Chevron

Chevron U.S.A. Inc.
P.O. Box 7408, Philadelphia, PA 19101

G. R. Moffitt
General Manager
Philadelphia Refinery

April 19, 1990

HAND DELIVERED

Mr. Stephen R. Wassersug, Director
EPA Region III
Hazardous Waste Management Division
841 Chestnut Street
Philadelphia, PA 19107

Dear Mr. Wassersug:

RCRA PERMIT NO. PAD049791098
RCRA FACILITY INVESTIGATION WORKPLAN

Part II.A of the RCRA permit issued by the U. S. EPA to the Chevron U.S.A, Inc., Philadelphia Refinery requires the submission of RCRA Facility Investigation (R.F.I.) Workplans for twelve (12) Solid Waste Management Units (SWMUs). Two (2) of the twelve (12) SWMUs are currently under appeal with the EPA Administrator (Chevron Corporation, Mr. Steven H. Roth to U. S. EPA, Office of the Administrator dated October 25, 1989). Enclosed are three (3) copies of the RCRA Facility Investigation (R.F.I.) Workplan which covers the remaining ten (10) SWMUs.

We will begin implementation of the workplan upon receipt of your approval. If you have any questions or need additional information, please contact our Mr. Mike Manigly at (215) 339-7466.

Very truly yours,

G. R. Moffitt

MTM/ssr
Enclosures
cc: PaDER

DAMES & MOORE A PROFESSIONAL LIMITED PARTNERSHIP
2360 MARYLAND ROAD, WILLOW GROVE, PENNSYLVANIA 19090 (215) 657-5000

April 16, 1990

Chevron USA, Inc.
30th Street and Penrose Avenue
Philadelphia, Pennsylvania 19101

Attention: M.T. Manigly
Environmental Specialist

Dear Mike:

Enclosed are two copies of the RFI Work Plan, as we had discussed.

We await your instructions.

Very truly yours,

DAMES & MOORE
A Professional Limited Partnership

Bruce C. Amig
Project Manager

BCA:pas
7613R

Enclosure

cc: Ralph T. Golia (D&M)

duplicate

EPA SUBMITTAL

RCRA FACILITY INVESTIGATION WORK PLAN

CHEVRON REFINERY

PHILADELPHIA, PENNSYLVANIA

APRIL 16, 1990

DAMES & MOORE

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

Appendix	
A	Well Construction Data
B-1	Slurry Wall Report
B-2	Slurry Wall/Oil Recovery System Report
C	Oil Recovery Trench Proposal
D	Lead Analytical Results (Soil)
E	Sampling Plan
F	Data Collection Quality Assurance Plan
G	Data Management Plan
H	Health and Safety Plan
I	Curriculum Vitae

1.0 INTRODUCTION

On September 27, 1989, the United States Environmental Protection Agency (EPA) issued a Resource Conservation and Recovery Act (RCRA) Corrective Action Permit (EPA I.D. No. 049 791 098) to Chevron USA, Incorporated (Chevron) for the Philadelphia Refinery (Figure 1) with an effective date of October 27, 1989. Part II - Specific Conditions of that permit set forth certain requirements relating to "corrective action for all releases of hazardous waste or constituents from any solid waste management unit" (SWMU) as provided under Section 3004 (u) of RCRA (Section 206 of the Hazardous and Solid Waste Amendments of 1984) and regulations promulgated in 40 CFR Section 264.101. Pursuant to and in compliance with Part II, Section (A), subsection (7)(a) of that permit and all relevant EPA reference guidance documents referenced therein, Chevron submits this required RCRA Facility Investigation (RFI) Work Plan and accompanying documents.

This RFI Work Plan will serve as a means to control activities associated with the assessment of the SWMUs as set forth in the referenced permit. Specifically, procedures for field investigation, field sampling, laboratory analysis, quality assurance, and health and safety information that are provided in this document will be followed in carrying out the investigations.

Ten SWMUs that require an RFI according to the permit are differentiated by operation practices and physical location into three separate groups. The designated categories with associated SWMUs are:

- Northwestern Fill Area
  (SWMU Nos. 87, 88, and 89)
- Storage Tank Area
  (SWMU Nos. 90, 91, 92, 93, 94, and 95)
- Bulkhead Seepage Area
  (SWMU No. 101)

The permit also requires that SWMU Nos. 96 and 97 be addressed in this RFI Work Plan. However, these two SWMUs are currently under appeal and, therefore, are not addressed in this Work Plan.

Additionally, as part of an ongoing assessment, Chevron has voluntarily conducted several investigations at the Philadelphia Refinery. The results of these earlier investigations were presented to the EPA and the Pennsylvania Department of Environmental Resources in the report entitled "Site Assessment Investigation, Volumes I and II, Chevron-Gulf Refinery, Philadelphia, Pennsylvania," dated February 13, 1987.

2.0 ENVIRONMENTAL SETTING

This chapter introduces and describes the three categories of SWMUs and the associated units. Location, physiography, hydrogeology, soil conditions, and surface water control at the site are also discussed.

2.1 LOCATION AND PHYSIOGRAPHY

The Chevron Refinery (the main plant) occupies approximately 350 acres in Philadelphia County, in southeastern Pennsylvania. The main plant is located in South Philadelphia at 30th Street and Penrose Avenue (Figure 1). This area of southern Philadelphia County is characterized by level topography composed of unconsolidated sediments of the Atlantic Coastal Plain Physiographic Province. The site lies within the Philadelphia 7.5-minute quadrangle at an approximate elevation of 10 feet above mean sea level. It is bounded to the north, west, and south by the Schuylkill River. The land surface gently increases in elevation to the east.

The RFI focuses upon the Northwestern Fill Area, Storage Tank Areas, and Bulkhead Seepage Area. The locations of the individual SWMUs associated with these areas are depicted on Figure 2 and discussed below.

2.1.1 Northwestern Fill Area

The Northwestern Fill Area is located in the northwestern corner of the main plant. It consists of SWMU Nos. 87, 88, and 89, which are adjacent to each other and separated by streets and avenues. This area is flanked to the north and west by the Schuylkill River and to the south and east by the plant.

2.1.1.1 SWMU No. 87

SWMU No. 87 (permit reference: Buried Lead Sludge Area 1) is bordered by the Schuylkill River, M Avenue, Second Street, and L Avenue. Inactive Process Unit No. 136, Inactive Cooling Tower 303, RCRA Hazardous Waste Tanks, and other structures are included in SWMU No. 87.

2.1.1.2 SWMU No. 88

SWMU No. 88 (permit reference: Buried Lead Sludge Area 2) is bordered by the Schuylkill River, M Avenue, and Second Street. Active Unit No. 137, including Cooling Tower 459, North Pump Room, South Pump Room, and other structures, are located within this unit.

2.1.1.3 SWMU No. 89

SWMU No. 89 (permit reference: Buried Lead Sludge Area 3) is bordered by the Schuylkill River, M Avenue, and Third Street. The unit contains No. 3 Separator, inactive Process Unit No. 2031, inactive Unit No. 2031 Flare, and Unit No. 433 Flare.

2.1.2 Storage Tank Areas

The Storage Tank Areas under investigation are located in the eastern half of the main plant. Groups of tanks have been assigned to each SWMU, primarily based upon divisions by streets and avenues. Individual SWMUs with their associated storage tanks are introduced below.

2.1.2.1 SWMU No. 90

SWMU No. 90 (permit reference: Buried Lead Sludge Area 4) is located in the northeastern section of the main plant area. It is bordered by Fifth Street, L Avenue, and Lanier Avenue. Product Storage Tanks 287, 288, 289, 290, 291, 292, and 300 are located in this unit.

2.1.2.2 SWMU No. 91

SWMU No. 91 (permit reference: Buried Lead Sludge Area 5) is located in the northeastern section of the main plant, bordered by Lanier Avenue, Pennypacker Avenue, Fifth Street, and L Avenue. Product Storage Tanks 276, 277, 278, 285, and 286 are located within this unit.

2.1.2.3 SWMU No. 92

SWMU No. 92 (permit reference: Buried Lead Sludge Area 6) lies in the east-central section of the main plant. It is bordered by Sixth Street, Penrose Avenue Bridge, Fifth Street, and Pennypacker Avenue. Product Storage Tanks 243, 244, 245, 246, 250, and 251 are located within this unit.

2.1.2.4 SWMU No. 93

SWMU No. 93 (permit reference: Buried Lead Sludge Area 7) lies in the southeastern section of the main plant. It is bordered by A Avenue, Second Street, B Avenue, and Third Street. Product Storage Tanks 201, 202, 203, 205, 206, 207, 208, 209, 210, 211, 212, 213, 214, 219, and 226 are located within this unit.

2.1.2.5 SWMU No. 94

SWMU No. 94 (permit reference: Buried Lead Sludge Area 8) lies in the south-central section of the main plant. It is bordered by B Avenue, Second Street, Old Penrose Ferry Road, and Penrose Avenue. Product Storage Tanks 215, 216, 217, 218, 220, 221, 223, 224, and 225 are contained within this unit.

2.1.2.6 SWMU No. 95

SWMU No. 95 (permit reference: Buried Lead Sludge Area 9) lies in the central section of the main plant, bordered by H Avenue, Second Street, and J Avenue. Inactive Product Storage Tanks 426, 427, 428, 429, 430, 431, 432, 434, 435, 436, 437, 438, 439, 440, 449, 450, 499, and 500 are included in this unit.

2.1.3 Bulkhead Seepage Area

The Bulkhead Seepage Area (SWMU No. 101) lies along the southwestern edge of the main plant and extends to south of the Penrose Avenue Bridge in the area of the inactive package and grease plant.

2.2 HYDROGEOLOGY

The hydrogeology of the main plant was investigated by Dames & Moore in 1986 and 1987. The data were derived from the installation of 62 shallow wells from 12 to 20 feet in depth and 6 deep wells from 25 to 85 feet in depth. Descriptive boring logs and monitoring well construction logs are presented in Appendix A. The results of the previous investigations are presented below. The geology of the site is introduced first, followed by a discussion of site hydrogeology.

2.2.1 Site Geology

The geologic units relevant to this investigation are Pleistocene-age and Cretaceous-age unconsolidated sediments. Specifically, the Pleistocene unit of relevance is the Trenton Gravel. The Cretaceous unit is the Raritan Formation (Lower Clay and Farrington Sand Members). These sediments are underlain by the Paleozoic-age Wissahickon Schist (bedrock).

To illustrate the spatial relationship of these units, using existing data, lines of cross section were selected (Figure 3) and cross sections A-A'-A", B-A-A', A-C, A-A'-A''', and C-A''' were constructed (Figures 4, 5, 6, 7, and 8). The cross sections illustrate that the site is underlain by unconsolidated sediments that increase in thickness to the southeast. These geologic units are discussed individually below.

2.2.1.1 Trenton Gravel and Fill Material

Directly underlying the main plant is the Pleistocene Trenton Gravel, which is composed of gravel, sand, silt, and clay. These sediments have been mixed with or underlie demolition debris used to fill low-lying areas. Specifically, the northwestern corner of the main plant was a swampy area filled in the 1930s.

2.2.1.2 Raritan Formation

The Raritan Formation underlies the Trenton Gravel. It is composed of the Lower Clay and Farrington Sand Members. The formation thickens to the southeast, as depicted in Figures 4, 7, and 8.

The thickness of the Lower Clay Member varies from 20 feet in the eastern area of the main plant to 70 feet at the Schuylkill River. The clay is first encountered at a depth of 5 to 10 feet.

The Farrington Sand underlies the Lower Clay Member in the area of the main plant. The Farrington Sand is composed of sand, gravel, and clay, and varies in thickness from 20 to 70 feet.

2.2.1.3 Wissahickon Formation

The Wissahickon Formation is competent bedrock. It is a mica schist with an upper surface that dips to the southeast (Figure 9). The contact between the Farrington Sand and the Wissahickon is unconformable.

2.2.2 Site Hydrogeology

Beneath the main plant are two separate aquifer systems separated by a confining unit. The aquifers occur in relatively coarse-grained unconsolidated deposits (Trenton Gravel and Farrington Sand) that are separated by a clay deposit (Lower Clay Member). These unconsolidated deposits overlie a competent schist bedrock that is probably an aquiclude. The aquifer associated with the Trenton Gravel and related deposits is designated the Upper Unconsolidated Aquifer. The aquifer associated with the Farrington Sand is designated the Lower Unconsolidated Aquifer. Both aquifers are discussed in further detail below.

2.2.2.1 Upper Unconsolidated Aquifer

The Upper Unconsolidated Aquifer occurs in the matrix of the Trenton Gravel and the demolition debris material. This unconfined aquifer is directly recharged by infiltration at the main plant. The horizontal components of flow are depicted on Figure 10. Two areas of mounded ground water exist within this aquifer: one in the north-central area, and the second in the south-central area of the main plant. The direction of flow is radially away from the mounds. A downward vertical component of flow exists between the Upper Unconsolidated Aquifer and the Lower Unconsolidated Aquifer. (The deeper wells have had water level elevations approximately 6 feet lower than the water elevations in the shallow wells.)

2.2.2.2 Lower Unconsolidated Aquifer

The matrix of the Lower Unconsolidated Aquifer is the Farrington Sand, which underlies the Lower Clay Member. The Lower Clay Member is the aquitard that separates the two aquifers. Thus, the Lower Unconsolidated Aquifer is confined in the study area, where the clay is absent. The horizontal component of flow is predominantly to the southwest, as depicted on Figure 11. The base of the aquifer is defined by the upper surface of the underlying Wissahickon Schist, which is less permeable than the overlying sand.

2.3 SOIL

The soil that underlies the main plant is classified as urban land series, which consists of artificial fill that overlies coastal plain and marsh deposits. The artificial fill consists of sand, gravel, silt, and clay with various debris.

2.4 SURFACE WATER

The main plant of the Chevron facility is located along the east bank of the Schuylkill River. Uncontrolled surface water would flow to the river. In the 1950s, the perimeter of the facility along the Schuylkill River was walled with 8,400 feet of interlocking steel sheet piling. As described in Section 2.1, the site is relatively level. Storm water run-off is controlled by a series of surface drains and underground drain lines that discharge to the oil/water separator units or the Schuylkill River. This storm water drainage system is depicted in Figure 2.

3.0 SOURCE CHARACTERIZATION

This chapter discusses the potential source characterization for contamination at the Northwestern Fill Area, the Storage Tank Area, and the Bulkhead Seepage Area. The discussion is subdivided into unit/disposal area characteristics, waste characteristics, and contamination characterization.

3.1 UNIT/DISPOSAL AREA CHARACTERISTICS

This section discusses general operating and waste management practices at the three categories of SWMUs. This information was developed from plant records and interviews with employees.

3.1.1 Northwestern Fill Area

The Northwestern Fill Area contains SWMU Nos. 87, 88, and 89, and is designated in the permit as a buried lead sludge area. This designation resulted from a Chevron submission to EPA, which indicated that the area had been used for sludge disposal. As discussed previously, this was a marshy area that had been filled before the development of refinery-related structures. The filling of this area probably occurred before the 1940s, prior to development of this area during World War II. After the filling of this area, cooling tower sludges and oily tank bottoms are believed to have been occasionally placed behind the cooling towers by the bulkhead. The precise placement and types of waste are not known. Currently, the waste associated with operation of the units within these SWMUs is handled and disposed of in accordance with applicable federal and state regulations.

3.1.2 Storage Tank Areas

Specific SWMUs with individual product tanks are identified in subsection 2.1.2. Petroleum products were stored in these tanks. Leaded sludges (K052) from tank bottoms were periodically removed from the tanks (approximately once every 10 years). The sludges were disposed of in areas near the tank cleanout ports by being placed directly on the ground or in shallow excavations approximately 2 to 4 feet in depth. The units began receiving waste in approximately 1960. This manner of tank sludge disposal was discontinued in January 1983. The production of leaded gasoline was discontinued in December 1987. Currently, tank bottom sludge is shipped off-site in accordance with applicable regulations. The disposal areas near the tank cleanout ports also may have received oily solids (K049), API separator sludge (K051), and spent catalysts (spent activated alumia). The storage tanks are located jointly or individually within berm- or dike-enclosed areas.

3.1.3 Bulkhead Seepage Area

No waste disposal activities are known to have occurred in the Bulkhead Seepage Area. This area contains several potential sources of leakage, including barge and train loading facilities, and underground pipeways. Minor seepage, if present, may include No. 2 oil, jet fuel, lube oil, and/or gasoline. This area has no known release controls south of SWMU No. 9. Also, Chevron has voluntarily developed and implemented two corrective measure tasks in the area of SWMU No. 101. The tasks included installation of a slurry wall with an oil recovery system and an oil recovery trench at separate locations. Supportive documentation for the slurry wall is provided in Appendices B-1 and B-2, and in Appendix C for the trench. See Section 4.3 for a discussion of each.

3.2 WASTE CHARACTERISTICS

The substances indicated as being potentially associated with disposal and seepage areas are discussed below. Specific constituents relative to each substance are summarized on Table 1.

Leaded tank bottoms have EPA Hazardous Waste No. K052. The hazardous constituent is lead. Tetraethyl lead may also be present.

API separator sludge has EPA Hazardous Waste No. K049. The hazardous constituents are lead and chromium.

No. 2 fuel oil contains naphthalene and the secondary constituents of benzene, toluene, and xylene.

Jet fuel contains naphthalene and the secondary constituents of benzene, toluene, and xylene.

Gasoline contains the secondary constituents of benzene, toluene, xylene, ethyl benzene, and naphthalene.

3.3 CONTAMINATION CHARACTERIZATION

The data developed during previous investigations conducted at the Northwestern Fill Area, Storage Tank Areas, and Bulkhead Seepage Areas are reviewed in this section. Tasks conducted during the previous investigations included the installation of monitoring wells and limited soil sample collection and analysis. The soil samples were collected primarily in the storage tank areas. This information will assist in showing the need for future investigations at the site.

3.3.1 Northwestern Fill Area

No analytical data are available for the Northwestern Fill Area. In order to identify free-floating hydrocarbons, eight shallow monitoring wells and one deep monitoring well were installed during 1986. The locations of these wells are depicted on Figures 2 and 3. Further discussion of well installation is provided in Section 2.2.

Floating petroleum hydrocarbon has been observed in two of nine wells (C97 and C65D). Ground water samples have not been collected from these wells for analysis. The floating petroleum in deep well C65D was identified as a low-molecular-weight hydrocarbon (diesel fuel or gasoline) through a GC fingerprint scan. The occurrence of the floating hydrocarbon in this well was attributed to a crack in the surface casing; therefore, the well was abandoned and tremie grouted in place. Well C61 was razed during construction of the RCRA Hazardous Waste Tanks. The floating petroleum hydrocarbon in well C97 has not been analyzed.

3.3.2 Storage Tank Areas

At the Storage Tank Areas, which involve SWMU Nos. 90, 91, 92, 93, 94, and 95, soil samples were collected from borings and test pits for analytical testing. Laboratory results are provided in Appendix D. The samples were analyzed for total lead. The sample locations were biased toward areas of suspected contamination based on known past operational practices. This sampling was conducted in 1986. The analytical results indicated that lead was present in the areas sampled at concentrations ranging from 15 ppm to 17,000 ppm. At most sample locations, lead concentrations decreased significantly with depth and did not exceed 500 ppm below a depth of 2 feet. At a few sample locations, lead concentrations increased with depth and were as high as 3,220 ppm at 4 to 5 feet below the ground surface at Tank 276. This sample was collected within an area posted for lead disposal. No direct correlation between visual appearance of the material sampled (sludge-laden soil) and the reported lead concentrations can be made, with the exception of tank bottom material, which was easily identified and generally had the highest lead concentrations. The sample locations are depicted in this report on Figure 12. The results are provided on Tables 2 through 7. The results of the soil sampling and analyses at each SWMU are discussed in the following subsections.

A total of 14 shallow monitoring wells and 1 deep well have been drilled in the area of SWMU Nos. 90, 91, 92, 93, 94, and 95. Well locations are depicted on Figure 3. According to water level elevations in the wells, the direction of ground water flow is most likely to the east. Floating petroleum hydrocarbon was not observed in the wells at the subject area during the initial study.

3.3.2.1 SWMU No. 90

Two test borings were drilled in an area east of Tank 289. A lead concentration of 1,970 mg/kg was detected in a sample collected from 2 to 2.5 feet in depth. In an area east of Tank 290, a lead concentration of 857 mg/kg was detected in a sample from 0.0 to 0.25 foot in depth. A soil sample collected at the same location, but at a greater depth (0.75 to 1.25 feet), had a lead concentration of 370 mg/kg. These results are summarized in Table 2.

3.3.2.2 SWMU No. 91

In the area of SWMU No. 91, three test borings were conducted in the possible disposal areas near Tanks 276, 277, and 286. All three samples indicated the disposal of leaded tank bottoms. These results are summarized in Table 3. At all three locations, the stratigraphically higher sample (from 0 to 2 feet) revealed the greatest concentration of lead. For example, boring 286 (0.5 to 1.0 foot) revealed a lead concentration of 1,630 mg/kg. The lead concentration detected in a sample collected from 3.0 to 4.0 feet in depth was 480 mg/kg.

3.3.2.3 SWMU No. 92

A total of 8 soil borings and 1 test pit have been performed at separate potential disposal areas in SWMU No. 92. Lead values ranged from 360 mg/kg in boring 244 at 3.0 to 4.0 feet in depth to 1,490 mg/kg at 1.0 to 1.5 feet in depth at boring 243. These analytical results are presented in Table 4.

3.3.2.4 SWMU No. 93

Seven soil borings and 1 test pit have been emplaced at potential disposal areas in SWMU No. 93. At locations near Tanks 202, 203, 205, 207, and 209, analytical results ranged from 29 mg/kg in boring 203 (1.5 to 2.0 feet) to 671 mg/kg in boring 209 (2.5 to 3.5 feet). Higher lead values were detected in borings 206 and 208, and in test pit 12 (near Tank 205), with values ranging from 330 mg/kg in boring 209 (1.0 to 1.5 feet in depth) to 1,080 mg/kg in test pit 12 (0.5 to 1.0 foot). These results are summarized in Table 5.

3.3.2.5 SWMU No. 94

A total of 2 test pits and 2 soil borings have been conducted at SWMU No. 94. Lead concentrations ranged from 15 mg/kg in test pit 215 at 1.5 to 2.0 feet in depth to 17,000 mg/kg in test pit 224 at 0.5 to 1.0 foot in depth. These results are summarized in Table 6.

3.3.2.6 SWMU No. 95

A total of four borings were conducted at separate potential disposal areas in SWMU No. 95. Lead concentrations ranged from 50.2 mg/kg in boring 438 (1.0 to 2.0 feet in depth) to 1,760 mg/kg in boring 430 (0.0 to 0.5 foot). Analytical results and field observations are summarized on Table 7.

3.3.3 Bulkhead Seepage Area

The Bulkhead Seepage Area (SWMU No. 101) was not used for waste disposal. This area contains several loading facilities and underground pipeways that are potential sources of leakage. No soil samples have been collected for analysis from this area.

A total of eight ground water monitoring wells have been installed near this area. Six of these wells are shallow (A4, A8, A9, A11, A20, and A22) and one is deep (A21D). Floating petroleum hydrocarbon was noted in wells A4, A8, and A20. Additionally, a series of vertical culverts have been installed to delineate hydrocarbon extent. The culverts located along the Schuylkill River between F Avenue and Penrose Ferry Avenue have commonly been observed to contain floating hydrocarbon.

4.0 RCRA FACILITY INVESTIGATION

The primary purposes of the RFI are to:

- Further develop a detailed understanding of the geology and hydrogeology at the site.
- Characterize the nature, extent, and rate of migration of hazardous constituents in the soil and ground water to allow for the development of corrective measures.

Criteria, which will determine whether corrective measure studies are warranted, are not addressed specifically in the Work Plan. However, SWMU categories and/or each SWMU will be evaluated on an individual basis using the data derived from the implementation of the Work Plan. Example concentrations of substances meeting criteria for action levels may be used as presented in the permit (Attachment F; Table 1). For substances that are absent from this list and are revealed to be present, criteria will be developed using the recommended exposure assumptions as provided in the permit (Attachment F; Table 3).

Additional data are needed for the Chevron Refinery to evaluate the site conditions. The tasks in this RFI Work Plan are based on existing knowledge of the site.

Where contamination has been shown to exist through previous analytical results, this investigation focuses on degree and extent. Where no analytical data exist, this investigation focuses on initial assessment of the environmental conditions.

Specifically, ten SWMUs located within the main plant are addressed in this RFI Work Plan. A review of the background data reveals that some soil is contaminated with lead and that hydrocarbons were floating on the water table at some locations. These background data were originally collected to examine the worst-case situation and not to determine degree and extent.

As previously discussed, the ten SWMUs addressed in this Work Plan have been divided into three categories. Investigative tasks relative to each of the three SWMU categories (the Northwestern Fill Area, the Storage Tank Areas, and the Bulkhead Seepage Area) are provided in Sections 4.1 through 4.3. These tasks will be performed in accordance with the accompanying Sampling Plan (Appendix E), Data Collection Quality Assurance Plan (Appendix F), Data Management Plan (Appendix G), and Health and Safety Plan (Appendix H).

Also, the RFI is viewed as a dynamic process. Data will be collected to develop environmentally sound corrective measures. The degree of characterization depends on the goals of the corrective measures.

4.1 NORTHWESTERN FILL AREA (SWMU Nos. 87, 88, and 89)

The Northwestern Fill Area (SWMU Nos. 87, 88, and 89) will be investigated as a single unit with regard to soil and hydrologic conditions. Figure 2 depicts the locations of these units. In order to characterize this area with respect to soil quality, a soil assessment will be conducted, including a soil gas survey. To characterize the hydrogeology of the area, a ground water monitoring plan has been developed. The specific tasks that constitute these investigative plans are discussed in the following subsections.

4.1.1 Soil Assessment Plan

The soil assessment plan includes soil boring installation and a soil gas survey.

4.1.1.1 Soil Borings

A total of 15 soil borings will be drilled. The locations for 11 of the borings are random and non-biased. The other four locations have been selected based on the potential for material disposal behind the cooling towers. The boring locations are depicted on Figures 13, 14, and 15.

Each boring will be advanced by a hollow-stem auger drilling rig, if not obstructed by physical barriers. Soil samples will be retrieved by split spoons in 2-foot intervals. The borings will be advanced to the water table (approximately 3 feet). If a physical barrier obstructs movement of the drilling rig, the boreholes will be advanced by a tripod and/or hand auger. Samples will be obtained from the split spoons.

Each retrieved soil sample will be visually described and scanned by an organic vapor analyzer (OVA). The OVA will also be used to scan the borehole following boring completion. These readings and the visual description of the soil samples will be recorded on the daily field logs.

At each boring, a discrete grab sample will be collected from each retrieved interval above the water table, with a maximum of two samples per boring. Specific sample collection will be performed at the discretion of the field geologist and will be biased toward visually contaminated soil and on-site OVA readings. These samples will be analyzed for the targeted representative parameters listed on Table 8. These parameters have been selected because they are representative hazardous constituents suspected to be present at the Chevron Refinery, based on the types of wastes discussed in Section 3.2. One in every four samples (25 percent) will be randomly selected for analysis of the Skinner List constituents (Table 9).

4.1.1.2 Soil Gas Survey

The purpose of this task is to scan for the degree and extent of floating hydrocarbon associated with monitoring wells C65 and C97 using the relatively rapid mechanism of a soil gas survey. This methodology for assessment was selected for use here because light hydrocarbons are anticipated based on previous sampling results. Subsequent to this task, monitoring wells may be installed. The precise placement of these wells will be guided by the results of the soil gas survey.

A soil gas survey will be conducted in the vicinity of wells C65 and C97. In the proximity of well C65, a total of 20 sampling points are proposed. These points are illustrated in Figure 14. In the proximity of well C97, a total of 15 sampling points are proposed, and are illustrated in Figure 15. The points are arranged in a general grid pattern with a 50-foot spacing. Each grid is expanded in an upgradient direction to identify the potential source(s). Precise sampling locations may be slightly modified to account for facility structures. The proposed number and locations of sampling points should be sufficient to provide an initial characterization of the extent of floating petroleum hydrocarbon. However, should the data prove to be inconclusive, the soil gas survey may be expanded. Additional sampling locations would be proposed and analyzed with EPA oversight.

To conduct the soil gas survey, 3/8-inch holes will be made to a depth of 4 feet using a "rebar" and a hammer. A hollow stainless steel probe will be inserted temporarily into the bottom of each hole. The in-situ soil gas will be drawn through the probe and analyzed by an OVA and a gas chromatograph (GC). Before insertion of the stainless steel probe into the hole, the probe will be decontaminated internally and externally by a soapy water wash and a rinse with deionized water. Background readings will be taken with the OVA from the probe before its placement in the hole.

The OVA and GC will be calibrated at the beginning of each working day. Calibration procedures will be followed and documented as presented in Appendix F.

4.1.2 Ground Water Monitoring Plan

To assess the hydrogeologic conditions in the subject area, a two-phased approach will be implemented. The first phase will consist of:

- Installation of monitoring wells
- Sampling of recently installed and existing monitoring wells
- Collection and analysis of hydrologic data (if necessary)

The second phase of the plan, if necessary, will consist of installing additional monitoring wells to further define hydrologic conditions.

In order to evaluate the aquifer conditions underlying SWMU Nos. 87, 88, and 89, a total of 12 shallow monitoring wells will be used in the first phase. Seven shallow monitoring wells currently exist in the area (C53, C62, C63, C64, C65, C97, and C98). Five additional wells will be installed. The installation of these wells and other tasks of the monitoring plan are presented below.

4.1.2.1 Monitoring Well Installation

Five additional wells (C104 through C108) are proposed in the Northwestern Fill Area. Four of the wells will be emplaced around the perimeter of the area and one well will be placed in the southeast corner of SWMU No. 89. These well locations are illustrated in Figures 13, 14, and 15.

These wells will be drilled into the Upper Unconsolidated Aquifer to depths of 15 feet or less. The screened interval will extend above and below the water table to the total depth of the well. The well material will be Schedule 40 PVC. Monitoring well installation will be conducted in accordance with the procedures outlined in Appendix A. A schematic well completion diagram is provided in Figure 16.

If the water quality results from the shallow monitoring wells indicate significant levels of contaminants, Chevron will initially propose to install one deep well in the underlying Lower Unconsolidated Aquifer. If necessary, the well will be proposed after two rounds of water quality data have been collected from the shallow aquifer, as discussed in subsection 4.1.2.2. This deep well will be located hydrogeologically downgradient from the area of the Upper

Unconsolidated Aquifer that exhibits the highest level of contaminants. The well location will be submitted to EPA for comment and approval prior to installation. A generalized construction diagram is provided in Figure 17.

4.1.2.2 Sampling of Monitoring Wells

Once the monitoring wells have been installed, Chevron will collect and analyze ground water samples for four consecutive events, at 3-month intervals, from wells C53, C62, C63, C64, C65, C97, C98, C104, C105, C106, C107, and C108.

During the first sampling event, water samples will be analyzed for targeted representative parameters as listed on Table 10. These substances are representative of the hazardous constituents indicated by known historic operations.

During the second round, one sample will be selected for analyses of the Skinner List of constituents (Table 9). The well selected will have exhibited the highest concentrations of the representative parameters during the first sampling event. The other wells will continue to be analyzed as specified during the first event.

During the third and fourth events, water samples will be analyzed for the targeted representative parameters plus additional critical compounds detected during the Skinner List constituent evaluation. Ground water samples from additional wells will be collected during the next appropriate sampling event.

If floating petroleum hydrocarbon is noted in a monitoring well, a sample of the petroleum will be collected for GC characterization. Specific ground water sampling and analytical procedures are given in Appendix E. Quality assurance procedures will be followed as outlined in Appendix F.

4.1.2.3 Collection and Analysis of Hydrologic Data

Upon installation and development of the ground water monitoring system, and if contamination has been identified, the characteristics of the aquifer(s) underlying the Philadelphia Refinery will be evaluated. Characteristics to be evaluated include transmissivity, storativity, and the degree of interconnection between wells. This evaluation will be accomplished by performing a pumping test on the downgradient monitoring well with the greatest yield and using the other wells as observation points. The duration of the pumping test will depend on the well yield. The proposed test durations as triggered by well yields are:

- A 1- to 5-gpm (gallons per minute) yield will result in a 6-hour pumping test.
- A 5- to 20-gpm yield will result in a 12-hour pumping test.
- A yield greater than 20 gpm will result in a 24-hour pumping test.

Ground water will be removed by a submersible pump. Pump decontamination and handling procedures will be the same as the procedures used in well evacuation (Appendix E).

Water level data will be collected prior to the sampling or pumping of each well. These data will provide a measure of temporal variation of the water table. A potentiometric surface map or maps will be constructed using the data collected from the monitoring system. These data will be used to evaluate the placement of the new monitoring wells, and to determine whether additional wells are needed to complement the monitoring system.

4.2 STORAGE TANK AREAS

The investigation of the Storage Tank Areas involves SWMU Nos. 90, 91, 92, 93, 94, and 95. These units will be studied jointly or individually, depending upon their locations relative to each other. Specifically, SWMU Nos. 90/91 and 93/94 will be jointly investigated, while SWMU Nos. 92 and 95 will be individually investigated. In order to characterize soil and ground water conditions at these units, a soil assessment plan (including soil borings) and a ground water monitoring plan will be implemented. This section discusses specific information regarding these plans.

4.2.1 SWMU Nos. 90 and 91

SWMU Nos. 90 and 91 are located in the east-central section of the main plant (Figure 2). A total of 13 product storage tanks within 5 diked areas are present in the study area. Lead concentrations greater than 500 mg/kg have been found in areas near Tanks 276, 277, 289, and 290, as discussed in subsection 3.3.2. In order to further characterize these and other areas, a soil assessment plan and a ground water monitoring plan have been developed.

4.2.1.1 Soil Assessment Plan

Soil borings will be located in areas of concern identified by previous sampling results and in areas of suspected tank bottom disposal. Generally, borings are located in areas near tank ports. In SWMU No. 90, a total of 16 borings are proposed. In SWMU No. 91, a total of 22 borings are proposed. Soil samples will be collected from each boring at or near the surface and from the subsurface in order to evaluate the degree and extent of contamination. The boring locations and boring designations are depicted on Figures 18 and 19.

Each boring will be advanced by a hollow-stem auger drilling rig, if not obstructed by physical barriers. Soil samples will be retrieved by split spoons in 2-foot intervals. The borings will be advanced to the water table (approximately 3 feet).

If a physical barrier obstructs movement of the drilling rig, the boreholes will be advanced by a tripod and/or hand auger.

Each retrieved soil sample will be visually described and scanned by an OVA. The OVA will also be used to scan the borehole following boring completion. These readings and the visual description of the soil samples will be recorded on the daily field logs.

Samples will be collected to evaluate the vertical extent of contamination. At each boring location, the soil from the 0- to 0.5-foot interval will be collected for analysis. At least one additional sample will be collected from each boring. The selection of the additional sample(s) will be biased toward potentially contaminated sections based on visual observations and OVA readings. All samples will be discrete grab samples. These samples will be analyzed for the indicator parameters presented on Table 8. One in every four samples (25 percent) will be analyzed for the Skinner List constituents (Table 9).

4.2.1.2 Ground Water Monitoring Plan

The objective of the ground water monitoring plan is to evaluate the effect(s) of past site operations on ground water quality. To achieve the objective, a two-phase approach will be implemented. The first phase will consist of:

- Installation of monitoring wells
- Sampling of monitoring wells
- Collection and analysis of hydrologic data

The second phase, if necessary, will consist of installing additional monitoring wells to further characterize hydrologic conditions.

In order to evaluate the aquifer conditions underlying SWMU Nos. 90 and 91, eight shallow monitoring wells will be used during the first phase. Six of the wells (C109 through C114) will be installed; two of the wells currently exist.

4.2.1.2.1 Monitoring Well Installation

Six wells (C109 through C114) are proposed for SWMU Nos. 90 and 91. Four of the wells (C110, C111, C113, and C114) will be located east of the units along Lanier Avenue, which is hydrologically downgradient. Two of the wells (C109 and C112) are proposed at an upgradient position along Fifth Street. These wells will be shallow, with total depths not to exceed 15 feet. They will have screened intervals above and below the water table to the total depth of the well. The well material will be Schedule 40 PVC. Monitoring well installation procedures are outlined in Appendix E. A schematic well completion diagram is provided in Figure 16.

If the water quality results from the shallow monitoring wells show significant levels of contaminants, Chevron will initially propose to install one deep well in accordance with specifications as discussed in subsection 4.1.2.1 of this Work Plan.

4.2.1.2.2 Sampling of Monitoring Wells

Once the monitoring wells have been installed, Chevron will collect and analyze ground water samples for four consecutive events, at 3-month intervals.

During the first sampling event, water samples will be analyzed for the targeted representative parameters listed on Table 10. These substances are the primary hazardous constituents indicated by known historic operations.

During the second round, one sample will be selected for analyses of the Skinner List of constituents (Table 9). The well selected will have exhibited the highest concentrations of the targeted representative parameters during the first sampling event. The other wells will continue to be analyzed as specified during the first event.

During the third and fourth events, water samples will be analyzed for the targeted suite of parameters plus additional critical compounds detected during the Skinner List constituent evaluation. Additional ground water samples will be collected during the next appropriate scheduled sampling event.

If floating petroleum hydrocarbon is noted in a monitoring well, a sample of the petroleum will be collected for GC characterization.

Specific ground water sampling and analytical procedures are given in Appendix E. Quality assurance procedures will be followed as outlined in Appendix F.

4.2.1.2.3 Collection and Analysis of Hydrologic Data

Upon installation and development of the ground water monitoring system, and if contamination has been identified, the characteristics of the aquifer(s) underlying the Philadelphia Refinery will be evaluated. Characteristics to be evaluated include transmissivity, storativity, and the degree of interconnection between wells. This evaluation will be accomplished by performing a pumping test on the downgradient monitoring well with the greatest yield and using the other wells as observation points. The duration of the pumping test will depend on the well yield. The proposed test durations as triggered by well yields are:

- A 1- to 5-gpm yield will result in a 6-hour pumping test.
- A 5- to 20-gpm yield will result in a 12-hour pumping test.
- A yield greater than 20 gpm will result in a 24-hour pumping test.

Ground water will be removed by a submersible pump. Pump decontamination and handling procedures will be the same as the procedures used in well evacuation (Appendix E).

Water level data will be collected prior to the sampling or pumping of each well. These data will provide a measure of temporal variation of the water table. A potentiometric surface map or maps will be constructed using the data collected from the monitoring system. These data will be used to evaluate the placement of the new monitoring wells, and to determine whether additional wells are needed to complement the monitoring system.

4.2.2 SWMU No. 92

SWMU No. 92 is located in the east-central section of the main plant, immediately south of SWMU No. 91 (Figure 2). A total of six product storage tanks are present within the study area. Previous analytical testing has indicated lead concentrations greater than 500 ppm near Tanks 243 and 246. The soil boring plan and the ground water monitoring plan intended to characterize this unit are discussed in the subsequent subsections.

4.2.2.1 Soil Assessment Plan

A total of 24 borings will be emplaced in SWMU No. 92. Soil borings will be located in areas of concern identified by previous sampling results and in areas of suspected tank bottom disposal. Generally, the borings will be located in the corners of the bermed storage areas near tank ports. Soil samples will be collected from each boring at or near the surface and from the subsurface in order to evaluate the degree and extent of contamination. The boring locations are depicted on Figure 20.

Each boring will be advanced by a hollow-stem auger drilling rig, if not obstructed by physical barriers. Soil samples will be retrieved by split spoons in 2-foot intervals. The borings will be advanced to the water table (approximately 3 feet).

If a physical barrier obstructs movement of the drilling rig, the boreholes will be advanced by a tripod and/or hand auger.

Each retrieved soil sample will be visually described and scanned by an OVA. The OVA will also be used to scan the borehole following boring completion. These readings and the visual description of the soil samples will be recorded on the daily field logs.

Samples will be collected to evaluate the vertical extent of contamination. At each boring location, the soil from the 0- to 0.5-foot interval will be collected for analysis. The data generated from this sample analysis will allow the assessment of surface disposal. At least one additional sample will be collected from each boring. The selection of the additional sample(s) will be biased toward potentially contaminated sections based on visual observations and OVA readings. All samples will be discrete grab samples. These samples will be analyzed for targeted representative parameters as presented on Table 8. One in every four samples (25 percent) will be analyzed for the Skinner List constituents (Table 9).

4.2.2.2 Ground Water Monitoring Plan

The objective of the ground water monitoring plan is to evaluate the effects of previous site operations on the ground water in the immediate area of this unit. To achieve this objective, a two-phase approach will be implemented. The first phase will consist of:

- Installation of monitoring wells
- Sampling of monitoring wells
- Collection and analysis of hydrologic data

The second phase, if necessary, will consist of installing additional wells to further characterize hydrologic conditions.

In order to evaluate aquifer conditions at SWMU No. 92, four shallow monitoring wells will be used during the first phase. Three of the wells will be installed; one well, B94, was installed in 1986.

4.2.2.2.1 Monitoring Well Installation

Three wells (B115 through B117) are proposed for installation along the perimeter of SWMU No. 92. Two of these wells (B115 and B116) will be located along the eastern flank of the unit on Sixth Street, as is the existing well (B94), at hydrogeologically downgradient positions. One well (B117) will be placed along Fifth Street at a hydrogeologically upgradient position. Well locations are indicated on Figure 20. The wells will be shallow, with a total depth not to exceed 15 feet. The wells will have a screened interval above and below the water table to the total depth of the well. The well material will be Schedule 40 PVC. Monitoring well installation procedures are outlined in Appendix E. A schematic well completion diagram is provided on Figure 16.

If the water quality results from the shallow monitoring wells indicate significant levels of contaminants, Chevron will initially propose to install one deep well in the Lower Unconsolidated Aquifer in accordance with specifications as discussed in subsection 4.1.2.1 of this Work Plan.

4.2.2.2.2 Sampling of Monitoring Wells

The collection and analysis of ground water samples from wells B94, B115, B116, and B117 will be in accordance with specifications as provided in subsection 4.2.1.2.2.

4.2.2.2.3 Collection and Analysis of Hydrologic Data

The tasks specified in subsection 4.2.1.2.3 will be performed to further assess the aquifer underlying SWMU No. 92, if necessary.

4.2.3 SWMU Nos. 93 and 94

SWMU Nos. 93 and 94 are located in the south-central section of the main plant (Figure 2). A total of 21 product storage tanks within 17 diked areas comprise the units. Areas with lead concentrations greater than 500 mg/kg were discovered near Tanks 205, 206, 207, 208, and 209 at SWMU No. 93 and near Tanks 221 and 224 at SWMU No. 94.

4.2.3.1 Soil Assessment Plan

In the subject area, a total of 67 borings will be emplaced with 45 borings at SWMU No. 93 and 22 borings at SWMU No. 94. Boring locations were selected in areas of concern identified by previous sampling results and in areas of potential tank bottom disposal. Reportedly, tank bottom disposal occurred in the corners of diked areas near tank ports. Soil samples will be collected from each boring at or near the surface and from the subsurface in order to evaluate the degree and extent of contamination. The boring locations are depicted on Figures 21, 22, and 23.

Each boring will be advanced by a hollow-stem auger drilling rig, if not obstructed by physical barriers. Soil samples will be retrieved by split spoons in 2-foot intervals. The borings will be advanced to the water table (approximately 3 feet).

If a physical barrier obstructs movement of the drilling rig, the boreholes will be advanced by a tripod and/or hand auger.

Each retrieved soil sample will be visually described and scanned by an OVA. The OVA will also be used to scan the borehole following boring completion. These readings and the visual description of the soil samples will be recorded on the daily field logs.

Samples will be collected to evaluate the vertical extent of contamination. At each boring location, the soil from the 0- to 0.5-foot interval will be collected for analysis. The data generated from this sample analysis will allow the assessment of surface disposal. At least one additional sample will be collected from each boring. The selection of the additional sample(s) will be biased toward potentially contaminated sections based on visual observations and OVA readings. All samples will be discrete grab samples. These samples will be analyzed for targeted representative parameters as presented on Table 8. One in every four samples (25 percent) will be analyzed for the Skinner List constituents (Table 9).

4.2.3.2 Ground Water Monitoring Plan

In order to assess hydrogeologic conditions in the area of SWMU Nos. 93 and 94, a two-phase investigation will be implemented. The first phase will consist of:

- Installation of monitoring wells
- Sampling of monitoring wells
- Collection and analysis of hydrologic data

The second phase, if necessary, of the plan will consist of installing additional monitoring wells to further define hydrologic conditions.

At a minimum, ten monitoring wells will be used for ground water assessment during the first phase of the study. Five of these wells have been previously installed (A15, A16, A23, A26, and A91). For locations of these wells, see Figures 21, 22, and 23. Five additional wells will be installed. The installation of these wells and the other tasks of the monitoring plan are presented below.

4.2.3.2.1 Monitoring Well Installation

Five wells (A118 through A122) are proposed along the perimeter of SWMU Nos. 93 and 94. Two of these wells (A118 and A119) will be located along the northern flank. Three wells (A120, A121, and A122) will be drilled along the southern flank. Well locations are indicated on Figures 21, 22, and 23. As with the existing wells, the proposed wells will be shallow, with a total depth not to exceed 15 feet. These wells will be screened above and below the water table to the total depth of the well. The well components will be Schedule 40 PVC. Well installation procedures are outlined in Appendix E. A schematic well completion diagram is provided on Figure 16.

If the water quality results from the shallow monitoring wells indicate significant levels of contaminants, Chevron will initially propose to install one deep well in the Lower Unconsolidated Aquifer in accordance with specifications as discussed in subsection 4.1.2.1 of this Work Plan.

4.2.3.2.2 Sampling of Monitoring Wells

The collection and analysis of ground water samples from wells A15, A16, A23, A26, A91, A118, A119, A120, A121, and A122 shall be conducted in accordance with specifications as presented in subsection 4.2.1.2.2 of this Work Plan.

4.2.3.2.3 Collection and Analysis of Hydrologic Data

The tasks specified in subsection 4.2.1.2.3 of this Work Plan will be implemented to further assess the aquifer conditions underlying SWMU Nos. 93 and 94, if necessary.

4.2.4 SMWU No. 95

SWMU No. 95 is located in the west-central section of the main plant (Figure 2). Currently, a total of 18 product storage tanks within 1 diked area comprise the tank storage area of the unit. These tanks and associated process lines are scheduled for removal starting in July of 1990, with the exception of Tanks 429 and 437. The implementation of investigative tasks will commence after completion of tank and associated process line removal. Areas with lead concentrations greater than 500 mg/kg were identified near Tanks 426 and 430.

4.2.4.1 Soil Assessment Plan

At SWMU No. 95, a total of 20 borings will be drilled to assess soil quality. Some boring locations have been selected in areas of concern identified by previous sampling results. Three borings will be drilled in each area identified near Tanks 426 and 430. These borings will be spaced approximately 25 feet apart. Fourteen other borings will be placed in areas of suspected disposal and to verify previous

analytical results. Soil samples will be collected from each boring at or near the surface and from the subsurface in order to evaluate the degree and extent of contamination. Boring locations are depicted on Figure 24.

Each boring will be advanced by a hollow-stem auger drilling rig, if not obstructed by physical barriers. Soil samples will be retrieved by split spoons in 2-foot intervals. The borings will be advanced to the water table (approximately 3 feet).

If a physical barrier obstructs movement of the drilling rig, the boreholes will be advanced by a tripod and/or hand auger.

Each retrieved soil sample will be visually described and scanned by an OVA. The OVA will also be used to scan the borehole following boring completion. These readings and the visual description of the soil samples will be recorded on the daily field logs.

Samples will be collected to evaluate the vertical extent of contamination. At each boring location, the soil from the 0- to 0.5-foot interval will be collected for analysis. The data generated from this sample analysis will allow the assessment of surface disposal. At least one additional sample will be collected from each boring. The selection of the additional sample(s) will be biased toward potentially contaminated sections based on visual observations and OVA readings. All samples will be discrete grab samples. These samples will be analyzed for targeted representative parameters as presented on Table 8. One in every four samples (25 percent) will be analyzed for the Skinner List constituents (Table 9).

4.2.4.2 Ground Water Monitoring Plan

In order to assess the hydrogeologic conditions in the area of SWMU No. 95, a two-phase investigation will be implemented. The first phase will consist of:

- Installation of monitoring wells
- Sampling of monitoring wells
- Collection and analysis of hydrologic data

The second phase, if necessary, of the plan will consist of installing additional monitoring wells to further define hydrologic conditions.

At a minimum, four monitoring wells will be used for ground water assessment during the first phase of the study. The installation of these wells and the other tasks relative to the monitoring plan are discussed below.

4.2.4.2.1 Monitoring Well Installation

Four monitoring wells (B123, B124, B125, and B126) are proposed for installation along the perimeter of the unit. Well B123 will be located northeast of the unit, at a hydrologically upgradient position. Wells B124, B125, and B126 will be located along the southeastern flank of the unit, at hydrogeologically downgradient positions. Well locations are depicted on Figure 24. These wells will be drilled to a total depth of less than 15 feet. They will have a screened interval above and below the water table. The well components will be Schedule 40 PVC. Well installation procedures are outlined in Appendix E. A schematic well completion diagram is provided on Figure 16.

If the water quality results from the shallow monitoring wells indicate significant levels of contaminants, Chevron will initially propose to install one deep well in the Lower Unconsolidated Aquifer in accordance with specifications as discussed in subsection 4.1.2.1 of this work plan.

4.2.4.2.2 Sampling of Monitoring Wells

The collection and analysis of ground water samples from wells B123, B124, B125, and B126 will be conducted in accordance with specifications as presented in subsection 4.2.1.2.2 of this Work Plan.

4.2.4.2.3 Collection and Analysis of Hydrologic Data

The tasks specified in subsection 4.2.1.2.3 of this Work Plan will be implemented to further assess the aquifer conditions underlying SWMU No. 95, if necessary.

4.3 BULKHEAD SEEPAGE AREA (SWMU No. 101)

The Bulkhead Seepage Area (SWMU No. 101) is located in the southwestern perimeter of the main plant along the Schuylkill River (Figure 2). The bulkhead is comprised of interlocking steel sheet piling. Minor seeps to the Schuylkill River may have occurred in this area. In order to initially assess this area, Chevron has installed several monitoring wells and culverts (see Figure 2 for their locations). As a result of this work, Chevron identified areas of concern and voluntarily installed a slurry wall along the bulkhead just south of the Penrose Avenue Bridge.

The slurry wall was installed in the spring of 1988. It extends from the RCRA Container Storage Facility to Oil/Water Separator No. 8, with a total length of 450 feet and an approximate depth of 12 feet. The slurry wall is a bentonite/soil mixture. Recovery wells have been installed behind the wall to collect floating hydrocarbons. The slurry wall installation was documented in a Dames & Moore report entitled "Slurry Wall Design and Specification," April 27, 1988 (Appendices B-1 and B-2). Recovery well installation procedures are documented in Appendix E.

In January of 1990, a free-phase hydrocarbon recovery trench was installed immediately north of Warehouse No. 1 (Figure 25). This trench is approximately 225 feet long, 10 feet deep, and 3 feet wide. The trench was backfilled with clean stone gravel. A total of six sumps were built into the trench for removal of the floating hydrocarbons.

The RFI will focus on the area south of the slurry wall. In this area, limited data exist relative to aquifer conditions and ground water quality. Monitoring wells A4, A8, A9, A11, A20, and culvert 3WR2 are located in this area. Floating petroleum hydrocarbons were observed in wells A4, A8, and A20.

To assess this area, to determine the degree and extent of hazardous constituents in soil and ground water, and to develop a detailed characterization of the geology and hydrogeology underlying this unit, two investigative tasks will be conducted. The tasks are:

- Bulkhead reconnaissance
- Ground water assessment

Access to this area is very limited due to the number and location of aboveground process lines. Specific task details may require modification to account for site conditions. Modifications will be implemented with EPA approval. No soil samples are proposed because disposal areas are not known to exist in this SWMU and precise areas of discharge, if any, are also not known.

4.3.1 Bulkhead Reconnaissance

To visually locate areas of seepage and to target future areas of study, if necessary, a reconnaissance of the bulkhead will be performed. The reconnaissance will consist of observing the bulkhead from a boat in the Schuylkill River during low tide. This timing should allow for exposure of seepage areas, if any. Seepage areas, if any are observed, will be indicated on a site map and submitted to EPA in the RFI report.

4.3.2 Ground Water Assessment

In order to assess the hydrogeologic conditions in the area of SWMU No. 101, south of Oil/Water Separator No. 8, a two-phase investigation will be implemented. The first phase will consist of:

- Installation of well points
- Installation of monitoring wells
- Sampling from monitoring wells

The second phase, if necessary, may include installation of additional well points and/or monitoring wells.

At a minimum, 4 wells and 10 well points will be used for ground water assessment during the first phase of the study. The four wells (A4, A8, A9, and A11) have been previously installed. For locations of these wells, see Figures 2 and 25. The installation of the well points and the other assessment tasks are described below.

4.3.2.1 Well Point Installation

The purpose of the well points is to detect areas of floating petroleum hydrocarbons. The assessment methodology of well point installation was selected for this area because heavy hydrocarbons are anticipated based on operational practices in this area. The resulting data will allow for the siting of monitoring wells and/or the development of corrective measures. Additionally, well points can be easily installed without the access problems associated with an auger or drill rig.

A total of 10 well points (WP1 through WP10) are proposed. Additional well points may be installed contingent upon the results of the bulkhead reconnaissance. Eight of the well points are located along the bulkhead at an approximate spacing of 200 feet. Two of the well points (WP1 and WP2) are located hydrogeologically upgradient from well A4 in order to assess the degree and extent of floating hydrocarbons. Furthermore, the effectiveness of the recovery trench will be evaluated by data provided by well points 6 and 7, and well A8.

The well points will be installed to a depth of 6 to 8 feet below grade. The screened interval will be above and below the water table. The well components will be Schedule 40 PVC. Installation procedures are presented in Appendix E. These well points are considered temporary monitoring points and will be decommissioned when adequate data have been obtained.

4.3.2.2 Monitoring Well Installation

After two rounds of data have been collected from the well points and the existing wells, additional wells will be proposed, if necessary. If water quality results from the shallow monitoring wells indicate significant levels of contaminants, Chevron will initially propose to install one deep well in the Lower Unconsolidated Aquifer. This deep well will be located at a hydrologically downgradient position from the area of the shallow well that exhibits the highest levels of contaminants. The well location will be submitted to EPA for comment and approval prior to installation. A generalized construction diagram for the shallow well is provided on Figure 16. A generalized construction diagram for a deep well is provided in Figure 17.

4.3.2.3 Sampling from Well Points and Monitoring Wells

The collection and analysis of ground water samples from wells A4, A8, A9, and A12 shall be conducted in accordance with specifications as presented in subsection 4.1.2.2 of this Work Plan.

If petroleum is observed in the well points (WP1-10), a sample of the floating material will be obtained for GC analysis. Water samples will not be obtained for analysis, as the wells were not constructed to yield representative water samples.

If additional monitoring wells are installed, they will be sampled during the next scheduled sampling event.

4.3.2.4 Collection and Analysis of Hydrologic Data

The tasks specified in subsection 4.2.1.2.3 of this Work Plan will be implemented to further assess aquifer conditions underlying SWMU No. 101, if necessary.

5.0 PROJECT MANAGEMENT PLAN

5.1 TECHNICAL APPROACH

Chevron's RCRA Corrective Action Permit (EPA I.D. No. 049 791 098) Part II, Section (A), subsection (7)(a), presents a listing of specific SWMUs that require further investigation. The objectives of the investigations are to:

- Characterize the nature, extent, and rate of migration of documented releases of hazardous constituents to soil and ground water at this facility.
- Develop a detailed characterization of the geology and hydrogeology underlying the facility.

To accomplish these objectives, a series of tasks will be performed that are specified in the referenced permit. These tasks are:

- Surface soil sampling and analyses (where appropriate)
- Soil gas survey (where appropriate)
- Soil boring program (where appropriate)
- Ground water assessment program (where appropriate)

The designated sampling points for each of these referenced tasks have been selected with a bias toward encountering hazardous waste or hazardous waste constituents at each SWMU. This bias is based upon the following sources of information:

- Knowledge of operational practices
- Previous analytical soil data
- Previous hydrogeologic investigations
- Permit Fact Sheet
- Chevron employee interviews

5.2 SCHEDULE

Within 515 calendar days of written receipt of approval by the Regional Administrator of the RFI Work Plan, Chevron will submit the results of the RFI to the Regional Administrator (EPA) and the Director (PADER). A schedule for Work Plan implementation is provided in Figure 26.

5.3 PERSONNEL

This section provides project management and organization for the RFI at Chevron's Philadelphia Refinery. The project organization and activities are presented in Figure 27.

The Project Coordinator will have overall responsibility for the project and for fulfilling regulatory requirements.

Assisting the Project Coordinator will be the Project Director. The Project Director will oversee contractual and technical matters. In conjunction with the Project Director, the Project Manager will oversee personnel, technical, and budgetary concerns. These personnel will also report to and receive input from the Project Coordinator. Health and safety and quality assurance staff will support the project management team with progress reports on program elements.

The Project Manager will be responsible for implementing project plans and managing the day-to-day activities of project to achieve schedule and technical goals.

The Quality Assurance/Quality Control (QA/QC) Officer will independently plan, schedule, and approve system and performance audits and will report directly to the Project Manager. The QA/QC program will be planned and updated through the Project QA/QC Officer.

The Health and Safety Officer will support the project team during site characterization.

Mr. M.T. Manigly will serve as Project Coordinator for Chevron. Mr. Manigly is currently an Environmental Specialist with Chevron.

Mr. Ralph T. Golia, P.G., will serve as Project Director. Mr. Golia is currently an Associate in Dames & Moore's Philadelphia office.

Mr. Bruce Amig will serve as Project Manager. Mr. Amig is currently a Project Hydrogeologist in Dames & Moore's Philadelphia office.

Dr. Donald Supkow, P.G., will serve as a Principal Investigator. Dr. Supkow has more than 20 years' experience in hydrogeology. He has dealt extensively with investigating contaminated soil and ground water sites.

Mr. Thomas D. Whitman will serve as the Health and Safety Officer. Mr. Whitman is currently a Staff Environmental Scientist in Dames & Moore's Philadelphia office.

Mr. David K. Cook will serve as QA/QC Officer. Mr. Cook is currently an Associate in Dames & Moore's Philadelphia office.

Curriculum vitae of the project team are presented in Appendix J. The key personnel will be assisted by other professionals of appropriate discipline from Dames & Moore's Philadelphia and other offices on an as-needed basis.

Subcontractors will be procured to perform the following services for this project:

- Soil borings
- Monitoring well installation
- Laboratory analyses

6.0 DATA COLLECTION QUALITY ASSURANCE PLAN

The Data Collection Quality Assurance Plan is provided as Appendix F. This plan will be followed during implementation of field investigation outlined in this work plan.

7.0 DATA MANAGEMENT PLAN

The Data Management Plan is provided as Appendix G. This plan will be followed during implementation of the field investigation outlined in this work plan.

8.0 HEALTH AND SAFETY PLAN

The Health and Safety Plan is provided as Appendix H. This plan will be followed during the implementation of the field investigation outlined in this work plan.

9.0 COMMUNITY RELATIONS PLAN

Chevron will provide press releases and other information for public review and comment at appropriate times, which will include EPA acceptance of the RFI Report and CMS Report. Chevron will be provided with technical support by Dames & Moore, as needed.

10.0 PROJECT REPORTING

Periodic progress reports will be provided to EPA during the course of the project (see Figure 26). These reports may include:

1. Description and estimate of the percentage of the RFI completed
2. Summaries of all findings
3. Work completed in the previous month
4. Work in progress
5. Projected work for the next period
6. Out-of-scope work performed and justification
7. Problems encountered and corrective actions
8. Personnel changes during the reporting period
9. Summary of all communications with EPA

Within 515 days after written approval of the RFI, a report presenting the results of investigation will be submitted to EPA and PADER.

Emergency and priority situations will be reported to EPA by telephone and followed by a report within 24 hours. All communications will detail the nature of the situation, the proposed corrective measure, and the rationale for the proposed measure.

Completed draft task reports will be submitted as they are completed. Draft and final RFI reports incorporating the results of all previous reports will also be submitted as required by the permit. The final report will be sufficiently detailed to allow decisions to be made regarding the development of appropriate corrective measures.

This RFI Work Plan was prepared by:

DAMES & MOORE
A Professional Limited Partnership

Ralph T. Golia, P.G.
Associate

Bruce C. Amig
Project Manager

BCA:pas
7372R

TABLE 1

SELECTED PROPERTIES OF RELEVANT CONSTITUENTS
CHEVRON REFINERY
PHILADELPHIA, PENNSYLVANIA

	MW	S	d	BP
Organics				
Benzene	78.12	1,780 mg/l	0.879	80°C
Ethylbenzene	106.2	161 mg/l	3.66	136.2°C
Naphthalene	128.16	34.4 mg/l	1.152	217.9
Toluene	92.13	534.8 mg/l	0.8669	110.6°C
Xylene	106.17	160 mg/l	0.86	144°C
Metals				
Chromium (III)	51.99[1]	50 ug/l	7.2	2,672°C
Lead	207.19[1]	200 ug/l	1.65	1,740°C
Tetraethyl lead	323.45	30 mg/l	11.35	200°C

Notes:

MW = molecular weight
s = solubility in water
d = specific gravity
BP = boiling point
l = atomic weight

0854t

TABLE 2

RESULTS OF TOTAL LEAD ANALYSIS FROM
BORINGS AND TEST PITS
SWMU 90

Sample I.D.	Sample Depth (ft)	Total Lead Concentration (ppm)	Sample Description
TB289A	2.0-2.5	1,970	Sandy Gravel, Black, Wet
C289	-	55	-
TB290A	0.0-0.25	857	Sand with Flakes, Reddish-Brown
TB290B	0.75-1.25	370	Silty Clay and Sand, Blackish-Brown

Explanation

TP = Phase II Test Pit, 1986
TB = Phase II Test Boring, 1986
MTP = Phase I Test Pit
C = Confirmation samples taken by Chevron, 1988

TABLE 3

RESULTS OF TOTAL LEAD ANALYSIS FROM
BORINGS AND TEST PITS
SWMU 91

Sample I.D.	Sample Depth (ft)	Total Lead Concentration (ppm)	Sample Description
TB276A	1.0-2.0	4,950	Sand and Silt with Tank Bottoms, Brown; Strong Gas Odor
TB276B	4.0-5.0	3,220	Silty Clay, Black
C276	-	2,020	-
TB277A	0.0-0.5	1,120	Sand Silt, and Clay with Tank Bottoms, Brown
TB277B	1.0-1.5	340	Silty, Sandy, Clay, Blank; Strong Gas Odor
C277	-	355	-
TB286A	0.5-1.0	1,630	Sand and Silt with Tank Bottoms, Brown, Strong Gas Odor
TB286B	3.0-4.0	480	Silty Sandy Clay, Black
C286	-	210	-
C286	-	740	-
C286	-	70	-
C286	-	210	-

Explanation

TP = Phase II Test Pit, 1986
TB = Phase II Test Boring, 1986
MTP = Phase I Test Pit
C = Confirmation samples taken by Chevron, 1988

0816t/2

TABLE 4

RESULTS OF TOTAL LEAD ANALYSIS FROM
BORINGS AND TEST PITS
SWMU 92

Sample I.D.	Sample Depth (ft)	Total Lead Concentration (ppm)	Sample Description
TB243A	1.0-1.5	1,370	Fill (Glass, Brick, Wood), Some Silt and Sand, Brown-Black, Strong Gas Odor
TB243B	1.0-1.5	1,490	Fill (Glass, Brick, Wood), Some Silt and Sand, Brown-Black, Strong Gas Odor
C243	-	2,410	-
C243	-	454	-
TB244A	1.5-2.0	390	Silt and Sand with Tank Bottoms, Brown-Black; Gas Odor
TB244B	3.0-4.0	360	Silty Clay, Brownish-Gray
TB245A	1.0-1.5	190	Fill (Glass, Brick, Wood), Some Silt and Clay, Brown-Black, Strong Gas Odor
TB245B	1.0-1.5	230	Fill (Glass, Brick, Wood), Some Silt and Clay, Brown-Black, Strong Gas Odor
TB246A	1.0-2.0	1,440	Leaded Tank Bottom, Brownish-Gray; Gas Odor
TB246B	3.5-4.5	1,390	Clay and Tank Bottoms, Brownish-Black, Strong Gas Odor
C246	-	537	-
TB251A	1.0-1.5	370	Fill (Glass, Brick, Wood), Some Silt & Clay, Brown-Black, Strong Gas Odor
TB251B	1.0-1.5	694	Fill (Glass, Brick, Wood), Some Silt & Clay, Brown-Black, Strong Gas Odor

TABLE 4
(continued)

RESULTS OF TOTAL LEAD ANALYSIS FROM
BORINGS AND TEST PITS
SWMU 92

Sample I.D.	Sample Depth (ft)	Total Lead Concentration (ppm)	Sample Description
MTP11A	0.0-0.75	956	Clayey Sand with Silt, Dark Brown; Fill
MTP11B	0.75-1.25	912	Silty Clay, Dark-Gray; Brick Fragments

Explanation

TP = Phase II Test Pit, 1986
TB = Phase II Test Boring, 1986
MTP = Phase I Test Pit
C = Confirmation samples taken by Chevron, 1988

TABLE 5

RESULTS OF TOTAL LEAD ANALYSIS FROM
BORINGS AND TEST PITS
SWMU 93

Sample I.D.	Sample Depth (ft)	Total Lead Concentration (ppm)	Sample Description
TB202A	0.5-1.5	88.6	Fill (Glass, Brick, Wood), Some Silt and Sand, Brown Black
TB202B	3.0-4.0	310	Silty Sandy Clay, Brownish-Green
TP203A	0.0-0.5	410	Clay, Brown
TP203B	1.5-2.0	29	Sand, Brown to Blackish-Brown; Sandblast Sand
TP205A	1.5-2.0	55	Fill, Brown
TP205B	3.5-4.0	41	Fill, Bluish-Gray
TB206A	0.5-1.5	840	Silt and Sand with Sludge, Brownish-Gray
TB206B	3.0-4.0	420	Silt and Sand with Sludge, Brownish-Gray
TP207A	0.0-0.5	590	Clay, Brown, Rust
TP207B	1.0-1.5	280	Clay, Dark Bluish-Gray
TP208A	0.5-1.0	925	Silty Clay, Brown
TP208B	1.5-2.0	119	Fine-Medium Sand, Dark Gray
TB209A	1.0-1.5	330	Silty Sandy Clay, Gray; Sludge-like
TB209B	2.5-3.5	671	Sludge-like
MTP12A	0.0-0.5	652	Clayey Sand with Silt, Dark Brown; Some Orange Material and Coal
MTP12B	0.5-1.0	1,080	Silty Clay, Dark-Gray

Explanation

TP = Phase II Test Pit, 1986
TB = Phase II Test Boring, 1986
MTP = Phase I Test Pit
C = Confirmation samples taken by Chevron, 1988

0816t/5

TABLE 6

RESULTS OF TOTAL LEAD ANALYSIS FROM
BORINGS AND TEST PITS
SWMU 94

Sample I.D.	Sample Depth (ft)	Total Lead Concentration (ppm)	Sample Description
TP215A	0.0-0.5	501	Silty Clay, Dark Brown
TP215B	1.5-2.0	15	Clayey Silt, Bluish-Gray
TB221A	0.0-1.0	589	Silt and Sand, Brownish-Gray; Lead Flakes on Surface
TB221B	3.0-4.0	52.3	Silty Clay, Brownish-Gray
TP223A	0.0-0.5	180	Silty Clay, Medium Gray
TP223B	1.0-1.5	120	Silty Clay, Dark Gray
TP224A	0.5-1.0	17,000	Silt and Sand, Brown, Leaded Tank Bottom
TB224B	3.0-4.0	558	Silty Clay, Brownish-Gray
C224		792	
C224		8,450	
C224		800	
C224		19,000	
C224		6,860	
C224		6.20	

Explanation

TP = Phase II Test Pit, 1986
TB = Phase II Test Boring, 1986
MTP = Phase I Test Pit
C = Confirmation samples taken by Chevron, 1988

0816t/6

TABLE 7

RESULTS OF TOTAL LEAD ANALYSIS FROM
BORINGS AND TEST PITS
SWMU 95

Sample I.D.	Sample Depth (ft)	Total Lead Concentration (ppm)	Sample Description
TB426A	0.0-0.75	631	Clayey to Sandy Gravel, Grayish-Brown
TB426B	1.25-1.75	350	Silty Clay, Dark-Gray
TB430A	0.0-0.5	1,760	Silty Clay, Dark Brown; Rust Discoloration
TB430B	1.5-2.0	170	Silty Clay, Blackish-Gray, Strong Petroleum Odor
C430	-	1,650	-
C430	-	983	-
C430	-	1,110	-
C430	-	1,610	-
TB438A	0.0-0.5	610	Clayey Sand, Reddish-Brown
TB438B	1.0-2.0	50.2	Sandy Gravel, Medium to Dark Gray
TB440A	0.0-1.0	140	Sandy Clay, Grayish-Black
TB440B	2.0-2.5	99.8	Sandy Clay to Clayey Sand, Blackish-Brown, Wet, Strong Petroleum Odor
TB440C	2.0-2.5	370	Silt, Sand and Sludge, Brownish-Gray
TB440D	5.0-5.5	51.9	Silt, Sand and Sludge, Brownish-Gray

Explanation

TP = Phase II Test Pit, 1986
TB = Phase II Test Boring, 1986
MTP = Phase I Test Pit
C = Confirmation samples taken by Chevron, 1988

0816t/7

TABLE 8

ANALYTICAL PARAMETERS FOR SOIL SAMPLES
CHEVRON REFINERY
PHILADELPHIA, PENNSYLVANIA

Parameter		Method Number
Organic:	Benzene	EPA 8020
	Ethylbenzene	EPA 8020
	Toluene	EPA 8020
	Xylene	EPA 8020
	Total Petroleum Hydrocarbon (TPH)	SW-846 418.1
	Naphthalene	EPA 8270
Metals:	Chromium (total)	SW-846 7190
	Chromium (hexavalent)	Standard Method, 16th edition, 312B
	Lead	SW-846 7420

0902t

TABLE 9

SKINNER LIST
RCRA FACILITY INVESTIGATIONS
CHEVRON REFINERY
PHILADELPHIA, PENNSYLVANIA

** Acetonitrile (Ethanenitrile)
** Acrolein (2-Propenal)
** Acrylonitrile (2-Propenenitrile)
Aniline (Benzenamine)
Antimony
Arsenic
Barium
Benz (c) acridine (3,4-Benzacridine)
Benz (a) anthracene (1,2-Benzanthracene)
** Benzene (Cyclohexatriene)
Benzenethiol (Thiophenol)
Benzidine (1,1-Biphenyl-4,4 diamine)
Benzo(b)Fluoranthene (2,3-Benzofluoranthene)
Benzo(j)Fluoranthene (7,8-Benzofluoranthene)
Benzo(a)pyrene (3,4-Benzopyrene)
** Benzyl chloride (Benzene,(chloromethyl)-)
Beryllium
Bis(2-chloroethyl)ether(Ethane,1,1-oxybis(2-chloro-))
Bis(2-chloroisopropyl)ether(Propane,2,2-oxybis(2-chloro-))
** Bis(chloromethyl)ether(Methane, oxybis(chloro))
Bis(2-ethylhexyl)phthalate(1,2-Benzenedicarboxylic acid, bis (2-ethylhexyl) ester)
Butyl benzyl phthalate (1,2-Benzenedicarboxylic acid, butyl phenylmethyl ester)
Cadmium
Carbon disulfide (Carbon bisulfide)
p-Chloro-m-cresol
** Chlorobenzene (Benzene, chloro-)
** Chloroform (Methane, trichloro-)
** Chloromethane (Methyl chloride)
2-Chloronapthalene (Naphthalene, beta-chloro-)
2-Chlorophenol (Phenol, o-chloro-)
Chromium
Chrysene (1,2-Benzphenanthrene)
Cresols (Cresylic acid) (Phenol, methyl-)
** Crotonaldehyde (2-Butenal)
Cumene (Isopropyl Benzene)
Cyanide
Dibenz(a,h)acridine(1,2,5,6-Dibenzacridine)
Dibenz(a,j)acridine(1,2,7,8-Dibenzacridine)
Dibenz(a,h)anthracene(1,2,5,6-Dibenzanthracene)
7H-Dibenzo(c,g)carbazole(3,4,5,6-Dibenzcarbazole)
Dibenzo(a,e)pyrene(1,2,4,5-Dibenzpyrene)
Dibenzo(a,h)pyrene(1,2,5,6-Dibenzpyrene)
Dibenzo(a,i)pyrene(1,2,7,8-Dibenzpyrene)
** 1,2-Dibromoethane (Ethylene dibromide)
Di-n-butyl phthalate (1,2-Benzenedicarboxylic acid, dibutyl ester)

TABLE 9
(Continued)

* Dichlorobenzenes
** 1,2-Dichloroethane (Ethylene dichloride)
** trans-1,2-Dichloroethene(1,2-Dichloroethylene)
** 1,1-Dichloroethylene (Ethene, 1,1-dichloro-)
** Dichloromethane (Methylene chloride)
** Dichloropropane
Dichloropropanol
Diethyl phthalate (1,2-Benzenedicarboxylic acid, diethyl ester)
7,12-Dimethylbenz(a)anthracene
2,4-Dimethylphenol (Phenol, 2,4-dimethyl-)
Dimethyl phthalate (1,2-Benzenedicarboxylic acid, dimethyl ester)
4,6-Dinitro-o-cresol
2,4-Dinitrophenol (phenol, 2,4-nitro-)
2,4-Dinitrotoluene (Benzene, 1-methyl-2,4-dinitro-)
Di-n-octyl phthalate (1,2-Benzenedicarboxylic acid, dioctyl ester)
** 1,4-Dioxane (1,4-Diethylene oxide)
1,2-Diphenylhydrazine (Hydrazine, 1,2-Diphenyl-)
** Ethyleneimine (Azridine)
** Ethylene oxide (Oxirane)
Fluoranthene (Benzo(j,k) fluorene)
** Formaldehyde
Hydrogen sulfide (Sulfur hydride)
Indeno (1,2,3-cd)pyrene (1 10(1,2-phenylene)pyrene)
Lead
Mercury
Methanethiol (Thiomethanol)
3-Methylchlolanthrene (Benz(j)aceanthrylene, 1,2-dihydro-
3-methyl-)
** Methyl ethyl ketone (MEK)(2-Butanone)
Naphthalene
Nickel
p-Nitroaniline(Benzenamine, 4-nitro-)
Nitrobenzene (Benzene, nitro-)
4-Nitrophenol (Phenol, pentachloro-)
Pentachlorophenol (Phenol, pentachloro-)
Phenol (Benzene, hydroxy-)
Propyl benzene
Pyridine
Selenium
** Tetrachloroethanes
** Tetrachloroethylene (Ethene, 1,1,2,2-tetra chloro-)
** Toluene (Benzene, methyl-)
* Trichlorobenzenes
** Trichloroethanes
** Trichloroethene (Trichloroethylene)
* Trichlorophenols
Vanadium
Xylene

TABLE 9
(Continued)

Non-Appendix VIII Constituents of Concern

Cobalt
1-Methylnapthalene
Styrene
Hydroquinone
Anthracene
Indene
5-Nitro acenaphthene
Quinoline
Phenanthrene
Pyrene

Footnotes:

* If any of these groups of compounds are found, the specific isomers listed in Appendix VIII should be identified.

** Use Test Method 8240 for these volatile compounds.

Note:

Use Test Method 3050 in SW-846 for all metals.

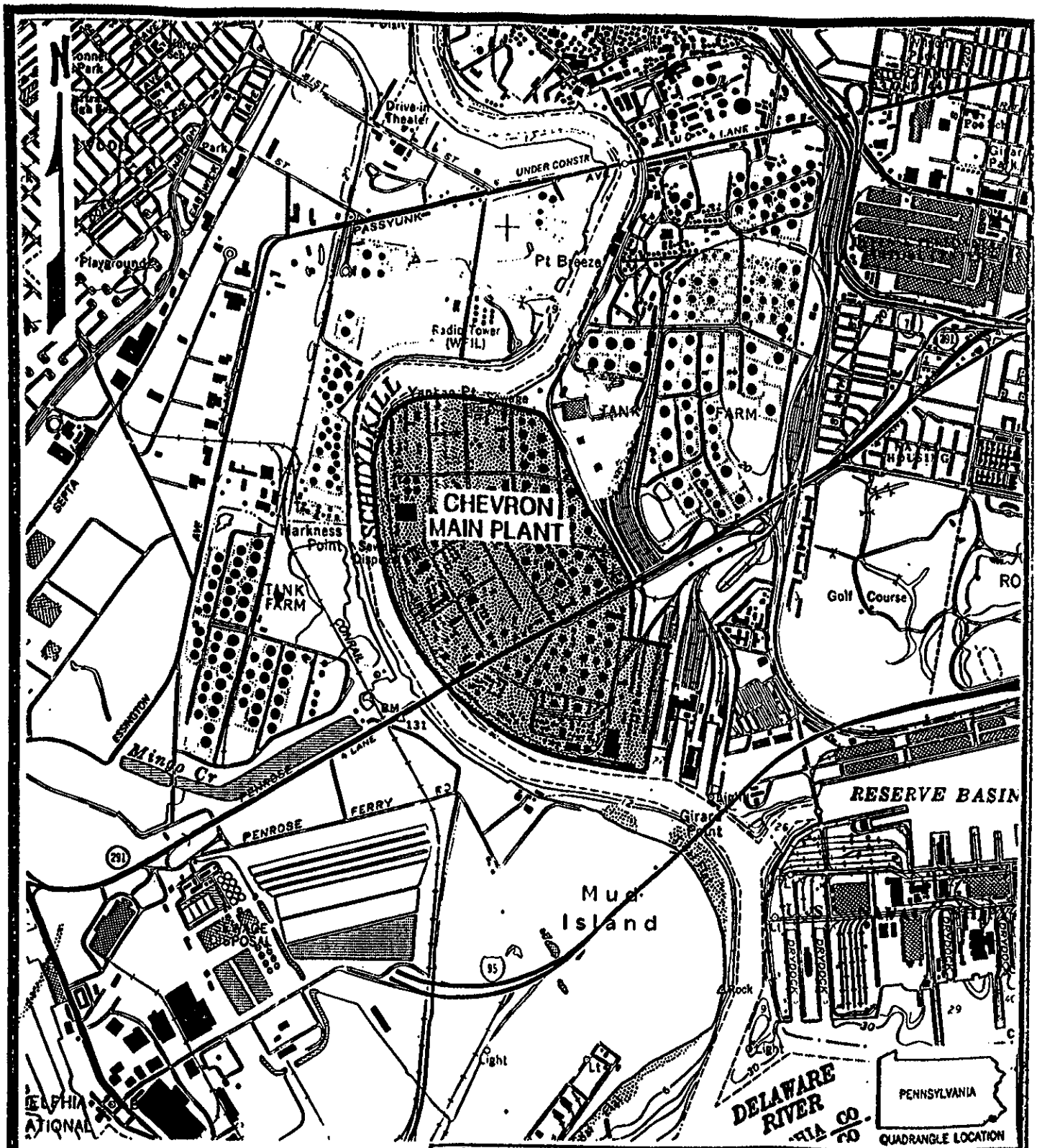
0915t

TABLE 10

ANALYTICAL PARAMETERS FOR GROUND WATER SAMPLES
CHEVRON REFINERY
PHILADELPHIA, PENNSYLVANIA

Permit Parameters	Method Number
Ammonium	EPA 350.2
Calcium	EPA 215.1
Chloride	EPA 300.0
Iron	EPA 236.1
Magnesium	EPA 242.1
Manganese	EPA 243.1
Nitrate	EPA 353.2
Phosphate	EPA 365.1
Potassium	EPA 258.1
Silicate	EPA 370.1
Sodium	EPA 273.1
Sulfate	EPA 300.0
Additional Parameters	
pH	EPA 150.1
Specific Conductance	EPA 120.1
Potential Site Contaminants	
Chromium (hexavalent)	Standard Method, 16th edition 312B
Chromium (total)	EPA 218.1
Lead	EPA 239.1
Total Petroleum Hydrocarbons (TPH)	SW-846 418.1
Benzene	EPA 8020
Ethylbenzene	EPA 8020
Toluene	EPA 8020
Xylene	EPA 8020
Naphthalene	EPA 8270

1240T



CONTOUR INTERVAL = 20 FEET

REFERENCE:
A PORTION OF USGS 7.5 MINUTE TOPOGRAPHIC MAP; PHILADELPHIA QUADRANGLE, PENNSYLVANIA, 1967, PHOTOREVISED 1985.

TITLE: SITE VICINITY MAP

PROJECT: CHEVRON REFINERY
PHILADELPHIA, PENNSYLVANIA

Dames & Moore
WILLOW GROVE, PENNSYLVANIA

SCALE AS NOTED	DWN. BY J.V.M.	JOB NO. 16000-188
DATE 7-14-89	APPR. BY D.W.	FIG. NO. 1

SWMU 89

SWMU 88

SWMU 87

SWMU 90

SWMU 91

SWMU 92

SWMU 93

SWMU 94

SWMU 95

SWMU 101

SCHUYLKILL RIVER

ATLANTIC REFINING CO. PROPERTY

J.H. TERRY & Co. FACILITY

CHEVRON PIPE LINES CROSSING RIVER

TWO 8" P.E. LINES CROSSING RIVER

TWO 8" SLUDGE LINES CROSSING RIVER

SLURRY WALL

OUTFALL #001

OUTFALL #002

OUTFALL #003 (CLOSED)

OUTFALL #004

OUTFALL #005

OUTFALL #009

OUTFALL #010

OUTFALL #011

OUTFALL #012

OUTFALL #014

OUTFALL #015

UNIT No 137

UNIT No 2031

UNIT No 2031 FLARE

UNIT No 433 FLARE

UNIT No 1232 FLARE

UNIT No 1231 FLARE

UNIT No 1232 PRECIPITATOR

UNIT No 1232

UNIT No 532

UNIT No 1431

UNIT No 1231

UNIT No 1231 BOILER

UNIT No 8735

UNIT 433

UNIT No 1732 & 1733

UNIT No 1332

UNIT No 1333

UNIT No 231 & 232

UNIT No 1735

450 STOREHOUSE STORAGE

STOREHOUSE BLDG No 450

MAINTENANCE BLDG No 440

MAINTENANCE STORAGE AREA

MAINTENANCE AREA

BLDG No 442 FIRE HOUSE GARAGE

BLDG No 714

COMPRESSOR HOUSE 412

RECOVERY PUMP HOUSE 413

PUMP HOUSE No 1

PUMP HOUSE No 2

PUMP HOUSE No 3

HOSE HOUSE No 12

BOILER HOUSE No 1 POWER PLANT No 1

BOILER HOUSE No 2

BOILER HOUSE No 3

SEPARATOR No 4

SEWER SEPARATOR No 4A

SEWER SEPARATOR No 4B

COOLING TOWER 469

COOLING TOWER 452

COOLING TOWER 490

COOLING TOWER 491

COOLING TOWER 722

CHLORINATOR BLDG

PROPANE LOADING RACK

PETROCHEMICAL LOADING RACK

SULFUR LOADING RACK

ETHYL PUMPHOUSE

FIRE TRAINING AREA

ATHLETIC FIELD

ATHLETIC FIELD

CONTRACTORS SECURITY GATE #5

SECURITY GATE #2

MAIN ENTRANCE GATE #24

LOCKER HOUSE 594

LOCKER HOUSE 609

LOCKER HOUSE 727

CANTEEN & LOCKER BLDG

BOILER HOUSE No 1 POWER PLANT No 1

RCRA HAZARDOUS WASTE TANKS

EAST & WEST SLUDGE BASINS RCRA TANK

SPENT CAUSTIC STORAGE TANKS

CONTAINER STORAGE AREA RCRA FACILITY

SCRAP YARD

TREATING PLANT

SLUDGE INCINERATOR

MAIN OFFICE BLDG

REFINERY LABORATORY

HUMAN RESOURCES BLDG

BUS STATION

SALES OFFICE

WAREHOUSE No 1

WAREHOUSE No 2

CONCRETE WHARF No. 1

CONCRETE WHARF No. 2

CONCRETE WHARF No. 3

GEORGE PLATT BRIDGE

PENNYPACKER AVENUE

SCALE: 1"=150'-0"

0 75' 150' 300' 450' 600' 750'

200 FOOT GRID BASED ON PENNSYLVANIA STATE RECTANGULAR COORDINATE SYSTEM, SOUTH ZONE 1927 N.A. DATUM

LEGEND

- PROPERTY BOUNDARY
- MONITORING WELLS
- PROCESS SEWERS, SANITARY SEWERS, OUTFALLS
- SWMU DESIGNATED EXTENT

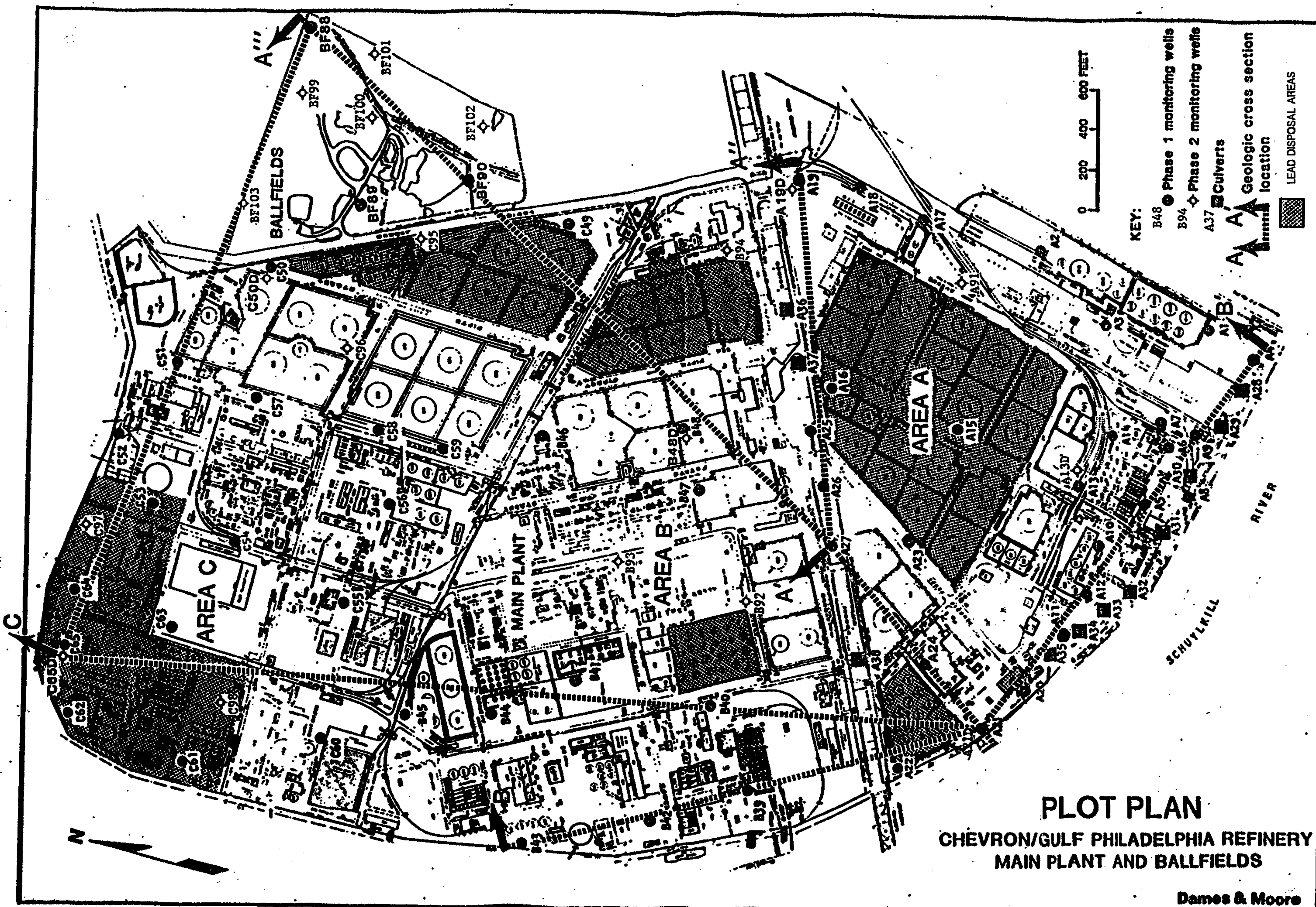
REFERENCE:
BASE MAP PROVIDED BY CHEVRON REFINERY, PHILADELPHIA, PENNSYLVANIA.

TITLE SOLID WASTE MANAGEMENT UNITS
RCRA FACILITY INVESTIGATION

PROJECT CHEVRON REFINERY
PHILADELPHIA, PENNSYLVANIA

Dames & Moore
WILLOW GROVE, PENNSYLVANIA

SCALE AS SHOWN	DWN. BY R.G.B.	JOB NO. 16000-230	
DATE 4-16-90	APPR. BY B.C.A.	FIG. NO. 2	

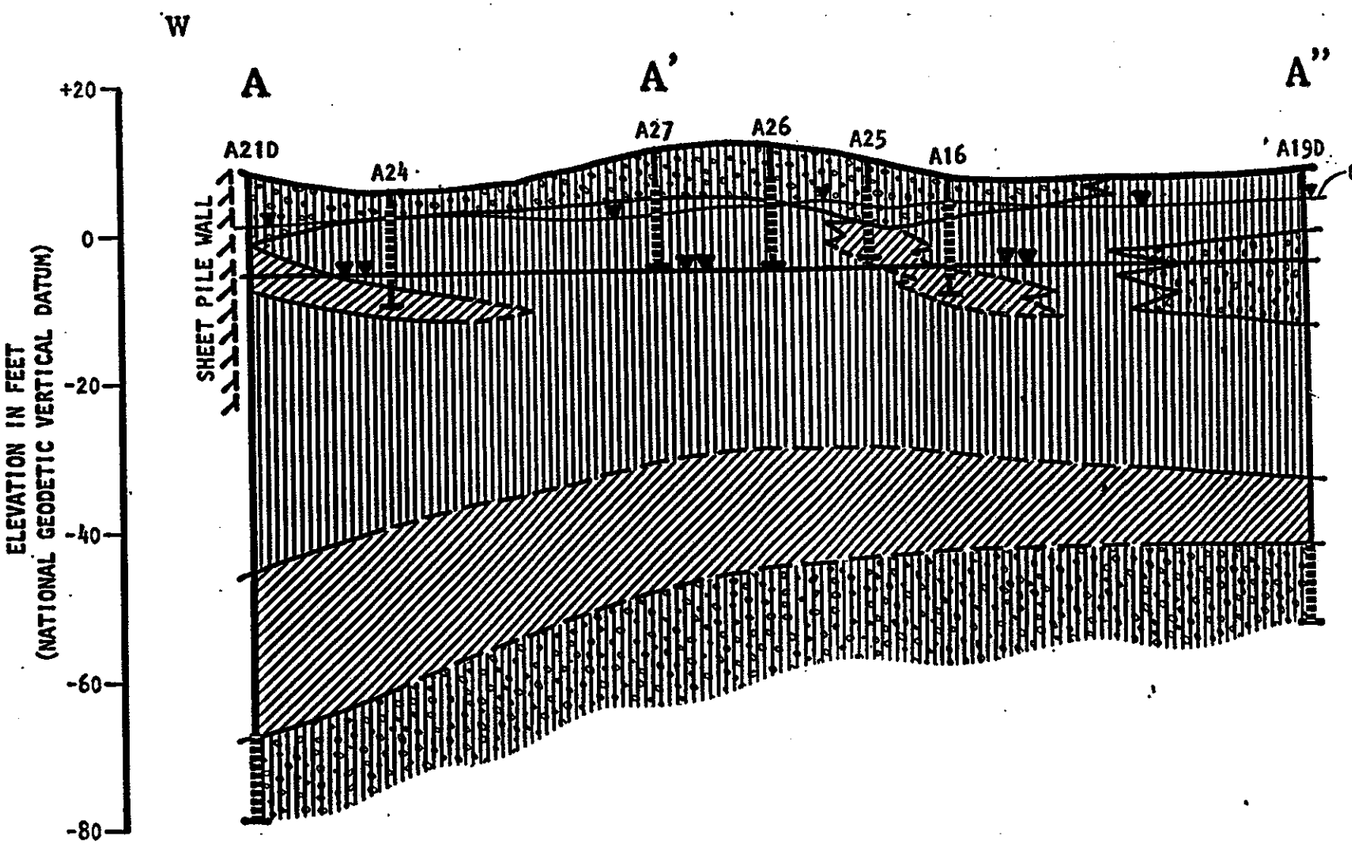


PLOT PLAN

CHEVRON/GULF PHILADELPHIA REFINERY
MAIN PLANT AND BALLFIELDS

Dames & Moore

FIGURE 3



GENERALIZED GEOLOGIC CROSS SECTION A-A'- A"

CHEVRON/GULF PHILADELPHIA REFINERY MAIN PLANT

0 400 800 FEET
(HORIZONTAL SCALE)
VERTICAL EXAGGERATION = 20 X

K E Y:

A24 — MONITORING WELL

MONITORING WELL SHOWING SCREENED INTERVAL

LITHOLOGIC BOUNDARIES; DASHED WHERE ESTIMATED

SILTY SANDS, SAND-SILT-GRAVEL MIXTURES

INORGANIC SILTS AND VERY FINE SANDS, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY

INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, SILTY CLAYS

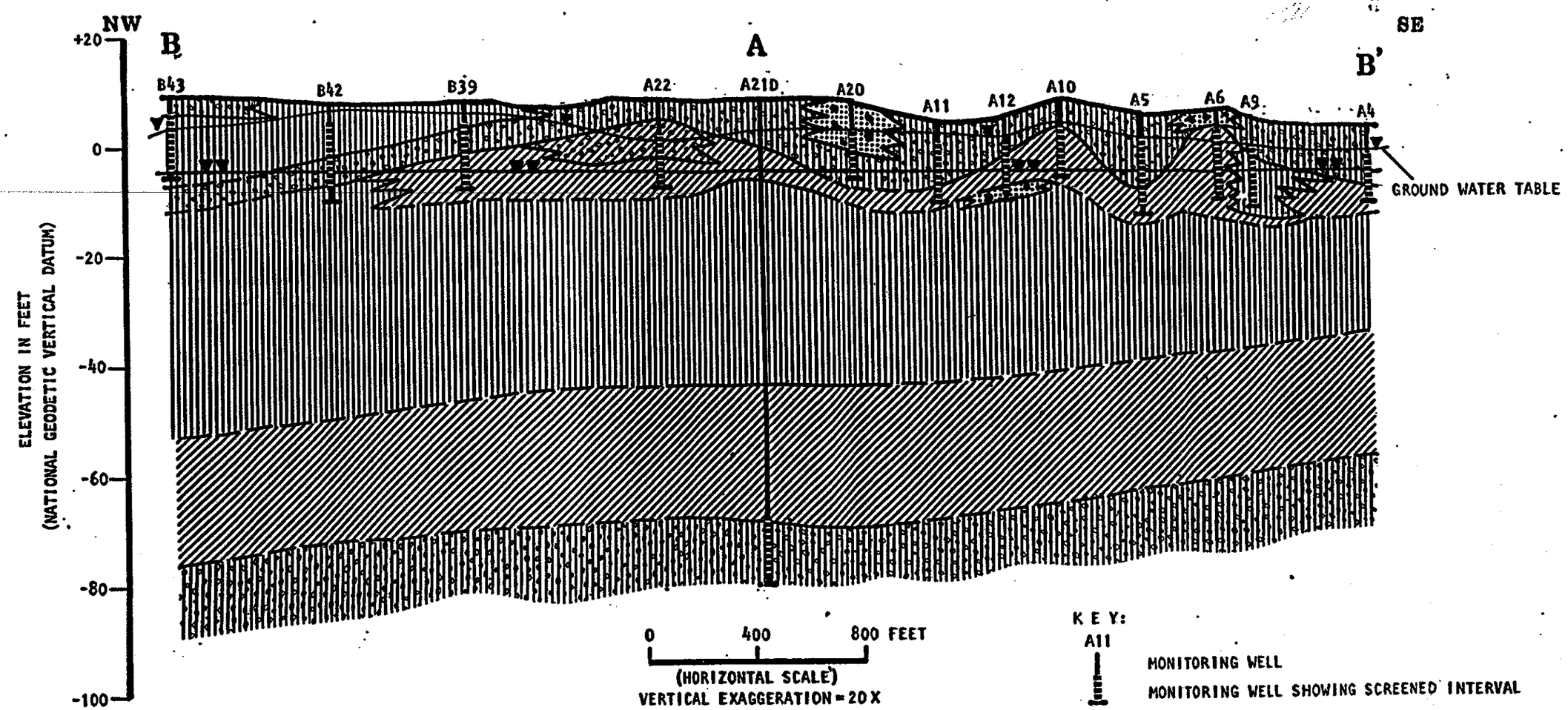
WATER TABLE IN UPPER UNCONSOLIDATED AQUIFER

PIEZOMETRIC SURFACE IN LOWER UNCONSOLIDATED AQUIFER

NOTE: THE SUBSURFACE SECTION SHOWN REPRESENTS OUR EVALUATION OF THE MOST PROBABLE CONDITIONS BASED UPON INTERPRETATION OF PRESENTLY AVAILABLE DATA. SOME VARIATIONS FROM THESE CONDITIONS MUST BE EXPECTED.

DAMES & MOORE

FIGURE 4



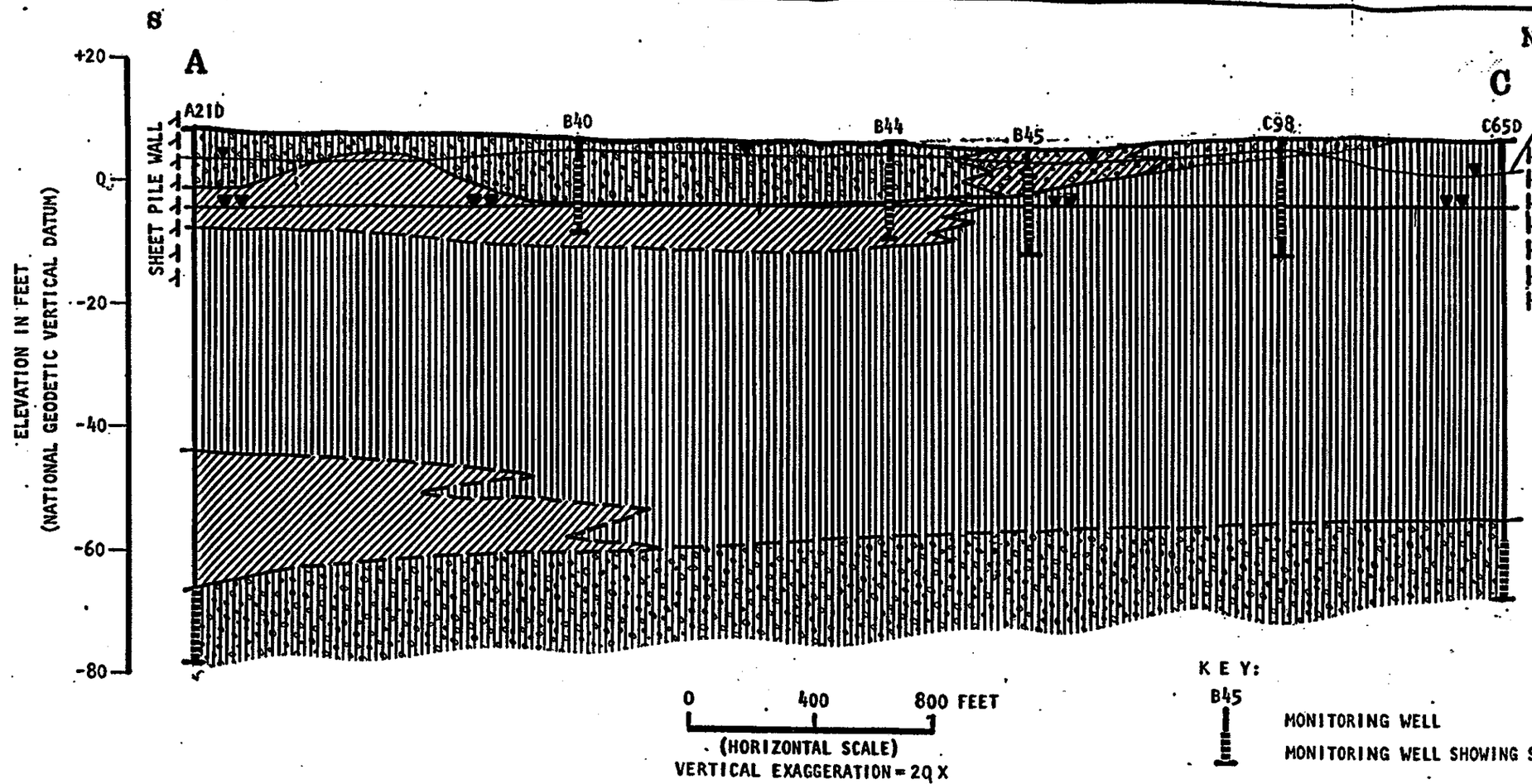
NOTE: THE SUBSURFACE SECTION SHOWN REPRESENTS OUR EVALUATION OF THE MOST PROBABLE CONDITIONS BASED UPON INTERPRETATION OF PRESENTLY AVAILABLE DATA. SOME VARIATIONS FROM THESE CONDITIONS MUST BE EXPECTED.

GENERALIZED GEOLOGIC CROSS SECTION B-A-B'

CHEVRON/GULF PHILADELPHIA REFINERY MAIN PLANT

DAMES & MOORE

FIGURE 5



GENERALIZED GEOLOGIC CROSS SECTION A-C

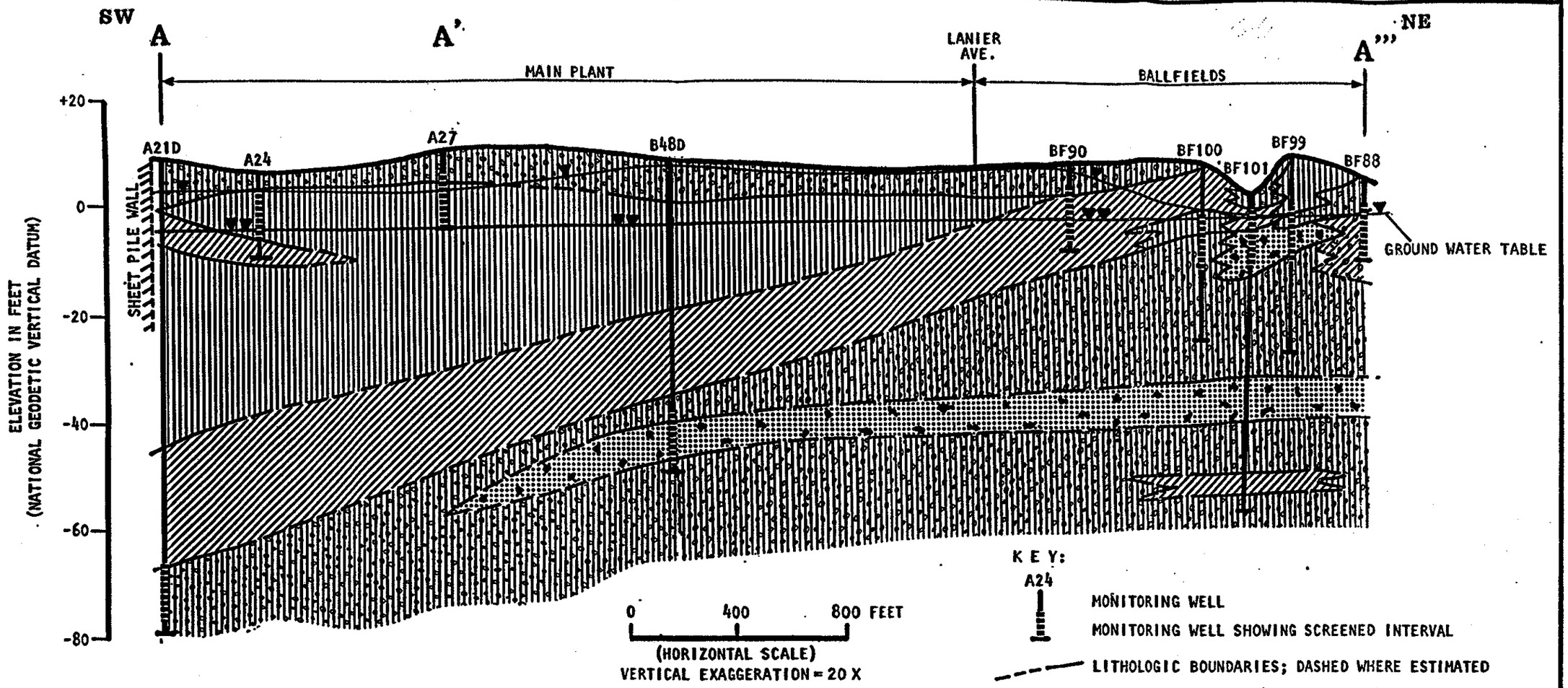
CHEVRON /GULF PHILADELPHIA REFINERY

MAIN PLANT

NOTE: THE SUBSURFACE SECTION SHOWN REPRESENTS OUR EVALUATION OF THE MOST PROBABLE CONDITIONS BASED UPON INTERPRETATION OF PRESENTLY AVAILABLE DATA. SOME VARIATIONS FROM THESE CONDITIONS MUST BE EXPECTED.

DAMES & MOORE

FIGURE 6



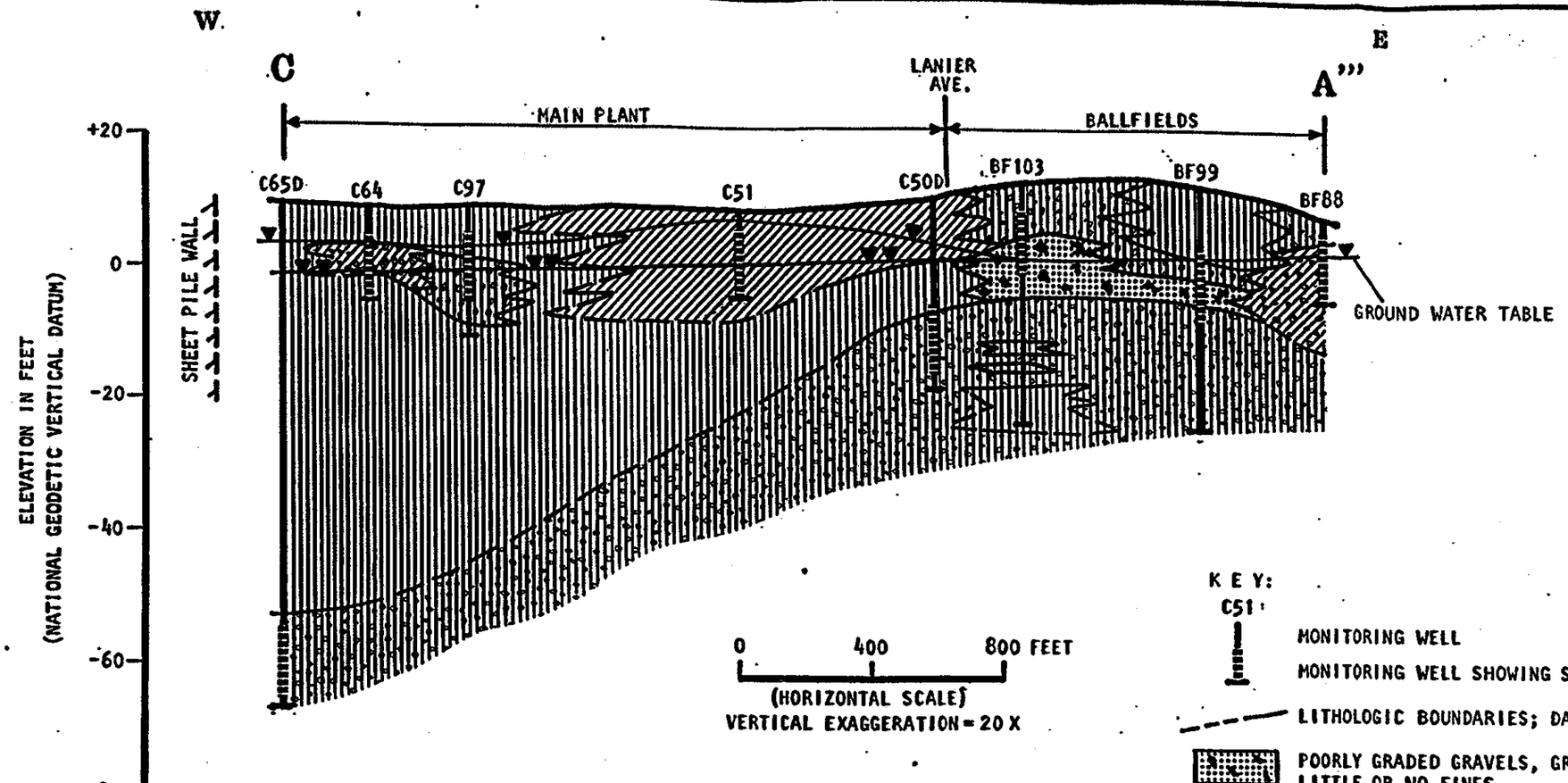
NOTE: THE SUBSURFACE SECTION SHOWN REPRESENTS OUR EVALUATION OF THE MOST PROBABLE CONDITIONS BASED UPON INTERPRETATION OF PRESENTLY AVAILABLE DATA. SOME VARIATIONS FROM THESE CONDITIONS MUST BE EXPECTED.

GENERALIZED GEOLOGIC CROSS SECTION A-A'-A'''

CHEVRON/GULF PHILADELPHIA REFINERY MAIN PLANT AND BALLFIELDS

DAMES & MOORE

FIGURE 7



GENERALIZED GEOLOGIC CROSS SECTION C-A'''

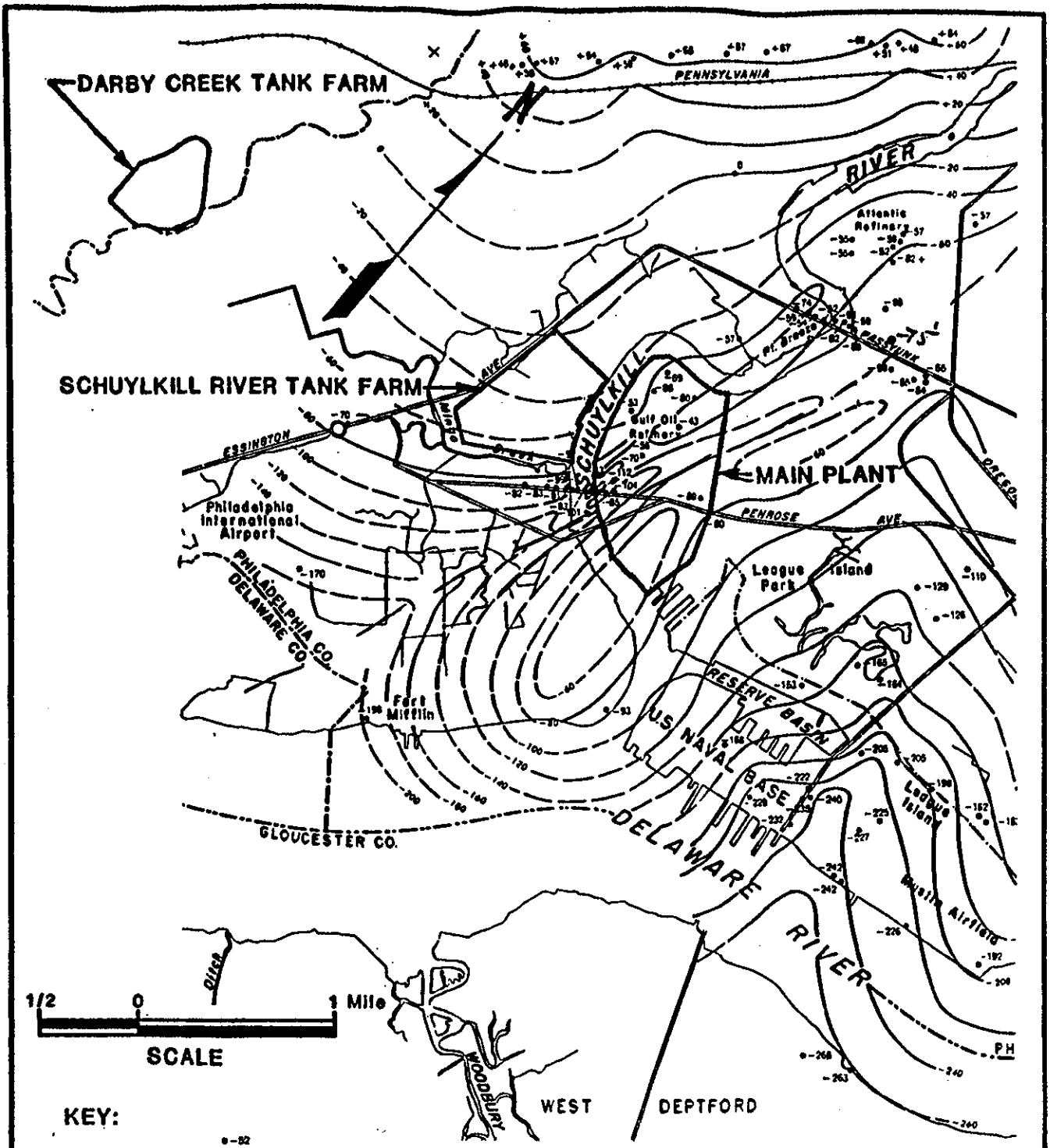
CHEVRON /GULF PHILADELPHIA REFINERY

MAIN PLANT AND BALLFIELDS

NOTE: THE SUBSURFACE SECTION SHOWN REPRESENTS OUR EVALUATION OF THE MOST PROBABLE CONDITIONS BASED UPON INTERPRETATION OF PRESENTLY AVAILABLE DATA. SOME VARIATIONS FROM THESE CONDITIONS MUST BE EXPECTED.

DAMES & MOORE

FIGURE 8



KEY:

•-82

Water well or boring

Number is altitude of the top of the bedrock surface, in feet, referred to mean sea level.

Contour line on bedrock surface, dashed where approximate. Contour interval—20 feet.

CONTOUR MAP OF BEDROCK SURFACE BENEATH THE COASTAL PLAIN SEDIMENTS

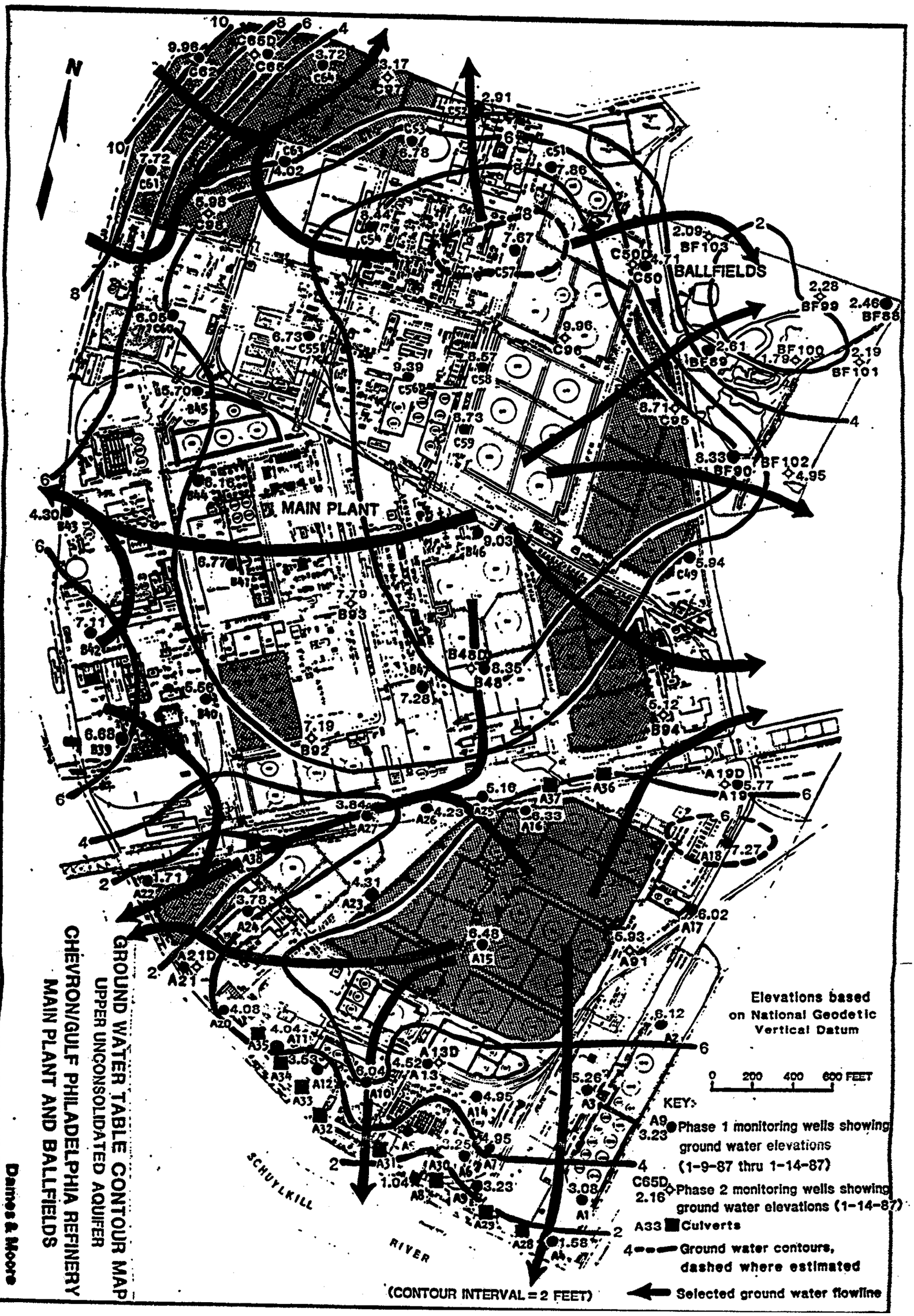
PHILADELPHIA COUNTY, PENNSYLVANIA

REFERENCE:

Ground Water Resources of the Coastal Plain Area of Southeastern Pennsylvania, Pennsylvania Geologic Survey Bulletin W-13; Plate 5.

Dames & Moore

FIGURE 9


GROUND WATER TABLE CONTOUR MAP
UPPER UNCONSOLIDATED AQUIFER
CHEVRON/GULF PHILADELPHIA REFINERY
MAIN PLANT AND BALLFIELDS
Dames & Moore
FIGURE 10
N
MAIN PLANT
BALLFIELDS
SCHUYLKILL RIVER
(CONTOUR INTERVAL = 2 FEET)
Elevations based on National Geodetic Vertical Datum
0 200 400 600 FEET
KEY:
Phase 1 monitoring wells showing ground water elevations (1-9-87 thru 1-14-87)
Phase 2 monitoring wells showing ground water elevations (1-14-87)
Culverts
Ground water contours, dashed where estimated
Selected ground water flowline

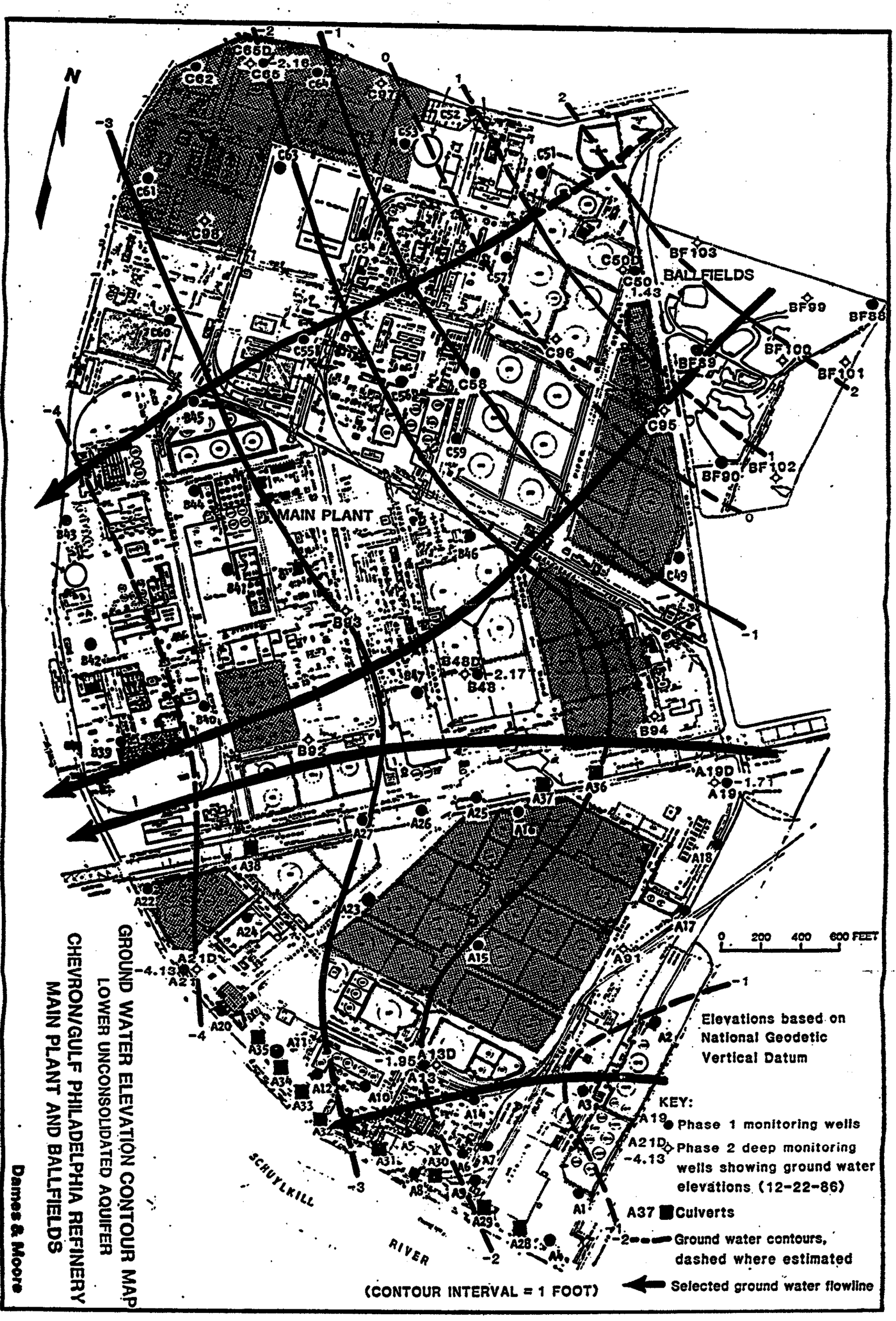

GROUND WATER ELEVATION CONTOUR MAP
LOWER UNCONSOLIDATED AQUIFER
CHEVRON/GULF PHILADELPHIA REFINERY
MAIN PLANT AND BALLFIELDS
Dames & Moore
MAIN PLANT
BALLFIELDS
SCHUYLKILL
RIVER
N
0 200 400 600 FEET
(CONTOUR INTERVAL = 1 FOOT)
Elevations based on National Geodetic Vertical Datum
KEY:
Phase 1 monitoring wells
Phase 2 deep monitoring wells showing ground water elevations (12-22-86)
Culverts
Ground water contours, dashed where estimated
Selected ground water flowline

FIGURE 11

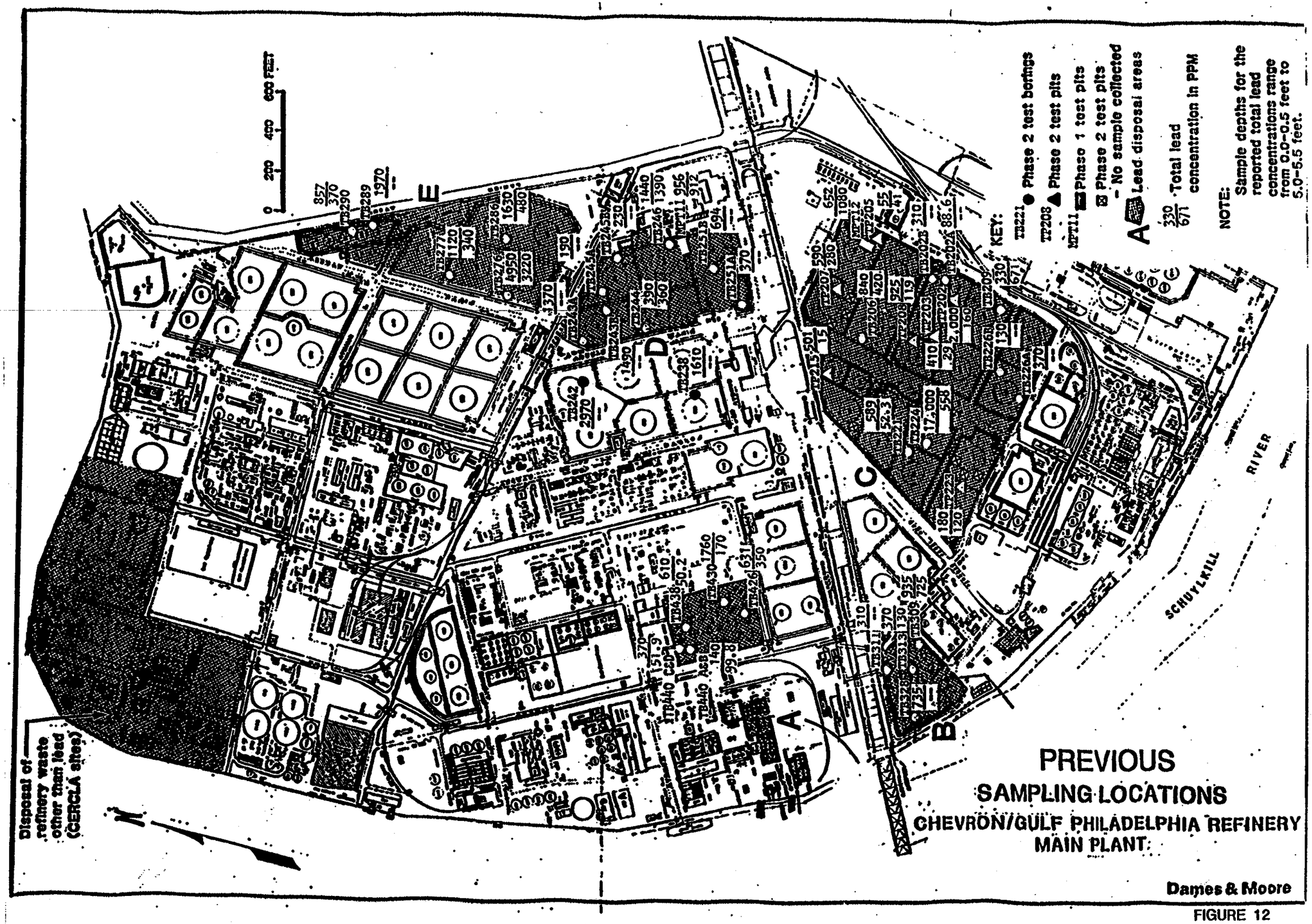
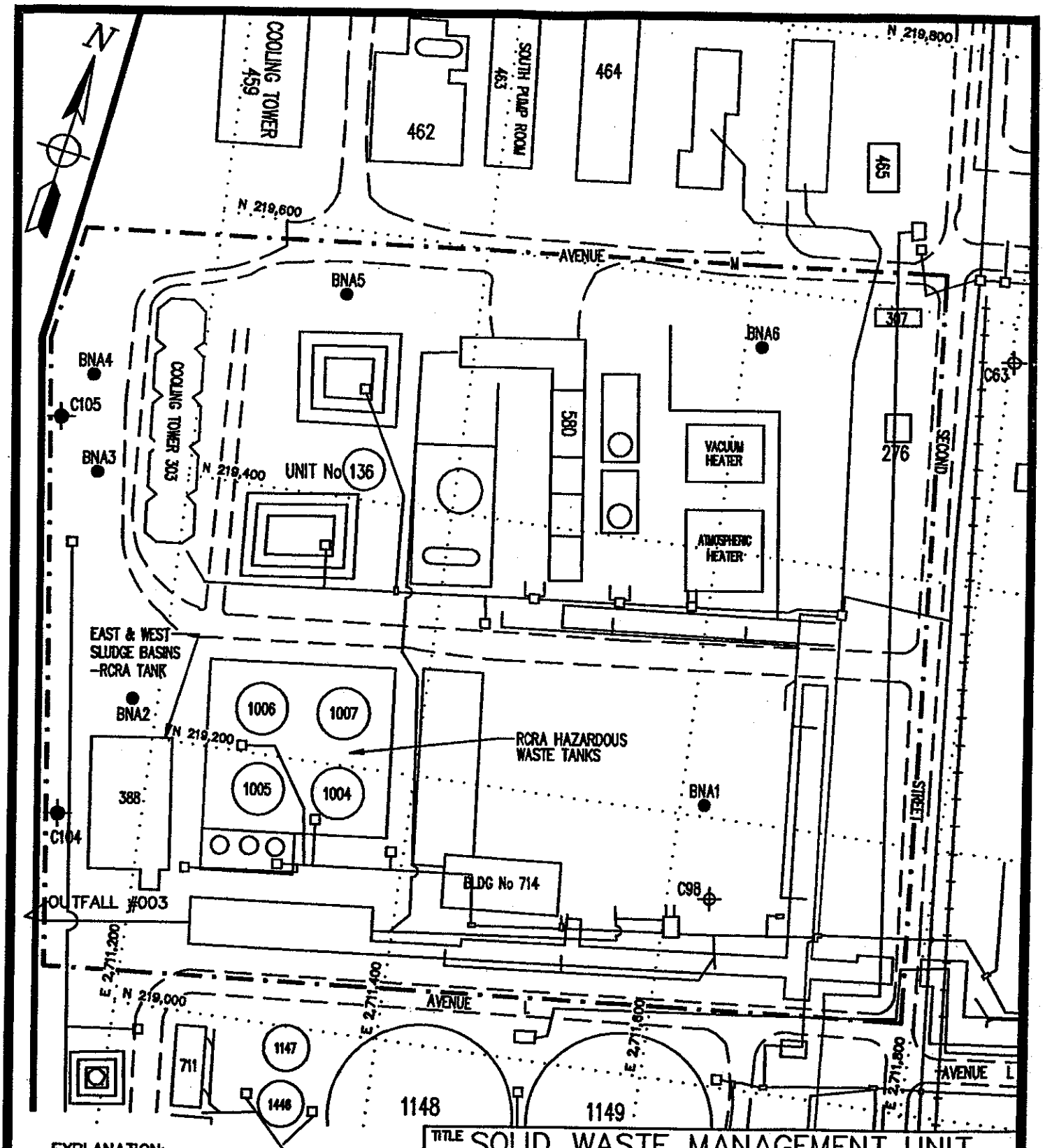

0 200 400 600 FEET
KEY:
TB221 ● Phase 2 test borings
TP208 ▲ Phase 2 test pits
MPT11 ▬ Phase 1 test pits
⊠ Phase 2 test pits
– No sample collected
A Lead disposal areas
330/671 Total lead concentration in PPM
NOTE:
Sample depths for the reported total lead concentrations range from 0.0–0.5 feet to 5.0–5.5 feet.
Disposal of refinery waste other than lead (CERCLA sites)
SCHUYLKILL RIVER
PREVIOUS
SAMPLING LOCATIONS
CHEVRON/GULF PHILADELPHIA REFINERY
MAIN PLANT
Dames & Moore

FIGURE 12



EXPLANATION:

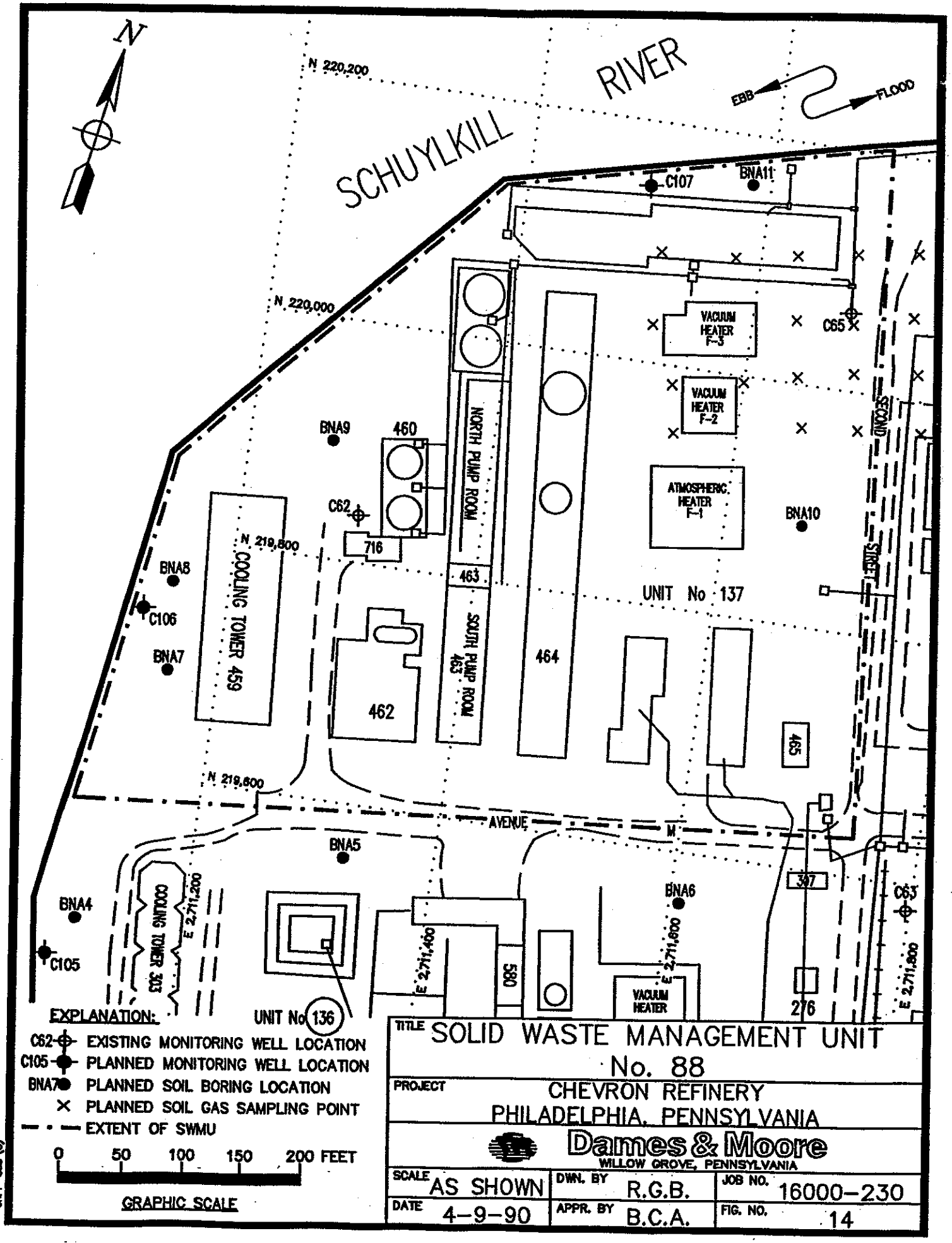
- C98 ⊕ EXISTING MONITORING WELL LOCATION
- C104 ⊕ PLANNED MONITORING WELL LOCATION
- BNA2 ● PLANNED SOIL BORING LOCATION
- — • — EXTENT OF SWMU

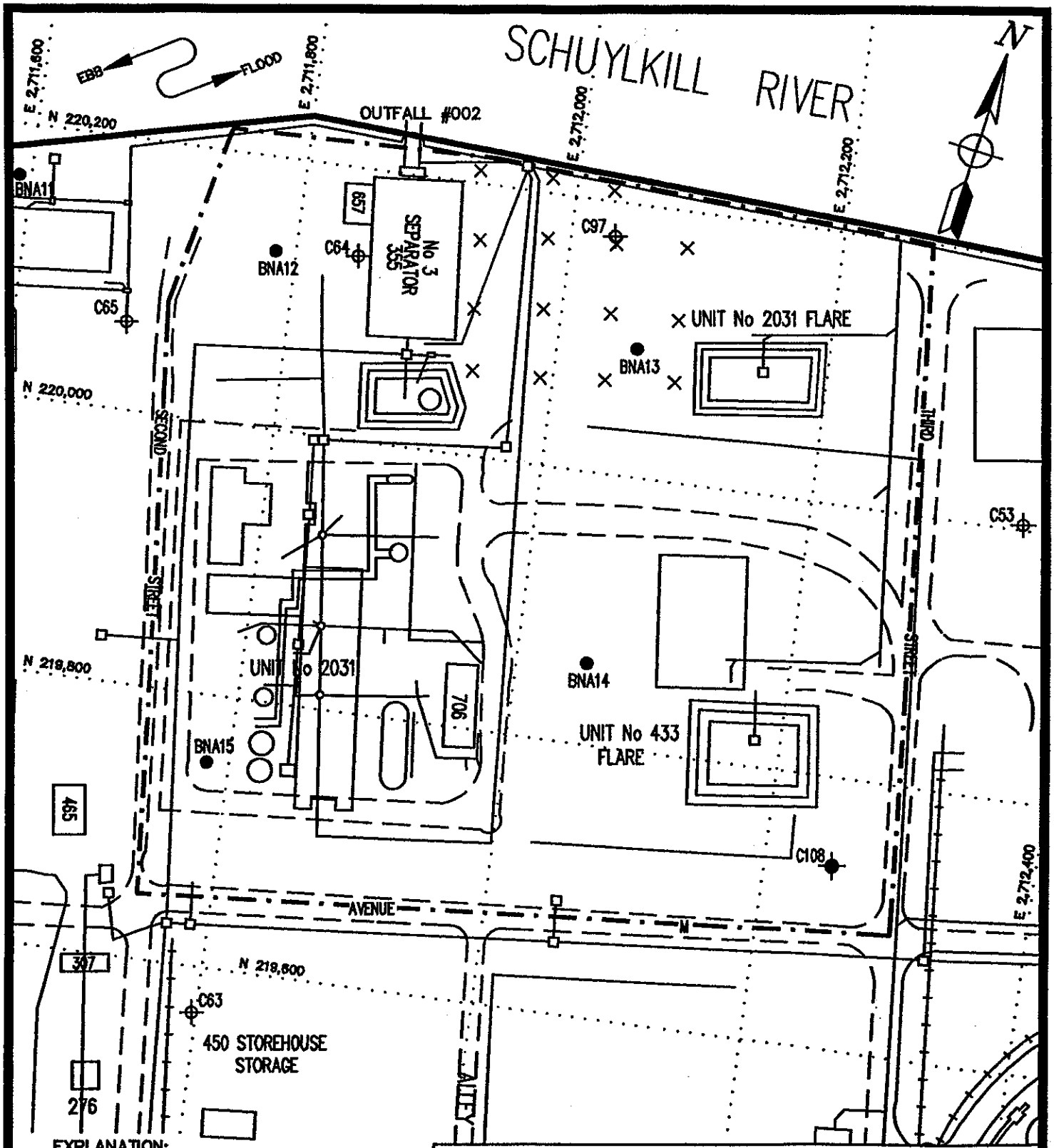
0 50 100 150 200 FEET

GRAPHIC SCALE

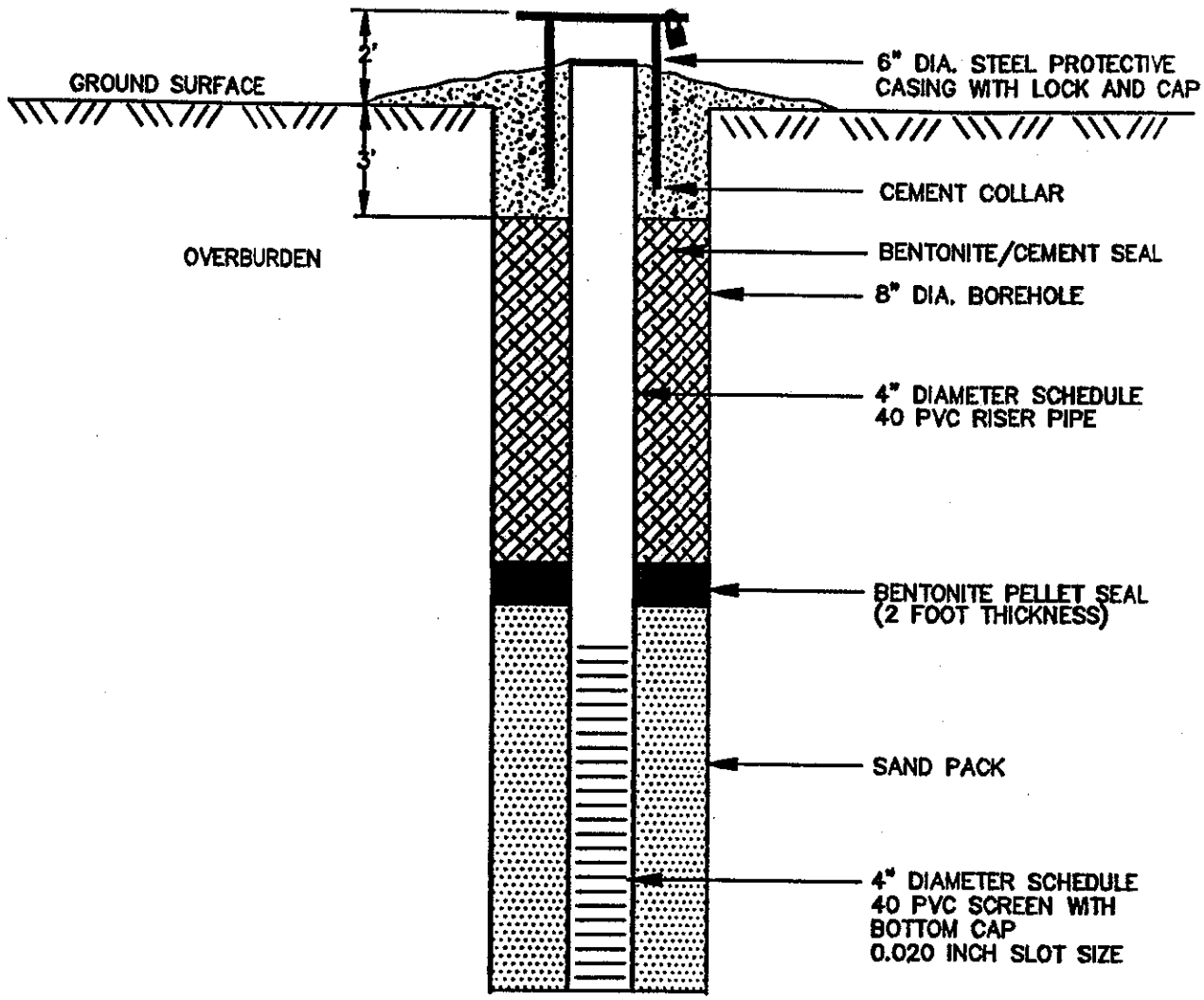
TITLE	SOLID WASTE MANAGEMENT UNIT No. 87		
PROJECT	CHEVRON REFINERY PHILADELPHIA, PENNSYLVANIA		
	Dames & Moore WILLOW GROVE, PENNSYLVANIA		
SCALE AS SHOWN	DWN. BY R.G.B.	JOB NO. 16000-230	
DATE 4-9-90	APPR. BY B.C.A.	FIG. NO. 13	

(S) 1857-480


N
N 220,200
SCHUYLKILL RIVER
EBB
FLOOD
C107
BNA11
N 220,000
VACUUM HEATER F-3
C65
VACUUM HEATER F-2
SECOND STREET
BNA9
460
NORTH PUMP ROOM
ATMOSPHERIC HEATER F-1
BNA10
C62
716
N 219,800
COOLING TOWER 459
BNA8
C106
463
UNIT No 137
BNA7
SOUTH PUMP ROOM 463
464
462
465
N 219,600
AVENUE M
BNA5
397
BNA4
COOLING TOWER 303
E 2,711,200
C105
E 2,711,400
580
BNA6
E 2,711,600
C63
VACUUM HEATER
276
E 2,711,800
UNIT No 136
EXPLANATION:
C62 EXISTING MONITORING WELL LOCATION
C105 PLANNED MONITORING WELL LOCATION
BNA7 PLANNED SOIL BORING LOCATION
PLANNED SOIL GAS SAMPLING POINT
EXTENT OF SWMU
0 50 100 150 200 FEET
GRAPHIC SCALE
TITLE SOLID WASTE MANAGEMENT UNIT No. 88
PROJECT CHEVRON REFINERY PHILADELPHIA, PENNSYLVANIA
Dames & Moore
WILLOW GROVE, PENNSYLVANIA
SCALE AS SHOWN
DWN. BY R.G.B.
JOB NO. 16000-230
DATE 4-9-90
APPR. BY B.C.A.
FIG. NO. 14



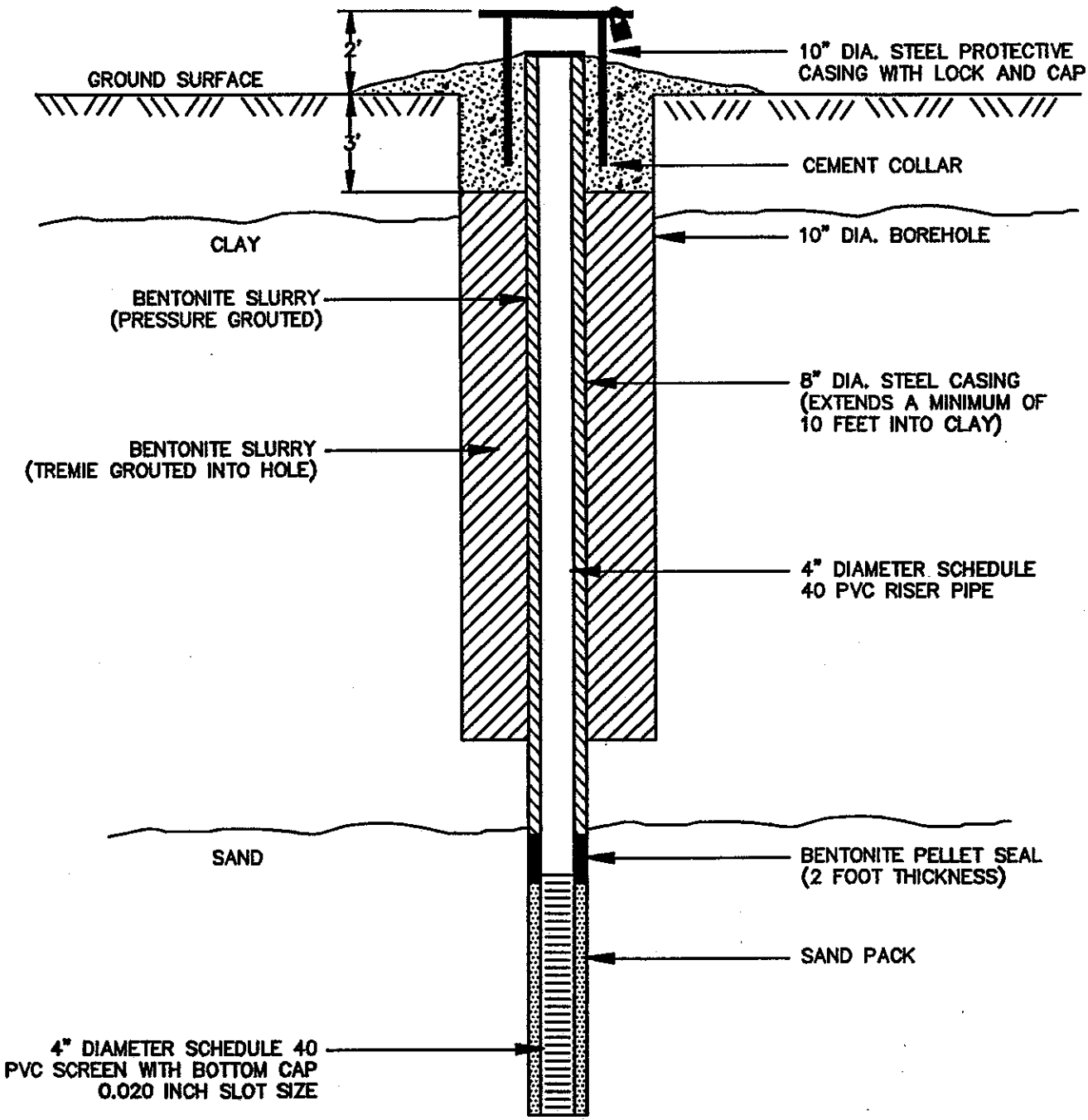
TITLE	SOLID WASTE MANAGEMENT UNIT No. 89		
PROJECT	CHEVRON REFINERY PHILADELPHIA, PENNSYLVANIA		
	Dames & Moore WILLOW GROVE, PENNSYLVANIA		
SCALE AS SHOWN	DWN. BY R.G.B.	JOB NO. 16000-230	
DATE 4-9-90	APPR. BY B.C.A.	FIG. NO. 15	



GROUNDWATER MONITORING WELL CONSTRUCTION DIAGRAM (SHALLOW WELL) CHEVRON REFINERY

NOT TO SCALE

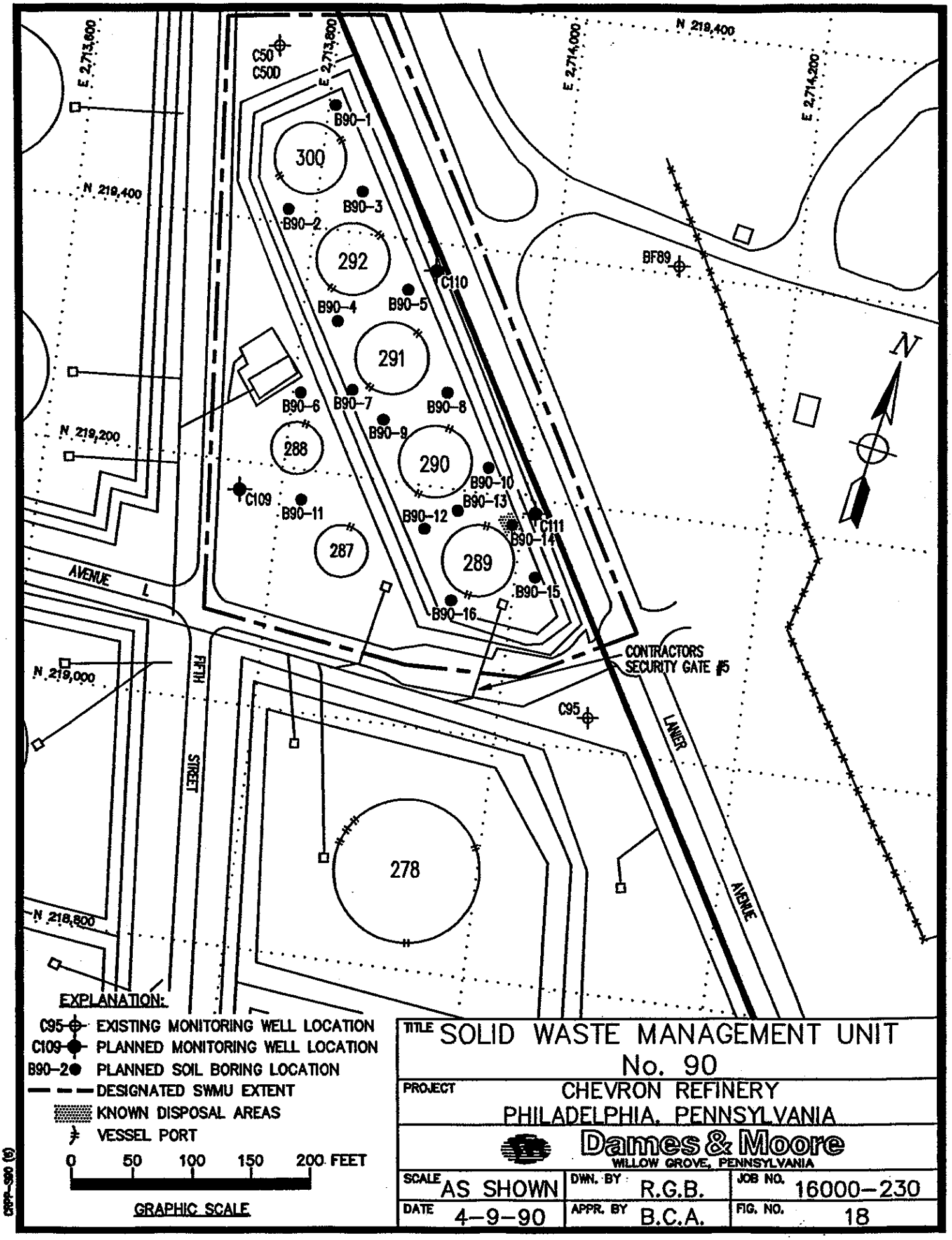
FIGURE 16
DAMES & MOORE



GROUNDWATER MONITORING WELL CONSTRUCTION DIAGRAM (DEEP WELL) CHEVRON REFINERY

NOT TO SCALE

FIGURE 17
DAMES & MOORE



TITLE SOLID WASTE MANAGEMENT UNIT No. 90

PROJECT CHEVRON REFINERY
PHILADELPHIA, PENNSYLVANIA

Dames & Moore
WILLOW GROVE, PENNSYLVANIA

SCALE	DWN. BY	JOB NO.
AS SHOWN	R.G.B.	16000-230
DATE	APPR. BY	FIG. NO.
4-9-90	B.C.A.	18

C899-S90 (5)

N 219,000
N 219,200
N 219,600
N 219,400
N 219,600
E 2,714,600
E 2,714,400
E 2,714,200
E 2,714,000
E 2,713,800
E 2,713,600
LANER AVENUE
FIFTH STREET
ETHYL PUMPHOUSE
LOCKER HOUSE 384
B95 CANTEEN BLDG
CONTRACTORS SECURITY GATE #5
PROCESS LINES
BF90
C49
C114
C113
C95
C112
B91-1
B91-2
B91-3
B91-4
B91-5
B91-6
B91-7
B91-8
B91-9
B91-10
B91-11
B91-12
B91-13
B91-14
B91-15
B91-16
B91-17
B91-18
B91-19
B91-20
B91-21
B91-22
278
277
276
286
285
275
274
273
245
243
343
342
491
AVENUE L
FIFTH

N

EXPLANATION:
- BF90 ⊕ EXISTING MONITORING WELL LOCATION
- C113 ● PLANNED MONITORING WELL LOCATION
- B91-6 ● PLANNED SOIL BORING LOCATION
- DESIGNATED SWMU EXTENT
- KNOWN DISPOSAL AREAS
- VESSEL PORT

0 50 100 150 200 FEET
GRAPHIC SCALE

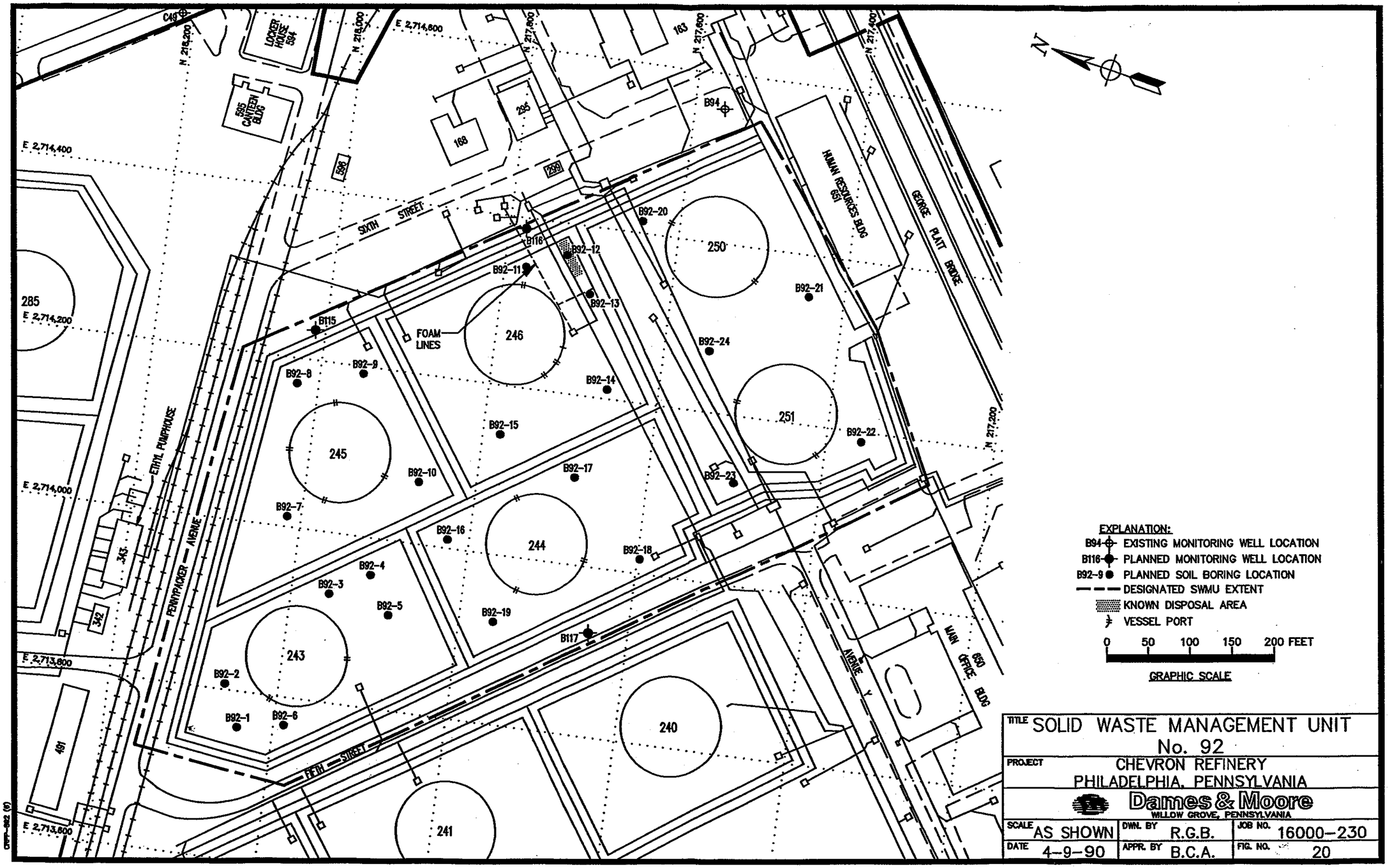
TITLE SOLID WASTE MANAGEMENT UNIT No. 91

PROJECT CHEVRON REFINERY PHILADELPHIA, PENNSYLVANIA

Dames & Moore
WILLOW GROVE, PENNSYLVANIA

SCALE	DWN. BY	JOB NO.
AS SHOWN	R.G.B.	16000-230
DATE 4-16-160	APPR. BY B.C.A.	FIG. NO. 19

GRPF-891 (2)

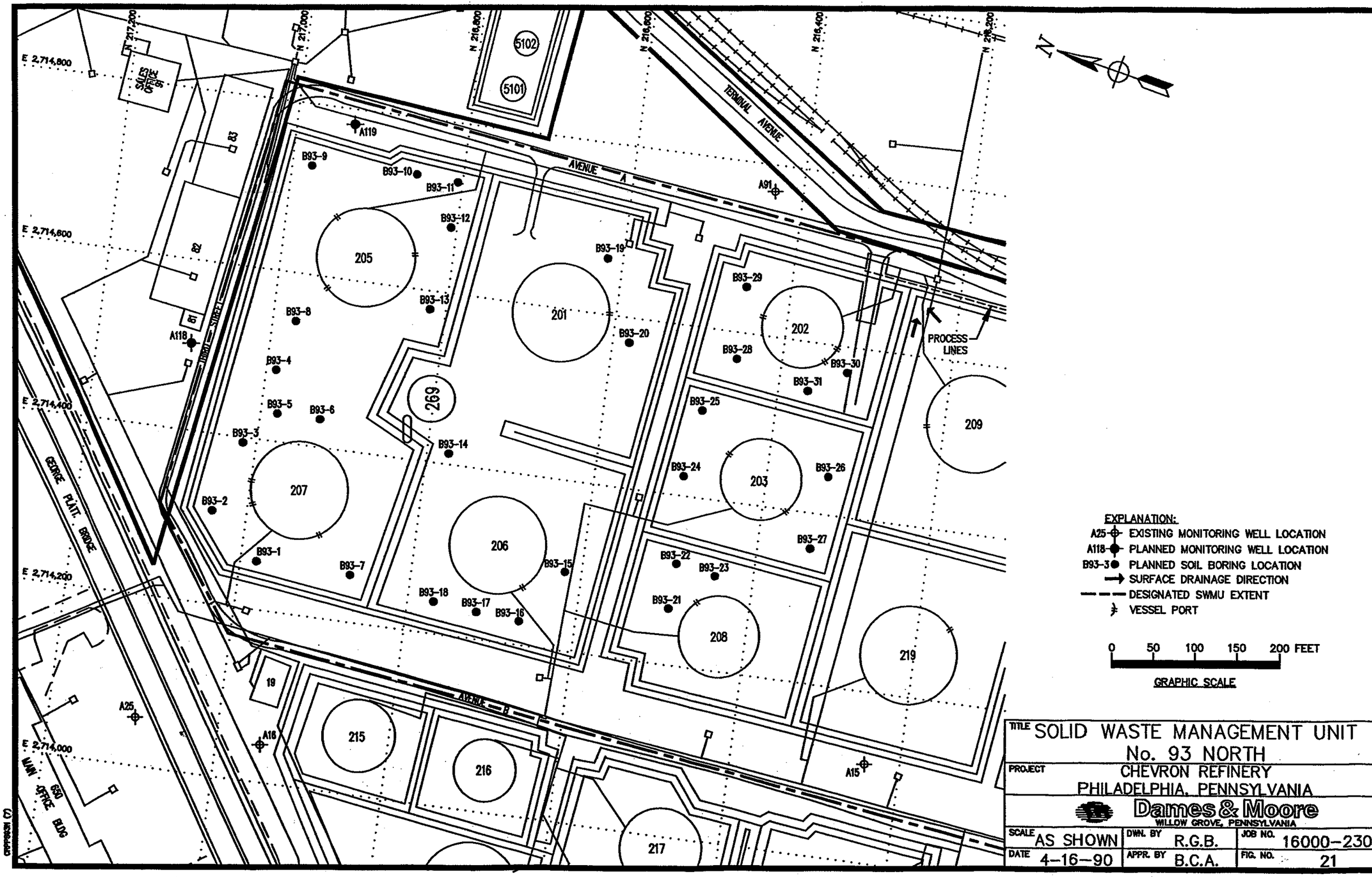


TITLE SOLID WASTE MANAGEMENT UNIT No. 92

PROJECT CHEVRON REFINERY PHILADELPHIA, PENNSYLVANIA

Dames & Moore
WILLOW GROVE, PENNSYLVANIA

SCALE AS SHOWN	DWN. BY R.G.B.	JOB NO. 16000-230
DATE 4-9-90	APPR. BY B.C.A.	FIG. NO. 20

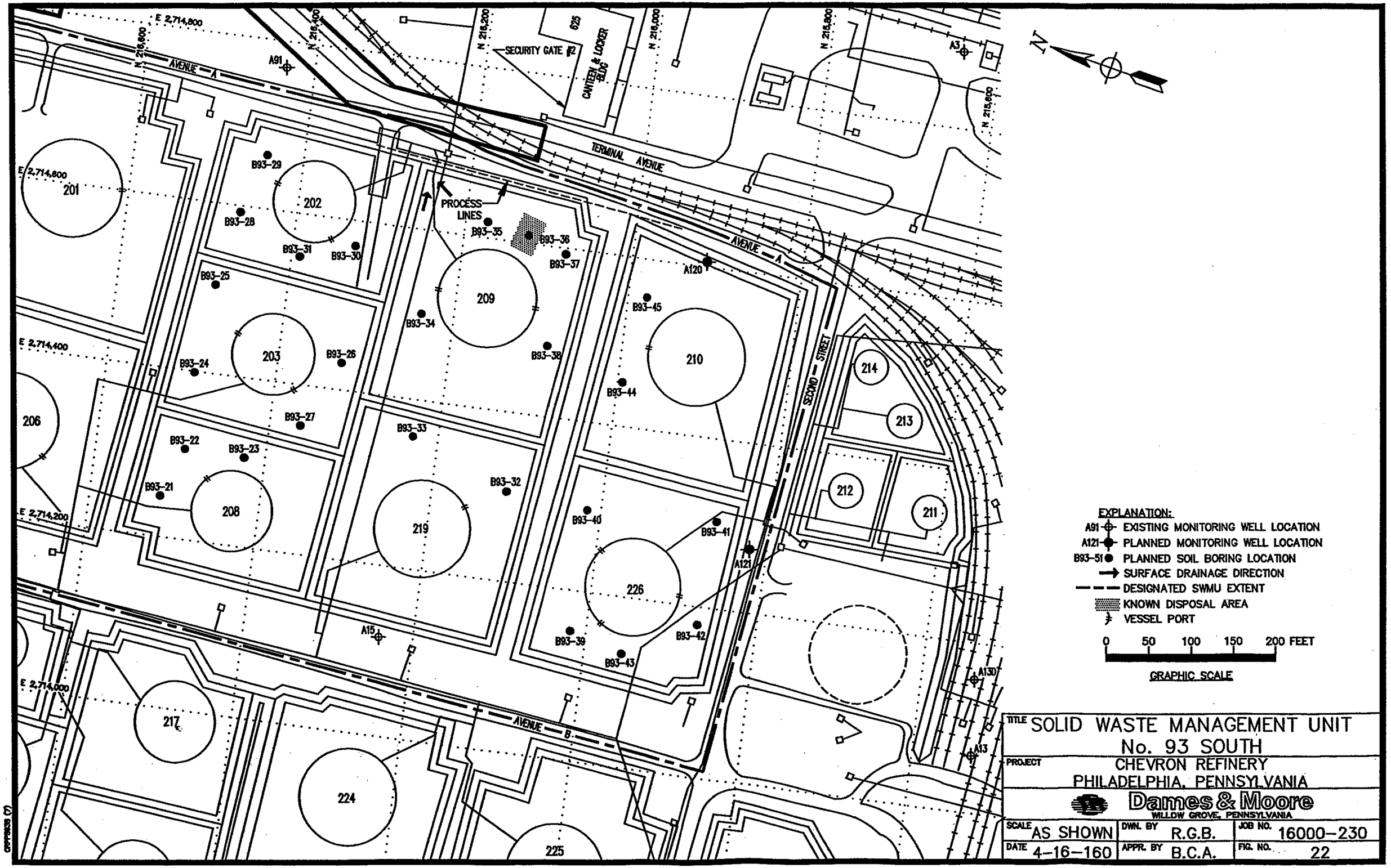


TITLE SOLID WASTE MANAGEMENT UNIT
No. 93 NORTH

PROJECT CHEVRON REFINERY
PHILADELPHIA, PENNSYLVANIA

Dames & Moore
WILLOW GROVE, PENNSYLVANIA

SCALE AS SHOWN	DWN. BY R.G.B.	JOB NO. 16000-230
DATE 4-16-90	APPR. BY B.C.A.	FIG. NO. 21

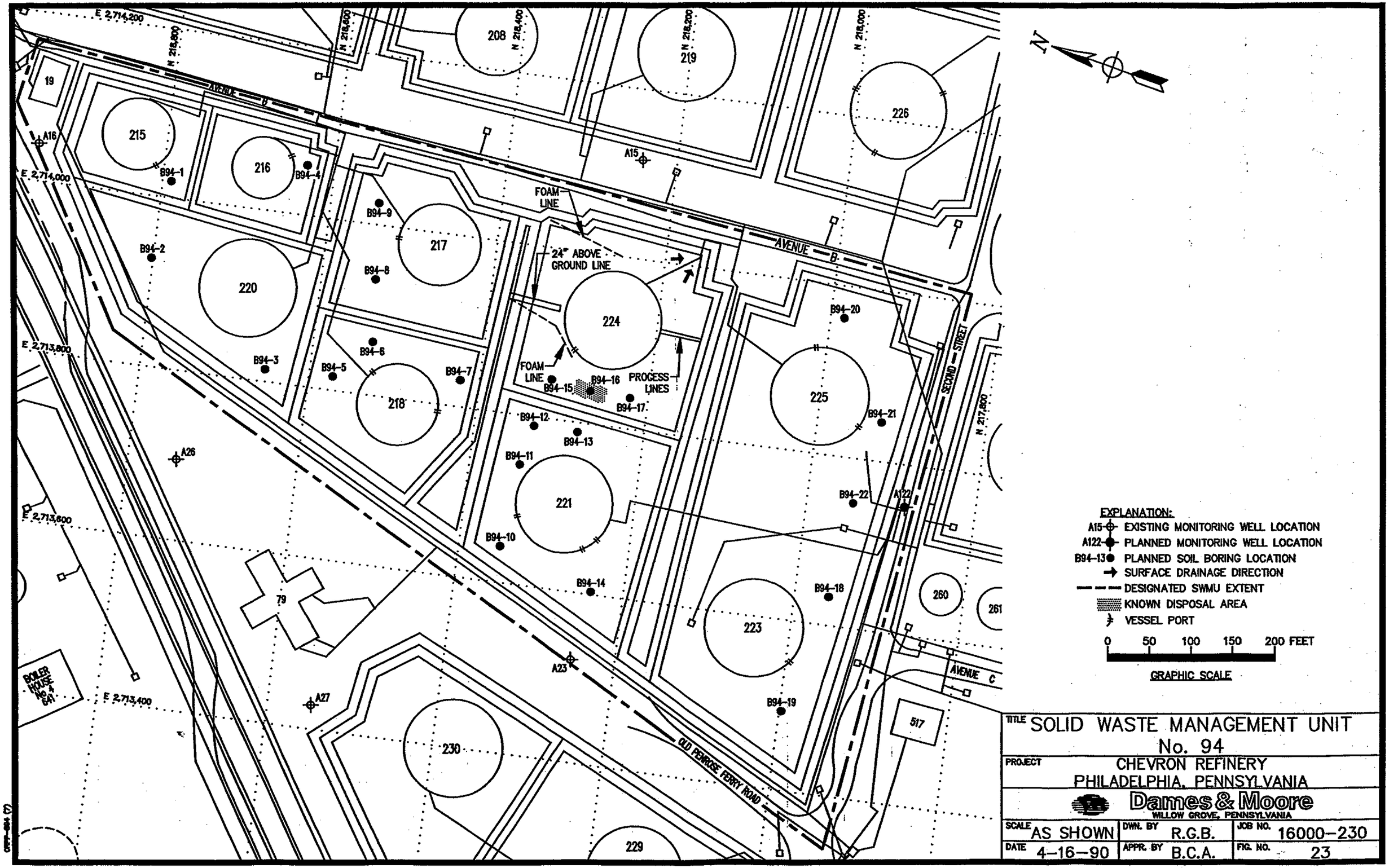


TITLE SOLID WASTE MANAGEMENT UNIT
No. 93 SOUTH

PROJECT CHEVRON REFINERY
PHILADELPHIA, PENNSYLVANIA

Dames & Moore
WILLOW GROVE, PENNSYLVANIA

SCALE AS SHOWN	DWN. BY R.G.B.	JOB NO. 16000-230
DATE 4-16-160	APPR. BY B.C.A.	FIG. NO. 22

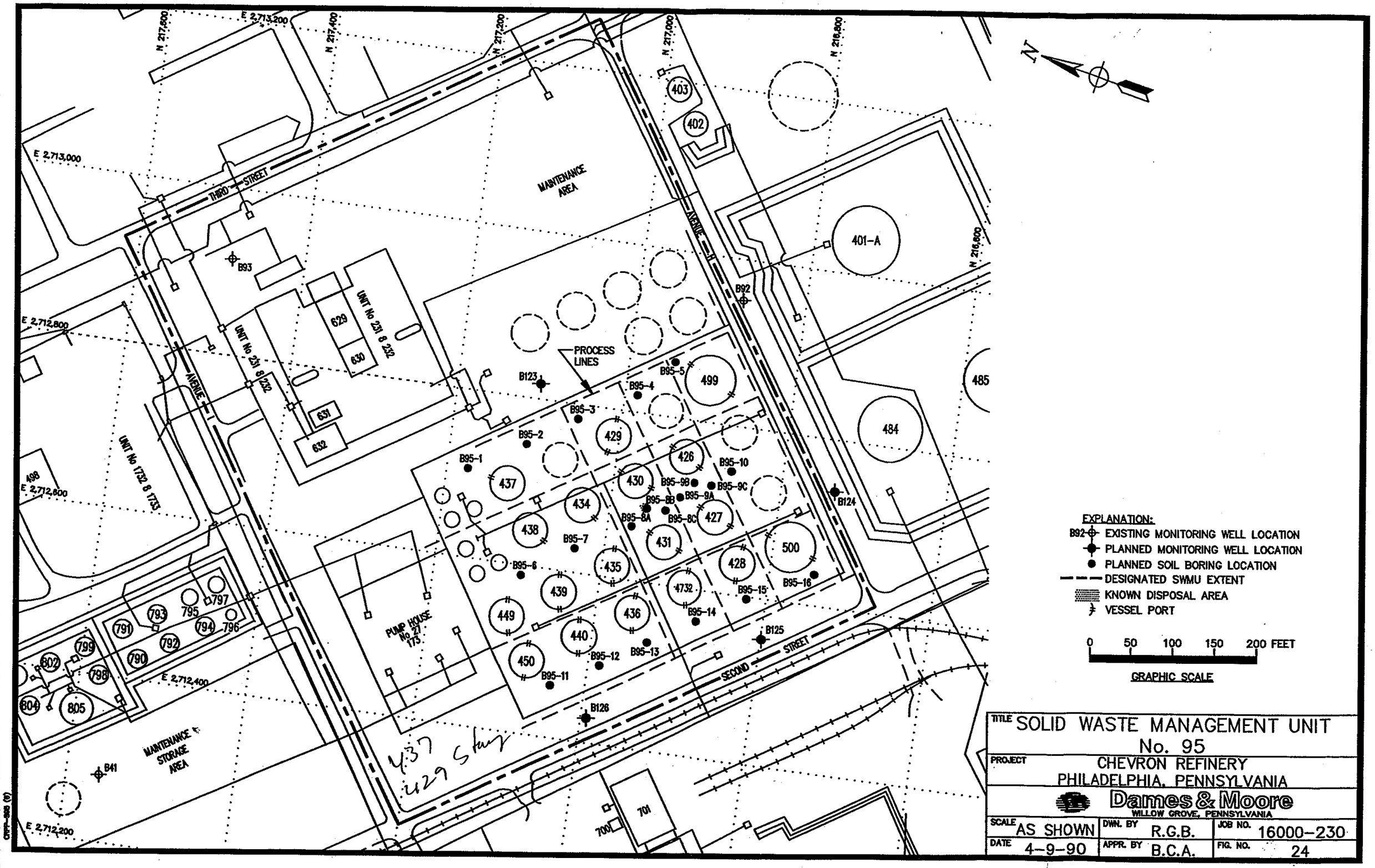


TITLE SOLID WASTE MANAGEMENT UNIT No. 94

PROJECT CHEVRON REFINERY PHILADELPHIA, PENNSYLVANIA

Dames & Moore
WILLOW GROVE, PENNSYLVANIA

SCALE AS SHOWN	DWN. BY R.G.B.	JOB NO. 16000-230
DATE 4-16-90	APPR. BY B.C.A.	FIG. NO. 23

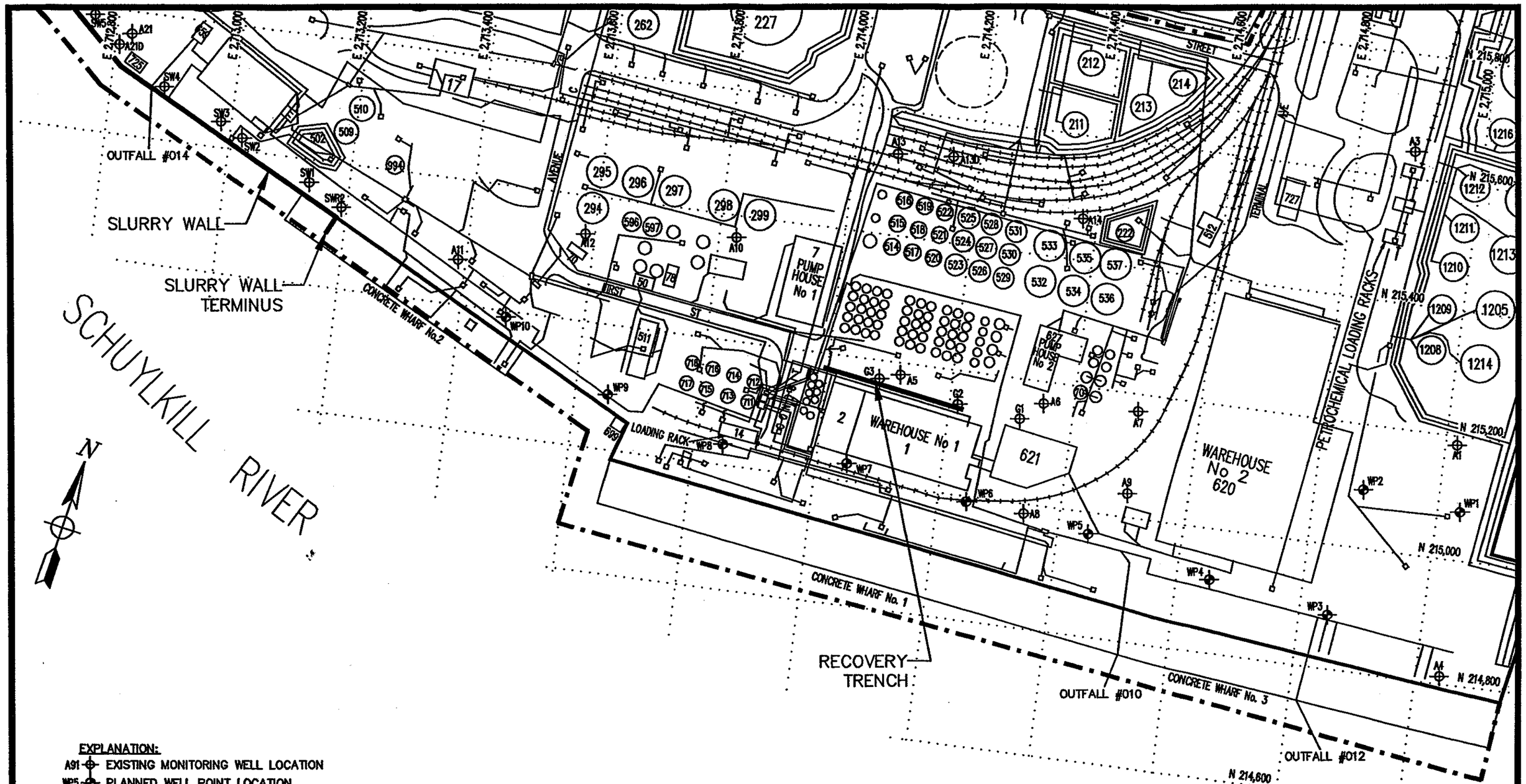


TITLE SOLID WASTE MANAGEMENT UNIT No. 95

PROJECT CHEVRON REFINERY PHILADELPHIA, PENNSYLVANIA

Dames & Moore
WILLOW GROVE, PENNSYLVANIA

SCALE	AS SHOWN	DWN. BY	R.G.B.	JOB NO.	16000-230
DATE	4-9-90	APPR. BY	B.C.A.	FIG. NO.	24



EXPLANATION:

- A91 ⊕ EXISTING MONITORING WELL LOCATION
- WP5 ⊕ PLANNED WELL POINT LOCATION
- DESIGNATED SWMU EXTENT
- DESIGNATED SWMU HOTSPOT

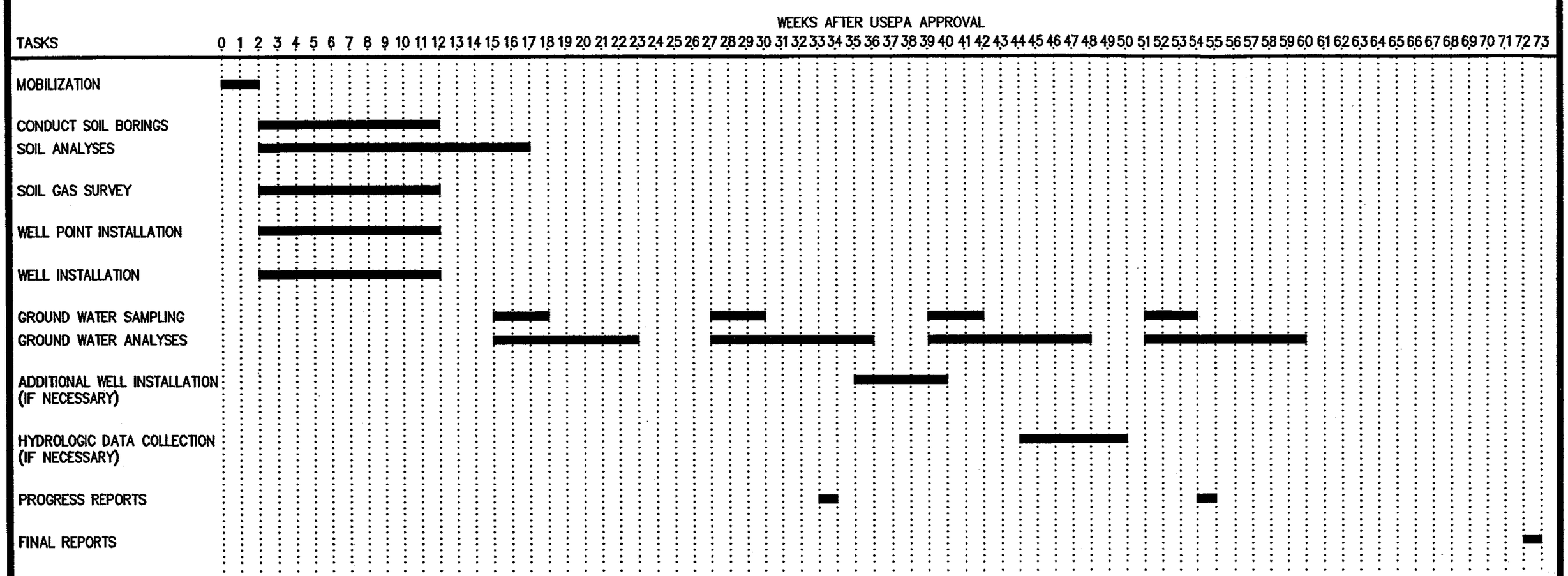
0 75 150 225 300 FEET

GRAPHIC SCALE

TITLE: SOLID WASTE MANAGEMENT UNIT No.101		
PROJECT: CHEVRON REFINERY PHILADELPHIA, PENNSYLVANIA		
Dames & Moore, WILLOW GROVE, PENNSYLVANIA		
SCALE: AS SHOWN	DWN. BY: R.G.B.	JOB NO.: 16000-230
DATE: 4-16-90	APPR. BY: B.C.A.	FIG. NO.: 25

(S) 10164R0

SCHEDULE FOR IMPLEMENTATION
RFI WORK PLAN
CHEVRON USA, INC.
PHILADELPHIA REFINERY



NOTE:
IMPLEMENTATION BEGINS UPON WORK PLAN APPROVAL.
ADDITIONAL WORK MAY BE SCHEDULED, IF NECESSARY.

FIGURE 26
DAMES & MOORE

PROJECT ORGANIZATION/ACTIVITY CHART
RCRA FACILITIES INVESTIGATION WORK PLAN
CHEVRON USA, INC.
PHILADELPHIA, PENNSYLVANIA

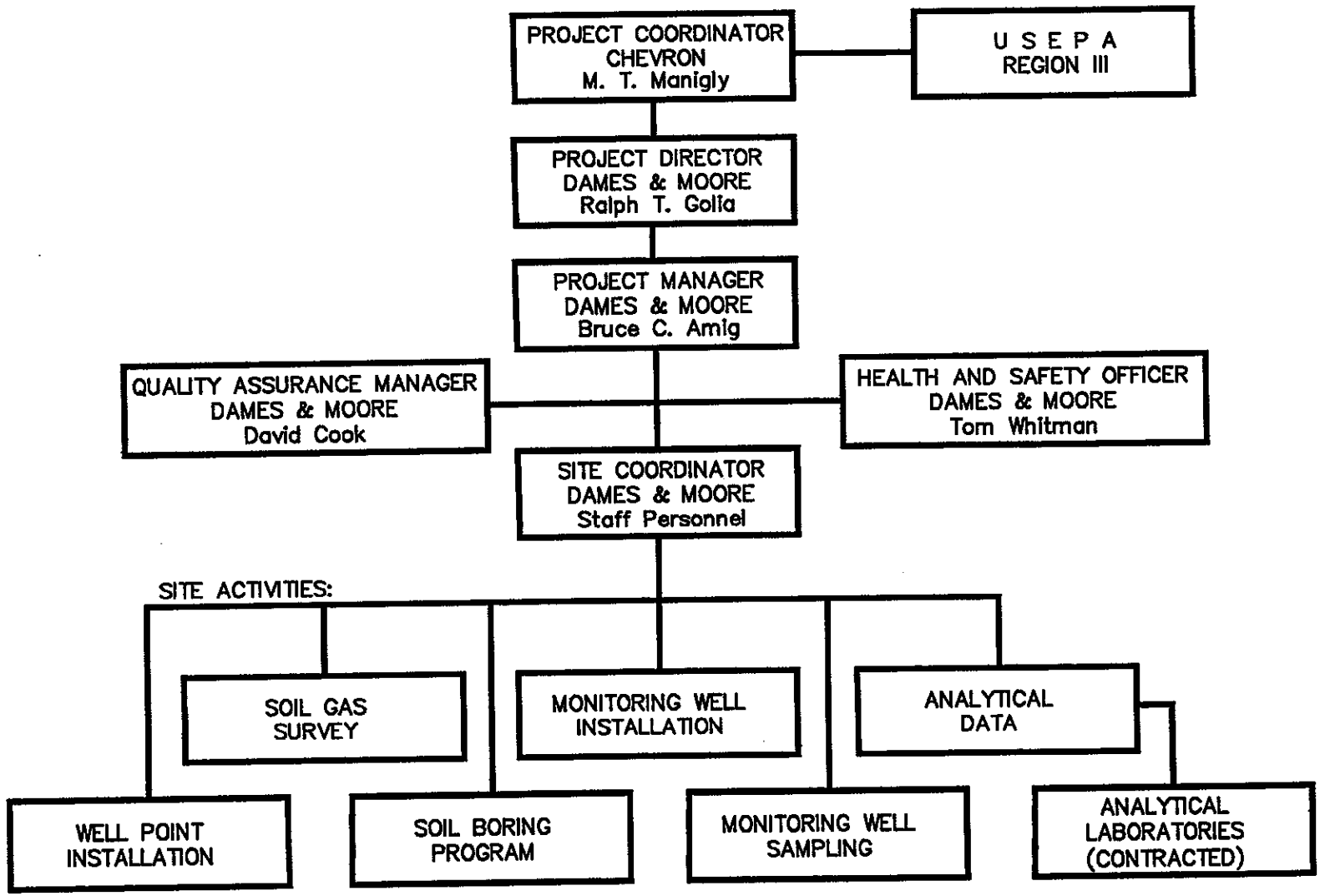


CHART (5)

FIGURE 27