RCRA
Variance

RCRA Facility Investigation Work Plan

Philadelphia Refinery
Sun Refining and Marketing Company
Philadelphia, Pennsylvania

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May 1991

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CERTIFICATION

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

Date ______________________

Signature ______________________

William F. Thompson
Refinery Manager
Philadelphia Refinery

EXECUTIVE SUMMARY

Sun Refining and Marketing Company (Sun) operates the Philadelphia Refinery owned by the Atlantic Refining and Marketing Corp. (Atlantic) located in southwest Philadelphia, Pennsylvania. The facility includes five Resource Conservation and Recovery Act (RCRA) Solid Waste Management Units (SWMUs) that were defined in the Hazardous Waste Management Permit issued to the facility by the U.S. Environmental Protection Agency (EPA) on November 8, 1988. The permit specified that the five SWMUs needed to be investigated for potential corrective action work. Sun has elected to bypass the verification investigation step in this process and proceed directly into the RCRA Facility Investigation (RFI). EPA Region III has given approval for this approach.

This document reviews existing data pertaining to the five SWMUs and presents the RFI work plan for the data collection effort proposed to evaluate possible releases from the five SWMUs: (1) Past Leaded Storage Tank Bottoms Disposal Area, (2) Past Disposal Area (PDA) No. 1, (3) PDA No. 2, (4) PDA Nos. 3 and 4, and (5) Guard Basin. The four PDAs are located adjacent to each other in the facility's West Yard and appear to be relatively similar in form and potential impact.

The RFI work plan proposes consolidating the PDAs into a single corrective action management unit (CAMU) and the proposed investigation is organized assuming EPA approval of such a strategy.

The work proposed at each SWMU is designed to supplement existing information on hazardous constituents that may have been released into the environment from that SWMU. A phased approach is recommended for this investigation as the most cost-effective method. Waste, soil, surface water, sediment, groundwater, and basin-water samples will be collected and analyzed. The work plan describes the locations and methods for the data collection effort and presents the rationale for including the various sampling points and analyses.

Additional geophysical, hydrological, and geological characterizations of the site will be made to assess the potential impacts of any hazardous constituents identified at the SWMUs. The relationship of the basin water, surface water, and groundwater at the site will be evaluated, and the shallow groundwater flow system will be described to define the downgradient impact areas for each SWMU.

Implementation of the proposed work plan will provide data to evaluate whether hazardous constituents have been released from the SWMUs.

CONTENTS

TABLES

FIGURES

FIGURES (continued)

Chapter 1
INTRODUCTION

Sun Refining and Marketing Company (Sun) operates the Philadelphia Refinery located at 3144 Passyunk Avenue adjacent to the Schuylkill River in southwest Philadelphia, Pennsylvania (Figure 1-1). The Philadelphia Refinery is owned by Atlantic Refining and Marketing Corp. (Atlantic). Both Sun and Atlantic are subsidiaries of the Sun Company, Inc. The facility has been subject to the Resource Conservation and Recovery Act (RCRA) interim status requirements since 1980. The land use at this site has a long history of petroleum transportation, storage, and processing. Current operations at the facility are limited to the production of fuels and asphalt (K.W. Brown, 1987).

On November 8, 1988, the U.S. Environmental Protection Agency (EPA) issued a Corrective Action and Waste Minimization Permit under the Hazardous and Solid Waste Amendments of 1984. Atlantic Refining and Marketing Company was named as the permittee. The permit's effective date was December 9, 1988. In the permit, EPA identified five Solid Waste Management Units (SWMUs) at the facility for further investigation and possible corrective action:

- Past Leaded Storage Tank Bottoms Disposal Area (North Yard)
- Past Disposal Area (PDA) No. 1 (West Yard)
- Past Disposal Area No. 2 (West Yard)
- Past Disposal Area Nos. 3 and No. 4 (West Yard)
- Guard Basin (South Yard)

EPA's corrective action program allows the consolidation of certain SWMUs into corrective action management units (CAMUs), although the decision to allow this ultimately rests with the agency. The SWMUs in the West Yard (PDA Nos. 1, 2, 3, and 4) are immediately adjacent to one another and appear to be relatively similar in form and potential impact. Consolidating the PDAs into a single CAMU could provide these advantages:

- It would allow a cost-effective approach to locating monitoring wells that would be used to sample groundwater quality around the PDAs.

- It would allow a realistic point of compliance to be determined for the groundwater associated with these three SWMUs.

- It would allow the movement of hazardous wastes between individual PDAs, if necessary during the RFI or future studies, without triggering hazardous waste permit requirements on land disposal restriction.

The RFI work plan assumes EPA approval of consolidating four PDAs into a single CAMU, with the potential corrective measure summaries and sampling investigation

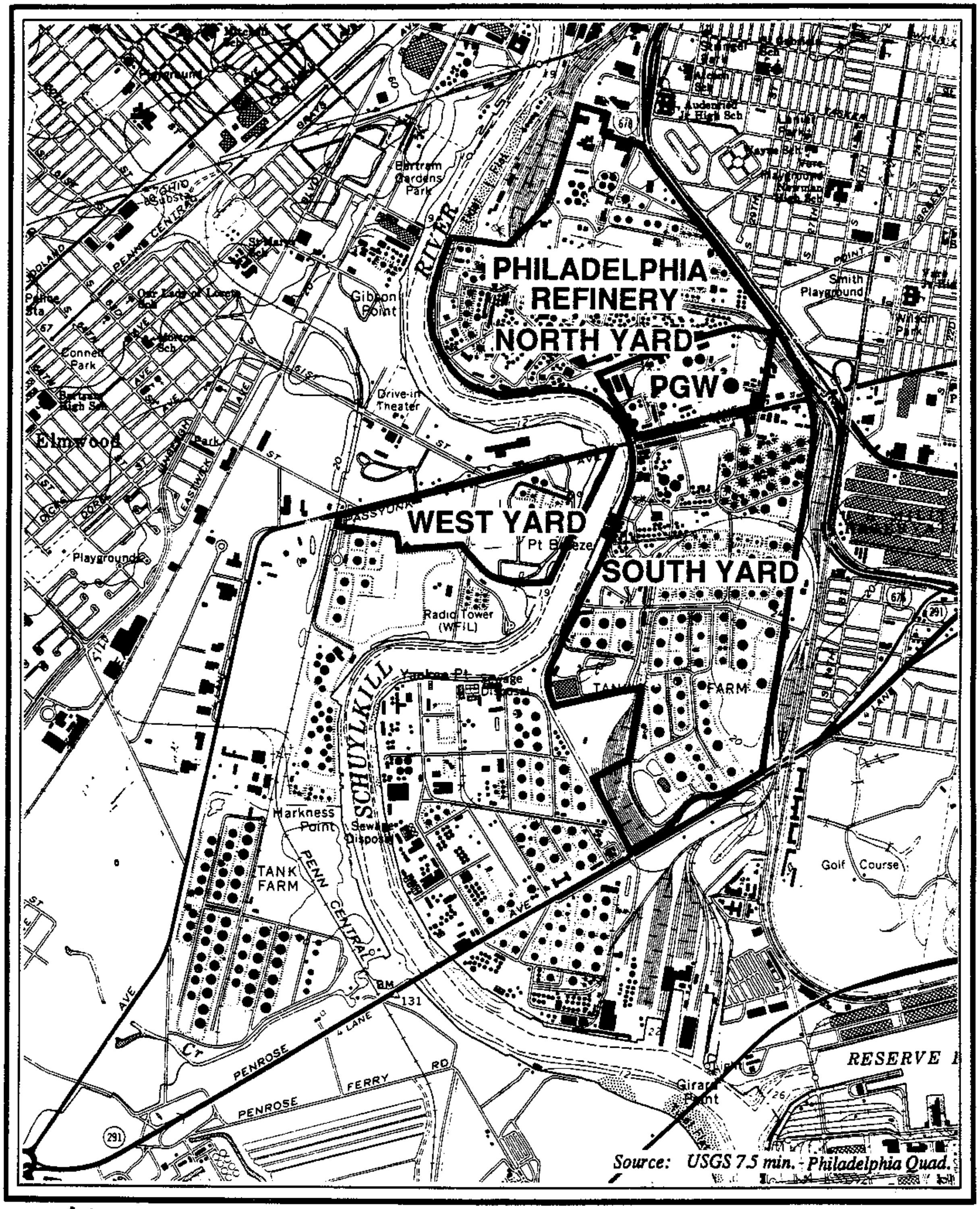

Figure 1-1

Refinery Boundary

Scale: 1" = 2,000'

0 2,000' 3,000' 4,000'

Location Map, Sun Philadelphia Refinery

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strategies organized accordingly.

The objectives of this RFI are: (1) to define the nature and extent of potential releases of hazardous waste or constituents from the SWMUs; (2) to determine whether a corrective measure study (CMS) is necessary and potentially establish preliminary media protection standards; and (3) to gather the necessary data to support a CMS if needed. A CMS evaluates the effectiveness of potential remedial actions, including ease of implementation, safety, and potential adverse effects of implementing remedies, to assist in developing a corrective action plan.

Typically, an RFI work plan consists of the following tasks (EPA, 1986):

- Task 1--Preliminary Report: Description of Current Conditions
- Task 2--Pre-investigation Evaluation of Corrective Measures Technologies
- Task 3--RFI Work Plan
- Task 4--Facility Investigation
- Task 5--Investigation Analysis
- Task 6--Laboratory and Bench-Scale Studies
- Task 7--RFI Reports

This document addresses the first three tasks for releases from the five SWMUs identified in the permit issued on November 8, 1988. The preliminary report is presented in Chapter 2, a pre-investigation evaluation of corrective measures technologies is addressed in a brief section in Chapter 3, and the RFI work plan is presented in Chapters 3 through 6. The Project Management Plan is in Chapter 3, the Sampling and Analysis Plan is in Chapter 4, and the Data Collection Quality Assurance Plan (DCQAP) is discussed in Chapter 4 and found in the appendix. The Data Management Plan is in Chapter 5, the Health and Site Safety Plan is in Chapter 6, and the Community Relations Fact Sheet and Plan are in Chapter 7. Implementation of the RFI work plan by Sun will occur following EPA review and approval of the work plan.

Chapter 2
PRELIMINARY REPORT: DESCRIPTION OF CURRENT CONDITIONS

FACILITY BACKGROUND

PLANT LOCATION

The Sun facility is located at 3144 Passyunk Avenue in southwest Philadelphia approximately 2.5 miles north of the confluence of the Schuylkill and Delaware Rivers. The site is bisected by the Schuylkill River, with the majority of the property located adjacent to the western bank. Surrounding land use is industrial and commercial.

OPERATIONAL HISTORY

Land use at this site has had a long history of petroleum transportation, storage, and processing. This facility was established by Atlantic Richfield Company (ARCO) in 1860s as an oil distribution center. In the 1900s crude oil processing began and full-scale gasoline production was initiated during World War II. In addition to refining crude oil, various chemicals, such as acids and ammonia, were also produced at this site for a time. Current operations at the plant are limited to the production of fuels and asphalt (K.W.Brown, 1987).

This facility was acquired from ARCO by Atlantic Refining and Marketing Corp. in September 1985, and Atlantic was acquired by Sun Company, Inc. during 1988-89. Sun Refining and Marketing Company is the current operator of the facility and Atlantic Refining and Marketing Corp. is the facility owner. Both Sun and Atlantic are subsidiaries of Sun Company, Inc.

REGULATORY HISTORY

A.T. Kearney, Inc., an EPA contractor, completed a Phase I Preliminary Review of Solid Waste Management Units at the ARCO Philadelphia refinery facility in January 1986, and in August 1986, completed an RCRA Facility Assessment (RFA) (EPA ID No. PAD 002-289 700) on this facility, then owned by Atlantic Refining and Marketing. The RFA was required when Atlantic applied for an RCRA Part B permit for a hazardous waste management facility. This report describes each of the potential solid waste management units and areas of concern based on site inspections and record reviews. No field investigations were conducted at this time.

In April 1988, another EPA contractor, NUS Corporation, completed a field investigation team report for the facility. This report was based on observations made during site inspections of the facility and forms the basis for the EPA conditions applied to the RCRA Corrective Actions and Waste Minimization Permit issued to Atlantic on December 9, 1988.

In the permit, the EPA identified five Solid Waste Management Units (SWMUs). As a condition of the permit, the EPA required additional investigation of these SWMUs to determine if corrective action would be needed.

As a condition of the permit, Atlantic was required to conduct a verification investigation. K. W. Brown & Associates was contracted to do this in 1988. Although a verification investigation work plan was produced, a field investigation was never initiated. Atlantic then contracted with Groundwater and Environmental Services, Inc. (GES) to collect additional information. Again, no field investigations were undertaken.

In addition to being subject to the state and federal hazardous waste program, this facility is also regulated by Pennsylvania solid waste regulations (applicable to operate a landfarm) and by federal NPDES regulations, which are implemented by the state.

PLANT LAYOUT

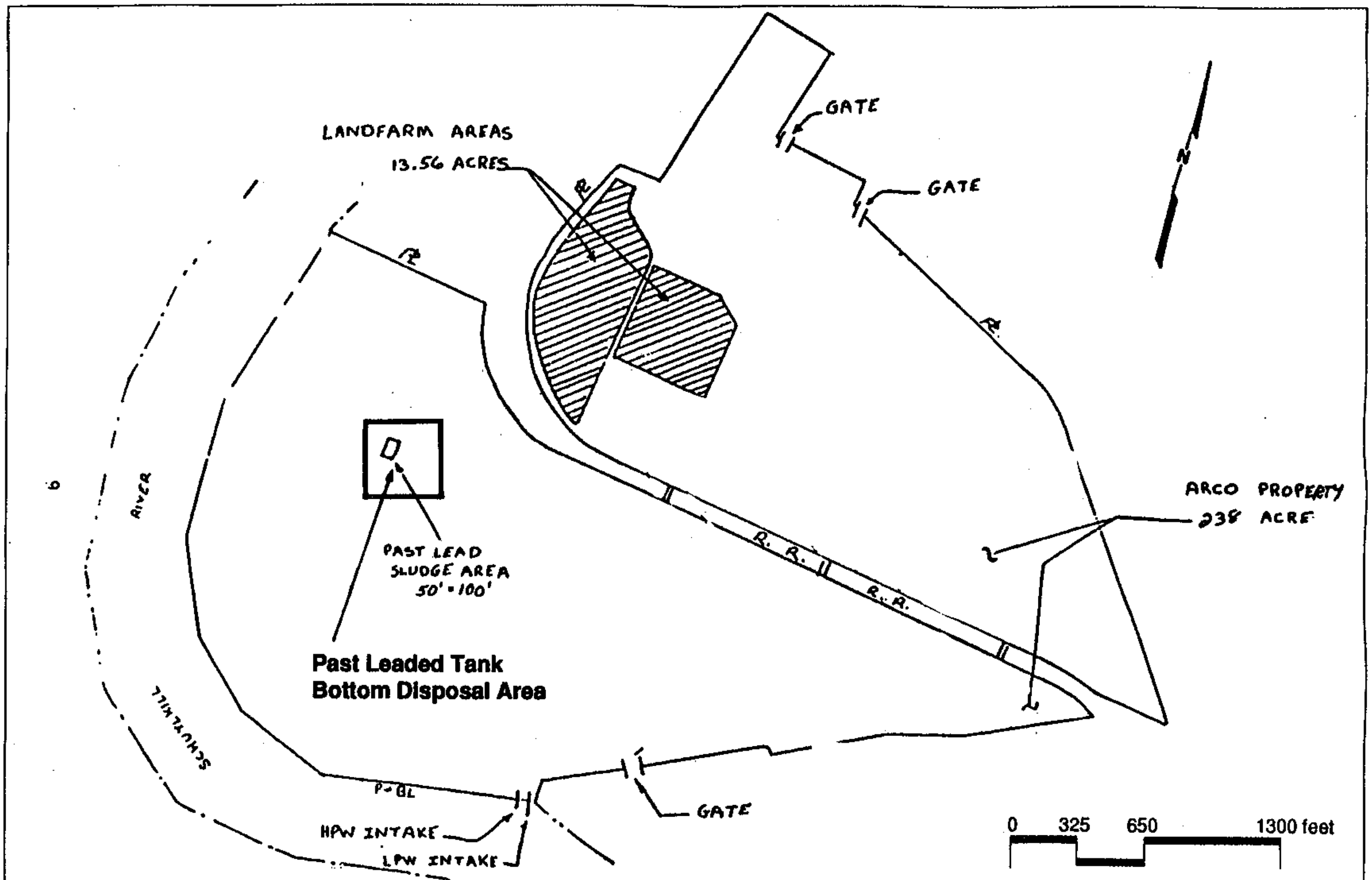
The Sun facility is divided into three distinct operational areas: the North Yard, the South Yard, and the West Yard (Figure 1-1).

North Yard

The North Yard is approximately 247 acres in size, and is located east of the Schuylkill River in the northern portion of the site. It is bounded by the Schuylkill River to the west and southwest, by Philadelphia Gas Works (PGW) and Passyunk Avenue to the south, and by commercial and industrial properties to the north and east (Figure 1-1).

Past production and waste handling operations in the North Yard include several lead sludge (from the tank bottoms) disposal areas, several PDAs and drum storage areas, asbestos storage, storage tanks, and a land farm area (A.T. Kearney, 1986). The lead sludge disposal area was removed from this area by 1980 (GES, 1989). In addition, approximately 45 storage tanks were removed from this area. Currently, there are 23 storage tanks in this area, 9 of which are out of service. The remaining 14 tanks are used to store asphalt.

The EPA has identified one SWMU, a past leaded tank bottom disposal area, in the North Yard that requires additional investigation and characterization. This SWMU consists of a 50-foot by 100-foot area on which leaded gasoline storage tank bottom sludge was placed and allowed to weather (Figure 2-1). The weathering process breaks down many of the petroleum and other organic and inorganic compounds.



Source: A.T. Kearney, August 1986.

Figure 2-1

Location Map of North Yard and Past Leaded Tank Bottom Disposal Area

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The exact startup date of this SWMU is not known. According to A.T. Kearney, Inc. (August, 1986) and NUS Corporation (1988), this unit was reportedly constructed of naturally occurring soils and fill material and was closed in the mid-1960s. However,GES (1989) reports that the disposal area was underlain by a concrete pad but was not bermed and that the sludge was removed and the area covered. A.T. Kearney (1986) and NUS Corp. (1988) report that closure of this unit consisted of covering the area with soil.

Based on their findings, NUS (1988) concluded that the potential for a release of hazardous material from this area to the subsurface was moderate. Currently, this area is graded and covered with a layer of crushed stone, obscuring all evidence of a past land disposal unit in this area.

There have been a total of 84 groundwater monitoring wells installed throughout the North Yard. Past groundwater monitoring has shown that groundwater varies from 3 to 31 feet below the land surface.

The results of groundwater samples collected during 1985 and 1986 from Well 38 (Figure 2-2) (located within 50 feet north of the past leaded tank bottom disposal area) are shown in Table 2-1. In summary, these samples show the following levels of metals:

- Arsenic (180 and 45 ppb)
- Barium (77 and 98 ppb)
- Vanadium (9 and 7 ppb)

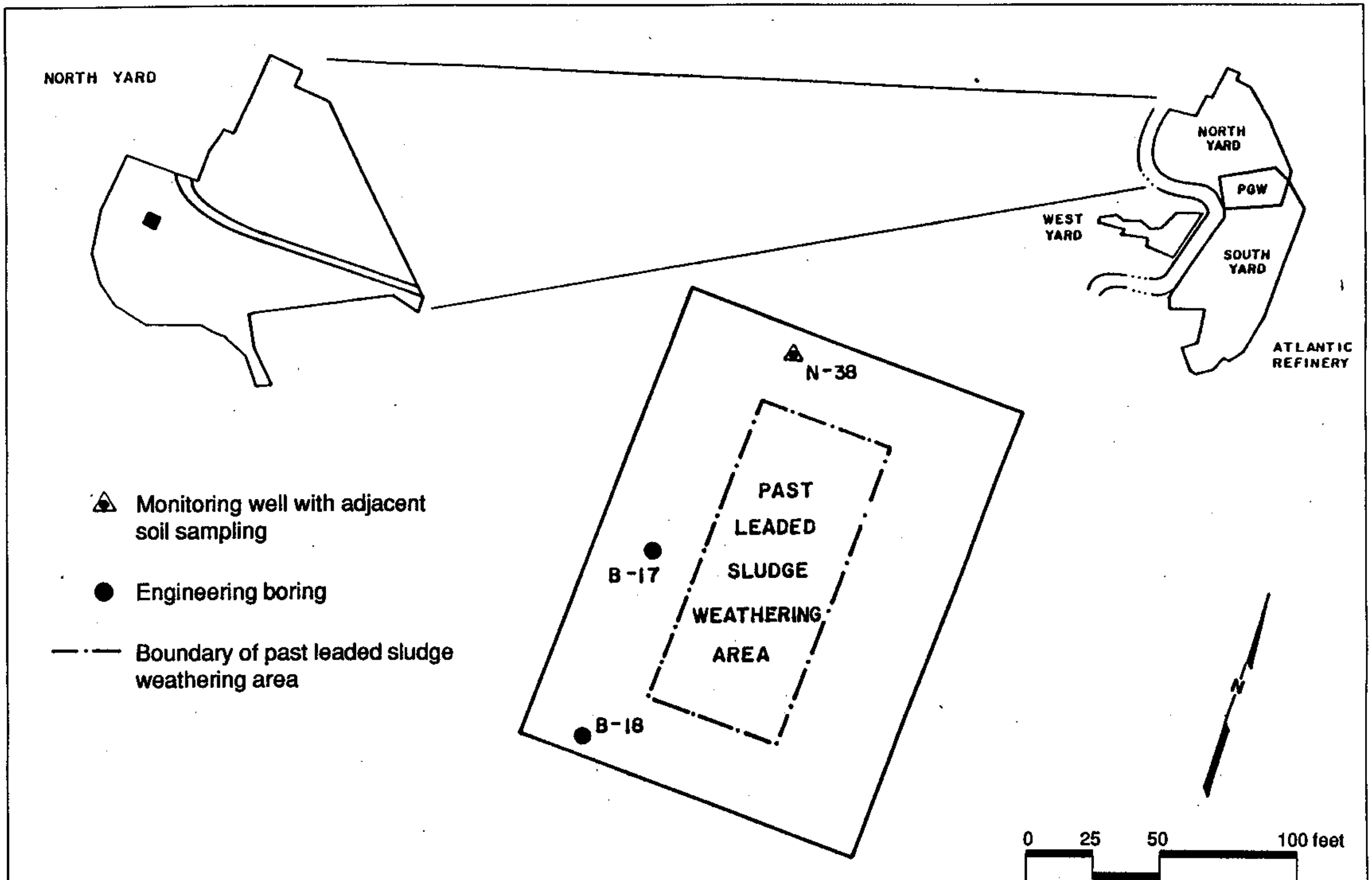
Some volatile organics and base neutral compounds are:

- 1-methylnaphthalene (below detection in 1985 and 67 ppb in 1986)
- Methyl ethyl ketone (below detection in 1985 and 52 ppb in 1986)
- Xylenes, ortho- and para- (below detection in 1985 and 6 ppb in 1986)

Soil analyses (Rocky Mountain Analytical Laboratory, 1985) from samples collected from the vicinity of Well 38 (located adjacent to and north of the past disposal area) show the following levels of metals:

- Barium (1200 ppm)
- Chromium (110 ppm)
- Lead (19800 ppm)
- Nickel (69 ppm)
- Vanadium (49 ppm)

VOCs and acid extractable/base neutral compounds were also present in this sample with VOCs ranging from 320 ppm to 60 ppm, base neutral compounds ranging from 420 ppm to 23 ppm, and acid extractable compounds ranging from 10 to 7.2 ppm (Rocky Mountain Analytical Laboratory, 1985). The complete results of soil analyses are presented in Table 2-2.



Source: GES, 1989

Figure 2-2

Previous Sampling Locations at the Past Leaded Tank Bottom Disposal Area

Table 2-1
Results of Soils Analyses

Parameters	Guard Basin			Past Leaded Tank Bottom Storage Area	PDA-1		PDA-2			PDA-3		PDA-4			
	Well 52 (mg/kg)	Well 50 (mg/kg)	Well 48 (mg/kg)	Well 38 (mg/kg)	WS-17-5 (mg/kg)	WS-17-10 (mg/kg)	WS-10 (mg/kg)	WS-18-5 (mg/kg)	WS-18-10 (mg/kg)	WS-20-5 (mg/kg)	WS-20-10 (mg/kg)	WS-21-5 (mg/kg)	WS-21-10 (mg/kg)	WS-22-5 (mg/kg)	WS-22-10 (mg/kg)
Metals															
Antimony	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	2	ND	ND	ND	ND
Arsenic	5	3	3	15	ND	17	11	5	5	12	2	4	9	19	4
Barium	37	20	110	1,200	10	120	26	30	50	170	86	100	180	110	800
Beryllium	0.28	0.30	0.27	0.9	ND	0.44	ND	0.60	ND	0.56	0.23	0.24	0.23	0.55	0.32
Cadmium	0.6	0.6	0.5	5	ND	0.8	0.6	0.8	ND	0.7	1.1	2.2	1.2	1.3	1.0
Chromium	10	8.5	9.7	110	6.3	52	3.1	14	15	380	97	120	41	26	22
Cobalt	4.6	6.0	3.8	21	ND	5.9	13	6.5	1.3	8.7	4.8	5.7	5.8	7.4	7.6
Lead	59	450	200	19,800	14	160	16	15	52	860	230	240	150	280	140
Mercury	ND	ND	0.60	1.7	ND	0.85	0.25	ND	ND	0.6	0.45	1.0	0.2	0.5	0.6
Nickel	10	6.5	9.1	69	ND	27	25	7	12	46	20	20	17	19	14
Selenium	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Silver	ND	0.4	0.4	3.6	ND	ND	ND	ND	ND	0.7	ND	0.8	0.8	0.7	1
Vanadium	13	11	31	49	4.9	75	10	24	15	110	47	140	42	49	29
Volatile Organics															
Benzene	BDL	BDL	BDL	60	BDL	BDL	BDL	0.006	0.052	BDL	BDL	0.86	BDL	BDL	BDL
Carbon disulfide	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Chlorobenzene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Chloroform	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
1,2-Dibromoethane	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
1,2-Dichloroethane	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
1,4-Dioxane	BDL	BDL	BDL	BDL	BDL	BDL	BDL	3.9	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Methyl ethyl ketone	0.120	BDL	BDL	BDL	BDL	BDL	BDL	0.069	0.25	BDL	BDL	BDL	BDL	BDL	BDL
Styrene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Ethyl benzene	BDL	0.006	0.009	100	BDL	0.010	BDL	0.010	0.048	0.95	BDL	0.22	BDL	BDL	BDL
Toluene	BDL	BDL	BDL	110	BDL	BDL	BDL	BDL	0.20	0.74	BDL	BDL	BDL	BDL	BDL
Xylenes	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Xylenes, meta-	BDL	0.005	0.006	320	BDL	0.010	BDL	0.53	0.33	3.0	BDL	1.1	0.030	BDL	BDL
Xylenes, ortho- and para-	BDL	0.007	0.005	210	BDL	0.012	0.32	0.13	0.13	2.9	BDL	0.69	0.034	BDL	BDL

Table 2-1
Results of Soils Analyses

Parameters	**Guard Basin**			**Past Leaded Tank Bottom Storage Area**	**PDA-1**		**PDA-2**			**PDA-3**		**PDA-4**			
	Well 52 (mg/kg)	**Well 50 (mg/kg)**	**Well 48 (mg/kg)**	**Well 38 (mg/kg)**	**WS-17-5 (mg/kg)**	**WS-17-10 (mg/kg)**	**WS-10 (mg/kg)**	**WS-18-5 (mg/kg)**	**WS-18-10 (mg/kg)**	**WS-20-5 (mg/kg)**	**WS-20-10 (mg/kg)**	**WS-21-5 (mg/kg)**	**WS-21-10 (mg/kg)**	**WS-22-5 (mg/kg)**	**WS-22-10 (mg/kg)**
Base/Neutral Organics															
Anthracene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.70	BDL	BDL	BDL	BDL
Benzo(a)anthracene	BDL	BDL	BDL	BDL	BDL	BDL	1.3	BDL	BDL	4.8	2.3	BDL	BDL	1.1	0.3
Benzo(b)fluoranthene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	10	BDL	0.84	BDL	0.90	2.0	0.4
Benzo(j)fluoranthene	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Benzo(k)fluoranthene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Benzo(a)pyrene	BDL	BDL	BDL	BDL	BDL	BDL	1.6	BDL	BDL	2.5	0.92	BDL	0.82	1.3	0.6
Bis(2-ethylhexyl)phthalate	BDL	BDL	0.41	BDL	BDL	BDL	2.6	BDL	BDL	9.1	BDL	23	BDL	BDL	BDL
Butyl benzyl phthalate	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	25	BDL	BDL	BDL	BDL	BDL	BDL
Chrysene	BDL	BDL	0.51	24	0.10	BDL	3.1	0.30	120	16	7.3	1.4	1.4	2.3	0.6
Dibenz(a,h)anthracene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.5
Di-n-butyl phthalate	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Dichlorobenzenes	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
o-Dichlorobenzene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
m-Dichlorobenzene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
p-Dichlorobenzene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Diethyl phthalate	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
7,12-Dimethylbenz(a)anthracene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Dimethyl phthalate	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Di-n-octyl phthalate	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Fluoranthene	BDL	BDL	0.27	BDL	BDL	BDL	1.1	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.2
Indene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Methyl chrysene**	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
1-Methylnaphthalene	BDL	BDL	BDL	420	BDL	53	BDL	0.57	190	20	26	63	1.4	2.1	0.4
Naphthalene	BDL	BDL	0.54	210	BDL	25	3.1	BDL	41	6.1	BDL	BDL	0.68	BDL	BDL
Phenanthrene	BDL	BDL	0.39	89	0.20	11	BDL	BDL	32	15	9.7	5.9	1.5	3.2	0.5
Pyrene	BDL	BDL	0.63	23	BDL	BDL	2.3	BDL	29	4.2	2.4	BDL	0.86	1.4	0.3
Pyridine*	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Quinoline	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL

Table 2-1
Results of Soils Analyses

Parameters	Guard Basin			Past Leaded Tank Bottom Storage Area	PDA-1		PDA-2			PDA-3		PDA-4			
	Well 52 (mg/kg)	Well 50 (mg/kg)	Well 48 (mg/kg)	Well 38 (mg/kg)	WS-17-5 (mg/kg)	WS-17-10 (mg/kg)	WS-10 (mg/kg)	WS-18-5 (mg/kg)	WS-18-10 (mg/kg)	WS-20-5 (mg/kg)	WS-20-10 (mg/kg)	WS-21-5 (mg/kg)	WS-21-10 (mg/kg)	WS-22-5 (mg/kg)	WS-22-10 (mg/kg)
Acid Organics															
Benzenethiol**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Cresols	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ortho-cresol	BDL	BDL	BDL	10	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
para- and meta-cresol	BDL	BDL	BDL	7.2	BDL	BDL	BDL	BDL	BDL	0.27	BDL	BDL	BDL	BDL	BDL
2,4-Dimethylphenol	BDL	BDL	BDL	9.3	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
2,4-Dinitrophenol	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
4-Nitrophenol	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Phenol	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL

NOTES:

BDL = Below detection limit
ND = Not detected
NA = Not analyzed
* = Not consistently recovered using Method 8270
Source: Rocky Mountain Analytical Laboratory, 1985

Table 2-2
Results of Groundwater Analyses

Parameters	Guard Basin						Past Leaded Tank Bottom Storage Area		PDA-2		PDA-4			
	Well 48		Well 50		Well 52		Well B-38		Well W-10		Well W-15		Well W-13	
	1985 (ppb)	1986 (ppb)	1985 (ppb)	1986 (ppb)	1985 (ppb)	1986 (ppb)	1985 (ppb)	1986 (ppb)	1985 (ppb)	1986 (ppb)	1985 (ppb)	1986 (ppb)	1985 (ppb)	1986 (ppb)
Inorganic														
Total Dissolved Solids	485,000	380,000	775,000	375,000	ND	1,010,000	825,000	800,000	660,000	800,000	1,470,000	1,480,000	1,200,000	1,680,000
Specific Conductance	717	734	709	563	1,174	1,570	1,210	708	844	1,190	2,190	2,120	1,880	2,480
Chloride	53,000	43,000	58,000	48,000	85,000	100,000	29,000	27,000	8,500	21,000	45,000	63,000	18,000	63,000
Sulfate	57,000	29,000	13,000	ND	96,000	66,000	49,000	40,000	43,000	54,000	110,000	67,000	5,100	41,000
Total Alkalinity	281,000	289,000	303,000	219,000	445,000	719,000	615,000	677,000	414,000	718,000	1,170,000	1,280,000	1,050,000	1,520,000
Fluoride	400	400	500	300	400	700	500	800	200	400	600	600	500	900
pH	8.09	8.21	8.11	7.09	8.00	7.39	7.98	7.61	7.86	6.93	7.94	7.32	7.82	7.11
Ammonia	NM	4,600	NM	5,100	NM	12,000	NM	5,600	NM	8,300	NM	5,500	NM	20,000
Nitrate+	100	ND	100	ND	ND	ND	ND	ND	ND	ND	ND	ND	6,500	1,000
Total Organic Carbon	20,000	26,000	44,000	32,000	28,000	63,000	49,000	44,000	120,000	65,000	60,000	57,000	70,000	100,00
Metals														
Aluminum	NM	570	NM	ND	NM	180	NM	ND	NM	ND	NM	ND	NM	ND
Antimony	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	3	ND	2	ND
Arsenic	2	5	2	8	6	7	180	45	22	6	7	6	6	ND
Barium	140	130	130	120	150	200	77	98	280	120	120	190	580	410
Beryllium	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Cadmium	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Calcium	66,000	72,000	59,000	54,000	137,000	221,000	137,000	122,000	111,000	94,000	280,000	228,000	250,000	196,000
Chromium	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Cobalt	12	ND	4	ND	7	ND	ND	ND	9	ND	ND	ND	ND	ND
Iron	NM	1,600	NM	510	NM	410	NM	1,800	NM	4,400	NM	110	NM	9,800
Lead	ND	30	ND	ND	ND	30	ND	ND	ND	ND	ND	ND	ND	ND
Magnesium	21,000	18,000	20,000	15,000	21,000	29,000	68,000	71,000	31,000	93,000	120,000	137,000	89,000	188,000
Mercury	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.2	ND	ND	ND	ND
Nickel	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Phosphate	NM	ND	NM	ND	NM	ND	NM	660	NM	ND	NM	ND	NM	ND
Potassium	5,400	6,100	5,600	4,600	7,000	11,000	12,000	9,000	5,800	11,000	16,000	19,000	17,000	18,000
Selenium	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Table 2-2
Results of Groundwater Analyses

Page 2 of 3

Parameters	Guard Basin						Past Leaded Tank Bottom Storage Area		PDA-2		PDA-4			
	Well 48		Well 50		Well 52		Well B-38		Well W-10		Well W-15		Well W-13	
	1985 (ppb)	1986 (ppb)	1985 (ppb)	1986 (ppb)	1985 (ppb)	1986 (ppb)	1985 (ppb)	1986 (ppb)	1985 (ppb)	1986 (ppb)	1985 (ppb)	1986 (ppb)	1985 (ppb)	1986 (ppb)
Silver	4	ND	3	ND	ND	ND	ND	ND	5	ND	ND	ND	ND	ND
Sodium	59,000	46,000	55,000	37,000	85,000	104,000	73,000	48,000	16,000	27,000	61,000	76,000	37,000	121,000
Vanadium	ND	5	ND	3	ND	5	9	7	ND	ND	4	10	ND	3
Volatile Organics														
Benzene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	260	BDL	BDL	BDL	BDL
Carbon disulfide	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Chlorobenzene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Chloroform	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
1,2-Dibromoethane	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
1,2-Dichloroethane	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
1,4-Dioxane	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Methyl ethyl ketone	580	BDL	2,100	BDL	BDL	BDL	BDL	52	BDL	BDL	BDL	BDL	160	BDL
Styrene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Ethyl benzene	BDL	BDL	100	BDL	BDL	BDL	BDL	BDL	1,100	210	BDL	BDL	BDL	BDL
Toluene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Xylene, meta	BDL	BDL	600	BDL	BDL	BDL	BDL	BDL	39,000	4,900	BDL	BDL	BDL	BDL
Xylene, ortho and para	BDL	BDL	120	9	BDL	BDL	BDL	6	29,000	4,100	BDL	BDL	BDL	BDL
Base/Neutral														
Anthracene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Benzo(a)anthracene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Benzo(b)fluoranthene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Benzo(k)fluoranthene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(a)pyrene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Bis(2-ethylhexyl)phthalate	BDL	BDL	53	BDL	35	BDL	BDL	BDL	BDL	BDL	44	BDL	18	BDL
Butyl benzyl phthlate	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Chrysene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Dibenz(a,h)anthracene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Di-n-butyl phthalate	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
1,2-Dichlorobenzene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL

Table 2-2
Results of Groundwater Analyses

Parameters	Guard Basin						Past Leaded Tank Bottom Storage Area		PDA-2		PDA-4			
	Well 48		Well 50		Well 52		Well B-38		Well W-10		Well W-15		Well W-13	
	1985 (ppb)	1986 (ppb)	1985 (ppb)	1986 (ppb)	1985 (ppb)	1986 (ppb)	1985 (ppb)	1986 (ppb)	1985 (ppb)	1986 (ppb)	1985 (ppb)	1986 (ppb)	1985 (ppb)	1986 (ppb)
1,3-Dichlorobenzene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
1,4-Dichlorobenzene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Diethyl phthalate	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
7,12-Dimethylbenz(a)anthracene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Dimethyl phthalate	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Di-n-octyl phthalate	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Fluoranthene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Indene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Methyl chrysene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1-Methylnaphthalene	BDL	BDL	38	25	BDL	BDL	BDL	67	BDL	14	BDL	BDL	BDL	10
Naphthalene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	130	120	BDL	BDL	BDL	16
Phenanthrene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Pyrene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Pyridine	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Quinoline	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Acid Organics														
Benzenethiol	BDL	ND	BDL	ND	BDL	ND	BDL	ND	BDL	ND	BDL	ND	BDL	ND
Ortho-cresol	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Para- and meta-cresol	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	22	BDL	BDL	BDL	BDL
2,4-Dimethylphenol	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	980	290	BDL	BDL	BDL	BDL
2,4-Dinitrophenol	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
4-Nitrophenol	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Phenol	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL

NOTES:

BDL = Below detection limits
ND = Not detected
NA = Not analyzed

All units are given in parts per billion except pH and Specific Conductance which are given in units and umhos/cm, respectively.

South Yard

The South Yard is 372.6 acres in size and is located east of the Schuylkill River in the south portion of the property. It is bounded by the Schuylkill River to the northwest, by Passyunk Avenue to the north northeast, by 26th Street to the east, and by Penrose Avenue and Laner Avenues to the southeast and southwest (Figure 1-1).

This has been an active refinery process area since at least the early 1950s. In the 1970s, there was a general restructuring and modernization of the entire refinery during which the South Yard waste water treatment plant was built (GES, 1989). A large portion of this area is utilized as tank farms for storing crude oil, fuel oil, and gasoline.

The EPA has identified one SWMU (the guard basin) in this area requiring additional investigation (Figure 2-3). The guard basin, which was built in 1959, is used to store stormwater runoff from the South Yard. It has also been referred to as the No. 4 Farm Stormwater Surge Pond. The guard basin has a surface area of 4.5 acres and is capable of storing 7.5 million gallons of water (GES, 1989). Stormwater is directed into a separator where sediment is allowed to settle out before flowing through an open channel, past an oil skimmer, and into the guard basin. A minimum water level must be maintained in the basin at all times for the skimmer to work; otherwise, water underflows the weir and by-passes the oil skimmer. GES (1989) reported that water that is pumped into the guard basin is sent through an oil/water separator first. Water discharges from the guard basin via an outfall pipe under the access road and berm located along the southwest edge of the guard basin into a bermed low-lying area. Accumulated water is pumped from this area as needed and discharged to the Schuylkill River through an NPDES outfall.

There are also several PDAs, a drum storage area, storage tanks, and a former railroad car yard in the South Yard. PDA's "A", "B", and "C" are located adjacent to and north-east of the guard basin (Figure 2-3). These PDAs received various refinery wastes including tower sludges, leaded tank bottom sludge, and spent catalyst as well as other unidentified wastes.

Monitoring wells in the South Yard show the depth to groundwater ranges from 6 to 34 feet below land surface. Free product in some of these wells was as thick as 7.5 feet during 1985 to 1988. Monitoring wells 50, 52, and 48 are located adjacent to and along the southwest edge of the basin (Figure 2-4). Groundwater analyses from these wells are shown in Table 2-1. Groundwater from these wells yielded a maximum level of VOCs of 110 ppm in 1985 and a maximum level of base neutral compounds of 7.98 ppm in 1986.

Soil samples collected from the nearby PDAs also show the presence of metals, base neutral-, and acid extractable-organics. Lead levels have been detected in nearby soils of 1,700 ppm (PDA "A", Well S-30), 1,600 ppm (PDA "B", Well S-43), and 2,100 ppm (near the rail yard, well S-51). The complete results of these analyses are shown in Table 2-1.

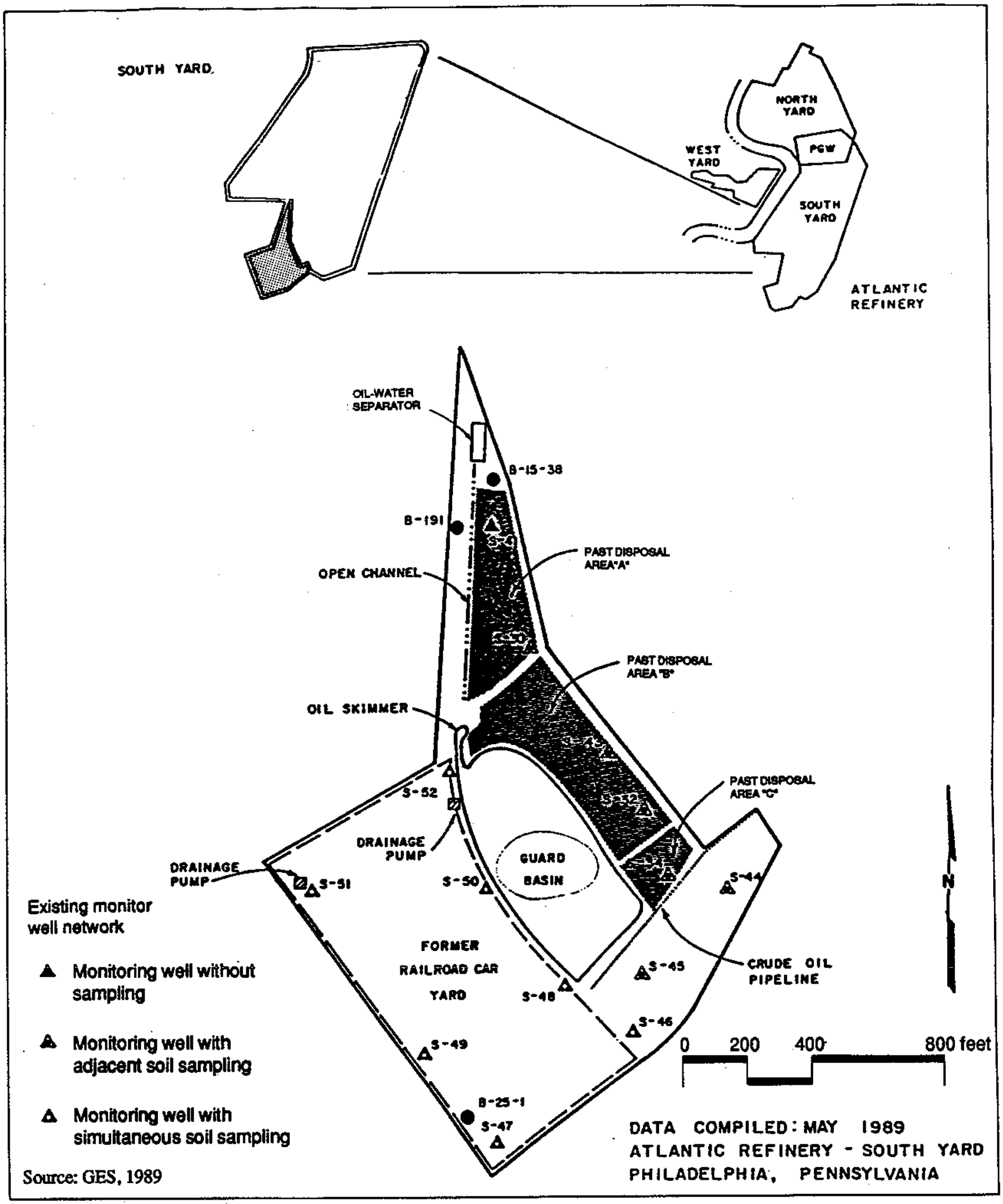


Figure 2-3

Map of Guard Basin and Vicinity

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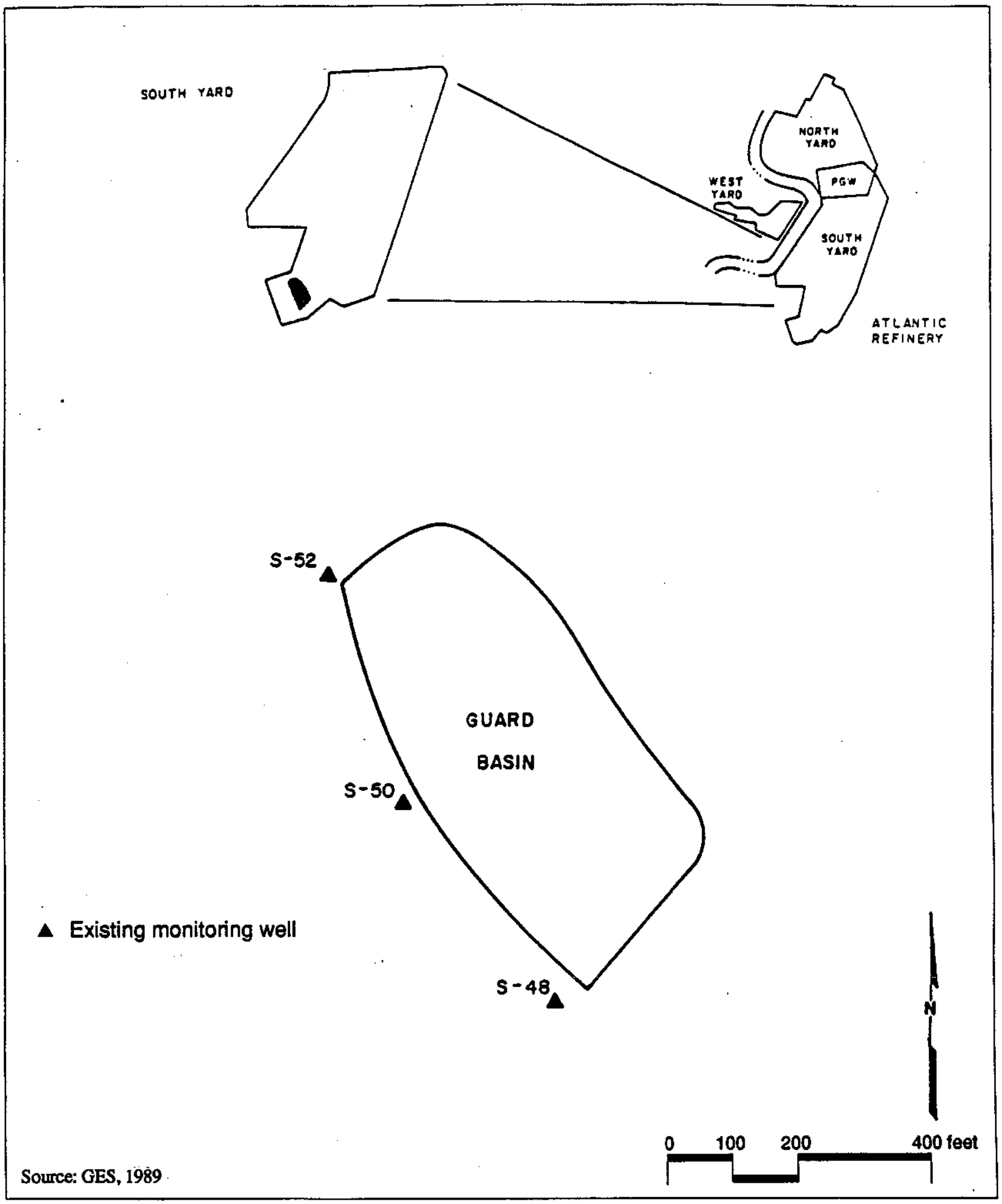

Figure 2-4

Existing Monitoring Well Locations at the Guard Basin

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West Yard

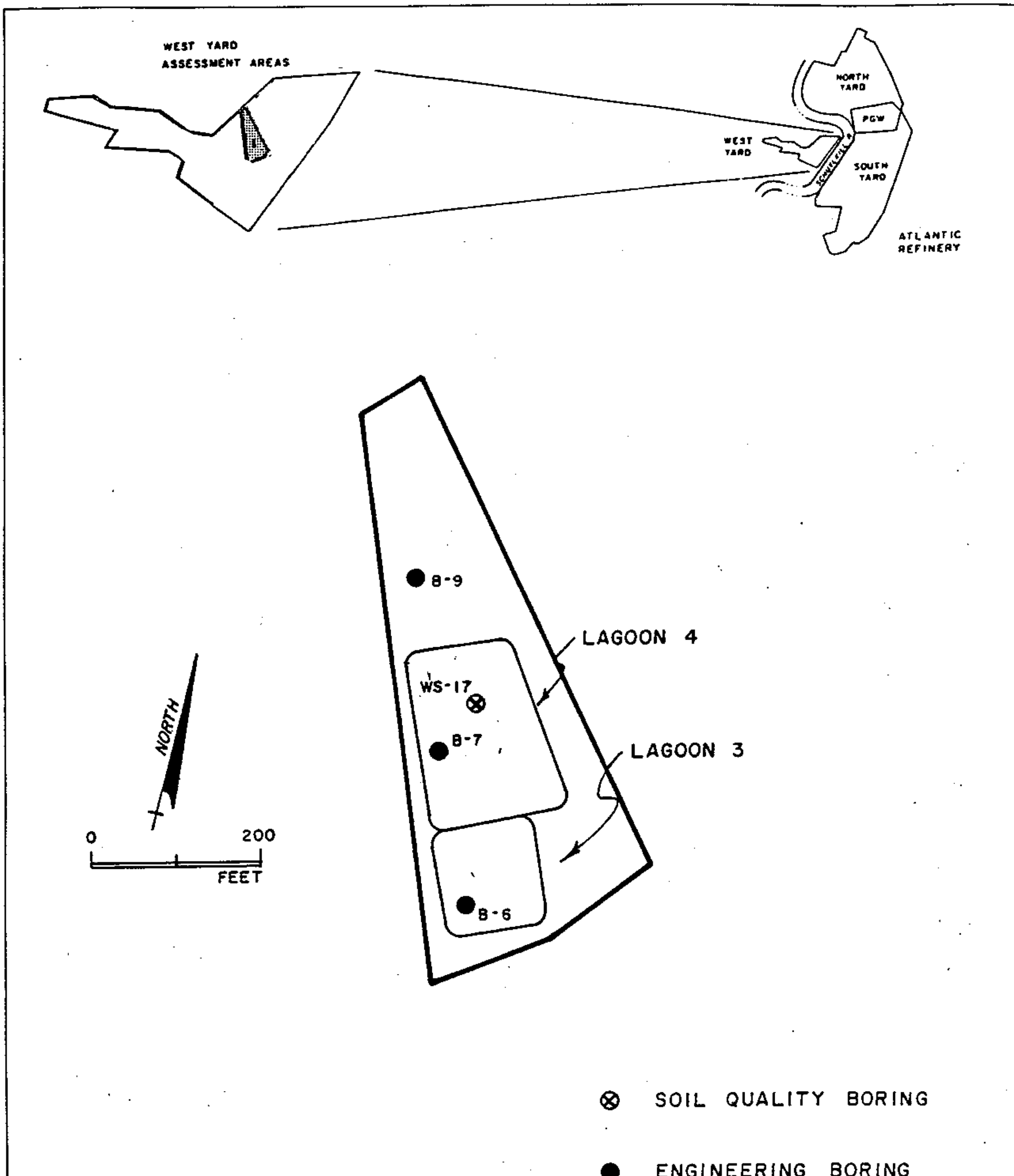
The West Yard is 52.5 acres in size and is located west of the Schuylkill River across from the northern portion of the South Yard. It is bounded by Passyunk Avenue to the north-northwest, by the Schuylkill River to the southeast, and by industrial properties to the southwest (Figure 1-1). The West Yard contains the past disposal areas PDA No. 1 (Figure 2-5); PDA No. 2 (Figure 2-6); PDA No. 3 (Figure 2-7); and PDA No. 4 (Figure 2-8).

These four PDA's in the West Yard comprise three of the SWMUs (PDA No. 1, PDA No. 2, and PDAs No. 3 and No. 4) (Figure 2-9) identified by the EPA at this facility. According to ARCO, these PDAs received waste ranging from refinery process wastes to trash until 1970 (ARCO memo, April 1980). The PDAs consisted of lagoons, seepage pits, and landfills. In 1980, Dames and Moore was retained by ARCO to design and install caps for PDA Nos. 1 and 2, and was told that none of the wastes disposed of in these areas would generate landfill gas if capped. According to GES (1989) cap leakage and asphaltic seeps have been observed on the top and sides of PDAs No. 1 and No. 2.

The landfill caps were constructed by grading the waste piles with several feet of crushed rock, then capping this with 0.5 to 2.0 feet of compacted clay. The clay permeability is reported to be 10^{-7} cm/sec. A final layer, also 0.5 to 2.0 feet thick and suitable for supporting vegetation, was then placed over the clay. Although these clay caps cracked and leaked during the summer following their installation (ARCO memo, July, 1980), K.W. Brown and Associates (April, 1989) noted during a January 1989 site inspection that there was no evidence of a "continuing release of hazardous materials." Dames and Moore (1980) provided support to ARCO to repair the cracked covers and noted that these failures were more likely to occur during hot summer months.

There are reportedly six monitoring wells located throughout the West Yard that show depths to groundwater ranging from 2 to 15 feet below land surface. Many groundwater samples show contamination by base neutral and volatile organic compounds. Most soil samples also had detectable levels of base neutral compounds and some soil borings intercepted petroleum saturated soil below the land surface.

In 1985 and 1986, Rocky Mountain Analytical Laboratory conducted a groundwater and soil sampling and analysis program for the Philadelphia Refinery. In the West Yard, groundwater samples were obtained from PDA Nos. 2 and 4. Soil samples were collected (in 1985 only) from all of the SWMUs (PDA Nos. 1, 2, 3 and 4). The results of these analyses are shown in Tables 2-1 and 2-2.



Source: GES, 1989

Figure 2-5

PDA-1

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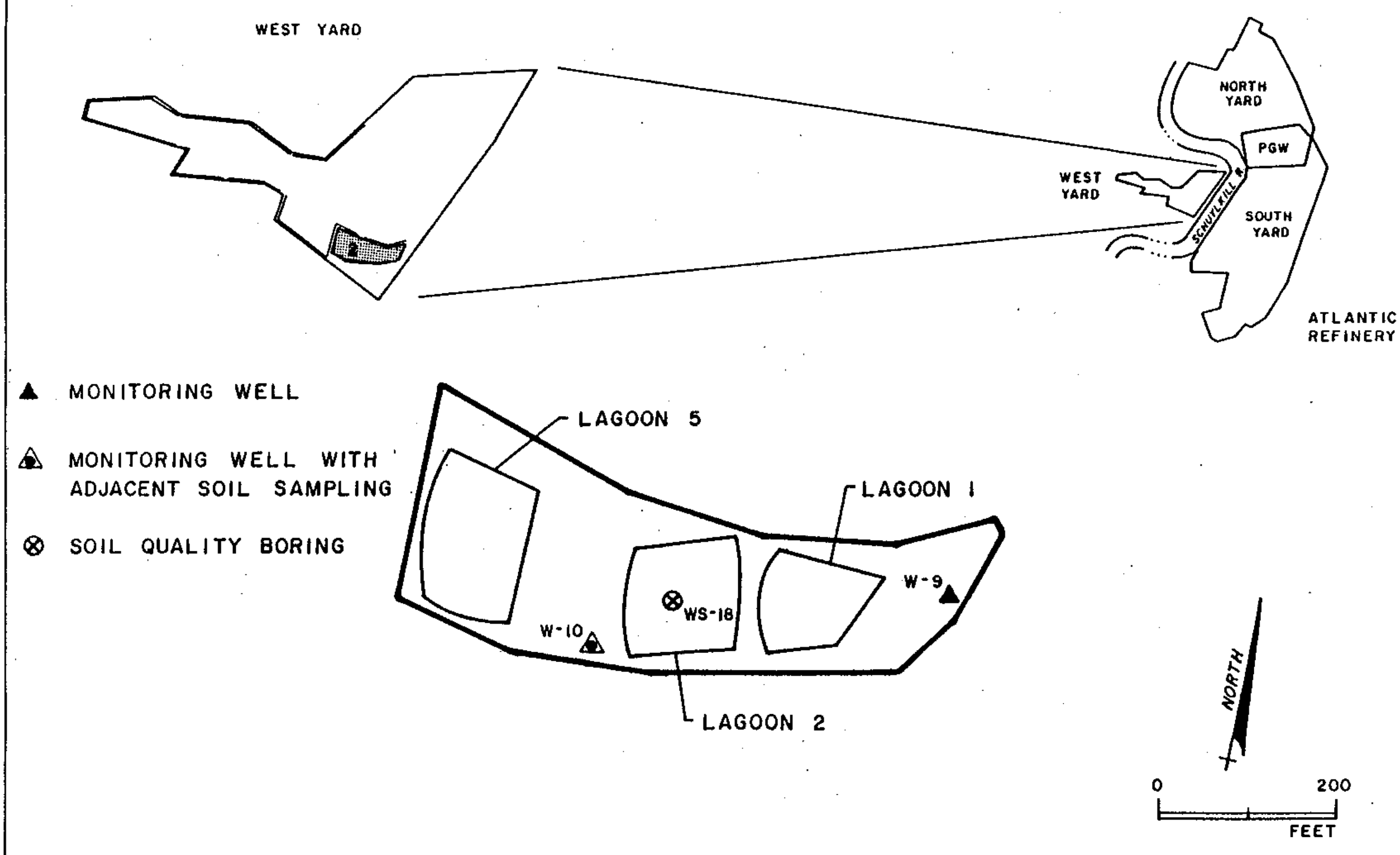
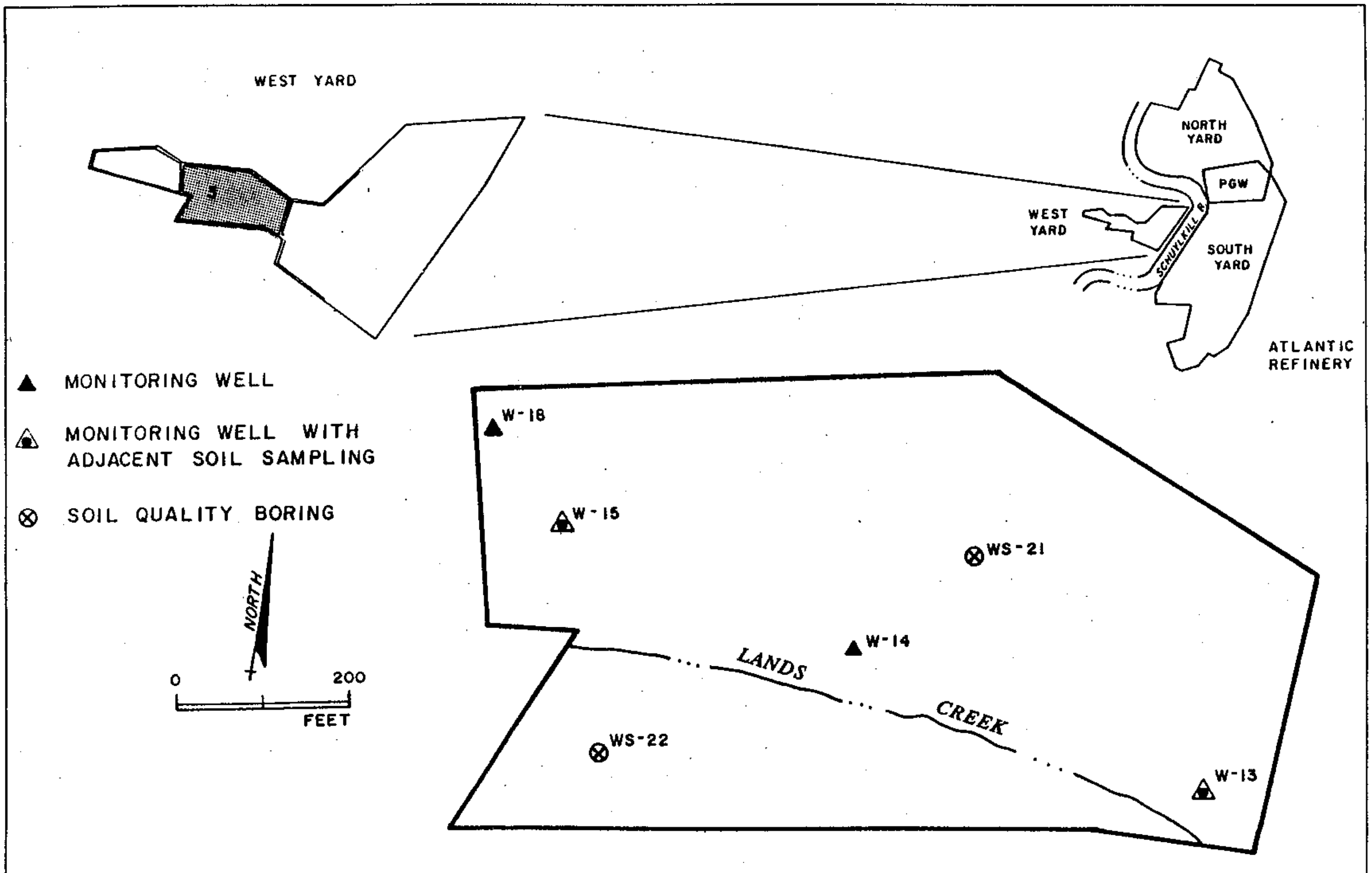


Source: GES, 1989

Figure 2-6

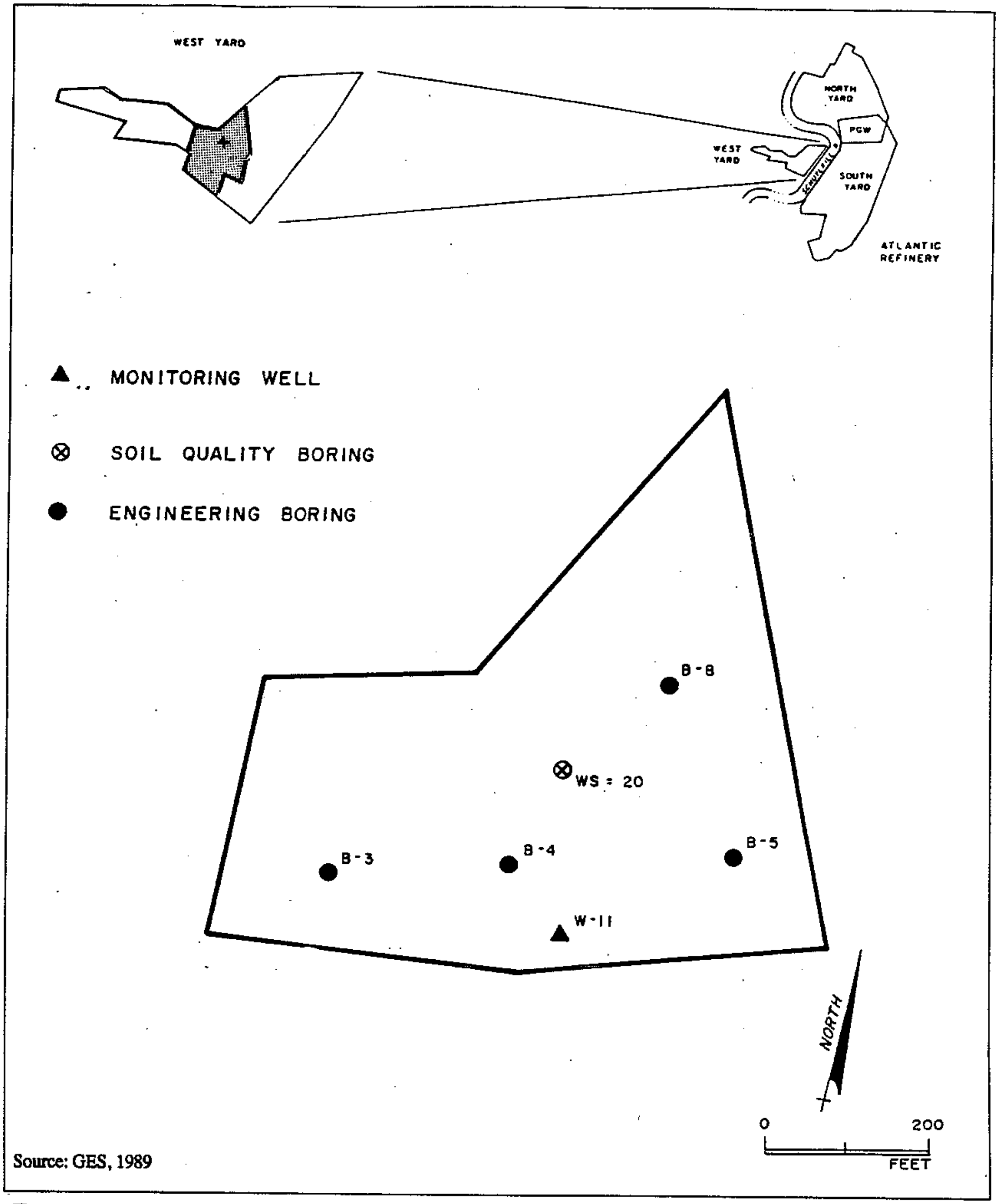
PDA-2



Source: GES, 1989

Figure 2-7

PDA-3



Source: GES, 1989

Figure 2-8

PDA-4

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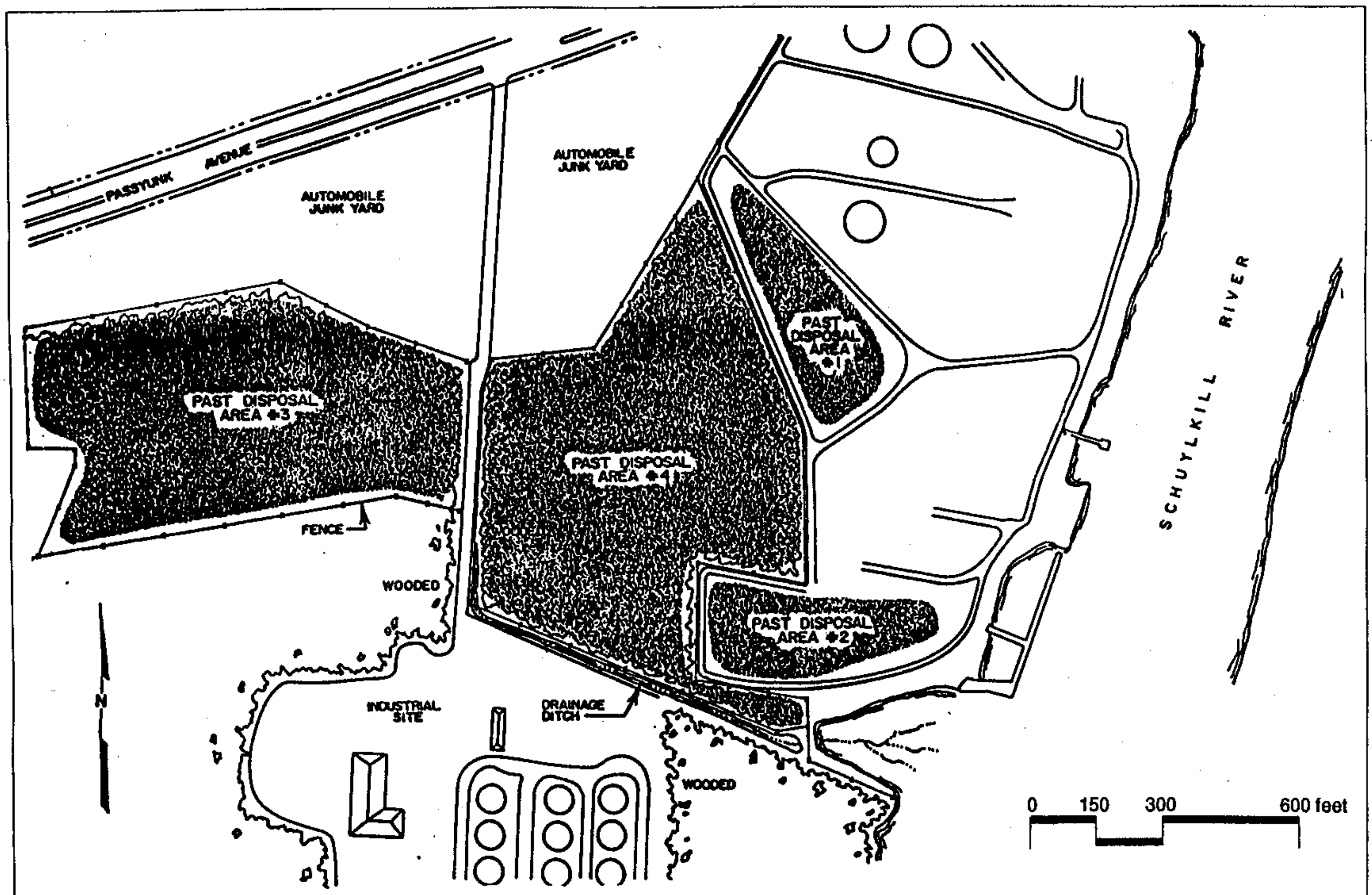

Figure 2-9

Location Map of Past Disposal Areas 1-4

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WASTE GENERATION AND MANAGEMENT

ARCO divided its waste stream into four categories. Category 1 and 2 Solid Wastes described below and in the *Atlantic Richfield Company, Point Breeze Refinery, Solid Waste Disposal Guidelines*, issued in September 1976 appear to have been disposed of within or near the EPA SWMUs. No basis was provided for the various categories, but they appear to be broken down according to the hazardousness of the material.

Category 1 Solid Wastes

Category 1 solid wastes were designated as those which require special consideration and handling during disposal. These wastes included:

- Bender catalyst
- Leaded tank bottoms

The disposal guidelines do not indicate the designated disposal areas for these materials. However, there are leaded tank bottom disposal areas in the North Yard.

Category 2 Solid Wastes

Category 2 solid waste materials were disposed of by spreading them out on the ground or using them as inert fill in designated areas. These wastes included the following:

- Alundum Balls
- A.P.Green KD-2 Refractory
- Attapulgas Clay (clean or mixed with dirt)
- Bauxite catalyst (clean and spent)
- C11-2-06 H_2 plant catalyst
- Calcium carbonate
- Ferrous sulfate
- HDS catalyst, mixed with dirt
- Sand, demineralizer
- Sand, blasting, contaminated
- Sand, blasting, spent
- Sludge, cooling tower
- Sulfur, elemental (uncontaminated and/or contaminated with dirt)

The Atlantic Richfield Solid Waste Disposal Guidelines, September 1976, indicate that Category 2 wastes were disposed of in South Yard PDAs located adjacent to and north of the guard basin.

In 1980, ARCO recognized that the passage of RCRA in 1976, and the startup of their land farm in the North Yard in 1979 "significantly altered solid waste practices at the Philadelphia refinery" and that the 1976 *Solid Waste Disposal Guidelines* were outdated.

At that point, most disposal areas had been closed for several years. In April 1980, there were four active waste disposal/storage areas in the refinery:

- Two drum storage areas located on concrete pads in the north and south yards
- One land farm in the north yard permitted by the Pennsylvania Department of Environmental Resources (PADER)
- One diked concrete pad in the north yard, used to weather leaded sludge

The exact location of each of these areas, along with a listing of the approved waste stream for each area and the rules and regulations to follow for waste disposal, are given in ARCO's *Revised Solid Waste Disposal Guidelines*, issued in September 1976.

PREVIOUS SITE INVESTIGATIONS AND EVALUATIONS

The following is a list of previous RCRA and other significant site investigations and evaluations used in this work plan, listed in chronological order.

MacPhee, A.V., Keers, L.M., and Condon, M.M. *Geological Evaluation of Atlantic Richfield's Philadelphia Refinery*. CVM Industries, Inc. (Geotechnical Division). June 10, 1985

Results from a Site Investigation at ARCO's Philadelphia Refinery. Rocky Mountain Analytical Laboratory. November 8, 1985.

Kearney, A.T., Inc., *Phase I Preliminary Review of Solid Waste Management Units at ARCO, Philadelphia PA*. January 1986.

Kearney, A.T., Inc., *Phase II Report, RCRA Facility Assessment, Atlantic Refining and Marketing Corporation, EPA I.D. # PAD 002-289-700*. August 1986.

1985 and 1986 Data Comparison for Atlantic Refinery, Parts I and II. Rocky Mountain Analytical Laboratory. November 15, 1986.

1985 and 1986 Data Comparison for Atlantic Refinery, Parts I and II. Rocky Mountain Analytical Laboratory. November 15, 1986.

Hydrocarbon Recovery Assessment, Atlantic Refinery, Philadelphia, Pennsylvania. Engineering Enterprises, Inc. (EEI). 1987.

NUS Corporation, Superfund Division, *Field Investigation Team Activities at Uncontrolled Hazardous Substances Facilities - Zone I*. April 1988.

Draft of US EPA, Permit, Corrective Action and Waste Minimization Under the Hazardous and Solid Waste Amendments of 1984. August 9, 1988.

Final US EPA Corrective Action and Waste Minimization Permit under the Hazardous and Solid Waste Amendments of 1984. December 9, 1988.

Notification from EPA of their final decision to issue a corrective action permit to Atlantic Refining and Marketing. This permit became effective December 9, 1988. Included with the notification were the following:

- *Permit Conditions for the Corrective Action and Waste Minimization Portion of the Final Draft Permit*
- NUS Fact Sheet
- EPA Comments (to fact sheet)
- Atlantic Comments (to fact sheet)

K.W. Brown and Associates. *Verification Investigation Work Plan.* April 1989

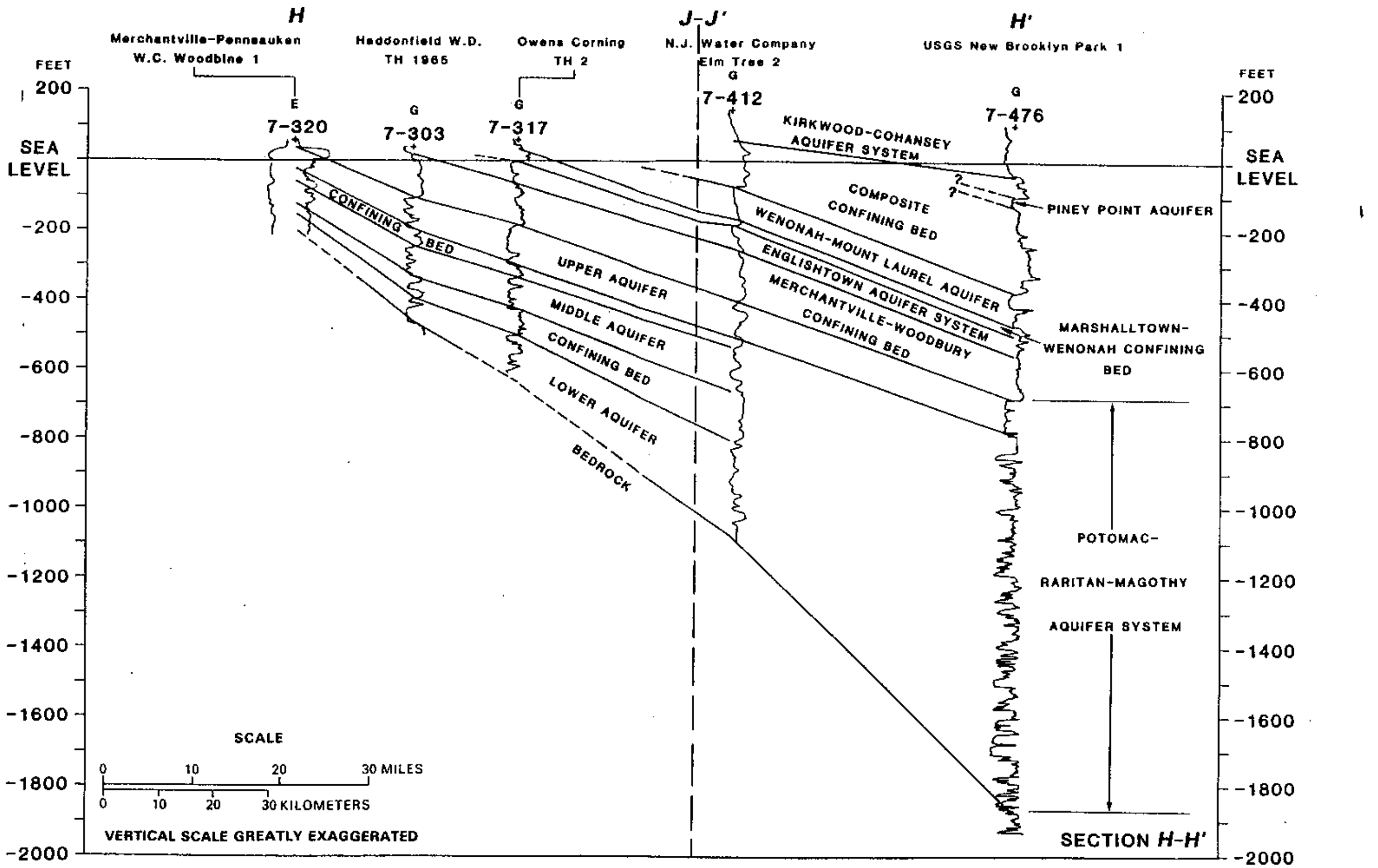
GES, *Environmental Assessment, Atlantic Refinery and Marketing. 1989 - 1990*

GEOLOGY AND HYDROGEOLOGY

REGIONAL GEOLOGY

The site is located along the westernmost boundary of the Coastal Plain physiographic province adjacent to a geologic zone known as the "Fall Line." The Coastal Plain is characterized by a southeasterly thickening wedge of unconsolidated sand, silt, clay, and gravel (Figures 2-10 and 2-11). This wedge is greater than 6,500 feet thick in Cape May, New Jersey, thinning to a featheredge along its western boundary just west of the Delaware River. Coastal Plain sediments were deposited by transgressive and regressive sequences of the ocean (rise and fall of sea level), and by associated fluvial and deltaic processes (rivers and bays) during portions of the Cretaceous, Tertiary, and Quaternary Periods of the earth's history.

West of the Delaware River, the Coastal Plain is relatively thin (generally less than 100 feet thick), consisting primarily of the Potomac Group and Raritan Formation (the lowermost unit of the Coastal Plain in this area) overlain by Quaternary and Holocene Deposits (youngest Coastal Plain Deposits) (Zapecza, 1989; Greenman and others, 1961) (Figure 2-12). Adjacent to the Delaware and Schuylkill Rivers, most of the Quaternary sediments have been removed by erosion (Greenman and others, 1961).



Source: Zapecza, 1989

Figure 2-10

Generalized Cross Section of the Coastal Plain Sediments

CH2M HILL

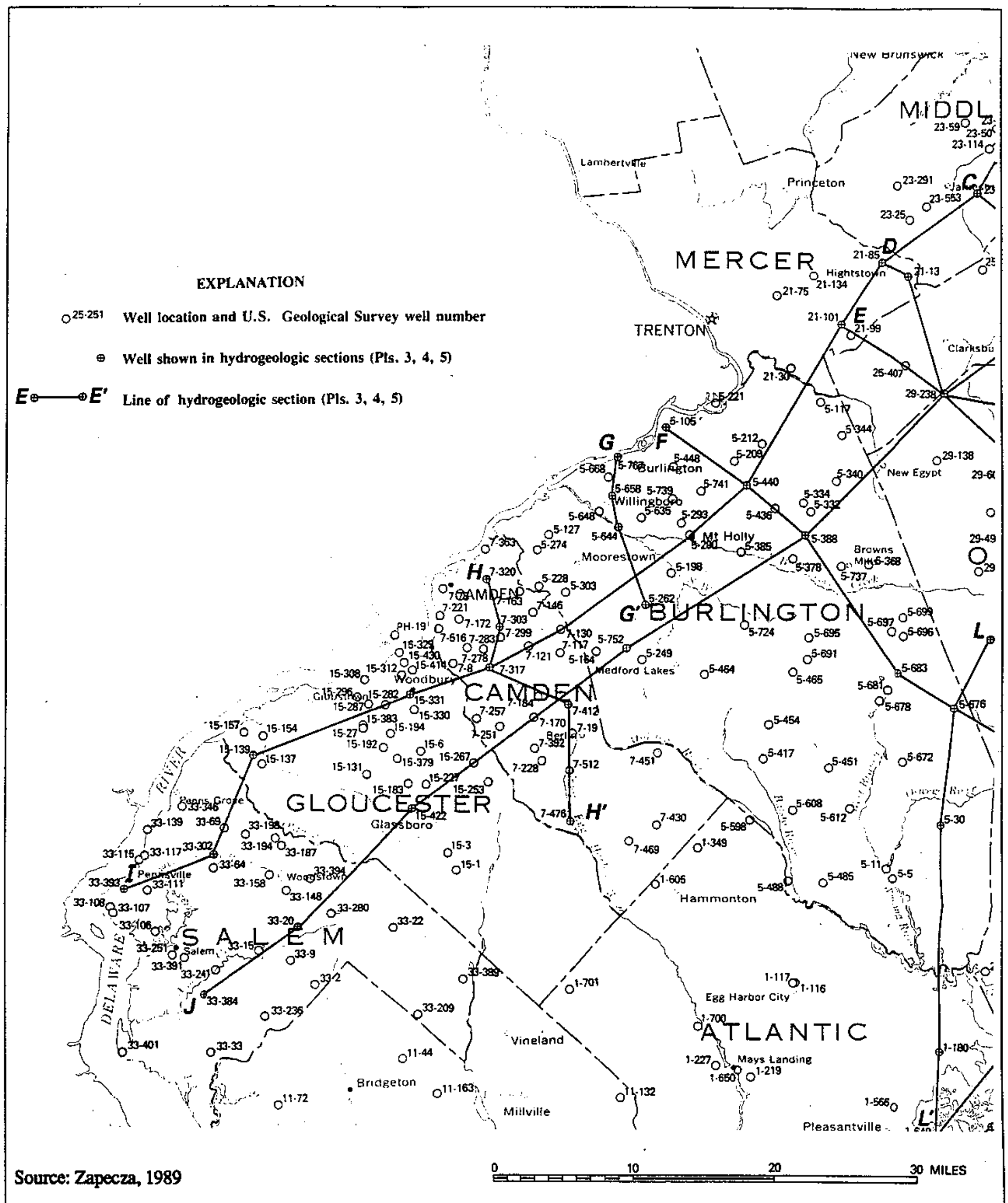


Figure 2-11

Cross-Section H-H' Location Map

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CH2M HILL

REGIONAL AQUIFER-SYSTEM ANALYSIS

TABLE 2.—*Geologic and hydrogeologic units in the New Jersey Coastal Plain*

SYSTEM	SERIES	GEOLOGIC UNIT	LITHOLOGY	HYDROGEOLOGIC UNIT	HYDROLOGIC CHARACTERISTICS
Quaternary	Holocene	Alluvial deposits	Sand, silt, and black mud	Undifferentiated	Surfical material, often hydraulically connected to underlying aquifers. Locally some units may act as confining beds. Thicker sands are capable of yielding large quantities of water
		Beach sand and gravel	Sand, quartz, light-colored, medium- to coarse-grained, pebbly		
	Pleistocene	Cape May Formation	Sand, quartz, light-colored, heterogeneous, clayey, pebbly		
Tertiary	Miocene	Pensauken Formation			
		Bridgeton Formation		Kirkwood-Cohansey aquifer system	A major aquifer system. Ground water occurs generally under water-table conditions. In Cape May County the Cohansey Sand is a confined aquifer
		Beacon Hill Gravel	Gravel, quartz, light-colored, sandy		
		Cohansey Sand	Sand, quartz, light-colored, medium- to coarse-grained, pebbly; local clay beds		
		Kirkwood Formation	Sand, quartz, gray and tan, very fine to medium-grained, micaceous, and dark-colored diatomaceous clay	Confining bed Rio Grande w-b[1,2] Confining bed[2]	Thick diatomaceous clay bed occurs along coast and for a short distance inland. A thin water-bearing sand occurs within the middle of this unit
				Atlantic City 800-foot sand	A major aquifer along the coast
				Composite confining bed	Alloway Clay Member or equivalent
	Eocene	Piney Point Formation	Sand, quartz and glauconite, fine- to coarse-grained	Piney Point aquifer	Yields moderate quantities of water locally
		Shark River Formation	Clay, silty and sandy, glauconitic, green, gray, and brown, fined-grained quartz sand		Poorly permeable sediments
		Manasquan Formation			
	Paleocene	Vincentown Formation	Sand, quartz, gray and green, fine- to coarse-grained, glauconitic, and brown, clayey, very fossiliferous, glauconite and quartz calcarenite	Vincentown aquifer	Yields small to moderate quantities of water in and near its outcrop area.
		Hornerstown Sand	Sand, clayey, glauconitic, dark green, fine- to coarse-grained		Poorly permeable sediments
Cretaceous	Upper Cretaceous	Tinton Sand	Sand, quartz, and glauconite, brown and gray, fine- to coarse-grained, clayey, micaceous		
		Red Bank Sand		Red Bank Sand[2]	Yields small quantities of water in and near its outcrop area
		Navesink Formation	Sand, clayey, silty, glauconitic, green and black, medium- to coarse-grained		Poorly permeable sediments
		Mount Laurel Sand	Sand, quartz, brown and gray, fine- to coarse-grained, slightly glauconitic	Wenonah-Mount Laurel aquifer	A major aquifer
		Wenonah Formation	Sand, very fine to fine-grained, gray and brown, silty, slightly glauconitic		
		Marshalltown Formation	Clay, silty, dark greenish-gray, glauconitic quartz sand	Marshalltown-Wenonah confining bed	A leaky confining bed
		Englishtown Formation	Sand, quartz, tan and gray, fine- to medium-grained; local clay beds	Englishtown aquifer system	A major aquifer. Two sand units in Monmouth and Ocean Counties
		Woodbury Clay	Clay, gray and black, micaceous silt	Merchantville-Woodbury confining bed	A major confining bed. Locally the Merchantville Fm. may contain a thin water-bearing sand
		Merchantville Formation	Clay, glauconitic, micaceous, gray and black; locally very fine grained quartz and glauconitic sand		
		Magothy Formation	Sand, quartz, light-gray, fine- to coarse-grained; local beds of dark-gray lignitic clay	Potomac-Raritan-Magothy aquifer: Upper aquifer	A major aquifer system. In the northern Coastal Plain, the upper aquifer is equivalent to the Old Bridge aquifer and the middle aquifer is the equivalent of the Farrington aquifer. In the Delaware River Valley, three aquifers are recognized. In the deeper subsurface, units below the upper aquifer are undifferentiated
		Raritan Formation	Sand, quartz, light-gray, fine- to coarse-grained, pebbly, arkosic, red, white, and variegated clay	Conf. bed Middle aquifer	
	Lower Cretaceous	Potomac Group	Alternating clay, silt, sand, and gravel	Conf. bed Lower aquifer	
Pre-Cretaceous		Bedrock	Precambrian and lower Paleozoic crystalline rocks, metamorphic schist and gneiss; locally Triassic basalt, sandstone, and shale and Jurassic diabase	Bedrock confining bed	No wells obtain water from these consolidated rocks, except along the Fall Line

Absent in Pennsylvania (bracket spanning Tertiary units through Magothy Formation)

[1] Rio Grande water-bearing zone
[2] Minor aquifer not mapped in this report.

Modified from Seaber, 1965, table 3

Source: Zapecza, 1989

Figure 2-12

Geologic and Hydrogeologic Units in the New Jersey Coastal Plain

PHL31374.AO/fmtrist4

CH2M HILL

In Pennsylvania, the Potomac Group and Raritan Formation represent nonmarine sediments, often deposited in upward fining cycles. Typically, each cycle begins with a series of coarse detrital deposits and closes with a series of silts and clays (Greenman, 1961). Greenman and others (1961) interpreted these cycles as corresponding to the units of the Raritan Formation identified within the Raritan Embayment to the northeast. From oldest to youngest, the units that make up the Raritan Formation are the Raritan Fire Clay, the Farrington Sand, the Woodbridge Clay, the Sayreville Sand, the South Amboy Fire Clay, the Old Bridge Sand, and the Amboy Stoneware Clay. However, Owens and Sohl (1969), state that the lithologic subdivisions of the Raritan Formation are not evident in the outcrops near the Delaware River. Because of the difficulty recognizing and differentiating these units, especially in South Jersey and Pennsylvania, many hydrogeologists divide the Potomac-Raritan-Magothy (the Magothy portion is generally not present in Pennsylvania) aquifer system (PRM) into the lower, middle, and upper aquifers (Figures 2-12 and 2-13). Each aquifer represents a sequence of more permeable sediments (gravel, sand and silt) overlain by an impermeable confining unit of silt and clay. In Pennsylvania, the lowermost clay separating the crystalline rocks of the Piedmont from the Coastal Plain is saprolite (decomposed bedrock).

The easternmost boundary of the Piedmont physiographic province is located just west of the study area. This province is characterized by Precambrian crystalline igneous and metamorphic rocks. Younger Coastal Plain sediments were deposited on top of the (older) Piedmont rocks and the crystalline bedrock occurs (with increasing depth to the southeast) under the Coastal Plain sediments in this area. In the areas adjacent to the Schuylkill and Delaware Rivers, the top of the crystalline units have been scoured by the ancestral channels of these rivers and now form buried valleys. These buried river valleys are typically filled with coarse, highly permeable channel deposits (Greenman and others, 1961). Four such channels have been identified in the south Philadelphia area trending south to southeast in the areas of Point Breeze, League Island, Greenwich Point, and Washington Square.

The Fall Line marks the boundary between the Coastal Plain and the Piedmont Provinces, and is so called because the change in elevation from the crystalline rocks to the sedimentary units produces a zone in which waterfalls are common.

REGIONAL HYDROGEOLOGY

Groundwater is generally abundant within the Coastal Plain. Where the units are sufficiently thick and permeable (containing abundant sand and/or gravel) they form aquifers. Where the units are relatively impermeable (abundant clay and silt), they form aquicludes or confining units.

In Philadelphia County, the lower and middle PRM aquifers are sufficiently thick and permeable in places to be high yielding (Hall, 1973; Greenman, 1961). The clay confining units are discontinuous in places and, where the clay layer is thin or lacking, the two units are nearly indistinguishable and function as one hydrogeologic unit.

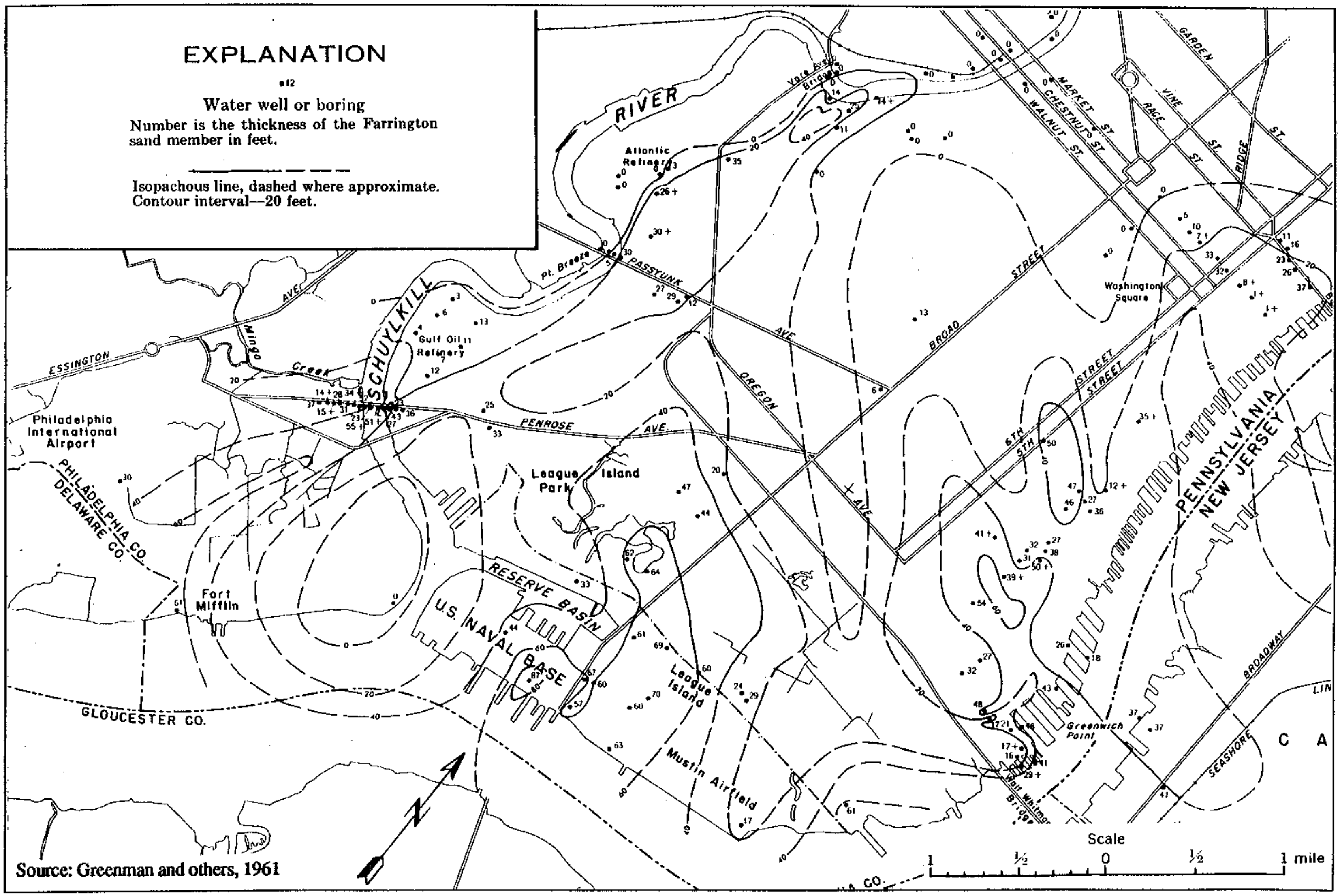

Figure 2-13

Thickness and Updip Limit of the Lower Aquifer of the Potomac Group and Raritan Formation in the Vicinity of the Atlantic Refinery (now Sun Oil)

CH2M HILL

Although the Coastal Plain of Pennsylvania has the potential to yield large, generally reliable supplies of groundwater, most water supplies in Philadelphia have been obtained from the Schuylkill and Delaware Rivers. This is due in part to the susceptibility of the sand and gravel aquifers to contamination, especially in the industrialized areas along the Schuylkill and Delaware Rivers. South Philadelphia has a long history of industrial land use, and groundwater contamination is common (Hall, 1973). Where there are functioning wells in southwest Philadelphia, most are only used to supply industrial water.

SITE GEOLOGY

ARCO has kept an extensive collection of boring logs for this site dating back to 1860. In 1985, C.V.M. Industries was retained by ARCO to conduct a geologic evaluation of the site. In reviewing the available boring logs, C.V.M. Industries noted that, although the collection of boring logs was extensive, they were in many cases not suitable for use in a comprehensive geologic evaluation. This is primarily due to the lack of standardization in soil descriptions and to poor location records. In addition to the boring logs provided by Atlantic, C.V.M. Industries installed a series of boring throughout the site to confirm existing data and obtain information where borings were lacking.

The C.V.M. Industries study evaluated the North, South, and West yards of the refinery. The borings showed that bedrock consists of undifferentiated gneiss and mica schist of the Wissahickon Formation and/or possibly the Baltimore Gneiss. The depth to bedrock across the site ranges from 20 feet at an elevation of -5 feet msl to 100 feet at an elevation of -80 feet msl. The boring program showed that the site has been criss-crossed by a number of river channels by the meandering actions of both the Schuylkill and Delaware Rivers.

North and South Yards

In general, the stratigraphy of the South Yard is more orderly than that of the North Yard. In the North Yard, sediments display a complex stratigraphy with many rapid horizontal and vertical gradations from coarse to fine-grained deposits. The prominent materials are silty sands and sandy silts and, in many cases, appear to be recent river alluvium. In the South Yard, the alluvium overlies a more orderly sequence of Cretaceous sediments and extends to elevations ranging between -25 feet msl and -55 feet msl. Since the site elevation is approximately 15 to 20 feet above msl, the river alluvium in the South Yard is approximately 40 to 75 feet thick.

Soil borings installed by Sprague and Henwood in 1956 show the subsurface in the North Yard adjacent to the Past Leaded Tank Bottom Storage Area (the North Yard SWMU) consists of approximately 12 to 14 inches of cinder and brick fill material underlain by 3 to 4 feet of river silt and decomposed vegetation. This is underlain by thin discontinuous layers of silt and sand overlying a thin (variable width) layer of sand, gravel, and decomposed mica schist. Top of bedrock occurs at elevation -43 feet msl in Boring No. 17 and -54 feet msl in Boring No. 18 (Figure 2-2). This stratigraphic sequence is typical of a meandering river channel deposit.

West Yard

Coastal Plain sediments in the West Yard primarily consist of recent alluvium overlying a thin veneer of Cretaceous sediments. As with the rest of this site, the natural deposits have been overlain by fill material. The recent alluvium was deposited by the Schuylkill and (in earlier times) the Delaware Rivers and consists of organic river silts, silty clay, silty sand, and occasionally, gravel deposits. The underlying Cretaceous sedimentary sequences have been interrupted by frequent erosional events and are poorly sorted and defined in the West Yard (C.V.M. Industries, 1985).

The entire site has been covered with a "stratum" of fill. Historically, the fill was used to reclaim (fill in) wetlands, obtain a desired grade, and to dispose of industrial waste, mainly coal, cinder, and ash. More recent fill material generally consists of soil and crushed rock. In the North Yard, there is a major north-south trending depressed area, interpreted to be a former tidal inlet that was been filled in (C.V.M. Industries, 1985).

The nature of the fill material across the site ranges from large structure foundations including piles and foundation walls, to a wide range of soil sizes.

SITE HYDROGEOLOGY

Although there are numerous monitoring wells installed throughout this site, a comprehensive hydrogeologic study for the purpose of characterizing the groundwater flow system has not been undertaken at this site. Hydrogeologic information given in this section are primarily based on a study conducted by Engineering Enterprises, Inc. (EEI, 1987). The purpose of this study was to evaluate the hydrocarbon recovery effort at the facility. All hydrogeologic conclusions for this facility are based on measuring hydraulic head in the monitoring wells in the North and South Yards, on one short step test in the North Yard, on several short vacuum recovery pumping tests in the South Yard, and on one 15-hour pumping test on Well No. 102 in the South Yard.

North Yard

Groundwater monitoring of the north yard suggests that there are three distinct hydrogeologic systems in this area, with the Rambo Creek fill acting as fourth system (EEI, 1987). EEI (1987) interprets these systems as follows:

- A deep confined aquifer which occupies the Farrington Sand (Middle Aquifer) unit of the Cretaceous age Potomac-Raritan System.
- An upper water table aquifer or water-bearing zone that occurs between the upper portion of the Cretaceous sediments and the base of the overlying Pleistocene sediments.
- A perched alluvium and fill water table aquifer
- A Rambo Creek fill aquifer (possibly)

The perched groundwater system that occurs at the interface between the fill and the uppermost naturally occurring Pleistocene sediments does not appear to be very well connected to the underlying naturally occurring water table aquifer. This interpretation is based on the average 3-foot difference seen between the two zones in 1987 (EEI, 1987).

The old Rambo Creek stream channel runs through the Pleistocene aquifer and has been filled with over 10 feet of cinders and ash. Water levels in the Rambo Creek channel are significantly less than those in the adjacent Pleistocene aquifer and there appears to be no deflection of groundwater in the Pleistocene aquifer toward the lower hydraulic head of the Rambo Creek (EEI, 1987). The lower water table elevations in the Rambo Creek channel suggests that this unit is hydrogeologically separated from the Pleistocene aquifer, and may be hydrogeologically connected to the Schuylkill River or may be drained by the city sewer system (EEI, 1987).

A short step test was conducted on Well W-6 in the North Yard. Although this test was not very comprehensive, the results of this test suggest that the transmissivity of the of perched alluvial-fill system is approximately 700 gallons per day per foot (gpd/ft). Permeability data from the North Yard range from less than 1 gallon per day per square foot (gpd/ft^2) to over 250 gpd/ft^2 (EEI, 1987).

In the vicinity of the North Yard SWMU (Past Leaded Tank Bottom Storage Area), groundwater elevations (Sprague and Henwood, 1952) from Boring Nos. 17 and 18 indicate that groundwater at Boring No. 18 may be upgradient from Boring No. 17. However, this data is suspect since no information is available to indicate the method or circumstances under which this data was obtained. Groundwater flow direction in the vicinity of this SWMU cannot be determined from this data. However, EEI (1987) measured groundwater elevations under a tank farm located approximately 2,000 yards northeast of this SWMU. These elevations showed shallow groundwater flow to be south under the tank farm, changing to the west just south of the tank farm.

South Yard

EEI (1987) identified only two aquifers in the unconsolidated sediments in the South Yard. The deepest is a confined aquifer that occurs in the Cretaceous Age sediments of the Potomac-Raritan system. This is overlain by a water table aquifer that occurs in the Pleistocene and younger sediments. In 1987, the deeper, confined aquifer was only penetrated by two wells along the eastern margin of the South Yard.

Boring log data indicate that the bulk of the shallow sediments in the South Yard consist of interbedded silty sands and clayey gravels. The only variation from this pattern was seen in the boring log for well No. 60, which indicated that sediments in this area consist of clean, poorly graded sands and gravels. The sediments are also more permeable than the others, which is displayed in the generally lower hydraulic head in this area. A east-northeast trend in groundwater elevations is seen in the vicinity of Well No. 60 and this may be an indication of the extent of the more permeable sand and gravel deposits (EEI, 1987).

A pump test in the more impermeable silty sand/clayey gravel sediments (Well Nos. 102 and 52) yielded a transmissivity of 6,200 gpd/ft, a specific yield of 0.22, and an estimated permeability of 344 gal/ft^2.

Based on 1987 groundwater elevations from the onsite monitoring well system, the shallow groundwater flow pattern indicated a groundwater depression around the hydrocarbon extraction Well RW-1. In 1987, this depression extended approximately 500 feet north, 800 feet south, 300 feet east, and 1,000 feet southwest of Well RW-1. The general groundwater flow across the site is in a south-southeasterly direction. In 1987, several groundwater mounds were detected in the South Yard. One mound was in the vicinity of Wells 29 and 40 in the southeast section of the South Yard. This was attributed to increased recharge in the tank farm area. The other groundwater mound was detected in the vicinity of Wells 47, 49, 50, and 51 in the southwestern edge of the South Yard. This mound was attributed to increased recharge from the guard basin. Two groundwater depressions were also identified in the 1987 EEI study. These depressions were located along the eastern boundary of the property near 26th Street and were attributed to a possible break in the city sewer line in this area.

West Yard

The subsurface beneath the west yard is defined by 24 shallow sampling and well borings and nine deep (greater than 70 feet) engineering borings (GES, 1990). The subsurface can be divided into four hydrostratigraphic units, which include from shallow to deepest, an unconfined shallow water-bearing zone, a thick confirming bed (30 to 60 feet), the Lower PRM Aquifer, and the bedrock basement, which functions as a lower confining unit. With the exception of the shallow water-bearing zone, these hydrostratigraphic units are fairly continuous across the site.

The shallow water-bearing zone consists of ash and cinder fill mixed with miscellaneous debris that is concentrated beneath PDAs 1 through 4. The fill ranges in thickness from 0 to 11 feet and generally thins with increasing distance from the Schuylkill River. Within the shallow zone, groundwater is encountered 2 to 10 feet below grade. All of the monitor wells located within the West Yard are installed within the shallow water-bearing zone. Potentiometric elevations, although inconsistent at several locations, indicated groundwater flows to the southeast toward the Schuylkill River. Shallow groundwater flow beneath PDA-3 and the west side of PDA-4 may be toward Lands Creek. Boring logs show there is no confining bed above or within the saturated portion of the shallow zone, indicating that the zone is unconfined.

The shallow water-bearing zone is underlain by a confining unit that ranges in thickness from 30 to 60 feet. This confining bed is composed of two time-stratigraphic units of similar lithologic composition. These units include Pleistocene age silts and organic materials deposited by the ancestral Schuylkill River and Early Cretaceous silts and clays of the Potomac Formation. Beneath most of the West Yard, the Pleistocene sediments are relatively thin (5 to 8 feet) and overlie the Cretaceous sediments. However, on the west side of PDA-4, a channel filled with black silt has been incised through the gray silts of the Cretaceous confining unit and into the sand and gravel of the underlying Lower PRM Aquifer. This filled channel defines the thickest portion of confining unit (60 feet).

The composite confining unit is underlain by the Lower PRM Aquifer. The aquifer consists of coarse to fine quartz sand and gravel deposited in fining upward cycles. To date, only one boring has penetrated the entire aquifer beneath the West Yard, revealing a thickness of 35 feet. None of the wells in the West Yard are screened within the Lower PRM. Presumably, groundwater flows to the southeast toward the Schuylkill River down the dip of the aquifer. Although the extent of the hydraulic connection between the aquifer and river is unknown, some component of flow may discharge to the river through the overlying confining bed.

The Lower PRM is the major source of groundwater in Philadelphia. Although originally a drinking water source, water quality has degraded with the industrialization of the area. Present use is primarily for industrial purposes. Wells screened within the thickest portions of the aquifer can yield from 700 to 1,100 gallons per minute (Greenman, 1961). Transmissivity of the unit ranges from 30,000 to 60,000 gpd/ft with storativities of 10^{-6} to 10^{-4}.

The Lower PRM is underlain by the Cambrian Wissohickon Schist, which defines the bedrock basement beneath the West Yard. The contact between the units is often marked by saprolitic clay, which can range in thickness from 0 to 10 feet forming a hydraulic barrier between the two units. Groundwater flow within the Wissohickon Schist is along secondary fractures. Although domestic wells are often installed within the schist, the unit is not considered a major source of groundwater production.

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Chapter 3
PROJECT MANAGEMENT PLAN

The project management plan is intended to document the overall management approach to the RFI and to ensure that field data collection activities and the RFI report satisfy the project objectives. The technical approach is designed to produce data and information to determine the applicability of, or need for corrective action to mitigate releases of hazardous constituents to the environment from the SWMUs at the Sun Refining and Marketing Company's Philadelphia Refinery. In the broadest sense, the RFI work plan has been prepared to evaluate whether hazardous constituents have been released or are continuing to be released from the SWMUs under consideration, and to gather data to support selection of corrective measures if needed. This section presents a discussion of pre-investigation-identified corrective action technologies that may be appropriate for implementation at the SWMUs and presents the technical approach to management of the project.

PRE-INVESTIGATION EVALUATION OF CORRECTIVE ACTION TECHNOLOGIES

A preliminary evaluation of corrective measure technologies has been conducted to maximize the extent to which data collected during the RFI supports the corrective measure selection process. A pre-investigation evaluation is useful in defining a technical approach and identifying probable data gaps. This evaluation helps focus the RFI planning effort. Although several environmental studies have been performed at the refinery, none have particularly focused on the SWMUs of concern. Subsequently, data gaps are large, and data collection has been designed to address a number of different corrective action measures.

METHODS

The purpose of the Pre-Investigation Evaluation of Corrective Measures Technologies is to identify corrective measure technologies that potentially may be used to remediate areas of concern and to then define the data needs that will allow the accurate evaluation and selection of final corrective measures, if required. The process consists of five steps as follows:

1. Review current knowledge of site
2. Identify compounds of interest at the site and/or each SWMU
3. Identify potential pathways associated with the site and/or each SWMU
4. Identify all Corrective Measures Technologies that are applicable to the different environmental media of concern

5. Identify the data needed to further evaluate the applicability of the technologies

CURRENT KNOWLEDGE

A thorough description of the current understanding of environmental conditions at Sun's Philadelphia Refinery has been presented in Section 2. EPA Region III has designated five SWMUs for RFI investigation with corrective action permit requirements for each (Table 3-1).

Table 3-1
SWMUs Identified by EPA for RFI Investigation

SWMU	Corrective Action Permit Requirements
Past Disposal Area No. 1* Past Disposal Area No. 2* Past Disposal Areas No. 3* and No. 4*	1. Establish presence, or absence of hazardous waste. 2. Determine if contaminants have migrated to the soil or groundwater. 3. Establish criteria for additional investigation.
Past Leaded Tank Bottom Disposal Area	1. Establish presence or absence of hazardous waste. 2. Determine if contaminants have migrated to the soil or groundwater. 3. Establish criteria for additional investigation.
Guard Basin	1. Establish presence or absence of hazardous waste. 2. Determine if contaminants have migrated to the soil or groundwater. 3. Assess environmental impact of Past Disposal Areas No. 4 and 5 (South Yard) on Guard Basin. 4. Establish criteria for additional investigation.

*As Past Disposal Areas No. 1 through 4 are similar in form, wastes received, location, and permit requirements, these units have been combined to form a single corrective action management unit (CAMU).

COMPOUNDS OF INTEREST

The list of compounds identified at the Sun site was compiled using data from past analyses performed at the site. For the most part, the list of compounds is based on only a small number of samples collected from each media near each SWMU. Tables 3-2 and 3-3 present compounds of interest for soil and groundwater near each SWMU. The compounds displayed in these tables were encountered at varying concentrations. Their representation in the tables does not indicate extremely high concentrations of any compound that were encountered in the soil or groundwater. All compounds measured above detection limits are included.

Table 3-2
Compounds of Interest Within the Soils

SWMU	Compounds
PDA 1 through 4	Volatile Organics Benzene 1, 4 Dioxane Methyl ethyl ketone Ethyl benzene Toluene Total xylenes Base Neutral Organics Benzo (a) anthracene Benzo (b) fluoranthene Benzo (a) pyrene Bis (2-ethylhexyl) phthalate Chrysene Fluoranthene 1-Methylnaphthalene Naphthalene Phenanthrene Pyrene Metals Arsenic Barium Chromium Cobalt Lead Mercury Nickel
Past Leaded Tank Bottom Disposal Area	Volatile Organics Benzene Ethyl benzene Toluene Total Xylenes Base neutrals Chrysene 1-Methylnaphthalene Napthalene Phenanthrene Pyrene Metals Arsenic Barium Cadmium Chromium Lead Mercury Nickel Silver
Guard Basin	Volatile Organics Ethylbenzene Xylene Methyl ethyl ketone Base Neutral Organics Bis (2-ethylhexyl) phthalate Chrysene Fluoranthene Napthalene Phenanthrene Pyrene Metals Arsenic Barium Beryllium Cadmium Chromium Cobalt Lead Mercury Nickel Silver Vanadium

Table 3-3
Compounds of Interest Within Groundwater

SWMU	Compounds
PDAs 1 through 4	Volatile Organics Benzene Ethyl benzene Methyl ethyl ketone Total xylenes Base Neutral Compounds Anthracene Benzoanthracene Benzo (a) pyrene Bis (2-ethylhexyl) phthalate Chrysene Indene Naphthalene Phenanthrene Total Petroleum Hydrocarbons Metals Arsenic Barium Nickel
Past Lead Tank Bottom Disposal Area	Volatile Organics Benzene Methyl ethyl ketone Total xylenes Total Petroleum Hydrocarbons Base Neutral Organics 1-Methylnaphthalene Metals Arsenic Lead Mercury
Guard Basin	Volatile Organics Methyl ethyl ketone Ethyl benzene Total xylenes Base Neutral Organics Bis (2-ethythexyl) phthalate 1-Methylnapthalene Naphthalene Metals Arsenic Barium Cobalt Lead Silver

EXPOSURE PATHWAYS

Selection of pathways for this investigation should not indicate that these routes may represent a site-originated risk. Selection for investigation is based upon a lack of data to eliminate these pathways for consideration. Table 3-4 presents potential exposure pathways that may be associated with the SWMUs at the Sun Refinery.

Table 3-4
Sun SWMU Potential Exposure Pathways

SWMU	Potential Exposure Pathways	Rationale for Proposed Action
Past Disposal Areas No. 1 through 4	Volatilization Direct Contact Leaching to Groundwater	Presence of seeping waste material, contaminated soil, and groundwater. Presence of surface water and sediment contamination unverified. All media will be investigated.
Past Lead Tank Bottom Disposal Area	Volatilization Direct Contact Leaching to Groundwater	Presence of soil contamination is verified. All media will be investigated.
Guard Basin	Volatilization Direct Contact Leaching to Groundwater	Presence of surface water, sediment, and soil contamination is unverified. Groundwater contamination is verified. All media will be investigated.

IDENTIFICATION OF AVAILABLE CORRECTIVE MEASURES TECHNOLOGIES

Remediation technologies can be grouped into nine general categories:

- Surface Water Controls
- Air Pollution Controls
- Leachate and Groundwater Controls
- Gas Migration Controls
- Waste and Soil Excavation and Off-Site Disposal
- Contaminated Sediments Removal and Containment
- In-Situ Treatment
- Direct Waste Treatment
- Contaminated Water Supply and Sewer Line Controls

The remediation technology categories potentially applicable to the Sun Refinery can be identified by relating site conditions to the technology categories that address them. A matrix is presented in Figure 3-1 that shows five of the nine remediation technology categories which may be potentially applicable to the Sun Refinery: surface water controls, leachate and groundwater controls, waste and soil excavation and off-site dis-

Site Problem	Surface Water Controls	Air Pollution Controls	Leachate and Groundwater Controls	Gas Migration Control	Waste and Soil Excavation and Removal and Land Disposal	Contaminated Sediments Removal and Containment	In-Situ Treatment	Direct Waste Treatment	Contaminated Water Supply and Sewer Line Controls
Volatilization of chemicals into air		●							
Hazardous particulates relased to atmosphere		●							
Dust generalization by heavy construction or other site activities		●							
Contaminated site run-off	●								
Erosion of surface due to wind or water	●								
Surface seepage of leachate	●								
Flood hazard or contact of surface water body with wastes	●								
Leachate migrating vertically or horizontally			●				●		
High water table which may result in groundwater contamination or interfere with other remedial technologies			●						
Precipitation infiltrating into site to form leaching	●		●						
Evidence of methane or toxic gases migrating laterally underground				●					
On-site waste materials in non-disposed forms: drums, lagooned wastes, wastepiles					●		●	●	
Contaminated surface water, groundwater or other aqueous or liquid waste					●		●	●	
Contaminated soils					●		●	●	
Toxic and/or hazardous gases which have been collected								●	
Contaminated stream banks and sediments					●	●		●	
Drinking water distribution system contamination									●
Contaminated sewer lines									●

Figure 3-1

Matrix of general remedial technology categories for specific site problems

(based on EPA/625/6-85/006).

posal, contaminated sediments removal and containment, and in-situ treatment. A more detailed evaluation of options will be performed after the RFI is completed and will take into consideration the interim measures already performed by Sun, such as capping of the PDAs.

In general, a no-action alternative is considered for all the SWMUs. The number of potential corrective technologies applicable at each SWMU will be reduced by applying the following proposed criteria:

1. The volume of contaminated soil, sediment, and/or waste

2. The type, concentration, and migration potential of contaminants present

3. Accessibility to the contamination

4. The ability of the technology to meet requirements for the protection of human health and the environment, both during and after remediation

5. Amount of risk reduction or augmentation afforded by performance of the technology (e.g., the risk posed by inhalation of contaminants volatilized during excavation)

A preliminary list of possible corrective action technologies appears in Table 3-5.

DATA REQUIREMENTS

Figure 3-2 is a general list of data needs for various corrective measures technologies. Further assessment of corrective technologies will determine the data to be collected.

TECHNICAL APPROACH

The work plan is based on a phased approach for implementation of the RFI. If the detection of contaminant releases from any of the SWMUs reveals that data gaps or additional investigation is required, suggestions for further investigation will be detailed in the RFI report. The following are objectives of the sampling investigation:

1. To assess the potential for containment releases to onsite subsurface/sediments and groundwater

2. To provide a characterization of site-specific hydrogeologic conditions

3. To identify the type and extent of contamination that may exist at the facility

Table 3-5
Possible Corrective Action Technologies for SWMUs at Sun's Philadelphia Refinery

SWMU	Corrective Action
Past Disposal Areas No. 1 through 4	• Cap, repair, and upgrade • RCRA capping on PDAs 3 and 4, redesign of Disposal Area geometry • In-situ treatment - Bioremediation - Soil vapor extraction • Surface water control systems • Contaminated sediment removal • Groundwater remediation - Pump and treat system - Trench collection system • No further action/monitoring only
Past Leaded Tank Bottom Disposal Area	• Excavation and removal of contaminated soil • In-situ remediation • Enhance waste containment • No action
Guard Basin	• Dredging and offsite disposal of contaminated sediments • Groundwater remediation - Pump and treat systems - Trench collection systems • In-situ remediation • Enhance waste containment • No action/monitoring only

Characterization of site-specific hydrogeology will include defining flow directions within the surficial groundwater zone and the Lower PRM Aquifer and describing spatial variations in hydraulic conductivity within and between each hydrostratigraphic unit. In addition, the magnitude of head and gradient changes caused by tidal fluctuations within the surficial water-bearing zone will be quantified.

Required Data Items		Controls: Air Pollution – Capping	Air Pollution – Dust Control Measures	Surface Water – Capping	Surface Water – Grading	Surface Water – Revegetation	Surface Water – Diversion and Collection Systems	Leachate and Groundwater – Capping	Leachate and Groundwater – Containment Barriers	Leachate and Groundwater – Groundwater Pumping	Leachate and Groundwater – Subsurface Collection Drains
General Site Conditions	Accessibility	●	●	●	●	●	●	●	●	●	●
	Topography	●	●	●	●	●	●	●	●		
	Native Vegetation	●	●	●	●	●	●	●	●		
Waste Characteristics	Physical State	●	●	●	●	●	●	●	●	●	●
	Chemical Composition	●	●	●	●	●	●	●	●	●	●
	Disposal/Burial Practices	●	●	●	●	●	●	●	●	●	●
	Physical/Chemical Properties	●	●	●		●	●	●	●	●	●
Site Geology	Seismic History	●		●	●		●	●	●		●
	Depth to Bedrock	●		●	●			●	●	●	●
	Bedrock Type			●	●				●	●	●
	Bedrock Profile								●	●	●
	Structural Configuration								●	●	●
	Structural Strength	●		●	●		●	●	●		
	Bedrock Permeability/Porosity								●	●	●
Soil Characteristics	Profiles to Bedrock	●		●	●	●	●	●	●	●	●
	Type-Texture	●	●	●	●	●	●	●	●		●
	Permeability/Porosity	●	●	●	●	●	●	●	●	●	●
	Engineering Properties	●		●	●		●	●	●		
	Soil Chemistry	●	●	●		●		●	●		
	Erosion Potential	●	●	●	●	●	●	●	●		
	Contaminant Profiles	●	●	●	●	●	●	●	●	●	●
	Moisture Content	●	●	●		●	●	●	●		●
Groundwater Characteristics	Natural Groundwater Chemistry								●	●	●
	Seasonal Potentiometric Surface	●	●	●	●	●	●	●	●	●	●
	Aquifer Profile								●	●	●
	Aquifer Characteristics								●	●	●
	Groundwater Velocity and Direction of Flow								●	●	●
	Groundwater Recharge and Discharge Areas								●	●	●
	Contaminant Profiles								●	●	●
	Supply Well Characteristics								●	●	●
Surface Water	Proximity of Nearest Surface Waters	●		●	●		●	●	●	●	●
	Presence of Leachate Seeps	●		●	●	●	●	●	●	●	●
	Floodplain or Coastal Storm Surge Boundaries	●		●	●	●	●	●	●	●	●
	Stream Profiles	●			●		●				
	Surface Water Use	●			●		●		●	●	●
	Drainage Area Runoff				●		●				
	Local Surface Water Quality				●		●				
	Stream Flow Characteristics				●		●		●	●	●
Climatology	Evapotranspiration Parameters	●	●			●	●	●			
	Wind Speed and Direction	●	●			●		●			
	Temperature Parameters	●	●			●					
	Precipitation	●	●	●	●	●	●	●	●	●	●
	Local Air Quality	●	●								
	Regional Air Quality										

Figure 3-2

Identification of data needs for various remedial techniques
(based on EPA/625/6-85/006).

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1 Waste Excavation and Removal
2 Contaminated Sediment Removal and Containment
3 In Situ Treatment

Required Data Items		Gas Migration Controls			1	2		3
		Capping	Collection (with or without Recovery)	Containment	Soil and Waste Excavation and Removal	Removal	Containment and Turbidity Control	In Situ Treatment
General Site Conditions	Accessibility	●		●	●	●	●	●
	Topography	●	●	●	●			●
	Native Vegetation	●			●			●
Waste Characteristics	Physical State	●	●	●	●	●	●	●
	Chemical Composition	●	●	●	●	●	●	●
	Disposal/Burial Practices	●	●	●	●	●	●	●
	Physical/Chemical Properties	●	●	●		●	●	●
Site Geology	Seismic History	●		●				
	Depth to Bedrock	●		●	●			●
	Bedrock Type							●
	Bedrock Profile							●
	Structural Configuration	●		●				
	Structural Strength	●	●	●	●	●	●	●
	Bedrock Permeability/Porosity					●		●
Soil Characteristics	Profiles to Bedrock	●	●	●	●		●	●
	Type-Texture	●	●	●	●	●	●	●
	Permeability/Porosity	●	●	●	●	●	●	●
	Engineering Properties	●			●	●		●
	Soil Chemistry	●	●	●	●	●	●	●
	Erosion Potential	●			●		●	
	Contaminant Profiles	●	●	●	●	●	●	●
	Moisture Content	●	●	●	●			●
Groundwater Characteristics	Natural Groundwater Chemistry							●
	Seasonal Potentiometric Surface							
	Aquifer Profile	●	●	●	●			●
	Aquifer Characteristics							●
	Groundwater Velocity and Direction of Flow							●
	Groundwater Recharge and Discharge Areas				●			●
	Contaminant Profiles				●			●
	Supply Well Characteristics							●
Surface Water	Proximity of Nearest Surface Waters				●			●
	Presence of Leachate Seeps	●	●	●	●	●	●	●
	Floodplain or Coastal Storm Surge Boundaries	●	●	●	●	●	●	●
	Stream Profiles					●	●	
	Surface Water Use					●	●	●
	Drainage Area Runoff	●	●	●	●	●	●	●
	Local Surface Water Quality					●	●	●
	Stream Flow Characteristics					●	●	
Climatology	Evapotranspiration Parameters	●	●	●				●
	Wind Speed and Direction	●	●	●	●			●
	Temperature Parameters	●	●	●	●	●	●	●
	Precipitation	●	●	●	●			●
	Local Air Quality		●		●	●		●
	Regional Air Quality							

Figure 3-2 (cont.)

Identification of data needs for various remedial techniques

(based on EPA/625/6-85/006).

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Based on information collected to date on each of the SWMUs, no formal air sampling program is proposed for the field investigation. However, during the course of field investigations, ambient air will be evaluated during soil boring, well installation, and sampling activities, and results will be included in the RFI report. Should ambient air sampling indicate a potential problem, an expanded air program will be detailed for implementation later.

Upon the completion of field activities and evaluation of preliminary data, additional field tasks will be proposed if further site characterization is necessary. Additional requirements that may be included in a second phase of investigation would focus on addressing data gaps in the present sampling/monitor network and characterizing the nature and extent of contaminant releases in support of the development of a corrective action plan.

CHARACTERIZATION OF SWMUs

EPA has identified five SWMUs requiring field investigation. Three of the SWMUs, PDA Nos. 1, 2, 3 and 4 are all covered, unlined, landfill or lagoonal disposal units located in the West Yard, and because of the similarity of their form, waste received, and proximal location, can be combined into a single CAMU (Figure 3-3). PDAs 1 through 4 received solid and liquid waste in the form of trash, tank bottom sludges, acid and caustic sludges, and other petroleum refining-derived wastes. Because the PDAs lie within 30 feet of each other, designing a field investigation program to identify contaminants released from each separate area is probably not feasible.

Past disposal practices at PDAs 1 through 4 included dumping liquid and solid wastes on the ground surface and in unlined but bermed lagoons. Although all the units have some form of cap (RCRA design on PDAs 1 and 2, clay and vegetative cover on PDAs 3 and 4), many liquified sludge seeps can be found on PDAs 1 and 2.

To date, six monitoring wells have been drilled near to PDAs 1 through 4. The purpose of most of these wells is for free-product gauging on top of the water table. Several groundwater samples, collected over the years, exhibit contamination by volatile organic and base neutral compounds. Most surface soil samples collected over several episodes of sampling had detectable levels of base neutral compounds and petroleum hydrocarbons.

To characterize the nature of the waste seeping from PDAs 1 through 4, three samples from each disposal area will be collected at locations where seeps are encountered. A 10-well monitoring network has been designed to characterize contaminant releases to the subsurface soil and groundwater of the surficial water-bearing zone and underlying Lower PRM Aquifer. The network will include three shallow-deep well clusters positioned upgradient (one cluster) and downgradient (two clusters) of the PDAs monitoring the surficial zone and Lower PRM Aquifer. In addition, four shallow wells will monitor the downgradient surficial zone. Soil samples for chemical and geotechnical analyses in the well borings will be collected from the vadose zone and each hydro-

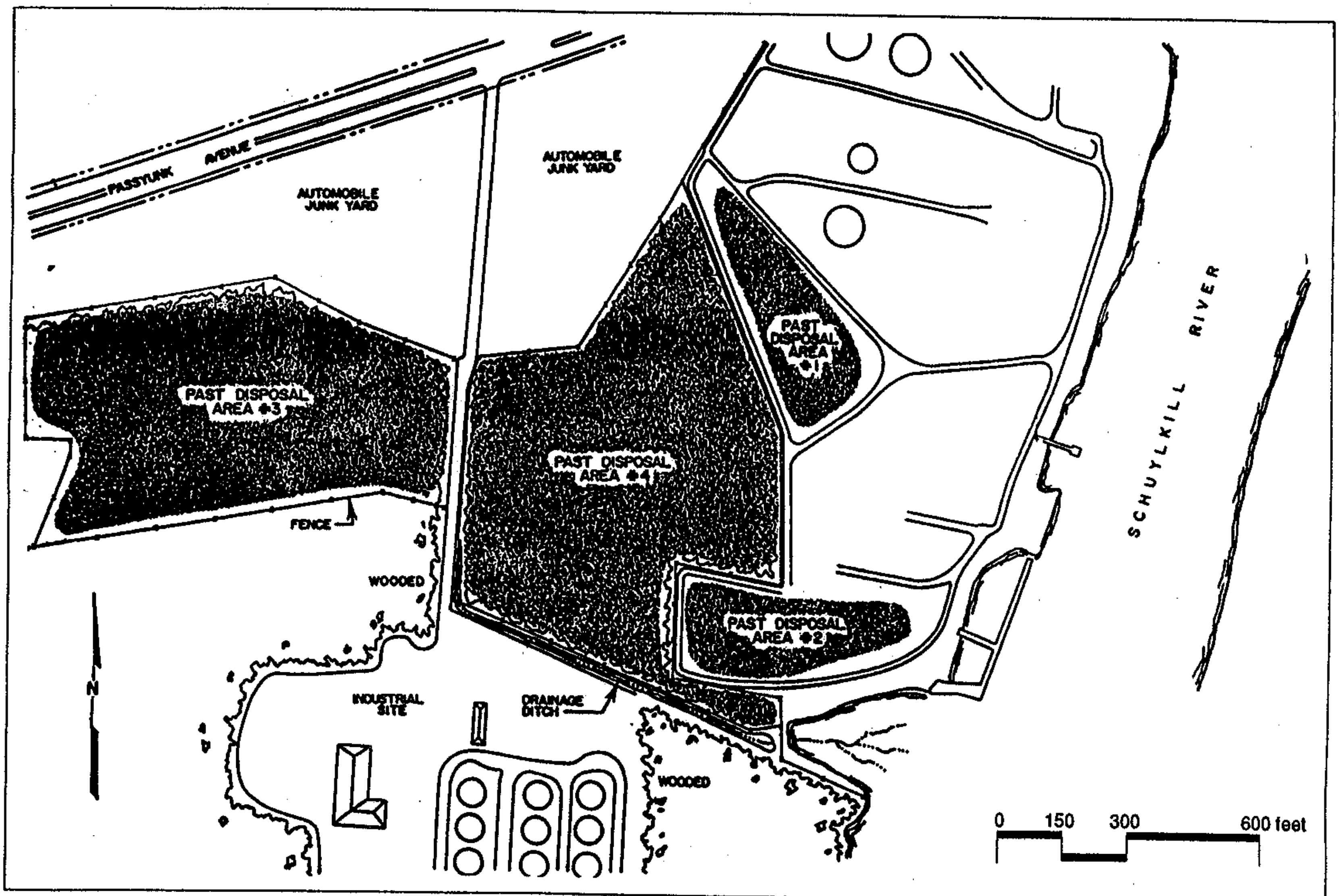

Figure 3-3

Location Map of Past Disposal Areas 1-4

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stratigraphic horizon. These sample selection criteria are based on a review of the available analytical data.

The past leaded tank bottom disposal area is a former sludge weathering pad used to degrade organic lead to inorganic lead. The pad was closed in 1980 and may have been destroyed or buried beneath soil and gravel cover material. The pad was relatively small (50 feet by 100 feet) and surrounded by numerous large sources of possible subsurface contamination, including fuel storage tanks. Since upgradient and background data may exhibit high concentrations of contaminants from these surrounding sources, field investigation activities will be restricted to the immediate area around and beneath the pad.

Several soil samples collected adjacent to the pad indicate elevated metals (lead, arsenic, mercury, and cadmium) concentrations to depths greater than 8 feet below grade. The approach to investigating contaminant releases from the pad includes attempting to locate the intact pad, or residual portions thereof, with surface geophysical (EM-31) methods and then characterizing contaminant releases to soil in the vadose zone.

A flexible soil exploration program has been developed to address two scenarios based on the results of the geophysical survey. These scenarios entail the following:

1. The pad is entirely intact and only covered with a few inches of soil and gravel.
2. The pad has been entirely or partially destroyed and removed.

Four trenches will be excavated on four sides of the pad (Scenario 1) or perpendicular to the long axis of the former pad location (Scenario 2). Soil samples will be collected from two intervals in each trench that include the vadose zone and the top of the water table.

The final SWMU, the guard basin (Figure 3-4), is a stormwater retention pond that receives stormwater from the South Yard and discharges to the Schuylkill River. Although stormwater passes through an oil-water separator and oil skimmer before entering the guard basin, several episodes of releases and leaks have occurred over the lifetime of the facility. In addition, three disposal areas (PDA "A", PDA "B", and PDA "C") and a fuel storage tank farm are located hydraulically upgradient of the unlined basin (Figure 3-4). These disposal areas received spent catalyst, leaded tank bottom sludges, and other wastes associated with petroleum refining activities. Three monitor wells are located on the western, presumably downgradient, side of the guard basin. Groundwater analyses show elevated concentrations of volatile organic and base neutral and acid extractable compounds as well as metals.

A 10-well monitoring network has been designed around the guard basin to detect contaminant releases from the basin and possible contamination migration within the groundwater toward the basin from PDAs "A", "B" and "C". Soil and groundwater samples will be collected from both the surficial water-bearing zone and the Lower PRM Aquifer. A tidal study will be conducted to determine the effects of tidal

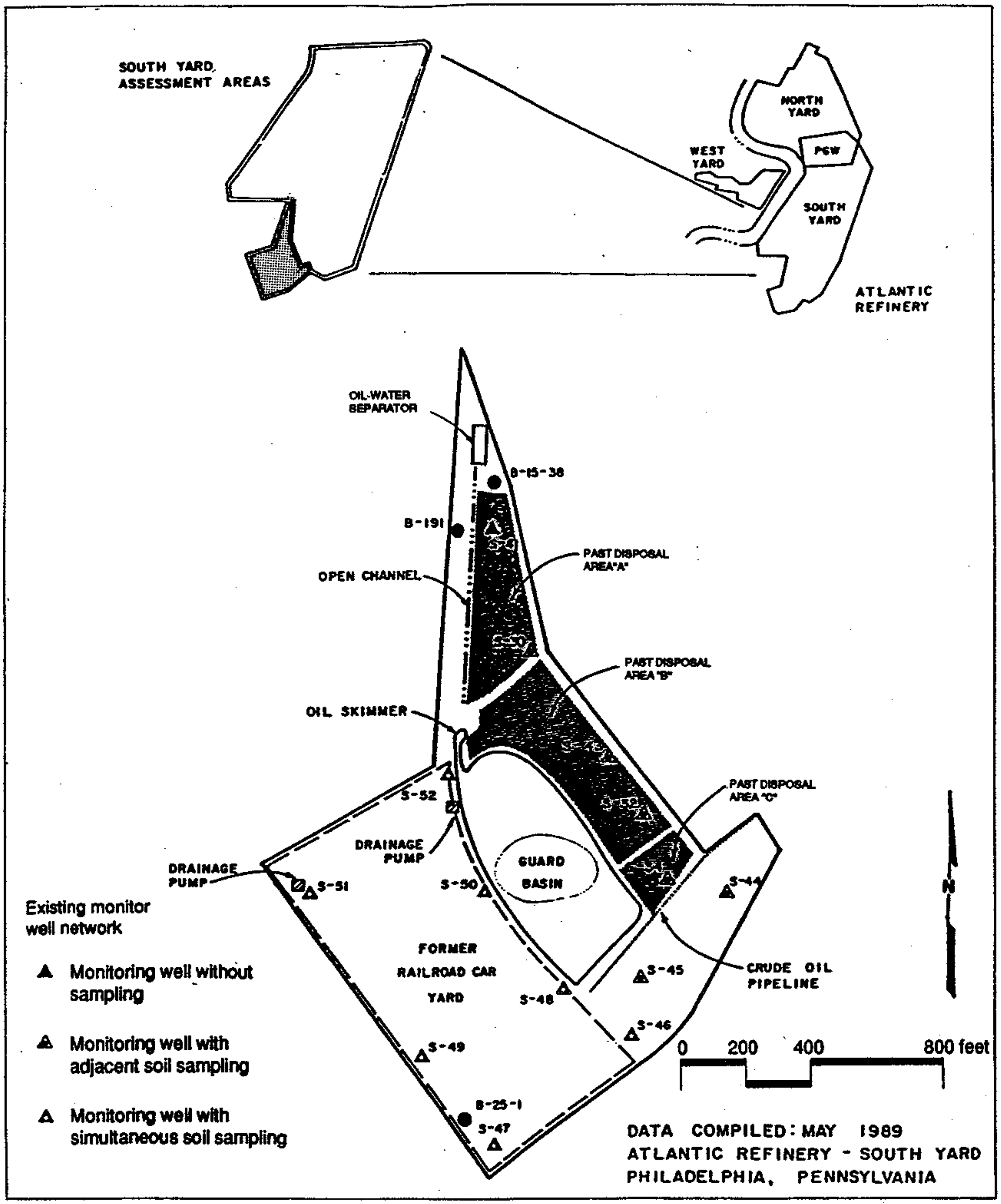

Figure 3-4

Map of Guard Basin and Vicinity

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fluctuations in the river on potentiometric surfaces in the surficial zone and Lower PRM Aquifer. Results of the tidal study should be useful in designing corrective action alternatives if a release has occurred to the shallow groundwater.

PROJECT PERSONNEL

Project management of the RFI incudes selecting, coordinating, and scheduling staff members, contractors, and subcontractors. Figure 3-5 presents a schematic diagram of the project organization.

The project will proceed under the overall management of the Sun Philadelphia Refinery Environmental Supervisor, Charles Barksdale.

The Prime Contractor Project Manager will have a least 5 years of professional experience and will be a registered professional in his/her area of expertise. The Project Manager will be responsible for the successful execution of the RFI work plan and will manage the RFI, taking responsibility for staffing, coordination, cost and schedule control, and technical quality.

The senior review team will review the technical and management activities of the project, including all project deliverables. This team will be composed of senior-level personnel or discipline specialists from the prime contractor's resource pool. The senior review team will be involved with the project during all phases and will function independently of the project staff, reporting directly to the project manager.

The field team leader will have at least 5 years of professional experience and will be a registered professional in his/her area of expertise. The field team leader will be responsible for the coordination of field efforts, will assure the availability and maintenance of sampling equipment and materials, and will be responsible for shipping and packing materials. The field team leader will supervise the field work and sampling operations of the field technicians and will be responsible for completion of the field notebook. The field team leader will maintain close coordination with the Sun Project Manager onsite.

The Site Safety Officer (SSO) will prepare a health and safety plan and ensure that the plan is implemented during field activities. The SSO will oversee all field activities involving contractor and subcontractor personnel. This individual has authority to terminate field activities if health-threatening situations arise or the site safety plan is not being executed properly. The SSO will coordinate field activities with the Field Team Leader and report directly to the Contractor Project Manager.

A Quality Assurance team will prepare a Data Collection Quality Assurance Plan (DCQAP) for field and laboratory tasks. The Quality Assurance Officers will ensure the requirements of the QAPP are met during the Field Investigation, Laboratory Analysis, and Data Validation tasks. Periodic site and laboratory audits may be con-

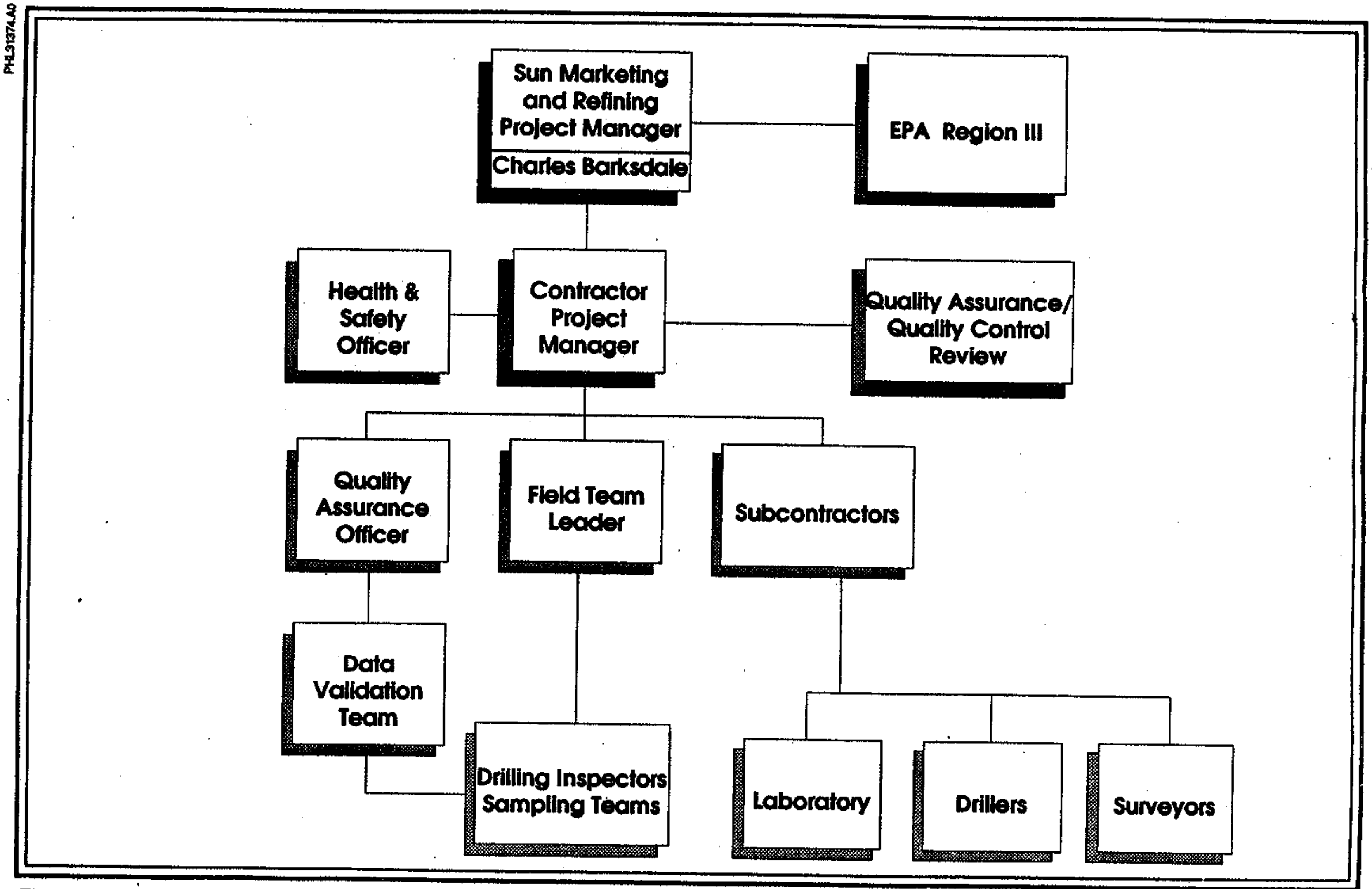

Figure 3-5

Project Organization Chart

ducted to observe activities and ensure data quality objectives are satisfied. The Data Quality Assurance Officers will report periodically to the Contractor Project Manager for debriefing of data quality.

Prior to initiation of field activities, the following plans will be finalized:

Sampling and Analysis Plan

To maintain project quality control and assurance, a sampling and analysis plan specific to the project personnel and contractors will be prepared before starting field activities. General requirements of the sampling and analysis plan are described in Chapter 4 and the Appendix of this work plan. The plan includes a site-specific sampling and analysis plan for each SWMU.

Field measurements and sampling and analysis will be conducted on the basis of compliance with the Part B permit, the interim final RCRA facility investigation guidance document (RFI Guidance) (EPA, 1989), the RCRA Groundwater Monitoring Technical Enforcement Guidance Document (TEGD) (EPA, 1986).

Data Management Plan

The data management plan presented in Chapter 5 of this work plan will be implemented during the RFI to document and track investigation results. Data documentation materials and procedures, project file requirements, and project-related progress reporting procedures and documents are identified.

Health and Safety Plan

A health and safety plan specific to the sampling activities will be developed before initiating RFI activities. This plan will meet the general requirements of the health and safety plan presented in Chapter 6 of this work plan. Upon approval of the work plan, the health and safety plan will be finalized to meet project- and personnel-specific requirements.

Health and Environmental Assessment

After data and field measurements have been collected and summarized, a health and environmental assessment will be conducted if appropriate.

After the initial results have been interpreted, a summary of the data will be submitted to EPA. At the completion of the initial investigation and any additional investigation, an RFI report summarizing the results of the data collection activities and meeting the requirements of the RFI Guidance and Part B permit will be prepared. This report will include but not be limited to the following sections:

- Environmental setting
- Source characterization
- Type and extent of contamination at the facility
- Contamination characterization, including migration pathways
- Qualitative and quantitative contamination assessments relative to background levels for the area
- Potential receptors
- Recommendations for further action at each SWMU

SCHEDULE

Figure 3-6 is the schedule of RFI activities. Quarterly progress reports describing the status of the technical work and the schedule will be sent to EPA Region III and Sun. These reports will include the following information:

- Description of tasks and percent complete of the RFI
- Results of all sampling and analysis activities conducted during the quarter
- Summary of findings
- Summary of changes made in the RFI
- Summary of contacts with the local community, public interest groups, and state government
- Summary of problems, potential problems, and corrective actions taken
- Changes in personnel
- Work projected for the next reporting period

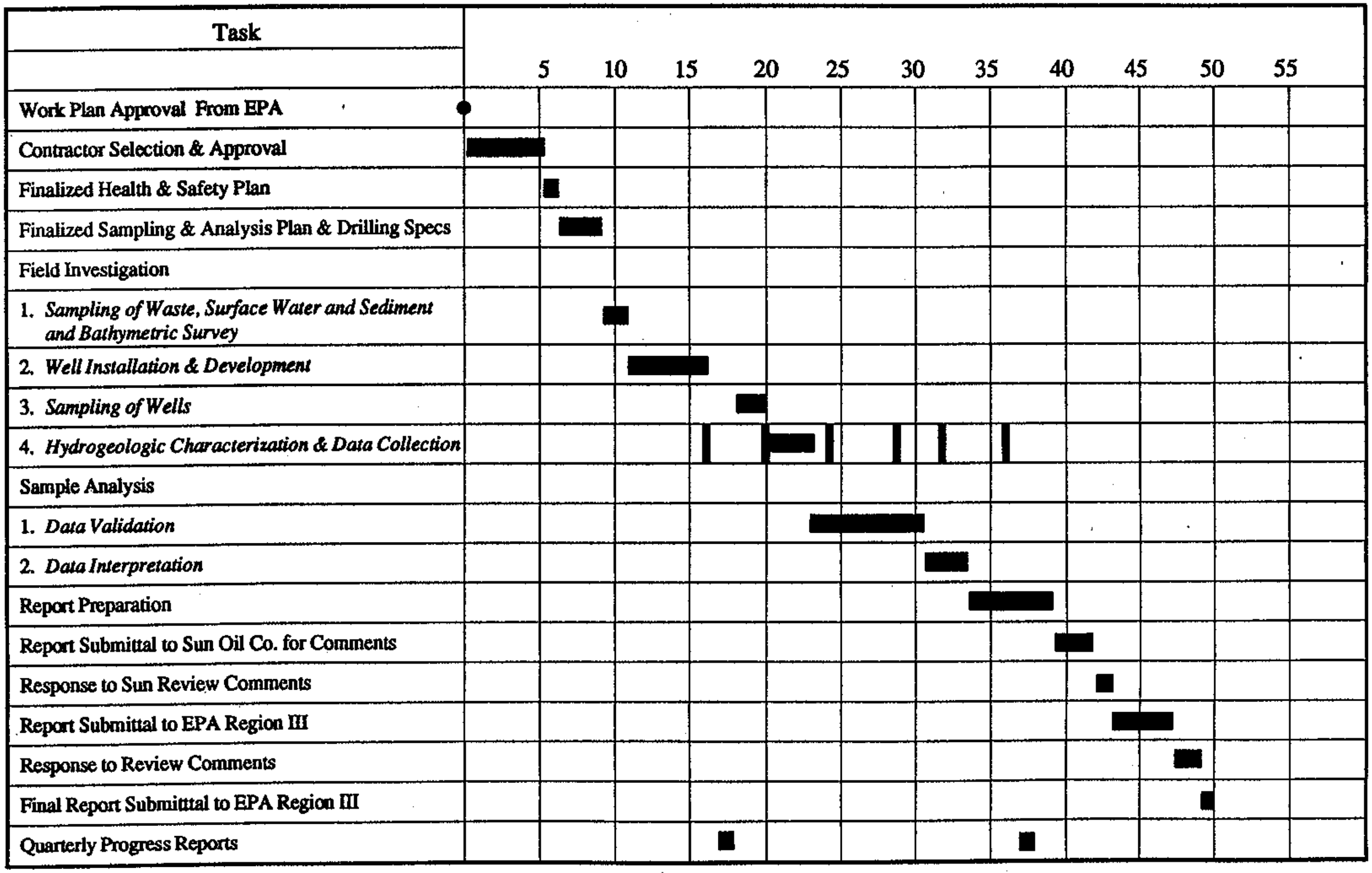

Figure 3-6

RFI Schedule

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Chapter 4
SAMPLING AND ANALYSIS PLAN

This chapter describes field investigation techniques, sampling, and analyses that will be performed for the Sun Refining and Marketing Company's RFI at the Philadelphia, Pennsylvania Refinery facility. The Data Collection Quality Assurance Plan for the Philadelphia Refinery is comprised of the Sampling and Analysis Plan in this chapter, the Data Management Plan in Chapter 5, and the Data Collection Quality Assurance Plan (DCQAP) located in the appendix of this work plan. The plan has been designed to address PDAs 1 to 4 as a single Corrective Action Management Unit (CAMU) because of the similarity of wastes disposed within each facility and their contiguous spatial configuration (Figure 4-1). The Guard Basin and past leaded storage tank bottom disposal area will each be addressed as separate SWMUs with a unique field investigation plan.

SAMPLE COLLECTION GOALS AND OBJECTIVES

The ultimate goals of the RFI Phase I sampling investigation are to examine potential contaminant releases to surrounding soils/sediments, surface water, and groundwater from each SWMU. Objectives developed to satisfy the goals of a Phase I investigation are detailed below according to SWMU.

SWMU NO. 1--PAST DISPOSAL AREAS 1 TO 4

- Characterize waste seeping from each of the disposal areas without breaching the integrity of their caps.
- Chemically and geotechnically characterize soils adjacent to the PDAs with particular concern to soil above and at the top of the water table, and at deeper stratigraphic horizons susceptible to contaminant migration and accumulation.
- Sample groundwater upgradient and downgradient of the PDAs from the surficial groundwater zone and deeper aquifer to determine whether a contaminant release from these facilities may have occurred.
- Characterize the hydraulic characteristics and flow regime within each hydrostratigraphic unit to evaluate possible contaminant migration routes and fate.
- Sample surface waters and sediments upstream, adjacent to, and downstream of the PDAs.
- Conduct 48-hour tidal study.

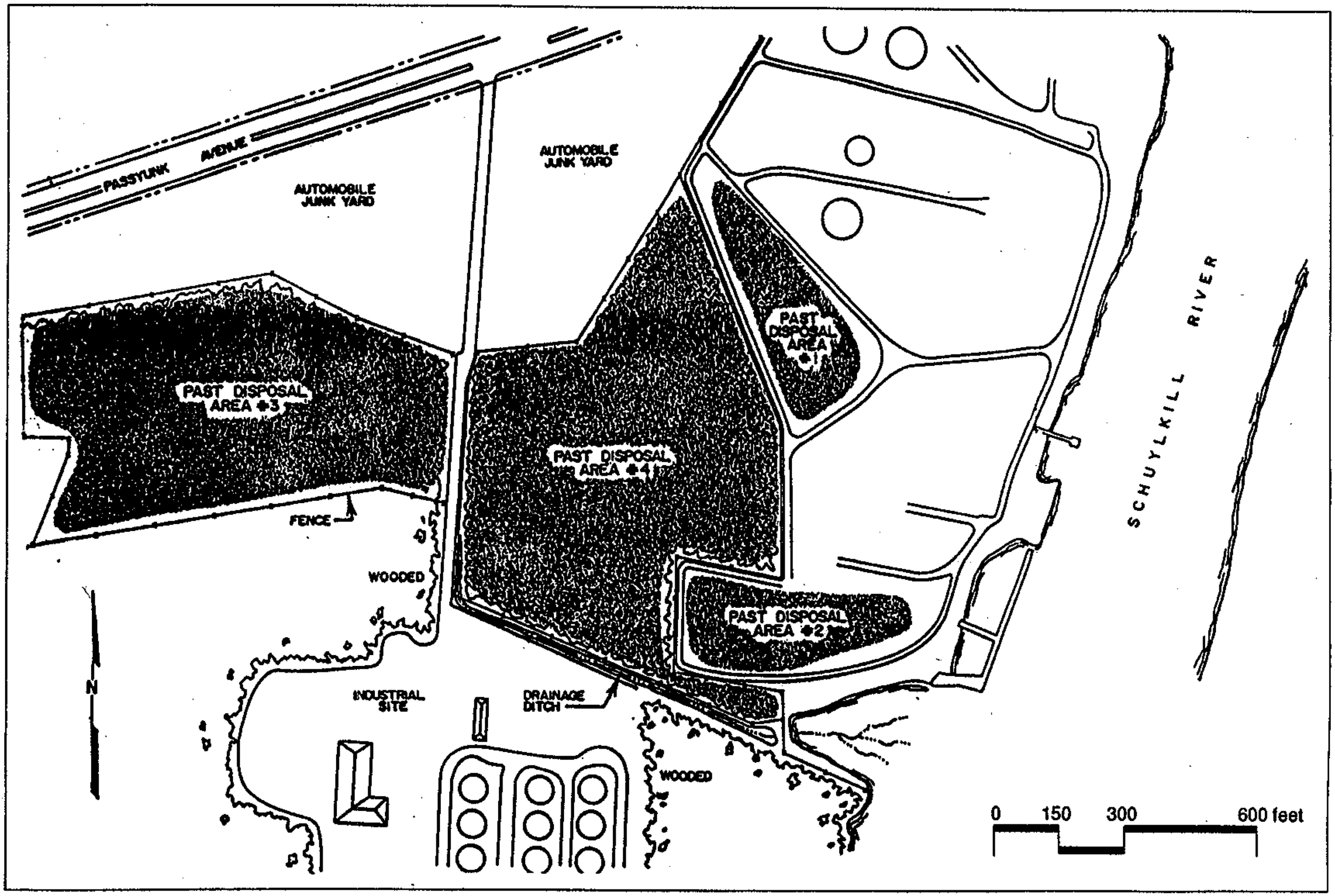

Figure 4-1

Location Map of Past Disposal Areas 1-4

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SWMU NO. 2--PAST LEADED TANK BOTTOM DISPOSAL AREA

- Conduct geophysical survey of the area.
- Determine the location and orientation of the former or buried sludge weathering pad.
- Sample soils beneath or adjacent to the pad to determine whether a contaminant release has occurred. A narrative explanation of sampling rationale is provided on page 4-14 of this work plan.

SWMU NO. 3--GUARD BASIN

- Determine whether surface water within the basin contain hazardous constituents.
- Determine whether sediments within the basin contain hazardous constituents.
- Sample surface water and sediments at a downgradient discharge area to determine whether contaminants are migrating from the basin.
- Characterize soils adjacent to the Guard Basin with particular concern to the top of the water table and deeper stratigraphic horizons susceptible to contaminant migration and accumulation.
- Sample groundwater from the surficial zone and deeper aquifer upgradient and downgradient of the Guard Basin to determine whether a release has occurred.
- Determine whether contaminants (if any) emanating from upgradient Past Disposal Areas "B" and "C" are migrating to the Guard Basin.
- Characterize the flow regime and hydraulic characteristics of the surficial groundwater zone and lower aquifer to evaluate possible contaminant migration routes and fate.
- Determine the depth of the Guard Basin and its effect on the surficial water bearing zone.
- Conduct 48-hour tidal study.

SAMPLING LOCATIONS AND MEDIA

SWMU NO. 1--PAST DISPOSAL AREAS 1 TO 4

Past Disposal Areas 1 to 4 encompass approximately 21 acres on the west side of the Schuylkill River south of Passyunk Avenue (Figure 4-1). Because of their similarity in form, waste received, and location, the four disposal areas will be considered as a single CAMU.

PDAs 3 and 4 began receiving heterogeneous waste including trash, construction rubble, tank bottom and separator sludges, and spent catalyst during the mid-1950s. Wastes were deposited directly on the natural soil or cinder fill surface. No natural (clay) or artificial liner underlies either area. Although there are no records or engineering designs for capping, visual inspection reveals that a soil and vegetative cap covers the fill material.

PDAs 1 and 2 were constructed later than PDAs 3 and 4 in the late 1950s and early 1960s, respectively. PDA 1 contains two lagoons with four seepage pits. Unknown wastes generated from petroleum refining activities were deposited within this facility. PDA 2 encompasses three waste lagoons with five seepage pits. Acid sludge, caustic waste, asphalt, coal slag, paraffin, bender catalyst, and leaded sludge were disposed of in PDA 2.

Although neither PDA is underlain by a liner, both areas were constructed in sections separated by earthen berms. RCRA--type caps were constructed over both areas in 1980. Numerous asphaltic seeps and fumaroles extrude from the top and sides of each disposal area.

Waste

To characterize the waste contained within PDAs 1 to 4, three grab samples will be collected from the seeps emanating from the sides of each unit (Figure 4-2). The clay caps or vegetative cover will not be breached during the Phase I sampling episode. Waste samples will be submitted to a lab and analyzed for the full Skinner Parameter List for soil (Table 4-1), soil pH, and the RCRA parameters (ignitability, corrosivity, reactivity, and toxicity.

Soil

To characterize subsurface soil adjacent to PDA 1 to 4, soil samples will be collected from seven borings drilled along the perimeter of the composite CAMU (Figure 4-3). Three borings will be drilled to bedrock (approximately 85 to 100 feet below grade) while the other four will be drilled to 10 feet below the top of the water table. To triangulate the deeper stratigraphic contacts, the deep borings will be installed near opposite corners of the CAMU (Figure 4-3). Continuous split-spoon/Shelby tube samples will be collected from one of the deep borings and all of the shallow borings.

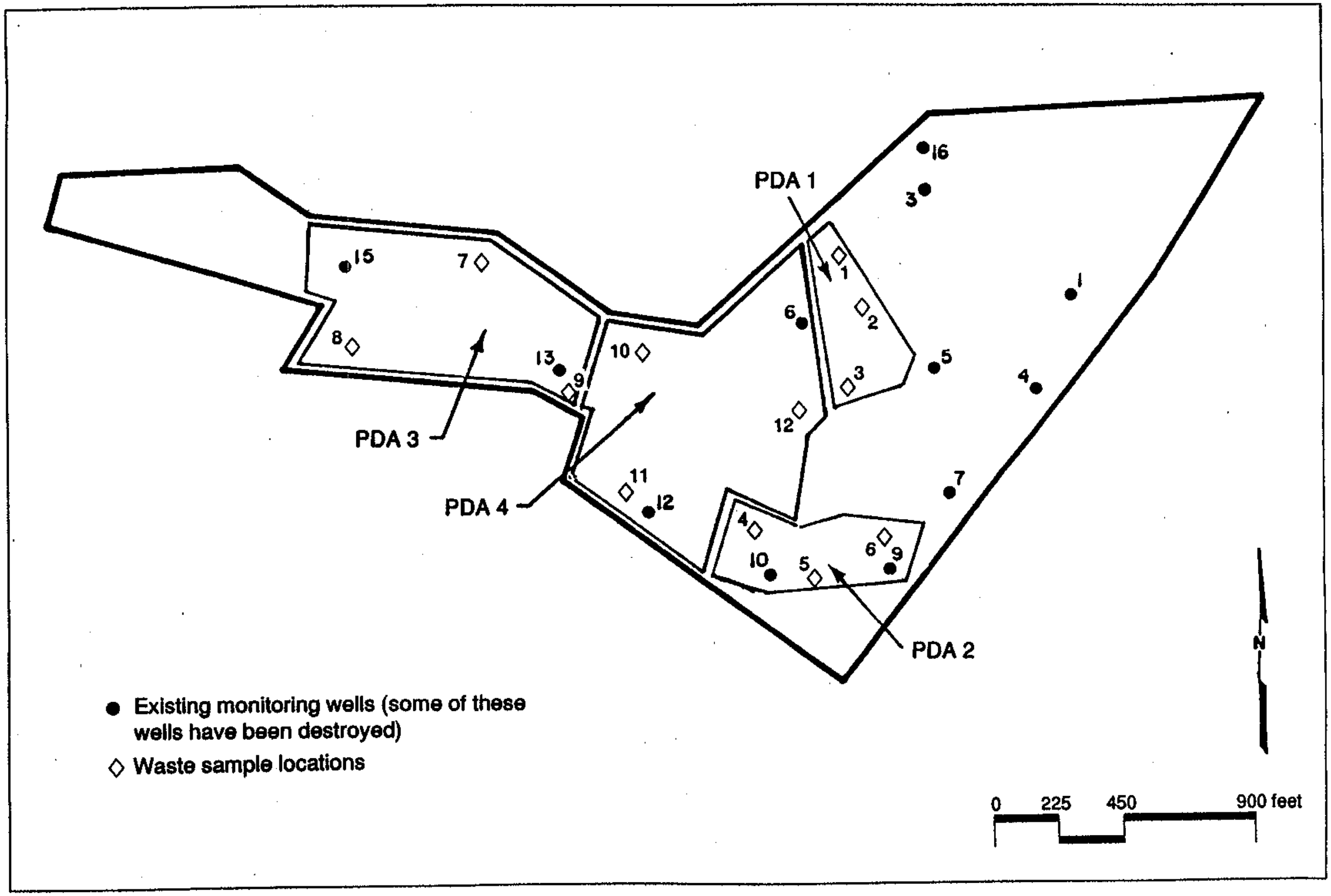

Figure 4-2

Proposed Waste Sampling Locations at Past Disposal Areas 1-4

Table 4-1
Modified Skinner List Parameters for Soil

Metals	Base/Neutral Organics
Antimony	Anthracene
Arsenic	Benzo(a)anthracene
Barium	Benzo(b)fluoranthene
Beryllium	Benzo(j)fluoranthene
Cadmium	Benzo(k)fluoranthene
Chromium	Benzo(a)pyrene
Cobalt	Bis(2-ethylhexyl)phthalate
Lead	Butyl benzyl phthalate
Mercury	Dibenzo(a,h)acridine
Nickel	Chrysene
Selenium	Dibenzo(a,h)anthracene
Silver	Di-n-butyl phthalate
Vanadium	o-Dichlorobenzene
	m-Dichlorobenzene
Volatile Organics	p-Dichlorobenzene
	Diethyl phthalate
Benzene	7,12-Dimethylbenz(a)anthracene
Carbon disulfide	Dimethyl phthalate
Chlorobenzene	Di-n-octyl phthalate
Chloroform	Fluoranthene
1,2-Dibromoethane	Indene
1,2-Dichloroethane	Methyl chrysene
1,4 Dioxane	1-Methylnaphthalene
Methyl ethyl ketone	Naphthalene
Ethyl benzene	Phenanthrene
Styrene	Pyrene
Toluene	Pyridine
Total xylenes	Quinoline
Acid Organics	
Benzenethiol	
o-Cresol	
meta- & para-Cresols	
2,4-Dimethylphenol	
2,4-Dinitrophenol	
4-Nitrophenol	
Phenol	

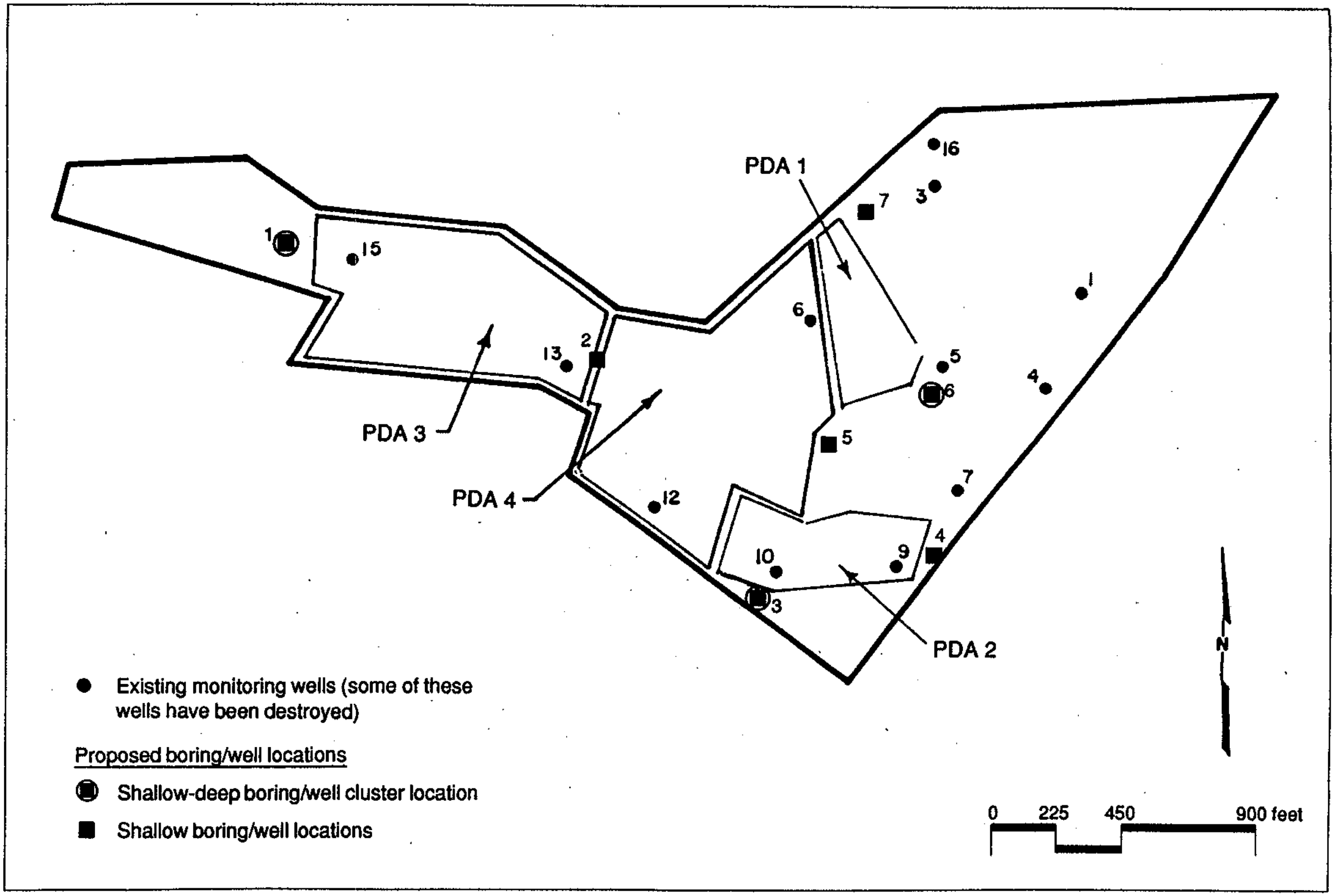

Figure 4-3

Proposed and Existing Monitor Well Locations at Past Disposal Areas 1-4

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Split-spoon samples will be collected at 5-foot intervals in the other two deep borings. Headspace screening and stratigraphic criteria will be used to select samples submitted for chemical and geotechnical analyses. Sample selection and analytical criteria were based on a review of available analytical data. Collection depths were based on assumed pathways for contaminant migration and accumulation.

Samples collected above the water table will be screened with an HNU Photo-ionization Detector (PID). Vadose zone samples exhibiting the highest measurement will be submitted for laboratory analysis. Within the deep borings, samples collected at the top of the water table, at the top of the gray silt, or Lower PRM confining layer and within the Lower PRM aquifer will be submitted for analysis. In the shallow borings, samples will be submitted from above the water table (dependent upon HNU measurement), at the top of the water table, and, if encountered within the boring, at the top of the Lower PRM confining layer. Within split-spoons selected for laboratory submission, sample material for chemical analysis will be collected first. If sufficient residual material remains in the spoon, a geotechnical sample will be collected from the same interval. If sufficient material is not available, the geotechnical sample will be collected from the next spoon interval.

Excluding quality assurance blanks, a maximum of 24 soil samples should be collected during the boring program around PDAs 1 to 4 (Table 4-1). Samples collected for chemical analyses will be analyzed for the Skinner Parameter List for soil and soil pH (Table 4-2).

Coarse granular soils selected as geotechnical samples will be analyzed for grain size distribution, moisture content, Atterberg limits, and bulk density. In fine-grained soils such as the Lower PRM confining bed, samples selected for geotechnical analysis will be collected with a Shelby tube sampler and submitted for vertical permeability along with the previously mentioned geotechnical index parameters (Table 4-2).

Groundwater

To characterize groundwater passing beneath PDAs 1 to 4 and to determine if a contaminant release has occurred, 10 monitor wells will be installed at 7 locations around the perimeter of PDAs 1 to 4 (Figure 4-3). Three locations will consist of a deep and shallow well cluster, while the remaining four locations consist of single shallow wells. Shallow wells will be screened across the water table to detect phase-separated liquids with low specific gravity. Deep wells will be installed at the top of the confined Lower PRM Aquifer to detect possible vertical migration of dense contaminants through the confining layer. Proposed screen locations were based on the nature of contaminant compounds encountered in the area to date.

The monitor well network will consist of an upgradient well cluster west of PDA 3; a single shallow well between PDA 3 and PDA 4; and downgradient monitoring locations including two shallow-deep well clusters (Figure 4-3). Seven of the ten wells will be installed in borings used to collect soil samples. The other three wells, the shallow half of the three deep-shallow well clusters, will be installed in unsampled borings. Drilling

Table 4-2
Proposed Soil Sampling for Phase I RFI

Sampling Medium	Location	Number of Samples	Analysis	Rationale
Waste	PDA's 1-4	12 (3 per disposal area)	- Skinner List[a] - Soil pH - RCRA Parameters[b]	Characterize nature and composition of waste material
Soil	PDA's 1-4	24 (4 per deep boring 3 per shallow boring)	- Skinner List - Soil pH - Geotechnical[c]	Define horizontal and vertical extent of contamination above water table, at top of water table at top of Lower PRM confining bed, in Lower PRM Aquifer.
Soil	Guard Basin	25 (4 per deep boring 3 per shallow boring)	- TCL[d] - TAL[e] - Soil pH - Geotechnical	Define horizontal and vertical extent of contamination above water table, at top of water table, at top of Lower PRM confining bed, in Lower PRM Aquifer.
Soil	Past Leaded Tank Bottom Disposal Area	8 (2 per trench)	- Skinner List - Soil pH - RCRA Parameters	Detect possible contaminant migration in vadose zone
Total of Soil/Waste Samples		69		

[a]Skinner Parameter List.
[b]RCRA parameters include ignitability, corrosivity, reactivity, and toxicity.
[c]Geotechnical parameters include grain size, permeability, moisture content, bulk density, and Atterberg limits.
[d]TCL is the Target Compound List parameters.
[e]TAL is the Target Analyte List parameters.

and well construction procedures are detailed in the next subsection under the heading "Sample Collection Procedures." Groundwater samples will be analyzed for the Modified Skinner List of parameters for groundwater (Table 4-3) including total and dissolved metals. Physical parameters, such as temperature, pH, and specific conductance will be measured in the field at the time of sampling (Table 4-4).

To fully characterize hydrogeologic conditions beneath PDAs 1 to 4, hydraulic conductivity testing will be performed on each of the three main hydrostratigraphic units (surficial water-bearing zone, silt and clay confining unit, and Lower PRM Aquifer). Vertical hydraulic conductivity of the silt and clay confining unit will be determined from laboratory analysis of Shelby tube samples. The horizontal hydraulic conductivity of the surficial water-bearing zone and Lower PRM Aquifer will be determined from the results of slug tests performed in the 10 new monitoring wells. Hydraulic conductivity coefficients, besides being useful in characterizing the subsurface environment, are essential for any conceptual designs of groundwater remediation systems, in the case of a contaminant release from PDAs 1 to 4.

The Schuylkill River, proximal to PDAs 1 to 4, exhibits fairly strong tidal fluctuations (approximately 4.5 feet), which may significantly alter hydraulic heads and gradients beneath the SWMUs. To assess the magnitude of gradient and head fluctuations due to tidal influence, a 48-hour tidal study will be performed. Water level measurements within the new wells proximal to the Schuylkill River will be collected for one 48-hour period during perigean high and low tides. To correlate subsurface measurements with actual tide fluctuations, monitoring stations in the form of staff gauges or stilling wells will be installed in the Schuylkill River and Lands Creek which flows across PDAs 3 and 4.

In addition to short-term, external (tidal) effects on heads and gradients within the shallow and deep aquifers, long-term observations will be collected over the course of a 6-month period. Water level measurements will be collected in the new wells once per month for 6 months. In addition, the existing free-product monitor wells will be evaluated (construction, screen setting, product thickness, etc.) to determine their usefulness for long-term potentiometric monitoring. Prior to the initiation of this task, all new and existing monitor wells incorporated in the network will be surveyed for horizontal location and vertical elevation by a Pennsylvania-licensed surveyor.

Surface Water and Sediments

To investigate the occurrence of a contaminant release to the surface water and sediments of Lands Creek, which runs through PDA 3 and along the boundary of PDA 4, three surface water and sediment samples will be collected along the course of this creek (Figure 4-4). Samples will be collected in an upstream location west of PDA 3, at the intersection of the creek and Tilly Lane between PDA 3 and PDA 4, and where the creek discharges to a turning basin and becomes confluent with the Schuylkill River. Sediment samples will be collected immediately below the surface water point of collection at each location.

Table 4-3
Modified Skinner List Parameters for Groundwater

Parameters	Base/Neutral Organics
Total Dissolved Solids	Anthracene
Specific Conductance	Benzo(a)anthracene
Chloride	Benzo(b)fluoranthene
Sulfate	Benzo(k)fluoranthene
Alkalinity, Total as $CaCO^3$ at pH 4.0	Benzo(a)pyrene
Alkalinity, Total as $CaCO^3$ at pH 4.5	Bis(2-ethylhexyl)phthalate
Alkalinity, Bicarb as $CaCO^3$ at pH 4.5	Butyl benzyl phthalate
Alkalinity, Carb. as $CaCO^3$ at pH 8.3	Chrysene
Alkalinity, Hydrox. as $CaCO^3$	Dibenz(a,h)anthracene
Fluoride	Di-n-butyl phthalate
pH	1,2-Dichlorobenzene
Ammonia	1,3-Dichlorobenzene
Nitrate plus Nitrate as N	1,4-Dichlorobenzene
Total Organic Carbon	Diethyl phthalate
Total Petroleum Hydrocarbons	7,12-Dimethylbenzanthracene
Metals	Dimethyl phthalate
	Di-n-octyl phthalate
Aluminum	Fluoranthene
Antimony	Indene
Arsenic	1-Methylnaphthalene
Barium	Naphthalene
Beryllium	Phenanthrene
Cadmium	Pyrene
Calcium	Pyridine
Chromium	Quinoline
Cobalt	
Iron	**Volatile Organics**
Lead	
Magnesium	Benzene
Mercury	Carbon disulfide
Nickel	Chlorobenzene
Phosphorus as P	Chloroform
Potassium	1,2-Dibromoethane
Selenium	1,2-Dichloroethane
Silver	1,4 Dioxane
Sodium	Methyl ethyl ketone
Vanadium	Ethyl benzene
	Styrene
Acid Organics	Toluene
	Total Xylenes
Benzenethiol	
o-Cresol	
Meta- & para-Cresols	
2,4-Dimethylphenol	
2,4-Dinitrophenol	
Phenol	

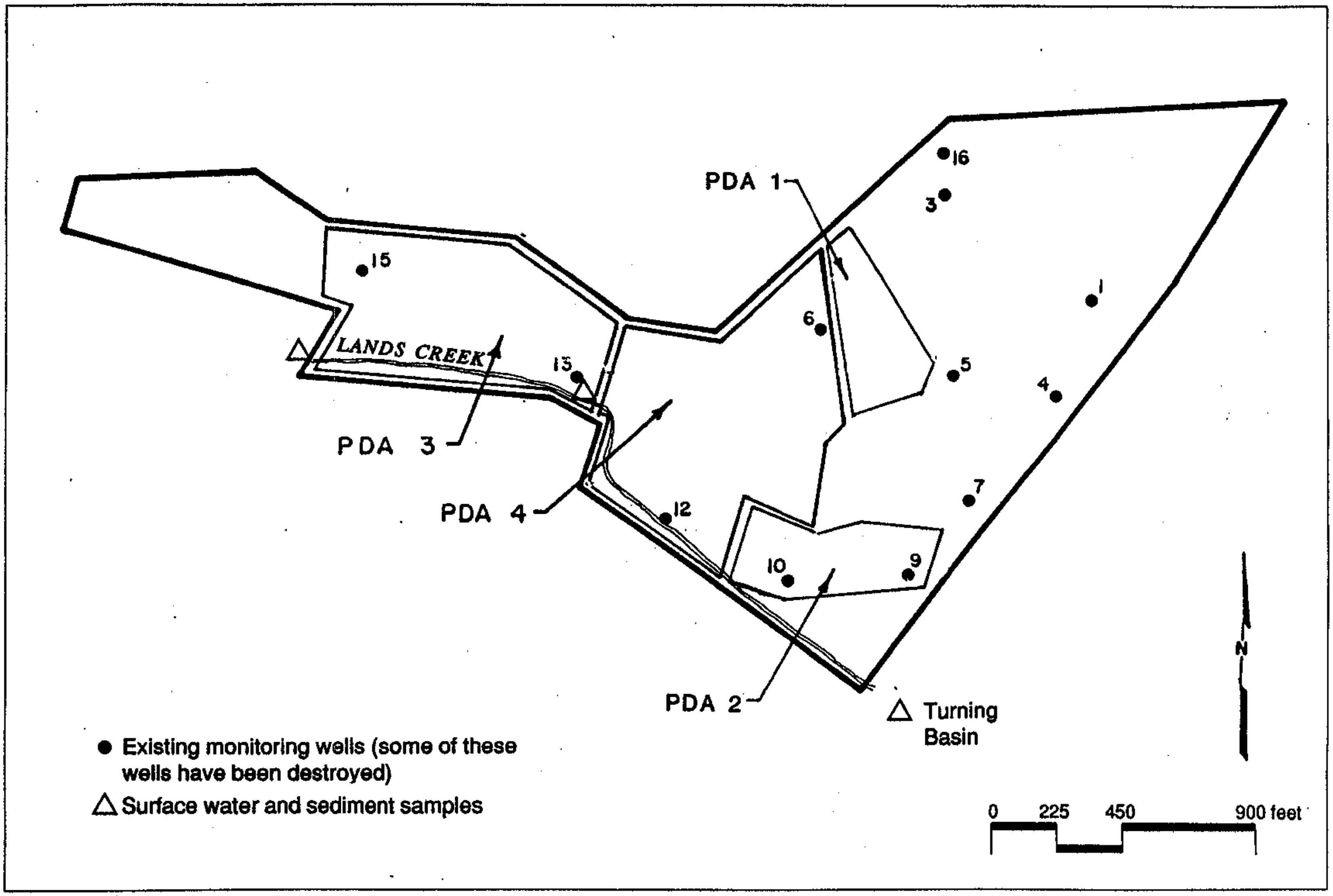

Figure 4-4

Proposed Surface Water and Sediment Sampling Locations at Past Disposal Areas 1-4

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Table 4-4 Proposed Groundwater Sampling for Phase I RFI Field Work				
Sampling Medium	**Location**	**Number of Samples**	**Analyses**	**Rationale**
Groundwater	PDAs 1-4	10	- Skinner List[a] - Water Elevations - Aquifer Testing	Detect possible contaminant release to surficial water bearing zone and Lower PRM aquifer.
Groundwater	Guard Basin	11	- TCL[b] - TAL[c] - Conventional[d] - Water Elevations - Aquifer Testing[e]	Detect possible contaminant release to surficial water-bearing zone and Lower PRM aquifer.
Total of groundwater samples		21		

[a]Skinner List is the Modified Skinner Parameter List for groundwater including total and dissolved metals.
[b]TCL is the Target Compound List Parameters.
[c]TAL is the Target Analyte List Parameters including total and dissolved metals.
[d]Conventional Parameters include TPH, TOC, oil and grease, TDS, nitrate, alkalinity, and sulfate.
Conventional parameters measured in the field will include pH, temperature, and specific conductance.
[e]Aquifer testing refers to slug tests.

Surface water samples will be analyzed for the modified Skinner List parameters for water (Table 4-5). Sediments will be analyzed for the Skinner Parameter List for soil, soil pH, and the RCRA parameters.

Table 4-5 Proposed Surface Water and Sediment Sampling for Phase I RFI Fieldwork				
Sampling Medium	**Location**	**Number of Samples**	**Analysis**	**Rationale**
Surface Water	Creek running through PDAs 3 and 4	3	- Skinner[a] - Conventional[b]	Detect possible contaminant release to onsite stream.
Surface Water	Guard Basin	4	- TCL[c] - TAL[d] - Conventional	Detect possible migration of contaminants in and out of Guard Basin.
Sediments	Creek running through PDAs 3 and 4	3	- Skinner[d] - RCRA Parameters[e]	Detect possible contaminant release to onsite stream.
Sediments	Guard Basin	4	- TCL - TAL - Conventional - RCRA Parameters	Detect possible accumulation of contaminants within Guard Basin.
Total of surface water/sediment samples.		14		

[a]Skinner is the Skinner Parameter List.
[b]Conventional parameters include pH, temperature, specific conductance, and dissolved oxygen, which will be measured in the field at the time of collection.
[c]TCL is the Target Compound List Parameters.
[d]TAL is the Target Analyte List Parameters.
[e]RCRA parameters include reactivity, corrosivity, ignitability, and toxicity

SWMU NO. 2--PAST LEADED TANK BOTTOM DISPOSAL AREA (SLUDGE WEATHERING PAD)

The past leaded tank bottoms disposal area or sludge weathering pad is a rectangular area, approximately 50 feet wide by 100 feet long, that was used to weather organic lead from leaded gasoline tank bottom sludges to inorganic lead (Figure 4-5).

Although historical plant records are not available, aerial photographs dating to 1940 indicate the area served as a leaded sludge weathering pad during two distinct time periods (GES, 1989). Prior to 1959, leaded sludges were deposited in a pit at the present location of the weathering pad. A refinery building occupied this area from 1959 to 1975. In 1975, the refinery building was razed and the remaining concrete slab foundation was used to weather leaded sludges. The sludge weathering area was closed again in 1980. Sludge materials were then transferred to a new sludge weathering unit. The concrete pad, in accordance with RCRA closure requirements, was swept clean of residuals and covered with clean gravel (GES 1989). Recent foundation borings in the area indicate most of the pad is intact.

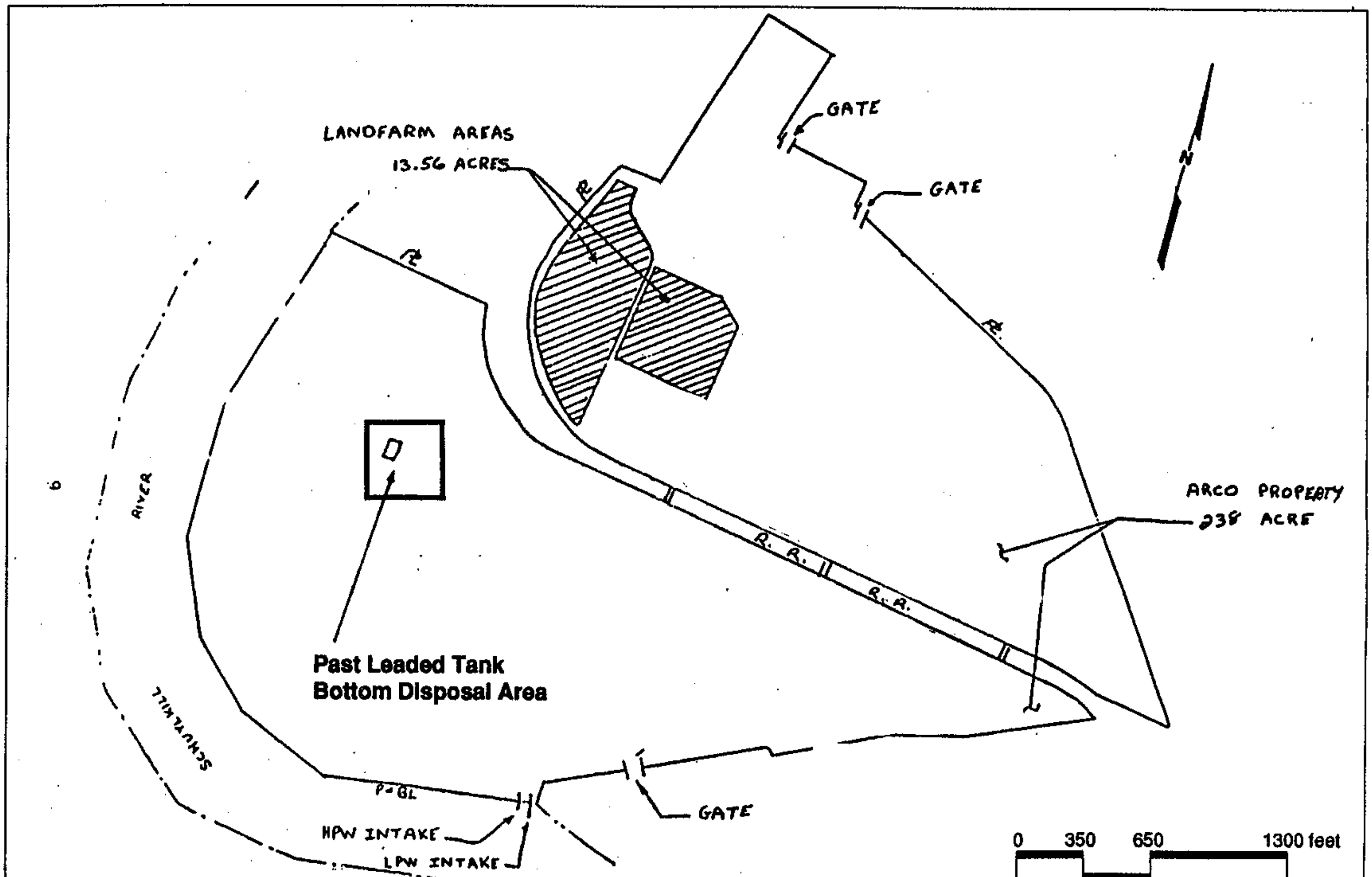
Geophysical Survey

To determine the location and orientation of the former sludge weathering pad, an electromagnetic (EM-31) survey will be performed over a 250 by 250-foot gridded area centered over the assumed location of the pad. The survey should be able to detect the relative condition of the pad (intact, broken, portions missing), along with the location of leaded wastes that spilled off the pad and spread into the subsurface.

Electromagnetic conductivity measurements will be obtained at 10-foot intervals along traverse lines spaced 20 feet apart. Measurements at each location will consist of conductivity and in-phase values. The in-phase reading is a valuable indicator of buried metal or underground utilities, and can be collected simultaneously with conductivity data.

Soil

To determine if a contaminant release has occurred to the soil surrounding the weathering pad, four trenches will be excavated next to the former pad. If the geophysical survey indicates the former pad is whole and intact, the trenches will be oriented parallel to the four sides of the pad (Figure 4-6). If the pad has been removed or broken up, trenches will be excavated perpendicular to the long axis of the pad at equidistant intervals. Trenches will be 20 to 50 feet long and will be excavated to 3 feet below the top of the water table. Soil samples will be collected at 2-foot intervals within each pit. Samples will be collected from the sidewall of the trench adjacent to the edge of the pad, if the pad is intact and beneath the pad if it is broken up. The vadose zone sample exhibiting the highest HNU reading along with a sample spanning the water table will be submitted for chemical analysis. Soil samples will be analyzed for the Modified Skinner List parameters, and soil pH (Table 4-2).



Source: A.T. Kearney, August 1986.

Figure 4-5

Location Map of North Yard and Past Leaded Tank Bottom Disposal Area

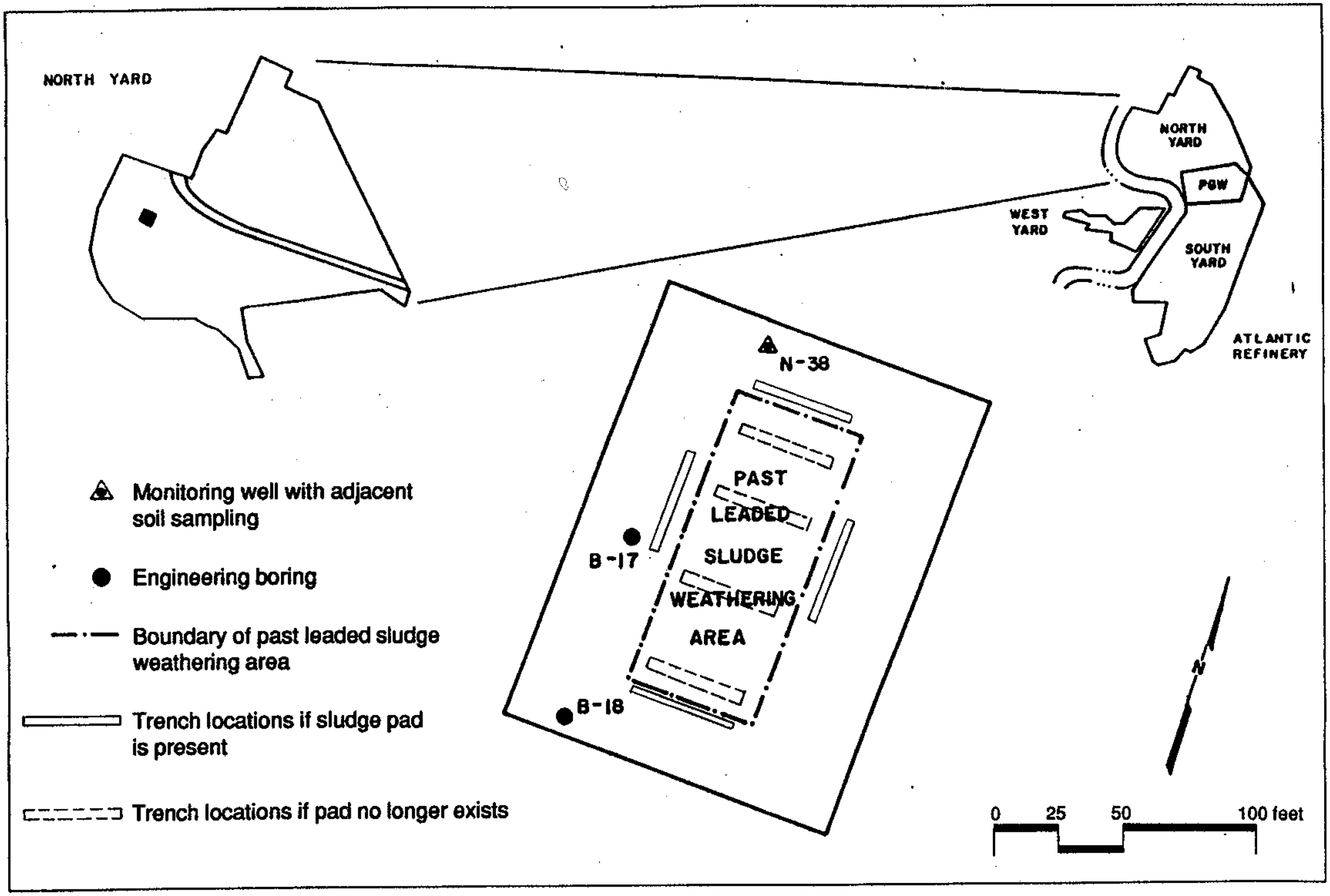


Figure 4-6

Proposed Waste Sampling Locations at Past Leaded Tank Bottom Disposal Area

SWMU NO. 3--GUARD BASIN

The Guard Basin is a stormwater retention pond in the southern portion of the South Yard. The basin began operation prior to 1959 (Figure 4-7). At the beginning of operations, the basin borders extended 175 feet southeast of its present boundary. The bottom of the basin is unlined and, therefore, may act as a source of recharge to or discharge from the surficial water-bearing zone. Channeled stormwater from the plant passes through an oil-water separator and oil skimmer before discharging to the Guard Basin. The treatment system is designed as a migration pathway barrier for potential contaminant releases to local surface water. Water passes through the basin and is discharged to the Schuylkill River via a pipe. Discharge to the river is regulated by the plant's NPDES permit.

Several past disposal areas (PDAs "A", "B" and "C") are located east of the Guard Basin. These areas accepted leaded and cooling tower sludges. Although the PDAs are capped, they may represent past or ongoing contaminant releases to the Guard Basin.

Bathymetric Survey

To establish bottom elevations and sediment thickness within the Guard Basin, a bathymetric survey of the basin will be conducted. The bottom elevations of the Guard Basin combined with potentiometric surface maps of the water table should elucidate the basin's hydraulic relationship with the surficial water-bearing zone.

The basin will be segmented into a grid based on 50-foot centers. Depth to bottom will be measured at each grid node with a calibrated sounding pole. Sediment thickness will be determined by driving the sounding pole through the loose sediments and recording the depth of refusal.

Surface Water and Sediment

To investigate the occurrence of a contaminant release to the surface water and sediments of the Guard Basin, four surface water and sediment samples will be collected along a transect spanning the long axis of the basin. Samples will be collected at the upgradient inflow to the basin and at the downgradient outfall to an adjacent basin, as well as at two locations within the basin. Samples within the basin will be collected at grid points established during the bathymetric survey (Figure 4-8).

In accordance with requirements of the corrective action permit, surface water samples will be analyzed for the TCL and TAL lists parameters (Table 4-6 and 4-7). TDS, TSS, alkalinity, sulfate, nitrate, ammonia, TOC, and TPH (Table 4-3). Sediments collected directly below the surface water point of collection will be analyzed for the TCL and TAL List Parameters, TOC, TPH, and RCRA parameters.

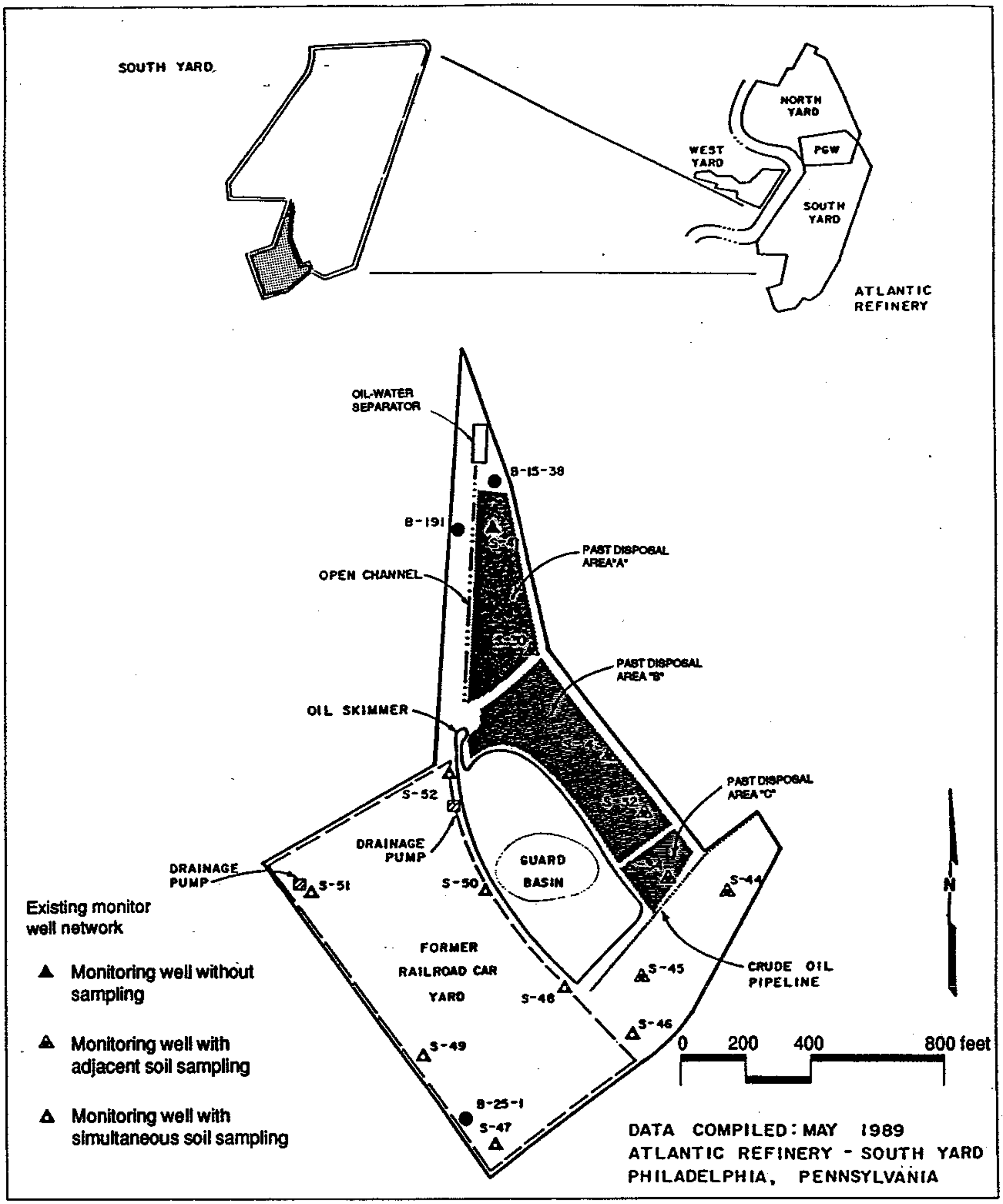


Figure 4-7

Map of Guard Basin and Vicinity

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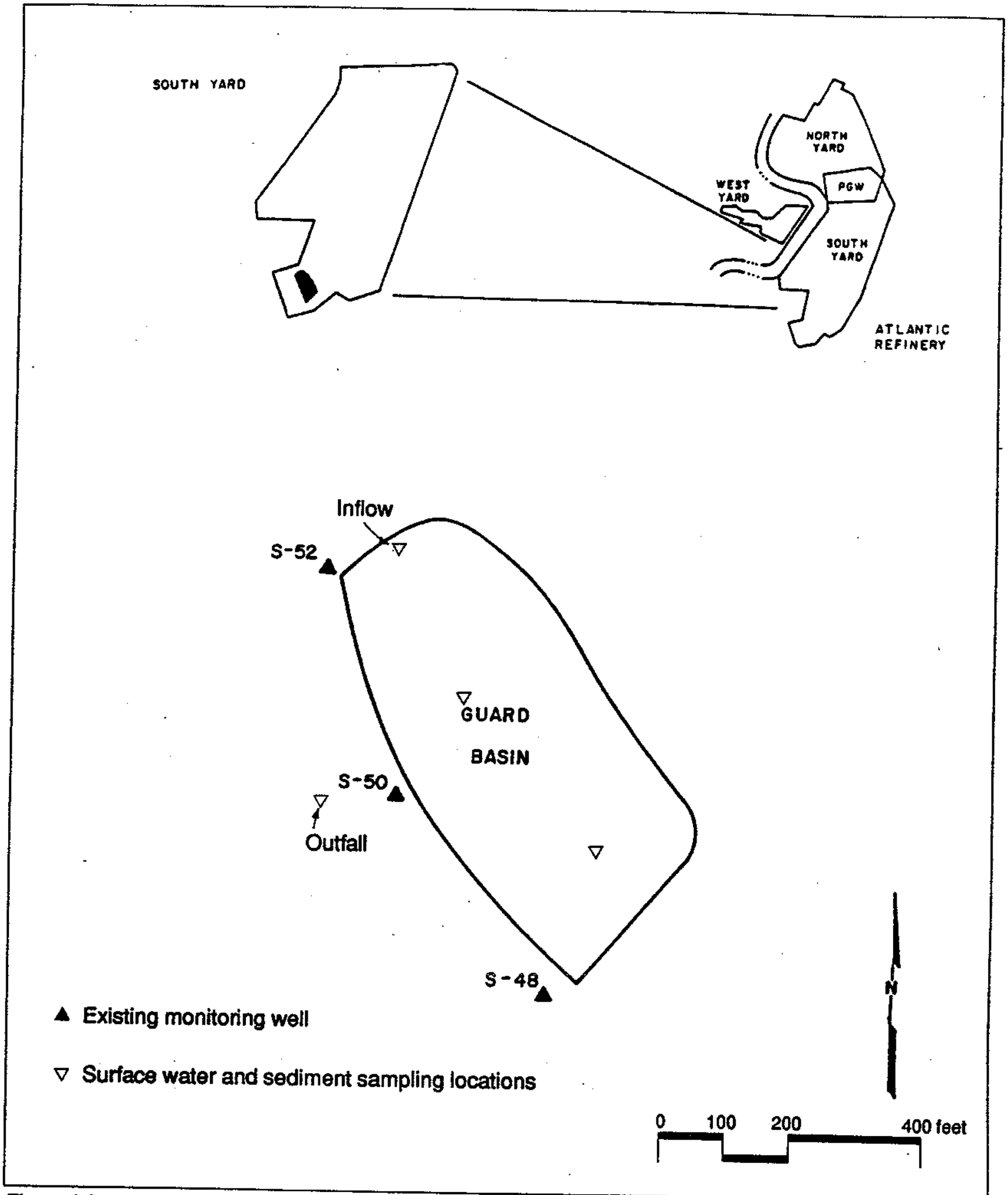

Figure 4-8

Proposed Surface Water and Sediment Sampling Locations at the Guard Basin

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Table 4-6
Target Compound List (TCL)

Volatile Organic Compounds (39)	**Acid Extractable Organic Compounds (14)**
Acetone	Benzoic acid
Acrolein	4 Chloro-3 methyl phenol
Acrylonitrile	2-Chlorophenol
Benzene	2,4-Dichlorophenol
Bromodichloromethane	2,4-Dimethylphenol
Bromoform	2-methyl-4,6-Dinitrophenol
Bromomethane	2,4-Dinitrophenol
2-Butanone	2-Methyl phenol
Carbon disulfide	4-Methyl phenol
Carbon tetrachloride	2-Nitrophenol
Chlorobenzene	4-Nitrophenol
Chloroethane	Pentachlorophenol
2-Chloroethyl vinyl ether	Phenol
Chloroform	2,4,5-Trichlorophenol
Chloromethane	
Dibromochloromethane	**Base-Neutral Extractable Organic Compounds (56)**
1,1-Dichloroethane	
1,2-Dichloroethane	
1,1-Dichloroethene	Acenaphthene
trans-1,2-Dichloroethene	Acenaphtylene
1,2-Dichloropropane	Aniline
cis-1,3-Dichloropropene	Anthracene
trans-1,3-Dichloropropene	Benzidene
Ethylbenzene	Benzo(a)anthracene
2-Hexanone	Benzo(a)pyrene
4-Methyl-2-pentanone	Benzo(b)fluoranthene
Methylene chloride	Benzo(k)fluoranthene
Styrene	Benzo(g,h,i)perylene
1,1,2,2-Tetrachloroethane	Benzyl alcohol
Tetrachloroethylene	bis(2-Chloroethyl) ether
1,1,1-Trichloroethane	bis(2-Chloroethoxy) methane
1,1,2-Trichloroethane	bis(2-Chloroisopropyl) ether
Trichloroethene	bis(2-Ethylhexyl)phthalate
Trichlorofluoromethane	4-Bromophenyl phenyl ether
Toluene	Butyl benzyl phthalate
Vinyl acetate	4-Chloroaniline
Vinyl chloride	2-Chloronaphthalene
Xylenes	4-Chlorophenyl phenyl ether
Methyl ethyl ketone	Chrysene

Table 4-6
Target Compound List (TCL)

Base Neutral Extractable Organic Compounds (56) (Continued)	Pesticides and PCBs (26)
Dibenzo(a,h)anthracene	Alpha-BHC
Dibenzofuran	Beta-BHC
Dibutyl phthalate	Delta-BHC
1,2-Dichlorobenzene	Gamma-BHC (Lindane)
1,3-Dichlorobenzene	Heptachlor
1,4-Dichlorobenzidine	Aldrin
3,3'-Dichlorobenzidine	Heptachlor epoxide
Diethyl phthalate	Endosulfan I
Dimethyl phthalate	Dieldrin
2,4-Dinitrotoluene	4,4'-DDE
2,6-Dinitrotoluene	Endrin
Di-n-octyl phthalate	Endosulfan II
1,2-Diphenylhydrazine	4,4'-DDD
Dowtherm A	Endosulfan sulfate
Fluoranthene	4,4-'DDT
Fluorene	Methoxychlor
Hexachlorobenzene	Endrin
Hexachlorobutadiene	Chlordane
Hexachlorocyclopentadiene	Toxaphene
Hexachloroethane	PCB-1016
Ideno(1,2,3-cd)pyrene	PCB-1221
Isophorone	PCB-1232
2-Methylnaphthalene	PCB-1242
Naphthalene	PCB-1248
2-Nitroaniline	PCB-1254
3-Nitroaniline	PCB-1260
4-Nitroaniline	
Nitrobenzene	
N-Nitrosodi-n-propylamine	
N-Nitrosodiphyenylamine	
Phenanthrene	
Pyrene	
2,3,7,8-Tetrachlorodibenzo-p-dioxin	
1,2,4-Trichlorobenzene	
2,4,6-Trichlorophenol	

Table 4-7
Target Analyte List (TAL)

Metals (23 Elements)	Miscellaneous (1 Compound)
Aluminum	Cyanide
Antimony	
Arsenic	
Barium	
Beryllium	
Cadmium	
Calcium	
Chromium	
Cobalt	
Copper	
Iron	
Lead	
Magnesium	
Manganese	
Mercury	
Nickel	
Potassium	
Selenium	
Silver	
Sodium	
Thallium	
Tin	
Zinc	

Soil

To characterize subsurface soil adjacent to the Guard Basin, soil samples will be collected from seven borings drilled along the perimeter and 200 feet east of the basin (Figure 4-9). Four borings will be drilled to bedrock, approximately 85 to 100 feet below grade, while the other three are drilled to 10 feet below the top of the water table, approximately 15 to 20 feet below grade. Continuous split-spoon/Shelby tube samples will be collected from one of the deep borings and all of the shallow borings. Split-spoon samples in the other three deep borings will be collected at 5-foot intervals. Proposed sample selection criteria are based on a review of available analytical data. Collection depths are assumed pathways or accumulation areas of contaminant migration.

Head-space screening and stratigraphic criteria will be used to select samples submitted for chemical and geotechnical analyses. Samples collected above the water table will be screened with an HNU PID. The sample exhibiting the highest measurement will be submitted for laboratory analysis. Within the deep borings, samples collected at the top of the water table, at the top of the gray silt or Lower PRM confining layer, and within the Lower PRM aquifer will be submitted for analysis. In the shallow borings, samples will be submitted from above the water table (dependent upon HNU measurement), at the top of the water table, and if encountered within the boring, at the top of the Lower PRM confining layer. Within split-spoons selected for laboratory submission, chemical samples will be collected first. If sufficient residual material remains in the spoon, a geotechnical sample will be collected from the same interval. If material is not available, the geotechnical sample will be collected from the next spoon interval.

Excluding quality assurance blanks, a maximum of 25 soil samples should be collected during the boring program around the Guard Basin (Table 4-2). Samples collected for chemical analyses will be analyzed for Skinner List Parameter for soil and soil pH (Table 4-2). Coarse granular soils selected as geotechnical samples will be analyzed for grain size distribution, moisture content, Atterberg Limits, and bulk density. In fine-grained soils, such as the Lower PRM confining bed, samples for geotechnical analysis will be collected with a Shelby tube sampler and submitted for the above parameters and vertical permeability.

Groundwater

To characterize groundwater passing beneath the Guard Basin and to determine if a contaminant release has occurred, 11 monitor wells will be installed at 7 locations around the perimeter (Figure 4-9). Four locations will consist of a deep and shallow well cluster, while the remaining three locations consist of single shallow wells. Shallow wells will be screened across the water table to detect phase-separated liquids with low specific gravity. Deep wells will be installed at the top of the confined Lower PRM Aquifer to detect possible deep vertical migration of dense contaminants through the confining bed.

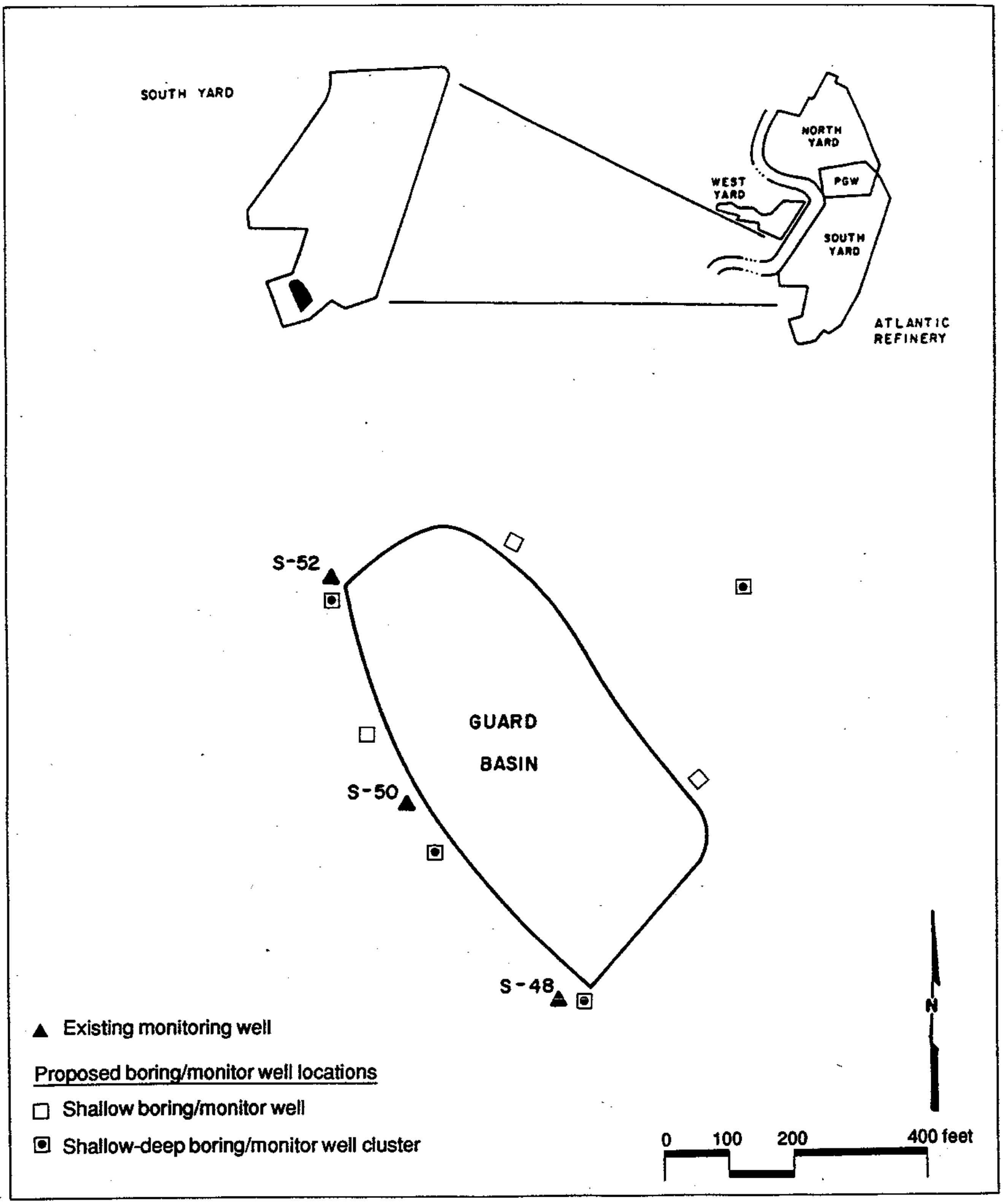

Figure 4-9

Proposed and Existing Monitor Well Locations at the Guard Basin

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The monitor well network will consist of three upgradient well locations including one shallow-deep well cluster and two single wells east of the Guard Basin and four downgradient monitoring locations including three shallow-deep well clusters (Figure 4-9) west of the basin. Two of the upgradient wells are sited between the basin and PDAs to detect possible contaminant migration toward the Guard Basin from these facilities. Seven of the eleven wells will be installed in borings used to collect soil samples. The other four wells, the shallow half of the four shallow-deep well clusters, will be installed in unsampled borings. Drilling and well construction procedures are detailed in the following subsection, "Sample Collection Procedures.". Groundwater samples will be analyzed for the TCL and TAL Lists plus total and dissolved metals, TOC, TPH, TDS, alkalinity, and TSS.

Physical parameters such as temperature, pH, and specific conductance will be measured in the field at the time of sampling. To fully characterize hydrogeologic conditions beneath the Guard Basin, hydraulic conductivity testing will be performed on each of the three main hydrostratigraphic units (surficial water-bearing zone, silt, and clay confining unit, and the Lower PRM Aquifer). Vertical hydraulic conductivity of the silt and clay confining unit will be determined from laboratory analysis of Shelby tube samples. The horizontal hydraulic conductivity of the surficial water-bearing zone and Lower PRM Aquifer will be determined from the results of slug tests performed in the ten new monitoring wells. Hydraulic conductivity coefficients, besides being useful in characterizing the subsurface environment, are essential for any conceptual designs of groundwater remediation systems in the case of a contaminant release from the Guard Basin.

The Schuylkill River proximal to the Guard Basin exhibits fairly strong tidal fluctuations (approximately 4.5 feet), that may significantly alter hydraulic heads and gradients beneath the basin. In addition, the hydraulic relationship between the Guard Basin and surficial water-bearing zone may alternate between periods of recharge and discharge due to tidal fluctuations.

To assess the magnitude of gradient and head fluctuations due to tidal influence, a 48-hour tidal study will be performed. Water level measurements within the new wells proximal to the Schuylkill River will be collected for one 48-hour period during perigean high and low tides. To correlate subsurface measurements with actual tide data, monitoring stations will be installed in the Schuylkill River and at several points within the Guard Basin.

In addition to short-term external observations (tidal) on heads and gradients within the shallow and deep aquifers, long-term observations will be collected over the course of a 6-month period. Water level measurements will be collected in the new wells once per month for 6 months. In addition, the existing free-product monitoring wells will be evaluated (construction, screen setting, product thickness, etc.) to determine their usefulness for long-term potentiometric monitoring. Prior to the initiation of this, all new and existing monitor wells incorporated in the network will be surveyed for horizontal location and vertical elevation by a Pennsylvania-licensed surveyor.

SAMPLE COLLECTION PROCEDURES

WASTE SAMPLING

Twelve waste samples will be collected at seep areas along the slopes of PDA Nos. 1 through 4. To preclude disturbing the integrity of the clay caps on these units, sampling activities will be limited to collecting grab samples from the surface. Waste samples will be collected with a chemically decontaminated stainless steel trowel or hand auger.

Upon retrieval of sample material from a seep, 40-ml volatile organic analysis (VOA) vials will be filled immediately by scraping material directly from the sampling instrument into the vials with a stainless steel spatula. Remaining sample material will be homogenized in a stainless steel pan with a stainless steel or teflon spatula. The homogenized soil will be used to fill the remaining sample bottles dedicated to Skinner List parameters (shown by Table 4-1) exclusive of the volatile organics. Samples will be cooled to 4°C immediately following sample collection and during transport to the laboratory.

Upon the completion of sampling, locations will be staked and photographed. Each location will be surveyed for horizontal location at the same time as the newly installed monitor wells.

SUBSURFACE SOIL SAMPLING

Soil borings will be advanced by hollow-stem auger or mud rotary methods. To develop an understanding of the site stratigraphy, deep borings will be drilled first. At cluster locations, only the deep boring will be sampled. One deep boring at PDA Nos. 1 to 4 and one at the Guard Basin will be sampled continuously, while the other deep borings at each unit are sampled every 5 feet.

The first sample interval selected for chemical or geotechnical analysis will be based on headspace screening of samples above the water table. Depth intervals for the remaining three samples--top of the water table, top of the confining layer, and within the Lower PRM--will be determined from boring log data of deep foundation borings drilled at PDA Nos. 1 to 4, and the Guard Basin (GES, 1989). Three samples will be collected in each of the shallow borings from intervals above the water table, at the top of the water table, and at the top of the confining layer.

Sample intervals designated for chemical analysis will be sampled with a chemically decontaminated 3-inch-diameter, 2-foot-long split spoon. Decontamination procedures for split spoons are detailed in Section 5 of the QAPP (Appendix A) and Chapter 4 of this work plan. Spoons will be driven 2 feet or to refusal, with a 140- or 300-pound hammer according to soil consistency.

Upon retrieval and opening of the spoon, the sample will be screened with an HNU at several points along its length. Sample material will be shaved from several intervals along the spoon "core" and placed in 40-ml vials for VOA analysis. The remaining sample material will be described, then homogenized in a decontaminated stainless steel tray with a stainless steel or teflon spatula. Sample bottles for analysis of the remaining Skinner List parameters will be filled with homogenized soil.

Samples designated for geotechnical analysis or lithologic description only will be collected in a 2-inch-diameter, 2-foot-long split spoon. Spoons will be driven with a 140- or 300-pound hammer according to soil consistency. Hammer blows will be recorded for Standard Penetration Tests (SPT) in accordance with ASTM Method D-1586. Geotechnical samples in fine-grained soils will be collected in 3-inch-diameter, 30-inch-long Shelby tubes. To prevent changes in moisture content and disturbance of the sample, tubes will be sealed with paraffin wax and stored and shipped in an upright position. All samples will be visually described and classified according to the Unified Soil Classification System (USCS-ASTM-Method D-422). Descriptions exclusive of grain size will be in accordance with standard engineering and geologic practice. Soil color will be described using the Munsell Soil or Rock Color Chart.

SUBSURFACE SOIL SAMPLES--TRENCHES

To investigate the possibility of a hazardous release, to the surrounding soils four trenches will be excavated in the vicinity of the past lead tank bottoms disposal area (sludge weathering pad). If the geophysical survey reveals the pad is no longer present or intact, four trenches will be excavated at equidistant locations perpendicular to the long axis of the assumed former location of the pad. If the pad is still in place beneath the gravel cover, the trenches will be excavated parallel to the four sides of the pad.

Trenching will be performed with an extended reach backhoe capable of excavating 15 to 20 feet below grade. Trenches will be 20 to 40 feet long and extend 3 feet below the top of the water table. Trenches will be excavated in 2-foot lifts. Soil or waste samples will be collected from the backhoe bucket at 2-foot intervals. Two samples from each trench will be submitted for laboratory chemical analysis. The first sample will originate from the zone above the water table and will be selected according to head space screening results with an HNU PID. The second sample submitted for analysis will be from the vadose zone-water table interface.

Sample material will first be scraped directly from the backhoe bucket into 40-ml vials for VOA analysis with a stainless steel spatula. A large amount of sample material will then be placed in a stainless steel tray and homogenized. The remaining sample bottles for Skinner List parameters, RCRA parameters, and soil pH will be filled with homogenized soil.

Excavation spoils will be placed on sheet plastic during digging. The spoils will be used to reclaim the trench they originated from.

SURFACE WATER AND SEDIMENT SAMPLE COLLECTION

Surface water and sediment samples will be collected from both the PDAs and the Guard Basin. Three surface water and three sediment samples will be collected from the creek running through PDA Nos. 3 and 4 and discharging to the Schuykill River. Samples will be collected at a location upstream of PDA 3, within PDA 3, and downstream of PDA 4 near the discharge to the Schuykill River.

Four surface water and four sediment samples will be collected along a transect spanning the long axis of the Guard Basin. Samples will be collected at the inflow, the outfall, and two other deep locations within the basin. Deep locations will be sampled to investigate possible contaminant traps or sinks in the deeper portions of the basin as determined by the bathymetric survey. Sample materials will be collected directly into the sample bottles preventing cross contamination between sampling instruments or contamination caused by residual decontamination solvents on a sampling implement.

Volatile organic samples will be collected first, followed in sequence by TCL and Skinner List base neutral and acid extractables, metals, TOC, and TPH. Physical parameters such as temperature, pH, specific conductance, and dissolved oxygen will be measured at the time of sample collection. Samples will be preserved in the field before shipment to the laboratory. Sample preservation techniques are described in Section 5 of the QAPP (Appendix A).

Sediment samples will be collected directly below the point where surface water samples were obtained. Selection of sampling instruments will be dependent upon the depth to the sediment surface. At locations where the creek or basin is less than 5 feet deep, a decontaminated stainless steel hand auger will be used to obtain sample material. The auger head type (sand, clay, peat) will be selected according to the type of sediment encountered. At locations where the sediment surface is greater than 5 feet deep, a Ponar dredge will be used to trap and retrieve sediments to the surface. The Ponar dredge consists of two stainless steel, spring-loaded jaws that are set against a retracting pin. The impact of the dredge on the sediment surface releases the pin allowing the jaws to close, trapping up to 30 ounces of soft sediment. The dredge and sample material are retrieved to the surface on a rope.

Volatile organic samples will be collected immediately upon retrieval from the hand auger or dredge. Remaining sample material will be homogenized in a decontaminated stainless steel tray. Sample bottles for the remaining Skinner List and RCRA parameters will be filled with homogenized sediment.

If the bathymetric survey (described below) in the Guard Basin reveals that sediment thickness is greater than 1.5 feet, several depth-discrete samples may be attempted. Depth-discrete samples will be obtained with a 2-inch-diameter stainless steel hand auger. A 3-inch section of PVC pipe will be advanced with the hand auger to prevent collapse of the borings before reaching the desired sampling depth.

BATHYMETRIC SURVEY

To establish the topography and sediment thickness on the bottom of the Guard Basin, measurements of sediment thickness and depth to bottom will be collected on 50-foot centers within the basin. The survey information will be used to determine applicability of collecting depth discrete samples (sediment thickness >1.5 feet) and the hydraulic relationship between the Guard Basin and the surficial water-bearing zone.

The bathymetric survey will be conducted by stretching a rope knotted in 50-foot segments across the basin perpendicular to its long axis. A survey crew in a row boat will move along the rope collecting depth-to-bottom and sediment thickness measurements at 50-foot intervals. When measurements have been collected along the entire span of rope or survey line, two crew members stationed at each of the rope will move the entire line 50 feet down the basin and measurements will be collected along the new line. The process will be repeated until the entire basin has been surveyed.

Survey measurements will be collected in two phases with a calibrated sounding pole. The pole will be set on bottom to obtain depth measurements, then pushed to refusal to obtain sediment thickness.

At the conclusion of the survey, a contour map will be generated of the bottom of the Guard Basin along with an isopach of sediment thickness. In addition, a profile of the bottom of the Guard Basin can be integrated into any hydrogeologic cross sections developed during the writing of the RFI report.

MONITOR WELL INSTALLATION

Groundwater monitoring networks, consisting of 10 monitor wells at PDA Nos. 1 to 4 and 11 wells at the Guard Basin, will be installed. The wells will monitor the surficial water table and the confined Lower PRM Aquifer. Both SWMUs are currently surrounded by numerous free-product gauging wells; however, their construction is not acceptable by EPA standards (lack of locking outer casing and lack of grout seal) for obtaining chemical samples for RCRA compliance. The construction details of these wells will be evaluated, however, to determine their usefulness for long-term potentiometric monitoring. Results of this evaluation will be provided in the RFI report.

Monitoring Well Locations

Both monitoring well networks were designed according to the geometry of the regulated unit and the complexity of the underlying geology in accordance with the *RCRA Ground Water Monitoring Technical Enforcement Guidance Document* (TEGD). Downgradient wells were sited as close to the units as physically possible. Upgradient wells were placed in slightly distal locations to prevent possible contamination from the subject SWMU. Shallow-deep well clusters were sited at an upgradient and two downgradient corners of each SWMU to triangulate subsurface information (bed contacts, facies geometry, etc.) and flow potential lines in the deep aquifer.

At PDA Nos. 1 to 4 a shallow-deep cluster was placed upgradient and at two downgradient location of the composite CAMU (Figure 4-3). Three additional downgradient shallow wells were distributed at equidistant points along the eastern border of the unit (Figure 4-3). In addition, a single shallow well has been sited between PDA 3 and 4 (Figure 4-3) to provide an additional potentiometric and chemical monitoring point between PDAs 3 and 4.

Three upgradient well locations (one shallow-deep cluster, and two shallow wells) have been sited east of the Guard Basin (Figure 4-9). Two of the shallow wells have been sited between the basin and Past Disposal Areas "A", "B" and "C". The disposal areas are former waste lagoons that have been reclaimed and capped. The wells are positioned to detect possible contaminant migration from the PDAs migrating to the Guard Basin. The third upgradient location consists of a shallow-deep cluster sited east of the PDAs (Figure 4-9).

Four downgradient well locations, including three shallow-deep clusters have been sited west of the Guard Basin to detect possible migration of contamination.

Drilling and Well Construction Methods

All shallow wells will be drilled with 4-1/4-inch-inside-diameter hollow-stem augers mounted on a truck- or trailer-mounted drill rig. Monitor wells will be installed in all the borings used for soil sampling. The seven shallow wells at the shallow-deep clusters will be installed in unsampled borings. All soil cuttings generated during drilling will be placed in USDOT-approved 55-gallon drums. At the end of drilling, drums will be labelled according to contents and transported to a central secure location to await disposal.

Shallow borings will be advanced to approximately 10 feet below the top of the water table. A 2-inch-diameter, 10-foot-long PVC .020-inch slot screen with flush thread Schedule 40 PVC riser will be installed within the augers. The screen will be positioned to intercept the water table with 2 to 3 feet of air space to accommodate tidal and seasonal fluctuations.

A Morie grade No. 0 sand filter pack will be installed to 2 feet above the top of the screen as the augers are incrementally withdrawn (Figure 4-10). A 2-foot bentonite pellet seal will be installed on top of the sand pack. Five to 10 gallons of water will be added to hydrate the bentonite pellets, which will be allowed to "charge" for one-half hour before resuming well construction.

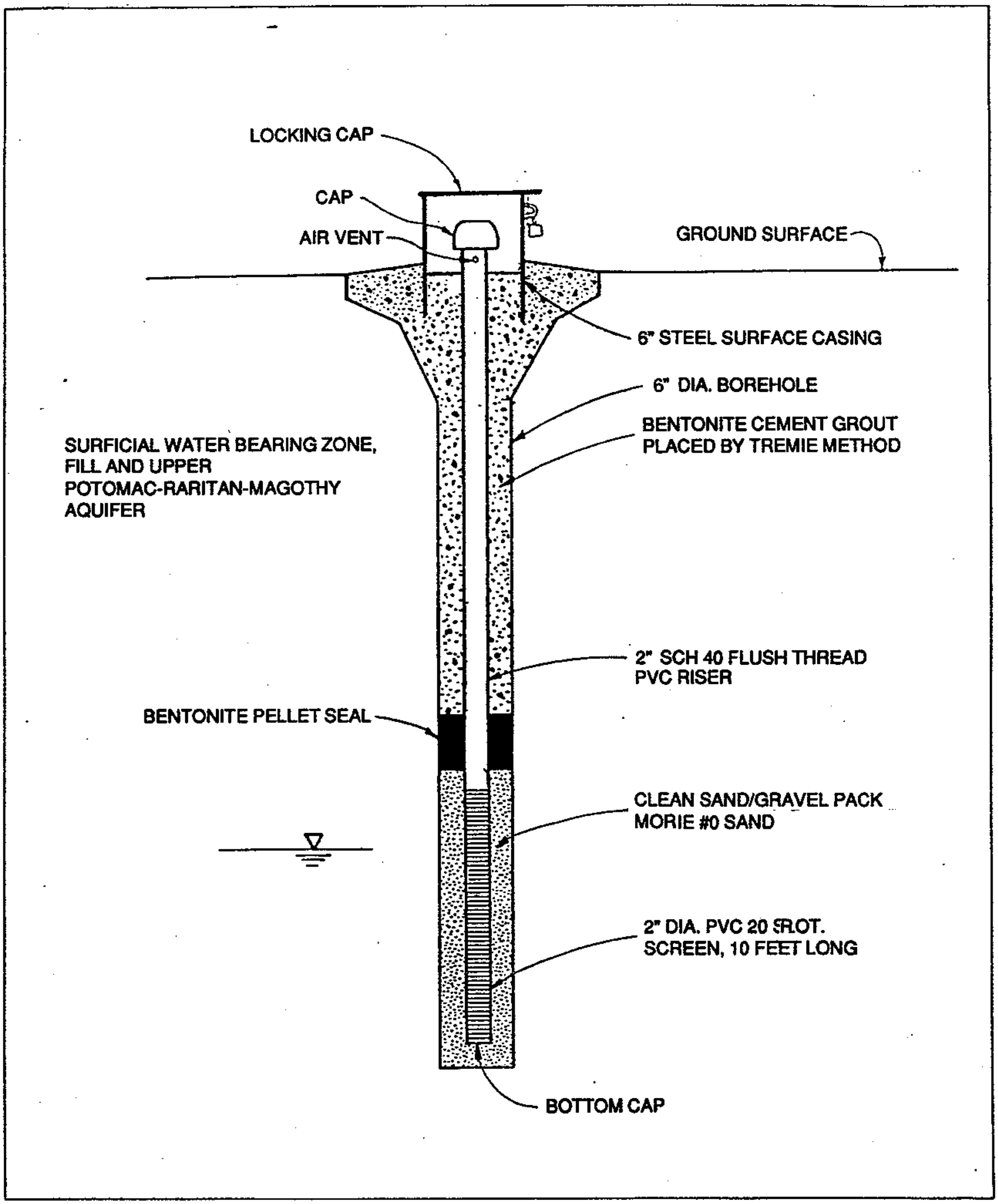

Figure 4-10

Typical Monitoring Well Construction

CH2M HILL

PHL31374.AO/format4

The wells will be grouted to the surface, using a grout mix consisting of 3 to 5 pounds of bentonite and 8 gallons of water per 94-pound bag of Portland Type I or II cement. Grout will be carefully added to the annular space of the well to prevent disturbing the bentonite seal.

Protective 4-inch-ID outer steel casing with keyed alike locking caps will be grouted over each well. A 3-foot by 3-foot concrete pad will be installed around the outer casing to ensure its structural integrity. The pad will be sloped away from the well to deflect surface runoff. In areas of high vehicular traffic, a steel, locking, flush-to-grade protective box with a sloping concrete pad may be installed over the shallow wells instead of the standard protective casing that protrudes 2 to 3 feet above grade.

Deep wells will be drilled using mud rotary techniques. To prevent hydraulic connection and possible cross contamination between the Lower PRM and surficial water-bearing zone, a 6-inch-ID steel casing will be set 5 feet into the top of the confining layer between the two zones (approximately 20 to 30 feet below grade) (Figure 4-11). The drilling schedule consists of advancing the boring, while sampling, with a 5-7/8-inch-diameter rock roller or drag bit to 5 feet into the top of the confining layer. The 5-7/8-inch borehole will then be reamed to the confining layer with an 8- or 10-inch-diameter bit. A 6-inch-ID weld-joint steel casing will be set 5 feet into the top of the confining layer. The annular space between the borehole wall and outside of the steel casing will be grouted to the surface. Grout will be installed through a 1-inch-diameter tremie pipe set 5 feet above the bottom of the casing to ensure the casing is grouted at the base. The grout will be allowed to "set up" for 12 hours before drilling is resumed.

The remainder of the borehole will be drilled to bedrock with a 5-7/8-inch bit. A 2-inch-ID, 10-foot-long, .020-inch slot PVC screen with flush thread Schedule 40 PVC riser will be installed at the top of the Lower PRM aquifer. If there is a significant interval between the top of bedrock and the bottom of the intended screen intervals, the bottom of the borehole will be backfilled to 2 feet below the screen with bentonite pellets. A Morie No. 0 sand-filter pack will be tremied in the annular space of the borehole to 2 feet above the screen or to the base of the confining layer. A 2-foot thick bentonite seal will be placed on top of the filter pack and keyed into the confining layer. The remaining annular space of the borehole will be tremie grouted to the surface using the grout mix described above.

A keyed-alike locking cap will be welded to the 6-inch surface casing, and a 3-foot by 3-foot concrete sloping pad will be installed around the casing. If the well is located in an area of heavy vehicular traffic, the 6-inch casing will be cut to below grade. A rubber gasket locking cap will be installed on the well with a bolted man-hole cover.

All cuttings and spent drilling fluids will be drummed. Drums will be labeled according to content and transported to a central, secure onsite location.

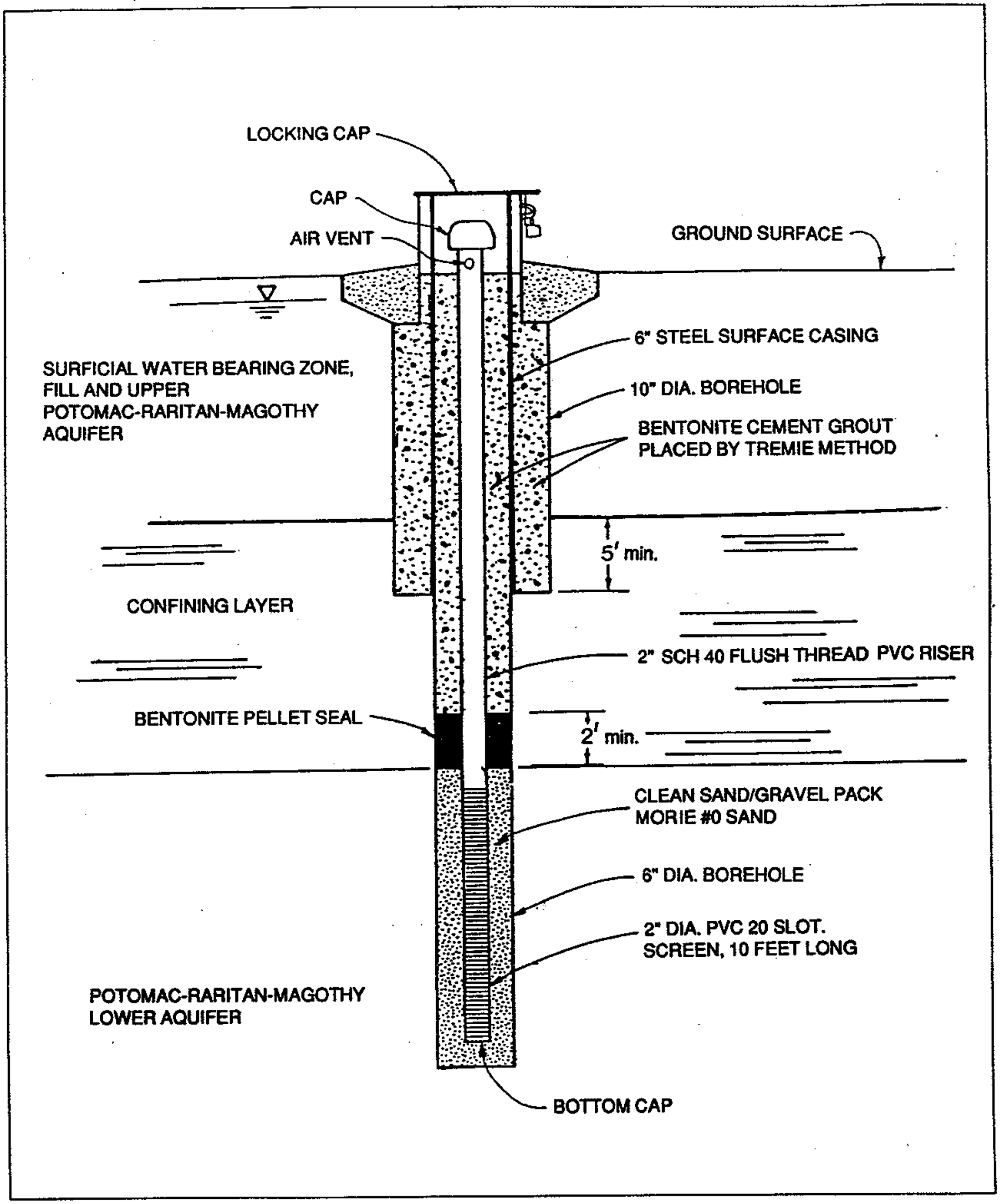

Figure 4-11

Typical Double-Casing Monitoring Well Construction

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Well Development

All new monitor wells will be developed after the grout has been allowed to set for 48 hours. Development will be performed by surge block, overpumping, or air lift methods. All downhole development equipment (tubing pumps, clamps, etc.) will be either dedicated or chemically decontaminated. If air lift pumping methods are used, the air compressor will be fitted with sufficient filters to remove all residual exhaust oil. Surging the well may consist of abruptly stopping flow during pumping and allowing the water column to fall back into the well, or repetitively driving a surge block through the screen to remove fines from the filter pack and screen openings.

Physical parameters such as pH, specific conductance, and temperature will be monitored during development. Development will continue until the discharged water runs silt free and physical parameters are relatively stable. Development water will be discharged to waste on the ground surface downgradient of the developing well.

GROUNDWATER SAMPLING

Groundwater measurements and samples will be collected no sooner than 2 weeks after well installation and development. Static water levels will be recorded before purging and sampling.

To obtain a representative sample of the groundwater, a volume of stagnant water in the wellbore will first be purged. The recommended length of time required to pump or bail a well before a sampling will depend on the well and aquifer characteristics, the type of sampling equipment being used, and the parameters being sampled. Wells will be pumped or bailed until the measurements of pH, temperature, and specific conductance have stabilized over at least three well volumes. Samples will be collected within 3 hours of purging.

Wells yielding greater than 1 gallon per minute (gpm) should be purged with a centrifugal pump. Three-quarter to 1-inch dedicated polyethylene tubing will be used as the downhole suction line. Pump discharge will be controlled with a normal 3/4-inch gate valve on the discharge side of the pump. Discharge rates will be held below 4 gpm to prevent agitation of the aquifer. Pump decontamination will be conducted as described in the RFI Work Plan Chapter 4 and Section 5 of the DCQAP. The polyethylene suction tubing will be cut up and properly disposed of after sampling.

In wells yielding less than 1 gpm, purging will be conducted with a teflon or stainless steel bailer. Bailers will be dedicated to a particular well and decontaminated in accordance with EPA-approved procedures outlined in this chapter and Section 5 of the DCQAP contained in the Appendix.

In the case of monitoring wells that will not yield water at a rate adequate for effective purging , several different procedures will be attempted. The first procedure includes removing water to the top of the screened interval to prevent the exposure of the gravel pack or formation to atmospheric conditions. The sample is then collected at a rate that would not cause rapid drawdown. Wells may also be pumped dry and allowed to recover. Samples should be collected as soon as a volume of water sufficient for the intended analytical parameters recharge the well.

Exposure of water entering the well for periods longer than 2 to 3 hours may render samples unsuitable and unrepresentative of water contained within the aquifer system. In these cases, it may be desirable to collect small volumes of water over a period of time, each time pumping the well dry and allowing it to recover.

Whenever full recovery exceeds 3 hours, samples should be collected in order of their volatility as soon as sufficient volume is available for a sample for each analytical parameter or compatible set of parameters. Parameters that are not pH-sensitive or subject to loss through volatilization should be collected last.

Samples will be collected with a teflon or stainless steel bailer with a 5-foot stainless steel leader. The bailers and leader will be laboratory decontaminated in accordance with procedures outlined in this chapter. To ensure the integrity of the samples during collection, parameters will be collected in the following order:

- Volatiles
- TOC, TPH
- Base neutrals
- Acid extractable
- Metals
- Other conventional parameters

Samples will be analyzed for pH, Eh, specific conductance, and temperature during purging. Samples collected for dissolved metal analysis will be field-filtered prior to preservation. A separate sample will be collected for metals that are not filtered.

Dissolved metal samples will be filtered through a disposable 0.45-micron filter with an electric vacuum or peristaltic pump. Tygon suction tubing and filter chamber will be decontaminated in accordance with procedures outlined in this chapter.

HYDRAULIC CONDUCTIVITY TESTING (SLUG TESTS)

Hydraulic conductivity tests will be performed in the form of rising head slug tests on each new monitor well. Slug tests will consist of displacing a volume of water with a decontaminated, solid PVC slug or stainless steel bailer from each well and measuring the rate of recovery. The water will be displaced by inserting the slug or bailer into the well below the top of the static water level. The water level in the well will be allowed to recover to the static level and then the slug will be removed from the well as rapidly as possible to simulate an instantaneous change in head. The rising water level will be recorded at a high frequency using a pressure transducer with a digital data logging recorder. To check the reproducibility of the method, two to three tests will be performed in each well.

Horizontal hydraulic conductivities in the unconfined surficial zone will be calculated using the Bower and Rice (1976) and Hvorslev (1951) methods. The Bower and Rice method is particularly suited to unconfined conditions with partially penetrating well screens spanning the water table. Slug test data from the Lower PRM will be analyzed using the Copper (1967) method for confined conditions.

TIDAL STUDY AND WATER LEVEL MONITORING

To determine the effects of tidal fluctuations in the Schuylkill River on the heads and gradients within the surficial water bearing zone and Lower PRM aquifer a survey consisting of continuous water level measurements in the wells and river will be conducted over several tidal periods (48 hours). Tidal surveys will be performed at both the Guard Basin and PDA Nos. 1 to 4. To observe the maximum tidal effects on the subsurface system, the tidal survey will be performed during perigean high and low tides.

To conduct the tidal survey, either transducer or Stevens mechanical continuous water level recorders will be installed in each well of the three shallow-deep well clusters at each SWMU. To correlate subsurface data to actual tidal fluctuations, periodic water level measurements will be collected: in the Schuylkill River and Lands Creek at PDA Nos. 1 to 4; and in the Guard Basin and the river at the Guard Basin. Head measurements in surface water bodies will be collected by transducers in a stilling wells or by periodic observations of calibrated staff gauge levels.

To observe long-term and seasonal changes in the potentiometric surfaces of the shallow water bearing zone and Lower PRM aquifer, water level measurements will be collected once per month in each of the new wells. In addition, wells within the existing monitoring network will be evaluated to determine their usefulness for long-term potentiometric monitoring.

Water levels measurements in each well will be collected from a surveyed point at the top of casing with an electric sounding device. Water levels will be measured to an accuracy of .01 feet. The time to the nearest minute will be recorded with each measurement. Survey periods will be designed to coincide with high or low tide.

DECONTAMINATION PROCEDURES

SAMPLING EQUIPMENT

To prevent cross contamination between samples, sampling equipment (bailers, spatulas, split spoons) will be cleaned using the EPA-approved "triple rinse" method. The triple rinse consists of a sequence of solvent washes and rinses as follows:

1. Wash and scrub with non-phosphate detergent

2. Tap water rinse

3. Distilled/deionized water rinse

4. Ten percent nitric acid rinse (1 percent nitric acid rinse on carbon steel split spoons)

5. Distilled/deionized water rinse

6. Acetone or methanol rinse followed by hexane rinse, solvents must be pesticide grade

7. Rinse with deionized water, demonstrated analyte-free (HPLC water)

8. Total air dry

9. Wrap in aluminum foil, shiny side out, for transport

Bailer cord or leader will be washed with low phosphate detergent and rinsed with deionized analyte free water.

If a submersible bladder or air drive pump is used for purging, the following decontamination procedure will be used. Decontaminate the pump by washing the outside of the pump, tubing, power, and support cords with low-phosphate detergent and analyte-free deionized water rinse. Rinse the inside of the pump and tubing with low-phosphate detergent and potable water, then analyte-free deionized water.

All wash and rinse water will be contained in steel 55-gallon U.S. DOT approved drums for proper disposal. Solvent and acid rinsates will be contained separately. All rinsates will be collected and disposed of in accordance with Pennsylvania state guidelines.

To prevent cross contamination between wells, all drilling equipment introduced into the boreholes, well screens, and casing materials will be thoroughly cleaned with high-pressure steam before use. Sampling and testing tools will be decontaminated using the triple rinse method described above.

DRILLING AND EXCAVATION EQUIPMENT

To prevent cross contamination between holes, all drilling, excavation, and sampling tools will be cleaned before the start of each boring and excavation. All soil and contamination adhering to the augers, backhoe bucket, and drill rods will be removed using a high-pressure steam rinse. A decontamination pad, where the rinse water and sediment can be collected and contained for proper disposal, will be constructed for this purpose.

Vehicles are to be steam cleaned prior to maintenance. The entire vehicle is to be steam cleaned prior to leaving the site paying particular attention to the undercarriage, wheel wells, lugs or tracks, and other areas where dirt accumulates. The site Safety Coordinator will personally inspect each piece of equipment.

PERSONNEL

Onsite personnel will follow the procedures outlined below at the designated decontamination area prior to leaving the work site: (1) drop equipment; (2) remove and dispose of boot covers; (3) wash boots; (4) wash and remove outer gloves; (5) remove and dispose of inner gloves; (6) remove boots; (7) remove SCBA or APR; (8) wash and rinse facepieces; (9) remove and dispose of inner gloves; (10) wash hands and face. Cleaning liquid will be 0.5 pounds of trisodium phosphate and sodium carbonate (1:1) mixed with 1 gallon of water, followed by a fresh water rinse. SCBAs or APRs will be washed in MSA sanitizer, rinsed in water, or cleaned with MSA wipes.

DECONTAMINATION OF FILTRATION APPARATUS FOR FILTERED AQUEOUS METALS SAMPLES

Filtration apparatus will be constructed of polyethylene or barosilicate glass. The apparatus will be precleaned with a 10 percent HNO_3 solution, followed by a demonstrated analyte-free deionized water rinse. The apparatus will be decontaminated in the same manner between each sample.

DISPOSAL OF ONSITE GENERATED WASTES

Wastes derived from the collection of samples will include drill cuttings, drilling fluid, decon water, protective clothing, and other contaminated materials. No drilling, sampling, or excavation materials will be removed from the site. Decontamination water and used protective clothing will be drummed. Drilling fluid and cuttings will be drummed, if necessary, depending on contamination levels, in accordance with the EPA protocol.

Drums will be labeled according to contents and assembled at a central secure area adjacent to each SWMU following drilling. Drum lids will be secured with 7/8-inch lug bolts. To determine the hazardous nature of drum contents, several representative samples will be collected from each group of drums and submitted for RCRA parameter analysis.

Chapter 5
DATA MANAGEMENT PLAN

The data management plan details the procedures for inventory, control, storage, validation, evaluation, and presentation of data during the RFI at the Sun facility.

A large variety of technical data will be generated during the course of the RFI. A data management program will be designed so that the integrity of the data is maintained and can be used in any future related or non-related study. Project tracking data, schedules, progress reports, and field notes will be maintained to monitor, manage, and document the progress of the RFI.

DATA RECORD

To efficiently track sample and analytical data, a computer data base will be developed. The data base will allow quick retrieval of individual or groups of sample analyses. In addition, the data base will be manipulated to generate summary tables according to SWMU, media, location, etc.

The following information will be entered into the data base:

- Sample and field measurement identification code
- Sample and field measurement location and type
- Sample and field measurement date
- Laboratory analysis identification number
- Parameters measured
- Results of analyses or measurements
- Reporting units

All incoming data and reports will be logged and dated. All information generated from field activities will be documented on appropriate forms including the following:

- Boring logs
- Water sampling logs
- Chain-of-custody record
- Field books
- Location sketch
- Photograph log
- Sample container inventory
- Telephone conversation log

Incoming documents will be filed. If distribution is required, the appropriate number of copies will be made and distributed to project personnel. In addition, all notes from project meetings and telephone conversations will be filed along with other project documents.

DATA VALIDATION

Data validation entails a review of the QC data and the raw sample data to verify that the analytical laboratory has operated within the required control limits, the analytical results are correctly transcribed from the instrument readouts, and which, if any, natural samples are related to any out-of-control laboratory QC samples. The objective of the data validation is to identify any qualitative, unreliable, or invalid laboratory measurements. If anomalies are discovered while reviewing laboratory data, the validation contractor will require additional written documentation from the laboratory as necessary.

The data validation process consists of two levels of review: contract compliance screening (CCS) and technical review, both to be conducted. CCS is an inspection process of contractual specifications and completeness as specified in the analytical laboratory's statement of work (SOW), and includes review of the following: laboratory holding times, instrument calibration, blanks, surrogate recovery, matrix spike/matrix spike duplicates, internal standards performance, and system performance. Data validation includes a technical review of the following: instrument tuning, blanks, field duplicates, Skinner list, and reported detection limits and tentatively identified compounds (TICs).

The laboratory responsible for analyzing the samples will send the analytical data to the validation contractor who will validate the analytical data using EPA protocols (*Laboratory Data Validation Functional Guidelines for Evaluating Organics Analyses* and *U.S. EPA Region III Inorganics Data Evaluation Checklist 1988*). Region III will be contacted to verify that the most current version is being used prior to conducting the data validation.

FACILITY MAPS

A number of sitewide and SWMU-specific facility maps will be generated from the RFI. The following maps will be included in the RFI reports:

- Topographic map of entire facility
- General base map explaining important facilities and potential receptors
- Study area maps
- Sampling and field measurement location maps
- Cross section line map
- Structure contour map of several important hydrogeologic units

- Spyder maps of spatial distribution of contaminant concentrations
- Isopach maps
- Topographic map of the bottom of the Guard Basin
- SWMUs' surface water run-on and runoff drainage system maps
- Facility pipelines (including sewer) map for areas near SWMUs

TABULAR DISPLAYS

Tables will be used to display a wide variety of data including the following:

- Analytical data summaries
- Well construction information
- Well development information
- Survey information
- Hydraulic conductivity data

GRAPHICAL DISPLAYS

Data that can be analyzed spatially or with time will be displayed in graphic form. Some of the figures anticipated for the RFI include:

- Cross sections
- Hydrographs of tidal data
- Hydrographs of monthly water level data
- Contaminant concentrations versus depth
- Flownets

Chapter 6
HEALTH AND SITE SAFETY PLAN FOR FIELD ACTIVITIES

Note that this is the CH2M HILL Health and Site Safety Plan. If another contractor is selected to conduct the RFI, they will need to develop their own site safety plan.

GENERAL INFORMATION

CLIENT:	Sun Refining and Marketing Company
JOB NO:	PHL31374.A0
SITE MANAGER:	Ken McGill/PHL
SITE SAFETY COORDINATOR:	Mark Lucas/PHL
SITE NAME:	Sun Refining and Marketing Company Philadelphia Refinery, Philadelphia, Pennsylvania
SITE LOCATION:	Philadelphia, Pennsylvania
ACTIVITIES PLANNED:	Site investigation to include drilling 20 wells, including installation, development and sampling, water level measurements, surface water and sediment sampling, waste sampling, and surface geophysical survey.
DATES:	January 1991 to July 1992
BACKGROUND INFORMATION FROM:	Site visits in December 1990 and site files

SITE CHARACTERISTICS

FACILITY DESCRIPTION

Sun Refining and Marketing Companies' Philadelphia Refinery is an integrated fuel refinery, with a crude oil processing capacity of 125,000 barrels per day. In the 1860s, Sun Refining began as an oil distribution terminal. In 1900, batch processing of crude oil began. Gasoline, which was initially a by-product of kerosene production, went into full-scale production during World War II. Other past operations include production of specialty chemicals, such as acids and ammonia. Today, the refinery strictly produces fuels and asphalts.

Crude Distillation Units

Crude oil is brought into the refinery by pipeline and is stored in tanks before it is charged to two crude distillation units. At the crude still, the crude is divided into its major components; light hydrocarbon gases, reformer stock, kerosene, furnace oil, gas oils, and asphalt.

862 Light Hydrocarbon Recovery Unit

The light hydrocarbon gases are combined with the light gases produced in other refinery units and are then sent to the 862 Light Hydrocarbon Recovery Unit. Here, the gases are separated into ethane and lighter for fuel gas, propane for bottled gas, and butane for gasoline blending.

860 and 864 Reformers

Reformer stock is charged to the 860 and 864 Reformers where the low octane gasoline components are converted into higher octane gasoline blending stocks. These components are then blended into three grades of gasoline; unleaded regular, unleaded supreme, and leaded regular.

865 Hydrosulfur Retention Unit

Furnace oil and kerosene are charged to the 865 Hydrodesulfurization Unit where sulfur in the materials is removed to meet all applicable environmental regulations. The sulfur produced by the 865 Unit is directed to the 867 Sulfur Recovery Plant where liquid sulfur is processed and sold as product.

859 Hydrocracker

The next heavier crude still boiling fraction, light gas oil, is fed to the 859 Hydrocracker and is subjected to high temperature and pressure in the presence of hydrogen where the oil fractures into lighter gasoline blending streams. The hydrogen gas necessary for the hydrocracking process comes from the 861 Hydrogen Plant where steam and methane react to form hydrogen and carbon dioxide. The carbon dioxide gas by-product is recovered in the 927 CO_2 Plant and is sold as "food grade" CO_2.

866 Hydrodesulfurization and 868 Fluid Catalytic Units

Heavy gas oil is charged to the 866 Hydrodesulfurization Unit where sulfur is removed. The desulfurized product is then charged to the 868 Fluid Catalytic Cracking Unit (FCCU). The heavy gas is cracked in the FCCU at high temperatures in the presence of a catalyst to form gasoline components and furnace oil. The crude still bottoms product, asphalt, is sent to tankage prior to its ultimate use as paving or roofing asphalts.

The Yards

The refinery site is separated into three "yards." Two areas that lie due north and south of Passyunk Avenue and east of the Schuylkill River are designated the North and South Yards, respectively. A third area lies west of the Schuylkill River and south of Passyunk Avenue and is designated the West Yard.

Currently, most refinery activities are in the South Yard while the North and West Yards are relatively inactive. The three Solid Waste Management Units (SWMUs) under investigation are distributed among the three yards. PDAs 1 through 4 lie in the West Yard, the former leaded tank bottom disposal area is in the North Yard, and the guard basin is in the South Yard.

North Yard. The North Yard of the Sun refinery is approximately 247 acres in size, a small portion of which was used for the disposal of leaded sludge from tank bottoms. Eighty-four monitoring wells have been installed throughout this area. Groundwater monitoring has shown that groundwater levels vary from 3 to 31 feet below the land surface. Of the 84 wells, 33 have been sampled. The results of groundwater analyses on these samples have shown concentrations of total petroleum hydrocarbons (TPHs), organic compounds, inorganic compounds, and metals.

West Yard. The West Yard is approximately 52.5 acres in size and contains four of the SWMUs (PDA Nos. 1, 2, 3, and 4) identified at this facility. These SWMUs are all former disposal areas (PDAs) that received waste ranging from refinery process wastes to trash through the 1970s. The wastes were deposited in lagoons, seepage pits, and landfills. The lagoons and seepage pits are reportedly capped, although some of the caps show signs of leakage. There are reportedly six monitoring wells located throughout this area that show depth to groundwater ranging from 2 to 15 feet below land surface. Many groundwater samples show contamination by base neutral and volatile organic compounds. Most soil samples also had detectable levels of base neutral compounds and some soil borings exhibited petroleum saturated soil below the land surface.

South Yard. The South Yard is an active refinery process area approximately 372.5 acres in size, a large portion of which is tank farms. The EPA has identified one SWMU (the guard basin) in this area. There are also several PDAs and a drum storage area in the South Yard. The PDAs received various refinery wastes including tower sludges, leaded tank bottom sludge, spent catalyst, as well as other unidentified wastes. Monitoring wells in this area show the depth to groundwater ranges from 6 to 34 feet below land surface. Groundwater analyses show elevated levels of volatile organic, base neutral, and acid extractable compounds, as well as metals.

Sun's RCRA Part B Permit requires an RCRA Facility Investigation (RFI) of six SWMUs. Each unit contains RCRA hazardous wastes including leaded tank bottom sludges, bender catalyst, caustic sludges, acid sludges, and other wastes associated with petroleum refining activities. Most of the raw wastes are contained within capped or closed waste disposal units. The integrity of a capped or bermed area will not be breached by sampling or drilling activities. Other contaminants that may be encountered during field investigation activities include petroleum fuels and waste motor oils.

STATUS (ACTIVE, INACTIVE, OR UNKNOWN)

Site has been active since the 1860s. The West and North Yards are relatively inactive.

PRINCIPAL DISPOSAL METHOD (TYPE AND LOCATION)

All spill and surface runoff goes into the ditch system that feeds into an underground culvert system that takes the runoff to an onsite water treatment system before discharge to the river. Sludges from the wastewater treatment plant are stored in closed bins prior to offsite incineration of hazardous wastes and onsite disposal at a permitted land treatment facility for non-hazardous wastes.

FEATURES OF THE SITE (POWER LINES, GAS LINES, WATER MAINS, TERRAIN, ETC.)

The site is paved with asphalt and small cement patches. Some portions of the North and West Yards are covered with gravel. Power lines are all above ground and transect the site. Most fuel transfer lines are above ground; however, several lines, such as a gas pipeline that traverses PDAs 3 and 4, are buried. This particular pipeline is marked by yellow standpipes that are placed at regular intervals.

Fire hydrants are fed by an underground pipeline that extends from an onsite pump house to the perimeter of the site. City water is piped to the site as the potable water supply.

HISTORY (WORKER OR NONWORKER INJURY, COMPLAINTS FROM PUBLIC, PREVIOUS REGULATORY ACTION)

A review of Sun Refinery files reveals little information regarding the site's historic regulatory interaction.

WASTE CHARACTERISTICS

WASTE TYPE(S)

Liquid_X_ Solid_X_ Sludge_X_ Gas___

CHARACTERISTICS

Corrosive X Ignitable X Radioactive_ Volatile X

Toxic X Reactive_ Unknown_ Other______

HAZARD EVALUATION

OVERALL HAZARD LEVEL

The overall hazard level for the planned site is low. The waste materials are primarily buried and no borings are anticipated to be drilled through any of the solid waste management units, thereby reducing personnel exposure during drilling operations.

CHEMICAL HAZARDS

Gasoline

Gasoline is a familiar fuel. It is a variable mixture of paraffins, aromatics, and olefins. Acute toxicity includes anesthetic effects and mucous membrane irritation. Symptoms of acute exposure include headache, blurred vision, dizziness, and nausea. Gasoline vapors measured during tank loading consist of more than 40 percent butane; 30 percent pentane; 7 percent hexane; 5 to 6 percent olefins; 8 percent C_7 to C_{11} compounds; and 3 percent benzene, toluene, and xylenes. Liquid gasoline contains a higher percentage of aromatic hydrocarbons; therefore, it is reasonable to assume that vapors from spills, where much of the product may have already vaporized, will contain a higher concentration of aromatics.

The major toxicity concern is benzene. Benzene is a known human carcinogen through inhalation. Gasoline typically contains 0.7 to 1.0 percent benzene, although some formulations may contain up to 4.8 percent. The OSHA TWA for benzene has been lowered from 10 ppm to 1 ppm, primarily due to the association between benzene and leukemia. NIOSH recommended lowering exposure limits for benzene to the lowest level that could be reliably measured because it is not possible to establish a safe level for a carcinogen.

The overall TLV for gasoline is 300 ppm, based largely on assumptions about the hydrocarbon content of gasoline. This TLV could result in benzene exposures of 3 to 7.5 ppm depending on the benzene content. If the gasoline TLV were lowered to 25 ppm, it would result in benzene exposures of 0.25 ppm to 0.6 ppm. Lowering the TLV is also supported in the documentation for the TLV if operations involve a gasoline spill rather than the normal bulk handling operations. This is because vaporization will change the relative composition of the constituents of gasoline.

Leaded Gasoline. Leaded gasoline contains tetraethyl and tetramethyl lead as anti-knock additives. Both compounds are volatile (VP = 0.2 mm Hg and 22 mm Hg, respectively) and both may be absorbed through skin. The concern for exposure to lead additives is because lead overexposure is associated with blood changes, CNS effects, gastrointestinal disturbances, kidney damage, altered spermatogenesis, and anemia. These effects may be produced when lead levels in the blood exceed 30 μg/100 grams. To maintain blood lead levels below this threshold, the OSHA PEL for lead is 0.05 mg/m^3. The OSHA PEL for both tetraethyl and tetramethyl lead is 0.075 mg/m^3 (as lead). Because lead is added to leaded gasoline in such relative small amounts, the contribution of leaded compounds to total gasoline health effects is low. In other words, control of gasoline vapor will control exposure to organic lead vapors.

Precautions to avoid dermal contact with leaded gasoline are important to prevent lead exposure. Skin contact with gasoline can produce immediate or delayed symptoms of dryness or irritation. If clothing becomes soaked with gasoline, the clothing should be immediately removed. Any skin that comes into contact with gasoline should be washed promptly with soap and water and dried carefully with a clean towel. If skin becomes inflamed, painful, or blistered, medical attention should be sought. If ingestion occurs, vomiting should not be induced. Instead, immediate medical attention should be sought and artificial respiration rendered if necessary.

Lube Oil Acid Sludge. Lube oil sulfuric acid sludge contains naphthalene, 1-methyl naphthalene, and sulfuric acid. Sulfuric acid is incompatible with organics, chlorates, carbides, fulminates, picrates, and metals.

Topical contact with the skin may result in burning and charring of the skin due to sulfuric acid's strong exothermic reaction with water (human tissue is mostly water). In a sludge media, sulfuric acid will stick to skin, clothing, and equipment making it difficult to quickly wash off and probably causing more serious injury. It is even more rapidly injurious to mucous (moist) membranes and is exceedingly dangerous to the eyes. Ingestion can cause serious burns to the mouth or perforation of the esophagus or stomach. Dilute sulfuric acid does not possess this property, but is an irritant to the skin and mucous membranes due to its acidity and may cause irreparable corneal damage and blindness as well as scarring of the eyelids and face.

Sulfuric acid mist exposure causes irritation of the mucous membranes, including the eyes, but principally the respiratory tract lining (epithelium). Breathing high concentrations of sulfuric acid causes tickling of the nose and throat, sneezing, and coughing.

A single exposure to sulfuric acid mist may result in laryngeal (nose and throat), tracheobronchial, (breathing tubes) and pulmonary (lungs) edema retention of fluid in tissues that causes swelling. In this case, edema will cause difficulties in swallowing and breathing and may lead to pneumonia. Long exposures are claimed to result in conjunctivitis (eye inflammation), frequent respiratory infections, emphysema (chronic irritation of the lining of the lungs), and digestive disturbances.

The ACGIH and NIOSH TWA value for sulfuric acid is 1 mg/m^3. There is no tentative STEL value set and the IDLH level is 80 mg/m^3

Hydrogen sulfide may also be associated with the lube oil sludge. Its rotten egg odor is detectable at levels as low as 0.0005 ppm. However, hydrogen sulfide quickly acts to deaden the olfactory nerves, making odor perception unreliable. Eye irritation has been reported for levels as low as 5 to 10 ppm, along with headache, sleep disturbance, and nausea. At higher concentrations, 10 to 300 ppm, respiratory irritation results and at concentrations greater than 300 ppm, death by respiratory paralysis can result. OSHA regards 300 ppm as the concentration that is immediately dangerous to life and health (IDLH). Cumulative effects are not seen with this compound. Return of an over-exposure victim to fresh air will result in recovery from hydrogen sulfide effects. The ACGIH TLV for worker exposure is 10 ppm averaged over an 8-hour work day.

Motor Oils

Motor oils may contain polynuclear aromatic hydrocarbons (PAHs), lead, and other carcinogenic or mutagenic substances at relatively low concentrations. These constituents may be absorbed through the skin and, therefore, dermal protection and decontamination are important to prevent exposure. There are no established exposure limits for motor oils.

PHYSICAL HAZARDS

Flammability

The major potential physical hazard at the site is flammability (gasoline has a flashpoint of -50°F, kerosene has a flashpoint of 100°F, and diesel fuel has a flashpoint of 100 to 130°F). The LEL for gasoline is 1.3 percent, or 13,000 ppm. The LEL for kerosene is 0.7 percent, or 7,000 ppm. Because the vapors of petroleum fuel products are heavier than air, their flammability hazard is increased. Vapors will tend to concentrate near the ground and in low-lying areas and will not be readily mixed or diluted with ambient air. When monitoring LEL, it is important to take measurements at ground level.

To prevent flammability hazards, each field investigation team member must make sure that no spark sources, such as lighters, matches, unapproved flashlights, and so forth, are brought into the exclusion zone. The SSC must inspect the exclusion zone for spark sources including wiring, motors, and so forth, and must enforce the requirements for fire prevention, including intrinsically safe electrical equipment, spark arrestors on vehicles, and exclusion of unauthorized personnel.

Traffic

Another physical hazard is traffic. If the work area is in or adjacent to a public road, local police coordination is needed to control traffic. If the work area is on private property, the owner must be contacted for permission to set up traffic cones and barriers to protect team members.

Utility Lines

Utility lines, both above ground and below ground, may pose a safety hazard for team members during excavation or boring. The driller must maintain a safe clearance (at least 10 feet) between overhead utility lines and the drill rig mast at all times during site operations. The location of utility lines must be determined prior to startup and the utility must be contacted 48 hours prior to excavation or drilling.

Liquid Immersion

A bathymetric survey will be conducted within the guard basin. Two field team members will be in a small boat while collecting depth-to-bottom measurements. The survey crew will wear life preservers at all times while in the boat. A third field investigation team member will be positioned on shore in case of emergency.

SAFETY PROCEDURES

SITE ORGANIZATION

Map/sketch attached X Site secured ___
Perimeter identified X
Zone(s) of contamination identified ___

TEAM ORGANIZATION

Team members	Responsibility
Ken McGill, Philadelphia	Project Manager
Mark Lucas, Philadelphia	Site Safety Coordinator
Dan Eisenstein, Philadelphia	Team Member
April Lloyd, Philadelphia	Team Member

PERSONNEL SAFETY EQUIPMENT

Level of protection: A___ B___ C X D X

Modifications: For all contact work, Tyvek must be poly- or saran-coated. Tyveks may be disposed of in sealed plastic bags with the facility's trash. Neoprene steel toe/shank boots, surgeons gloves under nitrile gloves (neoprene gloves are acceptable, but nitrile provides better protection against petroleum fuels), safety glasses, and hard hat must also be worn over washable clothing that is appropriate for the weather. CH2M HILL staff must wear a TLD badge. An extra set of clean work clothes must be available, in case clothing becomes wet or soiled.

A NIOSH/MSHA-approved full facepiece APR with organic vapor and acid mist cartridges available for potential upgrade to Level C must be worn. If Level C upgrade is required but APRs are not available, the site work must be discontinued.

For survey or observation work, field clothes can be worn. Areas of known or suspected contamination require the use of disposable booties over work boots or steel shank neoprene boots. A boot wash will be required prior to leaving contaminated areas.

CH2M HILL workers and subcontractors will also comply with the *Plant Rules and Regulations for Use by Contractors, Subcontractors, and Visitors*, presented as an attachment.

Safety Equipment and Materials: The following must be immediately available to field investigation team members:

- First aid kit
- Eyewash kit with sufficient supplies of clean water to deliver a 15-minute eye wash
- Type A, B, C 20-1b fire extinguishers
- A blanket or stretcher
- Wind direction indicator (surveyor's flagging)
- Outdoor thermometer (when temperature is expected to be above 70°F or below 35°F)

MONITORING EQUIPMENT AND PROCEDURES

Carefully inspect each piece of monitoring equipment and perform calibration prior to each day's use. Recharge instrument after each day's use. Record calibration and any problems in the SSC logbook. Call the project manager and do not work in the exclusion zone if required instruments are not working properly. Instruments are to be used in accordance with the manufacturer's written instructions.

HNU WITH 10.2 eV PROBE OR TIP OR OVA

Take background readings in an upwind position. Background *is not* taken in the area suspected to be contaminated. Take readings in the breathing zone upon initiating site work. Record readings at least every half hour in the breathing zone. The instrument should be read more frequently than every half hour to determine if action levels are met. Spikes above the action level do not call for an upgrade, but do require continuous monitoring until levels stabilize. During continuous monitoring, record levels every 10 minutes.

HNU, TIP, AND OVA ACTION LEVELS

- If readings are 0 to 25 ppm above background in the breathing zone, continue in to work Level D.
- Readings from 25 to 100 ppm above background that persist for 10 minutes in the breathing zone, or readings of 10 to 25 ppm above background that persist for an hour, require Level C (or leaving the site).
- Readings over 100 ppm in the breathing zone require immediate evacuation of the team. Allow the area to ventilate until levels are below 25 ppm before resuming work.

PLEASE NOTE, THIS PLAN IS NOT APPROVED FOR LEVEL B WORK.

EXPLOSIMETER

The explosimeter requires an inhibitor filter for leaded gasoline. Otherwise, the lead in the gasoline fumes will build up on the detector filament, rendering the instrument useless if a filter is not available. Monitor continuously during soil disturbance, excavation work, and other operations in the exclusion zone that may involve release of petroleum or natural gas vapors. If the explosimeter does not have an inhibitor filter for leaded gasoline, take readings at least every 15 minutes, then purge the instrument in clean air. The explosimeter is required to be used with the HNU, TIP, or organic vapor analyzer (OVA) to monitor the flammability/explosivity hazard at the source (i.e., borehole). The organic vapor meter is used primarily for breathing zone measurements to assess potential exposure.

EXPLOSIMETER ACTION LEVELS

The following action levels are measured at boreholes if there is drilling or at the physical lowest level (such as the bottom of a trench or tank) for other operations.

- If the LEL is <5 percent, continue drilling. Do not enter any confined spaces where there is a detectable LEL. Welding may be permitted with continuous monitoring and alertness to shutdown if the LEL rises to 20 percent.
- If the LEL is between 5 and 20 percent, continue drilling with caution. Do not allow any welding.
- If the LEL is greater than 20 percent, shut down operations and allow the area to ventilate until the LEL falls below 10 percent. Should readings remain above 20 percent, notify the PM and the owner. Should readings rise above 50 percent, immediately call the fire department.

HYDROGEN SULFIDE MONITOR

Conduct hydrogen sulfide (H_2S) monitoring using Exotex 50 with LED redout. Check calibration before each day's activity with H_2S gas cylinder according to manufacturers' instruction. Record in log book. Monitor continuously during soil disturbances and sampling/bailing activity. Record initial reading and at one-half hour intervals.

ACTION LEVELS

- Readings from 0 to 5 ppm--continue operations but be prepared to shutdown at breathing zone levels approaching 5 ppm.

- Readings from 5 to 10 ppm in the breathing zone that persists for 30 minutes requires shutdown of operations and evacuation of the work area. Use mechanical ventilators (e.g., blowers) to maintain H_2S concentrations below 5 ppm in the breathing zone.

Wind Flag

Remain upwind of well heads or any other operations.

WORK LIMITATIONS

- There will be NO eating, drinking, nor SMOKING within exclusion areas.

- No contact lenses will be worn within exclusion areas.

- A buddy system will be used within exclusion zones.

- No facial hair will be allowed that would interfere with respirator fit if respirators are worn. Beards and long sideburns are not permitted by the Sun safety requirements.

- Drill rigs must be equipped with a spark arrestor on the exhaust.

- Level C is not to be used without documentation that all personnel working within the exclusion zone are trained in accordance with 29 CFR 1910.120 and have been medically certified by a physician within the past 12 months for respirator use.

- Heat stress breaks will be taken every 2 hours or more frequently, if necessary, whenever ambient temperatures exceed 75°F.

- Warmup breaks will be taken for 10 minutes every 2 hours if ambient temperatures are below 30°F or it is raining and temperatures are below 55°F.

- There will be no spark sources within the exclusion zone.

SITE ENTRY

When entering the site, confirm emergency telephone numbers and the route to hospital prior to starting any work. Always designate a vehicle for emergency whenever team members are working within the exclusion zone. Be sure all team members know where the emergency vehicle keys are and that a site safety plan is in the vehicle. The SSC should identify safe evacuation routes and reassembly points for emergencies. Notify Charles Barksdale, Environmental Supervisor, of any presence of team members at the site and the field investigation plans. If there is only one CH2M HILL employee onsite, Mr. Barksdale must receive a copy of the emergency numbers in case of an accident (i.e., police, fire, etc.).

Prior to work onsite, a safety briefing with subcontractors must be conducted. This briefing shall include informing them of the hazards associated with site work, the chemicals anticipated, and the emergency procedures, including evacuation routes.

If there is drilling or excavation, notify Charles Barksdale and, if necessary, the local fire department of what is being done. Position the equipment and contractor upwind of the area to be excavated and upgradient of the tank and wells.

Exclusion Zones

The SSC is to define exclusion zones. For drilling, trenching, test pit digging, or tank removal, the exclusion zone radius must be at least 25 feet. The exclusion zone is to be defined with traffic cones, barriers, tape, or other means to warn and exclude the public. The SSC may reduce the exclusion zone radius for well sampling or other non-invasive tasks.

Inspect the exclusion zone for spark sources, paying careful attention to electrical equipment. PLEASE NOTE: A fire was started at another site by an electrical spark from faulty wiring. Fire spreads VERY quickly and is not easily controlled. Do not start excavation or boring work until sources of ignition have been removed. Secure the area to prevent the public from approaching within 25 feet of any sampling, digging, or drilling.

Decontamination Area

Set up a decon area upwind of the wells and excavations. This means get water and TSP in buckets to wash off boots and gloves prior to beginning work. The decon area should be established at a sufficient distance from the excavation or boring work to be reasonably sure it is not in an area that can become contaminated by splashing water or flying dirt.

Support Area

The support area is where trucks, emergency vehicles, and so forth are parked. This place is considered clean and should not become contaminized by any site activities. It is anticipated that work will start in Level D, but be prepared to upgrade or leave the site.

DECONTAMINATION

It is the responsibility of the SSC to make sure all pieces of equipment leaving the exclusion zone are properly decontaminated according to the procedures outlined below. Documentation of decontamination must be made in the field log notebook that will then become part of the permanent project file. The equipment number must be written in the field log notebook when the equipment comes offsite and is decontaminated. When the equipment is packaged for shipment, it should have a signed or initialed memo enclosed with a notation that proper decontamination procedures have been followed.

Sampling or Subsurface Disturbance Activities Personnel

Wash boots and outer gloves in TSP and water, rinse, and remove outer gloves. Remove and bag coveralls. If cotton coveralls are used, bag in plastic bags and wash prior to rewearing. Remove respirator, if worn. Remove surgical gloves and dispose in a plastic trash bag. Wash hands and face. Sanitize respirator nightly, if used. Take a shower and wash hair as soon as possible after leaving the site. The equipment needed for personnel decontamination is the following:

- Buckets
- Tub
- TSP
- Brushes
- Garbage bags
- Hand soap
- Paper towels

Sampling Equipment

The four-step decontamination process for equipment will include an initial clean water rinse followed by a TSP wash, a dilute methanol in water solution rinse, and a potable water rinse. The equipment need for sampling equipment decontamination is the following:

- Buckets
- Tub
- TSP
- Brushes

- Garbage bags
- Methanol
- HPLC grade distilled water

Heavy Equipment

Steam clean drilling rigs, equipment, and tools under the supervision of the SSC prior to mobilization onsite and following completion of work. Steam clean the equipment and tools before starting work on each well. The equipment needed to steam clean heavy equipment is the following:

- Steam cleaner
- Potable water source
- Buckets
- Brushes
- Garbage bags

Sampling

Wash hands after removing booties, if worn.

DISPOSAL OF MATERIALS GENERATED ONSITE

Contaminated Liquids: Contain in drum in a secure area. Follow written client instructions. Bag all health and safety-related disposable items, dispose of in dumpster onsite.

EMERGENCY INFORMATION

FORM 311

Form 311, Emergency Information, will be posted onsite.

INJURIES

The SCC is in charge during a medical emergency and should direct all onsite personnel who are involved in medical emergency aid. If an injury occurs onsite, take the following action:

- Stop work and prevent further damage. Initiate first aid. If the injury involves splashes to the eye, immediately begin a 15-minute eyewash.

- Get medical attention for the injured person immediately.

- Depending on the type and severity of the injury, notify the consulting or occupational physician for the injured person.

- Notify Marty Mathamel/WDC.

- Notify the injured person's personnel office.

- Fill out Form 306, CH2M HILL Accident Report (attached).

- Write down all circumstances surrounding the incident that caused the injury including, but not limited to, time of day, working conditions (weather, etc.), how long it had been since the last rest period when the injury occurred, what the person was doing when injured, what all other personnel onsite were doing, what level of protection was being used, if all safety procedures were being followed, etc. All team members that witnessed the incident should write down their recollection of the incident, and give it to the site safety coordinator who shall then write up an exposure report. Send exposure report needs to Sharon Robinson/ CVO and Marty Mathamel/WDC.

DANGEROUS INCIDENTS

In the event of a fire, explosion, or other incidents that can endanger the lives or cause harm to the team members, immediately evacuate to a safe position, preferably upwind. The SSC will assume control and direct a team member to call and meet the fire department. The SSC must warn others about the hazard and suggest safe evacuation routes. The fire department will assume charge as soon as it arrives. If a fire is small, the SSC may authorize the use of the fire extinguisher, but there must be no delay in calling the fire department because the fire could burn out of control. A gasoline fire can spread very rapidly because the vapors tend to concentrate near the ground. When directed by the SCC to call the fire department, be sure to know the location and not hang up until told to do so by the fire department.

EMERGENCY CONTACTS

Police:	911
Fire:	911
Ambulance:	911
Hospital:	Methodist Episcopal Hospital Broad Street 215/952-9000
Poison Control Center:	215/386-2100

Water: Philadelphia Waterworks
215/592-6300

Gas: Philadelphia Gas and Electric
215/235-1212

Electric: Philadelphia Gas and Electric
215/841-4141
1-800/242-1776 (Emergency)

Owner: Charles Barksdale, Environmental Supervisor
Sun Refining and Marketing Company
215/339-2215

EMERGENCY ROUTES (Map to be posted)

To hospital: Take 291-E approximately 2 miles to Broad Street, turn left on Broad Street, go three blocks on Broad Street; the hospital complex is on the right (see Figure 6-1).

CH2M HILL Medical Consultant

Name: Dr. Kenneth Chase, Washington Occupational Health Associates, Inc.

Phone: 202/463-6698 (8 a.m. to 6 p.m. EST)
202/463-6440 (or 24-hour answering service. Physician will return call within 30 minutes.) Provide name and phone number to answering service and state that it is an emergency.

CH2M HILL Health and Safety Manager

Name: Marty Mathamel/WDC

Phone: 703/471-1441 (Office)
703/476-0882 (Home)

CH2M HILL Occupational Physician

Name: Envirocare

Phone: 201/225-5454

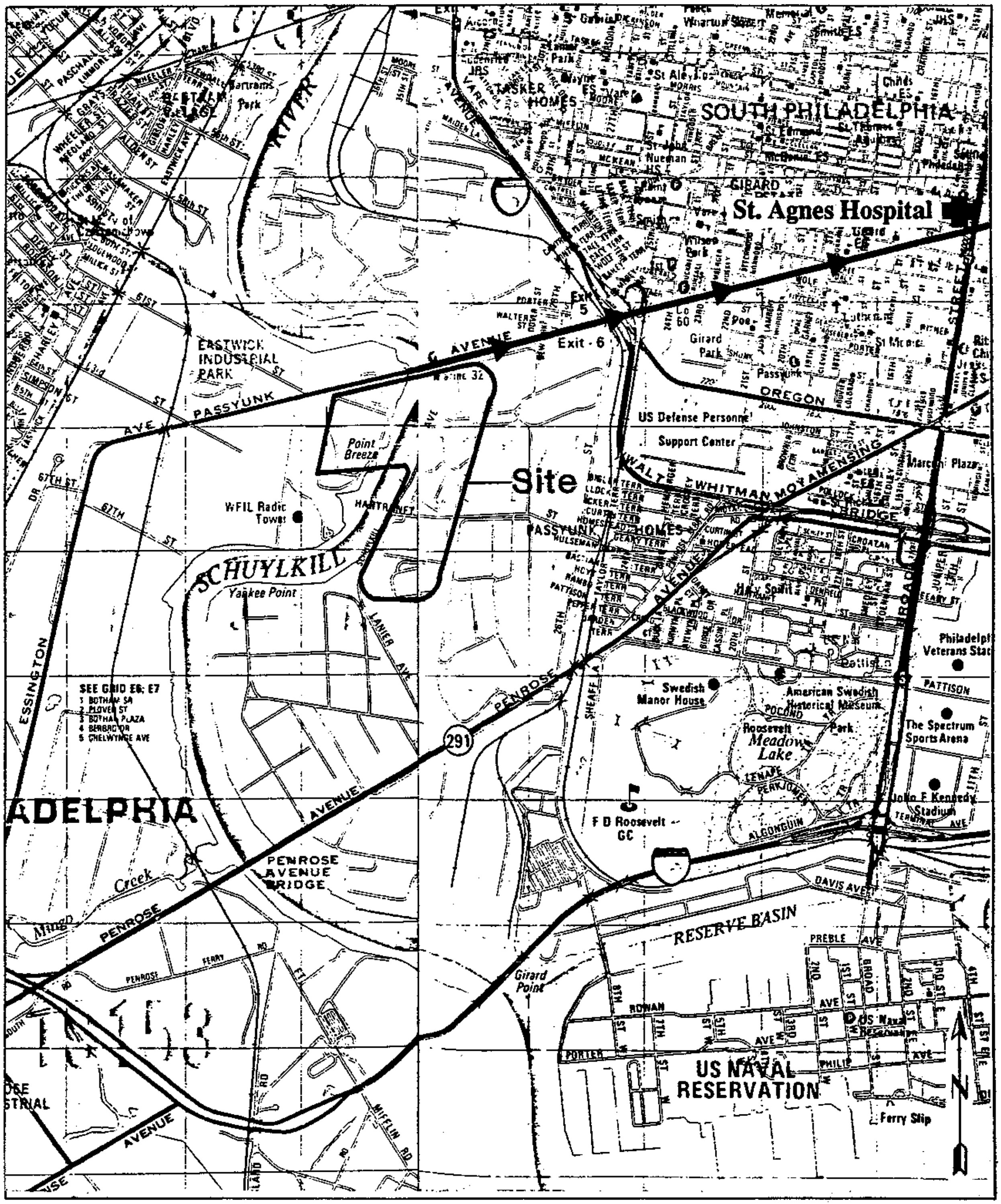


Figure 6-1

Route to Hospital

PHL31374.AO/format4

Team Members Under Above Physician's Care:

- Ken McGill
- Mark Lucas
- April Lloyd
- Dan Eisenstein

Subcontractor Occupational Physician

Name:

Phone:

Team Members Under Above Physician's Care:

CH2M HILL Project Manager

Name: Ken McGill/PHL

Phone: 215/563-4220 (Office)
609/665-5793 (Home)

Client Contact

Name: Charles Barksdale, Sun Refining and Marketing Company Philadelphia, Pennsylvania

Phone: 215/339-2215

CH2M HILL Regional Manager

Name: John Eick/PHL

Phone: 215/563-4220

CH2M HILL District Personnel Office

Name: Beth Sexton/WDC

Phone: 703/471-1441

Subcontractor's Personnel Office

Name:

Phone:

If an injury occurs onsite, please notify the injured person's personnel office as soon as possible after obtaining medical attention for the injured. Notification must be made within 24 hours of the injury.

CH2M HILL Director of Health and Safety

Name:	Marty Mathamel/WDC
Phone:	703/471-1441
Address:	CH2M HILL 625 Herndon Parkway Herndon, VA 22070

CH2M HILL Corporate Personnel Office

Name:	Marie Haezebrouck/DEN
Phone:	303/771-0900
Address:	CH2M HILL 6060 S. Willow Drive Englewood, CO 80111

PLAN APPROVAL

This site safety plan has been written for the use of CH2M HILL's employees. CH2M HILL claims no responsibility for its use by others. The plan is written for the specific site conditions, purposes, dates, and personnel specified and must be amended if these conditions change.

PLAN PREPARED BY: Mark Lucas DATE: 01-10-91

APPROVED BY: Katherine Walker DATE: 01-23-91

ATTACHMENTS

- Initial Site Safety Briefing/Site Safety Meetings
- Form 311, Emergency Phone Numbers
- Form 533, Record of Hazardous Waste Field Activity
- Form 308, Accident Report
- Site Location Map, Sun Philadelphia Refinery
- Sun Refining and Marketing Company Safety and Security Requirements for Contractors, January 1991

DISTRIBUTION OF APPROVED PLAN

- Project Manager (responsible for distribution to team members and client)

- Health and Safety Manager

Attachment

INITIAL SITE SAFETY BRIEFING/SITE SAFETY MEETINGS

Initial Site Safety Briefing

The initial site safety briefing is a form of training that acquaints the onsite project participants with the specific hazards posed by the site and the operations to be conducted on the sites. The initial site safety briefing typically lasts 4 hours, and is conducted on or near the site after the project team is assembled. When activities on a site are phased, the initial site safety briefing may be required for each new group of workers on site. The lead firm SSC provides the site safety briefing for company personnel, and the subcontractors working under the lead firm SSP. Those subcontractors that write and implement their own SSP (such as construction subcontractors) will provide the initial site safety briefing to their own personnel. The lead firm SSC or resident inspector will attend the site safety briefing for construction subcontractors. In addition to presenting the site safety plan, the topics typically discussed at the initial site safety briefing include but are not limited to the following:

- Site-specific chemical, physical, and operational hazards.

- Symptoms of exposure and first aid measures for the specific site hazards, including heat/cold injury.

- Escape routes from the site, and signals for undertaking emergency escape; assembly points after escape; personnel accountability; and rescue/retrieval plans after escape.

- Firefighting procedures, response to chemical releases, actions during inclement weather and other emergency response procedures.

- Activating community evacuations and procedures to be followed during that evacuation.

- Action levels, levels of personal protection, upgrading and downgrading procedures for personal protection, and reporting of accidents/incidents.

- Prohibited practices onsite (smoking, eating, etc.) and suggested behavior off-site (alcohol and drug usage, etc.)

- Decontamination practices for personnel, samples, sampling equipment, monitoring instruments, heavy equipment, facilities onsite, vehicles and other items, including emergency decontamination of injured parties.

- Vehicular safety, operation and maintenance.

- Limitations to work (time of day, wind direction,etc.) and use of the "buddy system."

- Transportation routes to hospital(s), including vehicles to be used, alternative routes, and specialized techniques (helicopter) and protection of hospital/emergency response personnel.

- Communication procedures, including hand signals and emergency signals.

- Personal hygiene.

- Site layout, including break areas, support zone, etc.

As part of the initial site safety briefing, the subcontractor SSC responsible for the site should also determine that all site personnel have been fit tested for the respiratory equipment in use, that the protective equipment is clean and in good condition, and that the use of any specialized safety equipment has been fully explained to all personnel. The subcontractor SSC will obtain written documentation, including signatures of attendees, of the presentation of the initial site safety briefing. This documentation is considered to be a project deliverable from the construction subcontractors to the lead firm.

Site Safety Meetings

Site Safety meetings are held periodically throughout the execution of the onsite work. The site safety meeting may be held to train workers in a new piece of equipment, to present modifications in the site safety plan, site operational procedures, decontamination procedures, or other changes in the normal routine. Site safety meetings are always held to present changes in the site safety plan. The meetings may be formal or informal, and typically lasts fifteen minutes. The person conducting the site safety meeting will enter date/time, topics discussed, and attendees into the site logs.

FORM 311

CH2M HILL
EMERGENCY PHONE NUMBERS

	Phone	Address	Contact
POLICE			
FIRE			
PARAMEDIC			
AMBULANCE			
WATER			
GAS UTILITY			
ELECTRIC			
TELEPHONE			
LOCAL SANATARIAN			
HOSPITAL			
OWNER			

This Notice is Located At: ____________________

WDCR297/076.50

FORM 533

RECORD OF HAZARDOUS WASTE FIELD ACTIVITY

SITE NAME:
SITE SAFETY COORDINATOR:
PROJECT NUMBER:
RECORD OF ACTIVITIES FOR (DATES):

Employee Name	Total Days Onsite	Days at the Site in			or	Number of days as SSC			Activities Employees Performed While Onsite
		Level B	Level C	Level D		Level B	Level C	Level D	
1.									
2.									
3.									
4.									
5.									
6.									
7.									
8.									
9.									
10.									

Signature of SSC:______________________________

WDCR297/077.50

FORM 308

ACCIDENT REPORT Date________

Note: To be completed only for representative of CH2M HILL, Inc.

Project:______________________________ Project No.__________

Injured Employee:______________________ Employee No.__________

Date Injured:__________________________ Time:________a.m. p.m.

Date Reported:_________________________ Last Day Worked:________

Did Employee Return to Work?___________ Date returned:__________

Where Accident Occurred:____

Witnesses:____

Work Performing When Injured:____

____

Kind and Extent of Injury:____

____

Name and Address of Doctor/Hospital:_________________________________

____

____

Description of Accident:____

____

Was There Equipment Malfunction? ____Yes ____No

Describe Damage to Equipment or Property:____________________________

____

____

Unsafe Condition or Act Causing Accident:____________________________

____

Action Taken To Prevent Similar Accident:____________________________

____

____

Additional Recommendations or Action:________________________________

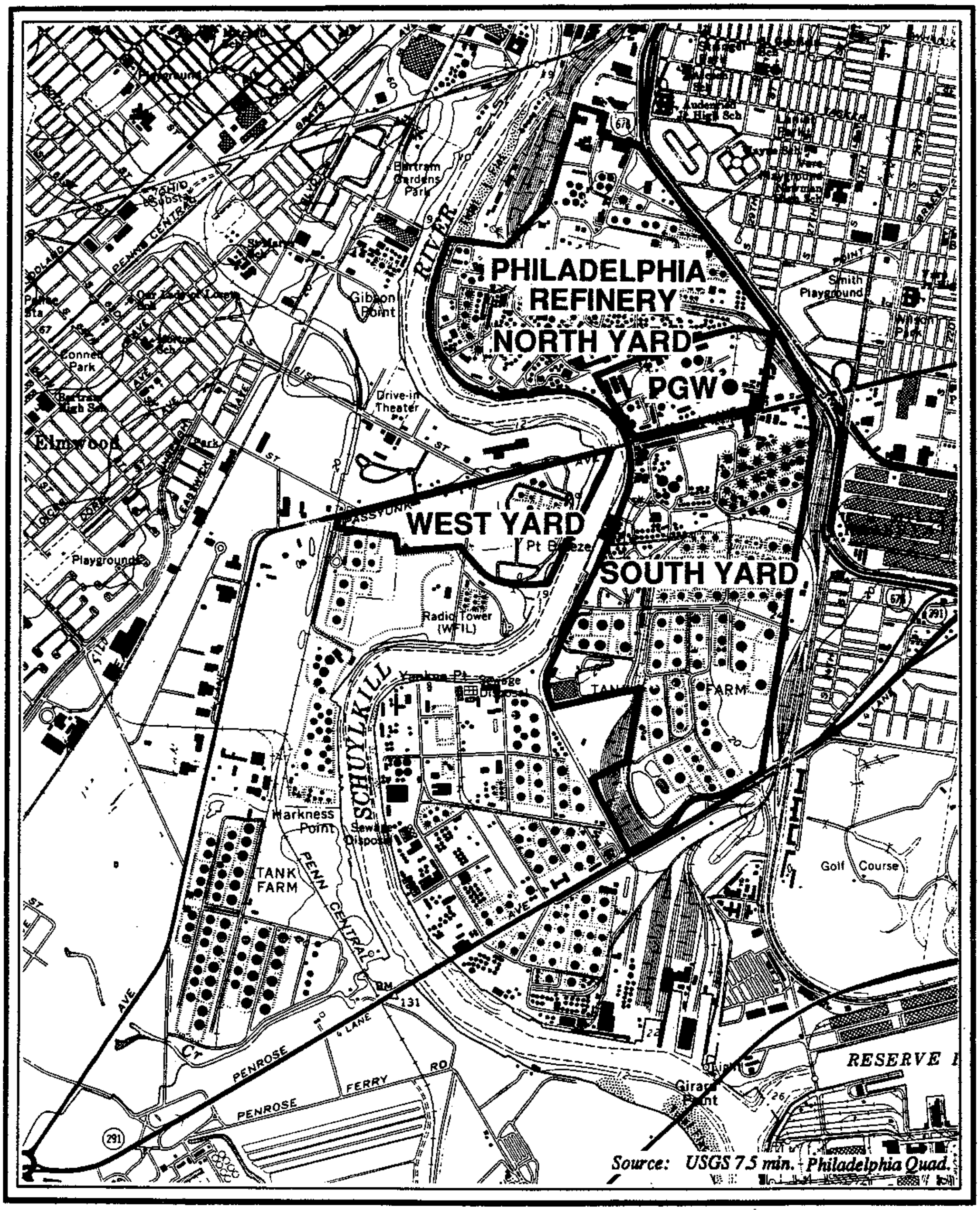
____

____

____

____Photo(s) Taken

Field Supervisor:______________________________



Refinery Boundary

Scale: 1" = 2,000'

0 2,000' 3,000' 4,000'

Location Map, Sun Philadelphia Refinery

CH2M HILL

Safety and Security Requirements for Contractors Working at Sun Refining and Marketing Company Refineries

Sun Refining and Marketing Company

Philadelphia Refinery

January 1991

SAFETY AND SECURITY REQUIREMENTS FOR CONTRACTORS WORKING AT SUN REFINING AND MARKETING COMPANY REFINERIES

This Edition Applies to:

Sun Refining and Marketing Company

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SAFETY AND SECURITY REQUIREMENTS FOR CONTRACTORS WORKING AT SUN REFINING AND MARKETING COMPANY REFINERIES

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INTRODUCTION TO SAFETY REQUIREMENTS

FOR CONTRACTORS WORKING AT

SUN REFINING AND MARKETING COMPANY

PHILADELPHIA REFINERY

To help promote safe contractor performance, protect personnel and equipment, and ensure the continuity of Sun's operations, the company requires all contractors working on Sun premises to comply with the company's established safety and security requirements. Contractors working for Sun must also follow the safe work practices of their industry and all rules and regulations, laws and ordinances of government agencies (local, state, federal) having jurisdiction over such work.

The nearness of processing units, storage tanks, sewers, compressors and other equipment containing hazardous materials makes it mandatory that the contractor take appropriate positive steps to instruct his employees in their responsibility in observing local plant safety regulations.

Sun will designate a Representative for each project to serve as liaison between the contractor and the various departments involved in issuing permits, passes or other authorizations. It shall be the duty of the contractor to consult with Sun's Representative regarding specific details in each case.

GENERAL RESPONSIBILITIES

CONTRACTOR will conduct his operation in a way that will prevent personal injury and property damage through fires, accidents or other means. To this end, the contractor will follow all applicable safety requirements and furnish all necessary and desirable protective equipment and devices. This includes those items specifically required by Sun and by any government agencies having jurisdiction, unless otherwise notified in writing by Sun's Representative prior to commencing work.

SUBCONTRACTOR is bound by the same regulations as the prime contractor; it is the prime contractor's responsibility to inform and require all subcontractors to follow the same regulations.

CODES-LICENSES-PERMITS required by National, State, County and Municipal laws will be complied with. All such licenses and permits will be obtained or secured by the contractor unless otherwise provided in writing by the contract agreement.

ENFORCEMENT and communication of these rules and regulations for contractor's employees is the responsibility of the contractor. The company reserves the right to request the contractor to remove from Sun property at any time any contractor employee it may deem necessary to assure the safety and security of the refinery.

CONTRACTOR'S ARRIVAL will be expedited by Sun's Representative so that contractor's employees and equipment can gain entrance to the plant or facility. The contractor must notify the designated Sun employee of his expected arrival so that arrangements can be made with the Security Group. The Sun Representative shall ensure that the contractor receives orientation training before work begins.

EMERGENCY PROCEDURES

1. The Sun Representative will furnish a list of emergency numbers to be called in a fire, accident or other emergency and identify the locations of area telephones. Before work begins, these numbers are to be posted by the contractor in strategic locations and in a way that will help the contractor's employees use them.

2. In some plants or facilities a "GAS WARNING ALARM" alerts personnel that hazardous concentrations of hydrocarbons or other gas may be present. All sources of ignition such as welding machines, cranes, compressors, welding torches, portable pumps, vehicles, etc. must immediately be shut down in the area of the alarm. Contractor personnel must evacuate the area.

The contractor is responsible for familiarizing his employees with the sound of these alarms and their duties in connection with each emergency.

When work is being performed by a contractor in or near an operating plant, close coordination between the company and the contractor is needed for the safety of both company and contractor employees. For this reason, the company reserves the right to stop all contract work if, in Sun's judgement, plant operating conditions make continued contract work unsafe at that time.

3. Should the contractor be responsible for any conditions which, in Sun's opinion, would endanger Sun personnel or property, Sun reserves the right to require the contractor to stop work and/or immediately correct the conditions. Sun will not be responsible for any damage suffered by any contractor, for example, wages due a contractor's employee under labor contract, if work is stopped for this reason.

AREA RESTRICTIONS

1. Contractor's employees are restricted to the areas where they are performing work or services; all other areas are "out of bounds". In going to and from such work areas, contractor's employees must remain on established roads or alternate routes specifically agreed to by Sun's Representative.

2. Smoking by contractor's employees on Sun's premises is prohibited except in areas specifically designated (see Smoking).

BUSINESS AGENTS

Union Business Agents shall be admitted to Sun's Refinery property only under the following conditions:

1. The Business Agent is entering the refinery for a scheduled meeting with the contractor with prior notification to appropriate Sun personnel.

2. The Business Agent is entering the refinery for a meeting with contractor employees with approval from the contractor and prior notification to appropriate Sun personnel.

3. Business Agents will be admitted only for the purposes specifically shown above with prior notification to Sun Company. Business Agents are to be escorted by a member of the contractor's supervision and appropriate Sun personnel at all times while on the refinery premises; they shall not be permitted to visit other areas of the refinery. Exceptions to this item are made by the Sun Representative prior to the start of the job.

SAFETY REQUIREMENTS FOR CONTRACTORS

1. ALARMS

A gas alarm, fire alarm, or evacuation alarm in the area where a permit is effective automatically stops all work. Work may not resume without specific permission of Risk Management.

2. ALCOHOLIC BEVERAGES AND NON-PRESCRIPTION DRUGS

Possessing, using, or passing any alcoholic beverages or non-prescription drugs that have the potential to alter behavior while on company property is not permitted. In addition, reporting to work under the influence of intoxicants or drugs is not permitted.

3. ASBESTOS (F/S-430)

Special handling procedures and personal protective equipment are required when cutting or handling asbestos or asbestos-containing materials. Approval by the company shall be obtained before undertaking these activities.

All insulation and transite board shall be considered as containing asbestos unless determined to be non-asbestos through methods approved by Risk Management.

WARNING: ASBESTOS IS KNOWN TO CAUSE CANCER AND OTHER RESPIRATORY DISEASES.

4. PASSES

Contractor's employees are required to have Sun issued identifying badges or passes to gain entrance and when working in the Refinery. This I.D. must be kept with the contractor while they are in the plant.

Vehicles passes will be required for contractor's vehicles entering Sun property, and are obtained from Security.

5. BLANKING (F/S-610)

Blanking procedures for all tanks, vessels, and other equipment is defined in F/S-610 in the Refinery Safety Manual and approved by Risk Management and the Maintenance Department. Blanking procedures shall be reviewed with contractor by the Sun Representative on a job by job basis.

6. BLOCKING ROADWAYS

Roadways should not be blocked by tools, equipment, vehicles, debris or mobile equipment; fire and emergency vehicles must have clear access to all parts of the refinery.

If it is necessary to block a roadway temporarily, permission must be secured from Risk Management by stating the length of time and the reason for blocking. If approval is secured, vehicles and equipment must always be attended by a qualified operator. Vehicles and equipment must be placed to avoid obstructing access to stretchers, fire equipment, ladders, stairs, or other facilities that might be needed in an emergency.

If a road is closed by Sun for an emergency, the contractor's employees must observe the barricade. They will not enter a barricaded area, by-pass or remove a road barricade without first obtaining permission from the Sun Representative.

7. COMPRESSED AIR

Never use compressed air for breathing purposes unless the compressor meets all breathing air quality requirements including appropriate alarms, monitors and filters as defined by OSHA 1910.134.

Air lines will not be kinked to cut off the air because this will weaken the hose. Do not attempt to change or adjust pneumatic tools or connect or disconnect air hoses by kinking the hose.

Compressed air will not be used for cleaning or cooling one's person other than in approved equipment or clothing.

If it is necessary to lay hose across roadways, provisions must be made to prevent damage to the hose by vehicles.

Because of danger to fellow employees from flying dust and particles, compressed air is not to be used for cleaning platforms, decks, stairways, steps, passageways or roadways.

8. COMPRESSED GAS CYLINDERS (F/S-710)

Compressed gas cylinders, including air, oxygen, acetylene, nitrogen, ammonia and hydrocarbons, must be handled and used in accordance with the Occupational Safety and Health Act of 1970. The Act includes but is not limited to the following:

a. Cylinders must be removed from an active operating area at the end of each day, when they are not in use, and immediately upon completing a job. Exceptions to this must be specifically authorized by the Sun Representative.

b. Cylinders must be used, stored and transported with extreme care.

c. Cylinders must be securely fastened and supported at all times.

d. Protective caps must be kept on all cylinders not in use; if a cylinder is left unattended with a hose and torch connected, the cylinder valve must be closed regardless of the length of time unattended.

e. Oxygen and acetylene cylinders stored at the same location must be segregated by a minimum distance of 20 feet or by a non-combustible barrier (steel plates) at least 5 feet high having a fire resistance rating of one half an hour.

f. The number of cylinders used on a job in an operating area must be kept to a minimum.

g. Cylinders being transported to or from a job by a truck or other conveyance must have protective caps and be securely fastened and supported in an up-right position (or be in a suitable cylinder basket). They may not be carried in a choke hitch.

h. Cylinders must be stored away from an operating area with protective caps in place and securely fastened or supported.

i. Oxygen cylinders must not be used or stored where oil could come into contact with the valve or attached equipment.

j. All cylinders must have a service status tag attached before they are put into use.

9. <u>DELIVERIES OF MATERIAL</u>

Bills of lading or approval from contractor's representative are required for gate entry in addition to a pass from Security.

10. DE-ENERGIZING, LOCK OUT AND TAGGING ELECTRICAL EQUIPMENT (F/S-351)

If the Sun Representative determines that equipment must be de-energized before beginning any electrical work, the contractor must review with the Sun Representative any operational problems and identify switches, valves, etc. involved.

Before starting any work on electrical equipment, the electrical circuit must be de-energized by turning the control switch to the off position and locking, tagging and sealing it in that position. The contractor must comply with Sun's local Lock Out/Tag Out regulations. Any operation of switches by the contractor will be outlined in the meeting with the Sun Representative.

11. DISMANTLING OF PLANT EQUIPMENT OR PIPING IN PLACE

a. Contact the unit supervisor to verify that the correct vessel or piping is about to be dismantled.

b. The unit operator will then drain and vent equipment and notify the Fire & Safety Inspector to verify the non-toxic content of the vessel and/or piping. An entry permit must be issued by the Fire & Safety Inspector to contractor verifying the safe condition of the equipment to be dismantled, or containing conditions required to make the equipment safe.

c. The operator will then issue a safe work permit to allow blanking of equipment.

d. The Fire & Safety Inspector will stipulate on Entry Permit all required conditions for entry, and if conditions warrant, will notify the Health Specialist to determine what personal protective gear must be used to proceed with work.

12. ELECTRICAL EQUIPMENT USED IN THE REFINERY (F/S-550)

All electrical tools, cords and equipment used in the refinery must be in compliance with OSHA 1910.309 Inspection and Testing and the National Electrical Code requirements for the hazardous area classification in which the equipment is to be used. Exceptions are permitted only when authorized by Sun's Electrical Group supervision.

General requirements include the use of:

- o Explosion proof plugs and receptacles
- o Explosion proof lights
- o Adapters or "cheater cords" are not allowed in the refinery.

Specific authorization must be obtained from the company and from the plant personnel in charge of the area:

- o Before using or connecting electrical equipment into existing plant electrical systems, circuits, plugs, etc. This electrical equipment includes welding machines, extension lights, and portable tools.
- o Before performing work on electrical circuits, wiring and electrically operated equipment, etc. which is tied into existing plant electrical systems or circuits. This includes motors, breakers, transformers.

The company's authorization may require close compliance with company electrical lock out procedures. During excavation, don't break into red concrete without the permission of the Fire & Safety Inspector.

13. <u>ENTRANCE OR EXIT OF CONTRACTOR EMPLOYEES</u>

Contractor employees must enter or exit the plant at a gate specified by Risk Management. The location of the work area will determine the gate and roads to be designated. The contractor must notify the designated Sun Representative of his expected arrival so arrangements can be made with the Sun Security Group.

Sun reserves the right to examine and open contractor vehicles and hand-carried items while they are entering, leaving, or within the refinery.

14. <u>EXCAVATION</u> (F/S-520)

Excavation work requires an EXCAVATION PERMIT stating the presence of underground lines, electrical conduits, or other underground obstruction. This permit is separate from the Unit Work Clearance required for general work and must be obtained prior to excavation. (See Section 12.)

The contractor must provide sufficient shoring to prevent cave-in which might damage existing structures. Any excavation 4' or deeper must have shoring. He must also provide all necessary safety devices, warnings and guard rails and night lighting along trenches, roadways, or crosswalks where plant operating personnel might be injured.

Use of Toothed Buckets is permitted only with the permission of Sun Representatives.

15. EXPLOSIVE BLASTING (F/S-333) - Dynamite, powder, blasting caps, or other explosives are prohibited within the refinery unless the following conditions and regulations are met:

a. Blasting work must not be started without first obtaining a blasting permit from the Fire & Safety Inspector.

b. Blasting permits are good only for the time and location specified and must be available at all times for inspection.

c. Blasting work must be done in accordance with the terms and conditions specified in the blasting permit under the direction of the person designated by the permit. Only qualified or licensed operators will be issued blasting permits, and such work must conform to federal, state and local regulations.

d. At no time shall explosives be left on the refinery premises overnight without the written permission of the Refinery Manager.

e. The contractor shall be responsible for insuring that all areas in which explosives are used are safe and that only personnel required to be present can enter areas where blasting is taking place.

These are general guidelines. Refer to F/S-333 for specific instructions.

16. FACIAL HAIR (F/S-234)

All contractor personnel working in the Philadelphia Refinery on assignments longer than one day will be required to be clean shaven, except for mustaches which do not exceed the corners of the upper lip and sideburns which do not extend below the earlobes. Questions regarding these requirements should be directed to the Sun Administrator of your contract.

17. FIREARMS

Carrying concealed weapons, firearms or explosives of any kind is not permitted. The possession of these items in a car or trunk of a car for any reason is not permitted.

18. FIRE HYDRANTS, HOSES ON REELS (F/S-152)

Fire hydrants and fire hoses are for fight fighting only and may not be used for any other purpose without requesting a permit from Risk Management. It will be necessary to state name, number of hydrant, location, use, and length of service.

19. FIRE PERMITS (HOT WORK) (F/S-331)

a. Fire or hot work permits are required daily and must be obtained through the Fire & Safety Inspector before such work is done.

   The procedures for issuing Fire Permits may vary from one plant to another; the rules applying to the plant or area involved must be determined by the contractor in consultation with the Fire & Safety Inspector. In certain areas written approval of the Captain of the Port is required. (USCG Regulations)

b. Fire permits are required for any operation or procedure where open fires, sparks, flames or other heat-producing devices might ignite flammable vapors. These include, but are not limited to the following procedures or equipment operations:

   Chain Saws
   Concrete Breaking
   Electrical Equipment (non-explosion proof)
   Electric Welding
   Emergency Lighting (non-explosion proof)
   Grinding
   Internal Combustion Engines
   Photo Flash Bulbs
   Sandblasting
   Compressors
   Electric Drills
   Electric Extension Cords and Lights (non-explosion proof)
   Gas Welding
   Hot Tap Operation
   Motorized Vehicles
   Portable Electrical Equipment
   Space Heaters

c. Fire permits are good only for the time and at the locations specified and must be available at all times for inspection at the location where the hot work is being done.

d. Hot work must stop immediately when a "Gas Warning Alarm", fire alarm or evacuation alarm sounds and may not be resumed until a new Fire Permit has been issued. (See also Emergency Procedure)

20. FIRE PROTECTION (F/S-151, 152)

Fire protection and extinguishing equipment must be available in all work areas, especially where "Hot Work" is being performed. Before beginning any work, the contractor must determine the type and amount of fire equipment needed. The contractor will be responsible for providing all portable fire extinguishing equipment required. All extinguishers must be approved by Risk Management. Whenever a fire extinguisher has been used, it must be reported immediately to the Sun Representative; the representative will then notify Risk Management for replacement.

21. FIRE DIKES AND OPERATING AREAS

No cars, trucks, or other internal combustion engine equipment, nor any fire or heat-producing equipment, will be permitted inside storage tank dikes or on designated plant roadways without first having obtained permits through the Sun Representative. For work going on in active dikes, a loader must be standing by to close the dike should an emergency arise. No active dike may remain open overnight. All such dikes must be closed at the end of the work day.

22. FIRST AID AND FIRST AID EQUIPMENT

The contractor is responsible for providing first aid assistance to his employees in the refinery and must furnish suitable first aid equipment and supplies. Sun's first aid equipment and dispensary facilities are intended for use by Sun's employees and are not routinely available for the contractor's employees. Sun's facilities should be used only in a serious life threatening emergency. If it is necessary to use Sun's facilities, the contractor agrees to hold Sun and Sun's employees or agents harmless for any action, treatment or procedure undertaken. A written accident report shall be supplied to Sun's Representative within one (1) working day of any accident.

23. FLASHLIGHTS

Flashlights used within the refinery or a storage area must be the type approved by Underwriter's Laboratory for use in hydrocarbon atmosphere. The flashlight must be marked "flashlight for use in hazardous locations Class I, Groups C&D".

24. GROUND FAULT CIRCUIT INTERRUPTERS (GFCI)

Ground fault circuit interrupters (GFCI) must be used when working in the refinery (OSHA standard 1926.400(A)).

25. GUARDING

All exposed hazards must be suitably guarded. Where guards, floor plates, handrails or manhole plates have been removed, they must be replaced at the end of the job or more frequently when required.

26. HAZARD COMMUNICATION STANDARD (F/S-411)

Contractors who provide and/or use chemicals must comply with the OSHA Hazard Communication Standard. Contractors must submit a Material Safety Data Sheet (MSDS) for any chemical including cleaning agents, paint, coatings or other chemicals to the Contract Administrator prior to bringing it to the refinery. In addition, containers of hazardous substances must be labeled properly.

Health, safety and storage information on products produced or used in the refinery is available to all contractors. MSDS manuals containing hazard identification and protective equipment requirements, as well as material safety data sheets are located in each control room. These manuals are available to contract employees but must not leave the control room.

Contractors must also receive Philadelphia Refinery Hazard Communication training prior to beginning any work. It is the contractor's responsibility to disseminate this information to their respective employees. The list of contractors needing this training is provided periodically to Risk Management by the Contract Administrator.

It is the responsibility of the contractor to provide its employees with the training required by the OSHA Hazard Communication Standard.

27. HEALTH HAZARDS (F/S-400 Series Regulations)

There are a number of materials in the refinery that may cause injury or illness, such as acids and caustics. Some materials, such as asbestos and benzene, may cause cancer. Special attention to handling these materials is necessary. The Refinery Permit System is intended to provide the maximum protection for any worker in the refinery. Follow permit instructions and Chemical Safety and Health Handling Sheet requirements closely and if you have any questions, contact your Sun Representative.

28. HOISTING AND RIGGING STANDARDS

a. The Fire & Safety Inspector shall be notified when any lift of over 40 tons or any lift of an unusual nature is contemplated.

b. Any crane used by the contractor within Sun's premises is subject to inspection by a representative designated by Sun. The Fire & Safety Inspector should be contacted to determine whether Sun chooses to make such inspection before using this equipment.

c. Sun's permission must be obtained from the Fire & Safety Inspector prior to using any plant equipment or structure as anchor or dead-man for rigging equipment.

d. The ground area underneath hoisting operations must be roped off and suitable signs installed by the contractor.

e. Special equipment is required by OSHA when using cranes for carrying personnel. Permission must be obtained from the Sun Representative prior to use for carrying personnel.

f. Personnel platforms (lifting cages) are not be used to transport people to high elevations if other means or access is possible.

29. HOUSEKEEPING (F/S-740)

Construction work areas must be kept orderly at all times. Avoid over-weighing of floors and cat-walks with equipment and debris. Stairways and passage-ways are to be kept open and free of obstruction. The contractor is responsible for keeping debris off Sun-owned property unless otherwise specified.

All debris, scrap and oil spills incidental to work must be cleaned up each day or at such other time as may be designated by the company.

30. INJURY TO CONTRACTOR EMPLOYEES

The contractor is responsible for providing first aid injury treatment, transportation, hospital arrangements, investigation and reporting of all accidents occurring to contractor's employees or individuals in the refinery at contractor's request while on Sun's premises or job. (See also First Aid and First Aid Equipment)

The contractor must report injuries promptly to Sun's Representative so the appropriate reports can also be filed in Sun's office. A written accident report shall be supplied to Sun's Representative within (1) working day of any accident.

31. <u>LADDERS</u> (F/S-532)

a. <u>Use of Ladders</u>

All ladders used must comply with "The Standard For Ladders of the Pennsylvania Department of Labor & Industry" and OSHA 1910.25. All inspection dates must be honored. Ladders past due for inspection must not be used until inspected and found to be in good working order.

Ladder safety shoes must be installed on ladders prior to use.

Portable metal ladders are not permitted in the refinery, with the exception of metal clamp-on scaffold ladders properly installed on scaffolds.

All portable ladders must be secured by typing off.

b. <u>Inspection of Ladders</u>

Before Each Use: The user should inspect the ladder for broken or cracked rungs, side rail cracks, etc. Any defects should be corrected before use or, if impossible, the ladder should be discarded in a trash container. Defective ladders should not be used.

The following inspection will be conducted:

Portable Straight Ladder (Metal Scaffold Clamp-on Only)

- o Inspect joints between rungs and side rails - repair or replace as necessary.
- o Inspect hardware and fittings - repair or replace as necessary (movable parts must be free/without undue play).
- o Inspect side rails and rungs for bends, dents, cracks, splits, and weld bead (replace as necessary).

Portable Straight Ladder (Wood)

- o Inspect joints between rungs and side rails - tighten as necessary.
- o Inspect hardware and fittings - secure as necessary (movable parts must be free/without undue play).
- o Inspect side rails and rungs for cracks, splits and dry rot (replace as necessary).
- o Test side rails and rungs by placing ladder in a horizontal position supported approximately 6" from each end and approximately 4" above surface. Walk the rungs with a person approximately 200 lbs. (if breaks or cracks occur, replace ladder).

Portable Extension Ladder (Wood)

- o All of the above (replace worn or frayed ropes).
- o All of the above.

Portable Straight Ladder (Fiberglass)

- o Inspect joints between rungs and side rails - tighten if possible or replace ladder.
- o Inspect hardware and fittings - secure as necessary (movable parts must be free/without undue play).
- o Inspect side rails for cracks, frays and twists (repair or replace ladder as necessary).

Portable Extension Ladder (Fiberglass)

- o All of the above (replace worn or frayed rope).

32. <u>LIFE LINES</u> (F/S-270)

When it is impractical to perform elevated work from an approved scaffold or platform, a life line shall be used for employee's personal safety.

The life line and hardware must be inspected before each use to establish its ability to support the required load.

33. LIFE PRESERVERS

Contractor's employees may be required to work over the water in boats or skiffs, where there is danger of drowning. In these cases, personnel must wear a U.S. Coast Guard approved life jacket or work vest.

Before using a life vest, inspect it to determine that the straps and fasteners work and that the unit has not been damaged in such a way to alter its strength or buoyancy. Defective units must not be used.

34. LINE SHUT-OFF

Sun's Unit Operator will close and open process and utility valves.

35. MATCHES AND LIGHTERS (F/S-260)

Disposable or single action open top lighters are not permitted in the plant; only an approved lighter with spring-loaded cover completely enclosing the striking mechanism or safety matches may be used.

36. PARKING (F/S-750)

Sun will provide the contractor's employees with parking at a reasonable distance from the work site whenever possible. Give advance notice of parking requirements to the Sun Representative: he will tell the contractor of the approved parking area and the gate which must be used to reach the designated area. The Sun Representative may arrange for special decals or tags for the contractor's vehicles using refinery roads.

Contractor's employees must not use parking facilities provided for refinery employees.

37. PERMITS

The following types of work require written permits. Upon reasonable notice, Sun's Representative will arrange for issuing these permits.

a. Hot Work or Fire Permits are required before working in any operating or storage area where using equipment might serve as a source of ignition. (F/S-331)

b. Blasting Permits are required before using explosives. (See Explosive Blasting) (F/S-333)

c. Excavation Permits are required within plant boundaries. (See Excavation) (F/S-520)

d. Work Permits are normally required before starting work in any operating area, tank farm or dock - inquire with local responsible Operating Representatives. (F/S-310)

e. Permits to open equipment that has been in-service are required - inquire locally. (F/S-310, 341)

f. Permits to Enter are required for personnel to enter equipment that has been in operating service. (F/S-321)

g. Powered Equipment Permits may be required before working on electrically- or engine-driven mechanical equipment to prevent equipment from being put into motion while work is underway - inquire locally. (F/S-351)

h. Hot Tap Permits are required. (F/S-541)

i. Radiological Test Permits are required - inquire locally. (F/S-361)

38. PERSONAL PROTECTIVE EQUIPMENT (F/S-200 Series Regulations)

Contractor must comply with all federal, state and local safety requirements pertaining to personal protective equipment. When working in the refinery, the contractor's employees must wear hard hats, eye protection and long sleeved shirts; they must be fully clothed. Canvas shoes, sleeveless shirts and short pants are prohibited. Designated areas require hearing protection.

NOTE: Jewelry (rings, bracelets, neck chains, etc.) should not be worn while using tools or working around machinery or electrical equipment.

Protective Equipment requirements are located on the Chemical Safety and Health Handling sheets for each material in the MSDS manuals. Equipment required may include:

Chemical Goggles	Face Shield	Attached to Hat
Chemical Gloves	PVC Suits	Rubber Boots

Respiratory protective equipment, i.e. organic vapor respirators or air breathing equipment may be required when working in or around equipment that has contained gasoline or other petroleum materials.

The contractor will supply all protective clothing and equipment; he should check with the Sun Representative to determine local conditions. The contractor is urged to become familiar with and adopt Sun's safety practices for Sun employees when working in the refinery.

39. PHOTOGRAPHS (F/S-315)

Photographic equipment is prohibited, except as specifically authorized in writing.

40. PIPE WORK (F/S-451)

The contractor shall not work on piping vessels or equipment prior to the installation of main isolation blanks by the company or as authorized by the company in all piping and line tie-ins. These blanks may be required to prevent additional liquids or vapors from entering piping, vessels or equipment on which work is to be done by the contractor. The contractor may not remove main isolation blanks except as authorized by the company.

41. PRECAUTIONS FOR HANDLING CHEMICAL AND PETROLEUM PRODUCTS (F/S-400 Series Regulations)

Refinery workers, including contractors, may come into contact with crude oils, intermediate products, or chemical additives and cleaners that may cause skin diseases. Some products, such as high boiling aromatic oils, have produced skin cancer in laboratory animal experiments where the product is repeatedly applied and not washed off. Avoid prolonged or repeated contact with any petroleum product or chemical used in the refinery. If skin contact is unavoidable, wear personal protective equipment.

Remove any oil-soaked clothing and launder before re-use. If specific information or handling procedures are needed for a product or chemical, contact your Sun Representative.

Light petroleum products including gasoline, naphtha and similar flammable liquids shall not be used or stored on company premises for any purpose without the company's permission. Upon approval of the company, these liquids shall only be stored in approved safety containers.

42. PROPERTY DAMAGE

Any damage, no matter how slight to any Sun property or equipment must be reported immediately to the Sun Representative. Any piece of equipment that is accidentally activated or shut down must be reported to the Sun Representative immediately.

43. RADIOACTIVE MATERIALS AND TESTING (F/S-361)

The users of radioactive materials shall comply with the State and Federal regulatory agency requirements. The use of radioactive material for radiography will be permitted only under the guidance of the Sun Representative and with a written permit. The contractor must provide evidence of the proper State and Federal Licensing requirements.

Contractors working around or on Sun equipment containing radioactive material must be under the guidance of the Sun Representative. Any radioactive equipment damaged by a contractor must be reported immediately to the Sun Representative and the Radiation Officer (Extension 2065 or 2286).

44. RAILROAD RIGHT-OF-WAYS AND RAILROAD CARS (F/S-470, 750)

Standard clearance of 9'6" on curves and 8'6" on straight tracks shall be maintained so as not to interfere with use of the tracks.

All railroad cars and other track equipment must be blocked to prevent movement and the brakes set manually.

ICC requires flags be installed between the cars and main track.

All work on the railroad right-of-way shall be reviewed with Sun's Risk Management. A written permit is required before beginning work.

45. REMOVAL OF MATERIALS

Contractor's employees must have passes authorized by Sun to remove materials, tools and equipment from refinery property. These passes must be obtained through the Sun Representative and given to the Guard at the designated gate. Removal of company materials by any other means shall be considered theft.

46. ROADWAY & VEHICULAR SAFETY PROGRAM (F/S-750)

a. All traffic signs, roadway markings and signals must be obeyed. Violators may be restricted from working at Sun facilities.

b. Plant speed limit is 15 MPH unless posted otherwise.

c. Beware of road blocks, road closings and one way roads. Such traffic barriers may not be violated.

d. Tank trucks must follow the "truck route" as posted from the Scale House to loading racks and back.

e. Decals, discs, or other permits are required for all vehicles to enter, park or drive in the plant. Contact Security for details.

f. All parking will be in the parking lot provided at plant entrances unless other arrangements have been made. Drivers whose vehicles are found parked outside of approved areas are subject to loss of privileges.

g. No vehicle may park so as to block a road at any time.

h. Equipment requiring staging in a roadway which blocks normal traffic flow must request a road closing permit from F/S Shift Foreman <u>before</u> equipment is set up.

i. Any injury resulting from a motor vehicle accident within the refinery must be reported to Risk Management immediately by the driver(s) or his/her/their supervision.

j. Any damage to Sun property or equipment caused by a motor vehicle must be reported to Risk Management immediately.

k. Sun reserves the right to limit the number of motor vehicles in the plant at any time.

l. All motor vehicles, regardless of ownership, are subject to search when entering, leaving, or while in the refinery.

m. Seatbelts must be used by drivers and passengers in the cab of all vehicles.

n. When personnel are transported to and from job sites in the refinery, those riding in the bed of pickups, etc. must sit on the floor, below the top of the side walls. Riding atop the sides of a pickup is strictly prohibited.

o. Except for pickups and light vans, all larger vehicles must be chocked when loading or unloading while in the refinery.

p. F/S 750, "Motor Vehicle Regulations" directly regulates trucks, cars, and other motor vehicles in the refinery.

q. The driver of a vehicle shall never leave the vehicle while the engine is running.

r. No more than two passengers and the driver of a vehicle will be permitted in the cab at one time.

s. No person will get on or off a vehicle while it is in motion.

t. No passengers are permitted to sit on the sides of an open pickup truck. Passengers of trucks must be seated on the truck bed or on seats specifically provided for carrying passengers.

u. No person is permitted to ride any load or material being pulled behind a vehicle.

v. CAUTION: Drivers should use caution on roadways blanketed with steam and fog. If another roadway is not available, drivers shall approach the edge of the obstructed area, come to a full stop, turn on lights, sound horn, and then proceed slowly.

w. All contractor vehicles must be identified by company markings.

x. Accident Reporting: <u>Any</u> accident that occurs on company property must be reported immediately to the Sun Representative.

y. Railroad Crossings: The railroad has the right-of-way through the refinery; therefore, extreme caution must be used when crossing railroad tracks.

z. Parking: Parking tickets will be issued for illegally parked vehicles. Personnel receiving excessive parking tickets will have their parking privileges revoked.

47. <u>SAFETY CANS</u> (F/S-410, 642)

Approved safety cans must be used for storage of flammable liquids.

48. <u>SANITARY FACILITIES</u>

The contractor must provide sanitary facilities that meet applicable local and federal codes for his and subcontractor's employees. Contractor's employees are not to use the refinery toilet, locker room, or wash-up facilities unless specifically authorized to do so by the Sun Representative.

49. <u>SCAFFOLDS</u>

Scaffolds must be of standard approved construction and must be erected to meet Federal, State and local codes.

50. <u>SECURITY</u>

The contractor is responsible for the security of all material and equipment. Special security problems should be discussed with Sun's Representative. In case of theft, the contractor shall advise Sun's Representative - in writing - where taken from and when. The contractor shall bear the responsibility of any such losses.

Vehicle Inspection: All vehicles are subject to inspection when entering or leaving the refinery. Packages or material must be accompanied by a Material Pass when leaving the refinery.

51. <u>SIGNS</u>

The erection of signs by a contractor on Sun property should be discussed with the Sun Representative prior to the installation.

52. <u>SMOKING</u> (F/S-260)

Sun's designated smoking areas or shelters may be used by the contractor's employees if specifically authorized by Sun's Representative. If overcrowding results because of the large number of contractor's employees, the Sun Representative will deny permission to use Sun's facilities. There is no smoking permitted inside any refinery building.

Requests for additional or alternate contractor smoking areas must be submitted to the Sun Representative in writing. Written approval must be obtained prior to erection or use of such alternate facilities or area.

53. <u>"STANDBY"</u> (F/S-321)

Any location in the refinery where a permit to enter is required (tank, vessel or area) shall be considered a confined space.

A permit to enter requires a "Standby". The contractor receiving the permit to enter will provide the "Standby".

The "Standby" shall be equipped with a minimum of supplied air respirator or self-contained breathing apparatus and a means of communication, either vocal or mechanical.

Where multiple tanks, vessels or other areas reasonably near each other are entered, a "Standby" will not be needed at every manhole or opening. However, the contractor is responsible for providing sufficient "Standby" coverage to keep personnel working in a confined space under proper surveillance.

The primary duties and responsibilities of a "Standby" are to provide communications and help to the personnel working in a confined space. The "Standby" will have a pre-planned rescue procedure and be able to put rescue operations into effect.

The secondary duties of the "Standby" will be to help the personnel in the confined space pass tools, materials or equipment. The designated "Standby" will not leave his area of responsibility until he is properly relieved when people are in the confined space.

54. TEMPORARY BUILDINGS

Temporary buildings must not be erected without first obtaining written approval of the Sun Representative and then only in accordance with such approval.

55. TEMPORARY WALKS AND FLOORS

Temporary walks and floors must be installed whenever an existing walk or floor is disturbed unless otherwise authorized by the Sun Representative.

56. UTILITY CONNECTION

Connection to any refinery utility system must be approved through the Sun Representative.

57. UNSAFE ACTS

No horseplay or other unsafe acts shall be permitted.

I have received a copy of the pamphlet entitled Safety and Security Requirements for Contractors Working at Sun Refining and Marketing Company Refineries and I understand its contents. This pamphlet was issued to me by a representative of the Sun Refining and Marketing Company.

Name (Print) ______________________________

Signature ______________________________

Social Security # ______________________________

Date ______________________________

Company ______________________________

Chapter 7
COMMUNITY RELATIONS PLAN

This community relations plan has been designed with the recognition that effective and forthright communication will help Sun strengthen relationships with employees and residents from the communities surrounding the Philadelphia Refinery. Sun is currently pursuing a RCRA Facility Investigation (RFI) on five sites located on the property of the Atlantic Refining and Marketing Corp.'s Philadelphia Refinery. This work is being performed to assist in complying with certain permit conditions in a Corrective Action and Waste Minimization Permit issued to the facility by the United States Environmental Protection Agency on December 9, 1988. The purpose of this community relations plan is to provide for the effective dissemination of information to employees and the public regarding investigation activities and their results.

FACILITY LOCATION AND BACKGROUND

The project site is located adjacent to Passyunk Avenue and the Schuylkill River in southwest Philadelphia. The five sites that are to be investigated are known as Solid Waste Management Units (SWMUs). The SWMUs to be investigated include four refinery waste disposal areas (PDA Nos. 1, 2, 3 and 4) in the West Yard, a former Leaded Storage Tank Disposal Area in the North Yard and a stormwater impoundment basin (Guard Basin) in the South Yard (Figure 1-1).

Land use at this site has a long history of petroleum transportation, storage, and processing. This facility was established by ARCO in the 1860's as an oil distribution center. In the 1900's, crude oil processing began and full scale gasoline production was initiated during World War II. In addition to refining crude oil, various chemicals, such as acids and ammonia, were also produced for a time at this site. Current operations at the plant are limited to the production of fuels and asphalt.

The Philadelphia Refinery is surrounded by industrial land uses. It is bounded by another refinery to the south, the Philadelphia Gas Works facility to the east, and numerous auto salvage and other oil storage areas facilities to the west. Several studies have been previously performed at the Philadelphia Refinery, including environmental investigations preparatory to developing a draft verification investigation work plan.

COMMUNITY RELATIONS PLAN OBJECTIVES

This community relations plan has the following objectives:

- Keep local and state officials, interested residents, and property owners in the vicinity informed of pertinent site-related developments including the projected schedule for investigation activities and the results of investigations.

- Provide timely information to the news media regarding RFI-related developments.

COMMUNITY RELATIONS ACTIVITIES

As part of the RCRA RFI Community Relations Program, certain activities are required. Others may be suggested for use depending on site conditions.

REQUIRED ACTIVITIES

Factsheet

A factsheet will be prepared that describes the scope and objectives of the RFI. The factsheet will be released to local officials or residents should any inquiries be made about the RFI.

The factsheet will be prepared by community relations personnel from the permittee's RFI consultant (a sample factsheet is included at the end of this chapter). Distribution of the factsheet will be the responsibility of the Sun Refining and Marketing Company.

Notification of Groundwater Contamination

If Sun discovers that hazardous constituents in groundwater that may have been released from an SWMU at the facility have migrated beyond the facility boundary in concentrations that exceed health-based levels, it must provide written notice to the Regional Administrator of the EPA and any person who owns or resides on the land that overlies the contaminated groundwater. The Sun Refining and Marketing Company will be responsible for this notification.

Notification of Air Contamination

Like the groundwater notification requirement, if Sun discovers that an SWMU has released hazardous constituents into the air that are migrating beyond the facility boundary in concentrations that exceed health-based levels, it must provide notification to both the Regional EPA administrator and the residences in the area that are subject to long-term exposure. The Sun Refining and Marketing Company will be responsible for this notification.

FACTSHEET

RCRA FACILITY INVESTIGATION--
PHILADELPHIA REFINERY
SUN REFINING AND MARKETING COMPANY

PROJECT PURPOSE

The Sun Refining and Marketing Company must investigate the presence of certain types of environmental contamination at the Philadelphia Refinery. If contamination is found, the company is responsible for correcting any potential problems. This responsibility is outlined in a Corrective Action and Waste Minimization Permit issued to the facility by the United States Environmental Protection Agency (EPA) under the federal Resource and Conservation Recovery Act (RCRA). The EPA has identified five locations at the refinery that must be investigated. Each location is a refinery waste disposal site that was closed before the effective date of RCRA. Wastes that have been disposed in these five locations include leaded sludge from tank bottoms, refinery process wastes, tower sludges, spent catalyst, and municipal waste generated at the refinery.

SITE HISTORY

The location of the Philadelphia Refinery has a long history of petroleum transportation, storage, and processing. The facility was established by ARCO in the 1860s as an oil distribution center. In the 1900s, crude oil processing began and full-scale gasoline production was initiated during World War II. In addition to refining crude oil, various chemicals, such as acids and ammonia, were also produced at this site for a time. Current operations at the plant are limited to fuels and asphalt.

The site was acquired from ARCO by Atlantic Refining and Marketing Corp. in 1985, and was acquired by Sun during 1988-1989. The facility is currently operated by Sun Refining and Marketing Company and is owned by Atlantic Refining and Marketing Corp. Both companies are subsidiaries of Sun Company, Inc.

PROJECT ACTIVITIES

The first step in the investigation is the development of a RCRA Facility Investigation (RFI) work plan, which needs to be approved by EPA.

The investigation of the five waste disposal locations will include a detailed examination of the physical and chemical characteristics of the groundwater, surface water, and soils at the site locations and in the general area of the facility. It will then be possible to determine the ability of the groundwater, surface water, and soils to mitigate the movement of any hazardous materials from the sites. The physical and chemical characteristics of the wastes will be identified and the extent of any contamination escaping the boundaries of the waste sites will be determined. Populations or environmental systems that may be impacted by hazardous materials migrating from the disposal locations will be identified.

The information developed during these investigations will allow the Sun Refinery and Marketing Company to determine the range of technology options that are available to address any contamination problems that may be found. These options are referred to as Corrective Measures and must be approved by the EPA before they are applied to any of the sites. The RFI work plan will be submitted for EPA review and approval in May 1991. The RCRA Facility Investigation activities at the five sites are expected to be initiated in 1991 and completed in 1992.

For further information please contact:

Jeffrey R. Peters
Sun Refining and Marketing Company
Telephone Number: (215) 997-6048

Appendix

Data Collection Quality Assurance Plan For the RCRA Facility Investigation at the Sun Refining and Marketing Company Facility Philadelphia, Pennsylvania

May 1991

Prepared by:

CH2M HILL, INC.
1216 Arch Street
Philadelphia, Pennsylvania 19107

DATA COLLECTION QUALITY ASSURANCE PLAN (DCQAP)
APPROVAL SHEET
SUN REFINERY AND MARKETING COMPANY
RCRA FACILITY INVESTIGATION

Prepared By: CH2M HILL
Reviewed and Approved By:

1.	Reviewed:	______________________ CH2M HILL's PM	________ Date
2.	Reviewed:	______________________ CH2M HILL's Designated QC Manager	________ Date
3.	Reviewed:	______________________ Sun Refining and Marketing Company Environmental Group	________ Date
4.	Approved:	______________________ EPA Region III Hazardous Waste Management Division	________ Date
5.	Reviewed:	______________________ EPA Region III Central Regional Laboratory	________ Date
6.	Reviewed:	______________________ Analytical Laboratory PM	________ Date
7.	Reviewed:	______________________ Analytical Laboratory QC Manager	________ Date

CONTENTS

TABLES

FIGURES

Section 1
INTRODUCTION

On November 8, 1988, the U.S. Environmental Protection Agency (EPA) issued a Corrective Action and Waste Minimization Permit, under authority of the Resource Conservation and Recovery Act (RCRA) Subtitle C, 42 USC § 6921-6939 (1976, as amended by Supp. IV, 1980 and the Hazardous and Solid Waste Amendments of 1984), to the Atlantic Refining and Marketing Corp.'s Philadelphia Refinery. The effective date of the permit is December 9, 1988. This facility is currently operated by Sun Refining and Marketing Company (Sun).

Included in this permit is a requirement to do certain corrective action work. After several revisions to a Verification Investigation work plan, SUN decided to bypass the normally required Verification Investigation step and proceed to the RCRA Facility Investigation (RFI) step. EPA has provided verbal approval for the RFI to proceed.

The permit stipulates that the RFI work plan shall include a Data Collection Quality Assurance Plan (DCQAP) to document the sample collection field measurement and sample analysis procedures to be performed during the RFI to characterize the environmental setting, source, and contamination so that the information and data gathered and resulting decisions are technically sound, and properly documented. The DCQAP for the Philadelphia Refinery is comprised of this appendix and by reference the Sampling and Analysis Plan in Chapter 4 and the Data Management Plan in Chapter 5 of the RFI work plan.

This DCQAP is prepared to present in specific terms, the policies, objectives, organization, functional activities, and quality assurance and quality control (QA/QC) activities designed to achieve the data quality goals of the RFI. Where possible, existing QA/QC guidelines, policies, and programs will be incorporated into the DCQAP by reference.

Section 2
PROJECT DESCRIPTION

PROJECT BACKGROUND AND SITE HISTORY

Sun has retained CH2M HILL to provide assistance in complying with certain permit conditions in a Corrective Action and Waste Minimization Permit issued to the facility by the U.S.EPA on November 8, 1988. The permit specified that six Solid Waste Management Units (SWMUs) needed to be investigated for potential corrective action work. As mentioned previously, Sun has elected to bypass the Verification Investigation step in this process and proceed directly into the RCRA Facility Investigation; EPA Region III has given verbal approval for this approach.

The project site shown by Figure 2-1, is located adjacent to Passyunk Avenue and the Schuylkill River in southwest Philadelphia. The SWMUs to be investigated include four refinery waste past disposal areas (PDA-1, -2, -3 and -4) in the West Yard, a former Leaded Storage Tank Bottoms Disposal Area (LDA) in the North Yard, and a storm-water impoundment basin (Guard Basin) in the South Yard. The Sun facility is bounded by another refinery to the south, the Philadelphia Gas Works facility to the east, and numerous auto salvage yards and other oil storage facilities to the west.

PROJECT OBJECTIVES

The objectives of the RFI are as follows:

- Characterize the nature, extent, and rate of migration of releases to soil, groundwater, surface water, and sediments from the SWMUs.
- Determine the criteria for and scope of corrective measures.
- Provide a detailed geologic and hydrogeologic characterization of the area surrounding and underlying the SWMUs.

QAPP OBJECTIVES

The objectives of the QAPP are to specify procedures to obtain samples which are precise, accurate, complete, representative and comparable as well as to specify sampling and analytical procedures that will permit identification of the contaminants of concern.

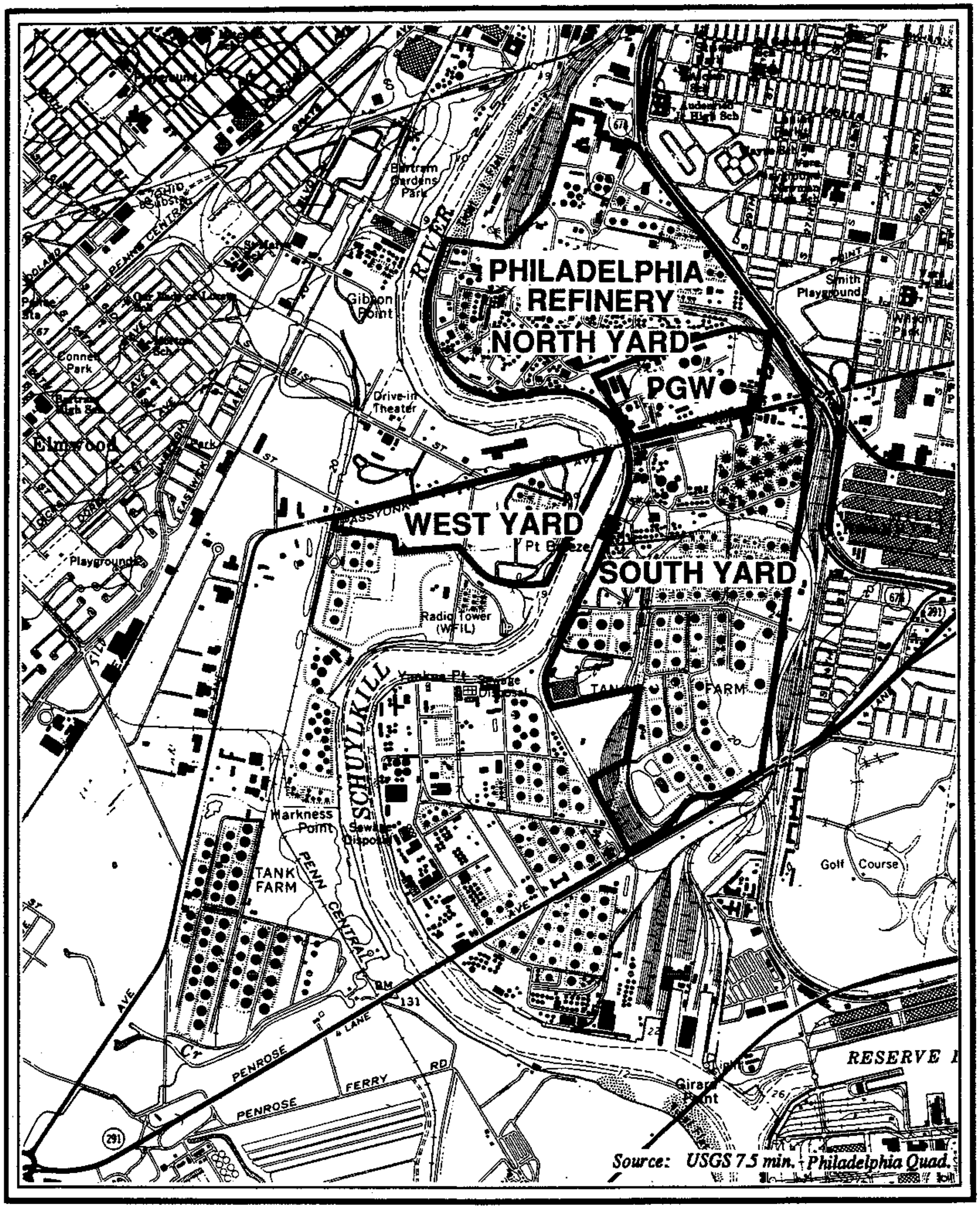

Figure 2-1

Refinery Boundary

Scale: 1" = 2,000'
0 2,000' 3,000' 4,000'

Location Map, Sun Philadelphia Refinery

CH2M HILL

SCOPE OF FIELD ACTIVITIES

The total number of samples to be collected by medium and by investigation areas are provided in Tables 2-1 and 2-2. The procedures for sample collection and documentation are detailed in Section 6 and those for sample custody in Section 7.

Field measurements will include those for pH, specific conductance and dissolved oxygen and also monitoring using the HNu. A summary of the sampling and analysis program is also presented in Tables 2-1 and 2-2.

Table 2-1
SUMMARY OF SAMPLING AND ANALYSIS PROGRAM FOR
PDAs 1-4 AND LEAD DISPOSAL AREA
Sun Refining and Marketing Company RFI

		No. of Samples To Be Collected						No. of QC Samples[c]			
			Soil								
Parameter	Analytical Method	Waste	PDAs 1-4	LDA	Groundwater	Surface Water	Sediment	Trip Blank[d,e]	Field Blank[d,f]	Equipment Blank[d]	Replicate[g]
Volatiles	SW-8240	12	24	8	10	3	3	3	3	20	9
1,2-Dibromoethane	SW-8010				10	3			3	3	2
BNA	SW-8270	12	24	8	10	3	3		3	20	9
Metals	SW-6010/7000	12	24	8	20[h]	3	3		3	20	10
TDS	SM 2540.C				10[i]				2[i]	2[i]	2[i]
Alkalinity	SM 2320.B				10						
Chloride	SW-9251				10						
Sulfate	SW-9035				10						
Fluoride	SM 4500-F-C				10						
Nitrate	SW-9200				10						
TOC	SW-9060				10				2	2	2
Geotechnical Parameters[a]			24								
RCRA Parameters[b]		12		8			3				

Notes:
SW=SW-846, 3rd Edition; SM=Standard Methods, 17th Edition.
[a]Geotechnical Parameters--Grain size distribution (ASTM D422), bulk density (ASTM D854), moisture content (ASTM D2216-80), Atterberg limits (ASTM D4318), and vertical permeability.
[b]RCRA Parameters-ignitability, reactivity, toxicity, and corrosivity
[c]Assume 1 day for waste sampling. Assume 15 days for subsurface soil sampling from 7 monitor well borings. Assume 2 days for groundwater sampling. Assume 1 day for surface water and sediment sampling.
[d]Frequency--1/day per media. Blanks will be analyzed for the same parameters as the samples.
[e]Trip blanks will be analyzed only for volatile organic compounds in water.
[f]Field blank will be analyzed for the same parameters as the water samples.
[g]Frequency--1/10 samples. Replicates will be analyzed for the same methods as the regular samples.
[h]Includes total and dissolved metals for each groundwater sample.
[i]TDS, alkalinity, chloride, sulfate, fluoride and nitrate will all be analyzed from a 1-liter container
PDA-Past Disposal Area; LDA-Lead Tank Bottoms Disposal Area; BNA-Base/Neutral/Acid Extractables

Table 2-2
SUMMARY OF SAMPLING AND ANALYSIS PROGRAM FOR THE GUARD BASIN
Sun Refining and Marketing Company RFI

Media	No. of Samples to be Collected per Analytical Method					No. of QC Samples[c]			
	TCL EPA-624	TCL EPA-625	TAL EPA-200	Geotechnical Parameters[a]	RCRA Parameters[b]	Trip Blank[d,e]	Field Blank[d,f]	Equipment Blank[d]	Replicate[g]
Soil	25	25	25	25				19	12
Groundwater	11	11	22[h]	--		2		2	4
Surface Water	4	4	4	--		1	1	1	3
Sediment	4	4	4	--	4			1	3

Notes:

[a]Geotechnical Parameters--Grain size distribution (ASTM D422), bulk density (ASTM D854), moisture content (ASTM D2216-80), Atterberg limits (ASTM D4318), and vertical permeability.

[b]RCRA Parameters-ignitability, reactivity, toxicity, and corrosivity

[c]Assume 15 days for subsurface soil sampling from 7 monitor well borings. Assume 2 days for groundwater sampling, and 1 day for both surface water and sediment sampling.

[d]Frequency--1/day. Blanks will be analyzed for the same methods as the samples.

[e]Trip blanks will be analyzed only for volatile organic compounds in water.

[f]Field blank will be analyzed for the same parameters as the water samples.

[g]Frequency--1/10 sample. Replicates will be analyzed for the same methods as the regular samples.

[h]Includes total and dissolved metals for each groundwater sample.

TCL-Target Compound List parameters

TAL-Target Analyte List parameters

The Guard Basin samples will be analyzed for TCL and TAL parameters to satisfy the EPA permit requirements.

Section 3
PROJECT ORGANIZATION AND RESPONSIBILITY

PROJECT ORGANIZATION

This section outlines the authorities and responsibilities of key members of the project team. Figure 3-1 illustrates the project organization. Subcontract management personnel are also indicated in the figure. Please note that this DCQAP is premised on CH2M HILL being the RFI contractor. The actual RFI contractor will be named at a later date by Sun.

CH2M HILL provides general project management. Primary responsibility for project quality rests with the Sun Philadelphia Refinery Environmental Group and the CH2M HILL project manager (PM). Independent QA review is provided by the field QC manager and the laboratory QC manager.

PROJECT MANAGER (PM)

The project manager will be responsible for project execution. He will be responsible for all technical, administrative, and Agency-related aspects of the project. He will also be responsible for progress reporting, schedule, and budget control. The PM will also select properly trained and qualified personnel for field and laboratory activities. The project manager will be the primary contact between CH2M HILL and Sun.

FIELD QC MANAGER

The field QC manager will review and advise on all aspect of QA/QC related to sample collection, shipping, custody, and documentation. Responsibilities include:

- Conducting field audits during execution of the program
- Auditing sample custody to determine if procedures specified in the DCQAP are followed
- Issuing corrective action orders when necessary

ANALYTICAL QC MANAGER

The Analytical QC Manager will review and advise on all aspects of QA/QC related to samples analysis. Responsibilities include:

- Auditing that field analytical QA procedures are as specified in the QA/QC program
- Conducting laboratory audits during execution of the program

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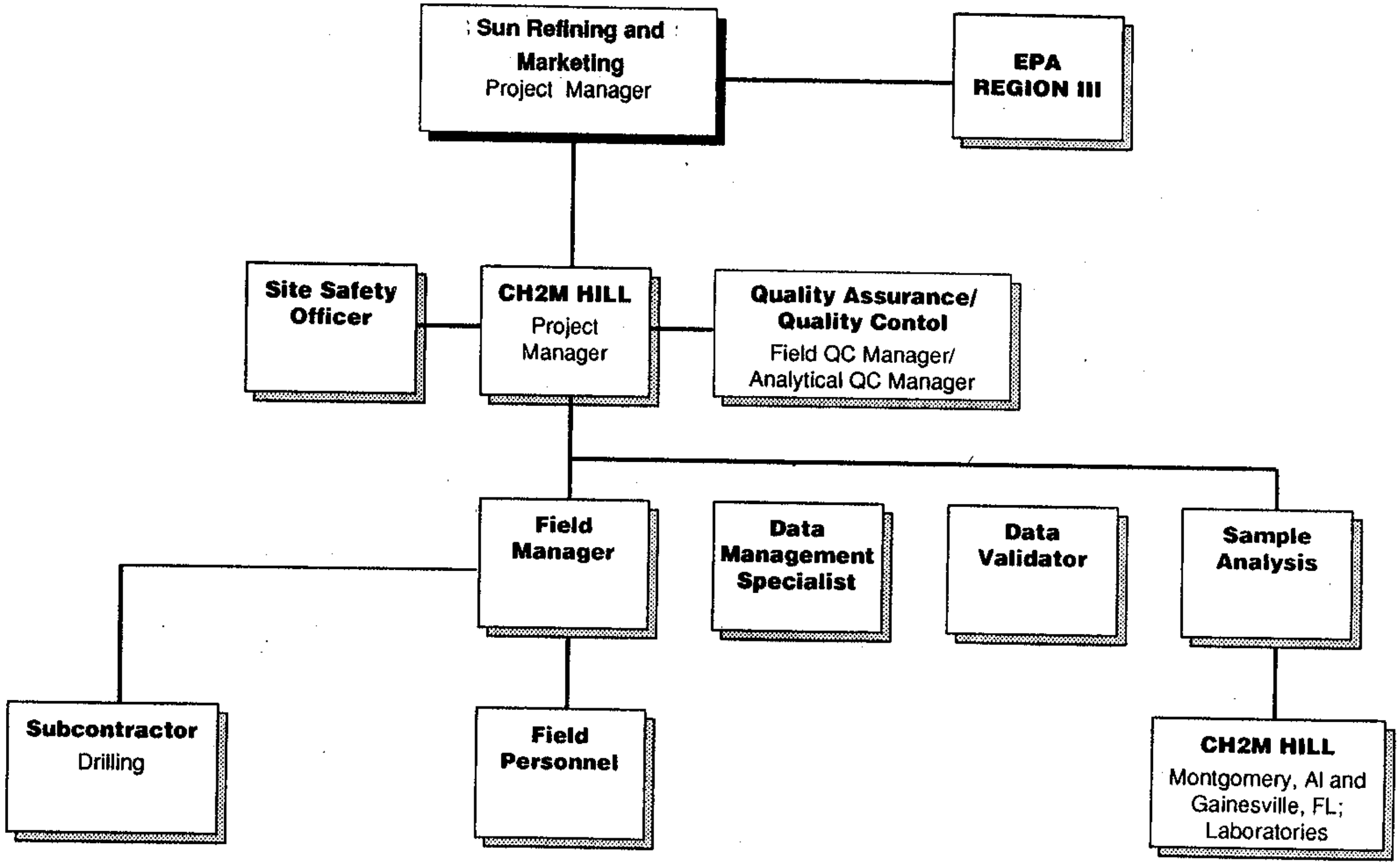

Figure 3-1
PROJECT QA ORGANIZATION CHART
Sun Marketing Refinery
RCRA Facility Investigation

- Making QC evaluations and, if necessary, submitting audit samples to assist in reviewing QA/QC procedures; making recommendations to the PM concerning repeat samples and analysis if problems are detected

- Auditing sample custody to determine if procedures specified in the DCQAP are being followed

FIELD MANAGER (FM)

The FM will schedule and coordinate all CH2M HILL field activities and will be present whenever field activities are being conducted. The FM will be responsible for the coordination and implementation of all field activities associated with the sampling and for adherence to all QA/QC procedures outlined in the DCQAP. These responsibilities include:

- Verifying that field personnel are trained and qualified in sampling procedures and field analytical procedures, prior to taking samples

- Verifying that field personnel are aware of the field sampling schedule and will be available when the activity is to occur

- Coordination of sample collection, documentation, and shipping activities

- Participating in the field sampling quality audits with the field QC manager

SITE SAFETY OFFICER

The site safety officer (SSO) will be responsible for auditing adherence of team members to the site safety requirements as described in the Site Safety Plan. Additional responsibilities of the SSO are as follows:

- Modifications of the levels of protection based on site conditions

- Determination and posting of locations and routes to medical facilities including poison control centers, and arranging for emergency transportation of medical facilities

- Examination of work party members for symptoms of exposure or stress

- Provision of emergency medical care and first aid as necessary onsite

FIELD PERSONNEL

Field personnel will collect the samples described in Table 2-1. The field personnel will be under the direction of the FM. The field personnel will be responsible for the following:

- Collecting and labeling the samples following the procedures outlined in Section 6
- Taking photographs of the sampling locations and wells
- Completing all necessary documentation
- Packing and shipping the samples
- Verifying that samples are collected, labeled, preserved, stored, transported, and when necessary, filtered as specified in Section 6
- Checking that all sample documentation (labels, field notebooks, chain-of-custody (COC) records, packing lists) is correct and transmitting that information with the samples to the analytical laboratory

DATA MANAGEMENT SPECIALIST

Responsibilities of the data management specialist will include:

- Scheduling of the analytical laboratory for delivery of sample containers and for sample analysis
- Coordination of appropriate paperwork for sample collection, custody and shipping
- Organization of analytical results into a computerized data base to be used for data validation, data evaluation and for reporting
- Coordination with data validation

DATA VALIDATOR (DV)

The DV will be responsible for conducting a systematic review of the analytical data for compliance with the established QA/QC criteria based on the Test Methods for Evaluating Solid Waste, SW-846, Third Edition, December 1986. The DV will also evaluate data accuracy, precision, representativeness, comparability (if different labs are used) and completeness, and determine data usability.

Section 4
QUALITY ASSURANCE OBJECTIVES

The overall QA objectives are to develop and implement procedures for field sampling, chain of custody, laboratory analysis, and reporting that will provide analytical data of known defensible quality. This section addresses objectives for field quality control; accuracy and precision; completeness; representativeness; comparability; and detection limits.

FIELD QUALITY CONTROL

DUPLICATES AND BLANKS

Duplicate (replicate) samples and field and trip blanks will be collected in the field and submitted to the analytical laboratory to assess the quality of data from the media sampled. Duplicate samples will be used to assess the combined effects of sample collection, handling, and analysis on data precision. Blanks will be analyzed to check for any procedural factors or ambient conditions at the site that may cause contamination. Trip blanks will accompany the shipment of the samples to be analyzed for volatile organic compounds. Trip blanks will indicate if there is any contamination during shipment and storage.

Duplicate (replicate) samples will be collected concurrently with actual samples in exactly equal volumes, at the same location, with the same sampling equipment, and in identical containers. These QC samples will be preserved and handled in the same manner as the regular samples. Blanks will consist of deionized, contaminant-free water and handled in the same manner as the regular samples. Duplicates will be collected at a rate of 1 duplicate for every 10 or fewer samples collected each day. Blanks will be collected at a rate of 1 blank each day.

FIELD MEASUREMENTS

Field measurements, including pH, dissolved oxygen, specific conductance, and temperature, involve measurements where QA concerns are appropriate but sample collection is not required. Procedures for field measurements, equipment calibration (where appropriate), and maintenance are documented in Sections 5, 6, and 13, respectively. The primary QA objective for field measurements are to obtain reproducible measurements with a degree of accuracy consistent with limitations of the analytical techniques used and with the intended use of the data.

DATA QUALITY OBJECTIVES

The Data Quality Objective (DQO) development process involves three stages, including (1) definition of the question or decision to be made, (2) clarification and precise identification of the information required, and (3) data collection program design.

The following parameters are indicators of the data quality: accuracy, precision, completeness, representativeness, and comparability. Table 4-1 summarizes the quantitative goals for the data quality indicator parameters described below. These parameters will be determined by QC measures taken in the field and in the laboratory. Frequencies of QC measures are shown in Table 4-2 and are described in detail in Section 10.

Table 4-1
Precision, Accuracy, and Completeness Objectives

Parameter	Method	Precision (Relative Percent Difference)	Accuracy % Spike Recovery	% Completeness*
Volatiles	SW-846-8240[a] EPA-624[b]	<±20	80-120	85
Acid/Base/Neutral Extractables	SW-846-8270[a] EPA-625[b]	<±20	80-120	85
Metals	SW-846-6010/7000[a] EPA-200[b]	<±20	80-120	85

[a] SW-846 refers to *Test Methods for Evaluating Solid Waste*, Third edition, December 1986.
[b] EPA methods for TCL and TAL parameters.

Table 4-2 Collection Frequencies of Field QC Samples				
Analysis	**Field Blank**	**Equipment Blank**	**Replicate**	**Additional Volume Needed for MS/MSD**
Volatiles	1/day	1/day	1/10 samples or fewer	Triple volume per 20 samples or fewer
Acid/Base/ Neutral Extractables	1/day	1/day	1/10 samples or fewer	Triple volume per 20 samples or fewer
Metals	1/day	1/day	1/10 samples or fewer	Double volume per 20 samples or fewer

ACCURACY AND PRECISION

Accuracy is a measure of the agreement between an experimental result and the true value of the parameter. Analytical accuracy can be determined using known reference materials or matrix spikes. Spiking of reference materials into the actual sample matrix is the preferred technique because it quantifies the effects of the matrix on the analytical accuracy. Accuracy can be expressed as the percent recovery (P) as determined by the following equation:

$$P = \frac{SSR - SR}{SA} \times 100$$

where:
SSS = spiked sample result
SR = sample result (native)
SA = spike added

Precision is the measure of the agreement or repeatability of a set of replicate results obtained from repeat determinations made under the same conditions. The precision of a duplicate determination can be expressed as the relative percent difference (RPD) which is determined by the following equation:

$$RPD = \frac{X1 - X2}{X1 + X2} \times 200$$

where:
X1 = first duplicate value
X2 = second duplicate value

For a given laboratory analysis, the replicate RPD values are tabulated, and the mean and standard deviation of the RPD are calculated. Control limits for precision are usually plus or minus two standard deviations from the mean. Laboratory precision limits for the analytical work will be those established by EPA, as indicated in Table 4-1.

Accuracy and precision will be monitored by using field replicate, matrix spike, and matrix spike duplicate samples. These data alone cannot be used to evaluate accuracy and precision of individual samples but will be used to assess the long-term accuracy and precision of the analytical method.

COMPLETENESS

Completeness is defined as the percentage of analytical measurements made that are judged to be valid with validity being defined by the DQOs. Percent completeness is calculated as the number of valid analyses divided by the total number of analyses performed multiplied by 100. The QA objective for this RFI is to obtain valid analytical results for a minimum of 85 percent of the samples collected.

REPRESENTATIVENESS

Representativeness expresses the degree to which sample data accurately and precisely represent parameter variations at a sampling point. Representativeness is a measure of how closely the measured results reflect the actual distribution and concentration of certain chemical compounds in the medium sampled. Section 5 describes the procedures to be used to collect samples. These procedures will generate samples that are as representative as possible. Documentation of field and laboratory procedures, as described in Section 5 and Section 8, will be used to establish that protocols have been followed and that sample identification and integrity have been maintained.

COMPARABILITY

Comparability is the term that describes the confidence with which one data set can be compared to another. Comparability refers to such issues as using standard field and analytical techniques and reporting data in the same units. This criterion becomes important if more than one field team is collecting samples or more than one laboratory is analyzing the samples.

DETECTION LIMITS

The detection limits for the analytical methods listed in Table 4-1 should be consistent with the Practical Quantitation Limits (PQLs) as defined by *Test Methods for Evaluating Solid Waste*, SW-846, Third edition, December 1986. The detection limits for the TCL and TAL parameters, being analyzed for at the Guard Basin, are as defined by the Contract Lab Program Statement of Work for Organics and Inorganics, February 1988 and July 1988.

Section 5
SAMPLE COLLECTION AND HANDLING PROCEDURES

SAMPLE COLLECTION

Sample collection goals and objectives, sampling locations and media, field measurements, and sample collection procedures are detailed in Section 4 of this RFI work plan. Samples will be collected from soil, waste, groundwater, and surface water and sediments.

SAMPLE HANDLING

SAMPLE CONTAINERS

The sample containers used to collect samples will be compatible with the analyses of interest. Water samples to be tested for organics analysis will be collected in glass bottles with Teflon-lined caps. Water samples for metals analysis will be collected in plastic (polyethylene) bottles. Soil samples will be collected in wide-mouth glass bottles with Teflon-lined caps. The sample containers will be cleaned by the laboratory using standard procedures and protocol for RCRA investigations before shipment to the site. The specific bottle requirements are listed in Table 5-1.

SAMPLE SHIPPING

Samples will be placed in metal coolers packed with an inert material, e.g., vermiculite, in order to avoid bottle breakage. Ice will be packed in ziplocked bags and placed in the coolers to keep the samples cooled to 4°C during shipment. A chain-of-custody form and return label will be sealed in a ziplock bag and taped to the inside lid of the cooler. The cooler will be secured with strapping tape, custody seals, and appropriate carrier's air bill for shipment to the laboratory. All samples will be shipped within 24 hours of sampling by Priority, overnight air express, or hand delivered to the laboratory so that they will reach the laboratory well within their respective holding times.

SAMPLE PRESERVATION

All field and QA samples will be preserved according to the procedures outlined in Table 5-1. The preservatives used on the samples will be HPLC quality, in concentrated form so that only small volumes of preservative will be needed to adjust the pH of the samples. To adjust pH, a disposable eye dropper will be used to add the preservative while the pH is measured simultaneously, with noncontaminating calorimetric tape. Calorimetric tape will not be placed directly in the sample jar. A small amount aliquot of sample will be spilled over the tape. All appropriate samples will be preserved and cooled to 4°C immediately following sampling.

Table 5-1
SAMPLE CONTAINER PRESERVATION AND HOLDING TIMES REQUIREMENTS

Analyte	Container	Preservation	Maximum Holding Time
WATER			
Volatile Organic Compounds	Three 40-mℓ glass vials with Teflon septa	4°C, pH <2 with HCL	14 days
Ethylene Dibromide	Two 125-mℓ amber glass jars with Teflon septa	4°C	14 days
Semivolatile Compounds	Three 1-liter amber glass jars with Teflon lined lids	4°C	7 days until extraction, 40 days after extraction
Metals	1-liter polyethylene bottle	4°C, pH <2 with HNO_3	28 days for Hg, 6 months for others
TDS, alkalinity chloride, sulfate fluoride, and nitrate	1-liter polyethylene bottle	4°C	7 days 48 hrs for nitrate
TOC	250-mℓ plastic bottle	4°C, pH <2 with H_2SO_4	7 days
SOIL/WASTE/SEDIMENTS			
Volatile Organic Compounds	Two 2-oz wide-mouth glass jars with Teflon lined lids	4°C	14 days
Semivolatile Compounds	8-oz wide-mouth glass jar with Teflon lined lid	4°C	7 days until extraction, 40 days after extraction
Metals	8-oz wide-mouth glass jar with Teflon lined lid	4°C	28 days for Hg, 6 months for others
TCLP, Reactivity, Corrosivity, Ignitability	16-oz wide-mouth glass jar		

Since early 1988, EPA sampling protocol has required VOA samples to be acidified to a pH <2. The pH of the samples will be adjusted to <2 by carefully adding 1:1 HCL drop by drop to the required 2 (40 ml) VOA sample vials. The number of drops of 1:1 HCL required will be determined on a third portion of sample water of equal volume. If acidification of the sample causes effervescence, the sample will be submitted without preservation except for cooling to 4°C.

DECONTAMINATION PROCEDURES

The following field equipment decontamination procedures will be used for all Teflon, stainless steel, or metal equipment used to collect samples for organic compounds or trace metals analyses:

1. Clean with tap water and a standard brand of phosphate-free detergent such as alconox or liquinox.

2. Rinse thoroughly with tap water.

3. Rinse thoroughly with deionized water.

4. Rinse twice with pesticide-grade isopropanol.

5. Rinse thoroughly with organic-free water and allow to air dry.

6. Wrap with aluminum foil to prevent contamination if equipment is stored or transported.

All auger flights, auger bits, drilling rods, drill bits, hollow stem augers, split-spoon samplers, shelby tubes, and other parts of the drilling equipment that will contact the soil, waste, and groundwater, will be steam-cleaned. A decontamination pad will be designated at the site for all steam cleaning activities. Fluids will be contained in a sump dug in a corner of the lined pad and pumped periodically into DOT-approved 55-gallon drums. Disposal of these containerized liquids are outlined in Chapter 4 of the RFI work plan.

The following cleaning procedure will be used to clean field equipment, i.e., water level indicator, bladder pumps, and any hoses used to purge groundwater wells:

1. Wash with phosphate-free detergent and tap water.

2. Rinse with tap water.

3. Rinse with deionized water.

4. Place equipment in a polyethylene bag or wrap with polyethylene film to prevent contamination during storage or transport as appropriate.

All personnel wash and rinse water will be placed in the decontamination pad sump and handled with those liquids. Disposable clothing and gloves will be placed in garbage bags and disposed of as outlined in the RFI work plan.

FIELD NOTEBOOKS

Field notebooks will be used to record general data collection activities performed by field personnel during the RFI. Entries will be in waterproof ink and written in sufficient detail so that a history of the sampling event can be reconstructed with minimum reliance on memory.

Field notebooks to be used will be bound field survey books. Notebooks will be assigned to all field personnel.

After project completion these documents will be in the custody of the Field Manager. Each notebook will be identified by the project-specific number. Pages will be numbered.

The cover of the notebook will indicate:

- Person or organization to whom book is assigned
- Book number
- Project name
- Start date
- End date

Notebook entries will contain a variety of information. At the beginning of each daily entry field personnel will record the date, start time, and current weather. Names of field personnel present, the level of personal protection being used onsite, the names of visitors to the site, and the purpose of their visit will be recorded. Difficulties, accidents, incidents, or deviations from the work plan will also be recorded and explained in the notebook. The bottom of each page will be signed by the person making entries. Each line on a page should be used or, if not used, should be crossed out, signed, and dated.

The person making entries will initial the entries. Corrections will be made by drawing a single line through the error and initialing and dating the correction. Information may not be erased or rendered unreadable. Wherever sample/data collection is recorded in the field notebook, a detailed description of the location of the station will be recorded.

Equipment used by field personnel to make measurements will be identified along with the data of last calibration. Any equipment used by field personnel to collect samples will also be noted, along with the time of sampling and all field parameters measured. All pages of the field notebooks will be photocopied and included in an appendix of the RFI final report.

Section 6
SAMPLE CUSTODY

During the RFI, samples will be collected for the purposes of defining the presence or absence of contamination. For this reason, the possession of samples must be traceable from the time the samples are collected until they are analyzed. Chain-of-custody procedures are used to maintain and document sample possession during collection and analysis. The principal documents used to identify samples and to document possession are:

- Sample labels
- Chain-of-custody record forms
- Air bills (e.g., Federal Express, Purolator, etc.)
- Field notebooks

SAMPLE LABELS

Samples will be identified by a unique number as soon as the sample is obtained. Labels will be attached to each sample container. The label will contain at a minimum the following information:

- Project name
- Boring designation
- Medium, e.g., soil
- Identification number
- Date and time of sample collection
- Name of sample collector

CHAIN OF CUSTODY

Before a sample is removed from the sample location and transferred to the laboratory for analysis, it will be preserved if required in accordance with prescribed procedures, and each will be identified with a separate chain- of- custody form shown by Figure 6-1.

DEFINITION OF CUSTODY

A sample is under custody if one or more of the following criteria is met:

- It is in the sample collector's possession.

- It is in the sample collector's view, after being in the person's possession.

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CHAIN OF CUSTODY RECORD

PROJECT NUMBER	PROJECT NAME
LABORATORY	

STA. NO.	DATE	TIME	COMP	GRAB	SAMPLE IDENTIFICATION	NUMBER OF CONTAINERS											REMARKS

SAMPLED BY AND TITLE *(SIGNATURE)*	DATE/TIME	RELINQUISHED BY: *(SIGNATURE)*	DATE/TIME	RECEIVED BY: *(SIGNATURE)*
RELINQUISHED BY: *(SIGNATURE)*	DATE/TIME	RECEIVED BY: *(SIGNATURE)*	RELINQUISHED BY: *(SIGNATURE)*	DATE/TIME	RECEIVED BY LAB: *(SIGNATURE)*

REMARKS

SAMPLE SHIPPED VIA ☐ UPS ☐ BUS ☐ FEDERAL EXPRESS

AIR BUS BILL NUMBER

DISTRIBUTION: WHITE — ORIGINAL ACCOMPANIES SHIPMENT, PINK — COPY TO COORDINATOR FIELD FILES, YELLOW — CLIENT

FORM 340

Figure 6-1
CHAIN OF CUSTODY RECORD FORM
Sun Marketing Refinery
RCRA Facility Investigation

- It was in the sample collector's possession and then safeguarded to prevent gross contamination.

- It is in a designated secure area.

FIELD CUSTODY PROCEDURES

The field sampler is personally responsible for the care and custody of the samples collected until they are transferred or dispatched properly under chain-of-custody procedures. Field custody procedures include:

- Collect only enough sample volume to provide a good representation of the media being sampled. The quantity and types of samples and sample locations are outlined in Section 5. As few people as possible should handle samples.

- Record the following information on the chain- of- custody form:

  - Project name
  - Identification number
  - Time, date, location, and depth of sample
  - Type of analysis requested
  - Sample preservation if used
  - Signature of person relinquishing/receiving sample

TRANSFER OF CUSTODY AND SHIPMENT

All shipments are accompanied by the Chain-of-Custody Record identifying its contents. The original record accompanies the shipment; the pink copy is retained by the FM. When transferring samples, the individuals relinquishing and receiving sign, date, and note the time on the record. This record documents sample custody transfer from the sampler, often through another person, to the analyst in the offsite laboratory.

Shipping containers are sealed for shipment to the laboratory. The method of shipment, courier name(s), and other pertinent information are entered in the "Remarks" section of the Chain-of-Custody Record.

LABORATORY CUSTODY PROCEDURES

A designated sample custodian will accept custody of the shipped samples and will verify that the identification numbers on the container labels match that on the chain-of-custody record form. The custodian will also verify that custody seals on the sample shipment containers are intact. The custodian will then enter the identification numbers into a bound logbook.

The laboratory custodian will then use either the identification number or will assign a unique laboratory number to each sample and will ensure that all samples are transferred to the proper analyst or stored in the appropriate secure area.

The custodian will distribute the samples to the appropriate analysts. Laboratory personnel are responsible for the care and custody of samples from the time they are received until the sample is exhausted or returned to the custodian.

When sample analyses and necessary QA checks have been completed, the unused portion of the sample must be disposed of properly. All identifying stickers, data sheets, and laboratory records will be retained as part of the permanent documentation.

SAMPLE DISPOSAL

Unless otherwise instructed, the analytical laboratory will dispose of unused sample portions, according to Resource Conservation and Recovery Act (RCRA) regulations, after the analyses have been completed and any outstanding issues between the contractor and the laboratory have been resolved.

Section 7
EQUIPMENT CALIBRATION

During the RFI, field measurements will be taken with the following equipment: pH meter, an HNu, a conductivity meter, and a dissolved oxygen meter.

FIELD EQUIPMENT CALIBRATION

Calibration procedures for the equipment to be used in the field (described above) are reported in Attachment A of this DCQAP.

If an individual suspects an equipment malfunction, the device shall be removed from service, tagged so that it is not inadvertently used, and the CH2M HILL equipment manager notified so that a substitute piece of equipment can be used. Back-up equipment will be available in the field for use in the event of a malfunction.

Equipment that fails calibration or becomes inoperable during use shall be removed from service and either segregated to prevent inadvertent use or tagged to indicate it is out of calibration. Such equipment shall be repaired and satisfactorily recalibrated. Equipment that cannot be repaired will be replaced.

Results of activities performed using equipment that has failed recalibration shall be evaluated. If the results are adversely affected, the outcome of the evaluation will be documented and the PM notified.

LABORATORY CALIBRATION

Laboratory calibration procedures and frequency of calibration are specified in the Standard Operating Procedures (SOP) of CH2M HILL's laboratory described in the *Quality Assurance Manual*, CH2M HILL SOUTHEAST, INC., Environmental Laboratory, June, 1990.

Section 8
ANALYTICAL PROCEDURES

Samples will be analyzed for compounds shown in Tables 8-1 and 8-2 using U.S. EPA approved analytical methods reported in *Test Methods for Evaluating Solid Wastes*, U.S. EPA SW846, Third Edition, December 1986; Standard Methods, 17th Edition; and for TCL and TAL parameters, the Contract Laboratory Program (CLP) Statement of Work (SOW), which was originally designed for CERCLA. Specific analytical methods are listed in Table 2-1, Table 2-2, and Attachment B. The PQLs for the individual compounds are also listed in Attachment B.

In order to achieve the data quality objectives identified in Section 4, three analytical levels, levels I, III, and IV, will be used during the RFI. These levels are described below:

- Level I--This is a screening level providing the lowest data quality but with the fastest results. An HNu will be used for Level I analysis.

- Level II--This analytical level also provides fast results with a better quality of data than Level I. Level II analysis will not be used during the RFI.

- Level III--This level of analysis is typically used for parameters relevant to the design of the corrective measure. Level III analysis during the RFI will consist of analysis of the geotechnical parameters--moisture content, bulk density, Atterberg limits, grain size distribution, and vertical permeability.

- Level IV--This level of analysis provides the highest level of quality data. The Skinner's list of compounds shown in Tables 8-1 and 8-2 will be analyzed using Level IV analysis. For the TCL and TAL parameters at the Guard Basin, full documentation as required by EPA under the CLP SOW will be required.

Table 8-1
Modified Skinner List Parameters for Soil

Metals	**Base/Neutral Organics**
Antimony	Anthracene
Arsenic	Benzo(a)anthracene
Barium	Benzo(b)fluoranthene
Beryllium	Benzo(j)fluoranthene
Cadmium	Benzo(k)fluoranthene
Chromium	Benzo(a)pyrene
Cobalt	Bis(2-ethylhexyl)phthalate
Lead	Butyl benzyl phthalate
Mercury	Dibenzo(a,h)acridine
Nickel	Chrysene
Selenium	Dibenzo(a,h)anthracene
Silver	Di-n-butyl phthalate
Vanadium	o-Dichlorobenzene
	m-Dichlorobenzene
Volatile Organics	p-Dichlorobenzene
	Diethyl phthalate
Benzene	7,12-Dimethylbenz(a)anthracene
Carbon disulfide	Dimethyl phthalate
Chlorobenzene	Di-n-octyl phthalate
Chloroform	Fluoranthene
1,2-Dibromoethane	Indene
1,2-Dichloroethane	Methyl chrysene
1,4 Dioxane	1-Methylnaphthalene
Methyl ethyl ketone	Naphthalene
Ethyl benzene	Phenanthrene
Styrene	Pyrene
Toluene	Pyridine
Total xylenes	Quinoline
Acid Organics	
Benzenethiol	
o-Cresol	
meta- & para-Cresols	
2,4-Dimethylphenol	
2,4-Dinitrophenol	
4-Nitrophenol	
Phenol	

Table 8-2
Modified Skinner List Parameters for Groundwater

Parameters
Total Dissolved Solids
Specific Conductance
Chloride
Sulfate
Alkalinity, Total as $CaCO^3$ at pH 4.0
Alkalinity, Total as $CaCO^3$ at pH 4.5
Alkalinity, Bicarb as $CaCO^3$ at pH 4.5
Alkalinity, Carb. as $CaCO^3$ at pH 8.3
Alkalinity, Hydrox. as $CaCO^3$
Fluoride
pH
Ammonia
Nitrate plus Nitrate as N
Total Organic Carbon
Total Petroleum Hydrocarbons

Metals
Aluminum
Antimony
Arsenic
Barium
Beryllium
Cadmium
Calcium
Chromium
Cobalt
Iron
Lead
Magnesium
Mercury
Nickel
Phosphorus as P
Potassium
Selenium
Silver
Sodium
Vanadium

Acid Organics
Benzenethiol
o-Cresol
Meta- & para-Cresols
2,4-Dimethylphenol
2,4-Dinitrophenol
Phenol

Base/Neutral Organics
Anthracene
Benzo(a)anthracene
Benzo(b)fluoranthene
Benzo(k)fluoranthene
Benzo(a)pyrene
Bis(2-ethylhexyl)phthalate
Butyl benzyl phthalate
Chrysene
Dibenz(a,h)anthracene
Di-n-butyl phthalate
1,2-Dichlorobenzene
1,3-Dichlorobenzene
1,4-Dichlorobenzene
Diethyl phthalate
7,12-Dimethylbenzanthracene
Dimethyl phthalate
Di-n-octyl phthalate
Fluoranthene
Indene
1-Methylnaphthalene
Naphthalene
Phenanthrene
Pyrene
Pyridine
Quinoline

Volatile Organics
Benzene
Carbon disulfide
Chlorobenzene
Chloroform
1,2-Dibromoethane
1,2-Dichloroethane
1,4 Dioxane
Methyl ethyl ketone
Ethyl benzene
Styrene
Toluene
Total Xylenes

Section 9
DATA REDUCTION, VALIDATION, AND REPORTING

Data reduction, validation, and reporting are steps in the overall management and use of both field and laboratory data. Figure 9-1 shows the flow of information and sample tracking forms. The Data Management Plan is detailed in Chapter 5 of the RFI work plan.

DATA REDUCTION

DEFINITION

Data reduction frequently includes computation of summary statistics and their standard errors. To allow for data reduction, field and analytical data collected will be input into a computerized data base. All entries will be double-entered and verified. The sample manager will handle data entries that are unverified.

Units for sediment sample results will be reported in mg/kg and for water samples, mg/1.

DATA COLLECTION

The data collected at the site includes pH, temperature, conductivity, dissolved oxygen, etc. These data will be recorded in log books.

BACKGROUND DATA

Background data produced for internal records and not reported as part of the analytical data include the following: laboratory worksheets, laboratory notebooks, sample tracking system forms, instrument logs, standards records, maintenance records, calibration records, and associated quality control. These sources will be available for inspection during audits and to determine the validity of data.

DATA VALIDATION

CH2M HILL will conduct the validation of the analytical data in accordance with the most current versions of the EPA documents, *Laboratory Data Validation, Functional Guidelines for Evaluating Organic and Inorganic Analysis.*

Region III will be contacted to verify that the most current version is being used before conducting the data validation. The data validation personnel are familiar with the

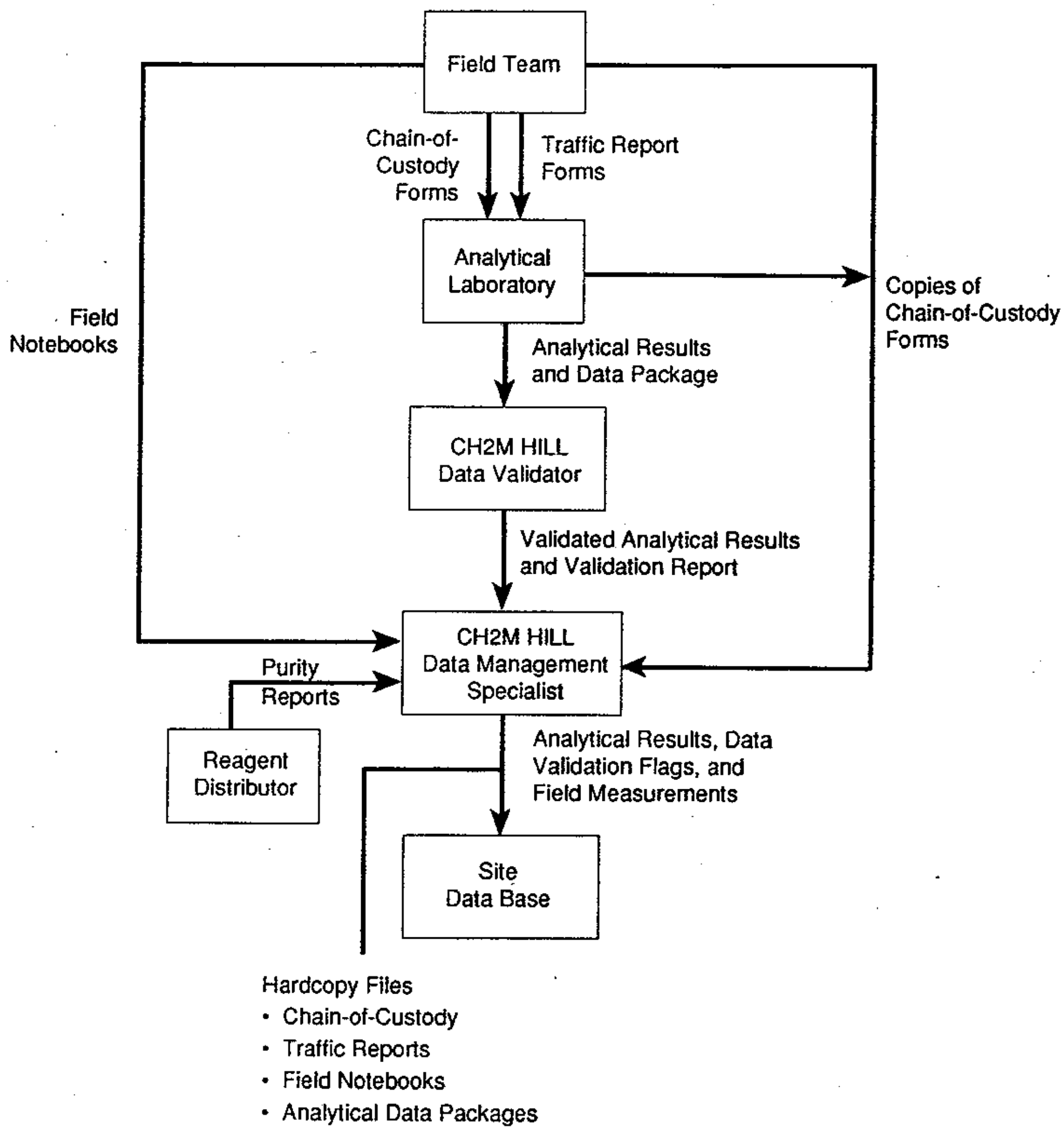

Figure 9-1
FLOW OF FORMS AND SAMPLE AND ANALYSIS INFORMATION
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Sun RFI, its objectives, and the intended use of the data. A data validation report using the format specified by the Region will be prepared.

REPORTING

CONTENTS OF REPORT

The laboratory report will contain such information for samples as:

- Title and location of the project
- Project identification number
- Name of the report
- Date report was prepared
- Name, address, and telephone number of the Subcontractor
- Sample identification number
- Name and location of sample
- Type of sample (water, soil, waste, air)
- Date on which analysis was performed
- Any special observations, circumstances, or comments that may be relevant for interpretation of the data
- The laboratory manager's signature

Each parameter tested will include: name of parameter, testing procedure references, results of analysis, and the units of the reported results.

RECORDS

The following describes procedures for maintaining the project's records:

- The PM shall maintain records in accordance with the requirements of this section until those records are turned over to Sun.

- Records of field activities that support the integrity of samples shall be entered on bound and numbered pages. Such records shall be dated and signed or otherwise authenticated on the day of entry.

- Records retained on file shall be indexed. The indexing system shall include the location of records within the indexing system. (The indexing system shall be in alphabetical, chronological or numerical order, or as otherwise indicated in written procedures).

- There shall be sufficient information in records to permit identification between the record and the item(s) or activity to which it applies. Identification of records will be by means that permit traceability.

- The records storage system shall provide for accurate retrieval of records without undue delay.

Section 10
QUALITY CONTROL CHECKS

A number of QA/QC samples will be collected to check the adequacy of sample collection and analysis and to monitor laboratory performance.

Duplicates, blanks, and spiked samples are used to test the sampling technique to determine if the technique affects the analytical results, to measure the internal consistency of the samples, and to estimate any variance or bias in the analytical process. The field and laboratory QA/QC sampling procedures are described below.

FIELD SAMPLING QUALITY CONTROL PROCEDURES

Several QA samples will be collected to confirm the reliability and validity of the field data gathered during the RFI. Replicate (duplicate) samples are used to provide a measure of the internal consistency of the samples and an estimate of variance and bias. Blanks provide a measure of cross-contamination sources, decontamination efficiency, and other potential errors that can be introduced from sources other than the sample. Table 4-2 shows the collection frequencies of the field QC samples.

REPLICATE/DUPLICATE SAMPLES

One field replicate (duplicate) sample will be obtained for every 10 field samples collected. The sampling station from which the duplicate is taken will be randomly selected for each event. Each replicate sample will be split evenly into two sample containers and submitted for analysis as two independent samples.

FIELD BLANKS

Field blank samples will consist of deionized contaminant-free water and be handled in the same manner as the regular samples. One such blank will be collected for each sampling event (sampling event is defined as duration of a specific set of field tasks, such as a one-week period of monitor well drilling and installation).

TRIP BLANKS

A trip blank is a 40-ml glass vial filled with Type II reagent grade water. The trip blanks will be supplied by the laboratory and accompany the analytical samples back to the laboratory and are handled like a sample. One trip blank will be submitted with each day's analytical samples that are shipped offsite for analysis of volatile organic compounds.

EQUIPMENT BLANK

One equipment (rinsate blank) will be included with each daily shipment of samples for each media sampled. These blanks will be collected in the field to identify errors, such as contamination resulting from poor sampling techniques. After sample collection equipment is decontaminated, it will be rinsed with distilled, deionized water and the rinsate will be collected, packed, and shipped with the other samples.

LABORATORY ANALYTICAL QUALITY CONTROL PROCEDURES

The analytical laboratory will use all of the quality control elements as specified by the EPA Contract Laboratory Program, including matrix spikes, duplicates, and laboratory blanks.

MATRIX SPIKES AND DUPLICATES

Matrix Spike will be spiked with the analyte being analyzed for two separate aliquots of a sample selected for a batch of 18 field samples. The MS/MSD and 18 field samples will consist of a batch of 20 samples. The MS/MSD results will be used to assess accuracy and precision. The MSD is not required for inorganic analysis.

The MSD is a sample identical to the MS which is analyzed to determine reproducibility of results.

Laboratory Blanks

For each extraction batch, a method blank will be analyzed to check on any background contamination for the laboratory.

Method blanks will be analyzed for background contamination from the laboratory as specified by the manual.

Section 11
PERFORMANCE AND SYSTEMS AUDITS

The audits will cover, in general, verification that approved procedures are used, personal responsibilities are clearly defined, a COC program and records retention program are in place, and corrective action of variances taken by personnel is responsive and timely.

LABORATORY PERFORMANCE AND SYSTEMS AUDITS

The analytical laboratory will conduct both internal and external quality control checks. External quality control checks include participation in EPA's certification programs in which laboratories analyze QC samples of known concentrations received from EPA. CH2M HILL's laboratory schedule for conducting audits is outlined in the *Quality Assurance Manual*, June, 1990.

FIELD TEAM PERFORMANCE AND SYSTEMS AUDITS

A performance audit will be conducted by the PM and FM during the first week of sampling to verify that proper procedures are followed and that subsequent sample data will be valid. The audit will focus on the details of the QA program. The audit checklist, which will serve as the guide for the performance audit for field procedures, is shown in Figure 11-1. The audit will evaluate the organization of responsibilities to determine whether the QA organization is operational, as well as verify whether or not the following is taking place:

- The quality assurance organization is operational
- Collection of samples followed the available written procedures
- COC procedures are followed for traceability of sample origin
- Specified equipment was available, calibrated, and in proper working order
- Sampling crews were adequately trained
- Recordkeeping procedures were followed; field notebooks, logsheets, bench sheets, and tracking forms are properly prepared and maintained
- Corrective action procedures are followed

An audit report summarizing any results and corrections will be prepared and filed in the project files. Significant variances from established procedures will be reported to the Sun.

Figure 11-1
FIELD PERFORMANCE AND AUDIT CHECKLIST

Project Responsibilities

Project No.: ____________________ Date: ____________________

Project Location: ____________________ Signature: ____________________

Team Members: ____________________

Yes ___ No ___ 1) Was a DCQAP prepared?
Comments ____________________

Yes ___ No ___ 2) Was a briefing held for project participants?
Comments ____________________

Yes ___ No ___ 3) Were additional instructions given to project participants?
Comments ____________________

Sample Collection

Yes ___ No ___ 1) Is there a written list of sampling locations and descriptions?
Comments ____________________

Yes ___ No ___ 2) Were samples collected as stated in the DCQAP?
Comments ____________________

Yes ___ No ___ 3) Were samples collected in the types of containers specified in the DCQAP?
Comments ____________________

Yes ___ No ___ 4) Was sample equipment available, calibrated, and in proper working order?
Comments ____________________

Yes ___ No ___ 5) Were samples preserved as specified in the DCQAP?
Comments ____________________

Yes ___ No ___ 6) Were the numbers, frequency, and types of samples collected as specified in the DCQAP?
Comments ____________________

Yes ___ No ___ 7) Were quality assurance checks performed as specified in the DCQAP?
Comments ____________________

Yes ___ No ___ 8) Were photographs taken and documented as specified in the DCQAP?
Comments ____
____
____

Document Control

Yes ___ No ___ 1) Have any accountable documents been lost?
Comments ____
____
____

Yes ___ No ___ 2) Have any accountable documents been voided?
Comments ____
____
____

Yes ___ No ___ 3) Have any accountable documents been disposed of?
Comments ____
____
____

Yes ___ No ___ 4) Are the samples identified with sample tags?
Comments ____
____
____

Yes ___ No ___ 5) Are blank and duplicate samples properly identified?
Comments ____
____
____

Yes ___ No ___ 6) Are samples listed on a chain-of-custody record?
Comments ____
____
____

Yes ___ No ___ 7) Is chain-of-custody documented and maintained?
Comments ____
____
____

Section 12
PREVENTIVE MAINTENANCE

Routine maintenance procedures and schedules for sampling equipment are described in the manufacturers' instruction manuals. All records of inspection and maintenance will be dated and documented in the field notebook.

Maintenance procedures and schedules for all field and laboratory analytical instruments will be in strict accordance with the recommendations of the equipment manufacturers. Routine maintenance will be performed by laboratory personnel as needed. All records of inspection and maintenance will be dated and documented in laboratory record books.

Critical spare parts for the pH and conductivity meters include batteries and electrodes; they will be included in the sampling kits to minimize downtime.

Section 13
DATA ASSESSMENT PROCEDURES

The precision and accuracy of data will be routinely assessed to ensure that they meet the requirements of the DQOs presented in Table 4-1. If enough data are generated, the precision, accuracy, and completeness may be assessed using statistical procedures.

Precision is commonly determined from duplicate samples; thus, precision is usually expressed as RPD or relative standard deviation (RSD). These quantities are defined as follows.

$$RPD = 100 \times 2 \frac{X_1 - X_2}{(X_1 = X_2)}$$

$$RSD = (100/\sqrt{2}) \times [2\ (X_1 - X_2)\ (X_1 + X_2)]$$

where X_1 and X_2 are the reported concentrations for each duplicate sample

Accuracy is commonly presented as percent bias or percent recovery. Percent bias is a standardized average error; that is, the average error divided by the actual or spiked concentration and converted to a percentage. Percent bias is unitless, so it allows the accuracy of analytical procedures to be compared easily.

Percent recovery provides the same information as percent bias. Accuracy is often determined from spiked samples. Percent recovery is defined as:

$$\%\ Recovery = \frac{R}{S} \times 100$$

where S = spiked concentration
R = reported concentration

Given this definition it can be shown that

% bias = % recovery - 100

Section 14
CORRECTIVE ACTIONS

The PM is responsible for initiating project corrective actions. Corrective action steps will include problem identification, investigation responsibility assignment, investigation, action to eliminate the problem, increased monitoring of the effectiveness of the corrective action, and verification that the problem has been eliminated.

Documentation of the problem is important to the overall management of the study. A Corrective Action Request Form for problems associated with sample collection, shown in Table 14-1, will be completed by the person discovering the QA problem. This form identifies the problem, establishes possible causes, and designates the person responsible for action. The responsible person will be either the FM or CH2M HILL's designated field QC officer.

The Corrective Action Request Form includes a description of the corrective action planned and has space for follow-up. The field QC officer will verify that initial action has been taken and appears to be effective and, at an appropriate later date, check to see if the problem has been fully resolved. The field QC officer receives a copy of all Corrective Action Request Forms and enters them into the Corrective Action Log. This permanent record will aid the field QC officer in follow-up and will assist in resolving quality assurance problems with the PM.

For the CH2M HILL laboratory, corrective action procedures are required as the result of nonconformance with QA/QC criteria or audit results. The first level of responsibility lies with the staff. The analysts will monitor performance and take actions as necessary. Documentation of nonconformance will be achieved by recording the circumstances in the daily logbook; successes and failures in corrective actions will be recorded as well. The laboratory operations manager will be notified in all cases. The second level of responsibility lies with the data reviewer as described in Section 9.0.

Examples of corrective actions include, but are not limited to, correcting COC forms, analysis reruns (if holding time criteria permit), recalibration with fresh standards, replacement of sources of blank contamination, examination of calculation procedures, reassignment of analytical responsibilities using a different batch of containers, or recommending an audit of laboratory procedures. An additional approach may be to accept the data and acknowledge the level of uncertainty or inaccuracy by flagging the data and providing an explanation for the qualification.

Figure 14-1
CORRECTIVE ACTION REQUEST FORM
(Sample Collection)

Originator: ______________________ Date ______________________

Person responsible for replying: ______________________

Description of problem and when identified: ______________________

____

____

____

____

State cause of problem, if known or suspected: ______________________

____

____

____

Sequence of Corrective Action (CA): (If no responsible person is identified, submit this form directly to the field QC officer.)

State date, person, and action planned:

____

____

____

____

____

____

____

CA initially approved by: ______________________ Date: ______________________

Follow-up date: ______________________

Final CA approval by: ______________________ Date: ______________________

Information copies to:

RESPONSIBLE PERSON: ______________________

Field QC Officer: ______________________

PM: ______________________

Section 15
QUALITY ASSURANCE REPORTS

A QA report will be completed at the end of the field activity to summarize the QA/QC status of the project and any problems. The report will be an assessment of the measured QA parameters; for example, precision, accuracy, and results of performance audits; any reported non-conformance; and any significant QA problems and the recommended solutions. Any change in the DCQAP will be summarized in a report or letter and sent to SUN and distributed to the CH2M HILL project team.

For this project, no separate report is anticipated to describe the QA/QC achieved. The final project report will contain separate QA sections that summarize QA/QC information generated during the course of the project.

Attachment A

STANDARD OPERATING PROCEDURES

1. Field Measurement of pH
2. Field Measurement of Specific Conductance and Temperature
3. Dissolved Oxygen Meter Monitoring
4. HNu Monitoring

SOP NO. 1: FIELD MEASUREMENT OF pH

I. PURPOSE

To provide a general guideline for field measurement of pH.

II. SCOPE

Standard field pH determination techniques for use on groundwater samples.

III. EQUIPMENT AND MATERIALS

- o pH buffer solution for pH 4, 7, and 10
- o Deionized water in squirt bottle
- o pH meter
- o Combination electrodes
- o Beakers
- o Glassware that has been washed with soap and water, rinsed twice with hot water, and rinsed twice with deionized water

IV. PROCEDURES AND GUIDELINES

A. CALIBRATION

Calibrate unit prior to initial daily use and at least once every 4 hours or every five samples, whichever is less. Calibrate with at least two solutions. Clean probe according to manufacturer's recommendations. Duplicate samples should be run once every 10 samples or every 4 hours.

1. Place electrode in pH 7 buffer solution.

2. Allow meter to stabilize and then turn calibration dial until a reading of 7.0 is obtained.

3. Rinse electrode with deionized water and place it in a pH 4 or pH 10 buffer solution.

4. Allow meter to stabilize again and then turn slope adjustment dial until a reading of 4.0 is obtained for the pH 4 buffer solution or 10.0 for the pH 10 buffer solution.

5. Rinse electrode with deionized water and place in pH 7 buffer. If meter reading is not 7.0, repeat sequence.

B. PROCEDURE

1. Before going out into the field:

   a) Check batteries.

   b) Do a quick calibration at pH 7 and 4 to check electrode.

   c) Obtain fresh solutions.

2. Calibrate meter using calibration procedure.

3. Pour the sample into a clean beaker.

4. Rinse electrode with deionized water between samples.

5. Immerse electrode in solution. Make sure the white KCl junction on the side of the electrode is in the solution. The level of electrode solution should be one inch above sample to be measured.

6. Recheck calibration with pH 7 buffer solution after every five samples.

C. GENERAL

1. When calibrating the meter, use pH buffers 4 and 7 for samples with pH <8, and buffers 7 and 10 for samples with pH >8. If meter will not read pH 4 or 10, something may be wrong with the electrode.

2. Measurement of pH is temperature dependent. Therefore, buffers temperatures should be within about 2 degrees C of sample temperatures. For refrigerated or cool samples, use refrigerated buffers to calibrate the pH meter.

3. Weak organic and inorganic salts and oil and grease interfere with pH measurements. If oil and grease are visible, note it on the data sheet. Clean electrode with soap and water and rinse with distilled water. Then recalibrate meter.

4. Following field measurements:

   a) Report any problems.
   b) Compare with previous data.
   c) Clean all dirt off meter and inside case.
   d) Store electrode in pH 4 buffer.

5. Accuracy and precision are dependent on the instrument used; refer to manufacturer's manual. Expected accuracy and precision are +/- 0.1 pH unit.

V. ATTACHMENTS

pH meter calibration sheet

VI. KEY CHECKS AND ITEMS

- o Check batteries
- o Calibrate

VII. PREVENTIVE MAINTENANCE

- o Refer to operation manual for recommended maintenance.
- o Check batteries, have a replacement set on hand.

pH METER CALIBRATION SHEET

			Instrument Readings				
			Uncalibrated (Two Required)		Calibrated (Two Required)		
Date	Time	Analyst Initials	@pH4	@pH7	@pH4	@pH7	Comments

SOP NO. 2: FIELD MEASUREMENT OF SPECIFIC CONDUCTANCE AND TEMPERATURE

I. PURPOSE

To provide a general guideline for field measurement of specific conductivity and temperature.

II. SCOPE

Standard field conductivity and temperature techniques for use on groundwater samples.

III. EQUIPMENT AND MATERIALS

- o Conductivity meter and electrode
- o Distilled water in squirt bottle
- o Standard potassium chloride (KCl) solution (0.01 N)

IV. PROCEDURES AND GUIDELINES

TECHNICAL: Detection limit = 1 umho/cm @ 25°C; range = 0.1 to 100,000 umho/cm

CALIBRATION

Calibrate prior to initial daily use and at least once every 4 hours or every five samples, whichever is less. Calibrate with standard solution. The standards should have different orders of conductance. Clean probe according to manufacturer's recommendations. Duplicates should be run once every 10 samples or every 4 hours.

1. With mode switch in OFF position, check meter zero. If not zeroed, set with zero adjust.

2. Plug probe into jack on side of meter.

3. Turn mode switch to red line and turn red line knob until needle aligns with red line on dial. If they cannot be aligned, change the batteries.

4. Immerse probe in 0.01 N standard KCl solution. Do not allow the probe to touch the sample container.

5. Set the mode control to TEMPERATURE. Record the temperature on the bottom scale of the meter in degrees C.

6. Turn the mode switch to appropriate conductivity scale (i.e., x100, x10, or x1). Use a scale that will give a midrange output on the meter.

7. Wait for the needle to stabilize. Multiply reading by scale setting and record the conductivity. The conductivity must then be corrected for temperature.

8. Calculate conductivity using the formula:

$$G_{25} = G_T / [1 + 0.02 (T - 25)]$$

Where:

G_{25} = conductivity at 25°C, umho/cm
T = temperature of sample, degrees C
G_T = conductivity of sample at temperature T, umho/cm

The table below lists the values of conductivity the calibration solution would have if the distilled water were totally nonconductive, however, even water of very high purity will still possess a small amount of conductivity.

Temperature °C	Conductivity (umho/cm)
15	1,141.5
16	1,167.5
17	1,193.6
18	1,219.9
19	1,246.4
20	1,273.0
21	1,299.7
22	1,326.6
23	1,353.6
24	1,380.8
25	1,408.1
26	1,436.5
27	1,463.2
28	1,490.9
29	1,518.7
30	1,546.7

9. Rinse the probe with deionized water.

10. Run sample and rinse with deionized water when done.

V. ATTACHMENTS

Conductivity meter calibration sheet

VI. KEY CHECKS AND ITEMS

- o Check battery.
- o Calibrate.
- o Clean probe with deionized water when done.
- o When reading results, note sensitivity settings.

VII. PREVENTIVE MAINTENANCE

- o Refer to operations manual for recommended maintenance.
- o Check batteries, and have a replacement set on hand.

CONDUCTIVITY METER CALIBRATION SHEET

Date	Time	Analyst Initials	Instrument Readings: Uncalibrated @EC=225	Instrument Readings: Calibrated @EC=225	Comments

SOP NO. 3: DISSOLVED OXYGEN METER MONITORING

I. PURPOSE

To provide general guidelines for the calibration and use of the Dissolved Oxygen (DO) meter.

II. SCOPE

This is a general guideline for the field use of a DO meter. For specific instructions, refer to the operations manual.

III. EQUIPMENT AND MATERIALS

- o Operations manual
- o A DO probe and readout/control unit with batteries
- o Electrolyte solution (KCl dissolved in deionized water) and probe membrane

IV. PROCEDURES AND GUIDELINES

A. CALIBRATION

Calibrate prior to initial daily use before any readings are taken. Clean probe according to manufacturer's recommendations.

1. Prepare DO probe according to manufacturer's recommended procedures using electrolyte solution.
2. In the off position, set the pointer to zero using the screw in the center of the meter panel.
3. Turn function switch to red line and adjust using red line knob until the meter needle aligns with red mark at the 31 degrees C position.
4. Turn function switch to zero and adjust to zero using the zero control knob.
5. Attach prepared probe and adjust retaining ring finger tight.

6. Allow 15 minutes for optimum probe stabilization (when meter is off or during disconnection of the probe).

7. Place probe in hollow stopper that is supplied for use with the YSI Calibration Chamber.

8. Place approximately 1/2 inch of deionized water into a 4-ounce, wide mouth screw cap bottle. Keep this bottle capped and with the DO meter.

9. Just before use, shake the bottle to saturate the water with air.

10. Remove cap, place probe in bottle keeping an air-tight seal around the rubber stopper. Swirl water around in the bottle while waiting for conditions to reach equilibrium.

11. Shield chamber from sun and wind to avoid temperature fluctuations during calibration.

12. Turn function switch to temperature and record temperature reading. Determine calibration factor for that temperature and altitude correction factor from tables supplied by manufacturer.

13. Multiply the calibration factor by the correction factor to get a corrected calibration value.

14. Turn function switch to appropriate ppm range and adjust the calibrate knob until the meter reads the corrected calibration value. Wait two minutes to verify calibration value. Readjust as necessary.

B. PROCEDURE

1. Before going out into the field:

   a) Check batteries

   b) Obtain fresh electrolyte solution

   c) Prepare DO probe

2. Calibrate meter using calibration procedure.

3. Place probe in water to be measured. In a stream (1 ft/sec or greater), the probe should be placed at mid depth in the main thread of flow. If the stream is not flowing at 1 ft/sec, the probe should be moved through the water at this velocity or use a probe with a built-in stirrer.

4. Allow sufficient time for probe to stabilize to water temperature and DO. Record DO meter reading.

V. ATTACHMENTS

DO meter calibration sheet

VI. KEY CHECKS AND ITEMS

- o Battery check
- o Calibration

VII. PREVENTIVE MAINTENANCE

- o Refer to operation manual for recommended maintenance.
- o Check batteries, have replacement set on hand.

DO METER
CALIBRATION SHEET

Date	Time	Analyst's Signature	Temp (C)	Alt. (ft)	Predict (ppm O_2)	Actual (ppm O_2)	Comment

RAYMK2/015.50

SOP NO. 4: HNu MONITORING

I. PURPOSE

To provide general guidelines for the calibration and use of the HNu photoionization detector.

II. SCOPE

This is a broad guideline for the field use of an HNu. For specific instructions, refer to the operations manual.

III. EQUIPMENT AND MATERIALS

- o Operations manual
- o An HNu readout/control unit and photoionization probe (either 10.2 or 11.7 eV depending on requirements) with fully charged battery pack
- o Charging unit
- o A cylinder of calibration gas, typically 100 ppm isobutylene in air
- o A regulator for the calibration gas cylinder
- o A short length of 1/8th-inch tube to transfer calibration gas from the cylinder to the HNu probe (as short as possible)

IV. PROCEDURES AND GUIDELINES

ONLY PROPERLY TRAINED PERSONNEL SHOULD USE THIS INSTRUMENT. FOR SPECIFIC INSTRUCTIONS, SEE OPERATIONS MANUAL.

A. CALIBRATE THE HNu

1. Identify the probe by lamp model.
2. Connect the sensor/probe to the readout/control unit.
3. Perform a battery check by turning the function switch to "Batt."
4. Turn function switch to "Standby" and set the readout to zero by turning the zero knob.

5. Hold the sensor/probe to your ear to verify that it is powered. A faint humming sound will be heard.

6. Set the range to the appropriate setting.

7. Connect the tube from the calibration gas cylinder to the end of the probe and open the valve on the calibration gas cylinder.

8. Sample the calibration gas and adjust to the proper reading with the span control knob.

9. If calibration cannot be achieved, disassemble the sensor/probe assembly and clean lamp. If the span knob setting is at the end of the span range, unit must be serviced by qualified personnel.

B. SAMPLING WITH THE HNu

1. Once calibration is complete, unit is ready for sampling. When not in use, set function knob to "Standby."

2. When done for the day, turn unit off and disconnect the sensor/probe.

3. Charge the battery overnight (complete recharge takes 14 hours).

4. For preventive maintenance, refer to instruction manual.

V. ATTACHMENTS

HNu calibration sheet

VI. KEY CHECKS AND ITEMS

- o Check battery.
- o Zero and calibrate.
- o Verify sensor probe is working.
- o Recharge unit after use.

VII. PREVENTIVE MAINTENANCE

A complete preventive maintenance program is beyond the scope of this document. For specific instructions, refer to the operations manual.

- o A complete spare HNu should be available on site whenever field operations require this instrument.
- o A spare lamp should be on hand so a defective unit can be changed without returning the unit.
- o Occasional cleaning of the lamp should be performed as needed.
- o Charge batteries daily.
- o Occasionally allow the batteries to totally discharge before recharging to prevent battery memory from occurring.

HNu CALIBRATION SHEET

Date	Time	Analyst Initials	Uncalibrated @10 ppm	Calibrated @10 ppm	Comments

Attachment B

INORGANICS

HAZARDOUS CONSTITUENT	CAS NO.	TCL	PPL	APP IX	HBN SOIL mg/kg	HBN WATER mg/l	PQL SOIL mg/kg	PQL WATER mg/l	SUGGESTED METHOD
Aluminum phosphide (as Al)	20859-73-8				3E+1	1E-2	2E+1	5E-1	6010
Antimony	7440-36-0	X	X	X	3E+1	5E-3	2E+1	3E-2	6010(s) 7041(w)
Arsenic	7440-38-2	X	X	X	4E-1	5E-2	3E+1	1E-2	6010(s) 7060(w)
Barium	7440-39-3	X		X	1E+3	5E 0	1E 0	2E-2	6010
Beryllium	7440-41-7	X	X	X	2E-1	1E-3	2E-1	3E-3	6010
Cadmium	7440-43-9	X	X	X	2E 0	5E-3	2E 0	1E-3	6010(s) 7131(w)
Chromium	7440-47-3	X	X	X	3E-1	1E-1	4E 0	1E-2	6010(s) 7191(w)
Lead	7439-92-1	X	X	X	1.5E+2	5E-2	2E+1	1E-2	6010(s) 7421(w)
Mercury	7439-97-6	X	X	X	2E+1	2E-3	1E-1	2E-3	7470
Nickel	7440-02-0	X	X	X	1E+3	1E-1	8E 0	2E-1	6010
Selenium	7782-49-2	X	X	X	2E+2	5E-2	4E+1	2E-2	6010(s) 7740(w)
Silver	7440-22-4	X	X	X	2E+2	5E-2	4E 0	2E-3	6010(s) 7761(w)
Thallium	7440-28-0	X	X	X	6E 0	1E-3	2E+1	1E-2	6010(s) 7870(w)
Vanadium	7440-62-2	X		X	1E+3	3E-1	4E 0	8E-2	6010
Zinc	7440-66-6	X	X	X	1E+3	7E 0	1E 0	2E-2	6010
Cyanide (amenable)	57-12-5				1E+3	2E-1	4E-2	4E-2	9010

DIOXINS & DIBENZOFURANS

HAZARDOUS CONSTITUENT	CAS NO.	TCL	PPL	APP IX	HBN SOIL mg/kg	HBN WATER mg/l	PQL SOIL mg/kg	PQL WATER mg/l	SUGGESTED METHOD
2,3,7,8-TCDDioxin	1746-01-6			X	4E-6	5E-8	2E-3	1E-5	8280
2,3,7,8-PeCDDioxins				X	8E-6	1E-7	2E-3	1E-5	8280
2,3,7,8-HxCDDioxins				X	4E-5	5E-7	2E-3	1E-5	8280
2,3,7,8-HpCDDioxins					4E-4	5E-6	2E-3	1E-5	8280
OCDDioxins	3268-87-9				4E-3	5E-5	2E-3	1E-5	8280
2,3,7,8-TCDFuran	51207-31-9			X	4E-5	2E-9	2E-3	1E-5	8280
1,2,3,7,8-PeCDFuran				X	8E-5	4E-9	2E-3	1E-5	8280
2,3,4,7,8-PeCDFuran	57117-31-4			X	8E-6	4E-10	2E-3	1E-5	8280
2,3,7,8-HxCDFurans				X	4E-5	2E-9	2E-3	1E-5	8280
2,3,7,8-HpCDFurans					4E-4	2E-8	2E-3	1E-5	8280
OCDFurans					4E-3	2E-7	2E-3	1E-5	8280

PESTICIDES & PCB'S

HAZARDOUS CONSTITUENT	CAS NO.	TCL	PPL	APP IX	HBN SOIL mg/kg	HBN WATER mg/l	PQL SOIL mg/kg	PQL WATER mg/l	SUGGESTED METHOD
Aldrin	309-00-2	X	X	X	4E-2	2E-6	3E-3	4E-5	8080
Aramite	140-57-8			X	3E+1	1E-3	7E-1	2E-2	8270
alpha-BHC *syn.* alpha-Hexachlorocyclohexane	319-84-6	X	X	X	1E-1	6E-6	2E-3	3E-5	8080
beta-BHC *syn* beta-Hexachlorocyclohexane	319-85-7	X	X	X	4E-1	2E-5	4E-3	6E-5	8080
gamma-BHC *syn.* Lindane	58-89-9	X	X	X	2E+1	2E-4	3E-3	4E-5	8080
Chlordane	57-74-9	X	X	X	5E-1	2E-3	2E-3	5E-5	8080
Chlorobenzilate *syn.* Ethyl-4,4'-dichlorobenzilate	510-15-6			X	1E+3	7E-1	3E-1	1E-2	8270
DDD	72-54-8	X	X	X	3E 0	1E-4	3E-3	1E-4	8080
DDE	72-55-9	X	X	X	2E 0	1E-4	3E-3	4E-5	8080
DDT	50-29-3	X	X	X	2E 0	1E-4	3E-3	1E-4	8080
Diallate	2303-16-4			X	1E+1	6E-4	3E-1	1E-2	8270
1,2-Dibromo-3-chloropropane *syn.* DBCP	96-12-8			X	3E-2	2E-4	5E-3	3E-5	8260(s) 8011(w)
2,4-Dichlorophenoxyacetic acid *syn.* 2,4-D	94-75-7			X	8E+2	7E-2	1E 0	2E-3	8150
Dieldrin	60-57-1	X	X	X	4E-2	2E-6	1E-3	2E-5	8080
Dimethoate	60-51-5			X	2E+1	7E-3	3E-1	1E-2	8270
Dinoseb *syn.* 2-(sec-Butyl)-4,6-dinitrophenol or DNBP	88-85-7			X	8E+1	7E-3	7E-1	2E-2	8270
Disulfoton	298-04-4			X	3E 0	1E-3	3E-1	2E-3	8270(s) 8140(w)
Endosulfan	115-29-7	X	X	X	4E 0	2E-3	9E-3	1E-4	8080
Endothall	145-73-3				1E+3	1E-1	/2	9E-2	8045 /2
Endrin	72-20-8	X	X	X	2E+1	2E-3	3E-3	6E-5	8080
Ethylene dibromide *syn.* EDB	106-93-4				8E-3	5E-5	5E-3	3E-4	8260(s) 8011(w)
Famphur *syn.* Famophos	52-85-7			X	2E+2	7E-2	7E-1	2E-2	8270
Heptachlor	76-44-8	X	X	X	1E-1	4E-4	2E-3	3E-5	8080
Heptachlor epoxide (alpha,beta,gamma isomers)	1024-57-3	X	X	X	8E-2	2E-4	2E-3	5E-5	8080
Methoxychlor	72-43-5	X		X	1E+3	4E-1	1E-1	2E-3	8080
Methyl parathion	298-00-0			X	2E+1	9E-3	3E-1	1E-2	8270
Octamethyl pyrophosphoramide *sym.* Schradan or OMPA	152-16-9				2E+2	7E-2	7E 0	2E-1	8270
Parathion	56-38-2			X	5E+2	2E-1	3E-1	1E-2	8270
Pentachloronitrobenzene *syn.* PCNB	82-68-8			X	2E+2	1E-1	1E 0	2E-2	8270
Pentachlorophenol *syn.* PCP	87-86-5	X	X	X	1E+3	2E-1	2E 0	5E-2	8270
Phorate	298-02-2			X	4E+1	2E-2	3E-1	1E-2	8270
Polychlorinated biphenyls (PCB's)	12767-79-2	X	X	X	9E-2	5E-4	4E-2	7E-4	8080
Pronamide	23950-58-5			X	1E+3	3E 0	3E-1	1E-2	8270
Strychnine & salts	57-24-9				2E+1	1E-2	1E 0	4E-2	8270
2,3,4,6-Tetrachlorophenol	58-90-2			X	1E+3	1E 0	3E-1	1E-2	8270
Tetraethyl dithiopyrophosphate *syn.* Sulfotepp or TEDP	3689-24-5			X	4E+1	2E-2	3E-1	1E-2	8270
Toxaphene	8001-35-2	X	X	X	7E-1	5E-3	2E-1	2E-3	8080
2,4,5-Trichlorophenoxyacetic acid *syn.* 2,4,5-T	93-76-5			X	8E+2	4E-1	2E 0	2E-3	8150
2,4,5-Trichlorophenoxypropionic acid *syn.* 2,4,5 TP	93-72-1			X	6E+2	5E-2	2E 0	2E-3	8150

VOLATILES & SEMIVOLATILES

HAZARDOUS CONSTITUENT	CAS NO.	TCL	PPL	APP IX	HBN SOIL mg/kg	HBN WATER mg/l	PQL SOIL mg/kg	PQL WATER mg/l	SUGGESTED METHOD
Acenaphthene	83-32-9	X	X	X	1E+3	2E 0	3E-1	1E-2	8270
Acetaldehyde *syn.* Ethanal	75-07-0				9E+1	5E-3	1E-1	1E-1	8240
Acetone *syn.* 2-Propanone	67-64-1	X		X	1E+3	4E 0	1E-1	1E-1	8240
Acetonitrile *syn.* Methyl cyanide	75-05-8			X	5E+2	2E-1	1E-1	1E-1	8240 *
Acetophenone	98-86-2			X	8E+1	4E 0	3E-1	1E-2	8270
Acrolein	107-02-8		X	X	3E+2	5E-1	5E-3	5E-3	8240 *
Acrylamide	79-06-1				2E-1	8E-6	1E-1	1E-1	8260 *
Acrylonitrile	107-13-1		X	X	1E 0	6E-5	5E-3	5E-3	8240 *
Allyl chloride *syn.* 3-Chloropropene	107-05-1			X	7E 0	3E-4	5E-3	5E-3	8240
Aniline *syn.* Benzeneamine	62-53-3			X	1E+2	6E-3	7E-1	1E-2	8270
Benz[a]anthracene	56-55-3	X	X	X	2E-1	1E-5	3E-1	1E-2	8270
Benz[a]anthracene	56-55-3	X	X	X	2E-1	1E-5	9E-3	1E-4	8310
Benzene	71-43-2	X	X	X	2E+1	5E-3	5E-3	5E-3	8260 (8240)
Benzidine	92-87-5		X		3E-3	2E-7	2E 0	3E-2	8270
Benzo[b]fluoranthene	205-99-2	X	X	X	4E-1	2E-5	3E-1	1E-2	8270
Benzo[b]fluoranthene	205-99-2	X	X	X	4E-1	2E-5	1E-2	2E-4	8310
Benzo[k]fluoranthene	207-08-9	X	X	X	8E+1	4E-3	3E-1	1E-2	8270
Benzo[k]fluoranthene	207-08-9	X	X	X	8E+1	4E-3	1E-2	2E-4	8310
Benzo[a]pyrene	50-32-8	X	X	X	6E-2	2E-4	3E-1	1E-2	8270
Benzo[a]pyrene	50-32-8	X	X	X	6E-2	2E-4	2E-2	2E-4	8310
Benzotrichloride	98-07-7				2E-4	1E-8	3E 0	5E-2	8120 /1
Benzyl alcohol	100-51-6	X		X	1E+3	1E+1	3E-1	2E-2	8270
Benzyl chloride	100-44-7				4E-1	2E-4	1E-1	1E-1	8260 (8240)
Bis(2-chloroethyl) ether *syn.* Dichloroethyl ether	111-44-4	X	X	X	6E-1	3E-5	3E-1	1E-2	8270
Bis(2-chloroethyl) ether *syn.* Dichloroethyl ether	111-44-4	X	X	X	6E-1	3E-5	3E-1	3E-3	8270(s) 8110(w)
Bis(2-chloroisopropyl) ether *syn.* Dichloroisopropyl ether	108-60-1	X	X	X	1E+3	1E 0	3E-1	1E-2	8270
Bis(2-ethylhexyl) phthalate *syn.* Diethylhexyl phthalate	117-81-7	X	X	X	5E+1	3E-3	3E-1	1E-2	8270
Bromodichloromethane	75-27-4	X	X	X	1E+3	7E-1	5E-3	5E-3	8260 (8240)
Bromoform *syn.* Tribromomethane	75-25-2	X	X	X	9E+1	4E-3	5E-3	5E-3	8260 (8240)
Butanol *syn.* n-Butyl alcohol	71-36-3				1E+3	4E 0	1E-1	1E-1	8240
Butyl benzyl phthalate	85-68-7	X	X	X	1E+3	7E 0	3E-1	1E-2	8270
Carbon disulfide	75-15-0	X		X	1E+3	4E 0	1E-1	1E-1	8240 *
Carbon tetrachloride *syn.* Tetrachloromethane	56-23-5	X	X	X	7E 0	5E-3	5E-3	5E-3	8260 (8240)
p-Chloroaniline	106-47-8	X		X	3E+2	1E-1	7E-1	2E-2	8270
Chlorobenzene	108-90-7	X	X	X	1E+3	1E-1	5E-3	5E-3	8260 (8240)
p-Chloro-m-cresol	59-50-7	X	X	X	1E+3	2E-1	3E-1	1E-2	8270
Chlorodibromomethane	124-48-1	X	X		1E+3	7E-1	5E-3	5E-3	8260 (8240)
Chloroform	67-66-3	X	X	X	1E+2	6E-3	5E-3	5E-3	8260
2-Chlorophenol	95-57-8	X	X	X	4E+2	2E-1	3E-1	1E-2	8270
Chloroprene *syn.* 2-Chloro-1,3-butadiene	126-99-8			X	1E+3	7E-1	5E-3	5E-3	8260

VOLATILES & SEMIVOLATILES

HAZARDOUS CONSTITUENT	CAS NO.	TCL	PPL	APP IX	HBN SOIL mg/kg	HBN WATER mg/l	PQL SOIL mg/kg	PQL WATER mg/l	SUGGESTED METHOD
Chrysene	218-01-9	X	X	X	4E 0	2E-4	3E-1	1E-2	8270
Chrysene	218-01-9	X	X	X	4E 0	2E-4	1E-1	2E-3	8310
Cresols	1319-77-3	X		X	1E+3	2E 0	3E-1	1E-2	8270
Cumene *syn.* Isopropyl benzene	98-82-8				1E+3	1E 0	5E-3	5E-3	8240
Dibenz[a,h]anthracene	53-70-3	X	X	X	1E-2	7E-7	3E-1	1E-2	8270
Dibenz[a,h]anthracene	53-70-3	X	X	X	1E-2	7E-7	2E-2	3E-4	8310
Di-n-butyl phthalate	84-74-2	X	X	X	1E+3	4E 0	3E-1	1E-2	8270
o-Dichlorobenzene	95-50-1	X	X	X	1E+3	6E-1	1E-2	1E-2	8260 (8270)
p-Dichlorobenzene	106-46-7	X	X	X	3E+1	7.5E-2	5E-3	5E-3	8260 (8270)
3,3'-Dichlorobenzidine	91-94-1	X	X	X	2E 0	8E-5	3E-1	1E-2	8270
Dichlorodifluoromethane	75-71-8			X	1E+3	7E 0	5E-3	5E-3	8260 (8240)
1,1-Dichloroethane	75-34-3	X	X	X	8E 0	4E-4	5E-3	5E-3	8260 (8240)
1,1-Dichloroethane	75-34-3	X	X	X	8E 0	4E-4	7E-4	7E-4	8021
1,2-Dichloroethane	107-06-2	X	X	X	8E 0	5E-3	5E-3	5E-3	8260 (8240)
1,1-Dichloroethylene	75-35-4	X	X	X	1E 0	7E-3	5E-3	5E-3	8260 (8240)
cis-1,2-Dichloroethylene	156-59-2				8E+2	7E-2	5E-3	5E-3	8260 (8240)
trans-1,2-Dichloroethylene	156-60-5		X	X	1E+3	1E-1	5E-3	5E-3	8260 (8240)
2,4-Dichlorophenol	120-83-2	X	X	X	2E+1	1E-1	3E-1	1E-2	8270
1,2-Dichloropropene	78-87-5	X	X	X	1E+1	5E-3	5E-3	5E-3	8260 (8240)
1,3-Dichloropropene	542-75-6	X	X	X	2E+1	1E-2	1E-2	1E-2	8240
Diethyl phthalate	84-66-2	X	X	X	1E+3	3E+1	3E-1	1E-2	8270
Diethylstilbesterol	56-53-1				1E-3	7E-8	3E-1	1E-2	8270
3,3'-Dimethoxybenzidine *syn.* Dianisidine	119-90-4				5E+1	3E-3	3E 0	1E-1	8270
Dimethylamine *syn.* DMA	124-40-3				2E+2	7E-2	1E-1	1E-1	8240
7,12-Dimethylbenz[a]anthracene	57-97-6			X	3E-2	1E-6	3E-1	1E-2	8270
3,3'-Dimethylbenzidine *syn.* o-Tolidine	119-93-7			X	8E-2	4E-6	3E-1	1E-2	8270
2,4-Dimethylphenol	105-67-9	X	X	X	4E+2	2E-2	3E-1	1E-2	8270
Dimethyl phthalate	131-11-3	X	X	X	1E+3	4E+2	3E-1	1E-2	8270
1,3-Dinitrobenzene *syn.* m-Dinitrobenzene	99-65-0			X	8E 0	4E-3	3E-1	2E-2	8270
2,4-Dinitrophenol	51-28-5	X	X	X	2E+2	7E-2	2E 0	5E-2	8270
2,4-Dinitrotoluene	121-14-2	X	X	X	1E 0	5E-5	3E-1	1E-2	8270
2,6-Dinitrotoluene	606-20-2	X	X	X	1E 0	5E-5	3E-1	1E-2	8270
Di-n-octyl phthalate	117-84-0	X	X	X	1E+3	6E-1	3E-1	1E-2	8270
1,4-Dioxane	123-91-1			X	6E+1	3E-3	1E-1	1E-1	8260 *
Diphenylamine	122-39-4			X	1E+3	9E-1	7E-1	1E-2	8270
1,2-Diphenylhydrazine	122-66-7		X		9E-1	4E-5	3E-1	1E-2	8270
Epichlorohydrin	106-89-8				7E+1	4E-3	1E-1	1E-1	8010 *
2-Ethoxyethanol *syn* Ethylene glycol monoethyl ether	110-80-5				1E+3	1E+1	1E 0	1E 0	8260 *
Ethyl acetate	141-78-6				1E+3	3E+1	1E-1	1E-1	8240
Ethylbenzene	100-41-4	X	X	X	1E+3	7E-1	5E-3	5E-3	8260 (8240)

VOLATILES & SEMIVOLATILES

HAZARDOUS CONSTITUENT	CAS NO.	TCL	PPL	APP IX	HBN SOIL mg/kg	HBN WATER mg/l	PQL SOIL mg/kg	PQL WATER mg/l	SUGGESTED METHOD
Ethyl ether *syn.* Diethyl ether	60-29-7				1E+3	2E+1	1E-1	1E-1	8240
Ethyl methacrylate	97-63-2			X	1E+3	3E 0	5E-3	5E-3	8240
Ethylene dibromide *syn.* EDB	106-93-4				8E-3	5E-5	5E-3	3E-4	8011
Fluoranthene	206-44-0	X	X	X	1E+3	1E 0	3E-1	1E-2	8270
Fluorene	86-73-7	X	X	X	4E+1	2E-3	3E-1	1E-2	8270
Fluorene	86-73-7	X	X	X	4E+1	2E-3	1E-1	2E-3	8310
Formaldehyde	50-00-0				1E+3	1E-3	/2	1E-2	8315(w) * /2
Formic acid	64-18-6				1E+3	7E+1	2E-1	2E-1	8015 *
Furan	110-00-9				8E+1	4E-2	1E-1	1E-1	8240
Hexachlorobenzene	118-74-1	X	X	X	6E+1	1E-3	3E-1	1E-2	8270
Hexachlorobenzene	118-74-1	X	X	X	6E+1	1E-3	3E-2	5E-4	8120
Hexachlorobutadiene	87-68-3	X	X	X	9E 0	4E-4	5E-3	5E-3	8260 (8120)
Hexachlorocyclopentadiene	77-47-4	X	X	X	3E+2	5E-2	3E-1	1E-2	8270
Hexachloroethane	67-72-1	X	X	X	5E+1	3E-3	3E-1	1E-2	8270
Hexachlorophene	70-30-4			X	2E+1	1E-2	4E-1	5E-2	8270
Indeno[1,2,3-cd]pyrene	193-39-5	X	X	X	4E 0	2E-4	3E-1	1E-2	8270
Indeno[1,2,3-cd]pyrene	193-39-5	X	X	X	4E 0	2E-4	3E-2	4E-4	8310
Isobutyl alcohol	78-83-1			X	1E+3	1E+1	1E-1	1E-1	8240 *
Isophorone	78-59-1	X	X	X	2E+2	9E-3	3E-1	1E-2	8270
Methacrylonitrile	126-98-7			X	8E 0	4E-3	3E-2	3E-2	8240 *
Methanol	67-56-1				1E+3	2E+1	1E-1	1E-1	8240
Methyl bromide *syn.* Bromomethane	74-83-9	X	X	X	1E+2	5E-2	1E-2	1E-2	8260 (8240)
Methyl chloride *syn.* Chloromethane	74-87-3	X	X	X	5E+1	3E-3	1E-2	1E-2	8260 (8240)
Methylene bromide *syn.* Dibromomethane	74-95-3			X	8E+2	4E-1	5E-3	5E-3	8260 (8240)
Methylene chloride *syn.* Dichloromethane	75-09-2	X	X	X	9E+1	5E-3	5E-3	5E-3	8240
3-Methylchloanthrene	56-49-5			X	7E-2	4E-6	7E-1	1E-2	8270
Methyl ethyl ketone *syn.* 2-Butanone	78-93-3	X		X	1E+3	2E 0	1E-1	1E-1	8240 *
Methyl isobutyl ketone *syn.* 4-Methyl-2-pentanone	108-10-1	X		X	1E+3	2E 0	1E-1	1E-1	8240 *
Methyl methacrylate	80-62-6			X	1E+3	3E 0	3E-2	3E-2	8240
Naphthalene	91-20-3	X	X	X	3E+2	1E-1	3E-1	1E-2	8270
Naphthalene	91-20-3	X	X	X	3E+2	1E-1	5E-3	5E-3	8260
Nitrobenzene	98-95-3	X	X	X	4E+1	2E-2	3E-1	1E-2	8270
2-Nitropropane	79-46-9				7E-2	4E-6	1E-1	1E-1	8260
N-Nitrosodi-n-butylamine	924-16-3			X	1E-1	6E-6	3E-1	1E-2	8270
N-Nitrosodiethylamine	55-18-5			X	5E-3	2E-7	7E-1	2E-2	8270
N-Nitrosodimethylamine	62-75-9		X	X	1E-2	7E-7	7E-1	1E-2	8270
N-Nitrosodiphenylamine	86-30-6	X	X	X	1E+2	7E-3	3E-1	1E-2	8270
N-Nitrosodi-n-propylamine	621-64-7	X	X	X	1E-1	5E-6	3E-1	1E-2	8270
N-Nitrosomethylethylamine	10595-95-6			X	3E-2	2E-6	7E-1	1E-2	8270
N-Nitrosopyrrolidine	930-55-2			X	3E-1	2E-5	1E 0	4E-2	8270

VOLATILES & SEMIVOLATILES

HAZARDOUS CONSTITUENT	CAS NO.	TCL	PPL	APP IX	HBN SOIL mg/kg	HBN WATER mg/l	PQL SOIL mg/kg	PQL WATER mg/l	SUGGESTED METHOD
Pentachlorobenzene	608-93-5			X	6E+1	3E-2	3E-1	1E-2	8270
Pentachlorophenol *syn.* PCP	87-86-5	X	X	X	1E+3	2E-1	2E 0	5E-2	8270
Phenanthrene	85-01-8	X	X	X	4E+1	2E-3	3E-1	1E-2	8270
Phenanthrene	85-01-8	X	X	X	4E+1	2E-3	5E-1	6E-3	8310
Phenol	108-95-2	X	X	X	1E+3	2E+1	3E-1	1E-2	8270
p-Phenylenediamine	106-50-3			X	5E+2	2E-1	3E-1	1E-2	8270
Phthalic anhydride	88-44-0				1E+3	7E+1	3E 0	1E-1	8270 /3
2-Picoline	109-06-8			X	1E+3	2E 0	5E-3	5E-3	8240
Pyrene	129-00-0	X	X	X	1E+3	1E 0	3E-1	1E-2	8270
Pyridine	110-86-1			X	8E+1	4E-2	5E-3	5E-3	8240
Styrene	100-42-5	X		X	1E+3	5E-3	5E-3	5E-3	8240
Styrene	100-42-5	X		X	1E+3	5E-3	1E-4	1E-4	8021
1,2,4,5-Tetrachlorobenzene	95-94-3			X	2E+1	1E-2	3E-1	1E-2	8270
1,1,1,2-Tetrachloroethane	630-20-6			X	3E+1	1E-3	5E-3	5E-3	8260 (8240)
1,1,2,2-Tetrachloroethane	79-34-5	X	X	X	4E 0	2E-4	5E-3	5E-3	8260 (8240)
1,1,2,2 Tetrachloroethane	79-34-5	X	X	X	4E 0	2E-4	1E-4	1E-4	8310
Tetrachloroethylene *syn.* Perchloroethylene	127-18-4	X	X	X	8E+2	5E-3	5E-3	5E-3	8260 (8240)
2,3,4,6-Tetrachlorophenol	58-90-2			X	1E+3	1E 0	3E-1	1E-2	8270
Toluene	108-88-3	X	X	X	1E+3	2E+0	5E-3	5E-3	8260 (8240)
2,4-Toluenediamine	95-80-7				2E 0	9E-5	3E-1	1E-2	8270
2,6-Toluenediamine	823-40-5				1E+3	6E 0	7E-1	2E-2	8270
Toluene diisocyanate	26471-62-5				1E+3	7E-1	3E-1	1E-2	8270 /4
o-Toluidine	95-53-4			X	3E 0	1E-4	3E-1	1E-2	8270
p-Toluidine	106-49-0				4E 0	2E-4	3E-1	1E-2	8270
1,2,4-Trichlorobenzene	120-82-1	X		X	1E+3	9E-3	3E-1	1E-2	8260 (8270)
1,1,1-Trichloroethane	71-55-6	X	X	X	1E+3	2E-1	5E-3	5E-3	8260 (8240)
1,1,2-Trichloroethane	79-00-5	X	X	X	1E+1	5E-3	5E-3	5E-3	8260 (8240)
Trichloroethylene	79-01-6	X	X	X	7E+1	5E-3	5E-3	5E-3	8260 (8240)
Trichlorofluoromethane	75-69-4			X	1E+3	1E+1	5E-3	5E-3	8260 (8240)
2,4,5-Trichlorophenol	95-95-4	X		X	1E+3	4E 0	2E 0	5E-2	8270
2,4,6-Trichlorophenol	88-06-2	X	X	X	4E+1	3E-3	6E-1	1E-2	8270
1,2,3-Trichloropropane	96-18-4			X	5E+2	2E-1	5E-3	5E-3	8260 (8240)
1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1				1E+3	1E+3	5E-3	5E-3	8260
sym-Trinitrobenzene *syn* 1,3,5-Trinitrobenzene	99-35-4			X	4E 0	2E-3	7E-1	1E-2	8270
Vinyl chloride	75-01-4	X	X	X	5E 0	2E-3	1E-2	1E-2	8240
Vinyl chloride	75-01-4	X	X	X	5E 0	2E-3	2E-4	2E-4	8021
Xylene (total)	1330-20-7	X		X	1E+3	1E+1	5E-3	5E-3	8260 (8240)

FOOTNOTES

HBN - Health-based number.

PQL - Practical quantitation limit.

1 - Benzotrichloride is hydrolytically unstable. Analyze for benzoic acid.

2 - Method not currently available for soil analysis.

3 - Phthalic anhydride is hydrolytically unstable. Analyze for phthalic acid.

4 - Toluene diisocyanate is hydrolytically unstable. Analyze for toluene diamine.

* - Indicates constituent should be analyzed by direct injection for analysis of water sample.

CH2M HILL Engineers Planners Economists Scientists

May 15, 1991

PHL31374.A0

Mr. Charles D. Barksdale, Jr., P.E.
Environmental Supervisor
Sun Refining and Marketing Company
3144 Passyunk Avenue
Philadelphia, Pennsylvania 19145-5299

Re: Response to EPA Comments on the RFI Work Plan

Dear Mr. Barksdale:

Pursuant to our May 10, 1991 meeting with EPA site manager Hon Lee, we are presenting for your review the finalized responses to EPA's comments on the RCRA Facility Investigation (RFI) Work Plan. To accommodate easy reference, the responses have been numbered and correspond to the sequence in which the original comments were presented. The EPA April 11, 1991 letter is enclosed, with the comments numbered for your reference. Responses reflect the EPA site manager's final resolution of the comments at our meeting last Friday.

A. Work Plan

1. Page 2-4. Sun will include a map of all existing monitor wells in the North Yard in the RFI report.

2. Page 2-12. The EPA site manager has agreed that analytical data from the wells at PDA's A, B, and C does not have to be included in the work plan because:

   a. PDA's A, B, and C are not part of the SWMU (Guard Basin) under investigation.

   b. The PDA's are hydraulically upgradient from the Guard Basin.

   c. At present, well construction data is not available for any of the wells within these PDAs. Most of the wells in this area do not meet the minimum EPA requirements (inert casing material, grout seals, locking outer casing, etc.) for monitor well construction.

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3. Page 2-15. The work plan text has been amended to specify seep locations, in paragraph 2, page 2-15.

4. Page 2-32. The work plan text has been amended to include a description of hydrogeology beneath the West Yard beginning in paragraph 3, page 2-32.

5. Page 3-3, Table 3-2. Table 3-2 has been amended to include compounds of interest within the soils adjacent to the Guard Basin.

6. Page 4-3 SWMU No. 2. The EPA site manager has agreed with the original approach of sampling adjacent to an intact pad. If contamination beneath the pad is evident during trenching, samples will be collected from the side wall of the trench proximal to the pad. The sampling rationale is provided on page 4-14 of the work plan.

7. Page 4-3, SWMU No. 3. The text has been amended on page 4-3 to include separate sentences concerning each media (sediments, surface water).

8. Page 4-7, Figure 4-3. The legend of Figure 4-3 has been amended to include location designations for borings/monitor wells.

9. Pages 4-4 to 4-13, SWMU No. 1

    a. No comment required. EPA agrees that PDAs 1 to 4 can be considered a single CAMU.

    b. The EPA site manager has agreed that the original upgradient location for the shallow-deep well cluster on the west end of PDA-3 is acceptable. The location proposed by EPA's hydrogeologist is off Sun's property and is located in a nearby auto salvage yard. In addition, EPA has agreed that the proposed shallow wells south of PDA's 3 and 4 are unnecessary. The wells lie on the opposite side of Lands Creek on Pioneer Oil Company property. Shallow groundwater flow on Pioneer's property is probably to the north toward the creek. Subsequently contaminants found in these wells could be attributable from operations at the Pioneer Terminal rather than from Sun's PDAs.

    c. The SWMU No. 1 boring/monitor well network was not changed, therefore, the number of samples in Tables 4-2 and 4-4 did not change.

10. Page 4-17. Section title on page 4-17 has been changed to "SWMU No. 3 -- Guard Basin."

11. Page 4-20, Table 4-6. Table 4-6 will remain the same, however Sections 4 and 8 of the Appendix, Data Collection Quality Assurance Plan (DCQAP), now reference the list of PQLs published in EPA SW-846 and are presented in the Appendix as Attachment B. In addition, only methods from EPA SW-846 are now referenced in Tables 2-1 and 2-2 of the DCQAP and in the work plan.

12. Pages 4-23 to 4-25, SWMU No. 3

    a. EPA has agreed to the following monitor well configuration at the Guard Basin:

        (1) A deep well has been located adjacent to the shallow well at the southwest corner of the Guard Basin, creating a fourth shallow-deep well cluster monitoring the SWMU.

        (2) None of the shallow wells have been removed from the southwest or assumed downgradient side of Guard Basin.

        (3) The distance between the two shallow wells on the northeast side of the Guard Basin have been increased, placing their locations nearer the northeast and southeast corners of the basin.

    b. An additional soil and groundwater sample has been added to Table 4-2 and 4-4 respectively.

13. Page 4-26, Waste Sampling. The text on page 4-26, paragraph 2 has been amended to indicate that samples will be cooled to 4°C immediately following collection.

14. Page 4-28, Surface Water and Sediment Collection. The additional two surface water and sediment samples will be collected at two deep points in the Guard Basin. These sample locations will be determined from the results of the bathymetric survey. The text of the report has been amended on page 4-28, paragraph 2.

15. Page 4-29, Monitor Well Installation

    a. The text has been amended on page 4-29, increasing the total number of monitor wells by one, reflecting the additional Guard Basin deep well.

    b. Results of the well evaluation will be included in the RFI report.

16. Page 5-2, Facility Maps. Additional maps will be generated for the RFI report. A map will be generated presenting facility pipelines (including sewer) in the areas around the SWMUs. In addition, surface water run-on and runoff drainage system maps will be generated for each SWMU.

B. Appendix

17. Page 2-4, Table 2-1

    a. All EPA analytical methods will be replaced with SW-846 methods or standard methods. Practical quantification limits for each compound will be referenced in Attachment B of the DCQAP.

    b. The number of samples on Table 2-1 did not change based on the final resolution of the Part A comments.

18. Page 2-5, Table 2-2

    a. Same response as 17(a).

    b. The number of samples on Table 2-2 were changed based on the final resolution of the Part A comments.

19. Page 4-5, Detection Limits. The text will be amended on page 4-5 to include PQLs and delete references to the Contract Laboratory Program Statement of Work (CLP SOW).

20. Page 5-4, Field Notebooks. All pages from the field notebooks will be copied and included in the RFI report as an appendix. The work plan text has been amended on page 5-5 to include this statement.

21. <u>Page 8-1, Analytical Procedures</u>

a.&b. The text on page 8-1 has been amended to include references to PQLs and delete statements citing the CLP SOW.

The meeting on May 10, 1991 was constructive and went very well. The extent and impact of EPA's comments were relatively minor and were often editorial in nature. The revisions as described will be incorporated into the RFI work plan and submitted to you on May 20, 1991. As we discussed today, you will send us a clean copy of Attachment (2) of the EPA April 11, 1991 letter which will be used as Attachment B of the DCQAP Appendix. You had also indicated you would send us a copy of the Geraghty & Miller recent groundwater study. If you have any questions or concerns, please do not hesitate to call.

Sincerely,

CH2M HILL

Kenneth McGill

Kenneth McGill, C.P.G.
Project Manager

Enclosure

PHL/F:\PHL31374\A0_001.51/ca

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
Region III
841 Chestnut Building
Philadelphia, Pennsylvania 19107

In reply refer to : 3HW51

APR 11 1991

RECEIVED
APR 22 1991
CH2M HILL/PHL

CERTIFIED MAIL
RETURNED RECEIPT REQUESTED

Mr. Charles D. Barksdale Jr., P.E.
Envirnomental Supervisor
Atlantic Refining & Marketing Corp.
3144 Passyunk Avenue
Philadelphia, PA 19145

Re: Atlantic Refining & Marketing Corp.
HWSA Corrective Action Permit No. PAD 00 228 9700

Dear Mr. Barksdale,

The U.S. Environmental Protection Agency (EPA) has reviewed the February 1991 RCRA Facility Investigation Workplan (RFI) submitted by Atlantic Refining and Marketing Corp. (Atlantic), Philadelphia, Pennsylvania, which was the result of implementing the referenced HWSA Corrective Action Permit.

In general, the material presented was adequate, however you will note that there are several specific comments which Atlantic will need to deal with in order to completely address the permit conditions. Some specfic comments are detailed below.

A. Workplan

1. Page 2-4 It is recommended that a location map of the 84 groundwater monitoring wells be provided if available in order to facilitate the evaulation of groundwater/hydrologic studies.

2. Page 2-12 There are no complete PDA "A", PDA "B" and PDA "C" analytical data in either Table 2-1 or Table 2-2.

3. Page 2-15 It indicates that some of the caps show signs of leakage and asphaltic seeps occur on some of the SWMUs. The word "some" is ambiguous and should be defined; i.e., information such as which SWMU has the leakage and which SWMU has the asphaltic seeps should be specified.

4. Page 2-32 West Yard Site Hydrogeology is missing.

5. Page 3-3 Table 3-2 It reveals that the Guard Basin has no soil or sediment data available. However, in Table 2-1 (see page 2-6), results of soil analyses are obtainable. It is requested that clarification be made.

6. Page 4-3 SWMU No.2 It is recommended that soil samples beneath and adjacent to the SWMU be taken in order to fully determine/investigate the occurrence of a contaminant release. However, soil samples can be taken either beneath or adjacent to the SWMU if an acceptable rationale is provided.

7. Page 4-3 SWMU No.3 The word "..or.." should be deleted and replaced by "and" since the presence of hazardous constituents for both surface water and sediments within the SWMU will be under investigation. Therefore, the statement should be read as "Determine whether surface water and sediments within the basin contain hazardous constituents."

8. Page 4-7 Fig. 4-3 Soil borings legend is missing.

9. Pages 4-4 to 4-13 SWMU No.1

a. EPA agrees with Atlantic that Past Disposal Areas 1 to 4 can be considered as a single CAMU because of their similarity in form, waste received and location.

b. Based on EPA's hydrogeologist point of view, the proposed 10 monitor wells at 7 locations for this unit are not adequate due mainly to its huge size; i.e., approximately 21 acres. It is recommended that 2 additional single shallow wells be installed at 2 new locations; one should be located south of PDA 3 and the other should be located south of PDA 4. In addition, the upgradient well cluster west of PDA 3 should be relocated at least 300 feet west of PDA 3 so that possible contaminant migration toward the CAMU can be detected. A revised monitor well network for SWMU No.1 is attached for your consideration (Attachment 1).

c. Based on the above recommendation, appropriate number of boring should therefore be drilled and number of soil samples should be collected accordingly. (Number of samples in Tables 4-2 and 4-4 should be corrected accordingly.)

10. Page 4-17 The title should be written as "SWMU No.3--GUARD BASIN" since the guard basin is a separate unit.

11. Page 4-20 Table 4-6 The Practical Quantitation Limits ("PQL") represent the lowest levels that can be reliably measured within acceptable limits of precision and accuracy during routine laboratory operations using the specified method. It is important to specify the appropriate level of data quality that is sufficient for making your decision. Therefore, analytical methods from Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW-846 (e.g., 8260, 8310,..) that are appropriate for those constitituents listed on the Table should be specified. A list of chemical constituents and their associated PQL numbers and suggested methods is attached for your infromation and use (Attachment 2).

12. Pages 4-23 to 4-25 SWMU No.3

a. According to EPA's hydrogeologist point of view, 11 monitor wells at 7 locations should be adequate in order to characterize groundwater passing beneath the Guard Basin and to determine if a contaminant release has occurred. However, the monitor well network is slightly different from the proposed one in Figure 4-9. Those three upgradient well clusters will remain where they are. One of the two single wells east of the Guard Basin is suggested to be relocated to the northeast corner of the unit and the other to be relocated to the southeast corner. One of the two single wells west of the Guard Basin is recommended to be relocated to the mid-point of east of the Guard Basin. The other single well should be shallow-deep monitor well cluster instead and its loaction should be at the northwest corner of the Basin. In all, the new well network will consist of four shallow-deep monitor well clusters and three shallow monitor wells. A revised well network drawing is enclosed as Attachment 3 for your consideration and use.

b. Based on the above proposed changes, 7 of the 11 wells will be installed in borings for soil samples. The other 4 wells, the shallow half of the 4 shallow deep well clusters, will be installed in unsampled borings. The number of samples in Tables 4-2 and 4-4 should be amended accordingly.

13. Page 4-26 Waste Sampling It indicates that samples will be cooled to 4°C during transport to the laboratory. In accordance with the SW-846 final draft of June, 1990, it is suggested that the temperature of collected samples be adjusted to 4°C immediately after collection. Of course, shipping coolers must be at 4°C and maintained at 4°C upon placement of the sample and during shipment until extraction and/or analysis are performed. These techniques are also described in Section 5 of the QAPP (Appendix A) of this workplan.

14. Page 4-28 Surface Water and Sedment Sample Collection
Rationale should be provided when selecting the two other locations for surface water sampling within the Basin in order to facilitate the determination of the nature and extent of potential releases of hazardous waste or constituents from the SWMU.

15. Page 4-29 Monitor Well Installation

a. Based on above comments, number of wells should be changed accordingly.

b. It reveals that the construction details of wells will be evaluated to determine their usefulness for long-term potentiometric monitoring. For future reference purposes, it is suggested that the evaluation report be included and provided in the RFI Phase II Report.

16. Page 5-2 Facility Maps In addition to the listed maps, please provide the following:

- o Drainage system map
- o Natural and artificial surface water drainage map
- o Storm drainage system map
- o Facility pipeline (including sewer) map
- o SWMUs' run-on and runoff system map

B. Appendix

Page 2-4 Table 2-1

17. a. For analytical method, please refer to the Part A. Page 4-20 Table 4-6 comments.

b. Based on Part A comments, number of samples should be corrected accordingly.

18. Page 2-5 Table 2-2 See Part B Page 2-4 Table 2-1 for comments.

19. Page 4-5 Detection Limits Please note that the detection limits for the analytical methods should be consistent with the practical quantitation limits (PQLs). See Attachment 2 for recommendation and consideration.

20. Page 5-4 Field Notebooks It is suggested that all information/data collection from all field notebooks be provided in the RFI Phase II Report for future references.

Page 8-1 Analytical Procedures

21. a. Please refer to Part A. Page 4-20 for comments.

b. Please note that the Contract Laboratory Program (CLP) is designed for CERCLA, not RCRA.

Atlantic must submit a response to EPA's comments within 45 days. If you have any questions in regard to this letter, please contact Hon Lee of my staff at 215-597-3181.

Sincerely,

Paul J. Gotthold, Chief
PA/DC Permits Section

Attachments
cc: H. Lee (3HW51)

bcc: J. H. Mulry
T. A. Roy
T. S. Stammel
File: Corrective Action
RFI Work Plan

Philadelphia Refinery

Sun Refining and
Marketing Company
3144 Passyunk Avenue
Philadelphia PA 19145-5299
215 339 2000

May 28, 1991

Mr. Paul J. Gotthold, Chief
PA/DC Permits Section (3HW51)
United States Environmental Protection Agency
841 Chestnut Building
Philadelphia, PA 19107

Re: Comments on the RFI Work Plan

Dear Mr. Gotthold:

Pursuant to the May 10, 1991 meeting with Hon Lee, we are presenting for your review the finalized responses to your comments on the RCRA Facility Investigation (RFI) Work Plan as well as three copies of the revised RFI Work Plan. To accommodate easy reference, the responses have been numbered and correspond to the sequence in which the original comments were presented. The EPA April 11, 1991 letter is enclosed, with the comments numbered for your reference. Responses reflect the final resolution of the comments at the May 10, 1991 meeting.

A. Work Plan

1. Page 2-4. Sun will include a map of all existing monitor wells in the North Yard in the RFI report.

2. Page 2-12. As agreed, the analytical data from the wells at PDA's A, B, and C do not have to be included in the work plan because:

   a. PDA's A, B, and C are not part of the SWMU (Guard Basin) under investigation.

   b. The PDA's are hydraulically upgradient from the Guard Basin.

   c. At present, well construction data is not available for any of the wells within these PDA's. Most of the wells in this area do not meet the minimum EPA requirements (inert casing material, grout seals, locking outer casing, etc.) for monitor well construction.

3. Page 2-15. The work plan text has been amended to specify seep locations, in paragraph 2, page 2-15.

ATLANTIC

4. Page 2-32. The work plan text has been amended to include a description of hydrogeology beneath the West Yard beginning in paragraph 3, page 2-32.

5. Page 3-3, Table 3-2. Table 3-2 has been amended to include compounds of interest within the soils adjacent to the Guard Basin.

6. Page 4-3 SWMU No. 2. As agreed, we will use the original approach of sampling adjacent to the intact pad. If contamination beneath the pad is evident during trenching, samples will be collected from the side wall of the trench proximal to the pad. The sampling rationale is provided on page 4-14 of the work plan.

7. Page 4-3, SWMU No. 3. The text has been amended on page 4-3 to include separate sentences concerning each media (sediments, surface water).

8. Page 4-7, Figure 4-3. The legend of Figure 4-3 has been amended to include location designations for borings/monitor wells.

9. Pages 4-4 to 4-13, SWMU No. 1

   a. No comment required. EPA agrees that PDA's 1 to 4 can be considered a single CAMU.

   b. As agreed, the original upgradient location for the shallow-deep well cluster on the west end of PDA-3 is acceptable. The location proposed by EPA's hydrogeologist is off Sun's property and is located in a nearby auto salvage yard. In addition, as agreed, the proposed shallow wells south of PDA's 3 and 4 are unnecessary. The wells lie on the opposite side of Lands Creek on Pioneer Oil Company property. Shallow groundwater flow on Pioneer's property is probably to the north toward the creek. Subsequently contaminants found in these wells could be attributable from operations at the Pioneer Terminal rather than from Sun's PDA's.

   c. The SWMU No. 1 boring/monitor well network was not changed, therefore, the number of samples in Tables 4-2 and 4-4 did not change.

10. Page 4-17. Section title on page 4-17 has been changed to "SWMU No. 3 - Guard Basin."

11. Page 4-20, Table 4-6. Table 4-6 will remain the same, however Sections 4 and 8 of the Appendix, Data Collection Quality Assurance Plan (DCQAP), now reference the list of PQLs published in EPA SW-846 and are presented in the Appendix as Attachment B. In addition, only methods from EPA SW-846 are now referenced in Tables 2-1 and 2-2 of the DCQAP and in the work plan.

12. Pages 4-23 to 4-25, SWMU No. 3

    a. The following monitor well configuration at the Guard Basin was agreed to:

        (1) A deep well has been located adjacent to the shallow well at the southwest corner of the Guard Basin, creating a fourth shallow-deep well cluster monitoring the SWMU.

        (2) None of the shallow wells have been removed from the southwest or assumed downgradient side of Guard Basin.

        (3) The distance between the two shallow wells on the northeast side of the Guard Basin have been increased, placing their locations nearer the northeast and southeast corners of the basin.

    b. An additional soil and groundwater sample has been added to Table 4-2 and 4-4 respectively.

13. Page 4-26, Waste Sampling. The text on page 4-26, paragraph 2 has been amended to indicate that samples will be cooled to 4°C immediately following collection.

14. Page 4-28, Surface Water and Sediment Collection. The additional two surface water and sediment samples will be collected at two deep points in the Guard Basin. These sample locations will be determined from the results of the bathymetric survey. The text of the report has been amended on page 4-28, paragraph 2.

15. Page 4-29, Monitor Well Installation

    a. The text has been amended on page 4-29, increasing the total number of monitor wells by one, reflecting the additional Guard Basin deep well.

    b. Results of the well evaluation will be included in the RFI report.

16. <u>Page 5-2, Facility Maps</u>. Additional maps will be generated for the RFI report. A map will be generated presenting facility pipelines (including sewer) in the areas around the SWMUs. In addition, surface water run-on and runoff drainage system maps will be generated for each SWMU.

B. Appendix

17. <u>Page 2-4, Table 2-1</u>

a. All EPA analytical methods have been replaced with SW-846 methods or standard methods. Practical quantification limits for each compound will be referenced in Attachment B of the DCQAP.

b. The number of samples on Table 2-1 did not change based on the final resolution of the Part A comments.

18. <u>Page 2-5, Table 2-2</u>

a. A note has been added to Table 2-2 stating that Guard Basin samples will be analyzed for TCL and TAL parameters as requested by EPA in the permit.

b. The number of samples on Table 2-2 was changed based on the final resolution of the Part A comments.

19. <u>Page 4-5, Detection Limits</u>. The text was amended on page 4-5 to include PQLs and make a distinction that the references to the Contract Laboratory Program Statement of Work (CLP SOW) are only applicable to the TCL and TAL parameters being analyzed at the Guard Basin.

20. <u>Page 5-4, Field Notebooks</u>. All pages from the field notebooks will be copied and included in the RFI report as an appendix. The work plan text has been amended on page 5-5 to include this statement.

21. <u>Page 8-1, Analytical Procedures</u>

a/b The text on page 8-1 has been amended to include references to PQLs and make a distinction that statements citing the CLP SOWs are only applicable to the TCL and TAL parameters being analyzed for at the Guard Basin.

We appreciated the opportunity to meet with EPA to discuss our RFI Work Plan. We will begin implementing the RFI as soon as our Work Plan is approved.

Please call me at (215) 339-2215 if you have any questions.

Very truly yours,

Charles D. Barksdale, Jr., P.E.
Environmental Supervisor

CDB/pk
Enclosure

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
Region III
841 Chestnut Building
Philadelphia, Pennsylvania 19107

In reply refer to : 3HW51

APR 11 1991

RECEIVED
APR 22 1991
CH2M HILL/PHL

CERTIFIED MAIL
RETURNED RECEIPT REQUESTED

Mr. Charles D. Barksdale Jr., P.E.
Envirnomental Supervisor
Atlantic Refining & Marketing Corp.
3144 Passyunk Avenue
Philadelphia, PA 19145

Re: Atlantic Refining & Marketing Corp.
HWSA Corrective Action Permit No. PAD 00 228 9700

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1. Page 2-4 It is recommended that a location map of the 84 groundwater monitoring wells be provided if available in order to facilitate the evaulation of groundwater/hydrologic studies.

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B. Appendix

Page 2-4 Table 2-1

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b. Based on Part A comments, number of samples should be corrected accordingly.

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20. Page 5-4 Field Notebooks It is suggested that all information/data collection from all field notebooks be provided in the RFI Phase II Report for future references.

Page 8-1 Analytical Procedures

21. a. Please refer to Part A. Page 4-20 for comments.

b. Please note that the Contract Laboratory Program (CLP) is designed for CERCLA, not RCRA.

Atlantic must submit a response to EPA's comments within 45 days. If you have any questions in regard to this letter, please contact Hon Lee of my staff at 215-597-3181.

Sincerely,

Paul J. Gotthold, Chief
PA/DC Permits Section

Attachments
cc: H. Lee (3HW51)