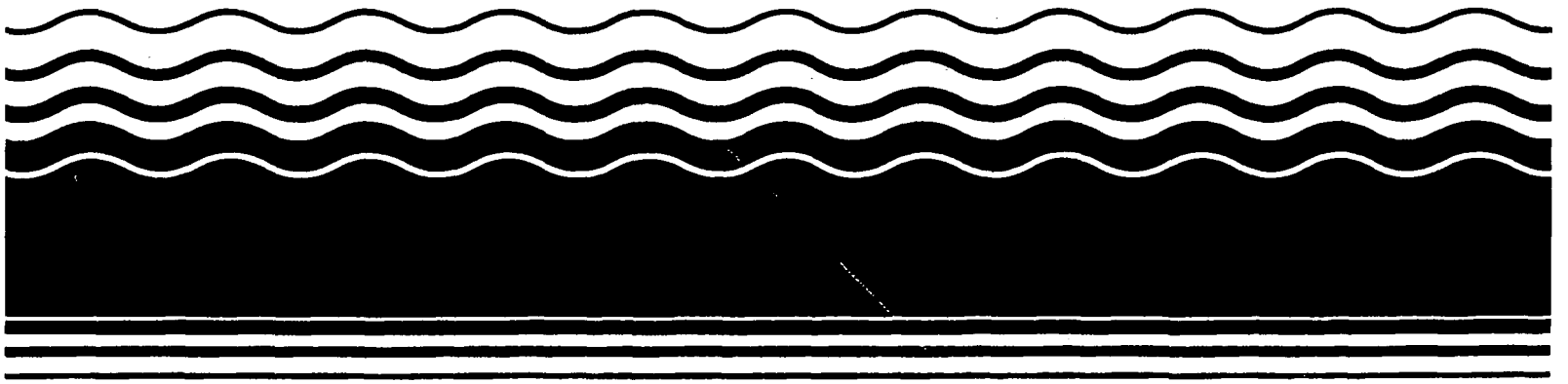
PB95-963926
EPA/ROD/R03-95/218
May 1996

EPA Superfund Record of Decision:

Naval Air Development Center (O.U. 3), Bucks County, Warminster Township, PA 3/10/1995



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 the selected remedial action for Operable Unit Three (OU-3) at the Naval Air Development Center Site 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. § 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.

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 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 remedy for OU-3 is the third response action addressing the Site. OU-3 consists of contaminated groundwater attributable to Area C at the Site. (Previous response actions have been selected and/or implemented to address Operable Units One and Two, which consist of contaminated groundwater

attributable to Areas A and B, and contaminated drinking water supplies, respectively.) The objective of the selected remedy for OU-3 is to restore contaminated groundwater attributable to Area C to a level protective of human health and the environment. Future actions at the Site will address disposed waste, soils, additional groundwater, and other media, as necessary to protect human health and the environment.

The selected remedy for OU-3 includes the following major components:

- Installation, operation and maintenance of groundwater extraction wells
- Installation, operation and maintenance of an onsite groundwater treatment system which includes precipitation, filtration, air stripping and carbon adsorption, and/or other necessary means of treatment
- Periodic sampling of treated water to ensure the effectiveness of the treatment system
- Discharge of treated water to an unnamed tributary of Little Neshaminy Creek
- Installation, operation and maintenance of a vapor phase carbon adsorption unit (if such a unit is necessary to control air emissions)
- Offsite treatment and/or disposal of solid residuals generated during water treatment and control of air emissions (if necessary)
- Monitoring of groundwater in monitoring wells and residential wells
- Installation and periodic sampling of observation wells to ensure the effectiveness of the groundwater extraction wells
- Periodic review of hydrogeologic data to evaluate the effectiveness of the groundwater extraction wells
- Modification of the groundwater extraction well system and/or groundwater treatment system as necessary based on periodic evaluations

STATUTORY DETERMINATIONS

Pursuant to duly delegated authority, we hereby determine, pursuant to Section 106 of CERCLA, 42 U.S.C. § 9606 that the selected remedy 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. This remedy utilizes permanent solutions and alternative treatment (or resource recovery) technologies to the maximum extent practicable, and it satisfies the statutory preference for remedies that employ treatment that reduces toxicity, mobility or volume as their principal element. Subsequent actions are planned to address other threats posed by the conditions at the Site.

A review will be conducted within five years of the initiation of the remedial action and every five years thereafter, as required by Section 121(c) of CERCLA, 42 U.S.C. Section 9621(c), to ensure that the remedy continues to provide adequate protection of human health and the environment.

Thomas C. Ames

Date 3/9/95

Thomas C. Ames
BRAC Environmental Coordinator
Naval Air Warfare Center, Warminster

Date 3/10/95

Thomas C. Voltaggio, Director
Hazardous Waste Management Division
EPA Region III

Concurrences								
Symbol	3HW72	3HW72	3HW70	3RC31	3RC31	3HW02	3HW00	3HW63
Surname	OSTRAUS	MYKIJEW	SOKOLO	EARLY	NISHITA	FERDAS	VOLTAGG	TAN
Date	2/9/95	2/9/95	2/9/95	3/9/95	3/9/95	3/9/95		3/10
Symbol	3HW50			3/9/95				
Surname	ALLEN							
Date	3/10/95							

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NAVAL AIR DEVELOPMENT CENTER

DECISION SUMMARY

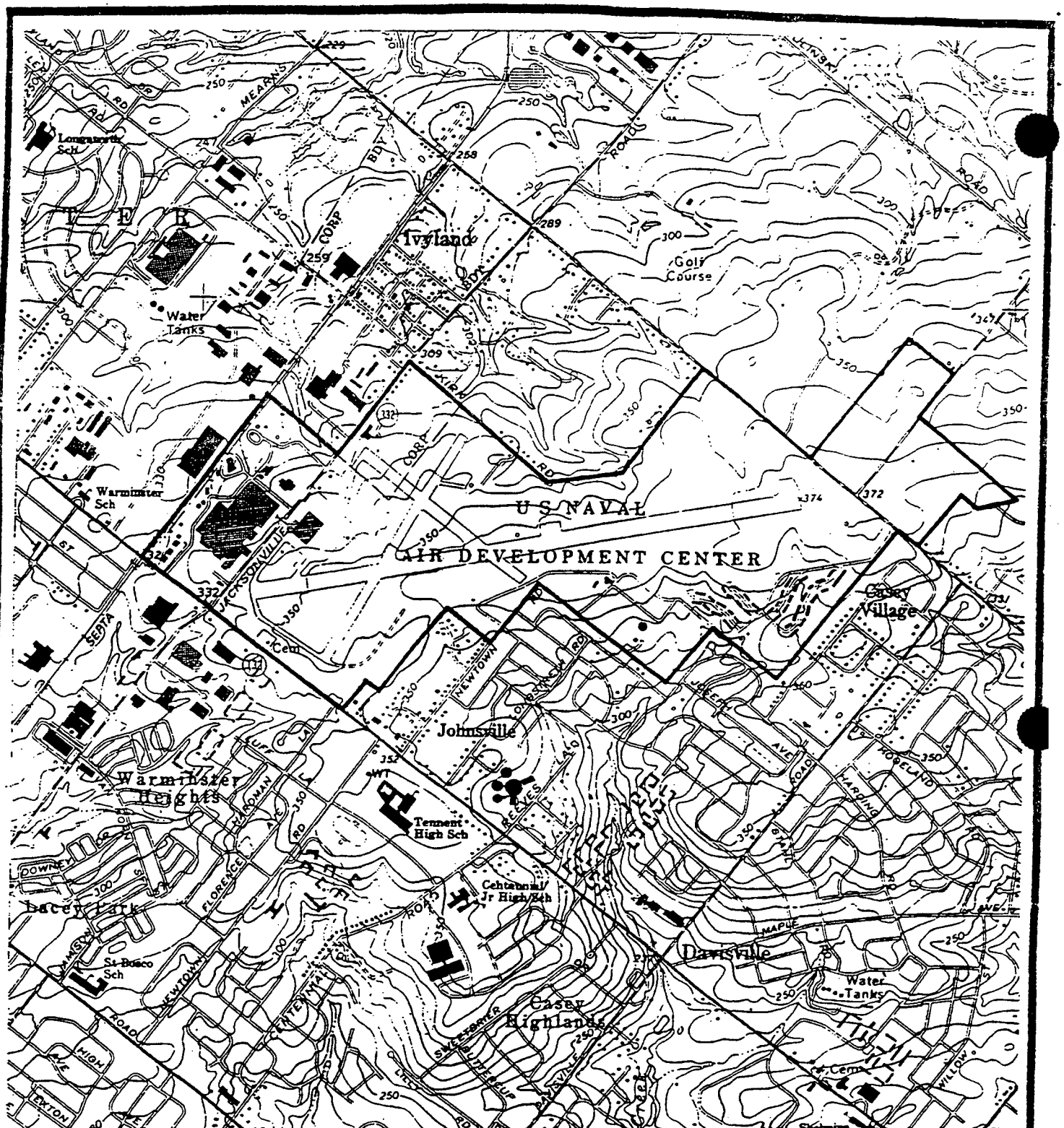
I. SITE NAME, LOCATION, AND DESCRIPTION

The Naval Air Development Center is a 734-acre Naval facility located in Warminster Township, Bucks County, Pennsylvania (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 small wooded area.

The longest runway, which is currently the only active 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 from 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 is research, development, testing, and evaluation for Naval aircraft systems. NAWC also conducts studies in anti-submarine warfare systems and software development. Under the Defense Base Realignment and Closure Act of 1990 (Public Law 101-510), the NAWC will be closed. All activities will be relocating to Patuxent River, Maryland, with the exception of an enlisted men's housing area in the southwestern corner of NAWC (see Figure 2). Current schedules indicate the NAWC will be relocated by September 1997.

NAWC currently has approximately 2,000 employees, and 1,000 people reside at the enlisted men's housing area year round. 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.



ADAPTED FROM THE U.S.G.S. HATBORO, PA 7.5 MINUTE QUADRANGLE (1966, PHOTOREVISED 1983)

FIGURE 1

NAWC WARMINSTER
SITE LOCATION MAP

NAWC is situated on an upland area divided between two local drainage basins, the Little Neshaminy Creek Basin on the north and the Southampton Creek Basin on the south. The northern 65 percent of the Site (including Area C) drains toward the north through several swales and storm sewers into small unnamed tributaries of the Little Neshaminy Creek. The southern 35 percent of the facility drains toward the south to the headwaters of Southampton Creek, a tributary of Pennypack Creek. Both local drainage basins lie within the regional drainage basin of the Delaware River. Several of the tributaries of Little Neshaminy and Southampton Creeks originate at, or near, the outfall points of culverts adjacent to the NAWC property boundary.

II. SITE HISTORY AND ENFORCEMENT ACTIVITIES

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 have been generated by NAWC during aircraft 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 of 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 identified as areas used for the disposal of wastes containing hazardous substances. A brief summary of these eight areas is provided in Table 1. Figure 2 provides the locations of these eight waste disposal areas. None of these areas are currently used for waste disposal. For investigative purposes, sites 1, 2 and 3 have been grouped into Area A, sites 5, 6 and 7 have been grouped into Area B, and sites 4 and 8 have been grouped into Area C. Figure 3 depicts site 4 and site 8, and other miscellaneous areas which collectively comprise Area C. Below is a description of the history of Area C.

1. Site 4

Site 4 is currently a grass-covered area covering 7 acres just north of the main runway along Kirk Road. Site 4 is the largest of the waste disposal locations referenced above and is less than 100 feet from the NAWC property line and Kirk/Newtown Roads. Private residences are located within approximately 200 feet of site 4. Surface drainage from site 4 discharges via two

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)

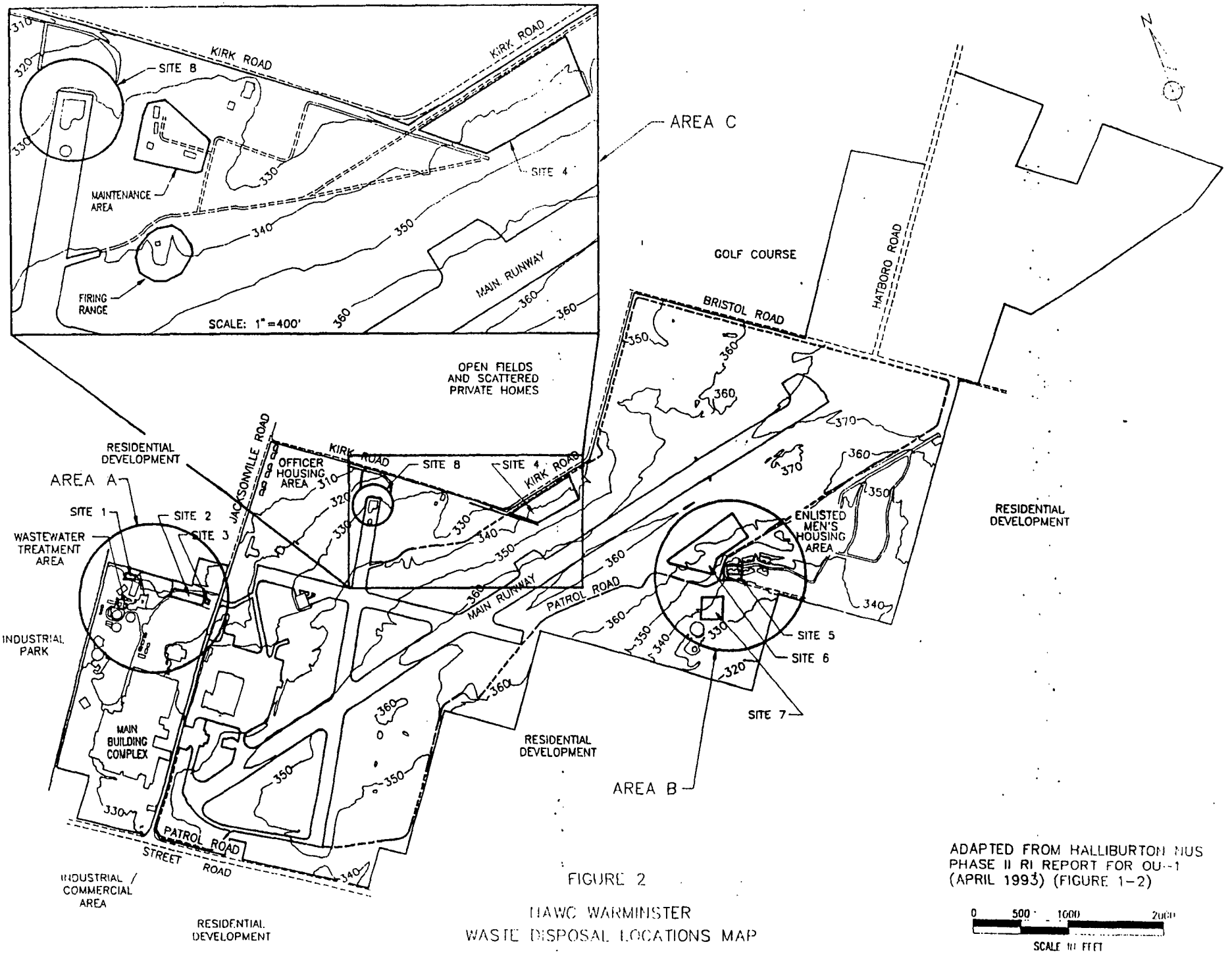


FIGURE 2

NAWC WARMINSTER

WASTE DISPOSAL LOCATIONS MAP

SOURCE: ADAPTED FROM HALLIBURTON NUS RI REPORT FOR OU-3 (AUGUST 1994)(FIGURE 1-2)

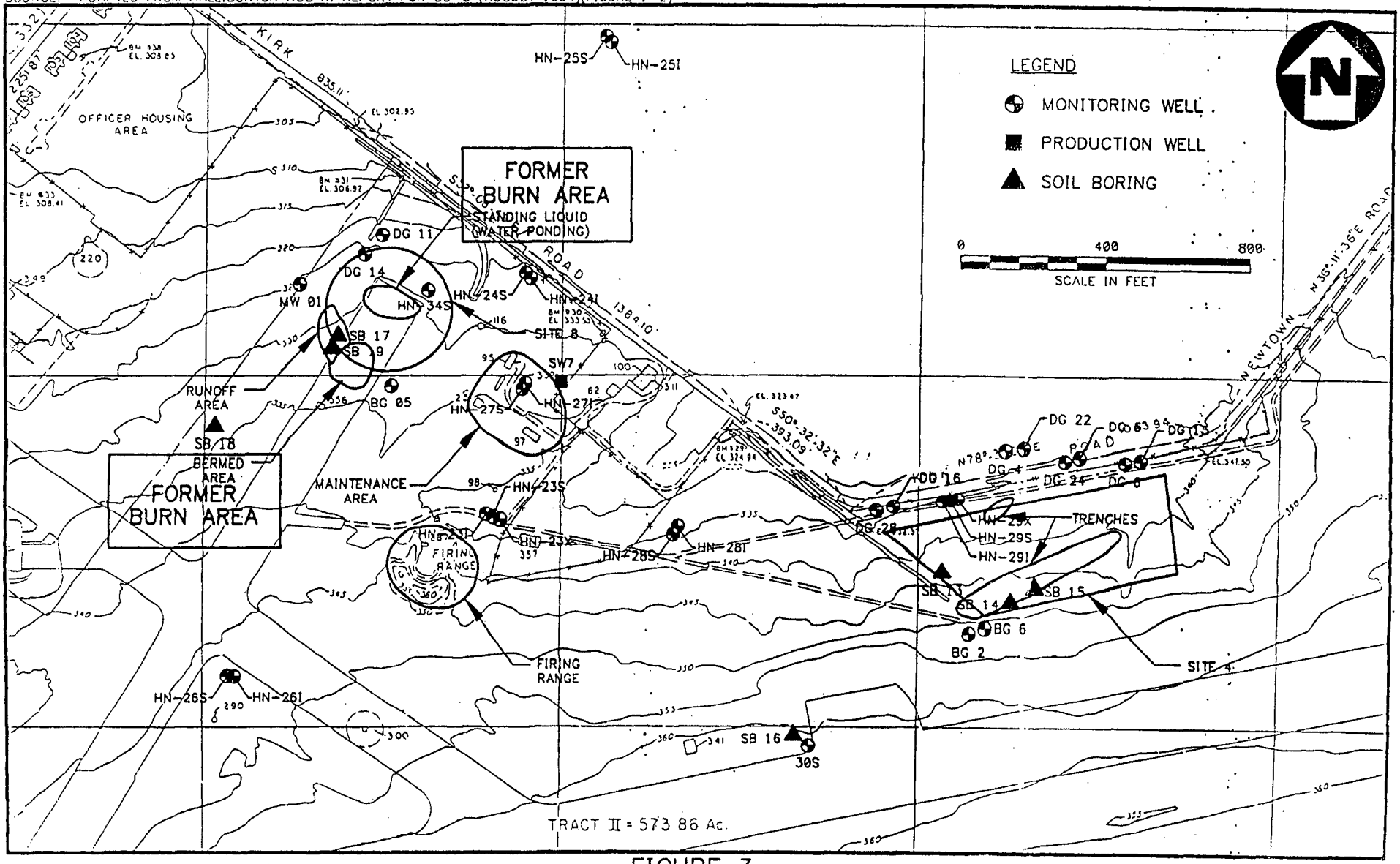


FIGURE 3
AREA C
(SITES 4, 8 AND MISCELLANOUS AREAS)
PRESENT/HISTORIC SITE FEATURES
NAWC WARMINSTER, PA

culverts to two separate unnamed tributaries of Little Neshaminy Creek located north of Kirk and Newtown Roads.

Site 4 reportedly was operated from 1966 to 1970. Up to seven trenches on site 4 reportedly were used to dispose of non-industrial solid waste, paints, waste oils, waste metals, construction debris, solvents, and sewage sludge from the sewage treatment plant. Each trench was reported to be approximately 12 feet wide, 1000 feet long, and nine feet deep. (The actual dimensions of the trenches are unknown.) Based on this estimate, a total of approximately 25,000 cubic yards of waste were deposited, with each trench holding approximately 3,600 cubic yards of waste. It is not known whether wastes were segregated prior to disposal or were placed randomly into each trench.

2. Site 8

The fire-fighting training area (site 8) is at the end of an abandoned runway running north off of the main airstrip. Directly to the northeast of site 8 are Kirk Road and Werner Park. Site 8 is about 300 feet from the NAWC property line and 400 feet from private residences on Kirk Road. A cement drainage culvert receives runoff from site 8 and discharges this runoff to an unnamed tributary of Little Neshaminy Creek which bounds Werner Park to the west.

The training area consisted of a 75- by 75-foot portion of the abandoned runway surrounded on three sides by a double soil berm. The berms were approximately 3 to 5 feet high. Site 8 was used for fire training exercises from 1961 to February 1988. Typically, flammable materials were poured on ponded water or debris on the runway, ignited, and extinguished to simulate fire-fighting procedures. Aviation fuel, scrapped cars and aircraft, and other debris were reportedly stored and burned within site 8. An estimated 3,000 gallons of aviation fuel were disposed annually at site 8. Historical aerial photos indicate that fire-training activities extended about 100 feet further down the abandoned runway during earlier years. Historically, residents along a unnamed tributary of Little Neshaminy Creek complained about white fire fighting foam in the creek after fire-fighting training exercises were held.

In October 1986, the Pennsylvania Department of Environmental Resources (PADER) recommended excavation and disposal of fire residuals and contaminated soils at site 8. By October 1988, the double soil berms had been removed. NAWC personnel reported that these berms, fire residuals, trapped liquids, and soil from eroded areas, had been analyzed and removed. The berm material was deposited in an area adjacent to site 8 and the area was regraded.

3. Miscellaneous Areas

A review of aerial photos and field observations indicate at least two additional areas within Area C which may be a source of hazardous substance releases. A pistol range was formerly located about 800 feet south of site 8 (see Figure 3). Aerial photos indicate standing liquids within a pit in the former pistol range. The pit has since been filled in and no other evidence of the former range is apparent at this time. Another potential area of concern is a small complex of maintenance buildings located approximately 400 feet southeast of site 8 (see Figure 3). Based on field observations, these buildings currently appear to be used primarily for storage and maintenance of lawn care equipment.

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 three phases: a Phase I RI, Phase II RI and a Focused 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. The 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 offsite wells to assess the impact of contaminated groundwater attributable to NAWC on offsite 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 determined this offsite 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 investigation of groundwater in the vicinity of the main building complex at the base (identified as Area D).

Investigative work addressing Area C under the Focused RI has been completed. The results of this work are summarized in an RI Report for OU-3 dated August 1994, where OU-3 has been defined as contaminated groundwater attributable to Area C.

In August 1994, the Navy also released a Focused Feasibility Study (FFS) Report for OU-3 at the Site. The FFS for OU-3 developed several remedial alternatives for addressing contaminated groundwater attributable to Area C.

III. HIGHLIGHTS OF COMMUNITY PARTICIPATION

Since 1988, the plans and results of CERCLA investigations and actions have been presented to a Technical Review Committee (TRC) for the Site. The TRC includes representatives of the Bucks County Health Department, Warminster Township, the Warminster Township Municipal Authority, Upper Southampton Township, the Upper Southampton Water and Sewer Authority, Northampton Township and the Northampton Municipal Authority. Beginning in December, 1993, the TRC became the Restoration Advisory Board (RAB). 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 in August 1994, presenting the preferred remedy for OU-3. The Proposed Plan and RI and FFS reports for OU-3 were among those documents included in the Administrative Record. The Administrative Record is available for review by the public at the following information repositories:

- NAWC Public Works Environment Staff Office
  Jacksonville Road (Building 2)
  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 preferred remedy for OU-3 was published in the Philadelphia Inquirer, Intelligencer, Public Spirit, and Courier Times on September 1 and 2, 1994. Additionally, the Proposed Plan and the Notice of Availability were mailed to local municipal and government agencies in the vicinity of the Site.

The public comment period for the Proposed Plan was from September 1, 1994 to September 30, 1994. A public meeting was held at McDonald Elementary School, Street Road, Warminster, Pennsylvania on September 8, 1994 to present the RI, FFS and Proposed Plan, address concerns, 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. § 9617(a)(2). Responses to significant oral comments during the public meeting are in the transcript of the meeting, which is now part of the Administrative Record. Responses to comments received during the public comment period are included in the Responsiveness Summary section of this ROD.

This Record of Decision presents the selected remedial action for OU-3 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 three operable units. These operable units (OUs) are as follows:

- OU-1: Contaminated groundwater attributable to Areas A and B
- OU-2: Contaminated off-site private wells
- OU-3: Contaminated groundwater attributable to Area C

The Navy and EPA have already selected an interim remedy for OU-1 in a ROD signed on September 29, 1993, while a removal action for OU-2 has been selected by EPA in a Removal Action Memorandum signed on July 14, 1993. The Navy initiated construction of the remedy for OU-1 in January 1995. The EPA initiated construction of the removal action for OU-2 in June 1994 and completed construction of this removal action in December 1994.

This ROD selects a remedy for OU-3, contaminated groundwater attributable to Area C at the Site. This groundwater presents an unacceptable threat to human health and sufficient information is available to select a remedy at this time. The objective of the remedy for OU-3 is to restore contaminated groundwater attributable to Area C to a level consistent with Federal and State Applicable or Relevant and Appropriate Requirements (ARARs), including drinking water standards, and to a level that is protective of human health and the environment.

Other media associated with the Site, including disposed wastes, soils, other groundwater, surface water and sediment, will be further investigated under the Phase III RI. 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 also be designated as an operable unit by the Navy and EPA.

V. SUMMARY OF SITE CHARACTERISTICS AND EXTENT OF CONTAMINATION

Summarized below are the primary findings of the RI with regard to contaminated groundwater attributable to Area C.

A. SITE CHARACTERISTICS

1. Soils and 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.

Soils observed within Area C during RI work have ranged from 2 to 15 feet in thickness. Soil types observed included orange-red, brown and maroon-red mixtures of silt, clay and sand, with finer-grained soils dominant. The U.S Soil Conservation Service (SCS) has mapped the soils at site 4 as Duncannon silt loam and Chalfont silt loam (USDA, 1975). The Duncannon silt loam is reported to have moderate permeability, and the Chalfont silt loam is described as having slow permeability. The SCS has mapped the soil at site 8 as Urban Land - Landsdale Complex, indicating that these soils were reworked from their natural state.

The soils at Area C lie over highly weathered bedrock which starts at 5 to 15 feet in depth. The weathered bedrock gradually grades into competent bedrock. The surface of the competent bedrock has a northerly slope across Area C. A minor trough in the bedrock surface is located between sites 4 and 8. This trough corresponds to a subdued topographic low which extends off of NAWC property to the north to the small stream that drains Area C.

The bedrock belongs to the late Triassic age middle arkose member of the Stockton Formation. The Stockton Formation underlying Area C consists of alternating lithologic units of predominantly gray and brown, fine-grained arkosic sandstone and red-brown siltstone/mudstone. Individual beds or defined sequences of rock units of predominantly one lithologic type range from a few feet to approximately 50 feet in thickness across the area. Major lithologic units can be traced over significant portions of Area C, although the thinner beds within a unit are often difficult to correlate and may pinch out over distances of several hundred feet.

Within Area C, a bedrock strike of north 70 degrees east and a dip of 9 degrees to the northwest have been measured based on correlations between geophysical logs from well borings. This strike and dip matches up well with regional information regarding the bedrock structure. The direction of slope of the ground surface across Area C generally mimics the direction of dip of the underlying bedrock; however, the beds dip more steeply than the ground surface. Based on projections made using the measured bedrock strike and dip, the lithologic units encountered at depth within the northern portion of Area C outcrop in or adjacent to the southern, topographically higher part of Area C.

In particular, some of the deeper units encountered outcrop along the runway area at the top of a hill south of Area C.

Fractures have been encountered at various depths in well borings within Area C. Both the coarser-grained sandstone units and the fine grained siltstones/mudstones were fractured to varying degrees. No generalizations regarding the frequency of fracturing relative to rock type have been identified, however the fractures in the sandstones generally were more likely to produce significant quantities of water than the siltstone/ mudstone fractures. Both cross-cutting fractures and bedding plane fractures were identified through interpretations of drilling and geophysical logs, and borehole camera tapes.

No direct observations of fracture orientations have been made due to the absence of any outcrops in the area; however, it is typical for well developed, systematic joint sets to occur within lithologic units along orientations parallel and perpendicular to bedrock strike, and of 45 to 60 degrees from bedrock strike.

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 C occurs primarily with 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 C 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. Limited hydraulic conductivity testing of the overburden has resulted in hydraulic conductivity estimates ranging from 0.2 to 2.3 ft/day, and yields from overburden monitoring wells are typically less than 1 gallon per minute (gpm).

3. Hydrology

An unnamed tributary of Little Neshaminy Creek is located north of site 4, in Munro Park. This stream originates at the base of the storm sewer drain east of site 4 and runs east to west through Munro Park immediately north of residences along Kirk Road.

During base flow conditions, this stream appears heavily silted and has an estimated maximum flow rate of seven to 10 gpm. The uppermost part of this stream is small and intermittent and during dry periods, water in the stream tends to be limited to pool areas. The stream channel is well developed despite the low and intermittent flow rates. Channel width is 3 to 5 feet and channel depth is 1 to 2 feet. Sediments in the stream are primarily sands and cobbles with some silts.

Site 8 is drained by a concrete swale that discharges directly to an intermittent stream through a culvert beneath Kirk Road north of site 8. The intermittent stream is channelized and flows to the north for approximately 750 feet until it joins the unnamed tributary of Little Neshaminy Creek that originates near site 4.

In addition, a groundwater seep on the western perimeter of site 4 drains to a second culvert under Kirk Road, which also discharges to the same unnamed tributary.

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 a prevailing direction of west-southwest.

5. Ecology

Open land, woodland, and wetland habitats are all found within or near Area C. These habitats include mowed fields and lawns, nonforested overgrown land, wooded areas, forested wetlands, scrub/shrub wetlands, and streams with associated riparian areas.

There are no known threatened or endangered species on or near Area C; however, some such species could traverse Area C.

Mourning doves, pheasants, and various songbirds such as sparrows, red-winged black birds, gold finches, cardinals, blue jays, and robins are present throughout the Site. Canada geese and ducks have been observed in the streams south of Area B and north of Area A. Snakes, leopard frogs, and muskrats have also been observed in or near these streams. Snails, earthworms, amphipods, and larval insects have also been observed. Small fish or minnows tentatively identified as creek chubs are present in each of the streams from which surface water and sediment samples were obtained. White-tailed deer, groundhogs, rabbits, and squirrels are common on NAWC property. Raccoon tracks have been observed in several adjacent streams.

A Wetlands Assessment for NAWC (NUS, 1994) has identified off-base areas receiving surface drainage from Area C as wetlands.

The discussion above is based on available information. A complete ecological assessment shall be completed for Area C (and the entire Site) as part of the RI for the Site.

6. Groundwater Use

Groundwater is the primary source of residential, industrial and commercial water supplies in the immediate vicinity of the Site. The groundwater is provided either through individual, privately owned wells or by larger supply systems which have their own wells. The location of former private wells in the immediate vicinity of Area C is provided in Figure 4. (All of these private wells have been connected to a public water system as part of a removal action addressing OU-2.) There are approximately thirty-five (35) domestic wells and one municipal water supply well within 3200 feet of Area C at this time.

B. NATURE AND EXTENT OF CONTAMINATION

The findings of the RI with respect to contaminated groundwater attributable to Area C are provided in detail within the RI Report for OU-3. A summary of the major findings for OU-3 are presented below.

Monitoring Wells

All monitoring wells in the vicinity of Area C are depicted in Figure 4. These wells monitor groundwater from 7 to 172 feet in depth and are located both on and off NAWC property.

Groundwater level measurements indicated that groundwater in overburden and shallow bedrock is flowing north from Area C to offbase areas along and north of Kirk Road.

Table 2 summarizes the analytical results for samples collected from these wells from January 1994 through May 1994. Tetrachloroethylene (PCE) and acetone were the two organic contaminants detected at significant concentrations and frequency. A level of 2 micrograms per liter (μg/l) of PCE was detected in monitoring well HN-25I, which is located approximately 500 feet from the NAWC property boundary.

Samples were also collected to identify both total (unfiltered) and dissolved (filtered) concentration of inorganics. Arsenic, beryllium and thallium were all detected at elevated levels. However only thallium appeared to be at a concentration above natural, background levels.

2. Offsite Private Wells

As part of the RI for OU-3, the private residential wells along Kirk Road and the NAWC property boundary were sampled from May 1993 through July 1994. The wells sampled include those noted as residential wells R1 through R9 in Figure 4. Seven of these wells contained PCE at levels over 5 μg/l, the Maximum Contaminant Level for this compound in public water supplies. Based on groundwater flow measurements, these levels appear to be attributable to Area C. However, based on available data, the specific location of the release within Area C is unknown. As previously stated, all homes on Kirk Road are now connected to a public water supply system.

SOURCE: ADAPTED FROM HALLIBURTON NUS RI REPORT FOR OU-3 (AUGUST 1994)(FIGURE 2-1)

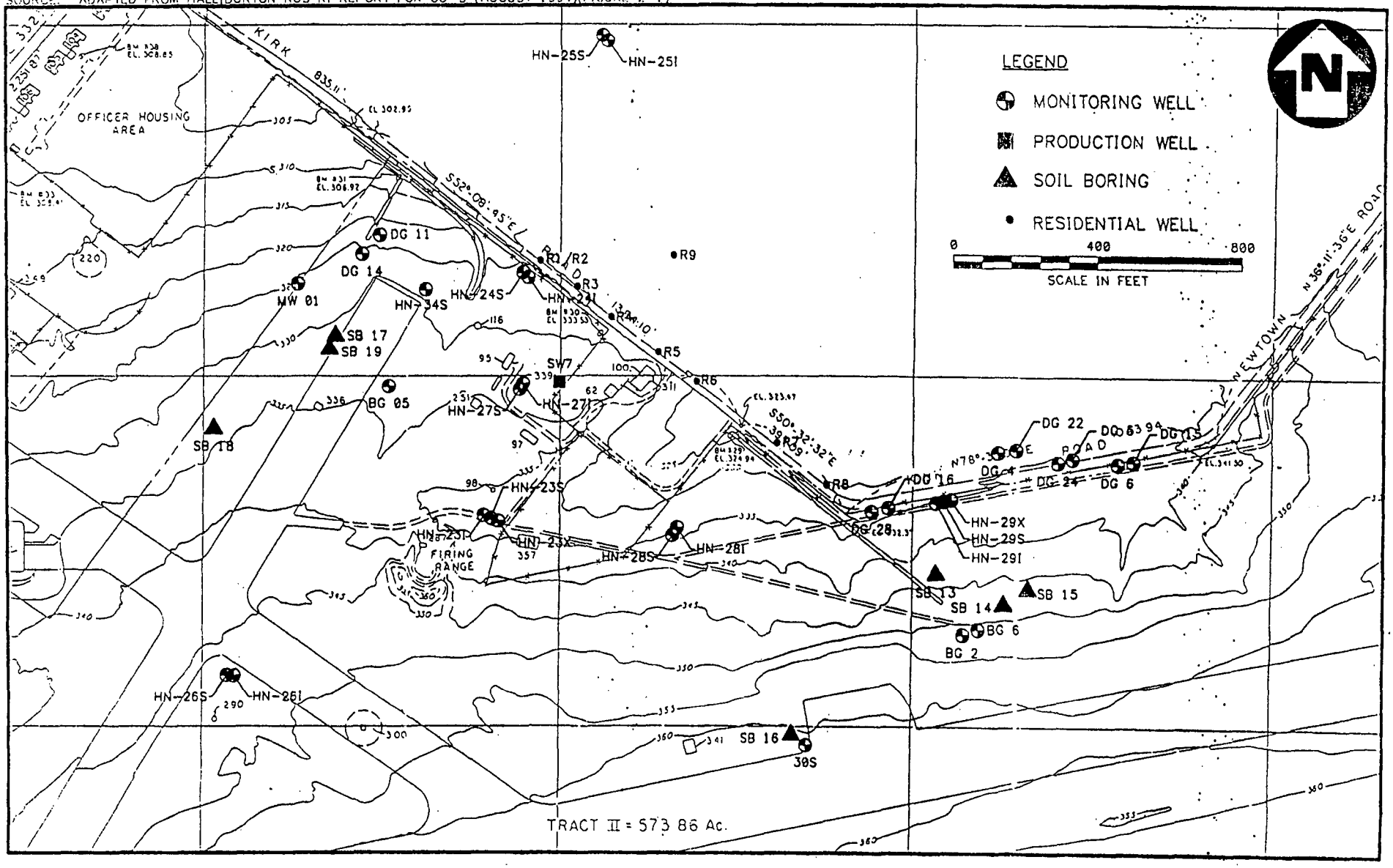


FIGURE 4
AREA C – WELL LOCATIONS
NAWC WARMINSTER, PA

3. Surface Water

The quality of surface water being discharged from Area C has not been fully characterized at this time. However, preliminary data (see Draft Phase II RI Report, NUS (1992)) suggests there are no impacts of concern on the tributary of Little Neshaminy Creek. The Phase III RI, scheduled to begin in 1995, will complete the investigation of surface water which may be impacted by Area C. Any remediation determined necessary will be addressed in a future OU.

TABLE 2
FREQUENCY OF OCCURRENCE AND DISTRIBUTION
POSITIVELY DETECTED SUBSTANCES - AREA C MONITORING WELLS
NAWC, WARMINSTER, PENNSYLVANIA

Chemical	Frequency of Detection	Range of Positive Results (µg/L)	Location of Maximum
ORGANICS			
Acetone	9/24	8-74	HN23-S
Toluene	2/34	1-2	DG-22
Tetrachloroethene	10/34	1-29	HN24-S
Diethylphthalate	1/22	1	HN24-I
Di-n-butylphyhalate	4/22	1-2	HN25-S,I
Endosulfan II	1/22	0.24	HN28-S
TOTAL METALS			
Aluminum	30/34	45.9-20,900	HN29-X
Antimony	1/34	47.3	HN29-I
Arsenic	17/34	3.0-13.6	HN28-S
Barium	34/34	40.8-593	DG-4
Beryllium	4/34	1.1-1.5	BG-6/HN25-S
Cadmium	8/34	3.2-4.4	HN25-S
Calcium	34/34	11,900-67,700	DG-15
Chromium	4/34	8.0-15.5	HN29-X
Cobalt	2/34	4.1-16.5	HN23-X
Copper	21/34	6.6-79.2	HN29-X
Iron	23/34	107-35,200	DG-4
Lead	12/34	1.0-11.9	BG-6
Magnesium	34/34	4,710-33,700	HN29-X
Manganese	31/34	13.5-1,840	HN29-X
Mercury	5/34	0.13-0.22	HN25-S
Potassium	32/34	865-2,360	BG-2
Sodium	34/34	5,370-35,200	HN24-I
Thallium	1/34	5.1	HN29-I
Vanadium	2/34	20.9-21.7	NH29-X
Zinc	13/34	8.4-225	DG-6

Adopted from - Halliburton NUS Corporation Remedial Investigation Report for Operable Unit 3, August 1994

TABLE 2 (Continued)
FREQUENCY OF OCCURRENCE AND DISTRIBUTION
POSITIVELY DETECTED SUBSTANCES - AREA C MONITORING WELLS
NAWC, WARMINSTER, PENNSYLVANIA

Chemical	Frequency of Detection	Range of Positive Results (µg/L)	Location of Maximum
DISSOLVED METALS			
Aluminum	1/34	372	BG-2
Antimony	12/34	35.2-64.7	HN26-I
Arsenic	4/34	3.7-10.9	HN28-S
Barium	34/34	45.7-552	DG-4
Cadmium	2/34	4.3-5.5	HN25-S
Calcium	34/34	9,070-64,000	DG-15
Copper	11/34	6.1-17.3	HN34-S
Cobalt	10/24	2-118	22.8
Iron	13/34	5.6-18,200	DG-4
Lead	2/34	1.7-15.9	MW01
Magnesium	34/34	2,790-28,000	HN29-X
Manganese	28/34	1.4-1,380	DG-15
Mercury	1/34	0.33	BG-6
Potassium	31/34	747-2220	BG-2
Sodium	34/34	5,380-34,600	HN24-I
Vanadium	2/34	3.6-3.8	HN26-I
Zinc	23/34	3.5-47.0	DG-6

Adopted from - Halliburton NUS Corporation Remedial Investigation Report for Operable Unit 3, August 1994

VI. SUMMARY OF SITE RISKS

This section summarizes available assessments of risk posed by contaminated groundwater attributable to Area C to human health and the environment. These assessments are based on RI information generated to date. The risk assessment process is designed to be conservative. The methods used for the risk assessment are consistent with current U.S. EPA guidance as outlined in:

> Risk Assessment Guidance for Superfund - Volume 1 - Human Health Evaluation Manual (Part A).
> U.S. EPA, December 1989.
>
> Risk Assessment Guidance for Superfund - Volume 1 - Human Health Evaluation Manual (Part A).
> Supplemental Guidance - Standard Default Exposure Factors, U.S. EPA, March 25, 1991.
>
> Dermal Exposure Assessment: Principles and Applications.
> U.S. EPA, January 1992.

Due to a removal action by EPA (under OU-2), residents are not exposed to contaminated groundwater apparently attributable to Area C at this time. As a result, this risk assessment assesses risks to potential future users of contaminated groundwater attributable to Area C.

A. HUMAN HEALTH

As part of the RI, a risk assessment was conducted with available data to estimate the potential risks to human health posed by the contaminated groundwater attributable to Area C. Since there is no current exposure to contaminated groundwater attributable to Area C, only potential exposure of residents to this contaminated groundwater is evaluated below.

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 carcinogenic risk increase from exposure should fall within a range of 1×10^{-6} (an increase of one case of cancer for one million people exposed) to 1×10^{-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 exposure to contaminated groundwater attributable to Area C were estimated for adult residents and child residents. To assess these carcinogenic and noncarcinogenic risks, primary organic and inorganic 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 described as 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 from animal studies. RfDs and CSFs used to calculate estimated risks in this case are identified in the RI.

The RI Report for OU-3 contains a detailed risk assessment for contaminated groundwater attributable to Area C at the Site in overburden and shallow bedrock. 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.

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.

Summarized below are the results of the risk assessment for contaminated groundwater attributable to Area C.

1. Area C

Cumulative, total estimated risks to human health due to potential exposure to noncarcinogenic and carcinogenic groundwater contaminants attributable to Area C at the Site are summarized in Tables 3 and 4, respectively.

The risk assessment for contaminated groundwater attributable to Area C (OU-3) found the carcinogenic risk for hypothetical exposure to this groundwater was an estimated 1.2×10^{-4}. The carcinogenic risk associated with PCE, the only organic contaminant contributing to this risk, was 3.1×10^{-6}. The carcinogenic risks for arsenic and beryllium were calculated at 8.7×10^{-5} and 3.3×10^{-5}, respectively. However as previously noted in Section V.B.1, the detected levels of arsenic and beryllium appear to be attributable to natural, geologic conditions. While thallium and acetone were both detected at levels above background, there was no carcinogenic risk associated with these substances.

The total Hazard Index and Hazard Indices for each substance were calculated using unfiltered monitoring well sample results. Using this data, the total Hazard Index was determined to be well in excess of one, primarily due to elevated levels of manganese, and to a lesser extent, antimony and thallium. However, it appears that manganese and antimony are naturally occurring and at background concentrations. No organic compounds were significant contributors to the Hazard Index. As a result thallium is the only contaminant attributable to Area C that has been determined to present an unacceptable non-carcinogenic risk.

The overall carcinogenic risk attributable to groundwater contaminated by Area C could potentially be considered acceptable. However, PCE has been detected in residential wells formerly used for drinking water and bathing purposes at levels ranging up to 31 μg/l, in excess of the Maximum Contaminant Level MCL) of 5 μg/l for PCE. Based on this information and the conclusions of the risk assessment described above, PCE and thallium are the groundwater contaminants attributable to Area C that present a threat to human health.

Actual or threatened releases of hazardous substances from NAWC, if not addressed by a response action, may present potential or actual threats to public health, welfare, or the environment.

TABLE 3
SUMMARY OF POTENTIAL NONCARCINOGENIC RISKS
AREA C GROUNDWATER

Exposure Route	Receptor	
	Adult Resident	Child Resident
Ingestion	11.6	27.0
Dermal Cont	NA	4.9E-3
Inhalation	NA	NA
Total Risk	11.6	27.0

TABLE 4
SUMMARY OF POTENTIAL CARCINOGENIC RISKS
AREA C GROUNDWATER

Exposure Route	Receptor	
	Adult Resident	Child Resident
Ingestion	1.2E-4	5.7E-5
Dermal Cont	NA	1.9E-7
Inhalation	4.4E-8	NA
Total Risk	1.2E-4	5.7E-5

Adopted from Halliburton NUS Corporation, Phase II Remedial Investigation Report, OU-3 August 199

B. ENVIRONMENT

Limited surface water investigations conducted during the Phase II RI suggest that contaminated groundwater attributable to Area C is not impacting the quality of an unnamed tributary of Little Neshaminy Creek. However, the investigations to date are incomplete. Additional investigations shall be performed as needed to determine whether contaminated groundwater attributable to Area C presents an unacceptable risk to human health and the environment due to impacts on surface water.

C. CONCLUSIONS

Contaminated groundwater attributable to Area C at the Site has been determined to present an unacceptable risk to human health. Actual or threatened releases of hazardous substances from the Site, if not addressed by implementing the remedial action selected in this ROD, may present an imminent and substantial endangerment to public health or welfare, or the environment.

VII. DESCRIPTION OF ALTERNATIVES

An FFS was conducted by the Navy to identify and evaluate remedial alternatives for contaminated groundwater attributable to Area C. Applicable engineering technologies for achieving the remedy objective to eliminate unacceptable risk associated with exposure (or potential exposure) to groundwater contaminants attributable to Area C 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 and the NCP. Three remedial alternatives were developed for OU-3. Costs and implementation times were estimated for each alternative described in this section.

A. ALTERNATIVE 1: NO ACTION WITH GROUNDWATER MONITORING

The NCP requires that the "no action" alternative be evaluated at every Site to establish a baseline for comparison with action alternatives. Under this alternative, no remedial action would be undertaken to address contaminated groundwater attributable to Area C. Monitoring of groundwater in overburden and shallow bedrock aquifers would be conducted for 30 years.

For cost estimation purposes, an estimated total of 16 wells would be sampled quarterly for an estimated 30-year period. The frequency of sampling may be reduced after a reliable trend has been established. 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 $1,853,000 over a 30-year period, with a capital cost of $69,696 and an annual operation and maintenance (O&M) cost of $116,000.

B. ALTERNATIVE 2: GROUNDWATER EXTRACTION, TREATMENT AT AREA C, AND DISCHARGE TO SURFACE WATER IN THE VICINITY OF AREA C

Under this alternative, contaminated groundwater attributable to Area C at the Site 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 on-site treatment system constructed specifically to treat groundwater and located within Area C. Water treatment would include precipitation, filtration, carbon adsorption, and/or other treatment methods as necessary to meet effluent limits consistent with National Pollution Discharge Elimination System (NPDES) requirements under the Federal Clean Water Act and Pennsylvania Clean Streams Law. 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. Part 268, Pennsylvania Hazardous Waste Management (25 Pa. Code, Article VII) and Residual Waste Regulation (25 Pa. Code, Article IX). (A detailed inventory of all applicable or relevant and appropriate requirements (ARARs) for the alternatives being evaluated is provided in Section X.B.) The treated water would be discharged to an unnamed tributary of Little Neshaminy Creek located immediately north of Area C and Kirk Road.

Concurrent with the design, construction, and operation of the extraction well network and treatment system, monitoring and investigations would be conducted both on and off NAWC property as necessary to fully identify the nature and extent of groundwater contamination attributable to Area C and to assess the effectiveness of the system. Monitoring of groundwater associated with Area C would be conducted throughout the implementation of the remedy. The extraction well network and treatment system would be modified as necessary based on the results of the monitoring and investigations.

To estimate the cost of this alternative, the following assumptions were made: a series of 8 extraction wells would be installed; a total flow of 52 gallons per minute (gpm) would be pumped to an adjacent treatment plant within Area C; 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 extraction wells were installed and additional groundwater were extracted and treated.) Based on these assumptions, the present worth of this alternative was estimated at $5,075,000, with a capital cost of $1,545,393 and an operation and maintenance cost of $229,629 annually. This alternative could be constructed in 12 months or less.

ALTERNATIVE 3: GROUNDWATER EXTRACTION, TREATMENT AT AREA C OR AREA A, AND DISCHARGE TO SURFACE WATER AT AREA A SYSTEM OUTFALL

Under this alternative, contaminated groundwater attributable to Area C at the Site 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 on-site treatment system at Area C or Area A. If pumped to Area A, the extracted groundwater would be treated either by the treatment system constructed within Area A pursuant to the ROD for OU-1 or by an additional and separate system constructed within Area A pursuant to this ROD. If such treatment is conducted by a separate additional system within Area A or a system within Area C, it is projected to include, at a minimum, precipitation, filtration and carbon adsorption. If treated by the treatment system constructed within Area A pursuant to the ROD for OU-1, water treatment would include air stripping. Organic and inorganic treatment residuals would be disposed offsite and handled as required by treatment, storage and disposal regulations of RCRA, including LDRs under 40 C.F.R. Part 268, 25 Pa. Code, Article VII and 25 Pa. Code, Article IX. (A detailed inventory of all applicable or relevant and appropriate requirements (ARARs) for the alternatives being evaluated is provided in Section X.B.)

Regardless of the location of the treatment system, the treated water would be discharged to the outfall of the treatment system constructed within Area A pursuant to the ROD for OU-1. (Treated water from a treatment system at Area C would be conveyed to Area A for discharge to this outfall.)

Concurrent with the design, construction, and operation of the extraction well network and treatment system, monitoring and investigations would be conducted both on and off NAWC property as necessary to fully identify the nature and extent of groundwater contamination attributable to Area C and to assess the effectiveness of the system. Monitoring of groundwater associated with Area C would be conducted throughout the implementation of the remedy. The extraction well network and treatment system would be modified as necessary based on the results of the monitoring and investigations.

The present worth of this alternative was estimated to range from $4,944,000 to $5,224,000 with a capital cost ranging from $1,186,852 to $1,839,690 and an operation and maintenance cost ranging from $214,729 to $244,444 annually. This alternative could be constructed in 12 months or less.

VIII. COMPARATIVE ANALYSIS OF ALTERNATIVES

To help select a remedial action, CERCLA and the NCP require 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 protect both human health and the environment by capturing and treating contaminated groundwater attributable to Area C at the Site and restoring the quality of the aquifer to levels protective of human health and the environment. Any additional monitoring necessary to determine the full nature and extent of groundwater contamination attributable to Area C would be conducted concurrently with the design, construction, and operation of the groundwater extraction and treatment system.

Alternative 1 would not restore the quality of contaminated groundwater attributable to Area C to levels protective of human health and the environment.

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

ARARs for both Alternatives 2 and 3 are identified in detail within Sections IX and X. Based on available information, it is unknown whether Alternative 2 could meet all ARARs (see Section VIII.F). Alternative 3 is expected to meet all ARARs. Since no remedial action would be taken under Alternative 1, there are no ARARs associated with remedial activity under this alternative.

C. LONG-TERM EFFECTIVENESS AND PERMANENCE

Alternatives 2 and 3 provide a permanent remedy and both would be effective over the long term in addressing groundwater contamination at Area C. Both alternatives require groundwater monitoring to evaluate their effectiveness. Operation and maintenance of the treatment plant and monitoring of the treated discharges would be required for both alternatives.

Alternatives 2 and 3 would also be effective over the long-term for remediating all contaminated groundwater attributable to Area C at the Site by preserving the capacity of the OU-1 treatment system currently being constructed within Area A to the extent necessary. Alternative 2 would do so by establishing a separate treatment facility within Area C; Alternative 3 would provide for a separate treatment system within Area A for treating groundwater from Area C, if appropriate.

Alternative 1 would not provide a permanent remedy and would not be effective over the long term.

D. REDUCTION OF TOXICITY, MOBILITY, OR VOLUME

Alternatives 2 and 3 would all 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 present potential unacceptable risks to human health.

F. IMPLEMENTABILITY

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

Alternative 2 includes the discharge of treated groundwater to the unnamed tributary of Little Neshaminy Creek north of Kirk Road. Due to the low flow rate of this tributary, it is unknown whether this discharge could meet NPDES requirements to be developed by Commonwealth of Pennsylvania.

Under Alternative 3, available information indicates that extracted groundwater could be treated to meet the NPDES requirements of concern.

No remedial action is included under Alternative 1.

G. COST

The present worth of Alternative 1 is $1,853,000. The present worth of Alternative 2 is $5,075,000. The present worth of Alternative 3 ranges from $4,944,000 to $5,224,000.

H. STATE ACCEPTANCE

The Commonwealth of Pennsylvania concurs with the selected remedy for OU-3 at this Site, Alternative 3 with treatment at Area A (see Section IX.).

I. COMMUNITY ACCEPTANCE

A public meeting on the Proposed Plan was held on September 8, 1994 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 VIII of this ROD). Comments from the local community generally reflected a

preference for Alternative 3: Treatment at Area A or Area C, and Discharge to Surface Water at Area A System Outfall.
One comment suggested the location of the treatment plant under this alternative be limited to Area A.

IX. SELECTED REMEDY

A. GENERAL DESCRIPTION

The Navy and EPA have selected the following remedy for OU-3: Groundwater Extraction, Treatment at Area A, and Discharge to Surface Water at Area A System Outfall, as the remedy for contaminated groundwater attributable to Area C. The selected remedy is as described under Alternative 3 in Section VII with the following modification: the location of the treatment system shall be limited to Area A.

The selected 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 remedy would be cost effective and would comply with applicable or relevant and appropriate requirements.

The selected remedy for OU-3 includes the following major components:

- Installation, operation and maintenance of groundwater extraction wells to recapture and treat contaminated groundwater attributable to Area C at the Site
- Installation, operation and maintenance of an onsite groundwater treatment system within Area A which includes precipitation, filtration, air stripping, carbon adsorption, and/or other necessary means of treatment
- Periodic sampling of treated water to ensure the effectiveness of the treatment system
- Installation, operation and maintenance of a vapor phase carbon adsorption unit (if such a unit is necessary to control air emissions)
- Discharge of treated water to the outfall of the Area A plant which is being constructed pursuant to the OU-1 ROD
- Offsite treatment and/or disposal of solid residuals generated during water treatment and control of air emissions (if necessary)
- Periodic monitoring of groundwater in monitoring wells and residential wells

- Installation and periodic sampling of observation wells to ensure effectiveness of the groundwater extraction wells

- Periodic evaluation of hydrogeologic data to ensure the effectiveness of the groundwater extraction system

- Modification of the groundwater extraction well system and/or groundwater treatment system as necessary based on periodic evaluations

The FFS estimated the present worth of this remedy from $4,944,000 to $5,224,000 over a 30-year period, with a capital cost of between $1,186,852 and $1,839,690 and an annual O&M cost of between $214,729 and $244,444.

Performance standards associated with the components above are described below.

B. PERFORMANCE STANDARDS

1. Groundwater Extraction Wells

The number, location and design of the extraction wells shall be sufficient to (1) prevent further migration of the contaminated groundwater attributable to Area C and (2) capture all contaminated groundwater attributable to Area C. Capture of the contaminated groundwater will be ensured by maintaining inward and upward gradients across the lateral and vertical boundaries of the contaminant plume.

Observation wells will be located and constructed to gather data to confirm these gradients and to characterize changes in contaminant concentrations within the plume and to ensure that previously uncontaminated portions of the aquifer are not adversely impacted by the extraction system.

Groundwater monitoring (see Section IX.B.6, below) and groundwater investigations shall be conducted as part of the Remedial Design and/or Remedial Action for OU-3 both on and off NAWC property, as necessary, to fully identify the nature and extent of groundwater contamination attributable to Area C and to assess the effectiveness of the system. Monitoring of groundwater associated with Area C shall be conducted during the entire course of the implementation of the remedy. The extraction well network and treatment system shall be modified as necessary based on the results of the monitoring and investigations.

The groundwater extraction wells shall be operated as necessary to reduce contaminant concentrations throughout the plume to Groundwater Cleanup Levels determined pursuant to Section IX.B.2 (see below). Groundwater Cleanup Levels shall be achieved in all monitoring wells within the plume. These monitoring wells shall be

installed and monitored per an Operation and Maintenance Plan for Groundwater Monitoring (see Section IX.B.6, below). The extraction well system may be shut down when a statistical analysis of groundwater sample results confirms that Groundwater Cleanup Levels have been attained throughout the plume for twelve consecutive quarters. If subsequent groundwater monitoring (as described in the Operation and Maintenance Plan for Groundwater Monitoring) indicate that contaminant concentrations are once again above Groundwater Cleanup Levels, the extraction well system shall be restarted and operated until the Groundwater Cleanup Levels have once more been attained for twelve consecutive quarters.

2. Groundwater Cleanup Levels

The Groundwater Cleanup Levels for contaminated groundwater shall be the background concentrations per Pa. Code Sections 264.90-264.100. The Commonwealth of Pennsylvania also maintains that the background cleanup standard is found in other legal authorities. The background concentrations shall be determined by the Navy and EPA in consultation with PADER during the Remedial Design in accordance with the procedures for groundwater monitoring outlined in 25 Pa. Code Section 264.97. Based on available information, concentrations of PCE and thallium should be reduced to background levels. Should additional investigations, sampling or groundwater monitoring (see Section IX.B.6 below) identify any other groundwater contaminants attributable to Area C which present a threat to human health and the environment, Groundwater Cleanup Levels shall also be established for these additional contaminants.

3. Groundwater Treatment System

The extracted groundwater will be pumped to an on-site treatment system at Area A, where it will be treated either by the treatment system constructed within Area A pursuant to the ROD for OU-1 or by an additional and separate system constructed within Area A pursuant to this ROD. If such treatment is conducted by a separate additional system within Area A, it is projected to include, at a minimum, precipitation, filtration and carbon adsorption. If treated by the treatment system constructed within Area A pursuant to the ROD for OU-1, water treatment will also include air stripping. In either case, the treatment system for extracted groundwater 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). Alternative treatment methods such as ion exchange, reverse osmosis and UV/oxidation may be used as necessary to meet the effluent limits. Upon being treated to meet these effluent limits, the water shall be discharged to an unnamed tributary of Little Neshaminy Creek through the outfall of the existing NAWC Wastewater Treatment Plant. (This outfall will also be used to

discharge treated water from the plant being constructed under OU-1.)

The treated groundwater shall be monitored as necessary to assure that prescribed effluent limits are being met prior to discharge. An Operation and Maintenance plan shall be developed and implemented to assure the continued effective operation of the Groundwater Treatment System.

4. Treatment of Air Emissions

Any air emissions from the groundwater treatment system, including air emissions from an air stripper (if necessary), will meet the requirements of 25 Pa. Code, Chapter 127, Subchapter A, as well as the National Emissions Standards for Hazardous Air Pollutants (NESHAPS) and the National Air Quality Standards for Criteria Pollutants 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 in this case. Vapor-phase carbon adsorption will be employed as necessary to meet these requirements.

5. Water and Air Treatment Residuals

Spent carbon from the carbon adsorption unit, spent carbon from the vapor-phase carbon adsorption unit associated with an air stripper (if necessary) 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 (LDRs) in 40 C.F.R. Part 268, Pennsylvania Hazardous Waste Management Regulations (25 Pa. Code, Article VII) and Residual Waste Regulations (25 Pa. Code, Article IX).

6. Groundwater Monitoring

An Operation and Maintenance Plan for Groundwater Monitoring for contaminated groundwater attributable to Area C shall be developed and implemented. The Plan will be approved by the EPA in consultation with PADER. Under the Plan, wells shall be monitored at locations on and off current NAWC property. Monitoring shall include residential and other privately owned wells as necessary. Monitoring wells shall be installed off of current NAWC property as necessary.

In addition, as part of the Remedial Design and/or Remedial Action, additional groundwater investigations shall be conducted both on and off NAWC property as necessary to fully identify the nature and extent of contaminated groundwater attributable to Area C. These investigations shall include any additional investigations necessary to confirm that there are no additional contaminants of concern. The extraction well network and treatment system shall be modified as necessary based on the results of these investigations.

7. Worker Safety

All work shall comply with Occupational Safety and Health Administration (OSHA) standards governing worker safety in 29 C.F.R. Parts 1910, 1926 and 1904.

8. Five Year Reviews

Because contaminated groundwater will likely remain at the facility after five years, a five-year review will be required. A five-year review will be conducted within five years of the initiation of the remedial action and every five years thereafter, as required by Section 121(c) of CERCLA, 42 U.S.C. Section 9621 (c), to ensure that the remedy continues to provide adequate protection of human health and the environment. A Five-Year Review Work Plan will be developed and approved by EPA in consultation with PADER.

X. STATUTORY DETERMINATIONS

A. PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT

The selected remedy is protective of human health and the environment by capturing and treating contaminated groundwater attributable to Area C at the Site. The selected remedy provides that groundwater contaminants attributable to Area C will be restored to background levels. The selected remedy will not pose unacceptable short-term risks to human health and the environment during implementation.

B. COMPLIANCE WITH ARARS

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

1. Chemical-Specific ARARs

The groundwater contaminants attributable to Area C which present a threat to human health and the environment will meet background levels per 25 Pa. Code Sections 264.90 - 264.100, specifically 25 Pa. Code Sections 264.97(i) and (j) and 264.100(a)(9). The Commonwealth of Pennsylvania also maintains that the background cleanup standard is found in other legal authorities. The background concentrations for contaminated groundwater shall be established in accordance with the procedures for groundwater monitoring in 25 Pa. Code Section 264.97, which are relevant and appropriate for this remedy.

2. 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 of groundwater within the Delaware River Basin.

3. 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).

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

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 will constitute treatment of hazardous waste (i.e., the groundwater containing hazardous waste), and will 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 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 remedy is managed in containers) and 25 Pa. Code, Subpart J (in the event that hazardous waste is managed, treated or stored in tanks). The 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 remedy.

Any surface water discharge of treated effluent will comply with the substantive requirements of Section 402 of the Clean Water Act, 33 U.S.C. § 1342, and the National Pollutant Discharge Elimination System ("NPDES") discharge regulations set forth at 40 C.F.R. Parts 122-125, the Pennsylvania NPDES regulations (25 Pa. Code §92.31), and the Pennsylvania Water Quality Standards (25 Pa. Code §§93.1-93.9) which are applicable to the selected remedy.

The Occupational Safety and Health Act ("OSHA") regulations codified at 29 C.F.R. Section 1910.170 are applicable for all activities conducted during this remedial action.

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").

Transportation of any hazardous wastes off-site shall also comply with the Department of Transportation ("DOT") Rules for Hazardous Materials Transport (49 C.F.R. Parts 107 and 171-179).

The following four Action-Specific ARARs apply to any air emissions from the groundwater treatment system and/or air stripping operations (if necessary):

The requirements of Subpart AA (Air Emission Standards for Process Vents) of the Federal RCRA regulations set forth at 40 C.F.R. Part 264 are relevant and appropriate and applicable to any air stripping operations which are conducted as part of the selected 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 127.12(a)(5) will apply to new point source air emissions that result from implementation of the selected 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 § 121.1.

The substantive requirements of 25 Pa. Code Section 127.11 will apply to the selected 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.

Volatile organic compound emissions from the air stripper will be treated by vapor-phase carbon adsorption as required 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 Superfund sites, is a standard to be considered.

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 §3004 and §3005 of RCRA and all applicable State requirements.

C. COST-EFFECTIVENESS

The selected remedy is cost-effective.

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

The remedy utilizes permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable.

E. PREFERENCE FOR TREATMENT AS A PRINCIPAL ELEMENT

The remedy satisfies the statutory preference for remedies that employ treatment that reduces toxicity, mobility, or volume as a principal element.

XI. DOCUMENTATION OF SIGNIFICANT CHANGES

The preferred alternative in the Proposed Plan was Alternative 3: Groundwater Extraction, Treatment at Area A or Area C, and Discharge to the Area A System Outfall. Based on public comments, the selected remedy is Alternative 3 with one modification. In particular, under the selected remedy, the location of treatment of contaminated groundwater attributable to Area C will be limited to Area A and thus will not be within Area C.

XII. RESPONSIVENESS SUMMARY

A. OVERVIEW

In a Proposed Plan released for public comment on August 19, 1994, the Navy, with the support of EPA, identified Alternative 3 as the preferred alternative for OU-3 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, including the Bucks County NAWC Economic Adjustment Committee, which is developing a reuse plan for NAWC in response to the planned realignment of NAWC. In addition, in one case, a preference was expressed for Alternative 3, but with the location of the treatment plant limited to Area A. Based on these and other comments received during the public comment period, the Navy and EPA have selected Alternative 3, with the treatment plant location limited to Area A as requested during the comment period. 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 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/Restoration Advisory Board meetings with local officials, communications with the media and the establishment of information repositories.

The Navy and EPA established a public comment period from September 1, 1994 to September 30, 1994 for interested parties to comment on the Proposed Plan, the RI Report, the FFS Report and other documents pertaining to OU-3. These and all other documents considered or relied upon during the final remedy selection process for OU-3 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 OU-3. A public meeting was held at McDonald Elementary School, Street Road, Warminster, Pennsylvania on September 8, 1994 to present the RI/FFS Reports and Proposed Plan, address concerns, and accept both oral and written comments for the OU-3 final remedy. Approximately 40 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 final remedy for OU-3. Responses to these comments are included in the section below.

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

Comments received during the public comment period regarding the final remedy for OU-3 have been summarized below with the responses of the Navy and EPA to these comments. The comments and associated responses have been organized by subject category.

Remedial Alternative Preferences

Comment 1: A number of written and verbal comments expressed a preference for Alternative 3. As noted above, one commentor expressed a preference for Alternative 3 with the condition that the treatment system be located within Area A. No preference was expressed for another alternative.

Response: Based in part on these comments, the Navy and EPA have selected Alternative 3, with the modification that treatment shall be limited to Area A.

Comment 2: Several commentors asked whether the treated water could be spray irrigated, reinjected into the groundwater or trucked offsite for disposal.

Response: Due to the fractured nature of the underlying bedrock and the associated unpredictability of the impacts of irrigation or reinjection, these approaches were not considered. Trucking the water offsite for disposal would be cost prohibitive.

Comment 3: One commentor suggested the Navy consider reserving some (or all) of the treated water for fire fighting purposes or for commercial, residential, recreational and/or industrial use.

Response: To assure that the remedy for OU-3 is implemented in a timely fashion, the Navy and EPA believe that the treated water should at least temporarily be discharged to the planned surface water outfall. However, the Navy will consider alternative means

of managing the treated water in the future, as necessary. The public may provide any further comments on this matter through the Restoration Advisory Board for NAWC.

Comment 4: Some commentors expressed concern about the quantity of water to be extracted and the potential impact of this extraction on water supply wells in use.

Response: With the total groundwater extraction rate at Area C estimated at 50 gallons per minute (gpm), there is little or no drawdown effect (or impact) projected for water supply wells currently in use.

Comment 5: Questions were raised as to why the treated water was being conveyed to a location north of Bristol Road and whether the Navy would be discharging into the same line that the Warminster Municipal Authority discharges to.

Response: The Navy plans to use its existing, permitted, treated-water discharge system, which conveys the treated water to the unnamed tributary of Little Neshaminy Creek via an existing pipeline for discharge at a location north of Bristol Road. The Warminster Municipal Authority wastewater treatment plant located further west on Bristol Road also discharges into Little Neshaminy Creek but through a different unnamed tributary.

Remedial Design and Implementation

Comment 6: Several commentors questioned if the extraction of contaminated groundwater should begin if the source of the contaminated groundwater has not been identified and cleaned up, and expressed concern regarding a brownish tint in ponded water near site 4.

Response: Since contaminants from Area C have already migrated into the bedrock aquifer, pumping and treatment of the groundwater is required in any case. To address buried waste at site 4, the Navy is conducting an Engineering Evaluation and Cost Analysis (EECA) to assess cleanup options. Remediation of the source at site 4 should prevent any additional contaminant migration to groundwater from the buried waste. The Navy also

plans to conduct a complete investigation of any surface water that may be impacted by site 4 in coordination with the EECA.

Comment 7: A number of commentors wanted to know how the 30 year treatment period was arrived at.

Response: Thirty (30) years is only an estimate of the number of years that may be needed to achieve the groundwater cleanup goals. The actual number of years will depend on the performance of the extraction system and will be established through the Five-Year Review process.

Comment 8: One comment expressed concern that the existing pipe carrying the treated water would not have sufficient capacity.

Response: Calculations have been made using standard engineering formulas on the outfall pipe capacity. With peak flows from the NAWC Sewage Treatment Plant and the new OU-1/OU-3 treatment plants, there is adequate capacity in the outfall pipe. It is noted that the flows from the NAWC Sewage Treatment Plant will be diminishing as the Navy relocates personnel from Warminster to Patuxent River, MD.