NEW YORK STATE SUPERFUND CONTRACT

Feasibility Study Report

United Plating Site
Remedial Investigation/Feasibility Study

Site No. 447018

Work Assignment No. D002676-10.1

DATE: January 1999

DEPARTMENT OF ENVIRONMENTAL CONSERVATION • NEW YORK STATE •

Prepared for:

New York State Department of Environmental Conservation

50 Wolf Road, Albany, New York 12233
John Cahill, *Commissioner*

Division of Environmental Remediation
Michael J. O'Toole, Jr., P.E., *Director*

By:

Lawler, Matusky & Skelly Engineers LLP

NEW YORK STATE SUPERFUND STANDBY CONTRACT

DRAFT
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FEASIBILITY STUDY
UNITED PLATING SITE
LMS PROJECT NO. 650-095

TABLE OF CONTENTS

TABLE OF CONTENTS
(Continued)

TABLE OF CONTENTS
(Continued)

LIST OF FIGURES

LIST OF TABLES

CHAPTER 1

SUMMARY OF REMEDIAL INVESTIGATION

1.1 INTRODUCTION

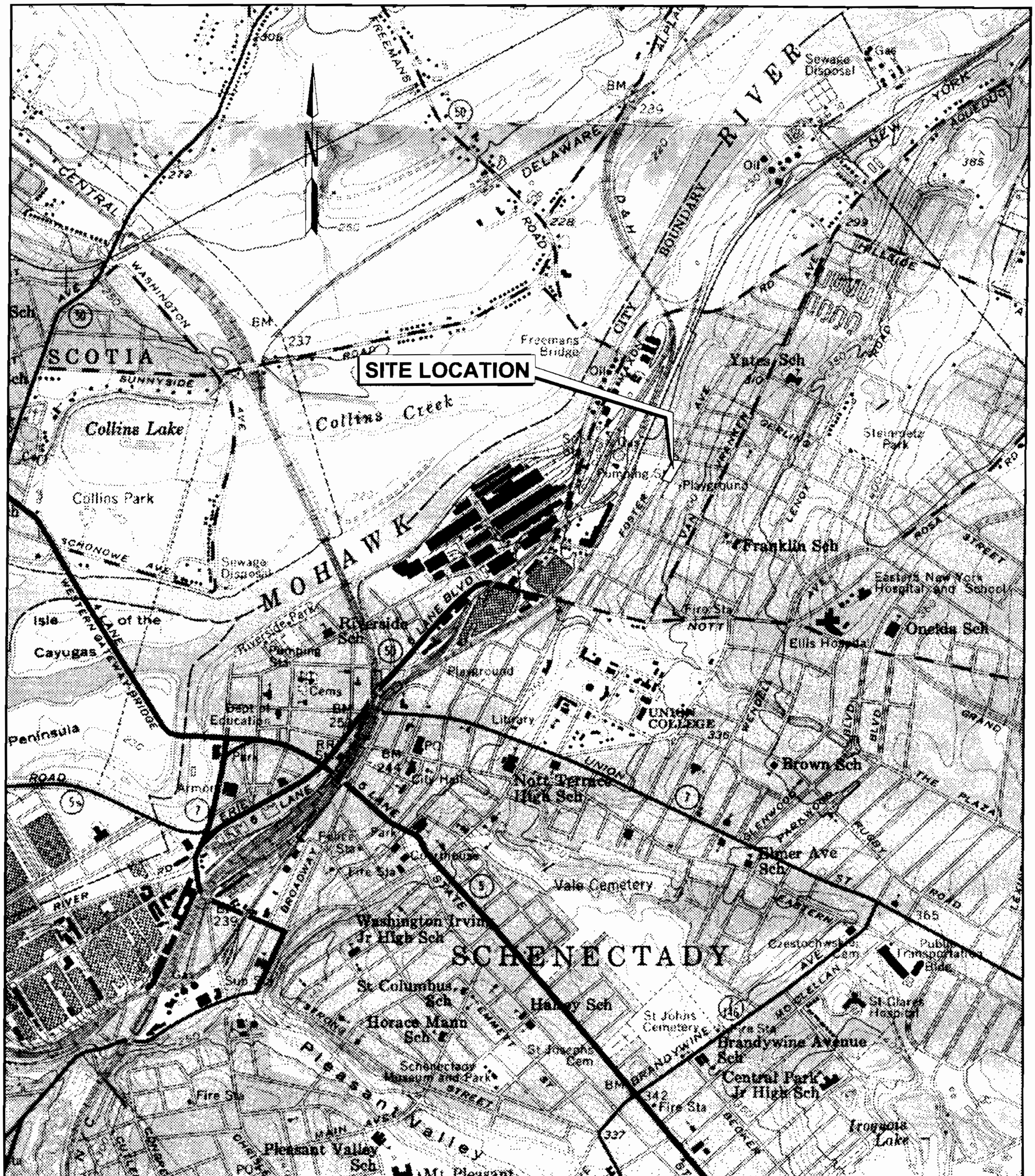
This report presents the feasibility study (FS) for the United Plating (UP) site conducted by Lawler, Matusky & Skelly Engineers LLP (LMS). This FS was prepared for the New York State Department of Environmental Conservation (NYSDEC) under work assignment number D002676-10 for site number 4-47-018.

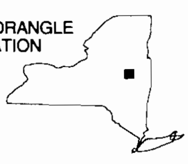
This FS is based on the results of the remedial investigation (RI) conducted by LMS (LMS 1998a). Chapter 1 includes a brief summary of the RI and the building demolition remedial action.

1.2 SITE DESCRIPTION

The UP site is located at 1776 Foster Avenue in the City of Schenectady, New York (Figure 1-1). The site is approximately 1.7 acres in size, one-third of which is covered by the building footprint. UP operated as a metal plating facility from 1945 until 1990. The site is bounded by Seneca Street to the north, Foster Avenue to the west, a vacant field to the east, and residential housing to the south (see Figure 1-2). A children's playground lies to the southeast of the site. The west side of the property consists of a parking area. The east side of the property consists of a graveled road, concrete pads, and an area of mostly grass and weeds. A chain link fence fitted with three-strand barbed wire surrounds the site. The Mohawk River is located approximately 0.25 mile northwest of the site. The natural topography drains to the northwest toward the Mohawk River.

The site is currently occupied by two buildings, the first containing the remnants of the plating or other operations and offices and the second containing the treatment facility. The building footprint is approximately 27,800 ft^2. Building 1 is a six-story brick building, which currently contains some vats or tanks used for treatment. Building 2 is one story in one area and two stories in another area and also contains old vats and tanks.





0 2000 ft

SCALE
1 in. = 2000 ft

Map source: USGS 7.5 minute quadrangle map, Schnectady, NY, 1954.

\091\USGS-LOC.dsf

Figure 1-1

Site Location

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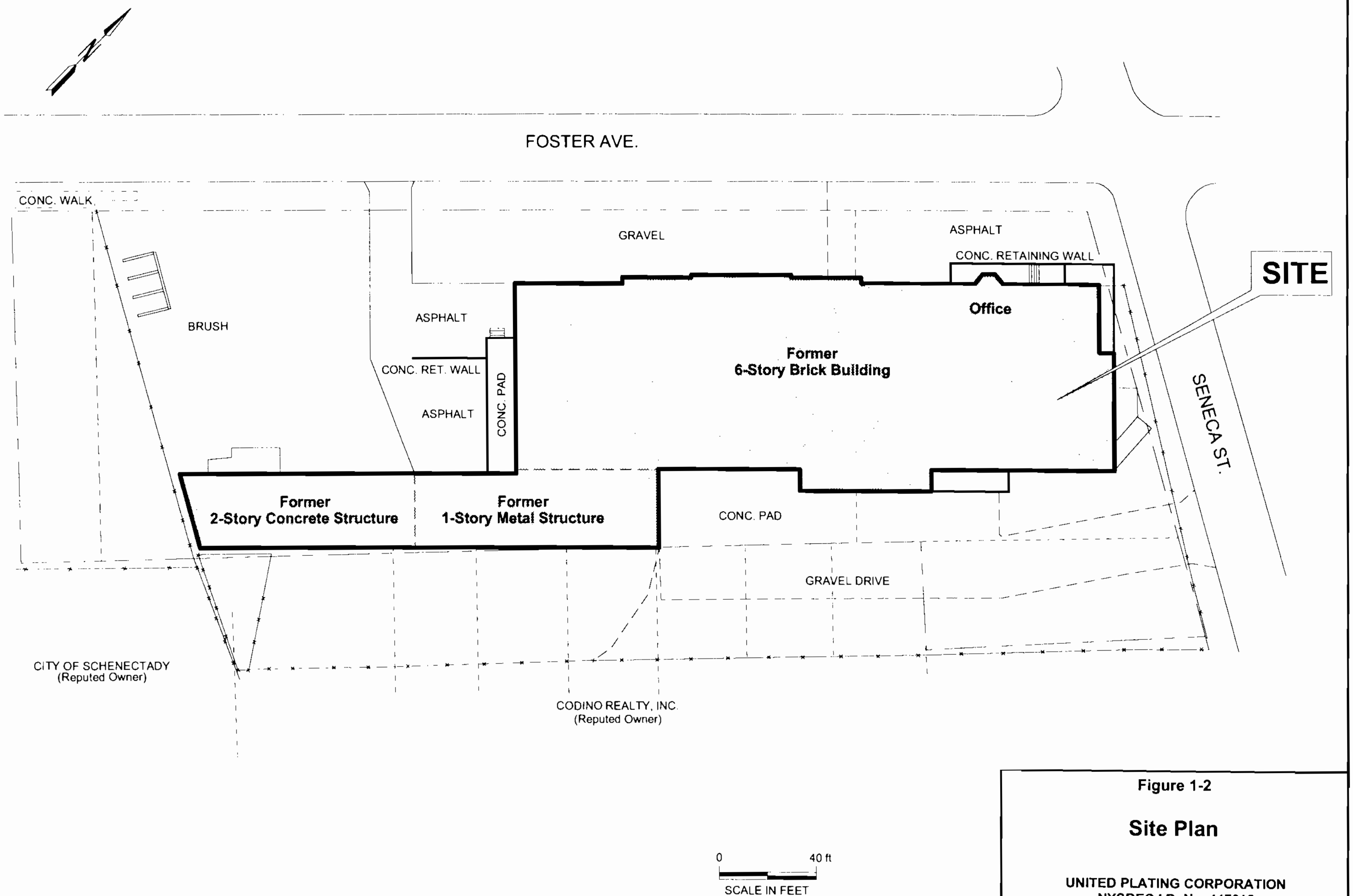

Base map source: M.J. Engineering and Land Surveying 1995.

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Figure 1-2

Site Plan

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1.3 SITE HISTORY

A complete site history, including sampling events and other environmental investigations conducted, is presented in the RI (LMS 1998a).

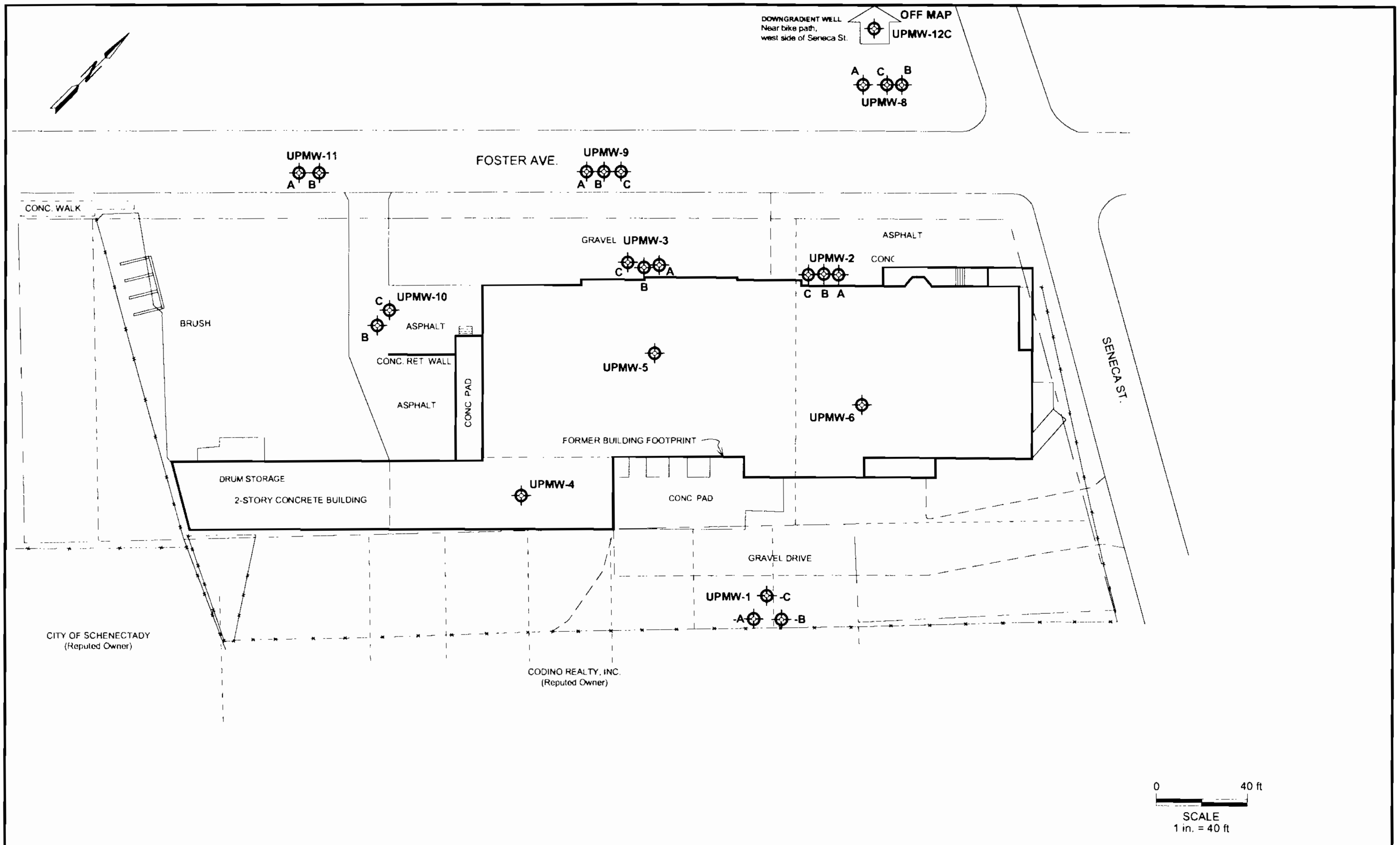
In April 1996 LMS prepared a focused FS (FFS) to evaluate alternatives for managing the contents of the UP building and the building itself. NYSDEC issued a record of decision (ROD) in 1997 to remove the contaminated debris in the UP building, clean the contaminated portions of the building, and demolish the building. In 1998 a building demolition remedial design plan was prepared for NYSDEC by Clough, Harbour & Associates LLP of Albany, New York. NYSDEC anticipates that this remedial plan will be implemented at the UP site in 1999.

1.4 NATURE AND EXTENT OF CONTAMINATION

This section outlines the nature and extent of contamination in the soil and groundwater underlying the UP site. This section does not discuss the nature and extent of contamination in the UP building as the building is scheduled to be demolished and removed from the site in 1999.

During the RI, soil and groundwater samples were collected and analyzed from various locations in and around the building using a probe (direct-push technology). The samples were taken to provide information on the subsurface soil and groundwater contamination and to aid in locating the monitoring wells. Shallow soil samples, i.e., from 0 to 6 in. in depth, were collected and analyzed from 40 locations both on site and off site to determine the extent of soil contamination. These data were also used in the risk assessment of the RI. Test pits were installed around the building to locate possible sources of contamination.

Twelve monitoring wells were installed in and around the building. At one upgradient and two downgradient locations, triplicate wells (i.e., cluster of 3 wells) were installed. The wells consisted of one shallow overburden well, one deeper overburden well installed at the overburden/bedrock interface, and one bedrock well. Three wells were installed in the overburden underneath the building. These monitoring well locations are noted in Figure 1-3. Each well was sampled twice. During the first round samples were collected and analyzed for target compound list (TCL) organics, target analyte list (TAL)



LEGEND

- Monitoring well location
- A Shallow overburden well
- B Intermediate overburden well
- C Bedrock well

Base map source: M.J. Engineering and Land Surveying 1995.

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Figure 1-3

Monitoring Well Locations as of December 1997

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inorganics, and cyanide. Both filtered and unfiltered metals were collected from most samples (sample volume recovery limited the actual analyses that could be done). The second round of samples were analyzed for volatile organic compounds (VOCs), polychlorinated biphenyls (PCBs), and unfiltered metals and cyanide.

An additional RI was performed in 1997 to further characterize the nature and extent of contamination identified during the previous RI. Fourteen additional monitoring wells were constructed and sampled as part of this phase. Groundwater samples were collected from the 12 existing and 14 new wells; most samples were analyzed for VOCs, TAL metals, cyanide, and PCBs.

1.4.1 **Shallow Soils**

Data collected from the shallow soil investigation were compared to the NYSDEC cleanup objectives, and none of the samples had VOCs which exceeded the cleanup objectives. No pesticides or PCBs were detected in excess of cleanup objectives. Nearly all samples had semivolatile organic compounds (SVOCs) exceeding the cleanup objective. The SVOC that drives the risk assessment is benzo(a)pyrene, the cleanup objective for which is 0.061 mg/kg. Although the levels of benzo(a)pyrene found exceed the cleanup objective and indicate a potential health concern, discussions with New York State Department of Health (NYSDOH) officials have indicated that these concentrations are typical of urban soils near commercial and industrial properties and may not be site related (LMS 1998b). The finding of benzo(a)pyrene in the shallow soils may be due to construction from industrial/commercial establishments found in the area. Background levels found away from the site are similar to the range found at the UP site. Conversations between NYSDEC and NYSDOH have indicated that remediation of the shallow soils based on the benzo(a)pyrene levels found at the site is not warranted.

For inorganic contaminants, the NYSDEC and NYSDOH data were used to derive the area background soil concentrations for chromium, copper, nickel, and zinc. For cadmium the eastern U.S. upper range concentration and NYSDEC cleanup objective of 1 mg/kg were used as some of the background data had detection limits higher than 1 mg/kg. For lead, the U.S. Environmental Protection Agency (EPA) guidance value of 400 mg/kg was used as the cleanup level (EPA 1994). For metals other than those that are site related (including mercury), which have a specified cleanup objective, the upper range of the eastern U.S. background was used as the cleanup objective. Only lead was found in concentrations above cleanup objectives in an area located outside the building footprint and below the area where a lead smelter was formerly located. Figure 1-4 shows the area where the surface soil (defined as 0 to 2 ft below grade) exceeded the site background or cleanup objectives for lead.

1.4.2 **Subsurface Soil**

None of the probe soil samples collected from subsurface soils exceeded any NYSDEC cleanup objective for VOCs, and none of the compounds detected exceeded 1 mg/kg. The sample from the boring drilled for UPMW-4, located inside the treatment building, had trichloroethylene (TCE) at 15 mg/kg, which is above the cleanup objective of 0.7 mg/kg. Although not analyzed for toxicity characteristic leaching potential (TCLP), this sample had the potential to exceed the 0.5 mg/l TCLP standard for TCE (based on the 20:1 dilution used by the TCLP test and dividing the total concentration by 20 provides a concentration that could exceed the TCLP standard if the TCE were all extracted). This sample also had many SVOC concentrations that exceeded the cleanup objective; the total SVOC criterion was also exceeded. No pesticides or PCBs were detected in concentrations above the cleanup objective. None of the test pit samples collected during the RI had any VOCs exceeding the cleanup objective. None of the soils collected from the installation of monitoring wells during the additional RI work had any VOCs above cleanup objectives.

Subsurface soils also contained elevated concentrations of inorganic compounds. However, the subsurface soils do not impact the risk assessment as these soils are not accessible to children or adults, i.e., they cannot be inhaled or ingested. However, the subsurface soils have the potential to impact the groundwater by acting as a contaminant source by leaching metals to the groundwater. Although TCLP metals were not analyzed, the data were evaluated using the same rationale used to evaluate the TCE data (if the total concentration for the metal were less than 20 times the TCLP standard, the metal would not be expected to leach to the groundwater at a hazardous level). The results of the evaluation are summarized on Figure 1-5, which shows the subsurface soils that have the potential to exceed the TCLP toxicity characteristic for hazardous waste for cadmium, chromium, and TCE. The area generally covers most of the footprint of the UP building and some area adjacent to the building footprint.

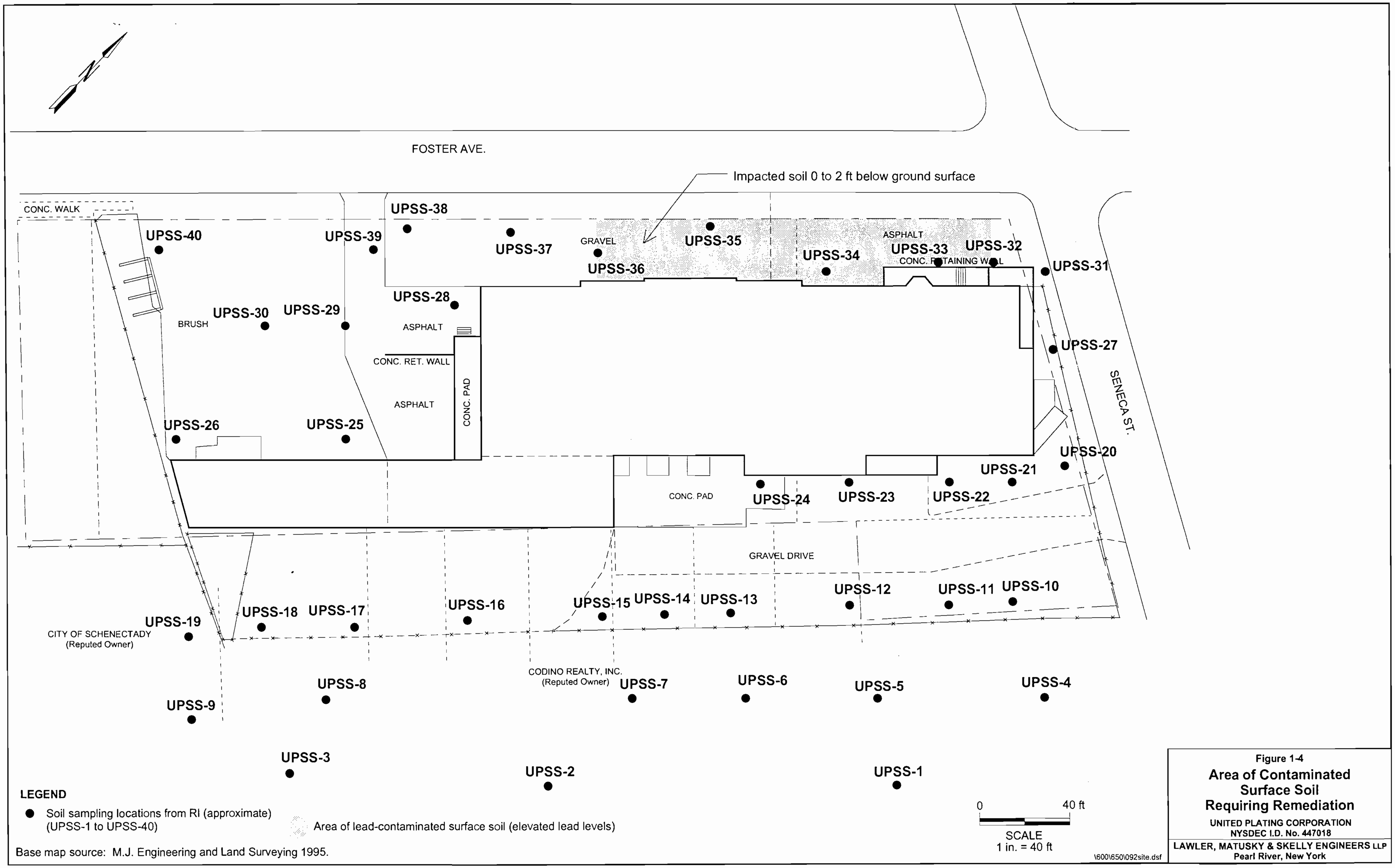

Figure 1-4
Area of Contaminated Surface Soil Requiring Remediation
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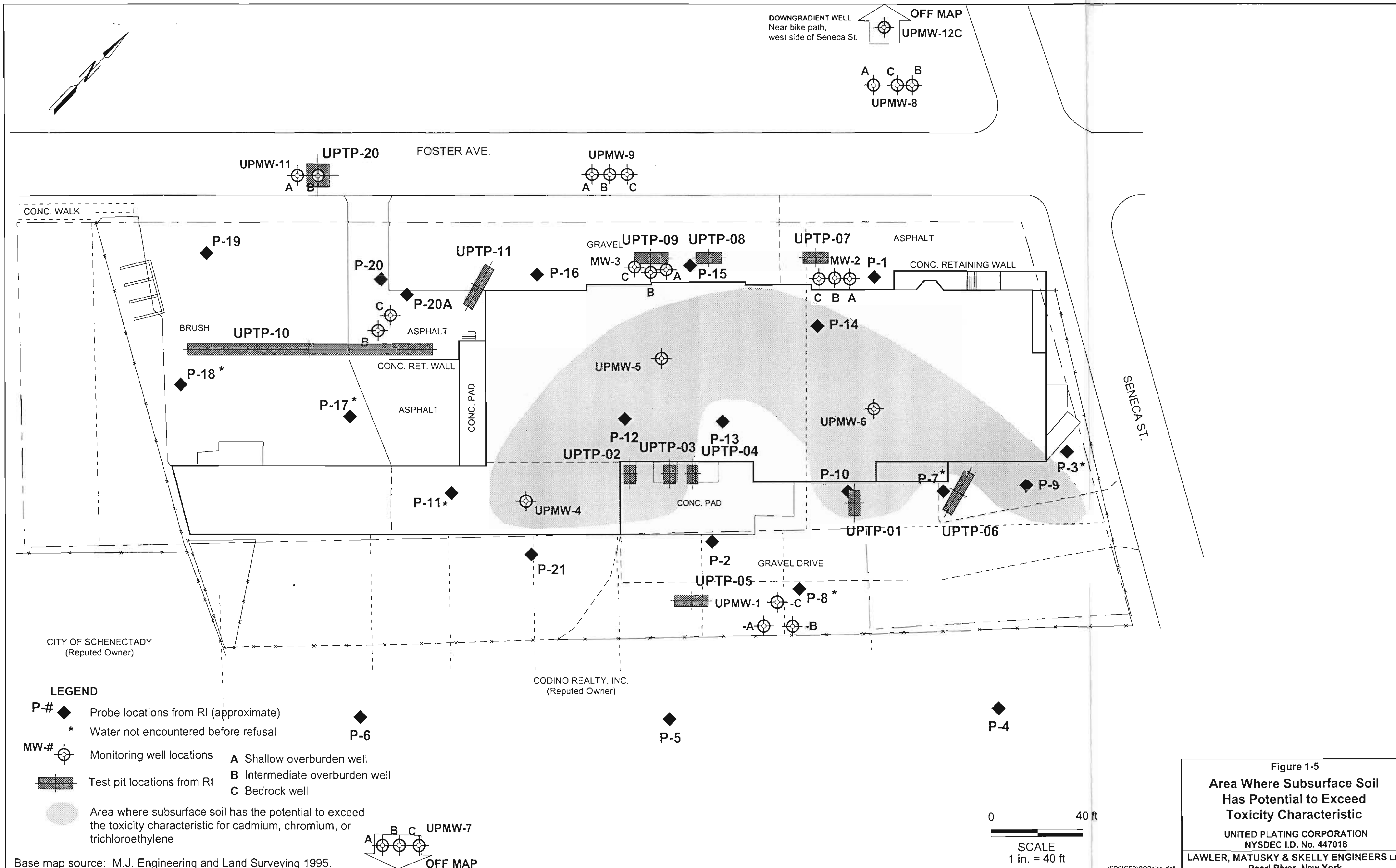

Figure 1-5

Area Where Subsurface Soil Has Potential to Exceed Toxicity Characteristic

1.4.3 **Groundwater**

Groundwater was screened in three zones at the UP site: shallow, intermediate, and deep zones. According to the risk assessment conducted in the RI, no human exposure pathways exist for the groundwater pathway. However, shallow groundwater is encountered at shallow depths (less than 5 ft) beneath the site and is therefore considered to act as a source of contamination to deeper media. Figure 1-6 shows the extent of the TCE and 1,1,1-trichloroethane (TCA) contamination at the UP site in the shallow groundwater; these are areas where TCE and TCA were found above the New York State groundwater standard of 5 μg/l. This figure is based on the results of the probe water sampling, the two rounds of groundwater monitoring well sampling, and the monitoring well sampling of the Additional RI. The area encompasses most of the building footprint. The contaminant plume spreads slightly to the southeast and to the northwest outside the building footprint.

No SVOCs or pesticides were found in concentrations above the groundwater standard in any of the monitoring well samples. PCBs were found above the groundwater standard of 0.1 ug/l for total PCBs in several samples during both rounds of the RI; however, the data are suspect due to possible cross contamination. The finding of PCBs in an upgradient well suggests that PCBs are at least in part originating off site.

Figure 1-7 shows the extent of the chromium contamination in the shallow groundwater, and Figure 1-8 shows the extent of cyanide contamination. The figures are based on the results of the probe water samples, two rounds of monitoring well sampling during the RI, and the round of groundwater sampling during the Additional RI work. The figures use the highest concentrations found in monitoring well sampling. Most of the chromium contamination is confined to the area beneath the building footprint. The cyanide contamination is confined to the area within the building footprint.

1.4.4. **Surface Water and Sediment**

Contaminated water and sediment in sumps and drains within the building are being removed as part of the building demolition remedial action. Therefore, these media were not considered in the FS.

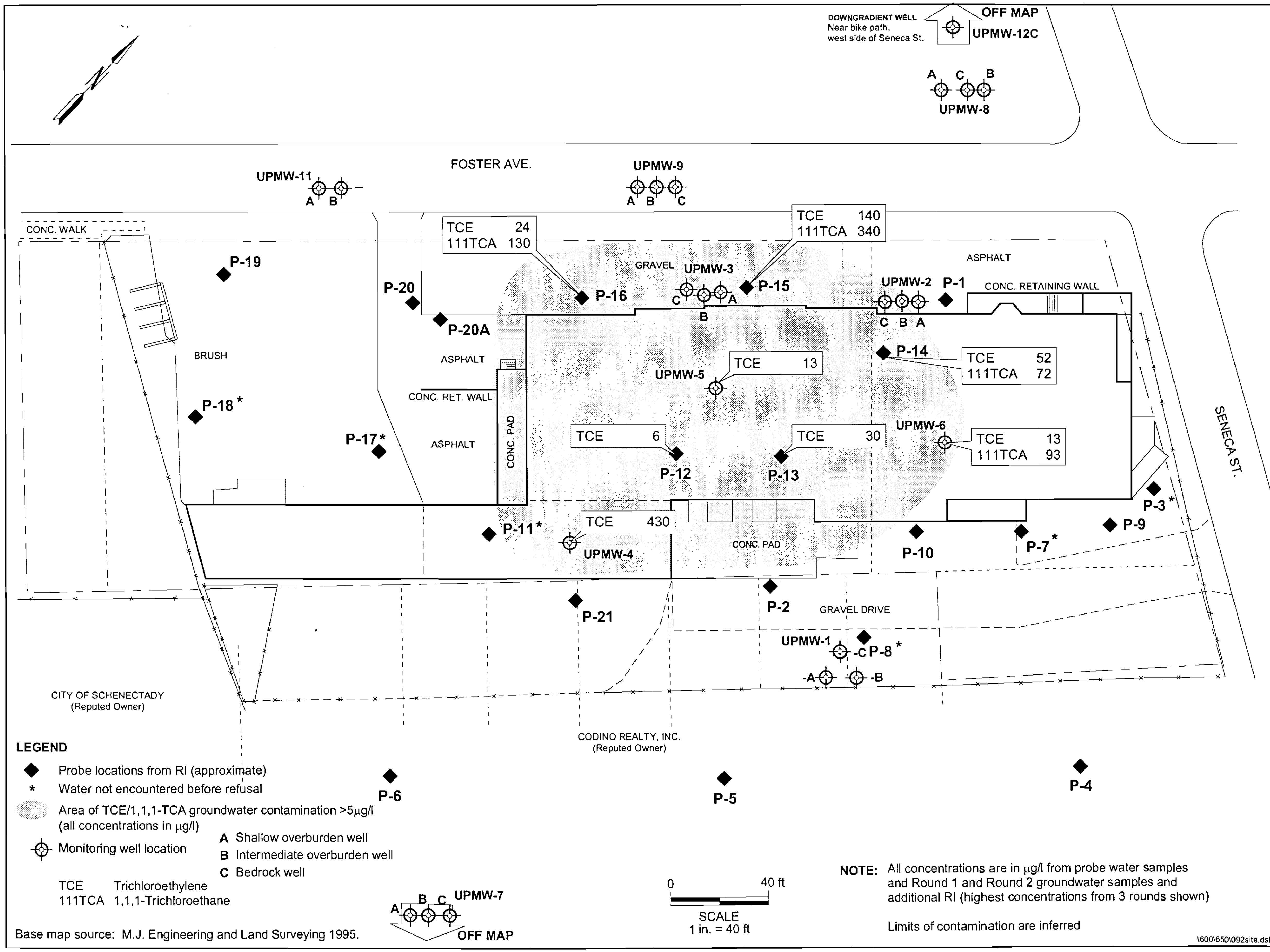

Figure 1-6
Area of TCE/1,1,1-TCA Contamination Shallow Groundwater

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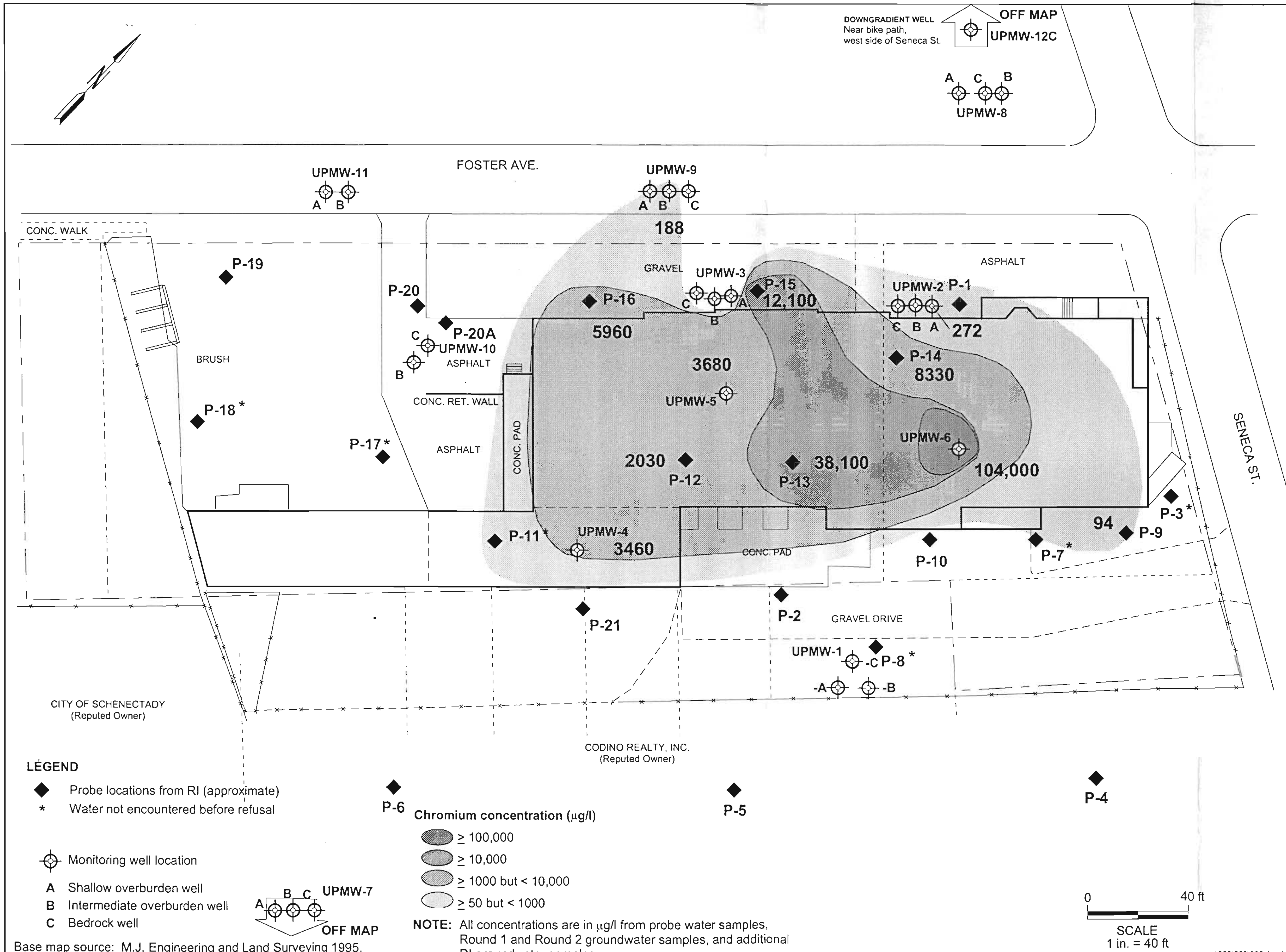

Figure 1-7

Area of Chromium Contamination in Shallow Groundwater

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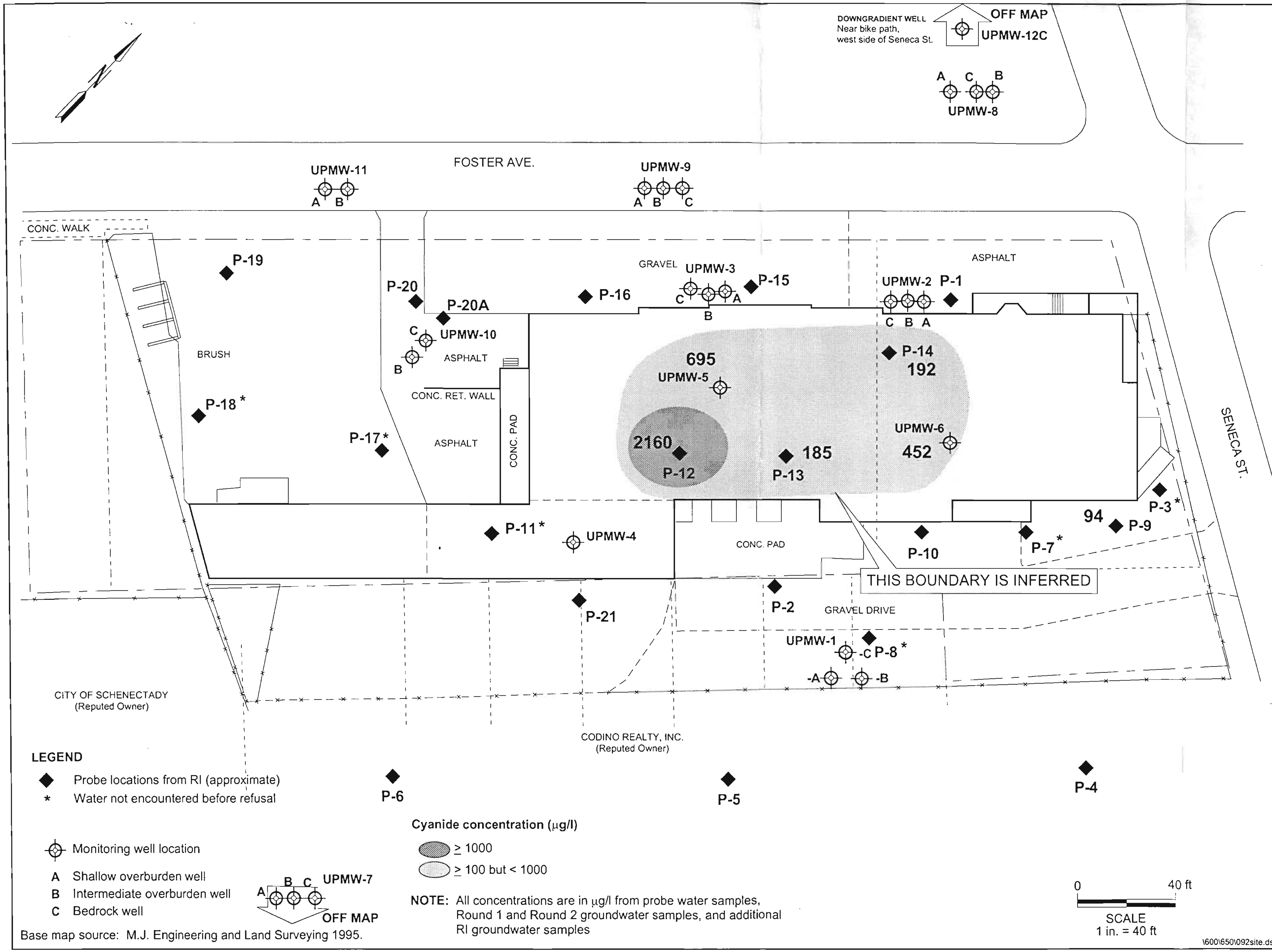

Figure 1-8

Area of Cyanide Contamination in Shallow Groundwater

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CHAPTER 2

OBJECTIVES OF THE FEASIBILITY STUDY AND APPLICABLE STANDARDS, CRITERIA, AND GUIDANCE

2.1 INTRODUCTION

This report constitutes the FS for the soil and groundwater contamination underlying the UP site. An FFS was prepared under separate cover by LMS (LMS 1996) to evaluate remedial alternatives for the contaminated UP building and its contents separately.

The primary objective of the FS is to ensure that appropriate remedial alternatives are developed and evaluated such that relevant information concerning the remedial action can be presented to a decision-maker and an appropriate remedy selected. The FS: (1) identifies remedial action objectives; (2) identifies potential treatment and containment technologies that will satisfy these objectives; (3) screens the technologies based on their effectiveness, implementability, and cost; and (4) assembles technologies and their associated containment or disposal requirements into alternatives for the contaminated media of the site. At the UP site, identified contaminated media include subsurface soil and shallow groundwater. No users of groundwater have been identified at or downgradient of the UP site.

2.2 APPLICABLE STANDARDS, CRITERIA, AND GUIDANCE

Applicable requirements are defined as those promulgated Federal or state requirements (e.g., drinking water standards, standards of control) that specifically address a hazardous substance, pollutant, or contaminant found at a Federal Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) site. Relevant and appropriate requirements are those Federal or state requirements that, while not applicable, address problems sufficiently similar to those encountered at CERCLA sites that their application is appropriate. Collectively, these terms are commonly referred to as applicable or relevant and appropriate requirements, or ARARs. In addition to ARARs, other criteria, advisories, or guidance may also apply to the conditions found at the site, and these are referred to as to-be-considered (TBC) items. TBCs are not legally binding but may be useful within the context of assessing site risks and determining site cleanup goals.

The UP site is not a CERCLA site but a New York State Inactive Hazardous Waste site. In the New York State regulations (6 NYCRR Part 375), the equivalent term to "ARARs" is "standards and criteria" and the equivalent term to "TBCs" is "guidance." The New York State regulations group these terms and refer to them as "standards, criteria, and guidance," or SCGs. In this FS, the terms "ARARs and TBCs" and "SCGs" are used interchangeably.

SCGs are generally divided into three categories: chemical-, location-, and action-specific SCGs. Chemical-specific SCGs provide guidance on acceptable or permissible contaminant concentrations in soil, air, and water. Location-specific SCGs govern activities in critical environments such as floodplains, wetlands, endangered species habitats, or historically significant areas. Action-specific SCGs are technology- or activity-based regulatory requirements or limitations on actions taken in remediating hazardous wastes.

2.2.1 **Chemical-Specific SCGs**

Chemical-specific SCGs for the contaminants of concern (COCs) at the UP site were identified in Section 6.2.4 of the RI. Applicable standards and criteria include the New York State groundwater standards, Federal drinking water standards, national ambient air quality standards (NAAQS) of the Clean Air Act. Relevant and appropriate guidances include New York State recommended soil cleanup objectives, Federal ambient water quality criteria, EPA drinking water health advisory levels, and exposure limitations established by the National Institute for Occupational Safety and Health (NIOSH), the Occupational Safety and Health Administration (OSHA), and the American Conference of Governmental Industrial Hygienists (ACGIH). Chemical-specific values associated with these SCGs are summarized in Table 2-1 for the site COCs.

2.2.2 **Location-Specific SCGs**

According to the habitat assessment conducted in the RI (LMS 1998a), there are no significant sensitive environmental areas at the UP site; therefore, there are no location-specific SCGs.

CHEMICAL-SPECIFIC STANDARDS, CRITERIA, AND GUIDANCES LISTED IN RISK ASSESSMENT

United Plating Site

	ARSENIC	CADMIUM	CHROMIUM[d]	COPPER	CYANIDE	LEAD
APPLICABLE STANDARDS AND CRITERIA:						
NYS Class GA Groundwater Standards (µg/l)	25	5	50	200	200	25
Federal Drinking Water Standards-MCL/MCLG (µg/l)	50/50	5/5	100/100	NS/1,300	200/200	0/0.015
National Ambient Air Quality Standards (mg/m³)	N/A	N/A	N/A	N/A	N/A	0.0015
OTHER GUIDANCES:						
NYS Recommended Soil Cleanup Objectives (mg/kg)	7.5 or SB	1 or SB	10 or SB	25 or SB	NS	SB
Federal Ambient Water Quality Criteria, Human Health (µg/l)	0.0022	10	50	N/A	200	50
EPA Drinking Water Health Advisory-DWEL (µg/l)	N/A	50	200	N/A	800	N/A
NIOSH IDLH (mg/m³)	5[a]	9[a]	250	100	N/A	100
OSHA PEL-TWA (mg/m³)	0.01	0.005	1	1	N/A	0.050
ACGIH REL-TWA (mg/m³)	0.002[b]	N/A[c]	0.5	1	N/A	0.1

a - IDLH based on noncarcinogenic effects only.
b - Carcinogenic compound; value given is 15-min ceiling value.
c - Carcinogenic compound; occupational exposures should be limited to lowest feasible concentration.
d - Chromium values based on total chromium.
e - Ceiling value.
f - Value for mercury vapor.
N/A - Not available.
NS - No standard.
SB - Site background.

TABLE 2-1 (Page 2 of 3)

CHEMICAL-SPECIFIC STANDARDS, CRITERIA, AND GUIDANCES LISTED IN RISK ASSESSMENT

United Plating Site

	MERCURY	NICKEL	SILVER	ZINC	BENZO (a) PYRENE	DIBENZO (a, h) ANTHRACENE
APPLICABLE STANDARDS AND CRITERIA:						
NYS Class GA Groundwater Standards (µg/l)	0.7	100.0	50	2000	ND	N/A
Federal Drinking Water Standards-MCL/MCLG (µg/l)	2/2	100/100	100[g]	5,000[g]	0/0.2	0/0.2
National Ambient Air Quality Standards (mg/m³)	N/A	N/A	N/A	N/A	N/A	N/A
OTHER GUIDANCES:						
NYS Recommended Soil Cleanup Objectives (mg/kg)	0.1	13 or SB	SB	20 or SB	0.061 or MDL	0.014 or MDL
Federal Ambient Water Quality Criteria, Human Health (µg/l	0.144	13.4	50	N/A	0.0028	0.0028
EPA Drinking Water Health Advisory-DWEL (µg/l)	10	600	200	10,000	N/A	N/A
NIOSH IDHL (mg/m³)	10	10[a]	10	N/A	80[a,h]	80[a,h]
OSHA PEL-TWA (mg/m³)	0.1[e]	1	0.01	N/A	0.2[h]	0.2[h]
ACGIH REL-TWA (mg/m³)	0.05[f]	0.015[c]	0.01	N/A	0.1[c,h]	0.1[c,h]

a - IDHL based on noncarcinogenic effects only.
c - Carcinogenic compound; occupational exposures should be limited to lowest feasible concentration.
g - Secondary maximum contaminant level (SMCL) for drinking water-nonenforceable limit.
h - Value for coal tar pitch volatiles.
N/A - Not available.
ND - A non-detectable concentration by the approved analytical method.
NS - No standard.
SB - Site background.
MDL - Method detection limit.

TABLE 2-1 (Page 3 of 3)

CHEMICAL-SPECIFIC STANDARDS, CRITERIA, AND GUIDANCES LISTED IN RISK ASSESSMENT

United Plating Site

	DIBENZOFURAN	FLUORANTHENE	PYRENE
APPLICABLE STANDARDS AND CRITERIA:			
NYS Class GA Groundwater Standards (µg/l)	N/A	50 GV	50 GV
Federal Drinking Water Standards-MCL/MCLG (µg/l)	N/A	N/A	N/A
National Ambient Air Quality Standards (mg/m^3)	N/A	N/A	N/A
OTHER GUIDANCES:			
NYS Recommended Soil Cleanup Objectives (mg/kg)	50[i]	50[i]	50[i]
Federal Ambient Water Quality Criteria, Human Health (µg/l	N/A	42	0.0028
EPA Drinking Water Health Advisory-DWEL (µg/l)	N/A	N/A	N/A
NIOSH IDHL (mg/m^3)	N/A	80[a,h]	80[a,h]
OSHA PEL-TWA (mg/m^3)	N/A	0.2[h]	0.2[a,h]
ACGIH REL-TWA (mg/m^3)	N/A	0.1[c,h]	0.1[c,h]

a - IDHL based on noncarcinogenic effects only.
c - Carcinogenic compound; occupational exposures should be limited to lowest
h - Value for coal tar pitch volatiles.
i - Recommended soil cleanup objective for individual SVOCs is 50 ppm.

GV - Guidance value.
N/A - Not Available.

2.2.3 **Action-Specific SCGs**

Action-specific SCGs for the site include compliance with Section 121, Subsections 104 and 106, of CERCLA of 1980 and amended by the Superfund Amendment and Reauthorization Act (SARA) of 1986, which state that the selected remedial alternative must eliminate, reduce, or control risks to human health and the environment. Similarly, 6 NYCRR Part 375 states that the selected remedy shall eliminate or mitigate all significant threats to the public health and to the environment presented by hazardous waste disposed of at the site through the proper application of scientific and engineering principles. The extent to which each of the remedial alternatives for the site complies with this requirement will be assessed during the detailed evaluation of alternatives.

The selected remedial alternative may include activities that require the generation, storage, treatment, transport, or disposal of hazardous waste. Handling of waste soil or groundwater that is determined to be "hazardous" must be performed in accordance with the Federal hazardous waste regulations (40 CFR Parts 260-268) promulgated under the Resource Conservation and Recovery Act (RCRA) as well as New York State hazardous waste regulations (6 NYCRR Parts 364 and 370-376).

A waste can be identified as hazardous under two categories: (1) a waste is a "listed" hazardous waste if it is specifically listed in 40 CFR Part 261 or 6 NYCRR Part 371, or (2) a waste is a "characteristically" hazardous waste if it exhibits the characteristic of ignitability, corrosivity, reactivity, or toxicity as defined in 40 CFR Part 261 or 6 NYCRR Part 371. It is not anticipated that during the remedial action any listed hazardous wastes would be generated. Some contaminated soil and groundwater that would be generated may be classified as characteristically hazardous based on toxicity testing. The toxicity characteristic (TC) limitations for the COCs represent the threshold values above which a waste is considered to be a characteristically hazardous waste for disposal. If any hazardous waste is generated during the remedial action, the classifications that would most likely be applicable include the following:

- D006 wastes exhibit the characteristic of toxicity for cadmium
- D007 wastes exhibit the characteristic of toxicity for chromium
- D008 wastes exhibit the characteristic of toxicity for lead
- D040 wastes exhibit the characteristic of toxicity for TCE

Federal and state land disposal restrictions (LDRs) (40 CFR Part 268 and 6 NYCRR Part 376, respectively) identify hazardous wastes that are restricted from land disposal. During the remedial action, hazardous soil and groundwater may be generated at the UP site and require off-site treatment or disposal. If this soil or groundwater is prohibited from land disposal under 40 CFR Part 268 or 6 NYCRR Part 376, it could not be disposed of in a landfill without prior treatment to reduce the contaminant levels. A hazardous waste may be land-disposed only if its constituent concentrations or an extract of the waste does not exceed regulatory constituent concentrations. Hazardous wastes containing halogenated organic compounds (HOCs) in concentrations greater than or equal to 1000 ppm are also restricted from land disposal. A hazardous waste may be treated to reduce its constituent concentrations to be below the regulatory LDR limits and subsequently be land disposed.

At the UP site, TCLP analyses have not been performed on soils; however, the elevated results of the total contaminant analyses suggest that some soils may be characteristically hazardous by exceeding the TC limit if a TCLP analysis were performed (particularly for cadmium, chromium, or lead). If the soil is found to be characteristically hazardous for cadmium, chromium, or lead and is to be land disposed of, the soil must be treated prior to land disposal to satisfy the same treatment standards as for hazardous waste. The treatment standard for cadmium-contaminated soil is 1 mg/l TCLP and for chromium- and lead-contaminated soil is 5 mg/l TCLP. Once these treatment standards are met, the soil can be land disposed of in a landfill.

Contaminated groundwater that is pumped to the surface is subject to similar regulations if it is found to be characteristically hazardous during the remedial action. As with soil, groundwater that exhibits the TC is subject to the same treatment standards as the characteristic waste with which it is contaminated. Groundwater containing 1000 ppm or greater HOCs is also prohibited from land disposal. The treatment standard for cadmium-contaminated groundwater is 1 mg/l and for chromium- and lead-contaminated groundwater is 5 mg/l. Once these treatment standards are met, the groundwater can be discharged on land but, more likely, would be further treated in an industrial wastewater treatment system.

Transportation of hazardous wastes must be conducted in accordance with all applicable regulations, including 40 CFR Part 263 and 6 NYCRR Part 372.

2.3 REMEDIAL ACTION OBJECTIVES

Remedial action objectives were developed in the RI to determine the levels to which contaminant concentrations must be reduced to protect human health and the environment. According to the RI, no human exposure pathways exist for the contaminants present in subsurface soil and groundwater. Remedial action objectives of 100 mg/kg for chromium, 20 mg/kg for cadmium, and for 10 mg/kg TCE were established in the RI for subsurface soils. These remedial action objectives were selected based on the level of contaminant that would produce a characteristically hazardous soil (i.e., soil that is hazardous for disposal based on its chemical content). For groundwater, remedial action objectives were established based on the NYSDEC Class GA groundwater standards, which are 50 μg/l for chromium, 100 μg/l for cyanide, 5 μg/l for TCE, and 5 μg/l for 1,1,1-TCA.

A human health risk assessment was conducted in the RI to evaluate the potential human health risks associated the site's surface soils. The human health risk assessment concluded that several contaminants at levels detected in surface soils, including certain carcinogenic polynuclear aromatic hydrocarbons (PAHs) (benzo(a)pyrene and dibenzo[a,h]anthracene) and metals (arsenic and chromium), may potentially result in increased cancer risks to exposed populations under the current land use scenario and potential future land use scenarios. However, the RI found that even though PAHs and metals concentrations exceeded cleanup objectives, these levels are typical concentrations found in urban soils near commercial and industrial properties as indicated by the wide range of levels found in the background soils. This finding was supported by NYSDOH and NYSDEC (LMS 1998b). The only area of surface soils requiring remediation is the "hot spot" near samples UPSS-32 to UPSS-36 containing elevated lead levels. The cleanup goal for the surface soils in this area follows the EPA soil cleanup objective of 400 mg/kg for lead.

2.4 QUANTITIES OF CONTAMINATED MEDIA

The RI identified the estimated quantities of contaminated media present at the UP site. Table 2-2 summarizes these quantities and lists the remedial action objectives by medium. Impacted areas and media of the UP site are described in Chapter 1. Figure 1-4 depicts the approximate location of the contaminated surface soils. An estimated 520 yd^3 of surface soil is contaminated above the remedial action objective. Figure 1-5 shows the

TABLE 2-2

REMEDIAL ACTION OBJECTIVES AND QUANTITIES OF CONTAMINATED MEDIA

United Plating Site

MATRIX	REMEDIAL ACTION OBJECTIVE	APPROXIMATE QUANTITY OF CONTAMINATED MATERIAL[a]
Surface Soil	Lead < 400 mg/kg[b]	520 yd^3
Subsurface Soil	Chromium < 100 mg/kg[c] Cadmium < 20 mg/kg[c] TCE < 10 mg/kg[c]	7,980 yd^3
Groundwater	Chromium < 50 µg/l[d] Cyanide < 100 µg/l[d] TCE < 5 µg/l[d] 1,1,1-TCA < 5 µg/l[d]	1.7 million gal

a - As reported in the Remedial Investigation report (LMS 1998).
b - Source: EPA Lead Cleanup Guidance
c - Twenty times TCLP limitation for toxicity characteristic
d - Source: NYSDEC Class GA Groundwater Standard

approximate location of the contaminated subsurface soils, which amount to approximately 7980 yd^3.

Figures 1-6 through 1-8 indicate the extent of the groundwater contaminant plume in the overburden soil aquifer, by contaminant. According to the RI, the quantity of contaminated groundwater at the UP site is estimated to be 1.7 million gal.

CHAPTER 3

IDENTIFICATION AND SCREENING OF TECHNOLOGIES

3.1 INTRODUCTION

The first step in developing a range of alternatives intended to achieve the remedial action objectives for the site is to identify potentially applicable remedial technologies. An initial screening is performed in which the applicability of the identified technologies to site conditions, contaminants, and contaminated media characteristics are evaluated. The most promising technologies are combined into sitewide remedial alternatives, which are then included in the detailed analysis of alternatives.

3.2 GENERAL RESPONSE ACTIONS

The remedial technologies identified for potential application to contaminated soil and groundwater are evaluated in this chapter. The technologies have been grouped by impacted media and general response action. A general response action is a category of technologies that represent a particular approach to achieving the remedial action objectives. General response action categories include institutional measures, containment, removal/collection, treatment, and disposal. General response action categories are further defined by technology types and process options. Technology types are general categories of technologies (e.g., chemical treatment), while process options are specific processes within each technology type (e.g., chemical treatment via oxidation). A brief description of each technology and process option is given; the references presented at the end of this report provide more detailed descriptions of each technology.

The review of remedial technologies presented in this FS is not an exhaustive list of all available remediation technologies, but it provides a synopsis of potentially applicable technologies that should be considered for the UP site.

3.3 REMEDIAL TECHNOLOGY SCREENING PROCESS

Listed in Tables 3-1 through 3-3 are the remedial technologies identified for potential use at the UP site. The technologies have been grouped according to the medium they address (although a particular technology may be applicable to more than one

SUMMARY OF REMEDIAL TECHNOLOGIES FOR SOURCE CONTROL

United Plating Site

GENERAL RESPONSE ACTION	TECHNOLOGY TYPE/PROCESS OPTION	APPLICABILITY TO SITE	SCREENING COMMENTS
No Action	None	Yes	Required by NCP.
Institutional Measures	A. Access restrictions	Yes	Reducing access to site will reduce chance of human contact with contaminants; recommended in conjunction with other remedial actions.
	1. Signs	Yes	None.
	2. Fencing	Yes	Existing fencing may require maintenance.
	B. Deed restrictions	Yes	May be used to prevent human contact with contaminants; will not prevent continued migration of contaminants to groundwater.
	C. Development restrictions	Yes	Same as deed restrictions.
Containment	A. Capping or surface sealing	Yes	Effective for prevention of human contact with contaminants and migration of contaminants from unsaturated soils to groundwater; will not prevent continued migration of contaminants in groundwater to off-site locations.
	1. Synthetic membrane	Maybe	Best used as part of a multilayer cap.
	2. Clay	Maybe	May shrink or crack due to freezing/thawing; best used as part of a multilayer cap.
	3. Asphalt	Maybe	Potentially applicable but is susceptible to weathering and cracking.
	4. Concrete	Maybe	Potentially applicable but is susceptible to weathering and cracking.
	5. Chemical additives/stabilizers	No	May be effective in forming a cap as well as in immobilizing any metals present in soils; not as permanent as other capping methods.
	6. Multilayer cap	Yes	Most reliable capping method; least susceptible to weathering, cracking.
In-situ Treatment	A. Biological	No	Suitable for organics that are easily biodegradable but not suitable for inorganics; metals present in soils may inhibit biodegradation.
	1. Biodegradation (aerobic or anaerobic)	No	Not effective for reducing concentrations of inorganic contaminants to achieve remedial action objectives.
	2. Bioventing	No	Common treatment for fuels; not effective for removal of metals.
	3. Phyto-treatment	No	Innovative technology that has not had wide spread application; may be effective for removing contaminants from surface soils. Requires bench scale testing. May be seasonally dependent.

SUMMARY OF REMEDIAL TECHNOLOGIES FOR SOURCE CONTROL

United Plating Site

GENERAL RESPONSE ACTION	TECHNOLOGY TYPE/PROCESS OPTION	APPLICABILITY TO SITE	SCREENING COMMENTS
In-situ Treatment (Continued)	B. Thermal	No	Generally, metals are gaseous at very high temperatures; most thermal treatment processes do not apply to metals contaminants.
	1. Vitrification	No	Not cost-effective for saturated soils (water table at site is shallow). Process is expensive and energy intensive.
	2. Radio frequency/electrical resistance heating	No	Generally used in conjunction with SVE to increase the mobility of volatile organics; no proven effectiveness on metals.
	C. Physical/chemical	Yes	Effective for removal/immobilization of metals and organics.
	1. Solidification/stabilization	Yes	Wide spread application for remediating metals-contaminated soils. Soils are stabilized and immobilized in solidified mass. Process reduces the bioavailability of organics. In-situ S/S may be more costly to achieve than ex-situ S/S due to the highly-compacted nature of the site's silty soils.
	a. Cement-based solidification	Yes	Increases volume of soil waste to be backfilled or disposed of off-site. The pH must be controlled to prevent leaching of metals.
	b. Silicate-based processes	Yes	Increases volumes of waste to be backfilled or disposed of off-site. May be more effective than cement-based processes, especially if organics are present.
	c. Organic polymer-based processes	No	May biodegrade over time; generally more expensive than other solidification technologies.
	d. Thermoplastic techniques	No	Suitable for heavy metals, however incompatible with cyanide and certain organics.
	e. Surface microencapsulation	No	Technology limited to specific waste types.
	f. Sorbents, lime, chemical additives	Maybe	Additives may help control pH of stabilized mass to prevent leaching.
	2. Soil flushing	No	Would require flushing wash solution through source area, which is presently covered by building foundation. Not uniformly effective on lower-permeability soils such as those present at site.
	a. Water	No	Primarily for the removal of soluble inorganics and organics.
	b. Surfactants	No	Increases organic contaminant mobility and solubility; chelating agents may be added to enhance removal of heavy metals. Difficult to apply uniformly in low permeability formations.
	c. Acids/bases	No	Hydrochloric acid has been demonstrated effective for the removal of heavy metals in soils, however, solution would be difficult to apply uniformly at site.

SUMMARY OF REMEDIAL TECHNOLOGIES FOR SOURCE CONTROL

United Plating Site

GENERAL RESPONSE ACTION	TECHNOLOGY TYPE/PROCESS OPTION	APPLICABILITY TO SITE	SCREENING COMMENTS
In-situ Treatment (Continued)	d. Cosolvents	No	Increase apparent solubility of organic contaminant in water; no proven effectiveness on metals.
	3. Chemical degradation/detoxification	No	No field demonstration for in-situ treatment to date. Requires injection of potentially hazardous agents in subsurface which may not be economically recovered.
	4. Dilution	No	Mixing of clean soils with contaminated soils to reduce concentrations to acceptable levels may by limited by volume of clean soils required and by depth of contamination. Generally not acceptable to regulatory agencies.
	5. Soil vapor extraction	No	Only effective for the removal of volatile organics; no demonstrated effectiveness in removing metals from unsaturated zone.
	6. Pneumatic and hydraulic fracturing	No	Enhancement technology for increasing soil permeability but is not applicable to this site.
	7. Photolysis	No	Limited to surface soils; not applicable to metals contaminants.
	8. Electroacoustic separation	No	Emerging technology that removes inorganic contaminants from clayey soils. Application has not yet been commercially demonstrated and significant bench- and pilot-scale tests would be required.
	9. Electrokinetics	No	Innovative technology that removes inorganics and some organics through electroosmosis and ion migration. Application has not been demonstrated extensively; significant bench- and pilot-scale tests would be required.
Removal	A. Excavation	Yes	May be easiest removal mechanism to implement for contaminated soils.
	1. Unsaturated soils	Yes	Can easily be accomplished using standard mechanical equipment (e.g., backhoe, trackhoe).
	2. Saturated soils	Yes	More difficult to accomplish due to need for dewatering, shoring of excavation, etc.

SUMMARY OF REMEDIAL TECHNOLOGIES FOR SOURCE CONTROL

United Plating Site

GENERAL RESPONSE ACTION	TECHNOLOGY TYPE/PROCESS OPTION	APPLICABILITY TO SITE	SCREENING COMMENTS
Ex-situ Treatment	A. Biological	No	Suitable for organics that are easily biodegradable but not suitable for inorganics; metals present is soils may inhibit biodegradation.
	1. Slurry phase biodegradation	No	Not effective in removing metals contaminants.
	2. Solid phase biodegradation	No	Not effective in removing metals contaminants.
	3. Landfarming	No	Requires large areas of land at site for treatment. Metals are not degraded in this process.
	4. Biopiles/composting	No	Same comments as landfarming.
	B. Thermal	No	In general, only organic contaminants are removed. Nonvolatile metals are not removed; volatile metals may be released into the atmosphere. Trivalent chromium may be oxidized to the more toxic hexavalent chromium.
	1. Low-temperature thermal desorption	No	Not effective for desorption of all metal constituents.
	2. High-temperature thermal desorption	No	Not effective for desorption of all metal constituents.
	3. Vitrification	No	Expensive, energy-intensive process.
	4. Incineration (rotary kiln, fluidized bed, liquid injection, multiple hearth, or infrared)	No	Not effective for metals. May meet with public opposition.
	5. Pyrolysis	No	Volatile organics are converted into non-toxic components, while inorganics form an insoluble solid char residue. Innovative technology that has not been commercially demonstrated.
	6. Molten salt/plasma arc	No	Innovative technology; application to hazardous waste sites has not been commercially demonstrated.
	C. Physical/Chemical	Yes	Effective for removal/immobilization of metals, organics.
	1. Solidification/stabilization	Yes	Same comments as in-situ solidification/stabilization. May be easier to accomplish than in-situ S/S given the highly compacted nature of the silty soils on site. High levels of organics may cause interference.
	a. Cement-based	Yes	Same as in-situ.
	b. Silicate-based	Yes	Same as in-situ.
	c. Organic polymer-based	No	Same as in-situ.
	d. Thermoplastic	No	Same as in-situ.
	e. Surface microencapsulation	No	Same as in-situ.
	f. Sorbents, lime, chemical additives	Maybe	Same as in-situ.

SUMMARY OF REMEDIAL TECHNOLOGIES FOR SOURCE CONTROL

United Plating Site

GENERAL RESPONSE ACTION	TECHNOLOGY TYPE/PROCESS OPTION	APPLICABILITY TO SITE	SCREENING COMMENTS
Ex-situ Treatment (Continued)	2. Soil washing	No	Space limitations on site prohibit use. Residues may require further treatment and ultimate disposal. Mobile units are available. May be difficult to find washing solution to remove all identified compounds.
	3. Dehalogenation (glycolate/base-catalyzed)	No	Only effective on halogenated organics; not effective for removal of inorganics, metals, and aliphatics.
	4. X-ray treatment	No	Emerging technology that only applies to organic contaminants.
	5. Photolysis/UV treatment	No	Limited to surface soils; not applicable to metals contamination.
Disposal	A. Off-site landfill	Yes	Hazardous wastes exceeding LDR levels require treatment to numeric treatment standards prior to disposal. Nonhazardous wastes can be landfilled.
	B. On-site landfill	Maybe	Excavated wastes will likely require treatment prior to landfilling to meet remedial action objectives. Soils that are solidified and stabilized may be landfilled on-site.
	C. Off-site treatment, storage, and disposal facility	Yes	Excavated wastes may be transported to a permitted TSDF for treatment (i.e., thermal, physical, chemical, etc.) and disposal.
	D. Waste pile	No	Wastes could not merely be collected and stored; they would require treatment. Does not achieve ultimate disposal goals of SARA. Appropriate only for temporary storage.
	E. Temporary storage (drums /roll-off containers)	Yes	May be necessary depending on treatment/disposal options.

SUMMARY OF REMEDIAL TECHNOLOGIES FOR GROUNDWATER RESPONSE

United Plating Site

GENERAL RESPONSE ACTION	TECHNOLOGY TYPE/PROCESS OPTION	APPLICABILITY TO SITE	SCREENING COMMENTS
No Action	None	Yes	Required by NCP.
Institutional Measures	Deed and Development Restrictions	Yes	See Source Controls for discussion.
	Groundwater Use Restrictions	Yes	Effective in preventing use of contaminated groundwater for potable or process source water.
Containment	A. Capping or surface sealing	Yes	See Source Controls for discussion.
	B. Barriers	Yes	Prevents clean upgradient groundwater from entering site and becoming contaminated. Must be tied into underlying low permeability formation. Must be combined with surface cap to prevent infiltration of stormwater.
	1. Location		
	a. Downgradient	Yes	Barrier must surround contamination zone to be effective and be keyed into low permeability formation.
	b. Upgradient	Yes	Barrier must surround contamination zone to be effective and be keyed into low permeability formation.
	c. Horizontal or diagonal (bottom sealing)	No	Unnecessary since a low permeability formation exists at the site (bedrock).
	2. Material/Construction		
	a. Soil/bentonite slurry wall	Yes	Most common type of slurry wall constructed at hazardous waste sites. Must be keyed into bedrock. Soil at site may not be conducive to creating soil/bentonite solidified backfill due to its high silt content.
	b. Cement/bentonite	Yes	Stronger than soil/bentonite slurry wall but may be more permeable.
	c. Grout curtains	No	Grout can be mixed to set up very quickly but is more expensive. Grout is subject to chemical attack.

SUMMARY OF REMEDIAL TECHNOLOGIES FOR GROUNDWATER RESPONSE

United Plating Site

GENERAL RESPONSE ACTION	TECHNOLOGY TYPE/PROCESS OPTION	APPLICABILITY TO SITE	SCREENING COMMENTS
Containment (Continued)	d. Sheet piling	No	May be difficult to install due to compactness of soil; not generally used as a long-term remedial technology.
	e. Synthetic membrane	No	Space limitation on site prohibits use. Direct contact with certain wastes may be prohibited depending on nature of membrane and characteristics of wastes.
	f. Vibration beam	No	May be difficult to install due to compactness of soil. Space limitation on site prohibits use.
	g. Compacted Clay	No	Not practical in poorly compacted saturated soils.
Collection	A. Groundwater pumping	Yes	Used in conjunction with other remedial actions to lower groundwater table and/or to extract contaminated groundwater for treatment and disposal.
	1. Function		
	a. Extraction	Yes	Effective groundwater and contaminant plume control mechanism however slow recharge of wells could make use difficult. This technology is dependent on aquifer characteristics and plume dimensions. Moderate aquifer transmissivities are desirable.
	b. Injection	No	Would not be effective at site due to the presence of low permeability soils.
	2. System Options		
	a. Well points or shallow wells	Yes	Use of wells as an extraction technique may be difficult due to slow well recharge. Dependent on depth to which groundwater level must be lowered.
	b. Deep wells	No	Focus of investigation is on shallow groundwater.
	c. Pulsed pumping	Maybe	Innovative technology that encourages diffusion of contaminants from stagnation zones into capture zones while reducing the volume of recovered groundwater. Additional study of this technology is necessary to determine its suitability is necessary.
	B. Subsurface collection system	Yes	Effective groundwater/runoff collection mechanism. Should be designed to enhance capture and avoid escape of contaminants around the collection systems.
	1. French drains	Yes	Effective groundwater capture mechanism where the amount of water to be drained is small and flow velocities are low.

SUMMARY OF REMEDIAL TECHNOLOGIES FOR GROUNDWATER RESPONSE

United Plating Site

GENERAL RESPONSE ACTION	TECHNOLOGY TYPE/PROCESS OPTION	APPLICABILITY TO SITE	SCREENING COMMENTS
Collection (Continued)	2. Trenches	Yes	Suitable for shallow groundwater contamination when tied into a low permeability substrate or otherwise lined to prevent reinfiltration. Disposal of excavated soil must be addressed.
	3. Pipe drains	Yes	Manageable option for shallow groundwater removal.
	4. Sedimentation basins	No	On-site space limitations and slow recharge would prohibit use.
	5. Vertical wells	Yes	Common type of system for groundwater extraction.
	6. Horizontal wells	No	Horizontal drilling is a means of installing a localized subsurface drain in unconsolidated material.
	7. Funnel and gate systems	Yes	Combination of barriers and passive treatment walls. May be difficult to find appropriate media to treat site contaminants in-situ.
In-situ Treatment	A. Biological	Maybe	Suitable for organics that are easily biodegradable.
	1. Biodegradation (aerobic or anaerobic)	Maybe	High concentrations of heavy metals, highly chlorinated organics, long chain hydrocarbons, or inorganic salts in groundwater are likely to be toxic to microorganisms.
	2. Nitrate enhancement	No	Has been demonstrated effective only on gasoline constituents to date; not expected to be effective for metals.
	3. Oxygen enhancement w/peroxide	Maybe	Usually used in conjunction with bioslurping or pump and treat systems to enhance the rate of biodegradation of organic contaminants by naturally occurring microbes.
	B. Thermal	No	Suitable for organic compounds only.
	1. Hot water or steam heating enhancement	No	Enhancement technique for vaporization of organic compounds only.
	C. Physical/chemical	No	Technology that may be difficult to implement due to geologic and hydrogeologic conditions.
	1. Passive treatment walls	No	Innovative technology for the removal of contaminants in subsurface permeable walls. Saturation of bed materials, plugging with precipitates, and short life of treatment materials make technology suitable primarily for temporary remediation.
	2. Free product recovery	No	Presence of free product phase has not been detected at site.

SUMMARY OF REMEDIAL TECHNOLOGIES FOR GROUNDWATER RESPONSE

United Plating Site

GENERAL RESPONSE ACTION	TECHNOLOGY TYPE/PROCESS OPTION	APPLICABILITY TO SITE	SCREENING COMMENTS
In-situ Treatment (Continued)	3. Hydraulic or pneumatic fracturing	No	Used to increase permeability of subsurface environment for subsequent in-situ treatment or groundwater extraction, especially for volatile organic contamination. Usually applied to low permeability formations, such as clays, tills, and bedrock.
	4. Air sparging	No	May be effective for volatilizing contaminants from aquifer through injection of air into subsurface. Generally implemented in conjunction with SVE to collect volatilized contaminants. No proven effectiveness for removal of metal constituents.
	5. Surfactants	No	Enhancement technology for increasing mobility and solubility of organic contaminants to improve pump and treat performance. Not widely applied to hazardous waste sites to date.
	6. Cosolvents	No	Enhancement technology for increasing mobility and solubility of organic contaminants to improve pump and treat performance. Not widely applied to hazardous waste sites to date.
	7. Electrokinetics	No	Innovative technology that removes inorganics and some organics through electroosmosis and ion migration. Application has not been demonstrated extensively; significant bench- and pilot-scale tests would be required.
	8. Dual phase extraction/bioslurping	No	May be effective for volatilizing contaminants from aquifer and capturing contaminants in an SVE system. No proven effectiveness for removal of metal constituents.
Ex-situ Treatment	A. Biological	No	Generally applicable to removal of biodegradable organics only. Bioabsorption may remove metals and biooxidation may be effective for cyanide removal. Heavy metals may inhibit biological treatment.
	1. Aerobic bioreactor (trickling filter, rotating biological contactor, activated sludge)	No	Generally applicable for removal of biodegradable organics only.
	2. Anaerobic bioreactor	No	Generally applicable for removal of biodegradable halogenated hydrocarbons only.

SUMMARY OF REMEDIAL TECHNOLOGIES FOR GROUNDWATER RESPONSE

United Plating Site

GENERAL RESPONSE ACTION	TECHNOLOGY TYPE/PROCESS OPTION	APPLICABILITY TO SITE	SCREENING COMMENTS
Ex-Situ Treatment (Continued)	B. Thermal	No	In general, only organic contaminants are removed. Nonvolatile metals are not removed; volatile metals may be released into the atmosphere. Trivalent chromium may be oxidized to the more toxic hexavalent chromium.
	1. Incineration (rotary kiln, fluidized bed, liquid injection, or infrared)	No	Not effective for metals or inorganics.
	2. Wet-air oxidation	No	Generally used as an alternative to biological treatment of organics in liquid wastes or sludges. Soluble metals will remain in effluent. Effective for removal of cyanide contaminants.
	3. Molten salt/plasma arc	No	Innovative technology that has not been commercially demonstrated at hazardous waste sites.
	C. Physical	Yes	May be used in conjunction with other processes as determined by waste characterization and treatability studies.
	1. Equalization	Yes	Effective when combined with other treatment technologies.
	2. Sedimentation	No	Effective on particulate-phase contaminants only; would require relatively large area at site.
	3. Carbon adsorption	Yes	Applicable for effluent polishing. May be effective in removing metals (through filtration) as well as organics (through adsorption).
	4. Ion exchange	Maybe	Effective but expensive process for removing metals. Generally effective for removal of inorganic contaminants only.
	5. Reverse osmosis	No	Expensive process in comparison with other treatment technologies. Membrane subject to chemical attack, fouling, and plugging.
	6. Liquid-liquid extraction	No	Expensive process in comparison with other technologies.
	7. Oil-water separation	No	Effective for removal of free product from waste streams; presence of free product has not been detected at site.
	8. Steam distillation	No	Effective but expensive process.
	9. Fabric or bag filters	No	Filter fabric subject to chemical attack, fouling, and plugging.
	10. Air stripping	Yes	Effective for removal of volatile organics that is commonly applied at hazardous waste sites.
	11 Steam stripping	No	Ineffective in removing metal contaminants.
	12. Dissolved air flotation	No	Effective for the removal of metals or organics associated with the particulate phase only.

SUMMARY OF REMEDIAL TECHNOLOGIES FOR GROUNDWATER RESPONSE

United Plating Site

GENERAL RESPONSE ACTION	TECHNOLOGY TYPE/PROCESS OPTION	APPLICABILITY TO SITE	SCREENING COMMENTS
Ex-Situ Treatment (Continued)	13. Adsorptive filtration	No	Effective for the removal of organics in a conventional activated sludge treatment system. Removal of some inorganics is possible.
	14. Ultrafiltration	No	Effective for the removal of dissolved metals. Other inorganics or organics present as suspended or colloidal solids may also be removed.
	15. Sorptive resins	Maybe	Effective but expensive process relative to other technologies.
	16. X-ray	No	Emerging technology breaks down organic contaminants to nontoxic compounds. Commercial demonstration of this technology has not been performed.
	D. Chemical	Yes	May be used in conjunction with other process as determined by waste characterization and treatability studies.
	1. Precipitation	Yes	Effective for removal of heavy metals but not organics.
	2. Flocculation/coagulation	Yes	Effective for the removal of metals and other settleable solids. May be effective for removal of some organic particulates. Pretreatment is required to reduce hexavalent chromium to trivalent chromium.
	a. Chemical additives	Yes	May be effective for removal of both organic/inorganic particulates.
	b. Alternating current electrocoagulation	No	Not a proven technology used at hazardous waste sites.
	3. Oxidation	Maybe	May effectively remove halogenated volatiles from wastewaters when combined with other processes. Incomplete oxidation may result in presence of more toxic constituents (e.g., vinyl chloride).
	a. Hydrogen peroxide	Maybe	Effective only for the removal of organics.
	b. Chlorine dioxide	Maybe	Treats only cyanide; does not remove metals or organics.
	b. Catalytic/photocatalytic oxidation	Maybe	May be more applicable to removal of organics. May oxidize trivalent chromium to the more toxic hexavalent chromium.
	4 Reduction (sulfur dioxide, sodium bisulfite, sodium metabisulfite, or sodium hydrosulfite)	Maybe	May be effective for removal of halogenated volatiles from wastewaters when combined with other processes. Incomplete oxidation may result in presence of more toxic constituents (e.g., vinyl chloride).
	5. Neutralization	Maybe	Not effective for removing contaminants but may be necessary as pretreatment for other processes.
	6. Chlorination	Maybe	Treats only cyanide but not effective for metals or organics.
	7. UV oxidation/ozonation	Maybe	May be effective in removing metals, cyanide, and organics in conjunction with other processes.

SUMMARY OF REMEDIAL TECHNOLOGIES FOR GROUNDWATER RESPONSE

United Plating Site

GENERAL RESPONSE ACTION	TECHNOLOGY TYPE/PROCESS OPTION	APPLICABILITY TO SITE	SCREENING COMMENTS
Disposal	A. Off-site treatment and/or disposal	Yes	Contaminated wastes exceeding LDR levels require treatment to numeric treatment standards prior to disposal.
	1. Publicly owned treatment works (POTW)	Yes	Contaminated groundwater will likely require pretreatment to POTW standards before being accepted.
	2. Surface water body via stormwater collectio	Yes	Contaminated groundwater will require pretreatment to satisfy the surface water standards prior to discharge to a stormwater collection system.
	3. TSDF	Yes	Pumped groundwater may be transported to a permitted TSDF for treatment and disposal. Not cost-effective for large volumes of contaminated water.
	B. On-site Discharge	No	Slow recharge precludes use at site.
	1. Well injection or deep well injection	No	Slow recharge precludes use at site.
	2. Seepage basin	No	Requires a very large area and would be restricted by available space at site.
	3. Surface impoundment	No	Liquid wastes could not merely be collected and stored; would require treatment. Does not achieve ultimate disposal goals of SARA. Would require large area that is not available at site.
	C. Temporary storage	Yes	May be necessary depending on treatment/disposal options.

TABLE 3-3

SUMMARY OF REMEDIAL TECHNOLOGIES FOR AIR CONTROLS

United Plating Site

GENERAL RESPONSE ACTION	TECHNOLOGY TYPE/PROCESS OPTION	APPLICABILITY TO SITE	SCREENING COMMENTS
No Action	None	Yes	The emissions generated from a treatment process may be below standards in which case no air treatment is required.
Institutional Measures	(See Source Controls for options)	Yes	Can prevent human contact with contaminants through restrictions on site uses.
Containment	A. Dust/particulate control measures	Yes	May be effective for controlling exposure to particulate-borne contaminants during remedial activities. Not intended for long-term controls.
	1. Water spraying	Yes	None.
	2. Wind fences/screens	Yes	May be effective in preventing dust migration from active work areas to other site areas.
	3. Synthetic dust covers	Yes	Used for preventing generation of airborne particulates form waste piles.
	B. Capping or surface sealing (see Source Controls for specific process options)	No	Dust control may be one benefit of capping. Capping specifically for gas control is neither necessary nor cost-effective.
	C. Vertical barriers (see Groundwater Controls) for specific process options)	No	Not necessary for gas control alone but will be a secondary benefit if barriers are used for other remedial objectives.
Collection	A. Dust collection - sweeping/vacuuming	Yes	Effective in removing dust from paved areas; not effective in active work areas.
	B. Gas collection	Maybe	May apply if substantial organics are generated from other processes.
Treatment	A. Activated carbon	Maybe	For off-gas treatment from other processes only. Not for direct site control. Metals will not be removed.
	B. Flares	Maybe	Process option selection depends on contaminants in off-gases.
	C. Afterburners	Maybe	Process option selection depends on contaminants in off-gases.

environmental matrix) and by general response action. Treatment technologies were identified for the soil, groundwater, and air media.

The initial screening of the technology types and process options is discussed below. This screening was based on the criteria of effectiveness for treating the contaminated media present at the site, implementability given site-specific constraints, and relative cost. The primary COCs at the site have been identified as cadmium, chromium, lead, and TCE in soil and chromium, cyanide, TCE, and 1,1,1-TCA in groundwater. The results of the RI field activities indicated that other organic and inorganic contaminants may also be of concern in limited areas of the site. Thus, the soil treatment technologies were screened for their effectiveness in reducing the toxicity of metal contaminants, while the groundwater treatment technologies were screened for their effectiveness in reducing the toxicity of inorganic and chlorinated organic contaminants.

In Tables 3-1 through 3-3, the technologies that are appropriate for treating the medium-specific contaminants were designated as "Yes" for their applicability to the site. As there are fewer technologies available that remove and/or destroy metals contaminants, especially in soil, a technology that applied only to VOCs and could not be easily incorporated in a treatment train was screened out (i.e., designated as "No"). A technology for which there is a site-specific constraint that would prohibit implementation was screened out of the analysis (i.e., designated as "No"). Some technologies were defined as "Maybe" for their applicability to the site in the absence of additional site-specific information at the time the technologies were screened. A number of innovative treatment technologies were evaluated and the most promising were retained as "maybe." Innovative technologies are alternative treatment technologies for which routine use at hazardous waste sites is inhibited by lack of data on performance and cost. In general, a treatment technology is considered innovative if it has had limited full-scale application.

Treatability studies and/or site demonstrations may be necessary to determine whether some technologies can be used at the UP site. Some emerging technologies were also identified; these are defined as technologies that are proven on the conceptual and bench-scale level but have not been demonstrated in the field. As these emerging technologies are still under development, they were screened out of the analysis.

3.3.1 **Source Controls**

Areas at the site were identified in the RI report in which surface and subsurface soils are contaminated. A limited area of lead-contaminated soil was identified between Foster Avenue and the UP building. Contaminated subsurface soils, containing TCE, cadmium, and chromium, were identified mainly beneath the UP building. Although there is no human exposure pathway for these contaminants, the source area could continue to leach contaminants to the underlying groundwater. Additional sampling may be required during the remedial design phase to further delineate the extent of subsurface soil contamination.

The surface and subsurface soils identified above are collectively referred to in this report as the "source area." Control measures for the contaminated soils are discussed below. General response actions as source controls include institutional measures, containment, in situ treatment, removal, on-site treatment, off-site treatment, and disposal.

3.3.1.1 ***Institutional Measures.*** Institutional measures applicable to the site include deed and development restrictions. Deed and development restrictions are intended to prevent human contact with contaminated media through restrictions on site uses. Deed restrictions limit or prohibit certain uses or development of the site in the event of a property transfer and serve to notify prospective owners of the existence of remaining contamination at the site. Development restrictions serve similar purposes to those of deed restrictions but apply to any new construction initiated by the current property owners. Institutional measures are retained for further evaluation.

3.3.1.2 ***Containment.*** The in-place containment of contaminated soils may be accomplished through capping or surface sealing. A variety of capping materials are available, including synthetic membranes, clay, asphalt, concrete, and chemical additives and stabilizers. Synthetic membranes are effective capping materials made of polyvinyl chloride (PVC), chlorinated polyethylene (CPE), or synthetic rubbers. Because a smooth subbase is required for the installation of synthetic membranes, synthetic membranes are best used as part of a multilayer cap, as discussed below. Clay may form an effective cap; however, natural clay soils may shrink or crack due to repeated freezing and thawing of the ground. A clay cap may be installed below the frost line to be more effective. Asphalt and concrete are appropriate single-layer capping materials for potential use at the site, particularly if used as a drainage system. Maintenance of the asphalt/concrete areas will be required to ensure the integrity of the cap. Chemical additives or stabilizers such as cement, lime, or fly ash may be mixed with surface soils to form a low-permeability cap. They may have the advantage of immobilizing metals present in the soils used to form the cap; however, a chemical additive cap does not have the same degree of permanence as other capping options. A typical multilayer cap design consists of a clay layer overlain by a synthetic membrane. A sand drainage layer is placed on top of the synthetic layer to collect runoff water. The drainage layer is protected by a topsoil and vegetative layers to prevent erosion. A cap approved under the RCRA is a type of multilayer cap. Capping is a viable alternative for source control and is, therefore, retained in the screening evaluation.

3.3.1.3 ***In Situ Treatment.*** In situ soil treatment technologies potentially applicable to this site include biological, thermal, and physical/chemical treatment processes. Many of these processes are innovative technologies, with limited commercial demonstration at hazardous waste sites; therefore, their applicability to the site and feasibility may require further evaluation in a treatability or pilot-scale study.

Biological Treatment. Biological treatment technologies include biodegradation, bioventing, and phytoremediation. Biodegradation is a process in which indigenous or inoculated microorganisms (i.e., fungi, bacteria, and other microbes) degrade (metabolize) organic contaminants in soil or groundwater. In the presence of sufficient oxygen (aerobic conditions), microorganisms will ultimately convert many organic contaminants to carbon dioxide, water, and microbial cell mass. In the absence of oxygen (anaerobic conditions), the contaminants will be ultimately metabolized to methane, a limited amount of carbon dioxide, and trace amounts of hydrogen gas. The in situ bioremediation of soil typically involves the percolation or injection of groundwater or uncontaminated water mixed with nutrients and saturated with dissolved oxygen. Biological treatment technologies do not appear to be appropriate for application on site soils because they have not been proven to reduce metal concentrations. Additionally, the metals present in the soils may tend to inhibit the biodegradation process.

Bioventing is a process that enhances biodegradation in soil by providing oxygen to existing soil microorganisms by supplying a low air flow to the soil. Oxygen is most commonly supplied through direct air injection into residual contamination in soil. This technology has been proven to remove petroleum hydrocarbons, nonchlorinated solvents, and other organic chemicals but has not been demonstrated to reduce metals concentrations.

Phytoremediaion involves the cultivation of specialized plants that are capable of taking up specific soil contaminants into their roots or foliage. This technology is considered to be innovative and is not expected to be effective on reducing metal and VOC concentrations in subsurface soils.

Thermal Treatment. Thermal treatment processes for soil decontamination include vitrification and radiofrequency/electrical resistance heating. In situ vitrification (ISV) uses an electric current to melt soil at extremely high temperatures (1600 to 2000°C), thereby immobilizing most inorganics and destroying organic pollutants by pyrolysis. Inorganic pollutants are incorporated within the vitrified glass and crystalline mass. Water vapor and organic pyrolysis combustion products are captured in a hood, which draws the contaminants into an off-gas treatment system. Vitrification results in significant subsidence of the treated soils and would preclude future construction in or near treated areas. In addition, this technology is primarily applied to unsaturated zone soils as treatment of saturated soils requires substantially increased energy inputs to vaporize any water present prior to vitrification of the soils. Radiofrequency or microwave heating generates superheated steam from the groundwater to vaporize organic constituents present in the unsaturated zone. Radiofrequency and microwave heating are generally used in conjunction with an extraction technology, such as soil vapor extraction. The subsurface soils are predominantly contaminated with metals, therefore, this technology is not appropriate for use at the site.

Physical/Chemical Treatment. A wide variety of physical/chemical treatment technologies are available for application to in situ soils, including solidification/stabilization (S/S), soil flushing, chemical degradation/detoxification, dilution, soil vapor extraction (SVE), pneumatic and hydraulic fracturing, photolysis, electroacoustic separation, and electrokinetics. S/S is one of the most common technologies for treatment of heavy metals in soils and may be used to prevent leaching of contaminants into the groundwater (EPA 1995). S/S is the in-place mixing of soils with chemical reagents to immobilize contaminants in the treated soils. In situ S/S techniques use auger/caisson systems and injector head systems to inject stabilization reagents to soils. Complete mixing of the soils and reagents is required for immobilization of the contaminants present, which may be difficult in situ. The target contaminant group for this technology is inorganics; however, S/S has been applied successfully to soil containing low levels of VOCs. In situ S/S process options that may be applicable include sorption/complexing, ion exchange, precipitation, and cement/chemical grout. Sorption/complexing involves mixing the soils with the adsorption/complexing agent at a neutral pH. Ion exchange requires mixing the soils with clays, resins, or xeolites with high ion exchange capacities and is effective for immobilization of cationic or anionic contaminants only. Precipitation is primarily used for the treatment of heavy metals; maintenance of optimum pH is important in this process. Cement and chemical grout are very effective in immobilizing contaminants; however, the overall volume of waste will be increased and the cement may be subject to long-term leaching.

In situ soil flushing is the extraction of contaminants from in-place soil by introducing a flushing fluid to dissolve adsorbed contaminants using an injection or infiltration process. The flushing solution must be recaptured and appropriately treated, recycled, and/or disposed of. At the UP site, it may be difficult to apply the flushing solution uniformly and then recapture it due to the hydrogeologic conditions at the site. Water may be used for the removal of soluble organics and some inorganics, while surfactants are effective for the removal of sorbed organics only. Chelating agents may be used to enhance the removal of heavy metals. Acids, particularly hydrochloric acid, are the effective flushing solution for the removal of heavy metals; however, they may have an adverse effect on any barrier materials present and will convert cyanide to its toxic, gaseous state. The use of chemicals to enhance contaminant destruction or recovery should be assessed in the remedial design phase. For this analysis, soil flushing is eliminated from further consideration due to the concerns discussed above.

Some soil contaminants may be degraded through the introduction of detoxification agents (e.g., hydrogen peroxide, hypochlorites), however, complete reaction may be difficult to ensure due to the silty soils of the site. Dilution involves mixing contaminated soils with clean soils to reduce the overall contaminant concentrations to acceptable levels. This option is generally not acceptable to regulatory agencies.

SVE involves the application of a vacuum to extraction wells installed in the soil, which creates a pressure gradient that induces volatilized contaminants to diffuse through the soils to the extraction wells for removal. The SVE technology has been applied successfully to VOC-contaminated soil but not soil contaminated with metals. SVE may not be effective in the silty soils present on site. Therefore, SVE is not given further consideration. Pneumatic and hydraulic fracturing are enhancement techniques designed to increase the efficiency of other in situ technologies in difficult soil conditions. The use of pneumatic and hydraulic fracturing is not anticipated to be needed in source removal activities.

Photolysis is the destruction of organic contaminants by exposure to light (e.g., sunlight or ultraviolet [UV] light) and is therefore limited to surface soils if applied in situ. Photolysis is not effective in degrading metals contaminants and is not given further consideration.

Electrokinetic remediation is an innovative technology that is conducted using direct currents across electrodes. The contaminants are either deposited at the electrode or removed from the conditioning fluid that circulates at the electrodes by a purification process. Bench-scale tests have shown removal of several inorganics, including cadmium, chromium, lead, and organic compounds (including TCE). The technology has been found to work particularly well with low-permeability soils, as are present in subsurface soils at the UP site. This technology was retained for review and evaluation as an innovative technology. Electroacoustic separation employs the electrokinetic remediation technology with the added feature of an acoustic source, which is used to generate acoustic waves to increase the leaching rate of contaminants. Based on preliminary tests, this process was found to be effective in removing inorganic contaminants from low-permeability soils but its limited application at hazardous waste sites precludes its use at the UP site.

3.3.1.4 ***Excavation.*** Excavation may be the most cost-effective method of removing soil contaminants, especially in removing contaminants from surface soils. The contaminants are permanently removed from the site, although appropriate treatment and/or disposal of the excavated materials is required. Soils may be readily removed using conventional earthmoving equipment, while excavation of subsurface soils below the water table will require the use of appropriate dewatering methods (i.e., use of sheet piling and/or groundwater pumping). Excavation is retained for further evaluation.

3.3.1.5 ***On-Site Treatment.*** On-site soil treatment technologies apply to excavated soils and are performed ex situ, or at the surface.

Biological Treatment. Biological treatment options for excavated soils include slurry and solid-phase biodegradation processes and landfarming. Slurry-phase biological treatment involves the controlled treatment of excavated and processed soil in a bioreactor. Soil and nutrient-amended water are combined to form an aqueous-phase slurry of 10 to 40% solids by weight; the solids are kept in suspension and oxygen is supplied to promote the bacterial metabolism of contaminants, primarily organics. Upon completion, the soil slurry is dewatered. In solid-phase bioremediation, the excavated soil is generally mixed with nutrients and placed on a treatment area that includes leachate collection systems and some form of aeration. The landfarming technology involves applying contaminated soils on a lined surface and periodically turning them to aerate the soil. All three bioremediation processes have been demonstrated to remove nonhalogenated volatile organic and hydrocarbon contaminants and have been less effective on halogenated volatile organics and semivolatile organics; bioremediation technologies are not applicable to the removal of metals and are marginally effective on SVOCs and, therefore, were not retained.

Thermal Treatment. The thermal treatment techniques that have the potential to handle on-site soils include low- and high-temperature thermal desorption, vitrification, incineration, and pyrolysis. Thermal desorption is a process that physically separates volatile contaminants from soil by heating the contaminated media. Low-temperature thermal desorption units typically run at temperatures between 200 and 600°F, while high-temperature units run between 600 and 1000°F. Offgases may be burned in an afterburner, condensed to reduce the volume to be disposed of, or captured by carbon adsorption beds. Ex situ vitrification is similar to in situ vitrification except that the contaminated soil is conditioned and blended to promote more uniform treatment. Incineration uses high temperatures (1600 to 2200°F) to volatilize and combust any organic contaminants present. Incineration technologies include rotary kiln, fluidized bed, multiple hearth, pyrolytic, infrared, plasma arc, and molten salt systems. Volatile metals, such as arsenic, cadmium, and lead, may be released to the atmosphere if not removed from the off-gas; nonvolatile metals will remain in the treated materials (i.e. bottom ash). In addition, trivalent chromium may be oxidized to the more toxic hexavalent chromium. These thermal treatment technologies do not degrade metal contaminants and are not cost effective to use in a treatment train.

Physical/Chemical Treatment. Physical or chemical treatment technologies for excavated soils include S/S, soil washing, dehalogenation, X-ray treatment, and photolysis (including treatment using UV light). S/S is generally applied to immobilize inorganic contaminants but may be effective in immobilizing low-level VOC contaminants. S/S could be applied as an ex situ or in situ technology at the UP site. Discussion with an experienced remedial contractor indicated that ex situ S/S would likely be more economical given the silty and inhomogeneous nature of the fill layer at the UP site. Ex situ S/S is retained for further evaluation.

In soil washing, contaminants sorbed onto soil particles are separated from the soils using a washing fluid. Space limitations at the UP site preclude the use of soil washing as a feasible technology. Dehalogenation and X-ray treatments also require large amount of space for soil stockpiling, which the UP site does not have. These technologies are eliminated from further consideration.

3.3.1.6 ***Disposal.*** Disposal options for soils excavated from the UP site include disposal to an off- or on-site landfill; a treatment, storage, and disposal facility (TSDF); or a waste pile. Land disposal and/or temporary storage of contaminated materials, partially treated materials, and fully treated materials may take place on- or off-site, depending on the nature of the material and degree of prior treatment. Although on-site landfilling is given the lowest priority in terms of the site's objectives (especially, if an alternative disposal option exists), it may be necessary for some soils if other cost-effective disposal options are not available.

Untreated excavated wastes may be transported to an approved waste handling facility or TSDF based on TCLP results. Treatment of hazardous waste performed by TSDFs could include stabilization, incineration, or dechlorination. The ash, residue, or stabilized product generated from treatment may then be disposed of in a secure landfill depending on the chemical and leaching characteristics of the waste. The contaminated soils would not be suitable for land application either on- or off-site except as fill, however, the wastes would need to be treated to meet all applicable requirements prior to land placement. As waste piles are not an acceptable disposal option, appropriately constructed piles (i.e., lined, covered, and bermed) may be necessary for temporary storage of waste prior to treatment or off-site transport. Storage options, such as drums, roll-off containers, or trucks, may also be used for temporary storage at the site.

3.3.2 **Groundwater Response.**

In the RI report, several contaminants were identified in the shallow groundwater that were present at levels above the New York State water quality standards. The groundwater was found to be contaminated with several inorganic and organic contaminants. The indicator compounds that were selected to represent the contaminants in the groundwater include TCE, 1,1,1-TCA, chromium, and cyanide. Additional testing would be needed to describe the horizontal and vertical extent of the plume. It is recommended that this testing be conducted in the early stages of the remedial design phase.

Control measures for the contaminated groundwater are discussed in the following subsections. General response actions for source control include institutional measures, containment, collection, in situ treatment, on-site treatment, and disposal.

3.3.2.1 ***Institutional Measures.*** Institutional measures applicable to this site are similar to those identified for source controls. Deed and development restrictions may restrict future actions involving the groundwater medium at the site. Groundwater use restrictions may be applied to prevent future site users from using contaminated groundwater as a potable or process water source. Institutional measures are retained for further consideration in the screening process.

3.3.2.2 ***Containment.*** Capping or surface sealing may be effective at this site to prevent the migration of contaminants from unsaturated soils to saturated zones by preventing surface water infiltration. This technology is effective on soil in unsaturated soils (i.e., contaminated soils above the groundwater table).

Vertical or horizontal barriers are another technology for the containment of contaminated groundwater or prevention of contaminant migration. Their applicability is dependent on site-specific geological conditions. A number of different subsurface barrier options are available for groundwater containment, including barrier placement options and construction materials. Barriers may be placed downgradient from the source area to decrease or prevent the migration of contaminated groundwater to uncontaminated areas, or they may be placed upgradient from the source area to decrease or prevent the flow of uncontaminated groundwater into the source area. The most effective method of barrier wall placement is to surround the contaminant plume completely, thereby isolating the source area. Horizontal barriers may be installed (referred to as "bottom sealing") to form a "floor" beneath the source area; however, this is unnecessary given the relatively shallow depth to bedrock.

Potential materials for construction of groundwater barriers include soil/bentonite, cement/bentonite, grout, sheet piling, synthetic membranes, vibration beams, and compacted clay. A soil/bentonite slurry trench may be constructed at the site and is the most common vertical barrier construction at hazardous waste sites. Clean sandy fill may need to be imported as on-site soils contain high silt levels, which would make soil/bentonite mixing difficult and costly. Cement/bentonite slurry as a barrier construction material is stronger than soil/bentonite but is generally more permeable. Grout curtains are formed by injecting grout into the subsurface in formations known as curtains. Grout curtains require less effort to install than slurry walls and cure more quickly; however, they are more costly and are subject to chemical attack.

Driving sheet piling to form an impermeable barrier may be difficult in the densely compacted till materials present in the source area. Due to the high cost and questionable structural integrity of sheet piles, sheet piling is generally used only for temporary dewatering and not as a permanent treatment solution. A synthetic membrane alone, or in combination with a slurry wall, may be used as a groundwater barrier, but it may deteriorate after direct contact with specific chemicals, depending on the nature of the membrane and characteristics of the waste. The vibrating beam slurry wall construction method is a recent development in which an I-beam is mechanically vibrated lengthwise down through the soil to the desired depth. As the beam is withdrawn, the slurry is injected into the void. This technology would not be easily implemented in the till layers of the site; furthermore, it has not been widely applied at hazardous waste sites. Compacted clay is a potential groundwater barrier material that may be used but would probably not be as effective as some other barrier materials due to its susceptibility to cracking during freeze-thaw periods.

Subsurface barriers may be difficult to construct at the UP site; however, soil/bentonite slurry walls are retained for further evaluation as they would be the most appropriate technology to apply at the UP site from this category. Groundwater barriers are frequently installed in conjunction with a cap. Capping will prevent the infiltration of stormwater, thereby minimizing the flow of uncontaminated groundwater through the source area.

3.3.2.3 ***Collection.*** Groundwater pumping is the most common collection method and may be used to extract contaminated groundwater for subsequent treatment and disposal. It may also be used to lower the water table in specific areas of the site to prevent leaching of contaminants to the groundwater and to reduce and/or reverse the off-site flow of groundwater. Pumping can be instituted alone or in conjunction with other remedial technologies.

Extraction wells can be used for plume containment, groundwater restoration, or both. Application of this technology is dependent on aquifer characteristics and plume dimensions as well as extracted groundwater treatment and disposal options. Moderate aquifer transmissivity is desirable; the relatively low aquifer permeability at the UP site may result in low pumping and recharge rates. Injection wells may be employed alone or in conjunction with extraction wells; however, the shallow depth of the water table may preclude the use of injection wells.

Other groundwater pumping system options include innovative technologies, such as pulsed pumping and contained recovery. Pulsed pumping involves the use of a noncontinuous pumping regime to encourage the diffusion of contaminants from stagnation zones into capture zones while reducing the overall volume of recovered groundwater. Additional study of this technology is necessary to determine its suitability to this site.

Subsurface collection systems are effective groundwater and runoff collection mechanisms and may be useful for controlling the movement of shallow groundwater at the site. This technology acts to centralize groundwater collection by increasing hydraulic conductivity locally within the saturated zone and could be designed to enhance the capture and avoid the escape of contaminants around the collection system. Process options for a subsurface collection system include French drains, interceptor trenches, and pipe drains. French drains would be effective at the site as the groundwater yield and flow velocity are expected to be low. Drainage ditches and trenches may be suitable for the upgradient portion of the site to divert flow; the downgradient areas northwest of the UP building are covered with pavement, making the use of drainage ditches and trenches somewhat difficult. Pipe drains may be used to collect and transport shallow groundwater in developed portions of the site. Horizontal drilling may be used to install the pipe drains without requiring excavation of the overlying soils; this technology is appropriate only in unconsolidated materials. Sedimentation basins are useful for extending the life of a subsurface collection system by collecting contaminant-laden sediments that might clog the system, but construction space at the site may limit the use of such technology. Vertical wells are effective in capturing groundwater when combined with a method of pumping.

3.3.2.4 ***In situ Treatment.*** In situ treatment technologies address treating contaminated groundwater without collecting or treating it. These techniques are most effective where the contaminant plume is well defined, homogeneous, shallow in depth, and small in areal extent. In situ groundwater treatment technologies potentially applicable to this site include biological, thermal, and physical/chemical treatment processes.

Biological Treatment. Enhanced biodegradation exploits the ability of indigenous or introduced bacteria to biodegrade organic compounds under favorable soil conditions by optimizing such factors as oxygen content, pH, and temperature of the groundwater. Inorganic contaminants (e.g., chromium and cyanide compounds) are not consistently degraded by microorganisms and, therefore, are not removed effectively from groundwater. Some chlorinated compounds, such as TCE and 1,1,1-TCA, are biodegraded in the environment, but the process is slow and the degradation products may still be toxic. The in situ technology requires injection of nutrients into the subsurface; recapture of the injection solution may be difficult due to the downward groundwater gradient in the source area and the underlying fractured bedrock. For these reasons, in situ biological treatment was not given further consideration.

Thermal Treatment. In situ thermal treatment processes strive to enhance the recovery of volatile and semivolatile organic contaminants by volatilization. In this process, steam or hot water is forced into an aquifer through injection wells. Vaporized contaminants rise to the unsaturated zone, where they can be removed by vacuum extraction and treated. Thermal treatment techniques are not effective in removing metals contaminants; therefore, this technology was screened from further consideration.

Physical/Chemical Treatment. Physical and chemical in situ treatment technologies potentially applicable to the site include passive treatment walls, funnel and gate methods, free-product recovery, air sparging, surfactant enhancement, cosolvent enhancement, electrokinetics, and bioslurping. Passive treatment walls or beds are an innovative technology for the removal of contaminants from groundwater by subsurface beds (a.k.a., in situ reactors) filled with adsorptive or reactive media (e.g., ion-exchange resins or limestone) through which contaminated groundwater flows. Within the adsorptive or reactive media, contaminants are captured and degrade over time. Disadvantages of this technology may include saturation of bed materials in a relatively short period of time, plugging of the bed with precipitates, and limited space available at the site for construction of the beds. The system also requires consistent control of pH levels to maintain the effectiveness of the treatment wall. Vertical groundwater gradients that may be present in the source area would result in groundwater flow beneath the treatment wall limiting their effectiveness for this site. In addition, if the contaminant plume has migrated off-site, it may be difficult or impossible to construct and install the treatment beds. A funnel and gate system consists of strategically placed in situ barriers that channel groundwater flow into passive treatment walls, thereby reducing the size of the treatment wall required. The "gate" part of this treatment system, i.e., the passive treatment wall, is subject to the same limitations as described above. For the reasons given, passive treatment walls are not considered further.

Free product may be removed from the subsurface through pumping or passive collection techniques (i.e., subsurface trenches); however, free product was not detected at the site during any of the field investigations activities. Hydraulic and pneumatic fracturing are both innovative technologies used to increase the permeability of the subsurface to enhance the effectiveness of other in situ treatment or collection technologies. Fracture technologies available for groundwater treatment are similar to those described for soils in Section 3.3.1.3. The use of these technologies may result in increased migration of contaminants through creation of new contaminant pathways, particularly vertical gradients, which may also adversely impact nearby underground utilities or structures.

Air sparging is an in situ groundwater treatment technology applicable for the removal of VOCs and is applied by forcing compressed air into the subsurface to volatilize the contaminants present. Air emissions generated must be monitored and treated appropriately. This technology is best suited for sites with coarse-grained materials (e.g., sand); the relatively low permeability of the till materials in the source area may inhibit airflow through the subsurface. Air sparging would not be effective in removing metals contaminants from groundwater; therefore, it is not given further consideration in this analysis. Dual-phase extraction is applied by simultaneously removing liquid and gas from low-permeability formations using a vacuum extraction well that is screened in the unsaturated and saturated zones. As the vacuum is applied to the well, soil vapor is extracted and groundwater is entrained by the extracted vapors. Once above grade, the extracted vapors and groundwater are separated and treated. Dual-phase extraction is generally combined with other technologies (e.g., air sparging or bioventing) that are intended to extract VOCs. Dual-phase extraction is not considered further due to its ineffectiveness at reducing metals contamination.

Controlled injection of surfactants or cosolvents into the groundwater is an emerging technology that is used to mobilize or dissolve contaminants. The surfactant and cosolvent flushing methods are used in conjunction with a conventional groundwater pump-and-treat system to increase the removal rate of nonaqueous-phase liquids (NAPL) by increasing the apparent solubility of the contaminant and reducing interfacial tension between the water and the NAPL. The use of surfactants and cosolvents at hazardous waste sites has not been fully demonstrated; furthermore, there is the potential for an undesirable condition to develop, such as the degradation of contaminants into more toxic compounds or a plume that is uncontrollable. In addition, the injected chemicals may not be recoverable because of the site's hydrogeological conditions.

Electrokinetic remediation is an innovative treatment technology that separates and extracts heavy metals and some organic contaminants from saturated soils by applying a low-intensity direct current on either side of a contaminated area. The electrical current causes electroosmosis and ion migration, which move the aqueous phase contaminants in the subsurface from one electrode to the other. The contaminants may then be extracted to a recovery system or deposited at the electrode. The electrokinetic remediation process has had limited commercial application at hazardous waste sites and is, therefore, eliminated from the technology review process.

3.3.2.5 ***On-Site Treatment.*** A wide variety of technologies are available for the treatment of collected groundwater when it is brought up to the surface, including biological, thermal, physical, and chemical methods. The choice of an appropriate treatment technology is dependent on the nature and concentration of the contaminants present as well as the relative cost and effectiveness of each of the technologies. The presence of more than one type of contaminant in the water stream may require the use of more than one process option in a treatment train. A brief discussion of the available process options for treating collected groundwater within each of the four treatment technology categories is presented below.

Biological Treatment. Biological treatment technologies that may be applicable to collected groundwater include treatment in an aerobic and anaerobic reactor. Examples of aerobic reactors include activated sludge, trickling filters, and rotating biological contactors. These technologies are generally applicable for the removal of organic constituents (VOCs and SVOCs) only; the presence of heavy metals may inhibit biological treatment. Metals may be metabolized to a limited extent by bioadsorption onto organic matter, while cyanide may be removed by biooxidation. Activated sludge or trickling filters may be used in conjunction with other treatment processes for the removal of metals. The applicability of these processes to treating collected groundwater needs to be determined in a treatability study. Rotating biological contactors can handle relatively low-strength wastes as compared to the activated sludge and trickling filter processes, while anaerobic filters are generally used for pretreatment of strong wastes. Because biological treatment has limited effectiveness on metal contaminants, it has been eliminated from the analysis.

Thermal Treatment. Thermal treatment technologies may be effective for the removal of organic constituents from collected groundwater. Nonvolatile metals will not be volatilized. Appropriate treatment of air emissions is required to remove any volatilized constituents prior to their release into the atmosphere. Thermal treatment units that have the potential to handle liquids include incinerators (e.g., rotary kiln, fluidized or circulating bed, liquid injection, or infrared), wet air oxidation, and molten salt/plasma arc units. Wet-air oxidation and molten glass/plasma arc are both innovative treatment technologies that have not yet been commercially demonstrated at hazardous waste sites; therefore, their reliability and effectiveness are unknown. Incineration is an energy-intensive process and is not generally effective for liquid streams with parts per million (ppm) contaminant concentrations. Administrative difficulties, including air emissions permitting requirements and potential public opposition, may make thermal treatment less likely to be implementable than other comparable treatment technologies. Thermal treatment processes were screened from the evaluation.

Physical Treatment. Numerous physical treatment processes are available for removing inorganic and organic constituents from collected groundwater. Flow equalization (i.e., mixing of wastestreams of different strengths), sedimentation, and filtration are commonly applied technologies for reducing contaminant concentrations. Sedimentation is a technology that requires a relatively large amount of space as compared to other particulate removal technologies. Activated carbon is also a commonly used treatment process for removing organics (through adsorption) and metals (through filtration). Activated carbon adsorption is also used as an effluent polishing step.

Ion exchange, reverse osmosis, sorptive resins, and steam distillation are costly but effective processes for the removal of metals and other contaminants. Reverse osmosis membranes may be subject to chemical attack, fouling, and plugging. The use of the liquid-liquid extraction technique is not appropriate for use at this site because it is considerably more expensive than other equally suitable methods. Oil-water separation is used if the wastewater stream contains NAPLs, but the use of this technology is not appropriate at the UP site. Air and steam stripping are used for the removal of VOCs from a liquid stream but are ineffective in removing inorganic chemicals. Air stripping is retained as a VOC-removal technology in case a treatment train is needed to remove contaminants from the groundwater medium. Air stripping is a commonly applied technology at hazardous waste sites containing VOCs in the water phase.

Dissolved air flotation is effective for the removal of metals and organics associated with the particulate phase only. Adsorptive filtration is an innovative technology for the removal of certain metals from wastestreams and has not yet been applied extensively at hazardous waste sites. Likewise, X-ray treatment has been introduced as an innovative technology for the removal of organic contaminants but has not had widespread demonstration. Dissolved metals may be removed by ultrafiltration; other inorganics or organics present as suspended or colloidal solids may also be removed, depending on the size of the particle (larger particles are more readily removed).

Of the physical treatment technologies, equalization, air stripping, ion exchange, and sorptive resins have been retained from this category for further evaluation.

Chemical Treatment. Chemical treatment technologies that may be applicable at the site in conjunction with other processes include precipitation, flocculation/coagulation, hydrogen peroxide or chlorine dioxide oxidation, reduction, neutralization, chlorination, UV light oxidation/ozonation. Both precipitation and flocculation/coagulation have proved effective for the removal of heavy metals. Any hexavalent chromium present may have to be reduced to trivalent chromium through pretreatment. Flocculation/coagulation may also be conducted using alternative current electrocoagulation; however, this is not a commonly used or proven technology at hazardous waste sites. These processes are effective for the removal of metals only, and treatability studies may need to be conducted to evaluate their effectiveness and optimum operating conditions.

Oxidation using hydrogen peroxide is effective for the removal of organics only, while chlorine dioxide oxidation and chlorination are effective primarily for cyanide removal and do not remove metals or organics. Pretreatment of hexavalent chromium to reduce it to trivalent chromium may be accomplished through the addition of sulfur dioxide, sodium bisulfite, sodium metabisulfite, or sodium hydrosulfite. Neutralization is not generally effective for the removal of metals, but may be required to meet discharge limitations or as pretreatment for other processes. UV oxidation/ozonation treatment may be effective in removing metals, cyanide, and organics when used in conjunction with other processes.

Of the chemical treatment technologies, precipitation, flocculation, coagulation, oxidation, reduction, neutralization, chlorination, and UV oxidation were retained for further evaluation.

3.3.2.5 ***Disposal.*** Disposal options for collected groundwater are dependent on the quantities of water for disposal, pretreatment/treatment requirements, and regulatory considerations. Disposal options were divided into off-site and on-site options and discussed below.

Off-site facilities that may potentially accept effluent from the site include the local publicly-owned treatment works (POTW) or a TSDF. The POTW will likely require pretreatment of the collected groundwater to meet the POTW pretreatment standards prior to being discharged. Collected groundwater may also be stored and transported to a TSDF for treatment and disposal; however, this alternative is not cost effective for large volumes of water and/or continuing discharges. Treated groundwater may also be discharged to a nearby surface water body, such as the Mohawk River, via a nearby stormwater drain. This discharge will likely require a temporary permit and may have to meet applicable surface water quality standards for the receiving waters. A plan to discharge collected groundwater (pretreated or not) would require the approval of the local public works department and other local agencies.

On-site discharge options include well injection, infiltration through a seepage basin, or containment in a surface impoundment. Reinjection of extracted groundwater through a well or seepage basin are both not technically feasible options at the UP site because of the low-permeability soils that are present and the shallow depths to groundwater. Seepage basins typically require large areas and would therefore be restricted by available space at the site. On-site discharge may require treatment to meet applicable groundwater quality standards. Appropriate permits would need to be ascertained for this disposal option. Surface impoundments may be used for temporary storage of collected surface waters/groundwater only as collection and storage of liquid wastes does not achieve the ultimate disposal objectives established by SARA. Well injection, seepage basins, and surface impoundments are all technologies that were screened out of the evaluation.

3.3.3 **Air Controls**

At the UP site, the use of air controls should be evaluated and implemented if: (1) if a source control or groundwater response treatment technology produces air emissions that require control under regulatory requirements, or (2) if soil excavation produces airborne dust that may cause harmful exposure to chemicals.

Air control measures are discussed in the following subsections. General response actions for air controls include institutional measures, containment, collection, and treatment.

3.3.3.1 ***Institutional Measures.*** The institutional measures for air controls are similar to those described for site soils (i.e., deed and development restrictions to prohibit movement of contaminated soil without engineering controls). Institutional measures are intended to reduce the possibility of human contact with contaminants present at the site; however, their effectiveness is limited as they provide a small deterrent to unauthorized access and do not protect workers at the site. Institutional measures are, therefore, generally recommended for use in conjunction with other remedial actions.

3.3.3.2 ***Containment.*** The movement of metals via dust and particulates in air may be a significant contaminant pathway, particularly during remediation. Dust/particulate control measures such as water spraying, wind fences or screens, or synthetic dust covers may be cost-effective measures to reduce concentrations of air contaminants during remedy implementation. Wind fences or screens may be used to prevent dust migration from active work areas to other site areas, and synthetic covers may prevent the generation of airborne particulates from excavated waste piles. Periodic wetting (with water) of unpaved surfaces may also help minimize the generation of dust. These dust/particulate control measures are short-term actions only; they are not intended as long-term remedial measures.

Capping or surface sealing may be used as long-term controls for dust generation or the migration of gases. Capping or surface sealing as a dust control technology would not be cost effective unless used to achieve other objectives, e.g., prevention of human contact with contaminants. The concentrations of VOCs detected at the site do not indicate that capping as a gas control measure is necessary.

Vertical barriers may also be used to control the migration of gases in the subsurface, but they are more commonly used for groundwater control or structural stabilization. If used for these purposes, gas control may be a secondary benefit; however, vertical barriers are not deemed necessary at this site for gas control alone. Vertical barriers are discussed in further detail in Section 3.3.2.2.

3.3.3.3 ***Collection.*** Sweeping and vacuuming are effective dust and particulate control methods that may be used at this site. They are effective in paved areas only, however, and cannot be used in active work areas. Volatilized organics may be collected at the site using gas extraction wells, collection headers, and vacuum blowers or compressors. The identified VOC concentrations present at the site do not warrant the use of these active gas control measures.

3.3.3.4 ***Treatment.*** Several technologies exist for the treatment of collected gases or off-gases from other treatment technologies employed at the site, including activated carbon, flares, and afterburners. All three process options are effective in removing VOC contaminants only; any metals present in the collected gases will not be removed. The design of an air control system should include a method of capturing particulates to remove particulate-phase metal contaminants from the air stream. Selection of a particular gas treatment option depends on the selection of the primary process option, the specific contaminants to be removed or destroyed, and the relative costs of each technology.

3.4 EVALUATION OF TECHNOLOGIES AND SELECTION OF REPRESENTATIVE TECHNOLOGIES

Table 3-1 indicates those technologies that successfully passed the screening of technologies (i.e., those technologies listed as "Yes" or "Maybe" in their applicability to the site). These technologies were considered for inclusion in the remedial alternatives based on their applicability to site conditions and expected effectiveness. The selection of remedial alternatives for the site is discussed in the following sections.

3.4.1 No/Minimal Action Alternatives

In the no or minimal action category, deed, development, and groundwater use restrictions were retained as appropriate institutional controls to prevent human contact with contaminants remaining at the site. Fencing was retained as a potential institutional control measure.

3.4.2 Containment Alternatives

Engineering controls to prevent exposure to contaminants rather than contaminant removal or treatment comprise another category of applicable technologies. Capping was retained as a potential option for isolation of soils contaminated at concentrations above the remedial action objectives. The most appropriate capping technology for application at this site was determined to be a multilayer cap consisting of clay, a synthetic membrane, and asphalt components. This cap is discussed in the detailed evaluation of alternatives.

Groundwater barriers may also be used to isolate the source area (i.e., contaminated soils present above and below the water table to an estimated depth of 10 ft). The most effective configuration of vertical groundwater barriers (i.e., slurry walls constructed of either soil/bentonite or cement/bentonite) is circumferential placement. Up- or downgradient barriers alone will not be as effective in preventing continued groundwater flow to or from the source area. As slurry walls are most effective when tied into an underlying low-permeability layer to prevent flow beneath the slurry wall, the slurry walls would be installed to the top of the bedrock layer. To conduct the detailed evaluation of alternatives, it is assumed that a vertical barrier consisting of a soil/bentonite construction would be effective and economical in comparison to other vertical barrier options. The soil/bentonite slurry wall would need to be keyed into a low-permeability layer, such as bedrock.

If this technology is selected as part of the selected sitewide remedy, an evaluation of other slurry wall construction techniques options should be evaluated during the remedial design to determine the most cost-effective and efficient alternative.

3.4.3 **In situ Treatment Alternatives**

Of the source control and groundwater response technologies, only the S/S technology was retained as an in situ treatment process. However, preliminary cost data indicate that ex situ S/S would be less costly to implement at the site due to the site-specific soil conditions. One vendor suggested that ex situ S/S would cost approximately \$50 to \$75 per yd^3 less than in situ S/S given the soil conditions at the site.

S/S was selected for inclusion in the final remedial alternatives based on its ability to treat metals contamination effectively and its proven application at hazardous waste sites. For the purposes of this FS, it is assumed that the most appropriate S/S process option for the UP site is a cement-based mixing. If this technology is selected as part of the selected sitewide remedy, an evaluation of other S/S options should be evaluated during the remedial design to determine the most cost-effective and efficient alternative.

3.4.4 **Collection/On-site Treatment Alternatives**

Following the initial technology screening process, with the exception of S/S, no source control technologies were retained in the on-site treatment category primarily due to on-site space limitations. The retained S/S option is described in the section above and detailed in the next chapter.

For the groundwater medium, several collection and on-site treatment technologies were retained. For alternatives that require groundwater collection, French drains, trenches, or pipe drains can be used on the site. Vertical wells have proven to recover too slowly at the site to use as a reliable extraction system.

Extracted groundwater will likely require treatment prior to off-site discharge or disposal. Treatment technologies that were retained following the initial screening include physical and chemical processes. Depending on the discharge location selected for a particular alternative, a treatment system that utilizes one or a combination of the retained treatment technologies could be designed to reduce contaminant concentrations to satisfy discharge limitations. However, low volumes of wastewater are expected to be generated, in which case it will be more economical to temporarily store extracted groundwater at the site, transport the water to an off-site treatment facility, and treat the water off-site.

Selection of an appropriate treatment train for extracted groundwater will depend on the quantity of groundwater pumped and the levels of contamination present. A preliminary evaluation of available water treatment technologies indicated that precipitation is an effective, relatively inexpensive technology for the removal of heavy metals. If necessary, the cyanide present may be removed by an oxidation process. Both precipitation and oxidation are commonly employed treatment technologies. Alternatively, ion exchange or adsorptive filtration may be used for the removal of inorganic contaminants. Both ion exchange and adsorptive filtration have been demonstrated to be very effective in removing inorganic compounds; however, they may be more expensive than precipitation. For the TCE and other VOC compounds in the groundwater, air stripping or carbon adsorption are effective removal technologies. Further evaluation of appropriate groundwater treatment technologies is presented in the detailed evaluation. Off-site facilities that accept wastewater for treatment are also considered in the detailed evaluation.

3.4.5 **Disposal Alternatives**

Disposal options retained for treated soils include off-site transport and disposal at an industrial waste landfill or replacement on-site. Untreated excavated soils that are hazardous for disposal may be transported off-site for stabilization treatment and subsequent landfilling to an approved TSDF. These three disposal alternatives have been retained for further evaluation, as the selection of a particular option is dependent on the contaminant concentrations in both the untreated and treated soils, the requirements for on-site replacement of soils vs disposal in an industrial waste landfill, and the quantities for disposal.

Groundwater disposal options include discharge to the local POTW, discharge to a nearby stormwater system, or disposal at a TSDF. As with soil disposal options, a cost-benefit analysis based on the quantities of water anticipated and effluent requirements for each of these options is included in the detailed evaluation of alternatives to determine the best feasible option. Disposal of collected (untreated) groundwater at an off-site TSDF may be applicable for small quantities of hazardous groundwater, if encountered.

CHAPTER 4

SELECTION OF ALTERNATIVES FOR DETAILED EVALUATION

4.1 INTRODUCTION

In accordance with NYSDEC's Technical and Administrative Guidance Memorandum (TAGM) HWR-89-4025, Guidelines for Remedial Investigations/Feasibility Studies (NYSDEC 1989), and HWR-90-4030, Selection of Remedial Actions at Inactive Hazardous Waste Sites (NYSDEC 1990), preliminary remedial alternatives for a site are developed by combining the remedial technologies that have successfully passed the screening stage into a broad range of alternatives. The preliminary alternatives are then evaluated against the criteria of effectiveness, implementability, and cost. The goal of this screening process is to reduce the number of alternatives that will be included for subsequent detailed analysis by identifying those most promising and cost effective for remediation of the site.

Chapter 3 identified and screened the remedial technologies for the UP site. Based on the relatively small number of potentially applicable technologies and existing site constraints, it was decided, in consultation with NYSDEC, that the development and formal evaluation of a wide range of unlikely preliminary alternatives was unnecessary for this site. Instead, a range of final remedial alternatives that appeared most feasible and appropriate for the site was developed for detailed evaluation. This chapter presents the final remedial alternatives that have been developed to address source control and groundwater response at the UP site.

4.2 SCOPE OF ALTERNATIVES

New York State hazardous waste regulations and the National Oil and Hazardous Substances Contingency Plan (NCP) include requirements for development of remedial alternatives to ensure that the alternatives selected will provide decision-makers with an appropriate range of options as well as sufficient information to compare the alternatives. The range of options will depend on site-specific conditions; however, to the extent possible, one or more alternatives in each of the following categories should be developed:

1. A range of alternatives that includes treatment to reduce the toxicity, mobility, or volume of contaminants present, including:

   a. An alternative that removes or destroys contaminants to the maximum extent possible and minimizes the need for long-term management of remaining wastes or waste treatment residuals.

   b. One or more alternatives that vary in the degree of treatment and long-term management required.

   c. An alternative that involves little or no treatment but protects human health and the environment through containment or institutional controls to prevent exposure to hazardous materials.

2. For groundwater response actions, a range of alternatives that achieve the contaminant-specific remedial action levels within different time periods.

3. One or more innovative treatment technologies, if any such technologies appear promising (i.e., comparable or superior performance for lower cost).

4. The no or minimal action alternative.

The development and selection of a final range of remedial alternatives that address the New York State and NCP requirements of FS are presented in this chapter.

4.3 DEVELOPMENT OF ALTERNATIVES

Tables 3-1 through 3-3 in Chapter 3 indicate technologies that successfully passed the screening (i.e., were listed as "Yes" and "Maybe" in relation to their applicability to the site). These technologies were considered for inclusion in the remedial alternatives based on their applicability to site conditions and expected effectiveness on the media to which they can be applied. Technologies that were retained but not incorporated into alternatives may be used as alternates if a certain technology proves ineffective following a bench- or pilot-scale study.

Five remedial alternatives were selected for inclusion in the detailed evaluation of alternatives as discussed in the previous chapter. The technical elements included in each of these alternatives are summarized in Table 4-1. This chapter provides a detailed description of each of the five final remedial alternatives. Chapter 5 presents the evaluation of these alternatives against the criteria of protection of human health and the environment; compliance with state and Federal ARARs; short-term impacts and effectiveness; long-

TABLE 4-1

REMEDIAL ALTERNATIVES FOR DETAILED EVALUATION

United Plating Site

ALTERNATIVE	GENERAL RESPONSE ACTION/TECHNOLOGY TYPE
ALTERNATIVE 1: No Further Action with Long-Term Monitoring	• Deed, development and groundwater use restrictions • Long-term groundwater monitoring • Natural attenuation
ALTERNATIVE 2: Source Isolation	• Deed and development restrictions • Site dewatering and off-site water disposal • Diversion of upgradient groundwater • Surface capping • Subsurface barrier • Natural attenuation • System performance monitoring
ALTERNATIVE 3: Ex-situ Solidification/ Stabilization	• Deed and development restrictions • Temporary site dewatering and off-site water disposal • Ex-situ solidification/stabilization • System performance monitoring
ALTERNATIVE 4A: Source Area Removal	• Temporary site dewatering and off-site water disposal • Excavation of source area • Backfill excavation • Off-site disposal of excavated soils
ALTERNATIVE 4B: Reduced Source Area Removal	• Deed, development, and groundwater use restrictions • Temporary site dewatering and off-site water disposal • Excavation of hot spot source areas • Backfill excavation • Off-site disposal of excavated soils • Long-term groundwater monitoring

term impacts, effectiveness, and permanence; reduction of toxicity, mobility, or volume; implementability; and cost. An exhaustive matrix of alternatives has not been provided here to simplify the detailed evaluation.

In costing remedial alternatives that involve a soil remedy, NYSDEC has instructed LMS to assume that the areal limit of soils requiring treatment is defined as the footprint of the building plus 10% (approximately 31,000 ft^2), and the vertical limit is 10 ft below ground surface (bgs). The total soil volume encompassed by these dimensions is approximately 11,500 yd^3. This area was selected as to include the contaminated surface soil, subsurface soil, and shallow groundwater that, if treated, would substantially reduce the threat of contaminant migration to downgradient areas. This area includes the fill layer and the top of the weathered till layer underlying the UP building. Alternatives 2, 3, and 4A address the remediation of the area described in this paragraph.

The descriptions of the alternatives include the primary technical elements involved in implementing each alternative. Enhancements to the remedial technologies should be considered and evaluated in the remedial design phase whenever appropriate.

4.3.1 **Alternative 1: No Further Action With Long-Term Monitoring**

The no further action with long-term monitoring alternative does not include any excavation or treatment of site soils or groundwater but does include institutional controls to minimize human contact with contaminated materials. The institutional controls included in Alternative 1 consist of deed, development, and groundwater use restrictions and long-term groundwater monitoring. Deed and development restrictions will prohibit construction in specified areas of the site that would expose workers or the surrounding public to remaining subsurface contaminants. Notices on deeds and building permits will act as flags or reminders of these development restrictions. Groundwater use restrictions will be implemented to prevent development of the underlying aquifer as a potable or process water source on-site and downgradient of the site. The groundwater use restrictions will apply in the areas of the existing groundwater plume and potential future migration of the plume.

The purpose of the long-term groundwater monitoring program included in this alternative is to monitor any migration and natural attenuation of the contaminant plume over time. The long-term monitoring program will continue for a period of 30 years according to the schedule proposed in Table 4-2. The 30-year time frame has been assumed in order to allow for cost comparisons among alternatives. The continued need for a monitoring program as described below may be evaluated and possibly discontinued at any time during the 30-year period if groundwater contaminant levels remain below the site remedial action objectives for two consecutive years. On the other hand, if contaminant levels continue to exceed the remedial action objectives at the end of the 30-year period, the monitoring program may be extended. In costing this alternative, it was assumed that the existing wells will be sufficient to assess long-term effects of the groundwater plume. Additional monitoring wells may be necessary to monitor the plume's movement.

In the first five years, 26 monitoring wells will be sampled annually for TAL metals, cyanide, and TCL VOCs. These monitoring wells are located upgradient, on-site, and downgradient of the site and are screened in three aquifer zones (shallow, intermediate, and deep wells). For the following 25 years, only wells located on site and downgradient of the UP building will be monitored; this includes 20 wells screened in the three aquifer zones previously mentioned. The purpose of monitoring from years 6 to 30 is to assess the extent of plume migration over time and to evaluate the effects of natural attenuation on contaminant concentrations. Records of contaminant concentrations over time will be kept and periodically evaluated to monitor data trends. The cost estimate for this long-term groundwater monitoring program (provided in Chapter 5) assumes replacement of two of the monitoring wells being sampled every three years during the 30 years of monitoring.

4.3.2 **Alternative 2: Source Isolation**

Alternative 2 is a source isolation alternative in which a cap and groundwater barriers are used to prevent human contact with and migration of contaminants from the site. The effectiveness of the containment system will be increased by incorporating site dewatering, which will serve a dual purpose of facilitating construction of underground barriers and removing contaminated groundwater. As contaminants will remain at the site, this alternative includes the institutional measures (i.e., deed and development restrictions), except groundwater use restrictions, discussed in Alternative 1 as well as a long-term groundwater monitoring program. Groundwater use restrictions would not be necessary as contaminated groundwater should not travel off-site. The elements of this alternative are discussed in the following sections.

TABLE 4-2

ALTERNATIVE 1 MONITORING PROGRAM SUMMARY[a]

United Plating Site

WELL	SAMPLING SCHEDULE[b] YEARS 1-5	SAMPLING SCHEDULE[b] YEARS 6-30
UPMW-1A	X	
UPMW-1B	X	
UPMW-1C	X	
UPMW-2A	X	X
UPMW-2B	X	X
UPMW-2C	X	X
UPMW-3A	X	X
UPMW-3B	X	X
UPMW-3C	X	X
UPMW-4	X	X
UPMW-5	X	X
UPMW-6	X	X
UPMW-7A	X	
UPMW-7B	X	
UPMW-7C	X	
UPMW-8A	X	X
UPMW-8B	X	X
UPMW-8C	X	X
UPMW-9A	X	X
UPMW-9B	X	X
UPMW-9C	X	X
UPMW-10B	X	X
UPMW-10C	X	X
UPMW-11A	X	X
UPMW-11B	X	X
UPMW-12C	X	X
TOTAL:	**26**	**20**

a - This is a preliminary monitoring program developed for cost estimation purposes; the final monitoring program will be established during the remedial design phase.

b - All samples will be analyzed for TAL metals, cyanide, and TCL VOCs.

4.3.2.1 ***Institutional Measures.*** Deed and development restrictions will be implemented and will have the same limitations described in Alternative 1.

4.3.2.2 ***Subsurface Barriers.*** Subsurface barriers are included in Alternative 2 to provide groundwater control and isolation of source areas. Subsurface barriers, constructed of a soil/bentonite mix, would prevent clean groundwater from contacting contaminated soils and groundwater on the UP site and migrating to clean areas downgradient. The containment system included in this alternative is intended to isolate the contaminant source (i.e., contaminated soils) as well as the most highly contaminated groundwater (as indicated by the RI monitoring) and to allow for natural attenuation of existing groundwater contamination inside and outside the containment system.

Prior to constructing the subsurface barriers, some site preparation will be necessary. The reinforced concrete floor slab, left in place following the building demolition, will be demolished in order to level the site. Concrete fragments and underlying soil will be excavated from the northern end of the building foundation where the grade elevation is higher than the site's western end. Concrete retaining walls and stairs on the northern and western sides of the remaining building foundation will be removed, broken into fragments, and placed in areas of lower elevation, such as the western side of the site. The entire area within the vertical barriers (see Figure 4-1) will be leveled so that the area is relatively flat in order to support the surface cap.

The vertical barrier would consist of a slurry trench keyed into underlying bedrock, which at the UP site occurs at approximately 25 ft bgs. During the remedial design phase, an evaluation should be conducted to determine whether the barrier walls could be tied into a shallow till layer rather than bedrock while achieving the same objectives. Reducing the depth of the vertical barrier installation would save considerable cost. Boring logs from the RI indicate that the subsurface material at the site is consists of fill and glacial till; this material may present some difficulty in the trench excavation and backfill placement phases. Any existing obstructions (i.e., old pipes, conduits) in the path of construction will be removed or demolished in place.

Slurry trenches or walls are commonly constructed of either soil/bentonite (SB) or cement/bentonite (CB) slurries. SB trenches generally have a coefficient of permeability in the range of 1×10^{-6} cm/sec. CB walls have a greater permeability (1×10^{-4} cm/sec to 1×10^{-5} cm/sec) than SB trenches but generally have increased structural strength. CB walls

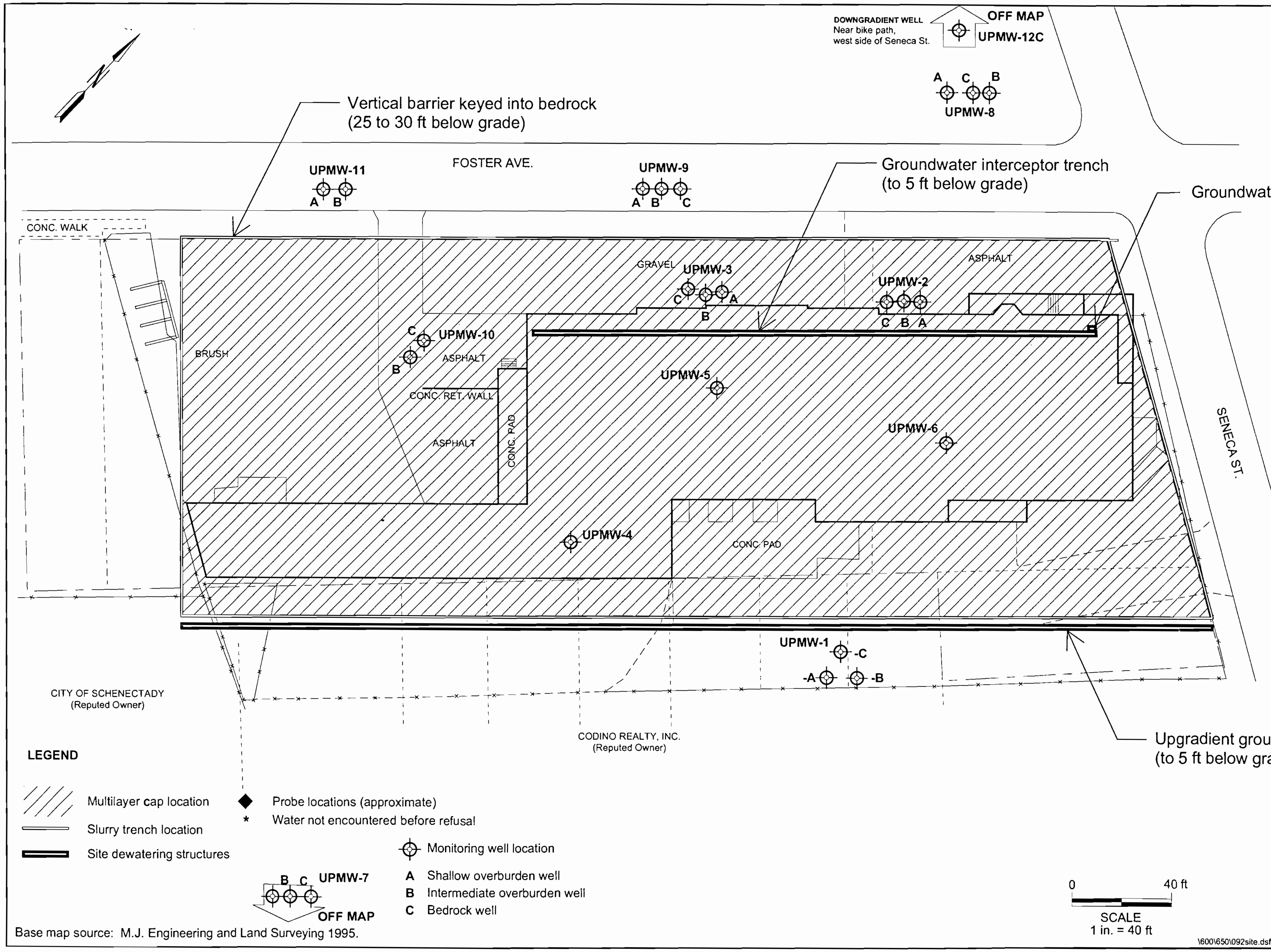

Figure 4-1

Vertical Barrier and Surface Cap Locations of Alternative 2

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are used primarily for sites with large changes in topography, structures in the area of slurry wall installation, and/or nearby underground utilities due to added strength of the CB wall and the decreased likelihood of shifting of the wall. As the UP site is relatively flat and there are no buildings and limited utilities immediately adjacent to the proposed locations of the slurry walls, SB construction is recommended for this site. SB trenches have the advantage of lower permeability and lower cost as compared to CB walls. At the concentrations present, the groundwater contaminants of concern (chromium, cyanide, TCE, and TCA) should not degrade or affect the performance of a SB slurry trench.

Soil samples collected from the fill layer beneath the UP site indicated that the fill contains fragments of debris, such as brick, wood, concrete, ash, asphalt, stone, plastic, wood, and tar paper. Due to the presence of these foreign materials, this fill could not be used to create stabilized backfill. Additionally, the material properties (low permeability and clay content) of the underlying till prohibit it from being used to create stabilized backfill. It is assumed that the fill and till excavated to create the slurry trench will be placed beneath the surface cap (i.e., within the vertical barriers). Clean common fill will be imported and mixed with bentonite to create the SB backfill for the slurry trenches.

The vertical slurry trenches will be installed around the perimeter of the former UP building approximately in the locations shown in Figure 4-1, a total of approximately 1160 lf of barrier wall. The barriers will extend approximately 25 ft bgs and be keyed into the bedrock aquitard. The proposed trench locations do not underlie any site buildings or intersect any surface or subsurface structures, and no active utilities are known to be present immediately adjacent to these locations. Any utilities that are encountered will be demolished and removed or plugged and abandoned in place. The trench locations may be impacted by the presence of Foster Avenue on the northern and Seneca Street on the eastern property boundaries; further evaluation of appropriate slurry trench locations will be conducted during the remedial design phase. Likewise, stability of the trenches will be evaluated to determine whether structural supports (e.g., sheeting) are necessary. The cost estimate prepared in Chapter 5 does not include costs for bracing the slurry trench with structural supports.

A slurry mix of approximately 4 to 7% bentonite is assumed to be necessary for construction of the SB slurry trenches. A water source is required for constructing the slurry trenches. Public water from the City of Schenectady is of sufficient quality to be used for the construction water requirement.

Once the SB wall is installed, an interceptor trench will be installed parallel to the upgradient (southern) wall in the location shown on Figure 4-1 (note that this location is outside the perimeter of the vertical barrier walls). The trench will serve several purposes, namely, to collect clean, upgradient groundwater flowing towards the slurry wall, prevent mounding and seeping of groundwater near the slurry wall, and reduce the stress on the slurry wall caused by groundwater flow. The interceptor trench will be excavated to approximately 5 ft bgs and filled with gravel. A perforated pipe will be placed at the bottom of the trench to collect groundwater. For the purposes of this FS and as discussed with NYSDEC, it is assumed that the groundwater will be discharged to a nearby storm sewer without treatment. The anticipated groundwater flow rate from this trench is approximately 60 gallons per day (gpd). This method of discharge should be verified in the remedial design phase.

There are no long-term maintenance costs associated with the subsurface barrier system, however, the life expectancy of the barriers is unknown. Breakdown of the barriers over time may result in a need for repair or replacement of the walls. No costs of repair or replacement have been included in this alternative as the containment system is expected to remain effective during the 30-year time frame established for evaluation of the remedial alternatives.

4.3.2.3 ***Site Dewatering.*** Pore water in the fill layer beneath the former UP building will be evacuated to remove metals and VOC-contaminated groundwater. One method of collecting the groundwater in the fill layer would be to construct an interceptor trench. To date, vertical wells have yielded small quantities of groundwater and have recharged slowly. An interceptor trench would provide a more effective method of groundwater recovery. A 4-ft-wide trench will be excavated to a depth of approximately 5 ft bgs and in the location shown in Figure 4-1. A perforated pipe will be installed at the base of the trench, then the trench will be filled with gravel. Groundwater that collects in the perforated pipe will be pumped to an on-site storage tank. For the purposes of this FS, it is assumed that the groundwater will be disposed of off-site as hazardous waste and brought to a TSDF for treatment. It is assumed that this interceptor trench will be pumped for a one-month period during active site remediation. Based on the geologic properties of the site reported in the RI, an estimated 30 gpd will be captured by the interceptor trench, or approximately 1000 gal in a one-month period.

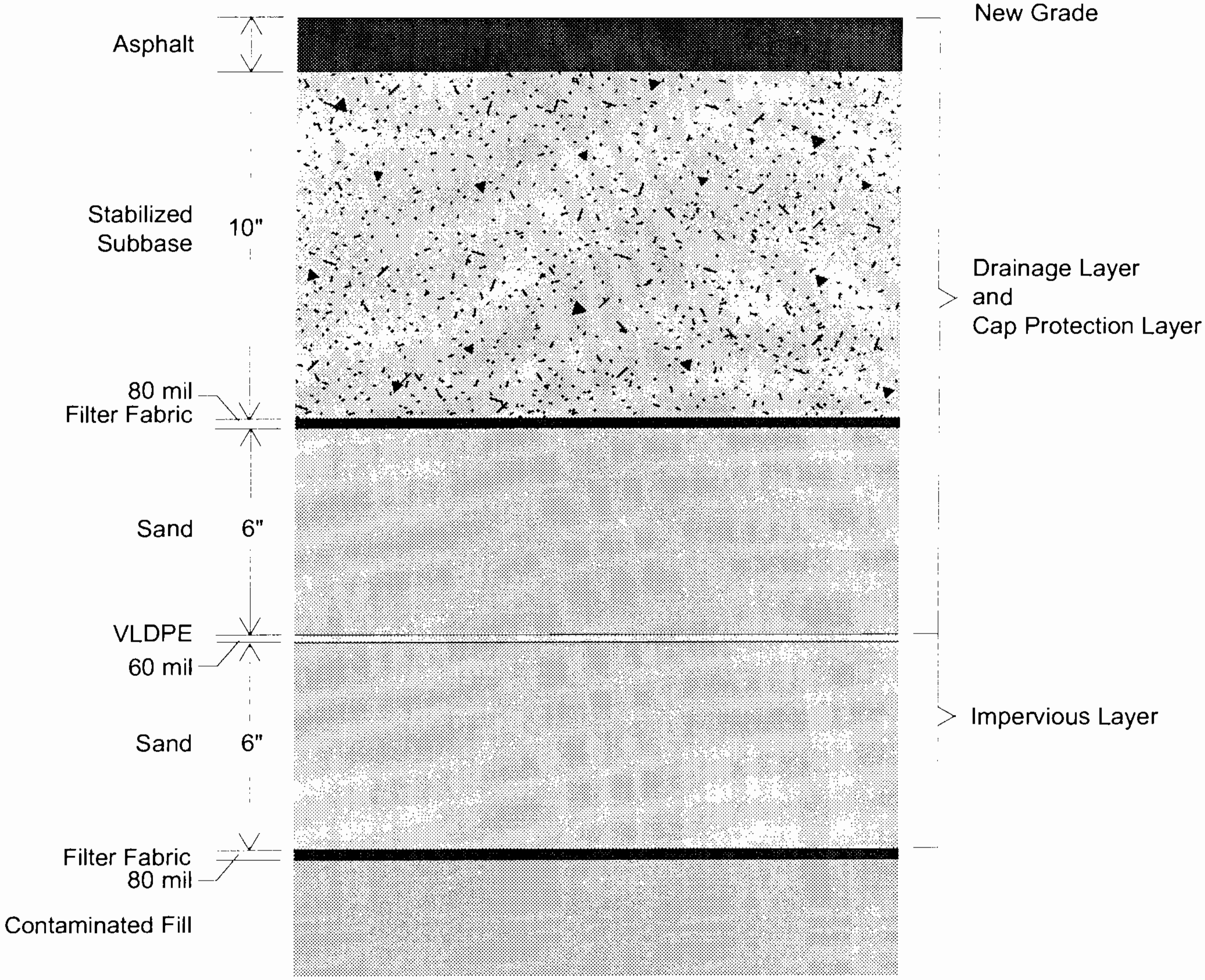
4.3.2.4 ***Surface Cap.*** Water that accumulates and infiltrates on the site (inside the vertical barriers) has the potential to dissolve metal and VOC contaminants present in soils and transport them to the underlying groundwater. In order to prevent further migration of contaminants to groundwater, a cap will be installed over the source area. A multilayer cap has been selected as the most appropriate capping option for the site as it achieves the action objectives at a relatively low cost. The multilayer cap, shown in Figure 4-2, is assumed to be constructed of the following layers from bottom to top: filter fabric, 6-in. sand layer, synthetic layer (e.g., very low density polyethylene [VLDPE]), 6-in. sand layer, filter fabric, 10-in. of subbase material, and 1-1/2 in. of asphalt. The purpose of the proposed cap design is to meet the landfill cover objectives of 6 NYCRR Part 360 and fulfill the site's remedial action objectives. If this alternative is selected, the design of the surface cap will be evaluated and finalized during the remedial design phase.

After the vertical barriers are installed and the interceptor trench is pumped for a one-month period, the site will be prepared to install the surface cap. The interceptor trench, building foundation, and floor slab will be abandoned in place and leveled as necessary. The area inside the vertical barrier walls will be leveled, graded, and filled with 6 in. of compacted sand. Overlying the sand layer will be an impermeable layer made of synthetic material, such as VLDPE. The impermeable layer will be covered with 6 in. of compacted sand and filter fabric. The area will then be covered with 10 in. of subbase material and covered with 1.5 in. of asphalt. The site will be slightly pitched such that stormwater flows away from the capped area and over the vertical barriers (cap will be designed such that it is tied into the vertical barriers).

The conceptual design introduced in this alternative assumes that no load-bearing structures will be placed on top of the barriers and cap in the future. The design of the cap and vertical barriers would need to be altered if the site is to be developed with structures following remediation.

Long-term maintenance costs associated with the surface cap system include periodic maintenance of the asphalt pavement.

4.3.2.4 ***Monitoring of System Performance.*** The long-term groundwater monitoring program included in this alternative is intended to assess the effectiveness of the source isolation technologies on the contaminant concentrations in the groundwater. Capping and construction of groundwater barriers at the site will prevent continued migration of



Cap Cross Section

NOT TO SCALE

Figure 4-2

Surface Cap Alternative 2

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contaminants into and through the on-site groundwater. The contamination present in groundwater outside the barrier system should therefore decrease through natural attenuation over time. Groundwater monitoring will evaluate system performance and the extent of attenuation and will determine the extent of any infiltration of groundwater through the barriers. Only downgradient wells outside the subsurface barrier system will be sampled as part of the monitoring program to evaluate system performance.

The long-term monitoring of system performance schedule included in Alternative 2 is summarized in Table 4-3. For a 30-year time period, nine downgradient monitoring wells will be sampled annually for TAL metals, cyanide, and TCL VOCs. Water levels routinely taken before the sampling of each well will be used to determine whether infiltration of groundwater is occurring through the slurry walls. As discussed in Alternative 1, if contaminants are not detected for a period of two consecutive years, the need for and frequency of monitoring may be reevaluated and adjusted. The costs for this monitoring program assume that two of the wells being sampled are replaced every three years.

4.3.3 **Alternative 3: Solidification/Stabilization**

Alternative 3 consists of ex situ S/S of the contaminated soil and shallow groundwater. The ex situ S/S technology was retained in the screening of the remedial technologies evaluation because it could be implemented easier and at a lower cost than the in situ S/S process. One vendor suggested that ex situ S/S would cost approximately $50 to $75 per yd^3 less than in situ S/S given the silty soil conditions and relatively shallow depth of contaminants (10 ft below grade) at the UP site. Ex situ S/S was selected for inclusion in the final remedial alternatives based on its ability to treat metals contamination effectively and its proven application at hazardous waste sites. For the purposes of this FS, it is assumed that the most appropriate S/S process option for the UP site is a cement-based mixing. If this technology is selected as part of the selected site-wide remedy, an evaluation of other S/S options should be evaluated during the remedial design to determine the most cost-effective and efficient alternative.

The area to be treated using this technology is indicated on Figure 4-3 and is based on the remedial action objectives presented in Table 2-2. The following sections present a detailed description of Alternative 3.

TABLE 4-3

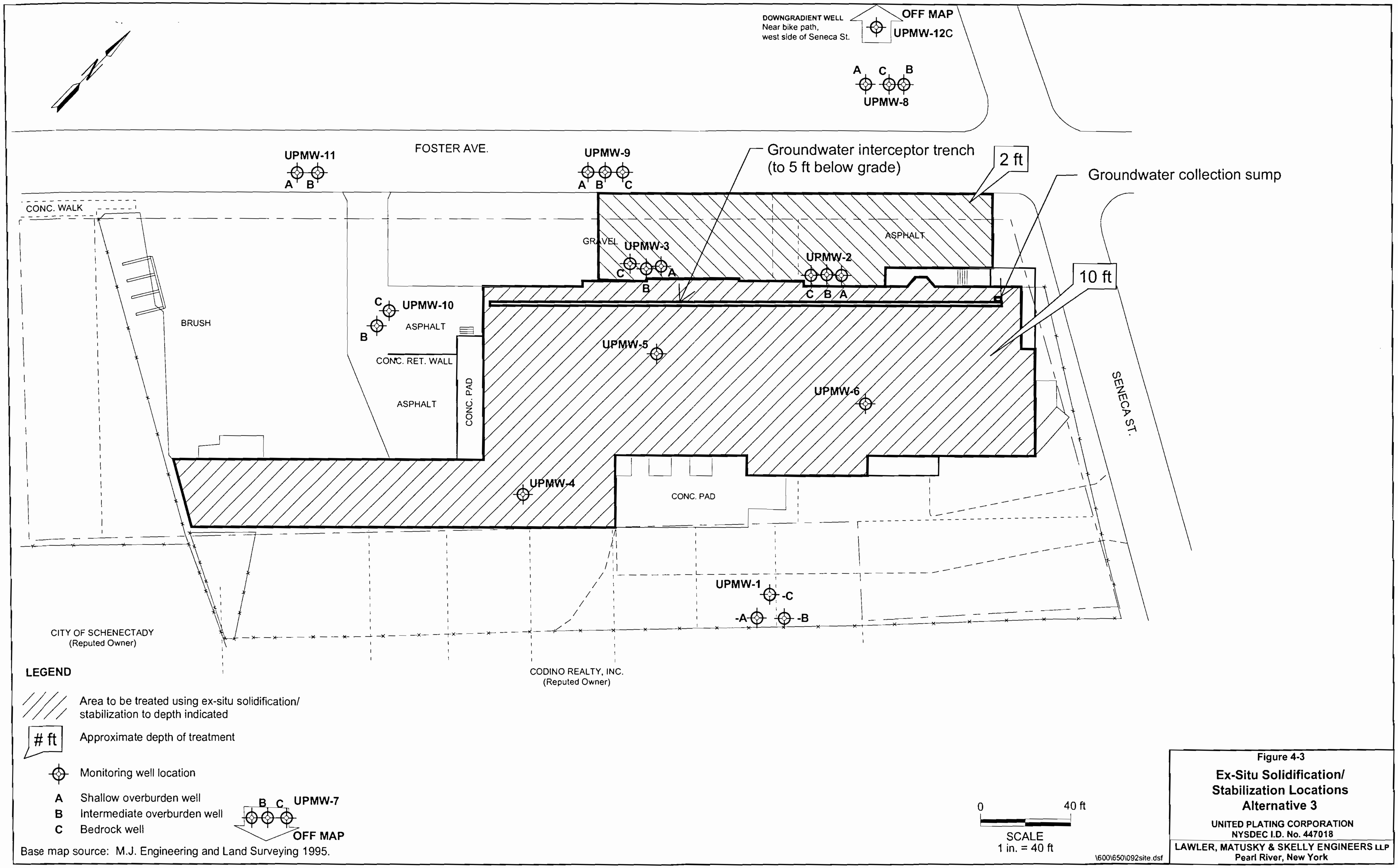
ALTERNATIVE 2 MONITORING PROGRAM SUMMARY[a]

United Plating Site

WELL	SAMPLING SCHEDULE[b] YEARS 1-30
UPMW-8A	X
UPMW-8B	X
UPMW-8C	X
UPMW-9A	X
UPMW-9B	X
UPMW-9C	X
UPMW-11A	X
UPMW-11B	X
UPMW-12C	X
TOTAL:	**9**

a - This is a preliminary monitoring program developed for cost estimation purposes; the final monitoring program will be established during the remedial design phase.

b - All samples will be analyzed for TAL metals, cyanide, and TCL VOCs.



Base map source: M.J. Engineering and Land Surveying 1995.

Figure 4-3

Ex-Situ Solidification/ Stabilization Locations Alternative 3

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4.3.3.1 ***Institutional Measures.*** The S/S process included in Alternative 3 will render the existing contaminated soils at the site nonhazardous by preventing future leaching of contaminants from the soils; however, the contaminants will not actually be removed from the site. The long-term stability of the final product is uncertain, as discussed below, so a potential for contaminant release from the solidified mass exists. Institutional measures, such as deed and development restrictions (as discussed in Alternative 1), are appropriate as part of this alternative.

4.3.3.2 ***Site Dewatering.*** A site dewatering strategy similar to that presented in Alternative 2 would be implemented as part of Alternative 3. Pore water in the fill layer beneath the former UP building will be evacuated using an interceptor trench to remove metals and VOC-contaminated groundwater. Groundwater would be collected and pumped to an on-site storage tank. Due to the low volume expected, for the purposes of this FS it is assumed that the groundwater will be disposed of off-site as hazardous waste and brought to a TSDF for treatment. It is assumed that this interceptor trench will be pumped for a one-month period.

4.3.3.3 ***Ex situ Solidification/Stabilization.*** Ex situ S/S is a technology that is commonly used at sites containing metals-contaminated soils and is a presumptive remedy for EPA Superfund sites where metals are the COCs in the soil medium. S/S reduces the leachability of heavy metals in two ways: the metals react with specific chemical additives to form less mobile species (stabilization), and the metals are physically bound within a cement-like matrix (solidification). The additives that may be used include portland cement (either alone or with additives such as soluble silicates or other proprietary mixes developed by specific vendors) and pozzolans (lime, fly ash, or cement kiln dust). In general, cement-based systems produce a higher-strength final product, have a faster curing time, and are generally more effective at stabilizing heavy metals than pozzolanic systems.

Selection of an appropriate treatment process for a particular site is generally accomplished by performing a bench-scale treatability study in which the effectiveness of several different reagents are determined on a representative soil sample from the site. After a particular treatment process is selected, further testing is required to determine the optimum dosage rate to provide the least volume increase while ensuring that the contaminants will not leach at levels to cause a failure to meet remedial action objectives.

Contaminated soils are excavated and stockpiled. In Alternative 3, all soils in the footprint of the UP building will be excavated to a 10-ft depth (plus an additional 10% by volume of soil is included). Ex situ S/S implementation is accomplished by applying the additives to the excavated soils with mixing of the soils and reagents occurring in aboveground mixing machinery. The treated soils are returned to the excavation, compacted, and left to cure for 28 days. Once cured, the area will be covered with asphalt pavement, which will serve to prevent stormwater infiltration that may result in leaching of contaminants from the solidified mass over time and will also prohibit human contact with the treated soils.

The minimum site area to be treated using the ex situ S/S process is shown in Figure 4-3 and totals approximately 30,700 ft^2 (0.7 acres). An estimated total of 11,500 yd^3 of soils will be treated assuming a treatment depth of 10 ft in all areas, except the lead-contaminated area north of the building footprint, which will be treated to a depth of 2 ft. Excavation and backfilling to 10 ft bgs may be accomplished using standard commonly available excavation equipment. For the purposes of this cost estimate, it is assumed that the excavation will be conducted in a manner where structural supports (e.g., sheeting) are not necessary. This assumption should be reviewed and evaluated in the remedial design. The limits of excavation described herein should also be reviewed in the remedial design stage.

The presence of shallow groundwater in these areas should not adversely impact the treatment process; any water will provide a portion or all of the water requirement for the S/S process. The existing floor slab will be demolished and removed from the site prior to implementing the excavation phase of this alternative. For the purposes of this FS it is assumed that the demolished slab will be disposed of off-site as nonhazardous construction and demolition debris.

The physical characteristics of the end product of the S/S process can be adjusted by varying the chemical dosage rate to meet regulatory specifications and the requirements of the final disposal option. For the UP site, the mix will be designed to provide a final product with an adequate unconfined compressive strength (UCS) to support the overlying asphalt pavement. In general, increasing the dosage of portland cement in cement-based solidification creates a more monolithic as well as a stronger final product. The UCS of the final product typically exceeds 50 psi, the guideline established by EPA for acceptable strength of S/S products. The final UCS for the site will be determined during the design phase and evaluated during the treatability study testing.

The S/S process equipment requires approximately 5000 ft^2 of space on the site, which is available in the western portion of the UP site. Decontamination areas for personnel and equipment will also be required at the site. A typical ex situ S/S operation can process approximately 600 yd^3 per day of soil. Ex situ treatment of the contaminated soils at the UP site would, therefore, require approximately two to four weeks, with additional time for contractor mobilization/demobilization.

Due to the addition of the chemical additives, some increase in the volume of soils will result from the S/S treatment process. The volume increase depends on the dosage rate of the chemical reagents, as determined in a bench-scale treatability study. The estimated volume increase for treated soils at the UP site using a cement-based process is 10 to 12%, resulting in a 14-in. average rise in the ground surface in treated areas of the site. The treated soils will be leveled and graded over the footprint of the UP building. The asphalt pavement will be constructed so as to drain stormwater runoff away from the S/S soil area.

4.3.3.4 ***Confirmatory Sampling and Analysis.*** Pre- and posttreatment analyses are required to confirm that the ex situ S/S treatment process is effective in immobilizing the COCs present in site soils. The number of pre- and posttreatment samples for each alternative included in this FS have been assumed based on technical judgment in the absence of specific sampling requirements. The actual number of samples to be collected will be established during the remedial design phase.

Pretreatment analyses will measure the TCLP concentrations of contaminants prior to treating the contaminated soils; TCLP analysis is necessary as no TCLP analyses have been performed on site soils to date. It was assumed that three soil samples will be collected prior to treatment analyzed for TCLP cadmium, chromium, lead, and TCE. These samples will provide a baseline for comparison with posttreatment samples to determine the decrease in leachability of the metals resulting from the S/S treatment. Posttreatment sampling will be conducted at the rate of one sample per 125 yd^3 of treated soil. Wet samples will be collected immediately after treatment as collection of ex situ samples at the site after curing has been completed would necessitate the use of a drill rig to obtain the samples. An additional 10% of the total number of samples analyzed is reserved for quality assurance/quality control (QA/QC) purposes, such as equipment blanks and split samples.

The posttreatment samples (approximately 92 samples total) will be cured for 28 days after collection. The samples will subsequently be analyzed for TCLP cadmium, chromium, lead, and TCE to confirm that the treatment process has reduced the leachability of these contaminants to below the TCLP standards. Ten percent of the samples (i.e., 10 samples) will be tested for UCS and permeability to confirm that site-specific requirements for these parameters have been achieved. Two samples will also be selected for durability testing (freeze/thaw and wet/dry testing). To evaluate the long-term stability of the treated product. The durability test samples will be subjected to up to 12 cycles of freezing/thawing and wet/dry conditions to simulate natural degradation processes. The samples will then be inspected for physical integrity and analyzed for TCLP metals to determine whether any decreases in integrity have resulted in increased metals leachability. The asphalt pavement will not be completed over the treated soils until the posttreatment analyses have been completed and the data reviewed to determine that the treatment process has satisfactorily met all specified performance standards.

4.3.3.5 ***Monitoring of System Performance.*** A long-term monitoring program is included in Alternative 3, as summarized in Table 4-4. The purpose of the monitoring program is to (1) monitor the effect of this source control alternative (i.e., treatment of the contaminated soils at the site to prevent continued leaching of metals and TCE to the groundwater) on the existing groundwater contaminant plume, and (2) monitor the long-term performance of the ex situ treatment process to ensure that the solidified mass does not degrade over time and begin to leach contaminants to the groundwater. Monitoring wells UPMW-2, UPMW-3, and UPMW-10 can be added or substituted into the monitoring program; these wells were not included in the program because of the high probability that they may be damaged during the S/S process.

The long-term monitoring program will continue for a period of 30 years. Annual sampling will be conducted of existing downgradient wells closest to the footprint of the UP building. All groundwater samples collected will be analyzed for TAL metals, TCL VOCs, and cyanide. As discussed in Alternatives 1 and 2, if contaminants are not detected for a period of two consecutive years, the need for and frequency of monitoring may be reevaluated and adjusted. The costs for this monitoring program assume that two of the wells being sampled are replaced every three years.

TABLE 4-4

ALTERNATIVE 3 MONITORING PROGRAM SUMMARY[a]

United Plating Site

WELL	SAMPLING SCHEDULE[b] YEARS 1-30
UPMW-8A	X
UPMW-8B	X
UPMW-8C	X
UPMW-9A	X
UPMW-9B	X
UPMW-9C	X
UPMW-11A	X
UPMW-11B	X
TOTAL:	8

a - This is a preliminary monitoring program developed for cost estimation purposes; the final monitoring program will be established during the remedial design phase.

b - All samples will be analyzed for TAL metals, cyanide, and TCL VOCs.

4.3.4 **Alternative 4A: Removal of Source Area**

Soils with elevated metals concentrations in the footprint of the UP building (plus 10% of the volume of soils beneath the building footprint) will be excavated in Alternative 4A, thereby removing the areas that act as a contaminant source and contribute most to groundwater pollution. The excavated soils will require appropriate treatment and/or disposal at an off-site location.

4.3.4.1 ***Institutional Measures.*** Deed and development restrictions are not included in this alternative as no contamination above the remedial action objectives will remain on site. Removal of contaminated soils and shallow groundwater should reduce downgradient contaminant concentrations in a reasonable time. Groundwater contaminants downgradient of the site will naturally attenuate, and levels should drop over time to meet NYSDEC groundwater standards. Under this alternative, no long-term groundwater use restrictions are warranted as the major contaminant source will be removed, but short-term restrictions may still be warranted while the natural attenuation is in progress in the groundwater.

Likewise, no long-term groundwater monitoring is proposed under this alternative as the removal of contaminated soil and shallow groundwater will reduce groundwater contaminant concentrations over time.

4.3.4.2 ***Site Dewatering.*** A site dewatering strategy similar to that presented in Alternatives 3 would be implemented as part of Alternative 4A. Pore water in the fill layer beneath the former UP building will be evacuated using an interceptor trench to remove metals and VOC-contaminated groundwater. Groundwater would be collected and pumped to an on-site storage tank. Due to the low volume anticipated, it is assumed that the pumped groundwater will be disposed of off-site as hazardous waste and brought to a TSDF for treatment. It is also assumed that this interceptor trench will be pumped for a one-month period.

4.3.4.3 ***Soil Excavation.*** The approximate location of soils to be excavated in Alternative 4A is shown in Figure 4-4. The excavation areas were delineated based on soils underlying the building footprint plus 10% by volume (including the lead-contaminated surface soils to the building's north). These soils contain elevated concentrations of cadmium, chromium, lead, and/or TCE, which exceed the remedial action objectives. The depth of excavation is assumed to be 10 ft in all areas, except the lead-contaminated area north of

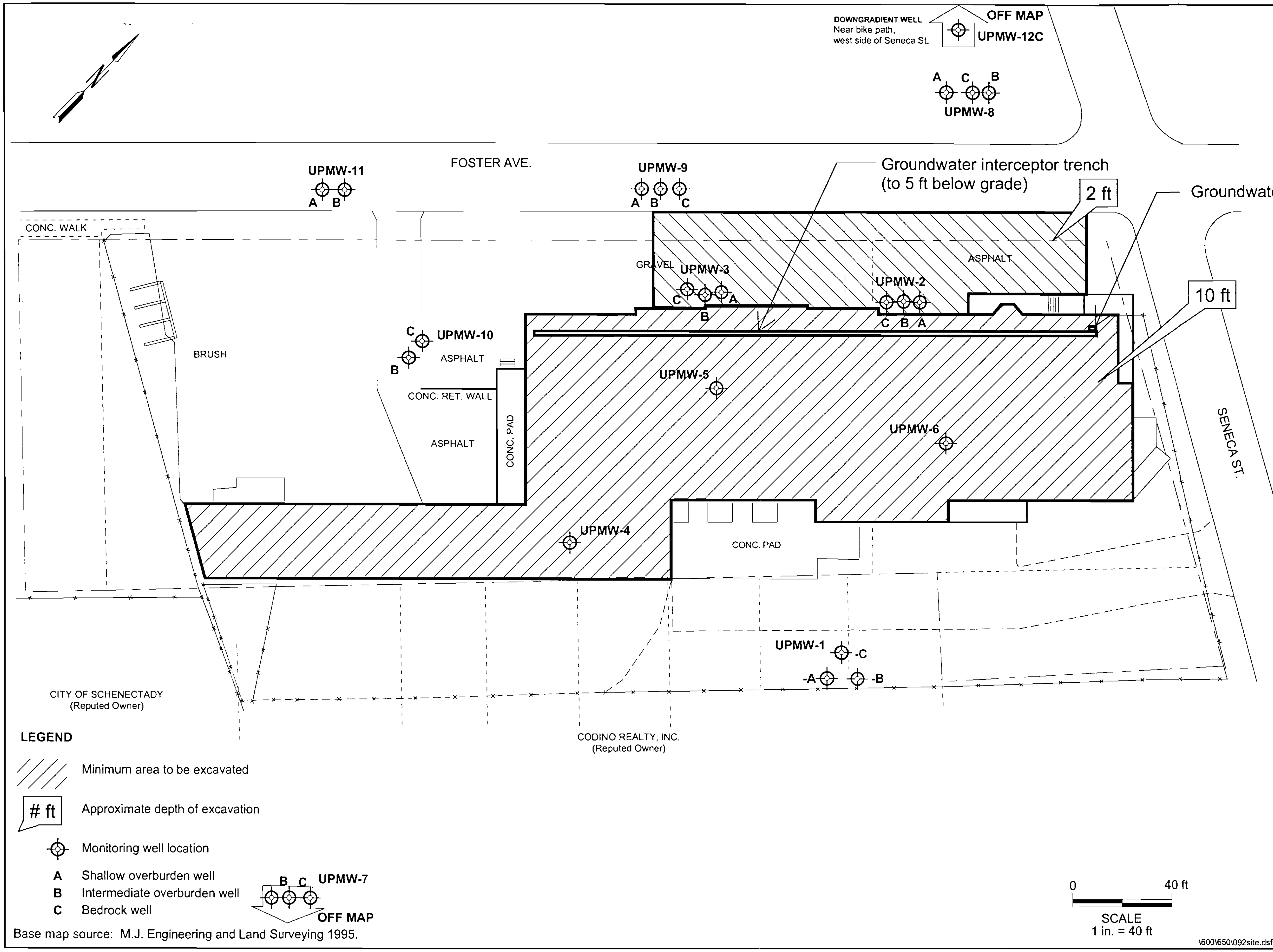

Figure 4-4

Soil Excavation Areas
Alternative 4A

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the building footprint, which will be excavated to a depth of 2 ft. The total estimated quantity of excavated soils is 13,800 yd^3, assuming a 20% increase in soil volume due to expansion upon excavation. The limits of excavation described herein should be reviewed in the remedial design stage. Postexcavation testing will be conducted to confirm the achievement of remedial action objectives.

Prior to excavating, the remaining floor slab will be demolished and removed off-site. It is assumed that the demolished floor slab will be disposed of in a construction and demolition landfill as nonhazardous waste.

The soil excavation will be conducted using conventional earthmoving equipment, such as backhoes and front-end loaders, at estimated rate of 600 yd^3 per day. At this rate, the excavation will require approximately one month to complete. This estimate assumes that the excavation would be designed such that it does not require structural support, such as driven sheeting; however, this assumption should be evaluated in more detail during the remedial design.

Excavated soils will be stockpiled on impervious liners to prevent cross contamination of previously excavated or clean site areas. A decontamination area will be established to wash equipment that contacts potentially contaminated soil and groundwater. Impervious covers will also be provided for the stockpiles to prevent infiltration and runoff of precipitation. Any runoff from stockpiled soils will be collected and combined with the wastewater generated from the dewatering operations for appropriate disposal. Excavated soils will be stockpiled in two separate areas, one for hazardous soils and one for nonhazardous, contaminated soils. The location of potentially hazardous soils will be determined based on the RI results; hazardous soils will be excavated first and stockpiled in one area. The location of nonhazardous soils will also be determined based on the RI results and will be excavated after the potential hazardous soils are removed. As soils are stockpiled, they will be sampled to determine whether they are hazardous or nonhazardous for disposal (see next section for discussion on sampling). Soils that are considered hazardous, i.e., contain cadmium, chromium, lead, or TCE exceeding the TCLP standards, have different handling and disposal requirements as compared to those that are nonhazardous.

Soil boring and test pit data from the RI indicate that cadmium, chromium, and TCE concentrations exceeding the remedial action objectives were generally present within the footprint of the UP building (main portion and side, one-story structure). The highest cadmium concentration (158 mg/kg) was detected at soil probe location P-12 at 2 to 3 ft bgs, located inside the building. The highest chromium concentration (775 mg/kg) was detected at test pit location UPTP-02 at 2 to 3 ft bgs, located outside the building. Very limited soil sampling was conducted inside the UP building during the RI; more sampling could not be performed primarily due to safety concerns. In many cases, cadmium and chromium concentrations decreased with depth. For the purposes of this FS, it is assumed that 20% of the soils to be excavated will be hazardous for disposal and 80% will be nonhazardous but contaminated for disposal. These percentages were determined from the sampling results obtained from the RI.

Confirmatory sampling will be conducted following completion of the excavations to the specified depths (as discussed in the next section). If contaminant concentrations are detected at levels exceeding the remedial action objectives, additional excavation will be conducted in those areas until remedial action objectives are achieved. After all soils with contaminant concentrations exceeding the remedial action objectives have been removed, the excavation will be backfilled with clean fill material, covered with 6 in. of topsoil, and seeded.

4.3.4.4 ***Laboratory Sampling and Analyses.*** Laboratory sampling will be conducted for two distinct purposes: (1) to ensure that all soils with contaminant concentrations exceeding the site remedial action objectives are removed and (2) to determine the end disposal location of excavated soils. Following excavation to the specified depths, soil samples will be collected from the bottom and sidewalls of the excavations at an assumed rate of one sample per 250 ft^2 of excavation, resulting in approximately 125 samples. Approximately 20% of the locations will likely require resampling (if additional material requires excavation) or QA sampling, for an additional 25 samples. These samples will be submitted for TAL metals, cyanide, and TCL VOCs analyses with a 48-hr turnaround time to provide rapid information on the need for additional excavation at the site. Use of an on-site mobile laboratory should be evaluated in the remedial design phase if data results can be obtained quicker and more economically than using a fixed laboratory. If an on-site laboratory is used, additional samples will be collected for QA/QC purposes.

Sampling and analyses are also required to identify whether excavated soils are hazardous or nonhazardous for off-site disposal. Excavated soils will be sampled at a rate of one composite sample per 200 yd^3 of excavated soil to determine their disposal characteristic (hazardous vs nonhazardous). These samples will be analyzed for TCLP cadmium, chromium, lead, and TCE using a one-week turnaround time to expedite treatment and/or removal of the wastes from the site. Soils containing cadmium, chromium, lead, or TCE at levels exceeding the TCLP standard will be treated as hazardous for disposal; soils with all four constituents below the TCLP standards will be treated as nonhazardous for disposal. Approximately 70 samples are estimated to be collected for waste disposal characterization purposes.

An additional 10% of the total number of samples analyzed is reserved for QA/QC purposes, such as equipment blanks and split samples.

4.3.4.5 ***Waste Disposal.*** Alternative 4A includes transport of the wastes to an off-site TSDF or double-lined landfill for appropriate treatment and/or landfilling. Hazardous wastes, including an estimated total of 2760 yd^3 of hazardous soils, will assumedly be transported by truck to the TSDF in Model City, New York, for stabilization treatment. Hazardous soils containing elevated levels of contaminants other than metals may require additional treatment, which has not been considered as part of this alternative because it is not anticipated. For instance, if the stabilized soils still exceed the LDR regulatory limits (e.g., for VOCs), the soil may require further treatment using a different technology. Transportation of the waste soils from the UP site to Model City must be conducted in accordance with all applicable regulations for the transport of hazardous materials. Currently available site analytical data and a representative soil sample for full chemical analyses must be submitted to the TSDF prior to waste acceptance. For the purposes of this estimate and based on laboratory results presented in the RI, it is assumed that approximately 20% of the soils excavated under Alternative 4A will be hazardous and 80% will be nonhazardous but contaminated.

In accordance with the LDRs, soils that are classified as hazardous under RCRA (i.e., exhibit the toxicity characteristic) must be treated and rendered nonhazardous prior to landfilling. S/S is the best demonstrated available technology (BDAT) for metals-contaminated soils; the soils will be stabilized at the TSDF prior to disposal in a landfill.

Nonhazardous soils will also be disposed of at an off-site landfill. Nonhazardous soils do not require treatment prior to landfilling; however, the presence of low levels of metals and VOC contamination in these soils indicate that they must be disposed of in an industrial, double-lined landfill. A nearby landfill that qualifies under these criteria is the High Acres

Landfill in Fairport, New York. This facility would be capable of accepting the 11,040 yd^3 of nonhazardous soils from this site. Transportation of nonhazardous soils does not need to be conducted in accordance with hazardous waste regulations but must follow other Federal and New York State Department of Transportation regulations.

The end disposal facilities mentioned herein are examples of available facilities that may be used for under this alternative. Actual disposal sites used during the remedial action phase may vary and the sites and rates should be confirmed in the remedial design phase.

4.3.5 **Alternative 4B: Reduced Source Area Removal**

The objectives of Alternative 4B are similar to Alternative 4A; however, a reduced quantity of contaminated soil would be excavated from the site. Only the potentially hazardous soils identified in the RI report will be targeted and removed. Figures 1-4 and 1-5 were reprinted from the RI and show the areas of surface and subsurface soils where the soils have the greatest likelihood of failing the toxicity characteristic (i.e., exceed the regulatory TCLP limit). The surface soils identified have the potential of failing the lead TCLP limit and the subsurface soils have the potential of failing the cadmium, chromium, or TCE TCLP limit. By removing the soils that have the greatest potential to be hazardous, the likelihood of the site containing any hazardous waste would be greatly reduced.

4.3.5.1 ***Institutional Measures.*** Deed, development, and groundwater use restrictions are included in this alternative since some contamination will remain on site following excavation. These institutional measures will be similar to those presented in Alternative 1.

4.3.5.2 ***Site Dewatering.*** A site dewatering strategy similar to that presented in Alternatives 4A would be implemented as part of Alternative 4B.

4.3.5.3 ***Soil Excavation.*** The approximate location of soils to be excavated in Alternative 4B is shown in Figure 4-5. The excavation areas were delineated based on Figures 1-4 and 1-5, which show the surface and subsurface soils that have the greatest potential to exceed the TCLP regulatory limit for cadmium, chromium, lead, and/or TCE. The total area shaded in Figure 1-5 (15,776 ft^2) was increased by 10% to account for squaring off of excavation areas and volume increases due to additional contamination that may be found. The depth of excavation is assumed to be 10 ft within the shaded area. In the additional 10% volume that was estimated was the lead-contaminated area north of the building

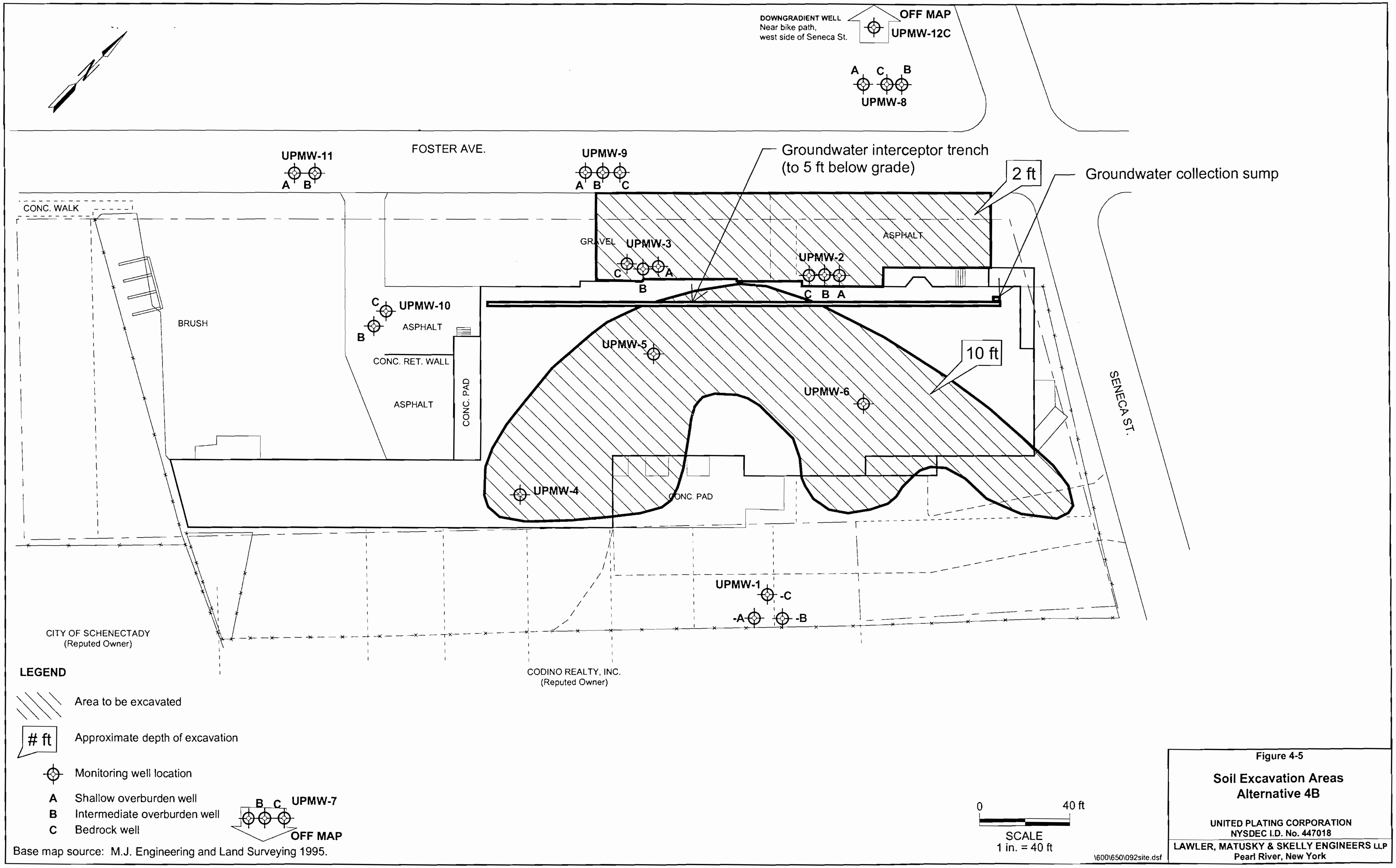

Figure 4-5

Soil Excavation Areas
Alternative 4B

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footprint, which will be excavated to a depth of 2 ft. The total estimated quantity of excavated soils is 7720 yd^3, assuming a 20% increase in soil volume due to expansion upon excavation. The limits of excavation described herein should be reviewed in the remedial design stage. Testing will be conducted during excavation to determine the depth where the remedial action objectives (20 times TCLP toxicity characteristic levels for cadmium, chromium, lead, and TCE) are satisfied.

Prior to excavating, the remaining floor slab will require demolition and off-site removal. Instead of removing only a portion of the slab, the entire slab will be removed as a safety precaution. A decontamination area will also need to be established prior to excavating.

The soil excavation will be conducted using conventional earthmoving equipment, such as backhoes and front-end loaders, at an estimated rate of 600 yd^3 per day. At this rate, the excavation will require approximately two weeks to complete. This estimate assumes that the excavation would be designed such that shoring is not necessary; however, this assumption should be evaluated in more detail during the remedial design.

Excavated soils will be stockpiled and disposed of off-site in the same manner as described in Alternative 4A. For the purposes of this FS, it was assumed that 40% of the soils to be excavated under Alternative 4B will be hazardous for disposal and 60% will be nonhazardous but contaminated for disposal. These percentages were determined from the sampling results obtained from the RI.

Confirmatory sampling will be conducted following completion of the excavations to the predetermined depths. If contaminant concentrations are detected at levels exceeding the remedial action objectives, additional excavation will be conducted in those areas until remedial action objectives are achieved. After all soils with contaminant concentrations exceeding the remedial action objectives have been removed, the excavation will be backfilled with clean fill material, covered with 6 inches of topsoil, and seeded.

4.3.5.4 ***Laboratory Sampling and Analyses.*** Confirmatory sampling will be conducted in a manner similar to the method described in Alternative 4A. Following excavation to the specified depths, soils samples will be collected from the bottom and sidewalls of the excavations at an assumed rate of one sample per 250 ft^2 of excavation, resulting in approximately 70 samples.. Approximately 20% of the locations will likely require resampling (if additional material requires excavation) or QA sampling, for an additional

14 samples. These samples will be submitted for TAL metals, cyanide, and TCL VOC analyses with a 48-hr turnaround time to provide rapid information on the need for additional excavation at the site.

Sampling and analyses are also required to identify whether excavated soils are hazardous or nonhazardous for off-site disposal. Excavated soils will be sampled at a rate of one composite sample per 200 yd^3 of excavated soil to determine their disposal characteristic (hazardous vs nonhazardous). These samples will be analyzed for TCLP cadmium, chromium, lead, and TCE using a one-week turnaround time to expedite treatment and/or removal of the wastes from the site. Soils containing cadmium, chromium, lead, or TCE at levels exceeding the TCLP standard will be treated as hazardous for disposal; soils with all four constituents below the TCLP standards will be treated as nonhazardous for disposal. An estimated 39 samples will be collected for waste disposal characterization purposes.

An additional 10% of the total number of samples analyzed is reserved for QA/QC purposes, such as equipment blanks and split samples.

4.3.5.5 ***Waste Disposal.*** Similar to Alternative 4A, Alternative 4B includes off-site treatment and/or landfilling as the disposal option for all excavated wastes. Alternative 4B includes transport of the wastes to an off-site TSDF or double-lined landfill for appropriate treatment and/or landfilling. Hazardous wastes, including an estimated total of 3090 yd^3 of hazardous soils, will assumedly be transported by truck to the TSDF in Model City, New York, for stabilization treatment. Hazardous soils containing elevated levels of contaminants other than metals may require additional treatment, which has not been considered as part of this alternative because it is not anticipated. For instance, if the stabilized soils still exceed the LDR regulatory limits (e.g., for VOCs), the soil may require further treatment using a different technology. For the purposes of this estimate and based on laboratory results presented in the RI, it is assumed that approximately 40% of the soils excavated under Alternative 4B will be hazardous and 60% will be nonhazardous but contaminated.

Nonhazardous soils will be disposed of at an off-site landfill. Nonhazardous soils do not require treatment prior to landfilling; however, the presence of low levels of metals and VOC contamination in these soils indicate that they must be disposed of in an industrial, double-lined landfill. A nearby landfill that qualifies under these criteria is the High Acres Landfill in Fairport, New York. This facility would be capable of accepting the 4630 yd^3

of nonhazardous soils from this site. Transportation of nonhazardous soils does not need to be conducted in accordance with hazardous waste regulations but must follow other Federal and New York State Department of Transportation regulations.

The end disposal facilities mentioned herein are examples of available facilities that may be used for under this alternative. Actual disposal sites used during the remedial action phase may vary and the sites and rates should be confirmed in the remedial design phase.

4.3.5.6 ***Long-Term Groundwater Monitoring.*** A long-term monitoring program is included in Alternative 4B as summarized in Table 4-5. The purpose of the monitoring program is to monitor the effect of this source control alternative on the existing groundwater contaminant plume. Monitoring wells UPMW-2, UPMW-3, and UPMW-10 can be added or substituted into the monitoring program; these wells were not included in the program because of the high probability that they may be damaged during excavation activities.

The long-term monitoring program will continue for a period of five years. Annual sampling will be conducted of existing downgradient wells closest to the footprint of the UP building. All groundwater samples collected will be analyzed for TAL metals, TCL VOCs, and cyanide. If contaminants are not detected for a period of two consecutive years, the need for and frequency of monitoring may be reevaluated and adjusted.

TABLE 4-5

ALTERNATIVE 4B MONITORING PROGRAM SUMMARY[a]

United Plating Site

WELL	SAMPLING SCHEDULE[b] YEARS 1-5
UPMW-8A	X
UPMW-8B	X
UPMW-8C	X
UPMW-9A	X
UPMW-9B	X
UPMW-9C	X
UPMW-11A	X
UPMW-11B	X
TOTAL:	**8**

a - This is a preliminary monitoring program developed for cost estimation purposes; the final monitoring program will be established during the remedial design phase.

b - All samples will be analyzed for TAL metals, cyanide, and TCL VOCs.

CHAPTER 5

DETAILED EVALUATION OF ALTERNATIVES

5.1 INTRODUCTION

This chapter presents the detailed evaluation of the remedial alternatives described in Chapter 4. The purpose of the evaluation is to identify the advantages and disadvantages of each alternative as well as key tradeoffs among the alternatives. The criteria used to evaluate the alternatives are specified in the EPA guidance (EPA 1988), which is widely accepted by NYSDEC, and are as follows:

- **Overall Protection of Human Health and the Environment:** This criterion evaluates the extent to which the alternative will achieve and maintain protection of human health and the environment and how the protection will be achieved, i.e., through treatment, engineering, or institutional controls.

- **Compliance with SCGs:** This criterion evaluates the compliance of the alternative with all identified chemical-, location-, and action-specific SCGs for the site. Chemical-specific SCGs for the site COCs are listed in Chapter 2.

- **Long-Term Effectiveness and Permanence:** Each alternative is evaluated for its long-term effectiveness in protecting human health and the environment following completion of the remedial action.

- **Reduction of Toxicity, Mobility, and Volume Through Treatment:** The NCP specifies that preference be given to alternatives that reduce the toxicity, mobility, or volume of contamination present through treatment. The degree to which each alternative results in a reduction is evaluated by this criterion.

- **Short-Term Effectiveness:** This criterion evaluates the impacts of each alternative on human health and the environment during the construction and implementation of the remedy.

- **Implementability:** The technical and administrative feasibility of implementing each alternative, including site features that may restrict application of the alternative, are evaluated for this criterion.

- **Cost:** The relative capital costs have been estimated for each alternative. Operations and maintenance (O&M) costs for each alternative are also included based on a 30-year life (EPA 1988). Actual operational time frames (time required for long-term groundwater monitoring or monitoring of soil remedy) may be shorter or longer than 30 years depending on the time for achievement of site remedial action objectives. The cost estimates included in this FS are for comparative purposes; detailed cost estimates are prepared in the remedial design phase.

Community and state acceptance is also to be considered in evaluating the remedial alternatives. Community acceptance cannot be assessed until public comments have been received on the RI/FS report and proposed remedial action plan. The ROD for the site will address community acceptance. State acceptance of the proposed remedial action plan will also be addressed in the ROD.

5.2 INDIVIDUAL ANALYSIS OF ALTERNATIVES

The individual analysis of the remedial alternatives with respect to the seven evaluation criteria is presented below.

5.2.1 Alternative 1: No Further Action With Long-Term Monitoring

5.2.1.1 ***Protection of Human Health and the Environment.*** Alternative 1 is protective of human health through the use of institutional measures to prevent human contact with the contaminants that will remain at the site; however, the potential for human exposure to the contaminants will remain. In addition, the site may continue to impact the surrounding environment through the migration of heavy metals and VOCs in soils to groundwater. Long-term groundwater monitoring as included in this alternative is not protective of human health and the environment, but will assess any migration or natural attenuation of the contaminant plume over time to document the nature of any continued risk posed by the contamination.

5.2.1.2 ***Compliance With SCGs.*** Chemical-specific SCGs for the site, including NYSDEC Class GA groundwater standards for shallow groundwater, will not be achieved by Alternative 1. Other chemical-specific SCGs for this site include the Federal Drinking Water Standards maximum contaminant level/maximum contaminant level goals (MCL/MCLGs), which are applied to all groundwater alternatives in conformance with NCP requirements. New York State has also promulgated MCLs for public drinking water systems that are similar to the Federal MCLs for the COCs at this site. For all groundwater COCs (chromium, cyanide, TCE, and 1,1,1-TCA), the Class GA groundwater standards are equal to or more stringent than the Federal and state drinking water standards. Note that there are no documented users of groundwater (for potable water purposes) downgradient of the UP site. Therefore, remediating the groundwater to achieve drinking water standards is considered a conservative remediation approach. Natural attenuation of groundwater contamination may occur over time, however, the continued presence of the contaminant source on site (i.e., contaminated soils) with this alternative indicates that groundwater contaminant levels are unlikely to fall below Class GA groundwater standards. With the exception of lead, there are no promulgated NAAQS; in addition, no on-site remedial activities are included in this alternative that would release contaminants to the air.

TBC items include other Federal and state advisories or guidelines that may be applied to the site but are not legally binding. The remedial action objectives for the soils of this site are based on the hazardous waste toxicity characteristic limitation for cadmium, chromium, lead, and TCE. These objectives were set at 20 times the TC limit, expressed as a total concentration in mg/kg. Alternative 1 will not achieve the specific site remedial action objectives. Other TBCs include the NIOSH IDLH, OSHA permissible exposure limits (PELs), and ACGIH threshold limit values (TLVs) for contaminants in air. As no on-site remedial activities are included as part of this alternative, these requirements are not applicable to this alternative.

Location-specific SCGs govern activities in critical environments, such as floodplains, wetlands, endangered species habitats, or historically significant areas. There are no regulated wetlands on-site, no threatened or endangered species were observed within the study area, and the site is not a critical or significant habitat for any threatened or endangered species. Therefore no location-specific ARARs apply.

Action-specific SCGs are technology or activity-based requirements. As Alternative 1 does not include any active remediation activities, there are no action-specific TBCs that apply to this alternative. Alternative 1 does not comply with the Federal or state requirement that states that the selected remedial alternative must attain a cleanup level that eliminates, reduces, or controls risks to human health and the environment.

5.2.1.3 ***Long-Term Effectiveness and Permanence.*** As the minimal action alternative, Alternative 1 does not provide a high degree of long-term effectiveness and permanence.

Environmental degradation may continue to occur due to migration of contaminants to surrounding media. Although human health risks may be minimized through the use of development and groundwater restrictions, these institutional measures will not eliminate the potential for human contact with site contaminants.

If this alternative is implemented, future use of the property would be limited by the institutional measures imposed. The property should not be developed for residential use. If a construction or utility project involving underground excavation is undertaken in the future, the project must be performed such that workers and the surrounding community are protected from exposure to contaminants.

5.2.1.4 ***Reduction of Toxicity, Mobility, and Volume Through Treatment.*** Alternative 1 will not result in a reduction in the toxicity, mobility, or volume of contaminated wastes present at the UP site. The long-term groundwater monitoring program will identify any natural attenuation of groundwater that may occur.

5.2.1.5 ***Short-Term Effectiveness.*** Alternative 1 will result in minimal short-term human or environmental impacts as the only active remedial activities that will occur at the site include sampling of existing monitoring wells. As sampling has already been accomplished at the site without causing negative short-term effects, sampling conducted in the future is not expected to cause concerns.

5.2.1.6 ***Implementability.*** Implementation of this alternative is straightforward and does not depend on the availability of vendors, materials, or services. Development, deed, and groundwater use restrictions would be implemented by NYSDEC. Long-term groundwater monitoring and sampling and are also readily accomplished.

5.2.1.7 ***Cost.*** There are no capital costs associated with Alternative 1. Estimated long-term O&M costs for Alternative 1 are included in Table 5-1. These costs are based on the assumptions included in the description of the alternative provided in Chapter 4 and have a range of accuracy of -30 to +50%. Annual O&M costs are estimated on a 30-year implementation basis and based on a 5% interest rate (EPA 1988) to estimate the present worth cost.

TABLE 5-1

COST ESTIMATE FOR ALTERNATIVE 1: NO FURTHER ACTION WITH LONG-TERM GROUNDWATER MONITORING

United Plating Site

ITEM	UNIT COST ($)		QUANTITY	COST (1999 $)[a]
CAPITAL COSTS				
A. Direct Costs				
Institutional Measures				
Deed & development restrictions				-[b]
Groudwater use restrictions				-[b]
			Subtotal	$0
B. Indirect Costs (None)				$0
O&M COSTS				
Long-term groundwater monitoring program				
Annual sampling of 26 wells for metals, VOCs & CN^- for first 5 years	$800	/well	130 wells	$90,000
Annual sampling of 20 wells for metals, VOCs & CN^- for next 25 years	$800	/well	500 wells	$177,000
Replacement of 2 wells every 5 years	$4,000	/well	10 wells	$20,000
			Present worth subtotal	$287,000
			TOTAL ANNUAL O&M COST	$19,000 /yr
PRESENT WORTH				
Based on a 30-yr life and a 5% interest rate				$291,000
				SAY $0.3 MILLION

a - Costs rounded to the nearest $1,000.
b - Administrative cost to community that is not included in cost estimate.
LS - Lump sum.

5.2.2 **Alternative 2: Source Isolation**

5.2.2.1 ***Protection of Human Health and the Environment.*** Alternative 2 is effective in preventing human contact with contaminated soils at the site, as long as the barriers are effective in isolating the source area and preventing plume migration. The containment system will also prevent contact with the most highly contaminated groundwater (i.e., that portion of the groundwater plume present beneath the site that would be contained by the slurry trench and cap). Only the on-site portion of the groundwater contaminant plume will be contained in this alternative; off-site portions of the plume would be unaffected. Natural attenuation of the contaminant levels is expected to occur over time for this contaminated portion of the plume through isolation of the contaminant source. Alternative 2 also includes site dewatering prior to cap installation; dewatering is intended to capture contaminated shallow groundwater and treat and dispose of it off-site.

5.2.2.2 ***Compliance With SCGs.*** Chemical-specific SCGs include NYSDEC Class GA groundwater standards and Federal and state drinking water standards for the site COCs. Alternative 2 will comply with these SCGs through isolation of contaminated soils and shallow groundwater to prevent continued migration of metals and VOCs to groundwater. Containment of the source of groundwater contamination is expected to result in natural attenuation of contaminant levels outside of the containment area to below the standards over time.

Alternative 2 will be implemented in a manner such that the NAAQS limit concentration for lead is not exceeded. Engineering controls, such as soil wetting or barrier fencing, will be used to prevent dust migration. A dust migration prevention plan and air monitoring plan must be developed in the remedial design phase to comply with the NAAQS requirements.

The remedial action objectives, TBCs for the soils of this site, are based on the hazardous waste toxicity characteristic limitation for cadmium, chromium, lead, and TCE. These objectives were set at 20 times the TC limit, expressed as a total concentration in mg/kg. Alternative 2 complies with the soil remedial action objectives through containment of all soils with contaminant concentrations exceeding the objectives; however, these soils will still be present on-site. Other TBCs include the NIOSH immediately dangerous to life and health (IDLH), OSHA PELs, and ACGIH TLVs for contaminants in air, which will be used to define worker health and safety guidelines during completion of the remediation.

As discussed in Alternative 1, no location-specific SCGs apply to the UP site. Action-specific SCGs identified for the activities proposed in Alternative 2 include regulatory requirements, which state that the selected remedial alternative must attain a cleanup level that eliminates, reduces, or controls risks to human health and the environment. Alternative 2 complies with these requirements by isolating the materials with contaminant concentrations exceeding the remedial action objectives; however, the contaminants will remain on site. Off-site transportation and disposal of hazardous waste (liquid generated during site dewatering) will be conducted in accordance with Federal and state regulatory requirements. This alternative will comply with all Federal and state requirements governing potential air emissions (particulates and volatile compounds) through the use of air monitoring and engineering controls during remediation. OSHA requirements for excavations greater than 5 ft deep and OSHA confined space entry procedures will be complied with, if applicable, during all soil removal and sampling activities.

5.2.2.3 ***Long-Term Effectiveness and Permanence.*** The long-term effectiveness and permanence of the containment system is unknown and will largely depend on the quality of construction. Long-term performance data for slurry trenches and caps indicate that these systems can be effective in isolating contaminated soil (EPA 1998). The time frame until failure of the containment system cannot be estimated. It is anticipated that the subsurface containment system will prevent significant migration of contaminants to the surrounding environment over the 30-year time frame included for evaluation of the remedial alternatives. The hydraulic conductivity of the vertical barriers and surface cap is estimated to be in the range of 10^{-6} to 10^{-7} cm/sec. If leakage through the barriers occurred in the future, installation of a groundwater pump and treat system would need to be evaluated to maintain the gradient of groundwater flow into the containment system.

If this alternative is implemented, future use of the property would be limited by the institutional measures imposed and the physical structures constructed as part of Alternative 2 (vertical barriers and surface cap). The property could not be developed with buildings or structures without including or replacing the functionality of the barriers and cap. Similarly, installation of utilities, stormwater collection systems, or other underground pipes or conduits must be conducted such that the functionality of the barriers and cap are not compromised.

5.2.2.4 ***Reduction of Toxicity, Mobility, and Volume Through Treatment.*** The site dewatering task of Alternative 2 will achieve some reduction in the toxicity, mobility, or volume of contamination present at the UP site. Contaminants will remain in site soils and their toxicity and volume will not be reduced; however, their mobility will be greatly reduced. The long-term groundwater monitoring program will identify any natural attenuation of groundwater contamination that occurs following isolation of the source of contamination.

5.2.2.5 ***Short-Term Effectiveness.*** Short-term human health and environmental impacts may occur as the result of implementing this alternative during the estimated 14 to 20 weeks required for completion of on-site remedial activities. These impacts may result from the generation of dust during construction activities and increased traffic at the site. Construction of the slurry trench and surface cap will generate dust and noise and will require the presence of heavy machinery at the site. Appropriate engineering controls (e.g., wetting of soils, use of impervious liners for stockpiling slurry trench construction materials) will be used to minimize these potential construction-related impacts. In addition, these activities may result in temporary releases of contaminants currently sorbed on soil particles to the groundwater as a result of the soil disturbance activities.

5.2.2.6 ***Implementability.*** Construction of slurry trenches and surface caps for the containment of contaminated groundwater is a commonly applied technology at hazardous waste sites; the equipment and labor required are readily available. Excavation of the site's silty soils may present some difficulty and require specialty excavation equipment.

5.2.2.7 ***Cost.*** Estimated capital and long-term O&M costs for Alternative 2 are included in Table 5-2. These costs are based on the assumptions included in the description of the alternative provided in Chapter 4 and have a range of accuracy of -30 to +50%. For this alternative, indirect costs include the following: 20% of direct costs are added for engineering and design costs, 10% of direct costs are added for legal and administrative costs, and 25% of direct costs are added for contingency. Annual O&M costs are estimated on a 30-year implementation basis and based on a 5% interest rate (EPA 1988) to estimate the present worth cost.

Note that for all alternatives, engineering oversight during remediation construction is not included in the engineering and design costs given.

COST ESTIMATE FOR ALTERNATIVE 2: SOURCE ISOLATION

United Plating Site

ITEM	UNIT COST ($)		QUANTITY	COST (1999 $)[a]
CAPITAL COSTS				
A. Direct Costs				
Institutional Measures				
Deed & development restrictions				-[b]
Bench Scale Test				$8,000
Site Preparation				
Contractor mobilization/demobilization	LS			$25,000
Establish decon area	LS			$2,000
Floor slab demolition	$2.73	$/ft^2$	20,000 ft^2	$55,000
Spread floor slab debris	$6.18	$/yd^3$	740 yd^3	$5,000
Site Dewatering				
Trench excavation	$23.10	$/yd^3$	150 yd^3	$3,000
Piping and sump installation/backfill	LS			$8,000
5000 gal holding tank for extracted groundwater	$3,000	/mo	1 mo	$3,000
Transportation and disposal of waste groundwater to TSDF (Model City, NY)	$2,500	/kgal	1 kgal	$3,000
Vertical Barrier Construction				
Barrier trench excavation	$6.71	$/yd^3$	4,850 yd^3	$33,000
Dike construction for slurry mixing	LS			$4,000
Furnish bentonite	$54.76	/ton	68 tons	$4,000
Mix and place slurry	$50.65	/kgal	1,000 kgal	$51,000
Key into aquitard and bottom clean	$20.12	$/yd^3$	700 yd^3	$14,000
Furnish sand for soil/bentonite mix	$3.63	$/yd^3$	4,950 yd^3	$18,000
Soil/bentonite mixing & placement in trench	$5.33	$/yd^3$	5,500 yd^3	$29,000
Construction testing	LS			$5,000
Upgradient groundwater diversion & storm sewer hookup	LS			$16,000
Clay Cap Construction				
Site backfilling & fill compaction	$2.65	$/yd^3$	6,000 yd^3	$16,000
Furnishing and installment of filter fabric	$0.11	$/ft^2$	67,200 ft^2	$7,000
Furnishing and installment of 6-in sand layer	$0.23	$/ft^2$	67,200 ft^2	$15,000
Furnishing and installment of 60 mil VLDPE layer	$1.62	$/ft^2$	67,200 ft^2	$109,000
Furnishing and installment of 6-in. sand layer	$0.23	$/ft^2$	67,200 ft^2	$15,000
Furnishing and installment of filter fabric	$0.11	$/ft^2$	67,200 ft^2	$7,000
Installment of 1-1/2 in. asphalt pavement with 10-in. subgrade	$0.95	$/ft^2$	67,200 ft^2	$64,000
			Subtotal	$519,000

COST ESTIMATE FOR ALTERNATIVE 2: SOURCE ISOLATION

United Plating Site

ITEM	UNIT COST ($)	QUANTITY	COST (1999 $)[a]
B. Indirect Costs			
Engineering and Design @ 20%			$104,000
Legal and Administrative @ 10%			$52,000
Contingency @ 25%			$130,000
		Total	$805,000
O&M COSTS			
Fence Maintenance			$1,000 /yr
Cap Maintenance			
Semi-annual inspection			$1,000 /yr
Asphalt cover repair/sealing			$4,000 /yr
Long-term groundwater monitoring program			
Annual sampling of 9 wells for metals, VOCs & CN^- for 30 years	$800 /well	270 wells	$111,000
Replacement of 2 wells every 5 years	$4,000 /well	10 wells	$20,000
		Present worth subtotal	$131,000
		Annual cost	$9,000 /yr
		TOTAL ANNUAL O&M COST FOR 30 YEARS	$15,000 /yr
PRESENT WORTH			
Based on a 30-yr life and a 5% interest rate			$1,036,000
			SAY $1.0 MILLION

a - Costs rounded to the nearest $1,000.
b - Administrative cost to community that is not included in cost estimate.
LS - Lump sum.

5.2.3 **Alternative 3: Solidification/Stabilization**

5.2.3.1 ***Protection of Human Health and the Environment.*** Alternative 3 is protective of human health through the treatment of all soils contaminated at levels above the site remedial action objectives and covering the treated soils with an asphalt pavement. The potential for human contact with contaminated soils will therefore be eliminated. S/S of the contaminated soils will also eliminate leaching of metals and VOCs to the groundwater beneath the site. Immobilization of the metal and VOC contaminants should result in natural attenuation of groundwater contamination over time. Alternative 3 also includes site dewatering, which is intended to capture contaminated shallow groundwater and treat and dispose of it off-site.

5.2.3.2 ***Compliance With SCGs.*** Alternative 3 complies with all chemical- and action-specific SCGs for the UP site. Chemical-specific SCGs include NYSDEC Class GA groundwater standards for the COCs (i.e., chromium, cyanide, TCE, and 1,1,1-TCA). Alternative 3 will comply with these ARARs through ex situ treatment of contaminated soils and shallow groundwater and backfilling to prevent continued migration of metals to groundwater. Containment of the source via immobilization should result in a reduction of contaminant levels to below the groundwater standards over time. Natural attenuation of off-site groundwater contamination (i.e., areas that are not receiving S/S treatment) should reduce metals and VOC concentrations to meet groundwater standards over time.

Alternative 3 will be implemented in a manner such that the NAAQS limit concentration for lead is not exceeded. Engineering controls, such as soil wetting or barrier fencing, will be used to prevent dust migration. A dust migration prevention plan and air monitoring plan must be developed in the remedial design phase to comply with the NAAQS requirements.

The remedial action objectives, TBCs for the soils of this site, are based on the hazardous waste toxicity characteristic limitation for cadmium, chromium, lead, and TCE. As agreed to by NYSDEC these objectives were set at 20 times the TC limit, expressed as a total concentration in mg/kg. Alternative 3 complies with the soil remedial action objectives through the excavation, ex situ S/S treatment, and backfilling of contaminated site soils. Other TBCs include the NIOSH IDLH, OSHA PELs, and ACGIH TLVs for contaminants in air, which will be used to define worker health and safety guidelines during completion of the remediation.

As discussed in Alternatives 1 and 2, no location-specific SCGs apply to the UP site. Action-specific SCGs identified for the activities proposed in Alternative 3 include regulatory requirements, which state that the selected remedial alternative must attain a cleanup level that eliminates, reduces, or controls risks to human health and the environment. Alternative 3 complies with these requirements by achieving the specified cleanup levels through permanent treatment of the contaminated materials. The LDRs are not applicable to the on-site replacement of stabilized soils as the soils will not be removed off the site but will be kept in a management unit on site. These soils will be treated by S/S prior to placement on-site beneath asphalt pavement, and are therefore in compliance with LDRs. This alternative will comply with all Federal and state requirements governing potential air emissions (particulates and volatiles) through the use of air monitoring and engineering controls during remediation.

5.2.3.3 ***Long-Term Effectiveness and Permanence.*** The ex situ S/S of contaminated soils will significantly reduce or eliminate the leaching of heavy metals and VOCs to the groundwater. Natural attenuation of downgradient groundwater contamination is expected to occur over time following removal of the source of the contamination. The long-term effectiveness of S/S will depend on the quality of mixing/construction and backfill placement. The solidified mass will be susceptible to weathering and cracking over time. Water infiltration will be minimized by constructing an asphalt pavement, which will divert stormwater runoff away from the solidified area. The asphalt pavement will also eliminate the potential for human contact with the treated materials. Maintenance of the asphalt pavement is necessary to ensure its integrity. Long-term groundwater monitoring will also be required to evaluate the attenuation of the metals and VOC contamination and to ensure that contaminants do not begin to leach from the solidified soils over time.

If this alternative is implemented, future use of the property would be limited by the institutional measures imposed and the solidified/stabilized material buried on site. The property could be developed with buildings or structures, but without disturbing or otherwise negatively impacting the on-site solidified/stabilized soils. For example, the installation of load-bearing structures on top of the solidified/stabilized soils may cause these soils to crack or fail. Construction of a structure must be designed to prevent negative impacts to the solidified/stabilized soils. Similarly, installation of utilities, stormwater collection systems, or other underground pipes or conduits must be conducted such that the solidified/stabilized soils are not impacted.

5.2.3.4 ***Reduction of Toxicity, Mobility, and Volume Through Treatment.*** Alternative 3 will reduce the mobility of the metals contamination present in site soils and shallow groundwater through the S/S process. The contaminants will remain in the treated soils; however, this treatment process will not result in a reduction of the toxicity of the contamination present. The volume of waste materials will increase slightly as a result of the S/S process. Site dewatering will also reduce the toxicity, mobility, and volume of contaminants present in shallow groundwater.

5.2.3.5 ***Short-Term Effectiveness.*** This alternative will result in increased traffic and activity at the site during implementation of on-site activities. The estimated time for completion of the ex situ treatment process, including contractor mobilization/ demobilization, is four to six weeks; however, the asphalt pavement cannot be completed until curing of the treated soils is complete and posttreatment analytical results are available and reviewed. The overall time frame for completion of this alternative is 16 to 22 weeks. Dust and noise will be generated during the excavation and treatment phases; potential short-term adverse health impacts may exist for workers implementing the remedy or the surrounding community from direct contact with contaminated soils and/or airborne particulates. During the remedial action phase, these risks will be minimized through the use of appropriate personal protective equipment by workers and dust suppression methods, such as soil wetting. In addition, the treatment process may result in greater concentrations of COCs in the groundwater in the short-term due to the placement of treated soils at or below the shallow groundwater table during treatment.

5.2.3.6 ***Implementability.*** S/S is an established technology that has been applied at many hazardous waste sites. A treatability study will be required in order to confirm the appropriate reagent and dosing concentrations needed to meet regulatory requirements for backfilling on site. Excavation of the site's silty soils may be difficult to achieve in certain areas and may require specialty excavation equipment.

Complete mixing of the soils and reagents is critical to the S/S treatment process. Trained operators are therefore required for effective implementation of this process as well as collection of frequent samples of the treated product to ensure that complete mixing has been achieved. Other technologies required for implementing this alternative, i.e., site dewatering, grading, and paving, are common technologies that may be easily implemented at this site.

5.2.3.7 ***Cost.*** Estimated capital and long-term O&M costs for Alternative 3 are included in Table 5-3. These costs are based on the assumptions included in the description of the alternative provided in Chapter 4 and have a range of accuracy of -30 to +50%. For this alternative, indirect costs include the following: 20% of direct costs are added for engineering and design costs, 10% of direct costs are added for legal and administrative costs, and 30% of direct costs are added for contingency. The field work involved in the S/S remedy involves a multistep technique (soils excavation/stockpiling and soil treatment/backfilling) that requires a greater contingency for unconsidered lag time. Annual O&M costs are estimated on a 30-year implementation basis and based on a 5% interest rate (EPA 1988) to estimate the present worth cost.

5.2.4 **Alternative 4A: Removal of Source Area**

5.2.4.1 ***Protection of Human Health and the Environment.*** Alternative 4A includes excavation of all on-site soils beneath the footprint of the UP building plus 10% and removal of shallow groundwater contaminated with metals and VOCs at levels exceeding the specified remedial action objectives, thereby removing the source of site-related contamination in groundwater. This alternative will therefore prevent further environmental degradation, and will also eliminate the potential health risks posed by human contact with the contaminated soils. Site dewatering conducted as part of Alternative 4A is intended to remove contaminants present in shallow groundwater.

The excavated wastes require appropriate treatment and disposal. The BDAT for metals-contaminated wastes practiced at TSDFs is stabilization treatment. The stabilization treatment required for hazardous wastes in accordance with the LDRs will immobilize the metal contaminants present, further ensuring that the likelihood of a release to the environment is reduced. This alternative includes transport of hazardous wastes to the TSDF in Model City, New York, for treatment and disposal. Nonhazardous wastes will be transported and disposed of in an industrial, double-lined landfill that is permitted to accept solid waste. Disposal of nonhazardous wastes in an industrial waste landfill will reduce the potential for human contact with the wastes or the migration of the contaminants to the surrounding site environment.

5.2.4.2 ***Compliance With SCGs.*** Alternative 4A will achieve compliance with chemical-specific SCGs for the site, including Class GA groundwater standards, through the removal

TABLE 5-3 (Page 1 of 2)

COST ESTIMATE FOR ALTERNATIVE 3: SOLIDIFICATION/STABILIZATION

United Plating Site

ITEM	UNIT COST ($)		QUANTITY	COST (1999 $)[a]
CAPITAL COSTS				
A. Direct Costs				
Institutional Measures				
Deed & development restrictions				-[b]
Treatability Study	LS			$10,000
Site Preparation				
Contractor mobilization/demobilization	LS			$70,000
Floor slab demolition	$2.73	/ft^2	30,760 ft^2	$84,000
Concrete waste transportation & disposal (nonhazardous)	$50	/yd^3	1,150 yd^3	$58,000
Establish decon and mixing areas	LS			$5,000
Site Dewatering (same as Alternative 2)				$17,000
Excavation & Solidification/Stabilization				
Soil excavation & stockpiling	$11.24	/yd^3	11,500 yd^3	$129,000
Ex situ solidification/stabilization[c]:				
Processing	$45	/yd^3	13,800 yd^3	$621,000
Reagents	$20	/yd^3	13,800 yd^3	$276,000
Pre- and Post-treatment analyses:				
TCLP Cd, Cr, Pb, TCE	$250	/sample	105 samples	$26,000
UCS/permeability	$450	/sample	10 samples	$5,000
Durability	$2,300	/sample	2 samples	$5,000
Site Restoration				
Backfilling of solidified material	$6.71	/yd^3	15,180 yd^3	$102,000
Installment of 1-1/2 in. pavement over solidified material	$0.95	/ft^2	31,000 ft^2	$29,000
			Subtotal	$1,437,000

COST ESTIMATE FOR ALTERNATIVE 3: SOLIDIFICATION/STABILIZATION

United Plating Site

ITEM	UNIT COST ($)	QUANTITY	COST (1999 $)[a]
B. Indirect Costs			
Engineering and Design @ 15%			$216,000
Legal and Administrative @ 10%			$144,000
Contingency @ 30%			$431,000
		Total	$2,228,000
O&M COSTS			
Long-term groundwater monitoring program			
Annual sampling of 8 wells for TAL metals, TCL VOCs & CN^- for 30 years	$800 /well	240 wells	$98,000
Replacement of 2 wells every 5 years	$4,000 /well	10 wells	$20,000
		Annual O&M cost for 30 year period	$6,000 /yr
PRESENT WORTH			
Based on a 30-yr life and a 5% interest rate			$2,320,000
			SAY $2.3 MILLION

a - Costs rounded to the nearest $1,000.
b - Administrative cost to community that is not included in cost estimate.
c - Assumes 20% volume expansion in excavated soils.
L - Lump sum.

of the contaminant source. The impacted shallow groundwater beneath the site will either be removed during site dewatering or during soil excavation. Contaminated groundwater not captured by the activities of Alternative 4A will achieve groundwater standards over time through natural attenuation processes.

Alternative 4A will be implemented in a manner such that the NAAQS limit concentration for lead is not exceeded. Engineering controls, such as soil wetting or barrier fencing, will be used to prevent dust migration. A dust migration prevention plan and air monitoring plan must be developed in the remedial design phase to comply with the NAAQS requirements.

The remedial action objectives, TBCs for the soils of this site, are based on the hazardous waste toxicity characteristic limitation for cadmium, chromium, lead, and TCE. These objectives were set at 20 times the TC limit, expressed as a total concentration in mg/kg. Alternative 4A complies with the soil remedial action objectives through excavation of all on-site soils with contaminant concentrations exceeding the objectives. Alternative 4A comes closer to meeting the NYSDEC soil cleanup objectives (TAGM 4046) than Alternative 4B by removing more soil from the site that is contaminated but not potentially hazardous. For this reason, Alternative 4A is more protective of human health and the environment than Alternative 4B.

Other TBCs include the NIOSH IDLH, OSHA PELs, and ACGIH TLVs for contaminants in air, which will be used to define worker health and safety guidelines during completion of the remediation.

As discussed in Alternatives 1, 2, and 3, no location-specific SCGs apply to the UP site. Action-specific SCGs identified for the activities proposed in Alternative 4A include regulatory requirements, which state that the selected remedial alternative must attain a cleanup level that eliminates, reduces, or controls risks to human health and the environment. Alternative 4A complies with these requirements by achieving the specified cleanup levels through active remediation and permanent removal of the contaminated materials. Attainment of the remedial action objectives in the groundwater medium is dependent on natural attenuation of the contamination present following removal of contaminated soils and shallow groundwater beneath the site. This alternative will comply with all Federal and state requirements governing potential air emissions (particulates and volatiles) through the use of air monitoring and engineering controls during remediation. OSHA requirements for excavations greater than 5 ft deep and OSHA confined space entry procedures will be complied with, if applicable, during all soil removal and sampling activities.

5.2.4.3 ***Long-Term Effectiveness and Permanence.*** The excavation and off-site disposal of contaminated soils and shallow groundwater will permanently remove metals and VOC contaminants in site media. Natural attenuation of contaminants not captured in groundwater is expected following removal of the contaminant source; however, the time frame anticipated for achievement of groundwater remedial action objectives is unknown. If this alternative is implemented, future property use would not be restricted.

5.2.4.4 ***Reduction of Toxicity, Mobility, and Volume Through Treatment.*** Alternative 4A will result in a significant decrease in the toxicity, mobility, and volume of contaminants found in site soils and shallow groundwater. Site dewatering will also reduce the toxicity, mobility, and volume of contaminants present in shallow groundwater.

5.2.4.5 ***Short-Term Effectiveness.*** Excavation of soils as included in Alternative 4A will result in potential adverse health effects for workers and the surrounding public through the generation of contaminated dust. The potential health hazards will be minimized through the use of engineering controls (e.g., soil wetting) and personal protective equipment by on-site workers. This alternative will result in an increase in noise and traffic at the site during site operations. Site dewatering, excavation of site soils, including contractor mobilization and demobilization and backfilling of the excavations, is expected to require at least 22 to 28 weeks to complete.

5.2.4.6 ***Implementability.*** Excavation is a commonly applied technology at hazardous waste sites and does not require special equipment or operators. If difficulty is encountered in excavating the soils at the site, specialty excavators may be needed. Backfilling is also an easily applied technology. Off-site transport of excavated wastes is easily implemented; however, approval and scheduling of waste transport and special requirements for transport of any hazardous wastes must be considered. This alternative is dependent on waste acceptance at the appropriate treatment and/or landfill facilities and the availability of adequate space at the landfills for waste disposal. This alternative assumes that hazardous waste will only require stabilization treatment to meet LDRs.

5.2.4.7 ***Cost.*** Estimated capital and long-term O&M costs for Alternative 4A are included in Table 5-4. These costs are based on the assumptions included in the description of the alternative provided in Chapter 4, and have a range of accuracy of -30 to +50%. The relatively large transportation and disposal costs associated with Alternative 4A account for more than half of the capital costs and skew the indirect costs to unreasonably high numbers. To account for this trend, the engineering and design costs were reduced to 5% of the capital costs and the contingency costs were assumed to be 15% of the capital costs. Legal and administrative costs were assumed to be 10% of the capital costs. There are no long-term O&M costs associated with this alternative. These costs are estimated on a 30-year implementation basis and based on a 5% interest rate (EPA 1988) to estimate the present worth cost.

5.2.5 **Alternative 4B: Reduced Source Area Removal**

5.2.5.1 ***Protection of Human Health and the Environment.*** Alternative 4B is similar to Alternative 4A but includes only the excavation of potentially hazardous soil from the UP site and not all soils beneath the footprint of the building (plus 10%), thus referred to as "reduced" source area removal. In excavating the potentially hazardous soil, some contaminated shallow groundwater will also be removed. This alternative will prevent further environmental degradation and will also eliminate the potential health risks posed by human contact with potentially hazardous soils. Site dewatering conducted as part of Alternative 4B is intended to remove contaminants present in shallow groundwater.

Off-site treatment and disposal of hazardous and nonhazardous soils will be conducted in a similar manner as described in Alternative 4A. Issues relating to the protection of human health and the environment for off-site transport, treatment, and/or disposal are similar to Alternative 4A.

5.2.5.2 ***Compliance With SCGs.*** In comparison to Alternative 4A, Alternative 4B will achieve the same level of compliance with chemical- and action-specific SCGs for the site except for attaining Class GA groundwater standards. By removing less contaminated soil (in comparison to Alternative 4A), the groundwater will likely take more time to naturally attenuate to achieve groundwater standards. However, groundwater standards are expected to be achieved over time.

TABLE 5-4

COST ESTIMATE FOR ALTERNATIVE 4A: REMOVAL OF SOURCE AREA

United Plating Site

ITEM	UNIT COST ($)		QUANTITY		COST (1999 $)[a]
CAPITAL COSTS					
A. Direct Costs					
Site Preparation					
Contractor mobilization/demobilization	LS				$75,000
Floor slab demolition	$2.73	/ft^2	30,760	ft^2	$84,000
Concrete waste transportation & disposal (nonhazardous, contaminated)	$50	/yd^3	1,150	yd^3	$58,000
Establish decon area	LS				$5,000
Site Dewatering (Same as Alternative 2)					$17,000
Excavation					
Soil excavation & stockpiling	$11.24	/yd^3	11,500	yd^3	$129,000
Confirmatory sampling and analyses for TAL metals, TCL VOCs, CN^-	$250	/sample	165	samples	$41,000
Liners/covers for stockpiling wastes	$0.20	/ft^2	100,000	ft^2	$20,000
Loading soils into trailers[c]	$1.55	/yd^3	13,800	yd^3	$21,000
Waste Disposal [b]					
TCLP analyses of stockpiled soil	$250	/sample	77	samples	$19,000
Hazardous soil (20%)					
Transportation	$90	/yd^3	2,760	yd^3	$248,000
Stabilization and landfilling	$225	/yd^3	2,760	yd^3	$621,000
Nonhazardous soil (80%)					
Transportation	$62.50	/yd^3	11,040	yd^3	$690,000
Landfilling	$30	/yd^3	11,040	yd^3	$331,000
Site Restoration					
Backfill of excavation with clean fill	$7.50	/yd^3	11,500	yd^3	$86,000
6-in. Topsoil	$17.17	/yd^3	575	yd^3	$10,000
Seeding	LS				$2,000
				Subtotal	$2,457,000
B. Indirect Costs					
Engineering and Design @ 5%					$123,000
Legal and Administrative @ 10%					$246,000
Contingency @ 15%					$369,000
				Total	$3,195,000
O&M COSTS (none)					$0
PRESENT WORTH					
Based on a 30-yr life and a 5% interest rate					$3,195,000
					SAY $3.2 MILLION

a - Costs rounded to the nearest $1,000.
b - Assumes excavated soil density of 1.5 tons/cubic yard.
c - Assumes 20% volume expansion in excavated soils.
LS - Lump sum.

The remedial action objectives, TBCs for the soils of this site, are based on the hazardous waste toxicity characteristic limitation for cadmium, chromium, lead, and TCE. These objectives were set at 20 times the TC limit, expressed as a total concentration in mg/kg. Alternative 4B complies with the soil remedial action objectives through excavation of all on-site soils with contaminant concentrations exceeding the objectives. However, by removing less contaminated but nonhazardous soil in this alternative, Alternative 4B does not come as close as Alternative 4A to meeting the NYSDEC soil cleanup objectives (TAGM 4046). For this reason, Alternative 4B is less protective of human health and the environment than Alternative 4A.

5.2.5.3 ***Long-Term Effectiveness and Permanence.*** The excavation and off-site disposal of contaminated soils and shallow groundwater will permanently remove metals and VOC contaminants in site media. Natural attenuation of contaminants not captured in groundwater is expected following removal of the contaminant source; however, the time frame anticipated for achievement of groundwater remedial action objectives is unknown and is expected to take a longer time as compared to Alternative 4A.

If this alternative is implemented, future use of the property would be limited by the institutional measures imposed. Construction or repair involving underground excavation must be conducted in such a manner as to prevent contaminant exposure by on-site workers and the surrounding community.

5.2.5.4 ***Reduction of Toxicity, Mobility, and Volume Through Treatment.*** By removing potentially hazardous soils from the UP site, Alternative 4B will result in a significant decrease in the toxicity, mobility, and volume of contaminants found in site soils and shallow groundwater. Site dewatering will also reduce the toxicity, mobility, and volume of contaminants present in shallow groundwater.

5.2.5.5 ***Short-Term Effectiveness.*** The short-term effectiveness of Alternative 4B is similar to Alternative 4A. Site dewatering, excavation of site soils, including contractor mobilization and demobilization, and backfilling of the excavations is expected to require at least 20 to 26 weeks to complete.

5.2.5.6 ***Implementability.*** Alternative 4B is equally as implementable as Alternative 4A.

5.2.5.7 ***Cost.*** Estimated capital and long-term O&M costs for Alternative 4B are included in Table 5-5. These costs are based on the assumptions included in the description of the alternative provided in Chapter 4 and have a range of accuracy of -30 to +50%. As in Alternative 4A, the relatively large transportation and disposal costs associated with Alternative 4B account for more than half of the capital costs; therefore, the engineering and design costs were assumed to be 7% of the capital costs (the engineering and design effort involved in Alternatives 4A and 4B are approximately the same), and the contingency costs were assumed to be 15% of the capital costs. Legal and administrative costs were assumed to be 10% of the capital costs. Annual O&M costs are estimated on a 5-year implementation basis and based on a 5% interest rate (EPA 1988) to estimate the present worth cost.

5.3 COMPARATIVE ANALYSIS OF ALTERNATIVES

In the previous section each of the remedial alternatives was individually evaluated with respect to the seven evaluation criteria. In this section the comparative performance of the alternatives is discussed where common elements exist among them.

5.3.1 Protection of Human Health and the Environment

Alternative 1 provides the least protection of human health and the environment as institutional controls may not be effective in preventing human contact with contaminated soils (particularly lead-contaminated surface soils), and they are ineffective in preventing continued migration of contaminants to the environment. Alternative 3 provides greater protection of human health and the environment than Alternative 2 as the wastes remaining on-site for this alternative will be treated using S/S to prevent leaching of contaminants to the underlying groundwater. Alternative 2 allows untreated wastes to remain on-site; a potential risk to human health and the environment will result if the subsurface containment system fails. Alternative 4A achieves the greatest degree of protection of human health and the environment through removal of soil and shallow groundwater contaminants at levels exceeding the remedial action objectives and adjacent contaminated but nonhazardous soils. Alternative 4B is slightly less protective of human health and the environment than Alternative 4A as it only involves removal of potentially hazardous soil and leaves some

TABLE 5-5

COST ESTIMATE FOR ALTERNATIVE 4B: REDUCED SOURCE AREA REMOVAL

United Plating Site

ITEM	UNIT COST ($)		QUANTITY	COST (1999 $)[a]
CAPITAL COSTS				
A. Direct Costs				
Institutional Measures				
Deed & development restrictions				-[b]
Site Preparation				
Contractor mobilization/demobilization	LS			$60,000
Floor slab demolition	$2.73	$/ft^2$	30,760 ft^2	$84,000
Concrete waste transportation & disposal (nonhazardous)	$50	$/yd^3$	1,150 yd^3	$58,000
Establish decon area	LS			$5,000
Site Dewatering (Same as Alternative 2)				$17,000
Excavation				
Soil excavation & stockpiling	$11.24	$/yd^3$	6,430 yd^3	$72,000
Confirmatory sampling	$250	/sample	93 samples	$23,000
Liners/covers for stockpiling wastes	$0.20	$/ft^2$	50,000 ft^2	$10,000
Loading soils into trailers	$1.55	$/yd^3$	7,720 yd^3	$12,000
Waste Disposal[c]				
TCLP analyses of stockpiled soil	$250	/sample	43 samples	$11,000
Hazardous soil (40%)				
Transportation	$90	$/yd^3$	3,090 yd^3	$278,000
Stabilization and landfilling	$225	$/yd^3$	3,090 yd^3	$695,000
Nonhazardous soil (60%)				
Transportation	$62.50	$/yd^3$	4,630 yd^3	$289,000
Landfilling	$30	$/yd^3$	4,630 yd^3	$139,000
Site Restoration				
Backfill of excavation with clean fill	$7.50	$/yd^3$	6,430 yd^3	$48,000
6-in. Topsoil	$17.17	$/yd^3$	320 yd^3	$5,000
Seeding	LS			$2,000
			Subtotal	$1,808,000
B. Indirect Costs				
Engineering and Design @ 7%				$127,000
Legal and Administrative @ 10%				$181,000
Contingency @ 15%				$271,000
			Total	$2,387,000
O&M COSTS				
Long-term groundwater monitoring program				
Annual sampling of 8 wells for metals, VOCs & CN⁻ for first 5 years	$800	/well	40 wells	$28,000
			Annual O&M cost for 5 year period	$6,000 /yr
PRESENT WORTH				
Based on a 30-yr life and a 5% interest rate				$2,413,000
				SAY $2.4 MILLION

a - Costs rounded to the nearest $1,000.
b - Administrative cost to the community not considered in this cost estimate.
c - Assumes excavated soil density of 1.5 tons/cubic yard.
LS - Lump sum.

contaminated soil on site. Alternatives 2, 3, 4A, and 4B achieve removal of contaminated shallow groundwater from the site through site dewatering.

5.3.2 **Compliance With SCGs**

Alternative 1 does not comply with any site SCGs with the exception of the Federal and state requirement to include a "no action" alternative in the range of detailed evaluation. Alternatives 2, 3, 4A, and 4B comply with all site SCGs except for the remedial action objectives for groundwater. These four alternatives address soils and shallow groundwater located on site only; however, the isolation or removal of the site source is expected to eliminate contaminant migration to downgradient areas via the groundwater pathway. Contamination currently present in groundwater is expected to attenuate over time.

5.3.3 **Long-Term Effectiveness and Permanence**

Alternative 4A is expected to provide the greatest degree of long-term effectiveness and permanence of the five alternatives. Excavated soils will be removed from the site and disposed of in a secure landfill where migration of remaining contaminants in the soils to the surrounding environment is prevented. Alternative 4B provides slightly less long-term effectiveness and permanence as compared to Alternative 4A as some contaminated but nonhazardous soils would remain on site following remediation activities. Alternative 3 is expected to be effective in preventing the further leaching of contaminants in site soils to the underlying groundwater; however, the long-term action of groundwater flow on solidified wastes cannot be predicted with certainty. Soils to be treated using the ex situ S/S process in Alternative 3 are present below the shallow groundwater table; the long-term action of groundwater flow on solidified soils cannot be predicted. Alternative 2 will prevent migration of and human contact with contaminants in the soils at the site; however, the untreated contaminants remain at the site and may be released to the environment in the event of failure of the containment system. Alternative 1 does not provide a high degree of long-term effectiveness or permanence as no active remediation measures are proposed.

Future use of the property would be restricted if Alternative 1, 2, 3, or 4B is implemented. Alternative 4A is the only alternative that does not include restrictions on future property use.

5.3.4 **Reduction of Toxicity, Mobility, and Volume Through Treatment**

Alternative 1 will not result in any reduction of toxicity, mobility, or volume of contamination present at the UP site as no active remedial measures are included. Alternative 2 is expected to result in some toxicity, mobility, and volume reduction through site dewatering and greater mobility reduction through capping and vertical barrier installation. Alternative 3 will result in a decrease in the mobility of contaminants present through S/S treatment, but the volume of contamination will remain the same as pre-remediation conditions. Alternatives 4A and 4B will result in a permanent decrease in the toxicity, mobility, and volume of contaminants present in excavated soils as the soils will be disposed of in an off-site landfill in accordance with Federal and state regulatory requirements. Alternative 4A will result in a greater volume reduction of contaminants compared to Alternative 4B as more contaminated soils will be removed as part of this alternative.

5.3.5 **Short-Term Effectiveness**

Alternative 1 results in the least amount of short-term impacts to human health and the environment as the only remedial activities included are sampling. Alternatives 2 and 3 will cause a similar disruption to the surrounding community due to the remedial activities to be conducted and will require approximately the same amount of time to implement. The potential hazards to workers implementing the remedy and the surrounding public due to implementation of these alternatives is expected to be essentially the same.

Alternatives 4A and 4B will result in greater site impacts during implementation than Alternatives 2 and 3 due to loading and off-site transport of soil wastes. Truck traffic, estimated at 10 to 15 truckloads per day, will be ongoing at the site for a period of four to six weeks. Alternatives 4A and 4B will require slightly more time to implement than the other alternatives.

5.3.6 **Implementability**

All five alternatives are implementable. Alternative 1 is the easiest of the five alternatives to implement as only establishment of institutional measures and a monitoring program are required. Alternative 2 involves commonly applied technologies at landfill sites for the installation of a surface cap and slurry walls. The ex situ S/S treatment process included in

Alternative 3 is a commonly applied technology at hazardous waste sites, but it must be implemented by an experienced remedial contractor. Alternatives 4A and 4B, excavation of contaminated soils, are easily implementable and utilize common excavation equipment. The disposal options included in Alternatives 4A and 4B, including off-site treatment and disposal at a TSDF or industrial landfill are common practices at hazardous waste sites and pose no special constraints to implementation.

5.3.7 **Cost**

The costs of each remedial alternative are summarized in Table 5-6. Alternative 1, the no further action alternative, has the lowest estimated present worth cost ($0.3 million) of the remedial alternatives. Alternative 2, the source isolation alternative, has the next highest estimated present worth cost ($1.0 million). Alternative 4B, the reduced source area removal alternative, and Alternative 3, the solidification/stabilization alternative, both have approximately the same present worth cost at ($2.3 to $2.4 million), with Alternative 3 costing slightly less. Alternative 4A, the source area removal alternative, has the highest present worth cost at $3.2 million.

5.4 **COST-SENSITIVITY ANALYSIS**

A sensitivity analysis was conducted to determine the impact of varying the quantities of key parameters in the remedial alternatives presented. The results of the sensitivity analysis are presented in Table 5-7. The quantities of contaminated soils for excavation, treatment, and/or disposal were varied according to the assumptions discussed below. The impact of the differing quantities on minor cost items such as the number of confirmatory samples was not accounted for in the estimated costs. Alternatives 1 and 2 are not impacted significantly by changes in the quantity of contaminated soils at the site.

Costs for Alternative 3 were evaluated by assuming a -25 to +50% change in the volume of contaminated soils to be treated using ex situ S/S treatment. The costs for Alternatives 4A and 4B were evaluated by assuming a -25 to +50% change in the total quantity of soils to be excavated from the site. The costs for these two alternatives were also calculated based on different percentages of hazardous vs nonhazardous materials present at the site, with no change in the overall quantity of excavated wastes for the respective alternative. The percent of hazardous vs nonhazardous materials for the cost estimates presented in Section 5.2 were 20% hazardous and 80% nonhazardous for Alternative 4A

TABLE 5-6

SUMMARY OF REMEDIAL ALTERNATIVE COST ESTIMATES[a]

United Plating Site

ALTERNATIVE	CAPITAL COST	O&M COSTS (ANNUAL)	PRESENT WORTH[b]
Alternative 1: No Further Action with Long-Term Monitoring	$0	$19,000	$300,000
Alternative 2: Source Isolation	$805,000	$15,000	$1,000,000
Alternative 3: Solidification/ Stabilization	$2,228,000	$6,000	$2,300,000
Alternative 4A: Source Area Removal	$3,195,000	$0	$3,200,000
Alternative 4B Reduced Source Area Removal	$2,387,000	$6,000	$2,400,000

a - Costs in 1999 dollars, all costs rounded to nearest $100,000.

b - Present worth based on a 30-yr life at 5% interest rate.

TABLE 5-7

COST SENSITIVITY ANALYSIS

United Plating Site

ALTERNATIVE	ASSUMPTIONS[a]	PRESENT WORTH[b]
Alternative 3	50% increase in volume to be treated	$3,200,000
	Current estimate (13,800 yd^3 total)	$2,300,000
	25% decrease in total volume	$1,900,000
Alternative 4A	50% increase in volume to be treated	$4,600,000
	25% increase in hazardous volume[c]	$3,400,000
	Current estimate (13,800 yd^3 total; 2760 yd^3 hazardous)	$3,200,000
	25% decrease in hazardous volume[c]	$3,000,000
	25% decrease in total volume	$2,500,000
Alternative 4B	50% increase in volume to be treated	$3,400,000
	25% increase in hazardous volume[c]	$2,600,000
	Current estimate (6,900 yd^3 total; 3,090 yd^3 hazardous)	$2,400,000
	25% decrease in hazardous volume[c]	$2,200,000
	25% decrease in total volume	$1,900,000

a - Calculated costs assume same treatment and disposal unit rates regardless of waste volume acutal unit rates may decrease with increased waste volume or increase for smaller waste volumes.

b - All costs rounded to nearest $100,000.

c - Total volume remains the same as current estimate.

and 40% hazardous and 60% nonhazardous for Alternative 4B. The sensitivity analysis assumed a 25% increase or decrease in the total quantity of hazardous wastes.

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