** Split-Spoon/Grab  
**Date:** 15-Jan-02  
**Borehole Dia:** 6-inch  
**Water Level (Init):** NA

**Construction Details**

**Total Well Depth:** 9  
**Screen Interval:** 2'-9'  
**Sand Pack Interval:** 2'-9'  
**Completion Details:** Completed with 8-inch manhole cover and locking cap

**Bentonite Interval:** 0'-2'  
**Cement/Grout Interval:**  
**Sand Pack Type:** No. 2 sand

	Backfill
	Cement/Grout
	Bentonite
	Sand

Depth (ft)	Sample Depth (ft)	OVM (ppm)	Lithology	Well Schematic
2	0-5	2.1	Dark brown SAND and GRVEL	
4				
6	6-7	4.5	Round GRAVEL	
8	8	106	Black, clayey SAND and GRAVEL	
	9	210	Wood encountered at 9 feet. Sediments are wet.	
10				
			Bottom of boring at 9 feet below ground surface	

**Aquaterra Technologies, Inc.**  
**Subsurface Log: MW-E**

**Project Name:** Philadelphia Refinery

**Location:** Short Pier

**Boring Number:** MW-E

**Casing Elevation:** 19.17

**Screen Diameter:** 4 inch      **Length:** 10

**Casing Diameter:** 4 inch      **Length:** 3

**Drilling Method:** Hollow Stem Auger

**Owner:** Sunoco, Inc. (R&M)

**Permit No.:** N/A

**Log By:** Kevin Martin

**Driller:** Parratt - Wolff

**Slot Size:** 0.020"

**Type:** PVC

**Sample Method:** Split-Spoon/Grab

**Date:** 15-Jan-02

**Borehole Dia:** 6-inch

**Water Level (Init):** NA

**Construction Details**

**Bentonite Interval:** 2-2.5

**Cement/Grout Interval:**

**Sand Pack Type:** No. 2 sand

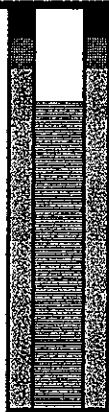
**Total Well Depth:** 13

**Screen Interval:** 3-13

**Sand Pack Interval:** 2.5-3

**Completion Details:** Completed with 8-inch manhole cover and locking cap

	Backfill
	Cement/Grout
	Bentonite
	Sand

Depth (ft)	Sample Depth (ft)	OVM (ppm)	Lithology	Well Schematic
2	0-3	45	Green-brown SAND	
4	4-5	0		
	5	2	Brown fine SAND	
6				
	7	4.5	Dark brown fine SAND, some clay.	
8				
10				
12	12	88	Black CLAY and SAND (moist)	
	13	151	(wet)	
			Bottom of boring at 13 feet below ground surface	

**Aquaterra Technologies, Inc.**  
**Subsurface Log: MW-F**

**Project Name:** Philadelphia Refinery

**Location:** Short Pier

**Boring Number:** MW-F

**Casing Elevation:** 30.24

**Screen Diameter:** 4 inch

**Length:** 10

**Casing Diameter:** 4 inch

**Length:** 11

**Drilling Method:** Hollow Stem Auger

**Owner:** Sunoco, Inc. (R&M)

**Permit No.:** N/A

**Log By:** Kevin Martin

**Driller:** Parratt - Wolff

**Slot Size:** 0.020"

**Type:** PVC

**Sample Method:** Split-Spoon/Grab

**Date:** 16-Jan-02

**Borehole Dia:** 6-inch

**Water Level (Init):** NA

**Construction Details**

**Total Well Depth:** 21.5

**Screen Interval:** 11-21

**Sand Pack Interval:** 10-21

**Completion Details:** Completed with 8-inch manhole cover and locking cap

**Bentonite Interval:** 9-10

**Cement/Grout Interval:** 0-9

**Sand Pack Type:** No. 2 sand

	Backfill
	Cement/Grout
	Bentonite
	Sand

Depth (ft)	Sample Depth (ft)	OV (ppm)	Lithology	Well Schematic
2	0-2	0	Dark brown, clayey SILT, some gravel	
4	2-5	0	(some rounded 1/2"-1" pebbles)	
6	5-7	15	Dark brown/gray SILT and CLAY (slightly moist)	
8	7-10	31.7		
10	10-13	76.7		
12	13-15	142		
14	15-18	418	Dark gray clay, little SILT	
16	18-20	1062		
18	20-21.5	1838		
20				
22			Bottom of boring at 21.5 feet below ground surface	

**Aquaterra Technologies, Inc.**  
**Subsurface Log: MW-G**

**Project Name:** Philadelphia Refinery  
**Location:** Short Pier  
**Boring Number:** MW-G  
**Casing Elevation:** 31.74  
**Screen Diameter:** 4 inch    **Length:** 20  
**Casing Diameter:** 4 inch    **Length:** 3  
**Drilling Method:** Hollow Stem Auger

**Owner:** Sunoco, Inc. (R&M)  
**Permit No.:** N/A  
**Log By:** Kevin Martin  
**Driller:** Parratt - Wolff  
**Slot Size:** 0.020"  
**Type:** PVC  
**Sample Method:** Split-Spoon/Grab




**Date:** 17-Jan-02  
**Borehole Dia:** 6-inch  
**Water Level (Init):** NA

**Construction Details**

**Total Well Depth:** 23  
**Screen Interval:** 12-35  
**Sand Pack Interval:** 11-35  
**Completion Details:** Completed with 8-inch manhole cover and locking cap

**Bentonite Interval:** 1-2  
**Cement/Grout Interval:** 0-1  
**Sand Pack Type:** No. 2 sand

	Backfill
	Cement/Grout
	Bentonite
	Sand

Depth (ft)	Sample Depth (ft)	OVM (ppm)	Lithology	Well Schematic
2	0-3	74.5	Fill Material, gravel	
4	3-5	289		
6	7-30			
8			Sludge, product saturated	
10			fs	
15				
20				
25				
30	30-35		Brown, red CLAY	
35			Bottom of boring at 35 feet below ground surface	

**Aquaterra Technologies, Inc.**  
**Subsurface Log: MW-H**

**Project Name:** Philadelphia Refinery  
**Location:** Short Pier  
**Boring Number:** MW-H  
**Casing Elevation:** 20.08  
**Screen Diameter:** 4 inch      **Length:** 20  
**Casing Diameter:** 4 inch      **Length:** 2  
**Drilling Method:** Hollow Stem Auger

**Owner:** Sunoco, Inc. (R&M)  
**Permit No.:** N/A  
**Log By:** Kevin Martin  
**Driller:** Parratt - Wolff  
**Slot Size:** 0.020"  
**Type:** PVC  
**Sample Method:** Split-Spoon/Grab


**Date:** 22-Jan-02  
**Borehole Dia:** 6-inch  
**Water Level (Init):** NA

**Construction Details**

**Total Well Depth:** 22  
**Screen Interval:** 2-22  
**Sand Pack Interval:** 2-22  
**Completion Details:** Completed with 8-inch manhole cover and locking cap

**Bentonite Interval:** 1-2  
**Cement/Grout Interval:** 0-1  
**Sand Pack Type:** No. 2 sand

<input type="checkbox"/>	Backfill
<input type="checkbox"/>	Cement/Grout
<input type="checkbox"/>	Bentonite
<input type="checkbox"/>	Sand

Depth (ft)	Sample Depth (ft)	OV (ppm)	Lithology	Well Schematic
2			Green-brown, fine SAND. (dry)	
4	0-4	7.5		
	5	5	Dark gray SAND and GRAVEL (dry)	
6	6	4	Black CLAY and SILT (dry)	
	7	0	(moist)	
8			Black clayey SAND, some gravel (moist)	
	9	110		
10				
12				
14				
16			no wood encountered	
18				
20				
22				
24			Gray-brown SILT, some clay.	
26				
Bottom of boring at 22 feet below ground surface				

**Aquaterra Technologies, Inc.**  
**Subsurface Log: MW-I**

**Project Name:** Philadelphia Refinery  
**Location:** Short Pier  
**Boring Number:** MW-I  
**Casing Elevation:** 21.44  
**Screen Diameter:** 4 inch      **Length:** 10  
**Casing Diameter:** 4 inch      **Length:** 18  
**Drilling Method:** Hollow Stem Auger

**Owner:** Sunoco, Inc. (R&M)  
**Permit No.:** N/A  
**Log By:** Kevin Martin  
**Driller:** Parratt - Wolff  
**Slot Size:** 0.020"  
**Type:** PVC

**Date:** 23 Jan 02  
**Borehole Dia:** 6-inch  
**Water Level (Init):** NA



**Construction Details**

**Total Well Depth:** 26  
**Screen Interval:** 16-26  
**Sand Pack Interval:** 15-26  
**Completion Details:** Completed with 8-inch steel stick-up casing and lock.

**Bentonite Interval:** 14-15  
**Cement/Grout Interval:** 0-14

**Sand Pack Type:** No. 2 sand

 Backfill  
Cement/Grout  
Bentonite  
Sand

Depth (ft)	Sample Depth (ft)	OVM (ppm)	Lithology	Well Schematic
2	0-2		Orange, fine SAND and GRAVEL	
4	3-5	1.4	Concrete	
6	5		Med brown fine-medium SAND and GRAVEL, little concrete.	
8				
10			Water encountered at 9 feet.	
12				
14		122	CLAY. Encounter wood at 14.5 feet auger through and set casing	
16		0	Grey, fine SAND, wet.	
18				
20		0	Soft, CLAY and SILT. Wet	
22				
24		0		
26				
			Bottom of boring at 26 feet below ground surface	

# Aquaterra Technologies, Inc.

## Subsurface Log: MW-J

**Project Name:** Philadelphia Refinery  
**Location:** Short Pier  
**Boring Number:** MW-J  
**Casing Elevation:** 20.41  
**Screen Diameter:** 4 inch      **Length:** 10  
**Casing Diameter:** 4 inch      **Length:** 5  
**Drilling Method:** Hollow Stem Auger

**Owner:** Sunoco, Inc. (R&M)  
**Permit No.:** N/A  
**Log By:** Kevin Martin  
**Driller:** Parratt - Wolff  
**Slot Size:** 0.020"  
**Type:** PVC  
**Sample Method:** Split-Spoon/Grab

**Date:** 24-Jan-02  
**Borehole Dia:** 6-inch  
**Water Level (Init):** NA

**Total Well Depth:** 15  
**Screen Interval:** 5-15  
**Sand Pack Interval:** 4-15  
**Completion Details:** Completed with 8-inch manhole cover and locking cap

**Construction Details**  
**Bentonite Interval:** 3-4  
**Cement/Grout Interval:** 0-3  
**Sand Pack Type:** No. 2 sand

	Backfill
	Cement/Grout
	Bentonite
	Sand

Depth (ft)	Sample Depth (ft)	OVM (ppm)	Lithology	Well Schematic
2	0-4		GRAVEL	
4			Clayey SAND	
6	5	12.3	Brown, Sandy CLAY (moist)	
8				
10	10	2.3		
12				
14	14	124	Encounter WOOD.	
			Bottom of boring at 15 feet below ground surface	



**Aquaterra Technologies, Inc.**  
**Subsurface Log: MW-K**

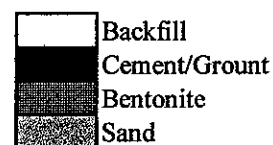
**Project Name:** Philadelphia Refinery  
**Location:** Short Pier  
**Boring Number:** MW-K  
**Casing Elevation:** 31.10  
**Screen Diameter:** 4 inch      **Length:** 20  
**Casing Diameter:** 4 inch      **Length:** 7  
**Drilling Method:** Hollow Stem Auger

**Owner:** Sunoco, Inc. (R&M)  
**Permit No.:** N/A  
**Log By:** Kevin Martin  
**Driller:** Parratt - Wolff  
**Slot Size:** 0.020"  
**Type:** PVC  
**Sample Method:** Split-Spoon/Grab

**Date:** 24-Jan-02  
**Borehole Dia:** 6-inch  
**Water Level (Init):** NA

**Total Well Depth:** 28  
**Screen Interval:** 8-28  
**Sand Pack Interval:** 7-28  
**Completion Details:** Completed with 8-inch manhole cover and locking cap

**Construction Details**  
**Bentonite Interval:** 6-7  
**Cement/Grout Interval:** 0-6  
**Sand Pack Type:** No. 2 sand



Depth (ft)	Sample Depth (ft)	OVM (ppm)	Lithology	Well Schematic
2	0-15	45	Grey, plastic, silty CLAY (wet)	
4				
6				
8				
10				
12				
14				
15	2.1	Medium brown, plastic, CLAY (wet)		
16	3.5	Grey, plastic, CLAY (wet)		
18				
20				
22				
23	159	Dark gray, clayey SAND and GRAVEL (wet)		
24				
26				
28				
			Bottom of boring at 28 feet below ground surface	



**Sunoco, Inc.**  
3144 Passyunk Avenue  
Philadelphia PA 19145-5299  
215 339 2000

February 10, 2003

Mr. David Burke  
Pennsylvania DEP  
Lee Park Suite 6010  
555 North Lane  
Conshohocken, PA 19428

Re: Site Characterization and Remedial Testing Report  
Short Pier, Pt. Breeze Processing Area

Dear Mr. Burke:

Enclosed are two copies of the Site Characterization and Remedial Testing Report for the Short Pier project in the Pt. Breeze Processing Area. The report details the monitoring well installation, results of monitoring and the pilot testing performed in 2002.

The pilot testing consisted of operating a total phase extraction system for an extended period of time. The total Phase extraction system was shut down prior to freezing weather. We are recommending that the re-deployment of total phase extraction at the site be evaluated in the spring based on LNAPL thicknesses in the wells. We are currently operating a soil vent system in the area.

Please feel free to contact me at (610) 859-1881 with any questions or comments.

Best Regards,

A handwritten signature in black ink, appearing to read "James R. Oppenheim", with a long, sweeping horizontal line extending to the right.

James R. Oppenheim, PE  
Sr. Environmental Consultant

Enclosure

Cc: Steve Coladonato, Sunoco, Inc. w/enclosure  
Ray Toto, Sunoco, Inc. w/o enclosure