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June 1990

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Superfund Record of Decision:

Army Creek Landfill, DE

50272-101

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16. Abstract (Limit: 200 words)

The Army Creek Landfill site, a former sand and gravel quarry, is approximately two miles southwest of New Castle, Delaware. The site abuts Army Creek/Pond and high quality wetlands to the south and east and lies adjacent to Delaware Sand & Gravel Landfill, another Superfund site. From 1960 to 1968, when the landfill reached capacity d closed, the 44-acre municipal landfill accepted approximately 1.9 million cubic ds of municipal and industrial wastes. Ground water problems first became apparent in 1971 when a residential well downgradient of the site developed water quality problems. Since 1972, EPA, the State, and the county have continued to sample the ground water and have identified ground water contaminants indicative of hazardous waste disposal. A contaminant plume has also been identified downgradient of the landfill. In 1973 the county installed recovery wells to intercept the contaminant plume and to create a ground water divide between the Army Creek Landfill and nearby potable water supply wells. A 1986 Record of Decision (ROD) provided for capping of the landfill and for the continued operation of the recovery well network to maintain the ground water divide. The extracted ground water currently discharged into Army Creek Pond untreated. (See Attached Sheet)

17. Document Analysis a. Descriptors
Record of Decision - Army Creek Landfill, DE
Second Remedial Action - Final
Contaminated Medium: gw
Key Contaminant: metals (iron)

b. Identifiers/Open-Ended Terms

c. COSATI Field/Group

Availability Statement	19. Security Class (This Report) None	21. No. of Pages 61
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EPA/ROD/R03-90/091
Army Creek Landfill, DE
Second Remedial Action - Final

Abstract (Continued)

This ROD, the second of two operable units, addresses the need to treat the recovered ground water prior to onsite discharge into Army Creek/Pond. The primary contaminant of concern with respect to the impact of discharge to surface water is iron.

The selected remedial action for this site includes ground water pumping using the recovery well network and treatment using a modified conventional precipitation water treatment plant which involves aeration, precipitation, sedimentation, and filtration followed by onsite discharge of the effluent to Army Creek/Pond; sampling and disposal of sludge generated during the treatment process; and monitoring of the sediment, recovered ground water, surface water, and wetlands. The estimated present worth cost for this remedial action is $4,900,000 which includes an annual O&M cost of $294,000.

PERFORMANCE STANDARDS OR GOALS: The recovered ground water will meet State water quality criteria prior to onsite discharge into Army Creek/Pond. Chemical-specific goals include iron 1,000 ug/l.

RECORD OF DECISION
ARMY CREEK LANDFILL
OPERABLE UNIT #2

DECLARATION

Site Name and Location

Army Creek Landfill Site
Operable Unit #2
New Castle, Delaware

Statement of Basis and Purpose

This decision document presents the selected remedial action for the Army Creek Landfill site in New Castle, Delaware, which was chosen in accordance with the requirements of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), and, to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). This decision document explains the factual and legal basis for selecting the remedy for this site.

The Delaware Department of Natural Resources and Environmental Control has not concurred with the selected remedy. The information supporting this remedial action decision is contained in the administrative record for this site.

Assessment of the Site

Actual or threatened releases of hazardous substances from this site, if not addressed by implementing the response action selected in this Record of Decision (ROD), may present an imminent and substantial endangerment to public health, welfare, or the environment.

Description of the Selected Remedy

This operable unit is the second of two operable units for the site. The Record of Decision for the first operable unit selected a remedial alternative for source control including the installation of a multi-layered landfill cap and the operation of a recovery well network downgradient from the site to prevent contaminated groundwater from migrating to potable water supply wells. This second operable unit addresses the need to treat the recovery well discharges prior to discharging to Army Creek/Pond. The selected remedy will reduce the concentration of iron in the extracted groundwater to a level that is protective of the designated uses of Army Creek. A monitoring plan will be implemented to ensure continued compliance with all applicable

standards. Together, the implementation of the overall remedial action strategy selected in the first operable unit ROD and the second operable unit ROD will provide a quality of water in Army Creek/Pond that is protective of human health and the environment. Hazardous substances will remain on site, therefore long-term management will be required.

The primary component of the selected remedy is the construction and operation of a water treatment facility that is capable of reducing the concentration of iron in groundwater recovered by the recovery well network prior to surface discharge, amounting to about 1.4 million gallons/day. This remedial action will require long-term management to assure compliance.

Declaration of Statutory Determinations

The selected remedy is protective of human health and the environment, complies with Federal and State requirements that are legally applicable or relevant and appropriate to the remedial action, and is cost-effective. This remedy utilizes permanent solutions and alternative treatment (or resource recovery) technologies to the maximum extent practicable, and it satisfies the statutory preference for remedies that employ treatments that reduce toxicity, mobility, or volume as their principal element.

Because this remedy will result in hazardous substances remaining on site above health-based levels, a review will be conducted within five years after commencement of remedial action to ensure that the remedy continues to provide adequate protection of human health and the environment.

6/29/90
Date

Edwin B. Erickson
Regional Administrator
Region III

RECORD OF DECISION
REMEDIAL ALTERNATIVE SELECTION

ARMY CREEK LANDFILL SITE
OPERABLE UNIT #2
NEW CASTLE, DELAWARE

DECISION SUMMARY

I. SITE LOCATION AND DESCRIPTION

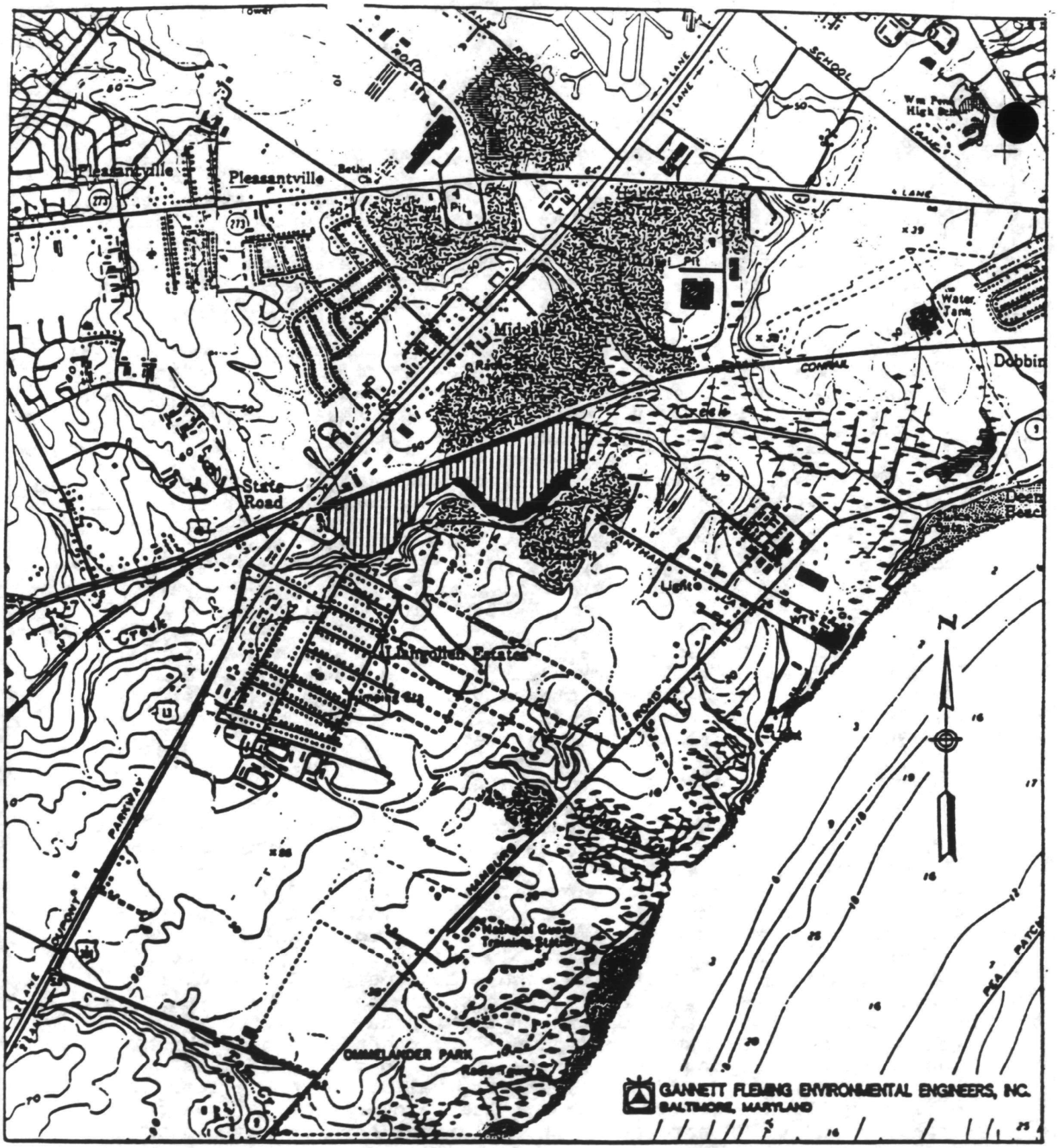
The Army Creek Landfill is located approximately two miles southwest of the city of New Castle, Delaware (Figure 1). The landfill is bordered to the north and west by Conrail tracks and on the south and east by Army Creek. The highways adjacent to the Landfill are Routes 13 and 40 to the west and Route 9 to the east (Figure 2).

Llangollen Estates, a residential development, is located 1/4 mile southwest of the site. Delaware Sand and Gravel, another landfill which has been placed on the Superfund National Priorities List, is adjacent to Army Creek Landfill and separated from it only by Army Creek, a tributary of the Delaware River.

The Army Creek Landfill, a former sand and gravel quarry, is owned by New Castle County. The County operated this approximately 44-acre landfill which accepted municipal and industrial wastes from 1960 until its closure in 1968. During that time, an estimated 1.9 million cubic yards of refuse were landfilled at the site, 30 percent of which (or approximately 600,000 cubic yards) now lies below the seasonal high water table.

In late 1971, water in a residential well southwest of the landfill developed quality problems, such as a distinctly disagreeable odor and permanent staining of porcelain fixtures. New Castle County began a multi-year field investigation to assess the problem. Results from that investigation showed that leachate originating from the Army Creek and Delaware Sand and Gravel Landfills was contaminating local aquifers.

The County's remedial investigation led to the installation of a groundwater recovery system designed to maintain a groundwater divide between the landfills and the Artesian Water Company Wellfield located downgradient of the landfills. Contaminated groundwater pumped from the recovery well system is currently discharged to Army Creek. Army Pond, oriented parallel to the southern site boundary, is ellipsoid in shape and approximately 2,000 feet long, 175 feet wide, and 1 foot deep. Storm water runoff from the site, as well as flows from the recovery wells, are collected in this pond. Upstream of the pond, Army Creek is a low-volume seasonal stream largely dependent on storm runoff which empties into the pond. Downstream of the pond the Creek is enlarged by the flow from the recovery wells, which averages 1.4 million gallons per day. Although the recovery well discharges represent up to 90 percent of the volume of Army Creek, historical aerial photos document that Army Creek/Pond was nearly the same size in the late 1950s. There are high quality wetlands associated with the Army Creek which are utilized by migratory birds.



LEGEND

ARMY CREEK POND

ARMY CREEK LANDFILL SITE

FIGURE 1

ARMY CREEK LANDFILL SITE LOCATION

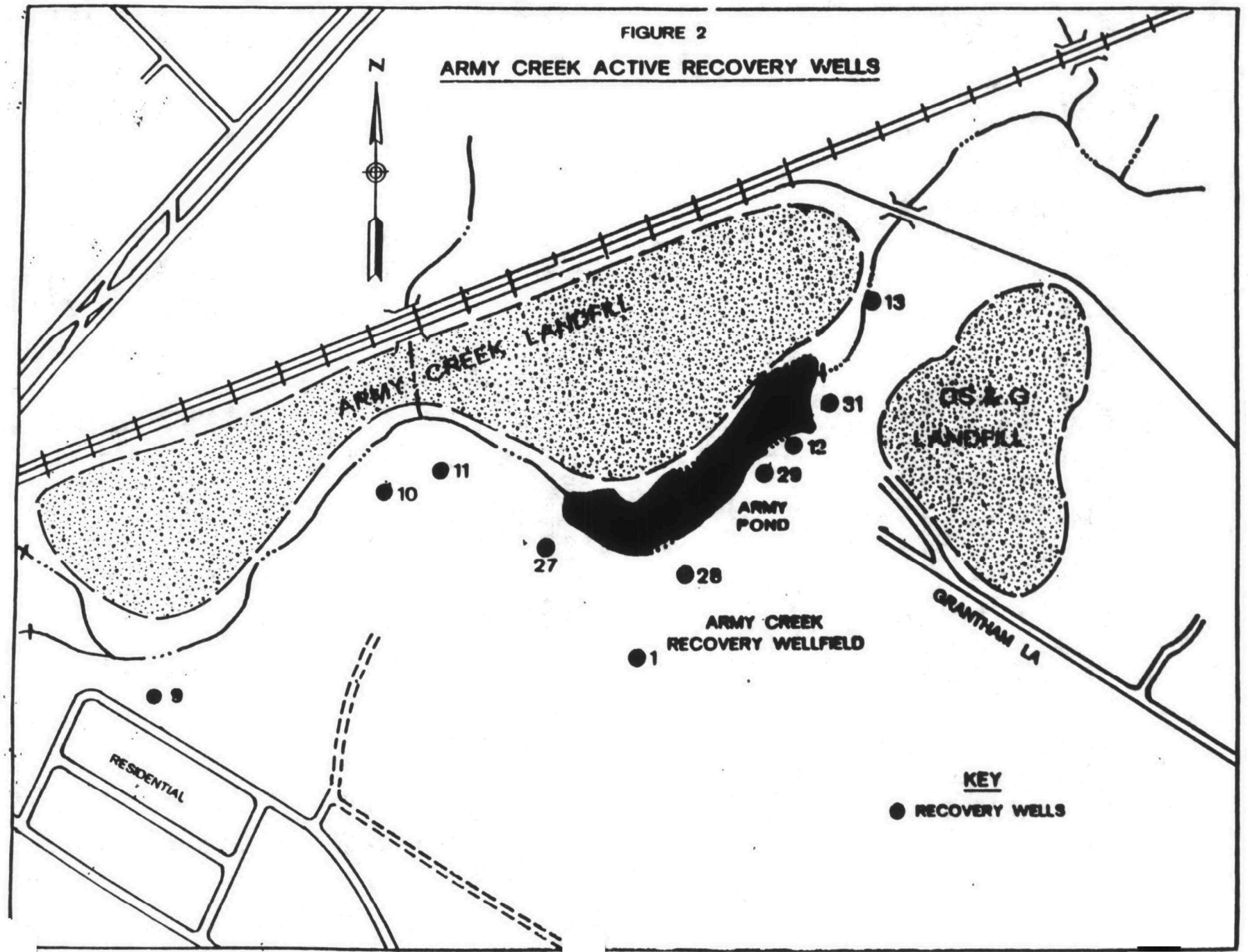
SCALE: 1" = 24,000

1 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

FIGURE 2

ARMY CREEK ACTIVE RECOVERY WELLS



GANNETT FLEMING, INC.
BALTIMORE, MARYLAND

Army Creek and its vicinity supports a diverse flora and fauna. Five species of special concern have been found in Army Creek or within the vicinity of the site. These are the bur-marigold, smallmouth bass, striped bass, white crappies and yellow bullheads. The bur-marigold is not found on the Army Creek Site, but rather at the mouth of Army Creek along the Delaware River. Because of the distance involved, it is not likely this species would be impacted by the Army Creek Site or its remediation. The four fish species listed above could potentially be impacted by the Army Creek Site. Although these species have been found in Army Creek, they do not appear to be common species in the Creek. White crappies and smallmouth bass were found two times out of six sampling events between 1975 and 1983, while yellow bullhead and striped bass were found only once.

Site Geology

The Army Creek Landfill is located within the Atlantic Coastal Plain physiographic province. The coastal plain is composed of a wedge-shaped body consisting of gravels, sands, silts and clays.

The site is underlain by two water-bearing formations, the Columbia and the Potomac. The Columbia, the upper-most aquifer beneath the landfill, is of Pleistocene Age and is from 10 to 60 feet thick at the site. This formation, which dips to the southeast, consists of medium to coarse grained sands, gravels, silts and clays which were deposited in shallow lens-shaped channels. The silt and clay units of the Columbia are discontinuous and do not form confining units.

The Potomac Formation of Cretaceous Age underlies the Columbia Formation and is generally separated from it by a confining clay layer at the site. The Potomac Formation dips to the southeast, is up to 600 feet thick and consists of silts and clays interbedded with sands and some gravel. The formation is divided into upper and lower units which are separated by a thick confining clay unit. The upper Potomac Formation silts and clays are discontinuous and nonuniform; in some places, the sands of the Columbia and Potomac are in contact.

Site Hydrogeology

Hydrologically, the Potomac upper clay functions as a confining zone for the underlying aquifer which is known as the upper Potomac Hydrologic zone. The direction of flow in the Potomac aquifer has been altered significantly over the past several decades due to withdrawal of water for industrial and domestic uses. The elevation of the potentiometric surface in the 1950s, before significant development of the aquifer, was about 19 feet below sea level and flow direction was toward Delaware Bay to the southeast. In the 1960s, after wellfields were developed in the Potomac Formation for public water supplies and industrial use, the direction of flow remained to the south and east.

The surface of the landfill is pocketed with depressions resulting from the differential subsidence of the refuse. These depressions, coupled with the remaining flat surface of the landfill, retards stormwater from running off the landfill. The cover is generally silty, sandy and quite permeable. However, deposits of clay have accreted in the depressions so that stormwater forms ponds in the depressions. These ponds contribute to the slow infiltration of water into the landfill. Because of these current surface conditions, it is estimated that at least 50 percent of the precipitation which falls directly onto the landfill surface infiltrates through the landfill cover and percolates through the refuse.

II. SITE HISTORY AND ENFORCEMENT ACTIVITIES

The Army Creek Landfill occupies an area that was formerly utilized as a sand and gravel pit. The gravel pit in which Army Creek Landfill was constructed was excavated until a hard zone was encountered. This zone marks the base of the Columbia Formation and the top of the underlying clay.

In 1960, the landfill began operation as a municipal refuse landfill. The landfill was operated by New Castle County continuously until 1968 when it was filled to capacity. Refuse placement, compaction and covering operations at the Army Creek Landfill were carried out by the operators of the gravel pit under contract to New Castle County. Refuse burial began at the eastern end of the pit and generally continued toward the pit entrance on the west. The cover material used was obtained from the pit and includes residential sands, tailing piles and siltation basin deposits. As the operation progressed, cover material and landfill space became depleted. This encouraged deeper excavation which may have removed much of the clay layer which separated the Columbia from the Potomac formations. This in turn could have created direct access routes for leachate from the Columbia to the Potomac. Direct access routes may also have occurred naturally due to the noncontinuous geometry of the Potomac clay.

In late 1971, water in a residential well downgradient of the Army Creek Landfill Site developed severe quality problems. In June 1972, New Castle County commenced a groundwater monitoring program which began with a well installation and sampling program. Monitoring by various agencies including EPA, New Castle County and the Delaware Department of Natural Resources and Environmental Control (DNREC) has continued up to the present. Monitoring has resulted in the identification of groundwater contaminants indicative of hazardous waste disposal as well as typical municipal refuse. It was also determined that the plume of these contaminants was moving toward the receptors located downgradient of the landfill. After considering alternative water supplies for the affected residents, New Castle County paid for an extension of Artesian's Water supply lines to the first contaminated residence and other homes along Grantham Lane. There was also a settlement with the homeowners to offset the monthly services costs.

In 1973, recovery wells were installed in the upper Potomac Aquifer by New Castle County. The purpose of the recovery wells was to intercept and contain the contaminant plume. The pumping of these wells created a groundwater divide between the Army Creek Landfill and the Artesian Water Company's Llangollen Wellfield.

A modified recovery system was installed in 1980, which included placement of new recovery wells closer to the landfill in order to pump more concentrated groundwater and therefore less clean water. The present recovery well system utilizes Wells 27, 28, 29, 31, RW-1, RW-9, RW-10, RW-11, RW-12 and RW-13 (Figure 2).

Based on the sampling analysis from the recovery and monitoring wells, the Army Creek Landfill site was proposed for the National Priorities List (NPL) in October of 1981 and was finalized on the list in September of 1983 due to extensive groundwater contamination. In August 1984, EPA entered into a Consent Agreement and Order with New Castle County to perform a Feasibility Study at the site. New Castle County submitted the final draft of the study in July 1986.

The Army Creek Record of Decision (ROD) for the first operable unit, issued on September 30, 1986, selected a remedial alternative for source control but deferred selection of appropriate remedial measures for sediments in Army Pond and a treatment for the groundwater recovery well discharges to a second operable unit decision document. The first operable unit ROD selected a two-phased approach:

Phase I

1. installation of a multi-layer landfill cap
2. continued operation of the downgradient recovery well network
3. evaluation of the remedial action for five years after the cap is installed to assess the effectiveness of the system during operation .

Phase II

1. based on the five-year evaluation, a determination will be made on whether to install upgradient controls
2. continue evaluation of the effectiveness of the system
3. operation and maintenance

The extensive studies that have been conducted at the site have identified contamination in both the groundwater and surface water. The remedial action strategy selected in the first operable unit, described above, addresses the groundwater contamination and the landfill leachate currently seeping into the surface water (Army Creek/Pond).

In August 1986, EPA issued Notice Letters to the identified Potentially Responsible Parties (PRPs) inviting them to design and implement the remedial action strategy selected in the first operable unit Record of Decision. The PRPs failed to achieve

settlement with the EPA. EPA completed the remedial design of a multi-layer landfill cap in August 1989.

In February 1989, EPA issued Special Notice Letters to the identified PRPs inviting them to conduct the focused Remedial Investigation and Feasibility Study with respect to the surface water (Army Creek/Pond) and sediments adjacent to the landfill. The noticed PRPs declined to perform the study. In February 1990, EPA completed the second operable unit RI/FS.

III. SCOPE AND ROLE OF OPERABLE UNIT

This is the second and final planned operable unit for the site. The first operable unit provided for the installation of a hydraulic barrier (cap) over the landfill to prevent vertical infiltration through the wastes and for the continued operation of the downgradient recovery well network to prevent the migration of contaminated groundwater to public supply wells. The recovery well system is currently operating and the remedial design of the landfill cap has recently been completed. Actual cap construction is planned to begin before December 1990. This second operable unit addresses the need to treat the recovery well discharges, which, as determined in the Remedial Investigation, do not present an unacceptable threat to human health but are potentially harmful to the environment. Sediment sampling revealed contaminant levels which were within a range expected to be found in a wetland environment and are therefore not an environmental concern.

The contaminated medium to be addressed in the second operable unit is the surface water of Army Creek/Pond in general and the recovery well discharge in particular.

IV. HIGHLIGHTS OF COMMUNITY PARTICIPATION

The RI/FS Report and the Proposed Plan for the second operable unit of the Army Creek site were released to the public for comment on March 18, 1990. These two documents were made available to the public in both the administrative record and an information repository maintained at the EPA Docket Room in Region 3 and at DNREC's New Castle office. The notice of availability for these two documents was published in the Wilmington News Journal on March 18, 1990. A public comment period on the documents was held from March 18, 1990, to May 2, 1990. In addition, public meetings were held on March 26 and April 21, 1990. At these meetings, representatives from EPA and DNREC answered questions about problems at the site and the remedial alternatives under consideration. A response to the comments received during this period is included in the Responsiveness Summary, which is part of this ROD.

V. SITE CHARACTERISTICS

As documented in the first operable unit ROD, the groundwater beneath and downgradient from the site is contaminated by both organic and inorganic pollutants at levels exceeding the drinking water standards. Drinking water standards are the applicable standards for groundwater because it is withdrawn and used as a potable water supply. The first operable unit ROD selected the

continued operation of the existing recovery well network to prevent the horizontal migration of the contaminants to any potable water supply well head.

The groundwater recovered by the recovery well network is currently being discharged to the Army Creek/Pond surface water. A determination on the level of treatment required for this recovered groundwater prior to surface discharge is the primary objective of this decision document. Drinking water standards are not applicable to the Army Creek/Pond surface water because the creek water is not classified as a potable water source. EPA and DNREC have established relevant water quality standards pursuant to Sections 304(a) and 303 of the Clean Water Act, respectively, in order to protect the designated uses of Army Creek/Pond. The designated uses for Army Creek/Pond include the following: secondary contact recreation; fish, aquatic life and wildlife. The fresh water segments are also designated for agricultural water supply uses.

Surface Water

Two studies have compared the stream biota of Army Creek from locations above and below the landfill, beyond the pond outlet. The study conducted in 1985 by the State of Delaware found species richness at stations above and below the landfill to be similar. Both stations exhibited high densities of macroinvertebrates but relatively low species diversity. Of the species present, facultative and pollution-tolerant organisms predominated. The authors suggested these communities were indicative of moderate inorganic enrichment. The second biomonitoring study was conducted in 1986 by EPA. This study had three study sites, one upstream from the landfill, the second in the Army Creek Pond, and the third downstream of Army Creek Landfill. Results of this study were similar to those found in the 1985 State of Delaware Study. The EPA study did find that the downstream benthic community had more taxa and fewer organisms per taxa as well as more groups intolerant of water pollution, indicating a slight improvement in water quality over upstream stations. The pond station exhibited very low species richness and 95 percent of the groups found in the pond were pollution tolerant. This indicates poor water quality in the pond. In summary, Army Creek both above and below the landfill appears to be nutrient enriched. Although chronic toxic effects due to landfill effluent may be present, the effects cannot be distinguished from the stream biotic communities due to the confounding effects of the stream enrichment. The improvement in the benthic macroinvertebrate community below the pond outfall does suggest that the pond may be operating in a limited capacity as a filter or aeration system, improving the water quality of the outflow water.

Based on questions raised by the State regarding the representativeness of the results cited in the Remedial Investigation and Proposed Plan (taken from a report on chemical analyses of fish samples collected in 1983) a new sampling event was conducted. In May 1990, separate bioassays were performed on composite fish fillet samples of five common carp and six american eel collected by DNREC. Results showed some inorganic contamination by zinc in both the carp (11.2 ug/g) and the eel (14.9 ug/g). No additional

inorganic constituents were identified. Organic analyses of the composite fish fillets have not yet been completed. The fish in the study were collected below the landfill at the edge of the Army Creek Site.

In August 1988, the EPA field investigation team sampled Army Creek for priority pollutants. The data indicated the presence of organic and inorganic contaminants in the waters of Army Creek (Table 1). Organics detected included: bis(2-chloroethyl)ether, 1,2-dichloroethane, and phenol. Inorganics detected in two or more sampling locations included: cadmium, chromium, iron, mercury, and zinc. The organic contaminants were well below the Delaware Surface Water Quality Standards (DSWQS) which are known to be protective of the aquatic environment. The concentration of bis-(2-chloroethyl)ether may exceed the numeric DSWQS for protection of human health via fish consumption (identified concentrations are below detection limits). The concentrations of cadmium, iron, mercury and zinc were found to exceed the Delaware Surface Water Quality Standards for chronic toxicity (Table 4). The analysis for chromium did not differentiate between valences; however, the relative toxicity of hexavalent chromium is greater than trivalent chromium. If the majority of the total chromium reported is in the hexavalent form, the level does exceed the criterion.

Groundwater Recovery Well Discharge

There are currently ten recovery wells pumping groundwater and discharging to Army Creek/Pond. New Castle County has arranged to direct the water pumped from one of the ten wells (RW#9) to the Wilmington POTW. The sampling of the remaining nine recovery well discharges was carried out on July 6, 1989. The recovery wells sampled, referred to by the well number assigned to them by New Castle County upon installation, were numbered 1, 10, 11, 12, 13, 27, 28, 29, and 31 (Figure 2).

To determine the combined effect of these discharges on Army Creek/Pond, the flow weighted average concentrations of the compounds found in the recovery well discharges were calculated. Although many organic (Table 2) and inorganic (Table 3) contaminants were detected in the discharges, only iron definitively exceeds the numeric surface water quality criteria. The flow weighted average concentration of bis(2-chloroethyl)ether in the discharges may contribute to an "in stream" concentration that may exceed the numeric criterion established to protect human health from the fish consumption exposure route. The current data is insufficient to make a definitive determination. The numeric and narrative criteria documented in the Delaware Surface Water Quality Standards as amended on February 2, 1990 (Table 4) are the standards relevant to surface water bodies.

Surface water quality criteria are constituent concentrations, levels or narrative statements that represent a quality of water that supports a particular designated use. As such, they apply "in stream." In determining maximum allowable discharge concentrations, the allowable dilution in the receiving stream is

Table 1
Summary of Analytical Results for Surface Water Sampling
Army Creek Landfill
New Castle, Delaware

Organic Contaminants

Chemical	No. of Positive Detections/ No of Samples	Range of Concentrations (ug/L)	*Average Concentration (ug/L)	Instrument Detection Limit (ug/L)	Method Detection Limit (ug/L)
Bis(2-Chloroethyl)-ether	3/8	*** 3.6-7.5	3.4	3.6	10.0
1,2-Dichloroethane	2/8	2-5	1.6	2.0	5.0
Phenol	8/8	92-213	157	50	50.0

Inorganic Contaminants

Chemical	No. of Positive Detections/ No. of Samples	*Range of Concentrations (ug/L)	**Average Concentration (ug/L)	Instrument Detection Limit (ug/L)	Method Detection Limit (ug/L
Cadmium	5/8	34-38	25	10.0	10.0
Chromium (Total)	7/8	57-150	84	50.0	50.0
Iron	7/8	980-2,860	1,549	500	500
Mercury	2/8	0.2	0.13	0.2	0.2
Nickel	1/8	150	62	100	100
Thallium	1/8	610	295	500	500
Zinc	8/8	25-640	167	10.0	10.0

* Concentrations in lab analyses labelled as estimated, "J", were assumed to equal listed concentrations.

** Values of 1/2 of the Instrument Detection limits were used for the values of the nondetected results in calculation of averages.

*** Each detection identified below the method detection limit; therefore, concentrations given are approximate values.

Note: Surface water was analyzed for TAL and TCL; only positive detections reported in summary table.

Table 2
Summary of Analytical Results for Recovery Well Discharge
Army Creek Landfill
New Castle, Delaware

Organic Contaminants

Chemical	No. of Positive Detect-tions No. of Samples	*Range of Concen-trations (ug/L)	** Flow Weighted Average Conc. (ug/L)	Instrument Detection Limit (ug/L)	Method Detec-tion Limit (ug/L)
Benzene	4/9	14-18	8.0	5	5
Bis(2-Chloroethyl)-ether	7/9	5-21	11.0	5	10
Bis(2-ethylhexyl)-phthalate	1/9	3	1.8	3	10
Chlorobenzene	3/9	3-18	4.0	3	5
Chloroform	1/9	6	2.8	5	5
1,4-Dichloroben-zene	1/9	6	3.6	6	10
1,2-Dichloroethane	2/9	22-50	8.4	5	5
Ethylbenzene	2/9	4	2.6	4	5
Tetrachloroethene	1/9	2	1.1	2	5
Toluene	1/9	19	4.2	5	5
Trichloroethene	1/9	2	1.1	2	5
Total Xylenes	2/9	7-10	4.4	5	5

*(1) Where duplicate samples were taken, the higher concentration was used.

(2) Concentration in lab analyses labelled as estimated, "J", were assumed to equal the listed concentration.

** Values of 1/2 of the Instruction Detection limits were used for the values of the nondetected results in calculation of averages.

ote: Discharges were analyzed for Target Compound List (TCL); only positive detections reported on summary table.

Table 3

Summary of Analytical Results for Recovery Well Discharge
Army Creek Landfill
New Castle, Delaware

Total Inorganic Contaminants

Chemical	No. of Positive Detections/ No. of Samples	*Range of Concen-trations (ug/L)	**Flow Weighted Average Conc. (ug/L)	Instrument Detection Limit (ug/L)
Aluminum	1/9	132.0	29.6	12.0
Arsenic	1/9	2.7	1.0	1.8
Barium	9/9	74.5-377.0	184	1.2
Calcium	9/9	8,760-18,800	11,470	17.1
Cobalt	3/9	22.7-36.9	11.8	2.7
Iron	9/9	488-34,300	12,400	8.6
Magnesium	9/9	3,630-13,600	6,670	24.3
Manganese	9/9	249-2,710	945	1.5
Potassium	9/9	1,940-17,000	6,770	407.8
Selenium	2/9	1.4-1.5	0.8	1.4
Sodium	9/9	9,690-80,600	26,840	21.8

* Concentrations in lab analyses labelled as estimated, "J", were assumed to equal listed concentrations.

** Values of 1/2 of the Instrument detection limits were used for the values of the nondetected results in calculation of averages.

Note: Discharges were analyzed for Total Analyte List (TAL); only positive detections reported in Summary Table.

Table 4

Chemicals Found to Exceed Delaware Surface Water Quality Standards as Amended on February 2, 1990 (DSWQS) in the Army Creek/Pond

Chemical	* Range of Concentrations (ug/L)	** Average Concentration (ug/L)	Delaware Surface Water Quality Criterion Human Health/Fish Consumption (ug/L)	Delaware Surface Water Quality Criterion for Protection of Freshwater Aquatic life	
				Acute Toxicity	Chronic Toxicity
From Recovery Well Discharge					
Iron	488-34,300	12,400	NA	NA	1,000
Bis(2Chloroethyl) Ether	ND-21	11	1.77	NA	NA

* Concentrations in lab analyses labelled as estimated, "J", were assumed to equal listed concentrations.

** Values of 1/2 of the Instrument detection limits were used for the values of the nondetected results in calculation of averages. Average concentration in Recovery well discharge is flow weighted.

ND Not Detected

NA Not Available

Note: Recovery well discharges and surface water were analyzed for Total Analyte List and Target Compound List. Only constituents which may exceed or may contribute to an excursion of the DSWQS are identified.

Table 4 (Continued)

Chemical	* Range of Concentrations (ug/L)	** Average Concentration (ug/L)	Delaware Surface Water Quality Criterion Human Health/Fish Consumption (ug/L)	Delaware Surface Water Quality Criterion for Protection of Freshwater Aquatic life	
				Acute Toxicity	Chronic Toxicity
From Surface Water					
Cadmium	34-38	25	NA	3.9 (a)	1.1 (a)
Chromium (Total)	57-150	84	840,000 (trivalent)	1,737 (a)	207 (a)
			4,200 (hexavalent)	16 (hex)	11(hex)
Iron	980-2,860	1,549	NA	NA	1,000
Mercury	ND-0.2	0.13	7.1	2.4	0.012
Zinc	25-640	167	NA	117 (a)	106 (a)
Bis(2Chloroethyl) Ether	ND-7.5	3.4	1.77	NA	NA

* Concentrations in lab analyses labelled as estimated, "J", were assumed to equal listed concentrations.

** Values of 1/2 of the Instrument detection limits were used for the values of the nondetected results in calculation of averages. Average concentration in Recovery well discharge is flow weighted.

(a) Hardness dependent criterion (100 mg/L used)

ND Not Detected

NA Not Available

Note: Recovery well discharges and surface water was analyzed for Total Analyte List and Target Compound List. Only constituents which may exceed or may contribute to an excursion of the DSWQS are identified.

considered. In the case of Army Creek, the upstream portion is considered an intermittent stream largely dependent on surface water run-off for flow. In accordance with DSWQS, the critical flows to be used in defining available dilution are: the 50th percentile or median flow; the flow of thirty-day duration with a recurrence interval of 5 years (30Q5); the flow of seven-day duration with a recurrence interval of ten years (7Q10); or the flow of one-day duration with a recurrence interval of ten years (1Q10), depending on the applicable criterion (human carcinogen, systemic toxicant, chronic toxicity or acute toxicity).

Sediments

In August 1988, the EPA field investigation team sampled sediments in Army Creek/Pond. The data indicated the presence of both organic and inorganic contaminants in the creek/pond sediments. Twenty organic chemicals were found in the sediment (Table 5) while only three were found in the surface water. The only organic chemical found in both surface water and sediment was phenol. Many of the chemicals found exclusively in the sediment samples have very high organic carbon partition coefficients, which indicates a propensity for soil and sediment adsorption. The metals found in the sediment samples include arsenic, chromium, copper, iron, lead, mercury, nickel, and zinc (Table 5).

Phenol was not detected in the recovery well discharge sampling performed for this RI/FS, but it had been detected in earlier sampling at concentrations far below the surface water concentrations shown in Table 1. Evidently, the source of phenol is either contaminated leachate from the landfill[1], or contaminated runoff from off site. Regardless of the source of phenol, its concentration in the surface water does not represent a hazard to human health or aquatic life.

Levels of metals observed in Army Pond and Army Creek sediments were compared to concentrations of metals occurring naturally in U.S. soils, shown in Table 6, as compiled by Brown and Associates (1983). All metals except iron were determined to fall within the ranges cited by this source. Although Brown and Associates did not include iron in their publication, the extremely high levels of iron measured in the creek/pond sediment is clearly an artifact from the introduction of high concentrations of dissolved iron in the recovery well discharges. The Army Creek/Pond bottom's orange appearance is due to the high levels of iron which have naturally precipitated out of the water column.

When comparing sediment and surface water chemical concentrations in the Army Pond versus those in Army Creek downstream of the pond the concentrations are generally of the same order of magnitude, with slightly lower values in the downstream locations. This illustrates the limited natural cleansing effect occurring in the creek/pond itself (volatilization/biodegradation of organics and precipitation/adsorption of inorganics).

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[1] First Operable Unit Remedial Investigation identified the presence of phenol contamination in some of the monitoring wells constructed through the Army Creek landfill.

VI. SUMMARY OF SITE RISKS

A primary component of the second operable unit remedial investigation is the public health and environmental risk assessment. This assessment defines the potential and actual risks to human health and the environment resulting from the presence of hazardous substances in the Army Creek/Pond surface water and sediments. The potential risk presented by the recovery well discharges alone was also evaluated.

To determine whether there is an actual exposure or a potential for exposure at this site with respect to surface water, the most likely pathways of contaminant release and transport, and the human and environmental activity patterns in the area were considered. A complete exposure pathway has three components:

1. a source of chemicals that can be released into the environment
2. a route of contamination transported through soil, sediment, air or water
3. an exposure or contact point for humans or the environment (plants and animals)

Potential sources of contamination are summarized as follows:

1. recovery well water discharge
2. creek and pond surface water
3. creek and pond sediments
4. air in the area of the creek and pond
5. fish caught for human consumption

Although many chemicals were detected during the sampling activities, only a few of the chemicals pose a risk to human health.

The identified indicator chemicals in the Army Creek/Pond surface water included: [1][2][3]bis(2-chloroethyl)ether, [2][3]1,2-dichloroethane, [1]cadmium, [1]chromium, [1]mercury, [1]nickel and [1]zinc. The human health risk assessment was calculated using the maximum concentration identified in the surface water.

The identified indicator chemicals in the Army Creek/Pond sediments included: [3]benzo(a)pyrene, [1]arsenic, [1]chromium, [1]lead, [1]mercury, [1]nickel and [1]zinc. The human health risk was calculated using the maximum concentration identified in the sediments.

The identified indicator chemicals in the recovery well discharges included: [1][2][3]benzene, [1][2][3]bis(2-chloroethyl)ether, [1][2][3]1,2-dichloroethane, [1]arsenic, [1]nickel and [1]zinc. The human health risk was calculated using the flow-weighted average concentration identified assuming a single discharge point.

(1) Potential contaminant of concern with respect to inadvertent ingestion route
(2) Potential contaminant of concern with respect to the inhalation route
(3) Potential contaminant of concern with respect to the dermal contact route

Table 5

Summary of Analytical Results for Previous Sediment Sampling
Army Creek Landfill
New Castle, Delaware

Organic Contaminants

Chemical	No. of Positive Detections/ No. of Samples	* Range of Concentrations (mg/L)	** Average Concentration (mg/L)	Instrument Detection Limit (mg/L)
Acenaphthene	1/8	0.165	0.092	0.165
Acetone	8/8	0.025-0.719	0.254	0.010
Anthracene	2/8	0.180-0.339	0.132	0.180
Benzo(a)Anthracene	3/8	0.258-1.25	0.344	0.258
Benzo(a)Pyrene	4/8	0.239-1.07	0.316	0.239
Benzo(b)Fluoranthene	4/8	0.203-1.33	0.382	0.203
Benzo(g,h,i)Perylene	3/8	0.165-0.715	0.202	0.165
Benzo(k)Fluoranthene	2/8	0.446-0.786	0.278	0.330
2-Butanone	5/8	0.004-0.029	0.009	0.004
Chrysene	4/8	0.274-1.58	0.453	0.274
Di-n-Butylphthalate	7/8	0.236-1.08	0.489	0.330
Fluoranthene	4/8	0.331-1.62	0.556	0.330
Fluorene	1/8	0.161	0.090	0.161
Indeno(1,2,3-cd) Pyrene	3/8	0.182-0.808	0.229	0.182
4-Methylphenol	1/8	0.139	0.079	0.139
Phenanthrene	3/8	0.402-1.71	0.478	0.330
Phenol	2/8	1.20-1.80	0.693	0.848
Pyrene	4/8	0.302-3.20	0.714	0.302
Toluene	2/8	0.009-0.033	0.007	.005
Total Xylenes	1/8	21	0.005	.005

Table 5 (Continued)

Inorganic Contaminants

Chemical	No. of Detections/ No. of Samples	*Range of Concentrations (mg/L)	**Average Concentration (mg/L)	Instrument Detection Limit (mg/L)
Arsenic	7/8	1.1-6	2.91	0.95
Chromium	6/8	8.3-45	19.4	5.0
Copper	6/8	11.3-43.9	21.3	5.0
Iron	8/8	1,830-68,800	22,205	50.0
Lead	7/8	6-97.8	49.6	0.49
Mercury	8/8	0.0459-0.119	0.071	0.01
Nickel	5/8	9.9-26.4	13.5	9.9
Zinc	8/8	16.4-273	106.7	10.0

* Concentrations in lab analyses labelled as estimated, "J", were assumed to equal listed concentrations.

** Values of 1/2 of the instrument detection limits were used for the values of the nondetected results in calculation of averages.

Note: Sediments were analyzed for both the Target Analyte List and the Target Compound List; only positive detections reported in summary table.

Table 6

Ranges and Averages of
Metals in Uncontaminated Soil

Army Creek Landfill
New Castle, Delaware

Chemical	Range of Concentrations (mg/kg)	Average Concentrations (mg/kg)	Comments
Arsenic	1-50	----	Usually 10 ppm or less
Chromium	1-1000	100	
Copper	2-100	30	
Iron	----	----	No information given
Lead	10-200	10	
Mercury	0.01-0.3	0.03	
Nickel	5-500	100	
Zinc	10-300	50	

---- No information given in Brown and Associates (1983).

The identified inorganic indicator chemical in fish tissue was zinc, organic analyses is forthcoming. Bis(2-chloroethyl)ether was identified as a potential indicator chemical based on its presence in Army Creek and its accepted bioconcentration factor.

Potentially exposed human and environmental receptors (plants and animals) are as follows:

1. persons trespassing on the site
2. persons residing or working downwind (to the north) of the site
3. aquatic biota in Army Creek/Pond
4. terrestrial flora and fauna living on site or seasonally using the site

Monitoring activities have shown that the Artesian Water Company production wells, used for potable water supply in the area, have not been adversely affected by site-related contamination. The continued operation of the recovery well network will prevent them from becoming contaminated in the future.

Identified potential human exposure routes included:

1. inadvertent ingestion of groundwater recovery well discharges (e.g., being splashed in the face), and surface water (e.g., falling into the pond)
2. inhalation of volatile organic compounds from groundwater recovery well discharges and surface water (e.g., while playing in or near the pond)
3. dermal absorption of contaminants from inadvertent exposure to recovered groundwater (e.g., being splashed by discharge) or surface water (e.g., falling into the pond)
4. fish consumption by recreational anglers

To calculate the risk to public health, certain exposure estimates were made based on human activity patterns.

- The ingestion rate of both surface water and recovery well discharges was set at 0.1 liter/day for a 70-kg adult and a 30-kg child. The absorption fraction was specified as 100 percent of all contaminants.

- The inhalation rate was set at 1 m^3/day for both a 70-kg adult and a 30-kg child. The absorption fraction was specified as 100 percent of all air contaminants.

- The sediment ingestion rate was set at 50 mg/day for a 70-kg adult and a 30-kg child.

- The dermal absorption exposure estimates were based on surface areas of 8,750 cm^2 and 19,400 cm^2 for 100 percent body exposure for a child and adult, respectively.

Common to all evaluated scenarios, the exposure frequencies were six exposures in 30 years for adults and one exposure per year for six years for a child. Carcinogenic risk was based on an exposure duration of 30 years. Carcinogenic risk for a child was based on an exposure duration of six years. A lifetime was considered to be 70 years.

The exposure estimate for ingestion of contaminated fish was set at 5.2 g/day which is the average consumption rate of freshwater fish by recreational anglers in Delaware. This exposure assessment assumes that 100 percent of the freshwater fish consumed by the receptor are taken from Army Creek/Pond. It is unlikely that a higher consumption rate will be realized based on the size of the creek and research conducted by the Delaware Division of Fish and Wildlife indicating "extremely low catches" in Army Creek.

Toxicity Assessment Summary

Cancer potency factors (CPFs) have been developed by EPA's Carcinogenic Assessment Group for estimating excess lifetime cancer risks associated with exposure to potentially carcinogenic chemicals (Table 7). CPFs, which are expressed in units of $(mg/kg\text{-}day)^{-1}$, are multiplied by the estimated intake of a potential carcinogen, in mg/kg-day, to provide an upper-bound estimate of the excess lifetime cancer risk associated with exposure at the intake level. The term "upper bound" reflects the conservative estimate of the risks calculated from the CPF. Use of this approach makes underestimation of the actual cancer risk highly unlikely. Cancer potency factors are derived from the results of human epidemiological studies or chronic animal bioassays to which animal-to-human extrapolation and uncertainty factors have been applied.

Reference doses (RfDs) have been developed by EPA for indicating the potential for adverse health effects from exposure to chemicals exhibiting noncarcinogenic effects (Table 7). RfDs, which are expressed in units of mg/kg-day, are estimates of lifetime daily exposure levels for humans, including sensitive individuals. Estimated intakes of chemicals from environmental media (e.g., the amount of a chemical ingested from contaminated water) can be compared to the RfD. RfDs are derived from human epidemiological studies or animal studies to which uncertainty factors have been applied (e.g., to account for the use of animal data to predict effects on humans). These uncertainty factors help ensure that the RfDs will not underestimate the potential for adverse noncarcinogenic effects to occur.

Risk Characterization Summary

Excess lifetime cancer risks are determined by multiplying the intake level with the cancer potency factor. These risks are probabilities that are generally expressed in scientific notation (e.g., $1x10^{-6}$ or 1E-6). An excess lifetime cancer risk of $1x10^{-6}$ indicates that, as a plausible upper bound, an individual has a one in one million chance of developing cancer as a result of site-related exposure to a carcinogen over a 70-year lifetime under the specific exposure conditions at a site. The summary of total potential carcinogenic risks (Table 8) shows that none of the exposure scenarios at this site, with respect to surface water and sediments, present an unacceptable risk to human health.

Table 7

Dose-Response Parameters for Indicator Chemicals

Army Creek Landfill
New Castle, Delaware

Chemical	Chronic Reference Dose mg/kg/day		Carcinogenic Potency Factor 1/(mg/kg/day)		** EPA Weight of Evidence Carcinogenic Classification
	Oral	*Inhl	Oral	*Inhl	
Inorganics					
Arsenic	0.001			50	A (I,O)
Cadmium	0.0005 (water) 0.001 (food)			6.1	B1 (I)
Chromium (Trivalent or total)	1.0 (III)				A (I)
Iron					
Lead	1.4E-3	4.3E-4			B2 (I,O)
Mercury	3E-4				B2 (I,O)
Nickel	0.02			0.84 (Dust)	A (I)
Zinc	0.2				

Table 7 Continued

Chemical	Chronic Reference Dose mg/kg/day		Carcinogenic Potency Factor 1/(mg/kg/day)		** EPA Weight of Evidence Carcinogenic Classification
	Oral	*Inhl	Oral	*Inhl	
Organics					
Benzene			0.029	0.029	A (I,O)
Benzo(a)pyrene					B2 (I,O)
Bis(2-chloroethyl)ether			1.1	1.1	B2 (I,O)
1,2-Dichloroethane			0.091	0.091	B2 (I,O)

* Inhalation

* A - Known human carcinogen

B1 - Probable human carcinogen. Limited evidence of carcino-genicity in humans.

B2 - Probable human carcinogen. Sufficient evidence of carinogenicity in animals with inadequate evidence in humans.

I - Inhalation.

O - Oral

Table 8

Summay of Total Potential Carcinogenic Risks

Media	Scenario	Age Group Exposed	
		Children 6-11 yrs	Adults 70-yr life span
Groundwater Recovery Well Discharges	Inadvertent ingestion	1.2x10E-8	5.3x10E-9
	Inhalation of organics leaving groundwater	7.2x10E-7	3.1x10E-7
	Dermal absorption	9.7x10E-7	9.2x10E-7
Sediment *	Inadvertent ingestion	4.1x10E-9	1.7x10E-9
Surface Water *	Inadvertent ingestion	6.5x10E-9	2.9x10E-9
	Inhalation of organics leaving surface water	1.8x10E-7	7.6x10E-9
	Dermal absorption	6.0x10E-8	5.7x10E-7
Fish **	Ingestion	NC	7.7x10E-7

* Sediment and surface water risks were calculated using the highest pollutant concentrations detected during sampling.

** Estimated using calculated average pollutant concentration during sampling, accepted bioconcentration factor and 5.2 g/day consumption rate.

NC These values could not be calculated due to a lack of sufficient information regarding fresh fish consumption for children 6-11 years old.

The potential for health effects resulting from exposure to noncarcinogenic compounds is estimated by comparing an estimated daily dose to an acceptable level. If the ratio exceeds 1.0, there is a potential health risk associated with exposure to that particular chemical. The ratios can be added for exposures to multiple contaminants. The sum, known as a Hazard Index, is not a mathematical prediction of the severity of toxic effects, but rather a numerical indicator of the transition from acceptable to unacceptable levels. Table 9 presents a summary of the total potential Hazard Indices for the exposure scenarios previously discussed. Since none of the total Hazard Indices exceeds 1.0, there is no cause of concern for noncarcinogenic hazard to human health at the Army Creek site.

Environmental Risks

EPA conducted a survey of the aquatic life present in Army Pond which identified a very low number of species in the pond. In addition, 95 percent of those species found in the pond were pollution tolerant organisms, indicating poor water quality. Numeric surface water quality criteria have been developed by EPA and DNREC [promulgated Delaware Surface Water Quality Standards (DSWQS)] and are of primary utility in assessing acute and chronic toxicity effects in aquatic organisms. Contaminant-specific maximum levels have been established in addition to the narrative criteria for the protection of freshwater aquatic life. The following contaminants were found to exceed the numeric criteria for freshwater aquatic life set by DNREC in the surface water: cadmium, chromium, iron, mercury, and zinc (Table 4). There are three potential sources of surface water contamination:

1. recovered groundwater discharged to the surface water
2. leachate seeps from the Army Creek Landfill
3. offsite/onsite surface runoff

The average value for contaminants identified in the recovered groundwater discharges was computed. The only contaminant found to exceed the numeric DSWQS for protection of freshwater aquatic life in the discharge is iron (Table 4). This indicates that the source of cadmium, chromium, mercury and zinc is either the leachate seeps or surface runoff from the drainage area.

The installation of the hydraulic barrier (cap) in accordance with the first Record of Decision will reduce the leaching of contaminants from the landfill and modify the flow of runoff in the area of the landfill surface (first operable unit). If the recovered groundwater is treated to reduce the concentration of iron (remedial objective of second operable unit) prior to being discharged to Army Creek/Pond, the numeric DSWQS known to be protective of the aquatic environment should be achieved.

Actual or threatened releases of hazardous substances from this site, if not addressed by implementing the response action selected in this ROD, may present an imminent and substantial endangerment to the environment.

Table 9

Summary of Total Potential Non-Carcinogenic Hazard Indices

Media	Scenario	Age Group Exposed	
		Children 6-11 yrs	Adults 70-yr life span
Groundwater Recovery Well Discharges	Inadvertent ingestion	.000015	.0000013
Sediment *	Inadvertent ingestion	.00036	.000031
Surface Water *	Inadvertent ingestion	.0008	.00069
Fish	Ingestion	NC	.0048

* Sediment and surface water risks were calculated using the highest pollutant concentrations detected during sampling.

NC These values could not be calculated due to a lack of sufficient information regarding average fresh fish consumption for children 6-11 years old.

If the Hazard Index exceeds 1.0, there is a potential health hazard associated with exposure to the medium.

VII. DESCRIPTION OF ALTERNATIVES

The Remedial Investigation found that neither the surface water nor the recovery well discharges present an unacceptable risk to human health or welfare; however, the most recent sampling results indicate that the discharges may be contributing to an excursion of the DSWQS numeric criterion for bis(2-chloroethyl)ether established for protection of human health via the fish consumption exposure route. The available data is insufficient to determine if the reported levels are representative of the character of the recovered groundwater or an anomaly; hence, chemical-specific treatment will not yet be proposed. The remedial objective of operable unit two is to ensure that the recovery well discharges do not exceed the applicable requirements set forth in the DSWQS that are protective of the designated uses of Army Creek/Pond. Based on historical and recent analyses, the level of iron in the discharges definitively contribute to an "in stream" concentration that exceeds the numeric criterion known to be protective of the aquatic environment. A reduction of iron prior to surface water discharge is therefore required.

Four remedial alternatives (including No Action) were developed as possible response actions for providing a level of water quality in the recovery well discharges that is protective of the aquatic environment. Each alternative includes a chemical and biological monitoring plan. In the event that further monitoring finds the discharges to be exceeding the numeric or narrative criteria listed in the DSWQS, a compliance program will be developed and implemented (excepting No Action).

The [recovered] groundwater monitoring plan described in the Proposed Plan was incorrectly identified as being undertaken in compliance with RCRA Subpart F, 40 C.F.R. 264.100. Reference to the statute has been deleted from this document.

Alternative #1: No Action - Monitoring Only

Capital Cost:	0
Annual Operation and Manintenance (O&M) Costs:	0
Present Worth:	0
Months to implement:	0

The first operable unit Record of Decision requires that groundwater be extracted from the aquifer adjacent to the site. Groundwater is currently recovered from the local aquifer by a series of wells which comprise a recovery well network. Under the No Action scenario this recovered groundwater would continue to be discharged into Army Creek/Pond untreated. The calculated average concentration of iron being discharged from the recovery well network is in the range of 6,000 to 12,000 ug/L. This is well above the Delaware Surface Water Quality Standard of 1,000 ug/L considered to be protective of the aquatic environment.

This alternative also includes long-term monitoring of the surface water, sediments and recovered groundwater quality to gauge the effectiveness of the remedy, and a wetland monitoring and evaluation plan consistent with the Record of Decision issued for the

adjacent Delaware Sand & Gravel Site. Chemical and biological monitoring of treated groundwater effluent will be conducted consistent with NPDES requirements (to ensure that criteria and standards pursuant to Section 304(a) of the Clean Water Act are being attained). At least two surface water and sediment sampling events in Army Creek/Pond will be required to assess habitat quality: at five years after completion of the landfill cap (consistent with OU1 ROD) and at one year after pumping and treatment has ceased. The surface water and sediment sampling will include chemistry analyses and toxicity testing (using chronic surface water and sediment bioassays).

Army Creek Landfill has affected the habitat (surface water and sediment) quality and the hydrology of Army Creek/Pond and its associated wetlands. The Army Creek watershed, previous to the existence of Army Creek Landfill, supported valuable wetland habitat. The wetland areas will be monitored to ensure that comparable habitat values will be maintained.

Alternative #2: Conventional Water Treatment

Capital Cost:	$1,874,250*
Annual O&M Cost:	260,860*
Present Worth:	3,900,000*
Months to implement:	14*

This alternative involves the construction and operation of a conventional precipitation water treatment plant. The water extracted by the recovery well network would be passed through a combination of unit processes including aeration (cascade aeration), precipitation (pH adjustment and polymer addition), and filtration (sand filtration) before being discharged to Army Creek/Pond. Support processes include sludge thickening and dewatering. Sludge generated by the treatment process will be sampled and disposed of appropriately.

This plant is anticipated to reduce the iron concentration in the recovered groundwater from the current range of 6,000 to 12,000 ug/L to less than 5,000 ug/L, but not to the 1,000 ug/L target level. The treatment plant will reduce the volume of iron in the recovered groundwater discharge by reducing the concentration. The mobility and potential toxicity to aquatic life associated with iron in the recovered groundwater would be reduced slightly.

This alternative also includes long-term monitoring of the surface water, sediments and recovered groundwater quality to gauge the effectiveness of the remedy, and a wetland monitoring and evaluation plan consistent with the Record of Decision issued for the adjacent Delaware Sand & Gravel Site. Chemical and biological monitoring of treated groundwater effluent will be conducted consistent with NPDES requirements (to ensure that criteria and standards pursuant to Section 304(a) of the Clean Water Act are being attained). At least two surface water and sediment sampling events in Army Creek/Pond will be required to assess habitat quality: at five years after completion of the landfill cap (consistent with OU1

* All cost and implementation times are estimated.

ROD) and at one year after pumping and treatment has ceased. The surface water and sediment sampling will include chemistry analyses and toxicity testing (using chronic surface water and sediment bioassays).

Army Creek Landfill has affected the habitat (surface water and sediment) quality and the hydrology of Army Creek/Pond and its associated wetlands. The Army Creek watershed, previous to the existence of Army Creek Landfill, supported valuable wetland habitat. The wetland areas will be monitored to ensure that comparable habitat values will be maintained.

The Army Pond habitat will be managed during groundwater treatment and for a period of five(5) years after cessation of groundwater treatment to ensure the dominance of species beneficial to fish and wildlife, and to control less desirable reed grasses (Phragmites spp.). Monitoring of plant species composition and implementation of a management plan will be reviewed by the appropriate state and federal natural resource managers.

Alternative #3: Modified Conventional Water Treatment

Capital Cost:	$2,710,000*
Annual O&M Cost:	294,000*
Present Worth:	4,900,000*
Months to implement:	14*

In order to ensure achieving the 1,000 ug/L iron surface water standard in the recovered groundwater prior to discharging to Army Pond, modifications to the Conventional Water Treatment (Alternative 2) can be incorporated. This "modified" conventional treatment plant is Alternative 3. Preliminary engineering evaluations indicate that these modifications should satisfy the objectives; however, other modifications to the conventional precipitation water treatment plant might be equally effective and therefore acceptable.

This alternative involves the construction and operation of a "modified" conventional precipitation water treatment plant. The water extracted by the recovery well network would be passed through a combination of unit processes including an influent flow equalization chamber, aeration (cascade aeration with a blower), precipitation (pH adjustment and polymer addition), sedimentation (settling and thickening chamber), and granular media filtration before being discharged to Army Creek/Pond. Support processes include sludge thickening and dewatering. Sludge generated by the treatment process will be sampled and disposed of appropriately.

By meeting the contaminant-specific ARAR (iron DSWQS numeric criterion of 1,000 ug/L), the effluent from the treatment plant should be protective of the aquatic environment. The treatment plant would reduce the volume of iron being discharged into Army Creek/Pond and the mobility would also be reduced. The potential toxicity to aquatic life associated with iron in the recovered groundwater would be eliminated. The facility should be designed in such a manner that

* All cost and implementation times are estimated.

This alternative also includes long-term monitoring of the surface water, sediments and recovered groundwater quality to gauge subsequent modifications may be incorporated in the event that the characteristics of the influent (recovered groundwater) change. the effectiveness of the remedy, and a wetland monitoring and evaluation plan consistent with the Record of Decision issued for the adjacent Delaware Sand & Gravel Site. Chemical and biological monitoring of treated groundwater effluent will be conducted consistent with NPDES requirements (to ensure that criteria and standards pursuant to Section 304(a) of the Clean Water Act are being attained). At least two surface water and sediment sampling events in Army Creek/Pond will be required to assess habitat quality: at five years after completion of the landfill cap (consistent with OU1 ROD) and at one year after pumping and treatment has ceased. The surface water and sediment sampling will include chemistry analyses and toxicity testing (using chronic surface water and sediment bioassays).

Army Creek Landfill has affected the habitat (surface water and sediment) quality and the hydrology of Army Creek/Pond and its associated wetlands. The Army Creek watershed, previous to the existence of Army Creek Landfill, supported valuable wetland habitat. The wetland areas will be monitored to ensure that comparable habitat values will be maintained.

The Army Pond habitat will be managed during groundwater treatment and for a period of five (5) years after cessation of groundwater treatment to ensure the dominance of species beneficial to fish and wildlife, and to control less desirable reed grasses (Phragmites spp.). Monitoring of plant species composition and implementation of a management plan will be reviewed by the appropriate state and federal natural resource managers.

Alternative #4: Enhanced Conventional Treatment Plant

Capital Cost:	$3,344,000*
Annual O&M Cost:	351,000*
Present Worth:	6,000,000*
Months to implement:	14*

The "Enhanced" conventional water treatment plant employs even further modification to the Conventional Water Treatment plant (Alternative 2). Preliminary engineering evaluations indicate that the Enhanced Conventional Water Treatment plant would achieve iron concentrations far below the remedial action objective of 1,000 ug/L known to be protective of the aquatic environment.

This alternative involves the construction and operation of an "enhanced" conventional precipitation water treatment plant. The water extracted by the recovery well network would be passed through a combination of unit processes including an influent flow equalization chamber, aeration (high velocity-nozzle aerator), precipitation (pH adjustment and polymer addition), sedimentation (settling and thickening chamber), granular media filtration and a

* All cost and implementation times are estimated.

catalytic/ion exchange polisher (using "green sand" zeolite) before being discharged to Army Creek. Support processes include sludge thickening and dewatering. Sludge generated by the treatment process would be sampled and disposed of appropriately.

By meeting the contaminant-specific ARAR (iron DSWQS numeric criterion of 1,000 ug/L), the discharge from the treatment plant should be protective of the aquatic environment. The treatment plant would reduce the volume of iron being discharged into Army Pond and the mobility would also be reduced. The potential toxicity to aquatic life associated with iron in the recovered groundwater would be eliminated.

This alternative also includes long-term monitoring of the surface water, sediments and recovered groundwater quality to gauge the effectiveness of the remedy, and a wetland monitoring and evaluation plan consistent with the Record of Decision issued for the adjacent Delaware Sand & Gravel Site. Chemical and biological monitoring of treated groundwater effluent will be conducted consistent with NPDES requirements (to ensure that criteria and standards pursuant to Section 304(a) of the Clean Water Act are being attained). At least two surface water and sediment sampling events in Army Creek/Pond will be required to assess habitat quality: at five years after completion of the landfill cap (consistent with OU1 ROD) and at one year after pumping and treatment has ceased. The surface water and sediment sampling will include chemistry analyses and toxicity testing (using chronic surface water and sediment bioassays).

Army Creek Landfill has affected the habitat (surface water and sediment) quality and the hydrology of Army Creek/Pond and its associated wetlands. The Army Creek watershed, previous to the existence of Army Creek Landfill, supported valuable wetland habitat. The wetland areas will be monitored to ensure that comparable habitat values will be maintained.

The Army Pond habitat will be managed during groundwater treatment and for a period of five (5) years after cessation of groundwater treatment to ensure the dominance of species beneficial to fish and wildlife, and to control less desirable reed grasses (Phragmites spp.). Monitoring of plant species composition and implementation of a management plan will be reviewed by the appropriate state and federal natural resource managers.

VIII. SUMMARY OF THE COMPARATIVE ANALYSIS OF ALTERNATIVES

The following nine criteria were used in the evaluation of the remedial action alternatives for Operable Unit II at the Army Creek Site:

Threshold Criteria

1) Overall protection of human health and the environment; and

2) Compliance with applicable or relevant and appropriate requirements.

Primary Balancing Criteria	3)	Long-term effectiveness and permanence;
	4)	Reduction of toxicity, mobility, or volume through treatment;
	5)	Short-term effectiveness;
	6)	Implementability; and
	7)	Cost.
Modifying Criteria	8)	State/support agency acceptance; and
	9)	Community acceptance.

A brief description of each of these criteria is provided in Table 10.

Overall Protection of Human Health and the Environment

Alternatives #3 and #4 will achieve the remedial objectives for this second operable unit. Each of these alternatives provide for the extracted groundwater to be passed through a water treatment facility which will reduce the iron concentration to 1,000 ug/L (or less in the case of Alternative #4), which is known to be protective of the aquatic environment.

The Conventional Water Treatment (Alternative #2) facility would reduce the iron concentration in the recovered groundwater from the current range of 6,000 to 12,000 ug/L to less than 5,000 ug/L, but not to 1,000 ug/L, which is the level known to be protective of the aquatic environment.

Compliance with ARARs

Alternatives #3 and #4 will meet the contaminant-specific ARAR for surface water discharge to Army Creek/Pond by achieving a maximum iron concentration equal to or less than the criterion that has been established by DNREC pursuant to Section 303 of the Clean Water Act. Surface water quality criteria are "in stream" maximum concentrations that are used by the NPDES program to determine maximum allowable concentrations in surface water discharges. In accordance with the Delaware surface water quality standards, when calculating the maximum allowable discharge concentration for the protection of aquatic life (chronic toxicity), the effect of dilution is based on the lowest flow over a seven-day period with a recurrence interval of ten years. Since the upstream portion of Army Creek is considered to be an intermittent stream, little dilution effect can be calculated; therefore, the concentration of iron in the effluent must come close to meeting the maximum allowable "in stream" standards. In the event that activities undertaken in accordance with the monitoring plan confirm that the level of bis(2-chloroethyl)ether is contributing to the excursion of the applicable criterion or find that the characteristics of the recovered groundwater change so that the applicable surface water standards are not being met, a compliance

TABLE 10

NINE EVALUATION CRITERIA

1. Overall Protection of Human Health and the Environment addresses whether or not a remedy provides adequate protection and describes how risks posed through each pathway are eliminated, reduced or controlled through treatment or engineering.

2. Compliance with ARARs: Whether or not a remedy will meet all Applicable or Relevant and Appropriate Requirements (ARARs) of Federal and State Environmental Statutes and/or provides grounds for invoking a waiver. Whether or not the remedy complies with advisories, criteria and guidance that EPA and DNREC have agreed to follow.

3. Long-Term Effectiveness and Permanence refers to the ability of a remedy to maintain reliable protection of human health and the environment over time once cleanup goals have been met.

4. Reduction of Toxicity, Mobility or Volume is the anticipated performance of the treatment technologies a remedy may employ.

5. Short-term Effectiveness addresses the period of time needed to achieve the protection, and any adverse impacts on human health and the environment that may be posed during the construction and implementation period until cleanup goals are achieved.

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

7. Cost includes estimated capital, operation and maintenance, and net present worth costs.

8. State Acceptance indicates whether, based on its review of the RI/FS and Proposed Plan, the State concurs with, opposes, or has no comment on the identified preferred alternative.

9. Community Acceptance indicates whether, based on its review of the RI/FS and Proposed Plan, the Community concurs with, opposes, or has no comment on the previously identified preferred alternative. Community comments and the Agency's responses have been included in the Responsiveness Summary.

plan will be developed and implemented. Action-specific ARARs, such as OSHA health and safety requirements, must be met at the treatment facility and will be further evaluated during remedial design activities.

Alternative #2 will reduce the iron concentration in the recovered groundwater to less than 5,000 ug/L but will not attain the ambient water quality criterion of 1,000 ug/L which is known to be protective of the aquatic environment.

Alternatives #2, #3 and #4 will meet the location-specific ARARs for protection and management of floodplains and wetlands pursuant to Federal Executive Orders 11988 and 11990 and State Executive Order 56. Long-term monitoring and wetland evaluation and management will meet the requirement to minimize the loss or degradation of wetlands, to restore and rehabilitate the wetland habitat; and to preserve the natural and beneficial values within the floodplain.

Long-Term Effectiveness

The long-term effectiveness of both alternatives #3 and #4 is anticipated to be good. The effectiveness will be maintained as long as the treatment plant constructed is operated and the landfill cap continues to function as a hydraulic barrier. The treatment of the recovered groundwater will be required until the recovery well network can be shut down or the extracted groundwater meets a level of water quality that is protective of the designated uses of Army Creek/Pond prior to treatment.

Alternative #2 will only attain marginal effectiveness by reducing iron concentrations to less than 5,000 ug/L. The marginal effectiveness attained will be maintained as long as the treatment plant constructed is operated and the landfill cap continues to function as a hydraulic barrier.

Reduction of Toxicity, Mobility and Volume

Alternatives #2, #3 and #4 use treatment to reduce the toxicity, mobility and volume of iron in the recovered groundwater. Both Alternatives #3 and #4 are equivalent in their reduction of the potential toxicity to aquatic life associated with iron in the recovered groundwater. Alternative #2 will reduce toxicity by reducing the concentration of iron, however, not by enough to eliminate the potentially toxic effect. Alternatives #4, #3, and #2, listed in order of effectiveness, each reduce the volume and mobility of iron released to the environment by reducing the concentration in the recovered groundwater prior to discharging to Army Creek/Pond.

Short-Term Effectiveness

Alternatives #3 and #4 would be expected to yield good short-term effectiveness with respect to the potential for chronic toxicity due to high levels of iron in the aquatic environment. Both the "Modified" and "Enhanced" water treatment facilities would achieve compliance with the surface water quality criterion (1,000 ug/L) prior to discharge to Army Creek/Pond within approximately two weeks

of plant start-up. However, the overall impact of this reduction is expected to be only moderate during the short-term because the overall strategy also relies on the positive effect to be realized from the installation of the hydraulic barrier (cap) over the 44-acre landfill.

Alternative #2 would be anticipated to yield moderate-to-low effectiveness with respect to the potential chronic toxicity to the aquatic environment presented by iron. Even after the facility achieved its performance standard, the effluent would not achieve levels known to be protective of the environment.

Implementability

Alternatives #2, #3 and #4 are equally implementable. The installation and operation of the water treatment facilities could be accomplished easily. The basic components conceptually included in all these alternatives are readily available and regularly installed by construction contractors. The operability of each of these alternatives is well understood and routinely carried out. The long-term monitoring plan included in each of the alternatives is also easily implemented.

Cost

CERCLA requires selection of a cost-effective remedy (not merely the lowest cost) that protects human health and the environment and meets other requirements of the statute. Project cost includes all construction and operation and maintenance costs incurred over the life of the project. An analysis of the present worth value of these costs has been completed for each alternative described in this Record of Decision, and is summarized in Table 11. Capital costs include those expenditures necessary to implement a remedial action. Annual operating costs are included in the present worth cost. The relative cost, in order of most to least is Alternative #4, #3, #2, and then #1.

Community Acceptance

The Proposed Plan was released to solicit public comment regarding the proposed remedial alternatives on March 18, 1990. At that time a 31 day comment period was opened. A public meeting on the Proposed Plan was held March 26, 1990, in New Castle, Delaware. Pursuant to the request of a citizen the public comment period was extended to May 2, 1990. Comments at the public meeting and during the comment period are referenced in the Responsiveness Summary included in this Record of Decision.

State Acceptance

The State of Delaware has not concurred with this selected Remedial Action.

IX. THE SELECTED REMEDY

Alternative #3: Modified Conventional Treatment - 1,000 ug/L iron performance standard.

Capital Cost: $2,710,000
Annual Operation & Maintenance Costs: $294,000
Present Worth: $4,900,000

Based upon consideration of the requirements of CERCLA, the detailed evaluation of the alternatives, and public comments, both EPA and the State of Delaware have determined that Alternative #3 is the most appropriate remedy for Operable Unit II of the Army Creek Site.

The objective of this alternative is to reduce the concentration of iron in the recovered groundwater to 1,000 ug/L prior to discharging to Army Creek/Pond. The overall goal of the remedial activities being taken with respect to the surface water at Army Creek is to attain the Delaware Surface Water Quality Standards established pursuant to Section 303 of the Clean Water Act. In the event that activities undertaken in accordance with the monitoring plan confirm that the level of bis(2-chloroethyl)ether is contributing to the excursion of the applicable criterion or find that the characteristics of the recovered groundwater change so that the applicable surface water standards are not being met, a compliance plan will be developed and implemented. The combined strategy of providing treatment to the recovered groundwater prior to discharge and installing a landfill cap over Army Creek Landfill to reduce leachate seepage into Army Creek (in accordance with ROD I) is expected to achieve an "in stream" water quality that supports the designated uses and is protective of the aquatic environment.

This alternative also includes long-term monitoring of the treatment plant influent, effluent and Army Creek/Pond surface water and sediment quality to gauge effectiveness of the selected remedy, and a wetland monitoring and evaluation plan. The Army Pond habitat will be managed during groundwater treatment and for a period of five (5) years after cessation of groundwater treatment to ensure the dominance of species beneficial to fish and wildlife, and to control less desirable reed grasses (Phragmites spp.).

A more detailed description of the selected remedy is provided in Section VII. The facility should be designed in such a manner that subsequent modifications may be incorporated in the event that the characteristics of the influent (recovered groundwater) change. It should be recognized that minor changes to the selected alternative may be made during design as long as the performance standard is achieved. These changes in general will reflect the usual modification resulting from the engineering process.

X. STATUTORY DETERMINATIONS

EPA's primary responsibility at Superfund sites is to undertake remedial actions that are protective of human health and the environment. In addition, Section 121 of CERCLA, as amended,

establishes several other statutory requirements and preferences. These specify that when complete, the selected remedial action for this site must comply with applicable or relevant and appropriate environmental standards established under Federal and State environmental laws unless a statutory waiver is granted. The selected remedy also must be cost-effective and utilize treatment technologies or resource recovery technologies to the maximum extent practicable. Finally, the statute includes a preference for remedies that permanently and significantly reduce the volume, toxicity or mobility of hazardous wastes. The following sections discuss how the selected remedy for this site meets these statutory requirements.

Protection of Human Health and the Environment

The selected remedy protects the environment by providing onsite treatment of recovered groundwater prior to discharging to Army Creek/Pond. The combined remedial strategy of capping the landfill (in accordance with ROD 1), which will reduce landfill leachate seeping directly into Army Creek/Pond, and operating a treatment facility to reduce the concentration of iron in the recovered groundwater prior to discharging will achieve a level of water quality that is protective of the environment.

The baseline human health risk assessment determined that there is no unacceptable risk to human health or welfare with respect to the surface water or sediments at the site. The exposure levels are well within the 10^{-4} to 10^{-7} range within which EPA manages potential carcinogenic risk and the Hazard Indices for non-carcinogens are much less than one. The remedy selected in the first Record of Decision will mitigate the risk presented to human health via groundwater ingestion.

Attainment of Applicable or Relevant and Appropriate Requirements

The selected remedy will attain all applicable or relevant and appropriate requirements for the site surface water and associated wetlands, the contaminants in the surface water, and the actions that will be implemented. The ARARs are presented below.

Action-Specific ARARs

Water Air Resources Act (7 Delaware Code Chapter 60, 1983)

The following State regulations are promulgated pursuant to Section 6010 of Chapter 60:

[Delaware] Surface Water Quality Standards (1990)

Sections that clearly apply:

* In accordance with CERCLA Section 121(e) no permit shall be required for actions conducted entirely onsite but substantive requirements must be met.

Regulations Governing the Land Treatment of Wastes (1988)
Section 4.1(a)(iii): Surface waters must be free from any pollutants which may interfere with attainment and maintenance of designated uses.

Section 9.2: General provisions prohibiting acute or chronic toxicity to aquatic life, adverse effects on human health from ingestion of contaminated aquatic organisms.

Section 9.3: Iron requirement of 1,000 ug/L for protection of aquatic life against chronic toxicity.

[State] Regulations Governing Control of Water Pollution (1983)

Section 3.01: Discharge of any pollutant from point source to surface water requires permit.*

Treatment plant sludge is subject to requirements of Part III(B) Section 301 pertaining to transportation, and treatment disposal.

Regulations Governing Solid Waste (1988)

(Section 6 pertains to industrial landfills)

Section 6.D.3.f: Residuals from on-site leachate treatment system must be sampled and analyzed for hazardous waste characteristics per Delaware Hazardous Waste regulations.

Section 6.K.1.a: post-closure care for 30 years.

Section 6.K.1.e: action necessary to mitigate threat to human health or the environment if evidence of contaminant release.

Erosion & Sedimentation Control (7 Delaware Code Chapter 40)

Erosion & Sedimentation Control Regulations (1989)

General state criteria: E&S plan must be developed and followed during construction of the water treatment plant to prevent increased sedimentation or accelerated erosion into Army Creek.

Clean Water Act (33 U.S.C. § 1251 et seq.)

Pursuant to Section 402 of the Clean Water Act, 33 U.S.C. § 1342, any discharge of pollutants from a point source to waters of the United State requires a National Pollutant Discharge Elimination System (NPDES) permit. The NPDES permit must contain conditions that are protective of human health and the aquatic life.

* In accordance with CERCLA Section 121(e) no permit shall be required for actions conducted entirely onsite but substantive requirements must be met.

Contaminant-Specific ARARs

Hazardous Waste Management Act (7 Delaware Code Chapter 63)

Regulations Governing Hazardous Waste (1988)

Section 262.11: Hazardous waste determination must be made on sludge generated by treatment of discharges.

Clean Water Act (33 U.S.C.§ 1251 et seq.)

Pursuant to Section 303 of the Clean Water Act, 33 U.S.C. § 1313, the State of Delaware has coupled federal Ambient Water Quality Criteria [established under Section 304(a)] with designated uses (described in Section 101) to determine Delaware Surface Water Quality Standards (DSWQS). The recovered groundwater must receive treatment to reduce the concentration of chemical constituents to a level that will not exceed DSWQS that support or are protective of Army Creek's designated uses.

Other criteria, advisories or guidance to be considered for this remedial action (TBC's)

State Executive Order 56 on Freshwater Wetlands (1988)

(Including Governor's Roundtable Report on Freshwater Wetlands, 1989)

General policy to minimize the adverse effects to freshwater wetlands resulting from the construction and operation of the treatment plant, including the resultant discharges.

Federal Executive Order 11988, Floodplain Management, 40 C.F.R. Part 6, Appendix A

Action must avoid adverse effects, minimize potential harm, restore and preserve natural beneficial value.

Federal Executive Order 11990, Protection of Wetlands, 40 C.F.R. Part 6, Appendix A

Action must minimize destruction, loss, or degradation of wetlands and preserve and enhance the natural and beneficial values of wetlands. The wetlands management plan will act to preserve the natural and beneficial valves of the wetlands to the wildlife be ensuring that the perimeter of the Army Creek/Pond is recolonized by indigenous species after the recovery wells are phased-out or shut down.

Cost-Effectiveness

EPA and the State believe the selected remedy is cost-effective in mitigating the risk posed by the surface water adjacent to the landfill. The selected alternative includes the least costly remedy which will effectively achieve our remedial objective for this second operable unit.

Utilization of Permanent Solutions Employing Alternative Technologies to the Maximum Extent Practicable

The selected remedy is the most appropriate solution for this operable unit and represents the maximum extent to which permanent solutions and treatment can be practicably utilized. Both alternatives #3 and #4 meet the threshold criteria of being protective and achieving ARARs and are equal in effectiveness with respect to long-term effectiveness and permanence; reduction in toxicity, mobility and volume through treatment; short-term effectiveness and implementability. Since alternative #3 and alternative #4 are equally effective and alternative #3 is less costly than alternative #4, alternative #3 was selected on the basis of being more cost-effective. The proposed selection of alternative #3 was well received by the State and community.

Preference for Treatment

This preference is satisfied since treatment is the principal element of the chosen alternative.

RESPONSIVENESS SUMMARY
FOR THE
PROPOSED REMEDIAL ACTION, OPERABLE UNIT 2
AT THE
ARMY CREEK LANDFILL SITE
NEW CASTLE COUNTY, DELAWARE

June 1990

RESPONSIVENESS SUMMARY
FOR THE
PROPOSED REMEDIAL ACTION, OPERABLE UNIT 2
AT THE
ARMY CREEK LANDFILL SUPERFUND SITE
NEW CASTLE COUNTY, DELAWARE

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RESPONSIVENESS SUMMARY
FOR THE PROPOSED REMEDIAL ACTION, OPERABLE UNIT 2
AT THE ARMY CREEK LANDFILL SUPERFUND SITE
NEW CASTLE COUNTY, DELAWARE

I. INTRODUCTION

In accordance with the U.S. Environmental Protection Agency's (EPA) community relations policy and guidance, the EPA Region III office held a public comment period from March 19, 1990, through May 2, 1990, to obtain comments on the Proposed Remedial Action Plan (PRAP) for Operable Unit 2 at the Army Creek Landfill Superfund site in New Castle County, Delaware. Operable Unit 2 encompasses the contaminated groundwater recovered through the existing groundwater recovery wells and discharged untreated into Army Creek. On March 26, 1990, EPA and the Delaware Department of Natural Resources and Environmental Control (DNREC) held a public meeting to obtain public comments on the proposed remedy. Approximately 80 community residents and interested persons attended the meeting. Copies of the PRAP were distributed at the meeting and were placed in the information repositories for the site.

In response to requests from the public, EPA and DNREC held a follow-up public meeting on Saturday, April 21, 1990, and extended the public comment period for two weeks. Approximately 22 individuals attended this meeting.

All public comments received during those meeting and in writing are documented and summarized in this Responsiveness Summary. Section II presents a summary of questions and comments expressed by the public at the March 26 and April 21 public meetings. Section III then contains a summary of written comments received during the comment period. All questions and comments are grouped into general categories, according to subject matter. Each question or comment is followed by EPA's response.

II. PUBLIC MEETING COMMENTS

This section contains questions and comments presented at the March 26, 1990, public meeting. It also summarizes comments and questions posed at a followup meeting with local residents held on April 21, 1990, in the Delaware Department of Natural Resources and Environmental Control offices at 715 Grantham Lane in New Castle, Delaware. Comments contained in this section are grouped according to subject discussed.

A. Comments on the Operable Unit 1 ROD, Signed September 1986

1. A commenter asked whether EPA had considered excavation as an alternative for the site, and if not, why not.

EPA Response: Excavation of the landfill was evaluated and screened out in the first Operable Unit Feasibility Study for the site, completed in 1986. Capping was selected as the most appropriate source control remedy in the first Record of Decision for the site, and based on that decision, the multi-layered cap has been designed and is ready to be constructed.

2. Another attendee stated that excavation would not seem to be a viable alternative because of the possibility that it would release contamination.

EPA Response: There are many good reasons why excavation was not selected as the best remedial alternative for the first Operable Unit. The details are contained in the July 1986 Feasibility Study.

B. The Proposed Remedy for Operable Unit 2

1. Several commenters asked whether the proposed treatment system was experimental and how EPA could ensure that it will not cause future environmental problems.

EPA Response: There are many treatment facilities currently operating at other locations that effectively employ the same basic technologies contained in this conceptual system. This remedial alternative contains no new, unproven technologies.

2. A meeting attendee asked why EPA is pumping the groundwater when the problem seems to be with surface water contamination.

EPA Response: The primary health risk originally identified at the Army Creek site was presented by

groundwater contamination. To prevent the contaminated groundwater from migrating to the Artesian water Company's public supply wellheads which are hydraulically downgradient from the landfill, a series of strategically located recovery wells was installed. This remedial action has proven to be effective; however, the second operable unit addressed the potentially adverse effects that are presented to the environment by discharging the recovered groundwater to Army Creek Pond.

3. **Several commenters asked how long it will take to determine whether the remedy chosen for the site is working.**

EPA Response: The improvement of surface water quality at Army Creek is dependent on two separate but related actions: treatment of the recovered groundwater prior to surface water discharge, and installation of the landfill cap to reduce leachate seepage to Army Creek Pond. Cap construction is expected to last 24 to 36 months. Construction of the treatment plant is expected to take approximately 14 months. The effectiveness of the remedial action will be monitored continuously. Five years after the landfill cap is installed, the necessity for further remedial action (see ROD I, Phase II) will be determined.

4. **A commenter asked for an explanation of the technological differences between modified treatment (Alternative 3) and enhanced treatment (Alternative 4).**

EPA Response: It should be noted that the details of the process are conceptual and may be modified during the remedial design activities as long as effectiveness is met. The primary difference between the two alternatives is the expected performance. As part of its initial process, the conceptual enhanced treatment employs a high-velocity aerator to oxygenate the water and increase the potential for organic compounds to volatilize. The final step in enhanced treatment uses "green sand," or zealite sand, which is a more effective filter than regular sand and captures iron as part of an ion exchange process. Therefore, the enhanced treatment uses a more effective aerator and a more effective filter than modified treatment.

5. **One meeting attendee asked whether there was any way that the community could request EPA to select enhanced treatment over modified treatment.**

EPA Response: EPA will take all comments made during the public comment period into consideration in reaching a final decision. Every significant question that is

brought up at the meeting or received in writing will be responded to in the Responsiveness Summary which will be included in the Record of Decision. Public comments definitely influence the Agency's decision.

6. **A commenter asked whether EPA had not in fact already chosen the remedy it preferred for the site, and whether the public comment period was meaningful. This commenter stated that he believed that the proposed remedy was currently being bid, and that there was a Consent Decree between the State and the County to implement the recommended alternative.**

EPA Response: No, EPA has not selected a final remedial action to address the recovered groundwater at the site (prior to issuance of the Record of Decision). New Castle County did enter into and is out of compliance with a Consent Decree with the State wherein the County agreed to construct, by June 1990, a treatment facility capable of achieving an iron concentration of less than 5,000 migrograms/liter (similar to the performance standards of Alternative 2). If New Castle County modified the design of the treatment facility to conform to the performance standards identified as the preferred alternative in the Proposed Plan, it was on their own initiative with no pre-decisional EPA approval.

7. **Several commenters asked questions about the proposed treatment plant, including whether its capacity will be able to accommodate additional wells, and whether it would produce any odors or entail storage lagoons.**

EPA Response: The plant will be designed to treat the high range of the current flow load, approximately 1.9 million gallons daily, with enough contingency capacity to handle additional wells, if necessary. EPA does not expect that the treatment plant will emit any unusual odors. With air dispersion, any extremely low-level organics that may be released will be dispelled. There will be no storage lagoons.

8. **Several commenters asked whether the treatment plant would produce any sludge and how that material would be disposed.**

EPA Response: The process by which iron is precipitated out of the groundwater will produce a sludge-like material. This will be treated by being filtered and compressed to eliminate the water. EPA will determine the appropriate method to dispose of this material after testing it to determine its composition, and will dispose of it in compliance with Federal and State guidelines.

Although traces of organic substances may remain in this "filter-cake," EPA expects that the major component would be metals.

9. **A commenter asked whether the treatment plant will not eventually become obsolete.**

EPA Response: There are two potential scenarios that could render the treatment plant obsolete: 1) The source control remedy is effective and it is determined that the Artesian Water Company's public supply wells would not be adversely affected if the recovery wells were shut down, or 2) The extracted groundwater meets a level of water quality that is protective of the designated uses of Army Creek/Pond prior to treatment.

10. **One commenter asked where the groundwater treatment plant would be located.**

EPA Response: The present, proposed location for the treatment plant is on land owned or controlled by New Castle County.

11. **One meeting attendee asked how long it will take to operate the treatment system before the levels of contamination in Army Creek are low enough to support aquatic life. Another asked whether the system will operate for 15 years, as it appears in the Proposed Plan.**

EPA Response: The 15-year figure used in the Proposed Plan was selected as a basis for cost comparison of all alternatives. The optimal amount of time for system operation will be determined after the cap is installed and data become available to evaluate the effectiveness of the source control remedy. This will be determined approximately 5 years after the cap is installed.

12. **One attendee stated that it appeared that EPA and DNREC were recommending an alternative to reduce risks to aquatic life rather than human health. She stated that it was hard to believe that the contaminants found posed a minute threat to human health, and asked whether EPA was protecting fish and wildlife instead of human health.**

EPA Response: The reason it may appear that EPA is emphasizing protection of the aquatic environment rather than human health as part of Operable Unit 2 is that Operable Unit 1 addressed risks to human health. The Agency has done extensive testing to determine whether the surface water at the site poses any risk to humans and found that there was no risk under existing conditions. Therefore, EPA next examined whether the

surface water at the site posed a risk to the environment. When EPA selected a strategy of capping the landfill, the strategy was specifically designed to prevent contaminated groundwater from reaching the Artesian Water Company's wells to protect human health. The first action that was taken -- installing the interceptor wells -- was to protect human health.

13. **Several commenters asked whether natural attenuation would be sufficient to cleanse the water without operating the treatment system. One asked whether EPA had considered installing the cap on the site and then conducting tests to see if levels of contaminants coming out of the landfill had been reduced sufficiently to eliminate the need for the treatment plant.**

EPA Response:

- If the water is not treated prior to discharge to the surface water it will not meet the standards established by DNREC to protect the designated uses of Army Creek.

- The selected alternative includes continuous monitoring of the recovered groundwater quality. I the extracted groundwater meets a level of water quality that is protective of the designated uses of Army Creek prior to treatment, the facility will be shut down.

14. **A meeting attendee asked whether the Artesian Water Company's wells would be threatened if the recovery wells ceased to operate.**

EPA Response: Under current conditions, EPA believes that if the water recovery wells were turned off, the Artesian Water Company's water supply wells may be threatened by continued groundwater emanating from both the Army Creek and Delaware Sand & Gravel Landfills. EPA will take a conservative approach to protect human health by implementing source control measures and then, if appropriate, phasing out the wells.

C. **Remedial Action for Operable Unit 1**

1. **One meeting commenter stated that the community was not aware what the first phase of the action planned at the site was and that they had not been told what it entailed.**

EPA Response: In accordance with EPA policy, a public meeting was held prior to the issuance of the Record of Decision for the first Operable Unit at the site. The

addresses of attendees at the first meeting were used to send out copies of the Proposed Plan for Operable Unit 2.

2. **A meeting attendee asked whether the site has been already capped.**

EPA Response: No. The design has been completed and EPA expects to begin the remedial action by the end of the calendar year 1990.

3. **Several commenters asked for an explanation of the cap design.**

EPA Response: First, a grade will be established. Next, the area will be covered with a one-foot layer of a fine, clay-like soil that meets an established specification. This material will be compacted so that water will not be able to pass through it at more than $1x10^{-5}$ centimeters/second. This will be covered by a synthetic liner at least 40 millimeters thick, whose composition is yet to be determined but which must meet strict performance standards established by EPA for such factors as puncture resistance and flexibility. This layer will be covered by a one-foot thick layer of sand, and finally by two feet of soil. Therefore, when rain hits the top of the landfill, it will pass through the top fill and the sand, stop at the liner which is a hydraulic barrier, travel along the barrier, and ultimately discharge as clean runoff into Army Pond. There also will be vents in the cap to allow the controlled release of methane gases which is commonly generated by degradation in landfills.

4. **Several commenters asked who pays for the cost of the remedial action.**

EPA Response: More than 30 potentially responsible parties (PRPs) have been notified of their potential liability. EPA may attempt to reach a negotiated settlement with one or more of these PRPs. If settlement is not achieved, EPA will sue one or more PRP(s) to recover all past and prospective costs to implement the remedy.

5. **One commenter asked how much soil would be required to construct a 60-acre cap and what its source would be.**

EPA Response: The cap may require up to 8,000 truckloads of soil. EPA has identified suitable borrow areas locally. The specific source will be determined after the project bid process.

6. **One commenter asked whether the cap will be able to stop leaching of the landfill materials into the groundwater.**

EPA Response: EPA believes installing the 60-acre cap will, in time, significantly reduce leaching of contaminants into the groundwater. The landfill cap will prevent vertical infiltration of precipitation; however, some wastes were landfilled below the seasonal high-water table. On the western end, the leaching of contaminants as a result of precipitation will be prevented, but some leaching is likely to continue due to horizontal migration of groundwater. The first Operable Unit ROD includes the continued monitoring of the groundwater. If it is determined that capping the site is not sufficient, upgradient controls will be implemented.

7. **One commenter informed EPA that he remembered a storm sewer that was buried on the site.**

EPA Response: An old, abandoned sewer does run through the eastern end of the site. A provision for "plugging" the sewer has been included in the remedial design.

D. Site History and Current Status

1. **Several commenters asked questions about the substances that were detected in the site groundwater and surface water. One attendee asked what substances were found and another asked whether they could pose a danger to humans. Several asked for a list of these substances.**

EPA Response: The first Record of Decision for the site, dated September 1986, identifies the contaminants that exceed the primary and secondary drinking water standards at the site. These substances were detected in one or more recovery wells adjacent to the site. The organic substances that were found to exceed primary or secondary drinking water standards include:

- Benzene,
- 1,2-Dichloropropane,
- Methylene chloride,
- 2,4-Dinitrotoluene,
- N-Nitrodimethylamine,
- 2,4,6-Trichlorophenol,
- Bis(2-chloroethyl)ether, and
- Tetrachlorodibromomethane.

The inorganic substances that exceed primary or secondary drinking water standards include:

- Beryllium,
- Cadmium,
- Chromium,
- Lead,
- Mercury,
- Nickle,
- Iron, and
- Manganese.

Under current conditions, these substances do not pose a threat to human health.

2. **One commenter asked whether all iron detected in sampling could be coming from the landfill and whether there are other measurable sources of iron.**

EPA Response: Iron is a naturally occurring metal throughout Delaware. The concentration of iron in the groundwater directly beneath and downgradient of Army Creek Landfill is exceptionally high. The elevated levels may be due to iron-laden wastes disposed of in the landfill or they may be the result of the leachate leaching iron from the naturally occurring soils. However, the source of the iron is immaterial. The presence of iron in the groundwater does not present a hazard to human health. The levels do not exceed the secondary drinking water standards. To prevent these compounds from migrating to the public supply wells, the recovery well network was installed. The aquatic species generally are not as sensitive as humans to organic compounds; however, they are more sensitive to metals (iron). Therefore, because the groundwater is being pumped to prevent the contamination of the public supply wells, the level of iron in the recovered groundwater must be reduced to levels that are protective of the aquatic environment prior to surface water discharge, regardless of the source of the iron.

3. **One commenter asked why the County has been using interceptor wells to pump contaminated groundwater as a temporary measure without capping the site.**

EPA Response: The County acted promptly to install the wells, taking immediate action to mitigate the situation. When contamination was detected at the edge of Llangollen Estates, the County acted immediately. EPA commends them for taking action and installing the recovery wells, which occurred before EPA's Superfund program was established.

4. **One commenter asked why, if the heavy metals find their way into the leachate that gets into the pond, the substances are not found in the**

groundwater that is affecting the discharges from the pumps.

EPA Response: Some of the metals are getting into the groundwater. A certain percentage of the contamination goes into the aquifer and is carried through the groundwater to the recovery wells, where it is captured and discharged into Army Creek. Another portion of substances is discharged from the side of the landfill directly into the pond. EPA expected to find elevated levels of metals, including chromium. A number of theories may explain this fact. Chromium is not a very mobile contaminant, so that it may take longer to be detected in the recovery wells. Also, chromium tends to absorb to soil particles, such as in the sediment. Each contaminant has a different mobility. Some contaminants do not move through the aquifer very well, and tend to stay at the bottom of the pond and not go further.

5. **An attendee asked whether the recovery wells would continue to be effective.**

EPA Response: Yes, the effectiveness of the wells is continuously monitored. Other than recovery wells, there are many monitoring and piezometer wells strategically located throughout the area. These wells are used to examine the water table level. Each recovery well creates a spherical "cone of depression" due to the withdrawal of groundwater. By monitoring daily discharge volumes and evaluating the piezomatic map (three-dimensional groundwater elevation), the operator can determine wether or not the recovery well is functioning effectively. When the recovery well's effectiveness decreases, it is rehabilitated. All wells at the site are rehabilitated approximately twice a year, during which the well is shut down and its screens are cleaned. Thereafter, it is put back on line fully effective. New Castle County will continue to pay for the operation and maintenance of the wells.

6. **Several commenters asked whether contamination at the site could affect any public supply wells.**

EPA Response: The continued monitoring undertaken in the area has consistently shown the recovery well network to be effectively creating a groundwater divide between the landfill and Artesian's wells.

7. **Several commenters stated that there had been several public meetings about the site in the past and numerous studies continuing for several years. They asked why it has taken so long to begin remedial action.**

EPA Response: EPA cannot take action at a hazardous waste site until it has completed a thorough study of the site and knows what contaminants are present. All data must be gathered and factored into a careful and informed decision. The Agency has recently completed the remedial design of the landfill cap and is prepared to begin construction.

8. **One commenter asked how much money has been spent at the site without accomplishing remedial actions there.**

EPA Response: Although the actual remedial action has not been implemented at the site, the studies were necessary to determine the nature and extent of contamination at the site and which technologies will best remediate the site contamination. To date, approximately $1.2 million have been expended for legal, technical, and civil investigative tasks associated with the site, all of which EPA expects to recover from the (potentially) responsible parties. Technical tasks completed include: Site Inspection and Preliminary Assessment; oversight of the first Operable Unit Feasibility Study; the first Operable Unit Remedial Design; and the second Operable Unit Remedial Investigation and Feasibility Study.

E. General Comments

1. **Several meeting attendees asked what role DNREC has in the remedial activities at the site.**

EPA Response: The Army Creek site is a Federal-lead project. However, DNREC reviews and comments on all documents and is involved in determining technical details of the project. EPA has been working closely with the State throughout the process and consults DNREC prior to making any final decisions.

2. **Several commenters asked what will happen to the pond after the groundwater recovery wells are shut down.**

EPA Response: The volume of the pond will likely decrease to its original size during the 1960s, before the installation of the recovery wells. The alteration of the hydrology may adversely affect the associated vegetation; hence, a provision for management of the area has been included in the selected remedy. The Agency's intention is not to artificially maintain the wetlands, but to ensure that comparable habitat values are maintained.

3. **One commenter asked whether EPA anticipates encountering any surprise contaminants at the Army Creek site.**

EPA Response: The groundwater has been monitored extensively for nearly 20 years. It is unlikely that new contaminants will be discovered.

4. **One commenter asked from which aquifer the recovery wells are drawing water.**

EPA Response: The recovery wells are drawing water from the Upper Potomac aquifer, which is the middle aquifer in the area.

5. **Several commenters asked from what source residents in Llangollen Estates receive their water.**

EPA Response: Llangollen Estates residents get their water from the Artesian Water Company, except for a few homes that have private wells. Artesian has wells in a variety of locations in New Castle County, including those near the Army Creek site.

6. **A commenter asked when the Army Creek site had been added to the National Priorities List.**

EPA Response: The site was on the original list published in September 1983.

III. WRITTEN COMMENTS

1. **New Castle County stated that there is no basis for a second operable unit Record of Decision. When the first operable unit was issued there was no discussion of embarking on a Second Operable Unit encompassing groundwater treatment.**

   EPA Response: The declaration section of the first operable unit Record of Decision, signed September 30, 1986, states, "Selection of a treatment alternative for the groundwater recovery well discharges has not been made at this time and will be the subject of a second operable unit decision document in the future."

2. **New Castle County stated that there was no substantive basis for EPA re-opening the 1986 [first operable unit] ROD.**

   EPA Response: The first operable unit ROD was not re-opened.

3. **New Castle county stated that EPA should have set the iron compliance level at 5,000 ug/L due to technology-based limits.**

   EPA Response: The Delaware Surface Water Quality Standards establish that 1,000 ug/L of iron is protective of Army Creek's designated uses. Treatment technology capable of achieving the required concentration of iron is readily available. A waiver of the ARAR based on technological limits is unjustified.

4. **New Castle County stated that the ARAR selection process is faulty. No mention is made in the Focused RI/FS of the Clean Water Act regulations that exclude manmade impoundments like Army Pond from the definitions of "waters of the United States."**

   EPA Response: This exclusion applies only to manmade bodies of water which neither were originally created in waters of the United States nor resulted from the impoundment of waters of the United States.

5. **New Castle County stated that the Focused RI/FS did not assess whether a treatment facility capable of treating the concentration of iron in the recovered groundwater to 5,000 ug/L would be adequate.**

   EPA Response: That scenario was evaluated as Alternative #2.

6. **New Castle County stated that the County itself did not operate the landfill during the relevant periods.**

EPA Response: The County operated the facility through a contractual relationship with Landfill, Inc.

7. **New Castle County stated that it is unclear which components comprise the "system" to be evaluated in accordance with operable unit one Phase II.**

EPA Response: The landfill cap and the recovery well network.

8. **New Castle County stated that it is unaware of any surface leachate seeps.**

EPA Response: They are at the southwestern edge of the landfill.

9. **New Castle County stated that engineers retained by the County believe that the performance standard included in Alternative #3 may be achieved more efficiently using different unit processes than those described.**

EPA Response: Modifications resulting from the engineering process may be made during design as long as the performance standard is achieved.

10. **New Castle County stated that it is their belief that the wetland monitoring and habitat management plan, referenced in the Proposed Plan, is limited to a two-year evaluation of pond and creek water levels and vegetation, as well as possible re-seeding with indigenous species should Phragmites dominate.**

EPA Response: The County is correct, with one minor modification. In the event that re-seeding is required within the first two years following recovery well shut down, an additional three years of management will be necessary to ensure the success of the management activities.

11. **A commenter wrote that he supports the preferred alternative but is concerned that non-volatile organics may remain in the effluent and suggested that a carbon filter be added to the treatment process.**

EPA Response: Based on the sampling event conducted during the Focused RI/FS, iron is the only constituent clearly exceeding the applicable numeric water quality criteria. The monitoring plan associated with the selected alternative will generate a solid water quality data base. If the recovered groundwater is found to have a persistent organic substance at a level that is not protective of the designated uses of Army Creek, a compliance program will be developed and implemented. All options available to meet the objective would be evaluated.

12. **One commenter asked what precautions would be taken to assure that all pollutants are removed to detection levels or below.**

EPA Response: The presence of a pollutant above its technological detection limit does not necessarily pose a risk to human health or the environment. The Agency will take actions to protect the designated uses of Army Creek.

13. **A commented asked what EPA was proposing to do about sediment and surface waters.**

EPA Response: Although the sediments are degraded, the risk assessment found the sediments to pose no unacceptable risk. The installation of the landfill cap and treatment of the recovered groundwater prior to discharge is expected to have a positive effect on both the sediment and surface water quality. In time, the remedial activities undertaken with respect to both operable units is expected to achieve a water quality that is protective of Army Creek's designated uses.

14. **A commenter stated that he thought that the 5.2 g/day freshwater fish consumption rate used in the risk assessment was low.**

EPA Response: Studies conducted by DNREC have documented that the average consumption rate of freshwater fish by recreational anglers in Delaware is 5.2 g/day. The exposure assessment assumes that the average fisherman catches 100% of the fish he consumes in Army Creek. Compared to other fishable freshwater waterways in the state, Army Creek is very small, has limited access, and, according to the "Stream and Inland Bays Fish Survey" (Delaware Division of Fish and Wildlife, 1989), Army Creek ranked 13th out of 14 with respect to number of fish caught in non-tidal streams. Using a higher consumption rate for this site specific study would be unrealistic.

15. **On commenter stated his concern that chemical compounds more toxic than iron may be discharged into the stream in the future.**

EPA Response: Groundwater investigations have documented the presence of various chemical constituents upgradient of the recovery well network that are not currently of concern in the context of this remedial action. Given this fact, the characteristics of the recovered groundwater have the potential to change. The Preferred Alternative identified in the Proposed Plan included a [recovered] groundwater monitoring plan. The Selected Remedy goes one step further to clarify that a compliance plan will be developed and implemented should the monitoring reveal a persistent change in the character of the recovered groundwater such that the

discharge is no longer protective of the designated uses of Army Creek. The applicable requirements with respect to water quality which must be achieved prior to surface water discharge are contained in the Delaware Surface Water Quality Standards as amended on February 2, 1990 (referred to as Delaware Ambient Water Quality Criteria in the Proposed Plan).