New York State Department of Environmental Conservation
50 Wolf Road, Albany, New York, 12233-7250
(518) 457-6934 Fax (518) 457-0629

Michael D. Zagata
Commissioner

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION

STATEMENT OF BASIS

FOR

Ciba Specialty Chemicals Corporation And Hercules Incorporated
Main Plant Site
Lower Warren Street
Glens Falls, NY 12801
EPA I.D.: NYD002069748

Public Noticed on: July 17, 1996

Dated: Nov. 5, 1996

By: [signature]
Norman H. Nosenchuck, P.E.
Director
Division of Solid & Hazardous Materials

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION
STATEMENT OF BASIS
FOR
CIBA SPECIALTY CHEMICALS CORPORATION AND HERCULES INCORPORATED
MAIN PLANT SITE
LOWER WARREN STREET
GLENS FALLS, NEW YORK 12801
EPA I.D. NO.: NYD002069748

Date: November 4, 1996

I. ANNOUNCEMENT OF PROPOSED CORRECTIVE MEASURES

The Statement of Basis (SB) has been developed by the New York State Department of Environmental Conservation (NYSDEC) under the authority of the Solid Waste Disposal Act, as amended, and more commonly referred to as the Resource Conservation and Recovery Act, as amended, or RCRA.

The SB describes the final corrective measure being selected for remediating the contaminated soil/waste material and groundwater identified at the Ciba/Hercules Main Plant Site (formerly known as the Ciba-Geigy/Hercules Main Plant Site) located in Glens Falls, New York (the "Facility"). This final corrective measures for the contaminated soil/waste material and groundwater at the Main Plant Site is to place a permeable cover over forty (40) acres and intercept and treat the contaminated groundwater at the downgradient boundary prior to its leaving the site. In addition, the soil/waste material within the five (5) acre RCRA Corrective Action Management Unit (CAMU), would be dewatered and stabilized as necessary to support a low permeability multi-layered cover. Institutional controls will be imposed to limit future use of the site; restrict the future movement and placement of contaminated soil/waste material and the use of contaminated groundwater; and inform potential future site owners of the residual contamination present.

For the Pretreatment Plant, the final corrective measure is to excavate soils above the target cleanup levels and redeposit the soils in the CAMU or elsewhere on the Main Plant Site. The groundwater contaminant level at the property line and immediately off-site, are just above the regulatory standards; therefore, a program will be initiated to monitor the level of contamination in the groundwater. Deed restrictions will be imposed on the use of groundwater, and if unrestricted use is not achieved for the soils, additional restrictions on soil use will be imposed. If contaminant levels in the groundwater are later found to be at unacceptable levels following contaminated soil removal, additional corrective measures will be evaluated.

For those portions of the industrial sewer which are to be decommissioned, the final corrective measure is to plug the sewer laterals and fill the manholes with sand or gravel.

An investigation is currently underway to determine the level of contamination in the bottom sediments of the adjacent surface waters due to releases from the site. If at the end of this investigation, it is determined that removal of contaminated bottom sediments is necessary, they may be deposited in the Main Plant Site CAMU after any necessary pretreatment (e.g., dewatering). If the volume of sediments to be deposited precludes placing all of them in the CAMU, priority for placement in the CAMU will be given to those sediments, if any, exhibiting a hazardous waste characteristic. If necessary, due to volume, the non-hazardous sediments may be deposited elsewhere on site under an appropriate soil cover.

The SB provides background information on the Facility, including a summary of investigative findings pertinent to the on-site soil/waste material and groundwater contamination; summarizes exposure and potential risks posed by the facility contamination; outlines the alternatives considered to remediate the contaminated soil/waste material and groundwater; and presents the technical approach and rationale for the selection of the preferred remedy.

II. Facility Background

A. Location/Hydrogeology

The Main Plant Site is located in the Town of Queensbury, just east of the City of Glens Falls, Warren County, New York. The site is situated on the northern bank of an eastwardly flowing segment of the Hudson River. The Glens Falls, Cement Co., Inc. owns the property on the western boundary of the site and the quarry on the south side of the river. It is bounded to the north by the Glens Falls Feeder Canal and Lower Warren Street (State Route 32), and to the east by the Warren County Recycling Center.

The topography generally slopes toward the Hudson River. Excavation and fill deposits associated with construction and past plant activities have modified the original topography. Most notable are the mounds created by the north and south soil/waste disposal units (i.e., waste piles) in the western portion of the site. Demolition of the plant buildings has resulted in a predominantly unvegetated site occupied largely by building foundations and intervening asphalt, gravel, and building debris.

The site is situated in an area of mixed development. Industry and commercial development (including a junkyard on the north side of Lower Warren Street directly north of the CAMU), surround the site immediately to the west, north and east. Residences are scattered among the industrial and commercial development. A significant feature to the south, across the Hudson River, is a large limestone quarry operated by the Glens Falls Cement Company.

The groundwater level contours indicate that the groundwater flows generally from north to south in the overburden and in each of three progressively deeper bedrock water-bearing zones known as Horizons A, B, and C. Groundwater in the overburden water-bearing zone flows southward and discharges to the Hudson River. Groundwater in the Horizon A bedrock water-bearing zone flows southward and generally discharges to the Hudson River. At times groundwater in this zone may flow beneath the river and discharge through seeps into the limestone quarry further south. Groundwater in the deeper bedrock water-bearing zones, Horizon B and Horizon C, flows southward and southwest respectively with the potential to discharge in the limestone quarry located on the far side of the Hudson River.

The Pretreatment Plant SWMU is part of the Main Plant Site for the purpose of RCRA corrective action. It occupies approximately four acres of the site, situated north of the Glens Falls Feeder Canal and River Street and east of Quaker Road and it is connected to the Main Plant Site by the wastewater force main and gravity sewer line.

The topography of the Pretreatment Plant SWMU is generally flat and consists of both paved and unpaved surfaces. The eastern two-thirds of the Pretreatment Plant Area is predominantly paved surfaces, and remnant foundations mark the location of several former structures. Several operating structures exist here, including a treatment building and an above-ground wastewater storage tank. The western one-third of the Pretreatment Plant Area consists of open fields with grass and other vegetation. Directly to the north and east are vegetated and marshy areas that grade away from the plant. A small stream flows near the northern boundary of the Pretreatment Plant area and into a marshy area east of the Pretreatment Plant. This marsh area drains to the Feeder Canal through an open section in the northern wall of the Feeder Canal. The Feeder Canal is situated adjacent to the Pretreatment Plant area and comprises much of its southern boundary. South of the Feeder Canal, the land surface slopes to the south-southeast towards another marsh area and stream situated in a topographically low area. Paved roads (River Street and Quaker Road) comprise the remainder of the southern and western boundaries of the Pretreatment Plant area, respectively.

Groundwater beneath the Pretreatment Plant area flows laterally through a shallow relatively permeable fill and lacustrine sands unit. A massive clay layer underlies most of the site and this together with the underlying bedrock unit forms a lower boundary to the shallow flow zone. The bedrock is only exposed to the shallow flow zone beneath a very limited portion of the site and the main fracture zones that exist beneath the Main Plant Site are not present here. Thus the bedrock under the Pretreatment Plant is not considered a significant contaminant pathway.

Groundwater flows generally west to east across the site but exhibits local variability caused by variations in the topography of the clay surface. At times a groundwater divide develops in the central portion of the site resulting in a diversion of groundwater flow to the west and southwest in the western portion of the site. In the eastern half of the site the groundwater flows toward and discharges to the stream and marshy area that lies to the north and east. A comparison of the water levels taken from staff gauges in the stream and marsh to water levels in piezometers further north and east confirms that the stream and marsh area acts as a groundwater divide. Groundwater flow in the shallow zone beyond this feature is not anticipated. In the southern part of the site groundwater flows to the south toward the feeder canal and then southeast and under the canal where the southward sloping surface of the clay unit dips beneath the bottom of the canal.

The Pretreatment Plant is situated in an area of mixed development consisting of industrial, commercial and residential properties. The property adjacent to the northern boundary of the Pretreatment Plant area is a corridor for electrical power lines operated by the Niagara Mohawk Power Corporation. The strip of property directly east of the Pretreatment Plant is denoted in the Town of Queensbury Tax Assessment Office as being residential. However, it is not a buildable lot because it is very narrow and isolated. Immediately beyond this strip to the east is property associated with the Feeder Canal and owned by the State of New York.

B. Site History

Industrial activity at the site began in the 1800's with American Wall Paper, which when incorporated, the name changed to Imperial Wallpaper. It manufactured and sold wallpaper from purchased paper stock and pigments. Then in 1907, the company began to develop inorganic pigments and formed a separate business unit, Imperial Color Works, Inc., to expand the manufacture and sale of a wide range of colored pigments. By the early 1920's, the manufacture of organic pigments had begun. During World War II, the plant expanded operations to produce zinc chromate (an anti-corrosive coating), chromium oxide (camouflage green) and magnesium powders (for flares and tracer bullets). Also, chromite ore was processed on-site to extract the metals needed for manufacturing operations. Ore tailings were then disposed of on-site as fill material.

Hercules Incorporated (Hercules) purchased Imperial (including the site) in 1960. Ciba-Geigy Corporation (Ciba-Geigy) purchased Hercules' pigment business (including the site) in 1979. During February 1989, Ciba-Geigy stopped production at the Main Plant Site located in Glens Falls. Subsequent to the closing of the Main Plant Site operations a major interim corrective action was implemented which saw all but one building demolished and most of the contaminated building debris disposed of in a secure landfill. Uncontaminated organic materials were disposed of in a solid waste landfill. Crushed building rubble was spread around the site. The building foundations presently remain on site.

On September 9, 1996, ownership of the Main Plant Site was transferred from Ciba-Geigy Corporation to Ciba Specialty Chemicals Corporation.

Remediation of approximately seventeen (17) acres was completed for the Eastern Portion of the Main Plant by excavating 13,000 cubic yards of soil mixed with residual chromite ore having chromium and lead concentrations in excess of 100 and 250 mg/kg. respectively, and storing it under cover on a building slab foundation elsewhere on the site. A building used for the storage of products manufactured at the facility was not demolished, but decontaminated to the New York State Health Department criteria. Since no RCRA hazardous waste was found on this portion of the site, boundaries were redrawn to remove it from the inactive site registry. During 1991 Ciba-Geigy sold these seventeen (17) acres, including the warehouse to Warren county for use as a recycling center.

From 1972 through 1973, Hercules constructed a wastewater treatment plant (now the Pretreatment Plant) to treat the wastewater generated at the main plant site prior to discharge to the Hudson River. A major portion of the Pretreatment Plant was decommissioned in 1990 in conjunction with the decommissioning and demolition of the main plant site. A scaled down version remains in operation to treat water collected in the Main Plant sewer system and effluent from the stripper located at the Building 56 slab. After treatment, the effluent is gravity fed to the effluent pump station, from where it is pumped to the City WWTP.

C. <u>Regulatory History/Hazardous Waste Activities</u>

During its operation by Ciba-Geigy, this Facility manufactured inorganic and organic pigments as well as pigment dispersions. The pretreatment of wastewater produced a sludge which consisted primarily of metallic hydroxides and waste pigments. The sludge is non-combustible, non-biodegradable, and cannot be recycled or reclaimed. It is a RCRA listed hazardous waste.

The open surface impoundment (north lagoon) located at the northwest end of the main plant site was used for emergency containment of waste sludge. This sludge (3-5% solids) from the wastewater treatment plant was pumped to the lagoon from the clarifiers via a pipeline, bypassing the filter press operation. The impoundment has not been used since late 1983. However, its usage after July 26, 1982 makes the unit a "RCRA Regulated Unit" subject to closure as a hazardous waste landfill and to post-closure permitting unless decontaminated at closure.

In 1984 a Federal hazardous waste permit application for the surface impoundment (north lagoon) and for a container storage area was submitted by Ciba-Geigy. Prior to permit issuance, New York State was granted authority to issue state hazardous waste operating permits (Part 373 Permits) and requested the submittal of a Part 373 permit application. After submitting this application, Ciba-Geigy decided to close the open surface impoundment and pursue a State Part 373 operating permit for the container storage area. On September 24, 1987, an operating permit was issued to Ciba-Geigy for storage of hazardous waste in containers and corrective action. The unit operated until 1989 when the waste was removed. After two cleaning operations were performed on the concrete slab, the Department accepted the certification of closure on March 31, 1992.

On September 28, 1989, the Department approved the closure plan for the north lagoon. This plan stated that the closure activities would take place when site-wide corrective measures were implemented since it was not technically feasible to close the lagoon without remediating the adjacent solid waste management units (i.e., the north and south waste piles).

On September 27, 1991, a State Part 373 post closure permit for the north lagoon was issued to Ciba-Geigy/Hercules Inc. Since at this time the State did not have authorization to administer the Hazardous and Solid Waste Amendments of 1984 (HSWA), the United States Environmental Protection Agency (USEPA) issued a HSWA Permit which was effective November 12, 1991. The combination of these permits covered the post-closure care of the north lagoon and the continuation of corrective action activities initiated under the container storage operating permit.

The corrective action requirements in the Part 373 post closure permit obligated the Permittee to perform an integrity evaluation on those portions of the industrial sewer which are used for conveyance of hazardous waste and/or liquids containing hazardous constituents. The results of this evaluation and subsequent repairs were presented in various reports. These reports detailed investigations and repairs of the industrial sewer that were acceptable to the regulatory agencies. The Permittee was allowed continued use of those portions of the industrial sewer passing the integrity evaluation.

It is the intent of the USEPA to terminate the HSWA permit upon selection of the final corrective measure(s). Implementation of the corrective measure(s) on-site will then proceed under state RCRA Corrective Action authority.

III. SWMU DESCRIPTION, HISTORY AND LEVELS OF CONTAMINATION

A. Site Characterization Overview

Based upon a review of available literature, the original December 1985 Preliminary Review divided the site into the following SWMUs: north lagoon, north waste pile, south waste pile, open pit incineration area, waste deposit areas designated as, area 1 - area 5, container storage area and stormwater impoundment basin.

As a result of the Phase 1 RCRA Facility Investigation (RFI) Report received in June 1987, it was realized that instead of discrete areas of contamination, the contamination was wide-spread and covered most of the site. Therefore, the contaminated areas were designated as follows:

1. SWMUs

(a) Units Subject to 6NYCRR Part 373 Closure Requirements:

(i) North lagoon (an open surface impoundment); and

(ii) Container storage area (closed as per approved closure plan).

(b) North and south waste piles.

(c) Wastewater Treatment:

(i) Storm water impoundment basin (currently in use, status to be resolved);

(ii) Industrial sewer; and

(iii) Pretreatment plant.

(d) On-Site Areas:

(i) Area north of Delaware and Hudson Railroad Property; and

(ii) Area south of Delaware and Hudson Railroad Property.

2. AREAS OF CONCERN

(a) Off-site areas:

(i) Adjacent off-site surface water sediments;

(ii) Adjacent off-site land; and

(iii) Delaware and Hudson Railroad Property.

* The industrial sewer SWMU is not addressed as a discrete unit in this document. The corrective measure requirements for the industrial sewer call for the unused portion to be decommissioned. Although the facility submitted a decommissioning plan, it was felt that the decommissioning should be addressed as part of the corrective measures for the Main Plant Site. Thus, the corrective measures are addressed in the alternatives for the SWMU containing the industrial sewer.

This Statement of Basis is to document how corrective measures were chosen for the Main Plant site, (including the north lagoon area, which will be designated a RCRA Corrective Action Management Unit (CAMU), the other on-site areas located north and south of the railroad property) and the Pretreatment Plant. Therefore, the investigation of the other off-site areas are not discussed in this document. A separate Statement of Basis will be written to document the choice of corrective measures, if necessary, after completing the off-site area investigations.

B. Site Characterization By Unit

1. North Lagoon Area: RCRA Corrective Action Management Unit (CAMU)

This CAMU is approximately five acres and includes three SWMUs: the inactive open surface impoundment; the north waste pile; the south waste pile; and approximately one hundred and fifty feet of property extending eastward from the eastern edge of the impoundment and the south waste pile.

The open surface impoundment was constructed in 1972 and is lined with a 30-mil chlorinated polyethylene membrane. It covers an area of approximately 0.9 acre and is underlain by two drains constructed just above bedrock to intercept groundwater flow beneath the liner. The lagoon overflow and groundwater collected in the subdrains are conveyed by the industrial sewer system to the pretreatment plant for pretreatment and discharge to the City of Glens Falls publicly owned treatment works (POTW). The volume of hazardous waste sludge which remains in the lagoon has been estimated at 8,000 cubic yards (Malcolm Pirnie, Inc., 1987).

The lagoon is situated between two soil/waste disposal units known as the north and south waste piles. The north waste pile is bounded to the north by the feeder canal and to the south by the north lagoon. The north waste pile was last used in 1978 and may be described as a mound with a relief of approximately 20 to 30 feet above original ground surface, covering an area of approximately 1.1 acres. The volume of the north waste pile has been estimated at 31,800 cubic yards (Malcolm Pirnie, Inc., 1987).

It was previously reported (Malcolm Pirnie, Inc., 1987) that the north waste pile was created from soil, fill, and ore tailings excavated during construction of the lagoons and deposited onto the original sloping ground surface. However, recent data indicate that the waste materials may include wastewater treatment plant sludge (ECKENFELDER INC., 1991) which is a listed hazardous waste. Interim corrective measures consisting of regrading and installation of silt fences were performed in 1992 to control erosion from the north waste pile, and additional measures were implemented as described in the "Glens Falls Cement Company Maintenance Work Plan" (Hercules, Inc. 1992).

The south waste pile is bounded to the north by the north lagoon and to the south by the railroad property. Similar to the north waste pile, the south waste pile can be described as a mound with a relief of approximately 25 feet above original ground surface, covering an area of approximately 1.0 acre. Underlying the south waste pile was a lagoon originally constructed in 1971 for storage of wastewater treatment plant hazardous waste sludge. The lagoon was built with an asphalt liner, which can now be considered permeable, over a sand and gravel subgrade containing four underdrains. Bedrock lays directly beneath two-thirds of the lagoon excavation. The lagoon was used from 1972 until 1976 for storage of the listed hazardous waste sludge. The sludge was left in place and the lagoon filled over with excavated soil, miscellaneous fill, ore tailings, demolition debris, and general industrial waste. These filling activities ceased in 1987. In 1983, the underdrains were cut and capped. The volume of the south waste pile has been estimated at 31,300 cubic yards (Malcolm Pirne, Inc., 1987).

Sampling and analysis of soil/waste materials and groundwater within the CAMU and at the other on-site areas, including those north and south of the railroad property, have been conducted with the results presented in the following RFI reports: (1) Preliminary Assessment (Malcolm Pirnie, Inc., 1987); (2) the Site-Wide Soil Sampling Report (ECKENFELDER INC., 1991); (3) the Site-Wide Soil Sampling Report Addendum (ECKENFELDER INC., 1992); and (4) RFI Report for Groundwater Volume I and Volume II, 1993, including all subsequent semi-annual groundwater monitoring reports. The hazardous constituents of interest include metals (arsenic, barium, cadmium, chromium, lead, mercury, selenium and vanadium), cyanide, volatile organic compounds (VOCs), and semivolatile organic compounds (SVOCs).

(a) Hazardous Constituents: Soil/Waste Material

Analytical data collected during remedial investigations indicate that the soil/waste material in the CAMU, including the adjacent property east of the piles, contains very high levels of contamination everywhere within the unit and it has the most frequently detected highest concentrations of hazardous constituents at the site. Add to this contamination the high residual metal contamination in the 5 to 6 feet of sludge left in the open impoundment, which was not measured, but known from experience to be enriched with heavy metals, and the CAMU becomes the most significant and focused source of hazardous constituents at the site. This significance is illustrated by the maximum and average concentrations, expressed in parts per million, of inorganic constituents detected in and around the north and south waste piles during the remedial investigation:

Inorganic Constituent	Maximum Concentration, mg/kg	Average Concentration, mg/kg
Arsenic	330.0	50.9
Barium	51,000.0	11,199.1
Cadmium	27,000.0	1,434.8
Chromium	114,000.0	20,676.6
Cyanide	5,760.0	2,110.3
Lead	199,000.0	35,022.3
Mercury	470.0	43.1
Selenium	169.0	18.8

Within this CAMU's area of investigation the south waste pile also exhibited the most frequently detected highest concentrations, expressed in parts per million, of organic hazardous constituents. Maximum total volatile organic compounds (VOCs) ranged from 2.4 to 1,073 mg/kg, with the maximum total semi-volatile organic compounds (SVOCs) ranging from 3.3 to 374.94 mg/kg. 1,2 - dichlorobenzene, not addressed as either a VOC or SVOC, had maximum concentrations ranging from 0.87 to 7.6 mg/kg.

The distribution of inorganic contamination in all three SWMUs extends from the surface down to the bottom of each unit. The trend for vertically distributed organic contamination is such that higher concentrations appear to occur more frequently at deeper depths within the south waste pile.

In addition to the contamination contributed by the three SWMUs located within the CAMU, adjacent properties extending approximately 150 feet east from the lagoon and south waste pile to the western edge of the Building 49 slab foundation, report elevated concentrations of metals and VOCs. Here total cadmium and total chromium concentrations averaged 209 mg/kg and 2,491 mg/kg respectively, with this contamination reaching down as deep as twelve feet at some locations. Also, a hot spot of VOC contamination was isolated in the vicinity of soil boring WP-3, about thirty feet west of that building slab. Similar, but much lower concentrations of VOCs were reported in soil borings SB-89 and SB-90 just south and north respectively of boring WP-3:

VOC	Maximum Concentrations, mg/kg		
Constituent	WP-3	SB-89	SB-90
Ethylbenzene	1,500	N.D.	0.013
Toluene	19	N.D.	0.008
Xylene	3,000	2.9	0.098

The highest concentrations of VOCs were detected four to six feet below the surface at WP-3. Soil samples at SB-89 and 90 were only taken at deeper depths, i.e., eight to twelve feet. However, these contaminated deeper samples suggest VOC contamination could extend south and north of WP-3, and possibly exist at higher concentrations closer to the surface at both locations thus extending this hot spot to between those two points.

(b) Hazardous Constituents: Groundwater

Limited leachate studies on the soil/waste material demonstrate that inorganic contamination within the CAMU, which includes the adjacent property located east of this area, exhibit a hazardous waste characteristic, (i.e., the waste exhibits a propensity to leach out inorganic constituents during precipitation events). Groundwater investigations appear to support the conclusion that the CAMU serves as a significant source of groundwater contamination at this site. Total dissolved chromium, total cyanide and total VOCs, indicator contaminants for the CAMU, have been detected at elevated concentrations expressed in parts per billion in the groundwater immediately and further downgradient of this area. Groundwater contamination by the CAMU source appears to be focused in the overburden and the adjacent underlying bedrock water-bearing zones known as Horizons A and B. Furthermore, it is probable that some of the groundwater contamination detected in wells located further downgradient, in the area south of the railroad property, has its main origins at the CAMU. Using the maximum concentration data generated during the remedial investigation, the following concentrations in parts per billion by water-bearing zone and indicator contaminants (that are representative of general contaminant distribution) demonstrate the magnitude of the groundwater contamination detected in the vicinity and downgradient of the CAMU:

Contaminant	Overburden	Horizon A	Horizon B
Dissolved Chromium	20,000 ug/l	500 ug/l	100 ug/l
Total Cyanide	50,000 ug/l	5,000 ug/l	100 ug/l
Total VOCs	10 ug/l	1,000 ug/l	10,000 ug/l

Unlike inorganic contamination, elevated VOC concentrations were not detected in the immediate vicinity of the south waste pile, with the exception of a localized hot spot at soil sampling location WP-3 (located approximately 150 feet east of the eastern edge of the north lagoon). Groundwater monitoring data suggests that the south pile contributes VOC contamination directly to the bedrock water-bearing zones. This bedrock VOC contamination could be attributed to a combination of circumstances existing at the south waste pile: i.e., (1) the VOC contamination in the waste pile seems more concentrated near its bottom and the potential exists for dense non-aqueous phase liquids (DNAPLs) to have penetrated into the bedrock and serve as sources for groundwater contamination; (2) that approximately three-quarters of the bottom rests on or very near Horizon A, the first bedrock water-bearing zone, which also was demonstrated to communicate hydraulically with the underlying bedrock zone, Horizon B; and (3) the possible diversion of most overburden groundwater to the periphery of the open impoundment and south waste pile by the open impoundment's lined northern section which was constructed down to bedrock. South of the CAMU the overburden water-bearing zone potentially receives some inorganic constituent contribution from the south waste pile.

The remedial investigation discovered a natural clay layer, of varying thickness, directly overlying bedrock under most of the site, except where excavated for such construction activities as building of the surface impoundments. This clay layer lies below the overburden water-bearing zone and serves as an aquitard that limits vertical migration of contamination from the overburden into the bedrock aquifers except where excavated or punctured.

The very deep bedrock water-bearing zone, Horizon C, was found to be contaminated with indicator contaminants detected in the CAMU. Tests have demonstrated limited natural vertical movement between this horizon and the one above. However, it appears that contamination from the upper water-bearing zones was allowed to migrate down into Horizon C, along some of the deep bedrock production wells that were present at the site. Decommissioning and sealing of these wells appears to have effectively eliminated this migration pathway into the deeper bedrock zone.

2. Area South of Railroad Property

This SWMU encompasses an area bounded to the north by the railroad property, to the west by the Glens Falls, Cement Co. property, to the south by the Hudson River, and to the east by the Warren County Recycling Center property. It is approximately twenty (20) acres with approximately twenty to thirty percent of the property occupied by production building concrete slab foundations. There is a gentle southward slope of the area which steepens greatly along the bank of the Hudson River. The steep river bank is covered with stone in some locations to protect it from erosion. Traveling west along the river bank, the bank's slope remains steep but its height diminishes at the far western boundary of this area. Here at one time an incineration area was located and used for burning factory debris. Currently this area is covered with vegetation, including some trees located close to the embankment by the river.

East of the incineration area lays the concrete slab foundation of Building 56. Within this structure and before its demolition organic pigments were manufactured and solvents were stored in tanks located adjacent to the southern edge of the building. Presently an interim corrective measure (ICM) operates at this location. The ICM pumps ten withdrawal wells placed in the overburden water-bearing zone creating a hydraulic barrier to groundwater flowing to the Hudson River. All extracted groundwater containing residual contamination, is treated before discharge to the Glens Falls POTW. The treatment system is located on the Building 56 slab foundation. Permeability tests carried-out on the soil/waste fill prior to the ICM implementation demonstrated that the fill is highly impermeable and will not be suitable for the application of soil vapor extraction technology.

(a) Hazardous Constituents: Soil/Waste Material

Analytical data collected during remedial investigations indicate that soil/waste material in the area south of the railroad property contains high concentrations of hazardous constituents. Inorganic hazardous constituents, including high concentrations of chromium, cadmium and lead were found throughout the area and as deep as thirty feet. This inorganic contamination did not appear to exhibit any strong lateral or vertical trends, but appears to be widespread and scattered throughout the area. Overall maximum and average concentrations, expressed in parts per million for the inorganic constituents, are as follows:

Inorganic Constituent	Maximum Concentrations, mg/kg	Average Concentrations, mg/kg
Arsenic	111.0	6.3
Barium	12,200.0	237.1
Cadmium	2,300.0	36.8
Chromium	14,800.0	1,460.9
Cyanide	72.0	10.9
Lead	65,000.0	1,160.1
Mercury	157.0	2.9
Selenium	11.8	1.7

Also, within this area investigations detected organic contamination. Over the entire area, maximum concentrations of volatile organic compounds (VOCs) ranged from 0.01 mg/kg to 1,073 mg/kg, with semi-volatile organic compound (SVOC) maximum concentrations ranging from 0.34 mg/kg to 281.2 mg/kg, and 1,2 - dichlorobenzene ranging from 0.006 to 100 mg/kg . However, an analysis by location demonstrated that the VOCs and SVOCs with elevated concentrations are focused in the vicinity of the Building 56 slab foundation and, at lesser concentrations, in the vicinity of the incineration area.

The hazardous constituent 1,2 - dichlorobenzene, which was not included as either a VOC or SVOC, had maximum concentrations ranging from 1.7 to 11 mg/kg at the Building 56 slab foundation and from 0.6 to 100 mg/kg at the incineration area. At the latter location this constituent's highest concentrations were found in the samples taken within the clay underlying the overburden water-bearing zone. It is likely that the elevated levels of contamination within the clay resulted from contamination that was carried down during the sampling event.

(b) Hazardous Constituents: Groundwater

Limited and random testing on the soil/waste material indicates that a large part of the area south of the railroad property exhibits a hazardous waste characteristic and demonstrates the potential to leach inorganic contaminants to the groundwater. Groundwater monitoring carried-out as part of the RFI for the area south of the railroad property provided the following generalized maximum concentration data for the indicator parameters:

Contaminant	Overburden	Horizon A	Horizon B
Dissolved Chromium	20,000 ug/l	3,000 ug/l	1,000 ug/l
Total Cyanide	20,000 ug/l	5,000 ug/l	1,000 ug/l
Total VOCs	20,000 ug/l	200 ug/l	10,000 ug/l

Analysis of groundwater monitoring data and corresponding soil/waste contamination profiles suggest that the incineration area and properties in the vicinity of Buildings 8, 45, and 56 slab foundations can be considered the primary contributing sources to overburden groundwater contamination in the area south of the railroad property. This becomes evident by examining chromium, cyanide, and VOC groundwater concentration contours for those locations. However, upon close examination it appears that the CAMU located to the north may also contribute to the contamination, particularly cyanide, found in the overburden groundwater at the southwestern part of the site.

Cyanide contamination in the overburden water-bearing zone in the vicinity of Building's 8 and 45 slab foundations may extend into the area north of the railroad property. Here elevated soil/waste cyanide concentrations were detected at borings RB-17 (213 mg/kg) and RB-15 (136 mg/kg). The data suggests that this overburden water-bearing zone is being contaminated by cyanide in the soil/waste material north of the railroad property, and to a lesser degree, by cyanide contamination in the vicinity of the Building's 8 and 45 slab foundations.

Organic contamination in the overburden water-bearing zone south of the railroad property appears to be primarily caused by VOCs found in soils/waste material located in the vicinity of the incineration area and Building 45 and 56 slab foundations. The highest VOC concentrations in this area were detected at the latter slab foundation. Also, recent groundwater monitoring detected the SVOC aniline as high as 1,000 parts per million south of the Building 45 slab foundation. This finding corresponds with the elevated aniline level (7.4 mg/kg) detected in soil at that location in boring IS-22.

The ICM operating behind Building 56 slab foundation appears to have effectively limited VOC migration and discharge to the Hudson River via the overburden groundwater at that location. Overburden VOC levels remain elevated and controlled within the overburden flow zone under the incineration area. This area contains soil/waste material where VOCs were most frequently detected, but only at an average concentration under one part per million. Since the CAMU to the north appears to be an unlikely source for the overburden VOC contamination, the incineration area must still remain suspect as being a primary VOC contamination source.

Groundwater data indicate that VOCs are present largely within in the Horizon B bedrock water-bearing zone at the southwestern part of the site. However, given the presence of the clay layer situated above the bedrock in this area it is unlikely that the incineration area soil/wastes are major contributors to contamination observed in this zone. The clay cap argument also may be used to presume that the CAMU serves as the source of chromium and cyanide bedrock contamination at the southwestern part of the site.

3. <u>Area North of Railroad Property</u>

This SWMU encompasses an area bounded to the north by the feeder canal and Lower Warren Street, to the east by the Warren County Recycling Center property, to the west by the CAMU, and to the south by the railroad property. It is approximately twenty (20) acres with at least seventy-five percent of the property occupied by production building concrete slab foundations. There is a gentle southward slope of the property towards the railroad track embankment.

Located on one building slab foundation is approximately 13,000 cubic yards of soil contaminated with inorganic hazardous constituents (i.e., heavy metals chromium, lead and cadmium) which did not exhibit a hazardous waste characteristic. This material was excavated as part of the remediation project for the far eastern part of the site which was subsequently sold to Warren County for its recycling center.

(a) Hazardous Constituents: Soil/Waste Material

Analytical data collected during the remedial investigations indicate that soil/waste material in the area north of the railroad property contains elevated concentrations of hazardous constituents. Higher concentrations of chromium, cadmium, and lead were detected less frequently than in the other SWMU and CAMU, and the contamination was highly scattered throughout the area. Most of this contamination was located within four feet of the surface. The area did produce higher concentrations of cyanide than the area south of the railroad property at several isolated locations. Overall maximum and average concentrations, expressed in parts per million for the inorganic constituents, are as follows:

Inorganic Constituent	Maximum Concentration, mg/kg	Average Concentration, mg/kg
Arsenic	10.6	5.3
Barium	8,100.0	453.3
Cadmium	280.0	31.3
Chromium	1,740.0	21.5
Cyanide	450.0	4.8
Lead	5,000.0	52.5
Mercury	7.4	3.1
Selenium	0.3	0.3

Organic contamination was also scattered throughout the area and showed no definitive trends in either the lateral or vertical directions. Several isolated hot spots were detected, but over the entire area, maximum volatile organic compounds ranged from 0.07 to 2.43 mg/kg with semi-volatile organic compounds ranging from 0.17 to 214.97 mg/kg.

(b) Hazardous Constituents: Groundwater

Given the overall lower concentrations of total metals found in the soil/waste material of this area, the material was not expected to exhibit a propensity to leach out during precipitation events. Therefore, leachate studies were not carried-out on the soil/waste material in the area north of the railroad property. Groundwater monitoring within the overburden zone was limited to one well located approximately in the middle of the area. Relatively low levels of VOCs and heavy metals have been detected. Also, overburden groundwater monitoring wells just south of the railroad property and adjacent to this area have detected only low levels of dissolved heavy metal contamination. However, as previously discussed this northern area SWMU does contribute significant cyanide contamination to the overburden water-bearing zone south of the railroad property.

4. Pretreatment Plant

This 4 acre SWMU is located north of the Glens Falls Feeder Canal and east of Quaker Road. It is connected to the Main Plant Site by a force main and gravity sewer line which pass underneath the Feeder Canal. A major portion of the Pretreatment Plant was decommissioned in 1990. The scaled down version currently in use, treats contaminated water collected at the Main Plant Site and effluent from the stripper located at the Building 56 slab prior to discharging to the Glens Falls WWTP.

In November 1991 an RFA was initiated at the Pretreatment Plant to characterize soil and groundwater conditions and to evaluate potential environmental impacts, if any. Based on the result of the RFA, an additional more detailed evaluation, the RFI was conducted based on a work plan approved on June 7, 1994.

(a) Hazardous Constituents: Soil/Waste Material

Analytical data collected during remedial investigations indicated that the highest concentrations of hazardous constituents in the soil are within the easternmost portion of the Pretreatment Plant. The concentrations decrease greatly towards the west, except for a small area in the central portion. The maximum concentrations were typically from zero to two feet below the surface, with contaminants down to four feet at isolated locations.

Going from the eastern portion to the west, there is a distinct break in the concentrations once a line connecting borings PT-14, PT-9 and PT-16 is reached. East of this line the inorganic constituents range up to 622 mg/kg for cadmium, 885 mg/kg for chromium, 4,570 mg/kg for lead, and 375 mg/kg for total cyanide. In boring PT-16-1 which is on the dividing line, at 0-2' below the surface, mercury was non-detect, while a duplicate sample indicated mercury at 52 mg/kg. The average level of inorganic contamination in the soils in this area is as follows: cadmium 36 mg/kg, chromium 139 mg/kg, lead 587 mg/kg, mercury 3 mg/kg and total cyanide 26 mg/kg.

The inorganic contamination in the soils to the west of the eastern portion (except for the contaminated area at boring PT-8) are above site background, but within the range of unrestricted use. It is felt that these elevated levels are due to filling low areas of the site with contaminated fill. In general cadmium is in the range of 4-5 mg/kg with its highest level being 7.9 mg/kg; chromium is generally in the range of 10-130 mg/kg, with the highest level being 197 mg/kg at boring PT-3; lead is generally in the range of 10-100 mg/kg with its highest level being 270 mg/kg at boring PT-12, all detections of mercury were below 1 mg/kg and total cyanide was not found above 110 mg/kg.

Sampling data indicates that the soil in the vicinity of boring PT-24 (0-2' below the surface) at the eastern portion, not only contains very high levels of total chromium and cadmium, but also exceeds the limit for a characteristic waste for these constituents.

No volatile organics were detected in the Pretreatment Plant soils during the RFA. Therefore, volatile organics were not analyzed for during the RFI. Except for estimated values found below the method detection level, no semi-volatile organics were found at the eastern area. The highest level found was 21 mg/kg of dimethyl-phthalate at boring PT-19. In general, the finds of semi-volatile organics were sporadic and in the range of 1-10 mg/kg. The semi-volatile organics were found in those areas which also have the highest inorganic contamination.

(b) Hazardous Constituents: Groundwater

Initial groundwater sampling from three monitoring wells placed around the perimeter of the site indicated that the groundwater was impacted by site operations. An extensive list of parameters was sampled for, however, the only contaminant detected at concentrations exceeding the groundwater protection standards was cyanide. During the RFI, temporary groundwater sampling points were placed along the southern and western perimeters of the site. Sampling from these additional points, along with the several piezometers and monitoring wells, provided much better definition of the groundwater chemistry beneath and immediately downgradient of the site. Cyanide concentrations range from slightly over the groundwater standard of 100 parts per billion at the perimeter and immediately downgradient of the site to a range of several hundred to over 5000 parts per billion within the central portion of the Pretreatment Plant area. Concentrations vary considerably both spatially and temporally.

The results from the temporary well points along the south side of the canal support the hydrogeologic model of the site. Here groundwater above the clay was absent from the area around the pipe bridge over the canal and to the west. Concentrations of cyanide were detected in the temporary well points installed further to the east indicating that the groundwater was passing beneath the canal in this area. Here cyanide concentrations varied from well below the groundwater standard to slightly above. Along the western perimeter of the Pretreatment Plant area cyanide concentrations were detected up to and slightly exceeding the groundwater protection concentrations. The migration to this area is likely due to the complex groundwater flow patterns caused by the interaction between the undulating surface of the clay unit, the relatively thin saturated thickness above the clay and fluctuations in the groundwater elevations. Cyanide bearing groundwater that migrates off the Pretreatment Plant site to the west or southwest, via the overburden, would most likely flow toward the Main Plant Site.

IV. Exposure and Risk Summary

A. Existing Release Mechanisms and Exposure Conditions (Main Plant)

The on-site human population with the potential for exposure to site contamination is limited to maintenance personnel, normally a single individual, and infrequent visitors. The general public is restricted from entering the site with restraints provided by perimeter fencing and gate control. As a further precaution a second fence line and locked gate restricts access to the highly contaminated land disposal units, i.e., the open surface impoundment and the north and south waste piles. Because these three solid waste management units remain uncovered they present the greatest potential threat on-site to human health and the environment.

The nature of the contamination found in the three solid waste management units and released to the underlying overburden and bedrock aquifers is summarized in Sub Section III, B.1 of this document. As a whole the three land disposal units contain very high average concentrations of inorganic hazardous constituents, including cadmium, chromium, lead, and cyanide. Both volatile and semi-volatile organic hazardous constituents were detected at significant concentrations in the south waste pile. Groundwater monitoring indicates contamination of the underlying overburden and bedrock aquifers with inorganic and organic constituents. Groundwater movement is generally to the south towards the Hudson River, with the overburden and the shallow bedrock aquifers entering the river. Groundwater flow in the deeper bedrock aquifers appears to cross under the Hudson River and discharge to a limestone rock quarry on the other side of the river.

The most plausible contaminant release mechanisms and exposure pathways placing potential human and environmental receptors at risk from the three land disposal unit's contamination include:

1. Precipitation leaching out contaminants from exposed soil/waste material, with the resulting leachate contaminating the natural groundwaters of the state, including overburden and bedrock aquifers underlying this part of the site. The groundwater in these aquifers are classified by the state as GA, with the intended future use being drinking water;

2. The contaminated groundwater pathway exposes the Hudson River and its sediments to contamination. The bedrock contaminated groundwater pathway flowing under the Hudson River has the potential to expose and further degrade a more extensive volume of the groundwater resource.

3. The potential exists for the off-site release of eroded surfacial contaminated soil/waste material by runoff during severe storm events. If left unattended such events will eventually overcome the interim measures implemented to mitigate such a release and expose wildlife occupying the wetlands located on the adjacent cement company property;

4. The release of soil/waste material through the air pathway as airborne particulate matter by strong and sustained winds during dry conditions. Such releases could expose potential human receptors, including unprotected maintenance workers on-site, at the Feeder Canal, and on cement company property by the inhalation pathway to contaminated airborne particulate matter. Exposure through the inhalation pathway would only occur when receptor presence coincides with strong wind events that create the airborne particulate matter. Although the probability of such a coincidence is very small, the potential for exposure through this pathway by potential human receptors cannot be rejected completely; and

5. The exposure of potential human receptors by direct incidental contact to contaminated soil/waste material located on-site and to that material which has migrated off-site.

Since public access to the entire site is restricted, the potential threat to human health and the environment by contaminated, exposed soil/waste material and groundwater at the remaining forty acres of the site would be through release mechanisms and exposure pathways similar to those discussed above. However, human and environmental exposure risk is reduced at some pathways because of prevailing site conditions existing at the areas located north and south of the railroad property.

Sub Section III, B.3. discusses the nature and extent of soil/waste contamination found in the area north of the railroad property. However, with more than seventy-five percent of the property north of the railroad property covered with concrete building slab foundations, and with most of the remaining properties covered with construction debris generated from post building demolition activities, releases to the groundwater by contaminated leachate would be of primary concern. Erosion of contaminated soil/waste material by storm water runoff or by wind is not very significant given the current conditions. Any exposed material eroded by storm water and carried by runoff would travel along the gentle southernly slope and deposit out at the foot of the railroad track embankment running along the entire southern perimeter of the area. Therefore, the Hudson River is not currently exposed to any contaminated soil/waste material that might transport by runoff during storm events from this area.

Should some exposed soil/waste material become airborne during dry, windy conditions as contaminated particulate material, unprotected occupational workers maintaining this site, the Feeder Canal, and working outdoors at the Warren County Recycling Plant could become potential human receptors; if present when climatic conditions cause the contamination to become airborne.

The release mechanism contributing to groundwater contamination at locations not covered by building slab foundation is leachate generated during precipitation events and percolating down to the overburden aquifer underlying this part of the site. The contaminant detected most frequently and above groundwater standards was cyanide. It appears to come from isolated and scattered hot spots located in the southern part of the area north of the railroad property. This contaminated groundwater pathway has the potential to expose the Hudson River and its sediments to the cyanide contamination.

As discussed in Sub Section III, B.2. of this document the area south of the railroad property was found to contain concentrations of inorganic and organic hazardous constituents similar to those detected north at the railroad property but at higher concentrations. At this area existing conditions are somewhat less protective than those north of the property. Here only approximately twenty to thirty percent of the area is covered by concrete building slab foundations with construction debris overlaying the exposed properties adjacent to these slabs. At the western boundary of this area exists approximately five acres, including the old incineration area. It is devoid of slab foundations, but covered with vegetation including some trees at the river's embankment. This vegetative cover helps to control erosion of surfacial soil/waste material into the Hudson River by storm water runoff and into the surrounding air on windy days. However, it does not afford protection against any direct incidental contact by potential human receptors. Moving from west to east the lack of vegetative cover and more widely spaced slab foundations leave more open area susceptible to erosion. Should severe erosion occur, the Hudson River and its sediments would become exposed to the highly contaminated material released from the site and transported by storm water runoff.

Unprotected occupational workers maintaining the site and working outdoors at the recycling plant to the east could become potential human receptors of contaminated particulate matter that becomes airborne from this area of the site during dry, windy conditions. Exposure would only occur when worker presence coincides with climatic conditions causing the air transport of the contaminants. Also, at risk from exposure to such airborne contamination is the adjacent stretch of the Hudson River and its sediments.

By far the most severely impacted environment located south of the railroad property is the groundwater. Contaminants detected most frequently and above state groundwater quality standards include total chromium, total cyanide, total volatile organic compounds, dichlorobenzene, and aniline. The land disposal units located in the CAMU to the northwest appear to be the major contributor of bedrock and to a lesser extent overburden groundwater contamination found downgradient from those units in the area south of the railroad property. Additionally, several locations within the southern area have the potential to add their own releases to the overburden groundwater contamination. This contaminated overburden groundwater pathway can expose the Hudson River and its sediments to this contamination.

B. <u>Existing Release Mechanisms and Exposure Conditions (Pretreatment Plant)</u>

The Pretreatment Plant, like the Main Plant Site, restricts public access by means of a perimeter fence and locked gate. Due to the less severe soil and groundwater contamination, this SWMU presents less of a threat to human health and the environment.

The contaminant release mechanisms and exposure pathways are the same as discussed for the Main Plant Site, however the environmental receptors are different. The groundwater release pathway introduces contamination into the Feeder Canal and further downgradient. Source removal would reduce the flux into the Feeder Canal and the low level of contamination downgradient of the Pretreatment Plant is not considered a serious threat. In the event of a severe storm, eroded material could be deposited in the Feeder Canal, or on to adjacent lands.

C. <u>Risk Summary and Management</u>

The intent of the RCRA Corrective Action program is to reduce the risk presented by site contamination to human health and the surrounding environment. Risk reduction can be accomplished by removing the toxicity associated with the site's contamination (e.g., through technically feasible and practical treatment or removal actions) or by preventing exposure (e.g., through physical controls like containment and institutional controls such as deed restrictions). Therefore, the level of risk reduction to be achieved at any given site should address the protection of human and environmental receptors that currently exist and those that might exist in the future.

If the site or portions of the site was to be allowed unrestricted use, then all soil/waste material must be remediated to target cleanup levels, also known as decontamination cleanup standards. The term "standards" is only used for the purpose of this document. It should be interpreted as the levels in soils that either treatment or removal actions would need to achieve at this site for unrestricted use of the remediated soils. It does not imply that a state or federal promulgated soil cleanup standard exists. The soil target cleanup levels presume establishment of residential dwellings and are protective of several pathways, including gardens growing crops whose deep roots can be subject to contaminant uptake; soil cleanup levels protective of the groundwater pathway via leachate contamination during precipitation events; direct ingestion of the soil by children; and the inhalation of soil contaminants. For the hazardous constituents existing at the site, complete decontamination would be achieved in the soils, if following remedial action the average soil hazardous constituent concentrations were at or below the following levels:

Hazardous Constituent	Soil Target Cleanup Levels
Arsenic, Total	0.4 mg/kg
Barium, Total	51.0 mg/kg
Cadmium, Total *	10.0 mg/kg
Chromium, Total *	50.0 mg/kg
Cyanide, Total	1600.0 mg/kg
Lead, Total	400.0 mg/kg
Mercury, Total	3.4 mg/kg
Selenium, Total	2.0 mg/kg
Semivolatile Organic Compounds, Total	10.0 mg/kg
Volatile Organic Compounds, Total	50.0 mg/kg

* Under review by the NYSDOH; values may be specified for trivalent and hexavalent chromium. Permittees will be notified of any changes in soil cleanup levels.

Should the final implemented remedy achieve soil target cleanup levels and allow for unrestricted usage of the property, institutional controls would still be needed to prevent human exposure to the contaminated groundwater. Such controls would remain in place until New York State's GA groundwater quality protection standards are met. Regulations stipulate that the groundwater quality standards are applicable to all non-saline groundwaters in the state, and the best usage of GA classified groundwater is potable water (i.e., drinking water). The same GA groundwater quality protection standards will serve as remediation goals for the final remedy necessary to clean up the contaminated groundwater at the site. If decontaminating the soils to target cleanup levels is not technically feasible or practical, final soil/waste remedies must be implemented to prevent direct exposure by potential human receptors; to address the management of significant releases of hazardous constituents to the groundwater underlying the site; and to mitigate any adverse impacts on the surrounding environment. Sub Section IV.A. above discussed existing potential human and environmental receptors that require protection. Should the site be considered for future industrial usage environmental receptors would not change, but potential human receptors would expand to include a larger population of occupational workers having access to the site. Both existing and future on-site workers require protection against incidental direct contact and inhalation exposure. Such protection can be afforded by properly designed, constructed, and maintained containment systems. However, institutional controls would need to be expanded beyond those for controlling groundwater usage, to include restrictions on the future movement and placement of any residual soil/waste material remaining on site.

Containment systems may also be employed as final remedies to prevent exposure of the surrounding environment like the Hudson River, groundwater and wetlands to contaminant releases from residual soil/waste material remaining on-site. Significant soil/waste sources, such as those existing at the CAMU, will require construction of containment systems that exhibit a high degree of impermeability to precipitation in order to mitigate continuing release of contaminants to the groundwater. Off-site migration of contaminated groundwater could be curtailed by a properly designed contaminated groundwater extraction system. This system would need to be located downgradient along the site's southern perimeter to be effective in preventing the exposure of off-site receptors to the groundwater pathway contamination. Employing such a groundwater extraction system would allow for the continued collection of contaminants draining from lesser contaminated areas contained with vegetative, permeable, soil covering.

V. Corrective Measures Technologies

A. Technology Screening

A technology screening study was conducted as part of CMS. Technologies were identified which correspond to four general categories of corrective action: containment, collection/treatment, in-situ treatment, and removal/treatment/disposal. The technologies were prescreened to eliminate those that are obviously inapplicable due to site or waste characteristics and those that are undemonstrated or unavailable. The candidate technologies were then screened further on the basis of effectiveness, implementability and cost, to select the most promising technologies for use in developing corrective measure alternatives.

The technologies retained after screening include the following:

Soils/Waste	Groundwater
Capping	Vertical cut-off walls
Soil vapor extraction	French drain
Excavation	Groundwater extraction wells
Stabilization/solidification	Groundwater sparging
Soil washing	
On-site redeposition	
Off-site landfill	

As a result of physical limitations imposed by site conditions, the following technologies have been discarded:

1. Soil Washing:

Soil washing processes are designed to reduce soil contamination through the use of particle size separation. Most organic and inorganic contaminants tend to bind (either chemically or physically) to clay and silt/soil particles. The soil washing process separates the fine clay and silt particles from the coarser sand and gravel particles, thereby separating and concentrating the contaminants into a smaller volume of soil that can be further treated and disposed. Thus, soil washing is more effective in treating soils with high sand and gravel content where a substantial volume reduction can be achieved.

Field classification of soil/waste samples collected during the RFI indicates that the majority of contaminated soils and waste deposits at the site are comprised of silts, including waste fill material, and clay more so than sands and gravels. Grain size testing was conducted to confirm the field observations. In nine of the eleven samples, greater than 50 percent of the samples passed through the No. 200 sieve. Due to the predominance of the silts and clays, soil washing was discarded as a viable technology.

2. Off-site Landfill:

Complete excavation and placement in an off-site landfill would involve excavation of all contaminated soils/waste, sludges, and other wastes exhibiting constituent concentrations above the target cleanup levels. Complete excavation would encompass the CAMU, the areas north and south of railroad property, and the industrial sewer. The total volume of contaminated soil/waste associated with the main plant site is estimated to be 920,000 cubic yards.

Excavation and off-site landfill disposal of the estimated 920,000 cubic yards of soil/waste would require approximately 80,000 truck trips. Transport of the estimated 80,000 truckloads would require between 2,000 and 8,000 days (5.5 and 22 years, assuming 365 day operation) using a single facility. This assumes that the facility would remain in operation throughout this period and have the capacity to accept the waste.

Due to the sheer volume of contaminated soil/waste to be handled, placement in an off-site landfill has been determined impracticable. Therefore, this technology has been discarded.

3. Groundwater Sparging:

Since this technology is in-situ air stripping of volatile and semi-volatile organics from groundwater in the overburden water-bearing zone, it is highly dependent upon the pneumatic permeability of the saturated soils. For the area south of railroad property (i.e., Building 56 slab foundation) with elevated levels of organic contamination, field pneumatic permeability testing has shown that these soils are not within the range which would allow sparging. Sparging is also not technically feasible for contamination in bedrock water-bearing zones. Therefore, groundwater sparging has been discarded as an acceptable technology for its limited applicability at this site.

4. Vertical cut-off walls

Vertical cut-off walls are low permeability barriers constructed to restrict lateral groundwater flow. These walls may be constructed of various materials using techniques suited to site conditions. One of the more common types of cut-off walls is a slurry wall. A slurry wall is constructed in a bentonite slurry-filled trench which allows for excavation at depth and/or below the water table in a confined vertical walled trench. The trench is backfilled with a low permeability soil and bentonite slurry or cement-bentonite mix. This type of cut-off wall is generally used for construction in unconsolidated deposits i.e., the overburden water-bearing zone. With a significant portion of the groundwater contamination occurring in bedrock aquifers at this site, the use of cut-off walls is not considered beneficial.

5. On-Site Landfill Redisposition

This technology involves construction of an on-site landfill for the disposal of materials excavated from other areas of the site. Limits on the availability of unobstructed on-site property to accommodate such landfill construction precludes redeposition as a viable alternative.

B. Retained Corrective Measures Technologies For Soils/Waste

1. Capping: Limiting rainfall infiltration through concentrated and highly contaminated soil/waste deposits at the site by impermeable capping would reduce the leaching of hazardous constituents from these deposits. Such capping is most effective at reducing leachate generation when infiltration by rainfall (as opposed to lateral groundwater flow through the soil/waste material) is the primary factor controlling the extent of saturation within the contaminated soil/waste. In addition to controlling migration via groundwater, impermeable capping restricts direct contact with the contaminated soil/waste and prevents air-borne migration of dust by creating a barrier atop the material. The latter exposure preventions can also be achieved by permeable capping. However, the permeable cap will allow precipitation to percolate down through the porous cap and underlying soil/waste material. Leachate will be generated where the soil/waste material exhibits a propensity to transfer contamination to the percolating precipitation. Therefore, the permeable caps should be limited to areas of the site where the potential to generate a concentrated contaminated leachate is minimal or non-existent; where the soil/waste concentrations are not considered significant sources and their continued flushing by precipitation would be considered beneficial; and where a downgradient groundwater extraction and treatment system is operational to assure continued collection and treatment of any contaminated groundwater resulting from the flushing action.

   Three types of caps were evaluated for use at this site. They are the low permeability cap (sometimes called a RCRA cap), permeable cap (soil cap) and asphalt cap.

   (a) low permeability cap: consists of (in descending order) - surface/protective layer, drainage layer, two low permeability layers, gas venting layer (if needed) and a bottom/protective layer. The thickness of the layers, number of layers, materials of construction and sequence of layers is determined during final design in accordance with site specific conditions. This type of cap significantly reduces, if not eliminates, rainfall infiltration.

   (b) Permeable cap (soil): consists of top soil over a layer of subsoil.

   (c) Permeable cap (asphalt): consists of a wearing course over a binder course. Can reduce rainfall infiltration over relatively flat, unmounded surface.

2. Soil vapor extraction

   A series of vertical or horizontal pipes installed in or below unsaturated granular waste/soil contaminated with relatively high concentrations of volatile and some semi volatile organic compounds. As the air passes through the soil/waste material, the contaminants enter the air stream and are removed from the contaminated soil/waste material. The vapors removed typically require some form of emission control.

3. Excavation (Partial)

   The contaminated soil/waste material is removed using earth moving equipment. The material may then be treated and redeposited or consolidated on site, or if from off-site, at the Main Plant Site.

4. Stabilization/Solidification

This process involves mixing the soil/waste material with a binding agent such as portland cement, silicate thermoplastic or organic polymer. This is a physical process which encapsulates the grains of soils/waste thus reducing the mobility of the constituents and minimizes the potential for leaching. The volume of soil/waste is increased by the addition of the binding agent.

C. Retained Corrective Measures Technologies for Groundwater

1. French drains

This technology involves constructing a drain within an excavated trench. The trench typically includes perforated piping placed within an aggregate drain. Groundwater is intercepted in the high permeability trench, collected in sumps, and pumped to a treatment facility. This type of collection system would be limited to collecting contaminated groundwater in the overburden aquifer.

2. Groundwater extraction wells

This technology involves installation of groundwater pumping wells within a contaminant source area or migration area for extraction of contaminated groundwater. Pumping creates a local depression in the piezometric surface of the aquifer, causing groundwater to flow towards the extraction wells. The contaminated groundwater is collected for treatment and then discharged back into the environment. This form of collection would be appropriate for collecting contaminated groundwater in both the overburden and bedrock aquifers.

D. Retained Corrective Measure Technology Alternatives (Soil/Waste)

Some alternatives presented in the Corrective Measure Study were not considered for further evaluation for previously discussed reasons. Therefore, the numbering of alternatives identified herein are not consecutive, but do correspond with the alternative numbering in the study.

Due to the physical characteristics of the Main Plant Site and the Pretreatment Plant Site, and the disposal of varied wastes, the retained corrective measure technologies for soil/waste have been grouped into several alternatives for evaluation:

1. Corrective Action Management Unit (CAMU)

Alternative 2 - Capping (low permeability)
Alternative 3 - Capping (low permeability) with soil vapor extraction
Alternative 4 - Stabilization/solidification and on-site redeposition with capping (low permeability).

2. Area North of Railroad Property

Alternative 2(a) - Capping (permeable)
Alternative 3 - Stabilization/Solidification and on site redeposition with capping (permeable).

3. Area South of Railroad Property

Alternative 2(a) - Capping (permeable)
Alternative 3 - Capping (permeable) with excavation of Building 56 Area

soil/waste and its redeposition in the CAMU.

- Alternative 4 - Capping (permeable) with excavated Building 56 Area soil/waste being redepositioned in the CAMU and followed by soil vapor extraction in the CAMU.
- Alternative 5 - Stabilization/solidification of soil/waste on-site and its redeposition with capping (permeable).

4. <u>Pretreatment Plant</u>

- Alternative 2(a) - Capping (permeable, soil-vegetative cover)
- Alternative 2(b) - Capping (permeable, asphalt cover)
- Alternative 3 - Excavation and redeposition at the Main Plant Site (with capping)
- Alternative 4 - Excavation with stabilization/solidification and redeposition at the Main Plant Site.

At the time the CMS Report was written there was very little information on the groundwater at the Pretreatment Plant. Since that time, an RFI has been completed which shows cyanide contamination leaving this site via groundwater at levels slightly above standards. Therefore corrective action will not be initiated at this time. A program of groundwater monitoring will be implemented at the Pretreatment Plant site to evaluate the long term water quality trends and the effectiveness of the corrective measures.

E. <u>Retained Corrective Measure Technology Alternatives (Groundwater)</u>

The following groundwater retained corrective measure technology alternatives have been evaluated for the Main Plant Site:

- Alternative 2 - Upgradient collection trench in overburden with a discharge to Glens Falls POTW
- Alternative 3 - Downgradient collection of contaminated groundwater in bedrock Horizons A and B water-bearing zones with extraction wells, pretreatment (as necessary) on-site and discharge to Glens Falls POTW.
- Alternative 4 - Downgradient collection of contaminated groundwater in overburden and bedrock Horizons A & B water-bearing zones with a combination of french drains and extraction wells, pretreatment (as necessary) on-site and discharge to Glens Falls POTW

At the Main Plant Site, the corrective measure technology alternatives for contaminated groundwater are linked with the corrective measures for the soil/waste. All of the corrective measure technology alternatives identified above for soil/waste material located in the areas north and south of the railroad property and the CAMU could employ collection of overburden and bedrock contaminated groundwater at the downgradient boundary of the site (i.e., along the edge of the property adjacent to the river). If a low permeability cap or stabilization/solidification was to be selected for covering all the areas, then the downgradient groundwater collection system for only the bedrock aquifers would be appropriate. This cap or treatment would curtail the further releases of leachate contamination from soil/waste material sources to the groundwater, but not address sources which might exist in the bedrock aquifers (i.e., dense non-aqueous phase liquid contamination that could have migrated into the bedrock from the south waste pile). Groundwater corrective measure technology alternative two (2), which considers upgradient overburden groundwater collection, incorporates low permeability caps for the areas north and south of the railroad property and the CAMU. This alternative would not address bedrock groundwater contamination from liquid solvents which may have migrated into the bedrock.

VI. EVALUATION OF THE CORRECTIVE MEASURES ALTERNATIVES

Since the different alternatives are various combinations of basic technologies; four for soils/waste and two for groundwater, the evaluation will be an evaluation of the technologies used in the alternatives.

A. General Standards For Remedy Selection

The initial evaluation of the retained technologies is based upon how they meet the four general standards for corrective measures which are:

1. Protective of human health and the environment;

2. Attain media cleanup standards;

3. Control the sources of releases; and

4. Comply with standards for waste management.

The final corrective measures for remediating the soils, waste and groundwater at the Main Plant Site is capping with a permeable cover at all SWMUs except those located in the CAMU. The CAMU would be capped with a low permeability cap as required by Part 373 for the closure of hazardous waste landfills. Remediation of the groundwater would be by the installation of a groundwater interception system at the downgradient boundary of the property that would collect the contaminated groundwater in the overburden and bedrock Horizons A and B for pretreatment (as necessary) prior to its discharge to the Glens Falls POTW. Institutional controls will be imposed to limit future use of the site; restrict the movement of contaminated soils and use of contaminated groundwater; and inform potential future site owners of the residual contamination present in the soils and groundwater. As an added benefit, this alternative, while adequately protecting human health and the environment, will impose the least restrictions for re-development of the site.

For the Pretreatment Plant, the final corrective measure is to excavate those soils contaminated above "target cleanup levels" and redeposit them at the nearby Main Plant Site. The excavated areas would be then filled in with clean soils. The deed restrictions mentioned in the above paragraph will be placed on the use of groundwater and on the use of the site in the unlikely event that soil cannot be removed down to "target cleanup levels".

1. Protective of Human Health and the Environment

All of the retained corrective measures alternatives would provide adequate protection of human health and the environment by eliminating, reducing, or controlling exposure to contamination through treatment, engineering controls or institutional controls. The final corrective measures for the Main Plant Site will curtail migration of contaminated groundwater off-site by collecting it at the southern-most boundary for treatment prior to discharge. The permeable cap north and south of the railroad property, and the low permeability cap at the CAMU will prevent exposure associated with direct contact or particulate inhalation of the soil/waste mix underlying these protective covers. The covers will serve to prevent migration of contaminated surfacial soil/waste material to the Hudson River through runoff during storm events. Also, the CAMU once capped will be eliminated as a significant groundwater source of contamination.

Institutional controls will be implemented as part of the final corrective measures. Controls will limit the future use of the site and regulate the future movement of the contaminated soil/waste and the use of the contaminated groundwater.

For the Pretreatment Plant, the final corrective measure, removal of contaminated soils above target cleanup levels and re-deposition at the Main Plant Site) will be protective of human health and the environment. The final corrective measures at the Main Plant Site for these re-deposited soils will protect human health and prevent releases into the environment. At the Pretreatment Plant monitoring of the groundwater, along with restrictions on its use, will protect human health and the environment. If levels of groundwater contamination increase, the initiation of corrective measures will be evaluated.

2. <u>Attainment of Media Cleanup Standards</u>

The only retained corrective measure technologies having the potential to achieve soil/waste decontamination cleanup standards (i.e., target cleanup levels) are vapor extraction and excavation. However, vapor extraction is limited to removing only volatile organic constituents. It will not lower non-volatile contamination levels attributable to inorganic metals and certain semi-volatile organic compounds with low vapor pressures. Achieving cleanup standards for non-volatile constituents would involve excavation.

Vapor extraction technology is not practical given the heterogeneous nature of the contamination existing in areas containing volatile contaminants. Lowering the residual levels of volatile organics to their respective decontamination cleanup standards at these isolated areas (i.e., the south waste pile, incineration area, and in the vicinity of Building 56) would still leave these areas contaminated with non-volatile organic and inorganic constituents above their decontamination cleanup standards. In order to achieve full decontamination of the soil/waste mixture excavation and transport off-site would be necessary. However, such a removal action would only serve to create decontaminated islands surrounded by contamination. Creating these small "clean islands" is not cost effective nor does it offer a significant benefit. The remaining soil/waste contamination residing in the vicinity of the "clean islands" would still dictate the future use of the decontaminated areas, and would require appropriate remediation to mitigate risks from exposure.

Meeting cleanup standards in the soil/waste mixture by excavation and off-site transport either in isolated small areas of the site or in larger areas such as the areas north or south of the railroad property is considered costly and impracticable. Potential health risks from exposure to the remaining soil/waste contamination can be adequately addressed by more pragmatic remedial solutions such as the proposed corrective measures alternative. This alternative will eliminate the health risks associated with direct exposure (i.e., direct ingestion, dermal contact) and with particulate inhalation of any soil/waste contamination remaining at the site. The installation of a low permeability cap over the CAMU will serve to cut-off future releases to the groundwater from this significant source. Areas where a permeable cap will be placed can also benefit by having these areas more accessible for future redevelopment. This more porous cap placed over areas with lower residual contamination, but still having some propensity to leach will allow continued flushing of the contamination with subsequent collection by the downgradient collection systems.

There are no short-term solutions for achieving groundwater cleanup standards. No in-situ technology exists that will allow the removal of inorganic metals or chlorinated organics. However, cutting off the most significant source, i.e., the

CAMU, and allowing the contaminants to flush out from the aquifers does offer the potential for achieving groundwater cleanup standards in the future.

For the Pretreatment Plant soils, it is possible to attain media cleanup standards by excavation of those soils above the standard and re-depositing them at the Main Plant Site. Since the groundwater contamination is slightly above media standards, it is possible that, after removal of contaminated soils, the natural flushing will eventually lower contamination to groundwater cleanup standards.

3. Controlling the Sources of Releases

Vapor extraction and stabilization/solidification are treatment technologies having the potential to control sources of releases to the groundwater pathway. Application of the former technology is considered suitable for controlling releases of only volatile organic constituents. The latter technology is effective in controlling releases of inorganic constituents. However, neither technology alone can control particulate releases, runoff or surfacial soil contamination, or prevent direct exposure without the addition of an appropriate cover.

Capping is considered appropriate for controlling source releases of particulate matter through the air pathway and runoff of surfacial soil contamination. However, the low permeability cap is also effective in controlling releases of all contaminants through the groundwater pathway. This type of cap can isolate the soil/waste mixture remaining in significantly contaminated areas from precipitation, thereby precluding the generation of leachate. It is contaminated leachate migrating down to the underlying aquifers that becomes the true source for groundwater contamination.

Although the permeable cap provides adequate exposure control for direct contact, runoff contamination and releases to the air pathway, it will not be effective for controlling the generation of leachate. Its use is limited to areas where leachate generation is not expected or where contaminated groundwater plume management will be implemented and flushing residual contaminants from less significant sources is a viable alternative.

4. Compliance with Waste Management Standards

All the retained soil/waste and groundwater alternatives that generate waste streams would comply with prevailing solid waste management standards. Also, the closure of the CAMU by a low permeability cap would meet applicable closure requirements set forth in state in federal RCRA regulations for hazardous waste land disposal. Contaminated groundwater collected by extraction wells and/or french drains would be treated (as necessary) to meet appropriate discharge limitations and discharge to the Glens Falls POTW. Also, organic emissions from vapor extraction would be required to meet state air quality based emission standards.

B. Remedy Selection Decision Factors

The following five selection decision factors are used to select the proposed corrective measures alternative which will provide the greatest protection for human health and the environment with the least risk and lowest incremental cost:

1. Long-term Reliability and Effectiveness

(a) Soil/waste material: With the proper long term maintenance, capping, vapor extraction, and solidification/stabilization will provide adequate reliability and effectiveness. Vapor extraction would involve mechanical equipment and be considered more complex and require a greater degree of maintenance. Excavation of contaminated soils at the Pretreatment Plant will eliminate any concern of long term reliability and effectiveness since all of the soils above the media cleanup standards will have been removed.

(b) Groundwater: The two primary groundwater technologies; the french drain and extraction wells, with proper maintenance will also provide adequate reliability and effectiveness. Due to its greater complexity, the extraction well system would require a greater degree of maintenance. However, this is the technology that will most likely be required to intercept the deeper bedrock aquifers since the use of french drains is limited to shallower applications.

2. <u>Reduction of Toxicity, Mobility or Volume of Wastes</u>

(a) Soil/waste material: The retained primary technologies; impermeable capping and stabilization/solidification can reduce the mobility of the wastes by limiting leachate generation during precipitation events. They will not reduce the toxicity or volume of the wastes like soil vapor extraction. Stabilization/ solidification of the waste, due to the addition of the stabilizing agent could increase the volume of waste up to fifty percent. The vapor extraction is limited to reducing only volatile contamination, and not the non-volatile constituents also mixed-in with the volatile soil/waste material. For the Pretreatment Plant, the excavation alternative reduces the volume of waste (contaminated soil); however, this volume is transferred to the Main Plant Site.

(b) Groundwater: The downgradient groundwater technologies will reduce the mobility of the waste in the groundwater at the Main Plant Site by preventing off-site migration. The upgradient collection system would not collect existing contaminated groundwater at the site and only reduce future mobility of contamination in the overburden.

3. <u>Short-term Effectiveness</u>

(a) Soil/Waste Material: The facility has estimated that to solidify/ stabilize the waste at the Main Plant Site would take forty-five months. This extended period of time is partially due to the pilot studies that would be necessary to select the proper stabilizing agents and due to the large volume of soil/waste to be processed. Soil vapor extraction system would need to operates for several years before results are achieved. The time estimated for capping is thirteen months. Due to the shorter implementation time, capping would start protecting human health and the environment approximately two and one half years sooner.

In addition, due to the in-situ nature of capping (the wastes are left in place), the risk to workers and the community are less. Since the waste are not handled, as is required during stabilization/ solidification or redeposition, there is less chance of release to the environment.

For the Pretreatment Plant, the facility estimates that each of the alternatives would take one month of field work with six months of pre-construction activities for a total of seven months. There is less risk to the workers and community with capping. Additional risk would be incurred with excavation and re-deposition at the Main Plant Site due to the additional handling and transportation.

(b) Groundwater: The time frames for implementing the Main Plant Site groundwater technologies are almost the same; ten months for the french drain and eleven to thirteen months for the extraction wells.

4. <u>Implementability</u>

(a) Soil/Waste Material: Capping the site is simpler and easier to implement than stabilization/solidification or vapor extraction. For capping, all of the work would be done at the surface; there would not be the need for either laboratory or field testing to determine the effectiveness of the treatment alternatives. If problems were noted, repair of the cap could be easily accomplished. If problems developed with the stabilized soil/ waste, it would need to be reworked to achieve performance criteria.

At the Pretreatment Plant, excavation and re-deposition at the Main Plant Site is easily implementable. Standard earth moving equipment could be used to excavate and transport the contaminated soils. The depth of excavation would be shallow and would not pose a threat to the workers. The distance to transport the soil for re-deposition would be approximately one-half mile.

(b) The installation of a downgradient french drains and extraction wells is necessary to prevent continued releases from the site. The french drain is the preferred technology for the overburden aquifer since it is more reliable and easier to operate than groundwater extraction wells. Due to the depth required to intercept flow of contaminated groundwater in the deeper bedrock aquifers, it is likely that groundwater extraction wells will have to be installed. A french drain has depth limitations especially on this site due to the closeness of the Hudson River. Due to the complex nature of pumps, their associated controls and the necessity of a groundwater stripping and treatment system it is likely that in addition to daily staffing, control systems (including remote alarms) be installed to allow automatic operation and response to mechanical failure. In addition, routine mechanical repairs and purchase of water treatment chemicals would be required.

The french drain, the preferred technology for remediating the overburden aquifer, is a passive groundwater collection system, that if not operated by gravity, would only require a simple pump to transport the collected water to the existing facility pump station.

5. <u>Costs For Retained Corrective Measure Technology Alternatives</u>

The facility has estimated the following costs for each of the retained alternatives:

<u>Corrective Measures Alternatives For Soil/Waste</u>

Alternative	SWMU	Present Worth Cost
	CAMU	
2	Capping (low permeability)	$ 1,408,000
3	Capping (low permeability) with soil vapor extraction	1,719,000
4	Stabilization/solidification and on-site redeposition with low permeability cap	7,052,000
	Area North of Railroad Property	
2(a)	Capping (permeable cover)	2,742,000
3	Stabilization/solidification and on-site redeposition with a permeable cover	27,482,000
	Area South of Railroad Property	
2(a)	Capping (permeable cover)	3,151,000
3	Capping (permeable cover) with excavation of Building 56 Area soil/waste and redeposition in the CAMU	3,383,000
4	Capping (permeable cover) with soil vapor stripping of Building 56 Area, soil/waste placed in the CAMU	3,383,000
5	Stabilization/solidification and on-site redeposition with a permeable cover.	32,524,000
	Pretreatment Plant	
2(a)	Capping (permeable, soil-vegetative cover)	231,000
2(b)	Capping (permeable, asphalt cover)	249,000
3	Excavation and re-deposition at Main Plant Site (with capping)	124,000
4	Excavation with stabilization/ solidification and re-deposition at Main Plant Site	199,000 *

<u>Corrective Measures Alternatives For Groundwater</u>

Alternative	Description	Cost
2	Upgradient collection system	$ 9,543,400
3	Downgradient collection from bedrock, pretreatment on-site and discharge to Glens Falls Treatment Plant	14,052,000
4	Downgradient collection from overburden and bedrock aquifers, pretreatment or site discharge to Glens Falls Treatment Plant	17,141,000 to 18,105,000

* Stabilization/solidification of the Pretreatment Plant soils would only be considered if this technology was selected for the SWMUs at the Main Plant Site.

VII. Summary Determinations

In summary, a permeable cover for the areas north and south of the railroad property with a downgradient collection system collecting both overburden and bedrock contaminated groundwater is the final corrective measure. Despite its higher cost, this option was chosen because, while providing protection of human health and the environment, it also allows for simpler and less costly redevelopment of the site. Should redevelopment occur, there will be no low permeability cap complicating the installation and repair of underground utilities or the construction of new on-site structures. Institutional controls will be imposed to restrict the site usage; control future contaminated soil removal and groundwater usage; and make future owners aware of the residual contamination.

For the CAMU, the final corrective measure is capping with a low permeability cap. Since this unit is undergoing closure as a RCRA land disposal unit, certain restrictions apply to its method of closure. The low permeability cap, while providing adequate protection to human health and the environment, also satisfies the legal requirements for closure.

Capping, either low-permeability, or permeable is a less complex technology, that can be implemented in a reasonable time frame, using readily available materials. With proper maintenance, this alternative will last indefinitely. The downgradient groundwater interception system, although more complex, with the proper operation and maintenance, will provide protection as long as required.

For the Pretreatment Plant, excavation of those soils above the target cleanup levels, and re-deposition at the Main Plant Site is the final corrective measure. This re-deposited soil would be covered by the cap (either in the CAMU, or elsewhere on site) which is the final remedy for the Main Plant Site. Removal of the contaminated soils from the Pretreatment Plant and re-deposition at the Main Plant Site is the only option that will allow cleanup standards to be met, is the least costly option, is permanent, can be implemented in the same time frame as the other alternatives and uses readily available equipment.

For those portions of the industrial sewer which are to be decommissioned, the final corrective measure is to plug the sewer laterals and fill the manholes with sand or gravel. This is a straightforward technology which can be easily implemented using readily available materials and will last indefinitely.