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EPA Superfund
Record of Decision:

NAVAL AIR DEVELOPMENT CENTER (8 WASTE AREAS)
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OU 05
WARMINSTER TOWNSHIP, PA
09/30/1997

EPA/541/R-97/178
<IMG SRC 971780>

RECORD OF DECISION
NAVAL AIR DEVELOPMENT CENTER

DECLARATION

SITE NAME AND LOCATION

Naval Air Development Center
Warminster Township
Bucks County, Pennsylvania

STATEMENT OF BASIS AND PURPOSE

This Record of Decision (ROD) presents a selected interim remedial action for Operable Unit Four (OU-4) at the former Naval Air Development Center in Warminster Township, Bucks County, Pennsylvania (the "Site"), chosen in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980, as amended, 42 U.S.C. º 9601 et seq. and, to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), 40 C.F.R. Part 300. This decision is based on the Administrative Record for this Site. In January 1993, the facility was renamed Naval Air Warfare Center (NAWC) Aircraft Division Warminster. NAWC ceased operations on September 30, 1996 and is now targeted for transfer to the private sector.

The Commonwealth of Pennsylvania has neither concurred nor non-concurred with the selected remedy as of the date of this Record of Decision. The concurrence/non-concurrence letter from the Commonwealth will be added to the Site Administrative Record upon receipt.

ASSESSMENT OF THE SITE

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

DESCRIPTION OF THE SELECTED REMEDY

The selected interim remedy for OU-4 is the fourth remedial action addressing the Site. OU-4 consists of contaminated groundwater underlying Area D at the Site. (Previous response actions have been selected and/or implemented to address Operable Unit One, which consists of contaminated groundwater attributable to Areas A and B, Operable Unit Two, which consists of contaminated drinking water supplies, and Operable Unit Three, which consists of contaminated groundwater attributable to Area C.) The objective of the selected interim remedy for OU-4 is to minimize the migration of the contaminated groundwater, initiate aquifer restoration, and obtain information about the response of the aquifer to remediation measures. In addition, a secondary objective is to limit or eliminate unacceptable exposure to the contaminated groundwater while the remedy is being implemented. A final remedial action for OU-4 will be selected in a final Record of Decision for OU-4 to be issued after the full nature and extent of contaminated groundwater underlying Area D is identified and will consider the information generated during the implementation of the interim remedial action. Future actions at the Site will address waste, soils, sediment, and/or other media as necessary.

The selected interim remedy for OU-4 is groundwater extraction, treatment of extracted groundwater at an existing on-base groundwater treatment system, discharge to surface water at the outfall of the subject treatment system, and institutional controls, to continue until the final remedy is implemented. The components of this interim remedy include:

(1) Determination of the contribution of on-base, open water supply wells on the vertical distribution of contamination in groundwater

(2) Reconstruction or abandonment of the subject wells, as necessary, to limit further contaminant migration

(3) Installation, operation and maintenance of groundwater extraction wells

(4) Pumping of contaminated groundwater and conveyance through piping to an existing on-base groundwater treatment system

(5) Installation (if necessary) and monitoring of observation wells to ensure effectiveness of the groundwater extraction wells

(6) Periodic evaluation of hydrogeologic data and the effectiveness of the groundwater extraction system

(7) Modification of the groundwater extraction well system as necessary based on periodic evaluations

(8) Operation and maintenance of existing onsite groundwater treatment system and expansion of this system if necessary to treat extracted groundwater from Area D

(9) Monitoring of treated water to ensure the effectiveness of the treatment system

(10) Discharge of treated water to an unnamed tributary of Little Neshaminy Creek

(11) Installation, operation and maintenance of vapor phase carbon adsorption units as necessary to control air emissions from treatment system

(12) Offsite treatment and/or disposal of solid residuals generated during water treatment

(13) Monitoring of groundwater in off-base monitoring wells

(14) Institutional controls to prevent the use of groundwater which presents an unacceptable health risk

(15) A review of the remedy on a five-year basis

STATUTORY DETERMINATIONS

Pursuant to duly delegated authority, we hereby determine, pursuant to Section 106 of CERCLA, 42 U.S.C. º 9606, that this interim action is protective of human health and the environment, complies with Federal and State applicable or relevant and appropriate requirements directly associated with this action, and is cost-effective. Although this action is not intended to fully address the statutory mandate for permanence and treatment to the maximum extent practicable, this interim action utilizes treatment and thus is in furtherance of that statutory mandate. Because this action does not constitute the final remedy for Operable Unit Four, the statutory preference for remedies that employ treatment that reduces toxicity, mobility, or volume as a principal element, although partially addressed by this remedy, will be addressed by the final response action. Subsequent actions are planned to address fully the threats posed by the conditions at the Site.

Because the interim remedy addressing groundwater is likely to result in hazardous substances remaining onsite above health-based levels, a review will be conducted within five years of the remedial action to ensure that the remedy continues to provide adequate protection of human health and the environment. Because this is an interim action ROD, review of this Site and of this remedy will be continuing as the U.S. Navy and EPA continue to develop final remedial alternatives for Operable Unit Four.

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RECORD OF DECISION

TABLE OF CONTENTS

FIGURES

TABLES

RECORD OF DECISION

NAVAL AIR DEVELOPMENT CENTER

DECISION SUMMARY

I. SITE NAME, LOCATION, AND DESCRIPTION

The Naval Air Development Center is a 840-acre Naval facility located in Warminster Township, Northampton Township and Ivyland Borough, Bucks County, Pennsylvania ("the Site") (see Figure 1 for Site Location Map). In January 1993, the Naval facility was renamed Naval Air Warfare Center (NAWC) Aircraft Division Warminster. The Site lies in a populated suburban area surrounded by private homes, various commercial and industrial activities, and a golf course. On-site areas include various buildings and other complexes connected by paved roads, the runway and ramp area, mowed fields, and a wooded area.

The longest runway is generally located along the topographically highest area at the Site. Many of the primary NAWC buildings are located west of the airstrip, along Jacksonville Road, a public road which traverses the Site north to south. A housing development for military enlisted personnel is within the southeastern portion of the Site. A wastewater treatment plant (WWTP) owned and operated by NAWC is located in the northwestern corner of the Site.

Commissioned in 1944, NAWC's main function until 1949 was aircraft manufacturing. From 1949 to 1996, NAWC was a research, development, testing, and evaluation facility for Naval aircraft systems. NAWC also conducted studies in anti-submarine warfare systems and software development. Pursuant to the Defense Base Realignment and Closure Act of 1990 (Public Law 101-510), NAWC ceased operations on September 30, 1996, and is targeted for transfer to the private sector. All activities have been relocated to Patuxent River, Maryland, with the exception of an enlisted men's housing area in the southwestern corner of NAWC, which will be retained by the Navy (see Figure 4).

During its operation, NAWC had approximately 3,000 employees, and 1,000 people continue to reside at the enlisted men's housing area year round. The residents living within the enlisted men's housing area are the nearest population center. The closest off-base home is about 200 feet away from the NAWC property line. Residential development is located along the length of the southern property line of NAWC, and to a lesser extent, along the northern property line. Industrial development is located along the west and northwest perimeter of NAWC property. Groundwater is used extensively as a source of water by both residents and industry in the immediate vicinity of the Site. The Site is located on a ridge, generally oriented east-west, with elevations ranging from 297 feet at the northwestern property boundary to 377 feet at the eastern boundary. Onsite slopes are gentle and average three to five percent.

The northern portion of the Site (about 65 percent) drains into small, unnamed tributaries of Little Neshaminy Creek. The remaining portion (about 35 percent) drains into unnamed tributaries of Southampton Creek. These streams are used for recreation and industrial purposes.

An unnamed tributary of Little Neshaminy Creek which flows immediately adjacent to the NAWC property line may be used for recreational purposes by children approximately 3000 feet downgradient of the Site. There are no known endangered species or critical habitats within the immediate vicinity of the Site.

Area D generally includes NAWC property located immediately northwest of the primary building complex at NAWC, Buildings 1 and 2, and extends to the NAWC property boundary northwest of this complex. Figure 2 provides the general location of Area D. Buildings 1 and 2 were built by the Brewster Aeronautical Corporation in 1942 and were subsequently transferred to the Navy in 1944. From 1942 through 1944, these buildings were used to manufacture aircraft and to support these manufacturing operations. Aircraft manufacturing operations continued until 1949, when NAWC re-organized into an aircraft research and development center. Since that time, Buildings 1 and 2 have housed miscellaneous laboratories and shops as part of this function. More detailed information regarding the history of Buildings 1 and 2 appears in an "Area D Remedial Investigation/Feasibility Study Workplan for NAWC" (Brown and Root (1996)) and "Environmental Baseline Survey for NAWC" (EA Engineering, 1995). Also located within Area D are a variety of other structures, including miscellaneous buildings, underground storage tanks and hazardous waste storage areas. Again, Brown and Root (1996) and EA Engineering (1995) provide detailed background information regarding this area. Figure 3

provides a more detailed map of Area D.

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II. SITE HISTORY

This section describes the history of waste disposal, and CERCLA investigations and response actions at the Site.

A. HISTORY OF WASTE DISPOSAL

Historically, wastes containing hazardous substances were generated by NAWC during aircraft manufacturing, maintenance and repair, pest control, fire-fighting training, machine and plating shop operations, spray painting, and various materials research and testing activities in laboratories. The wastes generated have included paints, solvents, sludges from industrial wastewater treatment, and waste oils. From 1940 to 1980, these wastes were disposed in pits, trenches, and landfills located on current NAWC property. In addition, wastes generated by NAWC were burned in a fire training area until 1988.

To date, eight (8) areas on current NAWC property have been reported as areas used for the disposal of wastes containing hazardous substances. A brief summary of these areas is provided on Table 1-1. Figure 4 provides the locations of these waste disposal areas, which cover approximately ten acres. None of these areas are currently used for waste disposal.

While no waste disposal has been reported within Area D, available groundwater data to be discussed later in this Record of Decision indicates that hazardous substances have been released to groundwater underlying Area D and that these hazardous substances may have been released either within Area D or immediately adjacent areas. In addition to hazardous waste generation and storage areas and areas of hazardous substance/material use within Area D, other potential sources of this groundwater contamination include hazardous substance releases from sewer lines under and adjacent to Buildings 1 and 2 and other operations within Area D. The investigation of the potential source(s) of contaminant releases to groundwater underlying Area D is discussed further in the next section.

TABLE 1
SUMMARY OF WASTE MANAGEMENT AND SITE OPERATIONS
NAWC WARMINSTER, PENNSYLVANIA

SITE NO.	DATES OF OPERATION	TYPES OF WASTES	METHOD OF OPERATION	POTENTIAL HAZARDS
1	1940 to 1955	Paints, oils, asphalt, roofing material, unspecified chemicals, firing range wastes	Burn pit within an eroded ravine	Various solvents, driers, pigments, PAHs, creosote, phenols, asbestos, binders, lead
2	1965 to 1970	Industrial wastewater sludges	2 disposal trenches	Biological wastes, heavy metals
3	1955 to 1965	Solvents, paints, roofing materials, and unspecified chemicals	Burn pit	Various solvents, driers, pigments, asbestos, binders
4	1966 to 1970	Non-industrial solid wastes, paints, waste oils, waste metals, construction debris, solvents, and sewage treatment sludge	7 disposal trenches	Various solvents, driers, pigments, lead, PAHs, biological wastes, heavy metals
5	1955 to 1970	Paints, solvents, scrap metal, and 30 drums of asphalt	6 to 8 disposal trenches	Various solvents, driers, pigments, creosote, phenols, PAHs
6	1960 to 1980	Paints, solvents, demolition wastes, waste oils, other flammable wastes, and grease trap wastes	Unknown number of disposal pits or trenches	Various solvents, driers, pigments, lead, PAHs
7	1950 to 1955	Industrial wastewater sludge	2 disposal trenches	Biological wastes, heavy metals
8	1961 to 1988	Aviation fuel, lubricants, coolants	Firefighting training area	PAHs, PCBs

ADAPTED FROM SMC MARTIN 1991 (TABLES 1-1 AND 4.3-4)

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B. CERCLA INVESTIGATIONS AND RESPONSES

The EPA completed CERCLA Preliminary Assessment (PA) and PA/Site Inspection (SI) Reports in 1979 and 1985 respectively. In 1986, the Site was proposed for inclusion on the National Priorities List (NPL). On October 4, 1989, the Site was placed on the final NPL. On September 20, 1990, the Navy and EPA signed an Interagency Agreement (IAG) which established a procedural framework for developing and implementing investigative and response actions at the Site in accordance with CERCLA and the NCP.

In response to the inclusion of the Site on the NPL and in accordance with the IAG, the Navy has investigated hazardous substance releases at the Site in multiple phases: a Phase I RI, Phase II RI a Focused RI, and a Phase III RI, which is, currently in progress.

The Phase I Remedial Investigation (RI) was initiated in late 1988 and was completed on September 11, 1990 with the release of the Phase I RI Report. Phase I initiated the investigation of sites 1 through 8 by screening these sites for volatile organic compounds (VOCs) via soil gas analysis and detecting any buried materials through electromagnetic surveys. The sites were also investigated through soil borings and the installation and sampling of shallow monitoring wells installed to monitor overburden and shallow bedrock aquifers. In addition, test pits were excavated, nearby wells were inventoried, and a bedrock fracture-trace analysis was conducted.

The Phase II RI was initiated in late 1991. Phase II work included the installation of additional overburden and shallow bedrock monitoring wells, sampling and analyzing groundwater, and an evaluation of aquifer characteristics through water-level monitoring, slug and step-drawdown tests and a pumping test. Four off-site wells were sampled during the Phase II RI.

Both the Phase I and Phase II RI investigated the nature and extent of shallow groundwater contamination within the vicinity of sites 1, 2, and 3 (collectively referred to as Area A), sites 5, 6, and 7 (Area B) and sites 4 and 8 (collectively referred to as Area C).

Based on the results of these investigations, the Navy completed Remedial Investigation and Feasibility Study Reports addressing contaminated groundwater in overburden and shallow bedrock attributable to Areas A and B (identified as Operable Unit One or OU-1) in April of 1993. Then Navy subsequently issued a Proposed Plan addressing OU-1 on April 26, 1993 and jointly signed a Record of Decision (ROD) with EPA for OU-1 on September 29, 1993. The ROD for OU-1 selected an interim remedy which included the pumping and treatment of groundwater to limit the migration of contaminated groundwater attributable to Areas A and B.

Beginning the week of April 28, 1993, the Navy initiated the sampling of off-base wells to assess the impact of contaminated groundwater attributable to NAWC on off-base groundwater users. Through September 30, 1994, the Navy had sampled more than 500 wells over several rounds of quarterly sampling. Seven (7) residential wells sampled exceeded EPA Removal Action Levels, while an additional thirty-nine (39) residential wells exceeded Maximum Contaminant Levels (MCLs) (developed pursuant to the Safe Drinking Water Act). At least part of this contamination is potentially attributable to the Site. In response, the Navy has conducted a CERCLA removal action, installing a water treatment system in each residence where either EPA Removal Action Levels or MCLs have been exceeded.

The EPA and the Navy determined this off-base groundwater contamination may present an imminent threat to human health. In response, the EPA and the Navy have conducted additional CERCLA removal action work which provided residences exceeding EPA Removal Action Levels, as well as residences in the immediate path of the groundwater contamination, with connections to public water supply systems. Residences addressed by these actions include all residences on Kirk Road. The work completed under this Removal Action is considered to be Operable Unit Two (OU-2).

A Focused RI was initiated in October 1993 to further investigate the nature and extent of contaminated groundwater attributable to Areas A, B, and C. In addition, the Focused RI initiated the CERCLA investigation of groundwater in the vicinity of Buildings 1 and 2.

Investigative work addressing Area C under the Focused RI was completed in 1994 and the results of this work summarized in an RI Report for OU-3 dated August 1994, where OU-3 was defined as contaminated groundwater attributable to Area C. In August 1994, the Navy also released a Focused Feasibility Study (FFS) Report for OU-3. The Navy subsequently issued a Proposed Plan addressing OU-3 on August 19, 1994, and jointly signed a ROD with EPA for

OU-3 on March 10, 1995. The ROD for OU-3 selected a remedy which included pumping and treatment of groundwater to restore contaminated groundwater attributable to Area C to a level protective of human health and the environment.

While work under the Focused RI continued, the Phase III RI was initiated in early 1995 to further investigate potential sources of contamination in Areas A, B and C, and to evaluate potential impacts of contaminant sources on surface water and sediment. These investigations have included soil gas and geophysical surveys, and sampling of wastes, soils, surface water and sediment.

Based on a preliminary evaluation of the results of Phase III RI work, in June 1996, the Navy initiated a removal action it Site 4. The response action at Site 4, a series of seven trenches used for the disposal of miscellaneous waste, was excavation and removal of the subject waste. Work was completed in December 1996. The former location of the subject trenches has now been capped with soil and seeded.

In response to groundwater contamination in Area D, in July, 1996, the Navy initiated a remedial investigation of the potential sources of this contamination. These investigations have included soil gas surveys and soil sampling both within Area D and Buildings 1 and 2, and have addressed sanitary and industrial sewer lines as well as numerous structures.

Based on the findings of the Focused RI work addressing groundwater, in October 1996, the Navy issued Remedial Investigation and Focused Feasibility Study (FFS) reports for Area D groundwater - OU-4. The FFS for OU-4 developed several interim remedial alternatives which would minimize contaminant migration and initiate groundwater restoration while the investigation of the Area D groundwater continues.

Again in response to findings of the Phase III RI work, in May 1997, the Navy initiated a removal action at Site 6, a series of trenches and pits used for waste disposal purposes. This response action, which includes waste excavation and removal, is in progress at this time.

III. HIGHLIGHTS OF COMMUNITY PARTICIPATION

Since 1988, the plans and results of ongoing CERCLA investigations and actions have been presented to a Technical Review Committee (TRC) and/or Restoration Advisory Board established for NAWC. The TRC and/or RAB has included representatives of Bucks County Health Department, Warminster Township, Warminster Township Municipal Authority, Upper Southampton Township, Upper Southampton Water and Sewer Authority, Northampton Township, Northampton Municipal Authority and Ivyland Borough.

In accordance with Sections 113 and 117 of CERCLA, 42 U.S C. Sections 9613 and 9617, the Navy, in conjunction with EPA, issued a Proposed Plan on June 5, 1997, presenting the preferred interim remedy for OU-4. The Proposed Plan and RI and FFS reports for OU-4 became available for review at the time and are among documents which comprise the CERCLA Administrative Record for NAWC. The Administrative Record is available for review by the public at the following information repositories:

- NAWC Public Affairs Office
  Jacksonville Road
  Warminster, Pennsylvania 18974

- Bucks County Library
  150 South Pine Street
  Doylestown, Pennsylvania 18901

An announcement of the public meeting, the comment period, and the availability of the Administrative Record for the interim remedy for OU-4 was published in the Intelligencer, Public-Spirit and Courier Times on June 4 and June 11, 1997. Additionally, the Proposed Plan and the Notice of Availability were mailed to local municipal and government agencies and local residents in the vicinity of the Site.

The public comment period for the Proposed Plan was from June 5 to July 3, 1997. A public meeting was held at the Warminster Township Building, Henry and Gibson Avenues, Warminster, Pennsylvania on June 16, 1997 to present the RI, FFS and Proposed Plan, answer questions, and accept both oral and written comments.

A transcript of the meeting was maintained in accordance with Section 117(a)(2) of CERCLA, 42 U.S.C. º9617(a)(2). As a result, responses to many oral comments during the public meeting are in the transcript of the meeting, which is now part of the Administrative Record. Responses to written comments received during the public comment period are included in the Responsiveness Summary section of this ROD.

This Record of Decision presents the selected interim remedial action for OU-4 at the Site chosen in accordance with CERCLA and, to the extent practicable, the National Contingency Plan (NCP).

All documents considered or relied upon in reaching the remedy selection decision contained in this ROD are included in the Administrative Record for the Site and can be reviewed at the information repositories.

IV. SCOPE AND ROLE OF THIS REMEDIAL ACTION

Section 300.430 (a)(1)(ii)(A) of the NCP, 40 C.F.R. Section 430(a)(1)(ii)(A) provides that CERCLA NPL Sites "should generally be remediated in operable units when early actions are necessary or appropriate to achieve significant risk reduction quickly, when phased analysis or response is necessary or appropriate given the size or complexity of the Site, or to expedite the completion of a total cleanup." In the case of NAWC, the Navy has organized work to date into four operable units. These operable units (OUs) are as follows:

-OU-1: Contaminated groundwater attributable to Areas A and B
-OU-2: Contaminated off-base private wells
-OU-3: Contaminated groundwater attributable to Area C
-OU-4: Contaminated groundwater underlying Area D

The Navy and EPA selected an interim remedy for OU-1 in a ROD signed on September 29, 1993, while a removal action for OU-2 was selected by EPA in a Removal Action Memorandum signed on July 14, 1993. The Navy and EPA selected a final remedy for OU-3 in a ROD signed on March 10, 1995. The construction of the remedy for OU-1 was initiated by the Navy in January 1995 and continues at this time. The EPA initiated construction of the removal action for OU-2 in June 1994 and completed construction of this removal action in December 1994. The operation of the remedy of OU-3 was initiated by the Navy in July 1996 and continues at this time.

This ROD selects an interim remedial action for OU-4 - contaminated groundwater underlying Area D at the Site, where Area D is the area of contaminated groundwater attributable to releases adjacent to and/or under Buildings 1 and 2. This groundwater presents unacceptable risks to human health. Sufficient information is available to select an interim remedy at this time.

The objective of the interim remedy in this case is to minimize the migration of the contaminated groundwater, initiate aquifer restoration, and obtain information about the response of the aquifer to remediation measures while additional RI work is performed to determine the full nature and extent of contamination. In addition, to the extent possible at this time, a secondary objective is to limit or eliminate unacceptable exposure to the contaminated groundwater while the remedy is being implemented.

The final remedy for OU-4 will be selected after the full nature and extent of the problem are identified and will consider the information generated during implementation of the interim remedy. In the Preamble to the publication of the revised NCP, it is noted that operable units "may include interim actions (e.g., pumping and treating of groundwater to retard plume migration) that must be followed by subsequent actions which fully address the scope of the problem (e.g., final groundwater operable unit that defines the remediation level and restoration timeframe)." (55 Fed.Reg. at 8705 (March 8,1990)). Therefore, a final ROD for OU-4 will be issued after the implementation of the interim action. The interim action will be consistent with planned future actions to the extent possible.

Other media associated with the Site, including wastes, soils, sediment and surface water are being further investigated under the RI/FS process. Additional remedial actions will be proposed and selected as soon as adequate information exists to support the selection of a remedy for a particular medium or group of media. Any such medium (or group of media) will be designated

as an Operable Unit by the Navy and EPA.

V. SUMMARY OF SITE CHARACTERISTICS AND EXTENT OF CONTAMINATION

Summarized below are the relevant findings of the RI work to date with regard to contaminated groundwater underlying Area D at the Site.

A. SITE CHARACTERISTICS

1. Geology

The Site is located in the Piedmont Physiographic Province, Triassic Lowlands Section, of southeastern Pennsylvania. The land forms have been modified by erosion to form moderate slopes and gently rounded hills with a dendritic drainage pattern.

Surface soils in the vicinity of the Site are generally fine-textured, predominantly silty loams, with moderate to low permeabilities. The soils are commonly underlain by saprolite (extensively weathered bedrock) at an approximate depth of four to 10 feet. Available information indicates saprolite on NAWC property varies from eight (8) and twenty-five (25) feet in thickness.

The bedrock underlying the saprolite belongs to the late Triassic age middle arkose member of the Stockton Formation. These rocks consist of fine- to medium-grained arkosic sandstone interbedded with red shale, siltstone and conglomerate. Units of varying lithology are irregularly interbedded with coarse-grained units commonly overlying fine-grained units. Individual beds commonly pinch out or form gradational contacts with overlying or underlying beds over lateral distances greater than several hundred feet.

The beds of the Stockton Formation strike to the northeast and dip from seven to 16 degrees to the northwest with an average dip of 12 degrees. The thickness of the middle arkose member of the Stockton Formation is estimated to be approximately 500 feet near the southeastern property boundary of NAWC, increasing to between 1,500 and 2,000 feet near the northwestern boundary. The Stockton Formation is extensively faulted and is cut by a well-developed joint or fracture system.

2. Hydrogeology

The Stockton Formation forms a multi-aquifer system of relatively discrete water-bearing zones separated by thicker, less permeable zones. Transmissivity and groundwater movement within water-bearing zones are greater parallel to bedding than across bedding. Vertical or nearly vertical fractures cutting across bedding and the weathering of various beds are expected to permit varying degrees of leakage between the main water-bearing zones, particularly near the surface. Groundwater in the Stockton Formation occurs locally under both confined and unconfined conditions.

Within water-bearing zones in the fine- and medium-grained sandstone of the Stockton Formation, groundwater is transmitted through primary intergranular porosity, as well as along fractures, joints, and bedding planes (secondary porosity). The shale and siltstone beds are commonly too fine-grained to transmit large amounts of groundwater through primary porosity, and fractures and joints are typically not well developed in these fine-grained beds. Consequently, the shale and siltstone beds often act as confining layers to groundwater. Fracture permeability is generally better developed in the sandstone layers compared to the shale and siltstone layers of the formation. This, along with greater primary permeability, allows the sandstone layers to function as the most productive water-bearing units of the Stockton Formation.

Groundwater in Area D occurs primarily within the bedrock (Stockton Formation) underlying the Site. Groundwater occurrence and movement through the Stockton Formation is primarily through secondary porosity (fractures) that exists within the rock mass. These fractures include both bedding plane partings and fractures that extend through individual rock units. In addition to the secondary porosity, there is likely some minor primary porosity, especially in the sandstone units, that contributes to groundwater occurrence and movement. In general, the coarser-grained (sandstone) units were observed to yield water more so than the finer-grained (siltstone and shale) units, although significant water-yielding fractures were encountered in all rock types.

Minor quantities of groundwater are also encountered within the lower portions of the thin

veneer of soils and weathered rock overlying competent bedrock. The observed saturated thickness of the soils and weathered rock (i.e., overburden) within Area D ranged from approximately 3 to 12 feet. Due to the overall clayey nature and resulting low permeability of the overburden, groundwater movement through the overburden is likely to be restricted in comparison to the migration through the underlying fractures in bedrock.

3. Hydrology

The Site is located in an upland area lying between two local drainage basins. The northern portion of the Site (including Area D) drains toward the north through several swales and storm sewers into a small unnamed tributary of Little Neshaminy Creek. The local drainage basin lies within the regional drainage basin of the Delaware River. Various studies conducted on the Site have revealed that no areas within the Site are included in the 100-year or 500-year floodplains.

Much of the natural drainage pattern has been altered by development and drainage within developed areas of the NAWC property is controlled primarily through constructed drainage systems. A significant portion of precipitation runoff from Area D is directed by surface grading and paving to culverts and storm sewers. The tributary of Little Neshaminy originates at the outfall points of a culvert on NAWC boundary.

4. Meteorology

The climate of the area is humid continental and is modified by the Atlantic Ocean. Temperatures average 76!F (24.4!C) in July and 32!F (0!C) in January. The average daily temperature for the NAWC location is 53.3!F (11.8!C). Precipitation averages 42.5 inches per year (106.25 cm per year), and snowfall averages 22 inches per year (55 cm per year). The distribution of precipitation is fairly even throughout the year. The relative humidity for the Site averages 70 percent. The mean wind speed for this area is 9.6 mph, with prevailing direction of west-southwest.

5. Ecology

Open land, woodland, and wetland habitats are all found within or near NAWC. These include mowed fields and lawns, nonforested overgrown land, wooded areas, forested wetlands, scrub/shrub wetlands, and streams with associated riparian areas. While the majority of Area D is paved, runoff from the area is directed to a tributary of Little Neshaminy Creek which runs through wetlands and wooded areas.

There are no permanent threatened or endangered species on or near NAWC; however, some transient species do traverse the area. No areas have been designated as wetlands on NAWC property according to Army Corps of Engineers criteria.

6. Soils

NAWC is underlain by soils of the Lansdale-Lawrenceville Association. This unit consists of nearly level to sloping, moderately well-drained soils and well-drained soils on uplands. The soils are deep and have a medium-textured surface layer and a medium-textured or moderately coarse-textured subsoil. They formed in material weathered from shale and sandstone and in silty, windblown deposits. They consist primarily of silt loam, shaly silt loam, silty clay loam, and some sandy loam. Some of the soils in this association have a seasonal high water table and restricted permeability.

Large portions of NAWC, including Area D, are urban land areas where the original soils have been graded, disturbed, filled over, paved over, or otherwise altered prior to construction of the base facilities. Various types of fill material, including the contents of the known waste areas at the Site, are included in the urban land areas. Much of Area D is covered by paved surfaces, buildings, or other engineered structures.

7. Groundwater Use

Groundwater has been the only source of water for NAWC and is the primary source of water for residences and commercial operations in the immediate vicinity of NAWC and Area D. Groundwater has been withdrawn from within Area D by NAWC and been used for drinking water, firefighting and miscellaneous purposes. Off-base, privately-owned wells have been used for domestic and commercial purposes and have been located as close as 1000 feet from Area D.

A public water supply well is presently located approximately 3000 feet from Area D. Figure 5 provides the location of municipal, residential and commercial wells known to be located within 3000 feet of Area D as well as the location of on-base supply wells located within and adjacent to Area D.

B. NATURE AND EXTENT OF CONTAMINATION

The findings of the RI to date with respect to groundwater are provided in detail within the Interim Remedial Investigation (RI) Report for OU-4. A summary of the major findings for groundwater underlying Area D is presented below.

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1. On-Base Supply Wells

Four on-base water supply wells are located either within or in the immediate vicinity of Area D. Figures 5 and 6 indicate the locations of these wells. Wells SW-1 and SW-2 are 247 and 248 feet deep respectively, while Wells SW-3 and SW-4 are 570 and 591 feet deep, respectively.

Groundwater contamination underlying Area D was initially detected as part of testing of NAWC supply water quality in October 1979. Testing from that date through August 1981 found levels of trichloroethylene (TCE) and, to a lesser extent, tetrachloroethylene (PCE) and 1,1,1-trichloroethane (1,1,1-TCA) in wells SW-1 and SW-2. TCE levels in well SW-2 were detected at up to 293 micrograms per liter (ug/l), while maximum levels of PCE and 1,1,1-TCA in this well were detected at up to 33 ug/l and 67 ug/l, respectively. Based on the results of this testing, wells SW-1 and SW-2 were permanently removed from service as a source of drinking water.

2. On-Base Monitoring Wells

Since the detection of contaminants in the subject on-base wells, numerous monitoring wells have been installed and tested on NAWC property. The location of all of these wells is provided in Figure 6.

In 1983, prior to the start of CERCLA RI work, monitoring wells MP-1, MP-2 and MP-3 were installed to monitor groundwater from 18 to 132 feet in depth. Initial testing of these wells found concentrations of trichloroethene (TCE) of up to 520 ug/l, as well as low concentrations of tetrachloroethylene (PCE) and 1,1,1-trichloroethane (1,1,1-TCA).

The remainder of monitoring wells indicated on Figure 6 were installed and tested as part of RI work. These wells monitor groundwater at depths from 24 to 300 feet.

During testing conducted as part of the RI in 1994 and 1995, the direction of groundwater flow within the area of these wells was variable with depth, with flow in shallow bedrock (less than 100 feet in depth) generally in a northwest direction and flow in deeper bedrock trending more toward the west.

Table 2 summarizes the analytical results for samples collected from the aforementioned supply and monitoring wells in June 1994. Trichloroethylene (TCE) was the organic contaminant detected at the most significant concentration and frequency. The highest level of TCE (170 ug/l) detected during this sampling event was in Well SW-2, which is located approximately 50 feet from the NAWC property boundary. During a subsequent sampling event in April 1996, the highest level of TCE (320 ug/l) was detected in HN-32S. (The full results of this sampling event will be issued at a future date.)

Samples were also collected in June 1994 to identify both total (unfiltered) and dissolved (filtered) concentrations of inorganics (metals). Generally, this round of testing did not confirm that inorganics concentrations were significantly above background. However, certain results were inconclusive (e.g., HN-201) and additional testing will be necessary to identify the extent of releases of inorganics, if any, to groundwater.

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TABLE 2

FREQUENCY/RANGE SUMMARY, POSITIVELY DETECTED ANALYTES
JUNE 1994
NAWC WARMINSTER, PENNSYLVANIA

Chemical	Frequency of Detection	Range (Ig/L)	Location of Maximum (Ig/L)
1,1,1-TCA	1/23	4	HN-33S
1,1-DCA	2/23	3-4	SW-1
1,1-DCE	1/23	4	HN-33S
Chloromethane	2/23	4.5-8	MP-1-AVG
Acetone	2/23	12-14	HN-211
Benzene	1/23	3	HN-331
Carbon disulfide	1/23	1	HN-201
Carbon tetrachloride	1/23	1.5	HN-31S
Chloroform	3/23	1-6	HN-42S
1,2-Dichloroethene (total)	1/23	4	HN-33S
Ethylbenzene	1/23	2	HN-331
Tetrachloroethene	4/23	2-3.5	HN-31S
Toluene	5/23	2-12	HN-331
Trichloroethene	18/23	2-170	SW-2
Xylenes (total)	1/23	8	HN-331
Diethyl phthalate	6/16	1-11	MP-1
Dimethyl phthalate	3/16	1-4	MP-1
Fluoranthene	1/16	2	HN-201
Aluminum	16/44	29-106,000	HN-201
Antimony	4/44	28-65	HN-32S-F
Arsenic	9/44	4-25	HN-201
Barium	37/44	68-4290	HN-201
Beryllium	4/44	2-14	HN-201
Cadmium	1/44	5	MP-2
Calcium	44/44	18,100-104,000	HN-031S-F-AVG
Chromium	7/44	7-50	HN-31S-AVG
Copper	14/44	5-20	HN-201
Iron	16/44	367-91,000	MP-2
Lead	8/44	2-159	HN-201
Magnesium	42/44	5.390-40,200	HN-201
Manganese	39/44	19-3,380	MP-2
Mercury	10/44	0.2-0.9	MP-2-F
Nickel	4/44	14-41	HN-201
Potassium	42/44	687-46,600	HN-17D
Sodium	44/44	8,870-221,000	HN-201
Vanadium	2/44	8-17	MP-2
Zinc	20/44	5-461	HN-201

Metals sample results are for total metals unless otherwise noted.
F - Filtered Sample
AVG - Average Concentration between sample and duplicate.

3. Off-Base Monitoring and Private Wells

As noted earlier, RI work for Area D groundwater continues at this time. This work includes the installation and testing of monitoring wells at off-base locations. Work conducted to date indicates that a level of 88 ug/l of TCE has been detected in a monitoring well installed at an off-base location west of Buildings 1 and 2. (The full results of this ongoing work will be issued at a future date.)

As indicated in Figure 5, a municipal water supply well is located approximately 3000 feet northwest of Area D. Historic sampling of this water prior to treatment and distribution has indicated the presence of TCE and other volatile organic compounds. Based on available information, the extent of contaminant migration toward this supply well and/or other off-base private wells identified in Figure 5 is unknown.

4. Vertical Extent of Contamination

Historical data from deep on-base wells indicate contamination at varying depths within the aquifer. These data-include MP-2, with a depth of 101 feet, which has had a reported concentration of 125 ug/l TCE; MP-3, with a depth of 132 feet, has had a reported concentration of 520 ug/l TCE; SW-1, 247 feet, had 104 ug/l TCE; and SW-2, 246 feet deep, had 188 ug/l TCE. Additional deep monitoring wells were installed in Area D during the Interim RI and although only trace levels of chlorinated organics were found, it appears that further studies are necessary to fully characterize deep groundwater downgradient of shallow groundwater contaminant sources.

In addition, in 1985, PCE was reportedly detected at 13 ug/l at 450 feet in supply well SW-3. Further RI work is necessary to determine whether contamination is present at this time at this location and depth and/or whether it is part of Area D groundwater.

VI. SUMMARY OF SITE RISKS

This section summarizes available assessments of risk posed by contaminated groundwater attributable to the Site in overburden and shallow bedrock aquifers to human health and the environment. These assessments are based on RI information generated to date.

A final assessment of risk presented by OU-4 will be included in the final Record of Decision for OU-4 to be issued after the full nature and extent of the groundwater contamination are identified.

A. HUMAN HEALTH

As part of the RI work to date, a risk assessment was conducted with available data to estimate the potential risks to human health posed by the contaminated groundwater underlying Area D. Since there is no current, known exposure to this groundwater, only potential exposure was evaluated.

The following exposure pathways were determined to present a potential risk to human health:

- Ingestion of the groundwater as a drinking water source.
- Dermal exposure to the groundwater (e.g., through handwashing, showering, and bathing).
- Inhalation of contaminants in groundwater (i.e., volatile compounds emitted during showering).

Potential human health risks were categorized as carcinogenic or noncarcinogenic. A hypothetical carcinogenic risk increase from exposure should ideally fall within a range of 1 X 10-6 (an increase of one case of cancer for one million people exposed) to 1 X 10 -4 (one additional case per 10,000 people exposed). Noncarcinogenic risks were estimated utilizing Hazard Indices (HI), where an HI exceeding one is considered an unacceptable health risk. Federal Maximum Contaminant Levels (MCLs) for public drinking water supplies were also utilized to assess potential risks posed by exposure to groundwater.

Carcinogenic and noncarcinogenic risks posed by hypothetical exposure to contaminated groundwater in overburden and shallow bedrock were estimated for adult residents, child residents and adult employees. To assess these carcinogenic and noncarcinogenic risks, potential contaminants of concern were selected based on their occurrence and distribution, mobility, persistence and toxicity.

An important component of the risk assessment process is the relationship between the intake of a contaminant and the potential for adverse health effects resulting from that exposure. Dose-response relationships provide a means by which potential human health impacts may be quantified. The dose-response relationships for carcinogenic and noncarcinogenic effects are reference doses (RfDs) and cancer slope factors (CSFs), respectively. The RfD is developed by EPA for chronic and/or subchronic human exposure to hazardous chemicals and is usually expressed as a dose per unit body weight per unit time (mg/kg/day). CSFs are applicable for estimating the lifetime probability of developing cancer as a result of exposure to known or potential carcinogens, are generally reported in units of 1/(mg/kg/day), and are derived through an assumed low-dosage linear relationship of extrapolation from high to low dose-responses determined form animal studies. RfDs and CSFs used to calculate estimated risks in this case are identified in the RI.

The Interim RI Report for OU-4 contains a detailed risk assessment for contaminated groundwater underlying Area D. The assumptions utilized in conducting this assessment are identified therein. These assumptions include exposure input parameters which estimate the exposure of an individual to a contaminant over time. Exposure to representative contaminant concentrations derived from data summarized in Table 2 was assumed.

In conducting this risk assessment, it is acknowledged that there are uncertainties associated with the evaluation of chemical toxicity and potential exposures. For example, uncertainties arise in the derivation of RfDs and CSFs and estimation of exposure point concentrations.

Cumulative, total estimated risks to human health due to potential exposure to noncarcinogenic and carcinogenic groundwater contaminants for adult and child receptors attributable to Area D at the Site in overburden and shallow bedrock are summarized in Tables 3 and 4, respectively.

The total HI and carcinogenic risk for hypothetical exposure to this groundwater exceeds values of one and 1 X 10 -4, respectively. Primary contributors to the unacceptable noncarcinogenic risk are manganese, iron, aluminum, and trichloroethene (TCE). Primary contributors to unacceptable carcinogenic risk are 1,1-dichloroethene, TCE, arsenic and beryllium.

Based on the sampling performed in 1994, trichloroethene, aluminum, barium, beryllium, cadmium, iron, lead, and manganese have been detected at concentrations that exceed MCLs in one or more wells within Area D.

B. ENVIRONMENT

While available RI data are inadequate to fully assess risk to the environment (e.g., risk to aquatic life in surface water) posed by contaminated groundwater underlying Area D, this data suggests that any such impacts are likely to be insignificant.

C. CONCLUSIONS

Contaminated groundwater underlying Area D at the Site has been determined to present an unacceptable risk to human health and/or the environment. As indicated in Section V., off base water supplies may be at risk.

Actual or threatened releases of hazardous substances from the Site, if not addressed by implementing the interim remedial action selected in this ROD, may present an imminent and substantial endangerment to public health or welfare, or the environment.

TABLE 3
SUMMARY OF RISKS - ADULT RECEPTORS
AREA D GROUNDWATER EXPOSURES
NAWC WARMINSTER, PENNSYLVANIA

RECEPTOR	RME RECEPTOR		CT RECEPTOR	
RISK	Hazard Index	Incremental Cancer Risk	Hazard Index	Incremental Cancer Risk
Ingestion	12.7	6.1 x 10 -5	6	1.07 x 10 -5
Dermal Contact	0.44	8.1 x 10 -6	0.29	2.0 x 10 -6
Inhalation	0.037	5.9 x 10 -6	0.025	1.5 x 10 -6
Total Risk	13.2	7.5 x 10 -5	6.3	1.4 X 10 -5

RME - Reasonable maximum exposure
CT - Central tendency
(Tables 3 and 4 risks exclude HN-201 inorganics)

TABLE 4
SUMMARY OF RISKS - CHILD RECEPTORS
AREA D GROUNDWATER EXPOSURES
NAWC WARMINSTER, PENNSYLVANIA

RECEPTOR	RME RECEPTOR		CT RECEPTOR	
RISK	Hazard Index	Incremental Cancer Risk	Hazard Index	Incremental Cancer Risk
Ingestion	29.7	3.6 x 10 -5	13.9	1.7 x 10 -5
Dermal Contact	0.74	3.5 x 10 -6	0.49	2.3 x 10 -6
Inhalation	0.098	3.9 x 10 -6	0.065	2.6 x 10 -6
Total Risk	30.5	4.3 x 10 -5	14.4	2.2 x 10 -5

RME - Reasonable maximum exposure
CT - Central tendency
(Tables 3 and 4 risks exclude HN-201 inorganics)

VII. DESCRIPTION OF ALTERNATIVES

An FFS was conducted by the Navy to identify and evaluate remedial alternatives for contaminated groundwater underlying Area D. Applicable engineering technologies for achieving the interim remedy objective of minimizing contaminant migration were initially screened in the FFS based on effectiveness, implementability, and cost. The alternatives meeting these criteria were then evaluated and compared to nine criteria required by CERCLA. Three interim remedy alternatives were developed for OU-4. Costs and implementation times were estimated for each alternative described in this section.

Costs and implementation times were estimated for each alternative described in this section. Costs shown represent a range from the estimated cost to 20% above the estimate within which the project is expected to be completed, including present unknowns

Alternative 1: No Action with Groundwater Monitoring

The NCP requires that a "no action' alternative be considered to provide a base-line for comparison with action alternatives.

Under this alternative, no remedial action would be undertaken at this time to address contaminated groundwater underlying Area D. Instead, additional studies necessary to fully identify the nature and extent of groundwater contamination would be continued as part of RI work at NAWC. In addition to these studies, monitoring of the groundwater would be initiated and conducted for an estimated thirty years.

Because this alternative would result in contaminated groundwater remaining at the facility, five year reviews would be required to monitor the effectiveness of this alternative. The present worth of this alternative is estimated to be $ 0 over a 30-year period with a capital cost of $0 and an operation and maintenance cost of $ 150,000 annually.

Alternative 2: Groundwater Extraction, Treatment at the Existing Treatment System, and Discharge to Area A System Outfall

Under this alternative, contaminated groundwater underlying Area D would be extracted using a series of extraction wells. The extraction well network would be located as necessary to maximize the effectiveness of the system. The extracted groundwater would be pumped to an existing, on-site groundwater treatment system which has been constructed specifically to treat groundwater. The existing plant would be modified and/or expanded as needed to treat groundwater being pumped from Area D. Water treatment would include air stripping to remove VOCs and carbon adsorption to remove semivolatile organics (or other means, if necessary). Emissions from the air stripper would be treated by vapor phase carbon adsorption as required by PA Code Chapter 127 and the National Ambient Air Quality Standards for Hazardous Air Pollutants (NAAQS) and National Emissions Standards for Hazardous Air Pollutants (NESHAPS) under the Federal Clean Air Act. Metals in the water would be treated by precipitation and filtration (or other means, if necessary). Organic and inorganic treatment residuals would be disposed offsite as required by treatment, storage and disposal regulations under the Federal Resource Conservation and Recovery Act (RCRA), including Land Disposal Restrictions (LDRs) under 40 C.F.R. Parts 262 and 268, Pennsylvania Hazardous Waste Management (25 PA Code, Article VII) and Residual Waste Regulation (25 PA Code, Article IX). Upon meeting effluent limits consistent with National Pollution Discharge Elimination System (NPDES) requirements under the Federal Clean Water Act and Pennsylvania Clean Streams Law, the treated water would be discharged to an unnamed tributary of Little Neshaminy Creek via an established outfall for the existing treatment system.

Concurrent with the design, construction, and operation of the initial extraction well network and treatment system, investigations would be conducted both on and off NAWC property as necessary to fully identify the extent of groundwater contamination underlying Area D. If additional contamination is identified, the extraction well network and treatment system would be modified as necessary during the interim action for OU4 to minimize migration of contaminants and to maximize the effectiveness of the extraction well network.

This alternative would also incorporate the sampling of existing on-site and off-site wells. Monitoring of groundwater in overburden and shallow bedrock aquifers would be conducted for an estimated 30 years.

To estimate the cost of this alternative, the following assumptions were made: a total of 25 extraction wells would be installed; a total flow of 56 gallons per minute (gpm) would be pumped to the existing treatment plant; and on-site and off-site wells would be constructed and monitored on a quarterly basis for an estimated 30 years. (Additional costs would be incurred if additional groundwater was extracted and treated.) Based on these assumptions, the present worth of this alternative was estimated at $1,528,000 to $1,840,000, with a capital cost of $675,000 to $810,000 and an operation and maintenance cost ranging from $50,000 to $60,000 annually. This alternative could be constructed in 12 months or less.

Alternative 3: Groundwater Extraction, Treatment at the Existing Treatment System, Discharge to Area A System Outfall, and Institutional Controls

Alternative 3 would include all of the elements of Alternative 2.

Alternative 3 would also include institutional control measures to prevent exposure to contaminated groundwater underlying Area D. The institutional control measures would consist of groundwater use restrictions for property determined to be affected by the contamination of concern. These restrictions would prevent the use of untreated, contaminated water underlying Area D where such water presents an unacceptable health risk. The restrictions would be applied to property which is presently owned by NAWC, as well as off-base property, to the extent possible at this time.

The present worth of Alternative 3 has been estimated to range from $2,100,000 to $2,500,000 with a capital cost ranging from $675,000 to $810,000, and an operation and maintenance cost ranging from $82,000 to $100,000 annually. This alternative could be constructed in 12 months or less.

VIII. COMPARATIVE ANALYSIS OF ALTERNATIVES

To help select a remedial action, CERCLA requires that remedial alternatives be evaluated under the nine criteria discussed below.

A. OVERALL PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT

Alternatives 2 and 3 would both limit the migration of contaminated groundwater attributable to Area D and provide valuable aquifer characterization. Alternative 3 would be further protective of human health and the environment by implementing institutional controls designed to minimize exposure to contaminated groundwater attributable to Area D. Under Alternative 1, the selection of a remedy addressing the contaminated groundwater would not be initiated until the completion of the studies necessary to fully identify the nature and extent of contaminated groundwater attributable to Area D.

B. COMPLIANCE WITH APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARs)

Under Alternatives 2 and 3, all applicable or relevant and appropriate requirements (ARARs), including those for discharge of treated water and air emissions, would be met. (Specific ARARs for the interim remedy in this case are identified in Section X.B. of this ROD.)

Since no remedial action would be taken under Alternative 1, there would be no action-specific ARARs. Chemical-specific and location-specific ARARs would not be met.

C. LONG-TERM EFFECTIVENESS AND PERMANENCE

By initiating an interim action at this time, Alternatives 2 and 3 may reduce the time necessary to restore affected groundwater relative to Alternative 1. Alternative 3 would have the added long-term benefit of institutional measures to prevent exposure to the contaminated groundwater. Alternatives 1, 2 and 3 all include long-term groundwater monitoring. Operation and maintenance of the treatment plant and monitoring of treated discharges would be required under Alternatives 2 and 3.

D. REDUCTION OF TOXICITY MOBILITY, OR VOLUME BY TREATMENT

Alternatives 2 and 3 would reduce the toxicity, mobility, and volume of groundwater contaminants by treatment. The treatment systems for these alternatives would generate residuals that would require further treatment or disposal.

Alternative 1 would not use treatment to reduce the toxicity, mobility, or volume of groundwater contaminants.

E. SHORT-TERM EFFECTIVENESS

There would be no additional risks to the public or the environment under Alternatives 2 and 3. In the case of these alternatives, workers would be required to wear protective equipment during activities where they may be exposed to hazardous materials.

Under Alternative 1, groundwater contaminants would continue to migrate and present a potential unacceptable risk to human health.

F. IMPLEMENTABILITY

For Alternatives 2 and 3, the remedial technologies and process options for groundwater extraction and treatment are all demonstrated and commercially available.

Under Alternative 3, planning and coordination with the Commonwealth of Pennsylvania, local municipalities and/or municipal authorities would be required to insure the successful implementation of the institutional measures for preventing exposure to contaminated groundwater.

No remedial action is included under Alternative 1.

G. COST

The present worth of Alternative 1 is $0. The present worth of Alternative 2 ranges from $1,528,000 to $1,840,000. The present worth of Alternative 3 ranges from $2,100,000 to $2,500,000.

H. STATE ACCEPTANCE

The Commonwealth of Pennsylvania neither concurs nor non-concurs with the remedy selected below at this time. A concurrence/non-concurrence letter from the Commonwealth will be added to the Site Administrative Record upon receipt.

I. COMMUNITY ACCEPTANCE

A public meeting on the Proposed Plan was held on June 16, 1997 in Warminster, Pennsylvania. Comments received orally at the public meeting and in writing during the public comment period are referenced in the Responsiveness Summary (Section XII of this ROD).

IX. SELECTED REMEDY

The Navy and the EPA have selected Alternative 3: Groundwater Extraction, Treatment at the Existing Treatment System, Discharge to Surface Water at Area A System Outfall and Institutional Controls as the interim remedy for remediation of contaminated groundwater underlying Area D at NAWC. This alternative includes the design and implementation of an interim remedial action to protect human health and the environment. More specifically, this alternative meets the objectives of minimizing the migration of contaminated groundwater, initiating aquifer restoration, and obtaining information about the response of the aquifer to remediation measures while additional RI work is performed to determine the full nature and extent of contamination. In addition, this alternative meets the secondary objective of limiting or eliminating unacceptable exposure to the contaminated groundwater while the remedy is being implemented. The final remedy for OU-4 will be selected after the full nature and extent of the contamination are identified and will utilize information generated during the implementation of the interim remedy. The final remedial action may incorporate elements of the interim remedial action.

The selected interim remedy is believed to provide the best balance of trade-offs among the alternatives with respect to the response criteria. Based on available information, the Navy and EPA believe the selected interim remedy would be cost effective and would comply with applicable or relevant and appropriate requirements. Although this interim action is not intended to fully address the statutory mandate for permanence and treatment to the maximum extent practicable, this interim action utilizes treatment to reduce volume and toxicity and thus is in furtherance of that statutory mandate.

The selected interim remedy for OU-4 includes the following major components:

(1) Determination of the contribution of on-base, open water supply wells on the vertical distribution of contamination in groundwater

(2) Reconstruction or abandonment of the subject wells, as necessary, to limit further contaminant migration

(3) Installation, operation and maintenance of groundwater extraction wells

(4) Pumping of contaminated groundwater and conveyance through piping to an existing on-base groundwater treatment system

(5) Installation (if necessary) and monitoring of observation wells to ensure effectiveness of the groundwater extraction wells

(6) Periodic evaluation of hydrogeologic data and the effectiveness of the groundwater extraction system

(7) Modification of the groundwater extraction well system as necessary based on periodic evaluations

(8) Operation and maintenance of existing onsite groundwater treatment system and expansion of this system if necessary to treat extracted groundwater from Area D

(9) Monitoring of treated water to ensure the effectiveness of the treatment system

(10) Discharge of treated water to an unnamed tributary of Little Neshaminy Creek

(11) Installation, operation and maintenance of vapor phase carbon adsorption units as necessary to control air emissions from treatment system to satisfy applicable or relevant and appropriate requirements

(12) Offsite treatment and/or disposal of solid residuals generated during water treatment

(13) Monitoring of groundwater in off-base monitoring wells

(14) Institutional controls to prevent the use of groundwater which presents an unacceptable health risk

(15) A review of the remedy on a five-year basis

The FFS estimated the present worth of this remedy at $2,100,000 to $2,500,000, with a capital cost of $675,000 to $800,000 and an annual O&M cost of $82,000 to $100,000.

B. PERFORMANCE STANDARDS

Performance standards for the subject interim remedy components are identified below. This section identifies or discusses ARARs in certain cases. However, all ARARs are not necessarily identified or discussed in this section. For a comprehensive identification of ARARs, see Section X.B. of this ROD.

Components 1 through 4

Migration of the contaminated groundwater will be minimized by pumping groundwater to achieve and maintain an inward and upward hydraulic gradient about the extraction wells.

Components 5 through 7

Hydraulic gradients shall be confirmed and the response of the aquifer and the contaminant plume to the extraction well operation characterized. A Performance Monitoring Plan shall be developed, approved by EPA by the EPA in consultation with PADEP, and implemented to achieve these goals. The information generated by work performed under the Performance Monitoring Plan will be evaluated in conjunction with additional hydrogeologic and contaminant distribution data generated during ongoing RI work. Based on these evaluations, the extraction well system will be modified as necessary during the interim action to optimize aquifer restoration and minimize groundwater contaminant migration.

Components 8 through 10

All extracted groundwater will be treated and will meet effluent limits developed in accordance with National Pollution Discharge Elimination System (NPDES) requirements under the Federal Clean Water Act, NPDES requirements under the Pennsylvania Clean Streams Law (25 PA Code, Chapter 92) and Pennsylvania Wastewater Treatment Requirements (25 PA Code, Chapter 95).

Component 11

All volatile organic compound emissions from the air stripper will be treated by vapor-phase carbon adsorption to meet the standards established by 25 PA Code, Chapter 127, Subchapter A, as well as the National Emissions Standards for Hazardous Air Pollutants (NESHAPs) and the National Ambient Air Quality Standards for Criteria Pollutants (NAAQS) under the Federal Clean Air Act. EPA Directive 9355.0-28, which covers emissions from air strippers at CERCLA sites, is a standard to be considered.

Component 12

Spent carbon from the carbon adsorption unit, spent carbon from the vapor-phase carbon adsorption unit and sludge generated during the treatment of metals will be handled in accordance with treatment, storage and disposal requirements under RCRA, including RCRA Land Disposal Restrictions in 40 C.F.R. Parts 262 and 268, Pennsylvania Hazardous Waste Management Regulations (25 PA Code, Article VII) and Residual Waste Regulations (25 PA Code, Article IX).

Component 13

To ensure that off-base groundwater does not present a threat to human health and the environment, a Groundwater Monitoring Plan will be developed and implemented. The Plan will be approved by EPA in consultation with PADEP and be revised on a periodic basis as necessary. The Plan will include monitoring of wells installed by the Navy and off-base wells used as a source of water supply. Additional monitoring wells shall be installed on off-base property as necessary. Monitoring will be conducted through the selection and implementation of the final remedy for OU-4 and for a projected thirty years.

Component 14

Existing supply wells within Area D shall not be used and no additional supply wells shall be installed within Area D. Institutional controls shall be implemented to prevent supply well use and installation. These institutional controls can be divided into two categories - those that address portions of Area D on current Navy property and those on current private property.

The institutional controls addressing Navy property will consist of restrictions on the use of water from existing wells and restrictions on the future installation of wells and/or the use of water from wells installed in the future. These restrictions will be included in leases for affected property and deeds entered into for the transfer of such property. The need for such restrictions shall initially be identified in Findings of Suitability to Lease and Findings of Suitability to Transfer, respectively, issued by the Navy.

Under this interim remedy, the institutional controls for affected private property will consist of the continued enforcement by the Township of Warminster of its Ordinance No. 32, which regulates well drilling in Warminster Township in order to promote the health of township residents.

Institutional controls must remain in place so long as a threat to human health and the environment is posed by the contaminated groundwater.

Component 15

The performance of the remediation with regard to the performance standards and the goals of protecting human health and the environment shall be reviewed every five years. A Five-Year Review Work Plan will be developed and approved by EPA in consultation with PADEP.

X. STATUTORY DETERMINATIONS

A. PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT

This interim action is protective of human health or the environment by minimizing the migration of and initiating restoration of groundwater contamination underlying Area D. This interim action is also protective by limiting or eliminating unacceptable exposure to the contaminated groundwater to the extent possible. The selected interim remedy will not pose unacceptable short-term risks to human health and the environment during implementation.

B. COMPLIANCE WITH ARARS

The selected interim remedy will comply with all applicable or relevant and appropriate requirements specific to this interim action. These ARARs include those identified in Section IX and those listed below:

1. Location-Specific ARARs

The substantive requirements of the Delaware River Basin Commission (18 C.F.R. Part 430) are applicable. These regulations establish requirements for the extraction and discharge of groundwater within the Delaware River Basin.

2. Action-Specific ARARs

Federal Clean Air Act requirements, 42 U.S.C. °°7401 et. seq., are applicable and must be met for the discharge of contaminants to the air. Pennsylvania's Air Pollution Control Act is also applicable, as are Pennsylvania's Air Pollution Control Regulations (25 PA Code, Chapters 121-142).

The requirements of Subpart AA (Air Emission Standards for Process Vents) of the Federal Resource Conservation and Recovery Act ("RCRA") regulations set forth at 40 C.F.R. Part 264 are relevant and appropriate and, (depending upon the levels of organics in the extracted groundwater and treatment residuals) may be applicable to the air stripping operations conducted as part of the selected interim remedy. These regulations require that total organic emissions from the air stripping process vents must be less than 1.4 kg/hr (3 lb/hr) and 2800 kg/yr (3.1 tons/yr).

25 PA Code, Section 123.31 is applicable to the selected remedial alternative and prohibits malodors detectable beyond the NAWC property line.

25 PA Code, Section 127.12(a)(5) will apply to new point source air emissions that result from implementation of the selected interim remedy. These Commonwealth of Pennsylvania regulations require that emissions be reduced to the minimum obtainable levels through the use of best available technology ("BAT") as defined in 25 PA Code, Section 121.1.

The substantive requirements of 25 PA Code, Section 127.11 will apply to the selected interim remedy. These Commonwealth of Pennsylvania regulations require a plan for approval for most air stripping and soil venting/decontamination projects designed to remove volatile contaminants from soil, water, and other materials.

Regulations concerning well drilling as set forth in 25 PA Code, Chapter 107 are applicable. These regulations are established pursuant to the Water Well Drillers License Act, 32 P.S. °° 645.1 et seq. Only substantive requirements of these regulations need be followed for onsite actions.

The groundwater collection and treatment operations may constitute treatment of hazardous waste (i.e., if the contaminated groundwater exhibits characteristics of hazardous waste), and may result in the generation of hazardous wastes derived from the treatment of the contaminated groundwater (i.e., spent carbon filters from carbon adsorption treatment of water and from vapor-phase carbon adsorption treatment of air emissions from air stripping operations). The interim remedy will be implemented in a manner consistent with the requirements of 25 PA Code, Chapter 262, Subparts A (relating to hazardous waste determination and identification numbers), B (relating to manifesting requirements for off-site shipments of spent carbon or other hazardous wastes), and C (relating to pretransport requirements); 25 PA Code, Chapter 263 (relating to transporters of hazardous wastes); and with respect to the operations at the Site generally, with the substantive requirements of 25 PA Code, Chapter 264, Subparts B-D, I (in the event that hazardous waste generated as part of the interim remedy is managed in containers) and 25 PA Code, Chapter 264, Subpart J (in the event that hazardous waste is managed, treated or stored in tanks). The interim remedy will be also be implemented in a manner consistent with 40 C.F.R. Part 264, Subpart AA (relating to air emissions from process vents), 40 C.F.R. Part 268, Subpart C, Section 268.30 and Subpart E (regarding prohibitions on land disposal and prohibitions on storage of hazardous waste) and 40 C.F.R. Part 264, Subpart AA (relating to air

emission standards for process vents).

25 PA Code, Chapter 264, Subchapter F, regarding groundwater monitoring is applicable to the selected interim remedy.

Any surface water discharge of treated effluent will comply with the substantive requirements of the Section 402 of the Clean Water Act, 33 U.S.C. º 1342, and the National Pollutant Discharge Elimination System ("NPDES") discharge regulations set forth at 40 C.F.R. Parts 122-124, the Pennsylvania NPDES regulations (25 PA Code, Section 92.31), and the Pennsylvania Water Quality Standards (25 PA Code, Sections 93.1-93.9).

25 PA Code, Sections 261.24 and 273.421 are applicable regulations for the handling of residual and other waste and for the determination of hazardous waste by the Toxic Characteristic Leaching Procedure ("TCLP").

3. Standards To Be Considered

Pennsylvania's Ground Water Quality Protection Strategy, dated February 1992.

EPA Directive 9355.0-28, which covers emissions from air strippers at Superfund groundwater remediation sites.

Pennsylvania Bureau of Air Quality Memorandum, "Air Quality Permitting Criteria for Remediation Projects Involving Air Strippers and Soil Decontamination Units".

EPA's Ground Water Protection Strategy, dated July 1991.

EPA OSWER Directive 9834.11 which prohibits the disposal of Superfund Site waste at a facility not in compliance with º3004 and º3005 of RCRA and all applicable State requirements.

C. COST-EFFECTIVENESS

The selected remedy is cost-effective in providing overall protection in proportion to cost.

D. UTILIZATION OF PERMANENT SOLUTIONS AND ALTERNATIVE TREATMENT TECHNOLOGIES OR RESOURCE RECOVERY TECHNOLOGIES TO THE MAXIMUM EXTENT PRACTICABLE

Although this action is not intended to fully address the statutory mandate for permanence and treatment to the maximum extent practicable, this interim action utilizes treatment and thus is in furtherance of that statutory mandate.

E. PREFERENCE FOR TREATMENT AS A PRINCIPAL ELEMENT

Because this action does not constitute the final remedy for Operable Unit Four, the statutory preference for remedies that employ treatment that reduces toxicity, mobility, or volume as a principal element, although partially addressed by this remedy, will be addressed by the final response action.

XI. DOCUMENTATION OF SIGNIFICANT CHANGES

None. The preferred alternative presented in the Proposed Plan was Alternative 3: Groundwater Extraction, Treatment at the Existing Treatment System, Discharge to Area A System Outfall, and Institutional Controls is the selected remedy based on public comments. The selected interim remedy for OU-4 is as described in the FFS and the Proposed Plan. Should additional RI work determine a remedial action is necessary to address groundwater in overburden and shallow bedrock attributable to another area at the Site, a Proposed Plan for that action shall be released to the public for comment prior to selecting a remedy.

XII. RESPONSIVENESS SUMMARY

A. OVERVIEW

In a Proposed Plan released for public comment on June 5, 1997, the Navy, with the support of EPA, identified Alternative 3 as the preferred interim remedial alternative for OU-4 at the Site.

Alternative 3 in the Proposed Plan was as described in Section VIII. of this ROD.

The majority of written and oral comments received during the public comment period were in support of Alternative 3 as described in the Proposed Plan and Section VIII. of this ROD. Based on these and other comments received during the public comment period, the Navy and EPA have selected Alternative 3 as the interim remedy for OU4. Other comments and the associated responses of the Navy and EPA are described below after a brief discussion of community involvement to date.

B. COMMUNITY INVOLVEMENT TO DATE

In July 1989, NAWC Warminster prepared a draft Community Relations Plan for RI/FS activities. Community relations activities to date have been conducted in accordance with this plan. These activities have included regular Technical Review Committee meetings with local officials, communications with the media and the establishment of information repositories.

The Navy and EPA established a public comment period from June 5, 1997 to July 3, 1997 for interested parties to comment on the Proposed Plan, the RI Report, the FFS Report and other documents pertaining to OU4. These and all other documents considered or relied upon during the interim remedy selection process for OU-4 are included in the Administrative Record, which has been in two information repositories accessible to the public since the beginning of the public comment period for OU4. A public meeting was held at the Warminster Township Building, Henry and Gibson Avenues, Warminster, Pennsylvania on June 16, 1997 to present the RI/FFS Reports and Proposed Plan, answer questions, and accept both oral and written comments for the OU-4 interim remedy. Approximately 15 people attended this meeting.

This Responsiveness Summary, required by CERCLA, provides a summary of citizens' comments identified and received during the public comment period and the responses of the Navy and EPA to those comments. All comments received by the Navy and EPA during the public comment period were considered by the Navy and EPA in selecting the interim remedy for OU-4. Responses to these comments are included in the section below.

C. SUMMARY OF COMMENTS RECEIVED DURING PUBLIC COMMENT PERIOD AND COMMENT RESPONSES

Comment #1:

Additional details should be provided on the institutional controls which are part of the preferred alternative.

Response #1:

A detailed descriptiin of the institutional controls which are a part of the selected remedy appears on page 34 (see Component 14) of this ROD.

Comment #2:

The institutional controls should be considered temporary in nature and readily adapt to changing circumstances.

Response #2:

See page 34 (Component 14) for a detailed description of institutional controls which are part of the selected remedy.

Comment #3:

The projected time frame for implementation of the final remedy should be provided.

Response #3:

The final remedy for OU4 will be selected and implemented after the full nature and extent of contamination attributable to Area D is identified and specific restoration standards for the affected groundwater can be established. The time frame in this case is dependent on the findings of ongoing and future Remedial Investigation work addressing OU-4 and information about the response of the aquifer to remediation measures. As a result, the timeframe cannot be

accurately projected at this time. However, because a final remedy for Area D groundwater on NAWC property should be operating properly and successfully before this property is transferred, every effort shall be made to select and implement the final remedy in this case as soon as possible.

Comment #4:

What is depth of groundwater contamination in Area D?

Response #4:

See Section V.B.4 of this ROD for a detailed discussion regarding the depth of groundwater contamination in Area D.

Comment #5:

The selected alternative should address containment of all contaminated groundwater in Area D: shallow, intermediate and deep. The extraction wells should be designed to contain deep contamination.

Response #5:

The interim remedy will be designed to minimize migration of and initiate restoration of all contaminated groundwater underlying Area D, including deep contamination. To facilitate this, certain additional RI work and/or design work will need to be completed and the results considered in the design of the initial extraction well network to be constructed and operated under the selected interim remedy. In particular, this work will include additional investigations on NAWC property to delineate the vertical distribution of contamination and to identify the effects of open pumping wells and long open boreholes in Area D which may locally induce contaminant movement in the aquifer.