ATSDR
AGENCY FOR TOXIC SUBSTANCES AND DISEASE REGISTRY

Public Health Assessment for

JACKSON PARK HOUSING COMPLEX (JPHC)

KITSAP COUNTY, WASHINGTON

EPA FACILITY ID: WA3170090044

JULY 29, 2008

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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Prepared by:

Site and Radiological Assessment Branch
Division of Health Assessment and Consultation
Agency for Toxic Substances and Disease Registry

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List of Abbreviations

ATSDR	Agency for Toxic Substances and Disease Registry
BEHP	Bis(2-ethylhexyl)-phthalate
BRA	benzene release area
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CREG	cancer risk evaluation guide (ATSDR)
CV	comparison value
Ecology	Washington State Department of Ecology
EMEG	environmental media evaluation guide (ATSDR)
EOD	explosive ordnance disposal
EPA	U.S. Environmental Protection Agency
FS	feasibility study
IAS	initial assessment study
JPHC	Jackson Park Housing Complex
MCL	EPA's maximum contaminant level
MEC	Munitions and explosives of concern
MRL	ATSDR's minimal risk level
NAD	Naval Ammunitions Depot
NHB	Naval Hospital Bremerton
NMPS	Naval Magazine Puget Sound
NPL	National Priorities List
NSK	Naval Station Kitsap
OU	operable unit
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
PHA	public health assessment
ppb	parts per billion
ppm	parts per million
ppt	parts per trillion
PSNS	Puget Sound Naval Shipyard
QA/QC	quality assurance/quality control
RBC	Risk-based concentration (EPA)
RCRA	Resource Conservation and Recovery Act
RDX	Royal Demolition Explosive (Cyclotrimethylenetrinitramine)
RfD	reference dose (EPA)
RI	remedial investigation
ROD	record of decision
RMEG	reference media evaluation guide (ATSDR)
SVOC	semi-volatile organic compound
TNT	trinitrotoluene
TPH	total petroleum hydrocarbons
VOC	volatile organic compound
WDOH	Washington State Department of Health

I. SUMMARY

Jackson Park Housing Complex (JPHC), located in central Kitsap County, Washington, consists of an off-site family housing area for military personnel stationed in the Bremerton area and Naval Hospital Bremerton (NHB), located immediately north of the military housing area. NHB is an independent facility under separate command that serves the Bremerton Naval Complex and other Navy installations in the area. Both the Naval housing area and NHB are grouped together as one site on EPA's National Priority List and, therefore, ATSDR will include NHB in its public health evaluation under JPHC. The entire complex, including NHB, covers approximately 265 acres in the Puget Sound lowland along the Ostrich Bay portion of Dye's Inlet, two miles northwest of the city of Bremerton.

JPHC is the site of the former Naval Ammunitions Depot (NAD). Navy operations associated with the former depot began in 1904. Munitions-related operations officially began at the depot in 1909. After closure in 1959, portions of land belonging to the former NAD were transferred to the city of Bremerton for the eventual construction of a park (102 acres) and part of State Highway 3 (33 acres). The Navy turned over the remaining land to the Puget Sound Naval Shipyard (PSNS) and began construction of JPHC in 1966.

The Agency for Toxic Substances and Disease Registry (ATSDR) prepared this public health assessment (PHA) to evaluate possible contaminant exposures resulting from activities associated with the former NAD. During the public health assessment process, ATSDR considers historical and current or future releases into the environment (in water, soil, air, and/or in the food chain). ATSDR evaluated information from environmental investigations associated with areas of contamination identified at JPHC as well as independent studies evaluating water quality, sediments, and marine organisms within Dyes Inlet and Ostrich Bay. ATSDR also reviewed available site reports and qualitatively assessed the potential for munitions-related materials to pose a "physical" public health hazard to residents and visitors of JPHC.

ATSDR conducted a site visit of JPHC in June 2004. During the site visit, ATSDR met with Navy personnel, toured the housing complex, and attended a Town Hall meeting for JPHC. ATSDR also met with a representative of the Suquamish Tribe to discuss the Tribe's concerns about contamination associated with historical Navy operations. During ATSDR's evaluation process, three potential exposure situations were identified where the potential for people to come in contact with site-related contaminants or munitions-related items exists.

Potential Exposure Situations Identified at Jackson Park Housing Complex

1. Past, current, and future exposures from eating contaminated fish or shellfish from Ostrich Bay.
2. Past, current, and future exposures from coming into contact with chemical contaminants in surface soils at JPHC
3. The potential in the future for coming into contact with munitions-related items in the terrestrial and marine environment.

To prepare this PHA, ATSDR reviewed available environmental sampling data from Navy investigations of JPHC and Washington State Department of Ecology (Ecology) reports for Dyes Inlet and Ostrich Bay. ATSDR also consulted with JPHC personnel, representatives from the Navy Environmental Health Center (NEHC), state and federal regulatory agency representatives, and representatives of the Suquamish Tribe about environmental and public health issues and specific community concerns associated with JPHC. ATSDR's conclusions related to the three exposure situations described above are provided below.

1. Past, current, and future exposures from eating contaminated fish or shellfish from Ostrich Bay:

During the operation of the former NAD, materials and chemicals related to the development, manufacturing, and storage of munitions were accidentally released into the intertidal portions of Ostrich Bay along what is currently the shoreline of JPHC. Ostrich Bay and the intertidal area at JPHC were used in the past for recreational fishing and shellfish harvesting.

Commercial and recreational harvesting of shellfish in Ostrich Bay is prohibited and all other types of fishing are restricted within the JPHC site boundary. The shellfish advisories, which were issued by the Kitsap County Health Department in 1969, are specifically posted for the west side of Ostrich Bay in the vicinity of JPHC for ordnance-related compounds in all bottom fish, shellfish, and crab. It is possible that clam harvesting occurred along the JPHC shoreline up until 1991. The state currently permits recreational harvesting in selected portions of Dyes Inlet near Ostrich Bay, such as Erlands Point. Ostrich Bay is closed to most commercial and all recreational shellfish harvesting because of chemical contamination and, in some locations, bacterial contamination. In addition, due to munitions-related wastes and the potential for explosive waste contamination associated with former NAD, portions of Ostrich Bay, in close proximity to JPHC, may also pose a physical hazard if people were allowed to fish and harvest shellfish in the future.

Past Exposure: The results of recent (i.e., since 1991) fish and shellfish sampling within Ostrich Bay and near Erlands Point show that the concentrations of contaminants ***are not*** at levels known to cause illness or health effects. However, given the history of the former NAD site and the limited information concerning the nature and extent of prior munitions contamination in Ostrich Bay there is not enough information to conclude that the fish and shellfish consumed in the past (i.e., prior to advisories being issued) were safe to eat.

Current and Future Exposure: Currently, Ostrich Bay is not being utilized as a significant fish or shellfish resource and contaminants have not been detected at harmful levels. The Navy has taken remedial actions (e.g., removal of creosote-treated pilings during 2001at Site 101 and shoreline stabilization at Site 103 to prevent erosion of contaminated soils) to help prevent site-related contamination from further impacting Ostrich Bay. The Navy is also conducting long-term monitoring for chemicals of concern identified during prior sampling investigations. ATSDR supports this long-term monitoring effort and recommends that the Navy continue to evaluate the nature and extent of parent munitions compounds and their degradation products in common edible fish and shellfish species in Ostrich Bay.

ATSDR evaluated whether the historical release of site-related contaminants into Ostrich Bay could result in harmful human exposure through bioaccumulation in the food chain if this resource is deemed "safe" (i.e., does not pose a physical hazard) and is used as a fishing and shellfish harvesting area in the future. Current levels of most contaminants measured in tissue samples collected within Ostrich Bay are not at levels that would likely cause harm or illness in people. However, ATSDR believes a more comprehensive assessment of the nature and extent of munitions-related compounds in fish and shellfish tissues is needed to ensure the safety of people who would likely use Ostrich Bay as a future resource for subsistence harvesting of fish and shellfish.

2. Past, current, and future exposures from coming into contact with surface soils at JPHC:

Industrial facilities at the former NAD were in operation between 1904 and 1959. Since 1991 environmental investigations have identified contaminants in surface soils associated with NAD activities, including munitions-related compounds, fuel components (e.g. benzene), and metals. Prior to the remedial actions taken by the Navy, residents at JPHC could have potentially become exposed to contaminated surface soils by directly coming into contact with or ingesting soil. During previous investigations, the Navy identified contaminated soil near beaches, recreational areas, and residential upland (i.e., more elevated areas away from the JPHC shoreline) areas of JPHC. However, as a result of identifying contaminated soils in places accessible to both children and adults, the Navy has conducted several soil removal actions as well as taken other remedial measures since 1991 to prevent human exposure.

Past Exposure: There is uncertainty regarding the levels of contamination that may have existed in the surface soil when people were living in the housing area during the 1970s and throughout the 1980s. The first site investigations measuring levels of chemical contamination in soil began in 1991. There are no soil data available prior to 1991 and children and adults used many portions of the site for recreational purposes prior to any remedial actions taking place at JPHC. Although ATSDR does not believe that site-related contamination occurred in the past at levels that could cause harm, there is insufficient information to make a definitive conclusion.

Current and Future Exposure: Recent analyses of contaminants in surface soil do not indicate contamination at levels that are known to cause health effects in humans. ATSDR does not believe that munitions-related compounds pose a chemical exposure hazard since the data show very low or non-detectable levels in surface soil. Additionally, large-scale remedial actions at JPHC have resulted in fewer areas of soil contamination throughout the complex. The recreational areas at JPHC, where children and other residents are most likely to come in frequent contact with surface soil, have been cleaned to safe residential soil standards.

3. The potential for coming into contact with munitions-related items in the terrestrial and marine environment:

Munitions and munitions-related items have been discovered at JPHC, both in the terrestrial soils and marine sediments. The Navy continues to identify and clear existing munitions items at JPHC. Most surface soil at JPHC has been cleared of munitions-related items to a depth of two inches below ground surface. According to the Navy, housing regulations prohibit residents and visitors from digging at the site and information is provided to residents regarding the past history and restrictions in place at JPHC. However, access to most portions of JPHC is not restricted and, although unlikely, unsupervised children or uninformed visitors could come into contact with munitions items that remain buried more than two inches below the surface or hidden in heavily vegetated areas. Munitions items may also remain buried underneath sediments within intertidal areas and along the immediate shoreline. The Navy is expected to begin additional investigations for OU 3-Marine. These investigations will be designed to evaluate the nature and extent of munitions-related items in Ostrich Bay, especially the subtidal portions of the bay in close proximity to JPHC. OU 3-Terestrial investigations, which include the intertidal portions of the housing complex, are ongoing.

Terrestrial Physical Hazards: The greatest hazard does not appear to be in close proximity to the actual housing units, which are mostly located away from the shoreline in the more highly elevated (Upland) portion of the site. Relatively few munitions items have been identified during site investigations in locations where most of the JPHC residents live. However, children do have access to most areas of JPHC and these areas may contain potentially dangerous munitions items beneath the surface and could pose a physical hazard.

Marine Physical Hazards: Currently, there are signs posted on JPHC property prohibiting swimming, fishing, and diving in Ostrich Bay. ATSDR supports the Navy's prohibition on these activities for JPHC residents. ATSDR advises against any recreational activities such as fishing, shellfish harvesting, swimming, or diving in the western portion of Ostrich Bay by JPHC residents or the general public until the Navy and state and federal regulators agree that munitions items located within marine sediments are sufficiently cleared or are not accessible.

II. BACKGROUND

Site Description and Operational History

Jackson Park Housing Complex (JPHC) consists of off-site family housing for military personnel stationed in the Bremerton area and Naval Hospital Bremerton (NHB) that serves the Bremerton Naval Complex and other Navy installations in the area. NHB is an independent facility under separate command and is being evaluated along with the housing area because they were grouped together and considered as one site on EPA's National Priority List (EPA 2004). The entire complex covers approximately 265 acres in the Puget Sound lowland along the Ostrich Bay portion of Dye's Inlet, two miles northwest of the city of Bremerton in Kitsap County, Washington (Figure 1) (U.S. Navy 1992; FWEC 2002a).

Navy operations at JPHC began in 1904 with the establishment of the Naval Ammunitions Depot (NAD) Puget Sound (FWEC 2002b). Munitions-related operations officially began at the depot in 1909 with the first shipment of ammunition and smokeless powder to the site (FWEC 2002a). The depot was officially renamed Naval Magazine Puget Sound (NMPS) in 1916. However, to maintain consistency with recent site documents released by the Navy that refer to the site by its original name, NMPS will be referred to throughout this report as NAD.

NAD's mission included assembly and maintenance of munitions and explosives, disposal of dangerous or outdated munitions and explosive components, storage of munitions and explosives, and stowage of munitions and explosives on marine vessels (FWEC 2002b). Specific munitions-related activities included case and projectile cleaning, tank and powder can repair, bag dyeing, and fuse operations. Items commonly produced at the depot included 5-inch projectiles, 14-inch bag charges, and 14-inch projectiles. In addition, 20mm and 40mm projectiles were also assembled in large quantities at the depot. These projectiles were filled with various munitions compounds, including black powder, TNT, and Explosive D. Tetryl and TNT were typically used to fill 20mm and 40mm cartridges, respectively (FWEC 2002b).

The site contained a number of buildings that supported these various activities including incinerators; paint, battery, industrial, and machine shops; and a boiler plant. NAD performed the following activities until closure in 1959:

- *Ammunition Assembly and Breakdown*. These activities were carried out in buildings along the shoreline of Ostrich Bay at the eastern edge of the site. Seventeen buildings supported ammunition assembly and breakdown at NAD at different times during the 50 years of facility operations.

- *Ammunition/Powder Storage*. Storage buildings were located near the shoreline of Ostrich Bay and expanded around the munitions assembly and breakdown area. One hundred forty-four buildings supported ammunition/powder storage at NAD at different times during the 50 years of facility operations.

- *Laboratory Testing Functions*. Laboratory tests were carried out in buildings at inland areas in the central and southern sections of the site.

- *Facility Support Buildings*. These buildings were located throughout NAD, with large concentrations in south-central inland areas and at Elwood Point. The support buildings were used for non-explosives ordnance support, inert storage, routine maintenance and fabrication, housing, and utilities.

- *Transportation*. Two piers, Pier 1 and Pier 2, were located in the central shoreline areas. Pier 1 was constructed in 1906 and Pier 2 was constructed in 1943: Pier 1 was demolished in the mid 1970s and Pier 2 remains. The piers were used for loading and unloading munitions and explosive material onto marine vessels. During the transfer of munitions on and off of barges losses occurred and it is likely that munitions items are present beneath the former and existing piers. Railroad facilities located at Elwood Point were also used for munitions transport (FWEC 2002a; 2002b).

After closure in 1959, the Navy gradually disassembled NAD and removed most buildings. Portions of land belonging to the former NAD were transferred to the city of Bremerton for the eventual construction of a park (102 acres) and part of State Highway 3 (33 acres). Some former NAD property was also transferred to other parties (e.g., private interests, Kitsap County, and Central Kitsap School District). The Navy turned over the remaining land to the Puget Sound Naval Shipyard (PSNS), and in 1966 began construction of JPHC. Construction of NHB began in 1977. Through a reorganization of naval command in 1998, authority of JPHC was reassigned to Naval Base Kitsap, (NBK). NBK is currently under the Navy Region Northwest Command (FWEC 2002a).

Regulatory and Remedial History

In 1981, an Initial Assessment Study (IAS) was conducted, which included Naval Submarine Base Bangor and the former NAD (FWEC 2002a). The IAS identified eight sites with the potential to contain hazardous materials at the former NAD. After a thorough assessment, investigators concluded that two of the sites (Site 101 and 103) warranted further investigation to characterize the nature and extent of contamination (FWEC 2002c).

In 1986, Congress enacted the Superfund Amendment and Reauthorization Act. As a result of this new legislation jurisdiction of environmental investigations associated with the Department of Defense's Comprehensive Environmental Response and Compensation Liability Act (CERCLA) was transferred to the U.S. Environmental Protection Agency (EPA) (FWEC 2002a). Under EPA's CERCLA program, the Navy completed a Current Situation Report in 1988. This report evaluated existing information, identified data gaps, and assessed the need for possible remedial actions for Sites 101 and 103 (Hart Crowser 1988).

In 1992, the Washington State Department of Ecology (Ecology) issued an enforcement order, which brought the state of Washington into the assessment and remediation process. In May 1994, JPHC was listed on EPA's National Priorities List (NPL) (FWEC 2002a). It is common for state and federal agencies and the Navy or other branches of the military to enter into an interagency agreement in order to facilitate the environmental evaluation and cleanup process. In December 2004, the Navy and U.S. EPA signed an interagency agreement.

During the CERCLA investigation and remediation process, JPHC was divided into five Operable Units (OUs). The OUs define a specific portion of the site (e.g. marine versus terrestrial), as well as specific types of hazards (e.g., chemical contamination versus physical munitions hazards). These OUs are described below:

- ***OU 1***. This OU addresses ecological risks associated with contaminated soil, groundwater, seeps and outfalls, and human health issues associated with the consumption of shellfish from Ostrich Bay. OU 1 comprises all terrestrial areas at JPHC, including piers, seeps, and outfalls along the shoreline of Ostrich Bay, residential housing, community facilities, recreation areas, forest, and the Naval Hospital Bremerton. A record of decision, signed in August 2000, established four distinct areas of concern

within OU 1. The associated remedial actions were completed in 2001. These areas are shown in Figure 2 and described below:

Site 101— This is an area approximately 200 feet wide and extending 2,400 feet along the shoreline to the south of Elwood Point. A large number of the military operations associated with the former NAD occurred at Site 101 and numerous buildings were constructed in this portion of JPHC to support these operations.

Site 101-A — This area includes approximately 880 feet of shoreline south of Site 101 and 7 acres of upland (i.e., more elevated areas away from the shoreline) area west of this section of the shoreline. The peak of production-related activities in Site 101-A was during World War II.

Site 103 — This area contains Elwood Point and about 500 feet of shoreline to the north. Elwood Point is approximately 1,500 feet wide and extends about 600 feet into Ostrich Bay.

Site 110 —This area includes most of the upland portion of JPHC, where most of the housing units and NHB buildings are located. Primary activities at Site 110 consisted of the storage of munitions, raw materials, and inert materials (FWEC 2002a; 2002d).

- ***OU 2***. This OU addresses environmental hazards associated with contaminated marine life and sediments. Ostrich Bay directly borders JPHC and formerly served as an active waterway for marine vessels entering and leaving NAD.

- ***OU 3 (Terrestrial)-JPHC and NHB***. These are two separate OUs that address physical hazards associated with munitions, munitions-related items (e.g., fuzes, depth charges, and detonators), and explosive material within the JPHC and NHB terrestrial areas. This also includes the intertidal areas, which are defined as the area of the beach above the mean lower low water mark.

- ***OU 3 (Marine)***. This unit addresses physical hazards associated with munitions-related items and explosive material within Ostrich Bay (FWEC 2002a).

Munitions and explosive assessment, identification, and removal have occurred in certain portions of the site as part of CERCLA's Time-Critical Removal Action process. These actions were associated with shoreline reconstruction and stabilization and the installation of new recreational facilities in shoreline areas. Additional identification and removal of munitions and explosives of concern (MEC) are ongoing at JPHC (FWEC 2002a). Additional descriptive information, waste disposal activities, investigations summaries, and remedial actions at these OUs are presented in Appendix A.

ATSDR Involvement

ATSDR visited JPHC in June 2004 to obtain information related to environmental studies at the site. During the site visit, ATSDR met with Navy personnel, toured the housing complex and naval hospital grounds, and attended an informational Town Hall meeting for JPHC. During the site visit Navy personnel escorted ATSDR on a windshield tour of JPHC. Most portions of the complex, including NHB, were observed during the windshield tour. During the site visit, ATSDR also met with a representative of the Suquamish Tribe to discuss the Tribe's concerns about contamination associated with the JPHC.

Demographics

ATSDR examines demographic information to identify the presence of sensitive populations, such as young children and the elderly, in the vicinity of a site. Demographics also provide details on residential history in a particular area, information that helps ATSDR assess time frames of potential human exposure to contaminants. Demographic information for the site and residential areas surrounding JPHC is presented in this section.

JPHC lies near two large population centers in Kitsap County: the city of Bremerton, less then three miles away, and Silverdale, less then 5 miles away (U.S. Navy 1992). According to the 2000 U.S. Census, the population of Bremerton is approximately 37,000, a small decline from the 1990 census. Kitsap County's population is approximately 230,000 and has experienced relatively slow (about 3 % annual) growth over the last 20 years (U.S. Census Bureau 1990; 2000). See Figure 3 for additional demographic information for areas within a one-mile radius around JPHC.

There are 870 housing units at the JPHC, which include as many as eight housing units per structure. In early 2004, the total resident population at JPHC was 2,714. This includes a total of 839 military personnel and 1,875 dependents; 1,105 of which are under 18 years of age (Ann Bazilwich, Naval Station Kitsap-Bremerton Environmental. Personal Communications, April 30, 2004).

Land Use, Topography, and Natural Resources

JPHC is situated in the southwest corner of Dyes Inlet along Ostrich Bay (Figure 1). Immediately north of the military housing area is NHB, immediately south of the housing area is a portion of NAD Park. Another portion of NAD Park is west of the housing area with State Route 3 between the housing area and NAD Park. Private residences are located to the north (north of NHB) and south of NAD Park (U.S. Navy 1992). The land surrounding JPHC consists of a mix of low-density residential areas, forests, farms, and undeveloped land. The developed areas are mostly found in the city of Bremerton and surrounding unincorporated areas and along the shorelines (URS 1996).

Land at JPHC, prior to construction of NAD in 1904, consisted of timber, marshes, and tidelands and a small settlement of Native Americans and Euro-Americans at Elwood Point. Much of Kitsap County remains relatively undeveloped today, and contains large areas of farmlands and forest (URS 1996; Kelly 1993; FWEC 2002a). The Port Madison Indian Reservation consisting of nearly 7,500 acres is located on the Kitsap Peninsula. The original inhabitants of the Port Madison Indian Reservation were primarily of the Suquamish Tribe.

Significant changes in land use have occurred at JPHC since operations at NAD began. Munitions and explosive components were handled extensively at NAD between 1904 and 1959. Beginning with closure of NAD in 1959, the site began its conversion to a military housing area and naval hospital. Currently the land is used for family housing, recreation, and hospital services. The portion of JPHC that contains housing units occupies 159 acres in both the upland portions of the complex and near the shoreline of Ostrich Bay. This includes a recreation area with sports courts and ball fields adjacent to the shoreline at Elwood Point. NHB occupies approximately 50 acres that include upland, shoreline and tidal areas (FWEC 2002a). Although the Navy's environmental investigations consider the military housing area and the hospital as two separate sites (i.e., OU-3 Terrestrial-JPHC and OU-3 Terrestrial-NHB have separate remedial investigations (RIs), feasibility studies (FSs), and record of decision's (RODs) submitted), unless stated otherwise in this report, any reference to JPHC includes NHB.

JPHC overlooks Ostrich Bay on a hillside at elevations ranging from sea level to180 feet above mean sea level (U.S. Navy 2000). Ostrich bay is a shallow muddy inlet with water depths generally less than 20 feet, except near the mouth, at Elwood Point, where water depths may exceed 40 feet. Ostrich bay consists of both course and fine-grained sediments. The northern shores at JPHC consist of sand and cobble beaches and low-bank bluffs, between 2 and 8 feet high, while bluffs as high as 20 feet extend along the site's southern shores. One pier, Pier 2, formerly used for ammunitions transfer, and numerous seeps and outfalls also line the waterfront (U.S. Navy 2000; URS 1995).

Most residential areas in close proximity to JPHC obtain drinking water from the city of Bremerton. The Bremerton Water Department supplies water to JPHC and surrounding areas from a municipal water distribution system that collects water from wells and surface water bodies in Kitsap County (Beverly Pavlicek, JPHC. Personal Communications, July 16, 2004). Some groundwater wells in Kitsap County are used for irrigation and for domestic, industrial, and public water supplies (Ecology 2003). Most domestic water wells are greater than one mile away from the JPHC boundary and at depths exceeding 200 feet below ground surface (URS 1995; Ecology 2003). There are three private wells located less than one-half mile north of the JPHC border. One of these wells is owned by the Kitsap Golf and Country Club and is used exclusively for irrigation. The other two wells are private wells reportedly used for domestic purposes. However, it is not known whether these two wells are used as a drinking water source (Ecology 2003).

Ostrich Bay supports a thriving shellfish population that includes crabs, littleneck clams, and may also include other native species such as geoducks (also known as longneck clams) and sea cucumbers. Recreational and commercial harvesting activities were common throughout Dyes Inlet in the past (Hart Crowser 1988). In August 1991, the Navy banned shellfish harvesting on all JPHC shoreline naval property. According to site reports, signs were posted in five different languages stating that shellfish harvesting was prohibited (U.S. Navy 1992).

Hydrogeology

Kitsap County contains over 200 miles of shoreline along the northern portion of Kitsap Peninsula. Numerous sheltered inlets, embankments, and natural harbors are evident along this shoreline (NEESA 1983). Ostrich Bay encompasses a sandy one-half mile wide portion of Puget Sound's Dyes Inlet with depths averaging about 6 meters and an average tidal range of approximately 2.6 meters. The bay belongs to the Port Orchard circulation system, which includes Liberty Bay, Agate Pass, Port Orchard Narrows, Rich Passage, Sinclair Inlet, Port Washington Narrows, and Dyes Inlet. Circulation inside the bay is primarily influenced by the tidal flow through Port Washington Narrows, which completely flushes Dyes Inlet about every four days (EA-EST 1998a).

Two groundwater aquifers underlie Kitsap County, an upper aquifer and a lower aquifer. The unconfined upper aquifer beneath Kitsap County overlies silt and clay geologic features with relatively low permeability referred to as an aquitard. Most of the local water wells are drilled into the lower aquifer, referred to as the Vashon Drift till formation. This is the primary aquifer used in the area (NEESA 1990). This aquifer ranges in thickness from a few feet to greater than 200 feet (NEESA 1983). Groundwater beneath JPHC generally flows east toward Ostrich Bay (URS 1995). No perennial streams or freshwater bodies enter JPHC. Surface water runoff collects in storm drains that empty into Ostrich Bay (URS 1995).

Quality Assurance and Quality Control

In preparing this PHA, 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 primarily from site characterization, remedial investigation, and monitoring reports prepared by the Navy and Navy contractors under CERCLA.

There is some uncertainty regarding the nature and extent of nitroaromatic and munitions[1] compounds in sediment and biota samples collected from Ostrich Bay. The Navy rejected munitions data analyzed from sediment and shellfish collected from Ostrich Bay during the Phase I Remedial Investigation (RI). Additionally, nitroaromatic and ordnance data for sediment and biota samples from the 1998 Treatability Study contain numerous data qualifiers that call into question the validity of the data.

ATSDR identified only three studies with valid ordnance screening results for Ostrich Bay: The Initial Site-wide Investigation at JPHC (Hart Crowser 1988); the 1994 Phase II RI (URS 1995); and the Long Term Monitoring Program, which began collecting samples in 2002 (EFANW 2003). Munitions data were rejected in biota and sediment samples in the Phase I RI for the following reasons: 1) The data were found to be suspect because munitions compounds were detected at low concentrations everywhere in the marine environment, including background stations; and 2) The results of the analyses were unable to be confirmed via dual-column or mass spectra methods. In addition, the quantitation limits may not have been low enough to adequately detect munitions-related compounds in biota and sediments collected during these studies.

ATSDR is not confident that the data adequately address questions regarding munitions compounds in the marine environment (EA-EST 1998a; URS 1994a). The munitions data from more recent sampling events do not indicate a human health concern. However, the munitions data from earlier tissue and sediment investigations were mostly rejected due to the analytical issues noted above. Therefore, "past exposure" cannot be adequately assessed for munitions-related compounds. After reviewing the nature and extent of munitions compounds in these media within Ostrich Bay ATSDR determined that the quality of data for the other chemical contaminants analyzed during environmental investigations at JPHC is adequate for making public health decisions.

[1] For purposes of consistency the term munitions is generally used in place of ordnance throughout the document. Reference to both munitions and ordnance data appear in many of the site documents ATSDR has reviewed. Although some technical differences may exist in how each term is defined, for this PHA ordnance is considered to be included within the definition of munitions-related items or compounds.

III. ENVIRONMENTAL CONTAMINATION, HUMAN EXPOSURE PATHWAYS, AND PUBLIC HEALTH IMPLICATIONS

In this section, ATSDR evaluates whether community members have been (past), are (current), or will be (future) exposed to harmful levels of chemicals or at risk of coming into contact with munitions or munitions-related items that pose a physical hazard. Figure 4 describes the exposure evaluation process for chemical contaminants used by ATSDR. ATSDR screens the concentrations of contaminants in environmental media (e.g., groundwater or soil) against health-based comparison values (CVs). Because CVs are not thresholds of toxicity, environmental levels that exceed CVs do not necessarily produce adverse health effects. If a chemical is found in the environment at levels exceeding its corresponding CV, ATSDR estimates site-specific exposure and evaluates the likelihood of adverse health effects. *A public health hazard only exists if exposure to a hazardous substance occurs at sufficient concentration, frequency, and duration for harmful effects to occur.*

What is meant by exposure?

ATSDR's PHAs evaluate the potential for human exposure or contact with environmental contaminants. Chemical contaminants released into the environment have the potential to cause adverse health effects. However, *a release does not always result in human exposure*. People can only be exposed to a contaminant if they come in contact with it—if they breathe, eat, drink, or come into skin contact with a substance containing the contaminant.

How does ATSDR determine which exposure situations to evaluate?

ATSDR scientists evaluate site conditions to determine if people could have been, are, or could be exposed (i.e., exposed in a past scenario, a current scenario, or a future scenario) to site-related contaminants. When evaluating exposure pathways, ATSDR identifies whether exposure to contaminated media (soil, sediment, water, air, or biota) has occurred, is occurring, or will occur through ingestion, dermal (skin) contact, or inhalation.

If exposure was, is, or could be possible, ATSDR scientists consider whether contamination is present at levels that might affect public health. ATSDR scientists select contaminants for further evaluation by comparing them against health-based comparison values (CVs). These are developed by ATSDR from available scientific literature related to exposure and health effects. CVs are derived for each of the different media and reflect an estimated contaminant concentration that is *not likely* to cause adverse health effects for a given chemical, assuming a standard daily contact rate (e.g., an amount of water or soil consumed or an amount of air breathed) and body weight.

About ATSDR's Comparison Values (CVs)

CVs are not thresholds for adverse health effects. ATSDR CVs represent contaminant concentrations many times lower than levels at which no effects were observed in experimental animals or human epidemiologic studies. If contaminant concentrations are above CVs, ATSDR further analyzes exposure variables (for example, duration and frequency of exposure), the toxicology of the contaminant, other epidemiology studies, and the weight of evidence for health effects. Some of the CVs used by ATSDR scientists include:

EMEGs — environmental media evaluation guides
RMEGs — reference dose media evaluation guides,
CREGs — cancer risk evaluation guides, and
MCLs — EPA's maximum contaminant levels (MCLs).

EMEGs, RMEGs, and CREGs are non-enforceable, health-based CVs developed by ATSDR for screening environmental contamination for further evaluation. MCLs are enforceable drinking water regulations developed to protect public health.

You can find out more about the ATSDR evaluation process by reading ATSDR's Public Health Assessment Guidance Manual at: http://www.atsdr.cdc.gov/HAC/HAGM/, or contacting ATSDR at 1-888-42ATSDR.

If someone is exposed, will they get sick?

Exposure does not always result in harmful health effects. The type and severity of health effects a person can experience as a result of contact with a contaminant depend on the exposure concentration (how much), the frequency and/or duration of exposure (how long), the route or pathway of exposure (breathing, eating, drinking, or skin contact), and the multiplicity of exposure (combination of contaminants). Once exposure occurs, characteristics such as age, sex, nutritional status, genetics, lifestyle, and health status of the exposed individual influence how the individual absorbs, distributes, metabolizes, and excretes the contaminant. Together, these factors and characteristics determine the health effects that may occur.

In almost any situation, there is considerable uncertainty about the true level of exposure to environmental contamination. To account for this 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 the levels that people are really exposed to. If the exposure levels indicate that adverse health effects are possible, ATSDR performs a more detailed review of exposure, also consulting the toxicologic and epidemiologic literature for scientific information about the health effects from exposure to hazardous substances.

What potential exposure situations were evaluated for JPHC?

Following the strategy outlined above, ATSDR reviewed the environmental data generated from environmental investigations conducted at JPHC and Ostrich Bay to identify past, current, or future public health hazards. This included soil, sediment, groundwater, surface water, and biological (e.g. fish tissue) sampling data as well as assessing potential physical hazards associated with munitions or other explosive materials. ATSDR identified three potential exposure situations associated with site-related contaminants at JPHC for further evaluation:

1. *Potential past, current, and future exposures from eating contaminated fish or shellfish from Ostrich Bay.*

2. *Potential past, current, and future exposures from coming into contact with chemical contaminants in surface soils at JPHC.*

3. *Potential for coming into contact with munitions-related items in the future in the terrestrial and marine environment.*[2]

Exposure situation is used to describe conditions and circumstances by which people could come into contact with contaminants. Table 1 provides a summary of the potential exposure situations evaluated in this PHA. Appendix B describes the evaluation process ATSDR used to identify potential exposure situations at JPHC. Appendix C describes the methods and assumptions ATSDR used in its evaluation of potential public health hazards. Appendix D contains a glossary of environmental health terms that are frequently used in ATSDR's PHAs.

[2] ATSDR reviewed information about munitions-related items at JPHC and associated remedial actions conducted by the Navy. ATSDR's public health evaluation for potential physical hazards at JPHC is based on a qualitative assessment of the potential hazards and not any quantitative risk calculations or modeling.

Table 1: Exposure Situation and Hazard Summary Table – Jackson Park Housing Complex					
Exposure Situation	***Time Frame***	***Exposure: Yes/No***	***Hazard***	***Actions Taken or Recommended***	***Comments***
1. Exposure to contaminants through consumption of fish and shellfish collected from Ostrich Bay					
▪ Eating fish or shellfish from Ostrich Bay. ▪ People who may harvest shellfish or fish in portions of Ostrich Bay that may be impacted by contaminants from the former NAD.	Past Current Future	Indeterminate Unlikely Unlikely	Early JPHC site documents suggested that recreational clamming was common along the JPHC shoreline prior to 1991. This is not consistent with advisories issued by Kitsap County Health Department that were issued in 1969. Fish and shellfish data are not available prior to 1991 and information is not available concerning the consumption of fish and shellfish near JPHC. Although recent sampling data do not indicate a concern, ATSDR does not have sufficient information to adequately evaluate past exposures. The levels of chemical contaminants detected in fish and shellfish from Ostrich Bay since sampling was initiated in 1991 do not pose a public Health Hazard. Some chemical contaminants have been detected above ATSDR's health-based screening values; however, a review of the toxicological literature showed they were not at levels that are known to cause adverse health effects.	▪ In 1991, the Navy banned fishing and shellfish harvesting at JPHC beaches and posted no fishing/ shellfish harvesting signs along the JPHC waterfront. ▪ ATSDR supports the State's current fish and shellfish advisory for Ostrich Bay for chemical and bacterial contamination. ▪ The analytical methods used by the Navy may not be sensitive enough to evaluate the presence of all munitions compounds or their breakdown products at JPHC. ATSDR supports the Navy's long-term monitoring program and recommends that the Navy continue to evaluate the nature and extent of parent munitions compounds and their degradation products. The criteria for what represents an adequate assessment of munitions compounds and their breakdown products should be agreed to by the Navy, EPA, and Ecology.	The Navy has posted signs warning against fishing and shellfish harvesting at JPHC beaches since 1991. It is likely that prior to 1991 people were harvesting and consuming shellfish and fish from portions of Ostrich Bay in close proximity to the JPHC shoreline. The past use of Ostrich Bay and the intertidal area at JPHC for fishing and shellfish harvesting represents a potential exposure pathway.

Table 1: Exposure Situation and Hazard Summary Table – Jackson Park Housing Complex					
Exposure Situation	***Time Frame***	***Exposure: Yes/No***	***Hazard***	***Actions Taken or Recommended***	***Comments***
2. Exposures to chemical contaminants in surface soil at JPHC.					
▪ Potential exposures (adult and child) from coming into contact with chemical contaminants in surface soils at JPHC	Past Current Future	Indeterminate Unlikely Unlikely	There is no information about what levels of contamination may have been in the surface soil when people were living in the housing area during the 1970s and throughout the 1980s. Children and adults used many portions of the site for recreational purposes prior to any remedial actions occurring. Although ATSDR does not believe contaminant levels in soil were at harmful levels in the past, data are not available to corroborate this statement. The Navy has removed contaminated soils and placed clean fill in recreational areas and other portions of the housing complex where people may be most likely to come in contact with soil. Chemical contaminants have not been detected in soils at JPHC at levels known to cause health effects in people.	▪ In 1995, the Navy removed surface soils contaminated with lead, arsenic, and PAHs from Site 110 at the former NAD Upland Bunkers, Buildings 98-104, and the Jackson Park Elementary School yard. ▪ In 1995, the Navy covered a small area of TPH-contaminated soil near the intersection of Elwood and Olding Roads with 3 feet of clean fill. ▪ In 2000, construction of a large soil cover was initiated. The cover was composed of 12-18 inches of clean fill overlying a black polyethylene-geo-textile fabric and covers approximately 280,000 square feet of contaminated soil at Sites 101, 101A, and 103. New athletic fields and other recreational facilities at Elwood Point were placed on top of the soil cover. ▪ In 2002, the Navy excavated and replaced PAH-contaminated soil detected adjacent to buildings 583 and 584 with clean fill.	ATSDR does not believe that munitions-related compounds pose a chemical exposure hazard since data show very low levels present in surface soil. The data are consistent with what is known in general about the persistence and environmental fate of many of the explosive compounds used at the former NAD.

Table 1: Exposure Situation and Hazard Summary Table – Jackson Park Housing Complex					
Exposure Situation	***Time Frame***	***Exposure: Yes/No***	***Hazard***	***Actions Taken or Recommended***	***Comments***
3. Potential for coming into contact with munitions-related items in the terrestrial and marine environment					
▪ Physical hazards from residents of JPHC coming into contact with munitions items or explosive materials that may be hidden below the surface. ▪ Physical hazards associated with activities such as swimming, diving, fishing, and shellfish harvesting in Ostrich Bay.	Current Future	Unlikely Unlikely	*Terrestrial physical hazard*: The greatest hazard appears to be in portions of the complex that are heavily vegetated. JPHC residents, including children, have access to most areas of JPHC and given the historical land uses, these areas could contain potentially dangerous munitions items beneath the surface. The potential physical hazard for coming in contact with munitions-related items appears to be quite low in close proximity to the actual housing units, which are all located in the upland portion of the site. *Marine Physical Hazard*: Munitions items remain buried underneath sediments within intertidal areas and along the immediate shoreline.	▪ In 1975, the Navy conducted a survey of munitions-related items along the shoreline pier area (Site 102). ▪ In 1981, the Navy conducted a search for munitions-related items along the intertidal area between the old railroad pier at Elwood Point and just south of the old oil pier. ▪ In 1998 and 1999, an investigation consisting of three phases was conducted in areas surrounding NHB to evaluate the nature and extent of munitions items near the hospital and to subsequently remove any identified MEC. ▪ A surface sweep of MEC for the top two inches of surface soil has been completed for OU-3Terrestrial-JPHC OU. Surface clearance of munitions and subsurface geophysical mapping of anomalies in the OU-3Terrestrial-NHB OU has not been completed. ▪ The Navy is expected to begin an investigation within OU 3-Marine designed to evaluate the presence of munitions items in Ostrich Bay, especially the subtidal portions of the bay in close proximity to JPHC.	Until the Navy and state and federal regulators agree that munitions items located within marine sediments are sufficiently cleared or are not accessible, ATSDR supports the current Navy policy at JPHC prohibiting recreational activities associated with Ostrich Bay (e.g., swimming, diving, fishing, shellfish harvesting).

1. Eating contaminated fish or shellfish collected from Ostrich Bay.

Issue

Are people who currently consume [or consumed in the past] fish or shellfish from Ostrich Bay exposed to harmful levels of contaminants?

Characterization of Potential Exposure Pathway

The Navy's extensive handling of munitions between 1904 and 1959 at piers, buildings, and beaches along the waterfront at Ostrich Bay has impacted the marine environment around JPHC. Munitions-related items have been found in Ostrich Bay sediments and have also washed up along the shoreline. Environmental investigations have identified mostly low levels of munitions-related compounds, metals, volatile organic compounds (VOCs), and polycyclic aromatic hydrocarbons (PAHs) in sediments and marine biota.

According to historical records, releases of site-related contaminants into Ostrich Bay occurred during operations at NAD between 1904 and 1959. Piers 1 and 2 were used to transfer live ammunition from Navy barges to the piers via cranes. Munitions from NAD were reportedly burned on the beaches as a disposal method. Additional contaminant releases occurred from the discharge of industrial waste drainage at NAD facilities through surface water runoff and seeps and outfalls along the shoreline (FWEC 2002a). Munitions were also transported in railcars by barge to the Elwood Point railroad pier where the entire railcar was transferred from the barge to the pier. However, the loss of munitions was limited because entire railcars were moved, limiting the potential for spills.

The primary human exposure pathway concern for contaminated portions of Ostrich Bay is through the food chain. Some of the pollutants that enter the marine environment break down slowly (e.g., metals such as mercury and arsenic) and are deposited in the marine sediments. The persistence, bioaccumulation, and bioavailability (e.g., able to be absorbed into the body) potential of these and other munitions-related compounds known to be used at NAD varies considerably depending on the specific compound. Some of the more persistent contaminants may accumulate over time in biota (e.g., plants, fish, and shellfish). Shellfish and many varieties of bottom feeding fish ingest contaminants from sediments and smaller organisms that are found on the bottom surface and these contaminants can subsequently accumulate in their tissues.

Ammunition/Ordnance-related Compounds That May Have Been Released into Ostrich Bay?

Ammonium Nitrate: This was used as a common component for many explosives. Although ammonium nitrate is normally stable and unlikely to explode spontaneously, accidental explosions can occur. While relatively stable in soil, it readily breaks down when released into water.

Amonium Picrate: This explosive is known by its common name as Explosive D. It is one of the least shock-sensitive (i.e., not easy to detonate) military explosives and requires a booster for detonation.

Black Powder: This material is also known as gunpowder and can be used for multiple purposes (e.g., as a propellant charge, to produce sound, in the ignition fuse of fireworks). Black powder is not highly toxic.

Picric Acid: This was often used as a booster to detonate another, less sensitive explosive, such as TNT. Picric acid is normally kept wet to lower its explosive potential. It does not evaporate or biodegrade quickly when released in soil or water. Picric acid has been detected at low levels in sediments and marine organisms in Ostrich Bay. However, the chemical does not significantly bioaccumulate in the food chain.

Royal Demolition Explosive (RDX): RDX is used as an explosive often used in combination with other ingredients in explosives. RDX can be broken down in air and water in a few hours, but it breaks down more slowly in soil. RDX does not readily accumulate in fish tissues or in people.

Smokeless Powder: The smokeless powder used at the former NAD was in the form of resin like cylinders of various sizes. Some forms of smokeless powder are very shock-sensitive and can be ignited by bullet impact or during the decomposition process. Smokeless powder was primarily used as the propellant for gun ammunition at NAD.

Tetryl: this compound is an odorless, yellow crystal-like solid that is not found naturally in the environment. Tetryl was used to make explosives, mostly during World Wars I and II. It is no longer manufactured or used in the United States. It breaks down rapidly in rivers and lakes that receive sunlight, but much more slowly in groundwater.

Trinitrotoluene (TNT): This is an explosive widely used in military shells, bombs, and grenades. In surface water, it is rapidly broken down into other chemical compounds by sunlight. Microorganisms in deeper water and sediment break it down more slowly. Small amounts of it can accumulate in fish and plants.

Note: The quantities of each of these compounds released into Ostrich Bay are not known.

People who harvest and consume fish and/or shellfish from contaminated source areas may be exposed to chemical contaminants. According to JPHC Site Reports from the 1980's, the beaches and shorelines at JPHC supported recreational clam harvesting and fishing during the 1970s and 1980s, before the Navy prohibited all fish harvesting and closed the JPHC beaches in 1991 (Hart Crowser 1988; US Navy 1992). Commonly harvested shellfish in the past included butter clams, native littleneck clams, manila clams, horse clams, Japanese littleneck clams, and oysters. People also caught some varieties of finfish (e.g., English sole) from the beach and fishing pier (Hart Crowser 1988). The next section will summarize the nature and extent of contamination in specific environmental media related (either directly or indirectly) to contamination of fish and shellfish in Ostrich Bay.

Nature and Extent of Contamination

Several site-related marine investigations have occurred since 1988, focusing primarily on the intertidal portions of Ostrich Bay. Studies conducted between 1991 and 1994 collected and analyzed marine sediments and biota for a variety of analytes, including VOCs, semi-volatile organic compounds (SVOCs), pesticides, PCBs, metals, munitions compounds (e.g., TNT, RDX, and picric acid). Analytes that were detected in these studies became the focus of subsequent marine investigations at JPHC.

In addition to chemical contamination from JPHC, bacterial contamination from numerous point sources has impacted portions of Dyes Inlet, including Ostrich Bay. As a result of this contamination, the Washington Department of Health has issued shellfish advisories and the inlet's use as a fish and shellfish harvesting resource has been significantly restricted. Bacterial levels in Dyes Inlet have steadily declined in recent decades following the significant reduction of untreated wastewater releases into the Inlet.

Surface water Seep and Outfalls

Site investigations along portions of the JPHC shoreline continue to monitor seeps and outfall releases into Ostrich bay. It is possible that site-related contaminants might be migrating into marine water and impacting sediments and marine organisms. Most of the seep and outfall contamination likely originated from historical operations at NAD. The most likely direct

sources of contamination are from liquid waste drainage at an ammunition depot (Building 39) prior to 1970 and a gasoline fuel release discovered in 1991 (Battelle 2003; URS 2003a).

Seep and outfall sampling were conducted in June 1998 along Sites 101, 101A, and 103 and more recent targeted sampling was conducted at the benzene release area (BRA). This area is located within Sites 101 and 110. The area is defined by two seeps that discharge through pipes along the shore of Ostrich Bay, and an upgradient area of known soil or groundwater contamination that extends approximately 450 feet upgradient of the seeps (NAVFAC 2005b). VOCs (e.g., benzene, vinyl chloride) and metals (e.g., arsenic and mercury) were detected in some shoreline seeps immediately south of Elwood point at Sites 101 and Site 110. Benzene was detected most recently at a maximum concentration of 316 ppb in a seep sample located along the shoreline of Ostrich Bay just south of the border of Site 101 and Site 103 (URS 2003b).

Marine Sediment Data

The Navy has conducted three sediment investigations in Ostrich Bay and Dyes Inlet since 1991 that focused on the subtidal and intertidal zones off the coast of JPHC and Erlands Point.[3] Extensive sampling occurred near the former Pier 1, remaining Pier 2, and at Elwood Point. Sampling also occurred at Erlands Point, the outer boundaries of Ostrich Bay, and selected areas within Dyes Inlet in order to delineate impacted marine areas. Metals, munitions compounds, and SVOCs have been detected in numerous sediment samples at varying concentrations.

During the initial 1991Phase I sediment study some metals were frequently detected at levels above typical background concentrations for the area. For example, cadmium was detected in some sediment samples in close proximity to the JPHC shoreline. Cadmium levels in eleven samples exceeded Washington State Sediment Quality Standards (SQS),[4] with the highest concentration (16.1 ppm) detected near Elwood Point. Other elevated cadmium concentrations were detected in samples collected near Site 101A (URS 1994a). The results of subsequent

[3] Phase I Study (1991); Phase II Study (1994); OU-2 Treatability Study (1997), which includes the Ostrich Bay Intertidal Clam Study, the Supplemental Site Characterization, the Sedimentology Study, and the Sediment Transport Study.

[4] The State of Washington has established sediment cleanup standards within an allowable range of contamination on a site-specific basis. The lower end of this range is the sediment cleanup objective, referred to as the sediment quality standards (SQS). The SQS for cadmium is 5.1 ppm.

marine sediment investigations conducted in 1994 and in 1997 showed significantly lower concentrations of cadmium (maximum concentration = 2.7 ppm) in sediments throughout much of Ostrich Bay (EA-EST 1998b).

During the Navy's environmental investigations, mercury detected in sediment samples collected from portions of Ostrich Bay and Dyes Inlet also exceeded the state's SQS.[5] This included eight samples collected during the Phase I and Phase II Investigations, between 1991 and 1994, and 12 samples collected in 1997 (EA-EST 1998a). The highest concentration of mercury (1.4 ppm) was detected in 1997 in a sample collected from Ostrich Bay's subtidal zone. Arsenic levels in sediment did not exceed the state's SQS (EA-EST 1998b).

All sediment samples collected since 1991 have been analyzed for selected munitions compounds. However, the munitions data from the Phase I RI (1991-1994) were rejected due to the significant potential for false negatives (i.e., the absence or non-reporting of a compound when it is actually present in the sample) and the lack of confirmation by the analytical method used (EA-EST 1998b).[6] Picric and picramic acid[7] were detected at levels as high as 3.5 ppm just north of Elwood Point (Station 337) and 0.17 ppm immediately north of Pier 2 (Station 327) respectively in sediment samples collected during the Phase II Investigation in 1994. Additional sampling conducted during the 1997 Treatability Study at JPHC did not detect the presence of munitions compounds (e.g., RDX and 2,4,6-TNT) in sediment.

As part of Ecology's evaluation of sediment toxicity for Ostrich Bay, sediment samples were collected in October 2004 from 12 locations in Ostrich Bay and evaluated for compliance with the Washington State Sediment Management Standards. Chemical analyses included SVOCs, metals, explosive compounds, and sulfides, as well as four bioassay tests. The results showed that both biological and chemical concentration-based regulatory criteria were exceeded in some instances (Ecology 2005).

[5] The Washington State SQS standard for mercury is 0.41 ppm
[6] Confirmation should be obtained either by using dual-column or mass spectra methods
[7] Picric acid is an explosive compound that was produced at NAD (see previous Text Box). This compound can also occur as a common breakdown product of tetryl, which was used at NAD to make certain explosives. Picramic acid is a breakdown product of picric acid.

For metals, only mercury exceeded regulatory standards (6 of 12 sampling stations exceeded the established sediment quality standard of 0.41 ppm; maximum detected mercury concentration in sediment = 0.48 ppm-dry weight). RDX was the only munitions compound detected in the sediment samples collected from Ostrich Bay (Maximum concentration = 0.38 ppm–dry weight). All RDX detections in sediment were reported to be estimated concentrations that were less than the method reporting limit, but greater than or equal the method detection limit. Most SVOCs were detected at low concentrations below their respective sediment quality standards or not detected at all. The results of the bioassay tests also showed a notable improvement in sediment toxicity compared to 1994 and 1997 sediment toxicity investigations (Ecology 2005).

Marine Tissue Sampling Data

Past Sampling Investigations: Sampling of marine tissue in Ostrich Bay began in 1988 from the intertidal area adjacent to JPHC. A total of six marine tissue investigations have been conducted in association with the JPHC site since 1988. Long-term monitoring of marine tissues for selected contaminants within Ostrich Bay is ongoing and the most recent data available (Summer 2004) are presented in this report. Table 2 presents the maximum concentrations and the sampling location of marine tissue samples collected from Ostrich Bay that exceeded their respective health-based screening values.

In 1988, samples were collected from a small number of marine species that included fish tissue (English sole and skate muscle), crabs, bivalves (i.e., clams), and sea cucumbers from Ostrich Bay and portions of Dyes Inlet. All marine tissues collected in 1988 were analyzed for metals, munitions compounds, VOCs, SVOCs, pesticides, and PCBs (Hart Crowser 1988). Most compounds were either not detected or detected at very low concentrations in marine tissue samples. Arsenic and bis(2-ethylhexyl)-phthalate (BEHP) exceeded their respective health-based screening values in clams and in English sole. BEHP is a common laboratory contaminant and may not truly reflect levels in the ambient environment. During the 1988 sampling effort arsenic was detected as high as 2.9 ppm in clams and 11 ppm in English sole. BEHP was detected as high as 0.47 ppm in clams and 2.1 ppm in sole and skate (Table 2) (Hart Crowser 1988).

Table 2. Maximum Concentrations of Marine Tissue Samples Collected within Ostrich Bay that Exceeded EPA's Region III Risk-based Concentrations (RBCs) for Fish Tissue (1988-2002).

Chemical	*Study* [1]	*Frequency of detection in Marine Tissue*	*Maximum Concentration (ppm)*	*Location of Max (ppm)*	*RBC-F (ppm)*
Bivalve (clam) tissue					
Antimony*	1991	5/45	15.3	MS-11	0.54
Arsenic *	2002	15/15	35.6 (4.7 wet wt)	Station 13	0.002
	2004	18/18	37.4	Station 34	
BEHP[4]	1991	7/45	4.4	MS-08	0.23
DCB[4]	1991	3/27	4.3	MS-05	0.007
RDX [4]	2002	2/15	0.46	Station 2	0.029
Vanadium*	1991	1/18	1,066	MS-28	1.4
Crab tissue					
Antimony*	1991	7/35	19.7	MS-26	0.54
Arsenic*	2002	10/10	64.1 (13 wet wt)	Station 1	0.002
	2004	13/13	66.4	Station 3 (FD)	
Mercury*	1991	25/35	0.27	MS-06	0.14
Vanadium*	1991	1/35	2.2	MS-25	1.4
Fish (English sole and skate muscle tissue)					
Arsenic*	1988	2/2	11	NA	0.002
BEHP	1988	2/2	2.1	NA	0.23
Heptachlor[5]	1988	1/2	0.013	NA	0.0007
Sea cucumber tissue					
BEHP	1988	1/1	0.56	NA	0.23

Sources: Hart Crowser 1988; URS 1994a, EFANW 2003

[1]Samples collected in 1988,1991,1997 and 2002 correspond with the Hart Crowser Investigation, Phase I RI, Treatability Study, and the OU1 LTM Program respectively.
[2] RBC-F = EPA Region III Risk Based Concentrations for Fish Tissue. Only inorganic compounds reported as wet weight concentrations should be compared with EPA's RBC-F values.
[3]Not available.
[4] BEHP=bis(2-ethylhexyl)phthalate; DCB=3,3-dichlorobenzidine; RDX = Cyclotrimethylenetrinitramine (also known as Royal Demolition Explosive).
[5] The maximum concentration of Heptachlor was detected in the skate muscle sample.

Note: ATSDR did not calculate estimated doses for DCB and Vanadium because they were detected infrequently (i.e., < 10 percent of the time) in tissue samples.

* Unless otherwise specified, inorganic compounds (i.e., antimony, arsenic, mercury, and vanadium) are reported as dry weight. Dry weight concentrations are generally higher than concentrations reported as wet weight and cannot be directly compared to other data reported as wet weight.

FD = field duplicate

In 1991, during the Phase I RI for JPHC, shellfish samples (i.e, clams and crabs) were collected from locations throughout Ostrich Bay and portions of Dyes Inlet (EA-EST 1998b). As previously noted with the analyses of sediments, the munitions-specific data associated with tissue samples collected during the Phase I Study did not meet acceptable quality assurance and quality control (QA/QC) standards. Other compounds including arsenic, BEHP, and mercury were detected frequently with some of the detected samples exceeding their health-based screening values in both crabs and clams (see Table 2).

In 1997, during the Intertidal Clam Study, the Navy collected additional samples of clams at locations near Erlands Point and the JPHC shoreline. Clams were collected from six sampling locations and analyzed for arsenic, antimony, thallium, mercury, vanadium, pentachlorophenol, 3,3'-dichlorobenzidine, and BEHP (EA-EST 1998a). The rationale for the selection of these contaminants for analysis was based on the results of the Phase I Study. Arsenic was detected above background concentrations in clams, at levels as high as 15 ppm. No other chemical contaminants were detected at levels exceeding their health-based screening values during the Intertidal Clam Study (EA-EST 1998b).

In July/August 2001, Ecology collected shellfish (clams and crabs) samples from portions of Dyes Inlet in order to confirm earlier sampling efforts that showed elevated concentrations of some contaminants (e.g., antimony, BEHP, and PAHs) in edible shellfish tissue. A total of three composite crab samples from Ostrich Bay were analyzed for antimony, BEHP, and PAHs. The results of this sampling effort showed no detectable concentrations of any of these compounds in shellfish samples collected from Ostrich Bay.

Current Sampling Investigations: Monitoring of Ostrich Bay has continued through the OU 1 long-term monitoring (LTM) program, established in 2000. According to the LTM program, the Navy agreed to collect crabs from the subtidal zone and clams from the intertidal zone at JPHC every two years (EFANW 2002). During the first round of LTM samples collected in 2002, two munitions compounds[8], RDX (0.46 ppm) and 4-amino-2,6-dinitrotoluene (0.28 ppm) and one

[8] The analytical results of munitions compounds detected in shellfish samples were qualified as estimated concentrations

metal, arsenic (64.1 ppm), were detected in shellfish (EFANW 2003). The most recent tissue sampling event was conducted in 2004. Arsenic concentrations in clam and crab tissue in 2004 were very similar to the 2002 sampling. The maximum detected arsenic concentration was 37.4 ppm (dry weight) in clam tissue and 66.4 ppm (dry weight) in crab tissue. RDX was detected in three clam tissue samples at slightly lower concentrations (max = 0.3 ppm) than during 2002 sampling (U.S. Navy 2005b).

In the 2005 Five-Year Review, the Navy recommended conducting tissue samples at five year intervals (U.S. Navy 2005b). Representatives from EPA Region 10 and the Navy continue to discuss the frequency of future shellfish monitoring in Ostrich Bay as EPA believes that the two year sampling interval should be maintained.

The most recent monitoring of crab and clam samples occurred during June/July, 2004. During this sampling round crab and clam samples were collected as part of the long-term monitoring agreement. Explosive compounds were not detected in most of the tissue samples. RDX was detected at an estimated maximum concentration of 0.28 ppm at three clam sampling stations. No explosive compounds were detected in crab tissue samples. Arsenic was also detected in all tissue samples with a maximum estimated concentration of 66.4 ppm (dry weight) in crab tissue (NAVFAC 2005a).

Evaluation of Potential Public Health Hazards

Chemical Contamination: In 1998, Dyes Inlet and Port Washington Narrows were placed on Washington State's list of impaired water bodies based on elevated levels of metal and organic contaminants detected in edible tissues of certain shellfish species. Chemical contaminants associated with historical releases from the former NAD have impacted the marine environment in Ostrich Bay. Current advisories issued by the Kitsap County Health District prohibiting commercial and recreational shellfish harvesting from Ostrich Bay and most other portions of Dyes Inlet have been in place since 1969 (Kitsap Sun 1998). However, other reports have stated that clam harvesting was permitted until 1991 (Hart Crowser 1988; URS 1996). Additionally, there are fish advisories posted for Ostrich Bay for ordnance-related compounds in all bottom fish, shellfish, and crab.

The activities associated with the former NAD resulted in unknown quantities of munitions compounds being released into Ostrich Bay for more than 50 years. Based on this information, investigators expected that munitions-related chemicals would be detected in the intertidal and subtidal sediments and in marine organisms sampled from the bay. However, munitions compounds were either not detected or only low levels were detected (e.g., picric acid and RDX) in either sediments or marine tissue during Navy investigations.

Although few munitions compounds were detected in Ostrich Bay there is some uncertainty as to the true concentration of these contaminants in sediments and marine tissues, especially with respect to the degradation compounds that may not be accurately measured or included in the suite of compounds that were analyzed. During two of the early Navy investigations most of the munitions data were rejected due to issues related to the analytical method used. Although the Navy used accepted analytical methods at the time, the true concentrations of the munitions compounds could not be determined. Among the validated data, the munitions-related compounds most frequently detected in sediments and marine tissues were RDX and picric acid, which are typically more persistent in the environment than other explosives compounds such as tetryl and 1,3,5-TNT(Battelle 2003).

ATSDR reviewed two recent studies that referenced munitions data collected from Ostrich Bay (Carr 2001; Nipper 2002). These studies were designed to evaluate the toxicity of surface sediments and pore water[9] from sediments and to identify specific compounds responsible for the observed toxic effects in selected marine organisms. These studies provide some additional perspective on the likely impacts of NAD-related contaminants in Ostrich Bay. Both studies concluded that concentrations of the parent munitions compounds in pore water from Ostrich Bay were not at high enough levels to account for observed toxicity in tests (e.g., fertilization and embryological development tests) in selected marine organisms. Although some specific compounds were mentioned as likely causative agents of toxicity (e.g., PAHs, PCBs, pesticides), it was also noted that not enough is currently known about the degradation products of munitions compounds in marine sediments and these may play a significant role in toxicity effects (Carr 2001; Nipper 2002). Given the potential for munitions-related compounds to have been released

[9] Pore water is the water filling the spaces between grains of sediment

into Ostrich bay, the nature and extent of degradation compounds should be carefully considered in any future investigations.

Bacterial Contamination: In addition to NAD-related contamination, bacterial pollution, primarily associated with the discharge of raw sewage from municipal outfalls, has impacted the marine environment in portions of Dyes Inlet, including Ostrich Bay. The Washington State Department of Health (WDOH) has classified most portions of Dyes Inlet as "prohibited" for commercial shellfish harvesting due to chemical and bacterial contamination (WDOH 2001). WDOH, Office of Food Safety and Shellfish, is responsible for classifying commercial shellfish growing areas in Washington State. Areas are classified as "*Approved," "Conditionally Approved," "Restricted,"* or "*Prohibited."* These classifications are based on a WDOH shoreline survey for potential contamination sources, and WDOH marine water monitoring for fecal coli bacteria.

The city of Bremerton has made improvements to its wastewater collection system that has largely eliminated the amount of wastewater combined with storm water that is released into the Port Washington Narrows during heavy rainfall. Port Washington Narrows is the body of water leading into Dyes Inlet. Bacterial levels in the inlet have steadily declined in recent decades. In October 2003, WDOH issued an initial order upgrading portions of northern Dyes Inlet between Silverdale and Bremerton from "prohibited" to "conditionally approved" (WDOH 2003). The permitted shellfish harvesting areas do not include Ostrich Bay, but do include nearby Erlands Point, primarily the portion facing Chico Bay.

Past Exposure

During the operation of the former NAD unknown quantities of materials and chemicals related to the development, manufacturing, and storage of munitions were released and/or disposed of into the intertidal portions of Ostrich Bay along what is currently the shoreline of JPHC. ATSDR believes that the past use of Ostrich Bay and the intertidal area at JPHC for recreational fishing and shellfish harvesting represented a completed exposure pathway. It is reassuring that the results of recent fish and shellfish sampling within Ostrich Bay and near Erlands Point show that the concentrations of contaminants ***are not*** at levels known to cause illness or health effects.

However, given the history of the former NAD site and the limited current information concerning the nature and extent of munitions contamination in Ostrich Bay, there is not sufficient information to conclude that the fish and shellfish consumed in the past were safe to eat. ATSDR used the following information to determine its conclusion.

On the basis of information presented in site documents, it is possible that prior to 1991 people were harvesting and consuming fish and shellfish from portions of Ostrich Bay in close proximity to the JPHC shoreline (Hart Crowser 1988; US Navy 1992). ATSDR has not been able to confirm this information is accurate and is not consistent with the shellfish advisories that were issues by Kitsap County in 1969. The average frequency and duration of fish and shellfish consumption from Ostrich Bay is not known. The longest tour of duty for JPHC residents is typically less than six years, so this would likely represent an upper bound limit on exposure duration. The earliest sediment and biota (i.e., fish and shellfish) data available for Ostrich Bay were from 1988. Since 1991, the Navy banned fishing and shellfish harvesting at JPHC beaches and posted signs along the JPHC waterfront that state the prohibition of shellfish harvesting in several languages common to the area (US Navy 1992). However, there is limited information about the nature and extent of contamination of fish and shellfish prior to 1991.

The quality of the munitions-related data from several of the Navy investigations are generally not reliable for evaluating the potential public health hazard associated with past consumption of shellfish and other marine organisms from Ostrich Bay. The available munitions data of sufficient reliable quality suggests that the bioaccumulation of most munitions compounds is not occurring at levels that would be of human health concern. These findings are consistent with what is known about the persistence and bioaccumulation potential of many of the explosive compounds that had been used at the former NAD. The lack of munitions data for earlier time periods combined with some uncertainty about what the more recent levels are make it difficult to evaluate any potential past exposures.

Current and Future Exposure

Kitsap County Health Department has a *current* advisory not to consume shellfish, bottom fish, or crab from the west side of Ostrich Bay in Dyes Inlet in the vicinity of the Jackson Park Naval housing development (WDOH 2005). The Navy does not permit fishing or shellfish harvesting along any portion of the JPHC shoreline. Commercial harvesting of shellfish in Ostrich Bay is prohibited and the state may issue fines for people who violate the commercial ban. In addition, the Kitsap County Health District has an ongoing advisory recommending against harvesting shellfish in Ostrich bay. Commercial harvesting of sea cucumbers is permitted in Ostrich Bay

(U.S. Navy 2005a; Michael Ulrich, Division of Fish and Wildlife, Personal Correspondence, June 9, 2005). The Navy and the State of Washington have observed only isolated instances of recreational shellfish harvesting in the bay in recent years; however, more precise harvesting and consumption information for Ostrich Bay are not available.

The state permits shellfish harvesting in selected portions of Dyes Inlet near Ostrich Bay, such as Erlands Point. The close proximity between permitted and banned harvesting zones may draw people inadvertently into restricted shellfish harvesting zones and signs prohibiting harvesting shellfish may not always deter people from utilizing the abundant shellfish resources in Ostrich Bay. Currently, it does not appear that Ostrich Bay is being utilized as a significant shellfish resource and contaminant levels in bottom fish and shellfish samples were not detected at levels known to cause health effects in people.

ATSDR evaluated whether the historical release of site-related contaminants into Ostrich Bay could result in future human exposure through bioaccumulation in the food chain if this resource is used as a fish and shellfish harvesting area in the future. The western portion of Ostrich Bay is closed to commercial and recreational shellfish harvesting primarily because of contamination associated with the former NAD. However, Ostrich Bay may also pose a physical hazard if people were allowed to fish and harvest shellfish in the future. Until the Navy demonstrates that Ostrich Bay, in general, and specifically the intertidal locations surrounding the shoreline of JPHC do not pose a physical hazard, ATSDR does not support allowing fishing or harvesting activities in the future. The potential for physical hazards in the marine environment is addressed later in this PHA.

With respect to chemical contamination, we believe that continued monitoring is needed to more adequately assess the nature and extent of parent munitions compounds and their degradation products in common edible fish and shellfish species (e.g., English sole, crabs, clams, and geoducks). The Navy is conducting long-term monitoring for selected metals (i.e., antimony, arsenic, vanadium), SVOCs (i.e., 3,3-dichlorobenzidine and pentachlorophenol [PCP]), and munitions compounds in crab and clam tissue. Although current monitoring efforts do not indicate harmful concentrations of contaminants in marine organisms, a more comprehensive

assessment (e.g., adequacy of analytical detection limits) of munitions-related compounds is needed to ensure the safety of people who use Ostrich Bay as a future resource for fish and shellfish.

Recent groundwater and seep monitoring indicates that benzene levels are increasing at some locations (NAVFAC 2005b). According to a recent evaluation of the BRA, the existing seeps do not adequately represent groundwater discharge to surface water. Installation of new point of compliance monitoring well points in the beach area east of the seawall may be needed (Batelle 2008).

As previously noted, we believe that most people do not currently consume bottom fish or shellfish from Ostrich Bay on a frequent basis. Restrictions on commercial harvesting and advisories for recreational harvesting are posted. ATSDR did evaluate whether contaminants detected with some frequency (i.e., detected more than 10 percent of the time) in fish and shellfish samples would likely exceed ATSDR's health-based screening values. ATSDR calculated exposure doses for three target populations; 1) JPHC residents; 2) non-JPHC recreational fishers and harvesters; and 3) a subsistence fishing population (with site-specific fish and shellfish ingestion rates based on the 90^{th} percentile consumption rates reported in the Suquamish Tribe's Fish Consumption Survey). The methodology, exposure assumptions, and dose tables for this evaluation are presented in Appendix C.

ATSDR's evaluation of potential future exposures shows that consumers of fish and shellfish from Ostrich Bay may be exposed to a few contaminants that exceed ATSDR's health-based screening values (see Tables C-2a through C-2c). However, the only two chemicals that substantially (i.e., more than 10 times) exceed their respective screening values are antimony and arsenic in shellfish. As mentioned in previous sections of this PHA, it is important to keep in mind that the health-based screening values are *not* thresholds of toxicity. Additionally, we believe that the levels of arsenic and antimony detected in shellfish do not pose a health hazard for consumers of fish and shellfish in Ostrich Bay for the following reasons:

1. A review of the toxicological literature shows that, for both antimony and arsenic, the estimated doses, which are based on the maximum concentrations detected in Ostrich Bay using very health-protective assumptions, are generally below levels known to be associated with adverse health effects (ATSDR 1992; 2000).

2. With respect to antimony, any likelihood of harmful exposure is further diminished when considering that antimony was detected in tissue samples fewer than 20 percent of the time. Moreover, recent shellfish monitoring suggests that the maximum concentration of antimony (19.7 ppm) detected in crab is not a true measure of what people would likely be exposed to, even in the most contaminated portions of Ostrich Bay. It is reassuring that antimony has not been detected in shellfish over the last two long-term monitoring sampling events conducted by the Navy (EFANW 2003; 2004).

3. Although arsenic was detected with greater frequency, most arsenic found in fish and shellfish is in the organic form.[10] Organic arsenic exhibits much lower toxicity than the inorganic form, which is typically found in minerals, either dissolved in water or in soils and sediments. In order to account for this large difference in toxicity, we assumed that only 10% of the total arsenic detected in shellfish tissue represents the inorganic form. This is very conservative and likely overestimates the toxicity from the reported concentrations.

4. The concentrations for all metals in tissue samples were reported as dry weight values. Although these dry weight values were used in estimating dose, dry weight concentrations are typically much higher (by a factor of 4 or more) than wet weight concentrations.

[10] Most of the arsenic in fish and shellfish is in an organic form. These organic forms of arsenic are of significantly less health concern because they are relatively non-toxic as compared to inorganic arsenic. In fish and shellfish, studies have typically shown that between 2 to 10 percent of the total arsenic is in the form of inorganic arsenic or its methylated metabolites (ATSDR 2000; 2004).

2. Potential exposures from coming into contact with surface soils at JPHC

Issue:

Are people who live at JPHC coming into contact with contaminated soil at levels that could pose a health hazard?

Characterization of Potential Exposure Pathway

The terrestrial portions of JPHC supported over 80 industrial facilities at the former NAD between 1904 and 1959, including munitions storage depots, manufacturing plants and handling facilities, laboratories, maintenance shops, fuel and utility stations, rail yards, landfills, burn pads, incinerators, and munitions burn areas (FWEC 2002a). Subsequent environmental investigations in recent years have identified contamination in surface soils associated with NAD activities, including munitions items and munitions-related compounds, fuel components, and metals. Residents at JPHC could potentially become exposed to contaminated surface soils by directly coming into contact with or ingesting soil. During previous investigations, the Navy identified contaminated soil near beaches, recreational areas, and residential upland areas of JPHC. The Navy has conducted several soil removal actions as a result of identifying contaminated soils in places accessible to both children and adults. The next section will summarize the available information regarding the nature and extent of contamination in surface soil throughout JPHC.

Nature and Extent of Contamination

Since 1991 the Navy has conducted four investigations at JPHC where soil samples were collected and analyzed for VOCs, SVOCs, PAHs, pesticides, PCBs, metals, and munitions compounds. According to site maps and Navy reports, there were several burn areas and at least two former incinerators that operated at the former NAD. Dioxin compounds, which are common byproducts of burning or incineration, were not included in any of the terrestrial surface soil analyses conducted by the Navy. However, most of the surface soil in areas adjacent to former burn pads and incinerators has been removed and covered with clean fill. Therefore, it is unlikely that past activities associated with the NAD burn pads or incinerators are impacting surface soils at the housing complex.

The Navy analyzed surface soil at JPHC as part of the 1993 (Site 110) investigation, 1994 Phase I and II RI, and 2001-2002 (Site 110) PAH soil sampling event. During the PAH soil sampling event, the Navy collected surface soil samples from the upland portion of JPHC within Site 110, near Buildings 583 and 584, and analyzed the samples for PAHs (FWEC 2002c). Table 3 presents contaminants detected in surface soil above ATSDR's health-based screening values during past soil investigations at JPHC. These results are summarized below.

RI— Phase I and Phase II: Between 1991 and 1993, the Navy collected 774 soil samples, from both the surface and subsurface, from Sites 101, 101A, and 103 as part of the Phase I and Phase II RI. Surface soils were collected from 48 sampling locations at Sites 101 (6 locations), Site 101A (13 locations), and Site 103 (29 locations) (URS 1995). A large number of soil samples were collected along Root Court within Site 101A, southwest of the Demolition Debris Landfill, and at recreation facilities in Elwood Point. At Site 101, sampling occurred near Pier 2 and adjacent Elwood Point (URS 1994a; 1995).

Arsenic was detected in surface soil samples collected near the fishing pier at a maximum concentration of 61.1 ppm. Other metals (i.e., antimony, cadmium, and lead)) were also detected infrequently (i.e., detected less than ten percent of the time) in surface soil samples collected from Sites 101A and 110.

Some PAHs, specifically benzo(a)pyrene, benzo(a)anthracene, and benzo(b)-flouranthene exceeded ATSDR's health-based screening values at several locations at Sites 101, 101A, and 103, with the highest concentrations found in surface soil samples collected at Elwood Point. With the exception of Site 103, PAHs were not detected in more than 10 percent of the samples collected. Low levels of VOCs (1,1,1-trichloroethane, ethylbenzene, toluene, and xylene) and pesticides were detected at Sites 101, 103, and 110. PCBs were detected at very low concentrations in surface soils from Site 103 (URS 1994a; 1994b).

Surface soil samples from all 49 sampling locations at Sites 101, 101A, and 103 were analyzed for a target list of munitions compounds. Munitions compounds (picric acid, picramic acid, RDX, and tetryl) were detected at low concentrations in surface samples from the central

shoreline at Site 101 and Site 103 at Elwood Point. No munitions compounds were detected at Site 101A (URS 1994a; 1994b).

Site 110 Investigation (1993): During the 1993 Site 110 Investigation, additional surface soil samples were collected from 76 locations throughout the large upland portion of JPHC, west of Sites 101, 101A, and 103 (URS 1994c). Arsenic (220 ppm), lead (1,020 ppm) and PAHs (3.2 ppm – benzo-a-pyrene) were detected above ATSDR's health-based screening values in samples collected within Site 110, near Buildings 583 and 584. The Navy analyzed 107 surface soil samples throughout Site 110 for munitions compounds. Many samples contained trace amounts of munitions compounds (e.g., picric and picramic acids, nitrobenzene, trinitrobenzene, and dinitrotoluene), but none exceeded their respective screening values (URS 1994c).

Site 110 PAH soil sampling (2001-202): In 2001-2002, the Navy collected additional surface soil samples from the upland portion of JPHC, east of Buildings 583 and 584, and analyzed the samples for PAHs. No PAHs exceeded ATSDR's health-based screening values during the 2001–2002 sampling effort (FWEC 2002c).

Table 3. Results of JPHC Surface Soil Samples Exceeding ATSDR Screening Values

Chemical	*Detection frequency*	*Maximum Concentration (ppm)*	*Location of Max*	*Ref Value (ppm)*	*Source*[5]
Site 101					
Arsenic	7/7	56.2	MW-5	20	Chronic EMEG-C
Benzo(a)pyrene	4/8	0.18	SB-22	0.1	CREG
Site 101A					
Antimony	1/18	69.9	SB-5	20	RMEG-C
Cadmium	1/18	12.9	SB-5	10	Chronic-EMEG-C
Benzo(a)pyrene	1/18	0.18	MWA-8	0.1	CREG
Site 103					
Arsenic	33/33	63.1	MW-7	20	Chronic EMEG-C
Benzo(a)anthracene	11/34	1.1	SB-16	0.87	RBC-RS
Benzo(a)pyrene	13/34	1.6	SB-16	0.1	CREG
Benzo(g,h,i)perylene	7/31	0.68	MW-18	NA	
Dibenz(a,h)anthracene	3/34	0.63	SB-16	0.087	RBC-RS
Indeno(1,2,3-cd) pyrene	11/34	1.3	SB-16	0.87	RBC-RS
Site 110					
Arsenic	11/107	220 J	USS-7	20	Chronic EMEG-C
Lead	3/107	1020	USS-7	400	EPA
Benzo(a)anthracene	6/110	3.1	SS-67	0.87	RBC-RS
Benzo(a)pyrene	7/110	3.2	SS-67	0.1	CREG
Benzo(b)flouranthene	10/110	3.1	SS-67	0.87	RBC-RS
Dibenz(a,h)anthracene	5/110	0.750 J	SS-57	0.087	RBC-RS
Indeno(1,2,3-cd)pyrene	5/110	1.7	SS-67	0.87	RBC-RS

Sources: URS 1994a, 1994b, 1994c, 1995

[1] RBC-RS = EPA Region III Risk Based Concentrations for residential soil.
[2] NA-Not available.
[3] J=estimated value.
[4] Source Key for (1) ATSDR Comparison Values.
CREG-Cancer Risk Evaluation Guide for $1x10^{-6}$ excess cancer risk.
EMEG-(c)-Environmental media evaluation guide (for children).
EPA = EPA action level for lead in residential soil.
RBC-RS = risk based concentration for residential soil.
RMEG-(c)- Reference dose media evaluation guide (for children).

Evaluation of Public Health Hazards

ATSDR evaluated whether contact with surface soils at JPHC in the past, currently, or in the future could result in harmful exposures to site-related contaminants. People may accidentally ingest soil and dust generated from soils during normal activities. Children, especially those of preschool age, tend to swallow more soil or dust than any other age group because of daily activities that allow more frequent contact with soil and because they tend to have more hand-to-mouth activity. Older children, teenagers, and adults tend to swallow much less, but still may inadvertently ingest small amounts of soil. The amount of grass cover in an area, the amount of time spent outdoors, and weather conditions also influence how much soil contact people may have.

Beginning in 1966, residential housing was constructed in several phases at the former NAD site. Most of the original buildings had been demolished to make room for the new housing. According to the Navy, some terrestrial areas received clean fill and/or soils were redistributed and graded before construction of JPHC (Karan Holmes, The US Navy's Engineering Field Activity Northwest (EFANW), Personal Correspondence, September 2004). It is evident that prior to the construction of most phases of military housing at JPHC there was no systematic plan in place to evaluate the presence of site-related contamination. Some of the areas at JPHC received clean fill whereas others received fill from other locations on site, which may have been contaminated. As a result, areas of surface soil contamination have been found across many portions of the site.

Since environmental investigations began, the Navy has implemented remedial or interim actions at multiple locations at JPHC. These actions include the removal of contaminated surface soil from Site 110 and the excavation of soils and the disposal of drums from a disposal area in the northeast portion of the site, near the intersection of Olding Road and Elwood Point Road (U.S. Navy 2000; FWEC 2002). Additional remedial actions at Sites 101, 101A, and 103 have included improved drainage systems, promotion of vegetative growth over a recently placed soil cover to prevent coming in contact with contaminated soil, and shoreline stabilization (e.g.

placing large rocks near the shoreline) to prevent soil and sediment erosion that could potentially release contamination into Ostrich Bay.

Past Exposure

According to site documents, the first site investigations measuring levels of chemical contamination in soil began in 1991. Prior to that time the primary terrestrial site characterization involved removing any potentially explosive or dangerous munitions items that was or could become accessible to people living at JPHC. Although current contaminant concentrations in surface soil are not at levels of health concern, there is no information about what levels of contamination may have been in the surface soil when people were living in the housing area during the mid-1970s and throughout the 1980s. Furthermore, we know that children and adults used many portions of the site for recreational purposes prior to any remedial activities taking place. Although it does not appear likely that contaminant levels in surface soils were high enough to pose a public health hazard, ATSDR does not have sufficient information to make a conclusive statement about past exposures.

Current and Future Exposure

Other than arsenic, which has been detected in surface soils collected at JPHC, and PAHs, which have been detected infrequently in some portions of the site, recent analyses of contaminants in surface soil do not indicate widespread chemical contamination and no contaminants have been detected at levels that are known to cause health effects in people. The Navy has taken numerous steps to mitigate any potential exposure to chemical contaminants in soil at JPHC. These remedial actions have resulted in the removal of contaminated soils and placement of clean fill in recreational areas and other portions of the housing complex where people may be most likely to come in contact with contaminated soil. ATSDR does not believe that munitions-related compounds pose a chemical exposure hazard since the data show very low levels present in surface soil. The data are consistent with what is known in general about the persistence and environmental fate in soil of many of the explosive compounds used at the former NAD.

3. Potential for coming into contact with munitions-related items in the terrestrial and marine environment.

Characterization of the Issue

Are people living at or in close proximity to JPHC at risk of coming into contact with explosive materials or other potentially hazardous items that remain from former NAD operations?

Characterization of Potential Exposure Pathway

JPHC has been used to house military personnel stationed in the area since the late 1960s. No industrial or munitions operations are currently taking place at any locations on site and have not occurred since 1959. Munitions and munitions-related items have been discovered in numerous locations since JPHC was constructed, both in the terrestrial soils and marine sediments. Children and adults may come into contact with munitions-related items through their daily activities such as walking, playing in fields or in heavily vegetated areas, and by digging beneath the ground surface. Although the likelihood of people coming in contact with munitions-related materials appears to be very low, access to most portions of JPHC is not restricted and unsupervised children could come into contact with dangerous munitions items that remain buried below the surface or hidden in heavily vegetated areas.

During the time that the site has been an active military housing area there have been no reported incidents of residents of JPHC being physically harmed by MEC. However, the Navy does not maintain a log or record of incidents where people have come into contact with munitions items associated with the former NAD (Karan Holmes, EFANW, Personal Correspondence, July 22, 2004). The 2002 Archive Search Report states that explosive ordnance disposal (EOD) incident reports are completed each time the Navy investigates an item suspected to be munitions-related. These EOD reports are normally retained for only three years; however, through archival searches investigators have found some older reports that describe prior incidents where munitions-related items were identified (FWEC 2002a). The next section will summarize some of the investigations that have been conducted at JPHC to locate and retrieve MEC items that have been identified on land or in the intertidal areas of JPHC.

Nature and Extent of Contamination

According to historical records, the two most common methods of disposal for waste munitions and related materials during the operation of the former ammunitions depot was either by burning on land or deepwater disposal (e.g., releasing the waste materials in approved designated locations). Records reviewed by the Navy documented the disposal of hundreds of tons of material, including large quantities of smokeless powder, using these two methods (FWEC 20002). In addition, some burial of munitions-related materials may have occurred in the more remote portions of the site, specifically the northern and northwestern portions of JPHC.

According to site reports, the shoreline of JPHC was primarily used for production and is not likely to contain large quantities of buried wastes. However, buried munitions may also be present in on-site fill materials used to level or fill other portions of JPHC (FWEC 2002b). Fill used to extend portions of the JPHC shoreline and has resulted in contamination along the shoreline and intertidal areas.

What types of munitions-related items might be buried on land or in Ostrich Bay?

Canisters: Some of the canisters were filled with explosive compounds or small arms ammunition.

Flares and Tracers: For example, projectiles or ammunition chemically treated to glow or give off smoke.

Fuzes: Detonating fuzes, mechanical time fuzes, and other types of fuzes.

Grenades: Small bombs with a bursting radius of about 30 yards that can be hurled a short distance by hand or rifle.

Projectiles: Five-inch and 14-inch were most commonly produced. Some larger projectiles have been found on site.

Small Arms Ammunition: A recent investigation (2003-2004) identified a total of 278 small arms rounds in the northwest portion of the housing area behind a historical munitions bunker.

Smokeless Powder: A nitrogen-based explosive used at NAD. Open burning of smokeless powder, primers, and powder boxes occurred at Elwood Point and other unspecified locations.

Other Munitions-related Items: Cartridges (20mm and 40mm), Munitions Casings, and Rocket Motor Assemblies have all been found at JPHC.

Note: These were the most frequently produced items at NAD Puget Sound and does not represent all munitions-related items that could be found at JPHC.

According to Navy reports, an initial demolition investigation and removal of approximately 8,000 munitions/ordnance items from the water occurred in 1975 (WDOH 1990). Several additional munitions recovery efforts at JPHC have occurred since 1975 ranging from individual items discovered during routine site activities to more extensive clearances of munitions near the

former munitions loading piers (FWEC 2002a). Recent munitions investigations and removals have occurred at JPHC including three distinct munitions-related investigations since 1997:

1) A pre-remedial investigation conducted between June 1998 and March 1999;

2) An investigation conducted in support of shoreline and marine improvements required in the OU 1 Record of Decision (ROD) (The ROD was signed in August 2000); and

3) A Time Critical Removal Action for OU 3 authorized in July 2000 (FWEC 2002b).

As part of the Archive Search Report, which was conducted in two phases between 1998 and 2001, the Navy searched and evaluated historical building and land-use records associated with the former NAD. These records do not provide a complete assessment of how or where abandoned munitions or munitions-related wastes were disposed throughout JPHC. However, historical land uses in certain portions of the site identified through archival searches are well correlated with locations of subsurface anomalies detected during recent geophysical investigations. The findings and significance of these investigations are discussed below.

Terrestrial: Munitions and munitions-related waste have been discovered mostly along and within a few hundred feet of the shoreline of JPHC. Some additional hot spots (i.e., grids containing munitions-related items) have been identified in scattered locations across the remainder of the housing complex. These include both inert (i.e., limited ability to react with other chemicals or materials) and potentially reactive or explosive munitions items (FWEC 2002b). Initially, munitions items released from buildings or land operated vehicles during NAD operations would have likely been deposited onto the surface or possibly shallow subsurface soil. However, these items, which vary considerably in size and weight, could have been relocated to other areas of the site at varying depths beneath the surface through various modes of transport. The most significant transport mode is the use of contaminated fill materials and re-grading or construction activities.

During the MEC investigation conducted from June 1998 to February 1999, more than 500 anomaly locations were investigated along the shoreline of JPHC/NHB and in adjacent areas. An additional 2,150 anomaly locations were investigated near BNH. In the shoreline areas, 201

MEC items, 5,780 MEC waste items, and 1,375 MEC scrap items were recovered. In the hospital grids, 110 MEC items, 747 MEC waste items, and 255 MEC scrap items were recovered. Additional MEC were recovered during clearance activities between 1999 and 2001 (Foster Wheeler 2002).

Beginning in March 2003, the Navy conducted Phase 1 of a 2-phase RI, which included three steps: 1) vegetation removal, 2) surface clearance, and 3) digital geophysical mapping (DGM) of OU 3T. The surface clearance sweeps involved the removal of metallic debris and shallow munitions and related materials (less than 2 inches below the surface). Small arm munitions were found during the 2003 RI surface clearance phase in the top two inches of surface soil in the northwest portion of the housing area behind a historical munitions bunker. A total of 75,005 higher probability targets were identified through the Phase 1 RI (Karan Holmes, EFANW, Personal correspondence, September 2, 2004; Tetra Tech 2008).

The Navy conducted geophysical surveys to identify subsurface metallic anomalies at JPHC. A selected number of sub-surface anomalies identified will be investigated during Phase II of the RI. The Navy divided JPHC into nine main grid areas and Figure 5 shows the locations where MEC were identified on site. Most MEC were found along the JPHC shoreline and in the intertidal areas, primarily surrounding the former pier (Pier 1) and Pier 2, which still remains in tact. Although MEC has been discovered in the upland portions of JPHC, which is where most residential housing is located, MEC occurrences were isolated to a small number of grids. MEC were also identified within two grids located in close proximity to NHB (NAVFAC 2004).

During the Phase 2 RI, conducted between April and December 2007, a total of 9,460 individual anomaly locations were investigated. Two discarded military munitions containing high explosives were recovered through the investigation; a 40mm round in the housing area and a 40mm projectile in the intertidal area. A total of 23,913 anomalies were removed from the excavations (Tetra Tech 2008).

Marine: The most likely locations where MEC was released unintentionally into Ostrich Bay are the areas near former Pier 1 and the existing Pier 2 where live ammunition was transferred from ships, off-shore locations near Elwood Point where open burning activities occurred, and the shipping routes into and out of the former depot where munitions may have been accidentally dropped or released from transport vessels (FWEC 2003). During NAD operations unintended releases of munitions items into the bay occurred and it is also possible that larger releases or intentional disposal occurred in near shore and in deeper offshore locations without routine documentation (FWEC 2003).

According to Navy reports, the most prevalent items identified in the marine environment were small caliber rounds, 20mm, and 40mm projectiles (FWEC 2002a). Historical records indicate that a barge load of smokeless powder was released into Ostrich Bay, however, there are no other records indicating that munitions-related materials were disposed into the Bay (FWEC 2002a). On several occasions between 1959 and 1975 EOD divers were called upon to investigate the area near the former ammunitions piers. During this time approximately 20 bombs were recovered from the sediment surrounding the piers. In 1981, the Navy conducted a clearance of the pier area between the old railroad pier at Elwood Point and just south of the old oil pier and identified over 18,000 ordnance items buried in sediments to a depth of two feet. The items recovered included small arms, 16-inch projectiles, and 500-pound bombs (live and inert) (FWEC 2002a; FWEC 2003). Over 3,200 additional MEC items have been recovered between 1998 and 2002 (NAVFAC 2004).

Evaluation of Potential Public Health Hazards

ATSDR's evaluation considers current and future physical hazards associated with munitions and munitions-related items at JPHC. According to a recent hazard assessment conducted by the Navy, approximately 60 percent of JPHC and NHB have a medium-high or high relative hazard for munitions. This assessment was based on a series of conservative hazard assumptions that considered available information including present site utilization (FWEC 2002d). Although surface clearance sweeps have been conducted for the top two inches of soil across JPHC it is likely that some munitions items remain greater than two inches beneath the surface.

Although there have been no reports of injuries resulting from explosive materials or coming into contact with munitions, there is uncertainty as to the likelihood that these items could cause harm under certain conditions. JPHC personnel are aware of the potential physical hazards associated with the site and the Navy is proceeding with efforts to identify and clear existing munitions items. The greatest hazard does not appear to be in close proximity to the actual housing units, which are all located in the upland portion of the site. Relatively few munitions items have been found during the Phase I RI in large portions of the site where most of the residences are located. However, access to most portions of JPHC is not restricted and children could come in contact with potentially dangerous munitions items that are buried beneath the surface.

Past historical operations and activities at the former NAD and previous marine investigations indicate that a large number of munitions items likely remain buried underneath sediments within portions of Ostrich Bay, especially in close proximity to the shoreline. The Navy is expected to begin additional investigations within OU 3-Marine designed to evaluate the presence of munitions items in Ostrich Bay, especially the subtidal portions of the bay in close proximity to JPHC. Until these investigations are completed and the impacted portions of Ostrich Bay are deemed safe, JPHC residents, visitors, and other people who live in nearby communities should avoid the western portion of the bay for any recreational activities.

IV. COMMUNITY HEALTH CONCERNS

ATSDR identifies community health concerns through meetings with community members, state and local officials, and JPHC personnel, and through review of site documents, including RODs and Community Relations Plans.

- During the site visit, ATSDR met with a representative of the Suquamish Tribe to discuss tribal concerns about the future use of Ostrich Bay as a natural resource for harvesting fish and shellfish. The tribe's primary concern involves subsistence fishing/harvesting in Ostrich Bay and adjoining water bodies such as Chico Bay and the larger Dyes and Sinclair Inlets, which have been partially or entirely restricted by the state. Based on discussions with a Suquamish Tribe representative, the tribe understands the need for restrictions at this time but would like a possible timeline for having the restrictions lifted.

ATSDR will continue to compile and address any additional concerns that the community may have regarding site-related contamination associated with JPHC.

V. CHILD HEALTH CONSIDERATIONS

ATSDR recognizes that infants and children may be more sensitive to exposures than adults in communities with contamination in water, soil, air, or food. This sensitivity is the result of a number of factors. Children are more likely to be exposed because they play outdoors and they often bring food into contaminated areas. Children are shorter than adults, which mean they breathe dust, soil, and heavy vapors close to the ground. Children are also smaller, potentially resulting in higher doses of chemical exposure per unit body weight. The developing body systems of children can sustain permanent damage if toxic exposures occur during critical growth stages. Most importantly, children depend completely on adults for risk identification and management decisions, housing decisions, and access to medical care. Therefore, ATSDR is committed to evaluating their special interests at sites such as JPHC.

Approximately 1,100 children under the age of 18 live in JPHC and approximately 800 of these children are under 10 years old. Like other people living or working at or near JPHC, children may come into contact with contaminated site media. Past, current, and future exposures for children living at JPHC could include coming into contact with and ingesting surface soil and unearthing munitions or munitions-related items. Young children under the age of 10 are at increased risk of being harmed by munitions items because they are unlikely to be aware of the potential physical hazards and would have a tendency to play with unfamiliar objects rather than stay away from them. The Navy has developed informational materials such as coloring books and word games that help educate children to potential dangers associated with certain activities at JPHC.

As indicated in previous sections, past exposures to contaminated soil and from consuming fish and shellfish are considered indeterminate. To evaluate whether children may experience adverse health affects from current or future exposures to site contaminants, ATSDR estimated the potential chemical-specific doses for children coming into contact with surface soil or consuming fish or shellfish from Ostrich Bay. To estimate these doses, ATSDR used very health-protective assumptions that are likely to overestimate the levels of actual exposure. These doses were compared to levels of known observed health effects in the toxicological literature and none of the estimated child doses exceeded levels known to cause harm or illness.

VI. CONCLUSIONS

After evaluating available environmental information, ATSDR has reached the following conclusions regarding the identified exposure situations at JPHC. On the basis of the most currently available information, ATSDR concludes that past exposures associated with fish/shellfish consumption and ingestion of potentially contaminated surface soil are indeterminate. ATSDR concludes that there are no current or future public health hazards associated with chemical contamination at JPHC. However, even though it appears to be a *low probability*, the potential for coming into contact with munitions or munitions-related items beneath the surface in terrestrial areas and in the marine environment poses a physical hazard for residents of JPHC, especially young children. ATSDR's conclusions regarding the potential exposure pathways evaluated are described below:

1. **Potential exposures from eating contaminated fish or shellfish from Ostrich Bay.**

   Past Exposure: During the operation of the former NAD unknown quantities of materials and chemicals related to the development, manufacturing, and storage of munitions were released and/or disposed of into the intertidal portions of Ostrich Bay along what is currently the shoreline of JPHC. Since 1991, the Navy banned fishing and shellfish harvesting at JPHC beaches. It is likely that prior to 1991 some people were harvesting and consuming shellfish and fish from portions of Ostrich Bay in close proximity to the JPHC shoreline. Military personnel stationed at JPHC would likely be exposed infrequently and for relatively short durations; whereas other non-JPHC residents could potentially be exposed over a longer period of time. The past use of Ostrich Bay and the intertidal area at JPHC for recreational fishing and shellfish harvesting, therefore, may have represented a completed exposure pathway.

   On the basis of known historical releases of munitions and chemical contaminants at the former NAD site and the limited current information concerning the nature and extent of munitions contamination in Ostrich Bay, there is not sufficient information to determine whether the fish and shellfish consumed in the past were safe to eat. Therefore, consumption of fish and shellfish in the past represents an *"indeterminate public health hazard."*

   Current and Future Exposure: Commercial and recreational harvesting of most fish and shellfish in Ostrich Bay is prohibited and the state issues fines for people who violate the commercial ban. One exception to the restrictions on commercial harvesting from Ostrich Bay pertains to sea cucumbers, which are not shellfish, but a class of echinoderms. The WA Department of Natural Resources sponsors a commercial season for sea cucumber harvesting in Ostrich Bay. The Navy and the State of Washington have observed only

isolated instances of recreational shellfish harvesting in the bay in recent years; however, the state does not generally enforce the ban for recreational fishers or for people harvesting shellfish. However, recent fish and shellfish tissue analyses suggest that current levels of contaminants would not result in human health effects and *ATSDR considers current exposures to pose "no apparent public health hazard.*"

ATSDR evaluated whether the historical release of site-related contaminants into Ostrich Bay could result in human exposure through bioaccumulation in the food chain if this resource is used for fishing and shellfish harvesting in the future. Assuming people are always exposed to the maximum detected concentrations, antimony and arsenic exceeded ATSDR's health guideline values. However, a review of the literature indicates that the estimated levels using very health-protective assumptions are not associated with adverse health effects. We do believe that additional monitoring is needed to more adequately assess the nature and extent of parent munitions compounds, their degradation products, and a couple of additional chemicals (i.e., antimony and arsenic), for common edible fish and shellfish species.

The BRA is being continuously monitored to ensure that benzene contamination is not adversely impacting the marine environment. ATSDR will consult with Region 10 EPA and decide whether a follow-up health consultation is needed to address health concerns about potential future exposures associated with the BRA. Additionally, until the Navy and other local or state public health and safety agencies conclude that Ostrich Bay, specifically the intertidal locations surrounding the shoreline of JPHC, does not pose a physical hazard, ATSDR does not advise allowing fishing or harvesting activities in the future.

2. **Potential exposures from coming into contact with surface soils at JPHC**

Past Exposure:

According to site documents, the first site investigations measuring levels of chemical contamination in soil began in 1991. Although current levels of contaminants in surface soil are not at levels of health concern, there is no information about what levels of contamination may have been in the surface soil when people were living in the housing area during the mid-1970s and throughout the 1980s. Furthermore, we know that children and adults used many portions of the site for recreational purposes prior to any remedial activities taking place. *Therefore, ATSDR considers past exposures to surface soil at JPHC to pose an "indeterminate public health hazard."*

Current and Future Exposure:

The Navy's extensive remedial actions at JPHC have resulted in fewer areas of soil contamination. Additionally, all the new recreational areas where children and other residents are most likely to come in frequent contact with surface soil have been cleaned to safe residential soil standards. Recent analyses of contaminants in surface soil do not indicate contamination at levels that are known to cause health effects in humans.

ATSDR does not believe that munitions-related compounds pose a chemical exposure hazard since the data show very low levels present in surface soil. The data are consistent with what is known in general about the persistence and environmental fate of many of the explosive compounds used at the former NAD. *Therefore, ATSDR considers current and future exposures to contaminants in surface soils to pose "no apparent public health hazard."*

3. **Potential for coming into contact with munitions-related items in the terrestrial and marine environment**.

Future Exposure

Terrestrial Physical Hazards: There have been no reports of injuries resulting from explosive materials or coming into contact with munitions. JPHC personnel are aware of the potential physical hazards associated with the site and are proceeding with efforts to identify and clear existing munitions items. The greatest hazard does not appear to be in close proximity to the actual housing units, which are all located in the upland portion of the site. Relatively few munitions items have been identified during geophysical investigations in large portions of the upland area. However, children do have access to most areas of JPHC and these areas may contain potentially dangerous munitions items beneath the surface. Therefore, although the likelihood that people will come in contact with munitions-related items is quite small, ATSDR concludes that there are potential physical hazard for people who live there.

Marine Physical Hazards: Munitions items likely remain buried underneath sediments within intertidal areas and along the immediate shoreline. The Navy is expected to begin additional investigations within OU 3-Marine. These investigations will evaluate the presence of munitions items in Ostrich Bay, especially the subtidal portions of the bay in close proximity to JPHC. Until the Navy and state and federal regulators agree that munitions items located within marine sediments are sufficiently cleared or are not accessible, ATSDR concludes that the marine portions of JPHC are hazardous.

VII. RECOMMENDATIONS

On the basis of ATSDR's conclusions about potential exposure pathways at JPHC, the following recommendations are provided below:

- Given the uncertainty of the quality of munitions analyses conducted during sediment and biota investigations at JPHC, ATSDR recommends that the Navy continue to work with EPA and Ecology to develop a formal protocol for reviewing future sampling and analysis work plans involving munitions-related contamination in Ostrich Bay. The protocol should list the munitions compounds to be evaluated including any compounds that may have to be evaluated based on surrogate analytes (e.g., ammonia or nitrate), the specific analytical method, the strengths and weaknesses of the method, the method detection limit (MDL), and a discussion of whether the MDL is adequate for evaluating the public health impact of any potential target compounds.

- ATSDR supports the continued educational efforts to inform the residents of physical hazards associated with the site. Specific information on what to do if munitions are found should be routinely distributed to all residents; placing special emphasis on ensuring that the primary care takers and children are educated about potential hazards. ATSDR also recommends installing fencing or other physical barriers to restrict access to areas where munitions are known to be present and have not been fully removed.

- ATSDR recommends that all fishing, shellfish harvesting, swimming, and diving in Ostrich Bay continue to be strictly prohibited until marine investigations conducted by the Navy are completed and there is agreement among the Navy and state and federal regulatory agencies that munitions-related items no longer pose a physical hazard.

VIII. PUBLIC HEALTH ACTION PLAN

The Public Health Action Plan (PHAP) for JPHC contains a description of actions taken and to be taken by ATSDR, the Navy, EPA, and other state or local agencies subsequent to the completion of this PHA. The purpose of the PHAP is to ensure that this PHA not only identifies potential and ongoing 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. The key public health actions that are completed, ongoing or planned are listed below.

Completed Actions

1. In 1975, the Navy conducted a survey of munitions-related items along the shoreline pier area (Site 102). The survey involved probing to a depth of 2 feet every 6 inches to a width of 50 feet along the shoreline. The survey identified 8,000 ordnance items, which was subsequently removed and disposed of.

2. In 1981, the Navy conducted a search for munitions-related items along the intertidal area between the old railroad pier at Elwood Point and just south of the old oil pier. EOD personnel removed over 18,000 ordnance items and transported them off site for disposal.

3. Between 1983 and 1997, the Navy conducted a number of removal actions across JPHC, including the removal of soil at the Upland Bunker area at Site 110, debris removal and drum disposal at Site 110, removal of petroleum-contaminated soil at Site 101/101A, and the removal of underground storage tanks at various locations.

4. In 1995, the Navy removed surface soils contaminated with lead, arsenic, and PAHs from Site 110 (near Buildings 583 and 584), Buildings 98-104, and the Jackson Park Elementary School yard[11].

5. In 1995, construction workers identified and removed a drum disposal site at the northeast corner of Olding Road and Elwood Point Road. Confirmatory sampling was conducted to ensure that current levels meet all state and federal clean-up standards. During this time the Navy also covered a small area of TPH-contaminated soil near the intersection of Elwood and Olding Roads with 3 feet of clean fill.

[11] The former NAD covered lands immediately south and east of JPHC that belong to the city of Bremerton, the Bremerton School District, and the State of Washington. Environmental cleanup and assessment of these areas, classified as Formerly Used Defense Sites (FUDS) falls under the authority of the U.S. Army Corps of Engineers (FWEC.2002a).

6. In 1998, a Time-Critical Removal Action was conducted near the helicopter pad on Site 103 to control erosion and help prevent the release of contaminants into the marine environment.

7. In 1998 and 1999, an investigation consisting of three phases was conducted in areas surrounding NHB to evaluate the nature and extent of munitions items near the hospital and to subsequently remove any identified MEC.

   The Navy also conducted surface sweeps across portions of the housing complex, removed items identified at the ground surface that might result in physical hazards and/or interfere with the detection of subsurface metallic items, and conducted geophysical surveys to identify the extent of subsurface munitions-related items.

8. In 2000, construction of a large vegetated soil cover was initiated. The cover was composed of 12-18 inches of clean fill overlying a black polyethylene-geo-textile fabric and covers approximately 280,000 square feet of contaminated soil at Sites 101, 101A, and 103. The textile fabric separates the soil cover from the native ground surface and prevents workers and other people from digging below the clean fill and coming in contact with potentially contaminated soil. New athletic fields, sports courts, and other recreational facilities at Elwood Point were placed on top of the soil cover. Prior to the installation of the soil cover, a time critical removal action (TCRA) was conducted on portions of Sites 101 and 103 to remove munitions that could be located immediately under the new recreation area. Most activities associated with the construction of the soil cap were completed by early 2002.

9. In 2002, the Navy excavated and replaced PAH-contaminated soil detected at Buildings 583 and 584 with clean fill. The contaminated soil was excavated to the east of Buildings 583 and 584 in three distinct areas to a depth of 2 feet.

10. In 2002, as part of a Time Critical Removal Action, the Navy conducted MEC clearance of marine sediments in selected areas beneath and surrounding Pier 2 and the former Pier 1 (FWEC 2002d).

11. Beginning in 2005, the Navy conducted a subsurface investigation of munitions-related items at JPHC.

12. The Navy intrusively investigated subsurface anomalies during 2005/2006. Based on the findings of that investigation a remedial action will likely begin in 2008.

13. In 2007, EPA initiated an Informal Dispute Resolution on the draft final Project Plan for the BRA, suggesting alternative locations for point of compliance monitoring wells and an alternative conceptual design for the air sparging pilot test (EPA 2007).

Ongoing and/or Planned Actions

1. For OU3–Terrestrial, the Navy plans on conducting an RI for NHB that will include a three-phase approach: 1) removal of vegetation; 2) surface clearance; and 3) a geophysical investigation. The RI will be completed in December of 2007. To date, more than 20,000 separate metallic items have been recovered during the investigation at the housing complex. Of these, 2 discarded military munitions items containing high explosive have been identified. The RI/FS report will be completed in 2008 and the Proposed Plan and ROD will be developed late in calendar year 2008. The first phase of the RI work for NHB was initiated in October of 2007 and will be completed by summer of 2008. Following completion of the RI/FS field work, a RI/FS report will be prepared. It is expected this report will be completed before the end of calendar year 2008.

2. The Navy plans to conduct a marine investigation beginning sometime in 2007 to identify and remove munitions-related items located in the intertidal and subtidal areas of Ostrich Bay.

3. The Navy continues its ongoing long-term monitoring program conducted under OU 1.

4. The Navy is continuing its community outreach program related to munitions education, including town hall meetings (approximately bi-annual), developing and distributing resident fact sheets (approximately bi-annual), website development, incoming resident information sessions (this will include viewing a short film on munitions safety and JPHC history, cleanup info, etc.).

5. The Navy continues to investigate the BRA. The OU-1 BRA needs a revised FS and ROD amendment based on Region 10 EPA's review of the Navy's 2005 Five Year Review of Record of Decision. The OU-1 BRA was identified as a failed groundwater remedy that was implemented in 2001. The remedy did not meet the ROD groundwater remediation criteria for TPH and benzene. The Navy has identified the benzene source as the NEX Gas Station and found free product under the station. The Navy has performed pilot tests to support a feasibility study for the BRA. The OU-1 BRA remains an ongoing source of contamination to Ostrich Bay until a revised remedy is evaluated and selected in a ROD Amendment (U.S. Navy 2005b).

6. ATSDR will consult with Region 10 EPA and decide whether additional focused health consultations will be needed to address concerns regarding the BRA and the monitoring of munitions compounds in shellfish tissues. ATSDR did not identify any on-site use of groundwater during its site visit and believed that BRA was confined to a relatively small area on site. However, monitoring results continue to indicate increasing benzene concentrations at some locations, even after attempts at remediation. Therefore, a follow-up health consultation may be issued to address the potential for exposures from the BRA.

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FIGURES

Figure 1: Site Map

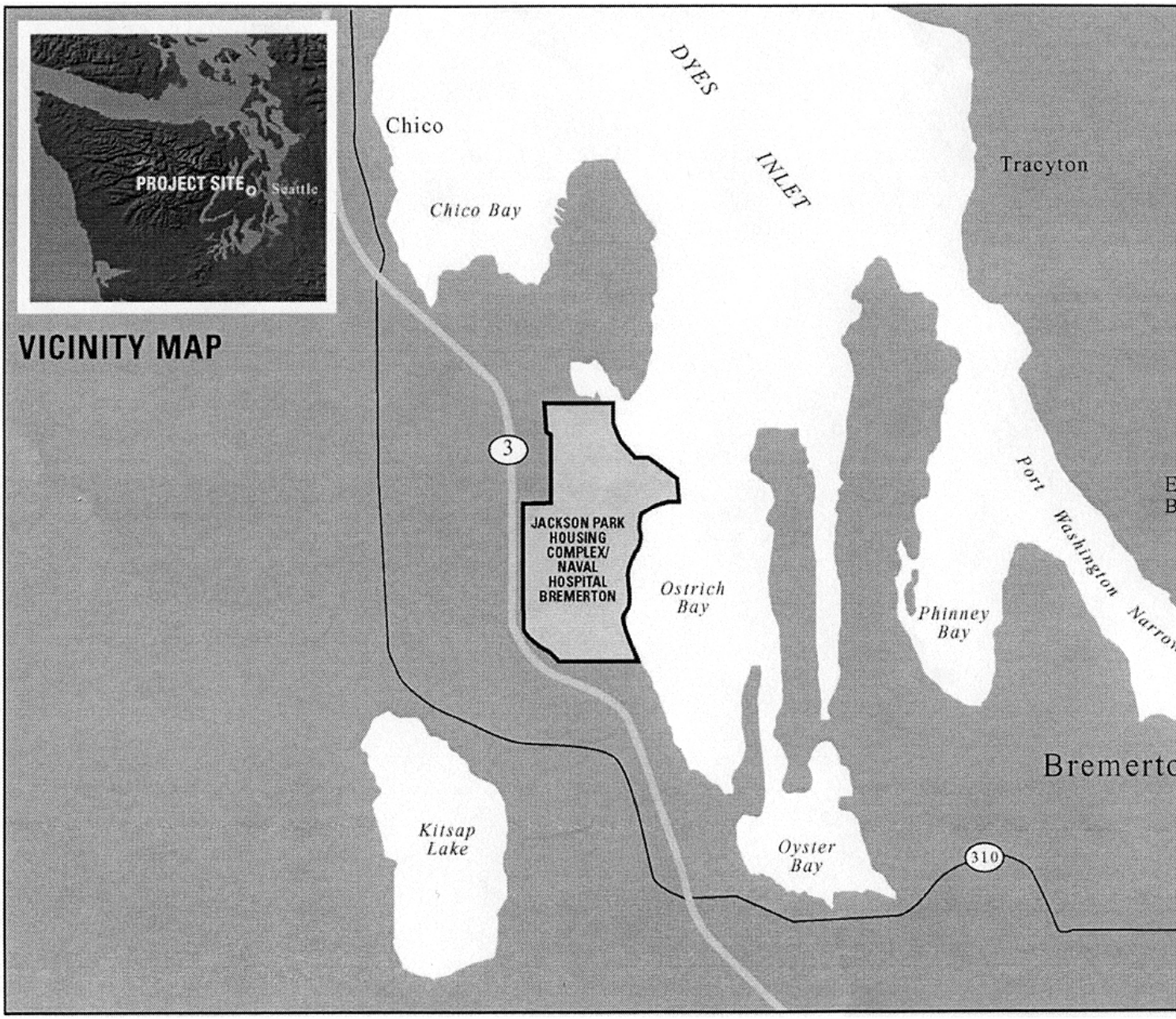


Figure 2: Location of Operable Units (OUs) within JPHC

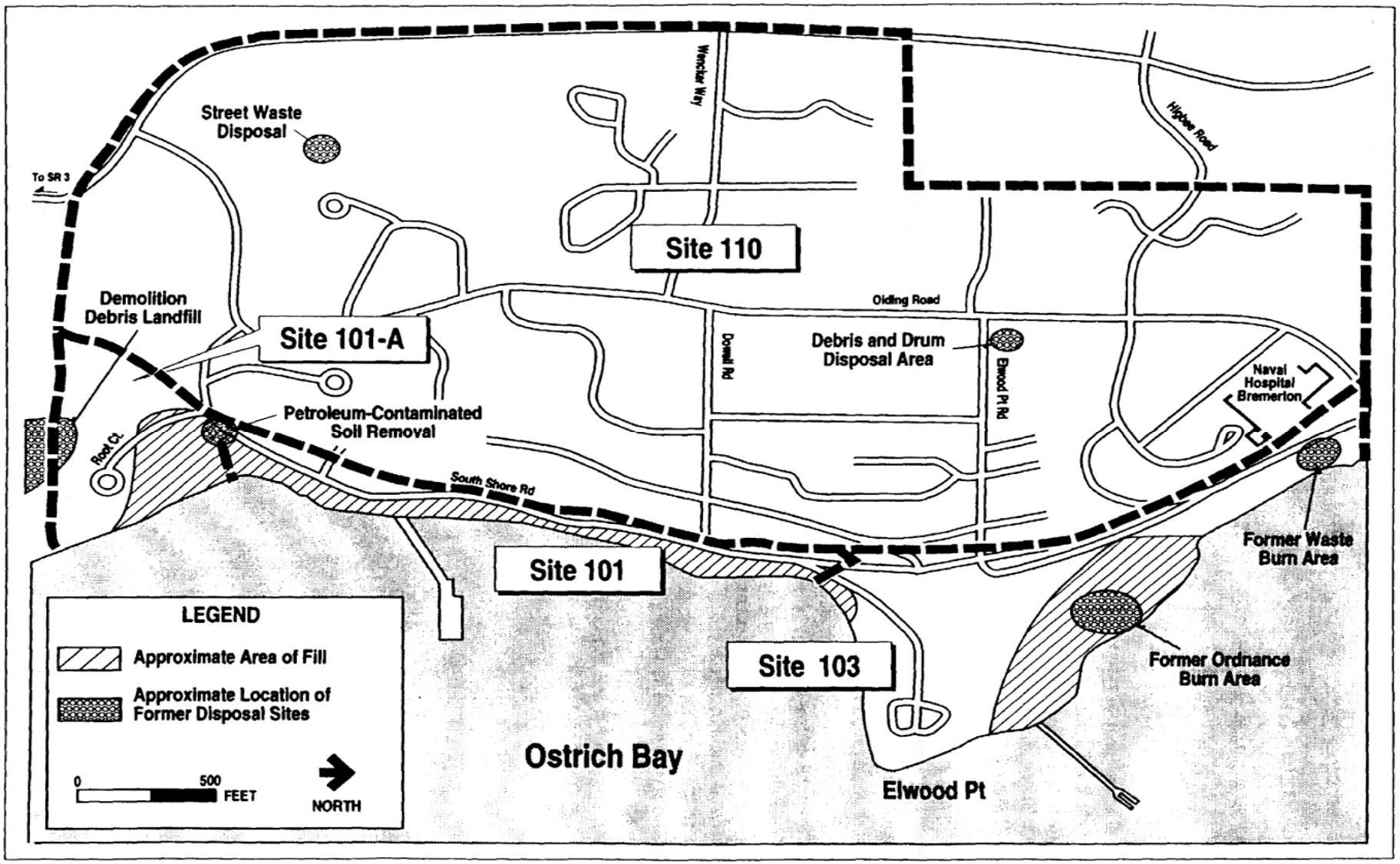
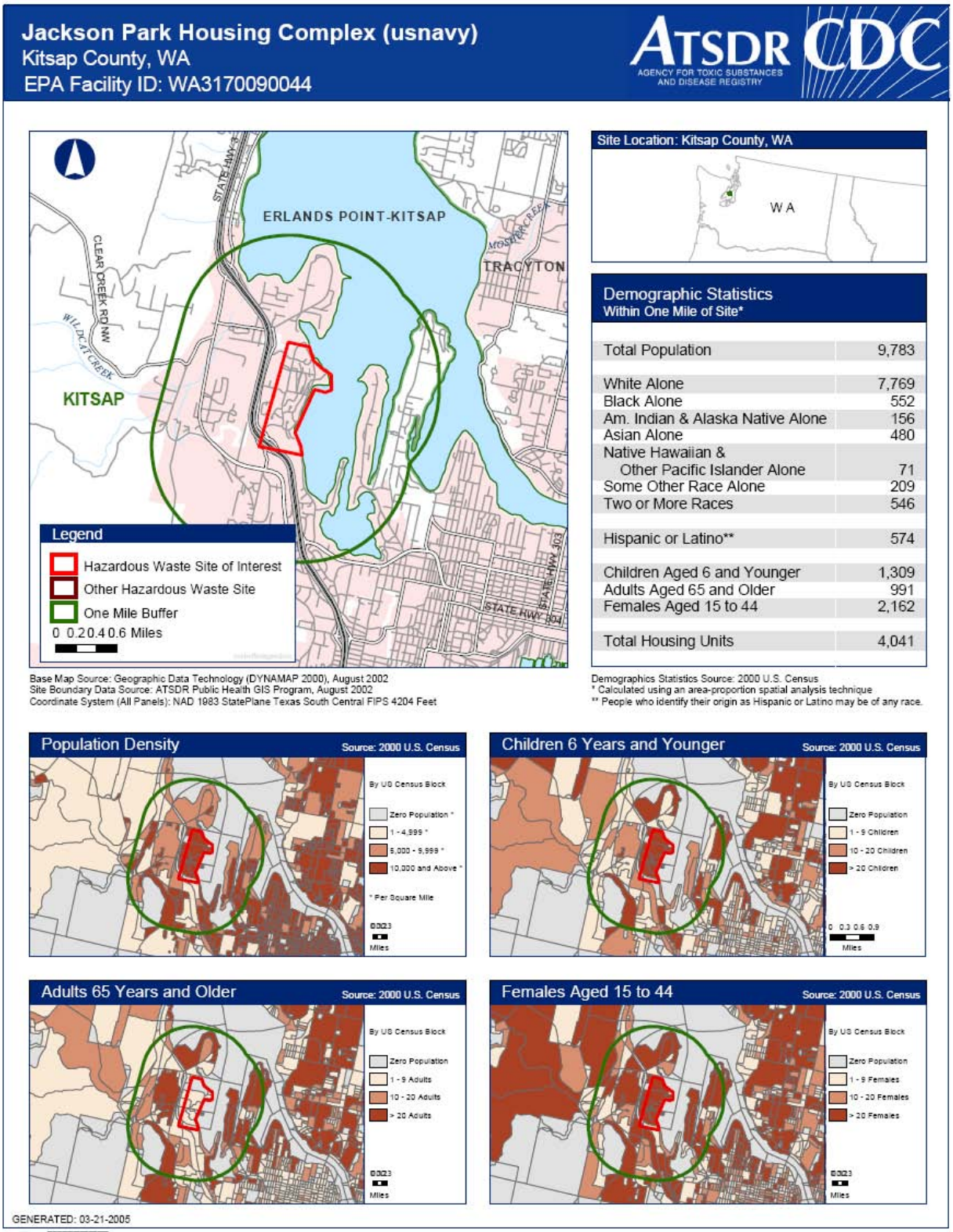


Figure 3: JPHC Demographic Map



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?

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:

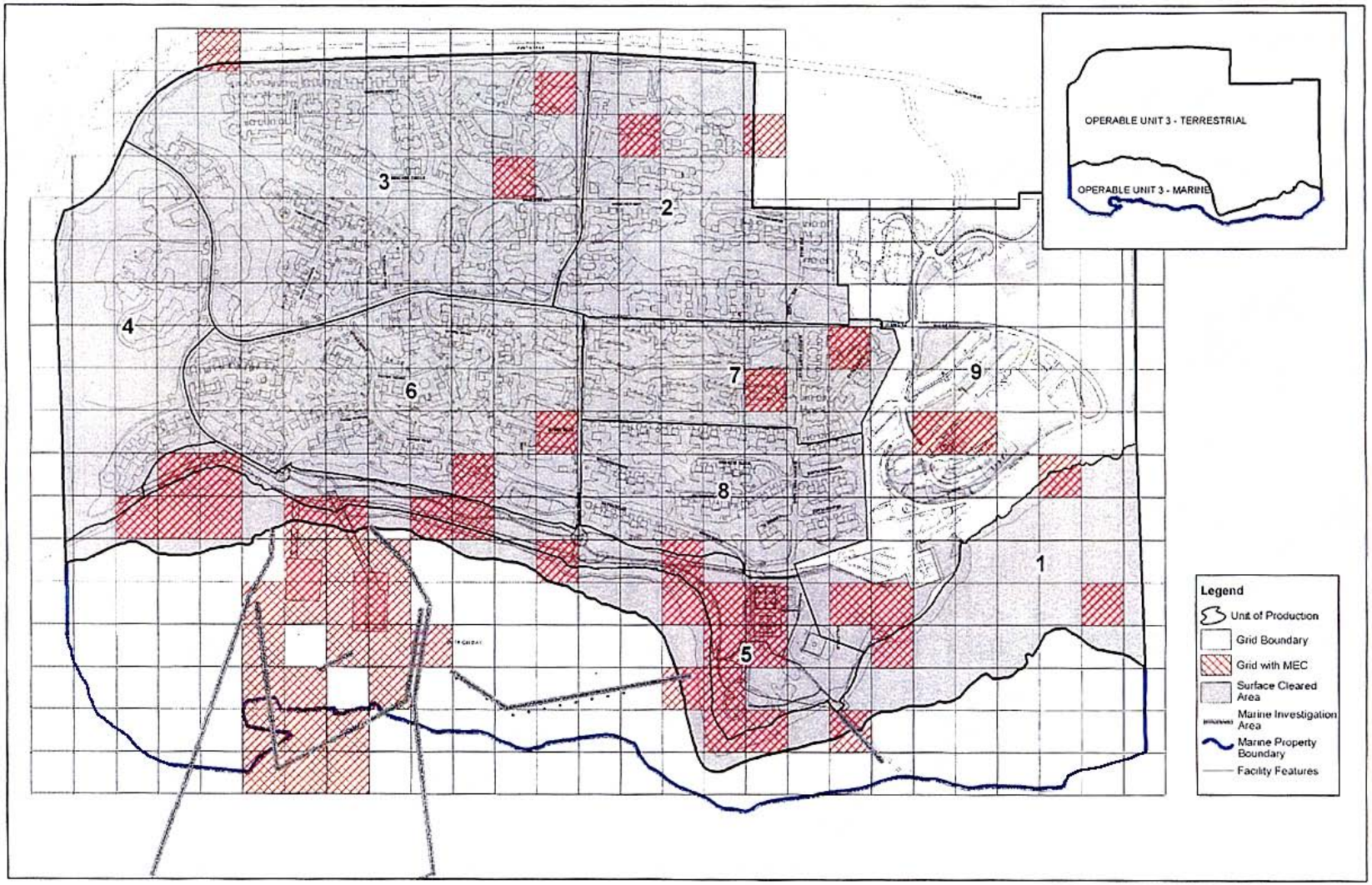
Inhalation
Ingestion
Dermal absorption

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.

Figure 5: MEC Recovery Locations at JPHC



APPENDICES

Appendix A: Site Description and Evaluation of Public Health Hazards

Appendix A: Site Description and Evaluation of Public Health Hazards Associated with Areas of Contamination at Jackson Park Housing Complex			
Site Description/Disposal History	**Investigation Results/ Environmental Monitoring Results**	**Corrective Activities**	**ATSDR Evaluation of Public Health Hazards**
OU 1			
Site 101 covers 2,400 feet of shoreline along Ostrich Bay south of Elwood Point. There are no housing units located within Site 101. The surface of the shoreline consists of backfill: sand, gravel, metal debris, and manmade materials. This site also includes a concrete seawall and an old pier (Pier 2) used for loading and unloading materials used at the former NAD. The Navy used Site 101 for munitions production, storage, and disposal activities from about 1908-1960. Navy remnants, such as abandoned drainage pipes and an old munitions pier (Pier 2) remain along the shoreline. VOCs were found in shoreline seeps and subsurface soils immediately south of Elwood Point at Sites 101 and Site 110. This contamination may have originated from the drainage of liquid wastes at an ammunition depot, Building 39, prior to 1970 or from a nearby fuel station.	OU1 Remedial Investigation (RI) Phase I and Phase II —1994: During the RI 12 groundwater samples and surface soils from six sampling locations were analyzed for metals, volatile organic compounds (VOCs), semi-volatile organic compounds (SVOC)s, polychlorinated biphenyls (PCBs), pesticides, and munitions compounds. The RI does not break down the number of soil samples collected at each location. During the RI, the Navy collected clams, crabs, and sediments from 54 sampling stations at inter and sub-tidal locations adjacent to sites 101 and 103. Tissue and sediment samples were analyzed for SVOCs, metals, and munitions compounds. In addition, sediments were analyzed for VOCs, pesticides, and PCBs. The Navy rejected the analytical results of all marine tissue and sediment munitions data because the data quality objectives were not met. The Navy collected samples from surface water seeps and outfalls at Sites 101 and 101A and analyzed the samples for metals, VOCs, SVOCs, PCBs, pesticides, and munitions compounds. *Groundwater*: Some metals were detected at levels that exceed ATSDR's health-based screening values.	1993-1994: The Navy removed contaminated soil and the buried foundation from former NAD Building 122 directly east of Building 91 (a.k.a. Building 575) in portions of Site 101 and 101A. 2000-2001: The Navy strengthened and stabilized the shoreline to reduce soil erosion. 2001: The Navy removed 152 creosote-fender piles and horizontal wood timbers around Pier 2. 2001: The Navy attempted to use a bioremediation technique, specifically injecting a patented Oxygen Release Compound (ORC) into 55 boreholes, to facilitate the process of benzene degradation in sub-surface soil. The technique did not have any substantial effect on benzene levels. 2000-2002: The Navy constructed a soil cover composed of 12-18 inches of clean fill over approximately 280,000 square feet of contaminated soil at Sites 101, 101A, and 103.	Site 101 does not pose a public health hazard for chemical contaminants. Residential access to Site 101 is not restricted. However, most residents do not use the area for recreational activities and there are no housing units situated at Site 101. Contaminants detected in surface soil during site investigations were not at levels known to cause illness or result in any health effects. Groundwater is not used at any locations at JPHC. There is a low risk of coming into contact with munitions items or explosive wastes. ATSDR believes this hazard has been substantially reduced because Navy personnel have removed munitions and explosives of concern (MEC) from the top 2 inches of soil throughout JPHC. The Navy continues to conduct geophysical surveys in areas suspected of containing MEC.

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	Surface Soil: Benzo(a)pyrene (0.13 ppm) and arsenic (56.2 ppm) were detected above their health-based screening values. *Marine Biota*: Some SVOCs and metals were detected above ATSDR's health-based screening values in marine areas adjacent to Site 101. *Seeps and Outfalls*: Extractable total petroleum hydrocarbons (ETPH) (1,470 ppb) and benzene (344 ppb) were detected at Site 101 in surface water seeps at levels above Washington State model toxic control act (MTCA) guidelines.		ATSDR recommends continued educational efforts to inform the residents of physical hazards associated with the site. Specific information on what to do if munitions are found should be routinely distributed to all residents.

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Site Description/Disposal History	**Investigation Results/ Environmental Monitoring Results**	**Corrective Activities**	**ATSDR Evaluation of Public Health Hazards**
Site 101A is a 7-acre area that consists of housing units (located on Root Court), a playground, beach area, and a landfill containing munitions waste material and debris. The city of Bremerton is directly to the north and Site 101 is directly to the south of Site 101A. Former naval operations at Site 101A began in 1908 and peaked during World War II; they included munitions production, storage, and disposal operations and boiler plant, fuel storage, and transfer operations. Navy remnants such as abandoned drainage pipes remain on the beach.	<u>OU1 Remedial Investigation (RI) Phase I –1994</u> During the RI, 21 groundwater samples and surface soils from 13 sampling locations were analyzed for metals, VOCs, SVOCs, PCBs, pesticides, and munitions. The RI does not break down the number of samples collected at each location. *Groundwater:* Some metals were detected above ATSDR's health-based screening values. *Surface Soil:* Polycyclic aromatic hydrocarbons (PAHs) metals exceeded ATSDR's health-based screening values.	1993-1994: The Navy removed contaminated soil and the buried foundation from former NAD Building 122 directly east of Building 91 (a.k.a. Building 575) in portions of Site 101 and 101A. 1993: The Navy removed six underground storage tanks (USTs) and impacted soils. 2000-2002: The Navy constructed a soil cover composed of 12-18 inches of clean fill over approximately 280,000 square feet of contaminated soil at Sites 101, 101A, and 103.	Site 101A does not pose a public health hazard for chemical contaminants. Contaminants detected in surface soil during site investigations were not detected at levels known to cause illness or result in adverse health effects. A surface soil cover, installed at portions of Site 101A, has made underlying fill materials that may contain munitions-related items less accessible to residents of JPHC. Although chemical contaminants have not been detected at harmful levels there is the potential that munitions-related items could be unearthed. ATSDR believes the potential for coming into contact with munitions-related items is a low probability, especially since the protective soil cap covers a large portion of Site 101A. Groundwater is not used at any locations at JPHC.

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Site Description/Disposal History	**Investigation Results/ Environmental Monitoring Results**	**Corrective Activities**	**ATSDR Evaluation of Public Health Hazards**
Site 103 is situated on Elwood Point and includes approximately 500 feet of shoreline to its north. The site consists of a playground, baseball diamond, sports courts (basketball, tennis, volleyball), a picnic area, a walking path, and a fishing pier. Former military operations began at Site 103 in the 1930s, and have included locomotive and equipment maintenance, sandblasting, paint and oil storage, munitions and trash burning, waste disposal, and shipping. During its period of peak operation, the site may have also contained civilian housing. According to site reports, some items such as abandoned drainage pipes remain on the beach.	<u>OU1 Remedial Investigation (RI) Phase I –and Phase II—1994</u> During the RI, 25 groundwater and surface soil samples from 29 sampling locations and sediments from 54 sampling locations were analyzed for metals, VOCs, SVOCs, PCBs, pesticides, and munitions compounds. The RI does not break down the number of samples collected at each location. The Navy also collected clams and crabs from 54 sampling stations at inter- and subtidal locations adjacent sites 101 and 103. Tissue samples were analyzed for metals, SVOCs, and munitions compounds. The Navy rejected all marine tissue and sediment munitions data because the data quality objectives were not met. *Groundwater:* VOCs and metals were detected above ATSDR's health-based screening values. *Surface Soil:* PAHs and one metal (arsenic) exceeded ATSDR's health-based screening values. *Marine Biota*: SVOCs and metals were detected above ATSDR's health-based screening values in marine areas adjacent Site 103.	1998: The Navy reinforced the north shore, near the helipad, at Site 103 in order to prevent erosion and the potential release of contaminated fill into Ostrich Bay. 2001: The Navy removed 450 creosote-treated piles and moorage dolphins associated with the fishing pier from the bay. 2000-2002: The Navy constructed a soil cover composed of 12-18 inches of clean fill over approximately 280,000 square feet of contaminated soil at Sites 101, 101A, and 103.	Site 103 does not pose a public health hazard. A soil cover serves as a barrier to potentially contaminated fill on a large portion of Site 103. The recreational areas and playground all have clean soil at the surface. Any human contact with original fill is likely to be limited to a few areas close to the shoreline. Historical operations at the former NAD included the operation of incinerators and burn pads. The Navy has either removed contaminated soils and/or placed clean fill over most areas in close proximity to the former burn pads and incinerators. ATSDR believes there is a low probability of people coming into contact with munitions-related items, especially since the protective soil cap covers a large portion of Site 103. There is the risk that unrestricted shoreline areas contain munitions items. ATSDR recommends continued educational efforts to inform residents of

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	Marine Sediment: PAHs, metals, and one explosive compound (picric acid) were detected above ATSDR's heath-based screening values in sediments adjacent to Site 103.		physical hazards associated with the site. Groundwater is not used at any locations at JPHC.

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Site 110 covers most inland portions at JPHC, which primarily consist of residential buildings and the Bremerton Naval Hospital. From 1908 until at least 1957, munitions were produced and stored at Site 110. Debris and residues may have been left behind following the demolition of naval facilities in the 1970s.	Final Site 110 Inspection Report—1993 During the Site 110 inspection (SI), groundwater samples from four monitoring wells and surface soil samples from 63 locations were collected and analyzed for metals, VOCs, SVOCs, PCBs, pesticides, and munitions compounds. The SI does not break down the number of samples collected at each location. *Groundwater:* One SVOC [bis(2-ethylhexyl) phthalate] and metals were detected above ATSDR's health-based screening values. *Surface Soil:* PAHs and metals exceeded ATSDR's health-based screening values.	1994-1995: The Navy excavated contaminated surface soils near four former bunkers in the upland bunker area. The excavation included contaminated surface soils from the Jackson Park Elementary School yard. 1995: The Navy removed waste and contaminated soil from a drum disposal pit at the northeast corner of Olding Road and Elwood Point Road. 1995: The navy covered a waste compost site with three feet of clean soil. 1996: The Navy removed four USTs and fuel-impacted soils. 2001: The Navy attempted to use a bioremediation technique (i.e., injecting a patented Oxygen Release Compound (ORC) into 55 boreholes) to facilitate the process of benzene degradation in sub-surface soil. The technique did not have any substantial effect on benzene levels 2002: The Navy excavated and replaced PAH contaminated soil behind buildings 583 and 584 in the northwestern portion of JPHC.	Site 110 does not pose a public health hazard. PAHs and metals such as arsenic and lead were detected in surface soil with some frequency. However, only a few samples were above ATSDR's health-based screening values. There is some access to surface soil throughout Site 110, but much of the area is either paved or covered with vegetation (primarily grass, shrubs, and trees). Contact with the original fill and surface soil would likely be limited, even among children playing in the area. Many of the recreational areas (e.g., playgrounds and fields) are located at Site 103, where extensive remedial actions have occurred. Groundwater is not used at any locations at JPHC.

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OU 2			
OU 2 addresses environmental hazards associated with contaminated marine life and sediments. Ostrich Bay directly borders JPHC and formerly served as an active waterway for marine vessels entering and leaving NAD. Ostrich Bay was the former launch point for naval activities at JPHC. The Navy performed industrial operations on Ostrich Bay beaches and piers at sites 101, 101A, and 103. During these operations, munitions compounds were released into the environment contaminating sediments, surface water, and marine life in and around Ostrich Bay.	OU2 Treatability Study—1998 The Navy performed two separate sediment investigations as part of the Treatability Study: (1) Sediments at 23 locations spread across the bay were sampled for mercury, cadmium, and munitions compounds; (2) sediments at six locations inside the intertidal zone adjacent Elwood Point were sampled for arsenic, antimony, mercury, vanadium, pentachloro-phenol, 3,3'-dichlorobenzidine, bis(2-ehtylhexylphthalate, and munitions compounds. *Sediment:* Mercury (1.4 ppm) and benzo-(a)pyrene (0.12 ppm) were detected above ATSDR's health-based screening values. The Navy collected batches consisting of between 50-90 clams from six sample stations along the intertidal zones adjacent Elwood and Erland's Point. Tissues were analyzed for arsenic, antimony, mercury, vanadium, pentachlorophenol, 3,3'-dichlorobenzidine, and bis(2ehtylhexyl-phthalate). *Marine Biota*: Arsenic was found (3.5 ppm) above ATSDR's health-based screening values.	ATSDR has not identified any corrective actions	Investigations associated with OU 2 were primarily designed to evaluate ecological impacts of site-related contaminants within Ostrich Bay. The primary human exposure pathway associated with OU 2 is through consuming contaminated fish and shellfish. Fish and shellfish advisories are currently in place within Ostrich Bay because of bacterial and chemical contamination. Recent analyses of marine tissue samples have detected mostly low concentrations of chemical contamination at levels that are not expected to be harmful. There is some uncertainty regarding the nature and extent of munitions compounds in marine tissue samples because of data quality issues.

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OU 3-Terrestrial			
The OU-3 Terrestrial ordnance investigation is a site wide assessment of residual munitions products at JPHC. It provides a historical examination of munitions production, their use and disposal, and an assessment of potential hazards from residual munitions that might still remain in the area.	1 Munitions Hazard Assessment: Munitions related risks were assessed at all areas throughout OU3 based on an analysis of historical records and present day land use. **2** Site Inspection Report for the Terrestrial Portion of JPHC: The Navy conducted site inspections near the hospital clinic expansion area, along portions of the shoreline, and at Elwood Point recreational areas (1998-2001). The Site Inspections recovered thousands of munitions-related items during OU-3 investigations.	1998-1999: 1. The Navy recovered a large number of MEC-related items during excavations at 290 test pits along shoreline and recreation areas. 2. The Navy recovered MEC-related items during soil excavations and stump removals near NHB. 1999-2001: Phase 1. The Navy conducted surface sweeps and recovered MEC-related items within a large area extending from the JPHC southern boundary to the northern side of Elwood Point. Phase 2. The Navy removed MEC-related items along the shoreline of JPHC/NHB.	ATSDR concludes that the presence of munitions-related items buried in fill materials and in subsurface soils throughout portions of JPHC poses a physical hazard. Historical records indicate that munitions-related items were found at JPHC at least four times since 1980: a mechanical time fuse in Building 83 (1980), an empty projectile casing at Elwood Point (1981), two projectile wind screens at Elwood Point (1981), and a pyrotechnic and demolition kit with 20 half pound block of TNT 75 ft from the south wall of the NHB in 1995. A navy study in 1983 reported that children might have encountered explosives while playing in buildings.

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Site Description/Disposal History	**Investigation Results/ Environmental Monitoring Results**	**Corrective Activities**	**ATSDR Evaluation of Public Health Hazards**
OU 3-Marine			
The OU-3 Marine ordnance investigation includes the marine portions of JPHC. It provides a historical examination of munitions production, their use and disposal, and an assessment of potential hazards from residual munitions that might still remain in the area.	2000-2001: In support of an OU 1 Record of Decision (ROD), the Navy cleared MEC-related items in support of removal of mooring dolphins, pilings, and railroad pier in Ostrich Bay as well as a fender pile removal at Pier 2. 2000-2001OU3-Marine Time Critical Removal Action (TCRA): the Navy conducted initial MEC clearance at Pier 2 and former Pier 1 between September 2000 and January 2001. This was followed up with an MEC investigation at the same location to determine the nature and extent of munitions contamination near Pier 2 and former Pier 1.	Munitions-related items were cleared during the 2000-2001 efforts supporting the ROD and during the 2000-2001 TCRA at Pier 2 and former pier 1.	ATSDR concludes that the presence of munitions-related items buried along the shoreline and near-shore portions of JPHC poses a physical hazard. Some signs are posted along the shoreline of JPHC prohibiting harvesting shellfish and diving. Access, however, is not restricted to shoreline and intertidal portions of JPHC.

Sources:
EA-EST 1998a, EA-EST 1998b, EFANW 2002, EFANW 2003, FWEC 2002a, FWEC 2002b, FWEC 2002c, Hart Crowser 1988, URS 1994a, URS 1994b, URS 1994c, URS 1994d, URS 1995, URS 2003a; 2003b, U.S. Navy 1992, U.S. Navy 2000.

Appendix B: List of Comparison Values Used by ATSDR

Comparison Values

ATSDR comparison values are media-specific concentrations that are considered to be safe under default conditions of exposure. They are used as screening values in the preliminary identification of site-specific "contaminants of concern." The latter term should not be misinterpreted as an implication of "hazard." As ATSDR uses the phrase, a "contaminant of concern" is a chemical substance detected at the site in question and selected by the health assessor for further evaluation of potential health effects. Generally, a chemical is selected as a "contaminant of concern" because its maximum concentration in air, water, or soil at the site exceeds one of ATSDR's comparison values.

Nevertheless, it must be emphasized that comparison values are not thresholds of toxicity. Although concentrations at or below the relevant comparison values could reasonably be considered safe, it does not automatically follow that any environmental concentration that exceeds a comparison value would be expected to produce adverse health effects. The principal purpose behind conservative, health-based standards and health-based screening values is to enable health professionals to recognize and resolve potential public health hazards before they become actual public health consequences. Thus comparison values are designed to be preventive—rather than predictive—of adverse health effects. The probability that such effects will actually occur does not depend on environmental concentrations alone, but on a unique combination of site-specific conditions and individual lifestyle and genetic factors that affect the route, magnitude, and duration of actual exposure.

Listed and described below are the various comparison values that ATSDR uses to select chemicals for further evaluation, as well as other non-ATSDR values that are sometimes used to put environmental concentrations into perspective.

CREG	=	Cancer Risk Evaluation Guides
MRL	=	Minimal Risk Level
EMEG	=	Environmental Media Evaluation Guides
IEMEG	=	Intermediate Environmental Media Evaluation Guide
RMEG	=	Reference Dose Media Evaluation Guide
RfD	=	Reference Dose
RfC	=	Reference Dose Concentration
RBC	=	Risk-Based Concentration
MCL	=	Maximum Contaminant Level

Cancer Risk Evaluation Guides (CREGs) are estimated contaminant concentrations expected to cause no more than one excess cancer in a million persons exposed over a lifetime. CREGs are calculated from EPA's cancer slope factors, or cancer potency factors, using default values for exposure rates. That said, however, neither CREGs nor cancer slope factors can be used to make realistic predictions of cancer risk. The true risk is always unknown and could be as low as zero.

Minimal Risk Levels (MRL) are estimates of daily human exposure to a chemical (doses expressed in mg/kg/day) that are unlikely to be associated with any appreciable risk of deleterious non-cancer 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 (15-364 days), and chronic (∃365 days) exposures. MRLs for specific chemicals are published in ATSDR toxicological profiles.

Environmental Media Evaluation Guides (EMEGs) are concentrations that are calculated from ATSDR minimal risk levels by factoring in default body weights and ingestion rates. They factor in body weight and ingestion rates for acute exposures (Acute EMEGs — those occurring for 14 days or less), for intermediate exposures (Intermediate EMEGs — those occurring for more than 14 days and less than 1 year), and for chronic exposures (Chronic EMEGs — those occurring for one year [365 days] or greater).

Reference Dose Media Evaluation Guide (RMEG) is the concentration of a contaminant in air, water or soil that corresponds to EPA's RfD for that contaminant when default values for body weight and intake rates are taken into account.

Reference Dose (RfD) is an estimate of the daily exposure to a contaminant unlikely to cause noncarcinogenic adverse health effects. Like ATSDR's MRL, EPA's RfD is a dose expressed in mg/kg/day.

Reference Concentrations (RfC) is a concentration of a substance in air that EPA considers unlikely to cause noncancer adverse health effects over a lifetime of chronic exposure.

Risk-Based Concentrations (RBC) are media-specific concentrations derived by Region III of the Environmental Protection Agency from RfD=s, RfC=s, or EPA=s cancer slope factors. They represent concentrations of a contaminant in tap water, ambient air, fish, or soil (industrial or residential) that are considered unlikely to cause adverse health effects over a lifetime of chronic exposure. RBCs are based either on cancer (Ac@) or noncancer (An@) effects.

Maximum Contaminant Levels (MCLs) represent contaminant concentrations in drinking water that EPA deems protective of public health (considering the availability and economics of water treatment technology) over a lifetime (70 years) at an exposure rate of 2 liters of water per day.

More information about the ATSDR evaluation process can be found in ATSDR’s Public Health Assessment Guidance Manual at http://www.atsdr.cdc.gov/HAC/HAGM/. A hard copy can be obtained by contacting the ATSDR information line toll-free at (888) CDC-INFO.

Appendix C: ATSDR's Methods, Assumptions, and Calculations

Contaminant Data Evaluation

In public health assessments, ATSDR addresses the likelihood that exposure to contaminants at the maximum or average concentrations detected would result in adverse health effects. While the relative toxicity of a chemical is important, the response of the human body to a chemical exposure is determined by several additional factors, including the concentration (how much), the duration of exposure (how long), and the route of exposure (breathing, eating, drinking, or skin contact). Lifestyle factors (i.e., occupation and personal habits) also have a major impact on the likelihood, magnitude, and duration of exposure. Individual characteristics such as age, sex, nutritional status, overall health, and genetic constitution affect how a human body absorbs, distributes, metabolizes, and eliminates a contaminant. A unique combination of all these factors will determine the individual's physiologic response to a chemical contaminant and any adverse health effects the individual could suffer as a result of the chemical exposure.

ATSDR has determined levels of chemicals that can reasonably (and conservatively) be regarded as harmless, based on the scientific data the agency has collected in its toxicological profiles. The resulting comparison values and health-based screening values, which include ample safety factors to ensure protection of sensitive populations, are used to screen contaminant concentrations at a site and to select substances ("chemicals of concern") that agency environmental health scientists and toxicologists scrutinize more closely.

It is a point of key importance that ATSDR's (as well as state and federal regulatory agency) comparison values, screening numbers and health-based screening values define very conservative and protective levels of environmental contamination and are not thresholds of toxicity. This means that although concentrations at or below a comparison value could reasonably be considered safe, it does not automatically follow that any concentration above a comparison value will necessarily produce toxic effects. To the contrary, ATSDR's comparison values are intentionally designed to be much lower, usually by orders of magnitude, than the corresponding no-effect levels (or lowest-effect levels) determined from scientific studies. ATSDR uses comparison values (regardless of source) solely for the purpose of screening individual contaminants. In this highly conservative procedure, ATSDR may decide that a compound warrants further evaluation if the highest single recorded concentration of that contaminant in the medium in question exceeds that compounds lowest available comparison value (e.g., cancer risk evaluation guides or other chronic exposure values) for the most sensitive, potentially exposed individuals (e.g., children or pica children). This conservative process results in the selection of many contaminants as "chemicals of concern" that will not, upon closer scrutiny, be judged to pose any hazard to human health. Still, ATSDR judges it prudent to use a screen that "lets through" many harmless contaminants rather than one that overlooks even a single potential hazard to public health. The reader should keep in mind the protective nature of this approach when considering the potential health implications of ATSDR's evaluations.

Because a contaminant must first enter the body before it can produce any effect on the body, adverse or otherwise, the toxicologic discussion in public health assessments focuses primarily on completed pathways of exposure (i.e., contaminants in media to which people are known to have been, or are reasonably expected to have been, exposed). Examples are water that could be used for drinking and air in the breathing zone.

To determine whether people were, or continue to be, exposed to contaminants originating from a site, ATSDR evaluates the factors that lead to human exposure. These factors or elements include (1) a source of contamination, (2) transport through an environmental medium, (3) a point of exposure, (4) a route of human exposure, and (5) an exposed population. Exposure pathways fall into one of three categories:

- *Completed Exposure Pathway*. ATSDR calls a pathway "complete" if it is certain that people are exposed to contaminated media. Completed pathways require that the five elements exist and indicate that exposure to the contaminant has occurred, is occurring, or will occur.
- *Potential Exposure Pathway.* Potential pathways are those in which at least one of the five elements is missing but could exist. Potential pathways indicate that exposure to a contaminant could have occurred, could be occurring, or could occur in the future. Potential exposure pathways refer to those pathways where (1) exposure is documented, but there is not enough information available to determine whether the environmental medium is contaminated, or (2) an environmental medium has been documented as contaminated, but it is unknown whether people have been, or could be, exposed to the medium.
- *Eliminated Exposure Pathway*. In an eliminated exposure pathway, at least one of the five elements is missing and will never be present. From a human health perspective, pathways can be eliminated from further consideration if ATSDR is able to show that (1) an environmental medium is not contaminated, or (2) no one is exposed to contaminated media.

Exposure Dose Estimation Methods, Assumptions, and Calculations

This section details the methods, assumptions, and calculations that ATSDR used to estimate exposure doses. As previously mentioned, commercial harvesting of shellfish is not permitted in Ostrich Bay and advisories are posted for recreational harvesting of shellfish and bottom fish from the western portion of the bay. Although current exposure is limited by these restrictions, ATSDR estimated the potential exposure dose for three target populations in the event that Ostrich Bay is used as a future resource for harvesting fish and shellfish:

1. JPHC residents who might harvest shellfish and fish during their tour of duty;
2. Recreational fishers and harvesters of shellfish who live in the area; and
3. Subsistence populations for whom a significant portion of their diet may consist of fish and shellfish from Ostrich bay.

ATSDR assumed that people would be exposed to the average concentration detected in fish and shellfish collected from Ostrich Bay. To be protective and account for the uncertainty surrounding how representative the exposure factors are for potential future consumers of fish and shellfish within Ostrich bay, ATSDR used health-protective assumptions to estimate the reasonable maximum exposure level (for example, assuming the 90th percentile of reported fish and shellfish ingestion [i.e., consumption] rates among the Suquamish Tribe for the subsistence population). This estimate is the individual daily exposure dose in milligrams of contaminant per kilogram body weight per day (mg/kg/day). It is intentionally conservative and likely overestimates the amount of chemical exposure that people consuming fish and shellfish from Ostrich Bay would actually have.

Deriving Exposure Doses

As noted above, exposure doses are typically expressed in mg/kg/day. When estimating exposure doses, health assessors evaluate chemical concentrations to which people could be exposed, together with the length of time and the frequency of exposure. Collectively, these factors influence an individual's physiological response to chemical exposure and potential outcomes. Where possible, ATSDR used site-specific information about the frequency and duration of exposures. In cases where site-specific information was not available, ATSDR applied several conservative exposure assumptions to estimate exposures.

Calculating exposure dose from eating fish and shellfish from Ostrich Bay

ATSDR used site-specific information (e.g., Suquamish Tribe Consumption Survey) about the frequency and consumption patterns of potential future heavy/subsistence fish/shellfish consumers. In cases where site-specific information was not available, ATSDR applied conservative exposure assumptions to estimate dose.

The following equation was used to estimate human exposure from consuming fish and shellfish from Ostrich Bay (See Table C-1 for equation definitions and assumptions used in calculating dose)*:*

$$\text{Estimated exposure dose (mg/kg/day)} = \frac{C \times IR \times CR \times EF \times ED}{BW \times AT}$$

Table C-1: Dose Assumptions: Exposure to Fish and Shellfish			
Parameter	***Abbreviation***	***Child***	***Adult***
Chemical Concentration in Fish[1]	C	Maximum Concentration (ppm)	Maximum Concentration (ppm)
Ingestion Rate[2]	IR	English Sole 90th % = 21.5 g/day Mean (i.e., average) = 5.5 g/day Shellfish[7] 90th percentile = 196.5 g/d Mean (i.e., average) = 73.5 g/day	English Sole 90th % = 43 g/day Mean (i.e., average) = 11 g/day Shellfish[7] 90th percentile = 393 g/d Mean (i.e., average) = 147 g/day
Exposure Frequency[3]	EF	Subsistence: 350 days/year JPHC Resident: 50 days/year Recreational Fisher: 50 days/year	Subsistence: 350 days/year JPHC Resident: 50 days/year Recreational Fisher: 50 days/year
Exposure Duration[4]	ED	All child populations: 6 Years	Subsistence & Recreational: 30 years JPHC Resident: 6 Years
Body Weight[5]	BW	16.8 kg	79 kg
Averaging Time Cancer effects	AT	N/A	25550 (70 years x 365 days/year)
Absorption Rate[6]	AR	0.1 (10%) Arsenic	0.1 (10%) Arsenic
Averaging Time Non-cancer effects	AT	Subsistence & Recreational: 2190 (6 years x 365 days/year) JPHC Resident 2190 (6 years x 365 days/year)	Subsistence & Recreational: 10950 (30 years x 365 days/year) JPHC Resident 2190 (6 years x 365 days/year)

Notes:

[1] Maximum chemical-specific concentrations for each species were used to estimate dose

[2] Fish ingestion rates are based on the 90th percentile of fish consumption reported by Suquamish adults in the Fish Consumption Survey (The Suquamish Tribe 1999). Child ingestion rates are assumed to be half the adult rate. The ingestion rate for English sole is based on the Group D rate for adult male respondents as reported in Table T-5 of the Suquamish survey. The shellfish ingestion rate is based on Group E for adult male respondents as reported in Table T-5 (The Suquamish Tribe 1999).

[3] ATSDR selected an exposure frequency of 350 days per year as an estimate for subsistence populations. This is based on the very conservative assumption that an individual who relies on subsistence practices for a significant portion of their nutritional intake would be consuming fish or shellfish from Ostrich bay almost daily. ATSDR selected an exposure frequency of approximately once a week for JPHC residents and non-JPHC recreational fishers/shellfish consumers. These are very health-protective assumptions and are likely to overestimate actual exposure.

[4] ATSDR used a standard exposure duration assumption of 6 years for children and 30 years for adults for both the subsistence and non-JPHC recreation fisher/shellfish consumer. For JPHC residents, ATSDR used 6 years as the exposure duration since this is generally reported to be the longest expected tour of duty for military personnel who reside at JPHC.

[5] Body weight values are based on average adult and children weights reported in the Fish Consumption Survey (The Suquamish Tribe 1999).

[6] ATSDR used 10% of the total concentration of arsenic actually detected in fish and shellfish tissue, which represents the toxic inorganic form (FDA 1993).

[7] Ingestion rates are based on the reported shellfish consumption (Group E) rate by the Suquamish Tribe. Actual contaminant concentrations were based on species that contained the highest level of a chemical (The Suquamish Tribe 1999).

Table C-2a. Estimated Exposure Dose from Eating Fish/Shellfish From Ostrich Bay: Subsistence
Non-Cancer Health Effects

Type of Fish	Maximum Conc. (mg/kg)	Adult Dose (mg/kg/day)	Child Dose (mg/kg/day)	Reference Dose (RfD) (mg/kg/day
English Sole				
Arsenic	11	**0.0006**	**0.001**	0.0003
BEHP	2.1	0.001	0.003	0.02
Heptachlor	0.013	0.000007	0.00002	0.0005
Shellfish				
Antimony	19.7	**0.1**	**0.2**	0.0004
Arsenic	64.1	**0.03**	**0.07**	0.0003
BEHP	4.4	0.02	**0.05**	0.02
Mercury	0.27	0.001	0.003	NA
RDX	0.46	0.002	**0.005**	0.003

BEHP = bis(2-ethylhexyl) phthalate
Conc = Concentration
MRL = Minimal Risk Level (oral, chronic)
mg/kg = parts per million (ppm)
Note: Refer to Table C-1 for specific ingestion rates reported for each species
Estimated dose values in **bold** text exceed their respective reference dose

Table C-2b. Estimated Exposure Dose from Eating Fish/Shellfish From Ostrich Bay: JPHC Residents.
Non-Cancer Health Effects

Type of Fish	Maximum Conc. (mg/kg)	Adult Dose (mg/kg/day)	Child Dose (mg/kg/day)	Reference Dose (RfD) (mg/kg/day
English Sole				
Arsenic	11	0.00002	0.0004	0.0003
BEHP	2.1	0.00004	0.00009	0.02
Heptachlor	0.013	0.0000002	0.0000006	0.0005
Shellfish				
Antimony	19.7	**0.005**	**0.01**	0.0004
Arsenic	64.1	**0.002**	**0.004**	0.0003
BEHP	4.4	0.001	0.003	0.02
Mercury	0.27	0.00007	0.0002	NA
RDX	0.46	0.0001	0.0003	0.003

BEHP = bis(2-ethylhexyl) phthalate
Conc = Concentration
MRL = Minimal Risk Level (oral, chronic)
mg/kg = parts per million (ppm)
Note: Refer to Table C-1 for specific ingestion rates reported for each species
Estimated dose values in **bold** text exceed their respective reference dose

Table C-2c. Estimated Exposure Dose from Eating Fish/Shellfish From Ostrich Bay: Non-JPHC Recreational Fishers/Harvesters

Non-Cancer Health Effects

Type of Fish	Maximum Conc. (mg/kg)	Adult Dose (mg/kg/day)	Child Dose (mg/kg/day)	Reference Dose (RfD) (mg/kg/day)
English Sole				
Arsenic	11	0.0001	0.0003	0.0003
BEHP	2.1	0.0003	0.0007	0.02
Heptachlor	0.013	0.000002	0.000004	0.0005
Shellfish				
Antimony	19.7	**0.04**	**0.09**	0.0004
Arsenic	64.1	**0.01**	**0.03**	0.0003
BEHP	4.4	0.008	0.02	0.02
Mercury	0.27	0.0005	0.001	NA
RDX	0.46	0.0008	0.002	0.003

BEHP = bis(2-ethylhexyl) phthalate
Conc = Concentration
MRL = Minimal Risk Level (oral, chronic)
mg/kg = parts per million (ppm)
Note: Refer to Table C-1 for specific ingestion rates reported for each species
Estimated dose values in **bold** text exceed their respective reference dose

Reference

U.S. Food and Drug Administration (FDA), Center for Food Safety and Applied Nutrition. 1993. Guidance Document for Arsenic in Shellfish. January 1993.

Appendix D ATSDR Glossary of Environmental Health 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/cm2
Milligram per square centimeter (of a surface).

mg/m3
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:

Office of Policy and External Affairs
Agency for Toxic Substances and Disease Registry
1600 Clifton Road, N.E. (MS F-59)
Atlanta, GA 30333
Telephone: 1-800-CDC-INFO

Appendix E: ATSDR's Responses to Public Comments

ATSDR released the Public Health Assessment (PHA) for Jackson Park Housing Complex (JPHC), Kitsap County, WA. for public comment on April 14, 2008. The public comment period, which ended on May 14, 2008. The document was made available for public comment at the following locations:

Kitsap Regional Library
Central Branch
1301 Sylvan Way
Bremerton, Washington 98310
phone: 360-405-9100

Kitsap Regional Library
Martin Luther King Jr. Branch
612 Fifth Avenue
Bremerton, Washington 98337
Phone: 360-377-3955

ATSDR thanks all individuals and agencies who took the time to comment. For those comments that questioned the factual validity of a statement made in the PHA, ATSDR verified and, when appropriate, corrected any errors. This appendix includes these comments and ATSDR's responses. If two or more comments pertain to similar issues and require the same response, they will be described under one comment and corresponding response. Editorial comments such as word spelling or sentence syntax and the commenter's statement of opinion about the agency or PHA process, in general, without pertaining to the factual accuracy of specific portions of the document are not included in this appendix.

1. **Comment:** The first paragraph on page 3 discussing the "Current and Future Exposure" concludes with the following statement. "Current levels of most contaminants measured in tissue samples collected within Ostrich Bay are not at levels that would likely cause harm or illness in people. However, ATSDR believes a more comprehensive assessment of the nature and extent of munitions-related compounds in fish and shellfish tissues is needed to ensure the safety of the people who would likely use Ostrich Bay as a future resource subsistence harvesting of fish and shellfish." We do not understand what is being implied. The first part of the sentence concludes the levels are not harmful, and then concludes a more comprehensive monitoring program is required to "ensure" safety. We suggest removing this sentence from the paragraph in that it has little added value and is confusing.

   Response: ATSDR included the statement that "a more comprehensive assessment of the nature and extent of munitions-related compounds in fish and shellfish tissues are needed" because it shares Environmental Protection Agency's (EPA's) Region 10 concerns regarding applicability of the analytical method used by the Navy to reliably and accurately measure munitions compounds in this matrix. ATSDR is reassured by the most recent round of fish and shellfish data collected and analyzed by the Navy, which reported lower method detection limits and indicates that munitions compounds are not present at levels of health concern. This current sampling data is consistent with the scientific literature indicating that most of the munitions-related compounds used at JPHC tend to break down quickly and do not persist in the environment for long periods of time. However, it is very important that the Navy work with the state and federal regulatory agencies and agree upon the best available methods for detecting munitions compounds and their breakdown products in biological tissue samples.

2. **Comment:** The last paragraph on page 4 states, "ATSDR advises against any activities such as fishing, shellfish harvesting , swimming, or diving in Ostrich Bay until the Navy and state and federal regulators agree that munitions items located within marine sediments are sufficiently cleared or not accessible." Restrictions to perform these activities are presently in place. Therefore, the sentence should state that ATSDR "supports" the restrictions to perform the specific activities. Only activities presently not restricted should be included in the comment/ recommendation.

   Response: ATSDR uses the suggested language in the paragraph referred to above: "ATSDR supports the Navy's prohibition on these activities for JPHC residents." However, the additional statement is provided to alert both JHPC and non-JPHC residents that the above stated activities in Ostrich Bay are not advisable until state and federal regulatory agencies deem them to be safe.

3. **Comment:** Page 11, third paragraph quotes a 1988 Hart Crowser comment, "Recreational and commercial harvesting of activities were common throughout Dyes inlet in the past. The paragraph continues with the fact that the Navy banned shellfish harvesting in 1991. Page 31 of the report records the fact that advisories prohibiting commercial and recreational shellfish harvesting in Ostrich Bay and other portions of Dyes Inlet have been in place since 1969. Therefore we would assume "in the past" refers to the years prior to 1969. Because the first Navy housing residents did not move into to Jackson Park Housing until the mid 1970's we would think recreational harvesting activity by Navy families was minimal in Ostrich Bay because of the existing advisories. This information should be included in the text on page 4 in that it is an important piece of the conceptual site model for Navy families living in Jackson Park Housing. Past harvesting activities for Ostrich Bay (adjacent to Jackson Park Housing) should be separate from Dyes Inlet, located north of Jackson Park Housing.

   The Hart Crowser document was from 1988. When they state recreational and commercial harvesting was conducted in the past it is somewhat true for Dyes Inlet. For the Jackson Park site one needs to remember the site has been in Navy ownership since 1904 (most of the site) and 1930 (Elwood Point and north). Therefore, only harvesting that would have gone on in Ostrich Bay was by the very few people who lived at the NAD or those who were trespassing on government property.

   Response: ATSDR agrees that if shellfish harvesting and fishing occurred in the past among JPHC residents, it was likely to be infrequent and of short duration due to the relatively short period of time that most military personnel reside at JPHC. However, non-JPHC residents may have accessed portions of Ostrich Bay for purposes of shellfish harvesting or fishing. Since ATSDR does not have sufficient information to estimate the extent of past recreational activities or the nature and extent of contamination prior to 1988 to either JPHC or non-JPHC residents, this potential exposure pathway has been categorized as an "indeterminate public health hazard." ATSDR will reassess this designation for JPHC residents if the Navy provides information to ATSDR that more definitively characterizes typical Ostrich Bay fish and shellfish consumption rates prior to 1988.

4. **Comment:** Page 17, Table 1 categorizes the past consumption of shellfish as an indeterminate health hazard. We do not agree with the classification for people living in Navy Housing. We feel that it is unlikely Navy Housing resident's harvested shellfish in sufficient quantity to create a health risk due to the relatively short duration (3-6 years) and the restrictions that have been in place since the housing opened. Exposure scenarios to fish and shellfish should be separated. Reconsideration should be made concerning the "indeterminate" category given for shell fish consumption by Navy Housing residents. A separate table should be developed for people living in Military housing.

   Response: ATSDR has added additional language in the "Conclusions" section to reflect the low likelihood of harmful exposure to JPHC residents in the past. However, for reasons stated in the previous response, ATSDR believes that "indeterminate public health hazard" is the appropriate designation for the past fish and shellfish consumption scenario.

5. **Comment:** Page 19, Table 1, "Potential for coming into contact with munitions": The third bullet under Actions Taken states that in 1998 and 1999 the Navy conducted investigations to evaluate the nature and extent of munitions items near the hospital and to conduct removals as required. We did not see where it was reported whether any munitions were located and subsequently removed. This information should be included within the Table and corresponding text.

   Response: ATSDR has provided additional information regarding the extent of munitions recovery from the investigation in the Final Release PHA. The information was added to the text in Exposure Situation 3: Potential for coming into contact with munitions-related items in the terrestrial and marine environment. The table was not modified since that level of detail was not presented for the other exposure pathways.

6. **Comment:** Page 21, The center of the pages states, "According to JPHC Site Reports from the 1980's, the beaches and shorelines at JPHC supported a large recreational clam fishery during the 1970s and 1980, before the Navy banned all fish harvesting and closed the JPHC beaches in 1991 (Hart Crowser 1988, Navy 1992)." Because the shellfish harvesting advisory restrictions have been in place since 1969 we question whether the statement is accurate. We understand residents fishing from the beaches and the piers, however recreational shellfish harvesting on a "large" scale seems very unlikely in that restrictions were in existence. This needs to be clearly addressed within the report. Pathways discussing fishing and shellfish harvesting need to be separated for accuracy.

   Response: ATSDR relied on early JPHC site documents for the information regarding the scale of shellfish harvesting and fishing along the JPHC shoreline. ATSDR has modified the original text so that the inference of shellfish harvesting and fishing along JPHC shoreline on a large scale is removed. However, there is sufficient information to indicate that fishing and shellfish harvesting occurred with some frequency along the shoreline of JPHC. ATSDR appreciates the recommendation on how to best present the fish and shellfish harvesting pathways and will take under consideration.

7. **Comment:** Pages 26 and 38, Tables 2 and 3; Tables C-1 and C-2a provide the maximum detected values ATSDR used in the health hazard evaluation. The report does not provide the average or 95 UCL of the mean typically used in CERCLA type risk assessments. We understand that ATSDR typically use worst cast exposure level contaminants as the basis for determining whether adverse health effects are possible. However, relying solely on the highest detected concentration does not represent site conditions, or "worst-case" exposure levels. We support the use of the highest detected concentration as a screening level to determine what chemicals need to be further investigated. However, we do not feel that the highest detected concentration is representative of "worst case" exposure level. This is particularly a concern when combined with worst case exposure parameters (subsistence ingestion rate). ATSDR owes the public a realistic, worst case exposure summary. A more appropriate value would be the use of the 95 UCL of the mean. We recommend using this value for estimating the final health hazard to a population.

Response: ATSDR does not intend to change the parameters of its media-specific evaluation of chemical contaminants at JPHC. We agree that the assumptions are overly protective and are very likely to overestimate individual exposures. If specific contaminants were identified as likely posing a public health hazard under the "worst case" assumptions used in this evaluation, ATSDR would consider modifying the "maximum concentration" assumption and try to collect additional site-specific information about the frequency and duration of activities that could result in exposure. However, our initial evaluations did not show contaminant exposures at levels of public health concern at JPHC.

8. **Comment:** Page 26, Table 2 presents information on samples collected from 1998 to 2002. It does not include the more recent sampling data collected in 2004. The Table provides the maximum concentration and the year the maximum concentration was detected. The information is difficult to digest and becomes even more confusing after reading the text describing the 2004 sampling results. The reader is left questioning whether chemical concentrations detected in marine tissues is increasing or decreasing. Furthermore, the manner in which the data is presented leaves to question whether the maximum concentration detected for each species is representative of the entire population. It may be appropriate to present the data in separate Tables by year (or study) and also show additional statistical data such as the 95% UCL of the mean concentration. This will allow the reader to better understand the history of the conditions of Ostrich Bay or to simply know whether conditions are improving or getting worse.

   Response: ATSDR has added the 2004 data to Table 2. ATSDR agrees that providing the 95% upper confidence limit (UCL) of the mean concentration provides additional perspective. However, the complete raw data set were not available to ATSDR during the evaluation. ATSDR inquired whether the Navy could provide a comprehensive electronic database that included all data from previous investigations. ATSDR was informed that the data from previous investigations were not available in this format. ATSDR has added some additional perspective regarding the data trends over time in the text of the report.

9. **Comment:** Page 40, "Past Exposure" ATSDR concludes past exposures to surface soil at JPHC do not appear likely that contaminated levels in surface soils were high enough to pose a public health hazard; ATSDR does not have sufficient information to make a conclusive statement about past exposures. We suggest addressing the pathway assuming a 3 to 6 year time period and using dose reconstruction values to determine the exposure point concentration.

   Response: ATSDR's preference is to use actual sampling data when available. However, ATSDR will consider findings from a dose reconstruction investigation to be appropriate under certain circumstances. ATSDR is not aware of any such investigation conducted at JPHC. ATSDR will consider additional information if it adds value to the PHA.

10. **Comment:** Pages 49-51, "Conclusions": We request that ATSDR consider the comments presented above when finalizing the conclusions for the Public Comment Draft.

    Response: ATSDR appreciates the comments and has addressed each one as indicated in the responses above.

11. **Comment:** The ingestion rate and body weight parameters presented in Table C-1 used to develop the exposure levels are not appropriate for populations living in Military housing. The exposure parameters are appropriate (sea food pathway) for Suquamish Tribal members only. They are not appropriate for non military residents living off base who may have harvested shellfish from Ostrich Bay. They are not remotely representative of military housing. We recommend that site specific screening values be calculated to accurately represent military housing.

    Response: ATSDR agrees that the parameters and assumptions used to estimate dose for JPHC residents are very conservative. However, the only contaminants that exceeded their respective reference dose were antimony and arsenic. ATSDR clearly states why the concentrations of these two contaminants do not pose a health hazard (see pages 33-34: Eating contaminated fish or shellfish collected from Ostrich Bay). Modifying the ingestion rate and body weight assumptions is not necessary because even at the more restrictive assumptions we did not find there to be chemical exposures that would likely result in adverse health effects.

12. **Comment:** Appendix C, Table C-1 assumes that all of the seafood consumed (393 grams per day for shellfish and 21.5 grams per day English Sole) is harvested from Ostrich Bay. This calculates to 137,550 grams or 303 pounds a year for shellfish and 15,050 grams per year or 33 pounds of English sole. Since this is a relatively small area it does not appear to be a reasonable assumption.

    Response: ATSDR used three different consumption scenarios; subsistence, recreational, and JPHC residential scenario. Only the subsistence fishing scenario assumes a frequency of 350 days per year. The other two scenarios assume a frequency of 50 days per year. Location-specific ingestion rates were not reported in the Suquamish Consumption Survey. ATSDR will consider any additional site-specific information that will help provide a better characterization of past exposures. However, since the dose estimates for contaminants detected in shellfish and fish were not found to be at levels of health concern, additional revisions of the assumptions and parameters for estimating dose would be of little added value.

13. **Comment:** ATSDR calculates ingestion rate for shellfish by combining the portion size, and frequency of consumption for individual shell fish. The shellfish included in the "total" ingestion rate are from Group E of the 1999 Fish Consumption Survey of the Suquamish Indian Tribe. Group E consists of the following shellfish:

    - Group E – Shellfish: Manila, littleneck clams, Horse clams, Butter clams, Geoducks, Cockles, Oysters, Mussels, Moon Snails, Shrimp, Dungeness crab, Red rock crab, Scallops, Squid, Sea Urchin, and Sea cucumber.

      Similarly, the fish ingestion rate for English Sole is based upon the Group D. Group D consists of the following fish:

    - Halibut, English Sole, Flounder, and Rockfish

    Several of the shellfish and fish included in the total ingestion rate habitats are not harvested from Ostrich Bay. Only those shellfish and fish harvested from the areas adjacent to Jackson Park Housing should be included in calculating the ingestion rate in the form of an appropriate percentage of the whole group. Note: The survey states that 81% of the total shellfish is harvested within Puget Sound. This, as a minimum should be a starting point for intake rates. Subsequently, specific intake rates for English Sole should be used, not the intake rate for the entire Group D. Please see Comment 14 on Fraction Ingested for additional information.

    Response: Refer to the response to Comment 12.

14. **Comment:** The intake rates for shellfish and fish for the children and adults is from the adult male respondents of the Suquamish Tribe Survey. The adult male respondents reported a consumption rate twice those reported by female respondents and children. Consumption rates for women and children should be used for estimating their dose. Likewise, consumption rates appropriate for non-subsistence (recreational) fishers should be used.

    Response: For children, ATSDR assumes ½ the adult ingestion rate (Refer to Table C-1). This is a standard assumption that is made for most estimates of dose, especially when site-specific ingestion rates are not available. Although the Suquamish Consumption Survey does include child-specific ingestion rates, ATSDR used ½ the adult rate because it was more health-protective. As mentioned previously, ATSDR did not identify contaminants at levels shown to cause adverse health effects.

15. **Comment:** ATSDR uses a shellfish and fish fraction ingested (FI) of 1.0. This assumes that 100% of all of the shellfish and fish consumed by the subsistence fisher is captured from Ostrich Bay. This is not representative of the Suquamish Tribe fishing habits described in the Survey. The Fraction ingested is a pathway specific value that "should consider local usage patterns."

    Response: ATSDR agrees with this comment. However, as mentioned previously, the dose estimates under these more restrictive assumptions simply overestimate exposure. Since the

estimated doses are not found to be at levels of health concern, revising the assumptions to reflect a reduced fraction ingested would not add any value to the findings.

16. **Comment:** Provided the comments above we suggest recalculating exposure dose for recreational and subsistence populations using site specific information appropriate for Ostrich Bay. Specifically, we do not feel using the maximum concentration detected in the fish/shellfish tissue, combined with assuming all consumers ingestion rates are that of the Adult Suquamish Tribe member and assuming 100% of the seafood consumed by the subsistence fisher is captured from Ostrich Bay is realistic, even under the most protective circumstances.

    ***Response*:** Refer to ATSDR's specific responses in comments 11 through 15.

17. **Comment:** P. 21: Did contaminant sampling include dinitrotoluene (DNT)? At another site we are familiar with DNT moved with groundwater at high concentrations and was discharged via seeps to Puget Sound. The local tribes were very concerned about the impacts of DNT to shellfish and fish.

    Response: According to the 1998 Technical Memorandum-JPHC/NHB OU 2 Treatability Study, 2,6-dinitrotoluene (2,6-DNT) was detected at 13 of 24 sediment stations in Ostrich Bay. DNT was also detected at low concentrations in clam tissue during 2002 sampling. However, during the most recent shellfish sampling in 2004, DNT was not detected in clam or crab tissue samples.

18. **Comment:** P. 55: Action 5 appears to be the first place where benzene "free product" is mentioned, apparently in groundwater. On page 23, there is a statement about a "benzene seep" along the shore with concentrations as high as 316 ppb. While it is not clear in the document if these are related, there may be a possible exposure risk to either or both of these releases. On page 11, we are told there are "two… private wells reportedly used for domestic purposes. However, it is not known whether these two wells are used as a drinking water source." With free product documented in groundwater, there should be a determination if the wells are a drinking water source and, if so, they should be sampled to assess the exposure risk. In addition, if buildings are present over the groundwater plume, the vapor intrusion pathway should be investigated to determine if indoor air has been impacted.

    Response: ATSDR plans to follow-up with Region 10 EPA regarding the benzene groundwater plume at JPHC. These discussions are expected to provide ATSDR with specific concerns to be addressed through a focused health consultation. ATSDR will discuss groundwater quality issues and will gather additional information about groundwater use in the vicinity of the plume. ATSDR has not identified any private wells in the area used as a primary source of drinking water. However, ATSDR has not confirmed the specific use of water from the two private wells mentioned above.

19. **Comment**: Arsenic data appears to be based on dry weight for clams and crab; wet weight should be used for evaluations.

    Response: ATSDR does not have the percent moisture information necessary to convert dry weight to wet weight values. We did add a note stating that "dry weight concentrations are generally higher than concentrations reported as wet weight and cannot be directly compared to other data reported as wet weight."

20. **Comment**: Crabs should be evaluated separately from other shellfish; the Suquamish Tribe has a specific consumption rate for crab.

    Response: ATSDR will take this under consideration in any future evaluations conducted for the Suquamish Tribe.

21. **Comment**: The English sole data are very old-about 20 years. Is it still representative of current conditions or should new data be collected?

    Response: ATSDR agrees that the English sole contaminant data is dated and may not adequately reflect current contaminant levels in the fish. However, the Navy continues to sample shellfish (crab and clam tissue) from Ostrich Bay. Since these species are bottom filter feeders, they should be sufficient as indicators of contaminant uptake in biota from Ostrich Bay. However, ATSDR will support additional recommendations for sampling of English sole or other fish species by the Navy or state agencies if there is concern about the safety of consuming these species in the future.

22. **Comment**: Washington State Department of Ecology has data on Puget Sound shellfish (information on pages 7 and 17, Table 5, Ostrich Bay sampling point). There is also arsenic speciation data for clams and crabs: http://www.ecy.wa.gov/pubs/0203057.pdf. The primary contaminants of concern in Ostrich Bat are munitions compounds, UXO, and smokeless powder.

    Response: ATSDR appreciates this additional information.