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SITE INVESTIGATION & RESTORATION

SUPERFUND PROGRAM PROPOSED PLAN

Halby Chemical Site

Operable Unit Two
Wilmington
New Castle County, Delaware

July 1997

Proposed Plan July 1997
Copy 1 of 1

Halby

INTRODUCTION

The United States Environmental Protection Agency Region III (EPA) has identified the Preferred Alternative to address hazardous contamination in ground water, soil, and sediment at the Halby Chemical Superfund Site (Site) located in Wilmington, New Castle County, Delaware (Figure 1). The major components of EPA's Preferred Alternative include constructing a cap over contaminated lagoon and marsh sediment and contaminated soil; surface water runoff controls; long-term monitoring, and institutional controls to prevent contact with, or consumption of, contaminated ground water.

This Proposed Plan is based on site-related documents contained in the Administrative Record for the Site including the Remedial Investigation, the Baseline Risk Assessment, the Ecological Risk Assessment, the Remedial Action Report and the Feasibility Study. The Administrative Record is at the following locations:

Wilmington Institute Library
10th and Market Streets
Wilmington, DE 19801
(302) 571-7416

U.S. EPA-Region III Docket Room
Ms. Anna Butch
841 Chestnut Building, 9th Floor
Philadelphia, PA 19107
(215) 566-3157

EPA and the Delaware Department of Natural Resources and Environmental Control (DNREC) encourage the public to review and comment on all the clean-up options evaluated in this Proposed Plan, and other documents in the Administrative Record file. The public comment period begins on July 30, 1997 and closes on August 29, 1997. On August 18, 1997, at 7:00 p.m., EPA will hold a public meeting to discuss the Proposed Plan at the DeLaWarr State Service Center, 500 Rogers Road, New Castle, DE. Written comments, postmarked no later than August 29, 1997, should be sent to:

Eric Newman (3HW23)
Remedial Project Manager
U.S. Environmental Protection Agency
841 Chestnut Building
Philadelphia, PA 19107

Interested persons are encouraged to submit their comments on the Proposed Plan and the other documents in the Administrative Record to EPA during the public comment period. Although EPA has selected a preferred alternative, no final decision has been made. EPA may modify the Preferred Alternative, select another response action or develop another alternative, if public comment warrants or if new material is presented. EPA, the lead agency, in consultation with the DNREC, the support agency, will make its final selection of a remedy for the contamination at the Site in a Record of Decision (ROD).

This Proposed plan fulfills the public notification requirements of Sections 113(k)(2)(B), 117(a), and 121(f)(1)(G) of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as amended (CERCLA), 42 U.S.C. §§ 9613(k)(2)(B), 9617(a), and 9621(f)(1)(G).

SITE BACKGROUND AND HISTORY

The Halby Chemical Site is located in a highly industrialized area near the Port of Wilmington, New Castle County, Delaware (see Figure 1). The 14-acre Site is generally bordered by Conrail tracks, Interstate 495, and Terminal Avenue, although the Site may be expanded to include the areal extent of contamination and all suitable areas in very close proximity to the contaminants necessary for the implementation of the response action. Surrounding land parcels include a steel plant to the north, an asphalt plant to the south and the Potts Property State Superfund site (Potts Property or Potts Site) to the east. The Potts Property comprises the entire 75 acre parcel between the Halby Chemical Site and the Christina River. Industrialization of the area began in the late 19th century; several nearby industrial facilities have risen and collapsed over the past 100 years. The Port of Wilmington area between Terminal Avenue and the Christina River was primarily marsh land until the wetlands were incrementally filled-in and built upon.

Major Halby Chemical Site features include three office buildings/warehouses housing at least five small businesses, and a lagoon with associated wetlands. Other features adjacent the Site include a diesel truck fueling station and a residential parcel with two trailer-homes.

The Halby Chemical plant was constructed at the southeastern portion of the property in 1948. Specialty chemicals, primarily sulfur compounds, were processed in the chemical manufacturing plant from 1948 to 1980. From 1948 to 1964, production wastewater and cooling water were disposed of in the unlined on-site lagoon. The lagoon drained into the adjacent tidal marsh through culverts beneath the railroad tracks. The tidal marsh drained to the Christina River through the Lobdell Canal. Currently, the on-site lagoon is bermed and consequently isolated

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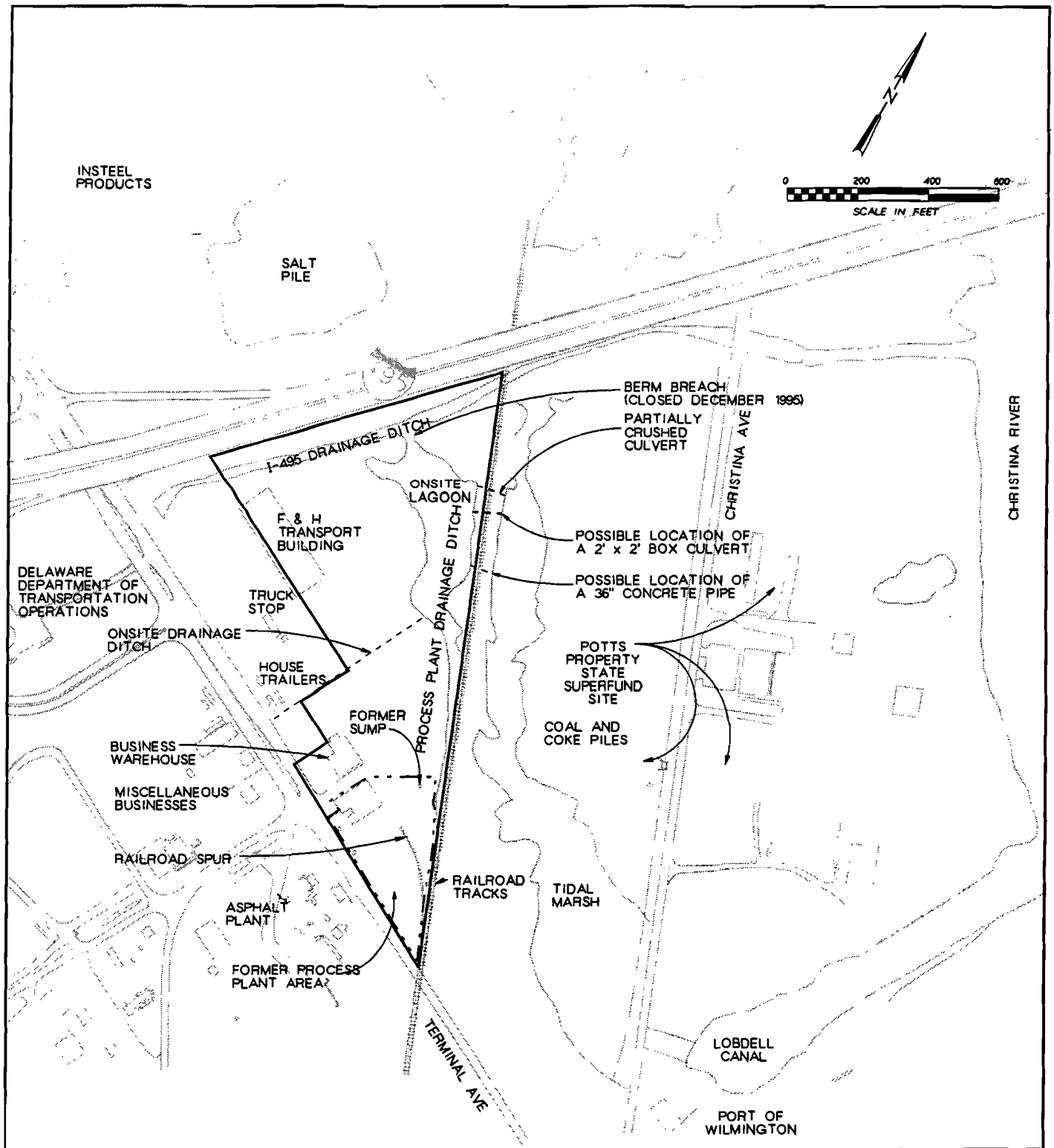

LEGEND

HALBY CHEMICAL SITE

FORMER PROCESS PLANT AREA BOUNDARY

Figure 1
SITE LOCATION
Halby Chemical Site

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from the off-site waterways; an emergency overflow spillway connects the lagoon to a stormwater runoff ditch, which parallels Route I-495 and drains to the Christina River.

Between 1964 and 1972, only cooling water and accidental spillage conveyed by uncontrolled stormwater or flow from the floor drains within the chemical production plant was reported to have entered the lagoon. During this period, production wastes were reportedly discharged into the sewer lines. After 1972, however, production wastewater was combined with the cooling water and stormwater runoff, treated, and again discharged into the lagoon.

Through the mid-1970's the lagoon was more than twice its current size, extending west to a point near the back edge of the F&H Transport building which was not constructed until 1988. The lagoon presently receives runoff from the railroad tracks and the Site.

The chemical production facility operating as Halby Chemical closed in 1977 and the property was sold to Brandywine Chemical Company (BCC). BCC reportedly produced a few batches of specialty chemicals between 1978 and 1980. BCC's business operations were limited to short-term storage of chemicals in the on-site tank farm from 1981 through 1995 when BCC stopped handling chemicals.

In 1984, EPA conducted an inspection of the Halby Chemical Site and in 1985 assigned a Hazard Ranking Score of 30.90. The Site was subsequently proposed for the National Priorities List (NPL) in September 1985 and was finalized on the NPL in June 1986.

SCOPE AND ROLE OF RESPONSE ACTIONS

The problems at the Halby Chemical Site are complex. As a result, EPA has divided the work into an immediate removal action and two components called "operable units (OUs)." These are as follows:

- OU-1: Contaminated surface soil within the former chemical process plant area.
- OU-2: Contaminated ground water, soil outside the former process plant area, and sediment in the on-site lagoon and adjacent tidal marsh.
- Removal Action: Building and tank dismantling and disposal; off-site disposal of chemicals in drums, containers and vessels; treatment of carbon disulfide contaminated soils.

In June 1991, EPA completed a Remedial Investigation and Feasibility Study for the Site. Surface soil within the process plant area was found to pose an unacceptable health threat to site workers through inadvertent breathing of dust and inadvertent eating of small amounts of contaminated soil. EPA issued a Record of Decision for OU-1 calling for stabilization of the top six inches of contaminated soil within the 3-acre former process plant compound followed by

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capping the contaminated soil. This cleanup action is in the design stage, which means that the engineers are developing specific plans for implementation of the remedy.

The Remedial Investigation for OU-2, including the site-wide Baseline Human Health Risk Assessment and the site-wide Ecological Risk Assessment, was based on field sampling conducted during the OU-1 investigation and augmented with additional sampling completed between 1993 and 1995. Based on these documents, as well as information gathered during the ongoing carbon disulfide removal action, a Feasibility Study describing the remedial action objectives and comparing cleanup alternatives for OU-2 was completed in June 1997. The findings of these reports are summarized below.

The Preferred Alternative described in this Proposed Plan is intended to be the final response action for this Site. The primary objective of the remedy is to reduce or eliminate the potential for human or ecological exposure to unacceptable risks associated with OU-2 of the Halby Chemical Site. However, because the soils addressed previously under OU-1 are similar in characteristic to the OU-2 soils and both areas will be used for industrial purposes, the scope of this Proposed Plan has been expanded to include the whole Site. The OU-2 Record of Decision will supersede the OU-1 Record of Decision. Therefore, the preferred cleanup option outlined in this Proposed Plan will comprehensively address the threats posed by the release of hazardous substances from the Site.

In addition to the response actions described above, EPA completed the first phase of a removal action at the Site in July 1995. Buildings and above-ground storage tanks within the former chemical process plant area were dismantled and disposed of off-site, leaving a warehouse within the fence. EPA addressed the contents of an estimated 600 small containers and 13 pressurized cylinders found in the abandoned laboratory area; an estimated 200 drums and 50 tanks found in the warehouse area, chemical processing area, and tank farm; and approximately 1,000 small containers found haphazardly mixed with shallow soil near a concrete sump in the northwest corner of the former process plant area. Chemicals in these containers and vessels including, but not limited to, carbon disulfide and ammonium thiocyanate were transported off-site for safe disposal.

During the removal activities, EPA identified a significant area of extremely high carbon disulfide contamination extending from the point that waste water was discharged from the chemical production facility to the lagoon (see Figure 2). A second phase removal action was initiated to address the principal threat posed by carbon disulfide contaminated soil on an expedited basis. In accordance with a unilateral administrative order issued in July 1995, a Potentially Responsible Party (PRP) has erected a security fence, installed a temporary plastic cap over the outfall ditch and constructed a berm to prevent the migration of contaminants from the on-site lagoon to the Christina River. Pilot-scale treatment of carbon disulfide contaminated soil completed in May 1997 demonstrated that carbon disulfide can be degraded to environmentally harmless compounds; full-scale treatment is scheduled to begin in July 1997 and be completed in Spring 1998.

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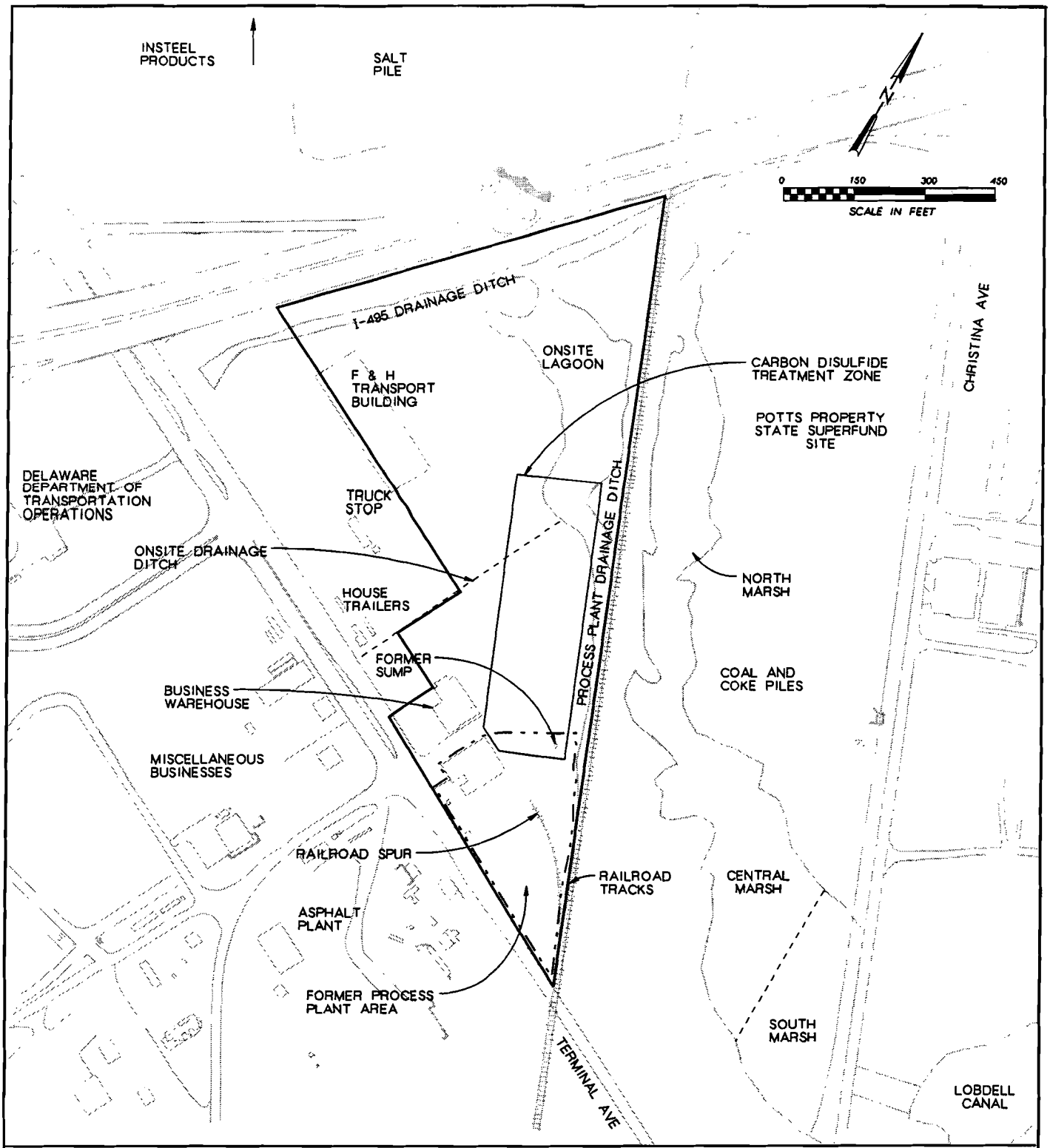

LEGEND

HALBY CHEMICAL SITE

FORMER PROCESS PLANT AREA BOUNDARY

Figure 2
SITE FEATURES
Halby Chemical Site

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NATURE AND EXTENT OF CONTAMINATION

Surface Soil Contamination: More than one hundred surface soil samples have been collected within the former process plant area, the process plant ditch area, the northwestern part of the site and the adjacent residential parcel. The following findings were noted:

- Elevated arsenic concentrations were detected in surface soil located in the former process plant area at concentrations up to 1,410 parts per million (ppm) and the former process plant drainage ditch area at concentrations up to 1,010 ppm. Arsenic was detected at up to 80 ppm in the backyard area of the adjacent residential parcel. The northwestern part of the property (between F&H Transport's office/warehouse and the lagoon) has been covered with slag to create a stable base for truck traffic; therefore arsenic contaminated soils are not exposed at the surface. Arsenic is the primary contaminant in surface soil at the Halby Chemical Site.

- Other contaminants detected at elevated levels in surface soil include:
  - beryllium (116 ppm);
  - manganese (26,100 ppm); and
  -carbon disulfide (59,000 ppm)

Subsurface Soil Contamination: Several hundred subsurface soil samples have been collected across the Site at more than 100 locations. A summary of the results is given below:

- Elevated arsenic concentrations were detected in subsurface soil located in the former process plant area at concentrations up to 1,300 ppm, the former process plant drainage ditch area at concentrations up to 11,900 ppm and the northwestern part of the site at concentrations up to 2,500 ppm. A sample collected from a soil pile excavated from the northwestern corner of the former process plant area contained 30,900 ppm arsenic. Arsenic is the primary contaminant in subsurface soil.

- Other contaminants detected at elevated levels include antimony (3,810 ppm), lead (3,590 ppm) and copper (24,300 ppm).

- Carbon disulfide has been detected at concentrations as high as 160,000 ppm in subsurface soil extending from the point that aqueous waste was discharged from the chemical production facility to the lagoon. The carbon disulfide in soil is already being addressed as part of an ongoing removal action. It is assumed that the carbon disulfide located down to 12 feet below the ground surface will not be an environmental problem which needs to be addressed in this Proposed Plan as it will be removed during on-going removal actions.

Elevated levels of metals in surface and subsurface soil may originate from multiple sources. Known production of arsenic containing chemical products at the Halby Chemical facility likely

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resulted in significant arsenic contamination of surface and subsurface soils. Observations documented during monitoring well installation indicate that 6-16 feet of soil has been deposited over the site which was historically a wetland. Soil used to backfill the property may have contained high levels of various metals prior to its deposition. Although high levels of arsenic and other metals occur in all areas of the property investigated, the concentrations are highly variable with discontiguous local areas of high metal concentration.

Surface Water Contamination: Surface water samples were collected from the on-site lagoon, the I-495 drainage ditch, the adjacent tidal marsh and the Christina River just upgradient of its confluence with the I-495 drainage ditch. A berm has been constructed to isolate the lagoon from the I-495 drainage ditch and thereby reduce the migration of Site-related contaminants to the river. The river sample from upstream of the Site can give some indication of background concentrations. Since the river is tidally influenced, there is no absolute "up stream" sample.

- The surface water quality in the on-site lagoon is generally degraded with concentrations of several metals, including arsenic, chromium, copper, iron, lead, nickel and cyanide exceeding Delaware water quality standards for protection of aquatic life. In addition, concentrations of ammonia and carbon disulfide were as high as 20,000 and 4,000 parts per billion (ppb), respectively.

- The surface water in the tidal marsh contained levels of cyanide, iron and zinc at concentrations exceeding Delaware water quality standards for protection of aquatic life. In addition, the concentration of ammonia was as high as 18,000 ppb.

- The surface water from the I-495 drainage ditch contained cyanide at a concentration exceeding Delaware water quality standards for protection of aquatic life. In addition, manganese was identified at 2,160 ppb.

Concentrations of metals in Christina River surface water are much lower than concentrations in the lagoon and tidal marsh. There are no current point source discharges to the lagoon or tidal marsh. Elevated concentrations are likely caused by erosion of contaminated surface soil, the continued leaching of contaminants from lagoon and tidal marsh sediment, and the natural discharge of contaminated ground water into the surface water bodies.

Lagoon and Tidal Marsh Sediment Contamination: Sediment samples were collected from the on-site lagoon, the adjacent tidal marsh, the I-495 drainage ditch and the Christina River. Sediment collected from both on- and off-site locations demonstrate poor quality and chemical degradation of the aquatic ecological system.

- Sediment in the on-site lagoon and the tidal marsh demonstrate substantial Site-related degradation; the north and central portion of the tidal marsh is more degraded than the southern portion. Inorganic compounds and metals which were identified in both the on-site lagoon and tidal marsh sediment at concentrations above levels known to be

protective of aquatic life include ammonia, arsenic, cadmium, cobalt, copper, lead, mercury, silver, thiocyanate and zinc. Nickel and vanadium were also found at elevated levels in the tidal marsh sediment. Concentrations of arsenic, copper, and thiocyanate in the on-site lagoon and tidal marsh sediment are more than 100 times higher than levels known to be safe for aquatic organisms. Zinc is also present at this level in the on-site lagoon. Volatile organic contaminants (VOCs) detected at levels of potential ecological concern include 2-butanone and carbon disulfide in both the on-site lagoon and tidal marsh. Semi-volatile organic compounds (SVOCs) were detected at elevated levels; however, SVOCs concentrations were similar to the levels identified in the Christina River and are not considered to be Site-related contaminants.

Arsenic was the only contaminant detected in on-site lagoon and tidal marsh sediments at a level of potential concern to human health.

- The following metals were identified in the southern marsh sediment at concentrations both six times above levels known to be protective of aquatic life and at least twice the concentration found in sediment collected from the Christina River: arsenic, cadmium, cobalt, copper, and zinc. Mercury and nickel are well above concentrations known to be protective. Semi-volatile organic compounds were detected at concentrations similar to the levels identified in the Christina River and are not considered to be Site-related contaminants. Arsenic was the only contaminant detected in southern marsh sediment at a level of potential concern to human health.

- Arsenic and copper were identified in the I-495 drainage ditch sediment at concentrations both thirteen times above levels known to be safe for aquatic life and at least four times the concentration found in sediment collected from the Christina River.

- Sediment collected from the Christina River contained levels of several semi-volatile organic compounds including benzo(a)anthracene, benzo(a)pyrene, benzo(a)fluoranthene, chrysene, fluoranthene, phenanthrene and pyrene at levels ten times greater than levels known to be protective of aquatic life. Based on the distribution of SVOCs, the SVOCs are not considered site-related compounds. Copper and zinc concentrations in river sediments were also elevated.

Hydrogeologic Evaluation: The Site is located within the Coastal Plain physiographic province which consist of unconsolidated interbedded sand, silt and clay layers which may have lenses of sand, silt or clay sediment. There are three water-bearing formations, or aquifers, beneath the Site. The water table is encountered between 5 and 15 feet below the ground surface. The Columbia formation and recent fill comprise the surficial aquifer which is approximately 20 to 30 feet thick across the Site. Below the Columbia Aquifer is an upper sand of the Potomac Aquifer which extends 60-75 feet below ground surface. Between these two aquifers, there is a 5-25 feet thick silt layer which reduces vertical water flow between them; however, this silt layer is absent beyond the Site toward the Christina River. The ground water in both the Columbia

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and Upper Potomac flows to the northeast, under the adjacent Potts Property State Superfund Site and toward the Christina River. The deepest unconsolidated aquifer at this Site is a lower sand of the Potomac Aquifer approximately 80-100 feet below ground surface. At the Site, the lower sand aquifer is confined with a 20-30 feet clay layer between it and the upper sand of the Potomac Aquifer. This clay layer appears to have prevented the movement of Site-related contaminants found in the shallower aquifers through to the lower sand of the Potomac Aquifer.

The Columbia and Upper Potomac aquifers have been chemically degraded with Site-related chemicals. A summary of the findings is provided in the section discussing ground water contamination below. There are no drinking water wells withdrawing ground water from either the Columbia or Upper Potomac Aquifers within 2 miles downgradient of the Site.

Although ground water passing beneath the Halby Chemical and Potts Sites most likely discharges to the river adjacent to the shore, some of the ground water may flow beneath the river. Additional data is being collected under the direction of DNREC pursuant to the on-going Remedial Investigation of the adjacent Potts Property State Superfund site, including an evaluation of ground water and contaminant flow at the Christina River interface. In the event that the Potts Site investigation determines that contaminated ground water naturally discharging to the Christina River presents an unacceptable risk to human health or the environment DNREC will evaluate the options for protecting the river and propose a Plan of Remedial Action.

Ground water contamination: Fifteen new ground water monitoring wells were installed on or around the Site to augment the 19 monitoring wells which were sampled as part of the 1990 Remedial Investigation. The wells identified as being downgradient of the Halby Chemical Site are actually placed within the Potts Property State Superfund site.

- The primary contaminants detected in ground water in the Columbia aquifer directly beneath the Site include arsenic (up to 535 ppb), ammonia (up to 178,000 ppb), manganese (up to 19,700 ppb), thiocyanate (up to 130,000 ppb), vinyl chloride (up to 31 ppb), trichloroethene (up to 37 ppb) tetrachloroethene (up to 25 ppb) and carbon disulfide (up to 333,000 ppb). The primary contaminants identified in Columbia aquifer monitoring wells located downgradient of the Site include arsenic (up to 1,400 ppb), ammonia (up to 392,000 ppb), manganese (up to 180,000 ppb) thiocyanate (up to 280,000 ppb), 1,1-dichloroethene (up to 110 ppb), toluene (up to 6,600 ppb) vinyl chloride (up to 230 ppb) and carbon disulfide (up to 210 ppb). Analyses of ground water in the Columbia aquifer upgradient of the Site identified ammonia (up to 3,200 ppb), manganese (up to 1,140 ppb), thiocyanate (up to 5,260 ppb), and trichloroethene (up to 41 ppb). No other site-related contaminant was identified above the detection limit.

  In addition, iron and zinc were identified in the Columbia aquifer located just beneath the central portion of the Site and downgradient central tidal marsh at concentrations up to 162,000 ppb and 132,000 ppb, respectively. Aquatic organisms may be adversely

affected by elevated levels of iron and zinc. This is significant due to the potential for natural discharge of ground water into the overlying lagoon and tidal marsh.

- The primary contaminants detected in ground water in the Upper Potomac aquifer directly beneath the Site include ammonia (up to 106,000 ppb), cadmium (up to 691 ppb), manganese (up to 87,000 ppb), nickel (up to 1,110 ppb), thiocyanate (up to 1,400,000 ppb), trichloroethene (up to 46 ppb), tetrachloroethene (up to 25 ppb) and carbon disulfide (up to 870 ppb). The primary contaminants identified in Upper Potomac aquifer monitoring wells located downgradient of the Site include ammonia (up to 94,000 ppb), nickel (up to 783 ppb), manganese (up to 98,000 ppb), thiocyanate (up to 29,000 ppb), and carbon disulfide (up to 71 ppb). Analyses of ground water in the Upper Potomac aquifer upgradient of the Site identified manganese up to 320 ppb. No other site-related contaminant was identified above the detection limit.

Dense Non-Aqueous Phase Liquids (DNAPLs): Carbon disulfide is nearly 1.3 times denser than water and will tend to accumulate in the deeper portions of the aquifer where it is found. A concentration of carbon disulfide found in the Columbia aquifer exceeded 15% of its reported solubility in water which suggest a strong likelihood that it is present as a DNAPL. In addition, subsurface soil sampled within the former process plant drainage ditch area contained up to 160,000 ppm carbon disulfide and free phase carbon disulfide has been observed within water-filled trenches created during subsurface soil sampling.

Extensive soil sampling conducted to date suggest that the greatest mass of carbon disulfide is located between 4-12 feet below the ground surface. The carbon disulfide contaminated subsurface soil will be treated to a depth of 12 feet during the on-going removal action at the Site discussed during the previous section of the Proposed Plan. The treatment project will remove a significant amount of carbon disulfide from the environment. Nevertheless, since treating the contaminated subsurface soil at a depth greater than 12 feet is not practical due to technological limitations, DNAPL will likely remain in the Columbia formation between 12 and 30 feet below the ground surface. DNAPL found in the aquifer can be a source for continued release of contamination, therefore, complicating cleanup. During the drilling of monitoring well #1, the only well installed directly within the carbon disulfide contaminated area, there was no direct visual evidence, such as staining of aquifer material, that DNAPL was present at depth. However, the Remedial Investigation did not include methods that can enhance the ability to visually identify the occurrence of DNAPL contamination (e.g., screening soil with ultra-violet, fluorescence or hydrophobic dye, etc.). The occurrence of DNAPL would have a significant impact on the ability to restore portions of the aquifer where DNAPL is present. If the selected remedy were to include active recovery of DNAPL at depth, additional data may need to be collected during the Remedial Design to identify and define the extent of residual or mobile DNAPL in areas where it is suspected to occur.

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SUMMARY OF SITE RISKS

The Remedial Investigation included analyses to estimate the human health and environmental hazards that could result if contamination at the Site is not cleaned up. These analyses are commonly referred to as Risk Assessments and identify existing and future risks that could occur if conditions at the Site do not change. The Baseline Human Health Risk Assessment (BLRA) evaluated human health risks and the Ecological Risk Assessment (ERA) evaluated environmental impacts from the Site. The BLRA and ERA considered environmental samples collected prior to June 1995. Recent soil samples collected within the carbon disulfide treatment zone reveal concentrations greater than those used in the risk assessments, therefore the baseline risks reported in Table 1 would likely be greater if the most recent information were integrated. The Nature and Extent of Contamination discussion above does describe our current understanding of the Site.

Baseline Human Health Risk Assessment: The BLRA assesses the toxicity, or degree of hazard, posed by contaminants related to the Site, and involves describing the routes by which humans could come into contact with these substances. Separate calculations are made for those substances that can cause cancer (carcinogens) and for those that can cause non-carcinogenic, but adverse, health effects.

The National Oil and Hazardous Substances Pollution Contingency Plan (NCP) established acceptable levels of carcinogenic risk for Superfund sites ranging from one excess cancer case per 10,000 people exposed to one excess cancer case per one million people exposed. This translates to a risk range of between one in 10,000 and one in one million additional cancer cases. Expressed as scientific notation, this risk range is between 1.0E-04 and 1.0E-06. Remedial Action is warranted at a site when the calculated cancer risk level exceeds 1.0E-04. However, since EPA's cleanup goal is generally to reduce the risk to 1.0E-06 or less, EPA also may take action where the risk is within the range between 1.0E-04 and 1.0E-06.

The NCP also states that sites should not pose a health threat due to a non-carcinogenic, but otherwise hazardous, chemical. EPA defines a non-carcinogenic threat by the ratio of the contaminant concentration at the site that a person may encounter to the established safe concentration. If the ratio, called the Hazard Index (HI), exceeds one (1.0), there may be concern for the potential non-carcinogenic health effects associated with exposure to the chemical. The HI identifies the potential for the most sensitive individuals to be adversely affected by the noncarcinogenic effects of chemicals. As a rule, the greater the value of the HI above 1.0, the greater the level of concern.

Based on the results of the Remedial Investigation, the primary contaminants associated with potential human health risk at the Site include:

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- VOCs (carbon disulfide and vinyl chloride); and,
- inorganic elements and compounds (arsenic, manganese, beryllium, cadmium, nickel, thiocyanate and ammonia).

The following groups of individuals could be exposed to Site contaminants either currently and/or in the future and were evaluated in the BLRA:

- current and/or future commercial or industrial workers;
- current residents living on the parcel next to the Site and using the public water supply;
- future construction workers on the Site;
- future off-site residents using ground water beneath or downgradient of the Site as a source of drinking or bathing water; and
- current and/or future trespassers.

Individuals could potentially be exposed to Site contaminants in various ways. The exposure routes evaluated in the BLRA include:

- placing objects such as hands contaminated with Site soil and sediment in the mouth;
- breathing vapors or contaminated dust from the Site;
- absorbing contaminants through the skin after touching contaminated soil or sediment;
- drinking, breathing toxicants while showering, and direct skin contact with ground water and surface water;
- eating fish from the on-site lagoon.

Different combinations of the above routes of exposure were considered for various groups of individuals that could be exposed to Site contaminants. Table 1 summarizes the respective risk levels presented to each group of individuals by the various contaminated media.

All groups of individuals could be exposed to unacceptable health risks if Site contamination is not addressed and no restrictions are placed on future use of the Site. Actual or threatened releases of hazardous substances from this Site, if not addressed by EPA's preferred alternative or one of the other cleanup alternatives considered, may present a current or potential threat to human health or welfare.

Table 1
Human Health Risks at the Site

Risk From On-Site Soil	Cancer Risk	Hazard Index
Site Worker exposed to soil	1.3E-03	9.9
Construction Worker exposed to soil	1.9E-04	34.2

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Youth Trespasser exposed to soil	1.4E-04	5.8
Risk From Sediment	**Cancer Risk**	**Hazard Index**
Site Worker exposed to: lagoon sediment tidal marsh sediment	2.0E-03 7.0E-04	13.2 4.3
Youth Trespasser exposed to: lagoon sediment tidal marsh sediment	1.7E-04 5.7E-05	7.1 2.2
Risk From Surface Water	**Cancer Risk**	**Hazard Index**
Site Worker exposed to: lagoon surface water tidal marsh surface water	6.7E-05 1.2E-06	1.5 0.1
Youth Trespasser exposed to: lagoon surface water tidal marsh surface water	7.3E-06 1.4E-07	0.6 0.1
Risk From Ground Water	**Cancer Risk**	**Hazard Index**
Off-Site Resident exposed to the Columbia Aquifer beneath the Site	1.3E-02	446.0 (child) 177.0 (adult)
Off-Site Resident exposed to the Columbia Aquifer downgradient of the Site	4.0E-02	1103.2 (child) 472.6 (adult)
Off-Site Resident exposed to the Upper-Potomac Aquifer beneath the Site	8.1E-04	1304.0 (child) 550.2 (adult)
Off-Site Resident exposed to the Upper-Potomac Aquifer downgradient of the Site	8.0E-04	531.1 (child) 230.0 (adult)
Risk From Soil on Residential Parcel	**Cancer Risk**	**Hazard Index**
Resident exposed to soil on adjacent property	3.8E-04	8.2 (child) 1.3 (adult)

Ecological Risk Assessment: EPA evaluated the ecological risks associated with the Site, primarily focusing on the aquatic ecosystem of the on-site lagoon and adjacent tidal marsh. The overall evaluation is based on: (1) chemical analyses of sediment and surface water in, and soil adjacent to, the on-site lagoon and tidal marsh; and (2) the results of bioassay studies. Laboratory analyses of samples collected have identified many chemicals, primarily inorganic compounds or metals, at levels much higher than concentrations known to be protective of aquatic plants and animals. Further, studies completed in the laboratory by exposing test animals to Site sediment or water extracted from Site sediment indicate that the lagoon and northern and central portion of the tidal marsh are causing harm to animals living there. The studies also

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suggest that contaminated sediments may be causing harm to animals living in the southern marsh.

For some of the contaminants, a concentration gradient exists along the historical flow path of aqueous wastes discharged to the on-site lagoon from the former Halby Chemical production facility. The aqueous wastes would flow from the on-site lagoon to the adjacent tidal marsh through a culvert beneath the railroad tracks and then south through the marsh to the Lobdell canal. A clear concentration gradient can be found for arsenic, cadmium, copper and zinc. Concentrations of ammonia and thiocyanate, two chemicals known to be Site-related based on Halby chemical plant records, are high in the Site lagoon but higher in the northern and central portions of the tidal marsh. Neither ammonia or thiocyanate was found at elevated levels in the southern tidal marsh. The Lobdell canal is a constructed waterway connecting the southern portion of the tidal marsh to the Christina River.

The most recent bioassay tests found that more than 70% of the test organisms died upon exposure to water extracted from sediment collected from the bottom of the lagoon. Subsequent tests run to determine the specific contaminant or contaminants causing the death of the animals were unable to discern a single contaminant responsible for the mortality. Any one, or several, of the dozens of different substances found at elevated concentrations within the lagoon sediment could cause or contribute to the observed mortality of test animals

It must be noted that surface soil across the Site contains concentrations of metals such as arsenic, lead and zinc at levels that have a high potential to affect ecological receptors. With respect to upland areas of the Site, the current and future industrial land use make it unlikely that wildlife would reside in any area other than the perimeter of the lagoon; however, transient exposure is likely.

The surface water in the on-site lagoon contains concentrations of several chemical compounds and metals, including arsenic, chromium, copper, iron, lead, nickel, carbon disulfide, cyanide and ammonia which have the potential to have significant adverse impacts on the aquatic ecosystem. Surface water in the tidal marsh contains potentially harmful concentrations of cyanide, iron and zinc. Ground water, which may be a pathway by which chemicals are discharged to the lagoon, tidal marsh, or river, is contaminated by several contaminants of ecological concern, particularly arsenic, iron and zinc.

SUMMARY OF ALTERNATIVES

The Feasibility Study dated June 1997 discusses the range of alternatives evaluated for the Site and together with the Administrative Record provides supporting information relating to the alternatives in this Proposed Plan. The Proposed Plan discusses alternatives for each of the areas requiring cleanup separately and concludes by presenting the preferred alternative based on the analyses to date. Based on the potential impacts to human health and the environment, the

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following areas and media (i.e., soil, water, sediment) of the Site warrant action to minimize potential exposure to hazardous substances:

- On-site surface/subsurface soil (including soil within former process plant area)
- Lagoon and tidal marsh sediment and surface water
- Ground water
- DNAPL

This Proposed Plan includes a "No Action" alternative required by the NCP and a few cleanup options for each of the above areas/media. The options presented are those that are protective of human health and the environment, achieve state and federal regulatory requirements, and best achieve the cleanup goals for the Site. These alternatives are based on those presented in the Feasibility Study. Reviewers are encouraged to comment on the additional alternatives presented in the Feasibility Study as well as those included in this Proposed Plan.

Alternative 1: No Action

Capital Cost:	$0
Annual O&M Cost:	$0
Present Worth Cost:	$0
Time to Implement:	0

The NCP requires that EPA consider a "No Action" alternative for every Superfund site to establish a baseline or reference point against which each of the Remedial Action alternatives are compared. In the event that the other identified alternatives do not offer substantial benefits in the protection of human health and the environment, the No Action alternative may be considered a feasible approach. This alternative leaves the Site in its current state and all current and potential future risks would remain. The no action alternative is the first alternative for each area discussed below (i.e., soil, lagoon, marsh and ground water).

SOIL

Alternative S-2: Cap with Paved Surface, Surface Water Runoff Controls, Long-Term Monitoring, and Institutional Control

Capital Cost:	$1,550,000
Annual O&M Cost:	$8,100
Total Present Worth Cost:	$1,700,000
Time to Implement:	10 months

This Alternative is based upon Alternatives S-2 and SS-2 from the FS, as modified by EPA, and includes the following components:

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A *cap* with a paved surface designed to withstand loads consistent with industrial land use would be installed over the area of the Site where surface and/or subsurface soil exceed cleanup standards (Figure 3). The surface would consist of asphalt or a pavement constructed with an "environmentally friendly" binder. A conceptual drawing of the cap profile is included in Figure 4; the actual cap profile (materials and thickness of respective layers) will be developed in the design. The cap would reduce the risk of direct exposure to the soil contaminants and control migration of contaminated soil. This cap would also reduce the amount of precipitation which infiltrates through contaminated soil above the water table and into the ground water. The actual size and locations of the capped areas would be determined during the Remedial Design phase of the project. The caps would cover all known contaminated soil, including the carbon disulfide treatment zone after the carbon disulfide removal process is completed.

Contaminated surface soil which has eroded onto the adjacent residential property would be excavated and consolidated under the cap along with existing contaminated soil. Preliminary soil sampling indicates that excavation on the residential property may be limited to a depth of approximately three feet in the backyard. The residential property would be backfilled with clean fill material, six inches of topsoil and vegetated.

A passive type of *gas collection system* using gas vents may be necessary in areas above the vicinity of the carbon disulfide treatment zone. The appropriateness of a gas collection system will be determined during the design process.

An engineered *surface water runoff and erosion control system* would be designed in accordance with Delaware Storm Water Control Regulations and installed to control surface water runoff. The system would include surface grading and storm water retention basins and outfall structures, as necessary.

Operation and Maintenance would be performed to ensure the integrity of the cap. Maintenance activities would include periodic resealing and repairing cracks in the cap and gas monitoring, as appropriate.

The deed would be restricted to ensure the property is not used in a manner inconsistent with the remedy.

Alternative S-3: Stabilization of Contaminated Soil, Cap with Paved Surface, Surface Water Runoff Controls, Long-Term Monitoring, and Institutional Controls

Capital Costs:	$16,000,000
Annual O&M Costs:	$8,100
Total Present Worth Cost:	$16,100,000
Time to Implement:	13 months

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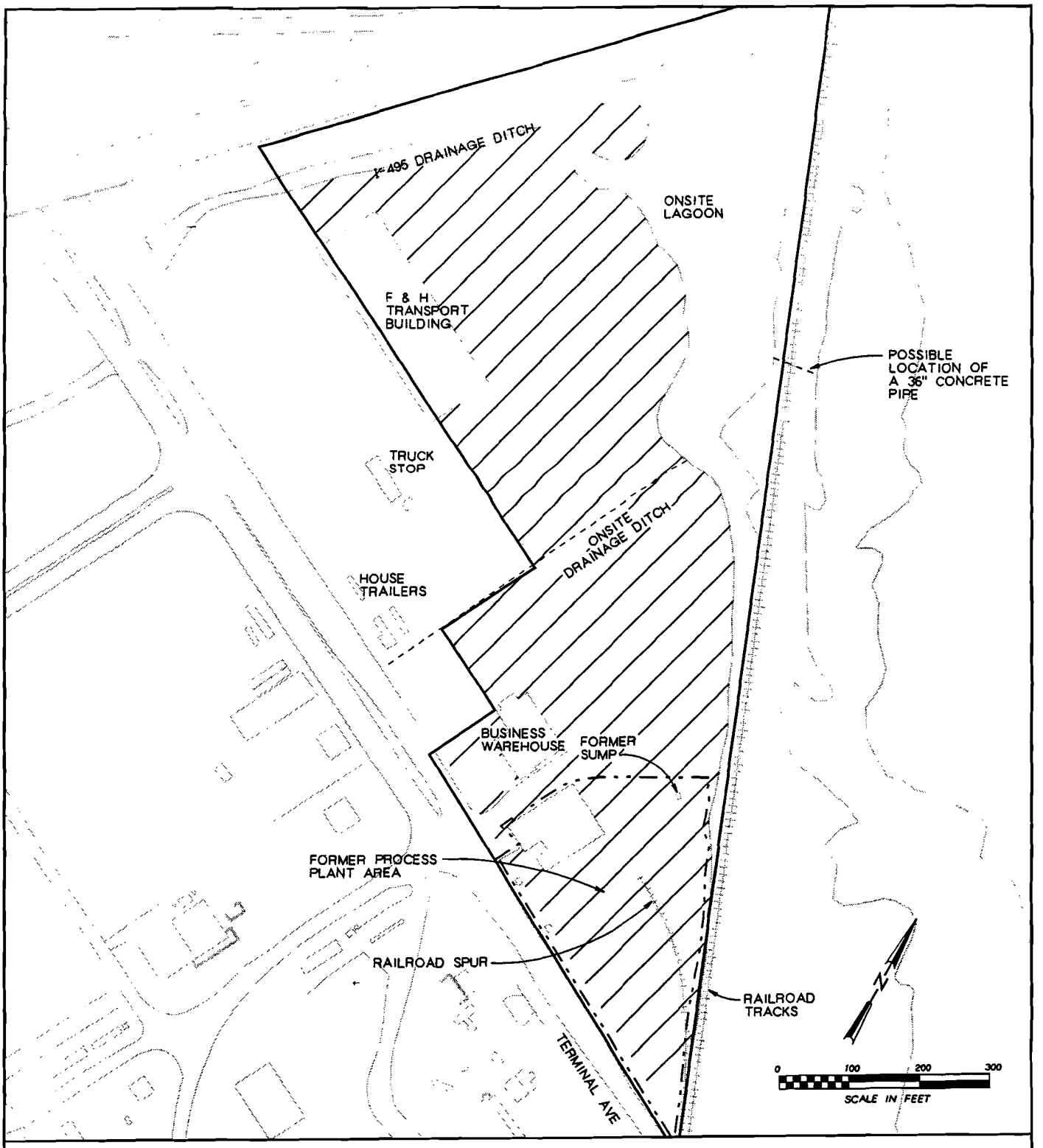

LEGEND

HALBY CHEMICAL SITE

FORMER PROCESS PLANT AREA BOUNDARY

LIMITS OF CAPPING

Figure 3
LIMITS OF CAPPING
ALTERNATIVE S-2
Halby Chemical Site

CH2M HILL

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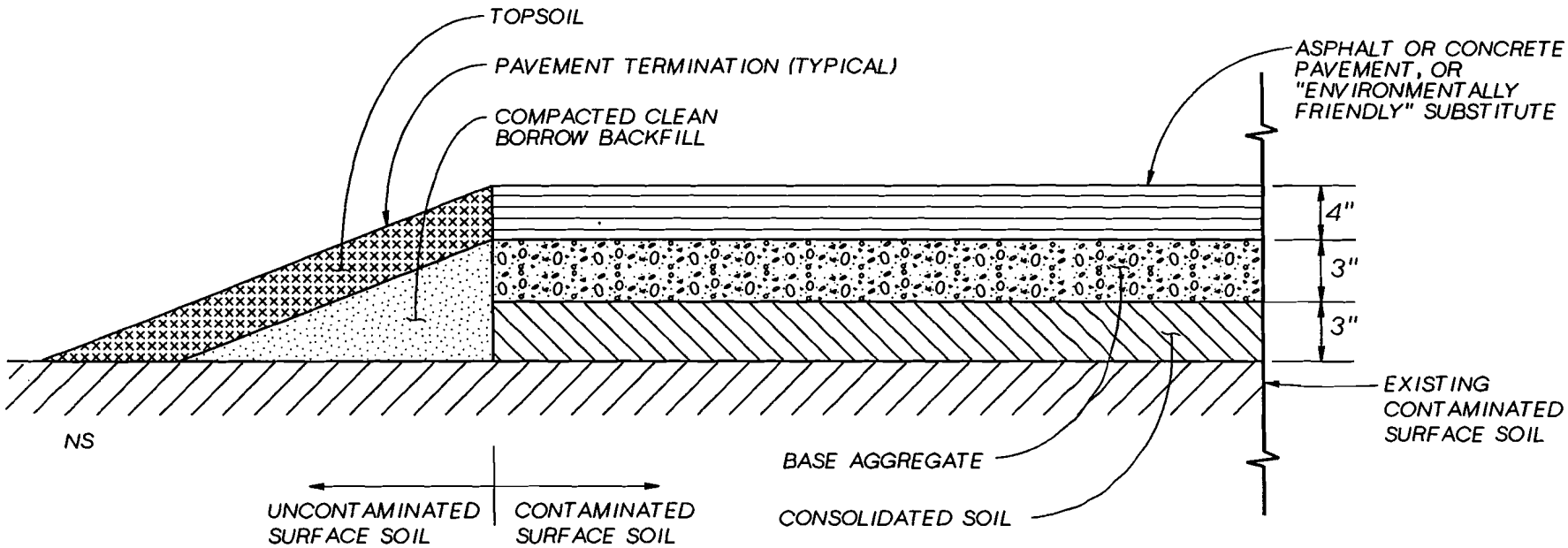

NOTE:
1. HYDRAULIC ASPHALT IN ACCORDANCE WITH ASPHALT INSTITUTE.

Figure 4
TYPICAL WEAR SURFACE
Halby Chemical Site

CH2M HILL

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This Alternative is based upon Alternatives S-3 and SS-3 from the FS, as modified by EPA, and includes the following components:

This alternative is similar to Alternative S-2 described above with the exception that contaminated soil would be stabilized to reduce the potential for migration of contaminants to the ground water before being covered with a cap. *Stabilization* would be accomplished on-site by large-scale mechanical mixing of contaminated soil with chemical reagents and/or cements of various types. Stabilization decreases the mobility and direct exposure potential of surface and subsurface soil.

Additional sampling to determine the actual volume of surface and subsurface soil exceeding cleanup standards and to better define the physical characteristics would be necessary during the design. The physical and chemical characteristics of soil are highly variable across the Site. Investigations have identified on-site soil ranging from very fine particle sized silt (former lagoon sediment which have been filled over) to unsorted fill material including construction rubble. Specific areas containing high levels of hazardous substances have been isolated, making it difficult to predict the full extent of contaminated soil with certainty. Therefore, the volume of soil to be stabilized may be greater than currently known and the stabilization project may require the use of a variety of binding materials and/or mixes specific to each region on the Site. Additional analysis and treatability testing would be required during the Remedial Design to define the type and the volume of material to be stabilized and to develop the specific reagent mixes to be added to contaminated soil.

In some areas, such as the industrial yard between the lagoon and the Christiana Motor Freight office building, it may be cost effective to first excavate and stockpile the imported slag material, then stabilize the underlying contaminated soil and former lagoon sediment.

The remaining components of the remedy would be the same as those described in Alternative S-2.

Alternative S-4: Soil Washing, Stabilization of Separated Soil Fraction, Off-site Disposal

Capital Cost:	$27,250,000
Annual O&M Costs:	$0
Total Present Worth Cost:	$27,300,000
Time to Implement:	16 months

This Alternative is based upon Alternatives S-4 and SS-4 from the FS, as modified by EPA, and includes the following components:

Contaminated soil would be excavated and segregated by density and grain size. Soil washing operates on the principle that most contamination is concentrated in the fine particle fraction and

that contamination of larger particles generally is not extensive. Water and chemical reagents are added to produce a slurry feed that is fed through separators to remove contaminated silts and clays from larger granular particles.

Soil washing the former lagoon sediment located at depth would be of marginal utility as the intent of this soil washing technology is to separate fine particulates which hold a majority of the contaminants in the soil, thus reducing the volume of hazardous material to be managed. The former lagoon sediments are comprised of more than 70% fine grained particulates, therefore minimal volume reduction would be realized. Accordingly, the former lagoon sediment located at depth would be stabilized in place, similar to Alternative S-3.

The soil washing process produces three output streams: 1) a coarse clean fraction; 2) a contaminated consolidated fine fraction; and 3) a contaminated process wash water. The contaminated fine soil will likely require drying and disposal in an off-site RCRA Subtitle C landfill. The process wash water will be treated on or off-site. Clean backfill would be added as needed to replace the contaminated fine fraction that was disposed of off-site. A gravel surface layer would be applied over the backfill material to provide a working surface suitable for an industrial yard.

Alternative S-5: Soil Excavation and Off-Site Disposal, Clean Backfill

Capital Cost:	$8,100,000
Annual O&M Cost:	$0
Total Present Worth Cost:	$8,100,000
Time to Implement:	16 months

This alternative is based upon Alternative S-6 and SS-6 in the FS with modifications by EPA.

Contaminated surface and subsurface soil would be excavated, sampled and segregated. Soil determined to be RCRA-characteristic wastes based on the sampling program would be transported to a RCRA Subtitle-C hazardous waste landfill. Soil identified as RCRA-characteristic wastes due to metals contamination would be treated by a stabilization technology prior to land disposal. Soil which is RCRA-characteristic due to reactive sulfides would likely be treated by chemical oxidation prior to land disposal. Soil found to be contaminated with a hazardous substance above the cleanup standards but determined not to be RCRA-characteristic wastes would be transported to a RCRA Subtitle-D landfill. The cost estimate for Alternative S-5 assumes that 90% of the volume will be sent to a RCRA Subtle-D landfill and 10% to a RCRA Subtitle-C landfill based on available data.

The excavated areas would be backfilled with clean material to replace the contaminated soil that was disposed of off-site. A gravel surface layer would be applied over the backfill material to provide a working surface suitable for an industrial yard.

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LAGOON AND MARSH[1]

Alternative LM-2: Sediment Excavation and Off-Site Disposal, Geomembrane Installation, Wetland Restoration, Long-Term Monitoring

Capital Cost:	$21,500,000
Annual O&M Cost:	$116,000
Total Present Worth Cost:	$23,800,000
Time to Implement:	23 months

This alternative is based upon Alternatives L-4 and MS-5 in the FS with modifications by EPA.

The lagoon and marsh would be temporarily drained. The uppermost 18 inches of sediment would be excavated, an impermeable geomembrane would be installed over the excavated areas, and an 18-inch soil layer would be installed over the geomembrane to allow re-establishment of wetlands at current elevations. The soil would be fine particulate clay or silt with a high organic carbon fraction to support the reestablishment of a viable wetland. The geomembrane installed at the excavated areas would prevent underlying contaminated sediment and ground water from serving as a long-term contamination source to the restored wetland. Most carbon disulfide near the surface will be treated by the ongoing removal action; nevertheless, the composition of the geomembrane must be compatible with carbon disulfide. The restored wetland would be planted with wetland species.

The uppermost 12 inches of sediment in the I-495 drainage ditch located between Terminal Avenue and the Christina River would also be excavated and then backfilled to the original grade with clean material to establish a conduit for tidal-driven surface water to move into the lagoon. The lagoon inlet and the marsh inlet at the confluence with the Lobdell Canal would be designed with energy dissipators to reduce potential for scouring of the lagoon and marsh bottoms.

For cost estimation purposes, it is assumed that a water treatment plant would be mobilized to the Site and operated to treat surface water extracted from the lagoon and marsh during construction activities. Standard sediment control measures will be evaluated for Site application during the Remedial Design. If engineering controls, such as a series of sedimentation basins, are determined sufficient to achieve adequate surface water quality during the lagoon and marsh construction activities the water treatment plant will not be required.

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[1] Each lagoon and marsh cleanup alternative assumes that: $1.5 million would be spent building a water treatment plant to treat surface water; and, six months would be required to build the water treatment plant before construction began on the lagoon. If appropriate standards can be met by implementing standard sediment and erosion controls, the projected cost and time estimates would be adjusted.

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Excavated sediment from the lagoon, marsh, and I-495 drainage ditch would be sent to an off-site landfill. It is assumed that the material would require treatment prior to land disposal in a RCRA Subtitle-C landfill.

Long-term monitoring would be required to ensure the restored wetland retains its functional value and is not recontaminated by residual contamination.

Alternative LM-2A: Sediment Excavation with On and Off-site Disposal, Geomembrane Installation, Wetland Restoration, Long-Term Monitoring

Capital Cost:	$17,500,000
Annual O&M Cost:	$116,000
Total Present Worth Cost:	$19,300,000
Time to Implement:	23 months

This alternative is based upon Alternative L-2 and MS-5 in the FS with modifications by EPA.

This alternative is identical to Alternative LM-2 above, except some of the excavated sediment would be placed beneath the cap included in Alternative S-2 or S-3. The Site does not have enough area to consolidate all of the stabilized sediment on-site, therefore, the excess volume would be transported to an off-site landfill. For cost estimating purposes, 35% of approximately 110,000 tons of lagoon, marsh and I-495 drainage ditch sediments to be excavated would be dewatered, stabilized and graded over the portion of the Site to be capped. A cap would be constructed over the stabilized sediments.

The current and continued use of the Site to support industrial businesses limits the volume of material which can remain on-site without materially altering the utility of the property. Alternative LM-2A would reduce the cost of implementing Alternative LM-2 by several million dollars by reducing the volume of material to be sent off-site.

The remaining components of the remedy would be the same as those described in Alternative LM-2.

Alternative LM-3: Sediment Stabilization, Cap Lagoon with Paved Surface, Wetlands Compensation, Institutional Control

Capital Cost:	$43,900,000
Annual O&M Cost:	$30,000
Total Present Worth Cost:	$44,600,000
Time to Implement:	25 months

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Alternative LM-4: Backfill, Cap Lagoon with Paved Surface, Wetlands Compensation, Institutional Control

Capital Cost:	$6,640,000
Annual O&M Cost:	$30,000
Total Present Worth Cost:	$7,300,000
Time to Implement:	10 months

This alternative is based upon Alternatives L-6 and MS-3 in the FS with modifications by EPA.

This alternative is the same as Alternative LM-3 except that the sediment would not be stabilized prior to backfilling the lagoon and marsh. Sediments excavated from the I-495 drainage ditch would be consolidated with the lagoon or marsh sediments prior to cap construction.

The remaining components of the remedy would be the same as those described in Alternative LM-3.

Alternative LM-4A: Backfill Lagoon and North/Central Marsh, Cap Lagoon with Paved Surface, Wetlands Compensation, Long-Term Monitoring of Southern Marsh, Institutional Control.

Capital Cost:	$5,400,000
Annual O&M Cost:	$97,000
Total Present Worth Cost:	$7,100,000
Time to Implement:	10 months

This alternative is based upon Alternatives L-6 and MS-2 in the FS with modifications by EPA.

This alternative is the same as Alternative LM-4 except the southern marsh would not be remediated.

Within the marsh ecosystem, previous investigations have determined the north and central marsh area (approximately 4 acres) to be: 1) chemically degraded by high concentrations of multiple hazardous substances; and 2) toxic to test organisms. The southern marsh (approximately 3 acres) characterized by samples collected near the Lobdell Canal is also chemically degraded; however, the concentrations were lower, as was demonstrated toxicity to test organisms. Actual delineation between the north/central and southern marsh areas would be accomplished with an intensive sampling program focused along the conceptual interface between the two areas. The sampling program would include at least 2 rounds of sample collection on a 50 feet grid. Sediment samples would be evaluated by both chemical analysis and bioassay tests.

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This alternative is based upon Alternatives L-5 and MS-4 in the FS with modifications by EPA.

The lagoon and marsh would be drained and contaminated sediment would be stabilized or solidified to a depth of 12 inches below the water table. Sediment in the I-495 drainage ditch would be excavated to a depth of 12 inches and consolidated with the lagoon and marsh sediment for stabilization. Clean fill would then be used to backfill the lagoon and marsh to surrounding grade. The lagoon would be capped with a surface such as asphalt pavement suitable for use in an industrial area. The former marsh area would be covered with topsoil and vegetated.

Storm water management structures would be installed as necessary to comply with Delaware storm water control regulations. Displaced surface water would be handled in the same manner as Alternative LM-2.

The I-495 drainage ditch would be backfilled with clean soil and graded to continue to provide a conduit for road runoff water to the Christina River.

Treatability testing would be required during the Remedial Design to develop the specific stabilization reagent mix to be added to contaminated sediment. Stabilization would reduce the potential for migration of contaminants from the sediment to ground water.
The elimination of the lagoon and marsh as wetlands (approximately 8 ½ acres) would require compensation by creating an equal value of healthy wetland habitat at an alternate location. The Halby Chemical Site is located in an industrial area completely surrounded by environmentally degraded parcels. The setting of the Site is significant in that the potential for successfully establishing and maintaining a healthy wetland habitat on a long-term basis, either on-site or in the immediate vicinity, is low. The only source of high quality water to the created or enhanced wetland would be rain water landing directly upon the wetlands. Water quality of the Christina River in the vicinity of the Port of Wilmington is generally poor. Therefore, creation or enhancement of wetlands to compensate for the loss due to implementation of this remedy would be accomplished off-site, preferably in the Christina River watershed, at a specific location yet to be determined.

Operation and Maintenance would be performed to ensure the integrity of the cap. On-site maintenance activities would include periodically resealing and repairing cracks in the cap. Off-site activities would include appropriate monitoring and/or maintenance of the created/enhanced wetland.

The deed would be restricted to ensure the lagoon and marsh property is not used in a manner inconsistent with the remedy.

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In this alternative, the on-site lagoon and the north and central marsh areas would be filled in with clean backfill to the surrounding grade. The lagoon area would be capped with a wear surface, such as asphalt pavement, suitable for use in an industrial yard. Storm water management structures would be installed as appropriate to comply with Delaware storm water control regulations. A monitoring program that includes both quantitative chemical testing and exposing test organisms to marsh sediment (bioassay tests) will be designed and implemented to ensure that the marsh is safe for wildlife.

Similar to alternatives which include loss of wetland areas associated with the on-site lagoon, the elimination of the north/central marsh as a wetland would require compensation by creating an equal value of healthy wetland habitat, for the loss of approximately 5 ½ acres and the reduced future productivity of approximately 3 acres of southern marsh wetlands, at an alternate location.

The remaining components of the remedy would be the same as those described in Alternative LM-4.

GROUND WATER

Alternative G-2: Institutional Control

Capital Cost:	$36,000
Annual O&M Cost:	$46,000
Total Present Worth Cost:	$740,000
Time to Implement:	Immediate

This alternative is based upon Alternative GC-2 in the FS with modifications by EPA.

Institutional controls would be put in place to create a ground water management zone (GMZ) in the vicinity of the Halby Chemical Site and the downgradient Potts Property State Superfund Site. The ground water management zone would eliminate the potential for future exposure to ground water by ensuring that no water extraction wells would be permitted in the Columbia or Upper Potomac aquifers in the areas potentially affected by the Halby Chemical and Potts Property State Superfund Sites. This GMZ is consistent with Delaware's proposed Comprehensive State Ground-Water Protection Program currrently under review by EPA. Ground water monitoring would be conducted to track site-related contamination over time. It is anticipated that 4 monitoring wells would be installed in new locations to optimize the ground water monitoring program.

Alternative G-2 recognizes that, while the Halby Chemical Site is a source of contaminants to the underlying Columbia and Upper Potomac aquifers, the larger picture is that there are multiple significant sources of contamination to ground water. Based on preliminary investigations conducted under the direction of DNREC, the adjacent Potts Property includes a landfill containing several hundred thousand cubic yards of waste soil from an ore processing plant. The

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soil is landfilled to a depth below the water table and contains elevated levels of inorganic hazardous substances. As a result, the ground water in the area should be evaluated on a larger scale as engineering controls implemented on a parcel-by-parcel basis would not likely lead to environmental benefit. If the on-going Remedial Investigation at the Potts Property State Superfund Site being conducted in accordance with the Delaware Hazardous Substance Cleanup Act (HSCA) determines that the intermingled ground water contamination presents an unacceptable risk to human health or the environment downgradient of the Potts Property, DNREC will evaluate the options and propose a Plan of Remedial Action which would address ground water.

Alternative G-3: Slurry Wall for Columbia Aquifer, Institutional Control for Upper Potomac Aquifer

Capital Cost:	$3,800,000
Annual O&M Cost:	$300,000
Total Present Worth Cost:	$8,400,000
Time to Implement:	10 months

This alternative is based upon Alternative GC-3 in the FS with modifications by EPA.

A slurry wall would be constructed around the perimeter of the Site, enclosing the horizontal limit of contaminants within the Columbia Aquifer. The estimated location of the slurry wall is shown in Figure 5. The primary purpose of the slurry wall is to isolate on-site soil containing hazardous constituents in the saturated and unsaturated portion of the Columbia Formation from the surrounding subsurface environment. It is estimated that a slurry wall 4,200 feet long by 30 feet deep would be required. The slurry wall along the eastern boundary of the Site would be physically constrained by the presence of railroad tracks. Most of the carbon disulfide DNAPL would be enclosed by the slurry wall, however, a stretch of the wall may pass through carbon disulfide contaminated soil. The 36-inch thick slurry wall would be constructed of a soil-bentonite mix, or may include an integral geomembrane, and would have an in-place permeability of less than 1×10^{-7} cm/sec. The slurry wall would tie-in to the Potomac clay at its base.

Several geophysical investigations would be performed prior to design of the slurry wall configuration, including, but not limited to: depth to Potomac clay along slurry wall alignment; investigation of chemical compatibility of bentonite design mix and Site-specific contaminants; and a plan to accommodate utilities servicing the businesses located on-site.

This alternative includes pumping water from the interior of the slurry wall to maintain a positive hydraulic gradient into the enclosed area. Approximately 5 to 10 gallons per minute would be continuously removed to keep pace with the combination of ground water leaking across the slurry wall and the local precipitation. It is anticipated that an on-site water treatment plant would be constructed and operated to treat this ground water prior to its discharge to the I-495 drainage

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ditch. The water treatment facility effluent would meet the contaminant-specific concentrations necessary for permitted discharge to a surface water body. In addition to these numeric criteria, the effluent would meet the chronic freshwater State Ambient Surface Quality Standards and Federal Ambient Water Quality Criteria narrative criteria which prohibit discharge of treated water that is toxic to aquatic organisms. Ground water monitoring would be included to track the effectiveness of the remedy.

Similar to Alternative G-2, institutional controls would be put in place to create a ground water management zone in the vicinity of the Halby Chemical Site and the downgradient Potts Property State Superfund Site.

Alternative G-4: Extract and Treat Ground Water from Columbia and Upper Potomac Aquifers, Discharge Treated Water to Surface Water, Institutional Control

Capital Cost:	$4,600,000
Annual O&M Cost:	$490,000
Total Present Worth Cost:	$12,200,000
Time to Implement:	18 months

This alternative is based upon Alternative GC-4 in the FS with modifications by EPA.

A ground water extraction and treatment system would be designed and installed to contain the contaminated ground water at the Site and prevent off-site migration of contamination. Approximately six 6-inch diameter extraction wells would be installed in the Columbia aquifer to an estimated depth of 30 feet; another 6 wells would be installed into the Upper Potomac aquifer to an estimated depth of 70 feet. The wells would intercept ground water migrating through the Site and prevent contaminated ground water from escaping the Site boundaries. It is estimated that the system would withdraw up to 25 gallons per minute. The actual number and location of extraction wells would be determined during the Remedial Design.

It is anticipated that an on-site water treatment plant would be constructed and operated to treat this ground water prior to its discharge to the I-495 drainage ditch. The water treatment facility effluent would meet the contaminant-specific concentrations necessary for permitted discharge to a surface water body. In addition to these numeric criteria, the effluent would meet the State Ambient Surface Quality Standards and Federal Ambient Water Quality Criteria narrative criteria which prohibit discharge of treated water that is toxic to aquatic organisms.

The conceptual ground water treatment system would include the following processes in sequence: flow equalization; a metal precipitation unit to extract high concentrations of inorganic contaminants; an air stripping system to remove the carbon disulfide and, if necessary, ammonia; ion exchange for arsenic and heavy metals; UV/hydrogen peroxide oxidation for cyanide/thiocyanate; and sludge dewatering, granulated activated carbon for treatment of off-gas

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from air stripper. The actual components of the system would be determined during the design to achieve surface water discharge requirements.

Operation and maintenance activities would include, but not be limited to, operation of the plant, maintaining extraction wells with periodic cleaning of well screens, periodic ground water level and chemical measurements to confirm that Site ground water is being captured, and routine chemical analyses of plant effluent with quarterly bioassay tests to confirm that the discharge meets State requirements. The net present worth cost estimate was based on a 30 year operation period, however, operation is expected to continue beyond 30 years.

Institutional controls would be put in place to create a ground water management zone which includes, at minimum, the Halby Chemical Site boundaries. Based on preliminary investigations conducted under the direction of DNREC, the adjacent Potts Property includes a landfill containing several hundred thousand cubic yards of waste soil from an ore processing plant. The soil is landfilled to a depth below the water table and contains elevated levels of inorganic hazardous substances. Therefore, even with this ground water pump and treat option at the Halby Chemical Site, it is likely that the ground water management zone would be similar to Alternative G-2. Institutional controls would be put in place to prevent the extraction of ground water from the Columbia or Upper Potomac aquifers in the vicinity of the Halby Chemical Site and the downgradient Potts Property State Superfund Site.

Alternative G-5: Extract and Treat Ground Water from Columbia and Upper Potomac Aquifers, Reinject to Ground Water, Institutional Control

Capital Cost:	$10,300,000
Annual O&M Cost:	$1,300,000
Total Present Worth Cost:	$30,200,000
Time to Implement:	18 months

This alternative is based upon Alternative GC-5 in the FS with modifications by EPA.

This alternative includes five extraction wells in each water-bearing unit for this alternative at the same depths as those described in Alternative G-4. However, this alternative adds 14 additional wells in each water-bearing unit for reinjection of the treated ground water. It is estimated that the system would withdraw up to 100 gallons per minute. The actual number and location of extraction/reinjection wells would be determined during the Remedial Design. The treatment standards for reinjection to the ground water would be based on drinking-water standards or risk-based concentrations if primary or secondary MCLs are not available. The ground water system would be a larger version of the system described as part of G-4.

The injection wells allow water circulation through the Columbia and Upper Potomac water-bearing units at a significantly higher rate than in Alternative G-4. By injecting the treated ground water both upgradient and downgradient of the Site, ground water extraction rates can be

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increased and a hydraulic barrier created to prevent migration of contaminated ground water off-site. The increased water extraction rate may decrease the time necessary to remediate the aquifer. The reinjection system may prevent the dewatering of the lagoon and marsh should the no action alternative be selected for the surface water bodies.

Institutional controls and ground water monitoring provisions would be the same as Alternative G-4.

DNAPL

Alternative D-2: Institutional Control

Capital Cost:	$0
Annual O&M Cost:	$0
Total Present Worth Cost:	$0
Time to Implement:	Immediate

This alternative is the same as Alternative G-2 above which is based upon Alternative GC-2 in the FS with modifications by EPA.

Natural chemical and physical properties (i.e., carbon disulfide is not water soluble) have resulted in the compound not moving far from the point of original release to the environment. Institutional controls would be put in place to create a ground water management zone in the vicinity of the Halby Chemical Site and the downgradient Potts Property State Superfund Site. The ground water management zone would reduce the potential for exposure to ground water by ensuring that no water extraction wells would be permitted in the Columbia or Upper Potomac aquifers in the areas potentially affected by the Halby Chemical and Potts Property State Superfund Sites. Ground water monitoring would be conducted (estimated cost of monitoring program is recorded in alternatives G-2 through G-5).

Alternative D-3: Slurry Wall Around DNAPL, Inject Surfactant, Extract and Treat Surfactant and DNAPL, Institutional Control

Capital Cost:	$1,200,000
Annual O&M Cost:	$4,700,000
Total Present Worth Cost:	$54,200,000
Time to Implement:	10 months

This alternative is based upon Alternative GC-6 in the FS with modifications by EPA and could supplement the ground water alternatives described above.

Carbon disulfide DNAPL has been observed in excavations as deep as 12 feet below the ground surface, above a local gray clay layer. The carbon disulfide located in the uppermost 12 feet is

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currently being removed as part of a removal action at the Site. The limits of the *in-situ* chemical oxidation treatment technology being implemented is approximately 12 feet. The objective of this alternative is to remove carbon disulfide located between 12 and 30 feet below the surface. A thick clay layer separating the Columbia and Upper Potomac water-bearing formations is located at the 30-feet depth.

This alternative includes installing a slurry wall approximately 1,500 feet long around the carbon disulfide treatment zone. The slurry wall would be constructed through the Columbia formation as describe in Alternative G-3. It is assumed that the DNAPL is directly beneath the carbon disulfide treatment zone (see Figure 2). Further investigation of the location and volume of carbon disulfide DNAPL would be completed prior to establishing final slurry wall alignment.

After the slurry wall is constructed, a surfactant would be injected into the interior of the wall through a series of four injection wells. Conceptually, the surfactant would be injected at a rate of one gallon per minute at each well. The DNAPL/surfactant/ground water mixture would be extracted through one extraction well at the lowest elevation within the base of the walled area and transported to an off-site thermal oxidation treatment facility.

A treatability study and pilot study would be necessary to determine the most effective surfactant. Significant issues to be resolved would include: 1) finding an effective surfactant which is not itself unacceptably hazardous to the environment; 2) designing a slurry wall composition compatible with the hazardous constituents involved in the project; and 3) establishing safeguards to avert significant mobilization of the carbon disulfide in the aquifer.

The projected duration of remediation is 17 years of continuous pumping and treating of extracted ground water surfactant fluid.

Similar to Alternative D-2, institutional controls would be put in place to create a ground water management zone in the vicinity of the Halby Chemical Site and the downgradient Potts Property State Superfund Site.

Alternative D-4: Extract and Treat DNAPL from Columbia Aquifer, Institutional Control

Capital Cost:	$510,000
Annual O&M Cost:	$660,000
Total Present Worth Cost:	$10,700,000
Time to Implement:	5 months

This alternative is based upon Alternative GC-7 in the FS with modifications by EPA and could supplement the ground water alternatives described above.

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This alternative is similar to Alternative D-3 in that it targets extraction and treatment of carbon disulfide DNAPL but no slurry wall would be installed nor would a surfactant be introduced into the aquifer. One or more extraction wells would be placed at the lowest elevation(s) and recessed into the Upper Potomac clay within the carbon disulfide contaminated area. Further investigation of the location and volume of carbon disulfide DNAPL would be completed prior to establishing specific extraction well location(s). Because of the viscosity of carbon sulfide, it is anticipated that intermittent pumping would be required to allow the DNAPL to recharge the area of influence of the extraction well(s). The recovered carbon disulfide would be hauled to an off-site thermal oxidation treatment facility. Although this technique has been used at other sites to extract some DNAPL mass from the environment, it has never successfully removed all of the DNAPL. The cost estimate for this alternative is based on a 30-year project period, however, operation is expected to continue beyond 30 years.

Similar to Alternative D-2, institutional controls would be put in place to create a ground water management zone in the vicinity of the Halby Chemical Site and the downgradient Potts Property State Superfund Site.

PREFERRED ALTERNATIVE

EPA's preferred alternative for addressing soil, lagoon and tidal marsh sediment, ground water, and DNAPL contamination are listed below.

SOIL

Alternative S-2: Cap with Paved Surface, Surface Water Runoff Controls, Long-Term Monitoring, and Institutional Control

LAGOON AND MARSH

Alternative LM-4: Backfill, Cap Lagoon with Paved Surface, Wetlands Compensation, Institutional Control

GROUND WATER

Alternative G-2: Institutional Control

DNAPL

Alternative D-2: Institutional Control

In selecting its preferred alternative, EPA evaluated each proposed remedy against the criteria specified in the NCP. The alternative must first satisfy the threshold criteria. Next, the primary

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balancing criteria are used to weigh the tradeoffs, or advantages and disadvantages, of the alternatives. Finally, after public comment has been completed, the modifying criteria will be considered.

Based on new information or public comments, EPA, in consultation with the DNREC, may later modify the preferred alternative or select another alternative presented in this Proposed Plan. The public, therefore, is encouraged to review and comment on all of the alternatives identified in this Proposed Plan. The Administrative Record, including the RI/FS, should be consulted for more information on these alternatives.

COMPARATIVE EVALUATION OF ALTERNATIVES

Below is a description of each of the nine criteria set forth in the NCP, 40 C.F.R. § 300.430(e)(9), used to evaluate each of the remedial alternatives summarized in this plan. These nine criteria can be categorized into three groups: threshold criteria, primary balancing criteria, and modifying criteria.

Threshold Criteria:

1. *Overall Protection of Human Health and the Environment* addresses whether a remedy provides adequate protection and describes how risks are eliminated, reduced, or controlled through treatment, engineering controls, or institutional controls.
2. *Compliance with Applicable or Relevant and Appropriate Requirements* (ARARs) addresses whether a remedy will meet all of the applicable, or relevant and appropriate requirements of environmental statutes and/or whether there are grounds for invoking a waiver. This criterion also addresses whether or not the remedy complies with advisories, criteria and/or guidance that may be relevant.

Primary Balancing Criteria:

3. *Long-term Effectiveness* refers to the ability of a remedy to maintain reliable protection of human health and the environment over time once cleanup goals are achieved.
4. *Reduction of Toxicity, Mobility, or Volume through Treatment* addresses the degree to which alternatives will reduce the toxicity, mobility, or volume of the contaminants causing site risks.
5. *Short-term Effectiveness* addresses the period of time needed to achieve protection and any adverse impacts on human health and environment that may be posed during the construction and implementation period until cleanup goals are achieved.
6. *Implementability* addresses the technical and administrative feasibility of a remedy, including the availability of materials and services needed to implement a particular option.
7. *Cost* includes estimated capital, operation and maintenance costs, and present worth costs.

Modifying Criteria:

8. *State Acceptance* indicates whether, based on its review of backup documents and the Proposed Plan, the State concurs with, opposes, or has no comment on the preferred alternative.
9. *Community Acceptance* will be assessed in the Record of Decision following a review of public comments received on the Proposed Plan and supporting documents included in the Administrative Record.

1. Overall Protection of Human Health and the Environment

A primary requirement of CERCLA is that the selected remedial alternative be protective of human health and the environment. A remedy is protective if it reduces current and potential risks to acceptable levels under the established risk range posed by each exposure pathway at the Site.

Soil Alternative 1 (No Action), would not effectively reduce risk to human health and the environment. The site workers and adjacent residents would continue to be exposed to potentially harmful levels of contaminants in soil. Contaminated surface soil would continue to erode off-site and into area surface water. Both current and potential future users of the Site would be exposed to unacceptable human health risks as indicated previously in Table 1 of this Proposed Plan. In addition, adverse ecological impacts would continue unabated at the Site. Because this alternative does not meet the threshold criteria of protection of human health and the environment, it will not be considered further in this analysis.

Alternatives S-2, S-3, S-4 and S-5 are all protective of human health and the environment. Each of these alternatives reduces the potential for exposure to and migration of Site contaminants, but each does it in a different way. Under Alternative S-2, the contaminated soil would remain in place, but the threat posed to people or animals from contact with the contaminated soil and the potential for further migration is reduced by placing a cap over the contaminated soil. Alternative S-3 stabilizes the soil to immobilize the contaminants prior to construction of the cap. Alternative S-4 separates and removes the concentrated waste for off-site disposal and backfills the excavated areas with clean soil. Alternative S-5 excavates all contaminated soil and hauls it to off-site landfills. Alternatives S-2 and S-3 include long-term monitoring to ensure the engineering controls continue to be effective and institutional controls to restrict the use of the Site and prevent potential exposure to any remaining contaminants.

Lagoon and Marsh Alternative LM-1 (No Action), would not effectively reduce risk to human health and the environment. Both Site workers and trespassers would have the potential for unacceptable risks as indicated previously in Table 1 of this Proposed Plan. In addition, adverse ecological impacts would continue unabated at the Site. Because this alternative does not meet

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the threshold criteria of protection of human health and the environment, it will not be considered further in this analysis.

Alternatives LM-2, LM-2A, LM-3, LM-4 and L-4A are all protective of human health and the environment. Each of these alternatives reduces the potential for exposure to contaminated lagoon and marsh sediment. Alternatives LM-2 and LM-2A would involve excavating sediment, installing a geomembrane liner and re-establishing a wetland system on this industrial parcel. Alternatives LM-3 and LM-4 would fill the on site lagoon and marsh with clean soil and require the compensatory creation or restoration of a wetland system at an off-site location which would have a better chance of long-term health. Alternatives LM-2 and LM-2A include extensive long-term monitoring to detect any re-degradation of the created wetlands.

Alternative LM-4A would be protective of human health, as potential for exposure to sediment with the highest concentrations of contaminants would be reduced through installation of a cap. The degree to which alternative LM-4A would be protective of the environment is marginal as the southern portion of the marsh would be managed by long-term monitoring. Although the southern marsh is not as severely degraded as the north/central portion of the marsh, several inorganic compounds are present in sediment at concentrations many times greater than levels known to be safe. Alternative LM-4A relies on natural attenuation of contaminant concentrations within sediment to achieve safe levels for the wildlife in the southern portion of the marsh.

Ground Water and DNAPL Alternatives G-1 and D-1 (No Action), would not effectively reduce risk to human health and the environment. People would have the potential for unacceptable risks posed by consuming ground water as indicated previously in Table 1 of this Proposed Plan. No persons are currently drinking contaminated water withdrawn from the Columbia or Upper Potomac aquifers; however, if no action were taken drinking water wells may be installed in the future. Because these alternatives do not meet the threshold criteria of protection of human health and the environment, they will not be considered further in this analysis.

Alternatives G-2, G-3, G-4 and G-5 are all protective of human health and the environment; Alternatives D-2, D-3, and D-4 would be implemented as enhancements to Alternatives G-2 through G-5 to target carbon disulfide DNAPL in ground water. The common element, and most important component, to each of these ground water protection alternatives is institutional controls to prevent the installation of drinking water wells in the vicinity of the Site. Alternatives G-3, G-4 and G-5 (along with the DNAPL enhancement provisions) each include active treatment of ground water or construction of engineering controls to reduce the migration of contaminated ground water. A mathematical model predicts that Alternative G-5 has the potential to restore the ground water to drinking water quality in approximately 50 years if the source of contaminants (all contaminated soil and subsurface DNAPL) is completely removed. However, the presence of the carbon disulfide DNAPL makes restoration technically impractable. Alternative G-4 includes extraction and treatment of ground water to contain the contamination on the Halby Chemical property. Although restoration could eventually occur

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under this alternative, the time frame is likely to be several hundred years. Alternative G-3 includes the installation of a slurry wall through the Columbia aquifer and along the perimeter of the Site. The objective of Alternative G-3, like Alternative G-4, is to reduce the migration of contaminated ground water beneath the Halby Chemical property to the downgradient Potts Property State Superfund Site. In summary, Alternatives G-2 through G-5 and D-2 through D-4 do achieve protection to human health through implementation of institutional controls. Alternatives G-2 through G-5 include long-term monitoring of ground water.

2. Compliance with Applicable or Relevant and Appropriate Requirements (ARARS)

Any cleanup alternative considered by EPA must comply with all applicable or relevant and appropriate federal and state environmental requirements. *Applicable* requirements are those substantive environmental standards, requirements, criteria, or limitations promulgated under federal or state law that are legally applicable to the Remedial Action to be implemented at the site. *Relevant and appropriate* requirements, while not being directly applicable, address problems or situations sufficiently similar to those encountered at the site that their use is well-suited to the particular site. The remedial alternatives evaluated in this Proposed Plan would comply with ARARs, as appropriate, unless grounds for invoking a waiver based on technical impracticability are presented.

Chemical-Specific ARARs

Soil/Sediment: There are currently no ARARs establishing acceptable concentrations for contaminants in soil or sediment at the Site. However, as noted previously, the BLRA and Ecological Risk Assessment determined that the concentration of contaminants in the soil and sediment at this Site do present an unacceptable risk to human health and the environment.

Surface Water: Water quality standards have been established for acceptable concentrations of contaminants in State waters and are set forth in Delaware Surface Water Quality Standards (DSWQS), as amended February 26, 1993. DSWQS would be applicable to ground water pump and treat alternatives (G-3 through G-5, D-3 and D-4). The discharge from the water treatment plant will comply with DSWQS. In addition, a long-term monitoring program for restoration of wetlands on-site (Alternatives LM-2, LM-2A and L-4A) would include monitoring of surface water at the Site to measure any adverse impact due to migration of contaminants from the Site.

Action-Specific ARARs

Water Wells: The construction, operation and maintenance of any ground water extraction or monitoring well would be completed in conformance with Delaware Regulations Governing Construction of Water Wells, amended April 6, 1997.

Discharge of Treated Ground water: The ground water extraction and treatment component of Alternatives G-3 and G-4 involves discharging treated water from the ground water treatment

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system into surface water. The more stringent of the substantive requirements of the Clean Water Act and the Delaware Regulations Governing Control of Water Pollution, amended June 23, 1983, regarding discharges to surfaces waters would be applicable to such discharges, including 40 C.F.R. Part 122 (National Pollutant Discharge Elimination System), 40 C.F.R. Part 131 (Water Quality Standards), Delaware Surface Water Quality Standards, as amended February 26, 1993 (regarding water quality criteria which must be used in the development of the discharge limits).

Underground Injection of Treated Water: Alternative G-5 which includes the underground injection of treated water would comply with the Safe Drinking Water Act Underground Injection Control Program (UIC) set forth at 40 C.F.R. Parts 144-147).

Identification of Hazardous Wastes: Excavated soils, sediments, extracted DNAPL or DNAPL/Surfactant mix, or water treatment plant residuals would be evaluated in accordance with the federal and state hazardous waste identification requirements (40 C.F.R. §§ 261.20-.24; DRGHW §§ 261.20-.24). On-site handling of any materials found to exhibit a characteristic of a hazardous waste would comply with the substantive portions of federal and state regulations that pertain to generators of hazardous waste (40 C.F.R. §§ 262.10, .20, .21, .23, .42, .50-.55, .57; DRGHW §§ 262.10-.33, .40, .42, .50) and transporters of hazardous waste (DRGHW §§ 263.30-.31). (Applicable to alternatives involving excavation of contaminated soils or sediments and residual sludge or filter cake from on-site water treatment plant)

Hazardous Waste Stored or Stockpiled: Several of the alternatives would include a considerable amount of excavation, extraction and handling of hazardous materials on-site. The hazardous materials would have to be temporarily stored or stockpiled until their ultimate disposition is completed (i.e., stabilized, soil washed, consolidated for off-site transport, etc.). Any on-site storage of characteristic hazardous waste would comply with the substantive portions of federal and state requirements regulating containers (40 C.F.R. § 264.175; DRGHW §§ 264.171-.178), tanks (40 C.F.R. §§ 264.191-.196, .198, .199; DRGHW §§ 264.191-.199), and waste piles (40 C.F.R. §§ 264.251-.256, .259; DRGHW §§ 264.250-.258(a)), depending on the type of waste present and the manner in which it is stockpiled.

Treatment, Storage and Disposal of Hazardous Waste: Alternatives which involve on-site recovery and treatment systems which handle hazardous or characteristic hazardous waste would meet the most stringent of federal and state requirements regulating hazardous treatment, storage and disposal facilities (40 C.F.R. Part 264; DRGHW Part 264).

Air Emissions: Air emissions from an air stripper included at a water treatment plant would meet Delaware Regulations Governing the Control of Air Pollution, Regulations Number 2, 19 and 24.

Sediment and Stormwater: A stormwater and sediment management plan consistent with substantive portions of the Delaware Sediment and Stormwater Regulations must be developed and approved by EPA before construction disturbing over 5,000 square feet of land can begin.

Ground Water Management Zone: The ground water management zone to be established as part of any of the ground water alternatives should be consistent with State of Delaware Groundwater Management Plan, November 1, 1987. The purpose of the GMZ is to provide continued assurance through institutional controls that future risk pathways are addressed.

Worker Safety: Worker safety requirements, including the handling of hazardous substances, set forth in 29 C.F.R. § 1910, are applicable to each alternative requiring physical contact with soil, sediment, ground water or residual sludge from ground water treatment.

Location-Specific ARARs

Protection of Wetlands: Provisions for carrying out Executive Order 11990 (Protection of Wetlands), set forth in 40 C.F.R. Part 6, Appendix A. Remedial alternatives for lagoon and marsh must avoid adverse effects, minimize potential harm, and restore and preserve natural and beneficial values. In the event that the selected alternative includes filling in on-site wetlands, creation/enhancement of off-site replacement wetlands would restore the natural values of the wetland habitat.

In summary, all alternatives would meet their respective applicable or relevant and appropriate requirements of federal and state environmental laws.

3. Long-term Effectiveness and Permanence

Soil Alternative S-2 provides a moderately permanent and effective long-term remedy by requiring regular and continuing maintenance of the cap. The construction of the cap would eliminate the risk due to direct contact with contaminants at the Site and would reduce mobility of contaminants in soil above the water table to the ground water. The degree of long-term effectiveness and permanence increases with Alternative S-3 which would stabilize contaminants in the soil and further reduce their migration into the ground water. By immobilizing the contaminants through treatment, Alternative S-3 relies less on continued maintenance of the cap to achieve long-term effectiveness and permanence. Alternatives S-4 and S-5 would remove contaminants from the Site, further increasing the long-term effectiveness and permanence.

Lagoon and Marsh Alternatives LM-2 and LM-2A have the potential to provide an effective remedy on a long-term basis. Some technical uncertainty exists in predicting the success of establishing a high quality wetland habitat upon a geomembrane. Altering the natural hydrology should not be a problem, as the project would be designed so that tidally driven surface water would provide routine water flow to the system. The lagoon and marsh are completely surrounded by industrial properties which have been chemically degraded due to past use. Even if these areas can be isolated from the underlying contaminated ground water, it is likely that the new wetlands will be chemically degraded over time due to the surrounding land use. Alternative LM-4A would have a high degree of long-term effectiveness because potential exposure to the most contaminated sediment, located in the north/central portion of the wetland

would be eliminated. The likelihood that the quality of the southern portion of the marsh would increase as natural processes wash the contaminants from the marsh bottom is uncertain.

Alternatives LM-3 and LM-4 have a greater potential for long-term effectiveness and permanence by preventing people and ecological receptors from coming into contact with contaminated sediment. Compensatory wetland habitat would be created or restored at an off-site location so that exposure of wildlife to Site-related contaminants would not be an issue. Alternative LM-3 would have the greatest degree of long-term permanence as the contaminated sediment would be stabilized prior to backfilling and capping.

Ground Water and DNAPL Alternatives G-2 through G-5 have a high degree of long-term effectiveness primarily due to the institutional controls included in each of the alternatives. The nature of the ground water contamination, including both carbon disulfide DNAPL and the continued migration of various metals from vast quantities of soil which were historically deposited on the Halby Chemical Site and the adjacent Potts Property State Superfund Site, makes successful ground water restoration immediately downgradient of the Site property boundary infeasible. Alternatives G-4, G-5 and the DNAPL Alternatives D-3 and D-4 would slowly extract contaminant mass from the ground water. Nevertheless, the ground water beneath the Halby Chemical Site or the downgradient Potts Property State Superfund Site would not be fit for human consumption in the next 30 years. The Feasibility Study estimated that between 50 and 300 years would be necessary to achieve drinking water standards if no additional contaminants migrate to the ground water. Thus, while Alternatives G-2 through G-5 do provide a high degree of long-term effectiveness, the long-term effectiveness of these alternatives hinge primarily on the institutional controls included in each alternative.

4. Reduction of Toxicity, Mobility, or Volume through Treatment

Section 121(b) of CERCLA, 42 U.S.C. Section 9621(b), establishes a preference for Remedial Actions which include treatment that permanently and significantly reduces the toxicity, mobility, or volume of contaminants.

Soil The principle threat identified at the Site is presented by high concentrations of carbon disulfide in soil extending from the point that waste water was discharged from the chemical production facility to the lagoon. EPA is expediting the clean-up by addressing the carbon disulfide through an immediate removal action. The carbon disulfide will be treated in-place by chemical oxidation. The alternatives evaluated in the Proposed Plan address the contaminants which will remain after implementation of the carbon disulfide treatment program.

Only Alternatives S-3 and S-4 include measures to reduce the mobility of Site contaminants through treatment. Alternative S-4 and S-5 would reduce the volume of contaminants from the Site by removing them. Both S-4 (Soil Washing) and S-5 (Off-site Disposal) would likely require pre-treatment of materials removed from the Halby Chemical Site prior to land disposal. Alternative S-3 requires use of a treatment technology (i.e., stabilization) which would reduce

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the mobility of the contaminants present in the soil. Alternative S-2 reduces mobility by requiring a cap to be constructed over the contaminated soil which would reduce infiltration of water and surface erosion.

Lagoon and Marsh Only Alternatives LM-2A and LM-3 include measures to reduce the mobility of Site contaminants through treatment. Both Alternative LM-2A and LM-3 require use of a treatment technology (i.e., stabilization) which would reduce the mobility of the contaminants present in the sediment. In addition, Alternative LM-2 would likely require stabilization of excavated sediment prior to disposal in an off-site landfill. Alternatives LM-4 and LM-4A reduce mobility of contaminants in sediment by capping the lagoon and covering the marsh with clean soil thereby reducing migration of contaminated sediment off-site though surface erosion.

Ground Water Alternatives G-3, G-4, G-5 and the DNAPL Alternatives D-3 and D-4 would slowly extract contaminant mass from the ground water thereby reducing the toxicity, mobility, and volume of contaminants in the ground water through treatment. However, even the combination of the most aggressive treatment alternatives (i.e., G-5 and D-3) are not expected to restore ground water beneath the Site to use for human consumption within the next 30 years. Alternatives D-2 and G-2 do not reduce the toxicity, mobility or volume of contaminants through treatment.

5. Short-Term Effectiveness

Soil Alternative S-2 offers the greatest short-term effectiveness, as excavation and handling of contaminated soil would be limited to the small-scale consolidation of low level soil-contamination from the adjacent residential parcel. Alternative S-2 would also have the shortest implementation time. Alternative S-3 would achieve very good short-term effectiveness, especially if the stabilization component could be achieved *in situ* to minimize exposure of construction workers to Site contaminants during the soil mixing process. The need to conduct treatability studies to develop proper reagent mixes for various areas of the Site may delay the implementation time of Alternative S-3. Alternative S-5 involves the excavation and off-site disposal of contaminated soil and could pose an increased short-term health risk to on-site workers and/or trespassers during earth-moving activities. Alternative S-4 would have the lowest short-term effectiveness as excavation and handling of the contaminated soil would be significant, leading to the increased potential for exposure of workers to Site-related contaminants. In addition, this alternative would likely require the most time to implement. All short-term risks to site workers would be minimized using standard safety measures.

Lagoon and Marsh Alternatives LM-4 and LM-4A offer the greatest short-term effectiveness. Alternatives LM-4 and LM-4A would have the shortest implemention times and are the only alternatives that do not require handling of contaminated sediment. Alternative LM-3 has good short term effectiveness, especially if the stabilization could be accomplished without first excavating the contaminated sediment. *In situ* stabilization would reduce the potential for exposure of Site workers to contaminated sediment. The treatability study required to develop

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the best reagent mix to immobilize the contaminants will extend the time required to implement the sediment stabilization. Alternatives LM-2 and LM-2A would achieve moderate short-term effectiveness as Site workers would have increased risk of exposure during sediment excavation, on-site handling required to stabilize and/or solidify the wet sediment, and during installation of the geomembrane in the degraded lagoon.

Ground Water Alternative G-3 would achieve moderate short-term effectiveness as Site workers would be at increased risk of exposure to contaminated soil and ground water during excavation and soil mixing involved with slurry wall installation. The most significant hazard would be presented during intrusive activities in the area of carbon disulfide contamination. Alternatives G-4 and G-5 would achieve good short-term effectiveness as the there would be little potential for significant exposure to contaminants during installation of recovery wells or construction of the on-site water treatment plant. Construction of the recovery well system and water treatment plant would require approximately one year. Potential for significant exposure to Site-related contaminants during the operation of the pump and treat system would be minimal. Adding either Alternative D-3 or D-4, targeting removal of carbon disulfide DNAPL, to any of the other alternatives would greatly increase the risk of exposure and the hazard associated with handling, storing, transporting and/or treating materials on the Site. Carbon disulfide is highly volatile, extremely flammable and toxic at low levels. The carbon disulfide would pose a greater risk to human health once removed from the subsurface than it does in its current state. Alternative G-2 would pose the lowest potential for adverse impacts to human health and the environment during implementation as the time required to establish a ground water management zone would be minimal. Since no actual construction would take place, Site workers would not be at risk of increased exposure.

6. Implementability

This evaluation criterion addresses the difficulties and unknowns associated with implementing the cleanup technologies associated with each alternative, including the ability and time necessary to obtain required permits and approvals, the availability of services and materials, and the reliability and effectiveness of monitoring.

Soil The installation of a cap in Alternative S-2 utilizes well-known construction methods. Necessary services and materials are readily available.

Alternative S-3 would require stabilization of contaminated soil prior to construction of a cap. Stabilization is a technology which is commonly used to immobilize inorganic contaminants in soil; nevertheless, additional studies would be required to determine appropriate reagent/additive, the method of application, and the limits of treatment. Verification of the success of the stabilization process would require a detailed quality assurance plan. The stabilization technology used in Alternative S-3 is more complicated to implement than the cap alone.

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Alternative S-5 requires excavation of contaminated soil, which is a relatively straightforward process. As with Alternatives S-3 and S-4, additional sampling and waste characterization will be necessary to more specifically determine the location and volume of soil requiring treatment. In addition, waste characterization will determine pre-treatment requirements, if necessary, and the appropriate type of landfill(s) for disposal. Appropriate landfill facilities with capacity for the contaminated soil should be available within several hundred miles from the Site; transportation costs may be significant.

Alternative S-4 would be the most difficult to implement due to the combination of technologies used and the uncertainties involved with each. Both soil washing and stabilization would have to be evaluated through treatability testing. Soil washing is generally considered to be technically inappropriate if the bulk of contaminants are already located within fine-sized particulate matter. This could be significant with the relatively large volume of contaminated former lagoon sediment.

Worker exposure and protective equipment requirements for construction activities can be readily achieved for all of the alternatives. Alternatives S-3, S-4 and S-5 include intrusive activities and would provide for monitoring the air for carbon disulfide. All alternatives would provide appropriate measures to control dust.

Lagoon and Marsh Alternatives LM-4 and LM-4A would utilize well-known construction methods. Necessary services and materials are readily available for the backfilling and capping of the lagoon and marsh. The low bearing capacity of the lagoon material must be addressed in the design. The use of geosynthetics to provide a base upon which fill can be placed over an unstable subsoil may be necessary, but is well-understood technically. Locating a suitable off-site location for creation or restoration of replacement wetland habitat would require significant effort and coordination with appropriate regulatory agencies.

The implementation of Alternative LM-3 would be similar to Alternative LM-4 with the additional technical complexities associated with the effective stabilization of contaminated sediment. Alternative LM-2 would also include the complications associated with stabilization of contaminated sediment. Alternatives LM-2 and LM-2A include excavation of sediment and installation of a geomembrane liner. Each of these subtasks would introduce significant technical challenges including establishment of suitable sub-base stability and management of surface water during the liner installation. The re-establishment of a functioning wetland habitat would require a specialty contractor. Significant post-construction monitoring and maintenance of the wetland would be required.

Ground Water and DNAPL Alternatives G-3 and D-3 would utilize slurry walls, a well-understood practice. A treatability study would be utilized to select an appropriate reagent/additive for Site-specific conditions and chemical compatibility. Hydrogeologic conditions are appropriate for application of this technology. Current and future utilities

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servicing the many business concerns located on the Site would be re-routed. Special coordination with the railroad and the utility companies would be required to place the slurry wall as close to the railroad tracks and high power line as technically practicable, while taking safety concerns into account.

Ground water extraction technologies included in Alternatives G-3 through G-5 are proven and can be readily implemented. Ground water modeling would be conducted to select the most efficient locations for extraction well placement. The current and future use of the property for industrial use including truck traffic would be considered prior to final placement of extraction wells. Pipes conveying recovered ground water to the on-site water treatment plant would be constructed below grade in a manner to withstand loads consistent with truck traffic. Materials and services are readily available.

The high iron, manganese and sulfate concentrations in the extracted ground water could complicate the pump and treat process because of the potential of fouling the well screens, clarifier, filter, and air stripper. The treatment plant required to treat the array of contaminants in the ground water would require several coupled water treatment technologies making the overall process technically complex. Nevertheless, vendors capable of constructing and operating such a system are readily available.

Alternatives D-3 and D-4 include DNAPL extraction and treatment which is more difficult to implement. Incremental reduction of carbon disulfide mass in the Columbia formation is possible, however, complete removal of the DNAPL is not technically feasible. Because of its viscosity and the complex hydrogeology, it may be difficult to locate a significant pool of DNAPL. If a pool is found, it would be difficult to extract in free phase because carbon disulfide is explosive. A submersible pump which utilizes nitrogen could be used to reduce the potential for an explosion. The extracted carbon disulfide would be stored in a special tank with a water and/or nitrogen blanket before it is disposed of off-site. The technical implementation of D-3 is theoretical at this point because an effective and acceptable surfactant must yet be identified. Regulatory approval of surfactant injection may be difficult.

Alternatives G-2 and D-2 could be readily implemented. DNREC has designated ground water management zones to prevent the installation of drinking water wells in chemically degraded aquifers at other locations.

7. Cost

Evaluation of costs of each alternative generally includes the calculation of direct and indirect capital costs and the annual operation and maintenance (O&M) costs, both calculated on a present worth basis. An estimated capital, annual O&M and total present worth cost for each of the Alternatives has been calculated for comparative purposes and is presented in Table 2.

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Table 2 Summary of Estimated Costs			
-	Capital Cost	Annual O&M Cost	Present Worth
Soil			
Alternative S-2	$1,550,000	$8,100	$1,700,000
Alternative S-3	$16,000,000	$8,100	$16,100,000
Alternative S-4	$27,250,000	$0	$27,300,000
Alternative S-5	$8,100,000	$0	$8,100,000
Lagoon and Marsh			
Alternative LM-2	$21,500,000	$116,000	$23,800,000
Alternative LM-2A	$17,500,000	$116,000	$19,300,000
Alternative LM-3	$43,900,000	$30,000	$44,600,000
Alternative LM-4	$6,640,000	$30,000	$7,300,000
Alternative LM-4A	$5,400,000	$97,000	$7,100,000
Ground Water			
Alternative G-2	$36,000	$46,000	$740,000
Alternative G-3	$3,800,000	$300,000	$8,400,000
Alternative G-4	$4,600,000	$490,000	$12,200,000
Alternative G-5	$10,300,000	$1,300,000	$30,200,000
DNAPL			
Alternative D-2	$0	$0	$0
Alternative D-3	$1,200,000	$4,700,000	$54,200,000
Alternative D-4	$510,000	$660,000	$10,700,000

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Direct capital costs include costs of construction, equipment, building and services, and waste disposal. Indirect capital costs include engineering expenses, start-up and shutdown, and contingency allowances. Annual O&M costs include labor and material; chemicals, energy, and fuel; administrative costs and purchased services; monitoring costs; cost for periodic Site review (every five years); and insurance, taxes, and license costs. For cost estimation purposes, a period of 30 years has been used for O&M. In reality, maintenance of a site with waste left in place would be expected to continue beyond this period. Similarly, the actual duration of operation for the ground water extraction and treatment system would depend on the ability to successfully limit off-site migration of Site-related contaminants. The actual cost for each alternative is expected to be in a range from 50 percent higher than the costs estimated to 30 percent lower than the costs estimated. The evaluation was based on the FS cost estimates, as modified by EPA.

8. State Acceptance

The State of Delaware supports the preferred alternative (S-2, LM-4, G-2 and D-2) but reserves its final concurrence until community comments are evaluated.

9. Community Acceptance

Community acceptance of the preferred alternative will be evaluated after the public comment period ends and will be discussed in the Responsiveness Summary of the Record of Decision for the Site.

PREFERRED REMEDIAL ALTERNATIVE

Based on the comparison of the evaluation criteria summarized previously for each of the alternatives in this Proposed Plan, EPA's preferred alternative is the combination of Alternatives S-2, LM-4, G-2, and D-2: *Cap Soil with a Paved Surface, Surface Water Runoff Controls, Backfill and Cap Lagoon and Marsh, Replace Wetlands at an Off-site Location, Institutional Controls for Ground Water, and Long-Term Monitoring*. The preferred alternative meets the threshold criteria of overall protection to human health and the environment and compliance with ARARs. In considering the balancing criteria, EPA believes this alternative can be readily implemented, achieves long-term effectiveness and permanence at a reasonable cost, minimizes the short-term impacts, and effectively reduces the mobility of Site contaminants through engineering controls. In-situ treatment of carbon disulfide contaminated soil will proceed as part of the on-going removal action.

The cumulative estimated cost of implementing EPA's preferred alternative is:

Capital Cost:	$8,225,000
Annual O&M Cost:	$84,100
Total Present Worth Cost:	$9,740,000

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THE ROLE OF COMMUNITY IN THE SELECTION PROCESS

This Proposed Plan is being distributed to solicit public comment on the appropriate cleanup action for the Site. EPA relies on public input so that the remedy selected for each Superfund site addresses the concerns of the local community. EPA is providing a 30-day public comment period beginning on July 30, 1997 and ending on August 29, 1997, to encourage public participation in the selection process. EPA will conduct a public meeting during the comment period in order to present the Proposed Plan and supporting information, answer questions, and accept both oral and written comments from the public. The public meeting will be held on August 18, 1997, at 7:00 p.m at the DeLaWarr State Service Center, 500 Rogers Road, New Castle, Delaware.

EPA will summarize and respond to comments received at the public meeting and written comments post-marked by August 29, 1997, in the Responsiveness Summary section of the Record of Decision, which documents EPA's final selection for cleanup. To obtain additional information relating to this Proposed Plan, please contact either of the following EPA representatives:

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