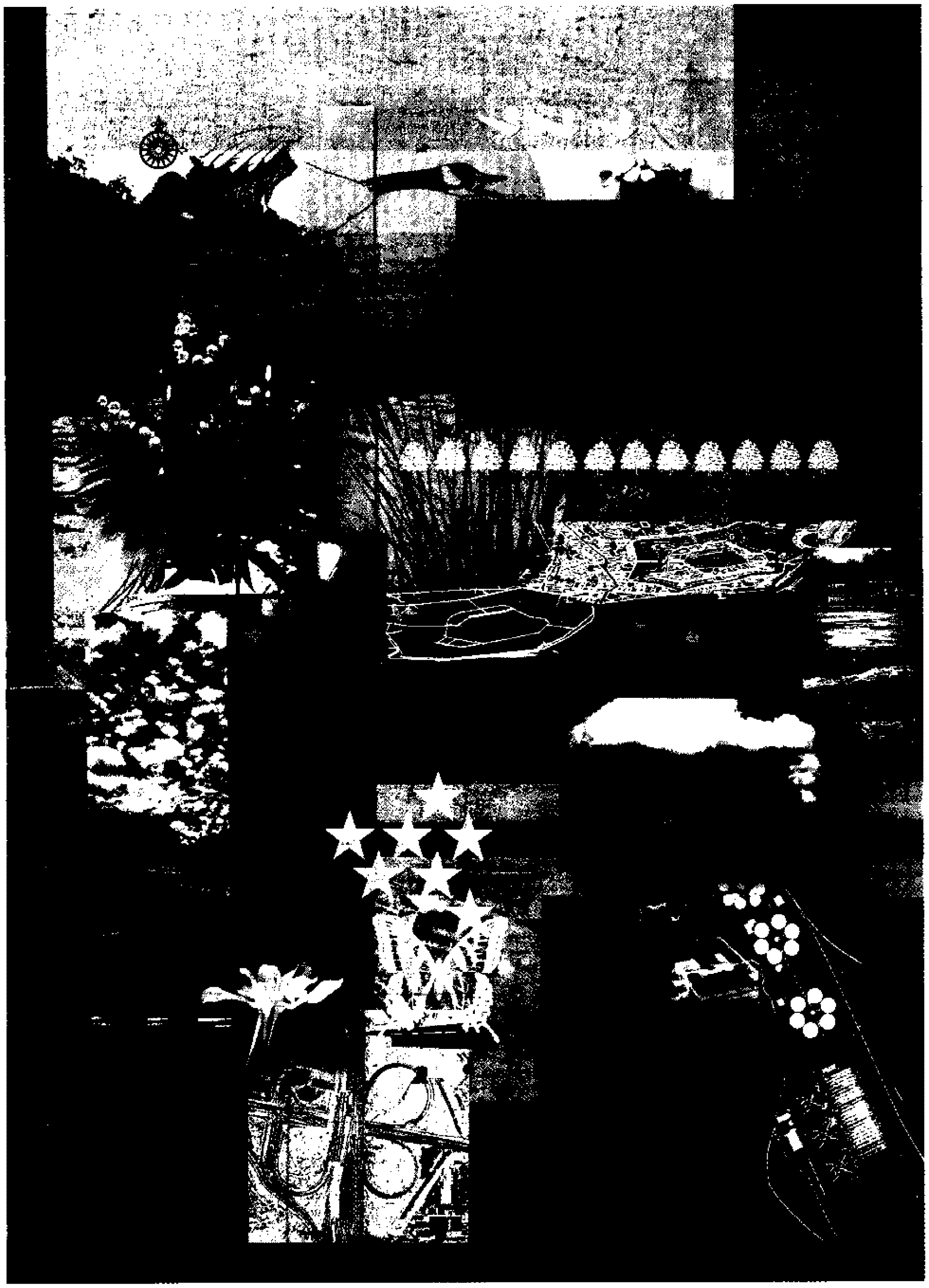

FEASIBILITY STUDY REPORT ORANGE & ROCKLAND UTILITIES, INC. WEST NYACK, NEW YORK INACTIVE HAZARDOUS WASTE SITE (ID#: 3-44-014)

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Quality through teamwork

March 1997

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1.0 INTRODUCTION

Under the requirements of an Order on Consent Index #W3-0508-93-12 dated August 2, 1994 between Orange and Rockland Utilities, Inc. (ORU) and the New York State Department of Environmental Conservation (NYSDEC), a Feasibility Study (FS) has been performed for the ORU facility (Site) located in a developed commercial and residential area of West Nyack, Rockland County, New York (Figure 1). The Feasibility Study was performed by Rust Environment and Infrastructure (Rust) in accordance with the Remedial Investigation/Feasibility Study (RI/FS) Work Plan, dated November 8, 1995.

1.1 PURPOSE AND ORGANIZATION OF REPORT

The purpose of the FS is to identify and analyze remedial alternatives that: are protective of human health and the environment; attain, to the maximum extent practicable, applicable or relevant and appropriate requirements (ARARs); and are cost effective. Accordingly, the FS is based on objectives, methodologies, and evaluation criteria as generally set forth in the following federal and NYSDEC regulations and guidelines:

- the Comprehensive Environmental Response Compensation and Liability Act of 1980 (CERCLA) and the Superfund Reauthorization Act of 1986 (SARA);
- the National Oil and Hazardous Substances Contingency Plan (NCP);
- Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA (USEPA, October 1988);
- CERCLA Compliance with Other Laws Manual, 1988, OSWER Directive No. 9234.1-01 and -02;
- NYSDEC Water Quality Regulations for Surface Waters and Groundwaters, 6NYCRR Parts 700-705;
- NYSDEC Technical and Administrative Guidance Memorandum (TAGM) #HWR-89-4022 "Records of Decision for Remediation of Class 2 Inactive Hazardous Waste Disposal Sites";
- NYSDEC TAGM #HWR-89-4025 "Guidelines for RI/FS's";
- NYSDEC TAGM #HWR-90-4030 "Selection of Remedial Actions at Inactive Hazardous Waste Sites";
- NYSDEC TAGM #HWR 94-4046 "Determination of Soil Cleanup Objectives and Cleanup Levels";
- NYSDEC Spill Technology and Remediation Series (STARS) Memo #1 "Petroleum-Contaminated Soil Guidance Policy";

- NYSDEC Strategy for Groundwater Remediation Decision Making at Inactive Hazardous Waste Sites and Petroleum Contaminated Sites in New York State, April 1996;
- NYSDEC "Technical Guidance for Screening Contaminated Sediments"; and
- NYSDOH Drinking Water Standards.

Since the Site is under investigation by the NYSDEC Division of Hazardous Waste Remediation, applicable guidelines set forth by this division will supersede other NYSDEC guidelines unless otherwise stated.

The remainder of Section 1.0 contains background information about the Site, and a brief summary of the scope of the RI and pertinent RI findings including the physical systems, nature and extent of contamination, and contaminant fate and transport. Section 2.0 identifies the remedial action objectives, general response actions, and remedial technologies, and presents the screening of the remedial technologies on the basis of effectiveness, technical implementability, and cost. In Section 3.0, the technologies are grouped into remedial alternatives, which are then screened to eliminate those that are not suitable. In Section 4.0, a detailed analysis of the alternatives retained is presented, and the recommended remedial alternative is identified and described.

1.2 BACKGROUND INFORMATION

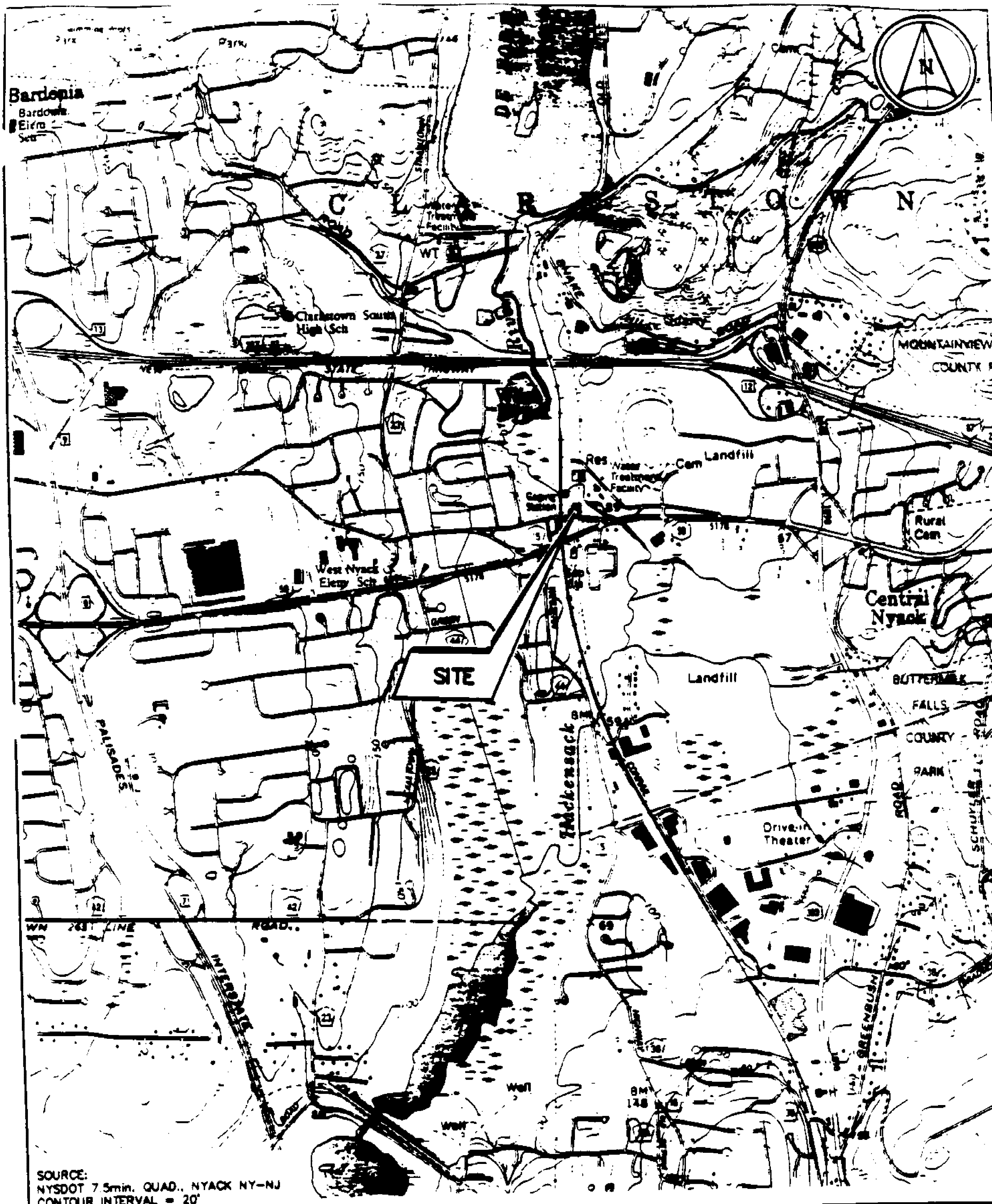
1.2.1 Site Description

The Site is approximately three acres in size and is situated north of Route 59 and immediately north of the Old Nyack Turnpike, and seven-tenths of a mile west of the intersection of Routes 59 and 303. The Site is bordered on the west by Consolidated Rail Corporation (Conrail) rail tracks and a small property occupied by Yaboo Fence Company, Inc. for storage purposes. The Hackensack River borders the Site to the north and east (Figure 1).

The Hackensack River flows from north to south, occupying a broad valley bottom of low relief. This valley bottom exists generally at elevations of 50 to 70 feet, but has rolling hills that rise from 100 to 150 feet. The river valley is approximately 6,000 feet wide where it is crossed by NYS Route 59, and maintains that width for about 2,000 feet north of the Site and about 6,000 feet south of the Site (Lawler, Matusky and Skelly, 1992 [LMS, 1992]).

The land surface rises steeply to a long north-south trending ridge at the eastern edge of the Hackensack River floodplain where elevations reach 300 to 500 feet. This long north-south trending ridge forms a topographic divide between the Hudson River and Hackensack River drainage basins. The land rises abruptly to elevations of about 250 feet on the western edge of the Hackensack River floodplain, though not as steeply as on the eastern edge.

One of the rolling hills in the Hackensack River valley mentioned above exists immediately to the west and south of the subject Site. The ground surface rises to 80 feet on the west and 100 feet on the south side of NYS Route 59. This landform creates a small local divide that separates shallow



SOURCE:
NYSDOT 7.5min. QUAD., NYACK NY–NJ
CONTOUR INTERVAL = 20'

RUST ENVIRONMENT & INFRASTRUCTURE

SITE LOCATION MAP

ORANGE AND ROCKLAND UTILITIES, INC.

VILLAGE OF WEST NYACK — ROCKLAND COUNTY, NEW YORK

PROJECT NO. 38301.200	DATE 9/94	DWG. NO. 38301-03	SCALE 1"=2000'	FIGURE NO. 1

groundwater and surface water that flows northeast toward and across the Site from waters that flow south and west into a large wetland area downstream from the Site.

The Site is mostly flat, sloping gently from southwest to northeast, with the southwest corner rising slightly to approximately 69 feet, which is about 6 to 7 feet higher than most of the Site. The range of elevations encountered at the Site is from 50 to 70 feet.

1.2.2 Site History

The Site is currently used as a satellite station for ORU's line crews with garage facilities for utility service repair trucks, parking space for ORU vehicles, and as office space for two outside tenants and for several other ORU departments. From the late 1920's to approximately 1981 the Site was used to store and repair electrical transformers, capacitors and other utility equipment. Two underground storage tanks located in the center of the Site were used to store gasoline for fueling ORU's utility service repair trucks. In April 1980, it was discovered that one tank was leaking. As a result, this tank was repaired and relined in 1980 and later removed in 1989 after failing tightness testing. The second tank was found to be sound and remains in service for diesel fuel storage.

1.2.3 Description of the Surrounding Area

The Site is located at 180 West Nyack Road in the hamlet of West Nyack, Town of Clarkstown, Rockland County, New York. The Town of Clarkstown has a population of 79,346 according to a 1990 Census. The surrounding region is an extensively developed commercial and residential area. There are three NYSDEC regulated wetland areas located within a one half mile radius of the Site and two NYSDEC regulated wetland areas located within a two mile radius of the Site.

1.2.4 Previous Investigations

Presented below is a chronological list of previous investigations performed at the Site. In addition, a brief summary of activities performed and recommendations provided, based upon review of results and conclusions from each investigation is also included:

<u>1980</u>: In response to concerns over the possibility of soil contamination and migration of Polychlorinated biphenyls (PCBs) into the Hackensack River due to the historical operation of the facility, Paulus, Sokolowski and Sartor (PSS) performed a soil, surface water, sediment, and groundwater investigation. PSS concluded that PCBs were not migrating from the Site but recommended that monitoring wells be installed and a short-term monitoring program be established.

<u>June-August, 1981</u>: ORU examined on-site air, soil, and groundwater and Hackensack River surface water and sediment for PCB content. PCBs were detected in low concentrations in the following media: soil (on-site), groundwater (on-site), surface water, and sediment from the nearby Hackensack River.

<u>May, 1987</u>: Wehran Engineering of Middletown, New York performed a Phase I investigation for the NYSDEC. Wehran recommended that a Phase II investigation be performed.

May, 1988: NUS Corporation (NUS) completed a Preliminary Assessment of the Site for the USEPA. The report recommended that surface water sampling be conducted at the intake point of the Nyack Water Company.

August, 1988: NUS completed a Final Draft Site Inspection Report of the Site for the USEPA in which recommendations for further action at the Site were identified as being a high priority.

July, 1989: Dames and Moore (D&M) of Pearl River, New York performed a groundwater investigation due to a failed integrity test on an on-site underground storage tank (UST) and the identification of "petroleum" contaminated soil during its subsequent excavation. D&M installed five monitoring wells and sampled the newly installed wells and three existing wells. Based on the analytical results, D&M confirmed the presence of petroleum-related constituents and the probability of chlorinated solvents in on-site groundwater.

February, 1990: ORU sampled on-site groundwater and surface water and sediment from the Hackensack River. All samples were analyzed for PCBs with PCBs being detected in only one sediment sample from the Hackensack River.

July, 1991: ORU signed a Consent Order with the NYSDEC to conduct a Phase II investigation to verify that no PCBs or chlorinated solvents were present in on-site soil and/or groundwater.

March, 1992: Lawler, Matusky and Skelly Engineers (LMS) performed a Phase II investigation. LMS conducted sampling of on-site soil (shallow surface and subsurface), surface water ,and sediment from the Hackensack River and on-site groundwater. Each sample was analyzed for the Target Compound List (TCL) organic parameters. PCBs were only identified in on-site soil and Hackensack River sediment samples while chlorinated solvents were identified in on-site soil and groundwater.

1.3 SUMMARY OF REMEDIAL INVESTIGATION

1.3.1 Scope of the RI

The overall objective of the RI was to gather sufficient information to determine the nature and extent of hazardous waste contamination which exists on and may be emanating from the Site to surrounding areas. This information was used to determine the most cost effective, environmentally sound, long term remedial action(s).

The gathering of information included both the utilization of existing information collected for the Phase II Investigation as well as the collection of new data to supplement and complement the existing information. Several existing monitoring wells were sampled. The installation of additional groundwater monitoring wells was minimal with new monitoring wells installed only in those areas where insufficient information existed on the quality of the groundwater in the various hydrogeologic units. Additional soil samples were proposed only in areas not covered by the Phase II Investigation.

Since the most likely route for the transport of contaminants from the Site is via the Hackensack River, several additional surface water and sediment samples were collected in the river.

1.3.2 RI Findings

This section provides a summary of the findings of the RI. Details of the RI are presented in the Remedial Investigation Report dated April 24, 1996.

1.3.2.1 Physical Setting

Site Geology

Geologic conditions in the vicinity of the Site have been previously characterized by Paulus, Sokolowski and Sartor (1980), Dames and Moore (1990) and Lawler, Matusky and Skelly (1992). Subsurface conditions were further evaluated by Rust during this RI through the performance of additional soil borings. Based on data obtained during the RI and on the results of previous investigations, the geology beneath the Site is generally composed of approximately 25 to 40 feet of unconsolidated sediments of glacial and post-glacial origin overlying Triassic age sedimentary bedrock.

Unconsolidated deposits present at the Site include, in order of increasing depth, fill; organic silt and sand; undifferentiated sand and gravel; and glacial till. The fill ranges in thickness from 1 to 8 feet and overlies the native material across the Site. A layer of black to dark brown organic silt with some fine to medium grain sand is present beneath the fill material over a majority of the northern half of the Site. The organic layer ranges in thickness from not present (i.e., in the southern half of the Site and in areas where it has been replaced by fill) to 6.5 feet. A relatively thick sequence of undifferentiated sand and gravel is present beneath the organic silt and sand layer, or below the fill materials where the organic layer is absent. This sequence ranges in thickness from approximately 20 to 30 feet. The final layer of glacial till ranges in depth from 26.2 feet to the top of bedrock (40.1 feet). This identification was made based on the very dense and compact nature of the material, low moisture content, and contains 10 to 15% silt, as a matrix to the sand and gravel.

The underlying bedrock is composed of the Brunswick formation. The depth of the bedrock surface ranges from 25 to 40 feet. The shallow bedrock beneath the Site is highly fractured and consists of red to red-gray sandstone, siltstone, and mudstone which appears to be consistent with the Geologic Map of New York. Weathering along the fractures has produced localized zones of solution cavities.

Site Hydrogeology

Groundwater beneath the Site is present in both the unconsolidated sediments (overburden) and bedrock. The geologic units present at the Site comprise three hydrogeologic units. Two of these include a shallow unconsolidated sediments (overburden) groundwater flow zone and a weathered bedrock interface groundwater flow zone. The third hydrogeologic unit is comprised by the glacial till. This unit likely serves as a confining or semi-confining layer to vertical groundwater flow between the two groundwater flow zones outlined above.

The overburden groundwater flow zone is comprised of fill materials (where fill has been placed below the water table), the organic silt unit, and the upper portions of the undifferentiated sand and gravel sequence. Groundwater in the overburden groundwater flow zone occurs under unconfined water table conditions and rises and falls with changes in recharge and discharge. The water table at the Site exists fairly close to the ground surface (3 to 6.5 feet below grade) and flows to the northeast.

Groundwater is present in the upper weathered portion of bedrock where there is an abundance of secondary porosity features (joints, fractures and solution cavities). This unit comprises a weathered bedrock interface groundwater flow zone. The groundwater in the bedrock flows to the northeast, similar to that in the overburden. The relatively flat hydraulic gradient across the Site indicates that there is good hydraulic communication throughout the weathered bedrock interface groundwater flow zone.

The glacial till deposit appears to serve as a confining or semi-confining layer to the weathered bedrock interface flow zone in the southwest corner of the Site. The hydraulic head in the overburden groundwater flow zone is appreciably higher than that in the weathered bedrock interface groundwater flow zone. This demonstrates that the two groundwater flow zones are hydraulically isolated from one another in this area at the Site. In the northern half of the Site, the deeper portion (i.e., between a depth of approximately 20 feet and the bedrock surface) of the undifferentiated sand and gravel sequence was observed to be highly compact and dense. Based on this, it is believed that this unit exhibits at least some confining properties between the two groundwater flow zones.

1.3.2.2 Nature and Extent of Contamination

Shallow Subsurface Soil

The shallow subsurface soil analytical data from the five borings completed during the RI indicate that the subsurface soil at depths greater than two feet in the vicinity of borings HA-4 and HA-5 are impacted by benzene, toluene, ethylbenzene, and xylene (BTEX). Shallow subsurface soil (1' to 4') in the western section of the Site (borings HA-1, HA-2 and HA-3) have not been impacted by petroleum related volatile organic compounds (VOCs). Omichron field test kit data indicate that soil in the immediate vicinity of borings HA-1, HA-2, HA-3, HA-4 and HA-5 have not been impacted by PCBs.

Underground Storage Tank Area

Field gas chromatograph (GC) and laboratory analytical data indicated that the extent of impacted subsurface soil, north, west and south of the UST area have been delineated. North of the USTs, subsurface impacted soil does not extend beyond SB-9A, SB-13A or SB-14A, to the west soil at SB-6 and SB-7 are not impacted and to the south soil at SB-22 and SB-19 are not impacted. SB-18 marks the approximate limit of impacted soil south-southeast of the UST area. To the east and southeast the limit of impacted soil lies between SB-16/SB-17 and SB-5/SB-5A. Northeast of the UST area, the horizontal limit of impacted soil lies between SB-25 and SB-SDA-SB-02. The depth of impacted soil ranges from 1 foot to 14 feet. Using 12 feet as an average depth of impacted soil and the areal extent as described above, there is potentially 6,000 cubic yards of soil impacted by petroleum related VOCs.

Suspected Dry Well Area

The field GC and laboratory dry well soil boring analytical data indicate that the soil in the vicinity of the borings do not represent a significant source of VOC hydrocarbons.

SB-24 Test Pit

The PCB sample analytical data from the test pits completed in the vicinity of UST SB-24, indicate that the high PCBs reported in the SB-24, 4'-4.5' sample is an isolated occurrence. The extent of subsurface soil impacted by PCBs at concentrations greater than 25 ppm is limited to the area in the immediate vicinity of SB-24.

Suspected Debris Disposal Area

The subsurface soil field GC VOC data and the laboratory VOC data from samples collected from the borings installed in the suspected debris disposal area and the PCB data indicate that the suspected disposal area does not represent a source of VOCs or PCBs. The analytical data indicate that subsurface soil in this area have not been significantly impacted by VOCs or PCBs.

Hackensack River Surface Water/Sediments

The RI surface water analytical data in conjunction with the historical surface water analytical data indicate that the Site has not had an impact on surface water quality with respect to PCBs. Review of all the available Hackensack River sediment PCB analytical data, indicate that concentrations significantly greater than upstream values are limited to three isolated areas. These areas are located approximately 300 feet downstream of the Nyack Water Company intake, at the small dam located near the southeastern boundary of the Site, and near the Route 59 Bridge.

The October 1991 surface water and sediment analytical data indicate that the Hackensack River surface water and sediment quality had not been impacted by VOCs. However, BTEX compounds may not have reached the Hackensack River by 1991.

In December 1996 surface water and sediment samples were collected from the Hackensack River and analyzed for volatile organics. One sample was collected upstream of the Site and three samples were collected to adjacent to or downstream of the Site. The December 1996 data confirmed the October 1991 analytical results and indicated that Hackensack River surface water and sediments have not been impacted with respect to Site related volatile organics. Analytical results from the December 1996 sampling event are presented in Appendix D.

Groundwater

The historical groundwater analytical data indicates that groundwater from monitoring wells MW-1, MW-2, MW-3 and MW-4 have exhibited BTEX compounds that have exceeded the NYSDEC groundwater standards. Historically, groundwater from monitoring wells MW-2 and MW-4 have exhibited the highest concentrations, with comparable xylene concentrations in the MW-1 groundwater samples. The BTEX concentrations in MW-4 generally increased from July 1989 to October 1991. Chlorinated VOCs have been detected in the MW-3 groundwater samples at concentrations that exceeded the NYSDEC groundwater standards. The groundwater samples from EXW-1, EXW-4 and EXW-5 indicate that groundwater in the vicinity of these wells has not been impacted by BTEX. However, chlorinated VOCs have been consistently detected in the EXW-4 and EXW-5 samples at concentrations which have exceeded the NYSDEC groundwater standards. Groundwater from weathered bedrock interface wells MW-8 and MW-6 exhibited chlorinated volatile compounds at concentrations that have exceeded the NYSDEC groundwater standard, the compounds detected are the same as identified in the overburden MW-3, EXW-4 and EXW-5 monitoring well samples.

The overburden groundwater analytical data indicate that BTEX concentrations have generally decreased over time. The one exception is the BTEX concentrations in MW-2 which are higher in the December 1995 sample than in previous samples. The EXW-1, EXW-4, EXW-5 and the MW-8S groundwater BTEX data indicate that VOC petroleum contaminants associated with the UST area have not migrated to the Site boundary. However, estimated groundwater flow rates indicate that BTEX compounds potentially had not reached the EXW-4 and EXW-5 locations by December 1995.

The chlorinated VOC analytical data indicate that groundwater concentrations in the vicinity of monitoring wells MW-3 and MW-4, and to a lesser extent EXW-4 have increased. The EXW-5 chlorinated VOC concentrations were consistent with historical values. Elevated concentrations of chlorinated VOCs were also detected in the MW-2 and the MW-8S overburden monitoring wells. Existing overburden groundwater and weathered bedrock flow data indicate that the trichloroethene (TCE) and 1,2-dichloroethene (1,2-DCE) detected in the MW-2, MW-3, MW-4, EXW-4 and EXW-5 and MW-8S samples may potentially be related to an off-site source.

The December 1995 PCB analytical data indicate that the overburden groundwater has not been significantly impacted by PCBs. Elevated concentrations were limited to monitoring wells MW-2 and MW-3. PCBs were not detected in the downgradient Site perimeter monitoring wells during either of the past two monitoring events (December 1995 and November 1991).

The TCE and 1,2-DCE detected in upgradient, background weathered bedrock interface wells MW-5B and MW-9B groundwater samples appears to be related to an off-site source. The available weathered bedrock flow data indicates that the TCE and 1,2-DCE detected in the weathered bedrock MW-6 and MW-8 groundwater samples is to some extent related to an off-site source. The 1,1,1-trichloroethane (1,1,1-TCA) and 1,1-dichloroethene (1,1-DCE) detected in the downgradient MW-6 and MW-8 weathered bedrock interface monitoring well samples appears to be Site related.

No PCBs were detected in the weathered bedrock interface groundwater monitoring well samples. Data indicates that the Site has not had an impact on weathered bedrock groundwater quality with respect to PCBs.

1.3.2.3 Contaminant Fate and Transport

The physical characteristics of the Site, surrounding area, and the Site chemical data indicate that transport mechanisms through which site related chemicals could migrate include groundwater movement away from the Site, erosion of Site surface soil, and discharge of groundwater to the Hackensack River. Groundwater at the Site exhibits VOC and PCB concentrations which exceed NYSDEC groundwater standards. Available data indicate that VOC chemicals of concern have not been detected in the Hackensack River surface water and sediment samples, indicating that this is not a pathway of concern with respect to VOCs. PCBs have not been detected in the Hackensack River surface water samples at concentrations elevated with respect to upstream concentrations indicating that groundwater discharge to the River and erosion of Site soil is not a pathway of concern with respect to impacts to Hackensack River surface water quality.

1.4 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARs)

Applicable or relevant and appropriate requirements (ARARs) are defined in Section 121(d) of CERCLA (P.L. 96-510), as amended by SARA (P.L. 99-499), as any Federal or State standard, requirement, criteria, or limitation that is legally applicable or relevant and appropriate under the circumstances of the contaminant release or threatened release. Section 121(d) of CERCLA, as amended by SARA, establishes standards that govern the degree of cleanup required at a site. The selected remedial measure must attain a level or standard of control that satisfies ARARs except under certain conditions.

New York State, in 6 NYCRR Part 375, has developed rules for selecting and designing remedial programs for inactive hazardous waste sites which are consistent with the CERCLA requirements. A remedial alternative must conform with NYS Standards and Criteria that are generally applicable, consistently applied, and officially promulgated, that are either directly applicable, or that are not directly applicable but are relevant and appropriate. The Site remedial program should also be selected with consideration given to NYS Guidance which is determined to be applicable on a case-specific basis. The Federal equivalent of Guidance is "To Be Considered" guidance and advisories (TBC).

The potential standards, criteria and guidance (SCG) are identified in the sections below and the associated tables. Standards, criteria and guidance may be specific to either the site location, the contaminants present, or the remedial actions planned.

1.4.1 Location-Specific ARARs

Location-specific ARARs, which relate to requirements for wetlands protection, floodplain management, fish and wildlife conservation, and historic preservation, apply to remedial alternatives within specific geographical locations. A comprehensive list of potential location-specific ARARs and their applicability to the Site are identified in Table 1-1.

1.4.2 Chemical-Specific ARARs

Chemical-specific ARARs are Federal or State standards or health/risk-based numerical values that are used to establish acceptable amounts or concentrations of constituents allowed in the environment. A comprehensive list of potential chemical-specific ARARs and their applicability to the Site are identified on Table 1-2.

There are no promulgated Federal or State chemical-specific ARARs for soil or sediments. NYS guidance regarding soil and sediments is identified in Section 1.4.4 of this report.

1.4.3 Action-Specific ARARs

Action-specific ARARs apply to specific treatment and disposal activities, and may set controls or restrictions on the design, performance and implementation of the remedial actions taken at a site. For example, RCRA requirements will be applicable if the remediation constitutes treatment, storage or disposal of a hazardous waste as defined under RCRA. Other examples of action-specific requirements are Clean Water Act standards for discharge of treated groundwater and New York State regulations 6 NYCRR Part 703, which establish surface water and groundwater quality standards and groundwater effluent standards.

Table 1-3 identifies the action-specific ARARs that are potentially applicable to the Site. Since action-specific ARARs apply to discrete remedial activities, their evaluation is presented with the detailed analysis of alternatives for each retained alternative.

1.4.4 Potential Guidance

There are instances when ARARs do not exist for a particular chemical or remedial action. In these instances, other State and Federal criteria, advisories and guidance may be used to aid in the evaluation and selection of a remedial alternative for a site. The guidance or advisories that may be relevant to the Site are identified on Table 1-4.

1.5 FOCUS OF THE FEASIBILITY STUDY

This FS focuses on the remedial alternatives that can be readily implemented and can achieve the remedial action objectives effectively. Technologies that could prove to be difficult to implement or may not be appropriate or feasible based on site-specific conditions, are eliminated from further consideration.

The results of the RI indicate that PCB contaminated soil exists on the Site and have been detected in various locations in the Hackensack River sediments. Results also indicate that the subsurface soils in the UST area exhibit levels of BTEX concentrations that are elevated with respect to the NYSDEC SCGs. The overburden groundwater has been impacted by these constituents at various locations. Specific chlorinated VOCs have also been detected in various overburden groundwater wells across the Site and have been detected in a majority of the weathered bedrock interface groundwater wells.

The focus of this FS is to prevent the migration of Site surface soil that contains PCBs to the Hackensack River via surface water runoff, and to eliminate to the extent possible contaminated soils as a source of groundwater contamination.

Table 1-1
Location-Specific ARARs
Orange and Rockland Utilities, Inc.

Requirement	Synopsis	Application
STATE:		
Use and Protection of Waters (6 NYCRR Part 608; ECL 15-0501 and 15-0505)	Under this regulation, a permit is required to change, modify, or disturb any protected stream, its bed or banks, sand, gravel, or any other material; or to excavate or place fill in any of the navigable waters or in any marsh, estuary or wetland, contiguous to any of the navigable waters of the State.	Possibly applicable. If disturbance of the bay is required as part of the remedy, these activities must be conducted in accordance with the regulations and typical permit requirements , although a permit from the NYSDEC may not be required.
New York State Ambient Water Quality Standards (6 NYCRR Parts 700-705)	Defines surface water and aquifer classification and lists specific chemical standards.	Possibly applicable. Classifications and standards may be used develop criteria for PCB levels in surface water and process water treatment effluent during implementation of the remedial alternative.
Endangered and Threatened Species of Wildlife (6 NYCRR Part 182)	Site activities must minimize impact on identified endangered or threatened species of fish or wildlife.	Possibly applicable. The Site has not been evaluated to determine if endangered species are present.
Coastal Zone Management (19 NYCRR Part 600-602)	Site activities must minimize impacts on the coastal zone.	Possibly applicable, since the Site is within the NYS Coastal Zone.
Water Quality Certification	A State Water Quality Certification is required if a federal permit is needed for discharge into navigable waters.	Possibly applicable, since a federal permit may be required.
FEDERAL:		
Clean Water Act, Section 404(b)(1)/U.S. Army Corps of Engineers Nationwide Permit Program (33 CFR 330)	Activities involving dredging or filling, or the construction or alteration of bulkheads, dikes, in navigable waters, including wetlands, are regulated by the Corps of Engineers.	Possibly applicable. If dredging and/or construction in the bay (i.e., installation of sheet piles and/or CDFs) is included as part of the remedial alternative, a Nationwide Permit would be required.
Fish and Wildlife Coordination Act (16 USC 662)	Any action that proposes to modify a body of water or wetland requires consultation with the U.S. Fish and Wildlife Service.	Possibly applicable if Cumberland Bay would be affected by a remedial action at the Site.
Endangered Species Act (50 CFR 200, 402)	Site activities must minimize impacts on identified endangered plant and animal species.	Possibly applicable. The Site has not been evaluated for the presence of endangered species.

Table 1-2
Chemical-Specific ARARs
Orange and Rockland Utilities, Inc.

Requirement	Synopsis	Application
STATE:		
NYSDEC Water Quality Regulations for Surface Waters and Groundwaters (6 NYCRR Parts 700-705)	Establishes standards for surface water and groundwater quality.	Applicable. Surface waters of New York.
NYSDEC Identification and Listing of Hazardous Waste (6 NYCRR Part 371)	Defines and regulates PCBs in NYS.	Applicable. Environmental media of New York.
NYSDOH Drinking Water Stanadards (10 NYCRR Part 5)	Enforceable drinking water standards.	Applicable.
FEDERAL:		
Effluent Limitations (40 CFR Part 401)	Enforceable drinking water standards.	Applicable.
Toxic Substance Control Act; TSCA (40 CFR 761)	Regulates management and disposal of materials containing PCBs	Applicable. Site soil cleanup levels and landfill construction and operation requirements.

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Note: If RCRA hazardous wastes are identified on site, the appropriate RCRA requirements would be followed.

Table 1-3
Action-Specific ARARs
Orange and Rockland Utilities, Inc.

FEDERAL	• Polychlorinated biphenyls (PCBs) Manufacturing, Processing, Distribution in Commerce, and Use Prohibitions (40 CFR 761); • Clean Water Act (CWA) - NPDES Permitting Requirements for Discharge of Treatment System Effluent (40 CFR 122-125); • CWA Discharge to Publicly Owned Treatment Works (POTW) (40 CFR 403); and • Occupational Safety and Health Standards for Hazardous Responses and General Construction Activities (29 CFR 1904, 1910, 1926).
STATE	• NYS Pollution Discharge Elimination System (SPDES) Requirements "Standards for Storm Water Runoff, Surface Water, and Groundwater Discharges" (6 NYCRR Parts 750-757); • NYSDEC "Water Quality Regulations for surface Waters and Groundwaters" (6 NYCRR Parts 700-705); • Standards for Hazardous Waste Management (6 NYCRR Parts 370-373); • Standards for Waste Transportation (6 NYCRR Part 364); and • Solid Waste Management Facilities (6 NYCRR Part 360).

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Table 1-4
Potential Guidance
Orange and Rockland Utilities, Inc.

FEDERAL	• USEPA Office of Water Regulations and Standards, Interim Sediment Criteria Values for Nonpolar Hydrophobic Organic Contaminants; May 1988, Updated for specific contaminants (primarily PAHs) in 1993; • USEPA Health Effects Assessment (HEAs); • TSCA Health Data; • Toxicological Profiles, Agency for Toxic Substances and Disease Registry, U.S. Public Health Service; • Policy for the Development of Water-Quality-Based Permit Limitations for Toxic Pollutants (49 Federal Register 9016); • Cancer Assessment Group (National Academy of Science Guidance); • Waste Load Allocation Procedures; • USEPA Soil Screening Guidance (EPA/540/R-94/101); • USEPA PCB Spill Policy; • Fish and Wildlife Coordination Act Advisories; and. • Executive Order 11990, "Protection of Wetlands".
STATE	• TAGM #HWR 4022 "Records of Decision for Remediation of Class 2 Inactive Hazardous Waste Disposal Sites"; • TAGM #HWR 4025 "Guidelines for Remedial Investigations and Feasibility Studies"; • TAGM #HWR 4030, "Selection of Remedial Actions at Inactive Hazardous Waste Sites"; • TAGM #4046 "Determination of Soil Cleanup Objectives and Cleanup Levels"; • TAGM #HWR 4046 "Determination of Soil Cleanup Objectives and Cleanup Levels"; • NYSDEC Spill Technology and Remediation Series, STARS Memo #1; • NYS Division of Fish and Wildlife, "Technical Guidance for Screening Contaminated Sediments"; • NYS Analytical Detectability for Toxic Pollutants; • NYS Toxicity Testing for the SPDES Permit Program (TOGS 1.3.2); • NYS Regional Authorization for Temporary Discharges (TOGS 1.6.1); • NYS Air Guidelines for the Control of Toxic Air Contaminants (Air Guide 1); • Technical Guidance for Regulating and Permitting Air Emissions From Air Strippers, Soil Vapor Extraction Systems and Cold-Mix Asphalt Units (Air Guide 29); and • Fugitive Dust Suppression and Particle Management Program at Inactive Hazardous Waste Sites (TAGM 4031). • NYSDEC Strategy for Groundwater Remediation Decision Making at Inactive Hazardous Waste Sites and Petroleum Contaminated Sites in New York State, April 1996.

2.0 IDENTIFICATION AND SCREENING OF TECHNOLOGIES

This section identifies the remedial action objectives, general response actions, and remedial technologies for the ORU West Nyack Site. A wide range of remedial technologies are identified as potentially capable of meeting the remedial action objectives. Each remedial technology is evaluated, and the most appropriate technologies are retained for use in developing remedial action alternatives.

2.1 REMEDIAL ACTION OBJECTIVES

Remedial action objectives for the Site are developed based on the constituents of concern, media of concern, identified exposure pathways, and potential receptors identified in the RI. The remedial action objectives, which are media-specific, provide for protection of human health and/or the environment. They have been selected to minimize or reduce to target levels, the potential for human exposure or environmental damage due to the presence or migration of site-related contaminants. Table 2-1 presents federal and state cleanup objectives for groundwater and soil. The site-specific remedial action objectives for groundwater and soil are as follows:

Groundwater

- Prevent ingestion of groundwater with concentrations of site-related constituents (primarily the TCA, TCE and BTEX) above current New York State Department of Health (NYSDOH) drinking water standards or, if more stringent, New York State groundwater standards.

- Prevent or limit to the extent possible, migration of groundwater containing site-related VOCs and PCBs to off-site receptors.

Soil

- Prevent human exposure to Site surface soils that contain PCBs posing an unacceptable risk to human health.

- Prevent migration of Site surface soils that contain PCBs to the nearby Hackensack River via surface water runoff.

- Eliminate to the extent possible, Site soils containing UST-related BTEX compounds, and PCBs as a source of groundwater contamination at concentrations in excess of current NYSDOH drinking water standards or, if more stringent, New York State groundwater standards.

Federal and state regulations and guidance provide PCB soil cleanup levels. EPA PCB spill policy states that the cleanup level for soils in restricted access areas is 25 ppm. The NYSDEC TAGM #HWR-94-4046 includes a recommended soil cleanup level for PCBs of 1 ppm for surface soil and 10 ppm for subsurface soil. Extensive shallow soil sampling (1 to 2 foot deep samples) for PCBs in the north and southeast sections of the Site during the Phase II Investigation indicated that PCBs above 1 ppm are present in these areas of the Site. No shallow samples exhibited results between 10 and 25 ppm but several "hot spots" exhibited concentrations over 25 ppm.

State regulations and guidelines provide soil cleanup levels for volatile and semi-volatile organic compounds. Shallow soil sample and soil boring data collected during the Phase II Investigation and the Remedial Investigation indicate concentrations of BTEX compounds in the former UST area that exceed cleanup levels outlined in the NYSDEC TAGM #HWR-94-4046.

Federal and state regulations and guidance provide surface water and groundwater standards. Groundwater samples collected during the Remedial Investigation indicate that concentrations of certain VOCs and BTEX compounds, and to a limited extent PCBs, exceed the current NYSDEC groundwater standards ("Water Quality Regulations for Surface Waters and Groundwaters", 6NYCRR Parts 700-705).

2.2 GENERAL RESPONSE ACTIONS

General response actions are actions that will satisfy the remedial action objectives. They may include treatment, containment, excavation, extraction, disposal, institutional controls, or monitoring, individually or in combination. The general response actions selected for groundwater and soil at the Site are identified below.

Groundwater:

- no action
- institutional controls and groundwater monitoring
- collection
- on-site/off-site discharge
- containment
- ex situ on-site treatment
- in situ treatment

Soil:

- no action
- institutional controls
- removal
- disposal
- containment (capping)
- in situ treatment
- ex situ treatment

The results of the Phase II investigation and RI indicate that several PCB aroclors, including Aroclors 1248, 1254 and 1260 commonly associated with transformer oils, were detected in the northern, central and southeastern sections of the Site and BTEX compounds were detected in the former UST area. The soil areas that may require remediation have been identified and the volumes to which the identified general response actions might be applied have been estimated to the extent possible. These areas and volumes are summarized below. In general, the volumes were estimated by making simple assumptions based on analytical data presented in the Phase II Investigation and RI, and taking past land use and geological information into account. Refinement of areas and volumes may be necessary during the remedial design phase.

The USEPA TSCA PCB soil cleanup level for restricted access sites is 25 ppm. The areas that exhibited soil PCB concentrations greater than 25 ppm represent an area of approximately 6,000 square feet and assuming an excavation depth of 2 feet, represent a volume of approximately 295 cubic yards. The NYSDEC recommended soil cleanup objectives for PCBs is 1 ppm surface soils and 10 ppm subsurface soils. There are approximately 3,000 cubic yards of soil (assuming excavation depth of two feet) with PCB levels above 1 ppm and an additional 50 cubic yards of subsurface soils with PCB concentrations exceeding 10 ppm. The volume of surface and subsurface soils with PCB concentrations exceeding 10 ppm is approximately 419 cubic yards.

Sampling for BTEX compounds in the vicinity of the former UST area during the RI indicated that the lateral and vertical extent of impact constitutes approximately 6,000 cubic yards of soil (includes both saturated and unsaturated zone). The 6000 cubic yard volume estimate is based on soils with a total xylene concentration greater than or equal to 1.2 ppm.

2.3 IDENTIFICATION AND SCREENING OF REMEDIAL TECHNOLOGIES

USEPA program guidance recommends screening alternative remedial technologies using the criteria of effectiveness, implementability, and cost (USEPA 1988). In this section, a broad range of remedial technologies is identified and screened to eliminate from further consideration those technologies and processes that may be of limited effectiveness, may not be able to be implemented at the Site, or may be cost-prohibitive. The purpose of this screening is to better focus the FS on those technologies that offer the greatest promise of being effective and that can be implemented at the Site.

Potentially applicable remedial technologies are identified for groundwater and soil, to satisfy each of the general response actions specified in Section 2.2. The remedial action objectives, general response actions, and remedial technologies are identified on Table 2-2 for groundwater and Table 2-3 for soil. These remedial technologies are evaluated based on site-specific information and are screened initially for technical applicability. Technologies are considered applicable if, individually or in combination, they would achieve the remedial action objectives. Technologies are not retained for further analysis if the area or volume estimates for the media of concern are such that these technologies can be presumed infeasible. Tables 2-4 and 2-5 provide the results of the initial screening of the remedial technologies, including the technical justification for eliminating technologies from further consideration.

Those technologies retained after the initial screening are further evaluated and screened based on effectiveness, implementability, and cost. The anticipated effectiveness of a technology refers to the ability of that technology to contribute to a remedial program that is protective of human health and the environment, and capable of meeting the stated remedial action objectives. In assessing the effectiveness of each technology, the demonstrated successful performance of each technology is considered. Implementability is the feasibility and the ease with which the technology can be applied at the Site. Implementability takes into consideration such practical factors as:

- ➢ Are the hazardous substances present at the Site compatible with the technology?
- ➢ Is there sufficient room at the Site to install and/or operate the technology?
- ➢ Is the technology compatible with site physical conditions?

- Is the use of the technology compatible with surrounding land uses?
- Will application of the technology unacceptably interfere with other ongoing uses of the Site?
- What permitting and other regulatory requirements apply to use of the technology?
- Does the technology require resources of a type or in a quantity that is not readily available at the Site?
- Are there experienced contractors that can provide, install, and operate the technology?

During this secondary phase of the screening process, the relative costs of the alternative technologies are also considered. Tables 2-6 and 2-7 present the results of the second level of screening for groundwater and soil, respectively.

2.4 SUMMARY OF REMEDIAL TECHNOLOGIES

2.4.1 Remedial Technologies Retained for Further Consideration

Groundwater

The groundwater remedial technologies retained for further consideration following the secondary phase of the screening process are listed below.

No Action: Consideration of the no action alternative is required by the NCP and EPA guidance.

Institutional Controls and Long-Term Groundwater/Surface Water Monitoring: A deed restriction would implemented which would prohibit the on-site use of groundwater. Additionally, groundwater and surface water monitoring would be performed to evaluate the effectiveness of the selected BTEX soil remedial alternative.

Air Sparging: Under this alternative groundwater in the overburden would be treated via air sparging. This would consist of installation of a series of air injection wells into the overburden groundwater flow zone via which air would be injected into the overburden groundwater using a blower. This process would volatilize the volatile organic compounds from the overburden groundwater and saturated soils. The air sparging would also secondarily result in increased biodegradation of the petroleum related chemicals. This alternative would also include a soil vapor extraction system to collect volatilized chemicals.

Plume Management through Groundwater Collection using Extraction Wells or Trenches and Vertical Groundwater Flow Barrier: Installation of vertical or horizontal extraction wells or an interceptor trench could be readily implemented, if necessary, to hydraulically manage the contamination plume or to optimize the recovery of affected groundwater. Installation of a vertical groundwater flow barrier adjacent to the river may be appropriate to limit extraction of non-impacted inflow from the river.

Treatment through Aeration/Stripping or Carbon Adsorption: These technologies are proven effective for the removal of TCA, TCE and BTEX compounds from groundwater.

On-site Discharge of Treated Groundwater: On-site discharge of treated water is retained. Routing of treated water directly to the Hackensack River, or to reinjection/infiltration points would be effective as long as water quality is in compliance with Federal, State or local water discharge requirements.

Off-site Discharge of Extracted Groundwater: Installation of vertical or horizontal extraction wells or an interceptor trench could be readily implemented for groundwater collection. The extracted groundwater could be discharged to a nearby sanitary sewer manhole for treatment at the local Publicly Owned Treatment Works (POTW).

Soil

The soil remedial technologies retained for further consideration following the secondary phase of the screening process are listed below.

No Action: Consideration of the "No Action Alternative" is required by the NCP and EPA guidance.

Deed Restriction: A deed restriction could be implemented at minimal cost.

Capping: A cap composed of asphalt would be effective for isolating and preventing exposure to or contact with soil containing PCBs or BTEX compounds. Installation of an asphalt cover over areas of contaminated soil would be relatively implementable. Capital and long-term maintenance costs would be relatively low.

Surface Controls: Diverting surface water flow and reducing the potential for soil erosion through the installation of stabilization fabrics such as erosion mats would effectively eliminate the potential for migration of soil in drainage ditches. Diversions may be necessary if surface water drainage ditches or retention basins are disrupted due to excavation or capping activities.

Excavation: Excavation is a proven method for remediation of affected soils. It is an effective long-term technology because the source of potential threat to human health or the environment is permanently removed.

Solidification/Stabilization: Solidification is often used in combination with excavation and off-site disposal to reduce the moisture content of the excavated soil so that it can be transported as a solid. Due to the high water table at the Site, excavated soil may require solidification prior to off-site disposal.

Off-site Disposal: Treatment and/or disposal of soil at an appropriate permitted off-site facility would effectively reduce or minimize the toxicity, volume, and mobility of the constituents. Permitted disposal facilities are available to receive soil containing PCBs.

Biosparging: Injection or point wells are used to aerate the groundwater at low pressure to enhance oxygen levels thereby promoting biodegradation and to a lesser extent volatilization. Monitoring wells are utilized to observe dissolved oxygen, carbon dioxide, and contaminant concentrations. Additional options include use of recovery wells for pumping groundwater to maintain groundwater flow thereby providing a transport mechanism for the dissolved oxygen. The recovered groundwater can then be reinjected into the ground surface. Capital and O&M costs for this alternative are relatively moderate. This alternative can be modified to include air injection into the unsaturated zone to enhance biodegradation. This alternative is evaluated further under BTEX-S4.

Soil vapor extraction: BTEX compounds in the unsaturated zone are amenable to vapor extraction. This alternative would be combined with a groundwater extraction and treatment system. The groundwater extraction system would depress the groundwater table which would enhance the effectiveness of the vapor extraction system while at the same time treating impacted groundwater. The groundwater extraction and treatment system would be designed so that both groundwater in the overburden zone and the shallow bedrock zone would be treated

2.4.2 Technologies Eliminated from Further Consideration

Groundwater

Groundwater technologies that are not retained for further consideration include the following:

Off-Site Treatment at a RCRA Facility: The lack of a nearby RCRA facility and the costs associated with transporting water over long distances makes off-site treatment at a RCRA facility impractical.

Ex situ Aerobic/Anaerobic biological treatment: Aerobic and anaerobic biological treatment are typically effective methods of degradation, however, these systems are difficult to implement and cost prohibitive.

Permeable Treatment Beds: With no obvious stratigraphic layer to tie a treatment bed into, to potential for impacted groundwater to by pass the treatment bed would exist.

Soil

Soil technologies that are not retained for further consideration include the following:

Vertical and Horizontal Groundwater Flow Barriers: Installation of flow barriers at this site is not practical. There is no relatively impermeable layer in the overburden saturated zone into which a flow barrier could be anchored.

Steam Stripping: Considering that other impacted media (i.e., groundwater containing TCA) is likely to take significantly longer to remediate than the BTEX-impacted soil, steam stripping (which essentially decreases the cleanup time associated with vapor extraction) is not considered warranted at this Site.

On-Site Disposal: Spatial limitations and Federal and State disposal requirements could make this alternative difficult to implement.

Capping with a geomembrane, clay, or soil cover: Capping using a geomembrane would require an overlying protective layer and may require drainage rerouting. A clay cap would require significant grade changes that are not feasible due to existing site conditions, and a soil cover is not an effective method of preventing infiltration. Additionally, this alternative would not address soil PCB concentrations which exceed both federal and state cleanup recommendations. Isolated groundwater samples have exhibited PCB concentrations above the groundwater standard, removal of the source will eliminate this issue.

Table 2-1
Soil and Groundwater
State Cleanup Levels
ORU West Nyack Site

Compound	NYSDEC TAGM #HWR 4046 Soil Cleanup level	USEPA Federal TSCA Soil Cleanup level	NYSDEC NYS Groundwater Standards 6NYCRR Part 703.5	NYSDOH Drinking Water Standards 10 NYCRR Part 5
Chloromethane	0.1	NA	5	5
Vinyl Chloride	0.2	NA	2	2
Chloroethane	1.9	NA	5	5
Acetone	0.11	NA	50 (GV)	
Carbon Disulfide	2.7	NA		
1,1-Dichloroethene	0.4	NA	5	5
1,1-Dichloroethane		NA	5	5
1,2-Dichloroethene (tota	0.3	NA	5	5
Chloroform	0.3	NA	7	50
1,1,1-Trichloroethane	0.76	NA	5	5
Bromodichloromethane		NA	50 (GV)	50
Trichloroethene	0.7	NA	5	5
Benzene	0.06	NA	0.7	5
Tetrachloroethene	1.4	NA	5	5
Toluene	1.5	NA	5	5
Ethylbenzene	5.5	NA	5	5
Xylene (for each isomer)	1.2	NA	5	5
PCBs	1.0 surface 10.0 subsurface	10 unrestricted acces 25 restricted access	0.1	0.1

NOTES:
1.) All units for groundwater are ug/L.
2.) All units for soils are mg/kg.
3.) "NA" designates not applicable.

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Table 2-2
Groundwater: Remedial Action Objectives,
General Response Actions, and Remedial Technologies
ORU West Nyack Site

Environmental Media/ Remedial Action Objectives	General Response Action	Remedial Technology	Process Options
Groundwater • Prevent ingestion of groundwater with concentrations of site-related constituents, primarily the VOCs TCA, TCE and BTEX, above current federal drinking water standards or, if more stringent, New York State groundwater standards. • Prevent or limit to the extent possible, the migration of groundwater containing site-related VOCs above current drinking water standards or, if more stringent, New York State groundwater standards. • Restore groundwater quality so that concentrations of site-related VOCs in the water bearing zone are reduced to current federal drinking water standards or, if more stringent, New York State groundwater standards.	No Action	Non-technology based	Not Applicable
	Institutional Controls	Access Restrictions	Deed Restrictions
		Alternate Water Supply	City Water Supply
			New Community Well
		Monitoring	Groundwater/Surface Water Monitoring
	Collection	Extraction	Vertical Extraction Wells
			Horizontal Extract. Wells
		Subsurface Drains	Interceptor Trenches
	Discharge	Onsite Discharge	Local Surface Water Body
			Recharge (Reinjection/Infiltration)
			Storm water System
		Offsite Discharge	Deep Well Injection
			Sanitary Sewer System/POTW
	Containment	Extraction	Vert/Horz Extract. Wells
		Subsurface Drains	Interceptor Trench
		Vertical Barriers	Slurry Wall
			Grout Curtain
			Vibrating Beam
		Horizontal Barriers	Grout Injection
			Block Displacement
	Ex Situ Treatment	Biological Treatment	Aerobic
			Anaerobic
		Physical Treatment	Stripping
			Carbon Adsorption
			Reverse Osmosis
		Chemical Treatment	UV Oxidation
			Precipitation
			Ion Exchange
		Off site Treatment	POTW
			RCRA Facility
	In Situ Treatment	Biological Treatment	Aerobic
			Anaerobic
		Physical Treatment	Air Sparging
			Permeable Treatment Beds
		Chemical Treatment	Chemical Reaction

Table 2-3
Soil: Remedial Action Objectives, General Response Actions, and Remedial Technologies
ORU West Nyack Site

Environmental Media/ Remedial Objective	General Response Action	Remedial Technology	Process Options
Soil • Prevent human exposure to site surface soils that contain site-related PCBs posing an unacceptable risk to human health. • Prevent migration of site surface soils that contain site-related PCBs to the nearby Hackensack River through sediments in surface water runoff. • Eliminate to the extent possible, site soils containing UST-related BTEX and PCB compounds as a source of groundwater concentrations in excess of current federal drinking water standards or, if more stringent, New York State groundwater standards.	No Action	Non-technology Based	Not Applicable
	Institutional Controls	Access Restrictions	Deed Restrictions
	Containment	Cap	Engineered Clay
			Soil
			Asphalt
			Concrete
			Synthetic Membrane
		Vertical Barriers	Slurry Wall
			Sheet Pile
			Grout Curtain
			Vibrating Beam
		Horizontal Barriers	Grout Injection
			Block Displacement
		Surface Controls	Diversion/Collection
			Grading
	Removal	Excavation	Soil Excavation
	Ex Situ Treatment	Biological Treatment	Landfarming (Treatment Cells)
		Physical Treatment	Solidification/Stabilization
			Soil Washing
		Chemical Treatment	Chemical Extraction
			Glycolate Dechlorination
			Nucleophilic Substitution
		Thermal Treatment	Rotary Kiln
			Fluidized Bed
			Infrared Thermal
			Low Temperature Thermal
	In Situ Treatment	Biological Treatment	Aerobic
			Anaerobic
		Physical Treatment	Solidification
			Soil Vapor Extraction
			Airsparging
			Steam Stripping
		Chemical Treatment	Vitrification
			Stabilization
	Disposal	On site Disposal	Common On-site Facility
		Off-site Disposal	Off-site Facility

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Table 2-4
Groundwater: Initial Screening of Remedial Technologies
ORU West Nyack Site

General Response Action	Remedial Technology	Process Options	Description	Screening Comments
No Action	Non-technology Based	Not Applicable	No action is taken	Potentially Applicable
Institutional Controls	Access Restrictions (non-technology based)	Deed Restrictions	Deeds would include restrictions on groundwater use, as appropriate	Potentially Applicable
	Alternate Water Supply	City Water Supply	Extension of existing municipal well system to serve residents in the area of influence	Not Applicable. No residents are currently using site groundwater as a source of drinking water
		New Community Well	New uncontaminated wells to serve residents in the area of influence	Potentially Applicable
	Monitoring	Groundwater/Surface Water Monitoring	Ongoing Site Well and Hackensack River Monitoring	Potentially Applicable
Collection	Extraction	Vertical Extraction Wells	Vertical wells to extract contaminated groundwater	Potentially Applicable
		Horizontal Extraction Wells	Horizontal wells used extract contaminated groundwater	Potentially Applicable
	Subsurface Drains	Interceptor Trenches	Perforated pipe in trenches backfilled with porous media to collect contaminated water	Potentially Applicable
Discharge	On-site Discharge	Local River/Stream	Extracted water discharged to the Hackensack River	Potentially Applicable
		Storm water System	Extracted water discharged to on-site storm water system	Potentially Applicable. Similar to above technology, therefore, will not be considered separately
		Recharge (Reinjection/Infiltration)	Extracted water discharged on-site through reinjection/ infiltration.	Potentially Applicable
	Off-site Discharge	Deep Well Injection	Extracted water discharged to deep well injection system	Not Applicable. Deep aquifer not suitable for injection of contaminated water.
		Sanitary Sewer System/ POTW	Extracted water discharged to local sanitary system for treatment at the POTW.	Potentially Applicable
Containment	Extraction	Extraction Wells	Vert. or horiz. wells are pumped to extract groundwater and hydraulically control flow	Potentially Applicable
	Subsurface Drains	Interceptor Trenches	Perforated pipe in trenches backfilled with porous media to collect groundwater and hydraulically control flow	Potentially Applicable
	Vertical barriers	Slurry Wall	Trench around areas of con-amination is filled with a soil (or cement) bentonite slurry	Potentially Applicable
		Grout curtain	Pressure injection of grout in a regular pattern of drilled holes	Potentially Applicable
		Vibrating Beam	Force to advance beams into the ground with injection of slurry as beam is withdrawn	Potentially Applicable

Table 2-4
Groundwater: Initial Screening of Remedial Technologies
ORU West Nyack Site

General Response Action	Remedial Technology	Process Options	Description	Screening Comments
Containment (continued)	Horizontal Barriers	Grout Injection	Pressure injection of grout at depth through closely spaced drilled holes	Not applicable due to large size of site and lack of known primary groundwater contamination source
		Block Displacement	In conjunction with vertical barriers, injection of slurry in notched injection holes	Not applicable due to large size of site and lack of known primary groundwater contamination source
Treatment	Ex Situ Biological Treatment	Aerobic	Degradation of organics using microorganisms in an aerobic environment	Potentially Applicable
		Anaerobic	Degradation of organics using microorganisms in an anaerobic environment	Potentially Applicable
	Ex Situ Physical Treatment	Stripping	Mixing large volumes of air with water in a packed column or shallow trays to promote transfer of VOCs to air	Potentially Applicable
		Carbon Adsorption	Adsorption of contaminants onto activated carbon by passing water through carbon bed	Potentially Applicable
		Reverse Osmosis	Use of high pressure to force water through a membrane leaving contaminants behind	Not applicable to organic contaminants
	Ex Situ Chemical Treatment	Precipitation	Alteration of chemical equilibria to reduce solubility of the contaminants	Not applicable to organic contaminants
		UV Oxidation	Dissolved organic contaminants are destroyed using chemical oxidation	Potentially Applicable
		Ion Exchange	Ion exchange processes are used to remove undesirable ions from water. Used typically for hardness removal and demineralization	Not applicable to organic contaminants
	In Situ Biological Treatment	Bioremediation	Several options are available to alter site conditions such as oxygen levels to promote microbial growth thereby enhancing biodegradation of hydrocarbons	Potentially Applicable
	In Situ Physical Treatment	Air Sparging	System of wells to inject air into groundwater to remove contaminants by volatilization	Potentially Applicable
		Permeable Treatment Beds	Downgradient trenches backfilled with activated carbon to remove contaminants from water	Potentially Applicable
	In Situ Chemical Treatment	Chemical Reaction	An oxidizer such as hydrogen peroxide is used to increase oxygen delivery thereby enhancing biodegradation	Potentially Applicable. Similar to bioremediation technologies, therefore, will not be considered separately
	Off-site Treatment	POTW	Extracted groundwater discharged to local POTW for treatment	Potentially Applicable
		RCRA Facility	Extracted groundwater discharged to licensed RCRA facility for treatment and/or disposal	Potentially Applicable

Table 2-5
Soil: Initial Screening of Remedial Technologies
ORU West Nyack Site

General Response Action	Remedial Technology	Process Options	Description	Screening Comments
No Action	Non -technology Based	Not Applicable	No action is taken	Potentially Applicable
Institutional Controls	Access Restrictions (non-technology based)	Deed Restrictions	Restriction to future use of affected areas are specified in the property deed	Potentially Applicable
Containment	Cap	Engineered Clay	Place and compact controlled layers of clay over areas of contamination	Not Applicable. This would require grade changes are not feasible due to existing site conditions.
		Soil	Cover areas of contamination with a layer of soil	Not Applicable. This would not be effective in preventing infiltration or erosion
		Asphalt	Apply a layer of asphalt over areas of contamination	Potentially Applicable
		Concrete	Installation of concrete slab over areas of contamination	Potentially Applicable
		Synthetic Membrane	Install synthetic membrane with soil over areas of contamination	Not Applicable. The integrity of this system could be compromised by existing site use
	Vertical barriers	Slurry Wall, Sheet Pile, Grout Curtain	Surround areas of contamination with a low permeability barrier.	Potentially Applicable to BTEX soil. Not applicable to PCB soil due to shallow depth, limited volume, and immobility of PCB-contaminated soil
	Horizontal Barriers	Grout Injection	Pressure injection of grout at depth through closely spaced drilled holes	Potentially Applicable to BTEX soil. Not applicable to PCB soil due to shallow depth, limited volume, and immobility of PCB-contaminated soil
		Block Displacement	In conjunction with vertical barriers, injection of slurry in notched injection holes	Potentially Applicable to BTEX soil. Not applicable to PCB soil due to shallow depth, limited volume, and immobility of PCB-contaminated soil
	Surface Controls	Diversion/Collection	Modify drainage to prevent or control soil erosion and sedimentation	Potentially Applicable
		Grading/Revegeta-tion	Modify soil topography and revegetate areas of contamination to prevent or control soil erosion	Potentially Applicable
Removal	Excavation	Soil Excavation	Remove soil by conventional excavation equipment	Potentially Applicable
Treatment	Ex situ Biological Treatment	Landfarming (Treatment Cells)	Construct shallow cells to encourage biodegradation	Not applicable due to limited open space on the Site
	Ex situ Physical Treatment	Solidification/ Stabilization	Introduce specially designed admixtures to excavated soil to improve its physical properties	Potentially Applicable
		Soil Washing	Soil is mechanically mixed, washed, and rinsed with water to remove contaminants	Not applicable due to limited volume of contaminated soil
	Ex situ Chemical Treatment	Chemical Extraction	Similar to soil washing, except solvents rather than water are used to extract contaminants	Not applicable due to limited volume of contaminated soil; process also generates waste solvents
		Glycolate Dechlorination	Catalysts and elevated temperatures are used to break down organic compounds and convert them to lower toxicity water soluble materials	Not applicable due to limited volume of contaminated soil

Table 2-5
Soil: Initial Screening of Remedial Technologies
ORU West Nyack Site

General Response Action	Remedial Technology	Process Options	Description	Screening Comments
Treatment (cont.)	Ex Situ Chemical Treatment (cont.)	Nucleophilic Substitution	Nucleophilic reagents are added to dechlorinate aromatic organics in a substitution reaction	Not applicable due to limited volume of contaminated so
	Ex Situ Thermal Treatment	Rotary Kiln	Combustion in a horizontally rotating cylinder designed for uniform heat transfer	Not applicable due to limited volume of contaminated soil
		Fluidized Bed	Waste injected into hot agitated bed of sand where combustion occurs	Not applicable due to limited volume of contaminated soil
		Infrared Thermal	Combustion using thermal radiation as the material passes on a conveyor belt through a treatment unit	Not applicable due to limited volume of contaminated soil
		Low Temperature Thermal	Soil is heated at low (non-combustible) temperatures to cause volatilization of contaminants	Not applicable due to limited volume of contaminated soil
	In Situ Treatment	Bioremediation	Several options are available to alter site conditions such as oxygen levels to promote microbial growth thereby enhancing biodegradation of hydrocarbons	Potentially applicable to BTEX soils. Not applicable to PCB soils
		Vitrification	Soil is heated to the melting point to destroy, volatilize, or immobilize contaminants in a monolithic mass	Not applicable due to limited volume of contaminated soil
		Solidification/ Stabilization	A solidification/stabilization agent and water are added to convert the affected soil to a hardened mass	Not applicable due to limited volume of contaminated soil
		Soil Vapor Extraction	Organic compounds are removed by drawing a vacuum toward vertical or horizontal vapor extraction wells	Potentially applicable to BTEX soils. Not applicable to PCB soils
		Airsparging	System of well to inject air into saturated zone to remove volatiles by volatilization.	Potentially Applicable
		Steam Stripping	Using wells to inject and recover steam to mobilize and remove volatile/semi-volatile compounds	Potentially applicable to BTEX soils. Not applicable to PCB soils
Disposal	On site Disposal	Common On-site Facility	Excavated material is placed in a common on-site disposal area	Not applicable due limited Site space.
	Off-site Disposal	Off-site Facility	Excavated material is transported to an appropriate off-site facility for final disposition	Potentially Applicable

Table 2-6
Groundwater: Remedial Technology Screening
ORU West Nyack Site

General Response Action	Remedial Technology	Description	Screening
No Action	Non-technology Based	No action is taken to remove, treat or control groundwater.	**Comments:** RETAINED. As required by the NCP and EPA Guidance (1988), this technology is retained for comparison to other alternatives.
Institutional Controls	Deed Restriction	Restrictions to future use of the Site are specified in the property deed.	**Effectiveness:** A deed restriction could be an effective means of controlling future use of the Site and preventing groundwater ingestion. Restrictions could include continued restricted site access, use of the property for industrial purposes only, no installation of drinking water wells in the uppermost water bearing unit without an accompanying treatment system. **Implementability/Cost:** Deed restrictions could be readily implemented at a minimal cost. **Comments:** Retained in conjunction with long-term monitoring and source removal.
	Groundwater and Surface Water Monitoring	On-going Monitoring of Wells and Hackensack River Surface Water	**Effectiveness:** On-going monitoring of existing or new monitoring wells and Hackensack River surface water sampling would be effective for evaluating long-term trends in groundwater and surface water quality and the performance of remedial actions. This alternative by itself would not address on -site use of groundwater or off-site migration of impacted groundwater. However, in conjunction with a deed restriction on-site use of groundwater would be eleminated and in conjunction with a source removal remedial action, future impacts to groundwater would be eliminated. Long-term monitoring would provide documentation that the source removal was effective and that Hackensack River water quality is not impacted. **Implementability/Cost:** Groundwater monitoring could be readily implemented at a minimal cost. **Comments:** Retained in conjunction with deed restriction and a source removal remedial action.
Collection	Vertical Extraction Wells	A system of vertical groundwater extraction wells is used to extract groundwater from the saturated zone of the impacted water bearing unit.	**Effectiveness:** Groundwater extraction wells have proven effective in removing and controlling the migration of groundwater contaminants in unconsolidated aquifers. This technology may not be as effective within the underlying fractured bedrock zone due to preferential flow through bedrock fractures that my not be well interconnected or may not intersect the extraction well. Also, the proximity to the Hackensack River could significantly increase the flow of non-impacted water to the extraction wells which would increase the quantity of water to be treated and decrease the cost effectiveness of this technology. Use of a containment wall between the recovery wells and the river would limit the hydraulic connection between the wells and the river. Removal of VOCs is dependent on the characteristics of the TCA, TCE and BTEX compounds and the nature of the unsaturated and saturated portions of the water bearing unit. **Implementability/Cost:** Installation of extraction wells could be readily implemented, if necessary, to control hydraulic gradients and to optimize recovery of impacted groundwater. **Comments:** RETAINED.

Table 2-6
Groundwater: Remedial Technology Screening
ORU West Nyack Site

General Response Action	Remedial Technology	Description	Screening
Collection (continued)	Horizontal Extraction Wells	A horizontal well or system of wells is drilled along the downgradient edge of the impacted groundwater. The wells are pumped to extract groundwater.	**Effectiveness:** Although this is a relatively new technology, more and more case studies are showing that horizontal wells can be successfully constructed and used to extract groundwater. Horizontal wells can be drilled through overburden or bedrock. Horizontal wells provide an advantage over vertical wells in fractured bedrock relative to intersecting vertical fractures. **Implementability/Cost:** Horizontal wells are generally installed over extended distances. They are initially drilled at an angle, then parallel to the ground surface, then again at an upward angle finally to reemerge at the ground surface. Access to the two ends of the well provides the advantage of being able to pull well materials from either end. However, ample space is required on either end of the well to allow for work areas. Specialized equipment and materials, and experienced contractors are needed for implementation of this technology, and availability of these may be limited. Installation of a horizontal well would be much more costly than a vertical well but may be more efficient. **Comments:** RETAINED.
	Subsurface Drains (Interceptor Trench)	A gravel-filled trench is placed on the downgradient edge of the impacted groundwater.	**Effectiveness:** A trench is an effective means of collecting groundwater and could be particularly effective in capturing groundwater in a fractured bedrock zone. However, the depth to bedrock at the Site is approximately 30 feet which may require an unusually deep trench. As discussed with the recovery wells, a trench located adjacent to the Hackensack River would likely be combined with a cutoff wall to prevent inflow of non-impacted river water. **Implementability/Cost:** Construction of an interceptor trench requires commonly available equipment and methods. **Comments:** RETAINED.
Discharge	On-site Discharge of Treated Groundwater	On-site discharge requires treatment of groundwater to applicable standards prior to discharge to the ground or surface water.	**Effectiveness:** Routing of treated water to any Site storm water drainage ways, directly to the river, or newly constructed recharge (reinfection/infiltration) points would be effective as long as water quality is in compliance with Federal, State or local water discharge requirements. **Implementability/Cost:** Treated water could be easily discharged to any of the above referenced points. Recharge points (reinfection/infiltration) could be readily installed. **Comments:** RETAINED.
Discharge (continued)	Off-site Discharge to a POTW	Off-site discharge involves piping or transporting extracted groundwater to a publicly owned treatment works (POTW). The discharge water must be either pretreated or contain levels of contaminants that can be treated by the particular POTW.	**Effectiveness:** Off-site discharge to a POTW via the sanitary sewer may be a feasible and effective method of groundwater treatment. However, sewer use ordinances may require pretreatment of water containing hazardous constituents. **Implementability/Cost:** Extracting groundwater and discharging to the POTW would require the installation of a sewer line to the nearest sanitary manhole. Construction requires commonly available equipment and methods. Transporting the extracted groundwater may not be as cost effective as piping directly, but is still considered a feasible option. **Comments:** RETAINED

Table 2-6
Groundwater: Remedial Technology Screening
ORU West Nyack Site

General Response Action	Remedial Technology	Description	Screening
Hydraulic Containment	Vertical and Horizontal Extraction Wells	Groundwater extraction wells are located and pumped at a rate such that the VOC plume is captured and off-site migration of VOCs in groundwater is prevented.	**Effectiveness:** Hydraulic containment using vertical or horizontal extraction wells is a proven effective means of controlling the migration of groundwater contaminants in unconsolidated aquifers. As discussed under Collection, vertical extraction wells may not be as effective as horizontal wells within the underlying fractured bedrock zone due to preferential flow through vertical bedrock fractures that my not be well interconnected or may not intersect the extraction well. Also, the proximity to the Hackensack River could significantly increase the flow of non-impacted water to the recovery wells which would decrease the cost effectiveness of this technology. Use of a cutoff wall between the extraction wells and the river would limit the hydraulic connection between the wells and the river. **Implementability/Cost:** Installation of vertical extraction wells could be readily implemented. Horizontal wells would require specialized equipment and contractors for installation and would require more space. Horizontal wells would be more costly. **Comments:** RETAINED.
	Groundwater Interceptor Trench	A gravel-filled trench is placed on the downgradient edge of the impacted groundwater. The elevation of groundwater within the trench is lowered only enough to mitigate downgradient migration of VOCs in groundwater.	**Effectiveness:** A trench is an effective means of collecting groundwater and could be particularly effective in capturing groundwater in a fractured bedrock zone. However, the depth to bedrock at the Site is approximately 30 feet which would require an unusually deep trench. As discussed with the recovery wells, a trench located adjacent to the Hackensack River would likely be combined with a cutoff wall to prevent inflow of non-impacted river water. **Implementability/Cost:** Construction of an interceptor trench requires commonly available equipment and methods. **Comments:** RETAINED.
Hydraulic Containment (continued)	Vertical Groundwater Flow Barrier	A low permeability vertical barrier to groundwater flow is created using a cutoff wall, grout curtain or sheet piling.	**Effectiveness:** Groundwater flow barriers are used frequently with other gradient control technologies. If constructed properly, a cut-off wall, grout curtain or sheet pile could create an effective barrier to groundwater flow, potentially increasing the effectiveness of a groundwater recovery system and reducing the inflow of groundwater that is not impacted. No localized source area has been identified to contain within vertical barriers. There is no obvious low permeability unit into which the vertical barrier would be embedded. The relative permeability of the bedrock below the fractured zone is unknown but may be considerably less than the fractured zone. The depth of the river relative to the hydrogeologic units would also have a function in the required depth of the vertical flow barrier. Further evaluation of Site conditions is required to determine the effectiveness of this technology. **Implementability/Cost:** Installation of a cut-off wall, grout curtain or sheet pile could be readily implemented at the Site except at locations of transmission towers or other utilities. **Comments:** RETAINED

Table 2-6
Groundwater: Remedial Technology Screening
ORU West Nyack Site

General Response Action	Remedial Technology	Description	Screening
Ex situ Treatment	Aeration/ Stripping	Volatile and some semi-volatile compounds are removed from extracted groundwater by creating turbulence or mixing to expedite partitioning into air.	**Effectiveness:** Aeration/stripping has been proven effective for the removal of TCA, TCE and BTEX compounds from groundwater. **Implementability/Cost:** This is a common technology and could easily be implemented. Pretreatment of groundwater may be necessary to remove iron or suspended solids which can foul the aeration/stripping process. Air emissions sometimes require treatment but may not be necessary due to the low concentrations of VOCs in groundwater. **Comments:** RETAINED.
	Carbon Adsorption	This process is used to remove constituents by passing the flow through a medium such as granular activated carbon (GAC) which adsorbs the constituents.	**Effectiveness:** Adsorption by GAC is commonly applied to remove a wide range of organics, including TCA, TCE and BTEX compounds, from aqueous streams. It would be an effective technology for treatment of extracted groundwater or air containing these compounds. The GAC could become a hazardous waste as a result of its use and be subject to the regulatory restrictions associated with those wastes. **Implementability/Cost:** Adsorption equipment is readily available and could be used on-site. Pretreatment of groundwater may be necessary to remove suspended solids which can foul the GAC. **Comments**: RETAINED.
	Off-Site Treatment at RCRA Facility	Extracted water is discharged or transported to a RCRA facility for treatment.	**Effectiveness:** A RCRA facility could effectively treat groundwater collected at the Site to levels below applicable standards. **Implementability/Cost:** A nearby RCRA facility is not available. The closest RCRA permitted facilities are located in northern New Jersey, western New York, and Boston, Massachusetts. It would be impractical and costly to transport water via tanker truck to one of these facilities compared with on-site treatment. **Comments:** ELIMINATED. The lack of a nearby RCRA facility and the costs associated with transporting water over long distances makes this technology impractical.
	Aerobic/Anaerobic biological treatment	The use of microorganisms to biodegrade contaminants for extracted groundwater.	**Effectiveness:** Aerobic and anaerobic biological treatment are typically effective methods of degradation, however, these systems are difficult to implement on-site. **Implementability/Cost:** Due to the impracticality of an on-site treatment system, the associated cost would not be feasible. **Comments:** ELIMINATED.

Table 2-6
Groundwater: Remedial Technology Screening
ORU West Nyack Site

General Response Action	Remedial Technology	Description	Screening
In situ Treatment	Air Sparging	Sparging wells are used to inject air below the water table, allowing VOCs to partition into the interstitial spaces of the soil and be extracted by a vapor extraction system.	**Effectiveness:** Air sparging has been used effectively at sites with VOCs in groundwater. Higher concentrations of VOCs partition more readily and are therefore recovered more efficiently than lower concentrations. The thickness and the hydraulic conductivity of the overburden water bearing unit appear to be amenable to air sparging in conjunction with vapor extraction. **Implementability/Cost:** This technology is potentially applicable and cost effective for treating volatile organics in the overburden flow zone. **Comments:** RETAINED.
	Biosparging	Creating a vacuum or injecting air into various point wells to enhance biodegradation and volatilization.	**Effectiveness:** Biosparging can be an effective in-situ remedy for hydrocarbon contaminated sites. Typically these methods target biodegradation of petroleum related hydrocarbons. This alternative offers the benefit of in-situ treatment and does not require collection of groundwater for treatment and discharge. This method is not feasable in the fractured bedrock and is generally not applicable to chlorinated hydrocarbons. Because of the BTEX impacted shallow overburden groundwater and saturated soils, this alternative is retained, is considered as part of the soil media, and is therefore discussed in further detail under the soil alternative BTEX-S4. **Implementability/Cost:** Construction activities associated with this alternative require commonly available equipment and methods. Capital and O&M costs for this alternative are relatively moderate. **Comments:** RETAINED.
	Permeable Treatment Beds	Downgradient trenches are backfilled with activated carbon to remove contaminants from water.	**Effectiveness:** Conditions at the Site are not conducive to the use of a permeable treatment bed because no obvious low permeability barrier exist for embedment of the bed material leaving the potential for impacted groundwater to bypass the treatment bed. The VOC-containing carbon may require removal and disposal at a future date. **Implementability/Cost:** Construction of an interceptor trench requires commonly available equipment and methods. **Comments:** ELIMINATED. The technology is not considered effective under the Site hydrogeologic conditions.

Table 2-7
Soil: Remedial Technology Screening
ORU West Nyack Site

General Response Action	Technology	Description	Screening
No Action	Non-Technology Based	No action is taken to remove or control affected soil.	**Comments:** RETAINED. This technology is retained for comparison to other alternatives.
Institutional Controls	Access Restriction	Restrictions to future use of selected areas are specified in the property deed.	**Effectiveness:** A deed restriction could be an effective means of controlling access and minimizing exposure to affected soil. Restrictions could include use of the property or portions of the property for commercial/industrial purposes only or no future development of selected areas. **Implementability/Cost:** Deed restrictions could be readily implemented at a minimal cost. **Comments:** RETAINED.
Containment	Cap	Soil exceeding cleanup goals is covered with asphalt or concrete.	**Effectiveness:** Caps composed of asphalt or concrete are effective for isolating and preventing exposure to or contact with soil containing PCBs or BTEX compounds and could limit further leaching of BTEX compounds into the groundwater by promoting runoff and reducing infiltration of precipitation. A cap would require long-term maintenance for continued effectiveness. **Implementability/Cost:** The placement of asphalt or concrete over areas of contaminated soil would be readily implementable. Capping around transmission tower footings and other utilities may cause some difficulties. Capital and long-term maintenance costs would be relatively low. **Comments:** RETAINED.
	Surface Controls	Affected soil is graded and stabilized, and surface water flow is diverted around the affected area to minimize erosion and runoff.	**Effectiveness:** Diverting surface water flow and reducing the potential for soil erosion through the installation of stabilization fabrics such as erosion mats would effectively eliminate the potential for migration of soil in drainage ditches. Diversions may be necessary if surface water drainage ditches or retention basins are disrupted due to excavation or capping activities. **Implementability/Cost:** Surface control measures vary in complexity and cost, and each type of measure serves a different purpose. Construction or modification of surface controls could be readily implemented using commonly available equipment. Whether the surface control measures consist of surface water diversion, soil regrading, or soil stabilization, the costs are relatively low in comparison to other remedial technologies. **Comments:** RETAINED.

Table 2-7
Soil: Remedial Technology Screening
ORU West Nyack Site

General Response Action	Technology	Description	Screening
Containment (continued)	Vertical and Horizontal Groundwater Flow Barrier	A low permeability vertical or horizontal barrier to groundwater flow is created using a cutoff wall, grout curtain , sheet piling, grout injection or block displacement.	**Effectiveness:** The soil impacted with BTEX compounds could be surrounded by groundwater flow barriers in combination with a low permeability cap to create a barrier to groundwater flow, thus minimizing the potential for migration of the BTEX compound through groundwater. However, there is no low perm material in the overburden in which to tie a barrier wall. Also, at this Site it is not practical to isolate a known potential source of BTEX compounds when other VOCs (TCA and TCE) are present in groundwater for which there is known identifiable source. Since the TCA and TCE in groundwater must be addressed during this FS, groundwater containing BTEX compounds would also be addressed. Removal of the known source of BTEX compounds should still be considered for cost caparison purposes. **Implementability/Cost:** Installation of vertical or horizontal flow barriers could be readily implemented in the area of the former UST. **Comments:** ELIMINATED. Installation of flow barriers to prevent leaching of BTEX compounds is not practical since VOCs from an unknown source exist that could not be addressed by this technology.
Removal	Excavation	Affected excavated areas are backfilled with clean material.	**Effectiveness:** Excavation is a proven method for remediation of affected soils. This is an effective long-term technology because the source of potential threat to human health or the environment is permanently removed. **Implementability/Cost:** Excavation equipment is commonly available. Special concerns with implementability can arise if accessibility is limited, if removal of affected soil could jeopardize the stability of a nearby building foundation or structure, or if the area is located in an active traffic or operations area. Soil disposal costs vary with the types of compounds contained in the excavated material. **Comments:** RETAINED.
In situ Treatment	Biosparging	Creating a vacuum or injecting air into various point wells to enhance biodegradation and volatilization.	**Effectiveness:** Biosparging can be an effective in-situ remedy for hydrocarbon contaminated sites. Typically these methods target biodegradation of hydrocarbons and simultaneously enhance volatilization. This alternative offers the benefit of in-situ treatment and does not require collection of groundwater for treatment and discharge. However, this method is not effective for deep contamination and is limited to shallow overburden to a depth of approximately 20 feet. **Implementability/Cost:** Construction activities associated with this technology require commonly available equipment and methods. Capitol and O&M costs are relatively moderate. **Comments:** RETAINED.

Table 2-7
Soil: Remedial Technology Screening
ORU West Nyack Site

General Response Action	Technology	Description	Screening
In situ Treatment (continued)	Soil Vapor Extraction	Organic compounds are removed by drawing a vacuum toward vertical or horizontal vapor extraction wells	<u>Effectiveness:</u> BTEX compounds are amenable to vapor extraction due to their low vapor pressures. However, the relatively shallow water table may not provide sufficient depth above the table for vapor extraction. This alternative would be combined with groundwater table depression via a dual phase groundwater/vapor extraction system. <u>Implementability/Cost:</u> Dual phase groundwater/vapor extraction is a relatively common technology and equipment and contractors are readily available. However, the additional cost of a slurry wall or sheet piles may not be as cost effective as other technologies. <u>Comments:</u> RETAINED
	Steam Stripping	Using wells, inject and recover steam to mobilize and remove volatile/semi-volatile compounds	<u>Effectiveness:</u> Steam stripping is a technology designed to enhance soil vapor extraction. Although steam could be used to increase the speed in which the BTEX compounds are remediated there would be a considerable added expense to the remedy associated with the equipment and energy usage to produce and transmit the steam to the appropriate subsurface location. Considering that other impacted media, i.e., groundwater containing TCA, is likely to take significantly longer to remediate than the BTEX-impacted soil with vapor extraction alone, steam stripping is not considered warranted at this Site. <u>Implementability/Cost:</u> Steam stripping could be implemented using an experienced contractor with specialized equipment , but the capital and O&M costs could be significant due to high energy requirements. <u>Comments:</u> ELIMINATED. The increase in speed of cleanup is not outweighed by the increase in costs.
Disposal	On-site Disposal	Excavated material is disposed in a common on-site disposal area.	<u>Effectiveness:</u> There is no convenient place to dispose of the soil impacted with BTEX compounds on site. If this soil is excavated, off-site disposal is likely to be more practical and cost effective than constructing a disposal area which complies with Federal and State requirements. Consolidation of PCB soils could be considered due to the relatively small volume but in place capping would be more practical since the requirements associated with active management of a hazardous waste would be avoided. <u>Implementability/Cost:</u> Construction of an on-site consolidation area could be implemented with commonly available equipment at reasonable costs. Compliance with Federal and State disposal requirements could make this alternative difficult to implement. <u>Comments:</u> ELIMINATED. Spatial limitations and Federal and State disposal requirements could make this alternative difficult to implement.

Table 2-7
Soil: Remedial Technology Screening
ORU West Nyack Site

General Response Action	Technology	Description	Screening
Disposal (continued)	Off-site Disposal	Excavated material is transported to an appropriate off-site permitted facility for final disposition.	**Effectiveness:** Treatment or disposal of soil at an appropriate permitted off-site facility would effectively reduce or minimize the toxicity, volume or mobility of the constituents. **Implementability/Cost:** Permitted disposal facilities are available to receive soil containing BTEX or PCBs. Disposal costs vary based on the soil's characterization and classification. **Comments:** RETAINED.

3.0 DEVELOPMENT AND SCREENING OF ALTERNATIVES

3.1 DEVELOPMENT OF ALTERNATIVES

In this section, the remedial technologies selected for further consideration are assembled into appropriate remedial alternatives that address the media and areas of concern, and achieve the remedial objectives. Although the objectives for remediation of soil and groundwater at this Site are not independent and distinct (i.e. BTEX soil source removal would impact long-term groundwater concentrations), the remedial alternatives for each medium are developed separately. However, the selected overburden soils remedial alternative would influence the selected groundwater remedial alternative. As required by the NCP, the "No Action" remedial alternative is included. Other non-technology-based alternatives such as institutional controls/deed restrictions are also considered.

3.1.1 Groundwater

The remedial alternatives considered appropriate for groundwater are as follows:

Alternative G1: No Action

Under this alternative, no action would be taken. The contaminated groundwater would not be pumped and treated, and concentrations of constituents in groundwater would not be monitored. The concentrations of TCA, TCE and other VOCs in groundwater would be reduced through natural attenuation and degradation processes such as dilution, dispersion, adsorption and possibly biological and chemical degradation. Groundwater containing VOCs in the overburden flows to the northeast across the Site discharging into the Hackensack River. Groundwater in the shallow bedrock flows both off-site and into the Hackensack River.

Alternative G2: Air Sparging

Under this alternative groundwater in the overburden would be treated via air sparging. Air sparging was initially evaluated as either a stand-alone alternative or in conjunction with the BTEX impacted soils alternative. Air sparging would involve installation of a series of air injection wells in the overburden groundwater flow zone through which air would be injected using a compressor. Sparging would volatilize the volatile organic compounds from the overburden groundwater and saturated soils. The air sparging would also result in increased biodegradation of the petroleum related chemicals. Typically, this technology is used to treat source areas. However, the source of the chlorinated organics in the overburden is unknown and therefore an air sparging system would be installed over the entire area of the Site north of the existing ORU building.

Due to the presence of a low permeability organic silt layer in parts of the area to be treated, there will be a tendency for sparge air to form a "bubble" beneath the low permeability zone and migrate laterally. This lateral migration may result in vapor entering basements or, over the course of the remedial program, the spread of contaminants to peripheral areas of the site and depositing of the contaminants there. In the event sparging were to be implemented without prior removal of the silt layer, it would be necessary to supplement the vapor extraction controls described above. In addition to horizontal extraction pipes, the following would also likely be required:

1. Permeability enhancement via installation of soil gravel columns by drilling or excavation of holes through the organic silt layer and backfilling of the holes with permeable stone.

2. Temporary pumping and treatment of shallow groundwater from above the silt layer to allow vapor extraction to remove BTEX in that zone.

3. Installation of perimeter vapor extraction wells around the area being treated to guard against lateral migration

Even with the application of the above measures to control migration and enhance remediation, the full scale effectiveness of the system could not be evaluated without significant further testing.

Alternative G3: Manage Plume with Groundwater Extraction System and Treatment System

This alternative would involve installation of a groundwater extraction system. The extraction system would be comprised of vertical and/or horizontal extraction wells, individually or in combination, or an interceptor trench. An evaluation of these technologies will be included in the detailed analysis and a selection made for the purpose of cost estimating. An extraction system would be designed to minimize the extraction of non-impacted water from the Hackensack River, therefore, efficiency and necessity of a cutoff wall to reduce inflow from the river is evaluated. The cutoff wall would consist of a sheet pile or bentonite slurry wall. An evaluation of these technologies will be included in the detailed analysis and a selection made for the purpose of cost estimating. The recovered groundwater would be treated using an on-site air stripping or carbon adsorption system (to be determined in the detailed analysis) to meet applicable drinking water standards. The treated water would be discharged to the Hackensack River, reinjected or discharged to a local POTW in accordance with applicable regulations. Deed restrictions would be implemented to control use of groundwater at the Site.

Alternative G4:InstitutionalControls/Long-Term Groundwater and Surface Water Monitoring

This alternative would include placement of a deed restriction on the site prohibiting the use of groundwater as a potable water supply without prior treatment. This would eliminate on-site use of impacted groundwater. The alternative would not be implemented as a stand-alone option, but would be considered in conjunction with a BTEX source removal remedial alternative. Groundwater and Hackensack River surface water monitoring would evaluate the long-term effectiveness of a soil source removal remedial alternative and document that there is no impact to Hackensack River surface water quality.

3.1.2 Soil

The remedial alternatives considered appropriate for soil are divided into soils containing PCBs and soils containing BTEX compounds because the technologies available to address these constituents in soil are significantly different.

3.1.2.1 Soil Containing PCBs

Alternative PCB-S1: No Action

Under this alternative, no action would be taken to contain, remove, or treat soil or to restrict use or access to the these areas. The surface and subsurface soil containing concentrations of PCBs greater than 25 ppm would be left in-place. The existing fence around the perimeter of the Site would continue to restrict access to the Site.

Alternative PCB-S2: Excavation, Disposal, Asphalt Cover and Institutional Controls

The purpose of this alternative is to excavate soil from selected areas with PCB concentrations greater than 10 ppm (approximately 419 cubic yards) and placement of an asphalt cover over remaining soils to prevent contact with surface soil. Because the soils containing PCBs would be left on-site, a deed restriction would be implemented to minimize exposure to acceptable levels and to eliminate potential residential-setting exposure scenarios. The deed restriction would prohibit all property use except for commercial/industrial use. These restrictions would be incorporated into the deed of the property owner. The existing fence around the perimeter of the Site would continue to restrict access to the Site.

Alternative PCB-S3: Excavation and Off-Site Disposal

This alternative involves excavation of approximately 3,050 cy of soil. Surface soils with concentrations greater than 1 ppm and subsurface soils with concentrations of 10 ppm would be excavated for off-site disposal at a TSCA permitted landfill. Excavated areas would be backfilled with clean fill material, graded to blend with surrounding areas. The excavation depth is above the water table, therefore, dewatering/solidification may not be necessary.

3.1.2.2 Soil Containing BTEX Compounds

Alternative BTEX-S1: No Action

Under this alternative, no action would be taken to contain, remove, or treat soil or to restrict use or access to the these areas. The soil containing BTEX compounds at concentrations above the ARARs, in the vicinity of the former UST would be left in-place. The existing fence around the perimeter of the Site would continue to restrict access to the Site.

Alternative BTEX-S2: Dual Phase Groundwater/Vapor Extraction

This alternative would involve installation of a system of extraction wells designed to depress the groundwater surface through groundwater extraction and to remove vapors from the vadose zone by drawing a vacuum toward the well. BTEX compounds present on the soil would move into the interstitial spaces between the soil particles and then would be removed by the vacuum. This alternative would also result in the active pumping and treatment of groundwater. The pump and treatment system could be designed to capture groundwater in both the overburden flow zone and the shallow bedrock flow zone.

Alternative BTEX-S3: Excavation and Off-Site Disposal

This alternative involves excavation of approximately 6,000 cy of affected soil in both the unsaturated and saturated zone in the vicinity of the former UST. The intent is to remove the BTEX impacted soils and eliminate these soils as a source of groundwater contamination. Soils exhibiting concentrations of total xylenes greater than the NYSDEC recommended soil cleanup objective of 1.2 ppm would be excavated and treated and or disposed of off-site. The volume of soil to be removed was estimated based on the average depth of soils exhibiting total xylene concentrations greater than 1.2 ppm, which range from a depth of approximately one foot below grade to a maximum depth of approximately 14 feet below grade. The limits of the areas to be excavated would be refined, if necessary, during excavation activities. Excavated areas would be backfilled with clean fill material and graded to blend with surrounding areas. The excavated soil would be transported to an appropriate off-site facility for final disposition.

Alternative G4 would be conducted in conjunction with this BTEX alternative. Alternative G4 consists of a groundwater and surface water monitoring program for a period of two years to monitor groundwater volatile organic concentrations at the Site boundary and evaluate the effectiveness of the BTEX source removal. At the end of the two year period the data would be reviewed to determine if further monitoring or additional remedial action was warranted.

Alternative BTEX-S4: Biosparging

The purpose of this alternative is to promote biodegradation through aerobic respiration by enhancing oxygen levels in the groundwater. This is accomplished by introducing air below the water table via an injection or point well(s) utilizing a blower. The method of biosparging injects air directly into an injection well below the water table. In addition, to enhance biodegradation, sparging can simultaneously promote volatilization.

Monitoring wells are utilized to observe dissolved oxygen, carbon dioxide, and contaminant concentrations. Recovery wells can be utilized for pumping groundwater to maintain groundwater flow thereby providing a transport mechanism for the dissolved oxygen. The recovered groundwater is reinjected into the ground surface.

This alternative offers the benefit of in-situ treatment and does not require collection of groundwater for treatment and discharge. Deed restrictions would be implemented to control use of groundwater at the Site. The existing fence around the perimeter of the Site would continue to restrict access to the Site.

This alternative would be used in the BTEX area to treat both groundwater and unsaturated zone soils. It is not applicable to groundwater in the shallow bedrock zone and is not very effective on chlorinated organic compounds. A detailed analysis of this alternative is presented in the BTEX soil section (Section 4.4.4).

3.2 SCREENING OF ALTERNATIVES

In this section, the remedial alternatives identified and described in Section 3.1 are screened to evaluate and potentially narrow the range of alternatives that will be carried forward for the detailed evaluation. Alternatives are screened on the basis of effectiveness, implementability (both technical and administrative), and cost, which are described below:

- **Effectiveness**: Each alternative is evaluated in terms of its protectiveness of human health and the environment through reduction in toxicity, mobility and volume of the hazardous wastes. Short-term effectiveness refers to the benefits derived during or immediately after implementation and considers the increased risks resulting from implementation of an alternative. Long-term effectiveness refers to the performance of a remedial measure and the certainty that this performance will be maintained.

- **Implementability**: Each alternative is evaluated with respect to its technical and administrative implementability. Technical implementability relates to the feasibility of constructing the remedial measures, taking into account the availability of equipment and materials, experienced contractors and the overall difficulty of construction. Long-term technical implementability considers the ability to reliably maintain and monitor the remedial system. Administrative implementability refers to: compliance with applicable rules, regulations, and statutes; the ability to obtain approvals; and the availability of treatment, storage, and disposal services and capacity.

- **Cost**: Each alternative is evaluated with respect to relative costs, since detailed cost estimates have not been performed. The costs include both capital, and operation and maintenance (O&M) costs.

The screening matrix for the groundwater remedial alternatives is presented in Table 3-1. The screening of the PCB-soil remedial alternatives is presented in Table 3-2 and the screening matrix for BTEX-soil remedial alternatives is presented in Table 3-3. All of the remedial alternatives developed for groundwater and soil are considered reasonably effective and implementable and are retained for detailed analysis.

Table 3-1
Groundwater: Preliminary Screening of Remedial Alternatives
ORU West Nyack Site

Remedial Alternative	Description	Screening
G1: No Action	No action is taken to remove, treat, control or monitor groundwater.	**Comments:** RETAINED. As required by the NCP and EPA Guidance (1988), this alternative is retained for comparison to other alternatives.
G2: Air Sparging	A system of air injection wells would be used to inject air into the saturated zone to enhance volatilization of chemicals. A vapor extraction system would be used to collect vapors and volatilize chemicals in the unsaturated zone.	**Effectiveness:** The volatile organics in groundwater would be volatilzed from the overburden saturated zone via injection of air into the saturated zone. This technology has been used to treat sources of VOC groundwater contamination.. The effectiveness of this technology with respect to site conditions and treatment of the chlorinated compounds in the overburden which do not have an identifiable source would be confirmed through implementation of a pilot test. **Implementability/Cost:** Construction activities related to this alternative utilizes commonly available equipment methods. The transmission towers and other utilities could interfere with placement of the air injection and vapor collection systems. A pilot test would be required to confirm the implementability of this technology at the Site. Capital and O&M costs are moderate to high. **Comments:** RETAINED.
G3: Manage Plume with Groundwater Extraction System and treatment.	A system of downgradient extraction wells or an interceptor trench would be used to manage the contamination plume. A cutoff wall would considered to limit the inflow of river water. Recovered water would be treated on-site.	**Effectiveness:** The contamination plume would be managed through steady groundwater pumpage. The effectiveness of pumping to intercept and remove VOCs in groundwater needs to be further evaluated but has been demonstrated at other sites with similar hydrogeologic conditions and compounds. Groundwater treatment and discharge would be performed in compliance with all applicable regulations and would therefore be protective to human health and the environment. **Implementability/Cost:** Construction activities related to this alternative requires commonly available equipment and methods. The presence of the transmission towers and other utilities could interfere with placement of the extraction system or the cutoff wall. This alternative would have relatively high capital and O&M costs. **Comments:** RETAINED.
G4: Groundwater and Surface Water Monitoring Program and Deed Restriction.	On-site groundwater monitoring and Hackensack River surface water monitoring to evaluate effectiveness of source removal. Deed Restriction to prohibit on-site use of groundwater.	**Effectiveness:** Groundwater monitoring would be performed to evaluate effectiveness of BTEX source removal. Surface water monitoring would be performed to confirm that Hackensack River surface water quality is not impacted by Site related chemical constituents. Deed restriction would be implemented to prohibit on-site use of groundwater. This alternative would only be implemented in conjunction with a BTEX impacted source removal remedial action. **Implementability/Cost:** Easily implemented. Would use the current monitoring well net work with addition of one additional monitoring well at site boundary along Hackensack River. **Comments:** RETAINED.

Table 3-2
PCB Soil: Preliminary Screening of Remedial Alternatives
ORU West Nyack Site

Remedial Alternative	Description	Screening
PCB-S1: No Action	No action is taken to remove or contain affected soil.	**Comments:** RETAINED. As required by the NCP and EPA Guidance (1988), this alternative is retained for comparison to other alternatives.
PCB-S2: Excavation, disposal, Asphalt cover, and institutional Controls	Soil exceeding 10 ppm would be excavated and disposed off-site. Remaining low level contaminated soil would be covered with an asphalt cap and future use of the Site would be restricted.	**Effectiveness:** An asphalt cover can be effective for isolation and for preventing exposure to soil containing constituents such as PCBs. The affected soil areas have not been identified as sources of groundwater contamination, however, excessive infiltration of precipitation or ponding in the area could promote chemical leaching and erosion. The cover would promote runoff and reduce infiltration. Deed restrictions could be used to limit the use of the property to commercial/industrial use only, or prohibiting future development of selected areas. **Implementability/Cost:** The installation of an asphalt cover over areas of contaminated soil would be readily implementable. Paving around transmission tower footings and other utilities could cause some difficulties. Capital and long term maintenance would be relatively low. **Comments:** RETAINED.
PCB-S3: Excavation and Off-Site Disposal	Surface soil exceeding the clean up goals of 1 ppm for surface soil and 10 ppm for soil at depths greater than 2 feet would be excavated, and backfilled with clean fill material. Excavated soil is tested and sent off site for disposal.	**Effectiveness:** Excavation is a proven method for remediation of affected soils. This is an effective long-term technology because the source of potential threat to human health or the environment is permanently removed from the site. Quantities requiring remediation as defined in the RI appear to be small, and therefore, could be easily transported off-site. No deed restrictions would need to be implemented with this alternative. **Implementability/Cost:** Excavation equipment is commonly available and could easily remove the soils in the areas of concern. Since the depth of the contamination is superficial, the volume to be excavated would not jeopardize the structural integrity of nearby structures. Soil disposal costs at landfills vary with the types of compounds contained in the excavated material. Permitted TSCA and RCRA waste landfills are available as disposal sites. This technology could be readily implemented and prove to be effective. However, this technology has a relatively high capital cost but has no associated OM&M costs. **Comments:** RETAINED.

Table 3-3
BTEX Soil: Preliminary Screening of Remedial Alternatives
ORU West Nyack Site

Remedial Alternative	Description	Screening
BTEX-S1: No Action	No action is taken to remove or contain affected soil.	**Comments:** RETAINED. As required by the NCP and EPA Guidance (1988), this alternative is retained for comparison to other alternatives.
BTEX-S2: Dual Phase Groundwater/ Vapor Extraction	A system of dual phase groundwater/ vapor extraction wells would be installed to remove BTEX compounds from the soil and the vapors present in the interstitial spaces of the soil.	**Effectiveness:** BTEX compounds are amenable to vapor extraction. Soil containing BTEX compounds was detected as deep as 10-12 feet below ground surface. Due to the relatively shallow water table (2-4 feet), depression of the groundwater surface would be required for soil vapor extraction to be effective. This would require the use of a dual phase groundwater/vapor extraction system. The stratigraphic unit in which the BTEX-impacted soil is situated would be conducive to groundwater/vapor extraction. **Implementability/Cost:** This technology could be readily implemented with relatively low capital and O&M costs. **Comments:** RETAINED.
BTEX-S3: Excavation and Off-Site Disposal	BTEX impacted soils in and above the organic silt layer, above and below the groundwater table are excavated and backfilled with clean material. Excavated soil sent off-site for disposal.	**Effectiveness:** Excavation is a proven method for remediation of affected soils. This is an effective long-term technology because the source of potential threat to human health or the environment is permanently removed from the site. Excavated soils would be treated off-site or disposed of in an approved landfill. **Implementability/Cost:** Excavation equipment is commonly available and could easily remove the soils in the areas of concern. Excavation would be performed in a manner to ensure the structural integrity of nearby structures. **Comments:** RETAINED.
BTEX-S4: Biosparging	A system of two air injection wells, a SVE system, and an asphalt cap would be utilized to enhance bio-degradation and volatilization to achieve soil clean up objectives of 1.2 ppm.	**Effectiveness:** This technology is proven an effective method for remediation of BTEX-affected soils, however, is only being considered for shallow overburden contamination. A pilot study is recommended to further investigate the feasibility of this technology at the Site. **Implementability/Cost:** This technology could be readily implemented with relatively moderate capital and O&M costs. **Comments:** RETAINED

4.0 DETAILED ANALYSIS OF ALTERNATIVES

This section describes the evaluation criteria for the detailed analysis of the alternatives retained after the preliminary screening of alternatives. Section 4.1 identifies and describes the evaluation criteria. Sections 4.2, 4.3, and 4.4 present the detailed analysis of the groundwater, PCB-contaminated soil, and BTEX-contaminated soil remedial alternatives, respectively. In these sections, the remedial alternatives are described and systematically assessed on an individual basis relative to the evaluation criteria. In Sections 4.5, 4.6, and 4.7 the alternatives are compared on the basis of these evaluation criteria. Section 4.8 identifies the recommended remedial alternatives for groundwater and soil.

4.1 EVALUATION CRITERIA

USEPA guidance on selection of remedial actions (USEPA, 1988 and 1989) presents seven criteria to be used for evaluating remedial alternatives that have passed the preliminary screening process. These criteria are as follows:

- Overall protection of human health and the environment;
- Compliance with ARARs;
- Long-term effectiveness and permanence;
- Reduction of toxicity, mobility or volume through treatment;
- Short-term effectiveness;
- Implementability; and
- Costs (capital, annual operation and maintenance, present worth).

There are two tiers to the above seven criteria. The first two are threshold factors, the next five are primary balancing factors. These two tiers are reflected in the detailed analysis. Descriptions of the criteria are provided below.

4.1.1 Overall Protection of Human Health and the Environment

This evaluation criterion is designed to determine whether a proposed remedial alternative is adequate with respect to protection of human health and the environment. The evaluation focuses on how each proposed alternative achieves protection over time, how Site risks are eliminated, reduced, or controlled, and whether any unacceptable short-term impacts would result from implementation of the alternative. The overall protection of human health and the environment evaluation draws on the assessments for long-term effectiveness and permanence, short-term effectiveness, and compliance with ARARs.

4.1.2 Compliance with ARARs

This evaluation criterion is used to assess compliance with chemical-specific, action-specific, and location-specific ARARs, and with other potential guidance, criteria, and advisories. ARARs for the ORU Site are discussed in Section 1.4. Proposed remedial alternatives are analyzed to assess whether they achieve ARARs under Federal and State environmental laws, public health laws, and State facility siting laws, or whether they may be subject to one of the six waivers allowed under CERCLA.

4.1.3 Long-term Effectiveness and Permanence

This criterion addresses the long-term effectiveness and permanence of the remedial alternative with respect to the quantity of residual chemicals remaining at the Site after response goals have been met. The principal focus of this analysis is the adequacy and reliability of controls necessary to manage any untreated media and treatment residuals. Characteristics of the residual chemicals such as volume, toxicity, mobility, degree to which they remain hazardous, and tendency to bioaccumulate must also be examined. Specifically, these considerations are:

- Magnitude of residual risk;
- Adequacy of controls; and
- Reliability of controls.

4.1.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

This criterion assesses the degree to which the remedial alternative utilizes recycling and/or treatment technologies that permanently decrease toxicity, mobility, or volume of the chemicals as their primary element. It also assesses the effectiveness of the treatment in addressing the predominant health and environmental threats presented by the Site. The specific factors considered under this evaluation criterion include:

- Treatment process the remedy would employ and the materials it would treat;

- Quantity of contaminants that would be treated or destroyed;

- Degree of expected reduction in toxicity, mobility, or volume (expressed as a percentage of reduction or order of magnitude);

- Type and quantity of treatment residuals that would remain following treatment accounting for persistence, toxicity, mobility and the tendency to bioaccumulate; and

- Whether the alternative would satisfy the statutory preference for treatment as a primary element.

4.1.5 Short-Term Effectiveness

This evaluation criterion is used to assess short-term potential impacts associated with the construction and implementation phase of remediation. Alternatives are evaluated with regard to their effects on human health and the environment. These considerations include:

- Protection of the community during implementation of the proposed remedial action (i.e., dust, inhalation of volatile gases);

- Protection of workers during implementation;

- Environmental impacts that may result from the implementation of the remedial alternative and the reliability of mitigative measures to prevent or reduce these impacts; and

- Time until remedial response objectives are met, including the estimated time required to achieve protection.

4.1.6 Implementability

This criterion assesses the technical and administrative feasibility of implementing a remedial alternative and the availability of various services and materials that would be required during its implementation. Factors considered include the following.

- Technical feasibility: includes the difficulties and unknowns relating to construction and operation of a technology, the reliability of the technology (including problems resulting in schedule delays), the ease of performing additional remedial actions, and the ability to monitor the effectiveness of the remedy.

- Administrative feasibility: involves coordinating with governmental agencies to obtain necessary permits or approvals.

- Availability of services and materials: includes sufficiency of off-site treatment, storage and disposal capacity; access to necessary equipment, specialists and additional resources; potential for obtaining competitive bids especially for new and innovative technologies, and availability of state-of-the-art technologies.

4.1.7 Costs

This criterion assesses the costs associated with a remedial action. It can be divided into capital costs, direct costs or expenses, annual operation and maintenance (O&M) costs, and net present worth costs.

Capital costs include:

- Construction and equipment costs: materials, labor, equipment required to install/perform a remedial action that result in a physical asset;

- Land and site-development costs: land purchase and associated expenses, site preparation of existing property; and

- Building and service costs: process and non-process buildings, utility connections, and purchased services.

Direct costs/Expenses include:

- Engineering expenses: administration, design, construction, supervision, drafting, and treatability testing;

- Legal fees and license or permit costs: administrative and technical costs expended to obtain licenses and permits for installation and operation;

- Start up costs incurred during initiation of remedial action;

- Contingency allowances: costs resulting from unpredicted circumstances (i.e., adverse weather, strikes, etc.); and

- Disposal costs: transporting and disposing of materials.

Annual O&M costs are post-construction costs expended to maintain and ensure the effectiveness of a remedial action. The following annual O&M costs are evaluated:

- Labor costs: wages, salaries, training, overhead, and fringe benefits for operational labor;

- Maintenance materials and maintenance labor costs: labor and parts, etc. necessary for routine maintenance of facilities and equipment;

- Auxiliary materials and utilities: chemicals and electricity needed for treatment plant operations, water and sewer services;

- Disposal of residue: disposal or treatment and disposal of residues such as sludge from treatment processes;

- Purchased services: sampling costs, laboratory fees, and professional fees as necessary;

- Administrative costs: costs associated with the administration of O&M that have not already been accounted for elsewhere;

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

- Replacement costs: maintenance of equipment or structures that wear out over time; and

- Cost of periodic Site reviews if a remedial action leaves residual contamination.

Net present worth consists of capital and O&M costs calculated over the lifetime of the remedial action and expressed in present day value. The lifetime of the remedial alternative varies depending on the alternative. Backup documentation for costs are presented in Appendix A.

4.2 GROUNDWATER ALTERNATIVES ANALYSIS

This detailed analysis evaluates the groundwater alternatives that passed the preliminary screening in Section 3 relative to the seven evaluation criteria. It focuses on the relative performance of each alternative. The groundwater remedial alternatives evaluated in the detailed analysis are as follows:

- Alternative G1: No Action
- Alternative G2: Air Sparging
- Alternative G3: Manage Plume with Groundwater Extraction and Treatment
- Alternative G4: Groundwater and Hackensack River Surface Water Monitoring

4.2.1 Alternative G1 - No Action

4.2.1.1 Description

Alternative G1 assumes that no actions would be taken to control, remove or monitor the groundwater plume (i.e., no groundwater pumping or treatment, no monitoring, and no deed restrictions). Groundwater is not currently being used at the Site and there is no pumping well present. A potable public water supply intake is located across the Hackensack River from the Site. There is no evidence to date that suggests that the Site groundwater plume has impacted the source of this water supply.

Groundwater in the overburden zone and to a lesser extent in the shallow bedrock zone, flows across the Site toward the Hackensack River which serves as a water bearing zone discharge point releasing groundwater from the subsurface to the surface water system. VOCs are removed, i.e. stripped, naturally from the water through volatilization resulting from the pressure drop and turbulence that accompanies this process.

Under the No Action Alternative, the VOC concentrations in the groundwater would primarily be reduced through natural attenuation and degradation processes such as dilution, dispersion, adsorption and possibly biological and chemical degradation. Groundwater VOCs that reach the river are volatilized from the surface water. However, groundwater from the shallow bedrock to some extent flows off-site and does not completely discharge to the Hackensack River.

4.2.1.2 Assessment

Overall Protectiveness of Human Health and the Environment

Under the No Action Alternative, there would be no action taken to prevent ingestion of groundwater containing VOCs above the current drinking water standards. Although there is no current usage of Site groundwater there would be no restriction on the use of the untreated water. Also, since no monitoring would be performed, the distribution, migration and natural reduction of VOC concentrations in groundwater and surface water would not be monitored. Therefore, there would be no long-term mechanism for documenting the nature and extent of the groundwater plume, verifying that the surface water quality and nearby water supply source are not affected. Since no construction is proposed for the No Action Alternative, no associated short-term risks would be posed.

Compliance with ARARs

Attainment of groundwater standards across the Site would eventually occur under this alternative as a result of the natural flushing and gradual attenuation and degradation of the groundwater plume. Important parameters affecting the cleanup time include hydraulic conductivity of the water bearing zones, groundwater recharge, effective porosity and retardation coefficient.

In the absence of pumping-induced drawdown and active groundwater capture, groundwater in the overburden and to a lesser extent the shallow bedrock water bearing zones underlying the Site would flow to the Hackensack River. The VOCs in this groundwater would be passively remediated by natural attenuation processes, including volatilization in the river. However, groundwater from the shallow bedrock to some extent flows off-site and does not completely discharge to the Hackensack River. Groundwater from the shallow bedrock that does not discharge to the Hackensack River would not be subject to volatilization.

Long-Term Effectiveness and Permanence

Residual risk: The No Action Alternative includes no provisions to prevent the ingestion of untreated groundwater, and therefore, poses potential long-term residual health risks.

Adequacy of controls: The adequacy of this alternative in reducing the concentrations within the groundwater plume through natural flushing would not be determined, since no monitoring is included in this alternative.

Reliability of controls: No controls would be implemented under this alternative.

Reduction of Toxicity, Mobility & Volume Through Treatment

No reduction in toxicity, mobility or volume would occur under the No Action Alternative other than through natural degradation and attenuation. The proximity of the groundwater discharge areas (Hackensack River) to the Site help to confine the overburden plume to a reasonably well-defined flow zone that terminates at the River where the residual VOCs are removed through a natural stripping process of volatilization. However, the shallow bedrock flow zone does not entirely discharge to the Hackensack River.

Short-Term Effectiveness

Since no construction activities are proposed for the No Action Alternative, no associated short-term risks to the community, workers and or the environmental would be created.