

VERIFICATION INVESTIGATION

E. I. du Pont de Nemours & Co.

Washington Works

April 1992

VOL. 1

Prepared for:

E. I. du Pont de Nemours and Company, Inc.
Washington Works
Parkersburg, West Virginia
April 1992

Prepared by:

E. I. du Pont de Nemours Environmental Engineering Team
Wilmington, Delaware

Washington Works Environmental
Parkersburg, West Virginia

and

Conoco Environmental Services Division
Ponca City, Oklahoma

ASH004705

VERIFICATION INVESTIGATION
E. I. du Pont de Nemours & Co.
Washington Works

April 1992
VOL 1

ASH004706

EID094266

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013027-5

ASH004707

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013027-5

ASH004712

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Wilmington, Delaware**

**Washington Works Environmental
Parkersburg, West Virginia**

and

**Conoco Environmental Services Division
Ponca City, Oklahoma**

ASH004718

EID094278



E. I. DU PONT DE NEMOURS & COMPANY

INCORPORATED

P.O. Box 1217

PARKERSBURG, W. VA. 26102

POLYMER PRODUCTS DEPARTMENT

CC: Mr. John J. Humphries, III, Chief*
General States Permit Section
U. S. EPA, Region III
841 Chestnut Building
Philadelphia, PA 19107

Mr. G. Max Robertson, Chief
Waste Management Section
Division of Natural Resources
1356 Hansford Street
Charleston, WV 25301

Dr. L. Eli McCoy, Chief
Division of Natural Resources
1201 Greenbrier Street
Charleston, WV 25311

April 3, 1992

**CERTIFIED MAIL -
RETURN RECEIPT REQUESTED**

Mr. Robert L. Allen, Chief
RCRA Programs Branch, 3HW50
U. S. Environmental Protection Agency, Region III
841 Chestnut Building
Philadelphia, Pa 19107

RE: Permit WVD045875291
Letter, Robert L. Allen to W. M. Stewart, September 30, 1991.

Dear Mr. Allen:

As requested in the referenced letter, the enclosed Verification
Investigation report is submitted for your approval.

If you have any questions or comments, please contact me at
(304) 863-4271.

Very truly yours,

W. M. Stewart
Environmental Control Consultant
Washington Works

Attachments

* Cover letter only.

/vlw
3308

BETTER THINGS FOR BETTER LIVING

EID094279

ASH004719

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Wilmington, Delaware

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and

Conoco Environmental Services Division
Ponca City, OK

ASH004720

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1.0 EXECUTIVE SUMMARY

This investigation was conducted in the winter of 1991 in accordance with the requirements of the United States Environmental Protection Agency (EPA) Resource Conservation and Recovery Act (RCRA) Permit WVD 04 587 5291. It was conducted for five Solid Waste Management Units (SWMU's) in accordance with the Verification Investigation Work Plan (December 14, 1990) and subsequent amendments (see EPA and Du Pont correspondence referenced and included in this report). The results of this study indicate the following key points:

- Organic constituents were detected in the unconfined alluvial terrace aquifer at three of the five SWMU's. These areas include the western and central parts of the Riverbank Landfill, the Anaerobic Digestion Ponds and the Burning Grounds. The ground water flow direction from these units is principally from the north (from the Ohio River) in towards the plant site to the south-southwest.

- Existing pumping from on-site water production wells, and spring capture and treatment along the Riverbank Landfill serve to control migration of constituents from these three SWMU's. The ground water quality data indicate that there has been no on-site or off-site impairment to ground water use in the unconfined alluvial terrace aquifer (the Principal Aquifer). Existing water quality and water level data from wellfield monitor and production wells downgradient from the SWMU's indicate that on-site ground water flow and constituent movement are controlled. This control is in accordance with the October 25, 1991 U. S. EPA memo regarding "stabilization" at RCRA facilities.

- Although the potential for constituent movement off-site is very low, to document that subsurface constituent migration is being adequately controlled and restricted to the plant site, it is recommended that additional permanent monitoring wells be installed. These wells should be located downgradient from the Riverbank Landfill, Anaerobic Digestion Ponds, and Burning Grounds. Vertical movement of constituents from the alluvial aquifer is not a concern because vertical ground water flow is restricted by the underlying low permeable shale of the Dunkard Group.

- Constituents in the ground water, surface water and soils at the Local Landfill were detected at very low concentrations. The landfill is operating in accordance with the state of West Virginia Department of Natural Resources Permit #3494. The data indicate that no further study at the landfill is required.

- Only very low concentrations of metals were detected at the Polyacetal Waste Incinerator. The concentrations were similar to background soil concentrations and well below EPA Proposed Action Levels (PAL's) and metal's concentrations typically found in natural soils. No further study is required at this site.

2.0 INTRODUCTION

2.1 PURPOSE

In March 1985, the U.S. EPA requested that Washington Works provide information on Solid Waste Management Units (SWMU's). As a result of the June 5, 1985 report submittal to EPA which included information on 14 SWMU's, EPA under the Resource Conservation Recovery Act (RCRA) Hazardous And Solid Waste Amendments (HSWA) issued a permit requiring that a Verification Investigation (VI) be completed on six of these 14 SWMU's.

The purpose of this investigation was to:

1. Evaluate, based on new and existing data, if and to what extent hazardous constituents have been released to the soil, to the surface water and/or to the ground water at the Du Pont Washington Works site near Parkersburg, West Virginia as a result of historic plant operations at six Solid Waste Management Units (SWMU's) (Figures 1 and 2 and Plate 1).
2. Define SWMU areas of concern where additional data are needed to determine the extent of constituent migration.

2.2 SCOPE OF WORK

2.2.1 TASK I: FIELD INVESTIGATIONS

Field investigations were conducted at five of the six SWMU's: the Local Landfill, the Riverbank Landfill, the Anaerobic Digestion Ponds, the Polyacetal Waste Incinerator and the Burning Grounds. Soil and water samples were taken in accordance with EPA protocol, as per the VI Work Plan Quality Assurance/Quality Control (QA/QC) Plan which details the sampling techniques used. Subsurface soil and ground water samples on the plant site were obtained from boreholes and temporary monitor wells that were drilled with a hollow stem auger drilling rig. Ground water samples from the adjacent Local Landfill SWMU were taken from permanent monitor wells that were installed to comply with West Virginia-Solid Waste Regulations and completed in 1989. A list of the media samples and duplicates taken at the five SWMU's is presented in Table 1. Ground water level and historic aquifer hydraulic test data, geologic and well construction data, a QA/QC summary report, field reports, and field analytical data results are presented in Appendixes A, B, D, E and G, respectively.

Detailed information verifying the closure of the two deep injection wells (the sixth SWMU) was previously presented in the December 14, 1990 VI Work Plan. The U.S. EPA (September 1991 letter, see Appendix F) accepted the closure plan, and as a result, no additional field investigations were conducted for the two deep injection wells.

Sample site locations are shown on Figure 6 and on Plate 1. Trip blanks accompanied each shipment of samples and rinsate blanks were completed on a daily basis. Duplicate samples were taken at an overall average of 18 percent.

Local Landfill

At the Local Landfill, two rounds of ground water quality samples were taken from the seven permanent monitor wells (14 ground water samples); surface waters from the three leachate collection ponds and the three surface water runoff streams were sampled once; and two upgradient and three downgradient surficial (0 to 2 feet deep) soil samples were taken. All samples were analyzed for the EPA Constituent List* (Table 18 parameters as per the December 14, 1990 VI Work Plan, see Table 2). The surficial (shallow) soil samples were added to the December 14, 1990 Work Plan at the request of the U.S. EPA, Region III (Appendix F). The three downgradient soil samples were taken along drainage basins and the two upgradient soil samples were taken along ridges. A total of one duplicate soil, two duplicate surface water and two duplicate ground water samples were taken.

Riverbank Landfill

At the Riverbank Landfill, there were a total of 24 subsurface soil samples taken from 12 boreholes, 12 ground water samples taken from the 12 temporary monitor wells, and two spring samples sampled and analyzed once for the EPA Constituent List, ammonium perfluoro-octanoate (C-8) and TRITON®, an alkyl phenyl ethoxylate nonionic surfactant (see Table 2). (MSDS information on FREON® 113, C-8 and TRITON® is located in Appendix C). Four duplicate soil, one duplicate surface water and three duplicate ground water samples were taken.

* FREON® 113 (1,1,2 Trichloro-1,2,2 trifluoroethane) was added to the EPA Constituent List

Anaerobic Digestion Ponds

At the Anaerobic Digestion Ponds, a total of nine soil samples from three boreholes, three ground water samples from these three temporary monitor wells, and eight soil and four ground water samples (from four of the boreholes that were also used to evaluate subsurface conditions at the Riverbank Landfill), were sampled and analyzed once for the EPA Constituent List, C-8 and TRITON®. One duplicate soil and one duplicate ground water sample were also taken.

Polyacetal Waste Incinerator

At the Polyacetal Waste Incinerator, a total of two soil samples were sampled and analyzed for m-cresol and phenol, and as per the U.S. EPA's September 30, 1991 request (Appendix F), for cadmium, chromium, lead and selenium. One duplicate soil sample was taken.

Burning Grounds

At the Burning Grounds, a total of 14 soil samples from seven boreholes, and seven ground water samples from the temporary monitor wells were sampled and analyzed once for the EPA Constituent List and selected wells for C-8. One duplicate soil and one duplicate ground water sample were also taken.

Upgradient Samples

An upgradient ground water sample was taken from domestic water production well 336 for the EPA Constituent List and C-8 analyses. Background soil samples were taken in two northeast and two northwest locations of the plant and three off-site locations and analyzed for selected parts of the EPA Constituent List. Two upgradient, shallow soil samples were also taken at the Local Landfill and analyzed for the EPA Constituent List.

2.2.2 TASK II: LABORATORY ANALYSES

Metals, volatile and semi-volatile organics in the ground water, surface water and soil samples were analyzed by Kemron Environmental Services, Inc., Marietta, Ohio. C-8 in water samples was analyzed by CH2M Hill's Montgomery, Alabama laboratory; TRITON® in water samples and C-8 in soil samples were analyzed by Du Pont's Washington Works laboratory; and formate ion (for formic acid) analysis was performed by Conoco's Ponca City, Oklahoma laboratory. The types of samples and constituents analyzed at each of the five SWMU's are presented in Tables 1 and 2, respectively. The constituents detected are summarized in Table 3. A list of the practical quantitation limits (PQL's), proposed action levels (PAL's), maximum contaminant levels (MCL's), EPA Drinking Water Standards, background soil and ground water constituent concentrations and representative soil concentration levels are presented in Table 4. A QA/QC summary report including daily and weekly status reports is presented in Appendix D. Laboratory analytical data reports are presented in Appendix G.

2.2.3 TASK III: DATA EVALUATIONS

A summary of the constituents detected is presented in Table 3. Constituent concentrations in water samples were compared to the practical quantitation limits (PQL's), EPA proposed action levels (PAL's) (July 27, 1990), maximum contaminant levels (MCL's), EPA Drinking Water Standards, and background concentrations in the ground water. Constituent concentrations in soil samples were compared to PQL's, EPA PAL's, background concentrations in the four soil samples taken on the plant site and in the two background soil samples taken at the Local Landfill, and to representative soil metal concentrations.

2.2.4 TASK IV: RECOMMENDATIONS

Based on the results of this investigation, preliminary conclusions and recommendations for additional investigative work are presented. A tentative schedule for implementing this work is included (Table 5).

3.0 SITE DESCRIPTION AND BACKGROUND

The E. I. du Pont de Nemours & Company Washington Works facility is located in Wood County, West Virginia, about 7 miles southwest of Parkersburg, West Virginia along Route 892 (Figures 1 and 2). The site covers about 1200 acres in the Ohio River Valley and is located along the south bank of the Ohio River. There are three production well fields completed in the alluvium (Principal Aquifer) located on the plant site that supply process and domestic water for the plant. There are also process water wells located on Blennerhassett Island which is located northeast of the plant site in the Ohio River.

The plant is located on Ohio River alluvial terrace material at elevation 590 feet msl on the north and about 660 feet msl on the south, with a topographic gradient of about 0.03 ft/ft across the plant site, decreasing in elevation to the north. The plant's northern boundary is the Ohio River. The average river water elevation is about 580 feet msl. Adjacent and immediately south of the plant is the Local Landfill at an elevation from about 630 to 860 feet msl. The Local Landfill is an industrial solid waste landfill used only by Du Pont.

Washington Works has been in operation since 1948 when it started producing bulk plastic materials. The first polymer products produced were polyethylene, nylon molding powders and filaments, acrylic molding powders, and later polyvinyl butyral, acrylic resins, fluoropolymers and polyacetals. The color and processing division was started in 1968 as a small lot custom color compounding operation.

4.0 GEOLOGY

4.1 REGIONAL GEOLOGY

Du Pont's Washington Works plant rests on Ohio River Quaternary alluvial deposits on the western edge of the Appalachian Geosyncline depositional basin. Regionally, the Quaternary alluvium ranges from 1 to 100 feet in depth and consists of unconsolidated river deposits of poorly to well sorted brown and gray sands, silts, clays and gravels. The Paleozoic Dunkard Series (Permian Age) sediments underlie the alluvium and consist primarily of red and vari-colored sandy shale, gray, green and brown sandstone, minor beds of coal, clay, black carbonaceous shale and limestone.

The Local Landfill is located immediately south of the plant and lies directly over the Dunkard Group and associated weathered sediments. Pre-Cambrian crystalline basement rock underlies the Paleozoic sediments at a depth in excess of 10,000 feet. The regional lithology and stratigraphy are shown on Figures 3 and 4. The regional bedrock structure dips to the east at about 25 feet per mile. It is controlled by the north-south trending Parkersburg syncline. Natural gas and brine producing strata occur in the underlying Paleozoic strata in the region. A natural gas well was completed on the plant site to a depth of 2,200 feet, and a brine zone was encountered in this well at a depth of 740 feet. This abandoned gas well is located along the Ohio Riverbank along the northwestern perimeter of the plant.

4.2 SITE GEOLOGY

4.2.1 PLANT SITE

The uppermost geologic unit directly below the plant consists of Ohio River terrace deposits of the Pleistocene Age. Total thickness averages about 60

feet along the riverbank and about 100 feet to the south in the SWMU areas. Along the riverbank, the upper deposits consist of silt, clay and fine-grained sand down to about 20 to 30 feet (Figure 5), followed by about 20 to 30 feet of coarse sand and gravel which extend down to the top of the bedrock, the Permian Age Dunkard Group (bedrock). To the south on the main plant area and above the riverbank, about 10 to 20 feet of silt, clay and fine-grained sand overlie about 80 to 100 feet of sand and gravel down to about 90 to 120 feet deep, to the top of the bedrock. These deposits are laterally continuous throughout the site.

The geologic cross sections (Figure 6) are shown on Figures 7 through 12. These cross sections were developed based on the detailed geologic logs obtained during the VI and less detailed historic geologic logs from test and production wells, and geotechnical borings drilled in the late 1950's through the early 1980's. Geologic logs of the recent and historic boreholes, and detailed discussion of the VI drilling program and subsurface geology at the Riverbank Landfill, Anaerobic Digestion Ponds, Burning Grounds and Local Landfill are presented in Appendix B.

Due to riverbank undercutting there is some slumping of clay and silt along the northern boundary of the property along the river's edge. An interpretation of typical Ohio River Bank stratigraphy is presented in Figure 5 (Carlston and Graeff 1955) and correlates well with the geologic data obtained from the six borings completed along the riverbank (RBLMW 1,4,6,7,10 and 11). The two springs located to the northwest and to the northeast along the river bank appear to be perched groundwaters which flow along the top of the underlying shallow clay and discharge as springs along the riverbank. Based on aerial photographs, the northwestern spring has been present since the 1960's.

The bedrock unit which underlies the Ohio River terrace deposits consists of interbedded sandstones, siltstones, claystones, shales, occasional limestones and coal zones. This formation belongs to the Permian Age Dunkard Group. Soil borings drilled in the early 1970's on-site in the northwest corner of the property (Boreholes BD-41, BD-44 and BD-46) indicate that the top of the bedrock zone (which immediately underlies the upper alluvial sand and gravel Ohio River deposits) is a shale at approximate elevation 530 feet msl (Figure 9). To the south of the plant site towards the edge of the Ohio River depositional valley, the Ohio River terrace deposits thin out. Bedrock of the Dunkard Group is present at ground surface south of the plant site at the Local Landfill.

4.2.2 LOCAL LANDFILL

A study of the Washington Works Local Landfill (September 1990) indicated that 75 percent of the underlying material (the Dunkard Group) consists of shale and claystone and the remainder consists of lenticular and discontinuous sandstone beds. Weathered sandstone and shale are present in thin zones up to 20 feet thick in the drainage areas. Elevations at the site range from about 630 to 860 ft msl, with valley wall slopes averaging about 75 percent. The area is well drained by ephemeral streams which empty into the Ohio River in the area of Washington Bottom. Detailed geologic logs and cross sections (Figure 6) through the landfill are presented in Appendix B, Figures B-23 and B-24.

5.0 GROUND WATER HYDROLOGY

5.1 REGIONAL GROUND WATER HYDROLOGY

5.1.1 QUATERNARY ALLUVIUM

The principal aquifer in the region used for industrial, municipal and rural supplies is the Quaternary alluvial unconfined aquifer. Well yields of 1.5 to 2,350 gallons per minute and radial collector wells in the Ohio River yielding as much as 3,500 gpm have been reported (Schultz, R.A., 1984). Natural recharge to the alluvial aquifer is derived from various sources, including: 1) infiltration of precipitation falling directly on the alluvium, 2) lateral movement of the river water through the alluvium via permeable sands and gravel zones, and 3) seepage from streams tributary to the river. The maximum amount of water available to the alluvium depends on the degree of hydraulic connection to the river. The degree of hydraulic connection depends on the condition of the river bottom, the permeability and thickness of the alluvium, and the distance and hydraulic gradient between wells and the river (Schultz, R.A., 1984). Active well fields near and parallel to the river (as are present on-site at Washington Works), lower the ground water level to below river stage. This induces water from the river to flow into the alluvium towards the wells, replacing water pumped from storage in the aquifer, helping to sustain high-yield pumping wells.

Some production wells in the alluvium decline in yield over time as a result of incrustation of the well screens and plugging of the surrounding sand and gravel with calcium carbonate or iron and manganese oxides (Schultz, R.A., 1984). As water levels are lowered by pumping, air is introduced into the alluvium resulting in the precipitation of minerals, clogging both the screen openings and the intergranular openings in the sand and gravel. Chemical treatment and well surging are used at Washington Works for well redevelopment.

According to Schultz, R.A. (1984), ground water quality in the alluvium in this region tends to be poor, having the highest median chloride, sulfate, hardness (as calcium carbonate), iron and manganese concentrations of all hydrogeologic units in the region. Water from the alluvium is generally a calcium-bicarbonate type, with a near neutral pH and high dissolved solids content. Based on ground water quality sampling conducted in 1982 (Schultz, R.A., 1984), the following constituent concentration ranges and median values were measured: pH, 6.1 to 8.6 pH units, and 7.2 units; hardness as calcium carbonate, 33 to 1700 mg/l, and 250 mg/l; alkalinity, 52 to 570 mg/l, and 180 mg/l; dissolved sulfate, 1 to 2400 mg/l, and 69 mg/l; dissolved chloride, 5.6 to 2200 mg/l, and 29 mg/l; dissolved iron, 0.003 to 21.0 mg/l, and 0.035 mg/L; and dissolved manganese, 0.001 to 1.7 mg/l, and 0.2 mg/l, respectively.

5.1.2 DUNKARD GROUP

The underlying Dunkard Group generally only yields enough water for domestic and farm use. Median yields for valley, hillside and hilltop wells were 6.5, 2.0 and 3.0 gpm, respectively (Schultz, R.A., 1982). Except for a few very localized areas where fractures are plentiful, there is little potential for higher well yields.

Based on ground water quality samples collected and analyzed by Schultz, R.A. (1982), the constituent concentration ranges and median values were as follows: pH, 6.5 to 8.9 pH units and 7.8 pH units; hardness as calcium carbonate from 2 to 470 mg/l, and 99 mg/l; alkalinity from 54 to 630 mg/l, and 240 mg/l; dissolved sulfate from 1 to 310 mg/l, and 21 mg/l; dissolved chloride from 1.2 to 320 mg/l, and 17 mg/l; total dissolved solids from 158 to 908 mg/l, and 363 mg/l; dissolved iron from 0.003 to 2.7 mg/l, and 0.17 mg/l; and dissolved manganese from 0.001 to 3.1 mg/l, and 0.26 mg/l, respectively. Waters in the Dunkard Group are generally a sodium bicarbonate type, (Schultz, R. A., 1982).

5.2 LOCAL GROUND WATER HYDROLOGY

5.2.1 OCCURRENCE

5.2.1.1 Plant Site

The principal aquifer underlying the plant site is located in the shallow Ohio River alluvial terrace deposits. The saturated zone is about 30 to 40 feet thick. The saturated zone extends from the water table (which averages about 23 to 33 feet deep along the riverbank, but is at a shallow depth of only 11.96 feet at well RBLMW-4 which is along the northwest part of the riverbank near the northwest spring), to about 60 to 70 feet deep to the south in the SWMU areas. The production water wells on-site yield 200-450 gpm per well. These wells are completed in the upper principal aquifer. This saturated zone extends down to the top of the bedrock unit, the underlying Dunkard Group. The underlying Dunkard Group is not a major aquifer. In fact, the upper zone of the Dunkard Group, (primarily a shale and silt matrix), bounds the lower portion of the principal aquifer on the plant site, and serves as a confining unit to underlying geologic units.

As discussed previously, it is believed that the two springs located along the Riverbank Landfill result from the discharge of shallow ground waters that are perched on shallow clay zones. Due to the absence of significant clay lenses on-site that could serve to perch other groundwaters (based on historic and recent borehole and water level data), it does not appear that there are perched ground water zones in other areas of the plant site.

5.2.1.2 Local Landfill

Ground water underlying the Local Landfill occurs in two zones. These include the saturated thin overburden of erosional material and/or highly weathered bedrock (which occurs in topographic lows), and in the thin lenses of sandstone that are sandwiched between the shales of the Dunkard Group. Depths

to ground water range from about 3 to 5 feet deep in wells completed in weathered materials near drainages; from about 20 to 30 feet in wells completed in zones less than 40 feet deep; and from about 75 to 130 feet deep in wells completed at depths of 90 to 155 feet deep in sandstone. Well yields from all of these zones are very low, ranging from <0.5 gpm to 1.5 gpm.

5.2.2 FLOW DIRECTION AND RATE

5.2.2.1 Plant Site

Ground water elevations, flow directions and flow rates on the plant site are strongly influenced by the on-site water production wells and the Ohio River (Figure 13). The general ground water flow direction is from the north to the south-southwest. The Ohio River is the primary source of recharge to the principal aquifer underlying Washington Works plant site. The on-site production wells consist of the Ranney Well, (a lateral collector well in the Ohio River which pumps 800 to 1000 gpm), the seven East Field Wells (which pump a combined average rate of 2000 gpm), and the five Du Pont-Lubeck Wells located adjacent to and southwest of the plant.

In 1986 and again in 1987, Du Pont was approached by the Lubeck Public Service District (LPSD) to see if we had an interest in purchasing their property with five water wells. The LPSD needed additional water well capacity to serve their needs and desired to relocate to a site located about three miles west of their present location. In 1988, Du Pont agreed to purchase these wells rather than install additional process water wells on Blennerhassett Island to meet expanding process water needs at Washington Works. Du Pont has been operating these wells since December 1991. This wellfield pumps about 700 gpm.

The ground water elevation contour map, which shows the direction of ground water flow in the principal aquifer, is presented in Figure 13. Ground water elevation data from which this map was prepared are presented in Appendix

A, Table A-1. In December 1991, ground water elevations on-site ranged from about 552 feet msl at water production well 337 (which pumps at the highest rate at about 450 gpm in the easternmost part of the East Well Field), to about 582 feet msl in well TW-1 along the Ohio River. The river water elevation averaged about 582.2 feet msl, slightly above the mean of 582 feet msl. As indicated, ground water flow in the northeast part of the site is toward the East Wellfield wells, from both the south and from the north from the Ohio River; ground water flow in the north-central part of the site is toward the Ranney well, from both the south and from the north from the Ohio River; and ground water flow in the central and western parts of the plant site is towards the southwest, towards the Du Pont-Lubeck Wellfield.

The average hydraulic gradient across the plant site from the edge of the Ohio River to the southwest is about 0.004 ft/ft. The gradient toward the Ranney well is about 0.01 ft/ft, and the gradient towards the East Wellfield wells is about 0.05 ft/ft. The gradient toward the Du Pont-Lubeck Wellfield is about 0.003 ft/ft. Additional ground water level elevation and aquifer hydraulic testing data obtained from additional, permanent monitor wells are needed to refine these estimates (see Appendix A, Table A-4).

5.2.2.2 Local Landfill

Ground water elevations at the Local Landfill are significantly higher than the plant ground water elevations. This is because the Local Landfill directly overlies the Dunkard Formation, not the Quaternary alluvium. Topographically, the Local Landfill ranges in elevation from 630 to 860 feet msl, whereas the plant site ranges in elevation from only 590 to 630 feet msl. Ground water elevations at the Local Landfill vary significantly, from about 724 feet msl at bedrock well LLMW-8, to about 625 feet msl at shallow well LLMW-7. These wells are in the southwest corner and south-central part of the

landfill. They are about 2300 feet apart. The general ground water flow direction through the shallow saturated weathered materials appears to be topographically controlled. It is difficult to determine the direction of ground water flow in the continuous sandstone unit. However, based on the ground water elevation data from the deeper sandstone wells LLMW-6, LLMW-4 and LLMW-8, the flow direction appears to be toward the north-northwest (Figure 13).

As discussed and as included in the VI Work Plan (December 14, 1990), a geologic/hydrogeologic evaluation of the Local Landfill was completed by Du Pont in September 1990. The results indicated that the upper 2.5 to 19.5 feet of the subsurface material consists of a reddish brown clay and weathered shales, with a very low average hydraulic conductivity of 5×10^{-7} cm/sec. This zone is underlain by weathered bedrock with competent bedrock at a depth of about 40 feet. Bedrock permeability is also low, at about 1×10^{-5} cm/sec. Monitor wells LLMW-1, 2, 3, 5 and 7 are completed in the upper clay and weathered bedrock zones in the first water-bearing zone. Wells LLMW-4, 6 and 8 are completed in the competent sandstone zone.

6.0 DESCRIPTION OF THE SIX SOLID WASTE MANAGEMENT UNITS

6.1 LOCAL LANDFILL

The Local Landfill has been operating since 1964. It is located immediately south of the main plant site along Route 892 and covers about 251 acres of which only 33 acres have been used for waste disposal. The landfill is permitted under West Virginia Department of Natural Resources Permit #3494 and a combined NPDES/SW permit application was submitted on September 21, 1989 to meet WV Solid Waste Regulation requirements. The three waste filled areas are shown on Figure 2 and Plate 1. The eastern half of the landfill has not been used. The wastes disposed of at the landfill have included inert acrylic polymer sludge, inert mixed plastics and ash produced from power generation and burning plant trash. Powerhouse ash comprised about 70 percent of the total waste. Disposal of calcium chloride sludge produced from hydrochloric acid neutralization with limestone was discontinued in 1982. Small quantities of RCRA hazardous ash were disposed of in the landfill prior to 1980. The ash was hazardous due to elevated levels of barium, cadmium, selenium and chromium resulting from the burning of plastics containing colored pigments.

The types of wastes previously disposed of in the landfill and some of the historic landfill leachate analytical data are included in Appendix C. Presently, the landfill is being used primarily for disposal of acrylic polymer sludge. Historic ground water quality data from Local Landfill monitor wells LLMW-1 through LLMW-8 were included in Appendix E of the December 14, 1990 VI Work Plan.

6.2 RIVERBANK LANDFILL

The Riverbank Landfill was operated from 1948 through the late 1960's and is located along the northern edge of the site, about 125 feet from the Ohio River (Figure 2 and Plate 1). It is about 150 feet wide and extends about 4,500

feet along the riverbank. The landfill was closed in the late 1960's and 6 to 35 inches of soil were placed on top of the fill area and then vegetated. Powerhouse ash, incineration ash, plastics, rubble and plant trash were disposed of in the landfill. Plant policy has always been to burn all liquid waste. About 200 drums of solid material were reportedly buried in this landfill. As in the Local Landfill, some of the ash waste might have been RCRA hazardous due to elevated metals levels resulting from pigment disposal. Historic ground water quality data on test wells along the Riverbank Landfill are presented in Appendix F of the VI Work Plan.

6.3 ANAEROBIC DIGESTION PONDS

The first (westernmost) anaerobic digestion pond was operated in the mid-1950's, and the two additional ponds to the east were constructed in the mid-1970's. The ponds were closed in 1988. Waste from the fluorocarbon manufacturing process was disposed of in the ponds in series from west to east into all three ponds. The ponds were about 6 feet deep with 60 foot wide earthen banks at the base. The combined volume of the ponds was about 3 million gallons. At the time of construction of the two additional ponds, the first pond was reconstructed and the two newer ponds constructed with 6 to 12 inch thick bentonite clay liners. A clay layer combined with polyethylene sheeting was used in the walls to restrict lateral seepage from the ponds.

Prior to 1964, the ponds were periodically inundated by flooding from the Ohio River. Flooding frequency and magnitude was reduced as a result of upstream dam construction on the Ohio and its tributaries.

In 1988 all of the liquid waste and sludge were pumped out of the ponds and disposed of off-site. As discussed in the VI Work Plan (December 14, 1990), the top 2 feet of the clay underlying the ponds contained TRITON®, (a non-ionic

ASH004743

surfactant readily degradable under anaerobic conditions), zinc chloride and ammonium perfluoro-octanoate (C-8, an ionic, inert surfactant which does not degrade). Consequently, the upper few feet of clay and the pond berm materials were removed. Approximately 56,700 cubic feet of soil was removed from Pond 1, 43,900 cubic feet of soil from Pond 2 and 46,900 cubic feet of soil from Pond 3. Pre and post-excavation soil analytical results are presented in Appendix C, Anaerobic Digestion Ponds. Additional historic data were presented in Appendix G of the December 14, 1990 VI Work Plan.

6.4 POLYACETAL WASTE INCINERATOR

The Polyacetal Waste Incinerator consisted of two open brick-lined pits which were operated between 1959 and early 1990 (Plate 1). Off-specification polyacetal polymer and other non-hazardous solid waste packaging materials were burned in the unit. The burning pits were about 10 feet deep, 6 feet below grade, and 9 feet by 10 feet in size. The pits were constructed of reinforced concrete lined with fire brick. In 1989 about 3.5 million pounds of solid waste was burned. The operating temperature was between 1000 and 1300 degrees F. No supplemental fuel was used.

The non-hazardous residue from the unit was primarily ash from cardboard containers and wooden pallets. The ash was landfilled in the Local and Riverbank Landfills. Some finishing area wastes and non-hazardous chemical area wastes which contained formaldehyde and trace amounts of toluene were also burned in the incinerator. A description of the products burned and methodologies are included in Appendix C.

6.5 INJECTION WELLS 1 AND 2

The two deep injection wells, 1-WW and 2-WW are located in the northwest part of the plant site (Figure 2 and Plate 1). These two wells were used for

injection of plant wastes from the operating divisions, including 112.5 million gallons of acid waste over the 11 year period from 1969 through 1980. By 1980 both wells had been closed. The principal waste stream was 6 to 15 percent hydrochloric acid combined with a 2 to 5 percent solution of formic acid and formaldehyde from the polyacetal manufacturing operations, nylon vent scrubber effluent, fluorocarbon chemicals and hydrogen fluoride. Injection well 1-WW was completed in the Mississippian-Age Big Injun Sand, a quartz sandstone at a depth of about 1,400 feet. This well was used from 1969 through 1976. Injection well 2-WW was completed in the Devonian-Age Harrell Shale, about 3,600 feet below grade. This well was used from 1972 through 1980.

Details on the construction and abandonment of these two deep wells was presented in Appendix I of the VI Work Plan (December 14, 1990). Both wells were constructed and closed in accordance with federal EPA and West Virginia deep well injection regulations.

6.6 BURNING GROUNDS

The Burning Grounds, located in the north-central part of the plant above the Riverbank Landfill, were used for open burning of plant trash and organic liquids (Figure 2 and Plate 1). The liquid wastes that were burned included acrylic monomer slurries, polyvinyl butyral ink slurries, high boiling liquid fluorocarbon compounds and solvents. Solid wastes included paper, trash and plastics. Drums of liquid were placed at the top of the riverbank with a gravity feed to a burner below. From 1948 to 1965, about 40 drums of liquid wastes were burned each month at this site. As detailed in the VI Work Plan (December 14, 1990), soils in this area were excavated in 1974 (2,800 cubic feet), in 1989 (1,800 cubic feet) and in 1990 (1,000 to 2,000 cubic feet),

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prior to construction of buildings B-256 and B-253, building B-253 expansion, and the drainage ditch, respectively. Pre and post-excavation soil samples from the trench area were analyzed for Appendix IX constituents. Post-exacavation soil sample analytical results from March 1990 are presented in Appendix C, Burning Grounds, and demonstrate that post-excavation levels of contaminants were significantly lower. Detailed historic data were presented in Appendix J of the VI Work Plan.

7.0 ANALYTICAL DATA RESULTS

Table 3 is a summary of the constituents detected, their concentrations, and a tabulated data evaluation summary (see footnotes). The data in Table 3 were compared to PAL's and MCL's (see Table 4). Concentration maps of the key constituents detected, including arsenic, barium, cadmium, lead, chloride, C-8, FREON® 113, methylene chloride, tetrachloroethene, and trichloroethene in the soils, ground and surface waters are presented in Figures 14 through 23. All of the original laboratory reports are included in Appendix G.

7.1 DISSOLVED VERSUS TOTAL METALS CONCENTRATIONS

Both soils and surface waters were analyzed for total metals. At the request of EPA Region III, ground water samples were analyzed for both total and dissolved metals. However, only dissolved metals concentrations in the ground water are discussed in this report for the following reasons.

As stated in the April 23, 1990 EPA Region III QA Directive (Appendix F), "Filtered samples represent dissolved metals concentration and are often more representative of mobil contamination (see exceptions below)". The exceptions to this include, geologic conditions (Karst terrain or clean gravel facies) where large particulates may be transported through an aquifer with little particle attenuation. In such cases, total metals concentrations are more representative of actual constituent concentrations flowing through an aquifer. As stated in the EPA Directive, if the hydrogeologic setting is not equivalent to such environments, and where there is inconsistency between filtered and unfiltered data, only filtered (dissolved) metals analyses should be evaluated.

The matrix of the Principal Aquifer at Washington Works includes silts, clays, sands and sandy gravels. There are no clean gravel facies through which

large particulates could, as mentioned above, flow freely without attenuation by the aquifer matrix. In addition, there were wide variations between the total and dissolved metals concentrations. Arsenic, barium, cadmium, nickel, lead, selenium and zinc are detected in ground waters at most of the SWMU's. However, the dissolved concentrations of these metals in the ground water are all typically below the PAL's and MCL's. Out of the forty four ground water samples analyzed, the only exceptions were dissolved arsenic at RBLMW-8, and dissolved barium and cadmium at ADPMW-3, which in all three cases were just slightly above the MCL's. In addition, none of the metals concentrations in any of the soil samples through which water percolates exceeded PAL's.

Evaluation of dissolved not total metals concentrations in the ground waters at Washington Works is the valid analytical approach. Evaluation of total metals concentrations in the ground water could lead to invalid conclusions regarding the ground water quality beneath the five SWMU's. The reader is urged to carefully read and consider the aforementioned EPA Region III QA Directive regarding this issue. Because this is such an important point, a copy of this directive has been included in Appendix F.

7.2 CONCENTRATION COMPARISONS

Both dissolved metals concentrations and organic constituent concentrations in the ground waters and in the soils should, (in order to complete a thorough data assessment), be evaluated on a sample-by-sample basis within each SWMU. There is variation in the distribution of constituents between the SWMU's and in many cases, at each SWMU. Elevated concentrations of a constituent at one sample media location at a SWMU does not necessarily indicate that elevated constituent concentrations are present throughout the SWMU or in all of the sample media.

The data evaluations in Sections 8, 9 and 10 discuss constituent concentrations relative to PQL's, PAL's, MCL's, background concentrations and representative natural concentrations in soils. These concentrations are presented in Table 4. Because of the large data base, relative and not specific concentrations are discussed in the text. The reader should refer to Table 3 for individual constituent concentrations at the sites, and to Figures 14 through 23 for areal distribution of the key constituents detected.

Two constituents present on-site, C-8 (an inert, nondegradable ionic surfactant) and TRITON® (a nonionic, degradable surfactant) were analyzed at the Riverbank Landfill, the Anaerobic Digestion Ponds and at a few selected wells at the Burning Grounds. These constituents are not Appendix IX constituents and do not have PAL's or MCL's assigned to them. Detection levels for C-8 were 0.0001 mg/l for water and 0.4 mg/kg for soil. The detection level for TRITON® in water was 0.1 mg/l.

Formate ion was analyzed by Conoco's Ponca City, Oklahoma laboratory (see December 20, 1991 letter, Appendix F). The method used (ion chromatography) detects both the formate ion and formic acid. Formate ion was detected at the highest levels in samples of relatively higher pH. Evidently, formate ion and not formic acid was the compound present. For low pH waters, formic acid is approximately equal to 1.02 the formate ion concentration. Detection levels ranged from 0.1 to 1 mg/l for water and 1 mg/kg for soil. Variation in the detection level for water samples was the result of laboratory analysis sample dilution.

7.3 QA/QC DISCUSSION

QA/QC problems are addressed in detail in Appendix D. Some of the key problems encountered included:

- Some distilled water used for cleaning sampling equipment and for collecting rinsate blanks contained chloroform at 0.032 mg/l. Chloroform showed up in some of the rinsate blanks, and in a few of the samples but at very low concentrations. Chloroform is a common laboratory contaminant.
- Methanol (used only for cleaning sample equipment) contained 2-butanone (1.9 mg/l), methylene chloride (0.08 mg/l), and toluene (0.09 mg/l).
- A second set of ground water samples were taken from RBLMW-2, 3, 5, 7, 8, 9, 10, 11 and 12 and from BGMW-2, 3, 4, 5, 6, and 7 for mercury and zinc due to initial contamination from a cotton rope that had been used initially for bailing and sampling the wells. An inert nylon rope was used during re-sampling. Although both sets of data for these wells are included in Table 3, only the second set of water quality data results for mercury and zinc should be considered for data evaluation.

The concentrations of mercury and zinc from a sample produced by submerging the rope in distilled water measured 0.11 mg/l and 0.38 mg/l, respectively. Trace amounts of chloride (2 mg/l) and selenium (0.007 mg/l) were also detected. The most significant rope contaminant was mercury, because of it's low PAL of 0.002 mg/l. Re-sampling results proved that the elevated levels of mercury and zinc originally measured in these wells were due to the cotton rope coating and not from SWMU contamination (Appendix D, Attachment D-8).

- A second set of ground water samples was taken from ADPMW 1, 2 and 3 for C-8 analysis. As indicated in Table 3, the first round of C-8 analytical data results were highly variable between the sites. As a result of this inconsistency, the wells were re-sampled. The second round analytical results had better surrogate recoveries and C-8 concentrations were at expected levels. Well ADPMW-3 was also re-sampled for all EPA Constituent List parameters due to the initial chloride result being much higher than wells ADPMW-1 and 2.

8.0 GROUND WATER QUALITY DATA RESULTS

8.1 UPGRADIENT WATER SUPPLY WELL

East Wellfield domestic water supply well 336 was sampled and analyzed for the EPA Constituent List and C-8 (see Table 2). Well 336 is completed in the Principal Aquifer, the same alluvial terrace aquifer underlying all of the plant site SWMU's. Because of the proximity of the East Wellfield wells to the Ohio River, most of the water recharged to this wellfield is from the river. Well 336 was selected because it is a domestic water supply well and is the westernmost East Wellfield production well, and therefore the closest production well to the Burning Grounds and Riverbank Landfill SWMU's. The analytical results are summarized in Table 3 and indicate that only total barium (0.08 mg/l), chloride (49 mg/l) and C-8 (0.0004 mg/l) were detected. Formate ion was detected at 1.2 mg/l. No other metals, volatiles or semi-volatiles were detected in this well.

8.2 LOCAL LANDFILL

Local landfill monitor wells LLMW 1 through LLMW 7 (completed in the Dunkard Group at depths from 20 to 147.5 feet, and static water levels from about 5 to 132 feet), were sampled and analyzed for the EPA Constituent List. The ground water quality meets primary EPA drinking water quality standards for the organics and dissolved metals. As summarized in Table 3, only arsenic, barium, cyanide, lead and zinc were detected in the ground waters, but at very low concentrations, below EPA PAL's and MCL's (Table 4 and Figures 14, 15 and 17). The only exception was at shallow well LLMW 7 (depth 29 feet), where total, not dissolved arsenic measured 0.083 mg/l in the second sample (but was non-detect in the first sample and non-detect in both samples for dissolved arsenic). Total barium was measured at 1.2 mg/l and 1.3 mg/l in the first and

second round samples from LLMW-7, but dissolved concentrations measured only 0.15 and 0.09 mg/l. By comparison, the MCL's for arsenic and barium are 0.05 mg/l and 1.0 mg/l, respectively.

The only organic constituents detected were chloroform (a common laboratory contaminant detected at levels around 0.032 mg/l as measured in the distilled water), and formate ion, which was detected at very low levels, generally less than 1 mg/l, and only up to 1.3 mg/l in shallow well LLMW 3 (depth of 20 feet). Ethylbenzene was detected at a trace level (0.006 mg/l) in the first water sample from LLMW1, but was not detected (<0.005 mg/l) in the second sample.

8.3 RIVERBANK LANDFILL

Monitor wells RBLMW 1 through 12 were sampled and analyzed for the EPA Constituent List, C-8 and TRITON®. The northern monitor wells along the riverbank ranged in depth from 31 to 38.8 feet, with static water level depths from about 12 to 31 feet. The southern monitor wells ranged in depth from 69.2 to 78.9 feet, with static water levels from about 60 to 71 feet. Total (not dissolved) metals (arsenic, barium, cadmium, mercury and zinc) were detected in most of these wells (Figures 14 through 16). As discussed previously, the elevated mercury detected at RBLMW 2, 3, 5, 8, 9, 10, 11 and 12 resulted from the rope used on the bailer during the initial sampling. The second set of samples from these wells (taken with a nylon rope) were re-analyzed for mercury and zinc, and as shown in Table 3 and discussed in Appendix D, did not indicate elevated levels of mercury or zinc. Therefore, the first set of mercury and zinc data from these wells, (included strictly for documentation), should not be evaluated further.

Only one dissolved metal concentration slightly exceeded the MCL. It was dissolved arsenic in RBLMW 8. The concentration was 0.069 mg/l as compared

to the MCL of 0.05 mg/l. The lowest dissolved metal concentrations were found in RBLMW 4, along the northwest side of the Riverbank Landfill (Figure 14).

FREON® 113, tetrachloroethene, trichloroethene, C-8 and TRITON® were the primary organic constituents detected in the ground waters at the western end of the Riverbank Landfill, and at lower concentrations in the central part of the landfill (Figures 19 through 23). Trace amounts of chloroform (0.006 mg/l) were detected, probably from the distilled water rinse. FREON® 113 was detected at elevated concentrations of 11 and 3.1 mg/l in wells RBLMW 2 and 3 along the southwestern part of the Riverbank Landfill. Known FREON® 113 spills have occurred above this area in the Teflon® plant. FREON® 113 was detected at much lower concentrations of 0.065 to 0.081 mg/l in RBLMW 1 and 5. FREON® 113 was also detected in the spring waters at RBLL 1 at 0.43 mg/l and at 0.14 mg/l at RBLL 2. Tetrachloroethene was detected above the MCL of 0.005 mg/l at RBLMW 2 at 0.019 mg/l, and at RBLMW 8 at 0.22 mg/l. Trichloroethene was detected above the MCL of 0.005 mg/l at RBLMW 2 at 0.027 mg/l, at RBLMW 3 at 0.11 mg/l, and at RBLMW 8 at 0.017 mg/l.

C-8 was detected in the ground water in all of the Riverbank Landfill monitor wells, but generally at low concentrations. The highest concentrations of C-8 were detected at RBLMW 3 at 7.1 mg/l, RBLMW 6 at 3.3 mg/l, and RBLMW 5 at 1.3 mg/l (Figure 19). These results were not unexpected, since these wells are located adjacent to and downgradient from the historic C-8 source area, the Anaerobic Digestion Ponds.

TRITON® was detected at very low concentrations in the Riverbank Landfill wells. The highest concentrations ranged from only 0.98 to 1 mg/l in RBLMW 3, 4 and 10. Formate ion was detected at low concentrations, generally less than 1 mg/l, and up to 1.5 mg/l at RBLMW 1.

8.4 ANAEROBIC DIGESTION PONDS

Three monitor wells, wells ADPMW 1, 2 and 3, were completed in the middle of the closed Anaerobic Digestion Ponds. These wells were completed to depths of 35 to 36.4 feet and were screened across the water table which was encountered at a depth of about 32 feet. Arsenic, barium, cadmium, (mercury at near detection levels), nickel, lead, and zinc were detected in all of the wells (Figures 14 through 17). With the exception of barium (at 1.3 mg/l versus the MCL of 1 mg/l) and cadmium (at 0.012 mg/l versus the MCL of 0.01 mg/l) in well ADPMW 3 only, all other dissolved metals concentrations were below PAL's and MCL's. Elevated chloride concentrations of 1600 and 980 mg/l were also detected in ADPMW 3 (Figure 18).

Not unexpectedly, C-8 and TRITON® were detected in all of the Anaerobic Digestion Pond monitor wells. C-8 concentrations ranged from 25 mg/l in ADPMW 2 to 38 mg/l in ADPMW 1. As shown in Table 3 and discussed in Appendix D, the initial C-8 results were not accurate. The second set of results (the higher values) are the correct concentrations. TRITON® concentrations were detected at only 0.78 mg/l in ADPMW 3, at 16.48 mg/l in ADPMW 1, and at 29 mg/l in ADPMW 2. FREON® 113 was detected at 0.015 mg/l in ADPMW 3, slightly above the 0.010 mg/l detection limit. Freon-113, methylene chloride, and phenol were detected in ADPMW 1 and 2 at similar concentrations of 4 and 3.8 mg/l, 0.29 and 0.26 mg/l, and 0.6 and 0.87 mg/l, respectively. Trace amounts of 2-Butanone, 4-methyl-2-pentanone and toluene were detected only in ADPMW 1 at 0.14 mg/l, 0.028 mg/l and 0.012 mg/l, respectively (2-Butanone and toluene were detected in the methanol used for cleaning sampling equipment). Formate ion was detected at or below the detection level of 1 mg/l in ground water from all of the Anaerobic Digestion Pond wells. The PAL for formic acid in water is 70 mg/l.

Riverbank Landfill monitor wells RBLMW 3, 4, 5, and 6 were also included in the evaluation of the ground water quality surrounding the Anaerobic Digestion Ponds. Similar but lower metals and organic constituents were detected in these wells. Only well RBLMW 3 showed similar concentrations of FREON® 113 and TRITON® (Figure 19). This is not surprising, since RBLMW 3 is immediately downgradient from the Anaerobic Digestion Ponds.

As previously mentioned, the ground water flow direction from the Anaerobic Digestion Ponds is to the southwest toward the Du Pont-Lubeck Wellfield. C-8 analysis was conducted on ground water samples taken on 9/12/91 from two Du Pont-Lubeck production wells and surrounding monitor wells. C-8 concentrations in these wells were very low, ranging from 0.0009 mg/l to 0.0017 mg/l. Analytical data from the two Du Pont-Lubeck wellfield monitor wells located downgradient of the Anaerobic Digestion Ponds but upgradient of the Du Pont-Lubeck Wellfield, TW-27 (90 feet southwest of Du Pont-Lubeck production well L-1), and monitor well TW-M4 (450 feet north of Du Pont-Lubeck production well L-4) indicate the presence of C-8 but at very low concentrations of 0.0012 mg/l and 0.0002 mg/l, respectively (Appendix C, Figure 13). No Appendix IX constituents were detected in either of these two monitor wells.

8.5 BURNING GROUNDS

A total of seven monitor wells (BGMW 1 through 7) were completed at the Burning Grounds at depths from 68 feet to 69.6 feet. Static depths to ground water ranged from about 60 to 64 feet. Barium and zinc were the only two dissolved metals consistently found, but at levels well below the MCL's (Figure 15). The mercury and zinc detected at BGMW 2 through 7 were due to the cotton sampling rope which was confirmed by re-analysis. FREON® 113 was detected at very low levels at BGMW 3, 4 and 7 (Figure 20). Elevated concentrations of carbon tetrachloride were detected at BGMW 1, 3 and 4 at 0.009 mg/l, 0.026 mg/l

and 0.036 mg/l, respectively. Elevated concentrations of tetrachloroethene were detected at BGMW 1, 2, and 4 at 0.014 mg/l, 0.025 mg/l and 0.011 mg/l, respectively (Figure 23). Elevated levels of trichloroethene were detected at BGMW 1, 2, 3, 4, and 7 at 0.027 mg/l, 0.069 mg/l, 0.32 mg/l, 0.28 mg/l and 0.063 mg/l, respectively (Figure 22).

Concentrations of C-8 in wells BGMW 2, 3, and 5 (which Du Pont selected to sample in addition to the required C-8 sample sites) were very low, ranging from 0.0023 mg/l to 0.0055 mg/l (Figure 19). Low C-8 concentrations were expected, since the historic source area for C-8 was the Anaerobic Digestion Ponds located in the northwest part of the plant.

9.0 SURFACE WATER LEACHATE WATER QUALITY DATA RESULTS

9.1 LOCAL LANDFILL

Surface water samples were taken from the three surface water runoff streams, LLL 1, 2 and 3, and from the three leachate collection ponds, LLP 1, 2 and 3. Samples were analyzed for the EPA Constituent List. The surface water at the Local Landfill (just as the ground water), is of good quality. The analytical results indicate that only total barium and chloride are consistently found, but at very low concentrations (Figures 15 and 18).

Mercury was detected at LLL 3 at 0.0003 mg/l (PQL of 0.0002 mg/l) and formaldehyde at 0.1 mg/l (which is the PQL). Total zinc was detected, but only at very low levels in LLP 1 and 2. Formate ion was detected at LLL 3 at 4 mg/l and at LLP 3 at 3.2 mg/l. The pH values at these sites measured 7.83 at LLL 3 and 7.95 at LLP 3, indicating that formate ion and not formic acid was present. No other volatile or semi-volatile organics were detected.

9.2 RIVERBANK LANDFILL

Riverbank Landfill springs RBLL 1 and 2 were sampled and analyzed for the EPA Constituent List, C-8 and TRITON®. Only total metals (arsenic, barium, mercury, selenium, and zinc) were detected, but at very low concentrations. Chloride (340 mg/l) was detected at RBLL 1. In addition, methylene chloride (390 to 410 mg/l), FREON® 113 (0.14 to 0.43 mg/l), a trace amount of toluene (0.007 to 0.017 mg/l), trichloroethene (0.007 to 0.008 mg/l) and tetrachloroethylene (at the detection limit of 0.005 mg/l) were detected at RBLL 1. The spring at RBLL 1 has been monitored and spring waters collected and treated on-site by carbon adsorption since mid-1991, when elevated levels of methylene chloride were first detected. Status reports documenting the treatment of this spring waste have been sent to R. L. Allen, U.S. EPA, Region III, on a quarterly basis as required by Permit WVD045875291. Due to the low

constituent concentrations and low, intermittent spring flow at RBLL 2, no immediate corrective action is required. However, additional monitoring of this spring is recommended.

FREON® 113 and C-8 were detected at low levels at both RBLL 1 and 2 (Figures 14 through 23). Trichloroethylene was detected at 0.012 mg/l at RBLL 2. Chloroform was detected at very low concentrations, attributed to the distilled water rinsate or laboratory contamination. Formate ion was detected at RBLL 2 at 2.3 mg/l, and below 1 mg/l at RBLL 1. The pH values were 6.95 and 6.15, respectively, indicating that formate ion and not formic acid was detected.

10.0 SOIL SAMPLE ANALYTICAL DATA RESULTS

10.1 BACKGROUND SOIL SAMPLES

10.1.1 PLANT SITE

Four shallow (0 to 3 feet deep) background (upgradient) soil samples (UGS 1, 2, 3 and 4) were taken on the plant site, two from the eastern edge of the plant (UGS 2 and 3) and two from the western edge (UGS 1 and 4). The analytical results at UGS 2 and 3 indicate the presence of low concentrations of arsenic (0.6 to 1.2 mg/kg), barium (75 to 28 mg/kg), cadmium (<0.05 to 0.12 mg/kg), chloride (20 mg/kg), nickel (10 to 6 mg/kg), lead (8.5 to 5.4 mg/kg), zinc (34 to 24 mg/kg) and methylene chloride (0.085 to 0.11 mg/kg) (Figures 14 through 18). The analytical results at UGS 1 and 4 also indicate the presence of low levels of arsenic (0.55 to 5.1 mg/kg), barium (68 to 76 mg/kg), cadmium (0.095 to 0.23 mg/kg), nickel (10 to 11 mg/kg), lead (9 to 11 mg/kg), zinc (46 to 63 mg/kg) and methylene chloride (0.06 to 0.088 mg/kg). These background concentrations are above PQL's, but well below PAL's (see Table 4).

10.1.2 LOCAL LANDFILL

Two upgradient (background) soil samples were taken at LLS 4 and LLS 5 located on the western and eastern parts of the Local Landfill on ridges, respectively. Arsenic, barium, cadmium, nickel, lead, zinc and methylene chloride were detected at both of these background topographically upgradient sites. The concentrations were consistent with those detected at the other three soil sample sites taken at the Local Landfill. All concentrations were well below PAL's (see Figures 14 through 23).

10.1.3 OFF-SITE

Three off-site shallow soil samples were taken from locations about 2.5 miles east at a private residence (sample designated as UGS 564), 4 miles west at the Du Pont employees recreation area (sample designated as Derc) and 30 miles east of the plant site at a private residence located in the town of St. Marys, WV (sample designated as UGS JWW). The analytical results from UGS 564 indicate the presence of arsenic, barium, cadmium, nickel, lead, zinc and methylene chloride at concentrations similar to those found on the plant site at background soil sample sites UGS 1, 2, 3 and 4 and at the Local Landfill background sites LLS 4 and 5. The concentration of methylene chloride in soil sample UGS 564 was 0.16 mg/kg. The concentration of methylene chloride detected in the background soils on the plant site ranged from 0.06 mg/kg to 0.11 mg/kg, and from 0.07 mg/kg to 0.89 mg/kg at the Local Landfill. Methylene chloride was detected at 0.009 mg/kg in the sample taken from the Du Pont employee recreation area (Derc). Methylene chloride and toluene were detected at 0.038 mg/kg and 0.010 mg/kg, respectively at the private residence in St. Marys, WV (UGS JWW).

10.2 LOCAL LANDFILL

Shallow soil samples were taken at three soil sample sites LLS 1, 2 and 3 located in and along the three surface water drainages. The analytical results indicate that arsenic, cadmium, chloride, mercury (at LLS 2 only), selenium (at LLS 3 only), nickel, lead, zinc, chlorobenzene (at LLS 2 and LLS 3 only) and methylene chloride were detected, but at very low concentrations, well below PAL's and similar to background concentrations found at LLS 4 and 5. Although bis-2-ethylhexylphthalate was detected at 0.28 mg/kg at LLS 1, it was also detected in the lab blank at 0.19 mg/kg. Formate ion was detected only at LLS 1 and LLS 3 at 1.4 and 2.0 mg/l, respectively. The PAL for formic acid in soil is 200,000 mg/kg.

10.3 RIVERBANK LANDFILL

Analytical results for subsurface shallow (0 to 2 feet and 2 to 4 feet deep) soil samples taken along the north side of the Riverbank Landfill (RBLs 1A,1B, 4A,4B, 6A,6B, 7A,7B, 10A,10B and 11A,11B) indicate the presence of arsenic, barium, cadmium, chloride, nickel, lead, selenium and zinc, but at very low concentrations, well below EPA PAL's and similar to background concentrations. Mercury was detected at 0.25 mg/kg in RBLs 6B, 8A and 11B. By comparison, the PAL for mercury in soil is 20 mg/kg. Very low concentrations of methylene chloride (from 0.17 mg/kg to 1.3 mg/kg) and chlorobenzene (from 0.005 mg/kg to 0.007 mg/kg), were detected in the shallow soils along the north side of the Riverbank Landfill. The PAL's for these constituents are 90 mg/kg and 2,000 mg/kg, respectively. In addition, very low concentrations (0.007 to 0.01 mg/kg) of toluene were detected at RBLs 6A, 6B, and 10B. The PAL for toluene is 20,000 mg/kg. Tetrachloroethene and trichloroethene were detected at RBLs 7B at 0.009 mg/kg and 0.071 mg/kg, respectively. The PAL's for these constituents are 10 mg/kg and 60 mg/kg, respectively (Figures 14 through 23).

Analytical results for subsurface shallow soil samples on the south side of the Riverbank Landfill (RBLs 2A,2B, 3A,3B, 5A,5B, 8A,8B, 9A,9B and 12A,12B) indicate the presence of arsenic, barium, cadmium, nickel, lead, selenium and zinc, all at levels below PAL's. Although cadmium, lead and zinc concentrations at RBLs 2A were higher than the concentrations detected at the other sites, the concentrations at underlying RBLs 2B were significantly lower than at RBLs 2A, consistent with the concentrations detected at the other sites. Methylene chloride and chlorobenzene were detected, but at very low concentrations. C-8 was detected at RBLs 3A, 5A and 8A at low concentrations, ranging from 0.4 to 0.98 mg/kg. Formate ion was not detected in any of the Riverbank soil samples

10.4 ANAEROBIC DIGESTION PONDS

Subsurface composited soil samples were taken from the three Anaerobic Digestion Pond boreholes (ADPMW 1, 2 and 3) at three depth intervals; 10 to 12 feet, 18 to 20 feet and 35 to 40 feet (below the water table). The samples were analyzed for the EPA Constituent List and C-8. Arsenic, barium, cadmium, chloride, nickel, lead and zinc were detected at low concentrations, below PAL's. Methylene chloride and C-8 were consistently found in the soil samples. Methylene chloride was detected at concentrations ranging from 0.015 mg/kg to 0.19 mg/kg. These levels are similar to those found in the background soil concentrations, (from 0.085 mg/kg to 0.16 mg/kg). Formate ion concentrations were less than 1 mg/kg in all of the soil samples, with the exception of ADPS 3A, where the concentration was 5.9 mg/kg. Other organics were not consistently found and were detected at very low concentrations, at or near detection limits. Concentrations of both the metals and organics decrease with depth, with the lowest concentrations found in the soils located below the water table (Figures 14 through 23).

10.5 POLYACETAL WASTE INCINERATOR

Shallow soil samples (0 to 2 feet deep) were taken from the southern and northern portions of the Polyacetal Waste Incinerator (PWIS 1 and 2). These soils were analyzed for m-cresol, phenol, and total cadmium, chromium, lead and selenium. The analytical results indicate consistent concentrations at both sample locations, with metals concentrations at or near plant background soil concentrations. Formate ion was detected at 1.4 mg/kg at PWIS 2, but was < 1.0 in the duplicate sample. No m-cresol or phenol was detected in either sample.

10.6 BURNING GROUNDS

Shallow composited soil samples were taken from depths of 2 to 4 feet and 5 to 7 feet from boreholes BGMW 1 through 7. These soils were analyzed for the EPA Constituent List. The analytical results indicate that arsenic, barium, cadmium, nickel, lead, zinc, chloride, and methylene chloride are consistently found in all of the soil samples, but at low concentrations consistent with plant background concentrations (Figures 14 through 21). The only exception to this was at BGS 2A (from 0 to 4 feet deep), where cadmium and zinc were slightly higher than at the other Burning Ground soil sample sites, but still well below PAL's. In addition, nine semi-volatile constituents were detected at BGS 2A, although at very low levels, all below PAL's. None of these semi-volatiles were detected in the underlying soil sample at BGS 2B taken from 5 to 7 feet.

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11.0 CONCLUSIONS AND RECOMMENDATIONS

11.1 LOCAL LANDFILL

The ground water, surface water and soil analytical data obtained from the seven Local Landfill monitor wells, six surface water sample sites and five soil sample sites indicate that soils, surface waters and ground waters at the Local Landfill have not been adversely impacted. The constituents detected (see Sections 8.2, 9.1, 10.1.2 and 10.2 for detailed discussion), were at concentrations significantly below PAL's and MCL's. The landfill is operated and permitted in accordance with the State of West Virginia, Department of Natural Resources Permit #3494. A combined Solid Waste and NPDES permit application is pending. The landfill will eventually be closed under the State of West Virginia Solid Waste Management Regulations. Ongoing monitoring of the landfill has and will continue to ensure that the surface waters and underlying ground waters will be protected. Data indicate that no further study is required at this site.

11.2 RIVERBANK LANDFILL

Based on the ground water, surface water and soil analytical data obtained at the twelve Riverbank Landfill monitor wells and two riverbank springs, and based on known historic spill and disposal areas, contamination is present in the western, and to a lesser extent, in the central part of the landfill (Figures 18 through 23). The key constituents detected include methylene chloride, FREON® 113, trichloroethene, TRITON® and C-8 (ammonium perfluoro-octanoate) in the western part, and tetrachloroethene and trichloroethene in the central part of the landfill.

Metals were detected in the soils, ground and surface waters, but well below PAL's and MCL's (Figures 14 through 17). With the exception of dissolved arsenic which exceeded the MCL by 0.019 mg/l at RBLMW 8, all other dissolved metals concentrations in the ground water were below the PAL or MCL.

The two constituents detected in the soil and underlying ground water included C-8 at RBLS 3, 5, and 8 and trichloroethene at RBLS 7.

Trichloroethene was detected at RBLL 2 and in surrounding groundwaters at RBLMW 7 and 8 (Figure 23). FREON® 113, trichloroethene, and methylene chloride were detected at RBLL 1, but only FREON® 113 and trichloroethene were detected in downgradient monitor wells RBLMW 2 and 3.

Methylene chloride and FREON® 113 were first detected at RBLL 1 in the middle of 1991. Du Pont immediately implemented spring capture and on-site treatment to control and treat this water. About 1.5 gpm of water is currently collected from this spring, processed in an on-site activated carbon adsorption treatment unit and discharged to the Ohio River. Methylene chloride removal efficiency is > 99%.

Constituents detected at eastern spring RBLL 2 are at very low concentrations and this spring flow is very small and intermittent. Additional study of the flow rate and sampling for detected constituents will be performed to better characterize the spring.

In conclusion, there is ground water contamination limited to the western and central parts of the Riverbank Landfill. The landfill has been inactive since the late 1960's. It is recommended that the ongoing corrective action program to treat the RBLL 1 spring be continued. Pumping from the Ranney and Du Pont-Lubeck water production wells controls ground water flow direction in towards the plant site and will be continued. Installation of additional downgradient monitor wells is recommended. Data obtained from these additional downgradient monitor wells will be used to determine the lateral extent and rate of constituent movement. In addition, the Du Pont-Lubeck and Ranney water production wells should also be sampled for the EPA Constituent List, C-8 and TRITON®. The results of this additional monitoring will be used to determine if the existing on-site pumping, and spring capture and treatment systems

are adequate for controlling constituent migration from the Riverbank Landfill (see Table 5 for proposed work schedule).

This approach is consistent with the October 25, 1991 U. S. EPA memo regarding "stabilization" at RCRA facilities which stresses the importance of controlling releases and stabilizing sites to prevent further constituent migration while the need for long-term corrective measures are evaluated (see Appendix F).

11.3 ANAEROBIC DIGESTION PONDS

Based on the analytical data from the three Anaerobic Digestion Pond monitor wells ADPMW 1, 2 and 3, and the nine subsurface soil samples taken from 10 to 12 feet, 18 to 20 feet, and 35 to 40 feet; the underlying ground water and soils contain C-8, FREON® 113, methylene chloride and TRITON® (Figures 19 through 21). Other organics detected concentrations near the PQL include phenol, 4-methyl 2-pentanone, 2-butanone and toluene (2-butanone and toluene may have come from the methanol used to clean sampling equipment).

Methylene chloride and C-8 were consistently found in the subsurface soils, with concentrations decreasing with depth.

C-8 and TRITON® are the principal constituents found at the Anaerobic Digestion Ponds. C-8 does not readily degrade and TRITON® is anaerobically degraded. The TRITON® concentrations in the pond monitor wells ranged from 13.35 mg/l to 18.6 mg/l, but in the aforementioned downgradient monitor wells, the concentration ranged from only 0.16 mg/l to 0.98 mg/l, respectively. In contrast, concentrations of C-8 ranged from 25 mg/l to 38 mg/l in the ponds, and from 0.065 mg/l to 7.1 mg/l in downgradient wells RBLMW 2 and 3, respectively. Installation of additional permanent monitor wells located downgradient from the Riverbank Landfill can be used to define the lateral extent of hazardous constituent migration from the Anaerobic Digestion Ponds.

Because there currently are no in-situ treatment technologies available for C-8 in water at these very low concentrations, Du Pont has initiated a study to evaluate the use of electrochemical techniques for in-situ stabilization of C-8 contaminated soils. Preliminary results of this work are scheduled for completion in 1993. This research is consistent with the EPA "stabilization" philosophy for immobilizing wastes (see Appendix F).

Only C-8 has been detected at very low concentrations in the downgradient Du Pont-Lubeck wells. Because the Du Pont-Lubeck wells influence downgradient ground water flow off-site, Du Pont will continue to pump this area to control groundwater flow to mitigate the spread of hazardous constituents beyond the site boundaries.

11.4 POLYACETAL WASTE INCINERATOR

Based on the analytical data results of the two shallow soil samples, only arsenic, barium, cadmium, nickel, lead, selenium, and zinc were detected at very low concentrations, similar to the plant background soil concentrations. No organic constituents were detected. No further investigation is warranted at this site. It is recommended that this SWMU be closed per a closure plan approved by EPA.

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11.5 BURNING GROUNDS

Based on the ground water and subsurface soil data obtained from the seven Burning Ground monitor wells, carbon tetrachloride was detected at three wells, BGMW 1, 3, and 4; tetrachloroethene and trichloroethene were detected in wells BGMW 1, 2, and 4; trichloroethene at BGMW 3 and 7; and very low concentrations of FREON® 113 were detected in BGMW 3, 4, and 7. The absence of these constituents in the East Wellfield wells and in the downgradient Du Pont-Lubeck wellfield monitor wells indicates that constituent movement from this SWMU is limited. However, because organic constituents were found, additional monitor wells should be installed to define the lateral extent of constituent movement from this SWMU.

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