ATSDR
AGENCY FOR TOXIC SUBSTANCES AND DISEASE REGISTRY

Public Health Assessment for

CONCORD NAVAL WEAPONS STATION
(a/k/a NAVAL WEAPONS STATION SEAL BEACH DETACHMENT CONCORD)
CONCORD, CALIFORNIA
EPA FACILITY ID: CA7170024528
JULY 15, 2005

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

THE ATSDR PUBLIC HEALTH ASSESSMENT: A NOTE OF EXPLANATION

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

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

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PUBLIC HEALTH ASSESSMENT

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EPA FACILITY ID: CA7170024528

Prepared by:

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

Foreword

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

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

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

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

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

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

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

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

Letters should be addressed as follows:

Attention: Chief, Program Evaluation, Records, and Information Services Branch, Agency for Toxic Substances and Disease Registry, 1600 Clifton Road, NE (MS E-32), Atlanta, GA 30333.

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List of Abbreviations

AOC	area of concern
ATSDR	Agency for Toxic Substances and Disease Registry
ATVs	all-terrain vehicles
bgs	below ground surface
Cal EPA	California Environmental Protection Agency
CCCMVAD	Contra Costa County Mosquito and Vector Abatement District
CCWD	Contra Costa Water District
CEL	cancer effect level
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CREG	ATSDR's cancer risk evaluation guide
CRP	community response plan
CVs	comparison value
DDD	dichlorodiphenyldichloroethane
DDE	dichlorodiphenyldichloroethylene
DDT	dichlorodiphenyltrichloroethane
DHHS	Department of Health and Human Services
DOD	Department of Defense
DoN	Department of Navy
DTSC	Department of Toxic Substances Control
EA	ecological assessment
EDDA	environmental due-diligence audit
EMEG	ATSDR's environmental media evaluation guide
EOD	explosive ordnance disposal
EPA	U.S. Environmental Protection Agency
ESQD	explosive safety quantity distance
FS	feasibility study
FY	fiscal year
IARC	International Agency for Research on Cancer
IAS	initial assessment study
IRP	installation restoration program
LOAEL	lowest-observed adverse effect level
MCL	EPA's maximum contaminant level
µg/dL	micrograms per deciliter
mg/kg/day	milligram per kilogram per day
MINS	Mare Island Naval Shipyard
MOTCO	Military Ocean Terminal Concord
MRL	ATSDR's minimum risk level
MTMC	Army's Military Traffic Management Command
NACIP	Navy Assessment and Control of Installation Pollutants
NFA	no further action

List of Abbreviations (continued)

NFRAP	no further response action planned
NOAEL	no-observed-adverse-effect level
NPL	EPA's National Priorities List
NTP	National Toxicology Program
NWSC	Naval Weapons Station Concord
NWS SBD Concord	Naval Weapons Station Seal Beach Detachment Concord
OEHHA	California Office of Environmental Health Hazard Assessment
OHA	off-site housing area
PAHs	polynuclear aromatic hydrocarbons
PCBs	polychlorinated biphenyls
PCE	tetrachloroethylene
PHA	public health assessment
PHAP	Public Health Action Plan
PHG	public health goal
ppb	parts per billion
ppm	parts per million
RAB	Restoration Advisory Board
RASS	remedial action subsites
RBC	EPA Region III's risk-based concentration
RCRA	Resource Conservation and Recovery Act
RFA	RCRA facility assessment
RfD	EPA's reference dose
RI	remedial investigation
RMEG	ATSDR's reference dose media evaluation guide
RMP	regional monitoring program
ROD	record of decision
SB	soil boring
SCLERA	screening-level ecological risk assessment
SFEI	San Francisco Estuary Institute
SI	site investigation
SVOCs	semi-volatile organic compounds
SWMUs	solid waste management units
TCE	trichloroethylene
TCRA	time-critical removal action
TDS	total dissolved solids
USCG	United States Coast Guard
USTs	underground storage tanks
VOCs	volatile organic compounds
WHO	World Health Organization

I. Executive Summary

The Agency for Toxic Substances and Disease Registry (ATSDR) prepared this public health assessment (PHA) to evaluate potential past and current exposures to contaminants originating from Naval Weapons Station Seal Beach Detachment Concord (NWS SBD Concord). NWS SBD Concord is located in Concord, California, in the north-central part of Contra Costa County.

NWS SBD Concord is a naval munitions storage and transshipment facility, which is divided into two parts—a Tidal Area and an Inland Area. In 1999, responsibility for Tidal Area port operations was transferred to the Army's Military Traffic Management Command (MTMC) (Tetra Tech 2003a). The Inland Area is located south of the Tidal Area and consists of about 5,200 acres of land. In 1999, the Inland Area was placed in a reduced operational status (Tetra Tech 2003a). Currently, the Navy leases most of the Inland Area to a local rancher for cattle grazing (USN 2003).

A number of past activities at NWS SBD Concord generated and released hazardous wastes into the environment. Most of the environmental contamination on base is a result of previous material storage practices, waste disposal practices, ordnance disposal practices, or fire training exercises. Environmental contaminants include solvents, acids, paint, metals, pesticides, fuel, oils, battery acid, and ammunition, ordnance materials and explosives. The Navy began environmental investigations at NWS SDB Concord in 1983. To date, the majority of the contaminated sites at NWS SBD Concord have been recommended for no further action (Tetra Tech 2003a, 2003b).

ATSDR used the PHA process to identify populations that could be exposed to base-related substances at levels that could cause health effects. Information was gathered from a variety of sources including ATSDR's 1991 and 2004 site visits and findings of site investigations conducted at NWS SBD Concord. ATSDR examined the nature and extent of contamination associated with the base, and evaluated possible exposures identified during the visits, review of environmental data and discussions with stakeholders. Stakeholders included the Navy, the U.S.

Environmental Protection Agency (EPA), the California Environmental Protection Agency (Cal/EPA), the state of California Regional Water Quality Control Board (RWQCB), other federal and state agencies, and local community members. While some areas of the base do have elevated concentrations of some environmental contaminants, ATSDR did not identify any potential exposure that would be expected to cause health effects for base residents or visitors, or the neighboring community. The following exposure situations are discussed in detail in this document:

- *Inhalation of contaminated airborne dust by trespassers operating dirt bikes or all-terrain vehicles (ATVs) in the Litigation Area.* Trespassers have been observed operating dirt bikes and ATVs in the Litigation Area. While some portions of the area have high concentrations of metals in the soil that could become airborne when disturbed, the estimated chemical exposures are below levels of health concern. In January 2005, the Navy completed fencing this area and posted warning signs to prevent future trespassing.

- *Exposure to arsenic-contaminated windblown dust by community members living near the Magazine Area/Site 22.* Surface soils in the Magazine Area/Site 22 contain elevated levels of arsenic. Residents living near this site were concerned that wind-blown dust might carry arsenic-contaminated surface soils into residential neighborhoods and Concord High School. ATSDR considered short-term inhalation exposures during tilling activities, long-term inhalation exposures to wind-blown dust, and possible accumulation of contamination in off-site soils from wind-blown dust from the Magazine Area/Site 22. In all cases, the estimated arsenic exposure is safely below levels of health concern.

- *Exposure of community members using permitted or unpermitted groundwater wells to Volatile Organic Compounds (VOCs).* Groundwater under NWS SBD Concord is not used to supply drinking or irrigation water to the station or surrounding community members. However, private and municipal wells are located off-base and used for a variety of purposes. Results of this evaluation indicate that none of the wells are likely to

be affected by base-related contaminants that would be expected to cause health effects. As a prudent public health action, ATSDR recommends that residents using private wells for domestic water supply periodically inspect their well and water quality.

- *Ingestion of contaminants in beef from cattle grazing on the station.* The majority of the Inland Area is leased for cattle grazing, including the Magazine Study Area. Surface soils throughout much of the Magazine Study Area contain elevated levels of arsenic. Some community members were concerned that arsenic could accumulate in the beef and cause health effects for beef consumers. Results of the evaluation indicate that small concentrations of arsenic would be expected in the beef, however the level would be less than the typical concentrations reported in grains, meat, fish and poultry. No health effects are expected for people who regularly consume beef from cattle or calves that graze on-base.

- *Exposure of off-base military housing residents to pesticide-contaminated soil.* Elevated concentrations of some pesticides have been detected in some of the soil samples from Quinault Village. The measured concentrations are similar to those found in rural, urban, and agricultural soils throughout the United States and Canada. Results of the evaluation indicates that Navy and U.S. Coast Guard families living in that area would not be exposed to pesticides at levels that would be expected to cause health effects. As a prudent public health action, ATSDR recommends that residents of Quinault Village be notified of the sample results and advised on methods to reduce potential exposure to pesticides and naturally occurring soil contaminants.

- *Exposure of mosquito abatement workers to contaminants in the Litigation Area.* Contra Costa County Mosquito and Vector Abatement District (CCCMVAD) mosquito abatement workers inspect and spray potential breeding areas. Some portions of the Litigation Area they access have contaminated soil, sediment, and surface water due to

previous activities. Mosquito abatement activities are conducted 30 times per year, take approximately 6 hours per visit, and tend to target different areas with each visit. The estimated exposure to the environmental contaminants is below levels of potential health concern.

- *Exposure to contaminants in Suisun Bay resulting from recreational activities.* The Suisun Bay borders the station on the north. Recreational activities in and around the station are limited due to lack of accessibility and development, but include some boating, fishing, duck hunting, and hiking. A variety of potential sources in the area have resulted in environmental contaminants measured in surface water, sediment, fish, and duck tissue in Suisun Bay. The estimated exposure of recreational users to environmental contaminants measured in the bay near the base is not expected to cause any type of adverse health effect. Consumers of fish and duck from Suisun Bay who follow the guidelines from the California Office of Environmental Health Hazard Assessment (OEHHA) are not expected to be exposed to levels of contaminants that could harm their health.

II. Introduction

The Agency for Toxic Substances and Disease Registry conducted a public health assessment of the Naval Weapons Station Seal Beach Detachment Concord (NWS SBD Concord). The focus of the assessment was to evaluate if the local community, including nearby residents, base visitors, and employees, were exposed to environmental contaminants originating from chemical disposals, spills, or previous base operations at levels that could cause health effects.

The primary components of the public health assessment process for NWS SBD Concord were

1. Reviewing and evaluating data and documents prepared by the Navy, the U.S. Environmental Protection Agency (EPA), and the California Environmental Protection Agency (Cal/EPA),
2. Meeting with the local community to identify their exposure concerns, and
3. Reviewing scientific literature describing the fate and transport of the contaminants in the environment and toxicity of the contaminants to the human body.

The reviewed documents describe the history of the environmental investigations and remediation at NWS SBD Concord and each specific site identified under the Department of Defense's Installation Restoration Program (IRP) and the Resource Conservation and Recovery Act (RCRA) Corrective Action Program. Specific site information describes the disposal or spill history, type of environmental contaminants expected, results of environmental sampling, the extent of environmental contamination at that site, and the planned and completed remedial activities for the site. ATSDR used this information to identify if the local community was, or could be, exposed to environmental contaminants by coming into contact with the air, soil, sediment, surface water, or groundwater in their community, and if that exposure would be expected to harm the health of the local community. ATSDR also met with members of the local community to identify their exposure concerns for NWS SBD Concord. The exposure concerns described activities or situations that could bring local community members into contact with environmental contaminants originating at NWS SBD Concord. ATSDR evaluated the potential

exposures using information available in the scientific literature describing the characteristics of the chemicals in the environment and their potential to harm human health.

This public health assessment (PHA) document briefly summarizes the assessment process and the results of the evaluations. If you would like additional information about the evaluations described in this document please contact ATSDR at 1-888-422-8737 and ask to speak with an environmental scientist about the NWS SBD Concord PHA.

II.A. Site Description and Operational History

Naval Weapons Station Seal Beach Detachment Concord (NWS SBD Concord) is located in Concord, California, in the north-central part of Contra Costa County. NWS SBD Concord is about 30 miles northeast of the city of San Francisco. The station is bordered on the north by the Suisun Bay, on the south and west by the city of Concord, and on the east by Los Medanos Hills and the city of Pittsburg (see Figure 1 for a regional map).

NWS SBD Concord is a naval munitions transshipment and storage facility, for loading, unloading and storing munitions and equipment from ships. The base is divided into two parts—a Tidal Area and an Inland Area (see Figure 2 for a base map).

- The Tidal Area encompasses approximately 7,648 acres of land, including 6,077 acres adjacent to the Suisun Bay and 1,571 acres on six islands in Suisun Bay. The Tidal Area is predominantly used for receipt, inspection, and staging of munitions transported to and from off-site locations (USN 2003). The Litigation Area, within the Tidal Area, is part of the land acquired between the 1960s and 1970s to increase the buffer zone on the eastern portion of the Tidal Area. Before Navy ownership this area was used for commercial industrial activities; the Navy is currently investigating and addressing environmental contamination resulting from the previous activities (Tetra Tech 2003c).

- The Inland Area is located south of the Tidal Area and consists of about 5,200 acres of land. This area includes various facilities for munitions storage and inspection as well as maintenance, administration, public works, supply and housing. The Inland Area also contains wildlife preservation areas, including a tule elk refuge and two golden eagle nest reserves. The Navy leases much of the Inland Area to local ranchers for cattle grazing (USN 2003). In 1999, the Inland Area was placed in a reduced operational status (Tetra Tech 2003a). Although the Navy does not actively use the majority of this area, the Inland Area will be reactivated if required in the future (USN 2003). Currently, the Navy is working with the city of Concord to explore joint use of NWS SBD Concord while the station is being held in an inactive state (Tetra Tech 2003b; G Smith, U.S. Navy, personal communication, 2005).

In 1854, the Navy established the first ordnance bunker at Mare Island Naval Shipyard, in the recently formed state of California. In the 1920s, the Navy relocated the ordnance to the Tidal Area of NWS SBD Concord, then known as Bay Point. The facility was officially commissioned as the Naval Magazine, Port Chicago (NMPC) on December 4, 1942 (NMPC) (E & E 1983; Tetra Tech 2003a). On July 17, 1944, a major explosion occurred at NMPC. Three and one-half million pounds of high explosives detonated, killing 320 people and injuring 390 others (Tetra Tech 2003a). In 1945 munitions handling exceeded the capacity of the waterfront (Tidal Area), and the Navy acquired an additional 5,143 acres of land located 1.5 miles south of the waterfront in the Diablo Creek Valley. This area of land became known as the Inland Area (Tetra Tech 2003a). On December 23, 1957, NMPC became the Naval Weapons Station Concord (NWSC) (E & E 1983). In March 1998, NWSC changed from an independent weapons station to a detachment of Seal Beach, becoming known as Naval Weapons Station Seal Beach Detachment Concord (NWS SBD Concord). In 1999, responsibility for port operations in the Tidal Area were transferred to the Army and the Inland Area was placed in a reduced operational status (Tetra Tech 2003a).

II.B. Remedial and Regulatory History

A number of activities at NWS SBD Concord generated and released hazardous wastes. Wastes were disposed of on-station

- in landfills or disposal areas,
- burned during ordnance disposal practices or fire training exercises,
- discharged into the soil, surface water, or wells, and
- buried.

These wastes were primarily generated by wood-hogging operations (the process of converting waste wood into chips), disposal activities, leaking underground storage tanks (USTs), automotive maintenance and repair, missile wings and fin repair, firing range activities, and the explosion of 1944. Wastes included solvents, acids, paint, ordnance materials, pesticides, fuel, oils, battery acid, ammunitions, and explosives.

A total of 57 sites across the base were investigated for potential environmental contamination under the DOD's IRP and the RCRA Corrective Action Program. At many sites, there was no evidence of environmental contamination at levels that could harm people or the environment. Others have already been remediated. The environmental contamination at some sites (the Litigation Area) is a result of material use and disposal practices of previous owners. Because the Navy is the current landowner, they are conducting investigations and performing the necessary remediation. Environmental investigations and/or remedial actions are currently in progress at 22 of the 57 sites (E & E 1983; Tetra Tech 1997, 1999, 2003a, 2003b, 2003c, and 2004a).

Environmental investigations and necessary remediation is conducted by the Navy in coordination with the EPA, the California Environmental Protection Agency's Department of Toxic Substances Control (DTSC), the state of California Regional Water Quality Control Board (RWQCB), and other federal and state agencies. The public also has an active role in the cleanup program. As part of the federal Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) process, community members joined together to form a Restoration Advisory Board (RAB) to 1) voice concerns on the base's environmental cleanup issues;

2) review, evaluate, and comment on environmental cleanup documents; and 3) recommend cleanup priorities among base sites (Tetra Tech 2003a).

II.C. ATSDR Activities

Through the public health assessment process, ATSDR assesses conditions at a site from a public health perspective to identify if the community can be exposed to site-related contaminants through contact with the site's groundwater/drinking water, surface water, soil, biota, or air. As part of the evaluation process, ATSDR conducted an initial visit to NWS SBD Concord in 1991. The purpose of the visit was to collect information to identify public health issues related to environmental contamination at the facility, and to identify community health concerns.

In January 2004 ATSDR visited NWS SBD Concord to obtain updated information related to environmental studies at the station. During the visit, ATSDR met with Navy and NWS SBD Concord personnel and representatives from federal and state agencies, attended a RAB meeting and met with local community members, and toured the base. After a review of these discussions, the site visit, and relevant data, ATSDR concluded at the time that there were no immediate threats to human health. However, seven exposure pathways were identified for further evaluation:

1. Potential inhalation of contaminated airborne dust by trespassers who operate dirt bikes and all-terrain vehicles (ATVs) in the Litigation Area.
2. Potential exposure to arsenic-contaminated windblown dust by community members living near the Magazine Study Area.
3. Potential exposure to Volatile Organic Compounds (VOCs) by community members from permitted or unpermitted groundwater wells.
4. Potential ingestion of contaminants in beef from cattle grazing on the station.
5. Potential exposure to pesticide-contaminated soil by residents in off-base military housing.

6. Potential exposure to contaminants in the Litigation Area by mosquito abatement workers.

7. Potential exposure to contaminants in Suisun Bay resulting from recreational activities.

II.D. Demographics

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

Currently, due to its reduced operational status, NWS SBD Concord does not have on-base housing, and only 105 military and civilian personnel work at the station (G Smith, US Navy, personal communication, 2004a). Off-base military housing units, located in the western section of the Inland Area, were vacated in 2001 as a result of the station's reduced operational status. Since then, the United States Coast Guard (USCG) has begun to re-occupy the some of the units (G. Smith, US Navy, personal communication, 2004a).

In 2000, approximately 58,581 people lived within 1 mile of NWS SBD Concord. Figure 3 shows 2000 demographics information for the population near the station. As the figure indicates, nearly 10% of the population living within a 1-mile radius of the station is children aged 6 years and younger. Approximately 22% of this population is women of childbearing age, and roughly 11% are elderly.

II.E. Land Use

ATSDR examined land use to determine how people could be exposed to base-related contaminants in soil, sediment, surface water or groundwater. Access to NWS SBD Concord is restricted to military and civilian personnel and lessees. The Navy operates the Inland Area and

handles Inland Area access and security. The U.S. Army currently operates the Tidal Area and handles Tidal Area access and security. A highway divides the Inland Area and the Tidal Area, which requires the two areas to be fenced separately, with each area having its own guarded gate (Tetra Tech 1997). Access to the Litigation Area, located inside the Tidal Area, is limited to Navy-approved personnel only, and access is denied to most personnel during ship loading events. The one access road in this area is blocked and gated with a chain-link fence. The Navy also uses regular security patrols and intermittent fencing near roads in the Litigation Area to further deter trespassers (Tetra Tech 2003c).

Ammunition storage was previously the largest single land use within the Inland Area (Tetra Tech 1997). Even though ordnance is no longer stored in the area, the Navy is required to maintain a safe distance between potential explosive sites and other portions of the installation — the so-called explosive safety quantity distance (ESQD) arcs — to protect against potential detonations (Tetra Tech 2002a). Most of the Inland Area is open space, much of which is leased for cattle grazing. The Inland Area also houses two preservation areas and the Diablo Creek Golf Course, a city-operated golf course that occupies a 162-acre triangle of land in the northwest corner of the Inland Area (80 of the 162 acres are owned by the city of Concord) (Tetra Tech 1997). A fence restricts access from the golf course to the base (G Smith, US Navy, personal communication, 2004).

The Tidal Area is an active facility operated by the U.S. Army for weapons storage and transshipment (Tetra Tech 2004a). The Tidal Area was renamed the Military Ocean Terminal Concord (MOTCO) by the Army. MOTCO processes, ships, and receives military ordnances, conducting two large-scale discharge and load out operations per year (Tetra Tech 2002a). The Tidal Area is located in a low marsh, the majority of the area is wetland and is the home to many endangered species and other wildlife. Fill material was placed in the wetland during construction of the original station, and an artificial sluice was built to regulate tidal inflows. Approximately 42% of the Tidal Area is leased for cattle grazing. The cattle do not have access

to the contaminated sites (Tetra Tech 1999; M Wallerstein, personal communication, December 8, 2004).

The Litigation Area is used as a buffer zone in the Tidal Area to ensure security for military operations. Most of the land falls within the ESQD arc to protect human life during ammunition loading activities in the Tidal Area. The site consists of natural wetland and upland habitat. No buildings are on the site and no agricultural use or livestock grazing occurs in this area. Several railroad tracks pass through the area (Tetra Tech 2003c).

The land surrounding NWS SBD Concord is made up of industrial and residential areas, rangeland (land on which the natural vegetation is suitable for grazing livestock), and open space (Tetra Tech 2004a; P Ramsey, personal communication, February 2005).

NWS SBD Concord is bordered on the south by residential sections of the city of Concord. Several public schools and parks border the Navy property line (Tetra Tech 2004a). A public entertainment facility, the Concord Pavilion, is located near the station's southern border. NWS SBD Concord is bordered on the north by Suisun Bay. Areas northeast of NWS SBD Concord are zoned for open space and agricultural land use. An industrial complex is located west of the station. In addition, the Contra Costa Water District operates a large water treatment plant and the Mallard Reservoir west of NWS SBD Concord (Tetra Tech 1997; P. Ramsey, personal communication, February 2005).

The unincorporated town of Clyde is located on a small patch of land between the Tidal Area and the Inland Area of NWS SBD Concord, just past the main gate (Tetra Tech 2003b). Clyde has a land area of 0.14 square miles and a population of 694 residents (Bureau of the Census 2000).

Los Medanos Hills divides the Tidal and Inland Areas of the station and contains the Los Medanos underground gas storage field. This land is privately owned and leased to the Pacific Gas and Electric Company for deep-well injection, and is also used for cattle grazing (Tetra Tech 1997).

II.F. Natural Resources

Natural resources used in the vicinity of NWS SBD Concord include groundwater and surface water for drinking water and irrigation, and surface-water bodies for recreational uses. Some of the key exposure concerns associated with NWS SBD Concord pertain to contaminated groundwater and potential contaminant releases to Suisun Bay. To determine how contaminants might migrate to or accumulate in these media, ATSDR obtained background information on the local groundwater hydrogeology and surface water hydrology and included pertinent information into the appropriate Exposure Pathways discussions.

II.G. Quality Assurance and Quality Control

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

III. Evaluation of Environmental Contamination and Potential Exposure Pathways

III.A. Introduction

Identifying and Evaluating Exposure

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

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

Exposure and Health Effects

In some cases, exposure to large amounts of environmental contaminants can cause adverse health effects. The type and severity depends on the exposure concentration (how much), frequency of exposure (how often), duration of the exposure (how long), and the route of exposure (breathing, eating, drinking, or skin contact). Once this exposure occurs, characteristics such as age, sex, nutritional status, genetics, lifestyle, and health status influence how an individual absorbs, distributes, metabolizes, and excretes the contaminant, and whether that individual could get sick from the exposure.

Potential Exposures of Concern at Naval Weapons Station Seal Beach Detachment Concord

Each source of contamination was evaluated at NWS SBD Concord to identify if the local community could be exposed to site-related contamination. For the majority of contaminated sites at NWS SBD Concord, there was no exposure of the local community to site-related contaminants that would be expected to cause health effects. Using evaluations made during the site visits, an examination of environmental data, and discussions with the community, Navy, and regulators, ATSDR identified seven potential exposure concerns for further evaluation. A list of all sources of contamination that have been identified by NWS SBD Concord's IRP is presented in Table 1. Table 2 shows the results of the exposure evaluation.

The remaining section of this PHA summarizes the evaluation of each of the following potential exposure concerns:

- Inhalation of contaminated airborne dust by trespassers who operate dirt bikes and all-terrain vehicles (ATVs) in the Litigation Area.
- Exposure to arsenic-contaminated windblown dust by community members living near the Magazine Study Area.
- Exposure to VOCs by community members from permitted or unpermitted groundwater wells.
- Ingestion of contaminants in beef from cattle grazing on the station.
- Exposure to pesticide-contaminated soil by residents in off-base military housing.
- Exposure to contaminants in the Litigation Area by mosquito abatement workers.
- Exposure to contaminants in Suisun Bay resulting from recreational activities.

Appendices A, B, and C are provided to acquaint the reader with terminology and methods used in this PHA. Appendix A provides a glossary of environmental and health terms presented in the discussion. Appendix B describes the comparison values (CVs) ATSDR used in screening contaminants for further evaluation. Comparison Values represent a contaminant concentration to which humans might be exposed to without experiencing adverse health effects. Contaminant with concentrations greater than the CV will not necessarily cause adverse health effects;

however, those contaminants will be evaluated in greater detail to determine whether a health hazard exists. Appendix C describes those evaluation methods.

III.B. Inhalation of contaminated airborne dust by trespassers who operate dirt bikes and all-terrain vehicles (ATVs) in the Litigation Area.

During the site visit, ATSDR observed some individuals riding dirt bikes, ATVs, and other recreational vehicles in RASS 4 (also known as Site 6) in the Litigation Area. This area is known to contain surface soil contamination. While the Navy does not permit such activities, trespassers were able to enter the site through gates that have broken locks. Recreational use of off-road bicycles and motorized vehicles can disturb surface soils, potentially exposing trespassers to airborne dusts including the soil contaminants. In January 2005, the Navy completed fencing this area to prevent future trespassing and posted signs stating the area is government property and contains hazardous substances. (S. Tyahla, personal communication, 2004; M. Wallerstein, personal communication, February 2005). ATSDR evaluated the potential exposure of trespassers during their occasional recreational activities at RASS 4.

Past Remediation Activities and Access

In 1968 the Navy purchased the 13 acres now known as RASS 4, as a part of a land-acquisition to provide a greater buffer zone around ordnance loading operations (Table 3). Before Navy ownership, this area was used as a small dumpsite for construction debris and a storage area for spent coke (a coal-derived material that has possibly been used as a catalyst in industrial processes). The Navy has conducted some removal activities at this site: roughly 1,500 cubic yards of spent coke was removed shortly after the purchase, and nearly 3,000 cubic yards of contaminated soils were removed in the 1990s. Currently, most of the area is covered with grasses, shrubs, and a small freshwater marsh (Tetra Tech 2003c).

Potential Exposure

Trespassers operating dirt bikes and ATVs might be exposed to airborne dusts including soil contaminants while riding in RASS 4. The magnitude of the exposure is largely a function of how frequently the trespassers ride at RASS 4 and the air concentrations of surface soil contaminants that the trespassers inhale during this activity. There are no measured data to describe either trespasser frequency or the air concentrations likely to result from this activity.

To complete this evaluation ATSDR made the following conservative assumptions about trespasser frequency:

1. An individual could ride a dirt bike or ATV at RASS 4 for 2 days per week all year (104 days per year).
2. An individual would spend up to 3 hours at RASS 4 during each visit.
3. Some individuals might visit the property for over 30 consecutive years.

Recreational activities involving dirt bikes and ATVs are known to create clouds of dust as the vehicles travel over soils. Although the dust clouds typically trail the vehicle, it is possible that drivers can inhale considerable amounts of airborne dusts, especially when multiple vehicles operate in a given area. The exact quantities generated by these vehicles depend on many factors, such as the weight and speed of the vehicle, surface soil conditions, and duration of the activity. Previous research indicates the estimated exposure concentrations range from 83 $\mu g/m^3$ (Berman 2004) to 380 $\mu g/m^3$ (ADHS 2000), depending activity levels and site conditions. To be conservative, ATSDR used the upper bound (380 $\mu g/m^3$) as the assumed exposure concentration for airborne dust.

ATSDR further assumed that the airborne dust is made entirely of surface soil from RASS 4, and that the same relative concentrations of the contaminants in the surface soil would be present in the suspended dust. Table 4 presents the average surface soil contamination levels measured

during the most recent soil sampling event at RASS 4.[1] These values were multiplied by the estimated airborne dust concentration to estimate ambient air concentrations of contaminants of concern during recreational activities. Table 4 lists these estimated ambient air concentrations and compares them to health-based comparison values for initial screening purposes.

Evaluation of Potential Public Health Hazards

The estimated ambient air concentrations of copper, lead, mercury, selenium, and zinc are at least an order of magnitude below their corresponding health-protective comparison values. Accordingly, these contaminants are not expected to cause adverse health effects at the concentration levels predicted for this exposure scenario. The estimated exposure concentrations of arsenic and cadmium are above their health-protective comparison value. However these comparison values assume the off-road enthusiasts are exposed to dust RASS 4 soil contaminants for 365 days per year for 70 years.

ATSDR estimated that the intermittent exposure of off-road enthusiasts trespassing on RASS 4 (6 hr/wk for 30 yrs) would reduce the exposure concentration to approximately 0.00068 $\mu g/m^3$ for arsenic and 0.0022 $\mu g/m^3$ for cadmium. Using EPA human health risk assessment protocols and a comparison of toxicological and epidemiological studies, these concentrations are below levels that would be expected to cause adverse health effects. The toxicological and epidemiological studies indicate these concentrations are hundreds to thousands of times less than those expected to cause health effects. This potential exposure to the soil contaminants was eliminated in January 2005, when the Navy completed fencing this area. In addition signs were posted warning trespassers that the area is government property and contains hazardous substances.

[1] The contaminants of greatest concern identified by the Navy, after multiple site investigations, are arsenic, cadmium, copper, lead, mercury, selenium, and zinc. ATSDR also evaluated potential exposures to additional contaminants that have been found at RASS4, but the estimated ambient air concentrations for these other contaminants (e.g., pesticides, semi-volatile organic compounds) were all considerably lower than health-based comparison values.

III.C. Exposure to arsenic-contaminated windblown dust by community members living near the Magazine Area/Site 22.

The Magazine Area/Site 22, which includes and is an expansion of Site 22, is located in the Inland Area of NWS SBD Concord. Surface soils throughout this area contain elevated concentrations of arsenic. The elevated arsenic levels could be caused by the Navy's past uses of herbicides, pesticides, and rodenticides. It is possible, however, that arsenical pesticide use could have occurred while the land was used for agriculture before its acquisition by the Navy. Residents who live adjacent to the Magazine Area/Site 22 have expressed concern about the possibility that wind-blown dust and periodic tilling operations might carry the arsenic-contaminated surface soils through the air into residential neighborhoods and to Concord High School. ATSDR evaluated the potential exposure due to the tilling operation in a separate technical consultation (ATSDR 2004). The evaluation concluded local residents and students would not be expected to develop adverse health effects resulting from arsenic exposure during the tilling operation. This section evaluates the public health implications of residents potentially exposed to arsenic contaminated dust blown by wind from the Magazine Area/Site 22.

Site Description and Access

The Magazine Area/Site 22 covers approximately 500 acres and is located along the southern boundary of NWS SBD Concord's Inland Area It was previously used to store munitions in dozens of bunkers; currently, the area is leased for cattle grazing. Two chain-link fences topped with barbed wire separate the residential properties that border the base from the Magazine Area. The first fence runs along the property lines of the residences' backyards. The second fence runs on NWS SBD Concord property and is approximately 50 feet from, and parallel to, the first fence. Every year, the Navy tills the soils in this buffer zone to prevent overgrowth of grasses and other vegetation.

Nature and Extent of Contamination

The Navy has conducted multiple studies to characterize soil contamination near the Magazine Area. The most extensive sampling was conducted during the summer of 2004. During this sampling event, arsenic was detected in each surface soil sample, and measured concentrations ranged from 2.6 to 199 mg/kg. The average concentration was approximately 40 mg/kg.

Potential Exposure

Local residents could be exposed to arsenic from the Magazine Area if the contaminated surface soils blow into the residential neighborhoods adjacent to the site. Accordingly, this PHA evaluates two possible scenarios: inhaling airborne dust containing arsenic, and contacting soils where wind-blown dust has deposited. There is no air monitoring data to evaluate either exposure scenario. Nevertheless, ATSDR believes results from the site investigations performed to date are sufficient to provide reasonable insights on the extent to which arsenic could migrate from the Magazine Area to off-site locations.

On windy days, surface soil particles — and any contaminants that might be found in those particles — can become airborne and migrate toward downwind locations. Wind-blown dust is a natural phenomenon, and the amounts of dusts blown into the air are determined both by soil properties and local weather conditions. An EPA model of this phenomenon suggests that the amounts of dust generated by the wind depends a variety of factors including the wind speed, the fraction of soil covered by vegetation, and the relative size of soil particles (EPA 1985).

The prevailing wind direction in the vicinity of NWS SBD Concord is roughly from west to east (TetraTech 2003d). Dusts generated by this wind would tend to travel to the east, away from, nearby residential neighborhoods or Concord High School. In addition, the variation of the measured soil arsenic concentrations suggests that arsenic is typically found within a central area. The only locations where surface soil concentrations of arsenic exceeded 10 mg/kg were within the Magazine Area. At all on-site sampling locations outside this area, the arsenic

concentrations ranged from 2.6 to 5.7 mg/kg — levels that are consistent with "background" concentrations near NWS SBD Concord. In other words, arsenic-contaminated soils appear to remain entirely within the Magazine Area, with no evidence of elevated soil concentrations in immediately adjacent lands. This observation suggests that wind-blown dust has not transported large quantities of contaminated surface soils to locations beyond the Magazine Area.

Evaluation of Potential Public Health Hazards

Overall, the prevailing wind directions, spatial trends in soil contamination levels, and ATSDR's previous assessment of potential airborne contamination levels all suggest that wind-blown dust from the Magazine Area does not expose off-site residents to arsenic at harmful levels.

III.D. Exposure of community members using permitted or unpermitted groundwater wells to volatile organic compounds (VOCs).

Approximately 5 to 10 percent of the potable water supply in the San Francisco Bay area is from groundwater (Tetra Tech 1997). Regionally, groundwater in the vicinity of NWS SBD Concord flows northward from Los Medanos Hills through the Inland Area to the Tidal Area towards Suisun Bay (Tetra Tech 1999). Groundwater directly under NWS SBD Concord is not used to supply drinking or irrigation water to the station or surrounding community members; however, groundwater in the vicinity of the base is used for a variety of purposes. The Contra Costa Water District (CCWD) provides the base and neighboring community members with treated municipal water almost entirely from surface water sources. Community members are not exposed to the groundwater located directly under the base.

While residential wells used for domestic water supply are believed to exist in the area, ATSDR did not identify any adjacent to the base. Known users of groundwater near the base include the City of Concord's Willow Pass Park, which uses groundwater for irrigation and filling the park's pond. Periodically, CCWD uses some wells in the vicinity of NWS SBD Concord to supply public drinking water. A series of potable water wells surrounding Mallard Reservoir to the

northwest of the station (west of the SWMU sites in the Inland Area) are used during droughts and emergencies to augment normal aqueduct supplies of drinking water to the reservoir (Tetra Tech 1997). Several wells within 1 mile of the Litigation Area sites are used by industry to supply non-potable water for industrial processes and cooling water (Tetra Tech 2003c). One water supply well located within the Diablo Creek Golf Course, adjacent to the Inland Area, is used for irrigation purposes and to supply water to golf course ponds, but is not used as a source of drinking water (Tetra Tech 2003c, 2004a). Further, an undetermined number of community members in the area may use off-base private wells, both permitted and unpermitted, for their water supply.

Three sites within the Inland Area have groundwater contamination that could possibly affect groundwater quality outside the station: SWMUs 2, 5, 7, and 18 (collectively treated as one site), Site 13, and Site 22. ATSDR evaluated these sites to identify if the local community could be exposed to base-related contaminants at levels that could affect their health.

SWMUs 2, 5, 7, and 18

Nature and Extent of Contamination

Studies of groundwater conditions at the SWMU sites have been conducted since 1992 primarily focused on VOC contaminants (i.e., chemicals used in solvents, cleaning solutions, and paints) from previous industrial operations in this location (Tetra Tech 2004a). Tetrachloroethylene (PCE) and trichloroethylene (TCE), industrial solvents, were identified as the primary chemicals of concern because they were detected above the current drinking water standard set by the EPA. Maximum concentrations for both compounds were found in the central portion of the site at SWMU 5. In this area, the local groundwater flow pattern is to the northwest. Groundwater samples taken from monitoring wells located around the plume illustrate that the contaminant concentrations decrease significantly with distance from the suspected source, and that the contamination is unlikely to extend off base (see Figures 5 and 6). Additionally, VOCs were not detected in groundwater samples taken from the Diablo Creek Golf Course irrigation well,

located west of the SWMU sites (Tetra Tech 2004a, Ramsey 2005). The sampling results indicate that these contaminants do not impact any off-base irrigation or drinking water wells.

Evaluation of Potential Public Health Hazards

The available information indicates that local residents are not exposed to groundwater contaminants from SWMUs 2, 5, 7, and 18. No one is drinking water from within the SWMU area and sampling data indicate that the contaminants from this source are not migrating off-base or affecting local off-base wells. The Navy continues to investigate remedial options to treat these plumes and their suspected source.

Sites 13 and 22

Nature and Extent of Contamination

Perchlorate, a rocket fuel component, has been detected in three of the four monitoring wells at Site 13 and four monitoring wells within Site 22 (Tetra Tech 2003e, 2005a). Explosives were not detected in these wells. The perchlorate concentrations were below currently available health-based screening values; the highest measured concentration was 2 ppb at one Site 13 monitoring well.

Groundwater is not used for drinking or other purposes in the area where perchlorate was detected. The nearest downgradient wells to Site 13 are in Willow Pass Park, the city park adjacent to the station. The two wells are located approximately ½ mile downgradient from Site 13, and a few hundred feet from the station fenceline (P Ramsey, USEPA, personal communication, 2004). One of the wells serves as the primary well, while the other serves as a back-up well, for irrigation and filling the Pixieland Amusement Park pond. Perchlorate was detected in the two wells (EPA 2005). The perchlorate concentrations were below currently available health-based screening values; the highest measured concentration was 2.9 ppb at the Willow Pass park back-up irrigation well.

The residential community, Dana Estates, is located on the western border of the station, downgradient from Site 22. One or two permitted irrigation wells, and possibly unpermitted irrigation wells, could exist in this community (K Stuart, Contra Costa County Environmental Health Department, personal communication, 2004). The nearest wells to Site 22 are at the Concord High School and Gehringer Park Recreation Club, which are located along the station's western border. Concord High School is located south of Site 22, adjacent to Dana Estates. The Gerhinger Park Recreation Club is located west of Site 22, downgradient from Site 22. These wells are used for irrigation only (Tetra Tech 2005b). Another off-base irrigation well, installed by the city of Concord within the last two years, is located between Site 13 and Site 22 where Willow Pass Boulevard crosses into the Inland Area (P Ramsey, USEPA, personal communication, 2005). Given the low levels detected in the monitoring wells and the distance from source areas to downgradient irrigation wells, it is unlikely that harmful levels of base-related perchlorate are in the water in these wells at levels that could cause health concerns.

Evaluation of Potential Public Health Hazards

Currently, no drinking water standard, or MCL, exists for perchlorate. However, the maximum measured concentrations of perchlorate (2 ppb for on-base; 2.9 ppb for off-base) are well under the California state action level, or public health goal (PHG), of 6 ppb for perchlorate (OEHHA 2004a). California's PHG is an estimate of the level of perchlorate in drinking water that would pose no significant health risk to individuals consuming the water on a daily basis over a lifetime. This level is based primarily on human studies involving perchlorate's effect on iodide uptake by the thyroid gland. The U.S. EPA also has studied extensively the toxic effects of perchlorate and currently uses a risk screening range of 4 ppb to 18 ppb perchlorate in drinking water.

Community members using groundwater wells located near the base, whether for domestic purposes, irrigation, or filling swimming pools, will not be exposed to harmful levels of base-related perchlorate. Both the on-base and off-base perchlorate concentrations were well below

levels of health concern. As a prudent public health action, ATSDR recommends that all residents using private wells for domestic water supply periodically inspect their well and their water quality.

Community members interested in having their well water tested at their own expense should contact a state-certified laboratory. A list of certified laboratories can be obtained from Contra Costa Health Services by contacting the Environment Health Office at 925-646-5225. Laboratory fees for testing for a full suite of chemicals range from approximately $300 to $400.

III.E. Ingestion of contaminants in beef from cattle grazing on the station.

Currently, the Inland Area is on reduced operational status and is not actively used for military operations. Of the Inland Area's approximately 5,200 acres of land, 4,491 acres (86%) are leased for cattle grazing (S. Tyahla, US Navy, personal communication, 2004) and are used as part of a tule elk reserve managed by the California Department of Fish and Game (Tetra Tech 2003d). The only land in the Inland Area not being leased for cattle grazing is the Administration area and a few isolated buildings (S. Tyahla, US Navy, personal communication, 2004). Approximately 375 cattle roam through the open grassland portions of the Inland Area, including the grasslands that surround Site 22 (S. Tyahla, US Navy, personal communication, 2004). Calves produced by the cattle grazing on the land are sold annually to other producers. These producers raise the calves in a different location, when they reach market weight they are used for commercial beef consumption (e.g., grocery stores, restaurants).

High arsenic levels were found in approximately 500 acres (11%) of the 4,491-acre land leased for cattle grazing. That said, however, arsenic was not detected in the vegetation in that area (S. Tyahla, US Navy, personal communication, 2004; M. Wallerstein and S. Tyahla, US Navy, personal communication 2004). Observations by Navy personnel indicate the cattle roam widely around the station, spending only a portion of their time on the contaminated land (S. Tyahla, US Navy, personal communication, 2004).

Some community members have expressed concern that people eating beef from cattle that had grazed on base could be exposed to arsenic at levels that could harm their health. To evaluate this concern, ATSDR used EPA's risk assessment methodology (EPA 1989) to estimate the arsenic concentration in beef from cattle that spent their entire life grazing on-base and cattle that spent their first year on base. The estimated concentration was compared with arsenic concentrations that have been measured in a variety of common foods, including meat. Details of the evaluation are shown in Appendix D.

Evaluation of Potential Public Health Hazards

Previous research indicates that the arsenic concentration in beef or milk from cattle grazing in areas with arsenic in the soil or vegetation is just a small fraction of the arsenic that is actually ingested by the cattle. Arsenic ingestion occurs while the cattle ingest large amounts of vegetation and small amounts of soil while foraging (EPA 1989).

ATSDR used the following assumptions to estimate the arsenic concentration in beef from the grazing cattle (see Appendix D for the basis of ATSDR's assumptions):

1. Cattle could gather 15% of their vegetation and soil from the Magazine Study Area.
2. While arsenic was not detected in the vegetation samples analyzed, the arsenic concentration was assumed to be equal to the detection limit in that analysis.
3. The most recent sampling event was used to calculate a conservative average soil concentration; this concentration was the average of the measured concentrations that were above the background level (this provided a conservative [high] estimate of the average soil concentration of arsenic).
4. All of the adult cattle diet was from foraged vegetation.
5. Calves were assumed to be weaned at 6 months, at which time they consumed approximately 60% of the vegetation and soil as an adult cow would.

6. The beef tissue concentration in the calves was the total of the arsenic ingested by milk and grazing; however after they were sold, ATSDR assumed the calves were no longer exposed to arsenic.

The results indicate that the arsenic concentration in the adult cattle and calves would be slightly less than the typical concentrations reported in grains, meat, fish and poultry. As a result, no health effects are expected for people who regularly consume beef from cattle or calves that graze on base.

III.F. Exposure of off-base military housing residents to pesticide-contaminated soil.

The Off-site Housing Area (OHA) of NWS SBD Concord comprises 63 acres of land in the western section of the Inland Area. Although the area occupies property from the Inland Area, it is considered off site from the station, given that no major thoroughfares connect the OHA to the base. OHA is composed of two sections: Quinault Village, constructed in 1964 and 1965, and Victory Village, constructed south of Quinault Village in 1989 (CDM 2003). The Navy vacated the off-site housing units in 2001 because of NWS SBD Concord's reduced operational status. Since then, the United States Coast Guard (USCG) has begun to re-occupy the units. Recent soil sampling in the OHA shows pesticide contamination that may have resulted from past applications (URS 2003). This section describes the nature and extent of the surface soil contamination surrounding the housing units and evaluates the public health implications.

Nature and Extent of Contamination

In 2003, the USCG conducted some soil sampling to evaluate the potential exposure to pesticides, specifically chlordane, dieldrin, and heptachlor epoxide, that were previously detected in surface soil at the housing projects (Hart Crowser 2003; URS 2003). Although ten different types of chemicals commonly used in pesticides were detected in these samples, only chlordane, dieldrin, and heptachlor epoxide were detected above ATSDR's CVs in a portion of the samples

from Quinalt Village. All of the chemicals detected in the soil samples from Victory Village were below ATSDR's CVs.

Evaluation of Potential Public Health Hazards at Quinault Village

Soil sampling results indicate that some portions of the soil surrounding the homes in Quinalt Village contain chlordane, dieldrin or heptachlor epoxide at concentrations greater than ATSDR's cancer CV but less than the non-cancer CV (see Appendix C). The EPA lists these chemicals as probable human carcinogens based on animal studies. These studies indicate that exposure to high concentrations of these chemicals could cause cancer in some animals; however, insufficient data exist to indicate if these chemicals could cause cancer in humans (EPA 2004b).

ATSDR's cancer CVs conservatively assume daily exposure to pesticides over the course of a lifetime. At NWS SBD Concord, the average tour for Navy- or USCG-enlisted personnel — and therefore the residence time in the housing area — is generally 3 years (G Smith, US Navy, personal communication, 2004). Estimated doses from exposure to pesticides in the soil, assuming daily exposures over a 3-year period, are well below those doses believed to cause an increase in cancer. Even if daily exposure occurs for extended periods of time (e.g., 30 years or more), estimated exposure doses still fall below levels believed to cause an increase in cancer. Therefore, ATSDR does not expect cancer effects for residents exposed to soil in Quinault Village. Because the pesticide concentrations exceeded their carcinogenic Public Health Goals (PHGs) in several of the soil samples, the USCG contractor recommended notifying the residents of the homes where these samples were collected of these findings and advising them of potential exposures to pesticides when digging or playing in bare soil areas (URS 2003).

As a prudent public health action, ATSDR recommends notifying Quinault Village residents about the community's sample results. Further, ATSDR recommends advising these residents that potential exposures to pesticides and other naturally occurring contaminants in the soil can be reduced by following good hygiene, including:

- wearing gloves when working with bare soil;
- not eating, drinking or smoking while working with the soil;
- washing and peeling home grown produce before consumption; and
- washing hands after working or playing in the yard.

In addition, maintaining vegetative ground cover (e.g., grass or plants) will significantly reduce exposures to all soil contaminants and leaving dirty shoes at the door will reduce the amount of soil contaminants that are brought into the home.

III.G. Exposure of mosquito abatement workers to contaminants in the Litigation Area.

In the Litigation Area, Contra Costa County Mosquito and Vector Abatement District (CCCMVAD) mosquito abatement workers inspect and sample ponded water for mosquito breeding, and spray breeding areas as necessary. As previously discussed (Section III.B), heavy metal contamination from previous site owners was found in this area. Mosquito workers could encounter contaminated soil, sediment, and surface water during their activities. Most mosquito abatement activities in the Litigation Area occur in RASS 1, and to a lesser extent in RASS 2, where the mosquito abatement ditches are located. Workers pass through RASS 3 to gain access to RASSs 1 and 2 (Tetra Tech 2003c). This section discusses the workers' exposure conditions in the Litigation Area and evaluates the public health implications.

Nature and Extent of Contamination

Past remedial actions addressed most of the contaminated soils in the Litigation Area. However, some contaminated soil was left in place because of concerns about disrupting critical habitats. Recent soil, sediment, and surface water samples indicate that the some metals are present at high concentrations (e.g., arsenic, antimony, cadmium, copper, lead, selenium, and zinc) (Tetra Tech 2003c).

Evaluation of Potential Public Health Hazards

Mosquito abatement activities are conducted 30 days per year. Inspection takes approximately 2 hours and spraying usually requires up to 4 hours. The same workers usually perform both activities. Workers wear protective clothing during these activities to protect against insecticide exposure, including long-sleeved shirts, long pants, steel-toed hip waders, goggles, gloves, and dust/mist masks (Tetra Tech 2003c).

Soil and sediment sampling results indicate the maximum concentration of several chemicals exceed their ATSDR CVs in RASSs 1, 2, and 3. Therefore, ATSDR calculated exposure doses for these chemicals, assuming 30 days of exposure per year over 30 years. When using the maximum concentrations, only arsenic had an estimated exposure dose above the health guidelines. The maximum concentration of arsenic in soil and sediment was found in RASS 1 (3,260 ppm), where most of the mosquito abatement activities occur. Still, the estimated exposure dose (0.00016 mg/kg/day) is several orders of magnitude lower than health effects levels reported in the scientific literature (no health effects occurred from exposure to 0.0008 mg/kg/day of arsenic; ATSDR 2000). Therefore, exposure to arsenic in the soil and sediment of the Litigation Area is not expected to result in harmful health effects.

The surface water in RASSs 1, 2, and 3 had 18 chemicals with maximum concentrations that exceeded their ATSDR CVs. Of the 18 chemicals, only antimony and arsenic had estimated exposure doses that were above health guidelines when assuming exposure to the maximum concentrations for 30 days per year over 30 years. Again, however, the estimated exposure doses calculated for antimony (0.00044 mg/kg/day) and arsenic (0.00022 mg/kg/day) are several orders of magnitude lower than health effects levels reported in the scientific literature: 0.35 mg/kg/day for antimony (EPA 2004), and 0.0008 mg/kg/d for arsenic (ATSDR 2000). Therefore, exposure to antimony and arsenic in the surface water is not expected to result in harmful health effects.

The actual exposure to the mosquito abatement workers is expected to be less than that calculated because they generally do not spend the entire 6 hours at a single location or return to

the same location with the maximum measured concentration during each visit. During their 30 visits over the course of a year, workers would only be exposed for a short period of time to any one location while conducting their activities. Therefore, exposure to high levels of contamination would be limited. The workers also wear extensive protective gear — including hip waders, masks, and gloves — which further protect them from incidental ingestion or dermal contact with contaminated soil, sediment, and surface water. Therefore under these conditions, workers performing mosquito abatement activities in the Litigation area would not be expected to develop adverse health effects resulting from their exposure to soil contaminants.

III.H. Exposure to contaminants in Suisun Bay resulting from recreational activities.

Suisun Bay is one of four interconnected subregions of the San Francisco Bay, a large estuary connected to large rivers and small ephemeral streams, urban and agricultural watersheds, and the Pacific Ocean (The Bay Institute 2003). The Suisun Bay borders NWS SBD Concord on the north. Currently, recreational activities in and around the station are limited due to the lack of accessibility and development, although some boating, fishing, duck hunting, and hiking does occur in the area near the station. However, fishing and duck hunting do not occur on NWS SBD Concord. This section describes the nature and extent of surface water and sediment contamination in and around Suisun Bay, results of fish tissue sampling, and public health implications for recreational users.

Nature and Extent of Contamination

Water quality in Suisun Bay is strongly influenced by current and historic inputs from industrial, agricultural, mining, and urban inputs — including automobile traffic and storm water runoff — from NWS SBD Concord and from other neighboring and upstream sources. The Tidal and Litigation Areas of NWS SBD Concord are located adjacent to Suisun Bay. Runoff from NWS SBD Concord drains almost exclusively northward into the Suisun Bay (Tetra Tech 2003c). While some contaminants from the station are likely to have migrated to Suisun Bay, remedial

activities at the station continue to reduce the potential for additional contaminant input from these on-base sources.

The San Francisco Estuary Institute (SFEI), in collaboration with California EPA's San Francisco Bay Regional Water Quality Control Board, implemented a regional monitoring program (RMP) in 1993. That program focuses on annual monitoring of contamination, bioaccumulation, and toxicity in the San Francisco Bay. SFEI tests surface water and sediment in the four subregions of the Bay, including Suisun Bay, for trace elements, pesticides, PAHs, and PCBs. Results for the sampling locations closest to NWS SBD Concord, Pacheco Creek, and Grizzly Bay indicate that some surface water and sediment samples contained concentrations of some metals and PAHs above the ATSDR health-based CVs.

The Navy analyzed fish tissue from the Tidal Area for metals, PCBs, pesticides, and dioxins in June 1998. Sculpin, stickleback, and mosquitofish collected from Tidal Area surface waters had similar contaminant concentrations as striped bass collected from Suisun Bay in 1997 by SFEI RMP (Tetra Tech 1999).

A variety of shorebirds and ducks have been observed in Suisun Bay and the Tidal and Litigation Areas of NWS SBD Concord. In addition, duck-hunting clubs maintain thousands of acres of wetlands along the northern shore of Suisun Bay as migratory waterfowl habitat. Duck tissue data for Suisun Bay are limited. One small study conducted in March 1989 collected six ruddy ducks from Suisun Bay and Tomales Bay in the San Francisco Bay (USGS 2004). Tissue samples from some of the ducks had reportable concentrations of PCBs and selenium.

Evaluation of Potential Public Health Hazards

ATSDR reviewed results for the sampling locations closest to NWS SBD Concord, Pacheco Creek and Grizzly Bay, to identify if contaminant concentrations measured in the Suisun Bay area would be expected to cause health effects for recreational users, specifically boaters and swimmers/waders (see Appendix C). For the evaluation, ATSDR conservatively assumed that recreational users had direct contact with the surface water and sediment of Suisun Bay both

days of every weekend (104 days per year) and were in direct contact with the maximum measured concentration during each visit. Even with these conservative assumptions, all of the estimated exposure doses were below health guidelines. Therefore, exposure to surface water and sediment in the Suisun Bay is not expected to cause health effects for recreational users.

The California Office of Environmental Health Hazard Assessment (OEHHA) has issued an interim fish consumption advisory for the entire San Francisco Bay, including Suisun Bay, due to health concerns based on exposure to sport fish potentially contaminated with methylmercury, PCBs, dioxins, and organochlorine pesticides (e.g., DDT). The advisory recommends that adults limit their consumption of San Francisco Bay sport fish to two meals per month, and to not eat any striped bass over 35 inches. The advisory also recommends that women who are pregnant, could become pregnant, or are breast-feeding, and children under 6 years of age, to not eat more than one fish meal per month and to not eat any meals of large shark (over 24 inches) or large striped bass (over 27 inches). The advisory does not apply to salmon, anchovies, herring, and smelt caught in the bay, other ocean-caught sport fish, or commercial fish (OEHHA 2004b).

ATSDR evaluated the fish data collected from the Tidal Area and Suisun Bay and concluded that fish consumers who follow the OEHHA guidelines for local fish consumption would not be expected to develop adverse health effects due to periodic consumption of local fish.

Currently, OEHHA has a duck consumption advisory listed for the Suisun Bay area due to elevated concentrations of selenium (SFEI 2004, RWQCB 2002). The advisory indicates people should not eat duck livers or more than 4 ounces of scaup or scoter meat in any two-week period. Details of the advisory are available in the hunting regulations produced by the California Department of Fish and Game (DFG 2004). Given the available information, ATSDR expects that the OEHHA advisory is prudent and protective.

IV. Community Health Concerns

Throughout the PHA process ATSDR gathered information about the local community's exposure concerns; specifically, situations or activities that community members suspect could bring them into contact with environmental contaminants released at NWS SBD Concord. Most of these concerns were identified during the ATSDR site visits in 1991 and 2004 through meetings with state, local, and Navy officials, and community members, and through review of site documents, including NWS SBD Concord's Community Relations Plan (CRP). The CRP provides guidance for involving the community and other interested parties in the remediation decision-making process and for distributing information to these parties. The Restoration Advisory Board (RAB) also provides a forum for discussion of community health concerns.

Several exposure concerns have been brought to ATSDR's attention. ATSDR addresses many of these concerns in the "Evaluation of Environmental Contamination and Potential Exposure Pathways" section of this PHA. The following are additional concerns expressed by community members.

Spent nuclear fuel trans-shipment

Some community members are concerned that there could be a danger from the transport of spent nuclear fuel through the station.

Spent nuclear fuel is the used fuel that has been removed from a nuclear reactor. The U.S. Department of Energy (DOE) plans to ship approximately 0.5 metric tons of spent nuclear fuel from foreign research reactors located in Pacific Rim countries through NWS SBD Concord to a storage site in eastern Idaho. DOE plans to make five or less rail shipments of 15 casks (total) of spent nuclear fuel and target material between 1998 and 2009. The first of these shipments from South Korea occurred July 21–22, 1998, and arrived safely in Idaho on July 23, 1998 (CEC 1998).

The risk of a transport accident resulting in a release of materials from these shipments is very low. The 26-ton casks used to transport the spent nuclear fuel have 8-inch-thick walls made of stainless steel and lead. They are well shielded, extremely rugged, and designed to withstand severe accident conditions. For example, the casks will not leak radioactive materials as a result of a 30-foot drop onto a hard surface (equivalent to about a 70-mph vehicle crash), exposure to fire, immersion in water, or a drop onto a steel pin (test for puncture resistance) (CEC 1998). In addition, in cooperation with state and local communities, DOE has developed intricate transportation plans to ensure that the travel route is free of potential hazards. Constant communications are maintained during shipment, emergency response crews are available all along the route, and local emergency responders stationed along the route have been adequately trained (CEC 1998).

An environmental assessment, conducted by the Navy to identify potential environmental effects of using NWS SBD Concord as a transshipment port, concluded that each shipment will be completed on station within 24 hours in a safe, secure, and accident-free manner, without significant contamination or adverse impact to the public, to workers, and to the environment (USN 1996a). The public, workers, and the environment will be protected because of the following:

1. Transshipment activities at the station are well separated from neighboring industry or residences;
2. Transshipment workers are well trained in hazardous materials handling;
3. Transshipment containers have been designed to facilitate remote handling to reduce potential worker exposures; and
4. Transshipment monitoring programs are in place to protect workers from overexposure.

Community members with additional questions about the nuclear fuel shipments may contact the DOE Public Affairs Office at 202-586-5575.

Wood from dunnage, possibly treated with pentachlorophenol, was used by community members to build fences.

There are reports that community members in Bay Point built fences in residential areas with lumber from dunnage and from shipping crates provided by NWS SBD Concord. Most of the shipping crates were treated with pentachlorophenol (PCP), a wood preservative (Tetra Tech 1999). There is concern that the PCP could have leached into the soil and pose a health hazard to those who come in contact with it.

Similar wood was also disposed of at the Wood Hogger Site (Site 11). ATSDR reviewed the sampling data for Site 11 to determine what types of soil PCP levels might be expected in areas with these fences, and if those levels could cause adverse health effects. The sampling results indicate that the levels of PCP in soil from Site 11 are significantly below ATSDR's CVs. In addition, the contamination at Site 11 came primarily from buried PCP-treated wood chips, we expect the soil levels near fences built with PCP-treated wood would be even lower. Therefore, ATSDR concludes that soil contamination from PCP-treated wood used to build fences would not pose a health hazard.

Other industrial impacts

There are several industrial facilities near the Tidal Area of NWS SBD Concord. Some local residents have expressed concerns about human health and ecological impacts associated with those facilities. In particular, the abandoned Chemical and Pigment Company facility borders the Tidal Area and includes a previously uncovered contaminated soil stockpile. California's Department of Toxic Substances Control (DTSC) is the lead agency overseeing environmental activities at the Chemical and Pigment Company facility. In January 2004, DTSC removed the stockpile of soil and sealed the underlying concrete foundation. DTSC continues to treat the stormwater and is planning additional environmental investigations. More information about this site is available from Ms. Jayantha Randeni (DTSC RPM) (510-540-3806). More information about the other sites under DTSC investigation and remediation can be found at DTSC's Web site, www.dtsc.ca.gov, or by calling (800) 728-6942.

Controlled burns

A community member expressed concern about the controlled burns at NWS SBD Concord. The Navy conducts periodic training burns at NWS SBD Concord, which serve a dual purpose. First, the burns allow the station's fire department to train with other fire fighting agencies with which they have mutual-aid agreements. Second, they create firebreaks between the station and off-base property. This ensures that if a fire were to break out on the station, the fire department would be able to extinguish it before it spreads off site into the surrounding community.

The fire department takes many precautions and complies with appropriate regulations to ensure training fires are conducted safely and to minimize the effect on the community. Training fires are planned by state-certified fire personnel and coordinated with the Bay Area Air Quality Management District. A public notice is published in the Contra Costa Times newspaper a few days prior to burning. Burning does not occur on the weekends or on days in which conditions are unfavorable for fires. Each training session burns 1 to 3 acres, and lasts approximately 2 hours, with additional time spent cleaning up. Because these are training sessions, fires are allowed to burn for a short time, extinguished, re-lit, extinguished, and so on. The fires are not allowed to become very large. Controlled burns are conducted when the wind is coming out of the west so that it carries smoke away from residential areas. The smoke typically dissipates by the time it reaches the eastern NWS SBD Concord property boundary. Prior to last year, small controlled burns were occasionally conducted inside the magazine areas, but this practice was stopped once the extent of the arsenic contamination was discovered. In spite of these precautions, it is possible that sensitive individuals could experience temporary respiratory irritation or an exacerbation of existing respiratory conditions due to the smoke. That said, however, the smoke is not expected to cause long-term health effects for the local community.

Past health effects from 1944 explosion

A community member is concerned that residents who lived in the area when the 1944 explosion occurred could have developed adverse health effects following exposure to air emissions from the blast.

On July 17, 1944, approximately three and one-half million pounds of explosives in the hold of a ship and in railroad boxcars on an adjoining pier detonated. Much of the station's Tidal Area was destroyed: the blast killed 320 sailors and merchant mariners, and injured 390 more. In the nearby community of Port Chicago some buildings were damaged, but there was no loss of life. Unexploded munitions and munitions that had undergone incomplete detonation were scattered throughout the Tidal Area in the vicinity of the docks and railroad car barricades; some of which were found in the tidal marsh during a 1983 investigation (E & E 1983).

Unfortunately, no air sampling data is available from this event to estimate the resulting air emissions. Therefore, ATSDR cannot conclusively evaluate the potential exposure to air contaminants. This type of explosion, however, typically consumes the majority of the original explosive material and releases substantial amounts of heat, pressure and shards of material traveling at high speeds, in addition to relatively small quantities of chemical by-products released during the explosion and combustion process. The heat and pressure of the explosion could emit chemicals hundreds of feet up into the air. The resultant plume would move slowly downwind and disperse. During the dispersion process, the air concentration of the contaminants would be reduced continually by mixing with the surrounding air so that ambient concentrations just a few hundred feet downwind would be significantly lower than those adjacent to the explosion. Therefore, people who were far enough away from the explosion to not suffer immediate effects from the heat, pressure or shrapnel released by the explosion were likely not exposed to air contaminants at levels that would be expected to cause long-term health effects.

Base Realignment and Closure and future land use issues, particularly the Tidal Area Landfill

Base Realignment and Closure (BRAC) is the process DOD uses to reorganize its installation infrastructure to support its forces more efficiently and effectively, to increase operational readiness, and to facilitate new ways of doing business. Congress has authorized a BRAC round in 2005. The DOD report to the BRAC Commission recommended closure of most of the NWS SBD Concord Inland area. Some Inland Area facilities necessary to support the operations in the

Tidal Area, and the Tidal Area were recommended for transfer to the Army (DoN 2005). These are the initial recommendations to the BRAC Commission and Congress, and could be modified in the commission's recommendations to the President. For more information about the BRAC process and BRAC 2005, please visit http://www.brac.gov/ and http://www.defenselink.mil/brac/index.html

Some community members are concerned that NWS SBD Concord PHA will not take into account future land uses that could result from the BRAC process. ATSDR's PHA is based on what is known about past and current land use, and future land uses that have been defined by the current property owners. Because we currently have no information about the potential land uses if the base is transferred to the community, they can not be specifically addressed in this document. However, in the event NWS SBD Concord remains on the final BRAC list, DOD will still be responsible for ensuring that all known contamination is addressed in accordance with all applicable federal, state, and local environmental laws and regulations. Oversight and enforcement by federal and state environmental regulators are designed to ensure that the Navy sponsored cleanup is protective of human health and the environment (G Smith, U.S. Navy, personal communication, 2005).

In the event that new information becomes available and a request is made to ATSDR, the findings of this PHA may be reevaluated if the new information is likely to change ATSDR's original decision about public health impacts.

Former copper smelter located in Tidal Area

The Tidal Area is located on a site originally occupied in part, from 1901 to 1908, by a copper smelting operation, and later by the Pacific Coast Shipbuilding Company. The copper smelting and ship building operations took place approximately 1,000 feet north of what is now the Tidal Area Landfill (Tetra Tech 2003f). A community member expressed concern that people could be exposed to contaminants from the former copper smelting operation. Primary contaminants of copper smelting include heavy metals, such as arsenic, cadmium, and manganese.

The Tidal Area, now under the control of the U.S. Army, has restricted access to the public, which prevents community members from coming into direct contact with this area. The evaluation of potential exposure to contaminants in the Suisun Bay indicates that this area would not be expected to cause health effects for recreational users, or for fishers and duck hunters who follow the OEHHA recommendations.

V. Conclusions

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

From this evaluation, ATSDR concludes that the environmental contamination at NWS SBD Concord poses ***no apparent public health hazard***. This means people may be exposed to some base-related environmental contaminants, but the exposures are below levels expected to cause harmful health effects.

1. Trespassers riding dirt bikes and all-terrain vehicles (ATVs) in the Litigation Area could be exposed to soil contaminants. The estimated exposure is, however, below levels of health concern. To prevent future trespassing, in January 2005 the Navy completed fencing this area and completed the posting of signs warning trespassers that the area is government property and contains hazardous substances. ATSDR categorized possible trespasser exposure as a ***no apparent public health hazard***.

2. Elevated arsenic levels were found in the soil of the Magazine Area/Site 22 (which includes both Site 22 and the surrounding magazine area). ATSDR determined that while the community could be exposed to small amounts of arsenic in the wind-blown dust from the Magazine Area, it does not present a public health hazard to residents living near the area or to students attending Concord High School. ATSDR categorized this as a ***no apparent public health hazard***.

3. Groundwater contaminants have been detected at some on-base locations. That said, however, groundwater from beneath the base is not used as a source for drinking water. Results of the evaluation indicate that none of the off-base wells are likely to be affected

by base-related contaminants at levels that would be expected to cause health effects. ATSDR categorized this as a ***no apparent public health hazard***. As a prudent public health action, ATSDR encourages residents using private wells for domestic water supply to periodically inspect their well and their water quality.

4. Most of the Inland Area is leased for cattle grazing. Elevated arsenic levels were found in soil of the Magazine Study Area. Results of the evaluation indicate that small concentrations of arsenic would be expected in the beef; however, the level would be less than the typical concentrations reported in grains, meat, fish and poultry. No health effects are expected for people who regularly consume beef from cattle or calves that graze on base. ATSDR categorized this as a ***no apparent public health hazard***.

5. Elevated concentrations of some pesticides have been detected in some of the soil samples from Quinault Village. Results of the evaluation indicate that the USCG families living in that area would not be exposed to pesticides at levels that would be expected to cause health effects. As a prudent public health action, ATSDR recommends that residents of Quinault Village be notified of the sample results and advised on methods to reduce their potential exposure to pesticides and naturally occurring soil contaminants. ATSDR categorized this as a ***no apparent public health hazard***.

6. Environmental contaminants were found in portions of the Litigation Area where mosquito abatement activities occur. The estimated exposures of mosquito abatement workers to those contaminants were below levels of potential health concern. ATSDR categorized this as a ***no apparent public health hazard***.

7. Recreational activities in Suisun Bay near the base are limited, but include some boating, fishing, duck hunting, and hiking. Due to a variety of potential sources, environmental contaminants have been measured in surface water, sediment, fish, and duck tissue in the bay. The estimated exposure of recreational users to the environmental contaminants is not expected to cause any type of health effect. Consumers of fish and duck from Suisun Bay who follow the OEHHA guidelines are not expected to be exposed to levels of

contaminants that could harm their health. ATSDR categorized this as a ***no apparent public health hazard***.

Recommendations

None.

VII. Public Health Action Plan

The public health action plan (PHAP) for NWS SBD Concord contains a description of actions taken or to be taken by NWS SBD Concord, ATSDR, and USEPA at and in the vicinity of the site. The purpose of the PHAP is to ensure that this PHA not only identifies and evaluates potential exposure concerns, but also identifies actions that have been taken or need to be taken to prevent adverse human health effects resulting from exposure to hazardous substances in the environment. The public health actions that are completed, ongoing, planned, or recommended are

Completed Actions

1. Since 1983, the Navy has identified 57 potential hazardous waste sites at NWS SBD Concord that required additional investigation or remediation to protect human health or the environment. Of the 57 IRP sites, 26 require no remediation because environmental investigations indicate they are not hazardous to human health, six have been remediated to cleanup standards, three were transferred to the underground storage tank program for investigation and remediation, and 22 are undergoing additional investigation or remediation.

2. ATSDR initially visited NWS SBD Concord in 1991 to identify potential exposure situations related to environmental contamination at the facility. That visit concluded that although areas of environmental contamination were present on the site, there were no potential exposure situations requiring immediate attention. ATSDR visited the site again in January 2004 to obtain updated information related to environmental studies at the station to complete the public health evaluation.

3. In January 2005, to prevent future trespassing, the Navy completed fencing this area and completed posting signs warning trespassers that the area is government property and contains hazardous substances.

Ongoing Actions

1. Twenty-two sites are currently in various stages of study, cleanup, or monitoring.

2. The Navy is evaluating potential cleanup alternatives for SWMUs 2, 5, 7, and 18.

Planned Actions

1. The Navy plans to conduct the following activities in the Inland Area:

    a. Sample tissue from a tule elk, when available, to determine arsenic levels of herbivorous mammals on the station.

2. Evaluate data quality and results from the December 2004 groundwater sampling conducted by EPA at sites adjacent to and downgradient from Site 13.

Further Action

ATSDR offers the following as a prudent public health actions:

1. Residents of Quinalt Village should receive basic information about the soil sampling conducted in that area. Information should include the results and advice on how they can reduce their potential exposure to pesticides and naturally occurring soil contaminants.

2. Residents using private groundwater wells for their drinking water supply are encouraged to periodically have their drinking water tested.

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Tables

Table 1. Evaluation of Public Potential Health Hazards at NWS SBD Concord

Site	Site Description/Waste Disposal History	Investigation Results/Environmental Monitoring Results	Corrective Activities and/or Current Status	Comments
Tidal Area Sites				
Site 1 Tidal Area Landfill	The Tidal Area was originally occupied, in part, by a copper smelting operation from 1901 to 1908, and later by the Pacific Coast Shipbuilding Company. Site 1 was a disposal area for Naval Weapons Station Seal Beach Detachment (NWS SBD) Concord from approximately 1944 to 1979. The landfill is approximately 13 acres and contains an estimated 33,000 tons of buried waste. Waste includes household garbage from the station and surrounding communities, solvents, acids, creosote-treated timbers, building materials, ordnance materials (including inert munitions), and shipboard waste. Responsibility for the area was transferred to the Army's Military Traffic Management Command in 1999.	1983: The base-wide initial assessment study (IAS) included the Tidal Area Landfill. 1988–1991: A formal Site Inspection (SI) included groundwater, surface water, soil, and sediment samples from the landfill. Results revealed volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), polycyclic aromatic hydrocarbons (PAHs), dieldrin, Arochlor-1260, and nitrobenzene. 1993: Confirmation sampling of a limited number of soil, sediment, and groundwater samples did not detect organic compounds or pesticides. 1995–1998: Heavy metals detected in the groundwater were not observed to be migrating from the landfill. 2003: The Navy conducted additional groundwater sampling. Heavy metals were detected.	1995–1998: The clean-up plan was based on an engineered native soil cap was proposed. 1999: The Navy issued a Proposed Plan and held a public meeting for community feedback on the cleanup approach. 2003: The Navy completed an additional groundwater study. 2004: The Navy is discussing and finalizing the Tidal Area Landfill Record of Decision (ROD) with the regulatory agencies. Remedy includes a soil cap with supplementary ditches and re-vegetation; land use and access restrictions; and monitoring of groundwater, landfill gas, and landfill cap integrity to ensure future effectiveness. 2009: Estimated Cleanup Complete	The public does not have access to the landfill itself. However, the Tidal Area is located adjacent to Suisun Bay. ATSDR evaluated the surface water, sediment, and fish data of Suisun Bay near the station since the public is potentially exposed to these media through recreational activities (boating/hiking), as well as via ingestion of fish and ducks caught in Suisun Bay near the station. See Table 2 for further detail.

Site	Site Description/Waste Disposal History	Investigation Results/Environmental Monitoring Results	Corrective Activities and/or Current Status	Comments
Site 2 R Area Disposal Site **Site 9** Froid and Taylor Road Disposal Area **Site 11** Wood Hogger	Site 2, 80-acres in a tidal marsh, used from the late 1940s until about 1976, for disposal of materials generated during the segregation of conventional munitions returned from the Pacific. Potential wastes include ordnance, VOCs, SVOCs, pesticides, PCBs, and metals. Site 9, 5.5-acres, contains an estimated 50 cubic yards of waste deposited between 1944 and 1979. Scrap metal and other debris were found in the adjacent tidal marsh. Potential waste types include metals, ordnance, VOCs, and SVOCs. Site 11, 51 acres and consists of wood chips deposited as fill in 10 acres of wetland adjacent to the hogger. Some wood was treated with pentachlorophenol (PCP), a wood preservative. Potential waste types include VOCs, SVOCs, metals, and pesticides.	1983: The base-wide IAS determined the potential for contamination at the Tidal Area Sites. 1992: The SI was conducted to obtain more information. A Resource Conservation and Recovery Act (RCRA) Facility Assessment (RFA) was also conducted. 1994–1998: The Navy prepared for and conducted additional studies, including an RI and RFA Confirmation Study (RFACS). 1999: The Draft RI discussed initial sampling results and conducted a confirmation groundwater study. Some levels of contaminants exceeded industrial preliminary remediation goals (PRGs) but the risks were at the lower end of the risk range. January 2002: The Navy completed a Revised Draft Final ERA and submitted it for public review. August 2003: The Navy submitted a Revised Draft Final RI to address regulatory agency comments.	Estimated Cleanup Complete: 2007	The public does not have access to Sites 2, 9, and 11. However, the Tidal Area is located adjacent to Suisun Bay. ATSDR evaluated the surface water, sediment, and fish data of Suisun Bay near the station since the public is potentially exposed to these media through recreational activities (boating/hiking), as well as via ingestion of fish and ducks caught in Suisun Bay near the station. See Table 2 for further detail.

Site	Site Description/Waste Disposal History	Investigation Results/Environmental Monitoring Results	Corrective Activities and/or Current Status	Comments
Site 7 1944 Explosion - Docks	On July 17, 1944, approximately three and one-half million pounds of explosives in the hold of a ship and in railroad boxcars on an adjoining pier detonated, destroying much of NWS Concord Tidal Area and the community of Port Chicago. Because of the explosion, munitions that had not exploded or had undergone incomplete detonation were scattered throughout the Tidal Area in the vicinity of the docks and railroad car barricades.	1944: A Navy survey team conducted an extensive investigation of the explosion. While attempting to determine the extent of the crater on the bottom of the berthing area, the survey team found many "steel obstructions" at 81 feet below the mean lower low water level. Unexploded munitions were found throughout the Tidal Area.	1959: EOD personnel recovered munitions lying exposed beneath the piers. 1983: The Navy conducted an Initial Assessment Study. Occasionally, degraded munitions are found in the tidal marsh. 1983: EOD personnel at NWS SBD Concord determined that the munitions located on the bottom of the berthing docks and in the marsh area do not threaten human health or the endangered species in the area. The Navy Assessment and Control of Installation Pollutants (NACIP) Department determined that no further investigation is warranted.	The public does not have access to Site 7. ATSDR does not have any information about the air emissions from the 1944 explosion. However, because this was an acute, or short-term, exposure, ATSDR believes that residents would not have developed long-term adverse health effects from the 1944 Port Chicago explosion. See the Community Concerns section of this PHA for more information.

Site	Site Description/Waste Disposal History	Investigation Results/Environmental Monitoring Results	Corrective Activities and/or Current Status	Comments
Site 8 1944 Explosion – Ryer Island	Two of the sixteen boxcars that were located on the pier at the time of the 1944 explosion were blown into the bay by the initial explosion.	1944: The cargo of the boxcars consisted of AN-MK 47 or AN-MK 54 depth bombs and AN-M7 or AN-N7 incendiary clusters, and was still blocked and braced.	The two boxcars were raised and buried on Navy-owned Ryer Island, north of the Tidal Areas. Ryer Island was formerly used as a hunting area for a duck club. 1983: EOD personnel determined that the boxcars reportedly buried on Ryer Island do not constitute a threat to human health or the environment. The NACIP Department determined that no further investigation is warranted.	No exposure concerns. The public does not have access to this site. The level of contaminants identified in the surface water, sediment, fish, and duck tissue indicate that recreational users in this area are not likely to be exposed to contaminants at levels that could cause health effects.
Site 10 Nichols Road Site	A small isolated pile of dark reddish-brown material, possibly spent coke, was located at the side of Nichols Road in the Port Chicago area. The pile of material had apparently been located there since 1965, when the Navy acquired the property. The spent coke pile apparently was used as support material for a cattle-loading ramp. The site contains 5 cubic yards of waste and existed from at least 1962.	May 1982: Public Works personnel collected a grab soil sample of the material for heavy metal analysis. The laboratory results indicated a lead concentration only slightly higher than the levels of lead usually found in natural soils in the region. No other heavy metals were detected.	1983: Since sampling showed no significant contamination at this site, the NACIP Department concluded that the Nichols Road material does not pose a significant threat to the environment and has determined that no further study is warranted.	No exposure concerns. Environmental investigations indicate low levels of environmental contamination. In addition, the public does not have access to this site.

Site	Site Description/Waste Disposal History	Investigation Results/Environmental Monitoring Results	Corrective Activities and/or Current Status	Comments
Site 12 Port Chicago	The explosion of July 1944, caused extensive damage to Port Chicago, a town located just south of the NWS SBD Concord Tidal Area. This destruction prompted the Navy to propose land acquisition programs to remove the civilian population from within the Explosive Quantity-Distance Separation Arcs of the ammunition loading piers. In 1967, the Navy received approval for the acquisition of 5,021 acres of land within a 2-mile radius of the loading piers. The town of Port Chicago was subsequently demolished. The town existed from the 1930s to 1976.	1983: Site 12 was included in the base-wide IAS.	1983: Waste at this site was estimated to be insignificant. The NACIP Department determined that no further study is warranted.	No exposure concerns. Environmental investigations indicate low levels of environmental contamination. In addition, the public does not have access to this site.
Site 30 Taylor Boulevard Bridge	Site 30 was discovered during the 1995 RI for Sites 2, 9, and 11. The site is located on a wetland and is less than 1 acre. The site contains visible surface debris (e.g., glass, ceramics, and wood).	February 1996–1998: The Navy collected sediment samples to assess the nature and extent of chemical contamination. In 1997, the Navy conducted sampling for the RI. 2002: Additional sampling indicated elevated concentrations of inorganic chemicals (primarily lead). 2003: Additional sampling is planned.	2003: An FS will be conducted following additional sampling to determine the most appropriate cleanup alternative. Estimated Cleanup Complete: 2009	No exposure concerns. The public does not have access to this site.

Site	Site Description/Waste Disposal History	Investigation Results/Environmental Monitoring Results	Corrective Activities and/or Current Status	Comments
Site 31 Area of Concern (AOC) 1	AOC1 is an underdeveloped 17.2-acre site off of Port Chicago Highway, about 1 mile east of the eastern entrance to NWS SBD Concord. The site is the former location of a nitrogen-phosphorous-potassium (N-P-K) fertilizer plant operated from 1955 to 1976, by Union Oil Company of California. In 1983, the Navy acquired the property to expand the safety buffer for pier-side munitions handling. In 1986, all buildings at the site were demolished and removed. In 1998, the Contra Costa Water District (CCWD) installed a pump station at the site, making the Navy aware of potential contamination at AOC 1.	1998: When the CCWD installed a pump station at the site, samples were collected to determine appropriate disposal of excavated soils. The samples showed that the soils were contaminated with lead, mercury, and selenium. 1999–2001: The Navy conducted a Preliminary Assessment (PA) and SI to further assess the degree of contamination, and identified three types of waste materials at the site: cinder roadbed material, ash-like material, and waste gypsum. Sampling showed that both the cinder roadbed material and the ash were contaminated with high concentrations of lead, selenium, and mercury.	2002: The Navy decided to promptly address ecological risks associated with metals-contaminated waste materials by conducting a Time-Critical Removal Action (TCRA) to excavate and remove the most contaminated wastes from the site. The removal action was completed in September 2002. 2003: The Navy began a RI at Site 31 to provide a more comprehensive evaluation of any remaining contamination risks. Estimated Cleanup Complete: 2010	No exposure concerns. The public does not have access to this site.

Site	Site Description/Waste Disposal History	Investigation Results/Environmental Monitoring Results	Corrective Activities and/or Current Status	Comments
Solid Waste Management Units (SWMUs)				
SWMU 2 (Building IA-7) Fire Station **SWMU 5** (Building IA-12) Locomotive Repair Shop **SWMU 7** (Buildings IA-15 and IA-16) Welding, Machine, Metals, Forge, Automotive Repair, and Paint Shops **SWMU 18** (Building IA-51) Steam-cleaning Facility	SWMU 2, Building IA-7, old fire station. Between 1969 and 1973 fuel oil and napalm were burned in a shallow pit. Residues were scraped off the ground and disposed of in Seal Creek. SWMU 5, Building IA-12, was the locomotive repair shop. Operations included oil storage tanks and battery maintenance. SWMU 7, Buildings IA-15 and IA-16. Previous machine shops, paint shops and offices. Included sumps storage tanks for oil, solvent, paint. SWMU 18, Building IA-51, was used as a steam cleaning facility for locomotives, trucks, and other vehicles, and as a tire maintenance shop until the mid-1970s. Oily waste from the steam cleaning operations was drained directly into a sump. The sump drained to the storm drain system, which in turn drained into Seal Creek.	June 1992: The California DTSC performed a RFA to evaluate potential for release of hazardous substances. 1994: Six soil samples from the SWMU 5 tank excavation detected total petroleum hydrocarbons (TPH). VOCs, PAHs, TPH-diesel, benzene, toluene, ethylbenzene, and total xylenes were not detected. 1997: Significant contamination related to the reported burning and disposal activities was not discovered. 1999: Groundwater monitoring was conducted at the four SWMUs. September 1999: Following SWMU 7 tank removal, removal of soil contamination occurred beneath three of the four tanks. Access to the residual soil was obstructed by utilities, and Building IA-12. 2002: Draft RI concluded groundwater below the SWMU sites contain unsafe levels of trichloroethylene (TCE) and tetrachloroethylene (PCE).	June 1992: Building IA-12's (SWMU 5) underground storage tank (UST) was removed. 1994: Based on the 1994 SWMU 5 sample results, 35 cubic yards of contaminated soil were excavated for off-site disposal. 1995: Case closure approval for the SWMU 5 UST removal was obtained. 1996: SWMU sites were proposed for a groundwater investigation to evaluate potential contamination by VOCs. January 1999: The four USTs were removed from SWMU 7. 2003: The Navy began preparing a soil gas survey to be included in the RI. An FS will then be conducted to determine the most appropriate cleanup response. Estimated Cleanup Complete: 2008	Elevated levels of TCE and PCE were found in groundwater below the SWMU sites. Groundwater monitoring results indicate that contaminant plumes are confined to the base. The public has no exposure to the contaminated groundwater. See Table 2 for further detail.

Site	Site Description/Waste Disposal History	Investigation Results/Environmental Monitoring Results	Corrective Activities and/or Current Status	Comments
Litigation Area Sites				
RASS 1 (Sites 4 & 5) Allied Sites A & B	RASS 1, about 210 acres near Suisun Bay, primarily comprised of tidally influenced brackish wetland. The Navy did not conduct any operations that contributed contamination; but has used the properties as buffer zones. The major contaminant sources were historic spills from adjacent businesses: Allied Signal/General Chemical facility and the Chemical and Pigment Company facility upstream on Nichols Creek. Site A is a 3 acre marshy area adjacent to the northwest portion of the Allied Signal property. Site B, contiguous to Site A, is approximately 8 acres and extends southward. In 1976, the California Water Quality Control Board determined that the site was contaminated with low pH runoff, possibly from the Allied Signal facility. The site contains about 5 acres of contaminated soils.	1976**:** The California Department of Fish and Game collected marsh water samples and found contamination due to low pH runoff, possibly from the Allied Signal plant's operations. 1977: Allied Signal conducted soil sampling in this area to determine the extent of contamination. 1980: The Navy included the site in the 1983 base-wide IAS. 1980-1981: Soil samples showed high levels of metals and one showed a low pH value. 1988: The U.S. Army Corps of Engineers (USACE) completed a RI/FS of the contaminated sites. The RI identified six metals (arsenic, cadmium, copper, lead, selenium, and zinc) as chemicals of concern, and the FS recommended remedial alternatives and soil cleanup criteria for each RASS.	1977: Allied Signal placed about 7,800 cubic yards of site-contaminated soils behind a dike and applied agricultural lime to control runoff. 1992-1995: The Navy removed the most contaminated soil from a portion of each site. Some contaminated soil was left in place to avoid destroying sensitive habitats. 1996: Completed re-vegetation. The Navy implemented a monitoring plan to assess effects of contaminants left in place. June 2003: The Navy's 5-Year Periodic Review indicated the remediation was successful where implemented and recommended additional study to address the potential ecological risk where contamination is still present. 2003: The Navy began conducting an additional ecological study.	Elevated levels of heavy metals were found in this area. Although the general public does not have access to RASS 1, mosquito abatement workers conduct their activities at this site. Results of the evaluation indicate that mosquito abatement workers are not exposed to environmental contaminants at level that could cause health effects. See Table 2 for further detail. Further, the Litigation Area is located adjacent to Suisun Bay. ATSDR evaluated the surface water, sediment, and fish data of Suisun Bay near the station since the public is potentially exposed to these media through recreational activities (boating/hiking), as well as via ingestion of fish and ducks caught in Suisun Bay near the station. Recreational users are not expected to experience health effects. See Table 2 for further detail.

Site	Site Description/Waste Disposal History	Investigation Results/Environmental Monitoring Results	Corrective Activities and/or Current Status	Comments
RASS 2 (Site 3) Kiln Site	RASS 2 is approximately 5 acres in size and is located on NWS SBD Concord property about 400 yards west of the Allied Chemical Company and immediately north of the Southern Pacific Railroad tracks. The Navy purchased the RASS 2 property in 1969. The Navy did not conduct any operations on the site that contributed contamination. The major sources of contamination to RASS 2 were from (1) on-site brick kilns operated by the former property owner (Allied Chemical Corporation) until 1974, (2) historic spills from the off-site and adjacent Allied Signal/General Chemical Company, and (3) dumping and historic spills carried from the off-site Chemical and Pigment Company through Nichols Creek to RASS 2.	1980: DHS notified the Navy of chemical releases from neighboring properties, which led to the area being included in a 1983 base-wide IAS. February 1982: NWS SBD Concord personnel collected two soil samples at the site. Analysis revealed arsenic and lead. Low, but higher than background, levels of tellurium and selenium in the samples suggest the presence of the same type of coke filter material at this site as found elsewhere in the Tidal Area. 1988: The USACE completed an RI/FS of the contaminated sites. The RI identified six metals (arsenic, cadmium, copper, lead, selenium, and zinc) as chemicals of concern, and the FS recommended remedial alternatives and soil cleanup criteria for each RASS.	1992-1995: The Navy removed the most contaminated soil from a portion of each site. Because the Litigation Area includes wetlands that provide habitat for several threatened or endangered species, some contaminated soil was left in place to avoid destroying sensitive habitat. 1996: Completed site re-vegetation. The Navy began monitoring to assess effects of contaminants left in place. June 2003: The Navy's 5-Year Periodic Review Assessment indicated the remediation was successful where implemented on the marsh surface and upland habitats. The assessment also recommended additional study to address the potential ecological risk to birds and fish in sloughs and ditches where contamination is still present. 2003: The Navy began conducting an additional ecological study.	Elevated levels of heavy metals were found in this area. Although the general public does not have access to RASS 2, mosquito abatement workers conduct their activities at this site. Results of the evaluation indicate that mosquito abatement workers are not exposed to environmental contaminants at level that could cause health effects. See Table 2 for further detail. Further, because the Litigation Area is located adjacent to Suisun Bay, ATSDR evaluated the surface water, sediment, and fish data of Suisun Bay near the station since the public is potentially exposed to these media through recreational activities (boating/hiking), as well as via ingestion of fish and ducks caught in Suisun Bay near the station. Recreational users are not expected to experience health effects. See Table 2 for further detail.

Site	Site Description/Waste Disposal History	Investigation Results/Environmental Monitoring Results	Corrective Activities and/or Current Status	Comments
RASS 3 (Sites 25, 26, and 28) Pump Station K-2 Area G-1 Area	RASS 3, approximately 71 acres of upland. The Navy did not conduct any operations on the site that contributed contamination. The major source of contamination was from historic dumping and spills from off-site chemical and petroleum companies. A small stream (Nichols Creek) flows next to the chemical companies and traverses the site before emptying into the tidal march. The chemical companies at one time dumped waste into the stream. The site contains about 5 acres of contaminated soils containing zinc, lead, arsenic, and copper from refinery wastes and coke debris from the Kiln Site (RASS 2).	1980: DHS notified the Navy of chemical releases from neighboring properties, which led to the area being included in a 1983 base-wide IAS. 1982: The Navy collected surface soil samples in the K-2 Area that showed high concentrations of arsenic, copper, lead, and zinc. Samples from the G-1 Area showed lead and zinc contamination. Contamination was only detected at the bottom of an abandoned sump. 1988: The USACE completed an RI/FS of the contaminated sites. The RI identified six metals (arsenic, cadmium, copper, lead, selenium, and zinc) as chemicals of concern, and the FS recommended remedial alternatives and soil cleanup criteria for each RASS.	1992-1995: The Navy removed the most contaminated soil from a portion of each site. Because the Litigation Area includes wetlands that provide habitat for several threatened or endangered species, some contaminated soil was left in place to avoid destroying sensitive habitat. 1996: Site re-vegetation was completed. The Navy implemented a monitoring plan to assess migration and effects of contaminants left in place. June 2003: The Navy's 5-Year Periodic Review Assessment indicated the remediation was successful where implemented on the marsh surface and upland habitats. The assessment also recommended additional study to address the potential ecological risk to birds and fish in sloughs and ditches where contamination is still present. 2003: The Navy began conducting an additional ecological study.	Elevated levels of heavy metals were found in this area. Although the general public does not have access to RASS 3, mosquito abatement workers conduct their activities at this site. Results of the evaluation indicate that mosquito abatement workers are not exposed to environmental contaminants at level that could cause health effects. See Table 2 for further detail. Further, the Litigation Area is located adjacent to Suisun Bay. ATSDR evaluated the surface water, sediment, and fish data of Suisun Bay near the station since the public is potentially exposed to these media through recreational activities (boating/hiking), as well as via ingestion of fish and ducks caught in Suisun Bay near the station. Recreational users are not expected to experience health effects. See Table 2 for further detail.

Site	Site Description/Waste Disposal History	Investigation Results/Environmental Monitoring Results	Corrective Activities and/or Current Status	Comments
RASS 4 (Site 6) Coke Pile Site	RASS 4, approximately 13 acres of upland and nontidal wetland areas almost 1.5 miles east of RASSs 1, 2, and 3. The Navy did not conduct operations on the site that contributed any contamination. The major sources of contamination to RASS 4 were from coke piles that were historically stored in the area and a dump operated by the former landowners. An adjacent off-site fertilizer plant may also have contributed some contamination. RASS 4 contains some heavy metals and has a low pH. Based on the data, surficial contamination from the pile area appears to be localized. Contamination migration in the groundwater may be limited due to the small gradient of the underlying groundwater and fairly impermeable soils. The groundwater in this area has never been used as a water supply. The site contains an estimated 1,500 cubic yards of spent coke and was used for approximately 20 years.	1980: DHS notified the Navy of chemical releases from neighboring properties, which led to the area being included in a 1983 base-wide IAS. 1984–1986: High levels of arsenic, cadmium, copper, lead, selenium, and zinc were found in surface soil. 1988: The USACE completed an RI/FS of the contaminated sites. The RI identified six metals (arsenic, cadmium, copper, lead, selenium, and zinc) as chemicals of concern, and the FS recommended remedial alternatives and soil cleanup criteria for each RASS. 1994: Surface soil sampling post-remediation. All sample means were lower than pre-remediation sampling means, except for arsenic, which was higher.	1992-1995: The Navy removed the most contaminated soil from a portion of each site. Some contaminated soil was left in place to protect habitat for several threatened or endangered species. 1996: Site re-vegetation was completed. The Navy implemented a monitoring plan as to assess migration and effects of contaminants left in place. June 2003: The Navy's 5-Year Periodic Review Assessment indicated the remediation was successful where implemented on the marsh surface and upland habitats and recommended studies to address the potential ecological risk to birds and fish in sloughs and ditches where contamination is still present. 2003-2004: The Navy began conducting the additional ecological study, including soils. 2004: The Navy installed fences/locked gates and posted signs to prevent trespassing.	Elevated levels of heavy metals were found in this area. Although the general public does not have access to RASS 4, trespassers have been observed riding dirt bikes and all-terrain vehicles (ATVs) on the site. Results indicate that the trespassers would not be exposed to contaminants at levels that would be expected to cause health effects. See text and Table 2 for further details. Further, the Litigation Area is located adjacent to Suisun Bay. ATSDR evaluated the surface water, sediment, and fish data of Suisun Bay near the station since the public is potentially exposed to these media through recreational activities (boating/hiking), as well as via ingestion of fish and ducks caught in Suisun Bay near the station. Recreational users are not expected to experience health effects. See Table 2 for further detail.

Site	Site Description/Waste Disposal History	Investigation Results/Environmental Monitoring Results	Corrective Activities and/or Current Status	Comments
Inland Area Sites				
Site 13 Burning Area	Heavily used from the 1940s to approximately 1974. Ordnance burned or buried includes: flares, photoflash cartridges, black and smokeless powder, and smoke chemicals from smoke generators. Small arms ammunition was burned in a "popping oven". Thermite generators were burned in water-filled dumpsters. Firefighters trained against napalm bombs (up to five bombs at once were ignited in a ditch). The remaining material was reportedly plowed under the burning area, or disposed of in the Tidal Area Landfill (Site 1). Stressed vegetation was found on the burn pit area. In 1976, the city of Concord installed several wells, about 2 miles downgradient. These wells do not normally supply drinking water but are used during droughts and emergencies to augment drinking water supplies.	1983: The Navy conducted an IAS of possible waste sites, which identified Site 13 as potentially contaminated and recommended further study. 1997: The RI reported perchlorate and explosives in groundwater. VOCs, SVOCs, total petroleum hydrocarbons, and metals were detected in soil. Lead, chromium, nickel, antimony, and arsenic slightly exceeded PRGs in at least one sample. 2000: Additional soil and groundwater sampling was conducted to confirm previous groundwater results at the site. June 2003: The Navy conducted groundwater sampling for explosives residue and perchlorate. Perchlorate was detected in low concentrations at the site.	1993: The Navy completed recommended excavation and removal of small areas of soil that appeared to be contaminated with napalm residue during the SI. October 1997: Subsequent RI activities completed recommended excavation and removal of small areas of soil that appeared to be contaminated with napalm residue. 2004: Current and next steps include preparing an SAP for additional perchlorate investigation and revising the RI to incorporate additional sampling. Estimated Cleanup Complete: 2006	No exposure concerns. Environmental investigations indicate low levels of environmental contamination under the station. However, the maximum perchlorate concentration measured (2 ppb) is well below current guidelines and not expected to affect downgradient off-base wells. See Table 2 for further detail.

Site	Site Description/Waste Disposal History	Investigation Results/Environmental Monitoring Results	Corrective Activities and/or Current Status	Comments
Site 14 Kinne Boulevard Wells	Site 14 includes the three water supply wells located along Kinne Boulevard. Well use was discontinued In the early 1960s. The pumps were pulled, rock was lowered part of the way down the casings in steel baskets, and the tops were closed and covered with concrete. During a drought in the mid- to late-1970s, an attempt was made to determine whether the wells could be re-opened. Public Works personnel removed the concrete cap from one well and reported strong chemical odors (allegedly due to disposal of contaminated fuel oil and other chemicals when originally closed). Public Works personnel did not collect samples but re-covered the well. In 1976, the city of Concord installed several wells, one (RD-3) is located approximately 2,500 feet downgradient from the closest Kinne well.	1993: During the SI, the Navy conducted groundwater and sediment sampling. Analysis indicated that no contaminants were present. 1995: The Navy conducted sediment sampling from each of the wells. The analytical results showed the sediment to be nonhazardous.	1995: Well closure plan was finalized.	No exposure concerns. Environmental investigations have not identified significant levels of environmental contamination. In addition, the public does not have access to this site.

Site	Site Description/Waste Disposal History	Investigation Results/Environmental Monitoring Results	Corrective Activities and/or Current Status	Comments
Site 15 Railroad Classifica-tion Yard	In 1982, two unbroken and several broken glass vials (4 inch by 1 inch) containing methyl bromide (rodenticide used by NWS SBD Concord since 1954 to control ground squirrels) were found along the embankment of the Railroad Classification Yard. No other vials have been found on the station. Shell casings (three-inch, 50-calibur, and 20-millimeter) were also found on the site, washing out of the railroad bed fill material. The casings seem to have been part of the original fill; reportedly, old casings and shells were common for fill.	1983: Site 15 was included in the base-wide IAS.	1983: The methyl bromide vials were removed from the site and disposed of. The NACIP Department determined that no further action is warranted.	No exposure concerns. The public does not have access to this site.
Site 16 Black Pit at Red Rock	Site 16, a 150 square-foot pit, between the Red Rock Disposal Area and current clean fill borrow area, 15 yards uphill from an old well and within 100 yards of Seal Creek. In 1983, the soil was observed to be very black. No records were found regarding its use .	1983: Results of surface sample analysis suggest that the site was used for disposal of waste generated at NWS SBD Concord. The site contained an estimated 50 cubic yards of contaminated soils.	None.	No exposure concerns. The public does not have access to this site.

Site	Site Description/Waste Disposal History	Investigation Results/Environmental Monitoring Results	Corrective Activities and/or Current Status	Comments
Site 17 Building IA24	Site 17 was an outdoor "sump" located at the southeast corner of Building IA24. The site was in use from the 1950s to 1988. For at least 20 years prior to 1974, battery acid from forklift batteries was drained into the sump. According to station personnel, the sump was assumed to be an earthen pit that was later filled. Two diesel USTs were previously used at this site.	1983: The Navy conducted an IAS of possible waste sites, which identified Site 17 as potentially contaminated and recommended further study. 1993: An SI revealed no significant contamination at the site. 1997: The subsequent RI revealed no significant contamination at the site. 2000: Confirmation groundwater sampling revealed no significant contamination at the site. Extensive sampling of areas rumored to contain the battery acid pit revealed no evidence of its existence.	2003: A ROD formalizing a conclusion of no further action is currently in process. Estimated Cleanup Complete: 2004	No exposure concerns. Environmental investigations have not identified significant levels of environmental contamination. In addition, the public does not have access to this site.
Site 18 Building IA25	Site 18 is an area behind Building IA25 that apparently was at one time a burn pit and solvent disposal area. Visual examination revealed no environmental damage.	1983: Site 18 was included in the base-wide IAS.	1983: No evidence of contamination from Building IA25 could be ascertained. The NACIP Department determined that no further action is warranted.	No exposure concerns. Environmental investigations have not identified significant levels of environmental contamination. In addition, the public does not have access to this site.

Site	Site Description/Waste Disposal History	Investigation Results/Environmental Monitoring Results	Corrective Activities and/or Current Status	Comments
Site 19 Seal Creek Disposal Area	Site 19, a natural, intermittent surface drainage area, 3 to 10 feet above the creek. Some evidence of trash and rubble disposal is visible at the creek's banks near Building 93. An eroding face of a debris fill was found adjacent to the creek bed. Materials in the eroding face, as well as the dry creek bed, included tree cuttings, rubble, wood, two empty 55-gallon drums, and other inert solid wastes. No evidence of potentially hazardous materials was found. Station personnel stated that the Seal Creek Disposal Area only temporarily served as a debris and rubble area during the 1960s. Specifics regarding waste quantity, type, and areal extent could not be determined, but the site contains approximately at least 100 cubic yards of asphalt, construction debris, and material washed in from off base.	1983: Site 19 was included in the base-wide IAS.	1983: The filled area adjacent to building 93 and on the north bank of Seal Creek appears to contain inert solid wastes. No documentation exists regarding downstream water quality problems associated with the burial site. The Seal Creek Disposal Area does not appear to be a source of hazardous material discharges into the creek. The NACIP Department determined that further study is not warranted.	No exposure concerns. Environmental investigations have not identified significant levels of environmental contamination. In addition, the public does not have access to this site.

Site	Site Description/Waste Disposal History	Investigation Results/Environmental Monitoring Results	Corrective Activities and/or Current Status	Comments
Site 20 Old Homestead, Seal Creek	Site 20 is a debris-filled gully located on the banks of Seal Creek. The gully contained coffee pots, bed pans, old cans, and other household items. Apparently, local ranchers used this site as a disposal site prior to 1943, before the Navy acquired the land. No hazardous waste was disposed of in this area. The site contains an estimated 5 cubic yards of waste.	1983: Site 20 was included in the base-wide IAS.	1983: No hazardous materials were disposed of at this site. The NACIP Department determined that further study is not warranted.	No exposure concerns. Environmental investigations have not identified significant levels of environmental contamination. In addition, the public does not have access to this site.

Site	Site Description/Waste Disposal History	Investigation Results/Environmental Monitoring Results	Corrective Activities and/or Current Status	Comments
Site 22 Area Around Building 7SH5	Site 22 is the area around a missile wings and fins repair facility (Building 7SH5), where small quantities of solvent and paint wastes generated from the building were disposed of. Less than 200 gallons per year were produced at this building, and no environmental effects were observed during a visual inspection. The site was used from the 1950s to the mid-1970s. An estimated total of 500 gallons of waste was disposed of on this area through the 20-year period.	1993: An SI was completed and a two-phase RI was initiated. Mid-late 1990s: Several studies were conducted to check for contamination from USTs - a potential source was previous activities at Building 7SH5, no significant contamination was discovered. However, elevated levels of arsenic in surface soils were detected in open grassland areas of the site. This finding was unexpected and may be the result of pervious use of herbicides or pesticides. 2003: Low concentrations of perchlorate were detected in groundwater collected from an existing well. 2004: Additional sampling was performed at Site 22 and the surrounding magazine area to determine the extent of the arsenic contamination. Elevated arsenic levels were found in the surface soil. However, no contamination was found in the plant tissue from this area.	1997: A former UST was removed. 1998: Groundwater wells were installed during the Phase II RI. 2000: The Final ROD concluded that no further action is warranted. 2003: The Navy began a Supplemental RI and conducted groundwater sampling to test for perchlorate. 2004: The Navy conducted additional sampling to determine extent of arsenic contamination. Estimated Cleanup Complete: 2006	Low levels of perchlorate were detected in the groundwater below Site 22. However, no exposure exists because groundwater below the site is not used, and potential migration is not expected to affect off-base wells. In addition, the public does not have access to this site. See Table 2 for further detail. Elevated levels of arsenic were found in the soil at Site 22 and the surrounding magazine area. However, no exposure concerns exist because the community is not exposed to windblown dusts at levels that would be expected to cause health effects. In addition, the public does not have access to this site. See Table 2 for further detail. Cattle grazing throughout the Inland Area are exposed to the contaminated soil. However, no exposure concerns exist because the estimated arsenic concentration in the beef is below the typical concentration measured in food. See Table 2 for further detail.

Site	Site Description/Waste Disposal History	Investigation Results/Environmental Monitoring Results	Corrective Activities and/or Current Status	Comments
Sites 23A & 23 B Inland Area Explosive Ordnance Disposal (1959 EOD & Eagle's Nest EOD)	Sites 23A and 23B were used as explosives ranges. Site 23A is located in the hills behind Building 5AT58. The EOD detachment detonated high explosives (limited to 50 pounds) from the late 1940s to late 1950s. Similar operations were conducted at Site 23B, near the eucalyptus grove, for about 12 years prior to being shifted to the Tidal Area in the 1960s.	1983: Sites 23A and 23B were included in the base-wide IAS.	1983: The limitations placed on the amounts of explosives disposed of at the two Inland Area EOD sites, combined with their relatively short-term use, lead to the conclusion that further study under the NACIP program is not warranted.	No exposure concerns. The public does not have access to this site.
Sites 24A & 24B Ranges (Pistol Range & Aircraft Range)	Site 24A, station pistol range, located near Building IA57, was in operation for over 25 years. Around 1978, berms were built over the original bank due to the high its lead content. Site 24B, located at Building IA56, used as an aircraft target range. Reportedly, an anti-tank weapons firing range was located in the hills above the station, location of the impact area may have been near the pistol range or possibly near Building 97.	1983: Siteswere included in the base-wide IAS. Lead was detected in the soil at the pistol firing range. 1997: Metals (antimony, arsenic, beryllium, cadmium, and lead), SVOCs, and PAHs were detected in the soil at the pistol firing range. Metals are not leaching from site soils but may be transported by surface soil erosion via runoff from the target berm into the drainage ditch. SVOC and PAH concentrations were localized, probably the result of the use of creosote-treated timbers at the berm.	1983: The station pistol range (Site 24A) berm contains a significant amount of lead. However, the berm has been recapped, reducing the chance of migration. The NACIP Department determined that further study is not warranted. 1997: RI recommended engineering controls, such as a sediment trap, should be added to alter the drainage pattern and minimize the off-site transport of eroded soil containing metals.	No exposure concerns. The public does not have access to this site.

Site	Site Description/Waste Disposal History	Investigation Results/Environmental Monitoring Results	Corrective Activities and/or Current Status	Comments
Site 27 Chemical and Materials Laboratory	Site 27 is a former chemical and materials laboratory that was in operation from 1964 to the mid-1990s. Potential waste types include oils, hydraulic fluids, and pesticides.	1993: The soil sampling around the UST indicated past leakage. 1997: An RI was conducted and determined that environmental contamination (primarily chlordane) existed at levels within EPA standards for industrial areas, but above EPA maximums for residential areas. Groundwater was not considered to be a medium of concern.	1997: As a result of the 1993 investigation, the UST was removed and the contaminated soil around it was excavated. 2003: The Navy began a FS to evaluate potential cleanup alternatives. Current and next steps include conducting additional arsenic analysis in soil per EPA's request and analyzing alternatives.	No exposure concerns. Environmental investigations have not identified significant levels of environmental contamination. In addition, the public does not have access to this site.
Site 29 Munitions Manufactur-ing, Testing, and Painting	Site 29 comprises Building IA25 and SWMU 13. SWMU 13 consists of a septic tank, a storm drain outfall, a sanitary sewer line, and a leach field northeast of Building IA25. Located within an earthen berm, Building IA25 was reportedly used to manufacture and test military explosives from the mid-1940s to the late 1980s. The building also included a spray paint booth for repainting components. The building was renovated significantly for rework of explosives in the late 1970s.	1987: Asbestos was found to on pieces of pipe insulation. 1990: Soil sampling indicates the shallow soils beneath the building contain low levels of organic compounds, pesticides, and metals. Lead was found in surface soils in the building crawl space (3,400 ppm). June 1992: The California DTSC performed a RFA at the site to delineate contamination associated with SWMU 13. No significant soil contamination was discovered. 1999: Additional subsurface soil sampling was conducted.	1997: The SWMU 13 septic tank was cleaned out, and SWMU 13 was then recommended for No Further Action. The Navy is planning to collect a confirmation groundwater sampling at SWMU 13 in 2004 to confirm this recommendation. 2003: The Navy began a FS to evaluate potential cleanup alternatives. Estimated Cleanup Complete: 2009	No exposure concerns. The public does not have access to this site.

Key:			
AOC	area of concern	ppb	parts per billion
ATVs	all-terrain vehicles	ppm	parts per million
CCWD	Contra Costa Water District	PCP	pentachlorophenol
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act	PRGs	preliminary remediation goals
		RAP	removal action plan
CV	ATSDR's comparison value	RASS	remedial action subsite
EOD	explosive ordnance disposal	RCRA	Resource Conservation and Recovery Act
EPA	U. S. Environmental Protection Agency	RFA	RCRA facility assessment
ERA	ecological risk assessment	RFACS	RFA confirmation study
DHS	Department of Health Services	RI	remedial investigation
DTSC	California Department of Toxic Substances Control	ROD	record of decision
FS	feasibility study	RWQCB	Regional Water Quality Control Board
IAS	initial assessment study	SAP	sampling and analysis plan
IRP	Installation Restoration Program	SI	site investigation
MCL	EPA's maximum contaminant level	SVOCs	semi-volatile organic compounds
NACIP	Navy Assessment and Control of Installation Pollutants	SWMUs	solid waste management units
N-P-K	nitrogen-phosphorous-potassium	TCE	trichloroethylene
NWS SBD	Naval Weapons Station Seal Beach Detachment	TCRA	time-critical removal action
OSHA	Occupational Safety and Health Act	TPHs	total petroleum hydrocarbons
PA	preliminary assessment	USACE	U.S. Army Corps of Engineers
PAHs	polycyclic aromatic hydrocarbons	UST	underground storage tank
PCBs	polychlorinated biphenyls	VOCs	volatile organic compounds
PCE	tetrachloroethylene		

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Table 2. Evaluation of Exposure Pathways at NWS SBD Concord

Pathway	Elements of an Exposure Pathway						Public Health Evaluation
	Source	Media	Point of Exposure	Route of Exposure	Time Frame	Exposed Population	
Exposure to contaminated airborne dust by trespassers who operate dirt bikes and all-terrain vehicles (ATVs) in the Litigation Area	Prior to the Navy's purchase in 1968, former owners used RASS 4 as a small dumpsite for construction debris and a storage area for spent coke.	Airborne soil	RASS 4	Inhalation	Past Current	Trespassers operating dirt bikes and all-terrain vehicles	ATSDR does not expect harmful health effects to occur. The estimated exposures are below levels of health concern, even when assuming trespassers engage in these activities 6 hours per week for 30 years. In addition, the Navy plans to prevent any future trespassing by fencing this area and posting signs warning trespassers that the area is government property and contains hazardous substances.
Exposure to arsenic-contaminated windblown dust by community members living near Site 22 and the surrounding magazine area	Arsenic-contaminated soil in the Magazine Study Area. The high arsenic concentrations are potentially a result of widespread application of an arsenic-containing herbicide in the late 1940s around the magazines in the area adjacent to the site.	Windblown dust	Dana Estates, Concord High School	Inhalation Incidental ingestion	Past Current Future	Community members living in Dana Estates (the housing community near Site 22) and students attending Concord High School (the school near Site 22)	ATSDR does not expect harmful health effects to occur. ATSDR considered several exposure scenarios: short-term inhalation exposures that might result during tilling activities, long-term inhalation exposures to wind-blown dust, and the possibility of contamination accumulating in off-site soils as a result of wind-blown dust. Although the available information suggests that some exposures to arsenic might occur, the estimated exposures are safely below levels of health concern.

Pathway	Elements of an Exposure Pathway						Public Health Evaluation
	Source	**Media**	**Point of Exposure**	**Route of Exposure**	**Time Frame**	**Exposed Population**	
Exposure of community members using permitted or unpermitted groundwater wells to volatile organic compounds (VOCs)	Past operations in the SWMU area and Site 22 involved paints, solvents, and other industrial chemicals. Past operations in Site 13 involved flares and rocket powder.	Groundwater	Permitted and unpermitted private residential and municipal wells and golf course irrigation well	Ingestion Dermal	Past Current Future	Community members with permitted and unpermitted private wells and golf course employees	ATSDR does not expect harmful health effects to occur. No one is drinking water from under the station, and no elevated contaminant levels have been detected in off-site wells. Tetrachloroethylene (PCE), trichloroethylene (TCE), and perchlorate are currently being monitored to ensure that contamination does not affect off-site community residential or municipal wells.
Exposure to contaminants in beef from cattle grazing on the station	Arsenic contaminated soil in the Magazine Study Area.	Soil, incidentally ingested by grazing cattle.	Beef	Ingestion	Past Current Future	Consumers of beef from station cattle offspring	ATSDR does not expect harmful health effects to occur. Conservative estimates of the arsenic concentration in beef for cattle grazing on the station is slightly below typical concentrations reported in grains, meat, fish and poultry, and the average concentration reported from the Total Diet Study. As a result, no health effects are expected for people who regularly consume beef from cattle or calves that graze on-base.

Pathway	Elements of an Exposure Pathway						Public Health Evaluation
	Source	**Media**	**Point of Exposure**	**Route of Exposure**	**Time Frame**	**Exposed Population**	
Exposure of off-base military housing residents to pesticide-contaminated soil	Past application of pesticides.	Soil	Quinault and Victory Villages	Dermal Incidental ingestion	Past Current Future	Residents living in the off-base housing units	ATSDR does not expect harmful health effects to occur. The average tour for Navy- or USCG-enlisted personnel is generally only 3 years. Even when assuming exposure of 30 years or more, the estimated exposures are below levels of health concern.
Exposure of mosquito abatement workers to contaminants in the Litigation Area	Metal contamination from waste disposal activities of prior owners and historic spills from neighboring chemical companies.	Soil Sediment	RASSs 1, 2, and 3	Dermal Incidental ingestion	Past Current Future	Mosquito abatement workers	ATSDR does not expect harmful health effects to occur to mosquito abatement workers exposed to site-related contaminants. Mosquito abatement activities are conducted during 30 visits per year, and take approximately 6 hours per visit. Estimated exposure doses were below levels of health concern.

Pathway	Elements of an Exposure Pathway						Public Health Evaluation
	Source	**Media**	**Point of Exposure**	**Route of Exposure**	**Time Frame**	**Exposed Population**	
Exposure to contaminants in Suisun Bay resulting from recreational activities	Point and non-point pollution sources, primarily deposition from the Sacramento and San Joaquin Rivers. Runoff from NWS SBD Concord may contribute contamination (heavy metals, VOCs, SVOCS, PAHs, PCBs, and/or pesticides) from past base operations in the Tidal Area and from previous property owners of the Litigation Area.	Surface water Sediment Biota	Suisun Bay Fish Ducks	Dermal Incidental ingestion Ingestion	Past Current Future	Community members participating in recreational activities in or around Suisun Bay near the station or ingesting fish or duck caught in or around Suisun Bay near the station	ATSDR does not expect harmful health effects to occur. Estimated exposure doses to surface water and sediment were below levels of health concern. OEHHA has issued an interim fish consumption advisory and a duck advisory for the entire San Francisco Bay, including Suisun Bay. Assuming people adhere to these advisories, exposures will be below levels of health concern.

Table 3. Timeline of Activities at RASS 4

Year	Activity
1968	Navy purchases 13 acres of land now known as RASS4
1983	Navy completes initial site assessment of environmental contamination at RASS4 and other sites
1988	Navy completes Remedial Investigation of contaminated sites, including RASS4
1989	Record of Decision signed, including provision for excavating 3,000 cubic yards of contaminated soils and removing construction debris from RASS4
1994	Navy finishes remediation activities at RASS4
1995–1999	Surface soil sampling occurs annually to characterize contamination levels throughout RASS4
2000	Surface soil sampling occurs to characterize contamination levels in ashy soils found in RASS4
2001	Wildfires burn approximately one-half the land at RASS4

Tetra Tech 2003c

Table 4. Estimated Ambient Air Concentrations of Contaminants of Concern during Use of Dirt Bikes and ATVs at RASS 4

Contaminant	Average Surface Soil Concentration at RASS4 (ppm)	Estimated Ambient Air Concentration during Use of Dirt Bikes and ATVs at RASS4 (µg/m^3)	Health-Based Comparison Value (µg/m^3)	Type of Health-Based Comparison Value
Arsenic	49.9	0.019	0.0002	CREG
Cadmium	5.7	0.0022	0.0006	CREG
Copper	48.0	0.018	150	RBC-n
Lead	359.8	0.14	1.5	NAAQS
Mercury	7.5	0.0029	0.2	EMEG-c
Selenium	35.1	0.013	18	RBC-n
Zinc	149.4	0.057	1,100	RBC-n

Notes: Average surface soil concentration computed from 50 samples collected during annual sampling activities at RASS4 between 1995 and 1999.
Estimated ambient air concentration was calculated by multiplying the surface soil concentration (in ppm) by the estimated airborne dust concentration (380 µg/m^3) during dirt bike or ATV use (based on research by Berman 2004 and ADHS 2000) and dividing by 1,000,000 (for unit conversion purposes).
Abbreviations used for health-based comparison values:

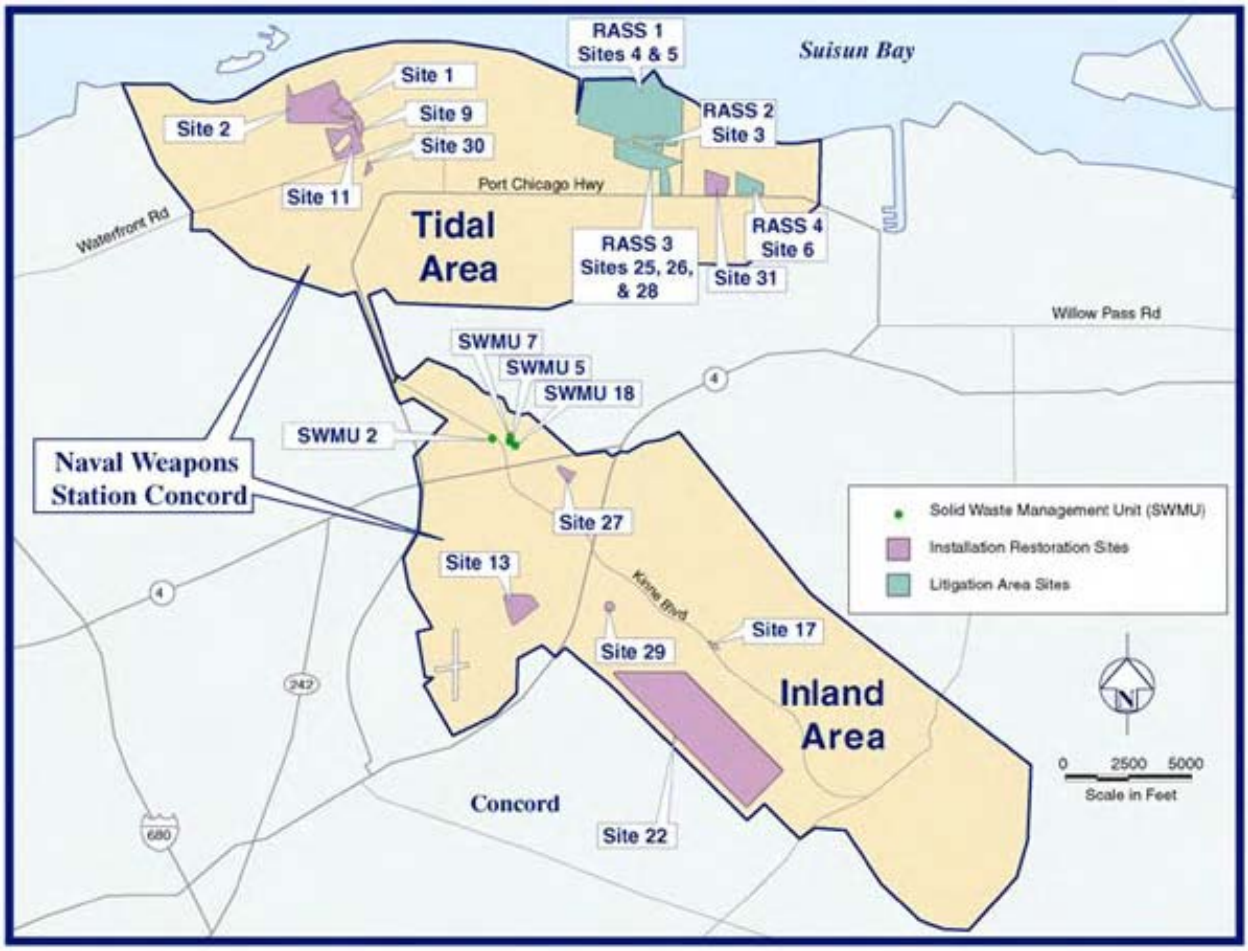
CREG = ATSDR's Cancer Risk Evaluation Guide
RBC-n = EPA Region III's Risk-Based Concentrations for non-cancer outcomes
NAAQS = EPA's National Ambient Air Quality Standard for lead
EMEG-c = ATSDR's Environmental Media Evaluation Guide for chronic exposures

Figures

Figure 1. Regional Map

Tetra Tech EM Inc. 2003b.

Figure 2. Base Map



US Navy. 2005.

Figure 3. Demographics Map

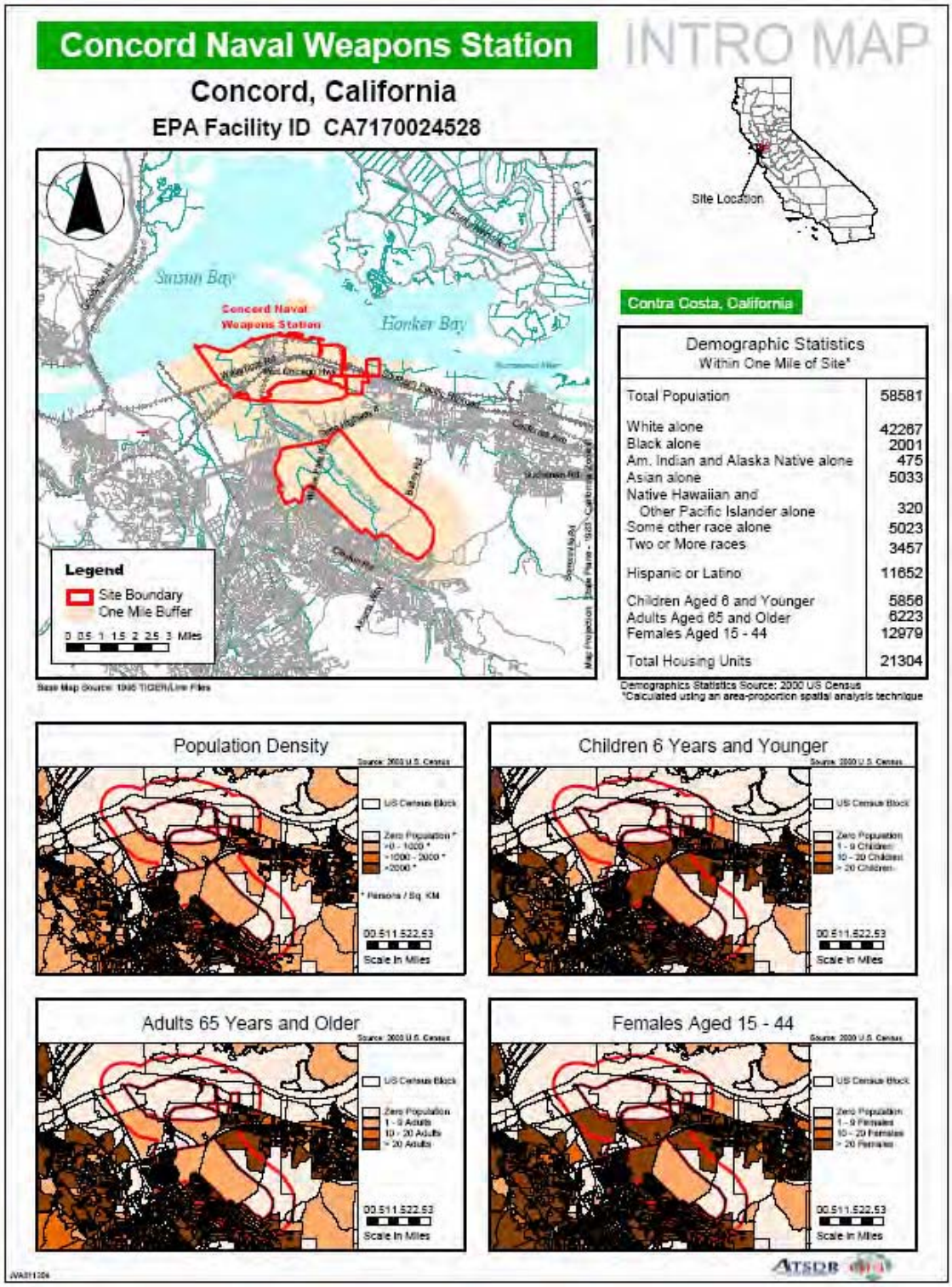


Figure 4. ATSDR's Exposure Evaluation Process

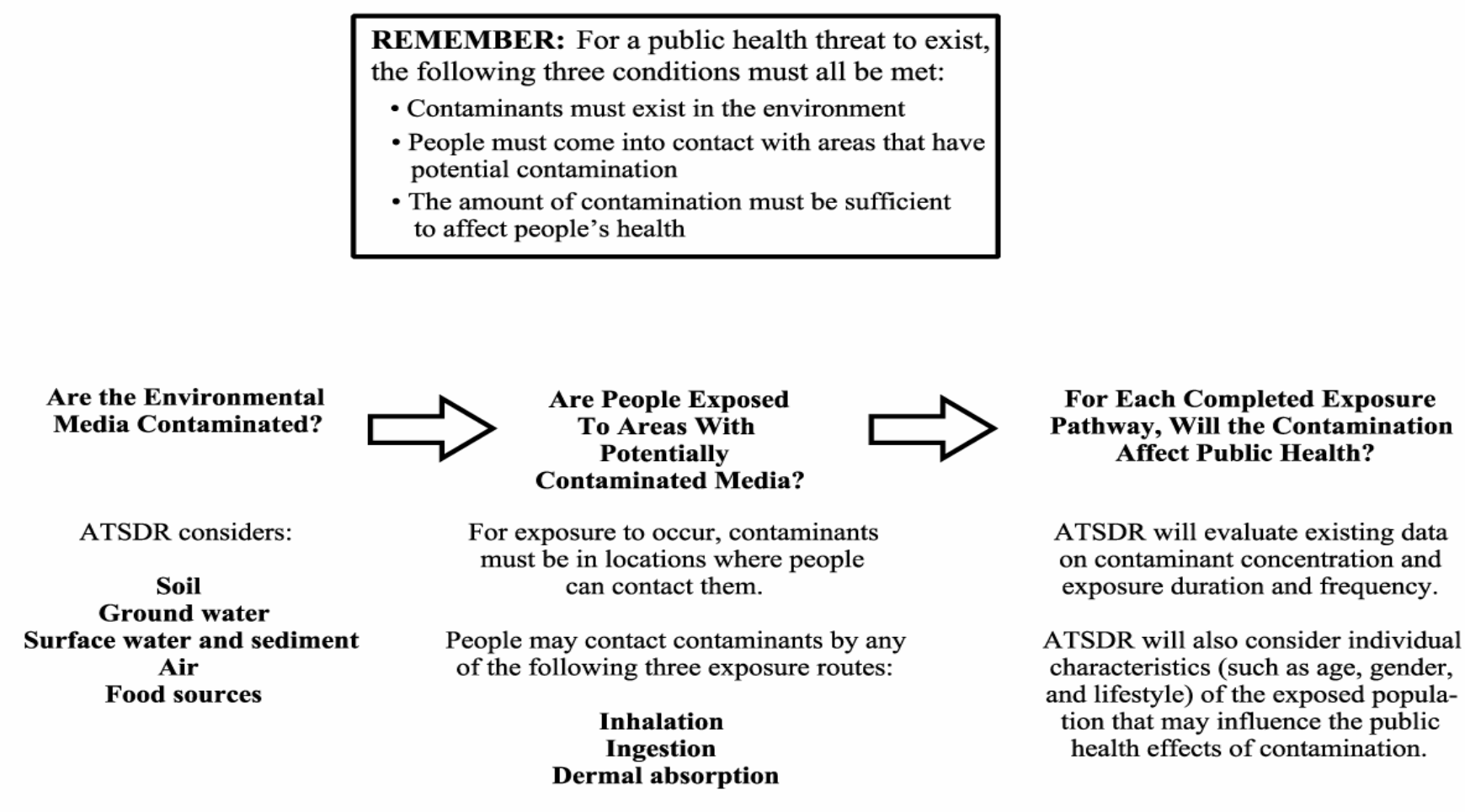


Figure 5. PCE Concentration Ranges in Groundwater

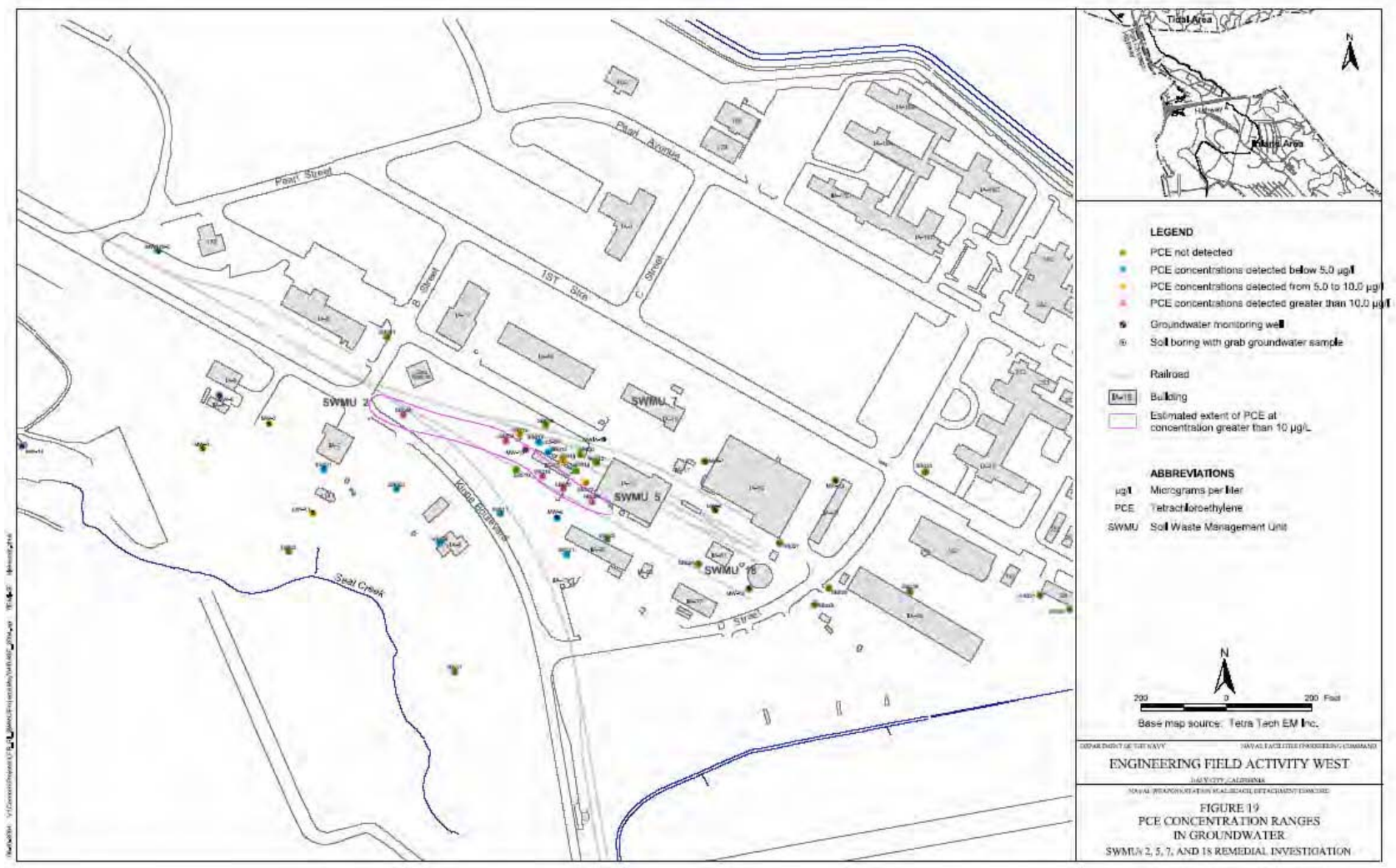
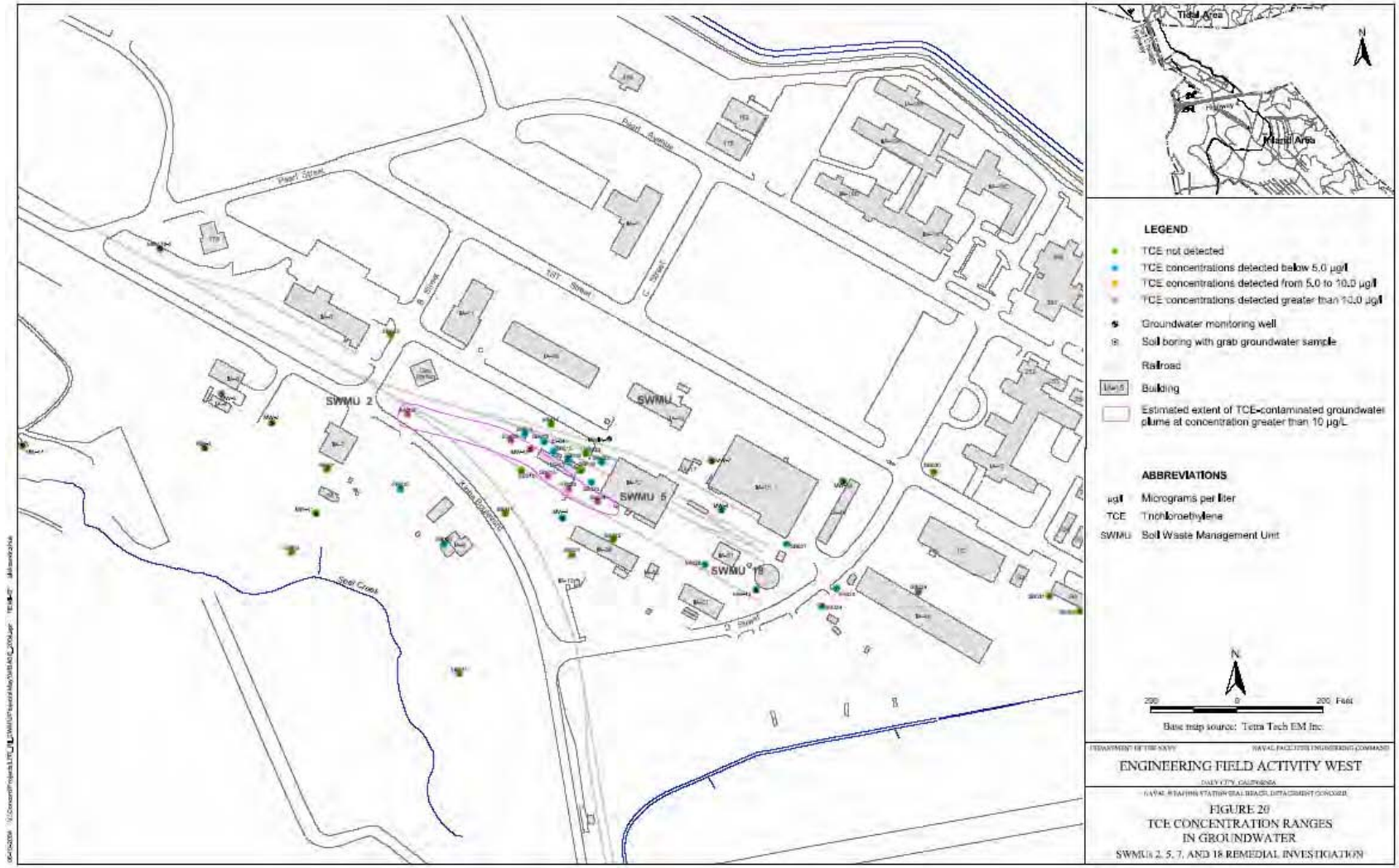


Figure 6. TCE Concentration Ranges in Groundwater



Appendix A: ATSDR Glossary of Terms

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

General Terms

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

Acute
Occurring over a short time [compare with chronic].

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

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

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

Aerobic
Requiring oxygen [compare with anaerobic].

Ambient
Surrounding (for example, ambient air).

Anaerobic
Requiring the absence of oxygen [compare with aerobic].

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

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

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

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

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

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

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

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

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

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

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

CAP [see Community Assistance Panel.]

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

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

Carcinogen
A substance that causes cancer.

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

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

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

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

CERCLA [see Comprehensive Environmental Response, Compensation, and Liability Act of 1980]

Chronic
Occurring over a long time [compare with acute].

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

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

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

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

Completed exposure pathway [see exposure pathway].

Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA)
CERCLA, also known as Superfund, is the federal law that concerns the removal or cleanup of

hazardous substances in the environment and at hazardous waste sites. ATSDR, which was created by CERCLA, is responsible for assessing health issues and supporting public health activities related to hazardous waste sites or other environmental releases of hazardous substances. This law was later amended by the Superfund Amendments and Reauthorization Act (SARA).

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

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

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

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

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

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

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

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

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

DOD
United States Department of Defense.

DOE
United States Department of Energy.

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

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

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

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

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

EPA
United States Environmental Protection Agency.

Epidemiologic surveillance [see Public health surveillance].

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

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

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

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

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

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

Exposure registry
A system of ongoing follow-up of people who have had documented environmental exposures.

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

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

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

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

Half-life (t½)
The time it takes for half the original amount of a substance to disappear. In the environment, the half-life is the time it takes for half the original amount of a substance to disappear when it is changed to another chemical by bacteria, fungi, sunlight, or other chemical processes. In the human body, the half-life is the time it takes for half the original amount of the substance to disappear, either by being changed to another substance or by leaving the body. In the case of radioactive material, the half life is the amount of time necessary for one half the initial number of radioactive atoms to change or transform into another atom (that is normally not radioactive). After two half lives, 25% of the original number of radioactive atoms remain.

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

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

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

Health consultation
A review of available information or collection of new data to respond to a specific health question or request for information about a potential environmental hazard. Health consultations are focused on a specific exposure issue. Health consultations are therefore more limited than a

public health assessment, which reviews the exposure potential of each pathway and chemical [compare with public health assessment].

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Metabolite
Any product of metabolism.

mg/kg
Milligram per kilogram.

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

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

Migration
Moving from one location to another.

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

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

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

Mutagen
A substance that causes mutations (genetic damage).

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

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

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

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

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

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

NPL [see National Priorities List for Uncontrolled Hazardous Waste Sites]

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

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

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

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

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

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

ppb
Parts per billion.

ppm
Parts per million.

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

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

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

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

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

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

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

Public health assessment (PHA)
An ATSDR document that examines hazardous substances, health outcomes, and community

concerns at a hazardous waste site to determine whether people could be harmed from coming into contact with those substances. The PHA also lists actions that need to be taken to protect public health [compare with health consultation].

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

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

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

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

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

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

Radionuclide
Any radioactive isotope (form) of any element.

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

Receptor population
People who could come into contact with hazardous substances [see exposure pathway].

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

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

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

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

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

RfD [see reference dose]

Risk
The probability that something will cause injury or harm.

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

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

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

Safety factor [see uncertainty factor]

SARA [see Superfund Amendments and Reauthorization Act]

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

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

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

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

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

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

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

Substance
A chemical.

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

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

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

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

Surveillance [see public health surveillance]

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

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

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

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

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

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

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

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

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

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

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

For more information on the work of ATSDR, please contact:
Office of Policy and External Affairs
Agency for Toxic Substances and Disease Registry
1600 Clifton Road, N.E. (MS E-60)
Atlanta, GA 30333
Telephone: (404) 498-0080

Appendix B: Comparison Values

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

CVs used in this PHA include

Cancer Risk Evaluation Guide (CREG)

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

Environmental Media Evaluation Guide (EMEG)

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

Reference Media Evaluation Guide (RMEG)

ATSDR derives RMEGs from EPA's oral reference doses (RfDs). The RMEG represents the concentration in water or soil at which daily human exposure is unlikely to result in adverse noncarcinogenic effects.

EPA's Region III Risk-Based Concentration (RBC)

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

EPA's Maximum Contaminant Level (MCL)

The MCL is the drinking water standard established by EPA. It is the maximum permissible level of a contaminant in water that is delivered to a free-flowing

outlet. MCLs are considered protective of human health over a lifetime (70 years) for individuals consuming 2 liters of water per day.

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

Minimal Risk Level (MRL)

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

Reference Dose (RfD)

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

Cancer Slope Factor (CSF)

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

Lowest-Observed-Adverse-Effect Level (LOAEL)

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

No-Observed-Adverse-Effect Level (NOAEL)

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

Cancer Effect Level (CEL)

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

Appendix C: ATSDR's Methods for Determining Whether a Health Hazard Exists

I. Overview of ATSDR's Methodology for Evaluating Potential Public Health Hazards

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

Selecting Exposure Situations for Further Evaluation

As an initial screen, ATSDR evaluated available data to determine whether contaminants were accessible to the public or were above ATSDR's comparison values (CVs). CVs are derived using conservative exposure assumptions. CVs reflect concentrations that are much lower than those that have been observed to cause adverse health effects. Thus, CVs are protective of public health in essentially all exposure situations. As a result, concentrations detected at or below ATSDR's CVs are not expected to cause health concern. While concentrations at or below the relevant CV could reasonably be considered safe, it does not automatically follow that any environmental concentration that exceeds a CV would be expected to produce adverse health effects. CVs are not thresholds of toxicity; the likelihood that adverse health outcomes will actually occur depends on site-specific conditions, individual lifestyle, and genetic factors that affect the route, magnitude, and duration of actual exposure, and not an environmental concentration alone.

For this PHA, ATSDR evaluated data that were collected from surface soil, surface water and sediment, and groundwater from sites at NWS SBD Concord to determine whether people were exposed to contaminant concentrations that exceeded ATSDR's CVs. The majority of the detected contaminants were either not accessible to the public or fell at or below comparison values and were therefore not evaluated further. ATSDR identified seven exposure pathways for further evaluation (as described in the text). One of the pathways, potential exposure of community members using groundwater wells VOCs, was evaluated qualitatively in the text. Based on the groundwater monitoring and planned sampling, it is expected that residents are not exposed to contaminants at levels that would be expected to cause health effects. The potential ingestion of contaminants in beef from cattle grazing on station is evaluated in detail in Appendix D. This section describes the evaluation of the remaining pathways:

- Inhalation of contaminated airborne dust by trespassers who operate dirt bikes and all-terrain vehicles (ATVs) in the Litigation Area
- Inhalation of arsenic contaminated dust by community members living near Site 22 and the surrounding magazine area.

- Exposure to pesticide-contaminated soil by residents in off-base housing.
- Exposure to contaminants in the Litigation Area by mosquito abatement workers.
- Exposure to contaminants in Suisun Bay during recreational.

Estimating Exposure Doses

ATSDR calculated exposure doses for those contaminants that were detected above ATSDR's CVs. When estimating exposure doses, health assessors evaluate chemical concentrations to which people could be exposed, together with the length of time and the frequency of exposure. Variables considered when estimating exposure doses include the contaminant concentration, the exposure amount (how much), the exposure frequency (how often), and the exposure duration (how long). There is often considerable uncertainty about the true level of exposure to environmental contamination, because we do not know exactly how long someone could have been exposed or to what concentration exposure occurred over time. Where possible, ATSDR used site-specific information about the frequency and duration of exposures. In cases where site-specific information was not available, ATSDR applied several protective assumptions to estimate exposures for residents, recreational users, and trespassers. These estimated exposure levels are usually much higher than those to which people are really exposed.

Using Exposure Doses to Evaluate Potential Health Hazards

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

For carcinogens, ATSDR also calculates a theoretical increase of cancer cases in a population using EPA's cancer slope factors (CSFs), which represent the relative potency of carcinogens. This is accomplished by multiplying the calculated lifetime exposure dose by a chemical-specific CSF. This calculation estimates a theoretical excess cancer risk expressed as the proportion of a population who could be affected by a carcinogen during a lifetime of exposure. For example, an estimated cancer risk of 1×10^{-6} predicts the probability of one additional cancer over the background level in a population of 1 million. Because conservative models are used to derive CSFs, the doses associated with these estimated hypothetical risks may be orders of magnitude lower than doses reported in the toxicology literature to cause carcinogenic effects. As such, a

low cancer risk estimate indicates that the toxicology literature would support a finding that no excess cancer risk is likely. At higher cancer risk estimates, ATSDR reviews the toxicology literature to evaluate potential cancer risks.

If noncancer health or cancer screening guidelines are exceeded, ATSDR examines the health effects levels discussed in the scientific literature and more fully reviews exposure potential. ATSDR reviews available human studies as well as experimental animal studies. This information is used to describe the disease-causing potential of a particular chemical and to compare site-specific dose estimates with doses shown in applicable studies to result in illness (known as the margin of exposure). For cancer effects, ATSDR compares an estimated lifetime exposure dose to available cancer effect levels (CELs), which are doses that produce significant increases in the incidence of cancer or tumors, and reviews genotoxicity studies to understand further the extent to which a chemical might be associated with cancer outcomes. This process enables ATSDR to weigh the available evidence in light of uncertainties and offer perspective on the plausibility of harmful health outcomes under site-specific conditions.

For this PHA, ATSDR estimated doses using the maximum detected concentration. It is expected, however, that no one will have contact with the maximum concentration on a daily basis, for an extended period of time. Therefore, this approach most likely resulted in estimated exposure levels that are much higher than the levels people are actually being exposed to.

Sources for Health-Based Guidelines

By Congressional mandate, ATSDR prepares toxicological profiles for hazardous substances found at contaminated sites. These toxicological profiles were used to evaluate potential health effects from contamination at NWS SBD Concord.

ATSDR's toxicological profiles are available on the Internet at http://www.atsdr.cdc.gov/toxpro2.html or by contacting the NCEH/ATSDR Information Center at 1-888-422-8737. EPA also develops health effects guidelines; in some cases, ATSDR relied on EPA's guidelines to evaluate potential health effects. These guidelines are found in EPA's Integrated Risk Information System (IRIS)—a database of human health effects that could result from exposure to various substances found in the environment. IRIS is available on the Internet at http://www.epa.gov/iris/. For more information about IRIS, please call EPA's IRIS hotline at 202-566-1676 or e-mail at hotline.iris@epa.gov.

II. Calculations of Theoretical Cancer Risk for Inhalation Exposures

Two sections of this PHA include estimates of theoretical cancer risk resulting from inhalation exposures to airborne metals that are known to be carcinogenic. This section details the calculations and assumptions that ATSDR made when deriving these estimates. Most generally, the theoretical cancer risk calculations were based on EPA human health risk assessment protocols, which specify that:

Theoretical Increased Cancer Risk : $Cancer\ Risk = UR \times C \times EF$
Where:

UR = EPA's unit risk factor, as published in the agency's Integrated Risk Information System, or IRIS (in units of $[\mu g/m^3]^{-1}$)

C = Exposure concentration (in units of $\mu g/m^3$)

EF = Exposure factor, which is a dimensionless number that express the fraction of time over a 70-year lifetime that residents might be exposed to the exposure concentration. For continuous exposure, the exposure factor equals 1. For intermittent exposures, the exposure factor will be between 0 and 1.

The remainder of this section describes how ATSDR applied the above equation to different inhalation exposure scenarios considered in this PHA.

The following table summarizes the inputs that ATSDR used when calculating theoretical increased cancer risk for inhalation exposure to arsenic when individuals operate dirt bikes and all-terrain vehicles (ATVs) at the RASS 4 site:

Parameter	Value	Notes
Arsenic UR factor	0.0043 $(\mu g/m^3)^{-1}$	Taken from EPA's IRIS system.
Exposure concentration	0.019 $\mu g/m^3$	Calculated by multiplying an estimate of the airborne dust concentration during the recreational activities (380 $\mu g/m^3$) by the average arsenic concentration in surface soils at RASS4 (49.9 ppm, which equals a mass fraction of 0.00499%).
EF	0.015	Exposures were assumed to occur 6 hours per week, 52 weeks per year, over 30 years, which equals a total of 9,360 hours. EF was calculated by dividing this number of hours by the total number of hours in a 70-year lifetime (613,200 hours).
Theoretical increased cancer risk	0.000001 (or 1 in 1,000,000)	Calculated using the equation shown above.

The following table summarizes the inputs that ATSDR used when calculating theoretical increased cancer risk for inhalation exposure to cadmium when individuals operate dirt bikes and ATVs at the RASS 4 site:

Parameter	Value	Notes
Cadmium UR factor	0.0018 $(\mu g/m^3)^{-1}$	Taken from EPA's IRIS system.
Exposure concentration	0.0022 $\mu g/m^3$	Calculated by multiplying an estimate of the airborne dust concentration during the recreational activities (380 $\mu g/m^3$) by the average arsenic concentration in surface soils at RASS4 (5.7 ppm, which equals a mass fraction of 0.00057%).
EF	0.015	Exposures were assumed to occur 6 hours per week, 52 weeks per year, over 30 years, which equals a total of 9,360 hours. EF was calculated by dividing this number of hours by the total number of hours in a 70-year lifetime (613,200 hours).
Theoretical increased cancer risk	0.00000006 (or 6 in 100,000,000)	Calculated using the equation shown above.

Note: As Section III.B. of the PHA describes, the airborne dust concentration during use of dirt bikes and ATVs (380 $\mu g/m^3$) is the highest concentration estimated in two previous evaluations of this issue (ADHS 2000; Berman 2004).

The following table summarizes the inputs that ATSDR used when calculating theoretical increased cancer risk for inhalation exposure to arsenic in wind-blown dust from the Magazine Study Area:

Parameter	Value	Notes
Arsenic UR factor	0.0043 $(\mu g/m^3)^{-1}$	Taken from EPA's IRIS system.
Exposure concentration	0.0008 $\mu g/m^3$	Calculated by multiplying the average PM10 concentration observed at nearby monitoring locations (20 $\mu g/m^3$) by the average mass fraction of arsenic in surface soils in and near the Magazine Study Area (0.004%).
EF	1	Assumed continuous, lifetime exposure.
Theoretical increased cancer risk	0.000003 (or 3 in 1,000,000)	Calculated using the equation shown above.

III. Evaluation of Exposure to Pesticide-Contaminated Soil by Residents in Off-Base Housing

ATSDR determined that chlordane, dieldrin, and heptachlor epoxide warranted further evaluation because their maximum concentrations exceeded their respective comparison values. The following equation was used to estimate exposure doses to these pesticides from incidental ingestion:

$$Estimated\ Exposure\ Dose = \frac{C \times IR \times EF \times ED}{BW \times AT}$$

where:

C:	Maximum concentration in parts per million (ppm)
IR:	Ingestion rate: adult = 100 milligrams (mg)/day; child = 200 mg/day*
EF:	Exposure frequency, or number of exposure events per year of exposure: 365 days/year
ED:	Exposure duration, or the duration over which exposure occurs: adult = 3 years (expected residence time); child = 3 years
BW:	Body weight: adult = 70 kilogram (kg); child = 15.4 kg** (EPA 1997)
AT:	Averaging time, or the period over which cumulative exposures are averaged (3 years x 365 days/year for noncancer effects; 70 years x 365 days/year for lifetime effects)

* 1 x 10^{-6} kg (kilogram) = 1 mg (milligram)
** Mean body weight for a child 1 to 5 years old

ATSDR applied this equation to the maximum concentration of chlordane, dieldrin, and heptachlor epoxide detected in soil (see Table C-1). None of the contaminants were measured above noncancer health guidelines or cancer screening guidelines based on the stated exposure estimates. Remember that health guidelines have built-in uncertainty or safety factors, making them considerably lower than levels at which health effects have been observed. In addition, conservative models are used to screen carcinogenic effects. Therefore, ATSDR concluded that no harmful health effects are expected from incidental ingestion of contaminants in Quinault Village soil.

IV. Evaluation of Exposure to Contaminants in the Litigation Area by Mosquito Abatement Workers

IV.A. Surface Soil and Sediment in RASSs 1, 2, and 3

ATSDR determined that arsenic, cadmium, iron, lead, manganese, zinc, Aroclor-1242, Aroclor-1248, and benzo(a)pyrene warranted further evaluation because their maximum concentrations in surface soil and sediment exceeded their respective comparison values. The following equation was used to estimate exposure doses to these contaminants from incidental ingestion:

$$\textit{Estimated Exposure Dose} = \frac{C \times IR \times EF \times ED}{BW \times AT}$$

where:

C:	Maximum concentration in ppm
IR:	Ingestion rate: adult = 100 mg/day*
EF:	Exposure frequency, or number of exposure events per year of exposure: 30 days/year
ED:	Exposure duration, or the duration over which exposure occurs: adult = 30 years (expected occupation time)
BW:	Body weight: adult = 70 kg
AT:	Averaging time, or the period over which cumulative exposures are averaged (30 years x 365 days/year for noncancer effects; 70 years x 365 days/year for lifetime effects)

* 1×10^{-6} kg (kilogram) = 1 mg (milligram)

ATSDR applied this equation to the maximum concentration of arsenic, cadmium, iron, lead, manganese, zinc, Aroclor-1242, Aroclor-1248, and benzo(a)pyrene detected in soil and sediment (see Table C-2). Arsenic was the only contaminant measured above noncancer health guidelines and cancer screening guidelines based on the stated exposure estimates. All other contaminants were detected below levels of health concern.

Arsenic

Although elemental arsenic sometimes occurs naturally, arsenic is usually found in the environment in two forms—inorganic (arsenic combined with oxygen, chlorine, and sulfur) and organic (arsenic combined with carbon and hydrogen). The organic forms of arsenic are usually less toxic than the inorganic forms (ATSDR 2000). To be protective of public health during the evaluation, all of the arsenic detected in RASSs 1, 2, and 3 was assumed to be in the more harmful inorganic form. Therefore, all of the effects levels reported from the literature are for exposure to inorganic arsenic.

Incidental ingestion of arsenic-contaminated soil or sediment is one way arsenic can enter the body. Once in the body, the liver changes some of the inorganic arsenic into the less harmful organic form (i.e., by methylation). This process is effective as long as the dose of inorganic arsenic remains below 0.05 mg/kg/day (ATSDR 2000). Both inorganic and organic forms of arsenic leave the body in urine. Studies have shown that 45–85% of the arsenic is eliminated within one to three days (Buchet et al. 1981a; Crecelius 1977; Mappes 1977; Tam et al. 1979b, all as cited in ATSDR 2000); however, some will remain for several months or longer.

Noncancer health effects

Exposure to the maximum concentration of arsenic in the soil for 30 days per year would result in an exposure dose of 3.8×10^{-4} mg/kg/day for mosquito workers (see Table C-2). As noted above, the metabolism (i.e., how it is broken down in the body) of inorganic arsenic has been extensively studied in humans and animals. ATSDR's estimated doses are well below those that inhibit the body's ability to detoxify or change arsenic to non-harmful forms (doses greater than 0.05 mg/kg/day inhibit detoxification). Therefore, the amount of arsenic that a person could incidentally ingest from soil on NWS SBD Concord should be controlled by normal metabolic processes in the body.

There is some indication in the scientific literature, however, that some dermal health effects could result from ingesting a lower dose of arsenic—hyperkeratosis and hyperpigmentation were reported in humans exposed to 1.4×10^{-2} mg/kg/day of arsenic in their drinking water for more than 45 years (Tseng et al. 1968 as cited in ATSDR 2000). The estimated exposure dose for mosquito workers (3.8×10^{-4} mg/kg/day) is also well below this health effect level.

Further, most of the available information on arsenic comes from epidemiologic studies in which humans drank contaminated water. When present in water, arsenic is readily absorbed by the body and is assumed to have 100% bioavailability; but the bioavailability of arsenic in soil is much lower (estimated 3% to 50%; Rodriguez et al. 1999; Ruby et al. 1996, 1999 as cited in ATSDR 2000). Therefore, only a portion of the arsenic in soil is expected to be readily absorbed into the human body. That said, however, ATSDR's evaluations assumed 100% bioavailability of arsenic from soil.

Therefore, ATSDR does not expect that mosquito workers incidentally ingesting soil and sediment from RASSs 1, 2, and 3 would experience adverse noncancer health effects.

Cancer health effects

The Department of Health and Human Services (DHHS), IARC, and EPA have all independently determined that inorganic arsenic is carcinogenic to humans (ATSDR 2000). Skin cancer was reported for people exposed to 1.4×10^{-2} mg/kg/day of arsenic in their water for more than 45 years (Tseng et al. 1968 as cited in ATSDR 2000). Additional CELs in the literature generally

ranged from 0.01–0.05 mg/kg/day (ATSDR 2000). The estimated lifetime dose for mosquito abatement workers (1.6×10^{-4} mg/kg/day) is two orders of magnitude below these levels. Additionally, ATSDR conservatively assumed 100% bioavailability of arsenic from soil. Even with these protective assumptions, the estimated doses are below levels of health concern for cancer effects.

IV.B. *Surface Water in RASSs 1, 2, and 3*

ATSDR determined that antimony, arsenic, cadmium, chromium, copper, iron, lead, manganese, molybdenum, nickel, selenium, thallium, vanadium, zinc, methylene chloride, bis(2-ethylhexyl)phthalate, aldrin, and dieldrin warranted further evaluation because their maximum concentrations in surface water exceeded their respective comparison values. The following equation was used to estimate exposure doses to these contaminants from incidental ingestion:

$$Estimated\ Exposure\ Dose = \frac{C \times IR \times EF \times ED}{BW \times AT}$$

where:

C:	Maximum concentration in ppm
IR:	Ingestion rate: 0.15 liters (L)/day* (adult)
EF:	Exposure frequency, or number of exposure events per year of exposure: 30 days/year
ED:	Exposure duration, or the duration over which exposure occurs: adult = 30 years (expected occupation time)
BW:	Body weight: adult = 70 kg
AT:	Averaging time, or the period over which cumulative exposures are averaged (30 years x 365 days/year for noncancer effects; 70 years x 365 days/year for cancer effects)

*The ingestion rate is based on swimming for 3 hours per event (EPA 1997).

ATSDR applied this equation to the maximum concentration of antimony, arsenic, cadmium, chromium, copper, iron, lead, manganese, molybdenum, nickel, selenium, thallium, vanadium, zinc, methylene chloride, bis(2-ethylhexyl)phthalate, aldrin, and dieldrin detected in surface water (see Table C-3). Antimony and arsenic were the only contaminants measured above noncancer health guidelines based on the stated exposure estimates; and arsenic was the only contaminant measured above the cancer screening guideline. All other contaminants were detected below levels of health concern.

Antimony

Antimony is naturally found in the environment. Only a small amount of antimony is absorbed by the blood following ingestion. Antimony is not metabolized, and animal studies have shown that ingested antimony is only partially absorbed from the gastrointestinal tract. Excretion of antimony is primarily via the urine and feces, and is also dependent upon valence state. Excretion of antimony occurs over several weeks (ATSDR 1992).

Exposure to the maximum concentration of antimony in surface water for 30 days a year would result in an exposure dose of 4.4×10^{-4} mg/kg/day for mosquito workers (see Table C-2). The

exposure dose was slightly above EPA's chronic RfD (4.0×10^{-4} mg/kg/day). However, this exposure dose is several orders of magnitude lower than the effects level seen in the scientific literature (0.35 mg/kg/day). EPA based its RfD on an animal study showing decreased longevity and alteration of blood chemistry in rats chronically exposed to potassium antimony tartrate (equivalent to 0.35 mg antimony/kg/day) in drinking water (EPA 2004b).

Given that the estimated exposure dose for incidentally ingesting surface water from RASSs 1, 2, and 3 is well below those levels found to cause adverse effects in chronically exposed rats, ATSDR does not expect that mosquito workers would experience adverse noncancer health effects.

Arsenic

As discussed in the previous soil and sediment section, elemental arsenic sometimes occurs naturally, and two forms of arsenic are usually found in the environment—inorganic and organic. The organic forms of arsenic are usually less toxic than the inorganic forms (ATSDR 2000). To be protective of public health during the evaluation, all of the arsenic detected in RASSs 1, 2, and 3 was assumed to be in the more harmful inorganic form. Therefore, all of the effects levels reported from the literature are for exposure to inorganic arsenic.

Noncancer health effects

Incidental ingestion of arsenic-contaminated surface water is one way arsenic can enter the body. Once in the body, the liver changes some of the inorganic arsenic into the less harmful organic form (i.e., by methylation). This process is effective as long as the dose of inorganic arsenic remains below 0.05 mg/kg/day (ATSDR 2000). Exposure to the maximum concentration of arsenic in the surface water for 30 days a year would result in an exposure dose of 5.2×10^{-4} mg/kg/day for mosquito workers (see Table C-3). This dose is well below those that inhibit the body's ability to detoxify or change arsenic to non-harmful. Therefore, the amount of arsenic that a person could incidentally ingest from surface water on NWS SBD Concord should be controlled by normal metabolic processes in the body.

There is some indication in the scientific literature, however, that some dermal health effects could result from ingesting a lower dose of arsenic—hyperkeratosis and hyperpigmentation were reported in humans exposed to 1.4×10^{-2} mg/kg/day of arsenic in their drinking water for more than 45 years (Tseng et al. 1968 as cited in ATSDR 2000). The estimated exposure dose for mosquito workers (5.2×10^{-4} mg/kg/day) is also well below this health effect level. Therefore, ATSDR does not expect that mosquito abatement workers incidentally ingesting surface water from NWS SBD Concord would experience adverse noncancer health effects.

Cancer health effects

DHHS, IARC, and EPA have all independently determined that inorganic arsenic is carcinogenic to humans (ATSDR 2000). Skin cancer was reported for people exposed to 1.4×10^{-2} mg/kg/day of arsenic in their water for more than 45 years (Tseng et al. 1968 as cited in ATSDR 2000). Additional CELs in the literature generally ranged from 0.01–0.05 mg/kg/day (ATSDR 2000). The estimated lifetime dose for mosquito workers (2.2×10^{-4} mg/kg/day) is two orders of magnitude below these levels. Therefore, the estimated dose is also below levels of health concern for cancer effects.

V. Evaluation of Exposure to Contaminated Surface Water and Sediment During Recreational Activities in Suisun Bay

V.A. *Surface Water in Suisun Bay*

ATSDR determined that arsenic, chromium, manganese, benzo(a)pyrene, and benzo(e)pyrene warranted further evaluation because their maximum concentrations in surface water exceeded their respective comparison values. The following equation was used to estimate exposure doses to these contaminants from incidental ingestion:

$$Estimated\ Exposure\ Dose = \frac{C \times IR \times EF \times ED}{BW \times AT}$$

where:

C:	Maximum concentration in ppm
IR:	Ingestion rate: 0.15 L/day* (adult and child)
EF:	Exposure frequency, or number of exposure events per year of exposure: 104 days/year**
ED:	Exposure duration, or the duration over which exposure occurs: adult = 30 years; child = 6 years
BW:	Body weight: adult = 70 kg; child = 15.4 kg** (EPA 1997)
AT:	Averaging time, or the period over which cumulative exposures are averaged (6 or 30 years x 365 days/year for noncancer effects; 70 years x 365 days/year for cancer effects)

*The ingestion rate is based on swimming for 3 hours per event (EPA 1997).
**Assumed both days of every weekend, or 2 days x 52 weeks per year
***Mean body weight for a child 1 to 5 years old

ATSDR applied this equation to the maximum concentration of arsenic, chromium, manganese, benzo(a)pyrene, and benzo(e)pyrene detected in surface water (see Table C-4). None of the contaminants were measured above noncancer health guidelines or cancer screening guidelines based on the stated exposure estimates. Therefore, ATSDR concluded that no harmful health

effects are expected from incidental ingestion of contaminants in Suisun Bay surface water near the station.

V.B. *Sediment in Suisun Bay*

ATSDR determined that arsenic, iron, manganese, and perylene warranted further evaluation because their maximum concentrations in surface soil and sediment exceeded their respective comparison values. The following equation was used to estimate exposure doses to these contaminants from incidental ingestion:

$$Estimated\ Exposure\ Dose = \frac{C \times IR \times EF \times ED}{BW \times AT}$$

where:

C:	Maximum concentration in ppm
IR:	Ingestion rate: adult = 50 mg/day; child = 100 mg/day*
EF:	Exposure frequency, or number of exposure events per year of exposure: 104 days/year**
ED:	Exposure duration, or the duration over which exposure occurs: adult = 30 years; child = 6 years
BW:	Body weight: adult = 70 kg; child = 15.4 kg*** (EPA 1997)
AT:	Averaging time, or the period over which cumulative exposures are averaged (6 or 30 years x 365 days/year for noncancer effects; 70 years x 365 days/year for lifetime effects)

* 1 x 10^{-6} kg (kilogram) = 1 mg (milligram)
** Assumed both days of every weekend, or 2 days x 52 weeks per year
*** Mean body weight for a child 1 to 5 years old

ATSDR applied this equation to the maximum concentration of arsenic, iron, manganese, and perylene detected in soil and sediment (see Table C-5). None of the contaminants were measured above noncancer health guidelines or cancer screening guidelines based on the stated exposure estimates. Therefore, ATSDR concluded that no harmful health effects are expected from incidental ingestion of contaminants in Suisun Bay sediments near the station.

VI. *Evaluation of Exposure to Contaminants in Fish Harvested from Suisun Bay*

ATSDR determined that total DDTs, dieldrin, total dioxins, mercury, trans-nonachlor, and total PCBs warranted further evaluation because their maximum concentrations in fish exceeded their respective comparison values. The following equation was used to estimate exposure doses to these contaminants from ingestion of fish:

$$Estimated\ Exposure\ Dose = \frac{C \times IR \times EF \times ED}{BW \times AT}$$

where:

C: Maximum concentration in ppm
IR: Ingestion rate: adult = 0.227 kg/meal; child = 0.1135 kg/meal*
EF: Exposure frequency, or number of exposure events per year of exposure: adults = 24 meals/year; child = 12 meals/year**
ED: Exposure duration, or the duration over which exposure occurs: adult = 30 years; child = 6 years
BW: Body weight: adult = 70 kg ; child = 15.4 kg*** (EPA 1997)
AT: Averaging time, or the period over which cumulative exposures are averaged (6 or 30 years x 365 days/year for noncancer effects; 70 years x 365 days/year for lifetime effects)

* 0.227 kg/day is equal to an 8-ounce meal. A child's ingestion rate was assumed to be half the adult ingestion rate.
**Based on the assumptions of OEHHA's fish consumption advisory, adults would consume no more than 2 meals per month (24 times per year); and children would consume no more than 1 meal per month (12 times per year).
** Mean body weight for a child 1 to 5 years old.

ATSDR applied this equation to the maximum concentration of total DDTs, dieldrin, total dioxins, mercury, trans-nonachlor, and total PCBs detected in fish (see Table C-6). Dioxin was the only contaminant measured above noncancer health guidelines and cancer screening guidelines based on the stated exposure estimates. All other contaminants were detected below levels of health concern.

Dioxins

Chlorinated dibenzo-p-dioxins (CDDs) are a group of 75 chemically-related compounds commonly known as chlorinated dioxins. Even though they are not naturally occurring, they are found everywhere in the environment. CDDs are not intentionally manufactured by industry except for research purposes. CDDs may be formed during the chlorine bleaching process at pulp and paper mills, the chlorination process at waste and drinking water treatment plants, and the manufacturing of certain organic chemicals. They also can be released into the air in emissions from municipal solid waste and industrial incinerators. Of the chlorinated dioxins, 2,3,7,8-tetrachlorodibenzodioxin (TCDD) is one of the most toxic (ATSDR 1998).

Noncancer health effects

The most prevalent health effect in people exposed to large amounts of 2,3,7,8-TCDD is chloracne. Chloracne is a severe skin disease with acne-like lesions that occur mainly on the face

and upper body. Other skin effects noted in people exposed to high doses of 2,3,7,8-TCDD include skin rashes, discoloration, and excessive body hair. Exposure to high levels of 2,3,7,8-TCDD may also causes changes in blood and urine that may indicate liver damage. Exposure to high concentrations of CDDs may induce long-term alterations in glucose metabolism and subtle changes in hormonal levels (ATSDR 1998).

Exposure to the maximum concentration of dioxins in fish would result in an exposure dose of 1.3×10^{-7} mg/kg/day for adults, and 1.5×10^{-7} mg/kg/day for children, assuming they adhere to OEHHA's fish consumption advisory for the San Francisco Bay (see Table C-6). The exposure doses were a magnitude above ATSDR's chronic MRL (5.7×10^{-8} mg/kg/day). However, ATSDR concludes that the fish advisory is protective, even for dioxins, based on the conservative nature of our assumptions, our understanding of dioxin toxicity, and its known presence at similar levels in water bodies across the country.

ATSDR compared its estimated exposure doses to the health guidelines based solely on 2,3,7,8-TCDD, one of the most toxic dioxins. The sampling data used for the calculations only considered the *total* dioxin level and did not distinguish between the different types—therefore, any less toxic forms of the dioxins were not taken into account. ATSDR also assumed exposure to the highest detected dioxin concentrations reported in available sampling data. Using these data most likely overestimates the degree of exposure to harmful levels of dioxin.

Further, OEHHA had taken dioxin-related concerns into account when developing their advisory. According to the Cal EPA (the parent agency of OEHHA), dioxin levels reported in fish in the San Francisco Bay pilot study, were no higher than the background level calculated by the US EPA for fish from North American water bodies with no known point sources of dioxin. They further stated that preliminary analysis of the 1997 sampling data of bay fish also showed dioxins to be within the range of national background levels (OEHHA 1999).

Cal EPA also stated that, in terms of reducing health risks from consuming bay fish, one should place a much higher priority on PCBs and methylmercury. According to Cal EPA, when taking into account all "dioxin-like" compounds, dioxin-like PCBs contribute 90 percent of the cancer risk, while dioxins and furans only contribute two to ten percent of the risk (OEHHA 1999). According to ATSDR's dose calculations, PCBs and methylmercury concentrations found on the station and in Suisun Bay do not exceed health guidelines when following the advisory recommendations.

Given this rationale, ATSDR concluded that no harmful noncancer health effects are expected from ingestion of fish from Suisun Bay near the station, assuming community members adhere to OEHHA's fish consumption advisory.

Cancer health effects

DHHS has determined that 2,3,7,8-TCDD may reasonably be anticipated to cause cancer. IARC categorized 2,3,7,8-TCDD as carcinogenic to humans (Group 1) based on limited evidence in humans and sufficient evidence in experimental animals. EPA has determined 2,3,7,8-TCDD is a probable human carcinogen (ATSDR 1998).

Exposure to the maximum concentration of dioxins in fish would result in a lifetime exposure dose of 5.7×10^{-8} mg/kg/day, assuming adherence to OEHHA's fish consumption advisory for the San Francisco Bay (see Table C-6). This exposure concentration translates into a theoretical increased risk of more than one cancer death for every 10,000,000 people exposed. EPA and other environmental agencies rarely, if ever, take actions to reduce exposures for such insignificantly small cancer risks. Therefore, ATSDR concludes that the fish advisory is protective, even for dioxins, based on the conservative nature of our assumptions, our understanding of dioxin toxicity, and its known presence at similar levels in water bodies across the country. As stated above, PCBs and methylmercury should be of higher priority, and the lifetime exposure doses of these two chemicals had cancer risks below cancer health guidelines.

Given this rationale, ATSDR concluded that no harmful cancer health effects are expected from ingestion of fish from Suisun Bay near the station, assuming community members adhere to OEHHA's fish consumption advisory.

Table C-1. Exposure Doses for Contaminants in Surface Soil in Quinault Village Greater than Comparison Values

Chemical	Maximum Concentration (ppm)	Comparison Value (ppm)	Comparison Value Type	Exposure Dose (mg/kg/day)			Health Guideline (mg/kg/day)	Health Guideline Type
				Adult	Child	Lifetime		
Chlordane	24	2	CREG	3.4E-05	3.1E-04	1.5E-06	6.0E-04	Chronic MRL
Dieldrin	2.6	0.04	CREG	3.7E-06	3.4E-05	1.6E-07	5.0E-05	Chronic MRL
Heptachlor epoxide	0.166	0.08	CREG	2.4E-07	2.2E-06	1.0E-08	1.3E-05	RfD

Note: Lifetime exposure dose represents a 70-year lifetime, and is used to compare to cancer effects.

CREG	cancer risk evaluation guide (ATSDR)
mg/kg/day	milligrams per kilogram per day
MRL	minimal risk level (ATSDR)
ppm	parts per million
RfD	reference dose (EPA)

Table C-2. Exposure Doses for Contaminants Detected in Surface Soil and Sediment in RASSs 1, 2, and 3 at Concentrations Greater than Comparison Values

	Maximum Concentration (ppm)	(ppm)	Comparison Value Type			Health Guideline (mg/kg/day)	Health Guideline Type
				Adult	Lifetime		
Arsenic	3,260	0.5	CREG	**3.8E-04**	**1.6E-04**	3.0E-04	Chronic MRL
Cadmium	832	10	Chronic EMEG Child	9.8E-05	4.2E-05	2.0E-04	Chronic MRL
Iron	76,600	23,000	Residential Soil RBC – Noncancer	9.0E-03	3.9E-03	3.0E-01	RfD
Lead	6,060	400	EPA Soil Lead Guidance Level	7.1E-04	3.0E-04	0.02	Acute LOAEL
Manganese	9,620	3,000	RMEG Child	1.1E-03	4.8E-04	2.0E-02	RfD
Zinc	89,300	20,000	Chronic EMEG Child	1.0E-02	4.5E-03	3.0E-01	RfD
Aroclor-1242	1.5	0.32	Residential Soil RBC - Cancer	1.8E-07	7.5E-08	Not Available	Not Applicable
Aroclor-1248	0.62	0.32	Residential Soil RBC - Cancer	7.3E-08	3.1E-08	Not Available	Not Applicable

Benzo(a)pyrene	0.41	0.1	CREG	4.8E-08	2.1E-08	Not Available	Not Applicable

Notes:
Bold text in the Adult Exposure column indicates the exposure dose was higher than the noncancer health guideline.
Bold text in the Lifetime Exposure column indicates the exposure dose was identified for detailed evaluation of the toxicological or epidemiological information (see text for details).
Adult exposure dose represents the average daily dose of a mosquito abatement worker; the potential for non-cancer health effects was evaluated by comparing that value to the Health Guideline.
Lifetime exposure dose represents a 70-year lifetime, and is compared to toxicological and epidemiological information related to cancer (see text for details)
Exposure doses for Aroclor-1242, Aroclor-1248, and benzo(a)pyrene were below cancer screening guidelines.

CREG	cancer risk evaluation guide (ATSDR)
EMEG	environmental media evaluation guide (ATSDR)
EPA	Environmental Protection Agency
LOAEL	lowest-observed-adverse-effect level
mg/kg/day	milligrams per kilogram per day
MRL	minimal risk level (ATSDR)
ppm	parts per million
RBC	risk-based concentration (EPA)
RfD	reference dose (EPA)
RMEG	reference dose media evaluation guide (ATSDR)

Table C-3. Exposure Doses for Contaminants in Surface Water in RASSs 1, 2, and 3 Greater than Comparison Values

	Maximum Concentration (ppb)	Comparison Value (ppb)	Comparison Value Type			Health Guideline (mg/kg/day)	Health Guideline Type
				Adult	Lifetime		
Antimony	2,500	4	RMEG Child	**4.4E-04**	1.9E-04	4.0E-04	RfD
Arsenic	2,970	0.02	CREG	**5.2E-04**	**2.2E-04**	3.0E-04	Chronic MRL
Cadmium	249	2	Chronic EMEG Child	4.4E-05	1.9E-05	2.0E-04	Chronic MRL
Chromium	2,800	100	LTHA	4.9E-04	2.1E-04	3.0E-03	RfD
Copper	7,240	300	Intermediate EMEG Child	1.3E-03	5.5E-04	4.0E-02	RfD
Iron	122,000	11,000	Tap Water RBC – Noncancer	2.2E-02	9.2E-03	3.0E-01	RfD
Lead	1,330	0.015	MCL	2.3E-04	1.0E-04	0.02	Acute LOAEL
Manganese	10,000	500	RMEG Child	1.8E-03	7.5E-04	2.0E-02	RfD
Molybdenum	44	40	LTHA	7.8E-06	3.3E-06	5.0E-03	RfD
Nickel	1,390	100	LTHA	2.4E-04	1.0E-04	2.0E-02	RfD
Selenium	66	50	Chronic EMEG Child	1.2E-05	5.0E-06	5.0E-03	Chronic MRL

Chemical	Maximum Concentration (ppb)	Comparison Value (ppb)	Comparison Value Type	Exposure Dose (mg/kg/day)		Health Guideline (mg/kg/day	Maximum Concentration (ppb)
				Adult	Lifetime		
Thallium	87	0.5	LTHA	1.5E-05	6.6E-06	7.0E-05	RfD
Vanadium	290	30	Intermediate EMEG Child	5.1E-05	2.2E-05	1.0E-03	RfD
Zinc	105,000	3,000	Chronic EMEG Child	1.8E-02	7.9E-03	3.0E-01	Chronic MRL
Methylene Chloride	41	5	CREG	7.2E-06	3.1E-06	6.0E-02	Chronic MRL
Bis(2-ethylhexyl) phthalate	33	4.8	Tap Water RBC - Cancer	5.8E-06	2.5E-06	2.0E-02	RfD
Aldrin	0.02	0.002	CREG	3.5E-09	1.5E-09	3.0E-05	Chronic MRL
Dieldrin	0.041	0.002	CREG	7.2E-09	3.1E-09	5.0E-05	Chronic MRL

Notes:
Bold text in the Adult Exposure column indicates the exposure dose was higher than the noncancer health guideline.
Bold text in the Lifetime Exposure column indicates the exposure dose was identified for detailed evaluation of the toxicological or epidemiological information (see text for details).
Adult exposure dose represents the average daily dose of a mosquito abatement worker; the potential for non-cancer health effects was evaluated by comparing that value to the Health Guideline.
Lifetime exposure dose represents a 70-year lifetime, and is compared to toxicological and epidemiological information related to cancer (see text for details)

CREG	cancer risk evaluation guide (ATSDR)
EMEG	environmental media evaluation guide (ATSDR)
LTHA	lifetime health advisory for drinking water (EPA)
mg/kg/day	milligrams per kilogram per day
MRL	minimal risk level (ATSDR)

ppb	parts per billion
RBC	risk-based concentration (EPA)
RfD	reference dose (EPA)
RMEG	reference dose media evaluation guide (ATSDR)

Table C-4. Exposure Doses for Contaminants in Surface Water in Suisun Bay Greater than Comparison Values

Chemical	Maximum Concentration (ppb)	Comparison Value (ppb)	Comparison Value Type	Exposure Dose (mg/kg/day)			Health Guideline (mg/kg/day)	Health Guideline Type
				Adult	Child	Lifetime		
Arsenic	3.7	0.02	CREG	2.3E-06	1.0E-05	9.7E-07	3.0E-04	Chronic MRL
Chromium	122	100	LTHA	7.5E-05	3.4E-04	3.2E-05	3.0E-03	RfD
Manganese	1,213	500	RMEG Child	7.4E-04	3.4E-03	3.2E-04	2.0E-02	RfD
Benzo(a)pyrene	0.006	0.005	CREG	3.6E-09	1.6E-08	1.5E-09	Not Available	Not Applicable
Benzo(e)pyrene	0.008	0.005	CREG (Benzo(a)pyrene)	5.0E-09	2.3E-08	2.1E-09	Not Available	Not Applicable

Notes:
Adult exposure dose represents the average daily dose of adults incidentally ingesting bay water during recreational activities; the potential for non-cancer health effects was evaluated by comparing that value to the Health Guideline.
Child exposure dose represents the average daily dose of children incidentally ingesting bay water during recreational activities; the potential for non-cancer health effects was evaluated by comparing that value to the Health Guideline.
Lifetime exposure dose represents a 70-year lifetime, and is compared to toxicological and epidemiological information related to cancer (see text for details)
Exposure doses for benzo(a)pyrene and benzo(e)pyrene were below cancer screening guidelines.

CREG	cancer risk evaluation guide (ATSDR)
mg/kg/day	milligrams per kilogram per day
LTHA	lifetime health advisory for drinking water (EPA)
MRL	minimal risk level (ATSDR)
ppb	parts per billion
RfD	reference dose (EPA)
RMEG	reference dose media evaluation guide (ATSDR)

Table C-5. Exposure Doses for Contaminants in Sediment in Suisun Bay Greater than Comparison Values

Chemical	Maximum Concentration (ppm)	Comparison Value (ppm)	Comparison Value Type	Exposure Dose (mg/kg/day)			Health Guideline (mg/kg/day)	Health Guideline Type
				Adult	Child	Lifetime		
Arsenic	9.2	0.5	CREG	1.9E-06	1.7E-05	8.0E-07	3.0E-04	Chronic MRL
Iron	40,241	23,000	Residential Soil RBC - Noncancer	8.2E-03	7.5E-02	3.5E-03	3.0E-01	RfD
Manganese	5,980	3,000	RMEG Child	1.2E-03	1.1E-02	5.2E-04	2.0E-02	RfD
Perylene	0.113	0.1	CREG (Benzo(a)pyrene)	2.3E-08	2.1E-07	9.9E-09	Not Available	Not Applicable

Notes:
Adult exposure dose represents the average daily dose of adults incidentally ingesting bay sediment during recreational activities; the potential for non-cancer health effects was evaluated by comparing that value to the Health Guideline.
Child exposure dose represents the average daily dose of children incidentally ingesting bay sediment during recreational activities; the potential for non-cancer health effects was evaluated by comparing that value to the Health Guideline.
Lifetime exposure dose represents a 70-year lifetime, and is compared to toxicological and epidemiological information related to cancer (see text for details)
Exposure doses for perylene were below cancer screening guidelines.

CREG	cancer risk evaluation guide (ATSDR)
mg/kg/day	milligrams per kilogram per day
MRL	minimal risk level (ATSDR)
ppm	parts per million
RBC	risk-based concentration (EPA)
RfD	reference dose (EPA)
RMEG	reference dose media evaluation guide (ATSDR)

Table C-6. Exposure Doses for Contaminants in Fish in Suisun Bay Greater than Comparison Values

	Maximum Concentration	Comparison	Comparison				Health Guideline (mg/kg/day)	
Total DDTs	0.025	0.0093	RBC - Cancer	5.3E-06	6.1E-06	2.3E-06	5.0E-04	RfD
Dieldrin	0.002	0.0002	RBC – Cancer	4.3E-07	4.8E-07	1.8E-07	5.0E-05	Chronic MRL
Total Dioxin	6.2E-04	2.1E-08	RBC – Cancer (2,3,7,8-TCDD)	**1.3E-07**	**1.5E-07**	**5.7E-08**	1.0E-09	Chronic MRL
Mercury	0.53	0.14	RBC – Noncancer (Methylmercury)	1.1E-04	1.3E-04	4.8E-05	3.0E-04 (Methylmercury)	Chronic MRL
trans-Nonachlor	0.004	0.0007	RBC – Cancer (Heptachlor)	8.5E-07	9.7E-07	3.7E-07	5.0E-04 (Heptachlor)	RfD
Total PCBs	0.017	0.0016	RBC - Cancer	3.6E-06	4.1E-06	1.6E-06	Not Available	Not Applicable

Notes:
Bold text in the Adult Exposure column indicates the exposure dose was higher than the noncancer health guideline.
Bold text in the Lifetime Exposure column indicates the exposure dose was identified for detailed evaluation of the toxicological or epidemiological information (see text for details).
Adult exposure dose represents the average daily dose of adults consuming two fish meals per month from the bay; the potential for non-cancer health effects was evaluated by comparing that value to the Health Guideline.
Child exposure dose represents the average daily dose of children consuming one fish meal per month from the bay; the potential for non-cancer health effects was evaluated by comparing that value to the Health Guideline.
Lifetime exposure dose represents a 70-year lifetime, and is compared to toxicological and epidemiological information related to cancer (see text for details)
Exposure doses for total PCBs were below cancer screening guidelines.

mg/kg/day	milligrams per kilogram per day
MRL	minimal risk level (ATSDR)
ppm	parts per million
RBC	risk-based concentration (EPA)
RfD	reference dose (EPA)

Appendix D: Estimated Concentration of Arsenic in Beef from Cattle Grazing at the Magazine Study Area

Background

Beef cattle graze on the inland portion of the base. Soil sampling results indicate the arsenic concentrations in the surface soil at the Magazine Study Area range from background to approximately 199 mg/kg. The grazing cattle are part of a cow-calf production operation. Once a year, calves are sold to other cattle operations to be raised to their full size and slaughtered. Approximately 375 animals graze on-base, all year. Of the Inland Area's approximately 5,200 acres of land, 4,491 acres (86%) are leased for cattle grazing (S Tyahla, personal communication, 2004). The Magazine Study Area with elevated arsenic concentrations in the soil is approximately 500 acres; a little over 11% of the grazing area (500/4491 = 11%).

Methodology

ATSDR followed the basic procedure described in EPA guidance (EPA 1998) for estimating the concentration of arsenic in beef of cattle and calves due to grazing on-base. The estimated concentration of arsenic in beef was compared to arsenic concentrations reported in other common foods.

Assumptions

1. The Magazine Study Area with high arsenic concentrations in soil represents approximately 11% of the total grazing area; however the cattle were assumed to ingest 15% if their food by grazing in the Magazine Study Area.
2. The soil arsenic concentrations in the Magazine Study Area ranged from background to 199 mg/kg. The arsenic concentration in the soil in the Magazine Study Area was assumed to be equal to the average of the measured concentrations above the background level.
3. The remaining 89% of the grazing area had soil arsenic concentrations within the background level for this area.
4. Arsenic concentrations in soil less than 10 mg/kg are believed to represent background conditions for this area (M. Wallerstein and S. Tyahla, personal communication, August 31, 2004).
5. All of the cattle's diet was provided by foraging on-base.
6. The calves are weaned after approximately 6 months and then begin to forage (EPA 2004).
7. Grazing calves consume approximately 60% as much as adult cattle.

8. The arsenic concentration in the plant material consumed by cattle foraging in the Magazine Study Area was assumed to be equal to the detection limit used during vegetation sampling.

9. At slaughter the animal would produce at least 330 kg (730 lb) of beef (USU 1999). This is approximately 60% of the total weight of the cow at slaughter. Calves at 1 yr have a gross weight of approximately 360 kg (800 lb), assuming the same proportions, these calves approximately 215 kg (480 lb) of beef.

Conclusions

The estimated concentration of arsenic in beef is slightly below typical concentrations reported in grains, meat, fish and poultry, and the average concentration reported from the Total Diet Study. As a result no health effects are expected for people who regularly consume beef from cattle or calves that graze on-base.

Estimated Concentration of Arsenic in Beef Grazing in the Magazine Study Area

$$C_{beef} = \left[(F_1 \times O_1 \times C_1) + (F_1 \times Q_s \times C_s \times B_s) \right] \times B_a \times MF$$

Where:

C_{beef} = Concentration of arsenic in the beef [mg arsenic/kg tissue]
F_i = Fraction of forage or soil intake from Magazine Study Area [unitless]
Q_i = Quantity of forage consumed per day [kg plant/d]
C_i = Concentration of arsenic in forage [mg arsenic/kg forage]
Q_s = Quantity of soil consumed per day [kg soil/d]
C_s = Average concentration of arsenic in soil [mg arsenic/kg soil]
B_s = Bioavailability of arsenic in soil [unitless]
B_a = Biotransfer of arsenic ingestion to beef tissue [d/kg Fresh Weight tissue]
MF = Metabolism factor [unitless]

Summary of Input Values

Variable	Input Value	Rationale
F_i	0.15	Assume cattle ingest 15% from Magazine Study Area
Q_i	11.8 kg forage/d	Total dietary intake from EPA Guidance [1]
C_i	0.3 mg arsenic/kg forage	Assume arsenic concentration is equal to detection limit [2]
Q_s	0.5 kg soil/d	Average value from EPA Guidance [3]
C_s	57 mg arsenic/kg soil	Average of concentrations in area with elevated concentrations
B_s	1.0	Default recommended by EPA guidance [4]
B_a	0.002 d/kg FW tissue	Recommended by EPA guidance [5]
MF	1.0	Default recommended by EPA guidance [6]

Notes:
1. EPA 1998; pg 5-46.
2. Arsenic was not detected in vegetation samples; detection limit was 0.3 mg/kg
3. EPA 1998; pg 5-48.
4. EPA 1998; pg 5-48.
5. EPA 1998; Table A-3-14; Chemical-specific Inputs for Arsenic (7440-38-2).
6. EPA 1998; pg 5-49.

Under these conditions the estimated concentration of arsenic in beef is 0.0096 mg/kg (C_{beef} = 0.0096 mg/kg)

Estimated Concentration of Arsenic in Calves Grazing in the Magazine Study Area

$$C_{calves\ grazing} = \left[(F_1 \times O_1 \times C_1) + (F_1 \times Q_s \times C_s \times B_s) \right] \times B_a \times MF$$

Where:

$C_{calves\_grazing}$ = Concentration of arsenic in the beef from grazing [mg arsenic/kg tissue]
F_i = Fraction of forage or soil intake from Magazine Study Area [unitless]
Q_i = Quantity of forage consumed per day [kg plant/d]
C_i = Concentration of arsenic in forage [mg arsenic/kg forage]
Q_s = Quantity of soil consumed per day [kg soil/d]
C_s = Average concentration of arsenic in soil [mg arsenic/kg soil]
B_s = Bioavailability of arsenic in soil [unitless]
B_a = Biotransfer of arsenic ingestion to beef tissue [d/kg Fresh Weight tissue]
MF = Metabolism factor [unitless]

Summary of Input Values

Variable	Input Value	Rationale
F_i	0.15	Assume calves ingest 15% from Magazine Study Area
Q_i	7.1 kg forage/d	Assume calves eat 60% of adults; from EPA Guidance [1]
C_i	0.3 mg arsenic/kg forage	Assume arsenic concentration is equal to detection limit [2]
Q_s	0.3 kg soil/d	Assume calves eat 60% of adults; from EPA Guidance [3]
C_s	57 mg arsenic/kg soil	Average of concentrations in area with elevated concentrations
B_s	1.0	Default recommended by EPA guidance [4]
B_a	0.002 d/kg FW tissue	Recommended by EPA guidance [5]
MF	1.0	Default recommended by EPA guidance [6]

Notes:
1. EPA 1998; pg 5-46.
2. Arsenic was not detected in vegetation samples; detection limit was 0.3 mg/kg
3. EPA 1998; pg 5-48.
4. EPA 1998; pg 5-48.
5. EPA 1998; Table A-3-14; Chemical-specific Inputs for Arsenic (7440-38-2).
6. EPA 1998; pg 5-49.

Under these conditions the estimated concentration of arsenic in "beef" is 0.0058 mg/kg ($C_{calves\_grazing}$ = 0.0058 mg/kg)

Estimated Concentration of Arsenic in Cow Milk

$$C_{milk} = \left[(F_1 \times Q_1 \times C_1) + (F_1 \times Q_s \times C_s \times B_s) \right] \times B_a \times MF$$

Where:
C_{milk} = Concentration of arsenic in the milk [mg arsenic/kg milk]
F_i = Fraction of forage or soil intake from Magazine Study Area [unitless]
Q_i = Quantity of forage consumed per day [kg plant/d]
C_i = Concentration of arsenic in forage [mg arsenic/kg forage]
Q_s = Quantity of soil consumed per day [kg soil/d]
C_s = Average concentration of arsenic in soil [mg arsenic/kg soil]
B_s = Bioavailability of arsenic in soil [unitless]
B_a = Biotransfer of arsenic ingestion to milk [d/kg Wet Weight milk]
MF = Metabolism factor [unitless]

Summary of Input Values

Variable	Input Value	Rationale
F_i	0.15	Assume calves ingest 15% from Magazine Study Area
Q_i	11.8 kg forage/d	Average value from EPA Guidance [1]
C_i	0.3 mg arsenic/kg forage	Assume arsenic concentration is equal to detection limit [2]
Q_s	0.5 kg soil/d	Average value from EPA Guidance [3]
C_s	57 mg arsenic/kg soil	Average of concentrations in area with elevated concentrations
B_s	1.0	Default recommended by EPA guidance [4]
B_a	0.006 d/kg milk	Recommended by EPA guidance [5]
MF	1.0	Default recommended by EPA guidance [6]

Notes:
1. EPA 1998; pg 5-46.
2. Arsenic was not detected in vegetation samples; detection limit was 0.3 mg/kg
3. EPA 1998; pg 5-48.
4. EPA 1998; pg 5-48.
5. EPA 1998; Table A-3-14; Chemical-specific Inputs for Arsenic (7440-38-2).
6. EPA 1998; pg 5-49.

Under these conditions the estimated concentration of arsenic in beef is 0.029 mg/kg (C_{milk} = 0.029 mg/kg)

Estimated Concentration of Arsenic in Calves from Milk

$$C_{calve's\ milk} = \left[\left(Q_{milk} \times C_{milk}\right)\right] \times B_a \times MF$$

Where:
C_{calves_milk} = Concentration of arsenic in the beef [mg arsenic/kg tissue]
Q_{milk} = Quantity of milk consumed per day [kg plant/d]
C_{milk} = Concentration of arsenic in milk [mg arsenic/kg milk]
B_a = Biotransfer of arsenic ingestion to beef tissue [d/kg Fresh Weight tissue]
MF = Metabolism factor [unitless]

Summary of Input Values

Variable	Input Value	Rationale
Q_{milk}	6.5 kg milk/d	Based on typical milk consumption [1] and milk density [2]
C_{milk}	0.029 mg arsenic/kg milk	From previous calculations
B_a	0.02 d/kg FW tissue	Assume transfer efficiency is 10 times greater than that recommended by EPA guidance [3]
MF	1.0	Default recommended by EPA guidance [4]

Notes:
1. Ugarte 1989; in Speedy and Sansoucy 1989.
2. Elert 2004.
3. EPA 1998; Table A-3-14; Chemical-specific Inputs for Arsenic (7440-38-2).
4. EPA 1998; pg 5-49.

Under these conditions the estimated concentration of arsenic in "beef" is 0.0038 mg/kg (C_{calves_milk} = 0.0038 mg/kg).

Estimated Concentration of Arsenic in Cows Grazing for One Year and then Raised in a Separate Location for One Year Prior to Slaughter

$$C_{calve's\ beef} = \left[C_{calves\ grazing} \times \left(M_{one\ year} / M_{slaughter}\right)\right]^{*}$$

Where:

C_{calves_beef} = Concentration of arsenic in the beef at slaughter [mg arsenic/kg tissue]
$C_{calves\_grazing}$ = Concentration of arsenic in beef at one year [mg arsenic/kg tissue]
$M_{one\ year}$ = Weight of calf at one year [kg]
$M_{slaugher}$ = Weight of calf at slaughter (approximately 2 yr) [kg]

* Note that this method assumes arsenic exposure at the separate location is insignificant

Summary of Input Values

Variable	Input Value	Rationale
$C_{calves\_grazing}$	0.0096 mg/kg	From previous calculations [1]
$M_{one\ year}$	480 lb (215 kg)	Utah State University 1999
$M_{slaugher}$	800 lb (360 kg)	Utah State University 1999
Notes: 1. Assume concentration of arsenic in the beef is equal to the sum of arsenic concentration from milk plus grazing (0.0038 mg/kg + 0.0058 mg/kg = 0.0096)		

Under these conditions the estimated concentration of arsenic in "beef" is .0057 mg/kg ($C_{calve's\_beef}$ = 0.0057 mg/kg).

Comparison of Estimated Arsenic Concentrations in Grazing Calves and Cattle to Concentrations Measured in Other Foods

Arsenic Concentrations [mg/kg] Measured or Estimated in Food	
< 1	Background concentrations usually measured in living organisms [1]
0.0057	Concentration estimated in calves at time of slaughter [2]
0.0096	Concentration estimated in cows at time of slaughter [2]
0.02	Typical concentrations measured in grains in the US [1]
0.03	Average concentration measured in the Total Diet Study (for the US) [1]
0.14	Typical concentrations measured in meat, fish, and poultry in the US [1]
Notes: 1. ATSDR 2000; pg 269-273. 2. Previous calculations.	

References

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