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New York State Department of Environmental Conservation

PHASE I / PHASE II FEASIBILITY STUDY REPORT

REMEDIAL INVESTIGATION AND FEASIBILITY STUDY

Booth Oil Site
City of North Tonawanda,
Niagara County, New York
(Site Registry No. 9-32-100)

DRAFT

Dvirka and Bartilucci
Consulting Engineers

FEBRUARY 1991

BOOTH OIL INACTIVE
HAZARDOUS WASTE SITE
CITY OF NORTH TONAWANDA, NEW YORK
PHASE I/II FEASIBILITY STUDY

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Summary

EXECUTIVE SUMMARY

This report, entitled "Phase I/II Feasibility Study (FS)", was prepared to assess potential remedial alternatives for the Booth Oil Inactive Hazardous Waste Site in North Tonawanda, Niagara County, New York. The FS was performed in general comformance with the New York State Department of Environmental Conservation (NYSDEC) Technical and Administrative Guidance Memorandum (TAGM) on Selection of Remedial Actions at Inactive Hazardous Waste Sites (HWR-90-4030, Revised May 15, 1990, hereinafter referred to as the TAGM). As required by the TAGM, the overall FS process is divided into three phases. Phase I is the development of remedial alternatives; Phase II is the initial screening of alternatives; and Phase III is the detailed analysis of alternatives. This report presents Phases I and II.

The Booth Oil Inactive Hazardous Waste Site is a former waste oil collection, storage, and reclamation facility. As a New York State Superfund Site (NYSDEC Registry No. 9-32-100), the site was initially characterized during the Phase I Remedial Investigation (RI) conducted by Dvirka and Bartilucci Consulting Engineers, Syosset, New York. From the Phase I RI, it was determined that the site contains approximately 30,000 cubic yards of contaminated soil. Groundwater in the shallow aquifer beneath the site is also contaminated. Contaminants found in both the soil and groundwater include a number of semivolatile and volatile organic compounds, polychlorinated biphenyls (PCBs), and heavy metals. A floating nonaqueous phase liquid (NAPL) layer was also detected in two of the 12 on-site monitoring wells.

The Phase I RI also determined that the storm water sewer system south of the Booth Oil Site contains contaminated sediment and surface water. The sediment and surface water contain a mixture of semivolatiles, volatiles, PCBs, and metals. Based on the data obtained during the Phase I RI, the storm water sewer system has been designated as an operable unit. This storm water sewer eventually discharges into the Little River. Therefore, a pathway exists for contaminants detected in the catch basin system to migrate into the Little River. As a result, an Interim Remedial Measure (IRM) may be undertaken to remove contaminated sediment from the Catch Basin/Robinson Street Storm Water Sewer System as part of the RI/FS to mitigate releases to the Little River, prior to selection and implementation of a long-term remedial action. Additionally, a video inspection of the storm sewer system is recommended and will be scheduled for the Spring of 1991. Remediation of the storm water sewer will involve slip lining, or mechanically or hydraulically removing the sediment and subsequently decontaminating the interior surface of the sewer line.

As recommended by the TAGM, Phase I of the FS process includes a site description and history, identification and characterization (based on the Phase I RI) of operable units and media requiring remediation, and identification of potential exposure pathways and general response actions.

Based on this site-specific information, potentially applicable remedial action technologies are identified and described. An initial screening is performed to eliminate those technologies that cannot be implemented.

Specifically, the Phase I FS identifies and screens the following eleven technologies for remediation of contaminated soil:

- Containment technolgoes (RCRA cap and slurry wall),
- Stabilization/solidification processes,
- Solvent extraction processes,
- Dechlorination processes,
- Wet air oxidation,
- Thermal separation processes,
- Incineration processes (off-site and on-site),
- In situ vitrification,
- Bioremediation, and
- Soil vapor extraction.

The Phase I initial screening concludes that the following soil remediation technologies should be retained for further evaluation in Phase II: containment technologies (RCRA cap and slurry wall), solvent extraction, thermal separation, incineration, and stabilization/solidification.

With respect to groundwater, the Phase I FS identifies and screens technologies for each of the following components of a groundwater remediation program: extraction technologies, NAPL removal technologies, organics treatment, metals treatment, and treated groundwater discharge. Specifically, the following technologies are evaluated and screened:

- Groundwater extraction: extraction wells and trench drains,
- NAPL removal: oil/water separation,
- Organics treatment: air stripping, granular carbon adsorption, ultraviolet (UV) light enhanced oxidation, and a combination of bioremediation and powdered activated carbon adsorption,
- Metals treatment: pH adjustment/precipitation, iron-based coprecipitation, and ion exchange, and
- Treated groundwater discharge: sanitary sewer, storm water sewer/NYSPDES permit, and groundwater replenishment via injection wells or infiltration basins.

With the exception of pH adjustment/precipitation and ion exchange, the Phase I FS concludes that each of the above technologies should be carried forward for further evaluation in Phase II.

In Phase II of the FS, the potential remedial action technologies for soil and groundwater treatment that passed the initial screening are combined into six potential remedial action alternatives. These alternatives are:

- Soil treatment by solvent extraction and a groundwater pump and treat system,

- Soil treatment by thermal separation and a groundwater pump and treat system,
- Soil treatment by on-site incineration and a groundwater pump and treat system,
- Soil treatment by off-site incineration and a groundwater pump and treat system,
- Soil treatment by stabilization/solidification and a groundwater pump and treat system, and
- Containment and a groundwater pump and treat system.

Each alternative is evaluated for effectiveness and implementability in accordance with the NYSDEC TAGM. This includes both a discussion of effectiveness and implementability, and completion of the TAGM scoresheets. The Phase II effectiveness and implementability evaluations conclude that each of these six alternatives appear promising for the Booth Oil site, and should, therefore, be carried forward for detailed analysis as part of the Phase III FS.

Section 1

SECTION 1

INTRODUCTION

The Booth Oil Inactive Hazardous Waste Site is a former waste oil collection, storage and reclamation facility located in North Tonawanda, Niagara County, New York. The Site is a New York State Superfund Site (NYSDEC Site Registry No. 9-32-100) and, as such, is the subject of a formal Remedial Investigation and Feasibility Study (RI/FS). The purpose of the RI is to characterize the nature and extent of contamination at the site, while the FS is intended to evaluate remedial action alternatives.

Note that the Phase I RI did not fully characterize the Booth Oil Site. It did, however, provide sufficient information concerning the types of contaminants and extent of contamination to allow the completion of the first two phases of the FS process -- Development of Remedial Alternatives (Phase I) and Preliminary Screening of Alternatives (Phase II). Development of Alternatives is provided in Section 2.0, while Preliminary Screening is provided in Section 3.0. The Phase II RI will be completed prior to Phase III (final phase) of the FS, Detailed Analysis of Alternatives.

This Phase I/Phase II FS is prepared in general conformance with the following guidance:

- Technical and Administrative Guidance Memorandum (TAGM) on Selection of Remedial Actions at Inactive Hazardous Waste Sites - Revised, HWR-90-4030, New York State Department of Environmental Conservation, May 15, 1990

The Phase I FS, Development of Remedial Alternatives, is intended to identify remedial action alternatives which could potentially be applicable, taking into account site specific considerations. As such, this phase includes the following steps:

- Identification and characterization of areas and media requiring remediation (based on the results of the RI and Baseline Risk Assesement reports).

- Development of remedial action objectives specifying the contaminants and media of interest, and exposure pathways.

- Development of general response actions for each exposure pathway.

- Identification of potentially applicable remedial action technologies, including a description of technologies and a discussion of applicability to the Booth Oil Site. Technologies which can not be implemented will be eliminated at this point.

- Formulation of potentially applicable remedial action alternatives, comprised of the more promising technologies for each of the media of concern.

Phase II, Preliminary Screening of Alternatives, includes an evaluation of each potentially applicable alternative for the following factors:

- Effectiveness
- Implementability

In accordance with the TAGM, this evaluation includes the completion of score sheets which are used to rate the alternatives. Note also that, in the most recent revision of the TAGM, cost is no longer considered in the preliminary screening of alternatives. Based on the results of the scoring excercise, alternatives are either recommended for further evauluation in the Phase III FS (Detailed Evaluation), or are removed from further evaluation. To be considered in the Phase III FS, an alternative must score a minimum of 10 out of a maximum of 25 for effectiveness, and a minimum of eight out of a maximum of 15 for implementability.

Section 2

SECTION 2

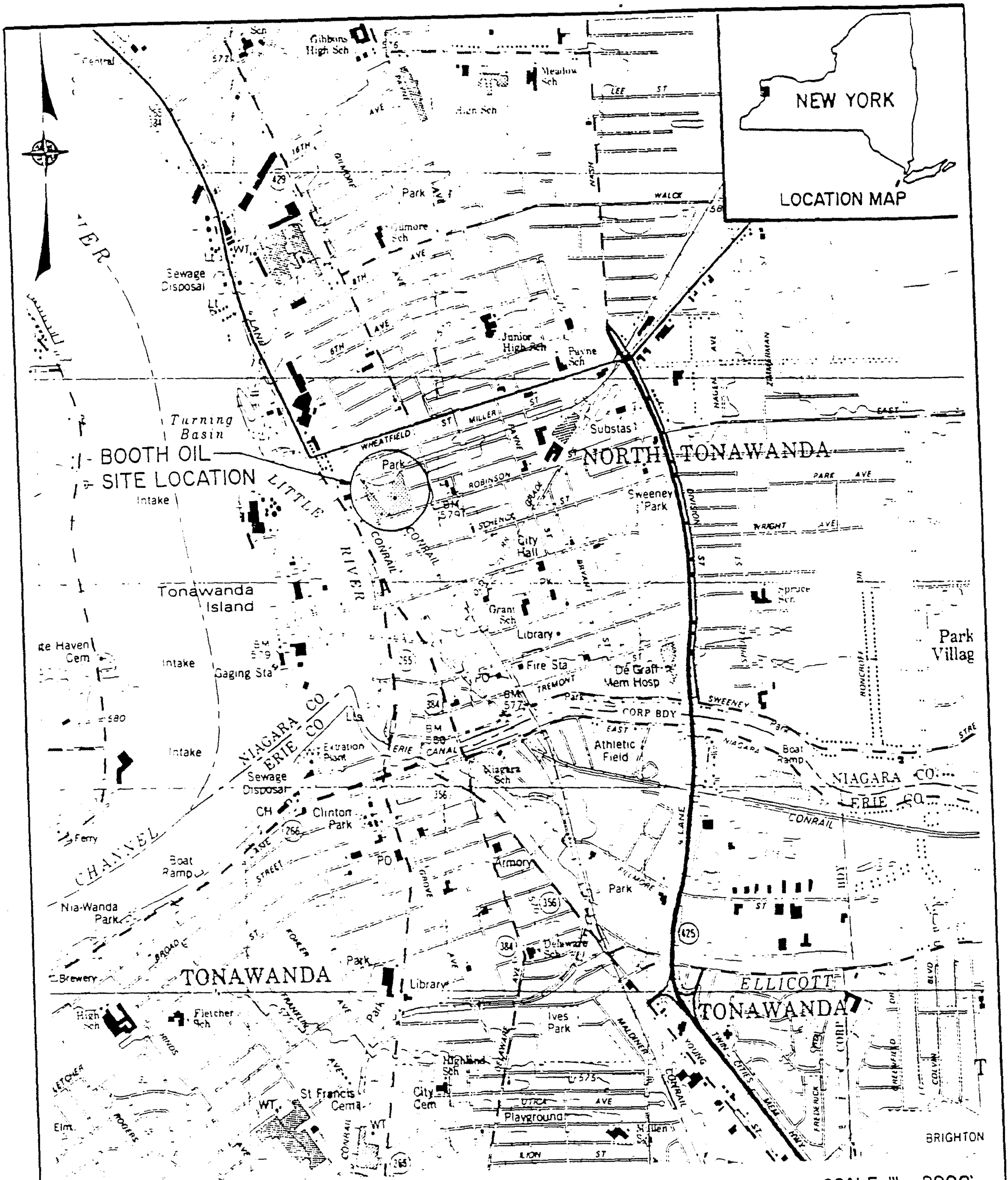
DEVELOPMENT OF REMEDIAL ALTERNATIVES

2.1 BACKGROUND

2.1.1 Site Description

The Booth Oil Company operated a waste oil collection, storage and reclamation facility for more than 50 years at its plant on Robinson Street in North Tonawanda, Niagara County, New York (Figure 2-1). Processing of the waste oil ceased in the early 1980s when site closure was initiated; however, oil storage was continued until 1985. Removal of oil sludges and storage tanks commenced during 1986 and was terminated on October 12, 1987 with removal of the last remaining above ground storage tank. As a result of known and suspected contamination at the site, and the refusal of the property owner to undertake further action, the New York State Department of Environmental Conservation (NYSDEC) placed Booth Oil on its list of inactive hazardous waste sites as a facility at which a Remedial Investigation and Feasibility Study must be performed.

The Booth Oil Inactive Hazardous Waste Site (Booth Oil Site, NYSDEC Site Registry No. 9-32-100) occupies two parcels of land, bisected by tracks of the Erie Railroad (Figure 2-2). The eastern parcel, which comprises



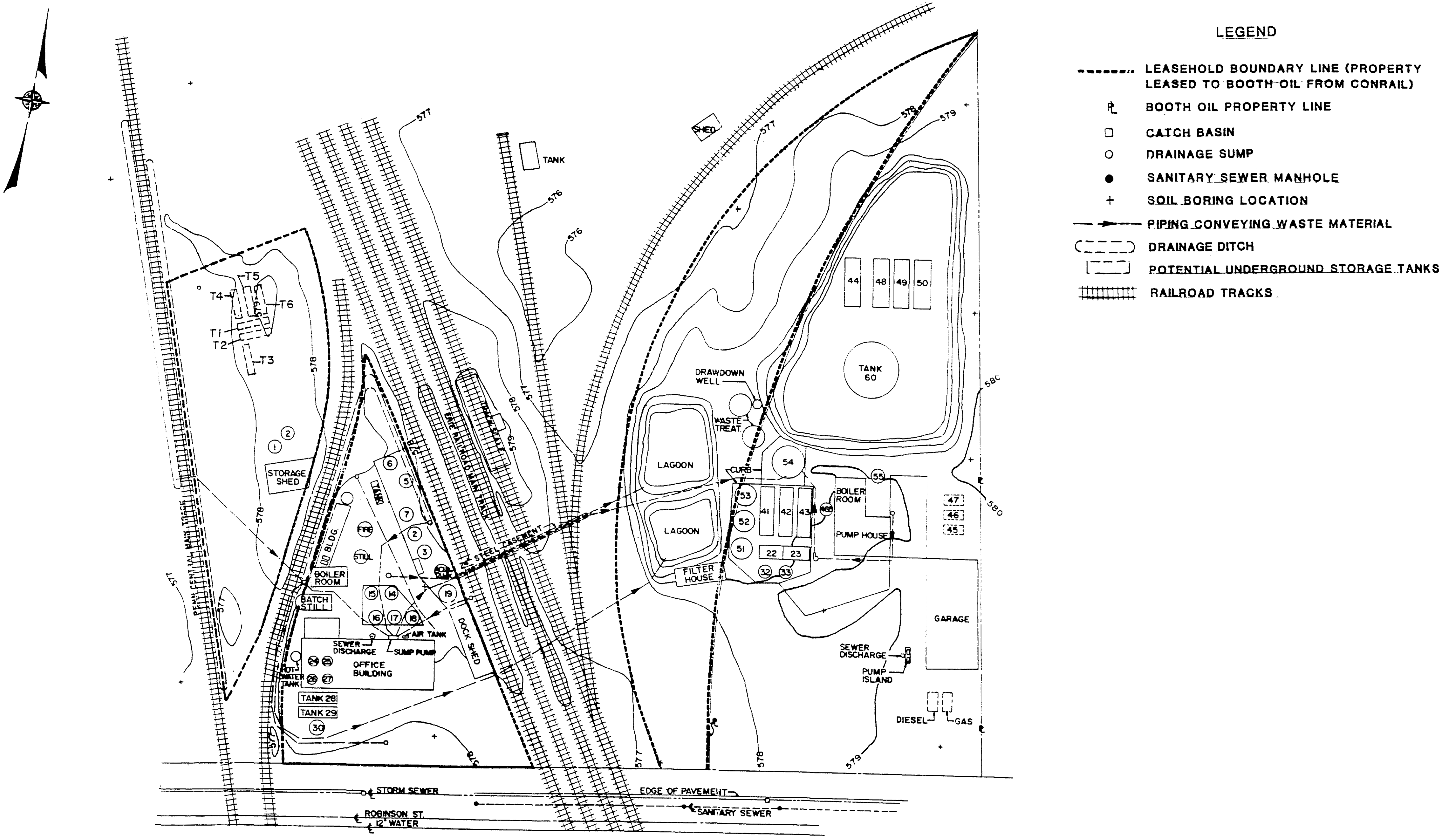
SOURCE: USGS

SCALE: 1" = 2000'

BOOTH OIL SITE
NORTH TONAWANDA, NIAGARA COUNTY, NEW YORK

SITE LOCATION MAP

FIGURE 2-1



SCALE: 1" = 60'

BOOTH OIL SITE
NORTH TONAWANDA, NIAGARA COUNTY, NEW YORK

FACILITY LOCATION MAP

Dvirka and Bartilucci
CONSULTING ENGINEERS

FIGURE 2-2

approximately 2.6 acres, consists of one section formerly owned by Booth Oil and a second section leased to Booth Oil by the Consolidated Rail Corporation (Conrail, owner of the Erie Railroad and Penn Central Railroad lines). The western parcel also consists of two sections leased to Booth Oil by Conrail. These sections are bisected by a spur line of the Penn Central Main Track and comprise approximately 1.3 acres.

The topography of the Booth Oil Site is generally flat, ranging from a low of 576 feet above mean sea level to a high of 580 feet above mean sea level. Based upon a review of available information, it appears that during plant operation, frequent spillage occurred throughout the site. This has been documented by State and local (Niagara County Health Department) inspections which indicated the presence of oil-soaked ground and pools of oily material at various locations throughout the site. This spilled material was either discharged via surface runoff to storm water catch basins and storm drains adjacent to the facility or infiltrated into the groundwater underlying the facility via percolation. An existing unlined, waste lagoon on-site was rebuilt during 1969 to receive the storm water runoff and other process wastes resulting from activities at the Booth Oil Site.

With respect to site-specific conditions, based upon soil borings installed at and immediately adjacent to the site during June and July of 1980 by Earth Dimensions, Inc., the site is underlain with cinder/gravel slag to a depth of approximately 3 feet below ground surface. Beneath this slag is approximately 2 feet of sand and gravel with some silt, which is followed with a layer of silty clay. This corresponds closely with the results obtained during the D&B Phase I RI boring program. However, the results of this program indicate that the cinder/gravel slag layer is discontinuous throughout the site and that it does not represent a major soil unit. Although the borings installed by Earth Dimensions, Inc. did not encounter bedrock, research has indicated that bedrock occurs at approximately 40 feet below the ground surface. The water table at the site has been shown to be at a depth ranging from approximately 2 to 6 feet below the ground surface. Based upon limited existing information, a localized groundwater pattern in the western parcel of the site appears to be in a west-southwest direction towards the Little River.

With respect to land use, although this area of North Tonawanda is primarily an industrial use area, there are residential housing units in the area as well. Specifically, residential units exist at the northern and eastern boundary of the Booth Oil Property. In addition, a small playground area exists immediately north of the site. In the past, during facility operation, complaints were made to the Niagara County Health Department (NCHD) by these adjacent homeowners regarding odors from the site.

The Booth Oil Site is located less than one-eighth of a mile east from the Little River, a sidestream of the Niagara River caused by the presence of Tonawanda Island. Storm sewers located on Robinson Street, which form the southern boundary of the site, discharge directly into this waterway via a storm sewer outfall. On at least two occasions, NYSDEC had determined, based upon sampling data, together with physical field evidence and observations, that Booth Oil was responsible for oil discharges into the Niagara River. At that time, DEC requested the company to clean the catch basins adjacent to the facility, place sorbent material within these basins, monitor the sorbent material on a daily basis and replace as necessary. In addition, Booth Oil was requested to implement a similar program at the first catch basin from the river, as well as install a functional oil containment boom at the storm sewer outfall with regular monitoring and replacement of the boom material as necessary.

During operations at the site, sanitary waste from the office building, as well as condenser water, were the only water streams being directly discharged into the sanitary sewer system. There was the possibility that oil was entering the condenser water due to spills, resulting in an oil/water mixture being discharged into the sanitary sewer. In fact, based on a review of the files of the NCHD by our project team, there is evidence that on numerous occasions during the late 1960s and early 1970s, the City of North Tonawanda Sewage Treatment Plant notified Booth Oil to cease the discharge of oily material into the sewer system.

2.1.2 Site History

George T. Booth and Son, Inc., engaged in the process of refining used oil at its Robinson Street Plant in North Tonawanda, New York for more than 50 years, until the early 1980s. Spent and waste oils were brought to the plant either by tanker trucks or via rail cars. This oil was stored in numerous above ground and underground tanks throughout the facility until processing of the oil was completed.

Oil and water were separated by means of a centrifuge with resultant sludge from this process being sold for use as road oil. During the winter months when road maintenance was not practiced, this sludge was stored at the facility. The concentrate resulting from the centrifuge process was refined using a process similar to that used in the refining of crude oil. This process includes high temperature distillation, cooling, and treatment utilizing sulfuric acid followed by clay contacting. The acid tar residue (acid waste) was transported off-site for landfilling.

Because of environmental concerns raised as a result of the handling of waste oil at the site, Booth Oil retained Hill and Hill Engineers, Inc. of North East, Pennsylvania to address certain operational problems. In January of 1969, Hill and Hill prepared a report recommending changes to the facility to better handle the waste associated with the oil reclamation processes. These recommendations included the construction of several drainage ditches parallel to both the Penn Central Main Track and the Erie Railroad Tracks to contain and control runoff water, the construction of sumps within each drainage ditch to pump the water to the central sump located north of the office building on the western parcel, and the installation of a 24-inch steel encasement to house piping from the main sump, underneath the Erie tracks, for discharge to the lagoons (Figure 2-2). Process waste (acid waste and emulsified oil) was also recommended to be pumped through this encasement, but to the process waste treatment plant rather than the lagoons. The treatment plant would break the emulsified oil and neutralize the acid waste, and subsequently discharge these materials to the same lagoon. These recommendations, some of which are believed to have been implemented, are illustrated in Figure 2-2. It is unknown, however, whether the 24-inch steel casement or the process waste treatment plant had been constructed.

The following chronology describes some major pertinent events from the late 1970s to present as assembled by Dvirka and Bartilucci Consulting Engineers regarding the Booth Oil Site. This chronology is based on the review of information from the Region 9 offices of the NYSDEC along with interviews of personnel and file reviews at the NCDH.

- <u>September 1978</u> - the NYSDEC investigated sources of waste oil collected by Booth Oil and concluded that the company had been receiving significant quantities of PCB-contaminated oil.

- <u>October 1978</u> - NCDH Inspection Report indicated that an oil slick in the Niagara River, identified by the U.S. Coast Guard, was the result of Booth Oil and discharges to the storm sewer adjacent to the site.

- <u>December 1978</u> - sampling performed by NCDH indicated the presence of PCBs at a concentration of 50 parts per million (ppm) from an "oil sample" taken from the lagoon at the Booth Oil Site.

- <u>May 1979</u> - NCDH Inspection Report indicated another oil slick in the Niagara River a a result of activities at the Booth Oil Site.

- <u>September 1979</u> - an inspection by NYSDEC noted several problems at the Booth Oil Site: the western drainage collection sump was not working properly; the entire site was wet and oil-soaked, leading to concerns regarding groundwater; and the lagoons had appeared to have overflowed as indicated by oil stains in the area.

- <u>November 1981</u> - a Final Closure Plan was prepared by Waste Resource Associates, Inc. on behalf of the Booth Oil Company for full site closure. The plan indicated that the lagoon would be backfilled with gravel.

- <u>May 1982</u> - NCDH Inspection Report indicated that site was saturated with oil, lagoons contained oily sludge material, 250 to 300 empty 55-gallon drums were present, and a tank was leaking.

- <u>August 1982</u> - NCDH Inspection Report indicated that: oil and oil stained areas are still present at numerous locations within the site; the dewatering wells had apparently been pumped but were not working at the time of inspection; the piping is being removed; oil was still being stored at several tanks on-site; sludge from the lagoon had not yet been removed; the western parcel was noted to be relatively clean; and oil was noted on the ballast along the railroad tracks.

- o <u>September 1982</u> - a letter from NYSDEC to Booth Oil regarding the ongoing site closure described the installation of a partial french drain along the east lagoon berm and discussed in situ solidification of semi-liquid materials with hydrated lime.

- o <u>September 1982</u> - NCDH Inspection Report indicated that: the western parcel had been cleaned for the most part; the contaminated ballast was used as fill for the lagoon; debris (pipe, steel, other metals) have been sold as scrap; the lagoon had been filled and graded (a french drain was installed and lime was used to solidify the materials in the lagoon); and the tank farm east of the lagoon appeared to be the major area remaining for cleanup.

- o <u>September 1984</u> - NYSDEC inspection indicated pools of oil on the western parcel adjacent to the tracks and an underground tank full of oil was located at the western parcel.

- o <u>July 1986</u> - a letter from NYSDEC to Booth Oil indicated the presence of PCBs at a concentration of 650 ppm in an underground tank, T-5. It is unclear whether this is the same tank as that found in September of 1984. In addition, it is stated that this tank may be interconnected with several other underground tanks in the area.

- October 1986 - EP Toxicity analyses indicated lead at concentrations of 16 ppm and 8.7 ppm at test pit number 2 and 3, respectively which were excavated from the two lagoon areas.

- June 1987 - analysis of a spill sample taken from the Robinson Street storm sewer indicated that this material was ignitable, contained lead at 37.1 ppm, and also contained PCBs at levels of 113 ppm for Aroclor 1254 and 266 ppm for Aroclor 1242. Although it was determined that the spill originated from the Booth Oil property, the exact source of the spill could not be identified.

- June 1987 - Booth Oil company submitted to NYSDEC, a closure plan for Tank No. 60, a 500,000 gallon tank and the last remaining above ground tank in use at the site. This tank was removed on October 12, 1987 and soil sampling was performed during October of that same year around the perimeter of the tank.

- July 1989 - the New York State Department of Health performed surface soil sampling at six oil-stained areas at and immediately adjacent to the western parcel of the Booth Oil Site. Analyses for PCBs did not indicate any significant concentrations.

In addition, pursuant to the Resource Conservation and Recovery Act (RCRA), Booth Oil notified the U.S. Environmental Protection Agency (EPA) of hazardous waste activity at its North Tonawanda Facility on August 18, 1989. The hazardous waste listed on the notification form were U049 and U052, slop oil emulsion solids from the petroleum refining industry and tank bottom (leaded) from the petroleum refining industry, respectively, both of which are listed wastes due to toxicity. This notification also listed Booth Oil as a generator, transporter and treatment, storage and disposal (TSD) facility. On November 19, 1980, Booth Oil submitted to EPA, a RCRA Part A Application, EPA I.D. No. NYD002131860. This application noted that Booth Oil handled ignitable wastes, corrosive wastes, and U054, which is not listed in the federal RCRA regulations. Booth Oil subsequently asserted that these applications were not required because of the fact that hazardous waste oil received at the facility was being re-refined and, thus, falls under the regulations promulgated under Title 40 of the Code of Federal Regulations, Part 261.6(a) regarding recycling. These applications were made by Booth Oil because of its intent to expand operations to process waste oils contaminated with listed waste solvents.

Based upon the soil borings undertaken by Earth Dimensions, Inc., during June and July of 1980, a geologic cross section of the Booth Oil Site was interpreted indicating the amount and area of oil contamination in the groundwater underlying the site. Based upon this study, draw-down wells were installed at the facility (one well each installed in the eastern and western parcel). Each well was 8 inches in diameter and approximately 20 feet deep. It is believed that these wells pumped oil for approximately three months. It is not known whether additional pumping occurred or whether additional groundwater remediation is required.

2.2 Identification and Characterization of Operable Units and Media Requiring Remediation

Based on the results of the Phase I RI ("Phase I Remedial Investigation Report", February 1991, prepared by Dvirka and Bartilucci Consulting Engineers), it is estimated that the Booth Oil Site contains approximately 30,000 cubic yards of contaminated soil. The majority, if not all, of the shallow groundwater beneath the site is contaminated. Also, the storm water sewer south of the site has been contaminated by surface runoff from the site and requires remediation. Tables 2-1, 2-2, and 2-3, developed from the data acquired during the Phase I RI, present summaries of the contamination found in the soil, groundwater, and storm water sewer, respectively.

The contaminated soil at the site contains a variety of semivolatiles, volatiles, PCBs, and metals. Semivolatiles present include 4-methylphenol (73787 ppb average), phenol (41504 ppb average), 2,4-dimethylphenol (22170 ppb average), ethyl phenol (30000 ppb average), and decane (27143 ppb average). The most widely encountered volatiles in the soil are xylene(total) (22266 ppb average), toluene (14185 ppb average), tetrachloroethene (10163 ppb average), 1,2-dichloroethene (7884 ppb average), and trichloroethene (7846 ppb average). Metals present in elevated concentrations include lead (1,912 ppm average), manganese (835 ppm average), iron (28,537 ppm average), aluminum (14,692 ppm average), and zinc (449 ppm average). PCBs in the soil are Aroclor 1242 (3971 ppb average), Aroclor 1254 (3747 ppb average),

TABLE 2-1
BOOTH OIL INACTIVE HAZARDOUS WASTE SITE
CONTAMINATED SOIL SUMMARY
SEMIVOLATILE ORGANICS

SEMIVOLATILE ORGANIC COMPOUNDS	AVERAGE SOIL CONCENTRATIONS (ug/kg)	MAXIMUM SOIL CONCENTRATIONS (ug/kg)	MINIMUM SOIL CONCENTRATIONS (ug/kg)	MEDIAN SOIL CONCENTRATIONS (ug/kg)
Acenaphthene	1215	16000	0	0
Acenaphthylene	27	460	0	0
Anthracene	47	400	0	0
Benzo(a)anthracene	180	1500	0	0
Benzo(b)fluoranthene	346	2900	0	0
Benzo(k)fluoranthene	137	1800	0	0
Benzoic acid	25	260	0	0
Benzo(g,h,i)perylene	63	560	0	0
Benzo(a)pyrene	110	1000	0	0
Benzyl alcohol	1	18	0	0
4-Bromophenyl-phenylether	0	0	0	0
Butylbenzylphthalate	497	9900	0	0
4-Chloroaniline	0	0	0	0
bis(2-Chloroethoxy)methane	0	0	0	0
bis(2-Chloroethyl)ether	0	0	0	0
bis(2-Chloroisopropyl)ether	0	0	0	0
4-Chloro-3-methylphenol	0	0	0	0
2-Chloronaphthalene	0	0	0	0
2-Chlorophenol	1	14	0	0
4-Chlorophenyl-phenylether	0	0	0	0
Chrysene	1006	8400	0	330
Dibenzo(a,h)anthracene	10	120	0	0
Dibenzofuran	30	440	0	0
Di-n-butylphthalate	767	6700	0	130
1,2-Dichlorobenzene	484	6500	0	0
1,3-Dichlorobenzene	0	0	0	0
1,4-Dichlorobenzene	39	890	0	0
3,3'-Dichlorobenzidine	0	0	0	0
2,4-Dichlorophenol	0	0	0	0
Diethylphthalate	17	150	0	0
2,4-Dimethylphenol	22170	270000	0	0
Dimethylphthalate	0	0	0	0
4,6-Dinitro-2-methylphenol	0	0	0	0
2,4-Dinitrophenol	0	0	0	0
2,4-Dinitrotoluene	0	0	0	0
2,6-Dinitrotoluene	0	0	0	0
bis(2-Ethylhexyl)phthalate	10711	84000	280	1800
Fluoranthene	1304	11000	0	260
Fluorene	359	4200	0	0
Hexachlorobenzene	0	0	0	0
Hexachlorobutadiene	0	0	0	0
Hexachlorocyclopentadiene	0	0	0	0
Hexachloroethane	0	0	0	0
Indeno(1,2,3-cd)pyrene	84	900	0	0
Isophorone	107	2900	0	0
2-Methylnaphthalene	17333	190000	41	1300
2-Methylphenol	7670	81000	0	0
4-Methylphenol	73787	1,000,000	0	0

TENTATIVELY IDENTIFIED COMPOUNDS	AVERAGE QUANTITY (ug/kg)
Decane	27143
Dodecane	1309
Ethyl phenol	30000
Hexadecane	4200
Octadecanal	359
Pentadecane	5625
Phenol, 2,3-dimethyl	17143
Tridecane	1364
Undecane	21191
Total unknowns	12240
Total unkown acids	14263
Total unknown alcohols	1604
Total unknown alkanes	18986
Total unknown alkenes	1415
Total unknown aromatics	11189
Total unknown benzenes	3289
Total unknown cycloalkanes	3216
Total unknown dimethyl naphthalenes	10314
Total unknown methyl fluorenes	314
Total unkown methyl naphthalenes	83
Total unknown naphthalenes	1533
Total unknown PAHs	1167
Total unknown phenols	7857
Total unknown trimethyl naphthalenes	1352

TABLE 2-1 (continued)
BOOTH OIL INACTIVE HAZARDOUS WASTE SITE
CONTAMINATED SOIL SUMMARY
SEMIVOLATILE ORGANICS

SEMIVOLATILE ORGANIC COMPOUNDS	AVERAGE SOIL CONCENTRATIONS (ug/kg)	MAXIMUM SOIL CONCENTRATIONS (ug/kg)	MINIMUM SOIL CONCENTRATIONS (ug/kg)	MEDIAN SOIL CONCENTRATIONS (ug/kg)
Naphthalene	7762	89000	0	68
2-Nitroaniline	0	0	0	0
3-Nitroaniline	0	0	0	0
4-Nitroaniline	0	0	0	0
Nitrobenzene	0	0	0	0
2-Nitrophenol	0	0	0	0
4-Nitrophenol	0	0	0	0
N-Nitrosodiphenylamine (1)	411	3800	0	0
N-Nitroso-di-n-propylamine	0	0	0	0
Di-n-octylphthalate	199	3400	0	0
Pentachlorophenol	1	25	0	0
Phenanthrene	5709	54000	0	1700
Phenol	41504	520000	0	0
Pyrene	3767	55000	0	330
1,2,4-Trichlorobenzene	76	1000	0	0
2,4,6-Trichlorophenol	0	0	0	0
2,4,5-Trichlorophenol	0	0	0	0

TABLE 2-1 (CONTINUED)
BOOTH OIL INACTIVE HAZARDOUS WASTE SITE
CONTAMINATED SOIL SUMMARY
VOLATILE ORGANICS

VOLATILE COMPOUNDS	AVERAGE SOIL CONCENTRATION (ug/kg)	MAXIMUM SOIL CONCENTRATION (ug/kg)	MINIMUM SOIL CONCENTRATION (ug/kg)	MEDIAN SOIL CONCENTRATION (ug/kg)
Acetone	1381	12000	19	48
Benzene	154	3000	0	0
Bromodichloromethane	0	0	0	0
Bromoform	0	0	0	0
Bromomethane	0	0	0	0
2-Butanone	350	1600	0	0
Carbon Disulfide	5	90	0	0
Carbon Tetrachloride	0	0	0	0
Chlorobenzene	0	0	0	0
Chloroethane	0	0	0	0
Chloroform	0	0	0	0
Chloromethane	0	0	0	0
Dibromochloromethane	0	0	0	0
1,1-Dichloroethane	718	15000	0	0
1,1-Dichloroethene	11	230	0	0
1,2-Dichloroethane	0	0	0	0
1,2-Dichloroethene (total)	7884	160000	0	8
1,2-Dichloropropane	0	0	0	0
cis-1,3-Dichloropropene	0	0	0	0
trans-1,3-Dichloropropene	0	0	0	0
Ethylbenzene	4168	75000	0	9
2-Hexanone	0	0	0	0
Methylene Chloride	465	6400	0	6
4-Methyl-2-pentanone	1	13	0	0
Styrene	0	0	0	0
1,1,2,2-Tetrachloroethane	0	0	0	0
Tetrachloroethene	10163	220000	0	0
Toluene	14185	300000	0	2
Trichloroethene	7846	170000	0	0
1,1,1-Trichloroethane	1058	22000	0	0
1,1,2-Trichloroethane	0	0	0	0
Vinyl Acetate	0	0	0	0
Vinyl Chloride	0	3	0	0
Xylene (total)	22266	390000	0	20

TENTATIVELY IDENTIFIED COMPOUNDS	AVERAGE QUANTITY (ug/kg)
Cyclohexane, methyl	2350
Naphthalene, decahydro-trani	17
1-Propanol	1
Total unknowns (unspecified)	130
Total unknown alkanes	5206
Total unknown alkenes	13
Unknown alkyl indene	90
Total unknown aromatics	120
Total unknown benzenes	6261
Total unknown cycloalkanes	1090
Unknown decahydro naphthalene	1925
Unknown freon	2
Total unknown naphthalenes	16

TABLE 2-2 (CONTINUED)
BOOTH OIL INACTIVE HAZARDOUS WASTE SITE
CONTAMINATED GROUNDWATER SUMMARY
NAPL SAMPLING
SEMIVOLATILE ORGANICS

SEMIVOLATILE ORGANIC COMPOUNDS	BOMW8GWO 8/7/90 (mg/kg)
Acenaphthene	U
Acenaphthylene	U
Anthracene	U
Benzo(a)anthracene	U
Benzo(b)fluoranthene	U
Benzo(k)fluoranthene	U
Benzoic acid	U
Benzo(g,h,i)perylene	U
Benzo(a)pyrene	U
Benzyl alcohol	U
4-Bromophenyl-phenylether	U
Butylbenzylphthalate	U
4-Chloroaniline	U
bis(2-Chloroethoxy)methane	U
bis(2-Chloroethyl)ether	U
bis(2-Chloroisopropyl)ether	U
4-Chloro-3-methylphenol	U
2-Chloronaphthalene	U
2-Chlorophenol	U
4-Chlorophenyl-phenylether	U
Chrysene	U
Dibenzo(a,h)anthracene	U
Dibenzofuran	U
Di-n-butylphthalate	U
1,2-Dichlorobenzene	U
1,3-Dichlorobenzene	U
1,4-Dichlorobenzene	U
3,3'-Dichlorobenzidine	U
2,4-Dichlorophenol	U
Diethylphthalate	U
2,4-Dimethylphenol	U
Dimethylphthalate	U
4,6-Dinitro-2-methylphenol	U
2,4-Dinitrophenol	U
2,4-Dinitrotoluene	U
2,6-Dinitrotoluene	U
bis(2-Ethylhexyl)phthalate	130
Fluoranthene	30
Fluorene	75
Hexachlorobenzene	U
Hexachlorobutadiene	U
Hexachlorocyclopentadiene	U
Hexachloroethane	U
Indeno(1,2,3-cd)pyrene	U

TENTATIVELY IDENTIFIED COMPOUNDS	AVERAGE QUANTITY (ug/l)
Benzene,1-methyl-3-propyl	1200000
Naphthalene, 1,4,6-trimethyl	690000
Unknown	900000
Total unknown alkanes	1157500
Total unknown benzenes	1120000
Unknown cycloalkane	850000
Unknown cyclohexane	660000
Unknown naphthalene	1200000

TABLE 2-2 (CONTINUED)
BOOTH OIL INACTIVE HAZARDOUS WASTE SITE
CONTAMINATED GROUNDWATER SUMMARY
NAPL SAMPLING
SEMIVOLATILE ORGANICS

SEMIVOLATILE ORGANIC COMPOUNDS	BOMW8GWO 8/7/90 (mg/kg)
Isophorone	U
2-Methylnaphthalene	620
2-Methylphenol	U
4-Methylphenol	U
Naphthalene	290
2-Nitroaniline	U
3-Nitroaniline	U
4-Nitroaniline	U
Nitrobenzene	U
2-Nitrophenol	U
4-Nitrophenol	U
N-Nitrosodiphenylamine (1)	42
N-Nitroso-di-n-propylamine	U
Di-n-octylphthalate	U
Pentachlorophenol	U
Phenanthrene	U
Phenol	U
Pyrene	29
1,2,4-Trichlorobenzene	U
2,4,6-Trichlorophenol	U
2,4,5-Trichlorophenol	U

QUALIFIERS

U: Analyzed for but not detected

TABLE 2-2 (CONTINUED)
BOOTH OIL INACTIVE HAZARDOUS WASTE SITE
CONTAMINATED GROUNDWATER SUMMARY
NAPL SAMPLING
VOLATILE ORGANICS

VOLATILE COMPOUNDS	BOMW8GWO 8/7/90 (ug/l)
Acetone	540000
Benzene	U
Bromodichloromethane	U
Bromoform	U
Bromomethane	U
2-Butanone	U
Carbon Disulfide	U
Carbon Tetrachloride	U
Chlorobenzene	U
Chloroethane	U
Chloroform	U
Chloromethane	U
Dibromochloromethane	U
1,1-Dichloroethane	U
1,1-Dichloroethene	U
1,2-Dichloroethane	U
1,2-Dichloroethene (total)	U
1,2-Dichloropropane	U
cis-1,3-Dichloropropene	U
trans-1,3-Dichloropropene	U
Ethylbenzene	75000
2-Hexanone	U
Methylene Chloride	U
4-Methyl-2-pentanone	U
Styrene	U
1,1,2,2-Tetrachloroethane	U
Tetrachloroethene	U
Toluene	38000
Trichloroethene	U
1,1,1-Trichloroethane	U
1,1,2-Trichloroethane	U
Vinyl Acetate	34000
Vinyl Chloride	U
Xylene (total)	500000

TENTATIVELY IDENTIFIED COMPOUNDS	AVERAGE QUANTITY (ug/l)
Unknown trimethyl benzene	860000
Unknown ethyl-dimethyl benzene	720000
Unknown methyl benzene	690000
Unknown indene	390000
Unknown	380000
Unknown alkyl benzenes	480000
Unknown cycloalkane	385000

QUALIFIERS

U: Analyzed for but not detected

TABLE 2-2 (CONTINUED)
BOOTH OIL INACTIVE HAZARDOUS WASTE SITE
CONTAMINATED GROUNDWATER SUMMARY
NAPL SAMPLING
PESTICIDES/PCBS

PESTICIDE/PCB COMPOUNDS	BOMW8GWO 8/7/90 (mg/kg)
Aldrin	U
PCB - 1242	820
PCB - 1016	U
PCB - 1232	U
PCB - 1254	190
PCB - 1260	U
PCB - 1221	U
PCB - 1248	U
alpha-BHC	U
beta-BHC	U
delta-BHC	U
gamma-BHC	U
alpha-Chlordane	U
gamma-Chlordane	U
4,4'-DDD	U
4,4'-DDE	U
4,4'-DDT	U
Dieldrin	U
Endosulfan I	U
Endosulfan II	U
Endosulfan Sulfate	U
Endrin	U
Endrin-Ketone	U
Heptachlor	U
Heptachlor Epoxide	U
Methoxychlor	U
Toxaphene	U

QUALIFIERS

U: Analyzed for but not detected

TABLE 2-3
BOOTH OIL INACTIVE HAZARDOUS WASTE SITE
STORMWATER SEWER SUMMARY
CATCH BASIN SEDIMENT SAMPLING
SEMIVOLATILE ORGANICS

where's this from

SEMIVOLATILE ORGANIC COMPOUNDS	BOCB3SD 6/27/90 (ug/kg)	BOCB3SDRE 6/27/90 (ug/kg)	SOIL CLEANUP CRITERIA (ug/kg)	CB SEDIMENT CONCENTRATIONS (ug/kg)
Acenaphthene	U	U	2220	0
Acenaphthylene	U	U	5140	0
Anthracene	U	U	65000	0
Benzo(a)anthracene	2000	1600	5	1800
Benzo(b)fluoranthene	3700	1500	55	2600
Benzo(k)fluoranthene	U	1200	55	600
Benzoic acid	U	U	167	0
Benzo(g,h,i)perylene	830	U	593110	415
Benzo(a)pyrene	U	U	---	0
Benzyl alcohol	U	U	32	0
4-Bromophenyl-phenylether	U	U	---	0
Butylbenzylphthalate	U	U	---	0
4-Chloroaniline	U	U	---	0
bis(2-Chloroethoxy)methane	U	U	---	0
bis(2-Chloroethyl)ether	U	U	68	0
bis(2-Chloroisopropyl)ether	U	U	---	0
4-Chloro-3-methylphenol	U	U	115	0
2-Chloronaphthalene	U	U	---	0
2-Chlorophenol	U	U	38	0
4-Chlorophenyl-phenylether	U	U	---	0
Chrysene	2300	2100	20	2200
Dibenzo(a,h)anthracene	U	U	713680	0
Dibenzofuran	U	U	---	0
Di-n-butylphthalate	U	U	41000	0
1,2-Dichlorobenzene	U	U	66	0
1,3-Dichlorobenzene	U	U	73	0
1,4-Dichlorobenzene	U	U	92	0
3,3'-Dichlorobenzidine	U	U	---	0
2,4-Dichlorophenol	U	U	0.65	0
Diethylphthalate	U	U	260	0
2,4-Dimethylphenol	U	U	50	0
Dimethylphthalate	U	U	---	0
4,6-Dinitro-2-methylphenol	U	U	---	0
2,4-Dinitrophenol	U	U	---	0
2,4-Dinitrotoluene	U	U	---	0
2,6-Dinitrotoluene	U	U	---	0
bis(2-Ethylhexyl)phthalate	9800	11000	1517325	10400
Fluoranthene	4300	2500	22892	3400
Fluorene	U	U	8180	0
Hexachlorobenzene	U	U	68	0
Hexachlorobutadiene	U	U	74	0
Hexachlorocyclopentadiene	U	U	---	0
Hexachloroethane	U	U	1270	0
Indeno(1,2,3-cd)pyrene	U	U	28	0
Isophorone	U	U	---	0
2-Methylnaphthalene	5200	5100	21250	5150
2-Methylphenol	U	U	---	0
4-Methylphenol	U	U	---	0

TENTATIVELY IDENTIFIED COMPOUNDS	AVERAGE QUANTITY (ug/kg)
Total unknowns (unspecified)	26900
Unknown acid	1900
Total unknown alkanes	13850
Total unknown benzenes	5200
Total unknown cycloalkanes	12575
Unknown naphthalenes	2500

TABLE 2-3 (CONTINUED)
BOOTH OIL INACTIVE HAZARDOUS WASTE SITE
STORMWATER SEWER SUMMARY
CATCH BASIN SEDIMENT SAMPLING
SEMIVOLATILE ORGANICS

SEMIVOLATILE ORGANIC COMPOUNDS	BOCB3SD 6/27/90 (ug/kg)	BOCB3SDRE 6/27/90 (ug/kg)	SOIL CLEANUP CRITERIA (ug/kg)	CB SEDIMENT CONCENTRATIONS (ug/kg)
Naphthalene	U	U	650	0
2-Nitroaniline	U	U	---	0
3-Nitroaniline	U	U	232	0
4-Nitroaniline	U	U	275	0
Nitrobenzene	U	U	104	0
2-Nitrophenol	U	U	162	0
4-Nitrophenol	U	U	162	0
N-Nitrosodiphenylamine (1)	U	U	---	0
N-Nitroso-di-n-propylamine	U	U	---	0
Di-n-octylphthalate	1600	U	5965	800
Pentachlorophenol	U	U	2555	0
Phenanthrene	6100	4900	57300	5500
Phenol	U	U	0.4	0
Pyrene	1500	2000	210000	1750
1,2,4-Trichlorobenzene	U	U	336	0
2,4,6-Trichlorophenol	U	U	---	0
2,4,5-Trichlorophenol	U	U	62	0

QUALIFIERS

U: Analyzed for but not detected

NOTES

---: Not established

TABLE 2-3 (CONTINUED)
BOOTH OIL INACTIVE HAZARDOUS WASTE SITE
STORMWATER SEWER SUMMARY
CATCH BASIN SEDIMENT SAMPLING
VOLATILE ORGANICS

VOLATILE COMPOUNDS	BOCB3SD* 6/27/90 (ug/kg)	BOCB3SDRE* 6/27/90 (ug/kg)	AVERAGE CB SEDIMENT CONCENTRATION (ug/kg)
Acetone	2300	6600	4450
Benzene	U	U	0
Bromodichloromethane	U	U	0
Bromoform	U	U	0
Bromomethane	U	U	0
2-Butanone	1100	2800	1950
Carbon Disulfide	U	U	0
Carbon Tetrachloride	U	U	0
Chlorobenzene	U	U	0
Chloroethane	U	U	0
Chloroform	U	U	0
Chloromethane	U	U	0
Dibromochloromethane	U	U	0
1,1-Dichloroethane	140	230	185
1,1-Dichloroethene	U	U	0
1,2-Dichloroethane	U	190	95
1,2-Dichloroethene (total)	1400	2000	1700
1,2-Dichloropropane	U	U	0
cis-1,3-Dichloropropene	U	U	0
trans-1,3-Dichloropropene	U	210	105
Ethylbenzene	1200	1700	1450
2-Hexanone	U	230	115
Methylene Chloride	590	1400	995
4-Methyl-2-pentanone	U	U	0
Styrene	U	U	0
1,1,2,2-Tetrachloroethane	U	U	0
Tetrachloroethene	U	680	340
Toluene	1500	1600	1550
Trichloroethene	U	U	0
1,1,1-Trichloroethane	U	U	0
1,1,2-Trichloroethane	U	U	0
Vinyl Acetate	U	U	0
Vinyl Chloride	850	2400	1625
Xylene (total)	3300	5500	4400

TENTATIVELY IDENTIFIED COMPOUNDS	AVERAGE QUANTITY (ug/l)
Unknown	2500
Total unknown alkanes	4050
Total unknown benzenes	4581
Unknown cyclohexane	1550

QUALIFIERS

U: Analyzed for but not detected

TABLE 2-3 (CONTINUED)
BOOTH OIL INACTIVE HAZARDOUS WASTE SITE
STORMWATER SEWER SUMMARY
CATCH BASIN SEDIMENT SAMPLING
INORGANIC CONSTITUENTS

COMPOUNDS	BOCB3SD 6/27/90 (mg/kg)	NJDEP SOIL ACTION LEVELS (mg/kg)
Aluminum	8760	----
Antimony	5.6 U	----
Arsenic	7.1	20
Barium	141	----
Beryllium	1 B	----
Cadmium	2.7	3
Calcium	126000	----
Chromium	64.5	100
Cobalt	3.8 B	----
Copper	76.9 E	170
Cyanide	1.5	12
Iron	18100	----
Lead	611	100
Magnesium	33300	----
Manganese	701	----
Mercury	0.14 U	1
Nickel	16.8	100
Potassium	1300 B	----
Selenium	0.91 B	4
Silver	1.2 U	5
Sodium	1350 B	----
Thallium	0.63 U	----
Vanadium	16.8 E	----
Zinc	388	350

QUALIFIERS

B : Compound found at a concentration less than contract required detection limit (CRDL) but greater than instrument detection limit (IDL)
E : Value is estimated due to interference
U: Analyzed for but not detected

NOTES

----: Not established

TABLE 2-3 (CONTINUED)
BOOTH OIL INACTIVE HAZARDOUS WASTE SITE
STORMWATER SEWER SUMMARY
CATCH BASIN SEDIMENT SAMPLING
PESTICIDES/PCBS

What are these from

PESTICIDES/PCB COMPOUNDS	BOCB1SD 6/27/90 (ug/kg)	BOCB2SD 6/27/90 (ug/kg)	BOCB3SD 6/27/90 (ug/kg)	BOCB5SD 6/27/90 (ug/kg)	PRELIMINARY SOIL CLEANUP CRITERIA (ug/kg)	AVERAGE CB SEDIME CONCENTRA (ug/kg)
Aldrin	NA	NA	U	NA	---	0
PCB - 1242	U	13000	13000	1900	85	6975
PCB - 1016	U	U	U	U	85	0
PCB - 1232	U	U	U	U	---	0
PCB - 1254	U	31000	4600	1200	275	9200
PCB - 1260	4500	140000	6800	2200	---	38375
PCB - 1221	U	U	U	U	---	0
PCB - 1248	U	U	U	U	205	0
alpha-BHC	NA	NA	U	NA	---	0
beta-BHC	NA	NA	U	NA	---	0
delta-BHC	NA	NA	U	NA	---	0
gamma-BHC	NA	NA	U	NA	---	0
alpha-Chlordane	NA	NA	U	NA	22	0
gamma-Chlordane	NA	NA	U	NA	22	0
4,4'-DDD	NA	NA	U	NA	---	0
4,4'-DDE	NA	NA	U	NA	---	0
4,4'-DDT	NA	NA	U	NA	---	0
Dieldrin	NA	NA	U	NA	---	0
Endosulfan I	NA	NA	U	NA	---	0
Endosulfan II	NA	NA	U	NA	---	0
Endosulfan Sulfate	NA	NA	U	NA	---	0
Endrin	NA	NA	U	NA	---	0
Endrin-Ketone	NA	NA	U	NA	---	0
Heptachlor	NA	NA	U	NA	---	0
Heptachlor Epoxide	NA	NA	U	NA	---	0
Methoxychlor	NA	NA	U	NA	---	0
Toxaphene	NA	NA	U	NA	---	0

QUALIFIERS

U: Analyzed for but not detected

NOTES

NA: Not Applicable
---: Not established

TABLE 2-3 (CONTINUED)
BOOTH OIL INACTIVE HAZARDOUS WASTE SITE
STORMWATER SEWER SUMMARY
CATCH BASIN SURFACE WATER SAMPLING
SEMIVOLATILE ORGANICS

SEMIVOLATILE ORGANIC COMPOUNDS	BOCB1SW 6/27/90 (ug/l)	BOCB3SW 6/27/90 (ug/l)	BOCB5SW 6/27/90 (ug/l)	BOCBFB 6/27/90 (ug/l)	AVERAGE CB SURFACE WATER CONCENTRATIONS (ug/l)
Acenaphthene	U	U	U	U	0
Acenaphthylene	U	U	U	U	0
Anthracene	U	1	U	U	0.3
Benzo(a)anthracene	U	U	U	U	0
Benzo(b)fluoranthene	U	U	U	U	0
Benzo(k)fluoranthene	U	U	U	U	0
Benzoic acid	10	U	10	U	6.7
Benzo(g,h,i)perylene	U	U	U	U	0
Benzo(a)pyrene	U	U	U	U	0
Benzyl alcohol	U	U	U	U	0
4-Bromophenyl-phenylether	U	U	U	U	0
Butylbenzylphthalate	U	U	U	U	0
4-Chloroaniline	U	U	U	U	0
bis(2-Chloroethoxy)methane	U	U	U	U	0
bis(2-Chloroethyl)ether	U	U	U	U	0
bis(2-Chloroisopropyl)ether	U	U	U	U	0
4-Chloro-3-methylphenol	U	U	U	U	0
2-Chloronaphthalene	U	U	U	U	0
2-Chlorophenol	U	U	U	U	0
4-Chlorophenyl-phenylether	U	U	U	U	0
Chrysene	U	U	U	U	0
Dibenzo(a,h)anthracene	U	U	U	U	0
Dibenzofuran	U	U	U	U	0
Di-n-butylphthalate	1	1	2	0.9	0.8
1,2-Dichlorobenzene	U	U	U	U	0
1,3-Dichlorobenzene	U	U	U	U	0
1,4-Dichlorobenzene	U	U	U	U	0
3,3'-Dichlorobenzidine	U	U	U	U	0
2,4-Dichlorophenol	U	U	U	U	0
Diethylphthalate	U	U	U	U	0
2,4-Dimethylphenol	U	52	U	U	17.3
Dimethylphthalate	U	U	U	U	0
4,6-Dinitro-2-methylphenol	U	U	U	U	0
2,4-Dinitrophenol	U	U	U	U	0
2,4-Dinitrotoluene	U	U	U	U	0
2,6-Dinitrotoluene	U	U	U	U	0
bis(2-Ethylhexyl)phthalate	4	7	5	2	5.3
Fluoranthene	0.6	U	0.8	U	0.5
Fluorene	U	U	U	U	0
Hexachlorobenzene	U	U	U	U	0
Hexachlorobutadiene	U	U	U	U	0
Hexachlorocyclopentadiene	U	U	U	U	0
Hexachloroethane	U	U	U	U	0
Indeno(1,2,3-cd)pyrene	U	U	U	U	0
Isophorone	U	U	U	U	0
2-Methylnaphthalene	U	4	U	U	1.3
2-Methylphenol	2	12	U	U	4.7

TENTATIVELY IDENTIFIED COMPOUNDS	AVERAGE QUANTITY (ug/l)
Total unknowns (unspecified)	16
Unknown acid	7
Total unknown alcohols	43
Total unknown alkanes	7
Total unknown benzenes	7
Unknown cycloalkane	57
Unknown naphthalene	4
Total unknown phenols	9

TABLE 2-3 (CONTINUED)
BOOTH OIL INACTIVE HAZARDOUS WASTE SITE
STORMWATER SEWER SUMMARY
CATCH BASIN SURFACE WATER SAMPLING
SEMIVOLATILE ORGANICS

SEMIVOLATILE ORGANIC COMPOUNDS	BOCB1SW 6/27/90 (ug/l)	BOCB3SW 6/27/90 (ug/l)	BOCB5SW 6/27/90 (ug/l)	BOCBFB 6/27/90 (ug/l)	AVERAGE CB SURFACE WATER CONCENTRATIONS (ug/l)
4-Methylphenol	U	69	U	U	23
Naphthalene	U	U	U	U	0
2-Nitroaniline	U	U	U	U	0
3-Nitroaniline	U	U	U	U	0
4-Nitroaniline	U	U	U	U	0
Nitrobenzene	U	U	U	U	0
2-Nitrophenol	U	U	U	U	0
4-Nitrophenol	U	U	U	U	0
N-Nitrosodiphenylamine (1)	U	U	U	U	0
N-Nitroso-di-n-propylamine	U	U	U	U	0
Di-n-octylphthalate	U	0.8	1	U	0.6
Pentachlorophenol	U	U	U	U	0
Phenanthrene	U	1	U	U	0.3
Phenol	U	U	U	U	0
Pyrene	U	U	0.9	U	0.3
1,2,4-Trichlorobenzene	U	U	U	U	0
2,4,6-Trichlorophenol	U	U	U	U	0
2,4,5-Trichlorophenol	U	U	U	U	0

QUALIFIERS

U: Analyzed for but not detected

TABLE 2-3 (CONTINUED)
BOOTH OIL INACTIVE HAZARDOUS WASTE SITE
STORMWATER SEWER SUMMARY
CATCH BASIN SURFACE WATER SAMPLING
VOLATILE OGRANICS

CLASS A STNDS ?

VOLATILE COMPOUNDS	BOCB1SW 6/27/90 (ug/l)	BOCB3SW 6/27/90 (ug/l)	BOCB5SW 6/27/90 (ug/l)
Acetone	12	17	U
Benzene	U	25	U
Bromodichloromethane	U	U	U
Bromoform	U	U	U
Bromomethane	U	U	U
2-Butanone	U	U	U
Carbon Disulfide	U	U	U
Carbon Tetrachloride	U	U	U
Chlorobenzene	U	U	U
Chloroethane	U	U	U
Chloroform	U	U	U
Chloromethane	U	U	U
Dibromochloromethane	U	U	U
1,1-Dichloroethane	U	49	U
1,1-Dichloroethene	U	U	U
1,2-Dichloroethane	U	U	U
1,2-Dichloroethene (total)	U	270	U
1,2-Dichloropropane	U	U	U
cis-1,3-Dichloropropene	U	U	U
trans-1,3-Dichloropropene	U	U	U
Ethylbenzene	U	19	U
2-Hexanone	U	U	U
Methylene Chloride	U	U	U
4-Methyl-2-pentanone	U	U	U
Styrene	U	U	U
1,1,2,2-Tetrachloroethane	U	U	U
Tetrachloroethene	U	U	U
Toluene	U	89	U
Trichloroethene	U	U	U
1,1,1-Trichloroethane	U	U	U
1,1,2-Trichloroethane	U	U	U
Vinyl Acetate	U	U	U
Vinyl Chloride	U	320	U
Xylene (total)	U	85	U

TENTATIVELY IDENTIFIED COMPOUNDS	AVERAGE QUANTITY (ug/l)
Total unknown alkanes	9
Total unknown benzenes	2

QUALIFIERS

U: Analyzed for but not detected

TABLE 2-3 (CONTINUED)
BOOTH OIL INACTIVE HAZARDOUS WASTE SITE
STORMWATER SEWER SUMMARY
CATCH BASIN SURFACE WATER SAMPLING
INORGANIC CONSTITUENTS

COMPOUNDS	BOCB1SW 6/27/90 (ug/l)	BOCB3SW 6/27/90 (ug/l)	BOCB5SW 6/27/90 (ug/l)	BOCBFB 6/27/90 (ug/l)	NYSDEC CLASS A SURFACE WATER STANDARDS/GUIDELINES (ug/l)	AVERAGE SURFACE WATER CONCENTRATION (ug/l)
Aluminum	336	121	432	171	----	296
Antimony	18	18	18	18	3 GV	18
Arsenic	1	8.5	1	1	50 ST	4
Barium	28.3	108	31 7 BE	3.4	1000 ST	45
Beryllium	1	1	1	1	3 GV	1
Cadmium	1	1	1	1	10 ST	1
Calcium	24700	143000	26400	133	----	64700
Chromium	3.2	3	7.3	3	50 ST	5
Cobalt	2	2	2	2	----	2
Copper	30.2	5.8	36.9	4	200 ST	24
Cyanide	18.5	10	5.8	10	100 ST	11
Iron	2570	2660	938	59.9	300 ST	2056
Lead	9.7	3.6	12.1	1	50 ST	8
Magnesium	3020	33000	3150	18	35000 ST	13057
Manganese	183	447	91.2	1	300 ST	240
Mercury	0.2	0.2	0.2	0.2	2 ST	0
Nickel	5	5	6.2	5	----	5
Potassium	2110	7270	1770	449	----	3717
Selenium	2	2	2	2	10 ST	2
Silver	4	4	4	4	50 ST	4
Sodium	19400	335000	12600	1030	----	122333
Thallium	2	2	2	2	4 GV	2
Vanadium	5	6	2	2	----	4
Zinc	76.7	4.8	145	11.1	300 ST	76
Petroleum Hydrocarbons	5.63	4.76	5.01	4.2	----	5

QUALIFIERS

U : Analyzed for but not detected

NOTES

GV: Guidance Value
ST: Standard
----: Not established
*: Value is hardness dependent

TABLE 2-3 (CONTINUED)
BOOTH OIL INACTIVE HAZARDOUS WASTE SITE
STORMWATER SEWER SUMMARY
CATCH BASIN SURFACE WATER SAMPLING
PESTICIDES/PCBS

What were Det. Limits

PESTICIDES/PCB COMPOUNDS	BOCB1SW 6/27/90 (ug/kg)	BOCB3SW 6/27/90 (ug/kg)	BOCB5SW 6/27/90 (ug/kg)	BOCBFB 6/27/90 (ug/l)	NYSDEC CLASS A SURFACE WATER STANDARDS/GUIDELINES
Aldrin	U	U	U	U	0.002 GV
PCB - 1242	U	U	U	U	0.01 ST
PCB - 1016	U	U	U	U	0.01 ST
PCB - 1232	U	U	U	U	0.01 ST
PCB - 1254	U	U	U	U	0.01 ST
PCB - 1260	U	U	U	U	0.01 ST
PCB - 1221	U	U	U	U	0.01 ST
PCB - 1248	U	U	U	U	0.01 ST
alpha-BHC	U	U	U	U	0.02 ST**
beta-BHC	U	U	U	U	0.02 ST**
delta-BHC	U	U	U	U	0.02 ST**
gamma-BHC	U	U	U	U	0.02 ST**
alpha-Chlordane	U	U	U	U	----
gamma-Chlordane	U	0.63	U	U	----
4,4'-DDD	U	U	U	U	0.01 ST
4,4'-DDE	U	U	U	U	0.01 ST
4,4'-DDT	U	U	U	U	0.01 ST
Dieldrin	U	U	U	U	0.0009 GV
Endosulfan I	U	U	U	U	----
Endosulfan II	U	U	U	U	----
Endosulfan Sulfate	U	U	U	U	----
Endrin	U	U	U	U	0.2 ST
Endrin-Ketone	U	U	U	U	----
Heptachlor	U	U	U	U	0.009 ST
Heptachlor Epoxide	U	U	U	U	0.009 ST
Methoxychlor	U	U	U	U	35 ST
Toxaphene	U	U	U	U	0.01 GV

QUALIFIERS

U: Analyzed for but not detected

NOTES

----: Not established
*: Applies to sum of aldrin & dieldrin
**: Applies to sum of all isomers

TABLE 2-1 (CONTINUED)
BOOTH OIL INACTIVE HAZARDOUS WASTE SITE
CONTAMINATED SOIL SUMMARY
INORGANIC CONSTITUENTS

PARAMETERS	AVERAGE SOIL CONCENTRATION (mg/kg)	MAXIMUM SOIL CONCENTRATION (mg/kg)	MINIMUM SOIL CONCENTRATION (mg/kg)	MEDIAN SOIL CONCENTRATION (mg/kg)
Aluminum	14692	31600	5690	13300
Antimony	11	156	0	0
Arsenic	17	80.7	1.4	14.2
Barium	472	3170	95.7	188
Beryllium	1	5.6	0.35	1.1
Cadmium	3	19.3	0.29	0.99
Calcium	71684	187000	12300	73300
Chromium	43	200	6.6	26.1
Cobalt	9	16.8	2.8	9.8
Copper	144	1160	23.4	73.9
Cyanide	2	8.9	0	0.75
Iron	28537	56500	13700	27000
Lead	1912	27700	11.2	171
Magnesium	25728	57100	6480	25300
Manganese	835	2550	389	745
Mercury	0	1.7	0	0.12
Nickel	29	182	4.8	26.6
Potassium	2253	5980	733	1800
Selenium	1	1.9	0	0.7
Silver	0	2	0	0
Sodium	587	1540	214	472
Thallium	24	443	0	0.21
Vanadium	25	47.4	9.4	21.9
Zinc	449	3040	74.2	249

TABLE 2-1 (CONTINUED)
BOOTH OIL INACTIVE HAZARDOUS WASTE SITE
CONTAMINATED SOIL SUMMARY
PESTICIDES/PCBS

PESTICIDE/PCB COMPOUNDS	AVERAGE SOIL CONCENTRATION (ug/kg)	MAXIMUM SOIL CONCENTRATION (ug/kg)	MINIMUM SOIL CONCENTRATION (ug/kg)	MEDIAN SOIL CONCENTRATION (ug/kg)
Aldrin	0.4	6.7	0	0
PCB - 1242	3970.6	25000	0	0
PCB - 1016	0	0	0	0
PCB - 1232	0	0	0	0
PCB - 1254	3747.1	39000	0	0
PCB - 1260	2232.9	13000	0	1200
PCB - 1221	0	0	0	0
PCB - 1248	7388.2	83000	0	0
alpha-BHC	0	0	0	0
beta-BHC	0	0	0	0
delta-BHC	0	0	0	0
gamma-BHC	0	0	0	0
alpha-Chlordane	0	0	0	0
gamma-Chlordane	0	0	0	0
4,4'-DDD	2.9	50	0	0
4,4'-DDE	0	0	0	0
4,4'-DDT	0	0	0	0
Dieldrin	0	0	0	0
Endosulfan I	0	0	0	0
Endosulfan II	0	0	0	0
Endosulfan Sulfate	0	0	0	0
Endrin	0	0	0	0
Endrin-Ketone	0	0	0	0
Heptachlor	0	0	0	0
Heptachlor Epoxide	0	0	0	0
Methoxychlor	0	0	0	0
Toxaphene	0	0	0	0

TABLE 2-2
BOOTH OIL INACTIVE HAZARDOUS WASTE SITE
CONTAMINATED GROUNDWATER SUMMARY
SEMIVOLATILE ORGANICS

Seems useless

What about mean for GA

SEMIVOLATILE ORGANIC COMPOUNDS	AVERAGE GROUNDWATER CONCENTRATION (ug/l)	MAXIMUM GROUNDWATER CONCENTRATION (ug/l)	MINIMUM GROUNDWATER CONCENTRATION (ug/l)	MEDIAN GROUNDWATER CONCENTRATION (ug/l)
Acenaphthene	0.2	2	0	0
Acenaphthylene	0	0	0	0
Anthracene	0	0	0	0
Benzo(a)anthracene	0	0	0	0
Benzo(b)fluoranthene	0	0	0	0
Benzo(k)fluoranthene	0	0	0	0
Benzoic acid	0.5	5	0	0
Benzo(g,h,i)perylene	0	0	0	0
Benzo(a)pyrene	0	0	0	0
Benzyl alcohol	0	0	0	0
4-Bromophenyl-phenylether	0	0	0	0
Butylbenzylphthalate	0	0	0	0
4-Chloroaniline	0	0	0	0
bis(2-Chloroethoxy)methane	0	0	0	0
bis(2-Chloroethyl)ether	0	0	0	0
bis(2-Chloroisopropyl)ether	0	0	0	0
4-Chloro-3-methylphenol	0	0	0	0
2-Chloronaphthalene	0	0	0	0
2-Chlorophenol	0	0	0	0
4-Chlorophenyl-phenylether	0	0	0	0
Chrysene	0	0	0	0
Dibenzo(a,h)anthracene	0	0	0	0
Dibenzofuran	0.2	2	0	0
Di-n-butylphthalate	320.09	3200	0	0
1,2-Dichlorobenzene	2.5	19	0	0
1,3-Dichlorobenzene	0	0	0	0
1,4-Dichlorobenzene	0.3	3	0	0
3,3'-Dichlorobenzidine	0	0	0	0
2,4-Dichlorophenol	0	0	0	0
Diethylphthalate	0	0	0	0
2,4-Dimethylphenol	531.6	3100	0	0
Dimethylphthalate	0	0	0	0
4,6-Dinitro-2-methylphenol	0	0	0	0
2,4-Dinitrophenol	0	0	0	0
2,4-Dinitrotoluene	0	0	0	0
2,6-Dinitrotoluene	0	0	0	0
bis(2-Ethylhexyl)phthalate	38.1	130	0	6
Fluoranthene	4.2	22	0	0
Fluorene	0.2	2	0	0
Hexachlorobenzene	0	0	0	0
Hexachlorobutadiene	0	0	0	0
Hexachlorocyclopentadiene	0	0	0	0
Hexachloroethane	0	0	0	0
Indeno(1,2,3-cd)pyrene	0	0	0	0
Isophorone	1.4	14	0	0
2-Methylnaphthalene	64.2	370	0	10
2-Methylphenol	324	2800	0	0
4-Methylphenol	1401	12000	0	0

TENTATIVELY IDENTIFIED COMPOUNDS	AVERAGE QUANTITY (ug/l)
Total unknowns (unspecified)	51
Undecane	385
1,4-dioxane	370
1,4-Dithiane	6
1,8-Naphthalic anhydride	50
Benzene, propyl	3
Unknown acid	22
Unknown alcohol	222
Total unknown alkanes	152
Total unknown alkenes	56
Total unknown benzenes	52
Total unknown cycloalkanes	40
Unknown cycloalkene	34
Unknown cycloketone	5
Unknown indene	7
Total unknown naphthalenes	27
Total unknown phenols	111
Unknown phthalate	2

TABLE 2-2 (continued)
BOOTH OIL INACTIVE HAZARDOUS WASTE SITE
CONTAMINATED GROUNDWATER SUMMARY
SEMIVOLATILE ORGANICS

SEMIVOLATILE ORGANIC COMPOUNDS	AVERAGE GROUNDWATER CONCENTRATION (ug/l)	MAXIMUM GROUNDWATER CONCENTRATION (ug/l)	MINIMUM GROUNDWATER CONCENTRATION (ug/l)	MEDIAN GROUNDWATER CONCENTRATION (ug/l)
Naphthalene	75.7	400	0	11
2-Nitroaniline	0	0	0	0
3-Nitroaniline	0	0	0	0
4-Nitroaniline	0	0	0	0
Nitrobenzene	0	0	0	0
2-Nitrophenol	0	0	0	0
4-Nitrophenol	0	0	0	0
N-Nitrosodiphenylamine (1)	0	0	0	0
N-Nitroso-di-n-propylamine	0	0	0	0
Di-n-octylphthalate	3.5	18	0	0
Pentachlorophenol	0	0	0	0
Phenanthrene	25.1	84	0	0
Phenol	391	3800	0	0
Pyrene	9.7	37	0	0
1,2,4-Trichlorobenzene	6.4	37	0	0
2,4,6-Trichlorophenol	0	0	0	0
2,4,5-Trichlorophenol	0	0	0	0

QUALIFIERS

TABLE 2-2 (CONTINUED)
BOOTH OIL INACTIVE HAZARDOUS WASTE SITE
CONTAMINATED GROUNDWATER SUMMARY
VOLATILE ORGANICS

VOLATILE COMPOUNDS	AVERAGE GROUNDWATER CONCENTRATION (ug/l)	MAXIMUM GROUNDWATER CONCENTRATION (ug/l)	MINIMUM GROUNDWATER CONCENTRATION (ug/l)	MEDIAN GROUNDWATER CONCENTRATIONS (UG/L)
Acetone	567.2	4500	0	5
Benzene	79.1	310	0.7	35
Bromodichloromethane	0.1	1	0	0
Bromoform	0	0	0	0
Bromomethane	0	0	0	0
2-Butanone	0	0	0	0
Carbon Disulfide	0.2	1	0	0
Carbon Tetrachloride	0.1	1	0	0
Chlorobenzene	0	0	0	0
Chloroethane	0	0	0	0
Chloroform	41.1	360	0	0
Chloromethane	0	0	0	0
Dibromochloromethane	0	0	0	0
1,1-Dichloroethane	407.7	1800	0	110
1,1-Dichloroethene	70	600	0	0
1,2-Dichloroethane	0.2	2	0	0
1,2-Dichloroethene (total)	14863.8	64000	49	730
1,2-Dichloropropane	0.1	0.9	0	0
cis-1,3-Dichloropropene	0.1	1	0	0
trans-1,3-Dichloropropene	0	0	0	0
Ethylbenzene	127.4	750	0	13
2-Hexanone	4.8	42	0	0
Methylene Chloride	115.8	630	0	2
4-Methyl-2-pentanone	20.1	180	0	0
Styrene	0.2	2	0	0
1,1,2,2-Tetrachloroethane	0.2	2	0	0
Tetrachloroethene	503.8	2000	0	2
Toluene	764.9	4100	0	99
Trichloroethene	381.9	2000	0	4
1,1,1-Trichloroethane	233.2	1400	0	0
1,1,2-Trichloroethane	0.1	1	0	0
Vinyl Acetate	0	0	0	0
Vinyl Chloride	14757.3	120000	36	850
Xylene (total)	723.6	4700	0	76

TENTATIVELY IDENTIFIED COMPOUNDS	AVERAGE QUANTITY (ug/l)
Cyclohexane	28
Cyclohexane, methyl	21
Decane	788
Undecane	1025
Total unknown alkanes	3843
Total unknown alkenes	4457
Total unknown benzenes	22000
Total unknown cyclohexanes	1375
Total unknown alkyl benzenes	249
Unknown indene	29
Unknown methyl benzene	15
Total unknown siloxanes	217

TABLE 2-2 (CONTINUED)
BOOTH OIL INACTIVE HAZARDOUS WASTE SITE
CONTAMINATED GROUNDWATER SUMMARY
INORGANIC CONSTITUENTS

PARAMETER	AVERAGE GROUNDWATER CONCENTRATION (ug/l)	MAXIMUM GROUNDWATER CONCENTRATION (ug/l)	MINIMUM GROUNDWATER CONCENTRATION (ug/l)	MEDIAN GROUNDWATER CONCENTRATION (ug/l)
Aluminum	18605	41700	5760	15100
Antimony	8	27.6	0	0
Arsenic	21	45.7	5.2	19.4
Barium	457	912	196	476
Beryllium	1	2	0	1.1
Cadmium	2	4.8	1.1	2.4
Calcium	303500	591000	163000	331000
Chromium	32	58.8	7.7	28.8
Cobalt	17	32.7	5.4	17.2
Copper	78	177	17.1	47.5
Iron	37875	78700	11300	36900
Lead	143	375	32.6	147
Magnesium	101525	169000	51700	117000
Manganese	1618	3210	667	1520
Mercury	0	0.24	0	0
Nickel	51	83.1	21.4	52.6
Potassium	17900	30600	13000	16300
Selenium	0	2.4	0	0
Silver	0	0	0	0
Sodium	169488	475000	26500	171000
Thallium	0	0	0	0
Vanadium	39	77.5	9.8	44.2
Zinc	238	559	85.7	265
Cyanide	0	0	0	0
Petroleum Hydrocarbons, (mg/l)	111	552	5.38	34

TABLE 2-2 (CONTINUED)
BOOTH OIL INACTIVE HAZARDOUS WASTE SITE
CONTAMINATED GROUNDWATER SUMMARY
PESTICIDES/PCBS

PESTICIDE/PCB COMPOUNDS	AVERAGE GROUNDWATER CONCENTRATION (ug/l)	MAXIMUM GROUNDWATER CONCENTRATION (ug/l)	MINIMUM GROUNDWATER CONCENTRATION (ug/l)	MEDIAN GROUNDWATER CONCENTRATION (ug/l)
Aldrin	0	0	0	0
PCB - 1242	423	3300	0	0
PCB - 1016	0	0	0	0
PCB - 1232	0	0	0	0
PCB - 1254	171	1500	0	0
PCB - 1260	135	870	0	0
PCB - 1221	0	0	0	0
PCB - 1248	0	0	0	0
alpha-BHC	0	0	0	0
beta-BHC	0	0	0	0
delta-BHC	0	0	0	0
gamma-BHC	0	0	0	0
alpha-Chlordane	0	0	0	0
gamma-Chlordane	0	0	0	0
4,4'-DDD	0	0	0	0
4,4'-DDE	0	0	0	0
4,4'-DDT	0	0	0	0
Dieldrin	0	0	0	0
Endosulfan I	0	0	0	0
Endosulfan II	0	0	0	0
Endosulfan Sulfate	0	0	0	0
Endrin	0	0.19	0	0
Endrin-Ketone	0	0	0	0
Heptachlor	0	0	0	0
Heptachlor Epoxide	0	0	0	0
Methoxychlor	0	0	0	0
Toxaphene	0	0	0	0

Aroclor 1260 (2233 ppb average), and Aroclor 1248 (7388 ppb average).

The contaminated groundwater beneath the site also contains a variety of semivolatiles, volatiles, PCBs, and metals. The most prevalent semivolatiles are 4-methylphenol (1401 ppb average), 2,4-dimethylphenol (531 ppb average), phenol (391 ppb average), undecane (385 ppb average), and 1,4-dioxane (370 ppb average). Volatiles present include 1,2-dichloroethene (14864 ppb average), vinyl chloride (14757 ppb average), total unknown alkenes (4457 ppb average), and total unknown benzenes (22000 ppb average). Metals present at concentrations exceeding New York State Class GA groundwater standards are iron (37875 ppb average), lead (143 ppb average), and manganese (1618 ppb average). The groundwater contains Aroclor 1242 (423 ppb average), Aroclor 1254 (171 ppb average), and Aroclor 1260 (135 ppb average).

A lighter than water, nonaqueous phase liquid (NAPL) was detected in onsite monitoring wells during the Phase I RI. The NAPL was present in 2 of the 8 groundwater wells sampled during the Phase I RI. The thickness of the NAPL in the two wells was 0.5 inches in one well and 12 inches in the other well. Semivolatiles present in the NAPL include 2-methylnaphthalene (620 ppm), naphthalene (290 ppm), unknown naphthalene (1200 ppm), and 1-methyl-3-propyl benzene (1200 ppm). The most prevalent volatiles are xylene (500 ppm), acetone (540 ppm), unknown ethyl-dimethyl benzene (720 ppm), and an unknown trimethyl benzene (860 ppm). Aroclor 1242 and Aroclor 1254 are present at concentrations of 820 ppm and 190 ppm, respectively.

The catch basin sediment contains a mixture of semivolatiles, volatiles, PCBs, and metals. The most widespread semivolatiles are bis(2-ethylhexyl)phthalate (10400 ppb average), phenanthrene (5500 ppb average), 2-methylnaphthalene (5150 ppb average), total unknown alkanes (13850 ppb average), and total unknowns (26900 ppb average). Volatiles present include acetone (4450 ppb average) and xylenes (4400 ppb average). Metals present in concentrations exceeding New York State Class A surface water standards are lead (611 ppm) and zinc (388 ppm). Aroclor 1242, Aroclor 1254, and Aroclor 1260 are present with average concentrations of 6975 ppb, 9200 ppb, and 38375 ppb, respectively.

The catch basin surface water contains semivolatiles, volatiles, and metals. No PCBs were detected in the catch basin water samples taken during the Phase I RI. The most prevalent semivolatiles are 2,4-dimethylphenol (17.3 ppb average), 4-methylphenol (23 ppb average), benzoic acid (6.7 ppb average), total unknowns (16 ppb average), total unknown alcohols (43 ppb average), and unknown cycloalkane (57 ppb average). Volatiles in the surface water include vinyl chloride (105 ppb average), 1,2-dichloroethene (90 ppb average), toluene (30 ppb average), and xylene (28 ppb average). Iron is the only metal present in excess of the surface water standards, having an average concentration of 2056 ppb.

2.3 Identification of Exposure Pathways and Remedial Action and General Response Actions

The overall objective of remedial action at the Booth Oil Site will be to meet the applicable standards, criteria, and guidelines (SCGs) and to mitigate the incremental risk, if any, to human health and the environment. Accomplishment of this objective requires that potential exposure to contaminants through various environmental pathways be reduced to applicable SCGs. Preliminary SCGs (preliminary ARARs) for the Booth Oil Site include NYSDEC Soil Cleanup Criteria Guidelines, New York Class GA Groundwater Standards and Guidance Values, New York State Class B Surface Water Standards and Guidance Values, and site-specific levels determined by the Human Health and Environmental Risk Assessment. A complete list of preliminary SCGs (preliminary ARARs) is contained in the Phase I Remedial Investigation Report. Potential pathways for exposure of humans and other biota to contaminants from the Booth Oil Site include the following:

- Ingestion of contaminated soil
- Dermal contact with contaminated soil
- Inhalation of fugitive dust and/or chemical vapors from contaminated soil
- Ingestion of contaminated surface water (aquatic life)

- Dermal contact with contaminated surface water

- Ingestion of contaminated fish

Pathways of exposure to contaminated groundwater do not appear to exist at the site. The groundwater in the vicinity of the site is perched, flows in an east-northeasterly direction, and, apparently, does not recharge the Little River. It is not used as a source of drinking water or industrial water.

Preliminary remedial action objectives addressing each of the possible exposure pathways are outlined in Table 2-4. General response actions for accomplishing the remedial action objectives are presented in Table 2-5.

2.4 IDENTIFICATION AND INITIAL SCREENING OF POTENTIALLY APPLICABLE REMEDIAL ACTION TECHNOLOGIES

This section identifies and examines remedial technologies that may be applicable for treatment of the contaminated soil, groundwater, and sediment at the Booth Oil Site. Each technology presented below is briefly described and analyzed for possible effectiveness as part of a remedial alternative for the site. Technologies judged effective will be combined to form potential remedial alternatives for screening in Section 3.

TABLE 2-4. REMEDIAL ACTION OBJECTIVES

Exposure Pathways	Environmental Media	Remedial Action Objectives
1. Ingestion of contaminated soil	Soil	Reduce contaminant concentrations to acceptable levels as defined by NYSDEC Soil Cleanup Criteria or the Risk Assessment
2. Direct contact (dermal exposure) with contaminated soil	Soil	Reduce contaminant concentrations to acceptable levels as defined by NYSDEC Soil Cleanup Criteria or the Risk Assessment
3. Ingestion of contaminated surface water	Surface water	Eliminate discharge to the Little River in excess of the SPDES discharge requirements
4. Direct contact (dermal exposure) with contaminated surface water	Surface water	Eliminate discharge to the Little River in excess of the SPDES discharge requirements
5. Inhalation of fugitive dust and/or chemical vapors from contaminated soil	Air	Reduce contaminant soil concentrations to levels that ensure compliance with the NYSDEC Ambient Guideline Concentrations; Meet requirements of Air Cleanup Criteria (NYSDEC Division of Air Resources, 1/90) Implement appropriate dust control procedures during the remedial action Use of appropriate personal protective equipment by remedial action workers
6. Ingestion of contaminated fish	Water	Control consumption of biota from Little River Meet New York State Class A Surface Water Quality Standards

TABLE 2-5. GENERAL RESPONSE ACTIONS

	General Response Actions		
Exposure Pathways	Institutional	Control	Treatment & Disposal
1. Ingestion of contaminated soil	Limit access to the site with fences and signs	Excavation and disposal of contaminated soil	On-site or off-site treatment of contaminated soil
		Place low permeability cover on the site	
2. Dermal contact with contaminated soil	Limit access to the site with fences and signs	Excavation and disposal of contaminated soil	On-site or off-site treatment of contaminated soil
		Place low permeability cover on the site	
3. Ingestion of contaminated surface water (aquatic life)		Removal and disposal of contaminated storm water sewer sediment and surface water and repair of sewer	On-site or off-site treatment of sediment and surface water removed and water from decontamination of storm water sewer
		Place low permeability cover on the site	
		Excavation and disposal of contaminated soil	On-site or off-site treatment of contaminated soil
4. Dermal contact with contaminated surface water		Removal and disposal of contaminated storm water sewer sediment and surface water and repair of sewer	On-site or off-site treatment of sediment and surface water removed and water from decontamination of storm water sewer
		Place low permeability cover on the site	
		Excavation and disposal of contaminated soil	On-site or off-site treatment of contaminated soil
5. Inhalation of fugitive dust and/or chemical vapors from contaminated soil	Limit access to the site with fences and signs	Excavation and disposal of contaminated soil	On-site or off-site treatment of contaminated soil
		Place low permeability cover on the site	
6. Ingestion of contaminated fish	Enact ordinances prohibiting fishing in the Little River and/or Niagara River	Implement control or cleanup strategy for the storm water sewer	

2.4.1 Contaminated Soils

Table 2-1 summarizes the analytical results for the Phase I RI soil samples. The results indicate that the soil contains a wide variety of semivolatiles, volatiles, PCBs, and metals. Semivolatiles present include 4-methylphenol (73787 ppb average), phenol (41504 ppb average), 2,4-dimethylphenol (22170 ppb average), ethyl phenol (30000 ppb average), and decane (27143 ppb average). The most widely encountered volatiles in the soil are xylene(total) (22266 ppb average), toluene (14185 ppb average), tetrachloroethene (10163 ppb average), 1,2-dichloroethene (7884 ppb average), and trichloroethene (7846 ppb average). Metals present in elevated concentrations include lead (1,912 ppm average), manganese (835 ppm average), iron (28,537 ppm average), aluminum (14,692 ppm average), and zinc (449 ppm average). PCBs in the soil are soil are Aroclor 1242 (3971 ppb average), Aroclor 1254 (3747 ppb average), Aroclor 1260 (2233 ppb average), and Aroclor 1248 (7388 ppb average).

Technologies that may be applicable for containment or treatment of the contaminated soil are analyzed below. Potential remedial alternatives for the site may include more than one of these technologies. The soil contains hot spots that contain unusually high levels of contaminants as compared with other areas of the site. It may be feasible to remove these hot spots for treatment with one technology while using another technology for treatment of the remainder of the soil.

2.4.1.1 No Action--

With this alternative, the Booth Oil Site would remain in its current condition without any remediation of the contaminated soil or groundwater. Fences would be erected and signs posted to control access to the site. Periodic monitoring of the soil and groundwater would be performed to detect migration of contaminants away from the site. This alternative will be analyzed in the Phase III Feasibility Study, in accordance with USEPA and NYSDEC guidelines.

2.4.1.2 Contaminant Containment Technologies--

Contaminant containment technologies include slurry walls and caps. These technologies are designed to prevent future migration of contaminants from the contaminated area. The technologies do not provide any treatment for the waste contained. NYSDEC ranks contaminant containment technologies fourth out of five possible remedial technology categories (destruction, separation/treatment, solidification/chemical fixation, isolation and containment, and off-site land disposal).

2.4.1.2.1 Resource Conservation and Recovery Act (RCRA) Cap--

This technology consists of constructing a RCRA cap over the entire surface of the site. The cap would prevent direct contact with contaminated soils and would minimize infiltration of storm water through the contaminated soil and into the groundwater. It would also eliminate the flow of contaminated runoff to the storm water sewer and further contamination of the perched groundwater. A RCRA cover typically includes three sections. The top section consists of vegetated topsoil and a soil layer. The middle section contains a filter which prevents clogging of the underlying drainage layer. The bottom section is comprised of a flexible membrane liner (FML), which overlies and protects a low permeability FML/compacted soil layer.

Since the Booth Oil Site is separated into parcels by railroad tracks, a continuous cap could not be placed on the site. These limitations will be further examined during the detailed analysis of alternatives.

2.4.1.2.2 Slurry Wall--

This technology involves constructing a slurry wall around the site and placing a RCRA cap on the site. The slurry wall would prevent migration of contaminated groundwater from the site. It would be keyed into a low permeability clay layer to prevent migration of contaminants beneath the wall. Since on-site backfill is not available, off-site backfill would be used in the soil-bentonite slurry. Extraction wells would be installed to provide gradient control across the slurry wall.

The RCRA cap would prevent direct contact with the contaminated soils and would minimize infiltration of storm water into the the contaminated soil and flow of contaminated runoff to the storm water sewer.

Since the Booth Oil Site is separated into parcels by railroad tracks, a continuous slurry wall could not be placed around the perimeter of the site without temporary removal of the tracks. These limitations will be further examined during the detailed analysis of alternatives.

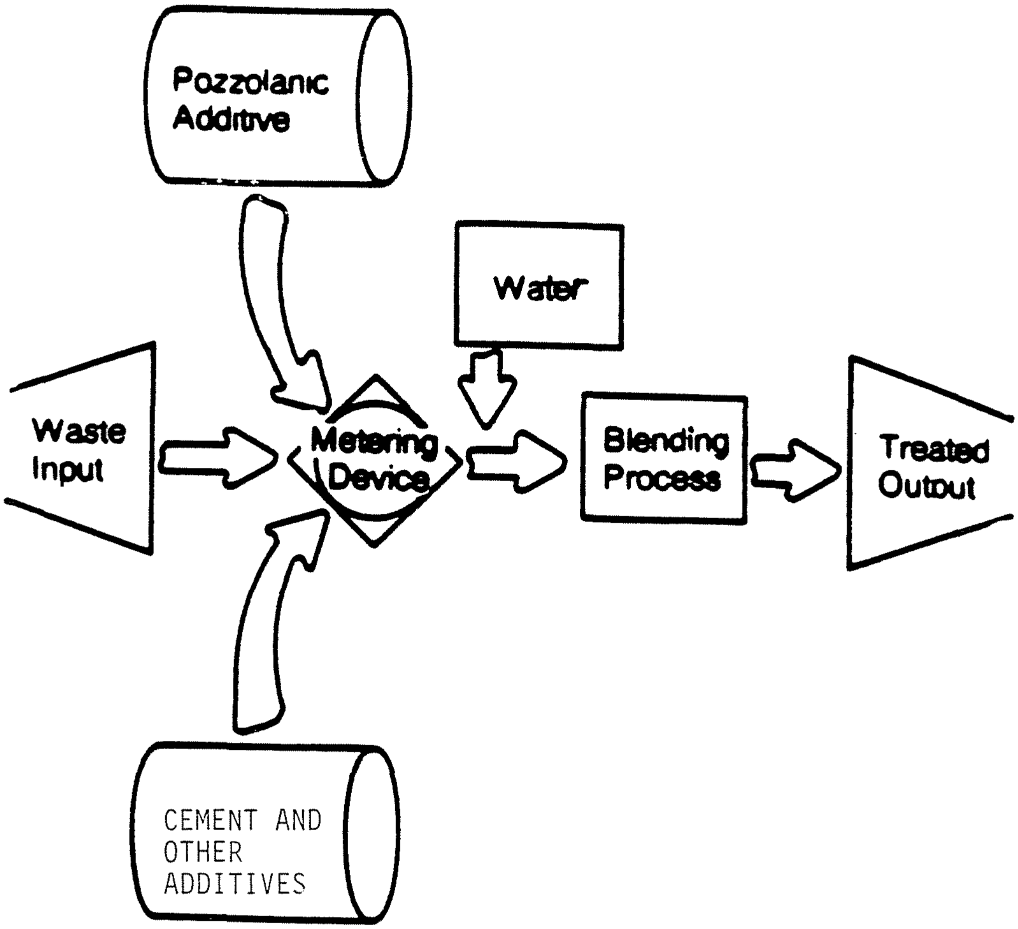
2.4.1.3 Solidification/Stabilization Technologies--

There are currently many variations of solidification/stabilization technologies (Figure 2-3) commercially available. Most are designed for inorganic contaminants. These technologies treat contaminated soil or waste with Portland Cement, pozzolans, and other reagents (some of which are proprietary) to produce a stable, non-leachable solid material. The stabilized material experiences a volume increase, generally in the range of 10 to 50 percent. If the stabilization process is performed on-site, the stabilized material could be backfilled on-site. If the process is performed at an off-site RCRA facility, the stabilized material could be disposed of at the facility.

Solidification/stabilization additives may chemically destroy or form bonds with the organic contaminants present in the waste, reducing their susceptibility to leaching. Inorganic contaminants, such as heavy metals, are encapsulated in the cementitious matrix. These technologies primarily reduce the mobility of the contaminants in the waste material.

FIGURE 2-3.

STABILIZATION / SOLIDIFICATION PROCESS FLOW DIAGRAM



Two solidification/stabilization systems have demonstrated effectiveness in treating waste containing organics and inorganics such as those found at the Booth Oil Site. These systems were developed by Qualtec and Wastech. Both are on-site treatment systems. Solidification/stabilization technologies would be ranked third among the five possible remedial action technology categories classified by the NYSDEC.

The Qualtec system mixes contaminated soil with Portland cement, pozzolans, and other additives to produce a nonleachable solid. The system was used to remediate the Pepper's Steel and Alloys Superfund Site where the contaminants were PCBs (Aroclor 1260), lead, and arsenic. Results from tests performed on the solid generated by the Qualtec system at the site indicate that the soild has become stronger and less leachable with time (Dole, 1990). The Qualtec system has not been proven effective on waste containing volatile and semivolatile organics such as those found at the Booth Oil Site.

The Wastech system consists of three steps. First, the soil is mixed with an appropriate catalyst and a reagent containing a hydrophobic carbon chain. The reagent molecularly bonds with the organics in the soil. Next, a reagent with hydrophilic and hydrophobic carbon chains is added. This reagent bonds with the molecularly bound organics to form stabilized micelles. Finally, a mixture of pozzolans and Portland cement is combined with the soil to form a strong, impermeable cementitious matrix that resists leaching.

Wastech has tested its system on a variety of soils and sludges containing PCBs, volatiles, semivolatiles, and metals. Tests on the stabilized solids indicate that the solid resists leaching of organic compounds. TCLP extracts have contained volatiles and semivolatiles at concentrations less than the regulatory limit (Wastech, 1990).

Since the Booth Oil Site contains PCB, volatiles, semivolatiles, and metals, the Wastech system would be better qualified to handle the waste material than the Qualtec system. It has been proven effective on soil containing volatiles and semivolatiles. The Qualtec system has not been proven effective on soils containing these contaminants.

There would be difficulties in disposing of any solidified mass at the Booth Oil Site. Assuming a 50% volume increase in the solidified material, the redeposited material would rise two and a half feet above the original grade. This assumes that soil to a five foot depth would be excavated and treated. Placement of a cap on the solidified mass would add another three feet to the mound. In addition, as previously mentioned, the cap would not be continuous because railroad tracks divide the site into several parcels.

2.4.1.4 Solvent Extraction Processes--

Solvent extraction processes typically employ direct contact of excavated soils with a select solvent in a soil contactor to remove the organic and/or inorganic contaminants. Often, the solvent is recovered from the solvent/contaminant mixture and recycled to the contactor. The organic contaminants which are extracted may be incinerated and metals which are extracted may be precipitated and landfilled or electrolytically recovered. Decontaminated soil can be landfilled or backfilled on-site, depending on the process removal efficiency and site specific factors, such as land restrictions and future land use. Soils with particle diameters less than two millimeters (colloids, clay, silt, and sand) are best suited for solvent extraction processes (Blank, 1990).

Several solvent extraction processes that may be effective treating the soil at the Booth Oil Site are discussed below. Each process is an on-site treatment process. The processes are separation/treatment processes and would be ranked second among the five remedial action technology categories classified by the NYSDEC.

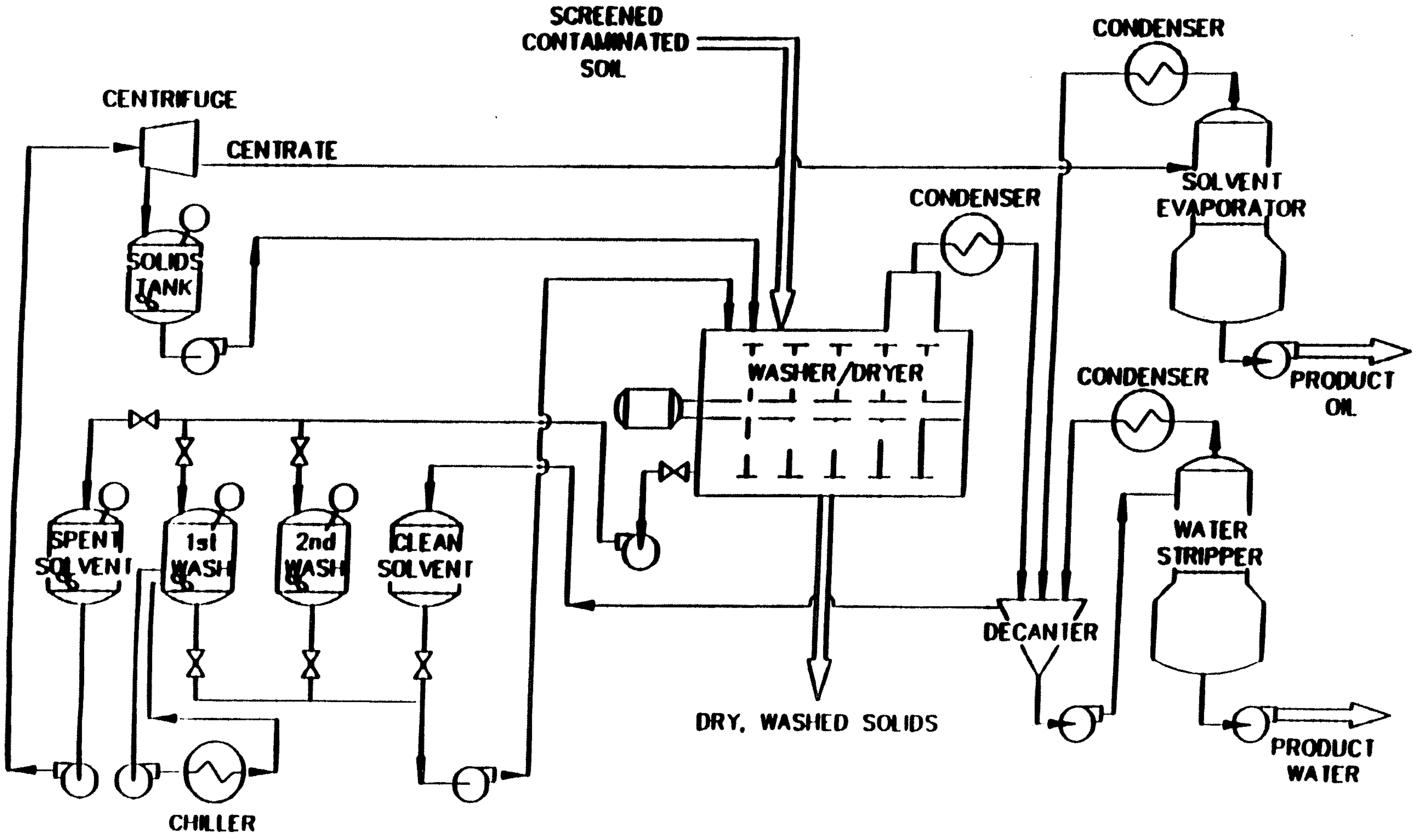
2.4.1.4.1 Triethylamine Extraction--

The on-site triethylamine (TEA) extraction process is designed to remove organic compounds (PCBs, volatiles, and semivolatiles) from soil or sludge to produce a non-contaminated soil. Figure 2-4 presents a flow diagram for the process. In the process, the soil is washed in the first extraction stage with TEA at 40 ^{O}F to remove organics. The TEA/organics/water mixture is decanted from the washer and heated to 130 ^{O}F to separate the TEA/organics and water phases. The TEA is steam stripped from the TEA/organics mixture and the water and recycled to the washer for re-use in further extraction stages. The

FIGURE 2.4

RCC Resources Conservation Company

B.E.S.T.® SOIL CLEANUP UNIT SCHEMATIC



organics are generally incinerated off-site in a liquid injection incinerator. The water is discharged to a surface water body or a wastewater treatment plant. Washed soil, before discharge, is dried in the soil contactor (a combination washer/dryer) to remove residual TEA. The TEA removed is condensed and recycled to the washer.

The triethylamine extraction process was tested by the USEPA at the General Refining Superfund Site near Savannah, GA. Like Booth Oil, the General Refining Site functioned as a waste oil re-refining facility. The waste at the site contained relatively low levels of PCBs (5-15 ppm). After processing the 3700 cubic yards of sludges, the residual solids contained less than 0.1 ppm PCBs (Weimer, 1989).

The TEA process can be used to treat soils containing the PCBs, volatiles, and semivolatiles found at the Booth Oil Site. Treatability studies would be required to determine the number of extraction stages needed to achieve the desired soil clean-up level. The process would not treat the metals in the soil. TCLP testing of the soil after TEA processing would be required for determining the need for metals removal or stabilization.

2.4.1.4.2 Acurex (proprietary) Extraction

In this on-site solvent extraction process, a proprietary solvent removes PCBs and other organics from contaminated soil. It does not treat the metals in the soil (TCLP testing of the soil after Acurex processing would be required for determining the need for metals removal or stabilization.). The process has been pilot-scale tested and proved able to reduce PCB concentrations of soil from 1,983 ppm to less than 2 ppm, a removal efficency of approximately 99.9% (EPA, 1986). It has neither been developed to or proven on a commercial scale.

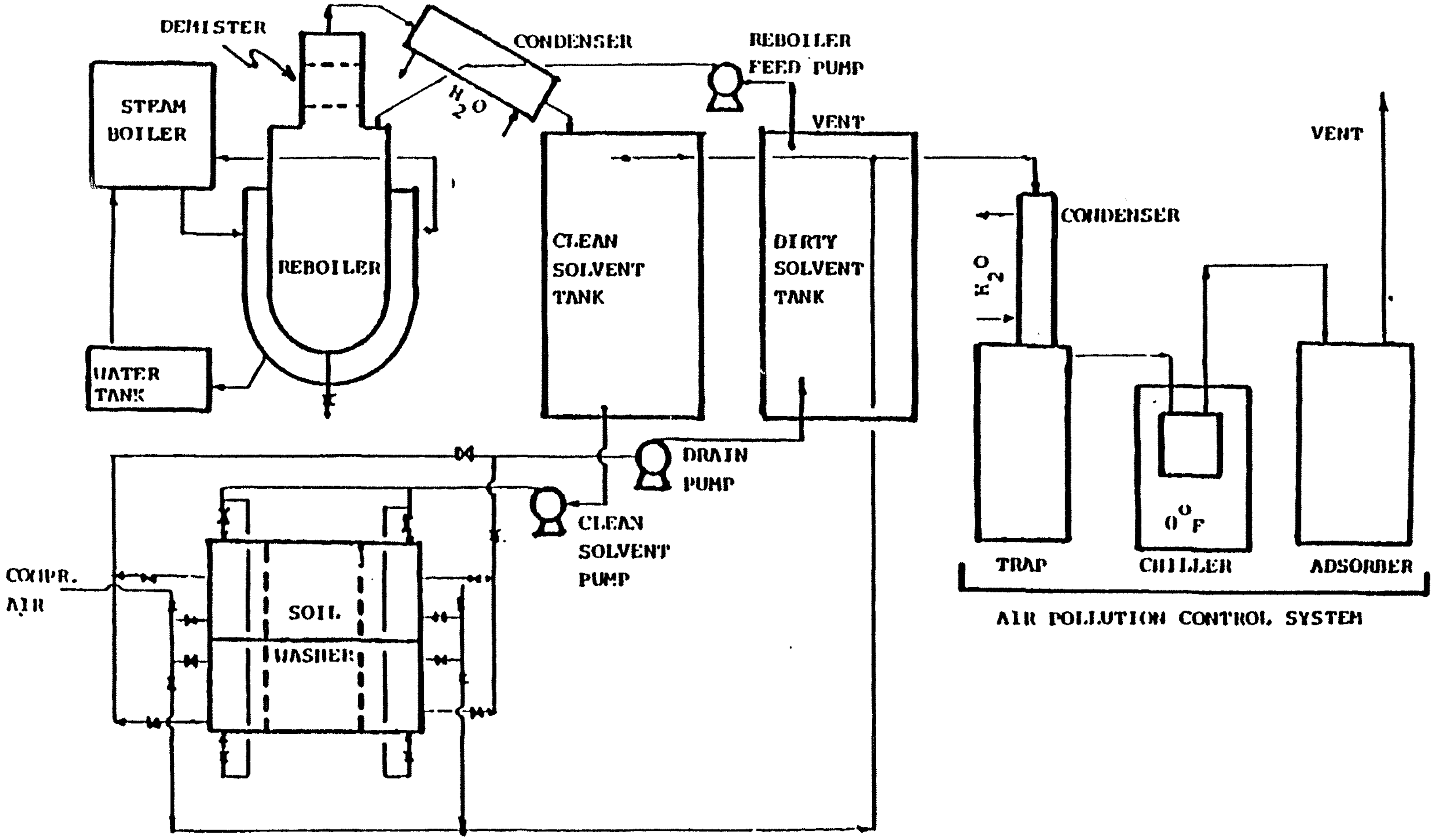
The soil/solvent mixture is agitated in the soil contactor. At the end of the extraction cycle, contaminated solvent is decanted from the contactor and stored in a contaminated solvent tank. The contaminated solvent is pumped to a reboiler where the solvent is stripped from the PCBs and condensed for reuse. The concentrated PCBs can be incinerated or treated with an alternative treatment process. A diagram of the Acurex process is presented in Figure 2-5.

The Acurex process has not been developed beyond the pilot-scale stage. Acurex can perform treatability studies at its facility. The company has no plans to produce a commercial-scale system.

2.4.1.4.3 Methanol Extraction

With this on-site technology, PCBs and other organic compounds are extracted from pre-dried soils with methanol. Metals are not treated (TCLP testing of the soil after Methanol processing would be required for determining the need for metals removal or stabilization.). A carbon bed removes the PCBs and other organics from the methanol after the extraction. Methanol with a low

FIGURE 2-5.



Note: Adapted From U.S. EPA, 1986a.

Schematic of Acurex Solvent Wash Process concentration of PCBs (10 ppm) is sold as fuel while the carbon contaminated with PCBs and other organics is incinerated. Clean soils are dried, removing residual methanol, and backfilled at the site. Sewage sprayed on the soil microbiologically degrades any remaining methanol. A diagram of the process is presented in Figure 2-6. The system was field tested in 1986 on PCB-contaminated soil at Minden, West Virginia in 1986. The system reduced the PCB concentration from 400 ppm to 25 ppm. Since the field test, the methanol extraction process has not been developed to a commercial scale by its vendor because of the costs associated with materials handling and processing. The vendor has no plans to develop a commercial-scale system.

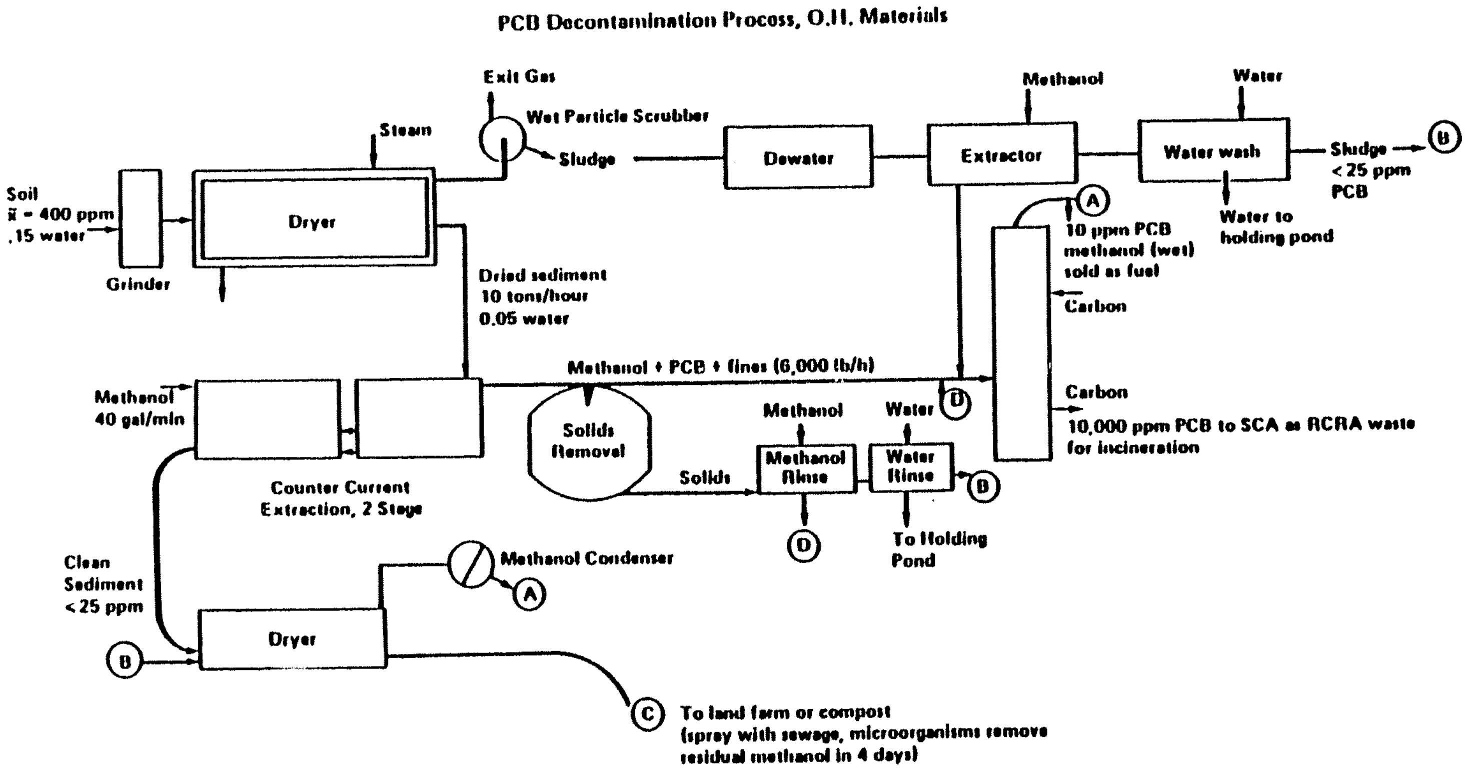
2.4.1.5.4 Acetone/Kerosene Extraction + Inorganic Acid Extraction

This on-site process uses organic solvents(acetone and kerosene) to extract organic compounds and an inorganic solvent to extract metals from soils. Figure 2-7 shows a diagram of the process. The process involves several steps:

- Contaminated soil is separated into solid and liquid fractions by centrifugation or filtration.

- The solid fraction is washed with acetone to extract organics. The acetone/organics/water mixture is decanted and goes to a liquid-liquid extractor. Acetone is steam stripped from the soil and recycled to the washer.

FIGURE 2-6.

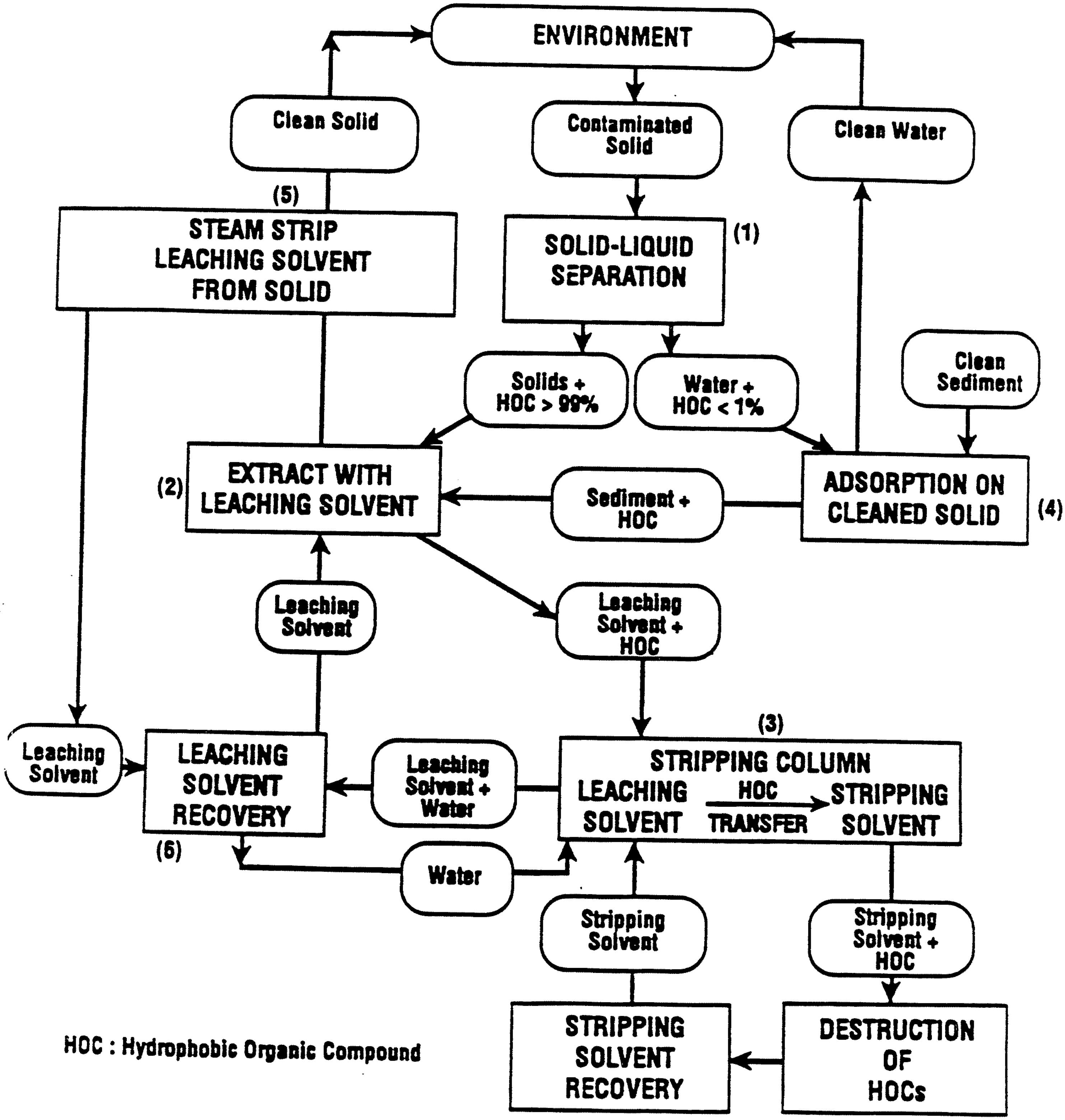


Note: Adapted From U.S. EPA, 1986a.

Conceptual Flow Sheet, Methanol Extraction of PCBs

FIGURE 2.7

Leep Technology Process Flow



HOC : Hydrophobic Organic Compound

- In the liquid-liquid extractor, the organics transfer to the kerosene (stripping solvent), a hydrophobic solvent amenable to destruction. The kerosene/organics mixture from the extractor is incinerated off-site in a liquid injection incinerator. The acetone/water mixture is distilled with the acetone returning to the washer and the water going to an adsorption unit.

- Water from the filter or centrifuge is processed in an adsorption unit which utilizes clean solids or other solid medium. The solid, after exhaustion, is sent to the washer. Clean water can be discharged to surface water or a sanitary sewer.

- Solids stripped of acetone are washed with an inorganic acid to remove heavy metals. The acid/metal solution is placed in a liquid-liquid extractor where the metals are transferred to another acid so that the leaching acid can be recycled. The metals may be recovered by electrolytic precipitation or chemically precipitated and stabilized prior to land disposal.

Metals removal is accomplished by sending the soil devoid of organics through the same processes as those in Figure 2-7, using inorganic acids as the solvents.

The acetone/kerosene extraction plus inorganic acid extraction has successfully treated PCBs, volatiles, semivolatiles, and heavy metals in bench-scale and pilot-scale tests (Blank, 1990). According to ART International, a commercial scale system will be available for on-site use by 1991.

Solvent extraction will be considered further. The most promising solvent extraction processes are the triethylamine extraction process and the acetone/kerosene extraction plus inorganic acid extraction process. The Acurex process and the methanol process are not promising because there are no plans to develop these systems to commercial scale.

2.4.1.5 Dechlorination Processes--

Dechlorination processes chemically or photochemically remove chlorine atoms from PCBs, dioxins, and other chlorinated hydrocarbons on contaminated soil. These processes consist of reactors where the chlorinated organics are extracted from the soil with a solvent and reacted with nucleophiles or ultraviolet light to remove the chlorines. The reactions detoxify the organic compounds. The liquid is decanted. Solvents and reagents used may be recovered for recycling to the reactor. Waste liquid is treated prior to discharge in conformance with applicable regulations. Soil can be backfilled on-site.

Dechorination processes are destruction processes. They would be ranked first among the five remedial action technology categories classified by the NYSDEC. Commercial systems are available for on-site treatment of halogenated organics-contaminated soil. Two dechlorination systems that may be effective for treating the halogenated organics at the Booth Oil Site are described below.

2.4.1.5.1 Alkali Metal-Polyethylene Glycol (APEG) Process--

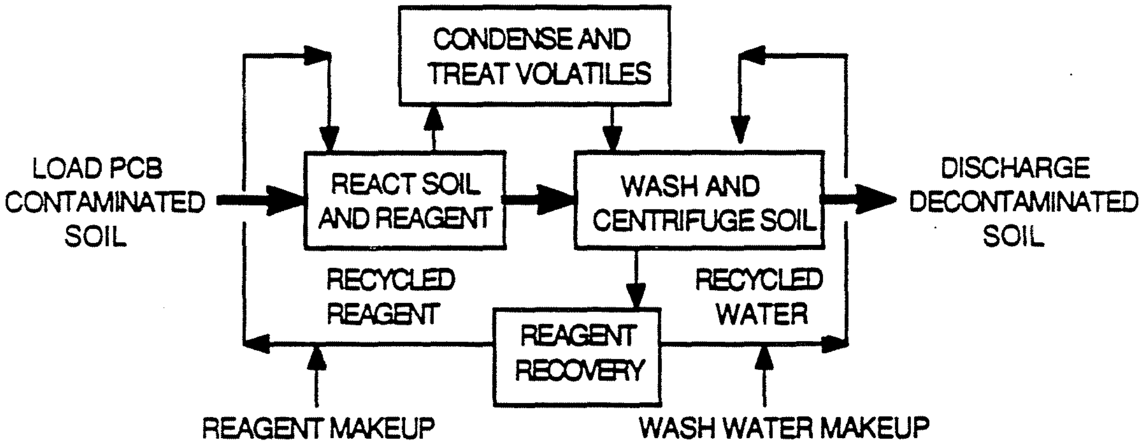
The alkali metal-polyethylene glycol (APEG) process removes chlorine from aromatic compounds such as PCBs and halogenated aliphatics. It results in the chemical destruction of chlorinated organic compounds and the formation of polyethylene glycol ethers and either potassium chloride or sodium chloride. Near total dechlorination of the aromatics is possible under favorable conditions (EPA, 1990).

The APEG process uses either sodium polyethylene glycol or potassium polyethylene glycol as the reagent and dimethyl sulfoxide as a co-solvent. Laboratory tests have revealed that KPEG is at least two times more reactive than NaPEG in the PCB destruction process. Also, KPEG is less sensitive to the water content of the soil (EPA, 1990).

Figure 2-8 shows a diagram of the APEG process. The process is carried out in a rotating mixer. Contaminated soil is charged to the mixer and the reagent, a mixture of polethylene glycol, sodium or potassium hydroxide, and dimethyl sulfoxide (a cosolvent), added. The reagent added is at a temperature of 150 ^{o}C. At the end of the reaction, the reagent/soil slurry is pumped to a centrifuge where the solids and liquids are separated. The soil is washed

FIGURE 2-8.

DIAGRAM OF APEG PROCESS



several times with water to removal residual reagent. Reagent and wash water are separated in the reagent recovery system with the reagent being recycled to the reactor and wash water being recycled to the centrifuge. The waste from the process will be approximately one reactor volume of reagent. This reagent can be burned in an off-site incinerator. The soil can be backfilled on-site.

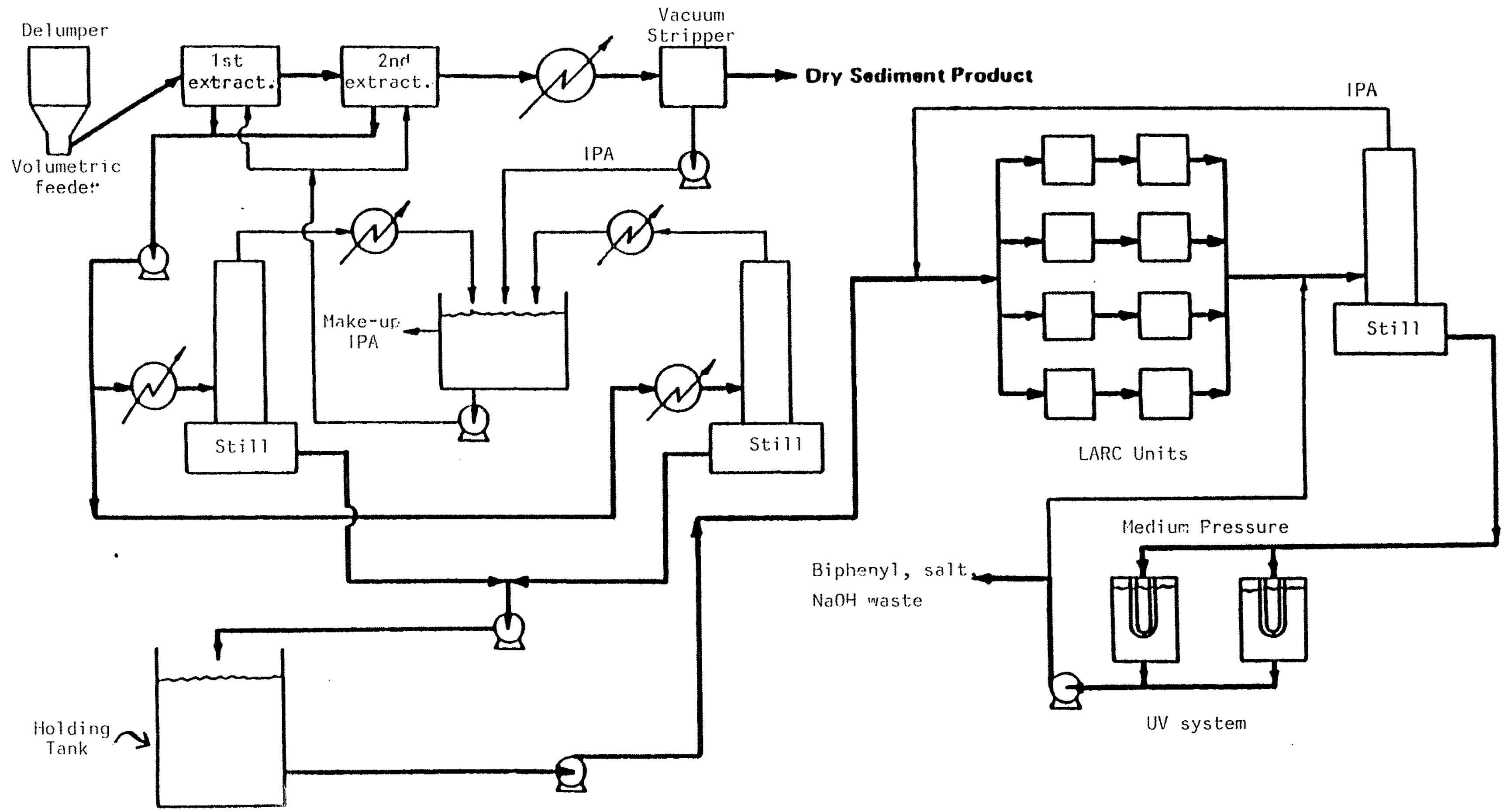
The APEG process was designed for the destruction of PCBs and other chlorinated aromatics. While the Booth Oil Site contains these compounds, it also is contaminated with a variety of aliphatic volatile and semivolatile compounds. The APEG process would treat the halogenated aliphatics, but at a slower rate than the halogenated aromatics. The process would not treat the nonhalogenated aliphatics or aromatics, nor would it treat the heavy metals. It would volatilize those organics with boiling points below 150 ^{o}C. The volatilized compounds are collected in a condensate trap and sent off-site for incineration.

2.4.1.5.2 Light Activated Reduction of Chemicals (LARC) Process--

The LARC process uses UV light and an optimized reducing environment to dehalogenate various chlorinated compounds, including PCBs, that have been solvent extracted. Isopropanol is the solvent used for the extraction.

A diagram of the process is presented in Figure 2-9. In the process, contaminated soil and isopropanol are contacted in the extractor. After a

FIGURE 2-9.



Note: Adapted From U.S. EPA, 1986a.

Schematic of LARC Mobile Unit for Destruction of PCBs in Soil

holding time of 15 to 20 minutes, the isopropanol containing chlorinated organics is decanted from the extractor and pumped to a distillation column where the isopropanol is recovered for recycle to the extractor and the chlorinated organics concentrated. Soil from the extractor goes through a second extractor where the extraction process is repeated. Soil from the second extractor is vaccum stripped for recovery of the isopropanol. Concentrated halogenated organics are pumped to a UV light reactor where hydrogen gas is bubbled through the solution. The UV light assists in dechlorination of the organics. Effluent from the reactor can be incinerated in a liquid injection incinerator off-site. Washed soil can be backfilled onsite.

The LARC process can chemically dechlorinate many of the halogenated organic compounds found at the Booth Oil Site. The technology is, however, not effective for the nonhalogenated volatile and semivolatile organics at the site, nor is it effective for heavy metals.

Although dechlorination is a destruction process and would be ranked first among the five remedial action technology categories classified by the NYSDEC, this technology would not address heavy metals or be effective treating many of the volatile and semivolatile organic compounds found at the site. Based on these reasons, dechlorination will not be considered further.

2.4.1.6 Low-Temperature Oxidation: Wet Air Oxidation--

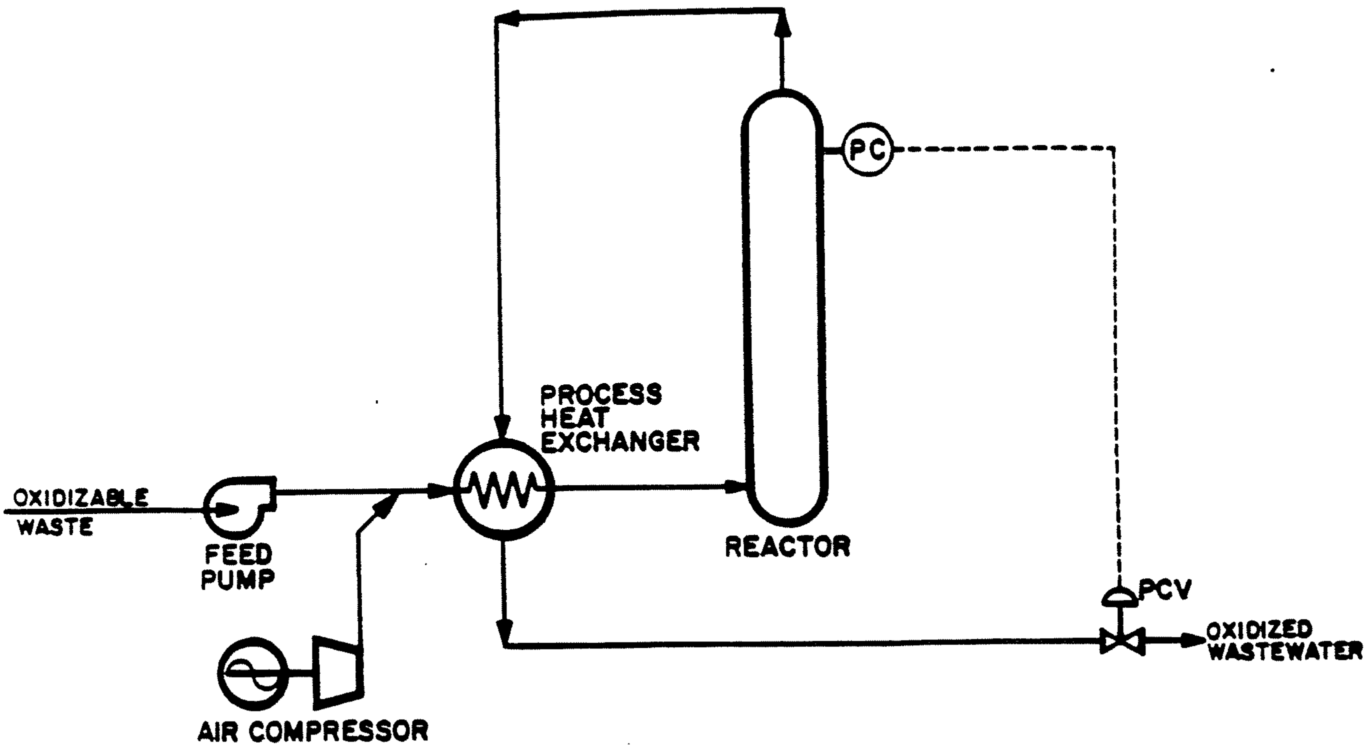
Wet Air Oxidation converts organic compounds in an aqueous solution to carbon dioxide and water. The reaction takes place at a temperatures between 350 and 620 °F and pressures of approximately 300 to 3,000 psig. The process is reportedly effective for volatiles, semivolatiles, and PCBs that are too dilute to incinerate and too concentrated to bioremediate (Dietrich, 1985). It does not treat heavy metals. The process is an on-site treatment process.

A diagram of a wet oxidation system is shown in Figure 2-10. For use on contaminated soils, the soil must first be slurried. The slurry is passed through a heat exchanger where it is heated to 370 °F and injected with compressed air. The slurry flows to a reactor where exothermic oxidation reactions raise the temperature to 430 °F. The oxidized slurry passes through a heat exchanger for cooling and to a dewatering unit. Dewatered solids, if they pass the Toxicity Characteristic Leaching Procedure (TCLP) and Toxic Substance Control Act (TSCA)-mandated cleanup level of less than 2 ppm PCBs, could be backfilled on-site.

Wet air oxidation is a destruction process and would be ranked first among the five remedial action technology categories classified by the NYSDEC. The process has been widely used to treat wastewater and municipal sludge. It has also been utilized to regenerate spent activated carbon.

FIGURE 2-10.

WET AIR OXIDATION GENERAL FLOW DIAGRAM



Bench-scale, pilot-scale, and full-scale tests of the process on contaminated wastewater have proven its effectiveness in destroying a variety of volatile and semivolatile compounds present at the Booth Oil Site. The system can achieve destruction efficiencies greater than 99 percent for many volatiles and semivolatiles. However, testing has determined that the system has difficulty destroying PCBs and other halogenated aromatic compounds that do not contain non-halogen functional groups, several of which are present at the Booth Oil Site. Destruction efficiencies for Aroclor 1254, 1,2- dichlorobenzene, and chlorobenzene in bench-scale tests were 63.0 percent, 69.1 percent, and 72.0 percent, respectively (Dietrich, 1985). Metals present in the aqueous phase are oxidized to their highest state by the system and remain in the aqueous phase.

An advantage of the wet air oxidation system is the lack of air pollution generated by the process. Oxidized organics are converted to carbon dioxide and water. Oxidized metals remain in the aqueous phase. The only gases that the system produces are carbon dioxide and unused air. No hazardous organics escape to the atmosphere.

Wet air oxidation is primarily a wastewater and sludge conditioning technology. Minimal research has been conducted on the use of the technology for treatment of contaminated soil. The technology has not been commercially proven in this application. For use in treating soil, the soil would need to be slurried with an appropriate solvent used to bring the organic contaminants into the aqueous phase.

Based on the forgoing discussion, Low-Temperature Wet Air Oxidation will not be considered further.

2.4.1.7 Thermal Separation Processes--

Thermal separation processes remove PCBs, volatiles, and semivolatiles from soil by volatilization. They do not treat heavy metals present in the soil. The organics are condensed and sent to a liquid injection incinerator off-site for destruction. Treated soil can be backfilled on-site.

Commercial thermal separation processes are available from several vendors for on-site treatment of contaminated soils. These processes, being separation and treatment, are ranked second among the five remedial technology categories classified by the NYSDEC. Three of several commercially available processes will be described below.

2.4.1.7.1 Closed-loop Thermal Separation--

One on-site thermal separation process tested in the USEPA SITE Program is a closed loop process. The process, diagrammed in Figure 2-11, involves feeding contaminated soil to a slowly rotating kiln (very similar to a rotary kiln incinerator) and heating it to a temperature between 500 ^{o}F and 800 ^{o}F with an external heat source (propane burners). Water, PCBs, and other organics are volatilized or steam stripped. The vapors are carried out of the dryer in a nitrogen gas stream. The exiting gas stream passes through a scrubber and two

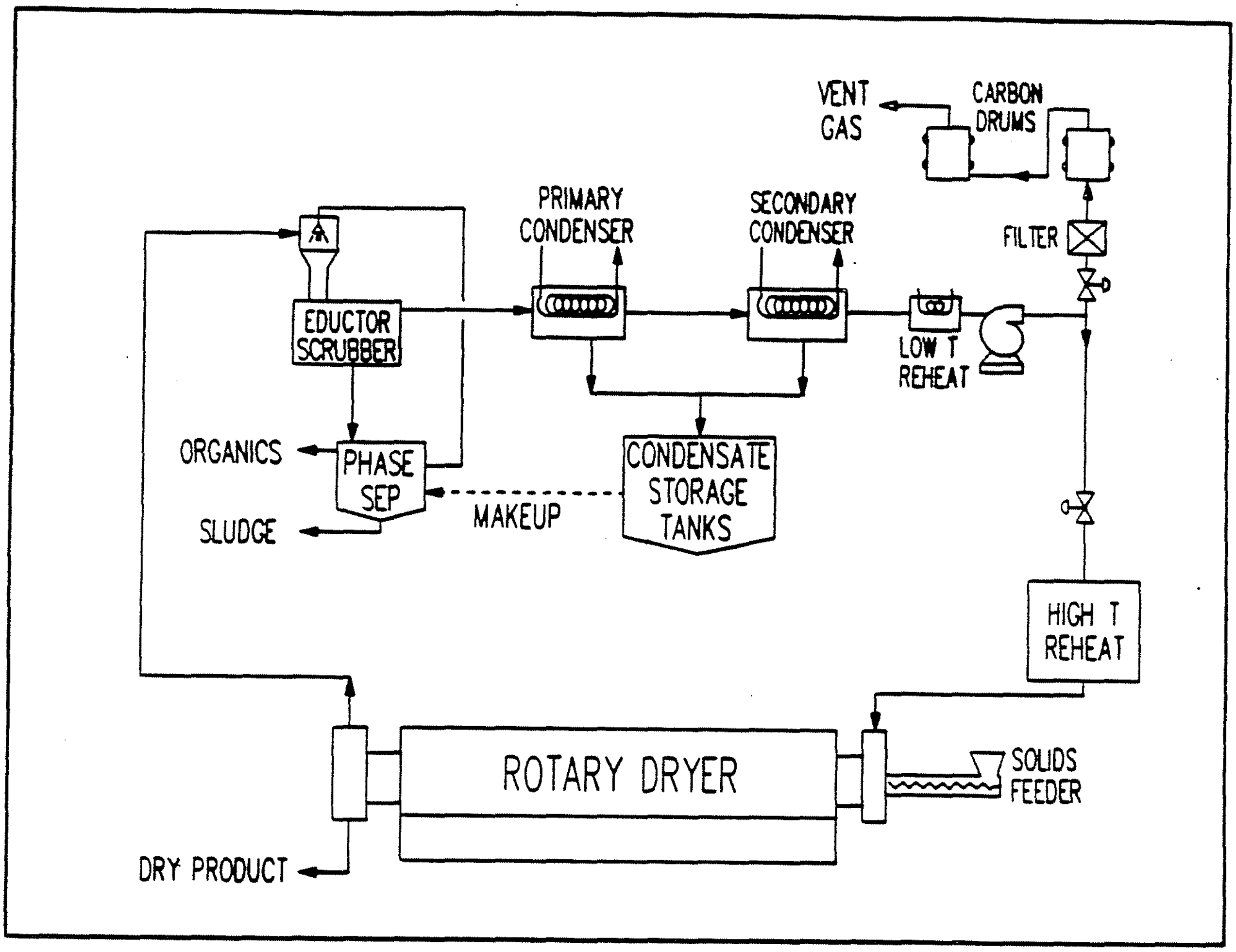


FIGURE 2-11. Closed-loop Therman Separation Process.
Source: Chemical Waste Management, 1989.

heat exchangers for particulate removal and condensation of the water and organics. Condensed organics and water enter a phase separator where the floating organics are removed. Water is recirculated to the scrubber. The nitrogen gas leaving the second heat exchanger is heated in an electric induction heater and passes through a blower. Five to ten per cent of the carrier nitrogen gas is passed through a particulate filter and carbon adsorption unit before being vented to the atmosphere. The remainder of the carrier gas is reheated to between 400 ^{o}F and 700 ^{o}F and recirculated to the dryer.

The SITE demonstration showed that the process can reduce PCB concentrations in sandy soils from 2000 ppm to less than 25 ppm. The 25 ppm level was the cleanup level promulgated in the Re-Solve Superfund Site Record of Decision (ROD). Test results indicated that reduction to 10 ppm or less could be achieved consistently (SCS - Bellevue, 1990).

The closed-loop separation process has been lab-scale and pilot-scale tested on soils containing PCBs, volatiles, and semivolatiles. Results of these tests indicate that the process can achieve a destruction and removal efficiency (DRE) of 99.99 % for hazardous organic constituents. In one lab-scale test, the system reduced the PCB concentration of a clay soil from 36,935 ppm to less than 2 ppm (CWM, 1989).

The closed-loop separation process is not designed to treat heavy metals present in soils. The heavy metals would either remain in the soil or be volatilized and collected in the gas treatment system.

2.4.1.7.2 Anaerobic Thermal Separation--

Another on-site thermal separation process operates under anaerobic conditions. In this process (Figure 2-12), contaminated soil charged to the processor passes through three zones. In the preheat zone, low-temperature hydrocarbons and water are volatilized at temperatures up to 500 °F. Oils and heavy hydrocarbons are volatilized in the reaction zone at temperatures between 700 °F and 1,150 °F under anaerobic conditions. The water and oil removed from the processor are condensed and collected in separate vapor train equipment.

Some thermal cracking usually occurs in the reaction zone, creating light hydrocarbons and coke (char). This cracking is a result of pyrolysis. The coke may be burned in the combustion zone between 1,100 °F and 1,500 °F to provide all or part of the heat requirements for the process. Hot sand from the combustion zone is recycled back to the reaction zone to provide the necessary heat for pyrolysis. Part of the sand is cooled for discharge, heating incoming solids in the preheat zone by thermal conduction through an annulus wall. Treated soil can be backfilled onsite or disposed of as a non-hazardous waste.

The anaerobic thermal separation process has been evaluated on petroleum refinery waste and PCB-contaminated soil. It exceeds the best demonstrated available technologies criteria defined in the ~~August 1988~~ Land Disposal

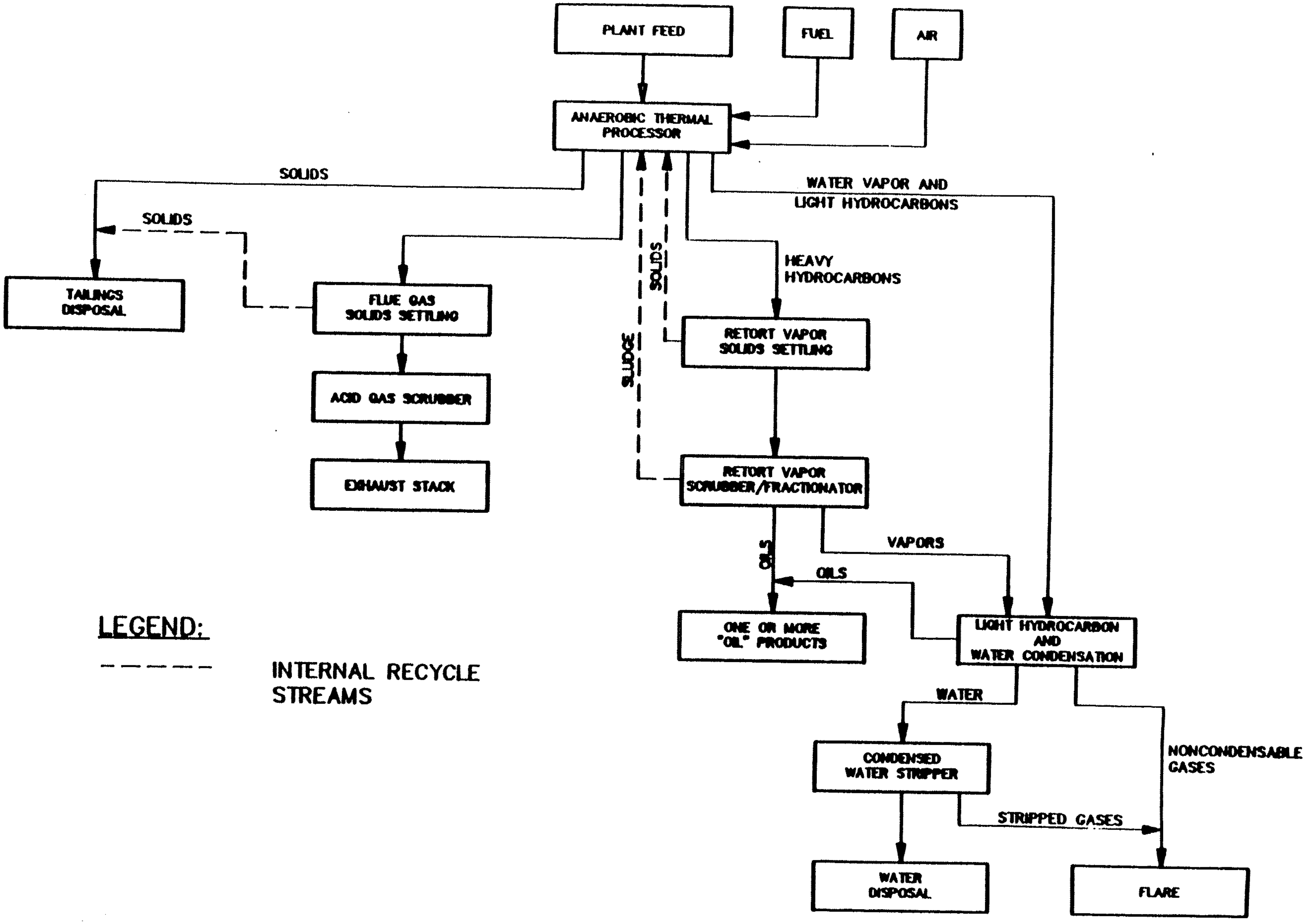


FIGURE 2-12. Anaerobic Thermal Separation Process Schematic.

Restrictions Rule ~~for First Third Scheduled Wastes (API, 1988).~~ The process has been selected for use to remediate 60,000 cubic yards of PCB-contaminated soil at the OMC Superfund Site in Waukegan, Illinois, beginning in early 1991 (SCS - Bellevue, 1990).

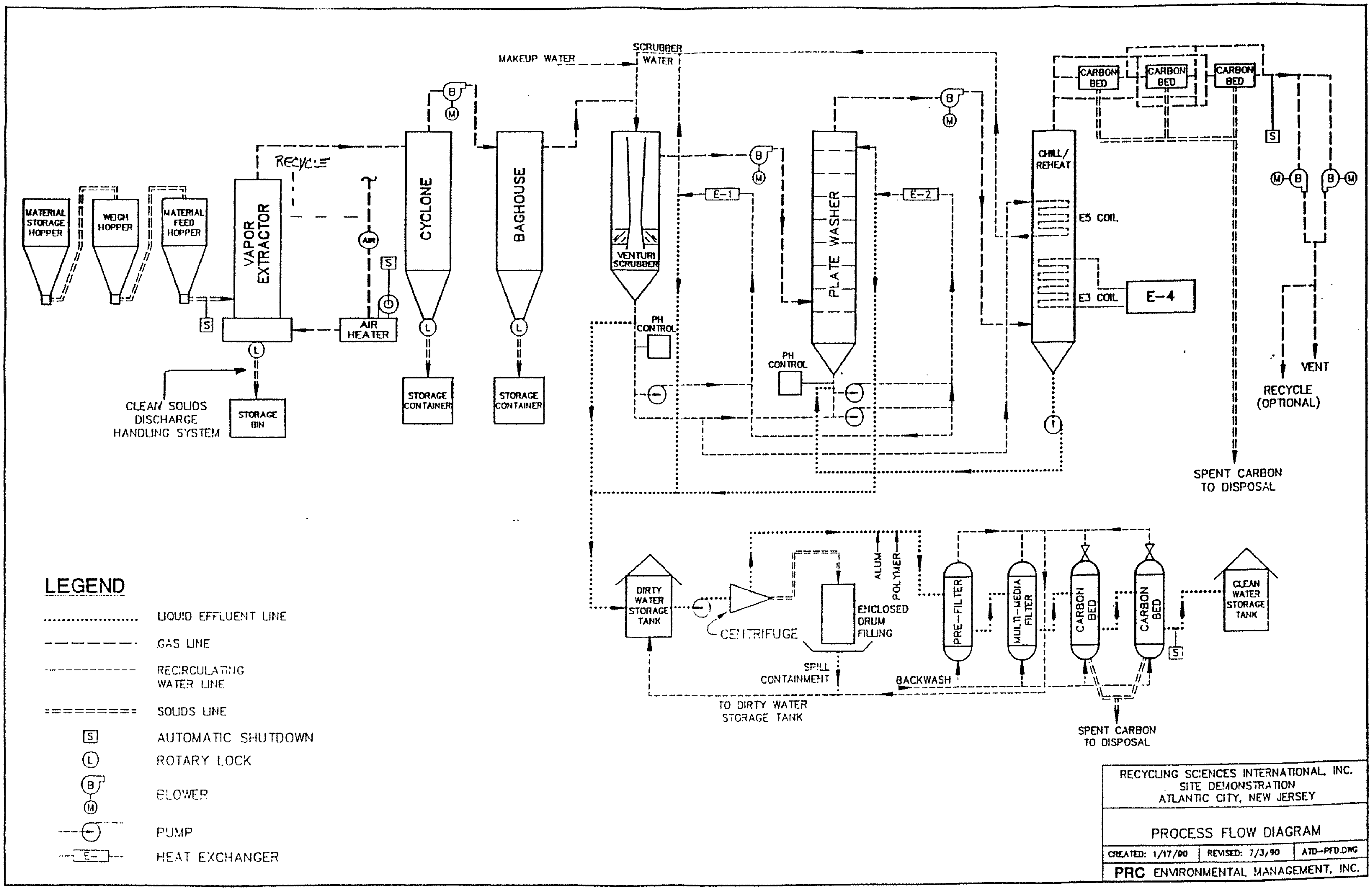
Hazardous volatiles, semivolatiles, and PCBs would be removed from the soil in the preheat or reaction stage. Air emissions from the process would be minimal. The process would not treat metals present in the soil.

2.4.1.7.3 Fluidized Bed Thermal Separation--

Another on-site thermal separation process volatilizes PCBs and other organics in co-current fluidized bed. This process is shown in Figure 2-13. In the bed, contaminated soil is contacted with heated air (320 °F to 400 °F), forcing the water, organics, and entrained solids into the air stream. Gas exits the fluidized bed and passes through a cyclone and baghouse for solids removal. From the baghouse, the gas enters a venturi scrubber and plate washer for cooling by a recirculated water stream. The gas then passes through finned coolers and a refrigerated chiller. The water vapor and organics condense in the water stream, coolers, and chiller. Contaminated water is pumped to a contaminated water storage tank.

Cooled gases pass through two carbon filters for removal of residual organic contaminants. As the beds become exhausted, the system is shut down and the

FIGURE 2-13. FLUIDIZED BED THERMAL SEPARATION



beds replaced. Carbon filters in parallel could be used to avoid the need for a shutdown.

The contaminated water is pumped to a centrifuge, where the organic compounds are spun out into a sludge ready for disposal. Liquid from the centrifuge enters a water filtration system that includes a sand filter, a clarifier, and two activated carbon beds. Clean water is pumped to a clean water storage tank for testing prior to discharge in an approved manner.

Thermal separation processes could effectively treat the PCBs and other organics in the contaminated soil at the Booth Oil Site. Thermal separation will be considered further in the remedial alternatives of Section 3.

2.4.1.8 Incineration Technologies--

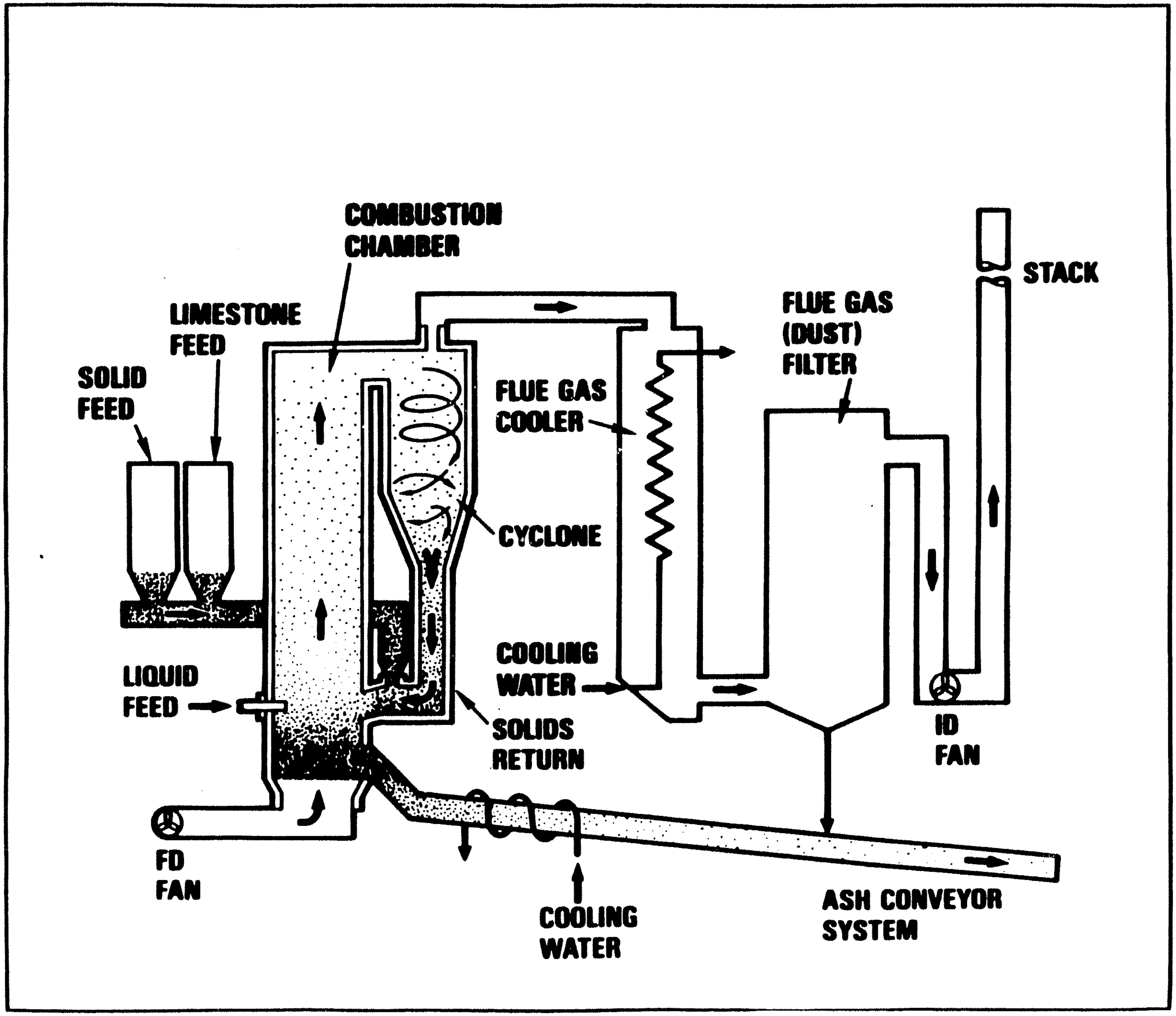
With these technologies, the contaminated soil would be excavated and burned for destruction of the PCBs, volatiles, and semivolatiles found at the Booth Oil Site. A few vendors, including Ogden Environmental Services (OES), O.H. Materials Corporation, ECOVA Corporation, and Weston Services, have transportable incineration systems that have obtained the required TSCA permits for PCB incineration. The Ogden Environmental Services system is a circulating bed combustor. The O.H. Materials Corporation and ECOVA Corporation units are infrared incineration systems. Weston Services operates a portable rotary kiln incinerator.

Incineration systems are classified as destruction processes. As such, they are ranked first among the five remedial technology categories classified by the NYSDEC. All of the systems mentioned above provide on-site treatment of the waste. Each has a TSCA permit for PCB destruction. Other vendors, including Rollins Environmental Services and General Electric, have permitted off-site rotary kiln incinerators. Contaminated soil could be transported to these facilities for incineration.

The circulating bed combustor of OES (Figure 2-14) consists of a combustion chamber, cyclone, fluegas cooler, baghouse, scrubber (if necessary), and ash conveyor system. Contaminated soil is fed into the solids return leg and combines with return solids from the cyclone to enter the combustion chamber. A fan fluidizes the soil particles. The high velocity of the air maintains a uniform temperature of 1600 ^{o}F around the combustion loop formed by the combustion chamber and the cyclone. Limestone added with the contaminated soil effectively neutralizes acid gases generated by the combustion process and controls sulfur dioxide emissions. Fluegas exits the loop above the cyclone while the cyclone returns solid particles to the combustion chamber. Fluegas enters a cooling chamber and then passes through a baghouse for particulate removal before leaving through the exhaust stack. If acid gases would pose a problem, a scrubber system could be placed in front of the baghouse. Ash is drawn from the bottom of the combustion chamber for disposal or treatment and disposal. The circulating bed combustor can process 4 tons/hour of contaminated soil.

FIGURE 2-14.

CIRCULATING BED COMBUSTOR PROCESS FLOW SCHEMATIC



The OES circulating bed combustor was tested successfully on waste from the McColl Superfund Site in California and PCB-laden soil at Alaska's Swanson River Oil Field. The system achieved a DRE exceeding 99.99% on such contaminants as benzene, toluene, xylene, ethylbenzene, naphthalene, 2-methylnaphthalene, and 1,1,1-trichloroethane at the McColl Site (EPA, 1989). The DRE for the system burning the PCB-contaminated soil at Swanson River exceeded 99.9999% (Warner, 1989). The Swanson River data was submitted to EPA as part of OES' application for a TSCA permit to burn PCBs. Subsequently, the EPA issued a TSCA permit to OES for the burning of PCBs in the circulating bed combustor. The permit is applicable in all 10 EPA regions. Currently, OES has four operable circulating bed combustors.

The O.H. Materials Corporation and ECOVA Corporation infrared incineration systems use infrared heating elements in the primary combustion chamber to provide the heat necessary for the combustion and desorption of organics in the contaminated soil. The systems have a primary combustion chamber (PCC) and secondary combustion chamber (SCC). In the PCC, infrared heating elements at 1600 ^{0}F desorb the organics from the soil. Some organics are combusted in the presence of combustion air. The gas stream enters the SCC where it is exposed to a temperature of 2200 ^{0}F and combustion air for the complete destruction of the organic compounds. Exhaust from the SCC passes through a Calvert scrubber for emissions control. The system can process five tons per hour of contaminated soil.

The ECOVA Corporation infrared incineration system (Figure 2-15) was tested under the Superfund Innovative Technology Evaluation (SITE) Program at the Peak Oil Site in Florida and the Rose Township Demode Road Site in Michigan. It also was tested at the Florida Steel Corporation mill site and the Twin Cities Army Ammunition Plant in Minnesota. All of these tests were performed on soils containing PCBs and other organic compounds. The system was capable of achieving RCRA-mandated DREs of 99.99% for hazardous organics and the TSCA-mandated DRE of 99.9999% for PCBs (EPA, 1989). TSCA trial burns at the Florida Steel Corporation mill site achieved the necessary DRE for PCBs (99.9999%), resulting in a TSCA permit for the ECOVA infrared incineration system, applicable in all 10 EPA regions.

The transportable rotary kiln incinerator of Weston Services (Figure 2-16) also has a TSCA permit applicable in all 10 EPA regions. The system consists of a primary combustion chamber operating between temperatures of 1200 ^{o}F and 2200 ^{o}F. The afterburner is designed for a gas residence time of two seconds at greater than 2200 ^{o}F. A fabric filter baghouse controls particulate emissions and a packed tower scrubber treats acid gas emissions. The system can process approximately six tons per hour of contaminated soil.

Incineration technologies could effectively destroy the organic compounds in the soil at the Booth Oil Site. They would not destroy the heavy metals in the soil. Because of the high temperatures of the incineration process, some metals would be volatilized. Volatilized metals would be condensed and collected in the off-gas treatment system. Non-volatile metals would

FIGURE 2-15. ECOVA INFRARED INCINERATION SYSTEM

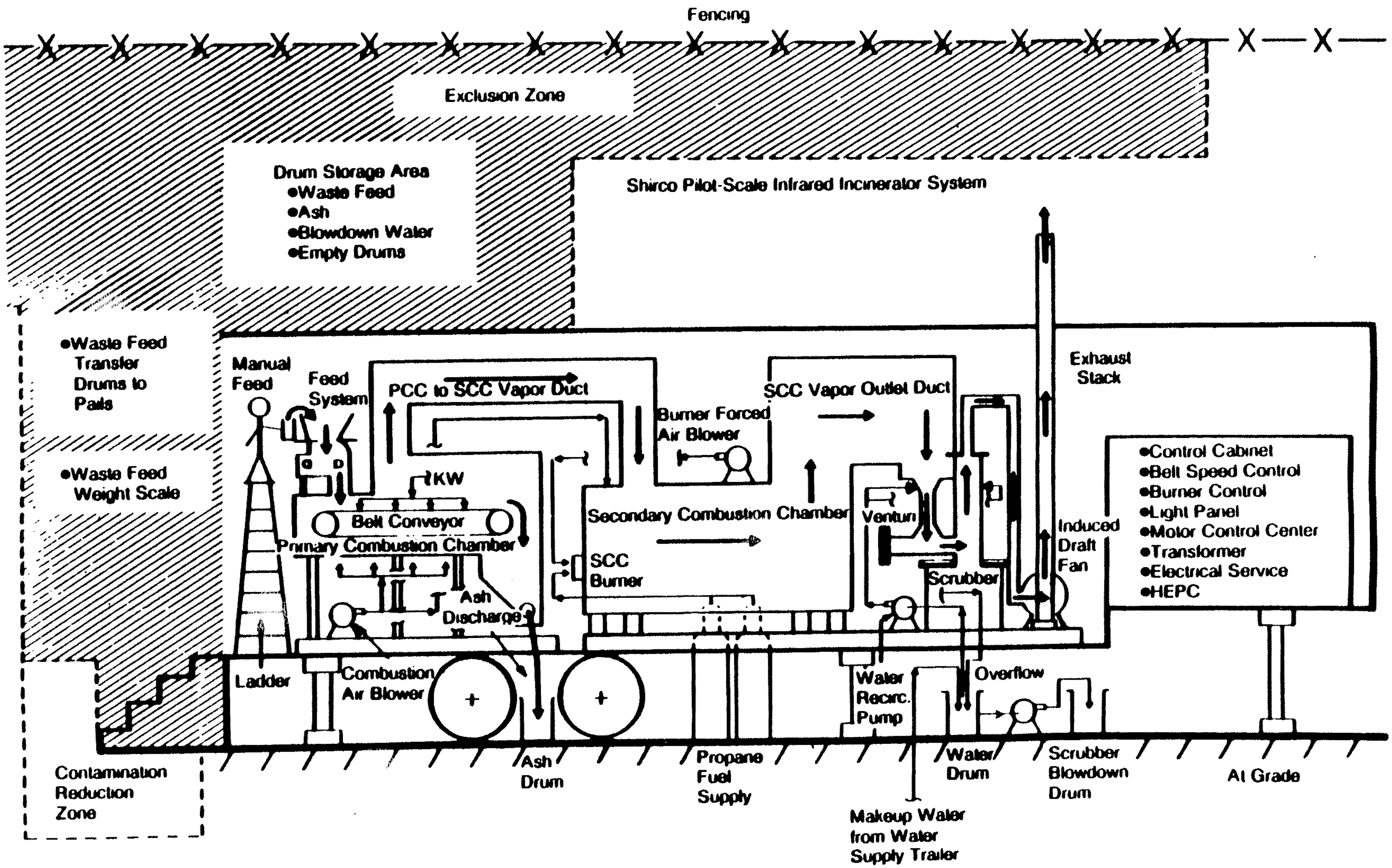
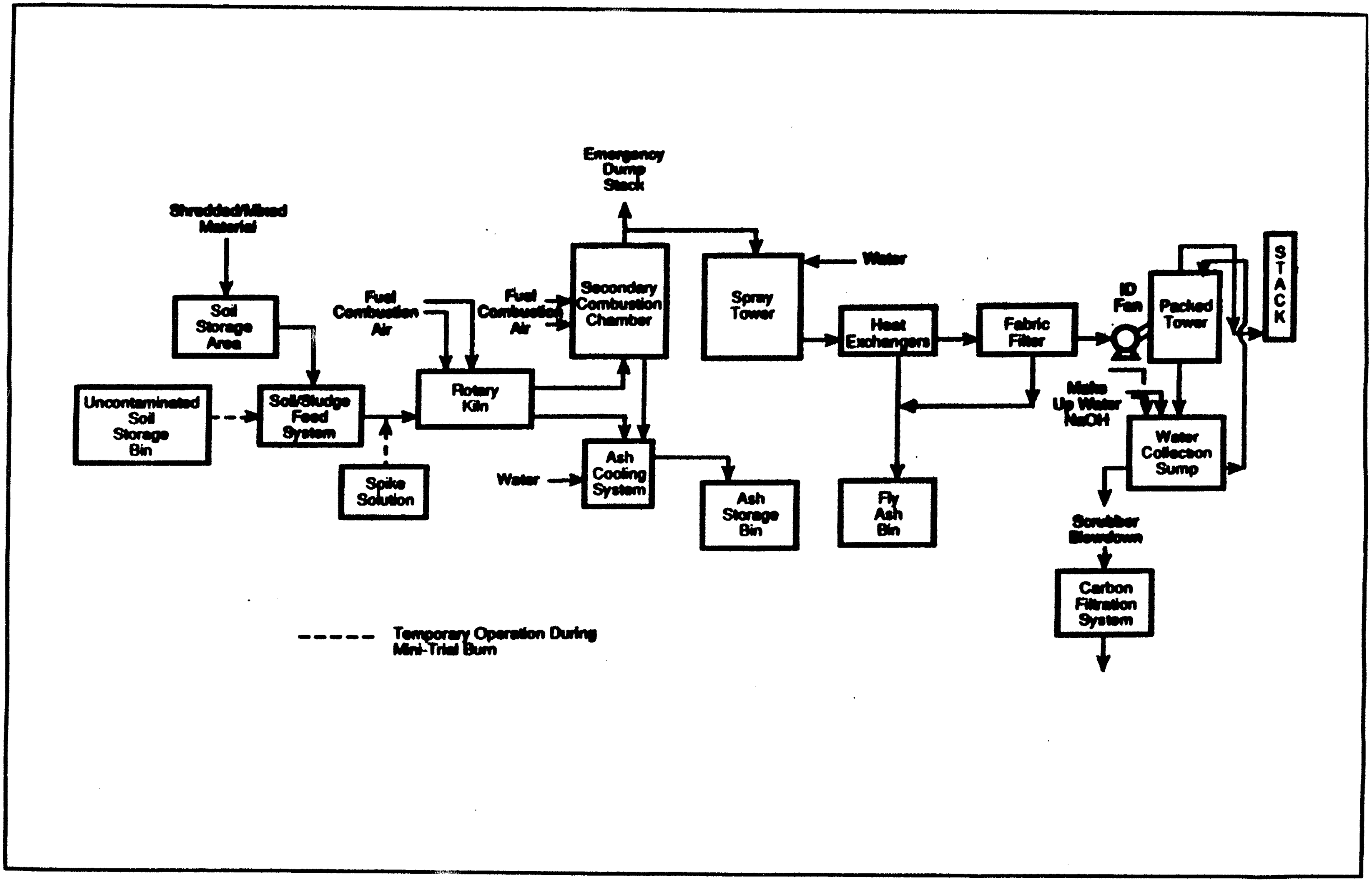


FIGURE 2.16

TIS PROCESS FLOW SCHEMATIC



remain in the soil. The technologies will be considered further as part of the potential remedial alternatives for the site.

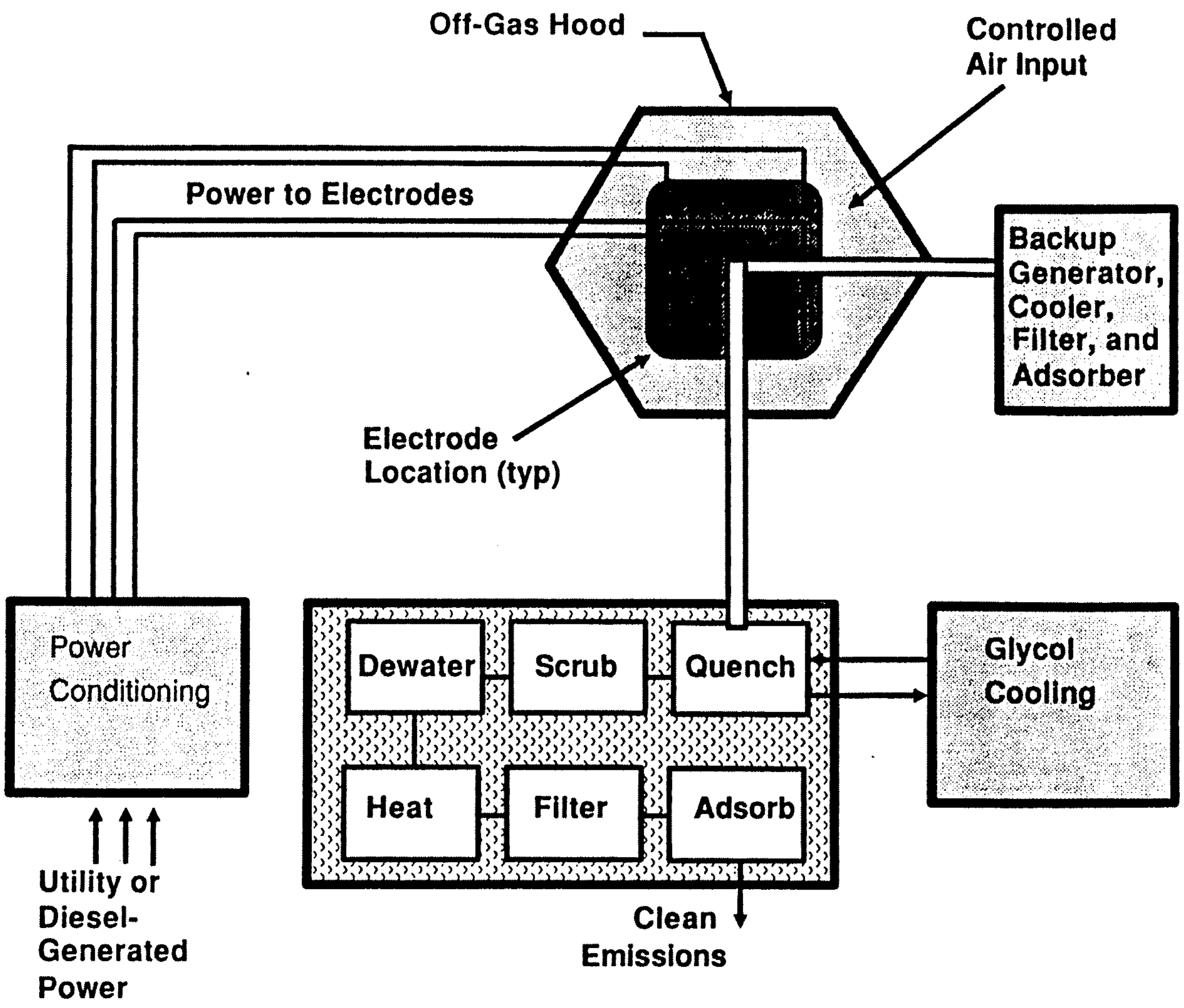
2.4.1.9 In Situ Vitrification--

With the in situ vitrification process, the contaminated soil at the Booth Oil Site would be melted into a nonleachable, glass-like solid. The technology utilizes four molybdenum electrodes, inserted into the ground spaced in a square configuration with 18-foot sides. Since soil does not usually have the electrical conductivity necessary to start the process, a graphite or glass frit is placed on the ground surface between the electrodes to start the melt. After power is turned on, the electricity heats the volume to between 1600 ^{O}F and 2000 ^{O}F and pyrolyzes the organics present in the soil. The heat melts the soil, incorporating any inorganics (i.e., heavy metals) into the structure of the melt. Off-gases are collected in a fume hood, and quenched and scrubbed before discharge to the atmosphere. Filters and activated carbon used to treat the scrubber water from the off-gas treatment system are placed on the soil for vitrification in a future vitrification setting. A schematic of the vitrification equipment is provided in Figure 2-17.

Vitrification is typically performed on a 30-foot by 30-foot area to a depth of 30 feet or a total soil mass of 800 to 1000 tons. Usually, it is not possible to attain both the areal dimensions and the depth with a single setting. If a soil mass of 800 to 1000 tons is contained in a 30-foot by

FIGURE 2-17.

GEOSAFE VITRIFICATION EQUIPMENT SYSTEM



30-foot by 15-foot cube, a single setting would not effectively vitrify material to a depth of 30 feet.

There are a couple of site-specific disadvantages in utilizing in-situ vitrification at the Booth Oil Site. The soil volume loss upon vitrification may affect the stability of the railroad tracks, garage, as well as privately owned structures in the immediate vicinity of the site. Also, soil moisture could pose an operational problem. Vitrification cannot proceed until all moisture in the soil is vaporized. The amount of electricity required to melt one pound of soil is the same as that required to vaporize one pound of water. The soil at the site may contain considerable moisture since the water table comes to within three to five feet of the ground surface. Thus, vitrification may require considerably more energy than at other sites where the water table and soil moisture content are lower.

Another operational disadvantage of the vitrification system is the off-gas treatment hood. The octagonal off-gas treatment system hood has a maximum dimension across the flats of 55 feet. In vitrifying areas at the perimeter of the Booth Oil Site, the hood would extend onto private property, roads, and the railroad tracks. This would not be acceptable.

Over 90 full-scale, pilot-scale, and bench-scale tests have been conducted with the in situ vitrification system. It has been shown capable of meeting the destruction and removal efficiency of 99.99% for hazardous organics and 99.9999% for PCBs (Chemical Engineering, October 1990). However, the system has not been used to remediate any Superfund sites yet, and as such, is an unproven technology. Many of its tests have been with radioactive and metallic materials. In situ vitrification has not been proven effective on many of the volatiles and semivolatiles detected at the Booth Oil Site.

A treatability study on sediments from the New Bedford Harbor Superfund Site using vitrification showed a destruction and removal efficiency of greater than 99.9999 percent for the PCBs at the site. Test results indicate that there was minimal migration of PCBs from the vitrified sediment to the surrounding soil. The study concluded that vitrification could effectively treat the New Bedford Harbor PCB-contaminated sediment (Battelle, 1988).

Because of the operational disadvantages cited above (particularly the high water table) and the lack of proven experience remediating Superfund sites, in situ vitrification will not be considered further.

2.4.1.10 Bioremediation--

Bioremediation options for contaminated soil generally include on-site landfarming systems or bioreactors. In either case, microbes would be mixed with the organics-contaminated soil and given time to metabolize the organics. For efficient performance, the process would require temperatures greater than 60 ^{o}F. Bioremediation of PCBs proceeds more slowly as the number of chlorines in the PCB molecule increases (EPA, 1990). According to the USEPA, only one vendor has a commercially permitted bioremediation process for treatment of PCB-contaminated waste.

Bioremediation systems require the development of a culture of bacteria capable of metabolizing all of the organic contaminants present at a site. The Booth Oil Site contains a large number of volatile, semivolatile, and PCB compounds. Some of these compounds may be degraded by a specific bacteria, while others may be biologically refractory in the presence of the same culture. It may be difficult to develop a culture that can metabolize all of the compounds.

A treability study with bioremediation on the PCB-contaminated sediment from New Bedford Harbor. The study concluded that a culture could be developed to degrade the PCBs in the sediment. However, only the di- and tri-chlorinated biphenyls experienced a significant degradation under the conditions that would be used to treat large quantities of sediment. Dechlorination of the less-degraded PCB isomers would be required to enhance the degradation rate (Radian, 1988).

Although bioremediation may be able to treat many of the volatiles and semivolatiles at the Booth Oil Site, the treatment would progress slowly. Additionally, many of the volatiles and semivolatiles at the site are not readily degradable. A bioremediation system would not treat the metals in the soil.

Treatment of the soil with microbes would require more time than other alternatives. Biodegradation of liquid phase contamination requires less time than solid phase treatment. A possibility for the Booth Oil Site may be to biotreat the concentrated liquid material generated by another technology (such as solvent extraction or thermal separation), rather than incinerating this material.

Because of the difficulties in developing an effective bacteria for the remediation, bioremediation will not be considered further as a primary treatment technology. The technology may be considered as a secondary technology for treatment of the liquid organics produced by another process.

2.4.1.11 Soil Vapor Extraction--

Soil vapor extraction is a process used for the removal of volatiles and some semivolatiles from the unsaturated zone of soils. Volatiles and semivolatiles can be present in the unsaturated zone as dissolved components of the aqueous phase, constituents adsorbed to the soil materials, or components in the aqueous or gas phases of the void space of the soil. Soil vapor extraction can be used effectively if the organic compounds have dimensionless Henry's Law Constants greater than 0.001. Also, the void space of the soil must have sufficient air-filled porosity for vapor transport. The system does not remove the less volatile organic compounds such as PCBs, nor does it remove metals from the soil.

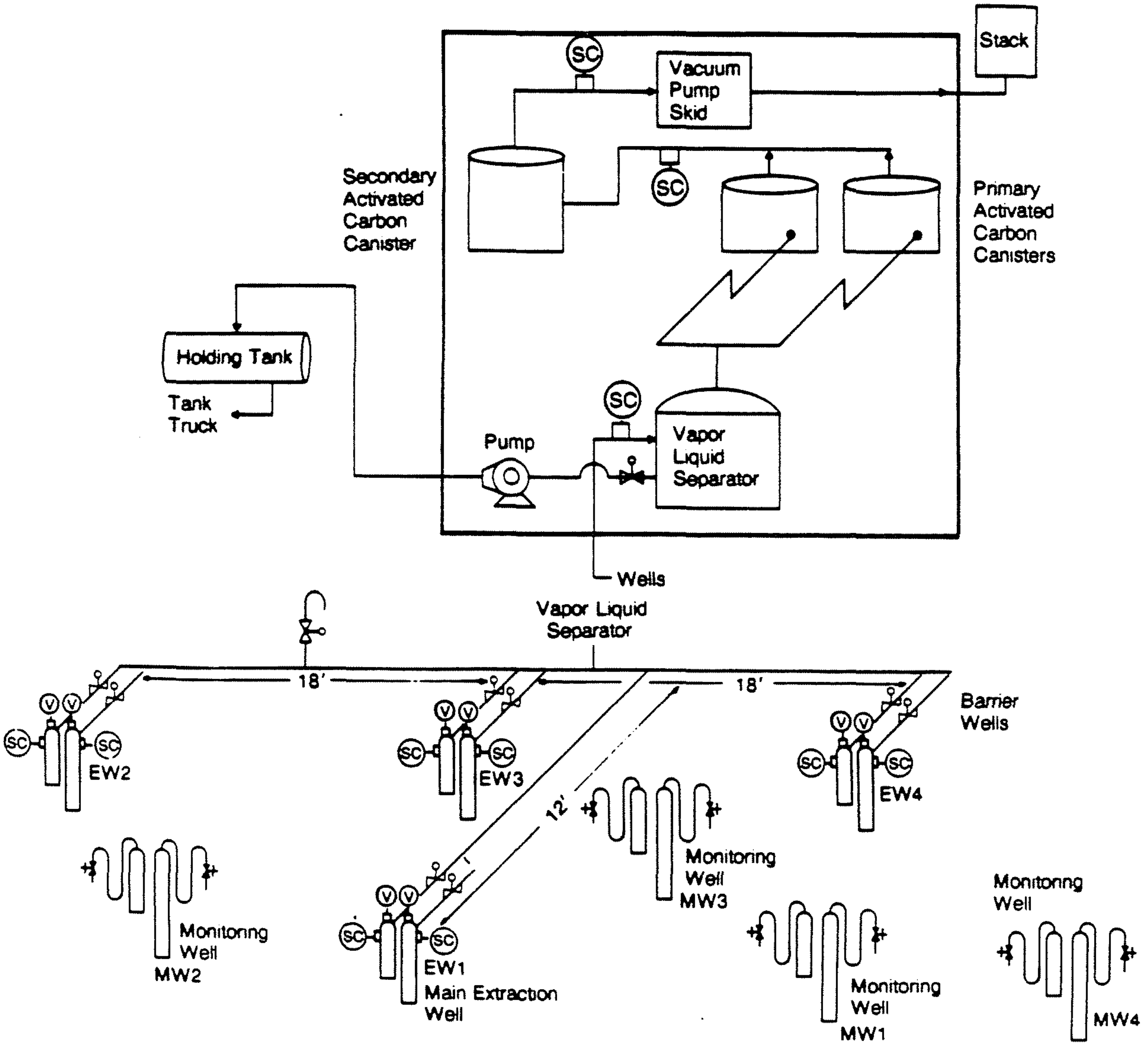
A typical soil vapor extraction system (Figure 2-18) consists of vacuum extraction wells that are screened in the unsaturated zone of subsurface soil contamination. Wells are placed throughout the contaminated area and connected to a common blower via a manifold system. The blower induces air flow in the soil, stripping and volatilizing the organic compounds in the air stream. Stripped contaminants from the blower are either discharged directly to the atmosphere or passed through a treatment system, based on applicable air pollution control regulations. Treatment options include carbon adsorption, catalytic incineration, and conventional vapor incineration.

A soil vapor extraction system could effectively remove the volatiles and a fraction of the semivolatiles at the Booth Oil Site. It would not, however, remove the PCBs or the heavy metals. It is not known if the system would strip the unknown semivolatiles from the soil. For these reasons, a soil vapor extraction system will not be considered further as a possible remedial technology for the site.

2.4.2 Groundwater

The Phase I RI detected three classes of chemical contamination in the Booth Oil groundwater. These include a floating, non-aqueous phase liquid (NAPL), soluble organics (volatiles, semivolatiles, and PCBs), and heavy metals. Table 2-2 summarizes the levels of contaminants found. Extraction, treatment, and disposal technologies are discussed below. Specific treatment processes

FIGURE 2-18. VAPOR EXTRACTION SYSTEM LAYOUT



SOURCE: EPA/540/A5-89/003, JULY 1989

are presented for each of the three classes of contaminants present at the site.

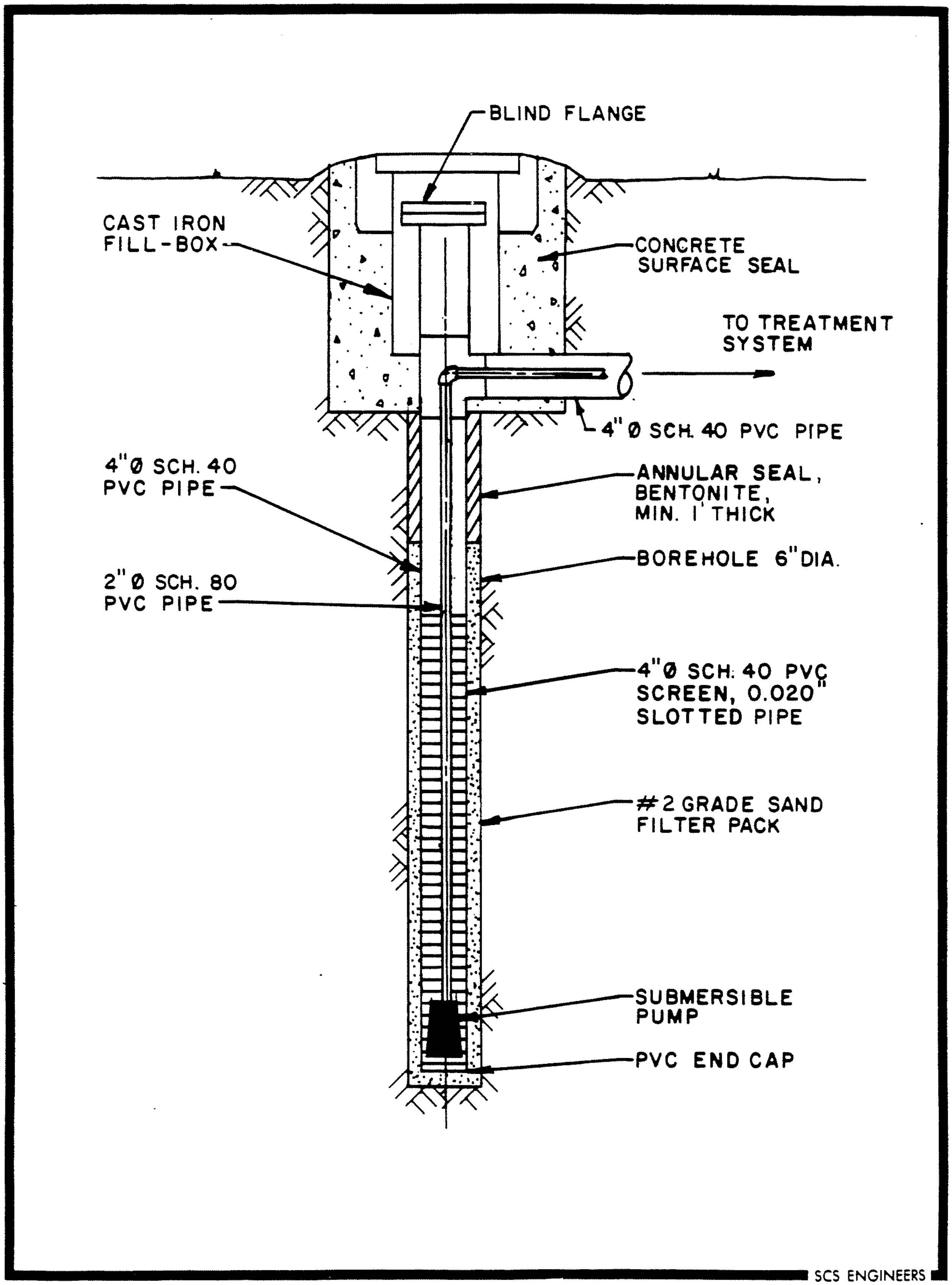
2.4.2.1 Groundwater Extraction Technologies--

Technologies for groundwater extraction remove the groundwater for further treatment. Potentially applicable extraction technologies for the Booth Oil Site include extraction wells and trench drains. Each of these technologies is discussed below.

2.4.2.1.1 Groundwater Extraction Wells--

Groundwater extraction involves the removal of contaminated groundwater and NAPL using subsurface pumps installed in groundwater extraction wells. A pumping system consisting of separate pumps for the NAPL and aqueous phases is commonly used when both dissolved contaminants and a floating NAPL phase are present. Contaminated groundwater containing dissolved contaminants are typically removed using a conventional extraction well and pump design, such as that shown in Figure 2-19. The extraction wells would be located downgradient of the shallow groundwater area. The groundwater would be pumped with submersible pumps at a rate determined by slug tests and/or pump tests. Based on the desired flow rate, the required number of extraction wells can be determined. A field study would be needed prior to design and implementation of an extraction well system.

FIGURE 2-19.
TYPICAL GROUNDWATER EXTRACTION WELL



Removal of the floating NAPL phase will require the use of scavenger pumps set within the NAPL zone in the extraction wells. Oil/water interface probes will also be installed. The probes will be used as controllers to prevent the scavenger pumps from removing groundwater. NAPL removed by the scavenger pumps will be piped to a holding tank on the surface. The presence of PCBs in the NAPL will require that it be sent off-site to a TSCA permitted incinerator.

2.4.2.1.2 Trench Drain System--

In a trench drain system, trenches are installed downgradient of the groundwater area. The trenches lead to sumps. Groundwater is pumped from the sumps to a treatment system. Because the system is a passive withdrawal system, it would likely require more time to remove a given volume of groundwater than an active system such as extraction wells. Trench drains do not draw the groundwater into the trenches as do extraction wells. A second disadvantage of a trench drain system for the Booth Oil Site is the presence of the NAPL phase. Removal of the NAPL phase could be accomplished in extraction wells easier than attempting to remove the floating phase from sumps.

Trench drains may be applicable in shallow zones where contaminated groundwater exists. A disadvantage to this use would be the large quantity of suspended solids that would runoff into the trenches. The suspended solids may interfere with the oil/water separation process. A large amount of solids would settle to the bottom of the separator. Any solids carryover to the organics removal process may inhibit effective operation of the process.

2.4.2.2 Technologies For the Removal of Non-floating Petroleum Products (oil/water separation)--

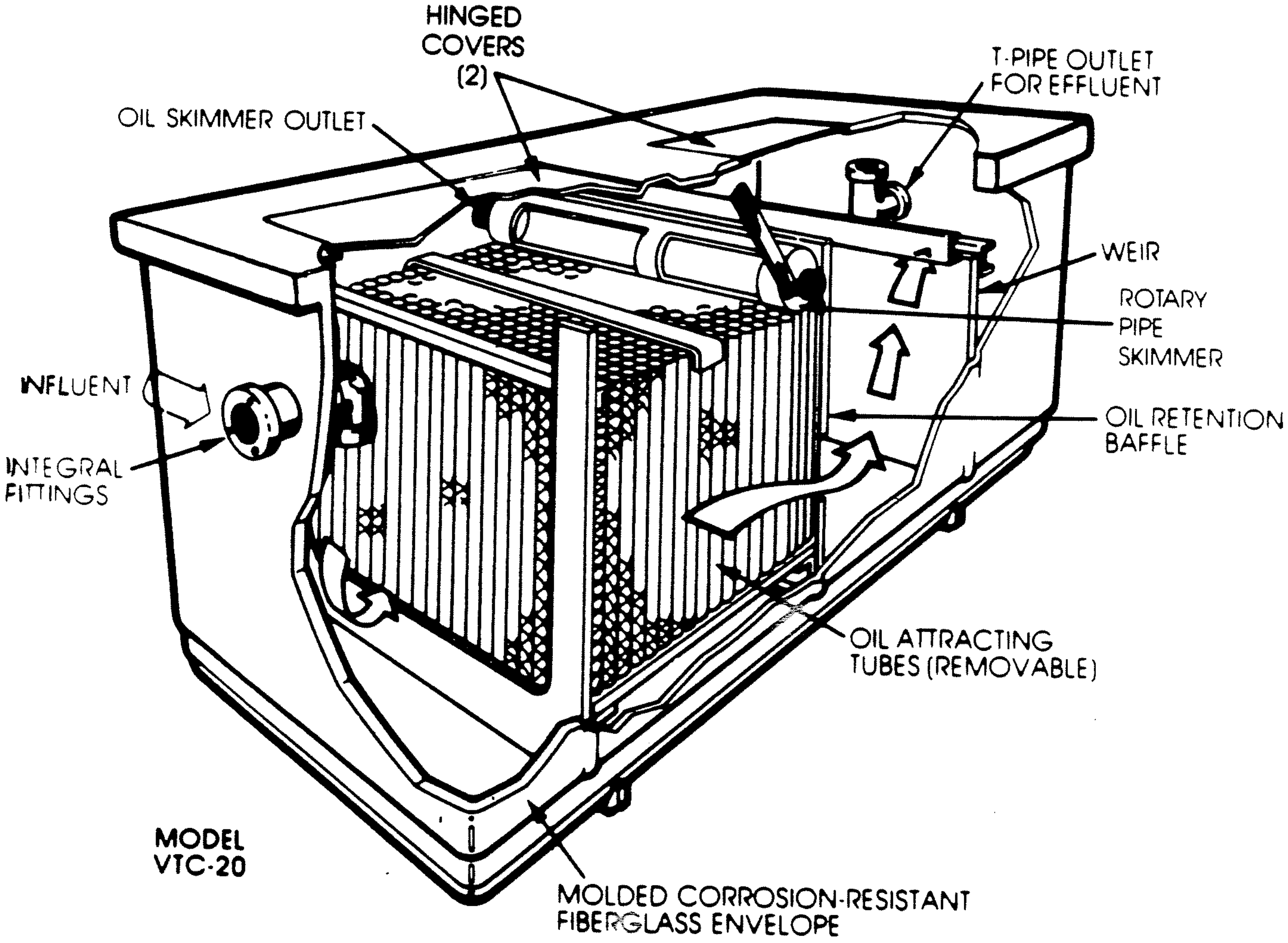
Oil/water separators (Figure 2-20) will be used to remove petroleum products (e.g., suspended oil droplets) that are not removed by the oil scavenger pump system. Such treatment will be performed prior to further treatment for heavy metals removal and organics removal. The water/oil mixture flows into the separator and through oleophilic (oil-attracting) and hydrophobic tubes or ribs. Upon contact with the tubes, oil particles greater than approximately 20 microns in diameter coalesce to form larger particles. As the particles increase in size, buoyancy forces increase and the particles rise to the surface. Oil at the surface is skimmed and stored in an internal storage container or external tank. Typically, an oil/water separator will remove sufficient petroleum hdyrocarbons such that the remaining concentration in the aqueous phase is less than 10 ppm.

2.4.2.3 Organics Treatment--

2.4.2.3.1 <u>Air stripping</u>--

Air stripping is used for removal of volatile and some semivolatile organic compounds from groundwater. A diagram of a typical air stripping system is

FIGURE 2-20.
Typical Oil/Water Separator



presented in Figure 2-21. The groundwater is pumped to the top of a tower containing a packed bed or trays. As the water flows downward through the tower, air from a blower enters the bottom of the tower and moves countercurrently upward. As the water contacts the air, volatile and semivolatile compounds with dimensionless Henry's Law Constants greater than appproximately 0.001 transfer from the liquid phase to the vapor phase and are carried in the air stream out of the top of the tower. The air leaving the tower may be discharged directly to the atmosphere, or may pass through a carbon adsorption system or catalytic incineration system for removal and/or destruction of the organic compounds. The need for treatment is dictated by applicable air pollution control regulations.

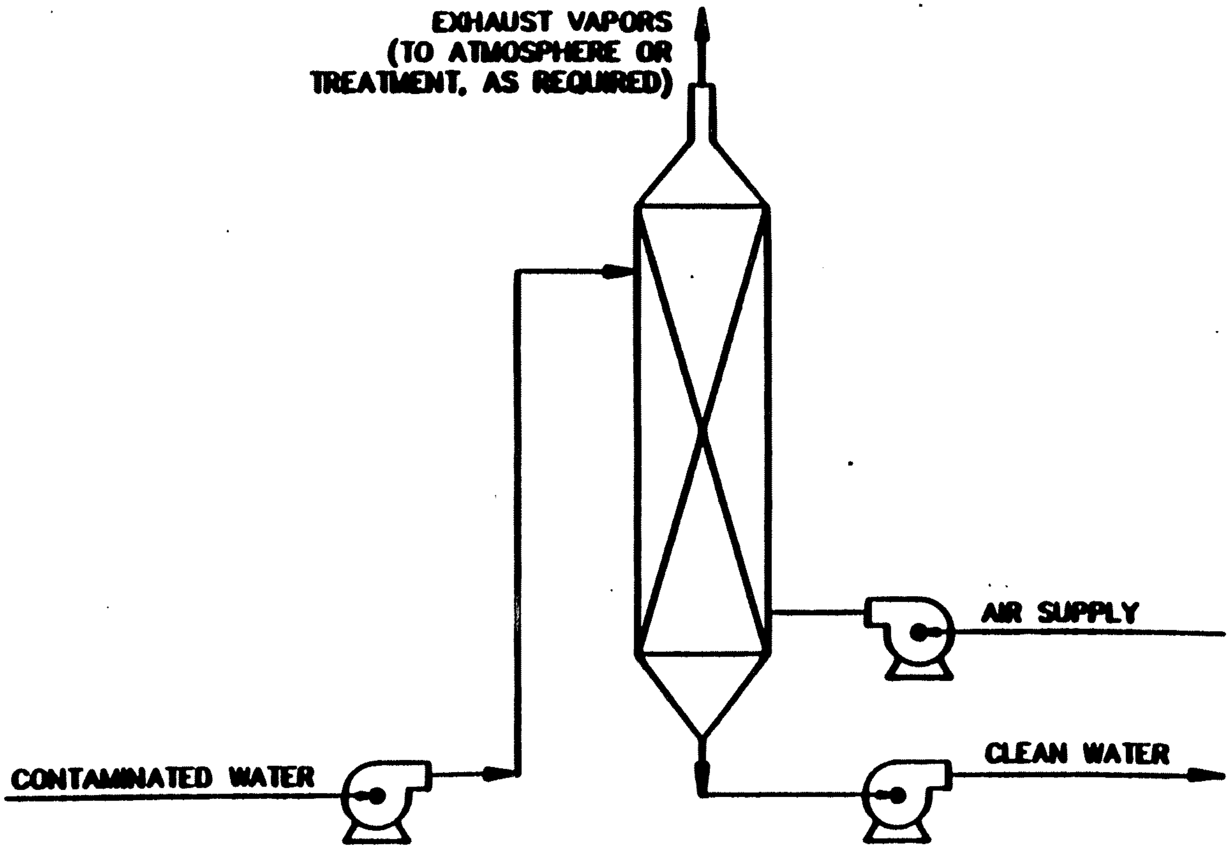
An air stripping system could remove many of the known volatiles and a fraction of the semivolatiles from the groundwater at the Booth Oil Site. It is doubtful that it could remove the unknown semivolatiles at the site. An air stripper would not be capable of removing the PCBs from the groundwater. Since air stripping could treat many of the contaminants present in the groundwater, it will be considered in the Phase III FS as a primary treatment technology with carbon adsorption as the secondary, polishing technology. The carbon would remove the organics the stripping tower fails to remove.

2.4.2.3.2 <u>Carbon adsorption</u>--

Carbon adsorption is a proven technology used at numerous hazardous waste sites for groundwater cleanup involving organic compounds. Figure 2-22

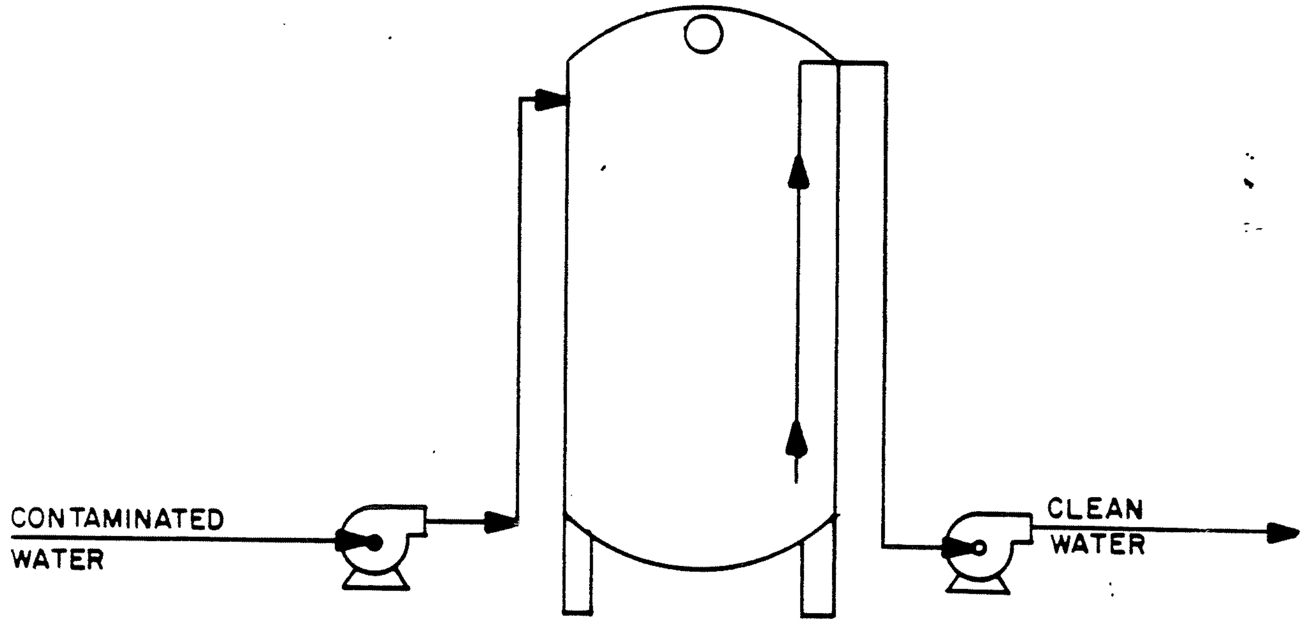
FIGURE 2-21.

AIR STRIPPER



SCS ENGINEERS

FIGURE 2-22.



CARBON ADSORPTION

presents a diagram of a typical carbon adsorption system. Water is pumped through a drum or canister containing a bed of activated carbon. The drum or canister is sized to provide sufficient retention time for adsorption of organics from the water. Depending on the cleanup levels, the effluent from the canister may pass through another canister prior to discharge. When the carbon bed becomes exhausted, it is regenerated or disposed in a RCRA landfill. Systems which utilize large quantities of carbon, as would be expected for the Booth Oil Site, generally either set up a carbon regeneration system onsite, or make arrangements for offsite regeneration. Such an arrangement is usually more economical than landfill disposal.

Isotherms are used to predict the carbon usage rate in terms of adsorptive capacity for specific compounds. Compounds most easily adsorbed by carbon are those with a molecular weight above 50 and a boiling point above 20 degrees centigrade. Ideally, the higher the concentration of the compound to be adsorbed, the greater the capacity of the carbon to remove it. Carbon adsorption capacities for organics can vary by several orders of magnitude, depending on the specific compound.

Practically all organics (volatiles, semivolatiles, and PCBs) can be removed from the groundwater by adsorption on carbon. Isotherms can be used to predict the carbon usage rates for individual known compounds, but would not give an accurate determination of the carbon usage rate for the mixture of compounds detected at the site. Also, carbon usage rates cannot be predicted for the unknown compounds at the Booth Oil Site since these compounds do not have established isotherms. Carbon adsorption will be considered for use as a secondary technology for use after an air stripper in the remedial alternatives of Section 3.

2.4.2.3.3 UV/oxidation--

UV/oxidation is a proven technology for the treatment of certain hazardous waste. Ultraviolet light, ozone, and/or hydrogen peroxide combine to oxidize a wide variety of organic compounds present in contaminated water. The UV light catalyzes the formation of hydroxyl radicals from the hydrogen peroxide and ozone. The organics are oxidized by the hydroxyl radicals. An advantage of the system is that there are no hazardous emissions or residuals that would require further treatment or disposal.

Commercially available systems (Figure 2-23) utilize either a baffle wall structure or a multi-stage reactor. In the baffle wall structure, a series of baffle walls is constructed to increase the contact time between the UV light/ozone/hydrogen peroxide and contaminants, and UV lights are placed vertically along the path of flow. In a multi-stage reactor, several small reactors are used in series to achieve the high destruction efficiency.

Phenols, chlorophenols, trihalomethanes, methylene chloride, perchloroethylene (PCE), trichloroethylene (TCE), and PCBs are some of the compounds that can be destroyed by the UV/oxidation process (Fletcher, 1987). The process would

FIGURE 2-23.

UV/Oxidation System

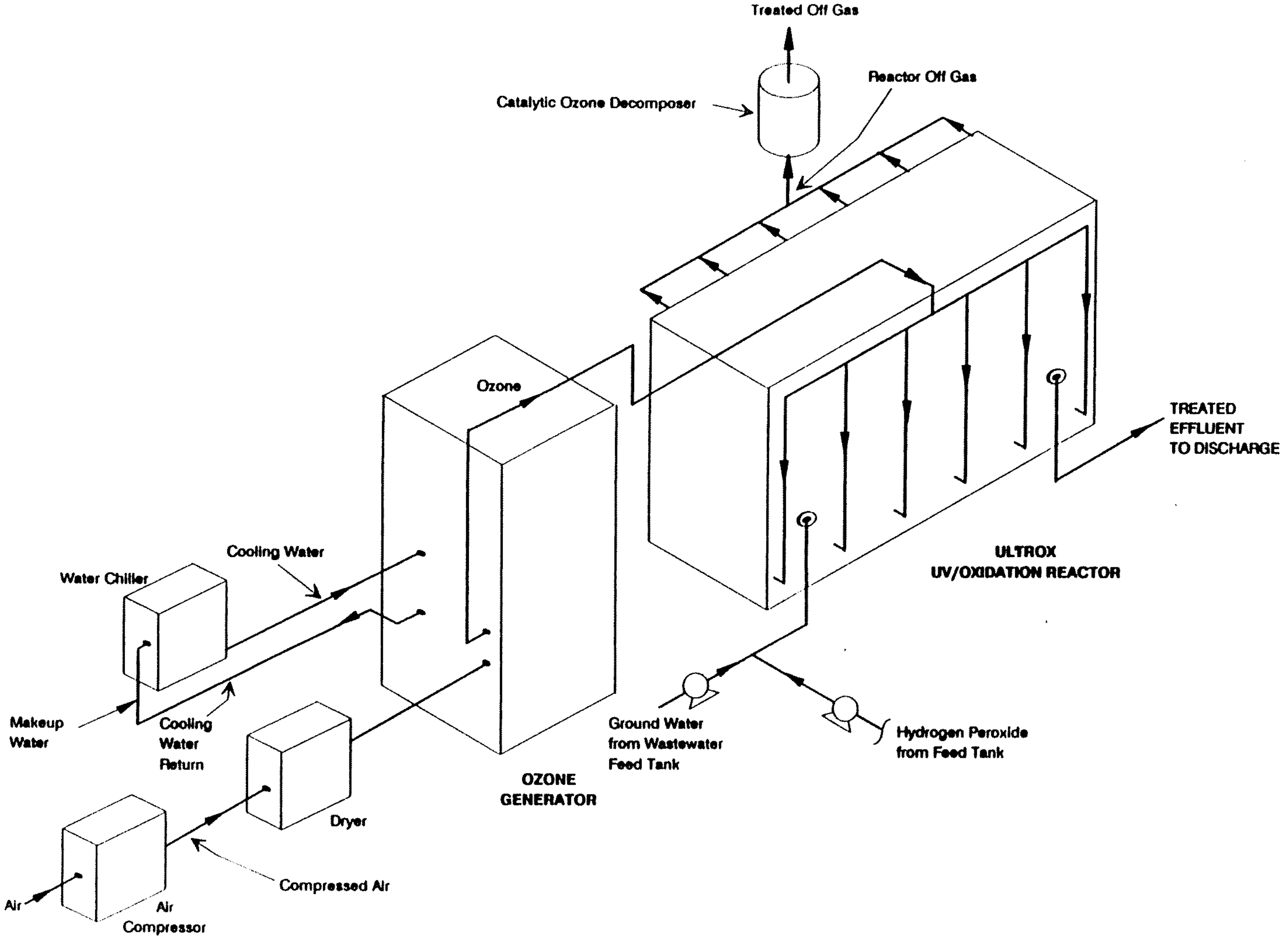


FIGURE 3-2

ISOMETRIC VIEW OF ULTROX SYSTEM

likely be able to treat the organic contaminants found at the Booth Oil Site. It will be considered in the remedial alternatives of Section 3.

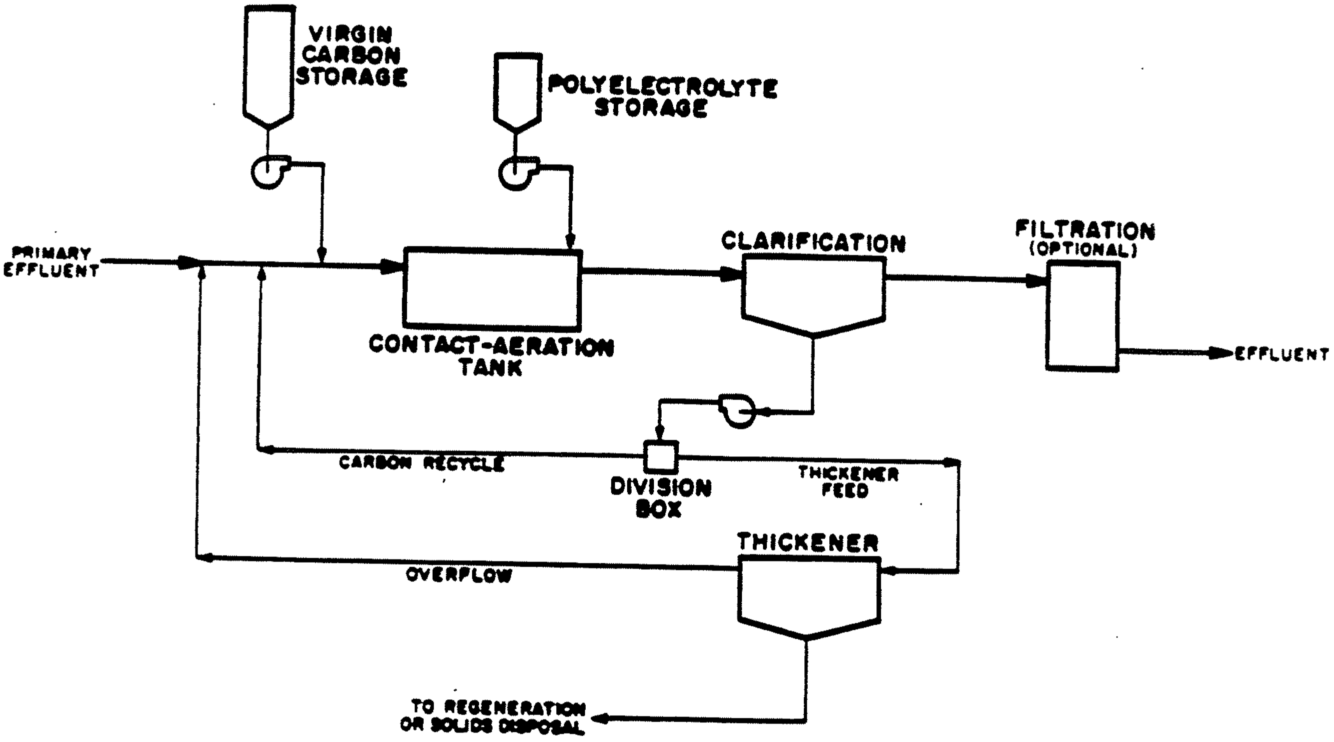
2.4.2.3.4 Bioremediation/Powdered Carbon--

A bioremediation/powdered carbon process uses activated carbon in combination with an activated sludge biological treatment system to remove hazardous organic compounds from groundwater and wastewater. In the process, shown in Figure 2-24, activated carbon is added to the influent as it enters the aeration tank containing activated sludge. Biodegradable organics are metabolized by the activated sludge, while non-biodegradable organics are adsorbed by the carbon. Effluent from the aeration tank flows to a settling tank where solids settle out. The solids are thickened before some is recycled to the aeration tank and others are wasted. The wasted solids may be dewatered and landfilled or regenerated by wet air oxidation. The effluent from the settling tank passes through a filter before discharge.

In tests at Superfund sites, the bioremediation/powdered carbon treatment process has effectively treated groundwater containing both biodegradable and non-biodegradable organic compounds (Meidl, 1986). The system could possibly treat the mixture of volatiles, semivolatiles, and PCBs in the groundwater at the Booth Oil Site. The system will be considered in the remedial alternatives of Section 3.

FIGURE 2-24.

PACT™ SYSTEM GENERAL PROCESS DIAGRAM



2.4.2.4 Metals Treatment--

The groundwater at Booth Oil contains antimony, iron, lead, and manganese at levels exceeding the New York State Groundwater Standards and Guidance Values. Metals treatment would reduce the concentrations of these three metals to acceptable levels. The common methods of metals removal are chemical precipitation and ion exchange. These technologies are discussed below.

2.4.2.4.1 pH adjustment and precipitation--

pH adjustment and precipitation for heavy metals removal is a well-established technology. There are three types of metals precipitation systems. Each adjusts the pH of the water to the level at which the metals in the water have their lowest solubility. The three metals precipitation systems are:

- The carbonate system.
- The hydroxide system.
- The sulfide system.

The carbonate system is difficult to control and relies on the use of soda ash and pH adjustment in the range of 8.2 to 8.5.

The hydroxide system is most widely used in the removal of metals. The system uses either lime, sodium hydroxide, or magnesium hydroxide to raise the pH of the water to precipitate the metals.

The sulfide system is effective in the removal of metals, except for arsenic. The increased removal is offset by the susceptibility of sulfide sludges to oxidize, resulting in the resolubilization of the metals.

pH adjustment and precipitation systems have been successfully used to treat industrial wastewater and groundwater. The systems are most efficient when the metals in the water have minimum or near-minimum solubilities within a narrow pH range. In this situation, very small quantities of the metal are discharged in the effluent.

A disadvantage for the systems results when the metals in the waste stream have their minimum solubilities (Figure 2-25) at widely varying pHs. When the systems adjust the pH of the solution to a fixed level, they are able to remove more of some metals and less of others. Some of the metals are less soluble than others. Metals that do not have their minimum solubility at the pH of the solution may solubilize and pass through the system.

Another disadvantage of the systems, in comparison with iron-based coprecipitation, is the volume of sludge generated. In general, pH adjustment and precipitation systems generate a larger volume of sludge than an iron-based coprecipitation system. They would have greater sludge disposal costs.

The above systems (Figure 2-26) consist of a reaction tank(s), flocculator,

FIGURE 2-25. Solubility of Metals Versus pH

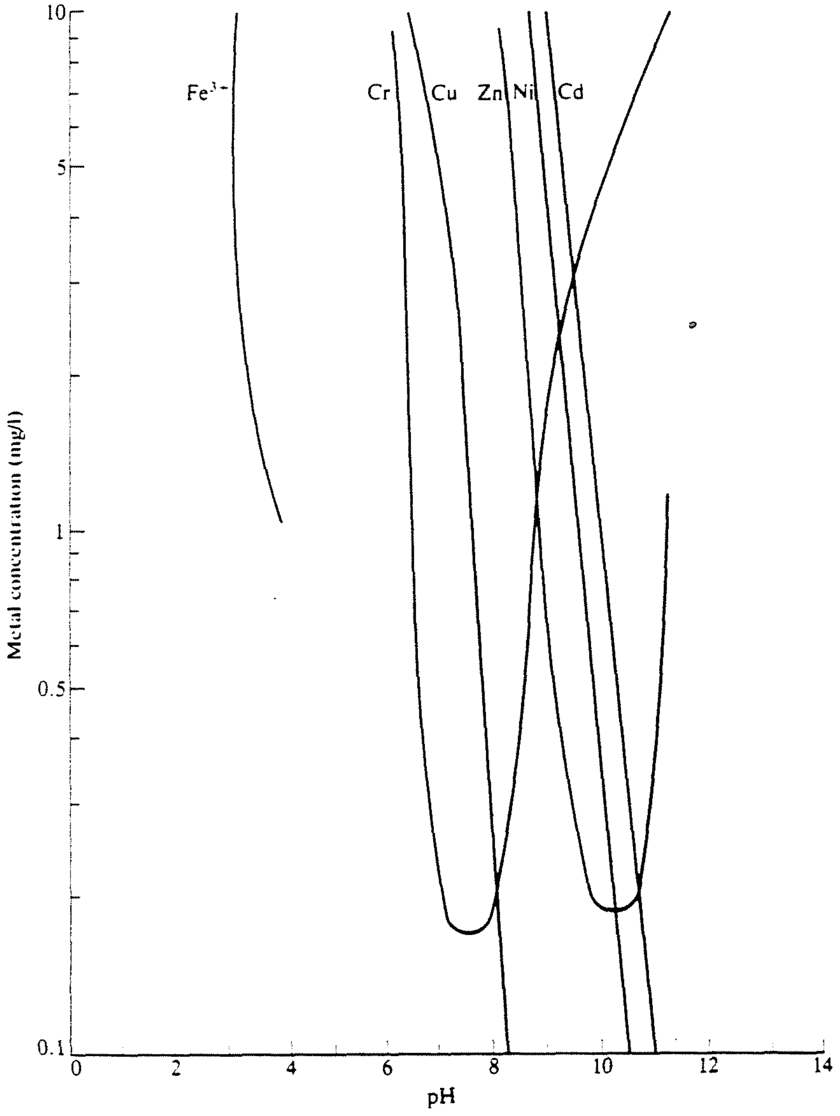
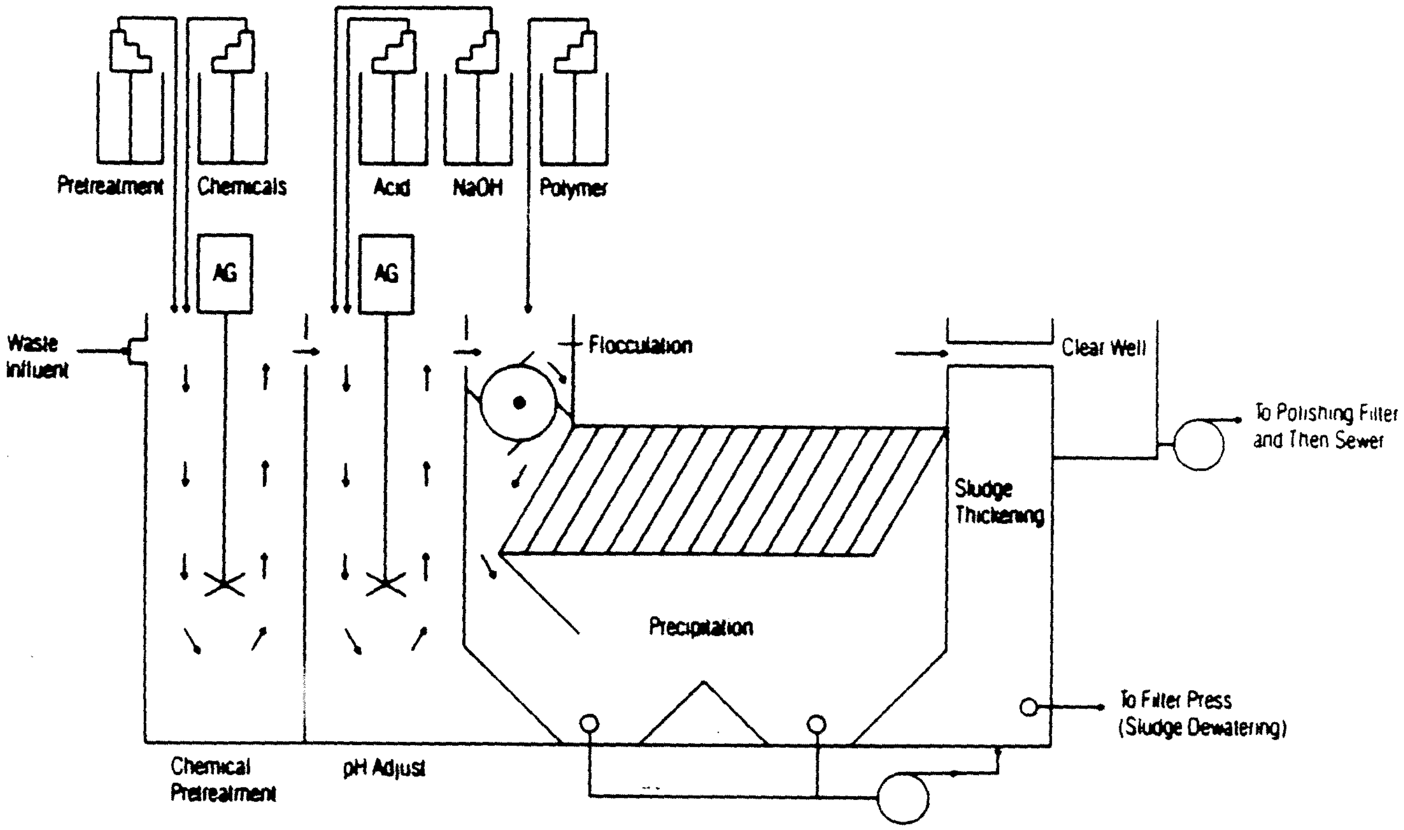


FIGURE 2 - 26

SCHEMATIC OF METALS PRECEPITATION SYSTEM

Heavy Metal Precipitation System



and a sludge handling system for thickening and dewatering. Because of the disadvantages outlined, they will not be considered further.

2.4.2.4.2 Iron-based coprecipitation--

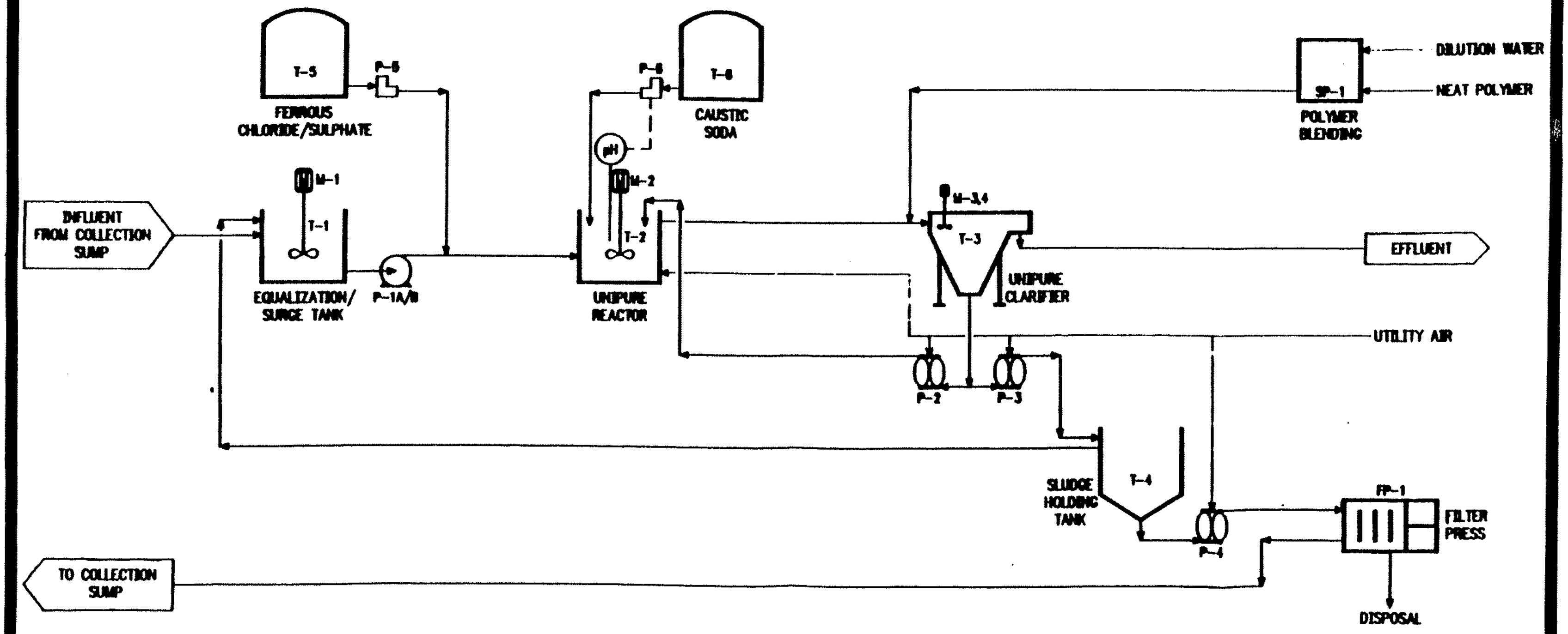
In this technology, soluble ferrous ions are added to the waste stream at a pre-determined rate (usually about four times the total amount of all the metals). Such systems usually operate in a pH range of 7.0 to 8.0. The oxidation of ferrous ions in the waste stream results in the precipitation of iron and the other metals. Heavy metals are entrapped in an insoluble iron matrix when iron is precipitated from the solution. This iron matrix can be defined as a gelatinous ferric "oxy" hydroxide formation, in which other metals are attached or adsorbed to the iron particles.

Iron-based coprecipitation has a couple of advantages over pH adjustment and precipitation. The technology generates a smaller volume of sludge in comparison with pH adjustment and precipitation systems. Also, its effectiveness depends on the solubility of iron, not on the solubility of all of the metals present in the water. It is best applied where the water already has a high iron concentration, as at the Booth Oil Site.

The system consists of a reaction tank, clarifier, and sludge-handling system for thickening and dewatering. A diagram of the system is presented in Figure 2-27.

FIGURE 2 - 27

UNOCAL IRON-BASED COPRECIPITATION



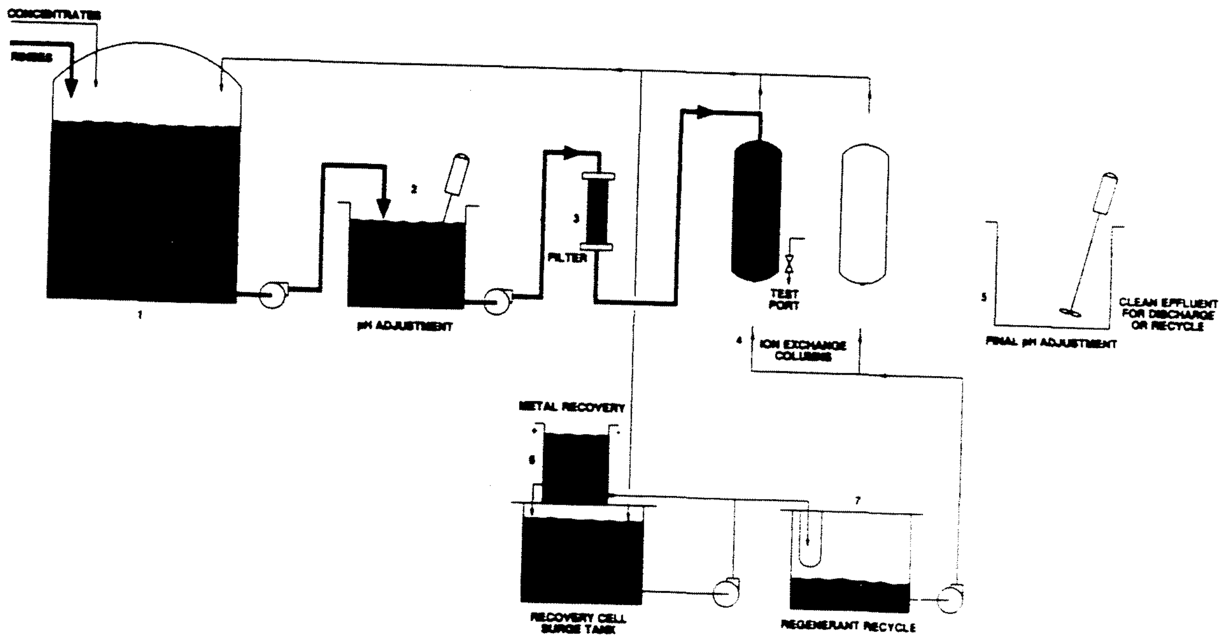
2.4.2.4.3 Ion exchange--

The ion exchange process (Figure 2-28) involves the reversible exchange of ions in solution with ions retained on a reactive solid material, i.e.,ion exchange resin. An ion exchange resin has either an ability to exchange positively-charged ions (cation exchange) or negatively-charged ions (anion exchange). A typical ion exchange system consists of a fixed bed of ion exchange resin with anions or cations held by electrostatic forces to the charged sites. As wastewater passes through the resin, metal ions exchange with the cations or anions at the charged sites. When the resin reaches its breakthrough point and is exhausted, it is regenerated by passing an acid through it to desorb the metals. The acid solution must be treated prior to discharge. Some systems electrolytically recover the metals from the regenerant acid so the regenerant can be reused. Others simply precipitate the metals from the regenerant.

Ion exchange systems are used primarily for treatment of industrial wastewater and demineralization of process water. The technology may encounter difficulties in treating groundwater. Colloidal particles and bacteria may foul the resin. If metals and metal complexes (e.g., permanganate and chromate) are present, anion and cation exchange resins both would be needed for treatment of the water. Also, the metals must be precipitated from the regenerant before the regenerant can be discharged. This operation would create a hazardous sludge for disposal.

FIGURE 2 - 28

ION EXCHANGE/ELECTROLYTIC RECOVERY SYSTEM



Based on the forgoing information regarding metals treatment technologies, iron-based coprecipitation is the technology of choice. It will be considered in Section 3.

2.4.2.5 Groundwater Discharge Options--

Treated groundwater may be discharged to the sanitary sewer, the storm water sewer, or the groundwater via injection wells or infiltration basins. Discharge to the sanitary sewer would require approval of the North Tonawanda Sewage Treatment Plant (NTSTP). To date, NTSTP has not specified treatment standards for the contaminants detected in the groundwater at the Booth Oil Site. However, wastewater treatment plant pre-treatment standards are generally less stringent than standards for discharge to surface water or groundwater. As such, disposal by discharge to NTSTP may allow a lesser degree of onsite treatment than would be required for the other disposal options.

Discharge to the storm water sewer would require a New York State Pollutant Discharge Elimination System Permit. Reinjection to the groundwater could be accomplished with injection wells constructed similar to extraction wells. A field study would be needed to determine the capacity of the aquifer where the water would be injected.

2.4.3 Storm Water Sewer System

The storm water sewer system south of the Booth Oil Site contains contaminated sediment and surface water. Table 2-3 summarizes the levels of pollutants found in the catch basin sediment and surface water during the Phase I RI. This table is summarized below. Remediation of the sediments in the storm water sewer is currently being considered as a potential interim action. Removal and decontamination of the sewer system, combined with remediation of the source (contaminated onsite soils) would eliminate the need for continued remediation of the sewer system.

The catch basin sediment contains a mixture of semivolatiles, volatiles, PCBs, and metals. The most widespread semivolatiles are bis(2-ethylhexyl)phthalate (10400 ppb average), phenanthrene (5500 ppb average), 2-methylnaphthalene (5150 ppb average), total unknown alkanes (13850 ppb average), and total unknowns (26900 ppb average). Volatiles present include acetone (4450 ppb average) and xylenes (4400 ppb average). Metals present in concentrations exceeding New York State Class A surface water standards are lead (611 ppm) and zinc (388 ppm). Aroclor 1242, Aroclor 1254, and Aroclor 1260 are present with average concentrations of 6975 ppb, 9200 ppb, and 38375 ppb, respectively.

The catch basin surface water contains semivolatiles, volatiles, and metals. No PCBs were detected in the catch basin water samples taken during the Phase I RI. The most prevalent semivolatiles are 2,4-dimethylphenol (17.3 ppb average), 4-methylphenol (23 ppb average), benzoic acid (6.7 ppb), total unknowns (16 ppb average), total unknown alcohols (43 ppb average), and unknown cycloalkane (57 ppb average). Volatiles in the surface water include vinyl chloride (105 ppb average), 1,2-dichloroethene (90 ppb average), toluene (30 ppb average), and xylene (28 ppb average). Iron is the only metal present in excess of the surface water standards, having an average concentration of 2056 ppb.

Remediation of the storm water sewer will require removal of the contaminated sediment and subsequent decontamination of the sewer line. The sediment can be removed mechanically with scrapers and buckets, or hydraulically, or with a slip line. Scraped material would be vacuumed and treated before final disposal. After removal of the sediment, the line would be washed with water. The outfall to the Little River could be collected and treated. The line would be washed as many times as is necessary for complete decontamination.

2.4.4 Summary

In this section, the technologies described above for each of the contaminated media and operable units are reviewed. Determinations are made about which technologies may be most effective at the Booth Oil Site. The technologies judged most effective will be combined into remedial action alternatives in Section 2.4.5 and screened in accordance with the NYSDEC TAGM in Section 3.

2.4.4.1 Contaminated Soil--

The contaminated soil at the Booth Oil Site contains a variety of semivolatiles, volatiles, PCBs, and metals. The levels of contaminants detected are summarized in Table 2-1. Eleven technologies for containing or treating the contaminants were described in Section 2.4.1. These technologies are reviewed below.

Contaminant containment technologies (RCRA Cover or Slurry Wall) would reduce exposure of the community to contaminants at the site. Acceptable risk levels would be attained. These technologies will be considered further.

Stabilization/solidification technologies could be used to treat the soil at the site. The stabilization system must be able to effectively immobilize the PCBs, volatiles, and semivolatiles present, in addition to the heavy metals. The Qualtec system has been used effectively on waste containing PCBs and heavy metals at the Pepper's Steel and Alloys Site near Miami (Dole, 1990). The Wastech system has generated a solid material that passes the TCLP after treating soils and sludges contaminated with PCBs, volatiles, semivolatiles, and heavy metals (Wastech, 1990). Stabilization/solidification technologies will be considered further.

Several solvent extraction processes were examined in this section. Two processes (the Acurex extraction and the Methanol extraction) have not been developed to a commercial scale; they will not be considered further. The triethylamine extraction process has been used to treat petroleum refinery sludge and contaminated soil at the General Refinery Site near Savannah, Georgia. The process has successfully extracted volatiles, semivolatiles, and PCBs with a removal efficiency greater than 99 per cent (Weimer, 1989). It does not remove metals. The acetone/kerosene extraction plus inorganic acid extraction can effectively remove PCBs and semivolatiles from sediment and sludges (Blank, 1990). The process has been tested on a lab-scale and pilot-scale. A commercial-scale system is planned for 1991. Solvent extraction will be considered in the remedial alternatives for the Booth Oil Site.

Two dechlorination processes exist that effectively treat soil contaminated with PCBs, halogenated aromatics, and halogenated aliphatics. The APEG Process or the LARC Process possibly could dechlorinate the chlorinated organics at the Booth Oil Site. However, the site also contains a significant concentration of nonhalogenated organics that the processes could not treat. The dechlorination processes will not be considered further.

The wet air oxidation process is used primarily to treat aqueous phase waste streams that are too concentrated to biotreat and too dilute to burn. Bench-scale tests with the system have shown removal efficiencies of greater than 99 per cent for many volatiles and semivolatiles. However, chlorinated aromatics that do not contain a nonhalogen functional group have been resistant to wet air oxidation. In one study, the removal efficiency for Aroclor 1254 was slightly greater than 60 per cent (Dietrich, 1989). For use in treating soil, the organics must first be solvated. Since the process has not been used to treat soil at other Superfund sites, there are no studies on the methods of solvation used for the process. Research on the use of wet air oxidation for treating contaminated soil is in its initial stages. Wet air oxidation will not be considered further.

Several thermal separation processes can remove PCBs, volatiles, and semivolatiles from contaminated soil for further treatment. The Anaerobic Treatment Process has effectively removed PCBs, volatiles, and semivolatiles from oil shale, refinery waste, and PCB-contaminated soil. This process will be utilized to remediate the PCB-contaminated sediment at the Waukegan Harbor Site, Waukegan, Illinois, beginning in 1991. The Fluidized Bed Thermal Separation Process has successfully removed PCBs and other organics from sediments at Waukegan Harbor and the Hudson River. The Closed-loop Thermal Separation Process has effectively treated soil containing PCBs, volatiles, and semivolatiles in lab-scale and bench-scale tests. None of the three processes removes metals from soil. Thermal separation will be considered in the remedial alternatives for the Booth Oil Site.

Incineration processes can effectively destroy PCBs, volatiles, and semivolatiles in contaminated soil. Metals may be volatilized and exit the incinerator through the stack, or remain in the soil after it is burned. Several incineration systems have received TSCA permits for the destruction of PCBs. These systems include rotary kiln incinerators, infrared incinerators, and a circulating bed combustor. Incineration will be considered in the remedial alternatives for the site.

In situ vitrification may be capable of removing the PCBs, volatiles, and semivolatiles from the soil at the Booth Oil Site. The process would encapsulate the metals in the melt. Two concerns make the technology undesirable for use at the site. The primary concern is the high water table and the soil moisture content. The high water table and soil moisture content would require a large amount of energy for removal of the water before vitrification could begin. Also, because the soil subsides as the vitrification process proceeds, structures in the area of the sight may be susceptible to collapse. In situ vitrification will not be considered further.

Bioremediation also may be able to treat the organic compounds in the soil at the site, but will not remove the metals. Also, there will be difficulty in developing a culture that can metabolize the variety of organics at the site. Even if a culture could be found, the process would proceed more slowly than other treatment processes. The PCBs at the site contain a significant amount of tetrachlorobiphenyls and pentachlorobiphenyls. PCBs degrade more slowly as the number of chlorines in the molecule increases (EPA, 1990). Bioremediation will not be considered further.

Soil vapor extraction could remove the volatiles and some of the semivolatiles from the soil at the Booth Oil Site. It would not remove the PCBs and some semivolatiles. Because it cannot remove all of the contaminants, the technology will not be considered further.

After reviewing eleven possible remedial technologies for the soil at the Booth Oil Site, four technologies appear to be the most promising for the remedial action. These four technologies are solidification/stabilization, solvent extraction, thermal separation, and incineration. These four technologies will be evaluated as components of remedial alternatives for the site.

2.4.4.2 Contaminated Groundwater--

Three chemical classes of contamination have been detected in the groundwater at the Booth Oil Site. These include a floating, nonaqueous phase liquid (NAPL), soluble organics (volatiles, semivolatiles, and PCBs), and heavy metals. Table 2-2 summarizes the levels of contaminants found. Extraction, treatment, and disposal technologies are described in Section 2.4.2. A summary evaluation of these technologies is presented below.

Two possible technologies for groundwater extraction are an extraction well system and a trench drain system. The extraction well system would utilize a pumping system containing two pumps for removal of the water and NAPL as separate phases. The trench drain system would consist of trench drains leading to sumps. As water accumulates in the sumps, it would be pumped to the treatment system. Extraction wells and trench drains will be considered further.

Oil/water separation is the only technology considered for removal of the residual NAPL from the extracted groundwater. The technology will be considered as a component of the remedial alternatives for the site.

Four technologies were considered for treatment of the dissolved organic contaminants in the groundwater: air stripping, carbon adsorption, UV/Oxidation, and bioremediation/powdered carbon. All of these technologies are capable of removing the volatiles, semivolatiles, and/or PCBs from the groundwater. Air stripping/carbon adsorption, UV/Oxidation, and bioremediation/powdered carbon will be evaluated as components of remedial alternatives for the Booth Oil Site.

Three technologies were considered for treatment of the heavy metals in the groundwater: pH adjustment and precipitation, iron-based coprecipitation, and ion exchange. Iron-based coprecipitation generates a smaller sludge volume than pH adjustment and precipitation. Also, it can theoretically achieve greater removal efficiencies since its chemistry depends only on the solubility of iron instead of the solubility of all of the heavy metals in the groundwater. Ion exchange utilizes a resin to remove metal ions from the water. The resin is subject to fouling from colloidal particles and bacteria found in groundwater. Metals must be precipitated from the regenerant before the regenerant is discharged. Iron-based coprecipitation will be considered as a component of the remedial alternatives for the Booth Oil Site; pH adjustment and precipitation and ion exchange will not be considered further.

Treated groundwater may be discharged to the sanitary sewer, the storm water sewer, or the groundwater via injection wells or infiltration basins. Discharge to the sanitary sewer would require approval of the North Tonawanda Sewage Treatment Plant (NTSTP). A NYSPDES permit would be necessary for discharge to the storm water sewer because it discharges to the Little River. Injection to the groundwater must meet the New York State Class GA Groundwater Standards. Since wastewater treatment plant pre-treatment standards are generally less stringent than standards for discharge to surface water or groundwater, discharge to the sanitary sewer will be the preferred option. The second choice will be discharge to the storm water sewer. Reinjection of the treated water is the least preferred alternative.

2.4.4.3 Storm Water Sewer System--

The storm water sewer system south of the Booth Oil Site contains contaminated sediment and surface water. The sediment contains PCBs, volatiles, semivolatiles, and heavy metals. The surface water is contaminated with volatiles, semivolatiles, and metals. Table 2-3 summarizes the levels of contaminants detected.

Remediation of the storm water sewer will require removal of the contaminated sediment and subsequent decontamination of the sewer line. The sediment can be removed mechanically with scrapers and buckets, or hydraulically, or by slip lining. Scraped material would be vacuumed and treated before final disposal. After removal of the sediment, the line would be washed with water. The outfall to the Little River would be collected and treated. The line would be washed as many times as are necessary for complete decontamination.

2.5 IDENTIFICATION OF POTENTIALLY APPLICABLE REMEDIAL ACTION ALTERNATIVES

In this section, remedial technologies for treating the contaminants at the Booth Oil Site are combined into remedial action alternatives. Only those technologies that were found acceptable in Section 2.4 are combined in the alternatives.

A list of the 6 potential remedial action alternatives is presented in Table 2-6. Each of these alternatives is described below.

2.5.1 Alternative 1: Soil Treatment by Solvent Extraction and a Groundwater Pump and Treat System

With this alternative, approximately 30,000 cubic yards of soil and sediment at the Booth Oil Site would be excavated and treated in a solvent extraction system. After treatment, the clean soil would be backfilled onsite. The contaminated groundwater at the site would be extracted using extraction wells and/or trench drains. A two-pump pumping system would remove the floating NAPL phase as a separate phase from the groundwater. Extracted water would be passed through a treatment train consisting of an oil/water separator,

TABLE 2-6
BOOTH OIL INACTIVE HAZARDOUS WASTE SITE
REMEDIAL ALTERNATIVES

ALTERNATIVE	SOIL TREATMENT	GROUNDWATER EXTRACTION	GROUNDWATER NAPL REMOVAL	GROUNDWATER METALS REMOVAL	GROUNDWATER ORGANICS REMOVAL	GROUNDWATER DISCHARGE
1A	Solvent Extraction	Extraction Wells and/or Trench Drains	Oil/Water Separation	Iron-based Coprecipitation	Air Stripping/ Carbon Adsorption	Stormwater Sewer/ Sanitary Sewer/ Other Means
1B	Solvent Extraction	Extraction Wells and/or Trench Drains	Oil/Water Separation	Iron-based Coprecipitation	UV/Oxidation	Stormwater Sewer/ Sanitary Sewer/ Other Means
1C	Solvent Extraction	Extraction Wells and/or Trench Drains	Oil/Water Separation	Iron-based Coprecipitation	Bioremediation/ Powdered Carbon	Stormwater Sewer/ Sanitary Sewer/ Other Means
2A	Thermal Separation	Extraction Wells and/or Trench Drains	Oil/Water Separation	Iron-based Coprecipitation	Air Stripping/ Carbon Adsorption	Stormwater Sewer/ Sanitary Sewer/ Other Means
2B	Thermal Separation	Extraction Wells and/or Trench Drains	Oil/Water Separation	Iron-based Coprecipitation	UV/Oxidation	Stormwater Sewer/ Sanitary Sewer/ Other Means
2C	Thermal Separation	Extraction Wells and/or Trench Drains	Oil/Water Separation	Iron-based Coprecipitation	Bioremediation/ Powdered Carbon	Stormwater Sewer/ Sanitary Sewer/ Other Means
3A	On-site Incineration	Extraction Wells and/or Trench Drains	Oil/Water Separation	Iron-based Coprecipitation	Air Stripping/ Carbon Adsorption	Stormwater Sewer/ Sanitary Sewer/ Other Means
3B	On-site Incineration	Extraction Wells and/or Trench Drains	Oil/Water Separation	Iron-based Coprecipitation	UV/Oxidation	Stormwater Sewer/ Sanitary Sewer/ Other Means
3C	On-site Incineration	Extraction Wells and/or Trench Drains	Oil/Water Separation	Iron-based Coprecipitation	Bioremediation/ Powdered Carbon	Stormwater Sewer/ Sanitary Sewer/ Other Means

TABLE 2-6 (CONTINUED)
BOOTH OIL INACTIVE HAZARDOUS WASTE SITE
REMEDIAL ALTERNATIVES

ALTERNATIVE	SOIL TREATMENT	GROUNDWATER EXTRACTION	GROUNDWATER NAPL REMOVAL	GROUNDWATER METALS REMOVAL	GROUNDWATER ORGANICS REMOVAL	GROUNDWATER DISCHARGE
4A	Off-site Incineration	Extraction Wells and/or Trench Drains	Oil/Water Separation	Iron-based Coprecipitation	Air Stripping/ Carbon Adsorption	Stormwater Sewer/ Sanitary Sewer/ Other Means
4B	Off-site Incineration	Extraction Wells and/or Trench Drains	Oil/Water Separation	Iron-based Coprecipitation	UV/Oxidation	Stormwater Sewer/ Sanitary Sewer/ Other Means
4C	Off-site Incineration	Extraction Wells and/or Trench Drains	Oil/Water Separation	Iron-based Coprecipitation	Bioremediation/ Powdered Carbon	Stormwater Sewer/ Sanitary Sewer/ Other Means
5A	Stabilization/ Solidification	Extraction Wells and/or Trench Drains	Oil/Water Separation	Iron-based Coprecipitation	Air Stripping/ Carbon Adsorption	Stormwater Sewer/ Sanitary Sewer/ Other Means
5B	Stabilization/ Solidification	Extraction Wells and/or Trench Drains	Oil/Water Separation	Iron-based Coprecipitation	UV/Oxidation	Stormwater Sewer/ Sanitary Sewer/ Other Means
5C	Stabilization/ Solidification	Extraction Wells and/or Trench Drains	Oil/Water Separation	Iron-based Coprecipitation	Bioremediation/ Powdered Carbon	Stormwater Sewer/ Sanitary Sewer/ Other Means
6A	Containment	Extraction Wells and/or Trench Drains	Oil/Water Separation	Iron-based Coprecipitation	Air Stripping/ Carbon Adsorption	Stormwater Sewer/ Sanitary Sewer/ Other Means
6B	Containment	Extraction Wells and/or Trench Drains	Oil/Water Separation	Iron-based Coprecipitation	UV/Oxidation	Stormwater Sewer/ Sanitary Sewer/ Other Means
6C	Containment	Extraction Wells and/or Trench Drains	Oil/Water Separation	Iron-based Coprecipitation	Bioremediation/ Powdered Carbon	Stormwater Sewer/ Sanitary Sewer/ Other Means

iron-based coprecipitation unit, and dissolved organics treatment unit for removal of the remaining NAPL, metals, and soluble organics, respectively. The dissolved organics treatment system would be either an air stripping/carbon adsorption, UV/oxidation, or bioremediation/powdered carbon system. Treated water would be discharged to the storm water sewer, sanitary sewer, or disposed of by other means. Waste from this alternative would include the NAPL phase removed from the extraction wells or trench drains, the floating oil removed from the oil/water separator, solvent extracted-organics from the soil, a metal sludge from the iron-based coprecipitation unit, and if used, spent carbon from the dissolved organics treatment unit.

2.5.2 Alternative 2: Soil Treatment by Thermal Separation and a Groundwater Pump and Treat System

In this alternative, approximately 30,000 cubic yards of soil and sediment at the Booth Oil Site would be excavated and treated in a thermal separation system. After treatment, the clean soil would be backfilled onsite. The contaminated groundwater at the site would be extracted using extraction wells and/or trench drains. A two-pump pumping system would remove the floating NAPL phase as a separate phase from the groundwater. Extracted water would be passed through a treatment train consisting of an oil/water separator, iron-based coprecipitation unit, and dissolved organics treatment unit for removal of the remaining NAPL, metals, and soluble organics, respectively. The dissolved organics treatment system would be either an air stripping/carbon adsorption, UV/oxidation, or bioremediation/powdered carbon system. Treated water would be discharged to the storm water sewer, sanitary sewer, or disposed of by other means. Waste from this alternative would include the NAPL phase removed from the extraction wells or trench drains, the floating oil removed from the oil/water separator, thermally separated-organics from the soil, solids from the vapor scrubber of the thermal separator, a metal sludge from the iron-based coprecipitation unit, and if used, spent carbon from the dissolved organics treatment unit.

2.5.3 Alternative 3: Soil Treatment by On-site Incineration and a Groundwater Pump and Treat System

In this alternative, approximately 30,000 cubic yards of soil and sediment at the Booth Oil Site would be excavated and treated in an on-site incinerator system. After treatment, the clean soil would be backfilled onsite. The contaminated groundwater would be extracted using extraction wells and/or trench drains. A two-pump pumping system would remove the floating NAPL phase as a separate phase from the groundwater. Extracted water would be passed through a treatment train consisting of an oil/water separator, iron-based coprecipitation unit, and dissolved organics treatment unit for removal of the remaining NAPL, metals, and soluble organics, respectively. The dissolved organics treatment system would be either an air stripping/carbon adsorption, UV/oxidation, or bioremediation/powdered carbon system. Treated water would be discharged to the storm water sewer, sanitary sewer, or disposed of by other means. Waste from this alternative would include the NAPL phase removed from the extraction wells or trench drains, the floating oil removed from the oil/water separator, thermally separated-organics from the soil, solids from the vapor scrubber of the incinerator, a metal sludge from the iron-based coprecipitation unit, and if used, spent carbon from the dissolved organics treatment unit.

2.5.4 Alternative 4: Soil Treatment by Off-site Incineration and a Groundwater Pump and Treat System

In this alternative, approximately 30,000 cubic yards of contaminated soil and sediment at the Booth Oil Site would be excavated and transported off-site for treatment in an off-site incinerator. Clean soil would be backfilled onsite. The contaminated groundwater at the site would be extracted using extraction wells and/or trench drains. A two-pump pumping system would remove the floating NAPL phase as a separate phase from the groundwater. Extracted water would be passed through a treatment train consisting of an oil/water separator, iron-based coprecipitation unit, and dissolved organics treatment unit for removal of the remaining NAPL, metals, and soluble organics, respectively. The dissolved organics treatment unit would be either an air stripping/carbon adsorption, UV/oxidation, or bioremediation/powdered carbon system. Treated water would be discharged to the storm water sewer, sanitary sewer, or disposed of by other means. Waste from this alternative would include the NAPL phase removed from the extraction wells or trench drains, the floating oil removed from the oil/water separator, a metal sludge from the iron-based coprecipitation unit, and if used, spent carbon from the dissolved organics treatment unit.

2.5.5 Alternative 5: Soil Treatment by Stabilization/Solidification and a Groundwater Pump and Treat System

In this alternative, approximately 30,000 cubic yards of soil and sediment at the Booth Oil Site would be excavated and mixed with chemical stabilizing agent(s), cement and/or pozzolans, and water to form a stabilized solid. If the treatment is performed on-site, the stabilized solid would be backfilled at the site. If the treatment is performed off-site, the stabilized solid would be disposed of off-site and clean soil backfilled on-site. The contaminated groundwater at the site would be extracted using extraction wells and/or trench drains. A two-pump pumping system would remove the floating NAPL phase as a separate phase from the groundwater. Extracted water would be passed through a treatment train consisting of an oil/water separator, iron-based coprecipitation unit, and dissolved organics treatment unit for removal of the remaining NAPL, metals, and soluble organics, respectively. The dissolved organics treatment unit would be either an air stripping/carbon adsorption, UV/oxidation, or bioremediation/powdered carbon system. Treated water would be discharged to the storm water sewer, sanitary sewer, or disposed of by other means. Waste from this alternative would include the stabilized solid, the NAPL phase removed from the extraction wells or trench drains, the floating oil removed from the oil/water separator, a metal sludge from the iron-based coprecipitation unit, and if used, spent carbon from the dissolved organics treatment unit.

2.5.6 Alternative 6: Containment and a Groundwater Pump and Treat System

In this alternative, the contaminated soil at the Booth Oil Site would be isolated by a slurry wall and cap system. Hot spots may be excavated prior to placement of the cap and transported for treatment at an off-site incinerator. The contaminated groundwater at the site would be extracted using extraction wells and/or trench drains. A two-pump pumping system would remove the floating NAPL phase as a separate phase from the groundwater. Extracted water would be passed through a treatment train consisting of an oil/water separator, iron-based coprecipitation unit, and dissolved organics treatment unit for removal of the remaining NAPL, metals, and soluble organics, respectively. The dissolved organics treatment unit would be either an air stripping/carbon adsorption, UV/oxidation, or bioremediation/powdered carbon system. Treated water would be discharged to the storm water sewer, sanitary sewer, or disposed of by other means. Waste from this alternative would include the NAPL phase removed from the extraction wells or trench drains, the floating oil removed from the oil/water separator, a metal sludge from the iron-based coprecipitation unit, and if used, spent carbon from the dissolved organics treatment unit.

Section 3

SECTION 3

PRELIMINARY SCREENING OF POTENTIALLY APPLICABLE REMEDIAL ACTION ALTERNATIVES

In this section, the six potential remedial action alternatives identified in Section 2 are screened for effectiveness and implementability. The screening is performed using the scoresheets from the NYSDEC TAGM. A summary of the resultant scores appears in Table 3-1. The completed scoresheets for each alternative appear in Appendix A. The reader is encouraged to review the scoresheets; many comments and qualifiers have been added to provide more accurate responses to the yes/no questions as presented in the TAGM. Narrative discussions of the effectiveness and implementability of the alternatives are presented below. The discussion of effectiveness of each alternative consists of four sections:

- Short-Term Risks,
- Location of Treatment and Disposal,
- Permanence of the Alternative, and
- Duration of the Alternative.

Implementation discussions contain the following five sections:

- Difficulty in Construction,
- Reliability in Meeting SCGs,

TABLE 3-1
SUMMARY OF PRELIMINARY SCREENING OF REMEDIAL ACTION ALTERNATIVES

ALTERNATIVE	EFFECTIVENESS*	IMPLEMENTABILITY*
Solvent Extraction and Groundwater Treatment	19 - 23	12
Thermal Separation and Groundwater Treatment	19 - 23	12
On-site Incineration and Groundwater Treatment	19 - 23	11
Off-site Incineration and Groundwater Treatment	19 - 23	13
Stabilization/Solidification and Groundwater Treatment	19 - 23	11 - 12
Containment and Groundwater Treatment	12 - 16	10

* - The reader is encouraged to review the scoresheets; many comments and qualifiers have been added to provide more accurate responses to the yes/no questions as presented in the TAGM.

- Coordination with Other Agencies,
- Availability of Technologies, and
- Monitoring Requirements.

The sections of the discussions closely follow the questions on the scoresheets in the NYSDEC TAGM.

3.1 ALTERNATIVE 1 - SOIL TREATMENT BY SOLVENT EXTRACTION AND GROUNDWATER PUMP AND TREAT SYSTEM

In this alternative, contaminated soil at the Booth Oil Site would be excavated and treated on-site by a solvent extraction system. Treated soil would be backfilled on-site. Contaminated groundwater would be extracted and treated for NAPL, metals, and dissolved organics removal prior to discharge. The majority of the NAPL would be removed by a pumping system containing a sensor that differentiates between the nonaqueous and aqueous phases. The floating NAPL would be pumped as a separate phase from the groundwater. Remaining NAPL, if any, would be removed with an oil/water separator. An iron-based coprecipitation system would precipitate the metals. Dissolved organics would be removed by either an air stripping/carbon adsorption, UV/oxidation, or bioremediation/powdered carbon system.

Descriptions of the aforementioned technologies are presented in Section 2. Specifically, solvent extraction is discussed in Section 2.4.1.4. The groundwater extraction, oil/water separation, and dissolved organics treatment technologies are discussed in Sections 2.4.2.1, 2.4.2.2, and 2.4.2.3, respectively. A description of the iron-based coprecipitation system appears in Section 2.4.2.4.2.

3.1.1 Effectiveness

3.1.1.1 Short-Term Risks--

The major potential short-term risks of the solvent extraction alternative are dust generated by excavation of the soil, and potential exposure of site workers and the nearby community to airborne contaminants. Dust can be minimized by keeping the excavated material wetted. Workers can limit their exposure to contaminants with the appropriate personal protective equipment.

If air stripping/carbon adsorption is the selected organics removal technology for contaminated groundwater, the air stream exiting the stripping tower would contain the stripped organics. If design analysis of the stripping tower indicate that the emissions would exceed permissible levels and pose a risk to the community, air pollution control equipment would be used to treat the air stream. A vapor-phase carbon or catalytic incineration system would be utilized to treat the stripped contaminants in the air stream.

3.1.1.2 Location of Treatment and Disposal--

Soil treatment with solvent extraction and groundwater pump and treat would be performed on-site. Residuals from the treatment systems may include extracted organics, NAPL, a metal sludge from the iron-based coprecipitation system, and spent carbon from the organics removal technologies. Extracted organics and NAPL would be destroyed in an off-site TSCA permitted incinerator. The metal sludge would be transported off-site to a RCRA facility for treatment and disposal. Any spent carbon would be regenerated off-site.

3.1.1.3 Permanence of the Alternative--

The solvent extraction alternative can be classified as a permanent remedy because the extracted organics would be incinerated. With respect to the groundwater, UV/oxidation and bioremediation/powdered carbon would also destroy organics, and are thus considered permanent remedies. Organics adsorbed to the powdered carbon would be destroyed when the carbon is regenerated. Air stripping would remove the organics from the water but would not destroy them, unless a catalytic incineration system is used. Vapor phase carbon could also be used to remove the stripped organics from the air exiting the stripper; these organics would be destroyed when the carbon is regenerated. Thus, with a vapor treatment system, air stripping is a permanent remedy.

After remediation, no untreated hazardous waste would remain at the site with this alternative. Treated soil would be backfilled at the site. Organics extracted from the soil and NAPL from the oil/water separator and pumping system would be incinerated off-site. Spent carbon would be regenerated off-site if air stripping/carbon adsorption or bioremediation/powdered carbon is the organics removal option. A metal sludge from the iron-based coprecipitation unit would be treated and disposed of at an off-site RCRA facility.

3.1.1.4 Duration of the Alternative--

The Booth Oil Site contains approximately 30,000 cubic yards (cy) of contaminated soil. Assuming a density of 2700 pounds/cy, the soil weighs approximately 40,500 tons. Solvent extraction system vendors indicate that the systems can treat 140 tons per day of contaminated soil. Remediation of the soil with a solvent extraction system that can process 140 tons of soil per day with an 80 percent online availability can be completed in 1.1 years. Including mobilization and set-up, off-site transportation and incineration of the extracted organics, backfilling of the site with the cleaned soil, and demobilization, the soil treatment could be completed in approximately 1.5 years.

The time for completion of the groundwater treatment component of the alternative cannot be predicted with certainty at this time. Most likely, treatment of the groundwater to comply with applicable SCGs will require at least two, and possibly up to ten, years. This is because the soil at the site is clayey and tends to adsorb the organic contaminants. An undetermined number of pore volumes will need to be withdrawn and treated in order to reduce the concentrations of the contaminants to acceptable levels.

3.1.2 Implementability

3.1.2.1 Difficulty in Construction--

Each of the technologies comprising this alternative can be easily constructed. A potential difficulty in construction is the placement of the solvent extraction system at the site. The vast majority of the site is contaminated. Only a small area is not contaminated; this area may not be large enough to contain the entire solvent extraction system. It may be necessary to first excavate an area of the site, then backfill with clean soil from off-site, to create sufficient space for placement and operation of the system.

3.1.2.2 Reliability in Meeting SCGs--

Several solvent extraction technologies are currently being marketed. The commercially available systems vary considerably in the type of solvent(s) used, method of waste/solvent contacting, and method of solvent removal and recovery. Two of the four systems described in Section 2.4.1.4 appear to be promising for the Booth Oil Site. These two systems (the TEA extraction and the acetone/kerosene extraction plus inorganic acid extraction) may be very reliable in reducing the levels of contaminants in the soil below the applicable SCGs. In order for these systems to perform reliably at the site, they must be optimized before final design. Optimization will consist of treatability tests using contaminated soil from the site. Optimum process parameters, such as the quantity of solvent needed in an extraction stage, residence time, and the number of extraction stages required for achieving a desired separation, can be determined during the tests. After the processes are optimized, they may achieve the desired removal efficiencies for contaminants in the soil. If the systems accomplish the desired efficiencies, contaminants would be removed to acceptable risk levels. No future remedial actions would be necessary.

The groundwater treatment technologies would be very reliable in reducing the concentrations of contaminants in the treated groundwater below the applicable SCGs. Air stripping/carbon adsorption, UV/oxidation, and bioremediation/powdered carbon have been proven to achieve removal efficiencies for organic contaminants exceeding 99 percent. After optimization, they could remove contaminants from the groundwater at the Booth Oil Site to acceptable risk levels. No future remedial actions would be necessary.

3.1.2.3 Coordination with Other Agencies--

The solvent extraction alternative would require normal coordination with other agencies. If air stripping is the selected organics removal option, an air permit may be needed from the NYSDEC Division of Air Resources. Transportation and disposal or treatment of extracted organics, NAPL, metal sludge, and spent carbon (if any) must comply with the USDOT regulations for shipment of hazardous materials and RCRA regulations for the shipment, disposal, and treatment of hazardous waste. A New York State Pollutant Discharge Elimination System (NYSPDES) permit must be obtained if the groundwater will be discharged to the storm water sewer. For groundwater discharge to the sanitary sewer, approval and/or a permit from the North Tonawanda Sewage Treatment Plant would be required.

3.1.2.4 Availability of Technologies--

The technologies of this alternative are commercially available. Numerous vendors market solvent extraction systems. As discussed in Section 2, a couple of these appear capable of treating the mix of contaminants in the soils at the site. Numerous vendors could bid on the components of a groundwater treatment system.

3.1.2.5 Monitoring Requirements--

After soil treatment by solvent extraction and backfilling of the clean soil, the Booth Oil Site would not require any long-term monitoring. However, the groundwater from the site will need to be monitored at least quarterly during treatment. After the treatment is completed, it would be advisable to monitor the groundwater yearly to ensure that the levels of contaminants still comply with applicable SCGs.

3.2 ALTERNATIVE 2 - SOIL TREATMENT BY THERMAL SEPARATION AND GROUNDWATER PUMP AND TREAT SYSTEM

In this alternative, a thermal separation system would remove organics from the contaminated soil for subsequent off-site destruction by incineration. Treated soil would be backfilled on-site. Contaminated groundwater would be extracted and treated for NAPL, metals, and dissolved organics removal. The majority of the NAPL would be removed by a pumping system containing a sensor that differentiates between the nonaqueous and aqueous phases. The sensor activates a pump that removes floating NAPL as a separate phase from the groundwater. Non-floating NAPL removal would be accomplished with an oil/water separator. An iron-based coprecipitation system would precipitate the heavy metals. Either an air stripping/carbon adsorption, UV/Oxidation, or bioremediation/powdered carbon system would treat the groundwater for dissolved organics removal and/or destruction.

Descriptions of the aforementioned technologies are provided in Section 2. Specifically, thermal separation is discussed in Section 2.4.1.7. The groundwater extraction, oil/water separation, and dissolved organics treatment technologies are discussed in Sections 2.4.2.1, 2.4.2.2, and 2.4.2.3, respectively. A description of the iron-based coprecipitation system appears in Section 2.4.2.4.2.

3.2.1 Effectiveness

3.2.1.1 Short-Term Risks--

The major potential short-term risks of the thermal separation alternative are dust generated by excavation and stockpiling of the soil, and potential exposure of site workers and the nearby community to airborne contaminants. Dust can be minimized by keeping the excavated material wetted. Workers can limit their exposure to contaminants with the appropriate personal protective equipment.

If air stripping/carbon adsorption is the selected organics removal technology for contaminated groundwater, the air stream exiting the stripping tower would contain the stripped organics. If design analysis of the stripping tower indicate that the emissions would exceed permissible levels and pose a risk to the community, air pollution control equipment would be used to treat the air stream. A vapor-phase carbon or catalytic incineration system would be utilized to treat the stripped contaminants in the air stream.

3.2.1.2 Location of Treatment and Disposal--

Soil treatment with a thermal separation system and groundwater pump and treat would be performed on-site. Residuals from the treatment systems would be transported off-site for further treatment and/or disposal. Separated organics and NAPL would be transported off-site for destruction in a RCRA- and TSCA-permitted incinerator. Metal sludge and solids from the vapor scrubbing system of the thermal separator (if any) would be transported to an off-site RCRA facility for treatment and/or disposal. Any spent carbon from the dissolved organics treatment technology would be regenerated off-site.

3.2.1.3 Permanence of the Alternative--

The thermal separation treatment would be classified as a permanent remedy for the soil because the separated organics would be incinerated. With respect to the groundwater, UV/oxidation and bioremediation/powdered carbon would also destroy organics, and are thus considered permanent remedies. Organics adsorbed to the powdered carbon would be destroyed when the carbon is regenerated. Air stripping would remove the organics from the water but would not destroy them, unless a catalytic incineration system is used. Vapor phase carbon could also be used to remove the stripped organics from the air exiting the stripper; these organics would be destroyed when the carbon is regenerated. Thus, with a vapor treatment system, air stripping can be classified a permanent remedy.

No untreated hazardous waste remains at the site after remediation with the thermal separation alternative. All contaminated soil and groundwater is treated. Concentrated organics from the thermal separator, groundwater pumping system, and oil/water separator are destroyed off-site by incineration. Solids from the vapor scrubber of the thermal separator (if any) and the metal sludge from the iron-based coprecipitation unit are treated and/or disposed of at an off-site RCRA facility. Any spent carbon fron the dissolved organics treatment system is regenerated off-site. Treated soil is backfilled on-site.

3.2.1.4 Duration of the Alternative--

The Booth Oil Site contains approximately 30,000 cubic yards (cy) of contaminated soil. Assuming a density of 2700 pounds/cy, the soil weighs approximately 40,500 tons. Thermal separation system vendors indicate that a thermal separation system can treat approximately 125 tons of soil per day. Remediation of the soil with a thermal separation system that can process 125 tons of soil per day with an 80 percent online availability can be completed in approximately 1.2 years. Including mobilization and set-up, off-site transportation and incineration of the separated organics, backfilling of the site with the cleaned soil, and demobilization, the soil treatment could be completed in approximately 1.6 years.

The time for completion of the groundwater treatment component of the alternative cannot be predicted with certainty at this time. Most likely, treatment of the groundwater to comply with applicable SCGs will require at least two, and possibly up to ten, years. This is because the soil at the site is clayey and tends to adsorb the organic contaminants. An undetermined number of pore volumes will need to be withdrawn and treated in order to reduce the concentrations of the contaminants to acceptable levels.

3.2.2 **Implementability**

3.2.2.1 Difficulty in Construction--

The technologies of the thermal separation alternative can be constructed without signnificant difficulty. The main difficulty in the construction is the lack of available space at the Booth Oil Site. Most of the site contains contamination and requires remediation. Only a small area of the site contains available, uncontaminated space. The thermal separation system may require a space as large as 15,000 square feet. In order to accomodate such a system, it may be necessary to first excavate contaminated soil from a portion of the site, then backfill with clean soil from off-site, to create a space for the system.

3.2.2.2 Reliability in Meeting SCGs--

Several thermal separation systems are on the market, each being different from the others. The three systems described in Section 2 may be very reliable in reducing the levels of contaminants in the soil below the applicable SCGs. In order to function reliably, the systems first need to be optimized during treatability tests. These tests would determine the optimal operating parameters, such as feed rate, temperature, and residence time. If the optimal parameters are used, the system should be able to reduce contaminants to acceptable risk levels. No future remedial actions would be necessary.

The groundwater treatment technologies would be very reliable in reducing the concentrations of contaminants in the treated groundwater below the applicable SCGs. Air stripping/carbon adsorption, UV/oxidation, and bioremediation/powdered carbon have been proven to achieve removal efficiencies for organic contaminants exceeding 99 percent. After optimization, they could remove contaminants from the groundwater at the Booth Oil Site to acceptable risk levels. No future remedial actions would be necessary.

3.2.2.3 Coordination with Other Agencies--

The thermal separation alternative would require normal coordination with other agencies. If air stripping is selected as the organics removal option, an air permit would be needed from the NYSDEC Division of Air Resources. Off-site transportation and disposal or treatment of separated organics, NAPL, metal sludge, vapor scrubber solids (if any), and spent carbon (if any) must comply with USDOT hazardous materials shipment regulations and RCRA regulations for the transportation, disposal, and treatment of hazardous waste. For groundwater discharge to the storm water sewer, a NYSPDES permit from the NYSDEC Division of Water Resouces would be required. Approval and/or a permit from the North Tonawanda Sewage Treatment Plant would be needed for a groundwater discharge to the sanitary sewer.

3.2.2.4 Availability of Technologies--

All technologies in the thermal separation alternative are commercially marketed. Several vendors market thermal separation systems. The three systems discussed in Section 2 appear capable of treating the mix of contaminants in the soil at the Booth Oil Site. Numerous vendors could bid on the groundwater treatment technologies.

3.2.2.5 Monitoring Requirements--

After soil treatment by thermal separation and backfilling of the clean soil, the Booth Oil Site would not require any long-term monitoring. However, the groundwater from the site will need to be monitored at least quarterly during treatment. After the treatment is completed, it would be advisable to monitor the groundwater yearly to ensure that the levels of contaminants still comply with applicable SCGs.

3.3 ALTERNATIVE 3 - SOIL TREATMENT BY ON-SITE INCINERATION AND GROUNDWATER PUMP AND TREAT SYSTEM

In this alternative, contaminated soil would be excavated and treated in an on-site incineration system. Treated soil would be backfilled on-site. Contaminated groundwater would be extracted and treated for NAPL, metals, and dissolved organics removal prior to discharge. The majority of the NAPL would be removed by a pumping system containing a sensor that differentiates between the nonaqueous and aqueous phases. The sensor activates a pump that removes the floating NAPL as a separate phase from the groundwater. An oil/water separator would remove any non-floating NAPL. Metals would be precipitated in an iron-based coprecipitation system. Dissolved organics would be removed by either air stripping/carbon adsorption, UV/oxidation, or bioremediation/powdered carbon.

Descriptions of the technologies are presented in Section 2. Specifically, incineration is discussed in Section 2.4.1.8. The groundwater extraction, oil/water separation, and dissolved organics treatment technologies are discussed in Sections 2.4.2.1, 2.4.2.2, and 2.4.2.3, respectively. A description of the iron-based coprecipitation system appears in Section 2.4.2.4.2.

3.3.1 **Effectiveness**

3.3.1.1 Short-Term Risks--

The main potential short-term risks of the on-site incineration alternative are dust generated during excavation and stockpiling of the soil, exposure of site workers and the nearby community to airborne contaminants, and untreated air emissions from the incinerator. Dust can be controlled by keeping the excavated material wetted. Workers can minimize their exposure to contaminants by wearing personal protective equipment. Air emissions from the incinerator would be reduced to acceptable levels by efficient scrubbers and/or baghouses.

If air stripping/carbon adsorption is the selected organics removal technology, the air stream exiting the stripping tower would contain the stripped organics. If design analysis of the stripping tower indicate that the emissions would exceed permissible levels and pose a risk to the community, air pollution control equipment would be used to treat the air stream. A vapor-phase carbon or catalytic incineration system would be utilized to treat the stripped contaminants in the air stream.

3.3.1.2 Location of Treatment and Disposal--

Soil treatment with an on-site incineration system and groundwater treatment is performed on-site. Residuals from the treatment systems would be transported off-site for further treatment and/or disposal. NAPL removed by the pumping system and oil/water separator would be transported off-site for destruction in a RCRA- and TSCA-permitted incinerator. Metal sludge from the iron-based coprecipitation unit and solids from the vapor scrubber of the incinerator would de treated and/or disposed of at an off-site RCRA facility. Any spent carbon fron the dissolved organics treatment technology would be regenerated off-site.

3.3.1.3 Permanence of the Alternative--

On-site incineration can be classified as a permanent remedy for the soil because the technology destroys the organic compounds present. With respect to the groundwater, UV/oxidation and bioremediation/powdered carbon would also destroy organics, and are thus considered permanent remedies. Organics adsorbed to the powdered carbon would be destroyed when the carbon is regenerated. Air stripping would remove the organics from the water but would not destroy them, unless a catalytic incineration system is used. Vapor phase carbon could also be used to remove the stripped organics from the air exiting the stripper; these organics would be destroyed when the carbon is regenerated. Thus, with a vapor treatment system, air stripping can be considered a permanent remedy.

No untreated hazardous waste remains at the site after remediation with the on-site incineration alternative. All soil and groundwater is treated in the alternative. Organics in the soil are incinerated. NAPL removed by the pumping system and oil/water separator are incinerated off-site. Solids from the vapor scrubber of the on-site incinerator and the metal sludge from the iron-based coprecipitation unit would be treatted and/or disposed of at an off-site RCRA facility. Any spent carbon from the dissolved organics treatment system would be regenerated off-site. Treated soil is backfilled on-site.

3.3.1.4 Duration of the Alternative--

The Booth Oil Site contains approximately 30,000 cubic yards (cy) of contaminated soil. Assuming a density of 2700 pounds/cy, the soil weighs approximately 40,500 tons. Vendors of on-site incineration systems indicate that their systems can process five tons of soil per hour. Remediation of the soil with an on-site incineration system that treats 5 tons of soil per hour with an 80 percent online availability can be completed in approximately 1.2 years. Including mobilization and set-up, backfilling of the site with the clean soil, and demobilization, the soil treatment could be completed in approximately 1.6 years.

The time for completion of the groundwater treatment component of the alternative cannot be predicted with certainty at this time. Most likely, treatment of the groundwater to comply with applicable SCGs will require at least two, and possibly up to ten, years. This is because the soil at the site is clayey and tends to adsorb the organic contaminants. An undetermined number of pore volumes will need to be withdrawn and treated in order to reduce the concentrations of the contaminants to acceptable levels.

3.3.2 Implementability

3.3.2.1 Difficulty in Construction--

The technologies of the on-site incineration alternative would not be difficult to construct. A potential uncertainty in construction is the availability of space for siting the treatment system. The Booth Oil Site has only a very small area that is uncontaminated and usable for placement of the treatment technologies. On-site incineration systems may require between 2,500 and 40,000 square feet of area for set-up, depending on the system selected. If a large system is chosen, it would be necessary to first excavate an area of the site, and then backfill with clean soil from off-site, to create a space for the system.

3.3.2.2 Reliability in Meeting SCGs--

On-site incinerators that are RCRA- and TSCA-permitted have been marketed for several years. The types of incinerators include rotary kiln, infrared, and circulating fluidized bed. These three systems, described in Section 2, would be very reliable in reducing the levels of contaminants in the soil below the applicable SCGs. In order to function reliably, the systems first need to be optimized with treatability tests. These tests would determine the optimal values of operating parameters, such as feed rate, temperature, excess air, and residence time. If the optimal parameters are used, the system would be able to reduce contaminants to acceptable risk level. No future remedial actions would be necessary.

The groundwater treatment technologies would be very reliable in reducing the concentrations of contaminants in the treated groundwater below the applicable SCGs. Air stripping/carbon adsorption, UV/oxidation, and bioremediation/powdered carbon have been proven to achieve removal efficiencies for organic contaminants exceeding 99 percent. After optimization, they could remove contaminants from the groundwater at the Booth Oil Site to acceptable risk levels. No future remedial actions would be necessary.

3.3.2.3 Coordination with Other Agencies--

The on-site incineration alternative would require extensive coordination with other agencies. The incinerator would need an air permit from the NYSDEC Division of Air Resources and a RCRA permit. If air stripping is selected as the organics removal option, an air permit also would be needed from the NYSDEC Division of Air Resources. Off-site transportation and disposal or treatment of NAPL, metal sludge, vapor scrubber solids, and spent carbon (if any) must comply with USDOT hazardous materials shipment regulations and RCRA regulations for the shipment, disposal, and treatment of hazardous waste. For groundwater discharge to the storm water sewer, a NYSPDES permit from the

NYSDEC Division of Water Resouces would be required. Approval and/or a permit from the North Tonawanda Sewage Treatment Plant would be needed for a groundwater discharge to the sanitary sewer.

3.3.2.4 Availability of Technologies--

All technologies in the on-site incineration alternative are commercially marketed. Several vendors market on-site incineration systems, and there are several remediation contractors that have purchased and now operate such systems. Those systems discussed in Section 2 appear capable of treating the mix of contaminants in the soil at the Booth Oil Site. Numerous vendors could bid on the groundwater treatment technologies.

3.3.2.5 Monitoring Requirements--

After soil treatment by on-site incineration and backfilling of the clean soil, the Booth Oil Site would not require any long-term monitoring. However, the groundwater from the site will need to be monitored at least quarterly during treatment. After the treatment is completed, it would be advisable to monitor the groundwater yearly to ensure that the levels of contaminants still comply with applicable SCGs.

3.4 ALTERNATIVE 4 - SOIL TREATMENT BY OFF-SITE INCINERATION AND GROUNDWATER PUMP AND TREAT SYSTEM

In this alternative, contaminated soil at the Booth Oil Site would be excavated and transported to an off-site incinerator for treatment. Ground water at the site would be extracted and treated for NAPL, metals, and dissolved organics removal prior to discharge. The majority of the NAPL would be removed by a pumping system containing a sensor that differentiates between the nonaqueous and aqueous phases. The sensor activates a pump that removes floating NAPL as a separate phase from the groundwater. An oil/water separator would remove the non-floating NAPL. An iron-based coprecipitation system would precipitate the heavy metals. Dissolved organics would be removed by either an air stripping/carbon adsorption, UV/Oxidation, or bioremediation/powdered carbon system.

Descriptions of the technologies are provided in Section 2. Specifically, incineration is discussed in Section 2.4.1.8. The groundwater extraction, oil/water separation, and dissolved organics treatment technologies are discussed in Sections 2.4.2.1, 2.4.2.2, and 2.4.2.3, respectively. A description of the iron-based coprecipitation system appears in Section 2.4.2.4.2.

3.4.1 Effectiveness

3.4.1.1 Short-Term Risks--

The major potential short-term risks of the off-site incineration alternative are dust generated during excavation of the contaminated soil, site worker and community exposure to airborne contaminants during excavation, and release of soil from trucks during transportation incidents. Dust can be controlled by keeping the excavated material wetted. Workers can minimize their exposure to contaminants with personal protective equipment.

If air stripping/carbon adsorption is the selected organics removal technology, the air stream exiting the stripping tower would contain the stripped organics. If design analysis of the stripping tower indicate that the emissions would exceed permissible levels and pose a risk to the community, air pollution control equipment would be used to treat the air stream. A vapor-phase carbon or catalytic incineration system would be utilized to treat the stripped contaminants in the air stream.

3.4.1.2 Location of Treatment and Disposal--

The off-site incineration alternative provides off-site treatment of the contaminated soil and on-site treatment of the contaminated groundwater. Residuals from the groundwater treatment system would be transported off-site for further treatment and/or disposal. NAPL removed by the pumping system and oil/water separator would be transported off-site for destruction in a TSCA-permitted incinerator. Metal sludge from the iron-based coprecipitation unit would be treated and disposed of at an off-site RCRA facility. Any spent carbon from the dissolved organics removal system would be regenerated off-site.

3.4.1.3 Permanence of the Alternative--

Off-site incineration can be classified as a permanent remedy for the soil because the technology destroys the organic compounds present. With respect to the groundwater, UV/oxidation and bioremediation/powdered carbon would also destroy organics, and are thus considered permanent remedies. Organics adsorbed to the powdered carbon would be destroyed when the carbon is regenerated. Air stripping would remove the organics from the water but would not destroy them, unless a catalytic incineration system is used. Vapor phase carbon could also be used to remove the stripped organics from the air exiting the stripper; these organics would be destroyed when the carbon is regenerated. Thus, with a vapor treatment system, air stripping can be considered a permanent remedy.

No untreated hazardous waste or treated residual remains at the site after remediation with the off-site incineration alternative. All contaminated soil and groundwater is treated in the alternative. The soil is incinerated off-site. NAPL removed by the pumping system and oil/water separator are incinerated off-site. Solids from the vapor scrubber of the on-site incinerator and the metal sludge from the iron-based coprecipitation unit are treated and/or disposed of at an off-site RCRA facilty. Any spent carbon from the dissolved organics removal system would be regenerated off-site.

3.4.1.4 Duration of the Alternative--

The Booth Oil Site contains approximately 30,000 cubic yards (cy) of contaminated soil. Assuming a density of 2700 pounds/cy, the soil weighs approximately 40,500 tons. A few off-site incinerators have indicated that they can treat 110 tons of soil per day. Remediation of the soil with an off-site incineration system(s) that burns 110 tons of soil per day can be completed in approximately 1.1 years. Including mobilization and set-up, off-site transportation and incineration of the soil, backfilling of the site with off-site backfill, and demobilization, the soil treatment could be completed in approximately 1.5 years.

The time for completion of the groundwater treatment component of the alternative cannot be predicted with certainty at this time. Most likely, treatment of the groundwater to comply with applicable SCGs will require at least two, and possibly up to ten, years. This is because the soil at the site is clayey and tends to adsorb the organic contaminants. An undetermined number of pore volumes will need to be withdrawn and treated in order to reduce the concentrations of the contaminants to acceptable levels.

3.4.2 **Implementation**

3.4.2.1 Difficulty in Construction--

The technologies of the off-site incineration alternative would be easily constructed. Off-site incinerators are currently in operation. The groundwater treatment units could be assembled on-site.

3.4.2.2 Reliability in Meeting SCGs--

Off-site rotary kiln incinerators would be very reliable in reducing the levels of contaminants in the soil below the applicable SCGs. In order to function reliably, the systems first need to be optimized during treatability tests. These tests would determine the optimal values of operating parameters, such as feed rate, temperature, excess air, and residence time. If the optimal parameters are used, the system would be able to reduce contaminants to acceptable risk levels. No future remedial actions would be necessary.

The groundwater treatment technologies would be very reliable in reducing the concentrations of contaminants in the treated groundwater below the applicable SCGs. Air stripping/carbon adsorption, UV/oxidation, and bioremediation/powdered carbon have been proven to achieve removal efficiencies for organic contaminants exceeding 99 percent. After optimization, they could remove contaminants from the groundwater at the Booth

Oil Site to acceptable risk levels. No future remedial actions would be necessary.

3.4.2.3 Coordination with Other Agencies--

The off-site incineration alternative would require normal coordination with other agencies. If air stripping is selected as the organics removal option, an air permit also would be needed from the NYSDEC Division of Air Resources. Off-site transportation of NAPL, metal sludge, and spent carbon (if any) must comply with USDOT hazardous materials shipment regulations and RCRA regulations for the transportation, disposal, and treatment of hazardous waste. For groundwater discharge to the storm water sewer, a NYSPDES permit from the NYSDEC Division of Water Resouces would be required. Approval and/or a permit from the North Tonawanda Sewage Treatment Plant would be needed for a groundwater discharge to the sanitary sewer.

3.4.2.4 Availability of Technologies--

All technologies in the off-site incineration alternative are commercially marketed. Several off-site incinerators are currently operating. Numerous vendors could bid on the groundwater treatment technologies.

3.4.2.5 Monitoring Requirements--

After excavation and transportation of the contaminated soil to the off-site incinerator, clean backfill would be placed at the Booth Oil Site. The site would not require any long-term monitoring. However, the groundwater from the site will need to be monitored at least quarterly during treatment. After the treatment is completed, it would be advisable to monitor the groundwater yearly to ensure that the levels of contaminants still comply with applicable SCGs.

3.5 ALTERNATIVE 5 - SOIL TREATMENT BY STABILIZATION/SOLIDIFICATION AND GROUNDWATER PUMP AND TREAT SYSTEM

In this alternative, contaminated soil would be excavated and mixed with chemical stabilizing agents and cement or pozzolans and water either on-site or at an off-site RCRA facility to form a stabilized solid. If the stabilization is performed on-site, the solid produced would be placed on-site and covered with a cap. If the process is performed at a RCRA facility, the solid would be landfilled at the facility. Contaminated groundwater would be extracted and treated for removal of NAPL, metals, and dissolved organics prior to discharge. The majority of the NAPL would be removed by a pumping system containing a sensor that differentiates between the nonaqueous and aqueous phases. The sensor activates a pump to remove floating NAPL as a separate phase from the groundwater. An oil/water separator would remove the non-floating NAPL for incineration. Metals would be precipitated in an iron-based coprecipitation system. Either an air stripping/carbon adsorption, UV/oxidation, or bioremediation/powdered carbon system would remove and/or destroy the dissolved organics.

Descriptions of the technologies are provided in Section 2. Specifically, stabilization/solidification is discussed in Section 2.4.1.3. The groundwater extraction, oil/water separation, and dissolved organics treatment technologies are discussed in Sections 2.4.2.1, 2.4.2.2, and 2.4.2.3, respectively. A description of the iron-based coprecipitation system appears in Section 2.4.2.4.2.

3.5.1 Effectiveness

3.5.1.1 Short-Term Risks--

The major potential short-term risks of the stabilization/solidification alternative are dust generated during excavation and stockpiling of the soil, exposure of site workers and the nearby community to airborne contaminants during excavation and treatment of the soil, and release of the solidified material from the trucks during transportation incident. Dust can be controlled by keeping the excavated material wetted. Workers can minimize their exposure to contaminants with personal protective equipment.

If air stripping/carbon adsorption is the selected organics removal technology, the air stream exiting the stripping tower would contain the stripped organics. If design analysis of the stripping tower indicate that the emissions would exceed permissible levels and pose a risk to the community, air pollution control equipment would be used to treat the air stream. A vapor-phase carbon or catalytic incineration system would be utilized to treat the stripped contaminants in the air stream.

3.5.1.2 Location of Treatment and Disposal--

Soil treatment by stabilization/solidification may be performed on-site or off-site. The groundwater treatment would be performed on-site. The solid from the stabilization process would be placed on-site if the process is performed on-site. The solid would be landfilled at an off-sit RCRA facility if the stabilization process is performed off-site. The metals sludge produced by the iron-based coprecipitation unit would be treated and disposed of at an off-site RCRA facility. NAPL removed by the pumping system and oil/water separator would be detroyed in an off-site TSCA-permitted incinerator. Any spent carbon from the dissolved organics treatment system would be regenerated off-site.

See [illegible] + EPA thinking?

3.5.1.3 Permanence of the Alternative--

Stabilization/solidification would not be classified as a permanent remedy for the soil. NYSDEC does not consider stabilization/solidification of waste containing organic compounds to be a permanent remedy. However, the stabilization/solidification systems discussed in Section 2 have been proven effective in stabilizing waste containing a variety of the organics present at the Booth Oil Site. With respect to the groundwater, UV/oxidation and bioremediation/powdered carbon would destroy organics, and are thus considered permanent remedies. Organics adsorbed to the powdered carbon would be destroyed when the carbon is regenerated. Air stripping would remove the organics from the water but would not destroy them, unless a catalytic incineration system is used. Vapor phase carbon could also be used to remove the stripped organics from the air exiting the stripper; these organics would be destroyed when the carbon is regenerated. Thus, with a vapor treatment system, air stripping can be considered a permanent remedy.

No untreated hazardous waste remains at the site after remediation with the stabilization/solidification alternative. All contaminated soil and groundwater is treated in the alternative. The soil is stabilized/solidified. If it is stabilized on-site, the solid produced is placed on-site. If the soil is stabilized off-site, the solid produced is landfilled off-site. NAPL removed by the pumping system and oil/water separator is incinerated off-site. The metal sludge from the iron-based coprecipitation unit are treated and disposed of at an off-site RCRA facility. Any spent carbon from the dissolved organics treatment system is regenerated off-site.

3.5.1.4 Duration of the Alternative--

9 Bulk

The Booth Oil Site contains approximately 30,000 cubic yards (cy) of contaminated soil. Assuming a density of 2700 pounds/cy, the soil weighs approximately 40,500 tons. Stabilization/solidification vendors indicate that systems can process 80 cy of soil per hour. Remediation of the soil with a stabilization/solidification system that can treat 80 cy of soil per hour with an 80% online availability can be completed in approximately 1 month. Including mobilization and set-up, stabilization/solidification and on-site placement of the stabilized solid, and demobilization, the soil treatment could be completed in approximately 6 months.

The time for completion of the groundwater treatment component of the alternative cannot be predicted with certainty at this time. Most likely, treatment of the groundwater to comply with applicable SCGs will require at least two, and possibly up to ten, years. This is because the soil at the site is clayey and tends to adsorb the organic contaminants. An undetermined number of pore volumes will need to be withdrawn and treated in order to reduce the concentrations of the contaminants to acceptable levels.

3.5.2 Implementability

ORGRS

3.5.2.1 Difficulty in Construction--

The technologies of the stabilization/solidification alternative would not be difficult to construct. Commercial stabilization/solidification system require minimal space; one system occupies only 1,000 square feet of space. In situ stabilization systems would not require a permanent space for set-up because the equipment would be moved over the site to treat the soil in-place. The groundwater treatment technologies could be set up on-site.

3.5.2.2 Reliability in Meeting SCGs--

Numerous vendors market stabilization/solidification technologies. Some have been proven for treating organics and inorganics together, while others are only able to treat waste containing inorganics. At the Booth Oil Site, a stabilization/solidification system would need to treat both organics and inorganics. A few of the proven systems may reliably stabilize the mix of contaminants at the site, reducing their leachability sufficiently. To perform reliably, the system would need to be optimized during treatability studies. During the tests, the optimal values for operating parameters, such as additive/cement/waste ratio and mixing and curing times, would be determined. The system then would be able to stabilize/solidify the waste to an acceptable risk level. No future remedial action would be anticipated.

The groundwater treatment technologies would be very reliable in reducing the concentrations of contaminants in the treated groundwater below the applicable SCGs. Air stripping/carbon adsorption, UV/oxidation, and bioremediation/powdered carbon have been proven to achieve removal efficiencies for organic contaminants exceeding 99 percent. After optimization, they could remove contaminants from the groundwater at the Booth Oil Site to acceptable risk levels. No future remedial actions would be necessary.

3.5.2.3 Coordination with Other Agencies--

The stabilization/solidification alternative would require normal coordination with other agencies. Off-site transportation and disposal or treatment of the stabilized solid, NAPL, metal sludge, and spent carbon (if any) must comply with USDOT hazardous materials shipment regulations and RCRA regulations for the transportation, treatment, and disposal of hazardous waste. If air stripping is selected as the organics removal option, an air permit would be needed from the NYSDEC Division of Air Resources. For groundwater discharge to the storm water sewer, a NYSPDES permit from the NYSDEC Division of Water Resouces would be required. Approval and/or a permit from the North Tonawanda Wastewater Treatment Plant would be needed for a groundwater discharge to the sanitary sewer.

3.5.2.4 Availability of Technologies--

All technologies in the stabilization/solidification alternative are commercially marketed. Numerous vendors market stabilization/solidification systems, although only a few sell systems that are proven on the contaminants at the Booth Oil Site. Numerous vendors could bid on the groundwater treatment technologies.

3.5.2.5 Monitoring Requirements--

The Booth Oil Site may require long-term montoring after completion of this remedial alternative, depending on whether the stabilization/solidification process is performed on-site or off-site. If the process is performed on-site and the stabilized solid is placed back on-site, the site will require a minimum of 30 years groundwater monitoring and maintenance. If the process is performed off-site and clean backfill is placed on-site, long-term monitoring would not be required. Groundwater from the site will need to be monitored at least quarterly during treatment. After the treatment is completed, it would be advisable to monitor the groundwater yearly to ensure that the levels of contaminants still comply with applicable SCGs.

3.6 ALTERNATIVE 6 - CONTAINMENT AND GROUNDWATER PUMP AND TREAT SYSTEM

In this alternative, the contaminated soil would remain at the site. Soil hot spots may be excavated and transported off-site for incineration. The contaminated soil at the site would be isolated by placing a slurry wall around the site and/or covering the site with an appropriate cap. The groundwater at the site would be extracted and treated for removal of NAPL, metals, and dissolved organics prior to discharge. The majority of the NAPL would be removed with a scavenger pump containing a sensor that differentiates between the nonaqueous and aqueous phases. The sensor activates the pump to remove floating NAPL as a separate phase from the water. An oil/water separator would remove the non-floating NAPL for incineration. Metals would be precipitated in an iron-based coprecipitation system. Either air stripping/carbon adsorption, UV/oxidation, or bioremediation/powdered carbon would remove and/or destroy the dissolved organics in the groundwater.

Descriptions of the technologies are presented in Section 2. Specifically, containment technologies are discussed in Section 2.4.1.2. The groundwater extraction, oil/water separation, and dissolved organics treatment technologies are discussed in Sections 2.4.2.1, 2.4.2.2, and 2.4.2.3, respectively. A description of the iron-based coprecipitation system appears in Section 2.4.2.4.2.

3.6.1 Effectiveness

3.6.1.1 Short-Term Risks--

The major potential short-term risks of the containment alternative would be dust generated during construction of the slurry wall, and site worker and community exposure to airborne contaminants during excavation. These risks would be less than those for the other five alternatives because only the soil where the slurry wall will be placed is excavated. This soil will not contain as great a quantity of contaminants as the soil excavated from the entire site. Dust can be controlled by keeping the excavated material wetted. Workers can minimize their exposure to contaminants by wearing appropriate personal protective equipment.

If air stripping/carbon adsorption is the selected organics removal technology, the air stream exiting the stripping tower would contain the stripped organics. If design analysis of the stripping tower indicate that the emissions would exceed permissible levels and pose a risk to the community, air pollution control equipment would be used to treat the air stream. A vapor-phase carbon or catalytic incineration system would be utilized to treat the stripped contaminants in the air stream.

3.6.1.2 Location of Treatment and Disposal--

The containment alternative combines isolation technology with on-site treatment technologies. After hot spot excavation, the soil would be isolated in place by the slurry wall and cap. The groundwater would be extracted and treated on-site to remove NAPL, metals, and dissolved organics. Residuals from the groundwater treatment processes would be transported off-site for treatment and/or disposal. The metal sludge produced by the iron-based coprecipitation unit would be treated and disposed of at an off-site RCRA facility. NAPL removed by the pumping system and oil/water separator would be destroyed in an off-site TSCA-permitted incinerator. Any spent carbon from the dissolved organics treatment technology would be regenerated off-site.

3.6.1.3 Permanence of the Alternative--

The containment alternative cannot be considered permanent for the soil. The soil that is not excavated as a hot spot would remain in place without treatment. With respect to the groundwater, UV/oxidation and bioremediation/powdered carbon would destroy organics, and are thus considered permanent remedies. Organics adsorbed to the powdered carbon would be destroyed when the carbon is regenerated. Air stripping would remove the organics from the water but would not destroy them, unless a catalytic incineration system is used. Vapor phase carbon could also be used to remove the stripped organics from the air exiting the stripper; these organics would be destroyed when the carbon is regenerated. Thus, with a vapor treatment system, air stripping would be considered a permanent remedy.

Contaminated soil that is not excavated as a hot spot would remain at the site as untreated hazardous waste. This quantity of soil would be greater than 50 percent of the total amount of waste. No treated residual would remain at the site. NAPL, metal sludge, and spent carbon (if any) from the groundwater treatment system would be transported off-site for treatment or disposal.

3.6.1.4 Duration of the Alternative--

A slurry wall around the perimeter of the Booth Oil Site would be approximately 1200 feet in length. It would key into a continuous clay layer beneath the site. Construction of this wall could be accomplished in approximately 1 month, according to a contractor who constructs slurry walls. A cap over the site would cover 3.9 acres; it could be constructed in approximately 4 months. Including mobilization and set-up, excavation and treatment of hot spots, construction of the slurry wall and cap, and demobilization, the containment action would require 9 months for completion.

The time for completion of the groundwater treatment component of the alternative cannot be predicted with certainty at this time. Most likely, treatment of the groundwater to comply with applicable SCGs will require at least two, and possibly up to ten, years. This is because the soil at the site is clayey and tends to adsorb the organic contaminants. An undetermined number of pore volumes will need to be withdrawn and treated in order to reduce the concentrations of the contaminants to acceptable levels.

3.6.2 Implementability

3.6.2.1 Difficulty in Construction--

A slurry wall for the Booth Oil site may be somewhat difficult to construct. To completely encircle the site, the wall would need to be constructed under small widths of the railroad tracks. To do this, the vendor would construct a concrete barrier wall to support the tracks. The slurry wall would be placed beneath the concrete barrier. For this construction, the railroad probably would need to be disturbed. Coordination with the railroad would be necessary in this situation.

The Booth Oil Site is divided into two parcels by railroad tracks. The cap system for the site would be constructed over these parcels. It would not be a continuous cap. The gap between the cap would present an opening for the infiltration of surface water. This situation is not desirable because the water could contact the contaminated soil.

3.6.2.2 Reliability in Meeting SCGs--

A slurry wall and cap system would minimize the infiltration of surface water to the contaminated soil by covering the contaminated soil. However, as noted above, infiltration could still occur through the gaps between the caps. It would prevent the migration of contaminated groundwater to and from the site. Also, it would inhibit human contact with the soil at the site. Thus, the technology would reduce the risk to acceptable levels at the site. The site would comply with health-based SCGs.

A problem for the slurry wall may be the concentrations of magnesium and calcium in the groundwater at the site. If a soil bentonite slurry is used, the calcium and magnesium would displace the sodium from the bentonite. This chemical attack would cause a two- to five-fold increase in the permeability of the wall. This increase in permeability would decrease the effectiveness of the wall in containing the groundwater.

3.6.2.3 Coordination with Other Agencies--

The containment alternative requires normal coordination with other agencies. Off-site transportation and treatment or disposal of NAPL, metal sludge, and spent carbon (if any) from the groundwater treatment system must comply with USDOT regulations for shipment of hazardous material and RCRA regulations on the transportation, disposal, and treatment of hazardous waste. An air permit for the stripping tower would be needed if air stripping is selected as the organics removal technology. For groundwater discharge to the storm water sewer, a NYSPDES permit from the NYSDEC Division of Water Resouces would be required. A permit from the North Tonawanda Wastewater Treatment Plant would be needed for a groundwater discharge to the sanitary sewer. Coordination with Conrail would be required for construction of the slurry wall.

3.6.2.4 Availability of Technologies--

All technologies in the containment alternative are commercially available. Numerous vendors construct slurry walls and caps. Numerous vendors could bid on the groundwater treatment technologies.

3.6.2.5 Monitoring Requirements--

After isolation of the site with a slurry wall and cap system, the site would require a minimum of 30 years of groundwater monitoring and maintenance. A closure plan would need to be developed for the site. The groundwater from the site will need to be monitored at least quarterly. The monitoring will indicate progress towards meeting the applicable SCGs.

Section 4

SECTION 4

CONCLUSION

The Phase I/II FS was prepared to assess potential remedial alternatives for the Booth Oil Inactive Hazardous Waste Site located in North Tonawanda, Niagara County, New York. The FS was performed in comformance with the NYSDEC TAGM. In the report, remedial alternatives for the Booth Oil Site were developed as part of the Phase I FS. The alternatives were screened for effectiveness and implementability as part of Phase II to determine which will be evaluated in the Detailed Analysis of Alternatives as part of the Phase III FS.

The Phase I FS identified and screened the following eleven technologies for remediation of contaminated soil:

- Containment technolgoes (RCRA cap and slurry wall),
- Stabilization/solidification processes,
- Solvent extraction processes,
- Dechlorination processes,
- Wet air oxidation,
- Thermal separation processes,
- Incineration processes (off-site and on-site),
- In situ vitrification,

- Bioremediation, and
- Soil vapor extraction.

The Phase I initial screening concluded that the following soil remediation technologies would be retained for further evaluation in Phase II: containment technologies (RCRA cap and slurry wall), solvent extraction, thermal separation, incineration, and stabilization/solidification.

With respect to groundwater, the Phase I FS identified and screened technologies for each of the following components of a groundwater remediation program: extraction technologies, NAPL removal technologies, organics treatment, metals treatment, and treated groundwater discharge. Specifically, the following technologies were evaluated and screened:

- Groundwater extraction: extraction wells and trench drains,
- NAPL removal: oil/water separation,
- Organics treatment: air stripping, granular carbon adsorption, ultraviolet (UV) light enhanced oxidation, and a combination of bioremediation and powdered activated carbon adsorption,
- Metals treatment: pH adjustment/precipitation, iron-based coprecipitation, and ion exchange, and
- Treated groundwater discharge: sanitary sewer, storm water sewer/NYSPDES permit, and groundwater replenishment via injection wells or infiltration basins.

With the exception of pH adjustment/precipitation and ion exchange, the Phase I FS concluded that each of the above technologies would be carried forward for further evaluation in Phase II.

In Phase II of the FS, the potential remedial action technologies for soil and groundwater treatment that passed the initial screening were combined into six potential remedial action alternatives. These alternatives are:

- Soil treatment by solvent extraction and a groundwater pump and treat system,
- Soil treatment by thermal separation and a groundwater pump and treat system,
- Soil treatment by on-site incineration and a groundwater pump and treat system,
- Soil treatment by off-site incineration and a groundwater pump and treat system,
- Soil treatment by stabilization/solidification and a groundwater pump and treat system, and
- Containment and a groundwater pump and treat system.

Each alternative was evaluated for effectiveness and implementability in accordance with the NYSDEC TAGM. This included both a discussion of effectiveness and implementability, and completion of the TAGM scoresheets. Each of the six alternatives appear promising for the Booth Oil Site, and will be carried forward for detailed analysis as part of the Phase III FS.

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Appendix A

APPENDIX A

NYSDEC Technical and Administrative Guidance Memorandum on Selection of Remedial Actions at Inactive Hazardous Waste Sites

15 (12-75)

C. Allen

New York State Department of Environmental Conservation

HWR-90-4030
REVISED MAY 1 5 [illegible]

MEMORANDUM

TO: Regional Hazardous Waste Remediation Engineers, Bureau Directors & Section Chiefs
FROM: Michael J. O'Toole, Jr., Director, Division of Hazardous Waste Remediation
SUBJECT: REVISED TAGM - SELECTION OF REMEDIAL ACTIONS AT INACTIVE HAZARDOUS WASTE SITES
DATE: MAY 1 5 1990

Attached is the revised Division Technical and Administrative Guidance Memorandum on Selection of Remedial Actions at Inactive Hazardous Waste Sites in its final form. The revisions are minor in nature and do not change the contents of the TAGM, originally issued on September 13, 1989.

The revision of the September 13, 1989 TAGM includes the following:

1. "Hierarchy of Remedial Technologies"

   Section 2.1 is revised to clarify the desirability of off-site land disposal of hazardous wastes.

2. Since New York State does not have ARARs in its statute and to avoid misinterpretation of New York State requirements, changes are made to replace "ARARs" with New York State Standards, Criteria and Guidelines (SCGs).

3. In accordance with the referenced TAGM, an alternative which does not meet the State Standards, Criteria and Guidelines (SCGs) and if a waiver to a SCG is not appropriate or justifiable such an alternative should not be further considered. It is possible that several alternatives may be dropped during the detailed analysis. Section 5.2.3 is rearranged so that alternatives are evaluated for criteria in the following order:

   (i) Compliance with New York SCGs;
   (ii) Protection of human health and the environment;
   (iii) Short-term effectiveness;
   (iv) Long-term effectiveness and permanence;
   (v) Reduction of toxicity, mobility and volume;
   (vi) Implementability; and
   (vii) Cost.

4. Tables 4.1 and 5.1 to 5.7 are slightly modified to reflect the changes made in the text.

This TAGM has been effective since September 13, 1989 and should be used for evaluation and selection of remedial alternatives for all new RI/FS and some on-going projects.

Attachment

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MAY 1 5 1990

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4030 REVISED	5/15/90	Selection of Remedial Actions at Inactive Hazardous Waste Sites	Program Management
4031	10/27/89	Fugitive Dust Suppression and Particulate Monitoring Program at Inactive Hazardous Waste Sites	Western Remedial Action
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4035	3/26/90	Project Manager and Contract Manager Responsibilities Under Standby Contract	Program Management
4036	3/29/90	Landfill Regulatory Responsibility	Eastern Remedial Action
4037	4/09/90	Major Milestone Dates for Tracking Remedial Projects	Program Management
4038	4/26/90	Remediation of Inactive Hazardous Waste Disposal Sites	Director's Office

HWR-90-4030
REVISED MAY 15 [illegible]

NEW YORK STATE DEPARTMENT OF
ENVIRONMENTAL CONSERVATION
DIVISION OF HAZARDOUS WASTE REMEDIATION
ALBANY, NEW YORK 12233-7010

TECHNICAL AND ADMINISTRATIVE GUIDANCE MEMORANDUM (TAGM)

FOR THE

SELECTION OF REMEDIAL ACTIONS AT INACTIVE HAZARDOUS WASTE SITES

1. INTRODUCTION: The use of treatment technologies at Inactive Hazardous Waste Sites has been underutilized primarily as a result of cost of such technologies. Recent federal Superfund Amendment and Reauthorization Act (SARA) and RCRA amendments which restrict land burial provide incentives to use treatment technologies in remedial programs. SARA added a more stringent statutory criteria governing the appropriate extent of clean-up. SARA requires that preference be given to remedies that permanently reduce the toxicity, volume, or mobility of the hazardous substances, pollutants or contaminants, and to remedies using alternative treatment technologies (SARA Section 121). In addition, the 1984 amendments to RCRA restricted land disposal of several types of wastes. The land disposal restrictions have several effects which include:

   o Prohibition of continued land disposal of untreated hazardous wastes beyond specified dates unless the waste meets treatment standards based upon the Best Demonstrated Available Technology (BDAT);

   o United States Environmental Protection Agency's (USEPA) requirement to develop specified levels or methods of treatment which achieve substantial reduction of toxicity and mobility;

   o Prohibition of storage of restricted hazardous wastes except for accumulation to facilitate recovery, treatment or disposal; and

   o Statutory "hammer provisions" that prohibit land disposal of hazardous wastes if USEPA does not promulgate standards by statutory dates.

This TAGM provides guidelines to select an appropriate remedy at Federal Superfund, State Superfund and Potentially Responsible Party (PRP) sites. This document also sets forth a hierarchy of remedial technology treatments which will be consistent with SARA and RCRA land disposal restrictions. It presents detailed guidelines for evaluation and selection of remedial alternatives for some on-going and all new Remedial Investigation/Feasibility Study (RI/FS) projects. The Division of Hazardous Waste Remediation (DHWR) would consider exempting an inactive hazardous waste site from this document if deemed appropriate. For example, if a remedial action for a site is readily apparent, it would not be beneficial to select remedies using the procedures set forth in this TAGM.

2. **IMPLEMENTATION OF REMEDIAL ACTIONS**: SARA clearly gives preference to treatment technologies "that, in whole or in part, will result in a permanent and significant decrease in the toxicity, mobility, or volume of hazardous substances, pollutants or contaminants," to the maximum extent practicable. The Department concurs with this position. In order to eliminate the significant threat to public health and the environment, the Department believes it is important to implement permanent remedies wherever practicable.

   It should be emphasized, however, that there will be many instances where permanent remedies will not be practicable. For example, it is likely that conventional isolation and control technologies with pumping and treatment of leachate/groundwater may be selected as appropriate remedial action for municipal landfill sites which are now classified as inactive hazardous waste sites. When remedies such as conventional isolation and/or control technologies are selected, the Record of Decision (ROD) shall discuss why a remedial action resulting in a permanent and significant reduction in the toxicity, volume or mobility of hazardous wastes was not selected. If a remedial action that leaves any hazardous wastes at the site is selected, such remedial action shall be reviewed no less than once each five years after completion of the remedial action to assure that human health and the environment are being protected by the implemented remedial action; this review will take place in addition to the regularly scheduled monitoring and operation and maintenance, even if the monitoring data indicates that the implemented remedy does not contravene any "cleanup criteria or standards." The objective of the review will be to evaluate if the implemented remedy protects human health and the environment and to identify any "permanent" remedy available for the site. In addition, if upon such review, it is the judgement of the Deputy Commissioner, Office of Environmental Remediation, that action is appropriate at such site, the Department shall take or require such action. Before taking or requiring any action, all interested parties including the responsible parties and the public shall be provided an opportunity to comment on the Department's decision.

2.1 **Hierarchy of Remedial Technologies**: The following provides the hierarchy of remedial technologies for hazardous waste disposal sites, from most desirable to least desirable. **The Department shall consider only on-site or off-site destruction or separation/treatment or solidification/chemical fixation of inorganic wastes as permanent remedies.** However, solidification/chemical fixation of wastes containing "low" level organic constituents may be considered as a permanent remedy if justified.

(a) Destruction: This type of remedy will irreversibly destroy or detoxify all or most of the hazardous wastes to "acceptable clean-up levels". The treated materials will have no residue containing unacceptable levels of hazardous wastes. **This type of remedy will result in permanent reduction in the toxicity of all or most of the hazardous wastes to "acceptable clean-up level(s);"**

(b) Separation/Treatment: Using on-site mobile or transportable unit, this type of remedial action will separate or concentrate the hazardous wastes from the wastes; this remedy would leave a treated waste stream with acceptable levels of hazardous wastes and a concentrated waste stream with high levels of contaminants - e.g. treatment of contaminated leachate by granulated activated carbon. **This type of remedy will result in permanent and significant reduction in volume of waste mixed with hazardous wastes.** In these instances where the concentrated waste stream can be destroyed or detoxified as in (a) above, preference shall be given to this additional treatment;

(c) Solidification/Chemical Fixation: This type of remedy will, for a site containing predominantly inorganic hazardous wastes significantly reduce the mobility of inorganic hazardous wastes. **This type of remedy** may not significantly reduce the toxicity or volume of the inorganic hazardous wastes, but **will significantly and permanently reduce the mobility** and hence the **availability of the inorganic hazardous wastes to environmental transport and uptake.**

(d) Control and Isolation Technologies: This type of remedial action will significantly reduce the mobility of the hazardous wastes, but will not significantly reduce the volume or toxicity of the hazardous wastes. It also includes construction of physical barrier to control migration of leachate, contaminated groundwater and surface runoff, solidification/fixation of organic hazardous wastes, and pumping and treatment of contaminated leachate/groundwater.

(e) Off-Site Land Disposal: This type of remedy will remove contaminated soil, sediment, leachate, groundwater, etc. and land dispose the wastes at an off-site permitted facility.

In evaluating treatment technologies, the Department should give or require that preference be given to technologies which have:

(i) been successfully demonstrated on a full scale or a pilot scale under Federal Superfund Innovative Technology Evaluation (SITE) Program;

or

(ii) been successfully demonstrated on a full scale or pilot scale at a Federal Superfund site, at a Federal facility, at a State Superfund site anywhere in the country, at a PRP site overseen by a State environmental agency or USEPA;

or

(iii) a RCRA Part B permit;

or

(iv) a RCRA Research and Development permit.

or

(v) a documented history of successful treatment such as granulated activated carbon unit.

3. **<u>DEVELOPMENT OF REMEDIAL ALTERNATIVES</u>**: Alternatives are typically developed, concurrently with the Remedial Investigation (RI). In developing alternatives, two important activities take place. First, volumes or areas of environmental media (air, water, soil/sediment) are identified where contamination is present; the media to be treated are determined by information on the nature and extent of contamination, applicable or relevant and appropriate New York State Standards, Criteria and Guidelines (SCGs), cleanup criteria/standards, etc. SCGs also include federal standards which are more stringent than State Standards, Criteria and Guidelines. Second, the remedial action alternatives and associated technologies including alternative treatment technologies are screened to identify those that would be effective for the hazardous wastes and media of interest at the site. The information obtained during these two activities is used in assembling technologies and the media to which they will be applied into alternatives for the site or specific operable unit. This process should consist of five general steps as briefly presented below:

1. Develop remedial action objectives specifying the contaminants and media of interest, and exposure pathways. The objectives developed are based on contaminant-specific cleanup criteria.

2. Develop general response actions for each medium of interest that may be taken to satisfy the remedial action objectives for the site or specific operable unit.

3. Identify volumes or areas of media to which general response actions might be applied, taking into account the requirements for protectiveness as identified in the remedial action objectives and the chemical and geological characterization of the site or a specific operable unit.

4. Identify and screen the technologies applicable to each medium of interest to eliminate those technologies that cannot be implemented technically at the site for that medium.

5. Assemble the selected representative technologies into appropriate alternatives.

4. **PRELIMINARY SCREENING OF REMEDIAL ALTERNATIVES**: The screening of alternatives follows the conceptual development of alternatives and precedes the detailed analysis of alternatives. Prior to screening, technologies should be identified and combined into alternatives, although specific details of the alternatives may not be defined. Initial set of alternatives developed shall include appropriate remedial technologies that are representative of each of the four categories of remedial technologies as described in Section 2.1. During the screening, the extent of remedial action (e.g., quantities of media to be affected), the sizes and capacities of treatment units, and other details of each alternative should be further defined, as necessary, so that screening evaluations can be conducted.

   The objective of remedial alternatives screening is to narrow the list of potential alternatives that will be evaluated in detail. In some situations, the number of viable alternatives to address site problems may be limited such that screening may be unnecessary or minimized.

   Screening is used as a tool throughout the alternative selection process to narrow the options being considered. When alternatives are being developed, individual remedial technologies should be screened primarily on their ability to meet medium-specific remedial action objectives, their implementability and their short-term and long-term effectiveness. **At this time, cost should not be used to guide the initial development and screen remedial technologies or alternatives.** Because the purpose of the screening evaluation is to reduce the number of alternatives that will undergo a more thorough and extensive analysis, alternatives should be evaluated more generally in this phase than during the detailed analysis.

4.1 **Effectiveness Evaluation**: A key aspect of the screening evaluation is the effectiveness of each alternative in protecting human health and the environment. Each alternative should be evaluated as to the extent to which it will eliminate significant threats to public health and the environment through reductions in toxicity, mobility and volume of the hazardous wastes at the site. Both short-term and long-term effectiveness should be evaluated; short-term referring to the construction and implementation period, and long-term referring to the period after the remedial action is in place and effective.

The expected lifetime or duration of effectiveness should be identified for each alternative. The control and isolation technologies may fail if any of the following is expected to take place:

(i) significant loss of the surface cover such as clay cap with a potential for exposure of waste material underneath the cap;

(ii) contamination of the groundwater by the leachate from the waste material;

(iii) contamination of the adjoining surface water by the leachate from the waste material or by the contaminated groundwater;

(iv) structural failure of the control or isolation technology.

Table 4.1 should be used in evaluating the effectiveness of each alternative in protecting human health and the environment. If an alternative is scored less than 10 out of a maximum score of 25, project manager may consider rejecting that remedial alternative from further consideration.

4.2 **Implementability Evaluation**: Implementability is a measure of both the technical and administrative feasibility of constructing, operating, and maintaining a remedial action alternative. Technical feasibility refers to the ability to construct, reliably operate and meet technical specifications or criteria, and the availability of specific equipment and technical specialist to operate necessary process units. It also includes operation, maintenance, replacement, and monitoring of technical components of an alternative, if required, into the future after the remedial action is complete. Administrative feasibility refers to compliance with applicable rules, regulations and statutes and the ability to obtain approvals from other offices and agencies, the availability of treatment, storage, and disposal services and capacity.

Determinations of an alternative not being technically feasible and not being available for implementation will preclude it from further consideration unless steps can be taken to change the conditions responsible for the determination. Often, this type of fatal flaw would have been identified during technology development, and an alternative which is not feasible would not have been assembled. **Remedial alternatives which will be difficult to implement administratively should not be eliminated from further consideration for this reason alone.**

Implementability of each remedial alternative should be evaluated using Table 4.2. If an alternative does not score a minimum of eight out of a possible maximum 15, then the Project Manager has the option of screening out this alternative from further consideration.

5. DETAILED ANALYSIS OF ALTERNATIVES

5.1 Introduction

5.1.1 Purpose of the Detailed Analysis of Alternatives: The detailed analysis of alternatives is the analyses and presentation of the relevant information needed to allow decision-makers to select a site remedy. During the detailed analysis, each alternative is assessed against the seven evaluation criteria described in this chapter.

The specific requirements that must be addressed in the Feasibility Study (FS) report are listed below:

- Be protective of human health and the environment
- Attain SCGs (explain why compliance with SCGs was not needed to protect public health and the environment)
- Satisfy the preference for treatment that significantly and permanently reduces toxicity, mobility, or volume of hazardous wastes as a principal element (or provide an explanation in the ROD as to why it does not)
- Be cost-effective

Seven evaluation criteria have been developed to address the requirements and considerations listed above. These evaluation criteria serve as the basis for conducting the detailed analyses during the FS and for subsequently selecting an appropriate remedial action. The evaluation criteria are:

- Short-term impacts and effectiveness
- Long-term effectiveness and performance
- Reduction of toxicity, mobility, or volume
- Implementability
- Compliance with SCGs
- Overall protection of human health and the environment

- Cost

5.1.2 The Context of Detailed Analysis: The detailed analysis of alternatives follows the development and preliminary screening of alternatives and precedes the actual selection of a remedy. The extent to which alternatives are analyzed during the detailed analysis is influenced by the available data, the number and types of alternatives being analyzed, and the degree to which alternatives were previously analyzed during their development and screening.

The evaluations conducted during the detailed analysis phase build on previous evaluations conducted during the development and preliminary screening of alternatives. This phase also incorporates any treatability study data and additional site characterization information that may have been collected during the RI. The results of the detailed analysis serve to document the evaluations of alternatives and provide the basis for selecting a remedy.

5.2 Detailed Analysis of Remedial Alternatives

5.2.1 Alternative Definition: The alternatives that remain after preliminary screening may need to be refined more completely prior to the detailed analysis. Alternatives have already been developed and initially screened to match contaminated media with appropriate treatment processes. This matching is done by identifying specific remedial response objectives and sizing process units to attain the objective.

The information developed to define alternatives at this stage in the RI/FS process may consist of preliminary design calculations, process flow diagrams, sizing of key process components, preliminary site layouts, and a discussion of limitations, assumptions, and uncertainties concerning each alternative.

5.2.2 Overview of Evaluation Criteria: The detailed analysis provides the rationale for a remedy selection. The FS analysis must provide sufficient quantity and quality of information to support the selection of a remedy. The seven evaluation criteria listed encompass technical, cost, and institutional considerations; and compliance with specific statutory requirements.

The level of detail required to analyze each alternative against these evaluation criteria will depend on the type and complexity of the site, the type of technologies and alternatives being considered, and other project-specific considerations. The analysis should be conducted in sufficient detail such that decision-makers understand the significant aspects of each alternative and any uncertainties associated with their evaluation.

Each of the seven evaluation criteria has been further divided into specific factors to allow a thorough analysis of the alternatives. These factors are shown in Table 5-1 and discussed in the following sections. The weight for each criteria is also noted in Table 5-1.

5.2.3 Analysis of Individual Alternatives

5.2.3.1 Compliance with Applicable New York State Standards, Criteria and Guidelines (SCGs) (Relative Weight = 10)

This evaluation criterion is used to determine how each alternative complies with applicable or relevant and appropriate New York State Standards, Criteria and Guidelines (SCGs). As stated in Section 3, the SCGs should also include federal standards which are more stringent than the State Standards, Criteria and Guidelines. There are three general categories of SCGs: chemical-, location-, and action-specific. SCGs for each category are identified in previous stages of the RI/FS process (e.g. chemical-specific SCGs should be preliminarily identified during scoping of the project). The detailed analysis should summarize which requirements are applicable or relevant and appropriate to an alternative and describe how the alternative meets these requirements. When a SCG is not met, justification for use of one of the six waivers allowed under CERCLA and SARA should be discussed.

The following should be addressed for each alternative during the detailed analysis of SCGs:

(1) Compliance with chemical-specific SCGs (e.g. groundwater standards) - This factor addresses whether the SCGs will be met, and if not, the basis for a waiver.

(2) Compliance with action-specific SCGs (e.g. RCRA minimum technology standards) - It should be determined whether SCGs will be met and if not, the basis for a waiver.

(3) Compliance with location-specific SCGs - As with other SCG-related factors, this involves a consideration of whether the SCGs will be met and if not, the basis for a waiver.

The actual determination of which requirements are applicable or relevant and appropriate is made by the DEC in consultation with the DOH. A summary of these SCGs and whether they will be attained by a specific alternative should be presented.

If an alternative complies with all SCGs, it should be assigned a full score of 10. If an alternative complies with none of the above-mentioned four specific aspects of the SCGs, it should receive a score of 0. Each component of the four specific aspects of the SCGs shall receive a maximum score of 2.5. **It is to be pointed out that if an alternative does not meet the SCGs and a waiver to the SCGs is not appropriate or justifiable such an alternative should not be further considered.** Table 5.2 may be used to evaluate remedial alternatives.

5.2.3.2 Overall Protection of Human Health and the Environment (Relative Weight = 20)

This evaluation criterion provides a final check to assess whether each alternative meets the requirement that it is protective of human health and the environment. The overall assessment of protection is based on a composite of factors assessed under other evaluation criteria, especially long-term effectiveness and performance, short-term effectiveness, and compliance with SCGs.

Evaluation of the overall protectiveness of an alternative during the RI/FS should focus on how a specific alternative achieves protection over time and how site risks are reduced. The analysis should indicate how each source of contamination is to be eliminated, reduced, or controlled for each alternative.

Table 5.3 outlines pertaining questions to be answered in order to assist the evaluator in assigning relative weighing scores to remedial alternatives.

5.2.3.3 Short-term Impacts and Effectiveness (Relative Weight: 10): This evaluation criterion assesses the effects of the alternative during the construction and implementation phase until remedial response objectives are met. Under this criterion, alternatives should be evaluated with respect to their effects on human health and the environment during implementation of the remedial action. The following factors of this analysis criterion should be addressed for each alternative:

(i) Protection of the community during remedial actions - This aspect of short-term effectiveness addresses any risk that results from implementation of the proposed remedial action, such as dust from excavation or air-quality impacts from the operation of an incinerator.

(ii) Environmental impacts - This factor addresses the potential adverse environmental impacts that may result from the implementation of an alternative and evaluates how effective available mitigation measures would be in preventing or reducing the impacts.

(iii) Time until remedial response objectives are achieved - This factor includes an estimate of the time required to achieve protection for either the entire site or individual elements associated with specific site areas or threats.

(iv) Protection of workers during remedial actions - This factor assesses threats that may be posed to workers and the effectiveness and reliability of protective measures that could be taken.

Score for this criterion should be assigned based on the analysis of factors (i), (ii), (iii) presented in Table 5.4. Analysis of the factor "protection of workers during remedial actions," should be used to design appropriate safety measures for on-site workers.

5.2.3.4 Long-term Effectiveness and Permanence (Relative Weight = 15)

This evaluation criterion addresses the results of a remedial action in terms of its permanence and quantity/nature of waste or residual remaining at the site after response objectives have been met. The primary focus of this evaluation is the extent and effectiveness of the controls that may be required to manage the waste or residual remaining at the site and operating system necessary for the remedy to remain effective. The following components of the criterion should be addressed for each alternative:

- Permanence of the remedial alternative.
- Magnitude of remaining risk - The potential remaining risk may be expressed quantitatively such as by cancer risk levels, or margins of safety over NOELs for non-carcinogenic effects, or by the volume or concentration of contaminants in waste, media or treatment residuals remaining at the site. The characteristics of the residuals that should be considered to the degree that they remain hazardous, taking into account of their toxicity, mobility, and propensity to bio-accumulate.
- Adequacy of controls - This factor assesses the adequacy and suitability of control, if any, that are used to manage treatment residuals or untreated wastes that remain at the site. It may include an assessment of containment systems and institutional controls to determine if they are sufficient to ensure that any exposure to human and environmental receptors is within protective levels.
- Reliability of controls - This factor assesses the long-term reliability of management controls for providing continued protection from residuals. It includes the assessment of the potential need to replace components of the alternative, such as a cap, a slurry wall, or a treatment system; the potential exposure pathway; and the risks posed should the remedial action need replacement. This factor should also include systems to warn the failure of remedial alternative, once in place.

Table 5.5 should be used during the analysis to assign scores for this criterion.

5.2.3.5 Reduction of Toxicity, Mobility and Volume (Relative Weight = 15)

This evaluation criterion assesses the remedial alternative's use for treatment technologies that permanently and significantly reduce toxicity, mobility, or volume of the hazardous wastes as their principal element. As a matter of the Department's policy, it is preferred to use treatment to eliminate any significant threats at a site through destruction of toxic contaminants, reduction of the total mass of toxic contaminants, irreversible reduction in contaminants mobility, or reduction of total volume of contaminated media.

This evaluation would focus on the following specific factors for a particular remedial alternative:

- The amount of hazardous materials that will be destroyed or treated, including how the principal threat(s) will be addressed
- The degree of expected reduction in toxicity, mobility, or volume measured as a percentage of reduction (or order of magnitude)
- The degree to which the treatment will be irreversible
- The type and quantity of treatment residuals that will remain following treatment

Table 5.6 lists typical questions to be addressed during the analysis of toxicity, mobility, or volume reduction.

Table 5.6 should be used as the basis for evaluation of remedial alternatives and in assigning score for this criteria.

5.2.3.6 Implementability (Relative Weight = 15): Of the total weight of 15, the technical feasibility shall receive a maximum score of 10 while administrative feasibility and availability of services and materials shall be assigned a combined maximum score of 5.

The implementability criterion addresses the technical and administrative feasibility of implementing an alternative and the availability of various services and materials required during its implementation. This criterion involves analysis of the following factors:

- Technical feasibility

Construction and operation - This relates to the technical difficulties and unknowns associated with a technology. This was initially identified for specific technologies during the development and preliminary screening of alternatives and is addressed again in the detailed analysis for the alternative as a whole.

Reliability of technology - This focuses on the ability of a technology to meet specified process efficiencies or performance goals. The likelihood that technical problems will lead to schedule delays should be considered as well.

Ease of undertaking additional remedial action - This includes a discussion of what, if any, future remedial actions may need to be undertaken and how difficult it would be to implement such additional actions. This is particularly applicable for an FS addressing an interim action at a site where additional operable units may be analyzed at a later time.

Monitoring considerations - This addresses the ability to monitor the effectiveness of the remedy and includes an evaluation of the risks of exposure should monitoring be insufficient to detect a system failure.

Table 5-5 should assist the evaluator in determining degree of technical feasibility among remedial alternatives. The maximum score for the technical feasibility is 10.

o Administrative feasibility

Activities needed to coordinate with other offices and agencies (e.g. obtaining permits for off-site activities or rights-of-way for construction)

o Availability of services and materials

Availability of adequate off-site treatment, storage capacity, and disposal services

Availability of necessary equipment, specialists and skilled operators and provisions to ensure any necessary additional resources

Availability of services and materials, plus the potential for obtaining competitive bids, which may be particularly important for alternative remedial technologies.

A combined scoring not to exceed five should be assigned to administrative feasibility and availability of services and materials.

Table 5.7 lists typical questions to be addressed during the analysis of administrative feasibility and availability of services and materials.

5.2.3.7 Cost (Relative Weight = 15)

The application of cost estimates to evaluation of alternatives is discussed in the following paragraphs.

(1) Capital Costs. Capital costs consist of direct (construction) and indirect (non-construction and overhead) costs. Direct costs include expenditures for the equipment, labor and materials necessary to install remedial actions. Indirect costs include expenditures for engineering and other services that are not part of actual installation activities but are required to complete the installation of remedial alternatives. Capital costs that must be incurred in the future as part of the remedial action alternative should be identified and noted for the year in which they will occur.

Direct capital costs may include the following:

o Construction costs - Costs of materials, labor (including fringe benefits and worker's compensation), and equipment required to install a remedial action

- Equipment costs - Costs of remedial action and service equipment necessary to enact the remedy; (these materials remain until the site remedy is complete)
- Land and site-development costs - Expenses associated with the purchase of land and the site preparation costs of existing property
- Buildings and services costs - Costs of process and non-process buildings, utility connections, purchased services, and disposal costs
- Relocation expenses - Costs of temporary or permanent accommodations for affected nearby residents
- Disposal costs - Costs of transporting and disposing of waste material such as drums, contaminated soils and residues.

Indirect capital costs may include:

- Engineering expenses - Costs of administration, design, construction supervision, drafting, and treatability testing
- Legal fees and license or permit costs - Administrative and technical costs necessary to obtain licenses and permits for installation and operation
- Start up and shakedown costs - Costs incurred during remedial action start up
- Contingency allowances - Funds to cover costs resulting from unforeseen circumstances, such as adverse weather conditions, strikes, and inadequate site characterization.

(2) Operation & Maintenance Costs. Annual costs are post-construction costs necessary to ensure the continued effectiveness of a remedial action. The following annual cost components should be considered:

- Operating labor costs - Wages, salaries, training, overhead, and fringe benefits associated with the labor needed for post-construction operations
- Maintenance materials and labor costs - Costs for labor, parts and other resources required for routine maintenance of facilities and equipment
- Auxiliary materials and energy - Costs of such items as chemicals and electricity for treatment plant operations, water and sewer services, and fuel

- Disposal of residues - Costs to treat or dispose of residuals such as sludges from treatment processes or spent activated carbon

- Purchased services - Sampling costs, laboratory fees, and professional fees for which the need can be predicted

- Administrative costs - Costs associated with the administration of remedial action O&M not included under other categories

- Insurance, taxes and licensing costs - Costs of such items as liability and sudden accidental insurance; real estate taxes on purchased land or rights-of-way; licensing fees for certain technologies; and permit renewal and reporting costs

- Replacement costs - Cost for maintaining equipment or structures that wear out over time

- Costs of periodic site reviews - Costs for periodic site reviews (to be conducted every five years) if a remedial action leaves any hazardous substances, pollutants or contaminants at the site.

(3) Future Capital Costs: The costs of potential future remedial actions should be addressed, and if appropriate, should be included when there is a reasonable expectation that a major component of the remedial alternative will fail and require replacement to prevent significant exposure to contaminants. It is not expected that a detailed statistical analysis will be required to identify probable future costs. Rather, qualitative engineering judgment should be used and the rationale should be well documented in the FS report.

(4) Cost of Future Land Use: Any remedial action that leaves hazardous wastes at a site may affect future land use and perhaps groundwater use. Access or use of such sites will be restricted, resulting in loss of business activities, residential development and taxes to the local, State and federal governments. During the feasibility study, potential future land use of the site should be considered. Based on this potential land use, economic loss attributable to such use should be calculated and included as a cost of the remedial alternative. In addition, the continuing presence of an inactive hazardous waste site, even though remediated, may have a negative effect on surrounding property values. This loss in value should also be considered as a cost of the remedial program developed for the site. Economic loss due to the future land use should be derived based on comparison with a neighboring community not affected by any of hazardous waste sites.

Cost of future land use should be determined for sites only when such cost is **deemed appropriate and significant**. When cost of land surrounding an inactive hazardous waste site located in the urban/suburban area is determined to be significant in relation to the cost of a remedial alternative, then cost of future land use as described above should be determined for inclusion in the present worth analysis of the remedial alternative.

Accuracy of Cost Estimates. Site characterization and treatability investigation information should permit the user to refine cost estimates for remedial action alternatives. It is important to consider the accuracy of costs developed for alternatives in the FS. Typically, these "study estimate" costs made during the FS are expected to provide an accuracy of 50 percent to -30 percent and are prepared using data available from the RI. Costs developed with expected accuracies other than +50 percent to -30 percent should be identified as such in the FS.

Present Worth Analysis. A present worth analysis is used to evaluate expenditures that occur over different time periods by discounting all future costs to a common base year, usually the current year. This allows the cost of remedial action alternatives to be compared on the basis of a single figure representing the amount of money that, if invested in the base year and disbursed as needed, would be sufficient to cover all costs associated with the remedial action over its planned life.

In conducting the present worth analysis, assumptions must be made regarding the discount rate and the period of performance. It is recommended that a discount rate equivalent to the 30-year U.S. treasury bond rate taxes and after inflation be used in determining the present worth of an alternative. The period of performance should not exceed 30 years.

Cost Sensitivity Analysis. After the present worth of each remedial action alternative is calculated, individual costs may be evaluated through a sensitivity analysis if there is sufficient uncertainty concerning specific assumptions. A sensitivity analysis assesses the effect that variations in specific assumptions associated with the design, implementation, operation, discount rate, and effective life of an alternative have on the present worth for the alternative. These assumptions depend on the accuracy of the data developed during the site characterization and treatability investigation and on predictions of the future behavior of the technology. Therefore, these assumptions are subject to varying degrees of uncertainty from site to site. The potential effect on the cost of an alternative because of these uncertainties can be observed by varying the assumptions and noting the effects on estimated costs. Sensitivity analyses can also be used to optimize the design of a remedial action alternative, particularly when design parameters are interdependent (e.g., incinerator capacity for contaminated soil and the length of the period of performance).

Use of sensitivity analyses should be considered for the factors that can significantly change overall costs of an alternative with only small changes in their values, especially if the factors have a high degree of uncertainty associated with them. Other factors chosen for analysis may include those factors for which the expected (or estimated) value is highly uncertain. The results of such an analysis can be used to identify worst-case scenarios and to revise estimates of contingency or reserve funds.

The following factors are potential candidates for consideration in conducting a sensitivity analysis:

- The effective life of a remedial action
- The O&M costs
- The duration of cleanup
- The volume of contaminated material, given the uncertainty about site conditions
- Other design parameters (e.g. the size of the treatment system)
- The discount rate (a range of 3 to 10 percent may be used to investigate uncertainties)

The results of a sensitivity analysis should be discussed during the comparison of alternatives. Areas of uncertainty that may have a significant effect on the cost of an alternative should be highlighted, and a rationale should be presented for selection of the most probable value of the parameter.

An alternative with the lowest present worth shall be assigned the highest score of 15. Other alternatives shall be assigned the cost score inversely proportional to their present worth.

5.2.4 Presentation of Individual Analysis

The analysis of individual alternatives against the seven criteria should be presented in the FS report as a narrative discussion accompanied by a summary table. This information will be used to compare the alternatives and support a subsequent analysis of the alternatives made by the decision-maker in the remedy selection process. The narrative discussion should, for each alternative, provide (1) a description of the alternative and (2) a discussion of the individual criteria assessment.

The alternative description should provide data on technology components (use of innovative technologies should be identified), quantities of hazardous materials handled, time required for implementation, process sizing, implementation requirements, and assumptions. These descriptions will also serve as the basis for selecting the New York SCGs. Therefore, the key SCGs for each alternative should be identified and integrated into these discussions.

The narrative discussion of the analysis should, for each alternative, present the assessment of the alternative against each of the seven criteria. This discussion should focus on how, and to what extent, the various factors within each of the seven criteria are addressed.

The uncertainties associated with specific alternatives should be included when changes in assumptions or unknown conditions could affect the analysis. The FS should also include a summary table highlighting the assessment of each alternative with respect to each of the seven criteria.

5.2.5 Comparative Analysis of Alternatives

Once the alternatives have been individually assessed against the seven criteria, a comparative analysis should be conducted to evaluate the relative performance of each alternative in relation to each specific evaluation criterion. This analysis is in contrast to the preceding analysis in which each alternative was analyzed independently without the consideration of interrelationships between alternatives. The purpose of this comparative analysis is to identify the advantages and disadvantages of each alternative relative to one another so that the key trade-offs to be evaluated by the decision-maker can be identified.

The first five criteria (short-term effectiveness; long-term effectiveness, and permanence; reduction of toxicity, mobility, and volume; implementability; and cost) will generally require more discussion than the remaining criteria because the key trade-offs or concerns among alternatives will most frequently relate to one or more of these five. The overall protectiveness and compliance with SCGs criteria will generally serve as threshold determinations in that they either will or will not be met. Community preference will likely be evaluated only preliminarily during the RI/FS because such information frequently is not available. Community preference can be addressed more thoroughly once comments on the RI/FS report and the proposed remedial action plan have been received and a final remedy selection decision is being made.

5.2.6 Presentation of Comparative Analysis

The comparative analysis should include a narrative discussion describing the strengths and weaknesses of the alternatives relative to one another with respect to each criterion, and how reasonable variations of key uncertainties could change the expectations of their relative performance. If destruction and treatment technologies are being considered, their potential advantages in cost or performance and the degree of uncertainty in their expected performance (as compared with conventional/isolation technologies) should also be discussed. The comparative analysis should also summarize the total sizing for each alternative.

The presentation of differences between alternatives can be measured either qualitatively or quantitatively, as appropriate, and should identify substantive differences (e.g. greater short-term effectiveness concerns, greater cost, etc) between alternatives, differences in total scores, etc. Quantitative information that was used to assess the alternatives (e.g. specific cost estimates, time until response objectives would be obtained, and levels of residual contamination) should be included in these discussions.

The Final Draft RI/FS or the Proposed Remedial Action Plan (PRAP) should present the remedial alternative recommended for the site and clear rational for the recommendation.

6. **COMMUNITY ASSESSMENT**: This assessment incorporates public comment into the selection of a remedy. There are several points in the RI/FS process at which the public may have previously provided comments (e.g. first phase of the RI/FS). The Department will solicit public comments on the remedial alternatives and the recommended alternative in accordance with the New York State Inactive Hazardous Waste Site Citizen Participation Plan and statutory and regulatory requirements. A document titled, "New York State Inactive Hazardous Waste Site Citizen Participation Plan," dated August 30, 1988, should be used as a guidance to solicit the public comments on the remedial alternatives and the recommended alternative. The public comments shall be considered. The remedy for the site will be selected and documented in accordance with the Organization and Delegation Memorandum #89-05 Policy - Records of Decision for Remediation of Class 2 Inactive Hazardous Waste Disposal Sites.

Table 4.1

SHORT-TERM/LONG-TERM EFFECTIVENESS

(Maximum Score = 25)

Analysis Factor	Basis for Evaluation During Preliminary Screening			Score
1. Protection of community during remedial actions.	° Are there significant short-term risks to the community that must be addressed? **(If answer is no, go to Factor 2.)**	**Yes** **No**	___ ___	0 4
	° Can the short-term risk be easily controlled?	**Yes** **No**	___ ___	1 0
	° Does the mitigative effort to control short-term risk impact the community life-style?	**Yes** **No**	___ ___	0 2
Subtotal (maximum = 4)				
2. Environmental Impacts	° Are there significant short-term risks to the environment that must be addressed? **(If answer is no, go to Factor 3.)**	**Yes** **No**	___ ___	0 4
	° Are the available mitigative measures reliable to minimize potential impacts?	**Yes** **No**	___ ___	3 0
Subtotal (maximum = 4)				
3. Time to implement the remedy.	° What is the required time to implement the remedy?	**≤ 2yr.** **> 2yr.**	___ ___	1 0
	° Required duration of the mitigative effort to control short-term risk.	**≤ 2yr.** **> 2yr.**	___ ___	1 0
Subtotal (maximum = 2)				
4. On-site or off-site treatment or land disposal	° On-site treatment* ° Off-site treatment* ° On-site or off-site land disposal			3 1 0
Subtotal (maximum = 3)				
*treatment is defined as destruction or separation/ treatment or solidification/ chemical fixation of inorganic wastes				
5. Permanence of the remedial alternative.	° Will the remedy be classified as permanent in accordance with Section 2.1(a), (b), or (c). **(If answer is yes, go to Factor 7.)**	**Yes** **No**	___ ___	3 0
Subtotal (maximum = 3)				

Table 4.1 (cont'd)

SHORT-TERM/LONG-TERM EFFECTIVENESS

(Maximum Score = 25)

Analysis Factor	Basis for Evaluation During Preliminary Screening		Score
6. Lifetime of remedial actions.	° Expected lifetime or duration of of effectiveness of the remedy.	25-30yr.____	3
		20-25yr.____	2
		15-20yr.____	1
		< 15yr.____	0
Subtotal (maximum = 3)			
7. Quantity and nature of waste or residual left at the site after remediation.	i) Quantity of untreated hazardous waste left at the site.	None ____	3
		≤ 25% ____	2
		25-50% ____	1
		≥ 50% ____	0
	ii) Is there treated residual left at the site? **(If answer is no, go to Factor 8.)**	Yes ____	0
		No ____	2
	iii) Is the treated residual toxic?	Yes ____	0
		No ____	1
	iv) Is the treated residual mobile?	Yes ____	0
		No ____	1
Subtotal (maximum = 5)			
8. Adequacy and reliability of controls.	i) Operation and maintenance required for a period of:	< 5yr. ____	1
		> 5yr. ____	0
	ii) Are environmental controls required as a part of the remedy to handle potential problems? **(If answer is no, go to "iv")**	Yes ____	0
		No ____	1
	iii) Degree of confidence that controls can adequately handle potential problems.	Moderate to very confident ____	1
		Somewhat to not confident ____	0
	iv) Relative degree of long-term monitoring required (compare with other remedial alternatives)	Minimum ____	2
		Moderate ____	1
		Extensive ____	0
Subtotal (maximum = 4)			
TOTAL (maximum = 25)			

IF THE TOTAL IS LESS THAN 10, PROJECT MANAGER MAY REJECT THE REMEDIAL ALTERNATIVE FROM FURTHER CONSIDERATION.

Table 4.2

IMPLEMENTABILITY
(Maximum Score = 15)

Analysis Factor	Basis for Evaluation During Preliminary Screening			Score
1. Technical Feasibility				
a. Ability to construct technology.	i) Not difficult to construct. No uncertainties in construction.		___	3
	ii) Somewhat difficult to construct. No uncertainties in construction.		___	2
	iii) Very difficult to construct and/or significant uncertainties in construction.		___	1
b. Reliability of technology.	i) Very reliable in meeting the specified process efficiencies or performance goals.		___	3
	ii) Somewhat reliable in meeting the specified process efficiencies or performance goals.		___	2
c. Schedule of delays due to technical problems.	i) Unlikely		___	2
	ii) Somewhat likely		___	1
d. Need of undertaking additional remedial action, if necessary.	i) No future remedial actions may be anticipated.		___	2
	ii) Some future remedial actions may be necessary.		___	1
Subtotal (maximum = 10)				
2. Administrative Feasibility				
a. Coordination with other agencies.	i) Minimal coordination is required.		___	2
	ii) Required coordination is normal.		___	1
	iii) Extensive coordination is required.		___	0
Subtotal (maximum = 2)				
3. Availability of Services and Materials				
a. Availability of prospective technologies.	i) Are technologies under consideration generally commercially available for the site-specific application?	**Yes** **No**	___ ___	1 0
	ii) Will more than one vendor be available to provide a competitive bid?	**Yes** **No**	___ ___	1 0

Table 4.2 (cont'd)

IMPLEMENTABILITY
(Maximum Score = 15)

Analysis Factor	Basis for Evaluation During Preliminary Screening			Score
b. Availability of necessary equipment and specialists.	i) Additional equipment and specialists may be available without significant delay.	**Yes**	___	1
		No	___	0

Subtotal (maximum = 3)

TOTAL (maximum = 15)

IF THE TOTAL IS LESS THAN 8, PROJECT MANAGER MAY REJECT THE REMEDIAL ALTERNATIVE FROM FURTHER CONSIDERATION.

Table 5.1
CRITERIA FOR DETAILED ANALYSIS OF REMEDIAL ALTERNATIVES

COMPLIANCE WITH APPLICABLE OR RELEVANT AND APPROPRIATE NEW YORK STATE STANDARDS, CRITERIA AND GUIDELINES (SCGs)(10)

- ompliance With Contaminant-pecific SCGs
- ompliance With Action-Specific CGs
- ompliance With Location-Specific CGs

PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT (20)

- °Environmental Impacts
- °Transport of Hazardous Materials
- °Health Impacts

SHORT-TERM EFFECTIVENESS (10)

- °Protection of Community During Remedial Actions
- °Protection of Workers During Remedial Actions
- °Environmental Impacts
- °Time Until Remedial Action Objectives Are Achieved

LONG-TERM FFECTIVENESS & ERMANENCE (15)

- agnitude of Residual Risk
- Adequacy of Controls
- Reliability of Controls

REDUCTION OF TOXICITY, MOBILITY AND VOLUME (15)

- °Treatment Process Used and Materials Treated
- °Amount of Hazardous Materials Destroyed or Treated
- °Degree of Expected Reductions in Toxicity, Mobility and Volume
- °Degree to Which Treatment is Irreversible
- °Type and Quantity of Hazardous Residuals Remaining After Treatment

IMPLEMENTABILITY (15)

- °Ability to Construct and Operate the Technology
- °Reliability of the Technology Based on its Acceptable Demonstrations
- °Ease of Undertaking Additional Remedial Actions, if Necessary
- °Ability to Monitor Effectiveness of Remedy
- °Availability of Necessary Equipment and Specialists
- °Timing of New Technology Under Consideration

COST (15)

- °Immediate Capital Costs
- °Operating and Maintenance Costs
- °Future Capital Costs
- °Cost to Future Land Use
- °Present Worth Cost

Table 5.2

COMPLIANCE WITH APPLICABLE OR RELEVANT AND APPROPRIATE NEW YORK STATE STANDARDS CRITERIA AND GUIDELINES (SCGs)

(Relative Weight = 10)

Analysis Factor	Basis for Evaluation During Detailed Analysis			Score
1. Compliance with chemical-specific SCGs	Meets chemical specific SCGs such as groundwater standards	**Yes**	___	4
		No	___	0
2. Compliance with action-specific SCGs	Meets SCGs such as technology standards for incineration or landfill	**Yes**	___	3
		No	___	0
3. Compliance with location-specific SCGs	Meets location-specific SCGs such as Freshwater Wetlands Act	**Yes**	___	3
		No	___	0

TOTAL (Maximum = 10)

Table 5.3

PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT
(Relative Weight = 20)

Analysis Factor	Basis for Evaluation During Detailed Analysis			Score
1. Use of the site after remediation.	Unrestricted use of the land and water. **(If answer is yes, go to the end of the Table.)**	**Yes**	____	20
		No	____	0
TOTAL (Maximum = 20)				
2. Human health and the environment exposure after the remediation.	i) Is the exposure to contaminants via air route acceptable?	**Yes**	____	3
		No	____	0
	ii) Is the exposure to contaminants via groundwater/surface water acceptable?	**Yes**	____	4
		No	____	0
	iii) Is the exposure to contaminants via sediments/soils acceptable?	**Yes**	____	3
		No	____	0
Subtotal (maximum = 10)				
3. Magnitude of residual public health risks after the remediation.	i) Health risk	**≤ 1 in 1,000,000**	____	5
	ii) Health risk	**≤ 1 in 100,000**	____	2
Subtotal (maximum = 5)				
4. Magnitude of residual environmental risks after the remediation.	i) Less than acceptable		____	5
	ii) Slightly greater than acceptable		____	3
	iii) Significant risk still exists		____	0
Subtotal (maximum = 5)				
TOTAL (maximum = 20)				

Table 5.4

SHORT-TERM EFFECTIVENESS

(Relative Weight = 10)

Analysis Factor	Basis for Evaluation During Detailed Analysis			Score
1. Protection of community during remedial actions.	° Are there significant short-term risks to the community that must be addressed? **(If answer is no, go to Factor 2.)**	**Yes**	____	0
		No	____	4
	° Can the risk be easily controlled?	**Yes**	____	1
		No	____	0
	° Does the mitigative effort to control risk impact the community life-style?	**Yes**	____	0
		No	____	2
Subtotal (maximum = 4)				
2. Environmental Impacts	° Are there significant short-term risks to the environment that must be addressed? **(If answer is no, go to Factor 3.)**	**Yes**	____	0
		No	____	4
	° Are the available mitigative measures reliable to minimize potential impacts?	**Yes**	____	3
		No	____	0
Subtotal (maximum = 4)				
3. Time to implement the remedy.	° What is the required time to implement the remedy?	**$\leq$ 2yr.**	____	1
		$\geq$ 2yr.	____	0
	° Required duration of the mitigative effort to control short-term risk.	**$\leq$ 2yr.**	____	1
		$\geq$ 2yr.	____	0
Subtotal (maximum = 2)				
TOTAL (maximum = 10)				

Table 5.5

LONG-TERM EFFECTIVENESS AND PERMANENCE
(Relative Weight = 15)

Analysis Factor	Basis for Evaluation During Detailed Analysis		Score
1. On-site or off-site treatment or land disposal	° On-site treatment*		3
	° Off-site treatment*		1
	° On-site or off-site land disposal		0
Subtotal (maximum = 3)			
*treatment is defined as destruction or separation/ treatment or solidification/ chemical fixation of inorganic wastes			
2. Permanence of the remedial alternative.	° Will the remedy be classified as permanent in accordance with Section 2.1(a), (b), or (c). **(If answer is yes, go to Factor 4.)**	**Yes** ___	3
		No ___	0
Subtotal (maximum = 3)			
3. Lifetime of remedial actions.	° Expected lifetime or duration of of effectiveness of the remedy.	25-30yr.___	3
		20-25yr.___	2
		15-20yr.___	1
		< 15yr.___	0
Subtotal (maximum = 3)			
4. Quantity and nature of waste or residual left at the site after remediation.	i) Quantity of untreated hazardous waste left at the site.	**None** ___	3
		≤ 25% ___	2
		25-50% ___	1
		≥ 50% ___	0
	ii) Is there treated residual left at the site? **(If answer is no, go to Factor 5.)**	**Yes** ___	0
		No ___	2
	iii) Is the treated residual toxic?	**Yes** ___	0
		No ___	1
	iv) Is the treated residual mobile?	**Yes** ___	0
		No ___	1
Subtotal (maximum = 5)			

Table 5.5 (cont'd)

LONG-TERM EFFECTIVENESS AND PERMANENCE
(Relative Weight = 15)

Analysis Factor	Basis for Evaluation During Detailed Analysis		Score
5. Adequacy and reliability of controls.	i) Operation and maintenance required for a period of:	**< 5yr.** ____	1
		> 5yr. ____	0
	ii) Are environmental controls required as a part of the remedy to handle potential problems? **(If answer is no, go to "iv")**	**Yes** ____	0
		No ____	1
	iii) Degree of confidence that controls can adequately handle potential problems.	**Moderate to very confident** ____	1
		Somewhat to not confident ____	0
	iv) Relative degree of long-term monitoring required **(compare with other remedial alternatives)**	**Minimum** ____	2
		Moderate ____	1
		Extensive ____	0
Subtotal (maximum = 4)			
TOTAL (maximum = 15)			

Table 5.6
REDUCTION OF TOXICITY, MOBILITY OR VOLUME
(Relative Weight = 15)

Analysis Factor	Basis for Evaluation During Detailed Analysis		Score
1. Volume of hazardous waste reduced (reduction in volume or toxicity). **If Factor 1 is not applicable, go to Factor 2.**	i) Quantity of hazardous waste destroyed or treated. **Immobilization technologies do not score under Factor 1.**	**99-100%** ____	8
		90-99% ____	7
		80-90% ____	6
		60-80% ____	4
		40-60% ____	2
		20-40% ____	1
		< 20% ____	0
	ii) Are there untreated or concentrated hazardous waste produced as a result of (i)? **If answer is no, go to Factor 2**	**Yes** ____	0
		No ____	2
Subtotal (maximum = 10) If subtotal = 10, go to Factor 3	iii) After remediation, how is the untreated, residual hazardous waste material disposed?	**Off-site land disposal** ____	0
		On-site land disposal ____	1
		Off-site destruction or treatment ____	2
2. Reduction in mobility of hazardous waste. **If Factor 2 is not applicable, go to Factor 3**	i) Quality of Available Wastes Immobilized After Destruction/Treatment	**90-100%** ____	2
		60-90% ____	1
		< 60% ____	0
	ii) Method of Immobilization		
	- Reduced mobility by containment	____	0
	- Reduced mobility by alternative treatment technologies	____	3
Subtotal (maximum = 5)			
3. Irreversibility of the destruction or treatment or immobilization of hazardous waste	Completely irreversible	____	5
	Irreversible for most of the hazardous waste constituents.	____	3
	Irreversible for only some of the hazardous waste constituents	____	2
	Reversible for most of the hazardous waste constituents.	____	0
Subtotal (maximum = 5)			
TOTAL (maximum = 15)			

Table 5.7

IMPLEMENTABILITY
(Relative Weight = 15)

Analysis Factor		Basis for Evaluation During Detailed Analysis			Score
1. Technical Feasibility					
a. Ability to construct technology.	i)	Not difficult to construct. No uncertainties in construction.		___	3
	ii)	Somewhat difficult to construct. No uncertainties in construction.		___	2
	iii)	Very difficult to construct and/or significant uncertainties in construction.		___	1
b. Reliability of technology.	i)	Very reliable in meeting the specified process efficiencies or performance goals.		___	3
	ii)	Somewhat reliable in meeting the specified process efficiencies or performance goals.		___	2
c. Schedule of delays due to technical problems.	i)	Unlikely		___	2
	ii)	Somewhat likely		___	1
d. Need of undertaking additional remedial action, if necessary.	i)	No future remedial actions may be anticipated.		___	2
	ii)	Some future remedial actions may be necessary.		___	1
Subtotal (maximum = 10)					
2. Administrative Feasibility					
a. Coordination with other agencies.	i)	Minimal coordination is required.		___	2
	ii)	Required coordination is normal.		___	1
	iii)	Extensive coordination is required.		___	0
Subtotal (maximum = 2)					
3. Availability of Services and Materials					
a. Availability of prospective technologies.	i)	Are technologies under consideration generally commercially available for the site-specific application?	**Yes** **No**	___ ___	1 0
	ii)	Will more than one vendor be available to provide a competitive bid?	**Yes** **No**	___ ___	1 0

Table 5.7 (cont'd)

IMPLEMENTABILITY
(Relative Weight = 15)

Analysis Factor	Basis for Evaluation During Detailed Analysis		Score
b. Availability of necessary equipment and specialists.	i) Additional equipment and specialists may be available without significant delay.	**Yes** ___	1
		No ___	0

Subtotal (maximum = 3)

TOTAL (maximum = 15)

Appendix B

APPENDIX B

Remedial Action Alternatives Scoresheets

SHORT-TERM/LONG-TERM EFFECTIVENESS
(Maximum Score = 25)

Alternative: Soil Treatment by Solvent Extraction and a Groundwater Pump and Treat System

Analysis Factor	Basis for Evaluation During Preliminary Screening			Score	
1. Protection of community during remedial actions.	o Are there significant short-term risks to the community that must be addressed? (If answer is no, go to Factor 2.	Yes	X	0	dust, exposure to airborne contaminants
		No		4	
	o Can the risk be easily controlled?	Yes	X	1	
		No		0	
	o Does the mitigative effort to control risk impact the community life-style?	Yes		0	
		No	X	2	
Subtotal (maximum = 4)			3		
2. Environmental Impacts	o Are there significant short-term risks to the environment that must be addressed? If answer is no, go to Factor 3.)	Yes	X	0	dust, exposure to airborne contaminants
		No		4	
	o Are the available mitigative measures reliable to minimize potential impacts?	Yes	X	3	
		No		0	
Subtotal (maximum = 4)			3		
3. Time to implement the remedy.	o What is the required time to implement the remedy?	<=2 yr.	X	1	soil & NAPL
		>2 yr.	X	0	groundwater (GW)
	o Required duration of the mitigative effort to control short-term risk.	<=2 yr.	X	1	
		>2 yr.		0	
Subtotal (maximum = 2)			1 OR 2		
4. On-site or off-site treatment or land disposal	o On-site treatment*		X	3	Soil & GW
	o Off-site treatment*		X	1	** residue
	o On-site or off-site land disposal		X	0	*** residue
Subtotal (maximum = 3)			0,1,3		

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* Treatment is defined as destruction or separation/treatment or solidification/chemical fixation of inorganic wastes.

** Residue treated off-site includes NAPL from the GW extraction and treatment system, extracted organics from the solvent extaction system, and any spent carbon from the dissolved organics treatment system.

*** Residue disposed off-site includes the metal sludge from the iron-based coprecipitation unit (after off-site treatment).

Short-Term/Long-Term Effectiveness
Soil Treatment by Solvent Extraction and Groundwater

5.	Permanence of the remedial alternative.	o Will the remedy be classified as permanent in accordance with Section 2.1 (a), (b), or (c)? (If answer is yes, go to Factor 7.)	Yes	X	3	
			No	X	0	Air Stripping w/o a vapor treatment system
	Subtotal (maximum = 3)			3		
6.	Life time of remedial alternative	o Expected lifetime or duration of effectiveness of the remedy.	25-30 yr.		3	
			20-25 yr.		2	
			15-20 yr.		1	
			<15 yr.		0	
	Subtotal (maximum = 3)					
7.	Quantity and nature of waste or residual left at the site after remediation.	i) Quantity of untreated hazardous waste left at the site.	None	X	3	(<1%)
			<=25%		2	
			25-50%		1	
			>=50%		0	
		ii) Is there treated residual left at the site? (If answer is no, go to Factor 8.)	Yes	X	0	Clean soil backfilled, other residues taken off-site
			No		2	
		iii) Is the treated residual highly toxic?	Yes		0	
			No	x	1	
		iv) Is the treated residual highly mobile?	Yes		0	
			No	X	1	
	Subtotal (maximum = 5)			5		
8.	Adequacy and reliability of controls.	i) Operation and maintenance required for a period of:	<5yr.	X	1	Soil & NAPL, GW unknown
			>5yr.		0	
		ii) Are environmental controls required as a part of the remedy to handle potential problems? (If answer is no, go to "iv".)	Yes	X	0	
			No		1	
		iii) Degree of confidence that controls can adequately handle potential problems.	Moderate to very confident	X	1	
			Somewhat to not confident		0	
		iv) Relative degree of long-term monitoring required (compare with other remedial alternatives)	Minimum	X	2	GW monitored quarterly throughout treatment, less frequently after treatment.
			Moderate		1	
			Extensive		0	
	Subtotal (maximum = 4)			4		
			TOTAL (maximum = 25)	19-23		

IF THE TOTAL IS LESS THAN 10, THE PROJECT MANAGER MAY REJECT THE REMEDIAL ALTERNATIVE FROM FURTHER CONSIDERATION.

IMPLEMENTABILITY
(Maximum Score = 15)

Alternative: Soil Treatment by Solvent Extraction and a Groundwater Pump and Treat System

Analysis Factor		Basis for Evaluation During Detailed Analysis		Weight	
1. <u>Technical Feasibility</u>					
a. Ability to construct technology	i)	Not difficult to construct. No uncertainties in construction.	___	3	
	ii)	Somewhat difficult to construct. No uncertainties in construction.	X	2	Lack of space for equipment may present difficulties
	iii)	Very difficult to construct and/or significant uncertainties in construction.	___	1	
b. Reliability of technology	i)	Very reliable in meeting the specified process efficiencies or performance goals.	X	3	Solvent extraction and GW technologies <u>when optimized</u>
	ii)	Somewhat reliable in meeting the specified process efficiencies or performance goals.	___	2	
c. Schedule of delays due to technical problems	i)	Unlikely	___	2	
	ii)	Somewhat likely	X	1	
d. Need of undertaking additional remedial action, if necessary.	i)	No future remedial actions may be anticipated.	X	2	
	ii)	Some future remedial actions may be necessary.	___	1	
Subtotal (maximum = 10)			8		
2. <u>Administrative Feasibility</u>					
a. Coordination with other agencies.	i)	Minimal coordination is required.	___	2	
	ii)	Required coordination is normal.	X	1	
	iii)	Extensive coordination is required.	___	0	
Subtotal (maximum = 2)			1		

3. Availability of Services and Materials

a. Availability of prospective technologies.	i) Are technologies under consideration generally commercially available for the site-specific application?	Yes	X	1	
		No		0	
	ii) Will more than one vendor be available to provide a competitive bid	Yes	X	1	GW technologies; solvent extraction uncertain.
		No		0	
b. Availability of necessary equipment and specialists.	i) Additional equipment and specialists may be available without significant delay.	Yes	X	1	GW technologies; solvent extraction uncertain.
		No		0	
Subtotal (maximum = 3)			3		
	TOTAL (maximum = 15)		12		

IF THE TOTAL IS LESS THAN 8, THE PROJECT MANAGER MAY REJECT THE REMEDIAL ALTERNATIVE FROM FURTHER CONSIDERATION.

SHORT-TERM/LONG-TERM EFFECTIVENESS
(Maximum Score = 25)

Alternative: Soil Treatment by Off-site Incineration and Groundwater Pump and a Treat System

Analysis Factor	Basis for Evaluation During Preliminary Screening			Score	
1. Protection of community during remedial actions.	o Are there significant short-term risks to the community that must be addressed? (If answer is no, go to Factor 2.	Yes	X	0	Dust, exposure to airborne contaminants, release of soil in transportation incident.
		No		4	
	o Can the risk be easily controlled?	Yes	X	1	
		No		0	
	o Does the mitigative effort to control risk impact the community life-style?	Yes		0	
		No	X	2	
Subtotal (maximum = 4)			3		
2. Environmental Impacts	o Are there significant short-term risks to the environment that must be addressed? If answer is no, go to Factor 3.)	Yes	X	0	Dust, exposure to airborne contaminants, release of soil in transportation incident.
		No		4	
	o Are the available mitigative measures reliable to minimize potential impacts?	Yes	X	3	
		No		0	
Subtotal (maximum = 4)			3		
3. Time to implement the remedy.	o What is the required time to implement the remedy?	<=2 yr.	X	1	Soil & NAPL groundwater (GW)
		>2 yr.	X	0	
	o Required duration of the mitigative effort to control short-term risk.	<=2 yr.	X	1	
		>2 yr.		0	
Subtotal (maximum = 2)			1 OR 2		
4. On-site or off-site treatment or land disposal	o On-site treatment*		X	3	GW
	o Off-site treatment*		X	1	soil & residues
	o On-site or off-site land disposal		X	0	** residue
Subtotal (maximum = 3)			0,1,3		

* Treatment is defined as destruction or separation/treatment or solidification/chemical fixation of inorganic wastes.

Soil from the site is treated at an off-site incinerator. Residues treated off-site include NAPL from the ground water extraction and treatment system and any spent carbon from the dissolved organics treatment unit.

** Residues disposed off-site include the metal sludge from the iron-based coprecipitation unit (after off-site treatment).

5.	Permanence of the remedial alternative.	o Will the remedy be classified as permanent in accordance with Section 2.1 (a), (b), or (c)? (If answer is yes, go to Factor 7.)	Yes	X	3	
			No	X	0	Air Stripping w/o a vapor treatment system.
	Subtotal (maximum = 3)			3		
6.	Life time of remedial alternative	o Expected lifetime or duration of effectiveness of the remedy.	25-30 yr.		3	
			20-25 yr.		2	
			15-20 yr.		1	
			<15 yr.		0	
	Subtotal (maximum = 3)					
7.	Quantity and nature of waste or residual left at the site after remediation.	i) Quantity of untreated hazardous waste left at the site.	None	X	3	(<1%)
			<=25%		2	
			25-50%		1	
			>=50%		0	
		ii) Is there treated residual left at the site? (If answer is no, go to Factor 8.)	Yes		0	Soil and residues taken off-site.
			No	X	2	
		iii) Is the treated residual toxic?	Yes		0	
			No		1	
		iv) Is the treated residual mobile?	Yes		0	
			No		1	
	Subtotal (maximum = 5)			5		
8.	Adequacy and reliability of controls.	i) Operation and maintenance required for a period of:	<5yr.	X	1	Soil & NAPL, GW unknown.
			>5yr.		0	
		ii) Are environmental controls required as a part of the remedy to handle potential problems? (If answer is no, go to "iv".)	Yes	X	0	
			No		1	
		iii) Degree of confidence that controls can adequately handle potential problems.	Moderate to very confident	X	1	
			Somewhat to not confident		0	
		iv) Relative degree of long-term monitoring required (compare with other remedial alternatives)	Minimum	X	2	Groundwater monitoring quarterly during treatment, less frequently after treatment.
			Moderate		1	
			Extensive		0	
	Subtotal (maximum = 4)			4		
			TOTAL (maximum = 25)	19-23		

IF THE TOTAL IS LESS THAN 10, THE PROJECT MANAGER MAY REJECT THE REMEDIAL ALTERNATIVE FROM FURTHER CONSIDERATION.

IMPLEMENTABILITY
(Maximum Score = 15)

Alternative: Soil Treatment by Off-site Incineration and a Groundwater Pump and Treat System

Analysis Factor		Basis for Evaluation During Detailed Analysis		Weight	
1. Technical Feasibility					
a. Ability to construct technology	i)	Not difficult to construct. No uncertainties in construction.	X	3	Incinerators operating, GW technologies easily constructed.
	ii)	Somewhat difficult to construct. No uncertainties in construction.		2	
	iii)	Very difficult to construct and/or significant uncertainties in construction.		1	
b. Reliability of technology	i)	Very reliable in meeting the specified process efficiencies or performance goals.	X	3	Incinerator and GW technologies very reliable when optimized.
	ii)	Somewhat reliable in meeting the specified process efficiencies or performance goals.		2	
c. Schedule of delays due to technical problems	i)	Unlikely		2	
	ii)	Somewhat likely	X	1	
d. Need of undertaking additional remedial action, if necessary.	i)	No future remedial actions may be anticipated.	X	2	
	ii)	Some future remedial actions may be necessary.		1	
Subtotal (maximum = 10)			9		
2. Administrative Feasibility					
a. Coordination with other agencies.	i)	Minimal coordination is required.		2	
	ii)	Required coordination is normal.	X	1	
	iii)	Extensive coordination is required.		0	
Subtotal (maximum = 2)			1		

3. Availability of Services and Materials

a. Availability of prospective technologies.	i) Are technologies under consideration generally commercially available for the site-specific application?	Yes	X	1	
		No		0	
	ii) Will more than one vendor be available to provide a competitive bid	Yes	X	1	Incinerators & GW technologies.
		No		0	
b. Availability of necessary equipment and specialists.	i) Additional equipment and specialists may be available without significant delay.	Yes	1	1	GW technologies & incinerators
		No		0	
Subtotal (maximum = 3)			3		
		TOTAL (maximum = 15)	13		

IF THE TOTAL IS LESS THAN 8, THE PROJECT MANAGER MAY REJECT THE REMEDIAL ALTERNATIVE FROM FURTHER CONSIDERATION.

SHORT-TERM/LONG-TERM EFFECTIVENESS
(Maximum Score = 25)

Alternative: Soil Treatment by Stabilization/Solidification and a Groundwater Pump and Treat System

	Analysis Factor	Basis for Evaluation During Preliminary Screening			Score	
1.	Protection of community during remedial actions.	o Are there significant short-term risks to the community that must be addressed? (If answer is no, go to Factor 2.	Yes	X	0	Dust, exposure to airborne contaminants, release of solid during transportation incident.
			No		4	
		o Can the risk be easily controlled?	Yes	X	1	
			No		0	
		o Does the mitigative effort to control risk impact the community life-style?	Yes		0	
			No	X	2	
	Subtotal (maximum = 4)			3		
2.	Environmental Impacts	o Are there significant short-term risks to the environment that must be addressed? If answer is no, go to Factor 3.)	Yes	X	0	Dust, exposure to airborne contaminants, release of solid during transportation incident.
			No		4	
		o Are the available mitigative measures reliable to minimize potential impacts?	Yes	X	3	
			No		0	
	Subtotal (maximum = 4)			3		
b.	Time to implement the remedy.	o What is the required time to implement the remedy?	<=2 yr.	X	1	Soil & NAPL groundwater (GW)
			>2 yr.	X	0	
		o Required duration of the mitigative effort to control short-term risk.	<=2 yr.	X	1	
			>2 yr.		0	
	Subtotal (maximum = 2)			1 OR 2		
4.	On-site or off-site treatment or land disposal	o On-site treatment**		X	3	Soil & GW
		o Off-site treatment		X	1	** residue soil
		o On-site or off-site land disposal		X	0	*** residue
	Subtotal (maximum = 3)			0.1.3		

* Treatment is defined as destruction or separation/treatment or solidification/chemical fixation of inorganic wastes.

** Residues treated off-site include NAPL from the groundwater extraction and treatment system and any spent carbon from the dissolved organics treatment system. The soil may be stabilized off-site.

*** Residues disposed off-site include the metal sludge from the iron-based coprecipitation unit (after off-site treatment). The stabilized solid will be disposed off-site if it is treated off-site.

5.	Permanence of the remedial alternative.	o Will the remedy be classified as permanent in accordance with Section 2.1 (a), (b), or (c)? (If answer is yes, go to Factor 7.)	Yes	X	3	NAPL & GW
			No	X	0	soil & air stripping without a vapor treatment system.
	Subtotal (maximum = 3)			0		
6.	Life time of remedial alternative	o Expected lifetime or duration of effectiveness of the remedy.	25-30 yr.	X	3	
			20-25 yr.		2	
			15-20 yr.		1	
			<15 yr.		0	
	Subtotal (maximum = 3)			3		
7.	Quantity and nature of waste or residual left at the site after remediation.	i) Quantity of untreated hazardous waste left at the site.	None	X	3	(<1%)
			<=25%		2	
			25-50%		1	
			>=50%		0	
		ii) Is there treated residual left at the site? (If answer is no, go to Factor 8).	Yes		0	Residuals taken off-site.
			No	X	2	
		iii) Is the treated residual highly toxic?	Yes		0	
			No		1	
		iv) Is the treated residual highly mobile?	Yes		0	
			No		1	
	Subtotal (maximum = 5)			5		
8.	Adequacy and reliability of controls.	i) Operation and maintenance required for a period of:	<5yr.	X	1	Soil & NAPL
			>5yr.		0	GW unknown
		ii) Are environmental controls required as a part of the remedy to handle potential problems? (If answer is no, go to "iv".)	Yes	X	0	
			No		1	
		iii) Degree of confidence that controls can adequately handle potential problems.	Moderate to very confident	X	1	
			Somewhat to not confident		0	
		iv) Relative degree of long-term monitoring required (compare with other remedial alternatives)	Minimum	X	2	GW monitored quarterly during treatment, less frequently after treatment.
			Moderate		1	
			Extensive		0	
	Subtotal (maximum = 4)			4		
			TOTAL (maximum = 25)	19-23		

IF THE TOTAL IS LESS THAN 10, THE PROJECT MANAGER MAY REJECT THE REMEDIAL ALTERNATIVE FROM FURTHER CONSIDERATION.

IMPLEMENTABILITY
(Maximum Score = 15)

Alternative: Soil Treatment by Stabilization/Solidification and a Groundwater Pump and Treat System

Analysis Factor	Basis for Evaluation During Detailed Analysis		Weight	
1. Technical Feasibility				
a. Ability to construct technology	i) Not difficult to construct. No uncertainties in construction.		3	Lack of space for equipment may be difficulty.
	ii) Somewhat difficult to construct. No uncertainties in construction.	X	2	
	iii) Very difficult to construct and/or significant uncertainties in construction.		1	
b. Reliability of technology	i) Very reliable in meeting the specified process efficiencies or performance goals.	X	3	GW technol.
	ii) Somewhat reliable in meeting the specified process efficiencies or performance goals.	X	2	Stabilization reliable, when optimized; leaching could be problem in future.
c. Schedule of delays due to technical problems	i) Unlikely		2	
	ii) Somewhat likely	X	1	
d. Need of undertaking additional remedial action, if necessary.	i) No future remedial actions may be anticipated.	X	2	
	ii) Some future remedial actions may be necessary.		1	
Subtotal (maximum = 10)		7 or 8		
2. Administrative Feasibility				
a. Coordination with other agencies.	i) Minimal coordination is required.		2	
	ii) Required coordination is normal.	X	1	
	iii) Extensive coordination is required.		0	
Subtotal (maximum = 2)		1		

3. Availability of Services and Materials

a. Availability of prospective technologies.	i) Are technologies under consideration generally commercially available for the site-specific application?	Yes	X	1	
		No		0	
	ii) Will more than one vendor be available to provide a competitive bid	Yes	X	1	GW technologies and Stabil./Solid. technologies
		No		0	
b. Availability of necessary equipment and specialists.	i) Additional equipment and specialists may be available without significant delay.	Yes	X	1	GW technologies; S/S technologies uncertain, depend on system
		No		0	
Subtotal (maximum = 3)			3		
	TOTAL (maximum = 15)		11-12		

IF THE TOTAL IS LESS THAN 8, THE PROJECT MANAGER MAY REJECT THE REMEDIAL ALTERNATIVE FROM FURTHER CONSIDERATION.

SHORT-TERM/LONG-TERM EFFECTIVENESS
(Maximum Score = 25)

Alternative: Containment and a Groundwater Pump and Treat System

	Analysis Factor		Basis for Evaluation During Preliminary Screening			Score	
1.	Protection of community during remedial actions.	o	Are there significant short-term risks to the community that must be addressed? (If answer is no, go to Factor 2.	Yes	X	0	Dust, exposure to airborne contaminants.
				No		4	
		o	Can the risk be easily controlled?	Yes	X	1	
				No		0	
		o	Does the mitigative effort to control risk impact the community life-style?	Yes		0	
				No	X	2	
	Subtotal (maximum = 4)				3		
2.	Environmental Impacts	o	Are there significant short-term risks to the environment that must be addressed? If answer is no, go to Factor 3.)	Yes	X	0	Dust, exposure to airborne contaminants.
				No		4	
		o	Are the available mitigative measures reliable to minimize potential impacts?	Yes	X	3	
				No		0	
	Subtotal (maximum = 4)				3		
3.	Time to implement the remedy.	o	What is the required time to implement the remedy?	<=2 yr.	X	1	Soil & NAPL
				>2 yr.	X	0	groundwater (GW)
		o	Required duration of the mitigative effort to control short-term risk.	<=2 yr.	X	1	
				>2 yr.		0	
	Subtotal (maximum = 2)				1 OR 2		
4.	On-site or off-site treatment or land disposal	o	On-site treatment*		X	3	GW
		o	Off-site treatment**		X	1	** residue
		o	On-site or off-site land disposal		X	0	*** soil & residue.
	Subtotal (maximum = 3)				0,1,3		

* Treatment is defined as destruction or separation/treatment or solidification/chemical fixation of inorganic wastes.

** Residues treated off-site include hot spots, NAPL from the groundwater extraction and treatment system, and any spent carbon from the dissolved organics treatment unit.

*** Soil would be isolated on-site. Residue disposed off-site includes the metal sludge from the iron-based coprecipitation unit (after off-site treatment).

5.	Permanence of the remedial alternative.	o	Will the remedy be classified as permanent in accordance with Section 2.1 (a), (b), or (c)? (If answer is yes, go to Factor 7.)	Yes	X	3	NAPL & GW soil & air stripping without a vapor treatment system.
				No	X	0	
	Subtotal (maximum = 3)						
6.	Life time of remedial alternative	o	Expected lifetime or duration of effectiveness of the remedy.	25-30 yr.	X	3	
				20-25 yr.		2	
				15-20 yr.	X	1	
				<15 yr.		0	
	Subtotal (maximum = 3)				1		
7.	Quantity and nature of waste or residual left at the site after remediation.	i)	Quantity of untreated hazardous waste left at the site.	None		3	
				<=25%		2	
				25-50%		1	
				>=50%	X	0	
		ii)	Is there treated residual left at the site? (If answer is no, go to Factor 8).	Yes		0	Residuals taken off-site.
				No	X	2	
		iii)	Is the treated residual toxic?	Yes		0	
				No		1	
		iv)	Is the treated residual mobile?	Yes		0	
				No		1	
	Subtotal (maximum = 5)				2		
8.	Adequacy and reliability of controls.	i)	Operation and maintenance required for a period of:	<5yr.	X	1	Soil & NAPL, GW unknown
				>5yr.		0	
		ii)	Are environmental controls required as a part of the remedy to handle potential problems? (If answer is no, go to "iv".)	Yes	X	0	
				No		1	
		iii)	Degree of confidence that controls can adequately handle potential problems.	Moderate to very confident	X	1	
				Somewhat to not confident		0	
		iv)	Relative degree of long-term monitoring required (compare with other remedial alternatives)	Minimum		2	Min. 30 year GW monitoring & maintenance plan. GW must also be monitored quarterly during treatment.
				Moderate		1	
				Extensive		0	
	Subtotal (maximum = 4)				2		
			TOTAL (maximum = 25)		12-16		GW must also be monitored quarterly during treatment.

IF THE TOTAL IS LESS THAN 10, THE PROJECT MANAGER MAY REJECT THE REMEDIAL ALTERNATIVE FROM FURTHER CONSIDERATION.

IMPLEMENTABILITY
(Maximum Score = 15)

Alternative: Containment and a Groundwater Pump and Treat System

Analysis Factor	Basis for Evaluation During Detailed Analysis		Weight	
1. Technical Feasibility				
a. Ability to construct technology	i) Not difficult to construct. No uncertainties in construction.	___	3	
	ii) Somewhat difficult to construct. No uncertainties in construction.	X	2	Construct under railroad trucks.
	iii) Very difficult to construct and/or significant uncertainties in construction.	___	1	
b. Reliability of technology	i) Very reliable in meeting the specified process efficiencies or performance goals.	___	3	
	ii) Somewhat reliable in meeting the specified process efficiencies or performance goals.	X	2	Contact with contaminants prevented. Ca^{++} and Mg^{++} in GW may attack soil bentonite wall to increase permeability.
c. Schedule of delays due to technical problems	i) Unlikely	___	2	
	ii) Somewhat likely	X	1	
d. Need of undertaking additional remedial action, if necessary.	i) No future remedial actions may be anticipated.	___	2	
	ii) Some future remedial actions may be necessary.	X	1	
Subtotal (maximum = 10)		6		
2. Administrative Feasibility				
a. Coordination with other agencies.	i) Minimal coordination is required.	___	2	
	ii) Required coordination is normal.	X	1	
	iii) Extensive coordination is required.	___	0	
Subtotal (maximum = 2)		1		

3. <u>Availability of Services and Materials</u>

a. Availability of prospective technologies.	i) Are technologies under consideration generally commercially available for the site-specific application?	Yes	X	1	
		No		0	
	ii) Will more than one vendor be available to provide a competitive bid	Yes	X	1	GW technologies, slurry wall, & cap.
		No		0	
b. Availability of necessary equipment and specialists.	i) Additional equipment and specialists may be available without significant delay.	Yes	X	1	
		No		0	
Subtotal (maximum = 3)			3		
		TOTAL (maximum = 15)	10		

IF THE TOTAL IS LESS THAN 8, THE PROJECT MANAGER MAY REJECT THE REMEDIAL ALTERNATIVE FROM FURTHER CONSIDERATION.

SHORT-TERM/LONG-TERM EFFECTIVENESS
(Maximum Score = 25)

Alternative: Soil Treatment by Thermal Separation and a Groundwater Pump and Treat System

	Analysis Factor	Basis for Evaluation During Preliminary Screening			Score	
1.	Protection of community during remedial actions.	o Are there significant short-term risks to the community that must be addressed? (If answer is no, go to Factor 2.	Yes	X	0	Dust, exposure to airborne contaminants
			No		4	
		o Can the risk be easily controlled?	Yes	X	1	
			No		0	
		o Does the mitigative effort to control risk impact the community life-style?	Yes		0	
			No	X	2	
	Subtotal (maximum = 4)			3		
2.	Environmental Impacts	o Are there significant short-term risks to the environment that must be addressed? If answer is no, go to Factor 3.)	Yes	X	0	Dust, exposure to airborne contaminants
			No		4	
		o Are the available mitigative measures reliable to minimize potential impacts?	Yes	X	3	
			No		0	
	Subtotal (maximum = 4)			3		
b.	Time to implement the remedy.	o What is the required time to implement the remedy?	<=2 yr.	X	1	Soil & NAPL groundwater (GW)
			>2 yr.	X	0	
		o Required duration of the mitigative effort to control short-term risk.	<=2 yr.	X	1	
			>2 yr.		0	
	Subtotal (maximum = 2)			1 OR 2		
4.	On-site or off-site treatment or land disposal	o On-site treatment*		X	3	Soil & GW
		o Off-site treatment*		X	1	** residue
		o On-site or off-site land disposal		X	0	*** residue
	Subtotal (maximum = 3)			0,1,3		

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* Treatment is defined as destruction or separation/treatment or solidification/chemical fixation of inorganic wastes.

** Residue treated off-site include NAPL from the GW extraction and treatment system, condensed organics from the thermal separator, and any spent carbon from the dissolved organics treatment unit.

*** Residue disposed off-site includes the metal sludge from the iron-based coprecipitation unit (after off-site treatment).

5.	Permanence of the remedial alternative.	o Will the remedy be classified as permanent in accordance with Section 2.1 (a), (b), or (c)? (If answer is yes, go to Factor 7.)	Yes	X	3	
			No	X	0	Air Stripping w/o a vapor treatment system
	Subtotal (maximum = 3)			3		
6.	Life time of remedial alternative	o Expected lifetime or duration of effectiveness of the remedy.	25-30 yr.		3	
			20-25 yr.		2	
			15-20 yr.		1	
			<15 yr.		0	
	Subtotal (maximum = 3)					
7.	Quantity and nature of waste or residual left at the site after remediation.	i) Quantity of untreated hazardous waste left at the site.	None	X	3	(<1%)
			<=25%		2	
			25-50%		1	
			>=50%		0	
		ii) Is there treated residual left at the site? (If answer is no, go to Factor 8.)	Yes	X	0	Cleaned soil backfilled, other residue taken off-site
			No		2	
		iii) Is the treated residual highly toxic?	Yes		0	
			No	X	1	
		iv) Is the treated residual highly mobile?	Yes		0	
			No	X	1	
	Subtotal (maximum = 5)			5		
8.	Adequacy and reliability of controls.	i) Operation and maintenance required for a period of:	<5yr.	X	1	Soil & NAPL, GW unknown
			>5yr.		0	
		ii) Are environmental controls required as a part of the remedy to handle potential problems? (If answer is no, go to "iv".)	Yes	X	0	
			No		1	
		iii) Degree of confidence that controls can adequately handle potential problems.	Moderate to very confident	X	1	
			Somewhat to not confident		0	
		iv) Relative degree of long-term monitoring required (compare with other remedial alternatives)	Minimum	X	2	GW monitored quarterly during treatment, less frequently after treatment.
			Moderate		1	
			Extensive		0	
	Subtotal (maximum = 4)			4		
			TOTAL (maximum = 25)	19-23		

IF THE TOTAL IS LESS THAN 10, THE PROJECT MANAGER MAY REJECT THE REMEDIAL ALTERNATIVE FROM FURTHER CONSIDERATION.

IMPLEMENTABILITY
(Maximum Score = 15)

Alternative: Soil Treatment by Thermal Separation and a Groundwater Pump and Treat System

Analysis Factor		Basis for Evaluation During Detailed Analysis		Weight	
1. Technical Feasibility					
a. Ability to construct technology	i)	Not difficult to construct. No uncertainties in construction.		3	
	ii)	Somewhat difficult to construct. No uncertainties in construction.	X	2	Lack of space for equipment may present difficulty
	iii)	Very difficult to construct and/or significant uncertainties in construction.		1	
b. Reliability of technology	i)	Very reliable in meeting the specified process efficiencies or performance goals.	X	3	Thermal separator & GW technologies <u>when optimized</u>
	ii)	Somewhat reliable in meeting the specified process efficiencies or performance goals.		2	
c. Schedule of delays due to technical problems	i)	Unlikely		2	
	ii)	Somewhat likely	X	1	
d. Need of undertaking additional remedial action, if necessary.	i)	No future remedial actions may be anticipated.	X	2	
	ii)	Some future remedial actions may be necessary.		1	
Subtotal (maximum = 10)			8		
2. Administrative Feasibility					
a. Coordination with other agencies.	i)	Minimal coordination is required.		2	
	ii)	Required coordination is normal.	X	1	
	iii)	Extensive coordination is required.		0	
Subtotal (maximum = 2)					

3. Availability of Services and Materials

a. Availability of prospective technologies.	i) Are technologies under consideration generally commercially available for the site-specific application?	Yes	X	1	
		No		0	
	ii) Will more than one vendor be available to provide a competitive bid	Yes	X	1	GW & thermal separation technologies
		No		0	
b. Availability of necessary equipment and specialists.	i) Additional equipment and specialists may be available without significant delay. Uncertain for thermal separation; depends on system selected.	Yes	X	1	GW technologies
		No		0	
Subtotal (maximum = 3)			3		
	TOTAL (maximum = 15)		12		

IF THE TOTAL IS LESS THAN 8, THE PROJECT MANAGER MAY REJECT THE REMEDIAL ALTERNATIVE FROM FURTHER CONSIDERATION.

SHORT-TERM/LONG-TERM EFFECTIVENESS
(Maximum Score = 25)

Alternative: Soil Treatment by On-site Incineration and a Groundwater Pump and Treat System

	Analysis Factor		Basis for Evaluation During Preliminary Screening			Score	
1.	Protection of community during remedial actions.	o	Are there significant short-term risks to the community that must be addressed? (If answer is no, go to Factor 2.	Yes No	X ___	0 4	Dust, exposure to airborne contaminants, untreated air emissions from the incinerator
		o	Can the risk be easily controlled?	Yes No	X ___	1 0	
		o	Does the mitigative effort to control risk impact the community life-style?	Yes No	___ X	0 2	
	Subtotal (maximum = 4)				3		
2.	Environmental Impacts	o	Are there significant short-term risks to the environment that must be addressed? If answer is no, go to Factor 3.)	Yes No	X ___	0 4	Dust, exposure to airborne contaminants, untreated air emissions from the incinerator
		o	Are the available mitigative measures reliable to minimize potential impacts?	Yes No	X ___	3 0	
	Subtotal (maximum = 4)				3		
b.	Time to implement the remedy.	o	What is the required time to implement the remedy?	<=2 yr. >2 yr.	X X	1 0	Soil & NAPL groundwater (GW)
		o	Required duration of the mitigative effort to control short-term risk.	<=2 yr. >2 yr.	X ___	1 0	
	Subtotal (maximum = 2)				1 OR 2		
4.	On-site or off-site treatment or land disposal	o	On-site treatment*		X	3	Soil & GW
		o	Off-site treatment*		X	1	** residues
		o	On-site or off-site land disposal		X	0	*** residues
	Subtotal (maximum = 3)				0,1,3		

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* Treatment is defined as destruction or separation/treatment or solidification/chemical fixation of inorganic wastes.

** Residue treated off-site include NAPL from the GW extraction and treatment system and any spent carbon from the dissolved organics treatment unit.

*** Residues disposed off-site include solids from the vapor scrubber of the incinerator, and the metal sludge from the iron-based coprecipitation unit (after off-site treatment).

3. Availability of Services and Materials

a. Availability of prospective technologies.	i) Are technologies under consideration generally commercially available for the site-specific application?	Yes No	X		
	ii) Will more than one vendor be available to provide a competitive bid	Yes No	X	1 0	On-site incinerators and GW technol ogies.
b. Availability of necessary equipment and specialists.	i) Additional equipment and specialists may be available without significant delay.	Yes No	X	1 0	GW technologie and incinerato
Subtotal (maximum = 3)			3		
		TOTAL (maximum = 15)	11		

IF THE TOTAL IS LESS THAN 8, THE PROJECT MANAGER MAY REJECT THE REMEDIAL ALTERNATIVE FROM FURTHER CONSIDERATION.