EPA REGION 3
AUGUST 1993

RECORD OF DECISION
E.I. DU PONT, NEWPORT SUPERFUND SITE
NEW CASTLE COUNTY, DELAWARE

RECORD OF DECISION
E.I. DU PONT, NEWPORT SITE

DECLARATION

SITE NAME AND LOCATION

E.I. Du Pont, Newport Site
Newport, New Castle County, Delaware

STATEMENT OF BASIS AND PURPOSE

This decision document presents the selected remedial action for the E.I. Du Pont, Newport Site (Site), in Newport, New Castle County, Delaware, which was chosen in accordance with the requirements of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as amended, 42 U.S.C. §§ 9601 et seq., and, to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), 40 C.F.R. Part 300. This decision document explains the factual and legal basis for selecting the remedy for this Site. The information supporting this remedial action decision is contained in the Administrative Record file for this Site.

The State of Delaware has elected not to concur on the selected remedy for the reasons outlined in its August 17, 1993 letter (see Attachment A of this Record of Decision). However, during the Record of Decision (ROD) development process, the State expressed support for many of the major components of the selected remedy.

ASSESSMENT OF THE SITE

The Site is highly contaminated and this contamination is mainly the result of decades of industrial waste disposal and plant operations. Pursuant to duly delegated authority, I hereby determine, pursuant to Section 106 of CERCLA, 42 U.S.C. § 9606, that actual or threatened releases of hazardous substances from this Site, if not addressed by implementing the response action selected in this Record of Decision (ROD), may present an imminent and substantial endangerment to public health, welfare, or the environment.

DESCRIPTION OF THE SELECTED REMEDY

This remedy addresses soils, sediments, surface water, and ground water contamination at the Site. This is a final Record of Decision for the Site. The principal threats at this Site are

contaminated soils containing hazardous substances at the north and south landfills and at the CIBA-GEIGY and the Du Pont Holly Run plants, and contaminated sediments containing hazardous substances in the north drainage way. Treatment is a major component of the remedy at the south landfill while containment is the major component at the other locations due to Site-specific conditions. Below is a summary of the selected remedy:

- Ballpark: Excavation of soils above 500 ppm lead with disposal in the north landfill.
    - Purpose: Prevent human exposure to elevated levels of lead.
- North landfill: Capping; wetland remediation, restoration, and monitoring; vertical barrier wall down to base of the Columbia aquifer; and ground-water recovery and treatment.
    - Purpose: Prevent continued releases of contaminants to the ground water which discharges to the river and the north wetlands, clean up areas of unacceptable environmental impact in the north wetlands, prevent exposure of plant and terrestrial life to contaminated soils.
- South landfill: Excavation and consolidation of contaminated soil underneath and to the east of Basin Road or South James Street onto the south landfill; *in-situ* soil stabilization of the combined soil; capping of the south landfill.
    - Purpose: Prevent continued releases of contaminants to the ground water which discharges to the river and the south wetlands, prevent unacceptable human exposure to contaminated soils from the landfill.
- South wetlands: Excavation, restoration, monitoring.
    - Purpose: Prevent unacceptable impacts to environmental receptors.
- Christina River: Dredging, monitoring.
    - Purpose: Prevent unacceptable impacts to environmental receptors.

- CIBA-GEIGY and Du Pont Holly Run plants: Vertical barrier wall along the Christina River at the CIBA-GEIGY plant, pave the rest of the ground within the contaminated plant areas, recover and treat the ground water up-gradient of the barrier wall, institute special health and safety plans for intrusive work.

    - Purpose: Prevent continued releases of contaminants to the ground water which discharges to the river, prevent unacceptable human exposure to contaminated soils.

- Ground water: Monitoring, provide public water supply along Old Airport Road, establish a ground water management zone.

    - Purpose: Prevent human exposure to Site-related contaminated ground water, prevent further contamination of the Columbia and the Potomac aquifers, protect the south wetlands.

The remedy for the ground water also includes invoking the "greater risk to human health and the environment" applicable or relevant and appropriate requirements (ARAR) waiver. This waiver applies to both the Columbia and Potomac aquifers. Attempts to remediate the Potomac aquifer will cause more contamination to migrate into the Potomac aquifer directly underneath the Site from the more highly contaminated Columbia aquifer. Attempts to remediate the Columbia aquifer will adversely affect the wetlands around the south landfill. These adverse effects outweigh the benefits of installing pump and treat systems in these aquifers. There is currently no human exposure to this ground water, nor is any expected to occur in the future. However, a long-term monitoring program will be instituted as part of this Record of Decision to make sure that this waiver continues to be justified. Appropriate remedial measures shall be taken if the monitoring data indicates a necessity to do so.

State of Delaware Surface Water Quality Standards (SWQSs) are being waived in the north wetlands and the river using the "technical impracticability" ARAR waiver because of off-site sources. Federal ambient water quality criteria are hereby being waived in the river for the same reason. SWQSs are also being waived in the south wetlands using the "greater risk to human health and the environment" waiver because compliance would require destruction of far more wetlands than is estimated necessary in order to protect the environment.

The total present worth cost of the selected remedy is approximately $47,700,000.

DECLARATION OF STATUTORY DETERMINATIONS

The selected remedy is protective of human health and the environment, complies with Federal and State requirements that are legally applicable or relevant and appropriate to the remedial action (or a waiver can be justified for any federal and state applicable or relevant and appropriate requirements that will not be met) and is cost-effective. This remedy utilizes permanent solutions and alternative treatment (or resource recovery) technologies to the maximum extent practicable, and it satisfies the statutory preference for remedies that employ treatment that reduce toxicity, mobility, or volume as their principal element.

Because this remedy will result in hazardous substances remaining on Site above health-based levels, a review will be conducted within five years after commencement of remedial action to ensure that the remedy continues to provide adequate protection of human health and the environment. Such reviews will be conducted every five years thereafter until EPA determines that the cleanup levels set forth in this ROD have been achieved, or that the hazardous substances remaining on the Site do not prevent unlimited use and unrestricted exposure at the Site.

Stanley L. Laskowski
Acting Regional Administrator
Region 3

8/26/93
Date

DECISION SUMMARY

SITE DESCRIPTION AND BACKGROUND

The E.I. Du Pont, Newport Superfund Site (commonly known as the Du Pont-Newport Site and referred to throughout this document as the "Site") is located partially in Newport, New Castle County, Delaware and partially in unincorporated New Castle County, Delaware. It is an approximately 120-acre site located at James and Water Streets in Newport, Delaware near the I-95, I-495, and Delaware State 141 interchange (see Figure 1). The Site includes land currently occupied by a paint pigment production facility (the CIBA-GEIGY plant), a chromium dioxide production facility (the Du Pont Holly Run plant), two industrial landfills separated by the Christina River[1] (the Site includes portions of the river in which Site-related contamination has come to be located), and a baseball diamond (owned by Du Pont and referred to as the ballpark) located just northwest of the CIBA-GEIGY plant across the Amtrak railroad (see Figure 2).

The pigment plant, originally built during the period from 1900 to 1902, was owned and operated by Henrik J. Krebs and manufactured Lithopone, a white, zinc- and barium-based inorganic paint pigment. In 1929, E.I. du Pont de Nemours & Company (Du Pont) purchased the plant and continued to produce Lithopone. Due to a decline in popularity, Lithopone production ceased in 1952. By this time, however, Du Pont had begun to produce different organic and inorganic pigments, as well as other miscellaneous products. Some of these included purified titanium dioxide (the titanium dioxide was produced elsewhere), titanium metal, blue and green copper phthalocyanine pigments (CPC), red quinacridone pigment (QA), high purity silicon, thoriated nickel, and chromium dioxide. In order to expand the production of chromium dioxide, Du Pont constructed the Holly Run plant during the 1970's. In 1984, Du Pont sold the pigment manufacturing operations to CIBA-GEIGY Corporation, but retained the chromium dioxide production operations.

The Holly Run plant and the CIBA-GEIGY plant were built on fill material placed over low-lying farmland. Most of the fill material underneath the CIBA-GEIGY plant and a small portion at the Du Pont plant is contaminated with heavy metals such as

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[1]Known locally also as the Christiana River. Public water supply; industrial water supply; primary contact recreation; fish, aquatic life and wildlife; and agricultural water supply are the designated uses for this area of the river per Delaware's Surface Water Quality Standards, as amended, February, 26, 1993. Boating, water skiing, and fishing have been observed adjacent to CIBA-GEIGY's plant.

cadmium, lead, barium, and zinc. This is a result of disposal operations and poor storage and handling practices of raw materials. As part of the CIBA-GEIGY pigment plant operations (although prior to CIBA-GEIGY's ownership), waste and off-specification products were disposed of in the north and south landfills.

The north landfill was constructed by building a berm along the Christina River on low-lying farmland adjacent to the Lithopone plant. Disposal activities involved backfilling behind the berm. Construction was such that waste and runoff could have flowed around the toe of the berm and into the river. There was no bottom liner in the landfill. It was used for the disposal of Lithopone wastes, other organic pigment wastes, chromium wastes, and other miscellaneous wastes including off-spec thoriated nickel. Wastes were disposed of in the north landfill from 1902 to 1974.

The south landfill was used for the disposal of large quantities of Lithopone wastes which were pumped through a hose on the river bottom and discharged to diked area in a wetland. There was no bottom liner, and some of the waste is currently in the water table. The south landfill operated from approximately 1902 to 1953.[2]

A small portion of the ballpark appears to have become contaminated when contaminated soil from the pigment plant was used to groom the field. It should be noted that this Site is located downstream of Churchman's Marsh which the Water Resources Agency of New Castle County is evaluating as a potential location of a public water supply reservoir. EPA does not expect the remedy outlined in the ROD to impact Churchman's Marsh but can not state so definitively until the remedial design is completed.

In the late 1970's and early 1980's, the Delaware Department of Natural Resources and Environmental Control (DNREC) and Du Pont sampled and analyzed ground water from on-site monitoring wells. The results indicated elevated levels of heavy metals (especially barium, cadmium, and zinc) and volatile organic compounds (mainly tetrachloroethene and trichloroethene) in ground water. During the mid 1980's, EPA and DNREC gathered and

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[2]Based on the information obtained during the remedial investigation and feasibility study, on-Site disposal activities stopped prior to the enactment of the Resource Conservation and Recovery Act (RCRA, 42 U.S.C. §§ 6901 et seq.). When necessary, the determination of whether or not RCRA is an ARAR is discussed for each area of the Site under the "Description of Alternatives and Summary of the Comparative Analysis of Alternatives" section and in the "Compliance With Applicable or Relevant and Appropriate Requirements" section of this Record of Decision.

reviewed information to determine whether or not the Site was eligible for the National Priorities List (NPL). The Site was proposed for inclusion on the NPL in January 1987 and was promulgated in February 1990.

On August 22, 1988 Du Pont entered into an Administrative Order by Consent with EPA whereby Du Pont agreed to perform a Remedial Investigation and Feasibility Study (RI/FS) for the Site. This study has included collection of ground water, soil, sediment, and surface water (both river and wetlands) samples. Although the Site was originally included on the NPL because of ground-water contamination caused by the north landfill, the RI/FS has found that the river and the adjacent wetlands are contaminated as well. Some areas show significant impacts to the ecosystem, although other areas have only minor impacts. The RI/FS also determined that the south landfill and the soil underneath the production plants are sources of ground-water contamination.

HISTORY OF OTHER ENFORCEMENT ACTIVITIES

On June 10, 1993, EPA and Du Pont entered into a removal consent order to address seepage of a heat transfer fluid (similar in composition to Dowtherm) into the Christina River. The seeps, along the north bank of the Christina River, are causing an oil sheen on the Christina River. CIBA-GEIGY has been reporting these releases to the National Response Center beginning in October 1992. Oil sorbing booms are currently in place to control the spread of the fluid. EPA has determined that the levels of Dowtherm are potentially hazardous to aquatic life and that the booms are not an adequate measure of control until such a time as this ROD is implemented which will permanently address this problem. Compliance with the EPA removal order will provide an interim remedy for the seeps.

Several other projects have taken place during the RI/FS in order to address environmental problems. CIBA-GEIGY removed an underground storage tank that at one time was used to store diesel fuel. CIBA-GEIGY also performed repairs to discharge piping to the Christina River. Cracks in the piping were allowing ground water infiltration which was causing discharges of zinc in excess of CIBA-GEIGY's NPDES permit.

HIGHLIGHTS OF COMMUNITY PARTICIPATION

Pursuant to Section 113(k)(2)(B)(i-v) of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as amended, the RI/FS reports and the Proposed Remedial Action Plan (Proposed Plan) for this Site were released to the public for comment on November 13, 1992. These documents were

made available to the public in the Administrative Record file located at the EPA Docket Room in Region 3's Philadelphia office, The Kirkwood Library in Wilmington, Delaware, and the Town Hall of Newport in Newport, Delaware. The notice of availability of these documents was published in The Wilmington News Journal on November 13, 1992. A public comment period on the documents was originally scheduled from November 13, 1992 to December 14, 1992. However, due to a timely request for an extension, 45 days were added to the comment period, extending it to January 28, 1993. In addition, a public meeting was held on December 2, 1992, at the Town Hall of Newport. At this meeting, representatives from EPA answered questions about conditions at the Site and the remedial alternatives under consideration. A response to the comments received during the public comment period, including those expressed verbally at the public meeting, is included in the Responsiveness Summary, which is part of this Record of Decision (ROD). This ROD presents the selected remedial action for the E.I. Du Pont, Newport Site in New Castle County, Delaware, chosen in accordance with CERCLA and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), 40 CFR Part 300. The decision for this Site is based on the Administrative Record placed in the above-mentioned locations.

SUMMARY OF SITE CHARACTERISTICS

Data collected during the RI/FS determined that the Site has extensive contamination in soils, sediments, ground water, surface water, and plant tissue. Some slightly elevated levels of contamination were also detected in one fish species. The following sections discuss the contaminants found in soils, sediments, ground water, and surface water. Data collected during the fish tissue studies, plant tissue studies, benthic studies, and sediment toxicity tests will be discussed in the "Summary of Site Risks" section.

SOILS

The RI determined that high concentrations of certain metals exist in soils in the north landfill, in the south landfill, and underneath the CIBA-GEIGY and the Du Pont Holly Run plants. Elevated levels of metals were also found in the ballpark. Background metal concentrations for soils in the vicinity of the Site were difficult to establish due to the generally disturbed nature of the soils in the area. For this reason, metals detected in the soils at the Site were compared to reported background soil concentrations in a northern Delaware site in the U.S. Geological Survey's "Element Concentrations in Soils and Other Surficial Materials of the Conterminous United States" (see Table 1) which EPA has determined are adequate for this RI. Figure 3 shows the location of soil samples collected during the RI and where metals levels exceeded background (i.e., where

contamination is present). It also lists contaminant levels at various locations. At many of these sampling locations, a number of samples were collected at different depths.

Barium, zinc, cadmium, arsenic, lead, mercury, silver, antimony, cobalt, copper, selenium, and vanadium were all detected above background levels. Of these metals barium, zinc, cadmium, and lead were the most prevalent. Contaminant levels underneath the CIBA-GEIGY plant are as high as 0.6% arsenic, 13% lead, 9% barium, and 6% zinc. The north landfill has levels as high as 4% barium, 5% zinc, and 5% lead. The south landfill has levels as high as 7% barium, 1.6% lead, and 1% zinc.[3]

As indicated above, the north and south landfills are heavily contaminated. See Table 2 for a list of estimated quantities of materials that were disposed of in the north landfill. One of the largest waste streams at the Site came from the Lithopone process where raw zinc and barium ores were refined to make a paint pigment. This waste stream consisted of insoluble residues from the zinc and barium refining process. This residue also contained all of the heavy metal contaminants present in the raw material ore as well as zinc and barium. Some of this waste appears to have been disposed of in the north landfill although most of it was disposed to the south landfill.

The Lithopone waste stream was pumped as a slurry through a pipeline to the south side of the Christina River and discharged into a wetland. Dikes had been built to control the movement of the sludge (which hardened upon exposure to air, forming the south landfill), however aerial photographs show that at times, the dikes were breached, and the sludge flowed into areas of which some are the present day wetlands.

The south landfill was covered in the early 1970's with soil excavated from the area which is now part of the Delaware Route 141 Christina River bridge approach ramp. This was done by the Delaware Department of Transportation (DelDOT) as part of the bridge construction. In order to construct this bridge, Basin Road (or South James Street) was moved west onto the south landfill. Historical aerial photographs show the south landfill extended to the edge of the original Basin Road. DelDOT soil borings taken in the early 1970's confirmed this when one of the stratigraphic units in several borings located between the new and old Basin Road was characterized as "chemical fill" (see Figures 4 and 5).

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[3]10,000 parts per million (ppm) are equivalent to one percent. Therefore, soil containing 5% lead is equivalent to soil containing 50,000 ppm lead.

At the contaminated plant areas, the highest metals concentrations are predominantly in the former barium and zinc ore storage areas associated with historic Lithopone production and in the Lithopone production areas at the central and eastern end of the CIBA-GEIGY plant. Construction of the original Lithopone plant began near James Street. As the plant was expanded, construction moved westward. Originally, the land was low-lying farmland. The elevation was raised with fill material. Photographs show that early raw material handling practices included open piles of barium and zinc ores. Some of these ores were probably mixed into the fill material. Also, a part of the central to western portion of the CIBA-GEIGY plant was constructed on top of a former industrial pond that most likely contained wastes from the Lithopone process. Undoubtedly, much of the contamination in the soils is a result of waste disposal in this pond.

Organic contaminants as well as metals were found in the soil at the contaminated plant areas. The organic contamination (mainly tetrachloroethene and trichloroethene, but also including polynuclear aromatic hydrocarbons (PAHs) such as benzo(a)anthracene, phthalate esters such as bis(2-ethylhexyl)phthalate, chlorobenzenes, dibenzofuran, and chlorophenols) was not nearly as prevalent as the metal contamination and was generally located in the central and western portion of the CIBA-GEIGY plant area. Past production of copper phthalocyanine (CPC), quinacridone (QA), and titanium metal are probable causes of the organic contamination. Utility operations which involved the burning of coal probably contributed to the PAH contamination. QA continues to be produced at the CIBA-GEIGY plant today.

Elevated levels of metals in the ballpark are primarily in the area adjacent to Ayre Street and the baseball diamond (see Figure 6 for sampling locations and contaminant concentrations). It is believed that the only source of these metals is from fill for the baseball field (as opposed to transport of airborne particulates). A review of aerial photography dating back to 1937 for this area of the Site suggests that the current location of the ballpark coincides with the recreational area that existed during much of the historical Lithopone operation era. Conversion of the ballpark into a parking lot coincided approximately with the termination of Lithopone operations in the early 1950's. By 1968, the area was returned to use as a ballpark. Fill material from the Site was reportedly used to manicure the baseball diamond over the history of its use (from pre-1940's). Pedestrian tracking to the parking lot from the Site and the use of fill material at the baseball diamond are believed to have been sufficient to create the concentrations of metals found there. Lead is the only metal elevated to a level of concern in the ballpark.

SEDIMENTS

Sediments at the Site have become contaminated in a variety of ways including: precipitation of some of the contaminants from ground water as it discharges to the Christina River or the wetlands; direct dumping (as in the case of the breached dikes at the south landfill); erosion/surface water runoff which in all likelihood carried contamination from the north disposal area to the river during the time the landfill was open; and the incoming tide carrying contamination from the north drainage way to the north wetlands. Sediments samples were collected in the north wetlands (including the drainage way), the south wetlands (including the south pond), and the river. Figure 7 shows the sampling locations and some of the actual chemistry analysis results. As can be seen from this figure, the contaminant levels are relatively high. For comparison purposes, see Table 3 for a list of EPA Threshold Value Guidelines (TVGs).[4] TVGs are not promulgated criteria, but are levels at which toxicity is expected to occur.

Since contaminant levels at a particular sampling location are very dependent on the physical characteristics of the sediments, grain size and total organic carbon (TOC) analyses were also performed. This physical data of the sediments allowed the chemistry data to be normalized[5] so differences between sampling stations could be ascertained. By plotting the normalized sediment data of the Christina River, it can be clearly seen that sediments adjacent to the north landfill and the CIBA-GEIGY plant have sharply elevated levels of a number of Site-related contaminants including lead, cadmium, chromium, barium, copper, mercury, and zinc (See Figure 8).

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[4]EPA Threshold Value Guidelines, National Perspective on Sediment Quality (1985).

[5]Due to the extreme variability that can occur in sediment contaminant levels due to naturally occurring physical/chemical conditions such as deposition rates, sediment types, grain size and organic matter content, comparing sediment chemistry from different sampling stations and sampling events to determine where anthropogenic (manmade) loading has occurred becomes difficult. Normalizing the data allows a more direct comparison of sediment chemistry between different stations to take place. In this case it was determined that the grain size of the sediments was the greatest cause of natural variability (see Environmental Evaluation, 8/7/92, page 4-6). By normalizing the data to grain size (dividing the actual contaminant levels by the percentage of sediments from that sample that pass through a 64 micron sieve) the effect of grain size on the sediment chemistry is removed.

GROUND WATER

Data collected during the RI/FS showed that two major aquifers are present beneath the Site: the Columbia (the upper aquifer) and the Potomac (the lower aquifer). The Potomac aquifer is subdivided into two water-bearing zones, the upper Potomac aquifer and the lower Potomac aquifer. All of the filling operations (for construction and waste disposal) have created another localized aquifer referred to as the fill zone (see Figure 9 for a simplified cross section). Low-permeability soils restrict ground water from flowing between the different *water-bearing zones and aquifers, but do not prevent flow.* This provides a pathway for contamination to migrate between the water-bearing zones and/or aquifers. Five rounds of ground-water samples were collected during the three phases of the RI. The chemical analyses performed on these samples are summarized in Tables 4 and 5. Figures 10, 11, 12, and 13 show the well locations in each of the water-bearing zones with examples of ground-water sampling results. Table 6 shows the maximum contaminant levels (MCLs) and the non-zero maximum contaminant level goals (MCLGs) for various contaminants at the Site. Figure 14 shows the extent of ground-water contamination that exceeds MCLs or non-zero MCLGs and is considered unsafe to drink. The chemicals that were found at concentrations which exceed MCLs or non-zero MCLGs include cadmium, PCE, TCE, lead, barium, beryllium, carbon tetrachloride, 1,2-dichlorobenzene, 1,4-dichlorobenzene, chlorobenzene, vinyl chloride, benzene, and antimony. Also, zinc, arsenic, and cobalt have been detected at levels at the Site that are considered unsafe to drink.

Generally, ground water in the Columbia aquifer flows toward the Christina River while ground water in the Potomac aquifer flows south. Ground water from the Potomac leaks upward into the Columbia, although in portions of the Site it is the other way around (see Figures 15 and 16 that show the direction of ground water flow between the different water-bearing units).

Data collected during the RI and during the early 1980's indicated that, although the ground water itself has been migrating, the size of the organic or inorganic contaminant plume has not appreciably changed. The limited migration away from the Site is probably caused by ground-water flow directions in the Columbia aquifer mainly confining the contaminants to the Site. For the Potomac aquifer, the fact that since the plant process water wells have ceased operation, there is only a small potential for contaminants to transfer from the Columbia aquifer to the Potomac aquifer thereby limiting the spread of contaminants. For the inorganic contaminants, this retardation has also likely occurred because at the leading edge of the plume where the contaminant levels are small, naturally-occurring anions in the ground water cause the inorganic contaminants to precipitate out of solution.

To date, EPA has not concluded that the nearby residential wells located southeast of the Site along Old Airport Road are affected by Site-related contamination.

SURFACE WATER

Surface water at the Site includes the Christina River, the north wetland area and drainage way, and the south wetlands. Surface water in these areas of the Site is being contaminated by discharging ground water and/or due to being in contact with contaminated sediments. Surface water in the Christina River also receives contamination from point-source discharges from the CIBA-GEIGY plant. These discharges are monitored through a National Pollution Discharge Elimination System (NPDES) permit. During the RI, a number of unpermitted discharge pipes were discovered that had been installed over the years of plant operation. These have since been plugged. Also, repairs have been made to some of the remaining discharge pipes because of cracks in the piping that were allowing contaminated ground water to enter and flow to the river, at times causing NPDES permit limits for zinc to be exceeded.

Most of the samples collected were analyzed for Target Analyte List (TAL) metals. A small number of samples (mostly leachate samples along the north river bank) were also analyzed for Target Compound List (TCL) volatile organic compounds. Several samples from this subset were also analyzed for TCL semi-volatile organic compounds. Figure 17 shows the surface water sampling locations and selected results. Contamination was found in all of the samples. One of the leachate samples from the north landfill was also analyzed for radioactivity. The results of the sampling were compared to Ambient Water Quality Criteria (AWQC) and the State of Delaware's Surface Water Quality Standards (SWQSs). The following contaminants exceeded AWQC and SWQSs at one or more locations (most were found over a vast portion of the Site): lead, copper, zinc, cadmium, aluminum, iron, chromium, mercury, *dichlorobenzenes*, and *tetrachloroethene*. See Table 7 for a list of the actual SWQS values. Note that while iron and aluminum may be considered Site-related contaminants, they exist in naturally-occurring high levels in soils and, therefore, in the ground water and surface water in this area. Also note that the *italicized* compounds were detected in leachate seeps along the north river bank in a localized area. These seeps are toxic to aquatic life. The ground-water seeps along the north bank of the river would require as high as a 600 to 1 dilution for zinc, as high as a 400 to 1 dilution for lead and as high as a 140 to 1 dilution for cadmium in order to reach their respective AWQC or SWQSs (see Figure 66, RI report, 8/26/92). These seeps are very likely to cause near-field AWQC

exceedances[6] and must be controlled in order to protect the environment.

Although there are other known sources of contamination to the Christina River upstream of the Site, several sets of metal loading calculations (see the Data Sufficiency Memorandum, Remedial Investigation-Phase 2, 4/27/89, and the Remedial Investigation Report, 8/26/92, in the Administrative Record) performed during the RI show that the Site potentially contributes greatly to the AWQC exceedances in the river. For example, one model showed the Site causing the zinc levels in the river to increase by 61 ppb. The AWQC for zinc is 110 ppb with exceedances occurring in the river at the Site. Controlling the discharge of the ground water to the river and wetlands would eliminate the toxic effects on aquatic life caused by the contamination in the ground water.

OTHER: RADIONUCLEIDE STUDIES

Because drums of solid waste containing thorium-232, which is a radioactive material, were disposed of in the north landfill from 1961 to 1966, data was collected before and during the RI to evaluate the potential threat of a release to soils or ground water. Most of these drums that were buried in the north landfill contained an off-specification product of nickel containing two to five percent thorium oxide. Plant records indicate that the drums were buried 10 feet below the surface. Since their burial, another two feet of soil has been placed on the north landfill. Du Pont reported in the RI that all thorium buried in the north landfill was in the thorium oxide form. Thorium oxide has a very low solubility, and under most natural environmental conditions, leaching of thorium oxide would not result in any significant ground-water contamination. Du Pont was also licensed to dispose of small quantities of soluble thorium salts which if present in the north landfill pose a greater potential threat of contamination to the ground water.

Thorium-232 is a commonly used metal in high temperature alloys such as those found in jet engines. It is also used in gas lamp mantels. Thorium is a radioactive material that decays spontaneously releasing radiation and producing various decay products, which are also radioactive and which can cause significant radiation exposure. The thorium oxide production and disposal operation was licensed by the U.S. Atomic Energy Commission.

Radiation emitted from the thorium and its decay products in the north landfill was not observed above background radiation

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[6]EPA interview of Rick Green, Water Resources Division, DNREC, 5/27/93

levels at the surface of the landfill. The cover of the landfill and the other wastes present in the landfill attenuate the gamma radiation from the thorium waste. One well, SM-4, had levels of radium-228 at 5.6 picoCuries per liter (piC/l). Radium-228 is a daughter product from the decay of thorium-232. Well SM-4 has also consistently exhibited gross alpha levels slightly above the MCL of 15 piC/l. Since SM-4 is located at the toe (southwest end) of the landfill, there was concern early in the RI that the drums of thoriated nickel were causing a release. Further sampling of ground water, leachate from the landfill, and river sediments provided no further evidence of a release. In fact, the results indicate that the levels detected in SM-4 are more likely caused by background thorium[7] since SM-3, which is between SM-4 and the suspected burial area, did not show any signs of a release.

The principle radiation hazard associated with the thorium waste is from direct gamma radiation emitted from the thorium and its decay products. If someone, who was not wearing proper personnel protective equipment, exposed the thorium waste at the surface by excavating through the cover, that individual could receive significant exposure from gamma radiation emitted by the thorium waste. In addition, inhalation of dust containing the thorium waste, ingestion of contaminated crops and ground water, and inhalation of radioactive radon-220 gas formed as a decay product of thorium-232 would cause radiation exposure which could be significant depending upon the concentration of the thorium in the waste and the conditions of the exposure.

EPA has determined that the most protective remedy for these drums involves leaving them buried in the north landfill as long as the only form of thorium that was disposed of is thorium oxide. Due to the method of disposal and the high insolubility of thorium oxide, it is highly unlikely that there would be any migration of radioactive contaminants at any significant levels away from the north landfill. Ground water monitoring can verify whether or not there is a release in the future. EPA has also determined that institutional controls can be implemented which are adequate to protect the public from direct contact exposure to the thorium. In the future, if potential changes in the land use indicate that the institutional controls may not be adequate, EPA may require further response actions at that time beyond those called for in this ROD.

Furthermore, if in the future, information becomes available that indicates that soluble forms of thorium were or probably were disposed of at the Site in large enough quantities to pose a

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[7]The background levels of radium-228 (a daughter product of thorium) in public drinking water supplies averages in the 4 to 6 piC/l range in some states.

significant threat to the public or the environment, EPA may at that time require further response actions beyond those called for in this ROD such as removing the drums to an EPA-approved off-site disposal facility.

SCOPE AND ROLE OF REMEDIAL ACTION

As part of the RI/FS, a risk assessment was performed by Du Pont to evaluate the actual and potential threats that the contamination poses to human health (Human Health Evaluation: 3/18/92)[8] and to the environment (Environmental Evaluation: 8/7/92). For a discussion of the results of the risk assessment, see the next section titled "Summary of Site Risks."

Once EPA determines from the risk assessment that remedial action is necessary at a site, EPA characterizes waste on-site as either a principal threat waste or a low level threat waste. The concept of principal threat waste and low level threat waste as developed by EPA in the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) is applied on a site-specific basis when characterizing source material. "Source material" is defined as material that includes or contains hazardous substances, pollutants, or contaminants that act as a reservoir for migration of contamination to ground water, to surface water, to air, or that acts as a source for direct exposure. Source materials are considered to be principal threat wastes when they contain high concentrations of toxic compounds (e.g., several orders of magnitude above levels that allow for unrestricted use and unlimited exposure) or are highly mobile and generally cannot be reliably contained.

From the results of the RI/FS, EPA has determined that contaminated soil or sediments in several areas of the Site are principal threats. The principle threats include the contaminated soil beneath the CIBA-GEIGY plant, the contaminated waste in the north and south landfills, and the contaminated sediments in the north drainage way (adjacent to the north landfill). The sediments in the north drainage way have contaminant levels as high as 3% lead and 2% zinc.

Section 300.430(a)(1)(iii) of the NCP states that "EPA expects to use treatment to address the principal threats posed by a site, wherever practicable," that "EPA expects to use engineering controls, such as containment, for waste that poses a relatively low, long-term threat or where treatment is impracticable," and that "EPA expects to use a combination of methods, as appropriate, to achieve protection of human health

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[8]EPA has independently reviewed Du Pont's human health risk assessment and has determined that it is acceptable to EPA.

and the environment." It also states that "EPA expects to use institutional controls...to supplement engineering controls as appropriate...," and that institutional controls may be used "where necessary, as a component of the completed remedy." However, the NCP also states that institutional controls "shall not substitute for active response measures...as the sole remedy unless such active measures are determined not to be practicable..." After giving careful consideration to the NCP, to available technologies, and to the Site characteristics, EPA has determined that treatment is practicable for one but not all of the principal threats at the Site.

EPA has determined that treatment of the contaminated soil in the south landfill is practicable. However, for contaminated soil beneath the CIBA-GEIGY plant, the contaminated soil in the north landfill, and the contaminated sediments in the north drainage way, EPA has determined that, due to Site-specific conditions, it is not feasible to meet the expectation that these principal threats be treated. *In-situ* stabilization[9] is not practicable and *ex-situ* stabilization is not feasible in the north landfill area[10] because of the debris that was buried there. For example, trash (glass, wood, paper, and cardboard), steel drums, concrete rubble, steel work, and artificial marble have been buried in the north landfill. It is also not very feasible to treat the contaminated soils under the CIBA-GEIGY plant since this would require the shut down and removal of the existing facility, and there is little value in tearing down the CIBA-GEIGY plant in order to stabilize the soil underneath the plant since the north landfill and the CIBA-GEIGY plant are one large contiguous area of contamination. In light of these Site-specific conditions, EPA has determined that for both current and potential future conditions, engineering and institutional controls at the north landfill and the CIBA-GEIGY plant will provide the necessary protection of human health and the environment.

The remedial alternatives in this ROD address contaminated soils, sediments, surface water, and ground water at the Site. The remedial action objectives are the following:

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[9]Stabilization (the use of a binding agent to reduce the mobility of contaminants) is the best demonstrated available technology (and the only available technology for a site of this size) for the treatment of metals. It should be noted, however, that even this technology will not destroy the waste (because much of the waste consists of elemental metals) but only greatly limit the ability for the contaminants to migrate.

[10]The remediation of the north drainage way is included with the remediation of the north landfill since the north drainage way cuts through the landfill and then runs along the base of it.

1. Prevent exposure to the contaminated ground water (see detailed discussion under "Ground Water" in the "Alternatives Analyzed" section as to why EPA is not proposing to return the ground water to its beneficial use).

2. Prevent further migration of the contaminated ground water.

3. Prevent exposure to contaminated soils.

4. Prevent exposure to contaminated sediments.

5. Prevent further degradation of the environment caused by the discharge of contaminated ground water to the Christina River and to the wetlands adjacent to the north and south landfills.

As discussed further in the next section, "Summary of Site Risks," preventing exposure to contaminated ground water is required to protect human health, preventing exposure to contaminated soils is required to protect human health and the environment, preventing exposure to contaminated sediments is required to protect the environment, and preventing exposure to highly contaminated surface water is necessary to protect the environment.

This ROD addresses all of the threats currently known that are posed by the contamination at this Site and is, at present, the final response action planned for this Site. This ROD includes the final remedy for the threats posed by the heat transfer fluid seeping into the Christina River that is being addressed on an interim basis by a June 1993 removal action order.

Among the factors considered by EPA in the ROD is the fact that the Du Pont Holly Run plant and the CIBA-GEIGY plant are currently active manufacturing plants. If one or both of the plants were to change materially their present operations, then EPA would assess any proposed change in operation at the Site and consider whether or not to take further response actions at the Site based upon the proposed change. EPA will review the effect that any proposed change in plant operations might have upon the remedy selected in this ROD.

Although this is the final remedy planned for this Site, changes in conditions may lead to further response actions. Other possible response actions include removal of the thorium drums if unacceptable levels of soluble thorium are discovered, further remediation of the wetlands and the river if long-term monitoring shows that the remedy selected in this ROD is no longer protective, further actions at the north landfill and the

CIBA-GEIGY and Du Pont Holly Run plant areas if there are changes in available treatment technologies or changes in the on-going operations of the chemical plants.

SUMMARY OF SITE RISKS

Du Pont prepared a baseline risk assessment to assess the potential human health and environmental impacts that may result from exposure to contaminants associated with the Site in the absence of active remediation. To determine whether there is an actual or a potential impact at the Site, a complete exposure pathway must be established. A complete exposure pathway consists of the following components:

1. A source or mechanism for contaminants to be released to the environment.

2. A medium through which contaminants may be transported such as water, soil, sediment, or air.

3. A point of actual or potential exposure or contact for humans or environmental receptors.

4. A route or mechanism such as ingestion, inhalation, or dermal contact for exposure at the contact point.

Current and potential future exposure scenarios were evaluated for complete exposure pathways which met the above criteria.

The Risk Assessment is a two-volume set of documents comprised of the Human Health Evaluation (HHE) and the Environmental Evaluation (EE). The HHE assesses the risks associated with the Site to people. The EE assesses risks associated with the Site to plants and animals. EPA has determined that actual or threatened releases of hazardous substances from this Site, if not addressed by implementing the response action selected in this ROD, may present an imminent and substantial endangerment to human health and the environment.

HUMAN HEALTH EVALUATION

The HHE is divided into two categories of impacts: carcinogenic and non-carcinogenic or systemic. Many contaminants cause both types of impacts. Remedial action is generally warranted when the calculated carcinogenic risk level exceeds $1x10^{-4}$ (meaning that one additional person out of 10,000 is at risk of developing cancer caused by a lifetime of exposure to contaminants at the Site) under current or future conditions for any of the evaluated exposure scenarios. Remedial action is also generally warranted if the calculated non-carcinogenic Hazard

Index[11] exceeds 1.0 under current or future conditions for any of the evaluated exposure scenarios.

The risks were calculated by first determining all the various ways in which humans come in contact with contaminants at the Site currently or potentially in the future. At the ballpark, children can come into contact with contaminated soils during recreational activities. At the north landfill, a maintenance worker can come into contact with surface soils while cutting grass.

At the south landfill, there are several different possible ways for humans to come into contact with contaminants. First, an owner-employed maintenance worker may accompany a New Castle County maintenance worker inspecting the sanitary sewer force main that runs through the south landfill. This same owner-employed maintenance worker may have other, although infrequent activities, at the south landfill. Although there are no currently planned construction activities at the south landfill, it was assumed that in the future some type of construction may take place that would involve earth-moving activities. The south landfill is also accessible to trespassers who are assumed to be adults and adolescents (ages 14-23 years, inclusive). It was assumed that humans would not come into contact with the sediments in the south wetlands.

In the Christina River, exposure to contaminated water (both the river water itself and leachate seeps along the river bank) can and/or does take place during recreational activities including fishing, boating, and swimming. In the Du Pont Holly Run and CIBA-GEIGY plant areas exposure to contaminated soils can and/or does take place during maintenance activities such as cutting grass and construction activities which involve soil excavation.

The ground water poses a potential future risk. No one is currently consuming ground water contaminated by the Site to levels above MCLs or non-zero MCLGs. However, in the future the plume of contamination may migrate to nearby private drinking water wells or a land owner adjacent to the south landfill could

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[11]The potential for health effects resulting from exposure to non-carcinogenic compounds is estimated by comparing an estimated dose to an acceptable level, or reference dose. If this ratio exceeds 1.0, there is a potential health risk associated with exposure to that chemical. The ratios can be added for exposures to multiple contaminants. The sum, known as the Hazard Index, is not a mathematical prediction of the severity of toxic effects, but rather a numerical indicator of the transition from acceptable to unacceptable levels.

drill a new well into the contaminated plume. This could happen in either the Columbia or Potomac aquifers.

Since the Site has been an operating industrial facility since at least 1902; since it is surrounded by two major highways (Interstate 95 and Delaware 141), a salvage yard, another Superfund site (Koppers), and a light industrial area; since it is separated from the nearest residential area by the northeast corridor line of Amtrak; and since potentially responsible parties currently own a vast majority of the contaminated areas; there was no future residential land use assumed. Therefore, there is no exposure scenario involving residents being exposed to soils at the landfills or the chemical plants or ground water directly underneath these areas.

Different routes for contaminants to enter the body (i.e., ingestion, inhalation, or dermal contact) were taken into account in the risk calculations as appropriate for each exposure scenario (see Table 8). Table 9 contains the major assumptions about exposure frequency and duration for each of the exposure scenarios.

The second step in the risk calculations involves determining which contaminants are contributing significantly to the total risk and should be labeled as contaminants of concern. Using procedures outlined in EPA's "Risk Assessment Guidance for Superfund" (EPA/540/1-89/002), a list of contaminants of concern was developed for each media in each area related to an exposure pathway.

Another part of a risk calculation is the cancer potency factors (CPFs)[12] or reference doses (RfDs)[13]. Used both in

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[12]CPFs, also known as slope factors, have been developed by EPA's Carcinogenic Assessment Group for estimating excess lifetime cancer risks associated with exposure to potentially carcinogenic chemicals. CPFs, which are expressed in units of $(mg/kg/day)^{-1}$, are derived from the results of human epidemiological studies or chronic animal bioassays to which animal-to-human extrapolation and uncertainty factors have been applied.

[13]An RfD is a toxicity value used to estimate the potential for adverse non-carcinogenic health effects. The model to determine RfDs from the dose-response assessment assumes that there is a concentration for non-carcinogens below which there is little potential for adverse health effects over a lifetime of exposure. The RfD is designed to represent this threshold level. The RfD is calculated from the highest chronic exposure level that did not cause adverse effects (the no-observed-adverse-

the screening steps and the actual risk calculations, CPFs and RfDs are estimates of the degree of a contaminant's toxicity.

The actual or potential risk is calculated by multiplying the CPFs and the RfDs by an intake factor (calculated from all of the exposure assumptions) and by the concentration of each contaminant of concern for each exposure pathway.[14]

Table 10 identifies both the carcinogenic and non-carcinogenic risks associated with various areas of the Site. Note in Table 10 that the Hazard Index was calculated with and without taking lead into account because, due to the biological complexity of lead exposure and toxicity, EPA does not currently have an approved reference dose for lead. The reference dose is a major component in the calculation of the Hazard Index. Therefore, EPA determined at this Site a clean-up criteria for lead of 500 ppm in residential settings and 1000 ppm in industrial settings.[15] See Figure 18 for surficial lead

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effect level, or NOAEL) in animals. The NOAEL is divided by a factor to account for any uncertainty such as using data on animals to predict effects on humans and an allowance for sensitive individuals. Uncertainty factors range from 1 to 10,000, based on the confidence level associated with the data. The resulting RfD (mg/kg-body weight/day) is used to quantify the risk.

[14]The concentration value used here is the 95% upper confidence limit (UCL) for the arithmetic mean of the levels of each contaminant found in the samples taken from the appropriate media in each area. This particular concentration value is a statistical estimate of the highest average concentration predicted to occur in 95 out of 100 sets of samples. The use of the 95% UCL produces an estimate of risks for the "Reasonable Maximum Exposure" (RME) scenario. The 95% UCL is used to account for the fact that the actual number of samples is relatively small to accurately predict the average. This method of calculating risks is designed to provide a conservative estimate and makes the underestimation of actual risks highly unlikely.

[15]EPA's Office of Solid Waste and Emergency Response (OSWER) Directive #9355.4-02 (dated 9/7/89) set forth an interim soil clean-up level for total lead for direct contact in residential settings at 500 ppm to 1000 ppm. Site-specific conditions may warrant the use of soil clean-up levels below the 500 ppm level or somewhat above the 1000 ppm level. EPA Region 3 Superfund Program practice is to use 500 ppm for residential settings unless there is evidence that 500 ppm is not protective in which case an uptake/biokinetic model that takes into account site-specific conditions may be used to determine a lead clean-up level. Since at this Site there are no true residential exposure

contamination levels. For many exposure scenarios, these criteria can be used in place of a reference dose in calculating the contribution of lead to the Hazard Index. For other scenarios, such as the recreational activity scenarios in the Christina River, this method overstates lead's contribution to the Hazard Index. The lead levels in the river are so low that EPA has determined they do not pose any significant health risk for someone undertaking recreational activities in the river and, therefore, were not included in the Hazard Index calculations for the recreational exposure scenarios in the Christina River.

The contaminants which contribute most to the human health risk at the Site are lead, vinyl chloride, arsenic, tetrachloroethene, trichloroethene, cobalt, zinc, cadmium, and manganese.

Receptors for which risks are unacceptable include the future construction worker and the adolescent trespasser at the south landfill area; the maintenance worker for the north landfill area and the Holly Run plant; the maintenance and future construction worker at the CIBA-GEIGY plant; and the resident, in the future, drinking contaminated ground water just off the south landfill property.[16]

The RI/FS also found no evidence that Site-related contaminants result in unacceptable health risks from eating fish in the Christina River because there were no data that showed elevated levels of metals in fish typically consumed by humans caught near the Site relative to those caught upstream and out of the influence of the Site.

ENVIRONMENTAL EVALUATION

The Environmental Evaluation (EE) focused on potential impacts to aquatic life in the wetlands and the river. However, it also examined potential impacts to terrestrial animals and plant life. Sediment chemistry, benthic (macroinvertebrates

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settings (recreational activities at the ball park and trespassing at the south landfill have only minimal exposure times to elevated levels of lead), EPA believes that 500 ppm is protective. EPA Region 3 Superfund Program practice is to use 1000 ppm for an industrial exposure scenario unless there is evidence that 1000 ppm is not protective. EPA has determined that a soil clean-up level of 1000 ppm for lead based on a direct contact industrial exposure scenario is appropriate for this Site.

[16]Although not reflected in the risk calculation, remediation of a lead hotspot is required at the ballpark because of lead levels above 500 ppm.

living in and on the sediments) studies, and sediment toxicity were the main indicators of aquatic impacts. Plant chemistry, literature research, and field observations were used to determine impacts to plant life. Estimates of impacts to terrestrial animals were calculated in a way similar to that used to calculate the non-carcinogenic risks to humans.

Figures 19 and 20 show some of the results of the biological tests and the ratio of the normalized metals concentrations at each station to those at the reference station (the enrichment factor). Figure 19 contains test results for the wetland areas, and Figure 20 contains test results for the river. The figures also include results of the sediment elutriate toxicity tests measuring percent survival of water fleas (*Ceriodaphnia*) and fathead minnows (*Pimephales promelas*); solid phase toxicity tests measuring percent survival of *Chironomus tentans* and *Hyallela azteca*; the density (number of organisms per unit area) and diversity (number of different types of organisms and relative abundance of each type) measurements of benthic organisms at different sampling stations as well as the relative frequency of pollution tolerant benthic organisms to the total population. Some of the other tests that are available in the RI include Target Analyte List (TAL) metals analyses data for the sediments, results of the sediment elutriate toxicity tests reproduction rate of water fleas (*Ceriodaphnia*) and the growth rate of fathead minnows (*Pimephales promelas*), solid phase toxicity tests measuring the growth rate of *Chironomus tentans* and *Hyallela azteca*.

Areas that were examined for potential environmental impacts included tidal wetlands adjacent to the north landfill, wetlands in a drainage way that cuts through the north landfill, non-tidal wetlands adjacent to the south landfill, a pond adjacent to the south landfill, upland areas (much of which is on top of the two landfills), and the Christina River (see Figure 21).

The tidal wetland area adjacent to the west end of the north landfill (excluding the lower part of the north drainage way) is approximately seven acres in size. Contamination was detected at the two sampling stations, with lead and zinc being detected as high as 10 times (on a normalized-to-grain size basis) the Site reference station (station RS15 located four to five miles upstream in the Christina River). The location of these two stations indicates that the contamination is present throughout the north wetland area. Contamination is most likely widespread due to the incoming tide carrying contaminated sediment and water throughout this area. Sediment toxicity tests and benthic studies were done to determine impacts caused by the contamination. Slight impacts could be determined from one of the toxicity tests and from the high abundance of pollution tolerant benthos species. Most of the toxicity test results did not indicate any significant levels of toxicity. EPA has

determined that currently no remedial action in the north wetlands is warranted because measured impacts are slight and preserving or enhancing the existing viable wetland habitat is preferable to stripping the wetland sediments and creating a new wetland.[17]

The worst toxicity results at the Site were for samples collected from the drainage way that crosses the north landfill and then wraps around the western base of the landfill and discharges to the Christina River. The mid- and lower sections of the drainage way (where it goes over the edge and potentially cuts into the landfill itself) show signs of extreme impact. Lead levels are extremely high (27,000 ppm maximum). Several of the sediment toxicity tests had no survivors, and the benthic density (number of macroinvertebrates per unit area) was also very depressed (one sampling station in the lower section had a benthic density less than 0.5% of that found in the upper portion of the drainage way). Remediation is required for the mid- and lower sections of the north drainage way in order to protect the environment. The upper end of the drainage way did not exhibit any measurable environmental impacts but did have slightly elevated levels of cadmium, copper, lead, and zinc. EPA has determined that remediation for the mid- and lower sections of the drainage way is necessary because of extreme environmental impact.

The non-tidal wetlands area adjacent to the south landfill is 18 acres in size. This area is not a tidal wetland because a tide gate prevents river water from entering the wetland at high tide. Very high levels of barium (34,700 ppm), lead (5,550 ppm), and zinc (12,800 ppm) have been found in sediments. In one area, the benthic density is depressed, there is a high abundance of pollution tolerant species, and the survival rate of *Hyallela azteca* was low. EPA has determined that remediation is necessary in part of the south wetlands due to unacceptable impacts to environmental receptors. The exact areal extent requiring remediation is unknown at this time.

The pond adjacent to the south landfill has barium levels as high as 60 times the reference station (on a normalized basis) and lead levels as high as 27 times the reference station (also on a normalized basis) showing that the pond has been affected by Site-related activities. The toxicity tests and benthic studies indicated only slight environmental impacts. Field observations

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[17]Although data collected to date do not show a need for remediating the north wetlands, data collected during the remedial design may show areas of the north wetland to be above the clean-up criteria and, therefore, that require remediation. See the discussion below in this section regarding the determination of clean-up criteria.

show this area to be a viable habitat for turtles and muskrats. Vegetation is abundant and representative of a relatively healthy ecosystem. Plant tissue analysis does show chemical uptake and there is concern about the potential impacts this may have to terrestrial receptors. Risk assessment calculations similar to that for determining the Hazard Index for humans show there is a potential impact to animals who consume plants from this area. Because the toxicity tests and the benthic studies did not indicate severe environmental impacts, EPA believes that remediation is not warranted for the south pond. However, monitoring should take place to make sure that the metals do not become bioavailable to aquatic or terrestrial life.

About 30 acres of the Site is considered upland areas (such as the north and south landfills) which provide habitat for animals. Signs of, or actual sightings of deer, beaver, fox, and mice have occurred. Estimates of risks were made due to ingestion of contaminated soils using the deer mouse as a representative species. EPA has determined that remediation of the upland areas is not warranted due to impacts to terrestrial life except for several areas of potential concern. One is a barren area at the southwest corner of the north landfill. High levels of metals (arsenic, barium, cadmium, copper, lead, nickel, and zinc) exist in the surface soil. Levels of zinc are high enough to likely produce toxic effects to the plant life thereby preventing vegetation growth. Although the lack of vegetation may not attract terrestrial life for feeding, bare spots are known to be used for daily habits of many ecological receptors (i.e., birds). EPA has determined that this barren area needs covering to prevent potential exposure to ecological receptors. Also, there are several small (less than one cubic yard) piles of Lithopone waste in the upland area to the west of the north landfill that EPA has determined require removal.

The Christina River flows through the Site and between the north and south landfills. Chemical analyses of the river sediments show high levels of heavy metals associated with the Lithopone process. Elevated levels of metals have been detected from the north drainage way to several miles downstream. All up-gradient sampling appears to have been done far enough up-river from the north landfill to be out of any influence of the Site (the Site is considered to be any place that Site-related contamination has come to be located). However, since the nearest up-river sampling location was over a mile and a half from the north landfill, the potential exists for contamination to have migrated up-river from the Site due to tidal influences and been deposited between the north landfill and the up-river sampling stations. Surficial sediments, which are contaminated by ground water, do have high levels of contamination that tests indicate are toxic in some areas (see data for RS11 and RS12 in Figure 20). EPA has determined that these contaminated sediments need to be remediated. The areal extent of this impact is not

known at this time. However, impacts appear to be highest near the north river bank in the area of the landfills and the CIBA-GEIGY plant.

During the RI, the Site reference station for both the wetlands and the river was RS15 which was about 5 miles upstream on the Christina River from the north drainage way. While apparently unaffected by the Site itself, data from station RS15 suggest that RS15 is influenced by some other site and is therefore not representative of pristine background conditions in the river. This fact should be taken into account when comparing data from Site sampling stations to the reference station to evaluate the presence and extent of any degradation. Efforts should be made during the remedial design and the remedial action to find a reference station, preferably near the Site, which is representative of background conditions (preferably a separate station for wetlands and for the river). Also, through examination of aquatic conditions at other areas of northern Delaware, a list of conditions should be developed that would be expected in a pristine environment (i.e., the ideal reference station).

As described above, EPA has determined that review of all available data (especially that of the toxicity tests, the benthic studies, and the chemistry tests) indicates that several areas of the wetlands and the river warrant remediation. Figure 22 generally outlines these areas. However, due to the broad spacing of samples collected during the RI/FS, the exact areal extent of remediation is currently unknown but will be determined during the remedial design (RD) phase. Figure 23 shows the area in which delineation of unacceptable impacts must be performed in order to determine the exact areas requiring remediation.

In order to make the determination of the exact areal extent of excavation practical, EPA has set Site-specific clean-up criteria for the wetlands and the river based on all available data with an emphasis on the toxicity tests and the benthic studies.[18] The clean-up criteria correspond to the concentration of contaminants found in areas which require remediation based on the results of the bioassessment data. During the remedial design, chemistry tests will have to be done to delineate the exact areas which require remediation. Due to the extreme variability that can occur in sediment contaminant levels due to grain size, it is best to normalize the contaminant levels to grain size in order to compare different sampling stations and sampling events. Therefore, the clean-up criteria

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[18]See the "Memo To File" dated 7/9/93 titled "River & Wetland Remediation Goals (Sediment Clean-up Criteria), Third and Final Edition" attached to this ROD (see Attachment B).

are stated as normalized (to grain size) contaminant levels. The clean-up criteria are:

Lead	1200	ppm
Cadmium	60	ppm
Zinc	5600	ppm

Areas where any one of the above normalized contaminant criteria is exceeded will be remediated. However, one area where EPA has determined that these criteria do not apply is the south pond. Although the above criteria would trigger remediation of the pond, the biological tests indicated no severe environmental impacts in the pond. For example, sampling station AS-01 in the pond had the highest recorded benthic density recorded during the RI and one of the most diverse benthic communities. The difference in the environmental conditions between the pond and the marshy wetlands may be causing a difference in the bioavailability of the contaminants. Due to the fact that 1) the above criteria are not applicable to the south pond and 2) the levels are relatively high compared to sediment contaminant levels that generally have been found to be toxic at other locations, a minimal amount of further toxicity testing will be done during the remedial design to make sure that the levels are protective. In each of the north wetlands, south wetlands, south pond, and Christina River, a minimal number of *Hyallela azteca* solid phase toxicity tests shall be performed in areas where the contaminant levels are below the Site-specific clean-up criteria but above the "apparent effects threshold" (AET) levels for cadmium, lead, and zinc (9.6 ppm, 660 ppm, and 1600 ppm respectively on an absolute basis).[19] EPA may decide to reduce the Site-specific clean-up criteria based upon the results of the toxicity tests although not to levels below the AET values described above. Any reduction may be done across the Site as a whole or independently for each area. The test in the south pond would be evaluated to confirm whether or not the whole pond should be remediated. No criteria will be set for the pond. It should be noted that any sediment clean-up criteria developed for this Site are site-specific criteria to be used at this Site only.

EPA has determined from the information collected during the RI that actual or threatened releases of hazardous substances from this Site, if not addressed by implementing the response action selected in this ROD, may present an imminent and substantial endangerment to public health, welfare, or the environment.

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[19]The cost estimate for the ROD assumed four sampling stations in each of the four areas with four replicates at each sampling station. See the attached 7/9/93 "Memo to File" for a detailed discussion (see Attachment B).

SUMMARY OF AREAS REQUIRING REMEDIATION

In summary, based on the potential impacts to human health and the environment, EPA has determined that the following areas of the Site warrant remediation:

1. Ballpark: The east entrance to the ballpark near the end of Ayre Street has surface soils above EPA's clean-up criteria of 500 ppm that create an unacceptable risk to human health.

2. North landfill including the drainage way: This area continually releases contaminants to the ground water in the fill and/or Columbia aquifers which affects shallow ground water in the direction of migration and ground-water discharge areas. One of the areas affected by the discharge is the Christina River which has AWQC or SWQS exceedances and some sediments which exhibit unacceptable environmental impacts. Another area affected by the discharge is the north drainage way, parts of which exhibit extreme impacts to ecological receptors.

3. South landfill: This area continually releases contaminants to the ground water in the fill zone and/or Columbia aquifers which affects shallow ground water in the direction of migration and ground-water discharge areas. The two discharge points are the river and the south wetlands which have AWQC or SWQS exceedances and some sediments which exhibit unacceptable environmental impacts. Future subsurface maintenance or construction activities would result in unacceptable risks to humans.

4. South wetlands: Part of this area exhibits unacceptable environmental impacts including low benthic density and poor benthic diversity (i.e., a high percentage of pollution tolerant species).

5. Christina River: Some of the sediments in the river exhibit unacceptable environmental impacts. AWQC or SWQS for several Site-related contaminants, including cadmium, lead, and zinc, are exceeded in the vicinity of the Site.

6. CIBA-GEIGY plant and a small portion of the Du Pont Holly Run plant: Exposure to surface and subsurface soils cause unacceptable risks to humans. This area continually releases contaminants to the ground water in the fill zone and/or Columbia aquifers which affects shallow ground water in the direction of migration, ground water in the Potomac aquifer where the hydraulic gradient is downward, and ground-water discharge areas. One of the discharge points that is affected is the river which has AWQC or SWQS exceedances and some sediments which exhibit unacceptable environmental impacts.

7. Ground water: The ground water in the fill zone and both the Columbia and the Potomac aquifers at the Site is not safe to drink. Levels of contaminants such as tetrachloroethene, trichloroethene, cadmium, barium, and lead exceed their MCLs or non-zero MCLGs in the Columbia aquifer. Arsenic, cobalt, manganese, and zinc also contribute to unacceptable human health risks in the Columbia aquifer. Levels of contaminants such as tetrachloroethene, cadmium, lead, and trichloroethene exceed their MCLs or non-zero MCLGs in the Potomac aquifers. Cobalt also contributes to unacceptable risks to humans. No one is currently consuming any ground water that has MCL or non-zero MCLG exceedances caused by the Site.

DESCRIPTION OF ALTERNATIVES AND SUMMARY OF THE COMPARATIVE ANALYSIS OF ALTERNATIVES

The following alternatives were evaluated in detail in the feasibility study to determine which would be the most effective in achieving the goals of CERCLA, and in particular, achieving the remedial action objectives for the Site. The detailed analysis of remedial alternatives for the areas of the Site are briefly described below. As required by the NCP, EPA used nine criteria to evaluate alternatives. These criteria are summarized in Table 11. The first two criteria (overall protection of human health and the environment, compliance with applicable or relevant and appropriate requirements (ARARs)) are threshold criteria. The selected remedy must meet these threshold criteria (except when an ARAR waiver is invoked). The next five criteria (long-term effectiveness and permanence; reduction of toxicity, mobility, or volume through treatment; short-term effectiveness; implementability; and cost) are the primary balancing criteria. The remaining two criteria (state and community acceptance) are referred to as modifying criteria.

Alternative #1 in each of the sections below is the "no action" alternative which, although not listed in each section, was evaluated for each area as required under Section 300.430(e)(6) of the NCP. This section of the NCP requires EPA to evaluate the "no action" alternative at every site to establish a baseline for comparison to other alternatives. Under the "no action" alternative, no action would be taken to address current or future exposure to contaminants remaining at the Site. No costs are associated with the "no action" alternative, and no time is required for implementation.

BALLPARK

ALTERNATIVE #2: A small area, where Ayre Street dead ends at the ballpark (see Figures 2 and 24), with lead levels above 500 ppm would be excavated. Samples would be taken to delineate the waste material and to determine if the soil to be excavated

would be classified as a RCRA-hazardous waste. Soil would be excavated to a depth and extent such that remaining lead levels are below 500 ppm. Confirmatory samples will be taken before the area is backfilled and reseeded. The estimated amount of soil requiring excavation is one cubic yard. Testing would be performed to show whether or not the excavated soil is a RCRA-hazardous waste (i.e., exceeds the Toxicity Characteristic Leaching Procedure (TCLP) criteria). If the excavated soil is not a RCRA-hazardous waste, then it would be disposed of in the north landfill. If the excavated soil is a RCRA-hazardous waste, it may be disposed of either in the north landfill or off-site at an EPA-approved facility in accordance with RCRA regulations. If the excavated soil is a RCRA-hazardous waste and is disposed of in the north landfill, the soil would be treated by stabilization until it is no longer a RCRA-hazardous waste in order for the disposal to be in compliance with RCRA land disposal regulations. The present worth cost for this alternative is $10,000.

COMPARATIVE ANALYSIS OF ALTERNATIVES: Alternative #1 (no action) does not protect human health due to the unacceptable levels of lead that would be left in the ballpark. Alternative #2 does provide overall protection to human health by preventing exposure to soils containing high levels of lead. If TCLP tests indicate that the soil is a RCRA-hazardous waste, RCRA land disposal requirements would be met through either on-site treatment (to achieve the requirements as ARARs) or off-site treatment (to achieve the requirements as regulations). Alternative #2 provides excellent long-term effectiveness since no soil will remain in the ballpark that could cause unacceptable risks to humans. Reduction of mobility through treatment would be met in Alternative #2 if the excavated soil is a RCRA-hazardous waste. The short-term effectiveness and implementability of Alternative #2 are also excellent since the amount of soil to be excavated is very small.

Alternative #2 has the support of the State. Written comments received from the public, including Du Pont, showed strong support to remove whatever contaminated soil is necessary from the ballpark in an expeditious fashion. Upon evaluation of the alternatives by the nine criteria, EPA has determined that Alternative #2 is the selected remedy.

NORTH LANDFILL

ALTERNATIVE #2: A low-permeability cover system (cap) would be installed to reduce infiltration in order to minimize continued ground water contamination from this area. For example, the cover could be a geosynthetic clay liner. Figure 25 shows the approximate area to be covered and a potential cross section of the cover system. The exact location of the thorium drums would be determined, and a marker indicating their location

would be installed on the surface of the landfill once the cap was completed.

A low-permeability cover system would also be placed on the river bank that extends from the crest of the bank down to the river (referred to as the river bank cover system). An example of a potential river bank cover system includes a concrete revetment mattress (a layer of concrete cast in place using connected fabric bags as forms) placed on top of a geosynthetic clay liner which is underlain by another geomembrane and anchoring layers of concrete-filled fabric bags placed on the lower portion of the liner (see Figure 26).

Several small (less than one cubic yard) piles of Lithopone waste in the upland area to the west of the north landfill would be consolidated in the north landfill prior to capping.

Part of the north drainage way would be covered by the cap. The wetlands associated with the lower part of the north drainage way would be remediated by removing the top one foot of sediments. The excavated area would be backfilled with clean fill and revegetated. The exact area requiring remediation would be determined during remedial design by sampling sediments throughout the north wetlands. The excavated sediments would be stabilized and placed underneath the cap.[20] The excavated areas would be restored as a wetland. In order to compensate for the wetlands lost due to capping (a small area on top of the landfill, the upper part of the drainage way, and any portions of the covered river bank that are classified as wetlands), approximately three quarters of an acre of upland area adjacent to the north wetland (unless EPA determines during the remedial design that the type of wetlands requires more than one-to-one replacement) would be graded to establish wetland hydrology. Then other measures would be taken to successfully establish the wetland including planting a variety of grasses and hydrophytic species common to the area.

The lower section of the north drainage way and the north wetlands will undergo long-term monitoring to ensure that the remedy is protective. Also as part of this alternative, long-term monitoring of the north wetlands would take place to make sure the remedy remains protective. The present worth cost of this alternative is $3,500,000.

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[20]RCRA land disposal regulations would be ARARs at this Site only if placement (i.e., disposal) occurs. For placement to occur, the sediments would have to fail the TCLP test and be treated "*ex-situ*." LDRs would not be ARARs for any "in-situ" treatment because no placement would occur since movement of sediments from the north wetlands to the north landfill is considered consolidation within an area of contamination.

ALTERNATIVE #3: This alternative includes everything from Alternative #2 plus the addition of a fill zone hydraulic barrier system (a system of pumping wells that would prevent migration of ground water past a line of recovery wells). The hydraulic barrier system would create a ground water divide that would prevent ground water from the fill zone from discharging to the river. The recovered ground water would be treated with a combination of air stripping to remove volatile organic compounds (VOCs) and precipitation to remove heavy metals. If necessary to comply with DNREC and EPA requirements and regulations, the off-gas from the air stripper would be treated. The treated ground water would be discharged to the Christina River in compliance with the substantive requirements of a National Pollution Discharge Elimination System (NPDES) permit. It is anticipated that the ground-water treatment sludges would be hazardous waste. Since one of the original uses of the tetrachloroethylene in the ground water was as a degreaser of magnesium in the production of titanium metal, any treatment residues containing tetrachloroethylene shall be considered F002 waste. Disposal of any treatment sludges or other wastes would be in accordance with appropriate Federal and State regulations. The present worth cost of this alternative is $12,000,000.

ALTERNATIVE #4: This alternative is the same as Alternative #2 with the addition of a physical barrier wall (an actual wall that limits migration of ground water) that would extend to the base of the Columbia aquifer (see Figure 27 for the approximate wall location). If necessary, this wall would be part of a fully circumscribing wall around the CIBA-GEIGY plant as discussed under the "CIBA-GEIGY and Du Pont Holly Run Plants" section below. Different barrier wall technologies were evaluated in the feasibility study, including deep soil mixing, sheet piles, and a soil/bentonite slurry. Further evaluation will take place in the remedial design. Use of geosynthetic membranes as a physical barrier will also be evaluated in the remedial design. The wall would limit to the maximum extent practicable contaminated ground water from the fill and Columbia zones from entering the Christina River. The wall will cause mounding of the ground water to occur in the landfill. Extraction wells would be installed to control the mounding effect. Ground-water treatment would take place as described under Alternative #3. The present worth cost of this alternative is $12,500,000.

ALTERNATIVE #5: This alternative is the same as Alternative #4 except this alternative leaves the natural vegetation on the river bank instead of installing the river bank cover system. The present worth cost of this alternative is $12,100,000.

COMPARATIVE ANALYSIS OF ALTERNATIVES: Alternative #1 (no action) would not provide overall protection of the environment since it would leave the area of worst environmental impact, the

north drainage way, unremediated. Each of the other alternatives does remediate the north drainage way by replacing the top one foot of sediments where biota (small aquatic organisms) live, thereby contributing to the protection of the environment. Alternatives #2, #3, #4, and #5 provide for capping the landfill which will greatly decrease, but not eliminate, this area's contribution to an overall Site ground water problem in which MCLs are exceeded.[21] However, in order to provide overall protection of human health and the environment and long-term effectiveness, the discharge of ground water from the fill zone and the Columbia aquifer must be limited to the maximum extent practicable. Discharge of the ground water will continually contaminate sediments and contribute to AWQC or SWQS exceedances in both adjacent wetlands and the Christina River. This is especially important of the fill zone ground water that discharges on the west side of the landfill into the drainage way where there is only very limited surface water to dilute the leachate. Alternatives #4 and #5, which include a provision for a physical barrier wall which extends to the base of the Columbia aquifer, limits the migration of contaminated ground water from this area to the maximum extent practicable and, therefore, meet the threshold criteria of overall protection of human health and the environment. Alternatives #2 and #3 do not adequately limit the discharge of ground water to the adjacent wetlands and the river (since they do not control the discharge of the Columbia aquifer) and therefore do not meet the overall protection of human health and the environment threshold criteria.

Although the river bank cover system in Alternatives #2, #3, and #4 would decrease the ability of contaminants in the landfill

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[21]RCRA Subtitle C landfill closure regulations are not considered ARARs for the north landfill. Since the north landfill was closed prior to the enactment of RCRA, RCRA landfill closure regulations are not applicable. The closure regulations are relevant since in all likelihood some of the waste in this landfill would fail the TCLP test. However, the closure regulations are not appropriate. The main technical parts of the closure regulations are that the cap must be less permeable than the bottom liner to prevent a bathtub effect and that the ground water must be monitored to determine if any contamination is migrating from the landfill. Since the landfill has no bottom liner, meeting the closure regulations would only require a slightly impermeable cap. EPA has determined that this is not protective enough of the environment. As for the ground-water monitoring, since the north landfill is adjacent to a river, since the Columbia aquifer is already contaminated, and since active ground-water remediation will not take place in this area, the monitoring requirements as described in 40 CFR 264.98 are not appropriate, and therefore, the closure regulations are not appropriate.

berm from leaching into the river, the natural river bank vegetation (as part of Alternative #5) offers better slope stability. The natural vegetation also provides feeding, roosting, breeding, and cover habitat for birds; provides spawning, nursery, feeding, and cover habitat for fish; and provides benefits for the river such as cooling. The benefits to the environment of the natural river bank vegetation are greater than the benefits of the river bank cover system when combined with the physical barrier wall in Alternative #4. Therefore, Alternative #5 offers a greater degree of overall protection of human health and the environment as compared to Alternative #4.

The ground-water treatment system associated with the installation of the physical barrier wall in Alternatives #4 and #5 would meet all air, water, and RCRA ARARs. The estimated withdrawal rate ranges from 25,000 to 200,000 gallons per day (from north landfill and the CIBA-GEIGY plant area combined). Unless the remedial design ascertains that the withdrawal rate will not exceed 50,000 gallons per day, Delaware River Basin Commission (DRBC) Ground Water Protection Area Regulations would be considered ARARs (although they would no longer be applicable if the actual withdrawal rate was below 50,000 gallons per day).

None of the alternatives would bring the north wetlands into compliance with the State of Delaware's Surface Water Quality Standards (SWQSs), which are ARARs for this area, due to upstream sources of zinc (entering the wetland with the tide) and possible background sources of iron and aluminum. Therefore, by issuing this ROD, EPA is invoking the "technical impracticability" waiver as outlined in Section 300.430(f)(1)(ii)(C)(*3*) of the NCP because it is not possible for remedial actions in the north landfill (wetlands area) to meet the SWQSs.

Alternatives #4 and #5 offer the greatest degree of long-term effectiveness since they limit to the maximum extent practicable the discharge of contaminated ground water which could recontaminate the remediated portions of the wetlands and the river. Alternatives #2, #3, #4, and #5 have potential for short-term impacts because they require locating the thorium drums and drilling into the landfill. A health and safety plan would be developed during the remedial design to protect the workers (including from radiological hazards). Alternatives #4 and #5 would have moderate short-term impacts due to temporary destruction of wetlands, potential construction worker exposure to waste in the north landfill, and sediment transport to the river due to erosion. Erosion controls would have to be implemented to reduce sediment transport. Each of the alternatives would require on-going maintenance since the waste is not being removed or treated to levels that allow unrestricted use.

The overall present worth costs of Alternatives #5 are less than those of Alternative #4. The present worth costs for both of these alternatives are significantly higher than the present worth costs for Alternative #2, due largely to the costs associated with treating the contaminated ground water prior to discharge. However, of the alternatives that meet the threshold criteria of overall protection of human health and the environment and achieves ARARs (Alternatives #4 and #5), Alternative #5 is the most cost-effective.

Overall, the State supports the selection of Alternative #5 except that the State does not agree with determination of the Site-specific clean-up criteria for the sediments. The State strongly believes that a substantial amount of sediment toxicity tests must be performed in the north wetlands to determine which areas must be remediated (see Attachment A for details on the State's position).

At the public meeting there was general support of the preferred alternative (which is practically the same as the selected remedy without the river bank cover system). Written comments from the public, including Du Pont, supported capping the north landfill and remediating the north drainage way, but did not support the potential remediation of the north wetlands or the need to control the discharge of the ground water into the river. However, only areas of the north wetlands that exceed the Site-specific sediment clean-up criteria will be remediated. The two sampling stations in the north wetlands in the RI did not show exceedances of the Site-specific sediment clean-up criteria. Also, as discussed above, EPA has determined that controlling the discharge of the ground water into the river is necessary to protect the environment and that the physical barrier wall that is discussed in Alternative #4 is the most effective means of limiting continued migration of the contaminated ground water in the fill zone and the Columbia aquifer to the Christina River and the north drainage way. Therefore, upon evaluation of the alternatives by the nine criteria, EPA has determined that Alternative #5 is the selected remedy.

SOUTH LANDFILL

ALTERNATIVE #2: This alternative would involve institutional controls, access road improvements on the berm in the south wetlands, excavation and backfilling of the portion of the landfill underneath and to the east of Basin Road (i.e., all of the landfill currently on Delaware property) with consolidation in the rest of the landfill, and installation of a low-permeability cover over the portion of the landfill on Du Pont property (see Figure 28). Also, in order to provide better Site security to control trespassing, additional fencing and a barrier of plants (perhaps thorny plants) would be installed around the entire south landfill area including the

landfill and the adjacent wetland area. The institutional controls would include a notification in the deed regarding past land use, and restrictions on future land use. Access road improvements would involve regrading the southern berm, installing erosion control matting, adding crushed stone on top of the berm and installing a culvert through the existing breach. The low-permeability cover would be of the same construction as on the north landfill. The present worth cost of this alternative is $7,000,000.

ALTERNATIVE #3: This alternative is the same as Alternative #2 with the addition of a physical barrier wall that extends to the base of the Columbia aquifer (technology to be chosen during remedial design from deep soil mixing, soil/bentonite slurry, sheet piles, or geosynthetic membrane) along the river and ground-water recovery and treatment similar to that described in Alternative #2 for the north landfill. The present worth cost of this alternative is $16,000,000.

ALTERNATIVE #4: This alternative is the same as Alternative #2 except that the waste in the south landfill will be stabilized *in-situ* prior to capping and the berm would be removed in order to mitigate the impacts that the increased volume of the landfill has on the floodplain. By stabilizing the waste, the ability of the metals to be leached by the ground water will be greatly reduced.[22] Currently the water table is in the waste material and even after capping, about two feet of waste will still be in the water table. For the purposes of the feasibility study, Portland Cement Type I was used as the stabilization agent although a design optimization study would have to be done to determine the appropriate agent to be used during the remedial action. Stabilization would continue until the waste passed the TCLP test and passed a TCLP-like test using background Site ground water instead of acetic acid to leach the contaminants. The criteria for passing this second test would be MCLs. The present worth cost of this alternative is $15,300,000.

ALTERNATIVE #5: This alternative is the same as Alternative #4 except instead of a double layer low-permeability cap, a RCRA Subtitle D cap (containing a minimum of 18" of 10^{-5} cm/s permeability soil on top or its equivalent) would be constructed on top of the south landfill. The present worth cost of this alternative is $14,300,000.

COMPARATIVE ANALYSIS OF ALTERNATIVES: The "no action" alternative does not meet the threshold criteria of overall protection of the environment because of continued contaminant release to the ground water which discharges to the adjacent

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[22]Since no placement would occur, RCRA land disposal regulations would not be triggered.

wetlands and contaminates the sediments and the surface water. Alternatives #2, #3, #4, and #5 call for capping the landfill which would significantly reduce the release of contaminants to the ground water thereby protecting the wetlands and the river and contributing to a reduction in ground-water contaminant levels (which exceed MCLs) and to a reduction in surface water contaminant levels (which exceed AWQCs in the south wetlands and the river). Also, by consolidating the landfill, all of the landfill could be capped, and potential worker exposure during any future subsurface work along Basin Road would be eliminated.

Currently, much of the waste in the south landfill is below the water table. Capping the landfill would reduce the ground-water mound, but approximately two feet of waste would still be in the water table even after the mound dissipates. By stabilizing the waste before it is capped (as called for in Alternatives #4 and #5), the amount the of contaminants that could be leached out by natural ground-water flow would be limited to the maximum extent practicable, thereby contributing to the protection of the ground water and the surface water.[23]

Most of the major ARARs for this part of the Site are related to the protection of wetlands with the exception of RCRA Subtitle D closure requirements and Delaware Regulations Governing Solid Waste (see Table 12). Alternatives #2, #3, #4, and #5 all meet their respective ARARs. Care would be taken during the design and construction to prevent any adverse affects in the south wetlands and the Christina River. Any wetlands that would be destroyed during remedial action would be replaced on a one-to-one area ratio.

RCRA Subtitle C landfill regulations (in particular those related to closure) are not ARARs for the south landfill. Although there is currently waste material in the south landfill that could be classified as RCRA-hazardous waste, disposal occurred before 1980 so these regulations are not applicable. These regulations would be relevant for Alternatives #2 and #3

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[23]Although in wastes with a large number of metal contaminants, stabilization has been shown in some studies to cause the leachability of some contaminants to increase while decreasing others, stabilization has been determined by EPA to be the best demonstrated available technology (BDAT) for soils and sludges with heavy metal contamination. A design optimization study would have to be done during remedial design to determine the proper type and amount of stabilization agent. It should also be noted that stabilization decreases mobility by not only decreasing the leachability, but also greatly decreasing the permeability of the waste and therefore reducing the ability of the leaching agent (in this case ground water or infiltrating rain water) from coming into contact with the waste.

since the waste being capped would be a RCRA-hazardous waste. However, for Alternatives #2 and #3, they are not appropriate because they are not well suited for this area. One of the major closure requirements is for a cap to be installed that is less permeable than the liner or natural subsoils underneath the waste (to prevent a bathtub effect). This is an inadequate requirement for this area because it would allow a cap that would not adequately control infiltration. For Alternative #4 and #5, since the waste is being stabilized to the point of no longer being a hazardous waste prior to capping, these regulations would not be relevant.

Alternatives #4 and #5 offer the greatest degree of long-term effectiveness although the difference from Alternative #3 is small. By stabilizing the waste material (as in Alternative #4 and #5), the leachability of the metals would be greatly decreased thereby reducing the ability of the contaminants from the south landfill to migrate to the wetlands and cause an impact to environmental receptors. While in Alternative #3, any ground water that comes into contact with waste material, would be extracted before it enters the river (and by pumping, this ground water could not enter the south wetlands), the extremely high amount of operations and maintenance (that would probably be required forever) greatly decreases (in comparison to Alternative #4) the ability to maintain reliable protection of the environment.

Stabilizing the waste would greatly reduce its mobility but would increase its volume by about 25%. Alternatives #2 and #3 offer no reduction of toxicity, mobility, or volume through treatment. Alternative #2 is the best in terms of short-term effectiveness (with Alternatives #4 and #5 being the worst) because it has the least number of major components. However, in all the alternatives (except the "no action" alternative), traffic along Basin Road, which is the only easy access to a number of salvage yards, would be greatly restricted and possibly halted during part of the construction. Alternatives #2, #3, #4, and #5 are all implementable with Alternative #2 being the easiest and Alternatives #4 and #5 being the most difficult. The net present worth cost of Alternative #2 is significantly less than the other three, with Alternative #5 being less than Alternative #4 which is slightly less than Alternative #3.

EPA has determined that Alternative #5 (consolidation, stabilization, and capping) is the preferred remedy because it provides a high degree of overall protection of human health and the environment (almost that of Alternative #4). Alternative #5 significantly reduces the ability of the contaminants at the south landfill to migrate where they contribute to ground-water MCL exceedances and the surface-water SWQS exceedances. It also meets EPA's preference for treatment and has the second highest degree of permanence and long-term effectiveness among the

compared alternatives. However, EPA has determined that the extra protection afforded by Alternative #4 is not necessary because the waste, once stabilized, would no longer fail the TCLP test and has selected the least costly of the two alternatives that offer overall protection to human health and the environment.

The State does not support the selection of Alternative #5. The State's position is that a low-permeability cap (such as that described in Alternative #2) would be sufficient to protect the environment (see Attachment A for details on the State's position). Written comments received from the public, including Du Pont, support capping or possibly stabilizing the waste but not both. Also, strong objections have been expressed to any temporary complete closing of Basin Road or South James Street. To alleviate the concerns, the performance standards state that the excavation must be conducted in such a way as to allow some traffic through this area during daily business hours.

SOUTH WETLANDS

ALTERNATIVE #2: This alternative involves determining the exact areal extent of unacceptable environmental impact (based on the clean-up criteria for cadmium, lead, and zinc (Figure 29 shows the approximate area requiring remediation, the exact areal extent will be determined during the remedial design), stabilization of the excavated sediments and then disposal in the south landfill,[24] backfilling the area of excavation to return the area to original grade, re-vegetating and re-establishing the wetlands, long-term monitoring of the entire south wetland area, and long-term maintenance of the tide gate to prevent the Christina River from entering the wetlands. The present worth cost of this alternative is $4,200,000.

ALTERNATIVE #3: This alternative is the same as Alternative #2 except that instead of using the sediment clean-up criteria to determine what area required remediation, remediation would take place wherever Delaware's SWQS exceedances occur in the wetlands. Work would be done during the remedial design to determine sediment clean-up criteria that would allow the surface water in the wetland to stay below the SWQSs. This is estimated to be a much larger area than if the sediment clean-up criteria in Alternative #2 are used. For the purposes of a cost estimate, it is assumed that the whole south wetland area would require remediation for this alternative. The present worth cost of this alternative is $9,900,000.

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[24]Since placement would not occur, RCRA land disposal regulations would not be triggered.

COMPARATIVE ANALYSIS OF ALTERNATIVES: Alternative #1 (no action) does not meet the threshold criteria of overall protection of the environment in that it leaves portions of the wetlands unremediated that have unacceptable environmental impacts. Alternatives #2 and #3 would comply with ARARs which prohibit the loss of wetland acreage and value.

Alternative #3 would comply with Delaware's Surface Water Quality Standards (SWQSs), especially if the ground water in the Columbia aquifer is remediated. In Alternative #2, Delaware's SWQSs may not be met in the south pond and in the southern portion of the south wetlands. For example at AS05, cadmium, chromium, copper, lead, and zinc exceed Delaware's SWQSs (aluminum and iron also exhibit exceedances although EPA has not concluded at this time that it is Site-related contamination) yet data collected during the RI show that this station is not expected to trigger EPA's Site-specific sediment clean-up criteria. EPA believes that it is mainly the contaminants in the sediments that are causing the exceedances and not discharging ground water (contaminant levels in the ground water at MW-5A are lower than in the surface water at AS05) although the ground water does contribute to the contamination in the surface water.

Although Alternative #3 would comply with water quality ARARs, EPA has determined relying on actual Site biological tests rather than the SWQSs to direct remediation provides a more protective remedy since the surface water contaminant levels are not much above SWQSs[25] and since compliance with SWQSs would

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[25]At AW01 (the same location as AS01 in the south pond, see Figure 7), lead and zinc exhibited SWQS exceedances. However, the total lead concentration was just above the SWQS while the dissolved concentration was below the SWQS. For zinc, during one sampling total and dissolved levels were below the SWQS and during the other sampling event, although the total concentration was above the acute SWQS, the dissolved concentration was below the chronic SWQS. At AW02, (the same location as AS02 in the south pond), the total lead concentration was above the chronic SWQS, but the dissolved lead concentration was below the chronic SWQS. At AS05, the total zinc concentration was above the acute SWQS, but it is expected that the dissolved concentration would be below the chronic SWQS (the dissolved zinc analysis was not done but the levels are generally two to ten times lower than the total concentration). For copper, the total concentration was just above the chronic SWQS. For cadmium, the total concentration was just above the chronic SWQS. For lead, the total concentration was above the chronic SWQS yet way below the acute SWQS, and the dissolved concentration, although not analyzed, is not expected to have been above the chronic SWQS. For chromium, the total concentration exceeded the chronic SWQS, but the dissolved concentration is not expected to.

likely involve stripping more wetlands than is necessary to protect the environment. Therefore, by issuing this ROD, EPA has determined that complying with the SWQSs in the south wetlands would create greater harm to the wetlands than relying mainly on the biological test data collected during the RI to decide where to remediate. EPA has also determined that Alternative #2 provides a greater degree of protection to human health and the environment, and EPA has decided to invoke the "greater risk to human health and the environment" ARAR waiver as outlined in Section 430(f)(ii)(C)(2) of the NCP. To make sure that there are not areas of the south wetlands where SWQSs exceedances are so extreme that the waiver is no longer considered protective, this waiver only applies as long as the dissolved concentration of a Site-related contaminant stays below its respective acute SWQS. If the dissolved concentration of any one Site-related contaminant goes above its respective acute SWQS, the sediments shall be removed regardless of whether or not there are exceedances of EPA's Site-specific sediment clean-up criteria.[26]

Alternative #2 provides for overall protection of the environment because it calls for removal of the portion of sediments that are creating unacceptable impacts to aquatic life. Long-term monitoring will provide a measurement of the effectiveness of the remedy and will help determine if the contamination left in the unremediated portions of the wetland becomes more bioavailable creating unacceptable environmental impacts.

The long-term effectiveness of Alternative #2 is expected to be good. Although Alternative #2 will not remove all of the contamination in the south wetlands and the remaining contamination will cause some impact to environmental receptors, EPA expects that the Site-specific sediment clean-up criteria will remain protective (i.e., EPA expects that in the future the impact of removing the rest of the contamination would be greater than the impact of the contamination itself). A reduction of mobility through treatment would occur if the waste material is stabilized. The short-term impacts are severe as the function of the wetlands will be lost during construction and, even after construction, re-establishing the wetland could take a significant period of time. Alternative #2 is implementable.

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[26]Since it is highly unlikely that the dissolved concentration of Site-related contaminants would exceed the acute SWQS, surface water chemistry samples do not need to be taken at every sampling station during the delineation of the areas that require remediation. Only 20% of those stations where the Site-specific clean-up criteria do not require remediation need surface water chemistry samples performed.

EPA has determined that Alternative #2 is the selected remedy for this area of the Site. The State does not support Alternative #2 because of its position that the Site-specific sediment clean-up criteria were developed without an adequate amount of data (see Attachment A for details on the State's position). Written comments received from the public, including Du Pont, supported the need for excavation; however, the public believed that hotspot remediation would be adequate.

CHRISTINA RIVER

ALTERNATIVE #2: This alternative involves determining the exact areal extent of unacceptable environmental impact (based on the clean-up criteria[27] for cadmium, lead, and zinc), hydraulic dredging of the river in this area, covering the area with clean fill, and dewatering and disposal of dredged sediments either on-site or off-site.[28] Silt curtains would be used to minimize transport of sediments away from the dredging area. Long-term monitoring would be conducted to determine if the unremediated areas develop unacceptable impacts and to confirm the long-term effectiveness of the remedy. The present worth cost of this alternative is $4,700,000 (based on disposal in the north landfill).

ALTERNATIVE #3: This alternative involves the determination of the exact areal extent of unacceptable environmental impact and capping this area with a concrete revetment blanket (a concrete revetment blanket is a series of connected fabric pillows that once anchored to the river bottom, is pumped full of concrete). Monitoring would occur to make sure the remedy remains protective of the environment. The present worth cost of this alternative is $2,700,000.

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[27]Whereas delineation of contamination in the wetlands involves only sampling the top six inches of sediments, delineation of sediment contamination in the river for Alternative #2 (dredging) would be done in six-inch increments to a depth of two feet. Any of these samples could trigger remediation. In areas where remediation is required, further vertical delineation of contamination would take place prior to dredging to a depth of two feet. This would insure that any sediments that would reasonably be expected to become mobile during a major regional storm event would be remediated. Dredging would continue until contaminant levels go below the clean-up criteria. The dredged area would be backfilled with clean sediments.

[28]RCRA Land Disposal regulations would be triggered only if disposal occurs off-site and if the dredged sediments fail the TCLP test.

COMPARATIVE ANALYSIS OF ALTERNATIVES: Alternative #1 (no action) is unacceptable because it does not provide for the overall protection of the environment. Alternatives #2 and #3 do protect the environment by preventing exposure of aquatic life to sediment contaminant levels that produce unacceptable impacts. However, Alternative #3 (capping) potentially causes greater harm to the environment because deposition is not expected to occur on the blanket and therefore, the remediated area would not support aquatic life (i.e, capping does prevent exposure to the contaminated sediment but also permanently destroys the habitat). The long-term monitoring in both alternatives would ensure the implemented remedy is protective of the environment.

Major ARARs include Federal AWQC, Delaware's SWQSs, the Delaware Regulations Governing the Use of Subaqueous Lands, and the Coastal Zone Management Act. EPA cannot ensure that Alternative #3 (capping) would be consistent with the State of Delaware's Coastal Zone Management Plan and therefore capping does not comply with the Coastal Zone Management Act.

Neither alternative would attain AWQC or SWQSs, which are ARARs for this area, in the river at the Site due to upstream sources of zinc. Therefore, EPA is invoking the "technical impracticability" waiver as outlined in Section 300.430(f)(1)(ii)(C)(3) of the NCP because it is not possible for remedial actions at this Site to attain the SWQSs for any contaminant where upgradient sources are causing the exceedances of SWQSs.

The long-term effectiveness of Alternative #2 is much greater than Alternative #3 because the sediments are removed from the area and, if necessary, treated before being properly disposed of. The ability of either of these alternatives to maintain reliable protectiveness depends on limiting the discharge of ground water from the Site into the river. The Site-specific sediment clean-up criteria are expected to remain protective.

Dredging offers some opportunity for reduction of toxicity, mobility, or volume through treatment in this area. Dredged material would, in all likelihood, be disposed of on-site. At the north landfill stabilization would likely be required to improve structural stability of the sediments. If disposed of in the south landfill, the dredged material would almost definitely require stabilization. This stabilization would also reduce mobility of the metal contaminants. However, dredging would also cause an estimated 1 to 2 percent of the sediments to migrate from the Site with the river current. Alternative #3 offers the best short-term effectiveness. However, by limiting the period of dredging to times of low current velocity and low aquatic life activity, impacts can be kept to a minimum. Relative to dredging, installation of the cap would not take very long. Both

Alternatives #2 and #3 are implementable with Alternative #3 being the easiest.

Capping is more cost effective than dredging, especially if the wastes are not disposed of in the north landfill since costs would go up significantly (an estimated additional $8.5 million for off-site disposal).

EPA has determined that Alternative #2 is the preferred remedy. Although Alternative #3 does protect aquatic life by preventing exposure to contaminated sediments, it also destroys a substantial area of habitat and thereby does not meet the overall protection of human health and the environment threshold criteria. Alternative #2 would allow the habitat to be restored thus providing greater overall protection to the environment. Careful implementation of Alternative #2 should keep any sediment transport to a minimum. The State does not support Alternative #2 because of its position that the Site-specific sediment clean-up criteria were developed without an adequate amount of data (see Attachment A for details on the State's position). Written comments received from the public, including Du Pont, strongly opposed dredging and stated that Alternative #3 should be selected due to the risk of sediment transport during dredging operations.

CIBA-GEIGY AND DU PONT HOLLY RUN PLANTS

The remedies in this section address the areas shown in Figure 30. This area includes the complete CIBA-GEIGY plant and a portion of the Du Pont Holly Run plant that has contaminated soils (called "contaminated plant areas" below). Only about 3% of the Holly Run plant area is included.

ALTERNATIVE #2: This alternative involves institutional controls, paving the remaining portions of the contaminated plant areas, installing ground-water recovery wells in the fill zone near the river, treating recovered ground water, and installing a river bank cover system (see Alternatives #2 and #3 in the "North Landfill" section for the description of the river bank cover system and the ground-water treatment system). Institutional controls would involve deed restrictions, ground-water use restrictions and a special health and safety plan to be used during any subsurface work in the contaminated plant areas. Paving the rest of the contaminated plant areas (the exact portion of the Holly Run plant requiring paving to be determined during the remedial design) would decrease infiltration of rain water and prevent exposure to soil lead levels above 1000 ppm. The combination of the river bank cover system and ground-water recovery system would prevent the flow of fill zone ground water to the river and prevent erosion of contaminated soil into the river. The present worth cost of this alternative is $9,300,000.

ALTERNATIVE #3: This alternative is the same as Alternative #2 except that a physical barrier wall (technology to be chosen during the remedial design from deep soil mixing, soil/bentonite slurry, sheet piles, or geosynthetic membrane) will be installed to the base of the Columbia aquifer along the river (see Figure 37 for the approximate location). Ground water would continue to be recovered on the plant side of the wall to control any ground-water mounding that could affect building foundations and that could force contaminated ground water downward into the Potomac aquifer. The present worth cost of this alternative is $11,500,000.

ALTERNATIVE #4: This alternative is the same as Alternative #3 except that the physical barrier wall would be placed completely around the contaminated plant areas (this wall would join both ends of the wall along the river side of the north landfill, completely surrounding all of the contaminated soil associated with the north landfill and the contaminated plant areas). A ground-water recovery system inside the wall would be needed to control any ground-water mounding as described in Alternative #3 and another would be needed north of the Site in Newport to control mounding that would occur up-gradient of the wall. An interceptor trench or a series of recovery wells would be installed on the Site (if an interceptor trench could be used) or on the north side of the railroad tracks, but very near the Site, to reduce the ground-water mounding. If no steps were taken to reduce the ground-water mounding effect, construction of the barrier wall would likely result in an increase in ground-water elevations over the approximately 50-acre area shown in Figure 31. The present worth cost of this alternative is $16,300,000.

ALTERNATIVE #5: This alternative is the same as Alternative #3 except that it does not include the river bank cover system. The natural vegetation would be left on the river bank. The present worth cost of this alternative is $11,000,000.

COMPARATIVE ANALYSIS OF ALTERNATIVES: Alternative #1 (no action) does not meet the threshold criteria of overall protection of human health and the environment in that nothing is done to prevent worker exposure to soils or to control the contaminated plant areas' contribution to impacts in the river and to MCL exceedances in the ground water.

Alternatives #2, #3, #4, and #5 do provide overall protection of human health by controlling worker exposure to contaminated soils. They also greatly decrease the plant areas' contribution to environmental impacts in the river. However, Alternative #2 does not address the Columbia ground-water discharge to the river which is contributing to AWQC exceedances and thus, does not provide overall protection to the environment and does not meet ARARs. Alternatives #3, #4, and #5 limit, to

the maximum extent practicable, contaminated Columbia aquifer ground water from entering the river. Although a circumscribing barrier wall would make it easier to ensure that in all areas of the plant there is an upward migration of the ground water between the Columbia and Potomac aquifers (which would prevent additional contamination from entering the Potomac and thereby provide a greater degree of overall protection to the environment), a barrier wall just along the river (Alternatives #3 and #5) can also greatly limit any downward migration because most of the area where the Columbia aquifer migrates to the Potomac aquifer is along the river where the recovery wells would be placed.

Although the river bank cover system in Alternative #2, #3, and #4 would decrease the ability of contaminants in the landfill berm from leaching into the river, the natural river bank vegetation (as part of Alternative #5) offers better slope stability. The natural vegetation also provides habitat for birds and provides benefits for the river such as cooling. The benefits to the environment of the natural river bank vegetation are greater than the benefits of the river bank cover system (only if the physical barrier wall is installed at least along the river). Therefore, Alternative #5 offers a greater degree of overall protection of human health and the environment as compared to Alternative #3.

Alternative #3, #4, and #5 would comply with ARARs for this area including the Archeological and Historical Preservation Act of 1974. Due to the digging along the river bank, inspection, documentation, and/or collection of artifacts would be done. Alternatives #3, #4, and #5 offer the same degree of long-term effectiveness. Alternative #2 has little long-term effectiveness because by not capturing the Columbia aquifer ground water before it discharges to the river, the area of remediation in the river could become recontaminated over time.

Alternative #2 would be the easiest to implement as well as have the greatest short-term effectiveness in that it would be the fastest alternative to construct and have operational. Installing a barrier wall, either along the river or completely around the contaminated area, will be difficult although judged to be implementable (however, Alternatives #3 and, especially, #5 would be much easier to implement than Alternative #4). For Alternatives #3, #4, and #5, plant utilities (sewer, nitrogen, and power lines) would potentially have to be moved. There is a strong possibility of production being interrupted in the CIBA-GEIGY and the Du Pont Holly Run plants, especially in Alternative #4. Also in Alternative #4, installation of recovery wells and piping would cause temporary impacts to lawn areas and could disrupt traffic in the area immediately adjacent to the north side of the railroad tracks. Of the alternatives that meet the threshold criteria of overall protection of human health and the

environment (Alternatives #3, #4, and #5), the net present worth cost of Alternative #5 is the least although it is only slightly less expensive than Alternative #3. Alternative #4 is significantly more expensive than the other alternatives.

EPA has determined that Alternative #5 is the selected remedy for this area of the Site in that it provides for overall protection of human health and the environment. Also, for the alternatives that meet the threshold criteria, Alternative #5 is the easiest to implement and costs the least. The State supports this determination. Comments (both verbal and written) opposed the circumscribing physical barrier wall that was proposed because of the need for a ground water recovery system in the Town of Newport to prevent any basement flooding. EPA has addressed these concerns by selecting a remedy which only specifies the physical barrier wall along the river. One commentor objected to the proposed river bank cover system because it destroyed valuable habitat along the river. The river bank cover system is not part of the selected remedy. Comments were also received which opposed any barrier wall since installation will cause disruptions for CIBA-GEIGY and since, in the opinion of some of the commentors, there is no need for the wall. However, EPA has determined that controlling the discharge of the ground water into the river is necessary to protect the environment and that the physical barrier wall that is discussed in Alternative #5 is the most effective means of limiting continued migration of the contaminated ground water in the fill zone and the Columbia aquifer to the Christina River.

GROUND WATER

In the discussions of the alternatives in several of the previous sections (north landfill, south landfill, and the CIBA-GEIGY and Du Pont Holly Run plants), ground water has been a major factor. Preferred alternatives were proposed in these areas which would prevent continued release of contaminants to the ground water. This section discusses alternatives to remediate the ground water in both the Columbia and Potomac aquifers that is already contaminated.

Generally, ground water in the Columbia aquifer flows toward the Christina River (i.e., on the north side of the river, the Columbia ground water flows south to the river and on the south side of the river, the Columbia ground water flows north to the river). Columbia ground water on the north side of the river discharges into the river and the wetlands on the west side of the north landfill. A small portion may flow underneath the river and discharge into the south wetlands. Columbia ground water on the south side of the river discharges into the river and the south wetlands. Ground water in the Potomac aquifer flows south. On-site ground water from the Potomac leaks upward

into the Columbia, although in portions of the Site it is the other way around.

The ground water at the Site is a Class IIA aquifer (i.e., the aquifer system, both the Columbia and the Potomac, is a current source of drinking water). Therefore, the NCP states that EPA's goal would be to return the ground water to its beneficial use by considering MCLs or non-zero MCLGs as ARARs. However, the NCP does provide certain instances where ARARs may be waived. Sections 300.430(f)(1)(ii)(C)(*1-6*) of the NCP outline six different ARAR waivers, including the interim measure waiver, the equivalent standard of performance waiver, the greater risk to human health and the environment waiver, the technical impracticability waiver, the inconsistent application of state standard waiver, and the Fund-balancing waiver. The greater risk to human health and the environment waiver may be invoked when compliance with an ARAR will cause greater risk to human health and the environment than non-compliance.

Section 300.430(f)(5)(iii)(A) of the NCP states that performance (for example, attainment of ARARs) shall be measured at appropriate locations in the ground water, surface water, etc. The preamble to the NCP explains that for ground water, remediation levels should generally be attained throughout the contaminated plume or at and beyond the edge of the waste management area when waste is left in place (55 FR 8753). Figure 32 shows the boundary of the "waste management area" for this Site and also indicates the area where MCLs or non-zero MCLGs are exceeded outside of the waste management area. The area outside of the waste management area is where MCLs or non-zero MCLGs are considered ARARs and is called the "area of attainment." The following alternatives address this area of attainment.

ALTERNATIVE #2: This alternative would involve institutional controls, ground-water monitoring, and placing residences and businesses along Old Airport Road on public water supply. Institutional controls would include deed restrictions and establishing a ground-water management zone in the area of the Site (see Figure 33 for the approximate area) to limit the future installation of drinking water wells. Long-term monitoring, including monitoring at the north landfill for thorium, of the Columbia and the Potomac aquifers would provide data to measure the rate of contaminant attenuation in the Columbia aquifer and the rate of contaminant migration in the

Potomac aquifer to the south.[29] The present worth cost of this alternative is $1,400,000.

ALTERNATIVE #3: This alternative includes everything from Alternative #2 with the addition of a ground-water recovery system installed along the south edge of the south landfill and in the south wetlands to clean up the Columbia aquifer south of the south landfill (see Figure 34 to see the area to be remediated and approximate locations of the recovery wells) and a ground-water recovery system that would create a hydraulic barrier in the Potomac aquifer. The hydraulic barrier would prevent migration of contaminated Potomac ground water from the waste management area and would remediate the ground water in the area of attainment (see Figure 35 for the approximate recovery well locations). The recovered ground water would be treated as discussed in the "North Landfill" section and discharged to the south wetlands to prevent any dewatering of the wetlands that might tend to occur due to the withdrawal of the Columbia ground water. The present worth cost of this alternative is $13,500,000.

COMPARATIVE ANALYSIS OF ALTERNATIVES: Each of the alternatives provides for the overall protection of human health except Alternative #1 (under the "no action" alternative, nothing would preclude someone, in the future, from drilling a drinking water well in the contaminated area). Alternative #2 does not meet ARARs since the ground water is not returned to its beneficial use by reducing contaminant levels to MCLs or non-zero MCLGs (except perhaps by natural attenuation which, even if it does occur, could take a very long time).

Alternative #3 would meet ground-water ARARs in the Potomac aquifer. However, the ground water upgradient of the hydraulic barrier will become more contaminated since the pumping will cause a reversal of the natural upward flow of the ground water into the Columbia aquifer and will pull more highly contaminated ground water down into the Potomac aquifer. Also in the Potomac aquifer, the long-term effectiveness and permanence is greatest with Alternative #2 because the plume should eventually attenuate naturally to levels safe to drink since the sources of

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[29]For the Columbia aquifer, the monitoring would include sampling MW-21A, MW-23A, MW-24A, MW-25A, and MW-26A for metals. For the Potomac aquifer, the monitoring would include sampling MW-6B, MW-18B, MW-21B, and MW-26BS. If the monitoring shows that any of the Site-related contaminants have migrated to any one of these wells at a level sufficient to produce a risk (cumulative risk caused by all Site-related contaminants) of either $1x10^{-6}$ for carcinogenic risks or 1 for non-carcinogenic risks, further remedial action separate from this ROD (such as restoration or containment of the ground water) will be considered at that time.

reduced and perhaps eliminated). However, if the monitoring shows that the plume is becoming unacceptable in area of extent, remedial measures in addition to the public water line selected in this ROD may be called for at that time.

In order to select Alternative #2, EPA must invoke the greater risk to human health and the environment waiver (NCP Section 300.430(f)(ii)(c)(*2*)) in recognition of the fact that to meet MCL or non-zero MCLG ARARs would create more harm than good.[30] Although ARARs would not be met with Alternative #2, the alternative would provide overall protection of human health and the environment. EPA has determined that Alternative #2 has advantages over Alternative #3 in that pumping the Potomac aquifer (as outlined in Alternative #3) would cause an increase in contaminant levels in a portion of the Potomac aquifer and pumping the Columbia aquifer (as outlined in Alternative #3) would potentially harm the south wetlands and cause greater contaminant levels in the Columbia aquifer. Further, implementation of Alternative #2 will be protective of human health since installation of a public water supply line to nearby residents and businesses along Old Airport Road and use of institutional controls to limit new wells from being drilled would prevent human exposure to ground water contaminated by harmful levels of Site-related contaminants.

The State supports the selection of Alternative #2 except that the State wants the ROD to state that if the long-term monitoring wells begin to exhibit levels of contaminants considered unsafe to drink, further remedial action would be taken rather than just considered (see Attachment A for details on the State's position). Written comments received from the public, including Du Pont, were generally supportive of Alternative #2.

SELECTED REMEDY: DESCRIPTION AND PERFORMANCE STANDARDS

Based on the findings of the RI/FS; the nine criteria identified in Section 300.430(e)(9)(iii) of the NCP (see Table 11); and written comments received from the public, including Du Pont; EPA has selected a remedy for this Site. The selected remedy addresses the human health and environmental risks presented by this grossly contaminated Site. Below is a summary and a detailed description with performance standards of

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[30]The "greater harm to human health and the environment" ARAR waiver also applies to the State of Delaware Regulations Governing Public Drinking Water (revised 3/11/91) Sections 22.2, 22.3, 22.4, 22.6, and 22.10 and the Delaware Regulations Governing Hazardous Substance Cleanup (1/93), Section 9 for the Columbia and Potomac aquifers.

contamination are being controlled. Active remediation in the Potomac aquifer would create a slug of contamination underneath the waste management area that would require pumping for a longer period of time than would be required to let the existing contamination in the Potomac aquifer to attenuate naturally to currently acceptable levels.

Alternative #3 also has the potential of meeting ground-water ARARs in the Columbia aquifer by remediating the contaminated portion of the Columbia aquifer in the area of attainment. However, the Columbia aquifer may become more contaminated because pumping the Columbia aquifer may cause the wetland area to become a recharge area for ground water instead of a discharge area for ground water. If the Columbia aquifer ground water is recharged from the surface water in the wetlands, higher levels of contamination may be introduced into the ground water by the washing of contaminants from the sediments. The active remediation of Alternative #3 does offer the greatest degree of long-term effectiveness and permanence for the Columbia aquifer. However, contaminant levels in the Columbia aquifer should decrease in Alternative #2 since the sources of contamination (releases from north and south landfills and the contaminated plant areas) are being controlled.

Alternative #3 offers some reduction in mobility or volume through treatment. However, evidence to date indicates that the plume has not migrated very much in the last 15 years. Alternative #2 rates the best in the area of short-term effectiveness because in Alternative #3 wells will be placed in wetlands. This will cause temporary and possibly permanent loss of these wetlands because access roads will have to built. Each of the alternatives is implementable, although Alternative #2 is the easiest to implement. Alternative #2 costs significantly less (approximately 10 times less) than Alternative #3.

EPA has determined that Alternative #2 (monitoring and installation of a public water supply line) is the preferred remedy for this area of the Site because it would provide the best overall protection of human health and the environment. Once this alternative is implemented, there would be no possibility of human exposure to contaminated ground water. The selected remedies for the other areas of the Site would minimize to the maximum extent practicable the release of contaminated ground water into the environment. EPA does not expect the contaminant plume in the Potomac aquifer to expand. To date, the plume has exhibited limited migration potential due most likely to anions in the natural ground water combining with the heavy metals and precipitating the metals out of solution so they are no longer mobile. Also, the selected remedy for the other areas of the Site will greatly decrease, if not eliminate, contaminant migration from the Columbia aquifer to the Potomac aquifer (i.e., the source of contamination to the Potomac will be greatly

the selected remedy. It should be noted that some changes may be made to the implementation of the remedy as a result of the remedial design and construction processes. Such changes, in general, reflect modifications resulting from the engineering design process. Any changes to the remedy will be done in accordance with the NCP.

SUMMARY OF EPA'S SELECTED REMEDY

1. Ballpark

   - Selected Remedy: Excavation of soils above 500 ppm lead with disposal in the north landfill (Alternative #2).

   - Purpose: Prevent human exposure to elevated levels of lead.

   - Cost: $10,000

2. North landfill

   - Selected Remedy: Capping; wetland remediation, restoration and monitoring; vertical barrier wall down to base of the Columbia aquifer; and ground-water recovery and treatment (Alternative #5).

   - Purpose: Prevent continued releases of contaminants to the ground water which discharges to the river and the north wetlands, clean up areas of unacceptable environmental impact in the north wetlands, prevent exposure of plant and terrestrial life to contaminated soils.

   - Cost: $12,100,000

3. South landfill

   - Selected Remedy: Excavation and consolidation of contaminated soil underneath and to the east of Basin Road or South James Street onto the south landfill; *in-situ* soil stabilization of the combined soil; capping (RCRA Subtitle D) of the south landfill (Alternative #5).

   - Purpose: Prevent continued releases of contaminants to the ground water which discharges to the river and the south wetlands, prevent unacceptable human exposure to contaminated soils from the landfill.

   - Cost: $14,300,000

4. South wetlands

   - Selected Remedy: Excavation, restoration, monitoring (Alternative #2).

   - Purpose: Prevent unacceptable impacts to environmental receptors.

   - Cost: $4,200,000

5. Christina River

   - Selected Remedy: Dredging, monitoring (Alternative #2).

   - Purpose: Prevent unacceptable impacts to environmental receptors.

   - Cost: $4,700,000 (based on disposal of the dredged sediments in the north landfill)

6. CIBA-GEIGY and Du Pont Holly Run plants

   - Selected Remedy: Vertical barrier wall along the Christina River at the CIBA-GEIGY plant, pave the rest of the ground within the contaminated plant areas, recover the ground water up-gradient of the barrier wall, institute special health and safety plans for intrusive work (Alternative #5).

   - Purpose: Prevent continued releases of contaminants to the ground water which discharges to the river, prevent unacceptable human exposure to contaminated soils.

   - Cost: $11,000,000

7. Ground water

   - Selected Remedy: Monitoring, provide public water supply along Old Airport Road, establish a ground water management zone, invoke the "greater risk to human health and the environment" ARAR waiver (Alternative #2)

   - Purpose: Prevent human exposure to Site-related contaminated ground water, prevent further contamination of the Columbia and the Potomac aquifers, protect the south wetlands.

   - Cost: $1,400,000

The total present worth cost of the proposed remedy is approximately $47,700,000. See Table 13 for a cost summary of the overall remedy and Tables 14 to 20 for a detailed cost of each portion of the remedy.

DETAILED DESCRIPTION AND PERFORMANCE STANDARDS

1. BALLPARK

1.1 **Soil Removal and Disposal**

DESCRIPTION: A small area, where Ayre Street dead ends at the ballpark (see Figures 1 and 24), with lead levels above 500 ppm shall be excavated. Samples shall be taken to delineate the waste material and to determine if the soil to be excavated should be classified as a RCRA-hazardous waste. Soil shall be excavated to a depth and extent such that remaining lead levels are below 500 ppm. Confirmatory samples shall be taken before the area is backfilled with clean fill from an EPA-approved off-site source and reseeded. The estimated amount of soil requiring excavation is one cubic yard. The excavated material shall be disposed of in the north landfill. Tests shall be performed to determined if the soil to be excavated is a RCRA-hazardous waste (i.e., exceeds the Toxicity Characteristic Leaching Procedure (TCLP) criteria). If the soil fails the TCLP test, the excavated soil shall, in compliance with RCRA land disposal regulations, be treated until it is no longer a RCRA-hazardous waste (through stabilization) and then disposed of in the north landfill. If testing reveals that the soil is not a RCRA-hazardous waste, it shall be disposed of in the north landfill without treatment. The present worth cost for this alternative is $10,000. See Table 14 for details of the cost including the capital cost and annual operations and maintenance costs.

PERFORMANCE STANDARDS: Below are the performance standards for the ballpark portion of the selected remedy:

1.1.1. A statistically significant number of surface soil samples (0-6" depth) to determine the areal extent of lead contamination above 500 ppm shall be collected in the ballpark in the vicinity of the end of Ayre Street. These samples shall be analyzed, at a minimum, for lead using standard EPA Contract Laboratory Program (CLP) protocols for metals.

1.1.2. All soils above the 500 ppm lead levels shall be excavated to a depth where the lead levels are below 500 ppm.

1.1.3. Confirmatory soil samples shall be collected from the excavated area (of sufficient number to statistically determine that the lead levels remaining in the excavation pit are below 500 ppm).

1.1.4. TCLP tests for metals (complete list of TCLP metals) shall be performed on soils which have been determined by the above testing (see paragraph 1.1.1) to be above 500 ppm total lead (either before or after excavating).

1.1.5. If the soil samples from the area requiring excavation fail the TCLP test for metals, the excavated soil shall be stabilized. Stabilization shall involve thoroughly mixing the excavated soils with a cementitious or pozzolanic reagent mixture developed specifically to bind the metal constituents within the stabilized matrix. The actual stabilization agent shall be selected during the remedial design and is subject to EPA approval. Due to the expected small volume of excavated soil (approximately one cubic yard) and to the use of the north landfill for disposal (which is not being stabilized), design optimization tests do not have to be performed to determine the stabilization agent. Instead, a literature review shall be performed to determine the nature and quantity of stabilizing agent to be used. The performance standard for the stabilized soil is that it shall pass the TCLP test for metals prior to disposal in the north landfill (RCRA land disposal regulations are ARARs).

1.1.6. The excavated soil shall be disposed of in the north landfill prior to capping.

1.2 **Ballpark Cost**

DESCRIPTION: The estimated present worth cost of Alternative #2 is $10,000.

2. NORTH LANDFILL

2.1. **Landfill Cover**

DESCRIPTION: A low-permeability cover system (cap) shall be installed to reduce infiltration in order to minimize continued ground-water contamination from this area. For example, the cover could be a geosynthetic clay liner. Figure 25 shows the approximate area to be covered and a potential cross section of the cover system. The thorium bearing drums shall be located.

PERFORMANCE STANDARDS:

2.1.1. Prior to capping, the exact location of the thorium drums shall be determined.

2.1.2. A landfill cap shall be installed that completely covers the north landfill (see Figure 25 for the approximate area of this cap).

2.1.3. The landfill cap shall sufficiently overlap or tie-in to the pavement at the CIBA-GEIGY and Du Pont Holly Run plants to prevent infiltration of water between the area that is paved and the area that is capped and shall sufficiently overlap or tie-in to the physical ground-water barrier wall to prevent infiltration of water between the area that is capped and the hydraulic barrier wall.

2.1.4. The landfill cap shall have a permeability of $1x10^{-7}$ cm/sec or less.

2.1.5. The landfill cap shall have at least two layers of low-permeability material, one of which shall be a geosynthetic membrane.

2.1.6. The landfill cap shall be designed and constructed: to function with minimum maintenance; to promote drainage and minimize erosion or abrasion of the cover; to accommodate settling so that the cover's integrity is maintained; and to provide adequate freeze protection for the liner.

2.1.7. The landfill cap shall be re-vegetated in such a way as to provide a high quality habitat for wildlife to the maximum extent practicable (without endangering the liner). The types of vegetation shall be identified in the remedial design. The remedial design is subject to EPA approval.

2.1.8. All material disposed of in the north landfill shall be of such structural strength as to adequately support the cap.

2.1.9. All material that is to be disposed of in the north landfill (see paragraphs 1.1.6, 2.2.1, 2.3.1, and 5.3.2) shall be disposed of prior to capping.

2.2. **Stabilization and Disposal of Upland Waste Piles**

DESCRIPTION: Several small (less than one cubic yard) piles of Lithopone waste in the upland area to the west of the north landfill shall be stabilized, if necessary, and then consolidated to the north landfill prior to the capping set forth in section 2.1.

PERFORMANCE STANDARDS:

2.2.1. The several small piles of Lithopone waste in the uplands adjacent to the north wetlands and to the west of the

north landfill shall be excavated and disposed of in the north landfill.

2.2.2. Samples from the material excavated per paragraph 2.2.1 shall undergo a TCLP test for metals. Any of the material that fails the TCLP test shall be stabilized prior to disposal in the north landfill.

2.2.3. Stabilization shall involve thoroughly mixing the excavated soils with a cementitious or pozzolanic reagent mixture developed specifically to bind the metal constituents within the stabilized matrix. The actual stabilization agent shall be identified in the remedial design and approved by EPA. Due to the expected small volume of excavated soil (approximately one cubic yard) and to the use of the north landfill for disposal (which is not being stabilized), design optimization tests do not have to be performed to determine the stabilization agent. Instead, a literature review shall be performed to determine the nature and quantity of stabilizing agent to be used. The performance standard for the stabilized soil is that it shall pass the TCLP test for metals prior to disposal in the north landfill.

2.3. **North Drainage Way and North Wetlands**

DESCRIPTION: The upper and parts of the mid- and lower north drainage way will be covered by the cap called for in section 2.1. The wetlands associated with the lower part of the north drainage way (i.e., those not covered by the cap described in paragraph 2.1 above) and the rest of the north wetlands that contain sediments in excess of the Site-specific sediment clean-up criteria shall be remediated by removing the top one foot of sediments. The exact area requiring remediation shall be determined during remedial design by sampling sediments throughout the north wetlands. The excavated sediments, if necessary, shall be stabilized to make a more structurally sound material and put underneath the cap. The excavated wetland area shall be restored.

PERFORMANCE STANDARDS:

2.3.1. The following shall be the Site-specific clean-up criteria for the sediments in the north wetlands (these are absolute chemistry values normalized to grain size):

Lead	1200	ppm
Cadmium	60	ppm
Zinc	5600	ppm

Areas that exceed any one of the above Site-specific clean-up criteria for the north wetlands, as revised if necessary pursuant

to paragraph 2.3.3, shall be excavated to a depth of one foot. The designation of areas which exceed the Site-specific clean-up criteria and require excavation is subject to EPA approval.

2.3.2. A statistically significant number (and a number sufficient to direct remedial activities) of samples shall be collected from the top 6" of the sediments in the north wetlands (see area in Figure 36) to delineate areas containing sediments above the Site-specific sediment clean-up criteria. The samples shall be analyzed for the complete Target Analyte List (TAL) of metals and grain size. The samples shall be collected from areas estimated to have a minimum of 50% fines (percentage of sediments that can pass through a 64 micron sieve).

2.3.3. A minimum of four solid phase sediment toxicity tests (involving four toxicity test replicates and total organic carbon (TOC), grain size, and TAL metals analyses) measuring the survival rate of *Hyallela azteca* shall be performed in the north wetlands in areas where the cadmium, lead, and zinc levels are below the Site-specific clean-up criteria and above their AET values (9.6 ppm, 660 ppm, and 1600 ppm, respectively, on an absolute basis). A 30% reduction in survival compared to the control sample shall be considered a significant impact. If significant impacts are seen in any of the toxicity tests performed for the north wetlands, EPA may modify the Site-specific clean-up criteria as described in Paragraph 2.3.1 (however, not below their respective AET values) for the north wetlands, if appropriate, to protect the environment.

2.3.4. Prior to excavating 32 work-hours shall be spent collecting and moving to an appropriate habitat any wildlife that is residing in areas to be affected by the remediation.

2.3.5. The excavated area shall be backfilled with clean fill from an EPA-approved source and returned to original grade.

2.3.6. The wetlands that will be directly affected by the cap construction and the north drainage way excavation shall be delineated to determine wetland type prior to remedial action using the "Federal Manual for the Delineation of Jurisdictional Wetlands" (Federal Interagency Committee for Wetland Delineation, 1989).

2.3.7. The excavation of the sediments shall be designed and performed in such a way as to minimize environmental damage and to utilize, to the maximum extent practicable, excavation methods such as vacuum dredging or other alternative excavation methods.

2.3.8. A portion of uplands (formerly farmland) adjacent to the north wetlands equal in size (unless EPA determines during the remedial design that the type of wetlands requires more than

one-to-one replacement) to any wetlands destroyed by the north landfill cap construction (this includes, for example, a small area on top of the landfill and the upper part of the drainage way) shall be graded to establish wetland hydrology. The exact location and size shall be identified in the remedial design. The remedial design shall be subject to EPA's approval prior to implementation.

2.3.9. The wetlands shall be successfully re-established. A complete restoration program shall be developed during remedial design to address the excavated area and the newly created wetland area. This program shall, at a minimum identify factors which are key to a successful restoration program including, but not limited to, replacing and regrading soils and re-establishment of vegetation. The program shall be implemented. Other appropriate measures, including but not limited to, periodic maintenance (i.e., planting) may also be necessary to ensure long-term restoration.

2.3.10. A variety of grasses and hydrophytic species common to the area shall be used to revegetate the wetland.

2.3.11. The newly constructed wetland shall be located and constructed in such a manner as to prevent the runoff from the north landfill cap from destroying or de-stabilizing the new wetland.

2.3.12. The excavated sediments shall be, if necessary, stabilized (or otherwise processed just for the purpose of removing or binding the water to make a sufficiently structurally sound material to adequately support the cap) and shall be disposed of in the north landfill (RCRA land disposal regulations would be triggered only if the sediments fail the TCLP test and are stabilized "*ex-situ*"). The remedial design shall describe tests and procedures for determining if stabilization or other physical processing is necessary to prior to putting the excavated sediments underneath the cap. These tests and procedures shall also include specifications for the final stabilized or otherwise processed material.

2.4. **North Wetlands Long-term Monitoring**

DESCRIPTION: The lower section of the north drainage way and the north wetlands shall undergo long-term monitoring to ensure that the remedy is protective.

PERFORMANCE STANDARDS:

2.4.1. A long-term monitoring plan shall be developed and implemented to monitor the effectiveness of the remedial action in the north wetlands/drainage way and to make sure that the

Site-specific clean-up criteria remain protective of the environment.

2.4.2. The monitoring plan shall include sediment monitoring stations located in both remediated and unremediated areas (also include a Site background location); TAL metals analysis and acute and chronic toxicity tests shall be performed (preferably using *Hyallela azteca*) at these locations.

2.4.3. The monitoring plan shall include appropriate field observations of plant growth and of the general conditions of the wetlands in sufficient detail to provide sufficient information to determine the successful establishment of the wetlands.

2.4.4. The monitoring plan shall identify the frequency of monitoring and reporting requirements. The reporting requirements shall include a discussion of the results in addition to data presentation.

2.4.5. The monitoring plan for the north wetlands shall include the determination of a reference station to be approved by EPA. The reference station shall be representative of natural background conditions in a tidal wetland and is, preferably, near the Site (EPA does not consider RS15 to be representative of natural background conditions). Also since there is probably no pristine area near the Site, a list of conditions that would be expected in a pristine tidal wetland shall be developed through examination of aquatic conditions at areas in northern Delaware or other appropriate areas.

2.4.6. Performance standards 2.4.1 to 2.4.5 above are the minimum requirements of the monitoring plan. The monitoring plan is subject to EPA approval. The discussion of the monitoring results is also subject to EPA approval. If at some time EPA determines that this monitoring data indicates that the Site-specific clean-up criteria are no longer protective (for example, the metals remaining in the sediments become more bioavailable due to changing conditions and cause a greater impact), additional remedial measures beyond those described in this ROD may be required including further dredging.

2.5. **North Landfill Physical Barrier Wall**

DESCRIPTION: A physical barrier wall (an actual wall that limits migration of ground water to the maximum extent practicable) shall be constructed to extend from the ground surface to the base of the Columbia aquifer keying into the aquitard which separates the Columbia aquifer and the Potomac aquifer (see Figure 27 for the approximate wall location). This wall shall connect to the physical barrier wall to be installed along the river bank at the CIBA-GEIGY plant as discussed under

the "CIBA-GEIGY and Du Pont Holly Run Plants" section below (see section 6.4). Because the wall may cause mounding of the ground water to occur in the landfill, ground-water extraction wells shall be installed to control any mounding effect. The recovered ground water shall be treated.

PERFORMANCE STANDARDS:

2.5.1. A physical barrier shall be constructed to extend from the surface to the base of the Columbia aquifer. The design shall be such as to minimize to the maximum extent practicable the flow of Columbia ground water underneath the barrier wall into the Christina River. The approximate barrier location is shown in Figure 27. The exact location of the physical barrier wall shall be identified in the remedial design and subject to EPA approval. The east end shall connect to the barrier wall in the CIBA-GEIGY plant. The west end shall extend far enough around the north landfill to capture all of the Columbia and fill zone ground water that has come into contact with contaminated soil.

2.5.2. The barrier shall have a permeability of $1x10^{-7}$ cm/sec or less.

2.5.3. Different barrier wall technologies including deep soil mixing, sheet piles, geosynthetic membranes, and slurry walls shall be evaluated in the remedial design. Of the technologies that are implementable, the remedial design shall identify the technology considered to have the longest life. More than one technology may be necessary depending on the wall location. EPA will make the final decision as to the type of barrier wall technology to be used.

2.5.4. Any unused piping found to cross the path of the barrier wall shall be plugged or removed to a distance to be identified in the remedial design, subject to EPA approval, that will keep a reservoir of potentially contaminated ground water from being formed adjacent to the barrier wall. Any used piping shall be inspected to make sure it is in proper working condition so that a seal can be formed between the pipe and the barrier wall that is of sufficient quality as to prevent a preferential flow path of ground water from forming.

2.5.5. Ground-water recovery wells shall be installed in sufficient number to control any mounding effect created by the barrier wall. The wells shall draw the water table down to the maximum extent practicable without affecting the water table underneath the chemical plants in such a way as to cause structural problems to buildings or pavement. The wells shall be installed in accordance with appropriate State regulations (see Table 12).

2.5.6. All extracted ground water shall be treated and discharged to the Christina River (or if determined by EPA during the remedial design to be acceptable, the treated ground water may be discharged to a publicly owned treatment works-POTW). This treatment shall include removing all contaminants (including metals, organics, and, if necessary, radionucleides) necessary to meet all discharge requirements (especially compliance with the substantive requirements of a National Pollution Discharge Elimination System [NPDES] permit if discharging to the Christina River). If an air stripper or other vented system is used to treat the ground water, secondary controls will be necessary in order to comply with Federal and State air ARARs (see Table 12) if the emissions exceed the specified amounts in these ARARs. Secondary controls will also be installed if necessary to ensure protectiveness of human health and the environment (for protection of human health, secondary emission controls shall be installed if the emissions from the air stripper cause a greater than $1x10^{-6}$ excess cancer risk). It is anticipated that the treatment sludges will be hazardous waste. Any treatment residues containing tetrachloroethylene shall be considered to be F002 waste. Disposal of any treatment sludges or other wastes shall be in accordance with appropriate Federal and State regulations (see Table 12).

2.6. **North Landfill Institutional Controls**

DESCRIPTION: Institutional controls shall be put in place in order to ensure the protectiveness of the remedy.

PERFORMANCE STANDARDS:

2.6.1. No excavation or construction, except as necessary to maintain the integrity and the level of protectiveness of the north landfill cap, shall be allowed once the cap is installed.

2.6.2. No uses of the north landfill shall be made which may impair the cap's integrity. Any change in land use following completion of the remedial action shall require the prior written approval of EPA, and/or its successors.

2.6.3. As long as the buried thorium is present, the property owner(s), and its successors-in-interest, shall continuously maintain a metal monument placed on the north landfill, said monument to be approved by EPA to warn of the presence of buried radioactive thorium-bearing material and to mark the specific location(s) of the thorium-bearing material in the north landfill.

2.6.4. The property owner(s), and its successors, shall notify EPA, and/or its successors, of its intent to convey any interest in the property described herein. Such conveyance shall

not be made without the prior written approval of EPA, and/or its successors. No conveyance of title, easement, or other interest in the property shall be consummated by the property owner(s), and its successors, without adequate and complete provision for continued maintenance and protection of the north landfill cap.

2.6.5. The property owner(s), its successors and assigns, shall not at any time institute legal proceedings, by way of quiet title or otherwise, to remove or amend these institutional controls unless EPA, and/or its successors, has given the property owner(s), and/or its successors, advance written approval.[31]

2.6.6. No drinking water wells shall be installed at the north landfill. No industrial water production wells shall be installed in the Potomac aquifer at the north landfill.

2.6.7. The north landfill shall not be used for residential purposes.

2.6.8. The north landfill shall not be used for recreational purposes as long as thorium remains present in the landfill.

2.6.9. Once remediation at the north landfill is completed and the vegetation is restored, the vegetation shall not be removed except for maintenance activities.

2.6.10. The restrictions on the use of the property shall be included in the deeds to the Site property. The deeds to the affected property shall also be modified to give notice to the public of past land disposal and of the fact that releases and threats of releases of hazardous substances have affected their respective parcels.

2.6.11. Additional measures may be required to implement the institutional controls outlined in paragraphs 2.6.1 to 2.6.10.

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[31]Paragraphs 2.6.2 to 2.6.5 are necessary for EPA to ensure adequate protection of human health and the environment from any potential risks posed by the buried thorium. The U.S. Nuclear Regulatory Commission (NRC) has commented to EPA that the possibility exists for NRC itself to exempt this Site from NRC's decommissioning regulations in 10 CFR Part 40.4. NRC would require a strong set of institutional controls to be in place before it would consider allowing the drums to remain at the Site.

2.7. **North Landfill Cost**

DESCRIPTION: The estimated present worth cost of Alternative #2 is $12,100,000. See Table 15 for details of this cost estimate including the capital cost and annual operations and maintenance costs.

3. SOUTH LANDFILL

3.1. **Excavation of the Basin Road Area**

DESCRIPTION: The portion of the landfill underneath and to the east of Basin Road (i.e., all of the landfill currently on Delaware property) shall be excavated and backfilled with clean fill, and the excavated soil shall be consolidated in the rest of the south landfill.

PERFORMANCE STANDARDS:

3.1.1. A statistically significant number of samples (to be analyzed for TAL metals) shall be collected to determine the extent (lateral and vertical) of the contamination at the south landfill on Delaware property underneath and to the east of Basin Road (or South James Street). See Figure 4.

3.1.2. The contaminant levels allowed to remain in soils at the Basin Road excavation area shall 1) not contribute to groundwater contamination, determined as follows: for soil left at the Basin Road area (above or below the water table), a TCLP-like leach test using clean ground water from near the Site, instead of acetic acid, shall meet MCLs; and 2) shall protect human health, determined as follows: the levels set shall produce a carcinogenic risk of no greater than $1x10^{-5}$ and a non-carcinogenic risk below 1 for a utility repair/construction scenario. These soil clean-up criteria are subject to EPA approval.

3.1.3. Soils above the clean-up criteria on Delaware property, and on whatever Du Pont property necessary to allow construction of the cap and to provide unlimited access to the boat ramp at the west side of the James Street bridge, shall be excavated and consolidated to the remaining portion of the south landfill.

3.1.4. The excavation activities (and potentially other remedial action tasks at the south landfill and south wetlands) will require temporary restrictions or re-routing of traffic. Nearby residents and business shall be notified in a timely manner of these activities. The scheduling of work shall be done in such a way as to allow limited road access through this area

during normal daily business hours for vehicles which do not have an alternate route.

3.1.5. A statistically significant number of confirmation samples shall be collected to determine whether or not the soil remaining in the excavation is below the clean-up criteria.

3.1.6. Once the excavation passes the confirmatory sampling, it shall be backfilled with clean fill from an EPA-approved source. Backfilling shall be done in such a way as to minimize settlement and provide an adequate base for Basin Road.

3.1.7. After the excavation is backfilled, Basin Road shall be reconstructed in accordance with DelDOT road construction requirements.

3.2. *In-situ* Stabilization

DESCRIPTION: The waste in the south landfill shall be stabilized *in-situ* prior to capping. By stabilizing the waste, the ability of the metals to be leached by the ground water will be reduced to acceptable levels. A design optimization study shall be performed to determine the appropriate stabilization agent to be used.

PERFORMANCE STANDARDS:

3.2.1. Prior to stabilization, corings shall be collected to adequately determine the depth of the waste material (TAL metals analysis may be necessary).

3.2.2. After excavation and consolidation of the soils/waste from the east portion of the south landfill (see section 3.1) and the sediments from the south wetlands (see section 4.1) into the remaining part of the south landfill, all of the soil, waste, and sediment in the south landfill shall be stabilized *in-situ* as necessary to pass the TCLP test. Stabilization shall involve thoroughly mixing a cementitious or pozzolanic reagent mixture without removing the soil from the landfill.

3.2.3. Prior to stabilization, design optimization tests shall be done in order to determine the proper nature and quantity of the stabilization agent. A task of the remedial design shall be to develop a work plan (subject to EPA approval) for the design optimization tests. The choice of stabilization agents is subject to EPA approval.

3.2.4. Stabilization shall continue until the soil, waste, and sediment material passes the TCLP test and passes a TCLP-like

test using background Site ground water instead of acetic acid. MCLs shall be used as the criteria for the second test.

3.3. **South Landfill Cap**

DESCRIPTION: A cap with a minimum of 18" of $1x10^{-5}$cm/s permeability soil (or its equivalent) shall be installed over the portion of the landfill on Du Pont property (see Figure 28).

PERFORMANCE STANDARDS:

3.3.1. Prior to excavating 32 work-hours shall be spent collecting and moving to a new environment any wildlife that is residing in areas to be affected by the remediation.

3.3.2. A landfill cap shall be installed that completely covers the portion of the south landfill that is on Du Pont property.

3.3.3. The landfill cap shall be designed and constructed in such a way as to limit to the maximum extent practicable any encroachment on the south wetlands, the south pond, and the Christina River. The wetlands constructed in place of the berm, as described in paragraphs 3.4.1 and 3.4.2, shall be used to replace the loss of any wetlands caused by the construction of the south landfill cap.

3.3.4. The landfill cap shall have or be equivalent to having a permeability of $1x10^{-5}$ cm/sec or less with a minimum of 18" of soil.

3.3.5. The landfill cap shall have a drainage layer of adequate thickness and appropriate permeability to ensure that any surface water infiltration at the south landfill is effectively distributed.

3.3.6. The landfill cap shall be designed and constructed: to function with minimum maintenance; to promote drainage and minimize erosion or abrasion of the cover; to accommodate settling so that the cover's integrity is maintained; and to provide adequate freeze protection for the cap.

3.3.7. The landfill cap shall be re-vegetated in such a way as to provide a high quality wildlife habitat to the maximum extent practicable (without endangering the liner). The types of vegetation shall be identified in the remedial design and are subject to EPA approval.

3.4. **Site Security and Berm Removal**

DESCRIPTION: The berm shall be removed to the maximum extent practicable without adversely affecting the south pond. Also, in order to provide better Site security to control trespassing, additional fencing and a barrier of thorny plants shall be installed around the entire south landfill area including the landfill and the adjacent wetland area.

PERFORMANCE STANDARDS:

3.4.1. The berm shall be removed to the maximum extent practicable without adversely affecting the south pond. As much area as possible shall be graded to allow wetland hydrology to develop. The south wetland restoration program, outlined in paragraphs 4.1.10 and 4.1.11 below, shall be performed in this area as well.

3.4.2. Human access to the Site shall be limited to the maximum extent practicable, without severely limiting the migration of terrestrial animals into this area. This shall be accomplished by using a combination of fencing and thorny plants. The locations of the fences and the thorny plants (see Figure 28 for the approximate location of the fences and bushes) and the choice of plants is subject to EPA approval.

3.5. **South Landfill Institutional Controls**

DESCRIPTION: Institutional controls shall be placed on the Du Pont property south of the Christina River to restrict future land use, to notify the public of past land use, and to ensure the protectiveness of the remedy.

PERFORMANCE STANDARDS:

3.5.1. No excavation or construction, except as necessary to maintain the integrity and the level of protectiveness of the south landfill cap, shall occur once the cap is installed.

3.5.2. The south landfill shall not be used for residential purposes.

3.5.3. Once remediation at the south landfill is completed and the vegetation is restored, the vegetation shall not be removed except for maintenance activities.

3.5.4. No drinking water wells shall be installed at the south landfill. No industrial water production wells shall be installed in the Potomac aquifer at the south landfill.

3.5.5. The restrictions on the use of the property shall be included in the deeds to the Site property. The deeds to the affected property shall also be modified to give notice to the public of past land disposal and of the fact that releases and threats of releases of hazardous substances have affected their respective parcels.

3.5.6. Additional measures may be required to implement the institutional controls outlined in paragraphs 3.5.1 to 3.5.5.

3.5. **South Landfill Cost**

DESCRIPTION: The estimated present worth cost of Alternative #5 is $14,300,000. See Table 16 for details of the cost estimate including the capital cost and annual operations and maintenance costs.

4. SOUTH WETLANDS

4.1. **South Wetlands Sediment Excavation**

DESCRIPTION: The exact areal extent of unacceptable environmental impact (based on the clean-up criteria for cadmium, lead, and zinc) shall be identified in the remedial design (Figure 29 shows the approximate area requiring remediation), subject to EPA approval. Sediments above these criteria shall be excavated to a depth of one foot. The excavated sediments shall be stabilized and then disposed of in the south landfill prior to placement of the south landfill cap as described in paragraphs 3.3.1 to 3.3.7 above. The area of excavation shall be backfilled to return the area to original grade and re-vegetated to restore the wetlands.

PERFORMANCE STANDARDS:

4.1.1. The following shall be the Site-specific clean-up criteria for the sediments in the south wetlands (these are absolute chemistry values normalized to grain size):

Lead	1200	ppm
Cadmium	60	ppm
Zinc	5600	ppm

Areas that exceed any one of the above Site-specific clean-up criteria in the south wetlands shall be excavated to a depth of one foot. Other areas may require excavation to a depth of one foot pursuant to paragraphs 4.1.2 to 4.1.6.

4.1.2. A statistically significant number (and a number sufficient to direct remedial activities) of samples shall be collected from the top 6" of the sediments in the south wetlands (see area in Figure 38) to delineate areas containing sediments above the Site-specific sediment clean-up criteria. The samples shall be analyzed for the complete Target Analyte List (TAL) of metals and grain size. The samples shall be collected from areas estimated to have a minimum of 50% fines (percentage of sediments that can pass through a 64 micron sieve).

4.1.3. A minimum of four solid phase sediment toxicity tests (involving four toxicity test replicates and total organic carbon (TOC), grain size, and TAL metals analyses) measuring the survival rate of *Hyallela azteca* shall be performed in the south wetlands in areas where the cadmium, lead, and zinc levels are below the Site-specific clean-up criteria and above their AET values (9.6 ppm, 660 ppm, and 1600 ppm, respectively, on an absolute basis). A 30% reduction in survival compared to the control sample shall be considered a significant impact. If significant impacts are seen in any of the toxicity tests performed for the south wetlands, EPA may modify the Site-specific clean-up criteria as described in Paragraph 4.1.1 (however, not below their respective AET values) for the south wetlands, if appropriate, to protect the environment.

4.1.4. A minimum of four solid phase sediment toxicity tests (involving four toxicity test replicates and total organic carbon (TOC), grain size, and TAL metals analyses) measuring the survival rate of *Hyallela azteca* shall be performed in the south pond. A 30% reduction in survival compared to the control sample shall be considered a significant impact. If significant impacts are seen in any of the toxicity tests performed for the south pond, the south pond shall be included in the area of the south wetlands to be remediated if EPA determines that it is appropriate to adequately protect the environment.

4.1.5. At 20% of the chemistry sampling locations called for in paragraph 4.1.2 above that are outside of the expected area of remediation (see Figure 29), surface water chemistry samples shall be collected and analyzed for total and dissolved TAL metals. Areas where the dissolved concentration of any one Site-related contaminant, present also in the sediments at that location, exceeds its respective Delaware acute SWQS shall be included in the area of the south wetlands to be remediated. EPA does not consider the "greater risk to human health and environment" ARAR waiver to be protective in these areas (i.e., in areas where the dissolved concentration of a Site-related contaminant exceeds its respective acute SWQS, EPA no longer considers the Site-specific sediment clean-up criteria to be protective).

4.1.6. Areas of the south wetlands that exceed any one of the Site-specific clean-up criteria for the south wetlands, as revised if necessary, or where the dissolved metal concentration of any one Site-related contaminant (present in the sediments in that particular area) exceeds its respective Delaware acute SWQS shall be excavated to a depth of one foot. The excavation of the sediments shall be designed and performed in such a way as to minimize environmental damage and utilize, to the maximum extent practicable, excavation methods such as vacuum dredging or other alternative excavation methods. The determination of which areas exceed the Site-specific clean-up criteria and require excavation is subject to EPA approval.

4.1.7. Prior to excavating 32 work-hours shall be spent collecting and moving to a new environment any wildlife that is residing in areas to be affected by the remediation.

4.1.8. The excavated area shall be backfilled with clean fill from an EPA-approved source and returned to original grade.

4.1.9. The excavated sediments shall be consolidated to the south landfill prior to stabilization and capping in accordance with the performance standards under the "South Landfill" section above.

4.1.10. The wetlands shall be successfully re-established. A complete restoration program shall be developed during remedial design to address the excavated area and the newly created wetland area. This program shall, at a minimum identify factors which are key to a successful restoration program including, but not limited to, replacing and regrading soils and re-establishment of vegetation. The program shall be implemented. Other appropriate measures, including but not limited to, periodic maintenance (i.e., planting) may also be necessary to ensure long-term restoration.

4.1.11. A variety of grasses and hydrophytic species common to the area shall be used to revegetate the wetland.

4.1.12. Only if EPA decides to include the south pond in the area of the south wetlands to be remediated, shall paragraphs 4.1.13 to 4.1.15 be complied with.

4.1.13. The south pond shall be excavated to a depth of one foot. The excavation of the sediments shall be designed and performed in such a way as to minimize environmental damage and utilize, to the maximum extent practicable, excavation methods such as vacuum dredging or other alternative excavation methods.

4.1.14. Paragraphs 4.1.6, 4.1.7, 4.1.8, 4.1.9, and 4.1.10 apply to the south pond also.

4.1.15. Vegetation of similar type and quantity that existed in the south pond prior to remediation shall be successfully re-established.

4.2. South Wetlands Long-term Monitoring

DESCRIPTION: Long-term monitoring of the entire south wetland area shall be conducted to ensure that the remedy remains protective.

PERFORMANCE STANDARDS:

4.2.1. A long-term monitoring plan shall be developed and implemented to monitor the effectiveness of the remedial action in the south wetlands to make sure that the Site-specific clean-up criteria remain protective of the environment and to make sure the restoration is successful.

4.2.2. The monitoring plan shall include sediment monitoring stations located in both remediated and unremediated areas (also include a Site background location). TAL metals analysis, TOC, grain size, acute and chronic toxicity tests (preferably using *Hyallela azteca*), and benthic density and diversity measurements shall be performed at these locations.

4.2.3. The monitoring plan shall include muskrat monitoring at the south pond and a background station every other year during the first five years after the remedy is implemented. The monitoring shall include whole body tissue analyses for TAL metals and organ histeopaths of the liver and kidney or blood and hair analyses for TAL metals.

4.2.4. The monitoring plan shall include appropriate field observations of plant growth and of the general conditions of the wetlands of sufficient detail to provide sufficient information to determine the successful establishment of the wetland.

4.2.5. The monitoring plan shall determine the frequency of monitoring and reporting requirements. The reporting requirements shall include a discussion of the results in addition to data presentation.

4.2.6. The monitoring plan for the south wetlands shall include the determination of a reference station to be approved by EPA. The reference station shall be representative of natural background conditions in a non-tidal wetland and, preferably, near the Site (EPA does not consider RS15 to be representative of natural background conditions). Also since there is probably no pristine area near the Site, a list of conditions that would be expected in a pristine non-tidal wetland shall be developed

through examination of aquatic conditions at areas in northern Delaware or other appropriate areas.

4.2.7. Performance standards 4.2.1 to 4.2.6 above are the minimum requirements of the monitoring plan. The monitoring plan is subject to EPA's approval. The discussion of the monitoring results is also subject to EPA's approval. If at some time EPA determines that this monitoring data indicates that the Site-specific clean-up criteria are no longer protective (for example, the metals remaining in the sediments become more bioavailable due to changing conditions and cause a greater impact), additional remedial measures beyond those described in this ROD may be required including further dredging.

4.3. **Tide Gate**

DESCRIPTION: The tide gate shall be maintained as part of the operations and maintenance of this area to prevent the Christina River from entering the wetlands.

PERFORMANCE STANDARDS:

4.3.1. The tide gate shall be maintained in such a way as to allow water to discharge from the south wetlands to the Christina River but not allow water, and therefore aquatic life, from the Christina River to enter the south wetlands.

4.4. **South Wetland Institutional Controls**

DESCRIPTION: Institutional controls shall be put in place in order to ensure the protectiveness of the remedy.

PERFORMANCE STANDARDS:

4.4.1. No drinking water wells shall be installed in the south wetlands area. No industrial water production wells shall be installed in the Potomac aquifer in the south wetlands area.

4.4.2. Paragraph 4.4.1 applies to all of the land between the south landfill and Old Airport Road that is currently owned by Du Pont and not just those areas classified as wetlands. These restrictions shall be included in the deeds to the Site property. Deeds to the affected property shall be modified to give notice to the public of past land disposal and of the fact that releases and threats of releases of hazardous substances have affected the property.

4.4.3. Additional measures may be required to implement the institutional controls outlined in paragraphs 4.4.1 to 4.4.2.

4.5. **South Wetlands Cost**

DESCRIPTION: The estimated present worth cost of Alternative #2 is $4,200,000. See Table 17 for details of the cost estimate including the capital cost and annual operations and maintenance costs.

5. CHRISTINA RIVER

5.1. **Delineation of Area to be Dredged**

DESCRIPTION: The exact areal extent of unacceptable environmental impact (based on the clean-up criteria for cadmium, lead, and zinc) shall be determined.

PERFORMANCE STANDARDS:

5.1.1. The following shall be the Site-specific clean-up criteria for the sediments in the Christina River (these are absolute chemistry values normalized to grain size):

Lead	1200	ppm
Cadmium	60	ppm
Zinc	5600	ppm

Areas that exceed any one of the Site-specific clean-up criteria in the Christina River, at sample depths described in paragraph 5.1.4 below, shall be dredged until the river bottom in the dredged area is below each Site-specific clean-up criteria described above (revised as necessary pursuant to paragraph 5.1.3 below).

5.1.2. A statistically significant number (and a number sufficient to direct remedial activities) of samples shall be collected from the Christina River (see area in Figure 39) to delineate areas containing sediments above the Site-specific sediment clean-up criteria. The samples shall be analyzed for the complete Target Analyte List (TAL) of metals and grain size. The samples shall be collected from areas estimated to have a minimum of 50% fines (percentage of sediments that can pass through a 64 micron sieve).

5.1.3. A minimum of four solid phase sediment toxicity tests (involving four toxicity test replicates and total organic carbon (TOC), grain size, and TAL metals analyses) measuring the survival rate of *Hyallela azteca* shall be performed in the Christina River in areas where the cadmium, lead, and zinc levels are below the Site-specific clean-up criteria and above their AET values (9.6 ppm, 660 ppm, and 1600 ppm, respectively, on an absolute basis). A 30% reduction in survival compared to the

control sample shall be considered a significant impact. If significant impacts are seen in any of the toxicity tests performed for the Christina River, EPA may modify the Site-specific clean-up criteria as described in paragraph 5.1.1 (however, not below their respective AET values) for the Christina River, if appropriate, to protect the environment.

5.1.4. Each sampling station in Paragraph 5.1.2 shall have four samples collected and analyzed for TAL metals. The samples shall be taken at depths of 0-6", 6-12", 12-18", and 18-24". Exceedance of any one Site-specific clean-up criteria, as revised if necessary, at any depth sampled shall cause the area represented by that sample to be included in the area(s) to be dredged. The area of dredging is subject to EPA approval. Small, localized hotspots located away from the CIBA-GEIGY/Du Pont facility may be excluded from the dredging if EPA determines that dredging the hotspot(s) is not cost effective and leaving them in the river is protective of the environment.

5.2. **Christina River Dredging**

DESCRIPTION: Hydraulic dredging of the river shall take place in this area(s) of unacceptable environmental impact. The dredged area shall then be covered with clean fill.

PERFORMANCE STANDARDS:

5.2.1. The area of unacceptable environmental impact as established pursuant to 5.1.4 above shall be dredged until the river bottom in this area(s) is below the Site-specific clean-up criteria.

5.2.2. Dredging shall only be carried out when the river current velocity is 1.5 feet per second (fps) or below (approximately one hour before and after slack tide).

5.2.3. Dredging shall only take place during the period of November to March (inclusive) to avoid anadromous fish runs and the time of greatest benthic activity.

5.2.4. All available engineering controls shall be used to minimize, to the maximum extent practicable, transport of sediments away from the dredging area. Examples of the types of controls to consider include increasing the percentage water intake at the cutter head, using silt curtains, and/or using hydraulic dredging equipment.

5.2.5. Monitoring shall be performed downgradient from the dredging area to monitor sediment transport. The remedial design shall specify unacceptable levels of sediment transport that

require dredging to be temporary halted or be modified. These levels shall be submitted to EPA for approval prior to dredging.

5.2.6. Dredged sediments shall be pumped to a treatment plant at the plant areas.

5.2.7. A statistically significant number of samples shall be taken after dredging to ensure that the sediments remaining on the river bottom are below the Site-specific clean-up criteria.

5.2.8. Clean fill from an EPA-approved source which meets specifications to be determined during the remedial design shall be placed in the dredged areas to return the river bottom to its original grade.

5.3. **Dewatering of Dredged Material**

DESCRIPTION: The dredged sediments shall be dewatered and properly disposed of either on-site or off-site.

PERFORMANCE STANDARDS:

5.3.1. The remedial design shall identify, subject to EPA approval, the best method for properly handling the dredged sediments and appropriately preparing them for disposal. Dewatering and/or stabilization may be used to provide adequate structural strength for disposal. If stabilization is required and the sediments fail the TCLP test, the sediments shall be stabilized in such a way as to pass the TCLP test.

5.3.2. The dredged sediments shall be properly prepared for disposal. The properly-prepared dredged sediments shall be disposed. The order of preference for the disposal location of the processed sediments shall be on-site in either the north or the south landfills, and then off-site in an EPA-approved disposal facility.

5.3.3. If off-site disposal will take place, TCLP tests shall be performed on the sediments to determine if they are a RCRA-hazardous waste prior to any processing other than physical dewatering. If they fail the TCLP test, RCRA land disposal regulations shall be complied with, and the sediments shall be stabilized so that they pass the TCLP test.

5.3.4. Any stabilization required to meet RCRA land disposal regulations shall involve thoroughly mixing the excavated soils with a cementitious or pozzolanic reagent mixture developed specifically to bind the metal constituents within the stabilized matrix. The actual stabilization agent shall be identified in the remedial design and subject to EPA approval.

The performance standard for the stabilized soil is that it shall pass the TCLP test for metals prior to disposal.

5.3.5. Disposal, whether on-site or off-site, shall occur in a timely manner.

5.3.6. Wastewater generated from the treatment of dredged sediments shall be discharged to the Christina River in compliance with the substantive requirements of a NPDES permit for such activity or discharged to a POTW in compliance with any necessary pre-treatment requirements.

5.4. **Christina River Long-term Monitoring**

DESCRIPTION: Long-term monitoring shall be conducted in the Christina River to determine if the unremediated areas develop unacceptable impacts and to confirm the long-term effectiveness of the remedy.

PERFORMANCE STANDARDS:

5.4.1. A long-term monitoring plan shall be developed and implemented to monitor the effectiveness of the remedial action in the Christina River and to make sure that the Site-specific clean-up criteria remain protective of the environment.

5.4.2. The long-term monitoring plan shall include sediment monitoring stations in the Christina River in both remediated and unremediated areas (and include a Site background station). TAL metals analysis, TOC and grain size tests, acute and chronic toxicity tests (preferably using *Hyallela azteca*), and benthic density and diversity measurements shall be performed at these locations.

5.4.3. The long-term monitoring plan shall determine frequency of monitoring and reporting requirements. The reporting requirements shall include a discussion of the results in addition to data presentation.

5.4.4. The monitoring plan for the Christina River shall include the determination of a reference station to be approved by EPA. The reference station shall be representative of natural background conditions in a tidal river environment and, preferably, shall be near the Site (EPA does not consider RS15 to be representative of natural background conditions). Also since there is probably no pristine area near the Site, a list of conditions that would be expected in a pristine tidal river environment shall be developed through examination of aquatic conditions at areas in northern Delaware or other appropriate areas.

5.4.5. Performance standards 5.4.1 to 5.4.4 above are the minimum requirements of the monitoring plan. The monitoring plan shall be submitted to EPA for approval. The discussion of the monitoring results shall also be submitted to EPA for approval. If at some time EPA determines that this monitoring data indicates that the Site-specific clean-up criteria are no longer protective (for example, the metals remaining in the sediments become more bioavailable due to changing conditions and cause a greater impact), additional remedial measures beyond those described in this ROD may be required including further dredging.

5.5. Christina River Cost

DESCRIPTION: The estimated present worth cost of Alternative #5 is $4,700,000. See Table 18 for details of the cost estimate including the capital cost and annual operations and maintenance costs.

6. CIBA-GEIGY AND DU PONT HOLLY RUN PLANTS

6.1. DESCRIPTION: The remedies in Section 6 address the area shown in Figure 30. This area includes the complete CIBA-GEIGY plant and a portion of the Du Pont Holly Run plant that has contaminated soils (called "contaminated plant areas" below). Only about 3% of the Holly Run plant area is included.

6.2. CIBA-GEIGY and Du Pont Holly Run Plants Institutional Controls

DESCRIPTION: Institutional controls shall be placed on the contaminated plant areas to restrict future land use, to ensure the protectiveness of the remedy, and to notify the public of past land use.

PERFORMANCE STANDARDS:

6.2.1. The contaminated plant areas shall not be used for residential purposes.

6.2.2. No drinking water wells shall be installed at the contaminated plant areas. No water production wells shall be installed in the Potomac aquifer at the CIBA-GEIGY Corporation Newport and Du Pont Holly Run plants.

6.2.3. The pavement and/or building structures located at the Site property shall be maintained in a manner which limits, to the maximum extent practicable, the infiltration of water.

6.2.4. The property owners, and/or their successors, shall notify EPA, and/or its successors, of their intent to convey any interest in the Site property. Such conveyance shall not be made without the prior written approval of EPA, and/or its successors. No conveyance of title, easement, or other interest in the Site property shall be consummated by the property owners, and/or their successors, without adequate and complete provision for continued maintenance of the property.

6.2.5. The property owners, and/or their successors, shall notify EPA, and/or its successors, of any substantial change to their present operations at the Site at least six months prior to the proposed change.

6.2.6. Any change in land use following completion of the remedial action shall require the prior written approval of EPA, and/or its successors.[32]

6.2.7. The respective Site owners shall modify the deeds to the affected Site property to give notice to the public of the past land disposal practices and of the fact that releases and threats of releases of hazardous substances have affected the property.

6.2.8. Additional measures may be required to implement the institutional controls outlined in paragraphs 6.2.1 to 6.2.7.

6.3. **Paving of Contaminated Plant Areas**

DESCRIPTION: The remaining unpaved portions of the contaminated plant areas shall be paved.

PERFORMANCE STANDARDS:

6.3.1. The remaining unpaved portions of the contaminated plant areas shall be paved. Paving shall be done in such a way as to minimize the need for maintenance and to limit to the maximum extent practicable infiltration of water into the ground.

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[32]Paragraphs 6.2.4 to 6.2.6 are necessary for EPA to ensure adequate protection of human health and the environment from any potential risks posed by the buried thorium. The U.S. Nuclear Regulatory Commission (NRC) has commented to EPA that the possibility exists for NRC itself to exempt this Site from NRC's decommissioning regulations in 10 CFR Part 40.4. NRC would require a strong set of institutional controls to be in place before it would consider allowing the drums to remain at the Site.

6.4. Plant Areas Ground Water Physical Barrier Wall

DESCRIPTION: A physical barrier wall (an actual wall that limits migration of ground water to the maximum extent practicable) shall be constructed to extend from the ground surface to the base of the Columbia aquifer keying into the aquitard which separates the Columbia aquifer and the Potomac aquifer (see Figure 37 for the approximate wall location). Ground water shall be recovered on the chemical plant side of the wall to control any ground-water mounding that could affect building foundations and that could force contaminated ground water downward into the Potomac aquifer. Recovered ground water shall be treated prior to discharge.

PERFORMANCE STANDARDS:

6.4.1. A physical barrier wall (an actual wall that limits migration of ground water to the maximum extent practicable) shall be constructed to extend from the ground surface to the base of the Columbia aquifer keying into the aquitard which separates the Columbia aquifer and the Potomac aquifer (see Figure 37 for the approximate wall location). The design shall be such as to minimize the flow of Columbia ground water underneath the barrier wall. The approximate barrier location is shown in Figure 37. The exact location of the physical barrier wall shall be identified in the remedial design and subject to EPA approval. The west end shall connect to the barrier wall in the north landfill. The east end shall extend far enough around the CIBA-GEIGY plant to capture all of the Columbia and fill zone ground water that has come into contact with contaminated soil.

6.4.2. The barrier shall have a permeability of $1x10^{-7}$ cm/sec or less.

6.4.3. Different barrier wall technologies including deep soil mixing, sheet piles, geosynthetic membranes, and slurry walls shall be evaluated in the remedial design. Of the technologies that are implementable, the remedial design shall identify the technology considered to have the longest life. More than one technology may be necessary depending on the wall location. EPA will make the final decision about what barrier wall technology will be used.

6.4.4. Any unused piping found to cross the path of the barrier wall shall be plugged or removed to a distance to be identified in the remedial design, subject to EPA approval, that will keep a reservoir of potentially contaminated ground water from being formed adjacent to the barrier wall. Any used piping shall be inspected to make sure it is in proper working condition so that a seal can be formed between the pipe and the barrier wall that is of sufficient quality as to prevent a preferential flow path for the ground water from forming.

6.4.5. Ground-water recovery wells shall be installed in sufficient number to control any mounding effect created by the barrier wall. The wells shall draw the water table down to the maximum extent practicable without affecting the water table underneath the chemical plants in such a way as to cause structural problems to buildings or pavement. The wells shall be installed in accordance with appropriate State regulations.

6.4.6. All extracted ground water shall be treated and discharged to the Christina River (or if determined by EPA during the remedial design to be acceptable, the treated ground water may be discharged to a publicly owned treatment works-POTW). This treatment shall include removing all contaminants (including metals, organics, and, if necessary, radionucleides) necessary to meet all discharge requirements (especially compliance with the substantive requirements of a National Pollution Discharge Elimination System [NPDES] permit if discharging to the Christina River). If an air stripper or other vented system is used to treat the ground water, secondary controls may be necessary in order to comply with Federal and State air ARARs (see Table 12) and to ensure protectiveness of human health and the environment (for protection of human health, secondary emission controls shall be installed if the emissions from the air stripper cause a greater than $1x10^{-6}$ excess cancer risk). It is anticipated that the treatment sludges will be hazardous waste. Any treatment residues containing tetrachloroethylene shall be considered F002 waste. Disposal of any treatment sludges or other wastes shall be in accordance with appropriate Federal and State regulations (see Table 12).

6.5. **Health and Safety Plan for Subsurface Work**

DESCRIPTION: A special health and safety plan shall be used during any future subsurface work in the contaminated plant areas.

PERFORMANCE STANDARDS:

6.5.1. A health and safety plan to protect workers against exposure to contaminated soils shall be developed and complied with for all future subsurface work.

6.5.2. The health and safety plan shall include a waste management section. This section shall discuss procedures for testing any soil excavated post-remedial action to determine of it is a RCRA-hazardous waste. If so determined, the soil shall be handled and disposed of as such.

6.6. **Contaminated Plant Areas Cost**

DESCRIPTION: The estimated present worth cost of Alternative #5 is $11,000,000. See Table 19 for details of the cost including the capital cost and annual operations and maintenance costs.

7. GROUND WATER

7.1. **Public Water Supply Line**

DESCRIPTION: To mitigate potential future risks from ground water, the residences and businesses near the Site along Old Airport Road shall be placed on public water supply.

PERFORMANCE STANDARDS:

7.1.1. A public water supply line shall be installed along Old Airport Road as far as, and including, private well #16 of the RI, located at Cress Collision Service, Inc. (see Figure 40).

7.1.2. Residences and businesses between the Site and private well #16, including well #16 (approximately 7 wells) that desire to have public water shall be connected to a public water supply line.

7.1.3. Costs of public water usage shall be the responsibility of the appropriate residence or business.

7.1.4. Coordination shall take place with a local water supply company that services this area (that is in compliance with the Safe Drinking Water Act and its implementing regulations) to ensure that the public water supply line is properly installed.

7.1.5. The existing private wells at businesses or residences that are connected to the public water supply line shall be abandoned in accordance with State regulations.

7.2 **Ground-water Management Zone**

DESCRIPTION: Institutional controls including deed restrictions and a ground-water management zone in the area of the Site (see Figure 33 for the approximate area) shall be established to limit the future installation of drinking water wells.

PERFORMANCE STANDARDS:

7.2.1. The State shall establish and maintain a ground-water management zone in the area of the Site for as long as levels of contaminants remain that make the ground water unsafe to drink. No drinking water wells shall be permitted to be drilled in areas where the contaminant levels make the ground water unsafe to drink or where the pumping of the well threatens to spread the contamination.

7.3. **Long-term Monitoring of the Ground Water**

DESCRIPTION: Long-term monitoring of the Columbia and the Potomac aquifers shall take place to monitor the rate of contaminant migration and attenuation in the Columbia aquifer and the rate of contaminant migration and attenuation in the Potomac aquifer to the south.

PERFORMANCE STANDARDS:

7.3.1. A long-term monitoring plan for the Columbia and the Potomac aquifers shall be developed, submitted to EPA for approval, and implemented to monitor the rate of contaminant migration and attenuation in the Columbia aquifer (for the area outside of the waste management area as shown in Figure 32) and to monitor the rate of migration and attenuation of contaminants to the south in the Potomac aquifer.

7.3.2. This plan shall outline which wells are to be sampled (new wells may be necessary if the current ones are not in the right locations), type and frequency of analyses, and frequency of reporting. The reports shall include a discussion of the monitoring results. At a minimum, for the Columbia aquifer, the monitoring shall include sampling MW-21A, MW-23A, MW-24A, MW-25A, and MW-26A for metals twice per year. For the Potomac aquifer, the monitoring shall include sampling MW-6B, MW-18B, MW-21B, and MW-26BS for metals twice per year. If any of the Site-related contaminants migrates to any one of these wells at a level sufficient to produce a risk of either $1x10^{-6}$ for carcinogenic risks or 1 for non-carcinogenic risks, EPA, in consultation with DNREC, may require active remedial measures (such as restoration or containment of the ground water) beyond those described in this ROD at that time. The monitoring reports, including all of the appropriate information, shall be submitted to EPA for approval.

7.3.3. The monitoring plan shall also provide for wells in each aquifer in the waste management area to help monitor the effectiveness of the remedy in these areas.

7.3.4. Monitoring for thorium shall take place every six months by sampling monitoring wells MW-33, SM-1, SM-3, and SM-4 for thorium-232 and its daughter products and gross alpha and beta radiation. The detection limits shall be low enough to provide adequate data to determine if a release is occurring. Monitoring for thorium will stop if all of the thorium is ever removed from the north landfill.

7.4. **Ground-water Cost**

DESCRIPTION: The estimated present worth cost of Alternative #2 is $1,400,000. See Table 20 for details of the cost estimate including the capital cost and annual operations and maintenance costs.

8. OTHER MISCELLANEOUS PERFORMANCE STANDARDS

8.1. DESCRIPTION: Below are other performance standards that apply to several areas of the Site or the Site as a whole.

8.2. **Operations and Maintenance Plan**

DESCRIPTION: An operations and maintenance plan shall be developed and implemented for each portion of the remedy.

PERFORMANCE STANDARDS:

8.2.1. The plan shall include a list of all vendor-required maintenance activities.

8.2.2. The plan shall include a list of potential operations and maintenance problems and their proposed solution.

8.2.3. The plan shall include a list of all required inspections and general guidelines for the inspections.

8.2.4. The plan shall include operating instructions for the ground-water recovery and treatment system.

8.2.5. The plan shall include reporting requirements and forms.

8.2.6. The plan shall include health and safety requirements.

8.2.7. The plan shall include tasks to inspect, document, and repair any erosion problems along either the north or the south river bank.

8.2.8. The plan shall include tasks to inspect, document, and repair any pavement or other problems that contribute to the infiltration of water in the contaminated plant areas.

8.2.9. Performance standards 8.2.1 to 8.2.8 are the minimum requirements of the operation and maintenance plan. The plan, including all of the appropriate information shall be submitted to EPA for approval.

8.2.10. All requirements of the approved plan shall be carried out.

8.3. **Erosion Control Plan**

DESCRIPTION: An erosion control plan shall be developed and implemented.

PERFORMANCE STANDARDS:

8.3.1. An erosion control plan shall be developed and implemented which outlines procedures to be used to control transport of soil and sediment due to erosion, to the maximum extent practicable and in accordance with the ARARs in Table 12, for all activities which present the potential for transporting soils or sediments. This plan shall also include procedures to be used to properly discharge stormwater from the construction areas.

8.3.2. This plan shall be developed in accordance with any State and local regulations and shall be submitted to EPA for approval.

8.4. **Particulate Air Emissions**

DESCRIPTION: All remedial work shall be done in such a manner as to minimize transport of airborne particulate emissions.

PERFORMANCE STANDARDS:

8.4.1. As part of the remedial action health and safety plan, levels of particulate considered to pose an unacceptable health risk shall be developed along with monitoring requirements to measure particulate counts.

8.4.2. Air monitoring shall be done at appropriate times to ensure protectiveness of human health.

8.4.3. If the air monitoring results indicate that particulate counts are high enough that EPA concludes that

unacceptable health risks are posed to people on-site or off-site, appropriate measures shall be taken to reduce the particulate count to safe levels off-site, and either to reduce the particulate count to safe levels on-site or to protect the workers through personal protective equipment.

8.5. **Waste Management Plan**

DESCRIPTION: A waste management plan shall be developed to handle any other wastes generated during remedial design or remedial action for which waste management performance standards have not previously been set.

PERFORMANCE STANDARDS:

8.5.1. A waste management plan shall be developed, submitted to EPA for approval, and implemented to handle any other wastes generated during remedial design or remedial action that have not previously had waste management performance standards set. The plan shall outline how all Federal, State, and local regulations will be complied with.

8.6. **ARARs**

DESCRIPTION: The selected remedy shall meet all chemical, location, and action specific ARARs that apply to the remedy unless waived formally by EPA.

PERFORMANCE STANDARDS:

8.6.1. The selected remedy shall attain, at a minimum, all chemical, location, and action specific ARARs listed in Table 12 unless waived formally by EPA.

8.7. **Habitat Value Balance Sheet**

DESCRIPTION: A balance sheet shall be developed during remedial design to keep track of and compare current and future land use values.

PERFORMANCE STANDARDS:

8.7.1. A balance sheet shall be developed during remedial design which accounts for all current habitat land use values at the Site and accounts for all habitat land use values post-remedial action. This balance sheet may be used by EPA to help review the remedial design. The balance sheet shall also describe any temporary habitat losses caused by construction.

STATUTORY DETERMINATIONS

EPA's primary responsibility at Superfund sites is to undertake remedial actions that are protective of human health and the environment. In addition, Section 121 of CERCLA, 42 U.S.C. § 9621, establishes several other statutory requirements and preferences. These requirements specify that when complete, the selected remedial action for each site must comply with applicable or relevant and appropriate (ARARs) environmental standards established under federal and state environmental laws unless a statutory waiver is invoked. The selected remedy also must be cost effective and utilize treatment technologies or resource recovery technologies to the maximum extent practicable. Finally, the statute includes a preference for remedies that permanently and significantly reduce the volume, toxicity, or mobility of hazardous substances. The following sections discuss how the selected remedy for this site meets these statutory requirements.

PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT

The selected remedy provides overall protection of human health and the environment. It protects human health by:

1. Removing all soil from the ballpark containing greater than 500 ppm lead will eliminate the possibility of children being exposed to unacceptable levels of lead during recreational activities.

2. Capping the north landfill to prevent exposure to maintenance workers cutting grass from contaminated soils. Capping will eliminate risks posed by this pathway.

3. Instituting health and safety plans for all subsurface work in areas of contaminated soil at the Du Pont Holly Run/CIBA-GEIGY plants and at the south landfill. This will prevent unacceptable levels of exposure for work activities to contaminated soils in these areas.

4. Capping the south landfill and providing improved Site-security by modifications to the fencing and installation of thorny plants around the south landfill and south wetlands will prevent exposure to adolescent trespassers from contaminated soils. Capping and improving Site security will address risks posed by this pathway.

5. Paving the remaining areas of the CIBA-GEIGY plant and contaminated area of the Du Pont Holly Run plant to prevent exposure of maintenance workers cutting grass to contaminated soils. Paving will eliminate risks posed by this pathway.

6. Installing a public water supply line to residents and businesses along Old Airport Road to prevent any potential future exposure to contaminated ground water caused by plume migration to existing wells. Installing a water supply line will eliminate any potential risks posed by this pathway.

7. Establishing a ground water management zone to prevent any new wells from being drilled into the plume. Preventing installation of new drinking water wells will eliminate risks to potential future users posed by this pathway.

8. Excavating contaminated soils underneath and to the east of Basin Road or South James Street to prevent future exposure by construction workers to contaminated soils. Following excavation and backfilling with clean fill, this pathway will no longer pose unacceptable risks to off-site workers.

9. Capping the north landfill, paving the contaminated plant areas, installing a physical barrier wall along the river in the area of the CIBA-GEIGY plant and the north landfill, controlling the hydraulic head of the Columbia aquifer upgradient of the barrier wall, capping and *in-situ* stabilization of the south landfill, excavating the soil underneath and to the east of Basin Road will limit to the maximum extent practicable any continued release of contamination to the Columbia and Potomac aquifers and therefore minimize, to the extent practicable and possibly prevent, the spread of contaminants in these two aquifers. These parts of the selected remedy will help prevent the potential for exposure of humans to contaminated ground water.

The selected remedy will protect the environment by:

1. Removing sediments in the north wetlands (including the north drainage way), the south wetlands, and the Christina River that are above the Site-specific clean-up criteria and then backfilling the wetland areas with clean sediments to prevent exposure of aquatic life to levels of contamination that EPA has determined at this Site produce unacceptable risks to environmental receptors. There will be some residual risk to environmental receptors in the remediated areas because, for example, it will be impossible to prevent some contamination from the unremediated portions of the wetlands and river to migrate to the remediated areas. However, the risks will be greatly reduced.

2. Capping the north landfill, paving the contaminated plant areas, installing a physical barrier wall along the river in the area of the plants and the north landfill, controlling the hydraulic head of the Columbia aquifer upgradient of the barrier wall (through ground-water pumping and treating), capping and *in-situ* stabilization the south landfill, and excavating the soil

underneath and to the east of Basin Road. This will greatly decrease the loading of contaminants (mainly heavy metals) to the river and the wetlands thus limiting to the maximum extent practicable any continued build-up of contaminant levels in sediments in the river and wetlands, and should significantly improve (especially in the river) the surface water quality which currently exceeds AWQC or SWQSs.

3. Removing the berm in the south wetlands will help mitigate adverse impacts to the floodplain caused by the volume increase at the south landfill due to stabilization. This will also eliminate any erosion of surface soils to the south wetlands that are creating or could create an adverse impact to the wetlands. Using this area to create wetlands in compensation for wetlands lost due to other construction activities at the south landfill will greatly increase the habitat value of this section of the Site.

4. Installing thorny plants around the south landfill/south wetland area to decrease Site access by humans and yet allow migration of terrestrial animals which are known to inhabit to Site.

5. Invoking the "greater harm to human health and the environment" ARAR waiver for the ground water. In the Columbia aquifer, this will prevent potential adverse affects on the south wetlands caused by pumping the aquifer and removing the natural source of recharge to the south wetlands and potentially introducing contamination from the wetland sediments into the Columbia aquifer. In the Potomac aquifer, invoking the ARAR waiver will prevent more contamination from being introduced to the portion of the Potomac aquifer underneath the waste management area. It is believed that most of the contamination in the Potomac aquifer is due to the use of process water wells at the pigment plant drawing contamination down from the Columbia aquifer to the Potomac aquifer. Recovery wells screened in the Potomac aquifer to remediate the portion of the plume outside the waste management area would have the same impact as the process water wells on the portion of the plume in the Potomac aquifer underneath the waste management area.

6. Instituting long-term monitoring of both remediated and unremediated portions of the wetlands and the river and long-term monitoring of the muskrat population at the south pond. The monitoring of the wetlands and the river will ensure the selected remedy remains protective. The muskrat monitoring will help ensure that the decision not to remediate the south pond continues to be protective of the environment.

COMPLIANCE WITH APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

The selected remedy shall attain all action, location, and chemical specific applicable or relevant and appropriate requirements for the Site which are listed in Table 12. Also included in the table are criteria, advisories or guidance to be considered (TBCs) for implementation of this remedy.

Several of the ARARs in Table 12 merit further discussion. First, RCRA Subtitle C landfill closure regulations are not considered ARARs for the north or the south landfill. Since the south landfill was closed prior to the enactment of RCRA, RCRA landfill closure regulations are not applicable. Also, once the stabilization process is complete at the south landfill, the landfill will no longer contain material similar to a RCRA-hazardous waste and RCRA Subtitle C closure regulations would not be considered relevant. Similarly, the north landfill was closed prior to the enactment of RCRA, so RCRA landfill closure regulations are not applicable. The closure regulations are relevant since some of the waste in this landfill may fail the TCLP test. However, the closure regulations are not appropriate. The main technical parts of the closure regulations are that the cap must be less permeable than the bottom liner to prevent a bathtub effect and that the ground water must be monitored to determine if any contamination is migrating from the landfill. Since the north landfill has no bottom liner, meeting the closure regulations would only require a slightly impermeable cap. EPA has determined that only a slightly impermeable cap would not be protective, and that the requirements of this ROD (a low permeability cap) are required to be protective of human health and the environment. As for the ground-water monitoring, since the north landfill is adjacent to a river, since the Columbia aquifer is already contaminated, and since active ground-water remediation will not take place in this area, the monitoring requirements as described in 40 CFR 264.98 are not appropriate,[33] and therefore, the closure regulations are not appropriate.

Second, EPA has determined that for the overall protection of human health and the environment at this Site, compliance with the MCL and non-zero MCLG ground water ARARs must be waived.[34]

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[33]Ground water monitoring at the north landfill will take place to monitor for releases of thorium. Metals analyses will also be performed to monitor the levels of contamination but this will not be in accordance with 40 CFR 264.98.

[34]The "greater harm to human health and the environment" ARAR waiver also applies to the State of Delaware Regulations Governing Public Drinking Water (revised 3/11/91) Sections 22.2,

The ground water at the Site is a Class IIA aquifer (i.e., the aquifer system, both the Columbia and the Potomac, is a current source of drinking water). Therefore, the NCP states that EPA's objective would be to return the ground water to its beneficial use by considering MCLs or non-zero MCLGs as ARARs. However, the NCP does provide certain instances where ARARs may be waived. Sections 300.430(f)(1)(ii)(C)(*1-6*) of the NCP outline six different ARAR waivers, including the interim measure waiver, the equivalent standard of performance waiver, the greater risk to human health and the environment waiver, the technical impracticability waiver, the inconsistent application of state standards waiver, and the Fund-balancing waiver. The greater risk to human health and the environment waiver may be invoked when compliance with an ARAR will cause greater risk to human health and the environment than non-compliance.

EPA has concluded that the "greater risk to human health and the environment" waiver should be invoked in this case. Active remediation in the Potomac aquifer will cause the ground water upgradient of the hydraulic barrier (underneath the waste management area) to become more contaminated since the pumping will cause a reversal of the natural upward flow of the ground water into the Columbia aquifer and will pull more highly contaminated ground water down into the Potomac aquifer (which is how the Potomac aquifer originally became contaminated). EPA does not expect the contaminant plume in the Potomac aquifer to expand. To date, the plume has exhibited limited migration potential due most likely to anions in the natural ground water combining with the heavy metals and precipitating them out of solution. Also, the selected remedy for the other areas of the Site will greatly decrease, if not eliminate, contaminant migration from the Columbia aquifer to the Potomac aquifer (i.e., the source of contamination to the Potomac will be greatly reduced, if not actually eliminated).

Active remediation in the Columbia aquifer may cause the Columbia aquifer to become more contaminated because pumping may cause the wetland area to become a recharge area for ground water instead of a discharge area for ground water. If the Columbia ground water is recharged from the surface water in the wetlands, higher levels of contamination may be introduced into the ground water by the washing of contaminants from the sediments.[35] As

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22.3, 22.4, 22.6, and 22.10 and the Delaware Regulations Governing Hazardous Substance Cleanup (1/93), Section 9 for the Columbia and Potomac aquifers.

[35]The clean-up criteria for the sediments were set to protect aquatic life only since there was not expected to be any human exposure by direct contact to the sediments. However, sediment contaminant levels that are protective of aquatic life

with the Potomac aquifer, EPA does not expect the plume in the Columbia aquifer to spread since the sources will be controlled. Also, in the Columbia aquifer, ground water generally flows toward the Christina River, thus keeping the plume from expanding.

As a result, EPA has determined that compliance with MCL and non-zero MCLG ground water ARARs will cause a greater harm to human health and the environment than non-compliance and invokes the "greater harm to human health or the environment" ARAR waiver. If, however, EPA determines through monitoring that the migration rate in either the Columbia aquifer or the Potomac aquifer is larger or different than expected and that, if left uncontrolled, the plume would pose a greater threat to human health or the environment, appropriate remedial measures beyond those called for in this ROD may be called for at that time.

Third, State SWQSs have been waived in the north wetlands, the south wetlands, and the Christina River. In the river, Federal AWQC were also waived. For both the north wetlands and river, background sources of contaminants prevent Site remedial measures from attaining these ARARs requiring that EPA invoke the "technical impracticability" ARAR waiver. For the south wetlands, substantially more sediments would have to be dredged than appears necessary to protect the wetlands. Stripping the complete south wetland just to attain SWQSs would cause more harm than good, thus EPA is invoking the "greater risk to human health and the environment" ARAR waiver.

COST-EFFECTIVENESS

Of the alternatives that offer adequate protection of human health and the environment, the selected remedy is the least costly. It also meets all other requirements of CERCLA and affords overall effectiveness proportionate to the cost. Also, the net present worth of $47.7 million is much less expensive than the estimated cost of $750 million for complete removal of the contamination. For several areas of the Site, cost had little to do with the selection of the remedy for that area of the Site because only one alternative passed the threshold criteria of overall protection of human health and the environment and compliance of ARARs. However, there are several issues relating to the cost-effectiveness of the selected alternative which do merit further discussion.

In the north landfill area, two alternatives met the threshold criteria. The alternative that provided the greatest degree of overall protection to human health and the environment

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may, as potentially in this circumstance, not be protective of human health through ingestion of ground water.

also happened to be the less costly of the two alternatives by $400,000.

In the south landfill area, the stabilization and cap alternative is $7 million more expensive than the cap only alternative. However, since the waste material is in the water table (and will continue to be even after the localized ground-water mounding dissipates after capping), EPA determined the cost was worth the extra degree of protection of the environment because stabilization will limit to the maximum extent practicable the migration of heavy metals to the river and the south wetlands. Also, stabilization and capping meet the statutory preference for treatment as a principal element. EPA has selected the stabilization alternative that does not include the most costly cap.

In the Du Pont Holly Run and CIBA-GEIGY plant areas, the alternative involving the physical barrier wall along the river was selected over the circumscribing physical barrier wall because it will provide the same degree of protection of the environment and yet will cost $5 million less. In the Christina River, dredging was selected over capping. EPA has determined that since capping of the river sediments would permanently destroy an area of habitat (even though it would protect aquatic life from the contaminated sediments), the dredging alternative would still be the preferred alternative even if the additional costs to dredging associated with off-site disposal of the sediments (estimated at $8.5 million) is considered.

UTILIZATION OF PERMANENT SOLUTIONS AND ALTERNATIVE TREATMENT TECHNOLOGIES TO THE MAXIMUM EXTENT PRACTICABLE

Of those alternatives that are protective of human health and the environment, EPA has determined that the selected remedy provides the best tradeoff in terms of long-term effectiveness and permanence, reduction in toxicity, mobility, or volume achieved through treatment, short-term effectiveness, implementability, and cost, also considering the statutory preference for treatment as a principal element and considering State and community acceptance.

For the ballpark, the north landfill, the south wetlands, the Christina River, and the ground water, the threshold criteria of overall protection of human health and the environment dictated the choice of the selected remedy. For the south landfill, a greater degree of overall protection of the environment and reduction of mobility through treatment played a major role in the selection of stabilization and capping. For the Du Pont Holly Run and CIBA-GEIGY plant areas, short-term effectiveness, implementability, and cost dictated the decision to select the alternative with the physical barrier wall along the river instead of around the complete area of contamination.

Also, the local community had expressed concern about an alternative that would raise the water table in the town of Newport as would the alternative involving a circumscribing barrier wall.

As discussed in detail in the "Scope and Role of Remedial Action" section, the only permanent solution to the principal threats at the Site is complete removal of the north landfill, the south landfill, and the CIBA-GEIGY plant (including its destruction). This is not practical for several reasons. The major reason is the cost. An estimated $750 million (includes the cost of plant reconstruction) would be needed to perform a complete removal of the principal threats. The need to incur costs of this magnitude is not warranted based on the risks to human health and the environment since for both current and potential future conditions, engineering and institutional controls can provide the necessary protection of human health and the environment. Also, although the contamination could be removed it can not be destroyed.

The only portion of the Site where a permanent solution was employed that allows unlimited and unrestricted access is the ballpark. EPA has determined that this is the only portion of the Site for which a permanent solution is practical. EPA has also determined that there are not alternative treatment technologies or resource recovery options suitable for implementation at this Site. Therefore, the selected remedy utilizes permanent solutions and treatment technologies to the maximum extent practicable.

PREFERENCE FOR TREATMENT AS A PRINCIPAL ELEMENT

From the results of the RI/FS, EPA has determined that several areas of the Site are principal threats. These include the soil beneath the CIBA-GEIGY plant, the north and south landfills, and the sediments in the north drainage way (adjacent to the north landfill). The major contaminants of concern in these areas are metals. Stabilization is the best demonstrated available technology (and the only available technology for a site of this size) for the treatment of metals. *In-situ* and *ex-situ* stabilization are not practicable in the north landfill area[36] because of the debris that was buried there. For example, trash (glass, wood, paper, and cardboard), steel drums, concrete rubble, steel work, and artificial marble have been buried in the north landfill. There is little value in tearing down the CIBA-GEIGY plant in order to stabilize the soil

[36]The remediation of the north drainage way is included with the remediation of the north landfill since the north drainage way cuts through the landfill and then runs along the base of it.

underneath the plant since the north landfill and the CIBA-GEIGY plant are one large contiguous area of contamination.

After giving careful consideration to available technologies and Site characteristics, EPA has determined that treatment of the south landfill is practicable. However, for the CIBA-GEIGY plant, the north landfill, and the north drainage way sediments, EPA has determined that treatment is not practicable. Therefore, the statutory preference for treatment as a principal element has been satisfied with the selection of stabilization as part of the remedy at the south landfill.

DOCUMENTATION OF SIGNIFICANT CHANGES

The selected remedy described in this ROD contains a number of significant changes from EPA's preferred alternative in the Proposed Plan. The changes were made in response to comments on the Proposed Plan and consultations with the State of Delaware and other federal agencies including the Nuclear Regulatory Commission (NRC), US Fish and Wildlife Service (FWS) and the National Oceanic and Atmospheric Administration (NOAA). The changes are described below.

1. The cost of the dredging alternative for the Christina River was reduced by approximately $8,000,000. The cost estimate in the Proposed Plan was based on off-site disposal of the dredged material. The cost estimate in the ROD more accurately reflects the cost of the preferred alternative in the Proposed Plan and the selected remedy for the Christina River which calls for the preference of on-site disposal.

2. In response to a resident's concern that contaminants are transported during heavy rainfall from the south wetlands to the south side of Old Airport Road, an area south of Old Airport Road has been added to the area of the south wetlands from which sediment sampling will take place. This sampling may delineate areas requiring remediation (see Figure 38). EPA verified the resident's concern by observing evidence that surface water had flowed from the South wetlands over Old Airport Road after a period of heavy rainfall.

3. The public water supply along Old Airport Road will be installed only to Cress Collision Service, Inc. and not to the end of the road as originally intended. This change was the result a Du Pont comment that due to the extent of the source control at the south landfill, it is not necessary at this time to install the water line to the end of the road. (See comment G.2 in the Responsiveness Summary.)

4. The selected remedy does not include the river bank cover along the north river bank at the north landfill and the

CIBA-GEIGY plant. This is in response to a Department of the Interior comment which raised concerns about stripping the vegetation along the river bank. (See comment H.11 in the Responsiveness Summary.)

5. In order to allow continued use of a boat ramp on the south bank of the Christina River between South James Street and the current South landfill fence, the boat ramp area shall be excavated and backfilled with clean fill along with the rest of the south landfill that is located on the State of Delaware's property.

6. In response to comments by Du Pont and the Town of Newport regarding the circumscribing physical barrier wall, EPA's selected remedy now specifies that the physical barrier wall be installed along the Christina River only. (See comment F.1 in the Responsiveness Summary.)

7. The sediment clean-up criteria in the ROD reflect slight revisions from those presented in the Proposed Plan, mainly because DNREC raised concerns that the criteria in the Proposed Plan were not based on a large enough data base. EPA, NOAA, DNREC, and the FWS have had numerous discussions in an attempt to develop mutually agreeable sediment clean-up criteria.

The ROD contains clean-up criteria developed by EPA after thoroughly considering the concerns of DNREC, NOAA, FWS, and the comments of Du Pont. These criteria include sediment chemistry values (on a normalized to grain size basis) which are slightly below the values presented in the Proposed Plan. Sediments containing normalized contaminant levels above the criteria will be dredged. The criteria also include performing a small number of *Hyallela azteca* solid phase toxicity tests in each of the north wetlands, the south wetlands, the Christina River, and the south pond to make that sure the sediment chemistry values are protective. The values may be lowered, if necessary to protect the environment, based on the results of the added toxicity tests. The sediment clean-up criteria in the ROD have the support of EPA, FWS, and NOAA. The complete details of the development of the sediment clean-up criteria are contained in the Administrative Record for the Site. The "Third and Final Edition" of the "Memo To File: River & Wetland Remediation Goals (Sediment Clean-up Criteria), Du Pont-Newport Site, Third and Final Edition" (dated 7/9/93) is attached to this ROD.

8. The ROD contains specific language describing where the long-term ground-water monitoring is to take place and how the results are to be used in evaluating whether the ground-water ARAR waiver remains protective of human health and the environment.

9. Several ARAR waivers are included in the ROD that were not discussed in the Proposed Plan. These include waiving Delaware's SWQSs for the north and south wetlands and the Christina River for either "technical impracticability" (as in the case of the north wetlands and the river) or for "greater risk to human health and the environment" (as in the case of the south wetlands). Federal AWQC are also being waived for the Christina River by invoking the "technical impracticability" ARAR waiver. The waivers do not affect the remedy itself. The selected remedy for the north and south wetlands and the Christina River is essentially the same as EPA's preferred alternative in the Proposed Plan.

10. After discussions with the U.S. Nuclear Regulatory Commission and review of its regulations, the selected remedy now includes a task to locate and mark the location of the thorium drums buried in the north landfill.

11. After further review of the sediment clean-up criteria outlined in the Proposed Plan, mercury and copper have been removed from the Site-specific clean-up criteria for the sediments that is part of the ROD. EPA determined that the use of lead, cadmium, and zinc was enough to adequately delineate the areas of sediments in the wetlands and the river that require remediation.

12. In response to comments received from Du Pont and concerns of the State of Delaware, the cap on the south landfill in the ROD only has to meet RCRA Subtitle D requirements instead of being a low-permeability cap identical to that called for at the north landfill.

13. EPA's preferred alternative in the Proposed Plan for the south landfill called for access road improvements and erosion controls to be installed at the south berm. The selected remedy calls for the berm to be removed to mitigate impacts to the floodplain caused by the volume increase of the south landfill due to the consolidation, stabilization, and capping. Restoring this area to a wetland will help compensate for lost wetlands due to the capping of the south landfill.

TABLE 1

TYPICAL BACKGROUND METAL CONCENTRATIONS (RANGES IN MG/KG (PPM))

Metal	Dragun, 1988 (Typical)	Shacklette & Boergner, 1984 (Eastern, US Range)	Shacklette & Boergner, 1984 (North Delaware)
Antimony	0.6 - 10	< 1 - 8.8	< 1
Arsenic	0.1 - 40	< 0.1 - 73	0.1 - 2.6
Barium	100 - 3,500	10 - 1,500	500
Beryllium	0.1 - 40	< 1 - 7	< 1
Cadmium	0.1 - 7.0	--	--
Chromium	5.0 - 3,000	1 - 1,000	50
Cobalt	1.0 - 40	< 3.0 - 70	< 3 - 5
Copper	2.0 - 100	< 10 - 700	< 1 - 10
Lead	2.0 - 200	< 10 - 300	20
Manganese	100 - 4,000	< 2 - 7,000	< 2 - 150
Mercury	0.01 - 0.8	0.01 - 3.4	0.051
Nickel	5.0 - 1,000	< 5 - 700	7 - 10
Selenium	0.1 - 2.0	< 1.0 - 3.9	0.5
Silver	0.1 - 5.0	--	--
Thallium	--	--	--
Vanadium	20 - 500	< 7 - 300	30 - 500
Zinc	10 - 300	< 5 - 2,900	28

TABLE 2

NORTH DISPOSAL SITE
WASTE DISPOSAL INVENTORY
DU PONT-NEWPORT SITE

MATERIAL	*ESTIMATED QUANTITY*
• *Garbage*	*Several tons*
• *Trash (glass, wood, paper, cardboard)*	*100 tons*
• *Steel Drums*	*Several hundred tons*
• *Lever Packs*	*Several hundred tons*
• *Sand and dirt*	*Several thousand tons*
• *Concrete*	
• *Steel work*	
• *Asbestos*	*5 tons*
• *Light ballasts - PCB's/PBB's*	*2 tons*
• *Rubber - gasket material, tires from garage*	*A few tons*
• *Nylon shutters*	*2 tons*
• *Artificial marble - "Corian"*	*4 tons*
• *Acrylates and latex emulsions*	*Several hundred lbs.*
• *Quinacridone tars*	*1,000 tons*
• *Off-grade quality copper phthalocyanine pigment*	*100 tons*
• *Off-grade quality quinacridone pigment*	
• *Off-grade quality "Afflair" pigment*	*Estimate 10,000-15,000 lbs.*
• *Off-grade quality Chromium Dioxide "Mylar" recording tape*	*6 tons*
• *"Afflair" fines (30% mica) plus (70% TiO_2)*	*Estimated 100,000 lbs.*
• *Off-grade quality Chromium Dioxide floor sweeping and bags*	*2 tons*
• *Thoriated nickel*	*20 tons of combined waste*
• *Dirt contaminated with zinc ore*	*Several hundred tons*
• *Raw materials left in bag liners and drums and leaks from drums*	*Several hundred tons*
- *Quinacridone*	*A few tons*
- *Copper phthalocyanine*	*A few tons*
- *"Afflair"*	*A few tons*
- *Magnetic products*	*A few tons*

TABLE 3

EPA THRESHOLD VALUE GUIDELINES (TVGs) FOR SEDIMENT*

ARSENIC	*33 ppm*
CADMIUM	*31 ppm*
CHROMIUM	*25 ppm*
COPPER	*136 ppm*
LEAD	*132 ppm*
MERCURY	*0.8 ppm*
NICKEL	*20 ppm*
ZINC	*760 ppm*

OTHERS: BARIUM <20 (GREAT LAKES HARBOR SEDIMENT GUIDELINE)

ppm = parts per million

**EPA Threshold Value Guidelines, National Perspective on Sediment Quality (1985)*

TABLE 4
GROUNDWATER SAMPLING SUMMARY
PHASE I REMEDIAL INVESTIGATION
DUPONT-NEWPORT SITE

Well Number	August, 1987	December, 1987
SM-1	X	
SM-2	X	X
SM-3	X	X
SM-4	X	X
SM-5	X	X
DM-4	X	
DM-6	X	X
DMU-7	X	X
DML-7	X	X
DM-8	X	X
WW-11		X
WW-13		
MW-1A	X	X
MW-1B	X	X
MW-1C	X	X
MW-2A	X	X
MW-2B	X	X
MW-2C	X	X
MW-3A	X	X
MW-3B	X	X
MW-3C	X	X
MW-4A	X	X
MW-4B	X	X
MW-4C	X	X
MW-5A	X	X
MW-5B	X	X
MW-5C	X	X
MW-6A	X	X
MW-6B	X	X
MW-6C	X	X
MW-7A	X	X
MW-7B	X	X
MW-7C	X	X
MW-8	X	X
MW-9	X	X
MW-11	X	X
MW-13	X	X
MW-14	X	X
MW-15	X	X
Necastro A*		X
Necastro B*		X

*Residential well located on Old Airport Road proximal to Du Pont property.

Note: The August 1987 groundwater samples were analyzed for the complete Hazardous Substance List (HSL) parameters. The December 1987 groundwater samples were analyzed for HSL volatile organics; HSL base/neutral semi-volatile organics; barium, cadmium, chromium, copper, lead, nickel, zinc, arsenic, sodium, beryllium, silver and sulfate.

TABLE 5
GROUNDWATER SAMPLING SUMMARY: DUPONT-NEWPORT SITE
REMEDIAL INVESTIGATION: PHASE II & III

Well No.	PHASE II ANALYSES
ROUND 1 - NOVEMBER 1988	
MW-5A	Total Zn, Dissolved Zn
MW-5B	Total Zn, Dissolved Zn
MW-5C	Total Zn, Dissolved Zn
MW-11	Total Zn, Dissolved Zn
MW-13	Total Zn, Dissolved Zn
Upgradient Well	TCL Organics, TAL Metals, Dissolved Metal, Cyanide
MW-16A	TCL Volatiles, Total Metals, Dissolved Metals
MW-17A	TCL Volatiles, Total Metals, Dissolved Metals
MW-17B	TCL Volatiles, Total Metals, Dissolved Metals
MW-18A	TCL Volatiles, Total Metals, Dissolved Metals
MW-19A	TCL Volatiles, Total Metals, Dissolved Metals
MW-19B	TCL Volatiles, Total Metals, Dissolved Metals
ROUND 2 - DECEMBER 1988	
DM-6	Total Zn, Cd, Ba, Dissolved Zn, Cd, Ba
DM-8	Total Zn, Cd, Ba, Dissolved Zn, Cd, Ba
DML-7	Total Zn, Cd, Ba, Dissolved Zn, Cd, Ba
DMU-7	Total Zn, Cd, Ba, Dissolved Zn, Cd, Ba
MW-1A	Total Zn, Cd, Ba, Dissolved Zn, Cd, Ba
MW-1B	Total Zn, Cd, Ba, Dissolved Zn, Cd, Ba
MW-1C	Total Zn, Cd, Ba, Dissolved Zn, Cd, Ba
MW-2A	Total Zn, Cd, Ba, Dissolved Zn, Cd, Ba
MW-2B	Total Zn, Cd, Ba, Dissolved Zn, Cd, Ba
MW-2C	Total Zn, Cd, Ba, Dissolved Zn, Cd, Ba
MW-3A	Total Zn, Cd, Ba, Dissolved Zn, Cd, Ba
MW-3B	Total Zn, Cd, Ba, Dissolved Zn, Cd, Ba
MW-3C	Total Zn, Cd, Ba, Dissolved Zn, Cd, Ba
MW-4A	Total Zn, Cd, Ba, Dissolved Zn, Cd, Ba
MW-4B	Total Zn, Cd, Ba, Dissolved Zn, Cd, Ba
MW-4C	Total Zn, Cd, Ba, Dissolved Zn, Cd, Ba
MW-5A	Total Zn, Cd, Ba, Dissolved Zn, Cd, Ba
MW-5B	Total Zn, Cd, Ba, Dissolved Zn, Cd, Ba
MW-5C	Total Zn, Cd, Ba, Dissolved Zn, Cd, Ba
MW-6A	Total Zn, Cd, Ba, Dissolved Zn, Cd, Ba
MW-6B	Total Zn, Cd, Ba, Dissolved Zn, Cd, Ba
MW-6C	Total Zn, Cd, Ba, Dissolved Zn, Cd, Ba
MW-7A	Total Zn, Cd, Ba, Dissolved Zn, Cd, Ba
MW-7B	Total Zn, Cd, Ba, Dissolved Zn, Cd, Ba
MW-7C	Total Zn, Cd, Ba, Dissolved Zn, Cd, Ba
MW-8	Total Zn, Cd, Ba, Dissolved Zn, Cd, Ba
MW-9	Total Zn, Cd, Ba, Dissolved Zn, Cd, Ba
MW-11	Total Zn, Cd, Ba, Dissolved Zn, Cd, Ba
MW-13	Total Zn, Cd, Ba, Dissolved Zn, Cd, Ba
MW-14	Total Zn, Cd, Ba, Dissolved Zn, Cd, Ba
MW-15	Total Zn, Cd, Ba, Dissolved Zn, Cd, Ba
MW-16A	TCL Volatiles, TAL Total Dissolved Metals
MW-17A	TCL Volatiles, TAL Total Dissolved Metals
MW-17B	TCL Volatiles, TAL Total Dissolved Metals
MW-18A	TCL Volatiles, TAL Total Dissolved Metals
MW-18B	TCL Volatiles, TAL Total Dissolved Metals
MW-19A	TCL Volatiles, TAL Total Dissolved Metals
MW-19B	TCL Volatiles, TAL Total Dissolved Metals
Necastro A	Total Zn, Cd, Ba, Dissolved Zn, Cd, Ba
SM-4	Total Zn, Cd, Ba, Dissolved Zn, Cd, Ba
SM-5	Total Zn, Cd, Ba, Dissolved Zn, Cd, Ba
WW-13	Total Zn, Cd, Ba, Dissolved Zn, Cd, Ba

TABLE 5 (Continued)
PHASE III Analyses

Drilled prior to Phase III	Drilled as part of Phase III
MW-18B	MW-6A (A)
MW-18A	MW-29B
MW-14	MW-28B
MW-7C	MW-28A
MW-7B	MW-21B
MW-7A	MW-23A
MW-13	MW-24A
MW-7C	MW-25A
MW-6A(F)	MW-26BS
MW-6B	MW-26BD
MW-11	MW-21A
MW-5C	MW-2A(A)
MW-5B	MW-1A(A)
MW-5A	MW-36A
MW-19B	MW-29A(A)
MW-4C	MW-29A(F)
MW-3C	MW-37A
MW-3B	DM-8
DM-6	SM-5
MW-8	MW-32B
MW-9	MW-32A
DM-U7	MW-32F
DM-L7	MW-33C
MW-4B	MW-33A
MW-4A	MW-31A
MW-15	MW-31F
MW-16A	MW-38F
MW-19A	MW-39F
MW-17B	MW-30B
MW-17A	MW-30A
MW-2C	MW-30F
MW-2B	MW-28C
MW-2A(F)	MW-27A
SM-3	MW-26A
MW-1C	MW-20A
MW-1B	MW-20B
MW-1A(F)	MW-33B
MW-3A	MW-31B
SM-4	MW-34B
SM-2	MW-35C
	MW-35B
	MW-35A

Note: Pre-Phase III (drilled prior to Phase III) wells analyzed for TCL VOA; TAL Metals (Total/Dissolved) as part of Phase III; Phase III (drilled as part of Phase III) wells analyzed for TCL VOA, SVOA Pest/PCBs; TAL Metals (Total/Dissolved)

TABLE 6

MAXIMUM CONTAMINANT LEVELS (MCLs) &
MAXIMUM CONTAMINANT LEVELS GOALS (MCLGs)
FOR SITE-RELATED GROUND WATER CONTAMINANTS

INORGANICS	MCLG (ppb)	MCL (ppb)
ANTIMONY	6	6
ARSENIC	N/A	50
BARIUM	2000	2000
BERYLLIUM	4	4
CADMIUM	5	5
CHROMIUM (total)	100	100
LEAD (at tap)	0	N/A*
MERCURY (inorganic)	2	2
NICKEL	100	100
ORGANICS		
BENZENE	0	5
CARBON TETRACHLORIDE	0	5
CHLOROBENZENE	100	100
1,2-DICHLOROBENZENE	600	600
1,4-DICHLOROBENZENE	75	75
TETRACHLOROETHENE	0	5
TRICHLOROETHENE	0	5
VINYL CHLORIDE	0	2
RADIONUCLEIDES		
GROSS ALPHA ACTIVITY	0	15 piCu/l
RADIUM-228	0	5 piCu/l

*EPA currently uses 15 ppb as an "action level" that provides adequate protection to human health.

TABLE 7

DNREC SURFACE WATER QAULITY STANDARDS
FOR SITE-RELATED CONTAMINANTS

	CHRONIC (ppb)	ACUTE (ppb)
CADMIUM*	1.1	3.9
CHROMIUM (VI)**	11	16
COPPER*	12	18
LEAD*	3.2	82
MERCURY	0.012	2.4
NICKEL*	160	1400
ZINC*	110	120
ALUMINUM	87	750
IRON	1000	N/A

BARIUM: No water quality criteria are available according to the Hazardous Substance Data Base, 1992, the average background concentration is 43 ppb with a range of 2 to 340ppb

*Values are hardness dependent; value listed is based on 100 ppm as $CaCO_3$; measured valures in wetlands near the north and south landfills range from 104 to 183 ppm $CaCO_3$

**US EPA

TABLE 8
CHEMICALS POTENTIALLY CONTRIBUTING TO RISK BY MEDIA OF CONCERN
DU PONT-NEWPORT SITE

Parameter	SDS	CG	HRP	NDS	CRSW	BP	CR Seeps	*CFGW	*PFGW
Antimony		X		X		X	X		X
Barium	X	X	X	X	X	X	X	X	X
Benzo(a)anthracene				X					
Beryllium	X		X	X		X	X		X
bis(2-ethylhexyl)phthalate									X
Cadmium	X	X		X	X	X	X	X	X
Carbon Tetrachloride							X		X
4-Chloroaniline							X		
Chlorobenzene							X		
Chromium	X	X	X	X	X	X	X		X
Cobalt	X	X	X	X		X	X	X	X
Copper	X			X		X			
1,1-Dichloroethene							X		
Manganese	X	X	X	X	X	X	X	X	X
Mercury				X					
Nickel	X		X	X				X	X
Trichloroethene					X		X	X	X
Thalium		X							
Trichloroethene								X	X
Vanadium			X	X	X	X			
Vinyl Chloride							X		
Zinc	X	X		X	X	X	X	X	X

Notes: SDS - South Disposal Area Soils NDS - North Disposal Area Soils CR Seeps - Christina River Seepage
CG - CIBA-GEIGY Plant Soils CRSW - Christina River Surface Water CFGW - Columbia Formation Groundwater
HRP - Holly Run Plant Soils BP - Ballpark Soils PFGW - Potomac Formation Groundwater

** Only four Columbia Formation wells were screened by the concentration-toxicity screen. No other screening was done for the Columbia Formation wells. All the Potomac Formation wellls were screened by the concentration-toxicity screen.*

TABLE 9

AREA (YEARS)	RECEPTOR	EXPOSURE TIME (HOURS/DAY)	EXPOSURE FREQUENCY(DAY/YEAR)	EXPOSURE DURATION
Ballpark	Children (Ages 6-14)	4 Hrs/Days	39	9Years
North Landfill	Maintenance Worker	8		45
South Landfill	Maintenance Worker	8	2	45
	Construction Worker	8	80	2
	Trespasser (Adult)	4	48	30
	Trespasser (Adolescent) (Ages 14-23)	4	48	9
Christina River	Swimmer (Adult)	3	39	30
	Swimmer (Children)	3	39	9
	Non-swimmer (Adult)	3	39	30
	Non-swimmer (Children)	3	39	9
CIBA-GEIGY Plant	Maintenance Worker	8	6	45
	Construction Worker	8	80	2
Holly Run Plant	Maintenance Worker	8	56	45
Ground Water	Resident (Adult)	2 liters/Day	365	30

TABLE 10

AREA OF INTEREST	POTENTIAL RECEPTOR*	CARCINO-GENIC RISK	HAZARD INDEX WITHOUT LEAD	HAZARD INDEX WITH LEAD
Ballpark	Recreational (Child)**	$7.2X10^{-7}$	0.16	0.38
North Landfill & Holly Run	Maintenance Worker	$4.1X10^{-6}$	0.075	4.0
South Landfill	Maintenance Worker	$9.0x10^{-8}$	0.0027	0.93
	Construction Worker***	$2.8x10^{-7}$	0.70	3.0
	Trespasser (Adult)	$7.0x10^{-7}$	0.032	0.96
	Trespasser (Adolescent)	$4.9x10^{-7}$	0.074	1.9
Christina River	Recreational (Child)**	$9.1x10^{-6}$	0.039	
	Recreational (Adult)	$6.6x10^{-6}$	0.016	
CIBA-GEIGY Plant	Maintenance Worker	$1.4x10^{-5}$	0.068	20
	Construction Worker	$1.1x10^{-5}$	6.0	26
Ground water	Residential (Adult)***			
	Columbia Aquifer	$3.0X10^{-4}$	170	190
	Potomac Aquifer	$4.6X10^{-6}$	3.6	5.9

* Exposure routes for these receptors included inhalation, ingestion, and dermal contact as appropriate for each scenario.

** The total risk associated with the Site to a Child partaking in recreational activities is the sum of the risks associated with the ballpark and the river. For non-carcinogenic risks, the total Hazard Index is 0.42.

*** Potential future use only.

TABLE 11

EVALUATION CRITERIA

Overall Protection of Human Health and the Environment: Addresses whether the remedy provides adequate protection and describes how risks posed through each pathway are eliminated, reduced or controlled through treatment, engineering controls, or institutional controls.

Compliance with ARARs: Refers to whether a remedy will meet all Applicable or Relevant and Appropriate Requirements (ARARs) of Federal and State environmental statutes and/or provides grounds for invoking a waiver. It also addresses whether or not the remedy complies with advisories, criteria, and guidance that EPA and DNREC have agreed to follow.

Long-Term Effectiveness and Permanence: Refers to the magnitude of residual risk and the ability of a remedy to maintain reliable protection of human health and the environment over time once clean-up standards have been met.

Reduction of Toxicity, Mobility, or Volume Through Treatment: Relates to the anticipated performance of the treatment technologies with respect to these criteria.

Short-Term Effectiveness: Refers to the period of time needed to achieve protection, and any adverse impacts on human health and the environment that may be posed during the construction and implementation, until clean-up standards are achieved.

Implementability: The technical and administrative feasibility of a remedy, including the availability of materials and services needed to implement a particular option.

Cost: The following costs are evaluated: estimated capital, operation and maintenance, and present worth.

State Acceptance: Indicates whether, based on its review of the feasibility study and the Proposed Plan, the support agency concurs with or opposes the selected remedy.

Community Acceptance: Relates to the comments received from the public, including the Potentially Responsible Parties, during the public comment period for the Proposed Plan.

TABLE 12

APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARs) AND TO BE CONSIDERED MATERIAL (TBCs) DU PONT-NEWPORT SITE

ARAR or TBC	Legal Citation	ARAR Class	Requirement Synopsis	Applicability to Selected Remedy	Area of Concern
I. CHEMICAL SPECIFIC					
A. Water					
1. Safe Drinking Water Act	42 U.S.C. § 300f et seq.				
a. Maximum Contaminant Level Goals (MCLGs)	40 C.F.R § 141.50-51	Relevant and Appropriate	Non-enforceable health goals for public water supplies. The NCP requires that non-zero MCLGs shall be attained by remedial actions for ground water that is a current or potential source of drinking water, where the MCLGs are relevant and appropriate under the circumstances of the release.	The "greater harm to human health and the environment" ARAR waiver has been invoked for both the Potomac and Columbia aquifers.	GW
b. Maximum Contaminant Levels (MCLs)	40 C.F.R § 141.11-12	Relevant and Appropriate	Enforceable standards for public drinking water supply systems (with at least fifteen service connections or used by at least 25 persons). The NCP requires that MCLs, for those contaminants whose MCLG is zero, shall be attained by remedial actions for ground water that is a current or potential source of drinking water, where the MCLs are relevant and appropriate under the circumstances of the release.	The "greater harm to human health and the environment" ARAR waiver has been invoked for both the Potomac and Columbia aquifers.	GW
c. Maximum Contaminant Levels (MCLs)	40 C.F.R § 141.11-12	Applicable	Enforceable standards for public drinking water supply systems (with at least fifteen service connections rf used by at least 25 persons). MCLs apply to public water systems that provide piped water for human consumption.	Installation of public water supply line shall be done in such a way as to provide drinking water in compliance with these standards.	GW
2. Health Effects Assessment		To be Considered	Non-enforceable toxicity data for specific chemicals for use in public health assessments. Also "to be considered" are Carcinogenic Potency Factors and Reference Doses provided in the Superfund Public Health Evaluation Manual.	To be considered where remedial action addresses risk-based criteria or when setting clean-up standards for the protection of human health.	NL,SL, CG/HR, GW

ARAR or TBC	Legal Citation	ARAR Class	Requirement Synopsis	Applicability to Selected Remedy	Area of Concern
3. Interim Guidance on Establishing Soil Lead Cleanup Levels at Superfund Sites	EPA OSWER Directive #9355.4-02, dated 12/8/89	To Be Considered	To be considered when remedial action addresses soils that cause a threat to human health through direct contact, ingestion, or inhalation of lead.	To be considered when lead is present and remedial action addresses soils that cause a threat to human health through direct contact, ingestion, or inhalation.	BP,NL, SL, CG/HR
4. State of Delaware Regulations Governing Public Drinking Water Revised March 11, 1991	Sections 22.2, 22.3, 22.4, 22.6, 22.10	Relevant and Appropriate	Sets criteria for public drinking water supplies. These requirements are not directly applicable since ground water at the Site is used as a private dirnking water supply. However, under the circumstances of this Site, these requirements are relevant and appropritate.	The "greater harm to human health and the environment" ARAR waiver has been invoked for both the Potomac and Columbia aquifers.	GW
6. State of Delaware Regulations Governing Public Drinking Water Revised March 11, 1991	Sections 22.2, 22.3, 22.4, 22.6, 22.10	Applicable	Sets criteria for public drinking water supplies.	Installation of public water supply line shall be done in such a way as to provide drinking water in compliance with these standards.	GW
7. Delaware Comprehensive Water Resources Management Committee Reports, December 13, 1983		To Be Considered	The reports were adopted as policy by the DNREC Secretary. Among these reports is the Groundwater Quality Management Report, July 1983, which provided Delaware with a number of tools for dealing with ground-water contamination.	To be considered for ground-water monitoring.	GW
8. Clean Water Act	Clean Water Act, Section 303	Relevant and Appropriate	Water quality criteria set at levels to protect human health for water and fish ingestion and protection of aquatic life in streams, lakes, and rivers.	These standards have been waived for the surface water in the Christina River by invoking the "technical impracticability" ARAR waiver due to non-Site related upstream sources of contamination.	CR
9. Delaware Surface Water Quality Standards as amended, Feb. 26, 1993	Sections 3, 4, 5, 6, 8, 9, 10, 11.1, 11.2, 11.3, 11.4, 11.6, 12	Applicable	Criteria are provided to maintain surface water for streams, lakes, rivers, and standing water in wetlands of satisfactory quality consistent with public health and recreational purposes, the propagation and protection of fish and aquatic life, and other beneficial uses of water.	1. Any surface water discharge must meet these levels if more stringent than federal regulations. 2. These standards have been waived for the surface water in the north wetlands and the Christina River by invoking the "technical impracticability" ARAR waiver due to non-Site related upstream sources of contamination. These standards have been waived for the surface water in the south wetlands by invoking the "greater harm to human heatlh and the environment" ARAR waiver.	NL,SW, CR, CG/HR

ARAR or TBC	Legal Citation	ARAR Class	Requirement Synopsis	Applicability to Selected Remedy	Area of Concern
B. Air					
1. Clean Air Act	42 U.S.C § 7401				
a. National Emissions Standards for Hazardous Air Pollutants	40 C.F.R Part 61	Relevant and Appropriate	Standards promulgated for air emissions from specific source categories. Not applicable but may be relevant and appropriate for emissions from air strippers at Superfund sites.	Relevant and appropriate for potential releases of vinyl chloride and radionucleides resulting from ground-water treatment.	NL, CG/HR
2. Delaware Ambient Air Quality Standards	Title 7, Delaware Code, Ch 60, Regulation 3, Section 6003	Applicable	Establishes ambient air quality standards.	Applicable for potential releases from air stripping of ground water, excavation work, or other remedial actions.	ALL
C. Miscellaneous					
1. Standards for Protection Against Radiation	10 C.F.R. Part 20	Relevant and Appropriate	These standards are designed to limit radiation hazards caused by Nuclear Regulatory Commission-licensed activities. The general requirement is that every reasonable effort to maintain radiation exposures "as low as is reasonably achievable" be made. This regulation also describes specific radiation dose limits for the protection of workers and memebers of the public, radioactivity concentration limits for effluents, precautionary procedures, and waste diposal requirements.	Remediation must take place in such a way as to prevent over-exposure of radiation to workers or public. Discharges to air or water must meet specific concentration limits for radionucleides. Waste disposal must also meet any pertinent requirements.	NL, CG/HR
2. Delaware Radiation Control Regulations	Title 16, Delaware Code, 7405	Applicable	Establishes regulations for registration of facilities, licensing of materials, standards of protection, safety requirements, and notification requirements.	May be applicable for work at the north landfill and the ground water pump and treat system at this area.	NL, CG/HR
II. LOCATION SPECIFIC					
1. Coastal Zone Management Act of 1972; Coastal Zone Act Reauthorization Amendments of 1990	16 U.S.C. 1451 et seq. 15 C.F.R. Part 930	Applicable	Requires that Federal agencies conducting or supporting activities directly affecting the coastal zone, conduct or support those activities in a manner that is consistent with the approved appropriate State coastal zone management program. (See Delaware's Comprehensive Update and Routine Program Implementation, March 1993)	On-site remedial actions are required to be consistent, to the maximum extent practicable, with Delaware's coastal zone management program. EPA must notify Delaware of its determination that the actions are consistent to the maximum extent practicable.	NL,SL, SW,CR, CG/HR

ARAR or TBC	Legal Citation	ARAR Class	Requirement Synopsis	Applicability to Selected Remedy	Area of Concern
2. The Archaeological and Historical Preservation Act of 1974	16 U.S.C § 469	Applicable	Requirements relating to potential loss or destruction of significant scientific, historical, or archaeological data	Archeological and historical resources have not been identified to date. However, the installation of the physical barrier wall along the Christina River has the potential for disturbing archeological resources. Further action will be taken to identify resources and, if identified, action will be taken to mitigate any adverse effects on those resources that would result from construction. If resources happen to be identified in other areas (although no specific actions will be taken to find), action will be taken to mitigate any adverse effects on those resources that would result from implementation of the remedial action.	NL, CG/HR
3. Protection of Floodplains	40 C.F.R. Part 6, Appendix A	Applicable	Sets forth EPA policy for carrying out provisions of Executive Order 11988 (Floodplain Management) which requires actions to avoid adverse effects, minimize potential harm, and restore and preserve natural and beneficial values.	Applicable since much of the remedial action will take place within the 500-year floodplain. Due to the volume increase of the south landfill, the berm in the south wetlands will be removed to mitigate the loss of volume inside a floodplain.	ALL
4. Protection of Wetlands	40 C.F.R. Part 6, Appendix A	Applicable	Sets forth EPA policy for carrying out provisions of Executive Order 11990 (Protection of Wetlands) which requires actions to avoid adverse effects, minimize potential harm, and restore and preserve natural and beneficial values.	Applicable since the construction of the north and south landfill caps will affect wetlands.	NL,SL, SW
5. Delaware Coastal Zone Act, 7 Delaware Code Chapter 70; Coastal Zone Act Regulations, 6/9/93	7 Delaware Code Sections 7003, 7004	To Be Considered	Controls the location, extent, and type of industrial development in Delaware's coastal areas.	Will be considered for consistency since the remedial action involves substantial aquatic habitat and is located in Delaware's coastal area although not in the defined coastal zone of this statute.	ALL
6. Delaware Wetlands Regulations Revised June 29, 1984	Sections 1, 2, 7	Applicable	Requires activities that may adversely affect wetlands in Delaware to be permitted. Permits must be approved by the county or municipality having jurisdiction.	Any substative requirements shall be met since wetlands will be destroyed and replaced in the north drainage way; and dredged (or excavated) and restored in the north and south wetlands. Since all of the wetland or remediation is considered "on-site", no permit will be obtained.	NL,SL, SW

ARAR or TBC	Legal Citation	ARAR Class	Requirement Synopsis	Applicability to Selected Remedy	Area of Concern
7. Delaware Regulations Governing the Use of Subaqueous Lands, amended September 2, 1992	Sections 1, 3, 4	Applicable	Requires activities that affect public or private subaqueous lands in the State be permitted.	Any substantive requirements shall be met since the remediation involves dredging of the Christina River. However, no permit shall be obtained.	NL, SL,SW, CR
8. Delaware Executive Order 56 on Freshwater Wetlands (1988)		To Be Considered	General policy to minimize the adverse effects to freshwater wetlands.	To be considered for wetland remediation and restoration.	NL,SL, SW
9. Governor's Roundtable Report on Freshwater Wetlands (1989)		To Be Considered	General policy to minimize the adverse effects to freshwater wetlands.	To be considered for wetland remediation and restoration.	NL,SL, SW
10. Ground Water Protection Strategy of 1984	EPA 440/6-84-002	To be Considered	Identifies ground water quality to be achieved during remedial actions based on aquifer characteristics and use.	The EPA aquifer classification will be taken into consideration during design and implementation of the treatment remedy.	GW
III. ACTION SPECIFIC					
A. Miscellaneous					
1. Council on Environmental Quality	40 C.F.R. 1500.2(f)	Relevant and Appropriate	Requires use of all practicable means, consistent with the requirements of NEPA to restore and enhance the quality of the human environment and avoid or minimize any possibe adverse effects upon the quality of the human environment.	Institutional controls shall be added to the north and south landfill properties to make sure they remain wildlife habitat.	NL,SL
2. Delaware Regulations Governing Hazardous Substance Cleanup, 1/93	Section 9	Relevant and Appropriate	Establishes clean-up criteria for hazardous waste sites. Only criteria considered relevant and appropriate are for ground water and soil ($1x10^{-5}$; Hazard Index of 1; or natural background if higher).	1. Waived for ground water using the "greater harm to human health and the environment" waiver. 2. Applies to the determination of soil clean-up criteria at the Basin Road portion of the south landfill.	SL,GW
B. Water					
1. Clean Water Act (CWA); National Pollutant Discharge Elimination System Requirements	40 C.F.R. Part 122-125	Applicable	Enforceable standards for all discharges to waters of the United States.	Discharge limits shall be met for all on-site discharges to surface water including treated ground water and wastewater from dewatering dredge material. Only substantive requirements shall be met and no permit shall be obtained.	NL, CG/HR, CR

ARAR or TBC	Legal Citation	ARAR Class	Requirement Synopsis	Applicability to Selected Remedy	Area of Concern
2. General Pretreatment Regulations	40 C.F.R Part 403	Applicable	Standards for discharge to POTW.	Applicable should the extracted ground water, treated ground water, or wastewater from dredge material be discharged to a POTW.	NL, CG/HR, CR
3. Section 10 of the River and Harbors Act	33 U.S.C. Section 403 33 C.F.R. Part 320-330	Applicable	Permitting requirements for dredging.	The river dredging will comply to any substantive requirements, but no permit will be obtained.	CR
4. State of Delaware Regulations Governing the Construction of Water Wells, January 20, 1987	Sections 3, 4, 5, 6, 7, 8, 9, 10	Applicable	Contain requirements governing the location, design, installation, use, disinfection, modification, repair, and abandonment of all wells and associated pumping equipment.	Installation of any monitoring and recovery wells and the abandonment of wells shall meet all substantive requirements.	NL,SL, SW, CG/HR, GW
5. Delaware Water Quality Standards, as amended, February 26, 1993	Sections 3-6, 8-10, 11.1, 11.2, 11.3, 11.4, 11.6, 12	Applicable	Standards are established in order to regulate the discharge into state waters in order to maintain the integrity of the water.	Applicable should the ground-water treatment system involve discharge to surface water.	NL, CG/HR
6. Delaware River Basin Commission (DRBC) Water Quality	DRBC Ground Water Protected Area Regulation, No. 4, 6(f), 9, 10; Water Code of the Basin, Sections 2.20.4, 2.50.2	Applicable	Regulate restoration, enhancement, and preservation of waters in the Delaware River basin.	Applicable if remedial action involves discharge of >50,000 gallons/day average over any month or a withdrawal of ground water of 100,000 gallons/day or more average over any month.	NL, CG/HR
7. Delaware Regulations Governing the Allocation of Water March 1, 1987	Sections 1, 3, 5.05	Applicable	Contain information pertaining to water allocation permits and criteria for their approval.	May be applicable for the ground-water recovery system or the public water supply line. No permit required.	NL, CG/HR, GW
8. State of Delaware Groundwater Management Plan November 1, 1987		To Be Considered	Policy for ground-water management.	To be considered in setting the ground water management zone.	GW
9. Delaware Regulations Governing Control of Water Pollution, amended 6/23/83	Section 7, 8, 9, 10, 11, 12, 13	Applicable	Contain water quality regulations for the discharging into surface and ground water.	Applicable for potential discharge of treated ground water into surface water. Also applicable for stormwater runoff into the Christina River.	NL, SL, CG/HR

ARAR or TBC	Legal Citation	ARAR Class	Requirement Synopsis	Applicability to Selected Remedy	Area of Concern
10. State of Delaware Regulations Governing Public Drinking Water March 31, 1991	Sections 22.2, 22.3, 22.4, 22.6, 22.10	Applicable	Establishes requirements for public drinking water supplies.	Applicable for the establishment of public drinking water service to residents along Old Airport Road.	GW
C. Air					
1. Control of Air Emissions from Air Strippers at Superfund Ground Water Sites, June 15, 1989	EPA OSWER Directive 9355.0-28	To be Considered	Policy to guide the selection of controls for air strippers at groundwater sites according to the air quality status of the site's location (i.e., ozone attainment or non-attainment area).	To be considered in determining if air emissions controls are necessary for an air stripper because New Castle is in an ozone non-attainment area. Sources most in need of controls are those with emissions rates in excess of 3 lbs./hour or 15 lbs./day or a potential rate of 10 tons/year of total VOCs.	NL, CG/HR
2. Delaware Regulations Governing the Control of Air Pollution	Regulations Number 2, 19, 24	Applicable	Sets forth the requirement that a permit is necessary to operate an air stripper if emissions will exceed 2.5 lbs./day. Section 2 describes general conditions. Section 19 deals with odor. Section 24 deals with volatile organic compounds.	If emissions exceed 2.5 lbs./day then the substantive requirements of the regulation must be met. In addition, the emissions from the air stripper must meet the Ambient Air Quality Standards set forth in Regulation 3 of 7 Delaware Code, Chapter 60, Section 6003.	NL, CG/HR
E. Sediments/Solids					
1. Delaware Sediment and Stormwater Regulations January 23, 1991	Section 3, 6, 9, 10, 11, 15	Applicable	Establishes a statewide sediment and stormwater management program.	A stormwater and sediment management plan consistent with Delaware requirements must be approved by EPA only before construction disturbing over 5,000 square feet of land can begin.	NL,SL, SW,CR, CG/HR
F. Waste Handling and Disposal					
1. RCRA Subtitle D Landfill Regulations	40 C.F.R. 258.60(a)	Relevant and Appropriate	Closure requirements for RCRA subtitle D landfills.	Provides some technical requirements for the cap at the south landfill.	SL
2. Delaware Regulations Governing Solid Waste	Sections 2, 5, 6	Relevant and Appropriate	Establishes regulations to implement an improved solid waste management program.	Relevant and appropriate for the south landfill.	SL

ARAR or TBC	Legal Citation	ARAR Class	Requirement Synopsis	Applicability to Selected Remedy	Area of Concern
3. Delaware Regulations Governing Hazardous Waste	SEE BELOW F.5, F.7, F.9, F.11, F.13, F.15, F.17	SEE BELOW	Delaware Regulations Governing Hazardous Waste Part 261 define "hazardous waste". The regulations listed below apply to the handling of such hazardous waste.	SEE BELOW	SEE BELOW
4. Resource Conservation and Recovery Act of 1976; Hazardous and Solid Waste Amendments of 1984	SEE BELOW F.6, F.8, F.10, F.12, F.14, F.16, F.18 Federal regulations would not apply for those regulations which Delaware has the authority from EPA to administer.	SEE BELOW	Regulates the management of hazardous waste, to ensure the safe disposal of wastes, and to provide for resource recovery from the environment by controlling hazardous wastes "from cradle to grave."	SEE BELOW	SEE BELOW
5. Standards Applicable to Generators of Hazardous Waste	Delaware Regulations Governing Hazardous Waste, Part 262.10-58	Applicable	Establishes standards for generators of hazardous wastes including waste determination manifests and pre-transport requirements.	Applicable to operator(s) of the wastewater treatment plant if the wastes generated by the groundwater treatment system is a RCRA-hazardous waste.	NL, CG/HR
6. Standards Applicable to Generators of Hazardous Waste	EPA Regulations, 40 C.F.R Part 262.10-58	Applicable	Establishes standards for generators of hazardous wastes including waste determination manifests and pre-transport requirements.	Applicable to operator(s) of the wastewater treatment plant if the wastes generated by the groundwater treatment system is a RCRA-hazardous waste.	NL, CG/HR
7. Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities (TSDF)	Delaware Regulations Governing Hazardous Waste, Part 264 (40 C.F.R Part 264)	Applicable	Regulations for owners and operators of TSDFs which define acceptable management of hazardous wastes.	Applies to onsite recovery and treatment systems which handle hazardous waste	NL, CG/HR
8. Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities (TSDF)	EPA Regulations, 40 C.F.R Part 264	Applicable	Regulations for owners and operators of TSDFs which define acceptable management of hazardous wastes.	Applies to onsite recovery and treatment systems which handle hazardous waste	NL, CG/HR

ARAR or TBC	Legal Citation	ARAR Class	Requirement Synopsis	Applicability to Selected Remedy	Area of Concern
9. RCRA Requirements for Use and Management of Containers	Delaware Regulations Governing Hazardous Waste, Part 264.170-178	Applicable	Requirements for storage of hazardous waste in storage containers.	Applicable for temporary storage containers and on-site treatment systems.	NL,SL, SW, CG/HR, CR
10. RCRA Requirements for Use and Management of Containers	EPA Regulations, 40 C.F.R Part 264.170-178	Applicable	Requirements for storage of hazardous waste in storage containers.	Applicable for temporary storage containers and on-site treatment systems.	NL,SL, SW, CG/HR, CR
11. RCRA Requirements for Tanks Systems	Delaware Regulations Governing Hazardous Waste, Part 264.190-199	Applicable	Requirements for storage or treatment of hazardous waste in tank systems.	Only applicable for onsite treatment systems and temporary storage tanks containing hazardous wastes.	NL,SL, SW, CG/HR, CR
12. RCRA Requirements for Tanks Systems	EPA Regulations, 40 C.F.R Part 264.190-199	Applicable	Requirements for storage or treatment of hazardous waste in tank systems.	Only applicable for onsite treatment systems and temporary storage tanks containing hazardous wastes.	NL,SL, SW, CG/HR, CR
13. The Hazardous Waste Permit Program	Delaware Regulations Governing Hazardous Waste, Part 122	Applicable	Requires a permit for the treatment, storage, or disposal of any hazardous waste as identified or listed in Part 261.	Any substative requirements will be met. But no permit will be obtained	NL,SL, SW, CG/HR, CR
14. The Hazardous Waste Permit Program	EPA Regulations, 40 C.F.R. Part 122	Applicable	Requires a permit for the treatment, storage, or disposal of any hazardous waste as identified or listed in Part 261.	Any substative requirements will be met. But no permit will be obtained	NL,SL, SW, CG/HR, CR
15. Identification and Listing of Hazardous Wastes	Delaware Regulations Governing Hazardous Wastes, Part 261	Applicable	Identifies solid wastes which are regulated as hazardous wastes.	Use to determine which materials to be disposed of are hazardous wastes.	ALL
16. Identification and Listing of Hazardous Wastes	EPA Regulations, 40 C.F.R. Part 261	Applicable	Identifies solid wastes which are regulated as hazardous wastes.	Use to determine which materials to be disposed of are hazardous wastes.	ALL

ARAR or TBC	Legal Citation	ARAR Class	Requirement Synopsis	Applicability to Selected Remedy	Area of Concern
17. RCRA Land Disposal Restrictions	Delaware Regulation Governing Hazardous Waste, Part 268	Applicable	Restrictions on land disposal of hazardous wastes.	Applies to remedial actions in the south landfill, the south wetlands, and the Christina River only if any stabilization is done ex-situ and waste is hazardous. Applies to dirt from the ballpark if it is hazardous.	BP,NL, SL,SW, CR
18. RCRA Land Disposal Restrictions	EPA Regulations, 40 C.F.R. Part 268	Applicable	Restrictions on land disposal of hazardous wastes.	Applies to remedial actions in the south landfill, the south wetlands, and the Christina River only if any stabilization is done ex-situ and waste is hazardous. Applies to dirt from the ballpark if it is hazardous.	BP,NL, SL,SW, CR

TABLE 13

COST SUMMARY FOR
SELECTED REMEDY
E.I. DU PONT, NEWPORT SUPERFUND SITE
(BASED ON 1992 DOLLARS)

	CAPITAL COSTS	O&M COSTS[1]	TOTAL
Ballpark	10,000	-0-	10,000
North Landfill	3,947,000	8,153,000	12,100,000
South Landfill	14,007,000	266,000	14,300,000
South Wetlands	3,111,000	1,046,000	4,200,000
Christina River	4,012,000	677,000	4,700,000
CIBA-GEIGY & Du Pont Holly Run Plant	3,555,000	7,445,000	11,000,000
Ground Water	378,000	1,020,000	1,400,000

Operation & Maintenance Costs, net present worth at 5% discount rate for 30 years.

TABLE 14

REMEDIAL COSTS FOR THE BALLPARK
(Based on 1992 dollars)

TOTAL DIRECT COSTS (including sampling, excavation, site restoration)		5,200
Mobilization & Demobilization Health and Safety Engineering Costs	60% of DC	3,100
		8,300
Contingency (20%)		1,700
O&M		0
TOTAL PRESENT WORTH COSTS		$10,000

TABLE 15

REMEDIAL COSTS FOR THE NORTH LANDFILL
(based on 1992 dollars)

DIRECT COSTS:	
Landfill cover	913,000
Barrier wall	622,000
Ground-water pump and treat system	444,000
Wetlands remediation & restoration	354,000
Other	134,000
TOTAL DIRECT COSTS	$2,467,000
Mobilization & Demobilization Health & Safety Engineering Costs Wetlands Mitigation Plan 30% of DC	740,000
	$3,207,000
Wetlands Contaminant Delineation	71,000
	$3,278,000
Contingency (20%)	656,000
O&M (5% Discount Rate, 30 Years):	
Wells/Pumps, Cover, Misc., Treatment System	7,580,000
Long-Term Monitoring 93,000/Event, 12 Events	573,000
TOTAL PRESENT WORTH COSTS	$12,100,000

TABLE 16

REMEDIAL COSTS FOR THE SOUTH LANDFILL
(based on 1992 dollars)

DIRECT COSTS:	
Cover	800,000
Berm removal/site security	92,000
Excavation, backfill, pavement	1,342,000
Stabilization	6,748,000
TOTAL DIRECT COSTS	$8,982,000
Mobilization & demobilization Health & safety Engineering costs	
30% OF DC	2,695,000
	11,677,000
CONTENGINECY (20%)	2,335,000
	14,012,000
O&M (5% DISCOUNT RATE, 30 YEARS): COVER, ACCESS ROAD, FENCING 18,000/YEAR	266,000
TOTAL PRESENT WORTH COSTS	$14,300,000

TABLE 17

REMEDIAL COSTS FOR THE SOUTH WETLANDS
(based on 1992 dollars)

DIRECT COSTS:	
Site clearing & sediment removal	128,000
Stabilization & consolidation	947,000
Confirmatory testing	88,000
Restoration	464,000
Other	51,000
TOTAL DIRECT COSTS	$1,678,000
Mobilization & demobilization Health & safety Engineering costs Wetlands mitigation plan	
40% OF DC	672,000
	2,349,000
Wetland contaminant delineation	244,000
	2,593,000
Contingency (20%)	518,000
	3,111,000
O&M (5% DISCOUNT RATE, 30 YEARS):	
Maintenance	298,000
50,000 for five years 17,000 for next five years 3,000 for last twenty years	
Long-term monitoring	748,000
$103,000/event, 12 events 46,000/event, 3 events	
TOTAL PRESENT WORTH COSTS	$4,200,000

TABLE 18

REMEDIAL COSTS FOR THE CHRISTINA RIVER
(based on 1992 dollars)

DIRECT COSTS:	
Dredging	192,000
Sediment dewatering	892,000
Disposal at north landfill	375,000
Water treatment	10,000
TOTAL DIRECT COSTS:	$1,469,000
Mobilization & demobilization **Health & safety** **Engineering costs**	
40% OF DC	588,000
	2,057,000
River contaminant delineation	1,287,000
	3,344,000
CONTINGENCY (20%)	699,00
	4,012,000
O&M (5% DISCOUNT RATE, 30 YEARS):	
Long-term monitoring $110,000/event, 12 events	677,000
TOTAL PRESENT WORTH COSTS	$4,700,000

TABLE 19

REMEDIAL COSTS FOR THE CIBA-GEIGY AND
DU PONT HOLLY RUN PLANT AREA
(based on 1992 dollars)

DIRECT COSTS:	
Paving	26,000
Barrier wall	347,000
Ground water pump and treat	443,000
TOTAL DIRECT COSTS:	$816,000
Mobilization & demobilization Health & safety Engineering costs	
40% OF DC	326,000
	1,142,000
CONTINGENCY (20%)	229,000
CIBA-GEIGY plant modifications	2,200,000
	3,571,000
O&M (5% DISCOUNT RATE, 30 YEARS):	
Paving $1300/year	20,000
Riverbank cover $9,140/year	141,000
Well maintenance $22,000/year	336,000
Water treatment $452,000/year	6,948,000
TOTAL PRESENT WORTH COSTS	$11,000,000

TABLE 20

REMEDIAL COSTS FOR THE GROUND WATER
(based of 1992 dollars)

DIRECT COSTS:	
Potable water supplies	225,000
TOTAL DIRECT COSTS	$225,000
Mobilization & demobilization Health & safety Engineering costs	
40% OF DC	90,000
	315,000
CONTINGENCY (20%)	63,000
	378,000
O&M (5% DISCOUNT RATE, 30 YEARS)	
Long-term monitoring	1,020,000
TOTAL PRESENT WORTH COSTS:	$1,400,000