ATSDR
AGENCY FOR TOXIC SUBSTANCES AND DISEASE REGISTRY

Public Health Assessment for

NAVAL AIR STATION (NAS) JACKSONVILLE
JACKSONVILLE, DUVAL COUNTY, FLORIDA
EPA FACILITY ID: FL6170024412
JULY 7, 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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Prepared by:

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

FOREWORD

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

Since 1986, ATSDR has been required by law to conduct a public health assessment at each of the sites on the EPA National Priorities List. The aim of these evaluations is to find out if people are being exposed to hazardous substances and, if so, whether that exposure is harmful and should be stopped or reduced. (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. The public health assessment program allows the scientists flexibility in the format or structure of their response to the public health issues at hazardous waste sites. For example, a public health assessment could be one document or it could be a compilation of several health consultations - the structure may vary from site to site. Nevertheless, the public health assessment process is not considered complete until the public health issues at the site are addressed.

Exposure: As the first step in the evaluation, ATSDR scientists review environmental data to see how much contamination is at a site, where it is, and how people might come into contact with it. Generally, ATSDR does not collect its own environmental sampling data but reviews information provided by EPA, other government agencies, businesses, and the public. When there is not enough environmental information available, the report will indicate what further sampling data 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 evaluate whether or not these contacts may result in harmful effects. ATSDR recognizes that children, because of their play activities and their growing bodies, may be more vulnerable to these effects. As a policy, unless data are available to suggest otherwise, ATSDR considers children to be more sensitive and vulnerable to hazardous substances. Thus, the health impact to the children is considered first when evaluating the health threat to a community. The health impacts to other high risk groups within the community (such as the elderly, chronically ill, and people engaging in high risk practices) also receive special attention during the evaluation.

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

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

ATSDR is primarily an advisory agency, so usually these reports identify what actions are appropriate to be undertaken by EPA, other responsible parties, or the research or education divisions of ATSDR. However, if there is an urgent health threat, ATSDR can issue a public health advisory warning people of the danger. ATSDR can also authorize health education or pilot studies of health effects, full-scale epidemiology studies, disease registries, surveillance studies or research on specific hazardous substances.

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

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

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

Letters should be addressed as follows:

Attention: Division of Health Assessment and Consultation, Agency for Toxic Substances and Disease Registry, 1600 Clifton Road (E-60), Atlanta, GA 30333.

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Acronyms

AT	averaging time
ATSDR	Agency for Toxic Substances and Disease Registry
BHC	benzenehexachloride
bls	below land surface
bq kq	becquerel per kilogram
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
COC	contaminant of concern
cpm	curies per meter
CREG	cancer risk evaluation guide
CRP	community relations plan
CV	comparison value
DCE	dichloroethene
DDD	dichlorodiphenyldichloroethane
DDE	dichlorodiphenyldichloroethylene
DDT	dichlorodiphenyltrichloroethane
DoD	U.S. Department of Defense
DPT	direct push technology
DRMO	Defense Reutilization and Marketing Office
EMEG	environmental media evaluation guide
EP Tox	extraction procedure toxicity
EPA	U.S. Environmental Protection Agency
FDEP	Florida Department of Environmental Protection
FDOH	Florida Department of Health
FFA	federal facility agreement
FFTA	Former Firefighting Training Area
FHMI	Family Housing Management Institute
FTA	Firefighting Training Area
g/day	gram per day
HCH	hexachlorocyclohexane

IAS	initial assessment study
IRA	interim removal action
IRP	Installation Restoration Program
IWTP	Industrial Wastewater Treatment Plant
kg	kilogram
LNAPL	light nonaqueous-phase liquid
LTA	lifetime health advisory
LUC	land use control
MCL	maximum contaminant level
MCPA	2-methyl-4-chlorophenoxyacetic acid
MCPP	2-(2-methyl-4-chlorophenoxy)propionic acid
mg/day	milligram per day
mg/kg/day	milligram per kilogram per day
NACIP	naval assessment and control of installation pollutants
NADEP	Naval Air Depot
NCRP	National Council on Radiation Protection and Measurements
NFRAP	no further response action planned
NIRP	Naval Installation Restoration Program
NOAEL	no-observed-adverse-effect-level
NPL	National Priorities List
ODA	Oil Disposal Area
OU	operable unit
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
pCi/g	picocuries per gram
pCi/L	picocuries per liter
PHA	public health assessment
PHAP	public health action plan
ppb	parts per billion
ppm	parts per million

PRG	preliminary remediation goal
PSC	potential source of contamination
PVC	polyvinyl chloride
PWC JAX	Navy Public Works Center Jacksonville
RAB	Restoration Advisory Board
RASO	U.S. Radiological Affairs Support Office
RBC	risk-based concentration
RCRA	Resource Conservation and Recovery Act
RI/FS	remedial investigation/feasibility study
RMEG	reference dose media evaluation guide
ROD	record of decision
RRDS	remedial response decision system
SAF	South Antenna Field
SARA	Superfund Amendments and Reauthorization Act
SDWA	Safe Drinking Water Act
SJRWMD	St. Johns River Water Management District
SOC	synthetic organic compound
SSL	soil screening level
SVOC	semi-volatile organic compound
TCE	trichloroethene
TM	trademark
TPH	total petroleum hydrcarbon
TRC	Technical Review Committee
USGS	U.S. Geological Survey
UST	underground storage tank
VC	vinyl chloride
VOC	volatile organic compound
WWI	World War I
WWII	World War II
WWTP	Waste Water Treatment Plant

Summary

The Agency for Toxic Substances and Disease Registry (ATSDR) prepared this public health assessment to evaluate contamination at the Naval Air Station (NAS) Jacksonville, and to determine if site contamination could potentially harm people who live at or near the station. After an extensive examination of site sampling data, groundwater modeling, and other environmental evaluations at NAS Jacksonville, ATSDR concludes that any contamination found at the station is not a threat to public health.

NAS Jacksonville consists of 3,896 acres in Jacksonville, Duval County, Florida. The station is situated along the western bank of the St. Johns River, about 9 miles south of downtown Jacksonville. Military use of NAS Jacksonville began in 1909 and continues today under U.S. Navy (Navy) ownership and operation. The Navy operates more than 100 tenant commands at NAS Jacksonville, which is the third largest naval installation in the United States. Over 25,000 military, civilian, and contract employees work at NAS Jacksonville on a daily basis.

As a result of NAS Jacksonville's past disposal practices, pesticide applications, aviation-related activities, and other operations, contaminants have been released into the environment. Under the Department of Defense's Installation Restoration Program (IRP), the Navy has been conducting investigations at areas of potential contamination since the 1970s. Contaminants have been detected on site in groundwater, surface soil, surface water, sediment, and in fish.

Because of site-wide contamination, on November 21, 1989, the U.S. Environmental Protection Agency (USEPA) placed NAS Jacksonville on its National Priorities List (NPL) of sites requiring further environmental investigation. In 1993 the Navy established the NAS Jacksonville Partnering Team to manage the Naval Installation Restoration Program (NIRP) at the station and to guide all restoration decisions and activities.

As part of the public health assessment process, ATSDR conducted a site visit in January 2004. ATSDR staff met with NAS Jacksonville and Navy representatives, toured the 54 potential sources of contamination (PSCs) at the facility, and requested site-related information. During the site visit, ATSDR did not identify any exposure situations that presented imminent threats to people living on or near the station. After the site visit and after a review of available environmental data, ATSDR reached the following conclusions regarding each potential exposure pathway:

Groundwater Pathway: Groundwater is contaminated with volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), pesticides, herbicides, radionuclides, cyanide, and metals. That said, however, the contaminated groundwater at NAS Jacksonville is not used as a drinking water source. The station obtains drinking water from the deep Floridan aquifer, approximately 1,100 to 1,200 feet below ground surface; site contaminants have only been detected within 60 feet below ground surface.

Some off-site residents use private wells for drinking water. Limited sampling of private wells located north and west of the site boundary did not detect any contaminants exceeding health-based comparison values. Contaminants (arsenic, copper, and trichloroethene) were detected in private drinking water wells located adjacent to the site's southern fenceline. These residents'

drinking water wells, however, tap into the aquifer at depths of 200 or more feet below ground, which is far below levels at which site contaminants have been detected. In addition, the results of U.S. Geological Survey (USGS) groundwater modeling for the area indicate that groundwater from the southern portion of the station discharges toward the southeast to an unnamed stream, away from the off-site neighborhood.

Arsenic and copper detected at these wells were detected at levels below the regulatory limits for drinking water, and are therefore considered safe for public consumption. Trichloroethene (TCE) was detected above the regulatory limit for drinking water in one private well (one detection). A TCE filtration system was installed in 2001 to decrease TCE levels in this private well. ATSDR requested more recent sampling results to determine if TCE detected at this one location has decreased, but according to the Florida Department of Health (FDOH)-Duval County Health Department, the resident of this well did not permit the county to sample the well. ATSDR believes, however, that since the filtration system is in place, TCE levels have decreased at this well.

No one is currently exposed to NAS Jacksonville-related contaminants through groundwater. Though these wells could have received contaminants from other sources in the area, the one detection above its regulatory limit has presumably decreased since the TCE filtration system was installed. Therefore, because arsenic and copper were detected below the regulatory limits for drinking water and a TCE filtration system is in place at the private well where TCE was detected, the groundwater pathway does not appear to pose a public health hazard for residents living adjacent to the southern fence line and whose household water comes from underground wells.

Surface Soil Pathway: Contaminants including SVOCs, herbicides, pesticides, PCBs, metals, and radionuclides are present in site-wide surface soil. At 35 out of 54 PSCs, however, the Navy uses fencing, guarded gates, and other security measures to restrict access to authorized personnel. Of the remaining PSCs that do no restrict site access, contaminated surface soil has only been detected at seven (20, 21, 22, 23, 32, 36, and 49). ATSDR calculated exposure doses for resident children and adults potentially exposed to contaminants in on-site surface soil and determined that no doses were above levels at which adverse human health effects have been observed. Therefore, no harmful health effects are expected from exposure to surface soil in accessible areas of the station.

Although none of these other areas are accessible, in the early 1990s residents expressed concern that neighborhood children had trespassed into the former landfill area to play in the landfill soil. This area had been fenced in the past, and in 1991 the Navy installed a higher fence to prevent children and others from trespassing. ATSDR calculated conservative estimates for potential exposures to children and adults who trespassed into this area before the higher fence was installed, and concluded that potential exposures were too low to have caused adverse health effects. Thus past exposure to surface soil in the landfill (where children trespassed) and all other inaccessible areas on site would not result in harmful health effects.

Surface Water and Sediment Pathway: Site-related surface water bodies include the St. Johns River, Casa Linda Lake, Lake Scotlis, the unnamed tributary adjacent to the former landfill (OU1), the unnamed creek adjacent to the southern fenceline, and the Ortega River. Surface water from the eastern portion of the station discharges directly to the St. Johns River; drainage from the western sections of the station discharges toward the Ortega River (off site) via three unnamed streams. ATSDR could not locate data that confirm if any contaminants from NAS Jacksonville have impacted the Ortega River surface water or sediment. The southern portion of the station is drained by an unnamed creek that discharges to the St. Johns River. In addition, NAS Jacksonville contains an extensive and complicated storm drainage system comprised of 66 identified drainage basins.

No one has access to the unnamed creek adjacent to the southern border or to the unnamed tributary adjacent to the former landfill area — fencing surrounds these two areas. People are permitted to catch-and-release fish from the shores of Casa Linda Lake and Lake Scotlis, but the Navy does not allow people to enter these water bodies. People fish and conduct other recreational activities in the St. Johns and Ortega Rivers, though no one swims in the portions of the St. Johns River adjacent to the station, and no areas of the Ortega River are adjacent to the station (the river is off site, ½-mile west of U.S. Highway 17). Sediment and surface water sampling for the St. Johns River detected contaminants in restricted areas of the river, but surface water contaminants from the outfall that discharges from the station to the river were not detected. Low levels of contaminants were detected in Ortega River sediments, but again, surface water sampling did not indicate any contaminants. If people were exposed to contaminants in sediment and surface water within these water bodies, any exposures via fishing, boating, and jet skiing would be infrequent and for short periods of time. Infrequent exposure to low levels of contaminants is unlikely to cause adverse health effects.

Consumption of Fish and Shellfish Pathway: Residents, station personnel, military personnel, and others permitted station access could have consumed fish from Casa Linda Lake and Lake Scotlis in the past. ATSDR conservatively estimated potential exposure doses based on lifetime exposures to fish via ingestion from these water bodies. Though most residents only live at the station for 3 years, non-residents living in the area (e.g., active duty and retired military who do not live at the station) and people working at the station could have fished at these lakes for a longer period of time. Using conservative assumptions about the duration of potential exposures, all doses were below levels shown to cause adverse health effects. Therefore, adverse health effects would not be expected from past consumption of fish from Casa Linda Lake or from Lake Scotlis. Currently, under NAS Jacksonville's catch-and-release program, no one is permitted to consume fish from these lakes. But even if these fishing restrictions were lifted, as long as contaminant levels remain the same or decrease, adverse health effects would not be expected from current and future consumption of fish from these lakes.

No fish or shellfish sampling data are available for areas of the St. Johns River bordering the station where people fish. Nevertheless, sediment toxicity tests have been conducted on various amphipods. Toxicity tests are often used on amphipods because they have limited mobility and are prone to pollutant accumulation, and as a result are good area contamination indicators (Grosse et al. 1986). Fish, on the other hand, are migratory and can move away from a specified area. Thus, where contamination was detected in fish, it might actually be associated with an area of the river not near NAS Jacksonville. Using accepted amphipod survival rates, investigators concluded that marine invertebrates (e.g., shrimp and crab) in these areas would not be adversely affected by contaminants in sediment (HLA 1999i; 1999q; and 1999t). Because invertebrates would not be adversely impacted by sediment contamination, and because these types of marine life lie closest to the sediment, fish or shellfish in the St. Johns River would not be expected to accumulate hazardous quantities of contaminants. Consequently adverse health effects would not be expected from consumption of fish or shellfish in the St. Johns River.

Background

Site Description

Naval Air Station (NAS) Jacksonville comprises 3,896 acres along the western bank of the St. Johns River in Jacksonville, Florida (AG&M 1991; Global Security 2002a; NAS 2004a). The station is about 9 miles south of downtown Jacksonville in southeastern Duval County (TtNUS 2003a). The Timuquana Country Club and the St. Johns River border NAS Jacksonville to the north. Many residential streets lie between the station's southern boundary and Interstate 295. The St. Johns River forms the station's eastern boundary, and U.S. Highway 17 (Roosevelt Boulevard) borders the majority of NAS Jacksonville to the west (ABB-ES 1998a; Davis et al. 1996; HLA 1998a; JDMAG 2003).

Two parts of NAS Jacksonville — Dewey Park and the Defense Reutilization and Marketing Office (DRMO) — lie west of U.S. Highway 17 (ABB-ES 1995a). The U.S. Navy (Navy) leases the 65-acre Dewey Park area to the city of Jacksonville for use as a recreational park, but has retained the remaining 3,831 acres for station-related activities that are detailed below (ABB-ES 1995a). Clay County is less than 1 mile south of the southern border, and the Ortega River, a tributary of the St. Johns River, is about ½ mile west of U.S. Highway 17 (ABB-ES 1998a; ABB-ES 1998b) (see Figure 1).

Although station areas along the St. Johns River coastline are not fenced (Wally Holdstein, public works manager, NAS Jacksonville, personal communication, 2004), a fence does surround all of the remaining areas of NAS Jacksonville. Historically and currently, NAS Jacksonville has restricted all station access to military and civilian station personnel only. The station issues temporary passes to authorized visitors (NAS 2004b).

Operational History

Throughout its history, NAS Jacksonville has been under government ownership. Military use of the station began in 1909 when the state of Florida garrisoned its militia troops at the site (ABB-ES 1998a; Davis 2003). During World War I (WWI), the U.S. Army (Army) operated the station as a training facility for military troops (ABB-ES 1995a, 1998a). After WWI, control of the station was returned to the state, which used the property as a Florida National Guard Training Center until 1939 (ABB-ES 1998a).

In 1939, Duval County officials proposed that the county purchase land for a naval air station, and then donate the property to the Navy. Following public approval, the land was purchased for NAS Jacksonville; it is the only military installation in the nation established by a direct gift of the people (AG&M 1991; JDMAG 2003). On October 15, 1940, NAS Jacksonville was commissioned to provide a Navy Aviation Trades School for ground crewmen and facilities for pilot training (AG&M 1991; Public Affairs Office 2003a).

During World War II (WWII), NAS Jacksonville provided support for military operations. As a result of these efforts, the station more than doubled in physical size (AG&M 1991; Public Affairs Office 2003). Before the end of WWII, the station had over 700 buildings, three operational runways, seaplane ramps, an 80-acre hospital, a prisoner-of-war compound, and additional facilities to assist in the war effort (Global Security 2002b; Haas Center for Business

Research and Economic Development 2003). By 1946, the station had a peak number of employees totaling 42,000 naval personnel and 11,000 civilians (AG&M 1991).

Since 1951, the station's mission has been to train pilots and ground crewmen and to support operational carrier squadrons (Public Affairs Office 2003). Currently, NAS Jacksonville houses more than 100 tenant commands, including the Naval Hospital, Defense Distribution Depot, Naval Air Depot (NADEP), and Commander, Navy Region Southeast (ABB-ES 1998a; NAS 2002a). On a daily basis more than 25,000 military, civilian, and contractor personnel work at the station (Haas Center for Business Research and Economic Development 2003; NAS Jacksonville 2002a). NAS Jacksonville is today the third largest naval installation in the United States (Haas Center for Business Research and Economic Development 2003).

Remedial and Regulatory History

The Navy conducts environmental investigations and activities at NAS Jacksonville under the U.S. Department of Defense's (DOD) Installation Restoration Program (IRP). IRP funds identification of potential hazardous waste sites, investigations of any contamination found at these sites, and performance of remedial activities to reduce or remove identified hazardous wastes. In 1993, the Navy established the NAS Jacksonville Partnering Team to manage the Naval Installation Restoration Program (NIRP) at the station. Today, this team continues to guide all restoration decisions and activities at NAS Jacksonville (TtNUS 2003a).

The *NAS Jacksonville Partnering Team* is comprised of representatives from the U.S. Navy, Florida Department of Environmental Protection (FDEP), and U.S. EPA, as well as government contractors who are involved with the site.

As the result of 1) former disposal practices, 2) hazardous waste storage, 3) contaminant spills, 4) pesticide use, and 5) other site-related activities, NAS Jacksonville has site-wide contamination. To address these areas, in the 1970s the Navy began environmental actions and studies at NAS Jacksonville (ABB-ES 1997a).

Using historical records, field studies, employee interviews, and aerial photographs, by the early 1980s the Navy had identified 38 potential source of contamination (PSC) sites at NAS Jacksonville (USEPA 2002, 2003a; Fred C. Hart Associates, Inc. 1983). These PSCs included former storage areas, landfill sites, firefighter training locations, fuel stations, waste disposal areas, spill sites, and other identified locations (Fred C. Hart Associates, Inc. 1983).

An initial assessment study (IAS) completed in March 1983 evaluated the types of contamination, the possible migration pathways, and the potentially impacted populations at each PSC. The IAS determined that none of the contaminated sites represented "an immediate threat," but that 10 of the 38 sites posed a "potential threat to human health or the environment" (Fred C. Hart Associates, Inc. 1983). To evaluate further these 10 sites and other identified PSCs, from August 1983 to March 1985 the Navy conducted a three-phase verification study. The verification study evaluated 18 potentially contaminated sites (AG&M 1985a, 1991). Sampling conducted for the study in August and September 1983 found volatile organic compounds (VOCs), metals, cyanide, and low-level radionuclides in shallow groundwater, and polychlorinated biphenyls (PCBs) and metals in soil (AG&M 1985a; USEPA 2003a).

> The EPA places sites on the NPL that have released or could release hazardous substances into the environment. Through the NPL, EPA is able to assess which sites require more investigation. To find information and clean-up status on NPL sites, go to EPA's Web site at http://www.epa.gov/superfund/sites/npl/ (USEPA 2003b).

Because of contamination identified at several locations throughout NAS Jacksonville, the station was added to EPA's National Priorities List (NPL) on November 21, 1989 (USEPA 2002). On October 23, 1990, the Navy entered into a three-party Federal Facility Agreement (FFA) with EPA and with the Florida Department of Environmental Protection (FDEP) (Davis 2003). The FFA was signed so that remedial activities at the station would be a collaborative, interagency effort regulated by EPA's Resource Conservation and Recovery Act (RCRA) and Superfund programs (USEPA 2002).

In 1994, the Navy instituted a Remedial Response Decision System (RRDS) at NAS Jacksonville. The Navy uses this system to set guidelines and determine criteria for assessing site data and recommending appropriate remedial activities (Navy 1997). Under this system, in October 1995 the Navy prepared a RRDS document that it uses to manage and identify the installation restoration sites at NAS Jacksonville; the RRDS document was last updated in October 2003 (Navy 1997; TtNUS 2003b).

For more than 20 years, the Navy has conducted environmental investigations to identify PSCs at NAS Jacksonville. As of December 2003, a total of 54 PSCs were identified throughout the station (Post-Closure Permit Application 2003) (see Figure 2). After reviewing and analyzing site investigations, potential exposure situations, and remedial actions to date, the Navy has determined that the majority of PSCs do not require any further remedial action. Still, groundwater, soil, surface water, sediment, and fish contamination are all present at different areas at the station from solvents, semi-volatile organic compounds (SVOCs), low-level radioactive waste, pesticides, herbicides, total petroleum hydrocarbons (TPH), PCBs, and metals (AG&M 2000; HLA 1998a, 2000a; Public Affairs Office 2003; TtNUS 2003b).

The Navy conducts remedial activities to decrease potential contact to contaminated areas and to reduce migration of the contaminants to off-site areas. To date, the Navy has grouped 21 different PSCs into 8 operable units (OUs) based on the nature of contaminants, geographic location, contaminated media, and type of contaminants (DTIC 2004). Table 1 provides the OUs and additional PSCs (33) and describes each area, past investigations, corrective actions, and ATSDR's public health evaluation. Figure 2 indicates the locations of the PSCs and OUs, and also identifies the PSCs that are located within each OU.

It is important to note that out of 54 PSCs, NAS Jacksonville restricts access to 35 through fencing, security guards, and other preventive measures. Of the remaining 19 areas to which a station resident could potentially have access (i.e., PSCs 17–25, 32–34, 36, 37, 40, 44, 49, 52, and 53), three have signs that indicate that contamination is present and that access is prohibited (17, 37, and 40); no wastes have been identified at five PSCs (19, 24, 25, 33, and 34); one PSC (PSC 52/OU6) contains contaminated groundwater — to which people are not exposed — and one PSC (53) has been cleaned and closed by the state of Florida under RCRA (Beason 2004a, 2004b). Table 1 provides details about all of the PSCs. ATSDR's environmental data analysis for each area is presented in Appendix B. In addition, Table 2 provides a reference guide for the current status of each PSC, the PSCs that are potentially accessible, and possible exposure scenarios for accessible PSCs.

Brief descriptions of the OUs and other PSCs are provided below:

OU1. This OU is situated in the southern portion of the station and it includes PSC 26 (Old Main Registered Disposal Area) and PSC 27 (Former Transformer Storage Area). In 1973, the Navy reported OU1 to the U.S. Radiological Affairs Support Office (RASO) because it was formerly used as a radioactive disposal area (ABB-ES 1996a). In 1980, the OU was officially registered with the EPA (Fred C. Hart Associates, Inc. 1983). The 1996 remedial investigation/feasibility study (RI/FS) determined that the following were of potential concern: PCBs, inorganics, SVOCs, and radionuclides in soil; light nonaqueous-phase liquid (LNAPL) and low-level VOCs in the shallow aquifer; and PCBs, pesticides, and inorganics in sediment in the unnamed tributary to the St. Johns River (ABB-ES 1996a, 1997a). A 1997 record of decision (ROD) proposed remedial actions for OU1, including excavating selected soils and sediments, addressing the LNAPL source, instituting land use restrictions (for example, putting a fence around the landfill), and covering/capping the landfill (ABB-ES 1996a, 1997a; HLA 2000a). As of January 1999, remedial construction was finished and long-term monitoring continued (HLA 2000a).

OU2. This OU is situated in the northern portion of the station and contains the following PSCs:

- PSC 2—Former Firefighting Training Area,
- PSC 3—Wastewater Treatment Plant Sludge Disposal Area,
- PSC 4—Pine Tree Planting Area,
- PSC 41—Domestic Waste Sludge Drying Beds,
- PSC 42—Wastewater Treatment Plant Polishing Pond, and
- PSC 43—Industrial Waste Sludge Drying Beds.

Environmental assessments between 1983 and 1991 identified VOCs in soil and contamination in the shallow aquifer at OU2. Remedial investigations that began in 1991 detected SVOCs, inorganics, and VOCs in soil and sludge, and inorganics in sediment and surface water (HLA 1998a). In September 1997, interim removal actions (IRAs) were completed at OU2 (HLA 2000a). An October 1998 ROD recommended groundwater monitoring, but “no further clean-up action” at the site (HLA 1998a).

OU3. This 134-acre OU is adjacent to the St. Johns River in the eastern section of NAS Jacksonville. This OU is primarily associated with activities at the Naval Air Depot and encompasses

- PSC 11—Building 101,
- PSC 12—Old Test Cell Building,

- PSC 13—Radium Paint Disposal Pit,
- PSC 14—Battery Shop Area,
- PSC 15—Solvent and Paint Sludge Disposal Area,
- PCC 16—Black Point Storm Sewer Discharge,
- PSC 48—Station's Dry Cleaners–Building 106,
- PSC 54—NADEP Cooling Basin,
- Building 780, and
- Groundwater Contaminated Areas A through G.

Since 1982, environmental assessments and radiological surveys identified the presence of metals, cyanide, pesticides, VOCs, SVOCs, and radionuclides in soil and groundwater at OU3. Removal activities began in 1992 at various areas within the OU. Two IRAs were instituted in 1997 to remove contaminants from PSC 48 and Building 780. The 1998 RI/FS determined that only lead and polycyclic aromatic hydrocarbons (PAHs) in sediment and VOCs in groundwater required remediation. The RI/FS did not identify any contaminants of concern (COCs) in soil or surface water. A 2000 ROD concluded that no further action was required at PSCs 11–15. The ROD recommended selective removal of tar balls from sediment at PSC 16, and various measures for the groundwater-contaminated areas (HLA 2000a). A clean up status decision is pending for PSC 54 (Post-Closure Permit Application 2003).

OU4. This OU consists of PSC 21 — the 11-acre Casa Linda Lake — located on the northern end of the NAS Jacksonville Golf Course (formerly known as the Casa Linda Oaks Golf Course) in the central portion of NAS Jacksonville. A 1993 sampling study and the 1997 RI showed that sediments at OU4 contained detectable levels of pesticides, metals, and SVOCs; fish contained metals, cyanide, PCBs, and pesticides. According to the 1999 RI/FS, only contaminants in fish were at levels of potential concern. That said, Casa Linda Lake is only used for catch-and-release fishing. To prevent exposure to contaminants in fish at PSC 21, the 2000 ROD proposed that the Navy conduct monitoring and continue its lake use restrictions (i.e., the catch-and-release program and posting advisory signs) at Casa Linda Lake (AG&M 2000).

OU5. This OU consists of PSC 51 — the South Antenna Field — that comprises the Former Fire Fighting Training Area (FFTA) and the former Oil Disposal Area (ODA). OU5 is situated just north of the station's southern fenceline at Patrol Road and Allegheny Road. Environmental investigations since 1996 detected VOC, metal, and low-level radioactive contamination in soil and VOC and metal contamination in groundwater. Remedial investigations conducted from 1999 to 2002 indicated that metals in surface soil and fuel and cleaning solvents in groundwater were at levels of potential concern. In 2002, the final RI/FS proposed clean up actions that included monitoring, implementing institutional controls, and allowing contaminants to degrade naturally in the environment (Public Affairs Office 2003; TtNUS 2002a).

OU6. This OU contains PSC 52 — Hangar 1000 — in the north-central portion of NAS Jacksonville. This OU had two solvent-containing underground storage tanks (USTs) that were closed in 1994. In March 1994, the tanks, related piping, and contaminated soils were removed. After the removal, sampling at the site indicated that groundwater contained trichloroethene (TCE), dichloroethene (DCE), and vinyl chloride (VC). The Navy is currently conducting pilot tests to decrease contaminant levels at OU6 (Davis 2003). In January 2004, the Navy completed its interim measure at OU6, which consisted of a nano-scale iron injection to reduce levels of contaminants in groundwater. The data analysis is currently under review. In addition, the Navy is in the process of preparing a ROD for OU6 (Allen 2004).

OU7. This OU contains PSC 46 — Defense Reutilization and Marketing Office Yard — which is located across from the southwest corner of the station, on the west side of U.S. Highway 17. Sampling analyses of the oil-water separator at OU7 detected benzene and metals in a sludge sample and lead in leachate. In addition, a 1994 reconnaissance found oily water on the ground near the oil-water separator opening and a potent chemical odor from a drainage ditch (ABB-ES 1997b). Sampling in 1997 detected metals and pesticides in groundwater; metals, PCBs, and SVOCs in soil; metals, PCBs, and SVOCs in sediment; and metals and pesticides in surface water. Remedial investigations in 2001 identified VOCs, pesticides, and radionuclides in groundwater; metals, PCBs, pesticides, SVOCs, and radionuclides in soil; PCBs, metals, and SVOCs in sediment; and pesticides and metals in surface water at OU7. The 2003 RI/FS concluded that the clean-up remedy should include excavation and off-site disposal of soils above industrial remediation goals, and use of institutional controls to prevent exposure to groundwater and soils that were above residential standards (TtNUS 2003b).

OU8. This OU consists of the Pesticide Shop (Building 536) — PSC 47 — located on the west-central portion of NAS Jacksonville. Remedial activities in 1991 included the removal of 30 rusted 55-gallon drums. Sampling in 1996 found pesticides and metals above detection limits in surface soil (ABB-ES 1997b). Currently, the Navy is completing the draft remedial investigation (including a draft risk assessment) and developing the feasibility study for OU8. The Navy anticipates that the complete RI/FS will be available for the public by March 2006 (at the earliest) (Greg Roof, TtNUS engineer, personal communication, 2004 and 2005).

In addition, the Navy has conducted environmental assessments at the other 33 PSCs (1, 5, 6-10, 17-20, 22-25, 28-40, 44, 45, 49, 50, and 53). Investigations performed from 1983 to the present reveal that 28 of these PSCs do not require any further remedial action. Some of these PSCs require the use of institutional controls — for example, posted warning signs to prevent access and contact with site contaminants (ABB-ES 1995a; TtNUS 2003b). The Navy has scheduled future RI/FSs for four PSCs (22, 23, 38, and 45) and will complete its land-use control (LUC) inventory for reporting on PSC 30 (Allen 2004).

ATSDR Activities

ATSDR prepares a public health assessment (PHA) for all sites listed on EPA's National Priorities List. Through the PHA process, ATSDR evaluates whether the public could be exposed to contaminants from the site through contact with groundwater/drinking water, soil, surface water/sediment, or fish and shellfish.

To begin the PHA process at NAS Jacksonville, ATSDR conducted an initial site visit in June 1991. At this time, ATSDR documented concerns about children trespassing over the 7-foot high fence that separated the station housing area from OU1, and entering into the former station landfill area. As a result, the Navy constructed an 8-foot high fence in 1991, which continues to prevent children from accessing OU1. The Navy also educated the parents of children living at the station during that time about hazards in the area (ATSDR 1992).

To continue its efforts in the PHA process, ATSDR conducted another site visit June 29 – July 2, 1992. During this visit, ATSDR toured the 45 PSCs at the station. ATSDR also met with the founder of the Citizens Reaction against Pollution group to discuss community members' environmental concerns and issues. The founder did not identify any specific health concerns for ATSDR to address. Following this visit, ATSDR noted concern about potential contamination migrating from OU2 to off-site private drinking water wells northwest of NAS Jacksonville's northern boundary. At that time, the Florida Department of Health (FDOH)-Duval County Health Department was testing the wells, and future actions were planned (these well results are discussed under the groundwater/drinking water pathway in the *Evaluation of Environmental Contamination and Exposure Pathways* section) (ATSDR 1992).

In 1995, ATSDR returned to NAS Jacksonville to collect additional information for the PHA. During this site visit, ATSDR noted two potential issues: 1) children playing in an old landfill near the family housing area (OU1), and 2) fish contamination in the St. Johns River near the station. After further evaluating and assessing available data, ATSDR concluded that neither issue represented a health concern (ATSDR 1996).

Since 1995, more environmental data have become available, and the Navy has identified additional potential sources of contamination (now a total of 54) at NAS Jacksonville. From January 12–14, 2004, ATSDR returned to NAS Jacksonville to obtain recent sampling data for all 54 PSCs and to conduct a thorough evaluation of the public's potential exposures to site-related contaminants. During the site visit, ATSDR met with NAS Jacksonville and Navy representatives, toured the 54 PSCs at the facility, and requested site-related files. Though ATSDR did not identify any exposure situations that posed an imminent public health hazard, some exposure pathways required further evaluation—groundwater/drinking water, surface soil, surface water/sediment, and fish and shellfish. ATSDR evaluated these pathways and presents the findings in the *Evaluation of Environmental Contamination and Exposure Pathways* section of this document.

Demographics and Land Use

ATSDR assesses demographic data to identify the population(s) possibly exposed to contaminants associated with a site such as NAS Jacksonville. ATSDR can also use these data to determine whether especially sensitive individuals or groups live in the area. Those who are more sensitive to the effects of potential contamination include children (birth to 6 years), women of childbearing age (15 to 44 years), and elderly persons (65 years and older). In addition, in an attempt to assess the time period that residents could have been exposed to site contaminants, ATSDR evaluates demographic data to examine how often persons in the target population move to other areas.

In addition to demographic data, ATSDR investigates how people living near a site use their surrounding land and its natural resources. By looking at these different land uses, ATSDR can identify specific activities that could expose people to certain contaminants, as well as the rate (i.e., how often they occur) of those activities.

The area north of NAS Jacksonville is mainly industrial and consists of various restaurants, shopping plazas, and other commerical establishments. Land to the south of the station consists of several residential streets with single family and attached (duplex) homes. The area to the west is mostly undeveloped land, but does contain some businesses as well as some single family homes in the Yukon and Ortega Hills communities (ABB-ES 1998a; TtNUS 2003a). These areas to the north, south, and west of the station are considered diverse and moderately populated (ABB-ES 1998a). As noted in Figure 3, 14,495 people live within 1 mile of the site, and 91,285 people live within 3 miles of the site.

In 1946, NAS Jacksonville experienced its peak number of employees — 42,000 naval personnel and 11,000 civilians (AG&M 1991). Before the end of WWII, the station had over 700 buildings, three operational runways, seaplane ramps, an 80-acre hospital, a prisoner-of-war compound, and additional facilities to assist in the war effort (Global Security 2002b; Haas Center for Business Research and Economic Development 2003). Presently, there are more than 100 tenant commands at NAS Jacksonville, making it the third largest naval installation in the country (ABB-ES 1998a; Haas Center for Business Research and Economic Development 2003). On a daily basis more than 25,000 military, civilian, and contract employees work at the station (Haas Center for Business Research and Economic Development 2003; NAS 2002a). NADEP, which employs more than 3,700 civilians, is the largest tenant command at NAS Jacksonville and also the biggest industrial employer of people living in northeast Florida and southeast Georgia (NAVAIR Depot 2004; TtNUS 2003a).

A fence surrounds all of NAS Jacksonville, except for areas located along the St. Johns River coastline (Wally Holdstein, public works manager, NAS Jacksonville, personal communication, 2004). Access to the station has always been restricted to military and civilian personnel. Although NAS Jacksonville issues temporary passes to authorized visitors, those visitors must receive sponsorship from a military member or station employee prior to driving onto NAS Jacksonville. Once visitors have authorized access, they must register their vehicles and provide valid identification at the main security office on Yorktown Road. Once a vehicle pass has been issued, visitors must show identification at all times when entering and leaving through the station's security gates (NAS 2004b). Even if people gain access to the station, entrance to the majority of contaminated areas is limited by fencing, security gates, or security patrols. See Table 2 for details on access restrictions related to each of the 54 PSCs.

NAS Jacksonville contains a total of 371 housing units — 84 for officers and 287 for enlisted personnel. Also, 36 mobile home spaces on NAS Jacksonville are available to all active, retired, or other military personnel (NAS 2001). These mobile home spaces were scheduled to close, however, as of December 2004. On average, residents live in station residences for 3 years or less (Imogene Mitchell, housing officer, NAS Jacksonville, personal communication, 2004).

According to 2000 census data, NAS Jacksonville and its vicinity have a total population of 2,485. The majority of area residents (660) are between the ages of 20 and 24, with a median age of 21.7 years. There are 290 residents (12%) under 5 years of age and 245 residents (10%) between 5 and 9 years of age. Only four residents (0.2%) are 65 years or older. The population is comprised of Caucasians (60%), African-Americans (28%), Asians (3%), and other races (9%). Out of 1,616 residents in the workforce, 1,251 (77%) are employed by the armed forces (US Census Bureau 2004). Figure 3 displays demographic information for NAS Jacksonville and surrounding areas.

NAS Jacksonville employees (civilian and military), military personnel (active and retired), and residents and their guests have access to various on-base recreational areas (AG&M 1999). The Florida Department of Environmental Protection (FDEP) classifies the St. Johns River as a Class III water body, indicating that the water is appropriate for fish and wildlife reproduction and for recreational use (ABB-ES 1998b). NAS Jacksonville has a marina located on the St. Johns River where those so authorized can dock their boats (NAS Jacksonville 2004b). People at the station do not swim in the adjacent portions of the St. Johns River, but they do use the water for fishing and boating. Fishing in the St. Johns River from NAS Jacksonville is only permitted at specified piers and outfalls (e.g., Manatee Point). Interested persons must obtain a permit from the marina before fishing at any of these areas; procedures for obtaining permits are detailed in NAS Jacksonville's *Hunting and Fishing Instruction Manual* available at NAS Jacksonville (Beason 2004b). People consume fish such as croaker and crappie, which they catch from specified locations along the St. Johns River. Through its catch-and-release program and by posting warning signs, NAS Jacksonville prohibits consumption of all fish caught from on-station lakes and ponds (Christine Bauer, natural resources manager, NAS Jacksonville, personal communication, 2004; Beason 2004b).

A 27-hole golf course at the station—The Naval Air Station Jacksonville Golf Course—is accessible to station personnel, military personnel, and residents and their guests (Haas Center for Business Research and Economic Development 2003). Also, NAS Jacksonville features numerous baseball fields, picnic areas, a recreational vehicle park, and other areas where recreational activities take place.

Quality Assurance and Quality Control

In preparing this PHA, ATSDR reviewed and evaluated information provided in the referenced documents. Documents prepared under EPA's Superfund program must meet standards for quality assurance and for quality control measures including chain-of-custody, laboratory procedures, and data reporting. The environmental data presented in this PHA are from

- Navy remedial investigations, remedial response decision system information, and sampling event reports,
- FDOH-Duval County Health Department well sampling,
- USGS groundwater sampling and monitoring reports,
- FDEP sediment and surface water sampling,
- the St. Johns River Water Management District (SJRWMD) sediment sampling, and
- the city of Jacksonville sediment sampling.

ATSDR determined that the quality of environmental data available for NAS Jacksonville is adequate for making public health decisions.

Evaluation of Environmental Contamination and Exposure Pathways

Introduction

Identifying Exposure

ATSDR's PHAs are exposure (or contact) driven. People who work or live in the area of an environmental release can only be exposed to a contaminant if they come in contact with it. Exposure might occur by breathing, eating, or drinking a substance containing the contaminant or by skin contact with a substance containing the contaminant. Consequently *a release does not always result in exposure*.

ATSDR evaluates site conditions to determine if people could have been (a past scenario), are (a current scenario), or could be (a future scenario) exposed to site-related contaminants. When evaluating exposure pathways, ATSDR identifies whether exposure to contaminated media (e.g., soil, water, air, waste, or biota) has occurred, is occurring, or will occur through ingestion, dermal (skin) contact, or inhalation. ATSDR also identifies an exposure pathway as *completed* or *potential,* or *eliminates the pathway from further evaluation*. Completed exposure pathways exist if all elements of a human exposure are present. (See "Exposure Pathway" in Appendix A for a description of the elements of a completed exposure pathway.) A potential pathway is one in which one or more of the pathway elements cannot be definitely proved or disproved. A pathway is eliminated if at least one element is absent.

Interested persons can learn more about the ATSDR evaluation process by reading ATSDR's Public Health Assessment Guidance Manual (available at

> As defined by ATSDR, an *exposure pathway* is 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 elements: 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 elements are present, the *exposure pathway* is termed a completed exposure pathway.

> ATSDR defines a comparison value (CV) as a 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.

http://www.atsdr.cdc.gov/HAC/HAGM) or contacting ATSDR at 1-888-42ATSDR.

Exposure and Health Effects

Given sufficient exposure levels, chemical contaminants disposed of or otherwise released into the environment can cause adverse health effects. The type and severity of health effects caused by contact with a contaminant depend on the exposure concentration (how much), the frequency or duration of exposure (how long), the route or pathway of exposure (e.g., breathing, eating, drinking, or skin contact), and the multiplicity of exposure (the combination of contaminants). Once exposure occurs, characteristics of the exposed person — for example, age, sex, nutritional status, genetics, lifestyle, and health status — will influence how the person absorbs, distributes, metabolizes, and excretes the contaminant. Together, these factors and characteristics determine the health effects that might occur as a result of exposure to a contaminant in the environment.

ATSDR selects contaminants for further evaluation by comparing them against health-based screening values. Screening values are developed from the available scientific literature on exposure and health effects. They are derived for each of the different media, and each reflects an estimated contaminant concentration that is *not expected* to cause adverse health effects for a given chemical, assuming a standard daily contact rate (e.g., amount of water or soil consumed or amount of air breathed) and a certain body weight. To be conservative and to be protective of public health, screening values are generally based on contaminant concentrations *many times lower than levels at which no effects were observed* in experimental animals or in human epidemiologic studies. ATSDR does not use screening values to predict the occurrence of adverse health effects, but rather to serve as a protective screen and a first step in the evaluation of public health implications.

Screening values include ATSDR's comparison values (CVs): these include environmental media evaluation guides (EMEGs), reference media evaluation guides (RMEGs), and cancer risk evaluation guides (CREGs). CREGs, EMEGs, and RMEGs are non-enforceable, health-based CVs developed by ATSDR for screening environmental contamination for further evaluation. By contrast, ATSDR also uses EPA's maximum contaminant levels (MCLs), which are enforceable drinking water regulations developed to protect public health. Please see Appendix C for a further description of CVs.

If contaminant concentrations are above screening values, ATSDR analyzes exposure variables (e.g., duration and frequency), the toxicology of the contaminant, and epidemiology studies for possible health effects. Figure 4 provides an overview of ATSDR's exposure evaluation process.

Possible Exposure Situations at NAS Jacksonville

ATSDR evaluated data for the 54 PSCs at NAS Jacksonville to determine whether any of these areas are related to past, current, or future public health hazards. Table 1 presents detailed information about each PSC and ATSDR's public health evaluation for each area. An extensive review of site data indicates that the majority of the 54 PSCs at NAS Jacksonville are not related to any known public health hazards because 1) contaminant concentrations detected are too low to pose a public health hazard, 2) hazardous substances were never identified, or 3) past, current, or future exposure to the general public has been and continues to be prevented.

Nevertheless, ATSDR's extensive analysis of available information and the 2004 site visit identified four exposure pathways at NAS Jacksonville that required additional evaluation:

- Consumption of contaminated groundwater/drinking water,
- Contact with contaminated surface soil,
- Contact with contaminants in surface water and sediment, and
- Consumption of fish and shellfish.

The following discussion provides ATSDR's exposure pathway evaluation in detail — a summary of this exposure evaluation is presented in Table 3. To familiarize the reader with methods and terminology used by ATSDR in this PHA, Appendix A presents a glossary of environmental and health terms used in this discussion and throughout the PHA. Appendix B presents ATSDR's evaluation of environmental monitoring results, Appendix C explains the comparison values used to evaluate environmental data in this assessment, and Appendix D provides calculations used to estimate potential exposure doses for surface soil ingestion and fish consumption.

Evaluation of the Groundwater/Drinking Water Pathway

Hydrogeology and Groundwater Use

Water underneath NAS Jacksonville is present in three main groundwater systems. In descending order from land surface, the systems include the surficial, shallow, or upper aquifer, intermediate Hawthorn aquifer (also known as the intermediate rock aquifer and secondary artesian aquifer), and Floridan aquifer (also known as the Upper Floridan aquifer). These different aquifer systems are detailed below (AG&M 1985a).

Surficial Aquifer

In general, the **surficial, shallow, or upper aquifer** ranges from 10 to 90 feet in thickness and contains unconsolidated sediments that include clay, silt, sands, shelly sands, and shell beds (AG&M 1999; TtNUS 2002b). Documents suggest that the surficial aquifer in some areas of NAS Jacksonville is 3 to 8 feet below land surface (bls), whereas the surficial aquifer in other on-station areas stretches from land surface to approximately 15–35 feet below ground (AG&M 1985a; Navy 1998 as cited in Davis 2003). Generally, groundwater in the surficial aquifer flows from high to low topography and toward surface water bodies (ABB-ES 1998b; Davis et al. 1996). Surficial groundwater in the north and east flows directly to the St. Johns River, and surficial groundwater in the west flows toward the Ortega River (AG&M 1985a; Davis et al. 1996). In addition to these river bodies, many ditches and small creeks drain groundwater from the surficial aquifer. The St. Johns and Ortega Rivers are the endpoints for surficial groundwater at NAS Jacksonville (Davis et al. 1996). An unnamed creek drains the southern portion of the station and travels through the off-station residential area adjacent to the southern fenceline (north of Interstate 295) prior to discharging into the St. Johns River (Fred C. Hart Associates, Inc. 1983). According to the U.S. Geological Survey (USGS), groundwater in the surficial aquifer is not a water supply for NAS Jacksonville or surrounding areas (Davis 2003). According to the Navy, all groundwater contamination at NAS Jacksonville has been detected within the layers of the "upper aquifer" and no contaminants have been detected below 60 feet in depth (Wally Holdstein, public works manager, NAS Jacksonville, personal communication, 2004).

Intermediate Hawthorn Aquifer

The intermediate Hawthorn aquifer primarily contains "silty clay, clayey sand, clay, and sandy limestone, all of which contain moderate to large amounts of black phosphatic sand, granules, and pebbles" (Fairchild 1972 as cited in AG&M 1999 and Davis et al. 1996). In the NAS Jacksonville vicinity, the intermediate Hawthorn aquifer ranges from about 35 to 400 feet bls, with the top layer between 35 and 100 feet bls (Davis 2003). The aquifer is about 10 to 75 feet below sea level and averages about 250 to 500 feet in thickness throughout Duval County, Florida (AG&M 1999; Davis et al. 1996). In some parts of Duval County phosphate beds and clean quartz sand are occasionally present in the intermediate aquifer at depths between 100 and 250 feet. Some private wells in the area of NAS Jacksonville, such as those situated on Collins Road adjacent to the station's southern border, are frequently located within these sediments (ABB-ES 1998b).

Floridan Aquifer

The Floridan aquifer begins about 400 feet bls at NAS Jacksonville and contains more than 1,000 feet of dolostone formations and limestone (ABB-ES 1998b; AG&M 1985a; TtNUS 2002). In descending order, the Florida aquifer includes the lower units of the Hawthorn aquifer that are linked (hydraulically) to the Floridan aquifer, the Ocala Group, Avon Park Limestone, Lake City Limestone, and Oldsmar Limestone (see text box) (Leve 1966 as cited in AG&M 1999).

Because of the artesian nature of the Floridan aquifer (water flows naturally to the surface), groundwater movement would likely be upward from the Floridan aquifer to the surficial aquifer, not downward from the surficial aquifer to the Floridan aquifer (TtNUS 2002). Groundwater from the Floridan aquifer flows toward the east-northeast (AG&M 1999). The Floridan aquifer is the principal freshwater source for industrial and public uses in Duval County — and therefore, northeast Florida — because it "contains good quality water" and flows easily throughout the aquifer (Bush and Johnston 1988 as cited in ABB-ES 1998b and Davis et al. 1996). According to the Navy, NAS Jacksonville obtains drinking water from three active wells (wells B, C, and D) within the Florida aquifer that are about 1,100 to 1,200 feet bgs (Wally Holdstein, public works manager, NAS Jacksonville, personal communication, 2004).

Because of the artesian nature of the Floridan aquifer (water flows naturally to the surface), groundwater movement between aquifers at NAS Jacksonville would likely be upward from the Floridan aquifer to the surficial aquifer, not downward from the surficial aquifer to the Floridan aquifer (Davis et al. 1996).

Floridan Aquifer Structure (Descending Order)
Lower units of Hawthorn aquifer
Ocala Group
Avon Park Limestone
Lake City Limestone
Oldsmar Limestone

Nature and Extent of Contamination at NAS Jacksonville

ATSDR conducted a comprehensive review of available groundwater sampling data for NAS Jacksonville. ATSDR analyzed data collected during groundwater investigations at various OUs and PSCs between 1983 and 2003. Contaminants detected in NAS Jacksonville groundwater include VOCs, SVOCs, pesticides, herbicides, radionuclides, cyanide, and metals. Table 4 presents a site-wide (excluding OU3) summary of the maximum chemical and radionuclide detections above CVs in groundwater.

Fifteen VOCs (1,1,2-trichloroethane, 1,1-dichloroethene, 1,2-dichloroethane, 1,2-DCE mix, 1,2-DCE total, benzene, chlorobenzene, chloroethane, chloromethane, cis-1,2-dichloroethene, methylene chloride, tetrachloroethene, toluene, trichloroethene, and vinyl chloride) were detected above CVs at various OUs and PSCs throughout NAS Jacksonville. Eight SVOCs [2-methylnaphthalene, 4-methylphenol, bis(2-chloroethyl)ether, bis(2-ethylhexyl)phthalate, carbazole, dibenzofuran, naphthalene, and pentachlorophenol] were detected above CVs in various OUs and PSCs only once, except for bis(2-ethylhexyl)phthalate.

Fourteen pesticides (4,4'-DDD, 4,4'-DDE, 4,4'-DDT, aldrin, alpha-benzenehexachloride [alpha-BHC], alpha-chlordane, beta- benzenehexachloride [beta-BHC)], delta-BHC, dieldrin, endrin, gamma-BHC, gamma-chlordane, heptachlor, and heptachlor epoxide) were detected above CVs. For all 14 pesticides, the maximum concentrations were detected at OU8; 11 of the pesticides were only detected in one sample. Two herbicides [2-methyl-4-chlorophenoxyacetic acid (MCPA) and 2-(2-methyl-4-chlorophenoxy)propionic acid (MCPP)] were detected above CVs at OU8. Two radionuclides (gross alpha and radium-226) were detected above CVs at OU7 and cyanide was detected above its CV at OU2. Finally, 15 metals (aluminum, antimony, arsenic, barium, beryllium, cadmium, chromium, iron, lead, manganese, mercury, nickel, silver, thallium, and vanadium) were detected above CVs in various OUs and PSCs at NAS Jacksonville.

Because of extensive contamination resulting from solvent use at OU3, groundwater at this area has been thoroughly investigated. Table 5 presents a summary of the contaminants detected above CVs in groundwater at OU3. Fourteen VOCs (1,1,1-trichloroethane, 1,1,2-trichloroethane, 1,1-dichloroethene, 1,2-dichloroethane, 1,2-dichloroethene total, benzene, bromoform, chloromethane, cis-1,2-dichloroethene, methylene chloride, tetrachloroethene, trans-1,2-dichloroethene, trichloroethene, and vinyl chloride) were detected above CVs in groundwater at OU3. Three metals (arsenic, iron, and manganese) were detected above CVs in OU3 groundwater, though none were detected above the maximum concentrations in site-wide groundwater.

Evaluation of Potential Public Health Hazards

It is important to note again that an environmental concentration above a health-based CV will **not** necessarily cause an adverse health effect. CVs are not toxicity thresholds — ATSDR uses these values to **screen** contaminant detections conservatively and to identify contaminants that need further study. The probability that adverse health effects will occur depends on numerous site-specific factors (discussed previously); an environmental concentration alone cannot affect public health.

On-Site Drinking Water: Past, Current, and Future

As a result of various on-station activities, groundwater underneath NAS Jacksonville (surficial aquifer and top layer of intermediate aquifer) has been contaminated with solvents, pesticides, SVOCs, herbicides, metals, radionuclides, and cyanide. Though these contaminants are present in on-site groundwater, no one who lives or works at the station has been or will be exposed to them through drinking water. The station has never relied on water from the surficial or intermediate aquifers as drinking water sources, and this groundwater will not be used for drinking water in the future. According to the Navy, contaminants have not been detected beyond surface depths of 60 feet. NAS Jacksonville has operated its own water supply system since the station opened in 1940, and those on-site drinking water wells have drawn from groundwater 1,100 to 1,200 feet bgs in the Floridan aquifer—more than 1,000 feet below detected contamination (Wally Holdstein, public works manager, NAS Jacksonville, personal communication, 2004). Therefore, no one living or working at the station has been or would be exposed to contaminants in shallow groundwater via on-site drinking water wells.

According to the Navy, contaminants have not been detected in groundwater beyond depths of 60 feet. All on-site drinking water wells draw from groundwater in the Floridan aquifer, which is between 1,100 and 1,200 feet below ground surface (Wally Holdstein, public works manager, NAS Jacksonville, personal communication, 2004).

Under the Safe Drinking Water Act of 1974, EPA sets health-based standards and specifies treatments for substances in public drinking water systems. NAS Jacksonville operates a water supply system, and is therefore required to monitor its drinking water. Monitored substances include 15 inorganic contaminants, 51 synthetic organic compounds (SOCs) and VOCs, and 4 radionuclides (USEPA 2004a).

After its evaluation of on-site well sampling results and groundwater use at NAS Jacksonville, ATSDR concluded that site-related contaminants have not and will not impact on-site drinking water wells. On-site drinking water has been, and continues to be, safe to drink.

Off-Site Drinking Water: Past, Current, and Future

According to the EPA, within 3 miles of NAS Jacksonville an estimated 300 people rely on private drinking water wells that draw from shallow groundwater (USEPA 2004b). ATSDR's research shows that some residents living in off-site areas to the north, south, and west of NAS Jacksonville rely on private wells for drinking water. Because the St. Johns River borders the site to the east, no residences are immediately east of the station. Still, people who live outside of NAS Jacksonville and use private groundwater wells for drinking water could potentially be exposed to site-related contaminants if contaminated groundwater migrated to these off-site areas.

Wells north and west of NAS Jacksonville

Sampling data and available groundwater information suggest that on-site contamination is not migrating toward these wells (AG&M 1985a; Davis et al. 1996; FDOH 2004). In 1989, the FDOH-Duval County Health Department conducted sampling on wells north and west of the station. ATSDR evaluated these sampling data for two private wells north of the station and two private wells west of the station. No contaminants were detected above CVs. According to

FDOH-Duval County Health Department, these are the only private wells located north and west of NAS Jacksonville that the agency was aware of at that time (Pawlowicz 2004 and 2005b). See Figure 5 for the location of these wells.

Wells South of NAS Jacksonville

Between 1989 and 2003, the FDOH-Duval County Health Department sampled various private drinking water wells located adjacent to the station's southern border — next to OU5 (PSC 51). See Figure 6 for the location of these wells. ATSDR evaluated the sampling results, which included data for 47 different private wells. Between 1992 and 2003, arsenic was detected above CVs in six private wells (total of nine detections, with the highest detections in 1992 and 1993). In 1997, copper was detected above its CV in one well. Although arsenic and copper were detected over ATSDR's conservative health-based screening CVs, neither arsenic nor copper were detected at levels that exceeded state and federal regulatory limits for public drinking water supplies. Additionally, it is likely that the arsenic and copper detections were naturally-occurring.

TCE was detected above its CV in one well in August 2001 (FDOH 2004). After detecting this TCE contamination, the FDOH-Duval County Health Department referred the well to FDEP for remediation. FDEP installed a filtration system at the location containing elevated TCE in November 2001, and has maintained the system since that time (Pawlowicz 2004 and 2005b). ATSDR requested sampling data to determine if the TCE levels in this well have decreased since the filtration system was installed. According to the FDOH-Duval County Health Department, the resident of this home would not give FDOH permission to sample the well (Pawlowicz 2005a).

The groundwater assessment during the RI/FS determined that the groundwater plume at OU5 started in the former FFTA area and ended at the monitoring well at the station's southern fenceline (TtNUS 2002a). Table 6 presents values detected above CVs in private drinking water wells south of NAS Jacksonville, and Table 7 provides detected concentrations in OU5 groundwater that exceeded CVs.

The Navy requested that the USGS conduct groundwater modeling of this area to assess groundwater flow and to evaluate whether groundwater contaminants from OU5 could flow toward the private drinking water wells situated south of the southern fenceline. USGS groundwater modeling data show an unnamed creek that travels through OU5 and off site to the St. Johns River (away from the residential area) is the primary receiver of OU5 groundwater. Groundwater in the north and south of OU5 discharges to this unnamed creek that is located south of OU5. Recreational activities do not occur in the creek, and a fence that surrounds it prevents access. Sampling indicates that VOCs detected in OU5 groundwater are not affecting creek surface water because only one VOC (2-butanone) was detected, and it was below its CV (TtNUS 2002a).

Residences located next to the station's southern boundary at OU5 rely on deep groundwater for drinking water, which comes from wells reportedly 200 feet or more below ground surface (TtNUS 2002a). As noted previously, site-related contamination has only been detected within 60 feet below ground surface (Wally Holdstein, public works manager, NAS Jacksonville, personal communication, 2004). It is highly unlikely that contaminants in shallow groundwater would migrate to the deeper zone — the confining aquifer layers and the artesian nature of the Floridan aquifer cause contaminants to flow upward, not downward. In addition, USGS modeling shows that the groundwater plume at OU5 does not extend beyond the southern fenceline and does not flow toward the residences located south of the station's border (TtNUS 2002a).

Using available sampling results and groundwater modeling, evidence indicates that groundwater at OU5 is not affecting private drinking water wells adjacent to the southern fenceline. Therefore, adverse health effects are not expected to result from past, current, and future exposure to groundwater used for drinking water in wells to the south of NAS Jacksonville.

Measures to Reduce Potential Future Exposures

The Navy is conducting several activities to ensure that the groundwater contamination presently at NAS Jacksonville will not impact local water supplies or surface water resources in the future. These activities include

- *Ongoing groundwater monitoring.* NAS Jacksonville conducts regular monitoring at many PSCs and OUs with groundwater contamination to ensure that groundwater is not migrating off site or to other areas at the station. As part of this process, the Navy uses monitoring to confirm that natural attenuation is successfully breaking down contaminant levels detected in groundwater.
- *Land use restrictions.* The PSCs and OUs identified with groundwater contamination are areas used for industrial purposes, and the Navy is required to maintain these areas for industrial operations only until the site meets residential cleanup levels. In the future, the Navy cannot use these areas for residential purposes nor use the groundwater as a drinking water source. In addition, the Navy has posted signs at several of these areas warning of on-site groundwater contamination (TtNUS 2002a).
- *Nano-scale iron injections.* To reduce contaminants at OU6, in 2004 the Navy used nano-scale iron injections to reduce solvents in groundwater that, after several years, would potentially discharge to the St. Johns River. The Navy applied the injections to decrease contaminants in groundwater before they could reach the river, and is currently evaluating the data analysis to assess if these measures were successful (Allen 2004).
- *Regular testing of the NAS Jacksonville on-site public water supply.* As mentioned previously, the EPA requires routine testing of every public water supply under the SDWA. As regulated by the SDWA, NAS Jacksonville monitors for 51 synthetic and volatile organic compounds, 4 radionuclides, and 15 inorganic contaminants. The Navy presents the annual sampling results in a water quality report that is available to the public. Contact Wally Holdstein, manager for Navy Public Works Center Jacksonville (PWC JAX), at (904) 542-3991, extension 4632, for questions about the NAS Jacksonville water supply (NAS 2002b).

Together, these activities work to ensure that groundwater contamination on site will not enter public drinking water supplies or local surface water resources (for example, the St. Johns River), therefore preventing future public health hazards.

Evaluation of the Surface Soil Pathway

Land Use

NAS Jacksonville personnel, active and retired military personnel, authorized visitors, and residents and their guests could access various recreational areas at NAS Jacksonville (AG&M 1999). The Naval Air Station Jacksonville Golf Course is located at the station and is accessible to military personnel, station personnel, and residents and their guests (Haas Center for Business Research and Economic Development 2003). In addition, NAS Jacksonville contains several picnic areas, baseball fields, a recreational vehicle park, as well as other recreational areas.

A fence surrounds all of NAS Jacksonville, except for areas located along the St. Johns River coastline (Wally Holdstein, public works manager, NAS Jacksonville, personal communication, 2004). Access to the station has always been restricted to military and civilian personnel, although permitted visitors are also allowed access (NAS Jacksonville 2004b). Within the main station fence, a number of areas contain internal fences (including several OUs and PSCs) and only authorized personnel can enter these areas. Many of these areas, such as NADEP and DRMO, also have guarded gates. NAS Jacksonville uses fencing, security guards, regular security patrols, and other measures to prevent access to 35 out of 54 PSCs (Beason 2004a, 2004b). Although the remaining 19 areas have no physical barriers to restrict entry, soil contamination has only been identified at 7 of these areas (PSCs 20, 21, 22, 23, 32, 36, and 49).

Nature and Extent of Contamination

Because of the Navy’s former disposal practices, hazardous waste storage, contaminant spills, and other on-site activities, NAS Jacksonville has site-wide contamination. Table 8 contains a site-wide summary of the maximum detections above CVs for each contaminant found at all PSCs and OUs within NAS Jacksonville. Seven SVOCs [benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, bis(2-ethylhexyl)phthalate, dibenzo(a,h)anthracene, indeno(1,2,3-cd)pyrene, and n-nitroso-di-n-propylamine] were detected above CVs. Two herbicides (MCPA and MCPP) were detected above CVs at OU8 only. Fourteen pesticides (4,4'-DDD; 4,4'-DDE; 4,4'-DDT; aldrin; alpha-BHC; alpha-chlordane; beta-BHC; delta-BHC; dieldrin; endrin; gamma-BHC; gamma-chlordane; heptachlor; and heptachlor epoxide) were detected above CVs throughout the site. Also, two PCBs (aroclor-1254 and aroclor-1260) were detected above CVs in site-wide surface soil. Twelve metals (aluminum, antimony, arsenic, barium, beryllium, cadmium, chromium, copper, iron, lead, nickel, and zinc) were detected above CVs throughout station-wide surface soil. Finally, two radionuclides (radium-226 and total radium) were detected above CVs at OU7.

Table 9 contains a summary of the maximum detections above CVs for accessible areas at NAS Jacksonville only. One pesticide (aldrin) and one PCB (aroclor-1260) were detected above CVs. Aldrin was only detected above its CV at PSC 20; aroclor-1260 was detected above its CV at PSCs 20 and 32. Three SVOCs were detected above CVs [benzo(a)anthracene, benzo(a)pyrene, and benzo(b)fluoranthene]. Although benzo(a)anthracene and benzo(b)fluoranthene were only detected above the CVs at PSC 20, benzo(a)pyrene was detected at PSCs 20, 21 (OU4), 23, and 32. Four metals (antimony, arsenic, cadmium, and lead) were detected above CVs at the following PSCs: antimony at PSCs 22 and 23; arsenic at PSCs 20, 21 (OU4), 22, 23, and 36; cadmium at PSC 20; and lead at PSCs 22 and 23.

Evaluation of Potential Public Health Hazards

Past and Current Exposures

Accessible Areas: Station residents have access to seven areas (PSCs 20, 21, 22, 23, 32, 36, and 49) where the Navy detected contaminants in surface soil during sampling events between 1993 and 1997. Table 9 presents the maximum detected concentrations above CVs in these accessible areas. ATSDR calculated potential exposure doses for child and adult residents who ingested surface soil from these areas. Even though residents only live at the station for a maximum of 3 years, ATSDR used conservative measures and estimated potential exposures over a lifetime (50 years for adults and 70 years for children). To estimate the most probable exposure, ATSDR used average chemical concentrations to calculate the exposure doses. ATSDR uses this approach because it is improbable that a child or an adult would ingest surface soil with the maximum concentration each time they consumed soil over a specified period of time. Therefore, average values are used to approximate realistic exposures. See Appendix D for more information.

ATSDR's assessment shows that no exposure doses were above levels at which adverse health effects of exposure to contaminants in surface soil have been observed — either in human studies or in epidemiological studies.

Therefore, no adverse health effects are expected from past or current exposure to surface soil in these accessible areas.

Inaccessible Areas: Trespassing at NAS Jacksonville is extremely unlikely because of fencing and because of strict security measures. Still, if someone did trespass into the restricted areas on the station, he or she would not be exposed to contaminants in high enough doses or for long enough periods that adverse health effects would occur. Therefore, any person who somehow did trespass onto the site would not experience harmful health effects from contaminants in surface soil. In addition, the Navy has posted warning signs at areas of soil contamination.

Though all of these other areas are inaccessible, in the past concern has been expressed that children trespassed from the station neighborhood, climbed over the site fence, and went into OU1 to play on the landfill. In 1991, the Navy replaced the fence with a higher 8-foot high fence to prevent access to the landfill from neighborhood children, and the landfill has since been capped (ABB-ES 1996a; ATSDR 1992). Between 1991 and 1995, surface soil samples at OU1 detected three pesticides (4,4-DDT, heptachlor, and heptachlor epoxide), two PCBs (aroclor-1254 and aroclor-1260), three SVOCs [benzo(a)pyrene, benzo(b)fluoranthene, and dibenzo(a,h)anthracene], and five metals (arsenic, cadmium, chromium, iron, and lead) above CVs. ATSDR calculated potential exposure doses for surface soil ingestion based on the average detections of these contaminants at OU1. ATSDR used the same assumptions presented above, but used 365 days a year for the exposure frequency; therefore, using a much **more conservative** estimate to calculate past exposures to children trespassing into OU1. Using these detected concentrations, potential exposure doses for children and adults ingesting surface soil from OU1 in the past or currently would not result in adverse health effects. Therefore, no health effects are expected from past exposure to soil at OU1, even if a child ingested this soil for 365 days a year over his or her lifetime (70 years).

Using calculated exposure doses from ingestion of surface soil, ATSDR concludes that no adverse health effects are expected to result from past or current exposures to soil in accessible areas at NAS Jacksonville. As long as restricted areas remain inaccessible, no public health hazards are expected to result from past or current exposures to these areas. Trespassing is extremely unlikely and would not result in high enough exposures of sufficient duration to cause adverse health effects.

Future Exposures

The Navy continues its efforts to reduce soil contamination and exposure to contaminated soil throughout NAS Jacksonville. In restricted areas, the Navy has posted warning signs where soil has not been remediated, used institutional controls to limit future property use, and excavated several areas with contaminated soil. Table 1 presents all of the remedial efforts conducted by the Navy at these PSCs. As long as industrial areas remain restricted, site usage does not change, and remedial activities continue at NAS Jacksonville, ATSDR does not anticipate any future health hazards from exposure to on-site surface soil within inaccessible areas.

Using the calculated doses presented above, no contaminants were present at sufficiently high levels to cause harmful health effects — either in the past or in the present. Future public health hazards are not expected from exposure to these accessible areas as long as site usage does not change, and as long as activities are not conducted that would result in the future release of contaminants onto these areas.

ATSDR concludes that exposure to surface soil at NAS Jacksonville in the future will not result in adverse health effects. Doses from contaminants detected in accessible areas are not sufficient to cause harmful health effects. In addition, if restricted areas continue to be inaccessible, land usage does not change, and warning signs remain in place, no adverse health effects are expected. Even if trespassing could occur in these restricted areas, exposures would not be for long enough periods of time or of high enough doses to cause harmful health effects.

Evaluation of the Surface Water and Sediment Pathway

Surface Hydrology and Use

Surface water drainage at NAS Jacksonville is primarily associated with two main water bodies — the St. Johns River and the Ortega River. NAS Jacksonville is located on the west bank of the St. Johns River (it forms the eastern boundary of the station). The Ortega River, a tributary of the St. Johns River, is located off site ½ mile to the west of U.S. Highway 17 (Roosevelt Boulevard). The majority of surface water drainage from the eastern portion of NAS Jacksonville discharges directly to the St. Johns River. Surface water from the western portion of the station drains indirectly to the Ortega River through three unnamed streams that flow underneath U.S. Highway 17. Two of the streams travel to the west through undeveloped land (including wetland

and forest areas) before discharging to the Ortega River. The southernmost stream travels west through Ortega Hills, an off-station residential area, before discharging into the Ortega River (Fred C. Hart Associates, Inc. 1983).

In addition, an unnamed creek drains the southern portion of the station and travels through the off-station residential area adjacent to the southern fenceline (north of Interstate 295) prior to discharging into the St. Johns River (Fred C. Hart Associates, Inc. 1983). According to USGS groundwater modeling, this unnamed creek travels south through OU5 (at the southern portion of the station) and off site to the St. Johns River. It is the primary receiver of OU5 groundwater, as groundwater in the north and south of OU5 discharges to this unnamed creek. Recreational activities do not occur in this unnamed creek and a fence surrounds the creek to prevent access (TtNUS 2002a).

NAS Jacksonville contains a complicated storm drainage system comprising numerous sewers, drainage ditches, and unnamed streams that manage wastewater and discharge it off site. In fact, 66 identified drainage basins are in place at NAS Jacksonville (AG&M 1999). Of most importance, however, is the unnamed tributary that flows south about 2,500 feet from the forested area along the southern border of OU1 to the St. Johns River. Though fencing prevents access to the tributary within the neighborhood, this tributary runs behind and through the on-station housing area adjacent to the southern fenceline (ABB-ES 1997a).

In addition, two main lakes are present on NAS Jacksonville — Casa Linda Lake and Lake Scotlis (AG&M 1999; Fred C. Hart Associates, Inc. 1983). Station personnel, residents, and their guests are permitted to fish in these surface water bodies. All fishing in lakes/ponds at NAS Jacksonville is catch-and-release only, and the Navy has posted signs in the area that warn of potential fish contamination. No swimming or body contact (e.g., entering the water to retrieve or collect golf balls) is permitted at any of the lakes/ponds at the station (AG&M 1999; Beason 2004b).

From the station, the St. Johns River flows upstream about 24 miles north and then east before discharging to the Atlantic Ocean near Mayport, Florida (AG&M 1999; City of Jacksonville 2004; TtNUS 2003a). The FDEP categorizes the St. Johns River as a Class III water body, which means the water is appropriate for fish and wildlife reproduction and recreational use (e.g., body contact) (ABB-ES 1998b). Though people at the station do not swim in the adjacent portions of the St. Johns River, they do fish and boat in the water. The Navy restricts fishing along the on-site coastline to specified piers and outfalls (for example, Manatee Point). Anglers must obtain a permit from the on-site marina before fishing at any of these areas, which are specified in NAS Jacksonville's *Hunting and Fishing Instruction Manual* available at the station (Beason 2004b). Unlike the on-station lakes and ponds, people are allowed to consume fish and shellfish from these designated areas along the St. Johns River (Christine Bauer, natural resources manager, NAS Jacksonville, personal communication, 2004; Beason 2004b). Commercial fisheries rely on the St. Johns River for croaker, striped mullet, shrimp, blue crab, sea trout, and American shad. Recreational anglers can catch blue crab, spotted sea trout, striped bass, and redfish from the river (NOAA, date unknown). The St. Johns River is not used as a drinking water source.

The Ortega River is located off site, about ½ mile west of U.S. Highway 17 (ABB-ES 1998b). Just south of Sadler Point, Florida, the St. Johns River splits to form the Ortega River (NOAA, date unknown). The public uses the Ortega River for recreational activities (e.g., boating, jet skiing) and fishing (Florida Fishing & Boating Guide 2004; Ortega River Boat Yard 2004).

Nature and Extent of Contamination

During 1987 – 1999 environmental investigations, sediment and surface water samples were collected to characterize contamination present in the following site-related water bodies: St. Johns River, Casa Linda Lake (OU4), Lake Scotlis, unnamed tributary adjacent to OU1, unnamed creek downgradient of OU5, and the Ortega River. During environmental and remedial investigations, the Navy collected sediment and surface water samples from Casa Linda Lake (OU4), Lake Scotlis (as part of OU4 RI), the unnamed tributary adjacent to OU1, and the unnamed creek downgradient of OU5. The city of Jacksonville, FDEP, the St. Johns River Water Management District (SJRWMD), and several Navy contractors have sampled sediment in the river near the station to characterize the sediment quality. FDEP and one Navy contractor have sampled surface water near the station. Limited sampling data are available for the Ortega River. ATSDR was able to locate sediment sampling data collected by FDEP (1988) contractors and surface water data submitted to the EPA in 1998. The available sediment and surface water data for these water bodies is presented below. Contaminants detected in surface water include VOCs, PCBs, pesticides, metals, and radionuclides. Contaminants detected in sediment in these various water bodies include SVOCs, metals, PCBs, radionuclides, and TPH.

St. Johns River

Surface Water: The FDEP regularly monitors for metals (e.g., copper, lead, and nickel) and cyanide in the surface water effluent that NAS Jacksonville discharges to the St. Johns River from its domestic wastewater facility. Using sampling data from January 2000 to March 2004, it appears that NAS Jacksonville has not discharged concentrations of these metals or cyanide that exceed CVs (FDEP 2004). In addition, in September 2001, FDEP individually sampled the effluent from NAS Jacksonville's wastewater treatment plant that discharges to the St. Johns River. No pesticides, herbicides, or organics were detected, and all metals were detected below CVs (FDEP 2001).

During remedial investigations at OU3 (1998–1999) and PSC 17 (1997), Navy contractors collected surface water samples from potentially affected areas of the St. Johns River. Table 10 provides the summary of maximum detections exceeding CVs in site-related areas of the river. During these sampling efforts, one PCB (aroclor-1254) and one pesticide (delta-BHC) were detected above CVs at PSC 17; one metal (thallium) was detected above its CV at OU3.

Sediment: Between 1987 and 1999, the city of Jacksonville, FDEP, SJRWMD, and Navy contractors conducted sampling to assess and characterize sediment in areas of the St. Johns River associated with contaminated areas at NAS Jacksonville. Sampling has been conducted in the St. Johns River near PSCs 17, 37, 40, and OU3. Table 10 summarizes maximum sediment concentrations that were detected above CVs. Within these areas seven SVOCs [benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(e)pyrene, dibenzo(a,h)anthracene, indeno(1,2,3-cd)pyrene, and perylene] and three metals (arsenic, iron, and thallium) were detected above CVs in sediment.

Casa Linda Lake (OU4)

Surface Water: In 1993 and 1997, surface water samples were collected and analyzed for SVOCs, pesticides, PCBs, metals, and cyanide. Also in 1993, samples were analyzed for VOCs. No samples were detected above CVs. As part of the remedial investigation in 1998, stormwater discharge from the northwest corner of the site was sampled because it was thought to drain areas at the site with the most potential for contamination (i.e., areas related to industrial activities), and then discharge into the lake. These samples were analyzed for VOCs, SVOCs, PCBs, pesticides, and metals. Only metals were detected, but none were detected above CVs.

Sediment: In 1993 and 1997, Navy contractors collected sediment samples from Casa Linda Lake, located within the station golf course. Table 11 summarizes the maximum concentrations detected in sediment exceeding CVs. Four SVOCs [benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and indeno(1,2,3-cd)pyrene] and three metals (arsenic, iron, and lead) were detected above CVs in Casa Linda Lake sediment.

Lake Scotlis

Surface Water: One surface water sample was collected at Lake Scotlis and analyzed for water quality. Ammonia and total nitrogen were detected, but at levels below CVs (AG&M 1999).

Sediment: Lake Scotlis was investigated during remedial investigations at OU4 in 1997. Lake Scotlis is not a designated area of contamination, but samples were collected because of its proximity to Casa Linda Lake. Sediment samples were collected and analyzed for SVOCs, pesticides, PCBs, metals, and cyanide. One SVOC [benzo(a)pyrene] was detected above its CV (AG&M 1999).

Unnamed Tributary to St. Johns River, Adjacent to OU1

Surface Water: Surface water in the unnamed tributary was sampled during remedial investigations in 1991, 1995, and 1996. Surface water samples in 1991 and 1995 were analyzed for VOCs, SVOCs, metals, cyanide, radionuclides, and TPH; samples in 1996 were only analyzed for VOCs and SVOCs. Four VOCs (benzene, methylene chloride, trichloroethene, and vinyl chloride) were detected in surface water above CVs. In addition, five metals (antimony, arsenic, cadmium, iron, and thallium) were detected above CVs in surface water within the tributary. Two radionuclides (gross alpha and thorium-234) were detected above CVs, though total alpha was used as a surrogate CV to screen thorium-234. In 2002, as part of an annual sampling effort at the unnamed tributary, no VOCs were detected above CVs.

Sediment: During remedial investigations between 1991 and 1995, sediment samples were collected from the unnamed tributary, which discharges to the St. Johns River 2,500 feet south of OU1. Sediment samples were analyzed for VOCs, SVOCs, PCBs, pesticides, radionuclides, TPH, dioxins/furans, cyanide, and metals. Two PCBs (aroclor-1248 and aroclor-1260) were detected above CVs. One SVOC [benzo(a)pyrene] and one metal (arsenic) were also detected above CVs in sediment of the unnamed tributary. Gross alpha, gross beta, and TPH were also detected, but there are no CVs for these contaminants.

Unnamed Creek Downgradient of OU5

Surface Water: In 1997, one surface water sample was collected and analyzed for VOCs. No contaminants exceeded the CVs. Sampling indicates that VOCs detected in OU5 groundwater are not affecting creek surface water (TtNUS 2002a).

Sediment: In 1997 and 1999, sediment samples were collected from the unnamed creek downgradient of OU5. Groundwater in the north and south of OU5 discharges to this creek. Samples were analyzed for VOCs, but none were detected above CVs.

Ortega River

Minimal sampling data are available for the Ortega River, and no data could be found to indicate if site-related contaminants have actually entered the river. In fact, the SJRWMD could not confirm if any direct discharges existed from the station to the Ortega River (Higman 2004). The river is not adjacent to NAS Jacksonville; it is ½ mile to the west of U.S. Highway 17. Drainage from the western portion of the station discharges toward the Ortega River via three unnamed streams that travel under the highway. Because Jacksonville, Florida, contains several industrial areas, ATSDR was not able to confirm or find documentation that connects any contamination in the Ortega River to sources from NAS Jacksonville. ATSDR contacted the city of Jacksonville, SJRWMD, and FDEP in attempts to locate surface water or sediment data; none of these agencies had Ortega River data for locations near NAS Jacksonville. ATSDR was, however, able to locate surface water data submitted to the EPA in 1998 and sediment sampling data collected in 1987 and 1988 for FDEP (USEPA 1998; Mote Marine Laboratory 1988).

Surface Water: Samples submitted to the EPA in 1998 indicated that Ortega River surface water was analyzed for specified parameters that included copper, lead, nutrients, coliforms, and total suspended solids. None of these substances exceeded the regulated limits (USEPA 1998).

Sediment: Sediment sampling was conducted for the FDEP in 1987 and 1988 at the Ortega River, northwest of NAS Jacksonville. Sediment samples were analyzed for SVOCs, pesticides, PCBs, and metals. Four SVOCs [benzo(a)anthracene, benzo(a)pyrene, benzo(e)pyrene, and perylene] were detected above CVs. Because there are no CVs for benzo(e)pyrene and perylene, both were compared with the CV for the most toxic PAH, benzo(a)pyrene. In addition, total PCBs were detected above the CV for sediment in the Ortega River (Mote Marine Laboratory and University of Florida 1988).

Evaluation of Potential Public Health Hazards

Past and Current Exposures

SVOCs, metals, and PCBs have been detected in sediment located in on-site surface water bodies. Contaminants have not been detected above CVs in surface water from Casa Linda Lake, Lake Scotlis, or the unnamed creek adjacent to OU5. Contaminants have only been detected above CVs in the St. Johns River surface water at PSC 17 (aroclor-1254 and delta-BHC) and OU3 (thallium), and in the unnamed tributary adjacent to OU1 (VOCs, metals, and radionuclides; though VOCs were not detected in 2002). Still, people are not permitted to enter Casa Linda Lake, Lake Scotlis, the unnamed tributary adjacent to OU1, or the areas along the St. Johns River adjacent to PSC 17 and OU3. Warning signs and other industrial controls prevent access to Casa Linda Lake, Lake Scotlis, and areas along the river, and fencing and signs prevent access to the unnamed tributary and unnamed creek.

Though Navy personnel, residents, and authorized visitors have access to the St. Johns River, sediment has only been collected in locations of the river that are associated with contaminated on-site areas (PSCs 17, 37, 40; OU3) — areas that are restricted from any human activity. Sediment sampling has not been conducted at other areas of the station where people are permitted, such as near the marina. Boating and fishing occurs at permitted areas, but people do not swim in these areas.

ATSDR was not able to confirm that contaminants from NAS Jacksonville have impacted the Ortega River. That said, contaminants were not detected in the river's surface water. Contaminants (SVOCs, pesticides, PCBs, and metals) were detected in sediment in 1987 and 1988, but these sampling efforts were conducted over 15 years ago. ATSDR is unable to determine the levels of contaminants in sediments presently in the Ortega River, but believes that incidental exposure to these sediments is unlikely to cause a health hazard.

Therefore, people are not expected to have contacted or to currently contact any contaminated surface water or sediment in these on-site surface water bodies. If people were to contact these surface waters or sediments (via ingestion or dermal contact), it is expected that exposures would be infrequent and for brief periods of time. These types of exposures would not produce sufficient doses to cause adverse health effects.

Therefore, ATSDR concludes that past or current incidental exposure to contaminants detected in on-site surface water and sediment of the St. Johns River, Casa Linda Lake, Lake Scotlis, the unnamed tributary adjacent to OU1, and the unnamed creek adjacent to OU5 is not expected to pose a public health hazard.

Future Exposures

Surface water and sediment contaminants detected at NAS Jacksonville are located within inaccessible areas. These areas remain restricted; fencing continues to prevent site access to the unnamed tributary adjacent to OU1 and the unnamed creek adjacent to OU5. Recreational activities continue at only permitted areas, regular monitoring continues, and warning signs remain in place. According to concentrations detected, adverse health effects are not expected from incidental exposures (via ingestion or dermal contact) to surface water and sediment in the

St. Johns River, Casa Linda Lake, Lake Scotlis, and the unnamed creek adjacent to OU5. Additionally, as long as access remains restricted, adverse health effects are not expected from exposure to surface water and sediment in the unnamed tributary.

ATSDR concludes that future incidental exposure to on-site contaminants detected in surface water and sediment of the unnamed tributary adjacent to OU1 would not present a public health hazard in the future, as long as the Navy follows its current restrictions and monitoring practices. Detected concentrations indicate that future incidental exposure to on-site contaminants found in surface water and sediment of the unnamed creek adjacent to OU5, St. Johns River, Casa Linda Lake, and Lake Scotlis is not expected to pose a public health hazard.

Evaluation of the Fish and Shellfish Consumption Pathway

> ATSDR defines biota as plants and animals in the environment. Some of these plants and animals might be sources of food, clothing, or medicine for people.

As a result of industrial activities at NAS Jacksonville, contaminants released to the environment can accumulate in biota (plants and animals). A wide array of wildlife lives on the land at NAS Jacksonville and within its associated surface water bodies. These include several fish species (e.g., crappie, spot, croaker, snapper, and bass), shellfish (e.g., shrimp and crab), alligators, manatees, turtles, ducks, and other species (AG&M 1999; Christine Bauer, natural resources manager, NAS Jacksonville, personal communication, 2004). Many people catch fish and shellfish at NAS Jacksonville, and as a result could potentially be exposed to contaminants when eating fish and shellfish caught from these water bodies.

Military personnel, NAS Jacksonville employees, authorized visitors, and residents and their guests are allowed to fish on the station. Fishing in the St. Johns River from NAS Jacksonville is only permitted at specified piers and outfalls (for example, Manatee Point). The Navy requires that everyone obtain a permit from the on-site marina before fishing at any of these specified areas, which are detailed in NAS Jacksonville's *Hunting and Fishing Instruction Manual* (Beason 2004b). People fishing at NAS Jacksonville consume fish and shellfish caught from these designated areas along the St. Johns River (Christine Bauer, natural resources manager, NAS Jacksonville, personal communication, 2004; Beason 2004).

The Navy allows people to fish in on-station lakes and ponds (such as Casa Linda Lake and Lake Scotlis), but consuming any of these fish is restricted through the Navy's catch-and-release program. Signs are posted along the lakes and ponds to warn people of potential contamination from consuming fish (Christine Bauer, natural resources manager, NAS Jacksonville, personal communication, 2004; Beason 2004b). Casa Linda Lake (11 acres) contains various fish species (bluegill, catfish, largemouth bass, and golden shiners) and is also a habitat for ducks, birds, alligators, and turtles (AG&M 1999; Fred C. Hart Associates, Inc. 1983). Lake Scotlis is a smaller lake (3 acres) and contains bluegill, largemouth bass, and redear sunfish (Fred C. Hart Associates, Inc. 1983).

Nature and Extent of Contamination

No fish or shellfish sampling has been conducted in the St. Johns River near NAS Jacksonville. ATSDR attempted to obtain data from the Navy, the City of Jacksonville, FDEP, and the SJRWMD; however, no data were available. None of the agencies had any knowledge of sampling ever being conducted in areas where people catch edible fish and shellfish. Though no fish or shellfish sampling has been conducted at adjacent areas of the St. Johns River, sediment toxicity tests have been conducted on various amphipods. Toxicity tests are often used on amphipods because they have limited mobility and are very prone to accumulating pollutants. As a result, they are good indicators of contamination in an area (Grosse et al. 1986). Fish, on the other hand, are migratory and can move away from an area. Thus if contamination were detected in fish, it could actually be associated with a different area of the river (not near NAS Jacksonville). Biota tests were conducted at three identified potential source areas of contamination (PSCs 17, 37, and 40) located on site along the St. Johns River. Using data on the survival rates of the amphipods, investigators concluded that marine invertebrates (for example, shrimp and crab) in these areas would not be adversely affected by contaminants in sediment (HLA 1999i, 1999q, and 1999t).

Though fish and shellfish data were not available for the St. Johns River, ATSDR was able to locate fish sampling data for Casa Linda Lake and Lake Scotlis — two lakes used for catch-and-release fishing. Sampling was conducted in 1993 for an electroshocking fish study at Casa Linda Lake and in 1997 as part of the remedial investigations at OU4. Table 12 presents a summary of Casa Linda Lake fish samples with above-CV detections. Sampling at Casa Linda Lake in 1993 and 1997 detected one SVOC (4-methylphenol) above its CV in fish filet samples. Five pesticides (4,4’-DDD, 4,4’-DDE, aldrin, alpha-BHC, and alpha-chlordane) were detected above CVs in various sample types that included fish liver/gonad, whole fish, and fish carcass. In addition, two PCBs (aroclor-1254 and aroclor-1260) were detected above CVs in fish liver/gonad and whole fish samples, respectively. Three metals (arsenic, mercury, and thallium) were detected above CVs in whole fish (arsenic and thallium) and fish filet (mercury) samples (AG&M 1999).

As part of the remedial investigations at Casa Linda Lake in 1997, samples were collected at Lake Scotlis. Sample results are presented in Table 13. During these sampling efforts, two pesticides (heptachlor and heptachlor epoxide) were detected above CVs in whole fish samples. Two PCBs (aroclor-1254 and aroclor-1260) were detected above CVs in fish filet and whole fish samples, respectively. In addition, two metals (antimony and mercury) were detected above CVs in whole fish and fish filets samples, respectively (AG&M 1999).

Evaluation of Potential Public Health Hazards

Past Exposure

People could have consumed fish from Casa Linda Lake and Lake Scotlis before these lakes were restricted to catch-and-release only. Little consumption of fish from these lakes was expected in the past. Nevertheless, ATSDR calculated potential exposure doses based on conservative estimates in which adults and children consumed 8 ounces and 4 ounces, respectively, of fish from Casa Linda Lake or from Lake Scotlis for 50 days a year over a lifetime. See Appendix D for more information.

Using doses calculated for each contaminant that exceeded its CV, all potential doses were below levels at which adverse health effects have been observed in human and animal studies and epidemiological studies. Therefore, adverse health effects from past consumption of fish from Casa Linda Lake and Lake Scotlis are not likely to result in adverse health effects. *If, however, people consumed more than the estimated amounts or for longer periods of time, potential health effects could have been possible depending on the parts of the fish that people consumed.*

No sampling has been conducted on areas of the St. Johns River used to catch fish and shellfish. Sediment toxicity tests indicate that marine invertebrates that consume sediments in these areas of the river would not be adversely affected by contaminants in sediment (HLA 1999i, 1999q, and 1999t). Even if fish and shellfish sampling had been conducted, fish are migratory species, and any contamination detected could not necessarily be linked to contaminants released from the station. Therefore, the sediment toxicity tests lead ATSDR to the conclusion that past consumption of fish and shellfish from the St. Johns River near NAS Jacksonville would not have resulted in adverse health effects. In addition, ATSDR concludes that adults and children who consumed 8 ounces and 4 ounces, respectively, of fish from Casa Linda Lake or Lake Scotlis for 50 days a year over their lifetimes would not have experienced adverse health effects in the past.

Current and Future Exposures

Consumption of fish from Casa Linda Lake, Lake Scotlis, and all other lakes and ponds on the station is not allowed at NAS Jacksonville. Signs are posted at all of these areas to warn of potential contamination. Because fishing is restricted, exposures are not expected to occur. If NAS Jacksonville removed these fishing restrictions, adverse health effects would still not be expected, given the doses calculated for each contaminant that exceeded its CV in the 1993 and 1997 fish samples. All potential doses were below levels at which adverse health effects have been observed in human and animal studies, and epidemiological studies. Therefore, if adults and children consumed 8 ounces and 4 ounces, respectively, of fish from Casa Linda Lake or Lake Scotlis for 50 days a year over their lifetimes, adverse health effects would not be expected to occur as long as contaminant levels remain the same or decrease. ATSDR uses conservative assumptions to overestimate exposure to the public. ATSDR evaluated fish consumption exposures based on 50 days a year over a lifetime because ATSDR believes that people actually consume less than these amounts from these lakes. Therefore, ATSDR calculated approximate doses that overestimate a person’s actual exposure from ingestion of fish from Casa Linda Lake and Lake Scotlis. See Appendix D for more information.

Current and future consumption of fish and shellfish from the St. Johns River is not expected to result in adverse health effects. The St. Johns River is used throughout northeast Florida for recreational and commercial fishing. Toxicity tests show that contaminants in sediment along the St. Johns River near NAS Jacksonville would not adversely impact marine invertebrates. Thus, adverse health effects are not expected from current and future exposures to contaminants in these sediments.

ATSDR concludes that adults and children who consume up to 8 ounces and 4 ounces, respectively, of fish from Casa Linda Lake or Lake Scotlis for 50 days a year over their lifetimes are not likely to experience adverse health effects in the present or future, as long as contaminant levels in fish remain the same or decrease. In addition, ATSDR concludes that current and future consumption of fish and shellfish from the St. Johns River is not likely to result in adverse health effects.

Community Health Concerns

For over 15 years the community has worked with the Navy to address clean-up activities and contamination issues at NAS Jacksonville. In 1989, a Technical Review Committee (TRC) was formed of community members and representatives of the Navy, FDEP, EPA, and the City of Jacksonville to review site documents, provide input on proposed clean up activities, identify community concerns, and track IRP progress. Today the public continues to work with the Navy to address site-related issues through NAS Jacksonville's Restoration Advisory Board (RAB)—the successor to TRC as of 1994 (ABB-ES 1998a). There are presently six community members on the RAB. The group meets on an irregular basis as issues arise, but it has meetings at least twice a year (Bill Dougherty, NAS Jacksonville public affairs specialist, personal communication, 2004). In addition, since 1991 the Navy has implemented a community relations plan (CRP) outlining methods to address surrounding communities' concerns and means to distribute information to these communities regarding clean-up activities at NAS Jacksonville (ABB-ES 1998a). According to recent discussions with NAS Jacksonville personnel, there is limited community concern regarding the station as this time (Bill Dougherty, NAS Jacksonville public affairs specialist, personal communication, 2004). To identify community health concerns, ATSDR reviewed the most recent CRP (1998) as well as past site-related documents. ATSDR presents the summarized health concerns and responses below.

Concern about Potential On-site and Off-site Impacts of Environmental Contamination for Residents.

On site: ATSDR's evaluation of environmental contamination and exposure pathways shows that on-site residential exposure is unlikely to occur. If exposure did occur, health effects are not expected to result from the type and duration of exposures that residents would experience. Because fencing, security gates, and authorization requirements prevent access to most PSCs and OUs, residents have access to very few PSCs and to only one OU (OU 4). In addition, detected concentrations of contaminants in surface soil in these accessible areas are too low to cause adverse health effects. Although groundwater throughout NAS Jacksonville has been contaminated with solvents, pesticides, herbicides, SVOCs, radionuclides, metals, and cyanide; all station residents receive water from wells that are 1,100–1,200 feet below ground surface. All groundwater contamination has been detected within the first 60 feet below ground surface (Wally Holdstein, public works manager, NAS Jacksonville, personal communication, 2004).

Contaminants are present in St. Johns River sediment (PSCs 17, 37, and 40; OU3) and surface water (PSC 17 and OU3) at locations adjacent to the station. No one is permitted to fish in these areas, however, and no one has been known to swim in them; in fact, the Navy prohibits all human activities in these portions of the river. Fishing and boating are permitted at designated areas, but not swimming. Fishing in the St. Johns River from NAS Jacksonville is only allowed at specified piers and outfalls (for example, Manatee Point), and anglers must obtain a permit from the station marina before fishing at any of these areas (Beason 2004b).

Off site: Residents to the north and south have expressed concerns about off-site exposures to site-related contaminants through private drinking water wells. To respond to community concerns, in 1989 the FDOH-Duval County Health Department sampled wells in residential areas to the north, west, and south (FDOH 2004; Pawlowicz 2005b). ATSDR evaluated available data for these wells and found that no contaminants were detected above CVs in wells to the north and west. Sample results for wells to the south, which have been monitored throughout the years since 1989, are discussed below.

ATSDR evaluated sampling data for private drinking water wells adjacent to the station's southern border—next to OU5 (PSC 51). Between 1992 and 2003, arsenic was detected in six wells (nine detections) at levels above CVs, and copper was detected above its CV in one well in 1997. Both arsenic and copper, however, were detected **below** state and federal regulatory limits for public drinking water supplies. Therefore, according to the guidelines of the state of Florida and the federal government, these wells supply drinking water that is safe for public consumption. In August 2001, trichloroethene (TCE) was detected above its CV in one well (FDOH 2004). After detecting this TCE contamination, the FDOH-Duval County Health Department referred the well to FDEP for remediation. FDEP installed a filtration system at this location in November 2001 to reduce TCE in this well (Pawlowicz 2004 and 2005b). In January 2005, ATSDR requested sampling data to confirm that the level of TCE has decreased in this well. According to FDOH, the resident did not allow additional sampling of this private well. Because a filtration system has been in place at this well since November 2001, ATSDR believes that the level of TCE detected in this well has decreased. The groundwater assessment during the RI/FS determined that the groundwater plume at OU5 begins in the former FFTA area and ends at the monitoring well at the station fenceline (TtNUS 2002a).

The Navy requested that the U.S. Geological Survey (USGS) conduct groundwater modeling at this area to assess groundwater flow and to evaluate if groundwater contaminants from OU5 could flow toward these private drinking water wells in the adjacent neighborhood. Using USGS groundwater modeling, ATSDR concludes that an unnamed creek flowing through OU5 and off-site to the St. Johns River (away from the residential area) is the primary receiver of OU5 groundwater. Groundwater in the north and south of the PSC discharges to this unnamed creek, which is southeast of OU5. The creek is not deep enough to sustain recreational activities such as swimming and fishing, and a fence surrounding the creek prevents access. Surface water sampling shows that VOCs detected in groundwater at OU5 are not affecting creek surface water; the only VOC detected (2-butanone) was below its CV (TtNUS 2002a).

Residences located next to the station's southern boundary at OU5 rely on deep groundwater for drinking water, which comes from wells reportedly 200 feet or deeper (TtNUS 2002a). As noted previously, site-related contamination has only been detected within 60 feet below ground surface (Wally Holdstein, public works manager, NAS Jacksonville, personal communication, 2004). Because of the confining layers in the aquifers and the artesian nature of the Floridan aquifer, it is highly unlikely that contaminants in shallow groundwater would migrate to the deeper zone (Davis et al. 1996). Also, the groundwater plume at OU5 does not extend beyond the fenceline nor flow towards the residential neighborhood (based on USGS modeling) (TtNUS 2002a).

Concern about Protecting Natural Resources, Particularly the St. Johns River.

NAS Jacksonville has a very complex drainage system (66 identified drainage basins) comprising several storm sewers that run throughout the station and discharge to the St. Johns River. Contaminants are treated before discharge and the station regulates all releases according to state regulations. The FDEP regularly tests the outfall for contaminants, including metals and water quality parameters. ATSDR evaluated data collected at the outfall since 2000. No metals were detected above CVs. In addition, in 2001 FDEP conducted an individual study that included surface water sampling and toxicity testing on the effluent discharged directly from NAS Jacksonville. Surface water samples were analyzed for metals, pesticides, herbicides, and organics. Only metals were detected, and at levels below health-based CVs. Toxicity tests were conducted to assess if acute toxicity would occur on two test species—the water flea and the bannerfin shiner. The FDEP uses these tests to examine if exposure to the effluent released from a facility will cause acute toxicity to the species, thus indicating contamination in the effluent. The test results show no acute toxicity following the species' exposure to NAS Jacksonville's effluent (FDEP 2001).

In addition, as part of its remediation efforts, NAS Jacksonville is taking steps to reduce levels of contaminants in on-site groundwater, which could potentially impact surface water resources over time. For example, in January 2004 the Navy conducted interim measures at OU6 that consisted of applying nano-scale iron injections to reduce groundwater contaminants. The Navy is currently conducting a data analysis to examine if the procedure was successful (Allen 2004). In addition, the Navy conducts regular groundwater and surface water monitoring at several of the PSCs and OUs (see Table 1). Monitoring is conducted to ensure that groundwater contaminants are naturally decreasing, have not reached off-site areas, and have not impacted surface water resources.

Concern about Specific Wastes—Arsenic and Lead.

ATSDR's evaluation of sampling data for all PSCs and OUs at NAS Jacksonville found that arsenic was detected above its CV in groundwater, surface soil, surface water, Casa Linda Lake sediment and fish, and St. Johns River sediment. Lead was detected above its CV in surface soil, surface water, and Casa Linda Lake sediment. Again, however, residents and unauthorized personnel do not have access to the majority of these contaminated areas.

Arsenic was detected in sediment above its CV (1.7 ppm) in one unrestricted area—PSC 44. This level is, however, too low to cause adverse health effects. Arsenic was detected in soil above its CV in four unrestricted areas—PSCs 20, 22, 23, and 36. Among the accessible areas, the highest level detected (4.7 ppm at PSC 20) would be too low to cause adverse health effects, even if an adult or child ingested 100 mg/day and 200 mg/day, respectively, of soil from PSC 20 for 365 days a year over 70 years.

NAS Jacksonville residents and their guests only have access to two areas where lead was detected above its CV: PSCs 22 and 23. Both of these PSCs were part of the Navy's golf course expansion that began in 2000 and has since been completed. During the expansion, soil was covered and the golf course was built directly on top of these areas. As a result of this expansion, surface soil exposure was largely eliminated at PSCs 22 and 23 (HLA 1999j). In addition, ATSDR calculated exposure doses for people potentially exposed to surface soil at these PSCs before the golf course expansion took place. Using the average detected concentration levels, the doses are lower than those shown to cause adverse health effects (e.g., even if an adult or child incidentally ingested 100 mg/day and 200 mg/day, respectively, of soil from these PSCs for 100 days a year over 70 years, adverse health effects would not be expected). Therefore, no health hazards are expected to occur from exposure to lead in soil at PSCs 22 and 23.

Concern about Specific Disposal Sites—OU1 and OU5 (PSC 51).

OU1. In the past, there was concern that children trespassed into OU1 to play on the landfill. Though the area had previously been fenced, in 1991 the Navy installed a higher, 8-foot tall fence to prevent access to the landfill from neighborhood children (ATSDR 1992). Following the 1993 focused RI to address light nonaqueous-phase liquid (LNAPL) contamination in the shallow aquifer at OU1, the Navy initiated an interim removal action (IRA) that included the installation of an ongoing LNAPL removal system (ABB-ES 1997a). In 1997, the Navy approved a record of decision that outlined the following remedial actions (ABB-ES 1996a):

- Collect LNAPL,
- Excavate selected sediment in the unnamed tributary and soil from outside the landfill and dispose of it under the landfill cap,
- Install a cap over the soil and debris at the landfill,
- Allow natural attenuation of groundwater,
- Monitor surface water and groundwater,
- Enforce land-use restrictions, and
- Conduct 5-year reviews.

These remedial actions were completed in 1997 (DERP 2002). Today, the landfill is capped and surrounded by an 8-foot high fence.

A review of sampling data and potential exposure scenarios confirms that no past or current public health hazards are expected at OU1. A fence prevents access from the housing area and Child Street to OU1. Groundwater is not used as a drinking water source, and past studies indicate that OU1 contaminants have not migrated to the adjacent station housing area (ABB-ES 1996a). ATSDR calculated doses for adults and children potentially exposed to surface soil and sediment at OU1 in the past, present, or future. The calculated doses are too low to cause adverse health effects in children or adults.

Sampling results suggest that exposure to surface water could potentially cause harm if they had been ingested in the past. Still, a landfill cap covered surface water in the perimeter ditch at OU1 (a restricted area), and fencing prohibits access to the unnamed tributary adjacent to OU1 (within the station housing area). Therefore, only residents who trespassed into these areas could have been exposed to surface water at OU1. In addition, surface water sampling in 2002 did not detect any VOCs above CVs. Because site access is restricted, no exposures are expected to occur, and therefore no adverse health effects are expected from surface water exposure at OU1. ATSDR does recommend, however, that 1) the fencing around this tributary, which prevents resident access, remain in place, 2) surface water monitoring (specifically, for VOCs, metals, and radionuclides) continue, and 3) signs (if not already in place) be posted along the fenced ditch system that runs though the station housing area.

OU5. Groundwater issues related to OU5 are discussed previously in ATSDR's response to the concern related to off-site residential impacts. Please refer to this concern for more information about OU5 in relation to the groundwater pathway. ATSDR's evaluation of available sampling data shows that past, current, and future public health hazards are not expected from exposure to OU5. A fence surrounds the entire OU area and only station personnel have site access. In 1998, the Navy removed the radiological-contaminated soil (about 1,000 cubic yards) from OU5. The groundwater at this OU is not used as a drinking water source. Because site access is restricted and the site is not used for any purpose, no exposures are likely to occur and therefore no adverse health effects are expected. Still, ATSDR conservatively calculated potential exposure doses for children and adults exposed to 200 mg/kg and 100 mg/kg, respectively, of average contaminant detections in soil over a lifetime. These estimated doses reveal that the detected concentrations in surface soil at OU5 are too low to cause adverse health effects. Thus, even if trespassing were possible (e.g., by children living in the neighborhood adjacent to the southern fenceline), adverse health effects are not expected from exposure to the contaminants detected in soil at OU5.

Child Health Considerations

ATSDR's child health considerations acknowledge that infants and children are especially vulnerable to site contaminants that could be present in their air, food, soil, or water. In many cases where hazardous substances have been released to the environment, children have a higher susceptibility than adults to be exposed and to receive exposures that could result in health effects. Generally, children have a higher probability of exposure because they play outside and frequently take food with them into contaminated areas. Because children are shorter and smaller than adults, they breathe in contaminants that are closer to the ground (e.g., via soil, dust, and heavy vapors) and take in higher doses of contaminants in comparison to their body weight. If toxic exposures took place during a child's critical growth stages, his or her body systems could suffer permanent damage.

As part of the child health considerations, ATSDR has tried to locate the populations of children who live at NAS Jacksonville and in the station's vicinity. According to the 2000 census, 290 children under 5 years of age and 245 children between 5 and 9 years of age live at the station and in surrounding areas. Of the population of 600 children who are 3 years and older and enrolled in school, 35 children attend preschool, 53 children are in kindergarten, 322 children attend elementary school (grades 1 to 8), and 190 children attend high school (grades 9 to 12) (US Census Bureau 2004). School age children who live at and around NAS Jacksonville attend Venetia Elementary School (pre-kindergarten to grade 5), Jeb Stuart Middle School (grades 6 to 8), or Robert E. Lee High School (grades 9 to 12) (NAS Jacksonville 2001; US Census Bureau 2004).

Children who live at the station or visit station residents may inadvertently contact low levels of contaminants present at the site. ATSDR carefully examined these potential pathways, especially in relation to children. In the past, concerns were expressed about children trespassing into one area of the station (OU1) to play on landfill soil. The Navy has since installed a much higher fence that prevents trespassing into this area, and the landfill has been capped. ATSDR thoroughly examined past potential doses to children for this possible exposure, but determined that no health effects would have occurred from children contacting surface soil in this area or in any other accessible areas at NAS Jacksonville. Through fencing or through security gates — or both — the Navy prevents access by children and unauthorized persons to the majority of contaminated areas. Therefore, children exposed to contaminants present in areas that were or are accessible are not expected to result in adverse health effects. For additional details about the potential exposure pathways evaluated by ATSDR, refer to the *Evaluation of Environmental Contamination and Exposure Pathways and Community Health Concerns* sections of this PHA.

Conclusions

ATSDR has reached the following conclusions based on available environmental data, information collected on NAS Jacksonville, and an evaluation of potential exposure pathways. See Appendix A for definitions of the hazard categories used in these conclusions.

1. Shallow groundwater (within the first 60 feet below ground surface) beneath NAS Jacksonville is contaminated with volatile organic compounds, semi-volatile organic compounds, pesticides, herbicides, radionuclides, cyanide, and metals. Since the station began operations, NAS Jacksonville has received drinking water from wells that draw water from the deep Floridan aquifer, between 1,100 and 1,200 feet below ground. No one who lives on site has been or will be exposed to the contaminants in shallow groundwater. Thus ATSDR concludes that residents were not exposed to harmful contaminants in groundwater in the past, and will not be exposed to these contaminants in the future. The groundwater pathway to on-site residents poses *no public health hazard*.
2. Some residents living in off-site neighborhoods to the north and west of the station rely on private wells for drinking water. The sampling data available for wells to the north and west of the station did not indicate the presence of contaminants above ATSDR's health-based CVs. Given the available data, ATSDR concludes that groundwater to the north and west of the station poses *no public health hazard*.
3. ATSDR evaluated various well sampling data on private wells located to the south of the station's southern border. These samples detected arsenic, copper, and trichloroethene (TCE) above CVs. Because the highest arsenic detections were from samples collected over 10 years ago, it is possible that these contaminants are no longer present in groundwater due to natural attenuation and other factors. Although copper was detected in an off-site well, it was not detected in samples collected from contaminated areas in the southern portion of NAS Jacksonville (OU5). In addition, these private wells reportedly draw drinking water from over 200 feet below ground surface —more than 140 feet below site-related groundwater contamination. The U.S. Geological Survey conducted groundwater modeling to determine whether groundwater contaminants from the southern portion of the station drained to this off-site residential area. Groundwater modeling confirmed that groundwater from the southern border of the station discharges toward the southeast (away from the neighborhood) into an unnamed creek that

discharges to the St. Johns River. In fact, groundwater from the neighborhood also discharges to this creek.

It is important to note that although the arsenic and copper detection levels exceeded ATSDR’s conservative health-based screening comparison values, the levels were below federal and regulatory limits for these contaminants in public drinking water supplies. In addition, a TCE filtration system was installed at the location containing elevated TCE and has been maintained since that time (Pawlowicz 2004). According to the Florida Department of Health-Duval County Health Department, the resident of the home with the well containing elevated TCE did not allow additional sampling in 2004. ATSDR believes that the TCE filtration system has successfully reduced the level of TCE detected in this well. The contaminants detected in these wells in the past are unrelated to groundwater contamination at NAS Jacksonville. Therefore, ATSDR concludes that groundwater in private drinking water wells located adjacent to the southern border poses *no apparent public health hazard because people may have been exposed to contaminants, but not at levels high enough to cause adverse health effects*.

4. Surface soil at NAS Jacksonville is contaminated with semi-volatile organic compounds, herbicides, pesticides, polychlorinated biphenyls, metals, and radionuclides. The Navy, however, restricts access to 35 out of 54 PSCs through fencing, guarded gates, restricted access to the station, and other measures. Out of the areas that a person could access, contaminants in surface soil (e.g., pesticides, semi-volatile organic compounds, and metals) only exceeded CVs at seven PSCs. ATSDR calculated potential exposure doses for children and adults exposed to detected contaminant levels in surface soil in these areas. No doses were above levels at which adverse health effects have been observed. Because people could have been exposed in the past or could be currently exposed to on-site soil in these areas — even at levels too low to pose a health hazard — ATSDR concludes that exposure to surface soil in accessible areas on NAS Jacksonville poses *no apparent public health hazard*.

5. Trespassing at NAS Jacksonville is extremely unlikely because of strict security measures and fencing. If a person did trespass into any restricted areas, he or she would not be exposed to contaminants at high enough doses or for long enough periods of time to result in adverse health effects. Because, however, exposure could potentially occur from trespassing, ATSDR concludes that exposure to surface soil within restricted areas at NAS Jacksonville poses *no apparent public health hazard*.

6. Surface water drainage from the eastern portion of the station discharges directly to the St. Johns River; drainage from the west flows toward the Ortega River via three unnamed streams. An unnamed creek that discharges to the St. Johns River drains the southern portion of the station. In addition, site-related contaminants have flowed into Casa Linda Lake, Lake Scotlis, and the unnamed tributary adjacent to the former station landfill (OU1). Contaminants including semi-volatile organic compounds, metals, PCBs, radionuclides, and total petroleum hydrocarbon have been detected in sediment within these water bodies; volatile organic compounds, polychlorinated biphenyls, pesticides, metals, and radionuclides have been detected in site-related surface water. Fencing restricts access to the unnamed tributary and to the unnamed creek, and only catch-and-

release fishing is permitted at Casa Linda Lake and Lake Scotlis. In addition, the Navy restricts all human activities at the areas where sediment contamination has been detected in the St. Johns River. Surface water sampling in the Ortega River and the St. Johns River did not detect contaminants above CVs. ATSDR reviewed sampling data and conducted an exposure pathway evaluation, and concludes that incidental exposure to surface water and sediment of the unnamed tributary adjacent to OU1 would not present a public health hazard as long as the Navy follows its current restrictions and monitoring practices. Incidental exposure to on-site contaminants detected in surface water and sediment of the unnamed creek adjacent to OU5, St. Johns River, Casa Linda Lake, and Lake Scotlis are also not expected to pose a public health hazard. Because, however, contact could be possible, ATSDR concludes that exposure to surface water and sediment from these water bodies would pose *no apparent public health hazard*.

7. Currently, the Navy only allows catch-and-release fishing at Casa Linda Lake, Lake Scotlis, and all other lakes and ponds at the station (fish data were only available for Casa Linda Lake and Lake Scotlis). If these fishing restrictions were lifted from Casa Linda Lake and Lake Scotlis, adverse health effects would not be expected based on exposure doses calculated by using conservative assumptions. Therefore, even if these fishing restrictions were removed, ATSDR concludes that future fish consumption from Casa Linda Lake and Lake Scotlis poses *no apparent public health hazard* as long as contaminant levels remain the same or decrease, and as long as people do not consume more than the amounts used in these conservative assumptions.

   ATSDR calculated potential exposure doses for people consuming fish from Casa Linda Lake and Lake Scotlis in the past. Using conservative assumptions, all exposure doses were below levels at which adverse health effects have been observed in animals or humans. Therefore, people could have been exposed to contaminants via fish consumption in the past, but not at levels causing adverse health effects. ATSDR concludes that past fish consumption from Casa Linda Lake and Lake Scotlis poses *no apparent public health hazard*.

8. Consuming fish and shellfish caught from the St. Johns River was and is allowed at designated areas at NAS Jacksonville. No fish or shellfish sampling data are available for the St. Johns River along NAS Jacksonville. ATSDR was, however, able to locate sediment toxicity studies conducted on amphipods living in sediment within the river near known contaminated areas at the station. Thus it is expected that sediment in areas where people are allowed to fish would be less contaminated than sediment in these known PSCs/OUs. These toxicity tests determined that marine invertebrates (e.g., shrimp and clams) exposed to this contaminated sediment would not be adversely impacted. Therefore, if people were or are exposed to contaminants in sediment via fish and shellfish consumption, levels would be too low to result in adverse effects. ATSDR concludes that fish and shellfish consumption from the St. Johns River poses *no apparent public health hazard*.

Recommendations

1. ATSDR recommends that residents of NAS Jacksonville abide by the Navy's catch-and-release fishing restrictions and no swimming policy at the St. Johns River, Casa Linda Lake, Lake Scotlis, and all other lakes and ponds on the station. ATSDR also recommends residents follow signs that limit access to restricted areas, which includes areas where sediment contamination has been detected.
2. Although evidence suggests that contaminants from NAS Jacksonville are not affecting the private wells located south of the base, because of the uncertainty and unpredictability of hydrogeology, ATSDR recommends monitoring these private wells periodically (either annually or every 2 years) to ensure that water in these wells remains safe to drink.

Public Health Action Plan

The public health action plan (PHAP) for NAS Jacksonville describes completed, ongoing, and future public health actions for the station. The Navy, EPA, FDEP, and ATSDR have conducted or will conduct public health actions at NAS Jacksonville. ATSDR prepares a PHAP to make certain that this public health assessment, in addition to identifying potential public health hazards, outlines a plan of action to reduce and prevent harmful health effects as a result of exposure to site-related contaminants in the environment. The completed, ongoing, and planned public health actions are listed below.

Completed Actions

1. On November 21, 1989, because contamination was identified at several locations throughout the station, EPA added NAS Jacksonville to its National Priorities List of sites requiring further investigation.
2. On October 23, 1990, the Navy signed a Federal Facility Agreement with EPA and FDEP as a collaborative effort to clean up the site.
3. Following concerns from residents about children trespassing into OU1 to play on the former landfill soil, in 1991 the Navy installed a higher 8-foot tall fence to prevent site access and educated parents regarding potential site contaminants.
4. In 1993, the Navy established the NAS Jacksonville Partnering Team with the Navy, FDEP, EPA, and government contractors to guide all restoration activities and decisions at the station.
5. In 1994, the Navy started the Remedial Response Decision System to establish guidelines and to determine criteria for assessing site data, and to recommend appropriate remedial activities. The Navy uses this decision system to document, manage, and identify installation restoration sites at NAS Jacksonville.
6. To date, the Navy has identified a total of 54 PSCs (including the 21 PSCs contained in OUs 1 through 8) under the U.S. Department of Defense's Installation Restoration Program. The Navy has conducted environmental investigations at all 54 areas at NAS Jacksonville.

7. Using environmental investigations and remedial actions at NAS Jacksonville from 1983 to the present, the Navy has identified 28 PSCs (1, 5-10, 17-20, 24, 25, 28-37, 39, 40, 44, 49, 50, and 53) as no-further-action-response-planned areas.
8. Since beginning remedial investigations at the operable units in 1991, no more removal actions are required at OUs 1, 2, 3, 4, and 5. The Navy is planning to remove contaminated soil from OU7. Record of decisions have been completed and finalized for OUs 1 through 4.
9. Because of concerns from off-site residents about groundwater contaminants migrating from OU5 to their neighborhood, the Navy requested that the USGS conduct groundwater modeling at the site. The USGS determined that groundwater from OU5 flowed toward an unnamed creek (away from the neighborhood) and that the groundwater plume did not extend beyond the station's southern fenceline.
10. The Navy has posted warning signs in areas where contamination has been detected in groundwater, surface water, soil, and sediment.

Ongoing Actions

1. Currently, the Navy is completing the draft remedial investigation (including a draft risk assessment) and developing the feasibility study for OU8. The Navy anticipates that the complete RI/FS will be available for the public by March 2006, at the earliest (Greg Roof, TtNUS engineer, personal communication, 2004 and 2005).
2. In January 2004, the Navy conducted nano-scale iron injections to reduce groundwater contaminants at OU6. The Navy is currently evaluating the data results to determine if these measures were successful (Allen 2004).
3. The NAS Jacksonville Restoration Advisory Board will meet as needed to discuss community concerns and evaluate future remedial activities planned for the site.
4. The Navy will continue to conduct regular groundwater monitoring to ensure that groundwater contaminants are naturally attenuating, not moving off site, and not impacting surface water bodies on or off site.
5. The Navy will continue to conduct surface water monitoring at required areas to ensure that groundwater contaminants are not affecting on-site surface water.
6. The Navy has initiated a catch-and-release program at all lakes and ponds on NAS Jacksonville. Through this program, the Navy limits the consumption of fish from these lakes and ponds that could contain site-related contaminants.
7. The Navy restricts human activities at areas along the St. Johns River that were identified as sources of contamination (PSCs 17, 37, 40; OU3). Signs are posted to warn people of potential contamination in these areas.

Planned Actions

1. The Navy has RI/FSs planned for PSCs 22, 23, 38, and 45. These investigations are scheduled to begin on October 31, 2007 (PSCs 22 and 23), January 1, 2008 (PSC 45), and October 30, 2010 (PSC 38).
2. The Navy will complete a land use control inventory for reporting at PSC 30.
3. The Navy will complete a Record of Decision for OU6 that details if the nano-scale iron injections were successful in reducing groundwater contaminants.

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Appendices

Appendix A: Glossary

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,
1-888-422-8737.

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 followup of people who have had documented environmental exposures.

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

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

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

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

Half-life ($t_{½}$)
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 EXIT
National Library of Medicine (NIH) EXIT

For more information on the work of ATSDR, please contact

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Appendix B: ATSDR's Environmental Data Analysis for NAS Jacksonville

Table B-1. ATSDR's Environmental Data Analysis for NAS Jacksonville

Site	***Data Analysis of Environmental Monitoring Results***
Operable Units (OUs) at NAS Jacksonville	
OU1	**Groundwater (Unfiltered):** Aluminum (up to 271,000 ppb), antimony (up to 26.0 ppb), arsenic (up to 47.1 ppb), barium (up to 1,360 ppb), benzene (up to 250 ppb), beryllium (up to 25.4 ppb), bis(2-chloroethyl)ether (38.0 ppb), bis(2-ethylhexyl)phthalate (up to 71.0 ppb), cadmium (up to 3.9 ppb), carbazole (4.0 ppb), chromium (up to 294 ppb), dibenzofuran (up to 45.0 ppb), 1,2-dichloroethane (up to 47.0 ppb), 1,1-dichloroethene (up to 150 ppb), iron (up to 168,000 ppb), lead (up to 53.3 ppb), methylene chloride (up to 8.5 ppb), nickel (up to 125 ppb), tetrachloroethene (21.0 ppb), thallium (1.9 ppb), 1,1,2-trichloroethane (59.0 ppb), trichloroethene (up to 3,000 ppb), total 1,2-dichloroethene (up to 1,800 ppb), vanadium (up to 378 ppb), and vinyl chloride (up to 710 ppb) were detected above CVs throughout the OU. In 1995, 10 samples collected within the landfill detected benzene (up to 92.0 ppb), bis(2-ethylhexyl)phthalate (up to 1,600 ppb), chlorobenzene (up to 800 ppb), chloroethane (62.0 ppb), and 2-methylnaphthalene (8,000 ppb) above CVs. **Sediment:** Aroclor-1248 (1.5 ppm), aroclor-1260 (up to 15.0 ppm), arsenic (up to 10.3 ppm), and benzo(a)pyrene (up to 0.29 ppm) were detected above CVs. There are no soil CVs for gross alpha (up to 3.5 picocuries per gram [pCi/g]), gross beta (up to 2.2 pCi/g), and total petroleum hydrocarbon (TPH) (up to 26,100 ppm). **Soil:** Aroclor-1254 (up to 3.6 ppm), aroclor-1260 (up to 15.5 ppm), arsenic (up to 19.6 ppm), benzo(a)pyrene (up to 0.548 ppm), benzo(b)fluoranthene (up to 1.0 ppm), cadmium (up to 164 ppm), chromium (up to 777 ppm), 4,4-DDT(up to 20.0 ppm), dibenz(a,h)anthracene (up to 0.237 ppm), heptachlor (0.35 ppm), heptachlor epoxide (0.35 ppm), iron (up to 42,900 ppm), and lead (up to 601 ppm) were detected above CVs in surface soil. The majority of detections were south of Child Street (not in samples collected north of Child Street). In subsurface soil, aroclor-1260 (2.1 ppm) and trichloroethene (2.0 ppm) were detected above CVs. There are no CVs for gross alpha (up to 11.0 pCi/g), gross beta (up to 10.0 pCi/g), and TPH (24,000 ppm). **Surface Water:** Antimony (up to 24.1 ppb), arsenic (up to 23.9 ppb), benzene (up to 11.0 ppb), cadmium (up to 4.5 ppb), gross alpha (up to 27.9 ppb), iron (up to 35,100 ppb), methylene chloride (11.0 ppb), thallium (1.5 ppb), thorium-234 (up to 209 ppb), trichloroethene (up to 37.0 ppb), and vinyl chloride (up to 8.0 ppb) were detected above CVs. There is no surface water CV for TPH (up to 21.2 ppb). The RI/FS addendum sampled surface water for VOCs and SVOCs; benzene (12.0 ppb) and vinyl chloride (2.0 ppb) were detected above CVs. In 2002, TtNUS resampled OU1 surface water in the unnamed tributary. No VOCs exceeded CVs.
OU2	**Groundwater:** During past investigations at OU2, arsenic (51.0 ppb), barium (819 ppb), benzene (3.8 ppb), beryllium (23.0 ppb), bis(2-ethylhexyl)phthalate (120 ppb), cadmium (40.0 ppb), chromium (300 ppb), cyanide (280 ppb), dichloromethane (1,250 ppb), lead (103 ppb), manganese (520 ppb), mercury (14.0 ppb), nickel (5,400 ppb), p-cresol (427 ppb), silver (72.0 ppb), trichloroethene (45.0 ppb), vanadium (440 ppb), and vinyl chloride (5.0 ppb) were detected above CVs. During RI/FS activities, aluminum (up to 449,000 ppb), antimony (up to 30.7 ppb), arsenic (up to 28.0 ppb), barium (up to 2,180 ppb), benzene (up to 69.0 ppb), bis(2-ethylhexyl)phthalate (8.0 ppb), cadmium (up to 24.0 ppb), chromium (up to 445 ppb), iron (up to 160,000 ppb), lead (up to 118 ppb), manganese (up to 780 ppb), methylene chloride (up to 9.5 ppb), nickel (up to 147 ppb), thallium (up to 5.0 ppb), and vanadium (up

Site	***Data Analysis of Environmental Monitoring Results***
	to 580 ppb) were detected above CVs. Sediment: During RI/FS activities, antimony (29.8 ppm), arsenic (up to 7.2 ppm), benzo(a)pyrene (0.37 ppm), cadmium (up to 711 ppm), lead (up to 1,590 ppm), nickel (up to 1,270 ppm), and silver (up to 329 ppm) were detected above CVs. There is no soil CV for chloromethane (0.031 ppm). **Sludge:** The RI/FS evaluated sludge piles at PSC 4. Antimony (up to 76.0 ppm), arsenic (up to 3.7 ppm), benzo(a)pyrene (up to 0.28 ppm), cadmium (up to 189 ppm), chromium (up to 6,320 ppm), iron (up to 43,700 ppm), lead (up to 856 ppm), and mercury (up to 231 ppm) were detected above CVs. **Soil:** Past investigations did not indicate the presence of hazardous waste. In the RI/FS site-wide evaluation of soil, antimony (up to 70.1 ppm), arsenic (up to 61.1 ppm), benzo(a)pyrene (1.2 ppm), cadmium (up to 134 ppm), chromium (up to 5,310 ppm), dieldrin (up to 0.14 ppm), indeno(1,2,3-cd)pyrene (0.99 ppm), and lead (up to 1,060 ppm) were detected above CVs. In subsurface soil, arsenic (0.85 ppm) was detected above the CV. In addition, the RI/FS combined its evaluation of different depths (surface and subsurface) of soil at PSC 43. Arsenic (up to 0.94 ppm), cadmium (up to 223 ppm), chromium (up to 47,700 ppm), lead (up to 1,220 ppm), manganese (up to 4,650 ppm), and nickel (up to 1,540 ppm) were detected above CVs. There is no CV for 4-methyl-2-pentanone (0.55 ppm). **Surface Water:** Arsenic (up to 13.6 ppb), barium (up to 862 ppb), benzene (4.0 ppb), cadmium (4.4 ppb), iron (up to 95,900 ppb), lead (up to 76.4 ppb), manganese (up to 523 ppb), and vanadium (up to 77.8 ppb) were detected above CVs.
OU3	**Groundwater:** As presented in the RI/FS, previous sampling results are combined for the areas of interest; these include Areas A through G and areas outside of A through G. *Area A:* Benzene (1.5 ppb), total 1,2-dichloroethene (up to 6,200 ppb), 1,1,2-trichloroethane (up to 9.3 ppb), trichloroethene (up to 31,000 ppb), and vinyl chloride (up to 1,600 ppb) were detected above CVs. *Area B:* Chloromethane (up to 14.0 ppb), tetrachloroethene (40.0 ppb), 1,1,2-trichloroethane (2.0 ppb), and trichloroethene (up to 9,800 ppb) were detected above CVs. *Area C:* Methylene chloride (27.0 ppb) and trichloroethene (up to 5,000 ppb) were detected above CVs. *Area D:* Arsenic (up to 23.0 ppb), bromoform (8.8 ppb), iron (up to 32,300 ppb), manganese (up to 662 ppb), methylene chloride (up to 11.3 ppb), tetrachloroethene (up to 34.0 ppb), total 1,2-dichloroethene (up to 190 ppb), and trichloroethene (up to 6,800 ppb) were detected above CVs. *Area E:* Tetrachloroethene (up to 16,000 ppb), total 1,2-dichloroethene (up to 610 ppb), 1,1,2-trichloroethane (0.95 ppb), trichloroethene (up to 670 ppb), and vinyl chloride (up to 43.0 ppb) were detected above CVs. *Area F:* 1,1-dichloroethene (up to 270 ppb), total 1,2-dichloroethene (up to 61.0 ppb), 1,1,2-trichloroethane (up to 6.5 ppb), trichloroethene (up to 27,000 ppb), and vinyl chloride (up to 3.4 ppb) were detected above CVs. *Area G:* Arsenic (4.9 ppb), benzene (1.1 ppb), 1,1-dichloroethene (up to 760 ppb), total 1,2-dichloroethene (up to 1,600 ppb), 1,1,1-trichloroethane (up to 570 ppb), 1,1,2-trichloroethane (5.1 ppb), trichloroethene (up to 3,800 ppb), and vinyl chloride (up to 66.0 ppb) were detected above CVs. *Areas Outside of A through G:* Benzene (up to 64.0 ppb), chloromethane (up to 30.0 ppb), 1,2-dichloroethane (1.0 ppb), cis-1,2-dichloroethene (up to 1,300 ppb), methylene chloride (up to 35.0 ppb), 1,1,2-trichloroethane (1.0 ppb), trans-1,2-dichloroethene (up to 520 ppb), and trichloroethene (up to 580 ppb) were detected above CVs. **Sediment:** Out of the contractors' samples, BEI detected the highest contaminant concentrations in sediment removed from the storm sewer in 1999. Arsenic (up to 4.0 ppm), cadmium (69.0 ppm), chromium (410 ppm), and lead (2,500 ppm) were detected above CVs. B&R detected benzo(a)pyrene (0.3 ppm) above

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	its CV in St. Johns River sediment. Samples collected from the St. Johns River for the RI/FS detected arsenic (up to 12.9 ppm), benzo(a)anthracene (up to 1.8 ppm), benzo(a)pyrene (up to 3.0 ppm), benzo(b)fluoranthene (up to 2.3 ppm), dibenz(a,h)anthracene (up to 0.74 ppm), indeno(1,2,3-cd)pyrene (up to 1.6 ppm), and iron (up to 23,950) above CVs. **Soil:** Arsenic (up to 200 ppm) was the only contaminant detected above its CV in all soil samples collected on and off site. **Surface Water:** Thallium (up to 10.9 ppb) was the only contaminant detected above its CV in samples collected from the St. Johns River. In the storm sewer, bromodichloromethane (3.0 ppb), methylene chloride (up to 8.0 ppb), total 1,2-dichloroethene (up to 98.0 ppb), trichloroethene (up to 170 ppb), and vinyl chloride (up to 13.0 ppb) were detected above CVs.
OU4	**Groundwater:** Aluminum (up to 25,700 ppb), arsenic (up to 24.8 ppb), chromium (up to 37.9 ppb), iron (up to 61,800 ppb), and vanadium (up to 38.6 ppb) were detected above CVs. **Sediment:** In 1993, arsenic (up to 91 ppm), benzo(a)anthracene (0.88 ppm), benzo(a)pyrene (0.79 ppm), benzo(b)fluoranthene (up to 1.3 ppm), iron (up to 55,200 ppm), and lead (up to 691 ppm) were detected above CVs. In the 1997 RI, arsenic (up to 208 ppm), benzo(a)anthracene (up to 1.2 ppm), benzo(a)pyrene (up to 1.5 ppm), benzo(b)fluoranthene (up to 1.9 ppm), indeno(1,2,3-cd)pyrene (up to 0.97 ppm), iron (up to 63,300 ppm), and lead (up to 481 ppm) were detected above CVs. **Soil:** Arsenic (up to 3.2 ppm) and benzo(a)pyrene (0.12 ppm) were detected above CVs. **Surface Water:** No contaminants were detected above CVs in 1993, 1997, or 1998. **Fish:** Even though a person is most likely to consume a fish filet than other parts of a fish, ATSDR analyzed fish filet, liver/gonad, and carcass samples collected in 1993. For fish filet samples, alpha-chlordane (up to 0.013 ppm), aroclor-1254 (up to 0.39 ppm), 4,4'-DDE (up to 0.12 ppm), and 4-methylphenol (14 ppm) were detected above CVs. For fish liver/gonad samples, aroclor-1254 (up to 2.8 ppm), 4,4'-DDD (0.03 ppm), and 4,4'-DDE (up to 0.85 ppm) were detected above CVs. For fish carcass samples, alpha-chlordane (up to 0.03 ppm), aroclor-1254 (up to 0.59 ppm), 4,4'-DDD (up to 0.023 ppm), and 4,4'-DDE (up to 0.2 ppm) were detected above CVs. Because there are no CVs for lead in fish, ATSDR calculated doses based on the lead concentrations detected. The highest concentration of lead (0.00091 ppm) was detected in the fish liver/gonad. The highest estimated dose would be for a child (0.000000888 mg/kg/day), which is significantly less than the lowest no-observed-adverse-effect-level (NOAEL) of 0.57 mg/kg/day. ATSDR evaluated filet and whole fish samples collected during the 1997 RI. For fish filet, aroclor-1260 (up to 0.248 ppm), 4,4'-DDE (up to 0.044 ppm), and mercury (0.142 ppm) were detected above CVs. For whole fish samples, aldrin (0.007 ppm), alpha-BHC (0.0019 ppm), aroclor-1260 (up to 0.585 ppm), arsenic (up to 0.953 ppm), 4,4'-DDE (up to 0.306 ppm), and thallium (up to 1.19 ppm) were detected above CVs.
OU5	**Groundwater:** In 1997, HLA detected antimony (5.1 ppb), arsenic (7.2 ppb), benzene (up to 240 ppb), toluene (up to 280 ppb), total 1,2-dichloroethene (up to 120 ppb), trichloroethene (up to 23.0 ppb), and vinyl chloride (up to 18.0 ppb) above CVs. Samples in 1998 detected radium-226 and thorium-230 (both up to 72.9 picocuries per liter [pCi/L]), as well as benzene (2.2 ppb) above CVs. Groundwater samples from 1999 detected benzene (up to 120 ppb), cadmium (up to 2.9 ppb), 1,2-dichloroethene mix (up to 64.0 ppb), and vinyl chloride (up to 2.9 ppb) above CVs. Between 1999 and 2000, radium-226 (up to 6.62 pCi/L) was detected above its CV.

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	In 2001, monitor well samples found benzene (up to 27.8 ppb) and vinyl chloride (up to 2.3 ppb) above CVs. A 2001 summary (monitoring wells and DPT borings) detected benzene (up to 240 ppb), cis-1,2-dichloroethene (up to 110 ppb), naphthalene (up to 120 ppb), toluene (up to 470 ppb), trichloroethene (up to 78.0 ppb), and vinyl chloride (up to 37.3 ppb) above CVs. **Soil:** Samples collected by HLA in 1997 detected alpha-BHC (0.2 ppm), antimony (up to 32.3 ppm), arsenic (up to 4.2 ppm), benzo(a)anthracene (1.8 ppm), benzo(a)pyrene (1.1 ppm), benzo(b)fluoranthene (1.4 ppm), cadmium (up to 16.8 ppm), chromium (up to 573 ppm), copper (up to 5,210 ppm), dieldrin (up to 0.056 ppm), and lead (up to 1,030 ppm) above CVs in surface soil. In subsurface soil, arsenic (up to 5.1 ppm), benzo(a)anthracene (1.2 ppm), benzo(a)pyrene (0.29 ppm), carbon tetrachloride (89.0 ppm), and lead (up to 423 ppm) were detected above CVs. In 1997, BEI radiological readings identified radiation ranging from 0 to 109,835 curies per meter (cpm) at the FFTA and 0 to 70,797 cpm at the ODA. BEI compared these results to background (7,378 cpm) plus 4,750 cpm. Thus, BEI used a comparison measure of 12,128 cpm for OU5 to identify potentially contaminated areas; these radiological readings exceeded BEI's comparative measure. Following the excavations in 1998, BEI sampled the soil at the FFTA and ODA excavated areas; only arsenic (up to 17 ppm) at the ODA was detected above its CV. Samples from 1999 to 2002 detected arsenic (up to 4.3 ppm) above its CV at the ODA. At the FFTA, antimony (up to 46.7 ppm), arsenic (up to 6.1 ppm), cadmium (up to 24.0 ppm), chromium (up to 1,280 ppm), copper (up to 7,310 ppm), iron (up to 40,400 ppm), and lead (up to 1,190 ppm) were detected above CVs. **Sediment:** Samples collected by TtNUS in 1999 from the unnamed creek only identified 2-butanone (5.7 ppm), but at a level much lower than its CV. **Surface water:** During the excavation at the ODA, groundwater intruded into the excavated area, but no groundwater intruded into the FFTA area. As a result, BEI installed a shallow boring at the FFTA in order to measure radionuclides in "surface water" samples from both excavated areas. Radium-226 and thorium-230 were detected above CVs (both measured 46.9 pCi/L at the FFTA). Uranium-238 (164 pCi/L) was detected at the ODA excavation area above its CV. Samples collected by TtNUS (1999 and 2001) from the unnamed creek at PSC 51 detected 2-butanone (0.7 ppb), but below its CV.
OU6	**Groundwater:** Measured concentrations of DCE (up to 4,280 ppb) and TCE (8,710 ppb) were detected above CVs.
OU7	**Groundwater:** In 1997, aldrin (0.0021 ppb), antimony (11.2 ppb), arsenic (up to 5.9 ppb), and pentachlorophenol (2.0 ppb) were detected above CVs. In 2001, chloromethane (4.0 ppb), 1,2-dichloroethane (1.0 ppb), dieldrin (0.018 ppb), and vinyl chloride (1.0 ppb) were detected above CVs. Two deep monitoring wells were also sampled. Arsenic (3.4 ppb), gross alpha (up to 34.3 pCi/L), radium-226 (up to 9.4 pCi/L), total 1,2- dichloroethene (62.0 ppb), and vinyl chloride (1.0 ppb) were detected above CVs. **Soil:** In 1997, aluminum (up to 171,000 ppm), antimony (up to 22.9 ppm), aroclor-1260 (up to 2.4 ppm), arsenic (up to 15.5 ppm), benzo(a)pyrene (up to 0.87 ppm), benzo(b)fluoranthene (up to 2.0 ppm), cadmium (up to 156 ppm), chromium (up to 1,300 ppm), copper (up to 16,600 ppm), iron (up to 76,400 ppm), and lead (up to 4,840 ppm) were detected above CVs. During 2001 RI activities, grid-based, biased, and perimeter ditch soil samples were collected at OU7. In *grid-based samples*, antimony (up to 36.0 ppm), aroclor-1260 (up to 1.8 ppm), arsenic (up to 6.7 ppm), cadmium (up to 58.8 ppm), chromium (up to 287 ppm), copper (up to 22,500 ppm), and lead (up to 739 ppm) were detected above CVs. In *biased samples*, aluminum (up to 204,000 ppm), antimony (up to 42.6 ppm), aroclor-1260 (up to 1.3

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	ppm), arsenic (up to 55.6 ppm), beryllium (up to 1,347 ppm), cadmium (up to 254 ppm), chromium (up to 1,240 ppm), copper (up to 24,300 ppm), 4,4'-DDE (up to 3.1 ppm), dieldrin (up to 0.13 ppm), iron (up to 86,000 ppm), lead (up to 1,690 ppm), and nickel (up to 1,200 ppm) were detected above CVs. In *perimeter ditch samples*, aluminum (up to 152,000 ppm), antimony (up to 45.8 ppm), aroclor-1254 (up to 1.5 ppm), aroclor-1260 (up to 2.1 ppm), arsenic (up to 12.1 ppm), benzo(a)anthracene (up to 4.7 ppm), benzo(a)pyrene (up to 4.3 ppm), benzo(b)fluoranthene (up to 8.6 ppm), cadmium (up to 88.8 ppm), chromium (up to 971 ppm), copper (up to 172,000 ppm), dibenz(a,h)anthracene (up to 1.4 ppm), indeno(1,2,3-cd)pyrene (up to 2.8 ppm), iron (up to 52,800 ppm), and lead (up to 1,240 ppm) were detected above CVs. During radionuclide soil sampling, only radium-226 (up to 98.5 pCi/g) and total radium (up to 97.2 pCi/g) were detected above CVs. **Sediment (Perimeter Ditch):** In 1997, aluminum (up to 154,000 ppm), antimony (up to 41.3 ppm), aroclor-1260 (up to 2.9 ppm), arsenic (up to 21.0 ppm), benzo(a)anthracene (up to 120 ppm), benzo(a)pyrene (up to 120 ppm), benzo(b)fluoranthene (up to 210 ppm), benzo(k)fluoranthene (up to 220 ppm), beryllium (up to 1,390 ppm), cadmium (up to 82.7 ppm), carbazole (up to 34 ppm), chromium (up to 2,560 ppm), chrysene (up to 110 ppm), copper (up to 102,000 ppm), dibenz(a,h)anthracene (up to 7.3 ppm), indeno (1,2,3-cd)pyrene (up to 63.0 ppm), iron (up to 168,000 ppm), lead (up to 1,610 ppm), and nickel (up to 2,070 ppm) were detected above CVs. During 2001 RI activities, aroclor-1254 (up to 2.0 ppm), aroclor-1260 (up to 1.3 ppm), arsenic (up to 9.8 ppm), benzo(a)pyrene (up to 0.7 ppm), benzo(b)fluoranthene (up to 1.3 ppm), cadmium (up to 199 ppm), chromium (up to 206 ppm), dibenz(a,h)anthracene (up to 0.25 ppm), iron (up to 29,500 ppm), and lead (up to 694 ppm) were detected above CVs. **Surface Water (Perimeter Ditch):** In 1997, antimony (up to 6.0 ppb), arsenic (up to 3.9 ppb), cadmium (up to 9.4 ppb), and lead (up to 27.4 ppb) were detected above CVs. In 2001, alpha-BHC (up to 0.021 ppb), antimony (up to 35.4 ppb), arsenic (up to 41.6 ppb), cadmium (up to 207 ppb), chromium (up to 174 ppb), copper (up to 1,490 ppb), iron (up to 75,200 ppb), lead (up to 1,140 ppb), manganese (up to 1,820 ppb), nickel (up to 217 ppb), vanadium (up to 56.8 ppb), and zinc (up to 4,890 ppb) were detected above CVs. No radionuclides were detected above CVs.
OU8	**Groundwater:** Aldrin (0.68 ppb), alpha-BHC (3.2 ppb), alpha-chlordane (up to 11.0 ppb), antimony (up to 6.3 ppb), arsenic (up to 332 ppb), benzene (2.0 ppb), beta-BHC (3.8 ppb), 4,4'-DDD (up to 18.0 ppb), 4,4'-DDE (up to 2.5 ppb), 4,4'-DDT (up to 9.0 ppb), delta-BHC (up to 5.2 ppb), dieldrin (0.93 ppb), endrin (up to 3.4 ppb), gamma-BHC (up to 1.3 ppb), gamma-chlordane (up to 9.0 ppb), heptachlor (1.1 ppb), heptachlor epoxide (0.06 ppb), iron (up to 18,700 ppb), MCPA (2,000 ppb), MCPP (6,800 ppb), and nickel (up to 384 ppb) were detected above CVs. There is no CV for dichloroprop (up to 17.0 ppb). **Soil:** In 1996, alpha-chlordane (up to 2.2 ppm), arsenic (up to 24.6 ppm), 4,4'-DDE (up to 14.0 ppm), 4,4'-DDT (up to 70 ppm), dieldrin (up to 1.0 ppm), and gamma-chlordane (up to 3.3 ppm) were detected above CVs. In 1997, aldrin (up to 4.5 ppm), alpha-BHC (up to 61.0 ppm), alpha-chlordane (up to 280.0 ppm), antimony (up to 21.3 ppm), arsenic (up to 1,570 ppm), benzo(a)pyrene (up to 0.29 ppm), beta-BHC (up to 23.6 ppm), cadmium (up to 15.4 ppm), chromium (up to 463.0 ppm), copper (up to 4,990 ppm), 4,4'-DDD (up to 3,100 ppm), 4,4'-DDE (up to 410 ppm), 4,4'-DDT (up to 12,000 ppm), delta-BHC (up to 77.0 ppm), dieldrin (up to 77.0 ppm), endrin (up to 94.0 ppm), gamma-BHC (up to 0.65 ppm), gamma-chlordane (up to 310 ppm), heptachlor (up to 12.0 ppm), heptachlor epoxide (up to 4.2 ppm), iron (up to 25,300 ppm), lead (up to 2,820 ppm), MCPA (up to 4,600 ppm), MCPP (up to 320 ppm), and n-nitroso-di-n-propylamine (0.11 ppm) were detected above CVs. There are no CVs for 4-chloro-3-methylphenol (0.117 ppm), dichloroprop (0.33 ppm), and 4-nitrophenol (0.248 ppm).

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Additional PSCs at NAS Jacksonville	
PSC 5	**Groundwater:** No samples exceeded CVs in 1985. In 1997, arsenic (up to 18.0 ppb), delta-BHC (0.01 ppb), iron (up to 51,600 ppb), manganese (up to 893 ppb), and methylene chloride (27.0 ppb) were detected above CVs. **Soil:** Arsenic (up to 2.4 ppm) and benzo(a)pyrene (up to 0.16 ppm) were detected above CVs in surface soil. In subsurface soil, arsenic (0.92 ppm) was detected above its CV. There are no soil CVs for gross alpha (up to 23.51 pCi/g) and gross beta (up to 15.91 pCi/g).
PSC 8	**Sediment:** Arsenic (up to 7.4 ppm), benzo(a)pyrene (0.21 ppm), and iron (up to 25,900 ppm) were detected above CVs. **Surface Soil:** In 1996, arsenic (up to 2.6 ppm), dieldrin (0.067 ppm), and heptachlor epoxide (0.087 ppm) were detected above CVs. In 1997, arsenic (up to 7.0 ppm), benzo(a)pyrene (up to 1.5 ppm), benzo(b)fluoranthene (up to 2.9 ppm), dibenz(a,h)anthracene (0.15 ppm), and dieldrin (up to 0.18 ppm) were detected above CVs. **Subsurface Soil:** Only arsenic (1.8 ppm) was detected above its CV. **Surface Water:** Alpha-HCH (0.01 ppb), delta-BHC (up to 0.01 ppb), dieldrin (up to 0.01 ppb), iron (up to 11,100 ppb), and trichloroethene (10 ppb) were detected above CVs.
PSC 9	**Groundwater:** Methylene chloride (1.2 ppb), trans-1,2-dichloroethene (21 ppb), and trichloroethene (1.2 ppb) were detected, but no levels exceeded CVs.
PSC 10	**Groundwater:** No contaminants were detected. **Soil:** No contaminants were detected.
PSC 17	**Sediment:** Arsenic (up to 7.7 ppm), benzo(a)anthracene (up to 0.88 ppm), benzo(a)pyrene (up to 0.86 ppm), benzo(b)fluoranthene (up to 1.6 ppm), and iron (up to 37,400 ppm) were detected above CVs. Samples in 1995 detected radionuclides between 3.0 and 10.1 pCi/g. However, the specific radionuclides and concentrations were not identified. Since the sediments were generally 15 or more centimeters below surface water, the submerged action criterion level of 15 pCi/g was deemed appropriate. **Surface Water:** In the 1980s, one surface water sample was collected, but it did not detect metal concentrations that differed from background levels. However, in 1997, two contaminants detected in surface water—aroclor-1254 (up to 0.34 ppb) and delta-BHC (up to 0.0064)—were above CVs. **Biota:** Sediment toxicity tests were conducted on the ampelisca abdita—a shrimp-like amphipod that serves as food for many fish species. Amphipods are often used to indicate contamination because they have little mobility and are very prone to pollution (Grosse et al. 1986). Based on the survival rates of the amphipods, the investigators concluded that marine invertebrates at Mulberry Cove would not be adversely affected by contaminants in sediment.
PSC 18	**Groundwater:** A low level of gross alpha radioactivity was detected (0 ± 3 pCi/L), but at a level much lower than its CV. **Soil:** In 1982, measurements did not indicate detections that were significantly above background levels. In 1993, no contaminated areas were detected in the picnic area or between the disposal area and the picnic area. Although, many areas within the disposal area produced elevated radiological readings. The majority of shoreline was absent of radiological contamination, but some areas were found within a few feet of the shoreline. The potential contaminants of concern were radium and thorium, but sampling results were not

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	available.
PSC 20	**Soil:** Aldrin (0.17 ppm), aroclor-1260 (up to 3.5 ppm), arsenic (up to 4.7 ppm), benzo(a)anthracene (2.8 ppm), benzo(a)pyrene (up to 1.4 ppm), benzo(b)fluoranthene (2.2 ppm), and cadmium (13.2 ppm) were detected above CVs.
PSC 22	**Soil:** In 1995, lead (up to 2,520 ppm) was detected above its CV. In 1997, antimony (up to 21.2 ppm), arsenic (up to 2.9 ppm), and lead (up to 3,970 ppm) were detected above CVs.
PSC 23	**Groundwater:** No VOCs were detected in groundwater. Thirteen metals were detected, but all concentrations were detected below CVs. **Soil:** Antimony (41.9 ppm), arsenic (up to 0.84 ppm), benzo(a)pyrene (up to 0.12 ppm), and lead (up to 2,820 ppm) were detected above CVs.
PSC 25	**Soil:** Based on sampling and monitoring results, no "hot spots" of radiological contamination were detected.
PSC 28	**Groundwater:** In 1985, tetrachloroethene (4 ppb) was detected below its CV. In 1993, bis(2-ethylhexyl)phthalate (up to 2 ppb) and toluene (3 ppb) were detected, but not above CVs. **Soil:** In 1983 and 1986, PCBs (total composite of 103 ppm in 1983; up to 1.7 ppm in 1986) were detected above CVs. In 1996, aluminum (162,000 ppm), antimony (58.1 ppm), cadmium (28.6 ppm), chromium (1,800 ppm), copper (17,500 ppm), iron (58,500 ppm), and lead (2,160 ppm) were detected above CVs.
PSC 29	**Groundwater:** In 1985, chloromethane (3.4 ppb) was detected above its CV. In 1997, arsenic (up to 14.2 ppb), iron (up to 21,000 ppb), and manganese (up to 1,520 ppb) were detected above CVs. **Soil:** Arsenic (up to 19.9 ppm), benzo(a)anthracene (up to 1.2 ppm), benzo(a)pyrene (up to 1.3 ppm), benzo(b)fluoranthene (up to 2.7 ppm), and dibenz(a,h)anthracene (up to 0.21 ppm) were detected above CVs.
PSC 30	**Groundwater:** Bis(2-chloroethyl)ether (54 ppb) was detected above its CV. In 1986, trichloroethene (7 ppb) was detected above its CV. **Soil:** Copper (0.020 ppm) and zinc (0.030 ppm) were detected, but at levels significantly lower than their CVs. Based on Extraction Procedure Toxicity (EP Tox) Tests, cadmium was the only contaminant detected at levels characteristic of hazardous waste. In 1986, soils collected in the excavated area detected cadmium (up to 1.18 ppm) slightly above the EP Toxicity threshold of 1.0 ppm.
PSC 31	**Soil:** Aroclor-1260 (up to 1.3 ppm), arsenic (2.8 ppm), benzo(a)anthracene (0.92 ppm), benzo(a)pyrene (up to 0.87 ppm), benzo(b)fuoranthene (2.0 ppm), chromium (up to 277 ppm), and dieldrin (up to 0.08 ppm) were detected above CVs. There is no CV for 4-chloro-3-methylphenol (0.046 ppm).
PSC 32	**Groundwater:** In 1985, methylene chloride (2.6 ppb) was the only VOC detected, but at a level below its CV. In 1997, arsenic (up to 7.8 ppb) and manganese (up to 626 ppb) were detected above CVs. **Soil:** Aroclor-1260 (up to 3.3 ppm) and benzo(a)pyrene (up to 0.18 ppm) were the only contaminants detected above CVs in both surface and subsurface soil.

Site	*Data Analysis of Environmental Monitoring Results*
PSC 34	No hazardous wastes are present at PSC 34 (ABB-ES 1995a).
PSC 35	**Soil:** Aroclor-1260 (up to 0.45 ppm), arsenic (0.75 ppm), bis(2-ethylhexyl)phthalate (46 ppm), and cadmium (50.1 ppm) were detected above CVs.
PSC 36	**Groundwater:** In 1986, chloroform was detected (1.6 ppb), but at a level significantly lower than its CV. No contaminants were detected in 1991. **Soil:** In 1991, no contaminants were detected. In 1993, arsenic (up to 1.4 ppm) was detected above its CV. **Surface Water:** No contaminants were detected.
PSC 37	**Sediment:** Arsenic (up to 11.2 ppm), benzo(a)pyrene (0.31 ppm), benzo(e)pyrene (0.28 ppm), iron (up to 32,700 ppm), perylene (0.31 ppm), and thallium (6.3 ppm) were detected above CVs. There is no CV for 1-methylphenanthrene (0.057 ppm). ATSDR compared it to the PAH NOAEL; it was below the NOAEL. **Biota:** No significant differences in average reburial or survival rates were reported in the amphipod from exposure to sediment at PSC 37.
PSC 38	**Groundwater:** Arsenic (up to 4.0 ppb), iron (up to 50,300 ppb), total 1,2-dichloroethene (73 ppb), trichloroethene (24 ppb), and vinyl chloride (57 ppb) were detected above CVs. **Soil:** Arsenic (up to 3 ppm), barium (up to 4,350 ppm), cadmium (29.4 ppm), chromium (up to 21,000 ppm), iron (up to 41,400 ppm), lead (up to 3,650 ppm), and zinc (up to 39,700 ppm) were detected above CVs in surface soil. No contaminants were above CVs in subsurface soil. **Sediment:** No contaminants were detected above CVs. **Surface Water:** No contaminants were detected above CVs.
PSC 39	**Soil:** Arsenic (up to 3.3 ppm) and benzo(a)pyrene (up to 0.27 ppm) were above CVs. PCBs were detected below CVs. Aroclor-1254 (0.36 ppm) was the only PCB detected in 1997, but at a level below its CV.
PSC 40	**Sediment:** The radiological survey detected radium-226 from 0.297 to 0.401 pCi/g, which was much less than NAS Jacksonville's action level of 5.4 pCi/g. Arsenic (up to 10.5 ppm), benzo(a)anthracene (0.96 ppm), benzo(a)pyrene (up to 0.85 ppm), benzo(b)fluoranthene (up to 0.99 ppm), dibenz(a,h)anthracene (0.58 ppm), and iron (up to 36,100 ppm) were detected above CVs. **Biota:** No significant differences in average survival and reburial rates were reported.
PSC 44	**Sediment:** Arsenic (1.7 ppm), benzo(a)anthracene (up to 10.0 ppm), benzo(a)pyrene (up to 8.5 ppm), benzo(b)fluoranthene (up to 14.0 ppm), benzo(k)fluoranthene (up to 16.0 ppm), and indeno(1,2,3-cd)pyrene (up to 2.8 ppm) were detected above CVs.
PSC 45	To date, there are no sufficient data to identify the presence of contaminants at PSC 45 (NAS JAX Consolidated Guide to Contaminated Sites).
PSC 49	**Soil:** Copper (6.6 ppm), lead (up to 38.8 ppm), and nickel (1.1 ppm) were detected at levels much lower than CVs.
PSC 50	**Groundwater:** Prior to the 1997 site screening, arsenic (9.8 ppb), chromium (177 ppb), and lead (73.5 ppb) were detected above CVs.

Site	***Data Analysis of Environmental Monitoring Results***
	In 1997, aldrin (0.0022 ppb), antimony (5 ppb), arsenic (5.1 ppb), and iron (up to 14,900 ppb) were detected above CVs. **Soil:** Aroclor-1260 (up to 5.8 ppm), arsenic (up to 1.9 ppm), cadmium (up to 67.3 ppm), chromium (up to 535 ppm), dieldrin (up to 0.18 ppm), lead (up to 420 ppm), and silver (up to 470 ppm) were detected above CVs.

Appendix C: Comparison Values

ATSDR health assessors use comparison values (CVs) to screen environmental data that are relevant to the exposure pathways. In general, to be conservative and protective of public health, ATSDR's CVs are based on contaminant concentrations that are several times lower than levels at which **no health effects have been observed** for a given chemical (based on standard assumptions for daily contact rate and body weight of adults and children). ATSDR developed CVs for each different media based on experimental animal studies and human epidemiologic studies that have thoroughly investigated exposure to various contaminants and health effects associated with each contaminant. ATSDR uses the **maximum concentration** of a contaminant to compare to the CV. Therefore, when the maximum contaminant concentration is below the CV, ATSDR concludes that no further data review is necessary. ATSDR uses these CVs to select contaminants for further evaluation in order to determine the possibility of adverse health effects.

However, if a contaminant concentration exceeds the CV, ATSDR conducts more analysis on that contaminant, including further evaluation of the toxicology of the contaminant, exposure variables (for example, concentration or duration), weight-of-evidence of potential health effects, and additional epidemiological studies. In addition, when contaminants do not have CVs, ATSDR uses surrogate CVs when appropriate. Surrogate CVs consist of contaminants that have similar chemical or radiological properties as the subject contaminant or properties that are even more toxic.

More information about the ATSDR evaluation process can be found in ATSDR's Public Health Assessment Guidance Manual at http://www.atsdr.cdc.gov/HAC/HAGM/ or by contacting ATSDR at 1-888-42-ATSDR. An interactive program that provides an overview of the public health assessment process ATSDR uses to evaluate whether people will be harmed by hazardous materials is available at: http://www.atsdr.cdc.gov/training/public-health-assessment-overview/html/index.html.

ATSDR uses a number of different CVs to determine if a contaminant requires further evaluation or if a contaminant is present at levels that are too low to cause harm (and therefore, do not require additional study). The CVs used in this public health assessment are described below.

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 potency factors.

Environmental Media Evaluation Guide (EMEG):

A media-specific comparison value that is used to select contaminants of concern. Levels below the EMEG are not expected to cause adverse noncarcinogenic health effects.

Lifetime Health Advisory (LTHA):

The concentration of a chemical in drinking water that is not expected to cause any adverse noncarcinogenic health effects for a lifetime of exposure.

Maximum Contaminant Level (MCL):

Enforceable drinking water regulation that is protective of public health over a lifetime at an exposure rate of 2 liters of water per day.

Risk-based Concentration (RBC):

A contaminant concentration that is not expected to cause adverse health effects over long-term exposure.

Reference Dose Media Evaluation Guide (RMEG):

Lifetime exposure level at which adverse, noncarcinogenic health effects would not be expected to occur.

Soil Screening Level (SSL):

Estimate of a contaminant concentration that would not be expected to cause noncancerous health effects over a specified duration of exposure or to cause less than one excess cancer in a million (10^{-6}) persons exposed over a 70-year life span.

Appendix D: Dose Calculation Formulas for Surface Soil and Fish

Dose Calculation Formula for Ingestion of Surface Soil

To calculate a potential dose for surface soil, ATSDR followed EPA's guidelines as presented in *EPA's 1997 Exposure Factors Handbook*. The handbook is accessible at http://www.epa.gov/ncea/exposfac.htm. ATSDR used EPA's dose formula as presented below:

ATSDR used the following parameters

$$\text{Dose} = \frac{\text{Concentration} \times \text{Ingestion Rate} \times \text{Exposure Frequency} \times \text{Exposure Duration}}{\text{Body Weight} \times \text{Average Time}}$$

Where:

- Concentration of contaminant: average concentration detected during sampling
- Ingestion rate: adult = 100 milligrams/day (mg/day), child = 200 mg/day (standard ATSDR assumptions)
- Exposure frequency: 100 days/year
- Exposure duration: adult = 50 years, child = 70 years (it is extremely conservative to estimate lifetime exposure because residents only live at the station for approximately 3 years; however, non-residents could also be exposed to these areas)
- Body weight: adult = 70 kilograms (kg), child = 10 kg (represents an infant to 1-year-old)
- Averaging time (AT): the time period over which cumulative exposures are averaged (expressed in days). For noncancer, AT = ED * 365 days/year, for cancer AT = 70 years * 365 days/year

Dose Calculation Formula for Fish Consumption

To calculate a potential dose for fish, ATSDR followed EPA's guidelines as presented in *EPA's 1997 Exposure Factors Handbook*. The handbook is accessible at http://www.epa.gov/ncea/exposfac.htm. ATSDR used EPA's dose formula as presented below:

$$\text{Dose} = \frac{\text{Concentration} \times \text{Ingestion Rate} \times \text{Exposure Frequency} \times \text{Exposure Duration}}{\text{Body Weight} \times \text{Average Time}}$$

Where:

- Concentration of contaminant: average concentration detected during sampling
- Ingestion rate: adult = 227 grams/day (g/day) or 8 ounces, child = 114 g/day or 4 ounces (child is likely to consume less fish than an adult)
- Exposure frequency: 50 days/year
- Exposure duration: adult = 50 years, child = 70 years (it is extremely conservative to estimate lifetime exposure because residents only live at the station for approximately 3 years; however, people who do not live at NAS Jacksonville also fish in these water bodies)
- Body weight: adult = 70 kilograms (kg), child = 16 kg (represents an older child because infants are not expected to eat fish)
- Averaging time: the time period over which cumulative exposures are averaged (expressed in days). For noncancer, AT = ED * 365 days/year, for cancer AT = 70 years * 365 days/year