ATSDR
AGENCY FOR TOXIC SUBSTANCES AND DISEASE REGISTRY

Public Health Assessment for

PORTSMOUTH NAVAL SHIPYARD
KITTERY, MAINE
EPA FACILITY ID: ME7170022019
NOVEMBER 27, 2007

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.

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PUBLIC HEALTH ASSESSMENT

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KITTERY, MAINE

EPA FACILITY ID: ME7170022019

Prepared by:

Site and Radiological 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, was established by Congress in 1980 under the Comprehensive Environmental Response, Compensation, and Liability Act, also known as the Superfund law. This law set up a fund to identify and clean up our country's hazardous waste sites. The Environmental Protection Agency, EPA, and the individual states regulate the investigation and clean up of the sites.

Since 1986, ATSDR has been required by law to conduct a public health assessment at each of the sites 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. 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 have cooperative agreements. The public health assessment program allows the scientists flexibility in the format or structure of their response to the public health issues at hazardous waste sites. For example, a public health assessment could be one document or it could be a compilation of several health consultations - the structure may vary from site to site. Nevertheless, the public health assessment process is not considered complete until the public health issues at the site are addressed.

Exposure: As the first step in the evaluation, ATSDR scientists review environmental data to see how much contamination is at a site, where it is, and how people might come into contact with it. Generally, ATSDR does not collect its own environmental sampling data but 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 are needed.

Health Effects: If the review of the environmental data shows that people have or could come into contact with hazardous substances, ATSDR scientists evaluate whether or not these contacts may result in harmful effects. ATSDR recognizes that children, because of their play activities and their growing bodies, may be more vulnerable to these effects. As a policy, unless data are available to suggest otherwise, ATSDR considers children to be more sensitive and vulnerable to hazardous substances. Thus, the health impact to the children is considered first when evaluating the health threat to a community. The health impacts to other high risk groups within the community (such as the elderly, chronically ill, and people engaging in high risk practices) also receive special attention during the evaluation.

ATSDR uses existing scientific information, which can include the results of medical, toxicologic and epidemiologic studies and the data collected in disease registries, to determine the health effects that may result from exposures. The science of environmental health is still developing, and sometimes scientific information on the health effects of certain substances is not available. When this is so, the report will suggest what further public health actions are needed.

Conclusions: The report presents conclusions about the public health threat, if any, posed by a site. When health threats have been determined for high risk groups (such as children, elderly, chronically ill, and people engaging in high risk practices), they will be summarized in the conclusion section of the report. Ways to stop or reduce exposure will then be recommended in the public health action plan.

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 warning 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 site 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 a site, 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 their comments. 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 comments, suggestions or questions we encourage you to send them to us.

Letters should be addressed as follows:

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Abbreviations

ATSDR	Agency for Toxic Substances and Disease Registry
BRAC	Base Realignment and Closure
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CREG	ATSDR's cancer risk evaluation guide
CVs	comparison value
CRP	community relations plan
DD	decision document
EMEG	ATSDR's environmental media evaluation guide
EPA	U.S. Environmental Protection Agency
FDA	Food and Drug Administration
FFA	Federal Facilities Agreement
IRP	installation restoration program
JILF	Jamaica Island Landfill
MB	mercury burial vault
MCL	EPA's maximum contaminant level
MEDEP	Maine Department of Environmental Protection
MRL	ATSDR's minimal risk level
NFA	no further action
NPL	EPA's National Priorities List
OU	operable unit
PAHs	polycyclic aromatic hydrocarbons
PCBs	polychlorinated biphenyls
PHA	public health assessment
PHAP	Public Health Action Plan
PNS	Portsmouth Naval Shipyard
ppb	parts per billion
ppm	parts per million
RAB	restoration advisory board
RBC	EPA Region III's risk-based concentration
RCRA	Resource Conservation and Recovery Act
RfD	EPA's reference dose
RI	remedial investigation
RMEG	ATSDR's reference dose media evaluation guide
ROD	record of decision
SSL	EPA's soil screening level
VOCs	semi-volatile organic compounds
1,1,1-TCA	1,1,1-trichloroethane
µg/dL	micrograms per deciliter
Navy	U.S. Navy
VOCs	volatile organic compounds
WWII	Word War II

I. Summary

The Agency for Toxic Substances and Disease Registry (ATSDR) prepared this public health assessment (PHA) to evaluate potential health hazards from exposures to contaminants released into the environment from Portsmouth Naval Shipyard (PNS). PNS is an active 278-acre naval shipyard facility in Kittery, Maine, located on Seavey Island in a tidal estuary of the Lower Piscataqua River that serves as the boundary between Maine and New Hampshire. Shipbuilding and submarine repair activities at PNS have generated hazardous wastes and released them into the environment on and around Seavey Island. Prior to approximately 1978, wastes were disposed of on site in landfills or discharged to storm water systems. These wastes came primarily from mechanical, structural, electrical/electronic, and public works activities; they included waste fuel, oils, solvents, pesticides, plating wastes, and paint. The U.S. Environmental Protection Agency (EPA) added PNS to the National Priorities List (NPL) on May 31, 1994, because of the contaminant releases at PNS. The NPL is part of EPA's Superfund Act.

ATSDR initiated the public health assessment process at PNS to identify populations that may have been or could be exposed to hazardous substances from PNS and determine the public health implications of those exposures. In 1995, after an initial evaluation, ATSDR prepared a health consultation that determined no immediate hazard existed, but recommended that additional environmental characterization and sampling of the site were needed to further assess environmental health hazards at the shipyard. After more sampling was completed, ATSDR visited PNS in 2005 to collect information for the PHA, and to identify public health issues and community health concerns related to environmental contamination at the shipyard. Using information gathered during the site visit and findings of site investigations conducted at PNS, ATSDR identified and evaluated three main exposure concerns:

1. **Possible exposure to contaminants for consumers of fish and shellfish.** Lobster tomalley and mussels contain potentially harmful levels of metals and polychlorinated biphenyls (PCBs). In compliance with the National Shellfish Safety Program, the harvest of mussels and other molluscan shellfish from the Piscataqua River is currently prohibited. These restrictions are unrelated to any contamination associated with PNS, but rather due to precautionary measures. People who follow the current statewide lobster tomalley consumption advisory and adhere to the shellfish restrictions are best protecting themselves against unwanted exposure to contaminants that might be present in lobsters or mussels caught near PNS.

2. **Possible exposure to contaminants in open water of the Piscataqua River near PNS.** PNS and other point sources have impacted the water quality and sediment of Piscataqua River. The portion of the river near PNS is not used for drinking water and is infrequently used for recreational activities such as swimming. The generally low concentrations of contaminants in accessible areas and the type of contact incurred through likely activities results in exposures below levels known to cause harmful health effects.

3. **Lead exposures in PNS housing.** Lead-based paint was used in PNS residences prior to1978. Children living at the shipyard are tested for lead exposure starting at their 6-month baby checkup and followed or treated as needed. Homes are being abated as occupants move out, and residents are advised of temporary measures to reduce lead hazards.

II. Background

Site Description and History

Portsmouth Naval Shipyard (PNS), Kittery, Maine, is an active naval shipyard facility located in a tidal estuary of the Piscataqua River that serves as the boundary between New Hampshire and Maine. Please see Figure 1 for the locations of PNS. PNS has expanded over the years to 297 acres by connecting Seavey, Jamaica, and Dennett Islands through dredging and landfilling of intertidal waters.

This 2001 photo shows the Portsmouth Naval Shipyard surrounded by the tidal estuary of the Piscataqua River.

Courtesy of Portsmouth Naval Shipyard.

PNS was commissioned in 1800 as the Navy's first shipyard. Major shipbuilding activity occurred there in support of both the War of 1812 and the Civil War. In response to World War II (WWII), the shipyard workforce rapidly increased as it developed into the largest submarine yard on the Eastern Seaboard. About half of the submarines used in the war effort were designed at Portsmouth. Portsmouth continued to be a leader in submarine innovation during the Korean War. In 1958, PNS became the first government shipyard to build a nuclear-powered submarine (Weston 1983). PNS is currently engaged in the repair and refitting of nuclear propulsion, fleet ballistic missile, and attack submarines for the United States Navy (Navy) (PNS 2005).

Remedial and Regulatory History

Past shipbuilding and submarine repair activities at PNS have generated hazardous wastes and released them into the environment on and around Seavey Island. Most of these releases occurred prior to 1978. Contaminated process waters were either discharged into the base's drainage systems or treated. Other wastes were disposed of on site in landfills which potentially discharged to surface water. These wastes came primarily from mechanical, structural, electrical/electronic, and public works activities; they included waste fuel, oils, solvents, pesticides, plating wastes, and paint.

Environmental investigations began in 1983 at PNS when the Navy investigated the hazardous releases and site condition through an initial assessment study. The Navy and their contractors continued environmental investigations at PNS in 1985 to 1994 through the Resource Conservation and Recovery Act (RCRA). RCRA provides a detailed tracking of hazardous substances, from generator to disposal. On May 31, 1994, because of the contamination detected at PNS, the U.S. Environmental Protection Agency (EPA) added PNS to the National Priorities List (NPL) of sites to be investigated. The NPL is part of EPA's Comprehensive Environmental

Response, Compensation, and Liability Act, or CERCLA, which is commonly known as "Superfund". Subsequently, environmental investigations at PNS have been conducted according to CERCLA guidance. A Federal Facility Agreement (FFA) that outlines the roles and responsibilities for cleanup at PNS was signed between the EPA and the Navy in September 1999 (EFANE 2005). The Navy and the State of Maine Department of the Environment also have an agreement regarding the cleanup of fuel related releases.

Most investigations at PNS focused on former waste disposal practices to determine if they posed any threats to public health or the environment. Through CERCLA, the Navy investigated contaminants including solvents (volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), inorganic compounds (metals), pesticides, and polychlorinated biphenyls (PCBs), in groundwater, soil, surface water, sediment, and biota at or near the shipyard. These investigations identified 14 sites under the Installation Restoration Program (IRP). Please refer to Table 2 for a list of the sites and their associated contamination and cleanup measures and to Figure 2 for the location of the sites at PNS.

The Navy with cooperation from EPA and Maine Department of Environmental Protection (MEDEP) have already investigated, sampled, and cleaned up many of the contaminant releases to the environment. Some areas of contamination are still being investigated, cleaned up, or are being monitored. Other areas the Navy investigated required no further action. ATSDR reviewed information regarding known or suspected contaminant releases to the environment. We considered current land use and potential land use changes with respect to people contacting environmental contamination and the impact on public health. ATSDR also considered land use restrictions and institutional controls in this evaluation.

ATSDR Activities

Through the public health assessment (PHA) process, ATSDR assesses conditions at a site from a public health perspective to determine whether people can be exposed to site-related contaminants through contact with the groundwater/drinking water, surface water, soil, sediment, biota, or air. The PHA does not include worker exposures under the jurisdiction of the Occupational Safety and Heath Administration (OSHA). ATSDR's PHA process is not related to any of the environmental investigation or cleanup actions ongoing by the Navy in coordination with EPA and MDEP. ATSDR conducts an independent review of available information collected by various sources and makes public health determinations which may be different than those identified during the CERCLA-based human health risk assessments.

As part of the PHA process, ATSDR conducted an initial visit to the PNS in 1993. The purpose of the visit was to collect information necessary to rank the site according to its potential public health hazard, to identify public health issues related to environmental contamination at the facility, and to identify community health concerns. During the visit, staff met with Naval and PNS personnel and representatives from federal and state agencies. ATSDR prepared a health consultation in1995 that evaluated contaminant concentrations in off-shore media (fish, shellfish, groundwater, and soil/sediment) to assist the MEDEP in assessing appropriate seafood consumption values and the need for a seafood consumption advisory. At that time, no seafood advisory was recommended by ATSDR.

ATSDR visited PNS in January 2005 to obtain updated information related to environmental studies at the base. ATSDR met with PNS personnel and toured the base. Based on discussions, the site visit, and data reviews, ATSDR concluded at the time that there was little potential for immediate threats to human health. ATSDR determined that three issues required a more indepth ATSDR evaluation to determine their public health impact. They are 1) ingestion of seafood caught in areas impacted by PNS releases, 2) direct contact with sediment in areas impacted by PNS releases and 3) exposure to lead-based paint in housing areas.

Demographics

ATSDR examines demographic information, or population information, to identify the presence of sensitive populations, such as young children (age 6 and under), the elderly (age 65 and older), and women of childbearing age (age 15 to 44). Demographic information also provides details on population mobility and residential history in a particular area. This information helps ATSDR evaluate how long residents might have been exposed to environmental contaminants.

PNS employs about 4,400 military and civilian personnel, including about 32 officers, 78 enlisted personnel, and 4,300 civilians. The Navy currently provides housing units for 29 officers’ families. Another 200-plus units (duplex and quadplex) are available at Admiralty Village in Kittery. School-age children attend schools off the shipyard. A childcare facility accommodating preschool-age children is available on the shipyard.

The city of Portsmouth, New Hampshire, located southwest of the shipyard at the mouth of the Piscataqua River, is the largest city in the region, having a population of over 25,000 (PNS 2005). Kittery, Maine, is a residential community of 9,500 people located across the Piscataqua River, north of Portsmouth. Area industry includes retail and wholesale trade, textile, manufacturing, power plants, and gas storage facilities. The countryside north and west of Kittery consists of forests and some farmland. Along the coast, south of Portsmouth, are small communities and seasonal dwellings (PNS 2005).

Land Use and Natural Resources

ATSDR examines land use to determine what activities might put people at risk for exposure to contaminants related to PNS. PNS encompasses over 297 acres, including about 278 acres at the shipyard and another 19 acres for family housing in Kittery. The shipyard itself is a highly developed industrial property. There are 179 buildings, including 49 ship repair/overhaul related buildings, 6,224 lineal feet of berthing, and three dry docks. PNS is capable of docking all active classes of submarines. Dry Dock No.2 is a fully enclosed climate controlled submarine overhaul and refueling complex (PNS 2005). Access to the shipyard is restricted to military personnel, shipyard residents, and civilian employees. The shipyard is not open to the public. The undeveloped areas around the shipyard area—such as Clark’s Island, located immediately east of the shipyard—support a variety of vegetation and animal life. Clark’s Island also provides habitat for small mammals and wintering and nesting area for a variety of waterfowl (McLaren/Hart 1994).

Land use in the vicinity of PNS consists of heavily populated residential areas immediately to the north (Kittery) and southwest (Portsmouth, New Hampshire), recreational areas, and some light commercial industry. Area industry includes retail and wholesale trade, textile, manufacturing, power plants, and gas storage facilities.

PNS is situated in the Lower Piscataqua River, part of a tidal estuarine boundary between New Hampshire and Maine. The Piscataqua River environment supports a variety of terrestrial and aquatic life, including an abundance of recreational and commercially important fish and shellfish species including lobster, finfish, mussel, oysters, and scallops. The river is open to recreational and commercial fishing as well as boating. The lower Piscataqua River is heavily industrialized; with port activities and sewage treatment plant discharges all potential sources of contamination.

The Piscataqua River originates at the junction of the Cocheco and the Salmon Falls Rivers in southeastern New Hampshire and flows southeast, by other industrial or commercial areas, before emptying into Portsmouth Harbor. The intertidal waters around PNS are characterized by lowland marshes, tidal mudflats, and channels of the tidal harbor located between the town of Portsmouth and the Atlantic Ocean (Weston 1983). The Lower Piscataqua River has tidal currents running at an average of 4 knots, some of the fastest currents on the east. The back channel behind PNS is also a popular fishing spot (NE Sportsman 2006).

The present shipyard area was been made by joining adjacent islands and their respective intertidal areas that have been filled in with natural materials, dredge spoils, and construction debris. The shorelines are a combination of steep, rocky banks and low-lying marshlands. Surface water runoff at the shipyard is controlled by extensive stormwater collection systems that direct drainage to specific outlets into the Piscataqua River. Two natural ponds (not used for recreation) drain an open area in the southern portion of the shipyard; a drainage outlet has been constructed from these ponds to the Piscataqua River to control excessive amounts of rain and snow to these areas.

Groundwater at the shipyard is found at shallow depth in the unconfined glacial outwash sands and gravels. Local groundwater varies in depth from about 13 feet at mean low tide to 5 feet at mean high tide, depending on recharge, discharge, and tidal fluctuations. Recharge to the groundwater comes from rain and snow that falls on the island, infiltrates the ground, and seeps downward to the groundwater. Groundwater recharge is reduced in the developed areas that make up much of the shipyard. Groundwater outflow to the Piscataqua River and the estuary waters surrounding the island probably accounts for most of the natural discharge from Seavey Island. There is no use of the underlying groundwater at the shipyard. PNS receives its drinking and industrial use water from the town of Kittery.

Although the Town of Kittery does provide water to residential, commercial, and industrial customers, there are areas in Kittery that use groundwater wells for drinking water purposes. Additionally, many of these areas also use septic systems for sanitary waste disposal (ATSDR 2006).

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.

III. Evaluation of Environmental Contamination and Potential Exposure Pathways

ATSDR's Public Health Evaluation Process

ATSDR's analyses are exposure, or contact, driven. Chemical contaminants disposed or released into the environment have the potential to cause adverse health effects. However, a release does not always result in exposure. *People can only be exposed to a contaminant if they come in contact with that contaminant.* A person who comes in contact with a contaminant is said to be "exposed." Exposure may occur by, eating, drinking, or breathing a substance containing the contaminant or by skin contact with a substance containing the contaminant. A critical part of determining if contamination from PNS could harm community members is understanding how people might come in contact with the contamination.

Exposure does not always result in harmful health effects. The type and severity of health effects that occur in an individual from contact with a contaminant depend on many factors, discussed below. Once exposure situations and conditions are defined, ATSDR performs mathematical calculations that incorporate exposure factors such as concentration (how much), the frequency and/or duration of exposure (how long), the route of exposure (breathing, eating, drinking, or skin contact), and the multiplicity of exposure (combination of contaminants or exposures). ATSDR then estimates a site-specific dose (similar to a medical dose) that uses the above parameters of daily exposure based on a person's body weight.

The estimated dose values are initially compared to screening levels. Exposure doses below screening level values are more certain to be without deleterious effects over a lifetime of daily exposure. Screening level comparisons are used to quickly rule out those situations that do not pose a health hazard. Site specific exposure dose estimates greater than screening values require more in depth evaluation based on the specific conditions of each site and the people affected. Those site specific exposure dose estimates greater than screening values are compared to exposure doses from research studies, health studies, epidemiological studies, animal studies, occupational studies, toxicological studies, exposure investigations, poison control databases, and other available scientific information in order to determine how likely people at the site are to experience adverse health effects.

Because no one study or source of information can provide 100 percent certainty of its conclusions, ATSDR uses many sources of information, which lowers the uncertainty, and thus, increases the confidence of our conclusions. Substantial evidence available from various sources provides the basis for determining whether adverse health effects are possible.

Adverse health effects can range in severity and can include some enzyme changes in the body that might not even be noticeable to the individual, to acute illness such as vomiting, or severe long-term illnesses such as cancer.

ATSDR's health evaluation differs significantly from classical risk assessment in purpose and methodology. As a public health agency, and not an environmental regulatory or clean up authority, ATSDR acts as advisors to citizens, groups, and agencies regarding the body of scientific knowledge of human exposures to chemicals in the environment and whether such exposures would likely result in adverse health effects. ATSDR makes recommendations to stop, reduce, or prevent exposures and for additional public health actions if needed.

ATSDR categorizes exposures in terms of their relative hazard. ATSDR uses five conclusion categories: 1) Urgent Public Health Hazard denotes acute exposures or physical hazards likely to result in adverse health effects that require immediate intervention, 2) Public Health Hazard is used to categorize likely long-term exposures or physical hazards that could result in adverse health effects, 3) Indeterminate Health Hazard denotes insufficient information to make a health determination, 4) No Apparent Public Health Hazard is used when human exposures have or are occurring to low levels of contaminants below those shown to produce adverse health effects, and 5) No Public Health Hazard applies where no exposure to site related compounds exits.

ATSDR reviewed data collected since 1985 for PNS's 14 IRP sites and other environmental issues to determine if the sites are associated with public health hazards. Table 1 describes each site and briefly summarizes the evaluation. When evaluating these areas, ATSDR assessed the level of contamination present or degree of physical hazard, the extent to which individuals come into contact with the contamination or hazard, and whether this contact would result in a public health hazard. The review indicated that most sites at the shipyard are not associated with any known public health hazards because (1) no site-related contaminants are present, (2) contaminant concentrations detected are too low to pose a health hazard, or (3) exposure of adults and children have been successfully reduced or eliminated through cleanup efforts and access restrictions. For some locations where environmental contaminant levels were high enough to be a concern to regulators, cleanup efforts have either already taken place or are currently underway.

During our review of the information, ATSDR identified **three exposure situations** that required more in depth ATSDR evaluation:

1. *Consumption of contaminated fish and shellfish*—ATSDR evaluates the potential for people to consume fish and shellfish from the estuary of the Lower Piscataqua River surrounding PNS. PNS as well as other sources may be responsible for the contamination in the river.

2. *Contact with contaminated water and sediment from the Lower Piscataqua River*—Surface water and sediment in certain locations of the Lower Piscataqua River along the PNS shoreline contain contaminants, some associated with former shipyard activities. Some of the highest levels of contaminants in sediments—including some at levels of potential health concern—occurred near the Site 32 and Site 34. Table 1 provides detailed information for each IRP site.

3. *Childhood exposure to lead-based paint*—Some homes built before 1978, such as some at PNS, might contain lead-based paint. Lead can be particularly hazardous to young children because they are generally prone to hand-to-mouth activities and their bodies tend to absorb higher amounts than adults.

In this PHA, ATSDR evaluates whether these exposure scenarios could lead to harmful health effects. ATSDR presents its evaluation in the following discussion and summarizes it in Table 2. Figure 4 provides an overview of ATSDR's exposure evaluation process. To acquaint the reader with terminology and methods used in this PHA, Appendix A provides a glossary of environmental and health terms presented in the discussion and Appendix B describes the comparison values (CVs) ATSDR used in screening contaminants for further evaluation. Appendix C describes the methodology ATSDR used to estimate exposure doses and evaluate public health hazards.

Table 1. Exposure Pathways

Exposed Population	Exposure Activity Media	Contaminants	Public Health Implications / Conclusions	Recommendations
Fish and Shellfish				
Adults and children Past Present Future	Eating fish and shellfish caught from the inland areas of the Piscataqua River between Kittery, Maine and Seavey Island. The Piscataqua River, which surrounds Portsmouth Naval Shipyard (PNS), forms the southern boundary between Maine (ME) and New Hampshire (NH)	Primarily polychlorinated biphenyls (PCBs) and mercury Fish: Contaminants detected in winter flounder, included arsenic (up to 1.75 ppm], methylmercury (up to 0.071 ppm), and total PCBs (up to 0.08 ppm) , but at levels typically below Food and Drug Administration (FDA) guidance levels or the Environmental Protection Agency's (EPA's) risk- based concentrations (RBCs) for fish. Lobster: Contaminants were detected in adult lobster (tail). Arsenic (2.7 ppm) was detected at levels above its EPA RBC for fish, but below FDA tolerance level of 76 ppm. Lobster Tomalley: (lobster hepatopancreas) PCBs (up to 2.6 ppm), were detected in lobster tomalley above the FDA tolerance level of 2 ppm. Other Shellfish: Mercury (mean of 0.3 ppm) and PCBs (mean of 0.18 ppm) were generally below their corresponding FDA action or tolerance levels in mussels collected from Seavey Island area. Arsenic and cadmium concentrations in mussels exceeded EPA's RBCs, but were similar to concentrations in mussels collected from other locations. Lead was detected in mussels (Max = 27 ppm; one sample contained an estimated lead	Fish: Past (1991-present): People may have consumed contaminated fish in the past. Concentrations of contaminants, such as metals and PCBs, found in fish (winter flounder) in the 1991/1993 and 1996/1997 sampling of Lower Piscataqua River are much lower than levels shown to cause illness. Therefore, people who ate fish caught from the Lower Piscataqua River are not likely to develop adverse health effects. Current and Future: ME and NH currently have statewide fish consumption advisories in place due to mercury, PCB and dioxin contamination. While contaminants in Piscataqua River fish have historically been below levels known to cause adverse health effects, adults and children who follow the current fish consumption advisories are best protecting themselves against unwanted exposure to contaminants that might be in fish. Lobster: Past (1991-present), Present, and Future: People may eat lobster caught from the open waters near PNS. People who eat lobster are not exposed to contaminants at high enough levels for a health concern to exist. Lobster Tomalley: Past (1991-present), Present, Future: Elevated levels of PCBs and other contaminants have been detected in lobster tomalley. Adults and children who follow the current lobster tomalley consumption advisories are best protecting themselves against unwanted exposure to contaminants that might be present in the tomalley of lobsters caught near PNS. Other Shellfish: Past (1991-present), Present, Future: Contaminants were not detected at levels of human health concern.	ATSDR advises people to follow the recommendations in the current ME and NH saltwater/freshwater and lobster tomalley advisories (see below). ATSDR also advises people to observe that the Piscataqua River (including portions along PNS), is closed to shell fishing due to bacterial contamination. Fish: Neither ME or NH has an advisory specific to Portsmouth Harbor or the Piscataqua River. Both ME and NH have issued a limited freshwater and saltwater fish consumption advisory for pregnant and nursing women, women who may get pregnant, and children. They further recommend that people follow certain salt water fish consumption limits for swordfish, shark, tilefish, king fish, blue fish and striped bass due to mercury, PCBs, and/or dioxin contamination. NH further recommends that all other individuals limit intake of freshwater fish to 4 meals per month. Lobster: Neither ME or NH has an advisory for adult lobster consumption. People are prohibited from trapping juvenile lobsters. Lobster Tomalley: ME and NH advise people against eating lobster tomalley state wide due to PCB and dioxin contamination. Other Shellfish: The Piscataqua River is closed to shell fishing as a precausionary measure to prevent bacterial contamination. The Maine's Department of Marine Resources has included the Piscataqua River and Kittery area in its Maine Shellfish Growing Area Program. Shellfish collection is prohibited in areas participating in this program.

Exposed Population	Exposure Activity Media	Contaminants	Public Health Implications / Conclusions	Recommendations
		concentration of 190 ppm).		
Lead-Based Paint				
Children who live in base housing built before 1978 with signs of chipped or peeling Past Present Future	Lead-based paint in PNS housing built before 1978	Lead-based paint. Environmental sampling indicated 40 microgram per cubic meter ($\mu g/m^3$) on floors and 250 $\mu g/m^3$ on sills.	Certain homes at PNS contain lead-based paint. According to the Navy's Pediatric Lead Poisoning Prevention Program, children living at PNS are screened (via questionnaire) for lead poisoning beginning at their 6-month baby visit. Blood lead levels are assessed depending on the responses to the questionnaire. Children under 6 who are at risk of lead exposure, have not previously been tested, or with elevated blood lead levels require additional care. One case of lead poisoning has been confirmed at PNS and followed up by the Maine Department of Health. If testing of the home reveals that elevated in the home was the likely source of lead poisoning, the family must be moved until abatement is complete. Families that follow the Lead Poisoning Prevention Program can best protect their children against lead exposures.	PNS has closed 5 (out of 34) homes/units due to lead. Other homes are being abated as occupants move out. Residents are advised of temporary measures to reduce lead hazards in their homes. Lead exposure is assessed and blood lead levels screened at beginning at a child's 6-month baby visit, and as needed until the child reaches the age of 6. ATSDR supports these actions as ways to reduce potential for exposure to lead in the home and risk of lead poisoning.
Sediment and Surface Water				
Adult and children Past Present Future	Swimming or wading in the Piscataqua River	Metals (i.e., arsenic, chromium) and polycyclic aromatic hydrocarbons (PAHs) were detected in sediment collected from Sites around Seavey Island, some at levels requiring further ATSDR evaluation.	People who swim in the Piscataqua River might come in contact with contaminants from PNS. The generally low concentrations of contaminants in areas accessible to and the type of exposure incurred by swimmers and waders results in exposure doses below levels known to cause harmful health effects.	

A. Consumption of Contaminated Fish and Shellfish

Summary

Adults and children who consumed finfish, lobster meat, and shellfish obtained along the intertidal areas of the Lower Piscataqua River may have been exposed to PCBs, metals, or other contaminants released from PNS or other nearby industrial sources. However, the levels of measured contaminants (e.g., PCBs and metals) detected in flounder and lobster meat sampled since 1991 are much lower than levels known to cause health effects. Therefore, exposure to chemical contaminants in flounder and lobster meat from these areas does not pose a public health hazard.

The tomalley functions as the lobster's liver and pancreas. It is found in the body cavity of the lobster and turns green when cooked. Some people consume the tomalley when eating a lobster meal.

Lobster tomalley (hepatopancreas) and mussels contain higher levels of contaminants, possibly from a variety of sources including PNS as well as point and non point sources throughout the region. Tomalley and mussels from the river have the potential to result in illness if they are consumed frequently. The states of New Hampshire and Maine have issued advisories warning people against eating the tomalley of lobster caught from coastal areas of both states and restrict shellfishing in the Piscataqua River due to chemical and biological contamination. People following these restrictions are protecting themselves against exposure to chemical and biological contaminants.

Discussion

This section discusses whether fish and shellfish of the Piscataqua River surrounding PNS have accumulated contaminants. It also considers whether and to what extent people might consume fish from this section of the Lower Piscataqua River.

Lower Piscataqua River/Great Bay Estuary

The Lower Piscataqua River is used for recreational and commercial fishing, boating, and shellfishing in the area surrounding PNS. Chemicals from PNS, sewage treatment plant discharge, and other upstream sources have impacted the river's water quality and sediment. The towns of Portsmouth and Kittery have their wastewater treatment plants in very close proximity (ATSDR 2006). Environmental investigations conducted around PNS have shown that metals, dioxins, polycyclic aromatic hydrocarbons (PAHs), and polychlorinated biphenyls (PCBs) are the primary contaminants in the river because contaminants, such as metals and PCB, do not decompose easily, so they remain in the environment for many years after release. Fish take in contaminants when they eat smaller fish or through incidental ingestion of contaminated sediments while foraging on benthic invertebrates that live in and accumulate contaminants present in the sediment, foraging on smaller fish, or most likely a combination of these (Navy 2006). In this way, larger and older fish can build up high levels of contaminants under certain circumstances (EPA 2000). Because of the high degree of mixing and dilution in the estuary due to the strong current, most uptake by fish and shellfish of PNS contaminants would occur near sources of contamination.

Neither Maine nor New Hampshire has fish consumption advisories specific to the Piscataqua River or the waters around PNS. Both states have state wide finfish consumption advisories because of elevated mercury, PCBs, and dioxin. Because of concerns about PCBs and dioxin, both states also advise consumers to refrain from eating tomalley of lobsters. The advisories set limits on fish and shellfish consumption for the general public, and recommends that pregnant women, nursing mothers, and children younger than six years avoid eating these fish (MDHHS 2005a, New Hampshire 2006). Additionally, in compliance with the National Shellfish Safety Program, the harvest of mussels and other molluscan shellfish from the Piscataqua River is currently prohibited. New Hampshire and Maine establishes permanently closed areas (i.e., safety zones) around wastewater facility outfalls to protect harvesters from chronic viral contamination, and to protect harvesters in the event of an unintended disruption in treatment at the plant. These restrictions are unrelated to any contamination associated with PNS, but rather due to precautionary measures.

Fish and Shellfish Monitoring Data

Several studies have collected flounder, lobster, and mussel samples to assess trends in contaminant concentrations in seafood of the Lower Piscataqua River. Lobster are fairly long lived, bottom scavengers that provide an important measure for assessing contaminant migration in the food chain. Mussels serve as a useful surrogate to evaluate uptake by a wide range of filter feeding organisms. For this reason, NOAA monitors mussels in their National Status and Trends Program and the Gulf of Maine Council also monitors contaminants in mussels. While samples were collected from various locations in the Lower Piscataqua River, ATSDR was interested in assessing data for fish and shellfish most likely affected by PNS. Even so, the exact contribution from PNS cannot be determined since other upstream sources contribute directly or indirectly to pollution in the river. The studies included:

- **Phase I and II (1991 and 1993)** The Navy collected flounder, lobster, and mussel samples in 1991 and 1993 through the Phase I and Phase II RI activities to support the Estuarine Ecological Risk Assessment (Tetra Tech NUS 1998). Samples were collected from 34 locations that included the 21 locations in the Lower Piscataqua River, two background locations, and nine locations extending from Portsmouth Harbor into the upper reaches of the Great Bay Estuary. Eleven locations in the Lower Piscataqua River were selected to characterize possible seafood contamination in association with specific sites of contaminant releases from Seavey Island. Another six stations at Clark Island were used to evaluate possible impacts of Jamaica Island Landfill. For more information on the offshore sampling procedures, please refer to the *1998 Phase I/Phase II Offshore Data Comparative Analysis Report* (Tetra Tech NUS 1998). The Navy selected York River as the background location for Phase I and the Isles of Shoals and Gulf of Maine for Phase II.

- **Gulfwatch (1993-2000)** The Gulf of Maine Council on the Marine Environment supports a surveillance program known as Gulfwatch that has monitored contaminants in blue mussels along the News Hampshire and Maine coast since 1993 (Gulfwatch 2005). Sample locations include Clark Island.

- **Navy Interim Offshore Monitoring Program (1999-present).** The Interim Offshore Monitoring Program, required by the Interim Record of Decision (ROD), collected blue mussel samples through seven sampling rounds from 14 monitoring stations around PNS and 4 reference stations in the Great Bay Estuary. Many of the samples collected as part of the interim offshore monitoring program were collected near the Phase I and Phase II samples.

Most samples of flounder fillet, lobster tail, lobster tomalley, and mussels were analyzed for metals, organochlorine pesticides, PAHs, and PCBs (Tetra Tech 1998; Gulfwatch 2005). Gulf Watch samples were analyzed for metals in 1993, 1994, 1995, 1996, 1997, and 2000; for PAHs in 1993, 1995, and 1996; and for PCBs in 1995 and 1996. The results form these studies confirmed that many of the samples from the Lower Piscataqua River contained metals, PCBs, or other contaminants, some of which may have originated from PNS. The concentrations of contaminants varied by species and sampling event as presented in Tables 3–6 and described in the discussions that follow:

- *Flounder* showed mercury concentrations that increased from Phase I (up to 0.035 parts per million [ppm]) to Phase II (up to 0.054 ppm). Even so, the mercury concentrations in the flounder were well below the FDA action level of 1 ppm. All other contaminant concentrations in flounder decreased or were comparable to Phase I concentrations.

- *Lobster (adult) tails* contained levels of PCBs and mercury below their FDA tolerance or action levels for commercially caught fish. Copper, zinc, and certain pesticide concentrations increased from Phase I to Phase II, while concentrations of other contaminants decreased or stayed the same. Still, the concentrations were similar to background locations.

- *Lobster (adult) tomalley* sampled during Phase I (up to 2.6 ppm) and Phase II (up to 1.2 ppm) Phase I data exceeded FDA's tolerance level for PCBs of 2 ppm. From Phase I to Phase II three metals, one PAH, and one pesticide in adult tomalley increased as much as 2 times the Phase I concentrations; however, most concentrations remained similar or decreased from Phase I to Phase II.

- *Mussels* showed the most significant increase in concentrations over time of all media sampled (Tetra Tech NUS 1998). In particular, the metals, lead (up to 27 ppm), manganese (up to 164 ppm), and mercury (up to 0.75 ppm) were 9, 20, and 7 times higher in Phase II than in Phase I. Similar increasing trends were observed for other contaminants, and even higher concentrations were detected in the latter round of sampling. Mercury concentrations (up to 2.31 ppm) measured in mussels during the interim offshore monitoring exceeded the FDA action level of 1 ppm for methylmercury, the form of mercury found in seafood.

The Navy collected environmental data between the 1980s and the present. Essentially no environmental data exist to describe site conditions before the 1980s. The lack of data before this time makes it challenging to fully assess past environmental effects of PNS operations before the 1980s, when the landfills and operations associated with the IRP sites were active. In the absence of these data, ATSDR relies on the existing site data and knowledge of environmental toxicology and chemical fate and transport to predict the likelihood of past health hazards.

Fish and Shellfish Exposure Pathways and Health Hazards

People are known to visit areas along the Lower Piscataqua River, including areas potentially receiving inputs from PNS. To determine if the consumption of seafood taken from these areas containing the detected levels of chemical contaminants was or is detrimental to human health, ATSDR estimated doses for individuals who eat fish (flounder), lobster, lobster tomalley, and shellfish (mussels) from the Lower Piscataqua River. Because uncertainty exists regarding how often people eat fish and how large a portion was eaten, ATSDR's estimates used the EPA-recommended intake of estuarine fish for an adult of 6.6 grams a day, or about ¼ pound per month; for children, ATSDR used half that amount. On the basis of information received during the public comment period, ATSDR reevaluated exposures using ingestion rates that are representative of an upper level fish ingestion rate for Maine recreational anglers. This evaluation is presented in Appendix D. ATSDR also assumed that fish consumed came solely from the Lower Piscataqua River and contained the highest probable level of contamination. Collectively, those health-protective assumptions allow ATSDR to evaluate the likelihood, if any, that eating fish and shellfish could cause harm to area consumers.

ATSDR then compared the estimated exposure doses to ATSDR minimal risk level (MRLs) or EPA reference dose (RfDs), as well as information on the detected contaminants in the toxicological literature. MRLs and RfDs (which themselves are derived from available toxicological studies) are health guidance levels, amounts of contaminant taken into the body (per unit weight per day) that are not likely to cause harmful health effects. At doses less than the guidance levels, no adverse health effects have been observed. Appendix C describes in greater detail ATSDR's methods, assumptions, and health guidance levels.

For both an adult and a child, the doses estimated for exposure to contaminants, including mercury and PCBs, in *flounder and lobster (meat)* are lower than those contaminants' screening values (ATSDR MRLs or EPA RfDs), and below levels associated with adverse health effects, suggesting that they have not accumulated chemical contaminants to levels known to cause health effects. *Based on this evaluation, ATSDR has determined that consumption of flounder (and similar fish) and lobster meat from the Lower Piscataqua River near PNS is not likely to result in adverse health effects in adults and children.*

In contrast, estimated exposure doses using the maximum levels for adult lobster tomalley and mussels showed levels above some comparison values. The maximum concentration of mercury in mussels was 2.31 mg/kg found in the Interim Offshore Monitoring Data at MS-05 and was above the FDA action level of 1 ppm. However, if the mean or average concentration is used, the mean mercury concentration of (0.29 mg/kg) does not exceed the FDA action level. Additionally, this mean value is similar to the mean concentration of mercury found in the reference samples (i.e., 0.27 mg/kg). As a whole this indicates that the mussels found within the river, are on average, less than the FDA action level.

Fish and shellfish data show that levels of chemical contaminants near PNS is similar to other areas of the Picataqua River. While the levels of contaminants in general have declined over the last 15 years, it is often difficult to make assumption about temporal trends over just a two year period based on the sampling data for lobster. Additionally, fish and shellfish move within the area which is flushed with high volume tidal waters causing mixing that makes assumptions about seafood caught in specific locations difficult as well. Due to the environmental (and other) programs in place at PNS (federal and state standards) which have clean up most source areas and stopped the migration of existing contaminants, contaminants released into the environment have dramatically decreased over time.

Comparison values are use as guides to help environmental agencies gauge the level of risk posed by specific chemicals in specific media. While the comparison values are based on theoretical health endpoints, there is much uncertainty in the science as to what precise chemical levels in foods (or other media) cause health problems in humans. In order to be protective of the entire and variable human population, agencies over estimate the exposures and lower the comparison levels. To be protective of the population, state wide consumption advisories are in place to protect the children of pregnant women and other groups who may be more susceptible to the hazards posed by chemical contaminants.

Certain people who frequently eat tomalley or mussels containing elevated concentrations of these contaminants are possibly at risk of developing health effects. PCBs and mercury are linked to developmental growth problems in infants born to women who ate contaminated fish and PCBs are suspected of posing a long-term risk of developing cancer. The states of Maine and New Hampshire have issued advisories warning people against eating lobster tomalley or prohibit shell fishing for the Piscataqua River, including the areas near PNS. People can best protect themselves against unwanted exposure to harmful levels of these chemicals by following the advisory. More information can be obtained from the Maine Department of Health and Human Services and the New Hampshire Fish and Game Department Web sites at http://www.maine.gov/dhhs/eohp/fish/saltwater.html and http://www.wildlife.state.nh.us/Fishing/fish_consumption.htm.

- ATSDR's evaluation suggests that the flounder has not accumulated harmful levels of chemical contaminants. ATSDR assumes that similar low concentrations would be observed in similar fish common to these waters, such as cod. However, as the Maine and New Hampshire limited fish consumption advisories state, people should limit their consumption of certain other marine species, including swordfish, shark, tilefish, kingfish, bluefish, and striped bass.

- A shell fishing restriction (due to bacteriological contamination) is in place along the Piscataqua River, which includes Topeka Pier D at Site 32, and the Maine Department of Marine Resources' Shellfish Protection Program prohibits shell fishing along the Piscataqua River. The restrictions mean that people should avoid harvesting mussels. More information can be obtained from the Department of Marine Resources' Web site: http://www.maine.gov/dmr/rm/public_health/shellfishgrowingarea.htm.

B. Contact with Potentially Contaminated Surface Water and Sediment

Summary

Based on data from several sources, low levels of metals and PAHs have affected the water quality and sediment of the Lower Piscataqua River. There are many point and non point sources of the contamination. Some contamination in these waters came from past PNS operations. Adults and children who visit the tidal waters around PNS could be exposed to low levels of contaminants in surface water or sediment. People do not use the river as a source of drinking water and, in general, only occasionally swim and/or engage in other recreational activities on a seasonal basis. Therefore, any exposure to contaminants in the waterways is minimal, and limited to infrequent, short-term dermal contact during boating, fishing, and shellfishing. This type of exposure would not be of health concern.

Discussion

This section discusses the Piscataqua River along PNS, surface water and sediment contamination in and around the PNS site, and possible sources of contamination. It also considers how people might come in contact with these contaminants and the health implications of these exposures.

Piscataqua River/Great Bay Estuary near Portsmouth Naval Shipyard

The Piscataqua River is part of the Great Bay Estuary. Estuaries are partially enclosed bodies of water along coastlines where freshwater and saltwater meet and mix. They act as a transition zone between oceans and land, where seawater is diluted with fresh water derived from land drainage. Estuaries are important habitats for marine species. The river surrounding the shipyard is classified as SC[1] for water contact recreation and fishing. Use of the area includes recreational and commercial fishing, lobstering, oystering, and boating (Navy 1997).

Little if any natural surface water runoff comes from this highly developed shipyard. Any surface water runoff is conveyed through an extensive stormwater system to outlets that empty into the Lower Piscataqua River (Navy 1997). Surface water from the southern portion of the shipyard drains into two natural ponds and subsequently into the Piscataqua River. Before the construction of the Industrial Waste Treatment Plant in 1976, liquid industrial wastes were discharged through outfalls to the river. A release pathway to the surface waters exists via the storm drains.

There are a number of sources of contamination in the estuary. Historically, municipal sewage waste, point, and nonpoint discharges have been the major sources of pollution in the estuary. Heavy metal contamination has been linked to industrial discharges, including chromium and nickel from tanneries, mercury from an electric station, and copper and zinc from foundries and metal plating operations (Johnston et al. 1994). Contamination in the river comes from a variety sources and cannot be attributed to any one specific source. However, measured contaminants associated with PNS activities are likely highest nearest shipyard source areas. According to the

1 http://janus.state.me.us/legis/statutes/38/title38sec469.html 8.C.(1) Tidal waters of the Piscataqua River and its tidal tributaries lying westerly of longitude 70`-42'-52" W., southerly of Route 103 and easterly of Interstate Route 95 - Class SC.

September 9, 1996 PNSY Relative Risk Evaluation Worksheet, “Several discharge points from storm and sanitary sewer water that discharge to the Piscataqua River were located at the western end of the Shipyard. During 1945 and 1975, industrial wastes were discharged to the river. Materials disposed: industrial wastes from plating and battery shops including: industrial wastewater (metals, oils, greases, PCBs, cyanide and phenols), solvents, and heavy metals. The use of these outfalls was terminated in 1975… Sediment and surface water have been impacted.”

In addition, “While the groundwater is not used or intended to be used for drinking water purposes and is separate from the mainland groundwater, there is migration of groundwater to the estuarine river… Seeps of groundwater are discharging contaminants to the Piscataqua River” (PNS 1997).

The currents rapidly move around and disperse pollutants released into the river. Because of the large volume of mixing and dilution in the river due to the tidal exchange, the highest levels of pollutants in surface water would be probably restricted to localized areas near source of contamination (Johnston et al.1994). The strong currents of the river scour sediment along the main channel, but where the current eddies slow down the flow, such as in the coves, sediment is deposited. The chemicals released from the shipyard have likely contributed to the overall level of contamination in the estuary.

Nature and Extent of Surface Water and Sediment Contamination near PNS

At PNS, sites 5, 6, 8, 10, 26, 32, and 34 may have contributed to surface water or sediment contamination. The Navy conducted surface water and sediment monitoring to study the effects of possible contaminant source areas on surface water and sediment quality. Samples were collected during the Phase I and Phase II RI activities and again during other environmental investigations. More than a hundred surface water and sediment samples were collected from along the shoreline of PNS. Samples are analyzed for VOCs, SVOCs, pesticides, PCBs, and metals. The Navy continues to monitor sediment as part of the long-term monitoring program.

Surface water and seep sampling: Generally low levels of contaminants (e.g. VOCs, SVOCs, metals, and pesticides) were detected in surface water and seep sampling locations along the shipyard shoreline. ATSDR screened the surface water and seep sampling data to health-based screening values.[2] Some of the highest concentrations of contaminants in surface water were found along Clark Cove and near the dry docks where currents are restricted. Few chemicals were present at levels that exceeded ATDSR’s screening values.

Sediment sampling: VOCs, SVOCs, metals, and pesticides were detected in near- and off-shore surface sediment. ATSDR reviewed surface sediment data collected near PNS and compared the results to ATSDR’s health-based soil screening values. ATSDR limited its evaluation to surface sediments because they represent the layer that is most available for human contact. Contaminant type and concentrations in surface sediment varied by location along the PNS shoreline. Some areas, such as coves or inlets, with finer sediment material tend to be more depositional and thus have a greater ability to accumulate certain contaminants. Metals and PAHs were among the contaminants detected most frequently and in the highest concentrations in surface sediment

[2] ATSDR does not have CVs for surface water or sediment; for comparison, ATSDR uses CVs for drinking water and soil. Using the drinking water and soil CVs is more protective because these CVs consider greater exposure to contaminants than people are likely to incur through incidental ingestion of surface water or contact with stream sediment.

collected at these areas. Metals, in particular copper and nickel associated with foundry slag, were detected along the shoreline of Site 32. Even so, the concentrations of these metals remained below their respective health-based screening values. Metals, primarily lead, and PAHs were also detected at Site 34. These contaminants are likely linked to the former oil gasification at that location (Tetra Tech NUS 2004b). Information from studies that collected deep core samples suggest that ongoing efforts are helping to reduce the pollutant burden in sediment because sediment sampling showed higher concentrations in the deeper sediment. Future dredging of sediments may cause a re-release of buried sediments containing higher levels of contaminants into the water column where they are available to accumulate in seafood.

The Navy is conducting additional tests to further characterize risk at Site 32 and 34 and will continue efforts to reduce or eliminate possible future sources of surface water and sediment contamination entering the Piscataqua River.

Evaluation of Public Health Implications of Surface Water and Sediment Contamination

Low levels of contamination have been detected in the estuarine waters around PNS. ATSDR examined whether people who visit the estuary could be exposed to harmful levels of the contaminants in surface water or sediment. The estuary is not widely used for contact recreation (e.g., swimming), nor is it used for drinking water. Therefore, little contact with surface water occurs. More people visit the area for boating and fishing.

Exposure to contaminants in surface water or sediment would by way of dermal contact (e.g., wading) and accidental ingestion. Exposures would likely be less than daily and of short duration due to the cold temperature of the water. Surface water and sediment data collected since 1991 indicate that low levels of contaminants were measured in the surface water and sediment samples on site. These levels are sufficiently below levels that have been shown to cause adverse effects following short-term contact. ATSDR concludes use of the estuary, which might result in exposure to contaminated surface water and sediments, is not likely to be a public health hazard. Ongoing cleanup at the shipyard described in site documentation should reduce or eliminate possible future sources of surface water and sediment contamination entering the estuary. However, dredging of contaminated sediments may cause a re-release of contaminants into the water column. ATSDR recommends that contaminant levels in surface water and sediment be monitored as part of any dredging operation.

C. Childhood Exposure to Lead-Based Paint

Children living in homes built before 1978 with chipped or peeling lead-based paint could be at risk of lead poisoning. Lead can be particularly hazardous to young children because they are generally prone to hand-to-mouth activities, and therefore could eat lead paint chips or lead-contaminated dust. Children living at PNS are screened for lead exposure and lead poisoning starting at their 6-month checkup, and after that if needed. To date, one childhood case of blood lead poisoning associated with base housing has been confirmed at the shipyard. Residents of the shipyard are informed about the potential hazards of lead in their houses before moving into PNS housing. They also are provided with instructions on how to safely clean chipped or peeled lead paint from their homes' interior surfaces. PNS is also removing lead from homes with lead-based paint.

Discussion

Lead Health Hazards

While ATSDR is concerned about the potential for children (6 years of age and under) to come into contact with lead, we realize that the shipyard is taking the necessary actions needed to stop or reduce the chance of lead exposure in children.

Lead was used in paint, as well as other commercial and household products, long before its harmful effects were known. In 1978, the U.S. Consumer Product Safety Commission banned the use of lead-based paint in homes due to the associated health hazard. At that time, PNS stopped using lead-based paints. About 75% of U.S. homes built before 1978 contain some lead-based paint (CSU 2003). Because the PNS homes were constructed before 1978, some of them contain lead-based paint (ATSDR 2005).

Public health screening for lead in children indicates that chipped or peeling lead-based paint in older homes (e.g., those built before 1978) is the most important risk factor for lead exposure in children (ATSDR 1999a, 1999b; EPA 2001). Children can be exposed to lead-based paint by accidentally ingesting lead paint chips or dust on their hands. Lead is absorbed through ingestion more readily than through inhalation or dermal contact. Lead is of particular concern to children because their growing bodies absorb more lead than adults' bodies, and their developing brains and nervous systems tend to be more sensitive to the damaging effects of lead. A child whose body accumulates high amounts of lead might experience behavioral problems, learning disabilities, and delayed growth, among other effects (ATSDR 1999a; EPA 1998).

Lead-Based Paint Hazards in PNS Housing

The Navy surveyed the 34 on-base housing units for lead-based paint (Dewberry and Davis 2004). (Units in Admiralty Village located off base in Kittery, Maine, were built after 1980, and therefore do not contain lead-based paint.) PNS tested the exterior and interiors of the homes for the presence of lead-based paint. To date, the Navy has removed five of the 34 units from service to encapsulate the lead-based paint and install HEPA vacuums. The Navy will abate leaded surfaces in other units as residents vacate their homes. The Navy also plans to remediate the outside of on-base housing (Portsmouth Naval Shipyard, personal communication, re: lead-based paint in housing, 2005).

The Navy provides residents a federally approved pamphlet on family protection from lead in the home. The information includes recommended practices for cleaning, maintenance and avoidance of exposure to children. The pamphlet distributed by the PNS Housing Division discloses information to residents about lead-based paint in PNS housing before they move into base housing (PNS Housing Division undated). Properly maintained lead-based paint poses little risk of lead poisoning. However, residents are encouraged to report any significant chipped or peeling paint so that it can be dealt with immediately. Until lead in affected homes is removed or covered, residents should keep children away from surfaces with chipped paint and avoid activities that disturb or damage lead-based paint, such as sanding or scraping painted surfaces. Also, residents can (1) collect small amounts of paint chips with duct tape and (2) clean the chipped surface with a solution high in phosphates (such as dishwashing detergents containing phosphates). Phosphates adhere to lead and keep it from spreading around. The chipped surface should be cleaned weekly and protective gloves should be worn while cleaning.

The Navy's Pediatric Lead Poisoning Prevention Program includes lead monitoring for Navy dependents less than 6 years of age starting at their 6 month checkup. One incidence of a child with elevated blood lead level related to on-base housing occurred in April 2004.

The Navy has a lead management program that predates both the program of the Department of Housing and Urban Development (HUD) and the Environmental Protection Agency (EPA). All Navy quarters were inspected for lead starting in the mid 1990s, and lead hazards were identified. Another detailed inspection was completed in 2004. Under this program items identified as major lead hazards are remediated, and lesser lead hazards are managed in place with interim controls until renovations can be completed. These interim controls include professional cleaning, paint repair, notification/disclosure of any lead hazards and education of residents; these controls met or exceeded all requirements under HUD and EPA standards (PNS 2006).

Public Health Implications of Exposure to Lead-Based Paint at PNS

Current and Future Exposure

Although there are still some homes containing lead-based paint, PNS is currently abating lead in residences at the shipyard built before 1978. Residents can help prevent childhood lead poisoning by complying with the following measures:

- *Reduce exposure*. While many of the older historic quarters at PNS contain lead-based paint, the Navy and GMH military housing minimize any risks to occupants through the use of interim controls and abatement. Residents can help to reduce the risks associated with lead-based paint by complying with the following measures: Be aware of and reduce lead-based paint hazards in the home. Keep children away from chipped surfaces. Contact PNS Housing/GMH with concerns about severely chipped surfaces. Treat minor chipped surfaces with caution keep children away, and avoid activities that disturb or damage lead-based paint. Additionally, wet mop floors before vacuuming.

- *Have lead exposure assessed starting at the 6 -month baby visit.* At PNS, a physician administers a questionnaire to the guardian of a child less than 7 years of age starting at the 6-month baby checkup. Information gathered from the questionnaire helps the physician determine the child's level of lead exposure and what type of further care is needed (Navy 2003).

- *Measure blood-lead levels in children at risk of lead exposure and provide follow-up.* A young child residing in or frequently visiting a housing unit that has chipping or peeling paint and was built before 1978 would be considered as "at risk for lead exposure." Children "at risk for lead exposure" should be routinely tested for blood lead levels starting at 6 months. Parents who are concerned about their child's exposure to lead should discuss it with their child's physician. Tests that measure lead levels in blood are typically used to assess lead exposure. Links between blood lead levels and health effects have been studied extensively to evaluate the potential for lead exposure to cause adverse health effects. In accordance with the Pediatric Lead Poisoning Prevention (PPLP) Program, children, children living at PNS are tested for blood lead levels at their 12-month well baby visits, at which time their physicians provide information about lead exposure to their guardians (Navy 2003). The Maine Department of Public Health investigates elevated blood lead levels, ensuring appropriate follow-up screening, education, and preventative measures for all identified cases of elevated blood lead levels (Navy 2003).

> The Centers for Disease Control and Prevention (CDC) indicate that blood lead levels of 10 μg/dL or greater are high enough to be a concern for lead poisoning. Children with blood lead levels in this range should have follow-up examinations, treatment, or both (ATSDR 1999b; CDC 2003).

Past Exposure

As with most homes built before 1978, lead-based paint was used at PNS and is still present in on-base housing. In some cases the paint was visibly chipped or peeling. Children living at PNS are screened for blood lead levels as part of the state of Maine and Navy well baby checkup. Since 1992, one child living in housing at PNS has tested positive for blood lead levels of 21 micrograms per deciliter (μg/dL), above the CDC-recommended level of 10 μg/dL. The elevated blood lead level was reported to the states of New Hampshire and Maine. Maine conducted further investigations of the affected residence, which resulted in elimination of the lead-based paint hazards (MDHHS 2005b).

IV. Community Health Concerns

Throughout the PHA process, ATSDR has gathered information about potential public health issues. Most of these issues were identified during the ATSDR visits in 2005; meetings with state, local, and US Navy officials; and review of site documents, including PNS's Community Relations Plan (CRP). The CRP provides guidance for involving the community and other interested parties in the remediation decision-making process and for distributing information to these parties. The Navy interviewed community members who are or may be affected by contamination at PNS while preparing the CRP.

No specific health concerns have been brought to ATSDR's attention, although general concerns about potential health hazards associated with the site and off-site migration of contaminants are identified in the CRP. ATSDR addresses these concerns in the "Evaluation of Environmental Contamination and Potential Exposure Pathways" section of this PHA.

As noted in this PHA, ATSDR did not identify any IRP sites at Portsmouth Naval Shipyard that pose a health hazard to the general public, based on the current site use. In May 2005, the shipyard was recommended for closure, but was rescinded by the Base Realignment and Closure (BRAC) commission. Under the BRAC Act of 1990, the Department of Defense is still responsible for cleaning up military bases to ensure that the property can be safely used in the future, in the event it is transferred to the community.

V. Child Health Considerations

In communities faced with air, water, or food contamination, the many physical differences between children and adults demand special emphasis. Children could be at greater risk than adults from certain kinds of exposure to hazardous substances. Children play outdoors and sometimes engage in hand-to-mouth behaviors that increase their exposure potential. Children are shorter than adults, so they breathe dust, soil, and vapors close to the ground. A child's lower body weight and higher intake rate results in a greater dose of hazardous substance per unit of body weight. If toxic exposure levels are high enough during critical growth stages, the developing body systems of children can sustain permanent damage. Finally, children are dependent on adults for access to housing, for access to medical care, and for risk identification. Thus adults need as much information as possible to make informed decisions regarding their children's health.

ATSDR has attempted to identify populations of children in the vicinity of PNS and any completed exposure pathways to these children. Kittery and Portsmouth, communities surrounding PNS and the Piscataqua River, contain residential neighborhoods with children and schools. Demographic data for 2000 indicate that 604 children under 6 years of age live in communities within a 1-mile radius of PNS. Children in these communities cannot easily trespass on PNS property because it is surrounded by the Lower Piscataqua River, perimeter fencing, and military security. Following a careful evaluation of potential exposure pathways as they relate to children, ATSDR believes that harmful exposures are not expected to occur under current land use conditions. Although contaminants have been detected in these areas, unsupervised children cannot access the PNS.

Like other people living at or near PNS, children might contact contaminants in non-IRP areas or be at risk from physical hazards. As discussed in the “Evaluation of Environmental Contamination and Potential Exposure Pathways” section, possible exposures to children include contact with the surface water and sediment of the Lower Piscataqua River, eating seafood caught from the river near PNS, and lead-based paint in the housing area. To date, no known cases of childhood illness related to site contamination or noted exposure situations have been reported. If parents choose not to follow the restrictions that pertain to consumption of fish, lobster tomalley, or shellfish, children might be exposed to low levels of contaminants present in fish and seafood taken from the Lower Piscataqua River. For that reason, ATSDR recommends that children and parents observe the current fish/seafood advisories issued by the states of Maine and New Hampshire.

ATSDR identified incidental ingestion of lead-based paint as a potential hazardous situation for children. Lead-based paint was used in base residences before 1978. Certain children living in shipyard housing might be at greater risk of experiencing lead-related health effects, depending on factors that influence exposure (e.g., age of children at exposure, play habits, presence and condition of lead-based paint in homes, and concurrent lead exposures). ATSDR recommends that children be kept away from paint-chipped surfaces and assessed for lead exposure at the 6-month baby visit under the Navy’s and the state of Maine’s blood lead screening program. Parents concerned about their child’s exposure to lead should discuss this with their child’s physician. This exposure pathway is discussed in the “Evaluation of Environmental Contamination and Potential Exposure Pathways” section of the PHA.

VI. Conclusions

Conclusions regarding potential exposure situations in Portsmouth Naval Shipyard (PNS), and in the areas near PNS, are based on evaluation of site investigation data and observations made during site visits. Conclusions about exposures are described below. (The public health hazard conclusion categories are described in Appendix A.)

- **Possible exposure to contaminants for consumers of fish and shellfish.** The mussels and tomalleys of lobsters caught from the open waters near PNS contain contaminants. People who eat frequent meals of mussels and tomalley may have an increased risk of developing adverse health effects. Adults and children who follow the current lobster tomalley consumption advisories issued by the states of Maine and New Hampshire and shell fishing restrictions are best protecting themselves against exposure. Flounder and lobster meat sampled from the Lower Piscataqua River around PNS contain low levels of metals and PCBs. Exposure to the low levels of these chemical contaminants should not pose a health hazard to those who eat, or ate, seafood from the water around PNS. Current fish **consumption advisories** in place for the Piscataqua River (NH and Maine state wide) recommend that pregnant and nursing women, women who may get pregnant, and children avoid salt water finfish, and set limits for swordfish, shark, tilefish, kingfish, bluefish, and striped bass for the general public **due to mercury, PCBs, and/or dioxin contamination and potential health risks associated with those contaminants.** Consumption of flounder (and similar types of fish not addressed under the advisories) and lobster meat from the intertidal waters surrounding PNS is not likely to result in adverse health effects in adults and children based on the chemical contaminants sampled.

- **Possible exposure to contaminants in surface water and sediments of the Piscataqua River near PNS.** PNS contaminants have been released into the Piscataqua River, which surrounds the shipyard. The portion of the river near PNS is not used for drinking water, nor is it widely used for swimming. The generally low concentrations of contaminants in areas accessible to, and the type of contact incurred by, people involved in boating, fishing, and clamming results in exposures below levels known to cause harmful health effects. Thus exposures to contaminants that entered the Lower Piscataqua River pose **no apparent public health hazard.** However, dredging of contaminated sediments may cause a re-release of contaminants into the water column.

- **Lead exposures in PNS housing.** Lead-based paint was used in PNS residences prior to1978. Because young children are prone to hand-to-mouth activities, they could eat lead paint chips or lead-contaminated dust, increasing their risk of developing lead poisoning. Both the BUMED PPLP and state regulations require a questionnaire/assessment of a child's lead-based paint risk at 6 months, a blood test at 12 months, and follow-up tests as needed until age 6. The Maine Department of Health and Human Services followed up on the child EBL. Abatement and the use of interim controls at PNS, in accordance with the Lead Management Plan, have minimized lead-based paint hazards. Housing and GMH military housing advise residents on temporary measures to reduce lead-based paint hazards in their homes. ATSDR supports these actions as ways to reduce potential for exposure to lead in the home and risk of lead poisoning.

VII. Recommendation

- Having evaluated the public health activities and the available environmental information, ATSDR recommends that people follow the current fish and lobster tomalley consumption advisories issued by the states of Maine and New Hampshire and the shell fishing restrictions issued for the Piscataqua River.

- Any future dredging of contaminated sediments may cause a re-release of contaminants into the water column. ATSDR recommends that contaminant levels in surface water and sediment be monitored as part of any dredging operation.

VIII. Public Health Action Plan

The Public Health Action Plan (PHAP) for the Portsmouth Naval Shipyard describes actions to be taken by ATSDR and other government agencies at and in the vicinity of the site after the completion of this public health assessment. The purpose of this PHAP is to ensure that this public health assessment not only identifies public health hazards, but also provides a plan of action designed to mitigate and prevent adverse human health effects resulting from exposure to hazardous substances in the environment. If additional information about Portsmouth Naval Shipyard becomes available, then that information could change a conclusion or the conclusions of this public health assessment; if that occurs, then human exposure pathways should be re-evaluated and these conclusions and recommendations should be amended, as necessary, to protect public health.

Completed Actions

1. The Navy began an investigation of the environmental conditions at Portsmouth Naval Shipyard in 1983 and 1984 to identify possible contaminant sources. The initial assessment—and subsequent Navy investigations—did confirm the presence of contamination at the shipyard.

2. EPA placed Portsmouth Naval Shipyard on the NPL in 1994.

3. The remedial investigation/feasibility study process began in 1985.

4. In September 1999, the Navy entered into a Federal Facilities Agreement with EPA regarding the cleanup of the environmental contamination at Portsmouth Naval Shipyard.

5. Through field investigations, the Navy identified contaminants in groundwater, soil, surface water, sediment, and fish/shellfish taken from or near the shipyard, some at concentrations above ATSDR screening values.

6. Portsmouth Naval Shipyard has instituted corrective actions to control the spread of contamination from IRP sites, including (1) Site 5, industrial waste outfalls stopped discharging wastes to the offshore in 1976; (2) Site 6, between 1993 and 1999, the Navy

capped areas containing high metal concentrations and installed storm water and erosion controls as an interim measure; (3) Site 8, the Navy constructed wetlands in Jamaica Cove and a hazardous waste cover over the Jamaica Island Landfill and instituted shoreline erosion controls; (4) Site 9, the Navy identified and removed mercury burial vaults; (5) Sites 10 and 11, the Navy removed the underground storage tanks (USTs) from service and covered the area with asphalt; (6) Sites 21, the Navy excavated and removed storage tanks and any associated contaminated soil; (7) Site 29, the Navy performed shoreline erosion control measures; (8) Site 32, shoreline controls instituted, and (9) Site 34, the Navy removed five drums of ash in 1999.

7. The Navy moved the Child Development Center away from the Jamaica Island Landfill although contamination from the landfill was not found to have impacted the former Child Development Center area. Currently, the landfill is capped with a multi-layer hazardous waste landfill cap. The top surface is covered with topsoil, or pavement, and gravel and is used for recreational activities and vehicle parking. The recreational activities include a baseball field, fitness area, and a jogging track (Tetra Tech EC 2005). Other uses of the landfill and adjacent area include equipment storage and a hazardous waste storage facility.

8. The Navy has instituted controls to restrict land and fresh water groundwater uses within the Jamaica Island Landfill boundary to prevent unacceptable human exposure to site contaminants. Institutional controls will also be used to prevent unrestricted disturbance of the hazardous waste landfill cover and shoreline erosion controls.

9. ATSDR visited Portsmouth Naval Shipyard in January 2005 to tour the site, meet with site representatives, and gather environmental and exposure information to complete the public health evaluation**.**

Ongoing and Planned Actions

1. The Navy plans to conduct ongoing monitoring at and routine maintenance of the Jamaica Island Landfill complex to assess the effectiveness of the remedy over the long term.

2. The Navy continues to conduct long-term monitoring and environmental investigations as part of CERCLA.

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Tables

Table 2. Description of Installation Restoration Program Sites at Portsmouth Naval Shipyard

Site	Description	OU	Contaminants and Media[1]				Completed Removal/ Corrective Action	Status	Potential for Human Exposures*
			GW	Soil	SW	Sediment			
5	Industrial Waste Outfalls	4				Arsenic PAHs	▪ No corrective actions identified. ▪ The Navy is conducting routine monitoring at off-shore sampling locations. The monitoring program includes sediment, mussel, and juvenile lobster sampling and analysis (Tetra Tech NUS 2007).	This site is part of OU4 (offshore area), which has an Interim 1999 ROD for off-shore monitoring. The offshore area is used for recreational fishing, lobster trapping, harvesting oysters, and boating. Use of the industrial waste outfalls (Site 5) was discontinued in 1975.	Seafood consumption Recent monitoring results indicate that flounder and lobster do not contain chemical contaminants at levels of health concern. ATSDR recommends following the current statewide lobster tomalley consumption advisory and adhere to the shellfish restrictions.
6	DRMO	2	1,2-DCA Arsenic Cadmium Mercury	Antimony Arsenic Cadmium Lead PAHs	Arsenic	Chromium Lead PAHs	▪ 1993-Capped site and installed storm water control. ▪ 1999-Installed interim erosion controls (Foster Wheeler 2001a). The slope at the DRMO, which was found to be heavily eroded, was stabilized.	Asphalt or an interim cap covers most of the surface within the fenced areas of the DRMO.	Although limited access to soil in grassy areas by personnel is possible, a cap was installed at the DRMO Storage Yard to prevent wind dispersal, surface run-off of, and direct contact with contaminated soils. Since access to this area is limited, any exposures to contaminants would be very limited and are not expected to pose a public health hazard providing the Navy continues to take necessary measures to prevent access to contaminants in the soils and sediment.

Site	Description	OU	Contaminants and Media[1]				Completed Removal/ Corrective Action	Status	Potential for Human Exposures*
			GW	Soil	SW	Sediment			
8	Jamaica Island Landfill (JILF) (and the Child Development Center)	3	1,2-DCA Arsenic Lead Mercury PCBs	Arsenic Copper PCBs PAHs DDT	Arsenic	Chromium	▪ 2001- The Record of Decision (ROD) for OU3, which includes Sites 8, 9, and 11) was signed in August 2001, documenting the selected remedy. ▪ 2002-excavation of debris and fill and construction of a salt water marsh was completed in the summer of 2002. ▪ 2003- Excavated material from salt water marsh was placed on the landfill area and covered with a cap. 2001-2003-Proposed actions consisted of institutional controls, erosion controls, and long-term monitoring (Tetra Tech NUS 2007).	JILF-The landfill is covered with topsoil, pavement, and gravel (and passive gas vents) and is used for recreational activities and vehicle parking. Other uses of the landfill and adjacent area include equipment storage and hazardous waste storage facility. Shoreline protection features were added around Clark Cove. Based on the results of an investigation in 2003, the Navy designated the site as "no further action (NFA)"	Seafood consumption, potential exposure to intertidal sediments and surface water. Exposure to contaminants in near- or off-shore sediments and surface water does not pose a public health hazard for children who may inadvertently ingest small amounts of sediments during recreational activities. Levels of contaminants in the sediments are too low to cause health effects given these infrequent exposures. Access to Site 8 is restricted and unlimited use by non-authorized personnel is not recommended prior to clean-up and approval by EPA. Recent monitoring results indicate flounder and lobster do not contain chemical contaminants at levels of health concern. ATSDR recommends following the current statewide lobster tomalley consumption advisory and adhere to the shellfish restrictions.

Site	Description	OU	Contaminants and Media[1]				Completed Removal/ Corrective Action	Status	Potential for Human Exposures*
			GW	Soil	SW	Sediment			
9	Mercury Burial Site (MBI)	3	Copper	PCBs PAHs DDT			▪ 1994-Excavated concrete pipe of mercury burial vault (MBI). ▪ 1997-Removed three remaining concrete blocks and contents and confirmed that soil concentrations were below action levels. ▪ 2000-Found and removed blocks and contents of MBII. (Foster Wheeler 2001b, c)	No further action (NFA) was recommended for MBI at this site.	Limited, if any. The vaults were found and removed and therefore there is no longer any exposure. The contents of the vaults were reported to be contained during the removal and there was no evidence of contamination to surrounding media.
10	Tank No. 24	1	Chromium Lead Manganese Thallium Vanadium	Antimony Arsenic Lead PAHs PCBs DDT			▪ 1984-Excavated tank and removed from service. ▪ 1986-Removed tank.	The site is covered with asphalt pavement. Based on November 2001 field work, a risk assessment and field investigations beneath Building 238 should be further investigated to better determine hazards from lead in soil (Tetra Tech NUS 2003). A final remedy has not been selected for OU1; A ROD for OU1 is scheduled to be signed in 2009 and any remedial activities scheduled to begin in 2010.	Seafood consumption Recent monitoring results indicate flounder and lobster do not contain chemical contaminants at levels of health concern. ATSDR recommends following the current statewide lobster tomalley consumption advisory and adhere to the shellfish restrictions.

Site	Description	OU	Contaminants and Media[1]				Completed Removal/ Corrective Action	Status	Potential for Human Exposures*
			GW	Soil	SW	Sediment			
11	Waste Oil Tanks No. 12	3	Benzene PAHs PCBs	Arsenic PAHs PCBs			▪ 1979-Excavated, inspected, and reburied tanks. ▪ 1989-Excavated and removed tanks, but found to be in good shape. Removed 320 tons of soil primarily contaminated with lead. ▪ 1994-Investigated soil contamination as part of the MILCON project for the construction of the Hazardous Waste Transfer Facility.	The site is covered with pavement.	No completed exposure pathways identified at Site 11.

Site	Description	OU	Contaminants and Media[1]				Completed Removal/ Corrective Action	Status	Potential for Human Exposures*
			GW	Soil	SW	Sediment			
21	Acid/Alkaline Tank	1	PAHs				▪ 1991-Excavated tank. Area was backfilled and covered with asphalt.	The site is industrial and covered with pavement. A NFA for soil and groundwater has been approved. A ROD for OU1 is scheduled to be signed in 2009 and a NFA designation for Site 21 is expected.	No completed exposure pathways identified at Site 21.
26	Oil/water Dumpsters (SWMU 26)	4†				Arsenic Chromium PAHs	▪ Modified operations at the still operational tanks to reduce spillage.	A NFA decision document (DD) was signed in August 2001. The site was removed from OU4. The tanks are now managed by the Portsmouth Naval Shipyard (PNS) Oil Spill Prevention Control and Countermeasure (Plan and RCRA Part B. (Navy 2001a).	Possible seafood consumption Recent monitoring results indicate flounder and lobster do not contain chemical contaminants at levels of health concern. ATSDR recommends following the current statewide lobster tomalley consumption advisory and adhere to the shellfish restrictions. Access to this area is restricted.

Site	Description	OU	Contaminants and Media[1]				Completed Removal/ Corrective Action	Status	Potential for Human Exposures*
			GW	Soil	SW	Sediment			
27	Fuel Oil Spill †	5	1,2-DCA 1,1,2-TCA Beryllium Cadmium Chromium Cobalt Lead Mercury	Lead PAHs PCBs			▪ 1978-Excavated and removed a section of a ruptured underground pipeline from Berth 6. No additional information on the release is available. ▪ 1981-Capped and abandoned in place two other fuel lines at Berth 6. Determined that the fuel oil tank farm was unrelated to the fuel oil spill area.	A NFA DD for this site was signed in August 2001. The site is covered with asphalt pavement. Remedial activities for the off shore in the vicinity of Site 27 are being addressed as part of operable unit 4 (OU4). The petroleum contamination at the site will be managed along with the tank farm under the Maine Department of Environmental Protection (MEDEP) (Navy 2001b).	No completed exposure pathways identified at Site 27.
29	Teepee incinerator Site	2	1,2-DCA Arsenic Cadmium Lead Manganese Mercury	Antimony Arsenic Cadmium Lead Manganese			▪ 2000-Prepared a risk assessment of Site 29 exposures. ▪ 2005-2006 - Emergency Removal Action (shoreline stabilization) conducted at Site 29 (Tetra Tech NUS 2007).	Site 29 is covered with buildings, pavement, and some grassy areas, but is not used for residential housing (Tetra Tech NUS 2000a). Shoreline erosion controls were completed in 2006; included placement of riprap and geotextile along the shoreline.	No completed exposure pathways identified at Site 29.

Site	Description	OU	Contaminants and Media[1]				Completed Removal/ Corrective Action	Status	Potential for Human Exposures*
			GW	Soil	SW	Sediment			
30	The Galvanizing Plant (Building 184)	NA	Metals	PAHs			▪ 2001 - Test pit excavated within acid pit, and samples of fill material and crystalline substance analyzed. ▪ In June 2006, the Navy removed crystals, cleaned the area, and placed a vinyl cover over the affected area within Building 184 (Tetra Tech NUS 2007).	The building currently operates as a welding school. This area is still under investigation to determine whether further action as part of an RI/FS is needed. In June 2006, an action memorandum was signed. The action will include periodic scraping and disposal of crystals and installation and operation of a pit dewatering system. The removal action is scheduled to begin in 2008.	No completed exposure pathways identified at Site 30.
31	The West Timber Basin	8	Metals	Metals PAHs			▪ 2006 - Removal of surface features and initial construction activities associated with expansion of Building 174 (Tetra Tech NUS 2007)	The RI is scheduled to begin in 2012. The results of the RI will determine whether remedial action at OU8 will be required.	No completed exposure pathways identified at Site 31.

Site	Description	OU	Contaminants and Media[1]				Completed Removal/ Corrective Action	Status	Potential for Human Exposures*
			GW	Soil	SW	Sediment			
32	Topeka Pier	7	Lead Arsenic	Metals PAHs	Metals	PAHs	▪ Emergency removal action (shoreline stabilization) conducted (Tetra Tech NUS 2007).	The 2003 Phase I remedial investigation (RI) recommends additional groundwater sampling for metals and soil sampling in select areas. (Tetra Tech NUS 2000b, 2004a). Shoreline erosion controls were completed in 2006; included placement of riprap and geotextile along the shoreline.	Possible soil (near shoreline) and sediment at low tide (personnel). Access to soil and/or sediments is limited and any inadvertent contact with contaminants does not pose a public health hazard. However, access to Site 32 is restricted, and unlimited use by non-authorized personnel is not recommended prior to clean-up and approval by EPA.
34	Oil Gasification (Building 62)	9	Metals	PAHs		Metals PAHs	▪ 1999-Removed six drums filled with excavated ash. These were not buried drums that were removed – some of the ash was excavated and put into drums for proper disposal.	The 2004 site screening report recommends an RI to assess the potential risks from the pre-1930 coal combustion operations and additional investigations under Building 62 and its annex to determine the presence or absence of source material (Tetra Tech NUS 2004b).	Possible soil and sediment Access to Site 34 is restricted, and unlimited use by non-authorized personnel is not recommended until additional environmental investigations are conducted.

[1] Only contaminants exceeding ATSDR health-based screening values are listed in this table.

* Contaminants released to groundwater or sediments may have migrated to the Piscataqua River or surrounding water bodies, potentially accumulating in fish, shellfish, and lobsters.

† Site 26 is no longer part of OU 4. Site 27 is no longer part of OU5.

Table 3. Range of Contaminant Concentration in Winter Flounder (ppm, dry weight)

Contaminant	Phase I 1991		Phase II 1993		Gulf of Maine	
	Frequency of Detection	Concentration	Frequency of Detection	Concentration	Frequency of Detection	Concentration
Aluminum	6/6	0.9030-2.6796	0/5	---	0/5	---
Arsenic	6/6	0.9600-1.7500	0/5	---	3/5	4.52-10.5656
Cadmium	2/6	0.0040-0.0117	3/5	0.00208-0.0043	5/5	0.00188-0.00404
Chromium	6/6	0.1200-0.3250	5/5	0.0387-0.07168	5/5	0.04444-0.07
Copper	6/6	0.1483-0.3510	1/5	0.1128	1/5	0.08282
Lead	6/6	0.0110-0.0950	5/5	0.00624-0.02585	5/5	0.01236-0.0202
Manganese	6/6	0.0660-0.7750	0/5	---	0/5	---
Mercury	4/5	0.0193-0.0351	5/5	0.02941-0.0542	5/5	0.06534-0.09204
Methyl mercury	Not Analyzed	---	2/2	0.03092-0.071	2/2	0.02282-0.06338
Nickel	6/6	0.1161-0.1766	0/5	---	5/5	0.04848-0.08342
Silver	2/6	0.0086-0.0142	0/5	---	0/5	---
Zinc	6/6	5.2460-10.5250	5/5	3.328-4.089	5/5	2.3124-2.7192
Aldrin	6/7	0.00014-0.00060	NA	---	NA	---
Alpha Chlordane	6/7	0.00014-0.00085	5/5	0.0008-0.00046	5/5	0.00006-0.00036
Heptachlor	6/7	0.00014-0.00060	NA	---	NA	---
Heptachlor Expoxide	6/7	0.00003-0.00060	NA	---	NA	---
Lindane	6/6	0.00005-0.00060	1/5	0.00008	5/5	0.00003-0.00022
Mirex	6/7	0.00014-0.00060	NA	---	NA	---
4,4-DDD	6/7	0.00005-0.00276	5/5	0.00022-0.00076	5/5	0.00011-0.0005
4,4-DDE	6/7	0.00052-0.00943	5/5	0.00047-0.00116	5/5	0.0011-0.00238
4,4-DDT	6/6	0.00023-0.00531	2/5	0.00011-0.00013	5/5	0.00012-0.00017
Benzo(a)pyrene					5/5	0.0001-0.00018
Total PCBs	7/7	0.00725-0.07987	5/5	0.01239-0.03852	5/5	0.02659-0.05606

Source: Tetra Tech 1998

Note: ATSDR used the Food and Drug Administration (FDA) action or tolerance levels as screening values for mercury (1 ppm), PCBs (2 ppm), chlordane (0.3 ppm), and DDT (5 ppm). These values were established for seafood sold through interstate commerce to protect humans from harmful substances in commercial foods. Although the FDA levels were not developed as regulatory standards for estuarine fish, they are often used by states when setting fish consumption advisories.

Table 4. Range of Contaminant Concentration in Adult Lobster Tail (ppm, dry weight)

Contaminant	Phase I 1991		Phase II 1993	
	Frequency of Detection	Concentration	Frequency of Detection	Concentration
Aluminum	6/6	1.8928-18.2970	6/6	0.36064-0.50566
Arsenic	6/6	0.7800-5.2600	6/6	0.81864-4.3152
Cadmium	5/6	0.0022-0.0109	3/6	0.00216-0.00496
Chromium	6/6	0.1308-0.2470	6/6	0.02592-0.07596
Copper	6/6	4.1040-5.8504	6/6	1.68364-7.0416
Lead	6/6	0.0090-0.1160	6/6	0.00579-0.01984
Manganese	6/6	0.3296-1.0633	6/6	0.02316-0.63736
Mercury	5/5	0.1767-0.3488	5/5	0.06202-0.18233
Methylmercury	Not Analyzed	--	3/3	0.04666-0.06355
Nickel	5/6	0.0414-0.2563	0/6	--
Silver	6/6	0.0680-0.2260	6/6	0.01544-0.11408
Zinc	6/6	14.1480-20.0100	6/6	17.6402-29.59384
Aldrin	6/7	0.00009-0.00047	NA	--
Alpha Chlordane	7/7	0.00005-0.00023	3/5	0.00006-0.00008
Heptachlor	6/7	0.00000-0.00015	NA	--
Heptachlor Expoxide	6/7	0.00002-0.00048	NA	--
Lindane	7/7	0.00007-0.00045	5/5	0.00009-0.00026
Mirex	6/7	0.00010-0.00015	NA	--
4,4-DDD	6/7	0.00015-0.00034	5/5	0.00008-0.00022
4,4-DDE	7/7	0.00028-0.00134	5/5	0.00052-0.00107
4,4-DDT	7/7	0.00015-0.00217	0/3	--
Benzo(a)pyrene	5/7	0.00399-0.15900	1/5	0.00544
Total PCBs	7/7	0.00820-0.02420	5/5	0.00666-0.01474

Source: Tetra Tech NUS 1998

Note: ATSDR used the Food and Drug Administration (FDA) action or tolerance levels as screening values for mercury (1 ppm), PCBs (2 ppm), chlordane (0.3 ppm), and DDT (5 ppm). These values were established for seafood sold through interstate commerce to protect humans from harmful substances in commercial foods. Although the FDA levels were not developed as regulatory standards for estuarine fish, they are often used by states when setting fish consumption advisories

Table 5. Range of Contaminant Concentration in Adult Lobster Tomalley (ppm, dry weight)

Contaminant	Phase I 1991		Phase II 1993	
	Frequency of Detection	Concentration	Frequency of Detection	Concentration
Aluminum	8/8	3.7843-12.8592	5/6	0.70905-8.4942
Arsenic	8/8	4.1700-14.3200	6/6	2.86136-6.878
Cadmium	8/8	2.0787-10.5750	6/6	0.6916-11.2068
Chromium	8/8	0.1439-0.4370	6/6	0.08475-0.26136
Copper	8/8	21.2134-168.0000	6/6	4.3775-582.912
Lead	8/8	0.0470-0.1920	6/6	0.019-0.34452
Manganese	8/8	2.5092-3.7179	6/6	0.97325-2.9106
Mercury	7/7	0.0472-0.1120	6/6	0.03827-0.30076
Methyl mercury	Not Analyzed	--	2/2	0.02834-0.05941
Nickel	8/8	0.1928-1.1400	1/6	0.2079
Silver	7/8	0.1790-1.3776	5/6	0.14288-0.58725
Zinc	8/8	14.8580-67.2000	6/6	9.538-36.828
Aldrin	6/7	0.00055-0.00346	NA	--
Alpha Chlordane	5/7	0.00057-0.01176	6/6	0.00014-0.01035
Heptachlor	6/7	0.00055-0.00114	NA	--
Heptachlor Expoxide	6/7	0.00055-0.00230	NA	--
Lindane	6/7	0.00057-0.01996	6/6	0.00033-0.00231
Mirex	5/7	0.00060-0.00120	NA	--
4,4-DDD	6/7	0.02046-0.03940	6/6	0.00079-0.06586
4,4-DDE	6/7	0.18620-0.42859	6/6	0.12912-0.36312
4,4-DDT	5/5	0.00060-0.00793	5/6	0.003-0.03158
Benzo(a)pyrene	3/3	0.03990-0.22540	4/6	0.00472-0.08536
Total PCBs	7/7	0.19030-2.65643	6/6	0.71047-1.23087

Source: Tetra Tech NUS 1998

Note: ATSDR used the Food and Drug Administration (FDA) action or tolerance levels as screening values for mercury (1 ppm), PCBs (2 ppm), chlordane (0.3 ppm), and DDT (5 ppm). These values were established for seafood sold through interstate commerce to protect humans from harmful substances in commercial foods. Although the FDA levels were not developed as regulatory standards for estuarine fish, they are often used by states when setting fish consumption advisories.

Table 6. Range of Contaminant Concentration in Mussels (ppm, dry weight)

Contaminant	Phase I 1991		Phase II 1993		Gulf Watch Program		Interim Offshore Monitoring Program, 1999-present	
	Frequency	Concentration	Frequency	Concentration	Frequency	Concentration	Frequency	Concentration
Inorganics (mg/kg or ppm)								
Aluminum	31/31	9.2280-58.9860	53/53	18.144-164.16	20/20	140 – 400	127/127	59.5 J -1,175
Arsenic	31/31	0.5100-2.2000	68/70	0.62013-4.944	20/20	0.05 - 0.18	127/127	4.01 – 10.9
Cadmium	30/30	0.1190-0.3432	53/71	0.11886-0.53856	20/20	1.30 - 2.73	127/127	0/69 – 3
Chromium	31/31	0.2145-0.6040	23/23	0.2737-0.9251	20/20	1.9 – 4.86	116/127	1.2 – 8.82
Copper	31/31	0.3575-3.1654	52/52	0.69916-5.5216	20/20	6 – 12	127/127	5.09 J– 101
Lead	31/31	0.2420-3.1200	72/72	0.1518-27.4	20/20	3.6 – 8.3	127/127	1.74 – 199 J
Manganese	31/31	0.6006-8.1360	52/52	1.0626-164.56	Not Analyzed		127/127	5.3 – 312
Mercury	29/29	0.0181-0.1096	31/31	0.03101-0.75344	20/20	0.41 – 1.1	126/127	0.14 – 2.31
Methyl mercury								
Nickel	31/31	0.0799-0.4681	23/23	0.14623-0.6425	20/20	0.9 – 3.0	83/127	0.82 – 12.9
Silver	29/31	0.0047-0.4077	21/53	0.00547-0.12614	Not Analyzed		81/127	0.2J – 0.74
Zinc	31/31	6.0500-25.0860	71/73	4.312-34.544	20/20	87 – 170	127/127	61.8 - 404
Pesticides (mg/kg or ppm)								
Aldrin	22/34	0.00011-0.00377	0/28	--	0/16	Not Detected	52/127	0.0003 - 0.0033.
AlphaChlordane	29/34	0.00010-0.00262	9/28	0.0002-0.00064	0/16	Not Detected	116/127	0.00044 – 0.0325
Heptachlor	2/34	0.00002-0.00002	0/28	--	0/16	Not Detected	77/127	0.00008 – 0.0049
Heptachlor Expoxide	3/34	0.00001-0.00025	0/28	--	0/16	Not Detected	48/127	0.00005 – 0.021
Lindane	4/34	0.00003-0.00414	0/28	--	0/16	Not Detected	Not Analyzed	
Mirex	2/34	0.00015-0.00015	0/28	--	0/16		50/127	0.000033 – 0.0029
4,4-DDD	34/34	0.00028-0.00954	21/28	0.00057-0.0028	13/16	0.0021-0.0041	127/127	0.00031 – 0.104
4,4-DDE	33/34	0.00053-0.01038	25/28	0.00114-0.00268	16/16	0.0041 – 0.0097	127/127	0.0028 – 0.099
4,4-DDT	30/34	0.00018-0.00963	27/28	0.00154-0.00486	0/16	Not Detected	102/127	0.00012 – 0.596
Polycyclic Aromatic Hydrocarbons/Polychlorinated Biphenyls (mg/kg or ppm)								
Benzo(a)pyrene	2/26	0.00390-0.00456	28/28	0.00132-0.06905	5/10	0.011 - 0.014	116/127	0.0032 – 3.148
Total PAHs					10/10	0.021 – 0.235	127/127	0.085 – 37.431
Total PCBs	31/31	0.00955-0.06002	28/28	0.01378-0.05911	12/12	0.016 - 0.075	127/127	0.041 – 0.695

Source: Tetra Tech NUS 1998; Gulfwatch 2005; Tetra Tech NUS 2002.

Note: ATSDR used the Food and Drug Administration (FDA) action or tolerance levels as screening values for mercury (1 ppm), PCBs (2 ppm), chlordane (0.3 ppm), and DDT (5 ppm). These values were established for seafood sold through interstate commerce to protect humans from harmful substances in commercial foods. Although the FDA levels were not developed as regulatory standards for estuarine fish, they are often used by states when setting fish consumption advisories.

Figures

Figure 1. Area Around Portsmouth Naval Shipyard

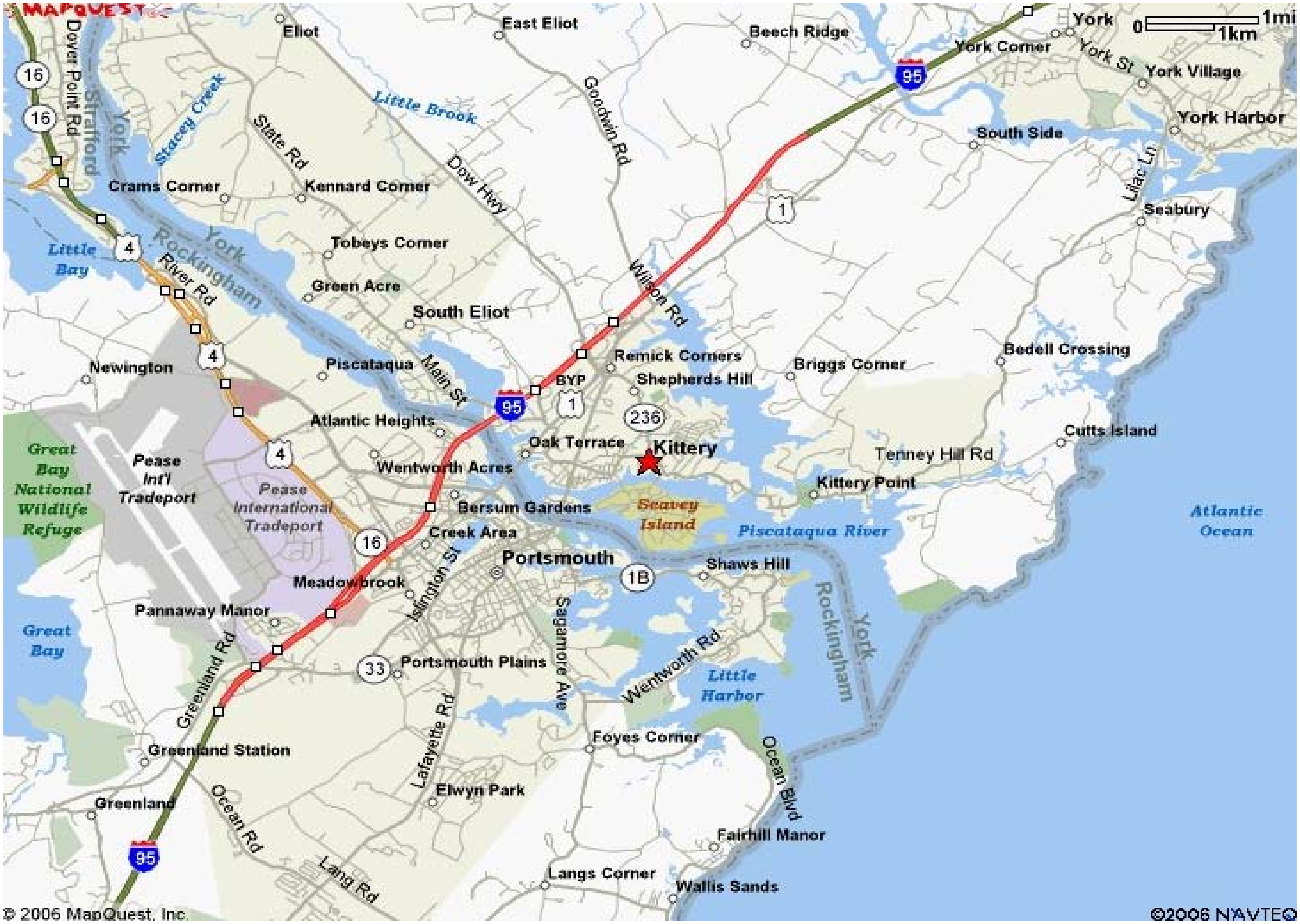
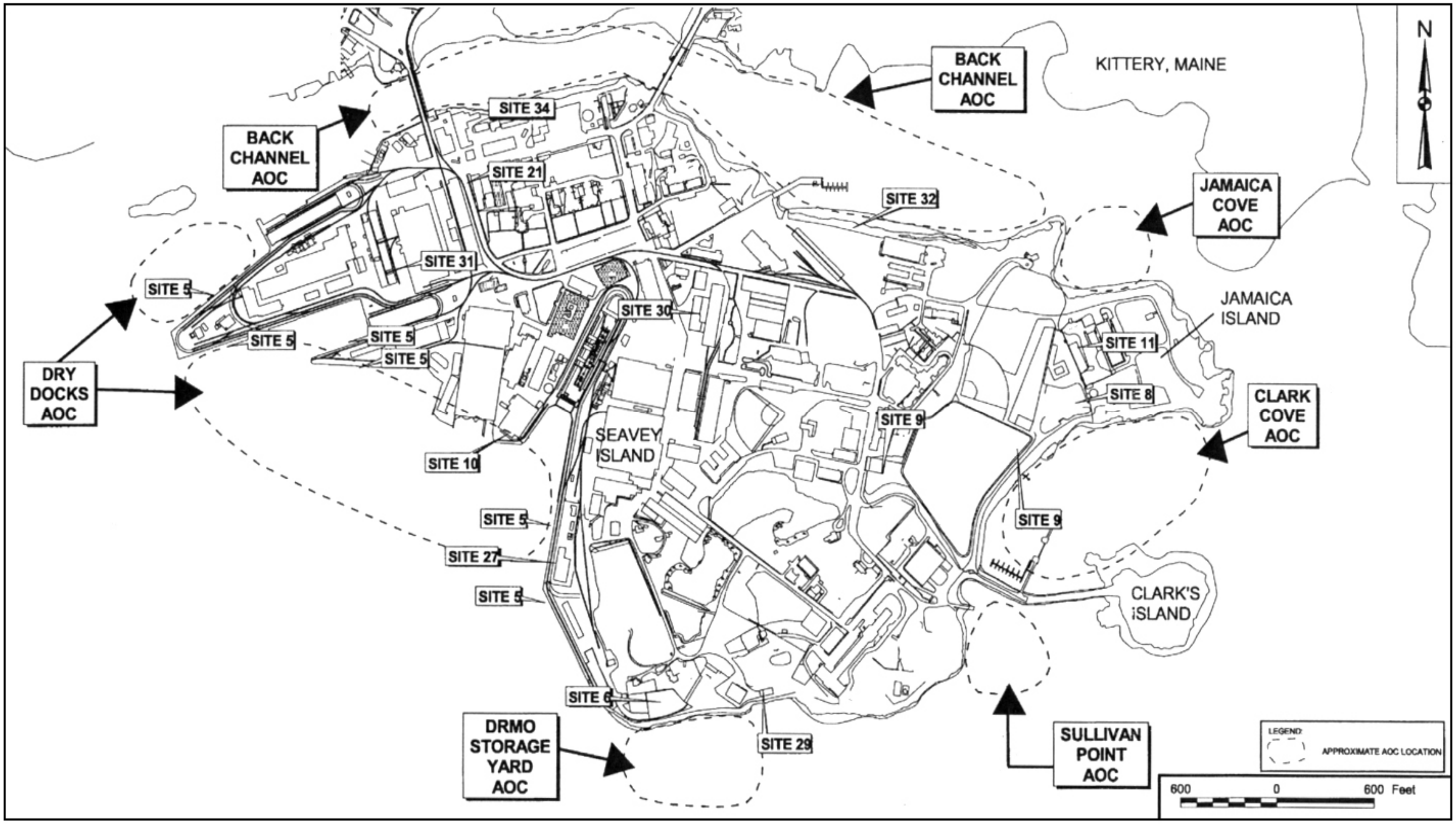


Figure 2. Portsmouth Naval Shipyard



Source: **FY06 Amended SMP. (P:\GIS\PORTSMTH NSY\APR\ARCHIVE\5003 201-01 .APR APPROXIMATE AOC LOCATIONS LAYOUT 7/12/04 JAL**

Figure 3. Demographics Around Portsmouth Naval Shipyard

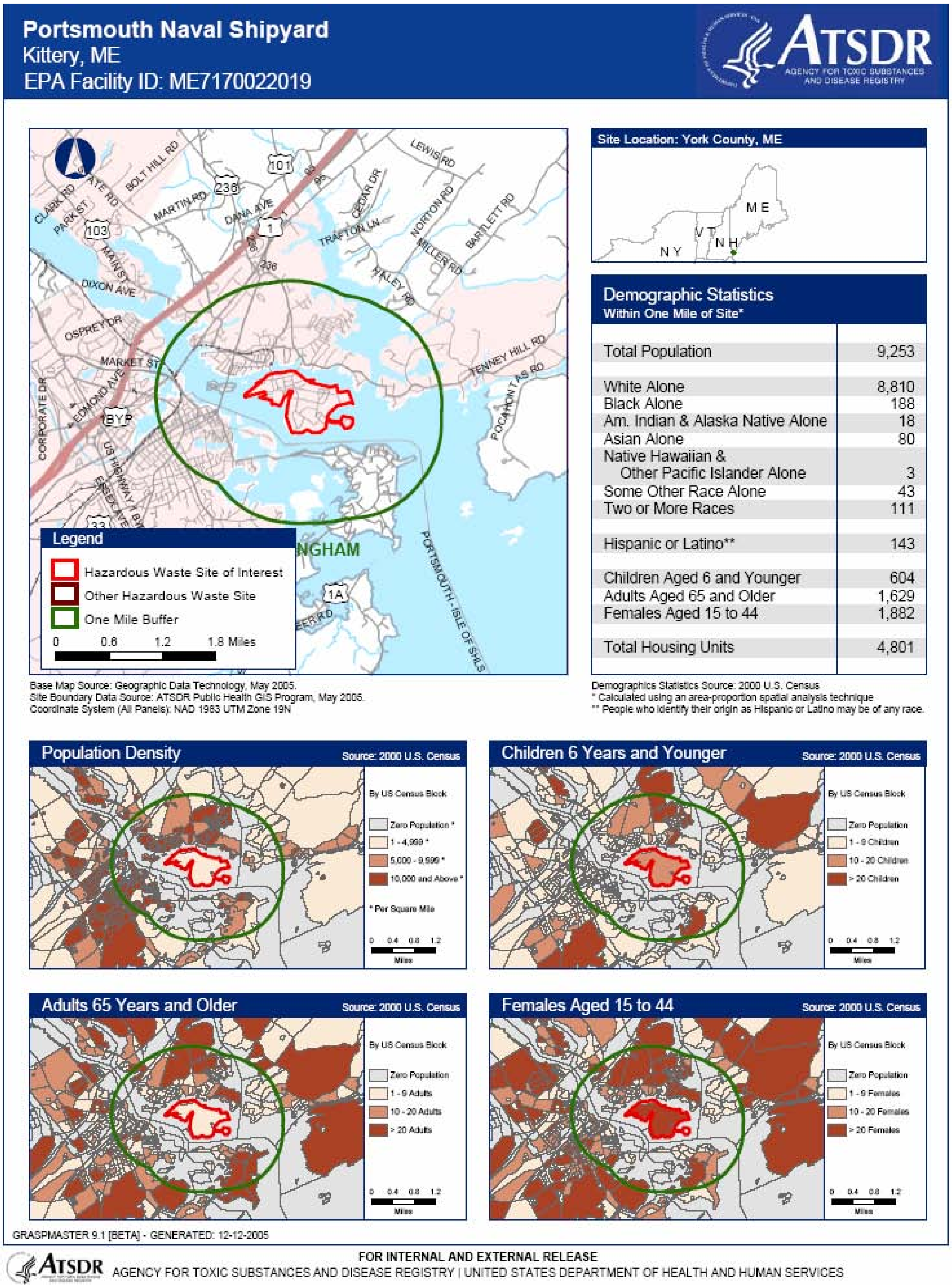


Figure 4. Exposure Evaluation Process

REMEMBER: For a public health threat to exist, the following three conditions must all be met:

- Contaminants must exist in the environment
- People must come into contact with areas that have potential contamination
- The amount of contamination must be sufficient to affect people's health

Are the Environmental Media Contaminated? → **Are People Exposed To Areas With Potentially Contaminated Media?** → **For Each Completed Exposure Pathway, Will the Contamination Affect Public Health?**

Are the Environmental Media Contaminated?

ATSDR considers:

Soil
Ground water
Surface water and sediment
Air
Food sources

Are People Exposed To Areas With Potentially Contaminated Media?

For exposure to occur, contaminants must be in locations where people can contact them.

People may contact contaminants by any of the following three exposure routes:

Inhalation
Ingestion
Dermal absorption

For Each Completed Exposure Pathway, Will the Contamination Affect Public Health?

ATSDR will evaluate existing data on contaminant concentration and exposure duration and frequency.

ATSDR will also consider individual characteristics (such as age, gender, and lifestyle) of the exposed population that may influence the public health effects of contamination.

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 (t½)
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:

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Agency for Toxic Substances and Disease Registry
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Appendix B. Comparison Values

ATSDR health assessors use comparison values (CVs) as a screening tool to evaluate environmental data that are relevant to the exposure pathways. These values represent media-specific contaminant concentrations that are much lower than exposure concentrations observed to cause adverse health effects. This means that CVs are protective of public health in essentially all exposure situations. If the concentrations in the exposure medium are less than the CV, the exposures are not of health concern and no further analysis of the pathway is required. However, while concentrations below the CVs are not expected to lead to any observable health effect, it should not be inferred that a concentration greater than the screening will necessarily lead to adverse effects. Depending on site-specific environmental exposure factors (for example, duration of exposure) and activities of people that result in exposure (time spent in area of contamination), exposure to levels above the screening value may or may not lead to a health effect. Therefore, ATSDR's CVs are not used to predict the occurrence of adverse health effects. Rather, they are used by ATSDR to select contaminants for further evaluation to determine the possibility of adverse health effects. ATSDR used drinking water comparison values when screening surface and groundwater data.

ATSDR CVs used in this PHA include:

Cancer Risk Evaluation Guide (CREG)

Estimated contaminant concentrations that would be expected to cause no more than one excess cancer in a million (10^{-6}) persons exposed over a 70-year life span. ATSDR's CREGs are calculated from EPA's cancer slope factors (CSFs).

Environmental Media Evaluation Guide (EMEG)

EMEGs are based on ATSDR minimal risk levels (MRLs) and factor in body weight and ingestion rates. An EMEG is an estimate of daily human exposure to a chemical (in mg/kg/day) that is likely to be without noncarcinogenic health effects over a specified duration of exposure to include acute, intermediate, and chronic exposures.

ATSDR also uses EPA's maximum contaminant levels (MCLs) as screening values to assess groundwater contamination.

EPA's Maximum Contaminant Level (MCL)

The MCL is the drinking water standard established by EPA. It is the maximum permissible level of a contaminant in water that is delivered to a free-flowing outlet. MCLs are considered protective of human health over a lifetime for individuals consuming 2 liters of water per day.

CVs are derived from available health guidelines, such as ATSDR's MRLs, EPA's RfDs, and EPA's CSFs. These guidelines are based on the no-observed-adverse-effect levels (NOAELs), lowest-observed-adverse-effect levels (LOAELs), or cancer effect levels (CELs) reported for a contaminant in the toxicological literature. A description of these terms is provided:

Minimal Risk Level (MRL)

MRLs are estimates of daily human exposure to a chemical (i.e., doses expressed in mg/kg/day) that are unlikely to be associated with any appreciable risk of deleterious noncancer effects over a specified duration of exposure. MRLs are calculated using data from human and animal studies and are reported for acute (≤ 14 days), intermediate (15 to 364 days), and chronic (≥ 365 days) exposures.

Reference Dose (RfD)

The RfD is an estimate, with safety factors built in, of the daily, lifetime exposure of human populations to a possible hazard that is *not* likely to cause them harm.

Cancer Slope Factor (CSF)

Usually derived from dose-response models and expressed in milligrams per kilogram per day, CSFs describe the inherent potency of carcinogens and estimate an upper limit on the likelihood that lifetime exposure to a particular chemical could lead to excess cancer deaths.

EPA Region III Risk-Based Concentration

EPA combines reference doses and carcinogenic potency slopes with "standard" exposure scenarios to calculate risk-based concentrations, which are chemical concentrations corresponding to fixed levels of risk (i.e., a hazard quotient of 1, or lifetime cancer risk of 10^{-6}, whichever occurs at a lower concentration) in water, air, fish tissue, and soil.

Lowest-Observed-Adverse-Effect Level (LOAEL)

The lowest dose of a chemical that produced an adverse effect when it was administered to animals in a toxicity study or following human exposure.

No-Observed-Adverse-Effect Level (NOAEL)

The highest dose of a chemical in a study, or group of studies, that did not cause harmful health effects in people or animals.

Cancer Effect Level (CEL)

The CEL is the lowest dose of a chemical in a study, or group of studies, that was found to produce increased incidences of cancer (or tumors)

Appendix C. Overview of ATSDR's Methodology

The health hazards that could plausibly result from exposures to contaminants detected in the vicinity of Portsmouth Naval Shipyard (PNS) are discussed in further detail in this appendix. It is important to note that public health hazards from environmental contamination happen only when (1) people are exposed to the contaminated media and (2) the exposure is at high enough doses to result in an effect.

Selecting Exposure Situations for Further Evaluation

For this public health assessment ATSDR reviewed surface water quality, sediment, and fish/shellfish data from the Lower Piscataqua River near PNS to determine whether contaminants were accessible to the public or were above ATSDR's comparison values (CVs). The majority of the detected contaminants in surface water and sediment were either not accessible to the public or were detected at or below health-based comparison values and were, therefore, not evaluated further. Exposure to contaminants in fish and shellfish collected near PNS were deemed worthy of further evaluation because some concentrations exceeded action or tolerance levels for contaminants in food set by the Food and Drug Administration or lacked comparison values for seafood.

Estimating Exposure Doses

ATSDR derived exposure doses for all contaminants in detected in fish and shellfish. Exposure doses are expressed in milligrams per kilogram of body weight per day (mg/kg/day). This represents the amount of contaminant mass that an individual is assumed to inhale, ingest, or touch (in milligrams), divided by the body weight of the individual (in kilograms) each day. When estimating exposure doses, ATSDR health assessors evaluate chemical concentrations to which people could be exposed, together with the length of time and the frequency of exposure. Variables considered when estimating exposure doses include the contaminant concentration, the exposure amount (how much), the exposure frequency (how often), and the exposure duration (how long). There is often considerable uncertainty about the true level of exposure to environmental contamination, because we do not know exactly how long someone could have been exposed or to what concentration exposure occurred over time. To account for the uncertainty and to be protective of public health, ATSDR scientists typically use worst-case exposure level estimates as the basis for determining whether adverse health effects are possible. These estimated exposure levels usually are much higher than actual exposure levels.

Using Exposure Doses to Evaluate Potential Health Hazards

ATSDR analyzes the available toxicological, medical, and epidemiological data to determine whether exposures might be associated with harmful health effects (non-cancer and cancer). As part of this process, ATSDR examines relevant health effects data to determine whether estimated doses are likely to result in harmful health effects. As a first step in evaluating non-cancer effects, ATSDR compares estimated exposure doses to conservative health guideline values, including ATSDR's minimal risk levels (MRLs) and EPA's reference doses (RfDs). The MRLs and RfDs are estimates of daily human exposure to a substance that are unlikely to result in non-cancer effects over a specified duration. Estimated exposure doses that are less than these values are not considered to be of health concern. To maximize human health protection, MRLs and RfDs have built-in uncertainty or safety factors, making them considerably lower than levels at which health effects have been observed. The result is that even if an exposure dose is higher than the MRL or RfD, it does not necessarily follow that harmful health effects will occur.

For carcinogens, ATSDR also calculates a theoretical increase of cancer cases in a population (for example, 1 in 1,000,000 or 10^{-6}) using EPA's cancer slope factors (CSFs), which represent the relative potency of carcinogens. This is accomplished by multiplying the calculated exposure dose by a chemical-specific CSF. Because they are derived using mathematical models, which apply a number of uncertainties and conservative assumptions, risk estimates generated by using CSFs tend to be overestimated. If health guideline values are exceeded, ATSDR examines the health effects levels discussed in the scientific literature and more fully reviews exposure potential. ATSDR reviews available human studies as well as experimental animal studies. This information is used to describe the disease-causing potential of a particular chemical and to compare site-specific dose estimates with doses shown in applicable studies to result in illness (known as the margin of exposure). For cancer effects, ATSDR compares an estimated lifetime exposure dose to available cancer effect levels (CELs), which are doses that produce significant increases in the incidence of cancer or tumors, and reviews genotoxicity studies to understand further the extent to which a chemical might be associated with cancer outcomes. This process enables ATSDR to weigh the available evidence in light of uncertainties and offer perspective on the plausibility of harmful health outcomes under site-specific conditions.

Sources for Health-Based Guidelines

By Congressional mandate, ATSDR prepares toxicological profiles for hazardous substances found at contaminated sites. These toxicological profiles were used to evaluate potential health effects from contamination at PNS. ATSDR's toxicological profiles are available on the Internet at http://www.atsdr.cdc.gov/toxpro2.html or by contacting the National Technical Information Service at 1-800-553-6847. EPA also develops health effects guidelines; in some cases, ATSDR relied on EPA's guidelines to evaluate potential health effects. These guidelines are found in EPA's Integrated Risk Information System (IRIS)—a database of human health effects that could result from exposure to various substances found in the environment. IRIS is available on the Internet at http://www.epa.gov/iris. For more information about IRIS, please call EPA's IRIS hotline at 1-301-345-2870 or e-mail at Hotline.IRIS@epamail.epa.gov.

Exposure to Contaminants from Consumption of Fish/Shellfish from the Lower Piscataqua River

Metals, pesticides, PAHs, and PCBs were detected in fish and shellfish caught from the tidal waters of the Lower Piscataqua River around Portsmouth Naval Shipyard. The primary exposure pathway of concern is through consumption of the fish and shellfish. Because people use this area or portions of this area for boating, fishing, and clamming, ATSDR evaluated the health effects that could possibly result from eating seafood containing these chemicals constituents.

In estimating to what extent people consume harmful levels of contaminants, ATSDR used the following exposure dose and protective assumptions about how often they eat seafood from the river and how much contaminated of a certain seafood they ingest each day.

Because some uncertainty exists regarding how long the contaminants have been in the seafood—no fish/shellfish sampling data prior to 1991—ATSDR conservatively assumed that an

Exposure Dose Equation for Fish and Shellfish Exposures

$$\text{Estimated dose} = \frac{\text{Conc. x IR x EF x ED}}{\text{BW x AT}}$$

where:

Conc.: Maximum concentration (mg/kg)
IR: Ingestion rate, adult=6.6 grams per day; child=3.3 grams per day
EF: Exposure frequency, or number of exposure events per year of exposure: 365 days/year
ED: Exposure duration, or the duration over which exposure occurs: adult = 30 years; child = 6 years
BW: Body weight: adult = 70 kg; child = 16 kg
AT: Averaging time, or the period over which cumulative exposures are averaged (6 years or 30 years x 365 days/year for noncancer effects; 70 years x 365 days/year for cancer effects)

* ATSDR assumes that older children (i.e., toddlers) would be more likely eat fish

adult ate contaminated fish for 30 years and a child for 6 years. In all likelihood, people may not have resided in the area for that long and the fish may have not been contaminated 30 years. Adults were assumed to eat 6.6 grams of fish each day and to weigh (on average for male and female) about 150 pounds (or 70 kilograms). Children were assumed to eat half the amount of an adult, or 3.3 grams per day, and to weigh roughly 35 pounds (16 kg). ATSDR assumed that people ate all their seafood caught from the area near PNS and that people ate seafood containing the highest concentration of contaminants. These assumptions create a protective estimate of exposure, and together, allow ATSDR to safely evaluate the likelihood, if any, that contaminants in fish/shellfish could cause harm to its users.

ATSDR estimated exposure doses from consumption of fish and shellfish for each chemical listed in Tables C-1 and C-2 using the formulas and assumptions described previously.

ATSDR then compared the estimated exposure doses to conservative health guideline values, including ATSDR's MRLs and EPA's RfDs. As indicated in Table C–1, the exposure doses for cadmium, copper, mercury, PCBs exceeded their respective MRL or RfD. Lead does not have a corresponding MRL or RfD and does not appear in Table C-1. However, since lead was detected in seafood some additional toxicity perspective will be provided below. All other exposure doses were at or below their respective MRLs and RfDs and therefore not at a level of health concern.

Cadmium

Cadmium is a naturally occurring element found in rocks and soil (ATSDR 1999a). Cadmium was detected in lobster tomalley and mussels at levels of 10.57 ppm and 3 ppm, respectively. Assuming people eat tomalley containing the maximum detected concentration, the estimated doses for ingestion of cadmium in tomalley were up to 0.0028 mg/kg/day for an adult and 0.00021 mg/kg/day for a child eating lobster tomalley. Though these slightly doses exceed ATSDR's MRL for chronic oral exposure to cadmium of 0.0002 mg/kg/day, these doses fall well below effect levels reported in the scientific literature. Specifically, ATSDR's MRL is based on studies in which no observed adverse health effects were reported in humans exposed to 0.002 mg/kg/day in rice (ATSDR 1999). This dose, called a no-observed effect level (NOAEL), is similar to or lower than estimated doses from exposure to cadmium in lobster tomalley or mussels. Based on these observations, ATSDR scientists conclude that ingestion of cadmium in seafood at detected levels in is not expected to result in adverse human health effects.

Though inhaled cadmium is classified as a known human carcinogen, there is little information available to provide sufficient evidence that human develop cancer effects from ingesting cadmium (ATSDR 1999a). Therefore, people eating seafood collected near PNS should face no apparent increase risk of cancer due to cadmium.

Copper

Copper is a reddish metal that occurs naturally in rocks, soil, water, and sediment. It is an essential element at low levels of intake for humans and other animals (ATSDR 2002). Copper was detected in seafood collected near PNS at levels up to 101 ppm. The highest concentration was found in mussels collected near a seep adjacent to Site 32.

ATSDR derived exposure doses to copper in mussels and lobster tomalley for an adult and child. The highest estimated exposure dose was 0.0208 mg/kg/day for a child. ATSDR reviewed the toxicologic literature to assess whether health effects were likely to occur at this dose. ATSDR found that estimated dose is just marginally higher than ATSDR's MRL for chronic oral exposure to copper of 0.02 mg/kg/day (ATSDR 2002). As noted earlier, an MRL is an estimate of the amount of a chemical that a person can be exposed to, on a daily basis that is not anticipated to cause noncancer adverse health effects over a person's lifetime. The MRL is based on the lowest level at which no adverse effects have been reported in humans drinking water containing copper. Amounts as low as 0.315 mg/kg/day have not resulted in adverse effects in humans drinking copper-tainted water. The dose at which no health effects have been observed in human studies is 17 times higher than the dose estimated for exposure to copper levels measured in seafood collected near PNS. EPA has determined that copper does not cause cancer in humans (ATSDR 2002).

Lead

ATSDR has not derived MRLs for lead and EPA has not developed a reference concentration (RfC) for lead. EPA has also decided that it would be inappropriate to develop a reference dose (RfD) for inorganic lead (and lead compounds) because some of the health effects associated with exposure to lead occur at low enough blood lead levels to be essentially without a threshold (ATSDR 2005). An RfD is typically derived from a concentration below which no adverse effects have been observed. EPA considers lead to be a special case because of the difficulty in identifying the classic "threshold" needed to develop an RfD. Therefore, EPA typically evaluates lead exposure by using blood-lead modeling, such as the Integrated Exposure-Uptake Biokinetic Model (IEUBK).

Numerous longitudinal and cross-sectional studies have attempted to correlate environmental lead levels with blood lead levels. These studies have provided a number of regression analyses and corresponding slope factors for various media including air, soil, dust, water, and food. To conservatively assess potential increase in blood lead levels for a child from eating seafood fish, ATSDR multiplied the maximum reported concentration of lead in seafood (27.43 ppm in mussels) by the media-specific slope factor for food of 0.24 micrograms per deciliter (μg/dL) per mg/kg of lead ingested in food for a child and 0.034 for adults (females) (ATSDR 2005). As mentioned, the CDC has determined that health effects are more likely to be observed if blood lead levels are at or above 10 μg/dL. ATSDR estimated contribution to blood lead levels for a child and adult eating fish containing the *maximum contaminant concentration detected* are 6.6 μg/dL and 1 μg/dL, respectively. The estimated contribution to blood lead level from consuming shellfish harvested near PNS for both child and adult are below 10 ug/dl.

Mercury

Mercury is a naturally occurring metal found in the environment. Mercury found in the environment is mostly in its inorganic form. Inorganic mercury can be released into the air, travel long distances, and then be deposited on soil or in water bodies. In water bodies, small organism convert mercury to the organic form, methylmercury. Mercury enters the aquatic food chain by binding with particles and sediment eaten by fish. Mercury tends to build up in tissue of larger fish. This build up is due in part to their eating smaller contaminated fish and, in part, to their slow rate of elimination of mercury.

Mercury was found in seafood collected near PNS at levels up to 2.31 ppm, and above the FDA action level for mercury of 1 ppm. The highest levels were measured in mussels taken from beds in an area north of the JILF, known as Jamaica Cove. ATSDR derived exposure doses to mercury in mussels for an adult and child. The highest estimated exposure dose was 0.000476 mg/kg/day for a child. ATSDR found that estimated dose is just slightly higher than ATSDR's MRL for chronic oral exposure to mercury of 0.0003 mg/kg/day. The MRL is based on the level at which no adverse effects have been reported following prenatal and post natal exposure to mercury in food. Amounts as low as 0.0013 mg/kg/day have not resulted elevated mercury levels

3 An estimated lead concentration of 199 ppm (dry weight) in mussel tissue was reported by the Interim Offshore Monitoring Program. Since this is only an estimated value ATSDR did not consider this as the maximum reported value. All other reported lead concentrations in mussels were at least 10-fold lower than the 199 ppm estimated value.

in hair of exposed women. The dose at which no health effects have been observed in human studies is twice as high as the dose estimated for exposure to mercury levels measured in seafood collected near PNS. EPA has not classified mercury as a human carcinogen.

PCBs

Some of the ways in which PCBs cause noncancer effects in adults include changes in the blood, liver, and immune functions. Children appear to be even more sensitive to the effects of PCBs than adults. Developmental problems have been reported in children whose mothers were exposed to PCBs even before becoming pregnant. PCBs can also pass through a mother's milk to her baby. Babies exposed to PCBs while in the uterus can have lower birth weights and delayed physical development (ATSDR 2000).

Lobster tomalley contained the highest levels of PCBs of any seafood. Over months or years eating contaminated tomalley, PCBs, can accumulate to levels that would affect ones health. Therefore, people who eat fish regularly can be particularly susceptible to PCBs that build up over time. Today, the states of Maine and New Hampshire have issued consumption advisories to urge people to refrain from eating lobster tomalley.

A person who eats one meal per 6.6 grams a day (or about ½ pound per month) of lobster tomalley might incur an exposure dose that is slightly higher but within the same order of magnitude as the MRL for PCBs (Aroclor 1254) of 0.00002 mg/kg/day. For more frequent consumption of lobster tomalley, estimated exposure doses would exceed the MRL by more than one order of magnitude.

Even though ½ pound per month slightly exceeds the ATSDR MRL, no harmful effects are expected at this level. The estimated exposure dose for consuming tomalley is in fact about an order of magnitude lower than the lowest dose at which health effects have been observed (LOAEL) of 0.005 mg/kg/day in other chronic oral animal studies (ATSDR 2000). Still, however, ATSDR recommends that people reduce their risk of exposure to PCBs by observing the Maine and New Hampshire consumption advisory warning for lobster tomalley.

A number of animal studies have examined the possibility of PCBs causing cancer, but epidemiological studies in humans do not provide enough information to determine if PCBs are carcinogenic. Several reviews of epidemiological studies (primarily, worker exposures to PCBs) have been inconclusive or have not shown an association between PCBs and cancer (ATSDR 2000). Compared to the cancer effect level found in animal studies, ATSDR's estimated human exposure dose (based on one fish meal per month) of 4.7×10^{-5} mg/kg/day for adults is approximately five orders of magnitude lower than the administered doses that induced cancer effects in rats. Rats that ingested certain PCB mixtures over their lifetimes developed liver cancer. Based on these animal studies, EPA classifies PCBs as a Category B2 carcinogen, indicating that it is a probable human carcinogen. The EPA's National Center for Environmental Assessment recommended that a cancer slope factor of 2.0 $(mg/kg/day)^{-1}$ be used for PCBs in biota. Therefore, the cancer risk from eating lobster tomalley under the assumed exposure scenario would be 9×10^{-5} . This risk level is lower than the range typically acceptable for the general population.

Again, it should be emphasized that the risk level calculation is extremely conservative and likely overestimates exposures. Moreover, given the inconclusive link between oral PCB exposure and human cancer, it is highly unlikely that the consumption of lobster tomalley is going to result in adverse cancer effects for people who eat lobsters. Still, as a prudent public health measure, ATSDR recommends that people continue to observe the consumption advisory for lobster tomalley.

Sources:

[ATSDR]. Agency for Toxic Substances and Disease Registry. 1999a. Toxicological Profile for Cadmium (Update). Atlanta: US Department of Health and Human Services.

[ATSDR]. Agency for Toxic Substances and Disease Registry. 1999c. Toxicological Profile for Mercury (Update). Atlanta: US Department of Health and Human Services.

[ATSDR]. Agency for Toxic Substances and Disease Registry. 2000. Toxicological Profile for Polychlorinated Biphenyls (Update). Atlanta: US Department of Health and Human Services.

[ATSDR]. Agency for Toxic Substances and Disease Registry. 2002. Toxicological Profile for Copper-Draft for Public Comment. Atlanta: US Department of Health and Human Services.

[ATSDR]. Agency for Toxic Substances and Disease Registry. 2005. Toxicological Profile for Lead (update). Atlanta: US Department of Health and Human Services. September 2005.

Table 7. Estimated Exposure Doses—Non-cancer Effects from Eating Fish or Shellfish

Contaminant	*Maximum Detected Contaminant Concentration (ppm)*	*Estimated Exposure Dose (mg/kg/day)*		*Health Guideline (mg/kg/day)*	*Basis for Health Guideline*
		Adult	*Child*		
Lobster Tomalley					
Cadmium	10.57	10E-04	2.2E-03	2.0E-04	chronic oral MRL
Copper	582.9	5.5E-02	0.12	2.0E-02	chronic oral MRL
Total PCBs	2.65	2.5E-04	5.5E-04	2.0E-05	chronic oral MRL
Mussels					
Cadmium	3	2.8E-04	6.2E-04	2.0E-04	chronic oral MRL
Copper	101	Below MRL	2.1E-02	2.0E-02	chronic oral MRL
Mercury	2.31	Below MRL	4.8E-04	3.0E-04	chronic oral MRL
Total PCBs	0.70	6.6E-05	1.4E-04	2.0E-05	chronic oral MRL

Key: ppm = parts per million; mg/kg/day = milligrams of contaminant per kilogram of body weight per day; MRL = ATSDR's minimal risk level; RfD = EPA's reference dose.

Table 8. Estimated Exposure Doses—Cancer Effects from Eating Fish or Shellfish

Contaminant	***Maximum Detected Contaminant Concentration (ppm)***	***Estimated Exposure Dose (mg/kg/day) (Adult)***	***CSF (mg/kg/day)$^{-1}$***	***Theoretical Excess Cancer Risk***	***CEL for Oral Exposure (mg/kg/day)***
Lobster Tomalley					
Total PCBs	2.65	1.1E-04	2	2.1 x 10^{-4}	1
Mussels					
Total PCBs	0.69	2.8E-05	2	5.6 x 10^{-5}	1

Note: CELs are reported in ATSDR Toxicological Profiles.
Key: ppm = parts per million; mg/kg/day = milligrams of contaminant per kilogram of body weight per day; MRL = ATSDR's minimal risk level; RfD = EPA's reference dose.

Appendix D. Response to Public Comments

The Public Health Assessment (PHA) for the Portsmouth Naval Shipyard (PNS) was released on September 20, 2006. The public comment period, which ended on October 30, 2006. The PHA was made available for public comment at the Kittery Town Hall and the Portsmouth Public Library.

The following section provides both the comments we received and the ATSDR response. For those comments that questioned the factual validity of a statement made in the PHA, ATSDR verified and, when appropriate, corrected any errors. The following responses to public comments do not include editorial comments such as word spelling or sentence syntax received during the public comment period. Please note that the page numbers and paragraph sections cited in some of the comments correspond to the Public Comment Release PHA, not the Final Release.

ATSDR received several comments expressing disagreement with our hazard category conclusion based on risk assessments of PNS. As a result of these comments, ATSDR has added a section in the main body of the PHA that describes the different purposes and methods of a risk assessment versus an ATSDR public health assessment. Redundant comments were not included.

Comment: The commenter disagrees with some of ATSDR's conclusions in the Draft PHA. Our primary disagreement is with ATSDR's identification of only three main exposure concerns. The MEDEP, USEPA and US Navy have identified several other sites where soil contaminant levels are high enough to present an unacceptable risk to people who come in contact with the soils. Currently, the receptors most at risk are construction/maintenance workers rather than the general public because the general public is restricted from the base. However, should the base close, as it almost did during the most recent BRAC round, the island will once again be accessible by the general public and it is very possible that new residences will be built there.

Response: ATSDR's health evaluation differs significantly from classical risk assessment in purpose and methodology. Risk calculations use numerical comparisons that are based on a single, peer-reviewed, animal study. They use default values that intentionally overestimate exposure and risk in order to be confident that contaminant levels remaining after clean up would not be harmful to people who might be exposed.

As a public health agency, and not an environmental regulatory or clean up authority, ATSDR acts as advisors to individuals, groups, and agencies about whether human exposure to chemicals in the environment would likely result in adverse health effects. ATSDR determines whether a site poses a health hazard based on the body of scientific knowledge available. ATSDR makes recommendations to stop, reduce, or prevent exposures and for additional public health actions, if needed.

ATSDR's PHA's use risk calculations as first level screening tools. Site specific exposure dose estimates greater than screening values are compared to exposure doses from research studies, health studies, epidemiological studies, animal studies, occupational studies, toxicological studies, bioavailability studies, exposure investigations, poison control databases, and other available scientific information in order to determine how likely people at the site are to experience adverse health effects.

Because no one study or source of information can provide 100 percent certainty of its conclusions, ATSDR uses many sources of information, which lowers the uncertainty, and thus, increases the confidence of our conclusions. Substantial evidence available from various sources provides the basis for determining whether adverse health effects are likely.

Adverse health effects can range in severity and can include some enzyme changes in the body that might not even be noticeable to the individual, to acute illness such as vomiting, or severe long-term illnesses such as cancer.

ATSDR reviewed the risk calculations that MEDEP, USEPA and US Navy identified as presenting an unacceptable risk to construction/maintenance workers. As summarized in Appendix B of the FY08 Site Management Plan, the main risk drivers were based on daily lifetime exposures to lead (55% of total risk ratio), antimony (36%), copper (3.3%), iron (2.2%), and dioxin (1%) in soil. Although contaminants at some of the IRP sites may have been detected at levels that exceed state acceptable risk levels, present site conditions and land use are not likely to result in adverse health effects. Information in the scientific literature states that typically, non-volatile chemicals in soil are bound in the soil matrix, do not readily dissociate, and have limited ability to be taken up by people.

Although, the purpose and methodology used in risk assessment differ from ATSDR's public health assessments, ATSDR supports the use of risk assessment by the Navy and regulators. If the site poses an unacceptable risk to construction/maintenance workers, ATSDR supports Occupational Safety and Health Administration (OSHA) regulations for those workers to assure that no employee is exposed to lead at concentrations greater than fifty micrograms per cubic meter of air (50 ug/m(3)) averaged over an 8-hour period. ATSDR recognizes that it is possible to exceed OSHA regulations under specific conditions for which the Navy and regulators are best for making that determination. To determine if current construction/maintenance workers are being exposed to lead at levels of health concern, ATSDR supports blood lead testing of those workers.

Future land use changes of the base remains a possibility. Environmental regulations state that the federal department or agency transferring the property remains responsible for the cleanup. Additionally, the law mandates certain assurances so that cleanup occurs in a timely fashion. ATSDR supports the regulation, the Navy, and regulators to enforce cleanup of the highly contaminated areas of PNS industrial areas prior to transfer for use as a residential area or for use by chemically sensitive populations such as young children.

Comment: The review indicated that most sites at the shipyard are not associated with any known public health hazards…" The commenter disagrees with this statement. Currently, Sites 6, 10, 29, 30, 31, 32, and 34 all have contaminants in soil whose concentrations exceed the state of Maine's acceptable risk levels. The presence of an asphalt or soil cover does not necessarily prevent contact with those contaminants.

Response: See the previous response.

Comment: The commenter agrees with ATSDR's conclusion that people who follow the State of Maine's current seafood consumption advisory and shell fishing restrictions for the Piscataqua River are best protecting themselves against unwanted exposure to contaminants that might be present in lobsters or mussels caught near the PNS. However, the long-term goal is to achieve an overall reduction of contaminants in the estuary such that a seafood consumption advisory is no longer necessary.

Response: ATSDR supports the long-term remediation goal to sufficiently reduce contamination in sediments and other media so that seafood advisories are no longer necessary. As an advisory public health agency, ATSDR does not have the regulatory authority to mandate environmental clean-up actions. The seafood consumption advisory and fishing restrictions currently in place are protective of public health providing that people are aware and adhere to them.

Comment: p. 20: "Following a careful evaluation of potential exposure pathways as they relate to children, ATSDR determined that no harmful exposures have occurred at the IRP sites in the past, nor are they expected to occur…" ATSDR (or anybody else) can not conclude that no harmful exposures have ever occurred at the IRP sites in the past. For example, the Jamaica Island Landfill was an open waste site for approximately 30 years and there is a residence directly across the street. It is entirely possible that children living at the residence and other people could have come into contact with hazardous materials during that time period. Another example is the DRMO which had exposed lead-contaminated soil for years.

p. 22, 2nd bullet: Again, ATSDR should not be making statements regarding past exposures as it is impossible to determine what sorts of exposures may have occurred.

Response: ATSDR has reviewed the wording in the referenced section under Child Health Considerations and has modified the text to better reflect an inherent level of uncertainty with respect to past exposures associated with public health evaluations. The bullet referenced (page 22) includes ATSDR's public health call of "no apparent public health hazard" for past, current, and future exposures. ATSDR agrees that it is not possible to make definitive statements about past exposures without extensive sampling during the past years of activity for PNS.

Comment: Page 9, A, Summary, first sentence. Add "potentially" before "released from the Portsmouth Naval Shipyard". These contaminants could have come from other sources of contamination in the river as well.

Response: ATSDR has modified the summary to reflect the potential for other sources to contribute to contamination of the fish and shellfish.

Comment: Pages 23 and 24, VIII, Public Health Action Plan, Completed Actions, item 6. Add that the industrial waste outfalls (Site 5) stopped discharging wastes to the offshore in 1976.

Response: ATSDR modified this action item as suggested

Summary

Comment: It is our understanding the shellfish (mussels) advisory for the Piscataqua River is primarily due to biological contamination, not chemical. It is also our understanding shellfish (mussel) harvesting from the Piscataqua River is prohibited due to the biological contamination. This will greatly impact the conceptual site model and should be clearly discussed within the text.

*Response***:** According to the New Hampshire Department of Environmental Services (NHDES), the harvest of mussels and other molluscan shellfish from the Piscataqua River is currently prohibited. In complying with the National Shellfish Safety Program, New Hampshire and Maine establishes permanently closed areas (i.e., safety zones) around wastewater facility outfalls to protect harvesters from chronic viral contamination, and to protect harvesters in the event of an unintended disruption in treatment at the plant. These closures are unrelated to any contamination associated with PNS; and, as noted above, not necessarily a result of monitoring of bacteriological contamination, but rather due to precautionary measures.

ATSDR has provided additional clarification regarding the shellfish restrictions along the Piscataqua River.

Comment: There are multiple point sources impacting the area of the Piscataqua River near the shipyard. This should be mentioned in the summary**.**

*Response***:** ATSDR modified the summary to reflect that multiple point sources have impacted the area of the Piscataqua River near the shipyard.

Comment: Fish is included in the first bullet title and never discussed. Is there possible exposure to contaminants for consumers ingesting fish from the Piscataqua River?

*Response***:** The results of fish monitoring (e.g., flounder) are discussed in the exposure pathway section of the report and potential exposures to fish are evaluated. For example, ATSDR concludes that flounder has not generally accumulated harmful levels of chemical contaminants. Due to space limitations, the report summary only highlights the most important findings in each of the three exposure situations identified.

Comment: Page 1, item 1. Add the following sentence (see page 6 too). “PNS as well as other sources may be responsible for contamination in the river.”

Response: It has been noted in the document (i.e., on page 6) that other sources may be responsible for contamination in the river. However, in the context of the bullet on page 1, ATSDR does not specifically imply that PNS is responsible for all contamination in the river. No changes to the document were made.

Comment: Page 1, item 2. It is not clear what data were used to support that PNS contaminants have impacted the water quality of the Piscataqua River. Based on seep data, there may be a potential for river water quality to be impacted, but it is not apparent from river water data that there has been an impact. The sentence should be reworded to indicate that PNS contaminants may have impacted river water quality.

Response: According to the September 9, 1996 PNS Relative Risk Evaluation Worksheet, several discharge points from storm and sanitary sewer water that discharge to the Piscataqua River were located at the western end of the Shipyard. Between 1945 and 1975, industrial wastes were discharged to the river. Although recent impacts to river water quality may be quite minimal, there is sufficient historical evidence to support the statement that “PNS contaminants have impacted the water quality and sediment of Piscataqua River.”

Background

Comment: Page 3 last sentence continued at the top of page 4. Revise to indicate “in areas potentially impacted by PNS releases” for number 1 and 2.

Response: ATSDR respectfully disagrees with this suggestion; no changes were made.

Comment: Page 5, Land Use and Natural Resources, last paragraph. PNS groundwater would not impact Town of Kittery groundwater. Add a sentences indicating that the groundwater aquifer at PNS is not connected to the groundwater aquifer in the Town of Kittery.
Response: ATSDR does not make any statements in this section that imply that groundwater contamination from PNS or any other source is occurring in aquifers beneath Kittery. The “Land Use and Natural Resources” section is included to provide the reader with additional information about where people obtain their drinking water as well as what other natural resources (e.g., parks, lakes, rivers, etc) are in close proximity to the site. There is no discussion of the nature and extent of contamination and there is no implied connection between the groundwater aquifer beneath PNS and the aquifers that supply drinking water to residents of Kittery. No changes were made.

ATSDR Activities

Comment: The exposure pathways listed are associated not only with industrial releases from the shipyard. There are other point sources contributing to the contamination of the Piscataqua River. Information on the contribution of background to the identified exposure pathways should be included in the summary.

Response: This PHA focuses on potential exposure pathways associated with sources of contamination from PNS. ATSDR reviewed site monitoring data that relied heavily on Navy sampling and made public health determinations largely based on these data sets. While ATSDR clearly acknowledges other potential sources of contamination in the PHA, we do not agree with the recommendation to add additional information on the potential contribution of other contaminant sources. No changes were made.

Consumption of Contaminated Fish and Shellfish

Comment: p. 11: "ATSDR used the EPA-recommended intake of estuarine fish for an adult of 6.6 grams a day, or about ¼ pound per month; for children, ATSDR used half that amount." Presumably these values are from EPA's 1997 Exposure Factors Handbook. However, the new Draft Guidance (EPA, 1999) has increased the consumption rate to 16 grams/day for recreational fishers. In addition the State of Maine believes 32.4 g/day is a conservatively representative upper level fish ingestion rate for Maine recreational anglers. We also note that the EPA 1997 Exposure Factors Handbook states that the mean consumption rate for New England is 16.3 g/person/day (Table 10-1). Therefore, we believe ATSDR's intake rates for fish are too low.

Response: ATSDR agrees that the ingestion rates used to estimate dose may not truly represent the intake of the highest fish and shellfish consumers in the community. However, it is equally important to note that ATSDR used the maximum detected concentrations for each contaminant. In reality, the average detected concentration is what people would likely be exposed to over their lifetime. Additionally, the higher ingestion rate of 32 grams per day represents the total intake of harvested fish and shellfish from all fishing/harvesting areas. ATSDR's assumption that people only harvest from the contaminated source areas where monitoring has been conducted is a worst-case scenario and likely results in a significant over estimate in exposure dose.

In response to concerns that ingestion rates used to estimate exposure dose were too low, ATSDR reevaluated the potential for health effects from consuming fish and shellfish based on the more conservative ingestion rates. The estimated doses used were based on 32 grams/day for adults and 16 grams/day for children; representing the upper bound ingestion rate for a recreational angler. The results of the conservative exposure scenario are presented below.

Table D-1 compares the original dose estimates associated with the consumption of lobster tomalley and mussels with the dose estimates based on the State of Maine's upper level fish ingestion rate of 32 and 16 grams per day for adults and children, respectively. The adult dose estimates for arsenic, copper, and mercury, which were all below their screening guideline at the lower ingestion rate, exceeded their screening guidelines when assuming a 32 gram per day ingestion rate. As a health-protective measure, people who consume fish and shellfish at these increased ingestion rates should strictly adhere to the current fish and lobster tomalley consumption advisories issued by the states of Maine and New Hampshire and avoid harvesting shellfish from known areas of contamination.

The use of upper bound dose estimates does not change ATSDR's recommendations concerning fish and lobster sampled from PNS. PCBs (flounder and lobster), and arsenic and methyl mercury (lobster) exceeded their screening guidelines by a very small margin when applying the higher ingestion rates (dose estimates not shown). However, further evaluation of the toxicological literature shows that the estimated doses are well below any adverse health effects observed in humans.

Table D-1: Estimated Exposure Doses—Non-cancer Effects from Eating Fish or Shellfish

Contaminant	*Maximum Detected Contaminant Concentration (ppm)*	*Original Dose Calculations* *Estimated Exposure Dose (mg/kg/day)*[1]		*Dose Calculations Using Higher Ingestion Rates* *Estimated Exposure Dose (mg/kg/day)*[2]		*Screening Guideline (mg/kg/day)*	*Basis for Screening Guideline*
		Adult	*Child*	*Adult*	*Child*		
Lobster Tomalley							
Arsenic	14.32	Below MRL	Below MRL	6.6E-04	1.4E-03	3.0E-04	chronic oral MRL
Cadmium	10.57	10E-04	2.18E-03	4.8E-03	1.1E-02	2.0E-04	chronic oral MRL
Copper	582.9	5.5E-02	0.12	0.27	0.58	2.0E-02	chronic oral MRL
Total PCBs	2.65	2.5E-04	5.5E-04	1.2E-03	2.7E-03	2.0E-05	chronic oral MRL
Mussels							
Arsenic	10.9	Below MRL	Below MRL	5.0E-04	1.1E-03	3.0E-04	chronic oral MRL
Cadmium	3	2.8E-04	6.2E-04	1.4E-03	3.0E-03	2.0E-04	chronic oral MRL
Copper	101	Below MRL	2.1E-02	4.6E-02	0.1	2.0E-02	chronic oral MRL
4'4-DDT	0.596	Below RfD	Below RfD	Below RfD	6.0E-04	5.0E-04	chronic oral RfD
Heptachlor Epoxide	0.021	Below RfD	Below RfD	Below RfD	2.1E-05	1.3E-05	chronic oral RfD
Mercury	2.31	Below MRL	4.8E-04	1.1E-03	2.3E-03	3.0E-04	chronic oral MRL
Total PCBs	0.70	6.6E-05	1.4E-04	3.2E-04	7.0E-04	2.0E-05	chronic oral MRL

Key: ppm = parts per million; mg/kg/day = milligrams of contaminant per kilogram of body weight per day; MRL = ATSDR's minimal risk level; RfD = EPA's reference dose.

[1] ATSDR's original dose estimates based on an ingestion rate of 6.6 grams/day for adults and 3.3 grams/day for children

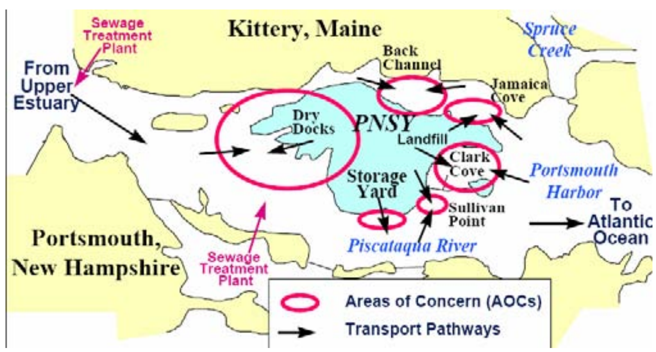
[2] Dose estimates based on conservative "upper bound" ingestion rate for a recreational angler in Maine (32 grams/day for adults and 16 grams/day for children).

Note: Only non-cancer effects are presented in Table D-1; total PCBs were the only contaminant that exceeded its screening guidelines in ATSDR's evaluation of cancer health effects.

Comment: Page 23 – Recommendation. This recommendation would be made regardless of whether or not there has been any impact from contamination from PNS or whether or not PNS was even present. The recommendation is for the Piscataqua River as a whole. The recommendation should be clarified (possibly removing "near PNS").

Response: ATSDR agrees that the shellfish bed restrictions for the Piscataqua River would be in effect regardless of PNS-related historical releases because of the federal regulations that require "safety zones" to be established within a specified distance from waste treatment outfalls. Additionally, a consumption advisory has existed since 1992 for the entire coast of Maine and New Hampshire for the consumption of lobster tomalley. No evidence of elevated levels of toxic contaminants was found in lobster meat. PCBs and metals were detected in the hepatopancreas and cooked tomalley at levels that could pose a health hazard. The advisory was also expanded to include bluefish and striped bass in 1996. Although other industrial sources in the region may contribute to the elevated PCB and metals contamination in the aquatic environment, the specific contribution of each of the sources to fish and shellfish contamination is unknown. ATSDR has modified the sentence to reflect that the fish and lobster tomalley advisory are in place because of multiple exposure sources and not only from releases associated with PNS activities.

Comment: Commenter is concerned about contamination in shellfish in Spruce Creek.



Response: Spruce Creek is tributary creek into the lower Piscataqua River north of Seavey Island. The map on the right shows the location of Spruce creek in relation to PNS. There are point and non-point source discharges of pollution into Spruce Creek.

The Navy conducted an ecological risk assessment at Spruce Creek and based on tidal studies determined that contaminants from the shipyard would not likely be transported to the creek. The Navy collected a small number of samples from the creek. According to the Ecological Risk Assessment conducted by the Navy, Spruce Creek did not have elevated levels of contaminants in the sediments compared to the other reference areas (stations not adjacent to Seavey Island) of the lower Piscataqua River (US Navy 2000).

Although there is no evidence that historical contaminant releases at PNS has contributed to elevated levels of chemical contamination at the creek, there are concerns regarding biological contamination in the shell fish from the creek. The Department of Marine Resources (DMR) collects shellfish samples and tests for biological contamination. The biological monitoring of shellfish from Spruce Creek showed high levels of fecal coliform in some portions of the creek. DMR has classified sections of Spruce Creek north of a line across Spruce Creek from Eagle Point to Goose Point as restricted and is closed due to a sewage bypass. Harvesting of clams, quahogs, mussels, or oysters is not permitted in these restricted areas (DMR 2007).

ATSDR recommends contacting the State of Maine Department of Marine Resources at: 207-624-6550 or accessing their web page at: http://www.maine.gov/dmr/index.htm to obtain the most current information regarding shellfish closings and advisories.

Contact with Potentially Contaminated Surface Water and Sediment

Comment: Commenter is concerned with the fact the Navy's risk assessment does not evaluate risk to young children. The commenter is specifically concerned with exposures to the off-shore sediments in the vicinity of the Jamaica Island landfill and Site 32 (Topeka Pier).

Response: ATSDR has consulted with the Navy regarding public access to Clark's Island, Jamaica Cove, and Topeka Pier (Site 32). The access around these locations, especially Jamaica Cove and Topeka Pier (Site 32) is restricted to military personnel, ship yard residents, and civilian employees. It is not expected that children will have any authorized access to these areas. Unauthorized trespassing in these areas may occur, but the exposure to surface water and sediments in these areas would be very infrequent.

ATSDR did review sediment data for off-shore locations in the event that children are or were able to occasionally access some of the off-shore areas that have been impacted by the Jamaica Island Landfill or Site 32 (Topeka Pier). Specifically, ATSDR reviewed all available sediment data collected in close proximity to Jamaica Cove, Clark Cove, and the Site 32 off-shore areas. ATSDR identified two metals (lead and copper) and three PAHs (benzo(a)anthracene, benzo(a)pyrene, and benzo(b)fluoranthene) in the off-shore sediments that are highly elevated. It is important to emphasize that even if children did come in contact with sediments from these areas, they would have to ingest these sediments in order to be significantly exposed. It is very unlikely that activities by children or adults in these off-shore locations would result in adverse health effects.

Comment: p. 21: ATSDR's PHA states that "…possible exposures to children include contact with the surface water…and eating seafood caught from the river near PNS." Commenter notes that contact with sediment is also possible, especially at low tide.

Response: Although contact with river and marine sediment is expected to be minimal, ATSDR agrees that children may have very limited contact with sediments when swimming or wading during low tide or in shallow areas. The infrequent contact with sediments is not likely to result in adverse health effects.

Comment: Commenter is concerned about dioxins in surface water, sediment and shellfish.

Response: During the Navy's environmental investigations between 1999 and 2005, dioxins were analyzed in sediment samples collected from six on-site locations and four off-site reference locations. The Navy reported the individual dioxin congeners as well as total equivalencies (TEQ) for each sediment sample analyzed for dioxin.

Dioxins and dioxin-like compounds, including certain PCBs and furans, are typically evaluated based on total toxicity equivalency factors (TEFs) as related to the most toxic dioxin, 2,3,7,8-tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD). The resulting toxic equivalency (TEQ) is used to evaluate concentrations and exposures. The TEFs are based on known toxicological information for each compound. A total equivalency (TEQ) is calculated by multiplying the chemical concentration by the TEF, and then summing all the values.

Dioxin (TEQ) concentrations collected on site ranged from non-detect to 228.8 parts per trillion (ppt) with a mean of all detected values of 6.3 ppt; whereas concentrations ranged from non-detect to 10.8 ppt with a mean of 1.3 ppt at off-site reference locations. There was a noticeable difference in the maximum dioxin TEQ concentration detected in on-site sediment samples compared to the samples collected at reference locations. The highest dioxin concentrations were from two on-site monitoring stations (MS-9 and MS-11). The minimal risk level (MRL)-based environmental media evaluation guide (EMEG) of 0.05 parts per billion (ppb) (i.e., 50 ppt) for dioxin TEQ is used as the basis for screening dioxin in soil and/or sediment. If the average (mean) dioxin concentration detected in soil or sediments exceeds this screening level further evaluation is required (ATSDR 2006). As shown in the table on the right, none of the average dioxin TEQ concentrations at any of the on-site sampling locations exceeded 50 ppt. The highest average dioxin concentration occurred at MS-9, which had a mean of dioxin TEQ of 35.6 ppt. The other sampling locations had average dioxin TEQ concentrations considerably lower than those observed at MS-9. ATSDR concludes that people are not likely to experience adverse health effects from dioxin exposure in sediments at PNS.

Results of Dioxin TEQ Sediment Analyses

Station	***Min Value***	***Max Value***	***Mean***
On-Site Sampling Locations			
MS-7	0.02	5.3	1.6
MS-8	0.001	58.1	4.5
MS-9	0.02	228.8	35.6
MS-10	0.01	11.3	1.9
MS-11	0.004	152.0	11.6
MS-12	0.1	9.1	3.5
Total	0.001	228.8	6.3
Reference Locations			
RS-1	0.06	4.0	1.2
RS-2	0.008	8.0	1.6
RS-3	0.03	10.8	1.5
RS-4	0.007	1.5	0.7
Total	0.007	10.8	1.3

Source: US Navy

TEQ = total equivalency
All samples were collected between September 1999 and August 2005.

Comment: The summary concludes people do not use the river for swimming. It is our understanding that recreational swimming and water activities take pace within the river during the summer season. Table 2 includes reference to swimming activities. The Summary should reflect that limited swimming and water activities occur in the river during the short summer season as outlined in Table 2.

Response: ATSDR modified the summary to reflect that some recreational activities such as swimming and wading do occur on a seasonal basis. This would not effect the overall conclusions since occasional exposures to very low concentrations of pollutants in the water would not be sufficient to cause health effects.

Childhood Exposure to Lead-Based Paint

Comment: "Lead Based Paint in Portsmouth Naval Shipyard Housing": There is no discussion on lead in water within the Public Health Assessment. Given the age of the water distribution system and potential community concern over water quality, we feel this may warrant discussion.

Response: According to PNS, "Portsmouth Naval Shipyard (PNS) drinking water is supplied by the Kittery Water District (KWD). Navy policy requires extensive sampling and testing to ensure water is safe for drinking. PNS routinely monitors for various contaminants in the water supply. The Shipyard uses Environmental Protection Agency (EPA)-approved laboratory methods to analyze the drinking water. Water samples are taken from the distribution system and customers' taps and then shipped to an accredited laboratory where water quality analyses are performed. These tests continue to confirm the Shipyard's drinking water meets or exceeds all Federal and State requirements and is safe to drink."

Tables and Figures

Comment: Table 2 (pages 30 to 34) does not look correct or consistent with IRP investigation results. It is not clear which data were used to develop the table. In particular, groundwater data collected prior to 1996 should not be used if more recent groundwater data are available. Groundwater samples collected prior to 1996 were collected by bailer; groundwater samples collected after 1996 were collected using low-flow sampling techniques. The samples collected using low-flow sampling techniques are considered more representative of groundwater chemical concentrations. Use of the industrial waste outfalls (Site 5) was discontinued in 1975. OU3 (Sites 8, 9, 11) remedy not reflected. Also, the table does not reflect the shoreline work conducted in 2005 and 2006 at Sites 29 and 32.

Response: ATSDR disagrees that Table 2 does not appear to be consistent with past IRP investigations. Table 2 is intended to provide an overview of the types of contaminants that have been detected at levels of concern historically at each of the installation restoration program (IRP) sites. It may not necessarily reflect the current or more recent contaminant levels at the site. Additionally, the table does not include specific sampling results associated with that particular site. When applicable, media-specific data tables are included in the PHA. ATSDR has updated the table to reflect recent activities at the site.

Comment: p. 30, Table 2, DRMO: Please add lead to sediment contaminants. Although the quantity of sediment at the DRMO is very low, samples show that it has very high levels of lead.

Also, "Possible Exposures" for DRMO should indicate possible access to soil by workers excavating under asphalt or grass cover.

p. 31, Table 2, Site 10: The "Possible Exposures" column should also include construction/maintenance worker contact with contaminated soil.

Response: ATSDR added lead to Table 2

ATSDR evaluates non-occupational exposures. Occupational exposures fall under the jurisdiction of the Occupational Safety and Health Administration (OSHA). OSHA requirements are protective for the construction worker scenarios.

Appendix C

Comment: Appendix C, "Overview of ATSDR's Methodology": Page C-1 states that ATSDR scientists typically use worst case exposure level estimates. Maximum concentrations were used in every calculation of exposure dose. We do not feel that using the maximum concentration to calculate dose represents site conditions, even under the most conservative scenarios (worst case exposure level estimates). We suggest using the 95% upper confidence level of the mean concentration when appropriate data sets are available, or when there is an adequate number of samples to calculate a representative 95% UCL. We support the use of the maximum concentration when comparing to the appropriate health based screening value.

Response: ATSDR does not disagree, in principle, with the use of a 95% upper confidence level of the mean (i.e., average) detected concentration for a given data set. ATSDR used the maximum concentration for the fish/shellfish data because the data were provided in summary form (i.e., min, max, mean) rather than results for each individual sample. In order to calculate the 95% upper confidence level we would need to obtain the results for each individual sample collected. Although the 95% upper confidence level may provide a more realistic dose scenario (less conservative) and would be health-protective, using the maximum concentration to calculate dose is not inappropriate and provides an added level of safety.

When an estimated dose exceeds ATSDR's health-based guidelines, additional evaluations (e.g., a review of the toxicological or epidemiological literature) are conducted to provide proper perspective. This process enables ATSDR to weigh the available evidence in light of uncertainties and offer perspective on the potential for adverse health effects under site-specific conditions.

Comment: Page C-5, "Lead": The text states, "To conservatively assess potential increase in blood lead levels for a child from eating seafood fish, ATSDR multiplied the maximum concentration of lead in seafood (199 ppm or mg/kg in mussels) by the media -

specific slope factor for food of 0.24 micrograms per deciliter (mg/dL) per mg/kg of lead ingested in food for a child and 0.034 for adults (females) (ATSDR 1999a). As mentioned, the CDC has determined that health effects are more likely to be observed if blood lead levels are at or above 10 mg/dL. ATSDR estimated contribution to blood lead levels for a child and adult eating fish containing the maximum contaminant concentration detected are 47 mg/dL and 6.7 mg/dL, respectively. While the dose for a child is higher than CDC's recommended action level of 10 mg/dL, ATSDR believes that children would incur much lower lead exposures, if any, and are not at risk of developing adverse health effects. In effort to be protective, ATSDR had evaluated the maximum detected concentration found in mussels, recognizing that, in any reasonable exposure situation, it is highly unlikely that a child could have been continuously exposed to the similarly high concentrations over time.

We are not familiar with this methodology for evaluating ingestion of lead via seafood. Normally, the appropriate lead model is used to estimate the percent of an exposed population who exceed 10ug/d blood lead level, with 5 % being the traditional benchmark. The report should include the background information and an explanation on how the "media-specific slope factor for food" was calculated.

Response: ATSDR acknowledges that there are different approaches to evaluating the potential toxicity of lead in various media. Since MRLs and/or RfDs are not available to screen estimated doses, ATSDR chose to estimate the contribution to blood lead levels attributed by ingestion of fish and shellfish obtained from areas in close proximity to PNSY. These estimates are calculated using slope-factors that have been generated based on studies that have attempted to correlate environmental lead levels with blood lead levels. ATSDR has added additional information to Appendix C to help explain the use of slope-factors as the basis for estimating the contribution of lead in shellfish to blood lead levels in children and adults.

References

[ATSDR] 2006. Agency for Toxic Substances and Disease Registry. Update- ATSDR Policy Guideline for Dioxins and Dioxin-Like Compounds in Residential Soil. Federal Register Draft. November 7, 2006. URL: http://www.atsdr.cdc.gov/substances/dioxin/policy/ATSDRUpdatedDioxinSoilPolicyDocument110706.pdf

[DMR]. Department of Marine Resources. Notice of Emergency Rule Repeal and Promulgation. April 20, 2007.

U.S. Navy, Marine Environmental Support Office. Estuarine Ecological Risk Assessment for Portsmouth Naval Shipyard, Kittery, Maine Final Report Volume I Technical Report. May 2000.

US Navy. The Navy provided an Excel file on CD (Received September 13, 2007) containing the results of all dioxin analyses at PNS.