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NAVAL SURFACE WARFARE CENTER
INDIAN HEAD DIVISION (NSWC-IHDIV)
(a/k/a INDIAN HEAD NAVAL SURFACE WARFARE CENTER)
INDIAN HEAD, CHARLES COUNTY, MARYLAND
CERCLIS NO. MD7170024684
JANUARY 2, 1998

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES

PUBLIC HEALTH SERVICE

Agency for Toxic Substances and Disease Registry

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PUBLIC HEALTH ASSESSMENT

NAVAL SURFACE WARFARE CENTER
INDIAN HEAD DIVISION
(NSWC-IHDIV)

(a/k/a INDIAN HEAD NAVAL SURFACE WARFARE CENTER)

INDIAN HEAD, CHARLES COUNTY, MARYLAND

CERCLIS NO. MD7170024684

Prepared by:

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

FOREWORD

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

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

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

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

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

Interactive Process: The health assessment is an interactive process. ATSDR solicits and evaluates information from numerous city, state and federal agencies, the companies responsible for cleaning up the site, and the community. It then shares its conclusions with them. Agencies are asked to respond to an early version of the report to make sure that the data they have provided is accurate and current. When informed of ATSDR's conclusions and recommendations, sometimes the agencies will begin to act on them before the final release of the report.

Community: ATSDR also needs to learn what people in the area know about the site and what concerns they may have about its impact on their health. Consequently, throughout the evaluation process, ATSDR actively gathers information and comments from the people who live or work near a site, including residents of the area, civic leaders, health professionals and community groups. To ensure that the report responds to the community's health concerns, an early version is also distributed to the public for their comments. All the comments received from the public are responded to in the final version of the report.

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

Letters should be addressed as follows:

Attention: Chief, Program Evaluation, Records, and Information Services Branch, Agency for Toxic Substances and Disease Registry, 1600 Clifton Road (E-56), Atlanta, GA 30333.

SUMMARY

The Navy has conducted munitions-related activities at the Naval Surface Warfare Center - Indian Head Division (NSWC-IHDIV) continuously since the base was established in 1890. These activities have evolved from the historical testing of guns, gunpowder, and other explosives to current activities in the manufacture and testing of propellants and propulsion systems for missiles and other weapons. Located approximately 35 miles south of Washington, D.C., in Charles County, Maryland, the base is comprised of the Naval Surface Warfare Center, which occupies the Cornwallis Neck peninsula, and two tenant organizations that occupy the Stump Neck Annex on the nearby Stump Neck peninsula.

The NSWC-IHDIV was designated in 1995 by the U.S. EPA as a National Priorities List (NPL) hazardous waste site. Wastes generated from base operations have included waste propellants, explosives, acids, paints, solvents, and metals: the NPL listing was driven by mercury contamination of surface waters on the base. Forty-eight (48) areas have been identified for characterization and potential clean-up under the Department of Defense Installation Restoration Program (IRP). Although several clean-up actions have been completed, the majority of the sites are currently entering the Remedial Investigation phase of the process in which more in-depth sampling and evaluation are conducted.

ATSDR evaluated the environmental information for NSWC-IHDIV and identified three situations where people are currently exposed to contaminants, have been potentially exposed to contaminants in the past, or may be exposed in the future. We determined that a fourth situation does not pose a concern for public health. Summaries and ATSDR's public health evaluation of these situations are provided below.

Public Health Hazard

Exposure to Residential Lead Sources: ATSDR has concluded that residential sources of lead at NSWC-IHDIV currently pose a public health threat because exposures to lead are taking place at concentrations that may cause adverse health effects in children and women of child-bearing age. The sources of lead include exterior and interior paints, foundation soils, and household dusts, at the on-base and off-base residential units. Calculations using lead data from foundation soils demonstrate the potential for blood lead levels of resident children to increase above the CDC public health standard of 10 micrograms per deciliter (µg/dL). ATSDR has recommended that actions be taken to improve the voluntary lead screening program at the base to ensure coordination of educational efforts, blood lead testing, reporting and tracking, and an action plan in the event that blood lead levels > 10 µg/dL are identified.

Potential (Indeterminate) Public Health Hazards

Two situations were identified in which exposures to contaminant levels of health concern could occur in the future or may have occurred in the past.

Mercury in Buildings 101 and 102: Spills of mercury impacted laboratory and general use areas of Buildings 101 and 102, potentially placing civilian employees in these buildings at risk of

mercury exposure. Using historical mercury vapor data and limited medical monitoring data, ATSDR has tentatively concluded that past mercury exposures may have occurred in Buildings 101 and 102 at levels of health concern. However, potential past exposure of civilians working in these buildings between 1981 and 1991 does not place these individuals at an increased risk for reproductive problems, nor is it likely to shorten their expected life spans. Any neurological effects associated with chronic low-level exposure to the mercury vapor would have ended after the exposure stopped and would not be evident today. However, because no environmental or medical monitoring records are available for review, ATSDR cannot eliminate the possibility that the pre-1981 employees of these buildings were exposed at higher levels. ATSDR has requested the retrieval of additional medical monitoring files for employees who worked in these buildings through 1991 for our evaluation.

Fish in Mattawoman and Chicamuxen Creeks: Concentrations of cadmium, mercury, and zinc in Mattawoman Creek fish tissue are below levels of health concern and do not pose a threat to public health through ingestion. However, ATSDR recommends that sampling and analysis for lead, silver, chromium, and copper be performed to determine if these metals are entering the food chain in Mattawoman and Chicamuxen Creeks and bioaccumulating to concentrations that require consumption limits to protect the health of people eating the fish.

No Public Health Hazard

Drinking Water Supply: Actions have been taken by the NSWC-IHDIV to ensure protection of the deep groundwater resources that serve as the water supply for the base and the region. The NSWC-IHDIV wellhead protection program, currently being developed by the base in conjunction with the Maryland Department of the Environment, will ensure that the network of groundwater wells at the base does not serve as a future conduit for the migration of the shallow contaminated groundwater at the base to the deeper aquifer.

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ACRONYMS, ABBREVIATIONS, AND GLOSSARY

adverse health effects	negative or unwanted effects on the health of an individual; for example, effects may include a specific illness or a general decrease in the overall health of a person
ATSDR	Agency for Toxic Substances and Disease Registry
aquifer	a geologic (rock) formation through which groundwater moves and that is capable of producing water in sufficient quantities for a well
bioaccumulation	the process by which plants or animals retain chemical pollutants in their tissues at levels greater than in the environment in which they live
CDC	Centers for Disease Control and Prevention
CERCLIS	Comprehensive Environmental Response Compensation and Liability Information System
conduit	a natural or artificial channel through which materials such as fluids are transported; for example, a water well
DOD	Department of Defense
EPA	Environmental Protection Agency
groundwater	water beneath the earth's surface in the spaces between soil particles and in rock
ingestion	eating and drinking; for example, children eating lead paint chips or swallowing lead in dust due to chewing and sucking activity on hands and toys
HUD	Housing and Urban Development (Department of)
IRP	Installation Restoration Program (Department of Defense)
medical monitoring	a set of medical tests and physical exams specifically designed to evaluate whether an individual is being exposed to a particular chemical at concentrations that could negatively affect that person's health

ACRONYMS, ABBREVIATIONS, AND GLOSSARY, continued

mercury vapor	mercury is a liquid metal that becomes an odorless, colorless gas (or vapor), which can be inhaled, at ordinary room temperatures
migration	moving from one location to another
mg/m^3	milligrams per cubic meter; a measure of the concentration of a chemical in a known amount (a cubic meter) of soil
mg/kg WW	milligrams per kilogram of wet weight; a measure of the concentration of a chemical in a known amount (a kilogram) of fish tissue which has not been dehydrated prior to making the measurement.
munitions	explosive military items; for example, grenades and bombs
NPL	National Priorities List (of Superfund sites)
NSWC-IHDIV	Naval Surface Warfare Center - Indian Head Division
ordnance	military supplies; for example, weapons, ammunition and vehicles
propellants	explosives for forcing forward projectiles such as rockets
Pb	Lead
PbB	Lead in blood
RCRA	Resource Conservation and Recovery Act
Remedial Investigation	the CERCLA process of determining the type and extent of hazardous material contamination at a site
solvent	a liquid capable of dissolving or dispersing another substance; for example, acetone or mineral spirits
surface water	water flowing in ditches, creeks, and rivers or standing in lakes and ponds
µg/dL	micrograms per deciliter; a measure of the concentration of a chemical in a known amount (deciliter) of liquid; for example, the concentration of lead in a blood sample

BACKGROUND

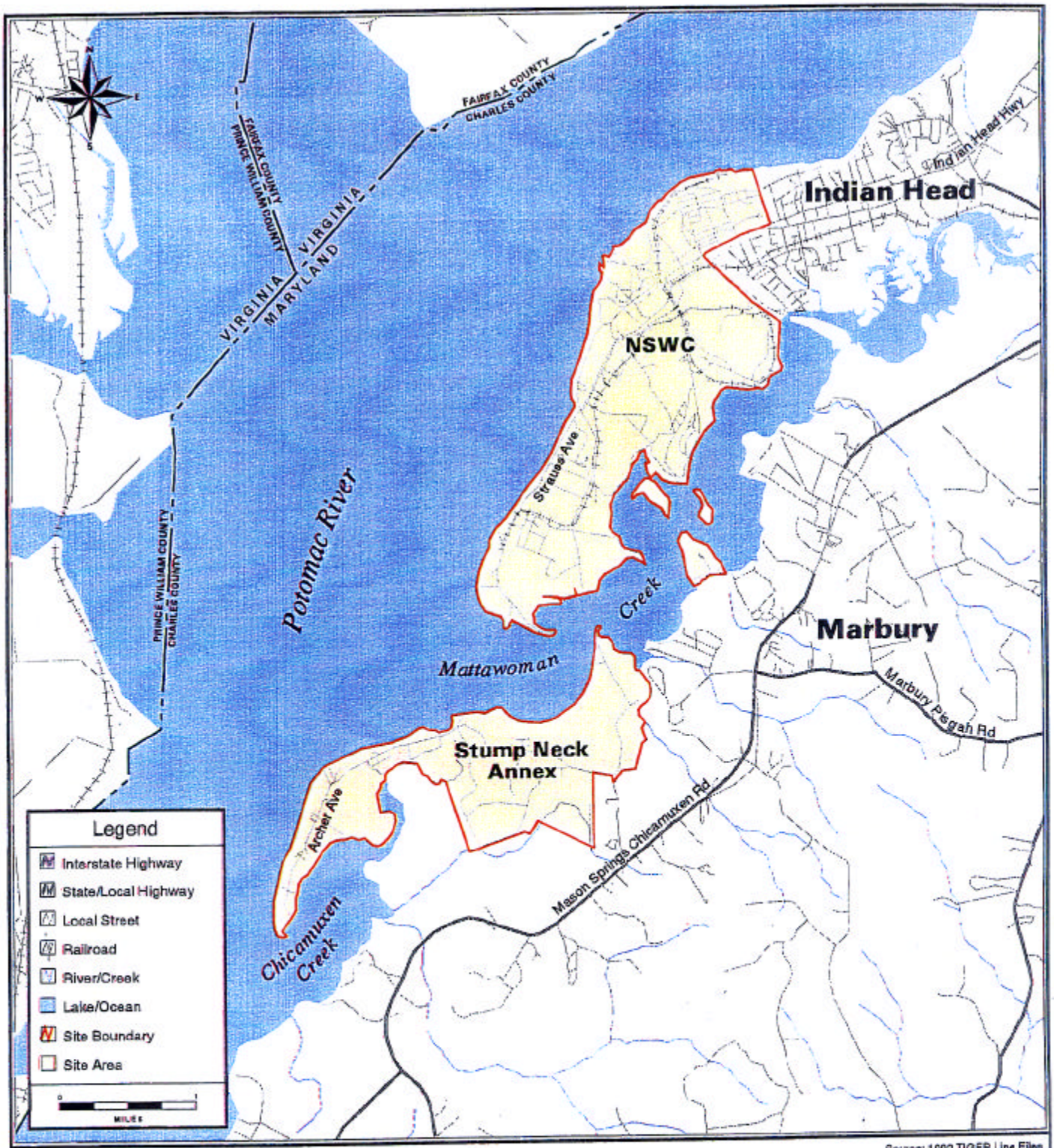
The NSWC-IHDIV is located approximately 35 miles south of Washington, D.C., in Charles County, Maryland. The Navy has conducted munitions-related activities on the property continuously since 1890. These activities have evolved from the historical testing of guns, gunpowder, and other explosives to current activities in the manufacture and testing of propellants and propulsion systems for missiles and other weapons [1].

The base occupies approximately 3,500 acres on two discrete land areas in the Potomac River drainage basin (Figure 1). The Naval Surface Warfare Center (NSWC) is located on approximately 2,500 acres on the Cornwallis Neck peninsula [2]. The base is bordered on the north and east by the Potomac River, and on the south and west by Mattawoman Creek. The town of Indian Head lies immediately outside the base entrance to the northwest.

The remaining acreage is located at the Stump Neck Annex on the Stump Neck peninsula. The Annex lies south of the NSWC and is occupied by tenant organizations [2]. The mission of the Naval Explosive Ordnance Disposal Technology Division at Stump Neck is to develop procedures for rendering safe weapons, missiles, and munitions. The Naval School, Explosive Ordnance Disposal, provides training in methods and procedures for recovery, evaluation, rendering safe, and disposal, of explosive ordnance (surface, underwater, conventional and nuclear types) [3]. The Stump Neck Annex is bordered on the north and east by Mattawoman Creek. Chicamuxen Creek and a sparsely populated area of Charles County lay to the south and west. Information on the demographic make-up of the base and surrounding community is provided in Appendix A.

Spills, disposal, and routine releases of chemical contaminants have occurred on both parts of the base [3,4,5] resulting in the U.S. EPA 1995 listing the Naval Surface Warfare Center-Indian Head Division as a National Priorities List (NPL) site for clean-up. Wastes from base operations have included waste propellants, explosives, acids, paints, solvents, and metals [6]: the NPL listing was driven by mercury contamination of surface waters (creeks, drainage ditches) at the base[6]. Forty-eight (48) areas at the NSWC have been identified for characterization and potential clean-up under the Department of Defense Installation Restoration Program (IRP). Although several clean-up actions have been completed, the majority of the sites are currently entering the Remedial Investigation phase of the process in which more in-depth sampling and evaluation are conducted. A summary of ATSDR's evaluation of these sites is provided in Appendix B.

To date, characterization and environmental clean-up activities at the Stump Neck Annex have progressed under the authorities of the EPA's Resource Conservation and Recovery Act (RCRA) Corrective Action program [3]. However, U.S. EPA has recently determined that the Stump Neck Annex is included in the NPL listing for the NSWC-IHDIV (Appendix B). This interpretation does not affect the scope of ATSDR's public health assessment activities: since chemical contaminants from both NSWC and the Stump Neck Annex have impacted local creeks, ATSDR evaluated the potential health effects associated with environmental



Source: 1992 TIGER Line Files

Indian Head Naval Surface Warfare Center

Indian Head, Maryland

CERCLIS No. MD7170024684

VICINITY MAP

Charles County, Maryland

ALD-042297

conditions at both locations in support of public health assessment goals.

ATSDR Involvement: ATSDR visited the NSWC-IHDIV base on November 18-21, 1996. The purpose of the visit was to collect the information necessary to identify any public health issues related to potential exposure to environmental contamination at the facility, to identify community health concerns, and to rank the NSWC-IHDIV among other Department of Defense (DOD) installations according to its potential public health hazard.

During our tour of the site to observe the environmental conditions at the base, we met with Navy personnel and representatives from the federal and state agencies with knowledge of the base. Our discussions addressed the nature and extent of chemical contamination at the NSWC-IHDIV, the proximity of chemically contaminated areas to on and off-base populations, and the types of human activities that could lead to exposures to the contamination. This information has been integrated with our review of environmental sampling data to draw the conclusions about public health issues at NSWC-IHDIV that are presented in this Public Health Assessment document.

What is exposure ?

ATSDR's public health assessments are exposure, or contact, driven. Chemical contaminants disposed or released into the environment have the potential to cause adverse health effects. However, ***a release does not always result in exposure.*** People can only be exposed to a chemical if they come in contact with the chemical. Exposure may occur by breathing, eating, or drinking a substance containing the contaminant or by skin (dermal) contact with a substance containing the contaminant.

When do health effects occur?

Exposure does not always result in health effects. The type and severity of health effects that occur in an individual from 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, life style, 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 as a result of exposure to a contaminant in the environment.

EVALUATION OF ENVIRONMENTAL CONTAMINATION, EXPOSURE PATHWAYS, AND PUBLIC HEALTH IMPLICATIONS

Based on the results of our site visit, and a review of the data and information currently available, we conclude that one exposure situation at NSWC-IHDIV currently poses a public health threat. Exposures to lead in the Navy housing are occurring at concentrations that may cause adverse health effects. In addition, two potential situations are identified in which exposures may have occurred in the past or could occur in the future to contaminant levels of health concern. A fourth situation does not pose a public heath concern because the base has taken action to reduce the chances of exposure to the chemical contaminants.

Table 1 summarizes ATSDR's public health conclusions for the exposure situations identified at NSWC-IHDIV, and a detailed discussion of each situation. Additional information describing ATSDR's public health conclusion categories is provided in Appendix C.

TABLE 1. Summary of ATSDR's Public Health Conclusions for NSWC-IHDIV.

CONCLUSION CATEGORY	SITUATION
Public Health Hazard	Exposure to Residential Sources of Lead
Potential Health Hazards	Exposure to Mercury in Buildings 101 and 102 Fish in Mattawoman and Chicamuxen Creeks
No Public Health Hazard	Drinking Water Supply-Patapsco and Patuxent Aquifers

I. Public Health Hazard: Exposure to Residential Sources of Lead

Summary: The lead in exterior and interior paints, foundation soils, and household dusts, at NSWC-IHDIV housing poses a health hazard to residents, particularly children 6 years of age and under and women of child-bearing age. Calculations using lead data from foundation soils demonstrate the potential for blood lead levels of resident children to increase above the CDC public health standard of 10 micrograms per deciliter (µg/dL). The base should take action to improve the voluntary lead screening program to ensure coordination of educational efforts, blood lead testing, reporting and tracking, and an action plan in the event that blood lead levels meet or exceed 10 µg/dL. A summary of our evaluation of this situation is provided in Table 2.

Background: NSWC-IHDIV currently maintains housing on the base (the Detached single family housing and the Riverview Village apartments). Off-base housing in the nearby towns of

La Plata and Waldorf was taken out of service in 1997. Additional Detached housing at the Stump Neck Annex was taken out of service in November of 1996. The housing ranges in age from approximately 30 to 80 years and has been identified by NSWC-IHDIV as a source of residential lead exposure requiring risk reduction and abatement actions.

Lead is a public health concern in private and public housing throughout the United States, particularly in urban areas with greater numbers of older housing units. Although use of lead-based paint in housing was banned in 1977, approximately 74 percent of housing in the United States built before 1980 contains lead paint. Lead-based paint is a significant source of child lead poisoning [7].

Children can be exposed to lead from multiple sources. At the NSWC-IHDIV, those sources include lead-contaminated paint chips, household dusts, and foundation soils (soils located near the base of the buildings). In 1991-1992, the Navy Public Works Center/Norfolk sampled the interior paint, household dusts, exterior paint, and foundation soils at each of the housing locations. The data demonstrate that the interior and exterior paint (Detached housing, Riverview Village, and La Plata), household dusts (Detached housing), and foundation soils (Detached, La Plata, and Waldorf) of many these residential units are contaminated with lead at levels exceeding Housing and Urban Development (HUD) action criteria [8].

Regardless of whether the HUD lead screening criterion for any single source is exceeded in a residential setting, ingestion and inhalation of lead from multiple sources in a child's environment may result in exposures that pose a potential health hazard.

The Centers for Disease Control and Prevention (CDC) recommends that all children be screened for lead poisoning at least annually, especially children between the ages of 6 months and 6 years of age [9]. Young children and fetuses are most vulnerable to lead toxicity for several reasons, including: (i) greater absorption and metabolism of lead than adults, (ii) rapidly developing nervous systems, and (iii) higher intakes of air, food, and water on a body weight basis. In addition, children age 3 and under tend to chew and mouth their hands, toys, and other objects, exposing them to lead dusts and paints [9]. Blood lead levels of 10-40 micrograms per deciliter (µg/dL) may not cause distinctive symptoms of lead poisoning, but are associated with impaired central nervous system development, lower IQs, and hearing problems in children [7,9].

Based on the toxicity of lead at low concentrations in the blood, the CDC recommends that children's blood lead levels fall below 10 µg/dL [9]. Historically, NSWC maintained no database of past blood lead testing results which could be reviewed by ATSDR during the public health assessment. However, blood lead tests conducted by the base in 1991 demonstrated that all children (6 months to 6 years of age) living in the Detached housing units tested positive for lead, with levels ranging from 2 to 9 µg/dL [8]. Although the range is below the CDC criterion, this data set represents blood lead concentrations at a single point in time several years ago and is limited to only a subset of the children living on the base in 1991. During the public health assessment, NSWC provided additional blood lead data obtained in 1997 through their

TABLE 2. Public Health Hazard Situation: Residential Lead

PATHWAY NAME	CONTAMINANTS	EXPOSURE PATHWAYS ELEMENTS					TIME	COMMENTS
		SOURCE	ENVIRONMENTAL MEDIA	POINT OF EXPOSURE	ROUTE OF EXPOSURE	EXPOSED POPULATION		
Lead-Based Paint in Detached, Riverview, Waldorf, and La Plata Navy residential housing	Lead	Flaking and deteriorating lead-based paint on interior and exterior surfaces of on-base and off-base Navy residential housing	Soil, Air	(i) Lead-contaminated household dusts (ii) lead-contaminated painted surfaces (ii) lead-contaminated paint chips, soils	Inhalation (of lead-contaminated dusts) Ingestion (paint chips, children teething on wood surfaces, dusts and chips ingested via hand-mouth and toy-mouth activity)	Children residents (particularly ages 6 and under; approximately 65 children*) Adult residents, particularly pregnant and nursing women, and women of child-bearing age (approximately 93 women between the ages of 15 and 44 years*)	Past Current Future	Calculations assuming exposure to NSWC-IHDIV residential foundation soil lead concentrations demonstrate potential increases in child blood lead levels above the CDC public health standard of 10 µg/dL. NSWC-IHDIV is evaluating and modifying its current blood lead poisoning prevention program to better address the specific residential lead exposure situation at the base.

* Population estimates based on July 1997 NSWC-IHDIV housing demographics; Waldorf and La Plata data were not provided.

voluntary blood lead screening program [10]. Data from five of the 65 children living in the Detached (one child) and Riverview (four children) housing demonstrate that these five children have not been exposed to lead at levels of health concern. Blood lead concentrations in these children ranged from 2 - 3 µg/dL, well below the CDC screening criterion. The U.S. national average blood lead concentration for children ages 1-2 years and 3-5 years is 4.1 and 3.4 µg/dL, respectively [7, 11].

Since the housing inspection results indicate that the children living in NSWC-IHDIV housing are at high risk for lead exposure, historical annual screening data and limited current blood lead data are available for these children, ATSDR evaluated the ***potential*** for blood lead levels of children residing in NSWC-IHDIV housing to exceed public health criteria. We used the site-specific NSWC-IHDIV soil lead data, and an algorithm that relates potential increases in blood lead levels to concentrations of lead in soils, to estimate the potential for blood lead levels to exceed the 10 µg/dL public health criterion for children. The algorithm, soil lead data, assumptions, and calculations are provided in Appendix D.

The calculations in Appendix D demonstrate the need for regular blood lead screening for the children in residence at the NSWC-IHDIV. Calculated increases in blood lead levels ranged from 7.1 (Riverview Village apartments) to 23.5 (Detached housing) µg/dL. Adding these values to the baseline blood lead concentrations for U.S. children (noted above), one arrives at predicted blood lead levels ranging from approximately 11 to 27 µg/dL for children living in NSWC-IHDIV housing. Thus, exposures to the foundations soils at the Detached housing, Riverview Apartments, La Plata and Waldorf units, could potentially result in increases in blood lead levels which exceed the 10 µg/dL screening criterion.

These calculations may overestimate potential increases in blood lead levels by assuming regular exposure to the lead-contaminated soils; however, the evaluation addresses only one (foundation soil lead) of several potential lead exposure pathways identified for children in the NSWC-IHDIV residential setting. *The value of the calculations lies in demonstrating the need for conducting regular blood lead level screenings on children living in NSWC-IHDIV housing.* Although a voluntary blood lead screening program exists at NSWC-IHDIV, medical personnel interviewed during the site visit indicated that participation in the program at the NSWC-IHDIV Medical Clinic is low.

Public Health Action Plan: Exposures to Residential Sources of Lead

Actions Taken and Proposed:
The Navy Public Works Center and NSWC-IHDIV have taken several actions to address the problem of lead in the residential setting.

1. NSWC-IHDIV medical personnel are currently reviewing the existing Navy Pediatric Lead Poisoning Prevention Screening Plan to determine how to adapt this plan to address the specific residential lead exposure situation at the base.

Educational outreach activities have been proposed by the NSWC-IHDIV medical personnel. These outreach efforts will include letters to military personnel entering base housing, and personal contacts with personnel already living in base housing, to inform them of the availability of blood lead level screening at NSWC-IHDIV. Blood lead screening for children who are six years of age and under, and women of child-bearing age, will be encouraged. These actions, planned as part of a continuing educational effort, will be initiated in July or August of 1997 [12].

2. In 1996, external lead risk-reduction activities (encapsulation) were initiated for the Detached housing and associated garages with external lead paint contamination. These activities will continue through 1997. However, risk-reduction activities for lead in foundation soils and abatement of lead in the interior of the housing units have not been initiated or scheduled. Execution of these activities at NSWC-IHDIV will depend on the Navy Public Works Center plan to perform abatement using a "worst-first" approach, and where the NSWC-IHDIV is ranked relative to other Navy bases with lead problems [12]. Funding for interior lead-based paint activities at the base has been approve [10].

3. Incoming residents are notified of the presence of lead in the housing per HUD requirements and given the option to live elsewhere. In addition, educational literature on the sources and health effects of lead are provided to the new residents. "Ledizolv", a lead-specific cleaning agent, is available from Housing upon request [10].

4. Family Housing has purchased a high efficiency filter vacuum and will schedule cleaning of window sills, areas around radiators, and other areas where paint chipping exists in the homes [10].

Recommendations:

Because children at the NSWC-IHDIV can be exposed to lead from many sources, and the potential increase in blood lead levels from exposures to lead in only one of the possible exposures pathways exceeds the 10 µg/dL blood lead screening criterion, ATSDR recommends that the revised Lead Poisoning Prevention Plan for NSWC-IHDIV include the following components:

1. The plan should integrate the activities of Primary Care and Housing, and the Bethesda lab. The program should coordinate ***education efforts***, provision of ***blood lead tests***, ***tracking*** of blood lead results, ***feedback*** to the residents, and a ***plan of action*** in the event that blood lead levels of health concern are identified.

2. The program should focus on children through 6 years of age with a goal of 100% voluntary participation.

3. Parents of dependents who participate in blood lead screening at military medical facilities other than the NSWC-IHDIV Clinic should be urged to share the results of those tests with NSWC-IHDIV Housing or Primary Care.

4. The blood lead screening program should continue until abatement or risk reduction activities have been completed and subsequent screening shows blood lead levels to be below levels of public health concern, or the housing is vacated.

5. NSWC-IHDIV should consider establishing baseline lead levels for the dependents of base residents upon acceptance into Navy housing. These baselines provide the data necessary for interpreting subsequent blood lead screening data.

6. Application of the algorithm demonstrated that the average soil concentration for *each* unit of Detached housing was high enough to drive the predicted blood lead levels above the public health criterion of 10 µg/dL. Considering this information and the multiple pathways of exposure to lead in this older housing area, ATSDR recommends that screening efforts focus early on children in Detached housing and that this housing receive early action for any proposed lead abatement or risk reduction activities addressing lead in soil and interior paint sources.

II. Potential Health Hazards

A. Mercury in Buildings 101 and 102

Summary: *Spills of elemental mercury impacted general use (non-laboratory) areas of Buildings 101 and 102, potentially placing civilian employees in these buildings at risk of mercury exposure. Based on historical mercury vapor data and limited medical monitoring data, ATSDR has tentatively concluded that past mercury exposures may have occurred in Buildings 101 and 102 at levels of health concern. However, the potential past exposure for workers between 1981 and 1991 does not place these individuals at an increased risk for reproductive problems, nor is it likely to shorten their expected life spans. Any neurologic effects associated with chronic low-level exposure to the mercury vapor would have ended after exposure stopped and would not be evident today. ATSDR cannot eliminate the possibility, however, that the pre-1981 employees of these buildings were exposed at higher levels since no environmental or medical monitoring records are available for review. A summary of our evaluation of this situation is provided in Table 3.*

Background: Buildings 101 and 102 were built in the early 1900s for propellant density and sensitivity testing: these tests incorporate the use of elemental mercury [13]. Mercury spills and routine historical releases of mercury to building drains have been documented, affecting both laboratory and general use areas of the buildings [13]. In the case of Building 102, for example, over 25 years elapsed between major mercury spills in the first floor laboratory in the early 1960s and the discovery of elemental mercury dripping from the first floor sub-flooring onto the basement coffee mess area [14, 15]. Similarly, elemental mercury and elevated mercury vapors were discovered in a basement office area of Building 101 six years after mercury use had ceased in that building [16, 17]. Both buildings are currently secured from entry and are included in the NSWC-IHDIV environmental program for future investigation and clean-up.

Based on the potential long history of uncontrolled mercury releases, the large volumes of mercury employed in these buildings, and the documented mercury contamination in general use areas of each building, ATSDR identified and evaluated three exposure situations with potential public health implications.

A.1. Past Exposure to Mercury in Buildings 101 and 102

NSWC-IHDIV instituted a medical monitoring program for mercury in 1983 and an industrial hygiene (air sampling) program for mercury in 1982. The spills of mercury in Buildings 101 and 102 represent *uncontrolled* sources of possible mercury exposure to workers who participated in the industrial hygiene and medical monitoring programs, but also to those people who worked in these buildings whose job did not involve use of mercury. In theory, these workers are not expected to be exposed to the hazardous substances in the workplace and are not typically included in the industrial hygiene and medical monitoring programs: this was the case at the NSWC-IHDIV for non-laboratory workers in Buildings 101 and 102. Therefore, outside of the

TABLE 3. Potential Public Health Hazard Situation: Mercury in Buildings 101 and 102

PATHWAY NAME	CONTAMINANTS	EXPOSURE PATHWAYS ELEMENTS					TIME	COMMENTS
		SOURCE	ENVIRONMENTAL MEDIA	POINT OF EXPOSURE	ROUTE OF EXPOSURE	POTENTIALLY EXPOSED POPULATION		
Past exposure to Mercury in Buildings 101 and 102	Mercury, as mercury vapor	Elemental mercury spills	Air, building materials (concrete, ceiling tiles, floorboards, drains, pipes, etc.)	(i) Breathing (inhalation) of mercury vapor	Inhalation	Potentially Exposed: Past employees in Buildings 101 and 102 (estimate of employees in these buildings from 1960-1991 is approximately 78 individuals*)	Past (approximately 1960 - 1991)	Based on historical mercury vapor data and limited medical monitoring data, ATSDR has tentatively concluded that past mercury exposures may have occurred in these buildings at levels of health concern. This past potential exposure does not place these individuals at an increased risk for current health related effects. ATSDR cannot eliminate the possibility that pre-1981 employees of these buildings were exposed at higher levels because no environmental or medical records are available for review.

* Estimate based on the assumption that 13-15 people worked in both buildings and stayed for a period of 4 to 5 years.

occupational exposures experienced by Building 101 and 102 personnel working with and around the mercury, *all* building personnel *may* have experienced additional exposures to uncontrolled mercury sources.

Because the mercury contamination was located primarily in wooden sub-flooring, ceiling tiles, and drain pipes, the primary route of potential exposure would have been inhalation of mercury vapors. Thus, our evaluation focused on whether past exposures to mercury vapor in these buildings are of potential health concern, particularly for those employees who were not participants in an occupational mercury monitoring program. Since these workers did not participate in a medical monitoring program, and their work areas were not included in the industrial hygiene environmental surveys, no information or data are available for review by ATSDR and NSWC-IHDIV for these employees. However, inferences about the potential for exposure to mercury vapor at concentrations of health concern can be drawn from the existing indoor air mercury vapor level data and the results of the occupational medical monitoring program for mercury.

The worker populations were divided into two groups for evaluation and discussion: (i) workers in Buildings 101 and 102 between 1981 and 1991, and (ii) workers in these buildings between 1960 and 1980. These groups were defined by the availability of environmental monitoring data from the buildings, availability of medical records for the workers, and estimates of the current ages of the employees. Environmental and medical records are available for 1981 through 1991, but pre-1981 records are extremely limited or not available. The 1960 cut-off date was established by calculating the current ages of past workers if they had been anywhere between 20 and 40 years of age during their employment in these buildings: these individuals would now be approximately 60 to 80 years of age.

Air Data Evaluation: ATSDR reviewed air monitoring data sets for Buildings 101 and 102 from 1978 through 1995. These data sets were typically generated by the base during the conduct of industrial hygiene surveys to evaluate the potential for occupational mercury exposure. In a few cases, the air data were collected in response to the discovery of previously spilled elemental mercury dripping from ceilings into general use areas of the buildings. The complete information on how the air sampling was conducted is not available for each data set; however, the bulk of the data were generated using direct read mercury vapor instrumentation (i.e. Bacharach Model MV-2 and Jerome Model 411).

The central nervous system is sensitive to exposures of inhaled metallic mercury vapor [18]. To draw conclusions about the potential for worker exposure at levels of health concern, the mercury vapor data sets for NSWC-IHDIV were compared with a mercury vapor value of 0.03 *milligrams per cubic meter* (mg/m^3). This concentration is at the low end of the range of concentrations at which chronic mercury vapor exposure may result in subtle health effects on the central nervous system [18].

Indoor Air Monitoring Data - Building 101: Indoor air mercury monitoring data from Building 101 is available for 1978 and 1983, 1990 through 1991, and 1995. These time intervals correspond to distinct periods of building use. During the years when mercury was used in the Building 101 laboratories (1978 and 1983 data), indoor mercury vapor concentrations ranged from 0.0019 to 0.015 mg/m^3 [19, 20, 21]. These data were collected from laboratory areas of the building: no data were found for the general use areas of the building where mercury vapors from uncontrolled releases may also have existed.

Between January 1990 and January 1991, the NSWC-IHDIV conducted extensive weekly air monitoring for mercury vapor in response to the discovery of beaded mercury on pipe insulation and elevated mercury concentrations in basement areas of the building [22]. The entire building, including general use areas, was screened for mercury vapors. Although mercury use ceased in Building 101 in 1984 [16], mercury vapor levels persisted up to a maximum value of 0.021 mg/m^3 in 1990-1991 [22]. These data represent the mercury vapor concentrations to which these workers, who were not participants in a medical monitoring program, may have been exposed. Thus, during the time period between 1983 and 1991 when workers occupied Building 101, the data indicate that mercury vapor concentrations probably did not exceed the 0.03 mg/m^3 concentration at which health effects may be observed due to chronic exposure [18].

A survey of the building in 1995 found mercury vapor concentrations ranging from 0.001 - 0.037 mg/m^3 [23]. This rise in concentrations likely resulted from lack of ventilation because the building was closed in 1994. Although the maximum mercury vapor value detected exceeds 0.03 mg/m^3, the building is currently unoccupied and there is no route exists for worker exposure to these vapors.

Indoor Air Monitoring - Building 102: Building 102 air monitoring data are available for two time periods: 1978 -1983 and 1987 -1989. In 1978 -1983, mercury vapor levels ranged from 0 to 0.04 mg/m^3, surging up to 0.08 mg/m^3 when mercury was cleaned from laboratory instrumentation with acid: the median mercury vapor value was 0.005 mg/m^3 [14, 19, 20, 24]. These mercury vapor readings were collected from laboratory and office areas: no general use areas appear to have been monitored. The workers who conducted the laboratory activities using mercury would have been participants in a medical monitoring program and over-exposures to mercury should have been revealed in the course of physical exams and biological testing. Other building employees would not have been expected to be exposed to these sources and levels of mercury.

Surveys were conducted in 1987 after the discovery of elemental mercury dripping from the first floor sub-flooring onto the basement coffee mess area. These survey data were generally reported as "well below 0.05 mg/m^3" [15, 25] and the survey included the room where elemental mercury was discovered and adjacent rooms in the building. Data collected in 1989 did not exceed 0.0036 mg/m^3 [26]. Building 102 was closed in 1989. Overall, the data do not suggest levels of mercury vapor at concentrations associated with health effects [18]. However, it is important to note that the air data were collected after the dripping mercury had been noticed and cleaned from the general use area: no data are available that represent the mercury vapor

concentrations to which workers were exposed to during the release of mercury to the coffee mess area.

Medical Monitoring Data- Building 101 and 102 Workers: The physical exam and biological (urine) evaluations for 4 of the approximately 20 medically monitored employees who worked in these buildings between 1981 and 1991 were provided to ATSDR. These results indicate that none of the employees in the mercury medical monitoring program, *for whom records have currently been retrieved,* were exposed to mercury at levels of health concern. These results suggest that other participants in the monitoring program, as well the people who did not work with mercury and may be presumed to have had lower exposures, did not experience exposure to mercury at levels of health concern between 1981 and 1991 in Building 101. ***However, the incomplete medical monitoring data for the occupational population, and the lack of medical monitoring data for the non-occupational population, introduces considerable uncertainty into this evaluation.***

No pre-1978 air monitoring data or pre-1981 medical monitoring data have been retrieved from NSWC-IHDIV files for Buildings 101 and 102. It is reasonable to assume that indoor air mercury vapor levels in the buildings may have been higher in the past when the mercury spills were recent and vaporization rates would have been higher. This scenario would be particularly likely in the basement areas of the buildings after the installation of impervious first floor coverings over contaminated sub-flooring in both buildings (mid-1960s through the early 1970s). Thus, ATSDR cannot eliminate the possibility that pre-1981 employees of Buildings 101 and 102 were exposed to the occupational and non-occupational mercury sources at levels of health concern.

Health Implications: Available air monitoring data do not suggest that workers in Buildings 101 and 102 were exposed to chronic high levels of mercury vapor. Thus, permanent effects of mercury exposure on the central nervous system and kidneys, which occur at chronic high doses, would not be expected.

At low doses of inhaled elemental mercury, the body is generally able to metabolize and excrete the mercury in the urine, feces, saliva and sweat [27]. Early signs of mercury toxicity due to chronic mercury vapor exposure may be observed as subtle neurologic effects, including fine tremors in the fingers, lips, and eyelids, effects on precision movements such as handwriting, headache, and short-term memory loss [28]. These symptoms tend to disappear, however, when the exposure is stopped [27]. In addition, studies on occupationally exposed workers indicate that neither reproductive problems [29], nor decreases in life span [30], are associated with mercury vapor exposure.

The biologic half-life of inhaled elemental mercury in the human body is about 60 days [27]. Thus mercury may be expected to be reduced to concentrations that are not distinguishable from the background levels of mercury in the body within one year after exposure to the mercury source ends. Since exposures to the mercury ceased no later than 1989 in Building 102 and

1991 in Building 101, no building-related mercury should persist in the bodies of individuals who worked in these buildings through this time period. Accordingly, no biological testing could be performed today to reveal whether these individuals had been exposed in the past to mercury from Buildings 101 and 102.

Public Health Action Plan: Past Exposures to Mercury in Buildings 101 and 102

Conclusions:

1. Based on historical indoor air screening data, the history of uncontrolled mercury spills, and incomplete (1981-1991) or unavailable (prior to 1981) medical monitoring data for these employees, ATSDR concludes that ***mercury exposures may have occurred in the past in Buildings 101 and 102 at levels of public health concern.*** However, for people who worked in these buildings, their ***potential past exposure does not place these individuals at an increased risk for reproductive problems, nor is it likely to shorten their expected life spans.*** Any neurologic effects associated with chronic low level exposure to the mercury vapor would have ended after exposure ceased and would not be evident today.

2. However, because no environmental or medical monitoring records are available for review, ATSDR cannot eliminate the possibility that pre-1981 employees of these buildings were exposed at higher levels.

3. The populations of primary concern include (i) those individuals who worked in these buildings prior to 1981 (regardless of job duty) and (ii) those individuals who worked in these buildings from 1981 or beyond and were not participants in the occupational mercury medical monitoring program.

Recommendations:

1. ATSDR needs additional data and information to complete our evaluation of potential past exposures to mercury in Buildings 101 and 102. ATSDR and NSWC-IHDIV are working together to obtain and evaluate records from any past mercury-related medical surveillance activities conducted by NSWC-IHDIV for employees working in Buildings 101 and 102. Some of these data have been provided by NSWC-IHDIV in a text summary form to ATSDR. ATSDR requests the primary data and medical records in order to draw conclusions about potential exposure-related health effects.

A.2. Potential for "Take Home" Mercury Contamination

The National Institute for Occupational Safety and Health (NIOSH) has examined the potential for the transport of hazardous substances from the workplace to the home. This "take home" contamination has been demonstrated to be a worldwide public health issue for workers, resulting in a wide range of contaminant-specific health effects [31]. Industrial hygiene programs, including the program currently in place at the NSWC-IHDIV, are designed to prevent take home contamination by workers who work with hazardous chemicals.

Chemicals such as mercury may be transported into the home unknowingly on work clothes and shoes, or deliberately by persons who are unaware of the hazards of workplace chemicals. Mercury contamination in the home can result in exposures to children and adult residents to vapors at concentrations of health concern. For residential properties, and for populations of people who may be more sensitive to chemical exposures such as young children and women of child-bearing years, ATSDR recommends that mercury vapor concentrations in indoor air not exceed 0.0003 mg/m^3 [32] in order to protect human health.

NIOSH has reviewed situations where exposure to mercury in the workplace has resulted in home contamination [32]. For example, mercury vapor concentrations in the range of 0.024 - 0.3 mg/m^3 were measured in the air of homes of thermometer manufacturing plant workers. Analyses of urine samples provided evidence of exposure to mercury in the home: concentrations of mercury in the urine of exposed children from these worker-contaminated homes were up to 5 times the concentrations measured in urine of unexposed children [31].

ATSDR believes that the historical mercury contamination situation in Buildings 101 and 102 presents a *potential* for past tracking of mercury from these buildings into the homes of workers. Observations which support this concern include: (i) the long history of mercury use in large quantities in both buildings; (ii) the documented spills and routine releases of mercury that resulted in contamination of the buildings; (iii) the undefined extent of mercury contamination in these buildings; (iv) the period of time between 1960 and 1980 when mercury contamination was present pre-dates the establishment of the base program for medical monitoring for mercury and environmental monitoring for worker exposure; (v) only limited medical monitoring data have been located for the 1980-91 time period; and, (vi) building common areas are generally not represented in the mercury vapor screening data sets for these buildings.

Taken together, these elements strongly suggest the opportunity for past workers in the building to come into contact with mercury contamination under conditions where it could be picked up on clothes and shoes unintentionally, or deliberately by a building employee not aware of the hazard, and tracked into the home. ATSDR's concern lies in the potential for current residents of these homes to experience on-going inhalation exposures to mercury vapors. Adults and children exposed to chronic low levels of mercury vapor may develop nervous system effects including fine tremors in the fingers, lips and eyelids, and effects on precision movements such as handwriting. Headaches and difficulties with short-term memory may also occur [28]. In general, individuals with diseases of the liver, kidney, lung, and nerves are considered to be at

greater risk of suffering from the toxic effects of mercury than individuals in good general health. Inhaled metallic mercury can reach the fetuses of pregnant women and can also be metabolized (changed) in the body into mercuric chloride [18]. Mercuric chloride is capable of entering the bloodstream and may be passed though mother's milk to breast-feeding infants. These pre-birth and post-birth exposures place these children at risk for nervous system development problems [18]. Additional information about exposures to mercury in the environment is provided in the ATSDR Public Health Statement which is provided in Appendix E of this public health assessment.

Public Health Action Plan: "Take Home" Mercury Contamination

Conclusion:

1. It is possible that some of the spilled mercury in Buildings 101 and 102 was tracked into the homes of workers.

Recommendation:

1. It is not possible to project back into the past and know with certainty whether worker home contamination has occurred. However, the conduct of simple visual inspections, combined with in-home mercury vapor screening, would provide the evidence needed to determine in any exposures to "take home" mercury are occurring today. Therefore, ATSDR recommends that IHDIV-NSWC perform environmental screening of the residences where Building 101 and 102 employees lived during their period of employment in those buildings. The list of residences proposed for screening should include the homes where any personnel who worked in these buildings between 1960 and 1991 resided.

   If the implementation of this recommendation is outside the appropriate scope of IHDIV-NSWC responsibilities and resources, ATSDR possesses the capability to coordinate with NSWC and perform the residential screenings in support of public health activities at the base.

A.3. Future Use of Buildings 101 and 102

No mercury clean-ups have been performed in Buildings 101 and 102. The mercury-contaminated area of Building 101 was closed in response to the discovery of elevated mercury vapors and remains secured from entry and posted with a warning sign. This building is currently unoccupied. Building 102 was closed in 1989 and remains secured from entry. The extent of contamination is currently unknown but will be determined during Remedial Investigation (RI) activities. However, neither building is currently scheduled as a priority (relative to the other areas of the base that present a greater threat to public health or the environment, or impact a military construction project) for RI characterization and clean-up

activities. Mercury vapors persist at detectable concentrations in areas of both buildings at concentrations as high as 0.03 mg/m^3: this concentration exceeds the ATSDR Minimal Risk Level and EPA's Reference Concentration for mercury vapor. Therefore, indoor air levels of mercury in these buildings exceed acceptable levels that are protective of public health.

ATSDR was concerned that indoor air concentrations could increase in response to future building uses that disturb the mercury, including renovation activities, *before completion of clean-up activities.* However, during the course of the public health assessment, the NSWC Safety department determined that use of Buildings 101 and 102 will not be permitted until the mercury within the buildings has been remediated [10]. Preventing use of the buildings eliminates the exposure pathway to the mercury vapors and ATSDR's public health concern.

B. Fish in Mattawoman and Chicamuxen Creeks

Summary: Concentrations of cadmium, mercury, and zinc in Mattawoman Creek fish tissue do not pose a threat to public health through ingestion. However, to protect people eating fish, sampling and analysis for lead, silver, chromium, and copper should be performed to determine if these metals are entering the food chain in Mattawoman and Chicamuxen Creeks and bioaccumulating to concentrations requiring consumption limits. A summary of our evaluation of this situation is provided in Tables 4a and 4b.

Background: Studies conducted by the U.S. Fish and Wildlife Service provide data on levels of mercury, cadmium, and zinc in selected fish and shellfish collected from Mattawoman Creek (Figure 1) between 1987 and 1991 [33, 34]. Overall, the concentrations of these metals in Mattawoman Creek fish tissue ranged from below to slightly above levels documented in similar monitoring programs in Potomac River, Maryland, and U.S. studies [34]. ATSDR evaluated these data using the chemical-specific Risk-Based Concentration (RBC) values for fish tissue [35]. U.S. EPA's RBCs are useful data-screening tools that assume exposure to only one contaminant and hold the risk to exposed individuals at highly conservative (protective) levels. The fish data and RBC screening values are provided in Table 5.

Cadmium was not detected in whole fish tissue samples above the detection limit (0.1 milligrams per kilogram [mg/kg]), which is well below the RBC for that metal (0.68 mg/kg). Mercury concentrations were also below the RBC (0.41 mg/kg), ranging from undetected to 0.37 mg/kg. Similarly, maximum zinc concentrations in tissue samples from six species of fish and the brackish water clam ranged from 14 to 55 mg/kg. These values are 7 to 29 times lower than the RBC for zinc (410 mg/kg).

Using available data, we conclude that the 1991 concentrations of cadmium, mercury, and zinc in Mattawoman Creek fish and shellfish do not pose a public health threat through ingestion. In each case, the concentrations of these chemicals in *whole fish* tissue were below the RBC screening value. Although only five (5) fish of each species were collected and analyzed, *the amount of contaminant to which an individual would normally be exposed in the edible portion of the fish would be less than the whole fish concentrations reported in Table 5.* Consumption of fish caught from these creeks is not a health concern.

Other chemical contaminants from the NSWC-IHDIV have also impacted the surrounding sediments: lead, silver, chromium and copper are documented to occur in Mattawoman Creek sediments at elevated concentrations relative to background and Chesapeake Bay reference sites [33]. These chemicals may bioaccumulate in certain species of fish. However, because these chemicals were not included in the fish tissue analyses that have been conducted, it is not known whether they are entering the food chain in Mattawoman and Chicamuxen Creeks and bioaccumulating. The U.S. Fish and Wildlife Service has recommended that additional fish tissue analyses be performed and that the concentrations of selected chemicals in the base's discharges be reduced [33].

TABLE 4a. No Apparent Public Health Hazard Situation: Fish Consumption

PATHWAY NAME	CONTAMINANTS	EXPOSURE PATHWAYS ELEMENTS					TIME	COMMENTS
		SOURCE	ENVIRONMENTAL MEDIA	POINT OF EXPOSURE	ROUTE OF EXPOSURE	POTENTIALLY EXPOSED POPULATION		
Contaminated fish in Mattawoman and Chicamuxen Creeks	Mercury, zinc, cadmium	Releases of hazardous substances to soils and shallow groundwater at the site, and historical discharges of munitions process waste waters to the creeks	Fish	Eating (ingestion of) contaminated fish	Ingestion	Potentially Exposed: people who eat contaminated fish from the creeks	Future	No apparent health hazard is posed by the metals contaminants to people eating fish caught from the creeks. Concentrations are below levels of health concern

TABLE 4b. Potential Public Health Hazard Situation: Fish Consumption

PATHWAY NAME	CONTAMINANTS	EXPOSURE PATHWAYS ELEMENTS					TIME	COMMENTS
		SOURCE	ENVIRONMENTAL MEDIA	POINT OF EXPOSURE	ROUTE OF EXPOSURE	POTENTIALLY EXPOSED POPULATION		
Contaminated fish in Mattawoman and Chicamuxen Creeks	Lead, silver, chromium, copper	Releases of hazardous substances to soils and shallow groundwater at the site, and historical discharges of munitions process waste waters to the creeks	Fish	Eating (ingestion of) contaminated fish	Ingestion	Potentially Exposed: people who eat contaminated fish from the creeks	Past, current, future	Future sampling should also include tissue analyses for lead, silver, chromium, and copper to determine if these metals are bioaccumulating to concentrations of public health concern.

TABLE 5. Maximum whole body[a] concentrations of total mercury, cadmium, and zinc (mg/kg WW)[b] in fish collected from Mattawoman Creek (1987-1991)[c] compared with EPA Risk-Based Concentration[d] values.

Species	Mercury	Cadmium[e]	Zinc
Channel Catfish	0.068	< 0.1	55
Largemouth Bass	0.370	< 0.1	NA[f]
Bluegill	0.078	< 0.1	NA
Gizzard Shad	0.034	< 0.1	14
Brown Bullhead	0.072	< 0.1	14
White Perch	0.072	< 0.1	38
Black Crappie	ND[g]	< 0.1	7.9
Spot	0.035	< 0.1	18
Brackish Water Clam	0.025	< 0.1	17
Risk-Based Concentration (RBC) screening value	0.41	0.68	410

Note: mercury, cadmium, and zinc were chosen by the U.S. Fish and Wildlife Service for analysis in tissue samples based on records of maximum discharge concentrations from NSWC-IHDIV and chemical-specific bio-concentration factors in the literature (Reference 33).

[a] determinations were made on whole body fish samples.
[b] mg/kg WW: data and RBC values are expressed in units of mg metal per kilogram wet weight of fish tissue.
[c] fish tissue data are summarized from References 33 and 34.
[d] U.S. EPA Region III Risk Based Concentration values are derived from Reference 35.
[e] detection limit for cadmium analysis: 0.1 mg/kg WW.
[f] NA: data not available.
[g] ND: chemical not detected.

Public Health Action Plan: Fish in Mattawoman and Chicamuxen Creeks

Conclusions:

1. Concentrations of mercury, cadmium, and zinc in fish from Mattawoman Creek are below levels of health concern and do not pose a threat to people eating the fish.

2. Insufficient data exist to evaluate whether lead, silver, chromium or copper are bioaccumulating in fish tissue to concentrations of public health concern.

Actions Taken or Proposed:

1. Numerous efforts by NSWC-IHDIV to reduce or eliminate discharges to the Mattawoman and Chicamuxen Creeks and the Potomac River include (i) the connection of the industrial wastewater discharges to the sanitary sewer system, which permits sampling and treatment prior to release (rather than discharging directly to the local creeks and river); and (ii) the construction of sediment and erosion controls at the wastewater outfalls, many of which are ditches, in order to prevent the release of suspended sediments into the creeks and river. In the future, a central sewage system connection is planned for the Stump Neck Annex in order to eliminate septic tank discharges.

2. Clean-up actions already been completed by NSWC-IHDIV, and clean-up activities will be completed in the future, will reduce the contaminated soil runoff and shallow groundwater discharges of contaminants to the creeks and river.

Recommendations:

Mattawoman Creek supports significant recreational and limited commercial fishing activity. However, Remedial Investigation studies at NSWC and RCRA Corrective Action investigations at the Stump Neck Annex do not currently include sampling activities to monitor possible future food chain contamination in Mattawoman and Chicamuxen Creeks [3, 4]. Therefore, ATSDR makes the following recommendations:

1. If follow-up studies conducted by the U.S. Fish and Wildlife Service do not include fish tissue analyses for lead, silver, chromium, and copper, we recommend that NSWC-IHDIV initiate a sampling program to fill this data gap.

2. In the event that future remedial, RCRA closure, or RCRA corrective action activities, will disturb wastes and release contaminants to the creeks, ATSDR recommends additional collection and analysis of fish at that time.

Both sampling recommendations will permit NSWC-IHDIV to determine whether metals in the water and sediments are bioaccumulating in fish to concentrations requiring consumption limits to protect public health. In the event that such sampling is proposed, ATSDR requests

involvement in the review of the Work Plan for those activities in order to ensure that the proposed sampling and analyses will generate the type and quality of data needed to draw conclusions about potential human health impacts.

III. No Public Health Hazard: Drinking Water Supply - Patapsco and Patuxent Aquifers

Summary: NSWC-IHDIV is implementing a wellhead protection program to ensure that the groundwater wells at the base do not serve, in the future, as conduits for the migration of shallow contaminated groundwater to the deeper aquifers. This plan is needed to ensure protection of the deep groundwater resources that serve as the drinking water supply for the base and the region. A summary of our evaluation of this situation is provided in Table 6.

Background: Past activities at the NSWC and Stump Neck Annex of NSWC-IHDIV resulted in the release of chemical contaminants to soils and shallow groundwater at IRP and RCRA sites located throughout the facility [3, 5, 3]. This shallow groundwater contamination does not currently pose a public health threat: drinking water supplies for the NSWC-IHDIV and the majority of the surrounding community are obtained from the deep Patapsco and Patuxent groundwater aquifers. These aquifers are separated from the contaminated surface soils and shallow groundwater by deposits of low-permeability materials (e.g., clay, silty clays) [13]. Off-base deep wells, as well the shallow wells which exist in some areas around the Stump Neck Annex, lie upgradient from the contaminated areas at the base. These off-base private wells are not threatened by the shallow groundwater contamination at the facility which flows toward, and discharges to, the river and Mattawoman and Chicamuxen creeks.

Older wells with deteriorated casings, and out-of-service wells not abandoned in accordance with current groundwater protection standards, may serve as conduits for migration of chemical contaminants to the deeper groundwater resources. This potential situation exists at NSWC-IHDIV. The majority of the wells are older, dating back to 1945 at the Stump Neck Annex and to the early 1900s on the Cornwallis Neck peninsula [5]. In addition, NSWC-IHDIV is experiencing problems with lowered water tables and saline water intrusion related to increased regional water demands [3, 36, 37]. Lowered water tables, saline water intrusion and the *potential* for chemical contamination of the deeper aquifer are inter-related phenomena. In the same way that increased groundwater pumping rates and volume will lower water tables and permit the infiltration of saline water into the freshwater aquifer, the reduction of pressure exerted by the deep aquifer in the well casings increases the possibility of downward migration of chemically contaminated shallow groundwaters.

Public Health Action Plan: Drinking Water Supply - Patapsco and Patuxent Aquifers

Conclusion

1. These existing water supply problems, combined with the *potential* future public health issue of chemical contamination, underscores the need for wellhead protection activities at the NSWC-IHDIV.

Actions Taken and Planned

1. Since ATSDR's site visit in 1996, the NSWC-IHDIV worked with the Maryland Department of the Environment to establish a wellhead protection program. Current and proposed efforts include record searches to locate missing wells, verification that abandoned wells have been properly abandoned, and camera surveys to determine well casing integrity. Based on the results of these efforts, wells will be repaired, replaced, or abandoned, as appropriate [12].

Recommendations

1. NSWC-IHDIV should ensure that wells located hydraulically down-gradient of chemically contaminated areas and, therefore, at greater risk of contamination, receive high priority for early action under the wellhead protection program.

TABLE 6. No Public Health Hazard: Drinking Water Supply

PATHWAY NAME	CONTAMINANTS	EXPOSURE PATHWAYS ELEMENTS					TIME	COMMENTS
		SOURCE	ENVIRONMENTAL MEDIA	POINT OF EXPOSURE	ROUTE OF EXPOSURE	POTENTIALLY EXPOSED POPULATION		
Drinking Water Supply - Patapsco and Patuxent Aquifers	Solvents, mercury, silver, lead, other metals, nitrate esters	Historical releases of hazardous substances to soils and shallow groundwater at sites located throughout the base	Soils, shallow groundwater	NSWC-IHDIV drinking water supply system	Water supply wells that (i) are aged (dating to early 1900s) (ii) are improperly abandoned (iii) are out of service but not abandoned, or (iv) cannot be located, potentially serving as conduits for shallow groundwater contaminant migration to the deeper supply aquifer	Potentially Exposed: residents, employees at NSWC-IHDIV	Future	To date, water well sampling does not indicate contamination of the deeper aquifer by the shallow contaminated groundwaters. The on-going development and implementation of a wellhead protection program by NSWC-IHDIV should prevent possible future exposure.

COMMUNITY HEALTH CONCERNS

The following health concerns have been identified by ATSDR through meetings, correspondence, and telephone calls with the NSWC-IHDIV, the state environmental protection agency, and community members.

Several concerns were expressed in comments to the draft version of this report. The NSWC-IHDIV Public Health Assessment was released for public comment on October 3, 1997 and the comment period ended on November 7, 1997. Written comments were received from the base, a member of the Restoration Advisory Board, and a representative of the Friends of Mattawoman Creek organization. Additionally, ATSDR attended a Restoration Advisory Board meeting on October 16, 1997, and received oral comments on the draft report. These comments are included in summarized form.

What actions are being taken, or should be taken, to ensure the safety of the remediation (clean-up) workers at NSWC-IHDIV?

During the site visit, ATSDR spoke with representatives from the base's Installation Restoration Program (IRP) which is responsible for the clean-up of chemical contamination at the base, and with the Safety and Emergency Response groups. We concluded that procedures to protect worker safety are being followed at NSWC-IHDIV. Remediation workers are subject to the requirements of the Occupational Safety and Health Administration for ensuring workplace and worker safety. Specifically, plans for base clean-up work must include a Health and Safety Plan. Standards for these plans require many components, including identification of the physical and chemical hazards present, the potential health effects associated with exposure to the hazards, and actions and protective clothing and gear to be used by workers to ensure that exposures of health concern do not take place. These actions are supplemented by monitoring of chemical hazards in the field during clean-up activities. All workers are required to read and sign the health and safety plan, abide by the standards set forth in the plan, and participate in a medical monitoring program. The Health and Safety Plan is the responsibility of the contractor who drafts the plan based on site-specific information provided by the IRP Program, Safety, and Emergency Response. An example of a Health and Safety Plan for the NSWC-IHDIV is available in the site document repository at the La Plata Public Library.

What actions are being taken, or should be taken, to ensure the safety of employees at NSWC-IHDIV who work in proximity to the contaminated sites?

A primary purpose of the site visit and the Public Health Assessment document is to evaluate whether the environmental contamination at a site poses or has posed a health threat to people located off-base, to on-base residents, and to employees who are likely to work in proximity to the areas of environmental contamination. For the contamination to pose a public health concern, there must be a mechanism (an exposure pathway) for people to come into contact

with the contamination. ATSDR staff reviewed the available chemical contamination data and site information for, and personally visited, each of the IRP sites at NSWC-IHDIV. We found that employees do not generally come into contact with the contamination at the IRP sites; therefore, these sites do not pose a health hazard to employees working at the facility. For example, the shallow contaminated groundwater which is present at several of the sites, is not utilized as a drinking water or industrial water resource. The Town Gut Landfill/Site 8 pond has received contaminants from several contaminated sites within its watershed; however, because the pond is not used for swimming or recreational fishing, direct contact with, or ingestion of, site contaminants is prevented. ATSDR observed that areas of soil contamination, including the network of drainage ditches that ultimately discharges into Mattawoman Creek and the Potomac River, are well vegetated and in some cases have been paved over: this prevents direct contact with the soils or inhalation of contaminated dusts from these areas. Finally, in some cases, portions of buildings or entire buildings are contaminated (e.g., Buildings 101 and 102): in these cases, the contaminated areas are secured from entry.

Metals-contaminated soils from Removal Actions at IRP Sites 5 and 8 have been secured in on-site disposal areas at NSWC and the Stump Neck Annex. What actions have been taken, or should be taken, to ensure that future activities do not inadvertently disturb these disposal locations and release these contaminants?

Silver-contaminated soils from two drainage ditches at Site 5 have been secured in two locations. Soils from Swale (ditch) 1 were chemically stabilized and placed into the *base* of a newly constructed 30 foot high soil berm at Site 5. Soils from Swale (ditch) 2 were used to reclaim the old Rum Point soil borrow pit at the Stump Neck Annex. These soils were covered with one foot of low permeability (clay) material, one foot of common fill, six inches of topsoil, and then reseeded. Caution tape, stating "silver contaminated soil" was placed *between* the clay and common fill layers. Similarly, mercury contaminated soils from Site 8 were incorporated into the soil cover of an explosives storage magazine. The contaminated soils were covered with clay, caution tape labeled "mercury contaminated soils", common fill, top soil, and then reseeded. The presence of this tape at both disposal areas ensures that, should someone mistakenly dig at these locations, the presence of the contaminated soils will be immediately known.

Finally, the contractors prepared drawings documenting the exact placement locations for these metals contaminated soils. These "as-built" drawings are available at NSWC-IHDIV and at the Engineering Field Activity, Chesapeake, for reference by the Navy and contractors when planning future earth-moving and construction activities.

Local deer graze on the base, potentially eating forage grown in contaminated soils and drinking from contaminated ponds on the base. Is there a health risk to people consuming meat from the local deer population?

People are not at risk for exposure to chemical contaminants from NSWC through the consumption of deer meat from the local herd. Only a very small percentage of the NSWC property has contaminated soils with the potential for growing grasses and other deer forage with elevated levels of chemicals. In addition, the deer obtaining food and water at the base are not confined to the main base and Stump Neck Annex properties. Because they are free to range on and off the base, they are obtaining food and water from multiple sources: forage and water from NSWC would represent only a small fraction of their total food intake.

Does shallow contaminated groundwater at the Stump Neck Annex pose a threat to off-base shallow residential wells?

Shallow groundwater contamination at the NSWC and the Stump Neck Annex does not pose a threat to shallow residential wells located off-base. The movement of shallow groundwater (and associated chemicals) will be primarily controlled by the three surface water bodies surrounding the Cornwallis Neck and Stump Neck peninsulas: Mattawoman Creek, Chicamuxen Creek and the Potomac River. Shallow groundwater flows toward, and discharges to, these surface waters. Evaluations of the locations of waste areas at the base indicate that they are generally downgradient of off-base residential areas. Additional text has been added to the groundwater discussion to clarify this issue.

The small sample sizes (5 fish per species sampled) and range of concentrations reported in the U.S. Fish and Wildlife Service data set for mercury in fish tissue from Mattawoman Creek may not be adequate for drawing public health conclusions.

The U.S. Fish and Wildlife Service analysis for mercury was conducted on whole fish tissue samples rather than the portion of the fish that is actually prepared and consumed. Edible fillets do not include bones and organs of the fish. Therefore, *concentrations of mercury in the <u>edible fillet</u> portions of those same fish would have been even lower than the concentrations reported by U.S. Fish and Wildlife*. When ATSDR compared the reported maximum whole fish tissue concentrations to EPA's Risk Based Concentrations (RBCs), we found that the concentrations of mercury in whole fish tissue collected from Mattawoman Creek were below levels of health concern for each fish species analyzed. The concentrations in edible fillets would also be below levels of health concern.

Although efforts such as increasing the sample size (and analyzing the edible fillet tissue) would improve the representativeness of the data set, the sample size of 5 fish per species does not compromise the usability of the data set for drawing public health conclusions for the purposes of this public health assessment. This is particularly true since the whole fish tissue values were below levels of health concern.

This same discussion applies to the other fish tissue analyses reported for Mattawoman Creek. Additional clarifying text has been added to the public health assessment discussion of this issue.

The role of potentially contaminated submersed aquatic vegetation as a food source to fish and waterfowl is not addressed in the public health assessment, for example, the relationship between contaminant uptake by wild celery and consumption by local hunters of the mallards which feed on the plants. Testing of the submersed aquatic vegetation (plants) would improve the thoroughness of the PHA.

The purpose of a public health assessment is to evaluate releases of contaminants into the environment from a facility and the potential for people to be exposed to those contaminants at levels that may cause health effects. This evaluation is most appropriately made at the point of exposure, that is, where the person comes into direct contact with the chemical through eating, breathing, or skin contact. Although testing of submersed plants would improve overall understanding of differences in metals uptake by different species of plants and how the Mattawoman Creek ecosystem functions, this type of analysis is not within the scope of a public health assessment. No information was provided to ATSDR that indicated terrestrial populations (deer, beaver) or waterfowl are contaminated and are being consumed by people at frequencies to be of public health concern.

Do exposures to sediments in Mattawoman Creek pose a health risk to people participating in water-contact sports?

In the past, NSWC-IHDIV discharged chemicals from base operations to local surface waters, including Mattawoman Creek. The base has taken steps to reduce or eliminate these discharges. Limited sampling performed by the base indicates that the sediments near some of the base discharge locations show elevated levels of metals. The full nature and extent of the contamination is not yet known, but will be determined by the base as part of the on-going Remedial Investigation studies. The shore areas of the base are posted "No Trespassing" and water contact sports such as bathing are not likely to occur in these areas where the concentrations are likely to be highest (near base discharge points). Infrequent, short-term, exposures through accidental ingestion of, or skin contact with, metals bound to suspended sediments during bathing, water- and jet-skiing, or drag net fish collection activities are not likely to pose a health risk.

It would be helpful if ATSDR addressed the disposition of dredge materials from Mattawoman Creek.

The comment noted that the U.S. Fish and Wildlife Service reported metals concentrations in the creek sediments below state thresholds triggering special handling of the dredge materials. In addition, no pathway was identified for people to be exposed to these dredge materials. Therefore, ATSDR did not perform a public health evaluation of this issue.

An assessment of the relevance of fish lesions to public health was not provided in the PHA. It would seem appropriate that additional studies be conducted to confirm these findings in light of the recent outbreak of Pfiesteria in tributaries of the Chesapeake.

The Fish and Wildlife study noted a significant elevation of the total number of lesions (wound or injury) and the number of non-parasitic lesions on fish collected around Marsh Island in Mattawoman Creek. However, no information was presented to ATSDR suggesting the cause of the fish lesions, therefore, it is not possible to evaluate whether the presence of these lesions on fish in the creek have implications for the health of people using the creek for recreational activities. In addition, no evidence was presented to suggest that the lesions were caused by exposures to chemicals in the environmental from NSWC-IHDIV.

No outbreaks of Pfiesteria have been reported in Mattawoman Creek. This small aquatic organism is neither a bacteria nor a virus and is not infectious or contagious. Pfiesteria does produce a chemical called a toxin: the presence of large populations of toxin-producing Pfiesteria have been correlated with specific patterns of lesions on fish and fish kills in the Chesapeake Bay and its tributaries. Early research suggests that people are not exposed to the toxin by eating fish.

Considerable research on the occurrence, causes, and effects of Pfiesteria is being conducted by a consortium of state, federal, and university researchers. Readers wanting additional information about Pfiesteria should contact the Maryland Department of Natural Resources either directly or by accessing the MDNR Internet page at: www.dnr.state.md.us/.

In general, it is good public health practice to avoid eating fish, from any source, that exhibit lesions or other evidence of disease.

HEALTH OUTCOME DATA

ATSDR conducts a review of existing health outcome data (e.g., birth and death certificates, birth defects registries, cancer registries, etc.), when available, if people have been exposed to site contaminants or if the community has concerns related to specific health outcomes.

ATSDR did not evaluate health outcome databases in conjunction with our evaluation of metals in fish tissue, or chemicals in groundwater, because we determined that the people who live on and off the base were not exposed to site contaminants at levels that might cause public health hazards.

Although the potential for lead exposures of children at levels of health concern exists, the NSWC-IHDIV maintained no database of past blood lead testing results which could be made available for review by ATSDR. Thus exposed individuals could not be identified, nor could health outcome data, if such data exist, reviewed. NSWC provided blood lead data obtained in 1997 through their voluntary blood lead screening program. Data from five of the 65 children living in the Detached (one child) and Riverview (four children) housing demonstrate that these children are not being exposed to lead at levels of health concern.

ATSDR has requested from the NSWC-IHDIV, and will review, the physical examination and biologic testing results for the Building 101 and 102 workers who participated in the mercury medical monitoring program. Our evaluation of these health outcome data will be incorporated into an addendum to the Final Public Health Assessment.

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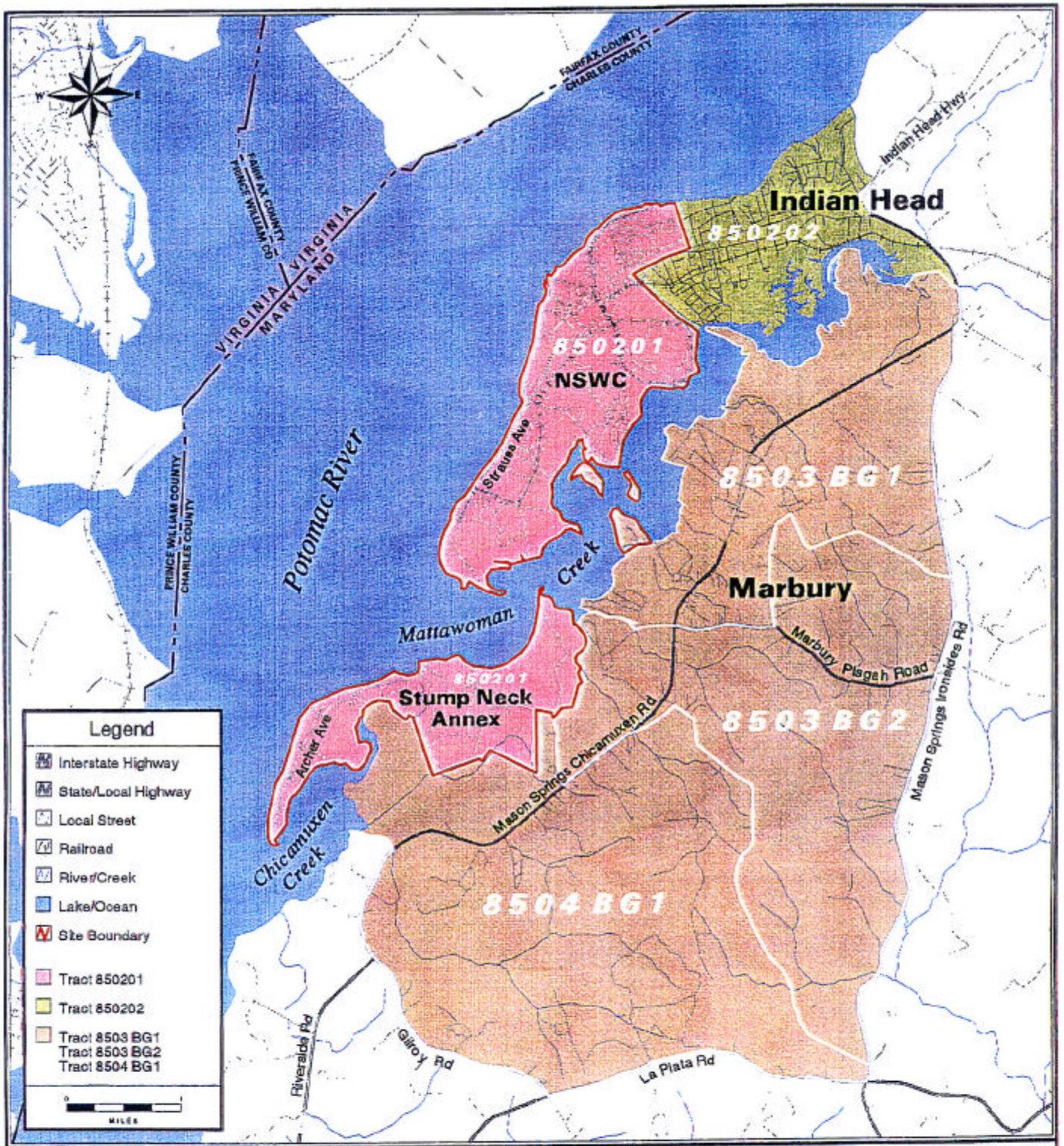
APPENDICES

APPENDIX A: Population and Housing Data; Census Tract Map



Source: 1992 TIGER Line Files

Indian Head Naval Surface Warfare Center

Indian Head, Maryland

CERCLIS No. MD7170024684

CENSUS TRACT MAP

Charles County, Maryland

ALD 042297

TABLE A-1: POPULATION DATA TABLE

	Base*	Town of Indian Head**	Surrounding Community***
Total persons	971	4,346	2,918
Total area, square miles	5.24	2.28	22.85
Persons per square mile	185	1,908	128
% Male	61.4	48.2	50.1
% Female	38.6	51.8	49.9
% White	84.3	77.5	54.7
% Black	9.9	20.0	42.9
% American Indian, Eskimo, or Aleut	1.2	1.1	1.8
% Asian or Pacific Islander	2.3	1.2	0.4
% Other races	2.3	0.2	0.2
% Hispanic origin	6.7	0.9	0.9
% Under age 10	22.3	15.4	14.9
% Age 65 and older	0.3	12.4	9.7

Source: Census of Population and Housing, 1990: Summary Tape File 1A (Maryland) [machine-readable data files]. Prepared by the Bureau of the Census. Washington, DC: The Bureau [producer and distributor], 1991.

* Tract 850201
** Tract 850202
*** Tract 8503, Block Groups 1 and 2; and Tract 8504, Block Group 1.

TABLE A-2: HOUSING DATA TABLE

	Base*	Town of Indian Head**	Surrounding Community***
Households	229	1,702	918
Persons per household	3.20	2.55	3.14
% Households owner-occupied	20.5	75.5	80.2
% Households renter-occupied	79.5	24.3	19.8
% Households mobile homes	17.5	0.6	9.9
% Persons in group quarters	24.5	0.0	9.9
Median value, owner-occupied households, $	162,500	79,700	104,800
Median rent paid, renter-occupied households, $	535	449	293

Source: Census of Population and Housing, 1990: Summary Tape File 1A (Maryland) [machine-readable data files]. Prepared by the Bureau of the Census. Washington, DC: The Bureau [producer and distributor], 1991.

* Tract 850201
** Tract 850202
*** Tract 8503, Block Groups 1 and 2; and Tract 8504, Block Group 1

Note: A household is an occupied housing unit, but does not include group quarters such as military barracks, prisons, and college dormitories.

TABLE A-3: LENGTH OF RESIDENCE IN CURRENT HOUSEHOLD, 1990

	Base*	Town of Indian Head**	Surrounding Community***
Total households	213	1,716	938
Percentage householders moving into current housing unit, by time period			
1989-90	67.1	17.9	11.3
1985-88	28.6	33.9	19.9
1980-84	2.3	9.8	15.0
1970-79	0.0	10.0	25.7
1960-69	1.9	13.3	11.5
Before 1960	0.0	15.0	16.5

Source: 1990 Census of Population and Housing, Summary Tape File 3 (Maryland). U.S. Bureau of the Census, Washington, DC.

* Tract 850201
** Tract 850202
*** Tract 8503, Block Groups 1 and 2; and Tract 8504, Block Group 1

TABLE A-4: SOCIOECONOMIC DATA

	Base*	Town of Indian Head**	Surrounding Community***
Persons age 25 and older	369	2,835	1,689
% With at least a high school diploma	96.2	75.4	67.6
Total households	205	1,705	859
Median income, $	29,821	35,062	35,940
% Below poverty level	3.4	6.7	14.4
Employed persons age 16 and older (civilian)	143	2,232	1,279
% In blue-collar jobs	21.0	29.9	44.3
% In white-collar jobs	79.0	70.1	55.7
Total housing units	293	1,823	981
% With water from public system or private company	96.9	89.9	6.2
% With water from individual well or other source	3.1	10.1	93.8

Source: 1990 Census of Population and Housing, Summary Tape File 3 (Maryland). Prepared by Bureau of the Census, Washington, DC.

* Tract 850201
** Tract 850202
*** Tract 8503, Block Groups 1 and 2; and Tract 8504, Block Group 1

APPENDIX B: Summary of Site Evaluations

APPENDIX B: Summary of Site Evaluations, NSWC-IHDIV, Indian Head, Maryland

Site Location and Number		Evaluation	Comments
NSWC:	Sites 51, 52	There is no evidence of contaminant release(s) at these sites.	These sites have been removed from the IRP list and designated as "No Further Action" required.
NSWC:	Sites 5, 8	These are sites with surface, sub-surface, shallow groundwater and surface water contamination. However, based on the information and data currently available for these sites, ATSDR concludes that there are no public health issues associated with these areas of contamination (other than those situations identified in the text of the PHA). ■ No past exposure situations were identified for these sites ■ No current exposure situations were identified. Areas of soil contamination, including the network of drainage ditches that discharge into the creeks and Potomac River, are well vegetated and in some case have been paved. Although shallow groundwater at the base is contaminated, sampling data indicate that the contaminants have not migrated off-site into the community. Both the base and Charles County residential and industrial water supplies are obtained from the deeper Patapsco and Patuxent groundwater aquifers. Employees do not generally work in the areas of contamination or otherwise come into contact with the contamination at these sites, therefore, no health threat is posed to base employees. In some cases, portions of a building or entire buildings are contaminated; in these cases, the contaminated areas are secured from entry. ■ No future exposure scenarios were identified. Exposure of site clean-up workers and employees to contaminants is minimized or prevented through implementation of Health and Safety Plans and environmental surveillance monitoring during clean-up activities.	Removal actions were completed at these sites in 1996.
NSWC:	Sites 1, 2, 3, 4, 6, 7, 8, 9, 10, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29		These sites are designated for future (unscheduled) Site Screening Activities.
NSWC:	Sites 43, 44, 45, 48, 50		These sites are proposed for future (unscheduled) Remedial Investigation/Feasibility Study activities
NSWC:	Sites 11, 12, 39, 42, 43, 46, 47, 49, 53, 54, 55, 56		These sites are proposed as "high priority" sites for Remedial Investigation /Feasibility Study activities beginning in 1997.
Stump Neck:	Sites 30, 31, 32, 33, 34, 35, 36, 37, 38	This property has been used primarily for explosives training, mixing, assembly, and disassembly of ordnance, The RCRA Facility Assessment evaluation documents few releases of hazardous substances to the environment. Characterization and clean-up of these sites will proceed under the RCRA Corrective Action Program.	ATSDR's primary concern with the Stump Neck Annex relates to releases of contaminants to the Mattawoman and Chicamuxen Creeks entering the aquatic food chain.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION III
841 Chestnut Building
Philadelphia, Pennsylvania 19107-4431
Dennis C. Orenshaw
Remedial Project Manager 3HW50

May 22, 1997

Mr. Shawn Jorgensen
Indian Head Division
Naval surface warfare Center
101 Strauss Avenue
Indian Head, MD 20640-5035

RE: NPL Status of Stump Neck Annex

Dear Mr. Jorgensen:

As per our past discussions, it is my belief that the Stump Neck Annex is to be considered a part of the National Priority List (NPL) site for the Indian Head Division of the Naval Surface warfare Center. This is based on the following circumstances:

* The original Hazardous Ranking System (HRS) package describes the facility as consisting of two primary areas: the main Indian Head Peninsula and Stump Neck. The drawing showing the facility boundaries includes the Stump Neck area, and the text describes the facility as occupying approximately 3,400 acres.

* There was no separate HRS package developed for the Stump Neck Annex.

This will require the Stump Neck Annex to be addressed in the Interagency Agreement (I.G.) which will be developed for Indian Head. I look forward to working with you and the Maryland Department of the Environment personnel to determine how best to handle the Stump Neck Annex and any necessary RCRA / CERCLA integration.

Sincerely,

Dennis C. Orenshaw
Remedial Project Manager

cc: Ms. Donna Lynch, MDE

Mr. Rob Sadorra, U.S. Navy EFACHES

Customer Service Hotline: 1-800-438-2474

Attachment B

APPENDIX C: Public Health Assessment Conclusion Categories

APPENDIX C: ATSDR Public Health Assessment Conclusion Categories

Category	Definition	Criteria
A. Urgent public health hazard	This category is used for sites that pose an urgent public health hazard as the result of short-term exposures to hazardous substances.	• evidence exists that exposures have occurred, are occurring, or are likely to occur in the future AND • estimated exposures are to a substance(s) at concentrations in the environment that, upon short-term exposures, can cause adverse health effects to any segment of the receptor population AND/OR • community-specific health outcome data indicate that the site has had an adverse impact on human health that requires rapid intervention AND/OR • physical hazards at the site pose an imminent risk of physical injury
B. Public health hazard	This category is used for sites that pose a public health hazard as the result of long-term exposures to hazardous substances.	• evidence exists that exposures have occurred, are occurring, or are likely to occur in the future AND • estimated exposures are to a substance(s) at concentrations in the environment that, upon long-term exposures, can cause adverse health effects to any segment of the receptor population AND/OR • community-specific health outcome data indicate that the site has had an adverse impact on human health that requires intervention
C. Potential (indeterminate) public health hazard	This category is used for sites with incomplete information.	• limited available data do not indicate that humans are being or have been exposed to levels of contamination that would be expected to cause adverse health effects; data or information are not available for all environmental media to which humans may be exposed AND • there are insufficient or no community-specific health outcome data to indicate that the site has had an adverse impact on human health
D. No apparent public health hazard	This category is used for sites where human exposure to contaminated media is occurring or has occurred in the past, but the exposure is below a level of health hazard.	• exposures do not exceed an ATSDR chronic MRL or other comparable value AND • data are available for all environmental media to which humans are being exposed AND • there are no community-specific health outcome data to indicate that the site has had an adverse impact on human health
E. No public health hazard	This category is used for sites that do not pose a public health hazard.	• no evidence of current or past human exposure to contaminated media AND • future exposures to contaminated media are not likely to occur AND • there are no community-specific health outcome data to indicate that the site has had an adverse impact on human health

APPENDIX D: Application, to the NSWC-IHDIV soil data set, of the algorithm relating soil lead concentrations to potential increases in blood lead levels

Appendix D: Application, to the NSWC-IHDIV soil data set, of the algorithm relating soil lead concentrations to potential increases in blood lead levels. References are noted in parentheses.

Application of the Algorithm
The following formula describes the observed relationship between soil lead concentrations and increases in blood lead (PbB) levels [9]:

$$\ln(PbB) = 0.879 + 0.241 \ln(Pb\ soil)$$

where the PbB data are expressed in units of µg/dL and the concentrations of lead in soil (Pb soil) are expressed as parts per million (ppm) (i.e., µg/g, mg/kg).

If the baseline PbB levels are defined, and the potential increase in PbB levels is calculated using the above formula, the sum of the two values provides an estimate of the predicted total lead concentration in blood if blood lead testing were performed. This value is compared to the CDC public health PbB screening criterion for children of 10 µg/dL to determine if PbB testing of the exposed population is recommended [9]:

Testing is recommended if:

$$PbB\ baseline\ level + increase\ in\ PbB \geq 10\ \mu g/dL$$

Testing is not recommended if:

$$PbB\ baseline\ level + increase\ in\ PbB < 10\ \mu g/dL$$

Assumptions:

Baseline blood lead (PbB) levels
Baseline PbB values in exposed communities will vary depending on a number of socio-demographic factors including age, gender, race, income level, and environment [7].
The National Health and Nutrition Examination Survey (NHANES) for 1976 - 1991 provides baseline PbB data for the U.S. population [11]. These data are averaged over age group categories for children, e.g, 1-2 years, 3-5 years, 6-11 years, etc. Neither baseline PbB data nor site-specific demographic data were available for the children residing in the NSWC-IHDIV housing; therefore, for the purposes of these calculations it was assumed that the mean baseline PbB values at the facility are not significantly different from the national averages for the overall U.S. population [11]. Based on the CDC recommendation for blood lead screening of children ages 6 years and under [9], we used the NHANES 1-2 year and 3-5 year age group mean values:

Age	Mean PbB level (µg/dL)
1-2 years	4.1
3-5 years	3.4

Exposure

The calculations assume that the children regularly play in the lead-contaminated soils around the NSWC-IHDIV housing : this may lead to an overestimate in the potential increase in PbB levels due to soil exposure. However, the calculations do not integrate the increases in PbB which may occur due to exposure to other sources of lead in the NSWC-IHDIV residential setting including inhalation and ingestion of household dusts and ingestion of indoor paint chips.

Calculations

All NSWC-IHDIV soil lead data values were obtained from the NSWC-IHDIV Housing Inspection Report [8]. The average soil lead concentration was calculated for each unit in each housing area: samples collected from foundation garden, pedestrian path and play areas were used. (Data from background and roadside samples were not included in the calculations.) The housing unit with the highest average soil lead concentration for a particular housing area was used in the PbB calculations. These calculations are presented below.

Detached Housing

Average foundation soil Pb concentrations ranged from 88.6 (115 Strauss) to 12,669 (7 Pickens) ppm for the NSWC-IHDIV Detached housing units.

For the highest average soil Pb concentration (7 Pickens), the calculated potential increase in PbB is 23.5 µg/dL:

$$\ln(PbB) = 0.879 + 0.241 \ln(12{,}669)$$
$$\ln(PbB) = 3.155$$
$$PbB = 23.5\ \mu g/dL$$

The predicted increase in PbB due to exposure to lead contaminated soils at this average concentration exceeds the screening criterion. *Compare the sum of the baseline PbB and increase in PbB to the screening criterion of 10 µg/dL:*

1-2 years	4.1 + 23.5 = 27.6 µg/dL PbB
3-5 years	3.4 + 23.5 = 26.9 µg/dL PbB

For children 5 years of age and under, the predicted PbB levels exceed the screening criterion of 10 µg/dL by a factor of two.

La Plata Housing

The highest average lead concentration in soils at the La Plata housing units = 1213.5 ppm (Unit 6).

For the highest average soil Pb concentration, the calculated potential increase in PbB is 13.3 µg/dL:

$$\ln(PbB) = 0.879 + 0.241 \ln(1213.5)$$
$$\ln(PbB) = 2.59$$
$$PbB = 13.3\ \mu g/dL$$

Compare the sum of the baseline PbB and increase in PbB to the screening criterion of 10 µg/dL:

1-2 years	4.1 + 13.3 = 17.4 µg/dL PbB
3-5 years	3.4 + 13.3 = 16.7 µg/dL PbB

For children 5 years of age and under, the predicted PbB levels exceed the screening criterion of 10 µg/dL.

Waldorf Housing

The highest average lead concentration in soils at the Waldorf housing units = 483 ppm (Unit 2).

For the highest average soil Pb concentration, the calculated potential increase in PbB is 10.7 µg/dL:

$$\ln(PbB) = 0.879 + 0.241 \ln(483)$$
$$\ln(PbB) = 2.36$$
$$PbB = 10.7\ \mu g/dL$$

Compare the sum of the baseline PbB and increase in PbB to the screening criterion of 10 µg/dL:

1-2 years	4.1 + 10.7 = 14.8 µg/dL PbB
3-5 years	3.4 + 10.7 = 14.1 µg/dL PbB

For children 5 years of age and under, the predicted PbB levels exceed the screening criterion of 10 µg/dL.

Riverview Village Apartments

The highest average lead concentration in soils at the Riverview apartments = 91.5 ppm (Unit 16).

For the highest average soil Pb concentration, the calculated potential increase in PbB is 7.1 µg/dL:

$$\ln(PbB) = 0.879 + 0.241 \ln(91.5)$$
$$\ln(PbB) = 1.96$$
$$PbB = 7.1\ \mu g/dL$$

Compare the sum of the baseline PbB and increase in PbB to the screening criterion of 10 µg/dL:

1-2 years	4.1 + 7.1 = 11.2 µg/dL PbB
3-5 years	3.4 + 7.1 = 10.5 µg/dL PbB

For children 5 years of age and under, the predicted PbB levels exceed the screening criterion of 10 µg/dL.

APPENDIX E: ATSDR Public Health Statement on Mercury

MERCURY

1. PUBLIC HEALTH STATEMENT

This Statement was prepared to give you information about mercury and to emphasize the human health effects that may result from exposure to it. The Environmental Protection Agency (EPA) has identified 1,300 hazardous waste sites as the most serious in the nation. These sites comprise the "National Priorities List" (NPL): Those sites which are targeted for long-term federal cleanup activities. Mercury has been found in at least 600 of the sites on the NPL. However, the number of NPL sites evaluated for mercury is not known. As EPA evaluates more sites, the number of sites at which mercury is found may increase. This information is important because exposure to mercury may cause harmful health effects and because these sites are potential or actual sources of human exposure to mercury.

When a substance is released from a large area, such as an industrial plant, or from a container, such as a drum or bottle, it enters the environment. This release does not always lead to exposure. You can be exposed to a substance only when you come in contact with it. You may be exposed by breathing, eating, or drinking substances containing the substance or by skin contact with it.

If you are exposed to a substance such as mercury, many factors will determine whether harmful health effects will occur and what the type and severity of those health effects will be. These factors include the dose (how much), the duration (how long), the route or pathway by which you are exposed (breathing, eating, drinking, or skin contact), the other chemicals to which you are exposed, and your individual characteristics such as age, gender, nutritional status, family traits, life-style, and state of health.

1.1 WHAT IS MERCURY?

Mercury is a metal (element) that occurs naturally in the environment in several forms. In the metallic or elemental form, mercury is a shiny, silver-white, odorless liquid familiar to anyone who has used a mercury thermometer. Some evaporation of metallic mercury occurs at room temperature to form mercury vapor, a colorless, odorless gas. Some people who have breathed mercury vapors report a metallic taste in their mouth. Mercury can also combine with other elements, such as chlorine, sulfur, or oxygen, to form inorganic mercury compounds or "salts". Most inorganic mercury compounds are white powders or crystals, except for mercuric sulfide (also known as cinnabar) which is red and turns black after exposure to light. In the following text, we include both metallic mercury (liquid and vapor) and inorganic mercury compounds under the generic term "inorganic mercury."

Mercury can also form a chemical bond with carbon to create a large number of organomercurial compounds. It is customary to refer to mercury with bonds to carbon as "organic" mercury. However, only two of these organomercurial compounds (methylmercury and phenylmercury) have been identified at hazardous waste sites. In most instances in the text, we refer to these chemicals by name rather than using the generic term "organic mercury." Like the inorganic mercury compounds, both methylmercury and phenylmercury exist as "salts" (for example methylmercuric chloride or phenylmercuric acetate). When pure, most forms of methylmercury and phenylmercury are white crystalline solids.

Several mercury compounds are found naturally in the environment. The most common forms of mercury naturally found in the environment are metallic mercury, mercuric sulfide, mercuric chloride, and methylmercury. The mercury portion of these forms does not break down into other chemicals. However, the form of mercury found in the environment can be changed slowly by microorganisms and natural processes. Metallic mercury vapor may be changed into inorganic forms, such as mercuric chloride, and inorganic forms may be changed in organic forms of mercury (and vice versa). Methylmercury is the usual organic form of mercury created by these natural processes. It is of particular concern because it can build up in certain fish to levels that are many times greater than in the surrounding water (see Section 1.2)*.

Mercury is mined as mercuric sulfide. Metallic mercury is then refined from the mercuric sulfide by heating the ore above 1000 degrees Fahrenheit and capturing the metallic mercury vapor that is released. There are many different uses for metallic mercury. It is used in the production of chlorine gas and caustic soda. It is also used in thermometers, barometers, batteries, and electrical switches. Silver-colored dental fillings typically contain about 50% metallic mercury. Metallic mercury is also used to extract gold from ore or to reclaim gold from gold-containing articles. Some Mexican-American and Asian populations have used metallic mercury in folk remedies for chronic stomach disorders. Metallic mercury has also been used by Latin-American and Caribbean cultures in occult practices. Inorganic salts of mercury, such as ammoniated mercuric chloride or mercuric iodide, have been used in skin lightening creams. Mercuric chloride has also been used as a topical antiseptic or disinfectant agent. Some chemicals containing mercury, such as mercurochrome and thimerosal, are still commonly used in medicine as antiseptics or as preservatives in eye drops, eye ointments, nasal sprays, and vaccines. Neither mercurochrome or thimerosal have been identified at hazardous waste sites. Mercuric sulfide and mercuric oxide are used as pigments in paints. Mercuric sulfide is also used as a pigment for tattoos. Mercurous chloride was widely used at one time in medicinal products, such as laxatives, worming medications, and teething powders. It has since been replaced by safer and more effective agents. Some inorganic mercury compounds are used in fungicides.

Methylmercury is generally produced by microorganisms in the environment, rather than made by human activity. However, at one time methyl- and ethylmercury compounds were used to protect seed grains from fungal infections. This use has been banned since the 1970s. Phenylmercuric compounds were used as antifungal agents in paints until 1991, when this use was also stopped. Mercury compounds may be found in the air, soil, and water near hazardous waste sites. Chapter 3 contains more information on the physical and chemical properties of mercury. Chapter 4 contains more information on the production and use of mercury.

1.2 WHAT HAPPENS TO MERCURY WHEN IT ENTERS THE ENVIRONMENT?

Mercury is a naturally occurring metal found throughout the environment as the result of normal breakdown of minerals in the earth's crust by weathering processes involving wind and water. The total amount of mercury entering the environment from natural processes throughout the world is about equal to, or maybe less than, the total amount released by human activities. However, with the exception of mercury ore deposits, the amount of mercury that naturally exists in any one place is usually very low. In contrast, the amount of mercury that may be found at a particular waste site because of human activity can be high. The mercury in air, water, and soil at hazardous waste sites may come from both natural sources and human activity.

Most of the mercury found in the environment is inorganic mercury (metallic mercury and inorganic mercury compounds). This inorganic mercury can enter the air from deposits of ore that contain mercury, from the burning of coal or garbage, and from the emissions of factories that use mercury. Inorganic mercury may also enter water or soil from rocks that contain mercury, factories or water treatment facilities that release water contaminated with mercury, and the disposal of wastes. Inorganic or organic compounds of mercury may be released to the soil through the use of mercury- containing fungicides.

Metallic mercury is a liquid at room temperature. It can evaporate into the air and can be carried long distances before returning to water or soil in rain or snow. As mentioned before, some microorganisms in the water or soil can change inorganic forms of mercury to methylmercury. Methylmercury can enter the water and remain there for a long time, particularly if there are particles in the water to which the methylmercury can attach. If mercury enters the water in any form, it is likely to settle to the bottom where it can remain for a long time. Mercury also remains in soil for a long time. Mercury usually stays on the surface of the sediments or soil and does not move through the soil to underground water.

Small fish and other organisms living in the water can take up methylmercury and inorganic forms of mercury. When larger fish eat small fish or other organisms that contain methylmercury, most of the methylmercury originally present in the small fish will be stored in the bodies of the large fish. As a result, large fish living in contaminated waters can collect a relatively large amount of methylmercury. Plants may have a greater concentration of inorganic mercury in them if they are grown in soil that contains higher than normal amounts o mercury. For further information on what happens to mercury in the environment, refer to Chapters 4 and 5.

1.3 HOW MIGHT I BE EXPOSED TO MERCURY?

Because mercury occurs naturally in the environment, everyone is exposed to very low levels of mercury in air, water, and food. However, some people may be exposed to higher levels of mercury. One of the most likely ways that the general population will be exposed to higher levels of mercury is through eating fish or shellfish contaminated with methylmercury. Some fish contain such high levels of methylmercury that selling them for human consumption has been prohibited. In addition, public health advisories have been issued by state and federal authorities to discourage anyone from catching fish from some areas for human consumption. Other foods typically contain very little methylmercury or other forms of mercury. The other most likely form of exposure is by absorbing mercury vapors released from dental fillings. Most silver-colored dental fillings are about 50% metallic mercury and slowly release small amounts of mercury vapor.

Sources of higher exposure to mercury include breathing air containing mercury vapors released from metallic mercury spills, incinerators, and facilities that burn mercury-containing fuels (for example, coal or other fossil fuels). Exposure near hazardous waste sites is likely tc occur by breathing contaminated air, having contact with contaminated soil, or drinking contaminated water. Persons may be exposed to mercury compounds in medicinal products, such as antiseptics or skin lightening creams, that contain small amounts of mercury.

In the past, the level of mercury found in outdoor air has been reported to be between 10 and 20 nanograms of mercury per cubic meter (ng/m^3) of air in urban areas. Background or natura levels are generally about 6 ng/m^3 or less. Mercury levels found in surface water are generally less than 5 ng per liter of water. Levels normally found in soil range from 20 to 625 ng of mercury per gram of soil. The Food and Drug Administration (FDA) has estimated that, on average, most people are exposed to about 50 ng of mercury per kilogram of body weight per day in the food they eat. This amount translates to about 3.5 micrograms (µg) of mercury per day for an adult of average weight. A large proportion of this mercury, in the form of methylmercury, is likely to come from fish. Furthermore, people who eat a lot of fish are likely

to have higher exposure to methylmercury. Mothers with mercury in their blood can expose their unborn children to methylmercury. Infants who nurse can be exposed to methylmercury and inorganic mercury in their mother's milk.

Workers in some occupations may also be exposed to inorganic mercury (metallic and inorganic mercury compounds) in the workplace. Most exposures on the job occur as a result of breathing air that contains mercury vapors. Exposure occurs in the medical, dental, and other health services, and in the chemical, metal processing, electrical equipment, automotive, building, and other industries. Families of workers may be exposed to mercury in the home if the workers' clothes have been contaminated with mercury. Dentists and their assistants may also be exposed to metallic mercury from skin contact with materials used to fill cavities in the teeth and breathing metallic mercury vapor released from these materials.

Exposure to mercury can be determined by measuring amounts in blood, urine, and hair. Levels found in blood, urine, or hair may show whether health effects are expected (see Section 2.5). Refer to Chapter 5 for more information on how you might be exposed to mercury.

1.4 HOW CAN MERCURY ENTER AND LEAVE MY BODY?

Mercury can easily enter your body when you breathe in air containing metallic mercury vapor. Most of the mercury vapor you breathe in enters your bloodstream and goes rapidly to other parts of the body. Inhaled metallic mercury can reach the fetuses of pregnant women easily. Some metallic mercury can be changed by your body into mercuric chloride. Some mercury that enters your bloodstream as metallic mercury may stay in your body for weeks or months. It stays mostly in the kidney and brain, as either metallic mercury or mercuric chloride. Metallic mercury that you breathe in will leave your body in the urine, feces, and breath. Metallic mercury that you might swallow in the liquid form does not enter the bloodstream very easily, and most of it leaves the body in the feces.

Inorganic salts of mercury (mercurous chloride or mercuric chloride, for example) that are inhaled are not believed to enter your body as easily as inhaled metallic mercury vapor. However, these inorganic forms of mercury, if swallowed, enter the body more easily than metallic mercury. Inorganic mercury can also enter the bloodstream directly through the skin. However, only a small amount would pass through your skin compared with breathing or swallowing inorganic mercury. After entering the body, inorganic compounds of mercury can also reach many tissues. Mercurous mercury in your body breaks down to metallic mercury

and mercuric mercury. Some mercuric mercury may stay in your body, mostly in the kidneys. Mercuric salts of mercury cannot reach the brain as easily as metallic mercury. Inorganic mercury leaves your body in the urine or feces over a period of several weeks or months.

Some organic compounds of mercury (such as methylmercury) can evaporate slowly at room temperature and can enter your body easily as vapors through the lungs. Methylmercury in contaminated fish or other foods that you might eat enters your bloodstream easily and goes rapidly to other parts of your body. It can also enter the bloodstream directly through the skin, but only in small amounts. Organic mercury compounds (such as methylmercury) that are in the bloodstream are similar to metallic mercury because they can reach most tissues includin the brain and fetus. Methylmercury can change to inorganic mercury in the brain and remain there for a long time. Methylmercury that you swallow or breathe leaves your body in the fece mostly as inorganic mercury. It leaves the body over a period of several months For more information on how mercury can enter and leave your body, please refer to Chapter 2.

1.5 HOW CAN MERCURY AFFECT MY HEALTH?

Exposure to high enough levels of metallic, inorganic, or organic mercury can permanently damage the brain, kidneys, and developing fetus. The nervous system is very sensitive to mercury's effects. The changes that mercury causes in the brain are not specific for one type of brain function. Therefore, a variety of effects may occur. These effects include personality changes (irritability, shyness, nervousness), tremors, changes in vision or hearing, and difficulties with memory. Because of differences in the way that different forms of mercury are able to travel through the body, not all forms of mercury are equally able to affect the nervou system. For example, breathing in large amounts of metallic mercury vapors and breathing in or swallowing large amounts of methylmercury are more likely to cause nervous system effects than swallowing large amounts of inorganic mercury salts. This difference is because mercury transport into the brain is very low after exposure to inorganic salts of mercury, suct as mercuric chloride. Therefore, exposure to this form of mercury is less likely to cause nervous system toxicity. The extent of recovery depends on what kind of nervous system damage mercury caused.

The kidney is also very sensitive to mercury. All forms of mercury are able to cause kidney damage if large enough amounts enter the body. Recovery from the kidney effects of mercur is likely, once the body clears itself of the contamination, if the damage caused by the mercu is not too great.

In addition to the effects described above, short-term exposure to high levels of metallic mercury vapor in the air can damage the lungs, cause nausea, vomiting, or diarrhea, cause

increases in blood pressure or heart rate, and cause skin rashes or eye irritation. Long-term exposure of workers in several industries to metallic mercury has been shown to cause similar effects. Levels of metallic mercury in air were greater than the levels normally encountered by the general population. Current levels of mercury in workplace air are lower than in the past. Because of this reduction, fewer workers are expected to have symptoms from mercury exposure. Results of studies in humans showed that there were no effects on the ability to have children after breathing metallic mercury for a long time. Studies in workers exposed to metallic mercury vapors have not shown an increase in cancer. Skin contact with the metal mercury causes allergic reactions (skin rashes) in some people.

Other than effects on the kidneys, little is known about the effects of inorganic mercury salts on the body. Some people have shown nausea and diarrhea after swallowing large amounts of inorganic mercury salts, and some have shown nervous system effects. There is no information on long-term, low-level exposures in humans.

People who have eaten fish containing large amounts of methylmercury or seed grains treated with methylmercury or other organic mercury compounds have had permanent damage to the brain, kidneys, and the growing fetus. The amounts of organic mercury that cause these effects are higher than the amounts to which the general population is exposed daily. Exposure to methylmercury may cause brain damage in the developing fetus. Exposure to methylmercury is also likely to be more dangerous for young children than for adults. This is because relatively more methylmercury passes into the brains of young children than adults, and because methylmercury interferes with brain development.

Studies in animals show similar effects to those seen in people. Studies in animals have also provided more information on types of exposure for which human data are limited. For example, studies in animals provide information about the effects of long-term exposure to mercury through food, water, or inhaled dust. These studies show that long-term oral exposure to inorganic mercury salts can cause kidney damage, effects on blood pressure and heart rate, and effects on the stomach. Studies in animals also provide important information about an autoimmune reaction that may occur in sensitive populations after swallowing inorganic mercury salts. Some studies in animals also show that nervous system damage occurs after long-term exposure to high levels of inorganic mercury. Short- term high level exposure to inorganic mercury affects the fetus in animals. The general population is generally not exposed to levels high enough to produce these effects.

In addition to the effects observed in people who have eaten food contaminated with methylmercury, studies in animals exposed to methylmercury or phenylmercury show that long-term exposure to high levels can cause kidney damage, damage to the stomach and large intestine, changes in blood pressure and heart rate, adverse effects on the developing

fetus, sperm, and male reproductive organs, and increases in the number of spontaneous abortions and stillbirths. Adverse effects on the nervous system of animals occurred at lower doses than most other effects. This difference indicates that the nervous system is more sensitive to methylmercury toxicity than other organs in the body.

Studies also show that animals given inorganic mercury salts by mouth for most of their lifetime had increases in some kinds of tumors. Animals that received methylmercury or phenylmercury in their drinking water or feed for most of their lives had increases in cancer of the kidney. There is no information to show that mercury causes cancer in humans. The Department of Health and Human Services (DHHS), EPA, and the International Agency for Research on Cancer (IARC) have not classified mercury as to its human carcinogenicity. Chapter 2 contains information on health effects of mercury in humans and animals.

1.6 IS THERE A MEDICAL TEST TO DETERMINE WHETHER I HAVE BEEN EXPOSED TO MERCURY?

There are reliable, accurate, and easily available ways to measure mercury levels in the body. However, the most easily available tests do not determine the form of mercury to which you might have been exposed. Blood or urine samples can be taken in a doctor's office and testec using special equipment in a laboratory. Mercury in urine is used to test for exposure to metallic mercury vapor and to inorganic forms of mercury. Blood levels are measured less frequently. Measurement of mercury in whole blood or scalp hair is also used to monitor exposure to methylmercury. Urine is not useful for testing whether exposure has occurred to methylmercury. Levels found in blood, urine, and hair may be used to predict possible health effects that may be caused by the different forms of mercury.

Levels of mercury found in the urine provide information about recent exposures better than about long-term exposures. Blood and urine levels are useful during and after short- and long-term exposures. However, several months after exposure ends, mercury levels in the blood and urine are much lower. Hair can be used to show exposures that occurred many months ago, or even more than a year ago if the hair is long enough and careful testing methods are used. These methods for hair analysis are not easily available. Short-term exposure to mercury can also be evaluated by measuring mercury in the breath, but only within a few days after exposure. For more information on testing for mercury levels in the body, see Chapters 2 and 6.

1.7 WHAT RECOMMENDATIONS HAS THE FEDERAL GOVERNMENT MADE TO PROTECT HUMAN HEALTH?

The government has developed regulations and guidelines for mercury. EPA has established many regulations to control air pollution. These are designed to protect the public from the possible harmful health effects of mercury.

EPA and the FDA have set a limit of 2 parts mercury per billion (ppb) parts of water in drinking water. EPA also recommends that the level of inorganic mercury in rivers, lakes, and streams should be no more than 144 parts mercury per trillion (ppt) parts of water to protect human health (1 ppt is a thousand times less than 1 ppb). EPA suggests that a daily exposure to 2 ppb of mercury in drinking water for an adult of average weight is not likely to cause any significant adverse health effects. The FDA has set a maximum permissible level of 1 part of methylmercury in a million parts (ppm) of seafood products (1 ppm is a thousand times more than 1 ppb). The FDA also may seize treated seed grain containing more than 1 ppm of mercury.

The Occupational Safety and Health Administration (OSHA) regulates levels in the workplace. It has set a limit of 0.01 mg/m^3 for organic mercury and 0.05 mg/m^3 for metallic mercury vapor in the workplace air to protect workers during an %-hour shift and a 40-hour work week. The National Institute for Occupational Safety and Health (NIOSH) recommends that the amount of metallic mercury vapor in workplace air be limited to 0.05 mg/m^3 averaged over a 10-hour work shift.

1.8 WHERE CAN I GET MORE INFORMATION?

If you have any more questions or concerns, please contact your community or state health or environmental quality department or:

Agency for Toxic Substances and Disease Registry
Division of Toxicology
1600 Clifton Road NE, E-29
Atlanta, Georgia 30333
404-639-6000

This agency can also provide you with information on the location of occupational and environmental health clinics. These clinics specialize in the recognition, evaluation, and treatment of illness resulting from exposure to hazardous substances.

Note: This Public Health Statement on mercury is derived from the ATSDR Toxicological Profile for Mercury (Reference 17). Section and chapter references in the public health statement are contained in the toxicological profile.