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Site No. 902003

County Allegany

Town Wellsville

Foilable [✓ Yes] No

File Name Documents / Reports

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report. HW902003. 1991-03. Remedial-Investigation-Vol-1-of-4.

REMEDIAL INVESTIGATION REPORT

FOR THE

SINCLAIR REFINERY SITE
Wellsville, New York

VOLUME I OF IV
TECHNICAL REPORT

PREPARED FOR
ARCO
BY
EBASCO
An ENSERCH® Engineering and Construction Company

MARCH 1991

EXECUTIVE SUMMARY

The Sinclair Refinery Site, located in Wellsville, New York, was used to refine crude oil from the early 1900's until 1958. The refinery ceased operations at that time and the majority of the property was transferred to the Village of Wellsville. Subsequently, the site was redeveloped as an industrial park and campus of the State University of New York. The site covers an area of approximately 114 acres including a 90-acre former refinery area and the adjacent 10-acre landfill. A 14-acre area, a former off-site tank farm located approximately 1/4 mile west of the refinery area, is also considered to be part of the site.

In 1981 and 1982, a portion of the Landfill was eroded by flooding of the adjacent Genesee River. As a result of the erosion, the New York State Department of Environmental Conservation (NYSDEC) submitted a MITRE hazard ranking for the site in 1982. The NYSDEC also initiated sampling of the river and landfill and prepared the "Remedial Action Master Plan" for the site calling for additional work to be performed at the site. A remedial investigation at the site was then initiated. The remedial investigation (RI), feasibility study (FS) and a Record of Decision (ROD) for the landfill area was completed in 1985. The ROD required remediation of the landfill but did not include an evaluation of landfill area groundwater, the refinery area or the off-site tank farm. Work on the remedial investigation for the refinery and off-site tank farm areas by the NYSDEC and its contractors was only partially complete when work was stopped in 1987. Subsequently, in 1988, the Atlantic Richfield Company entered into an Administrative Order on Consent with the U.S. Environmental Protection Agency which called for additional site investigation work to be performed to complete the RI/FS for the site.

The Remedial Investigation was conducted: (1) to evaluate the physical and chemical characteristics of the Sinclair Refinery Site (exluding the landfill), (2) to provide data for the evaluation of risks to the public health or environment which are present due to past or current uses of the site and (3) to determine whether the past or present uses have resulted in levels of contaminants which may require remedial measures.

The Wellsville site is composed of the following major features; the former refinery area (ninety acres) including some remnant structures, a ten-acre landfill and a fourteen-acre off-site former tank farm area. The Genesee River runs adjacent to the northeastern side of the site and acts as the discharge point for groundwater. As part of the remedial investigation the groundwater, soils, sediments, surface water and remnant structures at the site were investigated.

Several site structures including the storm water sewers and northern separator were found to contain water or sediment with elevated levels of metals, volatile organic compounds (VOCs) and base/neutral/acid extractable compounds (BNAs). The off-site tank farm and Genesee River were found to be generally free of refinery-related contaminants.

In certain limited areas of the refinery, surface soils were found to contain elevated concentrations of lead. Several other metals and BNA compounds were also detected, though no VOCs were found.

The subsurface soils at the site showed only a few elevated lead concentrations, primarily in the general area of the former tetraethyl lead sludge pits. Several BNA and VOC compounds were found in the subsurface soil. Some of the VOCs may be attributable to the refinery. However, several chlorinated compounds were also detected. These compounds were not in general use at the time the refinery was operating and are likely the result of more recent discharges.

VOCs and BNAs were also detected at elevated levels in refinery area groundwater. Benzene and xylene were the most commonly detected VOCs. Chlorinated hydrocarbons were also detected in the groundwater. Elevated levels of arsenic in groundwater were also detected in some on-site wells, although no site sources were identified.

Landfill area groundwater was also found to contain low levels of arsenic, but was essentially free of BNAs and VOCs.

The drainage swale area, also contained elevated arsenic levels in some soil samples. No direct source to account for the elevated arsenic levels was identified.

An evaluation of the risks the Sinclair Refinery site poses to both human health and the environment was prepared by Versar for the EPA. This Endangerment Assessment is included as Appendix K in Volume IV of this report.

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1.0 INTRODUCTION

The Sinclair Refinery Site was proposed for inclusion on the National Priority List (NPL) in 1982, following the submittal of the MITRE Hazard Ranking (Federal Register, 1982). To evaluate potential hazards associated with the site, the Remedial Investigation (RI) and Feasibility Study (FS) process was then initiated by the New York State Department of Environmental Conservation (NYSDEC). Subsequently, the Atlantic Richfield Company (ARCO) entered into an Administrative Order on Consent with the U.S. Environmental Protection Agency (USEPA, 1988a) to complete the RI/FS initiated by the NYSDEC for the Sinclair Refinery Site.

The Sinclair Refinery Site was divided into two study areas by the NYSDEC: the refinery area (including an off-site tank farm (OSTF)), and the landfill area consisting of the Central Elevated Landfill Area (CELA) and the Southern Landfill Area (SLA). The RI/FS for the landfill area was completed by the NYSDEC and a Record of Decision (ROD) issued by EPA on September 30, 1985.

The RI/FS for the refinery area was performed by Ebasco under contract with ARCO. The RI report for the refinery area is presented in this document. The FS will be presented in a separate document.

1.1 PURPOSE OF REPORT

There are three main purposes for this RI report: (1) to present a description of the physical and chemical characteristics of the site based on presently available information; (2) to provide data for the evaluation of risks to public health or the environment which are present at the site, due to past or current uses of the site; and (3) to determine whether the past or present uses have resulted in levels of contaminants which may require remedial measures. As a result of this assessment, potentially responsible parties other than ARCO may be identified. Based on the remedial objectives identified as a result of this process, an assessment of potential remedial actions may be performed in an FS. Depending on this assessment, a remedial action may be selected or it may be determined that no action is required.

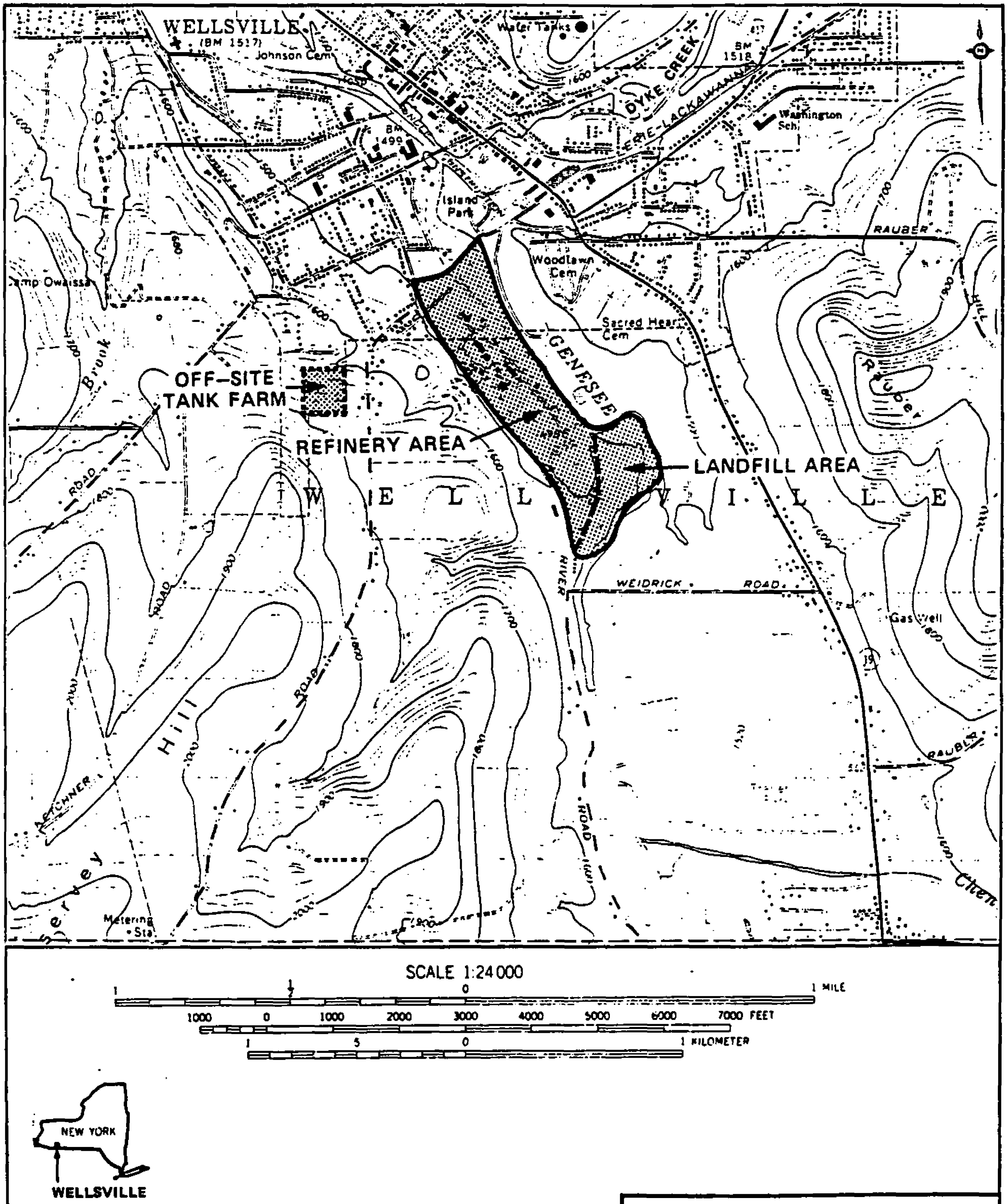
This RI report presents a description of the site investigations and the results of those investigations. The RI was initiated by SMC Martin, under contract to the NYSDEC. The firm performed a Phase I site investigation, previously described in a draft Phase I RI report (SMC Martin, 1985). Subsequently, SMC Martin initiated a Phase II investigation and began preparation of the Phase II report (SMC Martin, 1987). This Phase II report was not completed, and in fact, many of the sections of the report had not been written when work stopped. Some sections that had been written were still in the form of unedited, handwritten drafts. The Phase II site investigation was completed by Ebasco, and the current report includes a description of the Phase I and II field programs and results (excluding the landfill). Many of the descriptions of the SMC Martin Phase II studies are from the incomplete draft report. As a result, many of the descriptions are also incomplete. In some cases inconsistencies between the draft report and draft figures exist, but the data have been incorporated into this report since this draft information represents the only source of data available.

The scope of the RI report was discussed in detail in the Project Operation Plan prepared for the Sinclair Refinery Site (Ebasco, 1988). The RI report was prepared following the latest EPA guidance documents including "Guidance on Remedial Investigation Under CERCLA" (USEPA, 1985a) and "Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA" (USEPA, 1988b). These documents present the EPA's most recent guidance for complying with CERCLA and SARA requirements. When the RI and FS are completed, the EPA will prepare a Record of Decision, summarizing the results of the RI, the remedial alternative selected in the FS and the basis for selecting that alternative.

1.2 SITE BACKGROUND

1.2.1 Site Description

The Sinclair Refinery Site is located one half mile south of downtown Wellsville, New York, in Allegany County (Figure 1-1), and seven miles north of the New York-Pennsylvania border. Situated on the Genesee River, the site



SINCLAIR REFINERY SITE
WELLSVILLE, NEW YORK

FIGURE 1–1

SITE LOCATION MAP

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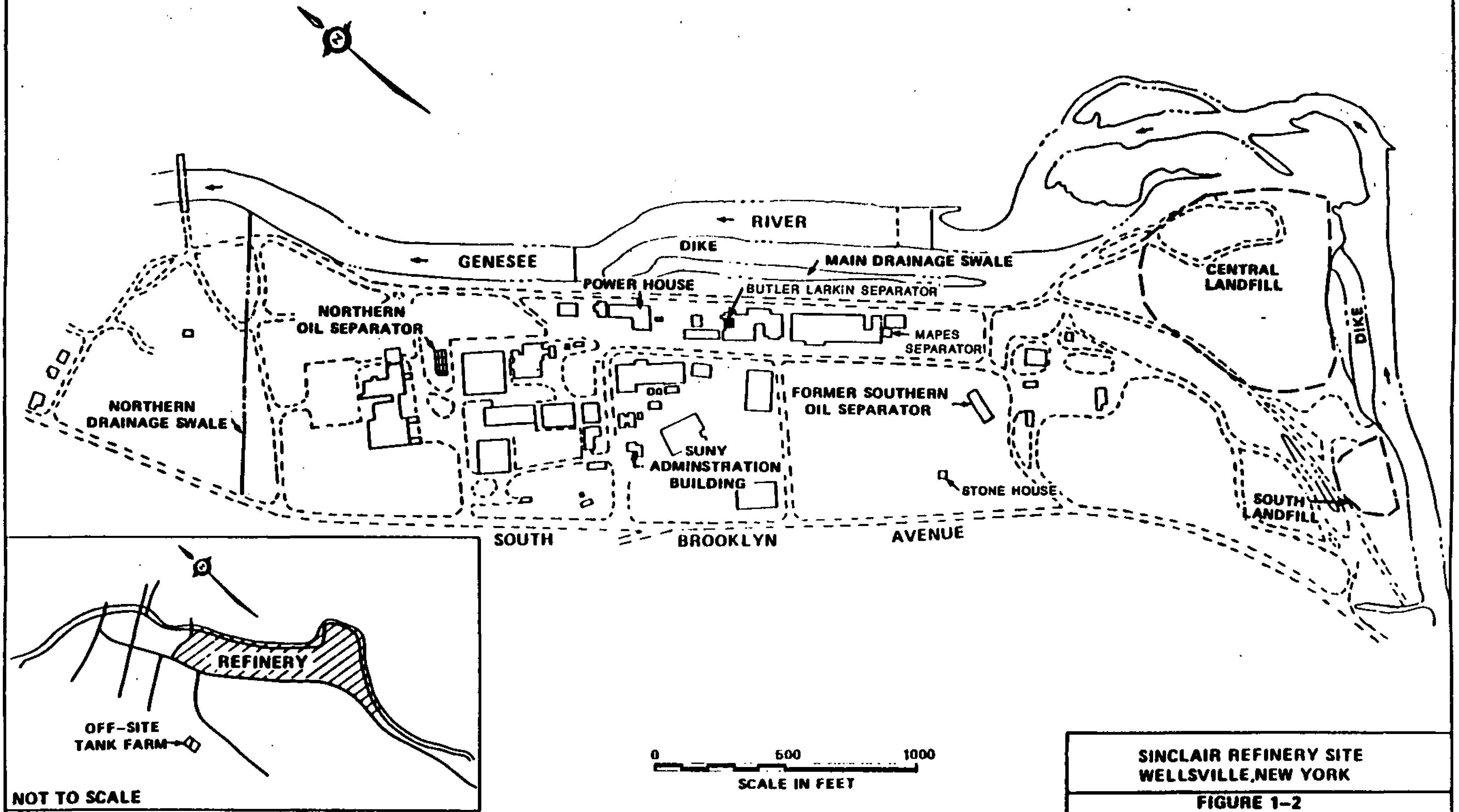
can be viewed as three separate areas (Figure 1-2). The first and largest of these is the refinery area, approximately 90 acres in size. Next is the landfill area, located adjacent to the southern end of the refinery area. The landfill is also on the Genesee River, and is approximately 10 acres in size. The third area is the Off-Site Tank Farm located west of the refinery area, on the west side of South Brooklyn Avenue (River Road), a 14-acre area formerly used as a tank farm for the storage of crude oil collected from local oil wells. Crude oil was then conveyed to the refinery area for processing (probably by gravity flow pipelines).

1.2.2 Site History

1.2.2.1 Prior Uses

The Sinclair Refinery was built in 1901 for the processing of Pennsylvania grade crude oil. Products manufactured by the facility were made from New York and Pennsylvania crude oil, including crude brought in from wells located several miles south of the refinery. Products manufactured included heavy oils and grease for lubrication, light oils for fuel, gasoline, lighter fluid, naptha and paraffin. During the early 1900s, operations at the site were started by the Wellsville Refining Company. In 1919, the facility was purchased by the Sinclair Refining Company (Wellsville Daily Reporter, 1930), who owned and operated the facility until 1958 (SMC Martin, 1985). When the Refinery closed in 1958, Sinclair transferred the majority of the property to the Village of Wellsville. The remaining property was turned over to the New York Refinery Project. Most of the structures, including the storage tanks at the tank farm, were removed by 1964 (SMC Martin, 1985), although new oil or gas storage tanks were constructed after the refinery closed, by subsequent site users. Some of the structures remained, including the oil separator, located on the north side of the site near the river, several refinery buildings, and the storm water sewer system. Some of the buildings were renovated by tenants of the existing industrial park and college campus, while others remain vacant (see Subsection 1.2.2.2 for details of existing structures).

Since the termination of refinery activities in 1958, the site has become integrated into the local community and local economy. The refinery area has been redeveloped with very few of the refinery structures remaining. This



ADAPTED FROM SMC MARTIN PHASE I SITE MAP

SINCLAIR REFINERY SITE
WELLSVILLE,NEW YORK

FIGURE 1–2

SINCLAIR REFINERY SITE MAP

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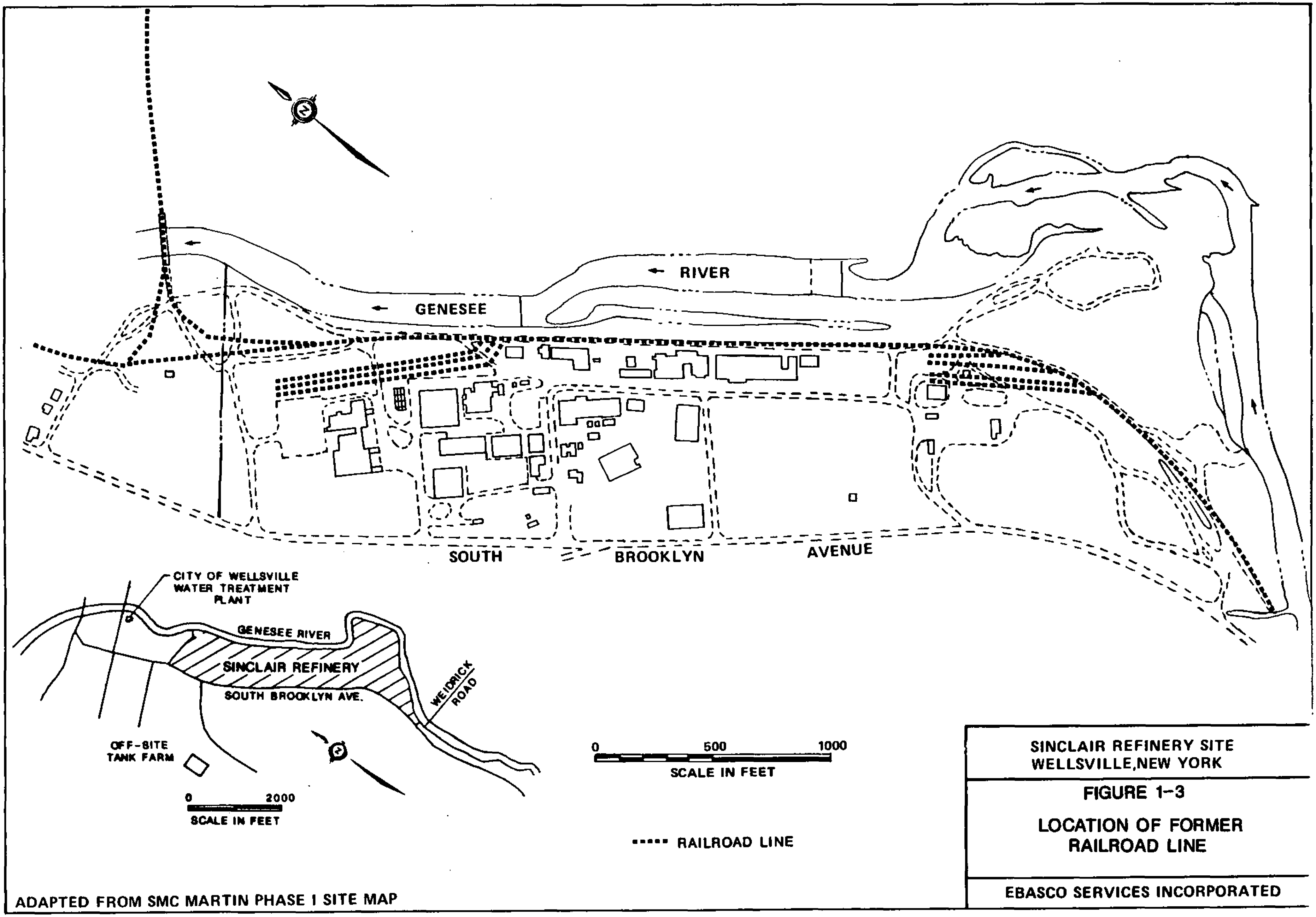
area is currently occupied by a number of manufacturing businesses and the State University of New York at Alfred (SUNY at Alfred). The Off-Site Tank Farm is not developed, and the landfill area is not currently used.

A portion of the site, along the Genesee River included a Wellsville, Addison and Galeton railroad line which passed through the site. Several railroad spurs were also present on the site. The former railroad line is now used as a dirt road and virtually all of the railroad ties have been removed from the site. However, a few ties were observed in a former spur area near Otis Eastern's offices. The former railroad and spurs are shown on Figure 1-3.

1.2.2.2 Current Uses

Seven companies are currently using the site along with the State University of New York (see Table 1-1 and Figure 1-4). Much of the land at the site is vacant, and a total of ten private and government groups own parcels of land at the site (Figure 1-5). The businesses operating at the site are: Butler-Larkin Company Inc.; Current Controls, Inc.; Mapes Industries, Inc.; National Fuel Co, Inc.; Otis Eastern Service, Inc.; Release Coatings, Inc.; and Niagara Mohawk. Butler-Larkin, Inc. is a manufacturer of drilling and completion equipment for oil, gas and water wells, and has its manufacturing facilities at the site. They also maintain a large storage area in the central portion of the site. Mapes Industries, Inc. manufactures toy chests, cribs and other finished wood products, with production facilities at the site. Otis Eastern Service, Inc. is a drilling and gas pipeline construction company, with its main offices and a construction equipment storage area at the site. Current Controls, Inc. is a manufacturer of small electrical transformers and other electronic control devices, with manufacturing facilities on site. Release Coatings, Inc. is a manufacturer of a material used to facilitate the extraction of molded products from their molds. National Fuel Co, Inc. is the local natural gas supplier, with both its customer service and vehicular maintenance facilities located at the site. Niagara Mohawk is an electric utility which maintains high voltage power poles and transmission lines on the site. The SUNY at Alfred campus is an agricultural and technical college that also has shops for automobile repair instruction.



ADAPTED FROM SMC MARTIN PHASE I SITE MAP

SINCLAIR REFINERY SITE
WELLSVILLE,NEW YORK

FIGURE 1-3

LOCATION OF FORMER RAILROAD LINE

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TABLE 1-1 (Sheet 1 of 2)

CURRENT PROPERTY OWNERS AND OCCUPANTS OF FORMER SINCLAIR REFINERY SITE

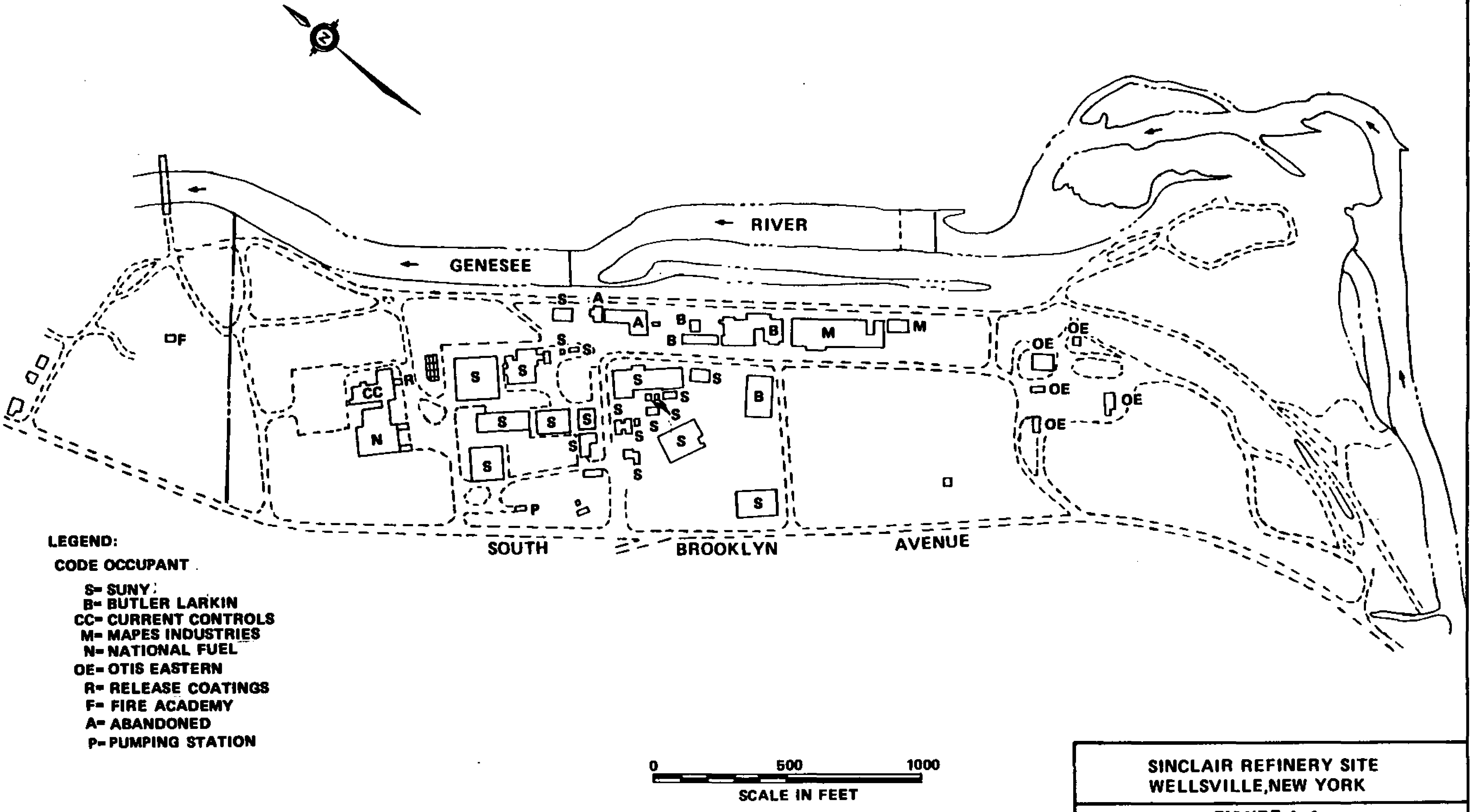
Owner	Occupant	Location
Alfred Education Foundation	SUNY-Alfred	Map 252, Block 1, Parcels 12, 13, 14, 15, 17, 18, 19, 20, 21. Map 239.13, Block 1, Parcel 37.
Town of Wellsville	None (Open Area)	Map 252, Block 1, Parcel 24.
Otis Eastern Service, Inc.	Otis Eastern	Map 252, Block 1, Parcels 26.1, 27.1.
Herald Ford, Inc.	Current Controls; Release Coatings	Map 239.13, Block 1, Parcels 38.1, 39.1.
Allegany County Industrial Development Agency	National Fuels	Map 252, Block 1, Parcel 16. Map 239.13, Block 1, Parcel 38.2.
Valley Industries, Inc.	Butler-Larkin	Map 252, Block 1, Parcels 22, 25.
Village of Wellsville	None (Open Area)	Map 239.13, Block 1, Parcel, 39.2, 75.

TABLE 1-1 (Sheet 2 of 2)

CURRENT PROPERTY OWNERS AND OCCUPANTS OF FORMER SINCLAIR REFINERY SITE

Owner	Occupant	Location
Instrument Systems Corporation	Mapes Co. Inc.	Map 252, Block 1, Parcel 23.
County of Allegany (former Wellsville, Addison, Galeton Railroad)	None (Dirt Road and Open Area)	Map 252, Block 1, Parcel 86.
Niagara Mohawk	None (Used as Transmission Line Corridor)	Map 252, Block 1, Parcels 26.2, 27.2

Note: Map, block and parcel numbers refer to tax maps prepared for the Allegany County Board of Legislators.



LEGEND:

CODE OCCUPANT

S= SUNY
B= BUTLER LARKIN
CC= CURRENT CONTROLS
M= MAPES INDUSTRIES
N= NATIONAL FUEL
OE= OTIS EASTERN
R= RELEASE COATINGS
F= FIRE ACADEMY
A= ABANDONED
P= PUMPING STATION

ADAPTED FROM SMC MARTIN PHASE I SITE MAP

SINCLAIR REFINERY SITE
WELLSVILLE, NEW YORK

FIGURE 1-4

OCCUPANTS OF CURRENT STRUCTURES

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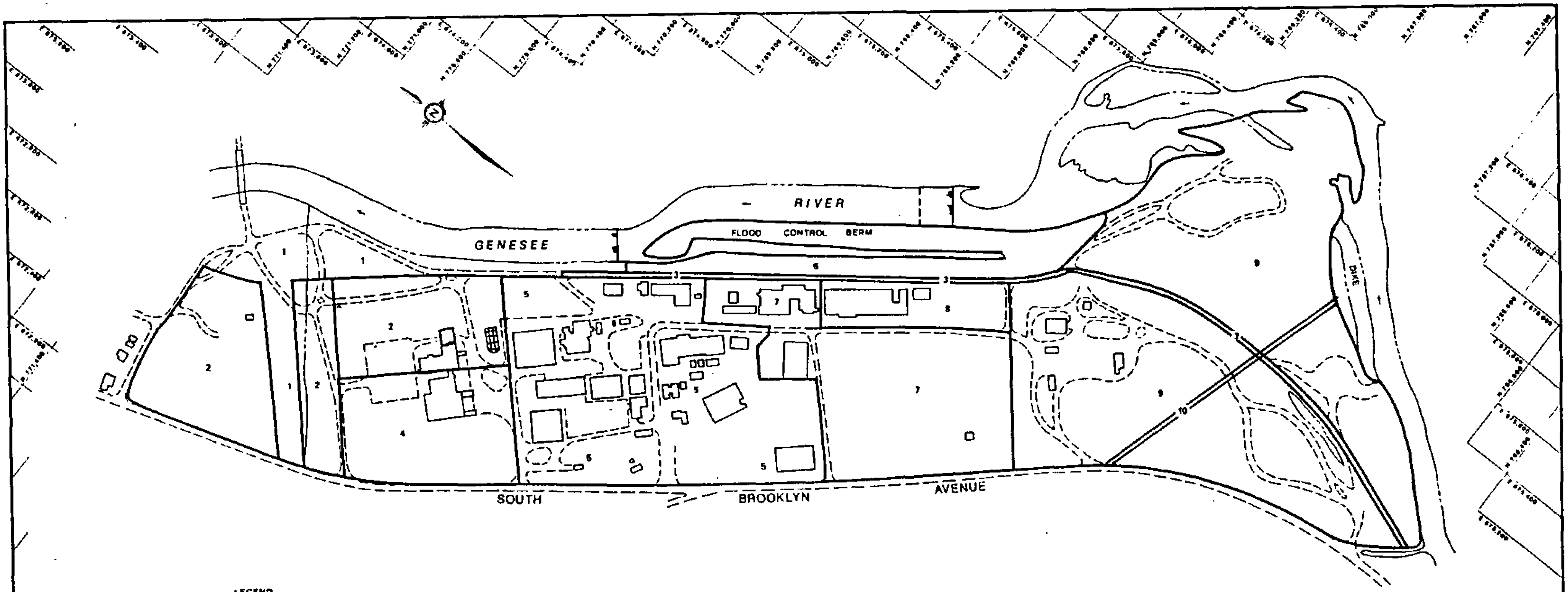

LEGEND

1 – VILLAGE OF WELLSVILLE
2 – HERALD FORD INC.
3 – COUNTY OF ALLEGANY (FORMER WELLSVILLE, ADDISON & GALETON RAILROAD CORPORATION)
4 – COUNTY OF ALLEGANY, INDUSTRIAL DEVELOPMENT AGENCY
5 – ALFRED EDUCATION FOUNDATION (S.U.N.Y. ALFRED)
6 – TOWN OF WELLSVILLE
7 – BUTLER - LARKIN
8 – INSTRUMENT SYSTEMS CORPORATION
9 – OTIS - EASTERN
10 – NIAGARA MOHAWK

0 100 200 300 500 1000
SCALE IN FEET

NOTE 1: BOUNDARY LOCATIONS ARE APPROXIMATE. FOR MORE PRECISE BOUNDARIES REFER TO TABLE 1–1, AND TAX MAPS 238.13 AND 252 OF THE ALLEGANY COUNTY BOARD OF LEGISLATORS.

SINCLAIR REFINERY SITE
WELLSVILLE, NEW YORK

FIGURE 1–5

CURRENT SITE OWNERSHIP

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The Village of Wellsville maintains its domestic water intake/pumping facility approximately one quarter mile south of the southern boundary of the South Landfill, upstream of the Sinclair Refinery Site. Wellsville also maintains a fire-fighting training building at the north end of the site.

The buildings occupied by each company are shown on Figure 1-4. The buildings and types of structures used are as follows. The SUNY at Alfred campus has approximately 21 buildings, of which eight are of brick construction, having been renovated from old refinery buildings. The remaining campus buildings are of corrugated aluminum and steel frame construction. Several of the campus buildings house shop facilities for automotive engine repair, body work, body painting and other repair instruction facilities. Most of these buildings have extensive floor drain networks. Butler-Larkin occupies seven buildings, of which two are renovated brick refinery buildings, and the other five are corrugated aluminum and steel frame construction. Otis Eastern occupies six buildings, of which five are renovated brick refinery buildings, and the sixth is aluminum and steel. The Wellsville Fire Academy has one small structure made of brick near the northern border of the refinery site. National Fuel has one large aluminum and steel building on the northern portion of the site, as does Current Controls and Release Coatings (an adjoining structure). Lastly, Mapes Industries occupies two modified refinery structures, one of them a large brick structure, the other a smaller building also of brick.

Several of the companies present on site generate significant heavy vehicular traffic. Specifically, National Fuel and Otis Eastern have large numbers of trucks and heavy construction equipment present on their property most of the time. The college campus, due to the nature of its vocational program, also introduces vehicular traffic into the area, although much of this consists of passenger vehicles, not heavy equipment.

Several of the existing manufacturing operations may involve the generation of hazardous waste. Between 1983 and 1986, NYSDEC found evidence that Mapes and Butler-Larkin were illegally disposing of hazardous waste inside and outside their buildings, in areas that directly or indirectly resulted in wastes discharging into the main drainage swale and the Genesee River (People vs.

Mapes, 1983; NYSDEC, 1986). The wastes dumped at Mapes allegedly included solvents, but results of analyses of the wastes were not found in site records. Wastes discharged by Butler-Larkin allegedly included chemicals including waste from a phosphatizing process, paint solids residue, cutting oil and solvents. The solvents included xylene, ethylbenzene, toluene and trichloroethane. The DEC detected discharge of some of these chemicals into the site stormwater sewer system (Olean Times, 1989). Exhaust fumes from lead melting pots were also found to have discharged to the atmosphere at the Butler-Larkin facility.

During the site investigation, Ebasco also observed a pipe-coating operation area used by Butler-Larkin. In this area, steel pipes were sprayed with a black (probably asphaltic) compound. The compound was also sprayed on the ground surface. No collection system for this excess material was observed. This spraying is being performed in Butler-Larkin's pipe and equipment storage area.

During November 1988, Ebasco personnel conducting field activities, also observed students participating in an automobile-repair class who were steam cleaning 8 to 12 car and truck engines directly into a storm drain.

1.2.3 Previous Investigations

Several studies or evaluations of the Sinclair Refinery Site were conducted prior to the initiation of the RI at the site. These generally focused on the landfill, but sometimes included consideration of the refinery. Sampling at the site to evaluate conditions began with sampling by the NYSDEC on October 30, 1981. This sampling indicated that benzene was present at elevated levels in some soil and water samples from the site, but that drinking water did not appear affected (CH2M Hill, 1983). Subsequently, in mid-1982 an EPA Field Investigation Team (FIT) visited the site and conducted sampling near the landfill area. This led to the use of the MITRE Hazard Ranking Model on the site in July 1982, with a resulting score of 67.46, and the listing of the site by New York State as a hazardous waste site (Nosenchuck, 1982).

A further analysis of the site was conducted for the Remedial Action Master Plan (RAMP) for the site in 1983, to identify sources of potential contamination at the site. Results of the chemical analyses discussed in this study indicated that in sediment and surface water there were levels of several compounds, including benzene, arsenic, lead and naphthalene, that exceeded background levels in the region. The major concern identified in the RAMP was erosion of the landfill by the Genesee River (CH2M Hill, 1983). Partial remediation of contamination associated with the landfill was implemented as a result of that investigation. Remediation measures included the removal of exposed barrels and localized soil cleanup.

In 1984 a Remedial Investigation of the Sinclair Refinery Site was begun by SMC Martin, working for the NYSDEC. The investigation was planned as a two-phase RI, with Phase I focusing on the landfill, with limited data-gathering in the refinery area. The Phase II RI plan focused on providing supplemental information in the landfill area and an investigation of the refinery area, as well as an investigation of the OSTF. The RIs for Phase I and Phase II (hereafter referred to as Phase IIa) begun by SMC Martin, along with the Phase II data gathered by Ebasco (hereafter referred to as Phase IIb), form the technical bases for this report.

1.2.3.1 Phase I Scope-of-Work

The Phase I RI, begun in 1984, culminated with the submission of a Draft Phase I Remedial Investigation report to the NYSDEC in March 1985 (SMC Martin, 1985). The report discussed the field investigations performed and the results of those investigations, including the work in both the landfill and refinery areas on the site.

In the refinery area, the investigation included:

- Twenty auger borings to depths of up to 50 feet with one soil sample taken for testing at each location.
- Eighteen surface soil samples from various locations including 14 in the refinery area, 1 at the OSTF and 3 background samples.

- Six monitoring wells completed in the shallow aquifer with soil samples taken for testing and two rounds of water samples obtained and tested.

Numerous other sampling and testing programs were performed, including a biological sampling program (terrestrial and aquatic), a geophysical testing program, river water and sediment sampling, an air and meteorological testing program, and seep and sediment sampling programs. Infiltration tests on the landfill and tests to evaluate the hydraulic conductivity of the shallow aquifer were also performed.

Each of these studies was discussed in the draft Phase I report.

1.2.3.2 Phase II Status

The Phase II RI began in 1985 with the preparation of a Work Plan for the field investigation. The proposed Phase IIa investigation was based on the results of Phase I. It focused on obtaining information on potential source areas identified but not sampled in Phase I, and potential contaminants of concern identified in Phase I. The field investigations were conducted primarily in the refinery area, although some samples in the landfill and OSTF were also obtained. Additional background sampling was also performed.

The additional characterization of the landfill included installing and sampling 17 wells in the landfill area, including wells completed in the shallow and deep aquifers, the clay aquitard and the landfill material. Each new well was to be sampled once, but the five Phase I wells in the landfill area were not included in the sampling.

A focused investigation of the on-site sewer and piping systems was also performed. This included sampling water and sediment in the sewer and soils near the sewers, outfall sampling, geophysical exploration to help define the locations of sewers, and tracer tests using dye to investigate flow patterns in the sewers.

Sampling in the refinery area included the installation of 21 additional wells in the shallow and deep aquifers and the clay aquitard. Each of the wells was sampled, but existing Phase I wells were not resampled. A supplemental auger boring and surface soil sampling program was also performed. Analytical testing of the surface samples was limited to metals, since the Phase I work had identified the presence of elevated levels of lead, but not organic compounds, in several areas. Infiltration tests and pump tests were also performed.

Work to complete characterization of the OSTF, background conditions and other site-related media (drainage swales, Genesee River, sediments) was also performed.

The field work and laboratory analysis to complete each of the above Phase IIa tasks were completed by late 1986. Some data analysis and preparation of a draft report had begun, when the contract between the NYSDEC and SMC Martin was terminated and work on the project stopped.

In 1988, ARCO assumed responsibility for completing the Phase II RI. A Projects Operations Plan (POP) was prepared (Ebasco, 1988) and Phase IIb sampling completed in late 1988 and early 1989. The sampling was to help further define potentially contaminated areas identified from a review of the Phase I and IIa data, and to obtain more data to assist in performing the risk evaluation and feasibility study for the refinery area. The completion of the field and analytical testing program was followed by the preparation of this RI report.

1.3 REPORT ORGANIZATION

The RI report consists of five sections and eleven appendices, contained in four (4) volumes. The following discussion identifies the organization of the RI and the contents of each section. The report has been prepared in accordance with the EPA's latest guidance for preparing RI reports (USEPA, 1985a and 1988b) and the Project Operations Plan (POP) for the site (Ebasco, 1988).

The first section, Introduction, describes the purpose of the RI report, and the RI/FS framework in which the RI report is prepared. The site background, which includes a site physical description, site history and a review of previous site investigations, is presented as an aid to those not familiar with these aspects of the site.

Following the Introduction, Section 2 presents a description of Phase I and II refinery and OSTF investigations. Each investigation program, including the number of samples taken, sample analytical parameters and sample locations, is presented. The descriptions of the SMC Martin Phase I and IIa site investigation programs are based on draft reports, draft maps and other information made available by the NYSDEC. Because these sources of information are draft versions, some level of uncertainty as to sampling locations and methods is sometimes present, as discussed in this report.

Section 3 describes the physical characteristics of the site. The primary emphasis of this description is on presenting the types of information relevant to performing the evaluation of public health and environmental risks, and to performing the FS. Subsections describing site surface features, meteorology, surface water, geology, soil, groundwater, land use and ecological characteris- tics are included.

Section 4 is similar to Section 3 except that the chemical characteristics of the site are described instead of its physical characteristics. The types of chemicals detected, their areal extent, and potential sources are described for each site medium (e.g., soils, groundwater).

The last section presents the summary and conclusions of the RI report. This consists of a review of the nature and extent of contamination, data limitations, and includes recommended remedial objectives for the site.

There are eleven appendices to this report. Volume II of the report contains Appendices A, B, C, D, and E which include the analytical data upon which the report is based. This volume presents the validated data generated by Ebasco (Appendix A), the Phase I and IIa SMC Martin data (Appendix B), and the tentatively identified compound results from Ebasco's Phase IIb sampling (Appendix C). A comparison of the Priority Pollutant and Target Compound Lists (TCL) of analytical parameters (Appendix D), and the boring logs prepared by both SMC Martin and Ebasco during the Phase I and II investigations (Appendix E) are also included in Volume II. Volume III of the report contains Appendices F through J. Appendix F presents the results of grain size analysis tests. Appendix G presents the results of Phase IIb pump test analyses. Data validation reports are included in Appendices H and I for Ebasco and SMC Martin data, respectively. Appendix J presents the results of the deep aquifer study. Appendix K, included in Volume IV, presents the Endangerment Assessment for the site, prepared by Versar for the EPA.

2.0 STUDY AREA INVESTIGATION

This section describes the scope of the site characterization programs performed in the refinery and off-site tank farm (OSTF) areas. The numbers of samples taken, locations and analytical parameters are described. Table 2-1 provides a summary of the samples taken. Sampling techniques are described briefly. More detailed descriptions for some Phase I and IIa procedures are available in documents prepared by SMC Martin, which are referenced as appropriate. However, in many cases detailed descriptions are not available. The Phase IIb sampling procedures used by Ebasco are described in more detail in the Project Operations Plan (POP) and revisions to Volume II of the plan (Ebasco, 1988).

During the Phase I and IIa investigations by SMC Martin, samples were usually analyzed for a list of chemicals commonly referred to as the Priority Pollutant List. This was one of the most commonly used lists of compounds to be analyzed at the time (1984-1985) and included various metals, volatile organic compounds (VOCs), semivolatile organic compounds (also called base/neutral/acid extractables or BNAs), and pesticides and PCBs. A list of the compounds on the Priority Pollutant list is included in Appendix D.

The Target Compound List (TCL) was used to specify compounds to be analyzed, in accordance with EPA procedures, when the Phase IIb was performed. Therefore, when samples were analyzed for Ebasco it was usually for compounds on the TCL. The TCL is also provided in Appendix D. The differences in the two lists are slight, but for completeness, the text of the RI specifies if TCL or Priority Pollutant analyses were performed.

Information was obtained from the following sources by SMC Martin during the preparation of their Phase I RI report:

Federal Agencies

- USEPA Region II, New York, NY
- USEPA Office of Research and Development, Las Vegas, NV

TABLE 2-1

SAMPLE SUMMARY

NUMBERS OF SAMPLES TAKEN AND ANALYZED IN PHASES I, IIa AND IIb(D)

	OIL SEPARATOR	SEWERS		OUTFALLS		GENESEE RIVER		DRAINAGE SWALE		SEEPS/POOLS/PONDS		SURFACE	SUBSURFACE		TANK FARM	
	LIQUID	WATER	SEDIMENTS	WATER	SEDIMENTS	WATER	SEDIMENTS	WATER	SEDIMENTS	WATER	SEDIMENTS	SOIL(B)	SOIL(B)	GROUNDWATER	SOIL(B)	GROUNDWATER
ANALYSIS																
METALS	-,2(C),-	-,3,1	-,3,-	3,-,1	4,-,-	22,4,3	8,4,3	-,3,3	-,6,9	7,5[A],2	7,-,-	17,13,37	31,47,54	22,27,20	1,12,-	-,3,-
VOCs	-,2,-	-,3,1	-,3,-	3,-,1	4,-,-	22,4,-	8,4,3	-,3,3	-,6,9	7,5,2	7,-,-	17,-,10	31,47,6	22,27,27	1,12,-	-,3,-
BNAs	-,2,-	-,3,1	-,3,-	3,-,1	4,-,-	22,4,-	8,4,3	-,3,3	-,6,9	7,5,2	7,-,-	17,-,10	31,47,6	22,27,20	1,12,-	-,3,-
PESTICIDES/ PCBs	-,2,-	-,3,-	-,3,-	3,-,-	4,-,-	22,4,-	8,4,-	-,3,-	-,6,-	7,5,2	7,-,-	17,-,-	31,47,-	22,27,-	1,12,-	-,3,-
TOTAL ORGANIC CARBON	-,-,-	-,-,-	-,-,-	-,-,-	-,-,-	-,-,-	-,-,-	-,-,-	-,-,3	—	—	-, -,5	-, -,4	—	—	—
GRAIN SIZE ANALYSIS	-,-,-	-,-,-	-,-,-	-,-,-	-,-,-	-,-,-	-,-,-	-,-,-	-,-,3	—	—	-, -,5	-, -,4	—	—	—

A - INCLUDES OFFSITE POND AND STREAM SAMPLES.
B - COMPOSITE SAMPLES IN PHASE I AND IIa.
C - NUMBERS OF SAMPLES TAKEN IN EACH PHASE A DASH,-, INDICATES NO SAMPLES ANALYZED FOR THIS PARAMETER.
-,2,- MEANS NO SAMPLES IN PHASE I, 2 IN PHASE IIa AND NONE IN PHASE IIb.

D - TABLE DOES NOT INCLUDE "CLAY" LAYER WELL WATER SAMPLES, ASBESTOS SAMPLES IN THE FORMER POWER STATION OR THE STONE HOUSE "SAMPLE".

- U.S. Geological Survey, Ithaca, NY
- U.S. Army Corps of Engineers, Buffalo District
- National Oceanic and Atmospheric Administration (climatic data)
- U.S. Department of Agriculture, Soil Conservation Service

State Agencies

- NYSDEC Headquarters, Albany
- NYSDEC Region 9, Buffalo
- NY State Department of Health
- NY State Department of Transportation
- NY State Geological Survey

Local Agencies

- Town and Village of Wellsville
  - Department of Public Works
  - Water and Light Department
- Allegany County Health Department

Non-Governmental

- Atlantic Richfield Company (including Sinclair Oil Company files)
- Local drillers
- Former Sinclair employees

Building on this extensive collection of information, Ebasco contacted the following institutions/agencies/personnel during Phase IIb of the RI.

- NYSDEC (Albany, NY)
  - project files including historical aerial photos, historical maps, previous reports, and partial data validation packages
- ARCO project files (Los Angeles, CA)
- Wellsville Library
  - newspaper articles, pamphlets

- Don MacFarquhar - Director of Public Works, Wellsville, NY
- SMC Martin, Inc.
- Police Department, Wellsville NY
- Fire Department, Wellsville, NY
- Otis Eastern files on gas wells
- Town/County Tax Authorities

2.1 SURFACE FEATURES INVESTIGATION

The surface features investigation included walking over the site to visually observe site conditions, as well as surveying for and preparing site base maps. The surveying included measuring the elevation and coordinates of sampling points and determining building locations to develop a base map of the site. Coordinates used to determine locations were based on the New York State grid system.

A survey of the OSTF was not performed in either Phase I or Phase II (except to determine elevation and coordinates of sampling locations) and no topographic or site features survey was performed. Therefore, site maps of the OSTF show only approximate locations.

2.2 CONTAMINANT SOURCE INVESTIGATIONS

The Phase I and II RI programs directly and indirectly addressed each of the potential contaminant source areas identified by SMC Martin during Phase I. These included the oil-water separators, the storm water sewer system, the coal pit, and a former underground tank. The site investigations for these potential sources are discussed in the following subsections. The RI also investigated potential current site discharges. Some of these were described in Subsection 1.2.2.2 "Current Uses" and others are described below. No potential existing sources were identified at the OSTF; hence it is not discussed in this subsection.

2.2.1 Oil-Water Separators

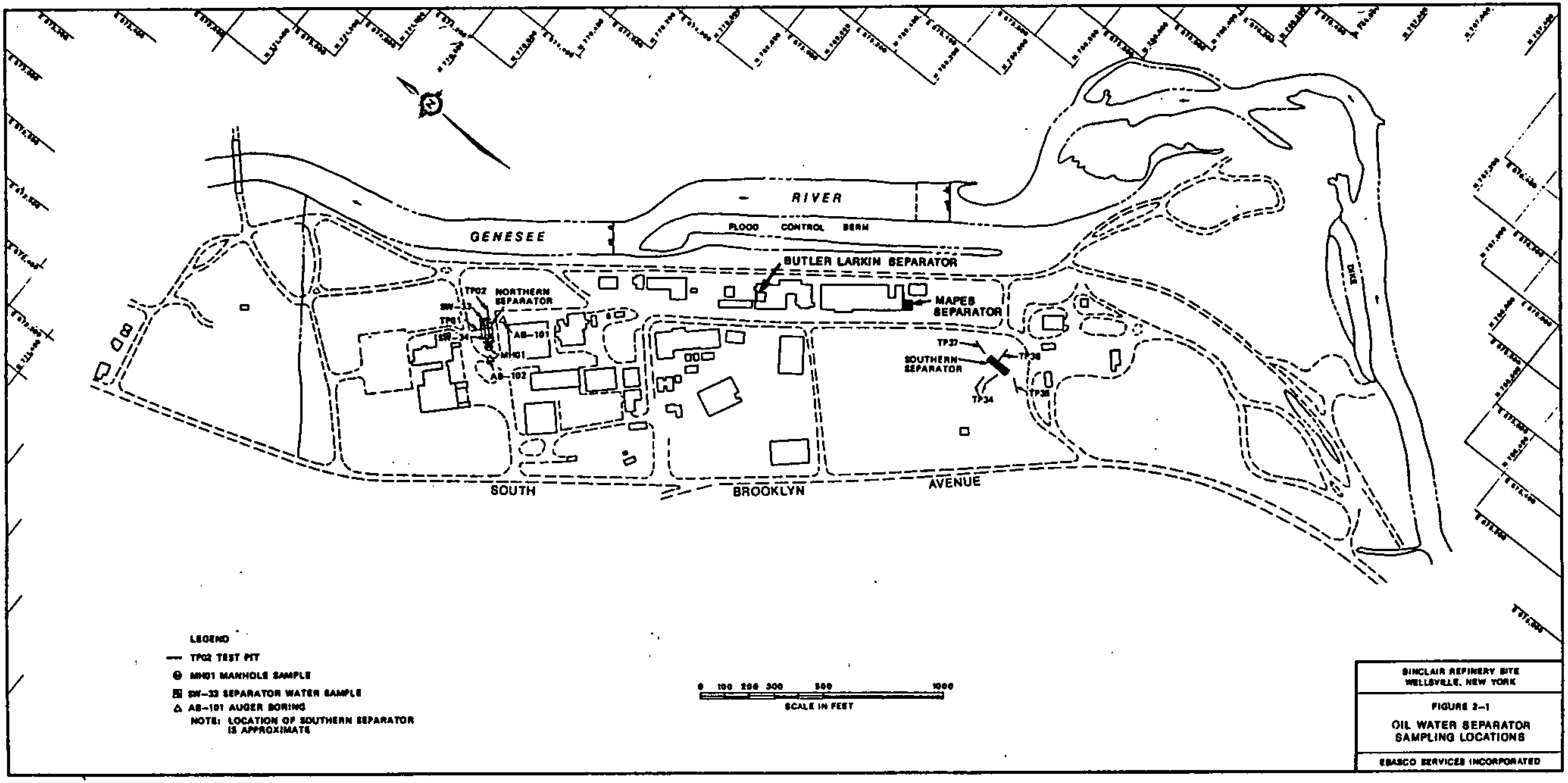
Sampling of the oil-water separators (Figure 2-1) focused on the existing northern separator, though some investigation of the buried southern separator and a small separator on the Mapes property (see Section 2.2.2.3) was also performed. A fourth separator on the Butler-Larkin property was not directly investigated though sampling of the discharge from this separator was performed (See Section 2.2.2). The approximate location of the separator on the Butler-Larkin property is shown on Figure 2-1. It is not known if this separator still exists. The sampling program included sampling of discharges into the northern separator, water in the northern separator and soils surrounding both the northern and southern separators. Groundwater sampling up and downgradient of both separators was also performed. The groundwater sampling program is discussed in Section 2.6.

The northern separator (Figure 2-1) is a concrete structure approximately 100 feet long and 45 feet wide (Figure 2-2). It is internally divided by concrete walls into cells approximately 14 feet square. The total depth of each cell is approximately 10 feet. Each cell is partially filled with water, and in one case, adjacent to where water enters the system, oily material was observed floating on the surface.

The southern separator (Figure 2-1) has been filled with soil except for a few control structures at one end of the separator. Based on maps of the site, it appears that this separator was slightly smaller than the northern separator. There is no evidence that the concrete structures comprising the separator were removed prior to its being filled.

2.2.1.1 <u>Northern Separator, Manhole Sampling</u>

A single sample of the water discharging into the northern oil-water separator (sample MH01-01) was taken by Ebasco. The manhole through which the sample was taken was approximately 15 feet west of the separator (Figure 2-1). The sample was taken by attaching a clean sample jar to a pole and lowering the jar into the water. The sample was then retrieved and poured into a sample container. The sample was analyzed for TCL metals, volatile organic compounds (VOCs), and Base-Neutral-Acid Extractable (BNA) compounds.



SINCLAIR REFINERY SITE
WELLSVILLE, NEW YORK

FIGURE 2-1

OIL WATER SEPARATOR
SAMPLING LOCATIONS

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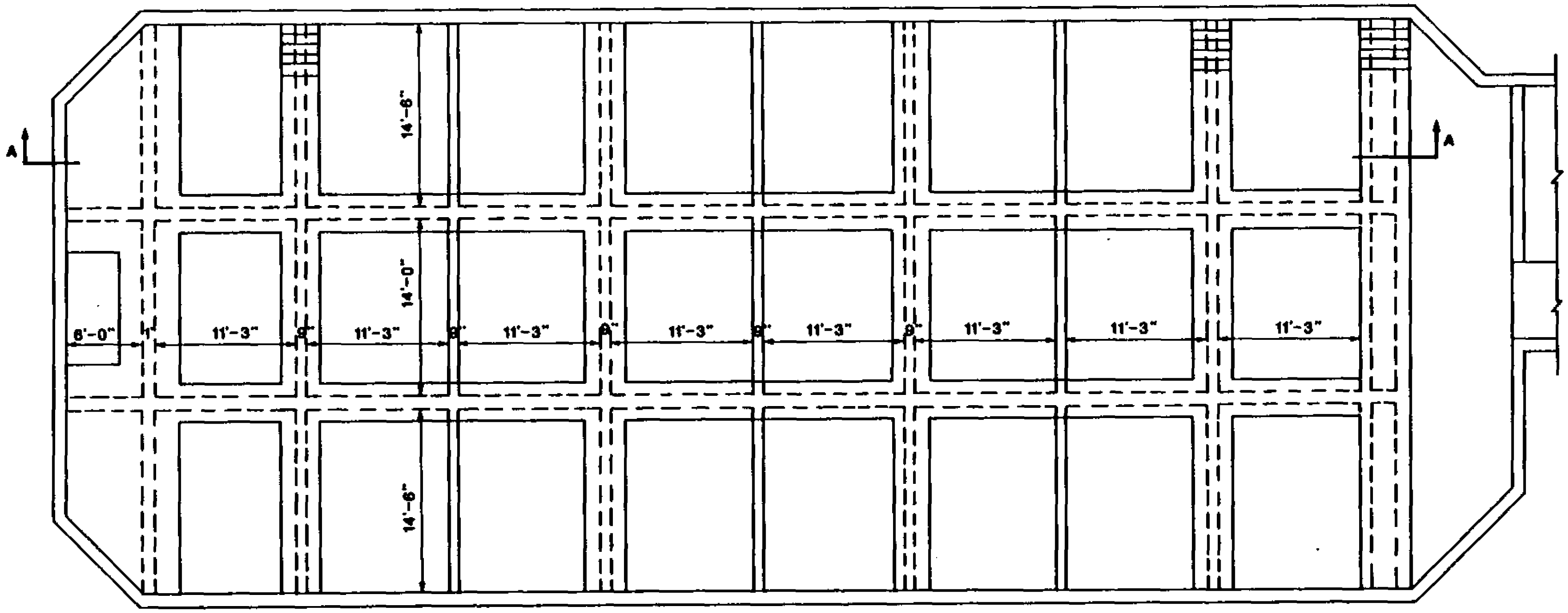
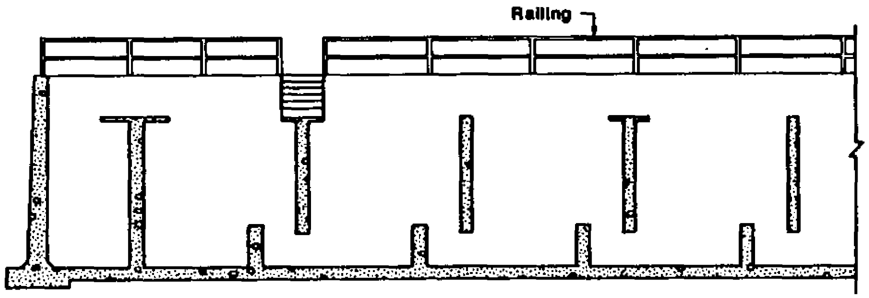


PLAN



SECTION A-A

SINCLAIR REFINERY SITE
WELLSVILLE, NEW YORK

FIGURE 2-2

NORTHERN OIL WATER SEPARATOR

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2.2.1.2 Northern Separator, Liquid Sampling

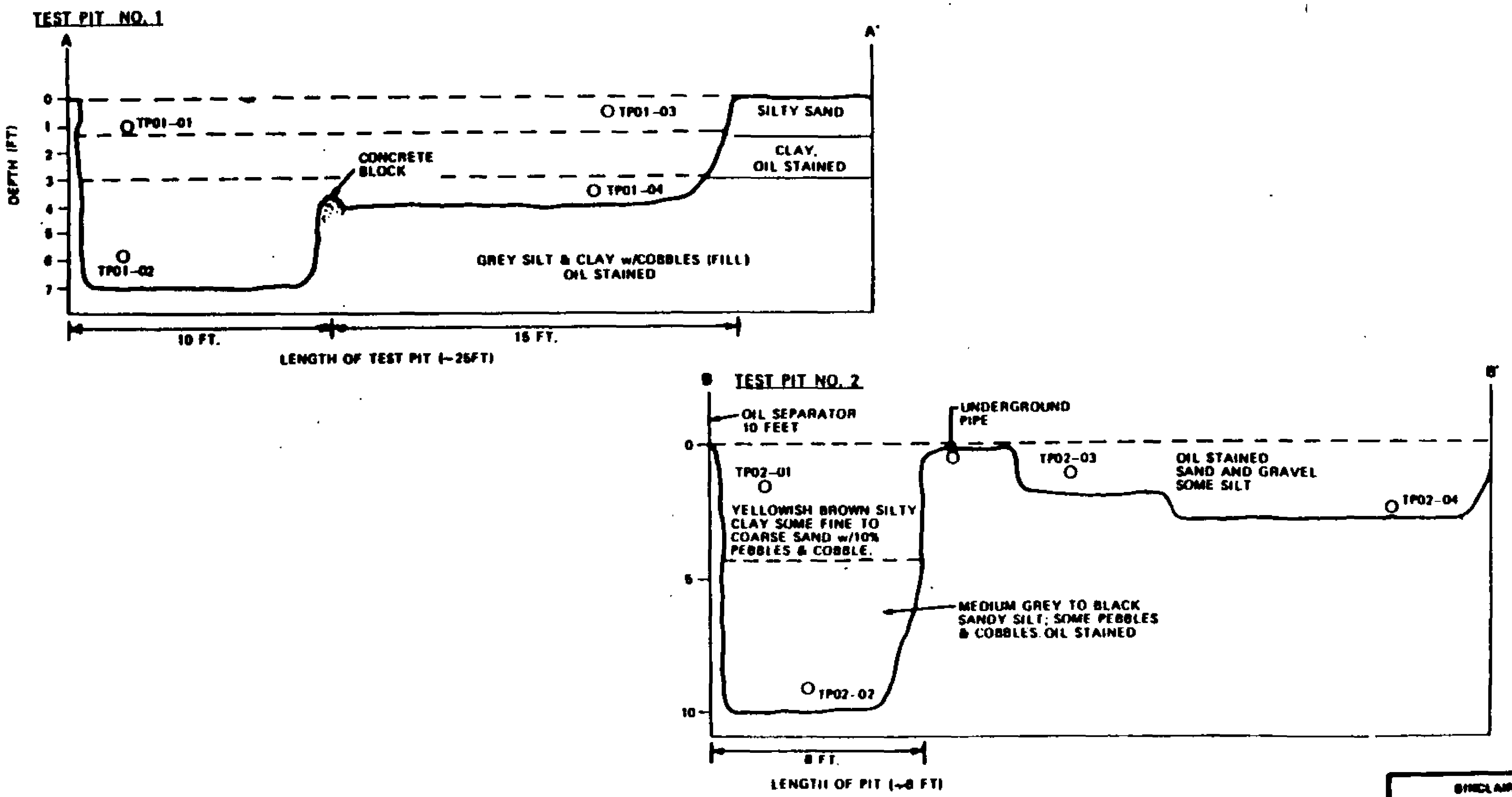
During the Phase IIa SMC Martin work, two liquid samples were obtained from the separator, one apparently near the west end, where water enters the separator, and one near the east end, where water leaves it (Figure 2-1). No records were found describing the sampling methodology. However, a reference is made on the sample results that the oil phase was sampled. The two samples (SW-33 and SW-34) were analyzed for the full priority pollutant compound list including VOCs, BNAs, pesticides/PCBs, metals, cyanide, and phenolics.

2.2.1.3 Test Pits

Test pits were excavated by Ebasco adjacent to both the northern and southern oil separators (Figure 2-1). The test pits were excavated and sampled to evaluate if there was soil contamination attributable to leakage from the separator. Two of the pits, numbered TP-01 and 02, were excavated adjacent to the northern separator and four pits, numbered TP-34, 35, 36 and 37, were excavated adjacent to the southern separator. Two soil borings (see 2.2.1.4 below) were also drilled near the northern separator in lieu of additional test pits.

Generally, the test pits were excavated to depths of 2 to 10 feet and ranged in length from 25 to 77 feet. Figures 2-3 and 2-4 show cross sections of each trench with its depth and length. Four samples were taken from each trench, with two samples analyzed for oil and grease and two for oil and grease as well as TCL VOCs, BNAs and metals. Sample locations are also shown on Figures 2-3 and 2-4.

The pits were excavated using a track-mounted back hoe in accordance with the procedures in the POP (Ebasco, 1988). The samples for analytical testing were taken from the bucket of the backhoe, using a stainless steel spoon, and placed either directly in sample containers (VOCs) or in sample containers after being homogenized in a stainless steel bucket (BNAs, metals and oil and grease). Samples were taken from both apparently clean and contaminated soils based on visual observation.



○ APPROXIMATE TEST PIT SAMPLING LOCATIONS

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WELLSVILLE, NEW YORK

FIGURE 2-3

TEST PIT CROSS SECTIONS
NORTHERN OIL
WATER SEPARATOR

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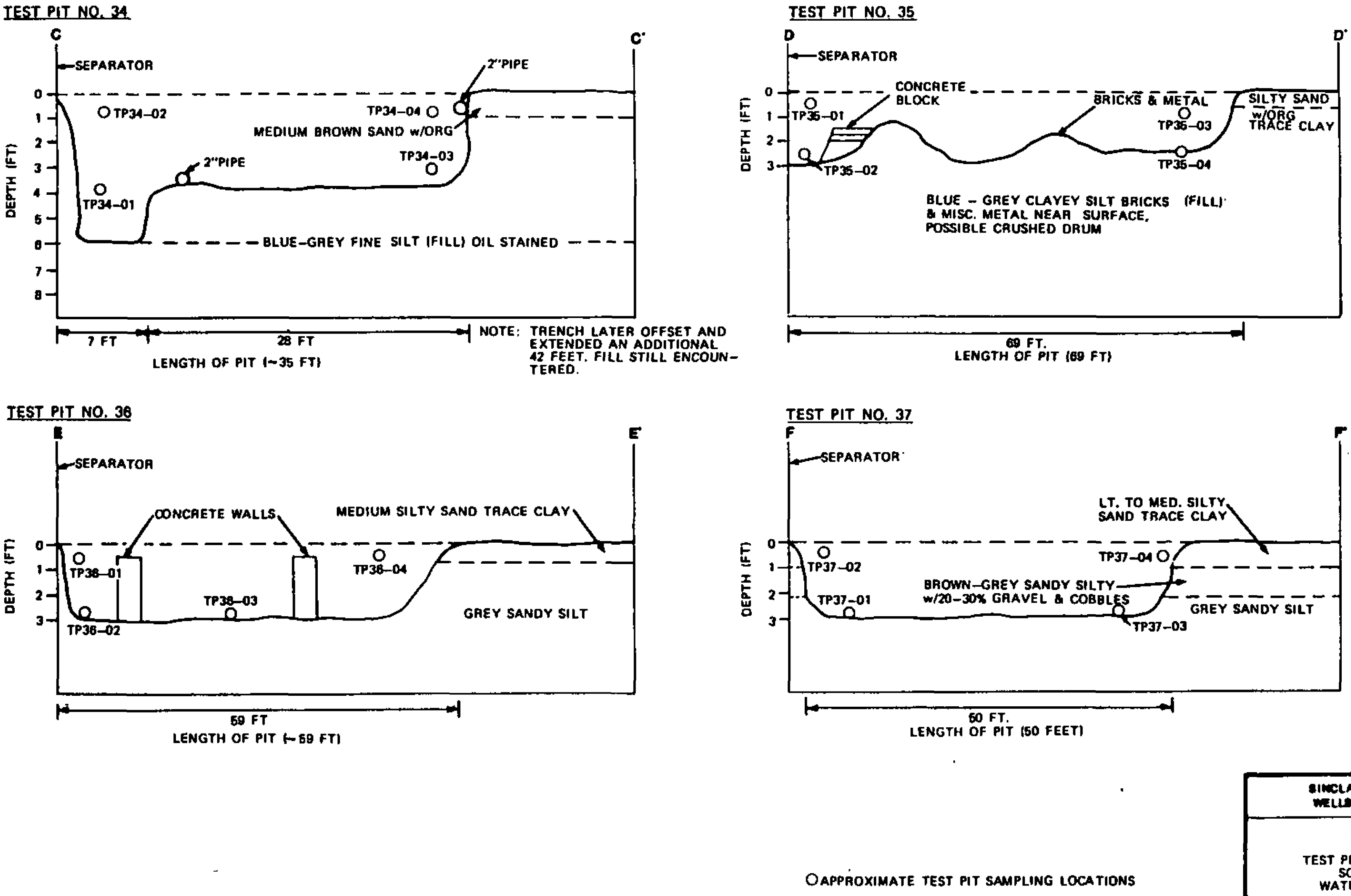

SINCLAIR REFINERY SITE
WELLSVILLE, NEW YORK

FIGURE 2-4

TEST PIT CROSS SECTIONS
SOUTHERN OIL
WATER SEPARATOR

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2.2.1.4 Soil Borings

Two soil borings (AB 101 and 102) were made near the northern separator when two of the originally planned test pits could not be excavated due to the presence of roadways and underground utilities. The borings extended to depths of 14 feet at both AB 101 and AB 102 (Figure 2-1) and samples were collected.

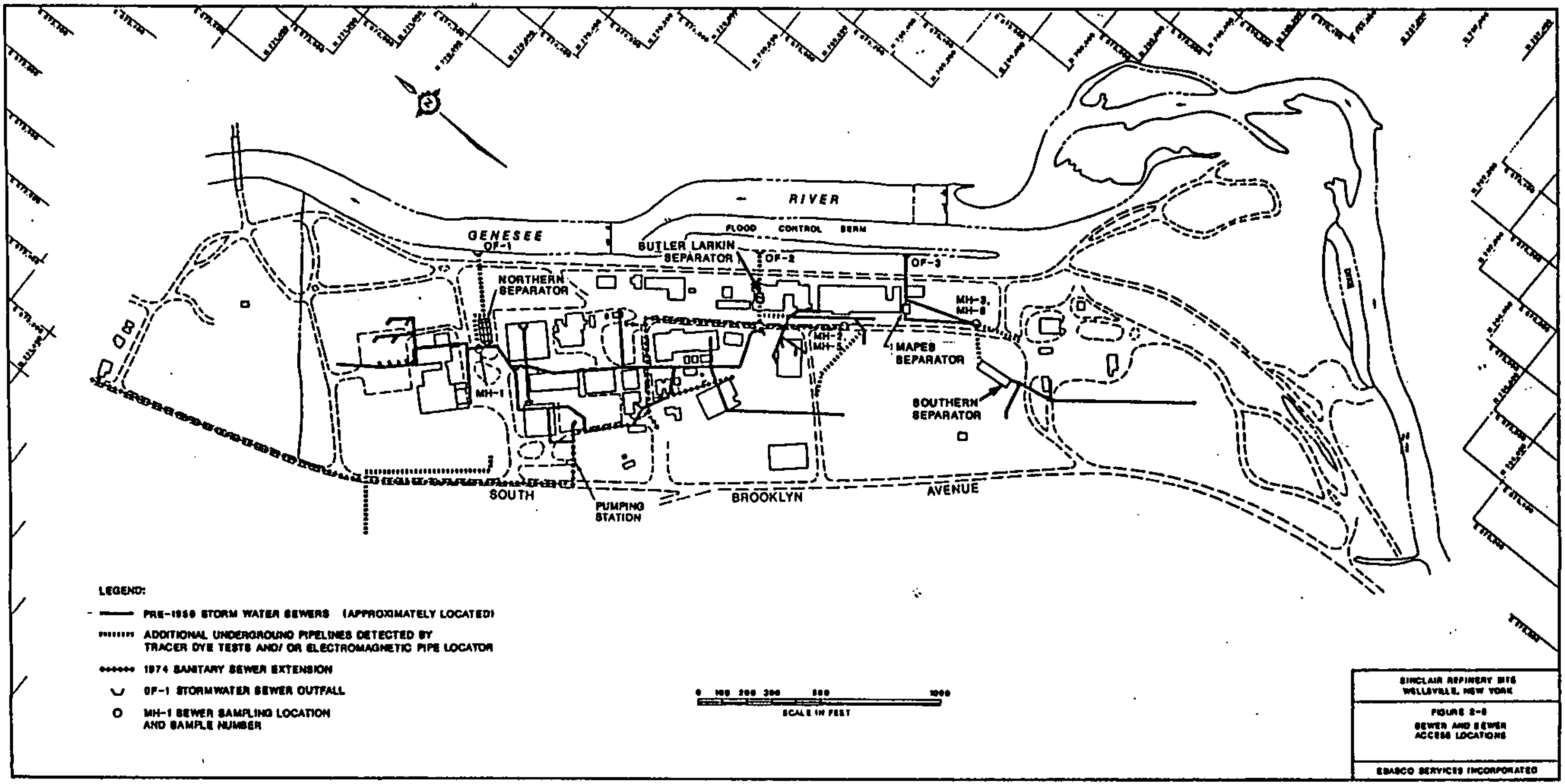
2.2.2 Storm-Water Sewer System Investigation

Several site characterization programs were undertaken to provide a better understanding of the site's storm-water sewer system, its relation to the oil-water separators, and the potential that the sewers were acting as a source or sink for contaminants potentially present at the site. These investigations were conducted during Phases IIa and IIb.

2.2.2.1 Reconnaissance Mapping

Early in Phase IIa, SMC Martin undertook a records search to locate records or maps describing locations of on-site sewer systems (SMC Martin, 1987) to facilitate the mapping and sampling of the sewers. The records search included contacting Otis Eastern, Inc.; the SUNY Campus at Wellsville; the Wellsville Department of Public Works; and the Wellsville Water Department. Of these, only the Department of Public Works was able to provide SMC Martin with site plans. These plans showed the locations of four pipelines (Figure 2-5). They included: the pipes leading from the northern and southern oil separators to the Genesee River; a pipeline, presumably from the OSTF, leading to the refinery from the northwest; and a sanitary sewer extension that was installed by the Village of Wellsville in 1974. This search was followed up by visually inspecting and mapping outfalls, manholes, and storm sewers visible at the site.

During Ebasco's work at the site, employees of the Wellsville Department of Public Works assisted in identifying underground sewer locations where excavation or drilling could not occur. They provided some limited additional information regarding sewer locations, such as the relationship of sumps on the SUNY campus to the oil-water separator.



SINCLAIR REFINERY SITE
WELLSVILLE, NEW YORK

FIGURE 2-6
SEWER AND SEWER
ACCESS LOCATIONS

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2.2.2.2 Geophysical Survey

Geophysical surveys of pipelines were conducted in two steps by SMC Martin. In the first step, an electromagnetic pipe locator was used to trace the pipelines located from the records search. In the second step, an electromagnetic (EM) conductivity survey was conducted to detect leaking pipelines in the refinery area of the site.

The following description of the electromagnetic pipe locator is taken directly from the 1987 SMC Martin draft RI Report.

"The electromagnetic pipe locator consists of two units: a transmitter and a receiver. The transmitter inductively generates an electromagnetic field that surrounds a metal object or travels along it, as in the case of pipelines. The receiver detects the electromagnetic field thereby pinpointing the exact location and orientation of the pipe. However, this equipment will not detect concrete or clay pipe. Therefore, only metal piping was located using this method.

"The major areas of investigation (the [off-site] tank farm pipeline, central refinery, and main [north] oil separator) were surveyed by first locating the approximate location of the pipeline in question. The area was then traversed in a direction perpendicular to the inferred pipeline orientation so as to first locate the pipe. Once the location had been determined, the orientation was easily ascertained by laterally tracing the pipe. As the pipeline was followed, survey stakes were emplaced for later referencing during the geophysical surveys. Piping that was not located via this method may be attributed to two possible scenarios: either the pipelines were removed after the disposition of parcels of land by the Village of Wellsville (or the purchasers of the parcels); or the pipelines may have been constructed of non-metallic materials."

Maps showing the exact location of the surveys were not found in the Phase I and IIa site records.

The EM survey was conducted by SMC Martin to detect "any groundwater quality changes in areas of suspected leaking pipelines and abandoned oil storage facilities" (SMC Martin, 1987). The 1987 SMC Martin Draft RI report describing their methodology is cited below. This survey is also discussed in Subsection 2.4.2 of this RI report, which describes other geophysical studies performed at the site.

"Terrain conductivity is a geophysical technique that allows rapid acquisition of subsurface conductivity values. SMC Martin personnel used an in-house Geonics EM34-3 conductivity meter to perform the survey. The instrument induces an electrical current into the ground by means of a primary magnetic field. The resultant secondary magnetic field is measured and evaluated in terms of conductivity. Since the conductivity value of subsurface materials is dependent upon the chemical and physical properties of the materials and its pore fluid, apparent conductivity measurements acquired in the field can identify any chemical or physical changes in subsurface materials.

"Five designated sections in the refinery area on the site were explored during the conductivity survey. These sections were chosen based on results of the Phase I geophysical survey [see Phase I RI, SMC Martin, 1985] and groundwater quality data. A total of 125 conductivity tests were performed at the five refinery sections. The designated refinery sections are:

Section 1 - Northern Portion of Refinery Site near Brooklyn Avenue (1A) and the Main [northern] Separator Unit (1B).

Section 2 - Central Site Storage Area (2A) and Southern Separator Unit Area (2B).

Section 3 - Woodworks Storage Area [Mapes] in East-Central part on site.

Section 4 - Otis Eastern Property at Southern Part of Refinery Site.

Section 5 - Storage Area at Southern Boundary of Refinery Site.

"Due to the high amount of cultural interference on the refinery site, such as underground piping, metal debris, and power lines, the conductivity surveys were designed to eliminate or minimize any interferences caused by these manmade structures. In areas of linear structures (fences and pipelines), the surveys were conducted with the orientation of the transmitter and receiver conductivity coils perpendicular to the linear interference. The receiving unit was also located at the greater distance from the linear interference to minimize any possible effects. Attempts were made to eliminate interference from non-linear structures such as metal debris. However, the complete elimination of interference at several locations was impossible, due to the large amount of metal debris present on site. The interference effects caused by the many on-site cultural structures can be readily observed in the Phase I EM conductivity survey conducted at the refinery site by Weston Geophysical in 1984" (SMC Martin, 1987).

The survey was designed so that the depth of investigation penetrated into the saturated subsurface material to acquire accurate measurements of possible pollutants in the groundwater. The conductivity survey was designed to explore to a depth of about 25 feet. The equipment used a 10-meter coil spacing in a horizontal dipole mode where the exploration depth is approximately 0.75 times the coil spacing.

2.2.2.3 Tracer Dye Testing

To evaluate if storm water still passes through the separators to outfalls along the river, and to locate these outfalls, SMC Martin conducted tracer dye tests. The tests were reportedly done using Uranine (trade name) fluorescent green, nontoxic dye. Tests were initiated at both separators and in two separate storm drains (MH-2 and MH-4). Prior to initiating the tests, the separators were visually inspected after a severe thunderstorm to determine whether or not water was flowing through the separators and that the additional volumes of water necessary to conduct the tests would not have any adverse affects (e.g., causing oil or other contaminants to flow into the Genesee River). The conclusion was made by SMC Martin that no adverse affects would result since water was freely exiting the separators under normal conditions. Therefore, ten gallons of dye were added to the northern separator and a small separator on the Mapes property (and the two storm drains). According to Mapes, the small separator consists of an uncovered, concrete-walled pit which occasionally accumulates water but is allegedly inactive. The outfalls along the river suspected to be connected to the separators were visually monitored until the dye became evident. The locations of the separators and manhole MH-2 used in the tests and the pipelines leading to the outfalls are shown are Figure 2-5. MH-4 was not shown on available site maps and hence is not shown on the figure.

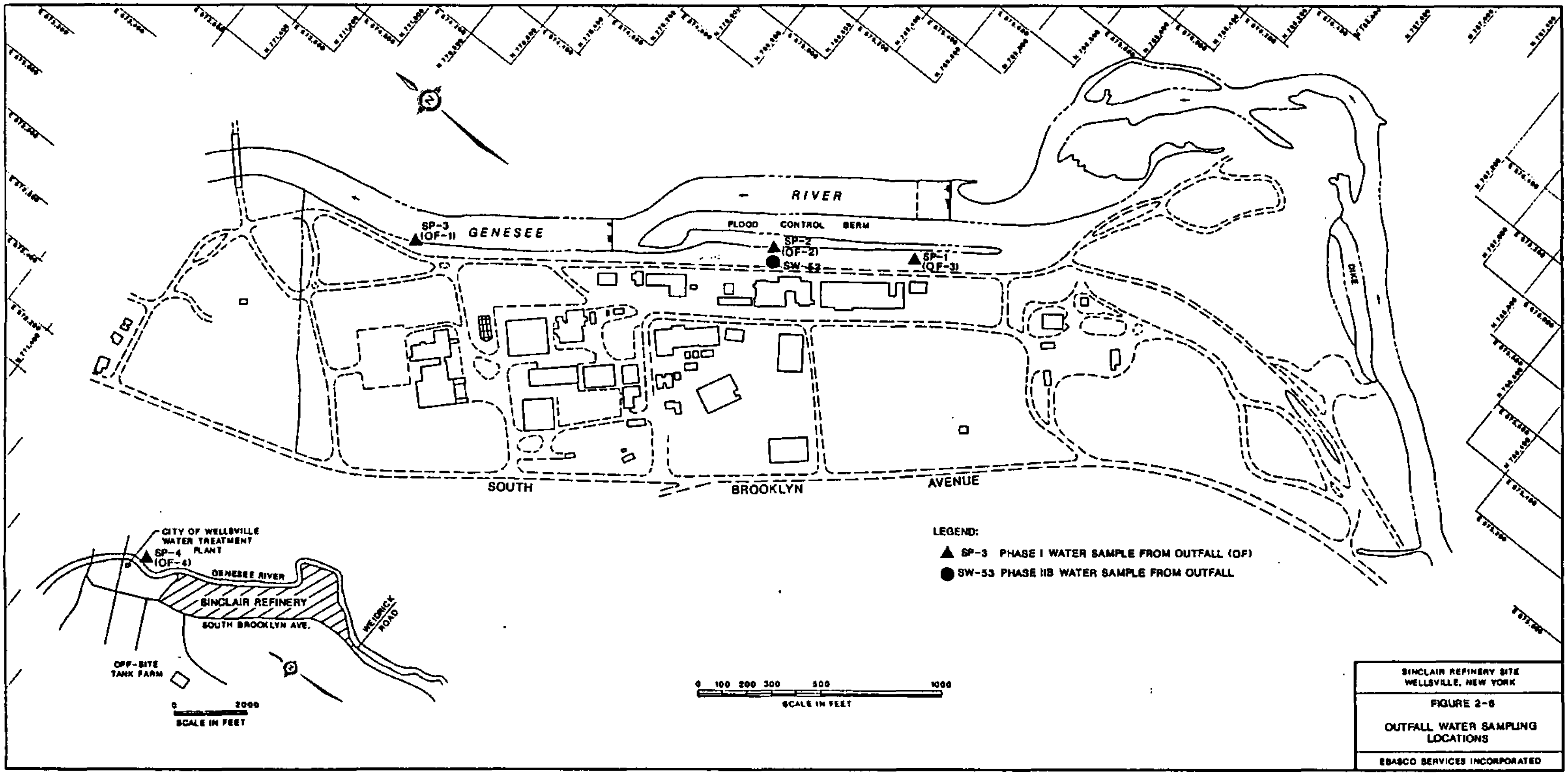
2.2.2.4 Sewer Sediment Sampling

Samples were obtained from sediments in sewers at three on-site locations by SMC Martin. Based on available records, the samples were obtained at manhole locations MH-1, 2 and 3, and analyzed for priority pollutants. The sampling locations are shown on Figure 2-5. No information regarding sampling techniques was provided in available site documents.

2.2.2.5 Outfall Sampling

Samples of liquid from three outfalls each apparently associated with a different separator, were obtained by SMC Martin during the Phase I investigation, to evaluate if contaminants were actively discharging to the drainage swale or the river. In addition, four sediment samples from outfalls were apparently taken, based on Phase I maps. The sampling technique is not discussed in the Phase I reports for these samples. The SMC Martin samples were analyzed for priority pollutants.

Ebasco subsequently resampled one of the outfalls, testing the sample for TCL metals, VOCs and BNAs. Ebasco obtained its sample by submersing the sample bottles directly into the pool of water at the outfall. The sampling locations for Phase I and II samples are shown on Figure 2-6. It should be noted that several other SMC Martin samples were labeled on maps as outfall



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WELLSVILLE, NEW YORK

FIGURE 2-6

OUTFALL WATER SAMPLING LOCATIONS

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samples but were not located close to any known outfalls. These samples are not included on Figure 2-6.

2.2.3 Abandoned Powerhouse

During Phase I, samples were collected from the abandoned powerhouse at the refinery site and analyzed for asbestos. The samples were apparently from debris in the powerhouse, where demolished materials were observed during the field program (SMC Martin, 1985). Two samples were collected from the powerhouse.

2.2.4 Other Refinery Area Sources

The Phase I site investigations identified potential on-site sources of groundwater contamination including the northern and southern oil separators, a former coal pit, an alleged former underground storage tank and a former unlined basin near the underground tank, and two drum storage areas. During the Phase IIa and IIb investigations each of these was evaluated by placing soil borings or wells adjacent to these areas. Figure 2-7 shows the identified potential source areas. The sampling locations, procedures and analytical parameters for borings and wells in this area are described in Sections 2.5 and 2.6 of this report.

In addition to the areas identified above, Ebasco identified the location of former tetraethyl lead sludge pits and a tank farm, built and operated after the refinery closed, based on a review of site documents. Based on the site documents, the pits had been excavated prior to 1961 (Sinclair, 1961). The location of these pits is shown on Figure 2-7. Ebasco drilled soil borings and sampled the soils for metals in the area. These samples are discussed in Section 2.5 of this report. The post-refinery tank farm area is shown on Figure 2-7. Several wells were drilled downgradient of this area.

2.3 SURFACE WATER AND SEDIMENT INVESTIGATIONS

Surface water and sediment samples from the Genesee River, tributary drainage areas, seeps or springs, and nearby surface waters were taken during the Phase I and II investigations. In several areas, multiple sets of samples were

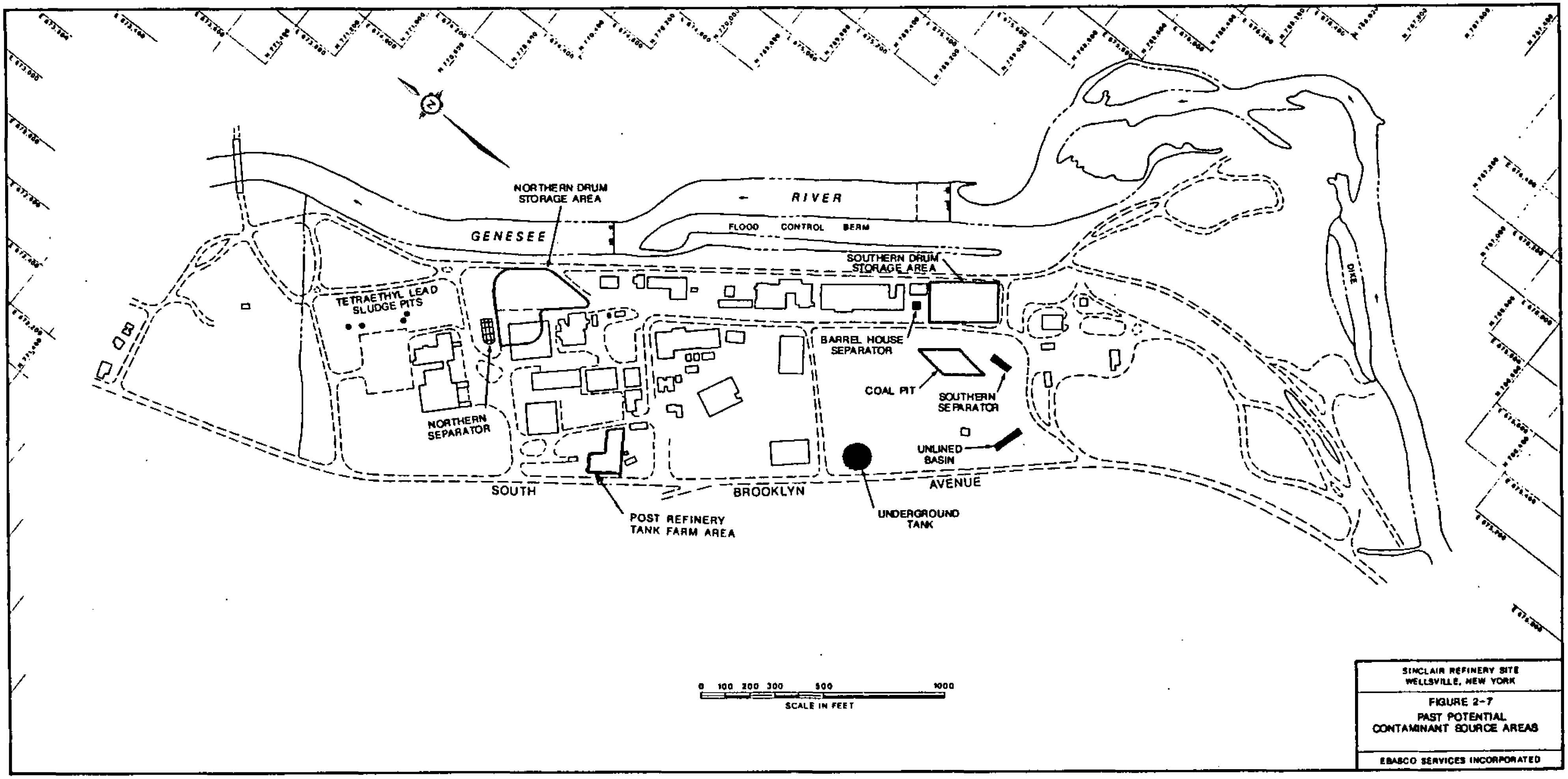

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FIGURE 2-7
PAST POTENTIAL
CONTAMINANT SOURCE AREAS

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obtained to characterize the conditions. The investigation program for each area is described below.

2.3.1 Genesee River

2.3.1.1 Genesee River Water

During the Phase I portion of the RI, a total of 22 surface water samples were obtained during four sampling events. Nine of the samples were collected from the river during a high flow condition, with one sample collected at each of three stations on three consecutive days (May 3, 4, and 5, 1984). This corresponded to conditions during the onset, peak and end of a storm event. The sample location and the corresponding sample numbers are shown on Figure 2-8.

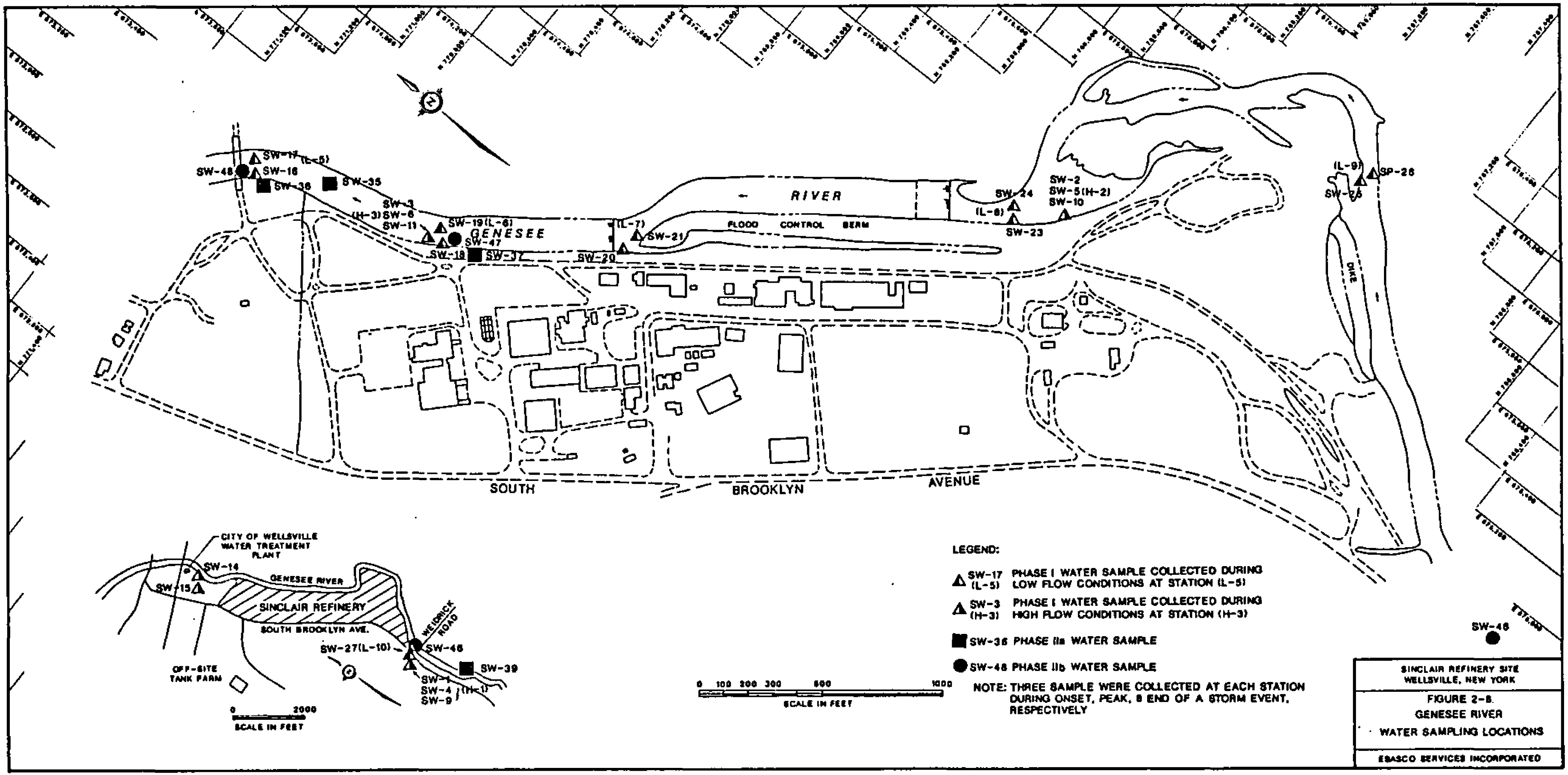
Thirteen other Genesee River samples were collected from the river during low flow conditions. The samples were generally taken in pairs, with one collected near the shore and one towards the middle of the stream. These locations are also shown on Figure 2-8. Sample collection methods are not described in available documents. The samples were analyzed for priority pollutants.

Surface water sampling continued in Phases II a and b. During Phase IIa, five surface water samples were taken at the locations shown on Figure 2-8. The sampling methods were presumably the same as in Phase I and samples were again analyzed for priority pollutants.

Ebasco took three surface water samples plus a duplicate sample (SW-47D) at one location to demonstrate the repeatability of their sampling technique. Samples were taken by immersing the sample jar directly into the river, as described in the Project Operation Plan (Ebasco, 1988). These samples were analyzed for TCL metals only, since metals were the only contaminants of potential concern identified in the river from prior investigation.

2.3.1.2 Genesee River Sediments

River sediment samples were collected during Phase I at four sampling stations along the Genesee River, with a shallow and deeper sample collected at each



LEGEND:

▲	SW-17 (L-5)	PHASE I WATER SAMPLE COLLECTED DURING LOW FLOW CONDITIONS AT STATION (L-5)
▲	SW-3 (H-3)	PHASE I WATER SAMPLE COLLECTED DURING HIGH FLOW CONDITIONS AT STATION (H-3)
■	SW-36	PHASE IIa WATER SAMPLE
●	SW-48	PHASE IIb WATER SAMPLE

NOTE: THREE SAMPLE WERE COLLECTED AT EACH STATION DURING ONSET, PEAK, & END OF A STORM EVENT, RESPECTIVELY

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FIGURE 2-8
GENESEE RIVER
WATER SAMPLING LOCATIONS

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station (Figure 2-9). The first sample at each of the locations was obtained as a grab sample from the river bed to a depth of about six inches. To obtain the second sample at a depth of 0.5 to 2.0 feet, a pipe was driven into the stream bed and the top six inches of sediment were removed with a stainless steel-type hand auger (SMC Martin, 1985). The samples were analyzed for priority pollutants.

Phase IIa sampling included taking four sediment samples, analyzed for all priority pollutants. The locations are shown on Figure 2-9. It is likely that the sampling technique was the same as for the shallow Phase I sediment samples.

The last of the sediment samples were taken in Phase IIb by Ebasco. The three sampling locations were the same as for the Phase IIb river water samples, but samples were analyzed for TCL metals, BNAs and VOCs, as well as for Total Organic Carbon (TOC) and grain size. The latter two tests were performed to assist in the performance of fate and transport modeling as part of the risk assessment. A duplicate sample for the chemical analyses was also taken.

2.3.2 Drainage Swale

2.3.2.1 Drainage Sample Surface Water

Sampling of the surface water in the drainage swale on the east side of the site was limited to Phases IIa and IIb. Two samples analyzed for Priority Pollutants were taken in Phase IIa and three samples analyzed for TCL metals, BNAs and VOCs were taken in Phase IIb. The sampling locations are shown on Figure 2-10. Sampling methods in Phase IIb (and presumably in Phase IIa) were the same as for Genesee River water sampling.

The draft Phase IIa maps show an additional sampling point (SW-32) as a swale sample, but the sample location is plotted along the banks of the Genesee River. It is not clear if the point is misplotted or mislabeled on the map. In the draft sample data sheet giving the results of laboratory analyses it is also listed as a swale sample, indicating that it was misplotted on the original map. The point (SW-32) is plotted on Figure 2-9, as shown on the draft Phase IIa maps.

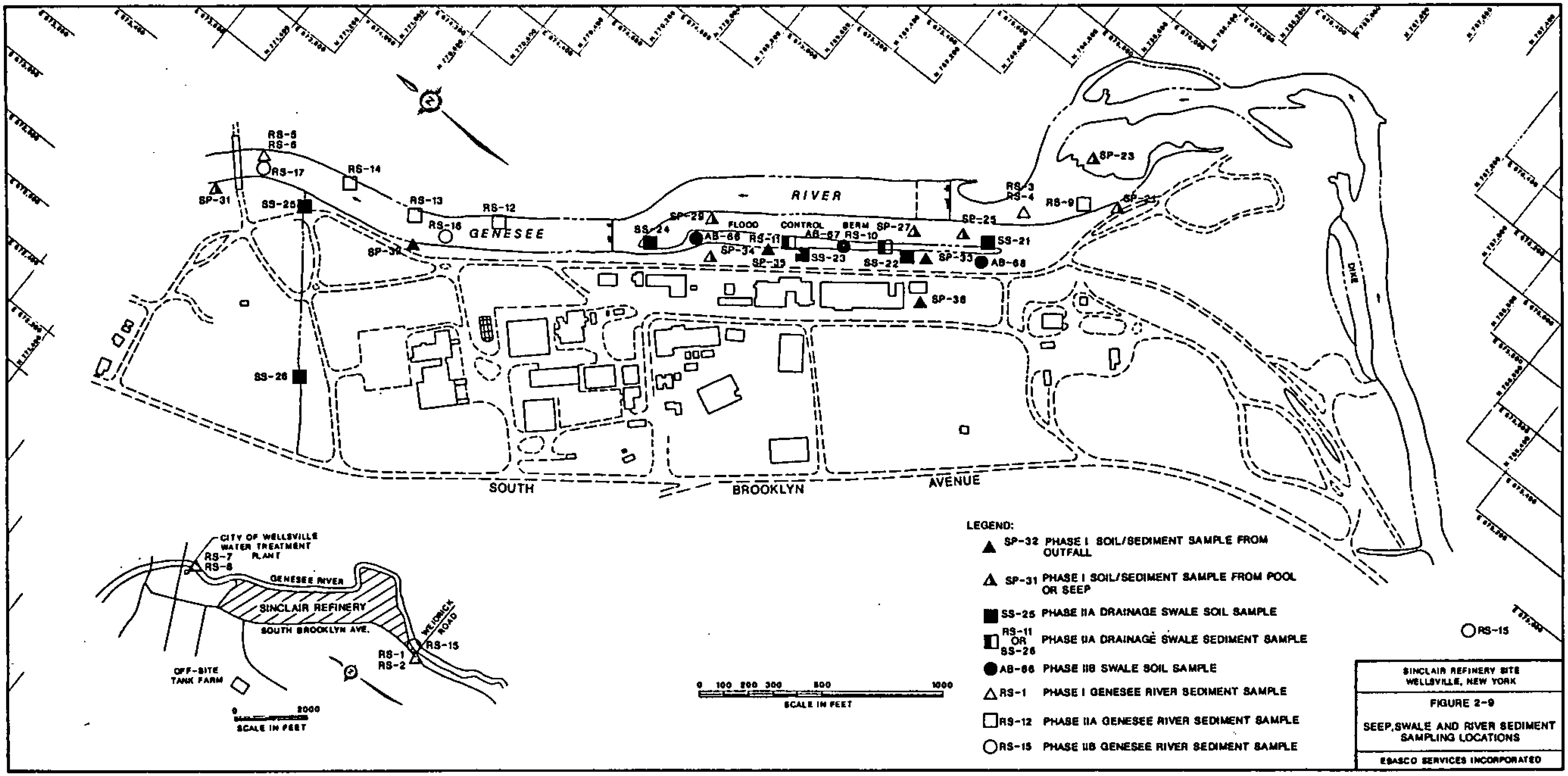

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FIGURE 2-9

SEEP, SWALE AND RIVER SEDIMENT SAMPLING LOCATIONS

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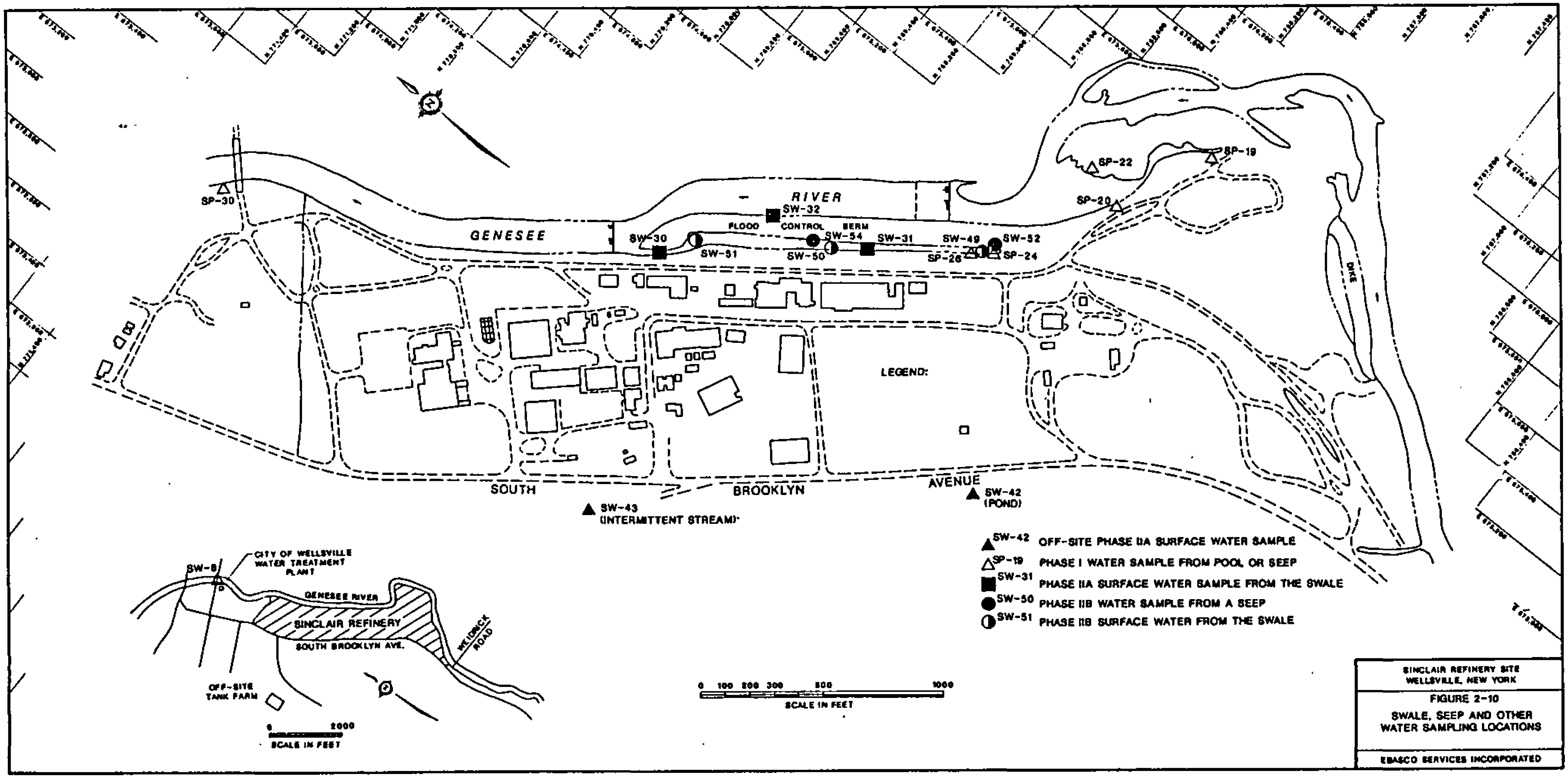

▲ SW-42 OFF-SITE PHASE IIA SURFACE WATER SAMPLE

△ SP-19 PHASE I WATER SAMPLE FROM POOL OR SEEP

■ SW-31 PHASE IIA SURFACE WATER SAMPLE FROM THE SWALE

● SW-50 PHASE IIB WATER SAMPLE FROM A SEEP

◐ SW-51 PHASE IIB SURFACE WATER FROM THE SWALE

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WELLSVILLE, NEW YORK

FIGURE 2-10

SWALE, SEEP AND OTHER WATER SAMPLING LOCATIONS

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2.3.2.2 Swale Sediments and Soils

Sampling in the swale was differentiated into sediment and soil sampling during Phase IIa. Although not discussed in sampling plans or the draft Phase II report, it appears (based on maps) that sediment samples were those at the base of the swale and soil samples were those on the banks or sides of the swale. Two swale sediment samples and four swale soil samples (Figure 2-9) were taken in Phase IIa and analyzed for priority pollutants. Each of these was a surficial sample. Two additional swale soil samples were taken, but locations were not plotted on the draft Phase IIa maps.

Phase IIb samples were taken at the bottom of the swale from 10-foot-deep soil borings. These locations are also shown on Figure 2-9. Three samples were taken at depths of 0 to 6 inches, 2 to 4 feet and 8 to 10 feet from each of the three borings and analyzed for TCL metals, VOCs, and BNAs. The surficial samples were also analyzed for TOC and grain size. These three sample locations are also discussed in Section 2.5 "Soils Investigations" of this report, which describes the Phase IIb soil boring program.

2.3.3 Seeps

Several seeps or springs have been observed discharging water along the banks of the Genesee River and the adjacent drainage swale. During Phase I, seven seeps were sampled, two at the south end of the drainage swale, three along the east bank of the Genesee River near the landfill, and two downgradient of the site (Figure 2-10). During Phase IIa three additional swale seep samples were taken (Note: SW-32 was labeled on maps and SMC Martin data as a swale sample but was plotted along the river. See Figure 2-10). A water sample was taken at each location and analyzed for priority pollutants. In Phase IIb, two additional seep samples were taken in the drainage swale and analyzed for TCL metals, VOCs and BNAs. The samples were taken in Phase IIb by allowing water from the seep to discharge directly into the sample bottle.

2.3.4 Off-Site Surface Water

A pond and a small intermittent stream are present on the west side of south Brooklyn Avenue, across the street from the site. Both of these were sampled during Phase IIa and the samples were analyzed for priority pollutant compounds. The sample locations are shown on Figure 2-10.

2.4 GEOLOGIC INVESTIGATION

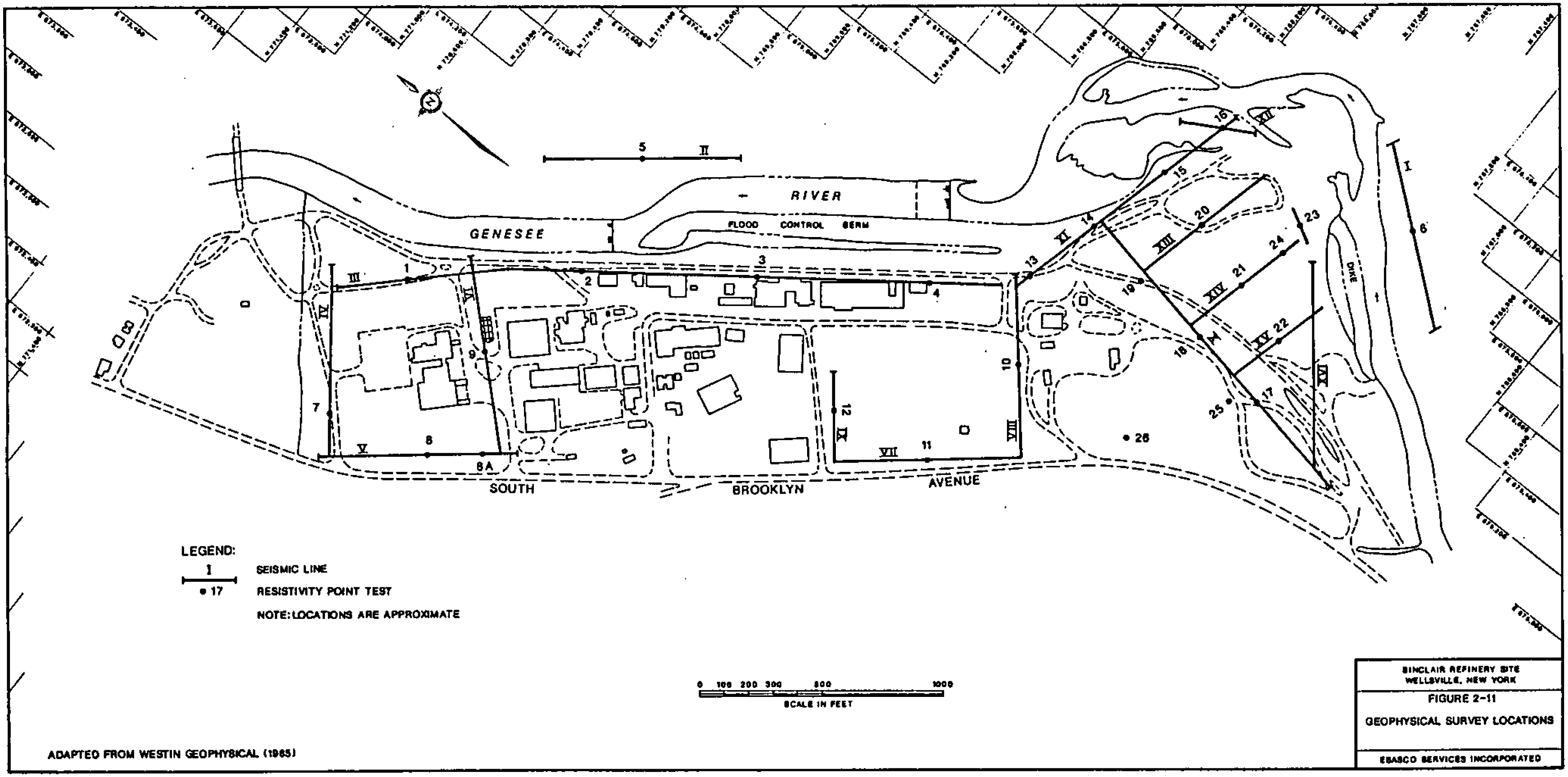
The geologic investigation of the Sinclair Refinery Site consisted of a well records search, a geophysical survey, and a soil boring and monitoring well installation program. The soil boring and monitoring well installation program was the most extensive portion of the investigation, and therefore furnished the majority of geologic data.

2.4.1 Geophysical Investigation

Geophysical surveys were conducted during Phases I and IIa of the Sinclair Refinery Remedial Investigation.

Seismic refraction and electrical resistivity surveys were performed in the refinery area of the Sinclair Site as part of the Phase I RI. These surveys, conducted from November 2 through 18, 1983, and December 8 through 10, 1983, were performed by Weston Geophysical Corporation of Westboro, Massachusetts. The objective of the Phase I geophysical investigation was to provide generalized subsurface data (i.e., depth to water, depth to bedrock, extent and continuity of clay/silt layers, preliminary delineation of contaminated areas) on the site in order to aid in planning other portions of the RI (e.g., auger boring, monitoring well installation).

A total of 14,600 feet of seismic refraction profiles, plus 400 feet of overlap shooting and offset points, was generated at the site (including the landfill). Figure 2-11 presents the locations of the seismic lines. Seismic lines were located so as to get broad coverage over the site. A 24-trace seismic recording system consisting of a Weston Geophysical Corp. Model 780 Universal seismic amplifier and a Southern Industrial Electronics Model PRO-11



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SINCLAIR REFINERY SITE
WELLSVILLE, NEW YORK

FIGURE 2-11

GEOPHYSICAL SURVEY LOCATIONS

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recording oscillograph was utilized. Seismic spreads of 400 and 800 feet were shot end to end (reversed shooting). Seismic energy was generated by small explosive charges at 5 points along most spreads.

The electrical resistivity survey consisted of 27 Wenner Point Tests and 3 Schlumberger Point Tests (both vertical profiling techniques), plus 4,000 feet of constant spacing resistivity profiling (horizontal profiling). The Schlumberger tests were run only for the purpose of test comparison. The Wenner tests (Lee-modified Wenner Array procedure) were more accurately modeled than the Schlumberger tests.

The resistivity tests were conducted along the seismic lines (Figure 2-11). A Bison Earth Resistivity Meter (Model 2350) was utilized for the Wenner soundings. A Scintrex TSP-3 transmitter and an IPR-10A receiver were utilized for the Schlumberger soundings. Constant spacing horizontal profiling was performed along lines 9 and 10 (Figure 2-11) in order to detect lateral variations in apparent resistivity at survey depths.

The sewer and piping system investigation performed during Phase IIa of the RI included an electromagnetic conductivity (EM) survey in the refinery area. The intent of this survey was to detect groundwater quality changes in areas of suspected leaking pipelines and abandoned oil storage facilities.

The EM survey, conducted by SMC Martin, utilized a Geonics EM34-3 conductivity meter. A total of 125 conductivity tests were performed in five areas. These areas were chosen based on Phase I geophysical survey results and groundwater quality data. The five areas chosen for investigation were:

Section 1 - Northern Portion of Refinery Site near Brooklyn Avenue (1A) and the Main (northern) Separator Unit (1B).

Section 2 - Central Site Storage Area (2A) and Southern Oil Separator Unit Area (2B).

Section 3 - Woodworks Storage Area (Mapes) in East-Central part on site.

Section 4 - Otis Eastern Property at Southern Part of Refinery Site.

Section 5 - Storage Area at Southern Boundary of Refinery Site.

The EM Survey was designed to penetrate into saturated subsurface materials (water table at approximately 12 feet) in order to identify the presence of any potential contamination plumes. A survey depth of approximately 25 feet was attained by using a 10-meter coil spacing in a horizontal dipole mode.

2.4.2 Site Drilling

A total of 62 auger borings and 48 monitoring well borings were drilled in the refinery and the OSTF areas of the Sinclair Site during the remedial investigation. All borings, except MWD-66 and MWDB-1, -2 and -3, were drilled using the hollow stem auger method. MWD-66 was drilled using the hollow stem auger and water rotary methods. MWDB-1, -2 and -3 were drilled using the hollow stem auger and air rotary methods. Split-spoon samples were obtained from all borings for geological classification and chemical analysis. Subsections 2.5.2 and 2.6.1 describe drilling and sampling procedures in more detail.

2.5 SOIL INVESTIGATIONS

Surface and subsurface soils were examined during the soils investigation at the Sinclair Refinery Site. During the three phases of the remedial investigation 59 surface soil samples were collected. Investigation of subsurface soils in the refinery area and at the OSTF involved the drilling of 62 auger borings and 48 monitoring well borings.

2.5.1 Surface Soils

During Phases I and IIa of the remedial investigation by SMC Martin at the Sinclair site 38 surface soil samples were collected. These included 6 background samples (off-site), 25 samples from the refinery area and 7 samples from the OSTF.

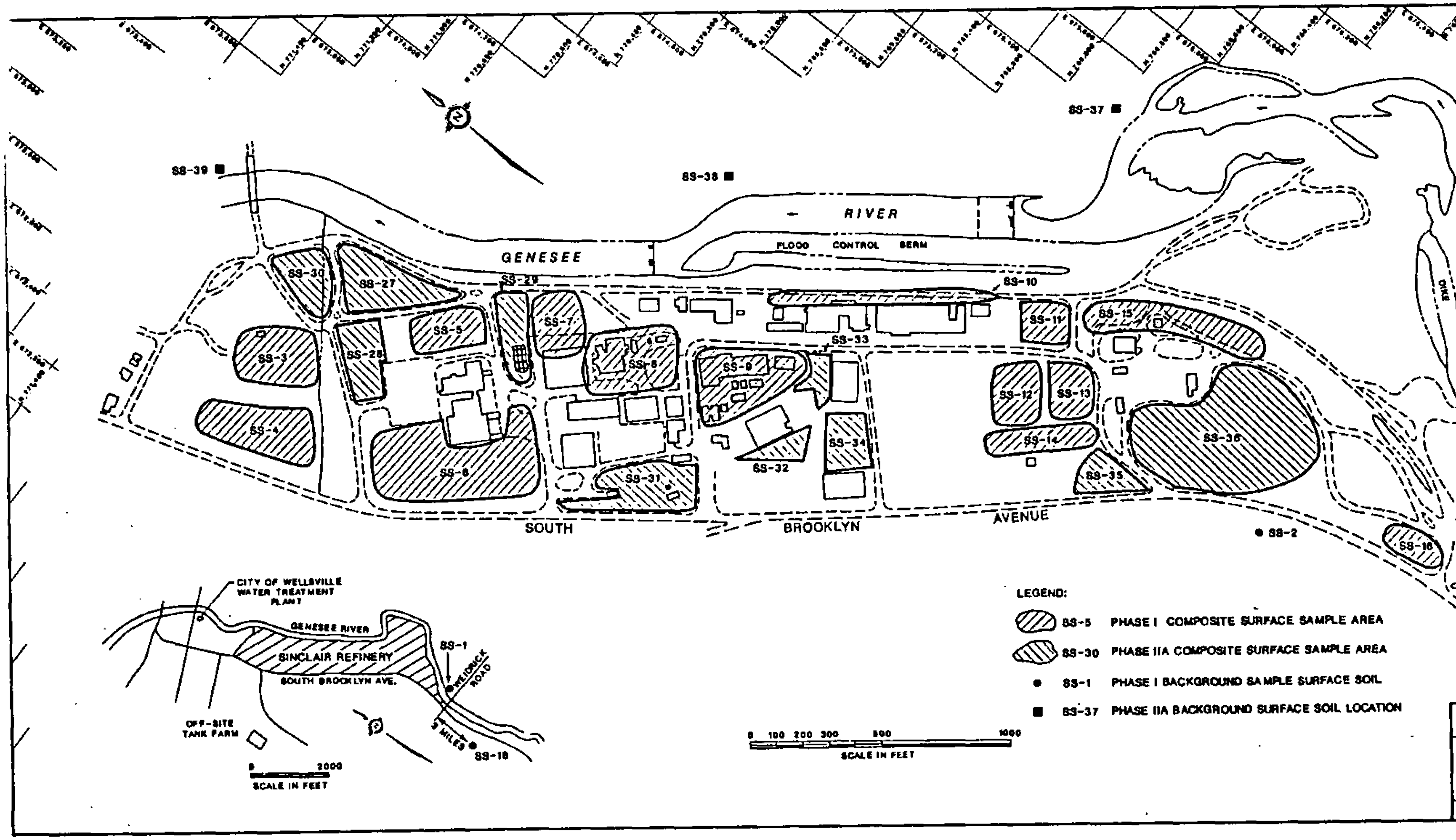
Background samples, collected both east and west of the Genesee River (Figure 2-12), were taken as composite samples over approximately 3-foot depths. Phase I background samples (SS-1, -2 and -18) were analyzed for priority pollutant metals. The analysis of Phase II background samples (SS-37, -38 and -39) was also limited to priority pollutant metals based on Phase I results (SMC Martin, 1987).

The 14 surface soil samples collected from the refinery area during the Phase I investigation were composite samples. Ten composites were also taken in Phase IIa. Sample locations were limited to areas of previous refinery facilities. Although refinery area surface soil samples were collected at discrete depths of 0 to 6 inches, each sample sent for chemical analysis consisted of a composite of 5 to 12 samples taken at different locations (SMC Martin, 1985). Figure 2-12 presents the areas from which composite samples were taken. Composite surface soil samples were analyzed for all priority pollutants in Phase I and priority pollutant metals in Phase IIa.

One on-site surface soil sample (SH-1) other than the 10 composite samples was taken during the Phase IIa study. This sample was collected from the basement floor of an abandoned refinery building, referred to as the "stone house" (shown on Figure 1-2 and located in the pipeyard of Butler-Larkin), and analyzed for full priority pollutants. These analytical results were used to assess soil quality at the time of refinery operations (SMC Martin, 1987).

Large-scale compositing during the Phase I and IIa investigations identified contaminants of concern at the site and delineated the areas in which these contaminants are found. In contrast to Phase I and IIa surface soil sampling, samples taken during the Phase IIb investigaton were collected as discrete 0 to 6 inches grab samples from single locations. Discrete sampling during the Phase IIb investigations was aimed at delineating possible surface soil contamination on a finer scale.

A total of 31 surface soil samples were collected from single locations at soil and well boring locations during the Phase IIb investigation (Figures 2-13 and 2-14). These include 26 from the refinery area, 3 from the main drainage swale and 2 from background locations. All samples were analyzed for TCL metals, because earlier investigations targeted heavy metals, (particularly



LEGEND:

- ▨ SS-5 PHASE I COMPOSITE SURFACE SAMPLE AREA
- ▨ SS-30 PHASE IIA COMPOSITE SURFACE SAMPLE AREA
- ● SS-1 PHASE I BACKGROUND SAMPLE SURFACE SOIL
- ■ SS-37 PHASE IIA BACKGROUND SURFACE SOIL LOCATION

SINCLAIR REFINERY SITE
WELLSVILLE, NEW YORK

FIGURE 2-12

COMPOSITE SURFACE SOIL SAMPLING LOCATIONS

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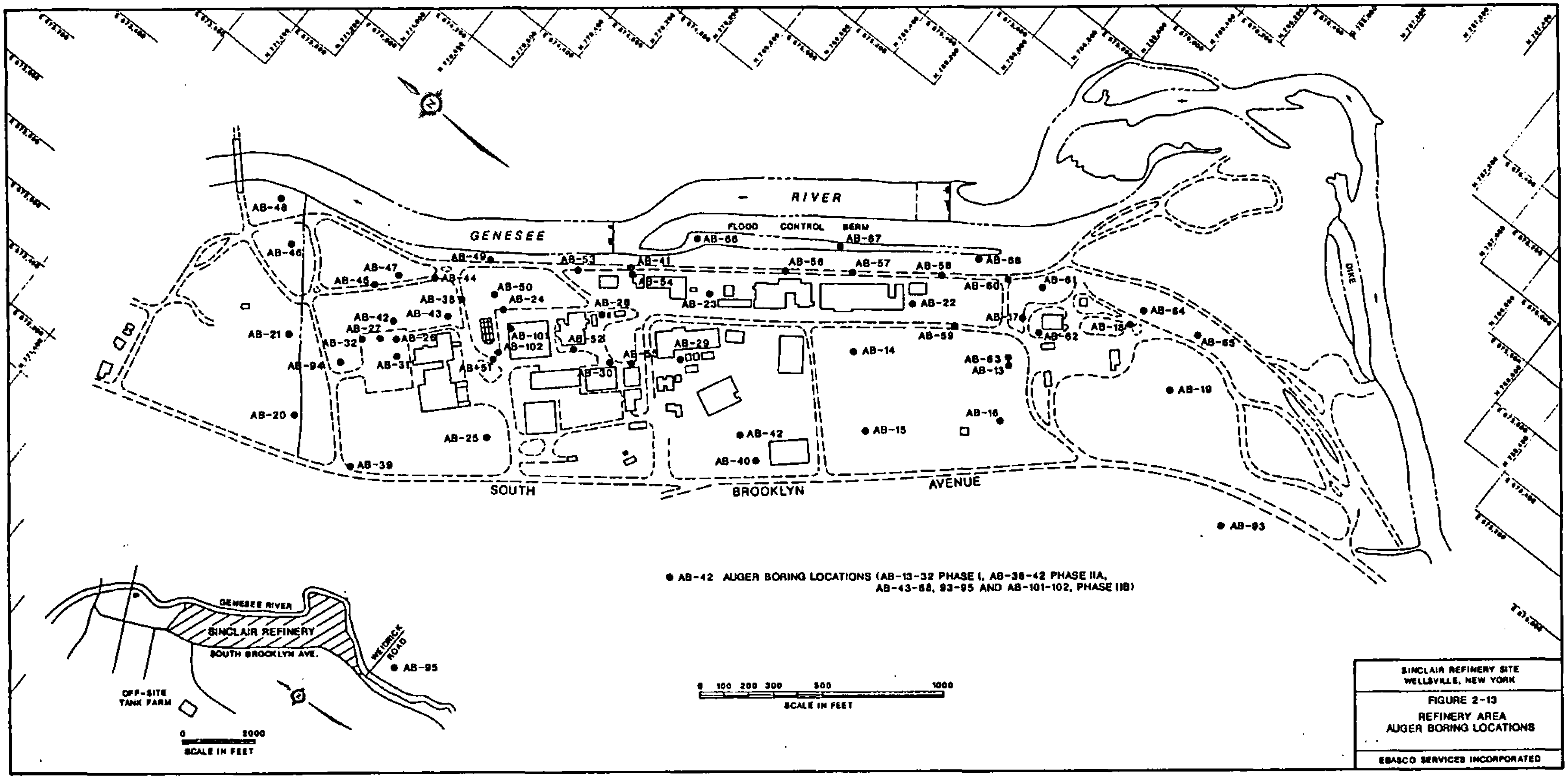

● AB-42 AUGER BORING LOCATIONS (AB-13-32 PHASE I, AB-38-42 PHASE IIA,
AB-43-68, 93-95 AND AB-101-102, PHASE IIB)

SINCLAIR REFINERY SITE
WELLSVILLE, NEW YORK

FIGURE 2-13

REFINERY AREA
AUGER BORING LOCATIONS

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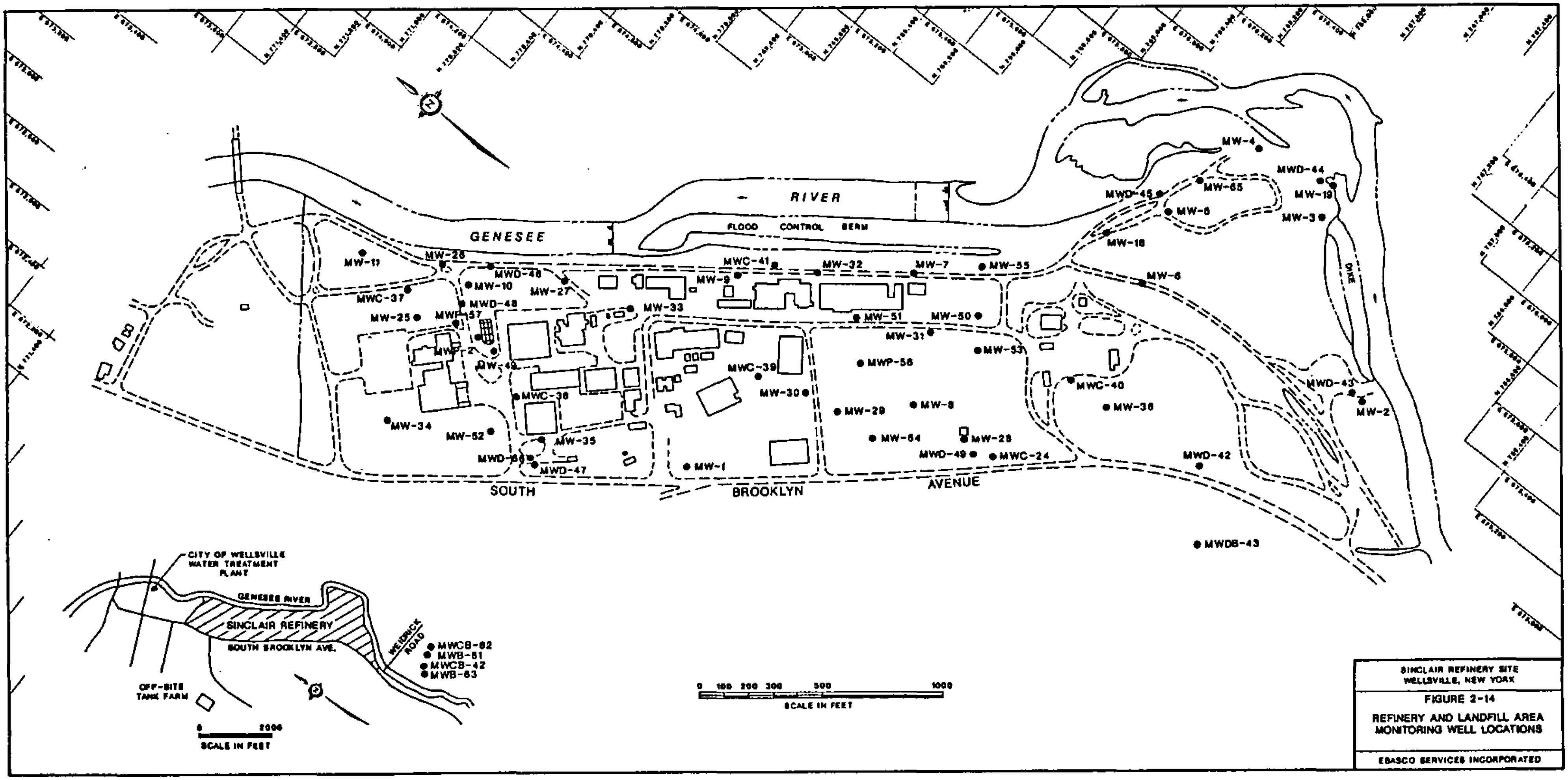

SINCLAIR REFINERY SITE
WELLSVILLE, NEW YORK

FIGURE 2-14

REFINERY AND LANDFILL AREA
MONITORING WELL LOCATIONS

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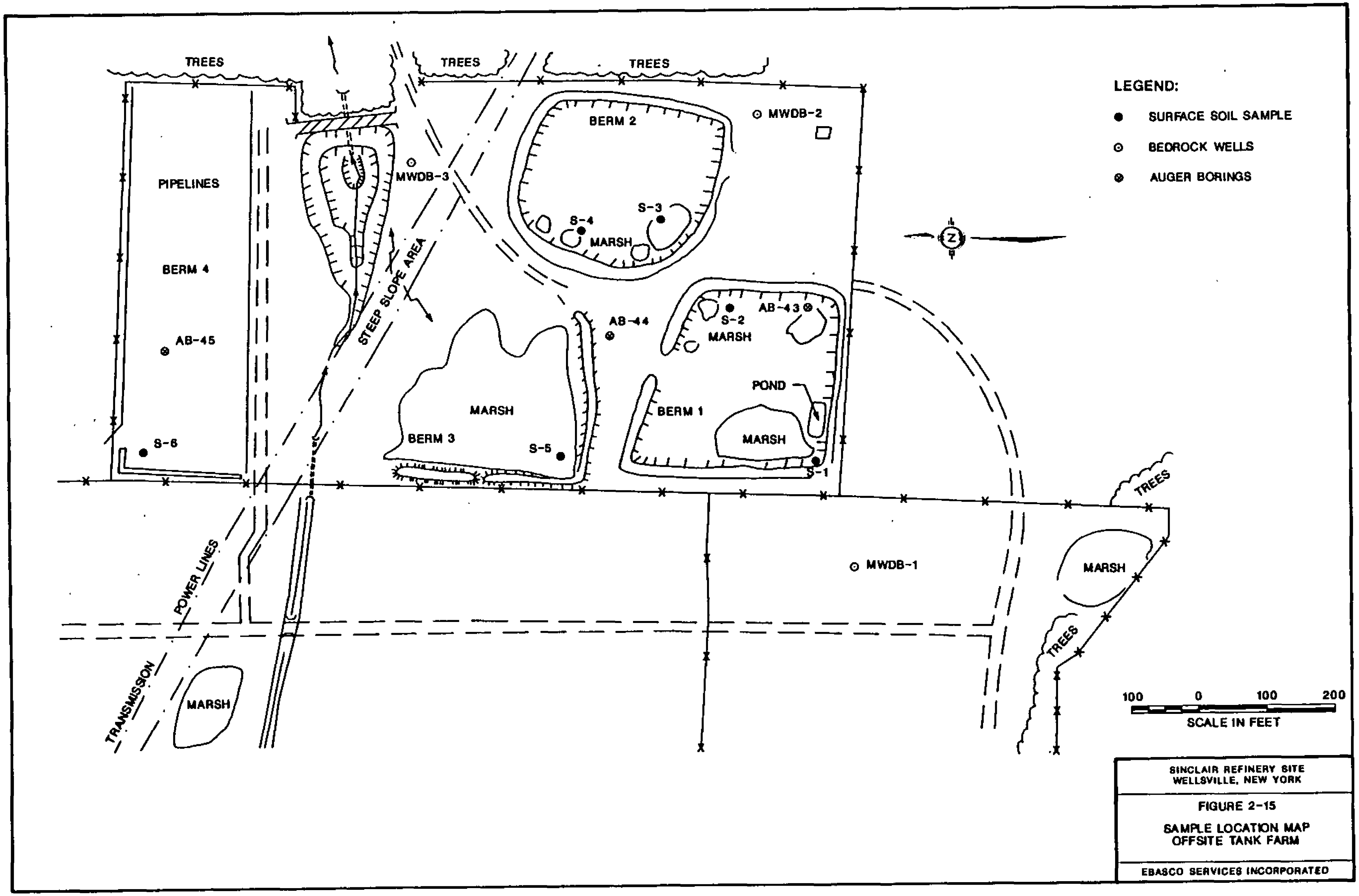
lead) as the contaminants of concern in on-site surface soils. Samples from the main drainage swale were also analyzed for TCL volatile and semivolatile compounds, as well as for total organic carbon and grain size.

Surface soil sampling at the OSTF was limited to the Phase I and IIa investigations. A single large-scale composite sample (0 to 6-inch depth from 10 locations) was taken during Phase I (SS-17) (SMC Martin, 1985). Six samples (S-1 through S-6) were collected during Phase IIa (Figure 2-15). Phase IIa samples were collected from and adjacent to the berms at the OSTF. The samples were collected from a depth of 0-6 inches. These samples were analyzed for priority pollutants.

2.5.2 Subsurface Soils

Table 2-2 presents a summary of subsurface soil samples taken in the refinery area and the OSTF during the two phases of study at the Sinclair site. Subsurface soil samples were obtained from both auger borings and monitoring well borings. As in the surface soil investigation, subsurface soil samples were created by large-scale compositing during Phases I and IIa and taken as single discrete samples during Phase IIb. As a result, analytical data from Phases I and IIa indicate the general type and extent of contamination, while Phase IIb data delineate the areal and vertical extent of contamination in finer detail.

Twenty auger borings (AB-13 through 32) and six monitoring well borings (MW-1, 7-11) were completed in the refinery area during the Phase I program. Borings were located in areas of originally suspected potential hazard (e.g., tank farm, waste storage areas, oil separators) and/or geophysical anomalies (SMC Martin, 1985). Borings were drilled using the hollow stem auger method. Split-spoon samples were obtained continuously, generally to two feet below visible contamination in auger borings and to the desired screen depth in monitoring well borings (SMC Martin, 1985). Auger boring depths generally ranged from 6 to 22 feet while monitoring well borings were advanced to depths as much as 79 feet. AB-25 was extended 30 feet below visible contamination for a total depth of 50 feet. A single sample for chemical analysis was created from each boring by compositing those split-spoons that contained visibly contaminated soils (SMC Martin, 1985). Information on the actual number of biased split-spoon samples incorporated into each composite is unavailable for many of the samples.



SINCLAIR REFINERY SITE
WELLSVILLE, NEW YORK

FIGURE 2-15

SAMPLE LOCATION MAP
OFFSITE TANK FARM

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TABLE 2-2 (Sheet 1 of 4)

SUMMARY
SUBSURFACE SOIL SAMPLES

Boring No.	Total Depth (ft)	No. Split Spoons Obtained	Depths of Intervals Included in Single Composite Sample	Individual (Discrete) Sample Depths
Phase I:				
AB-13	12	6	No depth information available	None
AB-14	18	9	No depth information available	None
AB-15	14	7	No depth information available	None
AB-16	20	10	No depth information available	None
AB-17	16	8	No depth information available	None
AB-18	16	8	No depth information available	None
AB-19	18	8	No depth information available	None
AB-20	16	7	No depth information available	None
AB-21	14	7	No depth information available	None
AB-22	22	11	No depth information available	None
AB-23	18	9	No depth information available	None
AB-24	18	9	No depth information available	None
AB-25	50	23	No depth information available	None
AB-26	17	8	No depth information available	None
AB-27	19	9	No depth information available	None
AB-28	18	9	No depth information available	None
AB-29	6	3	No depth information available	None
AB-30	18	9	No depth information available	None
AB-31	19	9	No depth information available	None
AB-32	17	9	No depth information available	None
MW-1	23	10	0 to 4'	None
MW-7	24	12	1 to 19'	None
MW-8	21	10	2 to 19'	None
MW-9	21	10	1 to 19'	None
MW-10	79	39	1 to 23'	None
MW-11	26	11	1 to 19'	None
Phase IIa:				
AB-35	17	-	10 to 17'	None
AB-37	22	-	0 to 22'	None
AB-38	22	-	No depth information available	None
AB-39	62	13	No depth information available	None
AB-40	42	9	No depth information available	None
AB-41	32	7	No depth information available	None
AB-42	37	8	No depth information available	None
MWP-2	27	5	5 to 27'(a)	None
MW-25	27	6	0 to 27'(a)	None
MW-26	27	6	0 to 27'(a)	None

TABLE 2-2 (Sheet 2 of 4)

SUMMARY
SUBSURFACE SOIL SAMPLES

Boring No.	Total Depth (ft)	No. Split Spoons Obtained	Depths of Intervals Included in Single Composite Sample	Individual (Discrete) Sample Depths
Phase IIa:(Cont'd)				
MW-27	32	6	5 to 32'(a)	None
MW-28	32	6	5 to 32'(a)	None
MW-29	32	7	0 to 32'(a)	None
MW-30	32	7	0 to 32'(a)	None
MW-31	32	6	5 to 32'(a)	None
MW-32	42	9	0 to 42'(a)	None
MW-33	32	7	0 to 32'(a)	None
MW-34	19	5	0 to 19'(a)	None
MW-35	23	5	0 to 23'(a)	None
MW-36	32	8	0 to 32'(a)	None
MW-49	12	3	0 to 2', 5 to 7', 10 to 12'	None
MW-50	12	3	0 to 3', 5 to 7', 10 to 12'	None
MW-51	17	4	0 to 2', 5 to 7', 10 to 12', 15-17'	None
MW-52	12	3	0 to 2', 5 to 7', 10 to 12'	None
MW-53	12	3	0 to 3', 5 to 7', 10 to 12'	None
MW-54	8	2	0 to 3', 5 to 7'	None
MW-55	12	3	0 to 2', 5 to 7', 10 to 12'	None
MWP-56	32	6	5 to 32'(a)	None
MWP-57	30	4	10 to 27'(a)	None
MWC-24	57	11	No depth information available	None
MWC-37	37	8	0 to 37'(a)	None
MWC-38	32	7	0 to 32'(a)	None
MWC-39	37	8	0 to 37'(a)	None
MWC-40(b)	37	8	0 to 37'(a)	None
MWC-41	33	7	0 to 32'(a)	None
MWD-42	82	11	No depth information available	None
MWD-46	125	23	0 to 112'(a)	None
MWD-47	115	18	1 to 112'(a)	None
MWD-48	117	13	5 to 112'(a)	None
MWD-49	87	14	5 to 87'(a)	None
MWCB-42	50	10	No depth information available	None
MWCB-43(c)	47	10	No depth information available	None
MWCB-61	17	4	No depth information available	None
MWCB-62	50	10	No depth information available	None
MWB-63	22	5	No depth information available	None

TABLE 2-2 (Sheet 3 of 4)

SUMMARY
SUBSURFACE SOIL SAMPLES

Boring No.	Total Depth (ft)	No. Split Spoons Obtained	Depths of Intervals Included in Single Composite Sample	Individual (Discrete) Sample Depths
Phase IIb:				
AB-42	10	2	None	2-4'; 8-10'
AB-43	10	2	None	2-4'; 8-10'
AB-44	6.33	1	None	2.5-4'
AB-45	10	2	None	2-4'; 8-10'
AB-46	10	2	None	2-4'; 8-10'
AB-47	10	2	None	2-4'; 8-10'
AB-48	10	2	None	2-4'; 8-10'
AB-49	10	2	None	2-4'; 8-10'
AB-50	10	2	None	2-4'; 8-10'
AB-51	10	2	None	2-4'; 8-10'
AB-52	10	2	None	2-4'; 8-10'
AB-53	10	2	None	2-4'; 8-10'
AB-54	10	2	None	2-4'; 8-10'
AB-55	10	2	None	2-4'; 8-10'
AB-56	10	2	None	2-4'; 8-10'
AB-57	10	2	None	2-4'; 8-10'
AB-58	10	2	None	2-4'; 8-10'
AB-59	10	2	None	2-4'; 8-10'
AB-60	10	2	None	2-4'; 8-10'
AB-61	10	2	None	2-4'; 8-10'
AB-62	10	2	None	2-4'; 8-10'
AB-63	10	2	None	2-4'
AB-64	10	2	None	2-4'; 8-10'
AB-65	10	2	None	2-4'; 8-10'
AB-66	10	2	None	2-4'; 8-10'
AB-67	10	2	None	2-4'; 8-10'
AB-68	12	3	None	2-4'; 10-12'
AB-93	42	11	None	8-10'
AB-94	10	2	None	2-4'; 8-10'
AB-95	10	1	None	8-10'
AB-101	14	3	None	7-9'
AB-102	14	3	None	2-4'
MW-65	18	4	None	None
MWD-66	110	24	None	108'-110'

TABLE 2-2 (Sheet 4 of 4)

SUMMARY
SUBSURFACE SOIL SAMPLES

Boring No.	Total Depth (ft)	No. Split Spoons Obtained	Depths of Intervals Included in Single Composite Sample	Individual (Discrete) Sample Depths
OSTF (Phase IIa):				
AB-43	14	2	No depth information available	None
AB-44	16	3	No depth information available	None
AB-45	42	9	No depth information available	None
MWDB-1	109	1	No depth information available	None
MWDB-2	109	5	No depth information available	None
MWDB-3	89	5	No depth information available	None

(a) Interval from which 2-foot samples were collected every 5 feet.

(b) Also refered to as MW-40 on some Phase IIa documents.

(c) Also referred to as MWDB-43.

(1) A surface sample (0-6 inches) was also taken at each Phase IIb location.

Seven auger borings (AB-35 and AB-37 through 42, see Figure 2-13. Locations of AB-35 and AB-37 are not known.) and 37 monitoring well borings (Table 2-2, Figure 2-14) were completed in the refinery area during the Phase IIa investigation. Five of the 37 monitoring well borings (MWCB-42,-61,-62, MWDB-43 and MWB-63) were located off-site in order to obtain background soil and groundwater information. The total depth of each boring was largely dependent upon the hydrologic unit in which the well was to be screened. Boring depths range from 8 feet for shallow aquifer wells to 117 feet for deep aquifer wells. Drilling and sampling procedures remained consistent with those carried out during Phase I (SMC Martin, 1985). Information on the number of samples and sample depths incorporated into each composite sample is available for most Phase IIa borings. This information is included in Table 2-2. The number of samples and sample intervals incorporated into single composite samples range from 2 samples over 7 feet to 23 samples over 112 feet (SMC Martin, 1987). All samples were analyzed for full priority pollutants.

Thirty-two auger borings (AB-42 through 68, 93 through 95, 101 and 102) and two monitoring well borings (MW-65, MWD-66) were completed during the Phase IIb investigation. Boring locations are the same as surface soil sampling locations (Figures 2-13 and 2-14). Twenty-five are located in areas previously identified as having elevated lead levels, as indicated by Phase I and Phase IIa analytical results, three are located in the main drainage swale, two were located near the northern separator and two are located off-site in order to yield additional background soils information. All borings except AB-42 through 44 were drilled by the hollow stem auger method. AB-42 through 44 were advanced with a hand auger and shovel. Samples were obtained with split-spoon samplers from drilled borings and with trowels and hand augers from AB-42 through 44. Auger boring samples were generally collected at depths of 2 to 4 feet and 8 to 10 feet from refinery and swale borings and 8 to 10 feet from background borings. These samples were analyzed for TCL metals. Swale samples were also analyzed for TCL volatiles and semivolatiles. In addition, total organic carbon and grain size analyses were performed on swale and selected refinery soil samples. Split-spoon samples from monitoring well borings were obtained approximately every 5 feet for geologic characterization only. A single sample for chemical analysis was obtained from MWD-66 from a depth of 108-110 feet.

An investigation of subsurface soils at the OSTF was conducted during the Phase IIa program. Subsurface soils data were obtained from three auger borings (AB-43 through 45) and three monitoring well borings (MWDB-1, -2, -3) (see Figure 2-15). Auger borings were advanced to bedrock (14-42 feet). Monitoring wells were completed in bedrock at depths ranging from 89 to 109 feet. As in all Phase IIa sampling, a single composite sample was created from the unconsolidated material in each boring (SMC Martin, 1987). Each sample was analyzed for full priority and selected nonpriority compounds.

2.6 GROUNDWATER INVESTIGATION

The groundwater investigation conducted at the Sinclair site during the two phases of the RI consisted of the installation, development and sampling of monitoring wells installed in the refinery and landfill areas of the site and at the OSTF. Hydrologic testing such as pumping tests, in situ permeability (slug) tests and infiltration tests were also performed during the groundwater investigation.

2.6.1 Well Installation

Seventy monitoring wells were installed during Phase I and Phase IIa of the Sinclair Remedial Investigation. These included 15 in the landfill area (does not include 5 wells completed in waste) or in clay below waste, 40 in the refinery area, 3 at the OSTF and 5 at background locations off-site. The wells were supposed to be screened so as to monitor the upper aquifer (shallow wells, MW-# and pumping wells, MWP-#), the underlying aquitard (clay wells, MWC-#) and the lower aquifer (deep wells, MWD-#). However in some cases, wells labeled as one type were actually used for another purpose. The OSTF wells monitor the relatively shallow bedrock underlying this area (MWDB-#). Two additional wells were installed in Phase IIb, one shallow landfill area well (MW-65) and one deep refinery area well (MWD-66). Table 2-3 presents a summary of the monitoring wells installed at the Sinclair site.

TABLE 2-3 (Sheet 1 of 4)

SUMMARY OF MONITORING WELLS INSTALLED AT THE SINCLAIR SITE

Well No.	Surface Elevation (ft - msl)	Screened Interval (ft below ground surface)	Elevation of Screened Interval (msl - ft)	Well Diameter	Well Material	Screen Slot Size
Landfill:						
MW-2	1509.10	11-26[a]	1498.10-1488.10	2"	Galvanized Steel	0.010"
MW-3	1498.39	3-18[a]	1495.4-1480.4	2"	Galvanized Steel	0.010"
MW-4	1497.50	2-17[a]	1495.5-1480.5	2"	Galvanized Steel	0.010"
MW-5	1500.14	7-20[a]	1493.1-1480.1	2"	Galvanized Steel	0.010"
MW-6	1501.52	7-22[a]	1494.5-1479.5	2"	Galvanized Steel	0.010"
MW-16	1499.10	10-20[a]	1489.1-1479.1	2"	Galvanized Steel	0.010"
MW-19	1496.34	10-20[a]	1486.3-1476.3	2"	Galvanized Steel	0.010"
MWC-14[d]	1499.8	25-40[a]	1474.8-1459.8	2"	Galvanized Steel	0.010"
MWC-15[d]	1496.1	30-45[a]	1466.1-1451.1	2"	Galvanized Steel	0.010"
MWC-18[d]	1509.8	45-60[a]	1464.8-1449.8	2"	Galvanized Steel	0.010"
MWC-23[d]	1499.5	20-35[a]	1479.5-1464.5	2"	Galvanized Steel	0.010"
MWD-43	1502.28	65-80[a]	1437.3-1422.3	2"	Galvanized Steel	0.010"
MWD-44	1496.95	65-80[a]	1431.9-1418.9	2"	Galvanized Steel	0.010"
MWD-45	1499.56	76-91[a]	1423.6-1408.6	2"	Galvanized Steel	0.010"
MW-65	1500.07	4.5.14.5	1495.6-1485.6	2"	Stainless Steel	0.010"

TABLE 2-3 (Sheet 2 of 4)

SUMMARY OF MONITORING WELLS INSTALLED AT THE SINCLAIR SITE

Well No.	Surface Elevation (ft - msl)	Screened Interval (ft below ground surface)	Elevation of Screened Interval (msl - ft)	Well Diameter	Well Material	Screen Slot Size
Refinery Area:						
MW-1	1505.92	7-22[a]	1498.9-1483.9	2"	Galvanized Steel	0.010"
MW-7	1498.48	8-23[a]	1490.5-1475.5	2"	Galvanized Steel	0.010"
MW-8	1489.25	5-20[a]	1484.2-1469.2	2"	Galvanized Steel	0.010"
MW-9	1497.62	5-20[a]	1492.6-1477.6	2"	Galvanized Steel	0.010"
MW-10	1495.93	10-25[a]	1485.9-1470.9	2"	Galvanized Steel	0.010"
MW-11	1494.37	10-25[a]	1484.4-1469.4	2"	Galvanized Steel	0.010"
MW-25	1495.52	15-25[a]	1480.5-1470.5	2"	Galvanized Steel	0.010"
MW-26	1495.30	6-16	1489.3-1479.3	2"	Galvanized Steel	0.010"
MW-27	1496.58	16-26	1480.6-1470.6	2"	Galvanized Steel	0.010"
MW-28	1498.87	12-22	1486.9-1476.9	2"	Galvanized Steel	0.010"
MW-29	1498.55	15-25	1483.6-1473.6	2"	Galvanized Steel	0.010"
MW-30	1498.15	13-23	1485.1-1475.1	2"	Galvanized Steel	0.010"
MW-31	1498.29	15-25	1483.3-1478.3	2"	Galvanized Steel	0.010"
MW-32	1498.29	19-29[a]	1479.3-1469.3	2"	Galvanized Steel	0.010"
MW-33	1497.09	15-25	1482.1-1472.1	2"	Galvanized Steel	0.010"
MW-34	1495.18	4-14	1491.2-1481.2	2"	Galvanized Steel	0.010"
MW-35	1498.56	5-15	1493.6-1483.6	2"	Galvanized Steel	0.010"
MW-36	1499.98	14-24	1486.0-1476.0	2"	Galvanized Steel	0.010"
MW-49	1496.34	7-12[a]	1489.3-1484.3	2"	Galvanized Steel	0.010"
MW-50	1497.22	5-10[a]	1492.2-1487.2	2"	Galvanized Steel	0.010"

TABLE 2-3 (Sheet 3 of 4)

SUMMARY OF MONITORING WELLS INSTALLED AT THE SINCLAIR SITE

Well No.	Surface Elevation (ft - msl)	Screened Interval (ft below ground surface)	Elevation of Screened Interval (msl - ft)	Well Diameter	Well Material	Screen Slot Size
Refinery Area:	(Cont'd)					
MW-51	1497.21	6-11[a]	1491.2-1486.2	2"	Galvanized Steel	0.010"
MW-52	1495.78	4-9[a]	1491.8-1486.8	2"	Galvanized Steel	0.010"
MW-53	1497.48	3-8[a]	1494.5-1489.5	2"	Galvanized Steel	0.010"
MW-54	1499.17	2.5-7.5[a]	1496.7-1491.7	2"	Galvanized Steel	0.010"
MW-55	1496.86	5-10[a]	1491.9-1486.9	2"	Galvanized Steel	0.010"
MWC-24[d]	1498.4	40-55[a]	1458.4-1443.4	2"	Galvanized Steel	0.010"
MWC-37[d]	1495.1	25-35	1470.1-1460.1	2"	Galvanized Steel	0.010"
MWC-38[d]	1496.68	22-32	1474.7-1464.7	2"	Galvanized Steel	0.010"
MWC-39[d]	1498.37	26-36	1472.4-1462.4	2"	Galvanized Steel	0.010"
MWC-40[d]	1498.79	25-35	1473.8-1463.8	2"	Galvanized Steel	0.010"
MWC-41[d]	1497.92	23-33	1474.9-1464.9	2"	Galvanized Steel	0.010"
MWP-2	1495.25	10-20	1485.2-1475.2	6"	Galvanized Steel	0.020"
MWP-56	1498.25	5-25	1493.2-1473.2	6"	Galvanized Steel	0.020"
MWP-57	1495.57	5-25	1490.6-1470.6	6"	Galvanized Steel	0.020"
MWD-42	1512.0	64-79[a]	1448.0-1433.0	2"	Galvanized Steel	0.010"
MWD-46	1495.77	10-20	1485.8-1475.8	2"	Galvanized Steel	0.010"
MWD-47	1502.13	100-110	1402.1-1392.1	2"	Galvanized Steel	0.010"
MWD-48	1496.0	95-105	1401.0-1391.0	2"	Galvanized Steel	0.010"
MWD-49	1498.44	73.5-83.5	1424.9-1414.9	2"	Galvanized Steel	0.010"
MWD-66	1501.40	82.1-92.1	1419.3-1409.3	2"	Stainless Steel[c]	0.010"

TABLE 2-3 (Sheet 4 of 4)

SUMMARY OF MONITORING WELLS INSTALLED AT THE SINCLAIR SITE

Well No.	Surface Elevation (ft - msl)	Screened Interval (ft below ground surface)	Elevation of Screened Interval (msl - ft)	Well Diameter	Well Material	Screen Slot Size
Background Wells:						
MWB-61	1505.12	7-17[a]	1498.1-1488.1	2"	Galvanized Steel	0.010"
MWB-63	1505.70	10-20[a]	1495.7-1485.7	2"	Galvanized Steel	0.010"
MWCB-42	1505.49	40-50[a]	1465.5-1455.5	2"	Galvanized Steel	0.010"
MWCB-62	1505.05	40-50[a]	1465.0-1455.0	2"	Galvanized Steel	0.010"
MWDB-43	1533.32	34-44[a]	1499.3-1489.3	2"	Galvanized Steel	0.010"
OSTF:						
MWDB-1	1695.48	9.5-108[b]	1685.0-1577.0	3.875"	Open borehole	-
MWDB-2	1657.30	27-109[b]	1630.3-1548.3	3.875"	Open borehole	-
MWDB-3	1617.54	26-89[b]	1591.5-1528.5	3.875"	Open borehole	-

[a] Screen depth approximated from SMC well construction data sheets.

[b] Open borehole.

[c] Double-cased well: 6" PVC to 74'; 2" stainless steel from 0 to 92.1 feet.

[d] Well decommissioned in 1988.

Figure 2-14 presents monitoring well locations in the refinery and landfill areas. Landfill monitoring wells (8 shallow, 3 deep) are located along the periphery of the landfill in order to monitor groundwater conditions between the landfill and the Genesee River. Refinery area monitoring wells (28 shallow, 6 clay, 6 deep) are located up and downgradient of suspected sources of contamination (e.g., oil separators, waste storage areas) and/or at the locations of geophysical anomalies (SMC Martin, 1987). MW-1, located along the western edge of the site, is intended to monitor groundwater conditions upgradient of the site (SMC Martin, 1985). Additional background wells (2 shallow, MWB-61 and 63; 2 clay, MWCB-42 and 62; 1 deep, MWDB-43) are located south of the site and monitor both sides of the Genesee River. Although MWDB-43 is labeled as a deep well, based on the boring log and surveyed elevations it may actually monitor the shallow aquifer.

All Phase I and IIa monitoring wells, except MWP-2,-56,-57, are 2 inches in diameter and were drilled with 4-1/4-inch I.D. hollow stem augers. Pumping wells MWP-2, -56 and -57, installed to conduct pumping tests, are 6 inches in diameter and were drilled with large diameter (8-1/4-inch I.D.) augers.

Monitoring well construction details furnished by SMC Martin (1985, 1987) are presented in Appendix E. All Phase I and IIa monitoring wells are constructed of galvanized steel screen and riser pipe with welded couplings. For pumping wells, 20-slot screens were used, while 10-slot screens were used for all others. Screens are 10 and 15 feet in length. Number 1 well sand was used to fill the annular space to a minimum of 1 foot above the screen in 2-inch wells. Filter gravel (size information not available) was used to fill the annular space in the pumping wells. A bentonite seal, made from bentonite pellets, was installed above the sand/gravel pack in all wells. The remaining annular space was filled to ground surface with a bentonite-cement slurry. All wells, except for MW-1, have a 4-inch protective outer casing with a 2 to 3 foot stick-up. MW-1's outer casing is flush mounted.

Shallow monitoring well borings were usually advanced until clay or silty clay (the aquitard) was encountered. The majority of shallow wells are completed in permeable materials (sands, gravels, sandy and silty gravels, silty sands, and sandy silts) just above the clay/silty clay unit. Exceptions to this include MW-7, -11, and -52. Portions of the screens in each of these wells intercept clay and/or silty clay units (see well construction sheets in Appendix E). Depth to the top of the shallow well screens range from 2 to 24 feet. Shallow well screens are 10 to 15 feet long.

Clay monitoring wells, installed to investigate the extent of contamination entering lower strata, are screened in the clay or silty clay unit, although in several cases it is possible that the screen is also partially in the upper aquifer. Screen depths range from 20 to 60 feet in these wells.

It is assumed that deep monitoring well borings were intended to advance through the clay and/or silty clay unit in order to set well screens and then monitor the more permeable materials comprising a lower aquifer beneath this unit. Well construction data sheets (Appendix E), however, indicate that many deep well screens are set in relatively fine-grained units (e.g., clays, silty clays, sandy clays) similar to those comprising the clay/silty clay aquitard. Deep well screen depths range from 64 to 110 feet. One deep well, MWD-46, was completed as a shallow well (screen set at 10 to 20 feet) because after being drilled 120 feet, the lower aquifer had still not been reached (over 100 feet of silty clay) (SMC Martin, 1987).

Two monitoring wells, MW-65 and MWD-66, were installed during Phase IIb of the Sinclair RI. MW-65, located along the northeastern perimeter of the landfill (see Figure 2-14), was installed to monitor shallow groundwater in this area because oil-stained soils were discovered at this location during soil investigations performed for the proposed dike adjacent to the landfill in 1988 (Bechtel, 1988). MW-65 was drilled using 4-1/4-inch I.D. hollow stem augers. This well is constructed of 2-inch flush joint 304 stainless steel screen and riser pipe. A 10-foot, 10-slot screen was set at 4.5 to 14.5 feet below ground surface to monitor shallow groundwater (screen intercepts the water table) at this location. Number 4 Q Rock (#1 sand equivalent) fills the annular space to approximately 1-1/2 feet above the screen. Above the sand, the annular space is filled with a 1-1/2-foot bentonite seal and bentonite-cement slurry to ground surface. A 4-inch I.D. surface casing was installed for well protection. A concrete pad was constructed around the surface casing to divert surface runoff away from the well. Special care was taken to insure the integrity of Phase IIb concrete pads, because concrete pads constructed around Phase I and Phase IIa wells were observed during the Phase IIb investigation to be cracked and in some cases weathered away.

MWD-66, located approximately 50 feet from MWD-47 in the northwestern portion of the refinery area, was installed as a replacement well for MWD-47, because this well could not be developed during Phase IIb groundwater sampling since it had been completed in a relatively impermeable clay. Attempts to redevelop MWD-47 to full capacity were aborted due to very low well yields. Development water from MWD-47 was still visibly turbid after approximately 46 gallons (about 2 well volumes in three days) were withdrawn from MWD-47. (See Section 2.6.2 for details on well development.) The well construction log for MWD-47 (see Appendix E) indicates that low yields are most likely the result of a screen set in fine-grained materials (approximately 9 feet of silty clay overlain by 1 foot of sandy clay). Therefore this well may never be developed to full capacity. MWD-47 was considered a critical well because it is the only deep well on site reporting elevated volatile contaminant levels.

Replacement well MWD-66 was completed as a double-cased well as a precaution against bringing down contaminants to greater depths during drilling (the boring log for MWD-47 reported petrochemical fumes and elevated HNu readings at 10-20 and 60-70 feet). Hollow stem augers (8-1/4-inch I.D.) were advanced below the zone of elevated HNu readings during the drilling of MWD-66 and until a substantial clay layer was encountered. Clay and silt were encountered at 64 to 74 feet in the borehole. HNu readings also dropped significantly at these depths. The upper portion of the borehole was isolated by pressure grouting a 6-inch O.D. PVC casing in place to a depth of 74 feet. A 3-inch roller bit (potable water used as drilling fluid) was then used to advance the borehole to a depth of 110 feet (the screen depth of MWD-47). Steel casing (4-inch O.D.) was advanced behind the roller bit.

Sampling at the 100- to 110-foot interval in MWD-66 confirmed the SMC Martin boring log, which indicates the presence of clay and silt at this depth. The anticipation of similar well development problems for MWD-66 if this well was screened in the same interval as MWD-47 resulted in a decision to screen the replacement well in sands and gravels encountered at 82.1-92.1 feet. Constructed in this way, MWD-66 fulfills the proposed objective of monitoring the lower aquifer (below the clay/silt unit encountered at 64 to 74 feet) in this area.

MWD-66 is constructed of 2-inch 304 stainless steel screen (20-slot) and riser pipe. Bentonite pellets were used to fill the borehole to approximately 1 foot below the screen depth. Annular space around the screen was filled with #4 Q Rock (#1 sand equivalent) to approximately 1-1/2 feet above the screen. This was followed by a cement-bentonite slurry to ground surface. A 4-inch O.D. steel casing was installed for well protection. The concrete pad installed around the outer casing was constructed as described for MW-65.

Attempts to obtain additional background data on shallow groundwater conditions by installing a third well off-site during Phase IIb were aborted when water-bearing layers were not encountered in the 9-1/2 feet of permeable materials overlying a more than 32.5-foot thick clay layer in this area (see Figure 2-13 for location AB-93).

The decommissioning of Phase IIa clay wells was also performed as part of the Phase IIb field effort. Clay wells were decommissioned because of their limited usefulness due to questionable construction (well construction data sheets suggest that some of the wells do not discretely monitor the clay bed, i.e., the bentonite seal is above the shallow aquifer/clay contact) and the potential for these wells to be pathways in which contaminants can move from the upper aquifer towards the lower. Of the 12 clay wells installed on and around the Sinclair site, 11 were decommissioned. MWCB-42, an off-site background well, was not decommissioned because it could not be located in the field.

The decommissioning procedure consisted of first grouting up the well screen and riser in place. Hollow stem augers were then used to free the screen and riser pipe so that it could be pulled out of the ground. Of the 11 wells decommissioned, 3 screens and risers (MWC-23, -24 and -41) could not to be pulled out of the ground; they were therefore grouted in place.

The OSTF bedrock wells (MWDB-1, -2, -3) were drilled with 6 1/4 inch I.D. hollow stem augers through the unconsolidated overburden, and then by the air rotary method through bedrock (3.875-inch borehole). The unconsolidated portion of the well was cased with 4-inch O.D. galvanized steel pipe. The bedrock portion of the well was completed as an open borehole. The last 8 to 10 feet of rock in each boring were cored with a 2.9-inch NX diamond core barrel. This portion of the borehole also remained open. The cores were reportedly used for lithologic and fracture trend determinations (SMC Martin, 1987).

2.6.2 Well Development

Phase I monitoring wells (MW-1 through MW-11) were developed by airlift pumping for approximately two hours per well. The Phase I RI report (SMC Martin, 1985) notes that wells were observed to be "relatively free of sediments following development." Phase IIa draft documents (SMC Martin, 1987) state that Phase IIa well development procedures were the same as those for Phase I. However, no specific information on water clarity is noted. Efforts to redevelop Phase IIa wells during the Phase IIb investigation suggest that it may not have been possible to develop all wells, especially clay wells, to clarity after only two hours of pumping.

The redevelopment of existing wells and the development of new wells took place during the Phase IIb investigation. Wells were developed by pumping with a centrifugal pump. Polyethylene tubing, dedicated to each well, was lowered to different depths within the screened interval to insure pumping and surging action along the entire length of the well screen. Surging was created by quickly moving the tubing up and down within the well. An attempt to develop all wells until the water was free of sand and silt-sized particles was aborted when most wells yielded turbid water after more than 100 well volumes were purged. All wells were developed for a minimum of four hours. Water from most wells at the end of development was reported as cloudy or turbid. Table 2-4 presents a summary of well development information.

It is unclear why the existing monitoring wells could not be redeveloped to clarity during the Phase IIb field effort. Possible explanations include inappropriate well screen size, inappropriate filter pack size, well screen breaching (gravel was observed to come out of some wells), or the presence of silt-size particles in most formations screened.

MWD-47, the only deep well slated for redevelopment and sampling, was developed by pumping and then bailing with a stainless steel bailer. Low yields from this well resulted in only 2.6 well volumes to be purged from this well over three days. Because MWD-47 could not be developed to satisfaction, a replacement well, MWD-66, was installed (see Section 2.6.1). MWD-66 was developed with a submersible bladder pump. Development water was observed to be clear after 4.5 hours (150 gallons) of pumping.

2.6.3 Well Sampling

Two rounds of groundwater samples were collected from Phase I wells (MW-1 through MW-11) during the Phase I investigation. Round 1 samples were collected from May 21 to 25, 1984. Round 2 samples were collected from July 9 to 12, 1984. Most samples were collected using a submersible stainless steel diaphragm pump with teflon tubing lowered to one foot above the bottom of the well. The pump was dismantled and decontaminated prior to sampling each well (SMC Martin, 1985). Decontamination involved rinsing with alconox, distilled water and acetone. Nitric acid was not used in the decontamination procedure (SMC Martin, 1985) even though groundwater samples collected were analyzed for metals. MW-3, -4 and -5 were sampled with a teflon or stainless steel bailer. The decontamination procedure for bailers was the same as for the pump (SMC Martin, 1985).

Approximately 3 well volumes were purged from each well prior to sampling. Samples were obtained directly from the teflon discharge line dedicated to each well, or from the bailer. Temperature, pH, Eh (oxidation reduction

TABLE 2-4

PHASE IIb WELL DEVELOPMENT RECORDS

Well No.	Approximate Well Volume (gals)	Volume Purged in gals. (# Well Vols)	Cumulative Hrs. Developed	Visual Observation at end of Development
MW-1	1.63	440 (269)	5.5	Cloudy, light brown
MW-3	2.23	118 (53)	7.5	Turbid; brown to clear
MW-7	1.91	335 (175)	4	Turbid when surged
MW-9	1.19	445 (374)	5.5	Slightly yellow
MW-10	1.84	224 (122)	5	Cloudy when agitated
MW-11	2.25	705 (313)	4	Turbid at pump start
MW-16	1.95	330 (169)	5	Cloudy at pump start, clears within 3 mins.
MW-25	2.15	580 (270)	4	Cloudy when continuously surged
MW-26	0.74	140 (190)	4	Turbid; light brown
MW-27	1.71	445 (260)	5	Cloudy
MW-28	2.62	1100 (420)	4	Very cloudy; light brown
MW-31	2.90	190 (65)	4	Turbid; light brown
MW-32	2.83	840 (295)	6.5	Gy-Bn (cloudy) at pump start, clears
MW-33	2.30	716 (312)	6	Clear
MW-34	1.64	280 (171)	6.5	Cloudy when surged but clears quickly
MW-35	1.03	38.5 (37)	5.5	Turbid
MW-36	2.85	610 (213)	6	Clear
MWDB-43	1.24	55 (44)	6	Turbid, brown
MWD-47	18.2	47 (2.6)	6	Cloudy*
MW-50	0.62	305 (492)	4	Green when surged
MW-51	0.70	435 (621)	4	Turbid, light brown
MW-52	1.13	16 (14)	4.5	Very turbid, dark grey
MW-53	0.80	198 (247)	6	Turbid, light brown
MW-54	0.31	38 (123)	4.5	Turbid, light brown; pebbles in well
MW-55	0.52	190 (369)	6	Cloudy
MWP-57	25.4	805 (32)	5.5	Cloudy
MW-63	2.62	810 (308)	4	Slightly cloudy
MW-65	1.29	53 (41)	13.5	Turbid, light brown
MW-66	15.49	150 (9.7)	4.5	Clear

* Well developed by pumping and bailing.

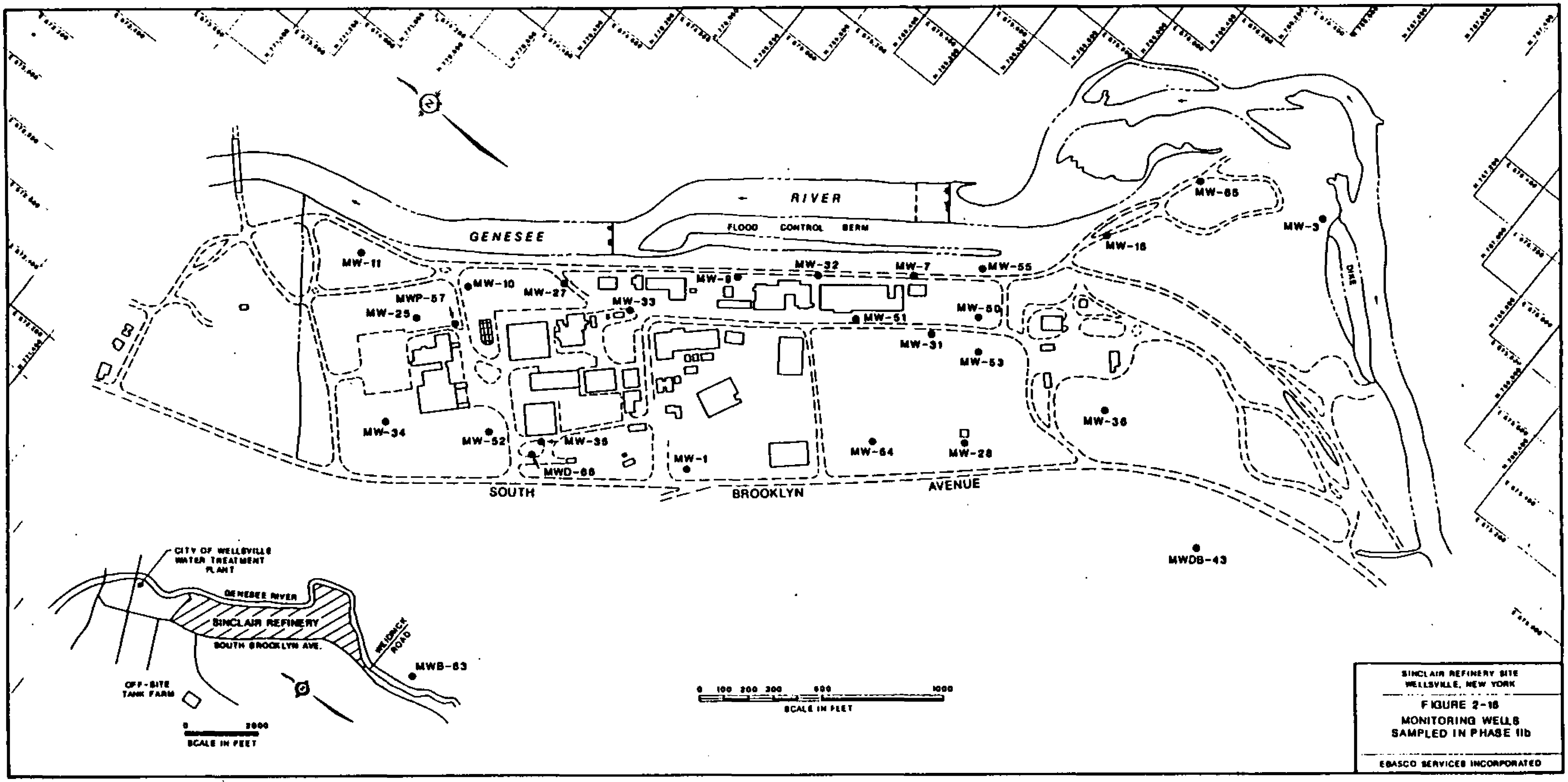
potential) and electrical conductivity measurements were made on each sample (SMC Martin, 1985).

Chemical analyses were performed by RECRA Research of Amherst, New York. Samples were analyzed for 129 priority pollutants plus xylene and methylethyl ketone, two compounds expected to be found on site. As a result of a library search run on 3 soil samples, 16 nonpriority pollutant compounds were added to the list of analytical parameters. The priority and nonpriority compound analyses performed on Phase I samples are presented in Appendix B.

Phase IIa groundwater sampling was performed on November 11, 1986, (upper aquifer and clay wells) and December 9, 1986 (deep wells). Sampling procedures reportedly remained consistent with those followed during Phase I sampling (SMC Martin, 1987). Phase IIa groundwater samples were analyzed for priority pollutants.

Twenty-five existing and two new monitoring wells (Figure 2-16) were sampled during the Phase IIb field investigation. These include 26 of the 39 shallow (upper aquifer) wells and MWD-66. Shallow wells MW-13, 19, 26 and 29 were not sampled due to well obstruction or damage. All samples were obtained with a stainless steel or teflon bailer suspended by teflon coated wire. Bailers and wires were decontaminated with alconox, potable water, acetone, nitric acid and distilled water between wells. A minimum of 3 well volumes was purged from each well prior to sampling. Field measurements of temperature, pH and specific conductivity were taken on each sample.

All samples, except those from MW-25, 34, 36, 51, 52, and 57, and MWD-66 were analyzed for EPA Target Compound List (TCL) parameters except pesticides, PCBs, cyanide and phenolics. The above samples were analyzed for TCL volatiles only, as specified in the POP (Ebasco, 1988). The EPA Target Compound List is presented in Appendix D.



SINCLAIR REFINERY SITE
WELLSVILLE, NEW YORK

FIGURE 2-16
MONITORING WELLS
SAMPLED IN PHASE IIb

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Because of the high turbidity of most groundwater samples collected during Phase IIb, an attempt was made to remove silt and sand-sized particles from duplicates of selected groundwater samples. Duplicate samples to be analyzed for metals were collected from MW-1, -3, -9, -10, -11, -27, -28, -31, -43, -53, -54 and -65 and were filtered in the field with 0.45-micron disposable filters. Additional duplicate samples from MW-10 and MW-53 were allowed time for settling and then the relatively silt-free liquid was decanted and analyzed for TCL BNAs. Additional duplicate samples from MW-7, -9, -10, -32 and -53 were centrifuged prior to decanting. Centrifuged samples were analyzed for TCL volatiles.

OSTF monitoring wells MWDB-1, 2, 3, were sampled during the Phase IIa investigation. Sampling procedures (bailers used) and analytical parameters remained consistent with Phase IIa refinery and landfill groundwater sampling (SMC Martin, 1987).

2.6.4 Hydrologic Testing

Two 72-hour pumping tests were conducted during the Phase IIa investigation at the Sinclair Refinery Site. MWP-56 and MWP-57 served as pumping wells (6-inch diameter) for tests conducted in the southern and northern portions of the site, respectively (see Figure 2-14 for pumping well locations). The pumping tests were conducted from February 19, 1987, through February 23, 1987, at MWP-56 and from March 4, 1987, through March 8, 1987, at MWP-57.

Phase IIa draft documents (1987) furnish only limited details on pumping test procedures. Step drawdown tests were conducted prior to the commencement of each pumping test in order to determine optimum pumping rates. MWP-56 was pumped at a rate of 50 gpm while MWP-57 was pumped at a rate of 10 gpm (SMC Martin, pumping test data packages). Monitoring wells in the vicinity of each pumping well were used as observation wells during the pumping and recovery stages of the tests. Test results were used to calculate transmissivity, specific yield and hydraulic conductivity values.

In situ permeability (short-term displacement slug) tests were reportedly performed on each monitoring well during Phase I and Phase IIa of the RI. In Phase I tests, a sealed galvanized cylindrical displacer (1.75 inches or 1.5

inches in diameter, 5-inch length) was used to displace a known volume of water within each well. No water was added or removed from the well. Short-term displacement levels were recorded with a pressure transducer (In situ model SE-1000) that was placed near the bottom of each well (measurements are accurate to within 0.01 feet). Ten measurements were taken in the first 2 seconds of the test and then less frequently for a total duration of 10 minutes per test. Both drawdown (displacer placed in well) and recovery (displacer pulled from well) tests were run at each monitoring well in order to obtain a range of permeability values (SMC Martin, 1985).

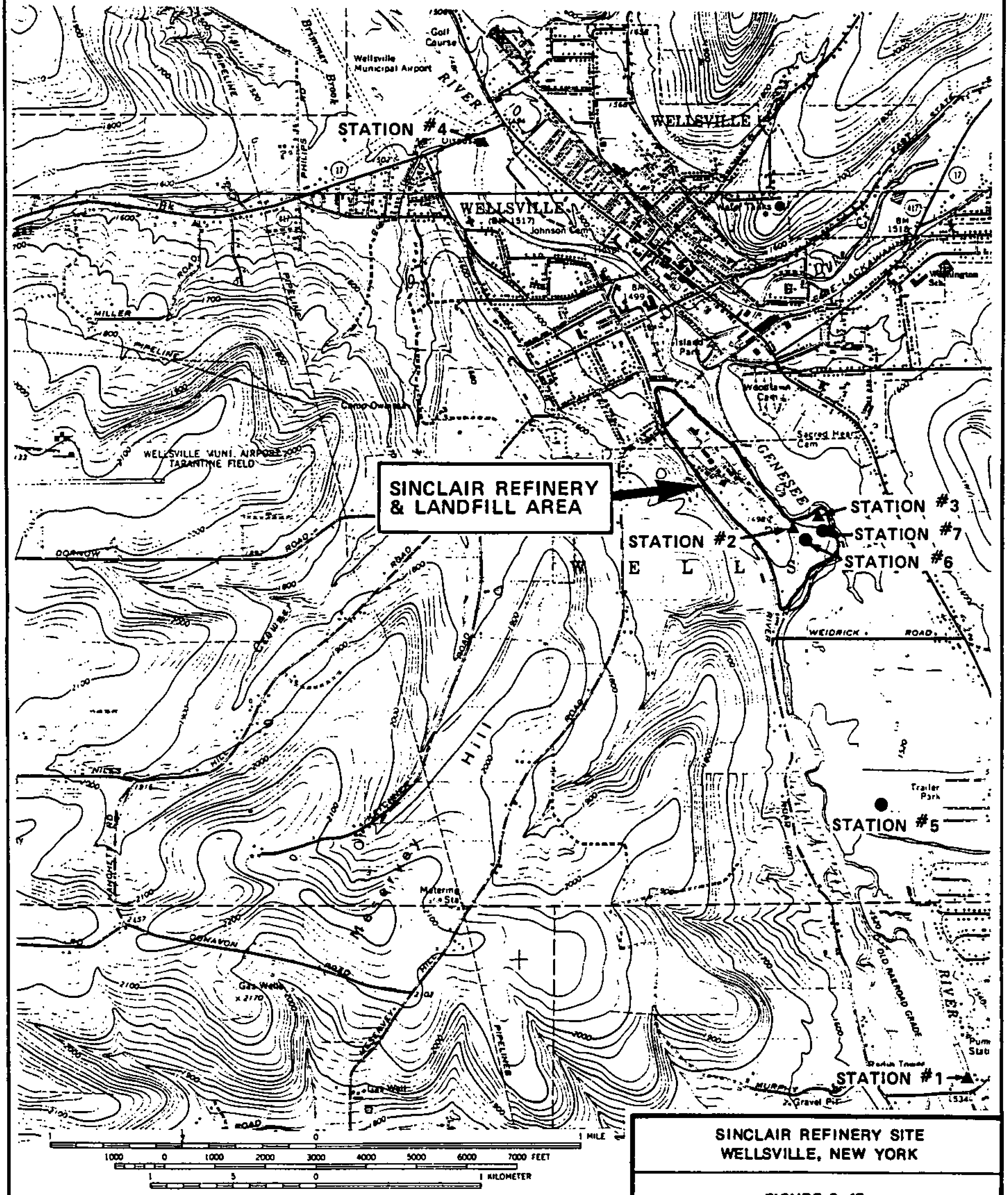
Details of Phase IIa in situ permeability tests are unavailable. Phase IIa test procedures were most likely consistent with those described above for Phase I.

Infiltration tests were also a part of the Phase IIa investigation. Five field infiltration tests were conducted in the refinery area in order to determine infiltration rates of cover materials in this area. The ASTM Double Ring Infiltration Method was used, utilizing a 20-inch high double ring infiltrometer (12-inch diameter inner ring and 24-inch diameter outer ring). Test durations ranged from 5.6 to 7.5 hours. Evaporation and precipitation control drums were maintained on site as a control measure during testing (SMC Martin, 1985).

2.7 BIOTIC SAMPLING

Biotic sampling was conducted at the Sinclair Refinery Site by representatives of Michael Baker, Jr. of New York, Inc. (New York, New York) and Aquatic Systems Corporation (Pittsburgh, Pennsylvania), working for SMC Martin. All field work was completed during July 1984.

Fish, aquatic macroinvertebrates and small terrestrial mammals were sampled. Figure 2-17 shows the locations of the aquatic and terrestrial sampling stations. The on-site stations were in the landfill area, but are included in the RI report for completeness.



SINCLAIR REFINERY SITE
WELLSVILLE, NEW YORK

FIGURE 2–17
PHASE I
BIOLOGICAL SURVEY
SAMPLING LOCATIONS

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LEGEND

▲ AQUATIC STATIONS

● TERRESTRIAL STATIONS

Fish were electroshocked and netted at three sampling stations (#1, #3, and #4). Station #3 was adjacent to the refinery site, while stations #1 and #4 were located two to two and one-half river miles upstream and one to one and one-half river miles downstream, respectively. Aquatic macroinvertebrates were collected using a Turber sampler at the three aforementioned stations, as well as station #2, a swale draining the refinery site. Small mammals were collected at three stations (#5, #6, and #7) using Victor snap-type mouse traps set in grids. Station #5 was located about one to one and one-half miles southeast of the refinery site, and was comprised of two 24-trap grids. One of the two grids was situated in an oil field area, and the other in an adjacent forest land. Station #6, located in an upland area of the refinery site, also was comprised of two 24-trap grids, each with traps set at approximately 10-meter intervals. Finally, station #7, also located on site, was an old field bordered by woodlands.

Specimens were grouped according to station and taxonomic classification. Taxa and station-specific lots were homogenized in an electric blender with a stainless steel blending assembly and standard borosilicate glass jar. Because of their small size, the fish samples were not filleted as planned. Instead they were homogenized whole, as were the other aquatic and terrestrial specimens. The jar decontamination procedure followed prior to blending is outlined by the following steps:

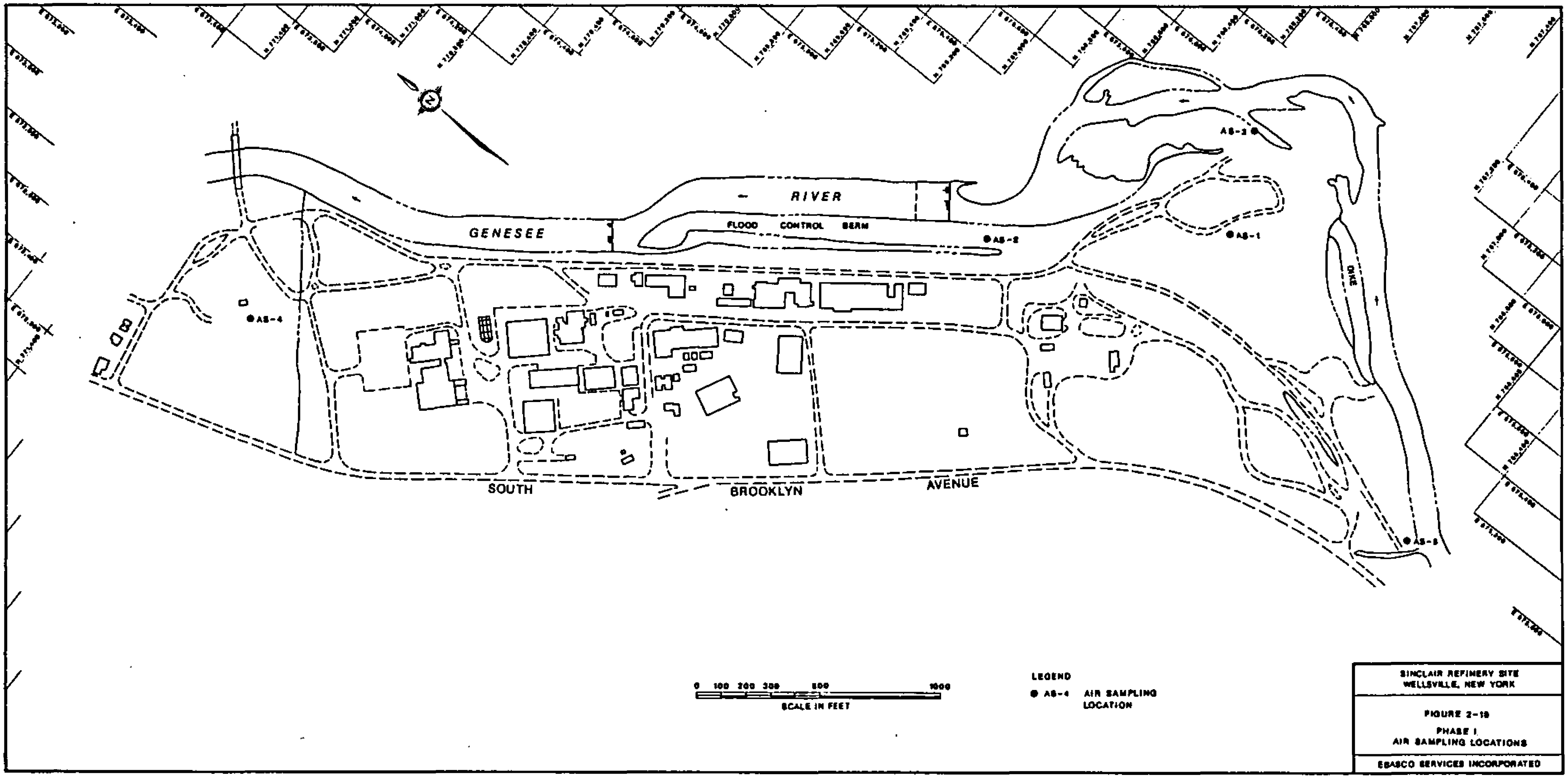
1. Washing with phosphate-free detergent and hot water
2. Rinsing with tap water
3. Rinsing with distilled water
4. Rinsing with acetone
5. Rinsing with hexane
6. Air drying

Dry ice was not used in the blending procedures, to avoid chemical transformations induced by CO_2 release during sublimation, and the resulting pH depression. Jars containing samples were delivered on dry ice to RECRA Research Labs (Amherst, New York), where they were analyzed for 61 priority pollutants.

2.8 AIR QUALITY INVESTIGATIONS

To evaluate the potential of volatile emissions from the site into the air, a series of air samples were collected by SMC Martin in Phase I. The samples were taken as four-hour composites from five locations around the site (Figure 2-18). The samples were obtained over a two-day period (07/13/84-07/14/84) using MSA Model C-210 portable air sampling pumps. These pumps provide a constant flow of sample through detector tubes and a means of determining total sample volume through adsorption tubes by automatically integrating the flow. They draw ambient air through sampling tubes, which have flow resistances of up to two inches of water, depending on the flow rates between 5 and 200 mL/min (SMC Martin, 1985).

Individual sample pumps were reportedly placed four to six feet above the ground surface on stakes or attached to small trees at a similar height. This sampling was performed during a period of warm, dry, sunny and slightly breezy weather (SMC Martin, 1985).



SINCLAIR REFINERY SITE
WELLSVILLE, NEW YORK

FIGURE 2-19

PHASE I
AIR SAMPLING LOCATIONS

EBASCO SERVICES INCORPORATED

3.0 PHYSICAL CHARACTERISTICS OF THE STUDY AREA

3.1 SURFACE FEATURES, STRUCTURES AND FACILITIES

The remedial investigation resulted in the characterization of several former refinery facilities on the site, including the sewer systems and oil separators. Information on the location of some past structures at the site and on site topography was also obtained.

3.1.1 Topography

The refinery area is characterized by generally flat land sloping gently towards the Genesee River on the eastern side of the site. The area is at an elevation of approximately 1,500 feet mean sea level (MSL). On the western boundary of the site, the elevation of the land surface rises rather steeply up a large hill. The former Off-Site Tank Farm (OSTF) is located on the hill. Near the north boundary of the site, a shallow drainage swale runs perpendicular to the Genesee River.

The former OSTF area is on a sloping area on the hill west of the site at an elevation of approximately 1,650 feet MSL. The OSTF is bisected by a small intermittent stream channel, which flows towards the refinery site. The stream flows to the drainage swale along the north end of the refinery. Several earthen berms up to approximately 15 feet high are present on the OSTF surrounding the locations of the former oil storage tanks (the tanks have been removed). There are several small pools of standing water or wet areas within the area of the berms.

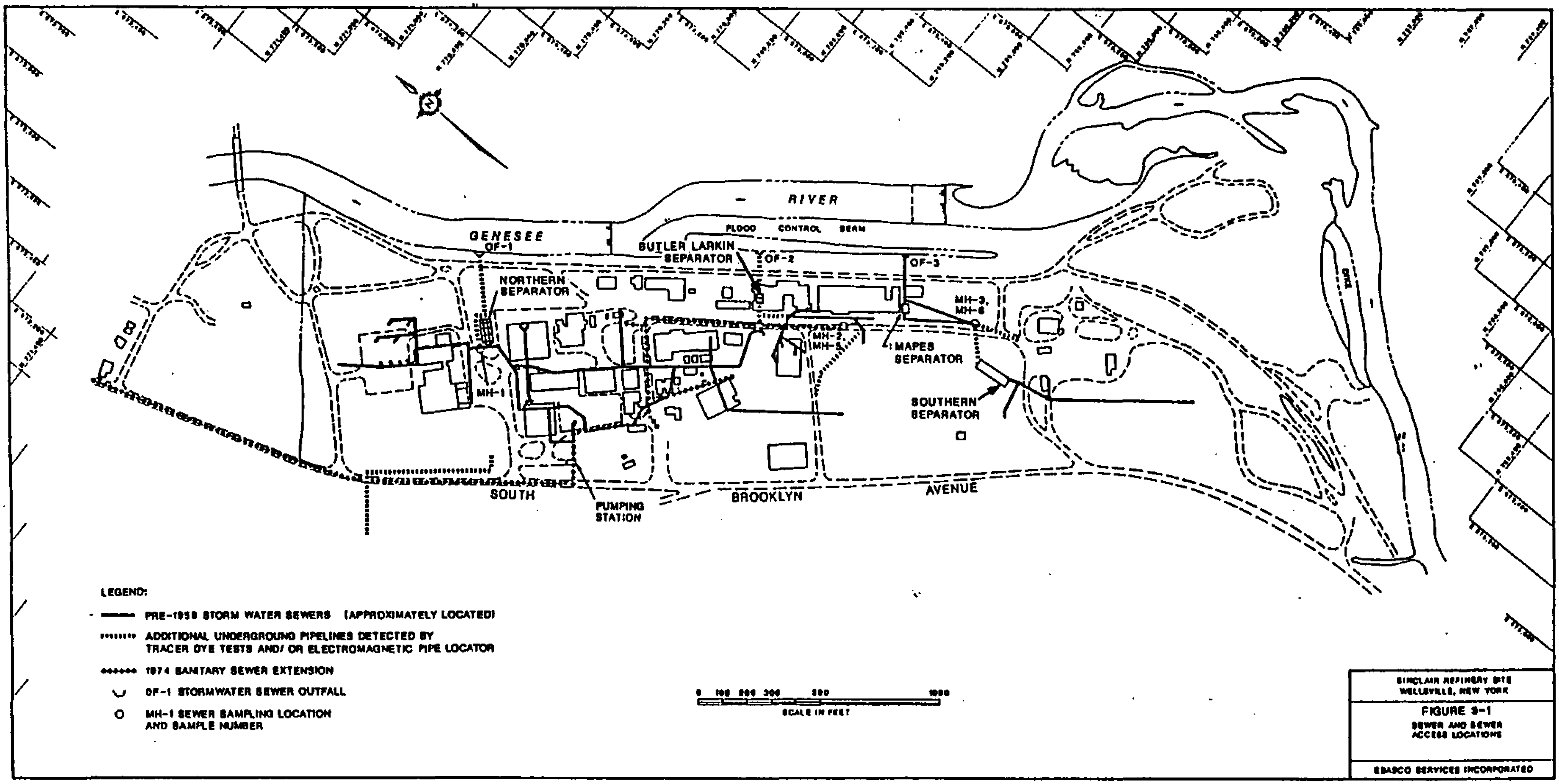
3.1.2 Sewer Systems and Separators

Based on the records search, it was possible to develop site plan drawings showing the locations of various refinery storm water systems and some related structures (i.e., the oil-water separators). The system, still used to collect storm water on the site, appears to consist of three subsystems draining to the Genesee River. The system is also used to collect runoff from steam cleaning at an automotive shop at the SUNY campus. Some of the oil-water separators were also determined to be directly connected to the storm water systems. The results of the characterization of the sewer system are described below. Figure 3-1 provides a map showing the extent of the sewer system.

3.1.2.1 Dye Test Results

The four dye tests in Phase IIa showed the relationships between some of the sewers and separators and the three outfalls along the main drainage swale and the Genesee River. During the first two tests, the dye was placed directly into the northern separator and the separator on the property of Mapes. Dye was "immediately" (the SMC Martin, 1987 draft report does not provide an exact length of time) noticed discharging from outfalls OF-1 and OF-3 (Figure 3-1). OF-1 is connected to the northern separator and OF-3 to the separator on the Mapes property, as well as to the southern separator.

In the second test, dye was placed in manholes MH-2 (Figure 3-1) and MH-4. The dye from MH-2 was "immediately" observed in Outfall 2 (OF-2). This test showed that three storm drain systems are present on the site. The test involving MH-4 indicated that a storm drain on the Mapes property is connected to the separator (the former barrel house separator) on the same property. (Note: SMC Martin Draft maps did not show location MH-4, but it was described in the draft report.) However, in this test, immediate results were not detected due to lower flows in the drain. The dye placed in MH-4 was not detected in the separator for two days. At that time, some dye was still visible in the storm drain where it had originally been placed. This led SMC Martin to conclude that 1) flow into the storm drain is limited, such that water moves slowly through the portion of the drain near MH-4, or 2) there is a blockage of the storm drain between the manhole and the southern separator that limits flow. The first theory appeared more reasonable to both SMC Martin (1987) and Ebasco, since SMC Martin noticed that the water level in the storm drain did not noticeably change between dry and storm conditions. It was also noted that various types of debris, including oily sediment, were present. It is possible that the storm drain is blocked before it reaches MH-4, limiting flow in the drain.



SINCLAIR REFINERY SITE
WELLSVILLE, NEW YORK

FIGURE 3-1
SEWER AND SEWER ACCESS LOCATIONS

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3.1.2.2 Characterization of Storm Water Drainage System

Based on observations made during the sampling of the manholes, it was possible to obtain information on the physical characteristics of the pipes used in the storm water system. SMC Martin observed that the pipes were made of steel with a diameter of 12 to 18 inches. The pipes also contained oily sediment.

The storm water drainage system appears to have been used primarily to direct site surface runoff to the oil-water separators. Oil contained in the runoff could then be removed, prior to discharge of the water to the river.

The storm water sewer system consists of three separate systems that serve the northern, central and southern portions of the refinery site. The north end of the refinery is drained to the northern separator basin, with effluent from the separator discharging directly into the Genesee River at OF-1. The central section includes most of the area now occupied by Mapes Woodworking and Butler Larkin Inc. All of this area discharges wastewater into the main drainage swale at OF-2. This water at one time apparently passed through a separator, which based on current and former site maps was located beneath or adjacent to one of the Butler-Larkin office buildings. It was not determined if the separator still exists.

A third storm drain system serves the entire southern end of the refinery and includes the southern separator. A second smaller separator (the former barrel house separator) is shown on drawings of the site in the area currently occupied by Mapes Woodworking, near their drum storage area where the dye test was performed. Both these separators discharge to OF-3.

3.1.2.3 Sanitary Sewer

A sanitary sewer system is also present on the site. This was installed in 1974 (SMC Martin, 1987). The location of the system is shown on Figure 3-1. The system drains to a pumping station adjacent to one of the SUNY buildings on the northwestern side of the site, which routinely discharges to the Wellsville Sewage Treatment Plant. The underground pipes in this system were essentially free of sediment.

3.1.3 Tetraethyl Lead Sludge Pits

Site records reviewed showed that, during operation of the Sinclair Refinery, tetraethyl lead sludge was temporarily buried in pits approximately six feet deep. The sludges were then oxidized or burned to change the lead to a less mobile form, lead oxide. The burned sludges were then removed from the pits and buried within the landfill. The DuPont Company supervised the burning and reburial of the sludge. Site records indicate that the original burial area was considered by DuPont to have been decontaminated (Sinclair, 1961). The original sludge burial pit areas are shown on Figure 3-2.

3.1.4 Post Refinery Tank Farm

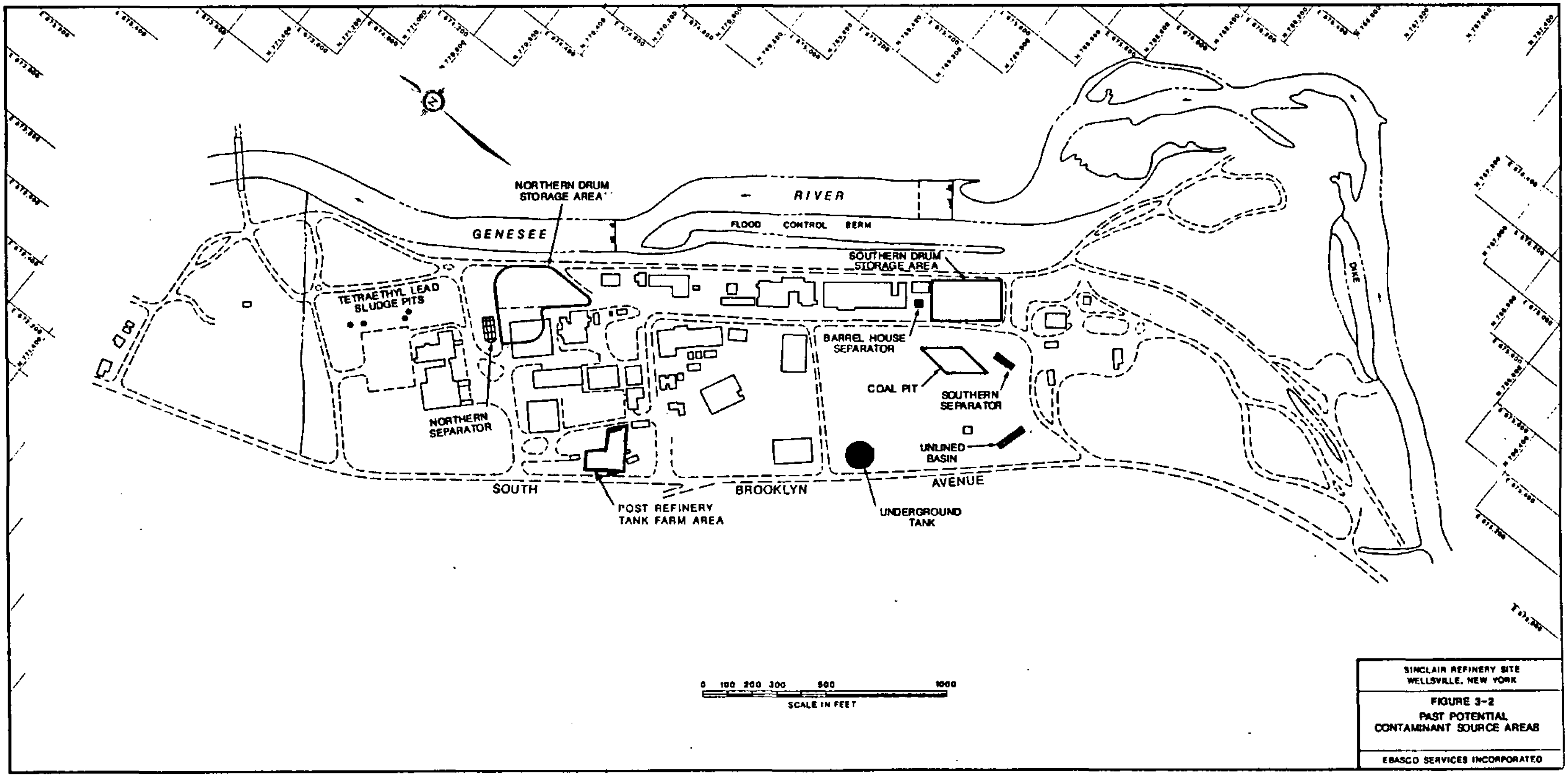
Photographs and topographic maps of the site show that between four and eight aboveground storage tanks were constructed on the site, after the refinery closed. These were apparently used to store oil or gasoline. Photographs show the tanks to be present on the site as late as 1982 but since SMC Martin did not identify them as a possible contaminant source, they were probably removed by 1985. The post refinery tank farm area is shown on Figure 3-2.

3.1.5 Other Source Areas

The SMC Martin Phase I RI report identified several potential source areas on the site. During Phase II little additional information regarding these sources was obtained. Each of the sources is shown on Figure 3-2 and briefly described below.

3.1.5.1 Propane Storage Tank

An alleged former underground storage tank was identified in Phase I as a possible source of contamination, apparently based on a review of aerial photographs. During the Phase II review of site maps, it was hypothesised that if the tank existed it was a former propane tank used to store fuel for a flare at that location. The geophysical survey detected an electromagnetic



SINCLAIR REFINERY SITE
WELLSVILLE, NEW YORK

FIGURE 3-2
PAST POTENTIAL
CONTAMINANT SOURCE AREAS

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low at this location. This could be indicative of clean fill placed after the tank was removed or the presence of an electrically nonconducting object at this location. Based on the limited data, it is not possible to determine if the tank, if it ever existed, has been removed; but the EM survey's "low" (Figure 3-3) tends to indicate that if it existed, it has been removed.

3.1.5.2 Coal Pit

It is unusual to store coal in pits where water can accumulate because coal, if very wet, does not burn well. It is more likely that the coal would be stored in a pile. The basis for identification of the pits was not provided in the prior Phase I and IIa reports.

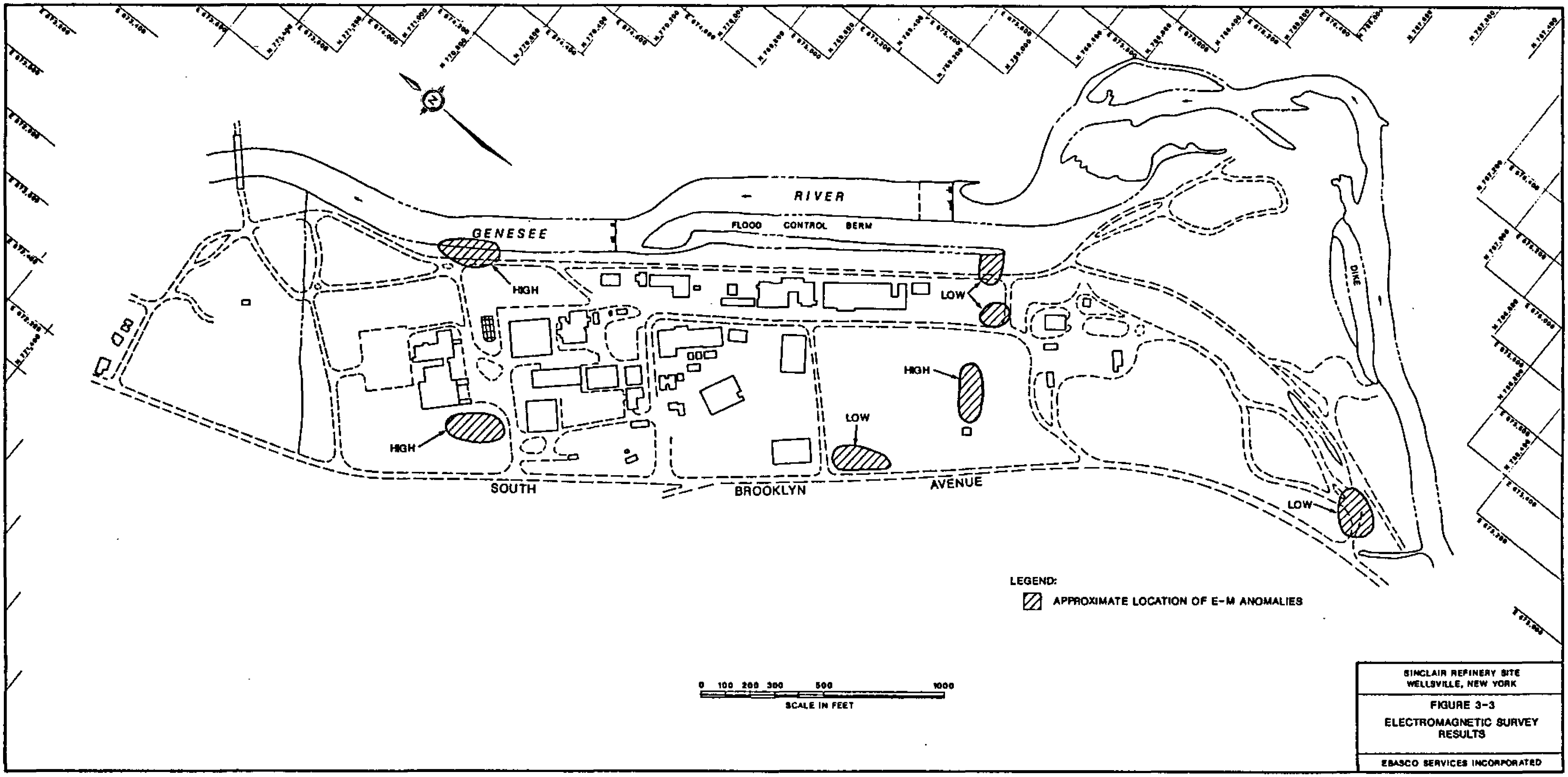
The trenching of test pit TP-34 for the southern separator was performed in the vicinity of the coal pit identified in Phase I. Several pieces of coal were observed in the area indicating that coal was stored in this area. However, no subsurface features indicating the presence of remaining volumes of coal or an old pit were detected.

3.1.5.3 Unlined Basin

No data on the past use of the unlined basin were obtained during Phase I or II.

3.1.5.4 North Drum Storage Area

An aerial photograph from 1974, 16 years after refinery operations had ceased, shows an area near the northern oil separator being used as a drum storage area. The company using the drums and the content of the drums could not be identified from site records. Photographs prior to 1974, from 1964 and 1970 do not show drums stored in this area. Similarly, a photograph taken in 1984 no longer shows the drums to be present in this area and no drums were observed during the Phase IIb field investigation. Soil staining was also observed near the drums in this area in the 1974 photo. This staining was not observed during the field investigation, probably because the area is currently used as a gravel covered parking area. According to maintenance personnel at SUNY, this area was first covered by gravel for use as a parking lot between 1983-1984.



SINCLAIR REFINERY SITE
WELLSVILLE, NEW YORK

FIGURE 3-3

ELECTROMAGNETIC SURVEY RESULTS

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3.1.5.5 South Drum Storage Area

Another potential source identified in the Phase I RI was a second drum storage area. The Phase I report states that the area was used as an open storage area for horizontal tanks and drums in 1964. This area, on the property owned by Mapes, is still used to store 55 gallon drums. This is also an area of Mapes' alleged dumping of hazardous materials in 1983 (People vs. Mapes, 1983).

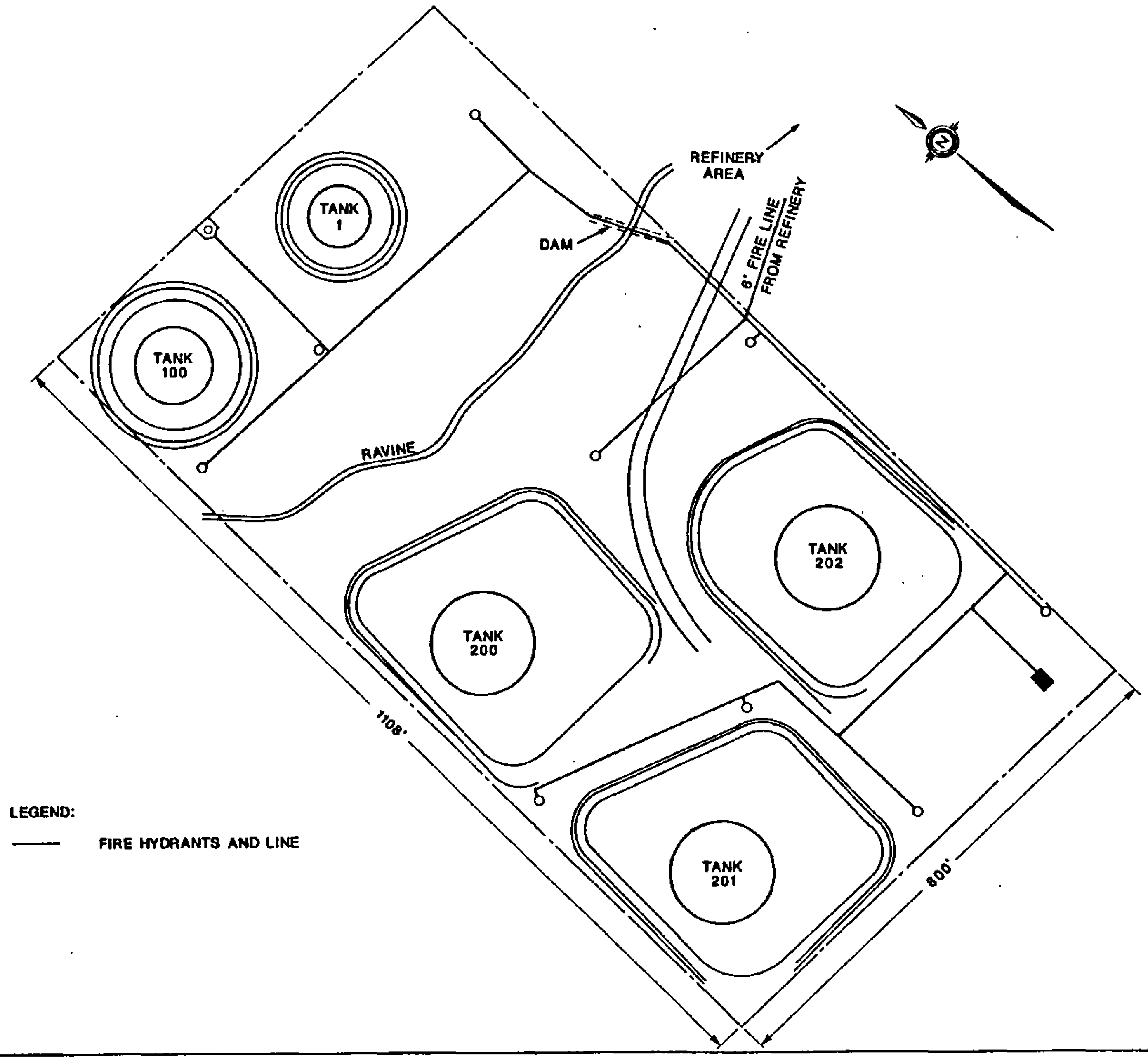
3.1.6 Off-Site Tank Farm (OSTF)

A map showing the locations of the five tanks in the OSTF was found during the site records search. The map indicated that a 6-inch line used for fire control connected the OSTF and the refinery. No maps showing the presence of an oil line in the same area were found. Figure 3-4 shows the layout of the OSTF.

3.2 CLIMATOLOGY

The climate of New York, including the climate at Wellsville, is moist continental, with abundant rainfall throughout the year. The area has warm, humid summers, and occasional outbreaks of arctic air during the winter. New York is divided into ten climatic divisions based on terrain and its proximity to major water bodies. Wellsville is in the Western Plateau division. This area consists of the generally hilly terrain of the Appalachian Mountains.

Thirty years of meteorological data are considered to be representative of the prevailing climatic conditions of a site. Temperature and precipitation data are available for the Western Plateau division for the period 1941-1970 in divisional averages (U.S. Department of Commerce, 1973); these averages are the simple arithmetic mean of data for all stations in the division. Divisional average data are summarized in Table 3-1. As shown in the table, the average daily temperature for the climatic division ranges from a low of 23.1°F in January to a high of 68.1°F in July. Precipitation as shown is fairly evenly distributed throughout the year, with approximately 3 inches of rain per month. Slightly more is expected in the summer months due to thundershower activity and slightly less is expected in the winter months.



SINCLAIR REFINERY SITE
WELLSVILLE, NEW YORK

FIGURE 3-4

OFF-SITE
TANK FARM

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TABLE 3-1

WESTERN PLATEAU
DIVISIONAL AVERAGES (1941-1970)

	Temperature (°F)	Precipitation (Inches)
Jan	23.1	2.30
Feb	24.0	2.18
Mar	32.4	2.89
Apr	45.0	3.33
May	55.2	3.79
Jun	64.4	3.65
Jul	68.1	3.78
Aug	66.3	3.28
Sep	59.9	3.12
Oct	50.0	2.91
Nov	38.4	3.34
Dec	26.5	2.70

Monthly totals range from 2.18 inches in February to 3.79 inches in May. Annual precipitation averages 37.3 inches for the 30-year period. Annual snowfall amounts vary from year to year but may be as high as 60 inches. Snowfall event totals may exceed 20 inches (U.S. Department of Commerce, 1982).

Generally more detailed weather information is collected at stations located at airports. There are no such stations in the Western Plateau division. The nearest airports are Buffalo, Rochester and Binghamton. Buffalo and Rochester are located along the Great Lakes and the meteorological conditions at those two locations are influenced by this proximity. Binghamton is located in the Eastern Plateau division. The meteorological patterns at this site do not differ much from those of the Western Plateau (U.S. Department of Commerce, 1973; U.S. Department of Commerce, 1982). Information on prevailing winds at Binghamton is available for the period 1952-1981 (U.S. Department of Commerce, 1982). These data are summarized in Table 3-2. The prevailing wind direction is west-southwest, with an overall mean wind speed of 10.3 mph.

For the same period of record, at Binghamton, New York, detailed temperature information is available, which helps to identify the number of freeze-thaw cycles (U.S. Department of Commerce, 1982). For the period 1952-1981 there was an average of 147 days per year with minimum temperatures of 32°F or lower. There was an average of 67 days per year with maximum temperatures of 32°F or lower. Therefore, during an average of 80 days per year, the temperature ranged from below freezing to above freezing, a freeze-thaw cycle.

3.3 SURFACE WATER AND RIVER SEDIMENTS

3.3.1 Surface Water Hydrology

The surface hydrology of the Sinclair Refinery Site in Wellsville, New York, is dominated by the Genesee River. The river flows northwest through the Southwestern Plateau and the Erie-Ontario Plain physiographic provinces before entering Lake Ontario at Rochester. The hydrology of the Wellsville area as a whole is also impacted by Dyke Creek, which enters the Genesee River from the east downstream of the refinery.

TABLE 3-2

BINGHAMTON, NY
WIND DATA SUMMARY (1952-1981)

	Mean Speed (mph)	Prevailing Direction
Jan	11.7	WSW
Feb	11.8	SSE
Mar	11.8	NW
Apr	11.5	WNW
May	10.1	NNW
Jun	9.2	NNW
Jul	8.4	WSW
Aug	8.3	SSW
Sep	8.8	SSW
Oct	9.8	WSW
Nov	10.9	NNW
Dec	11.4	WSW
Overall Mean	10.3	WSW

According to the available flow measurement data collected at the gauging station downstream of the Genesee-Dyke Creek juncture from 1980 to 1986, the mean daily flow was 355 cubic feet per second (cfs). The minimum during that period ranged from 21 to 28 cfs with a mean of 24 cfs. The minimum occurred uniformly between September 13 and October 13. The maximum flows were far more variable in timing and ranged from 3,220 cfs in 1983 to 15,800 cfs in 1981.

The peak flow on record of 38,500 cfs occurred in 1972, when a tropical storm soaked the area for five days. Extensive flooding during this period prompted construction of a variety of engineering projects on the Genesee River by the Army Corps of Engineers. These included channelization, bank stabilization, and diversion, in addition to the construction of check dams. In 1983, a dike was built near the southern boundary of the west bank to prevent further erosion of the refinery landfill.

On the Sinclair Refinery site, surface hydrology is impacted by local features. A drainage swale currently runs parallel to the river between the refinery and a dike. The dike was constructed on a former island in the river and the swale was part of the river channel before the dike was constructed. Any surface runoff from the southern or central part of the site that is not diverted by the storm sewer system on site enters the swale prior to discharge. This swale, referred to as the "main drainage swale", is a slow-flowing, low-lying marshy area. A smaller swale, the northern swale, runs perpendicular to the river on the northeastern side of the site (SMC Martin, 1985).

Surface water at the OSTF is either contained within the soil berms that formerly surrounded the oil storage tanks or runs off to an intermittent stream that crosses the OSTF. This stream drains to the drainage swale along the northeastern boundary of the refinery site. Ponded water was present within several of the bermed areas in the OSTF, but it is not known if these small areas are present throughout the year, or only during wet periods.

3.3.2 Sediments

Sediments in the Genesee River near the Sinclair Refinery Site generally consist of sand and gravels with some silt and clay. Grain size analyses of the sediment samples collected by Ebasco showed that they contain approximately 50 percent gravel and 50 percent sand. However, many of the larger pieces of gravel and all of the cobbles were removed from the samples prior to shipment to the laboratory. Hence the resulting measured percentage of gravel is probably much lower than is actually present. The grain size analyses of the river sediment samples (RS-15, 16 and 17) are presented in Appendix F.

Total organic carbon (TOC) measurements on stream sediments showed that they contain between 0.1 and 0.2% (1000 to 2000 ppm) organic carbon. The results of the analyses are shown on Table 3-3.

The river adjacent to the site is currently mined as a source of aggregate for construction purposes. The quantity of material removed annually from the river was not determined, but active mining was observed on several days during the Phase IIb field investigation.

3.4 GEOLOGY

3.4.1 General Geology

The Sinclair Refinery Site is situated in the Allegheny Plateau region of the Appalachian Uplands Province. This is a naturally dissected region characterized by a deeply incised dendritic drainage pattern forming broad, flat discontinuous ridges. Sandstones, shales and conglomerates of Devonian and Upper Mississippian age comprise the bedrock units in this region. Bedrock is found near the surface on the ridges and at depths up to 300 feet in the valleys.

Gravels, sands, silts and clays comprise the unconsolidated deposits that overlie bedrock. These deposits are glacial (Pleistocene age) and fluvial (Holocene age) in origin. Glaciolacustrine clay makes up the majority of glacial material in the area, although interbedded tills and glacial sands have also been observed. Fluvial sediments, comprised of channel and overbank deposits associated with the meandering Genesee River, overlie the glacial materials.

TABLE 3-3

TOTAL ORGANIC CARBON CONTENT IN REFINERY AREA SOILS

SAMPLE NUMBER	DEPTH	TYPE	TOTAL ORGANIC CARBON (ppm)
RS15-01	0-6"	River Sediment	1,390
RS16-01	0-6"	River Sediment	1,560
RS16-01D	0-6"	River Sediment	1,250
RS17-01	0-6"	River Sediment	1,680
AB52-03	8-10'	Auger Boring	8,550
AB56-01	0-6"	Auger Boring	57,900
AB56-02	2-4'	Auger Boring	8,520
AB56-03	8-10'	Auger Boring	5,440
AB66-01	0-6"	Auger Boring (Swale)	17,900
AB66-01D	0-6"	Auger Boring (Swale)	17,600
AB67-01	0-6"	Auger Boring (Swale)	14,300
AB68-01	0-6"	Auger Boring (Swale)	14,100
AB94-03	8-10'	Auger Boring	4,240

The Wellsville area (Allegany County) is a prominent oil and gas producing region of New York State. The Wellsville South, New York Quadrangle Map shows numerous oil fields south of the Sinclair site. Locally, Otis Eastern Corporation has drilled two gas wells on and adjacent to the site. Well T-1 is located in the southern portion of the site (Otis Eastern property) along South Brooklyn Avenue. This well was drilled to a depth of 1,350 feet into bedrock. T-2, the off-site well, is located in the vicinity of the Wellsville school bus garage (west side of South Brooklyn Avenue, adjacent to the southern portion of the site). Drilling logs of T-2 indicate a total depth of 1,471 feet, with gas encountered at 1,156 feet. Initial gas production of T-2 was 25,000 mcf/day. Presently T-2 is not a producing well.

3.4.2 Site Geology

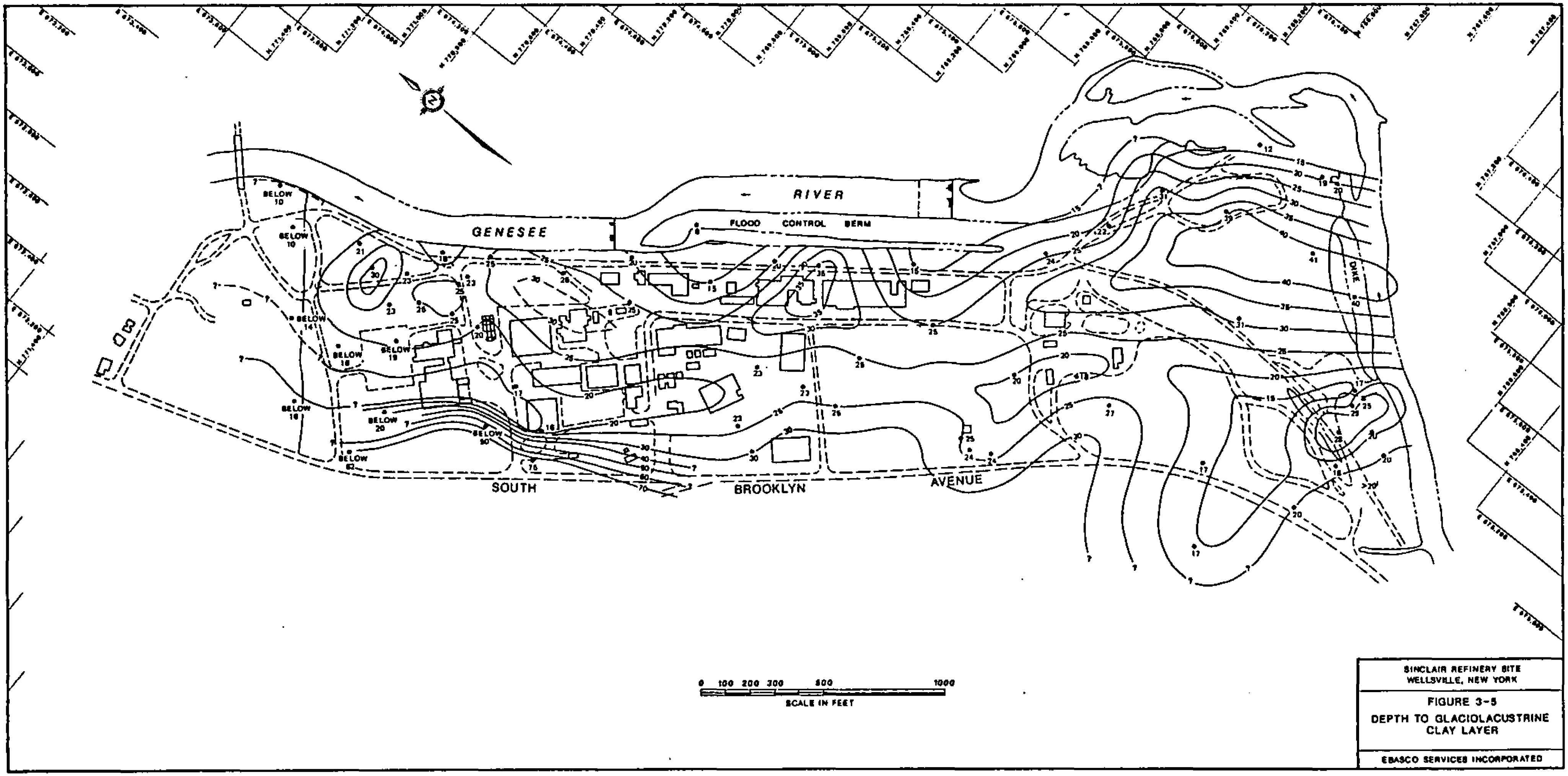
The characterization of subsurface stratigraphy at the Sinclair Refinery Site is based on data obtained from the drilling of auger borings and monitoring wells, and geophysical surveying during Phase I and Phase II of the Remedial Investigation. Boring logs for auger borings and monitoring well borings are presented in Appendix E.

The unconsolidated deposits beneath the site are highly variable, composed of sands, silts, clays, gravel and fill (SMC Martin, 1985). The fill material is made up predominately of silty sands, sandy clays and gravels. It is mixed in places with slag, concrete and construction debris and is found primarily within the central portion of the site. Thicknesses are highly variable, ranging from 0.5 to 8 feet, where present. The fill was apparently emplaced in various locations on site for grading purposes. Fill appears to be generally absent in the northern and southern portions of the site, though local areas of fill are present. It is often difficult to distinguish fill from natural soils, particularly if they are similar in their physical properties. In several cases fill soils were identifiable only because clay, concrete or construction debris had been mixed with the fill.

The uppermost natural soils are fluvial in origin. These soils have been classified as well-sorted and gravelly sands (SW), sandy gravels (GW), silty sands (SM) and sandy silts (ML) (SMC Martin, 1985). Clay and gravel lenses, tens to hundreds of feet in horizontal extent, are associated with these deposits. A near-surface clay layer, approximately 5 feet thick, is found more consistently within the upper 10 feet of soils in the northwestern portion of the site. The variable distribution of soils observed on site (i.e., discontinuous lenses) is characteristic of the erosional and depositional processes associated with the dynamics of a meandering river. In general, fluvial deposits range in thickness from 15 to 30 feet across the site.

Glacial sediments lie below the fluvial deposits. While the exact boundary between glacial and fluvial sediments is difficult to distinguish in the field, the top of a prominent clay bed believed to be a glaciolacustrine deposit marks the lower boundary of the fluvial sediments. A contour map of the depth to clay/silty clay is presented on Figure 3-5. In general, the contact of the clay is found at depths between 15 and 30 feet across the site. The clay bed varies between a high plasticity clay (CH) and a sandy or silty, low plasticity clay (CL) (SMC Martin, 1985). The thickness of the clay appears to vary, but is known only at a few locations across the site, as few borings have penetrated its entire thickness. Borings that penetrated the entire thickness of clay are deep monitoring well borings MWD-42, 47, 49 and 66, shown on Figure 3-6. Five other deep wells (MWD-43, 44, 45, 46 and 48) did not penetrate through the clay layer. Fifty feet of clay were encountered during the drilling of MWD-49, located in the southwestern portion of the site along South Brooklyn Avenue (see Figure 3-6). MWD-49 encountered gravel, sand and silt below the clay. MWD-46 and MW-10, located downgradient of the northern oil separator, encountered more than 100 feet and 56 feet of clay, respectively (SMC Martin, 1986). These two borings were terminated before the entire thickness of the clay unit was determined.

In the northwestern portion of the site, the upper contact of clay appears to be at much greater depths. AB-25 was drilled to a depth of 50 feet without encountering any clay. MWD-47 and MWD-66, just southwest of AB-25, encountered relatively thin (10 to 15 foot) clay beds at depths of 64 and 75 feet, respectively. Just to the east, however, MW-35 encountered over 10 feet of clay at



SINCLAIR REFINERY SITE
WELLSVILLE, NEW YORK

FIGURE 3-5

DEPTH TO GLACIOLACUSTRINE CLAY LAYER

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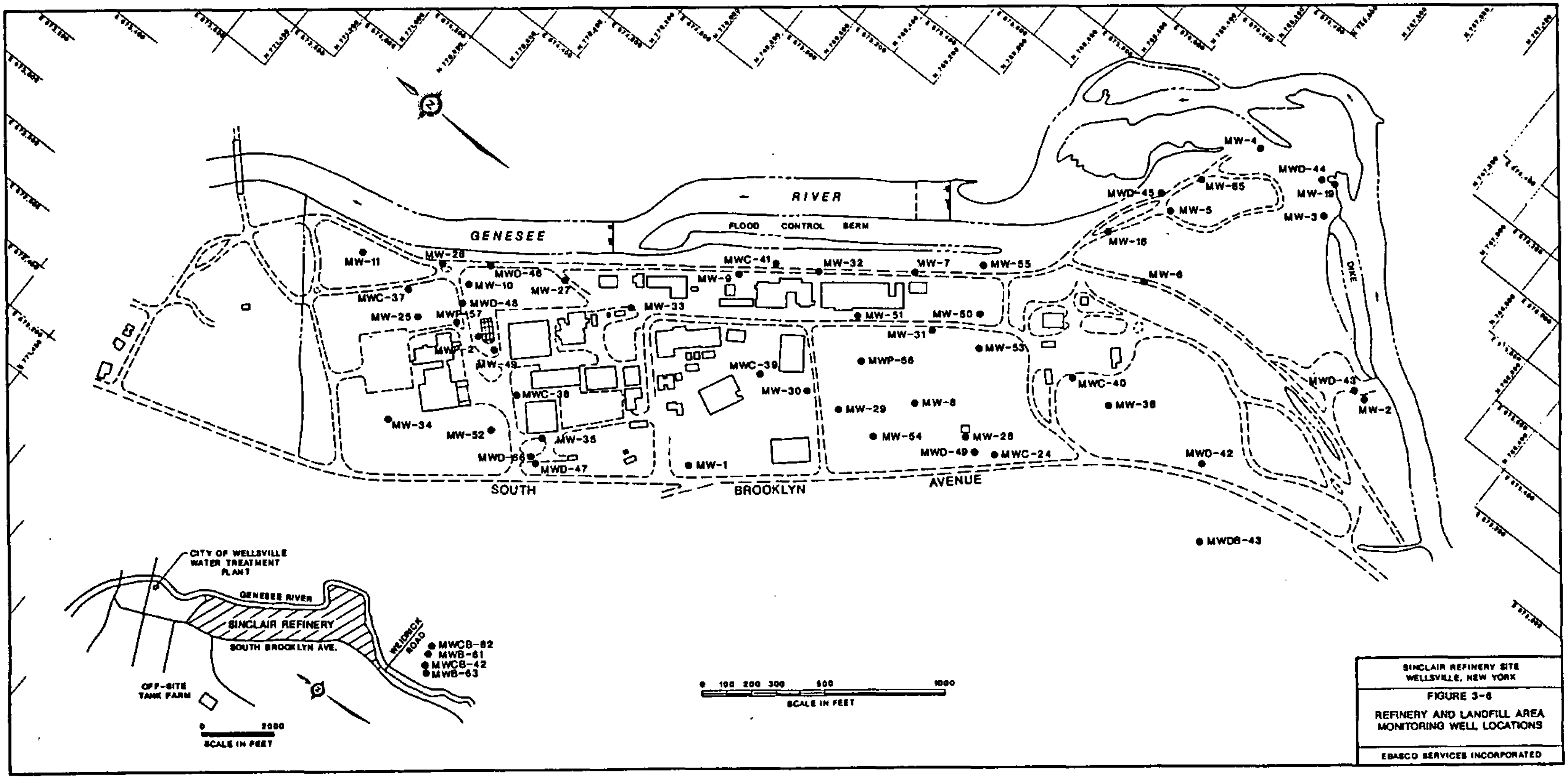


SINCLAIR REFINERY SITE
WELLSVILLE, NEW YORK

FIGURE 3-6

REFINERY AND LANDFILL AREA MONITORING WELL LOCATIONS

EBASCO SERVICES INCORPORATED

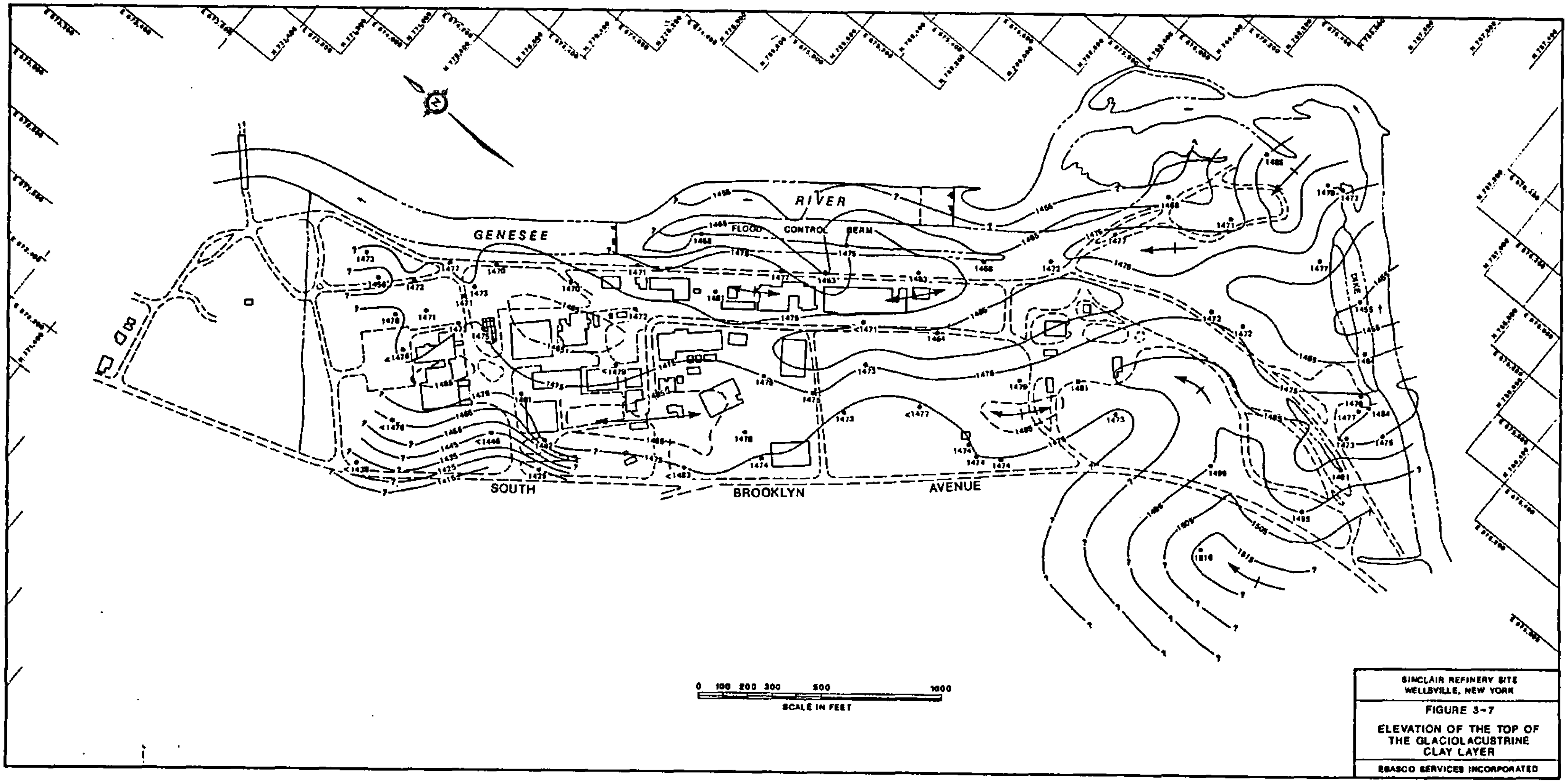
a depth of 16 feet. A general decrease in grain size towards the surface in soils at AB-25 and MWD-47, as well as the abrupt change in elevation of the upper contact of the clay bed between MWD-47/MWD-66 and MW-35, suggest the presence of an ancient river channel in this portion of the site. While the clay bed appears to be deeply incised in this area, the presence of a clay unit at great depth (75 feet) in MWD-47 suggests that the clay bed is not completely breeched. This is further supported by a regional resistivity survey conducted by Ranney (1977), which revealed the presence of early post-glacial river channels to the southwest of the present-day Genesee River. A shallower channel, running parallel to the current river through the middle of the site, is also apparent on the map showing the elevations of the top of the clay layer (Figure 3-7).

Borings drilled to bedrock during the remedial investigation are limited to the Off-Site Tank Farm located northwest of the Refinery Area. In these borings, bedrock was encountered at depths between 9 and 27 feet. A seismic profiling survey conducted during Phase I of the RI indicates that bedrock below the site dips steeply (an apparent dip of 14°) to the east. Depth to bedrock ranges from approximately 70 feet below South Brooklyn Avenue to more than 250 feet below the Genesee River (SMC Martin, 1985).

3.5 SOILS

The soils at the site were described in a geologic context in Section 3.4. As discussed, the soils are predominantly sands and gravels with lenses of clay present in the soils at or near the surface. Grain size and Total Organic Carbon (TOC) content analyses were performed on several soil samples at various locations at the site.

Based on the samples analyzed, the soils were predominantly sandy gravels, with over 70 percent gravel and sand with lesser amounts of silt and clay. However, in one sample, AB66-01 (Figure 3-8), the soil was a sandy silt with over 55 percent silt and clay. The grain size curves are included in Appendix F. Since larger pieces of gravel or cobbles will not enter a split spoon, the analyses may underrepresent the gravel portion of the sample.

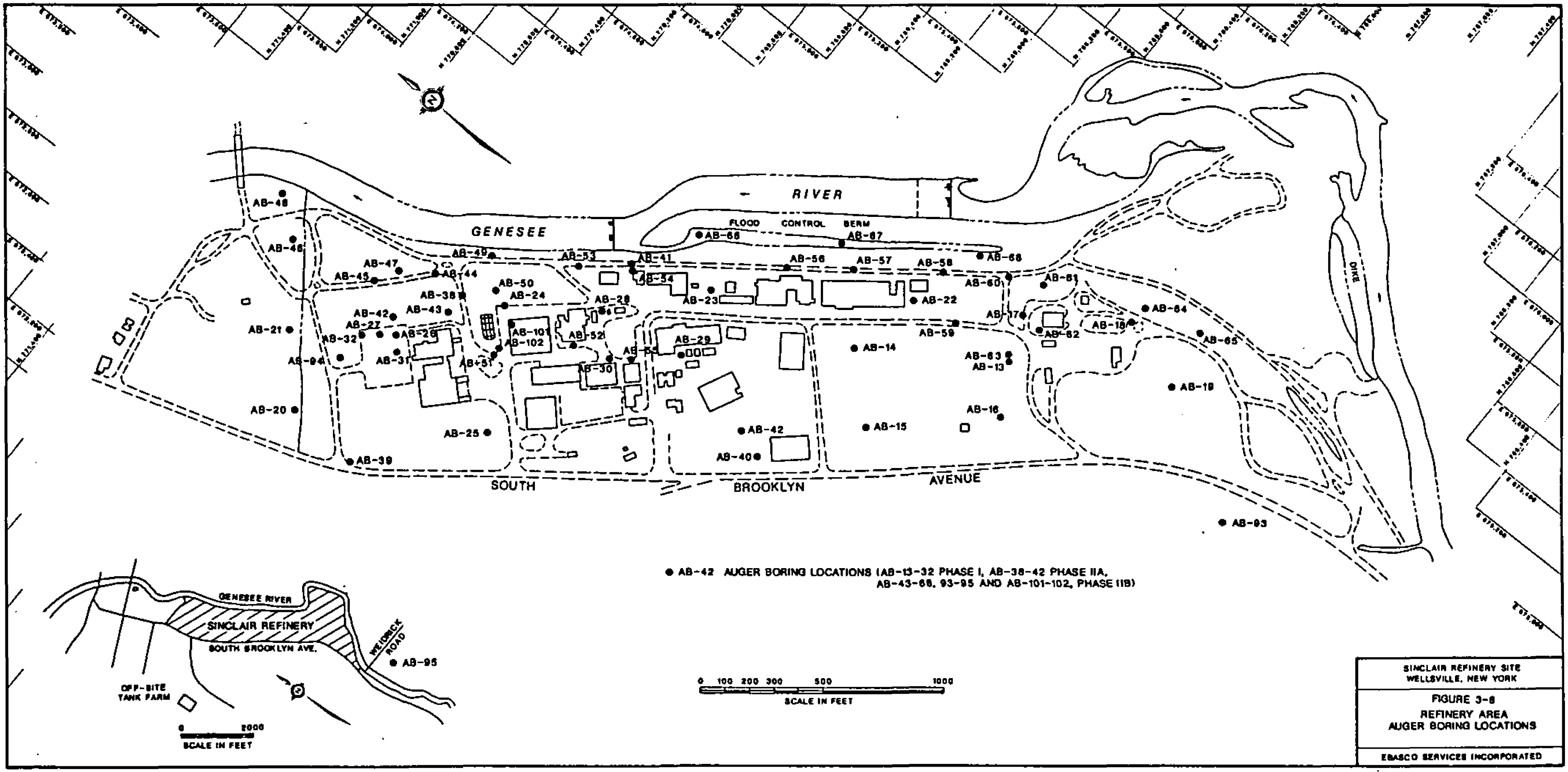


SINCLAIR REFINERY SITE
WELLSVILLE, NEW YORK

FIGURE 3-7

ELEVATION OF THE TOP OF THE GLACIOLACUSTRINE CLAY LAYER

EBASCO SERVICES INCORPORATED



● AB-42 AUGER BORING LOCATIONS (AB-13-32 PHASE I, AB-38-42 PHASE IIA, AB-43-68, 93-95 AND AB-101-102, PHASE IIB)

SINCLAIR REFINERY SITE
WELLSVILLE, NEW YORK

FIGURE 3-8
REFINERY AREA
AUGER BORING LOCATIONS

EBASCO SERVICES INCORPORATED

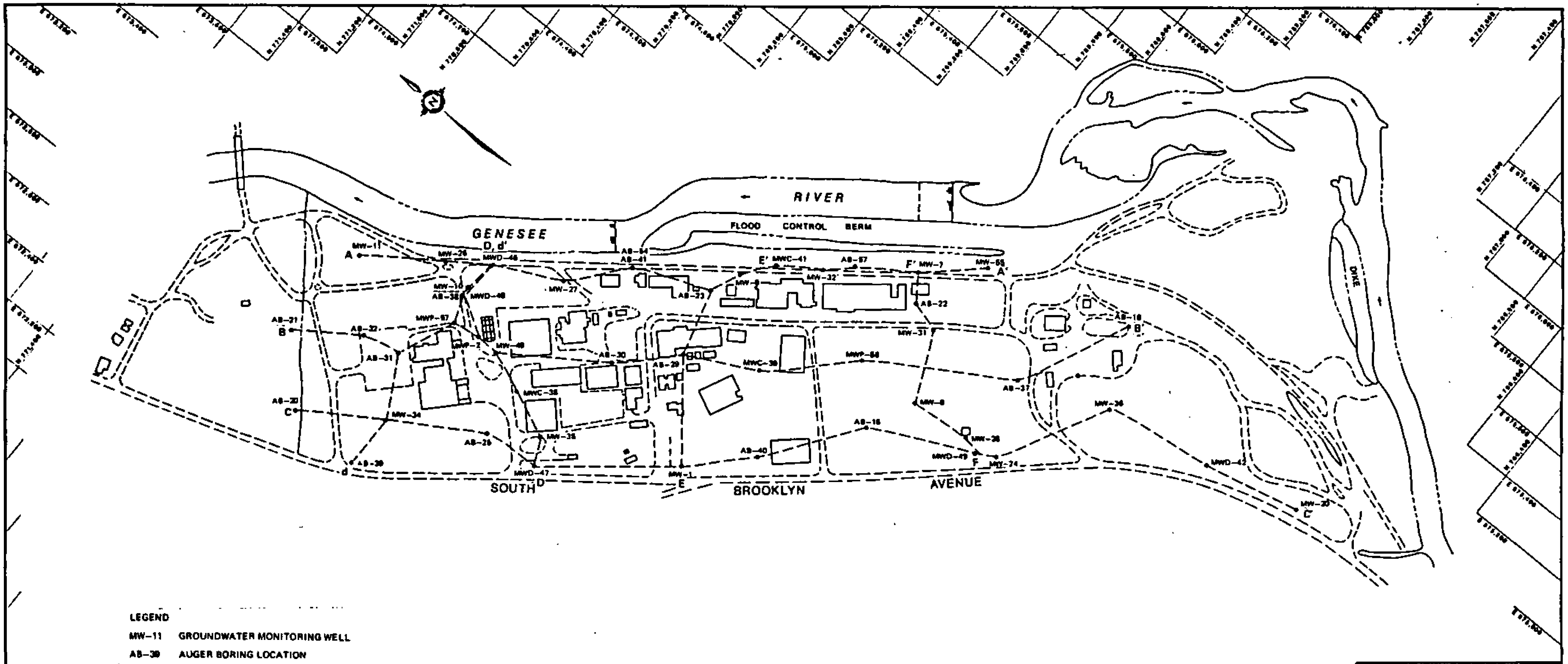
The TOC analyses showed organics ranging from 5.8 percent (57,900 ppm) in a surface soil sample at AB56 to 0.4 percent (4,249 ppm) in a sample at AB94, 8 feet below ground surface. Table 3-3 lists the sample locations, TOC content and sample depth for each sample analyzed for TOC.

3.6 HYDROGEOLOGY

Information obtained from auger borings, monitoring wells and geophysical surveying indicates the presence of at least three hydrologic units within the unconsolidated deposits beneath the Sinclair Refinery Site. These include an upper aquifer comprised of recent fluvial deposits, an aquitard comprised of glaciolacustrine clay/silty clay and one or more lower aquifer(s) comprised of glacial sands.

The upper aquifer is an unconfined (water table) aquifer. It includes the saturated portion of the alluvial sediments which overlay the glaciolacustrine clays/silty clays. The saturated thickness of the upper aquifer unit is approximately 10 to 20 feet across the site, although areas of greater thicknesses (e.g., 64 feet at MWD-66, 75 feet at MWD-47) have been observed locally. Figure 3-5 illustrates the thickness of the alluvial layer which contains the aquifer (i.e., depth to clay/silty clay) across the site.

Variable granular soils (e.g., sandy silts (ML), silty sands (SM), gravelly sands (SW) and sandy gravels (GW)) make up the majority of upper aquifer materials. Lenses of less permeable materials (e.g., clays, silty clays) as much as 1,000 feet long and 15 feet thick have been encountered within the upper aquifer in some areas (e.g., the northwest portion of the site). Geologic cross sections of the site (Figures 3-9 to 3-14) readily display the heterogeneous nature of the upper aquifer.



LEGEND

MW-11	GROUNDWATER MONITORING WELL
AB-39	AUGER BORING LOCATION
A — - — A'	CROSS SECTION LOCATION – SEE FIGURES 3-10 TO 3-14 FOR CROSS SECTIONS

0 100 200 300 500 1000
SCALE IN FEET

SINCLAIR REFINERY SITE
WELLSVILLE, NEW YORK

FIGURE 3-9
GEOLOGIC CROSS SECTION LOCATIONS

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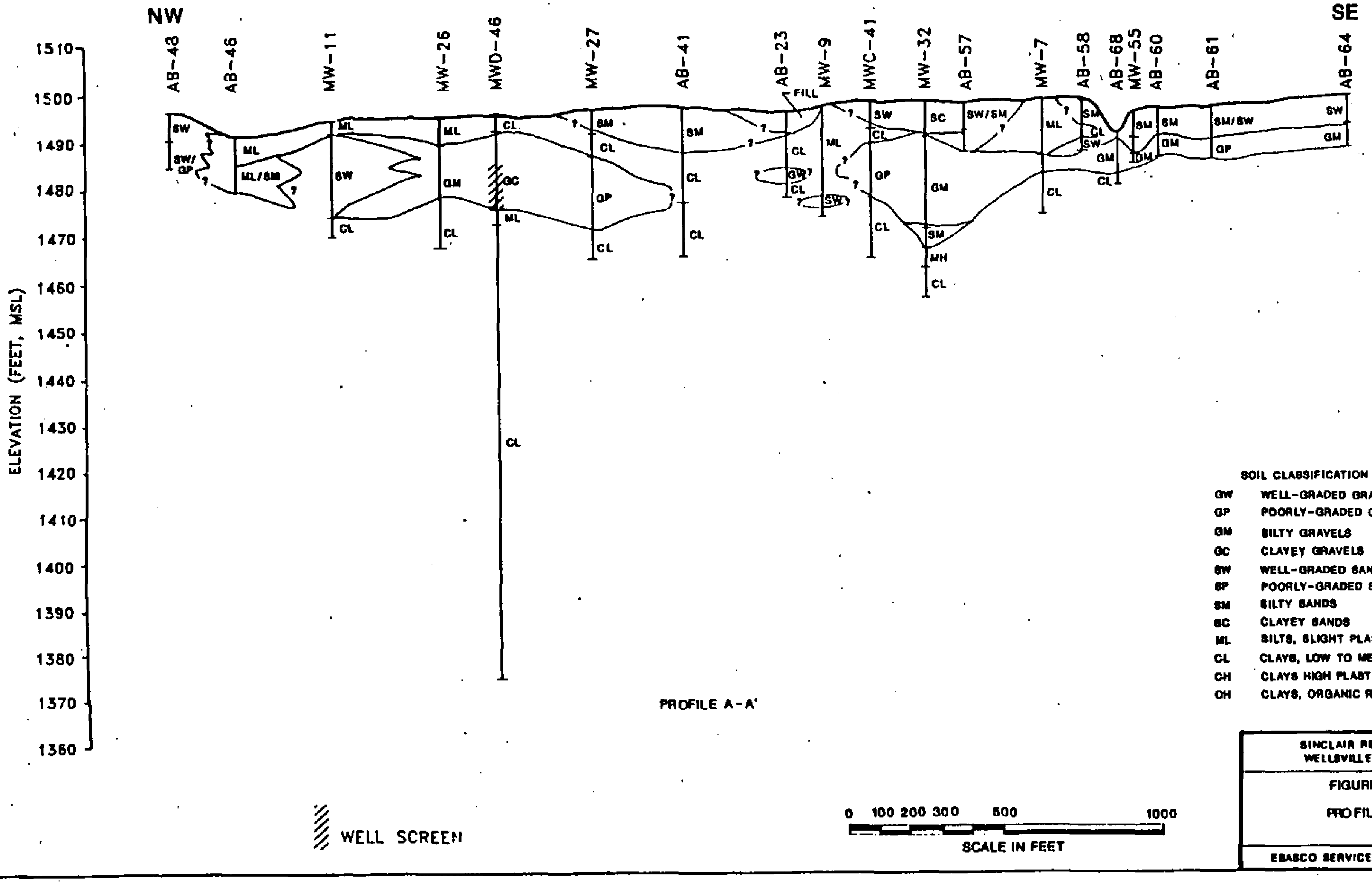

PROFILE A-A'

SOIL CLASSIFICATION SYMBOLS

GW	WELL-GRADED GRAVELS
GP	POORLY-GRADED GRAVELS
GM	SILTY GRAVELS
GC	CLAYEY GRAVELS
SW	WELL-GRADED SANDS
SP	POORLY-GRADED SANDS
SM	SILTY SANDS
SC	CLAYEY SANDS
ML	SILTS, SLIGHT PLASTICITY
CL	CLAYS, LOW TO MEDIUM PLASTICITY
CH	CLAYS HIGH PLASTICITY
OH	CLAYS, ORGANIC RICH

SINCLAIR REFINERY SITE
WELLSVILLE, NEW YORK

FIGURE 3-10

PROFILE A-A'

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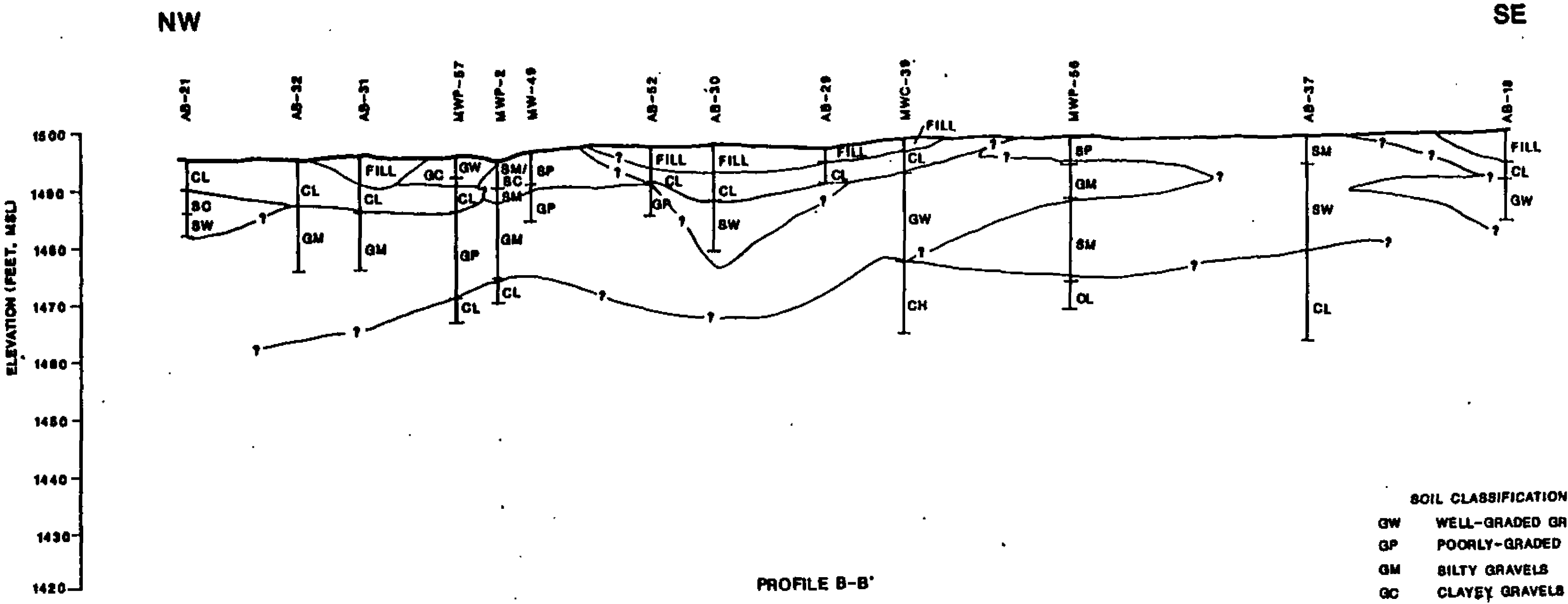

PROFILE B-B'

SOIL CLASSIFICATION SYMBOLS

GW	WELL-GRADED GRAVELS
GP	POORLY-GRADED GRAVELS
GM	SILTY GRAVELS
GC	CLAYEY GRAVELS
SW	WELL-GRADED SANDS
SP	POORLY-GRADED SANDS
SM	SILTY SANDS
SC	CLAYEY SANDS
ML	SILTS, SLIGHT PLASTICITY
CL	CLAYS, LOW TO MEDIUM PLASTICITY
CH	CLAYS HIGH PLASTICITY
OH	CLAYS, ORGANIC RICH

SINCLAIR REFINERY SITE
WELLSVILLE, NEW YORK

FIGURE 3-11
PROFILE B-B'

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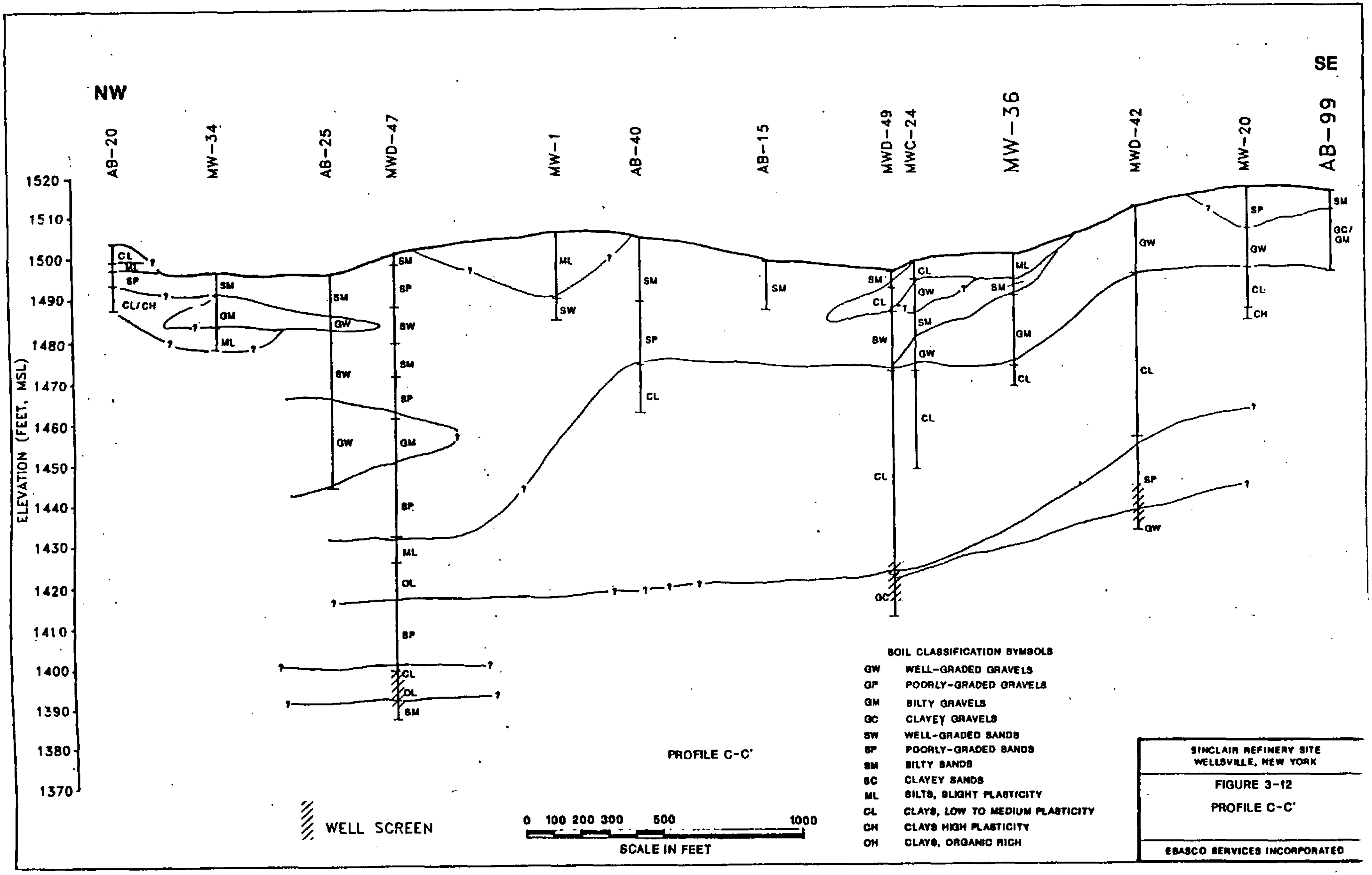


SOIL CLASSIFICATION SYMBOLS

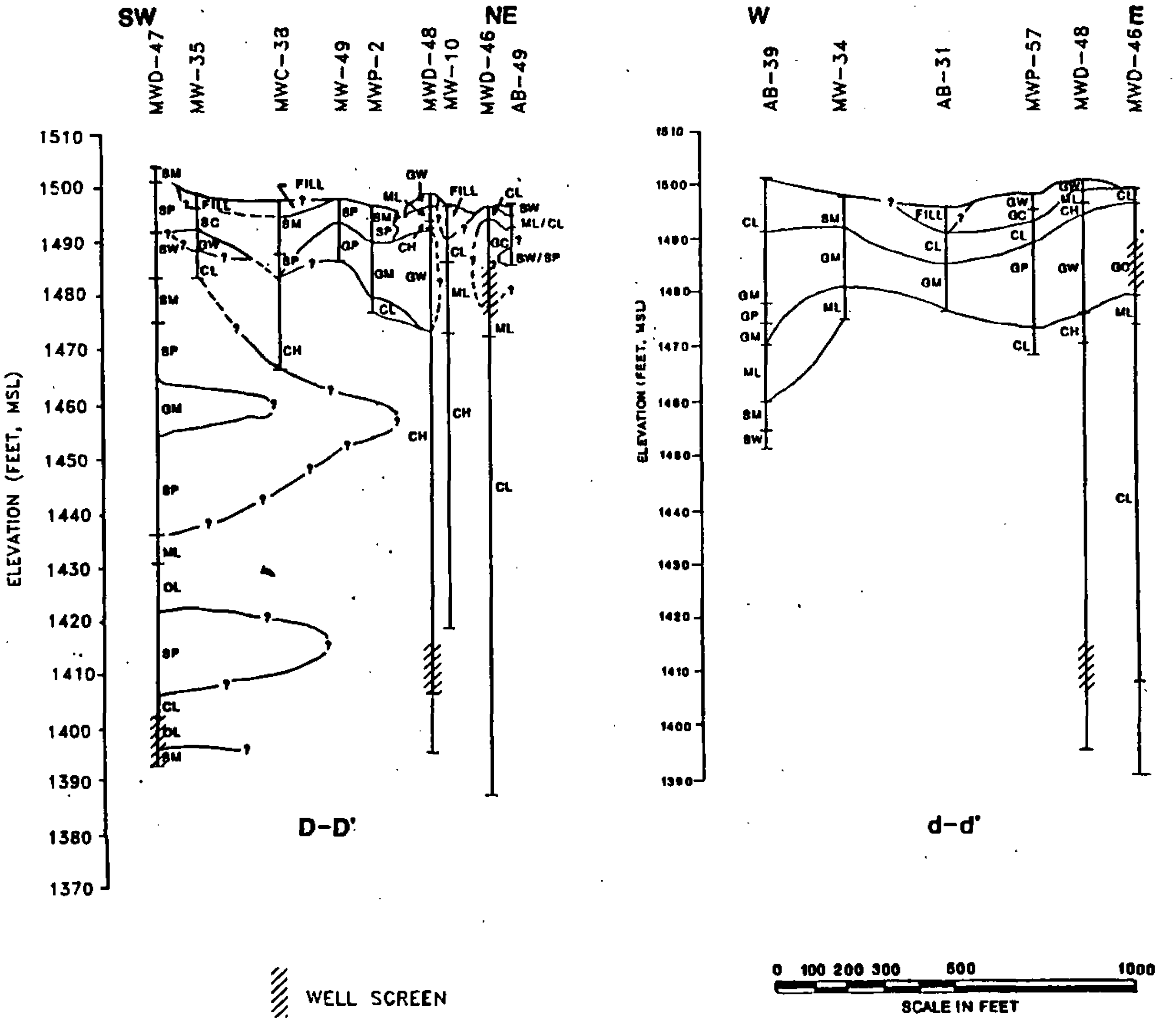
GW	WELL-GRADED GRAVELS
GP	POORLY-GRADED GRAVELS
GM	SILTY GRAVELS
GC	CLAYEY GRAVELS
SW	WELL-GRADED SANDS
SP	POORLY-GRADED SANDS
SM	SILTY SANDS
SC	CLAYEY SANDS
ML	SILTS, SLIGHT PLASTICITY
CL	CLAYS, LOW TO MEDIUM PLASTICITY
CH	CLAYS HIGH PLASTICITY
OH	CLAYS, ORGANIC RICH

SINCLAIR REFINERY SITE
WELLSVILLE, NEW YORK

FIGURE 3-12

PROFILE C-C'

EBASCO SERVICES INCORPORATED



SOIL CLASSIFICATION SYMBOLS

GW	WELL-GRADED GRAVELS
GP	POORLY-GRADED GRAVELS
GM	SILTY GRAVELS
GC	CLAYEY GRAVELS
SW	WELL-GRADED SANDS
SP	POORLY-GRADED SANDS
SM	SILTY SANDS
SC	CLAYEY SANDS
ML	SILTS, SLIGHT PLASTICITY
CL	CLAYS, LOW TO MEDIUM PLASTICITY
CH	CLAYS HIGH PLASTICITY
OH	CLAYS, ORGANIC RICH

SINCLAIR REFINERY SITE
WELLSVILLE, NEW YORK

FIGURE 3-13

PROFILE D-D'
PROFILE d-d'

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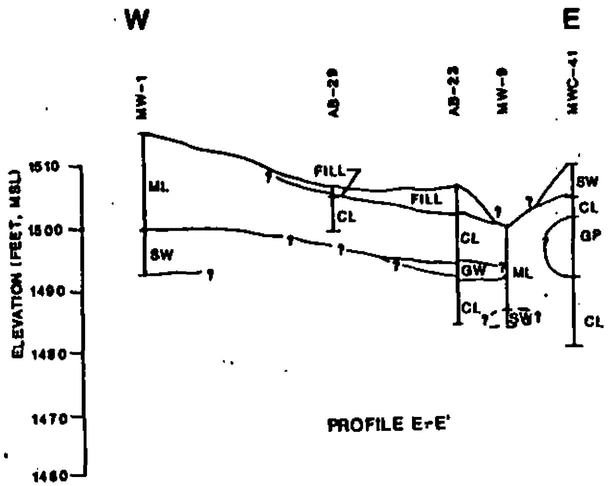
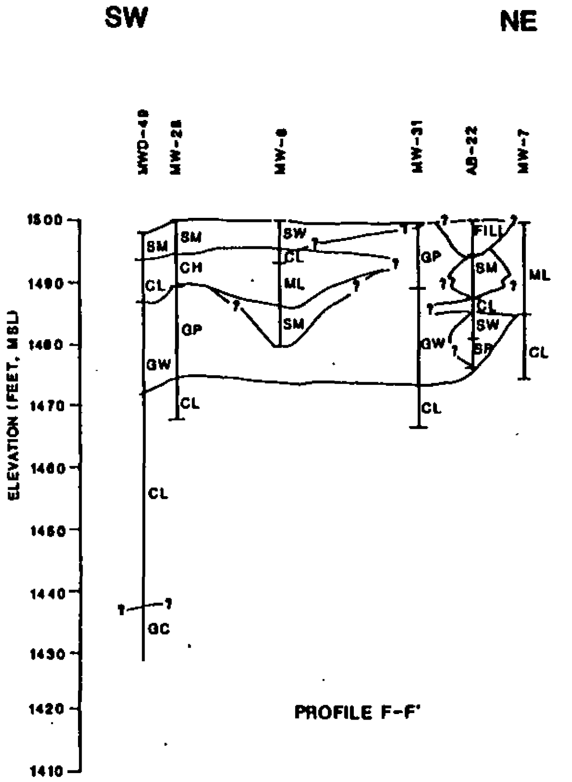


PROFILE E-E'



PROFILE F-F'

SOIL CLASSIFICATION SYMBOLS

GW	WELL-GRADED GRAVELS
GP	POORLY-GRADED GRAVELS
GM	SILTY GRAVELS
GC	CLAYEY GRAVELS
SW	WELL-GRADED SANDS
SP	POORLY-GRADED SANDS
SM	SILTY SANDS
SC	CLAYEY SANDS
ML	SILTS, SLIGHT PLASTICITY
CL	CLAYS, LOW TO MEDIUM PLASTICITY
CH	CLAYS HIGH PLASTICITY
OH	CLAYS, ORGANIC RICH

SINCLAIR REFINERY SITE
WELLSVILLE, NEW YORK

FIGURE 3-14

PROFILE E-E'
PROFILE F-F'

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Clay and silty clay deposited in a glaciolacustrine environment form a second hydrologic unit below the upper aquifer. A resistivity survey conducted by the Ranney Corporation in 1977 suggests that this unit is extensive throughout the area, with a surface expression that mimics present-day topography (i.e., ancient river channels). The increased depth to clay (64 to 75 feet) in the northwest portion of the site suggests the presence of an ancient channel at this location, thus supporting this finding. Limited site-specific information is available on the thickness of the glaciolacustrine clay/silty clay unit, as few borings were advanced through its entire thickness. However, boring logs indicate that the thickness of this unit ranges from 14 feet at MWD-47 to more than 85 feet at MWD-46. This unit appears to be a relatively effective confining layer, as indicated by the artesian conditions in monitoring wells installed in more permeable materials (sands and gravels) beneath the clays.

Glacial sands and gravels, apparently interbedded with the glacial clays (see boring logs for MWD-47 and MWD-66), form the lower aquifer unit(s). The lower aquifer was encountered in MWD-47, 49 and 66. The lower aquifer is a confined (artesian) unit. The Ranney Corporation reports deep overburden wells in the Wellsville area with good water-producing properties (Ranney, 1977).

Bedrock is estimated to occur 70 to 250 feet below the ground surface at the refinery and 9 to 27 feet below ground surface at the OSTF. Wells in the tank farm area were all drilled into bedrock, apparently because no shallow aquifer was present in the overburden.

3.6.1 Hydraulic Gradients

Water level measurements taken in the shallow wells during the Phase IIb RI are presented in Tables 3-4 and 3-5. Fluctuations in water level elevations over this two-month investigation (10/28/88-12/27/88) ranged from 0.13 to 0.90 feet. Water level fluctuations were slightly greater (0.40 to 2.7 feet) during the three-month period monitored during Phase I. Detailed water level data for Phase IIa are not available.

TABLE 3-4

WATER TABLE ELEVATIONS
SHALLOW WELLS

	DATE OF WATER LEVEL MEASUREMENT (ALL 1988)			
WELL NO.	11/14-11/15	12/15-12/16	12/27	VARIATION IN WATER LEVELS
	(Elevation-Mean Sea Level)			(feet)
MW-1	-	1502.79	-	-
MWP-2	1485.33	1485.42	1485.46	0.13
MW-9	1486.53	1486.67	1486.97	0.44
MW-10	1483.45	1483.57	1483.65	0.20
MW-11	1481.22	1481.79	1481.89	0.67
MW-13	-	1493.88	-	-
MW-16	-	1491.41	-	-
MW-26	1482.82	1483.01	1483 07	0.25
MW-27	-	1483.13	1483.33	0.20
MW-28	1493.69	1493.09	1494.27	0.60
MW-29	1492.16	1491.60	1491.93	0.56
MW-31	1490.78	1490.50	1491.01	0.51
MW-32	1486.72	1486.56	1487.16	0.6
MW-33	1486.35	1486.19	1486.30	0.16
MW-34	1492.16	1491.37	-	0.79
MW-35	1490.33	1489.95	-	0.38
MWD-46	1482.31	1483.16	1482.66	0.85
MW-50	1490.62	1490.38	1490.81	0.43
MW-51	1490.56	1489.74	1490.39	0.82
MW-52	1492.93	1492.52	-	0.41
MW-53	1491.70	1491.26	-	0.44
MW-54	-	1492.65	-	-
MW-55	1489.75	1489.60	1490.00	0.40
MWP-57	1484.46	1484.64	1484.66	0.20
MW-65	-	1492.04	-	-
MWB-63	-	1501.52	-	-

TABLE 3-5

WATER TABLE ELEVATIONS
DEEP WELLS

WELL NO.	DATE OF WATER LEVEL MEASUREMENT 11/14/88	 12/15/88
	(Elevation - Mean Sea Level)	
MWDB-43	1498.23(1)	-
MWD-45	-	1493.56
MWD-47	1503.93(2)	1503.93(2)
MWD-48	1501.65	1503.82
MWD-66	-	1503.82(2) (3)

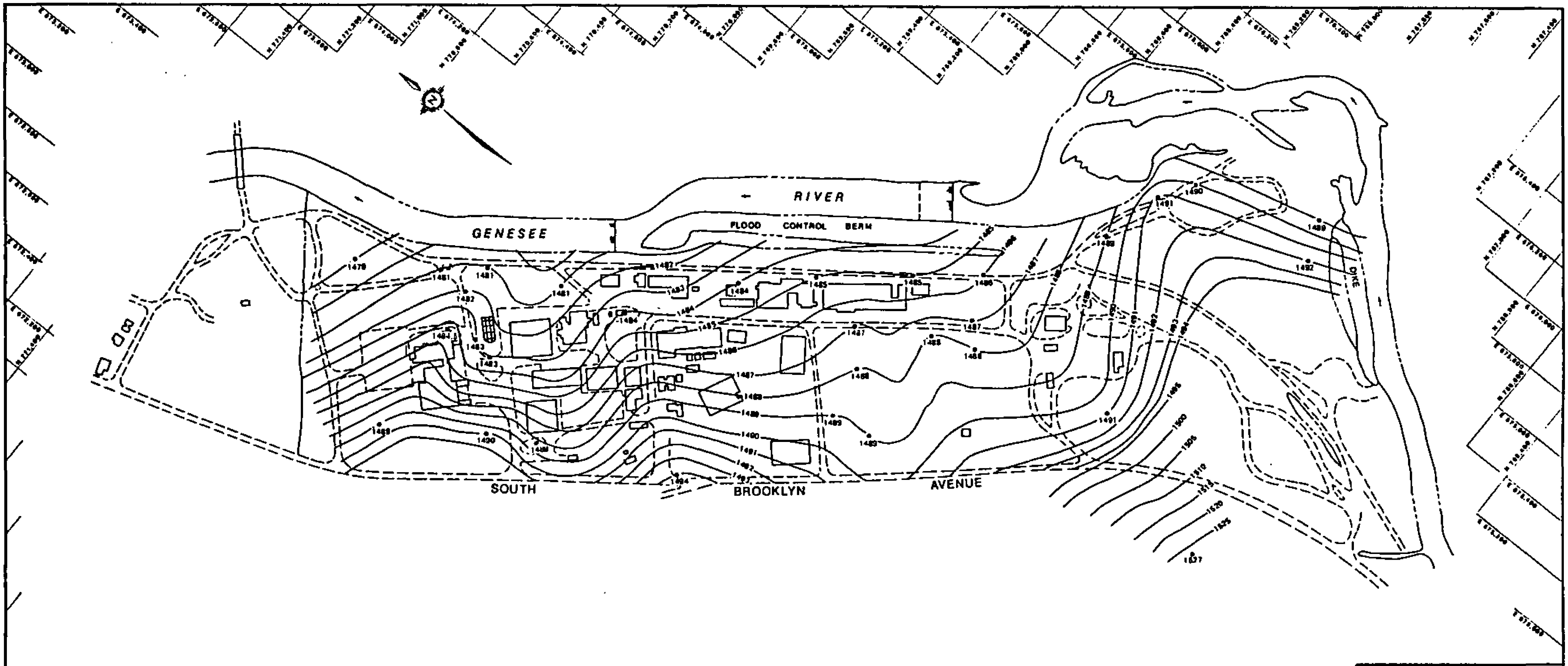
(1) Measured 11/30/88.

(2) Flowing well. Elevation is at top of casing. Actual level would be higher.

(3) Measured 1/4/89.

A potentiometric surface map of the water table generated from Phase IIb data is presented on Figure 3-15. Unlike the Phase I report potentiometric surface map, which utilized water level data from auger borings as well as monitoring wells, this map was generated from water levels measured in monitoring wells only. Water levels measured in auger borings are not as accurate as those measured in wells. Equipotential lines run subparallel with the Genesee River across the site. Groundwater flow in the upper aquifer is towards the river in a north to northeast direction. This is in general agreement with flow directions observed during Phases I and IIa of the RI, with the exception of the depressed water table thought to be present in the vicinity of MWD-47 after the Phase I investigation. Phase IIa draft documents do not report this depression.

Horizontal flow gradients from South Brooklyn Avenue to the river range from 1.6 feet per 100 feet in the northern portion of the site to 0.6 feet per 100 feet in the central area. Flow gradients appear to be steepest in the northern portions of the site and in the southern portions of the site along South Brooklyn Avenue. Phase IIa draft documents also report a steep horizontal flow gradient in the northwest portion of the site. Because Phase IIa water level data are unavailable, a direct comparison could not be made at this time. Figure 3-15 shows a flatter horizontal flow gradient in the central portion of the refinery area. The low density of data points in this area renders this interpretation tentative, although it agrees with the higher hydraulic conductivities measured in pump tests in this area. A potentiometric surface map of the lower aquifer could not be generated due to the limited number of deep wells on the site. However, water levels measured in deep monitoring wells suggest that flow in the deep aquifer is also towards the river (see Table 3-5, MWD-47, 48 and 66).



SINCLAIR REFINERY SITE
WELLSVILLE, NEW YORK

FIGURE 3-15
SHALLOW AQUIFER
POTENTIOMETRIC SURFACE MAP

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Vertical flow gradients were determined by comparing water level measurements in deep monitoring wells (MWD-47, 48 and 66) with water levels in nearby shallow monitoring wells. The difference between lower and upper aquifer water level elevations measured during Phase IIb ranged from 9.14 to 13.98 feet. In all cases, the lower aquifer wells had higher water level elevations, indicating an upward vertical flow of groundwater. This differs slightly from the Phase IIa investigation in that water level elevation differences were slightly less in MWD-48(3-6 feet) and no vertical flow gradient was observed at MWD-47. The clay layer above the lower aquifer ranges in thickness from approximately 10 feet at MWD-47 to 65 feet at MWD-48. As a result, vertical flow gradients estimated across this layer have a wide range of values (0.174 to 1.4 feet per foot).

3.6.2 Hydraulic Conductivities

Both in situ permeability (slug) and pumping tests were conducted in the upper aquifer during the Phase I and IIa Remedial Investigation. Pump tests influence relatively large areas on a site and as a result are generally considered to provide more representative data on average site hydraulic conductivities. However, each test generally takes weeks or months to complete. In comparison, slug tests influence only a very small area surrounding a well, but each test can be completed in minutes or hours.

At the Sinclair Refinery Site, 2 pumping tests and 20 slug tests were completed and hydraulic conductivities ranging from 5 to 245 feet per day were calculated.

3.6.2.1 Pumping Tests

Pumping tests were conducted in the southern portion of the site at MW-56 and in the northern portion at MW-57. (These wells are also referred to as MWP-56 and MWP-57 on some maps and references.) The two tests gave different results, indicating that the soils in the central area of the site are generally more permeable than those to the north. The pumping wells are 6-inch-diameter wells. During the tests, MW-57 was pumped at a rate of 10 gpm while MWP-56 was pumped at a rate of 50 gpm. In spite of this difference in pumping rates, drawdown in the wells was greater in MW-57 than in MW-56.

The data collected from the tests were analyzed by both SMC Martin and Ebasco, yielding similar ranges of calculated aquifer properties.

The SMC Martin analyses and Ebasco's preliminary analyses were performed using drawdown graphs prepared by SMC Martin. These graphs were not in a final report-ready form and are not included with this report. The aquifer coefficients were calculated by matching the field data plots and type curves derived from Boulton (1963). Transmissivities and the specific yield were then calculated. The calculated values are shown on Table 3-6. Notes with the SMC Martin calculations state that due to apparent changes in the behavior of the aquifer over the course of the tests, only the data from the end of the tests were used. They also state that for MW-56, recovery data, not drawdown data were used to calculate aquifer properties due to unspecified problems in the drawdown data. Correction values were applied by SMC Martin to some calculated transmissivities in the MW-57 pumping tests. The correction was an "infiltration adjustment from MW-33." The basis and need for this adjustment was not found in the calculation sheets and was not included in Ebasco's calculations.

In analyzing these same data, Ebasco, like SMC Martin, observed differences in the aquifer properties early and late in the tests. Ebasco then calculated each set of hydraulic properties for the early and late times. For the test at MW-56 the Ebasco calculations showed an apparent boundary condition, which is interpreted as an aquifer heterogeneity, with an area of low transmissivity farther away from the pumping well. The results of these calculations are reported on Table 3-6.

In the last set of analyses the log-log diagrams of the time/drawdown records from the pumping and the observation wells were matched with the analytical solution for groundwater flow into a pumping well under semileaky confinement (Hantush, 1956, 1960). The solution was obtained by inverting the Hantush's equation, and solving it for the coefficients of storativity (S), transmissibility (T), and leakage (Beta). The inversion and curve-matching was conducted using AQUIX software by INTERPEX LIMITED of Golden, Colorado. In each case

TABLE 3-6

AQUIFER CHARACTERISTICS

PUMP TEST MW-56

Observation Well	SMC Martin T (gpd/ft)	SMC Martin S	SMC Martin K (ft/day)	Ebasco Calculated T(Early) (gpd/ft)	Ebasco Calculated T(Late) (gpd/ft)	Ebasco Calculated S	Ebasco Calculated K (LATE) (ft/day)	Ebasco Computer Generated T (gpd/ft)	Ebasco Computer Generated S	Ebasco Computer Generated K (ft/day)
MW-56	8,131(2)	—	60.7	—(1)	—(1)	—	—	(1)	—	—
MW-3	10,225	0.016		70,450	15,620	0.013	—	—	—	—
MW-8	7,257	0.042	56.2	26,730	10,470	0.035	82	—	—	—
MW-29	9,549	0.032	60.7	19,890	10,710	0.025	68	11,798	0.026	113
MW-30	—	—	—	—	—	—	—	7,184	0.019	—
MW-31	15,484	0.020	121.9	24,240	13,040	0.018	102	8,723	0.025	68
MW-51	4,092	0.067	136.7	15,060	7,330	0.03	245	6,036	0.062	201
MW-53	10,231	0.016	—	—	—	—	—	20,129	0.13	—

PUMP TEST MW-57

Observation Well	SMC Martin T (gpd/ft)	SMC Martin S	SMC Martin K (ft/day)	Ebasco Calculated T(Early) (gpd/ft)	Ebasco Calculated T(Late) (gpd/ft)	Ebasco Calculated S	Ebasco Calculated K (LATE) (ft/day)	Ebasco Computer Generated T (gpd/ft)	Ebasco Computer Generated S	Ebasco Computer Generated K (ft/day)
MW-57	8,175	0.04	5.0	1,950	2,250	—	25	1,055	0.304	12
MW-2	1,232	0.03	15.0	4,590	3,300	0.02	40	3,647	0.009	44
MW-10	—	—	—	—	—	—	—	4,784	0.05	—
MW-25	1,443	0.02	14.8	26,730	6,040	0.004	62	1,761	0.00006	18

Note: T = Transmissivity in gallons per day per foot (gpd)
K = Hydraulic conductivity in feet per day (ft/day)
S = Storativity
— = Not calculated
(1) Calculated but not reported, raw data are of probable poor quality
(2) Based on recovery data

the maximum acceptable error in the curve fitting was set at 10 percent. The computer-generated printouts, including the time/drawdown records, are included in Appendix G. The range of the computed parameters is shown for each pumping or observation well analyzed in the "Model Parameters" box on the figures in the appendix. The results are also summarized in Table 3-6.

In the computer analyses, the time/drawdown data from the pumping tests were plotted on logarithmic scales. Data were analyzed only from the pumping or observation wells showing consistent time/drawdown trends. Records with oscillatory drawdown patterns or with drawdowns amounting to less than 0.1 foot, were not considered. This is because such drawdowns could be attributed to other than pumping effects, (e.g. temporal changes in the barometric pressure, changes in the nearby river stage, passage of heavy trucks on the nearby roads).

In the case of the pumping test from the well MWP57, the record from the observation well MWP25 plotted in an anomalous pattern. The record of the first 20 minutes shows the drawdown inconsistent with the trend for the time beyond the first 20 minutes. Considering the fact that the observation well MWP25 is located at a distance of 155 feet away from the pumping well (MWP57), it was assumed that the less-than 0.2 foot drawdown during the initial 20 minutes of pumping was not caused by the pumping test. Hence data for the early 20 minutes of drawdown in MWP25 (points indicated by x on the figure in Appendix G) were masked during the curve-matching procedure.

Another anomalous time/drawdown record was obtained from the pumping test in the MWP56. The time/drawdown record from the MWP56 pumping well shows a relatively gentle slope during the initial 16 minutes of pumping, and a much steeper slope during the remainder of the test. Such anomalous curves may suggest an aquifer heterogeneity, indicating a boundary of a material with a lower coefficient of transmissibility, located some distance from the pumping well. Yet unlike the earlier SMC Martin and Ebasco analyses, no such boundary was suggested by the time/drawdown records made during the same pumping test in the observation wells (MW29, MW30, MW31, MW51, and MW53). Furthermore, the well MWP56 time/drawdown data for the pumping period beyond the initial 16 minutes could not be used to converge on the solution for the equation for groundwater flow assuming any of the following:

a. confined conditions (Theis, 1935);
b. semileaky confined conditions (Hantush, 1960);
c. semileaky confined conditions with partially penetrating wells (Hantush, 1962); or
d. phreatic conditions (Neuman, 1972).

Therefore the Ebasco results for MW-56 are not reported in Table 3-6. However, the computer-generated plots and results are included in Appendix G.

Although each of the methods used to calculate aquifer properties gave somewhat different results, the range of values for the methods were overlapping, and differences in aquifer properties between the northern and central portions of the site are apparent in both tests. The pump test in the central area, using well MWP-56 for pumping, yielded a range of calculated hydraulic conductivities from 56 to 245 feet per day. However 10 of 12 calculated values were between 56 and 137 feet per day. This pumping test included measurements near all of the potential source areas in the central part of the site that had been identified by SMC Martin in the Phase I report. The results in this area are considered reliable, based on the limited range of calculated values and the relatively large area over which values could be calculated. The piezometric surface map in this area (Figure 3-15) also indicates relatively uniform aquifer properties, as demonstrated by the relatively constant spacing of the equipotential lines (contour lines) on the map.

The pumping test at MWP-57 in the northern area of the site did not include as many observation wells as the test at MWP-56, and the relative range of the values is higher. Calculated hydraulic conductivities ranged from 5 to 62 feet per day with an average of 26 feet per day. These hydraulic conductivities are lower than in the central area. This is consistent with the closely spaced equipotential lines in this area, on the potentiometric surface map (Figure 3-15) and the fine-grained soils observed in this area. The reported hydraulic conductivities in this area may be less reliable than those in the central area, as evidenced by the wider range of calculated values and the correction values that SMC Martin applied to their results. However, the range appears reasonable.

3.6.2.2 Slug Tests

In situ permeability (slug) tests were conducted on selected monitoring wells during the Phase I and IIa field investigations. In situ permeability test values must be considered with caution, as these tests are designed to estimate hydraulic conductivities within the immediate vicinity of the well only. The accuracy of these data is very dependent upon the construction of the well and the accuracy of the water level measurements. Plots of drawdown and recovery versus time were analyzed by SMC Martin using the Bouwer & Rice (1976) method. Calculated hydraulic conductivity values ranged from 6.7 to 69 feet per day (Table 3-7) (SMC Martin, 1985 and 1987). These values are within the range expected for sand and gravel sediments (Mercer, 1982) but are generally lower than the values derived from the pumping tests. The difference in aquifer properties across the site apparent in the pumping tests do not appear in the slug test results. These values support the pumping test data but are not considered as accurate as the pumping test results. Data on screen elevations, for the wells where slug tests were performed, are included on Table 2-3 and in Appendix E.

3.6.3 Infiltration

Five double-ring infiltrometer tests were conducted in the refinery area during Phase IIa of the RI. Average rates of infiltration measured ranged from 6.12 to 0.14 inches per hour. During the testing no statistically significant evaporation or precipitation occurred (SMC Martin, 1987).

In general, high infiltration rates are expected where cover materials are well-sorted sands, while low infiltration rates are expected where cover materials are poorly sorted with an abundance of clay-sized particles. At the Sinclair refinery site, these conditions exist in the central and northern portions of the refinery area, respectively.

TABLE 3-7

SLUG TEST DATA

Well Tested	Average Hydraulic Conductivity (ft/day)[A]
MW-1	30.34
MW-2	69.11
MW-3	30.86
MW-4	59.76
MW-5	34.47
MW-6	26.67
MW-7	9.05
MW-8	26.20
MW-9	87.90
MW-10	63.47
MW-11	46.90
MW-25	18.1
MW-27	45.7
MW-28	10.2
MW-29	29.2
MW-30	35.6
MW-31	11.7
MW-34	14.5
MW-35	6.7
MW-36	8.6

(A) Average of drawdown and recovery test

As anticipated, the two highest rates of infiltration measured (6.12 and 4.09 inches/hour) were in the central portion of the refinery area where the pumping tests showed higher hydraulic conductivities (SMC Martin, 1987). Cover soils at these locations are classified as silty sand mixed with small amounts of gravel. The third highest infiltration rate (1.9 inches/hour) was measured in the northwest portion of the site in soils described as organic-rich silty loam. The lowest infiltration rates were measured in poorly sorted gravels. However, these tests were conducted when the ground surface was frozen, rendering results unreliable (SMC Martin, 1987).

Phase IIa files and draft documents do not provide the raw data from the infiltration tests. Therefore cumulative inches versus time graphs are not presented.

Modification of surface conditions (i.e., construction of buildings, paving and gravel cover of roads and parking lots) in the refinery area as a result of industrial development must also be considered when evaluating infiltration rates across the site. Figure 3-16 illustrates surface cover in the refinery area. Approximately 30 percent of the refinery area is covered by buildings, blacktop or gravel. The gravel areas are used as roadways and parking areas. The soils in these areas are well compacted, impeding infiltration.

3.6.4 Groundwater Flow

The average groundwater flow through a porous medium can be estimated by Darcy's Law, which is expressed by:

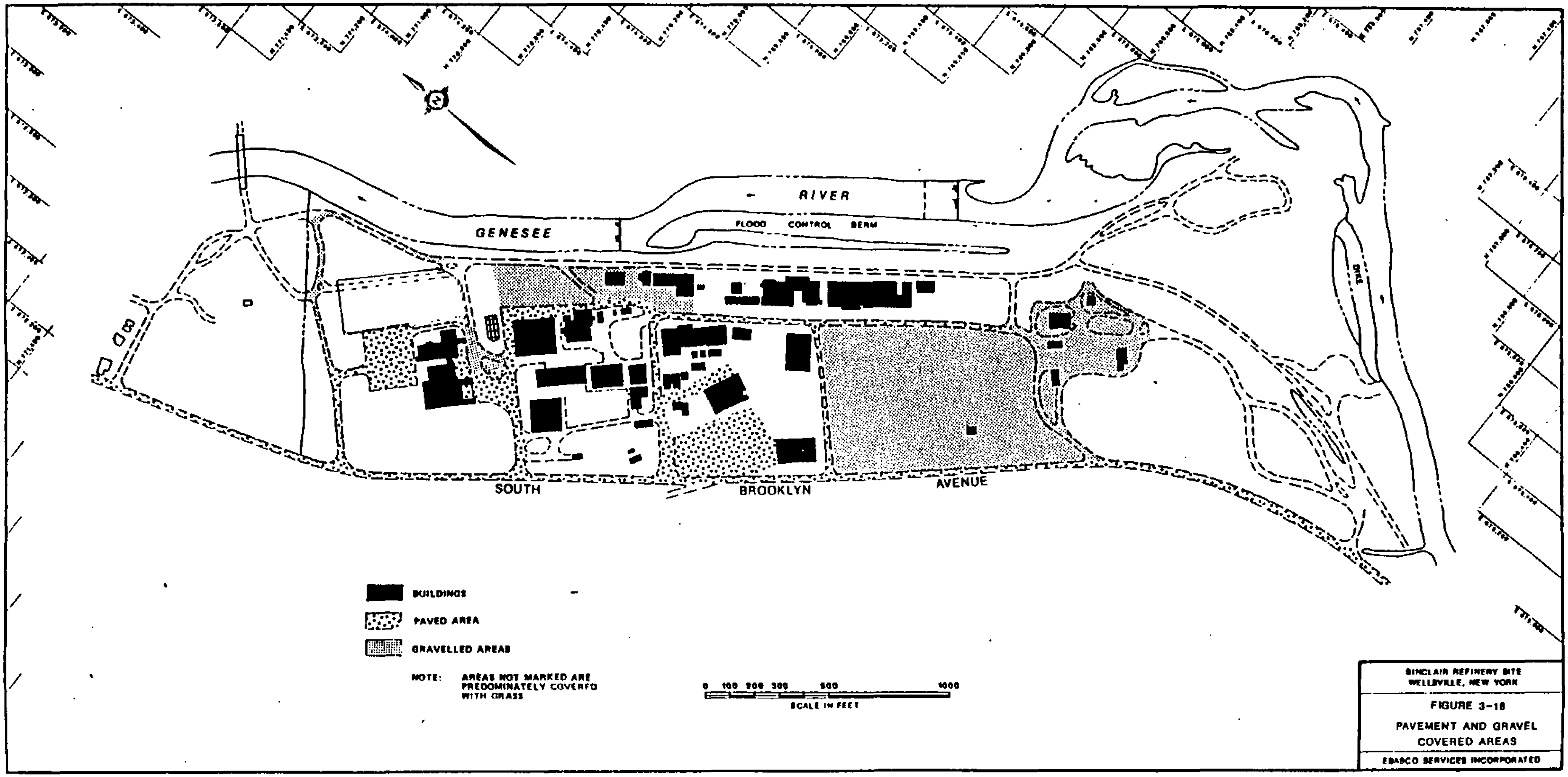
$$Q = KIA$$

Where Q = groundwater flow rate per unit time (ft^3/day)

K = hydraulic conductivity (feet/day)

$I = \frac{dh}{dl}$ = hydraulic gradient

A = cross-sectional area (at a right angle to the flow direction) through which the flow occurs (ft^2)



NOTE: AREAS NOT MARKED ARE PREDOMINATELY COVERFD WITH GRASS

SINCLAIR REFINERY SITE
WELLSVILLE, NEW YORK

FIGURE 3-16

PAVEMENT AND GRAVEL COVERED AREAS

EBASCO SERVICES INCORPORATED

Pumping tests indicate that hydraulic conductivity of the upper aquifer ranges from 5 to 62 feet per day across the northern part of the site and 56 to 245 feet per day across the central part. The hydraulic gradient was determined based on water levels taken on 12/15/88 (see Section 3.6.1). Hydraulic gradients average 1.5 feet per 100 feet and 0.7 feet per 100 feet in the two areas, respectively. These gradients were used in calculating groundwater flow at the site. Groundwater flow is generally north to northeast towards the Genesee River. The areas of flow considered for this estimation are divided into three parts: (1) the length of the refinery area along the river edge from the end of the main drainage swale to the northern drainage swale at the north end of the site (1,500 feet), (2) the north end of the drainage swale to the north end of the landfill (1900 feet) and (3) the north face of the landfill to the New York Dike (900 feet). A saturated thickness of 10 to 15 feet along these lengths results in cross-sectional areas of 15,000 to 22,000 ft^2, for area 1, 19,000 to 29,000 ft^2 for area 2 and 9,000 to 13,500 ft^2 for area 3. Substituting these values into Darcy's Equation, groundwater flows ranging from 8,800 to 159,000 gpd and 55,000 to 388,000 gpd can be estimated across the two refinery portions of the site, respectively. The best estimates of discharge to the Genesee River are 49,700 gpd and 136,500 gpd for the two areas for a combined discharge of 186,200 gpd. In the landfill area, flow under the landfill into the river is estimated at about 84,240 gpd. However, less data are available in the landfill area, since no pumping tests were performed.

Groundwater velocity can be calculated from the following equation:

$$V = \frac{(K)\frac{(dh)}{(dl)}}{N}$$

Where V = groundwater velocity
K = hydraulic conductivity
$\frac{dh}{dl}$ = hydraulic gradient
N = effective porosity

A value of 25% for effective porosity was estimated because of the low silt and clay content of the upper aquifer. The average calculated velocity across the site is 1.5 feet per day in the north, and 2.8 feet per day in the central area. The time for water to travel from the area of South Brooklyn Avenue is approximately two years and one year in the northern and central areas, respectively.

Flow from a deep artesian aquifer to a shallow water table aquifer can usually be estimated with a modified form of Darcy's Law expressed as:

$$Q_1 = (p/m)AH$$

Where Q_1 = quantity of leakage (ft^3/day)
p = vertical hydraulic conductivity of the confining unit (ft/day)
m = thickness of the confining unit (ft)
A = cross-sectional area (ft^2)
H = difference in head between the two aquifers (ft)

At the Sinclair Refinery site the rate cannot be estimated with any degree of accuracy for three reasons: 1) the hydraulic conductivity of the clay confining layer was not measured; 2) the thickness of the clay confining layer is highly variable across the site; and 3) the head differences were measured at only a few locations where deep and shallow wells are present. However, at each location where a deep and shallow well are present the pressures in the deep well are higher than in the shallow well, showing that flow is in an upward direction. This upward flow should serve to prevent the movement of contaminants from the upper to the lower aquifer.

3.6.5 Groundwater Use

A water well inventory of the facilities and residences immediately surrounding the Sinclar Refinery was conducted during the Phase I investigation. The methodology employed during the inventory included conversations with various public agencies, private companies, local residents and the State University of New York (SUNY) at Alfred. A comprehensive list of the business/agencies contacted is presented in Table 3-8.

TABLE 3-8

GROUNDWATER USE

AGENCIES AND COMPANIES CONTACTED REGARDING POTENTIAL WATER USERS AT THE SINCLAIR REFINERY SITE

GOVERNMENTAL AGENCIES

New York State Department of Health (NYSDOH) - Bureau of Toxic Substances
Allegany County Health Department
Wellsville Public Works
Wellsville Power & Light

SCHOOLS AND UNIVERSITIES

Wellsville School District Bus Garage
SUNY at Alfred, Wellsville Campus

PRIVATE COMPANIES

Otis Eastern, Inc., Wellsville, NY
Groundwater Associates, Beaver, PA
EDA Engineers, Rochester, NY
Butler-Larkin, Wellsville, NY

The results of the water well inventory indicated that two wells are currently operational outside the southern portion of the site along South Brooklyn Avenue upgradient of the site, one well is located at the Wellsville School District bus garage and the other is jointly owned by four residents north of Weidrick Road near the southern boundary of the site. SMC Martin reported that "based on the hydrogeological and ground-water chemistry data...there does not appear to be a potential threat to the two operating wells," (SMC Martin, 1987). Boring logs of the two wells are not available, but both are completed in deep aquifers. Earlier reports (Groundwater Associates, 1984; Ranney, 1977) state that a deep well had existed on the property owned by the Otis Eastern Company at the Sinclair Refinery. However, conversations with the president and vice president of Otis Eastern indicated that no record of the well exists in their office files and that they have no knowledge of the well.

All wells known to be used in the area have been completed in deep aquifers. No use of the shallow aquifer has been identified, probably due to the limited thickness of the shallow aquifer compared to the relatively high yields in the deeper wells.

Supplementary investigation into the Otis Eastern water well entailed contacting Groundwater Associates concerning their report of 1982. The engineer in charge of the 1982 project disclosed that the reference to the Otis Eastern well was taken from an earlier report done by Ranney (a subsidiary of Groundwater Associates) in 1977. However, the exact reference source concerning the water well could not be located in Groundwater Associates' nor Ranney's files. Thus it appears that this well, if it ever existed, is no longer in use (SMC Martin, 1987).

During the inventory, it was revealed that most of the residences and commercial establishments in the refinery and off-site tank farm area are within the corporate limits of the Village of Wellsville and therefore are connected to the public water supply; and that the residences outside the Village boundary are beyond the jurisdiction of the Wellsville Public Works Department. Therefore the Department does not have any records concerning these wells.

3.7 Demography and Land Use

The Wellsville Refinery site straddles the border between the Town and Village of Wellsville. Allegany County and the Town and Village of Wellsville are sparsely populated. The populations for these locations are approximately: 1) Allegany County, 50,500; 2) Town of Wellsville, 7,940; and 3) Village of Wellsville 5,070 (U.S. Bureau of the Census, Personal Communication, 1989). Projections of population growth from 1985 through the year 2010 for the Village of Wellsville show an increase of less than one percent of the 1985 population. The change in population for the Town of Wellsville is also quite small, and the population is projected to increase by a total of only 8.4 percent from 1985 to 2010 (NYSDEC, 1985).

Section 1.2 provides a detailed description of existing land use on the site. The former Sinclair Refinery Site is characterized by manufacturing, industrial and school campus uses. South of the Village of Wellsville, and east, south and west of the refinery, land is predominantly forested, agricultural and pastural land (USEPA, 1983). The Village of Wellsville is directly north of the site and has the largest nearby residential population. Three Wellsville schools are located approximately one mile away. Private residences and a university dormitory are located approximately 500 feet west of the refinery site. Immediately south of the refinery and landfill areas and north of Weidrick Road are four residences.

The area formerly used for the off-site tank farm (OSTF) is now open field. East of the OSTF is a residential area consisting of approximately ten homes. North to northwest of the OSTF are approximately one dozen additional recently constructed houses, which may suggest the dispersed growth of newer homes outward from the center of the Village of Wellsville (USEPA, 1983; USGS, 1978).

The Genesee River serves as a multiple resource for the Wellsville area. The Village acquires its potable water supply from the Genesee River. The intake pipe to the water supply system is presently located south of both the Refinery site and the Weidrick Road Bridge, upstream from the site. The Genesee River also serves as a recreation resource. Approximately 2,000 feet north of the site is Island Park, located on the eastern side of the Genesee River. It is a municipal park constructed on dredge spoils resulting from the initial channelization of the river in 1958. The park contains ballfields and picnic areas. The river is used for water-oriented activities such as tubing (Ebasco, 1988; USEPA 1983).

4.0 NATURE AND EXTENT OF CONTAMINATION

Introduction

This section discusses the chemical compounds detected at the site and the concentration and areal distributions of those compounds. In some cases, the potential source of the compound is also described. Compounds selected as likely to be of potential concern have been described in more detail in this section than other compounds. Maps illustrating the areal extent of these compounds are provided.

The data used to identify the nature and extent of the compounds were gathered in three distinct phases over a four-year period. As potential problem areas (or clean areas) were identified the site investigation program was modified to focus on those areas identified as requiring additional characterization. For example, metals in surface soils were identified as a potential concern in Phase I, and resampled in Phase IIa. Smaller areas were then sampled in Phase IIb to further define any potential problem areas identified by reviewing the Phase I and IIa data. Conversely, VOCs in surface soils were not identified as a potential problem, and were not resampled in Phase IIa or IIb. This approach allowed for detailed information to be gathered in areas with the highest contaminant levels and in areas identified as being of potential concern to citizens, even if measured levels were low (i.e. in the Genesee River). In general, this section is divided into various media of interest (e.g., structures, soils, and groundwater). The discussion of each medium describes the chemicals found in the medium, and their extent. Both Phase I and Phase II (a and b) data are reported on the same basis; organic results are on a wet basis, inorganics are on a dry basis.

Some differences in the data sets, such as the level of data validation are present. Since these differences impact on the relative reliability of the data sets, they are described in this introduction. Some other similarities and differences in the data sets are also described in this introduction.

Data validation is often performed on sample results to provide a measure of the reliability of data. EPA data validation procedures require a review of quality assurance and quality control (QA/QC) measures implemented in the field and in the laboratory to ensure that the results are reliable. In Phase IIa, it appears that packages for data validation were prepared for about 15 percent of the samples. According to a NYSDEC letter (NYSDEC, 1987) and discussions with NYSDEC, some or all of the data collected in Phase I and Phase IIa were validated. However, not all of the data validation results are available. Subsequently, as described below, these packages were validated by Ebasco using the EPA's current data validation procedures in SOW HW-1 and HW-2; and in some cases problems with the data were identified. However the data reported in Appendix B have not been modified to reflect this partial validation, since incorporation of this limited validation would not significantly change the quality of the data set. All of the Phase IIb data have been validated in accordance with current EPA protocols. Because of this validation, the Phase IIb data set is considered the most reliable data available for the site. Many of the metals results in Phase IIa were found to be estimated or rejected values based on the data validation (Appendix I). In Phase IIb most of the site media were resampled for metals, allowing new data to be used in the risk assessment. The data validation results for Phase IIb samples are included in Appendix H. Fewer problems were identified with the Phase IIa organics analyses.

An example of the Phase IIa data problems identified during data validation is lead in surface soils. Lead in sample SS-28 is reported at a value of 336.2 in the SMC Martin data base. However, data validation showed that the initial instrument calibration was 281 percent high, and the data should have been rejected (not used). In fact, in this sample chromium should also have been rejected, and antimony, arsenic, beryllium, cadmium, nickel, selenium, thallium and zinc should have been marked "estimated". However, neither the lead nor chromium values were rejected, nor were any of the other values marked "estimated". Similiar problems were found in most of the metal samples that could be validated. A more complete review of the partial validation of Phase IIa data is included in Appendix I.

The data validation of VOC, BNA and pesticide/PCB data did not show these types of problems. However, it should be noted that most of the validated Phase IIa samples were from clean areas where no contaminants were identified, limiting the usefulness of this validation in assessing data quality. A more detailed review of this data validation is also included in Appendix I.

One compound detected sporadically across the site, particularly in Phase IIb, is 2-butanone. The chemical compound 2-butanone is a substance commonly used in laboratories that can inadvertently contaminate a sample during the analytical process. Numerous Phase IIb sample results for this single chemical were rejected during data validation since it appeared that contamination was occurring in blanks or test samples. Although 2-butanone, sometimes referred to as methylethylketone (or MEK), could be associated with past site usage, it is more likely that many (or all) of the 2-butanone results that were accepted during data validation were actually the result of laboratory contamination.

Similarly, acetone is commonly used in the field and laboratory. These values are also included in this report, though in this case no potential site sources were identified.

Many compounds, which are potentially hazardous to man are found in the environment. Some, including metals such as arsenic, calcium, lead and zinc are naturally occurring and are usually found in samples of soils or rocks. Other compounds can be detected in the environment as a result of human activities introducing them into the environment. For example some BNAs which may occur naturally at low levels or not at all in a natural environment, may be detected in soil samples from developed areas where they are introduced by processes such as paving highways, or oil dripping from a car. Other compounds such as lead may be emitted in automobile exhaust fumes and be deposited on soil, raising the level of lead in the soil above its natural levels. (For instance, at location AB-93 the "background" lead level was measured at 93 mg/kg. This was likely influenced by runoff from a nearby roadway).

In order to quantify background or commonly occuring concentrations of compounds present in an area, off-site samples were taken in each phase of the RI. These levels may be compared to levels detected on the site to assist in evaluating if contaminants detected on the site are related to past or present site sources, or if the levels are representative of naturally occurring conditions or conditions which would normally be found in a developed area such as the refinery site. Table 4-1 summarizes the results of the background sampling performed in Phase I, IIa and IIb of the site investigation. Tables 4-2, 4-3, 4-4 and 4-5 provide sample by sample results for background soil, groundwater, river sediment and river water samples. These levels are used for comparison to concentrations of compounds detected on the site throughout the remainder of this report. The background sampling locations are shown on Figure 4-1.

Pesticides, PCBs and cyanide were analyzed in many of the Phase I and IIa samples. These compounds were only found at low concentrations in isolated samples. In addition, their occurrence is not related to any known past or present site users and the levels are generally at background levels. The pesticide, PCB and cyanide data from Phase I and IIa are included in Appendix B. However, they are not described further in this section of the report.

4.1 FACILITIES AND STRUCTURES

The Phase I and IIa data from sampling in or near structures used during refinery operations, which are still present at the site (e.g., oil separator, storm sewers and the stone house discussed in previous sections), reveal some elevated organic and metals concentrations relative to background surface soils and surface water at the site. During Phase IIb one sewer was resampled. These data indicate lower levels in the sewers than detected in Phase IIa. The lower concentrations of the validated Phase IIb data suggest two possible conclusions: 1) contaminants are gradually dissipating or 2) the unvalidated Phase I and partially validated Phase IIa sample data show higher levels of contamination than were actually present.

Facility and structure areas were sampled for soil/sediment and/or water matrices. The northern oil separator was sampled for the oil/water matrix. Both sediment and water were sampled in the sewers. SMC Martin reported sampling soil in the stone house. All samples were analyzed for metals, VOCs, BNAs, and pesticides/PCBs except for the one Phase IIb sewer sample (MH01-01), which was analyzed for metals, VOCs, and BNAs. Soil samples taken from test pits and borings near the northern and southern separators are discussed in Section 4.5 "Soils" of this report.

TABLE 4-1 (Page 1 of 3)

Summary of Chemical Analysis Results
Background Samples
Concentration in mg/kg (Sediment) or mg/l (Water)

	Genesee River Water			Non-River Surface Water	Genesee River Sediments	
	Phase I 1985	Phase IIa 1986	Phase IIb 1988	Phase IIa 1986	Phase I 1985	Phase IIb 1988
Number of Samples Analyzed	4	3	1	4	2	1
VOCs						
Benzene	ND	ND	NA	0.002 (1) (a)	ND	ND
BNAs						
Benzo(A)Pyrene	ND	ND	NA	0.016 (1)	ND	ND
Phenol	ND	0.042 (1)	NA	0.019-0.038 (3)	ND	ND
Di-N-Octylphthlate	ND	ND	NA	0.009 (1)	ND	ND
Metals						
Aluminum	NA	NA	0.049	NA	NA	5590
Arsenic	ND	ND	ND	ND	8.9-13 (2)	6.6
Barium	NA	NA	0.065	NA	NA	73
Beryllium	ND	ND	ND	ND	ND	0.38
Cadmium	0.009 (1)	ND	ND	ND	ND	ND
Calcium	NA	NA	18.9	NA	NA	711
Chromium	ND	ND	ND	0.011 (1)	5.4- 6.2 (2)	5.3
Cobalt	NA	NA	ND	NA	NA	7.6
Copper	0.007 (1)	ND	ND	ND	6.0- 8.2 (2)	8.8
Iron	NA	NA	0.21	NA	NA	15200
Lead	ND	0.014-0.024 (2)	ND	0.040 (1)	8.8-12 (2)	7.1
Magnesium	NA	NA	5.0	NA	NA	1510
Manganese	NA	NA	0.029	NA	NA	304
Mercury	0.002 (1)	ND	0.0003	ND	ND	
Nickel	0.012-0.031 (2)	0.46 (1)	ND	ND	ND	13
Potassium	NA	NA	2.5	NA	NA	354
Silver	0.008-0.009 (2)	ND	ND	0.083 (2)	6.4 (1)	ND
Sodium	NA	NA	10.8	NA	NA	ND
Vanadium	NA	NA	ND	NA	NA	6.0
Zinc	0.010-0.017 (2)	0.031-0.086 (3)	ND	0.035-0.073 (2)	51 -166 (2)	37

(a) Number in parenthesis indicates number of samples with value above detection limit.
ND = not detected
NA = not analyzed

TABLE 4-1 (Page 2 of 3)

Summary of Chemical Analysis Results
Background Samples
Concentration in mg/kg (Soil) or mg/l (Water)

	Groundwater			Soil		
	Phase IIa 1986	Phase IIb 1988 (Unfiltered)	Phase IIb 1988 (Filtered)	Phase I 1985	Phase IIa 1986	Phase IIb 1988
Number of Samples Analyzed	5	2	1	3	8	4
VOCs						
Acetone	ND	0.005 (1)	NA	ND	ND	0.017 (1)
Carbon Disulfide	ND	0.0009 (1)	NA	ND	ND	ND
Chloroform	0.0006 (1)	ND	NA	ND	ND	ND
1,1,1-Trichlorethane	0.0004 (2)	ND	NA	ND	ND	ND
Benzene	0.0003-0.002 (3)	ND	NA	ND	ND	ND
Toluene	0.003 -0.006 (2)	ND	NA	ND	ND	ND
Xylene	0.013 (1)	ND	NA	ND	ND	ND
BNAs						
Benzo(A)Pyrene	0.012 (1)	ND	NA	ND	ND	2.3 (1)
Pyrene	ND	ND	NA	ND	ND	4.8 (1)
Phenanthrene	ND	ND	NA	ND	ND	3.0 (1)
Anthracene	ND	ND	NA	ND	ND	0.2 (1)
Fluoranthene	ND	ND	NA	ND	ND	5.7 (1)
Benzo(a)Anthracene	ND	ND	NA	ND	ND	2.3 (1)
Bis[2-ethylhexyl]Phthalate	ND	ND	NA	ND	ND	0.3 (1)
Chrysene	ND	ND	NA	ND	ND	2.6 (1)
Benzo(b)Fluoranthane	ND	ND	NA	ND	ND	4.7 (1)
[1,2,3-CD]Pyrene	ND	ND	NA	ND	ND	1.6 (1)
Benzo[G,H,I]Perylene	ND	ND	NA	ND	ND	1.4 (1)
Metals						
Aluminum	NA	1.9 -32 (2)	0.05 (1)	NA	NA	5,200 -10,900 (4)
Antimony	ND	ND	ND	ND	162 (1)	ND
Arsenic	NA	0.022- 0.041 (2)	ND	7.9-19 (3)	ND	6.4 - 11 (3)
Barium	NA	0.135- 0.249 (2)	0.014- 0.09 (2)	NA	NA	28 - 162 (4)
Beryllium	ND	0.005 (1)	ND	ND	0.5 (1)	0.26- 0.56 (4)
Cadmium	ND	0.007 (1)	ND	NA	NA	ND
Calcium	NA	9.0 -13.8 (2)	8.5 -12.5	NA	NA	632 -53,800 (4)
Chromium	ND	0.061- 0.064 (2)	ND	7.5-14 (3)	3.1-21 (7)	6.8 - 15 (4)
Cobalt	NA	0.006- 0.04 (2)	ND	NA	NA	5.8 - 11 (4)
Copper	ND	0.064- 0.079 (2)	ND	7.2-12 (3)	5.6-20.3 (7)	13 - 20 (4)
Iron	NA	17.7 -79.9 (2)	0.016- 5.3 (2)	NA	NA	13,700 -27,300 (4)
Lead	0.050 (1)	0.073- 0.69 (2)	ND	1.3-29 (3)	2.8-58 (7)	7.5 - 94 (4)
Magnesium	NA	2.9 - 10.7 (2)	2.5 - 2.6 (2)	NA	NA	2,070 - 12,000 (4)

(a) Number in parenthesis indicates number of samples with value above detection limit.
ND = not detected
NA = not analyzed

TABLE 4-1 (Page 3 of 3)

Summary of Chemical Analysis Results
Background Samples
Concentration in mg/kg (Soil) or mg/l (Water)

	Groundwater			Soil		
	Phase IIa 1986	Phase IIb 1988 (Unfiltered)	Phase IIb 1988 (Filtered)	Phase I 1985	Phase IIa 1986	Phase IIb 1988
Number of Samples Analyzed	5	2	1	3	8	4
<u>Metals</u> (Cont'd)						
Manganese	NA	2.4 - 2.9 (2)	0.2 -2.8 (2)	NA	NA	190 - 953 (4)
Mercury	ND	ND	ND	ND	ND	0.14 (1)
Nickel	ND	0.037- 0.084 (2)	ND	22 -33 (3)	7.1-40 (8)	13 - 14 (2)
Potassium	NA	1.9 -10 (2)	1.0 -2.1 (2)	NA	NA	596 -1240 (4)
Silver	ND	ND	0.004 (1)	ND	ND	1.4- 2.7 (3)
Sodium	ND	2.3 - 6.9 (2)	2.3 -6.4 (2)	NA	NA	ND
Thallium	ND	ND	ND	0.41 (1)	ND	ND
Vanadium	NA	0.003- 0.047 (2)	ND	NA	NA	7.7- 14 (4)
Zinc	0.07-4.7 (5)	6.7 -86 (2)	2.5 -5.6 (2)	33 -67 (3)	18 -95 (8)	44 - 173 (4)

(a)Number in parenthesis indicates number of samples with value above detection limit.
ND = not detected
NA = not analyzed

TABLE 4-2
SINCLAIR REFINERY SITE
BACKGROUND SOIL SAMPLES (A) (B) (MG/KG)

SAMPLE ID	SR-AB93-01	SR-AB93-02	SR-AB95-01	SR-AB95-02	SS1	SS2	SS18	SS37	SS38	SS39	MWB-61	MWB-63	MWDB-43
DEPTH INTERVAL (FT.): 1	0.0	8.0	0.0	8.0				0	0	0	5	0	0
DEPTH 2	0.5	10.0	0.5	10.0				3	3	3	32	20	47
DATE SAMPLED	11/03/88	11/03/88	11/03/88	11/03/88	Ph1	Ph1	Ph1	10/86	10/86	10/86	10/86	10/86	10/86
ALUMINUM	9470.	10900.	5200.	7060.									
ANTIMONY													162.
ARSENIC	8.4	11.	6.4		7.9	18	19						
BARIUM	162.	119.	28.	62.									
BERYLLIUM	0.4	0.560	0.35	0.26									0.5
CALCIUM	7590.	1520.	53800.	632.									
CHROMIUM	11.	15.	6.8	7.8	7.5	10	14	11.4		7.5	3.1	3.2	21.
COBALT	8.5	11.	5.8	8.1									
COPPER	13.	18.	20.	15.	7.2	12	10		5.9	5.6	8.9	11.3	15.3
IRON	20300.	27300.	13700.	16600.									
LEAD	94.	16.	7.5	15.	1.3	29	20	2.8	33.2	14.6	13.8	34.7	43
MAGNESIUM	2130.	3480.	12000.	2070.									
MANGANESE	953.	521.	420.	190.									
MERCURY	0.140												
NICKEL			14.	13.	24	22	33				7.1	15.2	19.1
POTASSIUM	1240.	1210.	635.	596.									
SILVER	2.4	2.7		1.4									
THALLIUM							0.41						
VANADIUM	14.	13.	7.8	7.7									
ZINC	173.	59.	57.	44.	33	59	67	53.3	37.3	32	18.4	26.7	64
CYANIDE						1.5	0.61						
ACETONE		0.017											
TOLUENE													0.006
PHENANTHRENE	3.0												
ANTHRACENE	0.22												
FLUORANTHRENE	5.7												
PYRENE	4.8												
BENZO(a)ANTHRACENE	2.3												
CHRYSENE	2.6												
BENZO(b)FLUORANTHENE	4.7												
BENZO(a)PYRENE	2.3												
INDENO[1,2,3-CD]PYRENE	1.6												
BENZO[g,h,i]PERYLENE	1.4												

(A) - LIST INCLUDES ALL METALS, VOCs AND BNAs DETECTED IN LISTED SAMPLES. BLANKS MAY INDICATE THAT COMPOUND WAS NOT ANALYZED, ANALYZED BUT RESULTS REJECTED OR ANALYZED BUT NOT DETECTED. SEE APPENDICES A AND B FOR THE COMPLETE RESULTS OF EACH SAMPLE.

(B) - CLAY WELLS NOT INCLUDED.

Ph1 - SAMPLE TAKEN IN PHASE I. EXACT SAMPLE DATE AND SAMPLE DEPTH IS NOT AVAILABLE.

TABLE 4-3
SINCLAIR REFINERY SITE
BACKGROUND GROUNDWATER SAMPLES (A) (B) (MG/L)

SAMPLE ID	MWDB43	SR-GW43-02	SR-GW43-02F	MW63	SR-GW63-02	SR-GW63-02F	MWB61
DEPTH INTERVAL (FT.): 1	34	34.0	34.0	10	10.0	10.0	7
DEPTH 2	44	44.0	44.0	20	20.0	20.0	17
DATE SAMPLED	12/09/86	11/30/88	11/30/88	11/26/86	11/18/88	11/18/88	11/26/86
ALUMINUM		32.1	0.055		1.91		
ARSENIC		0.041			0.022		
BARIUM		0.249	0.014		0.135	0.093	
BERYLLIUM		0.005					
CADMIUM					0.0075		
CALCIUM		138.	12.5		9.09	8.54	
CHROMIUM		0.064			0.061		
COBALT		0.04			0.0064		
COPPER		0.079			0.064		
IRON		79.	0.016		17.7	5.3	
LEAD	0.0497	0.073			0.688		
MAGNESIUM		10.7	2.58		2.86	2.54	
MANGANESE		2.4	0.206		2.93	2.76	
NICKEL		0.084			0.037		
POTASSIUM		10.	2.1		1.92	1.04	
SILVER			0.004				
SODIUM			2.32		6.92	6.37	
VANADIUM		0.047			0.0032		
ZINC	0.245	6.67	2.47	1.56	86.3	5.59	4.67
ACETONE					0.005		
CARBON DISULFIDE					0.0009		
1,1-DICHLOROETHANE					0.0001		
CHLOROFORM	0.0006						
1,1,1-TRICHLOROETHANE							0.0004
BENZENE							0.0003
TOLUENE							0.0031
BENZO(a)PYRENE	0.012						

(A) - LIST INCLUDES ALL METALS, VOCs AND BNAs DETECTED IN LISTED SAMPLES. BLANKS MAY INDICATE THAT COMPOUND WAS NOT ANALYZED, ANALYZED BUT RESULTS REJECTED OR ANALYZED BUT NOT DETECTED. SEE APPENDICES A AND B FOR THE COMPLETE RESULTS OF EACH SAMPLE.

(B) - CLAY WELLS NOT INCLUDED

TABLE 4-4
SINCLAIR REFINERY SITE
BACKGROUND GENESEE RIVER SEDIMENT SAMPLES (A) (MG/KG)

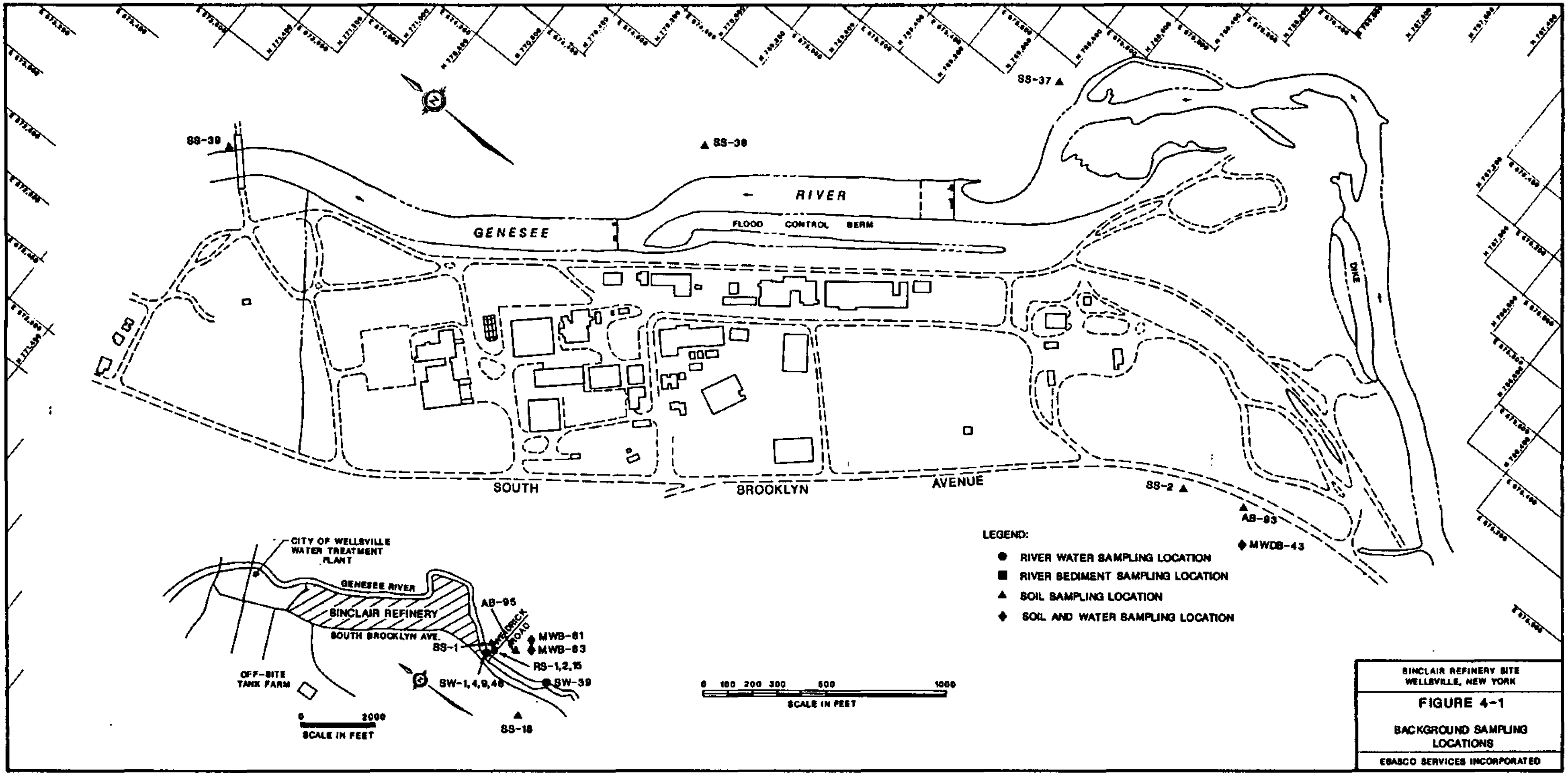
SAMPLE ID	SR-RS15-01	RS1	RS2
DEPTH INTERVAL (FT.): 1	0.0	0.0	0.5
DEPTH 2	0.5	0.5	2
DATE SAMPLED	10/28/88	8/21/84	8/21/84
ALUMINUM	5590.		
ARSENIC	6.6	13	8.9
BARIUM	73.		
BERYLLIUM	0.380		
CALCIUM	711.		
CHROMIUM	5.3	5.4	6.2
COBALT	7.6		
COPPER	8.8	6.0	8.2
IRON	15200.		
LEAD	7.1	8.8	12
MAGNESIUM	1510.		
MANGANESE	304.		
NICKEL	13.		
POTASSIUM	354.		
SILVER		6.4	
VANADIUM	6.		
ZINC	37.	51	166
CYANIDE		0.002	0.0006

A) - LIST INCLUDES ALL METALS, VOCs AND BNAs DETECTED IN LISTED SAMPLES. BLANKS MAY INDICATE THAT OMPOUND WAS NOT ANALYZED, ANALYZED BUT RESULTS REJECTED OR ANALYZED BUT NOT DETECTED. SEE APPENDICES A ND B FOR THE COMPLETE RESULTS OF EACH SAMPLE.

TABLE 4-5
SINCLAIR REFINERY SITE
BACKGROUND GENESEE RIVER SURFACE WATER SAMPLES (A) (MG/L)

SAMPLE ID DATE SAMPLED	SR-SW46-01 10/31/88	SW1 05/03/84	SW4 05/04/84	SW9 05/05/84	SW27 08/22/84	SW39 09/10/85	SW40 11/06/86	SW41 10/21/86
ALUMINUM	0.049							
BARIUM	0.065							
CADMIUM			0.009					
CALCIUM	18.9							
COPPER				0.007				
IRON	0.21							
LEAD						0.014	0.024	
MAGNESIUM	5.05							
MANGANESE	0.029							
MERCURY	0.00031		0.002					
NICKEL		0.031	0.012			0.46		
POTASSIUM	2.48							
SILVER			0.009	0.008				
SODIUM	10.8							
ZINC		0.017	0.010			0.039	0.031	0.086
PHENOL								0.042

(A) - LIST INCLUDES ALL METALS, VOCs AND BNAs DETECTED IN LISTED SAMPLES. BLANKS MAY INDICATE THAT COMPOUND WAS NOT ANALYZED, ANALYZED BUT RESULTS REJECTED OR ANALYZED BUT NOT DETECTED. SEE APPENDICES A AND B FOR THE COMPLETE RESULTS OF EACH SAMPLE.



SINCLAIR REFINERY SITE
WELLSVILLE, NEW YORK

FIGURE 4-1

BACKGROUND SAMPLING
LOCATIONS

EBASCO SERVICES INCORPORATED

4.1.1 Northern Oil Separator - Liquid Phase Samples

The northern oil separator is still directly connected to the site storm water system. As previously discussed (Section 3), runoff from the site and discharges to the sewer system (such as from steam cleaning of auto parts at the SUNY Campus) are still entering the separator.

Sampling of the separator consisted of two liquid phase samples (SW-33 and SW-34) during Phase IIa (Table 4-6). These were labeled as "oil phase" samples from the separator. Oily material was also observed floating in the separator during the Phase IIb field investigation. One of the samples, SW-33 contained elevated levels of several metals including arsenic, copper, lead, nickel and zinc. Levels of metal in SW-34 were generally lower than in SW-33. VOCs and BNAs showed similar patterns with concentrations of up to 42 mg/l for a single compound (chlorobenzene).

1,1,1-trichloroethane and trans-1,2-dichloroethane were both detected in the separator. Since these types of compounds have been commonly used at garages as well as other types of degreasing operations, it is likely that the compounds are related to recent site uses. Many of the other VOC and BNA compounds detected in the separator such as benzene, xylenes and other benzene related compounds, may be from recent site sources such as gasoline tanks present on the site or steam cleaning of car engines, or from former refinery operations.

The other separators were not sampled directly. However, outfalls from each of the separators were sampled and analyzed as discussed in Section 4.3.

4.1.2 Storm Water Sewers

Water and sediment samples were taken from the storm water sewer system. These samples are discussed below. In addition, soil borings and wells were drilled adjacent to the sewers. These samples are discussed in Subsection 4.5.2. Based on maps of contaminant distribution and the maps of the sewer system, the sewers are not a source of soil and groundwater contamination at the site. However, oily sediments are present within the sewers.

TABLE 4-6 (Page 1 of 2)

SUMMARY OF CHEMICAL ANALYSIS RESULTS(a)
SEWERS, OUTFALLS AND SEPARATOR

Concentration in mg/kg (Sediment) or mg/l (Water)

	Sewer Water Phase IIa (1986)	Sewer Water Phase IIb (1988)	Sewer Sediment Phase IIa (1986)	Outfall Water Phase I (1985)	Outfall Water Phase IIb (1988)	Outfall Sediment Phase I (1985)	Northern Separator Water Phase IIa (1986)
Number of Samples Analysed	3	1	3	3	1	3	2
VOCs							
Trans 1,1-Dichloroethene	0.003-0.14 (2)(b)	0.015 (1)	2.97 (1)	ND	ND	ND	0.055 -3.3 (2)
2-Butanone	0.024-3.2 (2)	ND	5.9- 36 (2)	ND	ND	ND	6.8(1)
1,1,1-Trichloroethane	0.032 (1)	ND	ND	ND	ND	ND	0.039 -1.1 (2)
1,1,2,2-Tetrachloroethane	0.24 (1)	ND	ND	ND	ND	ND	1.5 (1)
Trichloroethene	0.049 (1)	ND	5.9 (1)	0.002 (1)	ND	ND	0.03 -5 (2)
Benzene	0.004-0.28 (3)	0.014 (1)	0.006- 1.4 (3)	ND	0.0005(1)	ND	0.008 -3.3 (2)
2-Hexanone	0.019 (1)	ND	ND	ND	ND	ND	ND
Toluene	0.020 (1)	0.007 (1)	ND	ND	ND	0.96 (1)	ND
Xylene	0.003-0.14 (3)	0.036 (1)	0.008- 8.4 (3)	ND	ND	ND	2.7 (1)
Vinyl Acetate	0.002 (1)	ND	0.024- 5.5 (3)	ND	ND	ND	ND
Chlorobenzene	ND	ND	0.018- 3.3 (3)	ND	ND	ND	43 (1)
Ethylbenzene	ND	ND	ND	0.039 (1)	ND	ND	3.8 (1)
1,1-Dichloroethane	ND	ND	ND	ND	ND	ND	0.58 (1)
4-Methyl-2-Pentanone	ND	ND	ND	ND	ND	ND	20 (1)
Carbon Disulfide	ND	ND	ND	ND	ND	ND	0.11 (1)
BNAs							
Nitrobenzene	0.019 (1)	ND	ND	ND	ND	ND	ND
Butyl-Benzyl Phthalate	0.026 (1)	ND	1.3 (1)	ND	ND	ND	1.7 (1)
Napthalene	ND	ND	3.3 (1)	0.002 (1)	ND	ND	0.0009-0.15 (2)
2-Methylnapthalene	0.014 (1)	ND	1.6- 16 (2)	ND	ND	ND	0.002 -0.71 (2)
Phenol	NA	0.015 (1)	NA	NA	ND	NA	NA
Methylphenol	NA	0.015 (1)	ND	ND	ND	ND	ND
Di-n-Octyl Phthalate	0.01 -0.12 (3)	ND	1.6 (1)	ND	ND	ND	0.1 (1)
Benzo(k)Fluoranthene	0.024-0.35 (3)	ND	2.1 - 9.8 (3)	ND	ND	ND	0.58 (1)
Metals							
Aluminum	NA	5.4 (1)	NA	NA	0.040(1)	NA	NA
Antimony	ND	ND	ND	ND	ND	ND	ND
Arsenic	0.032 -0.035 (2)	0.010 (1)	4.2 - 18.4 (2)	0.006-0.013(2)	ND	0.017-0.052(2)	0.012 -0.65 (2)
Barium	NA	0.128 (1)	NA	NA	0.053(1)	NA	NA
Beryllium	ND	ND	ND	0.004 (1)	ND	ND	ND
Cadmium	0.004 (1)	ND	0.7 - 7.1 (3)	0.008 (1)	ND	ND	ND
Calcium	NA	30.8 (1)	NA	NA	39.2 (1)	NA	NA
Chromium	ND	0.051 (1)	18.6 (1)	0.01 (2)	ND	0.009-0.027(3)	ND
Cobalt	NA	0.006 (1)	NA	NA	ND	NA	NA
Copper	0.046-0.45 (3)	0.033 (1)	198 -1180	0.006-0.016(2)	ND	0.015-0.071(3)	0.03 -0.38 (2)
Iron	NA	10.5 (1)	NA	NA	0.23 (1)	NA	NA
Lead	0.060-0.37 (3)	0.06 (1)	111 - 663 (3)	0.012-0.041(2)	ND	0.037-0.26 (3)	0.81 -4.1 (2)

TABLE 4-6 (Page 2 of 2)

SUMMARY OF CHEMICAL ANALYSIS RESULTS(a)
SEWERS, OUTFALLS AND SEPARATOR

Concentration in mg/kg (Sediment) or mg/l (Water)

	Sewer Water Phase IIa (1986)	Sewer Water Phase IIb (1988)	Sewer Sediment Phase IIa (1986)	Outfall Water Phase I (1985)	Outfall Water Phase IIb (1988)	Outfall Sediment Phase I (1985)	Northern Separator Water Phase IIa (1986)
Number of Samples Analysed	3	1	3	3	1	3	2
<u>Metals</u> (Cont'd)							
Magnesium	NA	4.74	NA	NA	9.55 (1)	NA	NA
Manganese	NA	0.594	NA	NA	0.026 (1)	NA	NA
Mercury	ND	ND	ND	ND	ND	0.001-0.0016 (3)	ND
Nickel	0.046-2.3 (3)	0.022	37 - 83 (3)	0.021 (1)	ND	0.024-0.046 (3)	0.2- 2.6 (2)
Potassium	NA	5.4	NA	NA	2.8 (1)	NA	NA
Selenium	ND	ND	ND	ND	ND	ND	ND
Silver	0.007 (1)	ND	0.24- 0.85(3)	ND	ND	ND	ND
Sodium	NA	40.7	NA	NA	17.2 (1)	NA	NA
Thallium	ND	ND	ND	ND	ND	ND	ND
Vanadium	ND	0.008	ND	ND	ND	ND	ND
Zinc	0.21- 0.89 (3)	0.19	440 -2040 (3)	0.011-0.02(2)	ND	0.094-0.75 (3)	0.60- 0.61 (2)

(a) Compounds listed include all compounds detected two or more times in any phase and all indicator chemicals detected. If only one sample was analyzed (e.g., Sewer Water Phase IIb) all compounds detected are listed.

(b) Value in parenthesis indicates number of samples with value above detection limit.

ND = not detected
NA = not analyzed

4.1.2.1 Water

Four samples were taken from the storm water sewer, three in Phase IIa and one in Phase IIb (Table 4-6). The Phase IIb and one of the Phase IIa samples were taken at the same location (MH-01), near the northern separator. The samples from water in the sewers showed that metals were present in the water, but at very variable concentrations at different locations on the site; VOCs and BNAs were also detected.

The concentrations measured at MH-01, a manhole near the northern separator, generally decreased between Phase IIa and b. For example, the number of VOCs detected at MH01 decreased from six to four, with trans-1,2 dichloroethane decreasing from 0.14 to 0.015 mg/l, benzene decreasing from 0.048 to 0.014 mg/l, and xylene decreasing from 0.102 to 0.036 mg/l. Toluene, not detected in Phase IIa was detected at 0.007 mg/l in Phase IIb. BNAs showed a similar trend, with no BNA analyzed and detected in Phase IIa detected in Phase IIb, but two BNAs, not analyzed in Phase IIa (phenol and methylphenol) detected in Phase IIb.

The low levels of chlorinated solvents and components of gasoline (benzene, xylene and toluene) detected at MH-01 in Phase IIb may be attributed to steam cleaning of car parts at SUNY, runoff from nearby parking areas or other discharges to the storm water sewer system. Metals also showed some decreases at this location (MH-01). Arsenic, copper, lead, nickel and zinc concentrations varied from 0.032 to 0.010 mg/l, 0.046 to 0.033 mg/l, 0.37 to 0.06 mg/l, 2.3 to 0.02 mg/l and 0.22 to 0.19 mg/l in Phase I and Phase IIb, respectively. Chromium and vandium, not detected in Phase IIa were detected at 0.051 mg/l and 0.008 mg/l, respectively, in Phase IIb.

The other two sewers, sampled only in Phase IIa, also showed that metals, VOCs and BNAs were present. The BNA concentrations were highest at MH-3 in the southern portion of the site. Some chlorinated solvents as well as benzene and xylene were also present. The compounds benzene and xylene could be from recent site uses or refinery operations, while some of the BNAs could be from refinery operations or recent site uses such as the asphaltic pipe coating operation in Butler-Larkin's storage area.

4.1.2.2 Sediments

Three samples of sewer sediments were obtained in Phase IIa (Table 4-6). Sewer sediments were not analyzed in Phase IIb.

The concentration of compounds in sewer sediments was generally higher than in sewer water. This indicates that most of the compounds have either low solubilities or sorb preferentially to the sediments. The southern sewer again showed the highest levels of BNAs. The VOCs and metals detected showed a similar distribution to the sewer water samples.

4.1.3 Abandoned Powerhouse

Two samples were collected from the abandoned powerhouse. One was nondetect for asbestos and the other had a level of 30 percent chrysotile. The sample containing chrysotile was described as "gray to white low density fibrous material with a chalky appearance."

4.1.4 Other - Stone House

One soil sample was taken during Phase I at the stone house (see Figure 1-2). The structure was located in the area of Butler-Larkin's equipment storage area. It appears that given the generally low levels of contaminants, the stone house would not serve as a source for contaminant release (all compounds detected were at or near background levels). The prior use of the building is not known, however, the building is in an area currently used by Butler-Larkin, apparently for cutting pipes.

4.2 GENESEE RIVER

4.2.1 Surface Water

Surface water quality in the Genesee River does not appear to be affected by the Sinclair Refinery Site. Aluminum (0.028-0.059 mg/l), barium (0.071-0.075 mg/l) calcium (19.5-19.7 mg/l), iron (0.44-0.65 mg/l), magnesium (5.1 mg/l), mercury (0.0004 mg/l), potassium (2.5 mg/l) and zinc (10 mg/l) were each detected in surface water in Phase IIb. Each of these are comparable to the background levels detected of 0.049 (Al), 0.065 (Ba), 18.9 (Ca), 0.21 (Fe), 5.1 (Mg), 0.0004 (Hg), 2.5 (K) and 11 (Zn) mg/l respectively. Cobalt was detected in one downgradient sample at 0.006 mg/l, but not detected in the background or the other downgradient sample. Manganese was detected at levels of 0.13 and 0.15 mg/l downgradient compound to 0.029 mg/l upgradient of the site.

The metals detected in surface water in Phase I and IIa (arsenic (0.045-0.089 mg/l), cadmium (0.005-0.008 mg/l), copper (0.005-0.055), lead (0.011-0.051 mg/l), mercury (0.002 mg/l), nickel (0.005-1.3 mg/l), silver (0.006 mg/l) and zinc (0.009-0.26 mg/l)), were at non-detectable levels in Phase IIb as shown on Table 4-7, except for mercury. Each of the metals (except arsenic) was also detected in Phase I and IIb in background samples (no Phase IIa background was taken), usually at similar levels (cadmium 0.009 mg/l, copper 0.007 mg/l, lead 0.014-0.024 mg/l, mercury 0.002 mg/l, nickel 0.012-0.46 mg/l, silver 0.008-0.009 mg/l, and zinc 0.01-0.086 mg/l). The presence of these compounds in the background samples may indicate that they were associated with off-site, upstream sources, and not the Sinclair site. However, the number of samples where these compounds were detected, and the number of background samples were too small to be able to determine if any statistically relevant increase in concentrations occurred. For example, all of the metals detected in Phase I were detected in only one or two out of 18 downgradient samples compared to one or two out of four background samples. Arsenic, detected only in a downgradient sample was found in only one of 18 Phase I samples and 1 of 3 Phase IIa samples.

Regardless of the source of the metals, the Phase IIb data demonstrate that the metals detected in Phase I and IIa in the river are no longer at detectable levels and that therefore the site is not currently contributing any of these metals to the river at detectable (if any) levels.

Since the Genesee River is a dynamic system with continually changing water quality related to water levels and precipitation events, it is assumed that the Phase IIb data, as the most recent data, are the most representative data for current levels of metals in the River. The Phase IIb data (Table 4-7) show that aluminum, barium, calcium, cobalt, iron, magnesium, manganese,

TABLE 4-7

CHEMICALS DETECTED IN GENESEE RIVER WATER AND SEDIMENTS$^{(a)}$

RANGE OF CONCENTRATIONS

	River Water (mg/l)			Sediment (mg/kg)		
	Phase I (1985)	Phase IIa (1986)	Phase IIb (1988)	Phase I (1985)	Phase IIa (1986)	Phase IIb (1988)
Number of Samples Analyzed	18	3	$2^{(c)}$	6	4	$2^{(c)}$
VOLATILES						
Trans-1,2-Dichloroethene	0.002-0.019(3)$^{(b)}$	0.026-0.028 (2)	NA	ND	0.007 (1)	ND
2-Butanone	ND	0.008-0.013 (2)	NA	ND	0.032- 0.22 (3)	ND
1,1,1-Trichloroethane	ND	0.016 (1)	NA	ND	0.001 (2)	ND
Trichlorothene	ND	0.013 (1)	NA	ND	ND	ND
Benzene	ND	0.004 (1)	NA	ND	0.002- 0.011 (3)	ND
Chlorobenzene	0.010 (1)	ND	NA	ND	0.058 (1)	ND
Vinyl Acetate	ND	ND	NA	ND	0.003- 0.009 (2)	ND
1,1,2,2 - Tetrachloroethane	ND	ND	NA	ND	0.095 (1)	ND
2-Hexanone	ND	ND	NA	ND	0.006 (1)	ND
Toluene	ND	ND	NA	ND	0.005- 0.006 (2)	ND
Ethylbenzene Xylene	ND	ND	NA	ND	0.007 (1)	ND
BNAs	ND	ND	NA	ND	0.003- 0.071 (2)	ND
Nitrobenzene	0.002-0.02 (4)	0.003 (1)	NA	ND	ND	ND
Butylbenzylphthplate	ND	0.005 (1)	NA	ND	0.054- 0.078 (2)	ND
2-Methylnapthalene	ND	ND	NA	ND	0.074- 0.11 (2)	ND
Diethylphthalate	ND	ND	NA	ND	0.053- 0.055 (2)	ND
Phenanthrene	ND	ND	NA	ND	0.052- 0.053 (2)	ND
METALS						
Aluminum	NA	NA	0.028 - 0.059 (2)	NA	NA	3,500 - 5,300 (2)
Arsenic	0.089 (1)	0.045 (1)	ND	0.4 - 28 (6)	2.4 - 98.3 (4)	5.9- 6.2 (2)
Barium	NA	NA	0.071 - 0.075 (2)	NA	NA	45 - 124 (2)
Cadmium	0.005-0.008 (2)	ND	ND	1.2 (7)	ND	ND
Calcium	NA	NA	19.5 - 19.7 (2)	NA	NA	844 - 965 (2)
Chromium	ND	ND	ND	5.4 - 22 (6)	13 (1)	5 - 5.9 (2)
Cobalt	NA	NA	0.006 (1)	NA	NA	4.8- 6.7 (2)
Copper	0.005-0.008 (2)	0.018-0.055 (3)	ND	5.9 - 43 (6)	4.6 - 188 (4)	13 (1)
Iron	NA	NA	0.44 - 0.65 (2)	NA	NA	9,100 -17,300 (2)
Lead	ND	0.011-0.051 (3)	ND	8.5 - 43 (6)	2.3 - 11.4 (3)	5.6- 7.1 (2)
Magnesium	NA	NA	5.1 (2)	NA	NA	1,320 - 1,590 (2)
Manganese	NA	NA	0.13 - 0.15 (2)	NA	NA	185 - 597 (2)
Mercury	0.002 (1)	ND	0.0004 (1)	0.06- 0.1 (2)	ND	ND
Nickel	0.005-0.013 (2)	0.53 -1.3 (3)	ND	0.9 - 4.7 (6)	17 - 357 (4)	9.4- 13 (2)
Potassium	NA	NA	2.5 (2)	NA	NA	278 - 375 (2)
Silver	0.006 (1)	ND	ND	0.76- 12 (5)	0.056- 0.58 (3)	ND
Vanadium	NA	NA	ND	NA	NA	4.4- 7.7 (2)
Zinc	0.009-0.26 (5)	0.033-0.081 (3)	ND	25 -116 (6)	6.8 -1,030 (4)	25 - 39 (2)
Sodium	NA	NA	10 (2)	NA	NA	ND

(a) Compounds listed include all compounds detected two or more times in these media, in any phase, and all indicator chemicals detected.
(b) Value in parenthesis indicates number of samples with value above detection limit.
(c) One sample was analyzed in duplicate. Value reported for duplicate sample is average of two values.
ND = not detected
NA = not analyzed

mercury, potassium, and sodium are present in the river. These compounds (except mercury) were not analyzed in Phase I and IIa. Each of the compounds (except cobalt) was also detected in the background sample, generally at comparable levels (see Tables 4-1 and 4-7).

In Phase IIa, some VOCs were also detected. The primary group of compounds detected, the chlorinated hydrocarbons, are not known to have been used during refinery operation. However, these are the types of compounds (chlorinated hydrocarbon solvents) that Butler-Larkin and Mapes were alleged to have disposed at the site (NYSDEC, 1986; People vs Mapes, 1983). Nitrobenzene, a BNA, was detected in the river water in both Phase I and IIa at levels varying from 0.002 to 0.02 mg/l.

4.2.2 Sediments

Metals in Genesee River sediments, as in river water, showed variable results in the various phases of sampling (Table 4-7). However, levels were generally at background levels, and in Phase IIb all metals were at site-soil background levels. The range of concentrations for the metals detected in the sediment compared to upstream sediment background are: aluminum (3,500-5,300 vs 5,590 mg/kg) arsenic (5.9-6.2 vs 6.6 mg/kg), barium (45-124 vs 73 mg/kg) beryllium (not detected vs 0.38 mg/kg), calcium (844-965 vs 711 mg/kg), chromium (5-5.9 vs 5.3 mg/kg), cobalt (4.8-6.7 vs 7.6 mg/kg), copper (13 vs 8.8 mg/kg), iron (9,100-17,300 vs 15,200 mg/kg), lead (5.6-7.1 vs 7.1 mg/kg), magnesium (1,320-1,590 vs 1,510 mg/kg), manganese (185-597 vs 304 mg/kg), nickel (9.4-13 vs 13 mg/kg), potassium (278-375 vs 354 mg/kg), vanadium (4.4-7.7 vs 6 mg/kg), and zinc (25-39 vs 37 mg/kg). Where duplicate samples were available (i.e. for sample RS-16) the two results were averaged to obtain the value for that location, used to develop the range for metals on Table 4-7, and listed above.

VOCs and BNAs were analyzed at detectable levels in 1986 but were not detected in the last round of sampling in 1988. The analytical results are summarized on Table 4-7. The last round of samples (Phase IIb) are considered most representative of actual site conditions since the river and its sediments constitute a dynamic, changing system and the Phase IIb data are the latest data available for metals, VOCs, and BNAs.

4.3 SWALES AND OUTFALLS

4.3.1 Water

The drainage swale surface water samples in Phase IIa showed four metals present (Table 4-8). The range of concentrations for the metals detected in surface water in the swale compared to background Genesee River water in Phase IIb are: aluminum (0.029-0.44 vs 0.049 mg/l), barium (0.091-0.20 vs 0.065 mg/l), calcium (22.9-31.3 vs 18.9 mg/l), cobalt (0.005 vs not detected), iron (2.0-3.0 vs 0.2 mg/l), magnesium (6.8-11.2 vs 5.1 mg/l), manganese (1.4-3.7 vs 0.03 mg/l), mercury (0.0002 vs 0.0002), and potassium (2.4-3.4 vs 2.5). BNA compounds were also detected in earlier (Phase IIa) samples but were not detected in Phase IIb. Volatile aromatics were detected at low levels in Phase IIb. The difference in the two sets of data indicate that improvements in water quality have occurred.

The outfalls discharging to the swale and river also had decreases in concentrations over the period of the site investigation. OF-2 sampled in Phase IIb contained no BNAs, or levels of metals above background, and benzene was the only VOC detected at an estimated level of 0.005 mg/l. This compared to three BNAs (1,4-dichlorobenzene (0.029 mg/l);naphthalene (0.002 mg/l); and N-nitrosodiphenylamine (0.005 mg/l), and ethylbenzene at 0.039 mg/l detected in the same outfall in Phase I.

4.3.2 Sediments

As shown on Table 4-8 sediments in the swale also generally showed decreases in levels and numbers of contaminants detected between Phase IIa and b (Table 4-8). Lead decreased from levels as high as 802 mg/kg in Phase IIa to a range of only 8-25 mg/kg in Phase IIb, within background levels of 1.3-94 mg/kg. This decrease occurred for most metals, excluding arsenic. In Phase IIb, arsenic (ranging from 3.6-46 mg/kg) was measured at higher levels than in Phase IIa (1.4-7.4 mg/kg) and at above background concentrations (6.4-19 mg/kg).

TABLE 4-8

DRAINAGE SWALE SAMPLES
SEDIMENT AND WATER ANALYSES[a]

	Water Analyses (mg/l)		Sediment Analyses (mg/kg)		Background[b]
Compound	Phase IIa 4 Samples	Phase IIb 3 Samples	Phase IIa 8 Samples	Phase IIb 9 Samples	Soil (mg/kg)
VOLATILES					
2-Butanone	0.0067-0.0072 (3)[c]	ND	0.013 - 0.074 (5)	ND	ND
1,1,1 Trichloroethene	0.0021-0.37 (3)	ND	ND	ND	ND
Benzene	0.009 -0.0013 (2)	0.002 (1)	0.0022- 0.12 (7)	0.036 (1)	ND
Ethylbenzene	ND	0.0001-0.0013 (2)	ND	ND	ND
Total Xylenes	ND	0.001 -0.005 (2)	ND	ND	ND
Toluene	ND	0.0067 (1)	0.0018- 0.0047 (2)	ND	ND
Carbon disulfide	ND	ND	0.0027- 0.6068 (3)	ND	ND
2-Hexanone	ND	ND	0.051 (1)	ND	ND
1,1,2,2-Tetrachloroethane	ND	ND	0.031 (1)	ND	ND
BNAs					
Nitrobenzene	0.0013 (1)	ND	ND	ND	ND
Benzo(k)fluoranthene	0.0102 (1)	ND	0.32 - 0.59 (6)	ND	ND
Benzo(a)pyrene	0.0071 (1)	ND	0.29 - 0.86 (3)	ND	ND-2.3
Butyl-benzyl phthalate	0.0012-0.047 (4)	ND	0.091 - 0.12 (2)	ND	ND
Phenanthrene	ND	ND	0.11- 0.63 (4)	1.8 (1)	ND-3.0
Anthracene	ND	ND	0.029 - 0.078 (3)	ND	ND-0.2
Fluoranthene	ND	ND	0.033 - 1.2 (5)	ND	ND-5.7
Pyrene	ND	ND	0.036 - 0.99 (5)	ND	ND-4.8
Benzo(a)Anthracene	ND	ND	0.079 - 0.33 (4)	ND	ND-2.3
Chrysene	ND	ND	0.93 - 0.52 (4)	ND	ND-2.6
Bis(2-ethylhexyl)phthalate	ND	ND	ND	0.5-0.7(2)	ND-0.3
INORGANICS					
Copper	0.026 -0.048 (3)	ND	1.1 -147 (8)	6.6 - 18 (10)	5.6 -20
Lead	0.0051-0.155 (4)	ND	16.5 -802 (7)	8 - 25 (10)	1.3 -94
Nickel	0.244 -1.62 (4)	ND	16.1 -272 (6)	8 - 23 (10)	7.1 -40
Zinc	0.046 -0.33 (4)	ND	43.5 -172 (8)	26 - 64 (10)	18.4 -173
Mercury	ND	0.0002 (1)	ND	ND	ND-0.14
Arsenic	ND	ND	1.4 - 7.4 (6)	3.6 - 46 (8)	6.4 -19
Selenium	ND	ND	0.13 - 0.17 (2)	ND	ND
Chromium	ND	ND	10.9 - 34.2 (6)	3.7 - 13 (10)	3.1 -21
Barium	NA	0.091 -0.202 (3)	NA	49 -187 (10)	28 -162
Cobalt	ND	0.0052 (1)	ND	2.7 - 11 (10)	5.8 -11
Silver	ND	ND	0.047 - 0.24 (8)	ND	1.4 -2.7
Thallium	ND	ND	8.1 - 11.6 (2)	ND	0.41
Vanadium	ND	ND	ND	6.4 - 16 (10)	7.7 -14
Aluminum	NA	0.029-0.442 (2)	NA	4,230-11,500 (10)	5,200-10,900
Calcium	NA	22.9 -31.3 (3)	NA	1,080- 9,320 (3)	632-53,800
Iron	NA	2.0 -3.0 (2)	NA	11,700-40,300 (10)	13,700-27,300
Magnesium	NA	6.8 -11.2 (3)	NA	1,680- 5,630 (3)	2,070-12,000
Manganese	NA	1.4 -3.7 (3)	NA	208- 2,670 (10)	190- 953
Potassium	NA	2.4 -3.4 (3)	NA	313- 1,790 (10)	596- 1,240

(a) Compounds listed include all compounds detected two or more times in these media in any phase, and all indicator chemicals detected.
(b) Background value listed is highest value detected in a background soil sample.
(c) Value in parenthesis indicates number of samples with value above detection limits.
ND = not detected
NA = not analyzed

The range of concentration of metals detected in the swale compared to off-site soil (background) values are: arsenic (3.6-46 vs 6.4-19 mg/kg), barium (49-187 vs 28-162 mg/kg), chromium (3.7-13 vs 3.1-21 mg/kg) cobalt (2.7-11 vs 5.8-11 mg/kg), copper (6.6-18 vs 5.6-20 mg/kg), lead (8-25 vs 1.3-94 mg/kg), nickel (8-23 vs 7.1-40 mg/kg), vanadium (6.4-16 vs 7.7-14 mg/kg), zinc (26-64 vs 18.4-173 mg/kg), aluminum (42.30-11,500 vs 5,200-10,900 mg/kg), calcium (1,080-9,320 vs 632-53,800 mg/kg), iron (11,700-40,300 vs 13,700-27,300 mg/kg) magnesium (1,680-5,630 vs 2,070-12,000 mg/kg) manganese (208-2,670 mg/kg vs 190-953), and potassium (313-1,790 vs 596-1,240 mg/kg).

VOCs in swale and outfall sediments also decreased during the project. In Phase IIb, the only VOCs detected in swale sediments were acetone (a probable sampling contaminant) at a level of 0.018 mg/kg and benzene at a level of 0.036 mg/kg, each detected in a single sample at auger boring AB86. Each of the three samples from AB86 also contained one or two BNA compounds. The surface sample contained 2-methyl-napthalene and phenanthrene at concentrations of 4.6 and 1.8 mg/kg, respectively. The subsurface samples both contained bis(2-ethylhexyl) phthalate at concentrations of 0.67 mg/kg (2- to 4-foot depth) and 0.48 mg/kg (8-to 10-foot depth). This is a common laboratory and sampling contaminant. These levels of BNAs were comparable to Phase IIa levels, though the number of compounds detected and their frequencies of detection both decreased.

4.4 SEEPS AND POOLS

Seeps and pools were sampled in Phase I and some of the seeps were again sampled in Phase IIb.

4.4.1 Water

The samples of the water from the four seep and two pool samples generally contained few, if any contaminants. BNAs were detected in only one of the samples (a Phase I seep sample) and VOCs were detected in only two seep samples in Phase IIb and one in Phase I. One Phase IIb seep sample contained ethylbenzene at a concentration of 0.007 mg/l and the other contained benzene at a level of only 0.0006 mg/l. Acetone at 0.04 mg/l was also detected but it is likely a sampling contaminant. The Phase I sample (SP-24) with VOCs contained benzene (0.12 mg/l), ethylbenzene (0.2 mg/l) and toluene (0.05 mg/l). Arsenic at a level of 0.025 mg/l was detected in a Phase IIb sample and arsenic (0.011-0.031 mg/l), lead (5-108 mg/l) and nickel (5-37 mg/l) were detected in some of the Phase I samples.

4.4.2 Sediment

VOCs and BNAs were not detected in seep and pool sediments in Phase IIa. However, elevated levels of arsenic and lead were detected in some samples. The elevated arsenic values were primarily in seep sediment samples and the elevated lead values in pool samples, away from the main drainage swale.

4.5 SOILS

4.5.1 Surface Soil

Twenty-four surface soil samples were taken across the site during Phase I and Phase IIa (Table 4-9). Fourteen of them, taken during Phase I, were analyzed for metals, VOCs, BNAs, and pesticides/PCBs. The remaining 10 samples were taken during Phase IIa and were analyzed for metals only. The Phase I and IIa samples were composited over areas of up to 250,000 sq. ft. Consequently, the data is indicative of the general distribution of compounds on the site, but does not allow the definition of specific areas of contamination. The Phase IIb sampling was designed to investigate specific point concentrations, at potential problem areas identified from a review of the Phase I and IIa data.

The Phase IIb surface soil samples were taken both from points around the refinery and from the test pits that were dug near the former (southern) and northern separators. The surface samples were tested for metals only, while the test pit soils were analyzed for TCL metals, VOCs and BNAs.

TABLE 4-9

CHEMICALS DETECTED IN REFINERY AREA SURFACE SOILS[(a)]

RANGE OF CONCENTRATIONS (mg/kg)

	Phase I[(c)] (1985)	Phase IIa[(c)] (1986)	Phase IIb (1988)	Background[(b)]
Number of Samples Analyzed	14	10	35[(d)]	
Volatiles				
Methyl Chloride	0.076- 0.10 (2)[(e)]	NA	ND	ND
BNAs				
2-Methylnapthalene	ND	NA	0.38-13 (2)	ND
Phenanthrene	1.0 (1)	NA	0.27- 0.37 (1)	ND-3.0
Fluoranthrene	1.7 - 2.5 (2)	NA	0.32 (3)	ND-5.7
Pyrene	1.0 - 2.8 (3)	NA	0.34- 0.46 (3)	ND-4.8
Benzo(a)anthracene	1.5 - 7.5 (4)	NA	ND	ND-2.3
Benzo(b)fluoranthene	2.0 - 5.0 (2)	NA	0.42 (1)	ND-4.7
Benzo(a)pyrene	2.0 - 3.6 (2)	NA	0.25- 0.72 (3)	ND-2.3
Di-n-butylphthalate	ND	NA	0.13- 0.88 (2)	ND
Metals				
Aluminum	NA	NA	3470 -14,850 (35)	5,200 -10,900
Antimony	0.68 (1)	12.5-182 (3)	5.1 - 12 (4)	ND - 162
Arsenic	13 - 31 (14)	ND	4.3 - 43 (32)	6.4 - 19
Barium	NA	NA	28 - 3,130 (35)	28 - 162
Beryllium	0.5 - 1.2(4)	ND	0.24- 51 (29)	0.26- 0.56
Cadmium	NA	NA	1.1 - 3.5 (8)	ND
Calcium	NA	NA	1580 -53,800 (20)	632 -53,800
Chromium	9.2 - 26 (14)	6.3- 29.6 (9)	6.8 - 23 (26)	3.1 - 21
Cobalt	NA	NA	5.1 - 11.5 (35)	5.8 - 11
Copper	14 - 47 (14)	10 - 53 (10)	9.6 - 272 (34)	5.6 - 20
Iron	NA	NA	13700 -43,600 (35)	13,700 -27,300
Lead	53 -1,190 (4)	28 -373 (9)	7.5 - 1,020 (35)	1.3 - 94
Magnesium	NA	NA	486 -12,000 (31)	2,070 -12,000
Manganese	NA	NA	204 - 1,100 (35)	190 - 953
Mercury	0.07 - 1.9(14)	0.1 (1)	0.13- 9.4 (13)	ND - 0.14
Nickel	15 - 49 (14)	9.1- 26.1 (10)	7.2 - 26 (31)	7.1 - 40
Potassium	NA	NA	353 - 1,460 (32)	596 - 1,240
Silver	NA	NA	1 - 2.4 (20)	1.4 - 2.7
Sodium	NA	NA	42.5 - 314 (2)	ND
Thallium	0. 47- 0.98(4)	ND	2.0 (1)	ND - 0.41
Vanadium	NA	NA	7.8 - 19 (34)	7.7 - 14
Zinc	58 - 244 (14)	41 -131 (10)	45 - 586 (32)	18.4 - 173

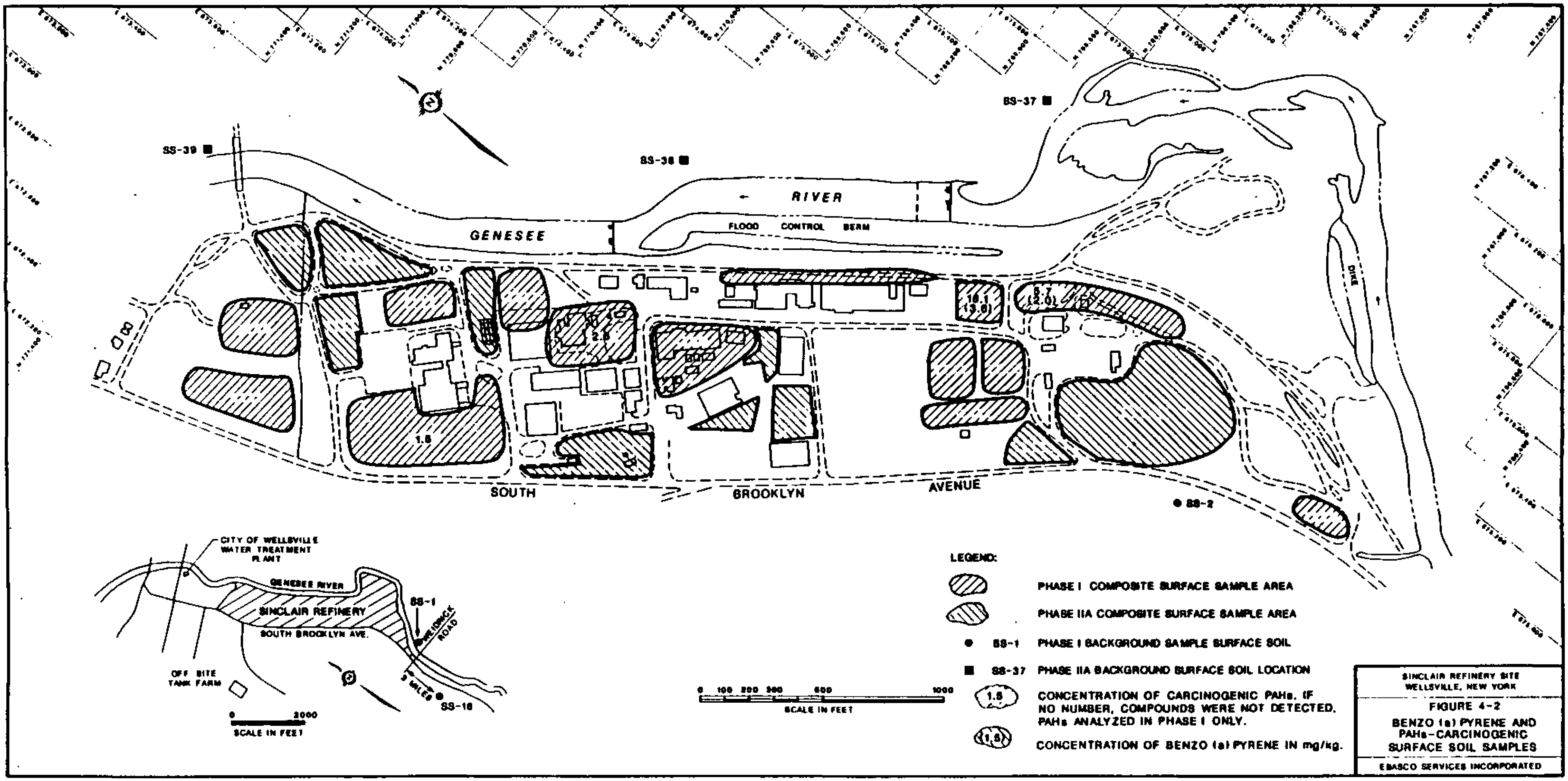
(a) Compounds listed include all compounds detected two or more times in this media, in any phase, and all indicator chemicals detedted.
(b) Background value listed is the highest value detected in a background soil sample.
(c) Composite samples
(d) includes 10 near surface test pit samples analyzed for volatiles, BNAs and metals and 22 surface soils for metals only
(e) Value in parenthesis indicates number of samples with value above detection limits.
ND = not detected, NA = not analyzed

The Phase I data showed that no VOCs (except methyl chloride, a probable laboratory contaminant) were present in the surface soils (Table 4-9). Figure 4-2 shows the concentration of benzo(a)pyrene and potentially carcinogenic polycyclic aromatic hydrocarbons (PAHs), a group of BNA compounds, detected in the surface soils in Phase I. Figure 4-3 shows the concentration of total PAHs in the surface soil.

Several metals, including lead, were detected in Phase I. Based on these results, additional sampling for metals was performed in Phase IIa and b. The Phase IIa data also showed elevated levels of lead, and elevated levels of antimony were also detected in a few samples. However, the highest antimony values, including a concentration of 162 mg/kg in a background sample, were all detected in one set of data analyzed by the laboratory. This indicates contamination of the samples in the field or a laboratory error, giving invalid data results or naturally elevated levels. In the Phase IIb sampling, antimony was only detected at low levels (5.1 to 12 mg/kg) in four samples (Table 4-9) indicating that the few elevated Phase IIa values were the result of a field or laboratory error.

After Phase IIa, the northern end of the site generally appeared to have the highest metal concentrations. The highest lead and zinc concentrations were all located there. Arsenic, however, had been found in all Phase I samples in fairly even concentrations but not in Phase IIa samples. Likewise, mercury was present in all Phase I samples but in only one Phase IIa sample. This suggested that the presence (or lack) of arsenic and mercury was due to an analytical error. The Phase IIb sampling, as described below, confirmed the presence of low levels of mercury and arsenic at the site.

A total of 22 metals were detected in the Phase IIb samples (See Table 4-9 and Appendix A). Arsenic (4.3-43 mg/kg), chromium (6.8-23 mg/kg), lead (7.5-1,020 mg/kg), vanadium (7.8-19 mg/kg) and zinc (45-586 mg/kg) were detected in all samples with valid analyses and all had at least one value which exceeded the range of measured off-site (background) concentrations (arsenic 6.4-19 mg/kg, chromium 3.1-21 mg/kg, lead 1.3-94 mg/kg, vanadium 7.7-14 mg/kg and zinc 18-173 mg/kg) in limited areas. These background values include sample



SINCLAIR REFINERY SITE
WELLSVILLE, NEW YORK

FIGURE 4-2

BENZO (a) PYRENE AND PAHs-CARCINOGENIC SURFACE SOIL SAMPLES

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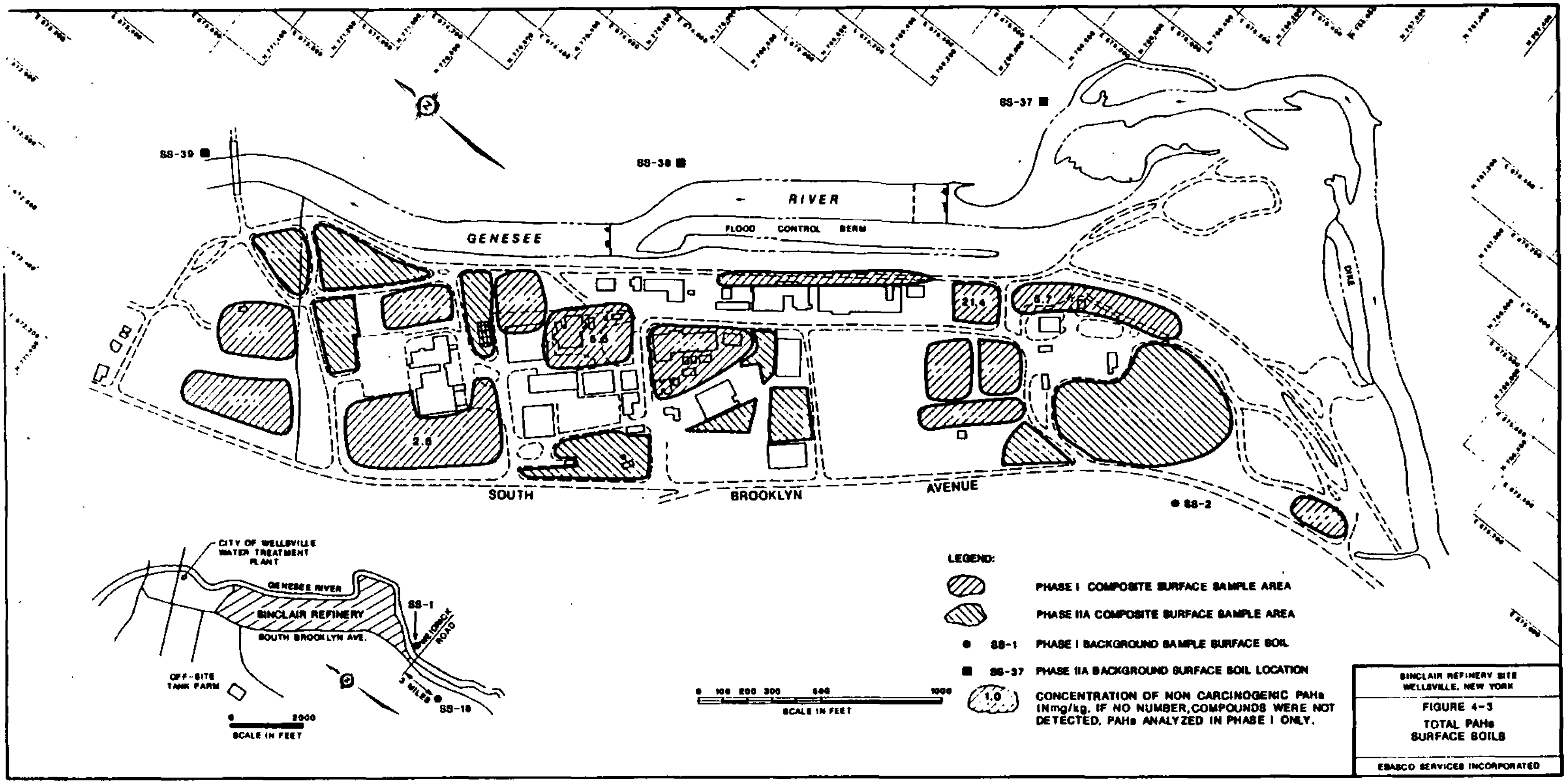

SINCLAIR REFINERY SITE
WELLSVILLE, NEW YORK

FIGURE 4-3
TOTAL PAHs
SURFACE SOILS

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results which may have been influenced by man's activities in the area (such as from runoff from roadways). However, these values may also be considered indicative of conditions which can be anticipated on-site near parking areas or roadways.

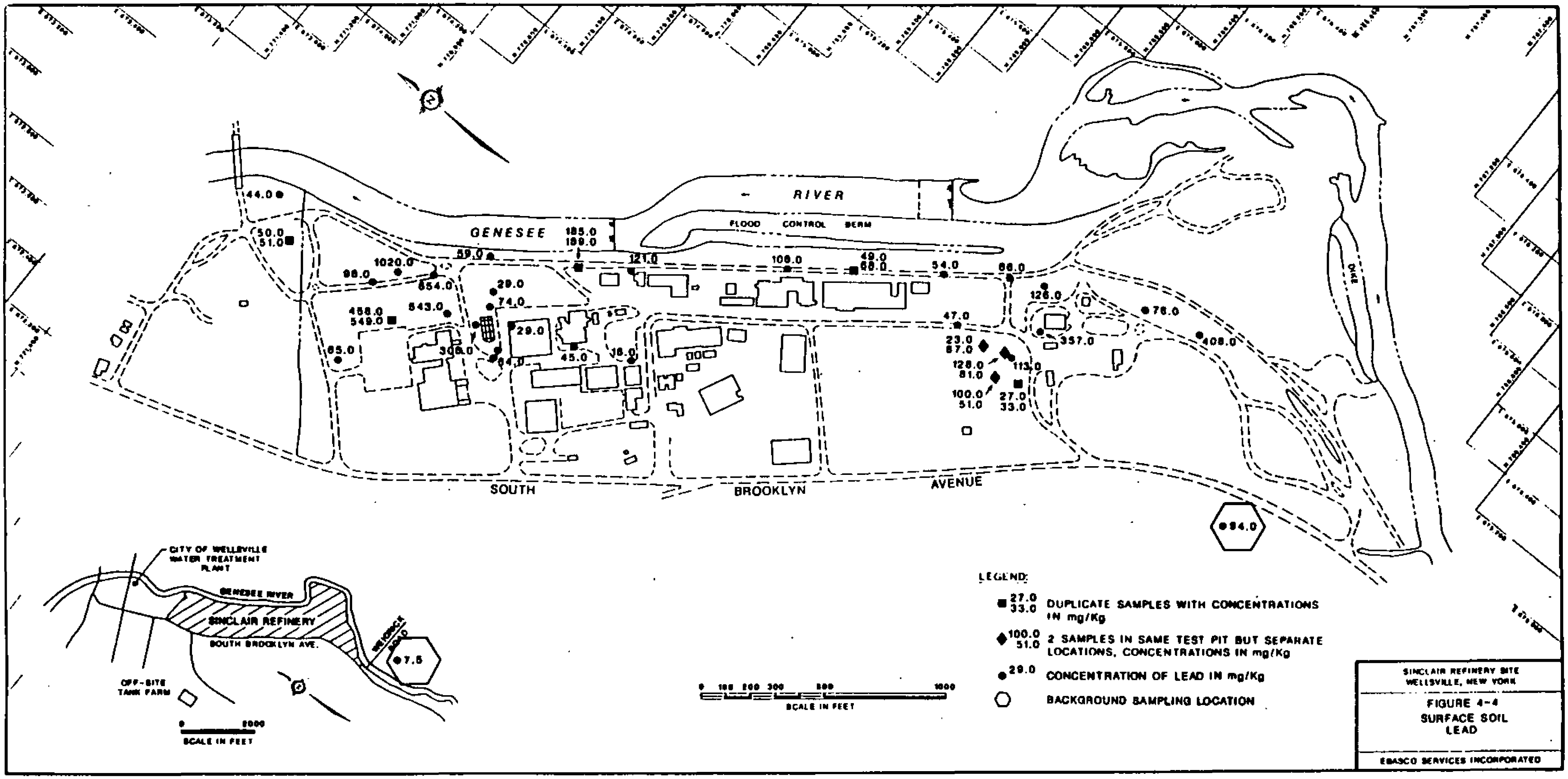
Mercury was present in 13 of 21 samples in concentrations ranging from 0.13-9.4 mg/kg compared to background levels of 0.14 mg/kg. Lead, arsenic, zinc and mercury are described in more detail below.

Common naturally occurring metals such as calcium, copper, magnesium, potassium and iron were also present in all valid samples. The copper is discussed in more detail below.

In the risk assessment and feasibility study, only the Phase IIb data is used to assess contamination of soils by metals, since it provides discrete sample data in each potentially contaminated area identified in Phase I and IIa. Discrete data facilitate the risk assessment and feasibility study processes. However, detailed descriptions of all phases of the data for several of the metals are provided below.

The elevated lead levels detected in discrete areas in each phase of the investigation are likely attributable to one or more of several past and present sources at the site described below. The highest levels of lead (over 1,000 mg/kg) were detected in a small area near the northeastern corner of the site (Figures 4-4 and 4-5), in single samples in both Phase I and IIb.

The Phase I composite sample (SS-5) with the highest level (1,190 mg/kg) included the area with the former tetraethyl lead sludge pits. These pits were decontaminated in about 1960. The Phase IIb sample (AB47-01) with the highest level (1,020 mg/kg) was obtained from the area between the former sludge pits and the Genesee River. In this area, the ground surface was very uneven, and it appeared that some soil had been relocated to this location. Because the Phase IIa composite sample in this area (SS-27) showed a low lead level (61.4 mg/kg), it is likely that the high level in AB47 is due to very localized soil relocation (fill). Since the average in SS-27 is so low compared to the 1,020 mg/kg in AB47, most of the soil in this area must contain soil with low levels of lead to bring the average concentration of



LEGEND:

■ 27.0 / 33.0 DUPLICATE SAMPLES WITH CONCENTRATIONS IN mg/Kg

◆ 100.0 / 51.0 2 SAMPLES IN SAME TEST PIT BUT SEPARATE LOCATIONS, CONCENTRATIONS IN mg/Kg

● 29.0 CONCENTRATION OF LEAD IN mg/Kg

⬡ BACKGROUND SAMPLING LOCATION

SINCLAIR REFINERY SITE
WELLSVILLE, NEW YORK

FIGURE 4-4
SURFACE SOIL
LEAD

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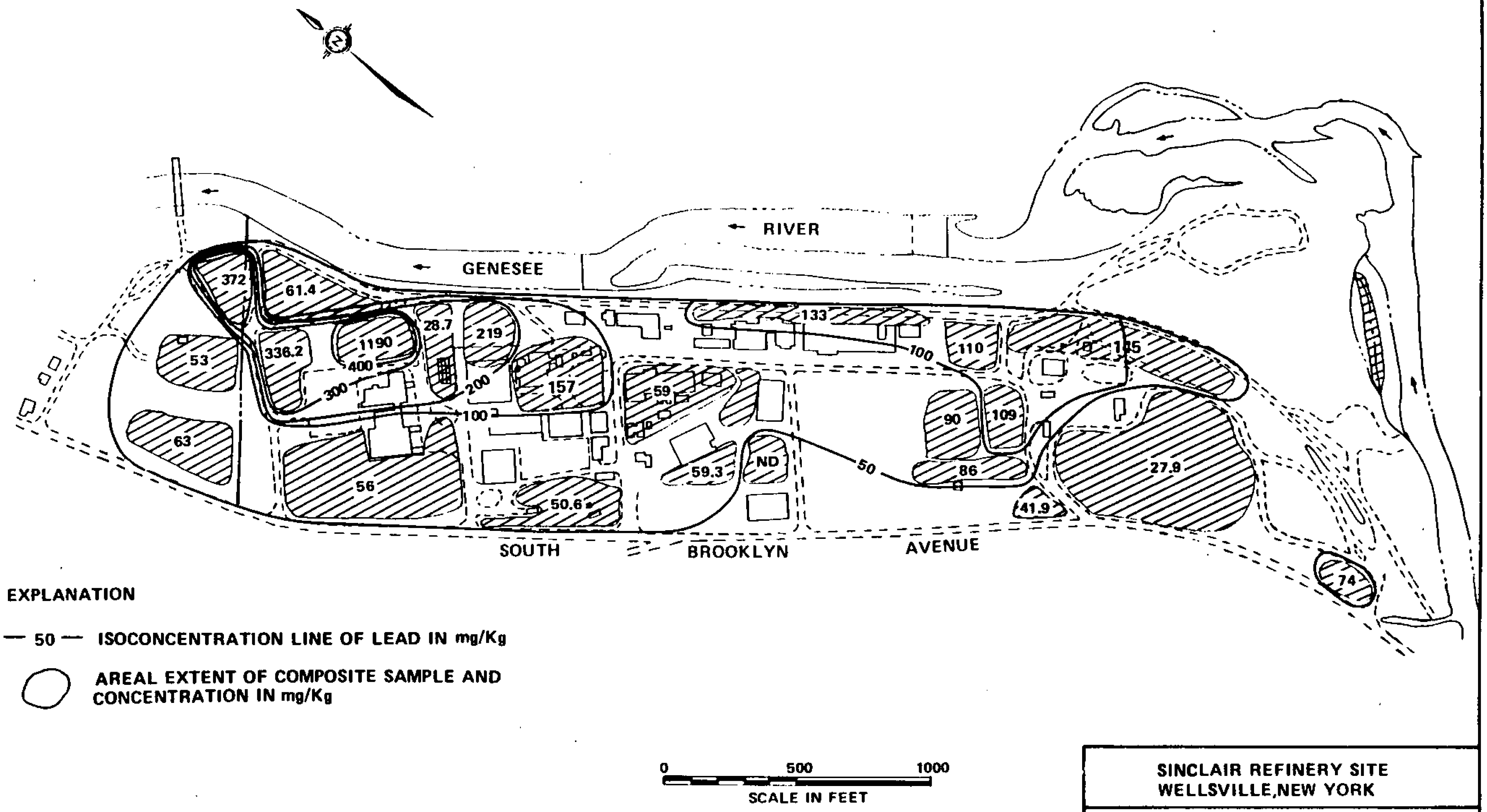

ADAPTED FROM SMC MARTIN PHASE I SITE MAP

SINCLAIR REFINERY SITE
WELLSVILLE,NEW YORK

FIGURE 4-5

LEAD IN SURFACE SOIL
COMPOSITE SAMPLES

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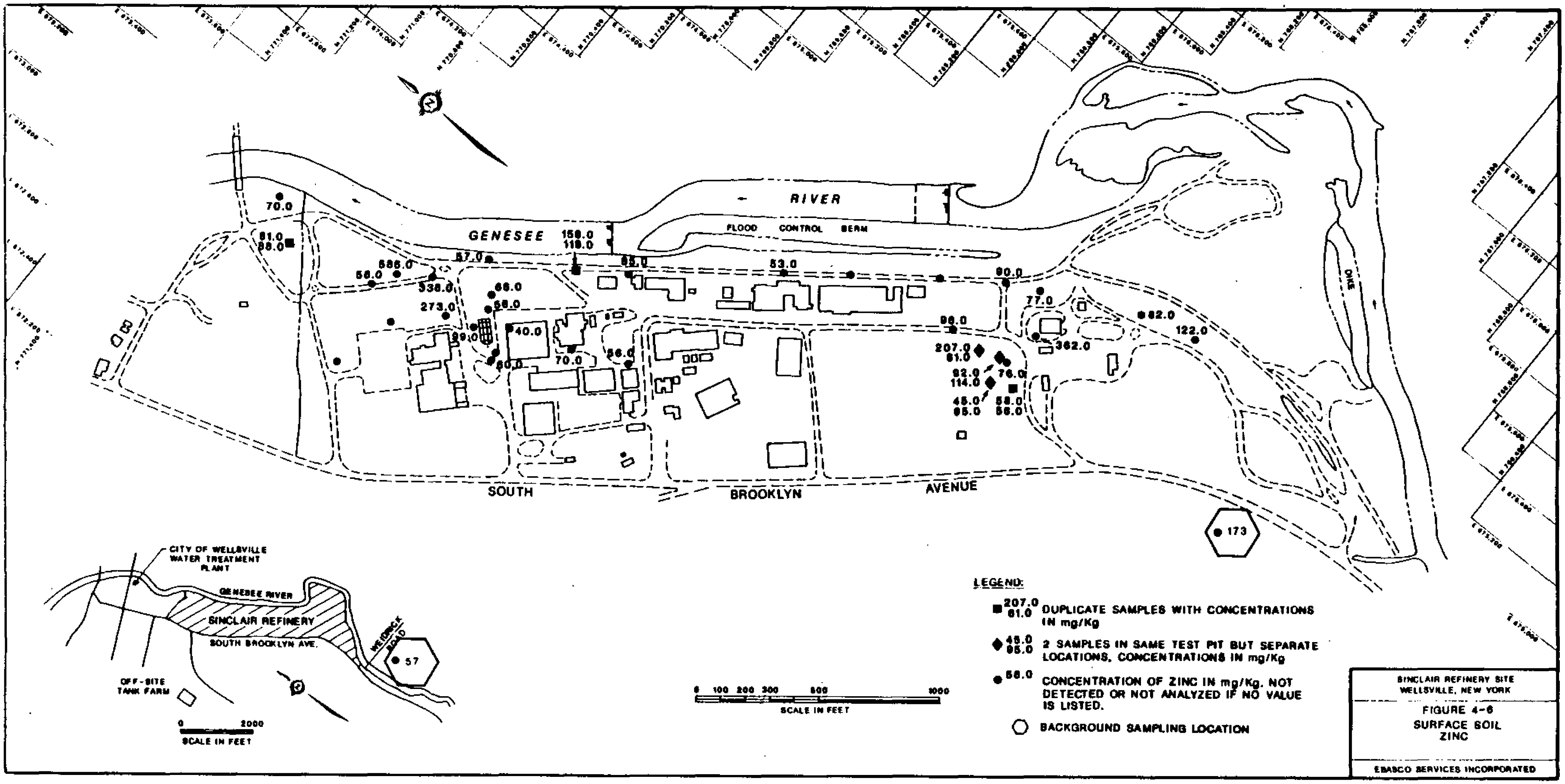
lead in the area (61.4 mg/kg) down to such a low number. Several other samples with concentrations over 100 mg/kg but under 1000 mg/kg were also found in the north area. The area where lead exceeds measured off-site levels (1.3-94 mg/kg) in the north part of the site is bounded by Current Controls to the west, the Genesee River to the east, the northern separator to the south, and the northern drainage swale to the north. The area with elevated levels can be seen on Figures 4-4 and 4-5.

In the east central and southeastern parts of the site several concentrations of lead over 100 mg/kg were also detected. These samples were almost entirely from the area along the former railroad right-of-way, as shown on Figures 4-4 and 4-5. These could be attributable to any or all of three distinct sources. As discussed in Subsection 1.2.2.2, Butler-Larkin formerly operated a lead pot that vented to the atmosphere. (It is not known if this is still operating.) Sample SS-10, a Phase I composite that included soils behind a Butler-Larkin building, detected a lead level of 133 mg/kg. However, this sample is also located along a former railroad track (Figure 1-3 shows the location of the former railroad track area.) The railroad track area is partially constructed of fill material, which may contain natural levels of metals higher than the on-site or background samples. Additionally, it is possible that the fill used for the railroad contained elevated levels of metals from activities in the fill source area. Spillage of gasoline from railroad cars or exhaust fumes from automobile, trucks and construction equipment using the area may also account for some of the lead levels.

Zinc was detected in background samples at levels of 18-173 mg/kg. This range of concentration was exceeded in only four Phase IIb site locations, AB43, 44, 47 and 62. Three of these, AB43, 44 and 47, are located close to each other (Figure 2-13) in the northern part of the site in the same area, as the highest elevated lead concentrations. No uses of zinc at the site were identified, although zinc compounds such as zinc stearate are used in many processes, including use as plastic mold releasing agents. The possibility that the few elevated zinc levels are naturally occurring or associated with fill in these areas must be considered. Figure 4-6 shows the distribution of zinc detected in surface soils in Phase IIb.



LEGEND:

■ 207.0 / 81.0 DUPLICATE SAMPLES WITH CONCENTRATIONS IN mg/Kg

◆ 45.0 / 95.0 2 SAMPLES IN SAME TEST PIT BUT SEPARATE LOCATIONS, CONCENTRATIONS IN mg/Kg

● 58.0 CONCENTRATION OF ZINC IN mg/Kg. NOT DETECTED OR NOT ANALYZED IF NO VALUE IS LISTED.

⬡ BACKGROUND SAMPLING LOCATION

SINCLAIR REFINERY SITE
WELLSVILLE, NEW YORK

FIGURE 4-6
SURFACE SOIL
ZINC

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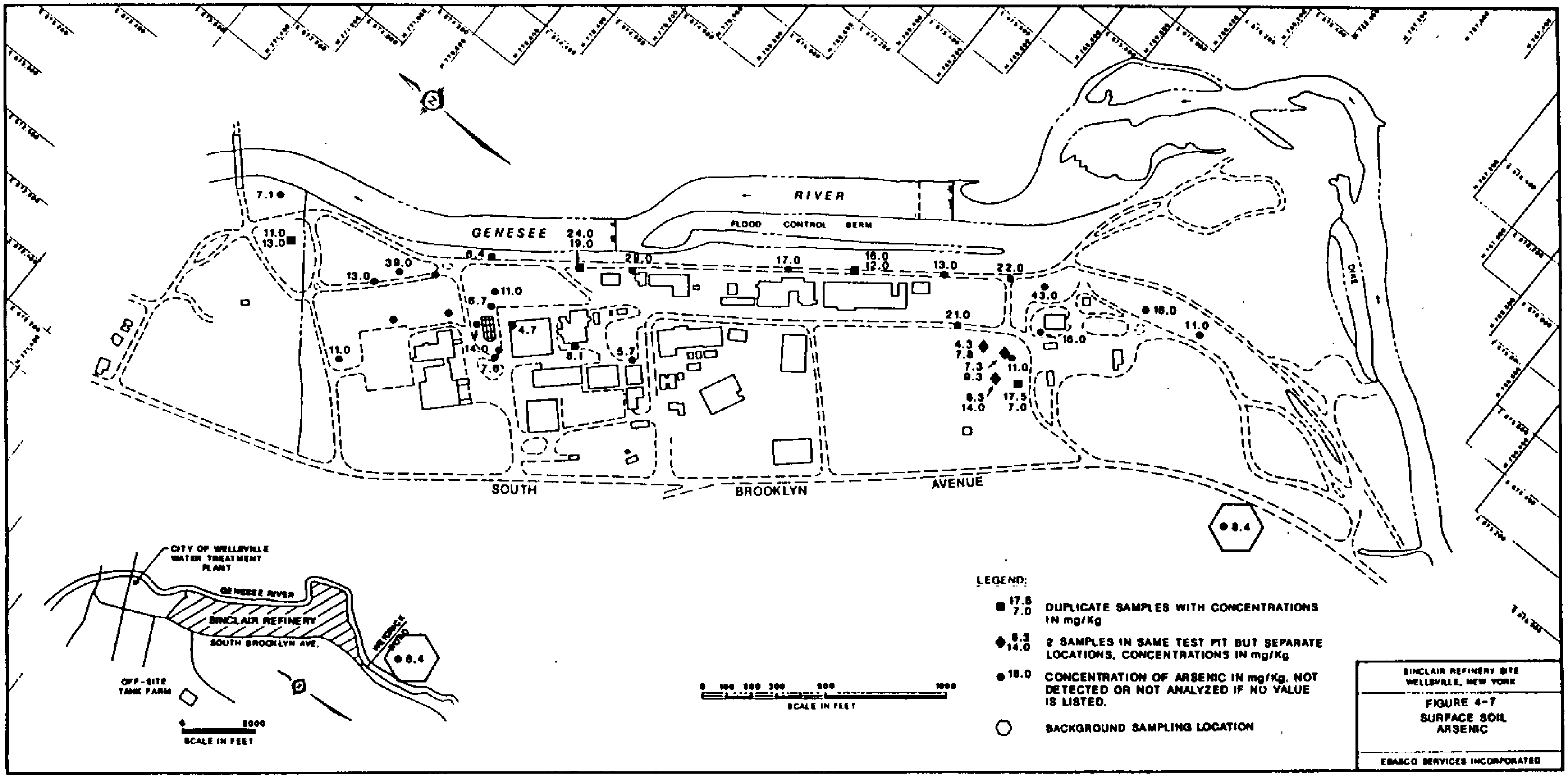
In Phase IIb arsenic was found at concentrations higher than background in five of 35 samples. Arsenic levels ranged from 4.3 to 43 mg/kg with background measured at 6.4-19 mg/kg. The higher values are on the former railroad right of way (Figure 4-7). Arsenic is not a compound commonly associated with oil refineries or other known site industries. Based on the alignment of the highest sample values along the railroad tracks, it is likely that the arsenic is associated with fill used in building the railroad embankment, or a preservative in railroad ties.

Copper was found in a pattern similar to the arsenic with 11 of the 12 highest concentrations (ranging from 34 to 272 mg/kg) detected along the old railroad (Figure 4-8) compared to off-site values between 5.6 and 20 mg/kg). The one exception was at AB62, where above background lead and zinc concentrations were also detected. Copper is sometimes used in the refining process (as $CuCl_2$), but its site distribution shows that it is associated with the railroad. As with the arsenic, it may have been in the fill used for the railroad or from a wood preservative in the railroad ties. Both arsenic and copper are commonly used in wood preservatives.

The most commonly detected metals in Phase I and IIa were arsenic, chromium, copper, lead, nickel and zinc. These metals were detected in most of the 55 samples. With the exception of lead, the vast majority were at or below background levels. The ranges for these metals were as follows: arsenic: 2.8-88 mg/kg, chromium: 3.3-54 mg/kg, copper: 5.6-1020 mg/kg, lead: 1.5-791 mg/kg, nickel: 8.0-58 mg/kg; zinc: 16.3-165 mg/kg compared to background ranges of 6.4-19 mg/kg; 3.1-20 mg/kg; 5.6-20 mg/kg; 1.3-94 mg/kg; 7.1-33 mg/kg; and 18.4-173 mg/kg, respectively.

Mercury exceeded the background level (0.14 mg/kg at AB95) in nine surface samples in Phase IIb auger borings and test pits. The highest level in the surface soils, at 9.4 mg/kg was at AB62, previously noted to contain elevated levels of zinc, lead, and copper. Test pit samples including TP36-04, at 5.2 mg/kg, TP36-01 at 0.7 mg/kg, and TP34-04 at 0.64 mg/kg, also contained mercury. AB63 and AB60 also contained concentrations at 1.0 mg/kg and 0.39 mg/kg, respectively. These are in the same general area as AB62 and the test pits near the south separator. The other samples above background ranges were detected in isolated samples around the site and had concentrations varying



SINCLAIR REFINERY SITE
WELLSVILLE, NEW YORK

FIGURE 4-7
SURFACE SOIL
ARSENIC

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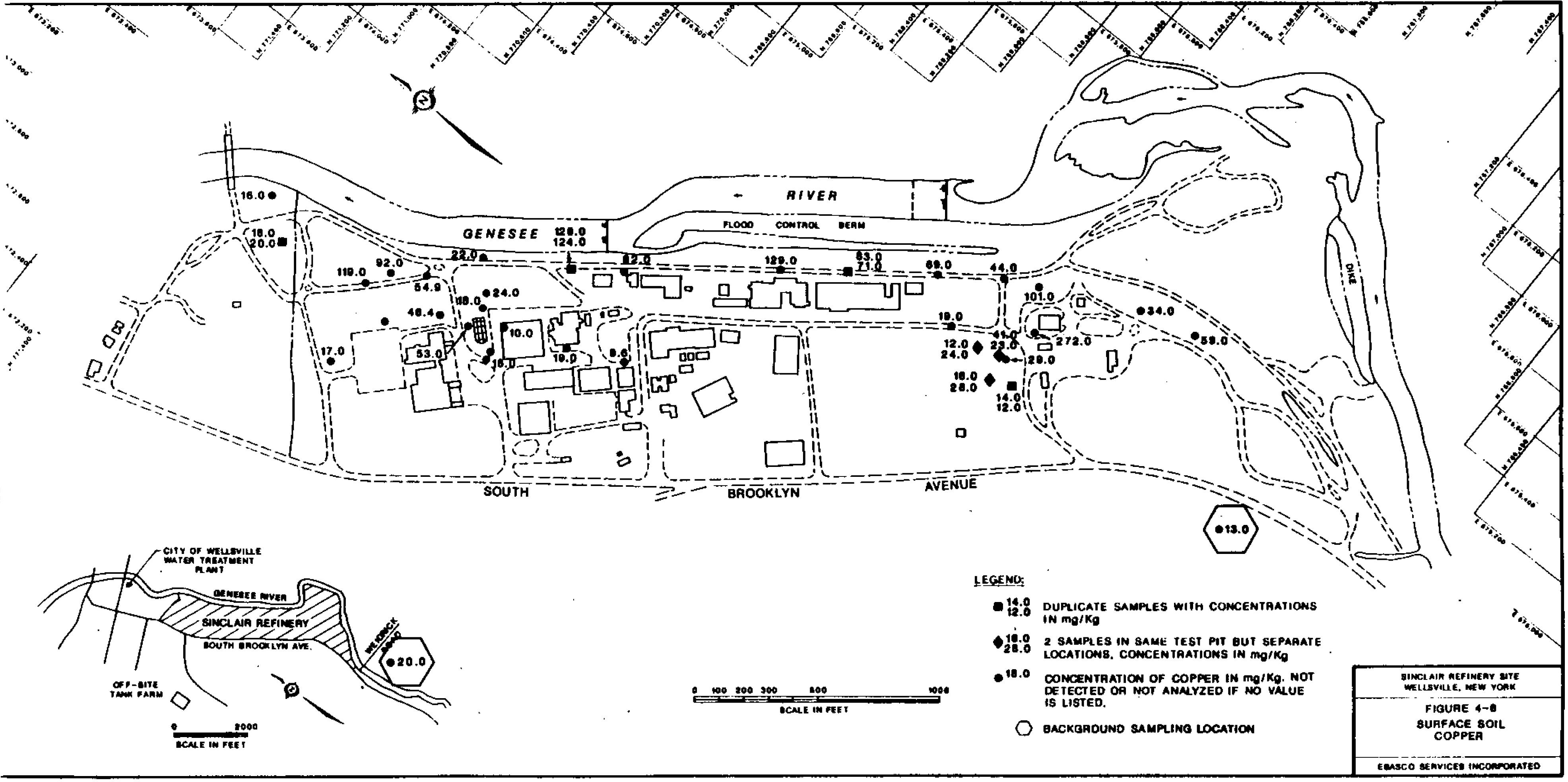

LEGEND:

■ 14.0 / 12.0 DUPLICATE SAMPLES WITH CONCENTRATIONS IN mg/Kg

◆ 16.0 / 28.0 2 SAMPLES IN SAME TEST PIT BUT SEPARATE LOCATIONS, CONCENTRATIONS IN mg/Kg

● 18.0 CONCENTRATION OF COPPER IN mg/Kg. NOT DETECTED OR NOT ANALYZED IF NO VALUE IS LISTED.

⬡ BACKGROUND SAMPLING LOCATION

SINCLAIR REFINERY SITE
WELLSVILLE, NEW YORK

FIGURE 4-8
SURFACE SOIL
COPPER

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from 0.22 to 0.29 mg/kg at locations AB52, AB54 and AB94. No potential past or present sources for the mercury were identified. Figure 4-9 shows the distribution of mercury detected in surface soils in Phase IIb.

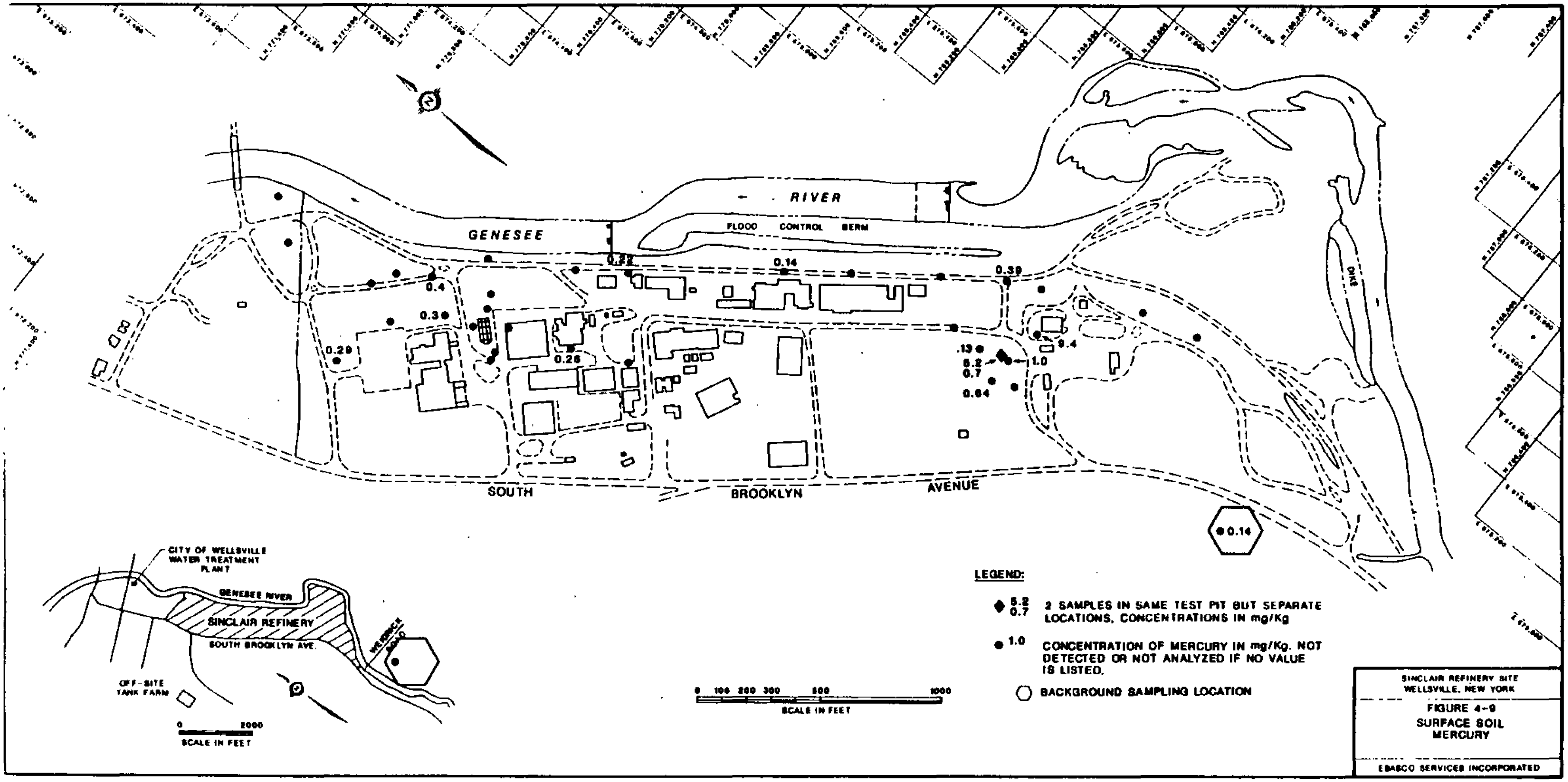
4.5.2 Subsurface Soil

The subsurface soil samples taken during Phase I and Phase IIa were taken from monitoring well borings and auger borings from three different subsurface soil layers: the upper aquifer, the clay layer and the deep aquifer. All of the samples were composited over depths of 4 to 40 feet. Soil samples from 55 on site, shallow monitoring well/auger borings were analyzed in Phase I and IIa.

As with the surface soil samples, the Phase IIb subsurface soils were taken from both auger borings and test pits. The auger boring samples (2'-4' and 8'-10') were analyzed for TCL metals only. The test pit samples were analyzed for TCL VOCs and TCL BNAs as well as TCL metals. A total of 53 samples were taken in the subsurface soils during Phase IIb.

The number of metals that were detected in the Ebasco sampling increased from the SMC data (Table 4-10). This is attributable in part to the greater number of metals analyzed. In most cases, where the same metals were analyzed in both sets the peak concentrations of metals found in both sets, such as for arsenic, had decreased. The levels of metals found in subsurface soils were generally at or below background levels (see Table 4-10 for a comparison of site and background ranges), and concentrations were less variable than in surface soils. Some metals, such as mercury, were also detected less frequently in the subsurface samples (Figure 4-10) than in the surface samples.

There does not appear to be much variation in the pattern of concentrations across depth or location for most of the metals in the discrete Phase IIb metal analyses. Detailed discussions of arsenic and lead are provided below, since in some locations, they were detected, potentially at above background concentrations.



LEGEND:

◆ 5.2 / 0.7 — 2 SAMPLES IN SAME TEST PIT BUT SEPARATE LOCATIONS, CONCENTRATIONS IN mg/Kg

● 1.0 — CONCENTRATION OF MERCURY IN mg/Kg. NOT DETECTED OR NOT ANALYZED IF NO VALUE IS LISTED.

○ BACKGROUND SAMPLING LOCATION

SINCLAIR REFINERY SITE
WELLSVILLE, NEW YORK

FIGURE 4-9
SURFACE SOIL
MERCURY

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TABLE 4-10 (Page 1 of 2)

CHEMICALS DETECTED IN SUBSURFACE SOILS(a)
ORGANIC COMPOUNDS

RANGE OF CONCENTRATIONS (mg/kg)

	Phase I(c) 1985	Phase IIa(c) Jan-Nov. 1986	Phase IIb Oct-Dec. 1988	Background
Total Number of Samples Analyzed	31	35	3(d)	
COMPOUNDS				
Volatiles				
Acetone	ND	1.2 (1)(b)	0.018-0.12 (2)	ND-0.017
Carbon Disulfide	ND	0.004 - 0.19 (19)	ND	ND
2-Butanone	ND	0.027 - 0.13 (3)	ND	ND
1,1,1-Trichloroethane	ND	0.0001- 0.018 (6)	ND	ND
Benzene	ND	0.0009- 1.45 (21)	ND	ND
4-Methyl-2-Pentanone	ND	0.14 - 5.1 (8)	ND	ND
2-Hexanone	ND	0.014 - 1.9 (8)	ND	ND
1,1,2,2-Tetrachloroethane	2.1 (1)	0.022 - 0.63 (6)	ND	ND
Toluene	ND	0.002 - 0.91 (5)	ND	ND
Chlorobenzene	ND	0.010 - 0.37 (6)	ND	ND
Ethylbenzene	ND	0.045 - 3.6 (8)	ND	ND
Styrene	ND	0.0017- 0.0018(2)	ND	ND
Total Xylenes	ND	0.0003-26 (17)	ND	ND
BNAs				
Nitrobenzene	ND	0.076 - 0.24 (2)	ND	ND
2,4-Dimethylphenol	ND	0.02 - 0.19 (2)	ND	ND
Napthalene	1.0 (1)	0.029 - 3.3 (14)	ND	ND
2-Methylnapthalene	ND	0.018 -17 (21)	37.1 (1)	ND
Dimethylphthalate	ND	0.033 - 0.037 (3)	ND	ND
Acenapthylene	ND	0.016 - 0.35 (2)	ND	ND
Acenapthene	ND	0.022 - 1.5 (4)	ND	ND
Dibenzofuran	ND	0.041 - 0.59 (6)	ND	ND
Diethylphthalate	ND	0.036 - 1.0 (14)	ND	ND
Fluorene	ND	0.031 - 2.5 (12)	ND	ND
N-Nitrosodiphenylamine	ND	0.13 - 0.58 (4)	ND	ND
Phenanthrene	1.2-1.5 (2)	0.005 - 6.1 (14)	22 (1)	ND-0.2
Anthracene	ND	0.024 - 1.5 (5)	ND	ND-5.7
Fluoranthrene	1.0-1.6 (3)	0.04 - 0.58 (7)	33 (1)	ND-2.3
Pyrene	2.6 (1)	0.06 - 1.5 (8)	30 (1)	ND-3.0
Butyl Benzyl Phthalate	ND	0.026 - 1.9 (7)	ND	ND
Benzo(a)Anthracene	1.7 (1)	0.014 - 0.57 (5)	17 (1)	ND-0.3
Chrysene	ND	0.14 - 0.8 (5)	25 (1)	ND-4.7
Di-N-OctylPhthalate	ND	0.007 - 0.4 (11)	ND	ND-4.8
Benzo(a)Pyrene	ND	0.026 - 1.0 (8)	0.44-19 (2)	ND-2.3
Bis(2-ethylhexyl)phthalate	ND	ND	0.48- 0.67 (2)	ND-2.6
Phenol	ND	0.036 - 0.1 (4)	ND	ND

TABLE 4-10 (Page 2 of 2)

CHEMICALS DETECTED IN SUBSURFACE SOILS
METALS

RANGE OF CONCENTRATIONS (mg/kg)

	Phase I(c) 1985	Phase IIa(c) Jan-Nov. 1986	Phase IIb Oct-Dec. 1988	Background
Total Number of Samples Analyzed	31	35	52(d)	
COMPOUNDS				
Metals				
Aluminum	NA	NA	4,230 -22,700 (46)	5,200-10,900
Antimony	ND	12. -134 (4)	4.6 - 15 (5)	ND-162
Arsenic	2.8 - 88 (31)	3.8 - 50 (27)	2.3 - 49 (44)	6.4-19
Barium	NA	NA	68 - 283 (46)	28-162
Beryllium	0.61- 0.65 (2)	0.5 - 1.3 (5)	0.26- 1.1 (38)	0.26-0.56
Cadmium	NA	1 - 1.3 (4)	1.1 - 2.8 (6)	ND
Calcium	NA	NA	632 -68,800 (25)	632-53,800
Chromium	3.3 - 23 (31)	3.3 - 54.4 (26)	6.7 - 23 (32)	3.1-21
Cobalt	NA	NA	4.6 - 15 (46)	5.8-11
Copper	10 -1,020 (31)	5.6 - 43.4 (32)	5.5 - 38 (46)	5.6-20
Iron	NA	NA	215 -34,000 (46)	13,700-27,300
Lead	3.2 - 791 (31)	1.5 - 77.2 (35)	7.7 - 763 (52)	1.3-94
Magnesium	NA	NA	1,270 - 8,590 (46)	2,070-12,000
Manganese	NA	310 -386 (2)	138 - 3,660 (44)	190-953
Mercury	0.03- 1.95 (10)	0.1 - 0.11 (5)	0.12- 0.94 (4)	ND-0.14
Nickel	9.1 - 39 (31)	8.0 - 57.7 (32)	9.6 - 31 (38)	7.1-40
Potassium	ND	NA	221 - 1,850 (41)	596-1,240
Silver	0.48- 1.5 (5)	0.24- 30.7 (8)	0.89- 2.5 (23)	1.4-2.7
Sodium	NA	NA	42 - 75 (7)	ND
Thallium	0.75- 0.95 (2)	2.0 - 6.2 (3)	2.0 (2)	ND-0.41
Vanadium	NA	10.1 (1)	5.4 - 30 (45)	7.7-14
Zinc	22- 158 (31)	16.3 -165 (35)	38 - 117 (43)	18.4-173

(a) Compounds listed include all compounds detected in two or more samples in this media, in any phase and all indicator chemicals detected.
(b) Value in parenthesis indicates number of samples with value above detection limits.
(c) Composite samples.
(d) Includes 3 samples analyzed for organics and 52 for metals.

ND = not detected
NA = not analyzed

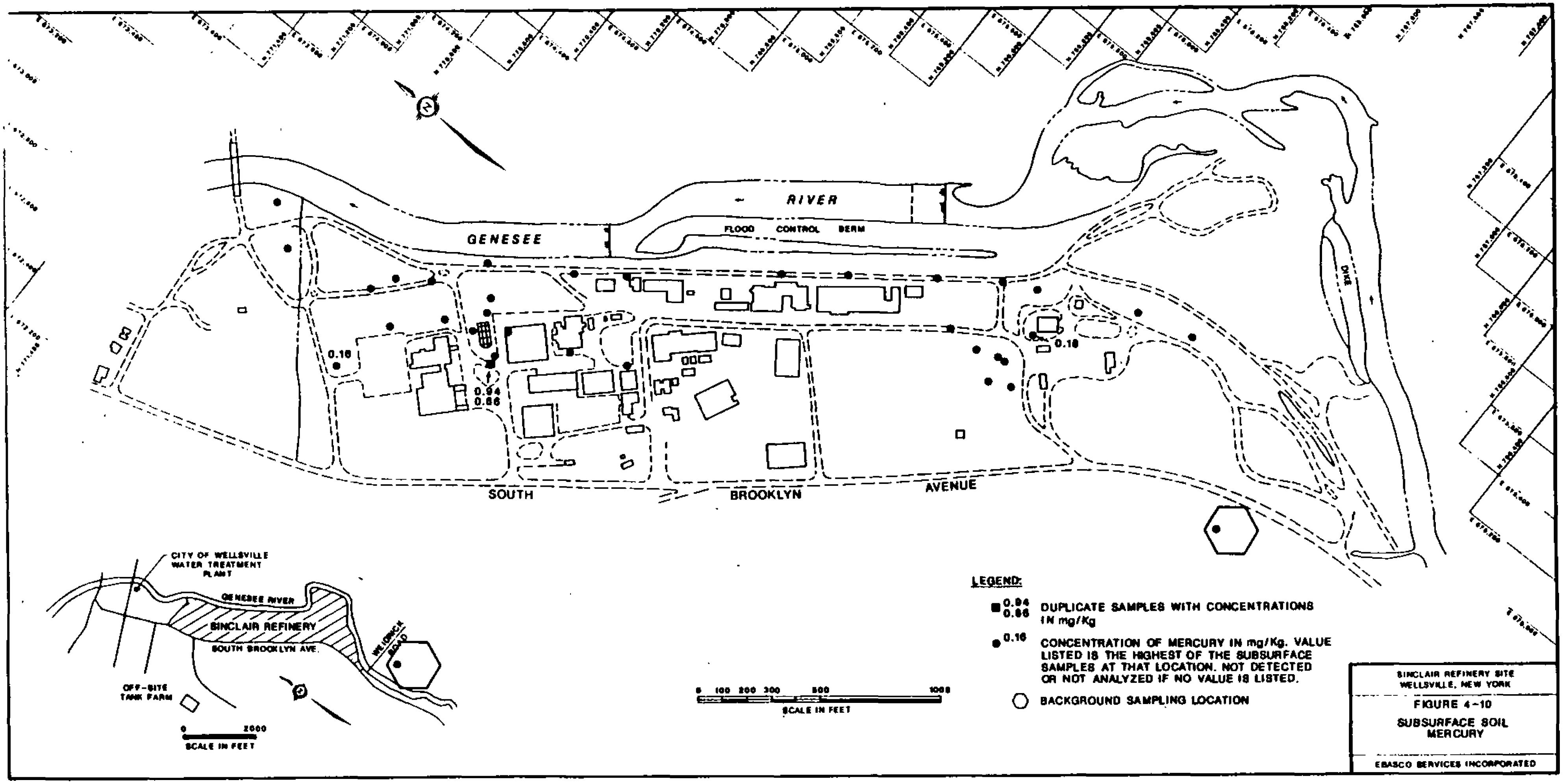

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FIGURE 4-10

SUBSURFACE SOIL MERCURY

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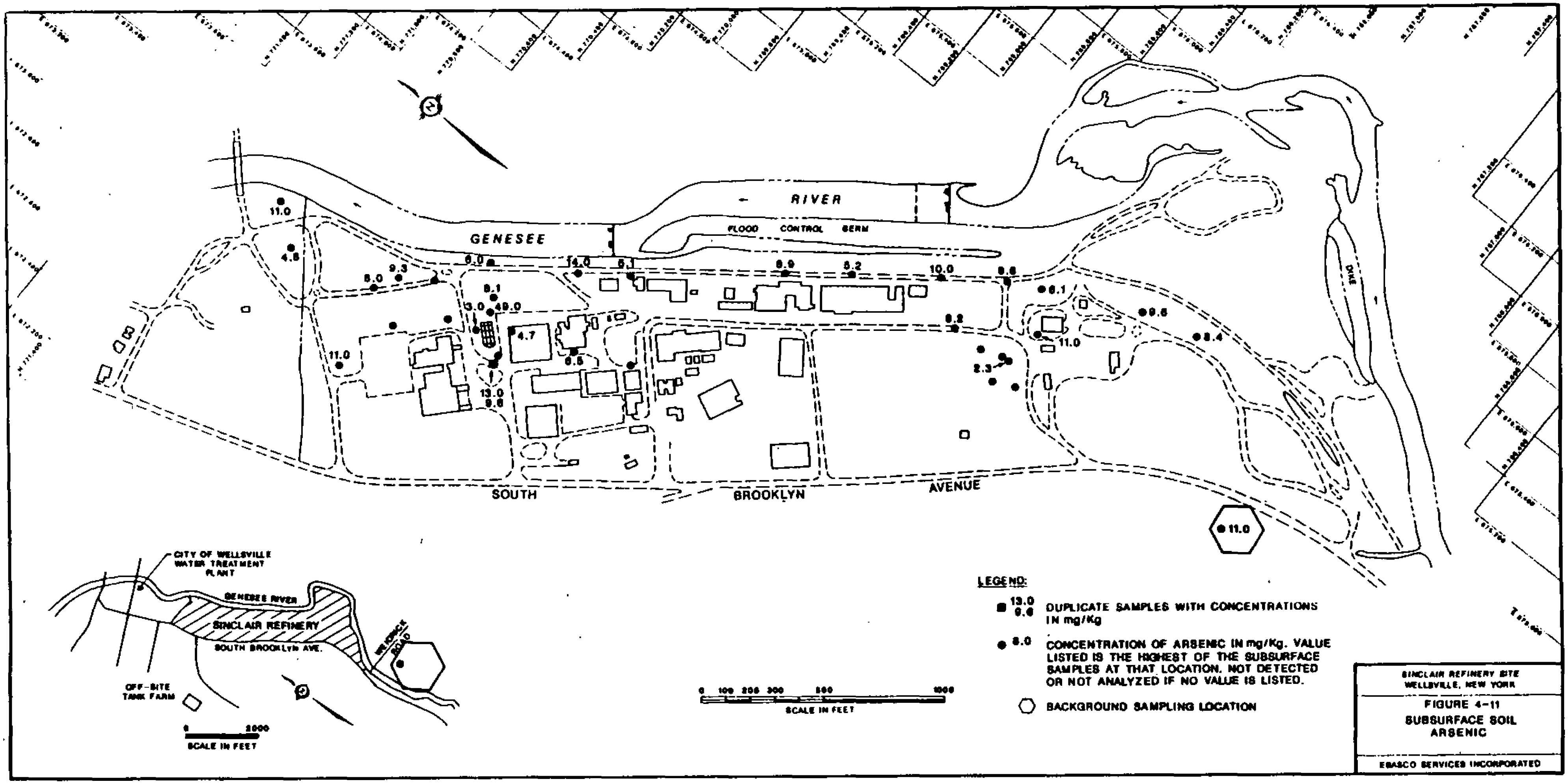
Twenty-two metals were detected in some of the 52 samples taken from the subsurface soils. Six of these--calcium (632-68,800 mg/kg), copper(5.5-38 mg/kg), iron (215-34,000 mg/kg), magnesium (1,270-8,590 mg/kg), potassium (221-1,850 mg/kg) and sodium (42-75 mg/kg)--are common in nature and appear in the samples at similar ranges compared to site background levels (calcium, 632-53,800 mg/kg; copper, 5.6-20 mg/kg; iron, 13,700-27,300 mg/kg; magnesium, 2,070-12,000 mg/kg; potassium, 596-1,240 mg/kg; and sodium, not detected, all background sodium data rejected).

Antimony (4.6-15 mg/kg) and cadmium (1.1-2.8 mg/kg) were each detected in six or fewer samples in Phase IIb. These metals were not detected in the background samples for the area in Phase IIb. However, the values detected are generally at or below contract required detection limits. The antimony values are also well below the background value (162 mg/kg) measured in Phase IIa. Mercury was detected, also at low levels, in only three samples at concentrations of 0.12 to 0.90 mg/kg (Figure 4-10).

In Phase IIb, both beryllium (0.26-1.1 mg/kg) and silver (0.89-2.5 mg/kg) were present in about half of the samples. The concentrations were close to or below the background levels of 0.26-0.56 mg/kg and 1.4-2.7 mg/kg, respectively.

The rest of the metals detected were present in most samples (no more than 3 nondetects) with valid analyses. These included: arsenic (2.3-49 mg/kg), chromium (6.7-23 mg/kg), lead (7.7-763 mg/kg), nickel (9.6-31 mg/kg), vanadium (5.4-30 mg/kg) and zinc (37-117 mg/kg). The measured site background values for these metals were: arsenic 6.4-19 mg/kg, chromium 3.1-21 mg/kg, lead 1.3-94 mg/kg, nickel 7.1-40 mg/kg, vanadium 7.7-14 mg/kg and zinc 18.4-173 mg/kg. In each case, the levels in the subsurface soils were close to background levels (within a factor of about 2) except for lead and arsenic (Table 4-10). These two metals were also detected at above background levels in Phase I and IIa.

Arsenic was found in one of the subsurface soils at levels above background values (19 mg/kg) (Figure 4-11). The one sample, from a test pit (TP02-04) adjacent to the northern separator, had a concentration of 49 mg/kg. This was the highest Phase IIb arsenic concentration measured. There is a strong



LEGEND:

- ■ 13.0 / 9.6 DUPLICATE SAMPLES WITH CONCENTRATIONS IN mg/Kg
- ● 8.0 CONCENTRATION OF ARSENIC IN mg/Kg. VALUE LISTED IS THE HIGHEST OF THE SUBSURFACE SAMPLES AT THAT LOCATION. NOT DETECTED OR NOT ANALYZED IF NO VALUE IS LISTED.
- ⬡ BACKGROUND SAMPLING LOCATION

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WELLSVILLE, NEW YORK

FIGURE 4-11
SUBSURFACE SOIL
ARSENIC

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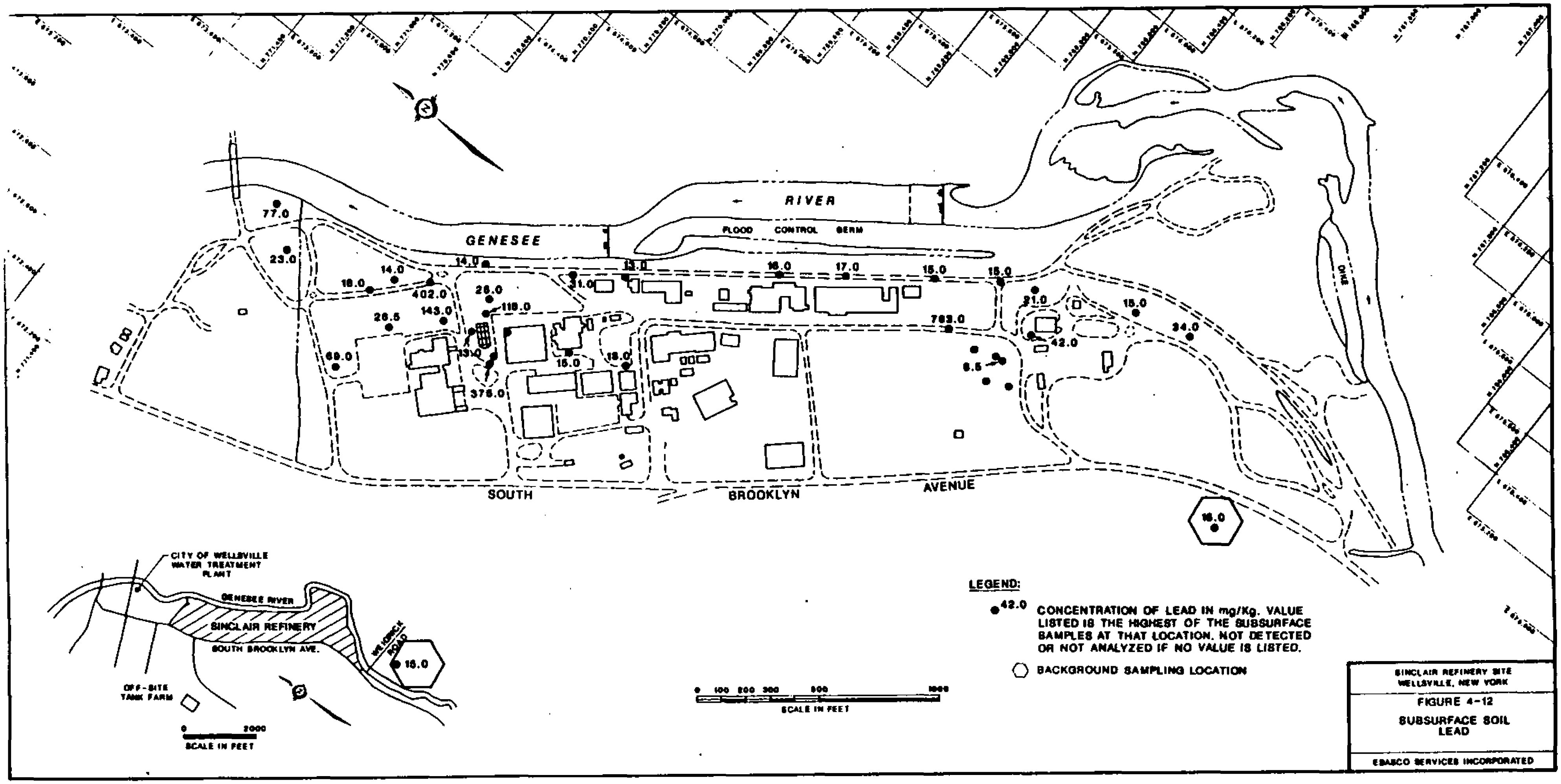
likelihood that the soil is fill, since excavation for the oil separator or the discharge line from the separator would likely have disturbed this area. No site-related arsenic sources (except preservatives in railroad ties) were identified. It appears that the elevated arsenic levels in the surficial soils noted along the railroad alignment do not extend below the surface (0 to 6"). This indicates that the arsenic is more likely associated with preservatives in the old railroad ties that have been released into the surface soils and not originally associated with the soil itself, since arsenic was not found at elevated levels in the deeper soil samples along the old railroad.

Lead was found at five subsurface locations in Phase IIb at a concentration above background (1.3-98 mg/kg). Four of these, at AB43, AB44, AB51 and TP02-04, are located in the northeast area of the site where elevated lead levels are detected in the surface soils. At location AB43 the surficial sample contained 543 mg/kg lead while the 2- to 4-foot depth contained 143 mg/kg. At 8 to 10 feet, only 14.2 mg/kg of lead was detected. In AB44 lead was at a concentration of 402 mg/kg at 8 to 10 feet, but only 13.8 mg/kg at 2-4 feet.

The surficial sample at AB51 contained only 64 mg/kg lead compared to 264 mg/kg (average of two duplicate samples with concentrations of 151 and 376 mg/kg) at a depth of 2 to 4 feet and 29 mg/kg at 8 to 10 feet. This apparent increase with depth at AB51 may have been caused by clean fill being placed on a contaminated layer. The test pit sample containing 116 mg/kg lead also had the highest site arsenic level. The last elevated lead value, 763 mg/kg, also was taken at a depth of 2-4 feet, from boring AB59. The surficial sample at this location contained only 47 mg/kg of lead. Figure 4-12 shows the distribution of lead detected in Phase IIb subsurface soil samples.

The Ebasco boring AB42 was performed in the area of the former tetraethyl lead sludge pits. Although lead was detected at elevated levels in the surface sample, lead in the two deeper samples was at concentrations of only 26.5 and 10 mg/kg.



LEGEND:

●42.0 CONCENTRATION OF LEAD IN mg/Kg. VALUE LISTED IS THE HIGHEST OF THE SUBSURFACE SAMPLES AT THAT LOCATION. NOT DETECTED OR NOT ANALYZED IF NO VALUE IS LISTED.

⬡ BACKGROUND SAMPLING LOCATION

SINCLAIR REFINERY SITE
WELLSVILLE, NEW YORK

FIGURE 4-12

SUBSURFACE SOIL
LEAD

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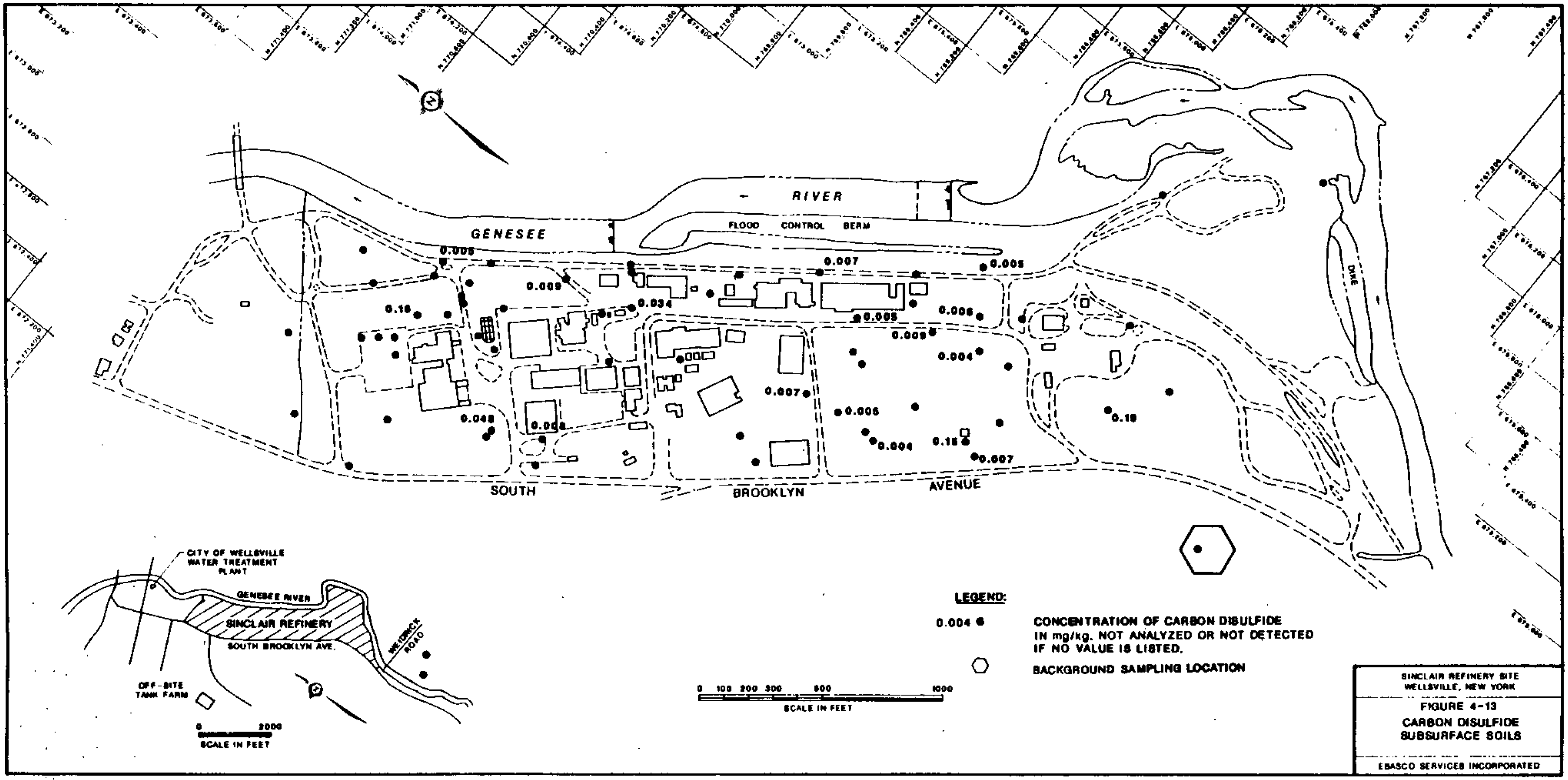
The clay layer between the upper and lower aquifer had more metals detected, in Phase I and IIa than in the shallow samples, which is expected given the physical and chemical properties of clay. Ten metals were detected in the six samples. Two, selenium (1.8 mg/kg) and the thallium (6.2 mg/kg) were each detected in only one sample. Selenium was not detected in any other site or background soil sample. The thallium in a background sample was at a concentration of 0.41 mg/kg.

Lead, (1.5-77.2 mg/kg) nickel (19.4-57.7 mg/kg) and zinc (46.4-165.1 mg/kg) were the only three metals detected in all six clay layer samples. The soil background concentration ranges for these three metals were 1.3-94 mg/kg, 7.1-40 mg/kg and 18-173 mg/kg, respectively. The other metals detected were not detected in at least one sample. The range of measured concentrations in the clay layer and its respective background concentrations are: arsenic 13.5-50 mg/kg (clay), 6.4-19 mg/kg (background); beryllium 0.5-1.3 mg/kg (clay), 0.26-0.56 mg/kg (background); chromium 9.4-54.4 mg/kg (clay), 3.1-21 mg/kg (background); silver 15.2-24.6 mg/kg (clay), 1.4-2.7 mg/kg (background), and copper 13.3-27.9 mg/kg (clay), 5.6-20.3 mg/kg (background).

Five metals were present in the single sample from the deep aquifer. They were arsenic, copper, lead, nickel and zinc. With the exception of arsenic, all of the concentrations were well below background levels. The arsenic was present at a concentration of 5 mg/kg, within background ranges. Arsenic was not reported in the Phase IIa subsurface background data.

VOCs in subsurface soils were analyzed primarily in Phase I and IIa samples. In Phase I, only one VOC was detected in a single subsurface sample. However in Phase IIa, thirteen priority pollutant volatiles were detected in the 35 samples (Table 4-10).

The three most commonly detected volatiles were carbon disulfide (0.004-0.19 mg/kg) (Figure 4-13), benzene (0.0009-1.45 mg/kg) (Figure 4-14), and total xylenes (0.0003-26 mg/kg) (Figure 4-15). These were present in 19 of 35



LEGEND:

0.004 ● CONCENTRATION OF CARBON DISULFIDE IN mg/kg. NOT ANALYZED OR NOT DETECTED IF NO VALUE IS LISTED.

⬡ BACKGROUND SAMPLING LOCATION

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FIGURE 4-13
CARBON DISULFIDE
SUBSURFACE SOILS

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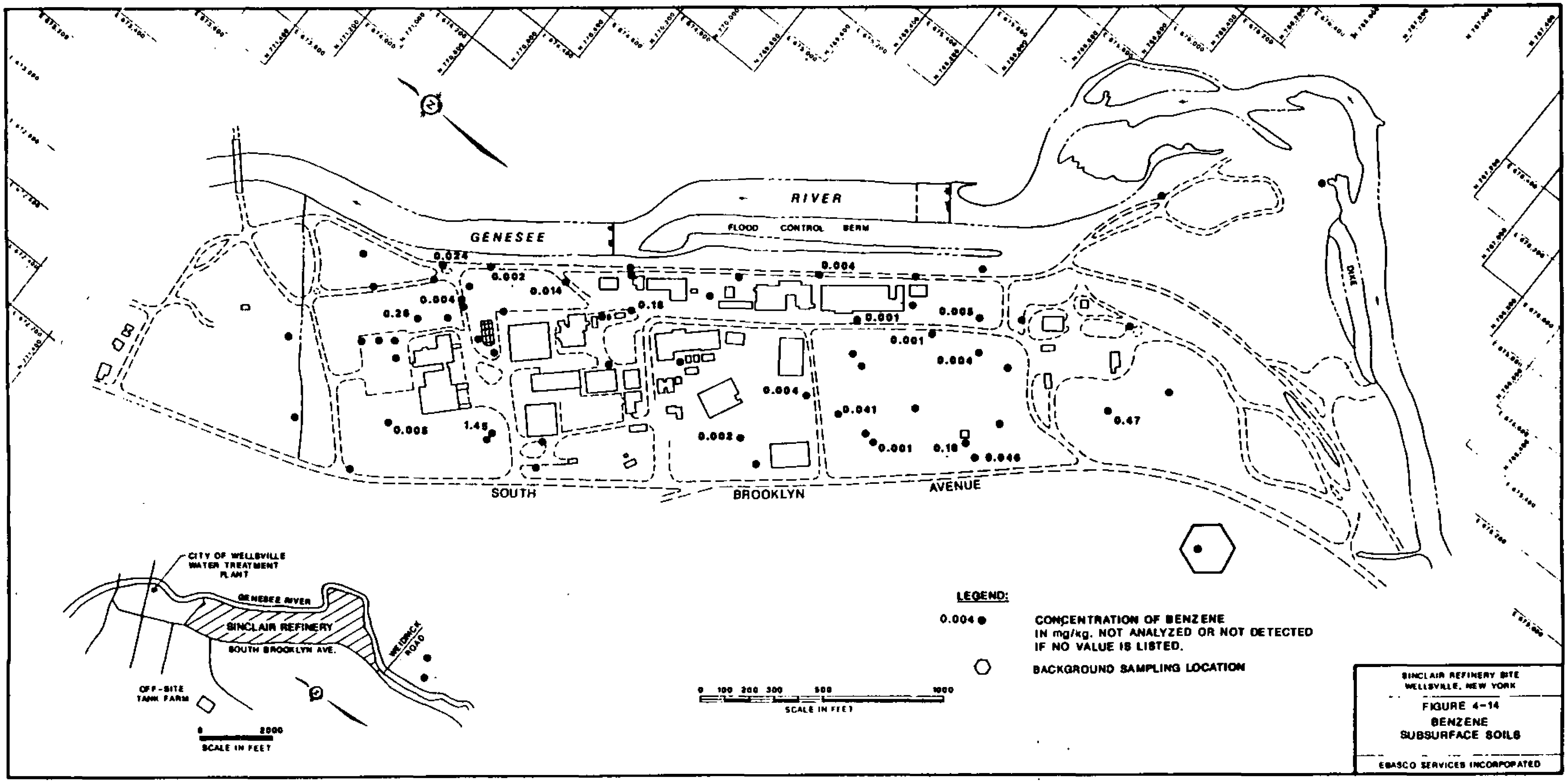

LEGEND:

0.004 ●	CONCENTRATION OF BENZENE IN mg/kg. NOT ANALYZED OR NOT DETECTED IF NO VALUE IS LISTED.
⬡	BACKGROUND SAMPLING LOCATION

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FIGURE 4-14
BENZENE
SUBSURFACE SOILS

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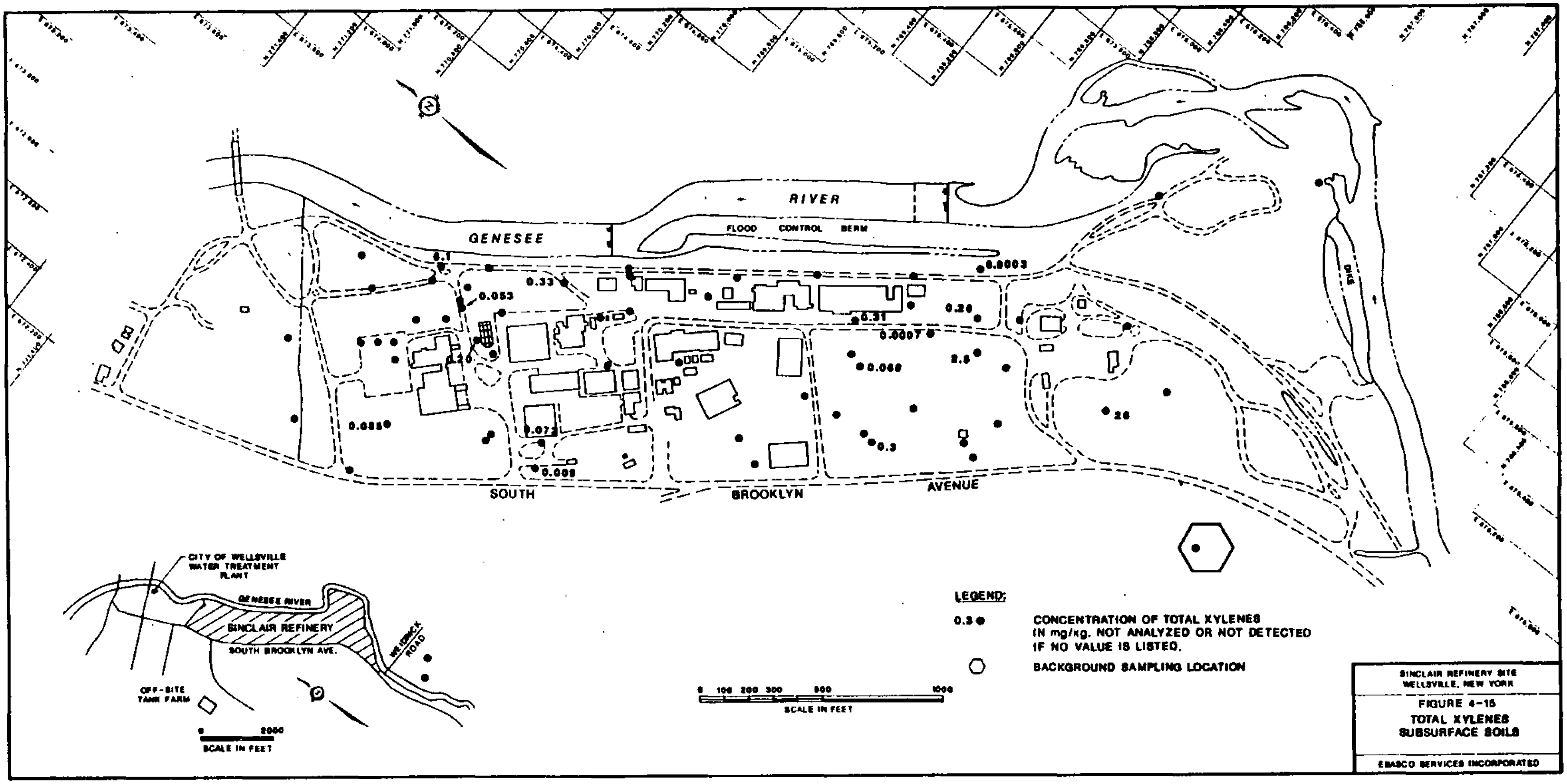

LEGEND:

0.3 ● CONCENTRATION OF TOTAL XYLENES IN mg/kg. NOT ANALYZED OR NOT DETECTED IF NO VALUE IS LISTED.

⬡ BACKGROUND SAMPLING LOCATION

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FIGURE 4-15
TOTAL XYLENES
SUBSURFACE SOILS

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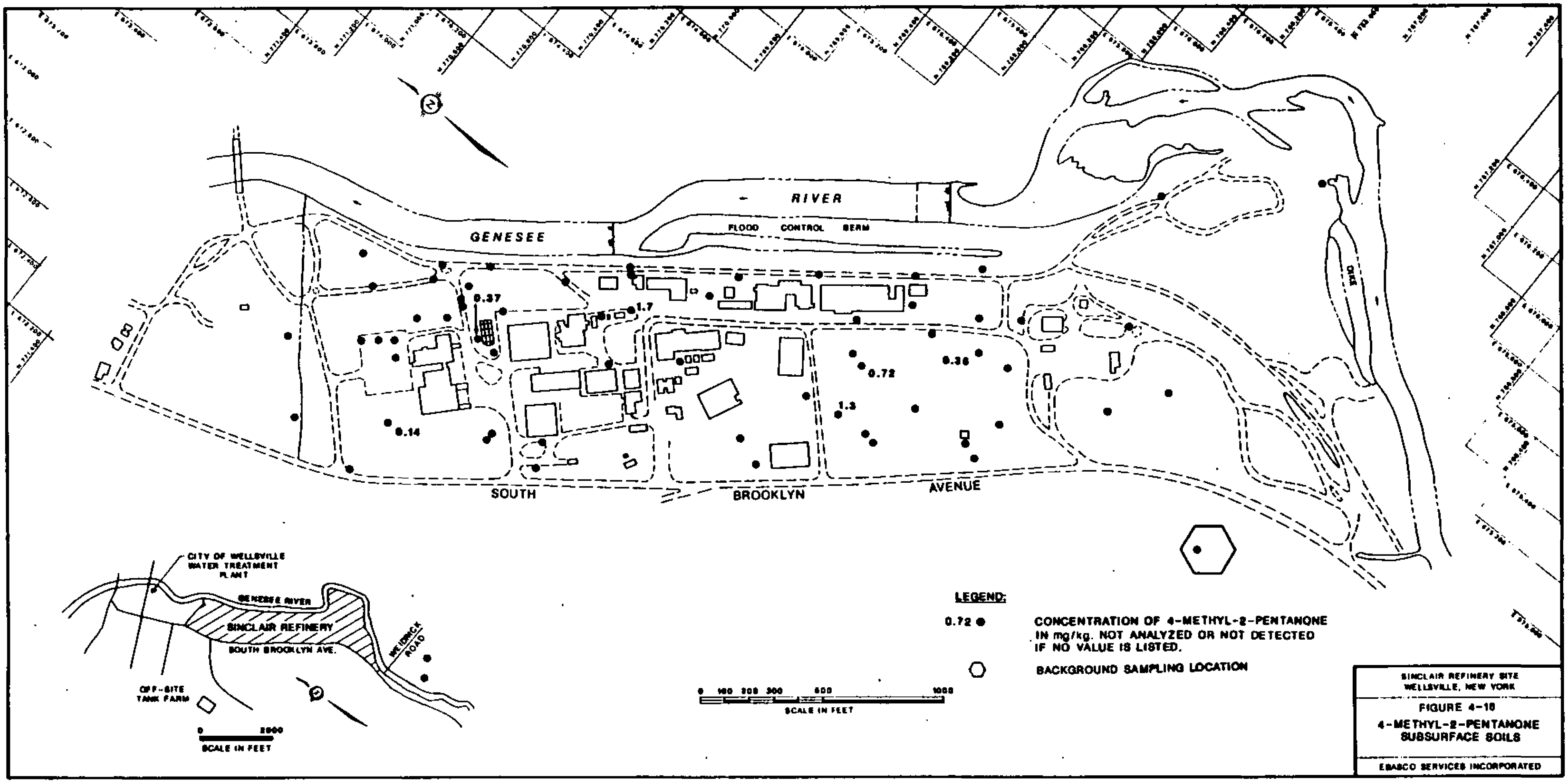
samples, 21 of 35 samples and 17 of 35 samples, respectively. 4-Methyl-2-Pentanone (Figure 4-16), 2-Hexanone (Figure 4-17), 1,1,2,2-tetrachloroethane (Figure 4-18) and ethylbenzene (Figure 4-19) were present in 6 or 8 of 66 samples in concentrations ranging from 0.14-5.1 mg/kg, 0.014-1.9 mg/kg, 0.022-2.1 mg/kg and 0.045-3.6 mg/kg, respectively. 2-Butanone, 1,1,1-trichloroethane, toluene (Figure 4-20) acetone, styrene and chlorobenzene were present in 6 or fewer samples of the 35. Their concentrations ranged from 0.002-0.91 mg/kg. Most of the concentrations were estimated.

The majority of the VOCs detected, as well as the higher concentrations were from samples taken at location MW49 through MW54. Five of these six sampling locations are in the Butler-Larkin storage area or on the adjoining Mapes property in the south central portion of the site. The sixth sample from MW-52 located in an open area at the north end of the site, also exhibited elevated levels of VOCs. However, most of the other samples from the storage area and at the same approximate depth (0-16 feet), exhibit neither the variety of compounds nor the elevated concentrations. Twelve of the fourteen VOCs detected were detected in these six borings. Carbon disulfide was detected in all six borings in concentrations ranging from 0.004-0.048 mg/kg. 1,1,2,2-tetrachloroethane, a solvent unlikely to have been used during refinery operation, was found in 4 of 6 samples in concentrations of 36-630 mg/kg. Chlorobenzene (0.01-0.13 mg/kg) and styrene (1.0007-0.0018 mg/kg), also unlikely to be refinery-generated contaminants, were present in 2 of 6 samples. In addition, 2-butanone, 1,1,1-trichloroethane, benzene, total xylenes, 2-hexanone, ethylbenzene and 4-methyl-2-pentanone were present, and detected in the storage area at concentrations ranging up to 2.5 mg/kg.

In Phase IIb, 3 subsurface samples were analyzed for VOCs. No VOCs except acetone, a probable laboratory or sampling contaminant, were detected.

As previously mentioned, almost all VOCs detected were in samples from borings MW-49 to 54. Other samples from locations near these wells did not contain VOCs. However, samples from MW-33 and MWP-2, which are located in the northern part of the site also showed elevated levels of VOCs. If the VOCs in the subsurface are determined to present risks, potentially requiring remediation, the validity of the results may need to be confirmed since nondetected and detected values occurred so physically close together.



LEGEND:

0.72 ●	CONCENTRATION OF 4-METHYL-2-PENTANONE IN mg/kg. NOT ANALYZED OR NOT DETECTED IF NO VALUE IS LISTED.
⬡	BACKGROUND SAMPLING LOCATION

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FIGURE 4-10

4-METHYL-2-PENTANONE
SUBSURFACE SOILS

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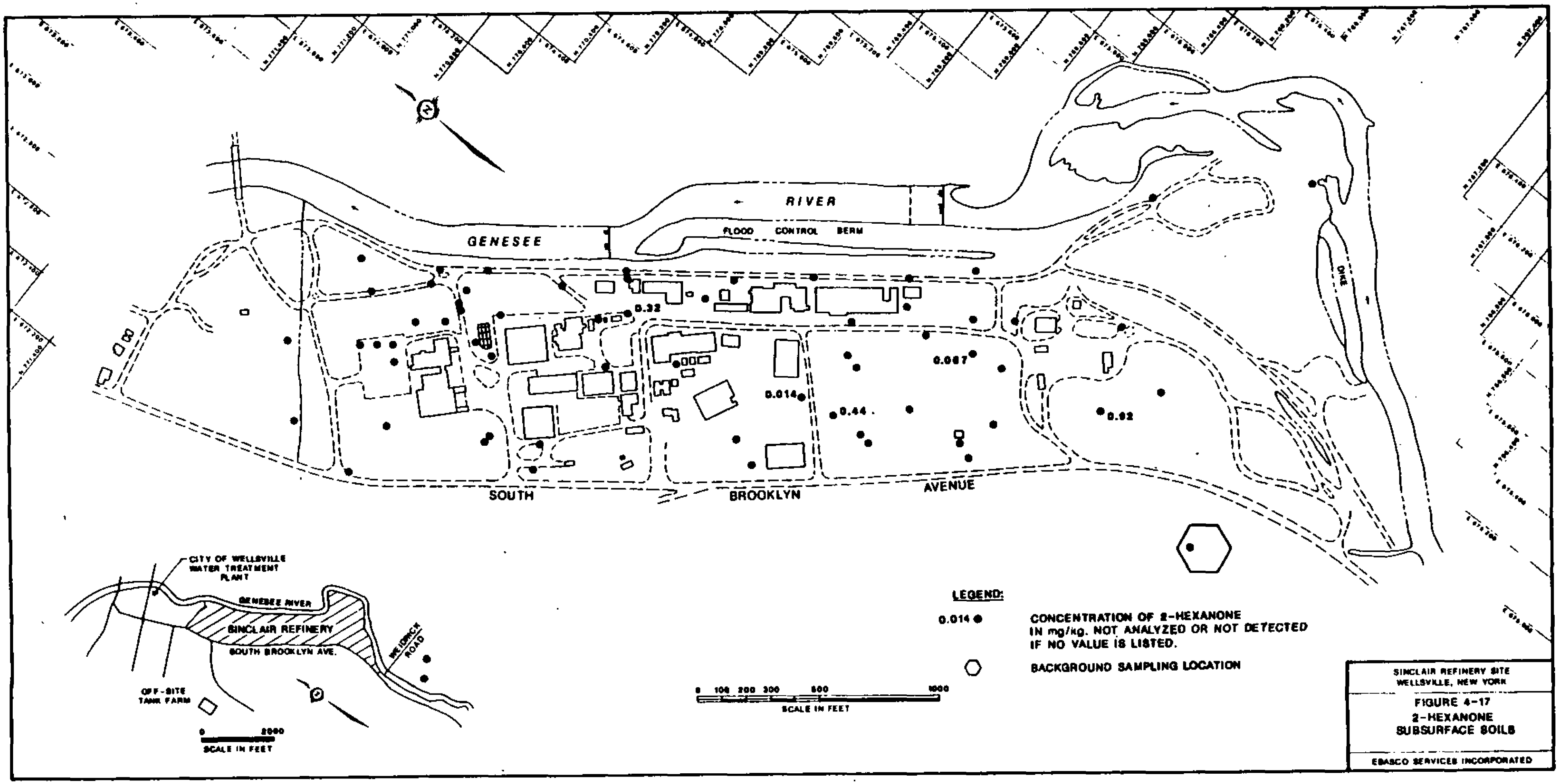

LEGEND:

0.014 ●	CONCENTRATION OF 2-HEXANONE IN mg/kg. NOT ANALYZED OR NOT DETECTED IF NO VALUE IS LISTED.
⬡	BACKGROUND SAMPLING LOCATION

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FIGURE 4-17
2-HEXANONE
SUBSURFACE SOILS

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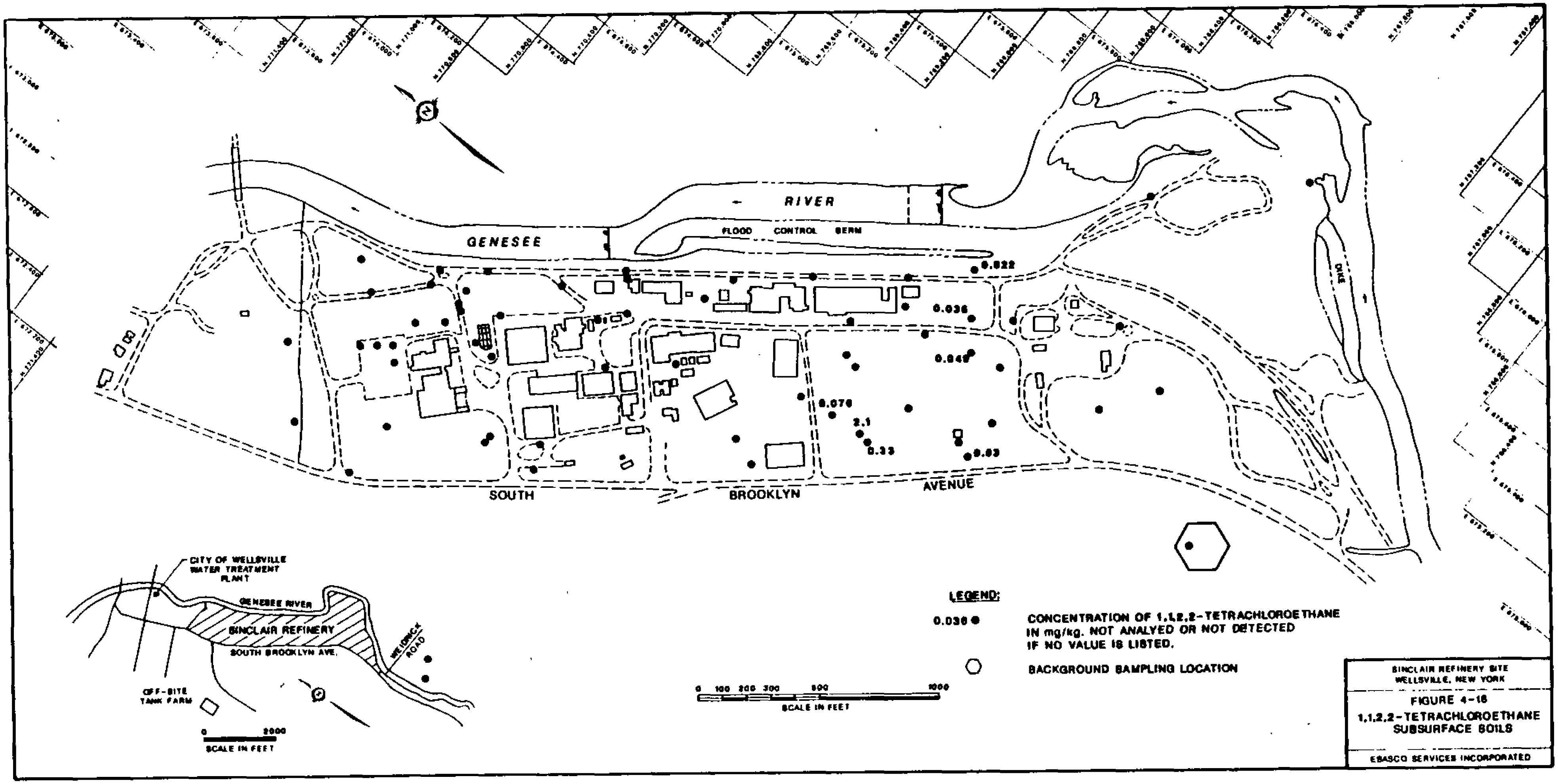

LEGEND:

0.036 ●	CONCENTRATION OF 1,1,2,2-TETRACHLOROETHANE IN mg/kg. NOT ANALYED OR NOT DETECTED IF NO VALUE IS LISTED.
○	BACKGROUND SAMPLING LOCATION

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WELLSVILLE, NEW YORK

FIGURE 4-16
1,1,2,2-TETRACHLOROETHANE
SUBSURFACE SOILS

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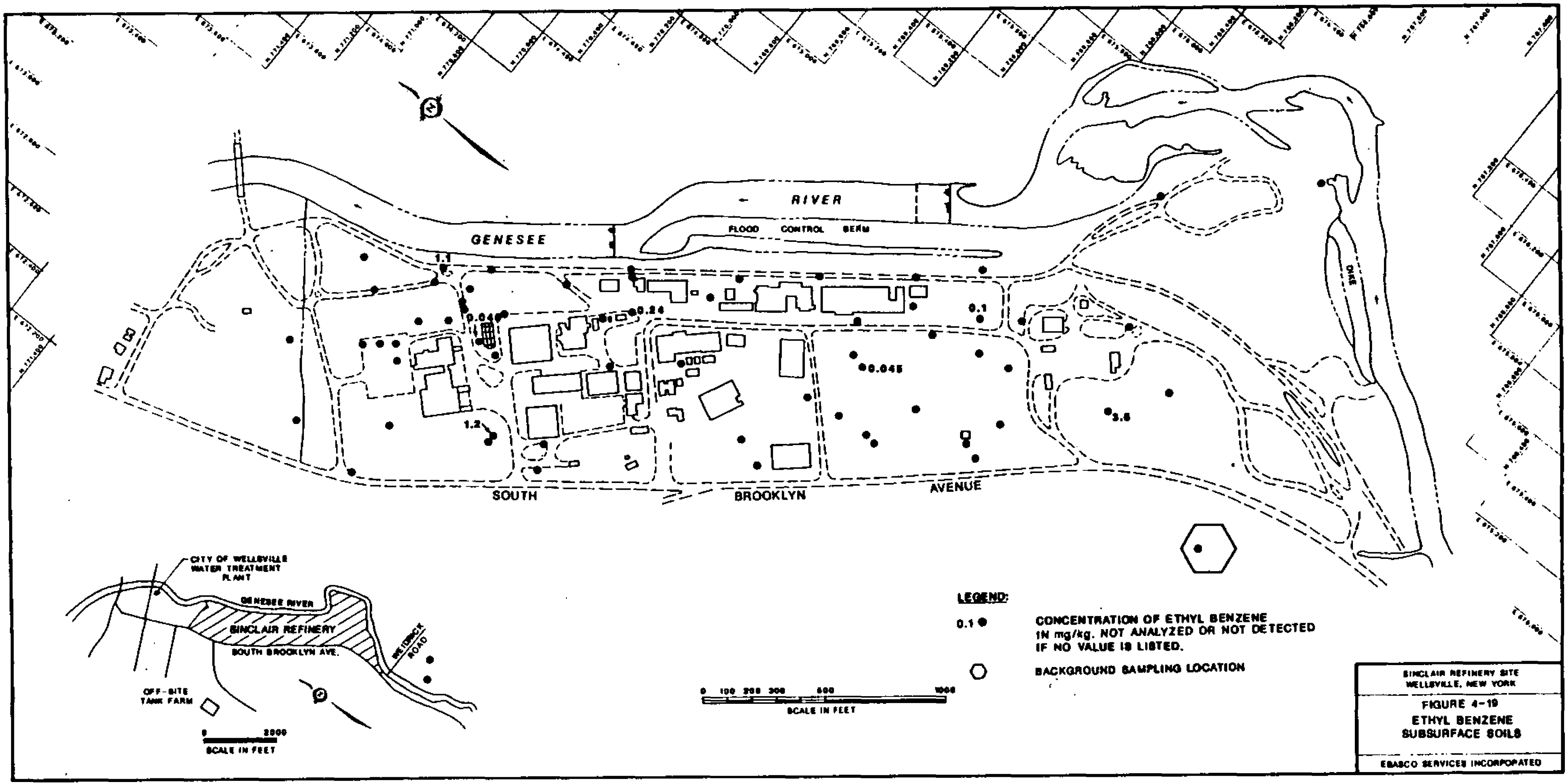

LEGEND:

0.1 ● CONCENTRATION OF ETHYL BENZENE IN mg/kg. NOT ANALYZED OR NOT DETECTED IF NO VALUE IS LISTED.

⬡ BACKGROUND SAMPLING LOCATION

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FIGURE 4-19
ETHYL BENZENE
SUBSURFACE SOILS

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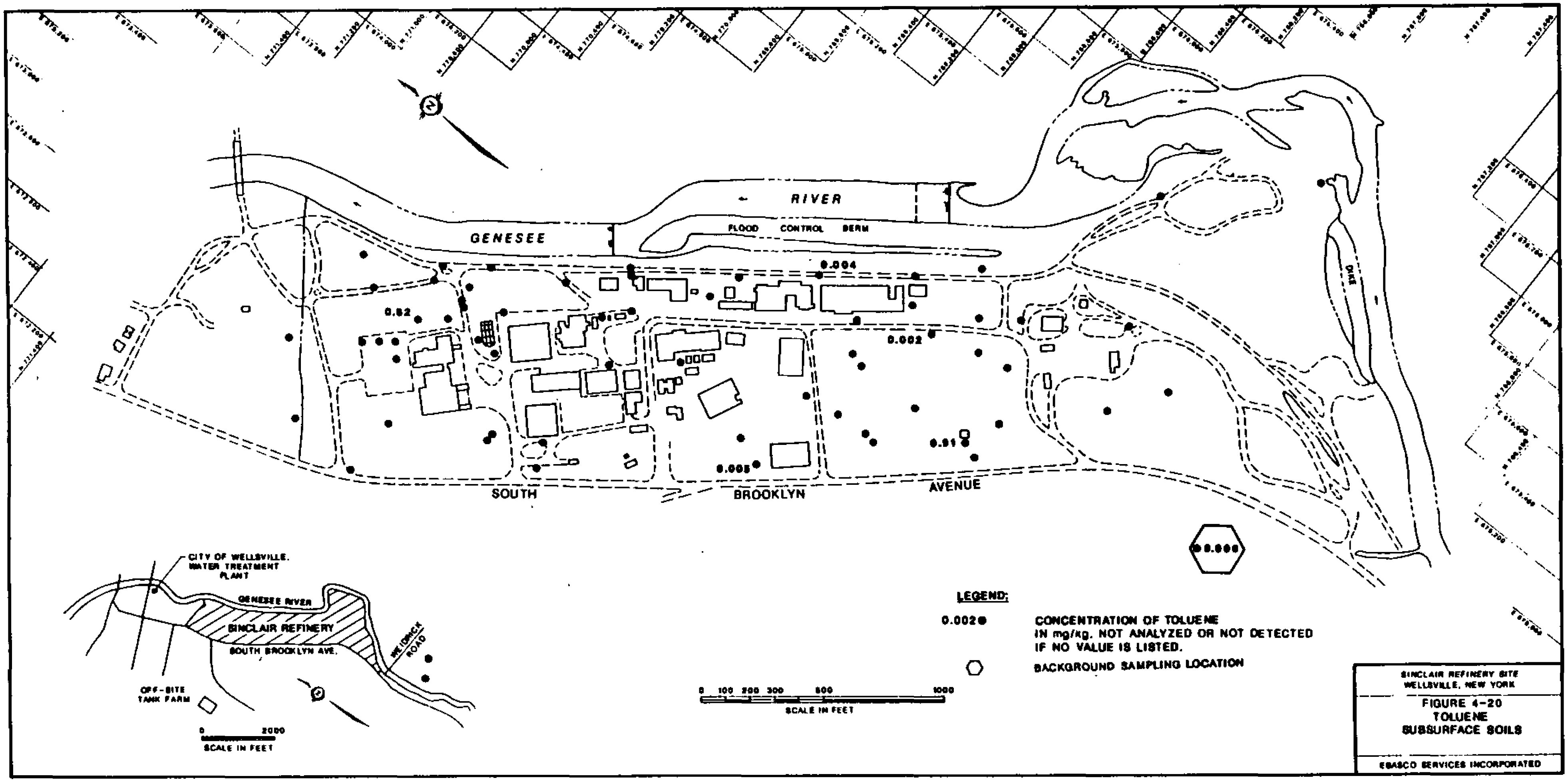

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FIGURE 4-20
TOLUENE
SUBSURFACE SOILS

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In the clay layer, benzene was detected in 1 of 6 samples at 0.002 mg/kg. In the soils in the deep aquifer, 1,1,1-trichloroethane (0.0006 mg/kg) and total xylenes (0.010 mg/kg) were detected, but no benzene was detected. It is possible that these low levels of contamination are due to contaminants being introduced into the sample during the drilling and sampling process. The comparatively higher levels of contaminants in the shallow aquifer may have contaminated the split spoon as it was lowered through the water in the hollow stem auger. Since the upward hydraulic gradient in the deeper units would tend to stop the downward migration of contaminants, the contamination of the sample during the drilling process must be considered a realistic possibility.

In Phase IIb the only detected VOCs, acetone and 1,2-dichloroethane were present in only 2 and 1 of 10 shallow test pit samples, respectively. The 1,2-dichloroethane concentration was 0.017 mg/kg; acetone concentrations were 0.018 mg/kg and 0.020 mg/kg. Given the fact that both compounds are industrial solvents and that acetone is widely used in the sampling process, it seems likely that these contaminants are from activities after the refinery ceased operations. The acetone is probably due to residue left on sampling devices after the decontamination process.

In Phase I, BNA compounds were detected in only 4 out of 31 samples. During Phase IIa, BNAs were detected at relatively low levels in several samples (Table 4-10). A total of 21 compounds were detected, but only 10 were present in more than 6 of 66 samples. These were naphthalene (0.029-3.3 mg/kg), 2-methylphthalene (0.018-17 mg/kg), diethylphthalate (0.036-1.0 mg/kg), fluorene (0.031-2.5 mg/kg), phenanthrene (0.005-6.1 mg/kg), fluoranthene (0.04-1.6 mg/kg), pyrene (0.06-2.6 mg/kg), butyl benzyl phthalate (0.026-1.9 mg/kg), di-n-octyl phthalate (0.007-0.4 mg/kg) and benzo(a)pyrene (0.026-1.0 mg/kg). Phase I and IIa PAHs and benzo(a)pyrene from subsurface samples are shown on Figures 4-21 and 4-22. Most of the BNAs detected were confined to samples from the Butler-Larkin storage area. These compounds may be attributable to refinery operation or the more recent pipe coating operation in the storage area.

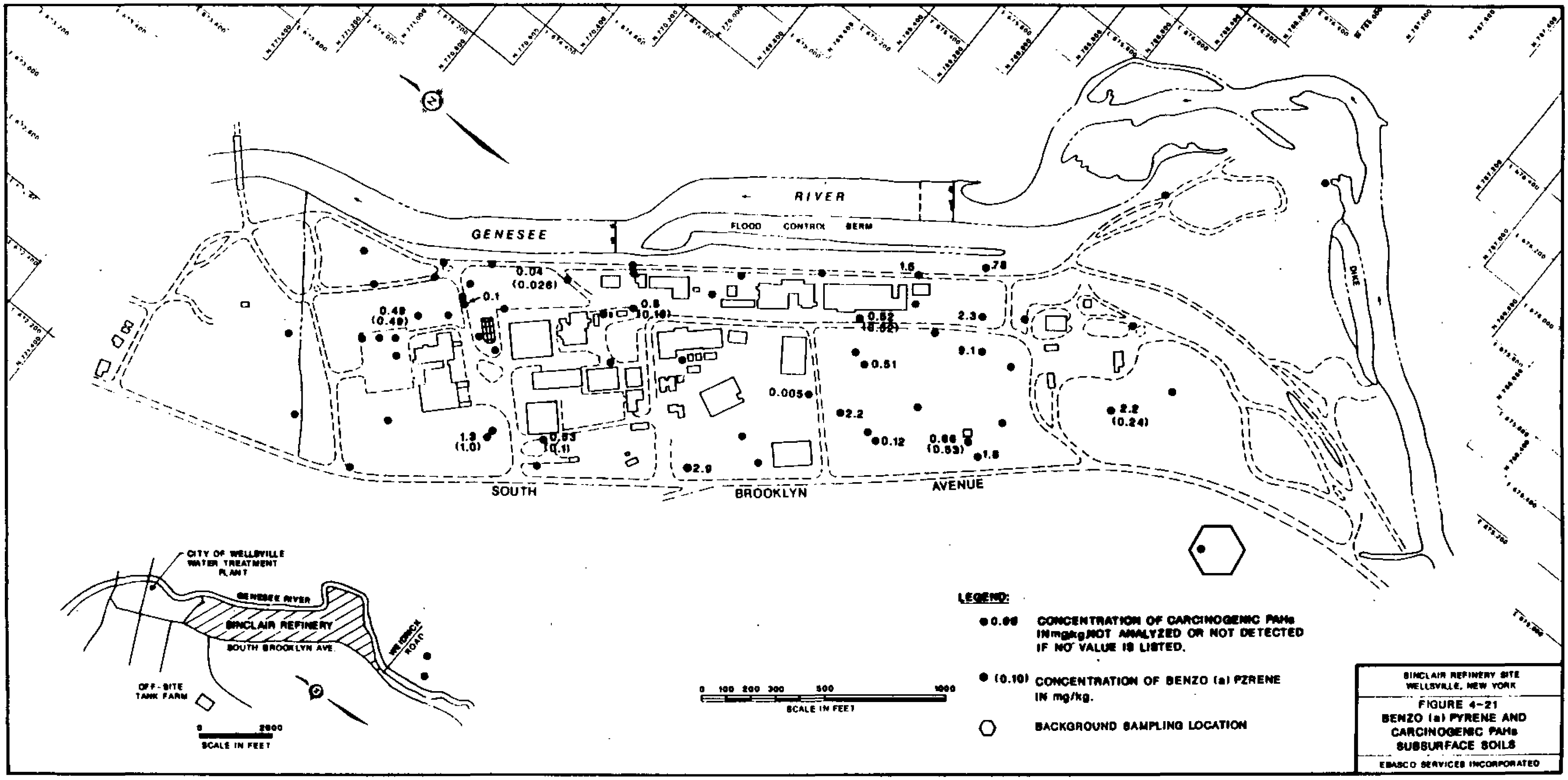

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FIGURE 4-21
BENZO (a) PYRENE AND CARCINOGENIC PAHs SUBSURFACE SOILS

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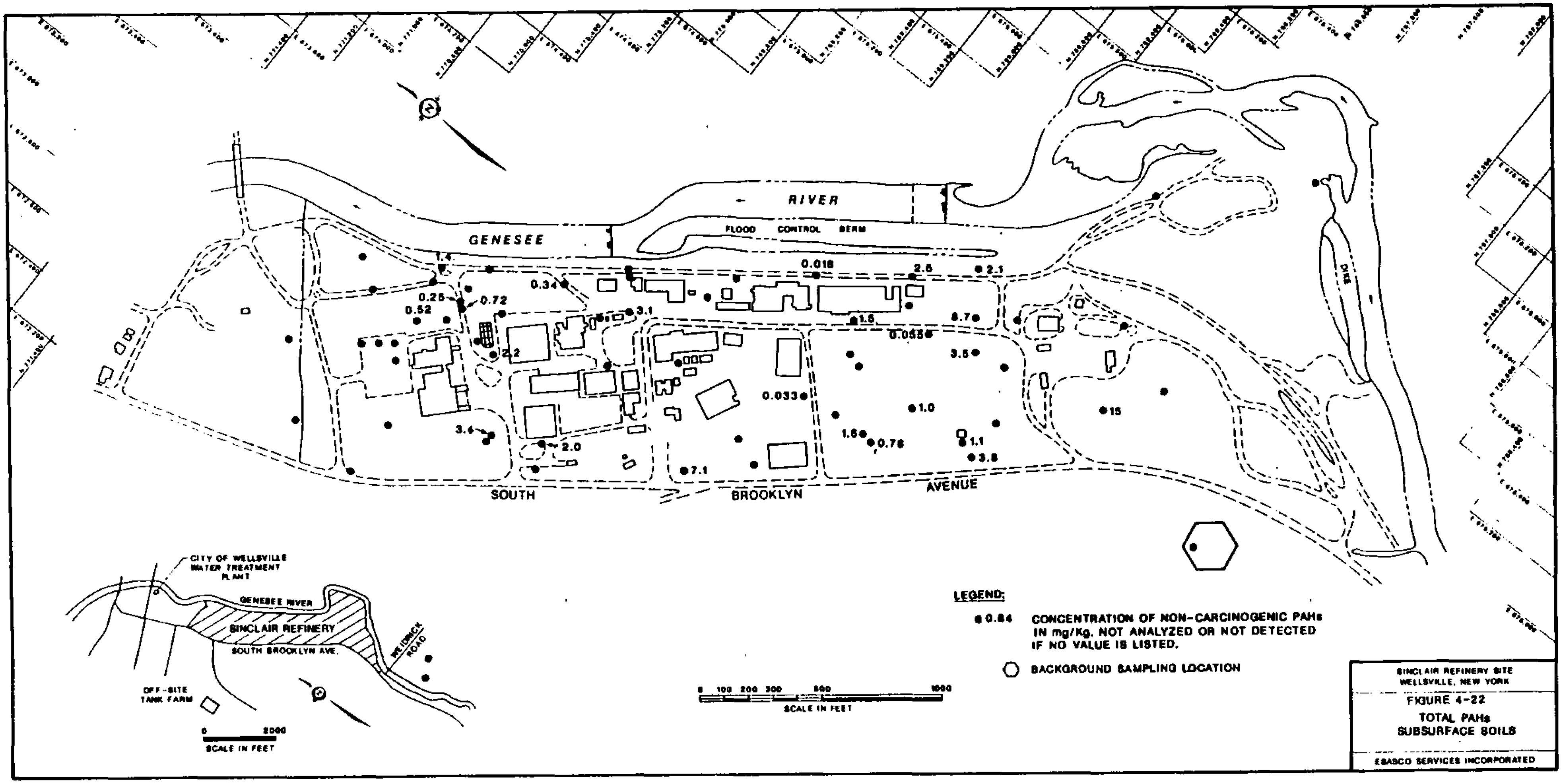

SINCLAIR REFINERY SITE
WELLSVILLE, NEW YORK

FIGURE 4-22

TOTAL PAHs
SUBSURFACE SOILS

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In the two deeper units, only the clay layer evidenced any BNA contamination. Di-n-octyl phthalate was detected in 1 of 6 samples at 0.29 mg/kg. Given the fact that this was present in only one of all the deep samples, it is possible that this is a sampling error (i.e., cross-contamination).

In Phase IIb, three samples were analyzed for BNAs. With the exception of di-n-butylphthalate, BNA compounds were detected in only 1 of the subsurface samples. (TP02-04), which was located in a test pit near the north oil separator (TP02). The contaminants in this sample included 2-methylnapthalene (37 mg/kg), fluoranthene (33 mg/kg), pyrene (30 mg/kg), chrysene (25 mg/kg), benzo(k)fluoranthene (22 mg/kg), benzo(a)anthracene (17 mg/kg), benzo(b)fluorene (16 mg/kg), phenathrene (22 mg/kg), benzo(a)pyrene (19 mg/kg), indeno[123]pyrene (13 mg/kg) and benzo(ghi)perlene (12 mg/kg). The latter six compounds were measured in estimated concentrations.

Tentatively identified compound (TIC) results are included in Appendices B (Phase I and IIa data) and C (Phase IIb data).

4.6 GROUNDWATER

A total of 33 groundwater samples were taken during the Phase I and IIa sampling series (Table 4-11). They were intended to be drawn from three distinct layers consisting of the upper aquifer, the clay layer and the deep aquifer. In fact, the "clay layer samples" was a misnomer. In many cases, the well screen in this layer intersected the upper aquifer, limiting the usefulness of this data. The clay layer samples are therefore not discussed below.

During the Phase IIb round of sampling, a total of 23 groundwater samples were taken on the refinery site and three from the landfill area. All of the monitoring wells sampled were screened in the upper aquifer except MWD-66, completed in the deep aquifer. Some of the samples from the upper aquifer were filtered (metal analysis), decanted (BNA analysis) or centrifuged (VOA) in order to explore the effect of suspended soil particles on the concentrations of contaminants in the water. The Phase IIb samples were taken from the same wells as used in the Phase I and IIa sampling, except for wells MW-65 and MWD-66 installed as part of Phase IIb. This round of sampling represents the

TABLE 4-11 (Page 1 of 2)

CHEMICALS DETECTED IN GROUNDWATER(a)
ORGANIC COMPOUNDS

RANGE OF CONCENTRATIONS (mg/l)

	Phase I 1985	Phase IIa(b) Dec. 1986	Phase IIb Nov-Dec. 1988	Background
Total Number of Samples Analyzed	11	22	23	
COMPOUNDS				
Volatiles				
Acetone	ND	ND	0.016-8.5 (8)	ND-0.005
1,1-Dichloroethane	0.044-0.067 (2)(c)	0.005 (1)	0.012-0.69 (3)	ND
1,1,1-Trichloroethane	0.113 (1)	0.001-0.24 (2)	0.035-1.8 (2)	ND-0.0004
Benzene	0.002-0.73 (6)	0.005-0.53 (15)	0.004-1.2 (14)	ND-0.002
Toluene	0.004-0.057 (6)	0.002-0.53 (7)	0.001-0.39 (12)	ND-0.006
Ethylbenzene	0.004-0.07 (4)	0.006-0.83 (10)	0.0004-0.17 (14)	ND
Total Xylenes	0.008-1.31 (5)	0.023-1.1 (11)	0.001-1.5 (17)	ND-0.013
BNAs				
Nitrobenzene	ND	0.011-1.7 (2)	8.2 (1)	ND
Naphthalene	0.001-0.075 (2)	0.003-0.17 (6)	0.032-0.23 (2)	ND
2-Methylnaphthalene	ND	0.007-0.34 (16)	0.008-0.27 (9)	ND
Phenanthrene	ND	0.015-0.090 (4)	0.018-0.053 (3)	ND

Note:

(a) Compounds listed include all indicator chemicals detected.

(b) Does not include landfill area samples

(c) Number in parenthesis indicates number of samples with value above detection limit

ND = not detected

NA = not analyzed

TABLE 4-11 (Page 2 of 2)

CHEMICALS DETECTED IN GROUNDWATER[a]
METALS

RANGE OF CONCENTRATIONS (mg/l)

	Phase I 1985	Phase IIa[b] (Dec 1986)	Phase IIb (Nov-Dec 1988) (Unfiltered)	Phase IIb (Nov-Dec 1988) (Filtered)	Background (Filtered)	Background (Unfiltered)
Total Number of Samples Analyzed	11	22	18	17		
Aluminum	NA	0.12 - 0.14 (5)	0.75 -113. (17)	0.021 - 0.070 (4)	0.05	1.9 -32.1
Arsenic	0.003-0.095 (9)[c]	0.005- 0.24 (20)	0.01 - 0.884 (17)	0.013 - 0.462 (14)	ND	0.02 -0.04
Barium	NA	0.078- 0.6 (9)	0.16 - 2.36 (18)	0.075 - 1.04 (17)	0.014-0.09	0.14 -0.25
Beryllium	ND	ND	0.001 - 0.007 (11)	ND	ND	ND - 0.005
Cadmium	0.003-0.005 (2)	ND	0.004 - 0.005 (2)	ND	ND	ND - 0.0075
Calcium	NA	14.2 -77.2 (9)	14.5 -105 (18)	14.9 -91.4 (17)	8.5 -12.5	9.1 -13.8
Chromium	0.005-0.006 (2)	0.010- 0.031 (5)	0.017 - 0.298 (17)	0.004 (1)	ND	0.061 -0.064
Cobalt	NA	0.011 (1)	0.005 - 0.089 (17)	0.005 - 0.016 (3)	ND	0.006 -0.04
Copper	0.004-0.016 (8)	0.028- 0.131 (3)	0.021 - 0.956 (17)	0.007 (1)	ND	0.06 -0.08
Iron	NA	5.2 -42.6 (9)	42.5 -280 (18)	0.548 -73.3 (17)	0.016-5.3	17.7 -79.9
Lead	ND	0.006- 0.102 (6)	0.026 - 0.249 (17)	ND	ND	0.05 -0.69
Magnesium	NA	2.4 -16.3 (9)	6.05 - 33.80 (18)	3.59 -19.5 (17)	2.5 -2.6	2.9 -10.7
Manganese	NA	0.659- 8.35 (9)	0.537 - 31.5 (18)	0.237 -27 (17)	0.2 -2.8	2.4 -2.9
Mercury	ND	ND	0.00015- 0.00025 (2)	0.0002 (1)	ND	ND
Nickel	0.004-0.026 (10)	ND	0.025 - 0.362 (17)	0.011 - 0.102 (1)	ND	0.037-0.084
Potassium	NA	1.0 - 6.9 (9)	2.850 - 12.900 (18)	0.801 - 4.580 (17)	1.0 -2.1	1.9 -10.0
Silver	0.002-0.020 (4)	0.011- 0.026 (2)	0.0043 - 0.0097 (6)	ND	0.004	ND
Sodium	NA	5.7 -54.4 (9)	4.570 - 70 (18)	4.97 -69.20 (17)	2.3 -6.4	ND-6.9
Vanadium	NA	NA	0.0046 - 0.149 (17)	0.0037 (1)	ND	0.003 -0.047
Zinc	0.750-7.35 (11)	0.059-18.1 (22)	0.273 - 21.5 (18)	0.015 - 2.0 (16)	2.5 -5.6	0.2 -86.3

Note:

(a) Compounds listed include all compounds detected in two or more samples in this media, in any phase and all indicator chemicals detected.

(b) Does not include landfill area samples

(c) Number in parenthesis indicates number of samples with value above detection limit

ND = not detected

NA = not analyzed

most recent data available, is the most samples taken at any one time and has been fully validated. Consequently, the Phase I and IIa data, although presented in Appendix B and Table 4-11 will not be discussed in this report since the more recent, validated Phase IIb data are available.

4.6.1 Refinery Area Groundwater

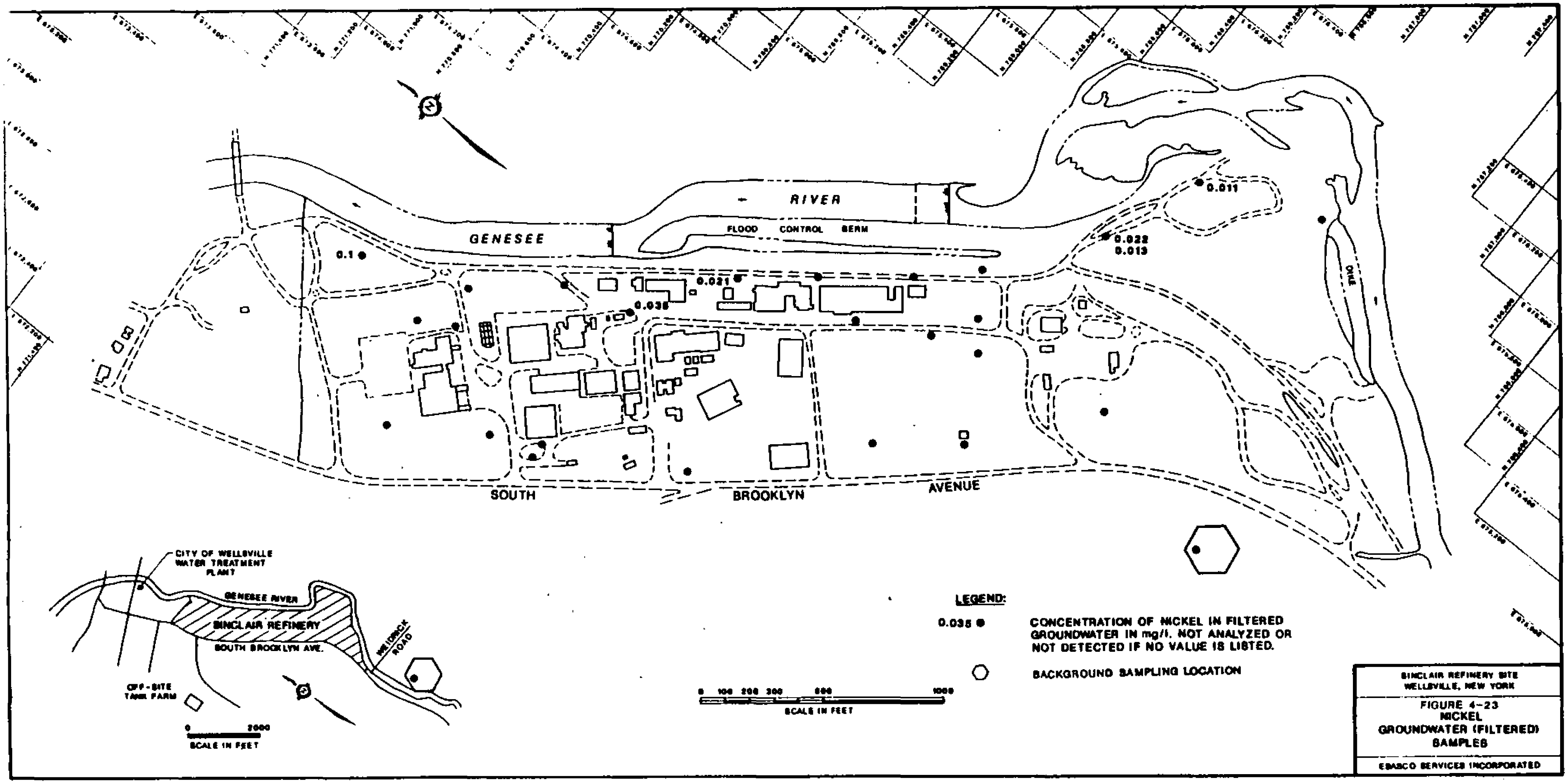
Both filtered and unfiltered analyses of metals were performed on the groundwater in Phase IIb. The EPA, Region II requires that unfiltered data be used for risk assessments, even though this may overestimate the potential risks associated with the groundwater if sediment-free samples cannot be obtained. Groundwater samples at the site were almost uniformly muddy when they were obtained. Since most metals have low solubilities and tend to bind with soils, the sediments in the samples tend to increase the amount of metals detected in a sample. Filtering samples removes the sediments from the water, but may remove some colloidal particulates which may transport metals through an aquifer. While filtered samples are probably more representative of aquifer conditions they may underestimate contamination due to partial removal of colloid matter from the samples. The following discussions describe both filtered and unfiltered results.

Eighteen Phase IIb unfiltered samples for analysis of metals were taken from the shallow aquifer. A total of 20 metals were detected. The unfiltered samples were uniformly muddy since the wells could not be developed. Water of this quality is not representative of groundwater conditions. It is therefore considered to be of limited usefulness in assessing groundwater quality but can be used to provide a conservative risk assessment for groundwater use. If the unfiltered samples were representative of aquifer water quality, the water could not be used for any industrial or personnel uses without treatment to remove the sediments. Of the 20 metals detected, 16 were present in 17 or 18 of the 18 samples. Most had values at or below local unfiltered background levels (Table 4-11), although there were also some samples where the concentration exceeded background ranges. Barium and cobalt, which contrary to other metals showed frequency increases over past sampling, were present in concentrations ranging from 0.16-2.4 mg/l and 0.005-0.089 mg/l, respectively, compared to background values of 0.14-0.25 mg/l and 0.006-0.04 mg/l, respectively. Calcium, copper, iron, magnesium, potassium and sodium all commonly occur in groundwater at widely varying concentrations. These are unlikely to be attributable to refinery activities. However, activities such as salting roadways in winter are likely to influence concentrations of sodium, calcium and potassium.

Four metals--arsenic, lead, nickel and zinc--were identified in the POP (Ebasco 1988) as potential contaminants of concern. These metals were present in nearly all samples at concentrations ranging from 0.01-0.88 mg/l for arsenic, 0.026-0.25 mg/l for lead, 0.025-0.36 mg/l for nickel, and 0.27-21.5 mg/l for zinc. The unfiltered background concentrations for these metals were 0.022-0.041 mg/l, 0.073-0.69 mg/l, 0.037-0.084 mg/l and 6.7-86.3 mg/l, respectively. These ranges, both on site and in background samples, are uniformly higher than the ranges initially detected by SMC Martin.

When the samples were filtered, the number of detected metals went from 20 to 17, and the maximum concentrations and mean concentrations decreased overall. Cadmium, beryllium and lead are the three metals that were no longer detected in on-site or background samples after filtering. Silver was detected only in the background filtered sample but not on-site. In addition, the frequency of seven metals--aluminum (0.021-0.07 mg/l), chromium (0.004 mg/l), cobalt (0.005-0.016 mg/l), copper (0.007 mg/l), mercury (0.0002 mg/l), nickel (0.011-0.102 mg/l) vanadium (0.004 mg/l),--dropped to 5 in 15 samples or fewer (Table 4-11). The concentration of nickel in filtered and unfiltered groundwater samples is shown on Figures 4-23 and 4-24, respectively. Of these seven metals, only aluminum (0.055 mg/l) was also detected in one of the filtered background samples. The zinc concentrations (0.015-2.0 mg/l) remained below filtered background (2.5-5.6 mg/l). These decreases show that the metals in the unfiltered samples were actually attached to colloidal or soil particles present in the sample, and not dissolved in the groundwater. As previously stated, while the unfiltered samples may overestimate concentrations, due to the presence of metals on the soils, the filtered results may underestimate concentrations due to the potential removal of colloidal particles.

As discussed in Subsection 2.6.2, the wells at the site could not be adequately developed during sampling to eliminate the presence of soil particles in the samples.



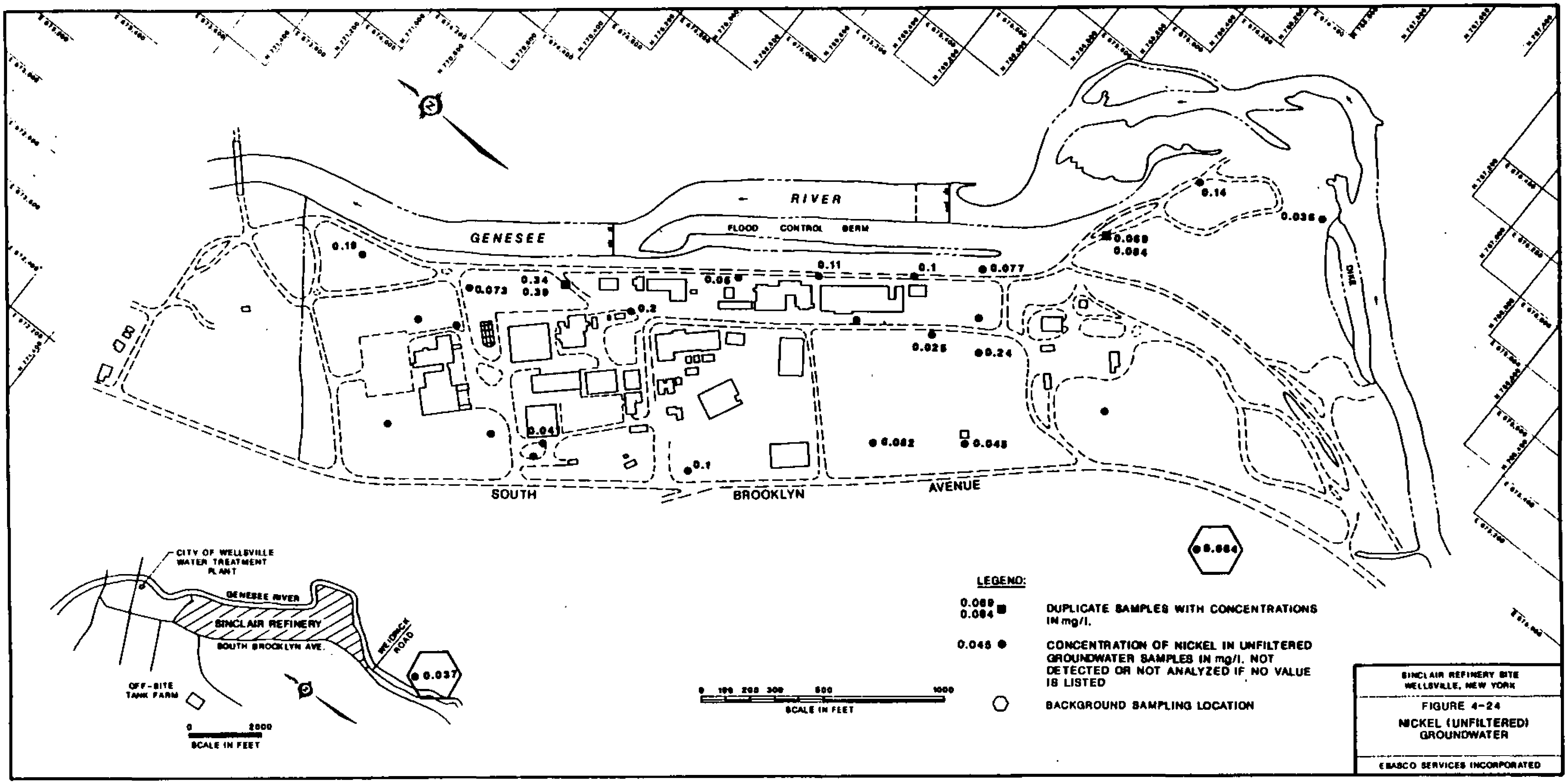
LEGEND:

0.035 ●	CONCENTRATION OF NICKEL IN FILTERED GROUNDWATER IN mg/l. NOT ANALYZED OR NOT DETECTED IF NO VALUE IS LISTED.
○	BACKGROUND SAMPLING LOCATION

SINCLAIR REFINERY SITE
WELLSVILLE, NEW YORK

FIGURE 4-23
NICKEL
GROUNDWATER (FILTERED)
SAMPLES

EBASCO SERVICES INCORPORATED



LEGEND:

0.069 0.084 ■	DUPLICATE SAMPLES WITH CONCENTRATIONS IN mg/l.
0.045 ●	CONCENTRATION OF NICKEL IN UNFILTERED GROUNDWATER SAMPLES IN mg/l. NOT DETECTED OR NOT ANALYZED IF NO VALUE IS LISTED
⬡	BACKGROUND SAMPLING LOCATION

SINCLAIR REFINERY SITE
WELLSVILLE, NEW YORK

FIGURE 4-24

NICKEL (UNFILTERED)
GROUNDWATER

EBASCO SERVICES INCORPORATED

Arsenic, barium, calcium, iron, magnesium, manganese, potassium and sodium, were still present in at least 14 of 18 samples. The concentrations were lower than in the unfiltered samples. The concentrations of these metals in the filtered samples were: arsenic 0.013-0.46 mg/l; barium 0.075-1.0 mg/l; calcium 15-91 mg/l; iron 0.55-73 mg/l; magnesium 3.6-20 mg/l; manganese 0.24-27 mg/l; potassium 0.80-4.6 mg/l and sodium 4.97-69.2 mg/l. Background concentrations in filtered samples were: arsenic not detected, barium 0.014-0.093 mg/l, calcium 8.5-12.5 mg/l, iron 0.016-5.3 mg/l, magnesium 2.5-2.6 mg/l, manganese 2.5-2.8 mg/l, potassium 1.0-2.1 mg/l and sodium 2.3-6.4 mg/l (Table 4-11).

Arsenic levels in filtered groundwater samples did not show a clearly definable pattern in the refinery area. However, most of the higher arsenic levels were found in a limited area in wells close to the river near the former railroad track, where elevated levels of arsenic in soils was also detected. Filtered and unfiltered arsenic results are shown on Figures 4-25 and 4-26, respectively.

Barium was detected at its highest levels (above 500 mg/l) in the same seven wells as the elevated levels of arsenic. An association of barium and arsenic that would account for this has not been identified.

Five of the seven highest calcium and sodium concentrations were also in these wells. Concentrations of iron, magnesium, manganese and potassium did not follow the same trends or correlate as well with each other except that in wells MW-27 and 33 high values were consistently detected.

The Phase IIb samples analyzed for VOCs that were not centrifuged prior to analysis contained 17 volatile organic compounds. Ten of these compounds had a frequency of only one of 22 samples*. The samples in which the 10 compounds

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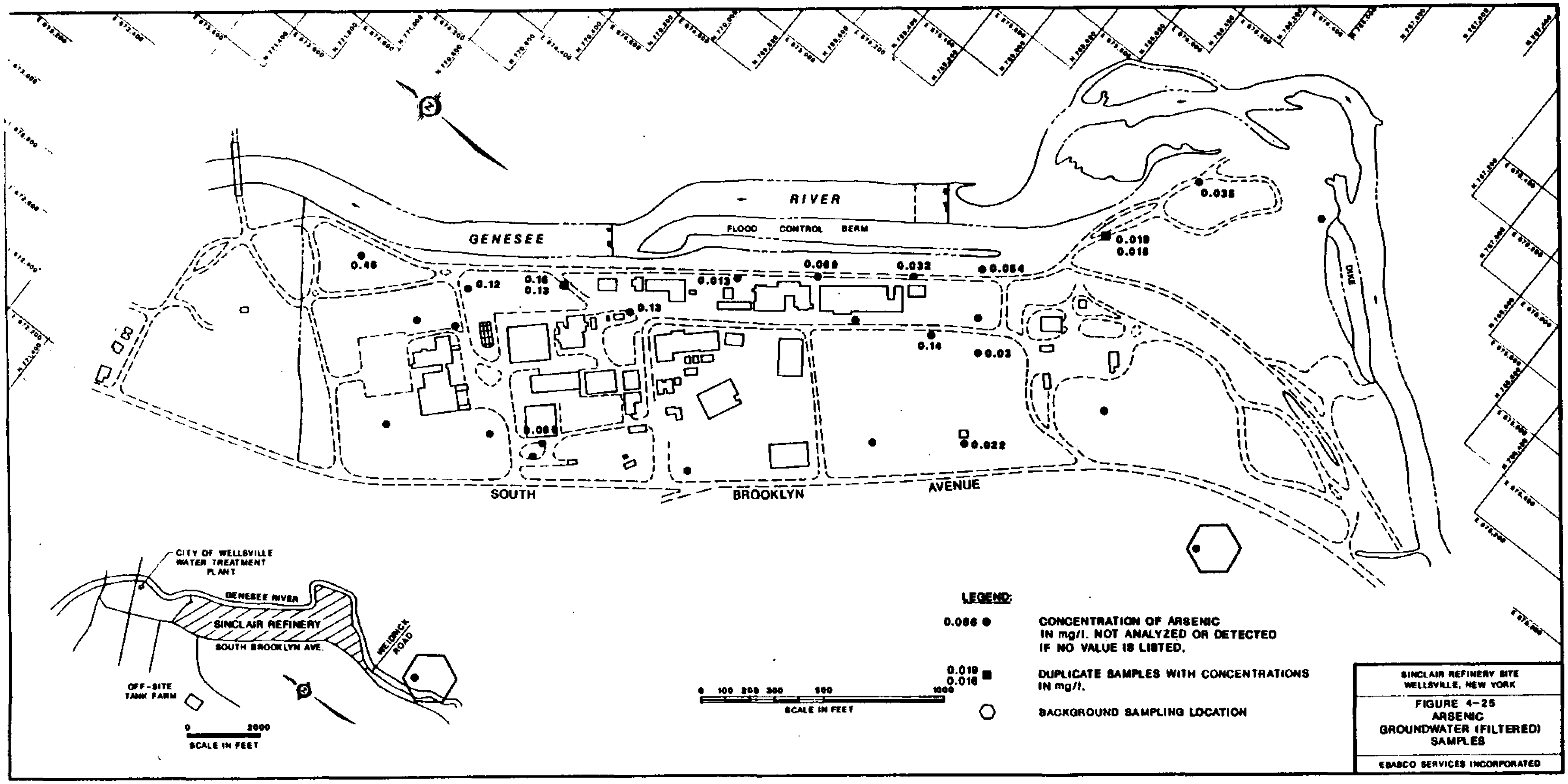
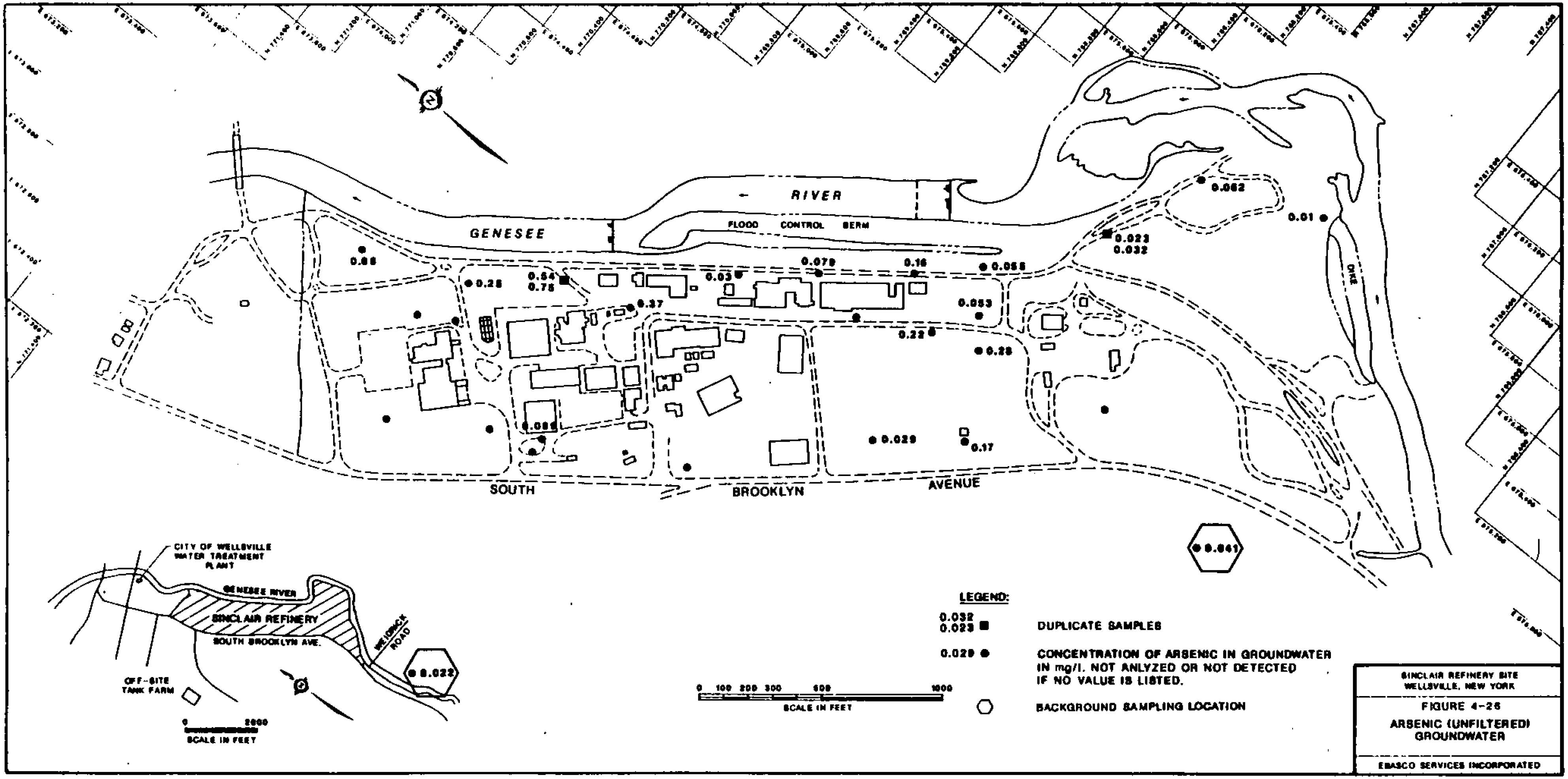
* 2-Butanone had only 10 valid analyses.



SINCLAIR REFINERY SITE
WELLSVILLE, NEW YORK

FIGURE 4-25
ARSENIC
GROUNDWATER (FILTERED)
SAMPLES

EBASCO SERVICES INCORPORATED



SINCLAIR REFINERY SITE
WELLSVILLE, NEW YORK

FIGURE 4-26

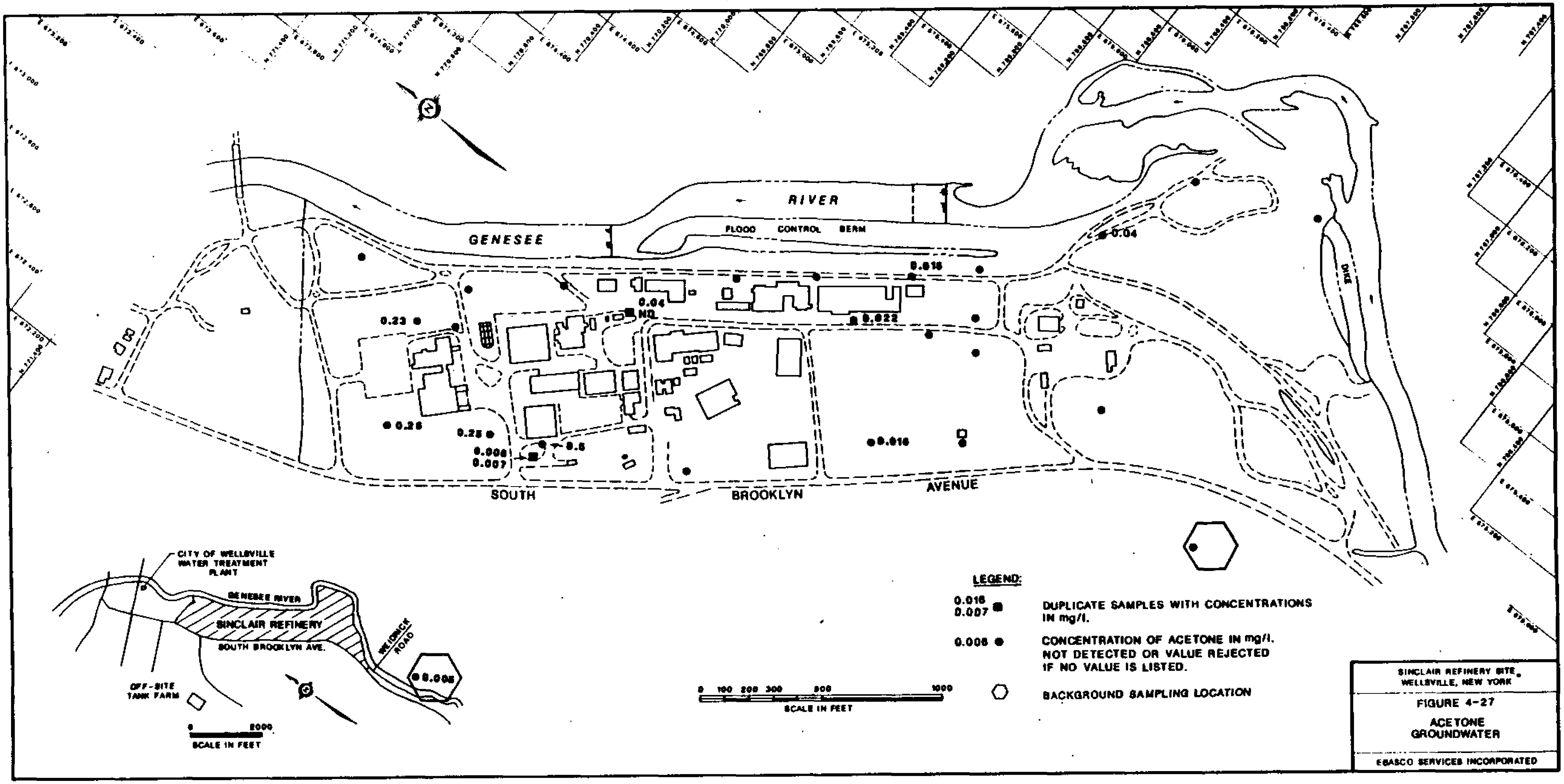
ARSENIC (UNFILTERED) GROUNDWATER

EBASCO SERVICES INCORPORATED

were found did not appear to be grouped in any constant way except that they were all drawn from the upper aquifer. The three of these 10 chemicals with the highest concentrations were 1,2-dichloroethane (9.7 mg/l), 2-butanone (2.1 mg/l) and vinyl chloride (0.094 mg/l), were found in wells MW-57, 35 and 10, respectively. These are all in a small area at the north end of the site between the industrial buildings and the river. Four VOCs were present in MW-36, which is located in an open area on the southern portion of the site. Vinyl acetate (0.019 mg/l), 4-methyl-2-pentanone (0.014 mg/l), 1,1,2,2-tetrachloroethane (0.007 mg/l) and chlorobenzene (0.001 mg/l) were detected in the well. However, surrounding wells did not show evidence of these compounds.

1,1,1-trichloroethane (0.035-1.8 mg/l) and 1,1-dichloroethane (0.012-0.69 mg/l) were present in 2 and 3 of 21 samples, respectively. (1,1-dichloroethane was also detected in background well MW-63 at 0.0001 mg/l.) The 1,1-dichloroethane was detected in wells MW-50, 53 and 57 and the 1,1,1-trichloroethane in MW-10 and 57. MW-50 and 53 are located on the Mapes and Butler-Larkin properties, respectively, and MW-10 and 57 are near the industrial facilities at the north end of the site. Chlorinated hydrocarbons such as these were not in use during the time the Sinclair Refinery operated and are likely attributable to post refinery sources. It should be noted that 1,2-dichloroethane and styrene, as mentioned above, were also detected in wells MW-57 and 10, respectively.

The other five compounds were present in six or more samples. Acetone, present in 6 of 22 samples, had concentrations ranging from 0.016 to 8.5 mg/l (Figure 4-27). This was likely the result of field or laboratory contamination. Benzene (Figure 4-28) and ethylbenzene (Figure 4-29) were each present in 14 samples in concentrations ranging from 0.004-1.2 mg/l and 0.0004-0.17 mg/l, respectively. Twelve of 22 samples contained toluene in concentrations ranging from 0.001-0.39 mg/l (Figure 4-30). Xylenes, most common, were detected in 17 of 22 samples in concentrations ranging from 0.001-1.5 mg/l (Figure 4-31).



LEGEND:

0.016 / 0.007 ■ DUPLICATE SAMPLES WITH CONCENTRATIONS IN mg/l.

0.006 ● CONCENTRATION OF ACETONE IN mg/l. NOT DETECTED OR VALUE REJECTED IF NO VALUE IS LISTED.

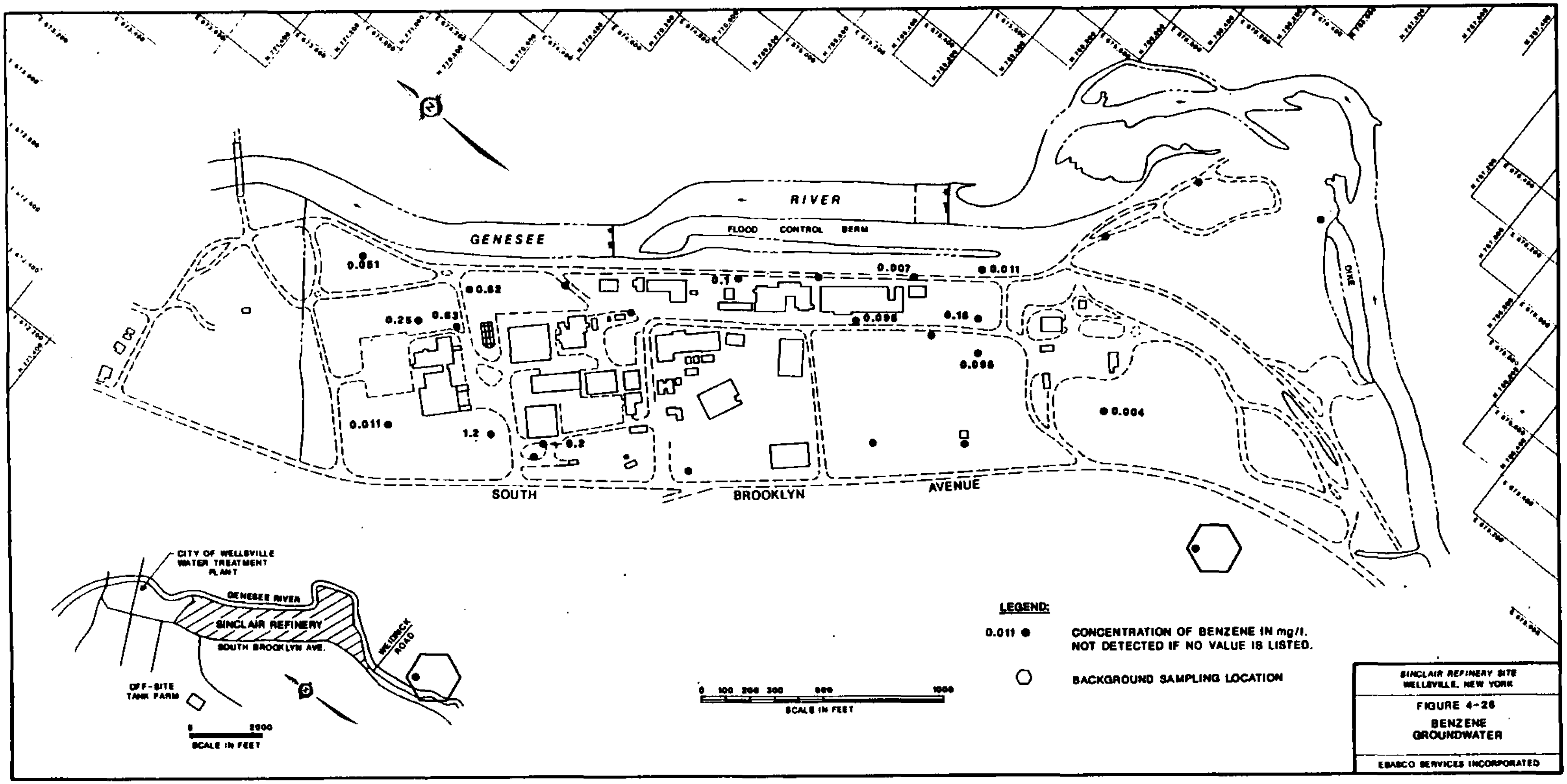
⬡ BACKGROUND SAMPLING LOCATION

SINCLAIR REFINERY SITE,
WELLSVILLE, NEW YORK

FIGURE 4-27

ACETONE
GROUNDWATER

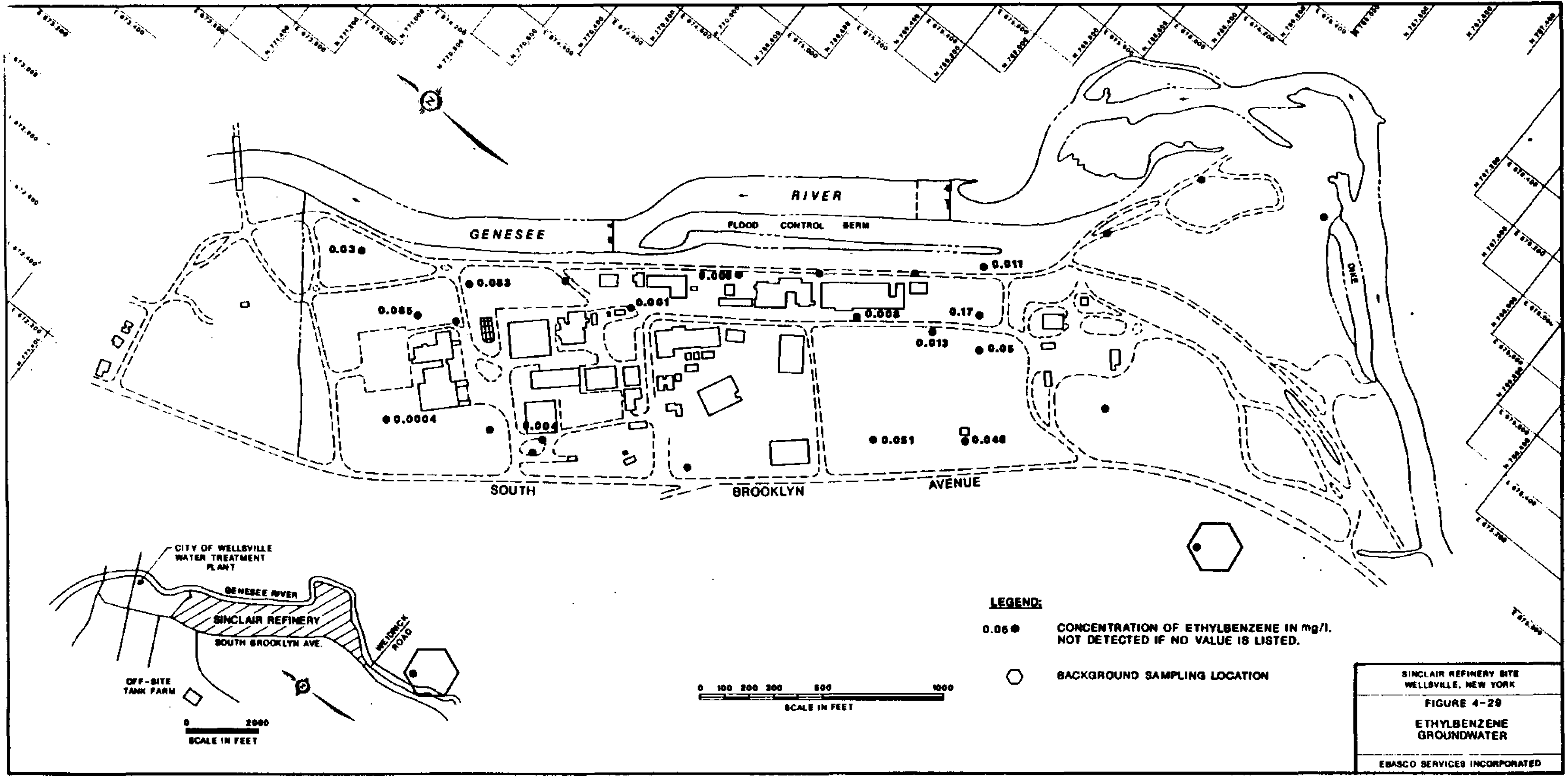
EBASCO SERVICES INCORPORATED



SINCLAIR REFINERY SITE
WELLSVILLE, NEW YORK

FIGURE 4-26
BENZENE
GROUNDWATER

EBASCO SERVICES INCORPORATED



LEGEND:

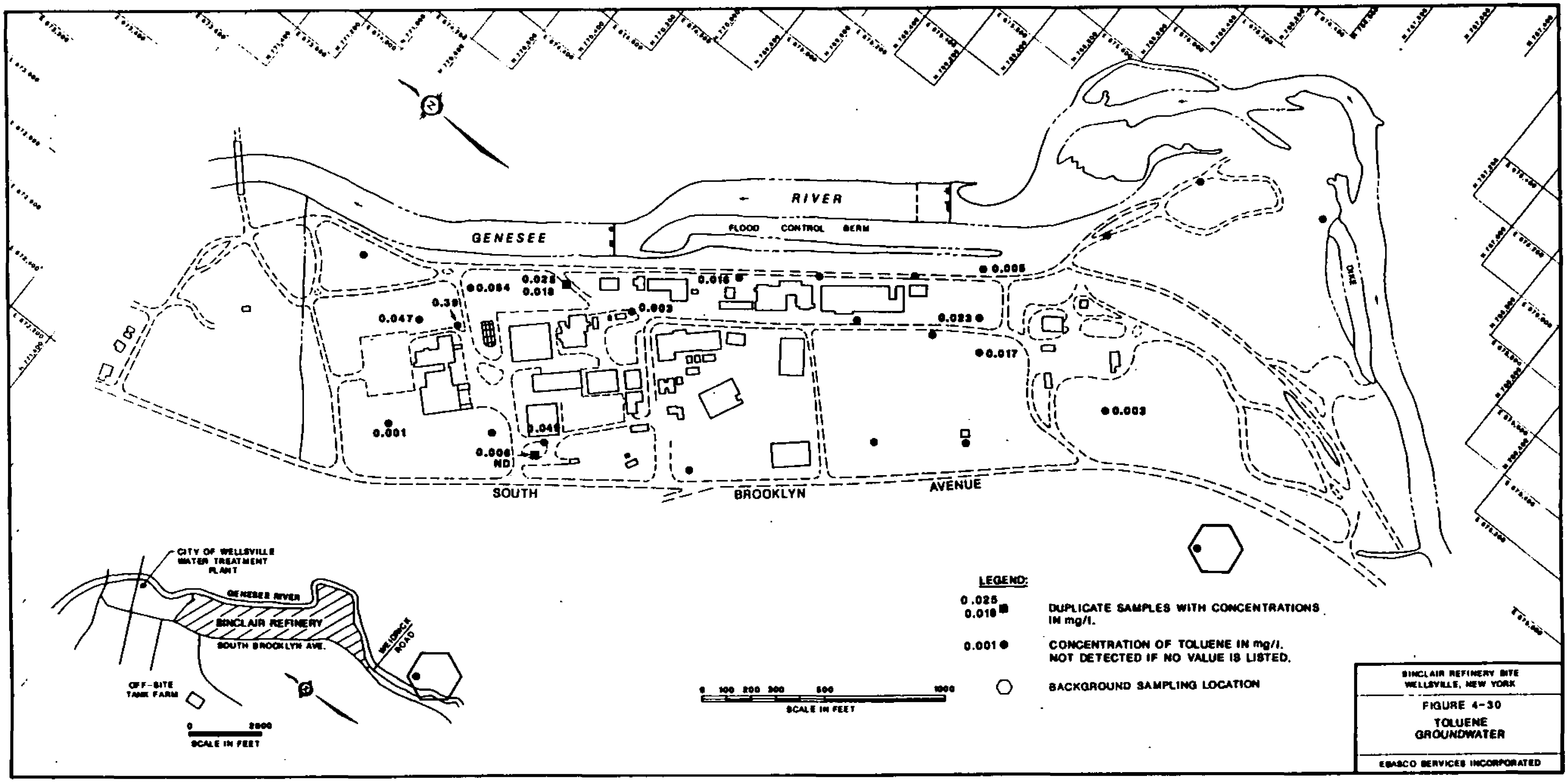
0.05●	CONCENTRATION OF ETHYLBENZENE IN mg/l. NOT DETECTED IF NO VALUE IS LISTED.
⬡	BACKGROUND SAMPLING LOCATION

SINCLAIR REFINERY SITE
WELLSVILLE, NEW YORK

FIGURE 4-29

ETHYLBENZENE
GROUNDWATER

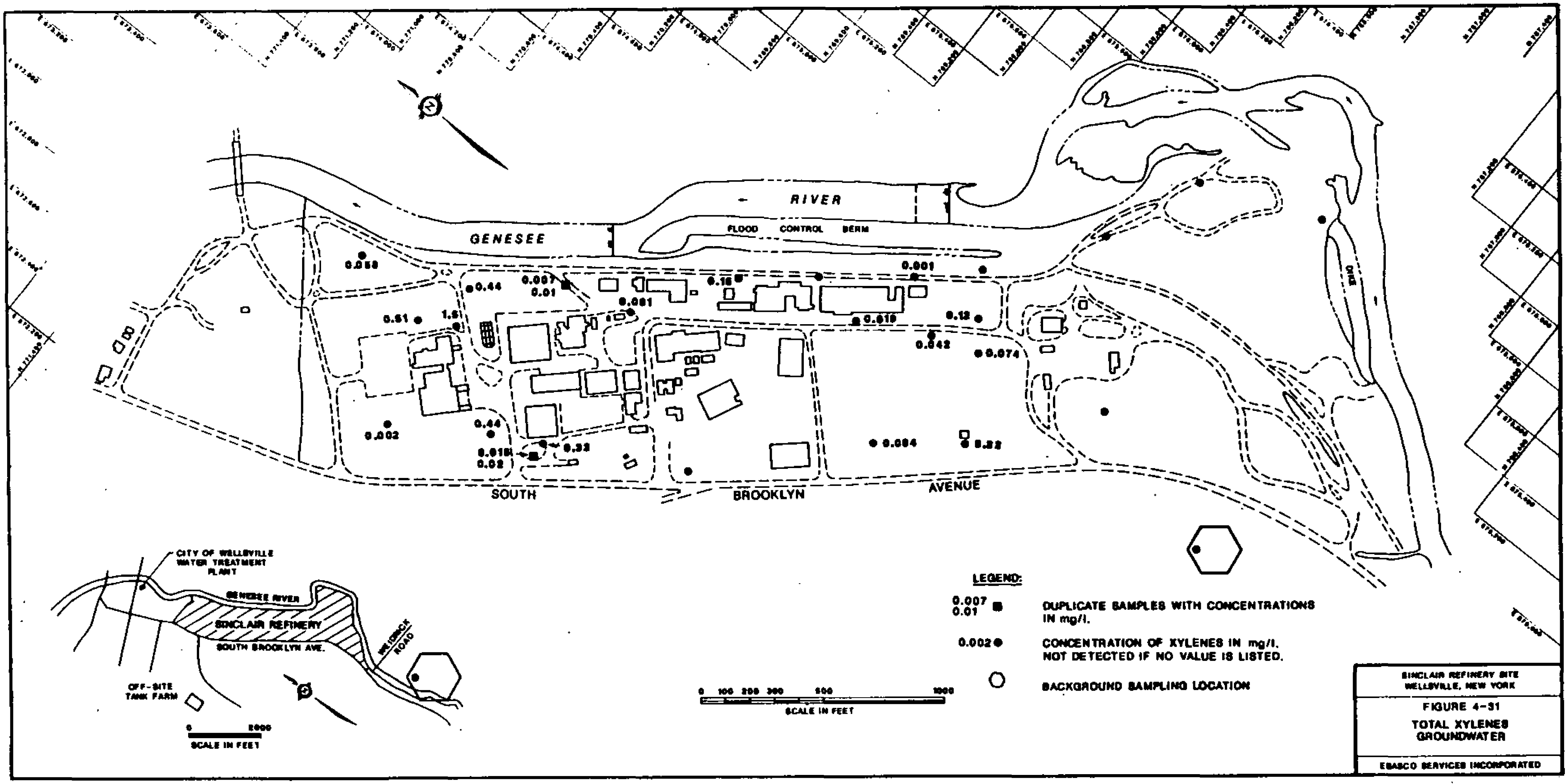
EBASCO SERVICES INCORPORATED



SINCLAIR REFINERY SITE
WELLSVILLE, NEW YORK

FIGURE 4-30
TOLUENE
GROUNDWATER

EBASCO SERVICES INCORPORATED



SINCLAIR REFINERY SITE
WELLSVILLE, NEW YORK

FIGURE 4-31

TOTAL XYLENES
GROUNDWATER

EBASCO SERVICES INCORPORATED

Duplicates of five samples were centrifuged to separate the suspended fines from the liquid. One of the five samples showed no contamination in either the centrifuged or noncentrifuged form. The other four samples (all located in the northern end of the site) showed variations in the concentrations between centrifuged and noncentrifuged samples, with some compounds such as 1,1-dichloroethane being detected in a centrifuged fraction of the sample but not detected in the uncentrifuged fraction. Other compounds increased, some decreased, and others were no longer detected after centrifuging. The results from the centrifuged samples are inconclusive. Consequently, these results will not be considered in further analysis of the site.

During Phase IIb, a sample was also taken from the deep aquifer accessed in MWD-66. Only volatile organic compounds were analyzed. Toluene and xylene at 0.004 mg/l and 0.017 mg/l, respectively, were detected. There is a significant decrease in concentrations from Phase IIa data from the adjacent well MWD-47. The Phase IIa well was not double-cased, and the high concentrations detected were likely the result of cross-contamination between the shallow and deep aquifer caused by well construction.

In the Phase IIb well MWD-66, more stringent well construction requirements were followed in order to try to eliminate the possibility of cross-contamination. Apparently this method was largely but not completely successful. The decrease in xylene from 1.0 mg/l to 0.017 mg/l showed the difference in the techniques. As prevously discussed in Subsection 3.6.4, the downward migration of compounds to the deep aquifer would be nearly impossible due to the strong upward hydraulic gradient across the thick (i.e., at least 20 feet) confining layer between the deep and shallow aquifers. Additional details regarding the deep aquifer are presented in Appendix J of this report.

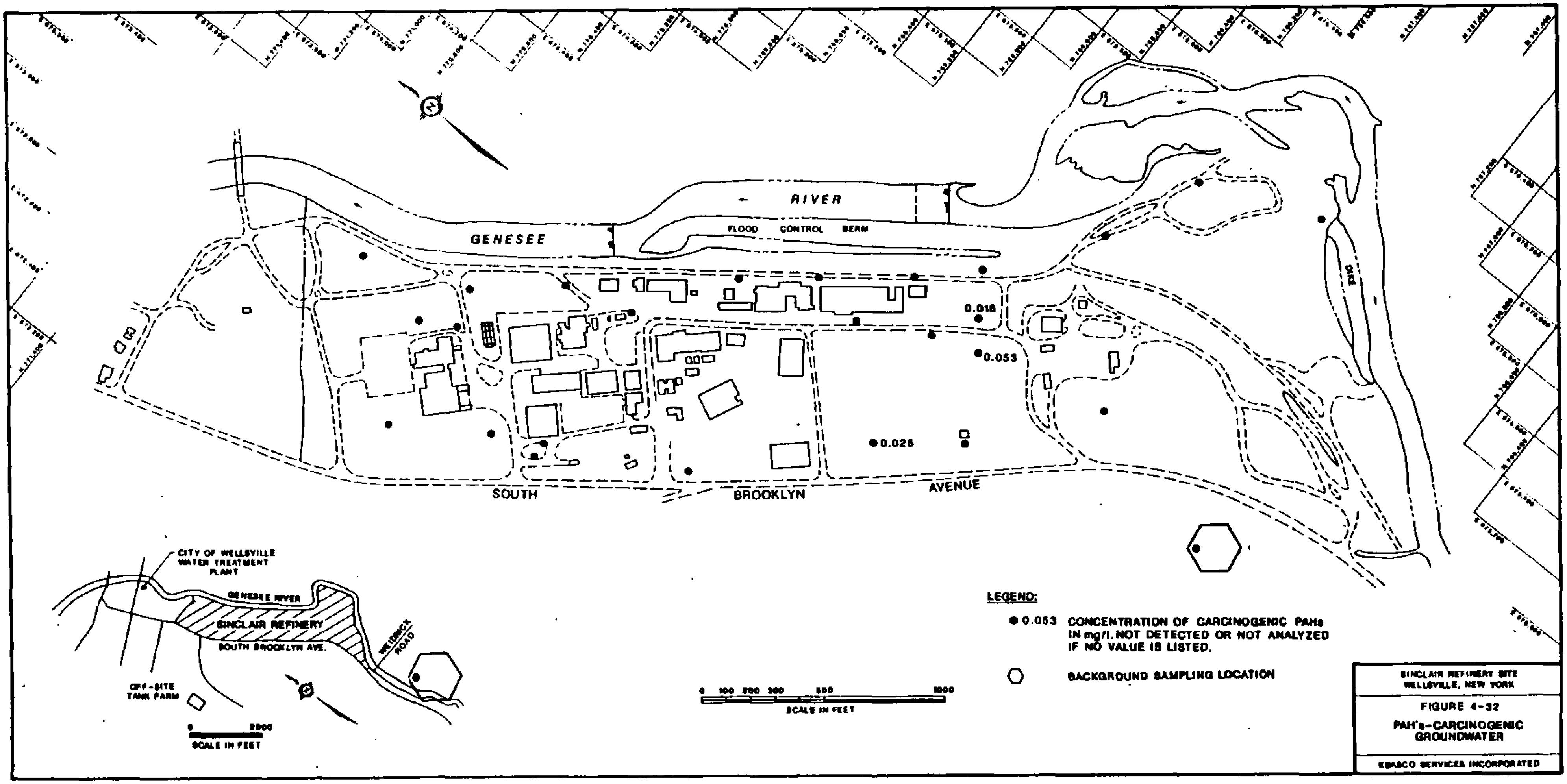
In the Phase IIb samples only seven BNAs were detected in the undecanted samples. Four--nitrobenzene (Well MW-27), 4-nitrophenol (well MW-27), fluorene (MW-53) and pyrene (MW-53)--were each detected one time. The concentrations were 8.2 mg/l, 0.028 mg/l, 0.21 mg/l and 0.018 mg/l, respectively. Napthalene (0.032-0.23 mg/l) and phenanthrene (0.018-0.053 mg/l) were present in 2 and 3 of 18 samples, respectively (Table 4-11). Nitrobenzene was detected in the same well in Phase IIa, but at a level of 1.7 mg/l compared to 8.2 mg/l in Phase IIb. 2-methylnaphthalene was detected in 9 of 18 samples in concentrations ranging from 0.009-0.27 mg/l. Well MW-53 located on the Butler-Larkin equipment storage area contained the highest levels of 2-methylnaphthalene, napthalene and phenanthrene and the most BNA compounds (5). This well also had elevated levels of VOCs. The distribution of PAHs in groundwater is shown on Figures 4-32 and 4-33. Most of the BNAs detected were confined to the area of the Butler-Larkins' storage area with other isolated detections such as at well MW-27. Tentatively identified compounds detected in the groundwater are listed in Appendix C.

Generally, removing the sediment suspended in the groundwater by decanting reduced the BNA concentrations. The results from the decanted samples also revealed a decrease in the kinds of BNAs. Only three BNAs detected in the undecanted samples were present in the decanted samples. They were 2-methyl-naphthalene (0.024-0.11 mg/l), naphthalene (0.15 mg/l) and phenanthrene (0.01 mg/l). Diethylphthalate and bis(2-ethylhexyl phthalate), both common laboratory contaminants, were newly present at concentrations of 0.01 mg/l and 0.007-0.012 mg/l, respectively.

4.6.2 Landfill Area Groundwater

Groundwater surrounding the landfill was sampled in each phase of the investigation yielding similar results. In the latest sampling (Phase IIb) the only VOC detected was acetone at a concentration of 0.04 mg/l in a single sample. This was probably the result of field or laboratory contamination of the sample. Similarly, no BNAs were detected in Phase IIb and BNAs in previous phases were either not detected or at very low levels (e.g., in Phase I only fluoranthene at 0.002 mg/l was detected in a single well).

Metals detected in the filtered landfill area groundwater samples were limited to the common metals (aluminum, barium, calcium, iron, magnesium, manganese, potassium and sodium) although arsenic was detected in two of three samples at levels of 0.017 and 0.035 mg/l compared to a filtered background level not detected for arsenic.



LEGEND:

● 0.053 CONCENTRATION OF CARCINOGENIC PAHs IN mg/l. NOT DETECTED OR NOT ANALYZED IF NO VALUE IS LISTED.

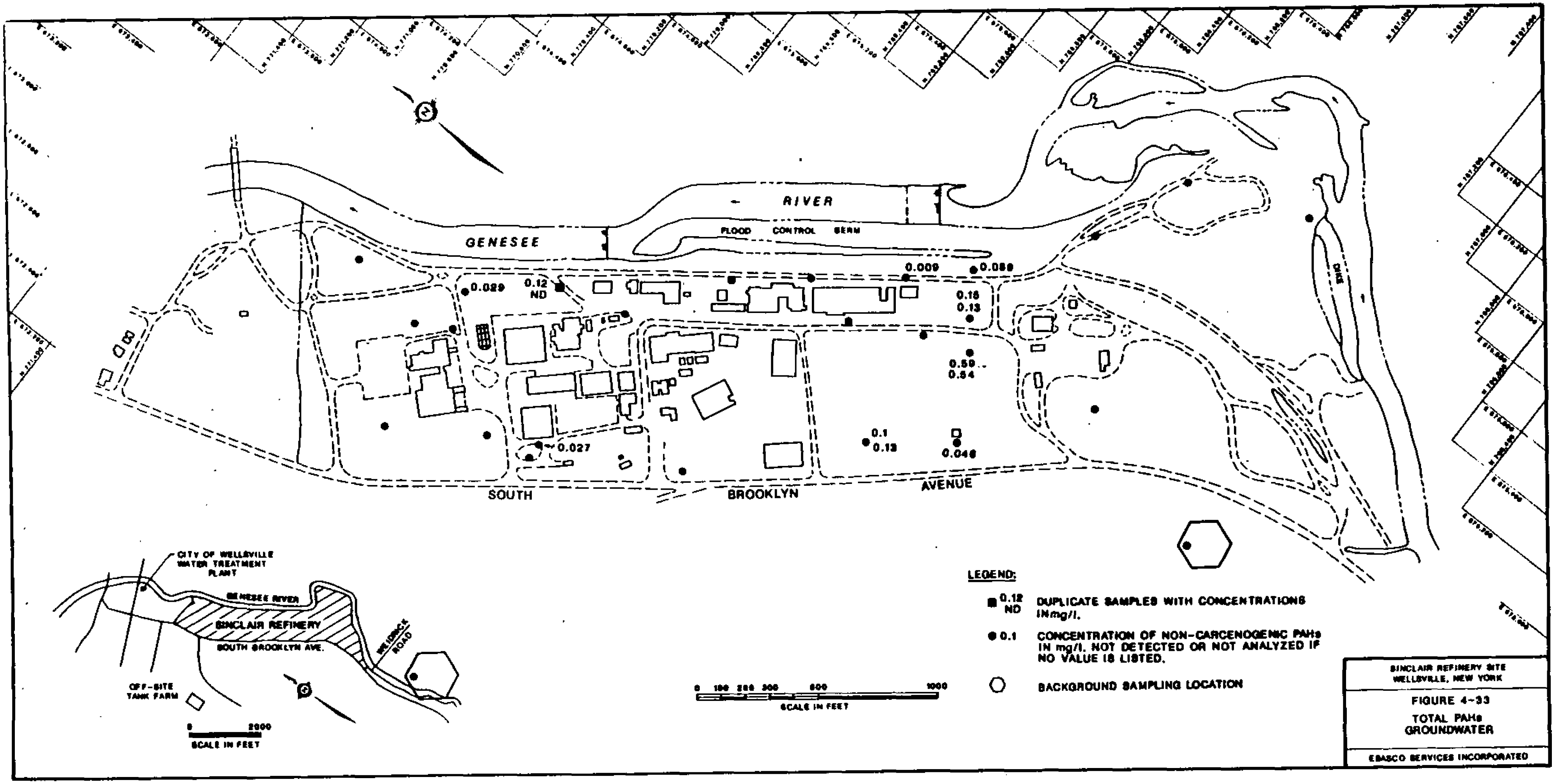
⬡ BACKGROUND SAMPLING LOCATION

SINCLAIR REFINERY SITE
WELLSVILLE, NEW YORK

FIGURE 4-32

PAH's-CARCINOGENIC
GROUNDWATER

EBASCO SERVICES INCORPORATED



SINCLAIR REFINERY SITE
WELLSVILLE, NEW YORK

FIGURE 4-33

TOTAL PAHs
GROUNDWATER

EBASCO SERVICES INCORPORATED

More metals were detected in the unfiltered samples (20) than in the filtered samples (10), and the metals detected were generally at higher levels than in the filtered samples. Table 4-12 lists the unfiltered Phase IIb metal results from the three landfill area wells and the corresponding measured off-site background values. The following discussion refers to unfiltered data.

Arsenic (unfiltered samples) was measured in the landfill wells at between 0.010 and 0.062 mg/l compared to the background at between 0.022 and 0.041 mg/l. Barium was at 0.17-0.80 mg/l compared to background at 0.14-0.25 mg/l. Calcium was at 14.5-30.8 mg/l compared to background levels of 9.1-13.8 mg/l. Chromium (28-107 mg/l), magnesium (7.2-27.9 mg/l), and manganese (0.54-8.0 mg/l) may also be compared to their background ranges 61-64, 2.9-10.7, and 2.4-2.9 mg/l, respectively.

Lead in unfiltered samples on site varied between 0.031 and 0.16 mg/l compared to the background range of 0.073 to 0.69 mg/l, while zinc on site varied from 0.06 to 12.3 mg/l compared to a background of 6.7 to 86 mg/l.

Mercury was measured at a value of 0.00021 mg/l, and silver at 0.006 mg/l, both in single, unfiltered samples. Both of these values, are at instrument detection limits.

The Record of Decision (ROD) for the landfill required that landfill area groundwater be further investigated. The data gathered in Phase I, IIa, and IIb have demonstrated that the quality of groundwater in the vicinity of the landfill is not significantly impacted based on data from perimeter monitoring wells. Hydrocarbons were identified adjacent to the landfill during excavation of the key trench for partial river channelization in September 1990.

4.7 OFF-SITE TANK FARM

Compounds detected in the vicinity of the Off-Site Tank Farm (OSTF) were generally at background levels (Table 4-13). Priority pollutant VOCs were either not detected or were detectable only at estimated concentrations below normal contract required detection limits.

Table 4-12

Metals Detected in Landfill Area Groundwater
(Unfiltered Phase IIb Data)

Compound	Monitoring Well (Concentration in mg/l)			
	MW-3	MW-16	MW-65	Background Range
Aluminum	7.8	17.5	43.1	1.9 - 32.1
Arsenic	0.01	0.028	0.062	0.022 - 0.041
Barium	0.17	0.322	0.80	0.135 - 0.249
Beryllium	0.003	0.001	0.004	ND-0.005
Cadmium	-	0.003	-	ND-0.007
Calcium	14.5	28.4	30.8	9.1 - 13.8
Chromium	0.028	0.048	0.11	0.061 - 0.064
Cobalt	0.012	0.018	0.042	0.006 - 0.040
Copper	0.067	0.045	0.099	0.064 - 0.079
Iron	61.5	49.4	116.	17.7 - 79.9
Lead	0.031	0.050	0.16	0.073 - 0.69
Magnesium	7.2	21.9	27.9	2.9 - 10.7
Manganese	0.54	7.85	5.95	2.4 - 2.9
Mercury	-	0.0001	-	-
Nickel	0.036	0.077	0.14	0.037 - 0.084
Potassium	4.6	4.7	7.6	1.9 - 10.0
Silver	-	0.006	-	-
Sodium	7.4	10.1	9.2	ND-6.9
Vanadium	0.014	0.022	0.055	0.003 - 0.047
Zinc	1.4	12.0	0.60	6.7 - 86.3

TABLE 4-13

CHEMICALS DETECTED OFF SITE TANK FARM[a]
RANGE OF CONCENTRATION
CONCENTRATION IN MG/KG (SOIL) OR MG/L (WATER)

	Soil		Groundwater	
	Phase IIa Jan-Nov. 1986	Site[b] Background	Phase IIa Jan-Nov. 1986	Site Background[b] (Unfiltered)
Number of Samples Analyzed	12		3	
Compounds				
Volatiles				
Benzene	0.0008- 0.001 (6)[c]	ND	ND	ND
Metals				
Arsenic	5.7 - 23.9 (8)	6.4-19	ND	0.041
Cadmium	1.8 - 7.0 (3)	ND	ND	0.007
Chromium	3.3 - 22.3 (9)	3.1-21	ND	0.064
Copper	7.7 - 33.7 (10)	5.6-20	ND	0.079
Lead	9.3 - 103 (12)	1.3-94	ND	0.69
Nickel	8.7 - 23.2 (10)	7.1-40	ND	0.084
Silver	13.9 - 16 (2)	1.4-2.7	ND	ND
Zinc	30.5 - 88.8 (12)	18.4-173	0.44-1.4 (3)	86

(a) Compounds listed include all compounds detected in two or more samples in these media, in any phase and all indicator chemicals detected.

(b) Background value is the highest off-site value detected.

(c) Value in parenthesis indicates number of samples with value above detection limits.

ND = not detected

NA = not analyzed

Groundwater data show similiar characteristics to the soil, with only one priority pollutant BNA and no VOCs detected. Metal levels were at or near background levels in all soil samples, as described below. In groundwater samples, SMC Martin reported detecting only zinc (0.44 - 1.4 mg/l compared to a background range of 0.2 - 86 mg/l).

Sampling at the OSTF was completed in Phases I and IIa. Further characterization was not necessary during Phase IIb.

4.7.1 Soil

Six surface soil samples were taken at the OSTF. Seven metals were detected in the soil. Arsenic (12.9 - 23.9 mg/kg) and lead (27.6 - 103.5 mg/kg) were present in all of the samples. Copper (20.4 - 33.7 mg/kg) and zinc (65.5 -88.8 mg/kg) were detected in five samples. Cadmium, chromium and nickel were present in 3, 4 and 4 of 5 samples at concentrations of 1.8-7 mg/kg, 3.3-10 mg/kg and 8.7 - 15.3 mg/kg, respectively. All were at or near background levels (arsenic 6.4-19 mg/kg, lead 1.3-94 mg/kg, copper 5.6-20 mg/kg, zinc 18.4-173 mg/kg, cadmium ND, chromium 3.1-21 mg/kg, and nickel 7.1-40 mg/kg). Similar levels were detected in the subsurface soils.

Of the VOCs, only benzene was detected in the surface soil. The levels detected were below contract required detection levels, and all concentrations were marked "estimated". In surface samples, concentrations ranged from 0.0008-0.001 mg/kg (Table 4-13). Benzene was not detected in subsurface samples.

Toluene was the only volatile identified in the subsurface soils. It was found in only one sample at an estimated concentration of 0.004 mg/kg.

4.7.2 Groundwater

Zinc was the only metal reportedly detected in groundwater samples, in concentrations ranging from 0.44-1.4 mg/l (Table 4-13). It is not clear from SMC Martin records if these are filtered or unfiltered results.

No VOCs were detected in groundwater samples from the OSTF. The only BNA detected was Di-n-octyl phthalate (0.016 mg/l), detected in one of the three samples.

4.8 BIOTIC SAMPLES

Sixteen aquatic samples and 6 terrestrial samples were collected. The terrestrial samples were collected primarily from the landfill area. Table 4-14 shows a master list of samples prepared and Tables 4-15 and 4-16 show the results of the inorganic analyses.

4.8.1 Aquatic Organisms

None of the organic compounds for which the samples were analyzed were found to be present above their respective detection limits in the aquatic samples.

Cadmium was not detected in any of the aquatic samples. Arsenic was detected in four bullfrog tadpole samples, in concentrations ranging from 0.40 mg/kg to 1.08 mg/kg. Arsenic was not detected in 12 of the aquatic samples. Lead was also detected in bullfrog tadpole samples. Lead was detected in 6 of the 16 aquatic samples analyzed, with levels ranging from 0.374 mg/kg (at the site) to 0.100 mg/kg (drainage swale). Nickel concentrations in white sucker samples ranged from 0.13 mg/kg to 6.17 mg/kg. Nickel was detected in 13 of the 16 aquatic samples analyzed.

4.8.2 Terrestrial Organisms

None of the organic compounds, for which the terrestrial samples were analyzed were present at concentrations above their limits of detection.

The results of the inorganic analyses show that neither arsenic nor cadmium was detected in any of the terrestrial samples. Lead and nickel, on the other hand, were detected in several terrestrial samples. Lead was detected in four of the five terrestrial samples analyzed, with concentrations ranging from 0.16 mg/kg to 0.26 mg/kg. Nickel, detected in all 5 terrestrial samples, occurred in concentrations ranging from 0.212 mg/kg to 0.787 mg/kg.

TABLE 4-14 (Sheet 1 of 2)

MASTER LIST OF SAMPLES PREPARED UNDER THE BIOLOGICAL PROGRAM

Sample Code	Station Code	Station Location	Number of Taxa	Common Name	Scientific Name	Specimens Homogenized	Samples Weight (g)	Specimen Length Range (mm)	Specimen Weight Range (g)
A-1	STA 1	Gen. River near Stannards	1 Species	Creek Chub	Semotilus atromaculatus	8	178	76-186	7-80
A-2	STA 1	Gen. River near Stannards	1 Species	White Sucker	Catostomus commersoni	11	150	97-310	9-329
A-3	STA 1	Gen. River near Stannards	1 Species	Rock Bass	Ambloplites rupestria	8	150	48-175	2-115
A-4	STA 1	Gen. River near Stannards	1 Family	Crayfish	Astacidae	16	135	—	—
A-5	STA 1	Gen. River near Stannards	1 Species	Bullfrog Tadpole	Rana catesbeiana	12	150	—	—
A-7	STA 2	On-Site Swale	1 Species	Bullfrog Tadpole	Rana catesbeiana	12	150	—	—
A-8	STA 3	Gen. River at Site	1 Species	Creek Chub	Semotilus atromaculatus	10	168	70-189	3-72
A-9	STA 3	Gen. River at Site	1 Species	White Sucker	Catostomus commersoni	5	150	179-315	60-292
A-10	STA 3	Gen. River at Site	1 Family	Pumpkinseed	Leopmis gibbosus	3	130	57-121	4-34
				Rock Bass	Ambloplites rupestris	6		51-105	3-26
				Largemouth Bass	Micropterus salmoides	2		55-61	3-4
				Smallmouth Bass	Micropterus dolomieul	2		83-105	9-14
A-11	STA 3	Gen. River at Site	1 Species	Crayfish	Astacidea	14	124	—	—
A-12	STA 3	Gen. River at Site	1 Species	Bullfrog Tadpoles	Rana catesbeiane	12	150	—	—
A-13	STA 4	Gen. River near Rt-17	1 Family	Golden Shiner	Notemigonus crysoleucas	5	142	77-95	4-9
				Common Shiner	Notropis cornutus	14		59-107	2-11
				Bluntnose Minnow	Pimephales notatus	20		42-81	1-7
A-14	STA 4	Gen. River near Rt-17	1 Species	White Sucker	Catostomus commersoni	7	150	117-266	14-204
A-15	STA 4	Gen. River near Rt-17	1 Species	Pumpkinseed	Lepomis gibbosus	22	150	56-122	4-41
A-16	STA 4	Gen. River near Rt-17	1 Family	Crayfish	Astacidae	17	143	—	—
A-17	STA 4	Gen. River near Rt-17	1 Species	Bullfrog Tadpole	Rana catesbeiana	12	150	—	—

TABLE 4-14 (Sheet 2 of 2)

MASTER LIST OF SAMPLES PREPARED UNDER THE BIOLOGICAL PROGRAM

Sample Code	Station Code	Station Location	Number of Taxa	Common Name	Scientific Name	Specimens Homogenized	Samples Weight (g)	Specimen Length Range (mm)	Specimen Weight Range (g)
T-4	STA 5	Off-Site Parcel	1 Species	Meadow Vole	Microtus pennsylvanicus	4	101	98-150	13-45
T-5	STA 5	Off-Site Parcel	1 Species	Deer Mouse	Peromyscus maniculatus	4	70	117-157	11-21
T-7	STA 6	On-Site Zone #1	1 Species	Shorttail Shrew	Blarina brevicauda	10	186	100-120	16-24
T-11	STA 6	On-Site Zone #1	1 Species	Meadow Vole	Microtus pennsylvanicus	2	81	136-152	42-43
T-18	STA 7	On-Site Zone #2	1 Species	Meadow Vole	Microtus pennsylvanicus	5	148	105-150	17-40
T-21	STA 7	On-Site Zone #2	1 Species	Shorttail Shrew	Blarina brevicauda	2	30	90-96	15-17

TABLE 4-15

INORGANIC ANALYSES
AQUATIC SAMPLES
Concentration in mg/kg

Parameter	A-1	A-2	A-3	A-4
Arsenic	ND	ND	ND	ND
Cadmium	ND	ND	ND	ND
Lead	ND	ND	ND	ND
Nickel	0.470	0.900	ND	ND

	A-5	A-7	A-8	A-9
Arsenic	0.885	0.930	ND	ND
Cadmium	ND	ND	ND	ND
Lead	0.173	0.100	0.196	ND
Nickel	1.70	1.40	3.69	6.17

	A-10	A-11	A-12	A-13
Arsenic	ND	ND	1.08	ND
Cadmium	ND	ND	ND	ND
Lead	ND	ND	0.374	0.123
Nickel	0.461	0.585	3.11	1.25

	A-14	A-15	A-16	A-17
Arsenic	ND	ND	ND	0.394
Cadmium	ND	ND	ND	ND
Lead	ND	ND	ND	0.197
Nickel	0.128	1.05	ND	4.88

Note: ND = not detected

TABLE 4-16

INORGANIC ANALYSES
TERRESTRIAL SAMPLES

Concentration in mg/kg

Parameter	T-4	T-7	T-11
Arsenic	ND	ND	ND
Cadmium	ND	ND	ND
Lead	ND	0.157	0.173
Nickel	0.466	0.452	0.787

	T-18	T-21
Arsenic	ND	ND
Cadmium	ND	ND
Lead	0.176	0.259
Nickel	0.470	0.212

Note: ND = not detected

4.9 AIR SAMPLES

The air sampling results were not directly available. However the Phase I SMC Martin report described the results as follows:

"Chemical analyses were conducted on five air samples collected at and around the site. Only volatile organic compounds were analyzed, and the only compound detected from the chemical analyses was methylene chloride. Because this volatile organic compound is used widely in analytical laboratories, and because it was the only compound reported, we feel that the detection of this compound may have been caused by laboratory conditions. The highest concentration reported was 3.6 mg/m^3, which in itself is insignificant as far as characterizing air contamination at the site."

5.0 SUMMARY AND CONCLUSIONS

This section summarizes the major findings of the RI report regarding the nature and extent of contamination, including potential sources of contaminants. Remedial response objectives are identified for use in the feasibility study. The summary includes discussions of each site area, by medium.

5.1 NATURE AND EXTENT OF CONTAMINATION

The groundwater at the off-site tank farm was found to be uncontaminated. Soils in this area contained benzene at very low levels (0.001 mg/kg or less) and lead at essentially background concentrations (28-103 mg/kg versus background levels of 1.3 to 94 mg/kg).

The sediments and water in the Genesee River adjacent to the site were also found to be generally free of site-related contaminants. No contaminants above background levels were detected in the most recent sampling.

Stormwater sewers and the northern oil separator were found to contain elevated levels of several metals, VOCs and BNAs. Some of the BNA compounds may be attributable to former refinery sources while many of the VOCs (such as chlorinated hydrocarbons) and some BNAs are not related to refinery operations and are probably attributable to continuing or recent site runoff and discharges to the stormwater sewer systems. Discharges from the sewers at the outfalls appear to be at very low concentrations. This implies that the separators may still be functioning, limiting off-site discharges, even though the separators are no longer maintained.

In contaminated areas of the refinery, surface soils were found to contain elevated concentrations of lead. Several other metals were also detected. The lead was found at levels of up to 1190 mg/kg in a limited area near the location of the former tetraethyl lead sludge pits. Lead, at lower concentrations was also found aligned with the former railroad tracks across the eastern border of the site. Elevated levels of arsenic and copper were also found along the railroad tracks but were not found at levels above background in surface soils elsewhere on the site. Arsenic and copper are common wood preservatives and may be associated with the railroad ties which would have been present along the former railroad alignment.

No VOCs, (except methylchloride in two samples) were found in surface soils, though several BNAs were detected. The benzo(a)pyrene and other BNAs found in surface soils at the site were not found in a single contiguous area but rather were found in isolated samples from the site. Due to this distribution of the contamination, a discrete source was not identified. However, it must be noted that site and background levels were essentially comparable, with maximum benzo(a)pyrene levels slightly higher on site and total PAH levels higher off-site.

The subsurface soils at the site showed only a few elevated lead concentrations, primarily in the general area of the former tetraethyl lead sludge pits. Arsenic was at a potentially elevated level in only a single subsurface Phase IIb sample, as was copper.

More BNA compounds were found in the subsurface than in the surface soils. Most of the compounds were detected in the area of the current Butler-Larkin storage area but BNAs were also detected in several other areas in single samples.

VOCs found in subsurface soil samples include benzene, xylene and carbon disulfide. These compounds were concentrated in the northern industrial area and the southern area near the Butler-Larkin storage yard. Some of the VOCs may be attributable to the refinery. However, several chlorinated compounds were also detected. The compounds were not in general use at the time the refinery was operating and are likely the result of more recent discharges.

VOCs and BNAs were detected at elevated levels in refinery area groundwater. Benzene and xylene were the most commonly detected VOCs, similar to the subsurface soils. Chlorinated hydrocarbons were also detected in the groundwater but one of the compounds detected (1,1-dichloroethane) was not detected in any of the soil samples.

Elevated levels of arsenic in groundwater (both unfiltered and filtered data) were detected in on-site wells, although no site sources were identified. Landfill area groundwater (both unfiltered and filtered data) was also found to contain arsenic on its downgradient side, but the water was essentially free of BNAs and VOCs (acetone, a probable field or laboratory contaminant was found in a single Phase IIb landfill sample).

The drainage swale area, also contained elevated arsenic levels in some soil samples. However, swale sediment samples, at the base of the swale, did not contain elevated arsenic levels.

5.2 DATA LIMITATIONS

The samples taken for the RI in Phase I and IIa were not analyzed and validated using current EPA standards and procedures, though some or all of the data were reportedly validated (NYSDEC, 1987). Therefore, there is some uncertainty as to the reliability of the data. The Phase IIb data were analyzed and validated in accordance with current procedures, designed to be legally defensible. Where possible, the report was based on these validated data.

5.3 RECOMMENDED REMEDIAL ACTION OBJECTIVES

The data collected and analyzed in this RI show that surface soils in the refinery and drainage swale areas contain elevated levels of contaminants. Lead and arsenic were found at levels of potential concern in surficial soils in the refinery area and arsenic at a level of potential concern in the swale soil. Therefore, measures should be taken to control or eliminate exposure to contaminated surface soils. None of these compounds are found in other site media at levels of potential concern.

Subsurface soils were found to contain VOCs, BNAs and metals. These could leach and migrate in the groundwater. Therefore an objective should be to reduce or prevent the generation of leachate from contaminated surface soils. Similarly, since VOCs and other contaminants were detected in groundwater, a goal should be to control or eliminate exposure to groundwater.

The stormwater sewers and oil separators were found to contain several contaminants including VOCs and BNAs. Access to these structures is restricted, however if site conditions were to change in the future (i.e., the fence around the northern separator could be removed) access to this area could occur. Therefore, measures should be taken to ensure that access to these structures is minimized or eliminated.

The evaluation of applicable, or relevant and appropriate requirements (ARARs) for the site is presented in the feasibility study.

For the Sinclair Refinery Site, the following remedial response objectives are set:

- Control or eliminate exposure to contaminated surface soils in the refinery and swale areas
- Reduce or prevent the generation of leachate from the contaminated subsurface soils
- Control or eliminate exposure to oil separator contents
- Control or eliminate exposure to the contaminated groundwater
- Ensure that constituent concentrations in the Genesee River do not exceed New York State Class A Ambient Surface Water Quality Standards
- Control or eliminate exposure to asbestos-containing material in the abandoned powerhouse.

Hantush, M.S., 1956, "Analysis of Data from Pumping Tests in Leaky Aquifers," Trans. Am. Geoph. Union, 27, p. 702-714.

Hantush, M.S., 1960, "Modification of the Theory of Leaky Aquifers," J. Geoph. Res., 65, p. 3713-3725.

Hantush, M.S., 1963, "Drawdown Around A Partially-Penetrating Well," Am. Soc. Civil Engrs. Trans., 127, p. 268-283.

Hawley, J.K., 1985, "Assessment of health risk from exposure to contaminated soil," Risk Analysis, 5:289-302.

Liss, P.S., and Slater, P.G., 1974, "Flux of gases across air-sea interfaces," Nature 247, 181-4.

Loehr, R.C., J.H. Martin, E.F. Neuhauser, R.A. Norton, M. R. Malecki, 1985. "Land Treatment of an Oily Waste - Degradation, Immobilization and Bioaccumulation," EPA/600/2-85/009. February 1985.

Lucier, G.W.; Rumbaugh, R.C.; McCoy, Z.; Hass, R.; Harvan, D.; and Albro, P., 1986, "Ingestion of Soil Contaminated with 2, 3, 7, 8-Tetrachlorodibenzo-p-dioxin (TCDD) Alters Hepatic Enzyme Activities in Rats," Fund. and Appl. Tox., 6:364-371.

Mackay, D., and Leinonen, P.J., 1975, "Rate of Evaporation of Low-solubility Contaminants from Water Bodies to Atmosphere," Environ. Sci. Technol., Vol. 9(13).

McConnell, E.E.; Lucier, G.W.; Rumbaugh, R.C.; Albro, P.W.; Harvan, D.J.; Hass, J.R.; and Harris, M.W., 1984, "Dioxin in Soil: Bioavailability after Ingestion by Rats and Guinea Pigs," Science, 223:1077-1079.

Mercer, J.W. et al., 1982, "Description of Parameters and Data (and Typical Ranges of Values) Useful for Evaluation of Migration Potential at Hazardous Waste Management Facilities," Draft Report submitted to USEPA under Contract No. 68-01-6464, May 1, 1982.

Neuman, S.P., 1972, "Theory of Flow in Unconfined Aquifers Considering Delayed Response of the Water Table," Water Resource Res., 8, p. 1031-1045.

New York State Department of Environmental Conservation, (NYSDEC), 1985, "Population Projections," New York State Water Quality Management Plan. Prepared by Division of Water, Bureau of Water Quality Management, September 30, 1985.

New York State Department of Environmental Conservation, (NYSDEC), 1986, Division of Law Enforcement, Case Number BU-174-86.

New York State Department of Environmental Conservation, (NYSDEC), 1987, Memorandum re: Wellsville Sinclair Site (#09-02-003), from John Rankin to Joe White, May 27, 1987.

Nosenchuck, N., 1982, Director, Division of Solid Waste, NYSDEC, "Interim Priority List of 115 Hazardous Disposal Sites Under the Comprehensive Environmental Response, Compensation and Liability Act of 1980," Letter to Mr. K. Stoller, Deputy Director, Division of Air and Water Management, USEPA, July 14, 1982.

Olean Times Herald, 1989, "Wellsville Firm to Answer DEC Charges in Court Today," January 27, 1989.

Pasquill, F., "The dispersion of material in the atmospheric boundary layer -- the basis for generalization," In: Futures on Air Pollution and Environmental Analysis. Boston, MA, American Meteorologic Society.

People vs. Mapes, 1983, "People vs. Mapes Industries and Louis Ellenson," Town Court of Wellsville, Allegany County, New York, February 2, 1983.

Poiger, H. and Schlatter, C, 1980, "Influence of Solvents and Adsorbents on Dermal and Intestinal Absorption of TCDD," Fd Cosmet. Toxicol., 18;477-481.

Ranney, 1977, The Ranney Company, "Geophysical Characterization of the Genesee River and Dyke Creek Valleys in Wellsville, New York," report to the Village of Wellsville, June 1977.

Schaum, J., 1985, "Risk Analysis of TCDD Contaminated Soil," USEPA Office of Health and Environmental Assessment, Office of Research and Development, Washington, D.C., EPA-600/8-84-031.

Scheuplein, R. J. and Blank, H., 1971, "Permeability of the skin," Physiological Reviews, 51:702-747.

Shen, T., 1981, "Estimating Hazardous Air Emissions From Disposal Sites," Pollution Engineering, 13(8):31-34.

Simiu, E.; Filliben, J.J.; and Changey, M.J., 1979, "Extreme Wind Speeds at 129 Stations in the Contiguous United States," NBS Building Science Series 118, U. S. Dept. of Commerce, National Bureau of Standards.

Sinclair Refinery Company, 1961, Letter to Mr. R.O Dingman, Director of Public Works, Village of Wellsville, from A.D. Hill, January 16, 1961.

SMC Martin, Inc., 1985, "Draft Phase I Remedial Investigation, Sinclair Refinery Site," Submitted to New York State Department of Environmental Conservation, March 14, 1985.

SMC Martin, Inc., 1987, "Incomplete Draft Phase II Remedial Investigation, Report," handwritten and partially typed.

Theis, C.V., 1935, "The Relation Between the Lowering the the Piezometric Surface and the Rate and Duration of Discharge of a Well Using Groundwater Storage," Trans. Am. Geoph. Union, 2, p. 519-524, 1935.

U.S. Bureau of the Census, Personal Communication, February 1989.

U.S. Department of Commerce, 1973, "Monthly Averages of Temperature and Precipitation for State Climatic Division 1941-1980: New York," Climatography of the United States No. 85 (by state), National Oceanic and Atmospheric Administration, Environmental Data Service, Asheville, North Carolina, July 1973.

U.S. Department of Commerce, 1982, "Local Climatological Data, Annual Summary with Comparative Data, 1981, Binghamton, New York," National Oceanic and Atmospheric Administration, Environmental Data Service, Asheville, North Carolina, July 1982.

U.S. Environmental Protection Agency (USEPA), 1979, "Water-Related Fate of 129 Priority Pollutants," EPA 440/4-79/029, Office of Water Planning and Standards, Washington, D.C.

U.S. Environmental Protection Agency (USEPA), 1982, "Aquatic Fate Process Data for Organic Priority Pollutants," EPA 440/4-81/014, Office of Water Planning and Standards, Washington, D.C.

U.S. Environmental Protection Agency (USEPA), 1983, Historical and Aerial Photographs and Narrative, Number TS-PIC-82083, Prepared by Environmental Monitoring Systems Laboratory, EPA, Las Vegas, NV, Contract No. 68-03-3161, May 1983.

U.S. Environmental Protection Agency (USEPA), 1984, "Health Effects Assessment for Polycyclic Aromatic Hydrocarbons (PAHs)," Environmental Criteria and Assessment Office, Cincinnati, Ohio, EPA 540/1-86-013, September 1984.

U.S. Environmental Protection Agency (USEPA), 1985a, "Guidance on Remedial Investigation Under CERCLA," EPA/540/6-85/003, June 1985.

U.S. Environmental Protection Agency (USEPA), 1986, "Superfund Public Health Evaluation Manual," EPA/540/1-86/060, Office of Emergency and Remedial Response, Washington, D.C.

U.S. Environmental Protection Agency (USEPA), 1986a, "Guidelines for Carcinogen Risk Assessment," Fed. Reg. 33992-34002, September 24, 1986.

U.S. Environmental Protection Agency (USEPA), 1986b, "Guidelines for the Health Risk Assessment of Chemical Mixtures," Reg. 51:34014-34023, September 24, 1986.

U.S. Environmental Protection Agency (USEPA), 1988, "Superfund Exposure Assessment Manual," Publication Number 540/1-88/001, OSWER Directive 9285.5-1.

U.S. Environmental Protection Agency (USEPA), 1988a, "Administrative Order on Consent," Index No. II CERCLA-80207, July 1988.

U.S. Environmental Protection Agency (USEPA), 1988b, "Guidance for Conducting Remedial Investigation and Feasibility Studies Under CERCLA," Interim Final OSWER Directive 9355.3-01, October 1988.

U.S. Environmental Protection Agency (USEPA), 1988c, "Integrated Risk Information System (IRIS)," Environmental Criteria and Assessment Office, Cincinnati, Ohio.

U.S. Environmental Protection Agency (USEPA), 1989a, "Interim Final Guidance for Soil Ingestion Rates," OSWER Directive 9850.4.

U.S. Environmental Protection Agency (USEPA), 1989b, Health Effects Assessment Summary Tables (HEAST), Second Quarter - FY 1989. OSWER (OS-230), April 1989.

U.S. Geological Survey, 1978, 7.5 Minute Series Topographic Map, Wellsville South Quadrangle, 1965 Map photorevised 1978.

Verschueren, K., 1983, "Handbook of Environmental Data of Organic Chemicals," Van Nostrand Reinhold Co., New York.

Westin Geophysical Corporation, 1985, "Geophysical Survey, Sinclair Refinery Site, Wellsville, New York," July 1985.

Wellsville Daily Reporter, 1930, "Wellsville of 1980 May Hinge on Sinclair Refinery," December 2, 1930.

Yang, J.J.; Roy, T.A.; and MacKerer, C.R., 1986, "Percutaneous Absorption of Anthracene in the Rat; Comparison of *In Vivo* and *In Vitro* Results," Toxicol. Inc. Hlth, 2(1):79-84.

Yang, J.J.; Roy, T.A.; and MacKerer, C.R., 1986, "Percutaneous Absorption of Benzo(a)pyrene in the Rat; Comparison of *In Vivo* and *In Vitro* Results," Toxcol. Inc. Hlth, 2(4):409-416.