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July 29, 1988  
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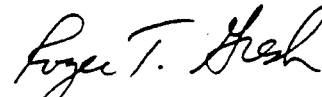
Re: RI/FS Work Plan  
Du Pont Newport Site

Dear Dr. Palmer:

Woodward-Clyde Consultants is pleased to submit four copies of the RI/FS Work Plan for the Du Pont Newport Site. This report encompasses the comments received from Du Pont and Region III of the U.S. Environmental Protection Agency.

Very truly yours,

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AR300852

**WORK PLAN**  
**REMEDIAL INVESTIGATION/FEASIBILITY STUDY**  
**DU PONT - NEWPORT SITE**  
**NEWPORT, DELAWARE**

**VOLUME I**

Prepared for:  
**E. I. DU PONT DE NEMOURS AND COMPANY**  
Wilmington, Delaware

Prepared by:  
**WOODWARD-CLYDE CONSULTANTS**  
Plymouth Meeting, Pennsylvania  
July 28, 1988

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**PROJECT OPERATION PLANS AND PROCEDURES**

**VOLUME IV**

**ATTACHMENT A - QUALITY ASSURANCE PROJECT PLAN (QAPP)**

**ATTACHMENT B - HEALTH AND SAFETY PLAN (HASP)**

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Du Pont - Newport RI/FS Work Plan

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**WORK PLAN**

**REMEDIAL INVESTIGATION/FEASIBILITY STUDY (RI/FS)  
DUPONT - NEWPORT SITE  
NEWPORT, DELAWARE**

**I. INTRODUCTION**

**PURPOSE**

This Work Plan is prepared in general accordance to the guidelines provided in the "U.S. EPA Guidance on Remedial Investigations Under CERCLA, May 1985", "U.S. EPA Guidance on Feasibility Studies Under CERCLA, April 1985" and reflects the emphasis and provisions of the Superfund Amendments and Reauthorization Act of 1986.

The purpose of this Remedial Investigation/Feasibility Study (RI/FS) Work Plan is to present the findings of the previous Remedial Investigations (Phase I), to revise the "Proposed Work Plan for RI/FS dated July 20, 1987", to define the technical approach, relevant project management activities, plans and schedules in order to address the objectives Remedial Investigation (RI) and Feasibility Study (FS) contained in the Consent Order.

This Work Plan consists of two major sections:

- o Description of Work Plan Tasks, and
- o Project Operations Plans and Procedures

The Work Plan Tasks required for completion of the RI and FS are grouped into seven consecutively numbered tasks consistent with the Work Plan objectives described in the Consent Order. Table I-1 presents a list of these tasks for the complete RI/FS. The Project Plans and Procedures are presented in Attachments A and B which include the Quality Assurance Project Plan (QAPP) and Health And Safety Plan (HASP). Data Management Procedures are outlined in Section 8.0 of the Work Plan.

28 July 1988

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**TABLE I-1**

**RI/FS WORK PLAN TASKS AND  
PROJECT OPERATION PLANS AND PROCEDURES**

**WORK PLAN TASKS**

**Remedial Investigation (RI):**

- Task 1 - Description of Current Situation
- Task 2 - Site Investigation
- Task 3 - Site Investigation Analysis
- Task 4 - Remedial Investigation (RI) Reports

**Feasibility Study (FS):**

- Task 5 - Remedial Alternatives Screening
- Task 6 - Remedial Alternatives Evaluation
- Task 7 - Feasibility Study (FS) Report

**Administrative**

- Task 8 - Data Management
- Task 9 - Schedule, Reporting, Document Control and Project Management

**PROJECT OPERATION PLANS AND PROCEDURES**

- Attachment A - Quality Assurance Project Plan (QAPP)
- Attachment B - Health And Safety Plan (HASP)

Of the heavy metals, aluminum and iron were consistently found at the highest concentrations. Mean concentrations of aluminum ranged from a minimum at downstream Station 3 of 13.69 ppm to a maximum of 20.69 ppm at Station 2. Similarly, mean concentrations of iron ranged from a minimum concentration of 21.4 ppm at downstream Station 3 to 37.26 ppm at upstream Station 1. Metals which occurred at levels on the order of 1 to 6 ppm at least once included barium, calcium, magnesium, manganese, potassium, and zinc. Metals which occurred at levels less than 1 ppm, and generally less than 0.1 ppm, included arsenic, beryllium, cadmium, chromium, cobalt, copper, lead, mercury, nickel, selenium, and sodium.

#### **1.2.2.9 WETLANDS DATA**

Field reconnaissance was conducted in December, 1987 by a WCC wetlands biologist at the Newport Site to evaluate the vegetation, surface soils, and characteristics of the wetlands along the south side of the Christina River (see Appendix K).

#### **Hydrology**

The hydrology of the investigated area is somewhat complicated by several previous alterations to natural drainage patterns. These include ditching, diking (the "berm"), and the installation of a tide gate at the point of discharge to the Christina River. This gate allows surface water from the wetland area to flow outward to the river through a discharge pipe at low tide, but is designed to prevent the inflow of river water when the tide level rises - sealing a flap valve on the outflow of the pipe. However, this valve no longer functions properly and inward leakage occurs as water pressure builds on the outflow side. A localized increase in water elevation inside the gate was noted in response to this inward leakage.

As indicated above, this area has also been subject to previous ditching and diking - both of which have altered it's hydrology. Because the history of this diking (berm) is

## II. REMEDIAL INVESTIGATION (RI)

The objectives of this RI, as outlined in the Consent Order, are to:

- o Determine if groundwater or surface water contamination related to the site has occurred on-site or off-site and the quality, concentration, and vertical and horizontal extent of contaminant flow, if any;
- o Identify any contaminated soil and/or sediment that may be present on the Site;
- o Determine if atmospheric air contamination related to the site has occurred on-site and the quality, concentration, and vertical and horizontal extent of air contamination, if any;
- o Define the physical site features that could affect potential contaminant migration, containment or remediation;
- o Quantify the potential risk to public health and the environment from the Site; and
- o Gather information necessary to support the Feasibility Study.

**1.0 TASK 1 - DESCRIPTION OF CURRENT SITUATION****1.1 SITE BACKGROUND****1.1.1 SITE LOCATION**

The Du Pont Newport Site is located within the property boundaries of the Holly Run (or Newport) Plant of E.I. du Pont de Nemours and Company in Newport, Delaware (Figure 1-1). The Site consists of two separate areas separated by the Christina River, which flows through New Castle County, Delaware, to the Delaware River. The northern portion of the Site, which is located north of the Christina River, is a seven acre parcel bounded on the north by the Du Pont and Ciba-Geigy plants and on its south side by the Christina River. The southern portion of the Site is a fifteen acre parcel bounded by the Christina River on the northwest. The former is referred to herein as the "North Disposal site," and the latter is referred as the "South Disposal site" (Figure 1-2).

The land to the north of the Holly Run and Newport Plants is primarily residential. The majority of the remaining adjacent property is low-lying land associated with the Christina River marshes. To the southwest is a sizeable expanse of marshland covered by auto junkyards and rimmed by a residential/commercial strip along Old Airport Road.

**1.1.2 SITE HISTORY**

The Newport Plant is a pigment manufacturing plant now owned by Ciba-Geigy located at James and Water Street in Newport, Delaware. The plant was originally owned and operated (from 1902 to 1929) by Henrik J. Krebs for the manufacture of Lithopone, a white inorganic pigment. In 1929, Du Pont purchased the plant and continued to manufacture Lithopone along with other materials, including organic and inorganic pigments. The pigment

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manufacturing operations were purchased by Ciba-Geigy in 1984, while chromium dioxide magnetic recording tape operations have been retained by Du Pont at their Holly Run Plant.

During plant operations, areas of the Site bordering the Christina River were landfilled as a means of waste disposal. Landfilling occurred in both the North Disposal site and the South Disposal site. The North Disposal site was used for disposal of general refuse and process wastes from the early 1902 until 1974. The North Disposal site received a variety of material, including plant debris such as off-spec product Corian (imitation marble) counters, empty steel drums, metal alloys, liquid wastes, and pigment muds. A detailed listing of likely waste composition is provided in Section 1.2.1. After disposal ceased in 1974, the North Site was capped with approximately two feet of clay.

The South Disposal site was operated from approximately 1902 to 1953. Materials deposited in this landfill consisted of primarily insoluble residues of zinc and barites ores, which were pumped as a slurry through a pipeline under the Christina River. Some dikes and berms were constructed to contain the material. In 1973, the State of Delaware Department of Highways, deposited approximately 130,000 cubic yards of additional soil for highway construction at this location, covering the South Disposal site with an average three feet of variable soil.

### 1.1.3 ENVIRONMENTAL SETTING OF THE SITE

The Newport Site is located adjacent to the north and south banks of the Christina River. Except in the landfilled disposal areas, the land adjacent to the river bank is mostly comprised of wetlands. The Christina River at this location demonstrated a tidal range of about 5 feet during a month of monitoring in June - August, 1987.

The North Disposal site is primarily covered with maintained grass and rimmed with pine trees and other heavy vegetation. A drainage ditch surrounds the landfill, emptying

into the Christina River west of the landfill. Except in areas sloping toward the drainage ditch, the surface elevation for most of the North Disposal site is at an elevation of 20 to 25 feet and at least 10 feet above the shallow water table.

The South Disposal site constitutes 15 acres of a 45-acre tract of land owned by Du Pont on the south side of the Christina River. This 45-acre tract of land is characterized by three distinct environmental conditions. The northern one-third of the tract is the South Disposal site, which is currently moderately to heavily vegetated. The previous landfilling operations resulted in grade elevations ranging from a high of about elevation 30 at the extreme northern corner to about elevation 2 at the southern end of the landfilled area. There is a gentle gradient, north to south, but with a steepening slope near the southern edge of the filled area (Figure 1-3).

The second significant topographic feature on the Du Pont property south of the Christina River is an existing dike that traverses the center of the tract in an east-west direction, curving in a northerly direction at the eastern and western boundaries of the Site. This dike has steep side slopes and an approximately 25-foot wide crest with a typical elevation of about 12 to 13 feet above mean sea level. A breach exists in the dike near its southwestern corner. As shown on Figure 1-3, there is a triangular wedge of lowlands (wetlands) and a small surface water pond that exists between the dike and the South Disposal site. The water in the ponded area is reportedly tidal in response to the adjacent Christina River.

The remaining southern portion of the 45-acre tract (approximately 40 percent) is relatively unaltered lowlands which have been designated by the U.S. Fish and Wildlife Service as "wetlands" (see Section 1.1.6.9). A series of ditches have been cut throughout this wetlands area, as shown on Figure 1-3. The water from the ditch system flows to the Christina River via a tide gate located just west of the northern property boundary with the Christina River. This tide gate is designed to allow surface water to flow from these

wetlands at low tide, but to prevent inflow of river water when the tide level rises by sealing a flap valve on the outflow side of the tide gate pipe. A detailed description of the wetlands area is included in Section 1.2.2.9.

#### **1.1.4 SITE GEOLOGY AND HYDROLOGY**

##### **1.1.4.1 PHYSIOGRAPHY**

The Newport Site is located within the Atlantic Coastal Plain Province, proximal to the Appalachian Piedmont Province (Figure 1-4). The Coastal Plain is a relatively flat and low area with elevations not exceeding 100 feet above mean sea level. The area adjacent to the Delaware Bay (see Figure 1-1) is exposed to tidal flooding and is characterized by conspicuous marshes and estuaries. Most of the streams in this zone, including the Christina River, are tidal or have at least a tidal segment. Stream valleys are shallow compared with those of the Piedmont Province to the north.

The Piedmont Province is an area of diversified relief dissected by narrow deep stream valleys with residual high areas rising above the general upland level. It is composed of folded Paleozoic and Precambrian metamorphic and igneous rocks consisting predominantly of banded gneiss and schist. The surface of these crystalline rocks of the Piedmont Province slopes southward and southeastward forming the basement under the wedge-shaped mass of sedimentary rocks of the Coastal Plain.

The Piedmont and Coastal Plain Provinces are separated by the Fall Zone (Figure 1-4), which divides the area of predominant erosion (Piedmont Province) from the area of predominant deposition (Coastal Plain Province). The Piedmont streams are characterized by relatively steep gradients and, therefore, most of their sediment load is transported out into the Coastal Plain and only a minor part is deposited in their channels and flood plains. The gradients of the Coastal Plain streams draining into Delaware Bay, however, are very

gentle and a large part of their sediment load is deposited before reaching the bay. The process of deposition is particularly effective in the tidal marsh area along the bay or its tributaries.

#### **1.1.4.2 STRATIGRAPHY**

The wedge-shaped mass of sedimentary deposits comprising the Coastal Plain in the Newport area consists of the Pleistocene Columbia Formation and the Cretaceous Potomac Formation (Figure 1-5).

**Columbia Formation** - The Pleistocene (Quaternary) sediments of the Columbia Formation were deposited on the eroded surface of the underlying Potomac Formation sediments in the area. This Formation includes gravelly coarse and medium sands with some interbedded silts and clays. The sands are moderately to poorly sorted, cross-bedded, yellow to brownish-yellow in color, and contain on the average about 5 percent clay and silty matrix. Fine sediments are abundant locally and gravels are subordinate. The Columbia Formation sediments were deposited in stream channels, flood plains, and associated environments.

In northern New Castle County, the Columbia Formation is generally thin, having an average thickness of about 30 feet, except in paleochannels where the maximum known thickness is about 105 feet. The Columbia Formation thickens to the south and reaches a maximum thickness in excess of 150 feet. In the Newport area, the reported thickness range of Columbia Formation sediments is 0 to in excess of 20 feet (Ref. 1).

**Potomac Formation** - The Potomac Formation consists of a southeastward thickening wedge of sand, silt, and clay beds that were deposited on crystalline bedrock by ancient streams as floodplain, channel, bar deposits, and, perhaps, by alluvial fans (Figure 1-5). This Formation and its stratigraphic equivalents extend from Long Island southward to

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the mid-Atlantic States. Within the area of interest, the Potomac sediments comprise more than 50 percent of the total sequence of the Coastal Plain sediments. The sand bodies are characterized by shoestring form, are discontinuous and, thus, individual sand beds are difficult to correlate laterally. The Potomac Formation thickens to the southeast and sandy units tend to occur mostly in the lower half of the Formation.

The Potomac Formation typically is divided into an upper and lower sandy unit, separated by a clay and silt unit. The thickness of the upper sandy unit may include thin interbedded clays or silts and is measured from the first Potomac Formation sand lying beneath the Columbia Formation downward to the top of a mappable clay unit. Well sorted, fine to medium sands generally make up the sandy section of the upper part of the Formation, but sands may locally be coarser in channels. The upper sandy unit is in direct contact with the overlying sediments of the Columbia Formation from the Greater Wilmington Airport area northward to the Christina River (Figure 1-5), but the unit apparently does not extend beneath the Christina River (Ref. 2). The clay underlying the upper sandy interval occupies about the middle one-third of the Potomac Formation and hydrologically separates the upper sands from the lower sandy unit (Ref. 2).

By comparison, the lower sandy zone of the Potomac Formation extends farther north than the upper sandy zone and underlies Columbia Formation sediments in the entire area surrounding the Newport Site until it pinches out farther to the north. The lower part of the Potomac Formation is typically described as variegated red, gray, purple, yellow, and white, frequently lignitic, silt and clays containing interbedded white, gray, and rust-brown coarse sands and some gravel (Ref. 1). The relative positions of these various stratigraphic units are shown schematically in Figure 1-5.

#### 1.1.4.3 HYDROGEOLOGY

Sand units of the Potomac Formation or its correlatives are important aquifers throughout the Eastern United States. In Delaware, the upper and lower sand units of the Potomac Formation provide significant quantities of potable water. Locally, the surficial Columbia Formation provides potable water, particularly to non-community systems and residential users. Within the Newport area, Woodruff (1981, 1984, 1985) and Petty et al. (1983) reviewed geologic, structural, and hydrologic data (Ref. 3, 4, 2, and 5). Their reports relied, in part, on previous reports of groundwater hydrogeology (Ref. 6 and 7). The regional hydrogeology of this area as described in these reports is synthesized briefly in the following paragraphs.

As a surficial, unconfined aquifer the Columbia Formation is recharged by infiltration from precipitation and can be an important aquifer where it is relatively thick or it contains sand or gravel units. In addition, as a hydrologic unit, the Columbia Formation serves to recharge lower aquifers. This may be true in areas where the Columbia Formation is in contact with sand units of the upper Potomac Formation and where the vertical gradients are downward. In areas where the vertical gradient from the underlying Potomac Formation to the Columbia Formation is upward, no such recharge would be anticipated.

The sand members of the Potomac Formation are the major aquifers in the Coastal Plain of Delaware. The sand members are separated from each other by the middle clays and silts which act to retard vertical leakage from one member to another. Recharge of the upper sand units in the Potomac Formation are by vertical leakage from the overlying Columbia Formation. The upper sand member of the Potomac Formation was not encountered at the Newport Site and is considered to pinch out a few miles southeast of the Site. The lower Potomac Formation sand member is recharged near its outcrop area east of the Fall Zone (Figure 1-4) and by vertical leakage through the overlying clay beds when the vertical gradients are downward and allow for recharge. Regional hydrologic analyses by Woodruff

(1985) and Petty et al. (1983) show that the valley of the Christina River, at Newport, is an area of groundwater discharge or upward flow from the lower Potomac Formation into the river and marshy areas of the Christina River valley (Ref. 2 and 5). Groundwater from the Columbia Formation would not be expected to infiltrate into the Potomac Formation aquifer in an area of groundwater discharge.

#### **1.1.4.4 SITE HYDROSTRATIGRAPHY**

Seven test borings were drilled by WCC during June and July, 1987 (Figure 1-6). The borings were geologically logged by WCC geologists based on split-spoon soil samples collected at five foot centers in advance of the boring (see Appendix A). In addition, each borehole was logged upon completion using geophysical methods. These geophysical logs were used, along with visual examination of the soil samples, to define five hydrostratigraphic units (Table 1-1). Complete details on the hydrogeology of the Site are provided in Appendix B.

Although the hydrostratigraphic units appear in all boreholes examined, the units frequently vary markedly in color and lithology. The lithology varies from thin bedded clays of apparent kaolinitic nature, to clayey silts, fine to coarse sands, gravels and cobbles. All of the sediments contain clay and only a few zones of limited thickness (usually less than 15 feet) appear to yield much water.

Due to the similarity of the lithologic sequences overlying the bedrock at the Site, the division of sediments into hydrostratigraphic units was subjective. The units were grouped according to stratigraphic characteristics and then were compared to downhole geophysical logs for confirmation. (Refer to Appendices A, B, and C for more detailed analyses.)

The hydrostratigraphic units identified in the study area differ in clay content and appear to define water-bearing units and semi-confining units (aquitards). These units are correlatable across the Site and appear to be correlatable to the regional stratigraphy discussed in Section 1.1.4.2 (refer to Figure 1-5). Unit I (Shallow Zone) is correlated with the Columbia Formation. Unit II (Semi-confining Unit) probably is equivalent to the silty clay unit discussed by Woodruff (1985) that separates the upper and lower sand members of the Potomac Formation; the upper sand member is not present at the Site (Ref. 2). Units III<sub>A</sub> (Intermediate Zone), III<sub>B</sub>, and IV (Deep Zone) are correlated with the lower Potomac Formation clayey sands (Figure 1-5). In summary, water-bearing units at the Site include Unit I (= Columbia Formation), Unit III<sub>A</sub> (= top part of the lower Potomac Formation sand member), and Unit IV (= bottom part of the lower Potomac Formation sand member), as discussed by Woodruff (Ref. 2). The confining beds (aquitards) include Unit II (= part of the middle Potomac Formation clays and silts) and Unit III<sub>B</sub> (= silty middle part of the lower Potomac Formation sand member) and Unit V (= decomposed bedrock).

Two topographic profiles and geologic cross-sections (Figure 1-8) to facilitate stratigraphic interpretation and hydrologic analysis are presented in Figures 1-9 and 1-10. The cross-sections are shown as straight lines and data from nearby borings and wells were projected into the profiles. Consequently, the topography along the cross-sections does not coincide with the top of well elevations at some well locations. The screened intervals of all of the previously existing active wells (Table 1-2) and the WCC installed wells (Table 1-3) are shown on the two cross-sections. Cross-section A-A' was drawn south of the North Disposal site and extends southeastward, approximately in the dip direction, through MW-6B to Old Airport Road (Figure 1-8). The section extends through part of the extensive auto salvage yards located south of the Christina River, west of the Du Pont property, and northwestward of Old Airport Road. Cross-Section B-B' extends from the MW-1 cluster to the MW-7 cluster through the North and South Disposal sites. The units are similar in character and thickness to those shown in cross-section A-A'. The data suggest that the units, as defined, are continuous

over the entire Site, and, although somewhat variable, can be considered as distinct hydrologic units.

Unit I (Columbia Formation) has been identified everywhere on the Site, both north and south of the Christina River. The base of the Columbia Formation extends across the Site and beneath the Christina River, which is about 12 feet deep in the area of the Site. It is variable and contains discontinuous sand beds that together serve as an upper water-bearing unit. Unit II, which is more than 20 feet thick throughout the Site, contains a dominant clay bed section that exceeds 15 feet in thickness throughout the Site, and separates the water-bearing Columbia Formation Unit (I) from the intermediate water-bearing zone (Unit III<sub>A</sub>), which belongs to the lower Potomac Formation. The deep water-bearing zone (Unit IV) is separated from Unit III<sub>A</sub> by a 20 to 30 foot unit (III<sub>B</sub>) that contains clay but is more sandy than the upper confining unit (II).

#### 1.1.5 INITIAL INVESTIGATIONS (1975 TO 1986)

Previous hydrogeologic groundwater quality investigations were conducted at Du Pont at the site under the approval of the State of Delaware Division of Natural Resources and Environmental Control (DNREC). On the basis of monitoring well and boring descriptions, as well as the groundwater level monitoring program conducted by Du Pont, an initial conceptual model of groundwater flow was made. These hydrogeologic deductions provided the basis for inferring the fate of contaminants introduced into the groundwater system and developing the plans for later hydrogeologic investigations.

In addition to the previously existing supply wells WW-11 and WW-13, 16 test borings and 13 monitoring wells were installed by Du Pont from 1975 to 1981 to evaluate the geologic and hydrogeologic conditions in the vicinity of the Newport Site. Table 1-2 provides a summary of the construction data and current operational status of all the monitoring and supply wells installed by Du Pont. Together with WW-11 and WW-13, ten of the original 13

monitoring wells are still utilized to monitor groundwater quality and water levels. These data have been collected quarterly and submitted to the DNREC.

#### 1.1.6 PREVIOUS REMEDIAL INVESTIGATIONS (1986 TO PRESENT)

The preceding subsection dealing with Du Pont's hydrogeologic investigations from 1975 through 1986 is focused primarily on the North Disposal site for two reasons. First, the North Disposal site was the subject of the Hazardous Ranking System (HRS) evaluation made by EPA in 1986 (Ref. 8). Second, the majority of the data discussed are from the north side of the Christina River. However, because certain waste products were also disposed in the South Disposal site, it was apparent that an RI assessment of the North Disposal site alone may not totally eliminate EPA's concerns regarding potential harm to the public and/or environment from contaminants associated with disposal of these wastes. Consequently, Du Pont directed WCC to conduct a series of RI tasks during June, July, and August of 1987 toward acquiring the following information:

- o additional data for a detailed hydrogeologic characterization of the South Disposal site;
- o additional data to refine the hydrogeologic characterization of the North Disposal site;
- o data to characterize the lateral and vertical extent of the North and South Disposal sites;
- o data concerning the groundwater quality in proximity to both disposal sites;
- o data concerning the water and sediment chemistry in the Christina River adjacent to the disposal sites;
- o data concerning ionizing radiation emanating from the North Disposal site, or documentation of the lack thereof;
- o data on the hydraulic characteristics of the site aquifers;
- o data concerning the hydrologic conditions within the disposal sites; and

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- o data concerning the characterization of fill and waste materials at the South Disposal site.

With the exception of the South site fill and waste characterization, these needs were addressed in the plan presented in Section 5.1 (Remedial Investigation) of the Proposed RI/FS Work Plan (WCC, July 20, 1987) submitted by Du Pont to the EPA in July 1987.

The overall objective of the previous RI was to provide documentation concerning the character of contamination sources, their areal extent and potential pathways to receptors of concern. The earlier literature study by WCC (March, 1987) identified the potential sources as being both the North and South Disposal sites. The transmission pathway was identified as groundwater flow from the North or South Disposal sites. The receptors of concern included the Christina River and downgradient groundwater users.

The previous RI consisted of an initial phase (Phase I) of hydrogeologic investigation designed to collect data to determine the need for a complete RI/FS program. If the data indicated that there was no potential threat to human health and environment further work as described therein (i.e., Phase II) would not be performed. Otherwise a second phase (Phase II) would be conducted to further define the extent of contamination, the potential migration pathways, contaminant loading rates, contaminant fates and all receptors of concern. This information would be used to develop a Remedial Investigation Report, and in conjunction with the Endangerment Assessment and the Feasibility Study, to remediate the site. The current status on the Newport Site is that the Phase I field tasks proposed in the July 1987 Work Plan were completed during the period of June through August 1987. The additional RI tasks (Phase II), along with the Endangerment Assessment and the Feasibility Study, will be conducted in accordance with this March 1988 RI/FS Work Plan. Sections 1.1.6.1 through 1.1.6.10 describe the RI tasks completed to date. A summary of the completed RI sampling and analysis efforts is shown in Table 1-3.

**1.1.6.1 GEOLOGIC AND HYDROGEOLOGIC INVESTIGATIONS**

As part of the previous RI tasks performed at the Du Pont Newport Site, 27 monitoring wells were installed by WCC during June and July, 1987 (Figure 1-7). The purpose of drilling and installing these wells was to obtain data on the vertical and horizontal gradients, permeability testing of the screened horizons, and groundwater quality assessment. Twenty-one of these wells were placed into seven clusters, each consisting of a deep, an intermediate, and a shallow well. The remaining six wells were installed as shallow perimeter wells. One test boring was performed at each of the seven well cluster locations. These test borings were drilled through the Columbia and Potomac Formations to a maximum total depth of 175 feet. Each test boring reached the bedrock and penetrated to a depth of 7 to 40 feet into decomposed bedrock. Then, they were completed as deep monitoring wells. Complete details on the test borings and monitoring well construction are provided in Appendix A.

Pennsylvania Drilling Company of Pittsburg, Pennsylvania, was subcontracted by WCC to drill the soil borings and install the monitoring wells.

**Test Borings**

At each cluster location, an initial test boring of nominal 4-inch to 8-inch diameter was drilled to obtain information about subsurface conditions which was then used to finalize the completion depths of the three monitoring wells in the cluster. This information was acquired utilizing standard geologic inspection in conjunction with downhole geophysics (see the subsection entitled "Borehole Geophysical Logging" presented later in this section).

The test borings were drilled using combination hollow stem auger/mud rotary rigs with split-spoon sampling capabilities. Potable water obtained by the driller from a City of Newport water hydrant at the Holly Run Plant was used in making up the sodium bentonite mud drilling fluid. Using a 2-foot split-spoon sampler, soil (overburden) samples were

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collected at 5-foot intervals from ground surface to the total depth of the test boring and stored in glass jars for future geological reference.

For each test boring, an experienced WCC geologist supervised the drilling of the hole, lithologically described all cuttings and samples from the hole, and generated a geologic log. The WCC Standard Operating Procedures were followed for the drilling, inspection, geologic logging, and analytical sample collection from these test borings (see QAPP - Section 6).

At the North Disposal site, the three test borings were scheduled to be cored with a 2-inch diameter NX bit five feet into the top of unweathered (not decomposed) bedrock. These cores were then to be laboratory tested for radioactivity. The determination to begin coring was to be made in the field on the basis of blow counts and the lithological description of cuttings. In order to optimize core recovery, coring was not to begin until an approximate blow count of 100 per 2 inches to 3 inches of penetration (refusal) was obtained while driving the split-spoon sampler. When the actual test borings were drilled, the advanced state of decomposition of the bedrock was such that refusal was never reached; thus coring was conducted. Based on the data obtained from all seven test borings, the thickness of decomposed bedrock exceeds 37 feet at the Newport Site.

Drilling and sampling were performed in a similar manner in the four test borings at the South Disposal site. The four southern test borings were terminated after from 7 to 37 feet of decomposed bedrock were drilled and sampled. To the extent necessary, the test borings were backfilled with sand pack material or bentonite-cement grout up to the bottom of the screen.

### Soil Sampling

In conjunction with the 3-inch O.D. split-spoon sampling for geologic evaluation of the soils, duplicate samples were also collected for chemical analyses from each of the deep test borings (see Appendix A). One set of soil sample bottles were collected for analysis from each of the split-spoon samples collected at five-foot intervals for the first 40 feet. After this depth was reached, analytical samples were collected at a minimum of every 20 feet (although split-spoon samples continued to be collected at five-foot centers), or at greater frequency if a sand unit was encountered below a thick clay.

The stainless steel split-spoons used to collect the analytical soil samples were decontaminated between every sample using a steam cleaner followed by a deionized water rinse. The sampling tools used to remove the soil from the split-spoons and to place it into the sample bottles were also made of stainless steel. An effort was made to collect the soil from the center of the split-spoon samples and along the entire length. The analytical samples were collected prior to the geological samples. The sampling tools were decontaminated using an alconox and water wash using potable water, followed by a deionized water rinse.

A total of 101 samples were collected plus 10 field duplicate samples (a minimum of one from each boring) and 10 field blank samples (a minimum of one at each deep boring location). The field duplicates and blanks were collected as part of the field quality assurance program.

All soil sample bottles containing soil samples for analyses were immediately placed into a cooler containing ice or frozen blue ice and stored there until they were shipped to ETC Corporation with freshly frozen blue ice in a sealed sample shuttle. ETC Corporation analyzed the soil samples for the complete Hazardous Substance List (HSL) using Contract Laboratory Program (CLP) protocol.

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### Cluster Monitoring Wells

Monitoring well clusters were defined as locations at which separate monitoring wells were drilled and completed with each well being screened in a different water-bearing (sand) zone. The purpose of screening different water-bearing zones at each cluster was to afford water level monitoring and groundwater sampling in potentially separate hydrologic units or water-bearing zones. Approximately 10 to 20-foot horizontal spacing was maintained between the wells at each cluster location. Three monitoring wells were designed for completion at each cluster location according. The actual drilling depths and completion data are shown in Table 1-4.

Because of the complex stratigraphic and hydrologic relations between the Columbia and Potomac Formations described in Section 1.1.4.2, detailed downhole data was needed to insure optimum selection of screened intervals at each cluster location. With this optimum selection, information from these wells provided and expanded the hydrogeologic data base from which the interpretations of groundwater movement and barriers to potential contamination migration were made. Moreover, the spatial distribution of the recharge/discharge relationships between the Columbia and Potomac water-bearing zones became more discernible along with the extent to which the Christina River acts to intercept groundwater flow from both Disposal sites.

The screened interval of each well in the clusters was selected by WCC based on a review of the detailed field boring logs prepared by WCC field geologists for the deep test borings in each cluster, as well as the borehole geophysics logs. The screened interval of each individual shallow (perimeter) well was selected on the basis of the auger cuttings. All the shallow well screens were positioned from above the observed water table depth down to at least several feet into the shallowest sand or gravel interval encountered at each drilling location. Procedures for installation of monitoring wells are presented in Section 6 of the QAPP.

In general, all of the wells were constructed of 4-inch I.D. Schedule 40 threaded flush joint PVC casing. The intermediate depth wells were completed using 0.020-inch slot wire-wrapped stainless steel screens. The deep wells, with the exception of those in clusters 1, 2, and 6, were also installed using 0.020-inch slot stainless steel screens. Those deep wells at clusters 1, 2, and 6 were constructed using 0.010-inch machine slotted PVC screens. The shallow wells were constructed using either 0.020-inch or 0.010-inch machine slotted PVC screens. The screen type and screened intervals are summarized in Table 1-4.

A well-sorted silica sand pack of appropriate size for the screen slot and formation materials was placed around the screen at each location. Depending upon the drilling method, different methods of placing the sand pack were used. For those borings advanced via mud rotary, the sand pack was placed to the bottom of the hole and around the screen either directly through a 1.5-inch PVC tremie line or down the annulus of the borehole while water was trickled through a tremie line placed to the bottom of the hole. When wells were installed through 6.25-inch I.D. hollow stem augers, the sand pack was placed around the screen as the augers were pulled from the well. The progress of the sand pack was constantly monitored with a weighted measuring tape as the sand was placed. For the wells in which mud rotary drilling was used, some natural sediment from the borehole wall occasionally collapsed as the sandpack was added. In most instances the collapse was gradual, thereby creating a silica sand/natural sediment mixture. At MW-5B, however, a majority of the screen was covered by natural sediments with a range of grain sizes not significantly different from the sand pack material.

A bentonite seal was placed above the sand pack using either bentonite pellets or, in a few cases, by pumping a thick, freshly mixed bentonite slurry (5 pounds of bentonite per gallon of potable water) over the sand pack.

A 5 percent bentonite-cement grout was then pumped from the top of the bentonite seal to the surface via a PVC tremie line. The typical grout mix was made up of 5

to 7 gallons of water per 94 pound bag of Portland Type I cement, with 5 percent dry weight bentonite. In the shallowest wells the boring was backfilled using bentonite pellets up to approximately three feet below ground surface.

A protective steel casing with a locking cap was cemented into the top of the borehole and around the well to protect the well casing and to prevent possible tampering. A concrete pad was placed around each steel casing.

After completion of the monitoring wells, each well was developed. A major objective in developing the intermediate and deep wells was to make all 14 wells available for pumping during an aquifer test. Therefore, the goals for the intermediate and deep well developments were to achieve:

- o maximum discharge rate;
- o high efficiency;
- o low sand content; and
- o low turbidity.

These goals were achieved by efficiently using a surge block, a submersible pump, and a sand pump. The surge block was used only as long as sand was being drawn into the wells. Then a sand pump was used to remove the sand and the submersible pump was used to pump the well to remove the fine-grained sediments as well as to measure the discharge rate. This cycle was continued until no further improvement could be seen in the above factors.

The goal in developing the shallow monitoring wells was essentially to increase the well yields sufficiently enough to allow efficient purging of the wells in preparation for groundwater sampling. The shallow wells were developed by bailing and/or pumping. All

downhole development tools were decontaminated by steam cleaning prior to introduction into each well. Well development procedures are presented in Section 6 of the QAPP.

### **Perimeter Monitoring Wells**

WCC also installed six individual shallow ("perimeter") monitoring wells around the perimeter of the South Disposal site at the locations shown on Figure 1-7. These wells were drilled, inspected, completed, and developed as described for the shallow wells in the preceding paragraphs on the cluster monitoring wells. Completion details are shown in Table 1-4.

### **Borehole Geophysical Logging**

The purpose of the borehole geophysical logging program at the Site was to identify potential water-bearing zones between land surface and bedrock and to assess the continuity of the hydrostratigraphic units across the study area. Appendix C provides detailed logs, methodology, and evaluation for the borehole geophysical logs. A suite of five logs was selected to meet the objectives including:

- o single point resistance log;
- o natural gamma ray log;
- o epithermal neutron log;
- o compensated density log; and
- o caliper log.

Borehole geophysical logs provide an indirect method for assessing changes in lithology and the hydrogeologic characteristics of the sediments penetrated in a borehole. One of the advantages of borehole geophysical logs includes the fact that logs provide a continuous measurement throughout the entire length of the borehole. They also record parameters not

readily apparent to the naked eye. Because geophysical logs largely rely upon indirect measurements, they were compared with the cuttings, cores and drilling logs to provide the maximum benefit from the field data collection program. Interpretations with respect to hydrogeology at the Site in this section are based upon the interpretation of the logs by a certified well log analyst (Society of Professional Well Log Analysts No. 5851), drilling logs, split-spoon samples collected in glass sample jars and discussions with field geologists present during drilling of the test borings.

Based upon a comparison of the suite of borehole geophysical logs run at the Newport Site and the split-spoon, samples, five "major" hydrostratigraphic units have been identified (Table 1-1). All five units have been identified in each of the seven test borings. However, the units commonly exhibit marked color and lithologic variation.

The borehole geophysical logs were used to identify the individual hydrostratigraphic units based upon the physical characteristics obtained from the logs. These criteria assess bulk resistivity of the saturated sediments (point resistance), natural gamma activity (gamma log), bulk porosity (neutron and density logs) and relative induration of sediments (caliper log).

Unit I, Shallow Zone - Highly variable in both split-spoon samples and geophysical logs. Two members of the Columbia Formation are of hydrogeologic significance: an upper water table sand (high resistance) and an underlying black to dark brown plastic, organic clay (low resistance) that appears to serve as an effective semi-confining or confining bed throughout the seven holes logged.

Unit II, Semi-Confining Unit - A clay matrix of low resistivity marks the top of this unit accompanied by a marked increase in porosity on the neutron and decrease in density on the density logs. As the middle of the unit is approached these trends tend to

reverse due to a slight increase in sand content. The bottom of Unit II is marked by an increase of sand content grading into Unit III<sub>A</sub>.

Unit III<sub>A</sub>, Intermediate Zone - The upper part of Unit III contains 10 to 15 feet of sands of probable moderate permeability. This zone characteristically shows the highest resistance on the point resistance logs, the greatest density and lowest porosity of the sediments in the borehole. The screened interval at each of the seven locations was positioned at the zone of highest resistance within this unit.

Unit III<sub>B</sub>, Semi-Confining Unit - Separates the Shallow and Intermediate Zones. Unit III<sub>B</sub> is similar in lithologic appearance to III<sub>A</sub> but has a marked increase in clay content. The increase in clay content is most notable on the resistance logs, and is marked by an increase in neutron porosity, and a decrease in formation density. Interfingering of clayey sands and sandy clays is most prolific throughout Unit III (A and B).

Unit IV, Deep Zone - Lowermost Potomac Formation unit zone overlying the weathered bedrock. The most characteristic member of this unit is an 8 to 12 foot producing zone which was screened in the seven deep wells. The unit may or may not contain a thin, black, organic clayey unit and/or a highly plastic clay at the very base of the unit.

Unit V, Decomposed Bedrock - Weathered bedrock moderately indurated, olive green schist, characterized by low resistivity, moderate porosity and high density.

Because the elastic sediments overlying bedrock at the Newport Site are primarily comprised of variable thicknesses of interbedded clays, silts, and sands, the mapping of individual lithologic layers between the wells would be subjective. These individual layers are interpreted as being either lenticular or else characterized by somewhat abrupt facies changes across the Site. However, sequences of sediments can be grouped into the five distinct units that are recognized in each of the seven boreholes. Lithologic variability across

the Site exists to the extent that there is a potential for leakage between the units overlying the bedrock; however, the extent of variation within each unit is fairly uniform between the seven test borings.

### **Aquifer Tests**

As part of the previous Remedial Investigation efforts during the summer of 1987, two constant rate aquifer tests were conducted by WCC to estimate the groundwater transmissivity and storage characteristics of hydrostratigraphic Unit III<sub>A</sub> (Intermediate Zone) of the lower Potomac Formation. The complete details of the aquifer tests are provided in Appendix D. The hydraulic characteristics of Unit III<sub>A</sub> were evaluated by separately pumping two monitoring wells, MW-3B and MW-6B, and monitoring water levels in adjacent observation wells. A secondary goal was to estimate the hydraulic relationship between the shallow and deeper water-bearing units. An evaluation of the aquifer test is presented in Section 1.2.2.1.

A NPDES discharge permit was applied for to allow for disposal of water recovered from pumping wells during the aquifer testing program. This permit was granted by the Delaware Department of Natural Resources on August 4, 1987. Field work on this task began after permit approval and was completed on August 25, 1987.

**Pumping Tests:** Table 1 of Appendix D presents the pump-on time and date, pump-off time and date, amount of time recovery was observed, percent of recovery observed and weather conditions during the test, for each aquifer test run. Appendix E contains hydrographs of water level response in each well as a function of time (from August 1, 1987 to August 25, 1987).

The following procedures are relevant to each aquifer test:

1. Water levels in the wells were measured using Enviro-Labs data loggers with eight channels attached to downhole pressure transducers. Data was recorded at different time intervals, depending when the pump was turned on or off.
2. A step-drawdown test of several hours duration was used at each pumping well, to estimate appropriate pump rates for the aquifer tests. Prior to each part of the test, as a minimum, the pumping well was shut down and allowed to recover for 24 hours.
3. "Static" water levels were measured electronically in the pumping well, adjacent monitoring wells, and the Christina River prior to each pump-on time at 15-minute increments.
4. Data was logged on a standard time schedule (see Appendix D) that allowed for more frequent observations early in each drawdown or recovery leg and less frequent observations at later times when more stable conditions were expected to prevail.
5. Discharge rates were continuously monitored using a in-line flow meter with a dial display and totalizer, and occasionally checked by filling 25 gallon bucket while measuring time on a stopwatch. They were adjusted by valves on the discharge line from the pump.

A step-drawdown aquifer test was performed on both of the wells, MW-3B and MW-6B, prior to the constant rate aquifer tests. This type of test involved pumping the designated well at a series of constant flow rates (steps), with each subsequent flow rate greater than the previous rate. Each step was run for a predetermined amount of time with dynamic water-levels being measured at increasing time intervals. At the end of the last step,

the pump was shut off and recovering water levels were measured and recorded over increasing time intervals.

The MW-3B test was run for four steps. The initial rate was 12.5 gpm for 1 hour 5 minutes (65 min). The next rate was 17.7 gpm for 30 minutes. The third rate was 27.3 gpm for 1 hour (60 minutes). The fourth rate was 30 gpm for 30 minutes.

The MW-6B test was run for four steps. The initial rate was 10 gpm for 45 minutes. The next rate was 20 gpm for 40 minutes. The third rate was 25 gpm for 35 minutes. The fourth rate was 33 gpm for 30 minutes.

The results of these tests are used to estimate specific capacities under different rates, and safe constant pumping rates to be used during the constant rate aquifer tests. The specific capacity for MW-3B ranged from 0.53 gpm/ft at 12.5 gpm down to 0.46 gpm/ft at 30 gpm. It was decided that 20 gpm would be a safe constant pumping rate for the long term test.

The specific capacity for MW-6B ranged from 0.86 gpm/ft at 10 gpm down to 0.81 gpm/ft at 33 gpm. It was decided that 25 gpm would be a safe constant rate for the long term test.

A constant-rate pumping test was performed on the same wells, MW-3B and MW-6B. The MW-3B was pumped at a constant discharge rate of 20 gallons per minute for a period of 100 hours. Once the pump was started, water-level drawdown in the wells were measured according to the standard time schedule: At 6000 minutes the pump was shut down and recovering water levels were measured in all wells being monitored. These measurements were taken on a similar schedule to the drawdown phase, until the affected wells had reached 90 percent recovery, or for 8 hours after the pump had been shut off.

After recovery, MW-3B was re-started for a shorter duration, higher stress constant-rate test. The well was pumped at 30 gallons per minute for a period of 12 hours. Monitoring was the same as in the initial test.

The constant rate pumping test conducted on well MW-6B involved a constant discharge rate of 25 gallons per minute for a period of 73.5 hours. Wells were monitored according to the standard time schedule. At 4410 minutes, the pump was shut off and recovery was begun. Copies of all data from the constant-rate pumping-tests for MW-3B and MW-6B can be found in Appendix D.

**Tide Corrections:** Total measured head in a well is a composite of elevation head, pressure head, and velocity head. Because groundwater usually flows very slowly, the velocity head is a very small component of total head. Examination of well hydrographs in Appendix E shows that many of the wells show significant changes in head during periods of no pumping stress.

Tides in the Christina River were expected to have some impact on some wells. Therefore, a transducer was installed in the river and a Stevens Recorder (Type F) was used at an elevation benchmark by the James Street bridge. The shapes of the hydrographs and the apparent relationship of time lag to distance from the river confirmed that tides are a major factor. If the results were not corrected to show the response without tidal influence, the simplistic analytical methods would not be accurate. Removal of all tidal influence was not possible, primarily because data was collected every 15 minutes rather than continuously during the representative tidal cycle, and other influences on groundwater level were also occurring. It is probable that atmospheric pressure effects, bank storage near the river, and groundwater recharge (infiltration to the water table) occurred during the period of record. Insufficient record length was available to evaluate the magnitude of their impact. The processed data shows that tidal influence correction appears to be the most important factor.

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To remove the influence of tides from the data sets, WCC constructed a computer program to consistently treat each piece of data in exactly the same way. The procedure used relevant pre-pumping data for a specific well and tidal values for the same time period. It assumes that tide is the only trend during that time period and that the relationship fits the general form of:

$$x(t) = x'(t) + (T(t + t') - T) * f$$

where:

|       |   |                                            |
|-------|---|--------------------------------------------|
| t     | - | is a time                                  |
| x(t)  | - | is the measured head at time t             |
| x'(t) | - | is the head without tidal effect at time t |
| T(t)  | - | is tidal head at time t                    |
| t'    | - | is the lag time                            |
| T     | - | is mean tide head                          |
| f     | - | is a scale factor.                         |

The correction procedure was to use generalized matrix inversion with ridge regression to solve many equations with four unknowns. The many equations are generated by having one equation for each data point set at a same time. There are actually only three unknowns, x'(t), t', and f. T (mean tide), can be evaluated independently of the algorithm and serves as a check on the optimization routine.

After the tidal effect is calculated, the tidal differences are subtracted from the data using the following equation:

$$x'(t) = x(t) - (T(t + t') - T) * f$$

This assumes that values obtained from the tidal baseline cycle can be extrapolated throughout the entire data set, namely August, 1, 1987 to August 25, 1987. It also assumes that the stressed system does not react differently than the unstressed system.

Examination of the corrected data sets for the times during the aquifer tests show that there are some minor influences that still remain, probably as a result of inaccuracies in adjusting lag on a data set incrementized on a 15 minute basis. The residual errors appear to be small enough to be hidden in the accuracy of the analytical solutions for hydraulic properties. Curve matching is most controlled by the early times where data was collected on a 2 to 240 second (0.03 to 4 minute) basis during the first 235 minutes of each drawdown and recovery log. This means that inaccuracies in log calculation when data are logged every 15 minutes should have a negligible effect on calculated hydraulic properties.

#### 1.1.6.2 GROUNDWATER SAMPLING

During the week of August 10, 1987, WCC collected groundwater samples from the 27 newly constructed monitoring wells and 10 of the 12 preexisting active monitoring wells. This constituted the first of two groundwater sampling rounds conducted in 1987 as part of the Phase I RI tasks.

The proper sample volumes, treatment, and container usage was coordinated with ETC Corporation, who performed the necessary laboratory analyses (see QAPP). The groundwater samples were analyzed for the full Hazardous Substances List (HSL) in accordance with USEPA Contract Laboratory Program procedures plus sulphate as  $\text{SO}_4$ . Gross alpha and gross beta radiation analyses were also conducted on samples from wells located north of the Christina River.

The first sampling round was conducted by WCC approximately two weeks after completion and development of the new monitoring wells. This two week period allows

for stabilization of the formation water prior to initial sampling. Monitoring well purging and sampling are presented in Section 6 of QAPP.

Prior to sampling, all of the monitoring wells were purged a minimum of three well volumes at a low discharge rate. Purging of the wells was accomplished using a centrifugal pump, a submersible pump, or a stainless steel or teflon bottom filling bailer (Table 1-5). In all cases, the wells were purged from the top of the water column to ensure that the collected sample was representative of the groundwater from the screened water-bearing zone.

After purging the wells, a bottom filling stainless steel or teflon bailer was used to collect the groundwater and to transfer it into the sample bottles. The bailers were acclimated to the groundwater by removing a few bailer volumes prior to filling the sample bottles. Sample bottles were provided by the laboratory and were shipped to the site in sealed shuttles. All purging and sampling equipment (pumps, hoses, and bailers) were steam-cleaned withalconox and potable water, then rinsed with deionized water before being entered in each well. New lengths of rope were tied to the bailer after decontamination, prior to use in each well. All decontaminated equipment was placed on clean plastic sheeting for transport to the next well. In addition, plastic sheeting was placed next to the well being purged or sampled so that, if necessary, the equipment could be laid down next to the well.

The following field preservation techniques were utilized for the various analytical parameters.

| <u>Parameters</u>         | <u>Field Preserved With:</u> |
|---------------------------|------------------------------|
| Volatile Organics         | Ice                          |
| Acid Extractables         | Ice                          |
| Base/Neutral Extractables | Ice                          |

|                                |                          |
|--------------------------------|--------------------------|
| Pesticides and PCBs            | Ice                      |
| Total Metals                   | HNO <sub>3</sub> and Ice |
| Total Dissolved Metals         | HNO <sub>3</sub> and Ice |
| Total Cyanide                  | NaOH and Ice             |
| Sulfates                       | NaOH and Ice             |
| Gross Alpha and Beta Radiation | HNO <sub>3</sub> and Ice |

The groundwater samples collected from the monitoring wells were prepared for total dissolved metals analysis by filtering in the field and preservation with nitric acid. If filtering was not possible, they were not preserved with acid so that the samples could be filtered in the laboratory before analysis. In the field, immediately after sampling, all of the sample bottles were placed into a cooler or sample shuttle filled with frozen blue ice. Samples were then shipped in sealed shuttles packed with freshly frozen blue ice. The accompanying chain-of-custody forms were completed just prior to shipment to ETC Corporation via overnight shipment.

In order to maintain quality assurance, field duplicates and field blanks were collected for ten percent of the total number of groundwater samples collected. In addition, a trip blank was included in each sample shuttle shipped to the laboratory.

A second round of groundwater sampling was conducted by Aqua Services, Inc., during the week of December 14, 1987. Thirty-six on-site monitoring wells and also two off-site residential wells (see Section 1.1.6.10) were sampled and preserved. These samples were then shipped to, and analyzed by, ETC Corporation for HSL organics and metals (total HSL, minus PCB's/Pesticides) plus sulphate as SO<sub>4</sub>.

### 1.1.6.3 SURFACE GEOPHYSICAL SURVEY

Between June 22, 1987 and July 3, 1987 numerous resistivity soundings were performed over both the North and South Disposal sites. These were conducted in order to increase the understanding of near surface stratigraphy and the vertical and lateral extent of waste materials at these locations. This effort was supplemented by a series of short terrain conductivity traverses around the perimeter of these sites. The purpose of these surveys was to better define, if possible, the boundary of fill material deposited within these two sites. Appendix F contains the details of these surveys.

In order to facilitate and integrate the various investigations, a 100-foot grid was surveyed and established by suitable markers in non-wetland areas (Figure 1-11). Resistivity soundings were made at 100-foot intervals along grid lines C, E and G in the North Disposal site and at those surveyed and marked 100 ft intervals along grid lines G, I, K, M and O in the South Disposal site. Wetland conditions in the southern area had precluded establishing a complete grid across this site. Conductivity traverses were made along all cleared surveyed grids at both disposal sites.

Resistivity soundings were made with an ABEM COPCO Terrameter and a Schlumberger electrode configuration. Observations were made at 24 different potential and current electrode patterns. The data obtained from each sound were converted to apparent resistivity as a function of current electrode spacing. This information was, in turn, corrected in order to derive approximations of true resistivity as a function of depth. All data were taken in ohms and converted to ohm-feet units by means of a geometric factor.

In order to assist the interpretations of the foregoing information, resistivity values at selected depths at each of the Disposal sites were depicted with computer-generated contours across the entire area surveyed. By illustrating these data in this fashion, it is possible to observe lateral change of resistivity at certain horizons. Resistivity values along

two orthogonal traverses (grid lines) at each site were also contoured to show resistivity change in a vertical section. This permitted observing lateral and vertical change of resistivity beneath a selected survey (grid) line.

Terrain conductivity surveys, employing the Geonics EM-31 instrument, were conducted over established grid lines on both sites. With this apparatus the maximum depth of the near surface zone observation was limited to approximately 18 feet. The data acquired was superimposed on the survey grid, krigged for contouring purpose and contoured.

To facilitate interpretation of the subsurface features at the disposal sites, a resistivity sounding was conducted near the location of test boring TB-1. These measurements were assumed to be representative of those that would be exhibited by the subsurface in its natural state.

#### 1.1.6.4 SOIL GAS SURVEY

The objective of the soil gas survey (see Appendix G) performed at the Du Pont Newport Site in June and July 1987 was to delineate possible trichloroethylene (TCE) and tetrachloroethylene (PCE) vapor concentrations in both the North and South Disposal sites. Volatile organics, including TCE and PCE were detected during previous groundwater sampling in pre-existing monitoring wells proximal to both sites.

VOCs in groundwater or soil can often be detected in soil gas. Soil gas is the gas in the spaces between soil particles in the unsaturated soil (vadose zone) above groundwater. VOCs volatilizing from groundwater or soil into soil gas will travel through the vadose zone by convection (air movements induced by changes in atmospheric pressure, temperature, evaporation, and winds) and diffusion.

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When groundwater containing VOCs has migrated away from source areas, the concentration of VOCs found in the soil gas may be correlated, in a general way, to the concentration of VOCs in the underlying groundwater. Similarly, in soil, as VOCs move away from source areas, a rough pattern of decreasing concentration with distance from the source may be detected in the soil gas. This pattern may be well defined in homogeneous systems. In non-homogeneous systems soil gas migration will follow a path of least resistance. Because of this, heterogeneous soil conditions, (like those on the North Disposal site) may obscure the pattern of VOC migration from soil source areas or from groundwater. Soil gas concentrations can also vary significantly with atmospheric changes. Soil gas samples taken at the same location, but days or weeks apart, may vary in concentration. Because these factors, impact the results of a soil gas survey, overall patterns of relative contamination should be assessed rather than interpreting soil gas concentrations from individual samples.

The presumed landfill boundaries served as the limits of the soil gas survey at both the North and South Disposal sites. Soil gas samples were taken at points along the 100-foot grid pattern surveyed over both sites.

All grid nodes surveyed within the fence line of the North Disposal site proved to be accessible soil gas sampling points. Several grid nodes surveyed on the South Disposal site were in areas of very shallow depth to groundwater and therefore were not used as soil gas sampling locations. Several soil gas samples were taken in places not surveyed as part of the site grid. A uniform sample depth of five feet was maintained wherever possible.

TCE and PCE were the primary VOCs previously detected in groundwater samples from wells on-site. Therefore, the soil gas analysis methodology employed was targeted for these two chlorinated organic compounds.

The soil gas survey at the Newport Site involved probe installation for soil gas withdrawal at sampling points throughout the Site. The soil gas samples were then analyzed by

a field operable gas chromatograph (GC) located on-site and equipped specifically for TCE and PCE analysis. Details on the method of soil gas sample collection and analysis used at the Newport Site are described in Appendix G and presented in Section 6 of QAPP.

The samples were analyzed within one-half hour of sample collection by injecting the sample directly into the gas chromatograph (GC). The GC used, a Varian 3400 series equipped with dual electron capture detectors (ECD), affords the most sensitive analysis for the chlorinated organic compounds of interest (TCE and PCE). Detection limits achieved during this survey were approximately 10 parts per billion (ppb) for the two compounds of interest (see Appendix G). The soil gas survey results are shown in Table 1-6 and discussed in Section 1.2.2.4.

#### **1.1.6.5 GROUND RADIOMETRIC SURVEY**

From 1961 to 1968, the Newport plant manufactured a thoriated nickel alloy that was used in the manufacture of supersonic jet engines. The alloy consisted mostly of nickel, some chromium and molybdenum, and small quantities of thorium (2 to 5 percent).

Solid and semi-solid waste material from this process (reportedly about 20 tons) was buried in the North Disposal site in accordance with federal regulations in effect at that time. The estimated weight of thorium dioxide disposed is between 0.4 and 1 ton. According to the Du Pont records, the thorium waste was placed in jars that were subsequently placed in 55 gallon barrels together with disposable protective clothing and debris from the waste handling operations. The barrels were placed in "holes" or small excavations which were nominally at depths up to 10 feet below the clay-capped present land surface of the landfill.

The exact number and locations of disposal "holes" at the North Disposal site are unknown. Based on existing plant records, the thorium waste was apparently buried within the area shown on Figure 1-12.

During 1979 and 1980, Du Pont conducted at least two radiometric surveys using a Victoreen 471 radiation meter (Geiger counter). The survey results in each case indicate no sustained readings above background levels measured in a city park approximately 1 mile from the disposal site.

Recent chemical analyses of groundwater from a depth of 20 to 25 feet in monitoring well SM-4 yielded Radium-228 and gross alpha concentrations slightly above drinking water standards (40 CFR Part 141.15). Radium 228 is a daughter isotope from the decay of thorium-232.

The background information previously discussed indicates that records showing accurate locations of buried thorium waste are lacking. Past reconnaissance surveys of radioactivity emanating through overburden did not indicate radioactivity levels elevated above background, and thus it was not possible to determine the specific source areas from these data.

A ground radiometric survey using gamma spectrometry was conducted by WCC in June 1987 during Phase I of the Remedial Investigation. The objective of this survey was to verify that anomalously high levels of gamma radiation from the buried thorium waste sources are not emanating from the North Disposal site.

At the time, the available information suggested the waste was buried between grid coordinates E6:E7 and G6:G7 (Figure 1-12). Information from plant records following completion of the survey indicated that the waste was buried as shown on Figure 1-12. Due to field conditions at the time, the survey was conducted along the grid lines as marked in the field. Although the radiometric survey did not cover the entire stippled area on Figure 1-12, a portion of it was covered, and there appears to be a high probability that thorium waste was buried beneath the area covered by the survey.

The ground radiometric survey was performed between June 19 and June 30, 1987, utilizing a portable gamma-ray spectrometer. The scope of the radiometric survey was divided into three parts. The first part involved a reconnaissance survey using a Ludlum radiation meter (Geiger counter) to evaluate the site entry risk to field personnel. Following the reconnaissance survey, systematic traverses with the gamma spectrometer were conducted along grid lines (Figure 1-12) laid out by a professional surveyor. Third, the data were reduced and krigged for contouring purposes. The details of the field procedures for both the reconnaissance and gamma spectrometer surveys are presented in Appendix H and Section 6 of QAPP.

#### **1.1.6.6 RADON GAS SAMPLING**

A radon-222 gas survey was conducted by WCC in June 1987 over a limited area of the North Disposal site in conjunction with the larger-scale survey of volatile organic compounds in soil gas. The samples were collected in the area where waste containing thorium-232 was believed buried at a depth of 10 feet. (Subsequent information has shown that buried waste is located elsewhere than originally thought at the time radon sample locations were selected.)

Radon-222 is a daughter of radium-226 which, in turn, is a daughter in the uranium-238 decay series. The data from the radon-222 analyses serve as an independent check on the occurrence of uranium-238 at the North Disposal site by comparing them with the indirect ground-level measurements of gamma radiation from uranium-238 taken during the field radiometric survey with a portable gamma spectrometer.

Background information from existing records at the Newport Site does not indicate the occurrence of uranium-238 in the landfill waste materials. Consequently, ten soil gas samples were obtained for analysis. The samples were obtained and shipped to Teledyne

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Isotopes, Westwood, New Jersey on July 8, 1987. The procedures for sample collection and analysis are presented in Appendix I and Section 6 of QAPP.

#### **1.1.6.7 CHRISTINA RIVER SEDIMENT SAMPLING**

A survey of the sediments from the Christina River was conducted June 16 to 23, 1987, in order to provide a preliminary indication of whether river sediments have been contaminated by materials disposed in the North and South Disposal sites. This assessment was facilitated by the collection and analysis of samples from three areas along the Christina River in the vicinity of the two disposal sites (Figure 1-13). The analytical results of the sediment sampling program are presented in Section 1.2.2.8.

To maximize the geographic coverage, sampling areas were proposed upstream of the South Disposal site boundary, downstream of the North Disposal site boundary, and directly between the North and South Disposal sites. In each sampling area, two sample stations were established approximately 50 feet apart on opposite sides of the river centerline. At each sample station, sediments were sampled to a depth of 5 feet below the sediment surface, were sectioned into discrete depth intervals, and were submitted for chemical analysis.

Data available prior to the program suggested that indicator parameters, which would imply origin within one of the two disposal sites, are limited in number. However, all samples submitted to the laboratory were analyzed for the entire HSL, including heavy metals. All samples were also analyzed for oils and grease, due to the proximity of the extensive automobile salvage yards.

**Christina River Hydrology**

As part of the 1987 Remedial Investigation (Phase I) efforts, a preliminary investigation of the Christina River's hydrology, channel morphology, and sedimentation patterns was conducted by WCC to provide a basis for determining procedures for collecting representative river water and sediment samples.

The Christina River is a tidal estuary stream which borders the Du Pont Holly Run Plant, and separates the North and South Disposal sites. In the vicinity of the disposal sites, the river is shallow, brackish, and meanders through tidal swamp and wetlands in route to its outlet on the Delaware Bay near Wilmington. The channel width varies along its length, but where it separates the two disposal sites, it ranges from approximately 260 to 330 feet wide.

During June to August 1987, the twice daily tidal fluctuations were observed to occur in a sinusoidal manner over an average daily range of 5 to 6 feet. The lowest tide observed at the Newport Site during the program occurred on June 11, 1987 at elevation (-) 1.8 feet (MSL). Conversely, the highest tide observed during the program occurred July 7, 1987 at elevation (+) 5.3 feet (MSL).

The flow velocity of the tidal water, into and out of the section of channel adjacent to the Site, varies in a sinusoidal manner similar to water elevation during the tidal cycle. Flow velocities in the channel also vary with channel width. Visual observations at the Site confirmed the existing map data, which indicated that the channel width increases from upstream to downstream. Map data and interpretative elevation data gathered during the sediment sampling program indicate a meandering trough or deeper area (thalweg) is present in the river channel adjacent to the Site. Visual observations suggest a velocity gradient across the channel where this thalweg is present.

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In a typical stream channel, the thalweg is characterized by higher flow velocities and erosional areas (the cutbank). The lower flow velocity areas (the point bar) are in shallow water and are where active sediment deposition occurs. Generally accepted theory is that the thalweg and associated erosional surfaces are usually located on the outside of a meander, while eroded material is deposited in the point bar area located on the inside of the next meander downstream. This is due to the helical flow pattern of water in stream channels. Interpretations of elevation and geologic data suggest that a similar morphology is present in the Chirstina River at the Newport Site.

In the deeper thalweg, where current velocities were highest, the surface sediments were generally relatively clean sands with few fines. Sediments tended to become finer with depth. Typically, there was a transition zone of fine sands with increasing clay and silt content, then a firm sandy clay with a large percentage of fines and 1 to 2-inch thick layers of vegetative debris throughout.

The thalweg was found to be the deepest, and the channel to be the narrowest in the area of Station 3 (Figure 1-13). The highest flow velocities would be expected in this area, and were observed here during the program. Thalweg sediments were difficult to recover using methods described below (indicating non-cohesiveness), and consisted of relatively clean sands. The thalweg depth is probably due to high channel flow velocities induced by the proximity of the James Street and Highway 41 bridge foundations. The concrete and wood-pile bulkhead along the northern river bank also contributes to thalweg depth and location in this area. Active deposition of sediments is probably occurring in the southern half of the channel near Station 3.

The channel becomes wider and the thalweg becomes less pronounced downstream of the James Street bridge. Interpretation of the channel morphology in this area suggests that higher velocity flows and erosion of coarse-grained deposits are prevalent in the

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northern half of the channel. Conversely, active fine-grained sediment deposition is probably occurring in the low velocity flows of the southern half of the channel in this area.

In the vicinity of Station 1, the channel is at its widest point in the study area. Elevation data suggest that only a slight thalweg may be interpreted to be located in the southern half of the channel. Stratigraphic logs from Station 1A and 1B tend to support this. Channel flow velocities appear to be low over the entire channel width and fine-grained sediment deposition is probably occurring over most of the channel width. A small sand bar island was found to be developing downstream of Station 1. The island's influence probably induces fine-grained sediment deposition in the northern half of the channel.

One area of probable active sediment deposition, where data are scant, is interpreted to exist between the locations of Stations 1 and 2. Based on the interpretation of data collected and visual observation of current flow velocities, a southward bending meander in the thalweg probably exists between the two stations and deposition (sedimentation) is probably active in the northern half of the channel in this area.

Because the Christina River flow direction at the Site alternates with the tidal cycle, conventional notions of downstream sediment transport must be modified for application at this Site. Sediments originating in the channel adjacent to the North and South Disposal sites are probably carried both upstream and downstream of the study area by the alternating current direction. Similarly, it is also probable that sediments originating from beyond the Site boundaries are carried upstream or downstream with the alternating current direction and deposited in the river adjacent to the Site.

#### **Sampling Methodology**

Christina River sediment samples were collected utilizing the WCC vibrator drive sediment sampler (VDSS) operating from a floating barge constructed for that purpose.

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Samples were collected from two stations in each of the three sampling areas. The three sampling areas and the locations of the respective sampling stations are shown on Figure 1-13.

The sediment sampling stations were selected in accessible areas upstream, adjacent to, and downstream of the North and South Disposal sites. Sample station locations were determined in the field by use of a marine sextant. Once the sampling barge had been anchored over a sample station, from that reference point the angles between three visible landmarks were measured and recorded. These landmarks had been located on the site map previously. Water depth was measured at each sample station by sounding, and was recorded along with the date and time of measurement. Elevations of all sample stations were back-calculated from the concurrent continuous measurements of tidal fluctuations recorded at the James Street bridge monitoring station.

The VDSS sediment sampler assembly consists of a steel sampler tube 5 feet in length with a 3.5-inch O.D. and a 2.75-inch I.D. The sampler tube is equipped with a cutting shoe at its leading edge, and a trailing-end cap compatible with an AW drill rod connection. is lined with a replaceable 2.75-inch O.D., 2.5-inch I.D. polybutyrate sleeve for sample collection. The interior of the liner sleeve is fitted with a 2.5-inch diameter o-ring sealed piston which provides necessary vacuum assistance in sediment sample recovery. The entire sampler assembly is attached with a AW drill rod connection to a vibrating drive head operated by compressed air.

The WCC vibration drive sediment core sampler is equipped with a 2.5-inch I.D. inner liner, five feet in length. The use of an inner liner allows the sediment core to be removed intact and in a sealed environment from the sampler, thus enabling:

- o Potential cross-contamination to be minimized;
- o Precise sectioning of the sample into desired depth segments;
- o Minimal exposure to air and consequent loss of volatiles; and

- o Specification of the type of liner material - from teflon for high sensitivity analysis to brass for low sensitivity analysis.

The sediment sampler assembly is lowered on an elevator mast to the sediment surface. Penetration of sediments is achieved by liquefaction of saturated sediments due to vibration and gravity advancement of the sampler assembly. Sediments slide into the interior of the sampler assembly liner, assisted by vacuum provided by the o-ring sealed piston. The piston is locked at a stationary position at the sediment surface. On recovery, the liner containing sampled sediments is removed from the sampler assembly, capped, and sectioned into appropriate depth intervals.

Equipment which came into contact with sample material was disassembled and decontaminated after each use. Decontamination was performed by washing with a mixture of Alconox and potable water, followed by thorough steam cleaning. Decontaminated sampling equipment was then reassembled, and wrapped in a protective layer of clean plastic or tin foil until needed. A clean unused polybutyrate liner was used at each sample station.

Sample liners containing recovered sediment material were sectioned, by cutting in the field, into three discrete depth segments whenever recovery was sufficient to do so. Typically, the recovered sample from a single sample station was sectioned into a 0.0 to 1.0-foot depth interval, a 1.0 to 2.5-foot depth interval, and a 2.5 to end-of-recovery depth interval. The depth intervals were selected in this manner to accommodate the analytical sample volume requirements. Table 1-7 provides a summary of sampling depths, sample recoveries, section logs, location and laboratory identifiers.

Following sectioning into discrete depth intervals, recovered sediment materials within each liner segment were individually extruded, bisected along the long axis if the material was cohesive, and representative portions were placed in laboratory cleaned containers. If the material recovered was not cohesive, an effort was made to collect a

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representative composite. Samples in laboratory cleaned containers were preserved by cooling with ice or frozen blue ice, were packed in laboratory provided shuttles, and were shipped to ETC Corporation on the date of collection in most cases. To facilitate QA/QC validation of the analytical data, two duplicate samples (10 percent) were submitted for analysis. In addition, two field blank samples were collected during the program. These field blanks and duplicates were in accordance with required protocols, as described in QAPP.

#### 1.1.6.8 CHRISTINA RIVER WATER SAMPLING

In conjunction with the first episode of groundwater sampling (Section 1.1.6.2) during the week of August 10, 1987, WCC also collected Christina River samples hourly for twelve hours. The purpose of this program was to collect samples from the river throughout one complete tidal sequence. A teflon bailer was lowered from the center of the James Street bridge to transfer river water to the sample bottles. The same decontamination and sample handling procedures that were used for the collection of groundwater samples were also used for the collection of the river water samples.

The samples were field preserved in the following manner for the analytical parameters listed below:

| <u>Parameters</u>         | <u>Method of Field Preservation</u> |
|---------------------------|-------------------------------------|
| Volatile Organics         | Ice                                 |
| Acid Extractables         | Ice                                 |
| Base/Neutral Extractables | Ice                                 |
| Pesticides/PCBs           | Ice                                 |
| Total Metals              | HNO <sub>3</sub> and Ice            |
| Total Dissolved Metals    | HNO <sub>3</sub> and Ice            |
| Total Cyanide             | NaOH and Ice                        |

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**1.1.6.9 WETLANDS INVESTIGATION**

Although not designated as part of the Remedial Investigation (Phase I) WCC conducted a wetlands investigation for the portion of the Newport Site located on the south shore of the Christina River. A field reconnaissance of this area was conducted on December 24, 1987 as part of this effort. The objective of the field effort was to identify the general hydrologic, vegetative, and surface soil characteristics of the site, and evaluate the accuracy of existing wetland mapping of the site by the U.S. Fish and Wildlife Service (USFWS).

The field reconnaissance effort involved a WCC biologist traversing the various habitats present and making spot evaluations of the three parameters which are utilized by the U.S. Army Corps of Engineers to define wetland boundaries - hydrology, vegetation, and soils. These spot evaluations were used to generally classify the vegetative, soils, and hydrologic characteristics of the site and served as the basis for evaluating the wetland boundaries mapped by the USFWS. These boundaries are based only on vegetation types as interpreted on small scale aerial photography and do not necessarily conform with the wetland area within the jurisdiction of the U.S. Army Corps of Engineers. Observations made during the reconnaissance effort which relate to each of the wetland parameters listed above are provided in Section 1.2.2.9.

**1.1.6.10 OFF-SITE RESIDENTIAL/PRODUCTION WELL  
SURVEY**

Water supplies in the vicinity of the Site were identified in the HRS scoring as potential receptors of groundwater contamination. These included two public water supplies (Artesian Water Company and Wilmington Suburban Water Corporation) and one area of private groundwater users along Old Airport Road.

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**Wilmington Suburban Water Corporation**

The Wilmington Suburban Water Corporation currently uses only surface water supplies although the Corporation formerly used groundwater supplies. The main surface water intake is located almost due west (upstream) of the Newport Site at the junction of the White City and Red Clay Creeks (tributaries to the Christina River).

**The Artesian Water Company**

The Artesian Water Company, with offices in Newark, Delaware, operates a water supply comprising 42 wells over an area of about 110 square miles. Total supply of the system averages approximately 11,000,000 gpd.

The wells nearest the site operated by Artesian Water Company are located at the Wilmington Airport approximately 1-1/2 miles southeast of the site. Three wells are operated at this location on an intermittent basis to meet the peak demand (4-6 months during the summer season). Quality of this water is considered to be poor due to high natural background concentrations of iron and manganese. When operating, these wells provide approximately 500,000 gpd, or less than 5 percent of the average system supply. On an annual basis, these wells provide about 2 percent of the Artesian Water Company production.

The primary supply of the Artesian Water Company is provided by wells 3 miles or more from the Newport Site which are interconnected in the distribution system. The permanently operated wells nearest the Site are located at Wilmington Manor, 3 miles southeast of the Site.

There is no evidence (Appendix B) that contamination from the Site is likely to migrate to the Artesian Water Company wells southeast of the site. In addition, the wells operated at the Wilmington Airport do not appear to represent an irreplaceable component of

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the Artesian Water Company system but, rather, they only provide low quality water used for water supply during peak demand periods.

### **Old Airport Road Wells**

To obtain groundwater use data in the immediate vicinity of the Newport Site, WCC conducted a survey of existing water wells southwest of the South Disposal site along Old Airport Road on December 16, 1987 (see Figure 1-14). This survey was conducted as part of the Remedial Investigation (Phase I). Information was obtained from users of 19 wells along Old Airport Road (see Table 1-8). There are residential and commercial buildings along this road, where access to any public water system has never been provided. However, public water supply could apparently be made readily available because Artesian Water Company has a water main along Old Airport Road, according to the chief engineer of the company, Mr. B. Lakshman.

The wells range in reported depths from 12 feet to 115 feet and therefore screened zones include all three of the water-bearing hydrostratigraphic units described in WCC's Hydrogeology Report (Appendix B).

Water quality problems reported by the owners/users were limited to ubiquitous iron staining and fairly abundant hydrogen sulfide ("sulfur") odors. One additional unique problem was a black precipitate reported from the Red Clay Consolidated School District's 60-foot well. Considering the significant sulfur smell, this black material appears to be some type of precipitate related to the hydrogen sulfide gas dissolved in the water. Despite the iron stains and sulfur smells, some of the residents use the water for cooking and drinking. Filtration is apparently the only type of water conditioning process used to treat any of the groundwater obtained from some of these wells.

As part of the second round of groundwater sampling of the Newport Site, Aqua Services, Inc., collected water samples from the two existing wells at Necastro's Auto Salvage on December 16, 1987. These two wells are located adjacent to the southwest corner of the Du Pont property which contains the South Disposal site.

The level of concern expressed by the local residents during the survey toward possible contamination of the local groundwater seemed primarily limited to the naturally occurring iron and sulfur-related problems. Only a few individuals expressed concern regarding possible impact of the auto salvage yards or Du Pont operations, although essentially all well users appeared cognizant of their existence. The long standing, preponderant habit of not using the ground water for drinking seems mostly related to the iron and sulfur problems.

## **1.2 NATURE AND EXTENT OF PROBLEM**

### **1.2.1 WASTE DISPOSED AT SITE**

This section summarizes available information concerning the quantities and characteristics of wastes disposed at the Newport Site. The primary sources of this information are the results of a preliminary waste characterization study at the South Disposal site conducted by WCC in December, 1987 and the following documents supplied by Du Pont:

- o "Notes on Lithopone" - C.K. Cooper, 8 August 1979;
- o Memorandum - P.E. Kress to J.C. Deming, 6 November 1979;
- o Letter - M. Barszcz (Du Pont) to R. Gordon (USEPA) titled Newport Waste Disposal Operations, 22 July 1980;
- o Memorandum titled "Waste Disposal Survey" - R.E. Kress to P.F. Brown -29 October 1980; and
- o Letter - R.J. Mattson (Du Pont) to S.R. Wassersug (USEPA) 21 May 1986.

An available inventory of waste materials disposed at the Site are summarized in Table 1-9.

#### **1.2.1.1 NORTH DISPOSAL SITE WASTE CHARACTERIZATION**

The North Disposal site received a variety of waste materials during its operations from 1902 to 1974. Table 1-9 presents a summary of materials known or suspected to have been disposed in the North Disposal site. The major waste materials containing potentially hazardous constituents, based upon available information, are discussed below.

##### **Lithopone Wastes**

The Lithopone process formerly used at the Newport Plant produced a white pigment composed of barium sulfide and zinc sulfate. Some Lithopone pigments (off-quality) and Lithopone wastes may have been disposed in the North Disposal site. Several thousand tons of fill dirt containing zinc and barite ores were also placed in the North Disposal site.

Wastes from the Lithopone process consisted of insoluble ore residues. Zinc ore was treated with sulfuric acid to dissolve zinc. Insoluble residues were precipitated with ferric hydroxide, resulting in a "red mud" which was disposed. The zinc process also produced a byproduct filter cake which was sold for cadmium recovery.

The barium sulfate ore was roasted in kilns to reduce the sulfate to barium sulfide, which was dissolved in hot water. The insoluble ore residues formed a "black mud", which was disposed. The waste muds were generated in an estimated ratio of 1 part red mud to 3 parts black mud. Best estimates indicate disposal of approximately 25,000 tons of this mixture over approximately 15 acres in the South Disposal site (see Section 1.2.1.2). After 1953, any remaining ore residue wastes were disposed in the North Disposal site. Potential contaminants from Lithopone wastes and ore residues include barium, zinc, and cadmium.

**Copper Phthalocyanine Wastes**

Copper phthalocyanine, a stable blue-green pigment has been manufactured at the plant since 1947. In general, byproducts have been discharged to municipal waste treatment facilities. Some off-quality pigments were disposed at the North Disposal site. According to data provided by Du Pont, copper phthalocyanine is essentially non-toxic by the oral route. It has been approved by the U.S. Food and Drug Administration (FDA) for use as a pigment in polymers used in food packaging. According to Merck (1983), this compound is also approved by FDA for use in polypropylene sutures.

**Quinacridone Wastes**

Quinacridone, a stable red organic pigment, has been manufactured at the plant since 1958. Byproducts of the process have generally been discharged to municipal wastewater treatment facilities, with the exception of an insoluble tarry solid, which was disposed in the North Disposal site until 1974. Primary constituents of this tar are biphenyl, diphenyl ether, and alpha-methyl naphthalene. The quinacridone process also used tetrachloroethylene and it is possible that some quinacridone wastes may have become contaminated with tetrachloroethylene or Dowtherm constituents. Off-quality quinacridone pigments were also disposed in the North Disposal site. Soluble components of quinacridone wastes, including tetrachloroethylene if present, represent potential groundwater contaminants from this material. According to data supplied by Du Pont, quinacridone itself is essentially non-toxic by the oral route, and has been approved by FDA as a colorant for polyolefins used in food packaging.

**"Afflair" Pigment Wastes**

Afflair, a stable white pigment, consists of mica coated with titanium dioxide. Some scrap mica (a natural mineral), was disposed at the North Disposal site. This material is unlikely to represent a significant source of contamination.

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**Metal Production Wastes**

From 1950 to 1960, several metals and metal alloys were manufactured at the plant. These included titanium, zirconium, and silicon, which are relatively inert substances. Unknown, small quantities of off-grade materials were disposed in the North Disposal site.

For about two years during this period, thoriated nickel (nickel containing 2-5 percent of  $\text{ThO}_2$ ) was produced. Approximately 20 tons of process wastes (primarily off-grade thoriated nickel) were disposed in the North Disposal site under NRC guidelines. Thorium is a radioactive substance (see Section 1.1.6.5).

Since the metals produced are essentially insoluble in their metallic forms, there is little potential for leaching of the disposed  $\text{ThO}_2$  and its daughters.

**Chromium Dioxide Wastes**

Chromium dioxide has been manufactured at the plant since 1966. Some of this material is used in the production of magnetic recording tape (mylar coated with chromium dioxide). Approximately 10 tons of off-quality chromium dioxide (in drums) and mylar recording tape (in bags) were disposed at the North Disposal site. The primary potential groundwater contaminant from this material is the heavy metal chromium.

**Miscellaneous Wastes**

As shown on Table 1-9 a variety of other wastes including low volume process wastes, lab packs, and garbage were disposed in the North Disposal site. A variety of low level contaminants could be present in these materials.

A variety of relatively inert materials, including trash, concrete, steel, rubber, refuse nylon shutters, and "Corian" (imitation marble sheets) were also disposed in the North Disposal site. No significant groundwater contamination would be expected from these materials.

#### **1.2.1.2 SOUTH DISPOSAL SITE WASTE CHARACTERIZATION**

##### **Fill Materials**

As described in Section 1.2.2.1, historical documents supplied by Du Pont indicate that waste materials ("muds") from the Lithopone pigment process were disposed at the South Disposal site.

To obtain more specific information about characterization of the Lithopone waste and other fill materials in the South Disposal site, eight test pits were excavated, visually examined, and sampled by WCC on December 17, 1987. These test pits, which were located to provide adequate site coverage in areas accessible to the backhoe (see Figure 1-15), disclosed that the soil cap placed over the Lithopone waste varied from 0 to 6 feet and averaged 3 feet. This soil covering is believed to be the fill materials placed on the site by the Delaware State Highway Department in 1973. The soil fill materials are highly variable, ranging from silty and sandy clays to sandy gravel, with cobbles and concrete rubble fill.

Below the soil fill cover, the test pits encountered a chemical waste fill material believed to be the Lithopone waste. Usually these materials were dark gray to black in color and had a constituency of sandy clayey silt. Sometimes the upper few inches to approximately 1-1/2 feet was hard and blocky, as if these materials had cemented into a "sandstone-like" material. However, below this upper crust the waste fill was observed to be soft to very soft and to have a "jello-like" consistency. This soft fill consistency was not

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expected based upon previous reports of how the Lithopone waste was expected to stabilize with time.

The Lithopone waste was encountered at depths ranging from 0 to 6 feet below the existing ground surface and averaged 3 feet. The Lithopone waste extended to the full depth (8 to 10 feet) of the test pits in all cases, with the thickness of the Lithopone waste penetrated varying from 4 to 8 feet and averaged 5 feet. The total thickness of the Lithopone waste is not known, but it probably extends down to about elevation 0. Whether or not the Lithopone waste is underlain by only natural soils, or interbedded with other fill materials or dredgings from the adjacent Christina River, is unknown.

Due to the potentially hazardous nature of the Lithopone waste, personnel did not enter the eight test pit excavations. Therefore, depth measurements and observations were made from the edge of each pit and from material brought up in the backhoe bucket.

Soil samples were collected from each test pit and analyzed by ETC Corporation for EP toxicity metals and reactive sulfide. Samples collected from test pits TP-2 through TP-8 were also analyzed by ETC Corporation for the complete HSL. Analytical results (see Appendix J) for compounds with concentrations above the method detection limit are summarized in Table 1-10. The sample collection and analysis procedures are addressed in Section 6 of QAPP.

EP Toxicity results indicate exceedance of the RCRA alert level for barium (100 mg/l) for four samples. These four samples were collected from the Lithopone waste in TP-1, TP-3, TP-6, and TP-8. Cadmium was measured above detection limits in TP-5 (0.84 mg/l), but did not exceed the RCRA alert level of 1 mg/l.

Reactive sulfide is a RCRA parameter used to measure the reactivity of a waste material. Toxic fumes can be generated when a sulfide-bearing waste is disposed with

or exposed to mildly acidic or basic wastes resulting in formation of H<sub>2</sub>S gas. An EPA action level of 500 mg/kg has been established for this parameter. Lithopone waste samples from test pits TP-1, TP-3, TP-4, TP-6, and TP-8 exceeded this level.

Results of the HSL analyses showed that seven organics and several metals (including aluminum, barium, iron, and zinc) were found above method detection limits. EP toxicity results indicated that the Lithopone waste would likely be classified as a RCRA hazardous waste at certain locations within the filled area.

### **1.2.2 EXISTING DATA EVALUATION**

#### **1.2.2.1 HYDROGEOLOGY**

Regional analysis of groundwater flow in the Newport area (Petty, et al., 1983; Woodruff, 1984) has been reported in the literature (Ref. 5 and 4). These studies have concluded that the Christina River valley in the vicinity of Newport is a groundwater discharge area where groundwater flow from the lower Potomac Formation aquifer discharges through the Columbia Formation to the Christina River. Groundwater level monitoring and aquifer testing and analyses conducted by WCC during the period of June through August 1987 as part of the Remedial Investigation (Phase I) supported the discharge area concept in the literature (see Appendix B).

#### **Groundwater Level Monitoring and Evaluation**

Site data from 27 groundwater monitoring wells installed by WCC (Appendix A), and 12 pre-existing wells (Figure 7) were used for hydrologic analyses. Static water levels at 31 wells and tide elevations were collected continuously (15 minute intervals) for at least 24 hours prior to the start-up of each test. In the period of August 1 through 8, all wells (except MW-11, MW-6A, MW-6B, MW-6C and MW-13, which are located at the southern

border of the Site, and wells DM-8, SM-5, and WW-11 located on the Ciba-Geigy plant) were monitored (Appendix E).

Static water elevations were collected manually at those wells not electronically monitored, and were incorporated into the analysis for this period. Because it was apparent that many of the wells respond to tidal fluctuations of the Christina River (see hydrographs in Appendix E), groundwater hydrologic analysis is presented for the range of tides that was observed on August 4, 1987. The purpose was to assess the sensitivity of groundwater flow at the Site to river stage.

The well hydrographs indicated that wells screened in the Intermediate (Unit III<sub>A</sub>) and Deep (Unit IV) Zones respond to a greater extent and at greater distance from the Christina River than wells completed in the Shallow Zone (Unit I). For example, a comparison of the hydrographs of well MW-4A with wells MW-4B or MW-4C demonstrates this phenomenon. The water level in the Shallow Zone at this location, although located about 100 feet from the river, does not respond measurably to tidal fluctuations, whereas the head in wells in the Intermediate and Deep Zones responds to the semi-diurnal tide of the Christina River. Similarly, the response of two other Shallow Zone wells, MW-1A and MW-2A, is immeasurable compared to the corresponding response of the associated Intermediate and Deep Zones. The failure of the Shallow Zone wells to respond to tidal ranges of 5 feet or more is attributed to the fact that the groundwater in the Shallow Zone occurs under water table (unconfined) aquifer conditions.

In order for a response to tidal fluctuations to occur under water table conditions, a mass of water must move to or away from the well as a direct result of tidal fluctuations, which apparently is not the case at any of the Shallow Zone wells. On the other hand, the response of head to confined conditions reflects a pressure change that requires a change only in the pressure head with little movement of water necessary. Accordingly, the

response at the Intermediate and Deep Zones is that of confined or semi-confined aquifer conditions.

Piezometric head maps of the Newport Site that include both the North and South Disposal sites, were prepared for the three water-bearing zones (Units I, III<sub>A</sub>, and IV) both for river low and river high-tide conditions for August 4, 1987 (Figures 7 through 12 of Appendix B). Contours for the Shallow Zone are typical for a water table aquifer in that they often mimic topography; that is, groundwater flows from areas of higher elevations to areas of lower elevations.

The contours of the Intermediate and Deep Zones, both for low and high tides, indicate piezometric surfaces that slope southeastward. The contour lines, however, are not evenly spaced across the Site. The gradients are four to ten times greater north of the southern shoreline of the Christina River than they are south of the Christina River. For example, the horizontal gradient of the Intermediate Zone at low tide from MW-2B to DM-4 located on the south side of the Christina River is about 0.01, whereas the horizontal gradient from DM-4 to MW-5B south of the river is about 0.001. This represents a ten-fold decrease in gradient. A similar reduction in gradient from steep to shallow is apparent in the Deep Zone. These marked changes in gradient indicate that the river acts as a hydraulic boundary.

To analyze the vertical flow further, hydraulic head contours in vertical sections were prepared along sections A-A' and B-B' for both low and high tide (Figures 13 to 16 Appendix B). Contours of the head data for the Shallow Zone were used to develop the water table shown in the profiles. Contours of heads for the Intermediate and Deep Zones along the profile lines were transferred to the tops of Units III<sub>A</sub> and IV, respectively. Contours of potentiometric head in profile then were developed for each vertical section.

An analysis of these contours indicates a strong upward gradient (0.1 or greater in some places) from Intermediate Zone, north of the southern edge of the Christina

River. Flow lines interpreted on the basis of these contours indicate that the potential for flow is from the Intermediate Zone through the semi-confining bed and upward through Unit I into the Christina River. Based on the piezometric head data, precipitation that infiltrates into the Columbia Formation (Unit I) north of Christina River at the Site, including the North Disposal site, would discharge to the Christina River. In addition, the Columbia Formation is partially recharged from the underlying Potomac Formation.

To estimate the extent of groundwater discharge to the surface in the vicinity of the North Disposal site, potentiometric head difference maps (Figures 1-16 and 1-17), both for low and high tide, were constructed. These figures show the difference in head between the Intermediate and Shallow Zones. In areas where the heads of the Intermediate Zone are greater than that of the Shallow Zone, an upward potential exists and groundwater would discharge to the surface. The data are explicit and show the Christina River valley in the vicinity of the Newport Site to be a groundwater discharge zone. No groundwater flow path from the surface of the Site north of the Christina River to the subsurface south of the Christina River has been identified.

#### Aquifer Testing And Analysis

As part of the Newport Site Phase I RI efforts, two aquifer tests were conducted, using one well on each side of the Christina River (Appendix D). The unit tested for the aquifer test was the Intermediate Zone (Unit III<sub>A</sub>), which is the uppermost water-bearing zone in the Potomac Formation at the Site. The pumping wells were MW-3B and MW-6B. Heads in more than 25 observation wells were monitored electronically during the drawdown and recovery portions of each of the tests (Appendix E).

Based on the results of the aquifer tests, the estimated transmissivity of this Unit III<sub>A</sub> ranged from 2000 to 7000 gpd/ft over the entire Site including the Du Pont property south of the Christina River. Estimates of the storage coefficient ranged from  $2 \times 10^{-4}$  to

$4 \times 10^{-4}$ . These estimates of transmissivity fall within a relatively narrow range and are consistent with the interpretation of the geophysical logs and stratigraphy of the area. (Stratigraphically, the water-bearing units show fairly uniform thickness and similar lithological variations in each of the seven test borings.) The storage coefficients are consistent with semi-confining nature of the Intermediate Zone.

The pumping test data indicates relatively uniform stratigraphic thickness and transmissivity in the water-bearing units. When interpreted along with the piezometric head data, the pumping test data reinforce the concept that the Christina River acts as a significant line of groundwater discharge, and that groundwater flows from the deeper water-bearing units upward through the shallow water-bearing units and into the Christina River.

#### **Groundwater Velocities**

Based on the estimated transmissivities, hydraulic gradients, and water-bearing zone thicknesses, groundwater flow velocities were evaluated using a formula derived from the Darcy equation. Within the Intermediate Zone (Unit III<sub>A</sub>), groundwater flow velocities are estimated to range from about 0.2 to 0.4 ft/day north of the Christina River and about 0.2 to 0.6 ft/day south of the Christina River.

#### **Conclusions**

The subsurface geologic, stratigraphic, and geophysical data collected at the Newport Site, together with the hydrologic data, provide ample information on the groundwater hydrology to allow assessment of groundwater flow potentials and an estimation of groundwater flow paths relative to the North Disposal site. The data on the Site confirm the hydrologic and geologic analyses performed by Petty et al., (1983, and Woodruff (1981, 1984, 1985) on the region (Ref. 5, 3, 4, and 2).

Infiltration north of the Christina River at the Site apparently percolates into the uppermost water-bearing unit (Unit I) and discharges to the Christina River. Vertical groundwater flow north of and underneath the Christina River is upward from Unit III<sub>A</sub> into the Unit I and to the Christina River, which is a groundwater discharge area. No groundwater flow path extending from the North Disposal site to the water-bearing units of the Potomac Formation has been identified.

#### **1.2.2.2 GROUNDWATER AND SOIL CHEMISTRY DATA**

The analytical results (Appendix J), obtained as part of the RI (Phase I), from the two rounds of groundwater sampling at the Newport Site and the subsurface soil sampling in the test borings will be evaluated (see Section 3.3) during the proposed RI (Phase II).

#### **1.2.2.3 SURFACE GEOPHYSICS DATA**

Upon reviewing the nature of the wastes disposed at both the North and South Disposal sites, it was assumed that they are conductive in character and that they would lower the resistivity of the subsurface zone in which they might be situated. In order to estimate the lateral and vertical extent of the wastes, it is necessary to compare resistivity observations from suspected areas with those taken from an undisturbed area. The sounding near test boring TB-1 was assumed to provide this natural resistivity background. This sounding shows: an average of 350 ohm-feet to a depth of 2 feet; 250 ohm-feet in a zone from 2 to 5 feet; 450 ohm-feet in a zone from 5 to 31 feet; and 230 ohm-feet in a zone from 31 to 80 feet (see Appendix F).

##### **North Disposal Site**

In comparing the undisturbed area information with the resistivity data at the North Disposal site, two zones of anomalous resistivity readings are suggested: from 7.5 to 30

feet west of grid line F; and from 30 to 45 feet in the southeast quadrant of the area surveyed at the North Disposal site. The two vertical profiles confirmed this circumstance from another perspective. These resistivity values, possibly associated with the waste material at the site, appeared to be dipping in a southeasterly direction at the 7.5 to 45 foot levels.

The results of the terrain conductivity survey showed lower resistivity (or higher conductivity) values concentrated along a northwest-southeast trend. Without knowing the exact electrical parameters of the waste materials, it is difficult to define the boundary of wastes from conductivity information alone. Instead, it is only possible to suggest the approximate location of zones of relatively higher conductivity that might be associated with concentrated zones of waste materials.

#### **South Disposal Site**

Assuming that the wastes disposed at the South Disposal site are less resistive than the natural material in the area, it is possible to infer, from the resistivity data, that the wastes might be contained, for the most part, in the easterly half of the site (i.e., east of grid line J/K) to a depth of approximately 15 feet. It appears, too, that a somewhat less resistive zone extends to a depth of about 45 feet.

The results of the terrain conductivity survey support the observations of the resistivity soundings. This survey did not permit defining an areal boundary of the wastes located at the South Disposal site, but the inference was made that areas which may contain relatively higher concentrations of waste materials appear to be confined to the northeast quadrant of this site.

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#### 1.2.2.4 SOIL GAS DATA

Table 1-6 summarizes field GC analyses for TCE and PCE concentrations detected at probe locations sampled. Significant concentrations were found only in the North Disposal site. All probes sampled in the South Disposal site were below the method detection limit of 10 ppb for TCE and PCE. However, a sample from the South Disposal site sent to an outside laboratory for confirmatory analysis, had a relatively high level of methylene chloride, which may have been a laboratory artifact.

Both disposal sites were surveyed along a 100-foot grid pattern, as shown in Figure 1-11. Lines of the survey which trended east-west, roughly parallel to the Christina River, were designated with numbers. The perpendicular lines of the survey, trending north-south, were designated with letters. Each sampling point is referred to by its letter and number coordinate. General concentration trends are referred to according to the grid line as a whole.

#### North Disposal Site

Thirty-two probes were installed and sampled on the North Disposal site. Sampling locations and PCE concentrations found on the North Disposal site are presented on Figure 1-18. TCE concentrations are presented on Figure 1-19.

**PCE:** Based on the data obtained, the predominant pattern of PCE distribution is an area of high concentration, 2,000 ppb at C-6, which decreases by at least an order of magnitude in the surrounding probes. C-6 seems to be the center of an oblong, east-west trending plume extending along the 6 and 7 lines, between the B and F lines.

Two other areas of relatively high concentrations were detected at I-7 (650 and 200 ppb) and H-5 (4000 and 1900 ppb). There doesn't seem to be a distinguishable plume in

these two areas and both readings stand out as anomalies. The remainder of the North Disposal site samples ranged in concentration from below method detection limits (BMDL) to 70 ppb.

In order to define more accurately the northern and western extent of the plume apparently centered at C-6, three additional probes were installed. These probes were installed at unsurveyed locations. Their exact placement was limited by inaccessibility and shallow depth to groundwater. The northern most of the three was located approximately at grid location C-3 on a vegetated hill, northeast of the drainage ditch which surrounds the North Disposal site. Probe B-4/5 was located outside the North Disposal site fence on a slope leading down to the drainage ditch. Probe C/B-7 was also located within the landfill fence.

Probe C/B-7 had a PCE concentration of 340 ppb. This was similar to the nearest probes, B-6, 480 ppb, and D-7, 700 ppb. Probes B-4/5 and C-3 were BMDL and trace concentrations (10 to 50 ppb), respectively.

TCE: Detected TCE concentrations, in general, were lower than PCE concentrations. As with PCE, relatively high readings were detected along the six line. Concentrations were 150 ppb at C-6, 340 ppb at D-6, and 280 ppb at E-6. They decreased eastward to trace concentrations at B-6, and westward to 130 and 110 ppb at F-6. TCE concentration increased farther west of F-6 to 420 ppb at G-6. The highest value was found at H-5, 600 ppb, but a duplicate analysis three days later showed 20 ppb.

Concentrations across the rest of the site varied from BMDL to 170 ppb, in no discernable pattern. As with PCE, probes B-4/5 and C-3, installed northwest of the landfill, were BMDL for TCE.

**South Disposal Site**

Forty probes were installed on the South Disposal site. Probe locations are presented on Figure 1-20. Six probes were not sampled because the area surrounding them was fairly well defined by surrounding probe data. Two surveyed locations, L-16 and J-14, were also not sampled because of the shallow depth to groundwater. Water was drawn through probes I-13 and J-14. None of the locations sampled showed TCE or PCE contamination above the method detection limit of 10 ppb.

In an effort to expand the soil gas investigation beyond the southern and western disposal limits of the South Disposal site, probes were placed at grid coordinate G-11 and at five other locations along the "berm" shown on Figure 1-20. These five locations were designated according to the closest grid coordinates: E-14; F-15; G-16; J-19; and M-20. None of these samples showed TCE or PCE concentrations above the method detection limit.

**Conclusions**

Delineation of PCE and TCE vapors in the vadose zone was accomplished at both sites within the limitations of the method detection limit of 10 ppb. No TCE or PCE vapors were detected in the South Disposal site above the method detection limit.

The data indicates that PCE and TCE are similarly distributed in the North Disposal site. There is a relatively high concentration centered around C-6 extending primarily east-west for several hundred feet. This area of the North Disposal site seems to generally correspond with the location of lower resistivity values observed in the surface geophysics survey.

According to laboratory analysis, methylene chloride, benzene, and trifluorochloromethane are also present in the vadose zone. While methylene chloride is a

common laboratory artifact, there does not appear to be any indication of methylene chloride contamination in the laboratory method blank. Methylene chloride was not targeted for soil gas analysis because available information showed that it was unlikely to have been disposed of in process wastes, and because it was found in very low concentrations in relatively few well samples.

Because the standard gas used contained methylene chloride, its retention time was documented. Upon review, several sample chromatograms recorded significant peaks with the same retention time as methylene chloride. However, column conditions allowed for interference by many other compounds; resulting peaks could represent one or a combination of chemicals. Because of this possible interference, the presence of methylene chloride and its possible concentration could not be confirmed.

Although there were only three laboratory samples which indicated methylene chloride, the location of the sampling points and the concentrations detected suggest that a source of methylene chloride may be present upgradient of, or on one or both disposal sites.

The concentrations of PCE and TCE detected in the soil gas on the North Disposal site suggested that a source of both chemicals might be present in or upgradient of the North Disposal site. However, because of the heterogenous nature of the North Disposal site vadose zone, a definite source location and concentration or migration pattern could not be defined with precision. For the same reason, it was not possible to determine to what extent, if any, the source or sources of soil gas contamination are related to groundwater transport.

Another factor for consideration is recent studies of chemical compounds showing TCE to be a biotransformation reaction product of PCE. Perhaps only a PCE source is involved at the Site and the associated TCE detections are a biotransformation product.

#### 1.2.2.5 GROUND RADIOMETRICS DATA

In the area of the North Disposal site where thorium waste appears to be buried (Figure 1-12), the total gamma radiation contours reveal some slight anomalies. However, the radiometrics data suggested that much of this response can be attributed to the presence of uranium-238 within the volume of earth sampled at each station. Although the contribution of radioactive potassium to the total count was not evaluated, it is possible that the presence of micas in the sediments may also contribute to the total gamma radiation at the site. The gradients expressed by the contour maps are gentle and radiation levels are only slightly above background. The likelihood that these anomalies represent a buried radioactive source is minimal.

From plant records, the thorium waste is buried approximately 10 feet below the landfill surface. This information, together with the fact that there is a 2-foot thick clay cap covering the waste materials, suggests that the distribution of anomalies may actually reflect variations in the composition and thickness of the cap across the disposal area. This interpretation is supported by the apparent similarity of uranium and thorium count figures (see Appendix H).

The results of the ground radiometric survey at the North Disposal Site may be summarized as follows:

1. Measured gamma radiation levels across the North Disposal site were generally the same as background levels.
2. Minor anomalies were present, but they are only slightly above background and have gentle gradients.

3. Minor anomalies were observed across the southern end of the landfill and in the northern apex area. Some were within the zone where thorium waste is believed buried, but they are not unique to this zone.
4. Minor anomalies were detected in both the uranium and thorium channel data in the area where thorium waste was reportedly buried. The contribution of uranium at the same locations of thorium anomalies suggested that the thorium waste was buried too deep to be detected by the gamma spectrometer.

Although the field survey did not cover the entire area of suspected radioactive waste disposal, and the detector was not placed directly on the ground surface, further ground radiometry may not be conclusive.

#### 1.2.2.6 RADON GAS DATA

The results of laboratory analysis for the radon gas sampling are depicted in Figure 1-21. The laboratory data are provided in Appendix I. Interpretation of the distribution of radon data is usually difficult because of the effects of many factors including, but not limited to: weather-related effects during sampling; subsurface saturation, permeability and porosity variations; and heterogeneity of materials.

Because the data are derived from a disposal area, it is difficult to define the source of the radon except to say that it ultimately is a decay product of uranium-238. Data from the soil gas survey suggest that radon gas appears to be accumulating beneath the clay cap.

The detected radon concentrations are 2 to 3 orders of magnitude above EPA's average outdoor level of 0.2 picocuries per liter. These data, however, may not be truly

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representative, given only one sampling event. Moreover, gamma radiation emanating from the site, based on ground radiometric surveys on the average, is consistent with background levels.

The conclusions reached by the radon gas investigation were:

1. Radon concentrations at depths of 3.5 to 5.5 feet are elevated above EPA's average outdoor level. Detected surface radiation levels are at background levels.
2. The source of the uranium is uncertain, but is thought to occur within natural organic rich materials buried beneath the clay cap. It is believed to be unrelated to buried radioactive wastes, which are known to contain only thorium-232.
3. The clay cover appears to be effective in limiting diffusion of radon gas into the atmosphere at the site. The enhancement of natural radioactivity barriers that retard the diffusion of radon gas is a recognized phenomenon.
4. Drilling or excavating within the North Disposal site may vent the radon gas and thus may pose a potential health risk to field personnel.

#### 1.2.2.7 CHRISTINA RIVER WATER CHEMISTRY DATA

Although data validation (see QAPP) and complete evaluation of these data will be conducted as part of Phase II of the Remedial Investigation, a preliminary evaluation of the Christina River water chemistry (see Appendix J) is provided in this section.

The following seven contaminants were found in surface waters of the Christina River in levels exceeding federal standards for protection of human health and/or aquatic life from the sampling conducted in August 1987:

Cadmium;  
Chromium;  
Copper;  
Lead;  
Zinc;  
2,4-dinitrotoluene; and  
tetrachloroethylene.

In two out of the twelve samples collected, cadmium levels exceeded the acute and chronic EPA ambient water quality criteria for the protection of freshwater aquatic life of 0.0018 ppm and 0.00066 ppm, respectively. The two levels were 0.0043 ppm, at slack and 0.0096 ppm at flooding tide.

Chromium was detected at low levels in all twelve samples collected with concentration ranging from a low of 0.0045 ppm, to a high of 0.012 ppm. The average concentration for all twelve samples collected over the tidal cycle was 0.008 ppm. With the exception of one sample, all levels were within standards. Sample RW-10, collected near high tide, had a chromium level of 0.012 ppm barely exceeding the chronic EPA ambient water quality criterion for protection of aquatic life at 0.011 ppm.

Copper was detected at levels ranging from 0.0062 ppm to 0.012 ppm in 11 out of 12 surface water samples collected in the Christina River. There are no standards for the protection of human health for this heavy metal, but the EPA Recommended Maximum Contaminant Level (RMCL) is 1.3 ppm. Concentrations exceeded the chronic criterion for the

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protection of freshwater aquatic life of 0.0065 ppm in 7 of 11 samples where the contaminant was detected.

Lead was detected at levels ranging from 0.021 to 0.72 ppm in five of 12 samples collected. The criterion for the protection of human health, based on the ingestion of water and organisms, is 0.05 ppm. Only one sample exceeded this concentration. Concentrations were all within the chronic criterion for the protection of freshwater aquatic life of 0.0013 ppm, but exceeded the acute criterion of 0.034 ppm in two samples.

Overall, lead was detected at rapidly increasing levels on the ebbing tide. From 0600 hours (near high tide) to 0800 hours (ebbing tide), lead concentrations increased from non-detectable to 0.072 ppm. By low tide (1200 hours), lead concentrations were again below detection limits, and remained below detection for the remainder of the flooding portion of the tidal cycle. This may indicate that at high tide, heavy loadings occur upgradient of the site, are transported downgradient on the ebbing tide, and precipitate out of the water column before the next tidal cycle begins.

Zinc was detected at levels ranging from 0.07 ppm to 0.287 ppm in all 12 samples collected, with an average concentration over the tidal cycle of 0.117 ppm. There are no standards for protection of human health or recommended contaminant levels for zinc. Of the 12 samples, all exceeded the chronic criterion for the protection of freshwater aquatic life of 0.047 ppm, and one exceeded the acute criterion of 0.18 mg/l.

As indicated above, only two organic contaminants were identified in levels exceeding standards. 2,4-Dinitrotoluene was detected at a level of 0.04 ppm in one of the 12 samples collected. This exceeds the criterion for carcinogenicity protection in humans, based on the ingestion of organisms only criterion of 0.0091 ppm. This level is within both the acute and chronic water quality criteria for the protection of freshwater aquatic life.

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Tetrachloroethylene was detected at a level of 0.0114 ppm in one out of the 12 samples collected. Because this contaminant is a suspected carcinogen, the RMCL is 0. The measured concentration also exceeds the criterion for carcinogenicity protection in humans, based on the ingestion of organisms only, of 0.00885 ppm. The concentration of 0.0114 ppm is within all available criteria for the protection of aquatic life.

#### **1.2.2.8 CHRISTINA RIVER SEDIMENT CHEMISTRY DATA**

The preliminary evaluation of the analytical results (see Appendix J) indicate that the levels of organics and heavy metals were generally low in the sediment samples collected from the Christina River in June 1987. Because there are not standards for contaminant levels in sediments, meaningful evaluation of the analytical data is difficult.

In all, six different organics and oil and grease were detected in the sediment samples as follows:

- methylene chloride;
- acetone;
- carbon disulfide;
- methyl ethyl ketone;
- di-n-butyl phthalate; and
- bis(2-ethylhexyl)phthalate.

With few exceptions, levels were generally well below or equal to 0.1 ppm. Oil and grease exceeded this level in several samples reaching a maximum concentration of 0.32 ppm at a depth of 1 to 2 feet at Station 2B. In general, organics were encountered more frequently and at higher concentrations in upgradient Station 1 samples.

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uncertain, whether diking was associated with the use of the site for pigment waste and dredge spoil disposal is unknown. As a result of this diking, a varied topography has been created inside the diked area, probably resulting from sedimentation. This diked area supports a variety of habitats ranging from upland to open water. The surface drainage pattern within the diked areas follows the topography to the open water area, which discharges to the ditch system at a cut in the dike.

Previous ditching in the area is evident from the arrangement of the channels south of the diked area. These channels contain standing water which was observed to be flowing slowly toward the tide gate.

### **Vegetation**

The area of investigation supports a wide variety of vegetative species ranging from upland trees (e.g., black locust) to wetland emergents (e.g., common reed, arrow-arum). Most of the area is vegetated with dense stands of common reed which have developed as a result of previous disturbance (i.e., ditching, diking, hydrologic control). Little evidence of what was probably the original wetland type (arrow-arum or pickerel weed marsh) was observed. This was in part due to the time of year, but decaying remains of such emergents were noted in the more natural open water channels which are present on the western portion of the Du Pont property. This area is bounded by filled areas associated with the adjoining junkyard and an unpaved utility road, which has been constructed heading north from Old Airport Road.

Small areas of woodland vegetation also occur. Those located south of the diked area are dominated by red maple, sweet gum and pin oak. In some areas the understory layer is dominated by green briar. A wooded area within the diked area is dominated by willow.

**Surface Soils**

Like the hydrology and vegetation, the surface soils present reflect previous disturbance. However, nearly all areas examined which are dominated by common reed (the exception being the dikes and other fill areas present) display the mottling and gray soil matrix which is typical of wetland soils. The wooded areas generally occur on higher elevations than common reed and the soils of these areas are brighter in color than the adjoining common reed areas, indicating that they dry sufficiently to become oxidized and, therefore, represent (at least in part) small uplands within what are otherwise largely wetland soil areas.

**Wetlands Mapping**

The scope of field work associated with this task was limited to a one-day field reconnaissance to evaluate the accuracy of existing U.S. Fish and Wildlife Service wetland mapping of the 45-acre area south of the Christina River. As shown on Figure 1-22, this mapping indicates that both open water and estuarine emergent wetlands occur. The areas mapped by the U.S. Fish and Wildlife (totalling about 17 acres) are for the most part the same as the open water and the previously ditched emergent wetlands observed during the field reconnaissance.

One difference is the extent of wetlands which are mapped by the U.S. Fish and Wildlife Service within the diked area, which is limited to a 3-acre open water area. WCC observations indicate that additional emergent wetlands (totaling about 4 acres) occur adjacent to the open water area. Thus, the WCC findings indicate that about 21 percent of the approximately 45 acres of Du Pont property located south of the Christina River meet the U.S. Army Corps of Engineer's definition of a wetland.

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**1.2.3 POTENTIALLY AFFECTED MEDIA**

The waste materials were placed in unlined disposal areas. The disposal areas are currently covered with mostly silts, clays and sandy materials with the thickness averaging 2 feet of mostly clay at the North Disposal site and averaging 3 feet at the South Disposal site.

The waste disposal areas may potentially affect the following media:

surface soil;  
groundwater; and  
surface waters and river sediments.

**1.2.4 POTENTIAL CONTAMINATION MIGRATION PATHWAYS AND ENVIRONMENTAL AND HEALTH EFFECTS**

Currently, the wastes in the disposal areas are covered and isolated from direct exposure of the public. Therefore, there are no apparent adverse environmental and public health effects present from direct contact with the disposal waste materials.

Surface run-off prior to capping or covering the two disposal sites could have resulted in the transport of some contaminated sediments into the river water. Potential exposure to the public could have been by direct contact or ingestion by humans or wildlife. However, since the capping or covering of each disposal area, surface run-off probably has not transported contaminants into the Christina River.

The potential migration pathway of any possible leachate from the disposal areas may reach the river water and sediments which may be transported in the flow direction of the Christina River. Potential exposure to the public via the contaminated groundwater and

surface water pathway would be by direct ingestion or indirect ingestion of bioaccumulated chemicals in the food chains.

Potential air emissions are likely reduced due to the current covers over the disposal areas. Potential exposure to the public from potential air emissions would be by inhalation.

### 1.3 HISTORY OF RESPONSE ACTIONS

According to the existing records, no prior remediation responses by local, state, federal or private parties have been performed at the Site, other than providing the 2-foot thick soil cover on the North Disposal site and the average 3-foot thick soil cover on the South Disposal site.

### 1.4 BOUNDARY CONDITIONS

The Holly Run Plant Site consists of the North and South Disposal sites within Du Pont's property located on the north and south banks of the Christina River (Figure 1-2). For the purpose of this RI/FS, the site boundary is defined as a conceptual boundary drawn at fifty feet distance of the waste limits around the disposal areas.

### 1.5 SITE MAP

A 1 inch = 200 feet scale site topographic map covering the Du Pont property with two feet contour intervals is available and was used during Phase I of the Remedial Investigation (reduced copy shown in Figure 1-3).

The map includes surface features such as existing water wells, bodies of water, buildings, access roads, and property boundaries.

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TABLE 1-1  
HYDROSTRATIGRAPHIC UNITS  
Du Pont Newport Site

| Unit             | Lithologic Appearance                                                                                                                                                                                                                                                                                                                                                         | Depth Range<br>to top of<br>Unit (ft) | Unit Range<br>of<br>Thickness (ft) |
|------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------|------------------------------------|
| I                | <u>Shallow Zone.</u> (Columbia Formation; Pleistocene) Clastics, yellow brown to orange sands and clays. Usually clayey near land surface, grading coarser with depth. This unit often contains a gray-black organic clay.                                                                                                                                                    | 0                                     | 25-34                              |
| II               | <u>Semi-Confining Unit.</u> (Top of Potomac Formation; Cretaceous) Marked by the first appearance of white-gray sand or reddish to orange sandy clays. Appears to be an effective semi-confining unit separating Unit I and Unit III <sub>A</sub> .                                                                                                                           | 25-34                                 | 23-40                              |
| III <sub>A</sub> | <u>Intermediate Zone.</u> Clayey sand unit, consisting of clayey sands in the upper section grading to a more clayey unit with depth. Sands range from fine to medium grained with varying clay content. Color ranges from red to orange to yellow.                                                                                                                           | 53-66                                 | 13-37                              |
| III <sub>B</sub> | <u>Semi-Confining Unit.</u> This unit is very similar to III <sub>A</sub> in color and shows interfingering of units except that the clay content increases significantly in the lower portion of this unit. The top of this unit is marked by a violet-red, manganese-stained clay. Appears to be an effective semi-confining unit separating Units III <sub>A</sub> and IV. | 75-93                                 | 10-39                              |
| IV               | <u>Deep Zone.</u> Usually contains a white and light gray to orange medium clayey sand, up to ten feet in thickness overlying the bedrock. This unit may contain red dense clays and/or black organic-rich layers generally less than 18 inches thick.                                                                                                                        | 90-118                                | 15-30                              |
| V                | <u>Decomposed Bedrock.</u> Olive green, friable, weathered schist and gneiss occasionally overlain by off-white clay. Probable low permeability; unit probably acts as base to active flow system.                                                                                                                                                                            | 110-140                               | 10-40+                             |

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**TABLE 1-2**  
**PRE-EXISTING MONITORING WELLS**  
**NEWPORT PLANT**

| <u>Designation</u> | <u>TD</u> | <u>Screened Interval</u> | <u>Aquifer</u> | <u>(MSL)<br/>Ground<br/>Elevation</u> | <u>Status</u>          |
|--------------------|-----------|--------------------------|----------------|---------------------------------------|------------------------|
| SM-1               | 24'       | 17' - 21'                | Columbia       | 21.1'                                 | Active                 |
| SM-2               | 25'       | 21' - 25'                | Columbia       | 13.5'                                 | Active                 |
| SM-3               | 35'       | 31' - 35'                | Columbia       | 25.0'                                 | Active                 |
| SM-4               | 51'       | 20' - 25'                | Columbia       | 3.8'                                  | Active <sup>(1)</sup>  |
| SM-5               | 20'       | 15' - 20'                | Columbia       | 18.6'                                 | Active                 |
| DM-1               | 56'       | 27' - 31'                | Columbia       | 16.0'                                 | Plugged <sup>(3)</sup> |
| DM-3               | 63'       | 53' - 62'                | Potomac        | 24.8'                                 | Plugged <sup>(3)</sup> |
| DM-4               | 50'       | 44' - 50'                | Potomac        | 7.6'                                  | Active                 |
| DM-5               | 81'       | 53' - 63'                | Potomac        | 7.7'                                  | Plugged <sup>(3)</sup> |
| DM-6               | 70'       | 60' - 70'                | Potomac        | 3.1'                                  | Active                 |
| DMU-7              | 50'       | 40' - 50'                | Potomac        | 9.5'                                  | Active                 |
| DML-7              | 155'      | 135' - 145'              | Potomac        | 9.5'                                  | Active                 |
| DM-8               | 126'      | 45' - 55'                | Potomac        | 3.8'                                  | Active                 |
| WW-11              | 65'       | 50' - 60'                | Potomac        | 22.0'                                 | Active <sup>(2)</sup>  |
| WW-13              | 112'      | 88' - 99'                | Potomac        | 23.2'                                 | Active <sup>(2)</sup>  |

- (1) Formerly DM-2; re-classified as SM-4 due to screened interval in Columbia.  
 (2) Not utilized for supply purposes since approximately 1980.  
 (3) "Plugged" wells have been abandoned by cement grouting from bottom to ground surface.

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TABLE 1-3

## PREVIOUS RI SAMPLING AND ANALYSIS EFFORTS

| <u>Matrix</u>                | <u>No. of<br/>Samples</u> | <u>Sampling<br/>Round</u> | <u>Test<br/>Parameters</u>                                      |
|------------------------------|---------------------------|---------------------------|-----------------------------------------------------------------|
| Groundwater <sup>(1)</sup>   | 37                        | August, 1987              | Field <sup>(2)</sup>                                            |
|                              | 36                        | December, 1987            | Total HSL <sup>(3)</sup><br>Field<br>HSL minus PCB's/Pesticides |
| Groundwater <sup>(4)</sup>   | 2                         | December, 1987            | Field<br>HSL minus PCB's/Pesticides                             |
| Christina River<br>Water     | 12                        | August, 1987              | Field<br>Total HSL, plus oil & grease                           |
| Christina River<br>Sediments | 16                        | June, 1987                | Total HSL, plus oil & grease                                    |
| Soils <sup>(5)</sup>         | 100                       | June-July, 1987           | Total HSL                                                       |
| Soil Gas                     | 64                        | June-July, 1987           | TCE & PCE <sup>(6)</sup>                                        |
|                              | 10                        | July, 1987                | Radon gas                                                       |
| Fill <sup>(7)</sup>          | 1                         | December, 1987            | EP TOX metals and reactive<br>sulfide                           |
|                              | 7                         | December, 1987            | EP TOX metals, reactive<br>sulfide, and Total HSL               |

## Notes:

- (1) On-site monitoring wells.
- (2) Field test for pH, temperature, and specific conductivity performed at time of sampling.
- (3) In addition, gross alpha and gross beta radiation analyses were conducted on groundwater samples from wells located north of the Christina River.
- (4) Off-site residential wells.
- (5) Seven test borings on-site.
- (6) TCE = trichloroethylene; PCE = tetrachloroethylene.
- (7) Soil fill and waste materials disposed in South Disposal site.

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TABLE 1-4  
TEST BORING AND MONITORING WELLS  
DRILLING AND COMPLETION DATA  
Du Pont Newport Site

| Well Number | Total Depth Drilled | Grout Plug Back Depth | Top of Decomposed Bedrock | Screen Interval | 4-Inch Screen slot Size and Material  |
|-------------|---------------------|-----------------------|---------------------------|-----------------|---------------------------------------|
| TB-1        | 152                 |                       | 133                       |                 |                                       |
| MW-1A       |                     |                       |                           | 5.0 - 15.0      | 10 PVC                                |
| MW-1B       |                     |                       |                           | 54.7 - 72.2     | 20 S.S.                               |
| MW-1C       |                     |                       |                           | 118.0 - 128.0   | 10 PVC                                |
| TB-2        | 152                 | 107                   | 115                       |                 |                                       |
| MW-2A       |                     |                       |                           | 5.0 - 15.1      | 10 PVC                                |
| MW-2B       |                     |                       |                           | 62.0 - 77.5     | 20 S.S.                               |
| MW-2C       |                     |                       |                           | 92.0 - 102.0    | 10 PVC                                |
| TB-3        | 147                 |                       | 135                       |                 |                                       |
| MW-3A       |                     |                       |                           | 6.75 - 16.75    | 10 PVC                                |
| MW-3B       |                     |                       |                           | 80.0 - 90.0     | 20 S.S.                               |
| MW-3C       |                     |                       |                           | 117.0 - 137.0   | 20 S.S.                               |
| TB-4        | 132                 |                       | 125                       |                 |                                       |
| MW-4A       |                     |                       |                           | 5.0 - 15.1      | 20 PVC                                |
| MW-4B       |                     |                       |                           | 53.3 - 76.6     | 20 S.S.                               |
| MW-4C       |                     |                       |                           | 110.0 - 120.0   | 20 S.S.                               |
| TB-5        | 162                 |                       | 140                       |                 |                                       |
| MW-5A       |                     |                       |                           | 2.7 - 12.7      | 10 PVC                                |
| MW-5B       |                     |                       |                           | 76.0 - 90.6     | 20 S.S.                               |
| MW-5C       |                     |                       |                           | 113.5 - 124.9   | 20 S.S.                               |
| TB-6        | 152                 | 118                   | 115                       |                 |                                       |
| MW-6A       |                     |                       |                           | 5.0 - 24.7      | 10 PVC                                |
| MW-6B       |                     |                       |                           | 65.0 - 77.0     | 20 S.S.                               |
| MW-6C       |                     |                       |                           | 100.5 - 110.5   | 10 PVC                                |
| TB-7        | 117                 |                       | 110                       |                 |                                       |
| MW-7A       |                     |                       |                           | 5.0 - 15.1      | 10 PVC                                |
| MW-7B       |                     |                       |                           | 63.0 - 78.5     | 20 S.S.                               |
| MW-7C       |                     |                       |                           | 94.0 - 109.0    | 20 S.S.                               |
| MW-8        |                     |                       |                           | 2.0 - 26.5      | 10 PVC                                |
| MW-9        |                     |                       |                           | 5.0 - 24.7      | 10 PVC                                |
| MW-11       |                     |                       |                           | 4.0 - 24.8      | 10 PVC                                |
| MW-13       |                     |                       |                           | 5.3 - 25.3      | 10 PVC                                |
| MW-14       |                     |                       |                           | 5.0 - 24.4      | 10 @ 5'-10' PVC<br>20 @ 10'-24.4' PVC |
| MW-15       |                     |                       |                           | 5.0 - 15.1      | 20 PVC                                |

Notes: All depths shown are measured in feet below ground surface.  
S.S. screen material represents stainless steel.

Du Pont Newport RI/FS Work Plan

TABLE 1-5  
GROUNDWATER SAMPLING DATA

| Well No. | Sample Date | Well Casing Diameter | Total Depth (ft) | Static TOC (ft) | Well Volume (gals) | Total Purge Volume (gals) | Purge Method | Sampling Device | pH    | Temp (°C) | Conduct (mV) |
|----------|-------------|----------------------|------------------|-----------------|--------------------|---------------------------|--------------|-----------------|-------|-----------|--------------|
| MW-1A    | 08-13-87    | 4"                   | 15               | 10.51           | 4.39               | 25                        | bail         | stainless steel | 5.54  | 24.6      | 85.4         |
| MW-1B    | 08-14-87    | 4"                   | 72               | 10.31           | 41.85              | 195.92                    | centrifugal  | teflon          | 5.15  | 15.0      | 92           |
| MW-1C    | 08-14-87    | 4"                   | 128              | 10.15           | 78.0               | 814.29                    | submersible  | stainless steel | 6.60  | 16.5      | 83           |
| MW-2A    | 08-13-87    | 4"                   | 15               | 6.52            | 7.03               | 27                        | bail         | stainless steel | 5.80  | 24.0      | 81.4         |
| MW-2B    | 08-14-87    | 4"                   | 77               | 7.72            | 46.60              | 188                       | centrifugal  | teflon          | 5.36  | 18.0      | 85.0         |
| MW-2C    | 08-14-87    | 4"                   | 102              | 7.67            | 62.67              | 234                       | centrifugal  | teflon          | 7.29  | 17.0      | 47           |
| MW-3A    | 08-14-87    | 4"                   | 18               | 6.06            | 8.01               | 22                        | bail         | stainless steel | 5.08  | 16.5      | 113          |
| MW-3B    | 08-14-87    | 4"                   | 90               | 4.02            | 57.61              | 361.5                     | submersible  | teflon          | 4.91  | 15.5      | 121          |
| MW-3C    | 08-14-87    | 4"                   | 137              | 3.04            | 88.70              | 608.8                     | submersible  | teflon          | 5.44  | 18.5      | 93           |
| MW-4A    | 08-12-87    | 4"                   | 15               | 12.70           | 3.04               | 20                        | bail         | stainless steel | 6.52  | 16.8      | 2.1          |
| MW-4B    | 08-12-87    | 4"                   | 77               | 11.52           | 44.02              | 180                       | centrifugal  | teflon          | 5.92  | 24.3      | 42.5         |
| MW-4C    | 08-12-87    | 4"                   | 120              | 12.25           | 71.6               | 531                       | submersible  | teflon          | 6.49  | 19.1      | 12.3         |
| MW-5A    | 08-11-87    | 4"                   | 12.5             | 4.32            | 7.2                | 35                        | bail         | stainless steel | 6.37  | 17.3      | 21.0         |
| MW-5B    | 08-11-87    | 4"                   | 91               | 3.81            | 58.5               | 234                       | centrifugal  | teflon          | 6.48  | 18.1      | 19.2         |
| MW-5C    | 08-11-87    | 4"                   | 124.5            | 3.99            | 80.1               | 982                       | submersible  | teflon          | 6.53  | 16.4      | 6.1          |
| MW-6A    | 08-10-87    | 4"                   | 25               | 5.92            | 14.3               | 60                        | bail         | stainless steel | 5.66  | 19.8      | 87.2         |
| MW-6B    | 08-10-87    | 4"                   | 77               | 7.26            | 46.9               | 388.3                     | centrifugal  | teflon          | 6.96  | 16.4      | -5.5         |
| MW-6C    | 08-15-87    | 4"                   | 110.5            | 7.17            | 68.9               | 382.5                     | submersible  | teflon          | 8.56  | 18.5      | -87          |
| MW-7A    | 08-11-87    | 4"                   | 14               | 6.19            | 7.6                | 35                        | bail         | stainless steel | 5.56  | 19.1      | 24.5         |
| MW-7B    | 08-11-87    | 4"                   | 78               | 6.15            | 48.4               | 435                       | centrifugal  | teflon          | 5.73  | 18.1      | 21.1         |
| MW-7C    | 08-11-87    | 4"                   | 109              | 4.6             | 69.5               | 749                       | submersible  | teflon          | 6.09  | 19.7      | -8.5         |
| MW-8     | 08-12-87    | 4"                   | 27               | 4.5             | 16.12              | 105.8                     | centrifugal  | stainless steel | 5.50  | 15.0      |              |
| MW-9     | 08-13-87    | 4"                   | 24               | 9.08            | 11.37              | 36                        | bail         | stainless steel | 6.31  | 20.8      |              |
| MW-11    | 08-11-87    | 4"                   | 25               | 7.2             | 13.1               | 55                        | bail         | stainless steel | 5.54  | 21.1      | 77.6         |
| MW-13    | 08-1-87     | 4"                   | 25               | 5.2             | 14.4               | 65                        | bail         | stainless steel | 5.83  | 18.8      | 56.3         |
| MW-14    | 08-12-87    | 4"                   | 30               | 7.2             | 16.65              | 65                        | bail         | stainless steel | 6.26  | 20.7      | 21.4         |
| MW-15    | 08-12-87    | 4"                   | 15               | 8.99            | 5.48               | 29.5                      | bail         | stainless steel | 11.06 | 19.5      | -241.5       |
| DM-5     | 08-12-87    | 2"                   | 51               | 7.42            | 7.42               | 45                        | bail         | stainless steel | 5.16  | 23.2      | 83.5         |
| DMU-7    | 08-13-87    | 4"                   | 50               | 8.58            | 27.97              | 120                       | centrifugal  | teflon          | 6.13  | 23.1      | 41.4         |
| DML-7    | 08-13-87    | 4"                   | 155              | 9.58            | 95.68              | 364                       | submersible  | stainless steel | 6.59  | 25.2      | 2.1          |
| SM-2     | 08-13-87    | 2"                   | 25               | 9.92            | 3.06               | 15                        | bail         | teflon          | 5.81  | 23.9      | 69.4         |
| DM-6     | 08-14-87    | 2"                   | 70               | 10.24           | 11.2*              | 36                        | bail         | stainless steel | 5.27  | 18.5      | 94           |
| SM-3     | 08-14-87    | 2"                   | 35               | 20.8            | 2.58               | 10                        | bail         | stainless steel | 6.28  | 17.5      | 31           |
| SM-4     | 08-15-87    | 2"                   | 25               | 2.75            | 3.56*              | 12                        | bail         | stainless steel | 5.70  | 17.0      | 77           |
| DM-8     | 08-15-87    | 4"                   | 55               | 9.08            | 29.84*             | 137.7                     | centrifugal  | stainless steel | 5.88  | 19.5      | 7.4          |
| SM-5     | 08-15-87    | 4"                   | 20               | 8.19            | 7.68*              | 60                        | bail         | stainless steel | 5.46  | 19        | 96           |
| SM-1     | 08-15-87    | 2"                   | 21               | 22.78           | 3.36*              | 13                        | bail         | teflon          | 7.54  | 17        | -27          |

\* Approximate  
TOC = Top of PVC casing

Duplicates

MW-D1 = MW-5C  
MW-D2 = MW-9  
MW-D3 = MW-3B  
MW-D4 = DM-8

Well volume = TD - ((Static TOC) - (Stick-up)) x  $\frac{\text{gals}}{\text{linear ft}}$   
 2" casing = .16 gals/linear ft  
 4" casing = .65 gals/linear ft

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TABLE 1-6

SOIL GAS SURVEY RESULTS  
FOR NORTH DISPOSAL SITE

| Sample    | CHEMICAL CONCENTRATION |                   | Date<br>Sampled | Probe<br>Depth |
|-----------|------------------------|-------------------|-----------------|----------------|
|           | Tetrachloroethylene    | Trichloroethylene |                 |                |
| B-4/5     | BMDL                   | BMDL              | 6/29            | 4.5 ft         |
| B-6       | 480                    | Tr                | 6/29            |                |
| C-3       | Tr                     | 110               | 6/29            |                |
| C-5       | BMDL                   | BMDL              | 6/29            |                |
| C-6       | 2,000                  | 150               | 6/25            |                |
| C/B-7     | 340                    | 90                | 6/29            |                |
| D-3       | Tr                     | 65                | 6/29            |                |
| D-4       | Tr                     | Tr                | 6/29            |                |
| D-5       | Tr                     | BMDL              | 6/29            |                |
| D-6       | 210                    | 340               | 6/26            |                |
| D-7       | 700                    | BMDL              | 6/29            | 3.5 ft         |
| E-3       | BMDL                   | 95                | 6/25            |                |
| E-4       | Tr                     | BMDL              | 6/25            |                |
| E-4 (Dup) | BMDL                   | BMDL              | 6/29            |                |
| E-5       | Tr                     | 130               | 6/25            |                |
| E-6       | 700                    | 280               | 6/25            |                |
| E-7       | Tr                     | 95                | 6/25            |                |
| F-3       | Tr                     | Tr                | 6/29            |                |
| F-4       | Tr                     | BMDL              | 6/29            |                |
| F-5       | BMDL                   | BMDL              | 6/29            |                |
| F-6       | 120                    | 130               | 6/25            |                |
| F-6 (Dup) | BMDL                   | 110               | 6/29            |                |
| F-7       | BMDL                   | Tr                | 6/25            |                |

\* Five feet unless otherwise stated.

NOTES: All units are parts per billion (ppb).

Tr Trace Amount - quantifiable only to between 10 and 50 ppb

BMDL Below Method Detection Limit of 10 ppb.

(Dup) Duplicate Sample

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TABLE 1-6 (Continued)

| <u>Sample</u> | <u>CHEMICAL CONCENTRATION</u> |                          | <u>Date<br/>Sampled</u> | <u>Probe<br/>Depth</u> |
|---------------|-------------------------------|--------------------------|-------------------------|------------------------|
|               | <u>Tetrachloroethylene</u>    | <u>Trichloroethylene</u> |                         |                        |
| G-4           | BMDL                          | Tr                       | 6/29                    |                        |
| G-5           | 70                            | 140                      | 6/26                    |                        |
| G-5 (Dup)     | Tr                            | Tr                       | 6/29                    |                        |
| G-6           | 60                            | 420                      | 6/26                    | 4 ft                   |
| G-7           | Tr                            | 150                      | 6/26                    | 3 ft                   |
| G-7 (Dup)     | Tr                            | Tr                       | 6/29                    | 3 ft                   |
| H-5           | 4,000                         | 600                      | 6/26                    |                        |
| H-5 (Dup)     | 1,900                         | 20                       | 7/01                    |                        |
| H-6           | BMDL                          | 130                      | 6/26                    |                        |
| H-6 (Dup)     | BMDL                          | BMDL                     | 6/29                    |                        |
| H-7           | BMDL                          | BMDL                     | 6/26                    |                        |
| H-7 (Dup)     | Tr                            | 65                       | 6/29                    |                        |
| I-5           | 80                            | BMDL                     | 6/29                    |                        |
| I-6           | Tr                            | 140                      | 6/26                    |                        |
| I-7           | 200                           | 170                      | 6/26                    | 3 ft                   |
| I-7 (Dup)     | 650                           | BMDL                     | 6/29                    | 3 ft                   |
| J-6           | BMDL                          | 120                      | 6/26                    |                        |

\* Five feet unless otherwise stated.

NOTES: All units are parts per billion (ppb).

Tr Trace Amount - quantifiable only to between 10 and 50 ppb  
 BMDL Below Method Detection Limit of 10 ppb.  
 (Dup) Duplicate Sample

TABLE 1-7

**SEDIMENT SAMPLE SECTION LOG  
CHRISTINA RIVER SEDIMENT SURVEY  
DU PONT NEWPORT SITE  
NEWPORT, DELAWARE**

| <u>Sample<br/>Station<br/>No.</u> | <u>Sampling<br/>Depth<br/>(ft)</u> | <u>Sample<br/>Recovery<br/>Length<br/>(ft)</u> | <u>Recovery<br/>Interval<br/>(ft)</u> | <u>WCC<br/>Sample<br/>No.</u> | <u>ETC<br/>Sample<br/>No.</u> |
|-----------------------------------|------------------------------------|------------------------------------------------|---------------------------------------|-------------------------------|-------------------------------|
| 1A                                | 5.0                                | 3.8                                            | 0.0 to 1.0                            | 1AA                           | BA9596                        |
|                                   |                                    |                                                | 1.0 to 2.5                            | 1AB                           | BA9597                        |
|                                   |                                    |                                                |                                       | 1ABR <sup>(1)</sup>           | BA9598                        |
|                                   |                                    |                                                | 2.5 to 3.8                            | 1AC                           | BA9599                        |
| 1B                                | 5.0                                | 3.75                                           | 0.0 to 1.0                            | 1BA                           | BA9600                        |
|                                   |                                    |                                                | 1.0 to 2.5                            | 1BB                           | BA9601                        |
|                                   |                                    |                                                |                                       | 1BBR <sup>(1)</sup>           | BA9602                        |
|                                   |                                    |                                                | 2.5 to 3.75                           | 1BC                           | BA9603                        |
| 2A                                | 5.0                                | 3.75                                           | 0.0 to 1.0                            | 2AA                           | BA9606                        |
|                                   |                                    |                                                | 1.0 to 2.5                            | 2AB                           | BA9607                        |
|                                   |                                    |                                                | 2.5 to 3.75                           | 2AC                           | BA9608                        |
| 2B                                | 5.0                                | 2.9                                            | 0.0 to 1.0                            | 2BA                           | BA9609                        |
|                                   |                                    |                                                | 1.0 to 2.0                            | 2BB                           | BA9610                        |
|                                   |                                    |                                                | 2.0 to 2.9                            | 2BC                           | BA9595                        |
| 3A                                | 5.0                                | 1.25                                           | 0.0 to 1.25                           | 3AA                           | BA9591                        |
| 3B                                | 5.0                                | 3.0                                            | 0.0 to 1.0                            | 3BA                           | BA9592                        |
|                                   |                                    |                                                | 1.0 to 2.0                            | 3BB                           | BA9593                        |
|                                   |                                    |                                                | 2.0 to 3.0                            | 3BC                           | BA9594                        |

(1) Field Duplicate Sample

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TABLE 1-3  
OLD AIRPORT ROAD WELL INVENTORY

| Ref.<br>Well No. | Usage<br>Category           | Owner or<br>Business Name                | Data<br>Source    | No. of<br>Buildings<br>Served | Reported<br>Well<br>Depth<br>(ft) | Reported<br>Casing<br>Size/<br>Depth | Year<br>Well<br>Drilled | Type<br>of<br>Pump | Drinking<br>or<br>Cooking<br>Usage | Reported Problems<br>and Comments                                                                                                                                                                                                                                                                                                                                                                                                         |
|------------------|-----------------------------|------------------------------------------|-------------------|-------------------------------|-----------------------------------|--------------------------------------|-------------------------|--------------------|------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1                | Commercial                  | Joe Horisk<br>Salvage                    | Office<br>Secy.   | 1                             | 80 +                              | -                                    | -                       | -                  | No                                 | Filter installed due to heavy<br>iron content.                                                                                                                                                                                                                                                                                                                                                                                            |
| 2                | Residential                 | Brzoska                                  | Mrs.<br>Brzoska   | 1                             | 28 +                              | -                                    | -                       | -                  | Both                               | No filter, no problems, clear<br>water.                                                                                                                                                                                                                                                                                                                                                                                                   |
| 3                | Commercial &<br>Residential | Elliott &<br>Son Machines                | Gene<br>Brzoska   | 3                             | 22                                | -                                    | -                       | -                  | Both                               | No problems; artesian water<br>company checked water quality<br>recently; planning to drill 80-<br>foot well to supply office<br>building on east end; no filter.                                                                                                                                                                                                                                                                         |
| 4                | Residential &<br>Commercial | Necastro's<br>Auto Salvage               | Vince<br>Necastro | 3                             | "shallow"                         | -                                    | -                       | Centr.             | Both                               | No problems; well serves 2 houses<br>and office; water was sampled by<br>Aqua Services on 12/16/87 and<br>labelled "Necastro-A"; former<br>second well with submersible pump<br>had problems and was abandoned;<br>third well was drilled 4 years ago<br>next to west side house, is not in<br>use and was sampled by Aqua<br>Services on 12/16/87 and labelled<br>"Necastro-B" and had total depth<br>measured at approximately 20 feet. |
| 5                | Commercial                  | Red Clay<br>Consolidated<br>School Dist. | Frank<br>Edmisten | 2                             | 60 +                              | 6 in.                                | -                       | Subm.              | No                                 | Replaced pump several times<br>recently due to black precipitate,<br>corrosion, and iron rust problems;<br>sulfur odor (H <sub>2</sub> S); filter system.                                                                                                                                                                                                                                                                                 |
| 6                | Residential                 | Vince<br>Necastro                        | Vince<br>Necastro | 1                             | -                                 | -                                    | -                       | -                  | Both                               | No problems.                                                                                                                                                                                                                                                                                                                                                                                                                              |
| 7                | Commercial                  | Kershaw<br>Exc. Co.                      | Bob<br>O'Grady    | 5                             | 115                               | 4 in.                                | 1985                    | Subm.              | No                                 | Shallow well replaced 2 years ago<br>because it went dry during the<br>summer; new well has more iron<br>than old well; filter system<br>installed due to iron rust.                                                                                                                                                                                                                                                                      |
| 8                | Commercial                  | Hardy & Son<br>Contractors               | Rick<br>Davis     | 2                             | 55 +                              | -                                    | -                       | Subm.              | No                                 | A lot of iron rust; reported 12-<br>foot depth pumping level.                                                                                                                                                                                                                                                                                                                                                                             |
| 9                | Residential                 | Goldsboro?                               | Not home          | 1                             | -                                 | -                                    | -                       | -                  | -                                  | -                                                                                                                                                                                                                                                                                                                                                                                                                                         |

AR300948

TABLE 1-8 (Continued)

| Ref. Well No. | Usage Category           | Owner or Business Name        | Data Source           | No. of Buildings Served | Reported Well Depth (ft) | Reported Casing Size/Depth | Year Well Drilled            | Type of Pump | Drinking or Cooking Usage | Reported Problems and Comments                                                                                                                                                                                                                                                                                           |
|---------------|--------------------------|-------------------------------|-----------------------|-------------------------|--------------------------|----------------------------|------------------------------|--------------|---------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 10            | Residential              | Claude Blevins                | Claude Blevins        | 2                       | 100 +                    | 25 + ft of 4 in. casing    | 1968 (Delmerna Drilling Co.) | Centr.?      | Both                      | Water tested 8 to 10 years ago by University of Delaware; owner concerned about groundwater contamination due to junkyards and Du Pont operations; pump in basement with foot valve; reported static water level 10 feet below ground; plans to call Al Palmer for copy of Du Pont Summer '87 Test Well Program results. |
|               | Residential              | Claude Blevins                | Claude Blevins        | 2                       | 100 +                    | 25 + ft of 4 in. casing.   | 1960                         | Centr.?      | Both                      | See well reference No. 10; both No. 10 and 11 are rented.                                                                                                                                                                                                                                                                |
|               | Residential              | Mitchell                      | Not home              | 1                       |                          |                            |                              |              |                           |                                                                                                                                                                                                                                                                                                                          |
|               | Commercial               | Delaware Auto Salvage         | Jerry Russell (Owner) | 2                       | 110 +                    |                            | 1972 +                       |              | Cooking                   | Owner reports bad sulfur smell and iron stains, although water is clear; uses filter system; some government agency sampled well 8 to 8 years ago but never provided results; concerned about Du Pont contamination of groundwater.                                                                                      |
| 14            | Residential              | Not home                      |                       | 1                       |                          |                            |                              |              |                           |                                                                                                                                                                                                                                                                                                                          |
| 15            | Commercial               | Bob Biggs Auto Parts          | Bob Biggs             | 1                       | 12 +                     |                            |                              | Centr.       | No.                       | No problems reported except iron stains; used for washing only.                                                                                                                                                                                                                                                          |
| 16            | Commercial & Residential | Cress Collision Service, Inc. | Millie Cress          | 3                       |                          |                            | 1957 +                       |              | No                        | Do not drink water due to possible contamination from Du Pont operations.                                                                                                                                                                                                                                                |
| 17            | Commercial               | Eastern Auto Salvage          | Mike Filipkowski      | 1                       | "shallow"                |                            |                              | Centr.       | No                        | No problems except a lot of iron and some sulfur smell.                                                                                                                                                                                                                                                                  |
| 18            | Residential              | Bill Puckett                  | Bill Puckett          | 1                       | 38 +                     |                            | 1975 +                       |              | Both                      | Water is rusty and hot water smells of sulfur; water softener in use.                                                                                                                                                                                                                                                    |
|               | Commercial               | B&F Towing                    | Employee              | 1                       | 65 +                     |                            |                              | Centr.       | No                        | Iron stains and sulfur odor.                                                                                                                                                                                                                                                                                             |

See Figure 1 for locations of referenced well numbers.

AR300949

TABLE 1-9

**WASTE DISPOSAL INVENTORY  
DU PONT - NEWPORT SITE**

**NORTH DISPOSAL SITE**

| <u>Material</u>                                                       | <u>Estimated Quantity</u>     |
|-----------------------------------------------------------------------|-------------------------------|
| o Garbage                                                             | several tons                  |
| o Trash (glass, wood, paper, cardboard)                               | 100 tons                      |
| o Steel drums                                                         | several hundred tons          |
| o Lever Packs                                                         | several hundred tons          |
| o Sand and dirt                                                       | several thousand tons         |
| o Concrete                                                            |                               |
| o Steel work                                                          |                               |
| o Asbestos                                                            | 5 tons                        |
| o Light ballasts - PCB's/PBB's                                        | 2 tons                        |
| o Rubber - gasket material, tires<br>from garage                      | a few tons                    |
| o Nylon shutters                                                      | 2 tons                        |
| o Artificial marble - "Corian"                                        | 4 tons                        |
| o Acrylates and latex emulsions                                       | several hundred lbs           |
| o Quinacridone tars                                                   | 1,000 tons                    |
| o Off-grade quality copper<br>phthalocyanine pigment                  | 100 tons                      |
| o Off-grade quality quinacridone pigment                              |                               |
| o Off-grade quality "Afflair" pigment                                 | estimated 10,000 - 15,000 lbs |
| o Off-grade quality Chromium Dioxide<br>coated "Mylar" recording tape | 6 tons                        |
| o "Afflair" fines (30% mica) plus<br>(70% $\text{TiO}_2$ )            | estimated 100,000 lbs         |
| o Off-grade quality Chromium Dioxide<br>floor sweepings and bags      | 2 tons                        |
| o Thoriated nickel                                                    | 20 tons of combined waste     |
| o Dirt contaminated with zinc ore                                     | several hundred tons          |
| o Raw materials left in bag liners<br>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                    |

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AR300950

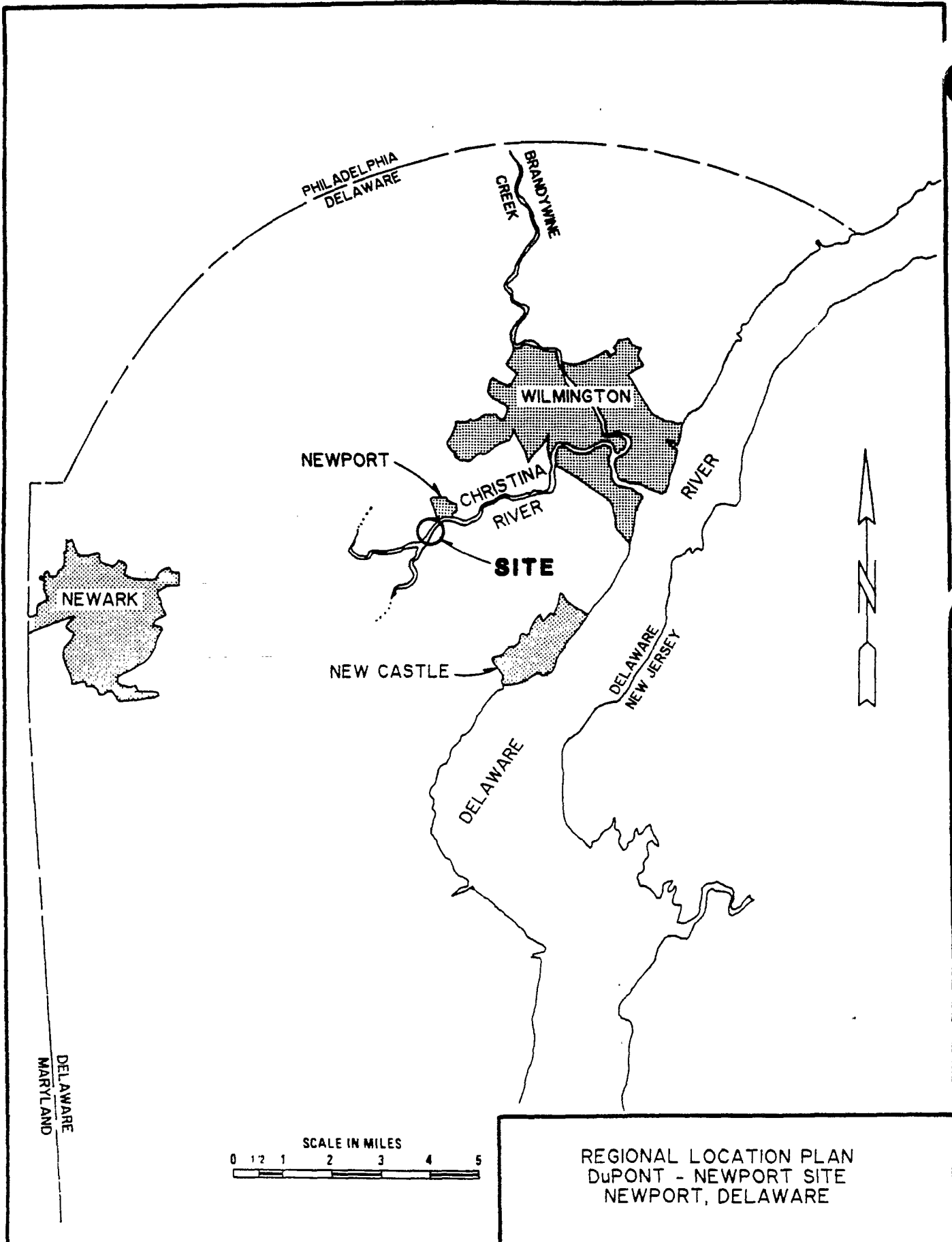
TABLE 1-10

SOUTH DISPOSAL SITE  
WASTE CHARACTERIZATION  
DU PONT NEWPORT SITE

| Parameter                  | Identified in<br>South Landfill<br>Waste (HSL) | South Landfill<br>Leachate<br>(EP TOX) |
|----------------------------|------------------------------------------------|----------------------------------------|
| Aluminum                   | Yes                                            | (2)                                    |
| Arsenic                    | Yes                                            | (1)                                    |
| Barium                     | Yes                                            | Yes                                    |
| Beryllium                  | Yes                                            |                                        |
| Cadmium                    | Yes                                            | Yes                                    |
| Calcium                    | Yes                                            |                                        |
| Chromium                   | Yes                                            | -                                      |
| Cobalt                     | Yes                                            |                                        |
| Copper                     | Yes                                            |                                        |
| Iron                       | Yes                                            |                                        |
| Lead                       | Yes                                            | -                                      |
| Magnesium                  | Yes                                            |                                        |
| Manganese                  | Yes                                            |                                        |
| Mercury                    | Yes                                            | -                                      |
| Nickel                     | Yes                                            |                                        |
| Potassium                  | Yes                                            |                                        |
| Selenium                   | Yes                                            | -                                      |
| Silver                     | Yes                                            | -                                      |
| Sodium                     | Yes                                            | -                                      |
| Vanadium                   | Yes                                            |                                        |
| Zinc                       | Yes                                            |                                        |
| Methylene chloride         | Yes(3)                                         |                                        |
| Acetone                    | Yes(3)                                         |                                        |
| Carbon Disulfide           | Yes                                            |                                        |
| Benzene                    | Yes                                            |                                        |
| Phenanthrene               | Yes                                            |                                        |
| Benzo(a)anthracene         | Yes                                            |                                        |
| 2-Butanone                 | Yes                                            |                                        |
| 1,2-Dichlorobenzene        | -                                              |                                        |
| 1,2-trans-Dichloroethylene | -                                              |                                        |
| 1,4-Dichlorobenzene        | -                                              |                                        |
| Chlorobenzene              | -                                              |                                        |
| Tetrachloroethylene        | -                                              |                                        |
| Trichloroethylene          | -                                              |                                        |
| 4,4'-DDT                   | -                                              |                                        |
| 4,4'-DDD                   | -                                              |                                        |
| Bis(2-ethylhexyl)phthalate | -                                              |                                        |
| Cyanide, total             | -                                              |                                        |
| 1,1,2-Tetrachloroethane    | -                                              |                                        |
| Phenol                     | -                                              |                                        |
| p-Chloro-m-cresol          | -                                              |                                        |
| Acenaphthene               | -                                              |                                        |
| 2,4-Dinitrotoluene         | -                                              |                                        |
| Di-n-butylphthalate        | -                                              |                                        |
| Sulfide or Sulfate         | Yes                                            | Yes                                    |

## KEY

- (1) - = not present  
 (2) Blank = not tested; EP TOX does not test for volatiles, organics, or base/neutral. Tests for: Arsenic, Barium, Cadmium, Chromium, Lead, Mercury, Selenium, and Silver.  
 (3) Probable laboratory artifact.



AR300952

FIGURE 1-1

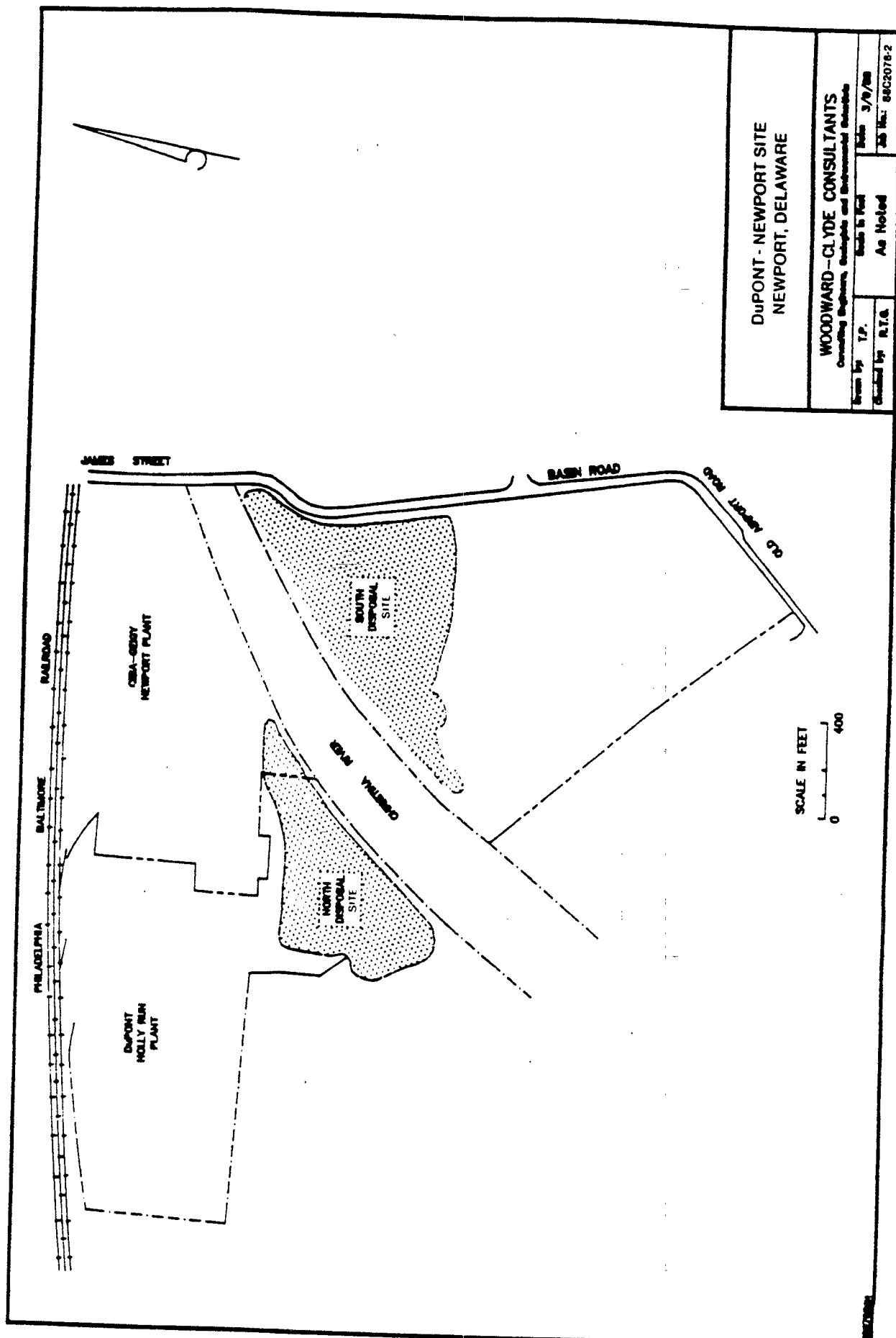
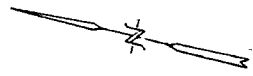
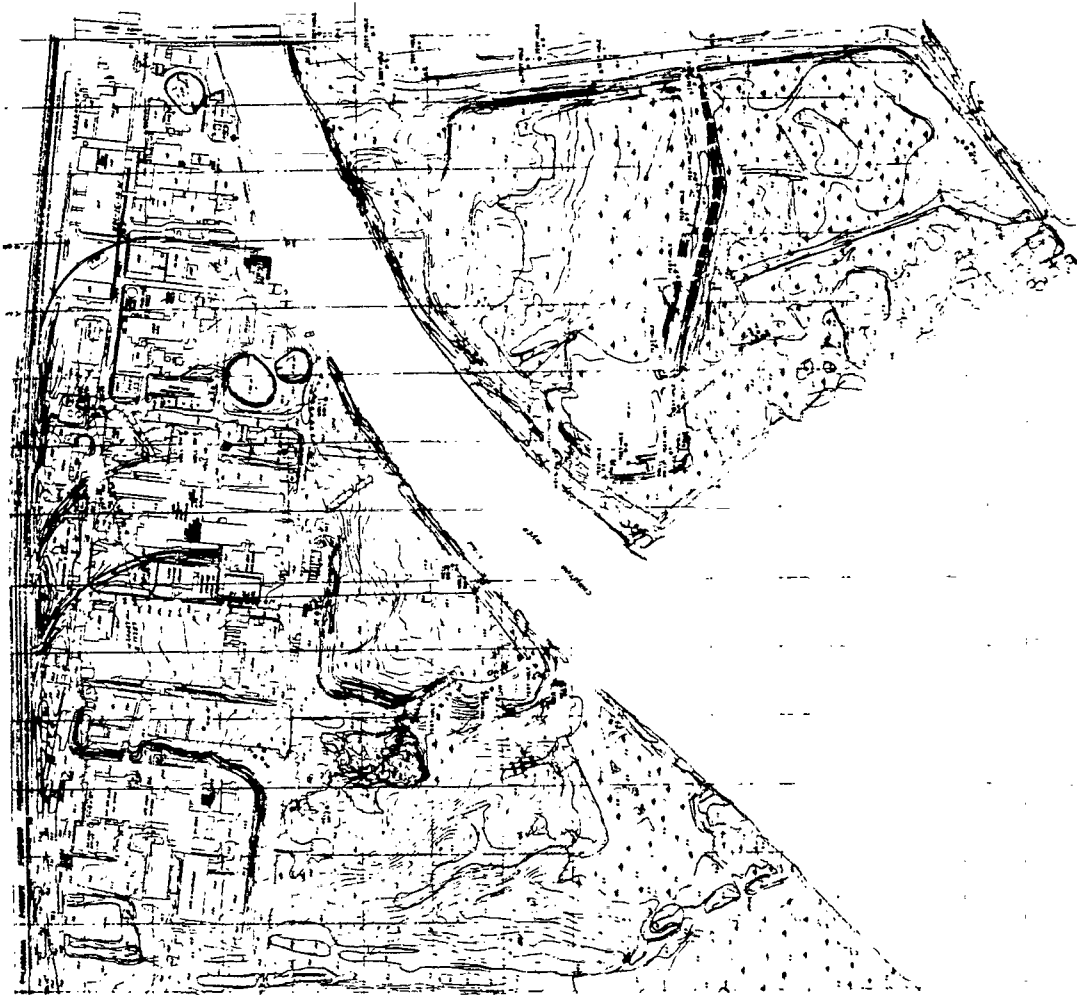


FIGURE 1-2

BR300953



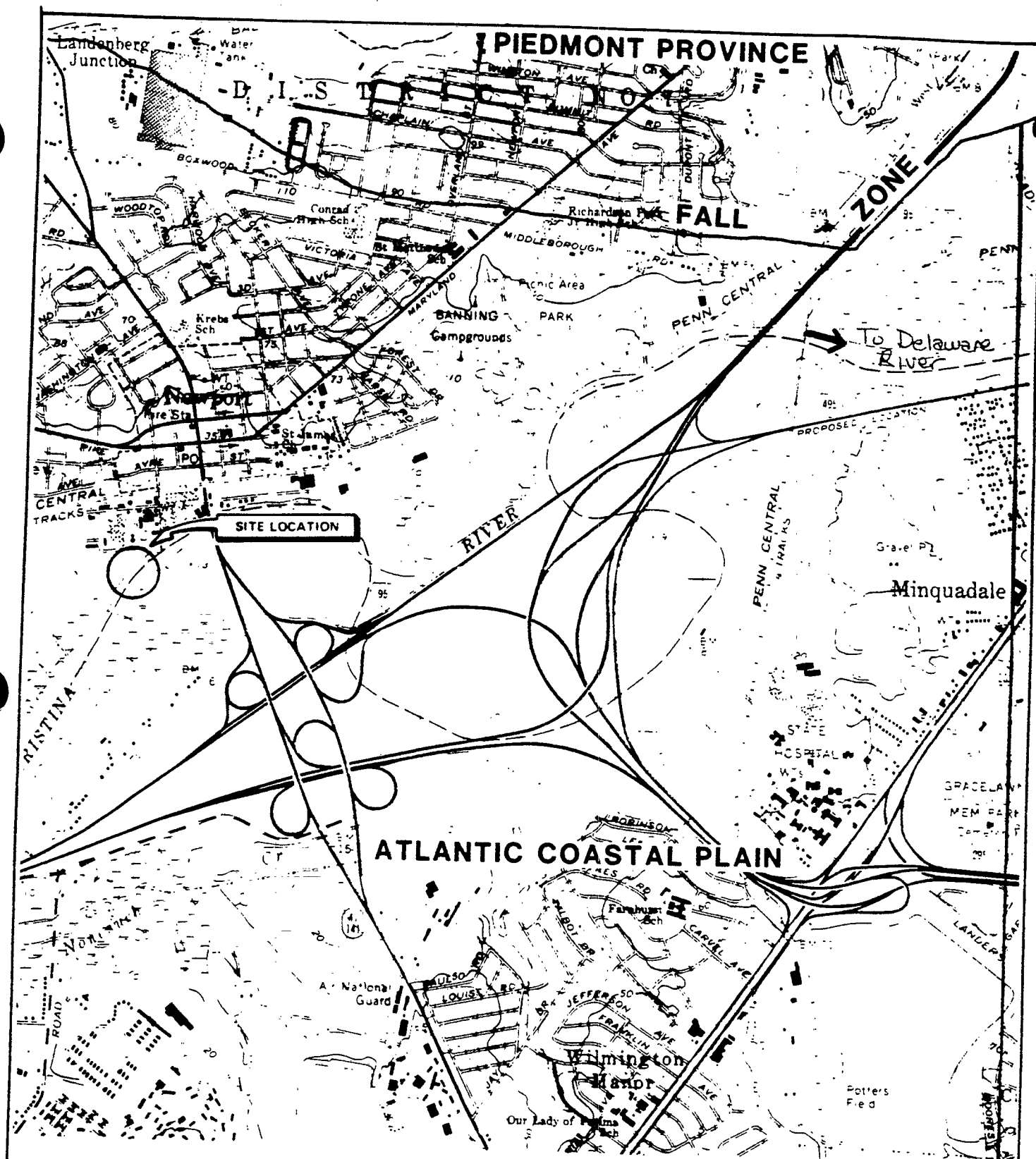
TOPOGRAPHY OF SITE AREA  
DUPONT NEWPORT, DELAWARE

**WOODWARD-CLYDE CONSULTANTS**  
CONSULTING ENGINEERS, GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS

|               |           |
|---------------|-----------|
| Drawn by      | 9/3/87    |
| Checked by    | JB        |
| Scale in feet | 0 400     |
| File No.      | 88C2076-2 |

FIGURE 1-3

AR300954



SCALE IN FEET

0 2000 4000

SOURCE: WOODRUFF (1984)

PHYSIOGRAPHIC PROVINCES  
AFTER PETTY, ETAL (1983)  
duPONT-NEWPORT SITE

**WOODWARD - CLYDE CONSULTANTS**

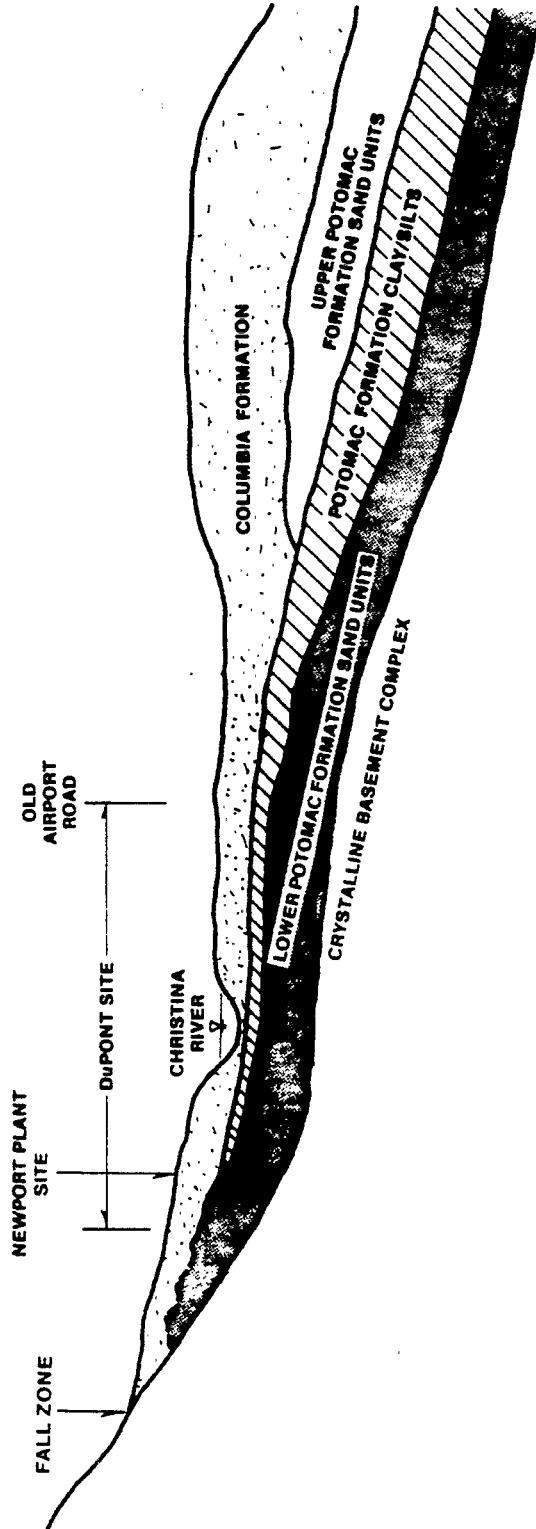
CONSULTING ENGINEERS GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS  
WAYNE NEW JERSEY

|         |     |       |               |         |           |
|---------|-----|-------|---------------|---------|-----------|
| DR BY   | TJD | SCALE | AS SHOWN      | PROJ NO | R8C2076-2 |
| CK'D BY | JR  | DATE  | 14 MARCH 1987 | FIG NO  | 1-4       |

AR300955

NW

SE

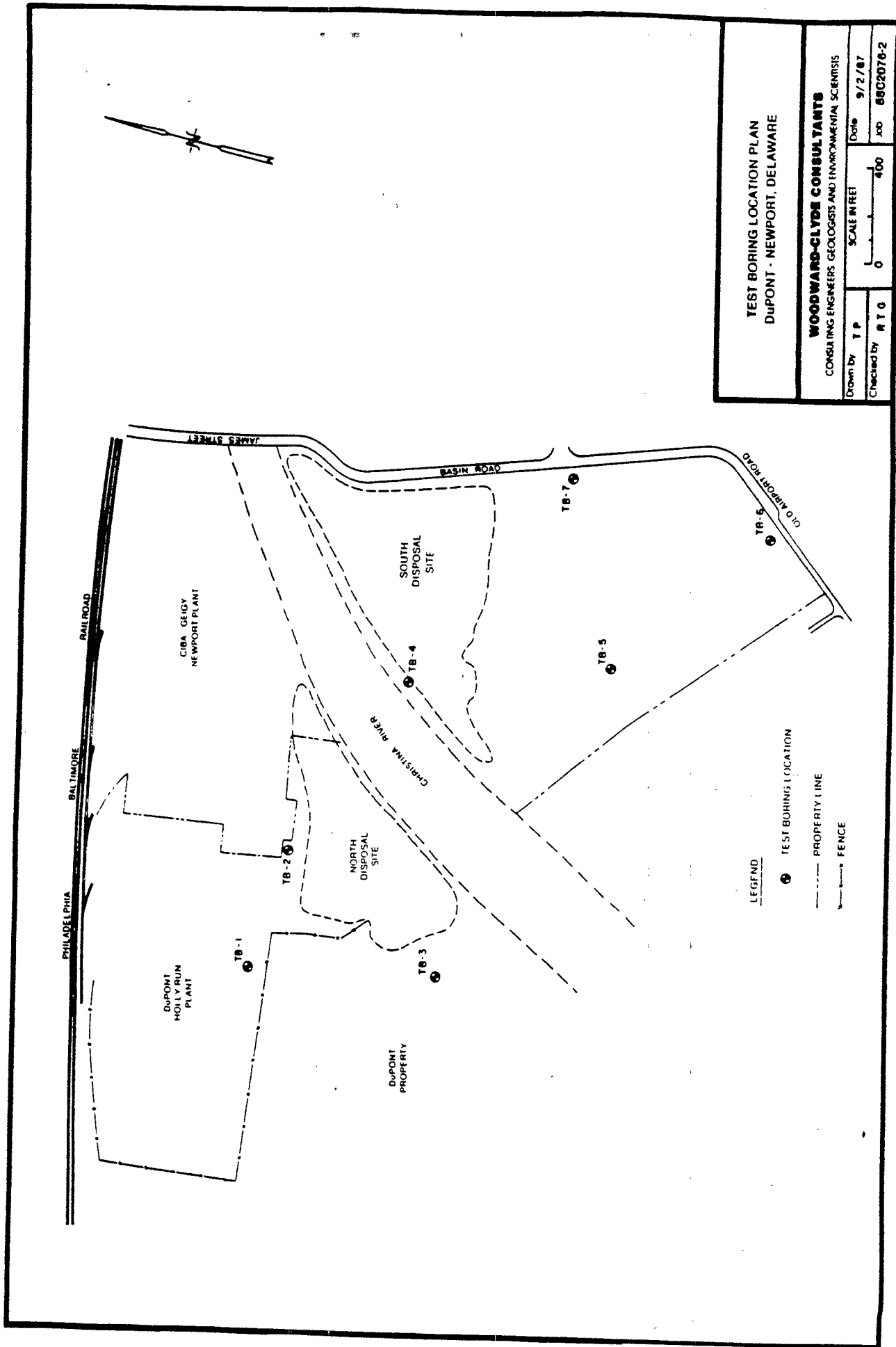


NOTES:  
 AFTER WOODRUFF, 1985  
 THE EXTENSION OF THE POTOMAC FORMATION CLAYS AND SILTS  
 NORTH OF THE CHRISTINA RIVER BASED ON DATA FROM THIS  
 NEWPORT SITE INVESTIGATION

|                                                                                                    |       |               |               |
|----------------------------------------------------------------------------------------------------|-------|---------------|---------------|
| DIAGRAMATIC CROSS-SECTION OF STRATIGRAPHY<br>DUPONT - NEWPORT SITE<br>NEWPORT, DELAWARE            |       |               |               |
| <b>WOODWARD-CLYDE CONSULTANTS</b><br>CONSULTING ENGINEERS, GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS |       |               |               |
| Drawn by                                                                                           | J. C. | SCALE IN FEET | Date 9/2/87   |
| Checked by                                                                                         | R. S. | N.T.S.        | Job 88C2078-2 |

FIGURE 1-5

AR300956



AR300957

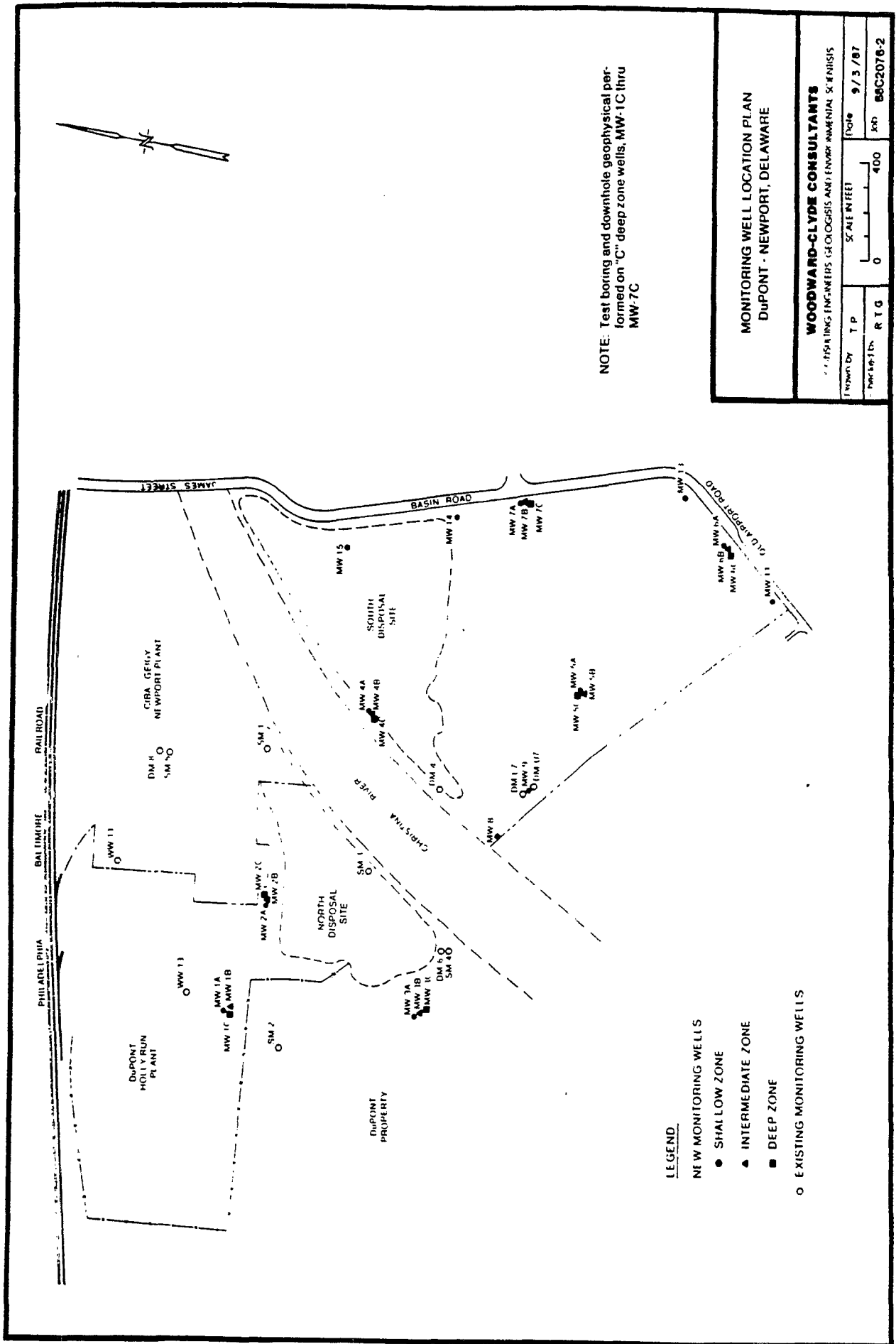
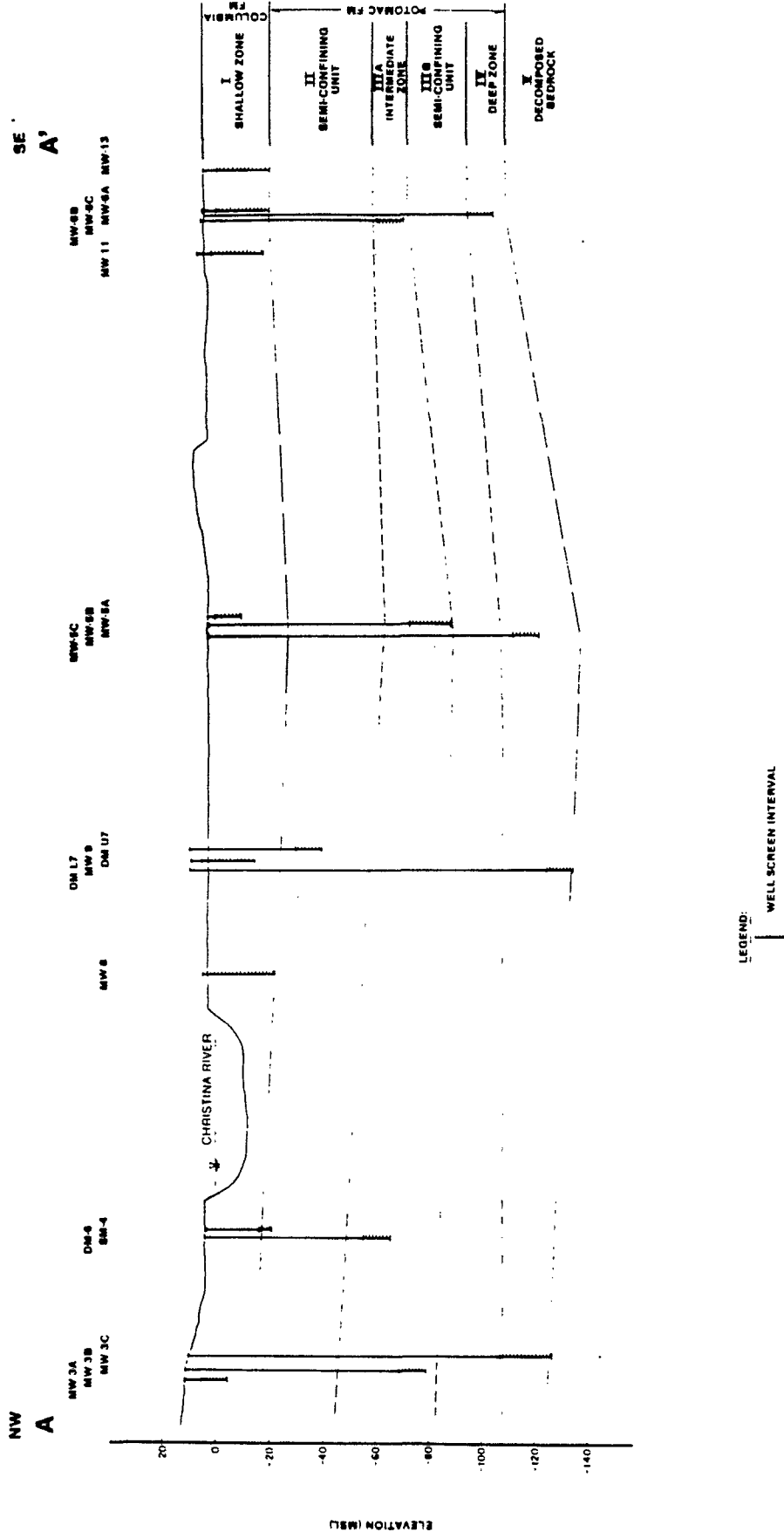


FIGURE 1-7

AR300958





| MONITORING WELL SCREEN POSITIONS<br>SECTION A-A'                                |          |                  |           |
|---------------------------------------------------------------------------------|----------|------------------|-----------|
| DuPont - NEWPORT, DELAWARE                                                      |          |                  |           |
| Woodward-Clyde Consultants<br>Geological Engineering and Environmental Sciences |          |                  |           |
| Sheet No.                                                                       | 1        | Horizontal Scale | 1" = 100' |
| Sheet No.                                                                       | 1        | Vertical Scale   | 1" = 20'  |
| Project No.                                                                     | 88C20762 |                  |           |

FIGURE 1-9

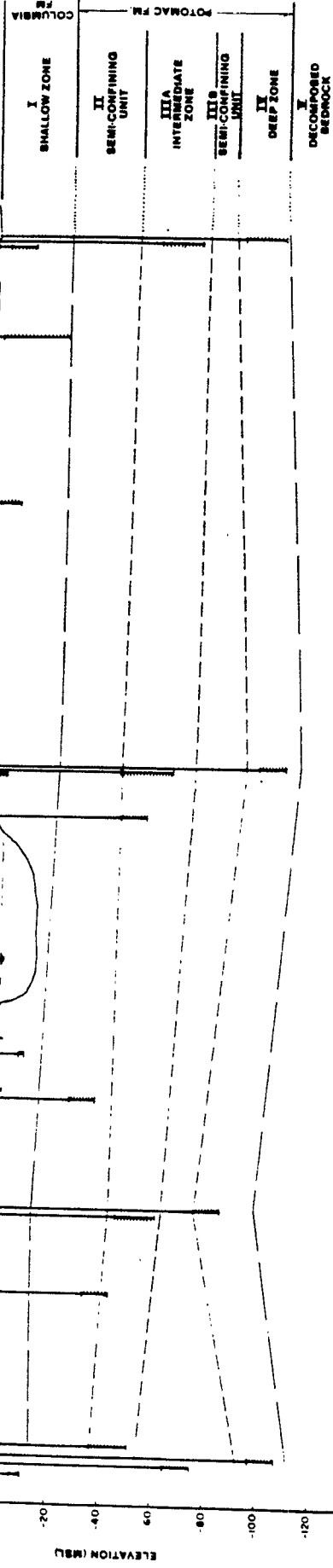
AR300960

NW  
B

SE  
B'

SM-2  
WW-13  
MW-1A  
MW-1C  
MW-1B  
WW-11  
MW-2A  
MW-2B  
MW-2C  
DM-8  
SM-5  
SM-3  
SM-1  
NEWPORT PLANT  
SITE  
DM-4  
MW-4A  
MW-4B  
MW-4C  
MW-18  
MW-14  
MW-7A  
MW-7B  
MW-7C

CHRISTINA RIVER



LEGEND  
WELL SCREEN INTERVAL

**MONITORING WELL SCREEN POSITIONS  
SECTION B-B'**

**DUPONT - NEWPORT, DELAWARE**

**Woodward-Clyde Consultants**  
Geological Engineering and Environmental Sciences

|            |        |             |           |
|------------|--------|-------------|-----------|
| Drawn by   | D.E.C. | Scale       | 1" = 20'  |
| Checked by | D.E.C. | Project No. | 88C2076-2 |

AR300961

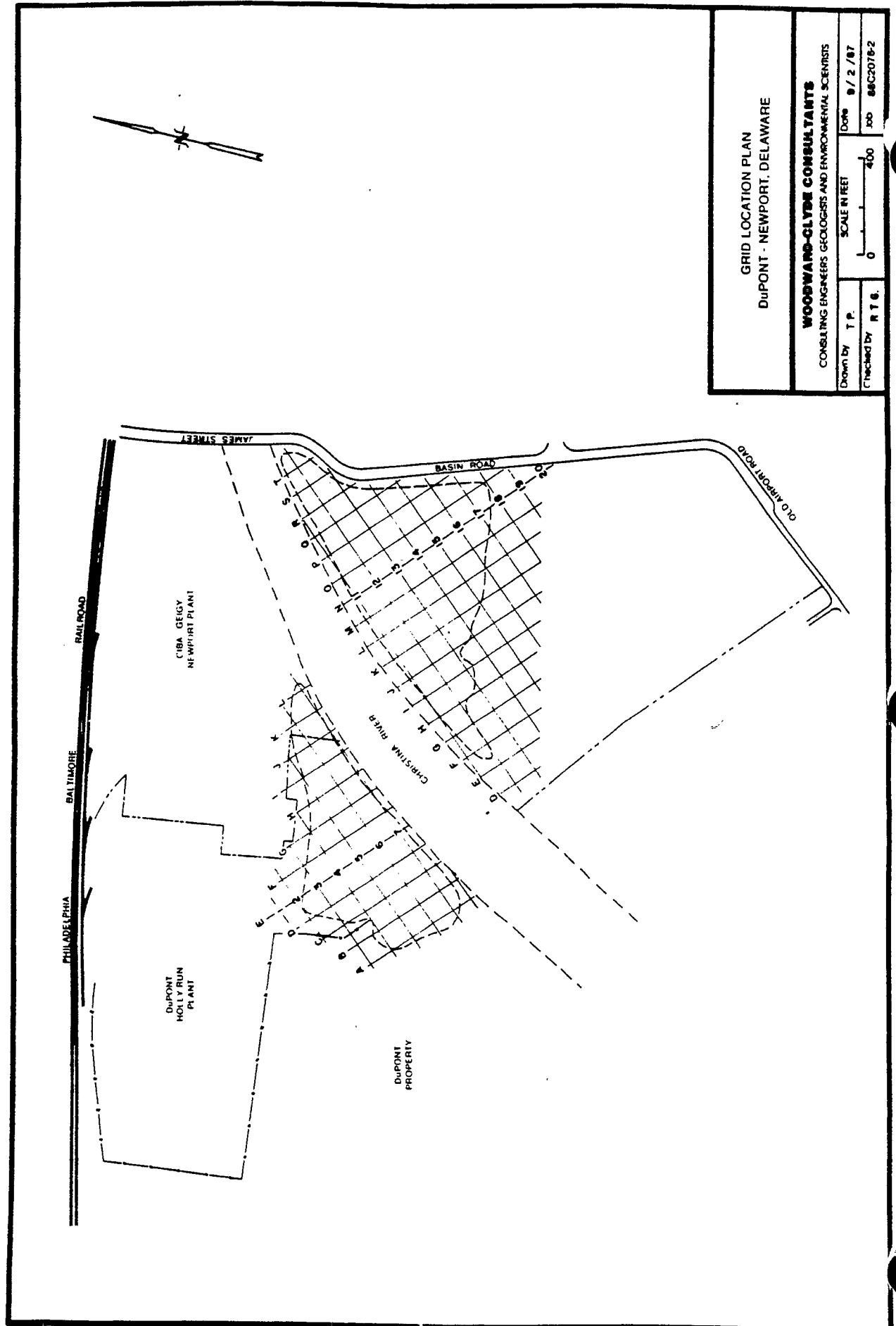
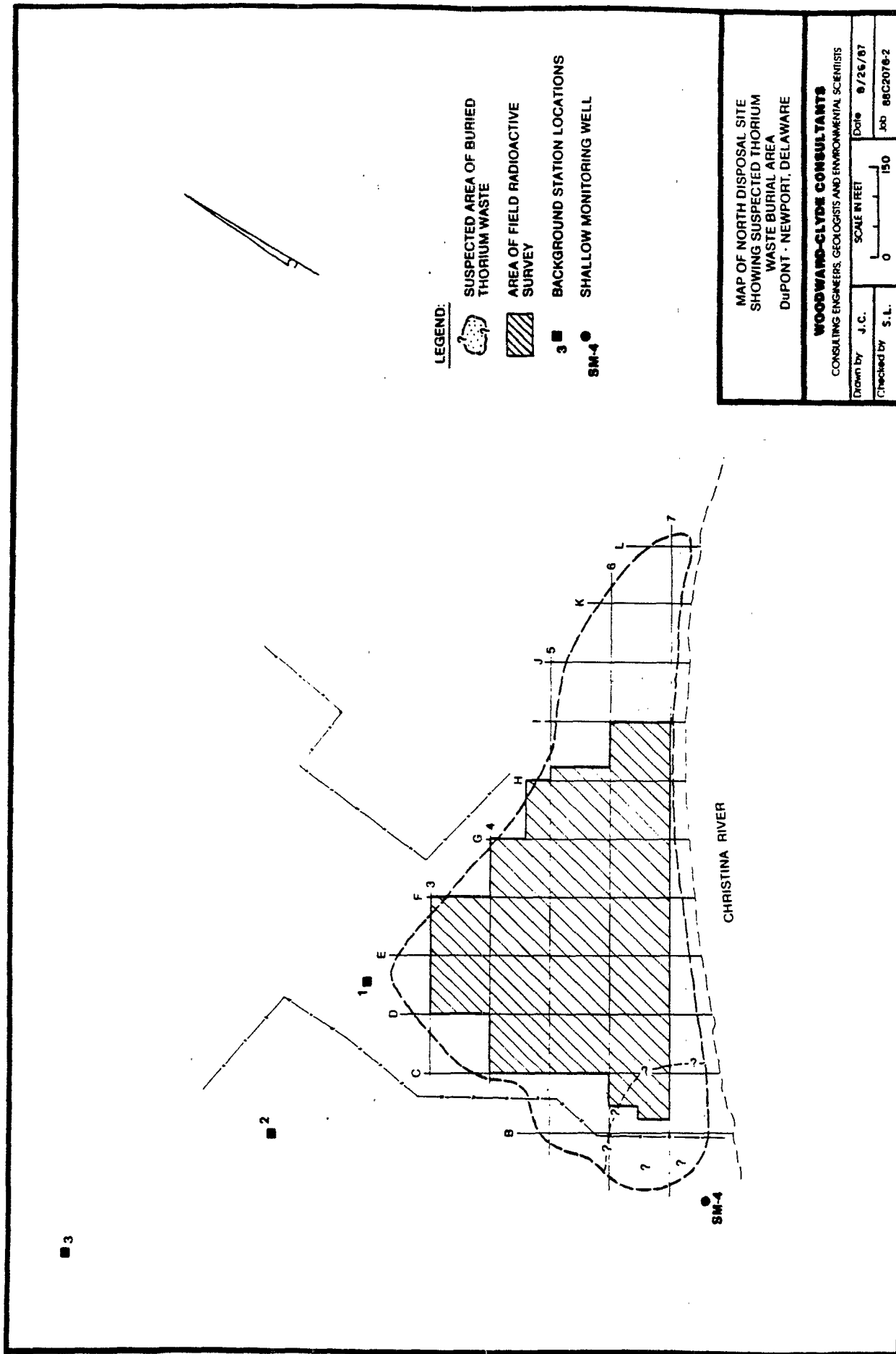


FIGURE 1-11

AR300962



**LEGEND:**



SUSPECTED AREA OF BURIED THORIUM WASTE



AREA OF FIELD RADIOACTIVE SURVEY



BACKGROUND STATION LOCATIONS



SHALLOW MONITORING WELL

MAP OF NORTH DISPOSAL SITE  
SHOWING SUSPECTED THORIUM  
WASTE BURIAL AREA  
DuPONT - NEWPORT, DELAWARE

**WOODWARD-CLYDE CONSULTANTS**

CONSULTING ENGINEERS, GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS

Drawn by J.C.

SCALE IN FEET

Date 6/25/87

Checked by S.L.

0

150

Job 88C2076-2

AR300963

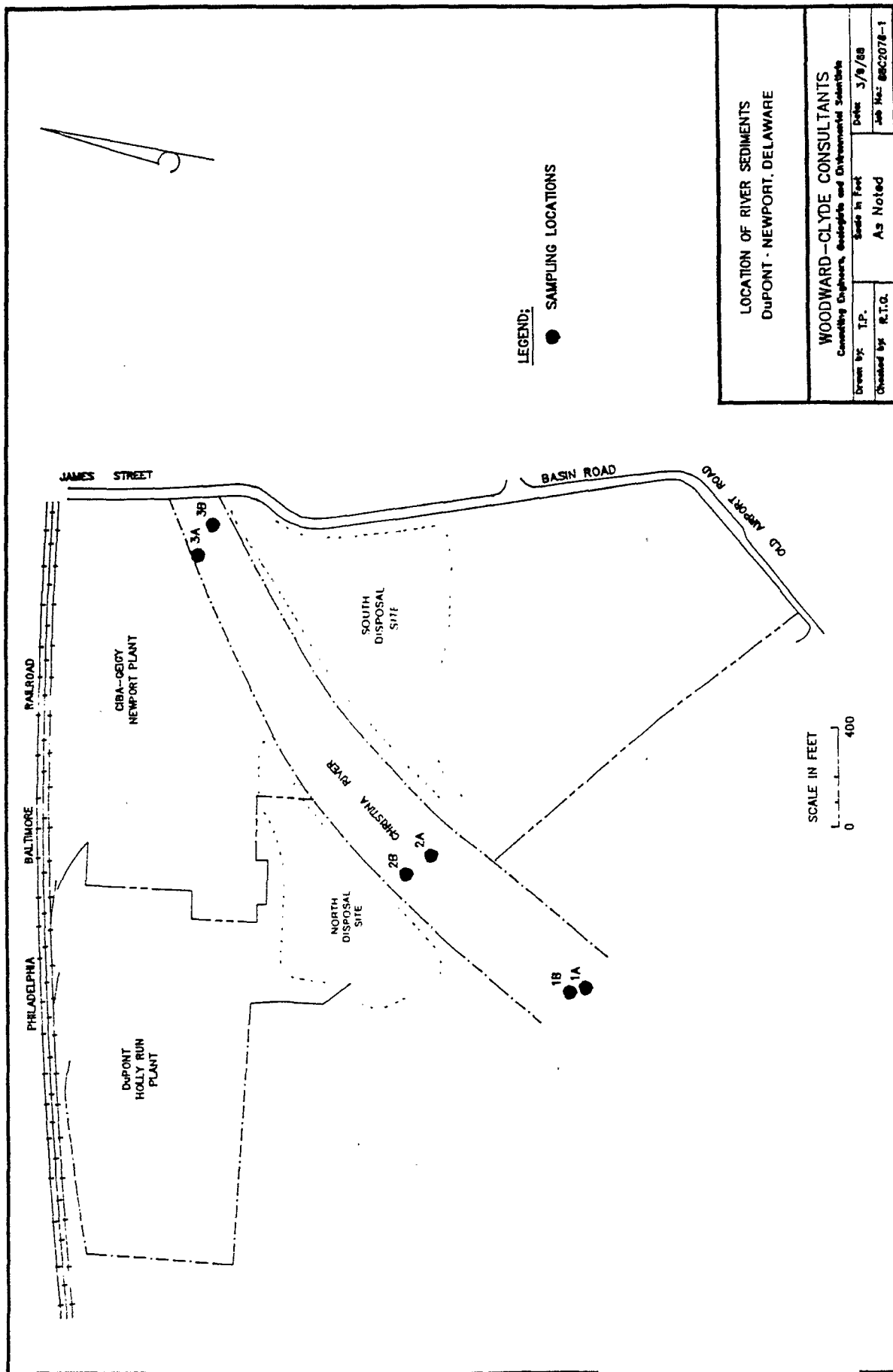
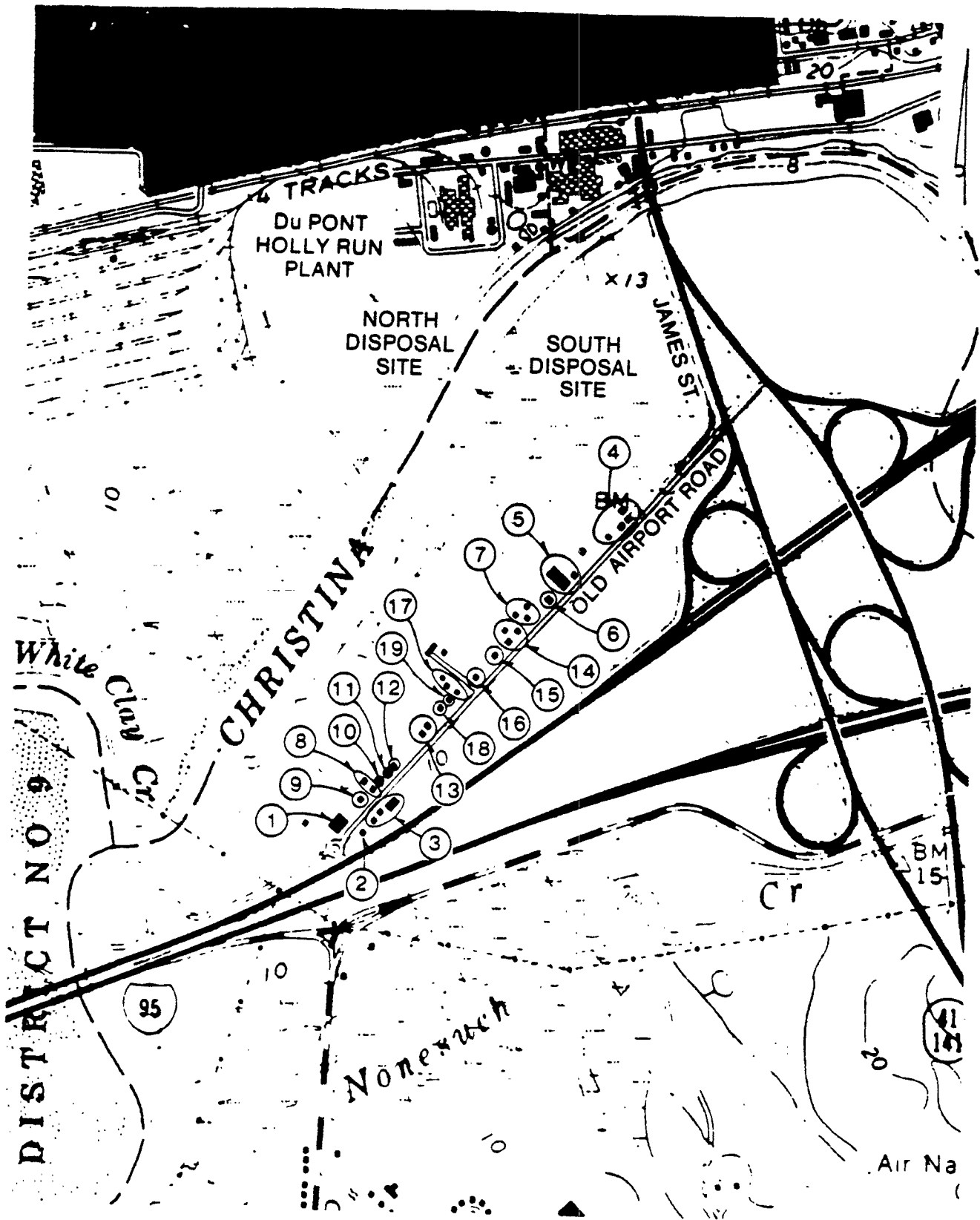


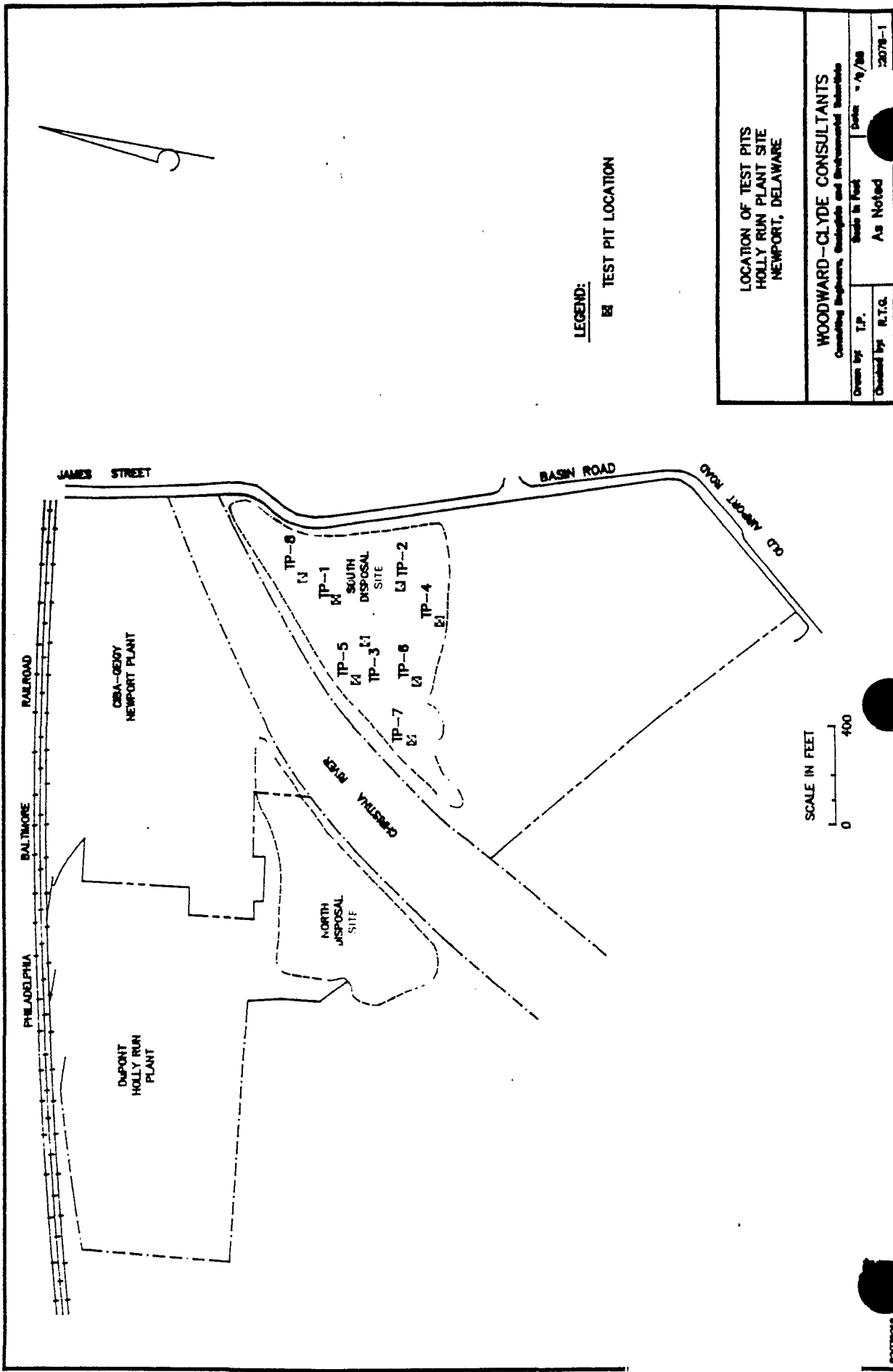
FIGURE 1-13



OLD AIRPORT ROAD WELL INVENTORY  
Du PONT - NEWPORT

AR300965

FIGURE 1-14



AR300966

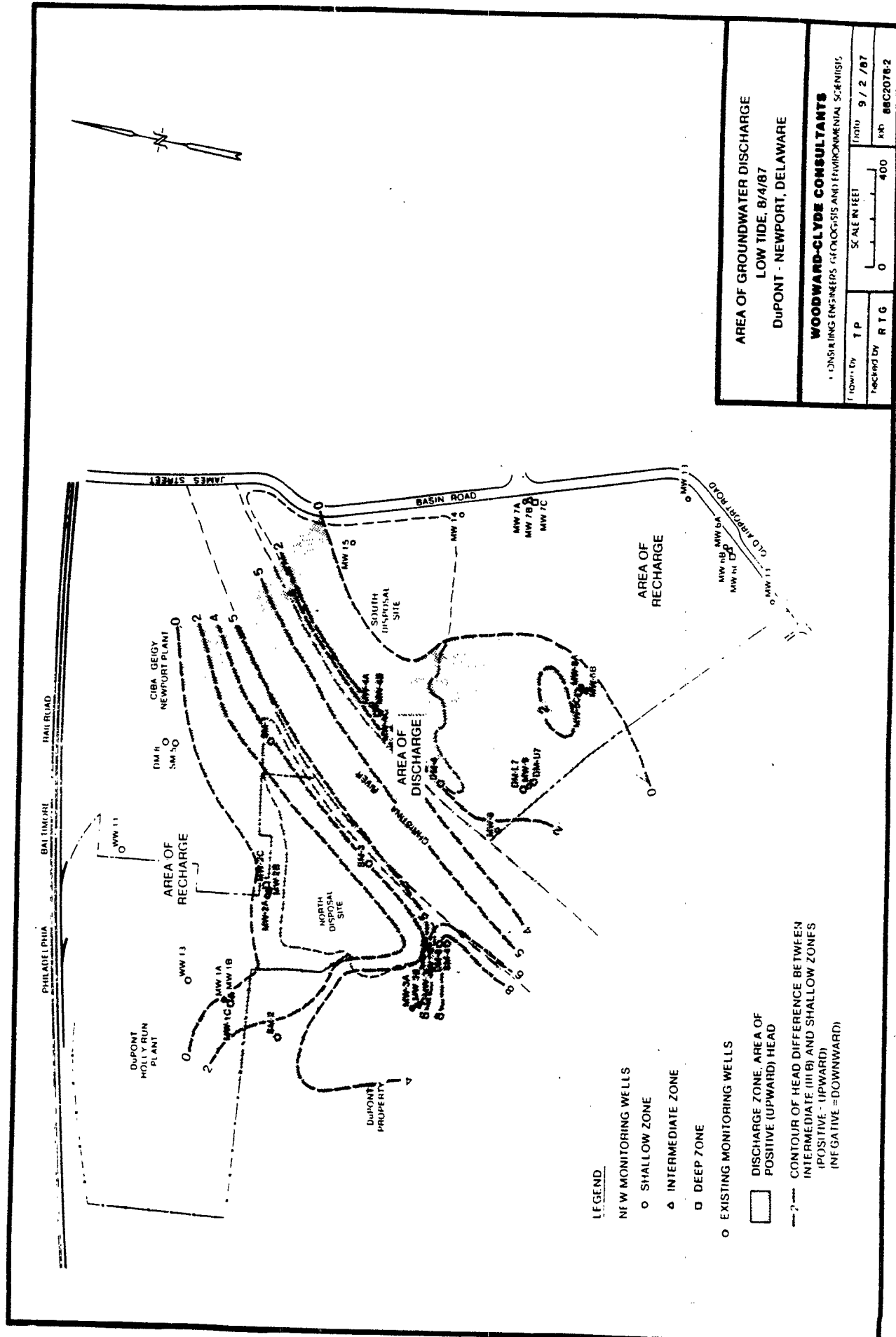
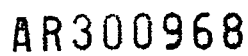
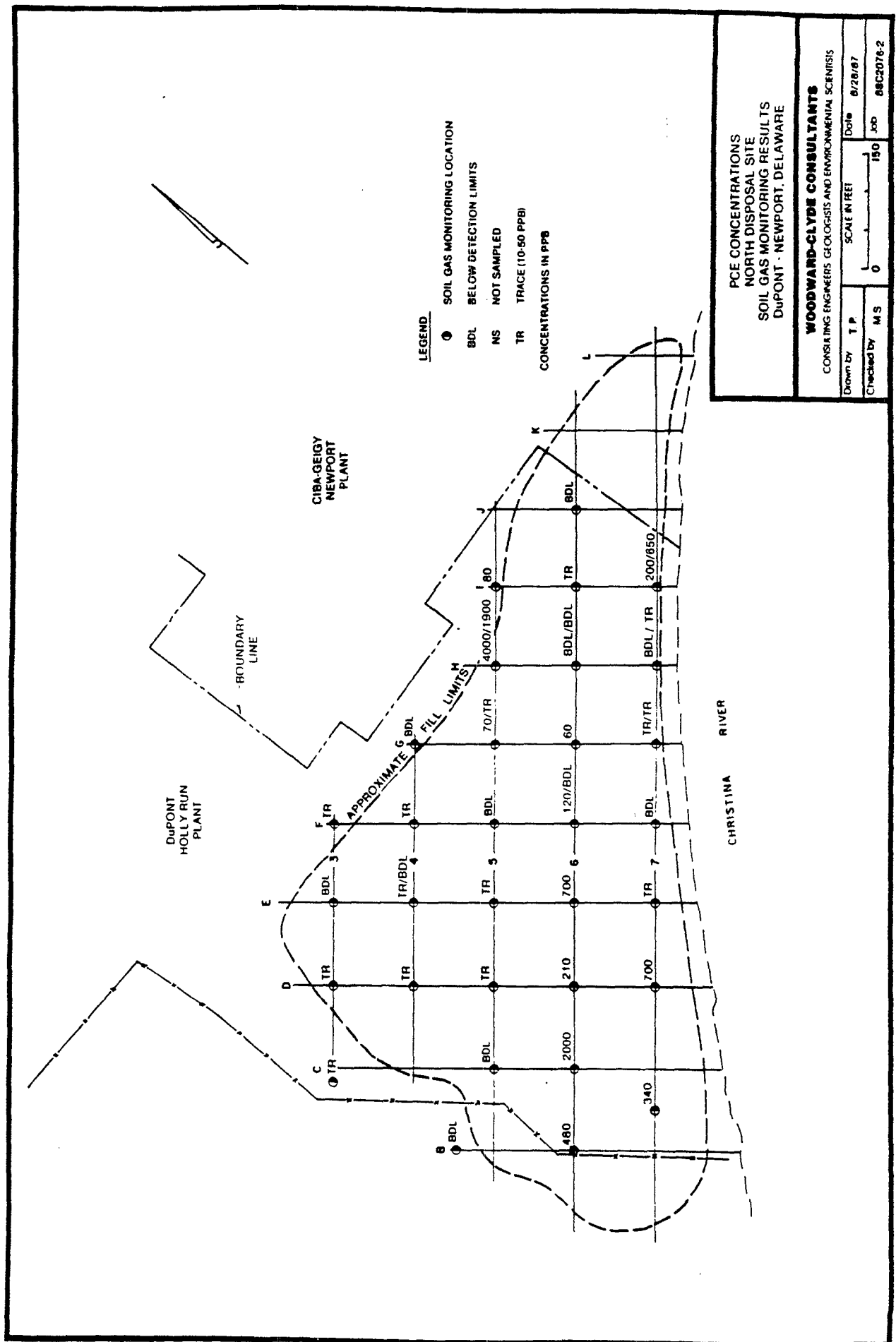


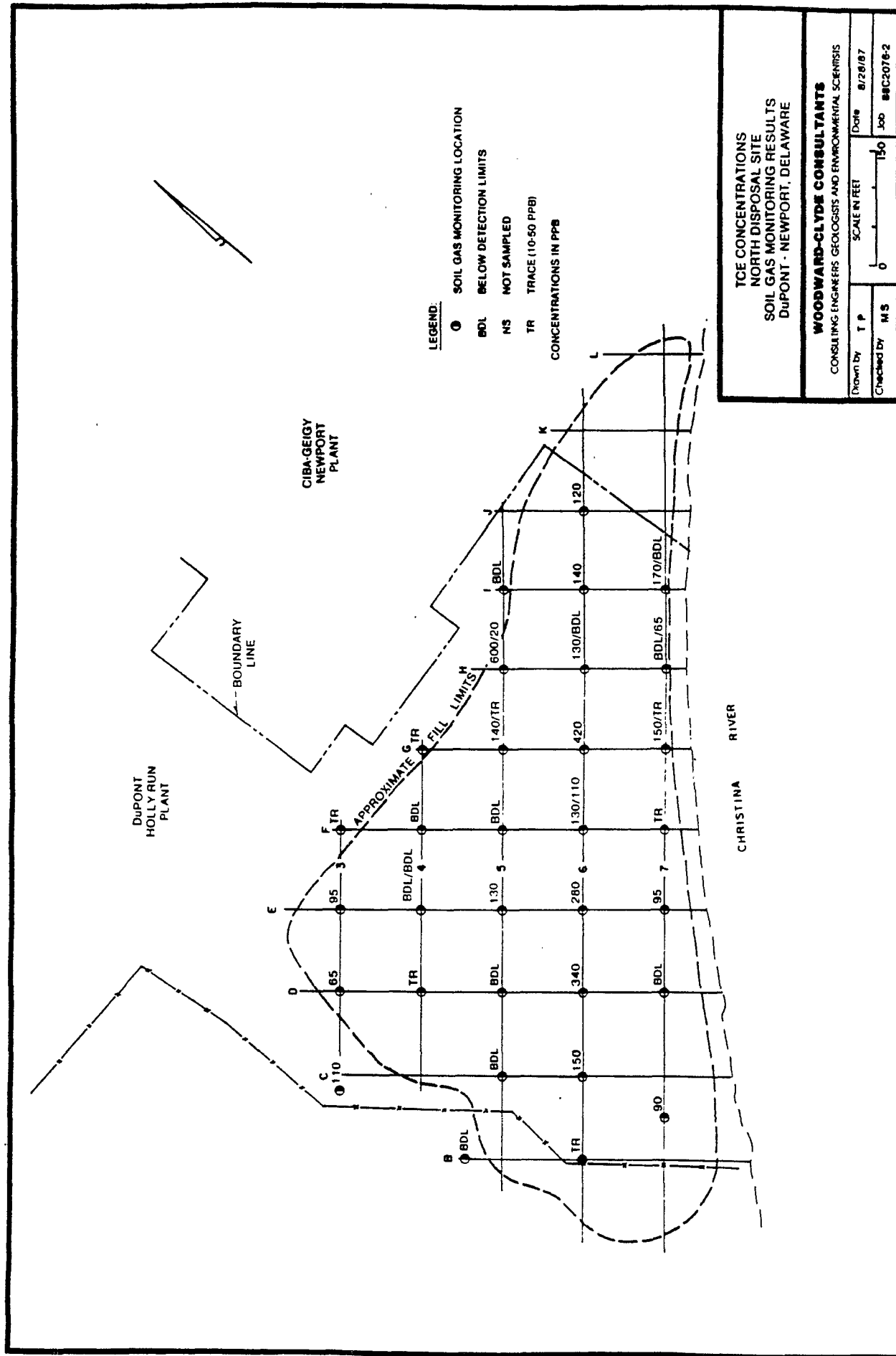
FIGURE 1-16

AR300967





AR300969



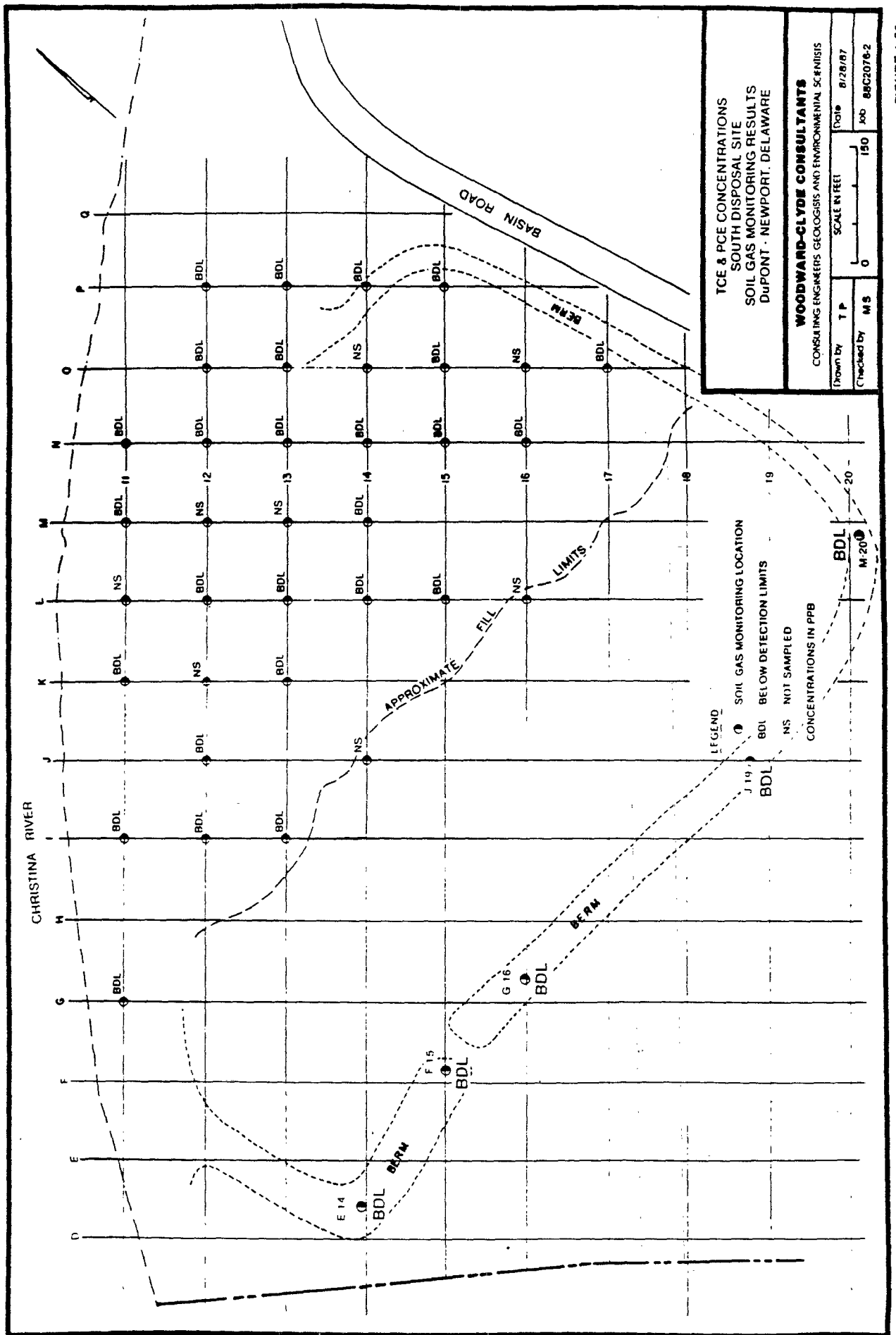


FIGURE 1-20

AR300971

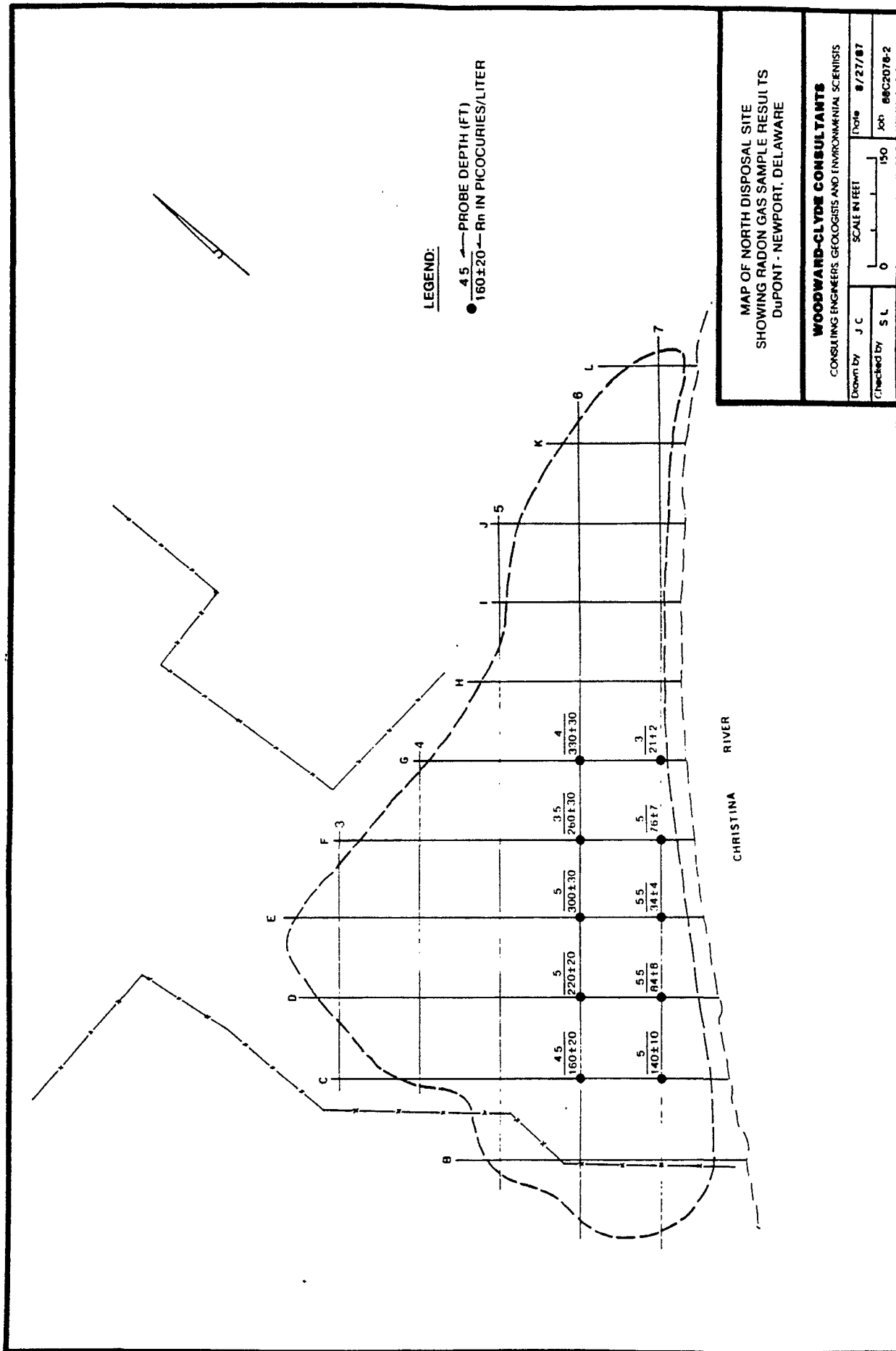
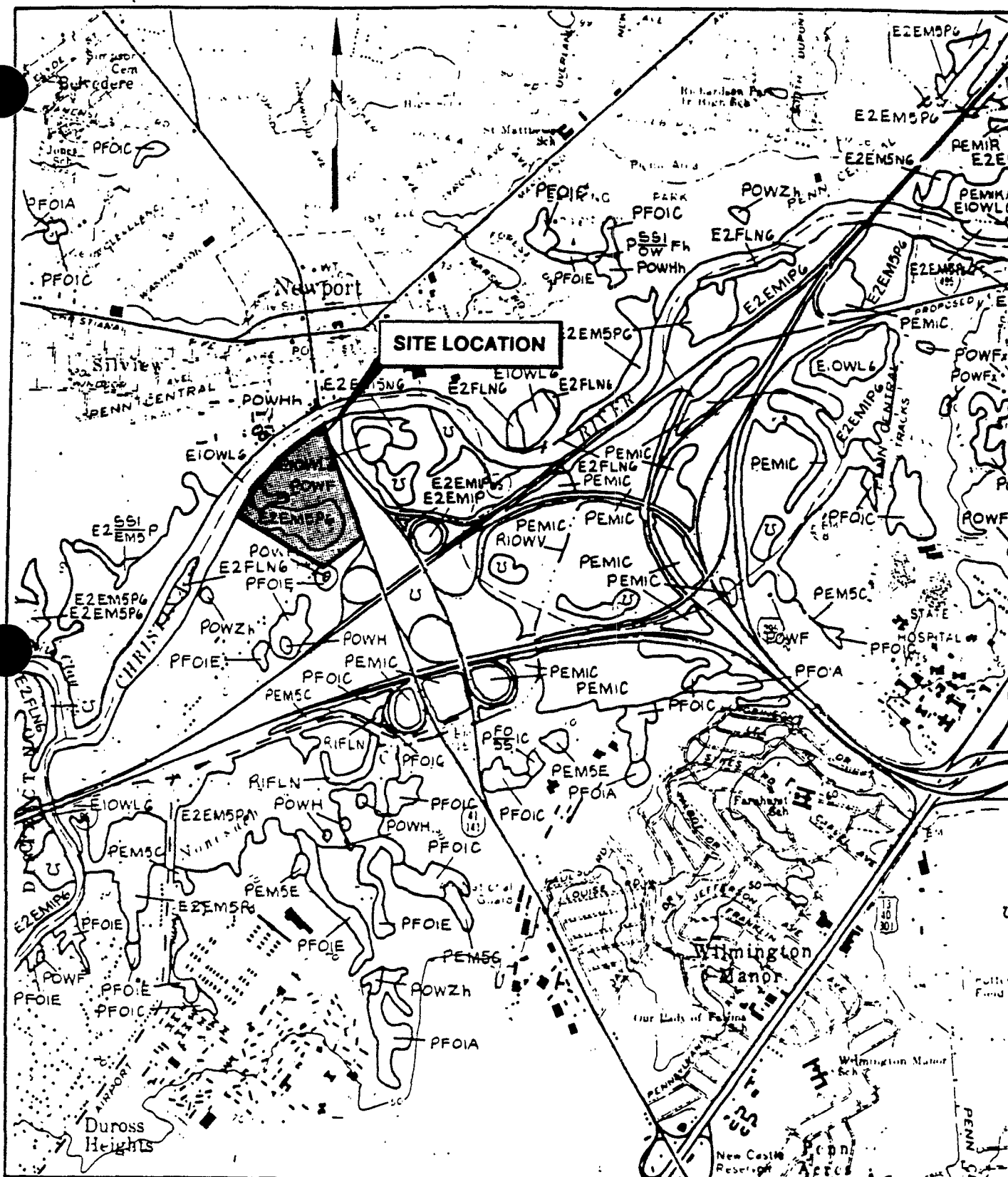


FIGURE 1-21

AR300972



SOURCE:  
NATIONAL WETLAND INVENTORY MAP,  
WILMINGTON SOUTH, DELAWARE

KEY: (IN PART)

POW F PAULSTRINE OPEN WATER (SEMIPERMANENT)  
E2EM56P ESTUARINE INTERTIDEL EMERGENT  
NARROW-LEAVED PERSISTENT,  
IRREGULARLY FLOODED, OLIGOHALINE

ED. OSGORNE  
R300973

## US FISH AND WILDLIFE SERVICE WETLANDS IN THE SITE AREA

**WOODWARD - CLYDE CONSULTANTS**

CONSULTING ENGINEERS, GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS  
WAYNE, NEW JERSEY

|         |     |                      |         |
|---------|-----|----------------------|---------|
| DR BY   | DRS | SCALE 1 IN = 2000 FT | PROJ NO |
| CK'D BY | RLH | DATE 8 JAN           |         |

**2.0 TASK 2 - SITE INVESTIGATION**

This section presents a summary of work tasks proposed for Phase II of the Remedial Investigation.

**2.1 WASTE CHARACTERIZATION**

All available information indicate that North and South Disposal sites received waste materials (see Section 1.2.1) only from the Du Pont Plant during landfilling operations, with the only exception being the average 3-foot thickness of variable highway construction soils (spoils) disposed over the South Disposal site by the State of Delaware, Department of Highways. During Phase II, Du Pont will endeavor to determine from its employees the previous disposal method for maintenance wastes and any possible additional details to better characterize and quantify these maintenance wastes.

A series of surface geophysical surveys (resistivity soundings) and soil gas surveys were conducted over the North and South Disposal sites to determine the vertical and lateral distribution of waste and to delineate potential TCE and PCE vapor concentrations at these locations (Sections 1.1.6.3 and 1.1.6.4). Additionally, a ground radiometric survey and a radon gas survey were conducted over the North Disposal Site due to the reported burial of thoriated nickel and related waste. The purpose of these surveys was to determine whether the buried waste was emitting detectable gamma radiation through the cover, and to assess the potential impact of this waste on the groundwater quality (Sections 1.1.6.5 and 1.1.6.6).

Eight test pits were excavated in the South Disposal site to verify the reported contents of the waste materials (Section 1.2.1.2). Chemical analyses of the collected waste material samples revealed that seven organic compounds were present at low concentrations along with several heavy metals (aluminum, barium, iron and zinc) at elevated concentrations (see Appendix J). By comparison the EP toxicity test results indicated that barium and

reactive sulfide exceeded the RCRA alert levels at some locations within the Lithopone waste fill material in the South Disposal site. Characterization of the waste materials in the South Disposal site is considered adequate to meet the data requirements of the Endangerment Assessment and Feasibility Study.

The quality of the groundwater in the monitoring wells in the immediate vicinity of the North Disposal site is deemed adequate indirect characterization of the disposed waste materials. The basis for this determination is primarily the leachate generation time from inception to cessation of disposal activities from 1902 to 1974. To the extent that the disposed waste materials are capable of leaching contaminants to the environment, this time frame is considered sufficient for the leachate generation potential to be indicated by the quality of groundwater proximal to the North Disposal site. In addition, as discussed in Section 1.2.4, the 2-foot clay cap probably has precluded both contaminant release to the air and the transport of waste materials off the disposal site by surface runoff since 1974. Thus, all contaminant transport mediums have been characterized at least indirectly.

However, in order to provide further direct characterization of the North Disposal site, five test borings approximately 20 feet deep each will be drilled into the landfilled area until the interface between the disposed materials and the original marsh sediments is encountered. Split-spoon samples will be obtained at approximately 8-foot intervals (3 samples per boring) and analyzed for the complete Target Compound List (TCL) in accordance with CLP protocol. One of these test borings will be located at the presumed thorium waste disposal area of the North Disposal site.

## **2.2 RADIOLOGICAL INVESTIGATION**

Based on the evaluation of the available ground radiometrics data (Section 1.2.2.5) and radon gas data (Section 1.2.2.6), no additional radiological investigation is proposed.

### **2.3 RESIDENTIAL WELL SAMPLING**

Additional sampling of about ten residential wells southwest of the Site along Old Airport Road will be conducted to provide additional data on the groundwater chemistry off-site. Representative wells will be selected on the basis of reported well depth such that samples can be collected from each of the three water-bearing zones (hydrostratigraphic Units I, III<sub>A</sub>, IV), if possible. In addition, four off-site residential wells located upgradient of the Newport Site, if existing and accessible, will also be sampled for background water quality. These residential well samples will be analyzed for the TCL parameters, in accordance with CLP protocol, plus field parameters (pH, specific conductivity, and temperature).

### **2.4 SURFACE SOIL SAMPLING**

To establish background contaminant levels for the soils at the Newport Site, four grab soils samples will be collected from representative areas located outside of the disposal sites and historical operations areas. The anticipated locations are in the northwest portion of the Du Pont property west of the Holly Run Plant and south of the railroad track. These soils samples will be analyzed for the complete TCL except volatiles in accordance with CLP protocol. The sampling procedure will consist of collecting composite samples from the ground surface to a depth of 6 inches using properly decontaminated stainless steel hand operated sampling tools. Two additional grab surface soils samples will be similarly collected and analyzed at the vegetationless area on the North Disposal site and at the MW-3 well cluster (one sample at each location).

### **2.5 HISTORICAL AERIAL PHOTOGRAPHY ANALYSIS**

A series of aerial photographs will be obtained for the Newport Site dating back to at least the 1940's and spaced at intervals no longer than 5 to 10 years apart, if

available. Evaluation of these photographs will allow a detailed chronology of visual changes to the Site and hopefully will assist in preparing a history of waste disposal.

## 2.6 GROUNDWATER SAMPLING

Groundwater analysis data collected during the two previous rounds of groundwater sampling (Section 1.1.6.2) could be considered sufficient to determine the groundwater quality at the site. The analytical data from the on-site wells presently located upgradient from the two waste disposal sites could be considered indicative of background water quality. The basis for this consideration would be that the former water supply production wells at the plant (WW-11 and WW-13) have not been operational since 1980 and that, as part of the hydrogeological investigation conducted in 1987, groundwater velocities have been estimated which indicate that groundwater recently collected from these well locations could represent upgradient chemistry.

However, during Phase II of the RI, additional groundwater sampling will be conducted to confirm the conclusions drawn from existing data. Two rounds of groundwater samples will be collected and analyzed for the TCL volatiles and metals plus field parameters from six additional new wells to be drilled during Phase II at the following locations and screened in the following hydrostratigraphic units:

- o One well (MW-16A) in the northeast corner of the South Disposal site screened in the Shallow Zone (Unit I);
- o A pair of wells located along the northern side of the Christina River about one-half way between existing well SM-1 and the James Street bridge; one well (MW-17A) screened in the Shallow Zone (Unit I) and one well (MW-17B) screened in the Intermediate Zone (Unit III<sub>A</sub>);

- o One well (MW-18A) located off-site immediately east of Basin Road about one-half way between MW-14 and MW-15 screened in the Shallow Zone (Unit I); and
- o A pair of wells located off-site a short distance southwest of the existing wells MW-8 and MW-9; one well (MW-19A) screened in the Shallow Zone (Unit I) and one well (MW-19B) screened in the Intermediate Zone (Unit III<sub>A</sub>).

If the chemical analysis of the new Unit III<sub>A</sub> well (MW-17B) located along the northern side of the Christina River indicates contamination, then a seventh new well (MW-18B) would be constructed adjacent to MW-18A and sampled for TCL volatiles and metals plus field parameters.

If the QA/QC evaluation for validation (Section 3.1) of the RI Phase I groundwater analytical results indicates that certain data cannot be validated, then additional groundwater sampling and analysis will be considered for those specific wells and parameters that could not be validated. Such additional sampling and analyses will be conducted if the desired data are required to adequately characterize the groundwater chemistry at the Site.

One additional sample of groundwater will be collected during Phase II of the RI from well SM-4 for Radium-228 analysis.

All Phase II well construction, groundwater sampling, and analyses will be constructed in accordance with the applicable sections of the QAPP.

## 2.7 AQUATIC BIOLOGICAL INVESTIGATIONS

The wetlands on the Site include both emergent and shallow open water habitats (Section 1.2.2.9). In an effort to better define the potential risk to the aquatic

resources that occur in these wetlands, a two step approach for additional investigation has been defined. This approach includes a preliminary investigation step and, then, a field collection and tissue analysis step.

In the preliminary investigations the following tasks will be performed:

- o define the extent of wetland habitats on the Site;
- o review literature on the behavior and ecological effects of the identified contaminants (at minimum, known Du Pont-related contaminants) on aquatic organisms;
- o identify "significant/critical biological populations" in the area, if any; and
- o identify aquatic test organisms.

Once these tasks have been performed, field collection and analytical work can proceed in an efficient and effective manner in the second step of the investigation. Field collections of aquatic organisms will be made to obtain samples of tissue for laboratory analysis. The biota tissue will be analyzed for the TCL metals. The selection of aquatic organisms to be collected will be dependent upon the results of the preliminary investigation. The goal is to select an organism(s) that will provide a measure of biological uptake occurring at the Site. In general, a species that is resident in the wetland (i.e., non-migratory) is preferred. Collections of the selected organism(s) will be made at five locations distributed over the Site's wetlands. These locations will be determined based on habitat/organism availability on the Site (to be determined during the preliminary investigation).

The data developed as part of this effort will be utilized to evaluate the on-site biological pathway for contaminants known to occur at the Site. The basis for the analysis will be the results of the aquatic organism lab analyses and knowledge of the site's food web based on the field reconnaissance effort in the preliminary step. Because the site is not open

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to public use, the pathway analysis will focus on the ecological effects of contaminant accumulation.

Sediments of the Christina River in the vicinity of the Site contain zinc, barium, and cadmium, which may be attributable to previous activities at the Site. Insufficient data are available to estimate the extent to which these parameters have dispersed in the Christina River and the associated wetlands at the Site.

Field work will include the collection of six surface-grab samples of wetland sediments. Four will be collected upstream and two will be collected between river mouth and the Site. In addition, nine surface grab sediment samples will be collected from the wetlands associated with drainageways at the Site. Four will be collected on the north side of the Christina River and five from the wetlands on the south side of the river. The 15 sediment samples will be tested for the complete TCL along with the following physical parameters: grain-size distribution (sieve and 24-hour hydrometer); percent moisture; percent combustible organics; and TOC.

Six surface water samples will also be collected from the wetlands associated with the drainageways at the Site. Three will be collected on the north side of the Christina River and three from the south side of the river. These six wetlands surface water samples will be analyzed for the complete TCL and the following field parameters: pH, specific conductivity; temperature; dissolved oxygen; Eh; TDS; alkalinity; hardness; and salinity. A duplicate of each water sample will be collected and filtered for a second analysis of TCL metals.

Of the nine wetlands sediment samples and six wetlands water samples, one each will be collected at each of the six locations where wetlands biota tissue are collected.

## **2.8 CAP (COVER) INTEGRITY STUDY**

Estimation of the surface runoff/infiltration characteristics of the landfill cover is important for evaluating the potential for leachate generation in the landfill. The objectives of the cover integrity study are to determine the physical characteristics of the cover materials and assess surface runoff/infiltration potential.

Cover thickness in the North Disposal site will be determined during the drilling of the five test borings described in Section 2.1. In the South Disposal site, some cover thicknesses were previously measured at eight test pit locations (Section 1.2.1.2). During Phase II of the RI, cover thicknesses will be measured at the five proposed test boring locations at the North Disposal site and at eight new locations at the South Disposal site by augering or split-spooning through the cap (cover) materials. The gradation of the cap materials will be measured by grain-size analysis of representative composite samples. In-place moisture/density tests will be completed to characterize water content in the cover. Computer modeling will be considered during evaluation of these physical data and available local meteorologic information to estimate the rate of infiltration through the cover and possibly develop a long term water balance for the landfill.

In the North and South Disposal sites, cover thickness measurement locations, grain-size analysis grab sample, and in-place moisture/density test locations will be identified during the RI activities.

## **2.9 AIR INVESTIGATION**

Based on the low concentrations of the VOCs detected in the landfill materials by the soil gas survey, no air quality problem is foreseen for the North and South Disposal sites. Therefore, no further air investigation is proposed.

TABLE 2-1  
PLANNED SAMPLING AND ANALYSIS EFFORT (PHASE II)

| Matrix                                                 | No. of<br>Stations | Freq. | No. of<br>Samples | Field(4)<br>Dup. | Field<br>Blanks | Matrix<br>Spike | Total(1)<br>Samples | Test<br>Parameters                                   |
|--------------------------------------------------------|--------------------|-------|-------------------|------------------|-----------------|-----------------|---------------------|------------------------------------------------------|
| Groundwater<br>(residential wells)                     | 14                 | 1     | 14                | 2                | 2               | 1               | 19                  | Field(2)<br>Total TCL(3)                             |
| Groundwater<br>(proposed wells)                        | 6                  | 2     | 12                | 2                | 2               | 1               | 17                  | Field (2)<br>TCL volatiles<br>and metals(3)          |
| Groundwater<br>(monitor well SM-4)                     | 1                  | 1     | 1                 | 1                | -               | -               | 2                   | Radium-228                                           |
| Wetlands Water                                         | 6                  | 1     | 6                 | 1                | 1               | 1               | 9                   | Field(6)<br>Total TCL(3)                             |
| River Sediment<br>(Christina River)                    | 6                  | 1     | 6                 | 1                | -               | 1               | 8                   | Total TCL(3)<br>Physical(7)                          |
| Wetlands Sediments                                     | 9                  | 1     | 9                 | 1                | -               | 1               | 11                  | Total TCL(3)<br>Physical(7)                          |
| Wetlands Biota                                         | 5                  | 1     | 5                 | 1                | -               | 1               | 7                   | TCL metals(3)                                        |
| Surface Soil                                           | 6                  | 1     | 6                 | 1                | -               | 1               | 8                   | Total TCL<br>except v                                |
| Subsurface Soil(5)<br>(cover soils)                    | 13                 | 1     | 13                | -                | -               | -               | 13                  | Soil identificati<br>and geotechnica<br>testing only |
| Subsurface Soil(5)<br>(North Disposal<br>Site borings) | 5                  | 3     | 15                | 2                | -               | 2               | 19                  | Total TCL(3)                                         |

**Notes:**

- (1) A trip blank will be included in each shipment containing water samples for Volatile Organic Compound Analysis. Trip blanks are not included in the total number of samples indicated.
- (2) Field test for pH, Specific Conductivity and Temperature will be performed at the time of sampling each monitor well and residential well.
- (3) TCL parameters are shown in Table 3-3 of QAPP.
- (4) Field duplicates will be based on 10 percent of all samples.
- (5) Samples will be obtained with split-spoon samplers.
- (6) Field test for pH, specific conductivity, temperature, dissolved oxygen, Eh, TDS, alkalinity, hardness, salinity will be performed for each surface water sample. An additional field-filtered sample will be collected for TCL metals analysis.
- (7) River and wetlands sediments will also be tested for grain-size distribution (with 24-hour hydrometer), percent moisture, percent combustible organics, and TOC.

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### 3.0 TASK 3 - SITE INVESTIGATION ANALYSIS

The objectives of this task are to:

- o perform QA/QC and data validation;
- o evaluate sufficiency of the collected data and information; and
- o evaluate, summarize and organize collected data and information.

#### 3.1 QA/QC AND DATA VALIDATION

The data collected during the Phase I and Phase II of the Remedial Investigation will be subjected to QA/QC evaluation for validation. QA/QC evaluation procedures are presented in the QAPP.

#### 3.2 DATA AND INFORMATION SUFFICIENCY

The validated data and information will be evaluated to determine whether they are sufficient to meet the following objectives:

- o To determine if groundwater or surface water contamination has occurred on-site or off-site;
- o to determine concentrations, and vertical and horizontal extent of contamination, if any;
- o to identify presence or absence of contaminated soil and/or sediment on-site or adjacent to the site;
- o to identify physical site features that may affect contaminant migration, containment or remediation; and
- o to provide sufficient data and information to support the Endangerment Assessment and the Feasibility Study.

QA/QC information and data sufficiency evaluation results will be submitted to U.S. EPA as a technical memorandum. If the collected information and data are deemed sufficient, they will be evaluated as outlined in Section 3.3. If additional data needs are identified in this memorandum, Du Pont will prepare a Work Plan for the additional site investigations (Phase III). Data and information evaluation activities will incorporate the additional results from the Phase III investigation, if conducted.

### **3.3 DATA AND INFORMATION EVALUATION**

The information and data collected during the site investigation will be evaluated, organized and presented in a format such that the relationships between site investigations for each site media can be evaluated. The following discussion presents a summary of the data analysis methods to be used in completing the RI.

#### **3.3.1 SURFACE GEOPHYSICS DATA**

Terrain conductivity survey data were plotted on a site map and conductivity contours were prepared. The contour plots will be re-evaluated to define the waste boundaries at the Site. These data will be reviewed in conjunction with the results of the soil-gas survey, surface radiometrics, and test pits data for waste characterization.

#### **3.3.2 SOIL GAS SURVEY, TEST PIT**

Soil gas and test pit data will be used to help characterize the chemical nature of the wastes in the landfills. The chemical data will be considered as sources of potential groundwater contamination in the hydrogeological model studies, if any, and in the endangerment assessment.

### **3.3.3 GROUND RADIOMETRICS DATA**

Surface gamma exposure rate survey data will be used to qualitatively determine the presence or absence of radioactive materials prior to site activities for worker health and safety protection purposes.

### **3.3.4 HYDROGEOLOGIC DATA**

Existing hydrogeologic information and data will be compiled and re-evaluated to define the hydrogeologic framework of the landfill site areas. The use of computer modeling will be considered during the hydrogeologic data evaluation.

Quantitative groundwater level and quality data will be used to establish the site specific hydrogeologic and groundwater quality, potential contaminant migration pathways, endangerment assessment, and the selection and design of appropriate remedial actions.

### **3.3.5 RESIDENTIAL/PRODUCTION WELL DATA**

Quantitative residential/production well water level and quality data will be used to evaluate the present and potential effects of the site on the existing residential and production well water quality. Also a comparison analysis will be performed between the chemicals potentially emanating from the site and the water quality of the residential and production wells. If a direct relationship between the potential site contaminants and the residential and production wells is found, then these data will be used in the endangerment assessment, and the selection and design of appropriate remedial actions.

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### **3.3.6 SURFACE SOIL DATA**

Quantitative surface soil data will be used to determine the presence or absence or extent of on-site and off-site soil contamination sources from the site. These data, including the background data, will be used in the endangerment assessment, and the selection and design of appropriate remedial actions.

### **3.3.7 CAP INTEGRITY DATA**

Soil samples from the cover materials will be tested in a geotechnical laboratory for physical properties. These properties (grain size, moisture density, and thickness data) will be used to assess the potential for leachate emanation from the Site wastes.

### **3.3.8 CHRISTINA RIVER WATER AND SEDIMENT DATA**

Christina River and/or on-site wetlands water and sediment quality data be used to determine whether river or wetlands water and sediments have been contaminated by materials in the North and South Disposal sites. These data, including the background data, will be used in the endangerment assessment, and the selection and design of appropriate remedial actions.

### **3.3.9 WETLANDS BIOTA DATA**

The biota data from the wetland areas in the vicinity of the North and South Disposal sites will be used to identify the receptor biota and potential bioaccumulation of the site related chemicals in the receptors. These data will be used in the endangerment assessment.

### 3.4 ENDANGERMENT ASSESSMENT (EA)

The objective of the endangerment assessment is to provide a determination of the magnitude and probability of actual or potential harm to public health or the environment by the release of a hazardous substance from the existing disposal sites. This objective will be attained by identifying and characterizing the following:

- o Hazardous substances present in affected media;
- o Environmental fate and transport mechanisms within the affected media;
- o Exposure pathways and extent of expected exposure;
- o Populations at risk;
- o Toxicological properties of specified hazardous substances; and
- o Extent of expected harm and the likelihood of such harm occurring.

The endangerment assessment process will be comprised of four separate components:

- o Contaminant Identification;
- o Exposure Assessment;
- o Toxicity Assessment; and
- o Risk Characterization.

The objective of contaminant identification is to screen the information available on hazardous substances present at the site and identify contaminants of concern. "Indicator chemicals" will be selected based on:

- o Their intrinsic toxicological properties;
- o Presence in large quantities; or

- o Potentially critical exposure routes.

The objective of an exposure assessment will be to identify actual or potential routes of exposure, characterize the exposed populations and determine the extent of the exposure. These objectives will be attained by performing the following four steps:

- o Analyze contaminant release;
- o Analyze environmental fate and transport;
- o Analyze exposed populations; and
- o Estimate or calculate expected exposure levels (doses incurred).

The objectives of the toxicity assessment will be to determine the nature and extent of health and environmental hazards associated with exposure to contaminants present at the site. This is a two-step process consisting of:

- o Toxicological evaluation; and
- o Dose-Response Assessment.

Risk characterization is the process of estimating the incidence of an adverse health or environmental effect under the various conditions of exposure defined in the exposure assessment. This objective is attained by integrating all of the information developed during the exposure and toxicity assessments to yield a complete characterization of potential or actual risk. The risk characterization will address all types of potential or actual risks at the site including:

- o Carcinogenic risks;
- o Noncarcinogenic risks;
- o Environmental risks; and
- o Risks to public welfare.

The assessment will include a summary of the risks associated with the site and the estimated uncertainty of the component parts of estimated risk, the distribution of risk across various sectors of the population and the assumptions contained within the estimates.

The Endangerment Assessment will be performed in accordance with the "The Endangerment Assessment Handbook" USEPA, August 1985 and the "Superfund Public Health Evaluation Manual" USEPA, October 1986 (Ref. 9 and 10).

**4.0 TASK 4 - REMEDIAL INVESTIGATION (RI) REPORTS**

The results of Tasks 1, 2, and 3 will be presented in a Remedial Investigation (RI) report to U.S. EPA according to the schedule of Figure 9-1. The RI report will be prepared in accordance with U.S. EPA RI Guidance Document (Ref. 11) and additional Guidance Documents which may be provided by U.S. EPA which are not inconsistent with the National Contingency Plan.

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### **III. FEASIBILITY STUDY (FS)**

The objectives of the Feasibility Study (FS) are to identify available remedial technologies, screen technologies, and develop and evaluate remedial alternatives based on the Remedial Investigation (RI) results for the Du Pont Newport Site. The FS will be conducted in accordance with the U.S EPA FS Guidance Document (Ref. 12).

#### **5.0 TASK 5 - REMEDIAL ALTERNATIVES SCREENING**

Scope of this task is to:

- o Describe the site conditions based on the RI findings;
- o Identify the environmental media that may require remediation (based on EA results);
- o Identify available remediation technologies;
- o Screen out non-applicable technologies;
- o Develop alternatives from remaining applicable technologies;
- o Evaluate and screen the developed alternatives; and
- o Prepare Alternatives Array Document, including ARARs.

#### **5.1 PRELIMINARY REMEDIAL TECHNOLOGIES**

The RI, as scoped in the Tasks 1 through 4, will be conducted to identify the nature of the waste in the two disposal sites and to determine the extent, magnitude of potential contamination and migration pathways of potential contaminants. Emerging and available technologies suitable for remediation of site media will be identified based on the RI results and the EA of the site. Technologies in this list will be initially screened based on site specific applicability and potential feasibility. The results of this screening, a list of

Preliminary Remedial Technologies, will be used for conceptual development of remediation alternatives.

## **5.2 DEVELOPMENT OF ALTERNATIVES**

A limited number of remedial alternatives will be developed based upon the remedial response objectives for the Site and applicability of the Preliminary Remedial Technologies. The technical approach for definition of suitable remedial alternatives is presented in the following sections.

### **5.2.1 ESTABLISHMENT OF REMEDIAL RESPONSE OBJECTIVES**

Site specific remedial response objectives will be established in formal consultation with U.S. EPA based on the following findings and regulatory criteria:

- o Current site conditions (RI results);
- o Site specific public health and environmental concerns (EA);
- o Section 300.68 of the National Contingency Plan (NCP); and
- o Site-specific ARARs as defined under SARA, Section 121.

### **5.2.2 ALTERNATIVE REMEDIAL ACTIONS**

The initially screened available technologies will be assembled in a systematic manner to develop remedial alternatives. The remedial alternatives to be developed will include:

- a. No Action Alternative - This alternative will be used as a baseline to evaluate the effectiveness of the other developed alternatives,

- b. Containment Alternatives - These alternatives will involve containment of waste constituents within identified boundaries with various engineered barriers to provide protection of human health and environment,
- c. Treatment for Contaminant Toxicity and Mobility Reduction Alternatives - These alternatives will involve various degrees of treatment of waste for reduction of toxicity and mobility of waste constituents along with containment technologies.
- d. Treatment Alternatives for Source Control - These alternatives will involve treatment of the waste source in such a way that a need for long-term management of remedial actions would not be required.

The waste in the North and South Disposal sites are presently covered with a 2 to 3 feet thick layer of primarily clay, silt, and sand materials. Therefore, the potential for direct exposure of humans to the waste materials appears to be reduced. During the development of alternatives, based on the EA results, emphasis will be placed on remedial technologies involving improvement of the landfill cap efficiency, and minimization of groundwater contamination or remediation of contaminated groundwater, if any is detected.

A limited number of groundwater remediation alternatives with a performance range of  $10^{-4}$  to  $10^{-7}$  cancer risk will be developed in this phase of the FS. An alternative that would restore the groundwater to a  $10^{-6}$  cancer risk level within five years will also be developed, if technically feasible.

Dynamic relationships between applicable remedial technologies for source control, waste treatment and groundwater remediation will be evaluated to develop a range of comprehensive remedial alternatives necessary to fulfill the requirements of the NCP.

**5.3 INITIAL SCREENING OF ALTERNATIVES**

The alternatives in groups (b) through (d), developed in Section 5.2.2, will be initially screened on the basis of the following criteria to prepare a short list of remedial alternatives which will be subjected to detailed analysis. Initial screening will be based on:

- a. Effectiveness; in terms of providing adequate protection for human health and the environment, attaining ARARs, reducing toxicity, mobility or volume of hazardous constituents and technical reliability,
- b. Implementability; in terms of availability, compatibility with the other technologies considered, safety, back-up and maintenance needs and administrative feasibility, and
- c. Cost; in terms of capital and O&M costs, including equipment replacement. Cost will be used as a screening criteria only for alternatives providing similar results.

The "No-Action" and "Containment" alternatives, groups (a) and (b) in Section 5.2.2, will be carried forward for detailed analysis during the initial screening process.

Alternatives involving innovative or emerging technologies which have reasonable potential for adequate performance and lower cost will be carried forward during this initial screening.

**5.4 ALTERNATIVES ARRAY DOCUMENT**

Following the initial screening of the alternatives, an "Alternatives Array Document" will be prepared for the purpose of identifying Federal and State ARARs. This Alternatives Array Document will include the following:

- o Brief history and site background;
- o Site characterization:
  - o Source and types of contaminants;
  - o Exposure or migration pathways of contaminants;
  - o Receptors;
  - o Other pertinent site features;
- o Initially screened alternatives:
  - o Remediation technologies considered;
  - o Typical construction activities;
  - o Estimated interaction with governmental authorities;
  - o Extent of remediation;
  - o Contaminant levels;
  - o Treatment/disposal methods; and
  - o A preliminary list of Federal and State ARARs.

A final listing of the ARARs pertinent to FS alternatives evaluation will be completed upon regulatory agencies' review of the Alternatives Array Document.

**5.5 BENCH AND PILOT STUDIES**

Following initial screening of alternatives and U.S. EPA's review of the Alternative Array Document, detailed analysis of the screened alternatives may require, as

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appropriate, bench or pilot treatment studies to obtain additional data and information for feasibility evaluation.

If the available data and information were found to be sufficient for detailed analysis of the screened alternatives, the FS will proceed with evaluation of remedial alternatives as described in Task 6.

If a Bench or Pilot Study is deemed necessary, a brief Work Plan for Bench or Pilot Study will be prepared and submitted to U.S. EPA for review and approval. The work plan for Bench or Pilot Study will include the following, as applicable:

- o A literature survey to identify existing data and information on treatment technologies.
- o Bench or pilot scale treatability tests including:
  - o Justification for treatability tests;
  - o Test plan to define goals and scope of study needed;
  - o QA/QC plan for the tests; and
  - o Uniform testing and recording procedures established by U.S. EPA.

Upon completion of the Bench or Pilot Study, if necessary, the results of the bench or pilot scale testing program will be summarized in a report and submitted to U.S. EPA for review and approval.

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**6.0 TASK 6 - REMEDIAL ALTERNATIVES EVALUATION**

The objective of this task is to evaluate the alternatives presented in the Alternatives Array Document for the following criteria:

- o Ability of each alternative to remediate the site in compliance with the Federal and State ARARs and other criteria, advisories and guidances identified in the Alternatives Array Document;
- o Applicability of discrete available and proven remediation technologies;
- o Applicability of developing or emerging remediation technologies; and
- o Short-term and long-term analyses of individual technologies and assembled alternatives for:
  - o performance, reliability, safety;
  - o implementability;
  - o potential negative affects of remedial construction activities on the environment; and
  - o cost.

The evaluations of each remediation technology and alternatives will be compared using a rating system based on the evaluation criteria given above.

The following "component measures" concepts will be considered for comparison of the alternatives:

- a. Component measures of effectiveness include the degree to which the alternative is protective of human health and the environment. Where health-based levels are established in ARARs, they will be used to establish the the minimum level of protection needed at the site. Where these levels do not exist, risk assessments will be used to help establish levels appropriate for the

site. The reliability of the remedy, including the potential need for and cost of replacement, is another important element of effectiveness. Specific measures also include other health risks borne by the affected population, population sensitivities and the impacts on environmental receptors. For groundwater response action, the potential for spread of the contaminant plume and the technical limits of aquifer restoration are necessary measures. Another important measure of effectiveness is the degree that the mobility, toxicity, or volume of the hazardous substance, pollutant, or contaminant is reduced.

- b. Component measures of "implementability" include the technical feasibility of the alternative, the administrative feasibility of implementing the alternative, and the availability of any needed equipment, specialists or off-site capacity. Specific measures for groundwater response actions include the feasibility of providing an alternative water supply to meet current ground water needs, the potential need for groundwater, the effectiveness and reliability of institutional controls.
- c. Component measures of "cost" include short-term capital and operational costs and any long-term operation or maintenance costs. Present worth analysis will be used to compare alternatives.

**7.0 TASK 7 - FEASIBILITY STUDY (FS) REPORT**

The results of Tasks 5 and 6 will be presented in a Feasibility Study Report for review and approval of U.S. EPA. The FS report will be prepared in accordance with U.S. EPA FS Guidance Document and additional Guidance Documents which may be provided by U.S. EPA which are not inconsistent with the NCP.

## 8.0 DATA MANAGEMENT

A data management system will provide a mechanism for data tracking, storage, retrieval and identification of appropriate QA/QC procedures. This section provides an outline of the procedures to be used in tracking and processing information and analytical data collected during the investigation phases of this work. The collected information and data will be processed and documented in a way which would make them available for use in site descriptions, groundwater modeling, endangerment assessments and engineering design of remedial alternatives.

The project data will be comprised of analytical test results of collected samples and geological/geotechnical data. Objectives of data management system are establishment of a computerized procedure to enter, track, store and retrieval of the following information and data:

- o Sampling media;
- o Selected sampling locations, sample types and quantities;
- o QA/QC duplicate and blank information and data;
- o Sampling methods;
- o Sampling containers, preservatives, shipping methods;
- o Contract laboratory sample delivery and data receipt schedules;
- o Establishment of computerized data transmittal procedures with the contract laboratory;
- o Scheduling data validation activities;
- o Computer entry of the validated information and analytical data; and
- o Establishment of data sorting and reporting procedures.

The validated chemical analysis data will be entered into the computer files as:

- o CAS number of the chemical compound;
- o Measured test value;
- o Laboratory qualifier, if any;
- o Data validation code (validated or not validated); and
- o Unit of measure.

Geological and geotechnical information and data to be collected are the following:

- o Geologic/geotechnical identifications of soils in borings and the cover material;
- o Geotechnical test results of soil samples;
- o Geophysical/geologic logs for borings;
- o Terrain conductivity data;
- o Logs of trench excavations; and
- o Water level data.

The geological, geotechnical and terrain conductivity information will be kept in the appropriate project files. Water level data will be loaded into computer for effective data sorting/manipulation purposes.

U.S. EPA may have access to the data management system for inspection of all validated sampling and analytical data records upon reasonable notice.

**9.0 SCHEDULE, REPORTING, DOCUMENT CONTROL AND PROJECT MANAGEMENT**

**9.1 SCHEDULE AND REPORTING**

The RI/FS activities in this work plan will be implemented according to the deliverables schedule set forth in the Article VI of the Consent Agreement. A list of project deliverables is presented in Table 9-1. The schedule of RI/FS activities will be submitted to U.S. EPA upon approval of the Work Plan by the Agency.

In addition to the deliverables identified in Table 9-1, monthly progress reports will be submitted to the U.S. EPA. The monthly progress reports will include the following:

1. A description of the action which has been taken toward achieving compliance with the Consent Order.
2. A description of difficulties encountered in performing work during reporting period and of actions taken or being taken to rectify problems.
3. A summary of results of sampling, validated analytical tests and quality checked data produced during the month and relating to the site.
4. Plans and procedures completed during the past month, as well as such actions, data, and plans which are scheduled for the next month.
5. Target and actual completion dates for each element of activity, including the project completion, and an explanation of any deviation from the schedules in the applicable Work Plan.
6. Changes in personnel carrying out the RI/FS Work Plan.

These reports are to be submitted to the U.S. EPA by the tenth calendar day of each month following the approval of RI/FS Work Plan.

Documents to be submitted to the U.S. EPA will be sent to the attention of the designated U.S. EPA Project Coordinator at the following address within ten calendar days of the scheduled dates:

Gerardo R. Amador (3HW16)  
U.S. EPA Region III  
DELMARVA/DC/WV CERCLA Remedial Enforcement Section  
841 Chestnut Building  
Philadelphia, PA 19107

## **9.2 DOCUMENT CONTROL**

The primary purpose of a document control system is to assure that all documents pertaining to or produced during an investigation will be accounted for at the conclusion of the project. This status of records is particularly important in projects that result in legal actions. Accountable documents include logbooks, correspondence, shipping papers, chain-of-custody forms, photographs and their negatives and any reports of test results or assessments of data.

Logbooks, sample labels (or tags), chain-of-custody forms and other field data records may be serialized prior to their use in the field. This procedure facilitates control and tracking of their use.

At the conclusion of their use in the field, these records will be placed into a project file and logged using a dated stamp which may contain space for a serialized code number for the document. Other documents pertinent to the project will likewise be logged and filed.

All project data, documentation, plans, and reports will be retained under conditions that minimize deterioration, facilitate retrieval, and provide control over access to documents. Originals of all material will be kept in the file. These documents may be

removed only after they have been logged out on a form that indicates the date removed, the name of the document, and the name of the person taking the document. Project personnel may retain copies of documents for reference after verifying that the original is in the file. Any copies made will be marked "copy" on at least the first page.

Resumes of all personnel involved with a project, along with descriptions of their jobs, will be maintained as a part of the permanent record. These documents are often used in enforcement actions to demonstrate the experience and professional competency of personnel who performed particular tasks during the investigation.

As previously noted, all entries recorded in logbooks, sample tags, custody records or other data sheets are written with waterproof ink. None of these accountable documents will be destroyed or thrown away, even if they are illegible or contain inaccuracies which require a replacement document or correction to the data.

If an error is made in recording data, the individual making the entry make contemporaneous corrections by marking a line through the error and entering the correct information adjacent to it. Any error discovered subsequent to the field work will be corrected by the person who made the entry. The original entry will not be totally obscured and the reasons for making the subsequent change must be stated. The corrections will be signed and dated.

Agencies may have access for inspection of all documents, with the exception of those which are asserted to be attorney work product or subject to privilege under law, upon reasonable notice. The documents identified as the attorney work product or subject to privilege under law will be assigned an "PRIV" to the end of the identifiers.

A master list of all documents and their subject matter will be kept in the "Master File" and periodically updated.

### 9.3 PROJECT MANAGEMENT

The designated Du Pont Project Manager is:

Alan B. Palmer, Ph.D.  
Manager - Safety, Health and Environment  
Chemicals and Pigments Department  
Brandywine 16270  
E.I. du Pont de Nemours and Company  
1007 Market Street  
Wilmington, Delaware 19898

All project work defined in this Work Plan will be performed under the direction and supervision of the WCC Project Manager, Alfred M. Hirsch, Ph.D., who is a qualified geologist.

Alfred M. Hirsch, Ph.D.  
Woodward-Clyde Consultants  
5120 Butler Pike  
Plymouth Meeting, Pennsylvania 19462

Duties of the WCC Project Manager will be to:

- o Interact with the Du Pont Project Manager on regulatory, technical and financial issues;
- o Interact with the Agency Project Coordinators on regulatory and technical issues; and
- o Implement the Work Plan Tasks through supervision of project contractors.

Resumes and qualifications of the Project Manager and key project staff and qualifications of subcontractors are provided in Appendix L.

The proposed project organization chart is presented in Figure 9-2.

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**10.0 REFERENCES**

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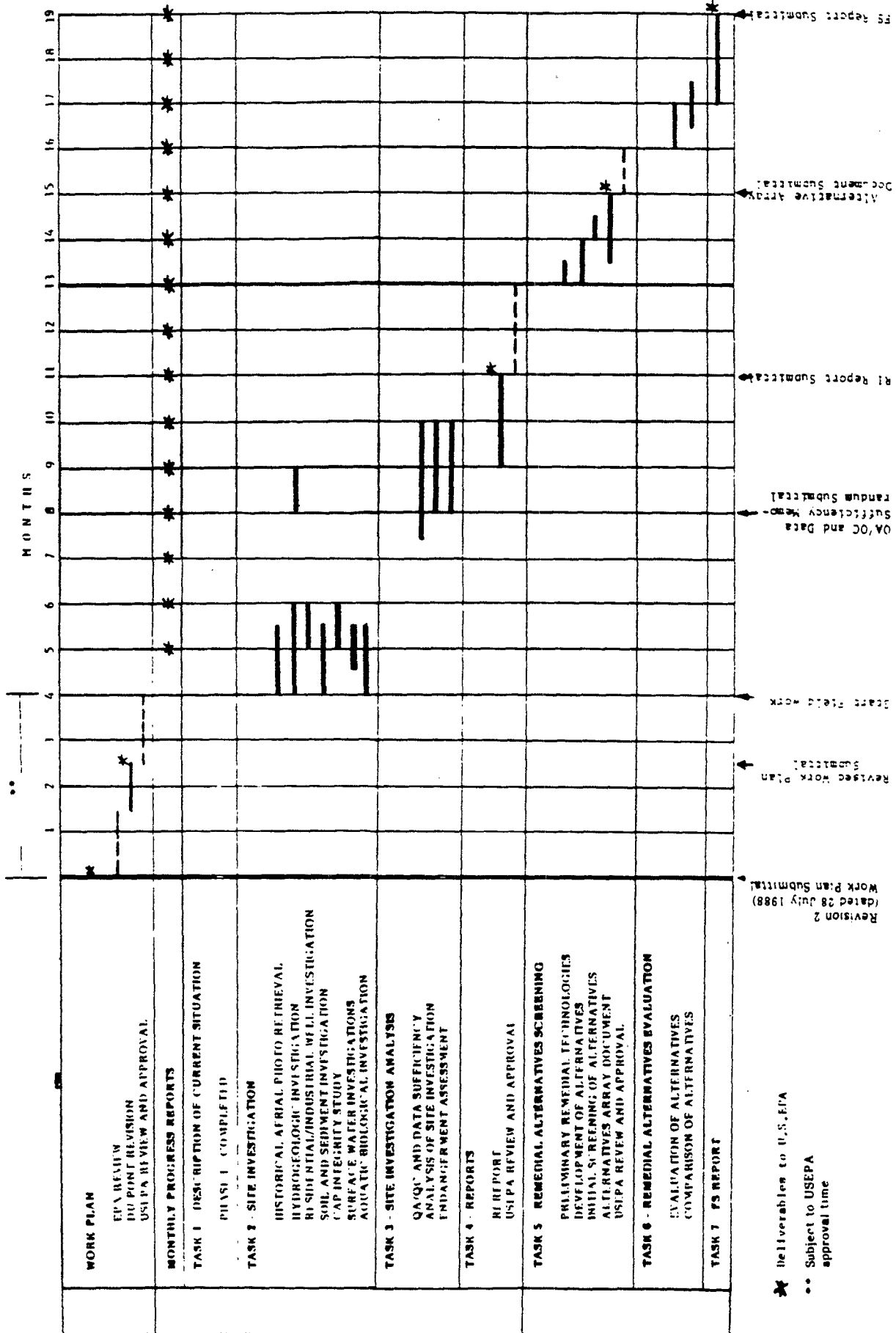


Figure 9-1 Du Pont Newport Site RI/FS Schedule

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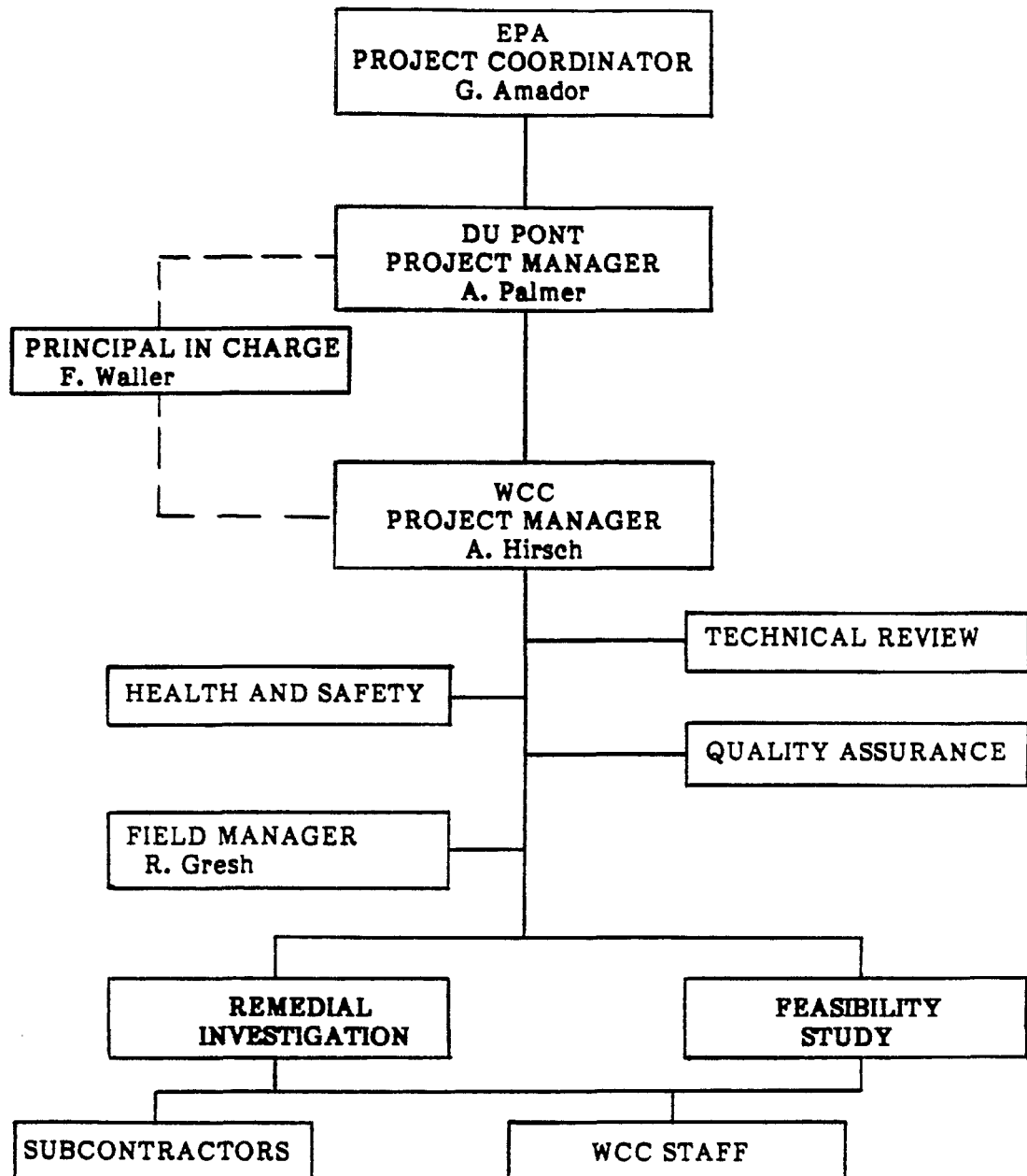


Figure 9-2  
PROJECT ORGANIZATION CHART

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