ATSDR
AGENCY FOR TOXIC SUBSTANCES AND DISEASE REGISTRY

Public Health Assessment for

NAVAL SUPPORT FACILITY (NSF) DAHLGREN
(A/K/A NAVAL SURFACE WARFARE CENTER – DAHLGREN)
DAHLGREN, VIRGINIA
EPA FACILITY ID: VA7170024684
OCTOBER 11, 2006

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
PUBLIC HEALTH SERVICE
Agency for Toxic Substances and Disease Registry

THE ATSDR PUBLIC HEALTH ASSESSMENT: A NOTE OF EXPLANATION

This Public Health Assessment was prepared by ATSDR pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA or Superfund) section 104 (i)(6) (42 U.S.C. 9604 (i)(6)), and in accordance with our implementing regulations (42 C.F.R. Part 90). In preparing this document, ATSDR has collected relevant health data, environmental data, and community health concerns from the Environmental Protection Agency (EPA), state and local health and environmental agencies, the community, and potentially responsible parties, where appropriate.

In addition, this document has previously been provided to EPA and the affected states in an initial release, as required by CERCLA section 104 (i)(6)(H) for their information and review. The revised document was released for a 30-day public comment period. Subsequent to the public comment period, ATSDR addressed all public comments and revised or appended the document as appropriate. The public health assessment has now been reissued. This concludes the public health assessment process for this site, unless additional information is obtained by ATSDR which, in the agency's opinion, indicates a need to revise or append the conclusions previously issued.

Use of trade names is for identification only and does not constitute endorsement by the Public Health Service or the U.S. Department of Health and Human Services.

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PUBLIC HEALTH ASSESSMENT

NAVAL SUPPORT FACILITY (NSF) DAHLGREN
(A/K/A NAVAL SURFACE WARFARE CENTER - DAHLGREN)

DAHLGREN, VIRGINIA

EPA FACILITY ID: VA7170024684

Prepared by:

Federal Facilities Assessment Branch
Division of Health Assessment and Consultation
Agency for Toxic Substances and Disease Registry

Foreword

The Agency for Toxic Substances and Disease Registry, ATSDR, is an agency of the U.S. Public Health Service. Congress established this agency in 1980 under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), also known as the Superfund law. This law set up a fund to identify and clean up our country's hazardous waste areas. The U.S. Environmental Protection Agency (EPA) and the individual states regulate the investigation and clean up of the areas.

Since 1986, ATSDR has been required by law to conduct a public health assessment at each of the areas on the EPA National Priorities List. The aim of these evaluations is to find out if people are being exposed to hazardous substances and, if so, whether that exposure is harmful and should be stopped or reduced. (The legal definition of a health assessment is included on the inside front cover.) If appropriate, ATSDR also conducts public health assessments when petitioned by concerned individuals. Public health assessments are carried out by environmental and health scientists from ATSDR and from the states with which ATSDR has cooperative agreements.

Exposure: As the first step in the evaluation, ATSDR scientists review environmental data to see how much contamination is at an area, where it is, and how people might come into contact with it. Generally, ATSDR does not collect its own environmental sampling data. Instead, it reviews information provided by EPA, other government agencies, businesses, and the public. When there is not enough environmental information available, the report will indicate what further sampling data is needed.

Health Effects: If the review of the environmental data shows that people have or could come into contact with hazardous substances, ATSDR scientists then evaluate whether or not there will be any harmful effects from these exposures. The report focuses on public health, or the health impact on the community as a whole, rather than on individual risks. Again, ATSDR generally makes use of existing scientific information, which can include the results of medical, toxicologic, and epidemiologic studies and the data collected in disease registries. The science of environmental health is still developing, and occasionally scientific information on the health effects of certain substances is not available. When this is so, the report will suggest what further research studies are needed.

Conclusions: The report presents conclusions about the level of health threat, if any, posed by an area. In its public health action plan, the report recommends ways to stop or reduce exposure. ATSDR is primarily an advisory agency, so usually these reports identify what actions are appropriate to be undertaken by EPA, other responsible parties, or the research or education divisions of ATSDR. However, if there is an urgent health threat, ATSDR can issue a public health advisory to warn people of the danger. ATSDR can also authorize health education or pilot studies of health effects, full-scale epidemiology studies, disease registries, surveillance studies, or research on specific hazardous substances.

Community: ATSDR also needs to learn what people in the area know about the area and what concerns they may have about its impact on their health. Consequently, throughout the evaluation process, ATSDR actively gathers information and comments from the people who

live or work near an area, including residents of the area, civic leaders, health professionals, and community groups. To ensure that the report responds to the community's health concerns, an early version is also distributed to the public for comment. All the comments received from the public are responded to in the final version of the report.

Comments: If, after reading this report, you have questions or comments, we encourage you to send them to us.

Letters should be addressed as follows:

Agency for Toxic Substances and Disease Registry
ATTN: Records Center
1600 Clifton Road, NE (Mail Stop E-60)
Atlanta, GA 30333.

Table of Contents

TABLES

FIGURES

List of Abbreviations

AST	above-ground storage tank
ATSDR	Agency for Toxic Substances and Disease Registry
AVGAS	aviation gasoline
BRAC	Base Realignment and Closure Program
BTEX	benzene/toluene/ethylbenzene/xylenes
CEL	cancer effect level
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CV	comparison value
DDD	dichlorodiphenyldichloroethane
DDE	dichlorodiphenyldichloroethylene
DDT	dichlorodiphenyltrichloroethane
DHHS	U.S. Department of Health and Human Services
DOD	U.S. Department of Defense
DRMO	Defense Reutilization and Marketing Organization
EEA	Explosives Experimental Area
EOD	Explosives Ordnance Disposal Unit
EPA	U.S. Environmental Protection Agency
FDA	U.S. Food and Drug Administration
FFA	Federal Facility Agreement
IRP	Installation Restoration Program
MEC	Munitions of explosive concern
mg	milligram
mg/kg	milligrams per kilogram
mg/kg/day	milligrams per kilogram per day
mg/L	Milligrams per liter
MCL	Maximum contaminant level (EPA)
NA	not available
ND	not detected
NEPA	National Environmental Policy Act
NPL	National Priorities List
NSF	Naval Support Facility
NSWCDL	Naval Surface Warfare Center, Dahlgren, Virginia
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
PCE	tetrachloroethylene, also known as perchloroethylene
PHA	public health assessment
ppb	parts per billion
ppm	parts per million
ppmv	parts per million by volume
ppt	parts per trillion
PRG	preliminary remediation goal (EPA)

List of Abbreviations

RAB	Restoration Advisory Board
RBC	risk-based concentration (EPA)
PCE	perchloroethylene, also called tetrachloroethylene
RCRA	Resource Conservation and Recovery Act
RI	Remedial Investigation
SARA	Superfund Amendment and Reauthorization Act
SSL	soil screening level
SSR	Site Summary Report
SVE	soil vapor extraction
SVOC	semi-volatile organic compound
SWMU	solid waste management units
TCDD	2,3,7,8-tetrachlorodibenzo-p-dioxin
TCE	Trichloroethylene
TPH	total petroleum hydrocarbons
TVH	total volatile hydrocarbons
µg	microgram
UST	underground storage tank
UXO	unexploded ordnance
VDEQ	Virginia Department of Environmental Quality
VOC	volatile organic compound

Summary

The Agency for Toxic Substances and Disease Registry (ATSDR) conducted a public health assessment (PHA) of the Naval Support Facility (NSF) Dahlgren. As a part of the assessment process ATSDR toured the base, met with base representatives and reviewed environmental information describing the investigations, sampling results and remediation actions performed at NSF Dahlgren. The purpose of the assessment was to identify if community members could come into contact with NSF Dahlgren-related environmental contaminants and evaluate whether that contact could cause adverse health effects.

NSF Dahlgren is an active Navy installation with an operational history extending back to 1918. Over the years, many activities conducted at NSF Dahlgren generated and released hazardous wastes into the environment. Most of the environmental contamination on base is a result of previous operations or disposal practices. Waste materials were primarily generated by ordnance testing and firing range activities, disposal activities, leaking underground storage tanks (USTs), and vehicle maintenance and repair. These wastes include fuel, oils, solvents, acids, paint, pesticides, and ammunitions, ordnance and explosive materials.

Numerous investigations have taken place throughout NSF Dahlgren to identify and characterize environmentally contaminated sites. Many of these investigations are still in process. As of June 2005, the Navy had identified 85 potential sites, 10 of these sites are being utilized for current base operations and have restricted access. Of the 75 sites investigated, 34 sites underwent clean-up, remediation or removal actions and were subsequently closed out (20) or require no further action (14). Of the 39 remaining sites, 11 sites require further evaluation and 28 sites are in the process of remediation or long-term monitoring following remediation. (Navy 2003a, Navy 2005b). Environmental investigations and necessary remediations are conducted by the Navy in coordination with the other federal and state agencies. Community members may participate in the environmental investigation and remedial process by attending Restoration Advisory Board (RAB) meetings to: (1) voice concerns on the base's environmental cleanup issues; (2) review, evaluate, and comment on environmental cleanup documents; and (3) recommend cleanup priorities among base sites.

ATSDR used the PHA process to identify if local community members (on-base residents, visitors or employees, or off-base residents) could be exposed to base-related substances at levels that could cause health effects. This assessment considers the disposal history for each site, the potential exposure concerns, and the chemical characteristics of the environmental contaminants. The potential exposure concerns were identified by community members and representatives of state and federal agencies participating in the base remedial activities. This document describes how the public health assessment was conducted at NSF Dahlgren and the results of the evaluation.

While some areas of the base do have elevated concentrations of some environmental contaminants, ATSDR did not identify any potential exposure that would be expected to cause health effects for the local community. In general, people do not have significant access to the environmentally contaminated sites. The occasional exposure that does occur is expected to be well below levels of health concern. ATSDR identified seven exposure situations where community members might encounter base-related environmental contaminants. Results of the

evaluations, described below, indicate that these potential exposure situations are unlikely to adversely impact the health of local community members.

Public concern about potential classified activities at NSF, Dahlgren. Past and current classified operations involved chemical, biological and radiological agents. Some community members are concerned that environmental contamination could exist yet not be reported due to the nature of the work. ATSDR did not identify evidence of potentially harmful exposures due to the classified work and supports base efforts to address community concerns related to this issue.

Potential River Safety concerns for recreational users. The Potomac River Test Range is used for ordnance testing. Boaters who consult navigational charts and follow directions from range control boats will not be exposed to safety hazards. People who follow base procedures for reporting projectiles and unexploded ordnance are unlikely to be harmed by range-related materials. ATSDR supports NSF Dahlgren's efforts to ensure people know how to respond if they find these materials.

Protection of Drinking Water System. NSF Dahlgren follows the EPA water-testing program. Sampling results indicate base-related contaminants have not affected base drinking water. ATSDR supports base efforts to monitor and protect the base drinking water supply.

Potential physical safety concerns for hunters at the Old Bombing Range (Site 1). A portion of the Old Bombing Range is used for hunting. The base provides notification and guidance to hunters so they may protect themselves from exposure to UXO. Hunters who follow base procedures are unlikely to be exposed to ordnance materials.

Potential dietary exposure by consumption of locally captured fish and game. Off-base fishing, crabbing, and shellfishing are regulated by the Commonwealth of Virginia. The Virginia Department of Health (VDH) conducts sampling and issues advisories as necessary. On-base anglers and hunters are provided information about the relevant fish and game restrictions and advisories when they apply for their base permit. Anglers and hunters who follow the advice from VDH and the base will not be exposed to base-related contaminants at levels known to harm human health.

Potential explosive hazards associated with soil vapor intrusion from methane migration. Methane was detected in some portions of the Site 17 landfill, near Building 1400. Past and current sampling for methane indicates methane is not accumulating in the building. Additional studies of the landfill are being conducted to identify the appropriate strategy to prevent methane migration from the Site 17 landfill. ATSDR supports the protective measures implemented by the base to reduce the potential for the accumulation of hazardous levels of methane.

Potential exposure to lead during redevelopment of the Historic Skeet Range. The Skeet Range was paved and is used as a parking lot. Under current land use conditions people are unlikely to be exposed to skeet range-associated lead, if it exists, at levels that could cause health concerns. When this site is to be re-developed, the base will evaluate the need for environmental sampling. ATSDR supports the base re-development policy to consider a sampling plan consistent with the historical and planned future use of this site, when re-development is considered.

Introduction

The Agency for Toxic Substances and Disease Registry (ATSDR) conducted a public health assessment (PHA) of the Naval Support Facility Dahlgren, Virginia (NSF Dahlgren). The focus of the assessment was to evaluate whether the local community, including nearby residents, base residents, base visitors, and base employees, were exposed to environmental contaminants originating from chemical disposals, spills, or previous base operations at levels that could cause health effects.

The primary components of the public health assessment process for NSF Dahlgren were:

1. Reviewing environmental data and documents prepared by the U.S. Navy, US Environmental Protection Agency (EPA) and Virginia Department of Environmental Quality (DEQ).

2. Characterizing the potential exposures concerns of the local community.

3. Reviewing scientific literature describing the fate and transport of the contaminants in the environment and toxicity of the contaminants to the human body. This information was used to evaluate the public health impacts of the potential exposures.

The reviewed documents describe the history of the environmental investigations and remediation at NSF Dahlgren, including each specific site identified under the Department of Defense's Installation Restoration Program (IRP) and the Resource Conservation and Recovery Act (RCRA) Corrective Action Program. Specific site information within those documents describes the operational, disposal, or spill history, type of environmental contaminants expected, results of environmental sampling, the extent of environmental contamination at that site, and the planned and completed remedial activities for the site. Potential contaminants released during NSF Dahlgren base activities include cleaning solvents, explosive residues, heavy metals, low-level radioactive materials, mercury, polychlorinated biphenyls (PCBs) and pesticides. ATSDR used this information to identify if the on-base and local communities were, or could be, exposed to the environmental contaminants by coming into contact with the air, soil, sediment, surface water, or groundwater in their communities and if that exposure would be expected to harm their health.

ATSDR also evaluated potential exposure concerns identified by the local community, base representatives, and state and federal officials. The potential exposure concerns described activities or situations that could bring the on-base or local community members into contact with environmental contaminants originating at NSF Dahlgren. ATSDR evaluated the potential exposures using information available in the scientific literature describing the characteristics of the chemicals in the environment and their potential to harm human health. The following table (Table 1) shows the potential exposure concerns evaluated in this document:

Table 1. Potential Exposure Concerns Evaluated During the Public Health Assessment

No.	*Potential Exposure Concern*
1.	Public Concern about potential classified activities at NSF Dahlgren
2.	Potential River Safety concerns for recreational users due to unexploded ordnance (UXO)
3.	Potential exposure to groundwater contaminants that may affect the drinking water system
4.	Potential physical safety concerns for hunters at the Old Bombing Range (Site 1) due to UXO
5.	Potential dietary exposure concerns due to consumption of locally captured fish and game
6.	Potential explosive hazards associated with soil vapor intrusion of methane from nearby landfills
7.	Potential exposure to lead during redevelopment or reuse of the Historic Skeet Range

This PHA document briefly summarizes the assessment process and the results of the evaluations. If you would like additional information about the evaluations described in this document please contact ATSDR at 1-888-422-8737 and ask to speak with an environmental scientist about the NSF, Dahlgren PHA. To acquaint the reader with terminology and methods used in this PHA, Appendix A provides a glossary of environmental and health terms presented in this document.

Background

Site Description and Operational History

NSF Dahlgren was established in 1918 with the primary mission of testing all naval ordnance materials. Since then the mission has evolved to include research and development operations (Navy 2003a). Organizationally, NSF Dahlgren is one of four shore installations within Navy District Washington and is managed by the Naval Support Activity South Potomac (G. Wagner, U.S. Navy, personal communication, March 2006).

NSF Dahlgren is located on the western shore of the Potomac River in King George County, Virginia, approximately 25 miles east of Fredericksburg and 40 miles south of Washington DC (Figure 1). The installation is bounded on the north by U.S. Highway 301 and on the east by the Potomac River. The area to the west and south is predominately rural with private homes and small farms. Upper Machodoc Creek flows in a general west-to-east direction through NSF Dahlgren, dividing it into two areas (Figure 2). These consist of the Mainside and the Explosive Experimental Area.

- The Mainside, located to the north of the creek, consists of 2,678 acres (Figure 3). Approximately 40 percent of the Mainside is composed of residential and developed areas, located on the southern portion. The northern and western portions of Mainside contain large blocks of forest, an airfield, and locations where various ordnance categories are tested in a secure area (Navy 2003a). Mainside facilities are used primarily for administration (e.g. public works, supply), research and development, housing, and community support activities. The area is surrounded by a perimeter fence and access is limited to the Main Gate and Gate B entrances (Navy 2003a).

- The Explosives Experimental Area (EEA), located to the south of the creek on Tetotum Flats, consists of 1,641 acres. The EEA is more commonly referred to as Pumpkin Neck (Figure 4). Approximately 8 percent of the EEA consists of developed areas, over 60 percent is hardwood and pine forest, and marshland is also common. Two large open field test areas are located in the center (Navy 2003a). These areas are used exclusively for testing naval ordnance and include static detonation arenas, drop test towers, static thrust stands, thermal test retaining cages, fast and slow cook-off facilities, shock test facilities, and high explosive vibration facilities. Access to the EEA is through a gated entrance and is open only on request with proper authorization. Access is denied to most personnel during explosive testing events when the one access road is blocked (Navy 2003a, B. T. Weedon, U.S. Navy, personal communication, January 18-20, 2005). Access within EEA is controlled by test specific Standard Operating Procedures (V. Lovejoy, U.S. Navy, personal communication, January 27, 2006)

Unaccompanied access to NSF Dahlgren is restricted to military personnel, authorized civilian personnel and base residents. Unauthorized access from the land is limited by the perimeter fencing. Unauthorized access from the Potomac River and Upper Machodoc Creek is limited by fencing and the rocky banks along the shore. Signs posted along the riverbanks indicate the area is a government facility and that unauthorized access is prohibited. Access to Mainside and the

EEA is controlled via guarded gates. Regular security patrols are also used to limit unauthorized access (B. T. Weedon, U.S. Navy, personal communication, January 18-20, 2005).

Remedial and Regulatory History

A number of activities at NSF Dahlgren generated and released hazardous wastes. Wastes were disposed of on base in landfills or disposal areas, buried, or burned during ordnance disposal activities. These wastes were primarily generated by disposal activities, leaking underground storage tanks (USTs), oil water separators, vehicle maintenance and repair, and ordnance testing activities. Wastes included solvents, fuel, oils, battery acid, paint, ammunitions, and explosives (Navy 2003a, R. Mayer, U.S. Navy, personal communication, January 27, 2006). As a result of past activities, environmental contaminants have been detected in the soil, surface water, and sediment at some sites.

As of June 2005, the Navy had identified 85 potential sites, 10 of these sites are being utilized for current base operations and have restricted access. Of the 75 sites identified for further environmental investigation, 34 sites underwent clean-up, remediation or removal actions and were subsequently closed out (20) or require no further action (14). Of the 39 remaining sites, 11 require further evaluation and 28 are in the process of remediation or long-term monitoring following remediation. (Navy 2003a, Navy 2005b).

Environmental investigations and necessary remediation are conducted by the Navy in coordination with the EPA, the Virginia Department of Environmental Quality (VDEQ), and other federal and state agencies. As part of the federal Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) process, community members may participate in the Restoration Advisory Board (RAB) to: (1) voice concerns on the base's environmental cleanup issues; (2) review, evaluate, and comment on environmental cleanup documents; and (3) recommend cleanup priorities among base sites (TtNUS 2004a).

ATSDR Activities

Through the public health assessment process, ATSDR assesses conditions at a site from a public health perspective to identify if the community can be exposed to site-related contaminants through contact with the site's groundwater, surface water, soil, biota, or air. As part of the evaluation process, ATSDR conducted an initial visit to NSF Dahlgren in 1992. The purpose of the visit was to collect information to identify public health issues related to environmental contamination at the facility. ATSDR did not identify any potential exposures that represented a public health concern due to a potential exposure to base-related environmental contaminants.

ATSDR conducted a second visit January 2005 to collect updated information related to environmental studies and remediation programs for the contaminated sites on the base. During the visit, ATSDR met with Navy and NSF Dahlgren personnel and representatives from federal and state agencies, as well as toured the base and surrounding areas. Based on these discussions, the site visit, and data reviews, ATSDR concluded there were no immediate threats to human health but identified seven exposure concerns for further evaluation (Table 1).

Demographics

ATSDR examines demographic information to identify the presence of sensitive populations, such as young children (age 6 years and under), the elderly (age 65 years and older), and women of childbearing age (age 15 to 44 years). Demographics also provide details on population mobility and residential history in a particular area. This information helps ATSDR identify and evaluate potential exposure concerns for the on-base and neighboring community.

The on-base community includes military and civilian personnel who work at NSF Dahlgren and military personnel and their families who reside on-base at Mainside. On-base personnel reside in housing units located in the southern portion of the base. With the exception of on-base fishing, boating and hunting, most on-base recreational activities are located near the base housing (e .g. indoor swimming pool, gymnasium facilities and children's play areas) (C. Ulrich, U.S. Navy, personal communication, January 18-20, 2005).

The off-base community includes approximately 3,067 people who live within one mile of NSF Dahlgren (Census, 2001). Figure 5 shows demographics information from the 2000 Census for the population near the base. As the figure indicates, children 6 years old and younger comprise 13.6% of the population living within a one-mile radius of the base. Women of childbearing age and the elderly comprise approximately 23.3% and 8.3% of the population respectively.

Land Use

ATSDR examined recreational and residential land use to determine how people could be exposed to base-related contaminants in soil, sediment, surface water or groundwater.

Residential and developed land cover 40% of the 2678 acres on Mainside, forests cover 41% and wetlands cover approximately 13%. The remaining areas on Mainside include open fields, brush and open water habitats (Brown and Root Environmental 1996). Recreational opportunities beyond the residential area of Mainside include hunting in designated areas, and fishing and boating in on-base ponds, the Potomac River and Upper Machodoc Creek. All other recreational activities are located in or near the residential area (C. Ulrich, U.S. Navy, personal communication, January 18-20, 2005).

No residential buildings are located on the EEA. Recreational opportunities are limited to hunting in designated areas during designated times in a controlled process. (Brown and Root Environmental 1996). Though the majority of the EEA is surrounded by the Upper Machodoc Creek and the Potomac River, access to the property by recreational boaters is not permitted (frequent signage warns boaters to not enter government property). Unauthorized use of the area by recreational boaters is unlikely due to the steep rocky shore.

Land around the perimeter of Mainside is used primarily for residential purposes with some commercial businesses. The land around the EEA is largely used for agricultural purposes with some residential use.

Natural Resources

Natural resources used in the vicinity of NSF Dahlgren include groundwater and surface water for drinking water and irrigation, and surface-water bodies for recreational uses. Some of the key exposure concerns associated with NSF Dahlgren pertain to the potential for exposure to contaminated soil and groundwater and the potential exposure to contaminants released to the Potomac River, Upper Machodoc Creek and Gambo Creek. To determine how contaminants might migrate to and accumulate in these media, ATSDR reviewed background information on the local groundwater hydrogeology and surface water hydrology.

Hydrogeology

The geology underlying the base is composed of unconsolidated deposits over a consolidated bedrock basement formation that dips towards the east. Approximately 25 miles to the west and northwest of the base, the bedrock basement exists near the surface. On-base the bedrock is beneath approximately 1,300 feet of Coastal Plain sediment (Brown and Root Environmental 1996).

The overlying sediments consist primarily of gravel, sand, silt and clay; the specific composition varies with location and depth. The variation in composition results in zones that can store and transport large quantities of groundwater separated by zones that essentially restrict groundwater movement. The Potomac Formation is a zone capable of supplying large quantities of groundwater water and is the primary source of drinking water for the base and the Dahlgren municipal water system. The Potomac aquifer overlies the bedrock basement and in turn, is overlain by less permeable sediments collectively known as the Aquia Formation. Though less permeable, the Aquia aquifer provides water to many light industrial, small municipal and domestic wells located around the base. The Aquia aquifer is overlain by deposits with very low-permeability that severely restrict vertical groundwater movement. Above that reside surface deposits that are part of the Tabb Formation. They are relatively permeable and form the Columbia aquifer. Most of the Columbia aquifer is unconfined and has the potential to be contaminated by base-related chemicals. Groundwater from the Columbia aquifer is believed to discharge to Gambo Creek, the Potomac River, or on-base surface water bodies (Brown and Root Environmental 1996).

The recharge zones for both the Potomac and Aquia aquifers are approximately 25 miles west of the base (Brown and Root Environmental 1996). Groundwater enters these deposits and slowly moves downward and eastward following the dip of the basement bedrock. Virginia based municipal, industrial and private wells drilled into the Potomac or Aquia aquifers obtain the groundwater before it passes through the base. These wells are not affected by base-related contaminants. The on-base drinking water wells are drilled deep within the Potomac aquifer. Studies indicate the Potomac aquifer is not completely isolated from the overlying aquifers by a confining layer and could be impacted by base-related contaminants (Brown and Root Environmental 1996); however, no evidence of contamination has been detected by the base drinking water monitoring program.

On the Mainside, groundwater in the Columbia aquifer generally enters along the northern boundary of the base and flows to the nearby surface water bodies including Gambo Creek and

the Potomac River (USGS 1996a, Brown and Root Environmental 1996). Private residential wells located just beyond the Mainside boundaries (to the west and north of the base) could be obtaining groundwater from the Columbia aquifer; however, due to the basic direction of groundwater flow in this aquifer these wells are also unlikely to be affected by base-related contaminants.

On the EEA, most of the groundwater in the Columbia aquifer enters the system through the soil surface during rainfall events, a small amount enters the EEA through the southern base boundary. Groundwater in this aquifer tends to flow towards Upper Machodoc Creek or the Potomac River. On the EEA there is some indication that the groundwater in the Columbia aquifer may flow into the underlying Upper Confining Layer and the Upper Confined Aquifer. However the groundwater flow direction within these units is similar to the Columbia aquifer and flows toward Upper Machodoc Creek or the Potomac River. Hence, off-base private wells are not likely to be affected by base-related contaminants (USGS 1996b).

Little information was identified describing the hydrogeology of southern Maryland and the prevalence of private residential wells. However, the southern tip of Maryland is almost one mile east of the base. Due to the low-permeability sediments that overlie the Potomac and Aquia aquifers and the distance from the base to potential western wells, it is unlikely that these wells would be affected by base-related contaminants.

Quality Assurance and Quality Control

ATSDR reviewed and evaluated information provided in the referenced documents. Documents prepared for the CERCLA program must meet standards for quality assurance and control measures for chain of custody, laboratory procedures, and data reporting. The environmental data presented in this PHA come from Navy site and remedial investigations. ATSDR has determined that the data's quality is adequate for making public health decisions.

Evaluation of Exposure Pathways of Concern

General Overview of Exposure Evaluation

Identification and Evaluation of Exposures

ATSDR's PHAs are exposure (or contact) driven. People who work or live near an area with environmental contamination can be exposed to a contaminant if they come in contact with the contaminated media (soil, water, air). *However, living or working near an area with environmental contamination does not always result in an exposure to the contamination.*

ATSDR evaluates the conditions at each contaminated site to determine if people could have been, or are currently, exposed to site-related environmental contaminants. The first step is to identify if, and how, the local community comes into contact with soil, sediment, surface water, or groundwater at a contaminated site. The second step is to evaluate if that contact could result in exposure to the environmental contaminants. The final step is to evaluate if the exposure would be expected to cause health problems.

Exposure and Health Effects

In some cases, exposure to large amounts of environmental contaminants can cause adverse health effects. The type and severity depends on the exposure concentration (how much), frequency of exposure (how often), duration of the exposure (how long), and the route of exposure (breathing, eating, drinking, or skin contact). Once this exposure occurs, characteristics such as age, sex, nutritional status, genetics, lifestyle, and health status influence how the individual absorbs, distributes, metabolizes, and excretes the contaminant, and whether the individual could get sick from the exposure. *Exposure does not always result in health affects.*

Public Health Evaluation

ATSDR identified and evaluated NSF Dahlgren-related exposure concerns to determine if the local community could be exposed to site-related environmental contaminants at levels that could cause health effects. The exposure concerns evaluated in this section were identified in several different ways. ATSDR met with individuals who are familiar with the base, reviewed the community concerns identified and summarized in Navy documents including the Community Involvement Plan (TtNUS 2004), and conferred with Navy, VDEQ, and EPA officials. ATSDR also reviewed available site documents to determine sources of contamination, potential pathways of contaminant migration, and potential points of human exposure to those contaminants. Finally, during the site visit ATSDR toured the base, observed the contaminated sites and identified potential exposure concerns for further evaluation.

These investigations indicate that for the majority of contaminated sites at NSF Dahlgren, the local community is not exposed to site-related contaminants at levels that would be expected to cause health effects. Based on these investigations, ATSDR identified seven potential exposure concerns for further evaluation (Table 1). Table 2 presents a summary of these evaluations. Contaminated sites that were evaluated in conjunction with the seven potential public health exposure concerns are presented in Table 3. Additional contaminated sites that were evaluated and determined to not present a potential public health hazard are described in Appendix B.

Table 2. Summary of Potential Exposure Concerns Evaluated During the Public Health Assessment

Exposure Concern	*Elements of An Exposure Pathway*						*Comments Actions Taken/Planned Recommendations*
	Potential Source of Contamination	*Environmental Media*	*Point of Exposure*	*Route of Exposure*	*Time Frame*	*Exposed Population*	
Public Concern about classified activities at NSF Dahlgren	Intellectual / Software related work	None	None	None	Past Current Future	None	No evidence of harmful exposure was identified
	Chemical and Biological Simulants	Soil/Air	Site of disposal or original use	Dermal and inhalation	Past Current Future	None identified	No evidence of harmful exposure was identified
	Landfills	Soil	Landfill site	Dermal and inhalation	Past Current Future	None identified	No evidence of harmful exposure was identified
Potential River Safety concerns for recreational users due to river range operations and unexploded ordnance (UXOs).	Ordnance fired from the River Test Range	River sediment within and downstream from the range	River Range during operations and sediment containing UXO following operations	Physical hazards for river users during testing, and for UXO in sediment	Past Current Future	Public while boating, fishing or oystering	No exposure expected if river users heed warning signs and safe boating information, and follow base notification procedures upon discovery of UXO
Potential exposure to contaminants that may migrate into the base Drinking Water System	On-base contaminant sources	On-base drinking water system	On-base drinking water taps	Ingestion	Past Current Future	On-base personnel	No evidence of past harmful exposure was identified Base remedial actions are expected to reduce potential for contaminants to impact the on-base aquifers. Base monitoring activities are expected to identify potential contamination before harmful exposures occur.
Potential safety concerns for hunters at the Old Bombing Range (Site 1)	UXO potentially located in surface soil	Soil	Bombing Range	Physical Contact	Past Current Future	On-base hunters	No exposures were reported during past activities. No exposure expected for hunters following base procedures.

Exposure Concern	*Elements of An Exposure Pathway*						*Comments Actions Taken/Planned Recommendations*
	Potential Source of Contamination	*Environmental Media*	*Point of Exposure*	*Route of Exposure*	*Time Frame*	*Exposed Population*	
Potential exposure to base-related contaminants by eating locally captured fish, shellfish, crab and game.	Base-related contaminants in animal habitats	Local food chain	Fish, shellfish, crab and game captured on or near the base while hunting or fishing	Ingestion	Past Current Future	On-base & local off-base hunters and anglers	Fish, shellfish, crab and game consumers following base and state advisories are not expected to be exposed to contaminants at levels that could cause health concerns.
Potential explosive hazards associated with soil vapor intrusion of methane into buildings near landfills.	Landfills located near buildings	Soil gas	Building 1400 located near Site 17	Physical hazard associated with methane accumulation above the lower explosive limit (LEL)	Past Current	On-base personnel	No exposure identified in the past Methane removal and monitoring systems put into place will mitigate future exposure concerns
Potential exposure to lead during redevelopment/reuse of the Historic Skeet Range on-base	Historic Skeet Shooting activities and resultant lead deposition; most of this area is currently beneath a parking lot	Soil River Sediment	Soil beneath parking lot Potomac sediment downstream of this historic skeet range	Incidental ingestion Dermal and incidental ingestion	Future Current Future	Future Construction workers Public while boating, fishing or oystering	No exposure expected if site history is considered in future redevelopment plans. No significant exposure expected due to the limited direct contact with the sediment during these activities.

Table 3. Sites Evaluated For Public Health Exposure Concerns

Site Name	*Site Use Description*	*Public Health Evaluation*
Site 1 – Old Bombing Range (Known as USEPA AOC-J)	A heavily wooded and vegetated site consisting of approximately 800 acres. It was used in the early 1940s as an aerial bombing range resulting in the deposition of UXO and explosive materials (Navy 2003a). Hunting by DOD and base personnel and their guests is currently permitted on this site (Wray 2005). The potential for exposure to UXO was the primary public health concern.	This site does not represent a public health concern because access to the site is controlled to limit accidental exposure to UXO. Except for hunting, there are no permitted uses of this area. The site is located in the industrial area of the base with infrequent access by base residents and visitors, the perimeter is fenced, and "no trespassing" signs posted every 50-100 feet. Use by hunters is governed by the base Natural Resources office, which provides hunters with sufficient information so they can protect themselves from dangerous encounters with UXO.
Site 10 – Hideaway Pond (Known as USEPA AOC-N)	A 15-acre manmade pond, which drains to Gambo Creek (Navy 2003a). DOD and base personnel and their guests use the pond for recreational fishing and boating (Weedon 2005). The potential for exposure to mercury in the surface water and fish were the primary public health concerns.	This site does not represent a public health concern because the surface water concentrations of mercury are below levels of concern for incidental exposure while boating or fishing. The catch and release fishing policy will prevent harmful exposure to the mercury measured in fish tissue. The catch and release fishing policy was instituted in 2000 (Navy 2003a). Signs describing the policy are visible at the entrances to the pond.
Site 17 – 1400 Area Landfill (Known as USEPA SWMU 30)	A 5-acre landfill used from 1943 to the mid-1960s for open storage of crates and barrels, and gravel mining. Wastes disposed off at this site in the 1970s include municipal garbage and sanitary waste (Navy 2003a). The potential for exposure to methane in the soil gas seeping from the landfill into the nearby building was the primary public health concern.	This site does not represent a public health concern, because sampling in the building has not detected methane and plans are being developed to limit methane migration from the landfill (Navy 2003a, Weedon 2005).
Site 55 – Cooling Pond (Known as USEPA SWMU 129)	A 9-acre wide and 0-3 ft deep pond that began operations in the 1920s. The pond received storm water and industrial effluent from up to 25 different point sources (Navy 2003a). The Cooling Pond has been used for recreational fishing by base personnel. The potential for exposure to contaminants in fish tissue was the primary public health concern.	This site does not represent a public health concern because only catch and release fishing is allowed from the pond (Navy 2003a). Signs describing the policy are located around the pond.

Issue 1: Public Concern about Classified Activities at NSF Dahlgren

Some members of the surrounding community have expressed concern that NSF Dahlgren has in the past, and is currently engaged in classified operations involving the use of chemical, biological and radiological agents. Their concern is that environmental contamination could exist yet not be investigated or reported due to the classified nature of the work or contaminants. To evaluate this concern ATSDR investigated the nature of the operations conducted at NSF Dahlgren, along with the potential agents of concern and pathways of exposure. The following is an unclassified discussion of these classified activities and ATSDR's public health evaluation.

Past classified activities included work with normal lab chemicals that were handled in accordance with Federal regulations. Current and future classified activities are related to intellectual, software and energy related functions. (A. Swope, U.S. Navy, personal communication, January 18-20, 2005).

Intellectual / Software Related Research

Currently most classified work conducted at NSF Dahlgren is of an intellectual nature and is related to software development and computer research. Due to the nature of these activities, no environmental media are contaminated (A. Swope, U.S. Navy, personal communication, January 18-20, 2005).

Chemical/Biological Exposures

Some research at NSF Dahlgren centers on studies to improve the Navy's ability to detect chemical and biological warfare agents. Research involving simulant chemicals is conducted to validate decontamination techniques and procedures; and to evaluate spill response techniques, chemical agent resistant coatings, riot control dispersion mechanisms and the effectiveness of chemical detectors (A. Swope, U.S. Navy, personal communication, January 18-20, 2005).

The majority of the research conducted prior to 1981involved simulant chemicals like water; water/methanol mixture; methyl salicylate (oil of wintergreen); diethyl malonate; Navy chemical agent simulant #82 (NCAS 82), which consists of 89-95% polyethylene glycol (PEG 200), 9.95% methyl salicylate, and 0.1% tinopal (CBS-X); fluorescein in glycol/water; SSLP-II (Blue Mix) in water/starch which consists of 74% water, 6% starch, 20% Blue mix (6.03 gm of an Eastman Kodak proprietary microencapsulated water based dye); sulfur hexafluoride; and Glacial Acetic Acid. These were released as mists to study their detection properties as part of an unclassified defensive research program (A. Swope, U.S. Navy, personal communication, April 5, 2005).

Beginning in 2003, the testing program involved the release of some common chemicals (glacial acetic acid, triethyl phosphate, sulfur hexafluoride) on the river range to simulate chemical agents. An Environmental Assessment of these chemicals was prepared under the National Environmental Policy Act (NEPA) regulations and no permits are required for their use. These chemicals are commonly used in food, cosmetics and other household and commercial products. The available toxicologic information on these chemicals indicates that environmental exposure to these chemicals would not be expected to cause health concerns (results of the literature search are summarized in Appendix C). Currently, NSF Dahlgren is not engaged in any

classified work involving the testing of chemical warfare agents (A. Swope, U.S. Navy, personal communication, April 5, 2005).

The base also maintains BioSafety level II and level III laboratories, which are engaged in unclassified work including development, testing and evaluation of detectors and/or decontaminating formulations for biological warfare agents. (S. Thomas, U.S. Navy, personal communication, April 5, 2005). All disposable materials used for testing are autoclaved prior to shipment offsite for incineration (S. Thomas, U.S. Navy, personal communication, April 5, 2005, R. Mayer, U.S. Navy, personal communication, March 16, 2006, A. Swope, U.S. Navy, personal communication, March 16, 2006).

On-base Hazardous Waste Landfills

Three unclassified, currently inactive, landfills were formerly used to bury metal ordnance materials like hardware and casings containing explosive residues, scrap metal, asbestos pipe wrappings, batteries, rinsed pesticide containers, machine parts, construction debris, vegetative matter, municipal solid waste, and canisters of mercury. Prior to 1970, ordinary laboratory chemicals used in base operations were also disposed of in some of these landfills. Additionally, ash from burn sites where fuel oils, spent solvents, metals, caustics, hypochlorite, polymers, glues, and decontaminated chemical warfare agent solution were burned (Chemical Burn Area Site 12) is buried in the landfills (Navy 2003a, A. Swope, U.S. Navy, personal communication, February 23, 2006).

As part of remedial actions, waste and soils were consolidated, a slurry wall was built to prevent leachate discharge into a sediment pond, a landfill was capped with a vegetative soil cap, contaminated sediments and soils from the landfills were disposed off-site or capped with liner systems and backfilled with clean fill dirt. These sites are also monitored as necessary, for contaminant migration in the groundwater and methane accumulation in the soil gas. Institutional controls at these sites include measures to limit unauthorized access to these sites, and limiting future development to industrial uses and exclusion of shallow groundwater use (R. Mayer, U.S. Navy, personal communication, January 18-20, 2005).

The 1981 Initial Assessment recommended radioactive monitoring for the Fenced Ordnance Burial Area (Site 2) to determine if thorium was present in the contaminated wastes (EPA 1997) While there was no evidence that radioactive waste was buried in any of the three on-base landfills, anecdotal information suggested misch metal [1] may have been buried in the landfills and could be a potential radiation source. The radiation survey did not identify any evidence of radiation contamination; the levels of radiation measured were within normal background levels. (S. Phin, U.S. Navy, personal communication, April 5, 2005).

Radiation

Unclassified work related to ionizing radiation has been conducted at NSF Dahlgren (S. Phin, U.S. Navy, personal communication, April 5, 2005). However, ATSDR did not identify any evidence of environmental exposure to base-related radionuclides. Non-ionizing radiation related

1 Misch metal is a mixture of lanthanide, or rate-earth, elements commonly used in the flints of cigarette lighters. It is not regulated as a radiation source due to its low level of activity.

work conducted in the past, present, and expected to continue in the future is classified and involves research on frequencies at which different antennae and receivers operate. However, an environmental exposure to non-ionizing radiation has not been identified as a public health concern (A. Swope, U.S. Navy, personal communication, January 18-20, 2005; P. Charp, ATSDR, personal communication, June 30, 2005).

How the Base is Addressing Concerns

The base conducts quarterly meetings with community members in King George and other surrounding counties and holds bi-annual Restoration Advisory Board (RAB) meetings to provide community members with updates on base environmental clean-up programs and related activities. The base newspaper also regularly runs articles on environmental and natural resource issues, and the investigations, remediation, progress, and success of the base environmental program (S. Prien, U.S. Navy, personal communication, January 18-20, 2005, A. Swope, U.S. Navy, personal communication, March 16, 2006). The base provides a schedule of River Range test activities on their website and supports a toll-free phone number to address community questions and concerns about the range activities

Sources of Additional Information

The NSF Dahlgren Public Affairs Office invites concerned community members to call and discuss their concerns regarding research conducted on base for Chemical/Biological Analysis and the Joint Warfare Analysis Command. The points of contact are:

Naval Surface Warfare Center Contact: Stacia Courtney (540) 65-8154

NSF Dahlgren (Base Public Affairs) Contact: Gary Wagner (540) 653-1475

Conclusions

ATSDR did not identify evidence of potentially harmful exposures to the public from the classified work conducted at NSF Dahlgren. ATSDR supports the base efforts to meet with community members and provide information about the base environmental clean-up programs and address concerns related to on-base research activities.

Issue 2: River Safety for Recreational Users

Background

The Potomac River Test Range is used by the Naval Surface Warfare Center (NSWC) at NSF Dahlgren to test munitions and explosive materials in a littoral environment (the air, water, land combination found in a shoreline or coastal area). The Potomac River Test Range extends from above Upper Machodoc Creek in King George County to the mouth of the river off Smith Point. Most operations take place in a 20-mile stretch known as the Middle Danger Area (NSF Dahlgren 2005).

Public Health Concerns

Some members of the surrounding community are concerned about the safety of using the river for recreational purposes. Specific concerns include the possibility of coming into contact with unexploded ordnance (UXO) in the river or on the beaches through boating, fishing, or wading. Some boaters are concerned about navigational hazards in the river like unmarked pilings (TtNUS 2004a).

Evaluation

The Middle Danger Area of the Potomac River Test Range is diagrammed in U.S. Coast Guard nautical charts of the river. The chart is also available online at the NSF Dahlgren website (available at: http://www.nswc.navy.mil/wwwDL/RANGE/boaters.html) for review along with instructions on safety precautions for river use. The pilings in the river are marked with reflectors and signs (with concurrence from the U.S. Coast Guard) and are annotated on current navigational charts. NSWC deploys Range Control Boats during actual test operations on the Potomac River, to warn recreational boaters of testing on the river and to act as safety observers. The boats clear surface traffic in and around the "hot zone" depending on the section of range being utilized in test operations and employ red flags, buoys and sirens to warn and guide river users. Surveillance cameras and spotters on the shores also assist in monitoring safety during testing. Radio communication is maintained between the Range Control Office and the local watercraft and if necessary, commercial traffic can be diverted. In addition, warning signs are posted every 50-100 feet along the water perimeter of Mainside and EEA sections of the base, warning against trespassing and advising boaters to not land in those areas (R. Mason, U.S. Navy, personal communication, January 18-20, April 5, July 11, 2005).

The munitions being tested include inert and explosive loaded projectiles from .22 - .50 caliber and 20mm – 5 inch. In a very small number of tests the fuze may have failed to detonate, or function as designed, which results in unexploded ordnance (UXO) falling in the river and landing in the sediment. Less than 1% of tested ordnance believed to end up in river sediment is in the form of UXO, with the remaining 99% of the ordnance existing as inert steel shells. (R. Mason, U.S. Navy, personal communication, April 5, 2005). NSWC does not routinely recover ordnance from the river (R. Mason, U.S. Navy, personal communication, April 5, 2005). However, NSWC does conduct recovery operations when the community reports UXOs following storm wash-ups (R. Mason, U.S. Navy, personal communication, April 6, 2005).

The base public relations office continually disseminates public safety information to the community as part of its outreach efforts through the base website (available at: http://www.nswc.navy.mil/wwwDL/RANGE/) and local media outlets, like newspapers. Information includes safe boating practices, firing range testing schedules (no testing is conducted on weekends and after 5pm on weekday evenings when recreational river traffic is greatest), and procedures to follow if community members find a projectile. As stated in that information, people who find a projectile should not touch or move the item but contact the base to report the projectile's location.

Conclusion

As a result of these procedures, boaters who consult the current navigational charts prior to entering unfamiliar territory, follow normal safe boating practices, and follow the directions of the range control boats, will not be exposed to safety hazards from range operations. In addition, people who follow base procedures if they find a projectile are unlikely to be harmed by the projectile. ATSDR supports the NSWC and NSF Dahlgren's public relations and community outreach efforts to ensure that people utilizing the river know how to respond if they find projectiles or UXO.

Issue 3: Protection of On-Base Drinking Water System

Background

Three wells on Mainside supply drinking water to the Mainside area of NSF Dahlgren. These wells draw from the Potomac Group groundwater aquifer, located at a depth of 800-900 feet. Well use is rotated every two days and two wells are used each day in the summer due to the higher water consumption. The Mainside distribution system includes four water towers, which are connected to the end users by a loop system. Potable water for the EEA on Pumpkin Neck is provided by one well and one reservoir tank using the Potomac Group Artesian Aquifer (B. Hornaman, U.S. Navy, personal communication. January 18-20, 2005). The water quality is monitored by the Naval District Washington, Naval Support Activity, Dahlgren, who holds the permit and ensures the potable water system is in accordance with state and federal regulations. The Base Public Works department operates and maintains the system (B. Hornaman, U.S. Navy, personal communication. April 5, 2005).

Public Health Concerns

Various sites on NSF Dahlgren contain soil contaminants that have the potential to migrate with infiltrating rainwater to the underlying groundwater. Because groundwater is used as the base drinking water source, ATSDR evaluated the potential for the drinking water aquifers to be affected by base-related contaminants. For this evaluation, ATSDR considered the location of the aquifers underlying the area, groundwater flow directions for each aquifer and the base program to ensure on-base drinking water quality.

The hydrogeological investigations indicate that although the aquifer used to supply the base drinking water system are 800-900 ft deep, they could be susceptible to base-related contaminants (USGS 1996a). The Virginia Department of Health, Division of Drinking Water (VDH-DDW) conducted a Source Water Assessment of the Mainside and EEA wells in May 2002 (VDH 2002b). All of the wells were classified as “highly susceptible” to contamination due to the proximity of base-related industrial activity and environmentally contaminated sites, and the well construction. While the State of Virginia does not mandate a wellhead protection program for potable water systems, the Naval Support Activity division within Naval District Washington is working to develop a plan for NSF Dahlgren that is consistent with EPA guidelines (B. Hornaman, U.S. Navy, personal communication. January 18-20, 2005).

The hydrogeological investigations also indicate that off-base groundwater users are unlikely to be affected by base-related contaminants. This is because the general groundwater flow direction is from the off-base community towards the base and ultimately towards the Potomac River (see the Hydrogeology section of this report for details).

Evaluation

To ensure the water quality of the base drinking water system, NSF Dahlgren follows a water sampling and distribution system inspection program in accordance with state and federal regulations (Virginia Office of Waterworks regulations are based on EPA’s Safe Drinking Water Act-SDWA). Drinking water samples are analyzed for microbiological contamination, metals, volatile organic chemicals (VOCs), inorganic chemicals, and radiological contamination. The

water is chlorinated prior to distribution and sampled for chlorine residuals and chlorine by-products. Sampling results that exceed regulatory standards are investigated and system modifications are promptly addressed (B. Hornaman, U.S. Navy, personal communication. April 5, 2005).

ATSDR reviewed recent past reports of the sample analyses and inspection reports for the system. The earliest survey record on chlorination and bacterial analysis dates back to 1954 and NSF Dahlgren files include sampling data on VOCs, metals, inorganic chemicals and radiological elements from 1989 onwards. Reports of recent inspection and sampling results indicate the water quality and distribution system meets or exceeds established state and federal drinking water standards (VDH 2003a, 2003b; Navy 2004a, 2004b, 2004c, 2004d, 2004e, 2004f, 2004g; VDH 2002a, 2004a). In addition, the samples collected from 1997 to 2002 and analyzed for environmental contaminants did not identify any impact of environmental contamination on the drinking water quality (VDH 2002b, 2002c).

Conclusions

The sampling results reviewed indicate there is no evidence of past or current exposure to base-related contaminants from the base-drinking water system. Environmental investigations and remedial actions in progress at the base are expected to reduce the potential for environmental contaminants to impact the drinking water aquifers. In addition, the base monitoring activities are expected to identify potential contamination before harmful exposures occur. ATSDR supports NSF Dahlgren efforts to develop a wellhead protection program to ensure the source water quality of the base drinking water system.

Issue 4: Hunting on Old Bombing Range (Site 1)

Background

The Old Bombing Range (Site 1) is located in the central part of Mainside. It is approximately 800 acres in size and was used in the early 1940s (1940-1945) as an aerial bombing range. Parts of the Old Range are still active and are used for other Range testing activities (Weedon, Personal Communication, April 2005). Development in the range has been largely restricted due to the possible presence of munitions of explosive concern (MECs). No complete decontamination clearing process or remedial process has been carried out across the entire site. However, two landfills located within the Old Range area were investigated and remediated.

The area is currently heavily wooded and vegetated. A portion of the range is one of many on-base locations where hunting is allowed (by permit) for military or base personnel and their guests using muzzleloaders, bow and arrow, and shotguns. Game species permitted by State game regulations include deer, turkey, squirrel, waterfowl, ducks and geese.

Public Health Concern

ATSDR identified this activity for further consideration to evaluate how the base ensures that hunters are not dangerously exposed to unexploded ordnance (UXO).

Evaluation

The site has not been used for aerial bombing since the late 1940s and only parts of it are still used for range testing activities. Access to the active test areas is not permitted. No past incidents involving accidental contact with UXOs have been noted. Though the site is not fenced, warning signs are posted every 50-100 feet along the perimeter, advising people to not enter the site. Several areas of the old bombing range, especially those around the perimeter of the elevated tree stands, were inspected for UXOs. Sweeps have been conducted in some of the areas in the past and many areas have been timbered and/or burned over the years. Base hunting regulations specify that handling ordnance is prohibited and that when ordnance is observed it needs to be reported to the Game Check Station assistant who in turn notifies the Explosive Ordnance Disposal (EOD) Detachment for further handling (T. Wray, U.S. Navy, Personal Communication, January 18-20, 2005).

The on-base Division of Natural Resources Management, which oversees the hunting and fishing programs, regulate on-base hunting activities. Hunters are required to obtain state licenses and base hunting permits, sign in with the Game Check Station prior to entering the hunting grounds, and follow specific procedures designed to keep them in areas believed to be clear of UXO.

Conclusions

The base provides sufficient information, notification and guidance to hunters so that hunters may protect themselves from dangerous exposure to the UXO. ATSDR supports NSF Dahlgren's efforts to educate hunters about the risks and procedures associated with hunting in this area.

Issue 5: Consumption of Locally Captured Fish & Game

Background

NSF Dahlgren is bounded on two sides by the Potomac River and Upper Machodoc Creek. The Mainside area of the Base contains both the Hideaway Pond and the Cooling Pond. Military and base personnel and their guests are permitted to fish in the Potomac River and Upper Machodoc Creek from on-base access areas, and the on-base ponds. Off-base public access to fishing areas on the Potomac River and Upper Machodoc Creek are also located near the base. Additionally, military and base personnel and their guests are permitted to hunt deer, turkey, squirrel, waterfowl, duck, and geese in designated areas on Mainside and the EEA. Base records indicate that approximately 85 hunters and 125 anglers use the on-base resources annually (T. Wray, U.S. Navy, personal communication, April 5, 2005).

Public Health Concerns

Some community members have expressed concern that eating locally captured fish and game may cause health effects due to base-related environmental contaminants. (TtNUS 2004a)

ATSDR evaluated the potential for exposure to base-related contaminants due to consumption of fish and game caught on-base, and the potential for exposure to contaminants reported in fish, crab and oysters taken from the Potomac River. This evaluation was based on information available from the documents describing on-base environmental contaminants and results of fish tissue sampling, results of the VDEQ fish tissue sampling performed in rivers and streams around the state (available at http://www.deq.virginia.gov/fishtissue/fishtissue.html and http://www.vdh.state.va.us/HHControl/pdf/Potomac.pdf), and scientific literature describing the environmental contaminant concentrations measured in game animal tissues from similar areas.

Evaluation

Fishing on base requires appropriate state licenses and base permits. During the base permitting process, anglers receive information about the fishing restrictions and advisories applicable to the on-base ponds and creeks and the Potomac River and Upper Machodoc Creek areas accessible from the base (T. Wray, U.S. Navy, personal communication, Sept 13, 2005).

Fishing in the Potomac River and Upper Machodoc Creek is regulated by the Commonwealth of Virginia. Periodic sampling of fish tissue and the issuance of fish advisories if necessary are provided by the Virginia Department of Health (VDH). Currently, there is one fish consumption advisory in effect for the Potomac River Basin including the tidal portion of Upper Machodoc Creek due to the presence of polychlorinated biphenyls (PCBs) in gizzard shad, white perch and channel catfish (VDH 2004c). VDH recommends people consume no more than two meals per month of these fish.

Some on-base fishing takes place from Gambo Creek. Common locations are the entrance of the creek onto the base at Route 301, the middle bridge and the mouth of the creek where it empties into the Upper Machodoc Creek. Fish that live in the upper portion of Gambo Creek are not exposed to significant levels of base-related contamination. The water level in the Gambo Creek, Upper Machodoc Creek, and Potomac River is influenced by the tidal activity of the Atlantic

Ocean. At low tide, Gambo Creek near the bridge is essentially a mud flat. At high tide, a significant amount of water may be present under the bridge. Some small species of fish may live their entire lives in this section of Gambo Creek. Larger fish, that might be caught and consumed, would likely need to migrate between the Upper Machodoc Creek and the middle reaches of Gambo Creek. As a result larger fish would likely not be exposed to specific site-related contaminants their entire life (R. Mayer and B. T.Weedon, personal communication, Aug 2005, T. Wray, personal communication, September 2005). Fish tissue sampling results from the Upper Machodoc Creek are believed to also be representative of the fish in Gambo Creek. As a result, the base advises on-base anglers to follow the VDH fish consumption limits for the entire Potomac River basin including Gambo Creek (T. Wray, U.S. Navy, personal communication September 13, 2005).

Although fishing is permitted in both on-base ponds, the base adheres to a catch and release fishing program. Signs stating the policy are posted at both ponds. The catch and release policy for Hideaway Pond (Site 10) was established in 1980 after the discovery of mercury in fish tissue samples (TtNUS 2004c). Sampling performed in 2001 and 2003 indicate that some of the fish sampled contained high levels of mercury; in a few cases the concentrations exceeded regulatory standards set to protect human health (TtNUS 2004c). Fish tissue sampling and the ‘catch and release’ restrictions are expected to continue until two consecutive rounds of sampling indicate the mercury levels in the fish are within regulatory standards (TtNUS 2004c, EPA 2000). Anglers who adhere to the base catch and release policy will not be exposed to mercury at levels that could cause adverse health effects.

Fish tissue sampling performed on fish from the Cooling Pond in 1982, 1983, 1992, and 2000 indicate detectable concentrations of mercury, some types of pesticides, PCBs and some metals were present in many of the samples. In general, the concentrations were below regulatory limits. However, the base instituted a catch and release policy for the Cooling Pond (Site 55) in 1993 as a protective measure due to the potential for contaminants to exist in the pond (Navy 2003b). Anglers who adhere to the base catch and release policy will not be exposed to mercury at levels that could cause adverse health effects.

Several industrial, stormwater, and sewage treatment plant outfalls discharge from the base and other neighboring industrial and municipal operations to Virginia’s water bodies. The Commonwealth of Virginia monitors these outfalls and issues permits for non-stormwater discharge. NSF Dahlgren discharges are regulated by two Virginia Pollutant Discharge Elimination System (VPDES) permits (G. Vick, U.S. Navy, personal communication, April 8, 2005). These describe the monitoring requirements, analytes and maximum concentrations that NSF Dahlgren is permitted to discharge through each outfall. When monitoring results of the effluent exceed the permitted discharge levels, the base identifies the source and makes the necessary corrections to remain within the permit guidelines (VDEQ 2000, VDEQ 2003, Navy 2005a, G. Vick, U.S. Navy, personal communication, April 8, 2005).

As a protective measure, the Commonwealth of Virginia typically closes the shoreline to shellfish harvesting in areas that could be impacted by environmental contaminants. These areas include locations near industrial and municipal outfalls and boat marinas. Closure to shellfish harvesting does not mean the area is contaminated. VDH closed most of the shoreline around NSF Dahlgren Mainside, Gambo Creek, Williams Creek, Deep Creek and the upstream portion

of Upper Machodoc Creek to shellfish harvesting (VDH 2005). Currently, there are no advisories for recreational crab harvesting in this area as long as the local regulations are followed (for details, see http://www.prfc.state.va.us/).

On-base hunting also requires state licenses and base permits. On-base hunting is permitted for a variety of wildlife including deer, rabbit, and squirrel. Base records indicate an annual average of 20 hunters harvest 38 deer, 2 hunters harvest 12 mourning dove, 2 hunters harvest 3 quail, 5 hunters harvest 25 rabbits, 5 hunters harvest 16 squirrel, and 12 hunters harvest 66 waterfowl during the Fall season (T. Wray, U.S. Navy, personal communication, April 5, 2005). These records indicate hunting and game consumption is a recreational rather than subsistence activity. NSF Dahlgren natural resource personnel monitor the health of the on-base wildlife populations by observing population sizes and behavioral patterns. In addition, each deer captured on base is visually inspected for signs of disease.

Tissue analysis of deer from other areas greatly impacted by mining or manufacturing operations indicate that the environmental contaminants generally do not accumulate in the muscle tissue of game animals (NYSDOH 1999, Pokorny and Ribaric-Lasnik 2000, Alberta Health and Wellness 2004). There is no evidence that recreational hunters or consumers of wild game would be exposed to contaminants at levels that could cause health effects by eating the muscle tissue. Consumers who would like to reduce their potential for exposure should avoid the internal organs such as the liver or kidney.

Conclusions

On-base hunters and anglers are required to have both state licenses and base permits. During the base permitting process, hunters and anglers are provided information about state and base restrictions and advisories. As a result, hunters and anglers as well as consumers of local fish and game who follow this guidance are not expected to be exposed to base-related contaminants at levels known to harm human health.

Issue 6: Soil Vapor Intrusion from Methane Migration

Background

Methane gas is frequently generated in landfills as buried wastes degrade. The amount and rate of methane formation depends on a variety of factors including the age and composition of the waste, and the soil's moisture content and temperature. Methane is lighter than air, and once produced, tends to migrate upward through the soil covering the landfill, into the atmosphere. Following the path of least resistance, methane tends to migrate though the more permeable sections of the soil. Landfill covers, or other highly impermeable layers may prevent the vertical migration of methane. In these situations, the methane may migrate horizontally before finding a crack or permeable soil path to the surface. In some cases, methane can migrate from a landfill to a nearby building and enter the building through openings like cracks in the foundation. The concern is that methane could accumulate in enclosed rooms to concentrations that could be an explosive or asphyxiation hazard. To prevent these safety hazards, capped landfills and buildings located close to landfills are typically inspected to determine if methane migration to, and accumulation in, neighboring buildings could occur.

NSF Dahlgren has three landfills, two (Sites 2 and 9) are capped and are not located near any buildings. Methane vents have been installed in the liner cap at both of these landfills. The vents are designed to release methane in the landfill as it is generated, thereby reducing the potential for methane to accumulate in, and migrate through the soil from, the landfills.

The third landfill, Site 17, is uncapped and approximately 5 acres in size. It is located 100 feet from Building 1400. Elevated levels of methane have been measured in some parts of the Site 17 landfill but are non-detectable in other parts. Methane was also measured in a background well outside the landfill. As a safety precaution, the base fire department periodically tested the basement of Building 1400 for the presence of methane; methane was not detected during any test (B. Weedon, U.S. Navy, personal communication, January 18-20, 2004).

Public Health Concern

Methane migration from landfills into adjacent buildings is a concern because of the potential for an increased threat of fire, explosion or asphyxiation. Because base engineers store and retrieve equipment from the basement of Building 1400, ATSDR reviewed the base program to prevent methane migration to, and accumulation in, this building.

Evaluation

All three landfills continue to be monitored and inspected to ensure methane accumulation in the landfill is identified and remediated before it begins to migrate beyond the landfill. Building 1400 near the Site 17 landfill was monitored on a weekly basis until automatic methane monitoring equipment was installed in 2005. In addition, signs posted at the entrance to the basement describe that methane monitoring is in progress and procedures to follow if the alarm sounds. To date, methane has not been detected inside the building.

Results from soil gas field investigations performed between April 2005 and January 2006 show that methane was detected at the southern end of the landfill and around the perimeter fence of

the Building 1400 area. However, samples obtained in January 2006 indicate the levels have decreased since the gas interceptor trench was installed in November 2005. Periodic sampling in the gas monitoring wells tracks the performance of the intercept trench. A Landfill Gas Migration Mitigation Plan is underway to reduce levels outside of the landfill cap boundaries. Additional sampling is underway to assist in this plan (B. Weedon, U.S. Navy, personal communication, April 5, 2004 and June 27, 2005, TtNUS 2006a, TtNUS 2006b, TtNUS 2006c)

Conclusion

Sampling results indicate Building 1400 was not impacted by methane migration from the landfill. Current monitoring equipment is expected to identify methane migration into Building 1400 before hazardous levels accumulate. The protective measures to be implemented by the base to limit methane migration from the landfills are expected to prevent hazardous accumulation in Building 1400.

Issue 7: Historic Skeet Range (near C Gate)

Background

From 1954 to 1983, a Skeet Range was located on base near C Gate. The skeet range was closed and paved-over in the late 1980s or early 1990s, and is currently used as a parking lot. While operational, skeet were launched from the parking lot area towards the river. As a result, most of the projectiles landed 50-100 feet into the Potomac River with a smaller number landing along the shore (C. Ulrich, U.S. Navy, personal communication, March 25, 2005).

The vast majority of skeet range-associated projectile material is likely to be situated in the river sediment. Most of these projectiles likely landed in the sediment when the skeet were originally shot. A smaller number of projectiles, which originally landed on the shore near the river, have been washed into the sediment as the riverbank along this portion of the Mainside has eroded (C. Ulrich, U.S. Navy, personal communication, March 25, 2005). This portion of the river is within the up-stream boundary of the Potomac River Test Range. Frequent access to this section of the river is limited by normal range operations, but some boating, crabbing and fishing occurs.

Public Health Concerns

Environmental investigations were not conducted prior to the paving operation. As a result, lead and steel shot may exist in the soil under the parking lot, along the riverbank and in the river sediment. ATSDR evaluated the current land use of the skeet area to determine if people could be exposed to hazardous amounts of lead. ATSDR reviewed base policy to determine if future construction workers re-building the site or future users of the re-developed site could be exposed to hazardous amounts of skeet range-associated lead.

Evaluation

Under the current land use conditions people are not exposed to skeet range-associated lead, if it exists, in the soil of the skeet range area because the soil is covered with asphalt. The area between the parking lot and the riverbank is well vegetated with trees and brush and not routinely used for recreational activities. While public access to the vegetated area is possible, frequent access is unlikely, and potential for exposure to the soil or lead, if it exists, is limited. A shoreline erosion project is expected to begin this year along this section of the cliff between the skeet range and the river. Completion of this project is expected to further reduce the potential for recreational exposure to the soil along the face of the cliff.(R. Mayer, U.S. Navy, personal communication, February 14, 2006).While it is likely that numerous projectiles are buried in the river sediment, it is unlikely that people would be exposed to contaminants from the projectiles at levels that could cause health effects. Boaters, crabbers, and anglers have infrequent and limited direct contact with river sediment. Most of the sediment stirred up by moving anchors, crab pots, or fishing equipment would be washed off the equipment by the river water as the equipment is raised from the river bottom to the boat. Signs posted along the perimeter of Mainside warn boaters that the area is government property and unauthorized access to the base from the river is not permitted.

The base re-development policy includes consideration of the site’s historical use. The base environmental program office has requested that the history of the skeet range area and the need

for appropriate sampling be considered when this area is proposed for redevelopment be added to the Base Master Plan (B. Weedon, U.S. Navy, personal communication, January 18-20, 2005 and February 14, 2006, R. Mayer, U.S. Navy, personal communication, February 14, 2006).

Conclusion

ATSDR did not identify an exposure concern that would be expected to result in people being exposed to skeet range-related contamination at levels that could cause health affects. ATSDR supports the base re-development policy to include the skeet range in the Base Master Plan and to consider a sampling plan consistent with the historical and planned future use of this site, when re-development of this site is considered. ATSDR also supports the base efforts to control shoreline erosion along the Potomac River in the areas adjacent to the skeet range.

Community Health Concerns

The Navy has routinely conducted surveys of residents from King George County and other surrounding counties. The most recent interviews were conducted between August and October 2003 (TtNUS 2004). ATSDR reviewed the survey results to identify potential exposure concerns of the community regarding NSF Dahlgren-related environmental contamination. The following section presents concerns not discussed in the previous section and ATSDR's evaluation.

- *Potential Exposure to Contaminants in the Potomac River by Drinking the Water*

Some members of the local community expressed concerns about potential exposure to environmental contaminant by drinking water from the Potomac River.

The river begins in the mountains of West Virginia and flows approximately 380 miles before reaching the Chesapeake Bay. The watershed incorporates over 14,000 square miles that funnels water from numerous industrial sites, agricultural areas, and large municipalities into the river. The average flow rate of the river, measured in Washington DC, is approximately 7 billion gallons of water per day (ICPRB).

Municipal water suppliers near Dahlgren primarily rely on groundwater for source water and not on the Potomac River for source water (VDH 2006, MDE). Community members who receive their water from a municipal system receive water that has been tested and treated to meet state and federal drinking water standards. Community members may request a copy of the Consumer Confidence Report from their municipal water supplier for details of their specific water quality.

As described in the PHA, local community members who receive their drinking water from private residential wells are unlikely to have their water affected by NSF Dahlgren-related environmental contaminants. This is because the groundwater tends to flow from the inland areas onto the base. Groundwater in the shallow, surficial aquifer is believed to empty to the river. Groundwater in the deep aquifers is believed to flow under the Potomac River; the degree to which the Potomac River contributes to groundwater flow is not known. The available information on groundwater flow patterns in this area indicate it is unlikely for base-related contaminants to be detected in groundwater on the other side of the Potomac River.

- *Potential Exposure to Contaminants in the Potomac River by Swimming in the Water*

Some members of the local community expressed concerns about potential exposure to environmental contaminant by swimming in the Potomac River., ATSDR was unable to identify recent Potomac River water sampling data about potential contaminant concentrations near the Dahlgren area in USGS or EPA databases. However, coliform bacteria levels are typically used to evaluate if the water is safe for swimming. Only a few areas along the Potomac River, that have been designated for swimming, are periodically monitored. Bacteria levels tend to rise immediately after storms and decrease a few days later (ICPRB). As a prudent public health action, ATSDR recommends that people who swim in the Potomac River use beach areas associated with public parks and follow the posted regulations.

- *Potential Exposure to Mercury in Hideaway Pond by Swimming or Boating*

Hideaway Pond is used for boating and catch-and-release fishing. Boy Scout camping trips take place in the neighboring area and include canoeing on the pond. Swimming is not permitted in Hideaway Pond. However, it is possible that adults or children could accidentally ingest some of the pond water while boating or canoeing. ATSDR evaluated the potential for adverse health effects to occur following exposure to mercury by incidental ingestion of water from Hideaway Pond.

Sampling results reported mercury concentrations in the water ranging from 0.005 to 0.016 µg/L. These concentrations are well below EPA's regulatory limit of 2 µg/L of mercury in drinking water. Adults and children who ingest water from Hideaway Pond while fishing or boating will not be exposed to mercury levels that would be likely to cause adverse health effects.

- *Noise from River Range Activities*

NSF Dahlgren base is an active test facility with regular testing schedules on the Potomac River Test Range (PRTR). Some off-base community members along the river range have expressed concerns over the noise emanating from test operations. The base maintains a continuous effort to limit the noise impact by following a 5-day (8AM to 5PM) firing schedule and providing information to the public about the history and necessity of the firing range as well as updated test schedule information.

Meteorological data, including temperature, wind speed, wind direction, relative humidity, and barometric pressure as functions of altitude, are used in the prediction of atmospheric sound focusing as part of the Sound Intensity Prediction System (SIPS). The SIPS program predicts sound intensity (noise) levels expected to occur over populated areas during range activities. This system is applied to long-range propagation or spread of impulse noise in the atmosphere from testing ammunition and guns, or by detonating suspect explosive materials. This information is used to reduce the impact of noise on the surrounding communities from explosive operations at NSF Dahlgren. Scheduled testing will be postponed or cancelled when high noise levels are predicted to occur over a populated area. Permanent noise meters are installed at various locations along the range to measure noise levels produced by gun firing and explosive testing, as they occur. These measured noise levels are used to address noise concerns and validate the predictions made by SIPS. (R. Mason, U.S. Navy, personal communication, April 5, 2005). As a point of reference, in the last few years, the base estimates noise exposure due to firing on the Potomac Test Range to be only 20% of levels experienced in the 1960s (R. Mason, U.S. Navy, personal communication, January 18-20, 2005).

ATSDR supports these base programs to reduce the level of impact from the noise and respond to community concerns about noise.

- *Environmental Contaminant Exposure Concerns*

Some residents in the area have questioned if environmental contaminants present at NSF Dahlgren could harm the health of on-base or neighboring residents. Specifically, is there evidence that local residents could develop cancer due to exposure to the base-related environmental contaminants?

ATSDR did not identify any exposure where local community members were exposed to NSF Dahlgren-related environmental contaminants that would be expected to cause any health concern, including cancer. The on-base drinking water system meets or exceeds federal requirements for monitoring and treatment. Neighboring residents relying on private groundwater wells are unlikely to be impacted by base-related contaminants. Anglers and hunters who follow base and VDH recommendations are unlikely to be exposed to harmful levels of environmental contaminants from fish, shellfish, of game captured from the base or it's access points to the river. On-base residents and visitors are unlikely to come into frequent and direct contact with the on-base contaminated sites.

Child Health Considerations

ATSDR recognizes that, for a variety of reasons, infants and children may be more sensitive to some environmental contaminant exposures than adults. Children are more likely to be exposed because they play outdoors and sometimes engage in hand-to-mouth behaviors that increase their exposure potential. Children are shorter than adults, which mean they breathe dust, soil, and heavy vapors close to the ground. Children are also smaller (lower body weight) and have higher relative intake rates, potentially resulting in higher doses of chemical exposure per unit body weight. The developing body systems of children can sustain permanent damage if toxic exposures occur during critical growth stages. Most importantly, children depend completely on adults for risk identification and management decisions, housing decisions, and access to medical care. Therefore, ATSDR is committed to evaluating their special interests at sites such as NSF Dahlgren.

NSF Dahlgren base housing, recreational activity areas, and school are concentrated in the southern part of the base. Recreational opportunities include a playground, gymnasium, and indoor swimming pool. While children are not physically restricted from any area of the base, they are unlikely to have frequent and direct contact with the contaminated sites. The contaminated sites are distributed around the base, outside of the residential area, and in many cases direct assess to the site is limited by a fence, heavy brush or distance from the main road.

Early childhood exposure to lead, especially by lead-based paint, is a significant concern in many older on- and off-base housing areas. NSF Dahlgren has participated in the Navy's pediatric lead exposure prevention program instituted in 1993. This program monitors children residing in on-base housing (housing built prior to 1973 may contain lead based paint) for indications of lead exposure. NSF Dahlgren medical clinic personnel indicated that no cases of elevated lead levels have been identified in children living in on-base housing.

Conclusions

ATSDR examined the nature and extent of environmental contamination resulting from previous material handling and disposal practices at NSF Dahlgren to evaluate the potential exposure of on-base residents, visitors, and employees, and local community members. The evaluation considered the available environmental data, information provided by the Navy, regulators and community members, and published scientific information on the characteristics of specific environmental contaminants.

As a result of this evaluation, ATSDR concludes that the environmental contamination at NSF Dahlgren poses ***no apparent public health hazard***. This means that people may be exposed to small amounts of some of the environmental contaminants on-base, but the exposures are below levels expected to cause harmful health effects.

Public Concern about classified activities at NSF Dahlgren. Past and current classified operations involve the use of chemical, biological and radiological agents. Some community members are concerned that environmental contamination could exist yet not be investigated or reported due to the classified nature of the work. ATSDR investigated the nature of the operations conducted at NSF Dahlgren, along with the potential agents of concern and pathways of exposure. Results indicate that most of the research has been conducted using common laboratory chemicals, and chemical and biological agent simulants. ATSDR did not identify evidence of potentially harmful exposures to the public from the classified work conducted at NSF Dahlgren. ATSDR supports the base community relations program designed to address these types of concerns. ATSDR categorized this as a *no apparent public health hazard*.

Potential River Safety concerns for recreational users due to UXOs. The Potomac River Test Range extends from above Upper Machodoc Creek in King George County to the mouth of the river off Smith Point and is actively used to test a variety of Naval ordnance systems. Boaters who follow normal safe boating practices, consult the navigational charts prior to entering unfamiliar territory, and follow the directions of the range control boats, will not be exposed to safety hazards from range operations. In addition, people who follow base procedures for reporting found projectiles and unexploded ordnance are unlikely to be harmed by them. ATSDR supports NSF Dahlgren's public relations and community outreach efforts to ensure that people know how to respond if they find UXO or projectiles. ATSDR categorized this as a *no apparent public health hazard*.

Protection of Drinking Water System. NSF Dahlgren follows the EPA mandated water-testing program to ensure safe drinking water. The sampling results reviewed indicate there is no evidence of past or current exposure to base-related contaminants from the base-drinking water system. Environmental investigations and remedial actions in progress at the base are expected to reduce the potential for environmental contaminants to impact the drinking water aquifers. The base monitoring activities are expected to identify potential contamination before harmful exposures occur. ATSDR supports base efforts to monitor and protect the base drinking water supply including efforts to develop a wellhead protection program. ATSDR categorized this as a *no apparent public health hazard*.

Potential physical safety concerns for hunters at the Old Bombing Range (Site 1) due to UXOs. A portion of the Old Bombing Range (Site 1) is used by military or base personnel and their guests for hunting (by permit). The perimeter of the area is clearly signed and base regulations require hunters follow specific procedures designed to keep them in areas believed to be clear of UXO. While ATSDR does not support the practice of hunting on the Old Bombing Range, it appears that the base provides sufficient notification and guidance to hunters so that they may protect themselves from dangerous exposure to the UXO. ATSDR supports NSF Dahlgren's efforts to educate hunters about the risks and procedures associated with hunting in this area. Hunters who follow the established base procedures are unlikely to be exposed to ordnance materials. ATSDR categorized this as a *no apparent public health hazard*.

Potential dietary exposure concerns due to consumption of locally captured fish and game. Military and base personnel and their guests are permitted to hunt and fish in designated areas of the base, fishing is permitted in the rivers bordering the base, and the on-base ponds and Gambo Creek. Fishing, crabbing, and shellfish harvesting in the Potomac River and Upper Machodoc Creek is regulated by the Commonwealth of Virginia. The Virginia Department of Environmental Quality (VDEQ) periodically conducts sampling and the Virginia Department of Health (VDH) reviews the data and issues advisories as necessary. On-base game has not been sampled for base-related contaminants. A review of the available literature indicates periodic consumption of on-base game is not likely to cause health effects. In general, consumers can reduce their potential exposure by adhering to the base and Virginia Commonwealth advisories. ATSDR categorized these as a *no apparent public health hazard.*

Potential explosive hazards associated with soil vapor intrusion from methane migration into building basements near landfills. Methane gas is frequently generated in landfills and can migrate into adjacent buildings causing an increased potential of fire, explosion or asphyxiation. Methane has been detected in some portions of the Site 17 landfill, approximately 100 feet from Building 1400. However, methane has not been detected in Building 1400. Automatic methane monitoring equipment was installed in the building and additional studies of the landfill are being conducted to identify the appropriate strategy to prevent methane migration from the Site 17 landfill. ATSDR supports the protective measures implemented by the base. ATSDR categorized this as a *no apparent public health hazard*.

Potential exposure to lead during redevelopment/reuse of the Historic Skeet Range. The Skeet Range, used 1954 to 1983, has been closed and paved, and is currently used as a parking lot. While operational, skeet were launched from the parking lot area, into the air and towards the river. Skeet range-associated projectile material is likely made of lead and steel and situated in the river sediment, along the river shore, and under the pavement. Under the current land use conditions, people are unlikely to be exposed to skeet range-associated lead, if it exists, at levels that could cause health concerns. When this site is considered for re-development, the base will consider a sampling plan consistent with the historical use and planned future use of the site. ATSDR supports the base re-development policy to consider a sampling plan consistent with the historical and planned future use of this site, when re-development of this site is considered. ATSDR categorized this as a *no apparent public health hazard.*

Recommendations

1) As a prudent public health action, ATSDR recommends that hunters and anglers follow the guidance issued by the base and Virginia Commonwealth concerning fish and game consumption restrictions and advisories.

2) As a prudent public health action, ATSDR recommends that people who wish to swim in the Potomac River use established beach areas associated with public parks and follow all posted regulations.

Public Health Action Plan

The public health action plan (PHAP) for NSF Dahlgren contains a description of actions taken, or to be taken by NSF Dahlgren, ATSDR, and EPA. The purpose is to ensure this PHA both identifies and evaluates potential exposure concerns, and identifies actions that have been taken or need to be taken to prevent adverse human health effects resulting from exposure to hazardous substances in the environment. The public health actions that are completed, ongoing, or planned include:

Completed Actions

The U.S. Navy, in cooperation with EPA and VDEQ, completed numerous environmental investigations to identify and characterize releases of environmental contaminants at NSF Dahlgren. Removal actions and site remediation has been initiated or completed at many of these sites.

NSF Dahlgren instituted catch and release fishing policies at the Cooling Pond and Hideaway pond. These restrictions are designed to be protective of human health and are expected to remain until monitoring results meet regulatory health-based goals.

NSF Dahlgren maintains strong public relations and community outreach efforts (1) to ensure people know how to respond if they find range-related materials, (2) to inform and protect the public about the river range testing activities, and (3) to address concerns about base research activities through community involvement and public base tours.

ATSDR visited NSF Dahlgren in 1992 to collect information and identify public health issues related to potential exposures to base-related environmental contaminants. ATSDR did not identify any potential exposures that represented an immediate public health concern.

ATSDR re-visited NSF Dahlgren in January 2005 to collect updated information related to environmental studies and remediation programs for the contaminated sites on the base. ATSDR concluded there were no immediate threats to human health but identified seven exposure concerns for further evaluation as part of its public health evaluation.

Ongoing and Planned Actions

The Navy and other state and federal agencies continue to seek out, evaluate, and remediate sites affected by the release of environmental contaminants at NSF Dahlgren.

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Figures

Figure 1. Regional Map - Location of Naval Support Facility, Dahlgren, Virginia

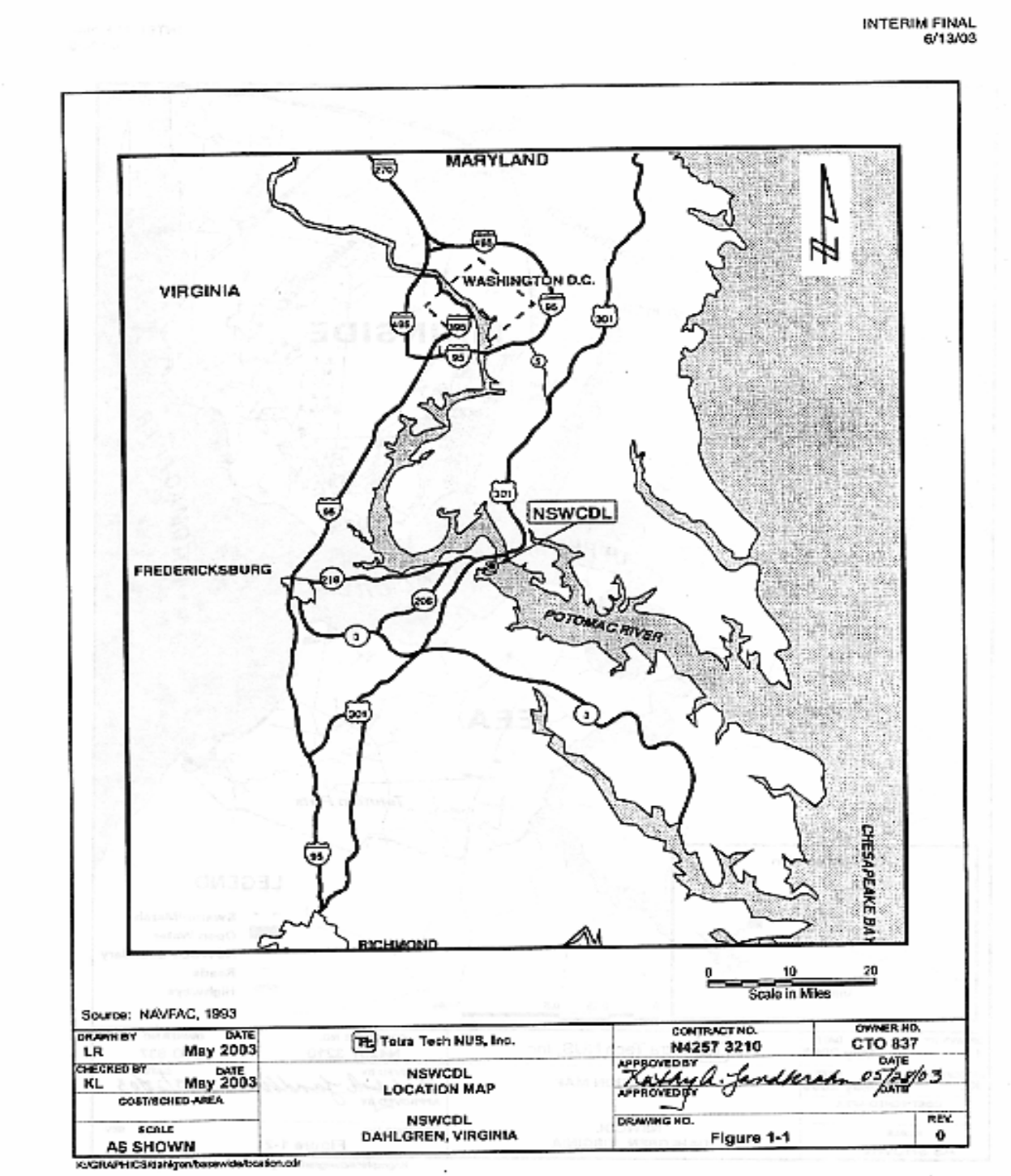


Figure 2. Map of NSF Dahlgren Base

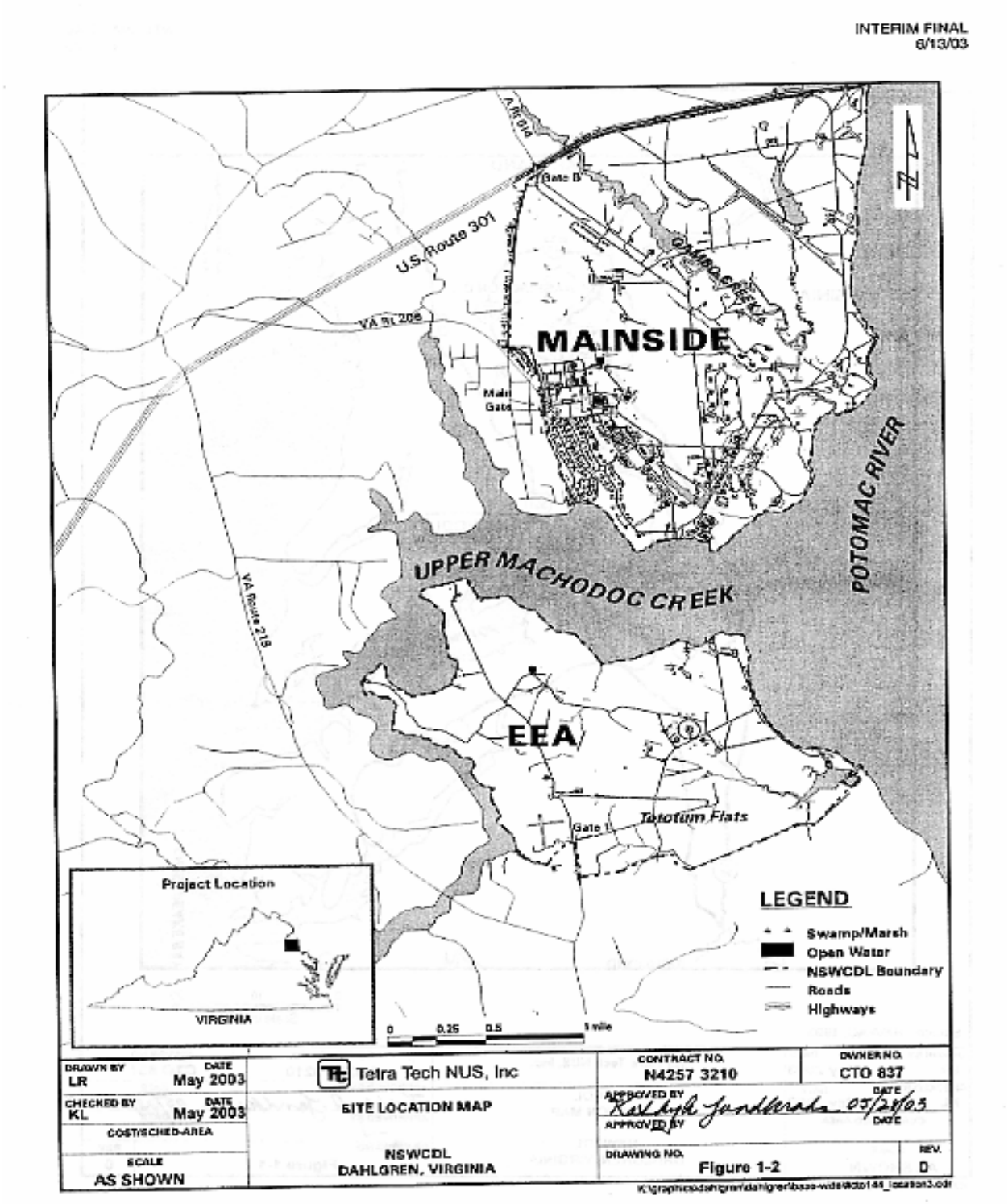


Figure 3. Map of NSF Dahlgren - Mainside

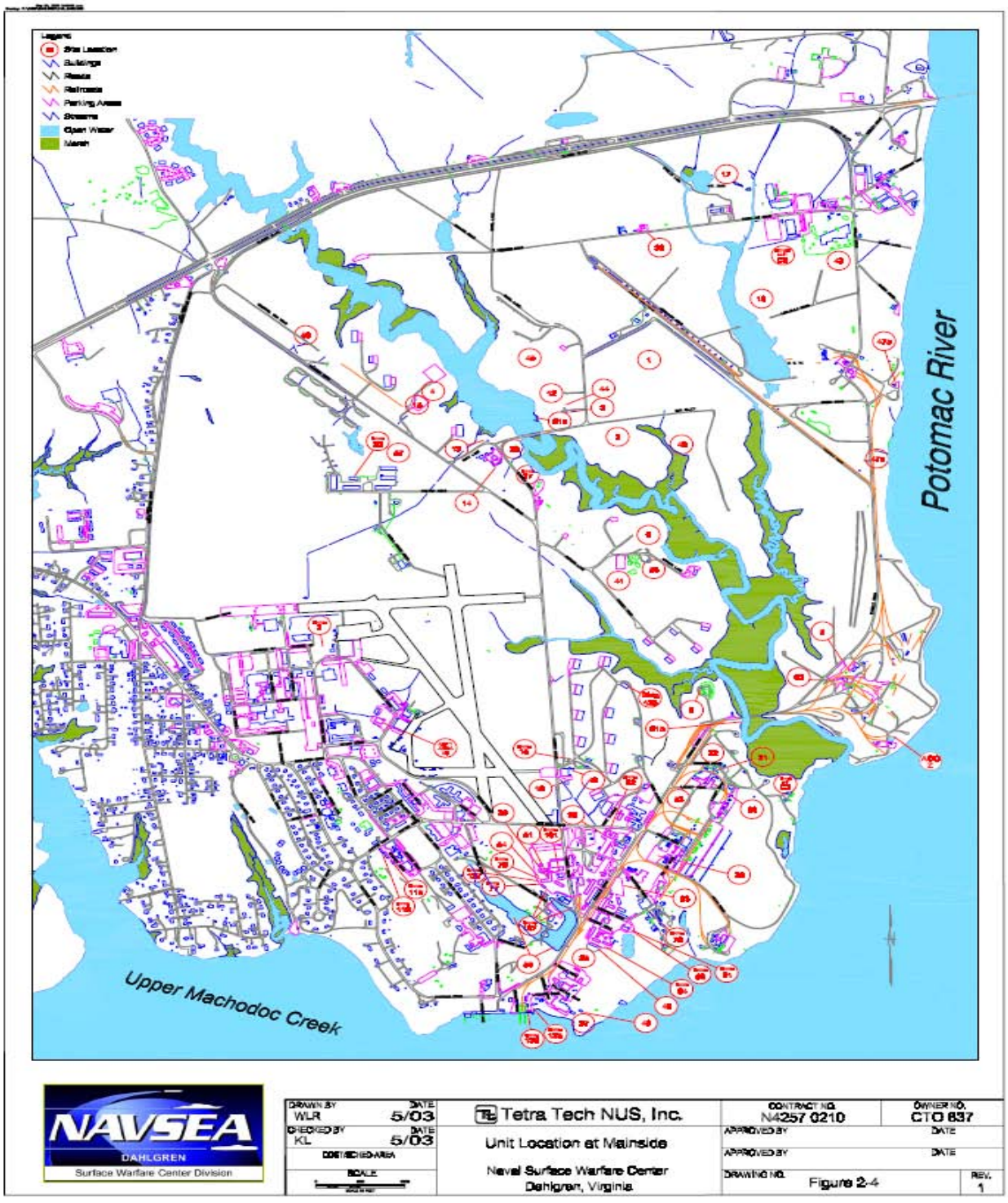


Figure 4. Map of NSF Dahlgren - Experimental Explosive Area (EEA)

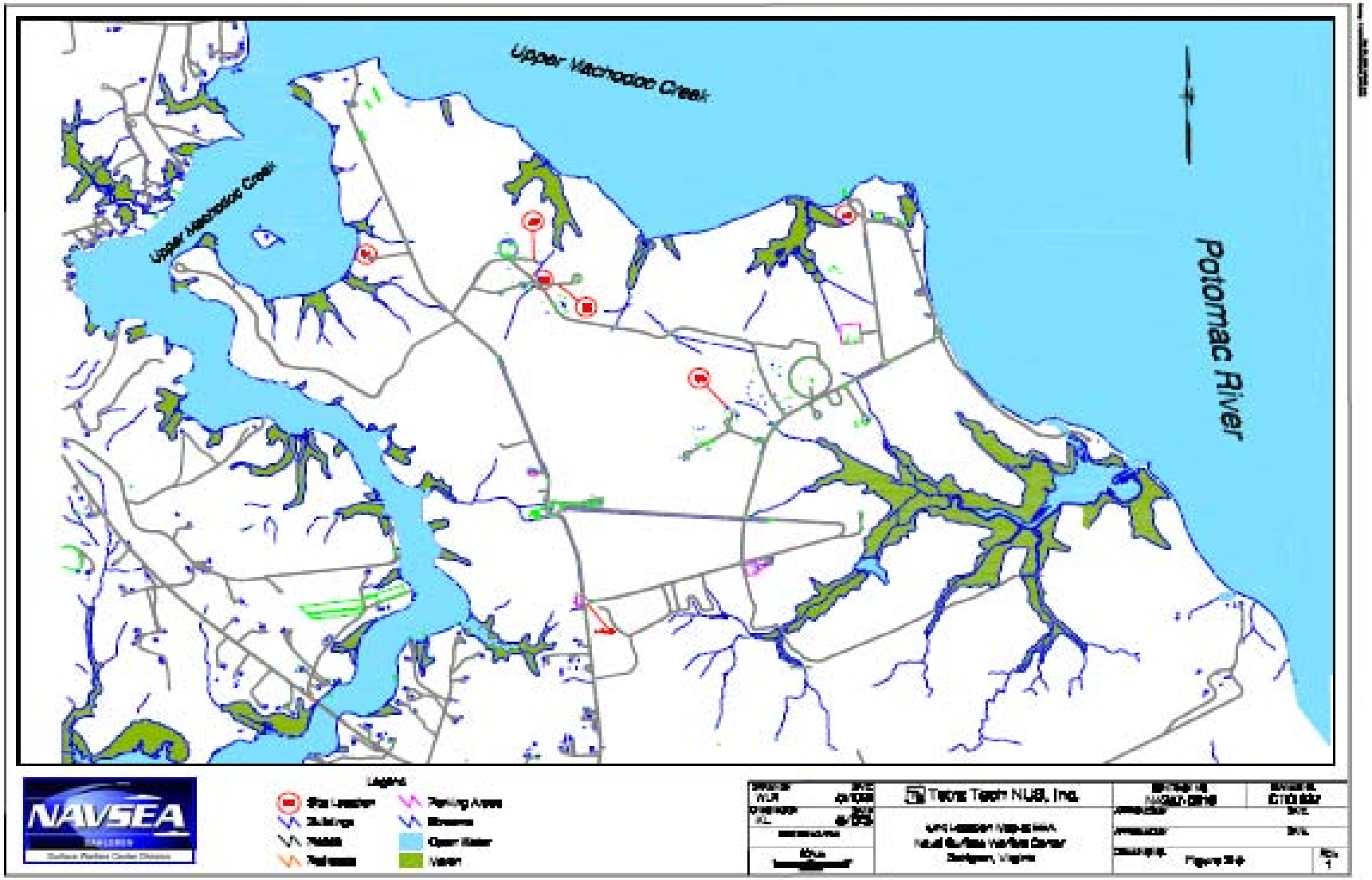
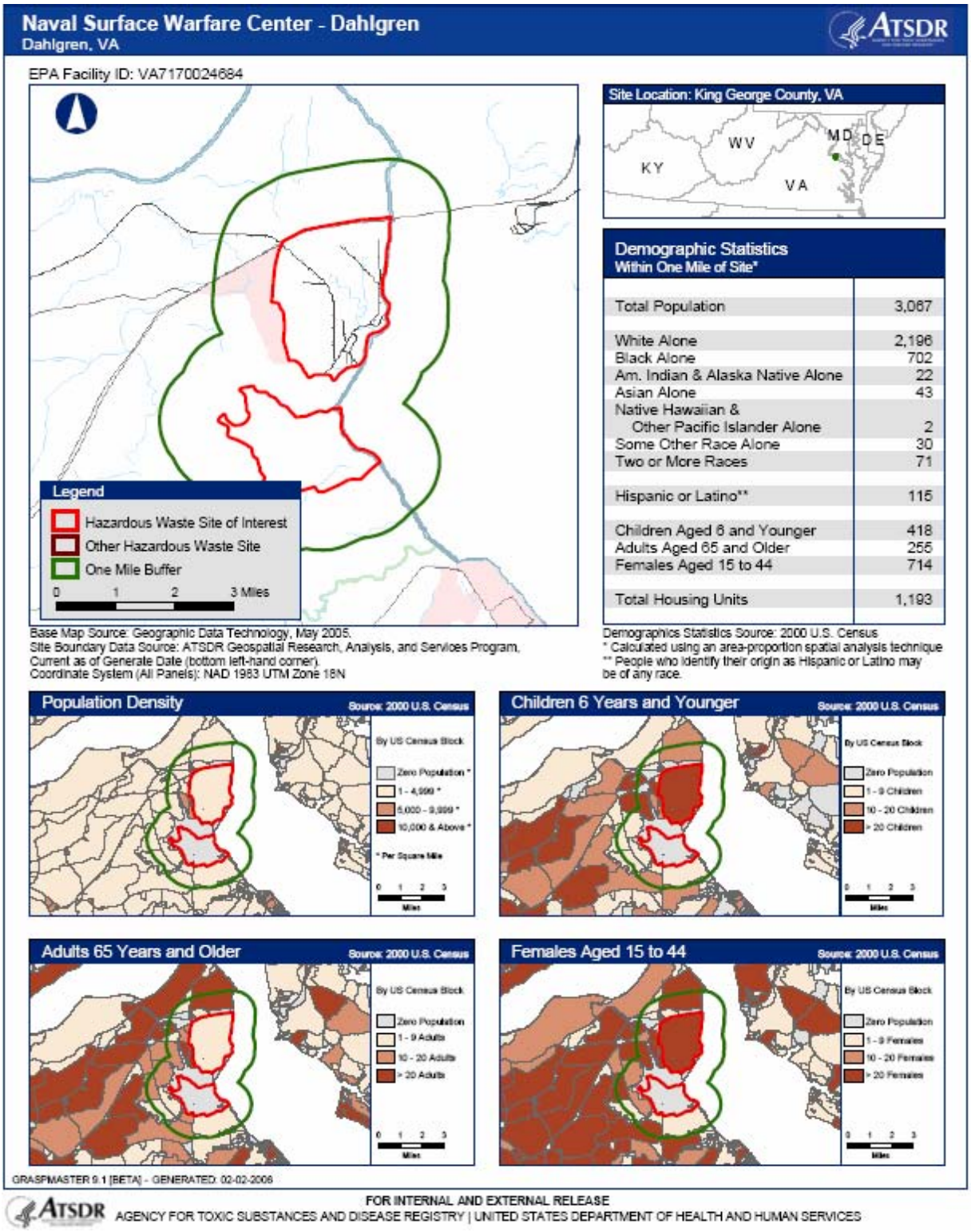


Figure 5. 2000 Census Demographics for 1-mile Radius Around NSF Dahlgren Base



Source: U.S. Census Bureau, 2000 Census of Population and Housing, Summary File 1 [Virginia]. Washington: The Bureau [producer and distributor], 2001

Appendices

Appendix A. Glossary of Terms

The Agency for Toxic Substances and Disease Registry (ATSDR) is a federal public health agency with headquarters in Atlanta, Georgia, and 10 regional offices in the United States. ATSDR's mission is to serve the public by using the best science, taking responsive public health actions, and providing trusted health information to prevent harmful exposures and diseases related to toxic substances. ATSDR is not a regulatory agency, unlike the U.S. Environmental Protection Agency (EPA), which is the federal agency that develops and enforces environmental laws to protect the environment and human health. This glossary defines words used by ATSDR in communications with the public. It is not a complete dictionary of environmental health terms. If you have questions or comments, call ATSDR's toll-free telephone number, 1-888-42-ATSDR (1-888-422-8737).

Absorption
The process of taking in. For a person or an animal, absorption is the process of a substance getting into the body through the eyes, skin, stomach, intestines, or lungs.

Acute
Occurring over a short time (compare with chronic).

Acute exposure
Contact with a substance that occurs once or for only a short time (up to 14 days) (compare with intermediate duration exposure and chronic exposure).

Additive effect
A biologic response to exposure to multiple substances that equals the sum of responses of all the individual substances added together (compare with antagonistic effect and synergistic effect).

Adverse health effect
A change in body function or cell structure that might lead to disease or health problems

Aerobic
Requiring oxygen (compare with anaerobic).

Ambient
Surrounding (for example, ambient air).

Anaerobic
Requiring the absence of oxygen (compare with aerobic).

Analyte
A substance measured in the laboratory. A chemical for which a sample (such as water, air, or blood) is tested in a laboratory. For example, if the analyte is mercury, the laboratory test will determine the amount of mercury in the sample.

Analytic epidemiologic study
A study that evaluates the association between exposure to hazardous substances and disease by testing scientific hypotheses.

Antagonistic effect
A biologic response to exposure to multiple substances that is less than would be expected if the known effects of the individual substances were added together (compare with additive effect and synergistic effect).

Background level
An average or expected amount of a substance or radioactive material in a specific environment, or typical amounts of substances that occur naturally in an environment.

Biodegradation
Decomposition or breakdown of a substance through the action of microorganisms (such as bacteria or fungi) or other natural physical processes (such as sunlight).

Biologic indicators of exposure study
A study that uses (a) biomedical testing or (b) the measurement of a substance (an analyte), its metabolite, or another marker of exposure in human body fluids or tissues to confirm human exposure to a hazardous substance (also see exposure investigation).

Biologic monitoring
Measuring hazardous substances in biologic materials (such as blood, hair, urine, or breath) to determine whether exposure has occurred. A blood test for lead is an example of biologic monitoring.

Biologic uptake
The transfer of substances from the environment to plants, animals, and humans.

Biomedical testing
Testing of persons to find out whether a change in a body function might have occurred because of exposure to a hazardous substance.

Biota
Plants and animals in an environment. Some of these plants and animals might be sources of food, clothing, or medicines for people.

Body burden
The total amount of a substance in the body. Some substances build up in the body because they are stored in fat or bone or because they leave the body very slowly.

CAP (see Community Assistance Panel.)

Cancer
Any one of a group of diseases that occur when cells in the body become abnormal and grow or multiply out of control.

Cancer risk
A theoretical risk for getting cancer if exposed to a substance every day for 70 years (a lifetime exposure). The true risk might be lower.

Carcinogen
A substance that causes cancer.

Case study
A medical or epidemiologic evaluation of one person or a small group of people to gather information about specific health conditions and past exposures.

Case-control study
A study that compares exposures of people who have a disease or condition (cases) with people who do not have the disease or condition (controls). Exposures that are more common among the cases may be considered as possible risk factors for the disease.

CAS registry number
A unique number assigned to a substance or mixture by the American Chemical Society Abstracts Service.

Central nervous system
The part of the nervous system that consists of the brain and the spinal cord.

CERCLA (see Comprehensive Environmental Response, Compensation, and Liability Act of 1980)

Chronic
Occurring over a long time (compare with acute).

Chronic exposure
Contact with a substance that occurs over a long time (more than 1 year) (compare with acute exposure and intermediate duration exposure)

Cluster investigation
A review of an unusual number, real or perceived, of health events (for example, reports of cancer) grouped together in time and location. Cluster investigations are designed to confirm case reports; determine whether they represent an unusual disease occurrence; and, if possible, explore possible causes and contributing environmental factors.

Community Assistance Panel (CAP)
A group of people from a community and from health and environmental agencies who work with ATSDR to resolve issues and problems related to hazardous substances in the community. CAP members work with ATSDR to gather and review community health concerns, provide information on how people might have been or might now be exposed to hazardous substances, and inform ATSDR on ways to involve the community in its activities.

Comparison value (CV)
Calculated concentration of a substance in air, water, food, or soil that is unlikely to cause harmful (adverse) health effects in exposed people. The CV is used as a screening level during the public health assessment process. Substances found in amounts greater than their CVs might be selected for further evaluation in the public health assessment process.

Completed exposure pathway (see exposure pathway).

Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA)
CERCLA, also known as Superfund, is the federal law that concerns the removal or cleanup of hazardous substances in the environment and at hazardous waste sites. ATSDR, which was created by CERCLA, is responsible for assessing health issues and supporting public health activities related to hazardous waste sites or other environmental releases of hazardous substances. This law was later amended by the Superfund Amendments and Reauthorization Act (SARA).

Concentration
The amount of a substance present in a certain amount of soil, water, air, food, blood, hair, urine, breath, or any other media.

Contaminant
A substance that is either present in an environment where it does not belong or is present at levels that might cause harmful (adverse) health effects.

Delayed health effect
A disease or an injury that happens as a result of exposures that might have occurred in the past.

Dermal
Referring to the skin. For example, dermal absorption means passing through the skin.

Dermal contact
Contact with (touching) the skin (see route of exposure).

Descriptive epidemiology
The study of the amount and distribution of a disease in a specified population by person, place, and time.

Detection limit
The lowest concentration of a chemical that can reliably be distinguished from a zero concentration.

Disease prevention
Measures used to prevent a disease or reduce its severity.

Disease registry
A system of ongoing registration of all cases of a particular disease or health condition in a defined population.

DOD
United States Department of Defense.

DOE
United States Department of Energy.

Dose (for chemicals that are not radioactive)
The amount of a substance to which a person is exposed over some time period. Dose is a measurement of exposure. Dose is often expressed as milligram (amount) per kilogram (a measure of body weight) per day (a measure of time) when people eat or drink contaminated water, food, or soil. In general, the greater the dose, the greater the likelihood of an effect. An "exposure dose" is how much of a substance is encountered in the environment. An "absorbed dose" is the amount of a substance that actually got into the body through the eyes, skin, stomach, intestines, or lungs.

Dose (for radioactive chemicals)
The radiation dose is the amount of energy from radiation that is actually absorbed by the body. This is not the same as measurements of the amount of radiation in the environment.

Dose-response relationship
The relationship between the amount of exposure (dose) to a substance and the resulting changes in body function or health (response).

Environmental media
Soil, water, air, biota (plants and animals), or any other parts of the environment that can contain contaminants.

Environmental media and transport mechanism
Environmental media include water, air, soil, and biota (plants and animals). Transport mechanisms move contaminants from the source to points where human exposure can occur. The environmental media and transport mechanism is the second part of an exposure pathway.

EPA
United States Environmental Protection Agency.

Epidemiologic surveillance (see Public health surveillance).

Epidemiology
The study of the distribution and determinants of disease or health status in a population; the study of the occurrence and causes of health effects in humans.

Exposure
Contact with a substance by swallowing, breathing, or touching the skin or eyes. Exposure may be short-term (acute exposure), of intermediate duration, or long-term (chronic exposure).

Exposure assessment
The process of finding out how people come into contact with a hazardous substance, how often and for how long they are in contact with the substance, and how much of the substance they are in contact with.

Exposure-dose reconstruction
A method of estimating the amount of people's past exposure to hazardous substances. Computer and approximation methods are used when past information is limited, not available, or missing.

Exposure investigation
The collection and analysis of site-specific information and biologic tests (when appropriate) to determine whether people have been exposed to hazardous substances.

Exposure pathway
The route a substance takes from its source (where it began) to its end point (where it ends), and how people can come into contact with (or get exposed to) it. An exposure pathway has five parts: a source of contamination (such as an abandoned business); an environmental media and transport mechanism (such as movement through groundwater); a point of exposure (such as a private well); a route of exposure (eating, drinking, breathing, or touching), and a receptor population (people potentially or actually exposed). When all five parts are present, the exposure pathway is termed a completed exposure pathway.

Exposure registry
A system of ongoing followup of people who have had documented environmental exposures.

Feasibility study
A study by EPA to determine the best way to clean up environmental contamination. A number of factors are considered, including health risk, costs, and what methods will work well.

Geographic information system (GIS)
A mapping system that uses computers to collect, store, manipulate, analyze, and display data. For example, GIS can show the concentration of a contaminant within a community in relation to points of reference such as streets and homes.

Grand rounds
Training sessions for physicians and other health care providers about health topics.

Groundwater
Water beneath the earth's surface in the spaces between soil particles and between rock surfaces (compare with surface water).

Half-life ($t_{½}$)
The time it takes for half the original amount of a substance to disappear. In the environment, the half-life is the time it takes for half the original amount of a substance to disappear when it is changed to another chemical by bacteria, fungi, sunlight, or other chemical processes. In the human body, the half-life is the time it takes for half the original amount of the substance to disappear, either by being changed to another substance or by leaving the body. In the case of radioactive material, the half life is the amount of time necessary for one half the initial number of radioactive atoms to change or transform into another atom (that is normally not radioactive). After two half lives, 25% of the original number of radioactive atoms remain.

Hazard
A source of potential harm from past, current, or future exposures.

Hazardous Substance Release and Health Effects Database (HazDat)
The scientific and administrative database system developed by ATSDR to manage data collection, retrieval, and analysis of site-specific information on hazardous substances, community health concerns, and public health activities.

Hazardous waste
Potentially harmful substances that have been released or discarded into the environment.

Health consultation
A review of available information or collection of new data to respond to a specific health question or request for information about a potential environmental hazard. Health consultations are focused on a specific exposure issue. Health consultations are therefore more limited than a public health assessment, which reviews the exposure potential of each pathway and chemical (compare with public health assessment).

Health education
Programs designed with a community to help it know about health risks and how to reduce these risks.

Health investigation
The collection and evaluation of information about the health of community residents. This information is used to describe or count the occurrence of a disease, symptom, or clinical measure and to evaluate the possible association between the occurrence and exposure to hazardous substances.

Health promotion
The process of enabling people to increase control over, and to improve, their health.

Health statistics review
The analysis of existing health information (i.e., from death certificates, birth defects registries, and cancer registries) to determine if there is excess disease in a specific population, geographic area, and time period. A health statistics review is a descriptive epidemiologic study.

Indeterminate public health hazard
The category used in ATSDR's public health assessment documents when a professional judgment about the level of health hazard cannot be made because information critical to such a decision is lacking.

Incidence
The number of new cases of disease in a defined population over a specific time period (contrast with prevalence).

Ingestion
The act of swallowing something through eating, drinking, or mouthing objects. A hazardous substance can enter the body this way (see route of exposure).

Inhalation
The act of breathing. A hazardous substance can enter the body this way (see route of exposure).

Intermediate duration exposure
Contact with a substance that occurs for more than 14 days and less than a year (compare with acute exposure and chronic exposure).

In vitro
In an artificial environment outside a living organism or body. For example, some toxicity testing is done on cell cultures or slices of tissue grown in the laboratory, rather than on a living animal (compare with in vivo).

In vivo
Within a living organism or body. For example, some toxicity testing is done on whole animals, such as rats or mice (compare with in vitro).

Lowest-observed-adverse-effect level (LOAEL)
The lowest tested dose of a substance that has been reported to cause harmful (adverse) health effects in people or animals.

Medical monitoring
A set of medical tests and physical exams specifically designed to evaluate whether an individual's exposure could negatively affect that person's health.

Metabolism
The conversion or breakdown of a substance from one form to another by a living organism.

Metabolite
Any product of metabolism.

mg/kg
Milligram per kilogram.

mg/cm^2
Milligram per square centimeter (of a surface).

mg/m^3
Milligram per cubic meter; a measure of the concentration of a chemical in a known volume (a cubic meter) of air, soil, or water.

Migration
Moving from one location to another.

Minimal risk level (MRL)
An ATSDR estimate of daily human exposure to a hazardous substance at or below which that substance is unlikely to pose a measurable risk of harmful (adverse), noncancerous effects. MRLs are calculated for a route of exposure (inhalation or oral) over a specified time period (acute, intermediate, or chronic). MRLs should not be used as predictors of harmful (adverse) health effects (see reference dose).

Morbidity
State of being ill or diseased. Morbidity is the occurrence of a disease or condition that alters health and quality of life.

Mortality
Death. Usually the cause (a specific disease, a condition, or an injury) is stated.

Mutagen
A substance that causes mutations (genetic damage).

Mutation
A change (damage) to the DNA, genes, or chromosomes of living organisms.

National Priorities List for Uncontrolled Hazardous Waste Sites (National Priorities List or NPL)
EPA's list of the most serious uncontrolled or abandoned hazardous waste sites in the United States. The NPL is updated on a regular basis.

National Toxicology Program (NTP)
Part of the Department of Health and Human Services. NTP develops and carries out tests to predict whether a chemical will cause harm to humans.

No apparent public health hazard
A category used in ATSDR's public health assessments for sites where human exposure to contaminated media might be occurring, might have occurred in the past, or might occur in the future, but where the exposure is not expected to cause any harmful health effects.

No-observed-adverse-effect level (NOAEL)
The highest tested dose of a substance that has been reported to have no harmful (adverse) health effects on people or animals.

No public health hazard
A category used in ATSDR's public health assessment documents for sites where people have never and will never come into contact with harmful amounts of site-related substances.

NPL (see National Priorities List for Uncontrolled Hazardous Waste Sites)

Physiologically based pharmacokinetic model (PBPK model)
A computer model that describes what happens to a chemical in the body. This model describes how the chemical gets into the body, where it goes in the body, how it is changed by the body, and how it leaves the body.

Pica
A craving to eat nonfood items, such as dirt, paint chips, and clay. Some children exhibit pica-related behavior.

Plume
A volume of a substance that moves from its source to places farther away from the source. Plumes can be described by the volume of air or water they occupy and the direction they move. For example, a plume can be a column of smoke from a chimney or a substance moving with groundwater.

Point of exposure
The place where someone can come into contact with a substance present in the environment (see exposure pathway).

Population
A group or number of people living within a specified area or sharing similar characteristics (such as occupation or age).

Potentially responsible party (PRP)
A company, government, or person legally responsible for cleaning up the pollution at a hazardous waste site under Superfund. There may be more than one PRP for a particular site.

ppb
Parts per billion.

ppm
Parts per million.

Prevalence
The number of existing disease cases in a defined population during a specific time period (contrast with incidence).

Prevalence survey
The measure of the current level of disease(s) or symptoms and exposures through a questionnaire that collects self-reported information from a defined population.

Prevention
Actions that reduce exposure or other risks, keep people from getting sick, or keep disease from getting worse.

Public availability session
An informal, drop-by meeting at which community members can meet one-on-one with ATSDR staff members to discuss health and site-related concerns.

Public comment period
An opportunity for the public to comment on agency findings or proposed activities contained in draft reports or documents. The public comment period is a limited time period during which comments will be accepted.

Public health action
A list of steps to protect public health.

Public health advisory
A statement made by ATSDR to EPA or a state regulatory agency that a release of hazardous substances poses an immediate threat to human health. The advisory includes recommended measures to reduce exposure and reduce the threat to human health.

Public health assessment (PHA)
An ATSDR document that examines hazardous substances, health outcomes, and community concerns at a hazardous waste site to determine whether people could be harmed from coming into contact with those substances. The PHA also lists actions that need to be taken to protect public health (compare with health consultation).

Public health hazard
A category used in ATSDR's public health assessments for sites that pose a public health hazard because of long-term exposures (greater than 1 year) to sufficiently high levels of hazardous substances or radionuclides that could result in harmful health effects.

Public health hazard categories
Public health hazard categories are statements about whether people could be harmed by conditions present at the site in the past, present, or future. One or more hazard categories might be appropriate for each site. The five public health hazard categories are no public health hazard, no apparent public health hazard, indeterminate public health hazard, public health hazard, and urgent public health hazard.

Public health statement
The first chapter of an ATSDR toxicological profile. The public health statement is a summary written in words that are easy to understand. The public health statement explains how people might be exposed to a specific substance and describes the known health effects of that substance.

Public health surveillance
The ongoing, systematic collection, analysis, and interpretation of health data. This activity also involves timely dissemination of the data and use for public health programs.

Public meeting
A public forum with community members for communication about a site.

Radioisotope
An unstable or radioactive isotope (form) of an element that can change into another element by giving off radiation.

Radionuclide
Any radioactive isotope (form) of any element.

RCRA (see Resource Conservation and Recovery Act (1976, 1984))

Receptor population
People who could come into contact with hazardous substances (see exposure pathway).

Reference dose (RfD)
An EPA estimate, with uncertainty or safety factors built in, of the daily lifetime dose of a substance that is unlikely to cause harm in humans.

Registry
A systematic collection of information on persons exposed to a specific substance or having specific diseases (see exposure registry and disease registry).

Remedial investigation
The CERCLA process of determining the type and extent of hazardous material contamination at a site.

Resource Conservation and Recovery Act (1976, 1984) (RCRA)
This Act regulates management and disposal of hazardous wastes currently generated, treated, stored, disposed of, or distributed.

RFA
RCRA Facility Assessment. An assessment required by RCRA to identify potential and actual releases of hazardous chemicals.

RfD (see reference dose)

Risk
The probability that something will cause injury or harm.

Risk reduction
Actions that can decrease the likelihood that individuals, groups, or communities will experience disease or other health conditions.

Risk communication
The exchange of information to increase understanding of health risks.

Route of exposure
The way people come into contact with a hazardous substance. Three routes of exposure are breathing (inhalation), eating or drinking (ingestion), or contact with the skin (dermal contact).

Safety factor (see uncertainty factor)

SARA (see Superfund Amendments and Reauthorization Act)

Sample
A portion or piece of a whole. A selected subset of a population or subset of whatever is being studied. For example, in a study of people the sample is a number of people chosen from a larger population (see population). An environmental sample (for example, a small amount of soil or water) might be collected to measure contamination in the environment at a specific location.

Sample size
The number of units chosen from a population or an environment.

Solvent
A liquid capable of dissolving or dispersing another substance (for example, acetone or mineral spirits).

Source of contamination
The place where a hazardous substance comes from, such as a landfill, waste pond, incinerator, storage tank, or drum. A source of contamination is the first part of an exposure pathway.

Special populations
People who might be more sensitive or susceptible to exposure to hazardous substances because of factors such as age, occupation, sex, or behaviors (for example, cigarette smoking). Children, pregnant women, and older people are often considered special populations.

Stakeholder
A person, group, or community who has an interest in activities at a hazardous waste site.

Statistics
A branch of mathematics that deals with collecting, reviewing, summarizing, and interpreting data or information. Statistics are used to determine whether differences between study groups are meaningful.

Substance
A chemical.

Substance-specific applied research
A program of research designed to fill important data needs for specific hazardous substances identified in ATSDR's toxicological profiles. Filling these data needs would allow more accurate assessment of human risks from specific substances contaminating the environment. This research might include human studies or laboratory experiments to determine health effects resulting from exposure to a given hazardous substance.

Superfund (see Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) and Superfund Amendments and Reauthorization Act (SARA)

Superfund Amendments and Reauthorization Act (SARA)
In 1986, SARA amended the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) and expanded the health-related responsibilities of ATSDR. CERCLA and SARA direct ATSDR to look into the health effects from substance exposures at hazardous waste sites and to perform activities including health education, health studies, surveillance, health consultations, and toxicological profiles.

Surface water
Water on the surface of the earth, such as in lakes, rivers, streams, ponds, and springs (compare with groundwater).

Surveillance (see public health surveillance)

Survey
A systematic collection of information or data. A survey can be conducted to collect information from a group of people or from the environment. Surveys of a group of people can be conducted by telephone, by mail, or in person. Some surveys are done by interviewing a group of people (see prevalence survey).

Synergistic effect
A biologic response to multiple substances where one substance worsens the effect of another substance. The combined effect of the substances acting together is greater than the sum of the effects of the substances acting by themselves (see additive effect and antagonistic effect).

Teratogen
A substance that causes defects in development between conception and birth. A teratogen is a substance that causes a structural or functional birth defect.

Toxic agent
Chemical or physical (for example, radiation, heat, cold, microwaves) agents that, under certain circumstances of exposure, can cause harmful effects to living organisms.

Toxicological profile
An ATSDR document that examines, summarizes, and interprets information about a hazardous substance to determine harmful levels of exposure and associated health effects. A toxicological profile also identifies significant gaps in knowledge on the substance and describes areas where further research is needed.

Toxicology
The study of the harmful effects of substances on humans or animals.

Tumor
An abnormal mass of tissue that results from excessive cell division that is uncontrolled and progressive. Tumors perform no useful body function. Tumors can be either benign (not cancer) or malignant (cancer).

Uncertainty factor
Mathematical adjustments for reasons of safety when knowledge is incomplete. For example, factors used in the calculation of doses that are not harmful (adverse) to people. These factors are applied to the lowest-observed-adverse-effect-level (LOAEL) or the no-observed-adverse-effect-level (NOAEL) to derive a minimal risk level (MRL). Uncertainty factors are used to account for variations in people's sensitivity, for differences between animals and humans, and for differences between a LOAEL and a NOAEL. Scientists use uncertainty factors when they have some, but not all, the information from animal or human studies to decide whether an exposure will cause harm to people (also sometimes called a safety factor).

Urgent public health hazard
A category used in ATSDR's public health assessments for sites where short-term exposures (less than 1 year) to hazardous substances or conditions could result in harmful health effects that require rapid intervention.

Volatile organic compounds (VOCs)
Organic compounds that evaporate readily into the air. VOCs include substances such as benzene, toluene, methylene chloride, and methyl chloroform.

Other glossaries and dictionaries:
Environmental Protection Agency (http://www.epa.gov/OCEPAterms/)
National Center for Environmental Health (CDC) (http://www.cdc.gov/nceh/dls/report/glossary.htm)
National Library of Medicine (NIH) (http://www.nlm.nih.gov/medlineplus/mplusdictionary.html)

For more information on the work of ATSDR, please contact:

Agency for Toxic Substances and Disease Registry
ATTN: Office of Policy, Planning and Evaluation
1600 Clifton Road, N.E. (Mail Stop E-28)
Atlanta, GA 30333
Telephone: (404) 498-0080

Appendix B: Sites That Do Not Pose a Public Health Hazard

The sites listed in the following table do not present a public health concern either because fencing restricts public access, access is restricted to authorized personnel only, frequent, direct contact is unlikely due to the limited accessibility of the site, or there is no evidence of contamination.

Site Name	***Site Use Description***
Site 2 – Fenced Ordnance Burial Area (Known as USEPA SWMU 46) A*	A fenced landfill containing ordnance hardware, and building and industrial materials
Site 3 – Ordnance Burn Structure (Known as USEPA SWMU 42) A*	A 0.2 acre open field, used from the 1960s to 1994 to thermally treat explosive contaminated waste.
Site 4 – Case Storage Area (No USEPA designation) A*	A 1.1 acre area used from the 1940s to the present for storing ordnance materials and other hardware
Site 5 – Projectile Disposal Area (Known as USEPA SWMU 51) A*	A 3 acre wetland area filled with construction rubble, and ordnance materials used from ~1920s-1930s
Site 6 – Terminal Range Airplane Park (Known as USEPA SWMU 54) A*	A 3 acres area used since the 1940s to store scrap metal, gun barrel preservative, and other materials.
Site 7 – Whole EEA Area (No USEPA designation) IAS*	The 1,641 acre EEA has been, and is currently, used for large-scale weapon testing.
Site 8 – Bombing Area (EEA) (No USEPA designation) IAS*	A small area constructed in 1943 within the EEA used for specific weapons tests.
Site 9 – Disposal/Burn Area (Known as USEPA SWMU 19) A*	An approximate 5 acre area used from 1937-2000 as a sanitary and construction debris landfill.
Site 11 – Wood Brush Disposal Area (No USEPA designation) IAS*	Limited amounts of wood, brush, stumps, etc. were disposed along a closed section of Bagby Road. No evidence of hazardous chemical disposal.
Site 12 – Chemical Burn Area (Known as USEPA SWMU 44) A*	An area adjacent to Gambo Creek used from 1943-1986 to burn decontaminated chemical warfare agents.
Site 13 – Gambo Creek Truck Wash Area (Known as USEPA SWMU 31) A*	An approximately 0.5 acre area used to dispose construction materials and dredged creek sludge
Site 14 – CW Evaporation Pond (Known as USEPA SWMU 28) A*	An evaporation pond (100ft by 45ft) used from 1967-late 1970s for decontaminated chemical agent and other solutions.
Site 15 – Scrap Area (No USEPA designation) A*	A 0.75 acre area surrounded by woodland and used to store a variety of wood and metal wastes since 1940s.
Site 16 – Oil Leak (Tank 280) (No USEPA designation) IAS*	In 1981 approximately 1,458 gallons of fuel oil leaked and migrated beneath the soil to the adjacent marsh
Site 18 –Classified Documents Incinerator Sewage Holding Tank (Known as USEPA AOC-X) B*	From 1974-1989 sanitary system effluent was distributed over a 100 ft^2 area.

Site Name	*Site Use Description*
Site 19 – Transformer Draining Area (Known as USEPA AOC-G) A*	Used from 1943 - 1980s for material storage. In 1950s ~1000 gal transformer oil was drained on the ground
Site 20 – Former Electroplating Waste UST (Known as USEPA SWMU 83) A*	Rinses and sludges from circuit board electroplating operations were stored in underground tanks between 1960s-1984 - no documented leaks or spills.
Site 21 – Gun Barrel Decoppering Area (Known as USEPA SWMU 52) A*	Gun barrels were cleaned in acid tanks between the early 1960s to 1980s
Site 22 – Gun Barrel Degreasing Area (Known as USEPA SWMU 53) A*	Used since the 1980s to store and degrease gun barrels
Site 23 – Building 480 Lot (PCB Storage) (Known as USEPA SWMU 72) A*	A 0.5 acre area with a 5ft high fence used to store transformers and other building materials since the 1960s. Some transformers may have had PCBs.
Site 24 – Sewage Collection/Treatment Plant (No USEPA designation) IAS*	The NSWCDL sewage treatment plant is a secondary treatment facility with a capacity of 400,000 GPD operating under permit since 1943. It included malfunctioning tile fields in use as late as 1968 and its 22 septic were connected to the plant by 1983 with dried sludge utilized as nutrient top cover around Mainside.
Site 25 – Pesticide Rinse Area (Known as USEPA SWMU 66) A*	Used to rinse empty pesticide containers, rinsate flowed into a marshy drainage swale.
Site 26 – PCB Inside Storage Bldg 319 (No USEPA designation) IAS*	Drums containing PCB contaminated transformer oils and other materials have been stored since 1977
Site 27 – Scrap Metal (No USEPA designation) IAS*	An area used to store scrap material.
Site 28 – Gambo Creek Compost Area (Known as USEPA SWMU 131) B*	A 2 acre area used from the 1950s-1960s for disposal of wood chips, mulch, sawdust, leaves, and trees.
Site 29 – Battery Service Area (Known as USEPA SWMU 79) A*	Waste battery acids (~150 gallons/year) discharged to a limestone neutralization pit from 1950s-1985 and/or an underground storage tank. Contaminated soils (were non-hazardous) were removed offsite.
Site 30 – Wide Scale Herbicide Application (EEA) (No USEPA designation) IAS*	Herbicides are periodically applied at recommended application rates to reduce vegetation and aid recovery of test fragments in the test range areas of the EEA.
Site 31 – Airplane Park Dump (EEA) (Known as USEPA SWMU 6) A*	A 2-acre area, used from the 1940s-1970s to dispose solid waste like scrap metal and construction debris.
Site 32 – Fast Cookoff Pit and Pond (EEA) (Known as USEPA AOC-F) A*	A flat area used to test munitions between 1980s-1990s. Also includes a lined, runoff containment pond.
Site 33 – Otto Fuel Spill (EEA) (Known as USEPA AOC-A) B*	A 15ft by 8ft area where 13 gallons of Otto fuel was reportedly spilled once on the soil in the 1970s.
Site 34 – Barbette/DU Contamination (No USEPA designation) IAS*	A large metal structure used for bomb testing and contaminated with DU.
Site 35 – Thorium-MG Misch Metal (Bldg 370) (No USEPA designation) IAS*	~200 pounds of misch metal rods reportedly stored in this location.
Site 36 – Depleted Uranium Mound (EEA) (Known as USEPA Other Units C1) A*	Between 1970-1990, 12mm DU shells were fired into the 80ft wide by12 ft high mound to test their trajectory.

Site Name	*Site Use Description*
Site 37 – Lead Contamination Area (Known as USEPA SWMU 108) A*	Sand used in this area for shoreline stabilization contains lead and other heavy metals.
Site 38 – Bldg 1349 Pest Control Outside Area (Known as USEPA AOC-I) A*	A 50q ft gravel parking lot and concrete pad used to mix pesticides and stage equipment transport.
Site 39 – Open Storage Area Main Battery (Known as USEPA AOC-X7) B*	Used since 1953 for industrial activities and material storage.
Site 40 – Bldg 120B DRMO Lot (Known as USEPA SWMU 14) A*	A 1-acre area with a 7-ft tall fence used since 1945 to store base supplies including scrap material and oil and solvents.
Site 41 – Compost Area (Known as USEPA SWMU 20) B*	A 2-acre compost area including wood chips, mulch, sawdust, and leaves used from the 1960s – 1992.
Site 42 – Gambo Creek Truck Wash Area (Known as USEPA SWMU 31) B*	Same as Site 13
Site 43 – Higley Road Land Application Area (Known as USEPA SWMU 35) A*	A 300ft by 25ft area where the base sanitary sewer sludge (including electroplating wastewater treatment sludge) was applied.
Site 44 – Rocket Motor Pit (Known as USEPA SWMU 41) A*	A 24X36X5ft pit, used from the 1960s to 1994, to anchor waste rocket motors as they burned in steel cylinders.
Site 45 – July 28 1992 Landfill B (Known as USEPA SWMU 45) A*	A 2.5-acre landfill used from the 1960s-1970s for solid waste, and ordnance and construction material disposal.
Site 46 – July 28 1992 Landfill A – Stump Dump Road (Known as USEPA SWMU 47) A*	A 5-acre landfill used from 1950s-1960s to dispose municipal waste, electrical and construction debris. A locked gate limits vehicular access.
Site 47 – WWI Munitions Mound (Known as USEPA SWMU 50) A*	A 0.5 acre mound 20-30ft high, contains live and dud WWI munitions from 1917 to the 1930s.
Site 48 – Bldg 448 Oil Storage/Tar Tank Area (Known as USEPA SWMU 67) B*	Used from 1985 –1993 to store tar used for road repair.
Site 49 – Depleted Uranium Gun Butt (Known as USEPA Other Units C4) A*	An open steel sand butt (~13,000 cubic feet of sand) used to test DU shells from 1940s-1991.
Site 50 – Fill areas Northeast (EEA) (Known as USEPA AOC-X9) A*	A 3 acre area used as a landfill from 1940s to 1955 for WWII aircraft parts and building debris.
Site 51 – Battery Locker Acid Draining Area (Known as USEPA SWMU 98) A*	A wooden sink and portable 35-gallon plastic tank inside Bldg 338, used since the mid-1980s to service batteries.
Site 52 – OWS 107-350 Yardcraft Area (Known as USEPA SWMU 125) B*	A 350-gallon oil water separator used since the 1980s to separate oil from bilge water.
Site 53 – OWS 207-300 (Known as USEPA SWMU 126) A*	A 300-gallon oil-water separator used from 1986-1992 to separate kerosene from gun barrel degreasing process water.
Site 54 – OWS 1121 - Old (Known as USEPA SWMU 128) B*	An oil water separator used from the 1960s-1989.
Site 56 – Gun barrel Degreasing Area, Railway Spur (No USEPA designation) A*	A one mile long section along a railway track was used from 1961-1975 to store and degrease gun barrels with Cosmoline and TCE.

Site Name	*Site Use Description*
Site 57 – Shell House Dump (Known as USEPA SWMU 133) A*	A 1-acre area used from 1960s-1970s to store metal objects, aircraft parts, munitions and construction debris
Site 58 – Building 1350 Landfill (Known as USEPA SWMU 134) A*	Used as a landfill from 1940s-1970s, contained drums of roofing tar, construction and paint materials and fenced.
Site 59 – Octagon Pad Dump (EEA) (Known as USEPA SWMU 135) B*	A 0.5 acre used from 1940s-1990s to store scrap metal, and target and ordnance test items prior to their disposal.
Site 60 – Bldg 445 Star Gauge Loading Dock (Known as USEPA SWMU 57) B*	Used since the 1940s for storage and handling of paint residues and gun barrel preservative.
Site 61a – Gambo Creek Ash Dump (No USEPA designation) A*	Ordnance material ash from the Powder Burn Area (Site 3) deposited here between 1952-1961.
Site 61b – Gambo Creek Projectile Disposal Area (Known as USEPA) B*	Gun projectiles, scrap metal and sand from old range gun butts were buried here in the 1930s-1940s.
Site 62 – Bldg 396 (No USEPA designation) A*	A building used for oil and gun cleaning fluid storage, slated for demolition.
USEPA SWMU 3 – Bldg 194AA (Concrete Pad) B*	A drum containing aircraft oil may have leaked
USEPA SWMU 15 – Bldg 120B Contractor Staging Area B*	A 1-acre area used in 1992 to store drums of diesel fuel, motor oil products, and scrap metal and wood.
USEPA SWMU 23 – Bldg 456 Oil Waste Drum B*	A 55-gallon drum with oily rags, papers, empty oil cans and wastes was stored here, some leakage was reported .
USEPA SWMU 27 – Tank 280 Contractor Staging Area B*	A 1 acre area used in 1992 to store drums containing waste oil, oily rags, oil product and diesel.
USEPA SWMU 61 – Paint Can Crusher B*	A hydraulic press device used from 1986-1993 to crush empty paint cans.
USEPA SWMU 62 – Paint Can Dumpster B*	A 10 ft^3 dumpster used from 1950-1993 to store crushed paint cans and related paint shop waste prior to disposal.
USEPA SWMU 64 – Bldg 448 Sand Blast Area B*	An area used for sandblasting.
USEPA SWMU 70 – Bldg 152 TCA AA B*	A building used since the 1960s to store hazardous materials and drummed solid wastes containing TCA.
USEPA SWMU 77 – Bldg 1329 Wash Area B*	A concrete pad used since the 1960s to wash maintenance trucks, possibly with petroleum based detergents.
USEPA SWMU 78 – Bldg 1121 Former Waste Oil UST B*	A 1000 gallon underground storage tank used until 1991 to store motor oil.
USEPA SWMU 82 –Electroplating Line and WWT B*	The electroplating line and waste water treatment unit was used from the 1970s-1993
USEPA SWMU 101 – Bldg 155 Auto Shop Waste Oil Filter and UST B*	A waste oil filter unit and underground storage tank were used to manage automobile oil since the 1960s.

Site Name	*Site Use Description*
USEPA SWMU 115 – Bldg 1282 Auto Hobby Outside Used Oil Storage B*	A storage area for used automobile oil and antifreeze since the mid 1980s.
USEPA SWMU 119 – Bldg 1282 Auto Hobby Used Oil Tank B*	A sheltered 1000 gallon storage tank used since 1992 to store used motor oil, includes secondary containment.
USEPA SWMU 127 – OWS 1121-300, 115-350, 402-30000, 486-1000 B*	Oil water separators, ranging from 300-30,000 gallons, received oil and grease containing wastewater .
USEPA SWMU 130 – Yardcraft Oil Storage Area B*	A storage area for upto five 55-gallon drums in operation since the late 1980s or early 1990s.
USEPA AOC O – Bldg 1369 Pesticide Spill Area B*	An 8ft by 15ft area lacking in vegetation due to a one time leak from a pesticide sprayer in 1992.
USEPA AOC Z – Terminal Range Bldg 109 B*	An open 25ftX15ftX20ft pit used from 1949-1985 for ordnance testing
Other Units C3 – Scar at Phalanx Test Area B*	A 5-acre area used as a rocket launch area from 1960s-1970s.
Other Units C6 – Former Radio Testing Area B*	Two trailers used to test radar or microwave radio equipment with drainage to Hideaway Pond.
Additional Areas X6 – South Hangar Former Tank Area B*	Aerial imagery has detected several stained zones (starting in 1983) mostly in the paved parking lot.
Building 126 – Former Powder Magazine B*	A powder magazine, struck by lightning, exploded and burned, throwing metal powder and debris into the area

Sources: Navy 2003a
Navy 2005b
VDEQ 2004
NEESA 1983

Appendix C: Chemicals Evaluated under Issue #1; Public Concern about Classified Activities at NSF Dahlgren

Chemical	*Common Uses*	*Toxicity Concerns*
Methyl salicylate	Commonly referred to as 'oil of wintergreen'; used in perfumes and to flavor food, beverages and gum (HSDB 2003a).	Toxicity is similar to that of aspirin; may be lethal at extremely high doses (HSDB 2003a). Expect the exposures from environmental concentrations resulting from base use to be significantly less than exposure to therapeutic use of aspirin.
Diethyl malonate	Commonly identified as a component of cigarette smoke and as a food additive.	No specific concerns were identified in the literature search. Expect the exposures from environmental concentrations resulting from base use to be less than exposure cigarette smoke.
Polyethylene glycol	Common uses include: food and food packaging, hair preparations, and cosmetics (HSDB 2003b).	Low toxicity in quantities used during industrial processes or commercial applications (HSDB 2003b). Expect the exposures from environmental concentrations resulting from base use to be significantly less than exposure to commercial sources.
Tinopal CBS-X	Commonly used as a whitening agent in commercial laundry detergents, its presence can be detected by UV light scans (USAF 1999).	No specific concerns were identified in the literature search. Expect the exposures from environmental concentrations resulting from base use to be less than exposure from laundry detergents.
Fluorescein	Common uses include: yellow dye in soaps, cosmetics, cleaners and other household products, and as a dye injected by IV (HSDB 2003c)	Some patients experienced adverse reactions after IV injection, most tolerate it well (HSDB 2003c). Expect the exposures from environmental concentrations resulting from base use to be significantly less than exposure experienced during IV injection.
Sulfur hexafluoride	Common uses include: electrical circuit interrupters, protective atmospheres and inert filler gas, and insulating medium (HSDB 2002a).	Relatively low toxicity although it can cause asphyxiation at high concentrations. TWA = 1000 ppm (HSDB 2002a). Expect the exposures from environmental concentrations resulting from base use to be significantly less than occupational exposure standard.
Glacial Acetic Acid	Common uses include: laboratory reagent, flavoring for pickles, fish, meat, candy and glazes, and other industrial processes (HSDB 2004)	High atmospheric concentrations can cause respiratory irritation or distress. TWA = 10 ppm (HSDB 2004). Expect the exposures from environmental concentrations resulting from base use to be significantly less than exposure to commercial sources.
Triethyl phosphate	Common uses include: catalyzing agent and ingredient in pesticides and other commercial products (HSDB 2002b).	Available information indicates it has low toxicity during occupational exposure (HSDB 2002b). Expect the exposures from environmental concentrations resulting from base use to be significantly less than occupational exposures.

Sources : HSDB 2003a
HSDB 2003b
HSDB 2003c
HSDB 2002a
HSDB 2002b
USAF 1999