Public Health Assessment for

U.S. NAVAL SUBMARINE BASE, NEW LONDON
GROTON, NEW LONDON COUNTY, CONNECTICUT
CERCLIS NO. CTD980906515
MAY 26, 1993

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

PUBLIC HEALTH ASSESSMENT

U.S. NAVAL SUBMARINE BASE, NEW LONDON

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Defense Facilities Assessment Section
Federal Programs Branch
Division of Health Assessment and Consultation
Agency for Toxic Substances and Disease Registry
Atlanta, Georgia

THE ATSDR PUBLIC HEALTH ASSESSMENT: A NOTE OF EXPLANATION

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

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

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ATSDR AND THE PUBLIC HEALTH ASSESSMENT PROCESS AT DEPARTMENT OF DEFENSE FACILITIES

The Agency for Toxic Substances and Disease Registry (ATSDR) is part of the U.S. Public Health Service. ATSDR's mission is to prevent or mitigate adverse human health effects and diminished quality of life resulting from exposure to hazardous substances in the environment. ATSDR has no regulatory authority, but does recommend public health actions that address potential adverse health effects resulting from environmental releases from hazardous waste sites.

The public health assessment is the cornerstone ATSDR uses to address public health issues. The document discusses available information about site-related hazardous substances and evaluates whether exposure to them -- in the past, present, or future -- might cause adverse health effects in members of the community.

ATSDR is responsible for preparing public health assessments according to the Comprehensive Environmental Response Compensation and Liability Act (CERCLA or Superfund) section 104 (i)(6) (42 U.S.C. 9604 (i)(6). As mandated by that law, ATSDR conducts public health assessments of hazardous waste sites listed or proposed for listing on the U.S. Environmental Protection Agency's (EPA) National Priorities List (NPL). ATSDR also responds to requests (petitions) to conduct public health assessments.

Three primary sources of information are used in a public health assessment: environmental data, community health concerns, and health outcome data. ATSDR does not routinely perform environmental sampling. The environmental data used in public health assessments are provided by the Department of Defense (DOD) component involved; EPA, state, and local environmental and health agencies; and other groups or individuals. In addition, ATSDR health assessors conduct site visits to observe firsthand current conditions at the site, land use, public accessibility, and demographic characteristics of the nearby community.

Concerns the community has about health are gathered to determine if specific health effects are being experienced by people who live or work near the site. Information from the public also helps ATSDR determine how people may have been or might be exposed to hazardous substances in the environment. Throughout the public health assessment process, ATSDR staff members talk with people living or working at or near the site about their site-related health concerns. Other sources of community health concerns are records from the installation's Public Affairs Office, EPA's Community Relations representative, and state and local health and environmental agencies.

Health outcome databases document health effects that occur in populations. Those data, which come from sources such as state tumor registry databases, birth defects databases, vital statistics records, or other records, may provide information about the general health of the community living near a site. Other more specific records, such as hospital and medical records and records from site-specific health studies, may be used. Demographic data that provide information on population characteristics (e.g., age, sex, socioeconomic status) are used when analyzing health outcome data.

ATSDR identifies actual and perceived site-related health effects and the level of public health hazard posed by the site. ATSDR then makes recommendations to the appropriate DOD components, EPA, and relevant state and local agencies on preventing or alleviating human exposures to site-related contaminants. When indicated, ATSDR identifies a need for any follow-up health activities -- such as epidemiologic studies, registries or community health education. Finally, ATSDR provides a mechanism to re-evaluate health issues as site conditions change (e.g., after site remediation or changes in land use) or when new data or information are available.

A public health action plan (PHAP) is included in the public health assessment. It contains a description of actions ATSDR and other parties will take at and in the vicinity of the site. The purpose of the PHAP is to provide a plan of action for preventing and mitigating adverse human health effects resulting from exposure to hazardous substances in the environment. ATSDR annually monitors the implementation of the plan. Public health actions may include, but are not limited to, restricting site access, sampling, surveillance, registries, health studies, environmental health education, and applied substance-specific research.

Public health assessments are distributed in three phases: an initial release (red cover), a public comment release (brown cover), and a final release (blue cover). The initial release document, which is prepared as part of the process of gathering, analyzing, and drawing conclusions and recommendations from the vast amount of information evaluated in a public health assessment, is provided for review and comment to the DOD component involved, EPA, and state and local environmental and health agencies. This release gives agencies the opportunity to comment on the completeness of information they have provided and the clarity of the presentation. The initial release comment period lasts 45 days. Following the initial release, ATSDR prepares the document for distribution to the general public. The public is notified of the document's availability at repositories (e.g., libraries, city hall) in the site area through advertisements and public notices in newspapers. The comment period lasts 30 days. ATSDR addresses all public comments and revises or appends the document as appropriate. The final public health assessment is then released; that document includes written responses to all public comments.

A public health assessment is an ongoing process. ATSDR revises final documents if new information about the environment, community health concerns, and health outcome data becomes available and is found to modify previous conclusions and recommendations. For more information about the ATSDR public health assessment process and related programs please write to:

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SUMMARY

The New London Submarine Base is divided by the town boundaries of Groton to the south and Ledyard to the north in New London County, Connecticut. In 1983, the Navy identified 16 potential source areas of environmental contamination during their investigations. The submarine base was listed on the U.S. Environmental Protection Agency's National Priorities List in August 1990 because of the potential for on-base groundwater contamination to migrate to off-base residential wells that are close to the New London Submarine Base.

After evaluating data from on-base environmental sampling of soil, groundwater, surface water, sediment, soil gas, and biota collected during the Phase I Remedial Investigation, ATSDR considers confined areas in the Nautilus Museum to be an indeterminate public health hazard because air sampling data is not available to determine if an explosive hazard exists.

A past completed exposure pathway has been identified for children who came in contact with contaminants through unintentional ingestion, inhalation, and dermal absorption of contaminated sediment and surface water in Area A. In the past, Area A Downstream Watercourses posed a health hazard to children who came in contact with lead and DDT contaminated sediment. This area is no longer a public health hazard because the Navy has installed a fence, preventing children from contacting contaminated sediment.

ATSDR has determined that the other on-base sites under the Remedial Investigation do not pose a public health hazard.

Based on data the Navy has collected from 23 off-base private residential wells, ATSDR considers the concentration of lead in one of the 23 wells to be a public health hazard for children and the fetuses of pregnant women. Sodium levels in six residential wells are of public health concern for persons on salt-restricted diets. Sources of residential well contamination have not been determined. Cadmium detected in one residential well from one sampling does not pose a public health hazard.

Residents have expressed concern about contamination of their residential wells. ATSDR met with concerned residents to answer health related questions about residential well contamination. Residents were also concerned about the numbers of neighbors diagnosed as having cancer. ATSDR has evaluated the Connecticut Tumor Registry data (health outcome data) to determine if excess cancer rates exists in the towns of Groton and Ledyard and if those excess cancers could be associated with contaminants at or migrating from the New London Submarine Base. At this time, it is not possible to associate elevated cancer rates to exposures

to environmental contaminants at or migrating from the New London Submarine Base.

ATSDR's Health Activities Recommendation Panel (HARP) has determined that based on the evaluation of available data and on current conditions on base and off base, an environmental health education program is recommended to advise public health professionals and the local medical community of the nature and possible consequences of exposure to contaminants at and in the vicinity of the New London Submarine Base. ATSDR's Division of Health Education will carry out this program in conjunction with the local medical community.

The public health action plan (PHAP) for New London Submarine Base contains a description of actions to be taken by ATSDR and other government agencies at and in the vicinity of the submarine base. The purpose of the PHAP is to ensure that this public health assessment not only identifies public health hazards, but also provides a plan of action to mitigate and prevent adverse human health effects resulting from exposure to hazardous substances in the environment. Included is a commitment on the part of ATSDR to follow up on this plan to ensure that it is implemented.

BACKGROUND

A. Site Description and History

The northern portion of the New London Submarine Base is in the Town of Ledyard and the southern portion of the submarine base is in the Town of Groton, Connecticut. The submarine base is situated on the east bank of the Thames River, six miles north of Long Island Sound (Appendix A, Figure 1).

The submarine base was established as an official Navy Yard in 1886 when it initially moored small craft and obsolete warships. At that time, the submarine base was also used as a coaling station for the Atlantic Fleet. The property was officially established as a permanent submarine base in 1916. In 1917, the submarine base facilities were expanded and a submarine school/training facility was established. The submarine Medical Center was established in 1918. The submarine base expanded in acreage and in the number of buildings during World War I and World War II to support the submarine fleet (1).

Today, the submarine base, including all the noncontiguous areas, encompasses 1,102 acres of land. The most active area of the submarine base is referred to as Main Base. Main Base occupies approximately 568 acres. The remaining 534 acres located beyond the outer perimeter of the Main Base are used for base housing and community support (2).

The Main Base contains submarine training facilities, military offices, medical facilities, some naval housing, and facilities designed for the review and maintenance of submarines. New London Submarine Base currently serves as a homeport for the naval nuclear powered submarine fleet in the Atlantic Ocean.

The area within the Main Base where berthing and support activities associated with the submarines takes place is referred to as the Lower Subase. It has pier space for 17 submarines and admittance is restricted (3).

The submarine base was first proposed to the U.S. Environmental Protection Agency's (EPA) National Priorities List (NPL) in October 1989, and placed on the NPL in August 1990, based on information the Navy collected during the Initial Assessment Study by Envirodyne in 1983, which identified 16 potential sources of environmental contamination (4).

The Navy evaluated three sites during a Verification Step 1A Study by Wehran in 1988. Environmental sampling provided

information on contaminant conditions at the Lower Subase. Recommendations were made for further investigations to fully assess risk and potential remediation alternatives (5).

The Installation Restoration Study performed by Atlantic Inc. in 1989 under the direction of the Navy consisted of two levels of environmental evaluation. The Step I Site Inspection Phase includes an initial field sampling program that evaluates sites to determine if there is any contamination that may be harmful to human health or to the environment (4). Each of the Step I sites that are recommended for Step II Remedial Investigations will be evaluated for the most appropriate remedial alternative(s) as part of the Feasibility Study.

Current Step I Sites

* Construction Battalion Unit (CBU) Drum Storage Area
* Rubble Fill at Bunker A-86
* Torpedo Shops
* Goss Cove Landfill
* Over Bank Disposal Area Northeast (OBDANE)
* Spent Acid Storage and Disposal Area
* Former Gas Station

Those areas identified by the Step I Site Inspection as having on-site environmental contamination undergo further evaluation in the Step II Remedial Investigation/Feasibility Study (RI/FS) to determine the extent of contamination, assess health and environmental risks, and evaluate remediation alternatives.

Current Step II Sites

* Area A
* Over Bank Disposal Area (OBDA)
* Defense Property Disposal Operation Area (DPDO)
* Lower Subase

A map of those areas on the submarine base is included as Appendix A, Figure 2.

Step I Sites (3)

Construction Battalion Unit (CBU) Drum Storage Area

Located in the central portion of the submarine base, this site is next to the Area A Landfill and a parking area for deployed military personnel. Twenty-six 55-gallon drums of waste oil, lube oil, and paint materials were stored at this location. Drums have since been removed by the Navy. As stated in the RI, no surface soil staining or stressed vegetation was evident. This site is unpaved, and surface drainage from the site flows northeast across the unpaved parking area toward the Area A Wetland. Currently, the site is not fenced; however, it is in a restricted zone and is patrolled.

Rubble Fill at Bunker A-86

Located in the center of the submarine base, this site is adjacent to a dirt access road that leads to Bunker A-86. The rubble area is adjacent to and north of the dirt road, west of Bunker A-86. Concrete, asphalt, an electric motor, tar buckets, wood and gravel debris have been disposed of at this site. Historically, this site was used as a coaling station. During Navy contractor's inspection, they found empty five-gallon containers that once held chemicals used in building construction. Surface drainage from the site flows across Area A Landfill into the Area A Wetland. This area is not fenced; however, it is in a restricted zone and is patrolled.

Torpedo Shops

This site is located approximately 800 feet from the North Lake recreation area. Formerly a quarry, this site currently includes three separate buildings 450, 325, and 477. Various fuels, solvents, paint, and petroleum products were used here. Otto fuel (a nitrated ester that produces hydrogen cyanide when burned), high octane alcohol, TH-Dimer (jet rocket fuel), methyl ethyl ketone, and 1,1,1 trichloroethane were commonly used in this area. A sink in one area was used for film developing and another sink served as a high alkaline battery overhaul area. The buildings each used separate septic tanks and leachfield systems until municipal sewers were installed in 1983. Chemicals used at the torpedo shop area may have been inadvertently discharged to the septic system and leachfields instead of being discharged into an underground waste tank (3). Building 450 and 325 are being used as weapons overhaul facilities. Building 477 is a small building used to store Otto fuel. Surface runoff flows toward the southwest into

storm sewers that merge with one of the Area A Downstream Watercourses originating at the Area A Wetlands and travel alongside the roadway leading to the North Lake recreational area and the Torpedo Shops. The water eventually flows into the Thames River at the DRMO Area. The torpedo shops area is a high security zone that is fenced and guarded. Several residences with private wells are about 2,500 feet (one-half mile) northwest of this area. Groundwater flow determinations have shown these private wells to be upgradient from the submarine base and indicate that groundwater does not flow toward the private wells. However, cracks and fissures in the bedrock may allow groundwater to flow in other directions possibly to those private wells. The Navy plans to further investigate area hydrology in the Phase II investigations.

Goss Cove Landfill

Located in the southwestern portion of the submarine base, this site is adjacent to the Thames River and Goss Cove. The submarine base used this area as a landfill from 1946 to 1957. Materials reportedly disposed of at this site consisted of inert rubble and incinerator ash from the municipal waste incinerator on the submarine base at that time. Today, the landfill is asphalt-covered and serves as a parking lot for the Nautilus Submarine Museum. Several large gas cylinders were excavated during the construction of a utility trench north of the museum. One tank leaked propane, one tank was filled with ammonia, and the other tanks were empty (1).

Over Bank Disposal Area Northeast (OBDANE)

This site is located in a heavily wooded area on the edge of a ravine northwest of Area A Landfill; a dirt road provides limited access to the property. Surface drainage from the area flows southwest into a stream that originates at the Area A Wetland. This stream (Area A Downstream Watercourses) flows into the surface drainage system for the Torpedo Shop and ultimately empties into the Thames River at the DRMO area. Currently, the area is not fenced; however, OBDANE is located in a restricted zone and is patrolled.

Spent Acid Storage and Disposal Area

Located in the southeast portion of the submarine base. This area was primarily used to temporarily dispose of waste battery acid during the 1940s. Batteries were placed on a concrete pad where many leaked. Spent battery acid was emptied into an

underground rubber-coated tank. When the tank was full, the acid was pumped into another tank and placed in the Area A Landfill. The site is now covered with concrete.

Former Gas Station

Located in the southwestern portion of the submarine base, the gas station operated from 1940 until the early 1960s, when it was demolished. The exact location of three underground storage tanks, and whether or not those tanks and associated piping were removed, is unknown. The site is currently beneath a road and an adjacent parking area.

Step II Sites (3)

Area A is divided into three areas: Area A Landfill, Area A Wetland, and Area A Downstream Watercourses.

Area A Landfill

This site was used as the main landfill on the submarine base until it was closed in 1973. All non-salvageable waste was disposed in this area. Discarded waste included battery acid, drums of industrial waste, transformers, electric switches, concrete, wood scrap, scrap metal, and tires. After the landfill was covered and partially asphalted, it was used as a storage area for heavy equipment and as a temporary holding area for excavated underground storage tanks and old transformers before being permitted for disposal off base. During the site visit, ATSDR personnel noted materials, such as sand bags and contractor's equipment temporarily stored on the asphalt pads.

Runoff from the landfill drains as overland flow north into the Area A Wetland, which subsequently discharges to two separate streams known as the Area A Downstream Watercourses before ultimately entering into the Thames River. One of the Area A Downstream Watercourses is routed around North Lake through a culvert system. The other stream flows near the Torpedo Shops and down alongside the road that leads to the North Lake recreational area and Torpedo Shops.

The landfill is adjacent to the Area A Wetland, which has been contaminated with pesticides. In the past, mosquito control techniques consisted of placing blocks of DDT pesticide in the middle of the frozen wetland ice during winter months. As the wetland ice thawed in the spring, the pesticide blocks dispersed DDT, killing insect larvae before they hatched. The

Area A Landfill is currently not fenced; however, the Navy plans to fence the entire landfill area. The Area A Landfill is in a restricted zone and is patrolled.

Over Bank Disposal Area (OBDA)

Adjacent to the Area A Landfill and Area A Wetland, this site is a steep bank at the slope of the dike where waste material was "thrown over the bank." ATSDR observed several 200-gallon rusted metal fuel tanks, rusted 55-gallon drums, wood, and metal debris along the bank. This area is currently not fenced; however, the Navy is planning to fence the site. The OBDA is located in a restricted zone and is patrolled.

Defense Property Disposal Operation Area (DPDO)

The site is at the northwestern corner of the submarine base next to the Thames River. It was operated as a landfill between 1950 and 1969. Disposed materials consisted primarily of incinerator ash and non-salvageable wastes. Currently, the area is home to the Defense Reutilization and Marketing Operation (DRMO) program where various metal containers (some empty), scrap metals, batteries, office equipment, and other materials are stored until they are sold at auction, recycled, or until they are transported off site for proper disposal. The southern portion of the site is paved. All surface drainage empties into the Thames River. The area is prone to flooding. The area is fenced and access is restricted. Once a month the DRMO area is open to the public for a public auction.

Lower Subase

The Lower Subase is a high security area that is fenced and guarded. Only authorized persons are permitted to enter through the guarded gates.

The Lower Subase is adjacent to the Thames River. It was the location of the original naval yard. Four areas of potential petroleum contamination exist in this area. The following is a brief description of these areas. The Navy proposes to sample and possibly excavate highly contaminated areas of soils beneath Building 31 prior to capping.

Building 79 Waste Oil Pit - Diesel train engines were repaired and maintained in this building. Oil and solvents used to clean the engines were disposed of in a waste oil pit. The pit is no longer in use and has been filled with concrete. A subsurface drain pipe from the pit extends outside toward Albacore Avenue and the Thames River.

The Power Plant Oil Tanks - Four concrete underground storage tanks, used since World War II were stored here until they were replaced in 1986. These tanks contained fuel oil, diesel oil, and waste oils.

Fuel Oil Storage Tanks at Building 107 - Five concrete underground storage tanks have been used at this site since before World War II. Three of the tanks contained diesel oil, one contained lube oil, and one contained hydraulic oil. The hydraulic oil and lube oil tanks have been replaced. The three diesel oil tanks have been cleaned and abandoned in place in accordance with state regulations.

Fuel Oil Distribution System - This system contains an abandoned fuel oil system located in utility trenches and an underground diesel fuel distribution system.

B. Site Visit

On October 10, 1990, a site visit was conducted by headquarters staff from the Agency for Toxic Substances and Disease Registry (ATSDR), ATSDR Region I Representative, and representatives from the Connecticut Department of Health Services (CTDHS), Connecticut Department of Environmental Protection, Atlantic Environmental Services, consultant to the submarine base, and Northern Division Naval Facilities Engineering Command. Contacts were established with mayors of the City of Groton and Town of Ledyard, a representative of the Town of Groton, a local physician, an environmental consultant to the City of Groton, and several concerned residents. ATSDR personnel documented community concerns during an informal "drop-in" session. A press release discussing the site visit and ATSDR's activities on October 10, 1990 was submitted to the New London newspaper: *The Day*.

A subsequent site visit was conducted by ATSDR personnel on April 28, 1992. New London Submarine Base representatives from the Public Works Department guided the tour.

The following are observations and information that were noted during visits to the New London Submarine Base:

General Comments

* Only authorized persons are allowed to enter the submarine base. The boundary of the submarine base is fenced and/or guarded. As indicated, some areas within the submarine base are further secured by fencing and additional guard gates or patrols.

* Orange colored sediments were noted at the OBDA and Area A Downstream Watercourses during the site visits. No other staining or stressed vegetation was noted on base.

* A six-foot chain-linked fence was installed in 1991 to prevent access to the Area A Wetland runoff from the North Lake recreational area. Area A Wetland runoff forms the Area A Downstream Watercourses. One of the Area A Downstream Watercourses is diverted by underground piping around the North Lake recreational area. The other stream forming the Area A Downstream Watercourses runs along side the road to the Torpedo Shops and North Lake recreational area.

* While installing power lines in 1991, utility workers encountered contaminated subsurface soil due to a leaking underground storage tank when excavating an area adjacent to the baseball field recreation area. The environmental manager is overseeing the installation efforts and is currently designing a remediation plan.

* Military housing reported problems with lead paints and asbestos used on the housing units, some within the family housing areas. Navy personnel are currently working to eliminate the problem.

ATSDR visited North Lake because residents were concerned about the safety of swimming in the lake. During the initial visit, ATSDR noted the following:

* Water from a stream, (Area A Downstream Watercourses) originating from the Area A Wetland, flows to North Lake and is subsequently diverted by an underground culvert, made of corrugated pipe, which runs around the lake. Water from the culvert empties into a concrete-lined basin that flows into yet another culvert under a road. Water from that culvert empties into a stream that flows through the golf course toward the Thames River.

* North Lake is filled each year with city water before the swimming season and is subsequently drained to a low-water level at the end of the season. City water is chlorinated on base before North Lake is filled. According to base

personnel, sediment and surface water samples are not routinely taken before the lake is filled. However, surface water samples are taken weekly during the swimming season and analyzed for specific pesticides, heavy metals, and volatile organic compounds. There was approximately 1 to 2 feet of water in North Lake during the site visits.

* ATSDR personnel discussed with base environmental and Navy contractor personnel the possible mechanisms of contaminant migration from the Area A Wetland to the lake via the Area A Downstream Watercourses. Three possible mechanisms for contaminant migration scenarios are as follows: 1) if the culvert were to flood producing overland flow into the lake, 2) if the corrugated pipe has corroded causing stream water to seep into the lake, and 3) if contaminated groundwater discharges to the lake.

C. Demographics, Land Use, and Natural Resource Use

Demographics

In order to collect information on the populations of people potentially exposed to contaminants at and near the New London Submarine Base, ATSDR has evaluated information from the Census Bureau, which describes the population on base and in the surrounding community. This census information is illustrated in Appendix A, Figure 1, by census tract number designations.

Demographic information on the New London Submarine Base is represented in the 1990 census tract number 7031. Populations in the areas surrounding the submarine base are represented by the 1990 census tracts numbered 6902, 6936, 6931, 7012, 7022, and 7023.

Data for tract 7031 are typical of areas containing military installations, with a very high percentage of males and no one over age 65. Nearly 83% of the population in this census tract are between the ages of 18 and 29. There are no owner-occupied housing units in tract 7031, and over 83% of the population live in group quarters, e.g., barracks. Enlisted personnel families live in Trident Park (400 units), Polaris Park (300 units), Dolphin Gardens (400 units), Cherry Circle trailer space (150 hook-ups), and Connery Towers (54 units). Officer personnel families live in Nautilus Park (1145 units). Single personnel live on private boats or in neighboring towns.

The census tracts 6902, 6936, 6931, 7012, 7022, and 7023 surrounding the submarine base have a combined population of 31,751. The percent of the population under age 10 is higher than the national average, while the percent of persons age 65 or older is a little lower than would be expected. The number

of persons per household, at 2.97, is higher than average. Over 40 percent of all households are renter-occupied, indicating a transient population.

Land Use

The area immediately adjacent to the submarine base is generally residential with some light commercial land use. North of the submarine base is the Town of Ledyard which is comprised of several communities. The Gales Ferry section of Ledyard is a residential development. Residential communities are also along Military Highway and Long Cove Road immediately north of the North Gate entrance of the submarine base. The eastern boundary of the submarine base is state highway Route 12. Several homes are located along Route 12 which transitions to a commercial area near the intersection of Crystal Lake Road. Crystal Lake Road forms the southern boundary of the submarine base. On the south side of Crystal Lake Road are several residential homes as well as military housing. A nursing home is less than one mile from the southeastern boundary of the submarine base.

Natural Resource Use

The submarine base is in the Northern Appalachian Mountain Belt of the New England Physiographic Province. The present topography is a result of glaciation. The site is in the Eastern Uplands area of Connecticut, which consists of irregular, hilly areas with many swamps, exposed rock ledges, and poorly drained uneven valleys (1).

An extensive wetland (Area A Wetland) is next to the Area A Landfill. Area A wetland was created due to the placement of dredge spoils from the Thames River in the late 1950s. These dredge spoils were contained within an earthen dike that extended from the Area A landfill to the south side of the Weapons Storage Area. Numerous aquatic and terrestrial animals have been observed in this area. No hunting is permitted on the submarine base property; however, hunting is known to occur in areas east of the submarine base.

Surface Water

The submarine base is located along the eastern bank of the tidal influenced Thames River, within the Thames River watershed. The upland area is bordered to the west by the tidal estuary of the Thames River. The western area of the submarine base is situated on a terrace of the Thames River. Sites within this terraced flat area include the DRMO, Goss Cove Landfill, and the Lower Subase. The Area A

Landfill, Over Bank Disposal Area, CBU Drum Area, Rubble Fill at Bunker 86, Spent Acid Storage and Disposal Area, and OBDANE areas are located in upland areas to the east of the river terrace. Surface drainage from the submarine base discharges to the west toward the Thames River. Several streams and lakes are located in the north/central section of the submarine base. There are approximately 20 storm water outfalls from submarine base surface drainage to the Thames River.

The Thames River, formed by the Shetucket and Quinebaug Rivers, originates in Norwich, Connecticut. The Yantic River also enters the Thames in Norwich. The Thames eventually discharges into Long Island Sound, approximately 6 miles south of the submarine base. The Thames River estuary extends from Long Island Sound north 16 miles to Norwich. Widths of the river vary from 1.5 miles at New London harbor to about 400 to 500 feet in width at Norwich (4).

The Connecticut Department of Environmental Protection (CTDEP) has classified the Thames River as SC/SB. This indicates the river is suitable for fish and wildlife habitats; aesthetically pleasing; suitable for recreational boating and, in some places, for swimming. However, this classification signifies that the Thames River does not meet the ambient water-quality criteria goal of SB for one or more designated uses because of local area industrial pollution (6).

The river is used for recreational purposes, including fin fishing. Commercial lobster and clam harvesting are permitted only at the mouth of the river. However, shellfish harvesting is prohibited because of high fecal coliform bacteria counts originating from sewage discharge into the Thames River. There are no fin fishing bans for the river. An advisory concerning eating striped bass and bluefish from the coastal waters of Connecticut, including Long Island Sound, was issued by the CTDHS on July 8, 1988 because of polychlorinated biphenyl (PCB) contamination. The advisory specifically indicates that pregnant women, women contemplating becoming pregnant in the near future, nursing mothers, and children under 15 years of age should not eat those fish, or at most, should limit consumption to a few meals a year (6). Sources of the contamination that resulted in this advisory have not been linked to the submarine base.

There are two lakes on the submarine base, North Lake and Rock Lake. The only uses of these lakes are for swimming in the warmer months and for ice-skating during the colder months. North Lake is filled each year with city water before the swimming season and is subsequently drained to a

low-water level at the end of the season. The city water is chlorinated on base before North Lake is filled. Rock Lake is maintained at full water level year round.

Groundwater

The CTDEP has classified the groundwater beneath the central and southern base as unsuitable for direct human consumption without need for treatment because of chemical waste discharges, spills, or leaks of chemicals or land use impacts, but groundwater in these areas may be suitable for industrial process water and cooling waters. The groundwater beneath the north portion of the submarine base including the DRMO site, Area A Landfill and adjacent sites is classified by the Connecticut Department of Environmental Protection as presumed suitable for direct human consumption without need for treatment. Based on hydrogeological data, groundwater from beneath the submarine base discharges into the Thames River (1).

Residents north and east of the submarine base use private wells for drinking water purposes. Community wells are located north and northeast of the submarine base at the Colonel Ledyard Mobile Home Park (one well), Christy Hills Apartments (two wells), and Grandview Trailer Park (two wells). The Groton Water Department provides potable water to the submarine base and to all base housing areas located south and southeast of the submarine base. The Groton water supply is principally provided by surface water reservoirs and is supplemented with wells. Water supplies are within the Poquonock River watershed, east of the submarine base. Some base housing areas are within this water supply watershed; however, Main Base is not (1). Furthermore, the Groton wells are located about 3.5 miles southeast of the site (7). The submarine base has been using the Groton Water supply since approximately 1945.

D. Health Outcome Data

ATSDR conducts a review of health outcome data if complete exposure pathways have been identified; if the toxicologic evaluation shows the likelihood of health outcomes; or if the community near the site has health concerns.

In response to local residents' concerns about an elevated incidence of cancer cases in the area, ATSDR searched state and local cancer databases for current information to help determine if an elevated incidence of cancer exists in the area. A discussion of ATSDR's evaluation is presented in the "Public Health Implications" section of this public health assessment.

COMMUNITY HEALTH CONCERNS

In meetings with officials from the Town of Ledyard and City of Groton, a local physician, and an advisor to the City of Groton, the following concerns were expressed:

* possible elevated cancer rates for residents living north of the submarine base, along Military Highway;
* possible elevated cancer rates for the City of Groton;
* health effects from human consumption of fish and other aquatic organisms from the Thames River and Long Island Sound;
* possible contamination of private and municipal wells located near the submarine base;
* use of North Lake for swimming;
* contamination of the Thames River from fly ash contaminants disposed in Goss Cove Landfill;
* the spread of contaminated river sediment dredgings and possible adverse environmental health effects related to contact with dredged material;
* the lack of information on the base's contribution of pollution into the Thames River; and
* the quality and completeness of the investigations planned for the submarine base as expressed in the 1989 Plan of Action (1).

During informal "one-on-one" meetings with residents, the following concerns were expressed:

* A couple living across the River from the submarine base mentioned that before the building of their home, the Navy/Army Corps of Engineers deposited Thames River dredged sediment on the property that has since become the site of their home. The couple is concerned that contaminated dredged material has contaminated their water supply. The couple currently uses bottled water for drinking water purposes.
* Officer's wives, who regularly participate in recreational activities with their children at the North Lake Swimming Area, are concerned that there has not been enough sampling performed on beach sand, sediment, or surface water at North

Lake to determine if the Lake is safe. They stated that only one sampling event took place in 1988 and that would not represent accurate or comprehensive information on the condition of the North Lake Area.

* Residents were concerned that the Navy has not informed the public of the potential risks to those who swim in North Lake. Residents felt that until comprehensive sampling has been performed, the North Lake Area should be closed.

* Community members are concerned about adverse health effects from incidental ingestion of contaminants and skin exposure to contaminants at the North Lake swimming area.

* A retired civilian employee is concerned about his past exposure to paints, thinners, fuels, and other fluids in the work place during his 20 years of Naval service.

* Community members are concerned about the potential toxic concentrations of contaminants in fish, shellfish, and marine organisms, and their impact on the human food chain. Residents stated that sampling of aquatic species has not been adequate to define the impact on the human food chain.

* Residents were concerned that there was a lack of comprehensive sampling data of Thames River sediment and surface water, which may contain toxic hot spots.

The Navy held a public meeting on July 26, 1990. Additional concerns were expressed during this meeting (8).

* Where does the submarine base now dispose of its toxic waste?

* Does the submarine base have radioactive waste?

* Does surface water drain into the Groton reservoir?

* Are there any controls for leachate from the submarine base to prevent contaminating the Thames River?

* When did the submarine base start receiving water from the City of Groton?

ATSDR held a public meeting on August 18, 1992 to answer residents' questions about the health hazards associated with elevated boron levels found in their drinking water wells. The following question concerns residents the most.

* What are the health effects associated with the level of boron in our drinking water wells? Is our water safe to drink?

Resampling of these residential wells by the Navy and CTDEP in October 1992, showed no elevated boron levels. Further investigation by the Navy revealed laboratory instrument interference of boron analysis with sulfur. All previous boron analysis is therefore, assumed to be erroneous. Subsequent resampling of surface water and groundwater at several locations showed no elevated boron levels.

ENVIRONMENTAL CONTAMINATION AND OTHER HAZARDS

Contaminants discussed in the subsequent sections of this public health assessment will be evaluated to determine whether exposure to them has public health significance. All the contaminants detected at each site are not included in this document. Instead, ATSDR has selected certain contaminants that require further evaluation in this public health assessment.

ATSDR selects and discusses contaminants based on several factors: concentrations of environmental contaminants on and off the submarine base, field and laboratory data quality, sampling design, and comparison of chemical concentrations to health assessment comparison values for carcinogenic and non-carcinogenic health effects. Community health concerns are also considered when selecting the contaminants presented in this public health assessment.

Listing a chemical contaminant in the data tables that follow does not mean that it will cause adverse health effects. Instead, the list indicates which contaminants will be evaluated further in the public health assessment. The potential adverse health effects from those selected contaminants of health concern will be discussed in the Public Health Implications section of this document. When selected in one medium, a contaminant will be reported in all media in which it is found.

The comparison values for ATSDR public health assessments are developed by environmental and health agencies to provide an estimate of chemical concentrations present in each environmental medium (air, water, soil) that should be evaluated for possible health effects if exposure to the contaminants occurs. In many cases, the values have been derived from animal studies or occupational studies. Health effects are related to the exposure dose, the routes of entry into the body, and the amount of chemical absorbed by the body. ATSDR uses the following comparison values.

The data tables include the following abbreviations for these comparison values.

AL Action Level. ALs represent levels at which the agency (EPA) must take additional action under its control to reduce the levels of the contaminant, and inform residents about the action they can take to lower exposure.

CREG Cancer Risk Evaluation Guide. CREGs are health assessment comparison values that correspond to one excess cancer in a million persons exposed over a lifetime. CREGs are calculated from standard cancer risk, adult body weight, adult ingestion rate, and EPA's cancer slope factor (toxicity values for carcinogenic effects).

EMEG Environmental Media Evaluation Guide. EMEGs are media-specific values that correspond to ATSDR's Minimal Risk Level (MRL). They are calculated by using ATSDR's conservative exposure assumptions that would protect the most sensitive populations.

DWEL Drinking Water Equivalent Level. DWELs are lifetime exposure levels specific for drinking water at which adverse health effects would not be expected to occur.

HA Health Advisory. An HA is an estimate of acceptable drinking water levels for a chemical substance based on health effects information. A health advisory is not a legally enforceable federal standard, but serves as a technical guidance to assist federal, state, and local officials.

LOAEL Lowest Observed Adverse Effect Level. The LOAEL is the dose of chemical in a study or group of studies that clearly shows adverse health effects.

LTHA Lifetime Health Advisory. LTHAs represent contaminant concentrations that EPA deems protective of public health over a lifetime (70 years) at an ingestion rate of two liters of water per day. LTHAs are not legally enforceable standards.

MCL Maximum Contaminant Level. MCLs represent contaminant concentrations that EPA deems protective of public health (considering the availability and economics of water treatment technology) over a lifetime (70 years) at an ingestion rate of two liters of water per day. MCLs are enforceable regulatory standards.

MCLG Maximum Contaminant Level Goals. MCLGs are drinking water health goals. MCLGs are set at a level at which no known or anticipated adverse human health effects occur. MCLGs are not enforceable standards.

MRL Minimal Risk Level. Developed by ATSDR, MRLs are estimates of daily exposure to a chemical that is not likely to cause adverse non-carcinogenic health effects. MRLs are based on the most current information available.

NOAEL No Observed Adverse Effect Level. The NOAEL is a dose of chemical in a study or group of studies that clearly shows no adverse health effects.

RfD Reference Dose. The EPA's RfD is an estimate (with uncertainty spanning perhaps a factor of ten) of the daily exposure of a person to a contaminant that is unlikely to cause adverse health effects. The RfD is operationally derived from the NOAEL (from animal and human studies) by a consistent application of uncertainty factors that reflect various types of data used to estimate RfDs and an additional modifying factor, which is based on a professional judgement of the entire database on the chemical.

Additionally, individual chemicals may be grouped into general chemical classifications based on their similar physical properties. The following abbreviations are used in the sections of the public health assessment that follow.

PAHs Polycyclic Aromatic Hydrocarbons. The chemicals in this group include chemical constituents found in coal tar and asphalt. PAHs are divided into two subgroups: carcinogenic PAHs and non-carcinogenic PAHs. Carcinogenic PAHs include benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, indeno (1,2,3-cd)pyrene, chrysene. Non-carcinogenic PAHs include naphthalene, acenaphthylene, fluorene, anthracene, pyrene, and others. Some PAHs are also considered Semi-Volatile Organics.

PCBs Polychlorinated Biphenyls. These chemicals are very stable and persistent in the environment. They are used as heat transfer liquids in transformers, hydraulic fluids, lubricants, and in plasticizers, surface coatings, inks, and adhesives. They are also used as pesticide extenders and for microencapsulation

of dyes for carbonless duplicating paper. PCB 1260 is a name for one specific chemical in this group. There are 209 chemicals are classified as PCBs.

Pesticides — There are many different physical properties of chemicals used to kill pests. In this public health assessment, DDT and its breakdown products DDD and DDE are included in this group of chemicals.

Inorganic Chemicals — Organic chemicals contain carbon; inorganic chemicals do not contain carbon. VOCs, SVOs, PAHs, PCBs, and some pesticides are organic chemicals. Elemental metals such as lead, mercury, cadmium, silver, nickel, and others are inorganic chemicals. Other non-metal inorganic chemicals include boron, antimony, and magnesium.

SVOs — Semi-Volatile Organics. The chemicals in this class slowly evaporate when exposed to air. Chemicals in the class include: 4-methylphenol, isophorone, dibenzofuran, etc. Other chemicals in this class are also PAHs, such as fluoranthracene, anthracene, naphthalene, pyrene, etc.

VOCs — Volatile Organic Compounds. The chemicals in this group readily evaporate or volatilize into gases when exposed to air. This chemical class includes tetrachloroethane, chloroethane, trichloroethylene, dichloroethylene, benzene, toluene, xylenes, etc.

An overview of the contamination found in soils, groundwater, surface water, and other environmental media may be helpful in understanding how the individual sites may be affecting the installation as a whole and the surrounding communities. For this reason, an overview is presented below and is followed by site-specific information. "Detected" denotes where contamination was found.

The information for this section was obtained from the Installation Restoration Study, Naval Submarine Base New London and the Phase I Remedial Investigation, Naval Submarine Base, New London as listed in the "References" section of this document.

A. Introduction

Soil (3)

Surface soil samples have been collected and analyzed at six of the installation sites. Contamination has been identified in surface soil at four of the sites. Subsurface soil samples have been collected and analyzed at nine sites. Contamination was identified in subsurface soils at five of those sites. The table that follows shows where surface and subsurface soil contamination has been identified. PCBs, PAHs, and inorganic chemicals are among the contaminants detected in both surface and subsurface soils. Site-specific contaminants requiring further evaluation within the public health assessment are included in the On-Base Contamination section.

Table 1: Overview of Soil Contamination (3)

Site	Surface Soil Contamination	Subsurface Soil Contamination
CBU Drum Storage Area	Detected	NA[a]
Rubble Fill at Bunker A-86	Detected	NA
Torpedo Shops	NA	Detected
Goss Cove Landfill	NA	Detected
Over Bank Disposal Area	Detected	Detected
Spent Acid Storage and Disposal Area	NA	Detected
Former Gasoline Station	NA	ND[b]
Area A	Detected	Detected
DRMO	Detected	Detected
Lower Subase	NA	Detected
North Lake	ND	ND
Rock Lake	NA	NA

[a] - NA = Not Analyzed
[b] - ND = Analyzed, but Not Detected

Groundwater (3)

Groundwater has been tested at five sites. Also, private wells have been sampled in a neighborhood near Area A Landfill. The shallow aquifer (overburden water table) has been sampled at all five sites. The bedrock (deep) aquifer has been sampled at three sites. A summary table of the on-site groundwater contamination follows. Contaminants detected include inorganic chemicals and volatile organic chemicals. The lists of selected contaminants and their concentrations appear in the On-Base Contamination section.

Table 2: Overview of Groundwater Contamination (3)

Site	Overburden Water Table Contamination	Bedrock Aquifer Contamination
CBU Drum Storage Area	NA[a]	NA
Rubble Fill at Bunker A-86	NA	NA
Torpedo Shops	Detected	ND
Goss Cove Landfill	Detected	NA
Over Bank Disposal Area	ND[b]	ND
Spent Acid Storage and Disposal Area	NA	NA
Former Gasoline Station	NA	NA
Area A	Detected	Detected
DRMO	Detected	ND
Lower Subase	Detected	NA
North Lake	NA	NA
Rock Lake	NA	NA

[a] - NA = Not Analyzed
[b] - ND = Analyzed, but Not Detected

Surface Water and Sediment (3)

Surface water samples have been tested at five on-base sites and two off-base areas (Thames River and a residential pond). Analysis of samples collected from Area A and the off-base Thames River identified contamination. Contaminated surface water was not detected at any other site.

Sediment samples have been collected at one on-base and two off-base sites. Contaminants were detected in the Area A and in the off-base area of a neighboring residence, but not in the Thames River. The specific contaminants identified in surface water and sediment samples are listed with their concentrations in the On-Base Contamination section.

Table 3: Overview of Surface Water and Sediment Contamination (3)

Site	Surface Water Contamination	Sediment Contamination
CBU Drum Storage Area	NA[a]	NA
Rubble Fill at Bunker A-86	NA	NA
Torpedo Shops	ND[b]	Detected
Thames River near Goss Cove	Detected	NA
Over Bank Disposal Area	Detected	Detected
Spent Acid Storage and Disposal Area	NA	NA
Former Gasoline Station	NA	NA
Area A	Detected	Detected
Thames River near DRMO	Detected	NA
Lower Subase	NA	NA
North Lake	ND	ND
Rock Lake	ND	NA
Off-base Thames River	Detected	ND
Off-base residential area	ND	Detected

[a] - NA = Not Analyzed
[b] - ND = Analyzed, but not Detected

Air (3)

No air monitoring has been performed at any site. Soil gas screening has been conducted at six sites. Levels of VOCs were reported as "high," "moderate," "low," or "trace." Measurements were recorded as volt/seconds (Vs), which represent relative quantities as compared to other measurements. A reading of greater than (>) >300 Vs was considered "high," a reading of 50.1 - 300 Vs was considered "moderate," a reading of 2.1 - 50 Vs was considered "low," a reading of 0.3 - 2.0 Vs was considered "trace," and a reading less than (<) <0.3 Vs was considered as "not detected." High and moderate levels of benzene and/or other VOCs were reported at five sites. A summary table of sites where high and moderate levels of VOCs were identified follows.

Table 4: Overview of Soil Gas Screening (3)

Site	Soil Gases Detected at High/Moderate Levels
CBU Drum Storage Area	NA[a]
Rubble Fill at Bunker A-86	NA
Torpedo Shops	Detected
Goss Cove Landfill	Detected
Over Bank Disposal Area	NA
Spent Acid Storage and Disposal Area	NA
Former Gasoline Station	ND[b]
Area A Landfill	Detected
DRMO	Detected
Lower Subase	Detected
North Lake	NA
Rock Lake	NA

[a] - NA = Not Analyzed
[b] - ND = Analyzed, but not Detected

Biota (3)

Frog and bird (catbird fledgling) tissues were collected from the Area A Wetland and analyzed for inorganic chemicals and pesticides. No contaminants were detected in the tissue samples. No other biota have been sampled at any other site.

B. On-Base Contamination

Contamination detected within the installation boundaries is considered on-base contamination. Contamination found at each site on the submarine base is discussed in this site-specific information. Although the specific sampling dates were not provided, all samples were collected and analyzed in 1990.

CBU Drum Storage Area (3)

Surface soil was the environmental medium sampled at the CBU Drum Storage Area.

Soil

Surface soil samples were collected to identify contaminants present in the top 18 inches of soil. Seven samples were collected from three on-site locations. The samples were collected at depths of 0 - 6 inches and at 12 - 18 inches. One sample was a composite of surface soil (0 - 6 inches) from two sampling locations at the site. VOCs, SVOs, pesticides, PCBs, total petroleum hydrocarbons (individual chemicals were not specified), and inorganic chemicals were analyzed. Only the composite sample was analyzed for inorganic chemicals. Lead was the only contaminant identified above comparison values. Cadmium was detected at 2,100 parts per billion (ppb), which is below health comparison values for soil.

Table 5: Contaminant in Surface Soil at CBU Drum Storage Area (3)

Chemical	Concentration (ppb[a])	Comparison Value	
		Concentration (ppb)	Source
Lead	NA[b] - 59,300	53,200[c]	Regional Background

[a] - ppb = parts per billion
[b] - NA = Not Analyzed
[c] - no health criteria established for this environmental medium; comparison value = background level (US Geological Survey regional value)

No other environmental medium has been sampled for analyses at this site.

Rubble Fill at Bunker A-86 (3)

Surface soil was the environmental medium sampled at the Rubble Fill at Bunker A-86.

Soil

Five soil samples were collected and analyzed from two sampling locations north (downgradient) of the site. Not all samples were analyzed for every chemical group. One of the five samples was a composite of soil from the two sampling locations. Only the composite sample (0 - 6 inches) was analyzed for SVOs, PAHs, inorganic chemicals, and pesticides. The inorganic chemicals, lead and cadmium were detected at low levels not exceeding comparison values. Three samples were analyzed for VOCs. No VOCs exceeded comparison values. Two surface soil (0 - 6 inches) samples were analyzed for PCBs. PCBs were not detected.

Table 6: Contaminants in Surface Soil at Rubble Fill at Bunker A-86 (3)

Chemical	Concentration (ppb[a])	Comparison Value	
		Concentration (ppb)	Source
Benzo(a)anthracene	NA[b] - 2,700	120	CREG[c]
Benzo(a)pyrene	NA - 1,800J[d]	120	CREG
Chrysene	NA - 3,200	120	CREG

[a] - ppb = parts per billion
[b] - NA = Not Analyzed (some samples)
[c] - CREG = Cancer Risk Evaluation Guide. The CREG value has been calculated using the EPA Region IV Interim Guidance for Cancer Slope Factor for the polycyclic hydrocarbon (PAH), benzo(a)pyrene.
[d] - J = estimated value

Torpedo Shops (3)

Environmental media sampled for this site consisted of subsurface soil, groundwater, and soil gas.

Soil

Nine soil samples were collected from the two former septic tank drainage line fields for Buildings 450 and 325. Building 450 lines are considered the North System while Building 325 lines are designated the South System. All nine samples were analyzed for VOCs, SVOs, pesticides, PCBs, and inorganic chemicals.

Three subsurface (2 - 4 feet) soil samples were collected from the North System area. Five subsurface (4 - 8 feet) soil samples were collected from the South System area. One surface/subsurface sample (0 - 2 feet) was collected from an upgradient area east of the site to represent possible background levels at this location on the submarine base. PAHs were detected at higher concentrations in the sample taken from the upgradient well boring location, adjacent to the Torpedo Shops. The levels of PAHs detected in soil were below comparison values. The PCB contaminant, PCB 1254 was detected in one of the nine subsurface soil samples analyzed for PCBs.

Antimony was detected in six of the nine subsurface soil samples. Samples containing antimony were identified from the upgradient well location, from one of three samples taken from the North System at a depth of 2 - 4 feet, and from four of the five samples taken from the South System. All samples containing antimony were identified at concentrations below comparison values.

Table 7: Contaminants in Soil at the Torpedo Shops (3)

Chemical	Concentration (ppb[a])		Comparison Value	
	North System	South System	Concentration (ppb)	Source
PCB 1254[b]	ND[c]	ND - 600	91	CREG[d]

[a] - ppb = parts per billion.
[b] - Polychlorinated Biphenyl. This chemical is grouped within a chemical classification of (PCBs).
[c] - ND = Not Detected
[d] - CREG = Cancer Risk Evaluation Guide

Groundwater

Three groundwater monitoring wells were installed at the Torpedo Shops. One well was installed in each system (North and South) and one well in the upgradient sampling area. The upgradient well was drilled into the bedrock and screened at a depth of 11 feet because of the shallow depth of bedrock in that area. The other wells are shallow overburden wells screened at 10 and 7 feet. Groundwater was analyzed for VOCs, SVOs, pesticides, PCBs, and inorganic chemicals.

Antimony was only detected in the one well in the South System. Lead and cadmium were detected at trace levels, below comparison values in all samples including the laboratory blanks, indicating a possible low level background concentration.

Table 8: Contaminants in Groundwater at the Torpedo Shops (3)

Chemical	Concentration (ppb[a])		Comparison Value	
	North System	South System	Concentration (ppb)	Source
Antimony	ND[b]	108J[c]	4	from RfD[d]

[a] - ppb = parts per billion
[b] - ND = Not Detected
[c] - J = estimated value
[d] - RfD = Reference Dose

Soil Gas

Twenty-eight soil gas measurements were taken at the site. However, the data were not reported as concentrations. Measurements were recorded as volt/seconds (Vs) which represent relative quantities as compared to other measurements. A reading of greater than (>) >300 Vs was considered "high," a reading of 50.1 - 300 Vs was considered "moderate," a reading of 2.1 - 50 Vs was considered "low," a reading of 0.3 - 2.0 Vs was considered "trace," and a reading less than (<) <0.3 Vs was considered as "not detected." The only "high" reading was an "unknown" compound that was speculated to be toluene. Benzene was recorded at "trace-low" readings. Benzene may have been present in other positive readings.

Goss Cove Landfill (3)

The field investigations at this site consisted of radiation, geophysical, and soil gas surveys. Additionally, samples were collected from soil, groundwater, and surface water.

At Goss Cove, 458 measurements for radiation were made at ground surface or at waist level. No readings were detected above normal background levels.

A geophysical survey consisting of a combination of magnetometry, electromagnetic conductivity (EM), and ground penetrating radar (GPR) was conducted on the ground surface to determine if drums or other metal objects were buried on the site. Buried metal objects were identified at three locations between 10 - 25 feet beneath ground surface.

Soil

Seven soil samples collected at depths ranging from 4 - 12 feet were analyzed for VOCs, SVOs, pesticides, PCBs, and inorganic chemicals. Oil stains and sheens were noted on approximately half the soil borings taken.

The soil borings showed the depth of fill to range from 10 to 20 feet. All soil samples were collected from within the landfill material, and generally at or below the water table.

PCBs were detected in three of seven samples collected. The PAHs, benzo(a)anthracene and chrysene were detected in all of the seven soil samples collected. Benzo(a)pyrene was detected in four of the seven samples collected. Indeno(1,2,3-cd)pyrene and benzo(g,h,i)perylene were detected in one of the seven soil samples collected. Both benzo(b)fluoroanthene and benzo(k)fluoroanthene were detected in five of seven samples collected. Since Goss Cove Landfill is asphalt covered, the source of these PAHs is questionable and could come from the asphalt covering. Lead was detected at estimated levels above background in six samples. PCB 1248 was detected in three of seven samples collected.

DDE, and DDD were detected in two of the seven samples analyzed. The levels of DDE and DDD were below the health related comparison values. DDT was detected in four samples. DDT was detected at levels below 100 ppb in three separate locations. Another sample identified DDT at an estimated concentration of 3,400 ppb.

Table 9: Selected Contaminants in Subsurface Soil at Goss Cove Landfill (3)

Chemical	Concentration (ppb[a])	Comparison Value	
		Concentration (ppb)	Source
PCB 1248	ND[b] - 4,900X[c]	91	EMEG[d]
Benzo(a)anthracene	320J[e] - 19,000	120	CREG[f]
Benzo(a)pyrene	ND - 9,300	120	CREG[f]
Benzo(b)fluoranthene	ND - 19,000	120	CREG[f]
Benzo(k)fluoranthene	ND - 7,600XJ	120	CREG[f]
Chrysene	340J - 20,000	120	CREG[f]
DDT	ND - 3,400XJ	2,100	CREG[f]
Indeno(1,2,3-cd)pyrene	ND - 4,100	120	CREG[f]
Lead	26,500J - 3,020,000J	53,200[g]	Regional Background

[a] - ppb = parts per billion
[b] - ND = Not Detected
[c] - X = computer edited value
[d] - EMEG = Environmental Medium Evaluation Guide
[e] - J = estimated value
[f] - CREG = Cancer Risk Evaluation Guide. The CREG value has been calculated using the EPA Region IV Interim Guidance for Cancer Slope Factor for the polycyclic aromatic hydrocarbon (PAH), benzo(a)pyrene.
[g] - no health criteria established for this environmental medium; comparison value = background level (US Geological Survey regional value)

Groundwater

Four monitoring wells, all screened in the overburden water table, were sampled for VOCs, SVOs, pesticides, PCBs, inorganic chemicals, and gross alpha and beta radiation. Three of the wells are located within the former landfill, while one well is upgradient of the site.

Naphthalene was detected in two of four groundwater samples collected. Gross alpha radiation was detected in three of four groundwater samples. Gross beta radiation was detected in three of four groundwater samples. In one of those samples, gross beta radiation exceeded comparison values.

Table 10: Selected Contaminants in Groundwater at the Goss Cove Landfill (3)

Chemical	Concentration	Comparison Value	
		Concentration	Source
Naphthalene	4J[a] - 62 ppb[b]	20 ppb	LTHA[c]
Gross Alpha Radiation	0.0 - 28.9 pCi/L[d]	15 pCi/L	MCL[e]
Gross Beta Radiation	21.7 - 134 pCi/L	50 pCi/L	MCL[f]

[a] - J = estimated value
[b] - ppb = parts per billion
[c] - LTHA = Lifetime Health Advisory
[d] - pCi/L = picoCuries per liter
[e] - MCL = Maximum Contaminant Level
[f] - screening value used; beta particles and photon radioactivity that results in </=4 milliRoentgen per year total body dose equivalent (the Maximum Contaminant Level)

Surface Water

One surface water sample was collected from the Thames River downstream from the Goss Cove Landfill. The sample was analyzed for VOCs, SVOs, pesticides, PCBs, inorganic chemicals, and gross alpha and beta radiation. No selected contaminants were detected above comparison values.

Soil Gas

Sixty-four soil gas points were analyzed. Most of the samples were taken from the area beneath the paved parking lot. Sampling results do not include analysis for methane gas. Methane gas is a naturally occurring gas produced during the decay process present in landfills. It is

highly explosive and elevated concentrations may become trapped in confined areas such as cabinets or closets. Phase II sampling will include analysis for methane gas.

Trace to low levels of the VOCs, tetrachloroethylene, 1,2-dichloroethylene, trichloroethylene, benzene, and toluene were detected. Actual sampling results were not included in the Installation Restoration Study (3).

Three samples containing moderate to high levels of unidentified compounds mixed with benzene, toluene, and xylenes were identified. Further analysis indicates the presence of a petroleum product (3). These elevated levels of VOCs are in the vicinity where elevated soil concentrations of petroleum hydrocarbons were detected.

Over Bank Disposal Area (3)

Soil and sediment were sampled at this site. The discussion of sediment sampling is included in the Area A Downstream Watercourses section that follows.

Soil

Five soil samples were collected from two locations at the site. Three of the samples were collected at depths of 0 - 6 inches, and two samples were collected at depths of 12 - 18 inches. One of the samples collected at the 0 to 6 - inch depth was a composite sample of the two locations. The 12 to 18-inch samples were analyzed for VOCs only. The composite sample was analyzed for SVOs, pesticides, PCBs, and inorganic chemicals. The other two 0 to 6-inch samples were analyzed for selected inorganic chemicals only. Lead and cadmium were detected at low levels below health related comparison values.

Spent Acid Storage and Disposal Area (3)

Soil was the medium sampled at the Spent Acid Storage and Disposal Area.

Soil

Six soil samples were collected at depths of 0 - 4 feet and 4 - 8 feet. One additional sample was collected from the gravel used to fill the spent acid tank. One sample collected near the sanitary sewer line was analyzed for VOCs, SVOs, pesticides, PCBs, and inorganic chemicals. The

other samples were analyzed for a selected number of inorganic chemicals only. No contaminants were detected at levels above health comparison values.

Former Gasoline Station (3)

Investigations at this site included geophysical survey, soil, and soil gas sampling.

A geophysical survey using GPR indicated that only one of the three underground storage tanks remains below the ground.

Soil

Five subsurface soil samples were collected at depths ranging from 8 - 16 feet. The samples were analyzed for VOCs and inorganic chemicals. Samples were collected to the north, east, and southwest of that location. Cadmium and lead were detected in all samples at trace concentrations not exceeding health comparison values.

Soil Gas

Eleven soil gas samples all collected beneath the paved road were analyzed. No VOCs were detected at moderate or high levels.

Area A (3)

Area A is divided into three areas: Area A Landfill, Area A Wetland, and Area A Downstream Watercourses.

The Step II investigations of Area A consisted of a radiation, geophysical, and soil gas survey within the former landfill only. Soil, groundwater, surface water, and soil gas sampling was performed throughout Area A. All groundwater data for Area A is combined in Table 14.

Area A Landfill (3)

A total of 1,272 measurements were taken for radiation. Radiation detected was determined to be naturally occurring.

Geophysical investigations using GPR, magnetic and electromagnetic conductivity were conducted at ground surface. Metal objects, some of which were "large," were determined to be at depths of 5 feet and 8 feet below ground surface (3).

Soil

Twelve subsurface soil samples were collected from eight locations in the landfill area. Two surface soil samples were also analyzed. The samples were collected at the site and analyzed for VOCs, SVOs, pesticides, PCBs, and inorganic chemicals.

In subsurface soil samples, benzo(a)anthracene was detected in three of twelve samples analyzed. Benzo(b)fluoranthene, benzo(k)fluoranthene, and chrysene were detected in approximately six of twelve samples collected. Benzo(a)pyrene was detected in three of twelve samples collected. Cadmium was detected at low levels not exceeding health related comparison values. Landfill materials were encountered during drilling to an approximate depth of 10 - 12 feet, which was beneath dredged sediment from the Area A Wetland.

In surface soil samples, PCBs, DDT, and lead were detected in both samples analyzed. Benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, and chrysene were detected in one of two samples collected.

Table 11: Selected Contaminants in Soil at Area A Landfill (3)

Chemical	Concentration (ppb[a])		Comparison Value	
	Surface Soil	Subsurface Soil	Concentration (ppb)	Source
PCB 1260	350J - 12,000	ND	91	CREG
Benzo(a)anthracene	ND - 130J	ND[b] - 570J[c]	120	CREG[d]
Benzo(a)pyrene	ND	ND - 310J	120	CREG[d]
Benzo(b)fluoranthene	ND - 220J	ND - 280J	120	CREG[d]
Benzo(k)fluoranthene	ND - 96J	ND - 560J	120	CREG[d]
Chrysene	ND - 160J	ND - 460J	120	CREG[d]
DDT	71J - 23,000	ND - 83XJ	2,100	CREG
Lead	36,200 - 85,700	5,500J - 277,000J	53,200[e]	Regional Background

[a] - ppb = parts per billion
[b] - ND = Not Detected
[c] - J = estimated value
[d] - CREG = Cancer Risk Evaluation Guide. The CREG value has been calculated using the EPA Region IV Interim Guidance for Cancer Slope Factor for the polycyclic aromatic hydrocarbon (PAH), benzo(a)pyrene.
[e] - no health criteria established for this environmental medium; comparison value = background level (US Geological Survey regional value)

Area A Wetland (3)

Investigations at the Area A Wetland included soil, sediment, surface water, and groundwater analysis. All groundwater data for Area A is combined in Table 14.

Soil and Sediment

Thirty-three subsurface soil samples were collected from twelve locations within the Area A Wetland. The sampling depths taken ranged from 0 - 2 feet to 16 - 18 feet. Benzo(a)anthracene and chrysene were detected in 15 of 33 samples collected. Benzo(a)pyrene was detected in six of 33 samples collected. Benzo(b)fluoranthene and benzo(k)fluoranthene were each detected in 11 of 33 samples collected. Lead was detected above naturally occurring background levels in three of 33 samples collected. Nine sediment samples were also collected. All samples were analyzed for VOCs, SVOs, pesticides, PCBs, and inorganic chemicals. Benzo(a)pyrene, indeno(1,2,3-cd)pyrene, benzo(g,h,i)perylene were each detected in one of nine samples collected. Benzo(a)anthracene and DDE were each detected in two of nine samples collected.

Benzo(b)fluoranthene, and benzo(k)fluoranthene, and chrysene were detected in three of the samples. Lead was detected above naturally occurring background levels in four of nine samples collected. Cadmium was not detected above naturally occurring background levels.

Table 12: Selected Contaminants in Soil and Sediment at Area A Wetland (3)

Chemical	Concentration (ppb[a])		Comparison Value	
	Subsurface Soil	Sediment	Concentration (ppb)	Source
Benzo(a)anthracene	ND - 370J	ND - 27,000	120	CREG[d]
Benzo(a)pyrene	ND - 390J	ND - 35,000	120	CREG[d]
Benzo(b)fluoranthene	ND - 550J	ND - 55,000Y	120	CREG[d]
Benzo(k)fluoranthene	ND - 390J	ND - 45,000Y	120	CREG[d]
Benzo(g,h,i)perylene	ND	ND - 23,000	120	CREG[d]
Chrysene	ND - 600J	ND - 42,000	120	CREG[d]
Indeno(1,2,3-cd)pyrene	270J	ND - 23,000	120	CREG[d]
Lead	3,600 - 298,000	21,300 - 241,000	53,200[e]	Regional Background

[a] - ppb = parts per billion
[b] - ND = Not Detected
[c] - J = estimated value
[d] - CREG = Cancer Risk Evaluation Guide. The CREG value has been calculated using the EPA Region IV Interim Guidance for Cancer Slope Factor for the polycyclic aromatic hydrocarbon (PAH), benzo(a)pyrene.
[f] - no health criteria established for this environmental medium; comparison value = background level (US Geological Survey regional value)

Area A Downstream Watercourses and Overbank Disposal Area (3)

Investigations at this site included geophysical evaluation (reported in under Area A geophysical evaluation), soil, and sediment analysis.

Soil and Sediment

Five subsurface soil samples were collected from five monitoring well locations. These sampling depths ranged from 0 - 3 feet to 3 - 5 feet. All samples were analyzed for VOCs, SVOs, pesticides, PCBs, and inorganic chemicals. Benzo(k)fluoranthene and DDD were detected in one of five subsurface soil samples. DDE and DDT were detected in two of five subsurface soil samples. Lead levels detected in the five samples did not exceed naturally occurring background levels.

Twenty-three sediment samples were collected from the Area A Downstream Watercourses, OBDA, and associated ponds. The samples were collected from 18 sampling locations. The samples were analyzed for VOCs, SVOs, pesticides, PCBs, and inorganic chemicals. Benzo(a)anthracene, and chrysene were detected in nine of 23 samples collected. Benzo(b)fluoranthene was detected in eight samples collected. Benzo(a)pyrene, and benzo(k)fluoranthene were detected in six samples collected. Lead was detected above naturally occurring regional background levels in six samples. Indeno(1,2,3-cd)pyrene, was detected in four samples. DDD, DDE, DDT were detected in 18 samples. PCB 1260 was detected in one sample collected.

Table 13: Selected Contaminants in Soil and Sediment at Area A Downstream Watercourses and Overbank Disposal Areas (3)

Chemical	Concentration (ppb[a])		Comparison Value	
	Subsurface Soil	Sediment	Concentration (ppb)	Source
Benzo(a)anthracene	ND	ND[b] - 850J[c]	120	CREG[d]
Benzo(a)pyrene	ND	ND - 640J	120	CREG[d]
Benzo(b)fluoranthene	ND	ND - 750J	120	CREG[d]
Benzo(k)fluoranthene	ND - 50JY	ND - 320J	120	CREG[d]
Indeno(1,2,3-cd)pyrene	ND	ND - 1,200J	120	CREG[d]
Chrysene	ND	ND - 1,200J	120	CREG[d]
DDD[e]	ND - 61	ND - 1,700,000J	2,900	CREG[f]
DDE[g]	ND - 28JY	ND - 28,000J	2,100	CREG
DDT[h]	ND - 74	ND - 240,000J	2,100	CREG
Lead	5,100 - 28,000	5,000J - 223,000	53,200[i]	Regional Background
PCB 1260	ND	ND - 280JX	91	CREG

[a] - ppb = parts per billion
[b] - ND = Not Detected
[c] - J = estimated value
[d] - CREG = Cancer Risk Evaluation Guide. The CREG value has been calculated using the EPA Region IV Interim Guidance for Cancer Slope Factor for the polycyclic aromatic hydrocarbon (PAH), benzo(a)pyrene.
[e] - DDD = p,p'-Dichlorodiphenyldichloroethane
[f] - CREG = Cancer Risk Evaluation Guide.
[g] - DDE = p,p'-Dichlorodiphenyltrichloroethylene
[h] - DDT = p,p'-Dichlorodiphenyltrichloroethane
[i] - no health criteria established for this environmental medium; comparison value = US Geological Survey background level

Groundwater

Twenty-eight monitoring wells were installed throughout Area A Landfill, Area A Wetland, and the Area A Downstream Watercourses. Eleven of these wells are in the shallow, overburden water table. The other 17 wells are screened in the bedrock aquifer. Samples were analyzed for VOCs, SVOs, pesticides, PCBs, inorganic chemicals, and radiation. Benzene, cadmium, 1,4-dichlorobenzene, lead, PCB 1254, 1,1,2,2-tetrachloroethane, trichloroethylene, and gross Beta radiation were each detected in one of 28 samples analyzed.

Gross Alpha radiation was detected in five of the 28 samples. Manganese was detected in three of the 28 samples. Sodium was detected at levels above health comparison values in 20 of the 28 samples analyzed.

Table 14: Selected Contaminants in Groundwater at Area A Landfill, Area A Wetland, and Area A Downstream Watercourses (3)

Chemical	Concentration	Comparison Value	
		Concentration	Source
Benzene	ND - 10J[a] ppb[b]	0 ppb	Carcinogen
Cadmium	ND[c] - 44.8J ppb	2 ppb	EMEG[d]
1,4-Dichlorobenzene	ND - 99J ppb	75 ppb	LTHA[e]
Lead	ND - 22.4J ppb	15 ppb	Action Level[f]
Manganese	2.3 - 8,130 ppb	3,000 ppb	RfD[g]
PCB 1254	ND - 150X[h] ppb	0.05 ppb	EMEG
Sodium	9,000 - 1,360,000 ppb	20,000 ppb	DWEL[i]
1,1,2,2-Tetrachloroethane	ND - 140 ppb	0.175 ppb	CREG[j]
Trichloroethylene	ND - 17 ppb	0 ppb	MCLG[k]
Gross Alpha Radiation	0 - 42.2 pCi/L[l]	15 pCi/L	MCL[m]
Gross Beta Radiation	2.8 - 56.3 pCi/L	50 pCi/L	MCL[n]

[a] - J = estimated value
[b] - ppb = parts per billion
[c] - ND = Not Detected
[d] - EMEG = Environmental Medium Evaluation Guide
[e] - LTHA = Lifetime Health Advisory
[f] - AL = Action Level. No health criteria established for this environmental medium
[g] - Reference Dose
[h] - X = computer edited value
[i] - DWEL = Drinking Water Equivalent Level (EPA guidance)
[j] - CREG = Cancer Risk Evaluation Guide
[k] - MCLG = Maximum Contaminant Level Goal
[l] - pCi/L = picoCuries per liter
[m] - MCL = Maximum Contaminant Level
[n] - screening value used; beta particles and photon radioactivity that results in </=4 milliRoentgen per year total body dose equivalent (the Maximum Contaminant Level)

Surface Water

Fifteen surface water samples were collected. Seven from Area A Wetland, six from Area A Downstream Watercourses, and two from the Thames River. The samples were analyzed for VOCs, SVOs, pesticides, PCBs, and inorganic chemicals. Four of the 15 samples analyzed for radiation detected levels below health comparison values. Cadmium was detected above health comparison values for drinking water in one of the 15 samples analyzed. DDD was detected in one of 15 samples analyzed. Lead was detected in 11 of the 15 samples analyzed.

Table 15: Selected Contaminants in Surface Water at Area A Wetland, Area A Downstream Watercourses, and the Thames River (3)

Chemical	Concentration (ppb[a])	Comparison Value	
		Concentration (ppb)	Source
Cadmium	ND[b] - 126J[c]	2	EMEG[d]
DDD	ND - 1.9	0.15	CREG[e]
Lead	ND - 7	15	Action Level[f]

[a] - ppb = parts per billion
[b] - ND = Not Detected
[c] - J = estimated value
[d] - EMEG = Environmental Medium Evaluation Guide
[e] - CREG = Cancer Risk Evaluation Guide
[f] - AL = Action Level. No health criteria established for this environmental medium

Soil Gas

Soil gas measurements were taken at 160 locations in the Area A Landfill. "High" readings were detected at 20 locations. The compounds detected in the "high" range are believed to include benzene, toluene, trichloroethylene, tetrachloroethylene, dichloroethylene, and xylenes.

Biota

Frog and bird (catbird fledgling) tissues from the Area A Wetland were analyzed only for metals and pesticides. No contaminants were detected.

DRMO (3)

The Step II investigations at this site consisted of radiation, geophysical, and soil gas surveys. Soil, groundwater, and surface water were the media sampled.

A total of 372 radiation measurements were made. All were within the naturally occurring background radiation levels for this region.

Because of the extensive surface metals (buildings and objects those awaiting auction) present at this site, the applicability of magnetic measuring methods is limited.

Soil

Four surface soil samples were collected at depths of 0 - 0.5 feet. All samples were analyzed for VOCs, SVOs, pesticides, PCBs, and inorganic chemicals. Benzo(b)fluoranthene and benzo(k)fluoranthene were detected in one of the four surface soil samples analyzed. Benzo(a)anthracene, chrysene, and lead were each detected in two of the four surface soil samples analyzed. PCB 1260 was detected in all four surface soil samples analyzed. Lead was detected above naturally occurring background levels in two of the four samples analyzed.

Twenty-four subsurface soil samples were collected at depths ranging from 0 - 2 feet to 8 - 10 feet. All samples were analyzed for VOCs, SVOs, pesticides, PCBs, and inorganic chemicals. PCB 1260 was detected in 12 of 24 subsurface soil samples analyzed. Benzo(a)anthracene and chrysene were each detected in 18 of 24 samples analyzed. Benzo(a)pyrene was detected in ten of 24 samples analyzed. Benzo(b)fluoranthene was detected in 16 of 24 samples analyzed. Benzo(k)fluoranthene was detected in 11 of 24 samples analyzed. DDD, DDE, DDT, and 1,1,2,2-tetrachloroethane were detected in one subsurface soil sample analyzed. Indeno(1,2,3-cd)pyrene was detected in six of 24 samples analyzed. Lead was detected above naturally occurring background levels in 14 of 24 surface soil samples analyzed.

Table 16: Selected Contaminants in Soil at DRMO (3)

Chemical	Concentration (ppb[a])		Comparison Value	
	Surface Soil	Subsurface Soil	Concentration (ppb)	Source
PCB 1260	550J[b] - 3,100J	ND[c] - 12,000J	91	CREG[d]
Benzo(a)anthracene	ND - 570J	ND - 4,600	120	CREG[e]
Benzo(a)pyrene	ND	ND - 4,500	120	CREG[e]
Benzo(b)fluoranthene	ND - 440J	ND - 4,700	120	CREG[e]
Benzo(k)fluoranthene	ND - 310J	ND - 4,000	120	CREG[e]
Chrysene	ND - 560J	ND - 4,200	120	CREG[e]
DDD	ND	ND - 16,000J	2,916.7	CREG[d]
DDE	ND	ND - 8,800J	2,100	CREG[d]
DDT	ND	ND - 33,000J	2,100	CREG[d]
Indeno(1,2,3-cd)pyrene	ND	ND - 3,600	120	CREG[e]
Lead	20,700J - 204,000	2,900J - 8,130,000	53,200	Regional Background
1,1,2,2-Tetrachloroethane	ND	ND - 34,000	3,500	CREG[d]

[a] - ppb = parts per billion
[b] - J = estimated value
[c] - ND = Not Detected
[d] - CREG = Cancer Risk Evaluation Guide
[e] - CREG = Cancer Risk Evaluation Guide The CREG value has been calculated using the EPA Region IV Interim Guidance for Cancer Slope Factor for the polycyclic aromatic hydrocarbon (PAH), benzo(a)pyrene.
[f] - no health criteria estabiished for this environmental medium; comparison value = US Geological Survey background level

Groundwater

Six monitoring well samples were analyzed for VOCs, SVOs, pesticides, PCBs, and inorganic chemicals. Five of the wells are screened in the overburden water table and one is screened in the bedrock aquifer.

Surface Water

One surface water sample was collected from the Thames River and analyzed for VOCs, SVOs, pesticides, PCBs, and inorganic chemicals.

Soil Gas

A soil gas survey was performed at the site. One "high" reading was detected; the chemicals detected are believed to include benzene, toluene, and other unknown constituents.

Lower Subase (3)

Field investigations consisted of a utility manhole inspection and waterfront bulkhead inspection for evidence of contamination sources/residuals. Other sampling included a soil gas survey, soil, and groundwater sampling. No radiological survey was performed at the Lower Subase.

A total of 212 utility manholes were inspected on two days in December 1990, and two days in April 1991. The utility manholes consisted of storm sewer, sanitary sewer, steam, electric, telephone, and sand manholes. Inspection consisted of removing manhole covers to note manhole type, and any visible evidence of oil contamination such as oil sheens on water or discolored sediment, or any petroleum odors. Neither air nor soil sampling was performed in the manholes. No oil sheens were observed along the waterfront.

Contamination sources in all but one manhole appear to be from product releases from underground fuel lines and storage tank leaks. Oil in one manhole possibly originated from the former waste oil pits in Building 79 (3).

Soil

Subsurface soil samples were collected from 17 borings and analyzed for VOCs, total petroleum hydrocarbons, and inorganic chemicals. The sampling depths ranged from 2 - 4 feet and 14 - 16 feet. In addition to those samples, five test borings were made at Building 79. Samples were screened for organic vapors and were visually inspected for contamination, but they were not analyzed for chemical constituents. Lead was detected in only one sample above background concentrations. Total petroleum hydrocarbons

were detected at concentrations ranging from not detected - 14,000,000 parts per billion. Although the individual constituents of "total petroleum hydrocarbons" were not provided, fluorescence spectroscopy data indicate the presence of waste lubricating oils, Number 2 fuel/diesel oil, asphalt/tar, and waste oil/heavy residual fuel oil (such as Number 6 fuel oil) mixture. No other contaminants above health comparison values were identified.

Groundwater

Groundwater samples were collected from 24 monitoring wells and analyzed for volatile organic chemicals, total petroleum hydrocarbons, and inorganic chemicals. All wells were screened in the overburden water table. Total petroleum hydrocarbons were detected in one sample at a concentration of 5,400 parts per billion. The individual constituents of "total petroleum hydrocarbons" were not provided, but fluorescence spectroscopy data indicate the presence of waste oil/heavy residual fuel oil (such as Number 6 fuel oil) mixture, Number 2 diesel oil, waste lubricating oils, and heavy residual fuel oil. The other selected contaminants are listed in the following table.

Table 17: Selected Contaminants in Groundwater at Lower Subase (3)

Chemical	Concentration (ppb[a])	Comparison Value	
		Concentration (ppb)	Source
Benzene	ND[b] - 5	1.2	CREG[c]
Cadmium	ND - 25.5J[d]	2	EMEG[e]
Lead	ND - 22.2	15	Action Level[f]

[a] - ppb = parts per billion
[b] - ND = Not Detected
[c] - CREG = Cancer Risk Evaluation Guide
[d] - J = estimated value
[e] - EMEG = Environmental Medium Evaluation Guide
[f] - AL = Action Level. This contaminant has been selected for further evaluation because no health criteria are available for evaluating its presence in drinking water; lead is classified by the Environmental Protection Agency as being a probable human carcinogen.

Soil Gas

A soil gas survey was conducted on the site. A total of 127 locations were sampled. Two "high" readings were identified. Benzene, toluene, and xylenes (among other unknown constituents) were the chemicals believed to cause these readings.

North Lake (7)

Soil and surface water were investigated at this site.

Soil

Sixteen soil (beach and sediment) samples at North Lake were collected in 1988 and 1990. Samples were analyzed for VOCs, SVOs, phthalate esters, pesticides, PCBs, and inorganic chemicals. The samples were all designated as "soil" samples without distinguishing which were from the beach area and which were sediments. No contaminants detected were above health comparison values.

Surface Water

Surface water samples were collected in 1988, 1990, and 1991 and analyzed for VOCs, SVOs, phthalate esters, pesticides, PCBs, and inorganic chemicals. No contaminants detected were above health comparison values.

Rock Lake

Surface water was the medium sampled at this site.

Surface Water

Samples were collected in 1991 and analyzed for the same parameters as the North Lake samples: VOCs, SVOs, phthalate esters, pesticides, PCBs, and inorganic chemicals. No contaminants above health comparison values were detected in the samples.

C. Off-Base Contamination (7)

During the assessment of the New London Submarine Base, the preparers of this document searched the Toxic Chemical Release Inventory (TRI) to determine other sources of chemical releases into the environment in the areas near New London Submarine Base. The TRI is an on-line database, maintained by EPA, that contains information (self-reported by chemical manufacturers and other industries) about more than 320 different chemicals released into the environment. Data has been compiled for the period between 1987 and 1990. The New London Submarine Base is not a manufacturing facility and, therefore, is not subject to reporting releases to the TRI. However, the submarine base must comply with all other state and federal reporting requirements for actual chemical releases.

TRI database reported chemical releases made to air, land, and surface water points for VOCs and inorganic chemicals such as heavy metals from industrial sources within the zip code areas of New London, Groton, and Norwich, Connecticut.

Residential Wells

A total of twenty-three residential wells were sampled to evaluate overall groundwater quality and to determine if on-base contaminants have migrated off base, impacting neighboring areas. Depths of residential wells vary widely from a surface spring to a 300-feet deep bedrock well. Wells are designated by the letters OSW followed by a number.

Groundwater

The first round of sampling in 1991 included analysis of 14 wells for VOCs, SVOs, inorganic chemicals, pesticides, and PCBs. Sampling locations were chosen based on proximity to the submarine base and willingness of individual homeowners to have their wells tested (7). Generally, the residential wells were located on roads closest to the Area A and DRMO sites: Sleepy Hollow, Pinelock Drive, Long Cove Road, and Route 12.

The second round of sampling in 1991 included confirmatory analysis of inorganic chemicals in four wells plus the inorganic chemical analysis on eight additional wells. One well from round 1 had only VOC analysis performed during the second round. The second round of sampling extended the sampling area to the east of Baldwin Hill Road and North Pleasant Valley Road.

The third round of sampling in 1991 included confirmatory inorganic chemical analysis on six wells from round 2 sampling plus total analysis (VOCs, SVOCs, inorganic chemicals, pesticides, and PCBs) on one additional well not previously sampled.

In August of 1992, the Connecticut State Department of Environmental Protection in conjunction with the Connecticut State Department of Health Services analyzed 10 of those previously sampled wells for VOCs and inorganic chemicals.

In September of 1992, the Navy performed boron analysis on two of those wells previously sampled by the state and eight residential wells previously sampled in the first round. Boron levels were near or below detection limits.

During the first sampling round, lead was detected above the action level of 15 ppb in OSW 10 (39 ppb). In the second sampling round, lead was detected above 15 ppb in OSW 23 (32 ppb), OSW 21 (18 ppb), and OSW 6 (estimated at 17 ppb).

Subsequent confirmatory sampling showed lead levels to be below the action level in all but two wells, OSW 10 and OSW 23. Concern for lead levels in those private wells prompted the Navy to performed detailed lead analysis. Water was taken at the well head and at the tap prior to flushing, then again after a five minute flushing at both locations. Well OSW 10 showed lead levels to be below the detection limit of 3 ppb in all four samplings. Further analysis by another lab showed the actual lead concentration to be 1.7 ppb. Well OSW 23 showed lead levels ranging from < 3 ppb to 37 ppb. This residential well showed lead levels to be lowest (< 3 ppb) after flushing the line for five minutes and highest prior to flushing. Overall, lead levels in private wells were higher than the levels found in groundwater at the Area A Landfill on base.

The VOCs, methylene chloride and total xylenes were detected at trace levels, below health comparison values in one residential well (OSW 15) during the first round. Chloromethane, another VOC, was also detected in that residential well at an estimated value above health comparison values for drinking water. This well was resampled during the second round of sampling and again by CTDHS; no VOCs were detected. Chloromethane has not been detected in groundwater at any of the sites on the installation.

Cadmium was detected during the first sampling round in residential well OSW 6. However, cadmium was not detected in that residential well in the second and third sampling rounds or by CTDHS. Cadmium was detected at trace levels in samples from seven other wells; however, the presence of cadmium in the wells is questionable because cadmium was also detected in the laboratory control samples.

Sodium was detected at levels above the health comparison value in six of the 23 residential wells tested.

Contaminants detected in private residential wells were found to be hydrogeologically unconnected, (depths of wells varied from shallow to deep) and geographically unconnected (homes not adjacent to each other). No defined plume of contamination has been identified beneath the submarine base. The source(s) of contamination in residential wells has not been identified.

Table 18: Selected Contaminants in Private Wells Located Off Base Near Area A Landfill (3)

Chemical	Concentration (ppb[a])	Comparison Value	
		Concentration (ppb)	Source
Chloromethane	ND[b] - 27J[c]	3	LTHA[d]
Cadmium	ND - 26.3	2	EMEG[e]
Lead	ND - 38.8	15	Action Level[f]
Sodium	3,540 - 34,600	20,000	DWEL[g]

[a] - ppb = parts per billion
[b] - ND = Not Detected
[c] - J = estimated value
[d] - LTHA = Lifetime Health Advisory
[e] - EMEG = Environmental Medium Evaluation Guide
[f] - This contaminant has been selected for further evaluation because no health criteria are available for evaluating its presence in drinking water; lead is classified by the Environmental Protection Agency as a probable human carcinogen.
[g] - DWEL - Drinking Water Equivalent Level

Residential Property (7)

An investigation consisting of surface water and sediment sampling was conducted as part of the RI/FS to determine if on-base contaminants have migrated off base, impacting neighboring areas.

Surface Water

Three sampling points were selected in an off-base stream originating along the perimeter road at the northern portion of the base and flowing off-base to the north. One round of sampling was conducted. All samples were analyzed for VOCs, SVOs, inorganic chemicals, pesticides, and PCBs. No contaminants were detected above health comparison values.

Sediment

Three sediment samples were collected from a stream bed, which flows from the submarine base, (north of the Area A Landfill/Wetland) north to off-base residential areas. The samples were analyzed for VOCs, SVOs, pesticides, PCBs, and inorganic chemicals. Pesticides DDE and DDD were detected in the sediment of the stream bed at the sampling point at the submarine base perimeter. The second sampling point further off base (north) and downgradient of surface water flow, detected only trace amounts of DDE and no DDD. The third sampling point off base in the residential area downgradient from the submarine base did not detect any pesticides. The levels of pesticides detected were below health comparison values for children. Lead was detected in sediment nearest the residential area at background levels. No chemicals were detected at levels above health comparison values.

Thames River (7)

An investigation consisting of surface water and sediment sampling was conducted at points adjacent to on-base areas of contamination to determine if on-base contaminants have migrated off base, impacting the Thames River.

Surface Water

Four surface water sampling points were selected in the Thames River adjacent to on-base surface drainage outfalls. One surface water sample was collected from the Thames River downstream from the Goss Cove Landfill. One sample was collected from an up-stream area at the DRMO site. Two samples were collected from outfalls of the Area A Downstream Watercourses. All samples were analyzed for VOCs, SVOs, pesticides, PCBs, inorganic chemicals, and gross alpha and beta radiation.

Sediment

Two sediment samples were collected from the Thames River, adjacent to on-base areas of contamination. The samples were analyzed for VOCs, SVOs, pesticides, PCBs, and inorganic chemicals. No chemicals were detected at levels above health comparison values.

D. Quality Assurance and Quality Control

The quality assurance/quality control (QA/QC) report was presented in Appendix C, Remedial Investigation, Naval Submarine Base New London, Groton, Connecticut. Sample collections and analyses followed proposed protocols. The data provided to ATSDR for review consisted primarily of laboratory summaries rather than actual laboratory reports. ATSDR's conclusions concerning the sites on this installation are determined by the accuracy of the data summaries when actual laboratory data were not available. ATSDR has determined that the data evaluated for this public health assessment are valid. Qualified data are indicated by a corresponding footnote.

Prompted by public concern over elevated boron levels, the Navy investigation revealed laboratory error caused by interference of sulfur in boron analysis samples (11). Surface water and groundwater samples were reanalyzed using two different labs and split sampling techniques. Confirmatory sampling revealed that boron concentrations in surface water and groundwater were not elevated.

E. Physical and Other Hazards

Physical Hazards

Soil gas concentrations of volatile organic compounds including benzene, toluene, and xylenes were detected at the Goss Cove Landfill. However, samples were not analyzed for methane, a gas produced by decaying matter, common at landfills. Since the Nautilus Museum is built on top of the landfill, soil gases may accumulate in the utility tunnel and mechanical room of the museum building potentially creating a physical explosive hazard. Proposed Phase II sampling will include methane analysis.

Other Hazards

Military housing reported that lead paints and asbestos were used on the housing units, some within the family housing areas. Navy personnel are currently working to eliminate the problem.

PATHWAYS ANALYSES

To determine whether humans are exposed to contaminants migrating from a site, ATSDR evaluates the environmental and human components that lead to human exposure. This evaluation or pathways analysis consists of five elements: source of contamination, environmental medium in which contaminants may be present or may migrate, points of human exposure such as a private water well, a route of human exposure such as ingestion, inhalation or dermal contact, and a receptor population (people who are exposed or potentially exposed).

ATSDR identifies exposure pathways as completed, potential, or eliminated. For a completed pathway to exist, all of the five elements must be present to provide evidence that exposure to a contaminant has occurred in the past, is occurring or will occur in the future. A potential pathway indicates that at least one of the five elements is missing, but could exist. Potential pathways indicate that exposure to a contaminant could have occurred, could be occurring or could occur in the future. Pathways are eliminated when at least one of the five elements is missing and will never be present.

Past, present, and future exposure pathways that may present a public health hazard are discussed in this section.

A. Completed Exposure Pathways

Private Well Pathway

A past, current, and future completed exposure pathway exists for residents who drink contaminated water or use it for other household purposes. Exposures to lead, cadmium, and sodium occur through the route of ingestion. Exposures to VOCs occur mainly through the route of ingestion; however, skin absorption and inhalation of contaminants may also occur.

During the first sampling round, lead was detected above the action level of 15 ppb in OSW 10 (39 ppb). In the second sampling round, lead was detected above 15 ppb in OSW 23 (32 ppb), OSW 21 (18 ppb), and OSW 6 (estimated at 17 ppb).

Subsequent confirmatory sampling showed lead levels to be below the action level in all but two wells, OSW 10 and OSW 23. The Navy then performed detailed lead analysis in those two wells. Water was taken at the well head and at the tap prior to flushing, then again after a five minute flushing at both locations. Well OSW 10 showed lead levels to be below the detection limit of 3 ppb in all four samplings. Further analysis by another lab showed the actual lead concentration to be 1.7 ppb. Well OSW 23 showed lead levels ranging from < 3 ppb to 37 ppb. This residential well showed lead levels to

be lowest (< 3 ppb) after flushing the line for five minutes and highest prior to flushing.

There are 11 estimated residences exposed to lead concentrations above the action level (OSW 10 serves 10 residences) from wells OSW 10 and OSW 23. Because lead levels fluctuated above and below the action level of 15 ppb, exposure to lead at concentrations above the health comparison value is intermittent, but could potentially last for longer than one year.

Lead found in these private wells does not appear to be originating from contaminant sources on base because 1) flushing of the pipes causes a drastic decrease in the concentration of lead from 37 ppb to < 3 ppb, 2) the location of wells containing lead are geographically isolated, and 3) because of the hydrogeology which shows that the varying depths of the wells tap different aquifers: shallow aquifer or bedrock aquifer.

Lead is a common contaminant of household water in the New England area because lead plumbing and/or lead solder were used in older houses. The natural acidity of the groundwater may cause the lead in pipes to leach into the water. Because the lead detected in OSW 23 dropped to < 3 ppb after flushing indicates that lead is not originating from the groundwater, but from piping leading to the home.

The VOCs, methylene chloride and total xylenes were detected at trace levels, below health comparison values in one residential well (OSW 15) during the first round. Chloromethane, another VOC, was also detected in that residential well at an estimated value above health comparison values for drinking water. This well was resampled during the second round of sampling and again by CTDHS; no VOCs were detected. Chloromethane has not been detected in groundwater at any of the sites on the installation. Because VOCs were detected in only one sampling event and not in any other subsequent samplings, exposure to VOCs is considered to be short-term to intermediate in duration.

Cadmium was detected during the first sampling round in residential well OSW 6. However, cadmium was not detected in that residential well in the second and third sampling rounds or by CTDHS. Because cadmium was detected in only one sampling event and not in any other subsequent samplings, exposure to cadmium is considered to be short-term to intermediate in duration.

Sodium was detected at levels above the health comparison values in four of the 23 residential wells tested. Past, current, and future exposure to sodium is considered to be long-term in duration.

Sodium is a naturally occurring contaminant in wells located in coastal areas. Saltwater intrusion of well water is a result of varying depths at which saltwater and fresh water meet. Depending on the rate at which underground freshwater moves and several other factors, such as underground sediment characteristics, wells contaminated with sodium, if not pumped, will over time, flush out saltwater contamination. Human activities also contribute sodium to natural waters. Sodium chloride used as a deicing agent on roads may also enter water supplies as runoff from both roads and storage depots.

Even though a definitive source has not been established for lead and sodium contamination, residents who use private wells for drinking water and household purposes have been and are being exposed to lead and sodium in their well water.

Preliminary findings from the Installation Restoration Study indicate that the shallow aquifer (overburden water table) generally flows toward the Thames River to the west of the installation. However, the flow may vary slightly at each site. Hydraulic connection between the shallow aquifer (overburden water table) and the deep (bedrock) aquifer has not been confirmed. The bedrock aquifer may flow in a northwest/southeast orientation at some areas of the installation (a small section of Area A Landfill), but the complex fracture structure of granite makes flow direction difficult to predict for all areas of the submarine base. The overburden water table is contaminated at several sites on the installation.

Soil Pathway

The DRMO site is an open-air site partially covered by dirt and gravel with some asphalt covered areas. This site is used as a holding area for scrap materials before they are sold at auction. Materials are placed in rows on the dirt, gravel, and asphalt covered areas by hand, trucks, and large lifting equipment. This continuous activity as well as wind from the Thames River frequently cause dust particles to be stirred up. Surface soil is contaminated with PCBs, PAHs, pesticides, and lead. There are three full-time employees at the DRMO site. Human contact with contaminated soil represents a past, current, and future completed exposure pathway through the routes of inhalation, dermal absorption, and unintentional ingestion of surface soil dust for workers.

Once a month, public auctions are held at the DRMO site. Public attendance ranges from approximately five to 50 people, including children. An intermittent, short-term completed exposure pathway exists for people who contact surface soil contaminants through inhalation, dermal contact, and unintentional ingestion of surface soil dust.

Surface Water and Sediment Pathways

Area A is comprised of Area A Landfill, Area A Wetland and Area A Downstream Watercourses. The Area A Landfill received all of the waste material from the submarine base until it was closed and partially paved in 1973. Area A Wetland is a man-made wetland adjacent to the landfill. Leachate from the landfill and surface drainage from the Rubble Fill at Bunker A-86 flows into the Area A Wetland. Surface water drainage flows through streams originating from the wetland. Several divergent streams known as Area A Downstream Watercourses flow through the Over Bank Disposal Area and around the Torpedo Shops past the North Lake recreational area, and the golf course to the Thames River.

A fence has been installed between the Area A Wetland, and another fence is under construction around the Area A Landfill to prevent people from walking through the wetland area closest to the landfill.

Prior to the installation of the fence, children were known to play in the streams near the recreational areas that abut the wetland and landfill. Those children and any adults coming in contact with surface water and creek sediment have been, in the past, exposed to contaminants in those areas.

The selected contaminants in surface water and sediment samples collected at Area A Landfill and in the downstream water courses include the PAHs: benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, indeno (1,2,3-cd)pyrene, and chrysene; DDT and its breakdown products: DDD and DDE; lead, cadmium, and PCBs. Exposure routes of those chemical were through dermal absorption, inhalation of volatilized materials, and unintentional ingestion of surface water and sediment.

Area A Landfill runoff accumulates in the Area A Wetlands region before draining toward the river. Contaminants in the water or in sediment can be washed through the stream systems to the river. Sediment contaminants may also stay in a localized area and be covered by new deposits of sediment.

B. Potential Exposure Pathways

Soil Pathway

The August 1991, Installation Restoration Study describes soil on the submarine base as generally having moderate to moderately rapid permeability. Therefore, vertical migration of surface contaminants is possible.

Runoff is rapid to very rapid and the pH is strongly to moderately acidic. The erosion hazard is considered severe. Drainage generally occurs toward the Thames River, west of the submarine base, but extensive filling has altered the topography at various locations on the submarine base. Surface soil is contaminated at the CBU Drum Storage Area, the Rubble Fill at Bunker A-86, the Area A Landfill, and DRMO.

Subsurface soil is contaminated at the Torpedo Shops, the Goss Cove Landfill, Area A Landfill, the DRMO, the Spent Acid Storage and Disposal Area, and the Lower Subase.

No completed exposure pathway through human contact with contaminated soil at the CBU Drum Storage Area, the Rubble Fill at Bunker A-86, the Area A Landfill, the Torpedo Shops, the Goss Cove Landfill, and the Lower Subase has been documented.

Access to the sites is currently restricted. However, people performing remedial or removal work on the sites may be exposed to contaminants in the surface and subsurface soil. Those workers could be exposed to the contaminants through incidental ingestion of contaminated soil particles, through inhalation of entrained particles and volatiles, and through dermal contact with contaminated soil.

Potential exposure of workers can be prevented or mitigated through use of protective equipment and by maintaining the current site restriction policy. Additionally, if excavation of the Goss Cove Landfill occurs, during the proposed future use plan, construction workers and people visiting the Nautilus Museum could be exposed to contaminants.

Surface Water and Sediment Pathways

Three distinct areas present potential exposure pathways.

The installation is located on the Thames River within the Thames River Watershed. Approximately 1,400 square miles of eastern Connecticut are drained by the Thames River and its tributaries. Surface water from the submarine base drains west toward the river by way of streams and storm sewers. The on-base streams and lakes located in the north central portion of the installation discharge to the Thames River at the DRMO site, the Lower Subase, and the Goss Cove Landfill. People who come into contact with contaminated surface water and sediment may be exposed to contaminants through the routes of incidental ingestion, inhalation of volatile compounds and aerosols, and dermal absorption.

Migration of sediment contaminated with DDE from on base to off-base residential areas has occurred. The adjacent off-base residential area consists of lush, densely vegetated areas with

large trees, rhododendron, and ferns. However, actual ground cover is minimal. Residences in this area are downhill from the submarine base. A stream and underground spring feed a small pond between the submarine base perimeter and one of the homes. Sediment accumulated in the off-base residential pond from runoff associated with on-base road construction activities. Sediment from the pond were sampled and found to contain trace levels of DDE. The Navy dredged the pond in December 1991. In August 1992, the Navy resampled sediment from this pond for pesticides and PCBs. No contamination was detected. Children swim in the pond in the summer. The pond is also used as an emergency source of water in case of fire. That home uses spring water (surface expression of groundwater) as its drinking water source. If any contaminated sediment interact with drinking water, this resident's drinking water may potentially become contaminated.

Currently, concentrations of contaminants detected in the unfenced portion of the Area A Downstream Watercourses do not pose a health threat for children. However, because sediment movement may occur over time due to natural occurrences, and because children are known to play in the stream alongside the road to the North Lake recreational area, a potential exposure pathway exists for children who come in contact with surface water and sediment contaminants.

Air and Soil Gas Pathway

Prevailing winds are southwesterly in the summer and northwesterly in the winter with an average wind speed of 10 miles per hour. The area is subject to storms, some of hurricane intensity, that travel up the Atlantic coast.

Soil gas surveys have detected VOCs at several sites (see Environmental Contamination section). No air monitoring data have been collected to determine concentrations of contaminants that may be present in the air as volatilized chemicals or as entrained particles. No completed exposure pathway has been identified as a result of air contamination.

Potential exposure pathways exist for on-site workers entering visibly contaminated manholes. Confined areas may cause a build up of volatile organic compounds creating a potential for human exposure through inhalation and skin contact. Additionally, because the Nautilus Museum is built on top of an old landfill, methane gas and other soil gases if present could potentially build up in the confined areas of the museum. Exposure of museum workers and incidental exposure of museum visitors would represent the most likely receptor population.

Future land use at the Goss Cove Landfill may present another potential exposure pathway depending on its actual use and/or future construction plans.

Biota Pathways

Species of local flora and fauna have been identified and are listed in the Installation Restoration Study Naval Submarine Base-New London Groton, Connecticut, Appendix F. People are not allowed to hunt or fish on the submarine base. However, people do fish in the Thames River. Despite the advisory on shellfish harvesting in the Thames River, it is known to occur. Several commercial shellfish beds are located north of the submarine base on the Thames River. All commercial shellfish are depurated for 30 days in approved waters to cleanse the shellfish of bacteria. However, this treatment does not removed chemical contaminants that may have accumulated in the shellfish tissue. Even though no contaminants were detected in river water and contaminants detected in river sediment were below health comparison values, shellfish may accumulate and concentrate any contamination that was present over time prior to sampling. If contaminants are detected in the shellfish, people who ingest contaminated shellfish would be exposed.

C. Eliminated Exposure Pathways

Surface Water and Sediment Pathways

North Lake and Rock Lake water and sediment have been sampled extensively. No selected contaminants have been identified in the samples. Therefore, no exposures exist for people who swim and play in the lakes.

Biota Pathways

The Connecticut Department of Health Services has issued an area-wide advisory warning residents not to consume striped bass and bluefish caught in Long Island Sound due to PCB contamination. The advisory is not linked to contaminants found on base. Human exposure to contaminated fish is eliminated if people do not consume striped bass and bluefish caught in the Long Island Sound. No farming or livestock operations are reported to occur within a 1-mile radius of the submarine base.

Appendix F of the Installation Restoration Study provides an ecological risk assessment based on surface water, sediment, and soil data. Although no fish tissue was analyzed, tissue data from frogs and birds (species not usually consumed) were collected from Area A Wetlands. No pesticides were detected in samples. Consumption of biota may result in a completed exposure pathway.

Completed Exposure Pathways

PATHWAY NAME	CONTAMINANT	EXPOSURE PATHWAY ELEMENTS					TIME	COMMENTS
		SOURCE	ENVIRONMENTAL MEDIA	POINT OF EXPOSURE	ROUTE OF EXPOSURE	EXPOSED POPULATION		
Private Wells	Chloromethane, Lead, Cadmium, Sodium	Unknown	Groundwater	Resident's tap	Ingestion, Inhalation, Skin Absorption	Residents, including children and pregnant women	Past Present Future	No groundwater contamination plume has been defined at the submarine base.
Surface Soil	PCBs, PAHs, Lead	DRMO site	Surface Soil	Contaminated surface soil at the DRMO Site	Unintentional Ingestion, Inhalation, Skin Absorption	Workers at the DRMO site Children playing in the soil during monthly public auction Adults attending monthly public auction	Past Present Future	Three full time workers are present at the DRMO site. Monthly auction attracts 5 - 50 people for a few hours at a time.
Surface Water	Cadmium, Lead, Pesticides	Area A Landfill	Surface Water	Area A Downstream Watercourses	Unintentional Ingestion, Inhalation, and Skin Absorption	Children playing in the streams and nearby recreational areas Adults using the recreational areas	Past	Access to Area A Wetland is prevented by a 7-foot fence. Access to the Area A Downstream Watercourses is not prevented.
Sediment	Lead, PAHs, PCBs, Pesticides		Sediment					
Sediment	DDE	On-base Areas	Sediment	Off-base Residential Areas		Residents coming in contact with contaminated sediment	Past	Latest sampling results did not detect any contaminants

PUBLIC HEALTH IMPLICATIONS

Chemicals released into the environment do not always result in human exposure. Human exposure to a chemical contaminant can only occur if people come in contact with the contaminant either by ingestion (eating or drinking a substance containing the chemical), inhalation (breathing air containing the chemical), or by dermal absorption (skin contact of a substance containing the chemical).

To understand the type and severity of health effects that may be caused from exposure to a specific chemical contaminant, several factors related to the interaction of the chemical with the individual must be considered. Such factors include the amount or chemical dose to which a person is exposed, the frequency and duration of exposure, the route the chemical enters the body (ingestion, inhalation or dermal absorption), and the multiplicity (combination of chemicals) of exposure.

Health effects are also related to such characteristics as age, sex, nutritional and health status, life style, and family traits, all of which may influence how a specific chemical is absorbed (taken up by the body); metabolized (broken down by the body); and excreted (eliminated from the body).

To determine the possible health effects produced by specific chemicals, ATSDR considers physical and biological factors as well as a variety of information, such as scientific literature, research reports, and reports from other federal agencies.

A. Toxicologic Evaluation

The following sections evaluate the potential health effects from contaminant exposure at New London Submarine Base. The toxicological evaluation of each contaminant assesses probable health effects from exposure to the contaminant. Health effects are related to contaminant concentration exposure route, exposure frequency, and potential exposed population. Populations known or suspected of being sensitive to the contaminant are included. Information will be presented in relation to those pathways identified as completed exposure pathways.

Cadmium

Cadmium is an element that occurs naturally in the earth's surface. Pure cadmium is a soft, silver-white metal; however, cadmium is not usually found in the environment as a metal. It is usually found as a mineral combined with other elements such as oxygen (cadmium oxide), chlorine (cadmium chloride),

or sulfur (cadmium sulfate, cadmium sulfide). Those compounds are solids that may dissolve in water, but do not evaporate or break down in the environment. A common use of cadmium is to electroplate steel to improve its corrosion resistance. Cadmium is also used in nickel-cadmium batteries, nuclear control rods and metal coatings. It is used as the basis of color pigments in ceramic glazes (12).

Cadmium was detected during the first sampling round in one of the 14 well samples at a maximum concentration of 26 ppb. However, cadmium was not detected in the second and third sampling rounds or by CTDHS sampling of that residential well. It is unknown why the contamination in the well was not detected upon resampling. Cadmium was detected at trace levels in seven other samples; however, the laboratory blanks also contained trace levels of cadmium suggesting a quality problem in the blank sample. If cadmium was present in the well sample, exposure of residents would be intermittent, short-term exposure through ingestion of contaminated well water.

EPA has suggested the concentrations of cadmium in drinking water that would not be expected to cause adverse health effects are 20 ppb for children for 1 - 10 day (short-term) exposure and 5 ppb for children for long-term exposure (over one year). For adults, a concentration of 40 ppb for 1 - 10 day exposure and 5 ppb for long-term exposure has been suggested (13).

The maximum detected concentration of cadmium converted to an estimated daily exposure dose is 0.002 mg/kg/day for children using a one liter per day water ingestion rate and 0.001 mg/kg/day for adults using a two liters per day water ingestion rate. Short-term exposure to cadmium at 0.1 mg/kg/day (50 - 100 times higher than the estimated dose from the level detected in residential well water) can cause stomach irritation, nausea, and vomiting. The Lowest Observed Adverse Effect Level is 0.01 mg/kg/day. Long-term exposure to cadmium at (LOAEL) 0.01 mg/kg/day can cause detectable adverse kidney effects. The LOAEL dose is five to ten times higher than the estimated dose from residential well water (12).

Comparison of the estimated daily exposure dose to EPA's reference dose of 0.0005 mg/kg/day for chronic exposure (RfD, an estimate of the daily exposure to a contaminant that is unlikely to cause adverse health effects) and ATSDR's minimal risk level for chronic exposure of 0.0002 mg/kg/day, (MRL, an estimate of daily exposure to a chemical that is likely to be without adverse non-carcinogenic health effects) indicates

that adverse non-carcinogenic health effects may occur for both children and adults who ingest drinking water containing cadmium at a concentration of 26 ppb for longer than 1 year. However, cadmium was not detected in the residential drinking water well in the second and third sampling rounds, indicating that cadmium is not always present and therefore, long term exposure to 26 ppb cadmium in drinking water is unlikely. Based on that information, cadmium at a concentration of 26 ppb in the residential drinking water well does not pose a health hazard.

Chloromethane

Chloromethane, also called methyl chloride is a colorless gas at room temperature. It is a naturally occurring chemical that is prevalent in oceans and is produced by some plants and rotting wood, and when grass, wood, charcoal, and coal are burned. Chloromethane is commonly found in tap water that has been chlorinated (14). When present in soil or water, chloromethane evaporates quickly.

Chloromethane was detected in one residential well at an estimated concentration of 27 ppb. Other VOCs were detected at estimated trace levels below health comparison values. Resampling of this residential well did not detect chloromethane or any other VOCs. Resampling indicates that chloromethane is not always present in drinking water, so long term exposure to chloromethane in drinking water is unlikely. Therefore, exposure to chloromethane from the drinking water well represents an intermittent, short-term exposure through ingestion, inhalation, and dermal contact. Chloromethane has not been detected at any of the other residential wells sampled nor at any of the sites at the submarine base.

Inhalation of volatilized chloromethane from heated water used for showering represents an inhalation exposure to chloromethane. Short-term inhalation exposure to levels one thousand times greater (200,000 ppb) than the level detected in well water has resulted in impaired ability to perform simple tasks (14). Long-term inhalation exposure to 265,000 ppb chloromethane has caused central nervous system effects such as blurry vision, dizziness, staggering, and confusion (14). The health comparison value used for chloromethane in drinking water is EPA's Child Longer Term Health Advisory (CLTHA) value of 400 ppb. The CLTHA is 16 times higher than the levels detected in private drinking water.

ATSDR was unable to identify any studies in the scientific literature regarding absorption of chloromethane in people or animals that ingested food or water containing chloromethane.

The health effects resulting from short-term or long-term exposure of animals or people to water containing specific levels of chloromethane are unknown. However, EPA has established a Lifetime Health Advisory (LTHA) level of 3 ppb in drinking water. LTHAs represent contaminant concentrations that EPA deems protective of public health for people over a lifetime (70 years) at an ingestion rate of two liters of water per day. The LTHAs are not legally enforceable standards, but guidelines to assist health professional. The LTHA is used as a guideline that assumes a person will drink two liters of water containing 3 ppb chloromethane per day, everyday, for 70 years without any adverse human health effects. Little information is available on short-term or long-term oral exposure to chloromethane. Therefore, the resulting adverse human health effects cannot be predicted.

Lead

Lead is a naturally occurring bluish-gray metal found in small amounts of the earth's surface. It is used to produce some batteries, pipes, solder, and paints. The amount and wide-range use of lead has decreased over the last several years because of the harmful effects of lead in people and animals (15).

Lead was detected above the action level of 15 ppb in OSW 10 (39 ppb) during the first sampling round and in OSW 23 (32 ppb), OSW 21 (18 ppb), and OSW 6 (estimated at 17 ppb) in the second sampling round.

Subsequent confirmatory sampling showed lead levels to be below the action level in all but two wells, OSW 10 and OSW 23. Concern for lead levels in those private wells prompted the Navy to performed detailed lead analysis. Water was taken at the well head and at the tap prior to flushing, then again after a five minute flushing at both locations. Well OSW 10 showed lead levels to be below the detection limit of 3 ppb in all four samplings. Further analysis by another lab showed the actual lead concentration to be 1.7 ppb. Well OSW 23 showed lead levels ranging from < 3 ppb to 37 ppb. This residential well showed lead levels to be lowest (< 3 ppb) after flushing the line for five minutes and highest prior to flushing. Overall, lead levels in private wells were higher than the levels found in groundwater at the Area A Landfill on base.

Exposure of residents would be through ingestion. Lead is not easily absorbed through the skin, or inhaled from contaminated water. Exposure to lead is particularly dangerous to the unborn and children less than 6 years old. Exposure to lead can cause deficiencies in a child's mental development and

ability.

There are 11 residences with lead concentrations above the action level (OSW 10 serves 10 residences) from wells OSW 10 and OSW 23. Because lead levels fluctuated above and below the action level of 15 ppb, human exposure to lead at concentrations above the health comparison value is intermittent, but could potentially last for longer than one year.

Normal baseline blood lead levels in children range from 3 - 8 μg lead per deciliter of blood (μg/dL) (15). The actual blood lead measurement is dependent on several factors including the sampling procedure, the analysis method, the variability in the laboratory, and the age of the child (16).

Epidemiologic studies have identified some children with blood lead levels as low as 10 μg/dL without distinctive symptoms that show signs of decreased intelligence and impaired neurobehavioral development (16). Maternal and cord blood lead levels of 10 - 15 μg/dL appear to be associated with reduced gestational age and reduced weight at birth (15). Additionally, women of child bearing age who may have an accumulation of lead in their bone marrow, when pregnant, can pull the stored lead from the bone marrow into the blood and can increase the amount of lead reaching the unborn child.

Increases in blood lead resulting from the ingestion of 39 ppb lead in drinking water are estimated to be between 2 - 4 μg/dL in children and 1 - 2 μg/dL in adults. Therefore, a child with a baseline blood lead level of 8 μg/dL who drinks water containing 39 ppb lead may develop a blood lead level of 12 ppb. Because lead is a common element in the natural environment, any additional exposure to lead that increases blood lead concentrations in children to levels greater than 10 μg/dL may result in adverse health effects. For children whose blood lead levels are between 10 - 14 μg/dL, ATSDR/CDC recommends intervention in preventing and reducing exposure. Therefore, ATSDR considers the lead concentrations present in drinking water wells to pose a health hazard for fetuses and young children.

Contact with lead contaminated sediment at the Area A Downstream Watercourses represents a past complete exposure pathway. Lead was detected at a maximum concentration of 223,000 ppb in the sediment of the Area A Downstream Watercourses. Because small children often ingest sediment as a result of hand-to-mouth activities, children generally receive greater doses of lead than do adults. Based on the estimated exposure dose for adults at this site, lead does not pose a health hazard to adults. Exposure of children who

played in the area would have been short-term, intermittent exposure through incidental ingestion of sediment mainly through hand-to-mouth action. That short-term, intermittent exposure to the concentrations of lead present in sediment could have potentially cause an increase in the blood lead levels of children. Therefore, exposure to sediment at the Area A Downstream Watercourses posed a public health concern for young children. Since the area has been fenced, it no longer poses a health hazard to children.

Another complete exposure pathway exists for people who have contact with lead contaminated surface soil at the DRMO site. Lead has been detected at a maximum concentration of 204,000 ppb in surface soil. Exposure of full-time workers would be long-term, chronic exposure through inhalation and incidental ingestion of surface soil, and surface soil dust. Visitors to the DRMO site during the monthly-held auction would be exposed to lead contaminated surface soil and surface soil dust for a short, intermittent duration.

Adults are less sensitive to the effects of lead because adults do not absorb lead as readily as do children, and adults are not as sensitive to the toxic effects of lead as are developing children. It is estimated that 15% of the lead that adults are exposed to is absorbed. Children, however, absorb approximately 50% of the lead from exposure (17).

Health effects associated with increases in blood lead levels of 35 - 100 ug/dL blood above normal levels include decreased reaction time, decreased memory, weakness in fingers and ankles, anemia, and colic (17). Estimated increases in blood lead levels for adult full-time workers would be approximately 2 ug/dL. Therefore, exposure of DRMO full-time workers to lead at the concentrations detected is not a public health concern.

Estimated increases in blood lead levels in children and adults from intermittent exposures to lead at the levels detected in DRMO surface soil are less than 1 μg/dL blood. No adverse health effects would be expected as a result of short-term, intermittent exposures of visitors to the levels of lead detected in surface soil at the DRMO site.

PCB 1260 - (Polychlorinated Biphenyls)

Polychlorinated Biphenyls represent a class of complex chemical mixtures that are formulated when biphenyls are chlorinated. The composition of the end product is determined by the degree of chlorination. The name PCB 1260 refers to a specific PCB chemical. The individual PCB mixtures are

identified by four digits: the first two digits of most PCB formulations indicate that the preparation is a mixture; the second two digits denote the approximate chlorine content by weight percent. For example, PCB 1260 is a mixture with a 60% average chlorine content.

PCB compounds are very inert, thermally and chemically stable compounds with dielectric properties. They have been used in as heat transfer liquids in transformers, hydraulic fluids, and lubricants. PCBs have also been used in plasticizers, surface coatings, inks, adhesives, pesticide extenders, and for microencapsulation of dyes for carbonless duplicating paper (18).

PCB 1260 has been detected at a maximum estimated concentration of 3,100 ppb in surface soil at the DRMO site. Exposure of full-time workers would be long-term, chronic exposure through dermal absorption, inhalation, and incidental ingestion of surface soil dust.

Adults attending the monthly auction would be exposed to contaminants for a short duration. Children, who may also attend the monthly auction, may have a greater exposure dose if they are allowed to play in the DRMO area. Exposure of visiting adults and children would be through dermal absorption, inhalation, and incidental ingestion of surface soil dust.

Studies have shown that concentrations 1,300 times (3,436,000 ppb) greater than those present in surface soil at the DRMO site have not resulted in elevated blood levels of PCBs (19). Short-term exposure to PCBs at higher levels (35,000 ppb) than detected at the DRMO site has resulted in skin irritation. Skin irritation is the only known acute adverse health effect from exposure to PCBs (20).

EPA has classified PCBs as probable human carcinogens based on evidence from animal studies that show PCBs cause cancer in some animals. Long-term exposure to PCBs has been associated with carcinogenic health effects. When evaluated using the cancer risk values, the maximum PCB concentration detected is not expected to cause any increased cases of cancer in full-time workers or in adults and children who visit the base monthly. Based on that information, PCBs at the levels detected at the DRMO site do not pose a public health hazard.

A complete exposure pathway exists for children playing in sediment in the Area A Downstream Watercourses. PCB 1260 was detected in sediment samples from the Area A Downstream Watercourses at an estimated maximum concentration of 280 ppb.

Exposure of children playing in those areas would be short-term, intermittent exposure through dermal contact and incidental ingestion of sediment mainly through hand-to-mouth action. Those short-term, intermittent exposures to the concentrations of PCB 1260 present in sediment are not expected to cause adverse health effects.

Polycyclic Aromatic Hydrocarbons (PAHs)

PAHs are a group of chemicals that are formed during the incomplete burning of coal, oil and gas, garbage or other organic substances. PAHs can occur naturally or be man-made. Only a few of the more than one hundred PAH compounds have known uses. However, PAHs are found throughout the environment. They are present in tobacco smoke, smoke from wood, creosote-treated wood products, cereals, grains, flour, and meat. Cooking meat or other foods at high temperatures such as during grilling, increases the amount of PAHs in the food (21).

PAHs are divided into two groups: carcinogenic PAHs and non-carcinogenic PAHs. Carcinogenic PAHs include benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, indeno (1,2,3-cd)pyrene, and chrysene. Non-carcinogenic PAHs include naphthalene, acenaphthylene, fluorocene, anthracene, pyrene, and others.

PAHs can enter the body quickly and easily by all routes of exposure: ingestion, inhalation, and dermal absorption. PAHs tend to be stored in fatty tissue and organs such as kidneys, the liver and spleen. Results from animal studies show that PAHs are not stored in the body for a long time. Instead, PAHs that enter the body are eliminated within a few days, primarily in the feces and urine (21).

Although there is little information that describes the effects of PAHs on humans, inhalation and dermal contact exposure have been associated with cancer in humans (21).

PAHs have been detected in the sediment of the Area A Downstream Watercourses at the following estimated concentrations: 850 ppb benzo(a)anthracene, 640 ppb benzo(a)pyrene, 750 ppb benzo(b)fluoranthene, 320 ppb benzo(k)fluoranthene, 1,200 ppb indeno (1,2,3-cd)pyrene, 1,200 ppb chrysene. Exposure of children playing in the sediment of the Area A Downstream Watercourses would be short-term, intermittent exposure through dermal absorption, inhalation, and incidental ingestion of sediment.

When evaluated using the cancer risk values, the maximum concentration of PAHs detected would not be expected to cause

any increased cases of cancer in children playing in the sediment from the Area A Downstream Watercourses. Based on that information, PAHs at the levels detected in the Area A Downstream Watercourses do not pose a public health hazard.

A complete exposure pathway exists for full-time workers and visitors to the DRMO site. PAHs have been detected at the following estimated concentrations: 570 ppb benzo(a)anthracene, 440 ppb benzo(b)fluoranthene, 310 ppb benzo(k)fluoranthene, 560 ppb chrysene. Exposure of full-time workers at the DRMO site would be long-term, chronic exposure through dermal absorption, inhalation, and incidental ingestion of surface soil dust.

Adults attending the monthly auction would be exposed to contaminants for a short duration. Children, who may also attend the monthly auction, may have a greater exposure dose if they are allowed to play in the DRMO area. Exposure of adults and children would be through dermal absorption, inhalation, and incidental ingestion of surface soil dust.

When estimated long-term exposure doses for full-time workers (based on an exposure duration of 40 hours per week for 20 years) are evaluated using the cancer risk values, the maximum concentrations of PAHs detected are not expected to cause any increased cases of cancer in full-time workers. When estimated short-term exposure doses for visiting adults and children (based on exposure duration of two hours per month for five years) are evaluated using the cancer risk values, the maximum concentrations of PAHs detected are not expected to cause any increased cases of cancer in those adults or children. Based on that information, PAHs at the levels detected at the DRMO site do not pose a public health hazard.

Pesticides DDT, DDD, DDE

DDT - p,p'-dichlorodiphenyltrichloroethane

From 1946 to 1972, DDT was one of the most widely used agricultural insecticides in the world. As of January 1, 1973, all uses of DDT were banned from the United States and Canada, but it is still used in Mexico and many tropical countries. DDT does not readily dissolve in water, instead it adsorbs to soil, and organic matter (22). DDE is the major degradation product in aerobic soil (in the presence of oxygen). Under anaerobic conditions (in the absence of oxygen), DDD is the major metabolite (22).

In people, DDT is metabolized by two pathways. A small percent is converted to DDE, which does not undergo further

biotransformation, but is stored in the fat (adipose) tissues. The major detoxification pathway is via dechlorination to DDD, which is readily degraded to a water soluble metabolite, DDA and is rapidly excreted into the urine (23).

DDT has been detected in sediment along the Area A Downstream Watercourses at an estimated concentration of 240,000 ppb. Because the area is now fenced, past exposure of children who played in the Area A Downstream Watercourses to DDT would have been through ingestion and dermal contact with contaminated sediment for an intermediate duration (14 - 365 days). Dermal exposure to DDT has not been associated with any illness or irritation (24).

EPA has classified DDT as a probable human carcinogen based on evidence that it causes cancer in animals and insufficient evidence that it causes cancer in humans.

Symptoms of DDT poisoning in people are abnormally increased sensitivity of the mouth and lower part of the face, which is followed by a burning or prickling sensation, and tremor of the extremities, confusion, malaise, headache, fatigue and delayed vomiting (23). It is reported that human poisoning has only occurred through ingestion of DDT. In general, symptoms occur as soon as 30 minutes after a large dose (unspecified concentration) or as late as 6 hours after a small dose (unspecified concentration) (24). In acute, short-term exposure, recovery is usually complete or well advanced in 24 hours. In severe cases, complete recovery may take a week or more (25).

The estimated exposure dose for children exposed to DDT contaminated sediment is 0.007 mg/kg/day. The Lowest Observed Adverse Effect Level (LOAEL) for intermediate human exposure was 0.07 mg/kg/day (10 times higher than the estimated dose for children) (26). The No Observed Adverse Effect Level (NOAEL) for DDT has not been established. A single oral dose of 10 mg/kg body weight produced illness in some persons, but no vomiting or convulsions occurred. When the dose was 16 mg/kg body weight or greater, convulsions occurred frequently. Generally, smaller doses did not produce illness although a dose of 6 mg/kg produced perspiration, headache and nausea in one man. Doses as high as 20 mg/kg might be taken without effect; however, doses that high have led to immediate vomiting so that the amount actually retained could not accurately be determined (23).

Since the difference in the estimated exposure dose for children and the LOAEL is only 10 fold, estimates for uncertainty (uncertainty factors) would make the doses equivalent, indicating a potential for adverse health effects.

Based on that information, past exposure to DDT posed a public health concern for children exposed to DDT contaminated sediment in the Area A Downstream Watercourses. When estimated intermediate doses for children are evaluated using the cancer risk values, the maximum concentrations of DDT detected would not be expected to cause any increase cases of cancer in those exposed children. No long-term adverse health effects (carcinogenic or non-carcinogenic) are expected to occur as a result of exposure to DDT contaminated sediment in the Area A Wetland and Area A Downstream Watercourses.

DDD - p,p'-dichlorodiphenyldichloroethane

In animals, DDD is less toxic than DDT. DDD poisonings also have a slower onset and a longer duration in contrast to DDT poisonings. Lethargy is more prominent in DDD poisonings, and convulsions are less frequent (27). The main action of DDD is on the liver, where it stimulates the hepatic microsomal oxygenation of drugs and corticosteriods (28).

DDD has been detected along the Area A Downstream Watercourses sediment at an estimated concentration of 1,700,000 ppb. Past exposure of children playing in sediment in the Area A Downstream Watercourses would have been intermediate, intermittent exposure to DDD through dermal contact, and ingestion of contaminated sediment.

A purified form of DDD used at high levels (usually 8 - 10 grams or 8,000,000 - 10,000,000 mg) therapeutically in humans to treat adrenal cortical carcinomas and Cushing's syndrome, produce some toxic effects, but were completely reversed when DDD exposure ended (29).

The estimated exposure dose for children is 0.005 mg/kg/day. Doses of 110 - 114 mg/kg/day did not produce any detectable injury to the liver, kidney or bone marrow, doses as high as 7500 mg/kg/day may also be tolerated without discernable side effects (30). No LOAEL or NOAEL has been determined for DDD exposure in humans (26).

When the estimated intermediate dose for children is evaluated using the cancer risk values, the maximum concentrations of DDD detected would not be expected to cause any increase cases of cancer in those exposed children. Exposure to DDD through ingestion of sediment is not expected to present any short-term or long-term adverse health effects. Therefore, exposure to DDD contaminated sediment in the Area A Downstream Watercourses does not pose a public health hazard.

DDE - p,p'-dichlorodiphenyldichloroethylene

DDE does not undergo any biotransformation in the human body, but is stored for an indefinite period in the fat (adipose) tissue (31). Other than several metabolic studies, there are no reports of acute human exposure to DDE.

DDE has been detected along the Area A Wetland and in the Area A Downstream Watercourses sediment at an estimated concentration of 28 ppb. Past exposure of children playing in sediment in the Area A Downstream Watercourses would have been intermediate, intermittent exposure to DDE through dermal contact, and ingestion of contaminated sediment.

The estimated exposure dose for children is 0.0003 mg/kg/day. Oral administration of 5 mg/kg DDE to one human volunteer for 92 days (intermediate exposure) produced no observed adverse health effects (32). When the estimated intermediate dose for children is evaluated using the cancer risk values, the maximum concentrations of DDE detected would not be expected to cause any increase cases of cancer in those exposed children. Based on the low estimated dose, past exposure to DDE through ingestion of sediment is not expected to cause any short-term or long-term adverse health effects.

Sodium

Sodium is a normal constituent of natural waters. It is derived geologically from the leaching of surface and underground deposits of salts such as sodium chloride, from the incorporation of evaporated ocean spray particles into rainfall, and from the intrusion of seawater into freshwater aquifers. Salt spray from the sea is often the largest contributor of sodium within 50 - 100 miles of seacoasts (34). Human activities also contribute sodium to natural waters. The sodium chloride used as a deicing agent on roads enters water supplies in runoff from both roads and storage depots.

Sodium has been detected in private residential wells at a maximum concentration of 34,600 ppb. Residents would be exposed by ingesting drinking water containing sodium.

A survey of 2,100 water supplies covering 50% of the population of the United States was taken between 1963 - 1966 by the CDC's Heart Disease Control Program, Division of Chronic Diseases of the U.S. Public Health Service. Concentrations of 20,000 - 49,990 ppb sodium in drinking water account for 19% of the water samples collected (35).

Sodium-restricted diets are required in the treatment of congestive cardiac failure, renal disease, cirrhosis of the liver, and toxemia of pregnancy (35)

A maximum level of sodium in drinking water of 20,000 ppb was suggested by the American Heart Association in 1957 (35). EPA's Drinking Water Equivalent Level is 20,000 ppb. Drinking Water Equivalent Levels are lifetime exposure levels specific for drinking water at which adverse health effects are not expected to occur.

The level of sodium in drinking water may influence blood pressure and may be associated with hypertension (36). Twenty percent of the adult U.S. population has hypertension (Intersociety Commission for Heart Disease Resources, 1971). In the treatment of essential hypertension, restriction of dietary sodium leads to a drop in blood pressure (35).

Sodium is added to many foods during processing. Although sodium is required for normal body functions, the average American's intake of sodium exceeds the body's need by 10 times or more.

Based on a representative survey of 15,778 persons aged 12 - 74 years, the National Center for Health Statistics estimated that 2.8% or approximately 6.2 million Americans are on low-sodium diets prescribed for reasons of illness. The low-sodium diets most commonly prescribed limit the patient to either 1.0 or 0.5 grams (g) of sodium per day. Where water supplies contain more than 20,000 ppb sodium, dietary sodium restriction to less than 1.0 g/day is difficult to achieve and maintain. Therefore, the presence of sodium at levels above 20,000 ppb represents a public health concern for persons on salt-restricted diets.

B. Health Outcome Data Evaluation

ATSDR has identified a completed exposure pathway for off-base residents who drink contaminated well water. The source of the contamination has not yet been determined. Another completed exposure pathway exists for people who had contact with sediment and surface water in the Area A Downstream Watercourses.

In evaluating the potential correlation between cancers observed in a population and the cause of those cancers, two factors must be addressed. First, there must be a causative chemical agent, or environmental chemical contamination at concentrations that would cause an increased risk of cancer. Secondly, a completed exposure pathway must exist for people to come in contact with that contamination.

After evaluation of these completed exposure pathways, no increase in cancer rates is expected because of the low

estimated exposure dose. However, ATSDR has evaluated the Connecticut Tumor Registry Data Base information to determine if an elevated cancer incidence exists within the submarine base area towns of Groton and Ledyard as compared the state of Connecticut in order to address community concerns about local cancer rates. The Connecticut Department of Health Services maintains one of the nation's most extensive Tumor Registry Data Bases. Information has been collected since 1935.

Cancer rates (Appendix B) are slightly elevated for the male "All Types" category in Groton and Ledyard as compared to the State of Connecticut. All types refers to the combined types of cancers. Many factors affect cancer rates, such as dietary influences, hereditary predisposition, and environmental exposure. In general, cancer represents a group of diseases with a variety of causes. Since it has not been determined that any singular cause of all types of cancer exists, the "All Types" category cannot be accurately evaluated.

For the other cancers such as lung and rectal, ATSDR does not have any information on the specific human risk factors such as smoking or diet. Those factors are important when evaluating cancer rates.

Only a few types of cancers have been linked with chemical specific environmental contamination. Among these, is the association of vinyl chloride with liver cancer and the association of benzene with certain types of leukemia.

At this time, it is not possible to link an elevation of cancer rates to an environmental source of contamination such as the New London Submarine Base.

C. Community Concerns Evaluation

In meetings with officials from the Town of Ledyard and City of Groton, a local physician, and an advisor to the City of Groton, the following concerns were expressed.

- **possible elevated cancer rates for residents living north of the submarine base, along Military Highway;**

  Military Highway, running north of the submarine base, is in the town of Ledyard. Cancer data were provided to ATSDR from the State of Connecticut Department of Health Services. Cancer Incidence data from the Ledyard was compared to that of Connecticut. However, ATSDR is not able to narrow the information down to the specific population along Military Highway. At this time, it is not possible to link any elevation of cancer rates to an environmental source of contamination such as the New

London Submarine Base.

- **possible elevated cancer rates for the city of Groton;**

The incidence of cancer for the Groton area was evaluated. Lung cancer rates were slightly elevated for Groton in the period from 1979-1981, but not in the later time period. Many factors such as smoking and occupation add to a persons risk for lung cancer. At this time, it is not possible to link elevated cancer rates to an environmental source of contamination such as the New London Submarine Base.

- **health effects from consumption of fish and other aquatic organisms from the Thames River and Long Island Sound;**

Four surface water and two sediment samples from various locations on the Thames River were analyzed. As yet, the Navy has not sampled any edible biota. However, Connecticut Department of Environmental Protection routinely sample edible biota in the Thames River. The Connecticut Department of Environmental Protection in conjunction with the Connecticut Department of Health Services has issued health advisories for shellfish caught in the Thames River due to high fecal coliform counts, but no health advisories exist for fish caught on the Thames River. Other health advisories exist for fish and shellfish caught in Long Island Sound due to PCB contamination of the region.

- **possible contamination of private and municipal wells located near the submarine base;**

The New London Submarine Base has sampled 23 private wells within 1 mile of the submarine base. Contamination has been found (see Environmental Contamination section of this public health assessment) in private wells near the submarine base. Contaminants detected include cadmium, chloromethane, lead, and sodium. The source of contamination has not been identified. The municipal wells and reservoirs are routinely sampled according to the Safe Drinking Water Act of 1974, as amended in 1986. To date, no contamination has been detected in those municipal wells or reservoirs.

- **use of North Lake for swimming;**

After additional sampling of the North Lake area, mercury contamination was found in only one of the 13 samples taken from the North Lake recreational area. Because only one isolated case contained a low level of mercury, ATSDR has determined that the North Lake swimming area does not

represent a health hazard.

- **contamination of Thames River from fly ash contaminants dumped in Goss Cove Landfill;**

  One surface water and one sediment sample from the Thames River have been analyzed from the Goss Cove Landfill. No contaminants were detected above health comparison values. However, because of proposed future changes in land use at the Goss Cove Landfill area, ATSDR has recommended additional sampling of sediment and surface water in those Goss Cove areas where people could come in contact with potentially contaminated environmental media.

- **the spread of contaminated river sediment dredged material and possible adverse environmental health effects related to contact with dredged material;**

  ATSDR recommends the Navy address the deposition of dredged river sediment, its location, its level of contamination, and the potential for human contact with the dredged material.

- **the lack of information on the submarine base's contribution of pollution into the Thames River;**

  ATSDR has recommended in this public health assessment that further characterization of the river near the submarine base be incorporated in future sampling plans in order to assess the potential for human exposure.

- **the quality and completeness of the investigations planned for the submarine base as expressed in the 1989 Plan of Action [2];**

  During the public health assessment process, ATSDR reviewed the information contained in the 1989 Plan of Action as well as the sampling results from the Phase I Remedial Investigation. In this public health assessment ATSDR identified specific data gaps, and made recommendations for further sampling in order to better characterize the extent of contamination and the potential for human exposure.

During informal one-on-one meetings with residents, the following concerns were expressed:

- **A couple living across Highway 12 from the submarine base mentioned that prior to the building of their home, the Navy/Army Corps of Engineers deposited Thames River dredged sediment on the property that has become the site of their home. The couple is concerned that contaminated dredged material has caused their water supply to be contaminated.**

The couple currently uses bottled water for drinking water purposes.

Two samples were taken from that residential well. Sodium was the only contaminant detected above health comparison values. Sources of the sodium have not yet been identified; however, it is likely that salt water has intruded the well.

- **Officer's wives, who regularly participate in recreational activities with their children at the North Lake Swimming Area, are concerned that there has not been enough sampling performed on beach sand, sediment, or surface water at North Lake to determine if the Lake is safe. They stated that only one sampling event has occurred in 1988, which would not represent accurate or comprehensive information on the condition of the North Lake Area.**

  Because of the community concerns and the one sample that showed mercury contamination from the Navy's data obtained in September 1990, the New London Submarine Base conducted further sampling to better characterize contamination in the North Lake swimming area. Beach sand, sediment and surface soil were analyzed. The additional sampling results did not detect any contamination in the North Lake swimming area. During summer months, routine sampling of surface water in the North Lake is analyzed for contamination. To date, no further contamination has been found.

  North Lake is filled each year with city water before the swimming season and is subsequently drained to a low-water level at the end of the season. City water is chlorinated on base before North Lake is filled.

- **Residents were also concerned that the Navy has not informed the public of the potential risks to those who swim in North Lake. Residents felt that until comprehensive sampling is performed North Lake Area should be closed.**

  Additional sampling results did not detect any contamination in the North Lake swimming area; therefore, there is no threat to public health.

- **Community members are concerned about adverse health effects from incidental ingestion of contaminants and skin exposure to contaminants at the North Lake swimming area. Children and pregnant women would be at greater risk of such exposures.**

  See above

- **A retired civilian employee is concerned about his past exposure to paints, thinners, fuels, and other fluids in the work place during his 20 years of Naval service.**

  ATSDR has referred this concern to OSHA for further investigation:
  Occupational Safety and Health Administration (OSHA)
  Regional Office
  133 Portland Street
  Boston, MA 02114
  617-565-7164

  The Navy recommends that past employees who are concerned about their exposure contact the servicing industrial hygiene department at Naval Hospital, New London. Industrial Hygiene surveys done in the past, along with past air monitoring results should give the employees some indication of their past exposure to chemical stressors at their old work place on the base.

- **Community members are concerned about the potential toxic concentrations of contaminants in fish, shellfish, and marine organisms, and their impact on the human food chain. They stated that sampling of aquatic species has not been adequate to define the impact on the human food chain.**

  The Connecticut Department of Environmental Protection routinely samples surface water and edible biota from the Thames River. The Connecticut Department of Environmental Protection in conjunction with the Connecticut Department of Health Services has issued health advisories for the shellfish caught in the Thames River due to high fecal coliform bacteria count from sewage discharge, but no health advisories exist for fish caught on the Thames River. Other health advisories exist for fish and shellfish caught in Long Island Sound due to PCB contamination of the region.

- **Concerns were expressed about the lack of comprehensive sampling data of Thames River sediment and surface water that may contain toxic hot spots.**

  Four surface water and two sediment samples from various locations on the Thames River were analyzed. No contaminants were detected in the Thames River.

A public meeting, conducted by the Navy personnel, was held on July 26, 1990. The following additional concerns were expressed during the meeting:

- **Where does the submarine base now dispose of its toxic wastes?**

  Currently toxic waste is taken off base to a regulated hazardous waste disposal area (37).

- **Does the submarine base have radioactive wastes?**

  Solid radioactive waste materials associated with maintenance and operation of naval nuclear-powered warships are packaged in federally approved containers and taken off base to U.S. Nuclear Regulatory Commission (NRC) licensed disposal areas (37).

- **Does surface water drain into the Groton reservoir?**

  No, all surface water and runoff from the New London Submarine Base drain into culverts that empty into the Thames River (3).

- **Are there any controls for leachate from the submarine base to prevent contaminating the Thames River?**

  Leachate drainage into the Thames River is regulated by the Clean Water Act, which controls the direct discharge of pollutants to surface waters through the National Pollutant Discharge Elimination System (NPDES) program. NPDES requires permits for direct discharges to surface water. The permits contain limits based upon either effluent (discharge) standards or, if they are more stringent, ambient (overall water quality) standards. NPDES permits are issued, monitored, and enforced by EPA, or by a state agency authorized by EPA to administer an equivalent state program (36). New London Submarine Base has applied for and received several NPDES permits.

- **When did the submarine base start receiving water from the city of Groton?**

  The submarine base has received water from the city of Groton since the 1940s.

ATSDR held a public meeting on August 18, 1992 to answer residents' questions about the health hazards associated with elevated boron levels found in their drinking water wells. The following question concerns residents the most.

More information on boron in drinking water can be found in ATSDR's health consultation, August 1992. A copy of the health consultation is available at local document repositories or a copy can be requested from ATSDR.

Prompted by concern over elevated boron levels, the Navy investigation revealed laboratory error caused by interference of sulfur in boron analysis samples (11).

Surface water and groundwater samples were reanalyzed using two different labs and split sampling techniques. All confirmatory sampling revealed that boron concentrations in surface water and groundwater were not elevated.

- **What are the health effects associated with the level of boron in our drinking water wells? Is our water safe to drink?**

  Because of boron's wide use and the estimated amount of boron normally ingested by people, the low levels of boron detected in private wells are not expected to substantially increase the relative body burden of boron. The amount of boron detected in private well water is not expected to cause any adverse health effects for children or adults. Therefore, water from these private wells is safe to drink.

CONCLUSIONS

1. ATSDR considers confined areas in the Nautilus Museum to be an indeterminate public health hazard because air sampling data are not available to determine if an explosive hazard exists. Soil gas concentrations of volatile organic compounds including benzene, toluene, and xylenes were detected at the Goss Cove Landfill. However, samples were not analyzed for methane, a gas produced by decaying matter, common at landfills. Since the Nautilus Museum is built on top of the landfill, soil gases may accumulate in the utility tunnel and mechanical room of the museum building. Proposed Phase II sampling will include methane analysis.

2. A past completed exposure pathway has been identified for children who came in contact with contaminants through unintentional ingestion, inhalation, and dermal absorption of contaminated sediment and surface water in Area A. In the past, Area A Downstream Watercourses posed a health hazard to children who came in contact with lead and DDT contaminated sediment. This area is no longer a public health hazard because the Navy has installed a fence, preventing children from contacting contaminated sediment.

3. ATSDR has determined that the other sites under the Remedial Investigation do not pose a public health hazard because of either the lack of exposure of people to contaminants, or the estimated low exposure dose to which people would be exposed.

4. Currently, concentrations of contaminants detected in the unfenced portion of the Area A Downstream Watercourses do not pose a health hazard for children. However, because sediment movement may occur over time due to natural occurrences, and because children are known to play in the stream alongside the road to the North Lake recreational area, a potential exposure pathway exists for children who come in contact with surface water and sediment contaminants.

5. Lead levels detected in one off-base residential well represents a public health hazard to young children and the fetuses of pregnant women who drink lead contaminated water.

6. Sodium levels detected in five off-base private residential wells are of public health concern to persons on salt restricted diets.

7. During residential well sampling, one of the 23 sampled wells showed VOC contamination. Another residential well showed cadmium contamination. Upon resampling both of the wells, no contaminants were detected. Levels of contaminants detected and the inability to find contamination during subsequent samplings of the wells indicate that exposures would be of short duration. Exposure to the concentrations of VOCs and cadmium detected in residential wells is not a public health hazard.

8. DDE contaminated sediment have migrated off base into a residential area by way of a seasonal stream. Current concentrations of DDE present in sediment do not represent a public health hazard to children or adults who may come in contact with the sediment; however, since the residents obtain their drinking water from a natural spring (surface expression of groundwater), although unlikely, the potential exists for residents' drinking water to become contaminated.

9. If the Goss Cove Landfill is proposed for use as a recreational area in the future, soil sampling must be reevaluated to determine potential exposure of construction workers and visitors who may be exposed to contaminated soil in the Goss Cove Landfill area.

10. Residents are concerned that people are possibly being exposed to contaminants in Thames River dredged material, which may have been deposited on their residential property.

11. ATSDR has evaluated the Connecticut Tumor Registry data (health outcome data) to determine if excess cancer rates exist in the towns of Groton and Ledyard and if those excess cancers could be associated to contaminants at or migrating from the New London Submarine Base. At this time, it is not possible to associate elevated cancer rates to exposures to environmental contaminants at or migrating from the New London Submarine Base.

RECOMMENDATIONS

During the Public Comment Release Period for the New London Submarine Base Public Health Assessment, the following recommendations were carried out.

1. Data provided to ATSDR did not contain analysis of soil gas samples for methane. Include methane in further soil gas analyses. Additionally, perform air monitoring in the confined spaces within the museum at locations that are frequented by workers.

   (Monitoring of confined spaces in the museum is included in the Phase II work plan. The proposed work plan includes monitoring in a mechanical room/workshop at the lowest level in the museum. Routine monitoring for explosive gases and oxygen content is done prior to confined space entry at the present time per OSHA requirements.)

2. Restrict access to the Area A Downstream Watercourses.

   (The Navy has installed a fence between the Area A Wetland, and another fence is under construction around the Area A Landfill to prevent people from walking through the wetland area closest to the landfill.)

3. Evaluate groundwater contamination near the off-base private residential drinking water wells to characterize the source and extent of contamination.

   (The Navy as well as the Connecticut Department of Environmental Protection in conjunction with the Connecticut Department of Health Services resampled those wells that were identified by ATSDR as having "contamination". All samples that were analyzed for VOCs showed no detectable VOCs. In one residential well that was reanalyzed for cadmium, no cadmium was detected.

   The Phase II Remedial Investigation, scheduled for initiation in the summer of 1993, will further evaluate hydrogeology and groundwater flow direction near the off-base wells.)

4. Advise those residents who are drinking lead contaminated well water (from the two off-base private residential wells that showed lead levels to be 32 ppb and 39 ppb) that children and pregnant women should not drink the well water because of the estimated increase in blood lead levels.

   (On October 23, 1992, the Navy send notifications to those residents with whose wells had elevated lead levels then, followed up with additional sampling on January 15, 1993. Results of this latest sampling showed no detectable lead in

the community well north of the base where lead was previously detected at 39 ppb.

Results for the residential well where lead was previously detected at 32 ppb showed a lead level of 37 ppb in a first draw sample closest to the well. Upon flushing, readings at that point and at a source farthest from the well showed levels of 11 ppb and < 3 ppb. The Navy has notified the residents of the results and has provided them with information on the lead in drinking water, its sources, and how individuals can protect themselves).

5. Residents using well OSW 23 should allow their water to run for a few minutes prior to collecting it to allow any contaminants coming from piping to be flushed out.

   (The Navy has notified the residents of the sampling results and has provided them with information on the lead in drinking water, its sources, and how individuals can protect themselves).

6. Advise residents on salt-restricted diets of elevated sodium levels detected in four off-base private residential wells.

   (On October 23, 1992, the Navy send notification letters to those residents whose wells had elevated sodium levels.)

7. Determine the hydrogeological connection between surficial water flow of the seasonal creek where DDE was detected and the resident's drinking water spring in order to determine the likelihood of continuous migration of contaminants.

   (The Navy plans to develop a program to determine if there is a hydrogeological connection between the wetland/stream and the spring used for drinking water on Sleepy Hollow Pentway.)

8. Perform further environmental sampling of sediment and surface water in Goss Cove to determine if potential exposure pathways exist for children who play in sediment and surface water at Goss Cove.

   (Sediment sampling of Goss Cove is proposed in the Phase II Remedial Investigation Work Plan.)

9. Determine the locations of any off base deposition of Thames River dredged material to evaluate the likelihood that people may be exposed to potential contaminants in the dredged material.

(The dredge material that residents referred to was taken from the Thames River in the 1950s by Navy contract with the Army Corps of Engineers. ATSDR has contacted the Army Corps of Engineers about the location of deposited Thames River dredge material, but has not yet received any information. ATSDR will incorporate relevant information in the future updated public health assessment.)

10. Perform air monitoring within the manholes to determine if levels of VOCs pose a physical explosive hazard to workers or a health hazard based on inhalation and/or dermal absorption of potential contaminants. Workers who enter manholes should wear protective clothing.

(As required by NAVSEA S-6470-AA-SAF-010 (Gas Free Engineering Program) and Chapter 27 of OPNAVINST 5100.23C (Confined Space Entry Program (Non-Maritime), it is required that individuals trained as "gas free engineers" conduct air monitoring prior to entrance of a confined space. Prior to entrance, there are specific ventilation, air sampling and certification requirements that must be met. Sampling in confined spaces for contaminants other than combustible gases and oxygen content is the responsibility of the base industrial hygiene community.)

Recommendation still under consideration:

11. In accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) as amended, the New London Submarine Base has been evaluated for public health actions. ATSDR's Health Activities Recommendation Panel (HARP) has determined that based on this evaluation and on current site conditions, an environmental health education program is recommended to advise public health professionals and the local medical community of the nature and possible consequences of exposure to contaminants at the New London Submarine Base. The value of obtaining a complete and accurate exposure history will be stressed as part of this program. In addition, information on the contaminants detected above health comparison values may include, but not be limited to, the physical nature of the contaminants, potential exposure pathways (i.e., soil, water, air, food), exposure routes (i.e., inhalation, ingestion, dermal), potential health effects, symptoms of exposure, and testing and treatment, if known). ATSDR's Division of Health Education will carry out the program in conjunction with the local medical community.

PUBLIC HEALTH ACTION PLAN

The public health action plan (PHAP) for New London Submarine Base contains a description of actions to be taken by ATSDR and other government agencies at and in the vicinity of the submarine base subsequent to the completion of this public health assessment. The purpose of the PHAP is to ensure that this public health assessment not only identifies public health hazards, but also provides a plan of action designed to mitigate and prevent adverse human health effects resulting from exposure to hazardous substances in the environment. Included is a commitment on the part of ATSDR to follow-up on this plan to ensure that it is implemented. The public health actions to be implemented are as follows:

A. Actions Undertaken

1. ATSDR held a public availability session during the initial site visit to meet with residents and to document their health concerns.

2. The Navy has installed a fence between the Area A Wetland, and another fence is under construction around the Area A Landfill to prevent people from walking through the wetland area closest to the landfill.

3. ATSDR met with the mayors of Groton and Ledyard as well as other Groton and Ledyard officials to collect local information and concerns from their constituencies.

4. The Navy has sampled off-base private residential wells to determine if people are being exposure to contaminants through groundwater.

5. The Navy held a public meeting to discuss the results of private well sampling with residents.

6. The Navy mailed letters to residents notifying them of elevated levels of sodium, boron (proven to be erroneous) and lead in their drinking water wells.

7. ATSDR held a public meeting to discuss the health effects of boron in residential drinking water.

8. The CTDHS in conjunction with the CTDEP sampled off-base residential wells for VOCs and inorganic chemicals. All wells tested showed levels below health comparison values.

9. The Navy investigated laboratory boron methodology and determined laboratory interference with boron analysis.

10. The Navy resampled surface water in the Thames River and off-base residential wells to determine if boron was present in drinking water. No boron was detected.

11. The Navy resampled two off-base (one community well and one private residential) wells that previously had lead concentrations above health comparison values. The community well showed lead levels below health comparison values. The residential well showed elevated lead levels as high as 37 ppb when first drawn.

12. The Navy has notified this resident that the lead level present in their well is a health hazard to children, pregnant women, and women contemplating pregnancy.

B. Actions Planned

1. ATSDR will review on-base environmental plans and information as they pertain to changes in future land use.

2. ATSDR's Division of Health Education will provide environmental public health education for civilian health care providers to assist the community in assessing possible adverse health outcomes associated with exposure to lead in their drinking water.

3. The Navy plans to further characterize off-base groundwater to determine actual or potential contaminant migration from on-base to off-base areas.

4. The Navy is designing plans for a detailed hydrogeologic investigation of residential well OSW 11, its groundwater and surface water interaction.

5. ATSDR will provide an annual follow up to this PHAP, outlining the actions completed and those in progress. That report will be placed in repositories that contain copies of this public health assessment and will be provided to persons who request it.

6. Communication and information exchange with off-base residents will continue. If additional information on exposure to contaminants at this site becomes available, ATSDR will re-evaluate this site for additional follow-up health activities.

ATSDR will re-evaluate and expand this PHAP when needed. New environmental, toxicological, or health outcome data, or the results of implementing the above proposed actions may determine the need for additional actions at the New London Submarine Base.

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Appendix A - Figures

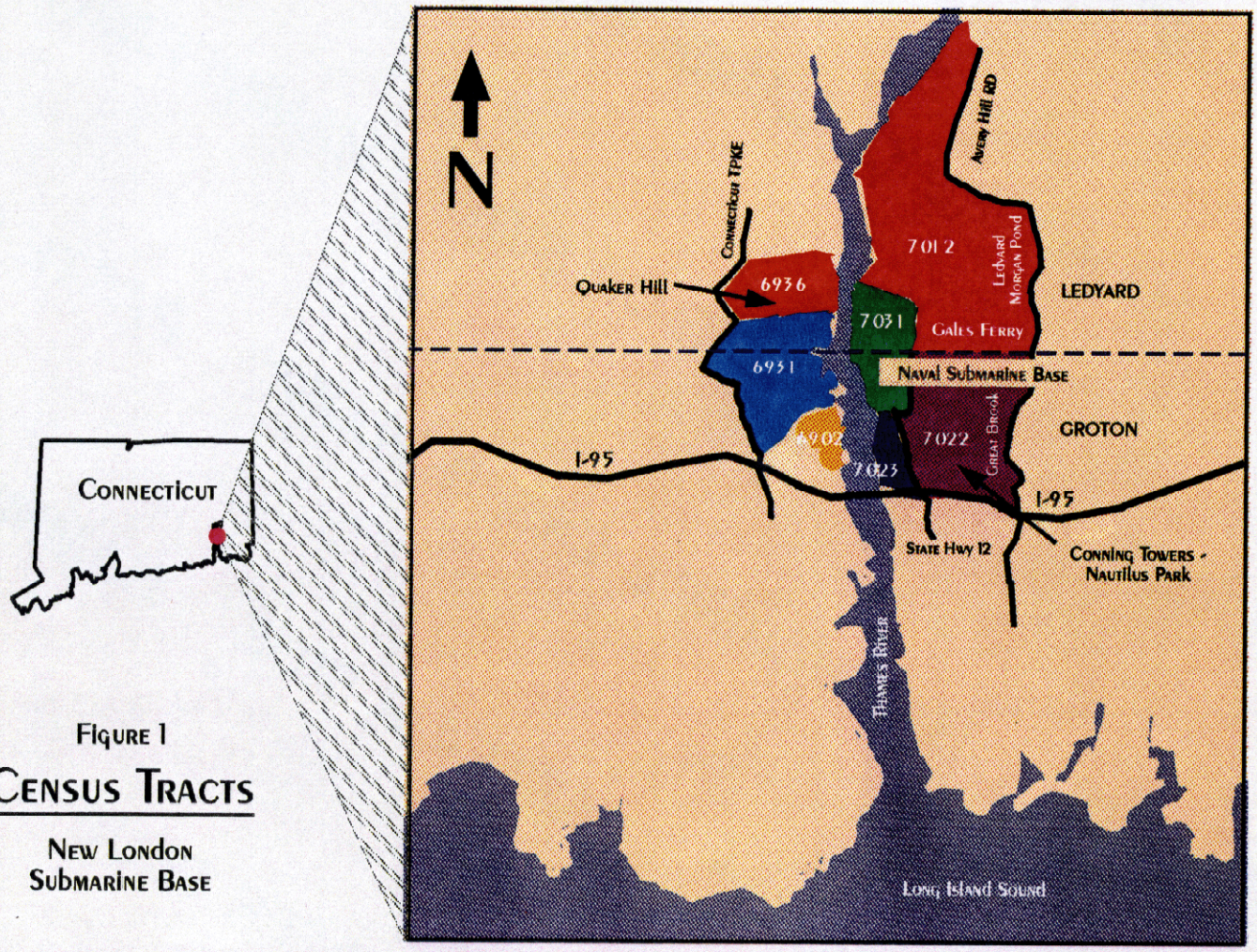

FIGURE 1

CENSUS TRACTS

NEW LONDON SUBMARINE BASE

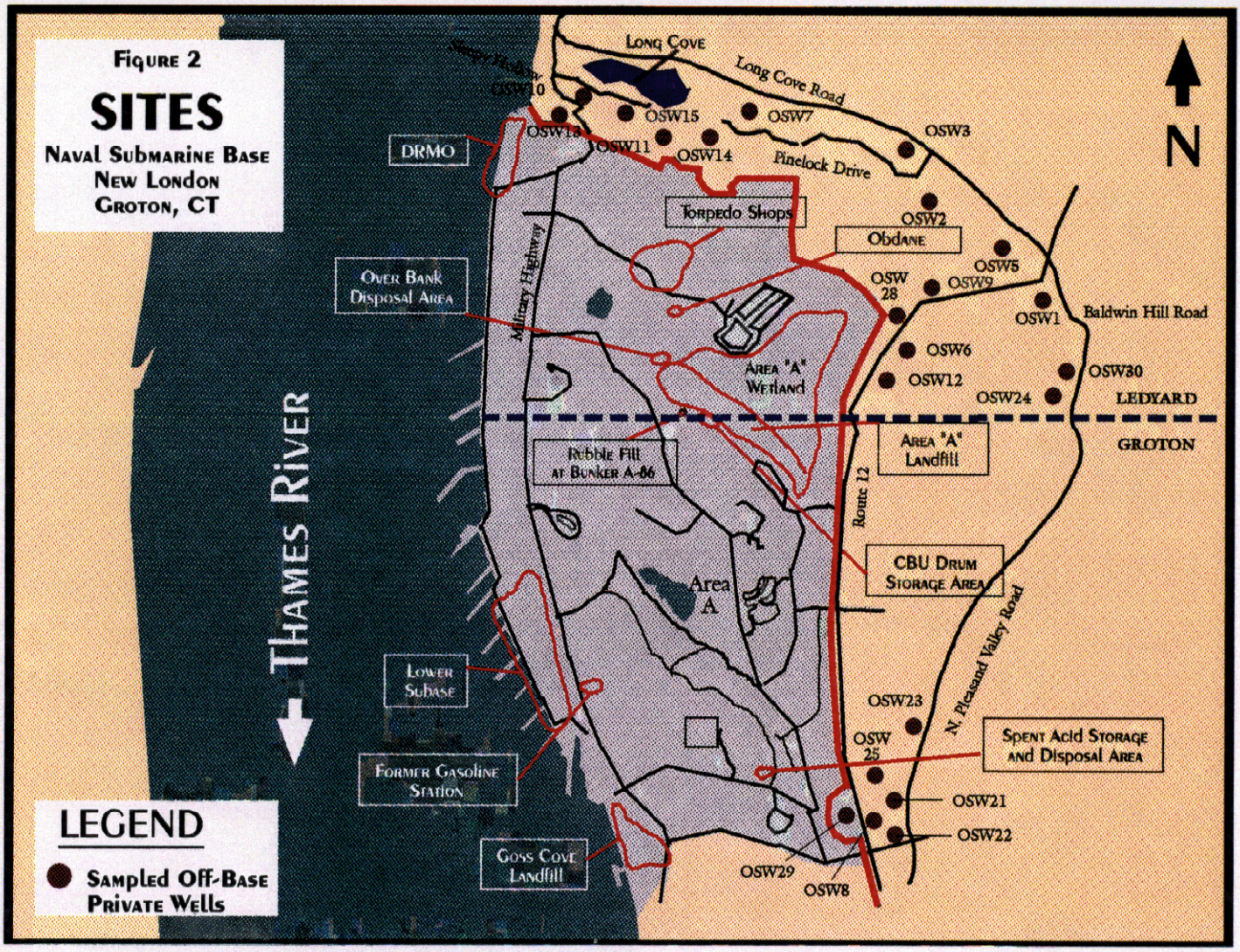
Figure 2
SITES
Naval Submarine Base
New London
Groton, CT
Long Cove
Long Cove Road
OSW10
OSW15
OSW7
OSW3
OSW13
OSW11
OSW14
Pinelock Drive
DRMO
Torpedo Shops
OSW2
Obdane
Military Highway
Over Bank
Disposal Area
OSW5
OSW
28
OSW9
OSW1
Baldwin Hill Road
OSW6
Area "A"
Wetland
OSW12
OSW30
OSW24
LEDYARD
GROTON
Rubble Fill
at Bunker A-86
Area "A"
Landfill
Route 12
CBU Drum
Storage Area
Area
A
N. Pleasant Valley Road
Lower
Subase
OSW23
OSW
25
Spent Acid Storage
and Disposal Area
Former Gasoline
Station
OSW21
OSW22
Goss Cove
Landfill
OSW29
OSW8
Thames River
N
LEGEND
Sampled Off-Base
Private Wells

0029 2027

Figure 3

Area Demographic Information

	Tract 7031 (contains base)	Combined Census Tracts surrounding base
Total persons	2,457	31,751
% Male	88.4	51.4
% Female	11.6	48.6
% White	83.3	91.8
% Black	11.5	4.2
% Other races	5.2	4.0
% Under age 10	2.8	19.4
% Age 65 and older	___	6.7
Households*	154	9,744
Persons per household	2.42	2.97
% Households owner-occupied	___	58.6
% Households renter-occupied	100	41.4
Median value, owner-occupied households ($)	___	148,000
Median rent paid, renter-occupied households ($)	602	590

* A household is defined as an occupied housing unit.
Source: 1990 Census of Population and Housing, Summary Tape File 1 (Connecticut). Prepared by Bureau of the Census, Washington, D.C., 1991.

Appendix B - Cancer Registry Summary Data

Cancer Incidence Rates per 1000 (Direct Age Adjusted)						
Cancer Types	1979 - 1981			1984 - 1986		
	Connecticut	Groton	Ledyard	Connecticut	Groton	Ledyard
All Types	12.4	15.1	14.8	13.0	13.1	12.0
Male	12.7	15.6	16.3	13.0	15.1	14.9
Female	12.1	14.8	13.1	13.1	13.5	9.7
Stomach	0.4	0.3	0.8	0.3	0.2	0.3
Male	0.4	0.6	0.5	0.4	0.1	0.3
Female	0.3	0.1	1.1	0.3	0.3	0.3
Colon	1.4	1.7	1.1	1.6	1.3	1.4
Male	1.4	1.6	1.5	1.6	1.2	1.9
Female	1.5	1.7	0.6	1.6	1.4	1.0
Rectum	0.7	1.0	1.8	0.6	0.7	1.0
Male	0.7	1.3	2.6	0.7	0.8	1.4
Female	0.6	0.9	1.0	0.5	0.6	0.5
Pancreas	0.3	0.3	0.3	0.4	0.5	0.9
Male	0.3	0.4	0.5	0.3	0.6	0.8
Female	0.3	0.4	0	0.4	0.4	0.9
Lung	1.8	2.5	2.6	1.9	2.2	2.0
Male	2.6	3.5	4.5	2.6	3.2	2.6
Female	1.1	1.5	0.5	1.4	1.4	0.8
Lymphomas(Hodgkin's)	0.4	0.7	0.2	0.5	0.4	0.2
Male	0.5	1.0	0	0.5	0.3	0.1
Female	0.4	0.5	0.5	0.4	0.3	0.4
Leukemia	0.3	0.5	0.8	0.3	0.2	0.2
Male	0.4	0.4	0.6	0.3	0.3	0.3
Female	0.3	0.6	0.9	0.3	0.2	0
Female Breast	3.4	3.7	5.8	3.8	4.7	3.0

Appendix C

Comments on New London Submarine Base Public Health Assessment

Appendix C

Comments on New London Submarine Base Public Health Assessment

The comments listed here were received by ATSDR in response to the public comment period for the New London Submarine Base Public Health Assessment. The list of comments does not include editorial comments concerning word spelling, sentence syntax, etc. It also does not include comments on accuracy of stated facts. If the accuracy of a statement was questioned, the statement was verified or corrected. Comments which requested that additional information be added to the document are not addressed here. The portions of the comments below that are in parenthesis were paraphrased by ATSDR for brevity or clarity.

Comment 1

Lead, boron, cadmium, VOCs and sodium were found at varying levels in the residential well supplies. Some of these (cadmium and VOCs) were only detected in one well, others were found in some or all of the wells (lead, boron, sodium). The report indicates that several rounds of testing were done. However, not all wells were tested for the same parameters, and it does not appear that confirmatory testing was done to verify all of the results from the first round (not all wells were resampled). This may be an important omission. One round of sampling is not conclusive, especially when important decisions about health and risk are to be based on the results. A better approach might be to sample the wells regularly, perhaps quarterly for a year, to obtain data on possible fluctuations in the water quality. This would offer a more accurate picture of the water quality and a better basis for making decisions.

Over the entire course of sampling, a total of 23 different off-base residential wells were sampled. During the first sampling round, 14 wells were sampled. A second round of sampling included those wells that showed detectable contamination during the first round plus the addition of eight unsampled wells.

Further sampling was performed by the Navy and Connecticut Department of Environmental Protection. Although no two sampling rounds contained analysis from all 23 wells, confirmation sampling has been performed on all but one of the 23 wells (OSW 11). In addition, the Navy is designing plans for a detailed hydrogeologic investigation of this well, its groundwater and surface water interaction.

Because confirmatory sampling indicates that sodium is the only

groundwater contaminant, and because no groundwater plume of contamination has been identified, routine monitoring is not recommended at this time. When further information becomes available in the Phase II Remedial Investigation, ATSDR will evaluate that information and make further recommendations to protect the health and safety of the citizens.

Comment 2

The report does not include any hydrogeologic data from this area. The wells may look from the surface to be "geographically isolated", but may in fact be hydrologically connected. Additional work should be done in this area to determine the hydrology and locate any potential contamination sources.

This public health assessment does not go into the detailed studies performed by the Navy on the hydrology of the base. That information is in the Navy documents located in the three local repositories: Bill Library, Ledyard, CT, Groton Public Library, Groton, CT, and New London Submarine Base Library, Groton, CT.

The Navy has planned a detailed hydrogeological investigation of the adjacent off-base areas in the Phase II Remedial Investigation.

Comment 3

It is concluded that the lead problem might be due to plumbing in the residences, rather than coming from the groundwater. This is possible, so why not sample the water immediately after the water tank, before the household plumbing, to determine if this is indeed so. If the problem is in the house, it still should be monitored and/or addressed.

In January 1993, the Navy resampled the two wells that had elevated lead levels. Four samples of each well were taken. Water was taken at the well head and at the tap prior to flushing, then again after a five minute flushing at both locations. Well OSW 10 showed lead levels to be below the detection limit of 3 ppb in all four samplings. Further analysis by another lab showed the actual lead concentration to be 1.7 ppb. Well OSW 23 showed lead levels ranging from < 3 ppb to 37 ppb. This residential well showed lead levels to be lowest (< 3 ppb) after flushing the line for five minutes and highest prior to flushing.

As discussed in the Recommendations section of this document, ATSDR recommends to the resident using well OSW 23 allow their water to run for a few minutes prior to using it.

Comment 4

There is a statement that shellfish harvesting is prohibited in the Thames River because of high fecal coliform. However, there are several leased shellfish beds on the east side of the Thames River in Ledyard just north of the Subase. Harvested shellfish are depurated prior to sale. I would like to see shellfish from beds near the Subase included in the biota sampling program.

The State of Connecticut Department of Environmental Protection in conjunction with the Connecticut Department of Health Services maintains active monitoring of shellfish from the Thames River. Analysis of several species of mollusks include inorganic chemical, PCBs, pesticides, VOCs as well as bacteriologicals such as fecal coliform testing. Quarterly monitoring results show only bacterial counts to be above health based standards.