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FINAL REMEDIAL INVESTIGATION REPORT VOLUME I OF III SITE 40 NAS PENSACOLA FL
1/20/1999
ENSAFE/ALLEN AND HOSHALL

FINAL REMEDIAL INVESTIGATION REPORT
SITE 40
NAVAL AIR STATION
PENSACOLA, FLORIDA

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Volume I of III
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Naval Air Station Pensacola, Florida

Prepared by:

EnSafe Inc.
5724 Summer Trees Drive
Memphis, Tennessee 38134
(901) 372-7962

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Caldwell, Brian E., (P.G. #1330, Florida [Exp. Date July 31, 2000]), Allison L. Harris

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19. Abstract

Site 40 represents about 8.5 miles of Bayou Grande coastline receiving storm water and groundwater discharge from NAS Pensacola. The investigation was performed in phases to better focus costly analytical sampling. Phase I identified areas of high TOC and low grain size where contaminants are more likely to accumulate. Phase II sampled at 143 locations in accordance with the site work plan and SAP to assess the nature and extent of contaminants. Metals, pesticides/PCBs, and SVOCs were detected across Bayou Grande. In Phase IIB/III, 10 locations were sampled to assess a range (i.e., low, medium, high) of contaminant levels as identified in Phase IIA. The samples were submitted for chemical analysis, toxicological tests, and benthic community analysis. In addition, prey fish were sampled for chemical analysis at one location.

Inorganic detections occurred across AZ-1 and do not appear to be related to NAS Pensacola IRP sites or activities associated with Forrest Sherman Field. Pesticides were generally not detected in AZ-1. PCBs were detected frequently. Few SVOC parameters and only one VOC were detected in AZ-1. Few contaminant source areas were identified for this AZ. Most of the detected concentrations at AZ-2 and exceedances of the applicable ecological screening criteria are in the upper reaches of Redoubt Bayou. This area of Redoubt Bayou receives surface and storm water from two significant drainage sources (1) Wetland W-2 and (2) Wetland 19B. Wetland W-2 is the major storm water conduit from the eastern portion of Forrest Sherman Field, to include aircraft parking areas and hangars on the eastern end of the airfield. W-2 also receives surface and storm water coming from the Barrancas Cemetery area, and the Public Works Center area. The exceedances for metals in AZ 3 were mostly distributed between three samples (Z302, Z319, and Z323). PCBs were evenly distributed within the sample population for AZ-3, but were mostly detected below applicable ecological screening criteria. Pesticide and SVOC detections were focused at the discharge points for Wetlands 4D and 65, and at the south landing for the bridge leading to NAS Pensacola. Wetlands 4D and 65 are conduits for surface and storm water from the NAS golf course. Golf course maintenance vehicles and pesticide application throughout the golf course would account for the pesticide and SVOC distributions off shore from Wetlands 4D and 65. Vehicle traffic and storm water runoff from the bridge would account for the SVOC detections from sample locations adjacent the southern bridge landing at the base. In AZ 4, most SSV exceedances were distributed within the middle to lower reaches of Woolsey Bayou which is a small arm of Bayou Grande west of the Yacht Basin, between the Yacht Basin and the main bridge leading to NAS Pensacola. This area of AZ-4 receives minor storm water runoff from the easternmost fairway of the NAS golf course, and from Murray Road. A single storm water outfall draining the northeast portion of the base also discharges into Woolsey Bayou. However, no IRP sites are near Woolsey Bayou.

Detections tend to be more frequent in the small southern depositional area within Redoubt Bayou (AZ-2), along the eastern edge of Redoubt (AZ-2), at the point of entry for wetland 4 (AZ-3), and within the smaller estuarine areas near Magazine Point (AZ-4). Landform distribution (e.g. several prominences indicative of early spit development) suggest that current movement and overall sediment load shift is dynamic within the Bayou. Movement is generally from the west to the east, towards the mouth of the Bayou and its entry into the Pensacola Bay.

The screening-level risk assessment (Phase IIA) indicated a potential risk to ecological receptors in Bayou Grande. However, results of the sediment quality triad performed during Phase IIB/III do not support additional action. Toxicity tests showed no effects to benthic species from exposure to Site 40 sediments. Although perturbations were observed in benthic community populations between stations, no effects were predicted or shown from the other two components of the sediment quality triad. Therefore, it is difficult to account for the differences in species diversity, but natural variability or physicochemical effects may be the cause. The occurrences of spoon worms, fanworms, and nannasticidea at 40-07, 40-04, and 40-06 are indicators of a healthy environment as are the fresh water clams (*polymedsoda*) at 40-04. Furthermore, contaminant concentrations in surface water did not indicate acute or chronic impacts to fish. Tissue concentrations from the composite fish samples were not at levels predicted to pose a risk to fish-eating birds. Concentrations did predict a risk to upper trophic level fish based on the model performed. One contributor to the excess was DDE. All the Site 40 detected concentrations of DDE are below its background concentration of 40 ppb indicating DDE's widespread occurrence in the PBS. Since measurement endpoints are not impacted, the assessment endpoints are not expected to be impacted either. Therefore, no ecological risk is predicted within Bayou Grande.

The only exposure pathways validated for human health risk are incidental ingestion of surface water and consumption of seafood collected from the site. Surface water data were summarized and screened against risk-based surface water PRGs and Federal AWQCs. Except for arsenic, no other chemical exceeded either screening value. Arsenic was reported in surface water at a concentration above its Federal AWQC. It was not subsequently identified as a COC based on the risk-based evaluation of fish tissue data. Whole-body tissue data from prey species and calculated tissue data from predatory fish suggest a risk to humans greater than Florida's acceptable risk level of 10^{-6}, mainly from organochlorine pesticide and PCB concentrations in a subsistence fisher scenario which assumes a daily consumption rate of 54 grams per day for the entire year (350 days per year). However, other risk management factors (i.e., type of contaminants, concentrations observed in the Pensacola Bay System, home range of the game fish, and realistic fishing frequencies) should be considered in assessing the excess risk. Based on the distribution of the contamination, the lack of toxicity, indicators of a healthy environment from the community analyses, the Navy is recommending no further action for Site 40.

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List of Abbreviations

%D	Percent difference
%R	Percent recovery
μg/kg	Microgram per kilogram
AL	Action level
AZ	Assessment zone
BCF	Bioconcentration factor
BEHP	Bis(2-ethylhexyl)phthalate
BRA	Baseline risk assessment
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CEC	Cation exchange capacity
CLEAN	Comprehensive Long-term Environmental Action Navy
CLP	Contract Laboratory Program
COC	Chain of custody
COPC	Chemical of potential concern
CPSS	Chemical present in site samples
CR III	Trivalent chromium
CR IV	Hexavalent chromium
CRQL	Contract required quantitation limit
CSAP	Comprehensive sampling and analysis plan
CSS	Contaminant source survey
CSV	Chemical-specific value
CT	Central tendency
C_w	Chemical concentration in groundwater
DCB	Decachlorobiphenyl
DI	Deionized
DMAA	Dimethyl Arsonic Acid
E/A&H	EnSafe/Allen & Hoshall, Inc.
E&E	Ecology and Environment, Inc.
ERA	Ecological Risk Assessment
EPTOX	Extraction procedure for toxicity
FB	Field blank
FDEP	Florida Department of Environmental Protection
FFA	Federal Facilities Agreement
FNAI	Florida Natural Areas Inventory
f_{oc}	Organic Carbon Fraction
FS	Feasibility Study
GC/MS	Gas Chromatograph/Mass Spectrometer
GFAA	Graphite Furnace Atomic Absorption
GPS	Global Positioning System
HQ	Hazard Quotient
ICW	Intracoastal waterway

ICP	Inductive Coupled Plasma
ICSA	Interference Check Sample
IDL	Instrument detection limit
IRP	Installation Restoration Program
IS	Internal Standard
IWTP	Industrial Wastewater Treatment Plant (now a sanitary plant)
J	The compound was positively detected, however, the reported concentration is considered to approximate the concentration within the sample
K_d	Density constant
K_{oc}	Organic carbon constant
LCS	Laboratory Control Sample
MAA	Methyl Arsonic Acid
MATC	Maximum acceptable toxicant value
mg/kg	Milligrams per kilogram
MS/MSD	Matrix Spike/Matrix Spike Duplicate
msl	Mean sea level
NACIP	Navy assessment and control of installation pollutants
NAS	Naval Air Station
NFESC	Naval Facilities Engineering Service Center
NOAEL	No observed adverse effects level
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
OU	Operable unit
PAH	Polycyclic aromatic hydrocarbon
PBS	Pensacola Bay system
PCBs	Polychlorinated biphenyls
PDE	Potential Dietary Exposure
PEL	Probable effects level
PRG	Preliminary remediation goal
QA/QC	Quality Assurance/Quality Control
R	The sample results are rejected due to serious deficiencies in the laboratory's ability to analyze the sample and meet QC criteria. The presence or absence of the compound cannot be verified
RAGS	Risk Assessment Guidance for Superfund
RC	Reference concentration
R_f	Retardation factor
redox	Oxidation reduction
RfD	Reference dose
RGO	Remedial goal options
RI	Remedial investigation
ROD	Record of Decision
RPD	Relative Percent Difference
RRFs	Relative response factors

SAP	Sampling and analysis plan
SDG	Sample delivery group
SF	Cancer slope factor
SMP	Site management plan
SOP/QAM	Standard Operating Procedures and Quality Assurance Manual
SOUTHNAVFACENGCOM	Southern Division Naval Facilities Engineering Command
SOW	State of Work
SQAG	Sediment quality assessment guidelines
SSV	Sediment screening value
SVOCs	Semivolatile organic compounds
TA	Target Area
TAL	Target analyte list
TCL	Target compound list
TEL	Threshold Effect Level
TOC	Total Organic Carbon
USCS	Unified Soil Classification System
UJ	The compound was not detected above the reported sample quantitation limit. However, the reported quantitation limit is an approximate and may or may not represent the actual limit of quantitation necessary to accurately and precisely measure the compound in the sample
UR	The compound was not detected above the reported sample quantitation limit. However, the sample results are rejected due to serious deficiencies in the laboratory's ability to analyze the sample and meet QC criteria. The presence or absence of the compound cannot be verified.
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
UST	Underground Storage Tank
VOCs	Volatile organic compounds

EXECUTIVE SUMMARY

Site 40 represents about 8.5 miles of Bayou Grande coastline receiving storm water and groundwater discharge from NAS Pensacola. The investigation was performed in phases to better focus costly analytical sampling. Phase I identified areas of high TOC and low grain size where contaminants are more likely to accumulate. Phase II sampled at 143 locations in accordance with the site work plan and SAP to assess the nature and extent of contaminants. Metals, pesticides/PCBs, and SVOCs were detected across Bayou Grande. In Phase IIB/III, 10 locations were sampled to assess a range (i.e., low, medium, high) of contaminant levels as identified in Phase IIA. The samples were submitted for chemical analysis, toxicological tests, and benthic community analysis. In addition, prey fish were sampled for chemical analysis at one location.

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There are general trends in which contaminant detections are higher near the previously noted prominences (likely depositional areas) and in samples further from shore (likely to be associated with finer grained, higher TOC sediments). Additionally, detections tend to be more frequent in the small southern depositional area within Redoubt Bayou (AZ-2), along the eastern edge of Redoubt (AZ-2), at the point of entry for wetland 4 (AZ-3), and within the smaller estuarine areas near Magazine Point (AZ-4). Landform distribution (e.g. several prominences indicative of early spit development) suggest that current movement and overall sediment load shift is dynamic within the Bayou. Movement is generally from the west to the east, towards the mouth of the Bayou and its entry into the Pensacola Bay.

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Based on the distribution of the contamination, the lack of toxicity, indicators of a healthy environment from the community analyses, the Navy, is recommending no further action for Site 40.

1.0 INTRODUCTION

Under the authority of the U.S. Navy Comprehensive Long-Term Environmental Action Navy (CLEAN) program, EnSafe, Inc., completed a Remedial Investigation (RI) for Site 40, Bayou Grande, at Naval Air Station (NAS) Pensacola. This site is listed in the Site Management Plan (SMP) of the Installation Restoration Program (IRP) for NAS Pensacola (U.S. Dept. Navy, 1997). Site 40 includes the southern portion of Bayou Grande which lies adjacent to NAS Pensacola. It extends from the western boundary of the base, near Jones Creek, to the northern extent of Magazine Point, where Bayou Grande connects with Pensacola Bay. This shoreline, measuring about 8.5 miles, was sampled at 143 locations for assessment of sediment contamination, in accordance with the approved work plan and sampling and analysis plan (SAP). The investigation meets the requirements of the federal Comprehensive Environmental Response, Compensation, and Liability Act of 1980 program, which administers the investigation and cleanup of hazardous waste sites. The RI report summarizes the activities, results, and conclusions of the investigation, including a baseline risk assessment (BRA), and provides the basis for the feasibility study (FS) to be completed at the site.

This investigation was completed in accordance with the primary documents specified in the SMP. Primary document references include the *Final RI/FS Work Plan, Sites 40 and 42, Bayou Grande and Pensacola Bay* (EnSafe/Allen & Hoshall [E/A&H], 1995), the Final RI/FS Sampling and Analysis Plan, *Sites 40 and 42, Bayou Grande and Pensacola Bay* (E/A&H, 1995), the *SAP-Addendum* (E/A&H, 1997), the *Final Comprehensive Sampling and Analysis Plan for Naval Air Station Pensacola* (CSAP) (E/A&H, 1994), and the U.S. Environmental Protection Agency (USEPA) Region IV, Environmental Services Division, *Standard Operating Procedures and Quality Assurance Manual* (SOP/QAM), (USEPA, 1996).

Objectives of the Remedial Investigation

- To characterize contaminant nature and extent in the portions of Bayou Grande surrounding NAS Pensacola that are potentially impacted by any IRP site establishing links between sources and the receptors.

- To identify those assumptions and endpoints used in determining risks to human health and the environment. This goal is accomplished through the BRA process.

The conclusions of the RI process will determine if a FS will be conducted to determine appropriate methods of addressing site contamination, based on data generated during the RI process.

1.1 Project Organization

The RI was executed in four parts. First, all available previous investigation reports in the administrative record were reviewed to develop a comprehensive understanding of the site history and background to develop the work plan and SAP. Second, a Phase I qualitative survey of the bayou was conducted to determine the impacts by any of the IRP sites. Phase I included a sediment assessment survey of the bayou determining depositional areas where contamination would likely occur. Areas of fine-grained sediment and high total organic carbon (TOC) were assumed to have a high potential to absorb contaminants discharged from onshore sites, and were given priority for sampling. The Phase I sampling results are presented in Section 4. Third, Phase IIA was conducted to characterize the nature and extent of contamination in the bayou north of NAS Pensacola. Sampling locations were selected based on criteria outlined in the work plan and SAP which best represent the potential contaminant loading. Similar areas, called assessment zones (AZs), were grouped for sampling and chemical analysis. The Phase IIA sampling results are described by AZ and are presented in Section 7. Finally, in Phase IIB/III sediment (and tissue at specific locations) was collected at 10 locations throughout the bayou for chemical, toxicological, benthic community, and tissue concentration studies. Phase IIB/III data was collected to complete a BRA which is included in this document as Section 10.

1.2 Purpose of Report

This RI report summarizes the activities, results, and conclusions of the overall investigation and provides the basis and justification for a FS and Record of Decision (ROD). The report also documents the data collection and analytical methods used during the investigation.

2.0 SITE DESCRIPTION AND HISTORY

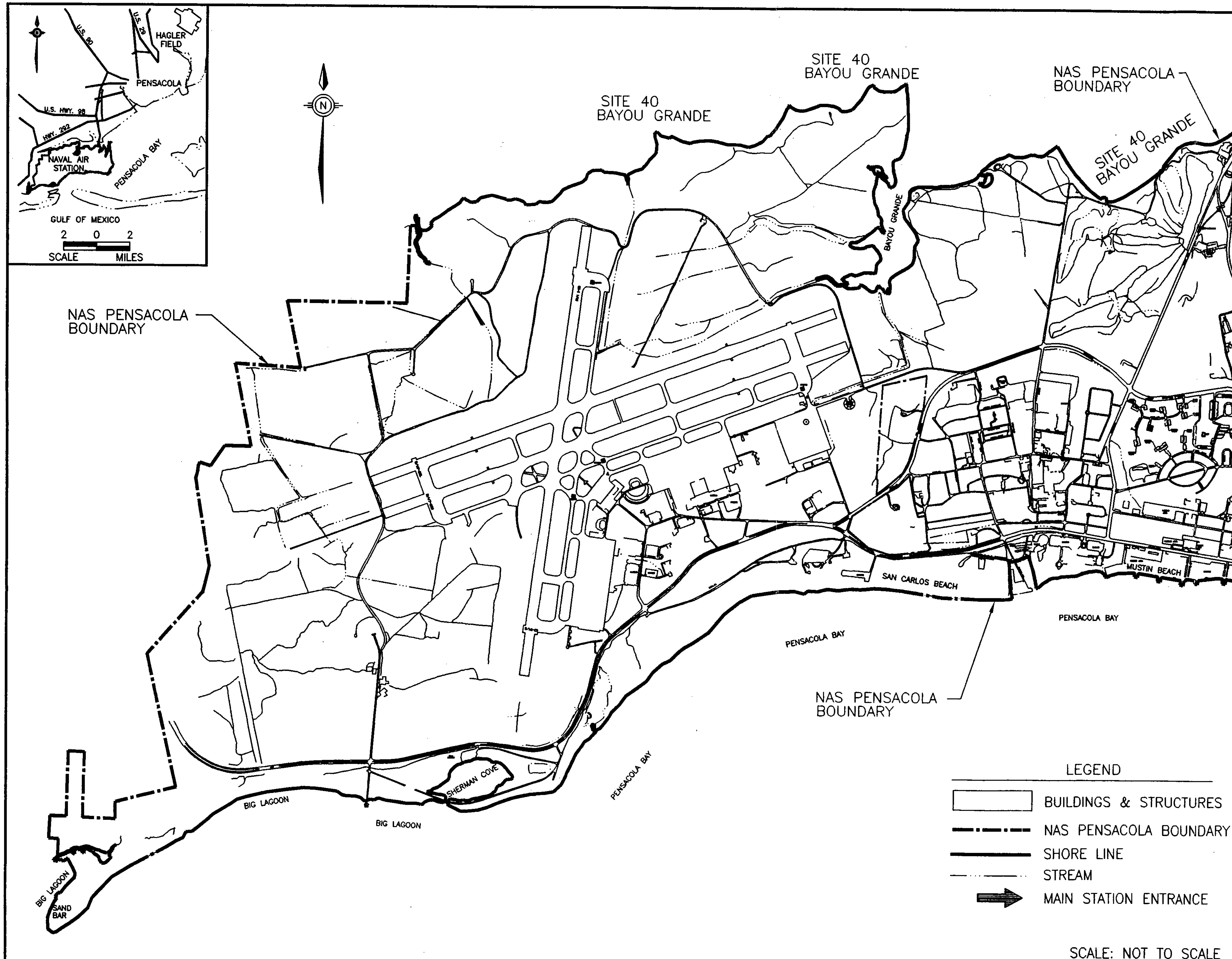
2.1 Site Area Description

As shown on Figure 2-1, Bayou Grande (Site 40) is an estuarine water body adjacent to the northern border of NAS Pensacola in Escambia County. It has a total surface area of approximately 1.5 square miles (Olinger et al., 1975) and approximately 20 miles of total coastline. Approximately 8.5 miles of Bayou Grande coastline border NAS Pensacola property (Figure 2-1). The mean depth of Bayou Grande is approximately 6.0 feet (Collard, 1991). The bayou is part of a larger surface water system known as the Pensacola Bay System (PBS). The PBS is described in the work plan for Sites 40 and 42.

2.2 Site History and Previous Investigations

Since the early 1950s, numerous investigations have been conducted in and around the PBS to monitor the ecological health of the bay and determine the impact of commercial, industrial, and municipal activities. Previous investigations have documented Navy industrial activities discharging to the PBS. Other studies have been associated with industrial activities of the PBS.

Collard (1991) summarizes the environmental-biological history of the PBS, documenting published as well as previously unpublished data from numerous studies conducted from the 1950s to the present. These studies were conducted to identify biological trends and help understand the current status of the PBS. Many studies have been performed with varying sampling methods, locations, and analytical procedures. These studies were presented in the work plan for Sites 40 and 42. Collard's biological trends analysis concluded: (1) the data did not support distinct, discernible trends and (2) there are significant database deficiencies.



SITE 40
REMEDIAL INVESTIGATION
NAS PENSACOLA
PENSACOLA, FLORIDA

FIGURE 2–1
SITE LOCATION MAP
PENSACOLA, FL.

DWG DATE:01/15/98 | DWG NAME:036LOCMP

Facility-specific studies related to NAS Pensacola, near Bayou Grande, are summarized below.

1982-1985 **FDEP** — Sediment samples collected from Pensacola Bay's turning basin south of the waterfront, Big Lagoon, and the mouth of Bayou Grande had elevated concentrations of mercury and lead. Ratios of Total Kjeldahl Nitrogen to TOC indicated nitrogen-enriched sediments in the turning basin and at the mouth of Bayou Grande.

1993 **NOAA-FDEP Study** — Within the upper reach, central bayou, and mouth of Bayou Grande, three mid-channel stations were sampled. Elevated concentrations of arsenic, cadmium, chromium, mercury, lead, and zinc were found. Polycyclic aromatic hydrocarbon (PAH) concentrations were not significant.

3.0 ENVIRONMENTAL SETTING

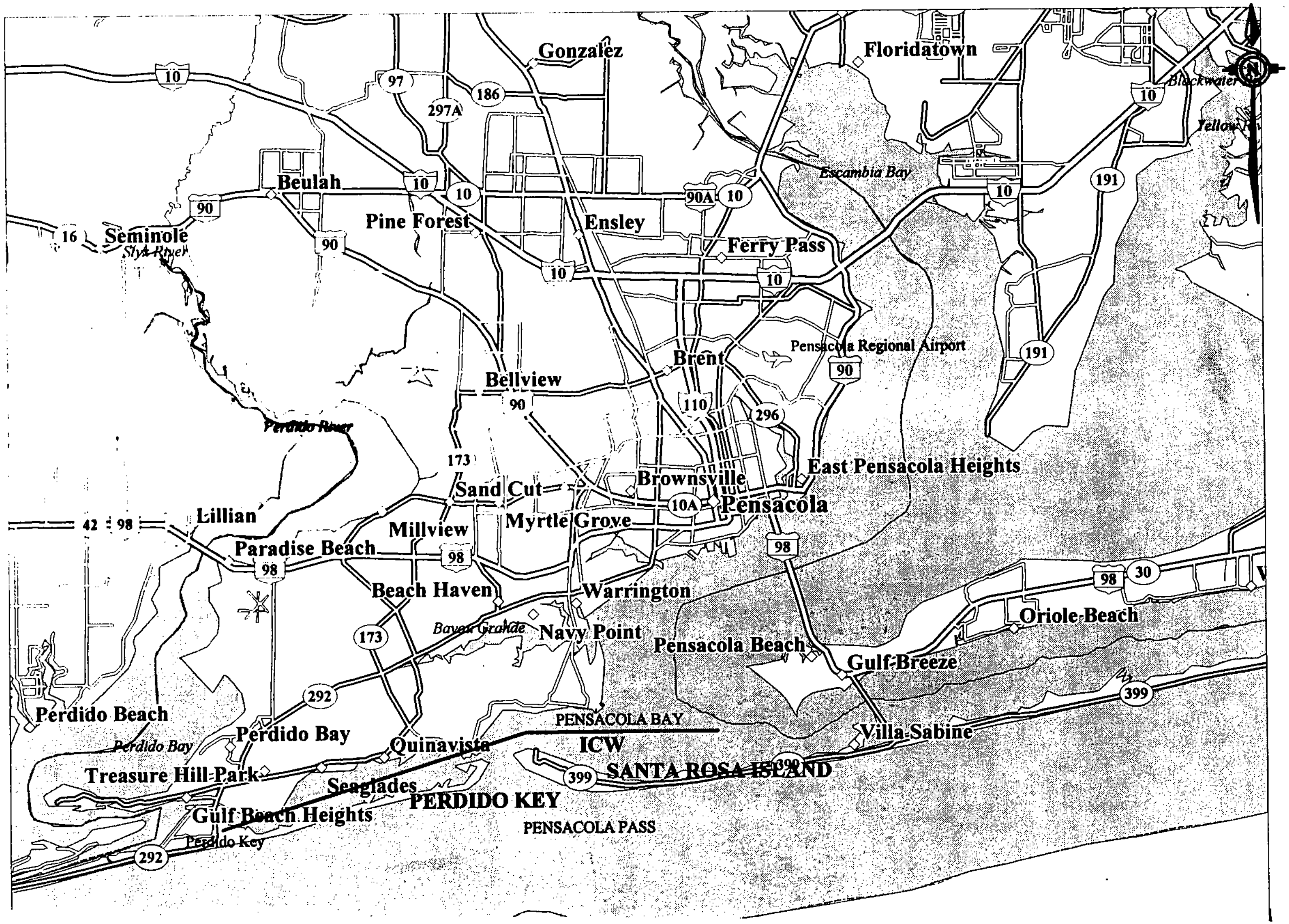
3.1 Physical Setting

NAS Pensacola, located on a peninsula in the Gulf Coast lowlands physiographic province, is bounded by Pensacola Bay to the south and east and Bayou Grande to the north (Figure 3-1). The primary topographic feature is a bluff paralleling the southern and eastern shorelines of the peninsula. Landward of the bluff is a gently rolling upland with elevations up to 40 feet above mean sea level (msl) (U.S. Geologic Survey [USGS], 1970a and 1970b). East and south of the bluff, a low and nearly level marine terrace constitutes the former Chevalier Field and Magazine Point. This marine terrace is approximately 5 feet or less msl.

In the vicinity of NAS Pensacola, Bayou Grande is a lower estuarine environment characterized by irregular tidal flushing from Pensacola Bay via the Gulf of Mexico. A Navy marina is located in the far eastern section of the bayou. Except for NAS Pensacola, other industrial influence in the bayou has not occurred. Residential property comprises the majority of land use along the bayou's shore. Jones Creek feeds into the bayou from the west.

3.2 Regional Ecological Setting

According to Wolfe et al. (1988), the Florida Panhandle has a wide variety of surface waters and physiographic regions, leading to an ecological diversity found in few other areas of the United States. Watersheds of the panhandle support a diverse array of habitats and vegetative communities. Bottom land hardwoods predominate in river floodplains, and pines, mixed with a variety of other shrubs, prevail in upland areas. Wetlands are prevalent along the coastal fringe and river floodplains. Barrier islands support dune vegetation communities and salt marshes. Bays supporting seagrass meadows and oyster reefs are present in intertidal and subtidal areas.



SITE 40
REMEDIAL INVESTIGATION
NAS PENSACOLA
PENSACOLA, FLORIDA

FIGURE 3-1
AREAL MAP OF
PENSACOLA BAY SYSTEMS

DWG DATE: 01/15/98 | DWG NAME: CLN11X8

Seven major rivers in the region discharge into seven bar-built estuaries formed at the mouths of the rivers. The Florida Panhandle is a crossroads where animals and plants from the Gulf Coastal Plain reach their eastward distributional limits, and where many northern species reach their southern limits. Many peninsular Florida species are also distributed there. Due to the wet temperate climate of the region, the panhandle area may support the highest diversity of species of any other similar-size territory in the U.S.

The high annual rainfall and low, gently sloping terrain create numerous wetlands in the region. Bogs, swamps, marshes, wet prairies, and wet flatwoods provide a diversity of wetland types supporting a wide variety of flora and fauna. Terrestrial vegetation includes open pine woods and hardwood forests; most are second-growth forests of pines and encroaching hardwoods.

The Florida Panhandle's estuaries and nearshore marine habitats are some of the greatest natural and economic assets of the region. Important commercial organisms (such as oysters and fish) abound in these areas and contribute to the region's economy. Coastal saltmarsh habitats provide critical nursery, feeding, and refuge for these important commercial species. Seagrass beds within estuaries also are vital to the seafood industry.

3.3 Ecological Setting at NAS Pensacola

NAS Pensacola, which occupies approximately 5,800 acres, is bounded by Bayou Grande to the north and Pensacola Bay to the east and south. To the west, the installation changes to less developed swampy lowlands. NAS Pensacola's eastern portion is largely developed with military and industrial facilities and historical/cultural sites. Most of the installation's activities are on the eastern side of the base. The less developed west side of the base has approximately 3,500 acres of natural or seminatural beach areas, forests, and wetlands.

NAS Pensacola is the setting for numerous aquatic and terrestrial habitats, from coastal strand and estuarine environments along the bay and bayou to inland pine flatwood communities. Wetland environments include a broad spectrum of both estuarine and palustrine wetlands, as well as various disturbed habitats, many in states of recovery as they undergo reforestation or return to their natural condition.

Vegetation Communities

NAS Pensacola natural vegetation communities fall into several broad categories: (1) coastal dune scrub communities, (2) pine flatwoods communities, (3) hardwood/pine communities, (4) sand pine scrub communities, (5) bay swamps, (6) freshwater marshes, and (7) estuarine coastal marshes (U.S. Fish and Wildlife Service [USFWS], 1987). Coastal dune scrub communities are associated with shorelines subject to high-energy waves. The vegetation consists of salt-tolerant plants able to establish themselves in shifting sands. Pine flatwood communities in coastal lowlands are characterized by trees that can tolerate various soil moisture conditions. Tree species in flatwood communities are short, with a wide variety of small shrubs and herbaceous plants in the understory. Hardwood/pine communities are highly diverse and considered biologically productive ecosystems. Sand pine scrub communities on well-drained sandy soil contain sand pines, oaks, and various shrubs. Bay swamps are wetlands with titi and cypress swamps known to contain permanent standing water and high accumulations of organic peat. Freshwater marshes occur as grass/sedge/rush/herb communities in areas with high soil saturation or standing water. Estuarine coastal marshes, including salt marshes, occur along low-energy shorelines and in tidal bayous (USFWS, 1987).

Wildlife

NAS Pensacola habitats provide potential ranges for a wide variety of animal life such as deer, squirrel, opossum, raccoon, fox, beaver, and bobcat. The station's beaches serve as resting, feeding, and nesting areas for various shorebirds. Ospreys have been observed nesting along undeveloped shoreline areas of the Big Lagoon, southeast of the Forrest Sherman Airfield. Numerous small mammals, amphibians, and reptiles also inhabit the base. The coastal marsh, submerged grass bed, and shallow water habitats at NAS Pensacola help support fishery communities within the Pensacola Bay estuarine complex. Approximately 180 species of bony fishes form the basis of the Pensacola Bay fish community (USFWS, 1987).

Threatened and Endangered Species

Appendix A of the *Comprehensive Natural Resources Management Plan for NAS Pensacola and Outlying Field Bronson* (USFWS, 1987) lists the rare, threatened, and endangered species that may be found within NAS Pensacola boundaries. EnSafe investigations of different areas of NAS Pensacola have identified osprey, great blue heron, alligator snapping turtle, Godfrey's golden aster, Carolina lilaeopsis, white-top pitcher plant, and narrow-leaved sundew. All are considered rare or endangered for Escambia County, Florida, by the Florida Natural Areas Inventory (Florida Natural Areas Inventory [FNAI], 1995).

Bayou Grande at NAS Pensacola

The biological communities comprising the Bayou Grande ecosystem are similar to those in Pensacola Bay. However, the species composition of aquatic communities are adapted to less saline environments than species in the lower Pensacola Bay. Also, communities adapted to low-energy environments (e.g., intertidal mud flats) are more prevalent in Bayou Grande than in Pensacola Bay.

The intertidal margin of Bayou Grande along NAS Pensacola generally consists of two different habitats. Relatively narrow, sandy strands with emergent vegetation, predominantly marshhay cordgrass (*Spartina patens*) and needlerush (*Juncus roemerianus*), occur along exposed portions of the shoreline. These exposed habitats support a relatively low diversity of species; fiddler crabs (*Uca* spp.) and marsh periwinkles (*Littorina irrotata*) are two of the more common species. In contrast, intertidal mud flats in protected inlets of the bayou contain a relatively diverse group of species, including small crustaceans, amphipods, and bivalve mollusks such as clams. During flooding tides, these intertidal mudflats are common feeding grounds for rays and bottom-feeding fish. During low tides, shore and wading birds such as ducks, herons, and egrets forage on the exposed flats. In areas designated for Phase IIB/III sampling, species diversity was assessed. The results are discussed in Section 10.

Although the shallow depth of Bayou Grande is conducive to benthic photosythesis, submerged aquatic vegetation does not exist in the bayou (Collard, 1991). Likewise, oyster beds are not as prevalent in the bayou. However, many of the commercial and recreationally harvested fish species in Pensacola Bay are residents or migrants in Bayou Grande.

3.4 Area Climate

The Pensacola area has a mild, subtropical climate with average annual temperature ranging from 55°F in the winter to 81°F in the summer. Daily temperatures can be more extreme, ranging from less than 7°F in the winter to more than 102°F in the summer. Thunderstorms, which occur on approximately half the summer days, can cause a precipitous drop in temperature of 10 to 20 degrees in a matter of minutes (Ecology & Environment, Inc. [E&E], 1992).

November is the driest month of the year, with an average rainfall of 3.2 inches, based on climatological data from 1962 to 1991. Rainfall averages approximately 60 inches a year, with the highest amounts in July and August, when thunderstorms occur almost daily. Thunderstorms resulting in 3 to 4 inches of rain in an hour are common. Rainfall is lowest during spring and fall (4 inches average per month). In general, spring and fall rains are less intense, last longer, and produce less surface runoff, but higher rates of infiltration and net recharge (E&E, 1992).

Winds, which prevail from the north during the winter and the south during the summer, are generally moderate in velocity, except during thunderstorms. A difference in the ocean-land temperature produces the sea-breeze effect, a daily clockwise rotation in the surface wind direction near the coast. Hurricanes and tornadoes can substantially damage the near-shore environment. Since 1980, 10 hurricanes have passed within 50 miles of Pensacola, the most recent being Hurricanes Erin and Opal in August and October 1995.

4.0 PHASE 1 – PRELIMINARY SURVEY

A preliminary survey for Site 40, conducted during February, 1995 included a Phase I sediment mapping survey developing the sampling strategy for Phase IIA sampling. Selection of sampling locations within Bayou Grande was based on three criteria. First, identified IRP sites were evaluated to determine the potential for contaminant input to bayou areas. Second, the potential for contaminant input from these identified IRP sites was assessed to determine the most likely point(s) of discharge into the bayou for identified contaminants. This determination took into account the presence of drainage ditches, outfalls, groundwater discharge and other pertinent transport mechanisms which may or may not have been identified during the work plan process. Third, a sediment assessment phase for the bayou was conducted to determine areas where deposition would likely occur. Areas of fine-grained sediment and high TOC were considered to have a high potential for absorption of contaminants discharged from onshore sites and thus were emphasized in the prioritization process. Finally, by subjectively assessing all of the information collected from the three criteria, low and high probability sampling locations were selected which best represented the potential contaminant loading to the water bodies surrounding NAS Pensacola.

The following sections describe how these criteria were developed and provide detailed information relative to applicable areas within Bayou Grande. For ease of assessment and discussion, sections of Bayou Grande shoreline were separated into four AZs based on known site influences and sediment type. Shoreline segments are described, along with the qualitative information used to distinguish the sections from adjoining shoreline segments.

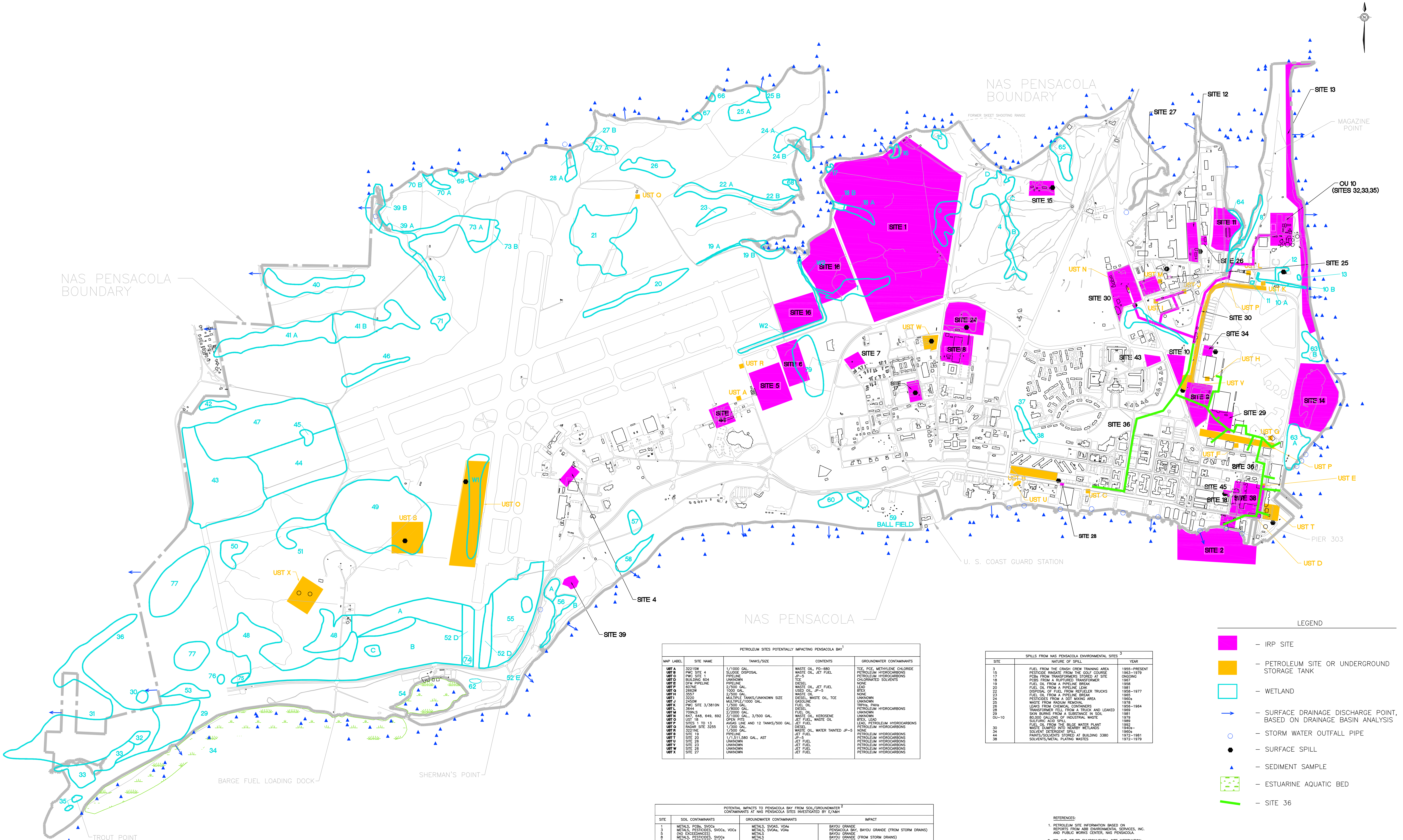
Criterion Descriptions

The RI report and other pertinent NAS Pensacola documents were reviewed to determine the contaminants of concern for sites that could impact portions of the bayou. For those sites identified as having a potential to impact the water bodies, transport pathways were identified. The suspected primary transport mechanisms being surface water and groundwater pathways. In accordance with the Work Plan and SAP, a contaminant source diagram was constructed, Figure 4-1, depicting the potential sources, site locations, spills, and stormwater outfalls affecting Bayou Grande. Table 4-1 provides information on pathway determination relative to sites at NAS Pensacola.

To assess bottom sediment characteristics at shoreline areas, a field survey was conducted to determine both qualitative and quantitative information. Throughout Bayou Grande, approximately 100 locations were sampled to determine sediment type. The qualitative assessment involved visually describing sediments using the Unified Soil Classification System (USCS) procedures along with noting relative significant differences in bottom types between surrounding locations. The quantitative assessment involved collection of 17 samples representative of the various bottom types to be laboratory-analyzed for TOC and grain size. Bottom sediment types determined during Phase I were based on USCS descriptions and are shown in Figure 4-2. Grain-size and TOC distributions are presented in Figures 4-3 and 4-4, respectively.

Section Descriptions

The shorelines of NAS Pensacola adjacent to Bayou Grande were divided into four AZs. Within each AZ, areas of special interest were selected based on known or suspected influence by land-based sources. These areas were referred to as Target Areas (TAs) and designated alphanumerically. For instance, if four TAs in AZ-2 were considered, they were designated as TA-2A through TA-2D. The sampling density within the TAs was higher than in other portions of the AZ. Figure 4-5 depicts the four assessment zones within Bayou Grande.



PETROLEUM SITES POTENTIALLY IMPACTING PENSACOLA BAY[1]				
MAP LABEL	SITE NAME	TANKS/SIZE	CONTENTS	GROUNDWATER CONTAMINANTS
UST A	3221SW	1/1000 GAL.	WASTE OIL, PD-680	TCE, PCE, METHYLENE CHLORIDE
UST B	PWC SITE 4	SLUDGE DISPOSAL	WASTE OIL, JET FUEL	PETROLEUM HYDROCARBONS
UST C	PWC SITE 1	PIPELINE	JP-5	PETROLEUM HYDROCARBONS
UST D	BUILDING 604	UNKNOWN	TCE	CHLORINATED SOLVENTS
UST E	DFM PIPELINE	PIPELINE	DIESEL	NONE
UST F	607NE	2/500 GAL.	WASTE OIL, JET FUEL	LEAD
UST G	2662W	1000 GAL.	USED OIL, JP-5	BTEX
UST H	3557	2/500 GAL.	WASTE OIL	NONE
UST I	3220	MULTIPLE TANKS/UNKNOWN SIZE	DIESEL, WASTE OIL, TCE	UNKNOWN
UST J	2450W	MULTIPLE/1000 GAL.	GASOLINE	UNKNOWN
UST K	PWC SITE 3/3810N	1/500 GAL.	FUEL OIL	TRPHs, PAHs
UST L	3644	2/8000 GAL.	DIESEL	PETROLEUM HYDROCARBONS
UST M	709N,S	2/2000 GAL.	FUEL OIL	UNKNOWN
UST N	647, 648, 649, 692	3/1000 GAL., 3/500 GAL.	WASTE OIL, KEROSENE	UNKNOWN
UST O	UST 18	OPEN PITS	JET FUEL, WASTE OIL	BTEX, LEAD
UST P	SITES 1 TO 13	AVGAS LINE AND 12 TANKS/500 GAL.	JET FUEL	LEAD, PETROLEUM HYDROCARBONS
UST Q	RADAR SITE 3255	1/300 GAL.	DIESEL	PETROLEUM HYDROCARBONS
UST R	3221NE	1/500 GAL.	WASTE OIL, WATER TAINTED JP-5	NONE
UST S	SITE 19	PIPELINE	JET FUEL	PETROLEUM HYDROCARBONS
UST T	SITE 20	1/1,511,580 GAL., AST	JP-5	PETROLEUM HYDROCARBONS
UST U	SITE 26	UNKNOWN	JET FUEL	PETROLEUM HYDROCARBONS
UST V	SITE 23	UNKNOWN	JET FUEL	PETROLEUM HYDROCARBONS
UST W	SITE 26	UNKNOWN	JET FUEL	PETROLEUM HYDROCARBONS
UST X	SITE 27	UNKNOWN	JET FUEL	PETROLEUM HYDROCARBONS

SPILLS FROM NAS PENSACOLA ENVIRONMENTAL SITES[3]		
SITE	NATURE OF SPILL	YEAR
3	FUEL FROM THE CRASH CREW TRAINING AREA	1955–PRESENT
15	PESTICIDE RINSATE FROM THE GOLF COURSE	1963–1979
17	PCBs FROM TRANSFORMERS STORED AT SITE	ONGOING
18	PCBS FROM A RUPTURED TRANSFORMER	1967
19	FUEL OIL FROM A PIPELINE BREAK	1958
20	FUEL OIL FROM A PIPELINE LEAK	1981
22	DISPOSAL OF FUEL FROM REFUELER TRUCKS	1958–1977
23	FUEL OIL FROM A PIPELINE BREAK	1965
24	PESTICIDES FROM A DDT MIXING AREA	1960s
25	WASTE FROM RADIUM REMOVAL	1978
26	LEAKS FROM CHEMICAL CONTAINERS	1956–1964
28	TRANSFORMER FELL FROM A TRUCK AND LEAKED	1969
29	SKIN BURNS FROM A SUBSTANCE IN SOIL	1981
OU-10	80,000 GALLONS OF INDUSTRIAL WASTE	1979
	SULFURIC ACID SPILL	1989
	FUEL OIL FROM THE BILGE WATER PLANT	1992
30	WASTE DUMPED INTO NEARBY WETLANDS	1940s–
34	SOLVENT DETERGENT SPILL	1960s
44	PAINTS/SOLVENTS STORED AT BUILDING 3380	1972–1981
38	SOLVENTS/METAL PLATING WASTES	1972–1979

POTENTIAL IMPACTS TO PENSACOLA BAY FROM SOIL/GROUNDWATER CONTAMINANTS AT NAS PENSACOLA SITES INVESTIGATED BY E/A&H[2]			
SITE	SOIL CONTAMINANTS	GROUNDWATER CONTAMINANTS	IMPACT
1	METALS, PCBs, SVOCs	METALS, SVOAS, VOAs	BAYOU GRANDE
3	METALS, PESTICIDES, SVOCs, VOCs	METALS, SVOAs, VOAs	PENSACOLA BAY, BAYOU GRANDE (FROM STORM DRAINS)
5	(NO EXCEEDANCES)	METALS	BAYOU GRANDE
8	METALS, PESTICIDES, SVOCs	METALS	BAYOU GRANDE (FROM STORM DRAINS)
9	METALS, PESTICIDES, SVOCs	METALS	BAYOU GRANDE
10	PESTICIDES, SVOCs	METALS	BAYOU GRANDE
11	METALS, PCBs, SVOCs	METALS, PESTICIDES	BAYOU GRANDE
12	METALS, PESTICIDES, PCBs, SVOCs	METALS, PESTICIDES	BAYOU GRANDE
13	METALS	METALS	PENSACOLA BAY
14	METALS	METALS	PENSACOLA BAY
15	METALS,PBS,SVOCs	METALS	BAYOU GRANDE
16	METALS, PESTICIDES, SVOCs	METALS	BAYOU GRANDE
17	METALS, PESTICIDES, PBS, SVOCs	METALS,	BAYOU GRANDE (FROM STORM DRAINS)
18	METALS, PBS, SVOCs	METALS	PENSACOLA BAY
24	METALS, PESTICIDES, PBS, SVOCs	METALS	BAYOU GRANDE (FROM STORM DRAINS)
25	METALS, PESTICIDES	METALS	BAYOU GRANDE
26	SVOCs	METALS, SVOAs, VOAs	BAYOU GRANDE
27	METALS, PESTICIDES, SVOCs	METALS, RADIATION	BAYOU GRANDE
28	METALS, SVOCs	METALS, SVOAs, VOAs	PENSACOLA BAY
29	METALS, PESTICIDES, SVOAs	(GW NOT INVESTIGATED)	BAYOU GRANDE
30	METALS, PESTICIDES, PBS, SVOCs	METALS, PESTICIDES	BAYOU GRANDE
31	METALS, SVOCs, PESTICIDES	METALS, PESTICIDES, SVOAs, VOAs	PENSACOLA BAY, BAYOU GRANDE
32	METALS, SVOCs, PESTICIDES	METALS, VOLATILES	PENSACOLA BAY, BAYOU GRANDE
33	METALS, SVOCs, PESTICIDES	METALS, VOLATILES	PENSACOLA BAY, BAYOU GRANDE
34	(NO SURFACE SOIL CONTAMINANTS)	METALS, SVOAs	
38	METALS, PESTICIDES, PBS, SVOCs	METALS, SVOCs, VOAs	PENSACOLA BAY
39			PENSACOLA BAY

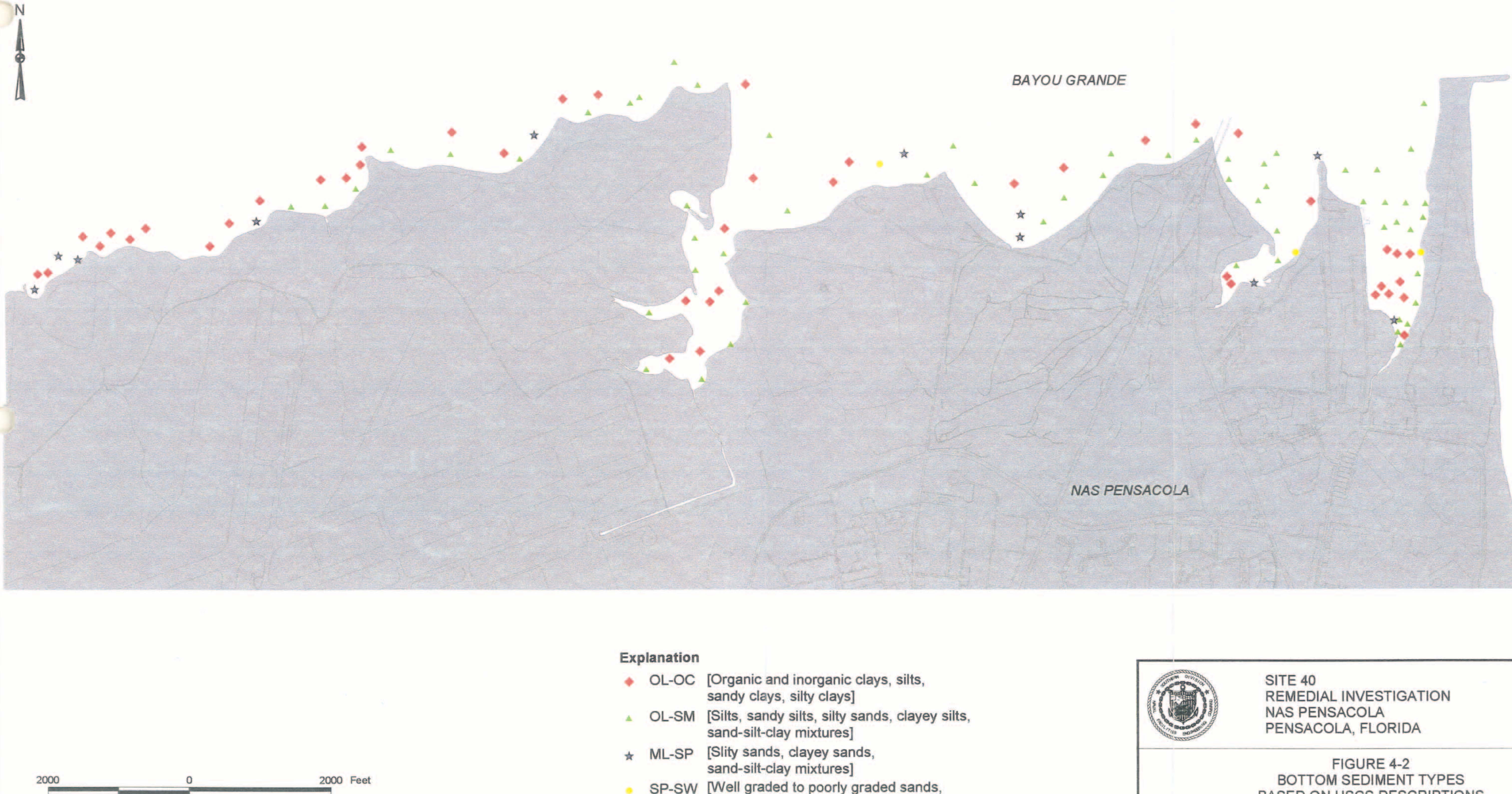
REFERENCES:

1. PETROLEUM SITE INFORMATION BASED ON REPORTS FROM ABB ENVIRONMENTAL SERVICES, INC. AND PUBLIC WORKS CENTER, NAS PENSACOLA.
2. IRP AND OTHER ENVIRONMENTAL SITE INFORMATION BASED ON ENSAFE/ALLEN & HOSHALL REPORTS.
3. SPILLS INFORMATION BASED ON NEESA, 1983 AND HISTORICAL DATA COMPILED IN E/A&H SITE SPECIFIC RI REPORTS.

SITE 40
REMEDIAL INVESTIGATION
NAS PENSACOLA

FIGURE 4-1
CONTAMINANT SOURCES AND
ECOLOGICALLY SENSITIVE AREAS

Dr by: K. BRONSON	Tr by: 0036-00138	
Ck by: C. TRIPLETT	App by: S. PARKER	Sheet 1
Date: 12/08/98	DWG Name:0036B002	Of 1



Explanation

- ◆ OL-OC [Organic and inorganic clays, silts, sandy clays, silty clays]
- ▲ OL-SM [Silts, sandy silts, silty sands, clayey silts, sand-silt-clay mixtures]
- ★ ML-SP [Slity sands, clayey sands, sand-silt-clay mixtures]
- ● SP-SW [Well graded to poorly graded sands, little or no fines]

SITE 40
REMEDIAL INVESTIGATION
NAS PENSACOLA
PENSACOLA, FLORIDA

FIGURE 4-2
BOTTOM SEDIMENT TYPES
BASED ON USCS DESCRIPTIONS
PHASE I

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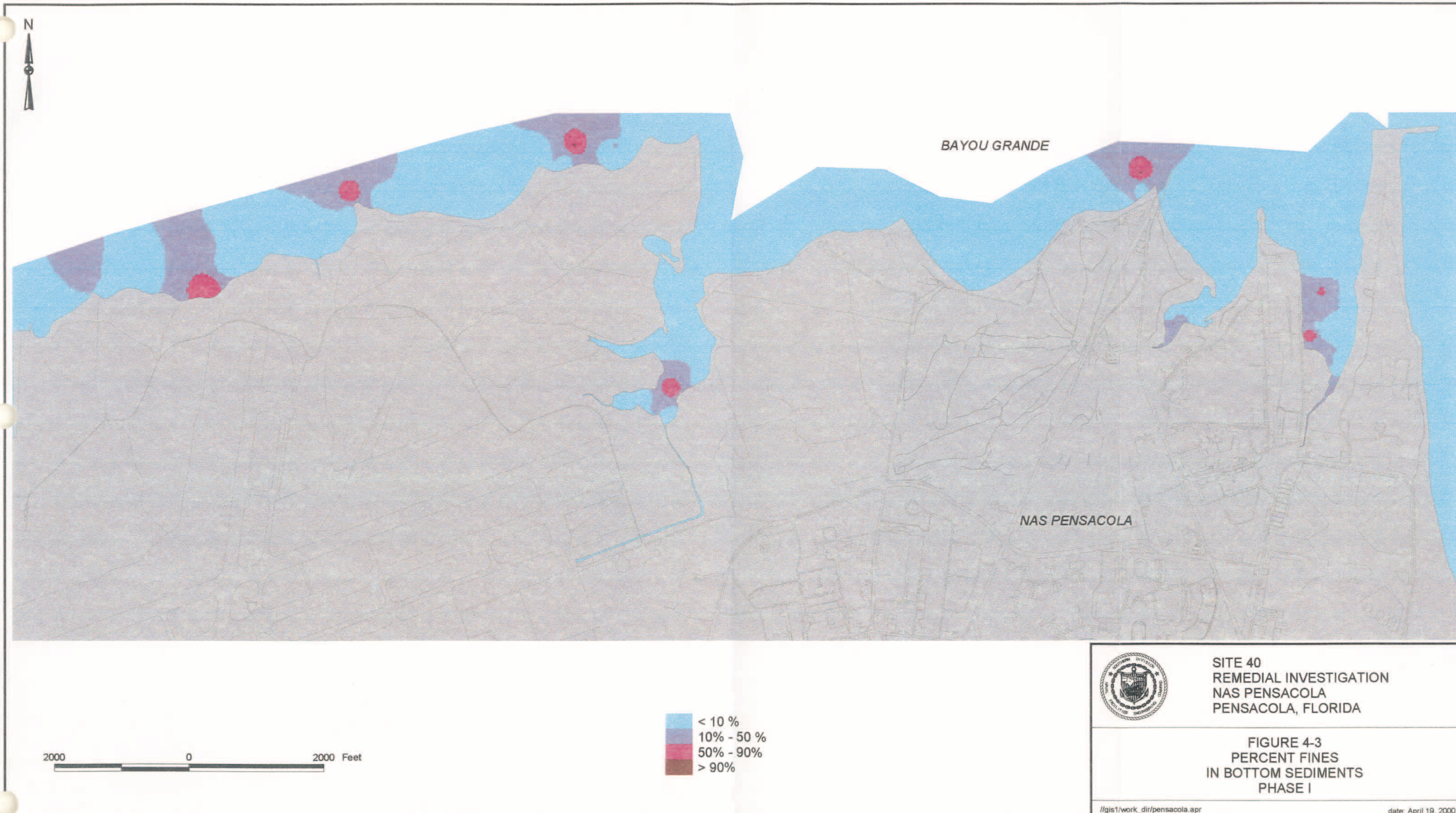
date: April 19, 2000



SITE 40
REMEDIAL INVESTIGATION
NAS PENSACOLA
PENSACOLA, FLORIDA

FIGURE 4-3
PERCENT FINES
IN BOTTOM SEDIMENTS
PHASE I

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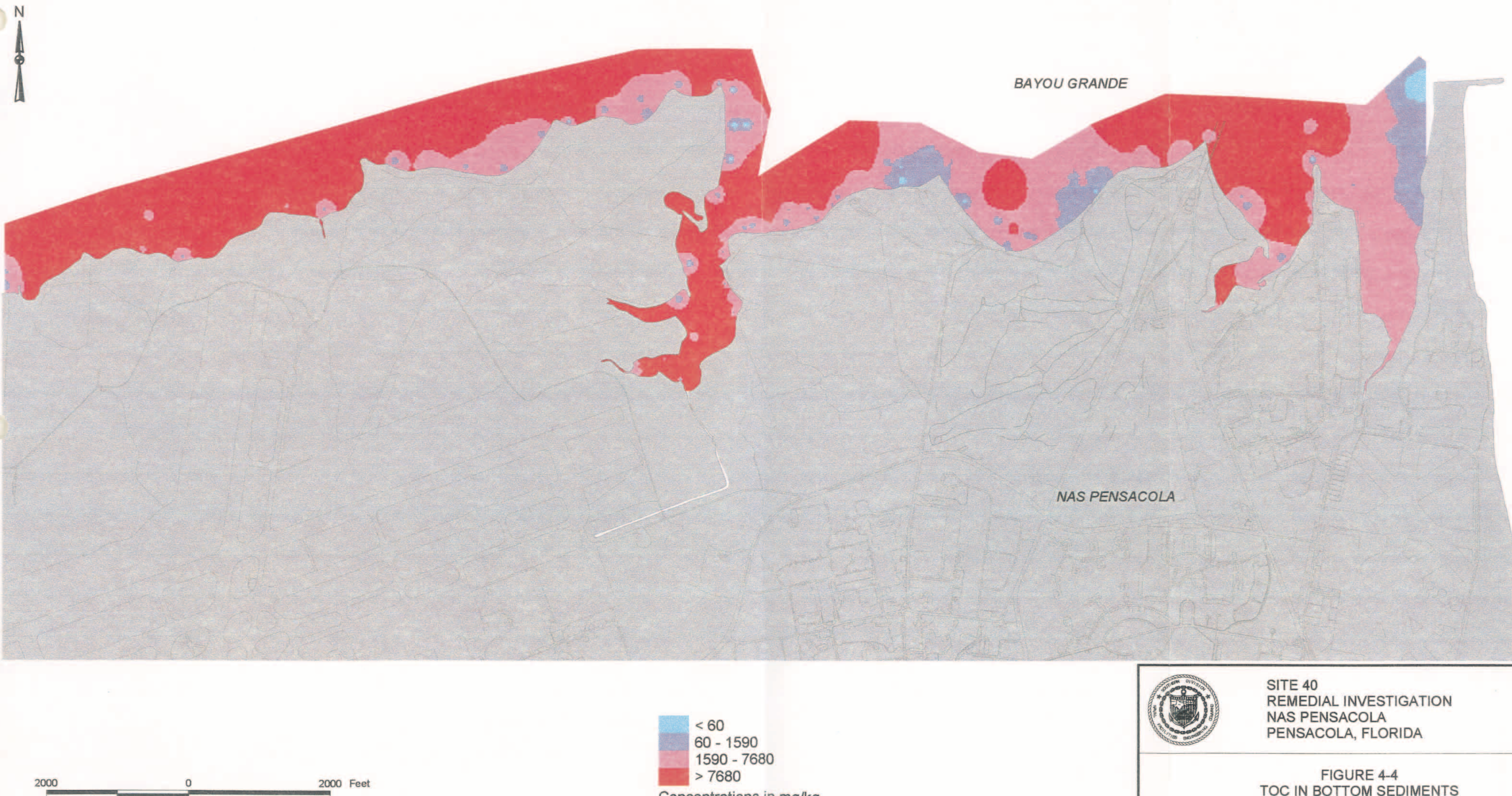
date: April 19, 2000



< 60
60 - 1590
1590 - 7680
> 7680
Concentrations in mg/kg

SITE 40
REMEDIAL INVESTIGATION
NAS PENSACOLA
PENSACOLA, FLORIDA

FIGURE 4-4
TOC IN BOTTOM SEDIMENTS
PHASE II

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date: April 19, 2000

Figure 4-5
B+W 11X17

Table 4-1
NAS Pensacola Sites Relative to Assessment Zones in Bayou Grande

Assessment Zone	Potential Source Site	Significant Pathway Descriptions	Suspected Contaminants
1	3	Surface water runoff through Wetlands 39, 70, 27, 25, and 28	Metals, VOCs
2	1	Surface water and groundwater discharge through Wetlands 15, 16, 17, 18, and 4; groundwater discharge directly to bayou	Metals, VOCs, SVOCs, Pesticides/PCBs, PAHs
3	1	Golf Course, Site 1 though Wetland 3 and 4, and Wetland 65	Metals, SVOCs, Pesticides
4	9-13, 29, 30, 36, and OU 10	Discharge into Yacht Basin Wetlands 64, 7, 8, 4, and 5. Golf course runoff.	Metals, VOCs, SVOCs, Pesticides/PCBs, PAHs

Notes:
NA = Not applicable.
OU 10 = Operable Unit 10
VOCs = Volatile organic compounds
SVOCs = Semivolatile organic compounds
PCBs = Polychlorinated biphenyls
PAHs = Polycyclic aromatic hydrocarbons

Bayou Grande Assessment

AZ-1 includes portions of the NAS Pensacola shoreline along Bayou Grande from a point near Soldiers Creek to Deepwater Point. Sediments within this zone are mostly fine-grained and characteristic of a low-energy tidal regime. Very few contaminant source areas were identified for this AZ. Potential sources include IRP Site 3 and Forrest Sherman Field, which lie south of the zone. Wetlands in this AZ include 39, 70, 27, 25, and 28. Because of the limited potential for contaminant input, all these wetlands have been considered as low priority for the Site 41 (wetlands) remedial investigation (RI).

AZ-2 extends from Deepwater Point to J. Kee Point and includes Redoubt Bayou. The shoreline in this area is characterized by sandy beaches with shallow, broad, sandy shelves extending out into the bayou in some areas. In these areas, fine-grained sediment is found at greater distance offshore than in AZ-1. The major contributing source to this area is IRP Site 1, potentially contributing inorganics (metals), volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), pesticides, and PAH compounds. Wetlands 15, 16, 17, and 18, which surround Site 1 and discharge into this zone, have been give a relatively high priority for the Site 41 RI. Wetland W-2, also known as the Southeast Drainage Ditch, conveys stormwater from the eastern end of Forrest Sherman Field to the southern end of Redoubt Bayou. W-2 is intersected by an unnamed drainage ditch which passes the southside of IRP Site 16, and which conveys surface water from the Barrancas Cemetery area. This intersecting ditch also receive stormwater from an outfall draining the NAS Public Works Center (an area encompassing IRP Sites 8, 17, 22, and 24. Other wetlands which discharge into the zone but are not considered to have a high contaminant input potential, include 19, 22, 24, and 68. Some near-shore contaminated groundwater monitoring wells have increased the priority for those portions of the shoreline.

AZ-3 extends from J. Kee Point to the Navy Boulevard bridge. Sediments in this zone are similar to those in AZ-2, with areas of sandy bottom parallel to the shoreline or extending into the bayou as bars. Primarily, pesticides from use on the NAS Pensacola Golf Course may be expected in this area. Contaminants may have been transport to this zone from Site 1 through Wetlands 3 and 4. Wetland 65 also discharges into this zone.

AZ-4 extends from the Navy Boulevard bridge to the pass which connects Bayou Grande to Pensacola Bay. This area includes Woolsey Bayou and portions of Bayou Grande just north of the Navy Yacht Basin (Buddy's Bayou). The upper reach of the Yacht Basin will be addressed by the Site 41 RI. Sediments in this zone are similar to those in AZ-3, with small areas of sandy bottom along the shore. Pesticides used on the NAS Pensacola Golf Course are suspected, along with other contaminants from the Yacht Basin's influence. Contaminants suspected within the Yacht Basin include VOCs, SVOCs, pesticides, inorganics, and PAHs as a result of inland IRP Sites 9 to 13, 29, 30, and 36, and Operable Unit 10.

5.0 FIELD INVESTIGATION METHODS

The Site 40 field investigation was conducted in February 1995 (Phase I), between October 1995 and January 1996 (Phase IIA), and from August to September, 1997 (Phase IIB/III). The investigation, which was conducted to confirm whether contaminants were present, compared identified constituents to previously established sediment screening levels to determine if measured contaminant concentrations were at levels that could impact onsite receptors. Work was performed in accordance with the Site 40 work plan, SAP, CSAP, and USEPA SOP/QAM. Where warranted by field conditions, deviations from the approved procedures were carried out and appropriately documented. Changes from these procedures, as provided in records, were to (1) discontinue the use of isopropyl alcohol during decontamination, and (2) add one toxicity test to the suite of tests proposed in the SAP. The discontinuation of isopropyl alcohol was based on a potential fire hazard aboard the sampling vessel. The toxicity test on mysid shrimp was added based on a request from the Engineer-in-Charge from Southern Division, Naval Facilities Engineering Command. Other deviations from the SAP were related to sampling locations. Surface water samples were not collected at locations 05 and 06 and a benthic diversity sample was not collected at location 8 because of an error in sampling process.

During the Site 40 field investigation, sediment, surface water and biota samples were collected for analysis. Phase I, IIA, and IIB/III analytical chemistry data are provided in Appendices A, B, and C, respectively. All Phase IIA sediment samples were analyzed for the full Target Analyte List/Target Compound List (TAL/TCL) in accordance with the Contract Laboratory Program (CLP).

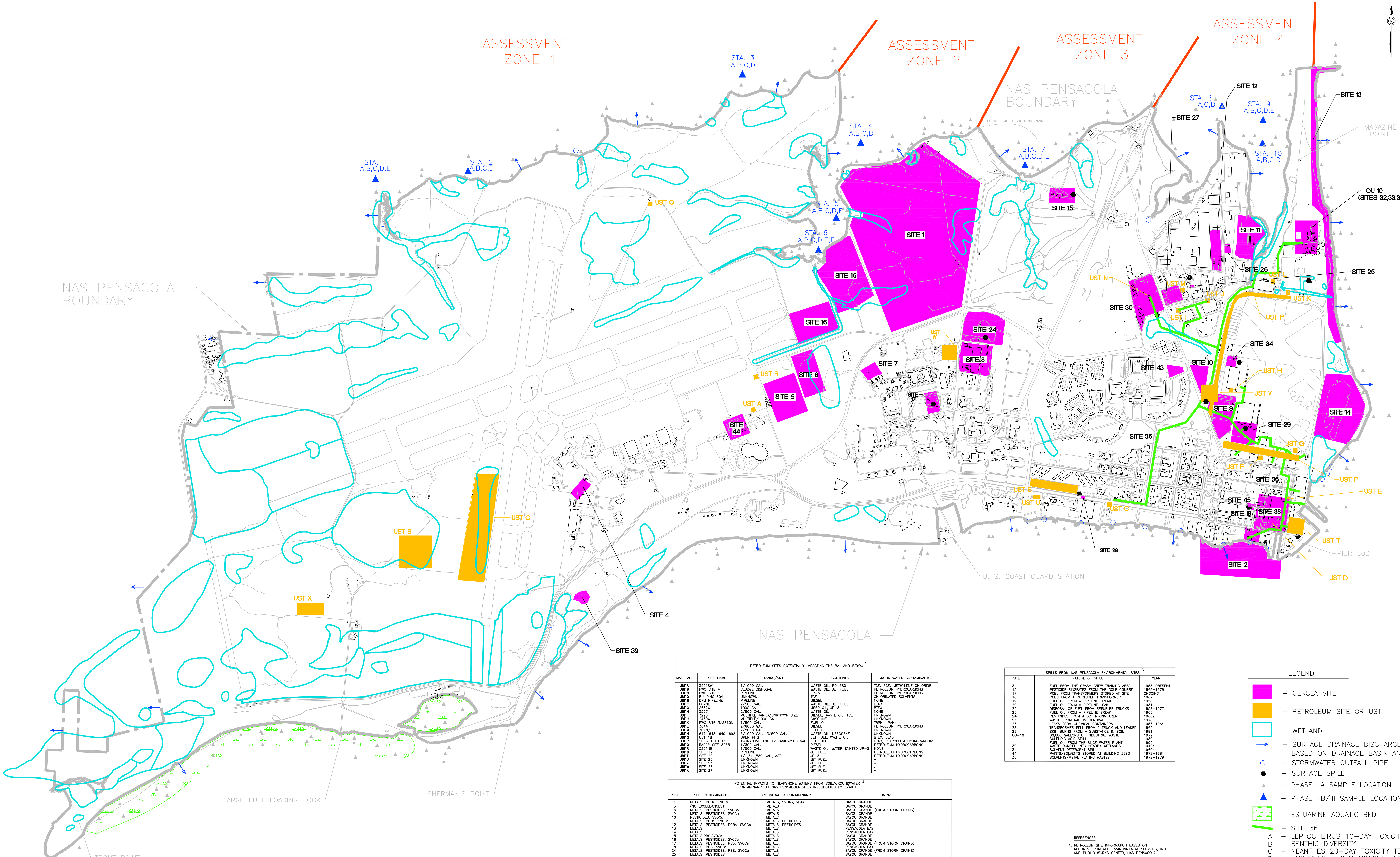
In addition to the TAL/TCL analysis, 18 Phase IIA sediment samples were analyzed using a total digestion technique which employs the use of hydrofluoric acid. The method was suggested by FDEP in order to determine the natural metal-to-aluminum relationship for Florida sediments. A comparison of the two methods was performed and the results from the CLP nitric acid digestion were similar to the total digestion results. The method of digestion, purpose of the specialized digestion, and comparison of the digestion results are summarized in Appendix D. The samples analyzed using the specialized digestion were not used in this report to assess nature and extent of contamination, because they were colocated with CLP samples, and will therefore not be discussed further.

Phase IIB/III sediment and surface water samples were analyzed for VOCs, SVOCs, pesticides/PCBs, metals and cyanide in accordance with SW-846 methods. Fish samples collected in Phase IIB/III were analyzed for SVOCs and pesticides/PCBs in accordance with SW-846 methods. Fish samples were also submitted for metals analysis. Except for barium, beryllium, cadmium, calcium, cyanide, magnesium, mercury, and potassium, all parameters on the TAL list were analyzed. SVOC analysis could not be run on fish tissue sample (040J4006-02) because of insufficient sample volume.

For Phase I TOC analyses were conducted by Thompson Engineering, Mobile, Alabama. Phase IIA chemical analyses were completed by CEIMIC Laboratories of Narragansett, Rhode Island, approved by the Naval Facilities Engineering Service Center (NFESC). To provide analytical data with sufficiently low detection levels, EnSafe provided CEIMIC a list of the sediment screening levels in the laboratory statement of work. This required the laboratory to specify in laboratory summaries when these levels were not attainable. Phase IIB/III chemical analysis was conducted by Savannah Laboratories, Savannah, Georgia. Toxicity testing was conducted by TRAC Laboratory, Pensacola, Florida, and benthic community analysis was performed by TAI Laboratory, Mobile, Alabama.

5.1 Field Investigation

The field investigation for Site 40 was conducted by EnSafe personnel in accordance with the site-specific SAP. Figure 5-1 charts the Site 40 Phase IIA and IIB/III sample locations. Sediment



PETROLEUM SITES POTENTIALLY IMPACTING THE BAY AND BAYOU [1]				
MAP LABEL	SITE NAME	TANKS/SIZE	CONTENTS	GROUNDWATER CONTAMINANTS
UST A	3221SW	1/1000 GAL.	WASTE OIL, PD-680	TCE, PCE, METHYLENE CHLORIDE
UST B	PWC SITE 4	SLUDGE DISPOSAL	WASTE OIL, JET FUEL	PETROLEUM HYDROCARBONS
UST C	PWC SITE 1	PIPELINE	JP-5	PETROLEUM HYDROCARBONS
UST D	BUILDING 604	UNKNOWN	TCE	CHLORINATED SOLVENTS
UST E	DFM PIPELINE	PIPELINE	DIESEL	NONE
UST F	607NE	2/500 GAL.	WASTE OIL, JET FUEL	LEAD
UST G	2662W	1000 GAL.	USED OIL, JP-5	BTEX
UST H	3557	2/500 GAL.	WASTE OIL	NONE
UST I	3220	MULTIPLE TANKS/UNKNOWN SIZE	DIESEL, WASTE OIL, TCE	UNKNOWN
UST J	2450W	MULTIPLE/1000 GAL.	GASOLINE	UNKNOWN
UST K	PWC SITE 3/3810N	1/500 GAL.	FUEL OIL	TRPHs, PAHs
UST L	3644	2/8000 GAL.	DIESEL	PETROLEUM HYDROCARBONS
UST M	709N,S	2/2000 GAL.	FUEL OIL	UNKNOWN
UST N	647, 648, 649, 692	3/1000 GAL., 3/500 GAL.	WASTE OIL, KEROSENE	UNKNOWN
UST O	UST 18	OPEN PITS	JET FUEL, WASTE OIL	BTEX, LEAD
UST P	SITES 1 TO 13	AVGAS LINE AND 12 TANKS/500 GAL.	JET FUEL	LEAD, PETROLEUM HYDROCARBONS
UST Q	RADAR SITE 3255	1/300 GAL.	DIESEL	PETROLEUM HYDROCARBONS
UST R	3221NE	1/500 GAL.	WASTE OIL, WATER TAINTED JP-5	NONE
UST S	SITE 19	PIPELINE	JET FUEL	PETROLEUM HYDROCARBONS
UST T	SITE 20	1/1,511,580 GAL., AST	JP-5	PETROLEUM HYDROCARBONS
UST U	SITE 26	UNKNOWN	JET FUEL	"
UST V	SITE 23	UNKNOWN	JET FUEL	"
UST W	SITE 26	UNKNOWN	JET FUEL	"
UST X	SITE 27	UNKNOWN	JET FUEL	"

POTENTIAL IMPACTS TO NEARSHORE WATERS FROM SOIL/GROUNDWATER CONTAMINANTS AT NAS PENSACOLA SITES INVESTIGATED BY E/A&H [2]			
SITE	SOIL CONTAMINANTS	GROUNDWATER CONTAMINANTS	IMPACT
1	METALS, PCBs, SVOCs	METALS, SVOAS, VOAs	BAYOU GRANDE
5	(NO EXCEEDANCES)	METALS	BAYOU GRANDE
8	METALS, PESTICIDES, SVOCs	METALS	BAYOU GRANDE (FROM STORM DRAINS)
9	METALS, PESTICIDES, SVOCs	METALS	BAYOU GRANDE
10	PESTICIDES, SVOCs	METALS	BAYOU GRANDE
11	METALS, PCBs, SVOCs	METALS, PESTICIDES	BAYOU GRANDE
12	METALS, PESTICIDES, PCBs, SVOCs	METALS, PESTICIDES	BAYOU GRANDE
13	METALS	METALS	PENSACOLA BAY
14	METALS	METALS	PENSACOLA BAY
15	METALS,PBS,SVOCs	METALS	BAYOU GRANDE
16	METALS, PESTICIDES, SVOCs	METALS	BAYOU GRANDE
17	METALS, PESTICIDES, PBS, SVOCs	METALS,	BAYOU GRANDE (FROM STORM DRAINS)
18	METALS, PBS, SVOCs	METALS	PENSACOLA BAY
24	METALS, PESTICIDES, PBS, SVOCs	METALS	BAYOU GRANDE (FROM STORM DRAINS)
25	METALS, PESTICIDES	METALS	BAYOU GRANDE
26	SVOCs	METALS, SVOAs, VOAs	BAYOU GRANDE
27	METALS, PESTICIDES, SVOCs	METALS, RADIATION	BAYOU GRANDE
28	METALS, SVOCs	METALS, SVOAs, VOAs	PENSACOLA BAY
29	METALS, PESTICIDES, SVOAs	(GW NOT INVESTIGATED)	BAYOU GRANDE
30	METALS, PESTICIDES, PBS, SVOCs	METALS, PESTICIDES	BAYOU GRANDE
31	METALS, SVOCs, PESTICIDES	METALS, PESTICIDES, SVOAs, VOAs	PENSACOLA BAY, BAYOU GRANDE
32	METALS, SVOCs, PESTICIDES	METALS, VOLATILES	PENSACOLA BAY, BAYOU GRANDE
33	METALS, SVOCs, PESTICIDES	METALS, VOLATILES	PENSACOLA BAY, BAYOU GRANDE
34	(NO SURFACE SOIL CONTAMINANTS)	METALS, SVOAs	
38	METALS, PESTICIDES, PBS, SVOCs	METALS, SVOCs, VOAs	PENSACOLA BAY
39			PENSACOLA BAY

SPILLS FROM NAS PENSACOLA ENVIRONMENTAL SITES [3]		
SITE	NATURE OF SPILL	YEAR
3	FUEL FROM THE CRASH CREW TRAINING AREA	1955-PRESENT
15	PESTICIDE RINSEATES FROM THE GOLF COURSE	1963-1979
17	PCBs FROM TRANSFORMERS STORED AT SITE	ONGOING
18	PCBS FROM A RUPTURED TRANSFORMER	1967
19	FUEL OIL FROM A PIPELINE BREAK	1958
20	FUEL OIL FROM A PIPELINE LEAK	1981
22	DISPOSAL OF FUEL FROM REFUELER TRUCKS	1958-1977
23	FUEL OIL FROM A PIPELINE BREAK	1965
24	PESTICIDES FROM A DDT MIXING AREA	1960s
25	WASTE FROM RADIUM REMOVAL	1978
26	LEAKS FROM CHEMICAL CONTAINERS	1956-1964
28	TRANSFORMER FELL FROM A TRUCK AND LEAKED	1969
29	SKIN BURNS FROM A SUBSTANCE IN SOIL	1981
OU-10	80,000 GALLONS OF INDUSTRIAL WASTE	1979
	SULFURIC ACID SPILL	1989
	FUEL OIL FROM THE BILGE WATER PLANT	1992
30	WASTE DUMPED INTO NEARBY WETLANDS	1940s-
34	SOLVENT DETERGENT SPILL	1960s
44	PAINTS/SOLVENTS STORED AT BUILDING 3380	1972-1981
38	SOLVENTS/METAL PLATING WASTES	1972-1979

REFERENCES:

1. PETROLEUM SITE INFORMATION BASED ON REPORTS FROM ABB ENVIRONMENTAL SERVICES, INC. AND PUBLIC WORKS CENTER, NAS PENSACOLA.
2. I R AND OTHER ENVIRONMENTAL SITE INFORMATION BASED ON ENSAFE/ALLEN&HOSHALL REPORTS.
3. SPILLS INFORMATION BASED ON NEESA, 1983 AND HISTORICAL DATA COMPILED IN E/A&H SITE SPECIFIC R I REPORTS.

800 0 800
SCALE FEET

LEGEND

- CERCLA SITE
- PETROLEUM SITE OR UST
- WETLAND
- SURFACE DRAINAGE DISCHARGE POINT, BASED ON DRAINAGE BASIN ANALYSIS
- STORMWATER OUTFALL PIPE
- SURFACE SPILL
- PHASE IIA SAMPLE LOCATION
- PHASE IIB/III SAMPLE LOCATION
- ESTUARINE AQUATIC BED
- SITE 36

A - LEPTOCHEIRUS 10-DAY TOXICITY TEST
B - BENTHIC DIVERSITY
C - NEANTHES 20-DAY TOXICITY TEST
D - MYSIDOPIS 7-DAY TOXICITY TEST
E - WATER QUALITY
F - BODY BURDEN ANALYSIS FISH

REVISION		
Rev Number: 000	Rev Date: 00/00/00	Rev By: NAME
Rev Number: 000	Rev Date: 00/00/00	Rev By: NAME
Rev Number: 000	Rev Date: 00/00/00	Rev By: NAME
Rev Number: 000	Rev Date: 00/00/00	Rev By: NAME
Rev Number: 001	Rev Date: 09/16/96	Rev By: C. TRIPLETT

REMEDIAL INVESTIGATION SITE 40
NAVAL AIR STATION PENSACOLA
PENSACOLA, FLORIDA

FIGURE 5-1
PHASE II AND III
SAMPLE LOCATIONS AND ANALYSES

Dr by: E/AH	Tr by: 0036-00130	
Ck by: C. TRIPLETT	App by: S. PARKER	Sheet 1
Date: 01/12/99	DWG Name: 0036M002	Of 1

sample locations for Phase IIA with their corresponding sample identification are shown by assessment zone in Figures 5-2 through 5-5. Sediment collection techniques were in accordance with Section 7 of the CSAP. Sediment samples were collected with either a Ponar grab or Eckman dredge in deeper water locations, and with a stainless-steel hand auger (Section 4.4 of the CSAP) in the shallowest locations. Samples were collected from a boat contracted from Osprey Charters, Milton, Florida. This vessel, a net boat, was 30 feet long and 10 feet wide, equipped with a electric-powered winch for lowering and retrieving sampling devices. For this investigation, all sampling stations were located with a Trimble global positioning system (GPS), allowing precision of ±1 meter.

5.2 Fieldwork and Sampling Protocols

Sample Handling and Management

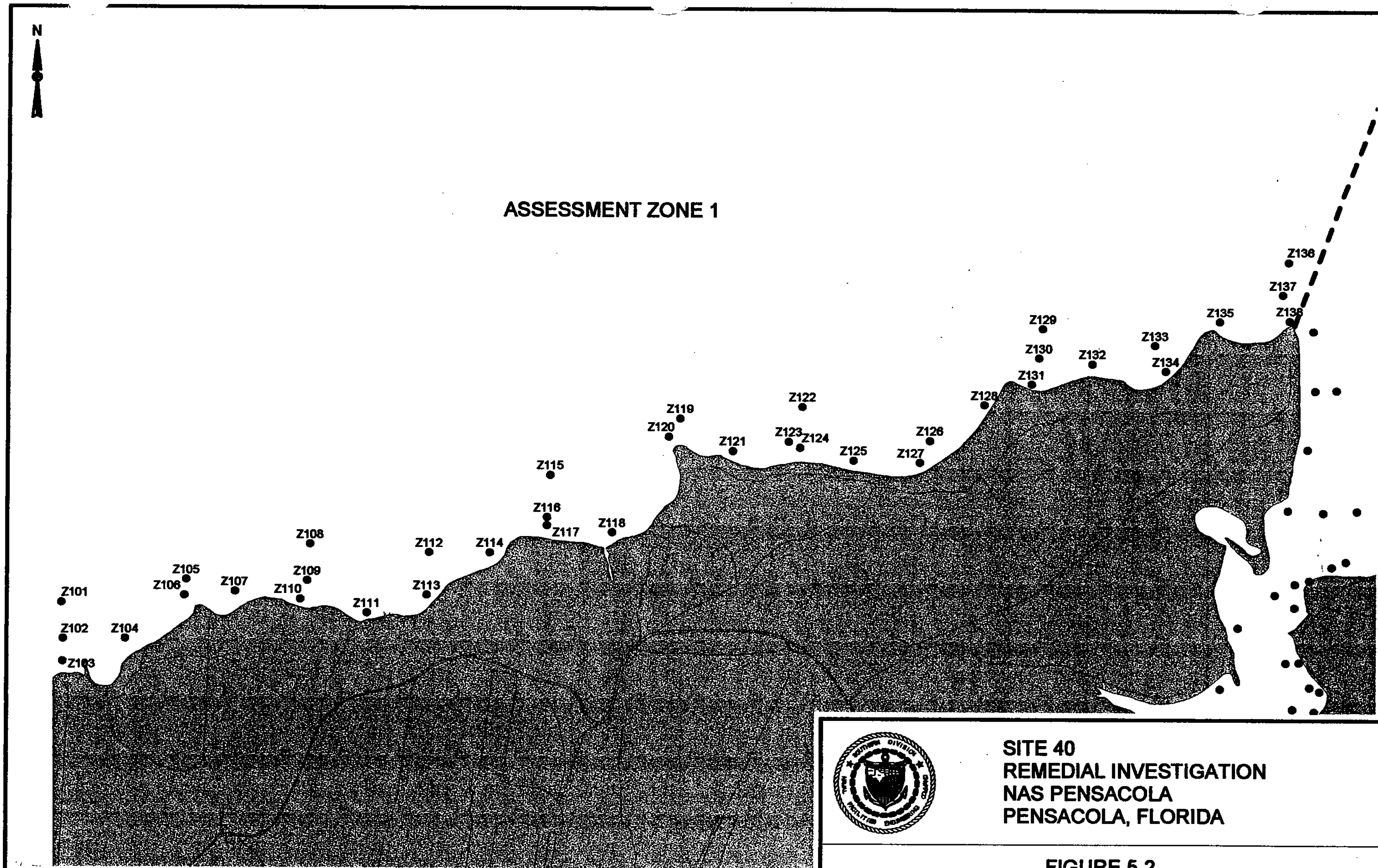
Sediment samples were collected in accordance with Chapter 7 of the CSAP. Clean latex or nitrol gloves were donned each time a new sample was collected. Decontaminated sampling devices were kept wrapped until the samples were collected. Samples were managed in accordance with Chapter 12 of the CSAP. Labeling, preservation, packing, chain-of-custody, and shipping carefully followed procedures in that section.

Quality Assurance/Quality Control Samples

QA/QC samples — field duplicates, field blanks, and matrix spikes/matrix spike duplicates (MS/MSDs) — were collected in accordance with Chapter 15 of the CSAP.

Sample Containers and Preservation

All laboratory-provided containers were precleaned and certified as specified in Chapter 12 of the CSAP. All samples were preserved with ice to 4° ±2° C in accordance with the CSAP.



SITE 40
REMEDIAL INVESTIGATION
NAS PENSACOLA
PENSACOLA, FLORIDA

FIGURE 5-2
ASSESSMENT ZONE 1
SAMPLE LOCATIONS
PHASE IIA

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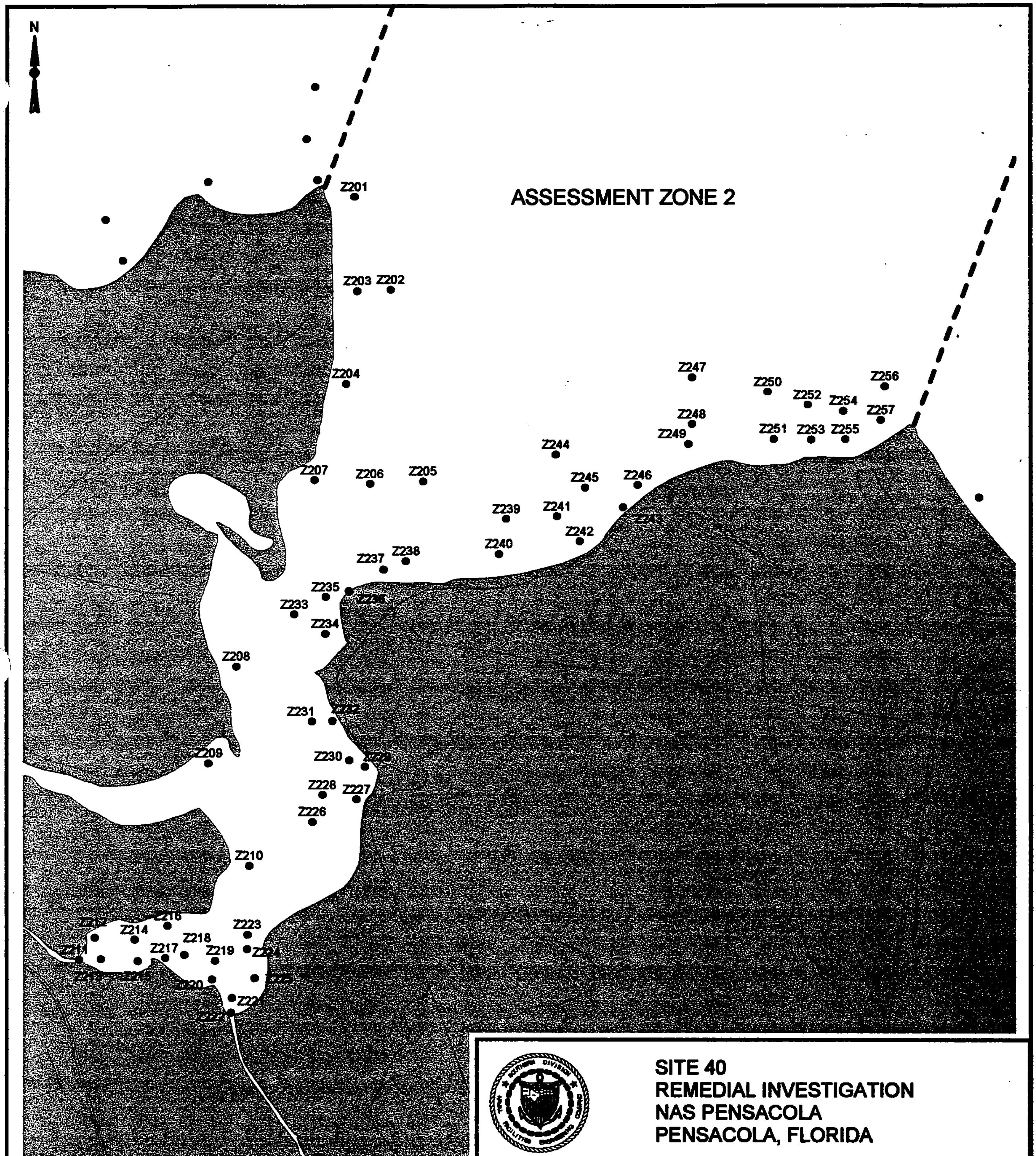
date: April 19, 2000



SITE 40
REMEDIAL INVESTIGATION
NAS PENSACOLA
PENSACOLA, FLORIDA

FIGURE 5-3
ASSESSMENT ZONE 2
SAMPLE LOCATIONS
PHASE IIA

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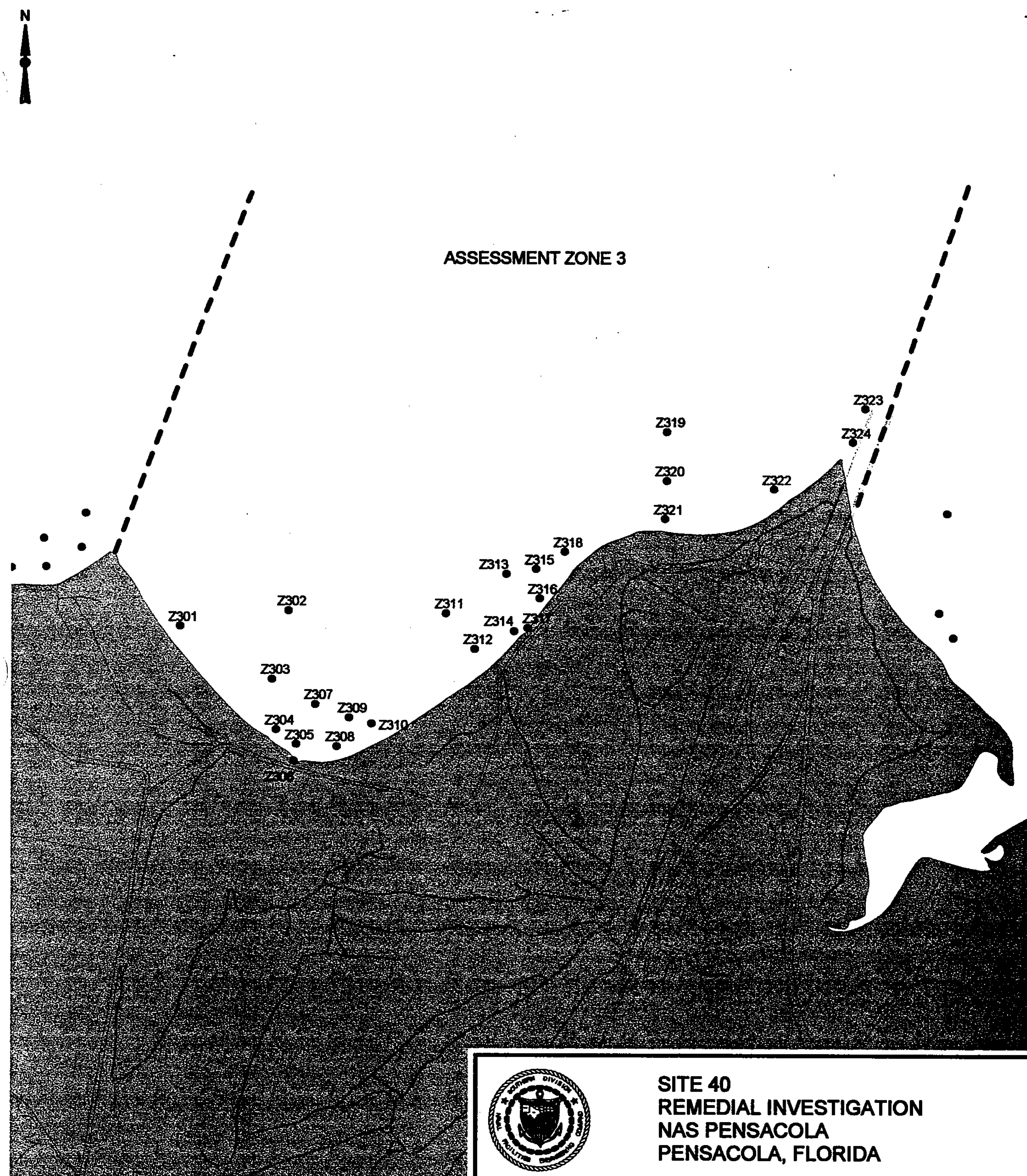
date: April 19, 2000



SITE 40
REMEDIAL INVESTIGATION
NAS PENSACOLA
PENSACOLA, FLORIDA

FIGURE 5-4
ASSESSMENT ZONE 3
SAMPLE LOCATIONS
PHASE IIA

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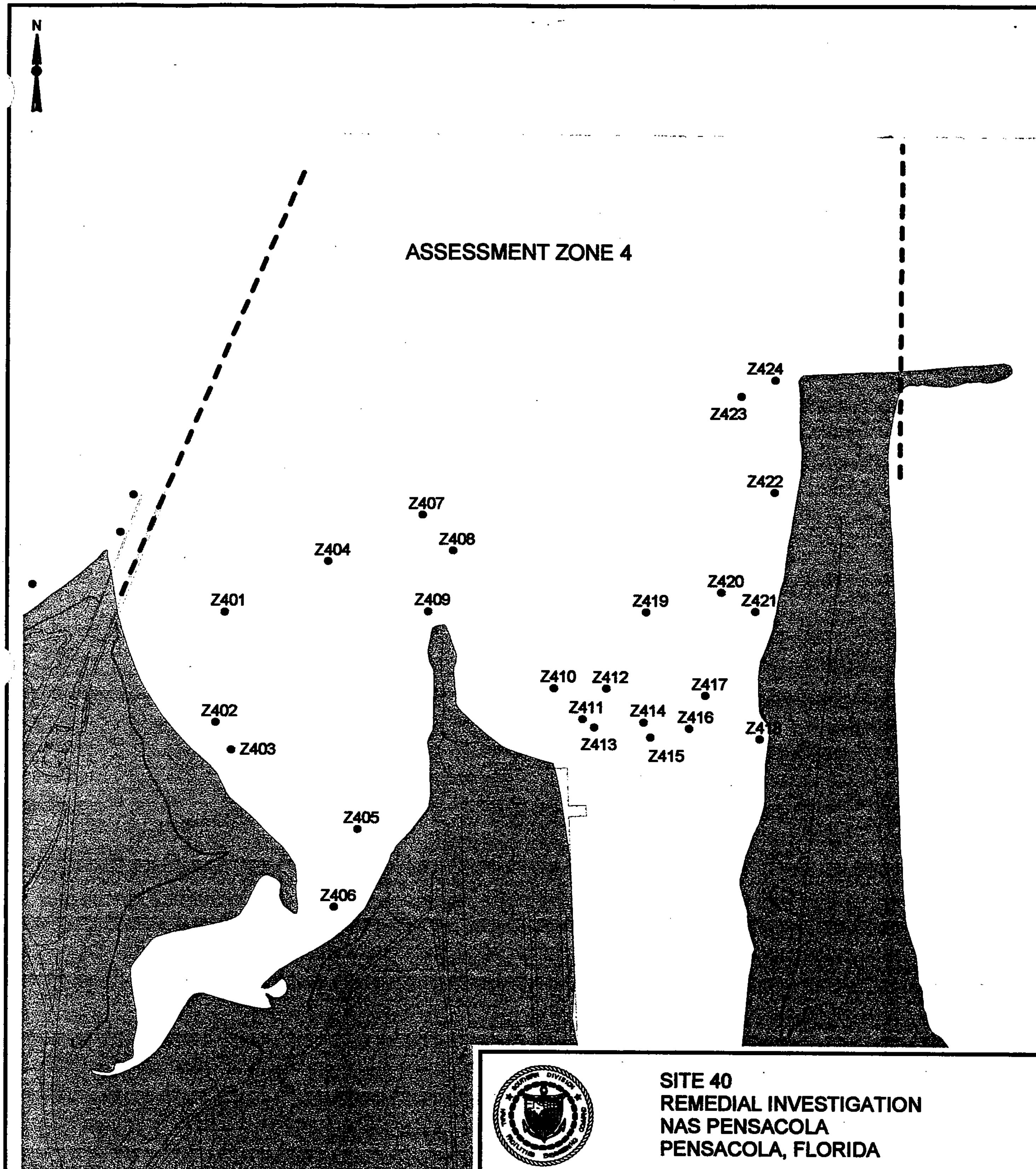
date: April 19, 2000



SITE 40
REMEDIAL INVESTIGATION
NAS PENSACOLA
PENSACOLA, FLORIDA

FIGURE 5-5
ASSESSMENT ZONE 4
SAMPLE LOCATIONS
PHASE IIA

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date: April 19, 2000

Field Data

Ancillary field data pertinent to the investigation were collected in accordance with Chapter 14 of the CSAP. Ancillary data included measuring field parameters (pH, specific conductivity, turbidity, dissolved oxygen, temperature, and salinity) at each sample location, in addition to water depth and a visual description of the sediments.

Decontamination

All exploration and sampling equipment used in the field investigation was decontaminated in accordance with Chapter 11 of the CSAP. Isopropyl alcohol was not used in the decontamination process aboard the sampling vessel. Transporting a sizable quantity of alcohol aboard the vessel posed both a fire and spill contamination hazard. Alcohol was deleted from the decontamination process. The revised decontamination procedure was modified as follows.

- A seawater rinse to remove mud and debris.

- A detergent wash using Liqui-Nox dissolved in American Society for Testing and Materials (ASTM) Type II water.

- Finally a triple rinse in ASTM Type II water.

Used decontamination fluids were properly disposed of onshore.

Toxicological Assessment

Sediment sample collection for use in toxicity tests during Phase IIB/III followed methods described in Chapter 8 of the CSAP. Samples were collected in precleaned 1-gallon plastic containers, placed on ice, and transported directly to the laboratory. Sediment toxicity tests included 10-day chronic Leptocheirus plumulosus (estuarine amphipod), 20-day chronic

Neanthes arenaceodentata (polychaete worm), and 7-day chronic *Mysidopsis bahia* (mysid shrimp) bioassays. The mysid test was added after completion of the SAP addendum. Specific test methods and procedures for referenced bioassays are provided in Appendix E.

Benthic Community Assessment

Sediment collection for assessment of the benthic community followed methods described in the Chapter 8 of the CSAP. Samples were shipped to TAI Laboratory for taxonomic sorting and enumeration. Specific methods used to sort and determine community metrics and results are listed in Appendix F.

Fish Sampling

Fish were collected at one sampling location over several days as described in Chapter 8 of the CSAP. Upon retrieval from traps, fish were identified, sorted, put in resealable bags, and placed on ice. Fish were frozen immediately upon returning from the field, and shipped on dry ice to Savannah Laboratories for whole-body analysis of SVOCs and pesticides/PCBs using SW-846 methods. SVOC analysis could not be run on one of the fish samples (040J400602) because of insufficient sample volume. Except for barium, beryllium, cadmium, calcium, cyanide, magnesium, mercury, potassium, and sodium, all TAL metals were analyzed.

The two fish samples were collected in Bayou Grande at the same sample location (Location 6 of Phase IIB/III). The fish were divided by type of fish to make two samples. The sample identification, type of fish, length and number of fish in each sample are summarized in Table 5-1. Analytical results for the fish samples are presented in Appendix C.

Table 5-1
Site 40 Fish Tissue

Sample ID	Type of Fish	Length (mm)*	Number of Fish in Sample
040J400601	killifish	90-122	4
040J400602	pinfish	55-75	9

Note:
* = Fish were measured from tip of nose to tip of tail fin

6.0 BATHYMETRY AND SEDIMENTOLOGY

Bathymetric sedimentologic, and hydrologic influences were studied for near-shore areas in Bayou Grande adjacent to NAS Pensacola, to determine areas of active sediment transport and deposition. Section 4 details the results of the sediment mapping phase of this study.

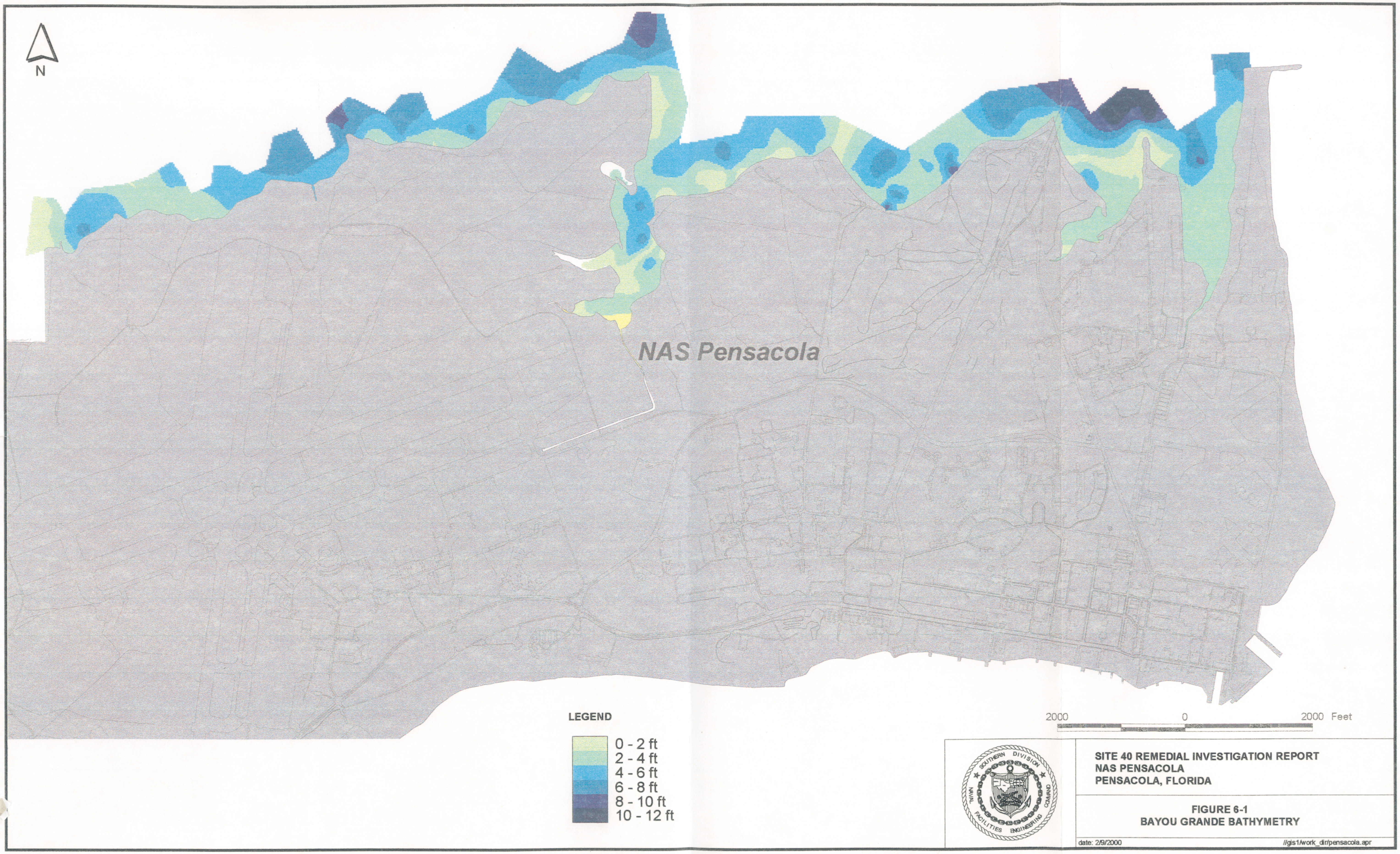
6.1 Bathymetry

Bathymetry is important when determining areas of sedimentation and erosion. Water depths in the Pensacola Bay System are a product of wave, tidal, and fluvial processes as Escambia Bay and Blackwater Bay discharge to Pensacola Bay. Complicating the issue further, the Intracoastal Waterway allows mixing of Big Lagoon and Pensacola Bay. Depths ranged from approximately a few inches in back bayous and upper portions of Bayou Grande to approximately 10 feet at offshore sample locations (Figure 6-1).

6.2 Sedimentologic Results

Figure 6-2 shows percent solids data for Bayou Grande sediment. This information was derived from grab samples collected during Phase I of the investigation. Grabs were collected and visually classified during a preliminary assessment of the bottom sediments. Data such as these were used to select subsequent Site 40 Phase II sample locations. Much of the site is covered with poorly graded fine-grained quartz intermixed with silt and clay particles.

As previously discussed in Section 4, sediment distribution can be generalized into three categories: mud, sand, and a transition from sand to mud or mud to sand (refer to Figures 4-2 and 4-3). As the study moved along the shore, finer silt and clay sediment deposition was interspersed with sand bars that radiated out from the shoreline. In deeper portions of the bayou, finer silts and clays, transitioning to black gelatinous clays, were predominant. The bayou's shoreline configuration contributes to deposition of fine-grained sediment. Low energy areas at the headwaters of the bayou (near Jones Creek), and in Redoubt Bayou, had sediments with higher


N
NAS Pensacola
LEGEND
0 - 2 ft
2 - 4 ft
4 - 6 ft
6 - 8 ft
8 - 10 ft
10 - 12 ft
2000
0
2000 Feet
SOUTHERN DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
SITE 40 REMEDIAL INVESTIGATION REPORT
NAS PENSACOLA
PENSACOLA, FLORIDA
FIGURE 6-1
BAYOU GRANDE BATHYMETRY
date: 2/9/2000
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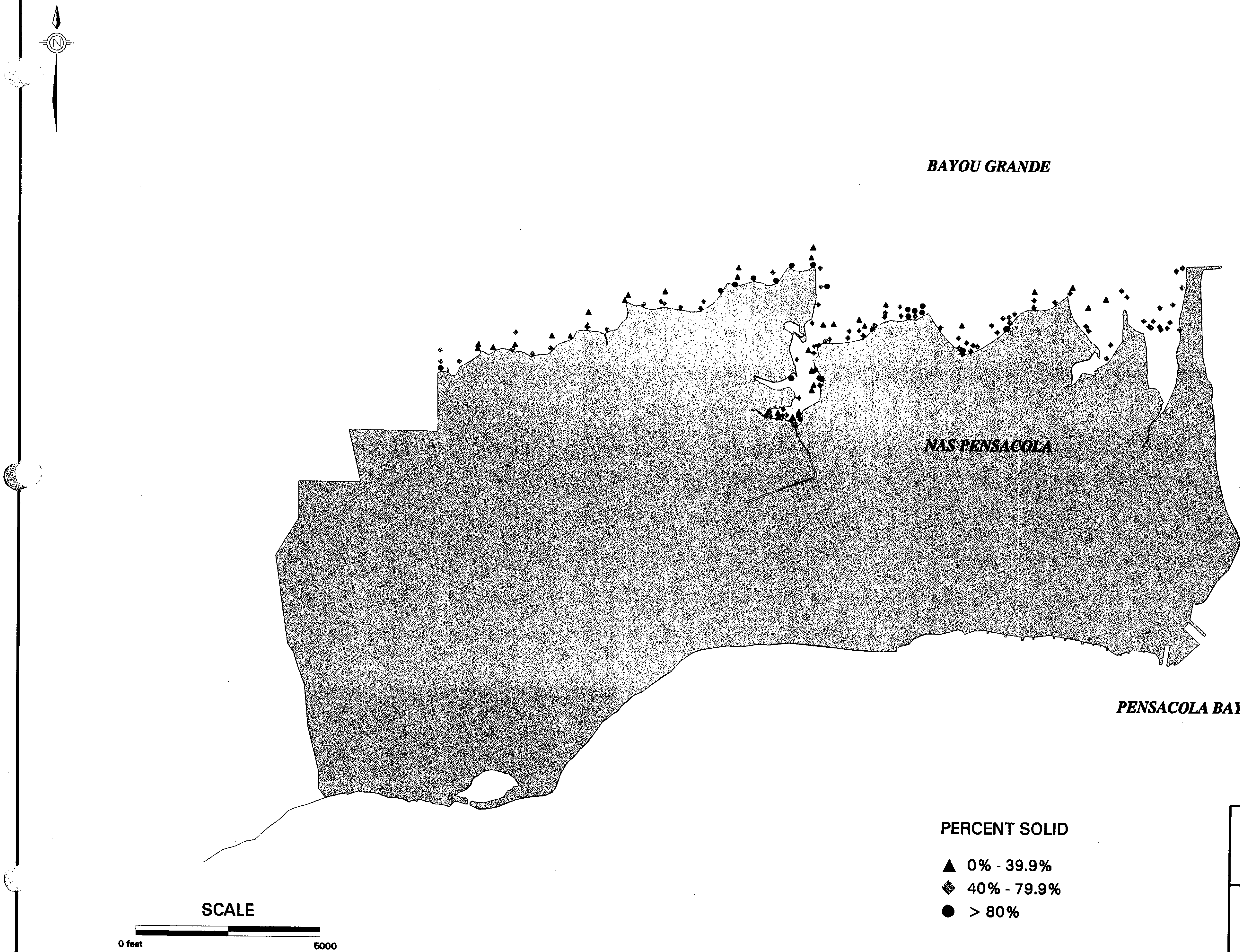


SITE 40
REMEDIAL INVESTIGATION
NAS PENSACOLA
PENSACOLA, FLORIDA

FIGURE 6-2

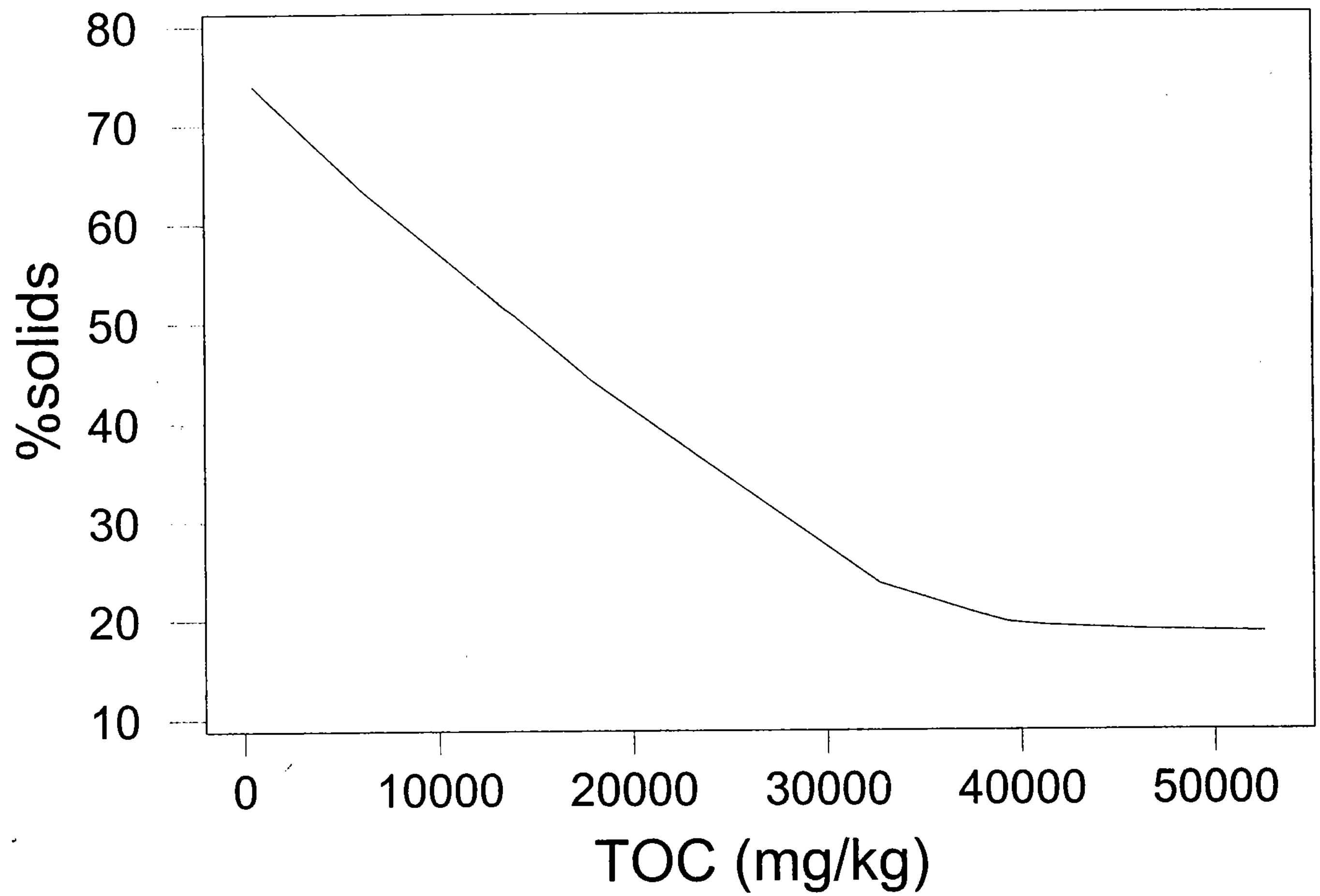
PERCENT SOLIDS
PHASE II

/home4/pensacola-dir/mapping-dir/maps40-41/solid40.aml percentages of fine-grained silts and clays, with sediments in the lower portion of the bayou (near Magazine Point) having higher percentages of sand. The shoreline for Bayou Grande consists of white fine-to-medium grained sand, extensively winnowed by wind and wave action. Accordingly, the shoreline was not sampled for this investigation.

Percent TOC distribution ranged from 0.06 to 7.24. Percent solids, which have been shown to be inversely correlated to TOC (Figures 6-3) at Site 40, can also be used to predict grain size (Figure 6-4). A moderate relationship between TOC and percent fines (silt/clay fraction) was also observed (Figure 6-5). The silt/clay fraction is that percentage of a sediment sample, by weight, that can pass through a #200 (65-74 μ) sieve (USCS).

6.3 Hydrologic Assessment

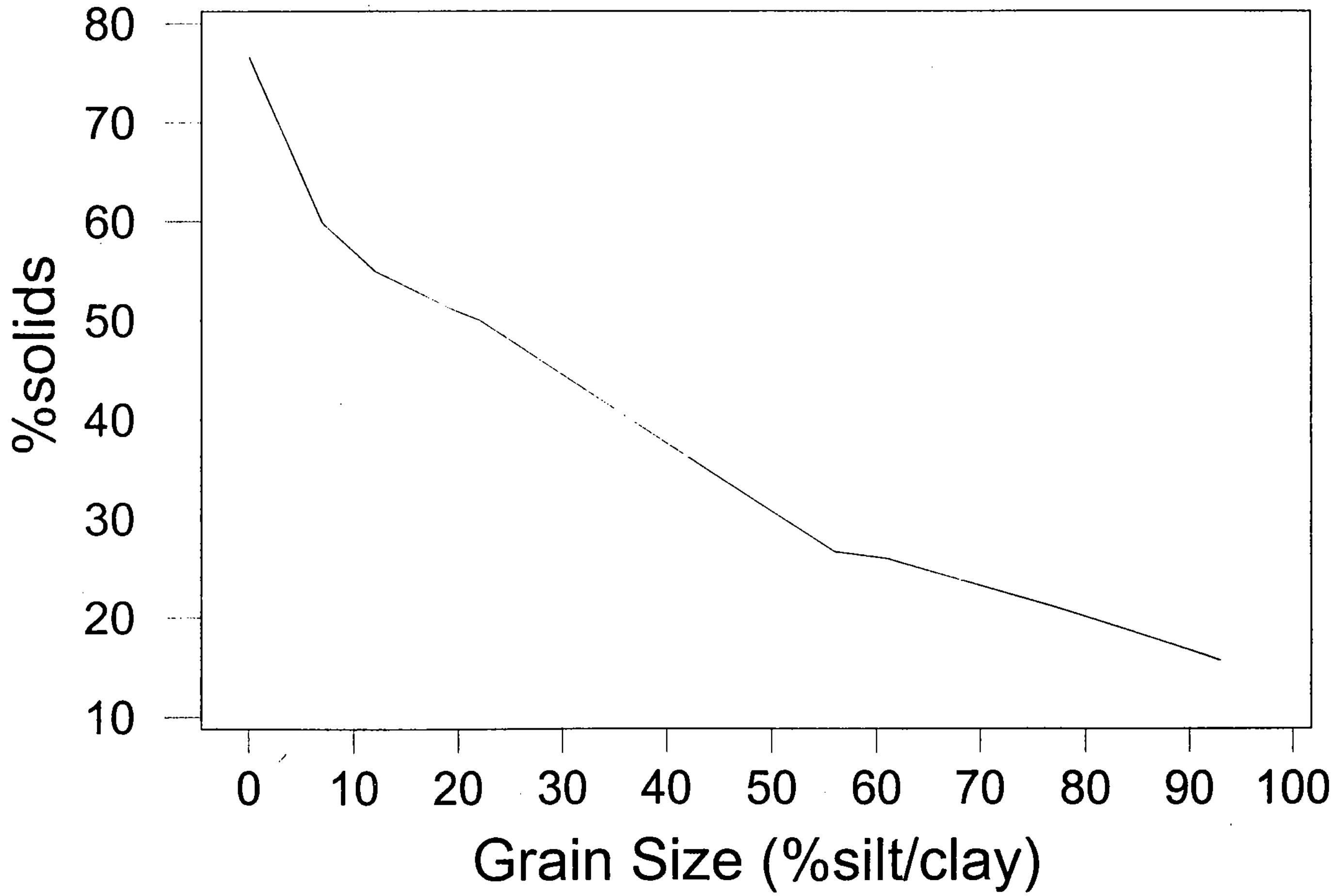
Water movement into and out of Bayou Grande is dominated by tidal fluctuations and rainfall. The tide causes the surface water elevation to fluctuate approximately one foot. The intensity of water movement within the bayou, from changing tides, is less than Pensacola Bay due to the restrictive nature of the connection with Pensacola Bay near Magazine Point. A distinct lag in tidal schedules (high or low tide) occur in the bayou compared to those observed in Pensacola Bay proper. Rainfall may periodically increase flow and transport of sediment into the bayou via Jones Creek, but its overall effects on sediment movement are insignificant.



SITE 40
REMEDIAL INVESTIGATION
NAS PENSACOLA

FIGURE 6-3
RELATIONSHIP OF PERCENT SOLID TO TOC

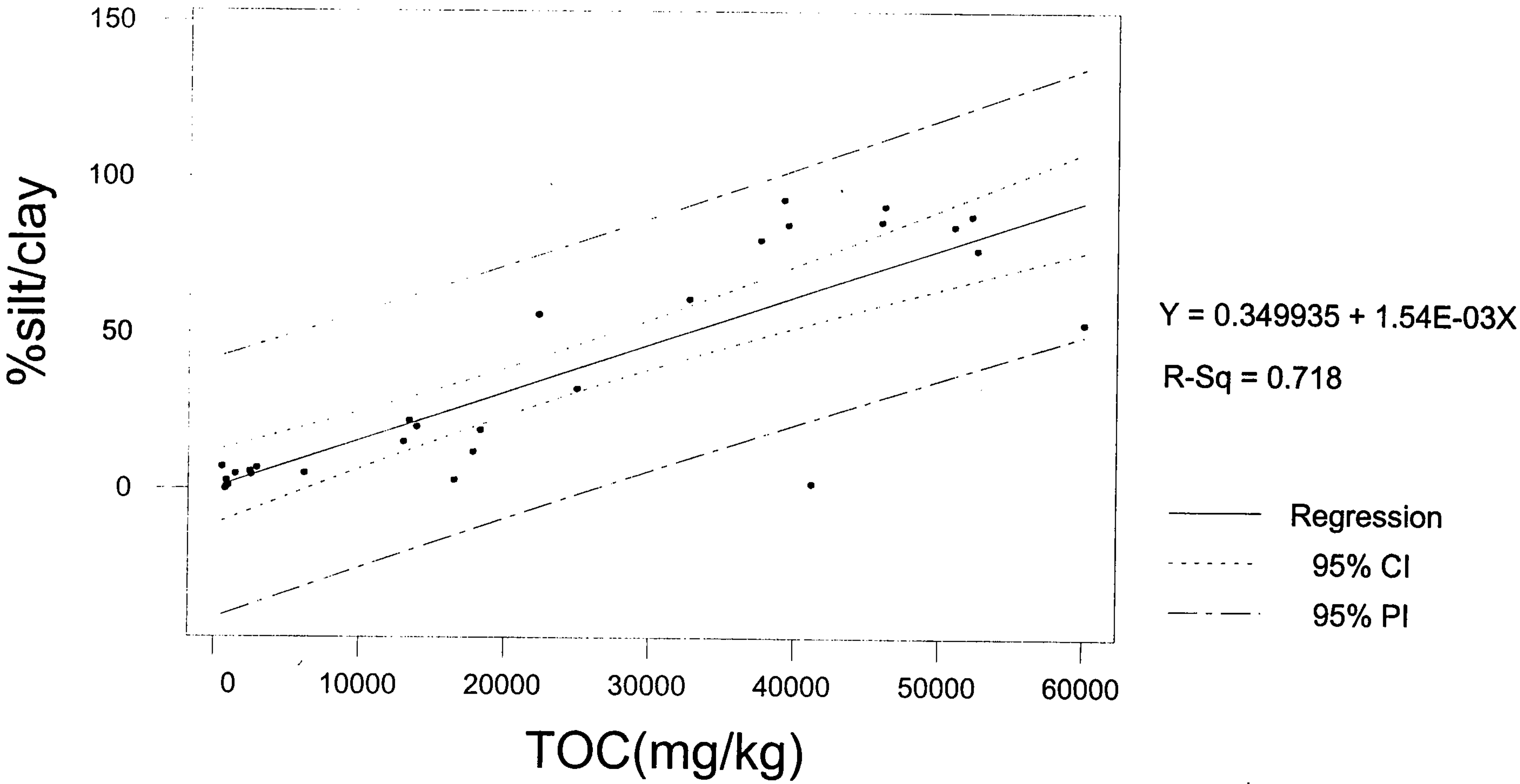
DWG DATE: 01/28/98 | DWG NAME: BORDER



SITE 40
REMEDIAL INVESTIGATION
NAS PENSACOLA

FIGURE 6–4
RELATIONSHIP OF PERCENT SOLIDS TO GRAIN SIZE

DWG DATE: 01/28/98 | DWG NAME: BORDER



SITE 40
REMEDIAL INVESTIGATION
NAS PENSACOLA

FIGURE 6–5
REGRESSION OF PERCENT SOLIDS
DATA TO TOC

DWG DATE: 01/28/98 | DWG NAME: BORDER

6.4 Conclusions

Near-shore areas where stormwater and groundwater discharge to the bayou are low energy systems, as evidenced by the persistence of silt-clay sized particles at near-shore stations. These tidal and fluvial processes, along with a lower energy regime system, encourage sedimentation. Tidal and fluvial currents provide the primary mode of sediment transport away from the shore. In areas of deposition, based on the high percentage of finer-grained material, black, thick, gelatinous silty clays dominated the bottom. The shoreline was determined to be a relatively high energy area containing fine-to-medium grained sand that is extensively winnowed by wind and wave action. Accordingly, the shoreline was not sampled for this investigation.

7.0 PHASE II – NATURE AND EXTENT OF CONTAMINATION

In accordance with the approved Site 40 and 42 work plan and SAP, 143 locations were sampled for sediment along approximately 8.5 miles of Bayou Grande coastline. The Phase IIA sampling approach was based on results of Phase I sampling, targeting fine-grain sediments and areas of high total organic carbon, as discussed in Section 4. Phase I was successful in assessing areas of deposition and erosion by mapping sediment types. Total organic carbon analysis provided relative adsorptive capabilities of these sediments. As discussed in Section 5, Phase IIA samples were analyzed using modified CLP methods to provide low levels of detection for all analytes in marine sediments in order to assess the nature and extent of contamination. Phase IIA analytical data are provided in Appendix B.

This section discusses the nature and extent of the analytes found during the Phase IIA investigation. Sections 7.1 through 7.4 will describe the positive analyte results for metals, pesticide/PCBs, VOCs, and SVOCs in each of the four assessment zones. Figures 7-1 through 7-29 (at end of text) illustrate the contaminant distributions for the Phase IIA data. For specific detected concentrations at each location, the reader is referred to Appendix B.

Phase IIB/III sampling locations were based on the results of the Phase IIA sampling. Samples collected during Phase IIB/III were analyzed for chemical contamination and associated toxicity as well as bioaccumulation. The Phase IIB and III data were used to assess effects of contaminants, not nature and extent, and are therefore discussed only in Section 10. Phase IIB/III analytical data are provided in Appendix C.

Only the areas of the four AZs within 300 feet of NAS Pensacola shoreline were sampled. These areas were expected to contain potential contamination based on the silt-and-clay sized particles typical in these sediments. The shoreline of these AZs were not sampled because of the extensive winnowing by wind and wave action of the fine-to-medium grained sand characteristic of these areas. Contamination was not expected to occur in these dynamic areas.

7.1 Background DDT Concentrations

Although its use has been banned in the United States since 1972, DDT and its metabolites are still detected in the Florida coastal sediments (Delfino *et al.*, 1991). Although DDT is not naturally occurring, it appears to be ubiquitous in the environment, i.e., in surface water, sediment, and biological tissues. DDT and its metabolites are generally highly lipophilic, resistant to biodegradation, and bioconcentrate in biota. DDT is then transferred to humans through the food chain. Atmospheric transport from Central America continues to contribute to the DDT concentrations in the Florida coastal sediment. Therefore, studies of the Pensacola Bay system (National Status and Trends Program [NSTP]) and NAS Pensacola (Sites 40 and 41) were reviewed to establish a background level for DDT and its metabolites for NAS Pensacola coastal sediments. The NSTP results are detailed in *Magnitude and Extent of Sediment Toxicity in Four Bays of the Florida Panhandle: Pensacola, Choctawhatchee, St. Andrew, and Apalachicola* (Long *et al.*, 1997). The NAS Pensacola results are detailed in this report for Site 40 and in the Site 41 Remedial Investigation Report (EnSafe, *in press*). The summary table from the NSTP study and a table presenting all the results from the Sites 40 and 41 investigation are presented in Appendix G. The resulting background concentrations should be considered the maximum concentration at which concentrations may be detected based on widespread use.

The NSTP study analyzed 24 sediment samples from the Pensacola Bay system for pesticides/PCBs. In the Sites 40 and 41 investigations, 265 sediment samples were analyzed for pesticides/PCBs. The NAS Pensacola Site 41 samples were further evaluated based on the color coding established for the wetlands remedial investigation (EnSafe, *in press*). Assigning a wetland as either red, orange, or blue was based on a subjective determination of contaminant distribution and exceedances of reference values and sediment and water quality benchmarks. The groupings are defined as the following:

Red: Contamination appears related to an IR site with consistent exceedance of reference values and benchmarks. Wetlands assigned the red designation (in the order discussed) are Wetlands 64, 5A/5B, 3, 4D, 16, 18, 10, 12, and W1.

Orange: Contamination may be related to an IR site. However, limited contaminants exceed reference values or benchmarks, or the contaminants exceed benchmarks but do not appear to be site-related. Wetlands assigned the orange designation (in the order discussed) are Wetlands 1, 15, 6, 63A, 48, and 49.

Blue: Isolated or no contaminants are detected which in most cases are below reference values and/or benchmarks and do not appear to be related to an IR site. Wetlands assigned the blue designation (in the order discussed) are Wetlands 13, 17, 19, 52, 56, 57, 58, 63B, 72, 79, and W2.

Reference: Contaminant from NAS Pensacola IRP sites is not expected based on the location of the wetland. Wetlands assigned as reference are Wetlands 25, 27, 32, and 33.

Tables summarizing the detected concentrations for the blue and reference wetlands are presented in Appendix G.

4,4-DDD

4,4-DDD was detected in 50% of the NSTP study locations at concentrations ranging from 2.58 ppb to 53.84 ppb. 4,4-DDD was detected in 29.7% of the NAS Pensacola sediment samples from Sites 40 and 41 from 0.2 ppb to 2,600 ppb (Wetland 48 of Site 41). In the blue-coded and reference wetlands, the concentrations ranged from 0.2 ppb in Wetland 72 to 24 ppb in

Wetland 32. Based on the concentrations in the NSTP study and the blue-coded and reference wetlands, the background concentration is established at 50 ppb.

4,4-DDE

4,4-DDE was not analyzed for in the NSTP study. 4,4-DDE concentrations in the Sites 40 and 41 investigations ranged from 0.21 to 620 ppb (Wetland 48). The concentration of 4,4-DDE in the blue- coded and reference wetlands ranged from 0.24 ppb (Wetland 72) to 37 ppb (Wetland 32). A background concentration was established at 40 ppb.

4,4-DDT

4,4-DDT was detected in 41.7% of the NSTP study samples. The concentrations ranged from 2.02 ppb to 37.06 ppb in that study. 4,4-DDT was detected in 23.6% of the NAS Pensacola Sites 40 and 41 sediment samples and ranged from 0.21 ppb to 1,800 ppb (Wetland 18B). The blue-coded and reference wetland concentrations ranged from 0.26 ppb (Wetland 72) to 13 ppb (Wetland 32). Based on the results of the NSTP study and the blue-coded and reference wetlands, a background concentration of 20 ppb was established for 4,4-DDT.

The detected concentrations for 4,4-DDD, 4,4-DDE and 4,4-DDT in the four AZs will be compared to the above listed reference concentrations in this section.

7.2 Assessment Zone 1

Thirty-eight sediment samples were collected from AZ-1 to assess the site conditions. Tables 7-1 through 7-3 summarize the frequency and range of detection, range of nondetected upper bounds, and average detected concentration. The ecological screening concentration and number of samples greater than the screening concentration are also provided to give the reader a general

Table 7-1
Inorganics Detected in AZ-1 Sediments, Phase IIA (mg/kg)

Parameter	Frequency of Detection*	Range of Nondetected Upper Bounds	Range of Detected Concentrations	Average Detected Concentration	Ecological Screening Concentration	Number Over Screen
Aluminum	38/38		162 - 32300	8866		
Antimony	6/23	0.13 - 0.71	0.19 - 0.71	0.39	12a	
Arsenic	34/38	0.12 - 0.14	0.17 - 18.4	7.4	7.24a, b	15
Barium	18/38	0.34 - 16.2	0.3 - 24.8	6.7		
Beryllium	16/38	0.06 - 0.98	0.07 - 1.2	0.67		
Cadmium	18/38	0.12 - 0.55	0.22 - 3.7	1.7	0.676b	14
Calcium	38/38		59.5 - 6150	1298		
Chromium	32/38	1.1 - 3.9	0.59 - 176	54.5	52.3a, b	14
Cobalt	18/38	0.12 - 0.63	0.13 - 5.6	2.5		
Copper	36/38	0.25 - 0.28	0.26 - 33.6	10.8	18.7a, b	13
Iron	38/38		174 - 34400	11055		
Lead	36/38	0.95 - 1.1	0.72 - 97.7	29.8	30.2a, b	15
Magnesium	38/38		130 - 10000	2967		
Manganese	38/38		0.54 - 235	57		
Mercury	7/38	0.05 - 0.28	0.21 - 2.2	0.58	0.13a, b	7
Nickel	24/38	0.55 - 2.5	0.64 - 16	6.7	15.9a, b	1
Potassium	34/38	57.5 - 70.3	46 - 4320	1329		
Selenium	18/38	0.25 - 1	0.32 - 2.8	1.3		
Silver	1/38	0.31 - 1.8	0.3800	0.38	0.733b	
Sodium	38/38		711 - 35300	9197		
Thallium	2/38	0.25 - 1.4	0.35 - 3	1.7		
Vanadium	38/38		0.44 - 54.2	16		
Zinc	27/38	1.1 - 14.9	2.3 - 163	64.7	124a, b	5

Notes:

* = For specific parameters, the total number of samples has been reduced by the number of rejected samples. See Section 8 of this report.
a = USEPA Screening Concentration for Sediment — USEPA SSVs
b = FDEP Screening Concentration for Sediment — FDEP SQAGs as listed in the *Approach to the Assessment of Sediment Quality in Florida Coastal Waters* by D.D. MacDonald, MacDonald Environmental Sciences, Ltd., Prepared for the Florida Department of Environmental Protection, November 1994.
mg/kg = milligram per kilogram

Table 7-2
Pesticides/PCBs Detected in AZ-1 Sediment, Phase IIA (μg/kg)

Parameter	Frequency of Detection*	Range of Nondetected Upper Bounds	Range of Detected Concentrations	Average Detected Concentration	Ecological Screening Concentration	Number Over Screen
4,4'-DDD	1/36	0.19 - 8.9	1.6000	1.6	1.22b	1
4,4'-DDE	13/37	0.19 - 2.7	0.99 - 4.4	2.4	2.07b	7
Aldrin	3/38	0.095 - 4.3	0.45 - 1.8	0.95		
Aroclor-1260	28/38	2.1 - 21	0.2 - 39	15.9	21.6a	9
Dieldrin	6/38	0.19 - 8.9	0.9 - 1.7	1.2	0.715b	6
Endosulfan II	1/36	0.19 - 8.9	1.3000	1.3		
Heptachlor	1/36	0.095 - 4.3	0.8100	0.81		
Heptachlor epoxide	3/37	0.095 - 4.3	0.11 - 1	0.48		
alpha-BHC	1/36	0.095 - 4.3	1.3000	1.3		
alpha-Chlordane	6/36	0.095 - 4.3	0.1 - 1.6	0.53		
gamma-BHC (Lindane)	6/36	0.095 - 4.3	0.73 - 1.3	1.1	0.32b	6
gamma-Chlordane	1/37	0.095 - 4.3	0.4100	0.41		

Notes:

* = For specific parameters, the total number of samples has been reduced by the number of rejected samples. See Section 8 of this report.
a = USEPA Screening Concentration for Sediment — USEPA SSVs
b = FDEP Screening Concentration for Sediment — FDEP SQAGs as listed in the *Approach to the Assessment of Sediment Quality in Florida Coastal Waters* by D.D. MacDonald, MacDonald Environmental Sciences, Ltd., Prepared for the Florida Department of Environmental Protection, November 1994.
μg/kg = microgram per kilogram

Table 7-3
SVOCs Detected in AZ-1 Sediment, Phase IIA (μg/kg)

Parameter	Frequency of Detection*	Range of Nondetected Upper Bounds	Range of Detected Concentrations	Average Detected Concentration	Ecological Screening Concentration	Number Over Screen
2,4-Dimethylphenol	1/38	380 - 2400	98	98		
2-Methylnaphthalene	1/38	38 - 240	94	94	20.2b	1
2-Nitroaniline	1/38	380 - 2400	23	23		
3-Nitroaniline	1/38	920 - 5700	200	200		
4-Chloroaniline	1/21	400 - 2400	61	61		
4-Methylphenol (p-Cresol)	5/38	380 - 2100	29 - 200	120		
4-Nitroaniline	1/38	920 - 5700	140	140		
Benzo(a)pyrene	1/38	38 - 240	85	85	88.8b	
Benzo(b)fluoranthene	7/38	38 - 170	91 - 170	120		
Benzo(g,h,i)perylene	1/38	38 - 240	85	85		
Butylbenzylphthalate	9/38	380 - 2100	21 - 170	54		
Di-n-butylphthalate	10/38	380 - 2100	21 - 270	78		
Diethylphthalate	2/38	380 - 2400	23 - 1800	912		
Fluoranthene	8/38	38 - 410	21 - 200	107	113b	3
Indeno(1,2,3-cd)pyrene	1/38	38 - 240	76	76		
Naphthalene	7/38	38 - 210	22 - 140	69	34.6b	3
Nitrobenzene	1/38	380 - 2400	90	90		
Pyrene	3/38	38 - 210	74 - 150	111	153b	
bis(2-Ethylhexyl)phthalate (BEHP)	19/38	380 - 2100	21 - 2400	208	182a,b	2

Notes:
* = For specific parameters, the total number of samples has been reduced by the number of rejected samples. See Section 8 of this report.
a = USEPA Screening Concentration for Sediment — USEPA SSVs
b = FDEP Screening Concentration for Sediment — FDEP SQAGs as listed in the *Approach to the Assessment of Sediment Quality in Florida Coastal Waters* by D.D. MacDonald, MacDonald Environmental Sciences, Ltd., Prepared for the Florida Department of Environmental Protection, November 1994.
μg/kg = micrograms per kilogram

impression of the level of impact. The sample locations and concentrations above the ecological screening concentration are discussed further in the risk assessment, Section 10.

Inorganics

Twenty-three metals were detected in sediment samples collected from AZ-1. Except for tin, every metal analyzed for was detected. Ten metals detected at AZ-1 have ecological screening concentrations and thirteen metals detected at this AZ have no ecological screening criteria. Detection frequency ranged from one in 38 samples (silver) to 38 in 38 samples (aluminum, calcium, iron, magnesium, manganese, sodium, and vanadium). The abundance of alkali metals in sediment will encourage the precipitation rather than solution of other less electropositive metals. Precipitation due to the presence of alkali metals, which is known as the "salting effect", provides an understanding as to why almost every metal analyzed for was found in the bayou sediments. In addition, Table 7-1 compares detected concentrations to ecological screening concentrations providing a qualitative basis for understanding which metals are of concern. This table also summarizes the frequency and range of detected concentrations, range of nondetected upper bounds, and the average detected concentrations. Figures 7-1 through 7-8 show the areal distribution of eight metals for which sediment criteria are available: arsenic, cadmium, chromium, copper, lead, mercury, nickel, and zinc. The ecological screening concentrations and risk evaluation results are further discussed in Section 10, Baseline Risk Assessment.

Except for the parameters detected in every sample, the widest distribution of metals at AZ-1 occurred with arsenic (34 detections), chromium (32 detections), copper (36 detections), and lead (36 detections). These metals also exceeded their respective ecological screening concentrations at similar frequencies (15 exceedances for arsenic, 14 exceedances for chromium, 13 exceedances for copper, and 15 exceedances for lead). The exceedances for these metals were equally distributed across AZ-1.

A lesser frequency of metals detections occurred with cadmium (18 detections), nickel (24 detections), and zinc (27 detections). Of these detections, five zinc concentrations, fourteen cadmium concentrations and one nickel detection exceeded the respective ecological screening concentrations for these metals. The distribution of cadmium and zinc are equal across AZ-1. The nickel exceedance occurred near the eastern end of the AZ, at the mouth of Redoubt Bayou.

The least distribution of metals occurred with antimony (six detections), mercury (seven detections), and silver (one detection). All seven mercury detections exceeded its ecological screening concentration. The mercury exceedances were distributed along the eastern portion of AZ-1. All antimony concentrations were below the ecological screening concentration for antimony. Fifteen antimony sample results were rejected because of laboratory problems. The silver exceedance is not considered related to any specific source.

Metals detected at AZ-1 for which no ecological screening criteria exist included aluminum, barium, beryllium, calcium, cobalt, iron, magnesium, manganese, potassium, selenium, sodium, thallium, and vanadium.

Pesticides/PCBs

Eleven pesticides and one PCB compound were detected in the 38 sediment samples collected from AZ-1. Four pesticides and the PCB detected at AZ-1 have ecological screening concentrations, and seven pesticides detected at this AZ have no ecological screening criteria. Figures 7-9, 7-10, 7-12, and 7-14 show the areal distribution of the four pesticides detected at AZ-1 which exceeded ecological screening criteria. Figure 7-15 shows the areal distribution for total PCBs, representing the distribution of Aroclor-1260 at AZ-1. The ecological screening concentrations and risk evaluation results are further discussed in Section 10, Baseline Risk Assessment. Table 7-2 summarizes the pesticides and PCBs detected at AZ-1.

Pesticides with ecological screening criteria detected across AZ-1 included 4,4-DDD, 4,4-DDE, dieldrin, and gamma-BHC. 4,4'-DDT was not detected at any of the sampling locations in AZ-1, however, it's daughter products, 4,4'-DDD (one detection) and 4,4'-DDE (13 detections) were sporadically found. Of the DDT metabolites detected at AZ-1, seven 4,4'-DDE detections and one 4,4'-DDD concentration exceeded the respective ecological screening concentrations for these compounds. None of the detected concentrations exceeded their background concentrations. All dieldrin and gamma-BHC detections at AZ-1 (six detections each) exceeded the ecological screening concentrations for each compound. The only PCB detected was Aroclor-1260 (28 detections). Nine Aroclor-1260 concentrations exceeded the ecological screening concentration for this PCB at AZ-1.

Pesticides detected at AZ-1 for which no ecological screening criteria exist included aldrin, endosulfan II, heptachlor, heptachlor epoxide, alpha-BHC, and alpha/gamma-chlordane.

The pesticide compounds exceeding ecological screening criteria at AZ-1 were either very widely or sporadically distributed throughout AZ-1. The PCB detected was widely but evenly distributed along the AZ. None of these detections can be related to an IRP site at NAS Pensacola.

SVOCs

Nineteen SVOCs were detected in the 38 sediment samples collected from AZ-1. Six SVOCs detected at AZ-1 have ecological screening concentrations, and thirteen SVOCs detected at this AZ have no ecological screening criteria. Figures 7-16, 7-21, 7-24, 7-26, 7-28, and 7-29 show the areal distribution of the six SVOCs with ecological screening criteria which were detected at AZ-1. The ecological screening concentrations and risk evaluation results are further discussed in Section 10, Baseline Risk Assessment. Table 7-3 summarizes the SVOCs detected at AZ-1.

The most widely distributed SVOC is bis(2-ethylhexyl)phthalate (BEHP) which was detected at 19 sample locations. Only two BEHP detections exceeded the appropriate ecological screening concentration. BEHP is also a common laboratory contaminant. Eight fluoranthene and seven naphthalene concentrations were detected, with three exceedances for each compound. The single 2-methylnaphthalene detection at AZ-1 also exceeded the ecological screening concentration for this compound. Benzo(a)pyrene and pyrene were detected below the ecological screening values for these compounds. Ten of the SVOCs found at AZ-1 had single detections.

SVOCs detected at AZ-1 for which no ecological screening criteria exist included 2,4-dimethylphenol, 2/3/4-nitroaniline, 4-chloroaniline, 4-methylphenol, benzo(b)fluoranthene, benzo(g,h,i)perylene, butylbenzylphthalate, di-n-butylphthalate, diethylphthalate, indeno(1,2,3-cd)pyrene, and nitrobenzene.

The distribution of SVOCs above the appropriate ecological screening criteria was sporadic, and mostly along the eastern portion of AZ-1, near the mouth of Redoubt Bayou. None of these detections can be related to an IRP site at NAS Pensacola.

VOCs

Acetone, was the only VOC detected in AZ-1, and it was detected at only one location (040MZ115; 140 μg/kg). No ecological screening criteria exists for acetone.

Conclusions for AZ-1

Inorganic detections occurred across AZ-1 and do not appear to be related to NAS Pensacola IRP sites or activities associated with Forrest Sherman Field. Pesticides were generally not detected in AZ-1. PCBs were detected frequently. Few SVOC parameters and only one VOC (acetone, a common laboratory contaminant) were detected in AZ-1.

Few contaminant source areas were identified for this AZ. Potential sources include former IRP site (underground storage tank [UST]) 18 and Forrest Sherman Field, which lie south of the zone. The UST 18 investigation determined that the contaminants were not migrating offsite (E/A&H, 1996). Wetlands 25 and 27 were used as reference wetlands for the Site 41 investigation because of the lack of a pathway from NAS Pensacola sites. In addition, the other wetlands in this AZ (Wetlands 39, 70, and 28) were determined not to have a pathway from NAS Pensacola sites and were not sampled in the Site 41 RI (EnSafe, *in press*). Wetland 72, which drains storm water from the north central portion of Forrest Sherman Field to Bayou Grande through Wetland 39 was sampled during the Site 41 RI. A Blue Coded wetland, Wetland 72 was expected to have isolated contaminant concentrations which were below applicable ecological screening criteria, and not related to any NAS Pensacola IRP site. The Site 41 RI discovered scattered metals, and a few pesticides and SVOCs in Wetland 72, indicating minimal potential impact on Wetland 39 and Bayou Grande from this drainage source (EnSafe, *in press*). The only other possible sources for AZ-1 are the numerous minor surface water drainage pathways which drain through the minor estuarine wetlands which line the shoreline throughout AZ-1. These cannot, however, be connected to an IRP site activity on the base.

7.3 Assessment Zone 2

Fifty-seven sediment samples were collected from AZ-2 to assess the site conditions. Tables 7-4, through 7-7 summarize the frequency and range of detected concentrations, range of nondetected upper bounds, and average detected concentrations.

Inorganics

Twenty-three metals were detected in sediment samples collected from AZ-2. Ten metals detected at AZ-2 have ecological screening concentrations, and thirteen metals detected in this AZ have no

Table 7-4
Inorganics Detected in AZ-2 Sediments, Phase IIA (mg/kg)

Parameter	Frequency of Detection*	Range of Nondetected Upper Bounds	Range of Detected Concentrations	Average Detected Concentration	Ecological Screening Concentration	Number Over Screen
Aluminum	57/57		148 - 28900	6082		
Antimony	7/33	0.12 - 0.71	0.16 - 4.6	1.1	12a	
Arsenic	45/57	0.12 - 1.6	0.14 - 21.8	5.5	7.24a, b	14
Barium	45/57	0.36 - 0.89	0.19 - 22.2	5.8		
Beryllium	18/57	0.06 - 0.11	0.08 - 1.1	0.71		
Cadmium	21/57	0.12 - 0.26	0.25 - 4.5	1.9	0.676b	16
Calcium	57/57		66.4 - 5020	952		
Chromium	57/57		0.62 - 174	34.0	52.3a,b	14
Cobalt	26/57	0.12 - 0.34	0.12 - 5.2	1.8		
Copper	49/57	0.24 - 0.28	0.27 - 40.1	10.1	18.7a, b	14
Iron	57/57		163 - 34400	8109		
Lead	53/57	1.2 - 1.8	0.74 - 131	31.1	30.2a, b	16
Magnesium	57/57		138 - 9520	2107		
Manganese	57/57		0.46 - 249	42.19		
Mercury	9/57	0.05 - 0.31	0.08 - 0.64	0.27	0.13a, b	8
Nickel	22/57	0.54 - 1	0.63 - 15.4	7.2	15.9a, b	
Potassium	50/57	66.3 - 95.2	48.1 - 3790	862		
Selenium	18/57	0.18 - 1.1	0.21 - 2.2	1.2		
Silver	1/57	0.24 - 1.5	0.3200	0.32	0.733b	
Sodium	57/57		736 - 31900	6236		
Thallium	3/57	0.18 - 1.6	0.6 - 1	0.84		
Vanadium	57/57		0.40 - 54.4	11.6		
Zinc	38/57	0.86 - 4.5	1.2 - 206	56.8	124a, b	11

Notes:
* = For specific parameters, the total number of samples has been reduced by the number of rejected samples. See Section 8 of this report.
a = USEPA Screening Concentration for Sediment — USEPA SSVs
b = FDEP Screening Concentration for Sediment — FDEP SQAGs as listed in the *Approach to the Assessment of Sediment Quality in Florida Coastal Waters* by D.D. MacDonald, MacDonald Environmental Sciences, Ltd., Prepared for the Florida Department of Environmental Protection, November 1994.
mg/kg = milligram per kilogram

Table 7-5
Pesticides/PCBs Detected in AZ-2 Sediments, Phase IIA (µg/kg)

Parameter	Frequency of Detection*	Range of Nondetected Upper Bounds	Range of Detected Concentrations	Average Detected Concentration	Ecological Screening Concentration	Number Over Screen
4,4'-DDD	18/56	0.21 - 9.8	0.26 - 16	4.1	1.22b	10
4,4'-DDE	25/56	0.21 - 0.81	0.22 - 13	3.2	2.07b	13
4,4'-DDT	17/56	0.18 - 9.8	0.21 - 22	3.1	1.19b	5
Aldrin	9/56	0.088 - 4.8	0.22 - 1.8	0.81		
Aroclor-1242	8/56	1.8 - 98	1.8 - 34	8.2	33b	1
Aroclor-1260	28/56	2.1 - 19	1.2 - 110	31.5	33b	16
Dieldrin	18/56	0.18 - 9.8	0.11 - 2.6	0.99	0.715b	8
Endosulfan I	3/56	0.088 - 4.8	0.11 - .12	0.12		
Endosulfan II	4/56	0.18 - 9.8	0.43 - 1.1	0.69		
Endosulfan sulfate	1/56	0.18 - 9.8	0.41	0.41		
Endrin	9/56	0.18 - 9.8	0.14 - 1.4	0.83	3.3a	
Endrin aldehyde	1/56	0.18 - 9.8	0.41	0.41	3.3a	
Endrin ketone	5/56	0.18 - 9.8	0.11 - 1.6	0.76	3.3a	
Heptachlor epoxide	3/56	0.088 - 4.8	0.15 - 2.5	1.2		
Methoxychlor	1/56	0.88 - 48	1.9000	1.9		
alpha-BHC	6/56	0.1 - 4.8	0.15 - 1.8	0.67		
alpha-Chlordane	12/56	0.1 - 4.8	0.12 - 1.5	0.75		
beta-BHC	2/56	0.088 - 4.8	0.19 - .38	0.29		
gamma-BHC (Lindane)	15/56	0.088 - 0.55	0.11 - 2.3	0.94	0.32b	10
gamma-Chlordane	5/56	0.088 - 4.8	0.21 - 1.4	0.82		

Notes:

* = For specific parameters, the total number of samples has been reduced by the number of rejected samples. See Section 8 of this report.
a = USEPA Screening Concentration for Sediment — USEPA SSVs
b = FDEP Screening Concentration for Sediment — FDEP SQAGs as listed in the *Approach to the Assessment of Sediment Quality in Florida Coastal Waters* by D.D. MacDonald, MacDonald Environmental Sciences, Ltd., Prepared for the Florida Department of Environmental Protection, November 1994.
µg/kg = micrograms per kilogram

Table 7-6
SVOCs Detected in AZ-2 Sediments, Phase IIA (μg/kg)

Parameter	Frequency of Detection*	Range of Nondetected Upper Bonds	Range of Detected Concentrations	Average Detected Concentrations	Ecological Screening Concentration	Number Over Screen
2,2'-oxybis(1-Chloropropane)	1/55	400 - 9100	44	44		
2-Methylnaphthalene	1/55	40 - 910	160	160	20.2b	1
4-Methylphenol (p-Cresol)	1/55	400 - 9100	78	78		
Acenaphthene	1/55	19 - 440	33	33	6.71b	1
Anthracene	1/55	40 - 910	80	80	46.9b	1
Benzo(a)anthracene	13/57	40 -910	22 - 230	103	74.8b	6
Benzo(a)pyrene	16/57	40 - 910	25 - 260	111	88.8b	7
Benzo(b)fluoranthene	21/57	40 - 910	22 - 380	131		
Benzo(g,h,i)perylene	10/57	40 - 910	60 - 240	110		
Benzo(k)fluoranthene	9/57	40 - 910	39 - 180	110		
Butylbenzylphthalate	8/55	400 - 9100	28 - 160	81.4		
Carbazole	1/55	400 - 9100	69.0000	69		
Chrysene	13/57	40 - 910	23 - 290	116	108b	6
Di-n-butylphthalate	20/56	400 -9100	18 - 110	41.6		
Dibenz(a,h)anthracene	1/55	40 - 910	42	42	6.22b	1
Diethylphthalate	3/55	400 -9100	24 - 30000	10375		
Fluoranthene	21/57	40 -910	22 - 490	147	113b	9
Fluorene	1/55	19 - 440	34	34	21.2b	1
Indeno(1,2,3-cd)pyrene	7/57	40 - 910	40 - 210	110		
Naphthalene	2/55	40 - 910	21 - 130	75.5	34.6b	1
Phenanthrene	7/56	40 - 910	20 - 260	104	86.7b	4
Phenol	4/55	400 - 9100	22 - 160	56.5		
Pyrene	17/57	40 - 910	31 - 480	163	153b	6
bis(2-Ethylhexyl)phthalate (BEHP)	9/55	69 - 9100	27 - 1500	258	182a,b	2

Notes:

* = For specific parameters, the total number of samples has been reduced by the number of rejected samples. See Section 8 of this report.

a = USEPA Screening Concentration for Sediment — USEPA SSVs

b = FDEP Screening Concentration for Sediment — FDEP SQAGs as listed in the *Approach to the Assessment of Sediment Quality in Florida Coastal Waters* by D.D. MacDonald, MacDonald Environmental Sciences, Ltd., Prepared for the Florida Department of Environmental Protection, November 1994.

μg/kg = micrograms per kilogram

Table 7-7
VOCs Detected in AZ-2 Sediments, Phase IIA (μg/kg)

Parameter	Frequency of Detection	Range of Nondetected Upper Bonds	Range of Detected Concentrations	Averaged Detected Concentration	Ecological Screening Concentration	Number Over Screen
Acetone	21/57	12 - 580	18 - 1200	226		
Carbon disulfide	1/57	11 -83	12	12		
Chloromethane	1/57	11 -83	1	1		
Methylene chloride	4/57	11 -83	3	8.5		

Notes:
a = USEPA Screening Concentration for Sediment — USEPA SSVs
b = FDEP Screening Concentration for Sediment — FDEP SQAGs as listed in the *Approach to the Assessment of Sediment Quality in Florida Coastal Waters* by D.D. MacDonald, MacDonald Environmental Sciences, Ltd., Prepared for the Florida Department of Environmental Protection, November 1994.
μg/kg = micrograms per kilogram

ecological screening criteria. Detection frequency ranged from one in 57 samples (silver) to 57 in 57 samples (aluminum, calcium, chromium, iron, magnesium, manganese, sodium, and vanadium). The abundance of alkali metals in sediment will encourage the precipitation rather than solution of other less electropositive metals. Precipitation due to the presence of alkali metals, which is known as the "salting effect", provides an understanding as to why every metal analyzed for was found in the bayou sediments. In addition, Table 7-4 compares detected concentrations to ecological screening concentrations providing a qualitative basis for understanding which metals are of concern. Figures 7-1 through 7-8 show the areal distribution of eight metals for which ecological concentration criteria are available: arsenic, cadmium, chromium, copper, lead, mercury, nickel, and zinc.

The widest distribution of metals with ecological screening criteria at AZ-2 occurred with arsenic (45 detections), chromium (57 detections), copper (49 detections) and lead (53 detections). These metals detections exceeded their ecological screening concentrations at similar frequencies (14 exceedances for arsenic, 14 exceedances for chromium, 14 exceedances for copper, and 16 exceedances for lead). The exceedances for these metals were distributed at the upstream end of Redoubt Bayou, where Wetlands W-2 and 19B discharge into this Bayou, and along the shoreline bordering IRP Site 1 (eastern shoreline of Redoubt Bayou). Samples from the western shoreline of Redoubt Bayou either had no detections or had concentrations below applicable ecological screening criteria for these metals.

A lesser frequency of metals detections occurred with cadmium (21 detections), mercury (nine detections), and zinc (38 detections). Of these detections, 16 cadmium, eight mercury, and 11 zinc concentrations exceeded the ecological screening concentrations. The cadmium exceedances were distributed at the upstream end of Redoubt Bayou and along the Site 1 shoreline. The mercury and zinc exceedances were also clustered at the upstream end of Redoubt Bayou, and along the northeast shoreline of redoubt Bayou, near Site 1.

Twenty-four antimony sample results were rejected because of laboratory problems.

Metals detected at AZ-2 for which no ecological screening criteria exist included aluminum, barium, beryllium, calcium, cobalt, iron, magnesium, manganese, potassium, selenium, sodium, thallium, and vanadium.

Pesticides/PCBs

Eighteen pesticides and two PCB compounds were detected in the 56 sediment samples analyzed for pesticides and PCBs from AZ-2. Eight pesticides and the two PCBs detected at AZ-2 have ecological screening concentrations, and ten pesticides have no ecological screening criteria. Figures 7-9, 7-10, 7-11, 7-12, and 7-14 show the areal distribution of the five pesticides detected at AZ-2 which exceeded ecological screening criteria. Figure 7-15 shows the areal distribution for total PCBs, representing the distribution of Aroclors-1242 and 1260. The ecological screening concentrations and risk evaluation results are further discussed in Section 10, Baseline Risk Assessment. Table 7-5 summarizes pesticide and PCBs detected at AZ-2.

Pesticides with ecological screening criteria detected across AZ-2 included 4,4'-DDT (17 detections), 4,4'-DDD (18 detections) 4,4'-DDE (25 detections), dieldrin (18 detections), and gamma-BHC (15 detections). Of the DDT and its metabolites detected at AZ-2, five 4,4-DDT, 10 4,4-DDD, and 13 4,4-DDE detections exceeded the ecological screening concentrations for these compounds. Only one 4,4-DDT concentration (22 ppb at Z2-224) exceeded its background concentration (20 ppb). The 4,4-DDD and 4,4-DDE concentrations were below their background concentrations. Eight dieldrin and 10 gamma-BHC detections at this AZ also exceeded the ecological screening concentrations for each compound. Concentrations of endrin, endrin aldehyde, and endrin ketone were also detected at AZ-2, with all detections below the applicable ecological screening criteria.

The PCBs detected at AZ-2 were the Aroclors-1242 (eight detections) and 1260 (28 detections). One Aroclor-1242 and 16 Aroclor-1260 concentrations exceeded the ecological screening concentration for these PCBs at AZ-2.

Pesticides detected at AZ-2 for which no ecological screening criteria exist included aldrin, endosulfan I/II/sulfate, heptachlor epoxide, methoxychlor, alpha/beta-BHC, and alpha/gamma-chlordane.

The pesticide compounds exceeding ecological screening criteria detected at AZ-2 were mostly distributed at the upstream end of Redoubt Bayou, with scattered distribution at its middle reaches. The PCB distribution was also focused at the upper end of Redoubt Bayou.

SVOCs

Twenty-four SVOCs were detected in the 57 sediment samples analyzed for SVOCs at AZ-2. Thirteen SVOCs detected at AZ-2 have ecological screening concentrations and eleven SVOCs detected at this AZ have no ecological screening criteria. Figures 7-16, 7-17, 7-19, 7-20, 7-21, 7-22, 7-23, 7-24, 7-25, 7-26, 7-27, 7-28, and 7-29 show the areal distribution of the thirteen SVOCs which exceeded appropriate ecological screening criteria at AZ-2. The ecological screening concentrations and risk evaluation results are further discussed in Section 10, Baseline Risk Assessment. Table 7-6 summarizes the SVOCs detected at AZ-2.

The widest distribution of SVOCs detected at AZ-2 included several low and high molecular weight PAHs, to include benzo(a)anthracene (13 detections), benzo(a)pyrene (16 detections), chrysene (13 detections), fluoranthene (21 detections), and pyrene (17 detections). Six detections each of benzo(a)anthracene, chrysene, and pyrene exceeded the ecological screening criteria for these compounds. There were seven and nine each exceedances of benzo(a)pyrene and fluoranthene, respectively. These PAHs were concentrated at the upstream end of Redoubt Bayou, with scattered detections of each compound spread throughout the middle and lower reaches of this bayou.

Less prevalent SVOCs detected at AZ-2 included the PAHs phenanthrene (seven detections), naphthalene (two detections); as well as single detections of 2-methylnapthalene, acenaphthene, anthracene, dibenz(a,h)anthracene, and fluorene. Four phenanthrene concentrations, one naphthalene concentration, and all of the single PAH detections mentioned exceeded the ecological screening concentrations for these compounds. Nine BEHP concentrations, with two exceedances were also detected and AZ-2. The pyrene exceedances were concentrated at the upstream end of Redoubt Bayou. Naphthalene and 2-methylnaphthalene were scattered at the middle reaches of Redoubt Bayou. The BEHP exceedances were scattered at the lower end of this water body. The single detections and exceedances of acenaphthene, anthracene, dibenz(a.h)anthracene, and fluorene occurred at the same sample location (Z-222), which was located at the point where Wetland W-2 discharges into Redoubt Bayou.

SVOCs detected at AZ-2 for which no ecological screening criteria exist included 2,2'-oxybis(1-chloropropane), 4-methylphenol, benzo(b)fluoranthene, benzo(g,h,i)perylene, benzo(k)fluoranthene, butylbenzylphthalate, carbazole, di-n-butylphthalate, diethylphthalate, indeno(1,2,3-cd)pyrene, and phenol.

VOCs

Acetone, carbon disulfide, chloromethane, methylene chloride were the VOCs detected in AZ-2. Acetone was the most widely detected (21 of 57 samples). Methylene chloride was detected in four of 57 samples. Both of the parameters are common laboratory artifacts. Carbon disulfide and chloromethane were each detected in one sample. No sediment ecological screening criteria exist for these VOCs. Table 7-7 summarizes the frequency of detection, the range of detected concentrations, range of nondetected upper bounds, and the average detected concentrations.

Summary

Most of the detected concentrations at AZ-2 and exceedances of the applicable ecological screening criteria are in the upper reaches of Redoubt Bayou. This area of Redoubt Bayou receives surface and storm water from two significant drainage sources (1) Wetland W-2 and (2) Wetland 19B. Wetland W-2 is the major storm water conduit from the eastern portion of Forrest Sherman Field, to include aircraft parking areas and hangars on the eastern end of the airfield. W-2 also receives surface and storm water coming from the Barrancas Cemetery area, and the Public Works Center area. The Public Works Center area contains a PCB site (Site 17), a petroleum program site (UST Site 26), a DDT mixing area (Site 8), and a pesticide site (Site 24). These sites have already been investigated, and are currently undergoing various stages investigation or remediation. Site 17 underwent an interim soil removal and was recommended for no further action. Inorganic and organic compounds were detected in Site 8 soil samples that exceeded preliminary remediation goals. Site 24 soil samples revealed exceedances of inorganic compounds (arsenic, aluminum, iron, and manganese), pesticides (dieldrin, aldrin, and heptachlor epoxide), and SVOCs (benzo(b)fluoranthene, benzo(a)pyrene, and dibenz(a,h)anthracene). Site 22 was transferred to the petroleum program and became UST Site 26. Benzene was detected in groundwater at concentrations exceeding criteria for a low yield, poor quality aquifer. Impacts to groundwater were limited vertically to the shallow surficial aquifer, and laterally to the center of the site. Geochemical data support that natural attenuation is occurring, and monitored natural attenuation is the chosen and FDEP-approved alternative for the site.

Wetland 19B is at the downstream end of a surface and storm water drainage feature which drains the area northeast of Sherman Field's main runways.

The Site 41 RI considered Wetlands W-2 and 19b to be Blue Coded, and expected these wetlands to contain only isolated contaminants. Inorganic and organic parameters found in sediments from both wetlands were also found in sediments from the upper reaches of Redoubt Bayou, though as might be expected, Wetland 19B had almost no organic contaminants detected (no IRP sites near this area). Over the years, major storm events have likely flushed contaminants through Wetlands W-2 and 19B, and into the upper end of Redoubt Bayou, where these elements and compounds have accumulated. Since Redoubt Bayou is a sheltered arm of Bayou Grande, there probably is not very much tidal flushing through this area, which has facilitated the buildup of these contaminants over time.

7.4 Assessment Zone 3

Twenty-four sediment samples were collected from AZ-3 to assess the site conditions. Tables 7-8 through 7-11 summarize the frequency and range of detection, range of nondetected upper bounds, and average detected concentration.

Inorganics

Twenty-three metals were detected in sediment samples collected from AZ-3. Ten metals detected at AZ-3 have ecological screening concentrations, thirteen metals detected at this AZ have no ecological screening criteria. Ten of the 23 inorganics were detected in every sample collected. The ten inorganics included: aluminum, calcium, chromium, copper, iron, lead, magnesium, manganese, sodium, and vanadium. Of these metals, copper, chromium, and lead have ecological screening values. Three copper, four chromium, and six lead detections exceeded the appropriate ecological screening concentrations for these metals. Arsenic (18 detections), barium (22 detections), potassium (23 detections), and zinc (23 detections) were detected in most of the samples collected. Three arsenic and two zinc concentrations exceeded the ecological screening concentrations for these metals. The remaining inorganics were detected in less than half of the samples collected. Of these, four cadmium, two mercury, and one nickel concentration exceeded the ecological screening criteria for these analytes. None of the detected antimony or silver concentrations exceeded the ecological screening criteria for antimony and silver. The distributions of arsenic, cadmium, chromium, copper, lead, mercury, nickel, and zinc are

Table 7-8
Inorganics Detected in AZ-3, Phase IIA (mg/kg)

Parameter	Frequency of Detection*	Range of Nondetected Upper Bounds	Range of Detected Concentrations	Averaged Detected Concentration	Ecological Screening Concentration	Number Over Screen
Aluminum	24/24		163 - 27400	3171		
Antimony	3/10	0.13 - 0.68	0.15 - 0.45	0.34	12a	
Arsenic	18/24	0.13 - 0.35	0.18 - 17.5	2.8	7.24a, b	3
Barium	22/24	0.06 - 0.61	0.19 - 21.6	2.9		
Beryllium	5/24	0.06 - 0.08	0.11 - 1.4	0.68		
Cadmium	7/24	0.13 - 0.24	0.2- 7.1	2.24	0.676b	4
Calcium	24/24		77.5 - 17500	1892		
Chromium	24/24		0.83 - 238	26.4	52.3a, b	4
Cobalt	9/24	0.13 - 0.21	0.16 - 5.3	1.5		
Copper	24/24		0.3-52.2	7	18.7 a, b	3
Iron	24/24		195 - 38000	4409		
Lead	24/24		2.4 - 134	25.8	30.2a, b	6
Magnesium	24/24		135 - 10100	1222		
Manganese	24/24		0.5 - 300	35.5		
Mercury	2/24	0.05- 0.19	0.14 - 0.35	0.24	0.13a,b	2
Nickel	6/24	0.58 - 0.97	0.96- 16.6	6.6	15.9a, b	1
Potassium	23/24	80.4 - 80.4	37.5 - 3900	472		
Selenium	5/24	0.19- 0.28	0.36 - 2.1	1.2		
Silver	1/24	0.25 - 1.3	0.3700	0.37	0.733b	
Sodium	24/24		687 - 33800	4156		
Thallium	5/24	0.19 - 1	0.23 - 0.38	0.29		
Vanadium	24/24		0.25 - 48.6	5.8		
Zinc	23/24	2.3 - 2.3	1.5 - 224	25.9	124a, b	2

Notes:
* = For specific parameters, the total number of samples has been reduced by the number of rejected samples. See Section 8 of this report.
a = USEPA Screening Concentration for Sediment — USEPA SSVs
b = FDEP Screening Concentration for Sediment — FDEP SQAGs as listed in the *Approach to the Assessment of Sediment Quality in Florida Coastal Waters* by D.D. MacDonald, MacDonald Environmental Sciences, Ltd., Prepared for the Florida Department of Environmental Protection, November 1994.
mg/kg = milligrams per kilogram

Table 7-9
Pesticides/PCBs Detected in AZ-3 Sediments, Phase IIA (µg/kg)

Parameter	Frequency of Detection	Range of Nondetected Upper Bounds	Range of Detected Concentrations	Averaged Detected Concentration	Ecological Screening Concentration	Number Over Screen
4,4'-DDD	3/24	0.21- 1.2	0.24 - 0.5	0.36	1.22b	
4,4'-DDE	10/24	0.21 - 0.67	0.21 - 4.4	1.48	2.07b	2
4,4'-DDT	10/24	0.21 - 1.2	0.23 - 1.9	0.7	1.19b	2
Aldrin	1/24	0.1 - 0.59	0.32	0.32		
Aroclor-1254	1/24	2.1 - 12.	5.3	5.3	21.6a	
Aroclor-1260	13/24	2.1 - 2.2	0.69 - 84	14.4	21.6a	3
Dieldrin	4/24	0.21 - 1.2	0.48- 99	26.7	0.715b	2
Endosulfan II	1/24	0.21 - 1.2	0.21	0.21		
Endosulfan sulfate	5/24	0.21 - 1.2	0.25 - 1.5	0.84		
Endrin	4/24	0.21- 1.2	0.19 - 3	1.1	3.3a	
Endrin ketone	1/24	0.21 - 1.2	1.7	1.7	3.3a	
Heptachlor	1/24	0.1 - 0.59	0.11	0.11		
Heptachlor epoxide	1/24	0.1 - 0.59	0.27	0.27		
alpha-BHC	5/24	0.1 - 0.59	0.4 - 1	0.61		
alpha-Chlordane	5/24	0.1 - 0.59	0.11 - 2.3	0.63		
gamma-BHC (Lindane)	1/24	0.1 - 0.59	0.64	0.64	0.32b	1
gamma-Chlordane	3/24	0.1 - 0.59	0.1 - 0.75	0.33		

Notes:

a = USEPA Screening Concentration for Sediment — USEPA SSVs

b = FDEP Screening Concentration for Sediment — FDEP SQAGs as listed in the *Approach to the Assessment of Sediment Quality in Florida Coastal Waters* by D.D. MacDonald, MacDonald Environmental Sciences, Ltd., Prepared for the Florida Department of Environmental Protection, November 1994.

µg/kg = micrograms per kilogram

Table 7-10
SVOCs Detected in AZ-3 Sediments, Phase IIA (μg/kg)

Parameter	Frequency of Detection	Range of Nondetected Upper Bounds	Range of Detected Concentrations	Averaged Detected Concentration	Ecological Screening Concentration	Number Over Screen
4-Methylphenol (p-Cresol)	1/24	400 - 21000	22.0000	22		
Acenaphthene	2/24	19 - 1000	32 - 10000	5016	6.71b	2
Anthracene	4/24	40 - 2100	41 - 5500	1440	46.9b	3
Benzo(a)anthracene	20/24	41 - 42	23 - 44000	2524	74.8b	11
Benzo(a)pyrene	20/24	40 - 42	21 - 21000	1426	88.8b	11
Benzo(b)fluoranthene	22/24	42 - 42	36 - 19000	1419		
Benzo(g,h,i)perylene	19/24	40 - 42	25 - 7700	731		
Benzo(k)fluoranthene	18/24	41 - 49	21 - 16000	1121		
Butylbenzylphthalate	2/24	400 - 21000	27 - 180	104		
Carbazole	2/24	400 - 21000	36 - 61	49		
Chrysene	21/24	42 - 42	25 - 44000	2451	108b	11
Di-n-butylphthalate	10/24	410 - 21000	21 - 160	41		
Dibenz(a,h)anthracene	3/24	40 - 2100	25 - 77	58	6.22b	3
Fluoranthene	21/24	42	26 - 52000	2881	113b	11
Fluorene	1/24	19 - 1000	7900.0000	7900	21.2b	1
Indeno(1,2,3-cd)pyrene	19/24	40 - 42	22 - 7500	675		
Naphthalene	2/24	40 - 2100	23 - 35	29	34.6b	1
Phenanthrene	15/24	41 - 130	27 - 25000	1862	86.7b	7
Pyrene	21/24	42	25 - 89000	4640	153b	9
bis(2-Ethylhexyl)phthalate (BEHP)	8/24	400 - 21000	28 - 280	81	182a, b	1

Notes:

a = USEPA Screening Concentration for Sediment — USEPA SSVs

b = FDEP Screening Concentration for Sediment — FDEP SQAGs as listed in the *Approach to the Assessment of Sediment Quality in Florida Coastal Waters* by D.D. MacDonald, MacDonald Environmental Sciences, Ltd., Prepared for the Florida Department of Environmental Protection, November 1994.

μg/kg = micrograms per kilogram

Table 7-11
VOCs Detected in AZ-3 Sediments, Phase IIA (μg/kg)

Parameter	Frequency of Detection	Range of Nondetected Upper Bounds	Range of Detected Concentrations	Averaged Detected Concentration	Ecological Screening Concentration	Number Over Screen
Acetone	7/23	12 - 430	14 - 150	52		
Carbon disulfide	2/23	11 - 71	6 - 23	15		

Notes:
* = For specific parameters, the total number of samples has been reduced by the number of rejected samples. See Section 8 of this report.
a = USEPA Screening Concentration for Sediment — USEPA SSVs
b = FDEP Screening Concentration for Sediment — FDEP SQAGs as listed in the *Approach to the Assessment of Sediment Quality in Florida Coastal Waters* by D.D. MacDonald, MacDonald Environmental Sciences, Ltd., Prepared for the Florida Department of Environmental Protection, November 1994.
μg/kg = micrograms per kilogram

presented on Figures 7-1 through 7-8, respectively. Table 7-8 presents the frequency of detection of the inorganic parameters.

The widest distribution of metals with ecological screening criteria at AZ-3 occurred with arsenic, chromium, copper, lead, and zinc. These metals detections also exceeded their ecological screening concentrations at similar frequencies. The exceedances for these metals were mostly distributed between three samples (Z302, Z319, and Z323). All four cadmium, the one nickel, one of two mercury, and both zinc exceedances also occurred within these samples.

Metals detected at AZ-3 for which no ecological screening criteria exist included aluminum, barium, beryllium, calcium, cobalt, iron, magnesium, manganese, potassium, selenium, sodium, thallium, and vanadium.

Pesticides/PCBs

Fifteen pesticides and two PCB compounds were detected in the 24 sediment samples analyzed for pesticides and PCBs from AZ-3. Seven pesticides and the two PCBs detected at AZ-3 have ecological screening concentrations and eight of the pesticides have no ecological screening criteria. Figures 7-10, 7-11, 7-12, and 7-14 show the areal distribution of the five pesticides detected at AZ-3 which exceeded ecological screening criteria. Figure 7-15 shows the areal distribution for total PCBs, representing the distribution of Aroclors-1254 and 1260 at AZ-3. The ecological screening concentrations and risk evaluation results are further discussed in Section 10, Baseline Risk Assessment. Table 7-9 summarizes pesticides and PCBs detected at AZ-3.

Pesticides with ecological screening criteria detected across AZ-3 included 4,4'-DDT (10 detections), 4,4'-DDD (three detections) 4,4'-DDE (10 detections), dieldrin (four detections), endrin (four detections), endrin ketone (one detection), and gamma-BHC (one detection). Of the DDT and its metabolites detected at AZ-3, two 4,4-DDT, and two 4,4-DDE detections exceeded ecological screening concentrations for these compounds. 4,4-DDT, 4,4-DDE, and 4,4-DDD concentrations were below their respective background concentrations. Two dieldrin and one gamma-BHC detections at this AZ also exceeded the ecological screening concentrations for each compound. Concentrations of endrin and edrin ketone were also detected at AZ-3, with all detections below the applicable ecological screening criteria.

The PCBs detected at AZ-3 were the Aroclors-1254 (one detection) and 1260 (13 detections). Three Aroclor-1260 concentrations exceeded the ecological screening concentration for this PCB at AZ-3. The Aroclor-1254 detection was below the applicable ecological screening criteria.

Pesticides detected at AZ-3 for which no ecological screening criteria exist included aldrin, endosulfan II/sulfate, heptachlor epoxide, alpha/beta-BHC, and alpha/gamma-chlordane.

Pesticide detections at AZ-3 were focused at the discharge points for Wetlands 4D and 65. The PCB distribution was more even throughout the sample population at AZ-3.

SVOCs

Twenty SVOCs were detected in the 24 sediment samples analyzed for SVOCs at AZ-3. Twelve SVOCs detected at AZ-3 have ecological screening concentrations. Eight SVOCs detected at this AZ have no ecological screening criteria. Figures 7-17, 7-19, 7-20, 7-21, 7-22, 7-23, 7-24, 7-25, 7-26, 7-27, 7-28, and 7-29 show the areal distribution of the twelve SVOCs with ecological screening criteria which were detected at AZ-3. The ecological screening concentrations and risk evaluation results are further discussed in Section 10, Baseline Risk Assessment. Table 7-10 summarizes the SVOCs detected at AZ-3.

The widest distribution of SVOCs detected at AZ-3 included several low and high molecular weight PAHs, to include benzo(a)anthracene (20 detections), benzo(a)pyrene (20 detections), benzo(b)fluoranthene (22 detections), benzo(g,h,i)perylene (19 detections), benzo(k)fluoranthene (18 detections), chrysene (21 detections), fluoranthene (21 detections), indeno(1,2,3-cd)pyrene (19 detections), phenanthrene (15 detections), and pyrene (21 detections). Eleven detections each of benzo(a)anthracene, benzo(a)pyrene, chrysene, and fluoranthene exceeded the ecological screening criteria for these compounds. There were one, seven, and nine each exceedances of indeno(1,2,3-cd)pyrene, phenanthrene, and pyrene, respectively. No ecological screening criteria exist for benzo(b)fluoranthene, benzo(g.h.i)perylene, benzo(k)fluoranthene, and indeno(1,2,3-cd)pyrene.

Less prevalent SVOCs detected at AZ-3 included 4-methylphenol (one detection), acenaphthene (two detections), anthracene (four detections), butylbenzylphthalate (two detections), carbazole (two detections), di-n-butylphthalate (10 detections), dibenz(a,h)anthracene (three detections), fluorene (one detection), naphthalene (two detections), and BEHP (eight detections). All acenaphthene, dibenz(a,h)anthracene, and fluorene detections exceeded the ecological screening concentrations for these compounds. Three anthracene, one naphthalene, and one BEHP concentrations exceeded ecological screening criteria. No ecological screening criteria exist for 4-methylphenol, butylbenzylphthalate, carbazole, and di-n-butylphthalate.

The distribution of SVOCs at AZ-3 are focused at the discharge points for Wetland 4D and 65, and at the south landing of the bridge leading to the base.

VOCs

Acetone and carbon disulfide were the only VOCs detected in AZ-3 sediment. Acetone, a common laboratory contaminant, was the most widely detected (seven of 23 samples). Carbon disulfide was detected in two of the 23 samples. Table 7-11 summarizes the VOCs at AZ-3.

Summary

The exceedances for metals were mostly distributed between three samples (Z302, Z319, and Z323). PCBs were evenly distributed within the sample population for AZ-3, but were mostly detected below applicable ecological screening criteria. Pesticide and SVOC detections were focused at the discharge points for Wetlands 4D and 65, and at the south landing for the bridge leading to NAS Pensacola. Wetlands 4D and 65 are conduits for surface and storm water from the NAS golf course. Golf course maintenance vehicles and pesticide application throughout the golf course would account for the pesticide and SVOC distributions off shore from Wetlands 4D and 65. Vehicle traffic and storm water runoff from the bridge would account for the SVOC detections from sample locations adjacent the southern bridge landing at the base.

7.5 Assessment Zone 4

Twenty-four sediment samples were collected from AZ-4 to assess the site conditions. Tables 7-12 through 7-15 summarize the frequency and range of detection, range of nondetected upper bounds, and average detected concentration.

Inorganics

Twenty-three metals were detected in sediment samples collected from AZ-4. Ten metals detected at AZ-4 have ecological screening concentrations, and thirteen metals detected at this AZ have no ecological screening criteria. Six of the 23 inorganics were detected in every sample collected. They include: aluminum, calcium, iron, magnesium, manganese, and sodium. None of these six metals have ecological screening criteria. Seven inorganics were detected frequently. These parameters include barium (19 detections), chromium (23 detections), copper (20 detections), lead (22 detections), potassium (23 detections), vanadium (20 detections), and zinc (19 detections). Of these metals, copper, chromium, lead and zinc have ecological screening values. Two copper, three chromium, four lead, and one zinc detections exceeded the appropriate ecological screening concentrations for these metals. The remaining parameters were detected more sporadically.

Table 7-12
Inorganics Detected in AZ-4 Sediments, PhaseIIA (mg/kg)

Parameter	Frequency of Detection*	Range of Nondetected Upper Bounds	Range of Detected Concentrations	Averaged Detected Concentration	Ecological Screening Concentration	Number Over Screen
Aluminum	24/24		23.5 - 217	2133		
Antimony	1/4	0.14 - 0.24	0.14	0.14	12a	
Arsenic	9/24	0.13 - 0.99	0.24 - 15.3	4.2	7.24a,b	2
Barium	19/24	0.16 - 0.85	0.17 - 18.3	2.5		
Beryllium	4/24	0.06 - 0.08	0.26 - 1.2	0.63		
Cadmium	10/24	0.19 - 0.22	0.28 - 5.1	1.4	0.676b	4
Calcium	24/24		51.5 - 9200	1254		
Chromium	23/24	0.53	0.62 - 177	21.1	52.3a,b	3
Cobalt	9/24	0.19 - 0.24	0.21 - 3.5	1.2		
Copper	20/24	0.27 - 1.3	0.47 - 46.9	6.1	18.7a,b	2
Iron	24/24		33.6 - 309	3178		
Lead	22/24	0.59 - 1.1	1.2 - 107	13.7	30.2a,b	4
Magnesium	24/24		123 - 9010	974.0		
Manganese	24/24		0.19 - 235	27.40		
Mercury	2/24	0.05 - 0.31	0.14 - 0.24	0.19	0.13a,b	2
Nickel	8/24	0.64 - 0.96	0.84 - 10.7	3.2	15.9a,b	
Potassium	23/24	81.3	44.8 - 3460	393		
Selenium	4/24	0.19 - 0.29	0.47 - 1.9	1.2		
Silver	1/24	0.25 - 1.3	0.33	0.33	0.733b	
Sodium	24/24		619 - 31600	3797		
Thallium	5/24	0.19 - 1	0.27 - 0.98	0.49		
Vanadium	20/24	0.29 - 0.54	0.37 - 40.6	5.1		
Zinc	19/24	1.2 - 3	2 - 187	27.7	124a,b	1

Notes:
* = For specific parameters, the total number of samples has been reduced by the number of rejected samples. See Section 8 of this report.
a = USEPA Ecological screening Concentration for Sediment — USEPA SSVs
b = FDEP Ecological screening Concentration for Sediment — FDEP SQAGs as listed in the *Approach to the Assessment of Sediment Quality in Florida Coastal Waters* by D.D. MacDonald, MacDonald Environmental Sciences, Ltd., Prepared for the Florida Department of Environmental Protection, November 1994.
mg/kg = milligrams per kilogram

Table 7-13
Pesticides/PCBs Detected in AZ-4 Sediments, Phase IIA (µg/kg)

Parameter	Frequency of Detection*	Range of Nondetected Upper Bounds	Range of Detected Concentrations	Averaged Detected Concentration	Ecological Screening Concentration	Number Over Screen
4,4'-DDD	3/22	0.21 - 1.1	0.26 - 1.3	0.64	1.22b	1
4,4'-DDE	4/22	0.21 - 0.26	0.23 - 1.6	0.98	2.07b	
4,4'-DDT	4/22	0.21 - 1.1	0.31 - 1.3	0.57	1.19b	1
Aroclor-1254	4/23	2.1 - 11	2.3 - 8.5	6.3	21.6a	
Aroclor-1260	13/21	2.1 - 14	1.0 - 120	12.3	21.6a	1
Dieldrin	4/22	0.21 - 0.26	0.24 - 2.2	1.0	0.715b	2
Endosulfan II	4/22	0.21 - 0.73	0.39 - 3.1	1.2		
Endosulfan sulfate	2/21	0.21 - 0.73	0.25 - 1.2	0.73		
Endrin	4/22	0.21 - 1.10	0.86 - 3.9	2.1	3.3a	1
Endrin aldehyde	1/21	0.21 - 1.10	0.60	0.60	3.3a	
Heptachlor	1/21	0.10 - 0.54	0.11	0.11		
alpha-BHC	10/22	0.10 - 0.54	0.13 - 2.90	0.61		
alpha-Chlordane	4/21	0.10 - 0.54	0.13 - 0.45	0.22		
beta-BHC	1/21	0.10 - 0.54	0.24	0.24		
gamma-BHC (Lindane)	4/23	0.10 - 0.54	0.16 - 9.20	2.9	0.32b	3
gamma-Chlordane	3/22	0.10 - 0.54	0.11 - 0.29	0.21		

Notes:

* = For specific parameters, the total number of samples has been reduced by the number of rejected samples. See Section 8 of this report.
a = USEPA Ecological screening Concentration for Sediment — USEPA SSVs
b = FDEP Ecological screening Concentration for Sediment — FDEP SQAGs as listed in the *Approach to the Assessment of Sediment Quality in Florida Coastal Waters* by D.D. MacDonald, MacDonald Environmental Sciences, Ltd., Prepared for the Florida Department of Environmental Protection, November 1994.
µg/kg = micrograms per kilogram

Table 7-14
SVOCs Detected in AZ-4 Sediments, Phase IIA (μg/kg)

Parameter	Frequency of Detection	Range of Nondetected Upper Bounds	Range of Detected Concentrations	Averaged Detected Concentration	Ecological Screening Concentration	Number Over Screen
2,4-Dimethylphenol	1/24	400 - 1400	37	37		
2-Methylnaphthalene	2/24	40 - 140	25 - 59	42	20.2b	2
4-Methylphenol (p-Cresol)	2/24	400 - 1400	31 - 82	57		
Acenaphthene	1/24	19 - 68	35	35	6.71b	1
Acenaphthylene	1/24	40 - 410	100	100	5.87b	1
Anthracene	1/24	40 - 420	120	120	46.9b	1
Benzo(a)anthracene	11/24	40 - 46	22 - 530	120	74.8b	5
Benzo(a)pyrene	9/24	40 - 46	21 - 470	133	88.8b	4
Benzo(b)fluoranthene	15/24	40 - 42	26 - 660	133		
Benzo(g,h,i)perylene	5/24	40 - 46	57 - 340	183		
Benzo(k)fluoranthene	6/24	40 - 46	21 - 310	133		
Butylbenzylphthalate	2/24	400 - 1400	30 - 39	35		
Carbazole	1/24	400 - 1400	62	62		
Chrysene	11/24	40 - 46	27 - 630	139	108b	5
Di-n-butylphthalate	10/24	400 - 510	26 - 90	43		
Fluoranthene	15/24	40 - 42	28 - 1100	185	113b	5
Fluorene	1/24	19 - 68	55	55	21.2b	1
Indeno(1,2,3-cd)pyrene	5/24	40 - 46	47 - 270	139		
Naphthalene	2/24	40 - 140	35 - 80	58	34.6b	2
Phenanthrene	9/24	40 - 46	24 - 460	119	86.7b	4
Pyrene	15/24	40 - 42	25 - 1100	176	153b	5
bis(2-Ethylhexyl)phthalate (BEHP)	2/24	400 - 1400	43 - 91	67	182a, b	

Notes:
a = USEPA Ecological screening Concentration for Sediment — USEPA SSVs
b = FDEP Ecological screening Concentration for Sediment — FDEP SQAGs as listed in the *Approach to the Assessment of Sediment Quality in Florida Coastal Waters* by D.D. MacDonald, MacDonald Environmental Sciences, Ltd., Prepared for the Florida Department of Environmental Protection, November 1994.
μg/kg = micrograms per kilogram

Table 7-15
VOCs Detected in AZ-4 Sediments, Phase IIA (μg/kg)

Parameter	Frequency of Detection*	Range of Nondetected Upper Bounds	Range of Detected Concentrations	Averaged Detected Concentration	Ecological Screening Concentration	Number Over Screen
Acetone	7/23	12 - 130	10 - 380	73		
Carbon disulfide	3/23	12 - 14	5 - 46	20		
Chlorobenzene	2/23	12 - 43	3 - 5	4		
Methylene chloride	1/23	12 - 43	22	22		
Tetrachloroethene	1/23	12 - 43	2	2		

Notes:
* = For specific parameters, the total number of samples has been reduced by the number of rejected samples. See Section 8 of this report.
μg/kg = micrograms per kilogram

Of the more sporadic detections, two arsenic, four cadmium, and two mercury concentrations exceeded the ecological screening criteria for these analytes. None of the detected antimony, nickel, or silver concentrations exceeded the ecological screening criteria for these metals. The distributions of arsenic, cadmium, chromium, copper, lead, mercury, and zinc are presented on Figures 7-1, 7-2, 7-3, 7-4, 7-5, 7-6, and 7-8. Table 7-12 presents the frequency of detection of the inorganic parameters.

Most of the metals exceeding criteria at AZ-4 (including arsenic, cadmium, chromium, copper, lead, and zinc) were distributed within the middle to lower reaches of Woolsey Bayou. The mercury exceedances were distributed in the Yacht Basin.

Metals detected at AZ-4 for which no ecological screening criteria exist included aluminum, barium, beryllium, calcium, cobalt, iron, magnesium, manganese, potassium, selenium, sodium, thallium, and vanadium.

Pesticides/PCBs

Fourteen pesticides and two PCB compounds were detected in the sediment samples analyzed for pesticides and PCBs from AZ-4. Nine pesticides and the two PCBs detected at AZ-4 have ecological screening concentrations, and seven pesticides have no ecological screening criteria. Figures 7-9, 7-10, 7-11, 7-13, and 7-14 show the areal distribution of the five pesticides detected at AZ-4 which exceeded ecological screening criteria. Figure 7-15 shows the areal distribution for total PCBs, representing the distribution of Aroclors-1254 and 1260 at AZ-4. The ecological screening concentrations and risk evaluation results are further discussed in Section 10, Baseline Risk Assessment. Table 7-9 summarizes pesticides and PCBs detected at AZ-4.

Pesticides with ecological screening criteria detected across AZ-4 included 4,4'-DDT (four detections), 4,4'-DDD (three detections), 4,4'-DDE (four detections), dieldrin (four detections), endrin (four detections) and gamma-BHC (four detections). One each of the 4,4-DDT and 4,4-DDD detections at AZ-4 exceeded the ecological screening concentrations for these compounds. The 4,4'-DDD, 4,4'-DDE, and 4,4'-DDT detected concentrations were all below their respective background concentrations. Two dieldrin, one endrin, and three gamma-BHC detections at this AZ also exceeded the ecological screening concentration for each compound. The concentrations of 4,4'-DDE and a single edrin aldehyde at AZ-4 were below the applicable screening criteria.

The PCBs detected at AZ-4 were the Aroclors-1254 (four detections) and 1260 (13 detections). One Aroclor-1260 concentration exceeded the ecological screening concentration for this PCB at AZ-4. The Aroclor-1254 detection was below the applicable ecological screening criteria.

Pesticides detected at AZ-4 for which no ecological screening criteria exist included endosulfan II/sulfate, heptachlor, alpha/beta-BHC, and alpha/gamma-chlordane.

Pesticide detections and exceedances at AZ-4 were mostly focused in Woolsey Bayou. PCB distribution was more even throughout the sample population at AZ-4. However, the single PCB exceedance also occurred in Woolsey Bayou.

SVOCs

Twenty-two SVOCs were detected in the 24 sediment samples analyzed for SVOCs at AZ-4. Thirteen SVOCs detected at AZ-4 have ecological screening concentrations, and nine SVOCs detected at this AZ have no ecological screening criteria. Figures 7-16, 7-17, 7-18, 7-19, 7-20, 7-21, 7-22, 7-24, 7-25, 7-26, 7-27, 7-28, and 7-29 show the areal distribution of the thirteen SVOCs with ecological screening criteria which were detected at AZ43. The ecological screening concentrations and risk evaluation results are further discussed in Section 10, Baseline Risk Assessment. Table 7-14 summarizes the SVOCs detected at AZ-4.

The widest distribution of SVOCs detected at AZ-4 included several low and high molecular weight PAHs, to include benzo(a)anthracene (11 detections), benzo(a)pyrene (nine detections), benzo(b)fluoranthene (15 detections), chrysene (11 detections), fluoranthene (15 detections), phenanthrene (nine detections), and pyrene (15 detections). Five detections each of benzo(a)anthracene, fluoranthene, chrysene, and pyrene, as well as four detections of benzo(a)pyrene and phenanthrene, exceeded the ecological screening criteria for these compounds. No sediment ecological screening criteria exists for benzo(b)fluoranthene.

Less prevalent SVOCs detected at AZ-4 included 2,4-dimethylphenol (one detection), 4-methylphenol (two detections), acenaphthene (one detection), acenaphthylene (one detection), anthracene (one detection), benzo(g,h,i)perylene (five detections), benzo(k)fluoranthene (six detections), butylbenzylphthalate (two detections), carbazole (one detection), fluorene (one detection), indeno(1,2,3-cd)pyrene (five detections), naphthalene (two detections) and BEHP (two detections). There were exceedances for the single detections each of acenaphthene, acenaphthylene, anthracene and fluorene, and two detections each of 2-methylnaphthalene and naphthalene. No sediment ecological screening criteria exist for 2,4-dimethylphenol, 4-methylphenol, benzo(g,h,i)perylene, benzo(k)fluoranthene, butylbenzylphthalate, carbazole, di-n-butylphthalate, and indeno(1,2,3-cd)pyrene.

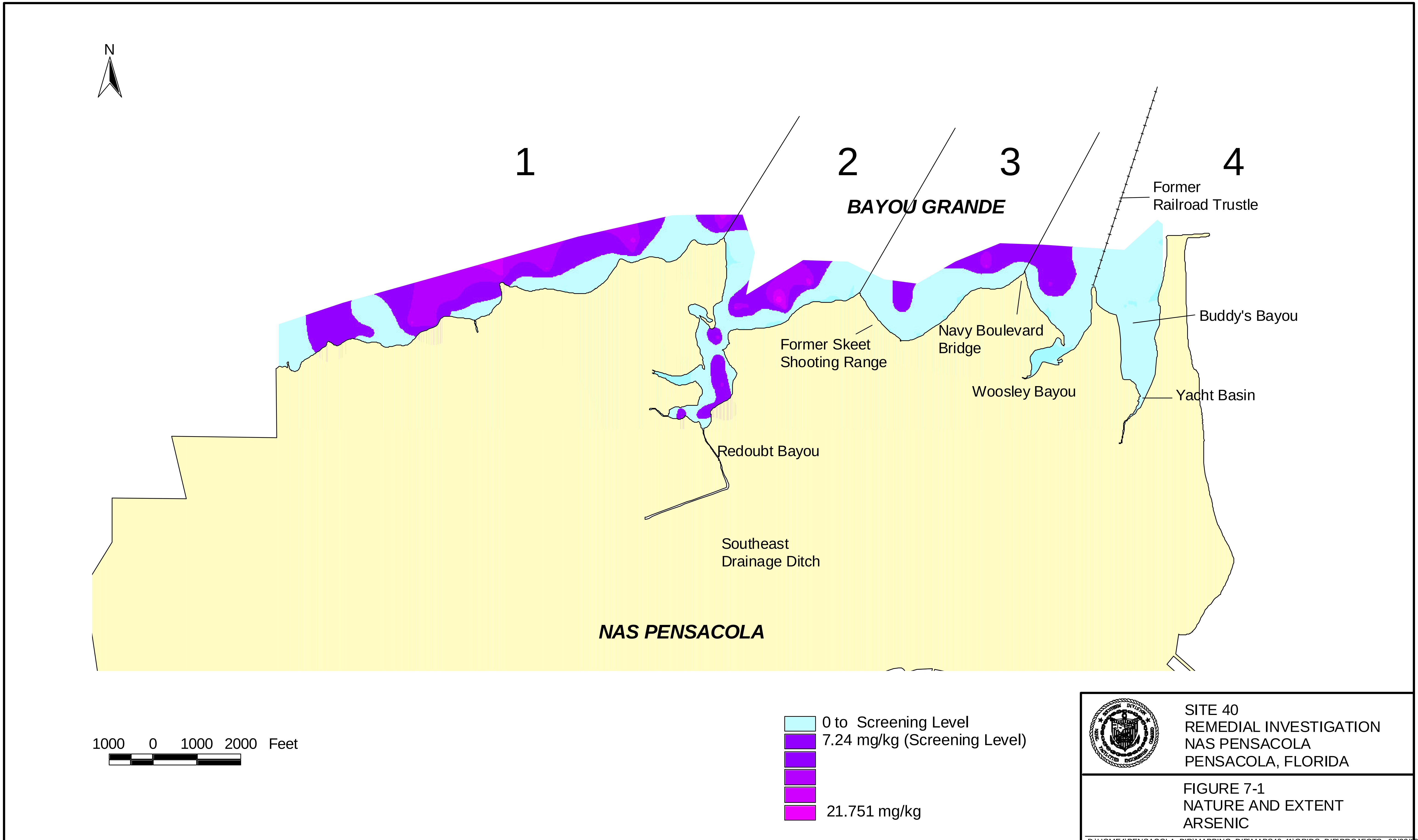
The distribution of SVOCs at AZ-4 are either sparsely distributed for compounds with fewer detections, or evenly distributed for compounds with several detections. However, SVOC detections exceeding the applicable ecological screening criteria tend to be distributed within Woolsey Bayou.

VOCs

Five VOCs were detected in AZ-4 sediment. The most frequently detected VOC was acetone (seven of 23 samples). Carbon disulfide, chlorobenzene, methylene chloride, and tetrachloroethene were also sporadically detected. Table 7-15 summarizes the frequency of detection, the range of detected concentrations, range of nondetected upper bounds, and the average detected concentrations.

Summary

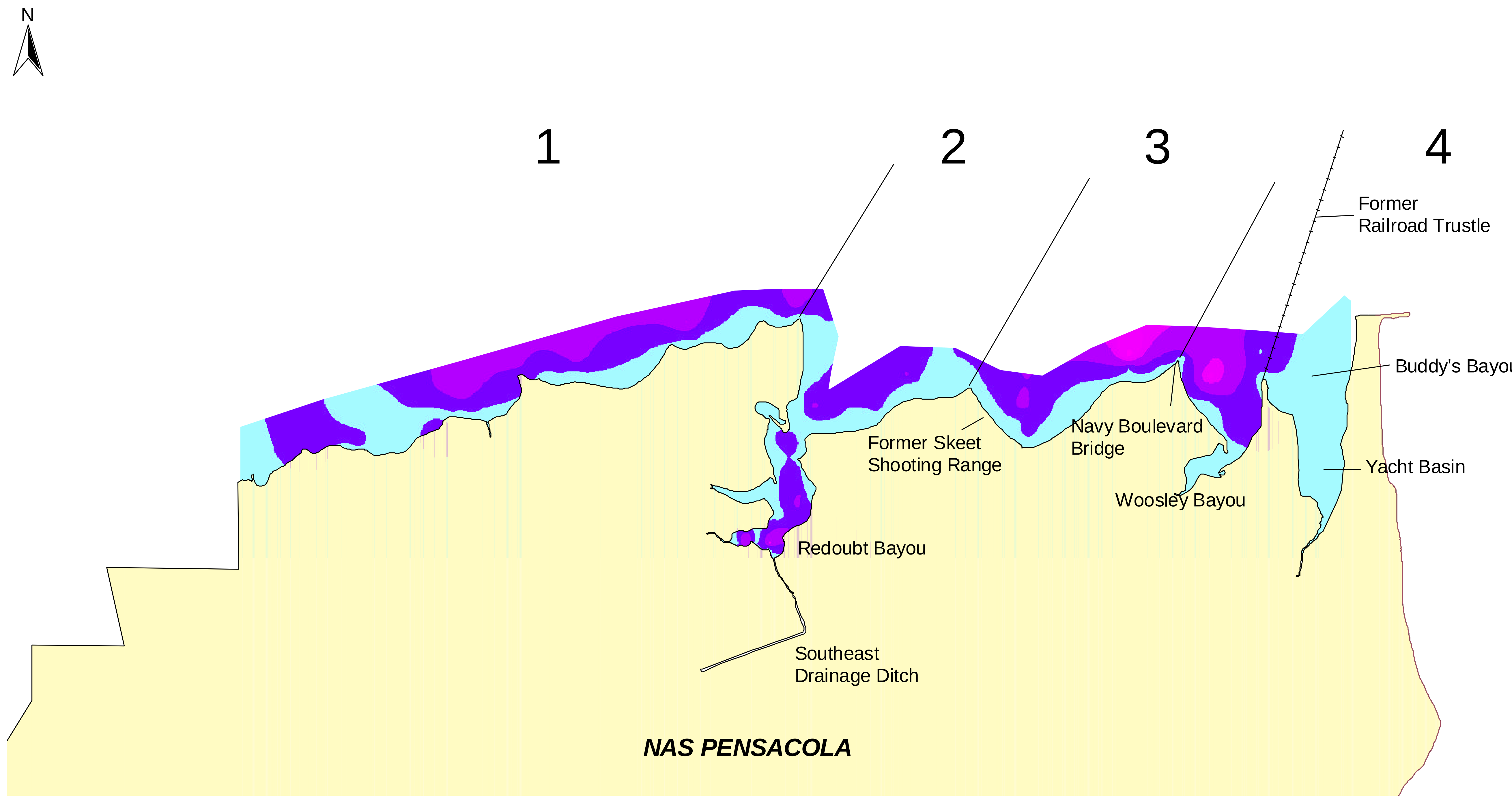
Most of the metals exceeding criteria at AZ-4 (including arsenic, cadmium, chromium, copper, lead, and zinc) were distributed within the middle to lower reaches of Woolsey Bayou. Pesticide and SVOC detections and exceedances at AZ-4 were mostly focused in Woolsey Bayou. The single PCB exceedance also occurred in Woolsey Bayou. Woolsey Bayou is a small arm of Bayou Grande west of the Yacht Basin, between the Yacht Basin and the main bridge leading to NAS Pensacola. This area of AZ-4 receives minor storm water runoff from the easternmost fairway of the NAS golf course, and from Murray Road. A single storm water outfall draining the northeast portion of the base also discharges into Woolsey Bayou. However, no IRP sites are near Woolsey Bayou, nor does it receive storm water runoff from any IRP sites, as the Yacht Basin does from the OUs 2, 6, and 10 sites, and Site 10 via the stream that flows through Wetland 6. Woolsey Bayou is not flushed by a stream, nor is it periodically dredged, like the Yacht Basin is. The stagnant water that sits within Woolsey Bayou allows for the buildup of contaminants in sediments there, which may account for the reason Woolsey Bayou contains more parameters over the requisite ecological screening values than the Yacht Basin does.



SITE 40
REMEDIAL INVESTIGATION
NAS PENSACOLA
PENSACOLA, FLORIDA

FIGURE 7-1
NATURE AND EXTENT
ARSENIC

D:\HOME4\PENSACOLA DIR\MAPPING DIR\MAPS40-41\GRIDS DIR\PROJECTS 03/22/0



1000 0 1000 2000 Feet

0 to Screening Level
0.676 (Screening Level)
6.931 mg/kg

SITE 40
REMEDIAL INVESTIGATION
NAS PENSACOLA
PENSACOLA, FLORIDA

FIGURE 7-2
NATURE AND EXTENT
CADMIUM

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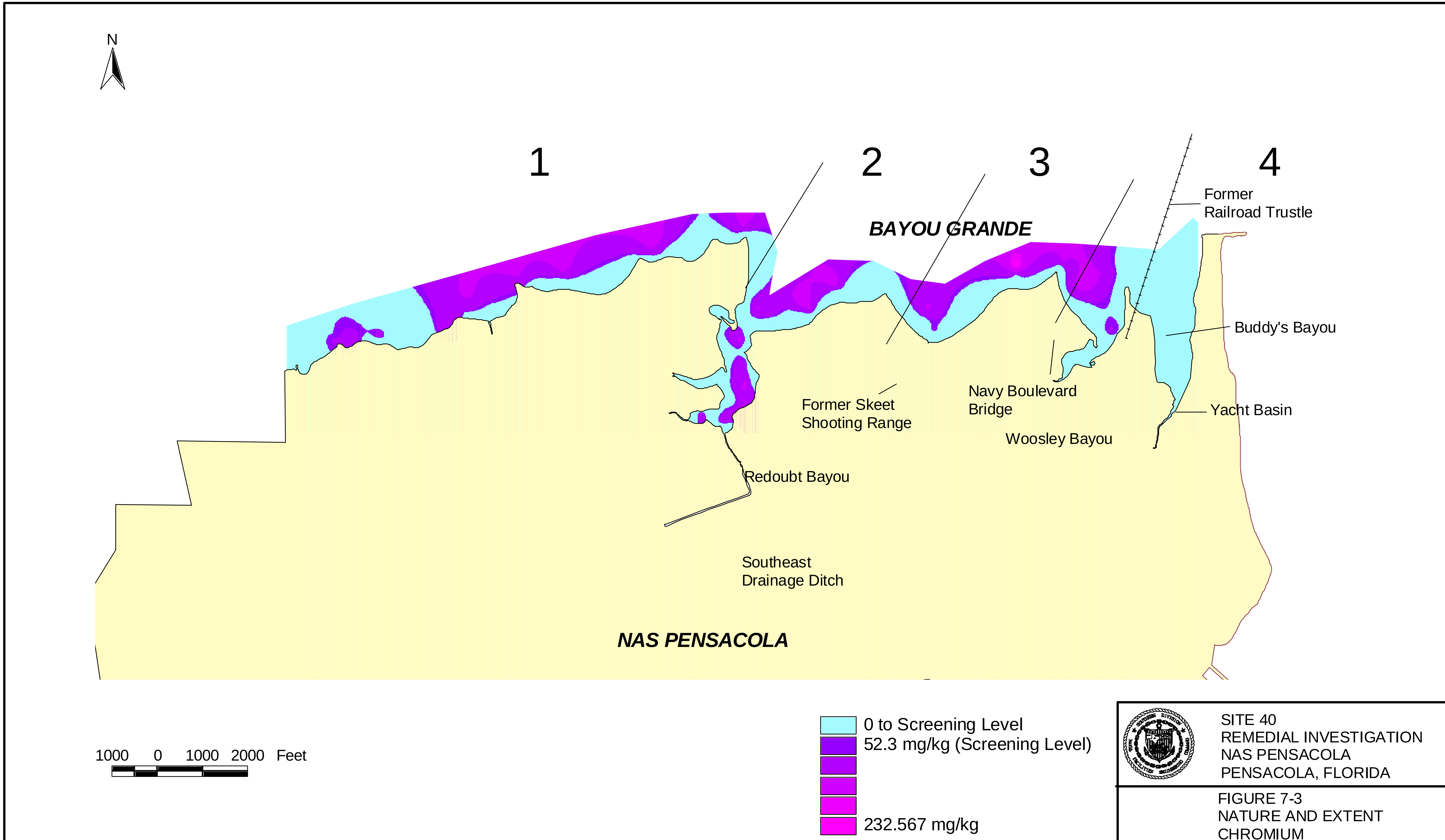

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REMEDIAL INVESTIGATION
NAS PENSACOLA
PENSACOLA, FLORIDA

FIGURE 7-3
NATURE AND EXTENT
CHROMIUM

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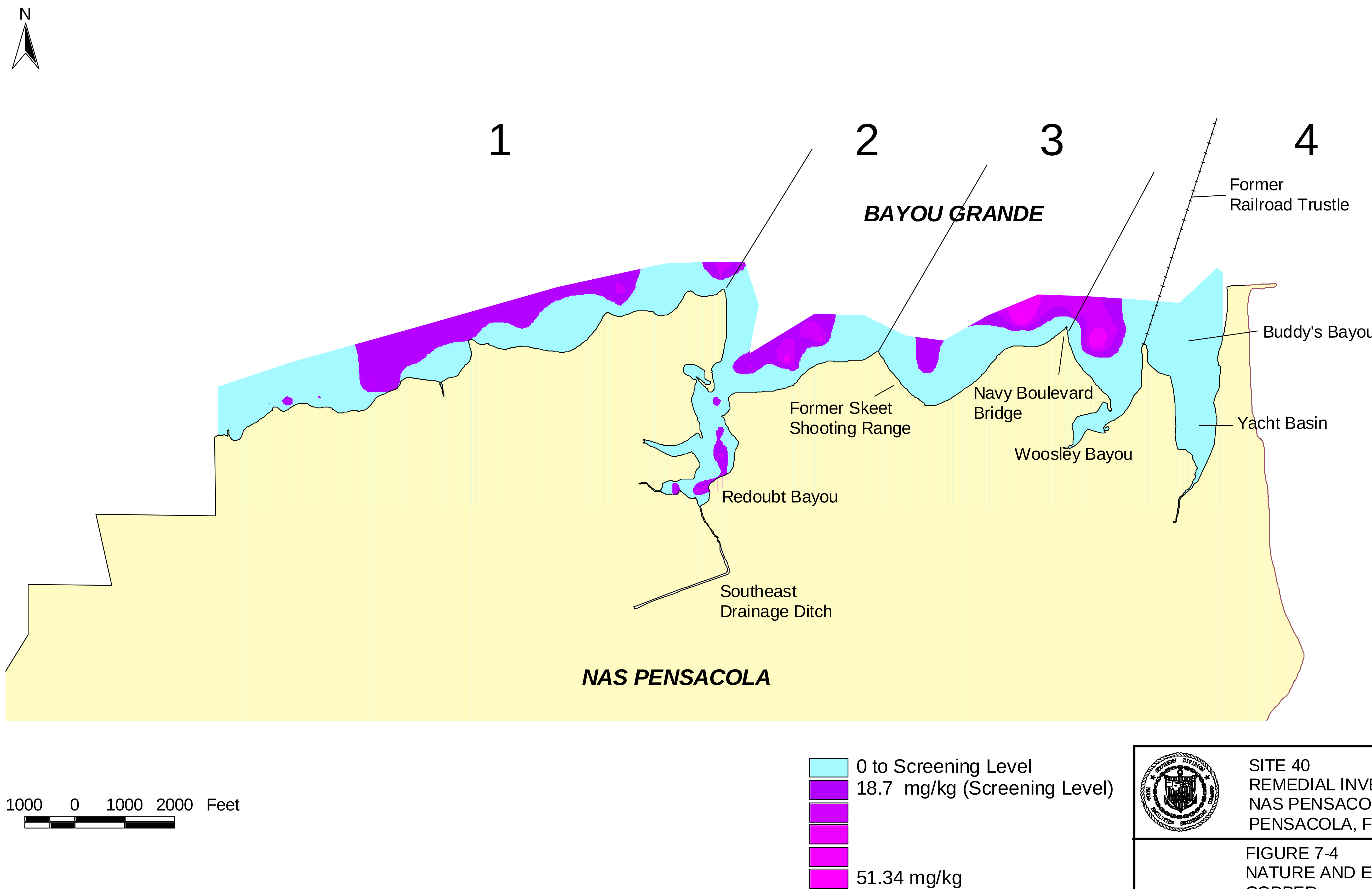

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REMEDIAL INVESTIGATION
NAS PENSACOLA
PENSACOLA, FLORIDA

FIGURE 7-4
NATURE AND EXTENT
COPPER

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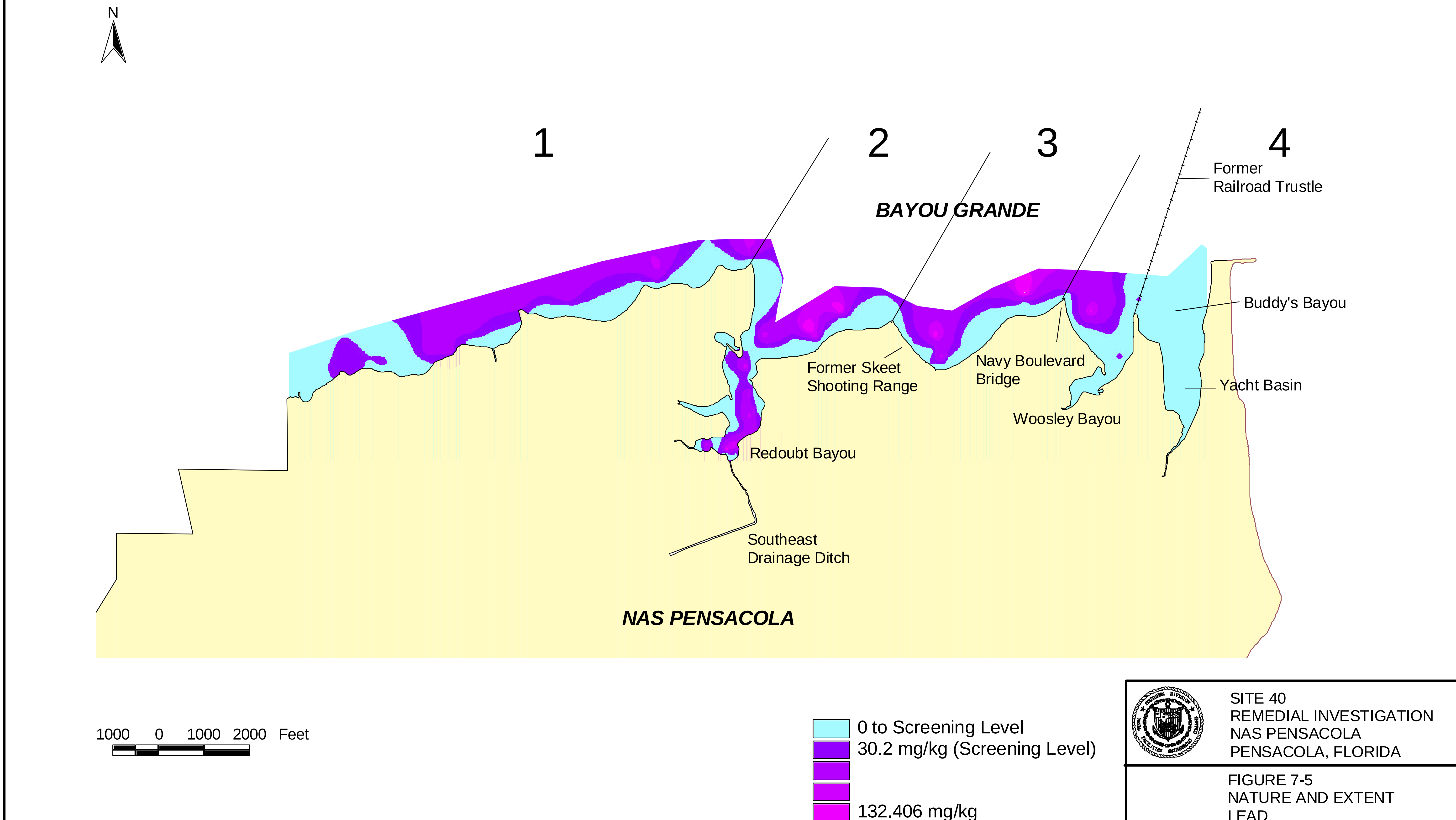

SITE 40
REMEDIAL INVESTIGATION
NAS PENSACOLA
PENSACOLA, FLORIDA

FIGURE 7-5
NATURE AND EXTENT
LEAD

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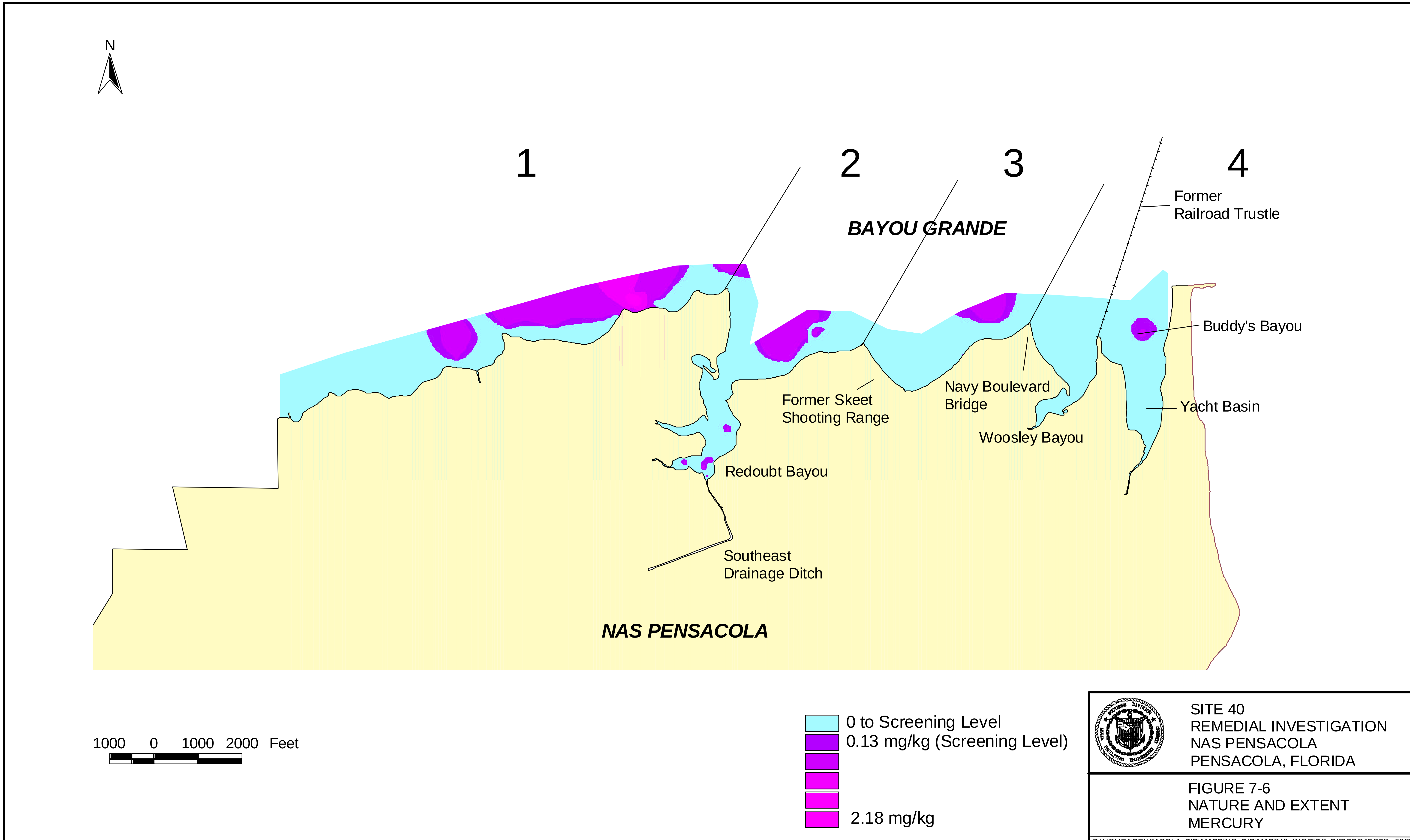
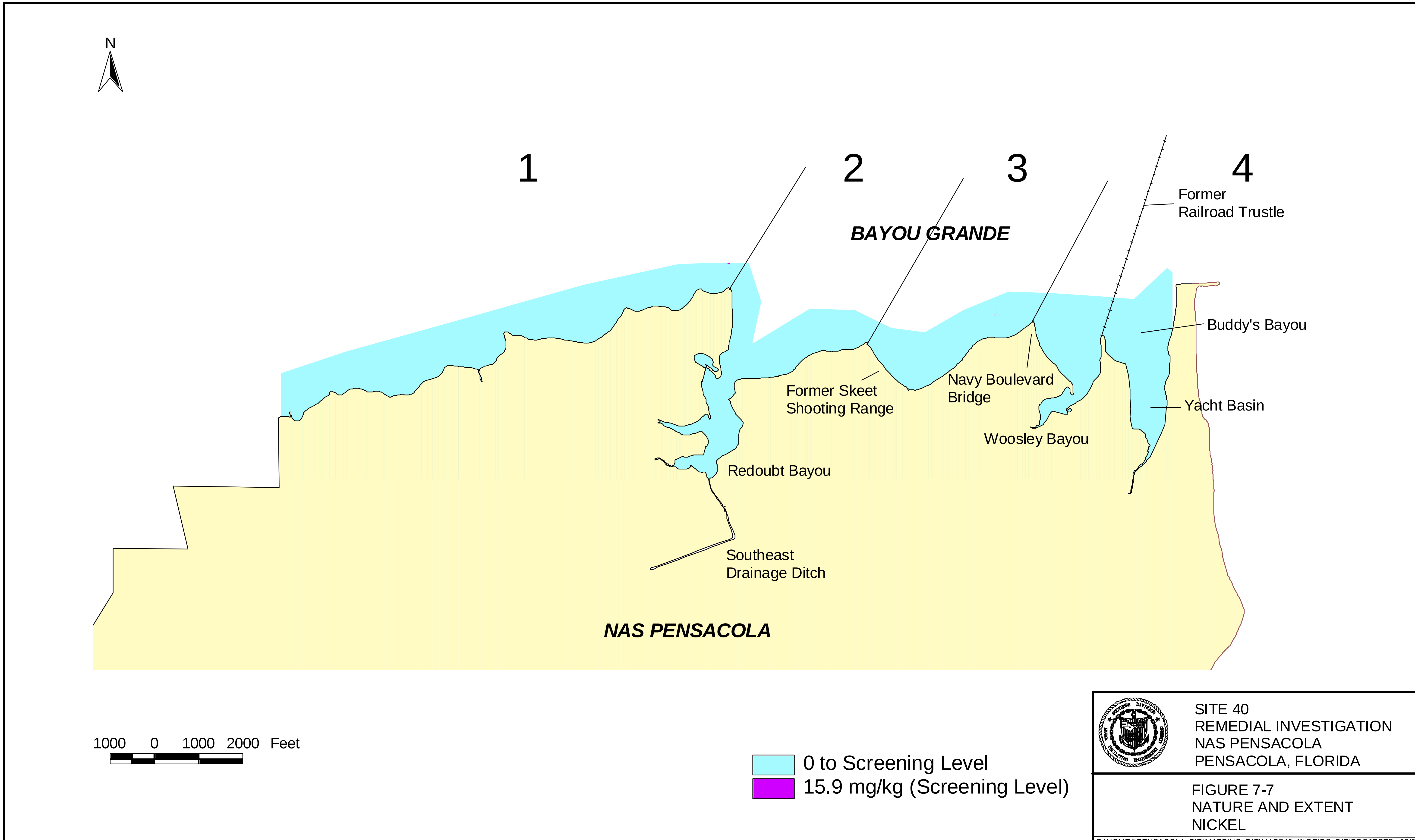
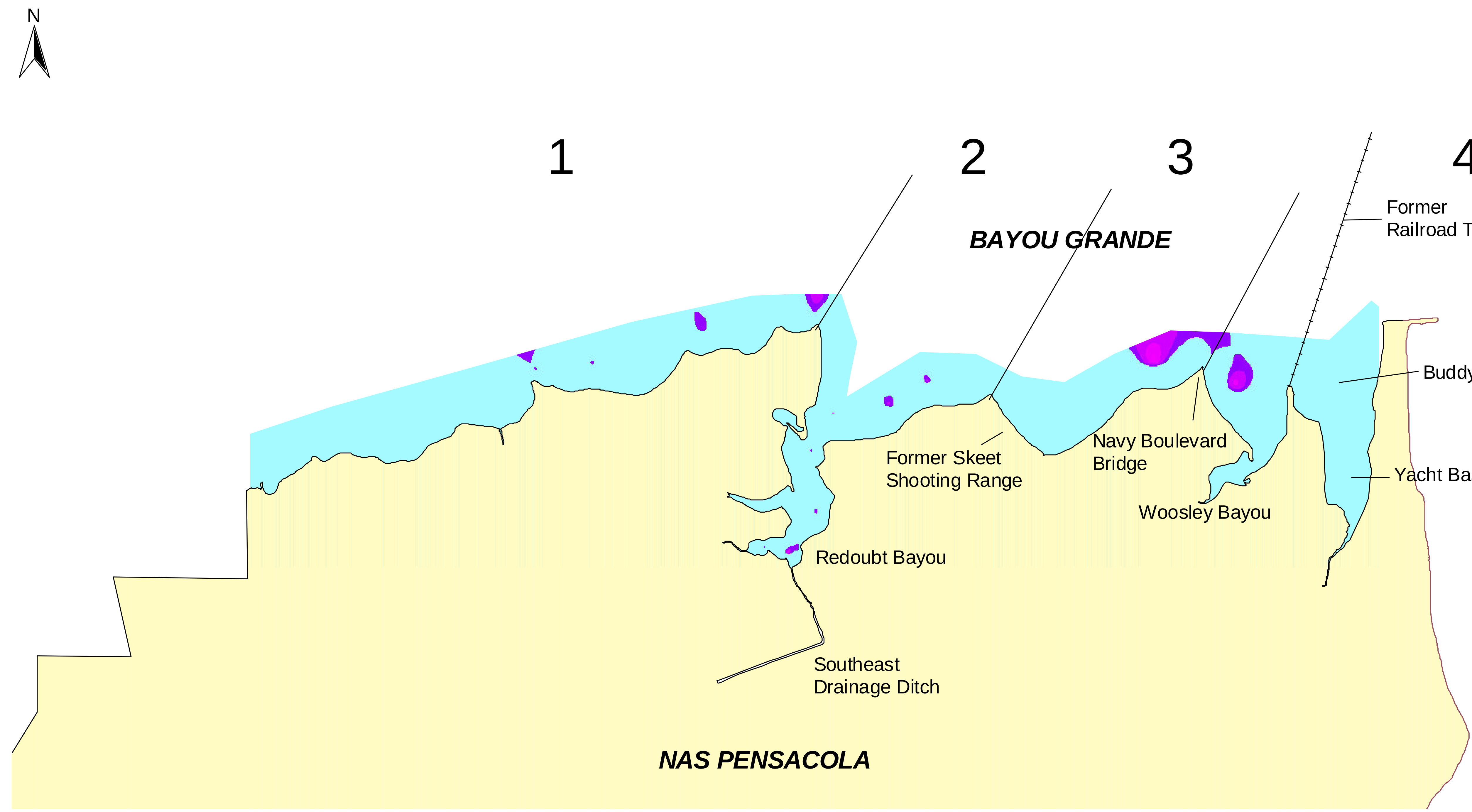


SITE 40
REMEDIAL INVESTIGATION
NAS PENSACOLA
PENSACOLA, FLORIDA

FIGURE 7-6
NATURE AND EXTENT
MERCURY



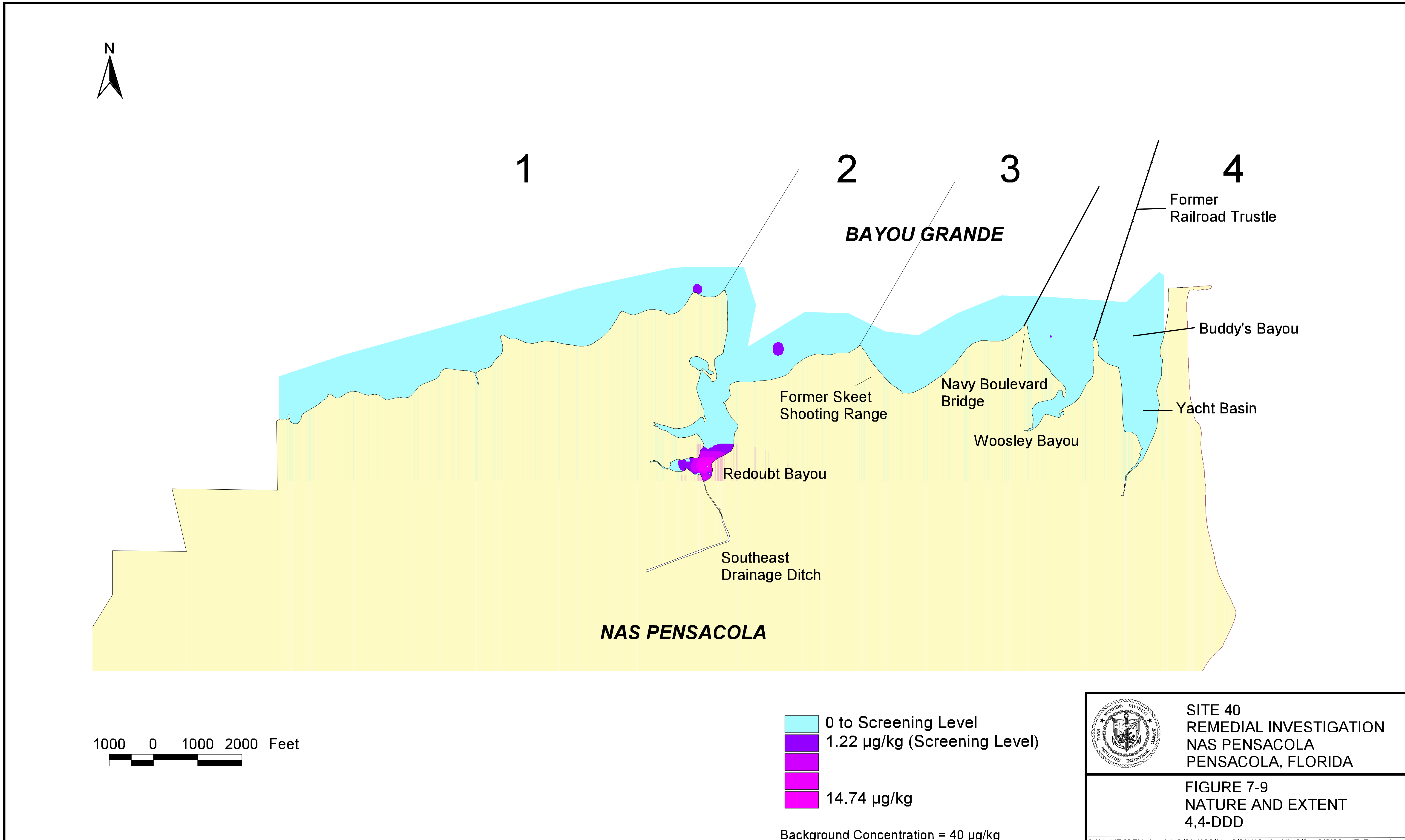
N
1
2
3
4
Former
Railroad Trustle
BAYOU GRANDE
Buddy's Bayou
Navy Boulevard
Bridge
Former Skeet
Shooting Range
Yacht Basin
Woosley Bayou
Redoubt Bayou
Southeast
Drainage Ditch
NAS PENSACOLA
1000 0 1000 2000 Feet
0 to Screening Level
15.9 mg/kg (Screening Level)
SITE 40
REMEDIAL INVESTIGATION
NAS PENSACOLA
PENSACOLA, FLORIDA
FIGURE 7-7
NATURE AND EXTENT
NICKEL
D:\HOME4\PENSACOLA_DIR\MAPPING_DIR\MAPS40-41\GRIDS_DIR\PROJECTS 03/22/00



SITE 40
REMEDIAL INVESTIGATION
NAS PENSACOLA
PENSACOLA, FLORIDA

FIGURE 7-8
NATURE AND EXTENT
ZINC

D:\HOME4\PENSACOLA_DIR\MAPPING_DIR\MAPS40-41\GRIDS_DIR\PROJECTS 03/22/00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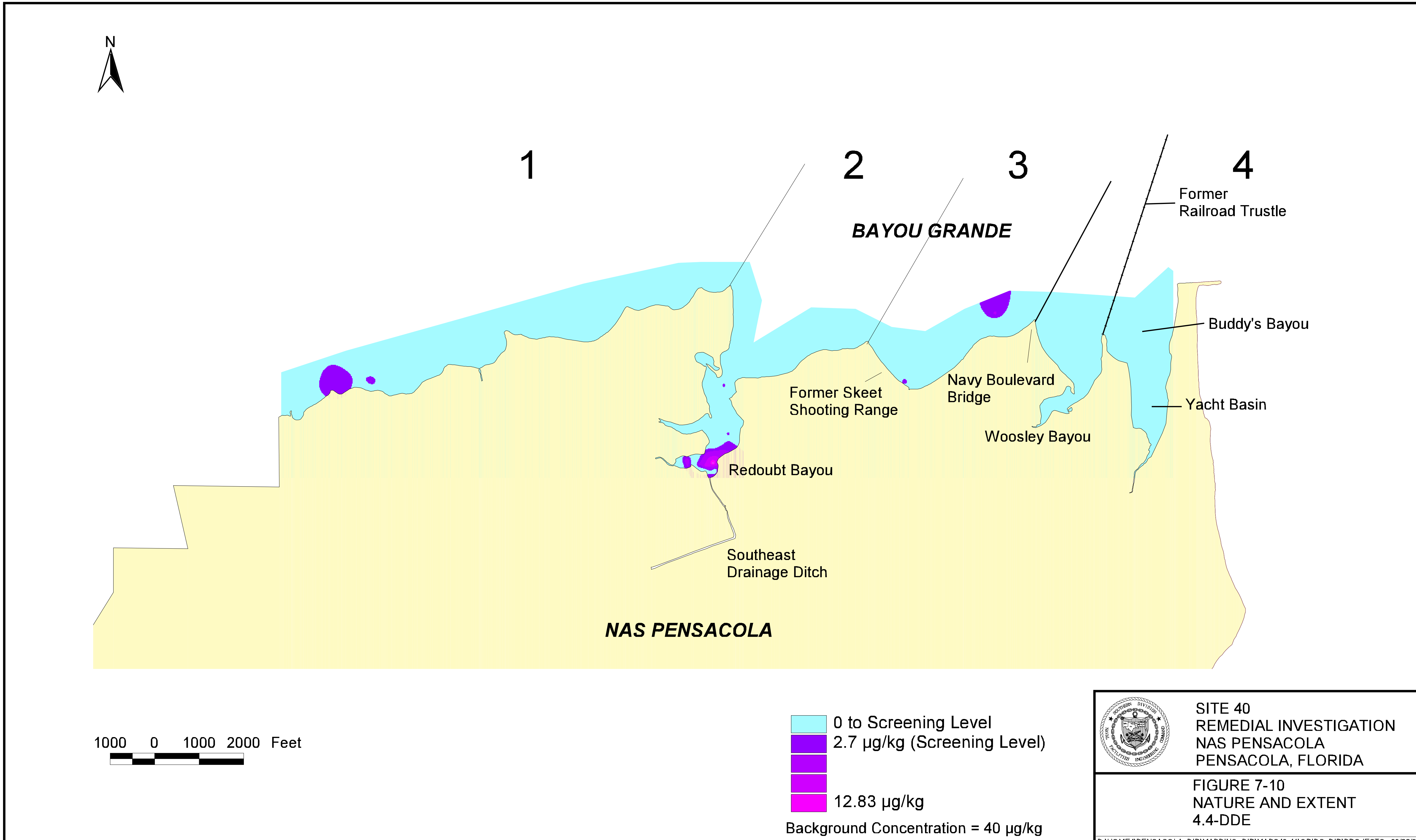
Former
Railroad Trustle
BAYOU GRANDE
Buddy's Bayou
Navy Boulevard
Bridge
Former Skeet
Shooting Range
Yacht Basin
Woosley Bayou
Redoubt Bayou
Southeast
Drainage Ditch
NAS PENSACOLA
1000 0 1000 2000 Feet
0 to Screening Level
1.22 µg/kg (Screening Level)
14.74 µg/kg
Background Concentration = 40 µg/kg
SITE 40
REMEDIAL INVESTIGATION
NAS PENSACOLA
PENSACOLA, FLORIDA
FIGURE 7-9
NATURE AND EXTENT
4,4-DDD
D:\HOME4\PENSACOLA_DIR\MAPPING_DIR\MAPS40-41\GRIDS_DIR\PROJECTS 03/22/00



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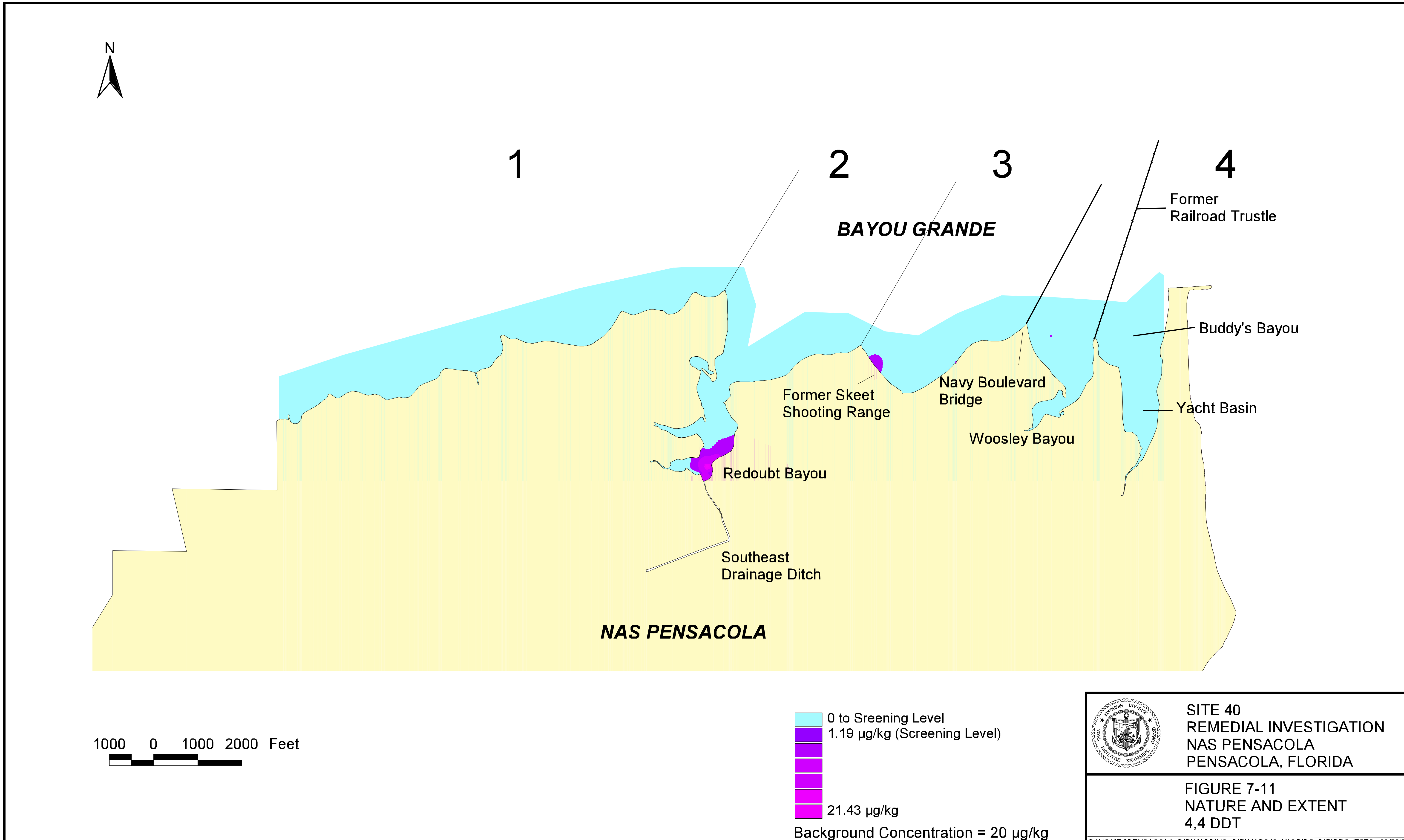
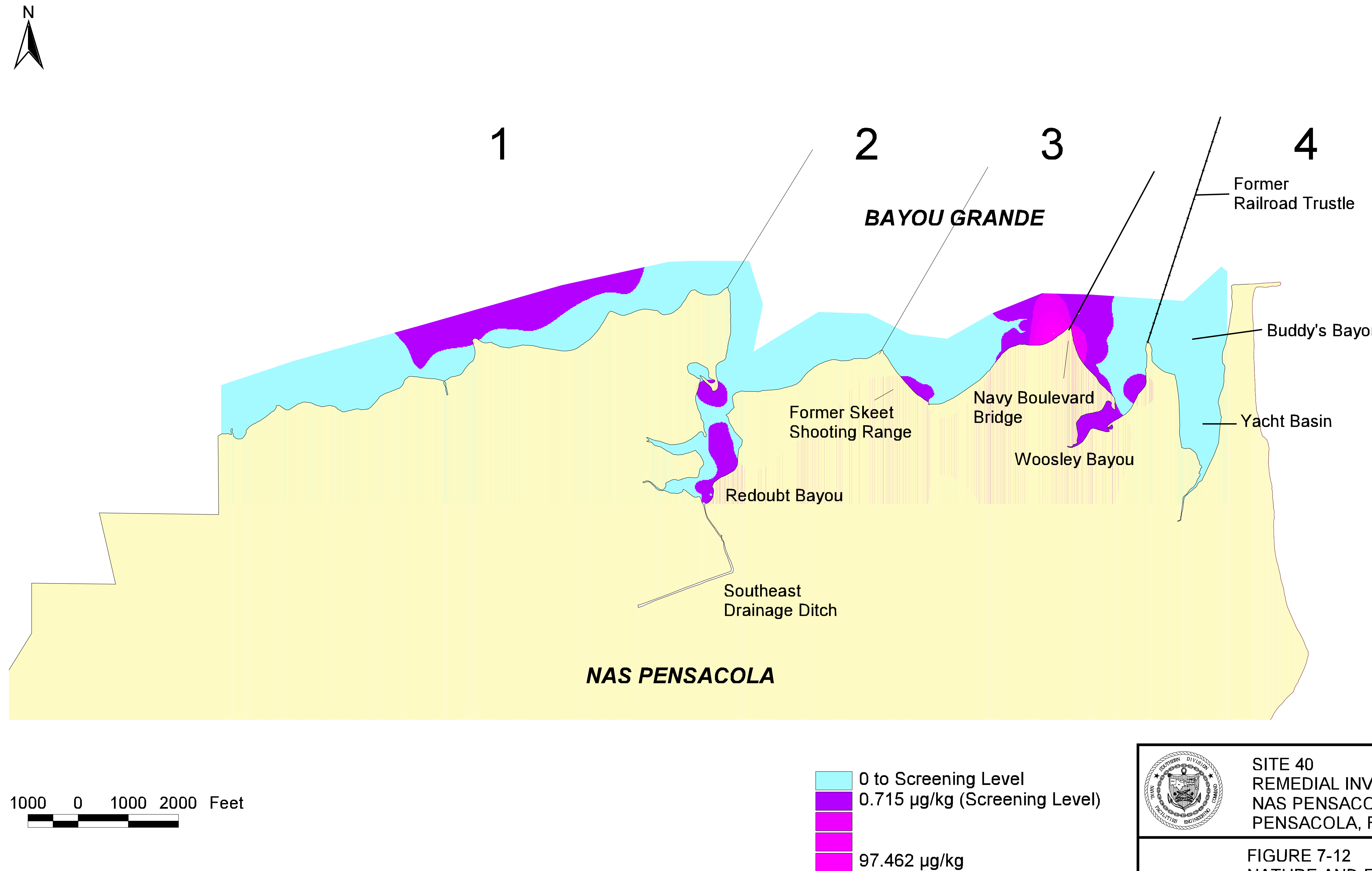
Former
Railroad Trustle
BAYOU GRANDE
Buddy's Bayou
Navy Boulevard
Bridge
Former Skeet
Shooting Range
Yacht Basin
Woosley Bayou
Redoubt Bayou
Southeast
Drainage Ditch
NAS PENSACOLA
1000 0 1000 2000 Feet
0 to Screening Level
2.7 µg/kg (Screening Level)
12.83 µg/kg
Background Concentration = 40 µg/kg
SITE 40
REMEDIAL INVESTIGATION
NAS PENSACOLA
PENSACOLA, FLORIDA
FIGURE 7-10
NATURE AND EXTENT
4.4-DDE
D:\HOME4\PENSACOLA_DIR\MAPPING_DIR\MAPS40-41\GRIDS_DIR\PROJECTS 03/22/00



SITE 40
REMEDIAL INVESTIGATION
NAS PENSACOLA
PENSACOLA, FLORIDA

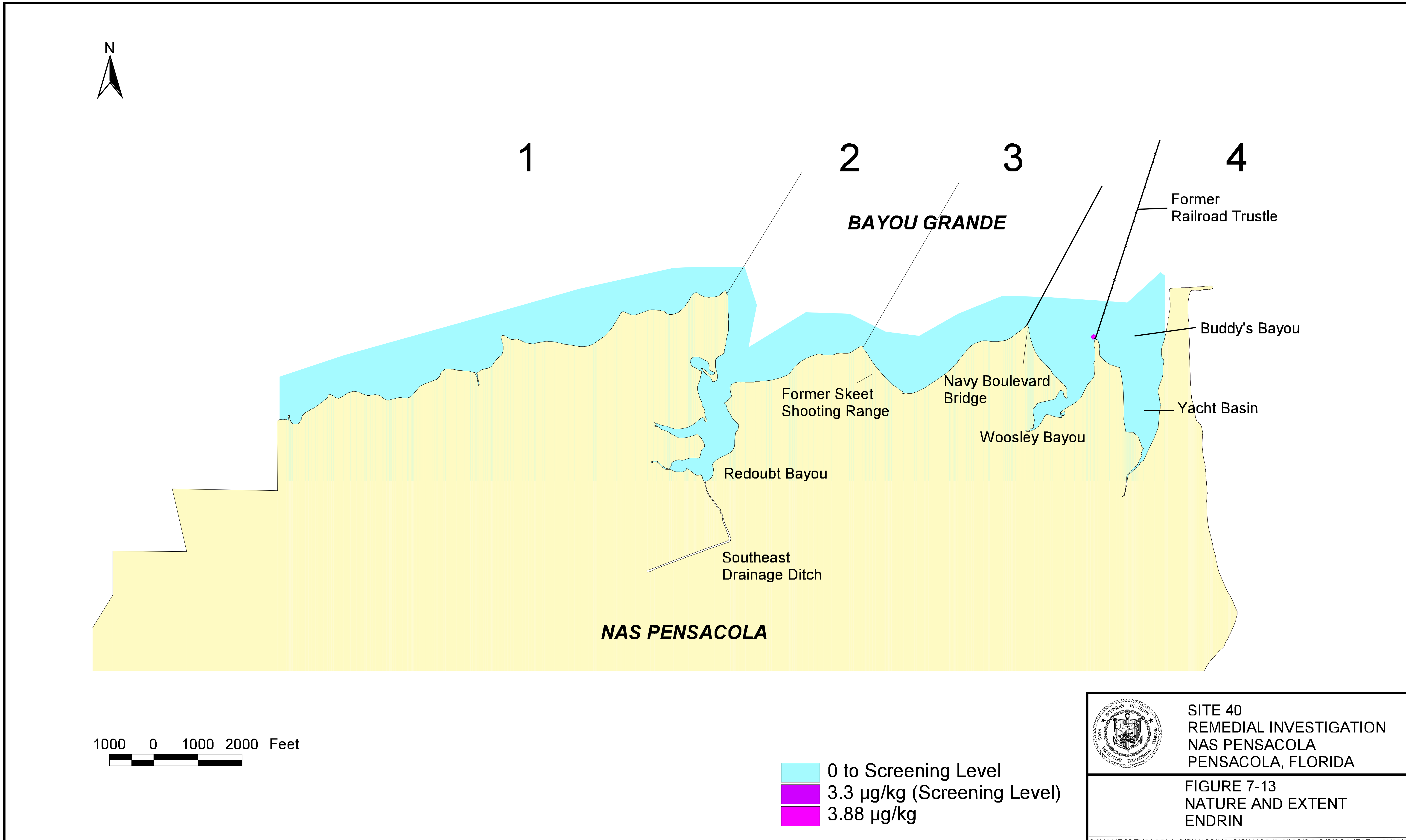
FIGURE 7-11
NATURE AND EXTENT
4,4 DDT



SITE 40
REMEDIAL INVESTIGATION
NAS PENSACOLA
PENSACOLA, FLORIDA

FIGURE 7-12
NATURE AND EXTENT
DIELDRIN

D:\HOME4\PENSACOLA_DIR\MAPPING_DIR\MAPS40-41\GRIDS_DIR\PROJECTS 03/22/00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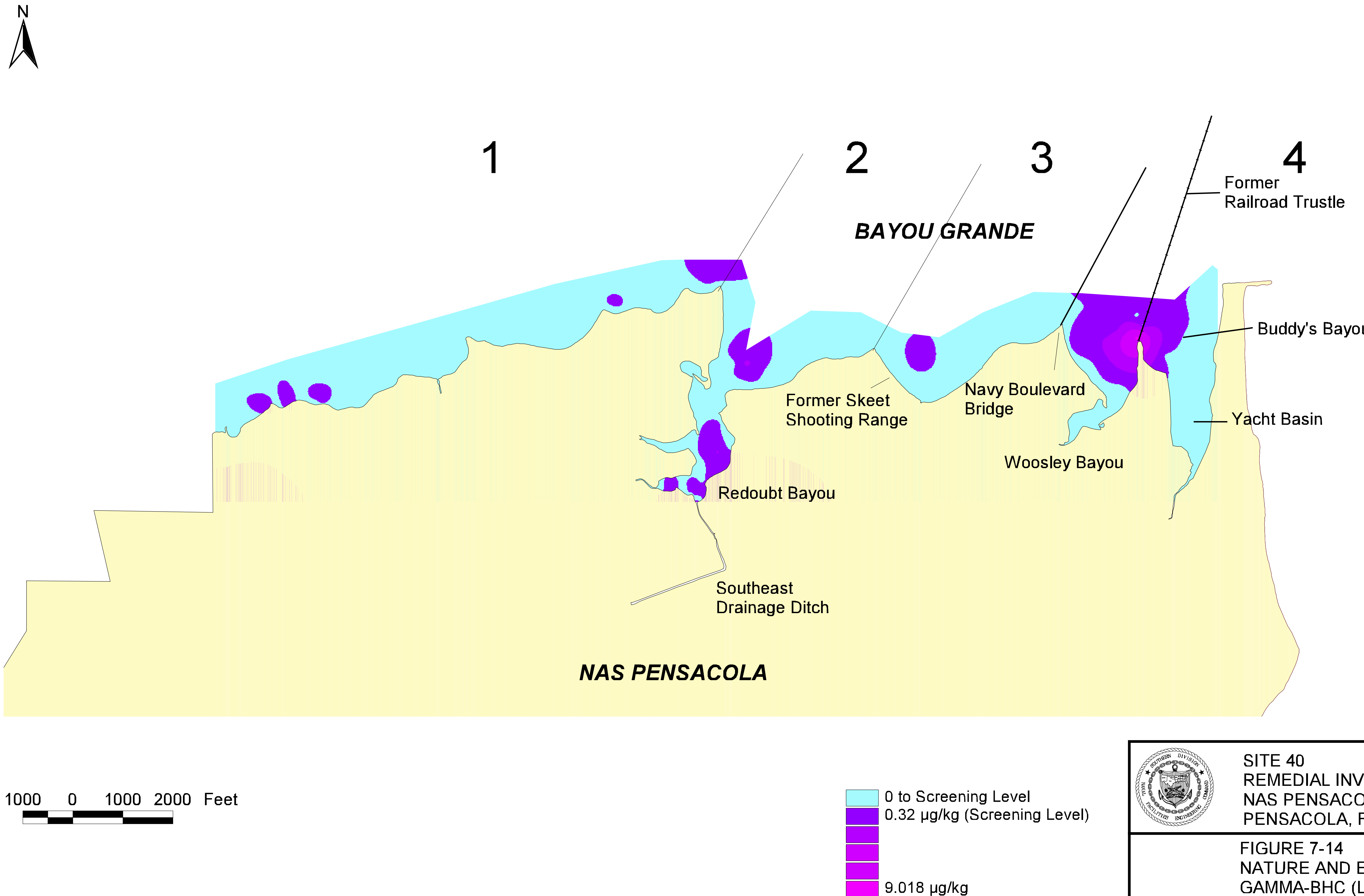
Former
Railroad Trustle
BAYOU GRANDE
Buddy's Bayou
Navy Boulevard
Bridge
Former Skeet
Shooting Range
Yacht Basin
Woosley Bayou
Redoubt Bayou
Southeast
Drainage Ditch
NAS PENSACOLA
1000 0 1000 2000 Feet
0 to Screening Level
3.3 µg/kg (Screening Level)
3.88 µg/kg
SITE 40
REMEDIAL INVESTIGATION
NAS PENSACOLA
PENSACOLA, FLORIDA
FIGURE 7-13
NATURE AND EXTENT
ENDRIN
D:\HOME4\PENSACOLA_DIR\MAPPING_DIR\MAPS40-41\GRIDS_DIR\PROJECTS 03/22/00



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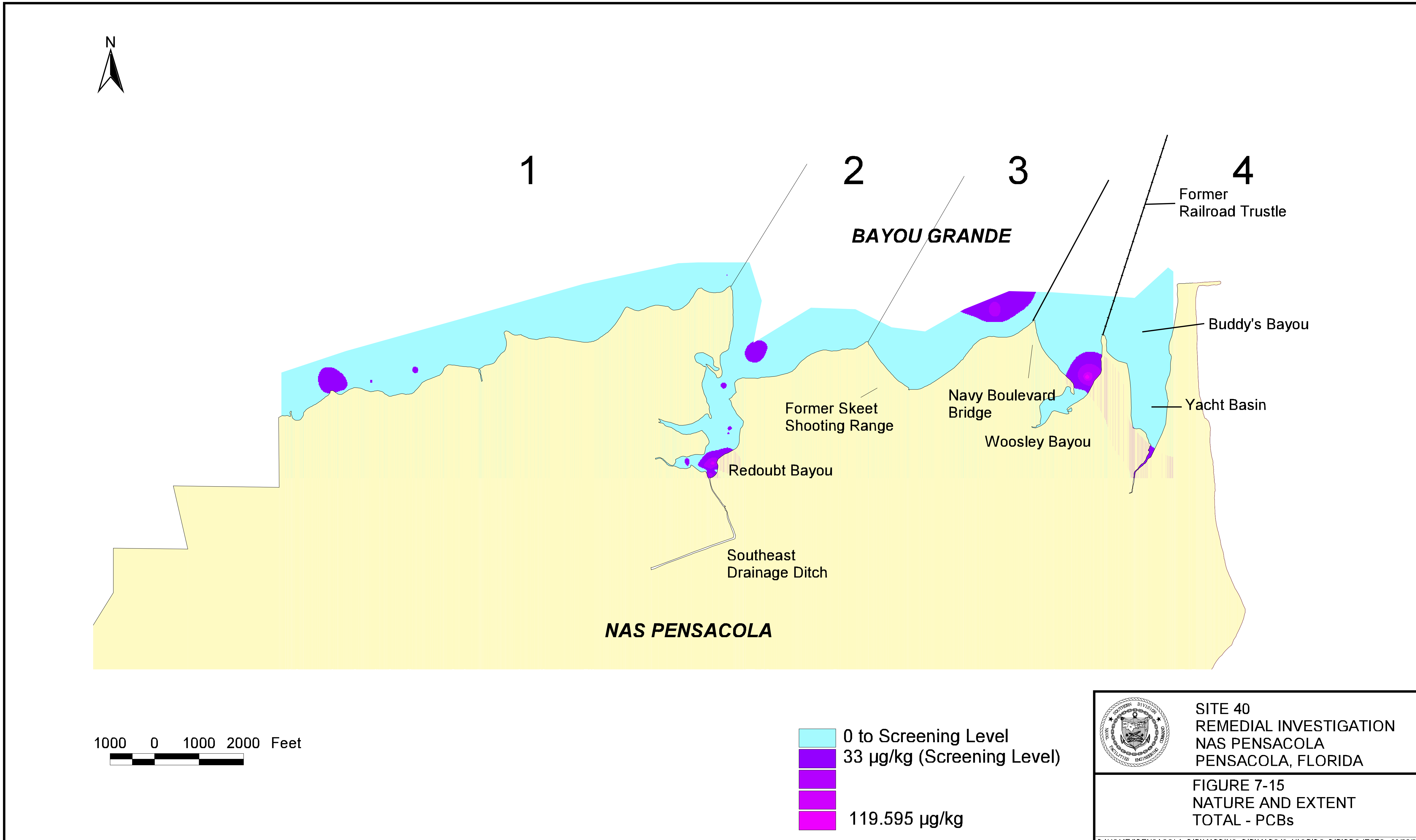
NAS PENSACOLA
PENSACOLA, FLORIDA

FIGURE 7-14
NATURE AND EXTENT
GAMMA-BHC (LINDANE)

D:\HOME4\PENSACOLA_DIR\MAPPING_DIR\MAPS40-41\GRIDS_DIR\PROJECTS 03/22/00


N
1
2
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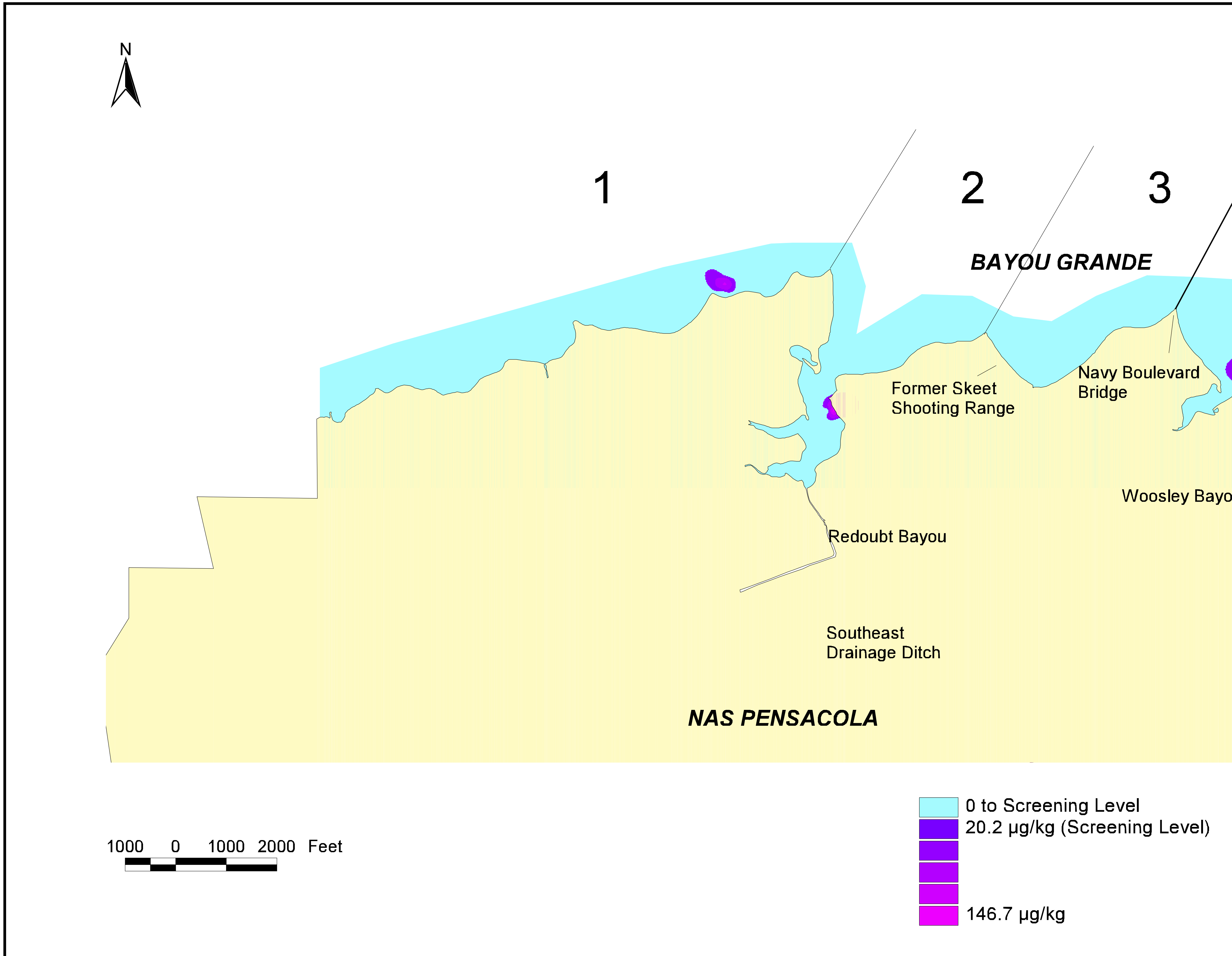
Former
Railroad Trustle
BAYOU GRANDE
Buddy's Bayou
Yacht Basin
Navy Boulevard
Bridge
Woosley Bayou
Former Skeet
Shooting Range
Redoubt Bayou
Southeast
Drainage Ditch
NAS PENSACOLA
1000 0 1000 2000 Feet
0 to Screening Level
33 µg/kg (Screening Level)
119.595 µg/kg
SITE 40
REMEDIAL INVESTIGATION
NAS PENSACOLA
PENSACOLA, FLORIDA
FIGURE 7-15
NATURE AND EXTENT
TOTAL - PCBs
D:\HOME4\PENSACOLA_DIR\MAPPING_DIR\MAPS40-41\GRIDS_DIR\PROJECTS 03/22/00



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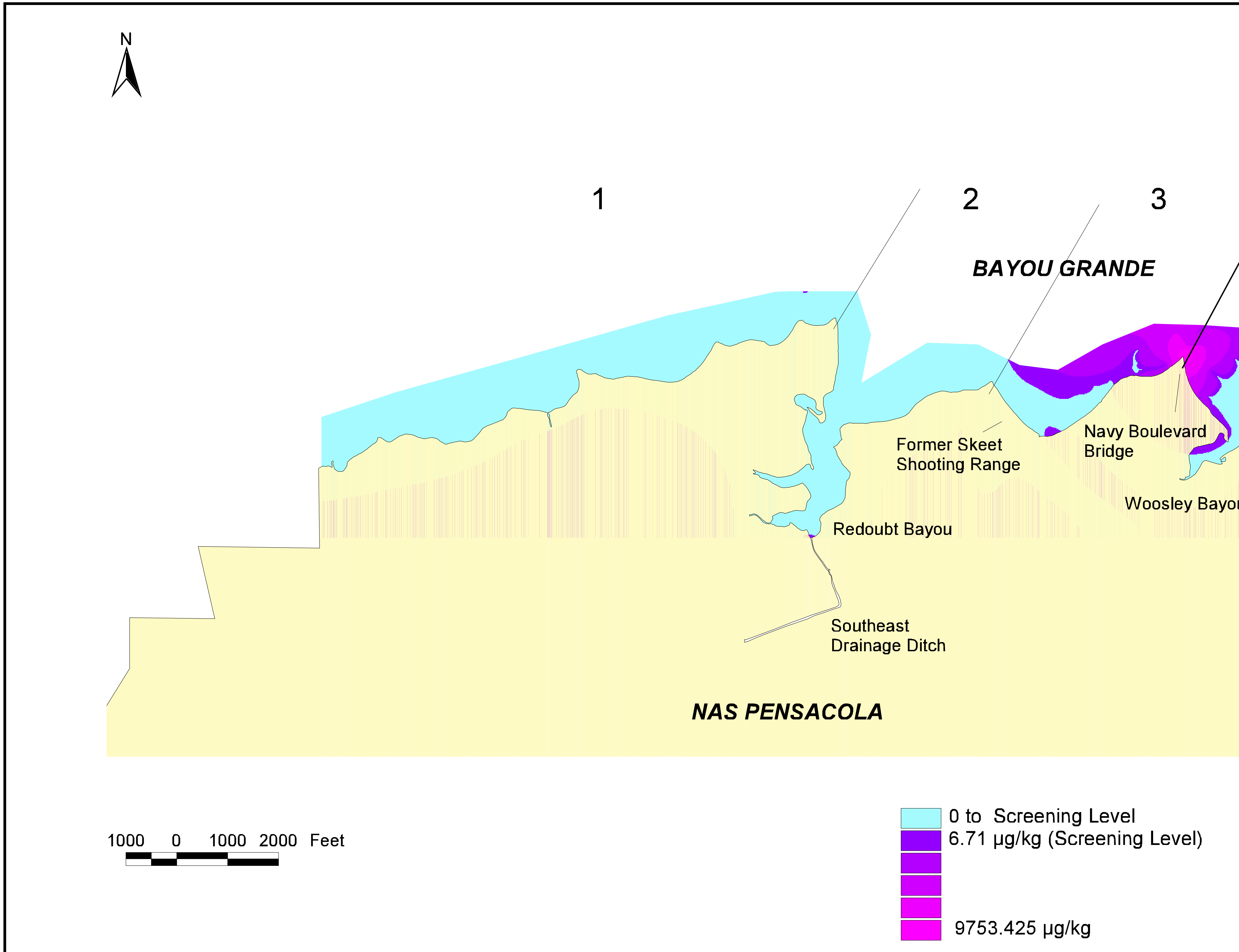
PENSACOLA, FLORIDA

FIGURE 7-16
NATURE AND EXTENT
2-METHYLNAPHTHALENE

D:\HOME4\PENSACOLA_DIR\MAPPING_DIR\MAPS40-41\GRIDS_DIR\PROJECTS 03/22/00



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NAS PENSACOLA
PENSACOLA, FLORIDA

FIGURE 7-17
NATURE AND EXTENT
ACENAPHTHENE

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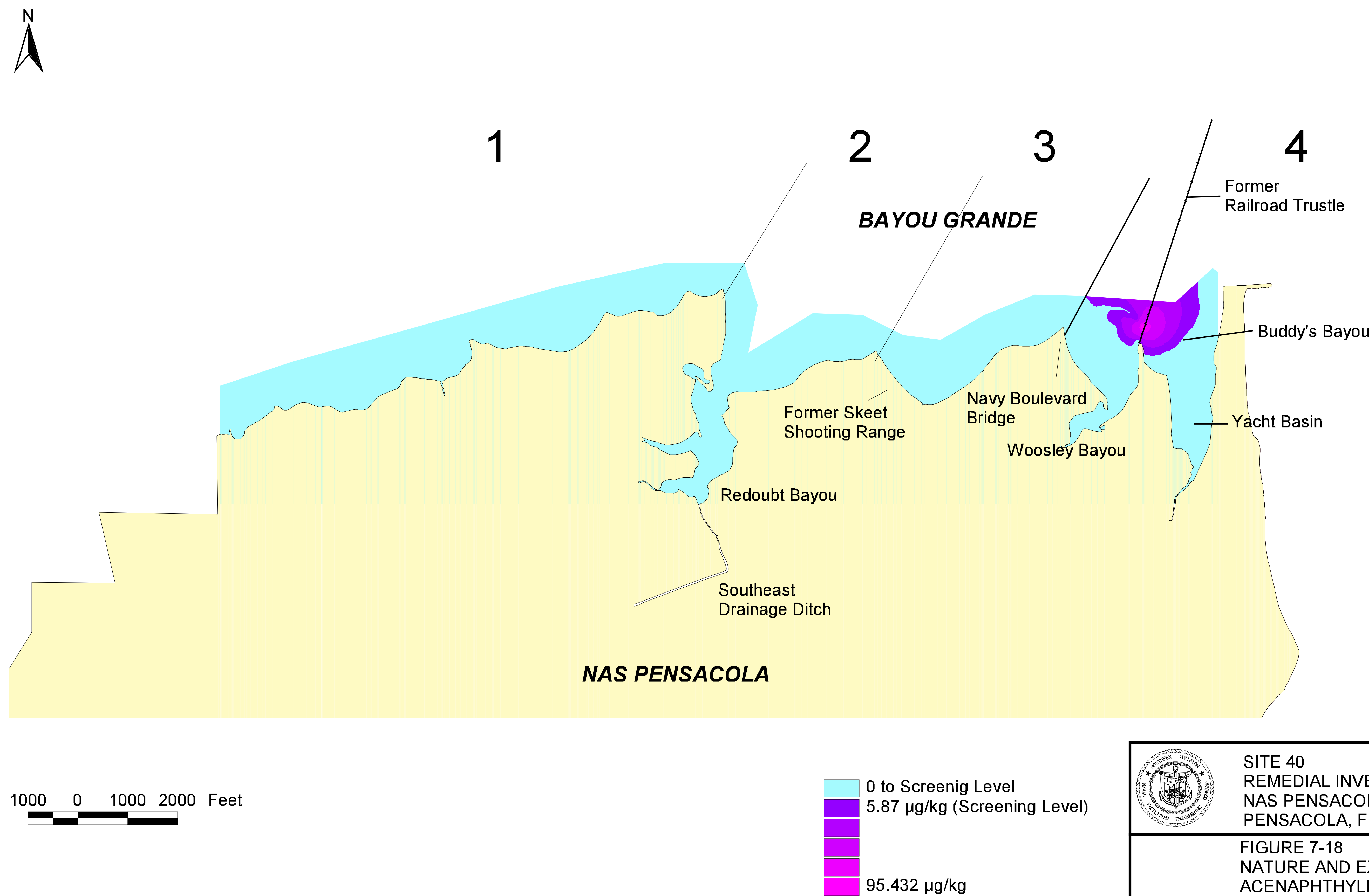


SITE 40
REMEDIAL INVESTIGATION
NAS PENSACOLA
PENSACOLA, FLORIDA

FIGURE 7-18
NATURE AND EXTENT
ACENAPHTHYLENE

D:\HOME4\PENSACOLA_DIR\MAPPING_DIR\MAPS40-41\GRIDS_DIR\PROJECTS 03/22/00

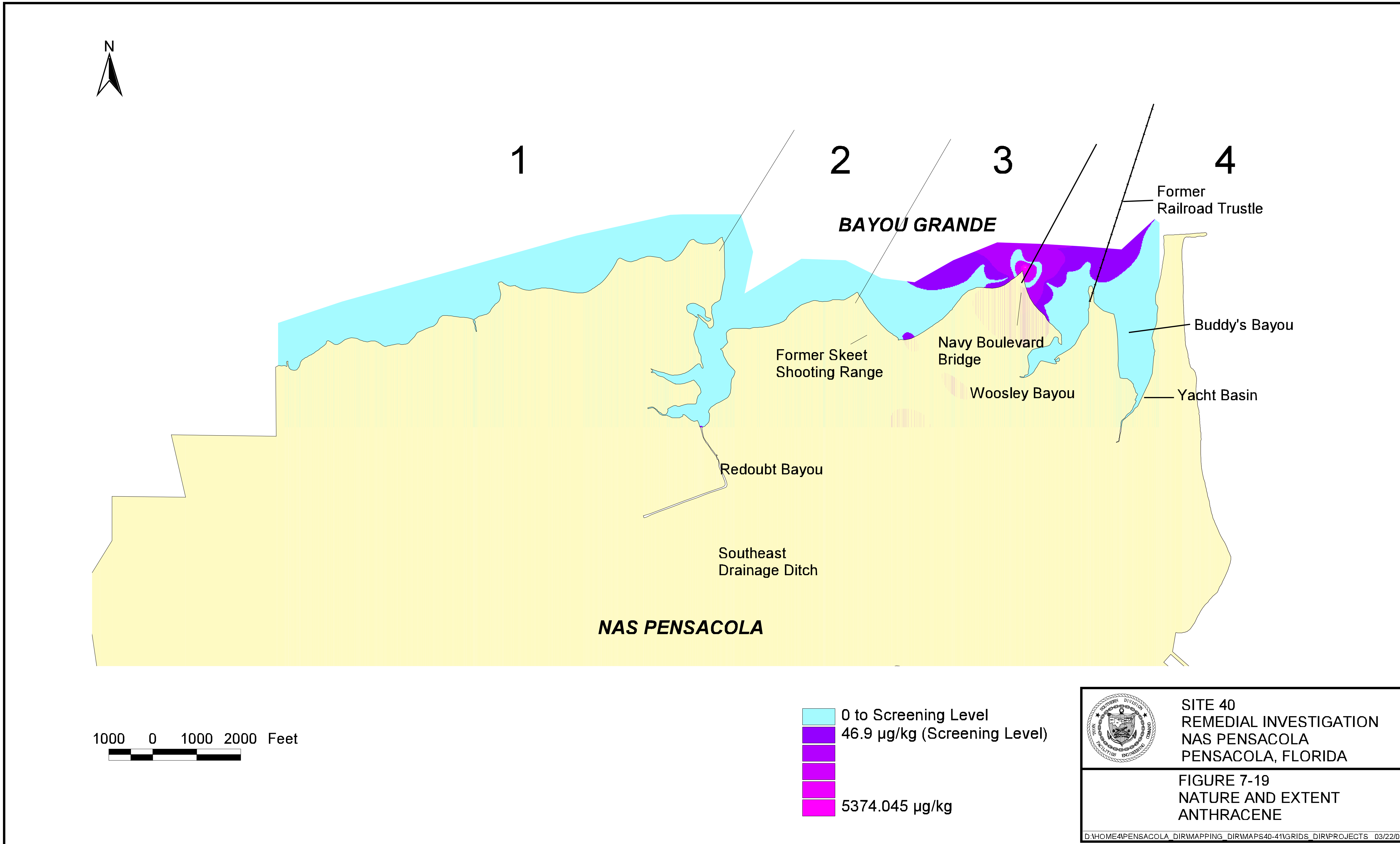
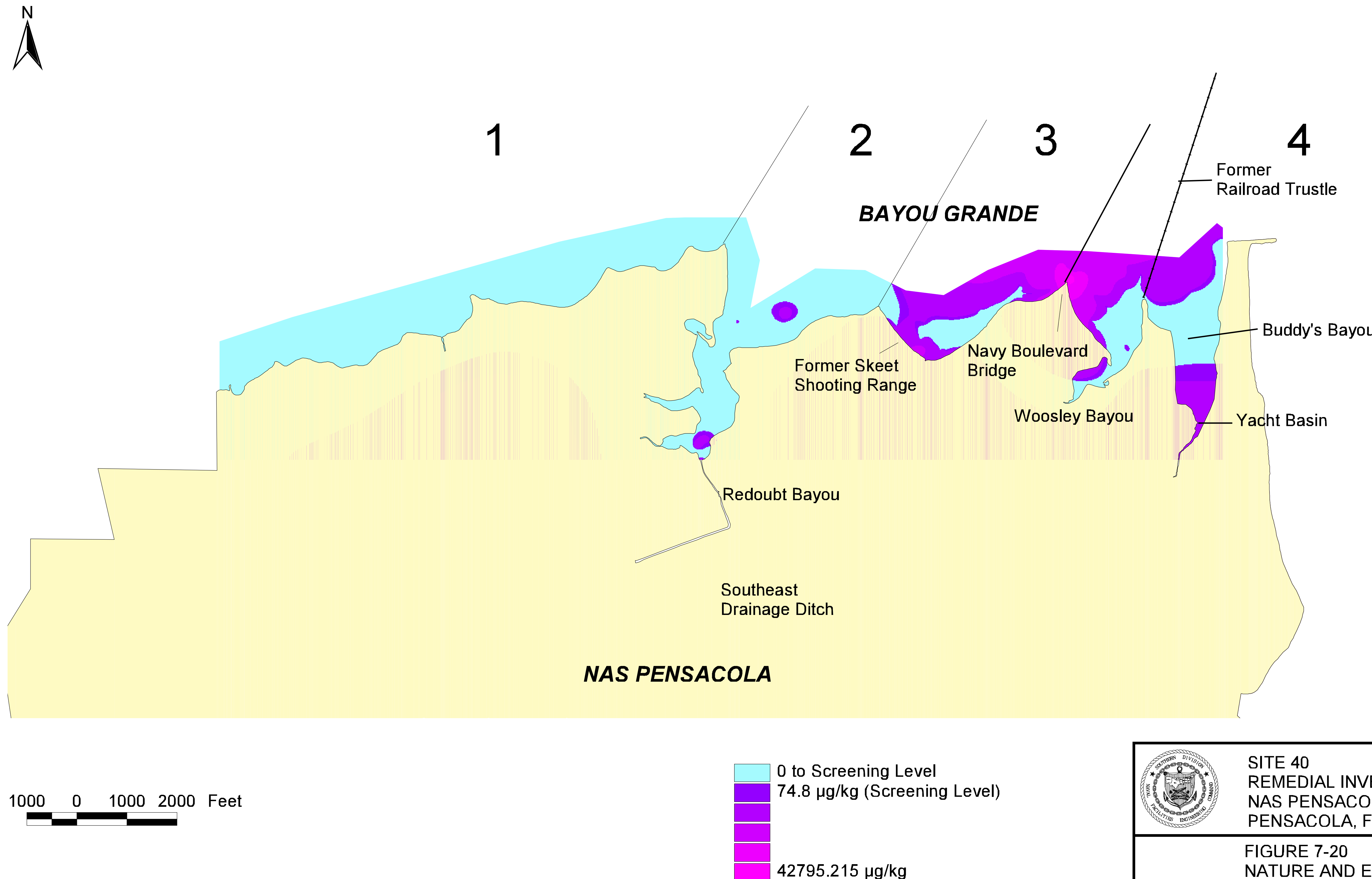


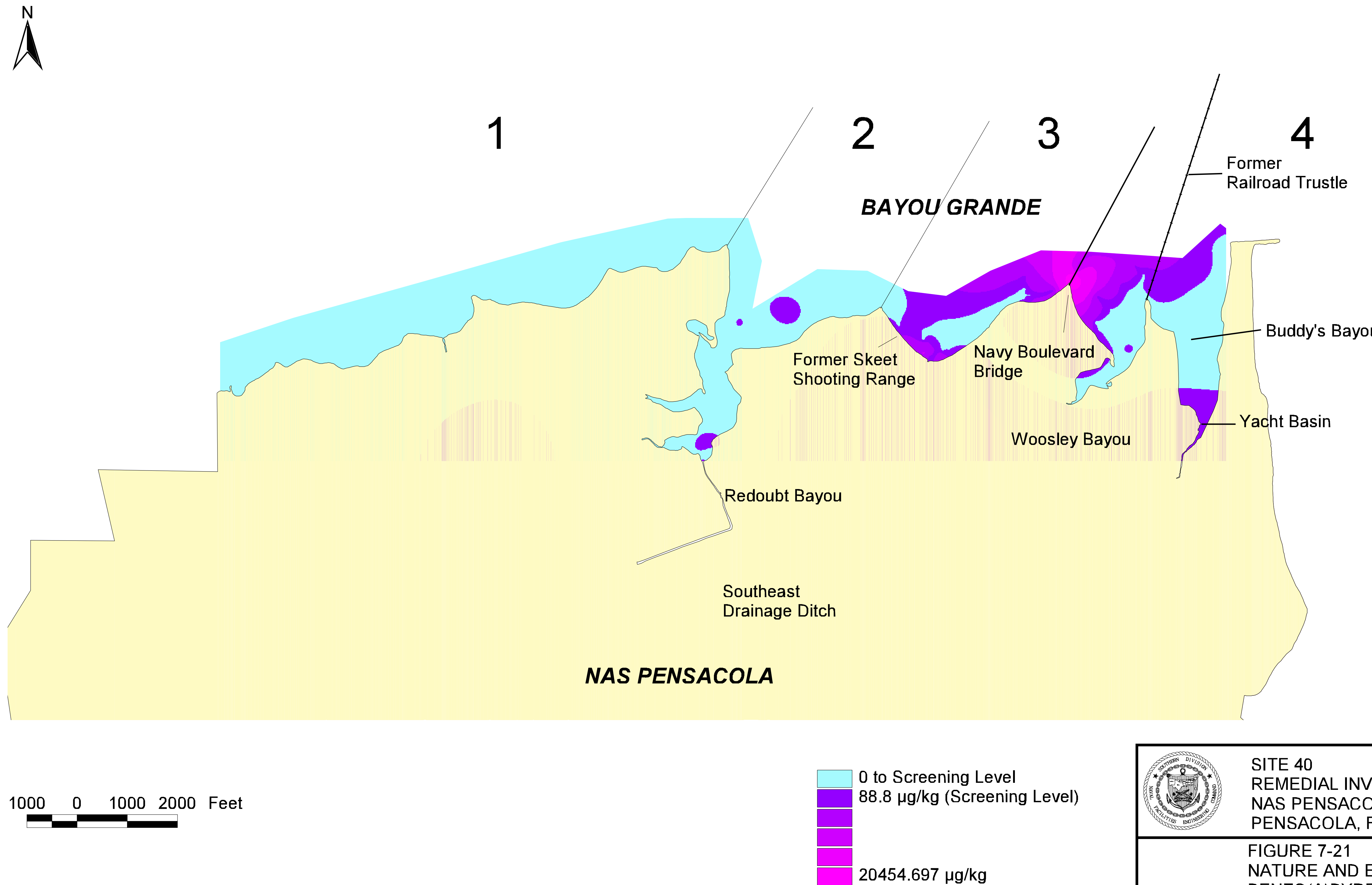
FIGURE 7-19
NATURE AND EXTENT
ANTHRACENE



SITE 40
REMEDIAL INVESTIGATION
NAS PENSACOLA
PENSACOLA, FLORIDA

FIGURE 7-20
NATURE AND EXTENT
BENZO(A)ANTHRACENE

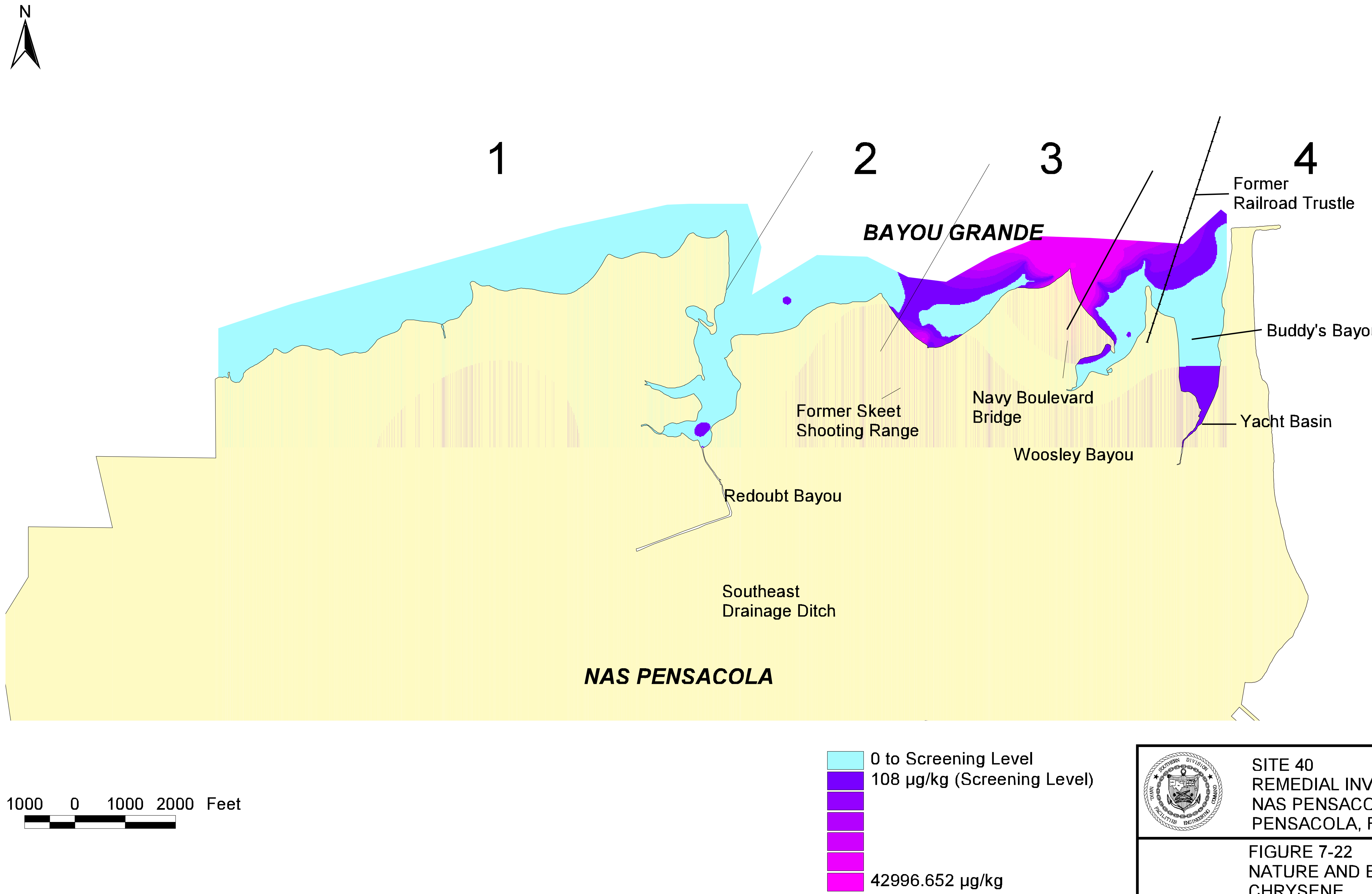
D:\HOME4\PENSACOLA_DIR\MAPPING_DIR\MAPS40-41\GRIDS_DIR\PROJECTS 03/22/00



SITE 40
REMEDIAL INVESTIGATION
NAS PENSACOLA
PENSACOLA, FLORIDA

FIGURE 7-21
NATURE AND EXTENT
BENZO(A)PYRENE

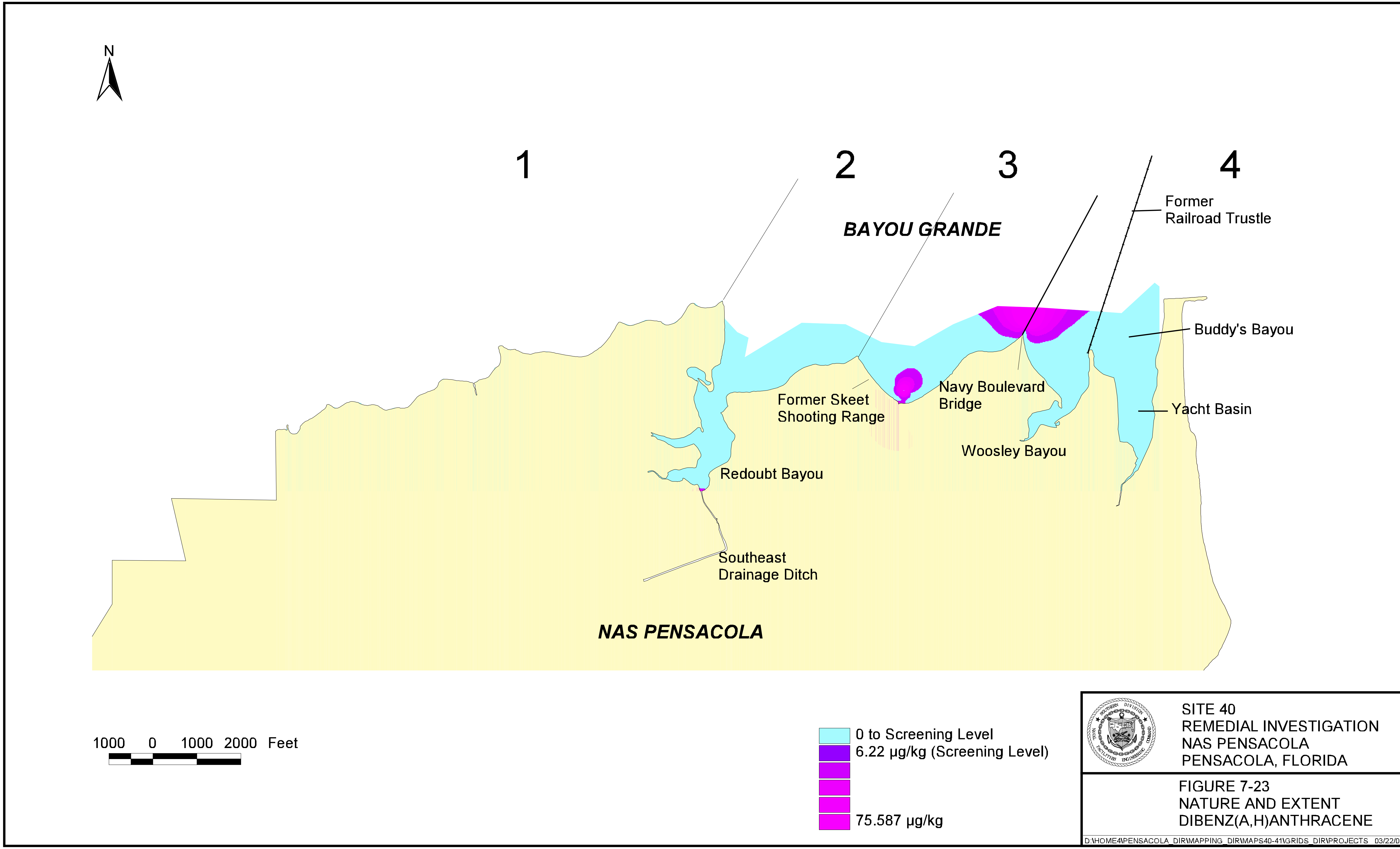
D:\HOME4\PENSACOLA_DIR\MAPPING_DIR\MAPS40-41\GRIDS_DIR\PROJECTS 03/22/00



SITE 40
REMEDIAL INVESTIGATION
NAS PENSACOLA
PENSACOLA, FLORIDA

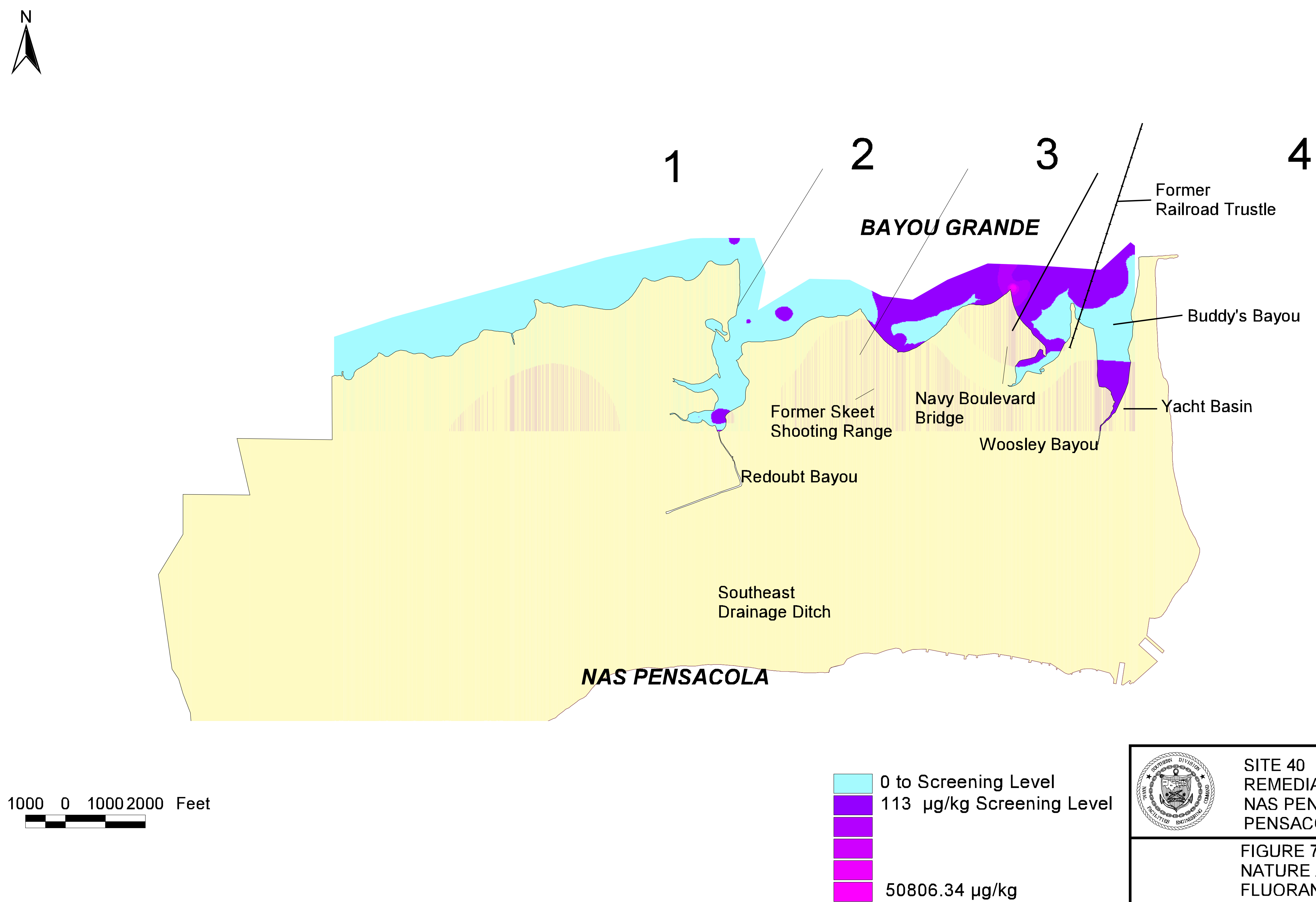
FIGURE 7-22
NATURE AND EXTENT
CHRYSENE

D:\HOME4\PENSACOLA_DIR\MAPPING_DIR\MAPS40-41\GRIDS_DIR\PROJECTS 03/22/00



SITE 40
REMEDIAL INVESTIGATION
NAS PENSACOLA
PENSACOLA, FLORIDA

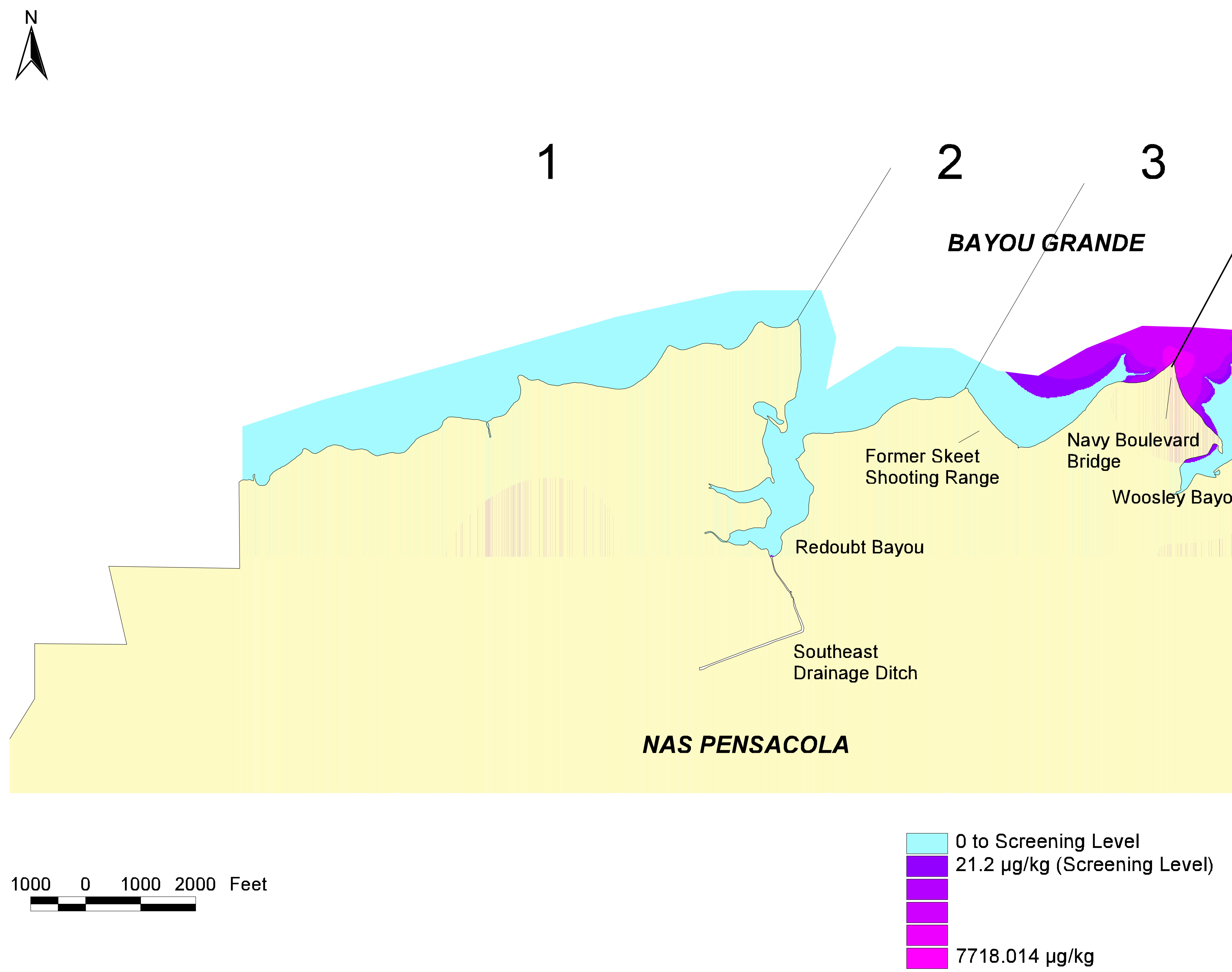
FIGURE 7-23
NATURE AND EXTENT
DIBENZ(A,H)ANTHRACENE



SITE 40
REMEDIAL INVESTIGATION
NAS PENSACOLA
PENSACOLA, FLORIDA

FIGURE 7-24
NATURE AND EXTENT
FLUORANTHENE

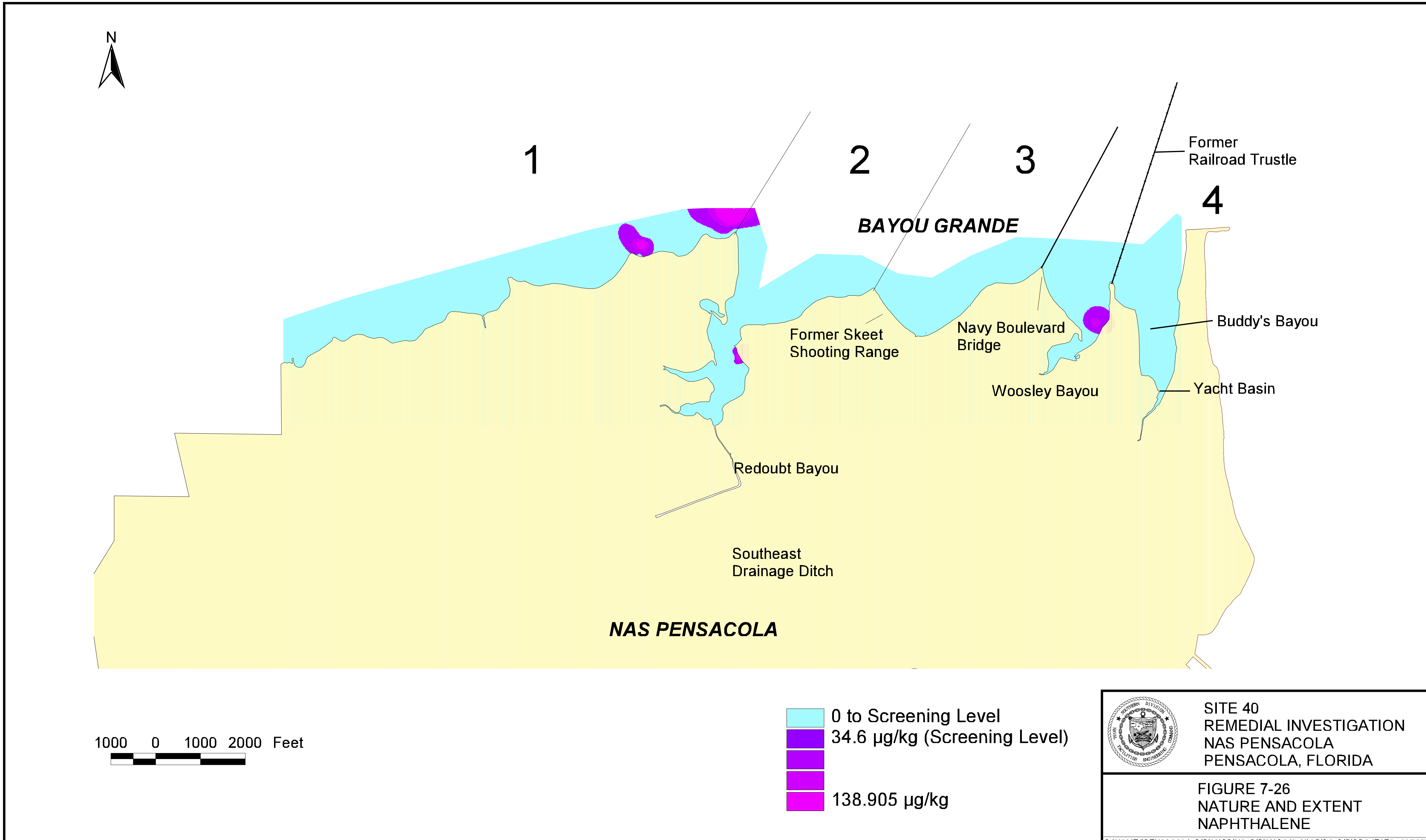
D:\HOME4\PENSACOLA_DIR\MAPPING_DIR\MAPS40-41\GRIDS_DIR\PROJECTS 03/22/00



SITE 40
REMEDIAL INVESTIGATION
NAS PENSACOLA
PENSACOLA, FLORIDA

FIGURE 7-25
NATURE AND EXTENT
FLUORENE

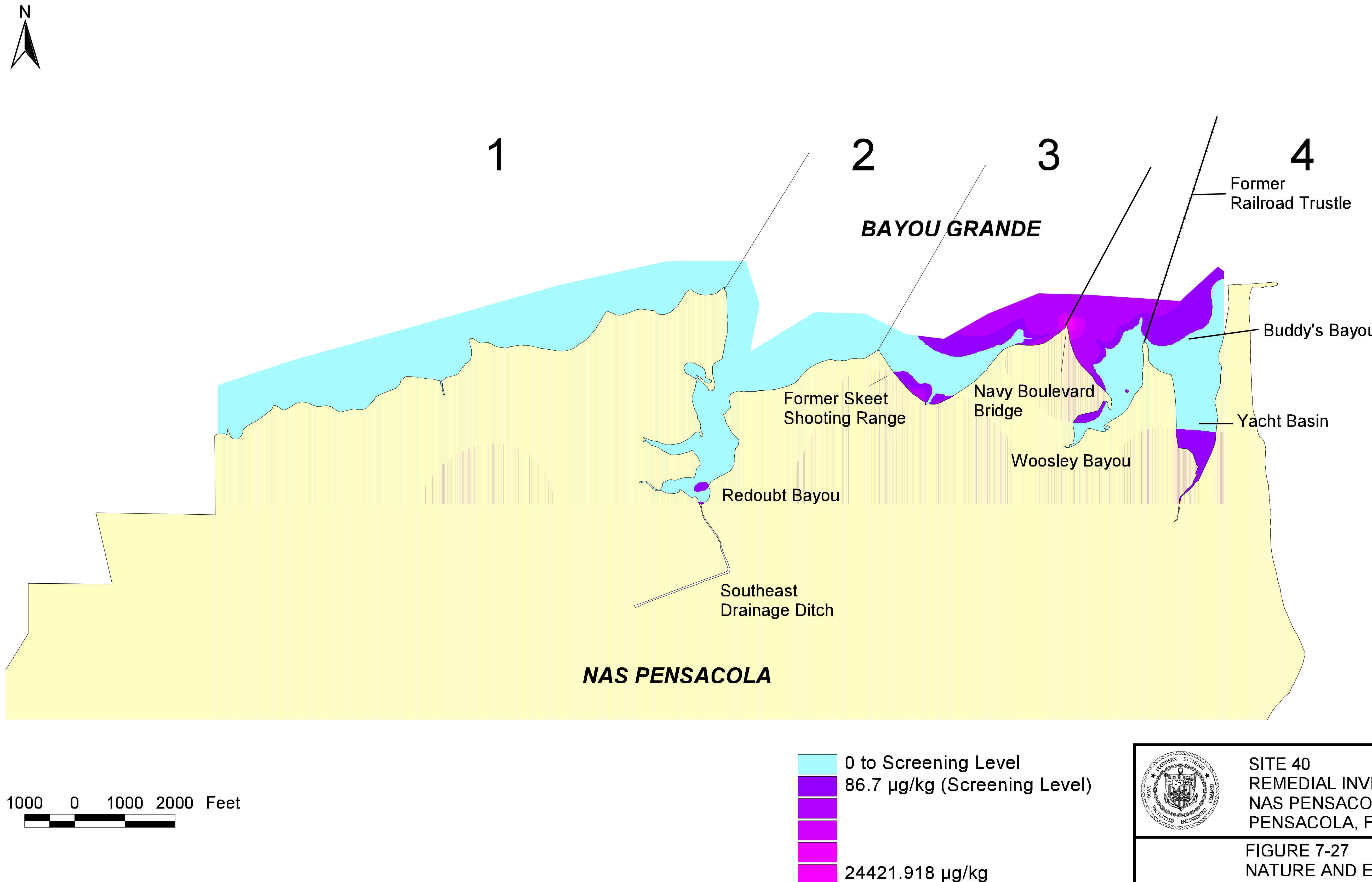
D:\HOME4\PENSACOLA_DIR\MAPPING_DIR\MAPS40-41\GRIDS_DIR\PROJECTS 03/22/00



SITE 40
REMEDIAL INVESTIGATION
NAS PENSACOLA
PENSACOLA, FLORIDA

FIGURE 7-26
NATURE AND EXTENT
NAPHTHALENE

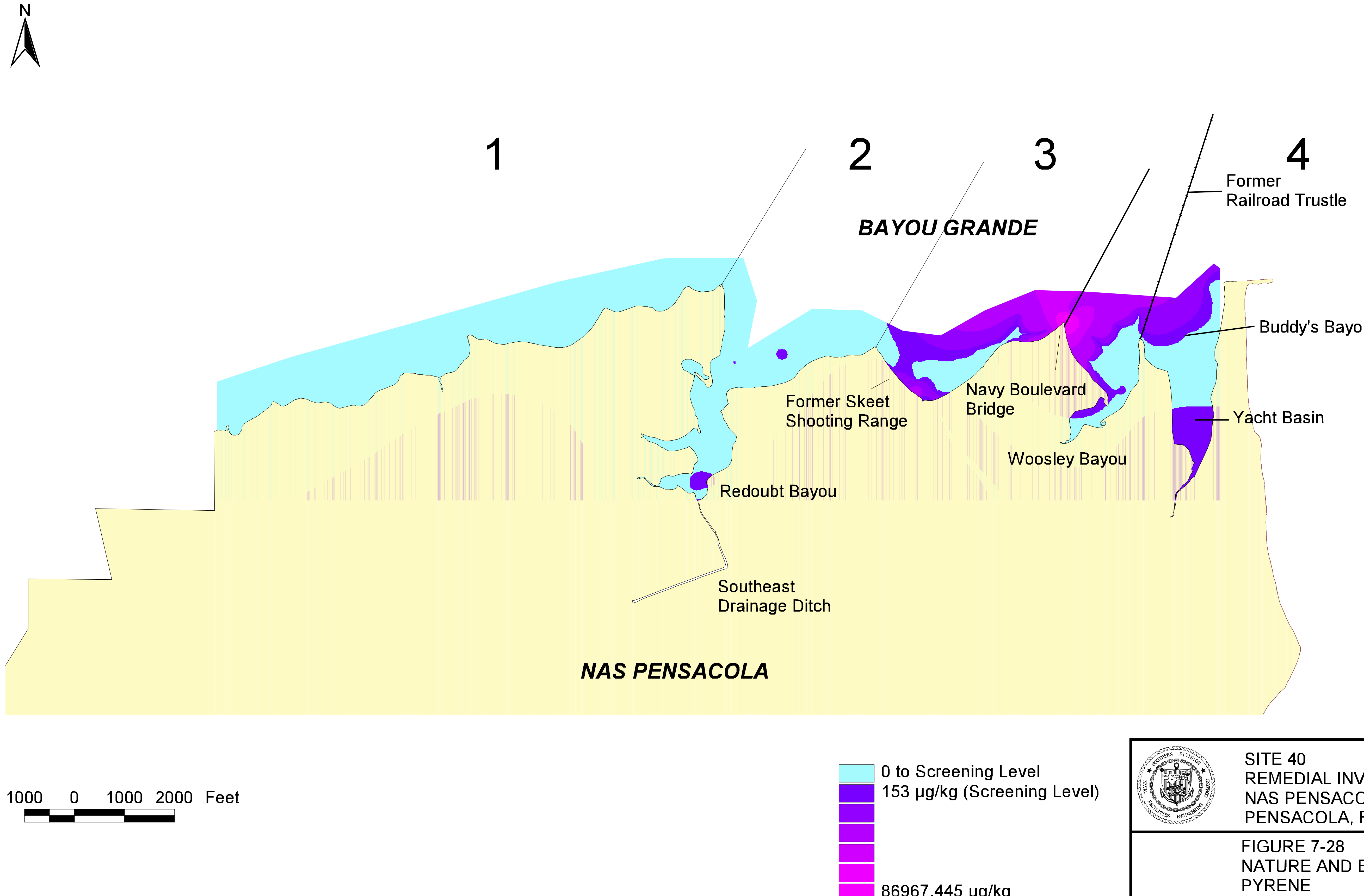
D:\HOME4\PENSACOLA_DIR\MAPPING_DIR\MAPS40-41\GRIDS_DIR\PROJECTS 03/22/00



SITE 40
REMEDIAL INVESTIGATION
NAS PENSACOLA
PENSACOLA, FLORIDA

FIGURE 7-27
NATURE AND EXTENT
PHENANTHRENE

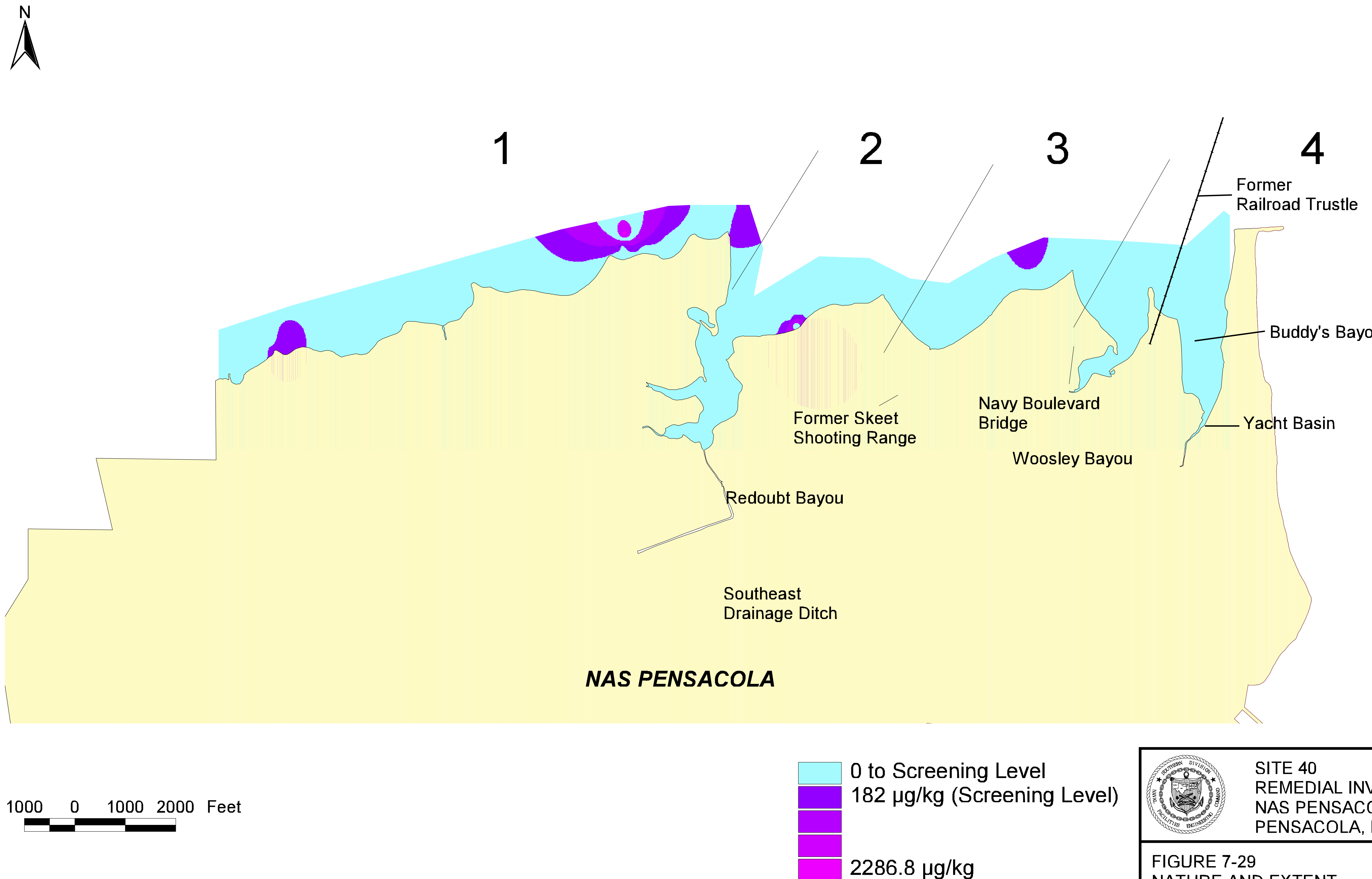
D:\HOME4\PENSACOLA_DIR\MAPPING_DIR\MAPS40-41\GRIDS_DIR\PROJECTS 03/22/00



SITE 40
REMEDIAL INVESTIGATION
NAS PENSACOLA
PENSACOLA, FLORIDA

FIGURE 7-28
NATURE AND EXTENT
PYRENE

D:\HOME4\PENSACOLA_DIR\MAPPING_DIR\MAPS40-41\GRIDS_DIR\PROJECTS 03/22/00



SITE 40
REMEDIAL INVESTIGATION
NAS PENSACOLA
PENSACOLA, FLORIDA

FIGURE 7-29
NATURE AND EXTENT
BIS(2-ETHYLHEXYL)PHTHALATE (BEHP)

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8.0 DATA VALIDATION

Site 40 data were validated by Heartland Environmental Services, Inc. of St. Charles, Missouri. Data were analyzed by CEIMIC Corporation in Narragansett, Rhode Island, and Savannah Laboratories, Savannah, Georgia, in accordance with the following guidance documents:

- NEESA Level D QA/QC guidelines as stated in: *Sampling and Chemical Analysis Quality Assurance Requirements for the Navy Installation and Restoration Program (NEESA 02.2-047B).*

- *USEPA Contract Laboratory Program, Statement of Work for Organic Analysis, Multi-media, Multi-Concentration*, USEPA Office of Solid Waste and Emergency Response (OSWER), (CLP Organic SOW), OLM01.8, March 1990 (USEPA, 1990a).

- *USEPA CLP Superfund Analytical Methods for Low Concentration Water for Organic Analysis*, (CLP Low Organic SOW), USEPA OSWER, October 1992 (USEPA, 1992a).

- *USEPA CLP, Statement of Work for Inorganic Analysis, Multi-media, Multi-Concentration*, (CLP Inorganic SOW), USEPA OSWER, ILM03.0, March 1990 (USEPA, 1990b).

- *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods* (SW-846), Third Edition, USEPA OSWER, revised July 1992 (USEPA, 1992b).

- *Methods for Chemical Analysis of Water and Wastes*, (MCAWW), EPA-600/4-79-020, March 1983.

Data were validated according to:

- *USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review*, February 1994 (EPA-540/R-94/012) (Organic Functional Guidelines [USEPA, 1994a]).

- *USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review*, February 1994 (EPA540/R-94/013) (Inorganic Functional Guidelines [USEPA, 1994b).

Data validation qualifiers are listed at the end of this section.

Samples were collected at Site 40 from November 13, 1995, through September 8, 1997. All samples were received by the laboratory in good condition and with proper custody documentation. Samples were analyzed for VOCs, SVOCs, pesticides/PCBs, and inorganic parameters. Samples submitted to CEIMIC Corporation were analyzed using the CLP Organic and Inorganic SOWs. Samples submitted to Savannah were analyzed using the CLP Inorganic SOW and SW-846 methodology. Selected samples were also analyzed for TOC using SW-846 method 9060 and hardness using MCAWW method 130.1. Two fish tissue samples submitted to Savannah Laboratories were analyzed for SVOCs and pesticides/PCBs. Except for barium, beryllium, cadmium, calcium, cyanide, magnesium, mercury, potassium, and sodium, the fish samples were analyzed for all TAL metals by Savannah Laboratories. SVOC analysis could not be run on sample 040J4006-02 because of insufficient sample volume.

Organic and inorganic results were reported by the laboratory in 22 sample delivery groups (SDGs): 041M10, EM0040, EM0100, EMD060, M00901, MZ1010, MZ2340, MZ6020, Z20601, Z22401, Z25001, Z30301, Z31001, Z41901, Z42101, Z50801, Z61101, PEN11, PEN12, PEN13, PEN14, and PEN15. Not included in this list are SDGs Z13601 and Z30201 which were analyzed for metals after digestion using hydrofluoric acid. Samples prepared using this modified acid digestion were not used to quantify specific analyte concentrations, but the validation results are presented in this section. Table 8-1, found at the end of this section, summarizes SDGs, samples analyzed, and methods used during the Site 40 investigation. Tables 8-2 through 8-5, also at the end of this section, summarize the parameters evaluated and QC outliers cited during data validation by SDG. TOC results were not validated because the data were used for qualitative purposes. Therefore, TOC data quality is not summarized in this section.

8.1 Organic Analysis

8.1.1 Holding Times

All technical and contractual holding times were within QC requirements for the VOC fraction.

Several samples were analyzed outside holding times in the SVOC and pesticide/PCB fractions. When a sample was analyzed or extracted outside holding times, positive and undetected results were qualified as specified in Organic Functional Guidelines. Based upon professional judgment, undetected values for samples which greatly exceeded holding times were rejected as "UR." Samples exceeding holding times and the qualifiers applied to them are summarized below.

Fraction/SDG	Sample IDs	Days Exceeded	Qualifier(s)
SVOC/EMD060	040MZ22401, 040MZ24501	23	J, UR
SVOC/Z31001	040MZ50401	3	J, UJ
SVOC/Z42101	040MZ42101, 040MZ42301	16	J, UR
PEST/EM0040	040MZ30401, 040MZ30401DL, 040MZ30601, 040MZ30801, 040MZ31401, 040MZ31701, 040MZ41801	1-4	J, UJ

Fraction/SDG	Sample IDs	Days Exceeded	Qualifier(s)
PEST/Z231001	040MZ31001, 040MZ31801, 040MZ40301, 040MZ40601, 040NZ40601, 040MZ41401, 040MZ41601, 040MZ41701, 040MZ50401, 040MZ50501, 040MZ52501, 040MZ52701	3-4	J, UJ
PEST/Z61101	040MZ40101, 040MZ40201, 040MZ40701, 040MZ60401, 040MZ60501, 040MZ60601, 040MZ60701, 040MZ60801, 040MZ60901	16-18	J, UR
PEST/Z61101	040MZ61001, 040MZ61101, 040MZ61201	16-18	J, UR
PEST/Z61101	040MZ61301, 040MZ61401, 040MZ61501, 040MZ61601, 040MZ61701, 040MZ61801	16-18	J, UR

8.1.2 Matrix Spike/Matrix Spike Duplicates

The MS is used to determine the accuracy of the analysis for a given matrix, while the MSD is used to determine the precision and accuracy of an analysis for a given matrix. The MS and MSD are used to detect matrix effects caused by contaminants that may interfere with the compounds of interest and that may also be present within the sample. Both the MS and MSD consist of a known quantity of stock solution added to the sample before its preparation and analysis. Evaluating the MS/MSD data involve two calculations. Accuracy is measured using an estimate of the percent recovery which is calculated by comparing the amount of the compound recovered by analysis to the amount added to the sample. Precision is measured using an estimate of relative percent difference (RPD) which is calculated using the recoveries for both the MS and MSD. No specific requirements have been established for qualifying MS/MSD data. However, guidelines to aid in applying professional judgment are discussed in Organic Functional Guidelines.

All reported MS/MSD results appeared satisfactory for the Site 40 investigation.

8.1.3 Calibrations

Instruments were initially and continually calibrated with standard solutions to verify that they could produce acceptable quantitative data. All VOC and SVOC compound quantitations were analyzed against GC/MS tunes that were within QC requirements.

Initial Calibration

The following SDGs were within VOC initial calibration QC criteria: 041M10, EM0040, EM0100, EMD060, M00901, MZ1010, MZ2340, MZ6020, Z20601, Z22401, Z25001, Z30301, Z31001, Z41901, Z42101, Z50801, Z61101, PEN11, PEN12, PEN13, PEN14, and PEN15. All VOC and SVOC SDGs were within initial calibration QC criteria.

Pesticide/PCB initial calibration criteria were met in all SDGs except: EM0040, EMD060, Z22401, Z25001, Z31001, Z41901, and Z61101. The SDGs which were outside pesticide/PCB initial calibration QC criteria are summarized below. For the following samples and noncompliant compounds, all positive results were estimated "J," and undetected values were estimated and qualified "UJ:"

SDG	Sample	Analytes
EM0D040	All Samples	alpha-BHC, delta-BHC
EMD060	040MZ24201	alpha-BHC
	040MZ24601	alpha-BHC
	040MZ24901	alpha-BHC
	040MZ24801	alpha-BHC
	040MZ24501	alpha-BHC
	040MZ24101	alpha-BHC
Z22401	All Samples	alpha-BHC
Z25001	All Samples	delta-BHC
Z31001	All Samples	alpha-BHC, delta-BHC
Z41901	All Samples	alpha-BHC, 4,4'-DDT
Z61101	040MZ00401	alpha-BHC, delta-BHC
	040MZ40801	alpha-BHC, delta-BHC

Continuing Calibration

All VOC SDGs had acceptable continuing calibration relative response factors (RRFs), except for EM0100. One sample in EM0100 had RRFs less than 0.050 and is considered non-compliant. For the affected sample and noncompliant compounds with RRFs less than 0.050, all positive results were estimated "J," and undetected values were rejected and qualified "UR:"

SDG	Sample	Analytes
EM0100	040MZ03601	acetone, 2-butanone

All SVOC SDGs had acceptable continuing calibration RRFs, except for Z41901. Four samples in SDG Z41901 had RRFs less than 0.050 and are considered non-compliant. For the following samples and noncompliant compounds with RRFs less than 0.050, all positive results were estimated "J," and undetected values were rejected and qualified "UR:"

SDG	Sample	Analytes
Z41901	040MZ80101	2,2'-oxybis(1-chloropropane), 3-nitroaniline
	040MZ90201	2,2'-oxybis(1-chloropropane), 3-nitroaniline
	040MZ90301	2,2'-oxybis(1-chloropropane), 3-nitroaniline
	040MZ90401	2,2'-oxybis(1-chloropropane), 3-nitroaniline

All fractions contained several compounds with percent differences (%Ds) outside the continuing calibration QC criteria. These QC deficiencies are within the normal fluctuations of laboratory function. All affected sample results were qualified for %D outliers as stated in the Organic Functional Guidelines.

8.1.4 Blanks

Laboratory method blanks are used to assess the presence and magnitude of potential contamination introduced during analysis. Additionally, field-derived *field blanks* and *trip blanks* were submitted to the laboratories. The field blank is a sample of water used during decontamination. The trip blank is a 40-milliliter (ml) volatile organic analysis vial filled with certifiable water used to assess cross-contamination during VOC sample shipment. When compounds are present both in samples and laboratory blanks analyzed within the same 12-hour period *and/or* field-derived blanks, the usability of the data depends on the reviewer's judgment and the blank's origin. According to the Organic Functional Guidelines, a sample result should not be considered positive unless the concentration of the compound in the sample exceeds 10 times the amount in *any* blank for common laboratory compounds (i.e., methylene chloride, acetone, and 2-butanone), or five times the amount for other compounds. These amounts are referred to as *action levels* (ALs). Because blank samples may not be prepared using the same weight, volume of sample, or dilution, these variables should be considered when using these blank criteria. The specific actions to be taken are as follows:

- If a compound is present in the blank but not the sample, no action is taken.
- If the sample concentration is greater than the AL, the concentration may be used unqualified.
- If the sample concentration is less than the PQL *and* the AL, the sample is reported as nondetect "U" at the PQL.

Example (using 10 x rule):

Water Sample

Blank result	=	1
Blank AL	=	10
PQL	=	5
Sample result	=	4J
Final result	=	5U

Diluted Water Sample

Blank Result	=	1
Dilution Factor	=	5
Blank AL	=	50
Diluted PQL	=	25
Sample result	=	4J
Final result	=	25U

In this example, data are not reported as 4U because it is less than the PQL. Also note that the dilution factor is used to calculate an AL of 50 (1 × 5 × 10).

- If the sample concentration is between the AL and PQL, the concentration is reported as nondetect "U."

Example (using 10 x rule):

Water Sample

Blank result	=	6
Blank AL	=	60
PQL	=	5
Sample result	=	50
Final result	=	50U

Soil Sample

Blank result	=	6
% Solids	=	80
Blank AL	=	75
PQL	=	5
Sample result	=	50
Final result	=	50U

Diluted Soil Sample

Blank Result	=	6
% Solids	=	80
Dilution Factor	=	5
Blank AL	=	375
PQL	=	25
Sample result	=	250
Final result	=	250U

In this example, water sample results less than 60 (or 10 × 6) would be qualified as not detected. Soil results of less than 75 would be qualified as not detected because percent solids are used to calculate the AL: [(6 ÷ 0.8)× 10]. Results less than 375 would be qualified as not detected in the diluted soil sample because dilution factors and percent solids are used to calculate the AL: [(6 ÷ 0.8)× 10 × 5].

Several compounds were detected in the blanks associated with the investigation of Site 40. They were considered to be common laboratory compounds: acetone, methylene chloride, and phthalate esters. Blank contaminants detected in investigative samples were qualified as recommended by the Organic Functional Guidelines. ALs were based on the highest concentration of any laboratory artifact present in associated method blank(s) or QC sample(s). No positive sample result for a common laboratory artifact was reported unless that particular artifact's concentration exceeded the ALs. All results thought to be attributed to blank contamination were qualified as undetected "U." Validation summary reports are provided in Appendix H and contain detailed information regarding blank contamination and affected samples.

8.1.5 Surrogates

Accuracy is the degree to which a given result agrees with the true value. To check the accuracy in a VOC, SVOC, and pest/PCB analysis, the methods require the addition of known amounts of *surrogate compounds*. If the surrogate percent recoveries (%R) are close to the known concentrations as defined within the method limits, the reported target compound concentrations are assumed to be accurate.

VOCs had acceptable surrogate %Rs, except for SDGs MZ6020 and Z30301, which had surrogate %Rs above the QC limits. Samples with surrogate %Rs that exceeded QC criteria are summarized below. All positive results for the listed samples have been estimated and qualified "J."

SDG	Sample	Surrogate
MZ6020	040MZ20501RE	1,2-dichloroethane-d_4
Z30301	040MZ30701	1,2-dichloroethane-d_4

All SVOC SDGs had surrogate %Rs within QC criteria.

Pesticide/PCB SDGs had surrogate %Rs within QC criteria, except for 041M10, EM0040, EM0100, EMD060, MZ1010, MZ2340, Z22401, Z31001, Z41901, and Z61101. Pesticide/PCB surrogates outside QC criteria indicated that the samples results may have been influenced by matrix interference. Samples with at least one surrogate %Rs outside QC criteria are summarized below. When surrogate %Rs exceeded the QC limit, only positive results were estimated and qualified "J." When surrogate %Rs were less than the QC limit, all positive and undetected results were estimated and qualified "J" and "UJ," respectively.

SDG	Sample	Qualifiers
041M10	040MZ31301, 040MZ32001, 040MZ32101	J,UJ
EM0040	040MZ30401	J, UJ
EMD060	040MZ24101	J
EMD060	040MZ24401	J, UJ
MZ1010	040MZ21101, 040MZ22101, 040MZ22901, 040MZ23701, 040MZ50701	J, UJ
MZ2340	040MZ22501, 040MZ22601, 040MZ22801, 040MZ23001, 040MZ23201, 040MZ23401, 040MZ23501, 040MZ23601, 040MZ23801, 040MZ23901, 040MZ24001	J
Z22401	040MZ20801, 040MZ21601, 040MZ21901, 040MZ21801	J
Z31001	040MZ31001	J
Z41901	040MZ41901	J, UJ
Z61101	040MZ40401, 040MZ40801, 040MZ40101, 040MZ61301, 040MZ61801, 040MZ60601	J, UJ

Three VOC surrogate %Rs were grossly outside QC limits. For surrogates with %Rs less than 10%, positive results were estimated "J," and undetected results were rejected and qualified "R." The following samples were affected:

SDG	Sample	Qualifiers
EM0100	040MZ11501, 040MZ12001	J,UR
EMD060	040MZ24201	J, UR

8.1.6 Internal Standards

Internal standards (IS) are added to VOC and SVOC samples and used to calculate the concentrations of target compounds. Two IS QC criteria must be met when a sample is analyzed. The retention time of the IS must not vary more than 30 seconds and the IS area counts must not vary more than a factor of two (-50% to +100%) from the associated calibration standard. For Site 40 samples, all VOC and SVOC IS retention times were within QC limits.

As detailed below, the following VOC SDGs had internal standards outside QC criteria: EMD060, MZ1010, MZ6020, Z22401, Z30301, and Z61101. Positive and undetected compounds associated with the noncompliant internal standards were qualified "J" and "UJ," respectively. All remaining VOC SDGs had acceptable IS.

SDG	Sample	Noncompliant Internal Standard
EMD060	040MZ24701, 040MZ24701RE, 040M18A101	chlorobenzene-d_5 chlorobenzene-d_5, 1,4-difluorobenzene
MZ1010	040MZ22101 040MZ22101RE	chlorobenzene-d_5 chlorobenzene-d_5, 1,4-difluorobenzene
MZ6020	040MZ10501, 040MZ10601, 040MZ10901, 040MZ10501RE, 040MZ10601RE, 040MZ10701RE, 040MZ10901RE, 040MZ20501	chlorobenzene-d_5
MZ6020	040MZ10701	chlorobenzene-d_5, 1,4-difluorobenzene
MZ6020	040MZ20501RE	All Internal standards
Z22401	040MZ21901, 040MZ22401RE	chlorobenzene-d_5, 1,4-difluorobenzene
Z30301	040MZ30701 040MZ30701RE	chlorobenzene-d_5, 1,4-difluorobenzene All internal standards
Z61101	040MZ40101	chlorobenzene-d_5, 1,4-difluorobenzene

All SVOC SDGs had acceptable IS, except for SDG EM0040. EM0040 had IS outside QC criteria. Positive and undetected compounds associated with the noncompliant internal standards were qualified "J" and "UJ," respectively.

SDG	Sample	Noncompliant Internal Standard
EM0040	040MZ11501, 040MZ12001	perylene-d_{12}

8.1.7 Field Duplicates

Representativeness expresses the degree to which sample data accurately and precisely represent the characteristic of a population, parameter variations at a sampling point, or an environmental condition. Duplicate samples help indicate overall field and laboratory precision. A greater variance should be expected for the soil sample duplicates compared to water sample duplicates, due to the matrix differences. All Site 40 samples demonstrated good field duplicate correlation, except for the following. Positive compounds in duplicate samples were qualified as estimated, "J."

Fraction	SDG	Duplicate Samples	Compound
VOC	Z22401	040MZ21801/040NZ21801	acetone
PEST	041M10	040MZ32301/040NZ32301	4,4-DDE, Aroclor-1260
PEST	EM0040	040MZ21801/040NZ21801	alpha-BHC, dieldrin, Aroclor-1260

8.1.8 Compound Quantization

For organic analyses, the data evaluator must assess the usability of values when multiple sample results are reported by the laboratory. The following paragraphs describe actions taken by the validator in these cases.

Re-analyzed Samples

Occasionally, organic samples may require re-analysis because of method requirements or QC results outside method criteria. Reasons for sample re-analysis include: samples analyzed outside 12-hour timing periods, extremely low surrogate %Rs, IS retention times and/or area counts outside QC limits, etc. In these instances, the laboratory may report results for the original and re-analyzed sample. During validation, the reviewer evaluates QC associated with the original and re-analyzed sample and assesses which sample represents the preferable quality. The sample with the preferable QC should be used for interpretation. The preferred analysis is reported as a primary sample in the EnSafe database and analytical tables.

The following samples were re-analyzed. The laboratory reported two samples results and the preferred analyses were used for interpretation:

VOC Fraction

SDG	Preferred Samples	Reason
041M10	040MZ31901	IS areas did not improve upon reanalysis
EM0100	040MZ11401, 040MZ11601, 040MZ11901	IS areas did not improve upon reanalysis.
EM0100	040MZ11501RE, 040MZ11801RE, 040MZ120010RE	IS areas improved upon reanalysis.
EMD060	040MZ24701	IS areas did not improve upon reanalysis.
MZ1010	040MZ22101	IS areas did not improve upon reanalysis.
MZ6020	040MZ10501, 040MZ10601, 040MZ10901	IS areas did not improve upon reanalysis.
MZ6020	040MZ10701RE	IS areas improved upon reanalysis.
MZ6020	040MZ20501	Surrogates and IS areas did not improve upon reanalysis.
Z22401	040MZ21901, 040MZ22401	IS areas did not improve upon reanalysis.
Z30301	040MZ30701	IS areas did not improve upon reanalysis.
Z61101	040MZ40101RE	IS areas improved upon reanalysis.
PEN12	040M2B0501, 040M2B0601, 040M2B0201	IS areas did not improve upon reanalysis.

SVOC Fraction

SDG	Preferred Samples	Reason
EM0040	040MZ31701, 040MZ31401	IS areas did not improve upon reanalysis.

Diluted Samples

When an analyte response exceeds the instrument's linear calibration range or is off-scale, the laboratory dilutes the sample. If one or more compounds are outside the calibration range during an initial analysis, the laboratory flags the analyte "E." When diluted, the sample results will be qualified "D." Generally, values from the initial analysis will be used unless they exceeded the calibration range. The diluted value will substitute for values exceeding the calibration range in the initial analysis to ensure the most representative data. The "D" qualifier will remain on the value to alert the data user that the secondary dilution value was used.

No VOC or SVOC samples were reported with a secondary diluted sample. The following pesticide/PCB samples were diluted because at least one compound exceeded the calibration range:

SDG	Preferred Samples	Reason
EM0040	040MZ30401	dieldrin, alpha-chlordane
M00901	RABM000101	4,4'-DDD, 4,4'-DDT
M00901	RABM000201	4,4'-DDE, 4,4'-DDT
MZ1010	040MZ22101	4,4'-DDD, 4,4'-DDT, Aroclor-1260
Z30301	040MZ40901	gamma-BHC, endrin

Pesticide/PCB Quantitation

Two columns and two separate detectors are used in pesticide/PCB analysis. Quantitation of target analysts and surrogates are generally performed and reported on both columns; however, only the lower of the two concentrations are reported. The lower of the two concentrations is used because if present, co-eluting interferences are likely to increase the calculated concentration of any target compound. For detected analysts, the percent difference between the two columns are calculated. If the percent difference between the calculated concentrations is greater than 25%, the laboratory flags the value with a "P" qualifier to alerts the data user of the potential problems in quantitating the analyte.

During the validation process, the laboratory's "P" flags are dropped. The values are qualified "J" by the evaluator when the percent difference between the calculated concentrations is greater than 25%. The validation qualifier alerts the data user that the pesticide/PCB value is an estimated concentration.

8.2 Inorganic Analysis

8.2.1 Holding Times

All samples were received by the laboratory in good condition with the seals intact and proper custody documentation. From the date of collection to the date of sample analysis, holding times were within method and contractual requirements except for SDGs EM0100, Z13601, and Z30201. For SDG EM0100, samples 040MZ11901, 040MZ12001, and 040MZ12101 exceeded holding times by 14 days for cyanide. Cyanide was not detected; therefore, cyanide was rejected and qualified "UR" in these samples. SDGs Z13601 and Z30201 were prepared using a modified acid digestion for comparison results only. These two SDGs were prepared using a hydrofluoric acid digestion method and were not used for interpretation.

8.2.2 Calibrations

Instruments are initially and continuously calibrated at the beginning of each analytical run and throughout. Initial and continuing calibrations were performed for the inorganics analysis within the criteria established by the USEPA CLP Inorganics SOW and SW-846 methods.

8.2.3 Blanks

Laboratory method blanks are used to assess the presence and magnitude of potential contamination introduced during analysis. Additionally, *field blanks* may be collected to assess potential contamination introduced during sample collection. When chemicals are present in samples and laboratory blanks, the data usability depends on the reviewer's judgment and the blank's origin. According to Inorganic Functional Guidelines, a sample result should not be considered positive unless its concentration exceeds five times the amount in *any* blank, amounts referred to as *action levels*. Because blank samples may not be prepared using the same sample weight, volume, or dilution, these factors should also be considered when using these blank criteria. The specific actions to be taken are as follows:

- If a chemical is present in the blank but not the sample, no action is taken.

- If the sample concentration is between the IDL and the AL, the concentration is reported as "U."

- If the sample concentration is greater than the AL, the concentration may be used unqualified.

When the blank concentration was less than the IDL (negative value), but had an absolute value greater than the IDL, the AL was 10 times the absolute value of the blank concentration. The specific actions are as follows:

- If the sample concentration is greater than the AL, the concentration may be used unqualified.

- If the concentration of any detected analyte was less than the AL, it was qualified as estimated "J" for positive results.

- If the result was nondetect, it was qualified as estimated "UJ."

Contamination was identified in all SDG blanks. Action levels were set for each affected element based on the highest concentration in any associated blank. Elements attributed to blank contamination were flagged undetected "U." No positive sample result was reported for an element detected in any blank unless that particular artifact's concentration exceeded the action level of five times the amount in any blank, per the Inorganic Functional Guidelines.

8.2.4 ICP Interference Check Sample Analyses

The inductive coupled plasma (ICP) interference check sample (ICS) is analyze to check the laboratory's instrument and the background correction factors. All %R criteria for the Site 40 samples were within the criteria established by the USEPA CLP Inorganics SOW and SW-846.

8.2.5 ICP Serial Dilutions

ICP serial dilutions are used to assess matrix interference. One sample from each set of similar matrix type is diluted by a factor of five. For an analyte concentration at least 50 times above the instrument detection limit (IDL) for CLP analyses and 10 times above the IDL for SW-846, the measured concentrations of the undiluted sample and of the diluted sample should agree within 10%. SDGs EM0040, M00901, Z13601, Z22401, Z30201, Z61101, PEN13, and PEN14 had ICP serial dilutions outside acceptable QC criteria. Elements outside QC criteria are summarized below. When an element was outside QC criteria, that analyte was qualified as estimated, "J," for all positive sample values in the SDG, as specified in Inorganic Functional Guidelines.

SDG	Affected Samples	Analyte
EM0040	040MZ30401, 040MZ30601, 040MZ30801, 040MZ31401, 040MZ31701, 040MZ41801, 040MZ42401	Lead, Calcium
M00901	RABW000101, RABW000201, RABW000301	Magnesium, Calcium
Z13601	040MZ13001	Selenium, Vanadium
Z22401	040MZ20801, 040MZ20901, 040MZ21601, 040MZ21701, 040MZ21801, 040NZ21801, 040MZ21901, 040MZ22301, 040MZ22401	Zinc
Z30201	040MZ30101	Iron, Lead
Z61101	All sediment samples	Zinc
PEN13	040M2B0901, 040M2B0701, 040M2B1001, 040SR10910, 040SR20920, 040SR30930,	Aluminum
PEN13	040M2B0801	Aluminum
PEN14	040W2B0101	Potassium
PEN15	040J400601, 040J400602	Copper, Iron, Manganese

8.2.6 Laboratory Control Samples

Laboratory control samples (LCS) are used to monitor the overall performance or accuracy of all steps in the analysis, including sample preparation. All LCS criterion were met for all SDGs, except for SDGs Z13601 and Z30201, which were used only to validate a specific digestion method using a different acid. Samples prepared using this hydrofluoric acid digestion method were not used for interpretation.

8.2.7 Laboratory Matrix Spikes

Laboratory spiked samples provide information about the sample matrix effects on the digestion and measurement methodology. Many matrix spike %Rs were outside QC criteria for the Site 40 data. As specified by CLP Inorganic SOW and the SW-846 methods, the matrix spike QC limits are 75% to 125%. When an element was outside matrix spike QC limits, that analyte's positive and undetected results were qualified for all samples in the SDG, as specified in

Inorganic Functional Guidelines. Spike results and qualifiers applied to these QC outliers are summarized below.

Analyte	**SDGs**	**Spike Result**	**Qualifier(s)**
Antimony	EM0040, EMD060, Z20601, Z25001, Z50801. PEN12	> 30% <75%	J, UJ
Antimony	041M10, EM0100, MZ1010	<30%	J, UR
Antimony	MZ2340, MZ6020, Z22401, Z30301, Z41901, Z42101, Z61101	<30%	J, UR
Arsenic	Z22401	>30% <75%	J, UJ
Cadmium	EM0040	>30% <75%	J, UJ
Copper	Z61101	>30% <75%	U, UJ
Lead	Z41901	>125%	J
Lead	Z42101	>30% <75%	J, UJ
Manganese	Z61101	>30% <75%	J, UJ
Mercury	EMD060	>125%	J
Mercury	PEN14	>30% <75%	J, UJ
Selenium	041M10, EM0040, MZ6020, Z22401, Z50801	>30% <75%	J, UJ
Selenium	Z42101	>125%	J
Silver	EM0040, MZ6020, Z22401, Z41901, Z42101	>30% <75%	J, UJ
Thallium	041M10, EM0040, Z30301	>30% <75%	J, UJ
Zinc	Z61101	>30% <75%	J, UJ
Zinc	PEN14	>125%	J
Cyanide	PEN12	>30% <75%	J, UJ

Several elements were outside matrix spike QC limits in SDGs Z13601 and Z30201. However, they were used only to validate a specific digestion method using a different acid. Samples prepared using this hydrofluoric acid digestion method were not used for interpretation.

8.2.8 Laboratory Duplicates

Laboratory duplicate samples are used to determine the precision of each parameter's analytical methods. The following SDGs were outside duplicate criteria: 041M10, EM0100, M00901, Z20601, Z25001, Z41901, and Z42101. Elements outside QC criteria and the qualifiers applied are summarized below.

SDGs	Analyte	Qualifier(s)
041M10	Calcium and Lead	J for positive results
EM0100, Z44901	Calcium	J for positive results
M00901 (waters)	Aluminum	J for positive results
Z20601	Aluminum	J for positive results
Z25001	Antimony	J for positive results
Z42101	Lead	J for positive results

8.2.9 Field Duplicates

Representativeness expresses the degree to which sample data accurately and precisely represent a population's characteristic, parameter variations at a sampling point, or an environmental condition. The duplicate samples indicate overall field and laboratory precision. A greater variance should be expected for the soil samples as compared to water sample duplicates because of matrix differences. Field duplicate RPDs exceeded the 50% QC criterion in SDGs: 041M10, Z22401 and Z42101 (calcium) and EM0040 (aluminum, iron, magnesium, manganese, vanadium, and zinc). When an element was outside QC criteria, it was qualified as estimated, "J" for all positive sample values in the SDG. All remaining SDGs had acceptable field duplicate precision.

8.2.10 Atomic Absorption Spike Recoveries

Antimony, arsenic, lead, silver, thallium, and selenium were analyzed by graphite furnace atomic absorption (GFAA). For elements analyzed by GFAA, every sample is spiked by the analyst to assess matrix interference. For the Site 40 samples, GFAA analytical spike %Rs met the control limits of 85 to 115% for all elements, except antimony and silver. Seventy seven antimony sample results had spike %Rs below 85% in the following SDGs: 041M10 (5), EM0100 (15), MZ1010 (7), MZ2340 (11), Z13601 (4), Z22401 (7), Z30301 (6), Z31001 (12), Z41901 (2), Z42101 (3), and Z61101 (5). Numbers in parentheses indicate how many samples were outside QC limits in the SDG. In addition, there was one analytical spike exceedance for both silver and thallium in SDG PEN14. Affected detections of antimony, silver, and thallium results were qualified as estimated "J." Affected undetected antimony, silver, and thallium results were estimated "UJ," unless they were previously qualified as rejected, "UR," for poor matrix spikes results.

8.3 Site 40 Data Summary

8.3.1 Completeness

Completeness is defined as the percentage of measurements made, which are judged to be valid. All of the samples analyzed for the investigation of Site 40 were valid with some qualification, except for the results qualified "UR." No positive results were rejected. There were 23,850 total measurements (number of unique sample and parameter pairs) validated for VOCs, SVOCs, pesticides/PCBs, and metals. Of this total, 366 measurements were qualified "UR" (greater than 98% completeness). Therefore, the data met the 95% completeness goal. Data completeness calculations were performed and presented as was cited in the approved QAPP.

EnSafe calculated completeness per fractions and the results were as follows.

VOCs:	4,973 total tests, 10 rejected undetected tests	Completeness = 99.8%
SVOCs:	10,176 total tests, 132 rejected undetected tests	Completeness = 98.7%
Metals:	3,956 total tests, 76 rejected undetected tests	Completeness = 98.1%
Pesticides/PCBs:	4,592 total tests, 147 rejected tests	Completeness = 96.8%

8.3.2 Comparability

Comparability is a qualitative parameter expressing the confidence with which one data set can be compared to another. Comparability is assured through the use of established methods of field sampling by experienced field personnel and laboratory analysis as specified by USEPA protocols. All Site 40 samples were collected using the USEPA Region IV Standard Operating Procedures and analyzed according to CLP SOW and SW-846 protocols.

8.4 Conclusion

The Site 40 data were validated independently from the laboratory to assess data quality. The validation process consisted of data screening, checking, auditing, verification, adding qualifiers, certification, and review. The CLP SOWs and SW-846 methods define acceptable criteria the laboratory must meet to assure that the data are adequate for their intended use. When a QC parameter was outside the method and review criteria, the validator qualified results to alert the data user. Many Site 40 analyses required qualification, but no positive results were rejected. Only undetected results that grossly exceeded the method or review criteria were rejected. With the appropriate qualification, the results are usable. Results that were estimated may be biased high or low, but are acceptable for interpretation.

Despite the minor qualifications described above, the data are considered complete and satisfactory for the Site 40 investigation. The data validation summary reports from Heartland Environmental Services, Inc., for Site 40, will be provided upon request or otherwise will become a part of the NAS Pensacola Site 40 final report reference file.

Table 8-1
Analytical Methods Used for Site 40 Investigation

SDG	Sample ID	METHODS: VOC CLP[a]	VOC Low CLP	SW-846 VOC[e]	SVOC CLP[a]	SVOC Low CLP[b]	SW-846 SVOC[e]	Pest/PCB CLP[a]	SW-846 Pest/PCB[e]	Metals CLP[c]	HF Metals[d]	SW-846 Metals[e]	CN CLP	SW-846 CN[e]	TOC 9060[e]	Hardness MCAWW 130.1[f]
041M10	040MZ31301	X			X			X		X					X	
	040MZ31501	X			X			X		X					X	
	040MZ31901	X			X			X		X					X	
	040MZ32001	X			X			X		X					X	
	040MZ32101	X			X			X		X					X	
	040MZ32201	X			X			X		X					X	
	040MZ32301	X			X			X		X					X	
	040MZ32401	X			X			X		X					X	
EM0040	040MZ30401	X			X			X		X					X	
	040MZ30601	X			X			X		X					X	
	040MZ30801	X			X			X		X					X	
	040MZ31401	X			X			X		X					X	
	040MZ31701	X			X			X		X					X	
	040MZ41801	X			X			X		X					X	
	040MZ42401	X			X			X		X					X	
EM0100	040MZ11401	X			X			X		X					X	
	040MZ11501	X			X			X		X					X	
	040MZ11601	X			X			X		X					X	
	040MZ11701	X			X			X		X					X	
	040MZ11801	X			X			X		X					X	
	040MZ11901	X			X			X		X					X	
	040MZ12001	X			X			X		X					X	
	040MZ12101	X			X			X		X					X	
	040MZ12201				X			X		X					X	
	040MZ12301				X			X		X					X	
	040MZ12401				X			X		X					X	
	040MZ12501				X			X		X					X	
	040MZ12601				X			X		X					X	
	040MZ12701				X			X		X					X	
	040MZ12801				X			X		X					X	
	040MZ12901				X			X		X					X	
	040WZ03601		X		X			X		X						

Table 8-1
Analytical Methods Used for Site 40 Investigation

		METHODS														
SDG	Sample ID	VOC CLP[a]	VOC Low CLP	SW-846 VOC[e]	SVOC CLP[a]	SVOC Low CLP[b]	SW-846 SVOC[e]	Pest/PCB CLP[a]	SW-846 Pest/PCB[e]	Metals CLP[c]	HF Metals[d]	SW-846 Metals[e]	CN CLP	SW-846 CN[e]	TOC 9060[e]	Hardness MCAWW 130.1[f]
EMD060	040MZ24101	X			X			X		X					X	
	040MZ24201	X			X			X		X					X	
	040MZ24401	X			X			X		X					X	
	040MZ24501	X			X			X		X					X	
	040MZ24601	X			X			X		X					X	
	040MZ24701	X			X			X		X					X	
	040MZ24801	X			X			X		X					X	
	040MZ24901	X			X			X		X					X	
M00901	RABM000101	X			X			X		X					X	
	RABM000201	X			X			X		X					X	
	RABM000301	X			X			X		X					X	
	RABW000101		X			X		X		X	X					
	RABW000201		X			X		X		X	X					
	RABW000301		X			X		X		X	X					
MZ1010	040MZ21101	X			X			X		X					X	
	040MZ22101	X			X			X		X					X	
	040MZ22901	X			X			X		X					X	
	040MZ23701	X			X			X		X					X	
	040MZ24301	X			X			X		X					X	
	040MZ25101	X			X			X		X					X	
	040MZ30501	X			X			X		X					X	
MZ2340	040MZ22501	X			X			X		X					X	
	040MZ22601	X			X			X		X					X	
	040MZ22701	X			X			X		X					X	
	040MZ22801	X			X			X		X					X	
	040MZ23001	X			X			X		X					X	
	040MZ23101	X			X			X		X					X	
	040MZ23201	X			X			X		X					X	
	040MZ23301	X			X			X		X					X	
	040MZ23401	X			X			X		X					X	
	040MZ23501	X			X			X		X					X	
	040MZ23601	X			X			X		X					X	
	040MZ23801	X			X			X		X					X	
	040MZ23901	X			X			X		X					X	
	040MZ24001	X			X			X		X					X	

Table 8-1
Analytical Methods Used for Site 40 Investigation

SDG	Sample ID	METHODS														
		VOC CLP[a]	VOC Low CLP	SW-846 VOC[c]	SVOC CLP[a]	SVOC Low CLP[b]	SW-846 SVOC[c]	Pest/PCB CLP[a]	SW-846 Pest/PCB[c]	Metals CLP[c]	HF Metals[d]	SW-846 Metals[c]	CN CLP	SW-846 CN[c]	TOC 9060[c]	Hardness MCAWW 130.1[f]
MZ6020	040MZ10101	X			X			X		X					X	
	040MZ10201	X			X			X		X					X	
	040MZ10301	X			X			X		X					X	
	040MZ10401	X			X			X		X					X	
	040MZ10501	X			X			X		X					X	
	040MZ10601	X			X			X		X					X	
	040MZ10701	X			X			X		X					X	
	040MZ10801	X			X			X		X					X	
	040MZ10901	X			X			X		X					X	
	040MZ11001	X			X			X		X					X	
	040MZ11101	X			X			X		X					X	
	040MZ11201	X			X			X		X					X	
	040MZ11301	X			X			X		X					X	
	040MZ13401	X			X			X		X					X	
	040MZ20501	X			X			X		X					X	
Z13601	040MZ13001										X					
	040MZ13601										X					
	040MZ21501										X					
	040MZ21801										X					
	040MZ22001										X					
	040MZ22201										X					
	040MZ22501										X					
	040MZ22601										X					
	040MZ22801										X					
	040MZ23101										X					
	040MZ23601										X					
	040MZ24401										X					
	040MZ24701										X					
	040MZ40501										X					
Z20601	040MZ20601	X			X			X		X					X	
	040MZ20701	X			X			X		X					X	
	040MZ21001	X			X			X		X					X	
	040MZ21201	X			X			X		X					X	

Table 8-1
Analytical Methods Used for Site 40 Investigation

SDG	Sample ID	VOC CLP[a]	VOC Low CLP	SW-846 VOC[c]	SVOC CLP[a]	SVOC Low CLP[b]	SW-846 SVOC[c]	Pest/PCB CLP[a]	SW-846 Pest/PCB[c]	Metals CLP[c]	HF Metals[d]	SW-846 Metals[c]	CN CLP	SW-846 CN[c]	TOC 9060[c]	Hardness MCAWW 130.1[f]
		METHODS														
Z22401	040MZ20801				X			X		X					X	
	040MZ20901				X			X		X					X	
	040MZ21601				X			X		X					X	
	040MZ21701				X			X		X					X	
	040MZ21801				X			X		X					X	
	040MZ21901				X			X		X					X	
	040MZ22301				X			X		X					X	
	040MZ22401				X			X		X					X	
Z25001	040MZ13001				X			X		X					X	
	040MZ13101				X			X		X					X	
	040MZ13201				X			X		X					X	
	040MZ13301				X			X		X					X	
	040MZ13501				X			X		X					X	
	040MZ13601				X			X		X					X	
	040MZ13701				X			X		X					X	
	040MZ13801				X			X		X					X	
	040MZ25001	X			X			X		X					X	
	040MZ25201	X			X			X		X					X	
	040MZ25301	X			X			X		X					X	
	040MZ25401	X			X			X		X					X	
	040MZ25501	X			X			X		X					X	
	040MZ25601	X			X			X		X					X	
	040MZ25701	X			X			X		X					X	
	040MZ31601				X			X		X					X	
	040MZ40501				X			X		X					X	
	040MZ41501				X			X		X					X	
Z30201	040MZ30101										X					
	040MZ30201										X					
	040MZ40801										X					
	040MZ42401										X					
Z30301	040MZ30101	X			X			X		X					X	
	040MZ30201	X			X			X		X					X	
	040MZ30301	X			X			X		X					X	
	040MZ30701	X			X			X		X					X	
	040MZ30901	X			X			X		X					X	
	040MZ31101	X			X			X		X					X	
	040MZ40901	X			X			X		X					X	

Table 8-1
Analytical Methods Used for Site 40 Investigation

		METHODS														
SDG	Sample ID	VOC CLP[a]	VOC Low CLP	SW-846 VOC[e]	SVOC CLP[a]	SVOC Low CLP[b]	SW-846 SVOC[e]	Pest/PCB CLP[a]	SW-846 Pest/PCB[e]	Metals CLP[c]	HF Metals[d]	SW-846 Metals[e]	CN CLP	SW-846 CN[e]	TOC 9060[e]	Hardness MCAWW 130.1[f]
Z31001	040MZ31001	X			X			X		X					X	
	040MZ31201	X			X			X		X					X	
	040MZ31801	X			X			X		X					X	
	040MZ40301	X			X			X		X					X	
	040MZ40601	X			X			X		X					X	
	040MZ41001	X			X			X		X					X	
	040MZ41101	X			X			X		X					X	
	040MZ41201	X			X			X		X					X	
	040MZ41301	X			X			X		X					X	
	040MZ41401	X			X			X		X					X	
	040MZ41601	X			X			X		X					X	
	040MZ41701	X			X			X		X					X	
Z41901	040MZ41901	X			X			X		X					X	
	040MZ42001	X			X			X		X					X	
Z42101	040MZ42101	X			X			X		X					X	
	040MZ42201	X			X			X		X					X	
	040MZ42301	X			X			X		X					X	
	040MZ42401	X			X			X		X					X	
Z50801	040MZ20101	X			X			X		X					X	
	040MZ20201	X			X			X		X					X	
	040MZ20301	X			X			X		X					X	
	040MZ20401	X			X			X		X					X	
	040MZ21301	X			X			X		X					X	
	040MZ21401	X			X			X		X					X	
	040MZ21501	X			X			X		X					X	
	040MZ22001	X			X			X		X					X	
	040MZ22201	X			X			X		X					X	
Z61101	040MZ40101	X			X			X		X					X	
	040MZ40201	X			X			X		X					X	
	040MZ40401	X			X			X		X					X	
	040MZ40701	X			X			X		X					X	
	040MZ40801	X			X			X		X					X	

Table 8-1
Analytical Methods Used for Site 40 Investigation

SDG	Sample ID	VOC CLP[a]	VOC Low CLP	SW-846 VOC[e]	SVOC CLP[a]	SVOC Low CLP[b]	SW-846 SVOC[e]	Pest/PCB CLP[a]	SW-846 Pest/PCB[e]	Metals CLP[c]	HF Metals[d]	SW-846 Metals[e]	CN CLP	SW-846 CN[e]	TOC 9060[e]	Hardness MCAWW 130.1[f]
		METHODS														
EAH030	040M000101														X	
	040M000201														X	
	040M000301														X	
	040M000401														X	
	040M000501														X	
	040M000601														X	
	040M000701														X	
	040M000801														X	
	040M000901														X	
	040M001101														X	
	040M001201														X	
	040M001301														X	
	040M001401														X	
	040M001501														X	
	040M001601														X	
	040M001701														X	
PEN11	040W2B0701			X			X		X	X			X			
	040W2B0901			X			X		X	X			X			
PEN12[e]	040M2B0101			X			X		X			X		X	X	
	040M2B0201			X			X		X			X		X	X	
	040M2B0301			X			X		X			X		X	X	
	040M2B0401			X			X		X			X		X	X	
	040M2B0501			X			X		X			X		X	X	
	040M2B0601			X			X		X			X		X	X	
	040M2B0701			X												
	040M2B0901			X												
	040M2B1001			X												
PEN13	040M2B0701						X		X			X		X	X	
	040M2B0801			X			X		X			X		X	X	
	040M2B0901						X		X			X		X	X	
	040M2B1001						X		X			X		X	X	
	040SR10910											X		X		
	040SR20920											X		X		
	040SR30930											X		X		
PEN14	040W2B0101			X			X		X	X			X			
	040TW09047			X			X		X	X			X			

Table 8-1
Analytical Methods Used for Site 40 Investigation

		METHODS														
SDG	**Sample ID**	**VOC CLP[a]**	**VOC Low CLP**	**SW-846 VOC[e]**	**SVOC CLP[a]**	**SVOC Low CLP[b]**	**SW-846 SVOC[e]**	**Pest/PCB CLP[a]**	**SW-846 Pest/PCB[e]**	**Metals CLP[c]**	**HF Metals[d]**	**SW-846 Metals[e]**	**CN CLP**	**SW-846 CN[e]**	**TOC 9060[e]**	**Hardness MCAWW 130.1[f]**
PEN15	040J400601						X		X			X				
	040J400602								X			X				

Notes:

a = USEPA *Statement of Work for Organic Analysis, Multi-media, Multi-Concentration*, OLM01.8 (CLP Organic SOW).
b = USEPA *Superfund Analytical Methods for Low Concentration Water for Organic Analysis*, October 1992 (CLP Low Organic SOW).
c = USEPA *Statement of Work for Inorganic Analysis, Multi-media, Multi-Concentration*, ILM03.0 (CLP Inorganic SOW).
d = USEPA *Statement of Work for Inorganic Analysis, Multi-media, Multi-Concentration*, ILM03.0 (CLP Inorganic SOW), modified using hydrofluoric digestion.
e = USEPA *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods* (SW-846), Third Edition, revised July 1992.
f = USEPA *Methods for Chemical Analysis of Water and Wastes*, (MCAWW, EPA-600/4-79-020), March 1983.

Table 8-2
Site 40 Volatile SDG Summary

SDG	Holding Times	GC/MS Tunes	ICal	CCal	I.S.	Blanks	Surr.	MS/ MSD	Field Dups	Overall
041M10				X		X				OK
EM0040						X				OK
EM0100				X		X				OK
EMD060				X	X	X				OK
M00901						X				OK
MZ1010				X	X	X				OK
MZ2340				X		X				OK
MZ6020				X	X	X	X			OK
Z20601				X		X				OK
Z22401				X	X	X			X	OK
Z25001				X		X				OK
Z30301				X	X	X	X			OK
Z31001						X				OK
Z41901				X		X				OK
Z42101				X		X				OK
Z50801				X		X				OK
Z61101				X	X	X				OK
PEN11						X				OK
PEN12				X						OK
PEN13				X						OK
PEN14						X				OK

Notes:
GC/MS = gas chromatography/mass spectroscopy
ICal = initial calibration
CCal = continuing calibration
I.S. = internal standards
Surr. = surrogates
MS/MSD = matrix spike/matrix spike duplicate

An "X" in a column means that one or more QC criteria were not met; one or more samples were qualified.
An "OK" in the Overall column means the data were acceptable with minor qualifications. No positive results were rejected; however, undetected may have been rejected and qualified "UR."

Table 8-3
Site 40 Semivolatile SDG Summary

SDG	Holding Times	GC/MS Tunes	ICal	CCal	I.S.	Blanks	Surr.	MS/ MSD	Field Dups.	Overall
041M10				X		X				OK
EM0040				X	X	X				OK
EM0100				X		X				OK
EMD060				X		X				OK
M00901	X			X						OK
MZ1010				X		X				OK
MZ2340				X		X				OK
MZ6020				X						OK
Z20601				X		X				OK
Z22401				X		X				OK
Z25001				X						OK
Z30301				X						OK
Z31001	X			X		X				OK
Z41901				X		X				OK
Z42101	X			X		X				OK
Z50801				X		X				OK
Z61101				X		X				OK
PEN11				X						OK
PEN12										OK
PEN13				X						OK
PEN14										OK
PEN15										OK

Notes:
GC/MS = gas chromatography/mass spectroscopy
ICal = initial calibration
CCal = continuing calibration
I.S. = internal standards
Surr. = surrogates
MS/MSD = matrix spike/matrix spike duplicate

An "X" in a column means that one or more QC criteria were not met; one or more samples were qualified.
An "OK" in the Overall column means the data were acceptable with minor qualifications. No positive results were rejected; however, undetected may have been rejected and qualified "UR."

Table 8-4
Site 40 Pesticide SDG Summary

SDG	Holding Times	I.P.	ICal	CCal	C.C.	Blanks	Surr.	MS/ MSD	Field Dups.	Overall
041M10							X		X	OK
EM0040	X		X	X			X			OK
EM0100		X		X			X			OK
EMD060			X				X			OK
M00901										OK
MZ1010							X			OK
MZ2340							X			OK
MZ6020										OK
Z20601		X								OK
Z22401			X				X		X	OK
Z25001			X	X						OK
Z30301				X						OK
Z31001	X		X	X			X			OK
Z41901			X				X			OK
Z42101										OK
Z50801				X						OK
Z61101	X		X	X			X			OK
PEN11						X	X			OK
PEN12										OK
PEN13										OK
PEN14										OK
PEM15						X				OK

Notes:
ICal = initial calibration
CCal = continuing calibration
Surr. = surrogates
I.S. = internal standards
I.P. = pesticide instrument performance
C.C. = pesticide cleanup checks
MS/MSD = matrix spike/matrix spike duplicate

An "X" in a column means that one or more QC criteria were not met; one or more samples were qualified.
An "OK" in the Overall column means the data were acceptable with minor qualifications. No positive results were rejected; however, undetected may have been rejected and qualified "UR."

Table 8-5
Site 40 Inorganic SDG Summary

SDG	Holding Times	Cal.	Blanks	Serial Dil.	ICP Check	LCS	MS	Lab Dup	Field Dups.	AA	Overall
041M10			X				X	X	X	X	OK
EM0040			X	X			X		X	X	OK
EM0100	X		X				X	X		X	OK
EMD060			X				X			X	OK
M00901			X	X				X		X	OK
MZ1010			X				X			X	OK
MZ2340			X				X			X	OK
MZ6020			X				X			X	OK
Z13601*	X		X	X		X	X	X			OK
Z20601			X				X	X		X	OK
Z22401			X	X			X		X	X	OK
Z25001			X				X	X		X	OK
Z30201*	X		X	X		X	X	X			OK
Z30301			X				X			X	OK
Z31001			X				X			X	OK
Z41901			X				X	X			OK
Z42101			X				X	X	X	X	OK
Z50801			X				X			X	OK
Z61101			X	X			X				OK
PEN11			X							X	OK
PEN12			X				X				OK
PEN13			X	X							OK
PEN14			X	X			X			X	OK
PEN15											OK

Notes:

*	=	SDGs Z13601 and Z30201 were prepared using a modified acid digestion. Samples were not used for interpretation.
Cal.	=	Calibrations
Serial Dil.	=	Serial Dilutions
ICP Check	=	ICP interference check
LCS	=	Laboratory Control Sample
Lab Dup.	=	Laboratory Duplicate
AA	=	Atomic Absorption Spike Recoveries

An "X" in a column means that one or more QC criteria were not met.
An "OK" in the Overall column means the data were acceptable with minor qualifications. No positive results were rejected; however, undetected may have been rejected and qualified "UR."

Validation Qualifiers

U **Undetected** — The analyte was not detected or was also found in an associated blank, but at a concentration less than 10 times the blank concentration for common constituents or five times the blank concentration for other constituents; the associated value shown is the quantitation limit.

J **Estimated Value** — One or more QC parameters were outside control limits.

NJ **Presumptive Identification** — This qualifier is used for pesticide/PCB analysis when the percent difference exceeds the QC limits by 100% or more. It indicates the presence of an analyte for which there is presumptive evidence to make a tentative identification at an estimated concentration. This qualifier is used for pesticide/PCB validation only.

UJ **Undetected and Estimated** — The analyte was not detected above the listed estimated quantitation limit; the quantitation limit is estimated because one or more QC parameters were outside control limits.

D **Diluted Result** — The result was obtained from a diluted sample.

R/UR **Unusable Data** — One or more QC parameters grossly exceeded control limits.

9.0 FATE AND TRANSPORT

9.1 Assessment Zone-Specific Fate and Transport

This section presents an analysis of sediment quality within the Bayou, with an emphasis on physical and chemical relationships between sources and potential pathways of contaminant migration. This section does not evaluate the ecological or risk-based fate and transport of contamination, which is done in Section 10. This analysis will consist of three parts:

1) The identification of potential sources and pathways for sediment contamination within the Bayou.

2) An evaluation of the potential transport mechanisms for contamination within the Bayou.

3) An evaluation of the detected contamination in the Bayou, and the validity of transport mechanisms within the Bayou.

9.2 Sources and Pathways

Sources and Pathways

The notable pathways for contaminant migration into the Bayou are 1) sediment migration and redistribution within the Bayou itself; 2) surface water drainage and 3) groundwater discharge. This section evaluates the physical configuration of the Bayou, and identifies the potential mechanisms and sources through which contamination may enter, migrate through, and leave the Bayou.

In the absence of sedimentation rate data, sediment distribution and potential movement within the Bayou can best be evaluated using the landforms typical of an estuarine system. Characterization of the Bayou allows a division of the shoreline into two main types:

1) A smooth, generally undulating coastline with poorly developed prominences. These prominences are representative of the juvenile stages of spit development. This type of shoreline is common in AZ-1 and AZ-3.

2) Smaller estuarine systems subsidiary to the Bayou. These are characteristic of main drainage pathways from the mainland, and are common in AZ-2 (Bayou Redoubt) and AZ-4 (Magazine Point area).

Sediment Influx

These landforms are strongly indicative of the direction of sediment movement into and within the Bayou. The main surface water drainage pathways feed into the Bayou coincident with the smaller estuarine systems, and the bulk of sediment movement along the shoreline of the Bayou results in the gently undulating shoreline. Preliminary spit development is characterized by shallower angles on the upcurrent side, along with the development of prominences at points of lower current energies — this is where sediment accretion occurs, and subsequent shoreline growth. The estuarine systems can be coupled with smaller depositional basins within themselves. Bayou Grande exhibits classic landform development of prominences with sharp, steeper angled coasts along the eastern shorelines — these are indicators that the bulk of sediment movement within the Bayou is to the east, into the Pensacola Bay. The smaller estuarine systems are straightforward in that their configurations show progressively widening mouths until the intersection with the Bayou. Bayou Redoubt, however, exhibits a smaller, rounded entry at the point of its connection with the mainland. This area represents a subsidiary depositional basin which accepts the first influx of sediment from the Sherman Field Area.

Stormwater drainage from the base plays an important role in sediment influx into the Bayou as well. The primary drainage pathways on the base have been channelized (due to the low elevation of the base itself), and feed directly into the Bayou through Bayou Redoubt, wetland 4, and the two drainage arms of the eastern side of the base within the Magazine Point area. Unlike the bases southern boundary, there are no discrete discharge pipes for the stormwater system within the Bayou Grande.

In summary, the pathways for sediment influx into the Bayou are from the mouth of the Bayou, to the west of the base; from channelized drainage off of Sherman Field into Bayou Redoubt, from drainage within the golf course area via wetland 4, and from channelized drainage into two smaller estuarine systems within the Magazine Point area. Sediment movement within the Bayou itself, based on landform analysis, is from the west to the east, towards the Pensacola Bay.

Groundwater Influx

Groundwater in both the shallow and intermediate depths of the shallow aquifer discharges as a non-point source from the base to the Bayou. Given the depth profile of the Bayou, shallow groundwater discharges form the shore to several tens of meters from the shore, whereupon discharge from the intermediate is the dominant expected inflow. Contamination within the intermediate depth has been noted at Site 1. Without exception, the known potential sources immediately adjacent to the Bayou are capable of affecting primarily the shallow depth.

The known sites of concern include the following:

1) Sherman Field — primarily fuel-related activities. Surface drainage, sediment entrainment, and groundwater discharge are the expected mechanisms of contaminant introduction to the Bayou. Primary affected areas are AZ-1 and AZ-2.

2) Site 1 — landfilling activities. Surface drainage, primarily non-point source, sediment entrainment and groundwater discharge are the expected mechanisms of contaminant introduction into the Bayou. Primary affected areas are AZ-2 and AZ-3.

3) Golf Course area and Site 15: pesticide and herbicide applications. Surface drainage, sediment entrainment and groundwater discharge are the expected mechanisms of contaminant introduction into the Bayou. Primary affected areas are AZ-3 and AZ-4.

4) Stormwater influx: although input to the Bayou may be discrete, the source of stormwater covers essentially the entire northern half of the base that has been developed. Thus, there are a myriad of sites that may contribute to this pathway. The primary affected areas are AZ-2, AZ-3, and AZ-4.

9.3 Transport Mechanisms

Contamination has previously been defined in this document as exceedances of Sediment Quality Screening Values. However, this is based on ecological effects, and may not account for the physical and chemical relationships between cross-media or intra-media transport. This section evaluates the dominant transport mechanisms in the Bayou, and develops appropriate screening methods for evaluating those mechanisms validity.

For transport considerations, some general explanation is required. The dominant methods of future physico-chemical mobilization of the detected contaminants in the Bayou Grande setting are sediment to surface water partitioning and sediment load movement and redistribution. The significance and directions of sediment redistribution can generally be evaluated using appropriate landform indicators. Partitioning of contamination from sediment to surface water is significantly less predictable. Contaminants mobility, both organic and inorganic, will to a great extent be governed by how strongly adsorbed to the sediment media they are. This adsorption is governed by a number of factors, including TOC, redox conditions in the sediment, porosity (both connected and closed), bulk density, temperature, pH and cation exchange capacity. Organic partitioning is somewhat easier to treat, as the primary factor governing mobility is the fraction of organic carbon in the sediment: higher carbon content emphasizes contaminant adsorption. Inorganic adsorption, especially in this setting, is primarily governed by redox conditions as well as organic content: organic content provides adsorptive surface area, and the generally oxidizing conditions provide for inorganic oxide precipitation. However, especially with depth within the sediment column, anaerobic conditions can prevail, reducing inorganics and releasing them into pore water. Clearly, the mechanisms governing sediment to water partitioning are complex, and at this point require a screening tool for further analysis of sediments within the Bayou Grande.

USEPA (1996) provides a basis for evaluating soil to groundwater cross-media transport. The process of sediment to surface water partitioning is governed by the same general principles. As a result, this analysis utilizes the principles presented in that document to derive quantitative Sediment Screening Levels (SSLs). These are defined as conservative concentrations of a given parameter which has the potential to leach from sediment to surface water. The theory behind the partitioning equation, as well as appropriate considerations and limitations regarding the partitioning principles are included in USEPA 1996 and are not repeated here. The following describes the approach taken in this analysis and provides the calculated SSLs:

Partitioning equation:

This equation is used widely to describe the transfer of constituents from solid media to a liquid media which has contacted it. It is the basis of the development of soil screening levels in USEPA (1996). The equation incorporates use of several parameters, and the basic form is:

Screening level = Target concentration (distribution coefficient [Kd] + water filled porosity/dry bulk density).

Where:

Target Concentration	=	Surface water standard x dilution factor
Distribution Coefficient	=	Kd (normalized for organics using a fraction of organic carbon content of 0.127)
Water filled porosity	=	20%
Dry Bulk Density	=	1.5 kg/L

For this analysis, the target concentration used incorporates the USEPA or FDEP surface water standard for a given parameter. In typical vadose zone calculations, the leachate concentration is diluted/attenuated by a factor of 20 (USEPA, 1996), and assumes leachate enters an aquifer matrix. However, the sediment to soil pathway allows leachate to enter a volume of water devoid of matrix, and therefore allows a greater dilution factor. In other words, an aquifer with 20% porosity has approximately 80% of its mass as solid matrix, thus leachate is diluted only by the water residing in the remaining 20% porosity. Surface water, on the other hand, has no mass as solid matrix, and allows for greater dilution over an aquifer (given equivalent masses of aquifer versus surface water, of course). If one assumes a porosity of 20% (a typical literature value for aquifer matrix), then the greater dilution for an equivalent mass of surface water is 100% (no solid matrix) versus 20% for the aquifer. This is an increase in dilutional capacity by a factor of five. Standard USEPA procedure is to utilize a dilution/attenuation factor of 20 in vadose zone calculations for leachate dilution; an increase in this by a factor of five (to approximate the greater dilutional capacity of surface water versus aquifer matrix) equates to a dilution factor of 100. Therefore, for these calculations, the surface water standard was multiplied by 100 to account for the increased potential for leachate dilution. Distribution coefficients were obtained from several sources, with the preferred being USEPA (1996). Coefficients for organic constituents were normalized with respect to the measured Total Organic Carbon: the calculated average for all sediment samples equates to a fraction organic carbon content of .0127. The water filled porosity of sediment was assumed to be 20%, and a literature value of 1.5 kg/L was utilized for dry bulk density (USEPA, 1996). In most cases, the distribution coefficients were of such high magnitude that porosity and bulk density were not critical to the resulting screening level. Table 9-1 presents the calculated screening levels for those parameters which were also detected above an ecological sediment quality screening value. This technique allows a focus on those chemicals presumed to be of concern. These sediment-screening levels (SSLs) are then used in the following discussions regarding validity of the transport pathways.

Table 9-1
Calculated Sediment Screening Values for Bayou Grande
NAS Pensacola Site 40

Parameter	USEPA or FDEP Surface Water Standard	Kd	SSL DF = 100	Maximum Concentration Detected	Leaching Potential DF = 100
INORGANIC	**(ppb)**		**(ppm)**	**(ppm)**	
Arsenic	50	2.9E+01	148	21.8	NO
Cadmium	9.3	7.5E+01	70	7.1	NO
Chromium	673,000	1.9E+01	1,323,500	236	NO
Copper	2.9	4.3E+02	125	52.2	NO
Lead	5.6	9E+02	504	134	NO
Mercury	.025	5.2E+01	.13	2.2	YES
Zinc	86	6.2E+01	539	224	NO
Nickel	8.3	6.5E+01	54.5	18.9	NO
ORGANICS	**(ppb)**		**(ppb)**	**(ppb)**	
4,4 DDE	0.14	5.68E+04	795,200	4.4	NO
4,4 DDD	.025	1.27E+04	31,751	1.6	NO
4,4 DDT	.001	3.34E+04	3,340	1.9	NO
Dieldrin	.0019	2.72E+02	51.8	99	YES
Endrin	.0023	1.56E+02	36	3.9	NO
Gamma BHC	.016	1.36E+01	22.8	9.2	NO
2 —methyl napthalene	NA	9.52E+01	NA	160	NO
Anthracene	110	3.75E+02	4,132,326	5500	NO
Acenapthylene	.031	3.94E+01	124	100	NO
Total PCBs	.031	3.92E+03*	12,154	84	NO
Acenapthene	2.7	9.91E+01	26,937	1000	NO
Benzo(a)anthracene	.031	5.05E+03	15,657	4,400	NO
Benzo(a)pyrene	.031	1.3E+04	40,302	21,000	NO
Chrysene	.031	5.05E+03	15,657	44,000	YES
Dibenzo(a)anthracene	.031	4.83E+04	149,732	77	NO
Fluoranthene	.37	1.36E+03	50,345	52,000	YES
Fluorene	NA	1.75E+02	NA	7,900	NO

Table 9-1
Calculated Sediment Screening Values for Bayou Grande
NAS Pensacola Site 40

Parameter	USEPA or FDEP Surface Water Standard	Kd	SSL DF = 100	Maximum Concentration Detected	Leaching Potential DF = 100
ORGANICS	**(ppb)**		**(ppb)**	**(ppb)**	
Napthalene	23.5	7.92E+02	1,862,765	140	NO
Phenanthrene	.031	3.81E+02	1,183	25,000	YES
Pyrene	11	1.33E+03	1,463,700	89,000	NO
Bis-2-ethyl Hexyl Phthalate	NA	1.92E+05	NA	2,400	NO

Notes:
* = based on Aroclor-1260
Kd for organics calculated using foc of. 0127 (numerical average of all sediment samples).
Kds are from: USEPA, 1996 (first preference); Superfund Chemical Data Matrix, 1996 (second preference); Texas Risk Reduction Program Concept Document 2, Volume 1, Appendix VII, 1996 (third preference); TERRA Model, Oak Ridge National Laboratory, 1984 (fourth preference — primary reference for inorganics).
Kd = normalized partitioning coefficient
SSL = sediment screening level
DF = dilution factor

9.4 Contamination and Transport Mechanism Validation

This section evaluates the detections with respect to the transport mechanisms defined in the previous section.

Sediment Movement Pathway

As previously evaluated, the sediment movement into the Bayou and within the Bayou are valid transport mechanisms within this system. Influx into the system is a clear possibility. Sediment movement within the Bayou, however, bears some further analysis. There are general trends in which contaminant detections are higher near the previously noted prominences (likely depositional areas) and in samples further from shore (likely to be associated with finer grained, higher TOC sediments). Additionally, detections tend to be more frequent in the small southern depositional area within Bayou Redoubt, along the eastern edge of Redoubt, at the point of entry for wetland 4, and within the smaller estuarine areas near Magazine Point. Landform distribution (e.g. several prominences indicative of early spit development) suggest that current movement and overall sediment load shift is occurring within the Bayou. Movement is generally from the west to the east, towards the mouth of the Bayou and its entry into the Pensacola Bay. Clearly, this pathway of transport is valid for the Bayou, with contaminants expected to occur coincident with areas of sediment accretion.

Sediment to Surface Water Pathway

Overall, there was only one inorganic parameter (mercury) and four organic parameters (dieldrin, chrysene, Fluoranthene, and phenanthrene) that were present at levels that exceeded SSLs. Clearly, the pathway has merit for these constituents. The following describes the distribution of these parameters, with emphasis on remarkable features.

Inorganics — Mercury was detected above its SSL at seven locations within AZ-1, eight locations within AZ-2, two locations within AZ-3, and two locations within AZ-4. The detections suggest that current hydrodynamics are governing distribution trends. Within the Bayou proper, detections are most common in areas of sediment accretion, based on landform analysis. Within Bayou Redoubt, detections are most common in the immediate southern depositional basin, as well as on the eastern side where deposition is most likely to be occurring. Sources for both AZ-2 and AZ-4 are likely associated with the surface drainage features feeding into them. The highest density of detections is in the southern basin of Bayou Redoubt, suggesting this as an area of risk consideration for this pathway.

Organics — Dieldrin was detected above its SSL at only one location, within AZ-3. Overall, detections of dieldrin are associated with the area immediately north of the airfield within AZ-1, within the southern basin and eastern side of Bayou Redoubt within AZ-2, at the mouth of wetland 4 and along the flanks of the golf course within AZ-3, and along the flanks of the golf course within AZ-4. The highest density of detections is within the Bayou Redoubt system: this contamination is likely associated with maintenance of the airfield complex and surrounding area.

The single SSL exceedance is anomalously high relative to the other detections, and is likely associated with application on the golf course. The presence of only one detection above SSL suggest that the pathway with respect to dieldrin may not be significant.

Chrysene was detected above its SSL at only one location, within AZ-3. Chrysene detections were somewhat pervasive within AZs-2, 3, and 4, and are likely associated with fuel combustion (potentially landborne and boating traffic) and stormwater runoff. The one exceedance is located immediately outside the main gate, along the corridor used by all landborne traffic entering and leaving the base from the north. Significant trends in the data are ambiguous, but the highest density of detections and the overall highest concentrations are associated with the entry of wetland 4 into the Bayou and with the general area near the main gate of the base. The presence of only one detection above the SSL suggests that the pathway with respect to chrysene may not be significant.

Fluoranthene was detected above its SSL at only one location, within AZ-3. Fluoranthene distributions resemble those for chrysene, indicating a similar provenance. The single exceedance of fluoranthene was coincident with that for chrysene, and the highest density of detections and the overall highest concentrations are associated with the entry of wetland 4 into the Bayou and with the main gate area. The presence of only one detection above the SSL suggests the pathway with respect to Fluoranthene may not be significant.

Phenanthrene was present above its SSL at two locations, within AZ-3. Although not as pervasive as chrysene, the distribution of phenanthrene detections is similar. One of the exceedances of this compound is coincident with that for chrysene and Fluoranthene, and the other is in the wetland 4 area. Again, the highest density of detections and the overall highest concentrations are associated with the wetland 4 entry into the Bayou, and with the general area near the main gate. The presence of only two detections above the SSL suggest that the pathway with respect to phenanthrene may not be significant.

10.0 BASELINE RISK ASSESSMENT

10.1 Introduction

This BRA evaluates the potential health hazard and/or cancer risk to humans and the environment from hazardous substances at Site 40. The assessment considers environmental media and exposure pathways that could result in unacceptable levels of exposure now or in the foreseeable future. This BRA addresses both ecological risk (Section 10.2) and human health exposure (Section 10.3). The risk assessment is used as a basis for making remedial decisions and depends upon an adequate site characterization of chemical contamination. The RI conducted by EnSafe, which has been presented in previous chapters, characterizes the site data.

The ecological risk assessment has been conducted in two phases. In the Phase II (screening level assessment), observed sediment concentrations are compared to sediment screening values considered to be critical exposure levels for marine fauna. Phase III (baseline ecological risk assessment) samples, or second round of samples (sediment, water, and tissue), were collected to determine if contaminants concentrations would produce measurable impacts to selected biota groups.

Human health was assessed by a preliminary screening evaluation of exposure potentials, based on Site 40 physical characteristics and exposure to fish tissue-borne contaminants collected during Phase III.

BRA Objectives

- Characterize the source media and determine the chemicals of potential concern (COPCs) for Site 40 at NAS Pensacola.

- Identify potential receptors and quantify potential exposures under current and future conditions.

- Qualitatively and quantitatively evaluate the adverse effects associated with site-specific COPCs.

The following BRA was prepared in accordance with the following guidance documents.

- USEPA (1992), *EPA Framework for Ecological Risk Assessment* (EPA/630/R-92001).

- USEPA/ERT (June 1997, Interim Final), *Ecological/Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments.*

- USEPA (December 1991, Interim), *Risk Assessment Guidance for Superfund, Volume I — Human Health Evaluation Manual*, Parts A & B, USEPA/OERR, EPA/540/1-89/002. (December 1989) and EPA/540/R92/003.

- USEPA (March 25, 1991), *Risk Assessment Guidance for Superfund, Volume I — Human Health Evaluation Manual. Supplemental Guidance-Standard Default Exposure Factors-Interim Final.* USEPA/OERR. OSWER Directive: 9285.6-03.

- USEPA (March 1989), *Risk Assessment Guidance for Superfund, Volume II — Environmental Evaluation Manual, Interim Final.* USEPA/OERR, EPA/540/1-89/001.

- USEPA (December 1991, Interim), *Risk Assessment Guidance for Superfund, Volume I — Human Health Evaluation Manual, (Part B, Development of Risk-Based Preliminary Remediation Goals)*, USEPA/OERR, USEPA/540/R92/003.

- USEPA (1994), *Supplement Guidance to RAGS: Region IV Bulletin, Development of Health-based Preliminary Remediation Goals, Remedial Goal Options and Remediation Levels* (Supplemental RGO Guidance).

- USEPA Region III (June 3, 1996), *Selection of Contaminants of Concern by Risk-Based Screening table*, (Roy L. Smith). (RBC Screening Table).

10.2 Ecological Risk Assessment

The ecological risk assessment (ERA) of the BRA was performed to develop a qualitative and/or quantitative appraisal of the actual or potential ecological effects from Site 40 contamination. The assessment considers environmental media and potential exposure pathways that could result in unacceptable exposure to flora and fauna now or in the foreseeable future. The results of each phase of the ERA are described below.

10.2.1 Phase I Sediment Mapping Results

Sediment distribution within the bayou was mapped to determine areas of highest potential contaminant deposition. As an inlet to Pensacola Bay, Bayou Grande is not subject to as much tidal influence or wave action as the bay itself, which limits sediment migration. As a result, areas of the bayou with the highest percentages of fine-grained material are considered to have received the highest historical contaminant deposition, and were selected for Phase IIA sediment sampling. The complete Phase I methodology and results are included in the SAP for Sites 40 and 42 (E/A&H, 1995).

10.2.2 Phase IIA Sediment Screening Values

The results of Phase I led to the selection of sampling locations for Phase IIA. To characterize risk to Site 40 receptors, contaminant concentrations from the Phase IIA sediment analysis were compared with sediment quality guidelines. These guidelines are the lower of either the

USEPA Region IV Sediment Screening Values (USEPA, 1995) or the FDEP Sediment Quality Assessment Guidelines (MacDonald, 1994). This section describes these screening values, how they were derived, and how they are used in assessing risk at Site 40.

Sediment Screening Values are based on contaminant concentrations associated with adverse effects to ecological receptors. The Office of Technical Services has developed these for use at USEPA Region IV hazardous waste sites. Since these values are based on conservative endpoints and sensitive ecological effects data, they represent a preliminary screening of site contaminant levels to determine whether further investigation is needed; they are not remediation levels. Sediment screening values are derived from statistical interpretation of effects databases obtained from the literature, as reported in publications from the State of Florida, the National Oceanic and Atmospheric Administration, and a joint publication by (Long et al., 1995). These values are based on observations of direct toxicity when available.

Sediment Quality Assessment Guidelines, developed by MacDonald (1994), are guidelines for evaluating sediment contamination in coastal ecosystems based on a contaminant effects-based data set specific to the State of Florida. Sediment contamination was assessed in a two-step process. First, each contaminant is compared with the threshold effects level (TEL). Below this level, contaminant concentrations are dominated by no biological effects data and they are not considered to represent a hazard to aquatic organisms. Secondly, each contaminant concentration is compared to the probable effects level (PEL). The PEL is usually associated with adverse biological effects. Above this level, contaminant concentrations are considered to represent a risk to aquatic organisms. Between the TEL and the PEL risk to aquatic organisms is possible but not certain.

These sediment quality guidelines have weaknesses that were recognized during their development. For example, they do not address the potential for bioaccumulation of persistent toxic chemicals, synergistic effects, or potential adverse effects on higher trophic level species in the food web.

In addition, the lack of consistency among organisms used to develop these data sets could reduce their relevance to species studied at NAS Pensacola. For the remainder of this Section 10, the lower of the USEPA sediment screening value or the Florida SQAG will be referred to as the SSV.

Preliminary Exposure Estimate

Once the appropriate SSVs were compiled, assumptions were made regarding the potential for a receptor to be exposed to site contamination. For estimating exposure to sediment-dwelling organisms, benthic fauna were assumed to be in the area surrounding each sample location for feeding and other life requisites. This screening approach also assumes that 100% of the contaminant found will be bioavailable to benthic organisms at the location. Applying both of these conservative assumptions in the screening assessment estimates a chemical's potential effects and using the following equation, a hazard quotient (HQ) was determined for each contaminant at each sampling location.

Equation 1

$$\text{Hazard Quotient (HQ)} = \frac{\text{Contaminant Concentration}}{\text{SSV}}$$

An HQ greater than 1 is interpreted by USEPA as a level at which adverse ecological effects are likely to occur. An HQ less than 1, however, does not indicate the absence of risk (USEPA, 1994).

10.2.3 Phase IIA Results

This section evaluates sediment contamination in each AZ at Site 40. Except for certain PAH compounds, all detections were of the same order of magnitude as the screening value. Although metal concentrations were elevated across the bayou, most exceedances were to the west in AZs-1 and 2 as were the pesticide and PCB exceedances. The SSVs for SVOCs were exceeded primarily in AZs-2 and 3, and based on their distribution, appeared to be associated with storm water discharge points. Overall, the most contaminated area was the southern portion of Redoubt Bayou in AZ-2.

For Site 40, HQs were determined only for contaminants exceeding the SSV. Thus, all quotients for the locations presented in Tables 10-1 through 10-12 will exceed 1 and those for locations not presented will be less than 1. The following paragraphs discuss exceedances and spatial relevance, along with an interpretation of the number of exceedances relative to the sample size for each AZ.

AZ-1

AZ-1 is the farthest upstream of the AZs. As discussed in Section 7, there did not appear to be any distinctive pattern or areas where contaminants were particularly elevated. Within the sediment, HQ values calculated for metals were greater than 1 for arsenic, cadmium, chromium, copper, lead, mercury, nickel, and zinc (Table 10-1). One HQ value calculated for metals exceeded 10 (mercury at sample location 040MZ130). Pesticides and PCBs exceeded SSV values for DDD, DDE, dieldrin, gamma-BHC, and PCBs (Table 10-2). The maximum HQ (4.1) calculated for pesticides/PCBs was for gamma-BHC at location 040MZ106. SVOCs showed HQs above 1 for fluoranthene, 2-methylnapthalene, napthalene, and BEHP (Table 10-3). One organic HQ value exceeded 10 (BEHP at sample location 040MZ129). Contaminants with HQ values above 1 in AZ-1 are summarized in Table 10-1.

Table 10-1
AZ-1 Phase IIA Inorganic Concentrations Exceeding Sediment Screening Criteria*

Contaminant	Sample ID	Concentration (ppm)	EPA Sediment Screening Value	SQAG TEL	SQAG PEL	HQ
Arsenic	040MZ105	9.4	7.24	7.24	41.6	1.3
	040MZ106	12.3				1.7
	040MZ107	13.7				1.9
	040MZ109	14.7				2.0
	040MZ112	17.3				2.4
	040MZ114	15.2				2.1
	040MZ115	15.8				2.2
	040MZ116	13.0				1.8
	040MZ119	17.2				2.4
	040MZ120	15.1				2.1
	040MZ122	17.3				2.4
	040MZ129	17.5				2.4
	040MZ130	16.2				2.2
	040MZ136	18.4				2.5
	040MZ137	15.6				2.2

Table 10-1
AZ-1 Phase IIA Inorganic Concentrations Exceeding Sediment Screening Criteria*

Contaminant	Sample ID	Concentration (ppm)	EPA Sediment Screening Value	SQAG TEL	SQAG PEL	HQ
Cadmium	040MZ105	1.0	1.0	0.676	4.21	1.5
	040MZ106	1.3				1.9
	040MZ107	1.5				2.2
	040MZ109	2.0				2.9
	040MZ114	1.8				2.7
	040MZ115	3.1				4.6
	040MZ116	1.6				2.4
	040MZ119	2.2				3.2
	040MZ120	1.9				2.8
	040MZ122	2.8				4.1
	040MZ129	3.7				5.5
	040MZ130	1.3				1.9
	040MZ136	2.9				4.3
	040MZ137	2.6				3.8
Chromium	040MZ105	53.4	52.3	52.3	160	1.0
	040MZ106	70.2				1.3
	040MZ107	88.6				1.7
	040MZ109	93.0				1.8
	040MZ114	103.0				2.0
	040MZ115	137.0				2.6
	040MZ116	93.6				1.8
	040MZ119	140.0				2.7
	040MZ120	103.0				2.0
	040MZ122	161.0				3.1
	040MZ129	176.0				3.4
	040MZ130	120.0				2.3
	040MZ136	164.0				3.1
	040MZ137	132.0				2.5
Copper	040MZ106	18.8	18.7	18.7	108	1.0
	040MZ107	21.3				1.1
	040MZ109	20.4				1.1
	040MZ112	28.7				1.5
	040MZ114	21.7				1.2
	040MZ115	23.8				1.3
	040MZ119	26.2				1.4
	040MZ120	21.7				1.2
	040MZ122	26.3				1.4
	040MZ129	30.0				1.6
	040MZ130	22.4				1.2
	040MZ136	33.6				1.8
	040MZ137	27.5				1.5

Table 10-1
AZ-1 Phase IIA Inorganic Concentrations Exceeding Sediment Screening Criteria*

Contaminant	Sample ID	Concentration (ppm)	EPA Sediment Screening Value	SQAG TEL	SQAG PEL	HQ
Lead	040MZ105	32.3	30.2	30.2	112	1.1
	040MZ106	40.9				1.4
	040MZ107	48.5				1.6
	040MZ109	53.5				1.8
	040MZ112	66.6				2.2
	040MZ114	58.1				1.9
	040MZ115	73.7				2.4
	040MZ116	50.4				1.7
	040MZ119	77.9				2.6
	040MZ120	59.2				1.9
	040MZ122	82.6				2.7
	040MZ129	95.3				3.1
	040MZ130	72.7				2.4
	040MZ136	97.7				3.2
	040MZ137	87.7				2.9
Mercury	040MZ115	0.30	0.13	0.13	0.696	2.3
	040MZ116	0.21				1.6
	040MZ119	0.27				2.1
	040MZ122	0.37				2.8
	040MZ129	0.33				2.5
	040MZ130	2.20				16.9
	040MZ136	0.39				3.0
Nickel	042MZ136	16.9	15.9	15.9	42.8	1.1
Zinc	040MZ119	126	124	124	271	1.0
	040MZ122	132				1.1
	040MZ129	141				1.1
	040MZ136	163				1.3
	040MZ137	141				1.1

Notes:
Sediment screening values are from USEPA 1995.
SQAG = Florida Department of Environmental Protection — Sediment Quality Assessment Guideline (MacDonald 1994)
TEL = Threshold Effects Level
PEL = Probable Effects Level
HQ = Hazard Quotient; Concentration/Effects Level.*
* = Effects level is the lower value of the USEPA sediment screening value or SQAG TEL

Table 10-2
AZ-1 Phase IIA Pesticide/PCB Concentrations Exceeding Sediment Screening Criteria*

Contaminant	Sample ID	Concentration (ppb)	EPA Sediment Screening Value	SQAG TEL	SQAG PEL	HQ
4,4'-DDD	040MZ135	1.6	3.3	1.22	7.81	1.3
4,4'-DDE	040MZ105	3.1	3.3	2.07	374	1.5
	040MZ106	3.4				1.6
	040MZ107	4.0				1.9
	040MZ109	4.4				2.1
	040MZ112	2.3				1.1
	040MZ115	2.1				1.0
	040MZ122	2.7				1.3
Dieldrin	040MZ115	0.9	3.3	0.715	4.3	1.3
	040MZ116	0.98				1.4
	040MZ119	1.4				2.0
	040MZ120	1.2				1.7
	040MZ122	1.7				2.4
	040MZ129	1.2				1.7
gamma-BHC (Lindane)	040MZ106	1.3	3.3	0.32	0.99	4.1
	040MZ107	1				3.1
	040MZ109	1.2				3.8
	040MZ130	0.73				2.3
	040MZ136	1.2				3.8
	040MZ137	1.1				3.4
Total PCBs	040MZ105	39	33	21.6	189	1.8
	040MZ106	39				1.8
	040MZ107	38				1.8
	040MZ109	38				1.8
	040MZ112	39				1.8
	040MZ122	28				1.3
	040MZ130	23				1.1
	040MZ136	28				1.3
	040MZ137	34				1.6

Notes:
Sediment screening values are from USEPA 1995.
SQAG = Florida Department of Environmental Protection — Sediment Quality Assessment Guideline (MacDonald 1994)
TEL = Threshold Effects Level
PEL = Probable Effects Level
HQ = Hazard Quotient; Concentration/Effects Level.*
* = Effects level is the lower value of the USEPA sediment screening value or SQAG TEL

Table 10-3
AZ-1 Phase IIA SVOC Concentrations Exceeding Sediment Screening Criteria*

Contaminant	Sample ID	Concentration (ppb)	EPA Sediment Screening Value	SQAG TEL	SQAG PEL	HQ
Fluoranthene	040MZ130	140	330	113	1494	1.2
	040MZ136	200				1.8
	040MZ137	130				1.2
2-Methylnaphthalene	040MZ130	94	330	20.2	201	4.7
Naphthalene	040MZ130	120	330	34.6	391	3.5
	040MZ136	140				4.0
	040MZ137	120				3.5
BEHP	040MZ107	510	182	182	2647	2.8
	040MZ129	2400				13.2

Notes:
Sediment screening values are from USEPA 1995.
SQAG = Florida Department of Environmental Protection — Sediment Quality Assessment Guideline (MacDonald 1994)
TEL = Threshold Effects Level
PEL = Probable Effects Level
HQ = Hazard Quotient; Concentration/Effects Level.*
* = Effects level is the lower value of the USEPA sediment screening value or SQAG TEL

Table 10-4
AZ-2 Phase IIA Inorganic Concentrations Exceeding Sediment Screening Criteria*

Contaminant	Sample ID	Concentration (ppm)	EPA Sediment Screening Value	SQAG TEL	SQAG PEL	HQ
Arsenic	040MZ205	14.5	7.24	7.24	41.6	2.0
	040MZ206	17.7				2.5
	040MZ214	15.0				2.1
	040MZ215	15.6				2.2
	040MZ219	13.0				1.8
	040MZ223	12.3				1.7
	040MZ224	12.0				1.7
	040MZ226	15.6				2.2
	040MZ228	13.7				1.9
	040MZ231	15.9				2.2
	040MZ233	17.8				2.5
	040MZ244	21.8				3.0
	040MZ245	19.5				2.7
	040MZ247	19.9				2.8

Table 10-4
AZ-2 Phase IIA Inorganic Concentrations Exceeding Sediment Screening Criteria*

Contaminant	Sample ID	Concentration (ppm)	EPA Sediment Screening Value	SQAG TEL	SQAG PEL	HQ
Cadmium	040MZ205	1.8	1.0	0.676	4.21	2.7
	040MZ206	2.3				3.4
	040MZ214	3.7				5.5
	040MZ215	3.6				5.3
	040MZ218	1.1				1.6
	040MZ219	4.5				6.7
	040MZ223	3.5				5.2
	040MZ224	3.3				4.9
	040MZ225	0.7				1.0
	040MZ226	2.5				3.7
	040MZ228	2.1				3.1
	040MZ231	1.9				2.8
	040MZ233	1.9				2.8
	040MZ244	1.9				2.8
	040MZ245	1.3				1.9
	040MZ247	2.2				3.3
Chromium	040MZ205	114.0	52.3	52.3	160	2.2
	040MZ206	134.0				2.6
	040MZ214	107.0				2.1
	040MZ215	99.0				1.9
	040MZ219	88.9				1.7
	040MZ223	97.7				1.9
	040MZ224	101.0				1.9
	040MZ226	145.0				2.8
	040MZ228	131.0				2.5
	040MZ231	116.0				2.2
	040MZ233	156.0				3.0
	040MZ244	174.0				3.3
	040MZ245	137.0				2.6
	040MZ247	169.0				3.2
Copper	040MZ205	27.8	18.7	18.7	108	1.5
	040MZ206	28.6				1.5
	040MZ214	31.0				1.7
	040MZ215	27.5				1.5
	040MZ219	40.1				2.1
	040MZ223	27.6				1.5
	040MZ224	28.6				1.5
	040MZ226	31.4				1.7
	040MZ228	25.1				1.3
	040MZ231	27.5				1.5
	040MZ233	29.9				1.6
	040MZ244	37.4				2.0
	040MZ245	30.2				1.6
	040MZ247	37.0				2.0

Table 10-4
AZ-2 Phase IIA Inorganic Concentrations Exceeding Sediment Screening Criteria*

Contaminant	Sample ID	Concentration (ppm)	EPA Sediment Screening Value	SQAG TEL	SQAG PEL	HQ
Lead	040MZ205	81.8	30.2	30.2	112	2.7
	040MZ206	99.8				3.3
	040MZ214	92.4				3.1
	040MZ215	83.3				2.7
	040MZ218	34.7				1.1
	040MZ219	131.0				4.3
	040MZ222	40.1				1.3
	040MZ223	102.0				3.4
	040MZ224	103.0				3.4
	040MZ226	94.2				3.1
	040MZ228	82.9				2.7
	040MZ231	81.5				2.7
	040MZ233	107.0				3.5
	040MZ244	125.0				4.1
	040MZ245	108.0				3.6
	040MZ247	129.0				4.3
Mercury	040MZ214	0.25	0.13	0.13	0.696	1.9
	040MZ219	0.28				2.2
	040MZ221	0.16				1.2
	040MZ223	0.22				1.7
	040MZ228	0.25				1.9
	040MZ244	0.64				4.9
	040MZ245	0.24				1.8
	040MZ247	0.28				2.2
Zinc	040MZ206	128	124	124	271	1.0
	040MZ214	132				1.1
	040MZ215	129				1.0
	040MZ219	206				1.7
	040MZ223	130				1.0
	040MZ224	135				1.1
	040MZ226	137				1.1
	040MZ233	135				1.1
	040MZ244	146				1.2
	040MZ245	124				1.0
	040MZ247	147				1.2

Notes:
Sediment screening values are from USEPA 1995.
SQAG = Florida Department of Environmental Protection — Sediment Quality Assessment Guideline (MacDonald 1994)
TEL = Threshold Effects Level
PEL = Probable Effects Level
HQ = Hazard Quotient; Concentration/Effects Level.*
* = Effects level is the lower value of the USEPA sediment screening value or SQAG TEL

Table 10-5
AZ-2 Phase IIA Pesticide/PCB Concentrations Exceeding Sediment Screening Criteria*

Contaminant	Sample ID	Concentration (ppb)	EPA Sediment Screening Value	SQAG TEL	SQAG PEL	HQ
4,4'-DDD	040MZ214	2.3	3.3	1.22	7.81	1.9
	040MZ215	1.7				1.4
	040MZ217	2.4				2.0
	040MZ218	5.2				4.3
	040MZ219	16.0				13.1
	040MZ221	7.6				6.2
	040MZ222	5.0				4.1
	040MZ223	12.0				9.8
	040MZ224	15.0				12.3
	040MZ244	1.8				1.5
4,4'-DDE	040MZ205	2.6	3.3	2.07	374	1.3
	040MZ214	5.8				2.8
	040MZ215	4.4				2.1
	040MZ218	4.6				2.2
	040MZ219	9.4				4.5
	040MZ221	4.2				2.0
	040MZ222	3.9				1.9
	040MZ223	9.7				4.7
	040MZ224	13.0				6.3
	040MZ226	2.9				1.4
	040MZ228	2.4				1.2
	040MZ233	3.3				1.6
	040MZ244	2.2				1.1
4,4'-DDT	040MZ218	2.2	3.3	1.19	4.77	1.8
	040MZ219	6.3				5.3
	040MZ221	12.0				10.1
	040MZ223	3.0				2.5
	040MZ224	22.0				18.5
Dieldrin	040MZ221	1.4	3.3	0.715	4.3	2.0
	040MZ223	0.93				1.3
	040MZ224	1.3				1.8
	040MZ226	2.3				3.2
	040MZ228	2.2				3.1
	040MZ231	1.8				2.5
	040MZ233	2.6				3.6
gamma-BHC (Lindane)	040MZ205	2.3	3.3	0.32	0.99	7.2
	040MZ214	1.4				4.4
	040MZ215	1.8				5.6
	040MZ219	2				6.3
	040MZ222	0.56				1.8
	040MZ224	1.2				3.8
	040MZ225	0.53				1.7
	040MZ226	2				6.3
	040MZ228	0.84				2.6
	040MZ231	0.66				2.1

Table 10-5
AZ-2 Phase IIA Pesticide/PCB Concentrations Exceeding Sediment Screening Criteria*

Contaminant	Sample ID	Concentration (ppb)	EPA Sediment Screening Value	SQAG TEL	SQAG PEL	HQ
Total PCBs	040MZ205	63	33	21.6	189	2.9
	040MZ206	27				1.3
	040MZ214	49				2.3
	040MZ215	34				1.6
	040MZ218	42				1.9
	040MZ219	96				4.4
	040MZ221	81				3.8
	040MZ222	46				2.1
	040MZ223	77				3.6
	040MZ224	110				5.1
	040MZ225	23				1.1
	040MZ226	34				1.6
	040MZ228	37				1.7
	040MZ231	33				1.5
	040MZ233	48				2.2
	040MZ244	29				1.3
	040MZ247	32				1.5

Notes:
Sediment screening values are from USEPA 1995.
SQAG = Florida Department of Environmental Protection — Sediment Quality Assessment Guideline (MacDonald 1994)
TEL = Threshold Effects Level
PEL = Probable Effects Level
HQ = Hazard Quotient; Concentration/Effects Level.*
* = Effects level is the lower value of the USEPA sediment screening value or SQAG TEL

Table 10-6
AZ-2 Phase IIA SVOC Concentrations Exceeding Sediment Screening Criteria*

Contaminant	Sample ID	Concentration (ppb)	EPA Sediment Screening Value	SQAG TEL	SQAG PEL	HQ
Acenaphthene	040MZ222	33	330	6.71	88.9	4.9
Anthracene	040MZ222	80	330	46.9	245	1.7
Benzo(a)anthracene	040MZ206	99	330	74.8	693	1.3
	040MZ219	230				3.1
	040MZ222	210				2.8
	040MZ223	170				2.3
	040MZ224	130				1.7
	040MZ244	210				2.8
Benzo(a)pyrene	040MZ206	140	330	88.8	763	1.6
	040MZ219	220				2.5
	040MZ222	160				1.8
	040MZ223	180				2.0
	040MZ224	150				1.7
	040MZ226	99				1.1
	040MZ244	260				2.9

Table 10-6
AZ-2 Phase IIA SVOC Concentrations Exceeding Sediment Screening Criteria*

Contaminant	Sample ID	Concentration (ppb)	EPA Sediment Screening Value	SQAG TEL	SQAG PEL	HQ
Chrysene	040MZ206	120	330	108	846	1.1
	040MZ219	290				2.7
	040MZ222	180				1.7
	040MZ223	170				1.6
	040MZ224	140				1.3
	040MZ244	180				1.7
Dibenz(a,h)anthracene	040MZ222	42	330	6.22	135	6.8
Fluoranthene	040MZ206	180	330	113	1494	1.6
	040MZ214	150				1.3
	040MZ219	490				4.3
	040MZ222	410				3.6
	040MZ223	290				2.6
	040MZ224	240				2.1
	040MZ226	130				1.2
	040MZ228	130				1.2
	040MZ244	300				2.7
Fluorene	040MZ222	34	330	21.2	144	1.6
2-Methylnaphthalene	040MZ232	160	330	20.2	201	7.9
Naphthalene	040MZ232	130	330	34.6	391	3.8
Phenanthrene	040MZ219	150	330	86.7	544	1.7
	040MZ222	260				3.0
	040MZ223	110				1.3
	040MZ224	130				1.5
Pyrene	040MZ206	190	330	153	1398	1.2
	040MZ219	480				3.1
	040MZ222	300				2.0
	040MZ223	330				2.2
	040MZ224	270				1.8
	040MZ244	290				1.9
BEHP	040MZ201	510	182	182	2647	2.8
	040MZ242	1500				8.2

Notes:
Sediment screening values are from USEPA 1995.
SQAG = Florida Department of Environmental Protection — Sediment Quality Assessment Guideline (MacDonald 1994)
TEL = Threshold Effects Level
PEL = Probable Effects Level
HQ = Hazard Quotient; Concentration/Effects Level.*
* = Effects level is the lower value of the USEPA sediment screening value or SQAG TEL

Table 10-7
AZ-3 Phase IIA Inorganic Concentrations Exceeding Sediment Screening Criteria*

Contaminant	Sample ID	Concentration (ppm)	EPA Sediment Screening Value	SQAG TEL	SQAG PEL	HQ
Arsenic	040MZ302	10.5	7.24	7.24	41.6	1.5
	040MZ319	17.5				2.41
	040MZ323	11.3				1.6
Cadmium	040MZ302	2.5	1.0	0.676	4.21	3.7
	040MZ307	1.5				2.2
	040MZ319	7.1				10.5
	040MZ323	3.6				5.3
Chromium	040MZ302	137.0	52.3	52.3	160	2.6
	040MZ307	73.1				1.4
	040MZ319	238.0				4.6
	040MZ323	130.0				2.5
Copper	040MZ302	27.5	18.7	18.7	108	1.5
	040MZ319	52.2				2.8
	040MZ323	30.3				1.6
	040MZ401	46.9				2.5
	040MZ404	27.1				1.4
Lead	040MZ302	113.0	30.2	30.2	112	3.7
	040MZ304	36.5				1.2
	040MZ307	104.0				3.4
	040MZ319	134.0				4.4
	040MZ323	82.1				2.7
Mercury	040MZ316	0.14	0.13	0.13	0.696	1.1
	040MZ319	0.35				2.7
Nickel	040MZ319	16.6	15.9	15.9	42.8	1.0
Zinc	040MZ319	224	124	124	271	1.8
	040MZ323	128				1.0

Notes:
Sediment screening values are from USEPA 1995.
SQAG = Florida Department of Environmental Protection — Sediment Quality Assessment Guideline (MacDonald 1994)
TEL = Threshold Effects Level
PEL = Probable Effects Level
HQ = Hazard Quotient; Concentration/Effects Level.*
* = Effects level is the lower value of the USEPA sediment screening value or SQAG TEL

Table 10-8
AZ-3 Phase IIA Pesticide/PCB Concentrations Exceeding Sediment Screening Criteria*

Contaminant	Sample ID	Concentration (ppb)	EPA Sediment Screening Value	SQAG TEL	SQAG PEL	HQ
4,4'-DDE	040MZ304 040MZ319	3.8 4.4	3.3	2.07	374	1.8 2.1
4,4'-DDT	040MZ301 040MZ317	1.9 1.6	3.3	1.19	4.77	1.6 1.3
Dieldrin	040MZ304 040MZ322	7 99	3.3	0.715	4.3	9.8 138.5
gamma-BHC (Lindane)	040MZ302	0.64	3.3	0.32	0.99	2.0
Total PCBs	040MZ319 040MZ323 040MZ324	84 26 24	33	21.6	189	3.9 1.2 1.1

Notes:
Sediment screening values are from USEPA 1995.
SQAG = Florida Department of Environmental Protection — Sediment Quality Assessment Guideline (MacDonald 1994)
TEL = Threshold Effects Level
PEL = Probable Effects Level
HQ = Hazard Quotient; Concentration/Effects Level.*
* = Effects level is the lower value of the USEPA sediment screening value or SQAG TEL

Table 10-9
AZ-3 Phase IIA SVOC Concentrations Exceeding Sediment Screening Criteria*

Contaminant	Sample ID	Concentration (ppb)	EPA Sediment Screening Value	SQAG TEL	SQAG PEL	HQ
Acenaphthene	040MZ308	32	330	6.71	88.9	4.8
	040MZ324	10000				1490.0
Anthracene	040MZ308	100	330	46.9	245	2.1
	040MZ323	120				2.6
	040MZ324	5500				117.3
Benzo(a)anthracene	040MZ301	77	330	74.8	693	1.0
	040MZ302	140				1.9
	040MZ304	3200				42.8
	040MZ305	320				4.3
	040MZ306	190				2.5
	040MZ307	210				2.8
	040MZ308	860				11.5
	040MZ310	110				1.5
	040MZ319	260				3.5
	040MZ323	780				10.4
	040MZ324	44000				588.2
Benzo(a)pyrene	040MZ301	91	330	88.8	763	1.0
	040MZ302	150				1.7
	040MZ304	3500				39.4
	040MZ305	380				4.3
	040MZ306	210				2.4
	040MZ307	250				2.8
	040MZ308	1100				12.4
	040MZ310	140				1.6
	040MZ319	400				4.5
	040MZ323	860				9.7
	040MZ324	21000				236.5
Chrysene	040MZ301	110	330	108	846	1.0
	040MZ302	160				1.5
	040MZ304	3500				32.4
	040MZ305	390				3.6
	040MZ306	210				1.9
	040MZ307	250				2.3
	040MZ308	1000				9.3
	040MZ310	140				1.3
	040MZ319	480				4.4
	040MZ323	750				6.9
	040MZ324	44000				407.0
Dibenz(a,h)anthracene	040MZ306	25	330	6.2	135	4.0
	040MZ307	77				12.4
	040MZ323	72				11.6

Table 10-9
AZ-3 Phase IIA SVOC Concentrations Exceeding Sediment Screening Criteria*

Contaminant	Sample ID	Concentration (ppb)	EPA Sediment Screening Value	SQAG TEL	SQAG PEL	HQ
Fluoranthene	040MZ301	130	330	113	1494	1.2
	040MZ302	200				1.8
	040MZ304	4000				35.4
	040MZ305	490				4.3
	040MZ306	210				1.9
	040MZ307	350				3.1
	040MZ308	1200				10.6
	040MZ310	160				1.4
	040MZ319	670				5.9
	040MZ323	430				3.8
	040MZ324	52000				460.0
Fluorene	040MZ324	7900	330	21.2	144	372.6
Naphthalene	040MZ308	35	330	34.6	391	1.0
Phenanthrene	040MZ304	1400	330	86.7	544	16.1
	040MZ305	180				2.1
	040MZ307	110				1.3
	040MZ308	590				6.8
	040MZ319	190				2.2
	040MZ323	160				1.8
	040MZ324	25000				288.4
Pyrene	040MZ302	180	330	153	1398	1.2
	040MZ304	4200				27.5
	040MZ305	460				3.0
	040MZ306	190				1.2
	040MZ307	470				3.1
	040MZ308	840				5.5
	040MZ319	520				3.4
	040MZ323	750				4.9
	040MZ324	89000				581.7
total PAHs	040MZ304	19800	1,684	1,684	16,770	11.8
	040MZ308	5757				3.4
	040MZ324	275900				163.8
BEHP	040MZ319	280	182	182	2647	1.5

Notes:
Sediment screening values are from USEPA 1995.
SQAG = Florida Department of Environmental Protection — Sediment Quality Assessment Guideline (MacDonald 1994)
TEL = Threshold Effects Level
PEL = Probable Effects Level
HQ = Hazard Quotient; Concentration/Effects Level.*
* = Effects level is the lower value of the USEPA sediment screening value or SQAG TEL

Table 10-10
AZ-4 Phase IIA Inorganic Concentrations Exceeding Sediment Screening Criteria*

Contaminant	Sample ID	Concentration (ppm)	EPA Sediment Screening Value	SQAG TEL	SQAG PEL	HQ
Arsenic	040MZ401	15.3	7.24	7.24	41.6	2.1
	040MZ404	9.7				1.3
Cadmium	040MZ401	5.1	1.0	0.676	4.21	7.5
	040MZ404	3.3				4.9
	040MZ405	2.0				3.0
	040MZ408	1.8				2.7
Chromium	040MZ401	177.0	52.3	52.3	160	3.4
	040MZ404	120.0				2.3
	040MZ405	72.8				1.4
Copper	040MZ401	46.9	18.7	18.7	108	2.5
	040MZ404	27.1				1.4
Lead	040MZ401	107.0	30.2	30.2	112	3.5
	040MZ404	65.5				2.2
	040MZ405	34.7				1.1
	040MZ408	37.3				1.2
Mercury	040MZ419	0.24	0.13	0.13	0.696	1.8
	040MZ420	0.14				1.1
Zinc	040MZ401	187	124	124	271	1.5

Notes:
Sediment screening values are from USEPA 1995.
SQAG = Florida Department of Environmental Protection — Sediment Quality Assessment Guideline (MacDonald 1994)
TEL = Threshold Effects Level
PEL = Probable Effects Level
HQ = Hazard Quotient; Concentration/Effects Level*
* = Effects level is the lower value of the USEPA sediment screening value or SQAG TEL

Table 10-11
AZ-4 Phase IIA Pesticide/PCB Concentrations Exceeding Sediment Screening Criteria*

Contaminant	Sample ID	Concentration (ppb)	EPA Sediment Screening Value	SQAG TEL	SQAG PEL	HQ
4,4'-DDD	040MZ401	1.3	3.3	1.22	7.81	1.1
4,4'-DDT	040MZ401	1.3	3.3	1.19	4.77	1.1
Dieldrin	040MZ401	1.2	3.3	0.715	4.3	1.7
	040MZ405	2.2				3.1
Endrin	040MZ409	3.9	3.3	NL	NL	1.2
gamma-BHC (Lindane)	040MZ401	1.5	3.3	0.32	0.99	4.7
	040MZ404	0.55				1.7
	040MZ409	9.2				28.8
Total PCBs	040MZ405	120	33	21.6	189	5.6

Notes:
Sediment screening values are from USEPA 1995.
SQAG = Florida Department of Environmental Protection — Sediment Quality Assessment Guideline (MacDonald 1994)
TEL = Threshold Effects Level
PEL = Probable Effects Level
HQ = Hazard Quotient; Concentration/Effects Level*
* = Effects level is the lower value of the USEPA sediment screening value or SQAG TEL

Table 10-12
AZ-4 Phase IIA SVOC Concentrations Exceeding Sediment Screening Criteria*

Contaminant	Sample ID	Concentration (ppb)	EPA Sediment Screening Value	SQAG TEL	SQAG PEL	HQ
Acenaphthene	040MZ408	35	330	6.71	88.9	5.2
Acenaphthylene	040MZ408	100	330	5.87	128	17.0
Anthracene	040MZ408	120	330	46.9	245	2.6
Benzo(a)anthracene	040MZ401	160	330	74.8	693	2.1
	040MZ404	270				3.6
	040MZ405	110				1.5
	040MZ407	91				1.2
	040MZ408	530				7.1
Benzo(a)pyrene	040MZ401	190	330	88.8	763	2.1
	040MZ404	240				2.7
	040MZ405	130				1.5
	040MZ408	470				5.3

Table 10-12
AZ-4 Phase IIA SVOC Concentrations Exceeding Sediment Screening Criteria*

Contaminant	Sample ID	Concentration (ppb)	EPA Sediment Screening Value	SQAG TEL	SQAG PEL	HQ
Chrysene	040MZ401	170	330	108	846	1.6
	040MZ404	280				2.6
	040MZ405	150				1.4
	040MZ407	110				1.0
	040MZ408	630				5.8
Fluoranthene	040MZ401	300	330	113	1494	2.7
	040MZ404	390				3.5
	040MZ405	260				2.3
	040MZ407	200				1.8
	040MZ408	1100				9.7
Fluorene	040MZ408	55	330	21.2	144	2.6
2-Methylnaphthalene	040MZ405	59	330	20.2	201	2.9
	040MZ415	25				1.2
Naphthalene	040MZ405	80	330	34.6	391	2.3
	040MZ415	35				1.0
Phenanthrene	040MZ401	120	330	86.7	544	1.4
	040MZ404	140				1.6
	040MZ405	110				1.3
	040MZ408	460				5.3
Pyrene	040MZ401	280	330	153	1398	1.8
	040MZ404	420				2.7
	040MZ405	220				1.4
	040MZ407	190				1.2
	040MZ408	1100				7.2
total PAHs	040MZ408	4600	1,684	1,684	16,770	2.7

Notes:
Sediment screening values are from USEPA 1995.
SQAG = Florida Department of Environmental Protection — Sediment Quality Assessment Guideline (MacDonald 1994)
TEL = Threshold Effects Level
PEL = Probable Effects Level
HQ = Hazard Quotient; Concentration/Effects Level*
* = Effects level is the lower value of the USEPA sediment screening value or SQAG TEL

AZ-2

AZ-2 receives drainage from Site 1 and other sites within its watershed (Figure 4-1). AZ-2 also receives drainage from Wetland W2, also known as the southeast drainage ditch. Wetland W2 conveys storm water from the eastern end of Forrest Sherman Field to the southern end of Redoubt Bayou. This wetland also receives surface water from an intersecting ditch which conveys water from the Barrancas Cemetery area and storm water from the NAS Public Works Center (an area which includes IRP Sites 8, 17, and 24 and petroleum site UST 26). Contaminants, primarily DDT and PCBs, were elevated in the southern portion of AZ-2, which is within Redoubt Bayou. HQs for metals in sediment exceeded one for arsenic, cadmium, chromium, copper, lead, mercury and zinc (Table 10-4). HQs for pesticides and PCBs exceeded one for DDD, DDE, DDT, dieldrin, gamma-BHC, and PCBs (Table 10-5). The maximum HQ value (18.5) calculated for pesticides/PCBs was for DDT at sample location 040MZ224. SVOCs exceeded SSVs for 13 individual constituents (Table 10-6). All of the HQ values were below 10. Contaminants exceeding SSVs in AZ-2 are summarized in Tables 10-4 through 10-6.

AZ-3

AZ-3, which receives drainage from Site 1 and the golf course (through wetlands 3 and 4) as well as other sites within its watershed (Figure 4-1) had the highest SVOC concentrations. Metals in sediment exceeded SSVs for arsenic, cadmium, chromium, copper, lead, mercury, nickel, and zinc (Table 10-7). Only one HQ exceeded 10 (cadmium at location 040MZ319); most other metals HQs were below 4. Pesticides and PCBs exceeded SSVs for DDE, DDT, dieldrin, gamma-BHC, and PCBs (Table 10-8), and only one exceeded 10 (dieldrin at location 040MZ322 which had an HQ of 138.5). SVOCs exceeded SSVs for 12 individual constituents (Table 10-9). Sample location 040MZ324 showed particularly elevated HQ values relative to the other sample locations for SVOCs. The sample was collected near a storm water scupper of the Navy Boulevard Bridge. Vehicle traffic and storm water runoff from the bridge would account for the SVOC detections. Contaminants exceeding SSVs are summarized in Tables10-8 through 10-10.

Wetland 4D was suspected of impacting the bayou where it drains from the south (Figure 4-1). Data from the Site 41 RI indicates that the contaminant levels were higher in the southern portion of Wetland 4D, on the opposite side from where it drains into the bayou. Site 41 sediment sample D-3, collected near the Wetland 4D drainage point into Site 40, showed relatively low levels of contamination compared with the other sediment samples. SSVs in sample D-3 were exceeded for three SVOCs, one pesticide, and no metals. None of the HQ values exceeded two. Therefore, impact to Bayou Grande from Wetland 4D into Bayou Grande is not considered significant.

AZ-4

AZ-4 receives drainage from the Yacht Basin, which in turn receives drainage from many of the former industrial areas of NAS Pensacola (Figure 4-1). However, HQ values were relatively low, with only two constituents exceeding 10. Within the sediment, metals exceeded SSVs for arsenic, cadmium, chromium, copper, lead, mercury, and zinc (Table 10-10). Most other metals HQs were below 3, and none exceeded 10. Pesticides and PCBs exceeded SSVs for DDD, DDT, dieldrin, endrin, gamma-BHC, and PCBs (Table 10-11). Only one HQ exceeded 10 (gamma-BHC at location 040MZ409). SVOCs exceeded SSVs for 12 individual constituents (Table 10-12), and only one HQ exceeded 10 (acenapthylene at location 040MZ408). Contaminants exceeding HQ values are summarized in Tables 10-10 through 10-12.

10.2.4 Uncertainties

Uncertainty factors related to field conditions, laboratory procedures, or other circumstances are inherent in field sampling. However, every effort was made through the phased approach to reduce uncertainty. Factors that may have resulted in over or underestimation of risks are listed below.

- Analytical matrix interferences due to excess organic material in sediment may have altered the sample results. Sampling in portions of the bayou required sampling large organic deposits with the sediment sample. (+)

- The lack of criteria or screening values for some chemicals increases the uncertainty for screening level assessments. (-)

- The HQ approach does not consider natural metal concentrations, synergistic effects, sediment grain size, or sediment TOC effects as they relate to bioavailability. (-)

- The dynamic nature of a marine ecosystem provides natural variability that is not considered in receptor exposure scenarios. (+ or -)

10.2.5 Phase IIA Contaminant Results and Effect Characteristics

After the contaminants of greatest concern were identified based on SSV exceedances in Phase IIA, sections of the bayou requiring more detailed study were identified along with the parameters of concern. The basis of this additional study was determined in part by the toxicity and interactions of the particular contaminants detected at Site 40. The following paragraphs discuss ecological effects from members of the three major contaminant types at Site 40: metals, pesticides/PCBs, and SVOCs. This information was used to develop the conceptual models and determine the most appropriate toxicity tests and bioaccumulation studies for subsequent phases.

Metals

Arsenic

According to Braman and Foreback (1973), the common forms of arsenic are arsenite, arsenate, methylarsonic acid (MAA), and dimethyl arsonic acid (DMAA). These forms can be coprecipitated with hydrated iron and aluminum oxides, or adsorbed/chelated by suspended organic matter in surface water. Arsenic in seawater is commonly detected at 2,000 mg/kg.

Arsenic bioaccumulates in numerous aquatic biota, but it has not been observed to biomagnify through other organisms (Jaagumagi, 1990). Arsenic is known for a variety of sublethal characteristics including effects on growth, reproduction, locomotion, behavior, and respiration (Eisler, 1988a).

Arsenic was frequently detected across Site 40 (106/143 samples), with samples from 34 locations exceeding the SSV of 7.24 mg/kg. The highest HQ of 3.0 was found at location AZ-2-44. According to Leatherland and Burton (1974), arsenic in coastal areas ranges from 3 mg/kg to 15 mg/kg depending on the parent rock. The detected range for arsenic at Site 40 was 0.14 mg/kg to 21.8 mg/kg.

Cadmium

Cadmium has been used in a wide variety of industrial applications, including electroplating, batteries, telephone wires, and stabilizers in plastics (MacDonald, 1994). Cadmium generally occurs in the Cd(II) form in surface waters, as a constituent of inorganic and organic compounds. Cadmium transport to sediment mainly occurs via sorption to organic matter, and through coprecipitation of iron, aluminum, and manganese oxides (Jaagumagi, 1990).

Cadmium, a relatively rare heavy metal, is a known teratogen and carcinogen, probably a mutagen, and has been implicated in severe deleterious effects on fish and wildlife (Eisler, 1985). Birds and mammals are comparatively resistant to the biocidal properties of cadmium. Freshwater organisms appear to be the most susceptible group to cadmium toxicity, which can be significantly altered by water hardness. Adsorption and desorption processes are likely to be major factors in controlling cadmium concentrations in natural waters. Cadmium adsorbs and desorbs rapidly on mud solids and particles of clay, silica, humic material, and other naturally occurring solids.

Cadmium exposure can have adverse effects on aquatic organisms. Toxicological data indicate that elevated cadmium concentrations are associated with high mortality, reduced growth, inhibited reproduction, and other adverse effects (Eisler, 1985). Sublethal effects studies have shown decreased growth, respiratory disruption, molt inhibition, and shortened life span in crustaceans. Effects in freshwater occurred at lower concentrations than those in saline environments.

Biotransfer in aquatic systems may occur, but the evidence for cadmium transfer through various trophic levels suggests that only the lower trophic levels exhibit bioaccumulation (Eisler, 1985).

Cadmium was detected at approximately 30% of the locations across Site 40 (56/143 samples), and the majority of the detections (38 locations) were above the SSV of 0.676 mg/kg. The highest HQ value was 10.5 at location AZ-3-19 in AZ-3.

Chromium

Chromium is a trace metal that has been widely used in industrial processes (MacDonald, 1994). Hexavalent chromium compounds are used by the chemical industry in the production of paints, dyes, explosives, and chrome plating. Worldwide concentrations in freshwater sediments range from less than 100 mg/kg to several thousand mg/kg. Distance from a source appears to be the significant factor in sediment concentrations.

Hexavalent chromium (Cr VI) produces more adverse effects on biota than does the trivalent phase (Cr III). In clayey sediments, trivalent chromium dominates and benthic invertebrate bioaccumulation is limited (Neff et al., 1978).

Adverse effects associated with chromium exposure include mortality and decreased growth, with plants being more sensitive than fish (CCREM, 1987). Although chromium does not appear to be significantly accumulated in fish (bioconcentration factor [BCF] < 3), this substance has been found at high concentrations in algal communities (BCF = 8500; CCREM, 1987).

Chromium was also frequently detected across Site 40 (136/143 samples), with samples from 35 locations exceeding the SSV of 52.3 mg/kg. The highest concentration, 238 mg/kg at location AZ-3-19, resulted in an HQ of 4.5 in AZ-3.

Copper

Anthropogenic copper sources include copper and brass pipe corroded by acidic waters and the use of copper compounds in algicides, sewage plant effluents, fungicides, and pesticides (MacDonald, 1994). Industrial sources of copper include iron and steel-producing industries, and mining, smelting, and refining industries (CCREM, 1987).

Under normal pH and redox conditions, copper tends to be present in sediments in the form of organic complexes and cupric carbonate complexes; it coprecipitates with iron and manganese oxides (Jaagumagi, 1990). Copper is an essential micronutrient, and can therefore be accumulated by aquatic organisms. This broad-spectrum biocide may be associated with both acute and chronic toxicity. Little difference has been observed in the sensitivity of aquatic organisms across taxonomic groups (CCREM, 1987).

Copper was frequently detected across Site 40 (129/143 samples), with samples from 32 locations exceeding the SSV of 18.7 mg/kg. The highest HQ value was 2.8 at location AZ-3-19 in AZ-3.

Lead

The ecological and toxicological aspects of lead and its compounds have been extensively reviewed (Eisler, 1988b). Widespread lead broadcasting through anthropogenic activities has increased lead residues throughout the environment. Lead is toxic to all phyla of aquatic biota, though effects are modified significantly by various biological and abiotic variables (Wong et al., 1978).

Lead, which has not been shown to biomagnify in food chains, reaches the aquatic environment through industrial and municipal discharges and highway runoff (USEPA, 1980a). Primary aquatic lead contamination sources are mining and metal finishing.

Lead adversely affects survival, growth, reproduction, development, and metabolism of most species under controlled conditions, but its effects are significantly modified by physical, chemical, and biological variables. In aquatic environments, dissolved waterborne lead is the most toxic form.

Lead was frequently detected across Site 40 (135/143 samples), with samples from 40 locations exceeding the SSV of 21.0 mg/kg. The highest HQ value was 4.4, also at location AZ-3-19 in AZ-3.

Mercury

Mercury is generally sorbed to particulate matter in aquatic systems. In natural systems, mercury can be present in three oxidation states: elemental Hg, Hg(I), and Hg(II). Both Hg(I) and Hg(II) can be methylated by microorganisms under anaerobic and aerobic conditions. Mercury tends to associate with organic matter in sediments. Under low dissolved oxygen conditions, mercury may combine with sulphur to form insoluble sulfides (Jaagumagi, 1990). Mercury is highly toxic to aquatic biota, with methylmercury being its most toxic form. Aquatic plants, invertebrates, and fish exhibit similar sensitivities to mercury, although a great deal of variability exists within each of these groups. Mercury can accumulate to high concentrations in aquatic organisms, with bioconcentration factors as high as 85,000 observed in some fish species (CCREM, 1987).

Mercury reacts with selenium which has been shown to protect against adverse or lethal effects induced by inorganic and organic mercury salts in algae, aquatic invertebrates, fish, and mammals. Selenite salts are known to release methylmercury from its linkage to proteins, which is evidence of antagonism between selenium and mercury. The precise mechanism for this antagonism has not been fully established (Eisler, 1987).

Mercury is known to be persistent and widespread in aquatic environments. The ultimate source of mercury in most aquatic systems is deposition from the atmosphere, primarily during rainfall events. Primary human-generated sources include coal combustion, chlorine alkali processing, waste incineration, and metal processing. Estimates today suggest that atmospheric mercury from human activities have double or tripled the amount of mercury in the atmosphere (Krabbenhoft and Ricket, 1995).

Mercury was detected infrequently across Site 40 (20/143 samples), but 19 of the 20 detections exceeded the SSV of 0.10 mg/kg. One concentration exceeded the SQAG-PEL of 0.696 mg/kg. Detections ranged from 0.08 mg/kg to 2.2 mg/kg. The maximum concentration, at location AZ-1-30, produced an HQ of 16.9. Data from 40 random sediment samples collected in the Pensacola Bay system as part of the National Status and Trends Program show that mercury was detected above its SSV in 32 of 40 samples, or 80% (Long et al., 1997). Considering that mercury exceeded its SSV in 19 of the 143 sediment samples, or 13%, it is possible that mercury concentrations in the bayou are a result of atmospheric deposition.

Nickel

Nickel ranks as the 23rd element in order of abundance in the earth's crust; it occurs naturally, mainly combined with sulphur, arsenic, and antimony. Nickel is primarily used to manufacture stainless steel, nickel plating, and other nickel alloys (MacDonald, 1994), and is also used as a catalyst in oil refining and industrial processes. Recently, it has been used in nuclear power generating plants, gas turbine engines, and pollution abatement equipment. The most important anthropogenic sources for nickel are fossil fuel combustion, mining, refining, and electroplating (CCREM, 1987).

In aquatic systems, nickel occurs primarily in the Ni(II) form (MacDonald, 1994). It is deposited in sediments by coprecipitation with iron and manganese oxides and sorption to organic matter. In sediments, nickel tends to form complexes with iron and manganese oxides, although it can form insoluble complexes with sulfides under low oxygen conditions (Jaagumagi, 1990).

Exposing aquatic organisms to nickel-contaminated sediments may result in adverse effects such as mortality, reduction in growth, and avoidance. Because nickel toxicity increases copper's presence, synergism may modify nickel's toxicity. While nickel bioconcentration has been observed in various organisms, particularly annelids, biomagnification is not a significant concern in aquatic systems (CCREM, 1987).

Nickel was detected across Site 40 (60/143 samples), with two concentrations exceeding the SSV of 15.9 mg/kg at sample location 040MZ136 in AZ-1 and 040MZ319 in AZ-3. The concentrations for both samples were below 17 mg/kg, and thus both HQs were less than 2.

Zinc

Zinc is a common crustal element which typically occurs as a sulfide, carbonate, or silicate ore (MacDonald, 1994). Principal sources in aquatic systems are municipal wastewater effluents, zinc mining, smelting, wood combustion, and iron and steel production (CCREM, 1987). Total zinc concentrations in soil and sediment seldom exceed 200 mg/kg (Eisler, 1993).

As an essential micronutrient, zinc uptake in most aquatic organisms appears to be independent of environmental concentrations (MacDonald, 1994). Although it has been found to bioaccumulate in some organisms, there is no evidence of biomagnification (Jaagumagi, 1990). In natural waters zinc speciates into the toxic aquo ion, other dissolved chemical species, and various inorganic and organic complexes, and is readily transported. Most zinc introduced into aquatic environments is eventually partitioned into sediments. Zinc bioavailability from sediments is enhanced under high dissolved oxygen, low salinity, low pH, and high inorganic oxide and humic substance conditions (Eisler, 1993).

Zinc adversely affects growth, survival, and reproduction in sensitive aquatic organisms. In freshwater fish, BCF values were between 51 and 500 times for whole individuals (USEPA, 1987), but duration of exposure and extrinsic factors such as water chemistry are important variables in uptake potential.

Zinc was frequently detected across Site 40 (107/143 samples), with samples from 19 locations exceeding the SSV of 68 mg/kg. No concentrations exceeded the SQAG-PEL of 300 mg/kg. The maximum concentration, 224 mg/kg at location AZ-3-19, produced an HQ of 1.8 in AZ-3.

Pesticides/PCBs

Organochlorine Pesticides (DDT and metabolites)

Organochlorine pesticides have been used extensively in the United States since the 1940s. They appear to be ubiquitous in the environment, i.e., in surface water, sediment, and biological tissues. They are readily absorbed by warm-blooded species and degradation products are frequently more toxic than the parent form. Food-chain biomagnification is usually low except in some marine mammals. The aquatic system is dynamic in that there is continuous interchange of pesticides between land, sediment, sediment-water interface, interstitial waters, aquatic organisms, and air-water interface (Cooper, 1991). Pesticides with a high potential to bioconcentrate in aquatic ecosystems are generally highly lipophilic and resistant to biodegradation, such as DDT and its metabolites. DDT is highly toxic and persistent in the environment and has been detected in Florida coastal sediments (Delfino et al., 1991). DDT adsorbs to sediments and biotransfers to upper level vertebrate species through the food web. In vertebrate species, DDT exposure can result in reproductive impairment. For Site 40, samples from 26 locations had DDT, or metabolite, concentrations exceeding referenced SSVs. The highest HQ produced was 18.5 at location AZ-2-24.

Dieldrin

Dieldrin, an organochlorine pesticide, was one of the most widely used domestic pesticides in the United States (CCREM, 1987) for control of soil, fruit, and vegetable pests. It appears to adsorb strongly to sediments, bioconcentrate in fish, and degrade slowly in the presence of sunlight. Dieldrin can bioconcentrate from 100 to 10,000 times in aquatic species. Although dieldrin was detected at 32/143 locations across Site 40, concentrations exceeded the SSV of 0.715 μg/kg at only 18 locations. The highest HQ, 138, was at location AZ-3-22 in AZ-3. The dieldrin concentration at this location (99 μg/kg) was much higher than detections at other locations. Because no other pesticide exceedances were noted at this same location, this concentration may be an anomaly. The second highest HQ produced was 9.7.

Endrin

Although endrin was detected at 17 locations, only one concentration — 3.9 μg/kg at 040MZ409 in AZ-4 — exceeded the SSV of 3.3 μg/kg, producing an HQ of less than 2.

Gamma-BHC (Lindane)

Lindane, one of the 45 components of technical grade chlordane, has an affinity for organic sediments and bioaccumulates in aquatic species. Toxicological effects can include reduced survival, immobilization, impaired reproduction, and histopathology. Lindane was detected at 26/143 locations across Site 40. Twenty detections exceeded the SSV of 0.32 μg/kg. The maximum concentration detected, 9.2 μg/kg at location AZ-4-09 in AZ-4, produced an HQ value of 28.

Polychlorinated biphenyls

PCB is the generic term for a group of 209 congeners with a varying number of substituted chlorine atoms in a biphenyl ring. Mixtures containing 21% to 54% chlorine by weight were used extensively in closed electric systems as dielectric fluids (MacDonald, 1994). PCBs tend to be associated with fine-grained particles and organic matter in sediments. Trace concentrations of the more persistent, more highly chlorinated PCBs have been detected in fish from almost every major river in the United States (Schmitt et al., 1983, and 1985). Maximum concentrations in whole fish have not changed much in recent years; concentrations near 100 mg/kg (fresh wet) were measured in 1978 by (Schmitt et al., 1983).

PCB exposure can affect aquatic organisms in a variety of ways, including acute and chronic lethality, developmental abnormalities, growth retardation, and reproductive toxicity (Moore and Walker, 1991). Aquatic species such as fish may exhibit reproductive toxicity, especially when exposed to more highly chlorinated, more lipophilic congeners. Bioconcentration of Aroclor-1254 by aquatic organisms varied from 60 to 340,000 times the ambient concentration (Eisler, 1986).

In fish, biochemical perturbations such as induced hepatic mixed function oxidase systems can occur from PCB exposure. USEPA (1980b) has published maximum acceptable toxicant concentrations (MATC) values for Aroclor PCBs in water based on life cycle, partial life cycle, or early life stages. In avian species, PCBs can disrupt normal patterns of growth, reproduction, metabolism, and behavior. Diet appears to be an important route for PCB accumulation; the highest liver concentrations have been found in birds that feed on fish (NAS, 1979).

PCBs (total) were detected at 90/143 locations across the site. Of these, 21 exceeded the SSV of 33 μg/kg. The highest concentration, 120 μg/kg at location AZ-4-05, produced an HQ of 3.6. Two composite fish samples were collected at Site 40 and analyzed for pesticides/PCBs. The tissue concentrations were modeled to determine if there was a potential impact to the great blue heron. The results are discussed in Section 10.2.6.

SVOCs

Polycyclic Aromatic Hydrocarbons (PAHs)

PAHs is the general term applied to a group of several hundred organic substances with two or more benzene rings. Their occurrence in the environment is primarily a result of incomplete organic matter combustion (e.g., forest fires, internal combustion engines, wood stoves, coal, coke, etc.). PAHs are also major constituents of petroleum and its derivatives; oil spills and refinery effluents are major sources of aquatic PAH contamination (MacDonald et al., 1992). In addition, wastewater treatment plant effluents and runoff from urban areas, particularly roads, are known to contain significant quantities of PAHs.

PAHs in aquatic environments tend to associate with suspended and deposited particulate matter (Eisler, 1987). This sorption to sediments is strongly correlated with the sediment TOC content (Gillam, 1991). Substances detected most frequently in sediments are acenaphthylene, anthracene, benzo(a)anthracene, benzo(a)pyrene, chrysene, fluoranthene, phenanthrene, and pyrene (Delfino et al., 1991). In general, elevated levels of sediment-associated PAHs are found near urban areas.

PAH exposure can result in a wide range of effects on biological organisms. Although some PAHs are known to be carcinogenic, others produce little or no carcinogenic, mutagenic, or teratogenic effects (Neff, 1979; USEPA, 1980c; NRCC, 1983). Sediment-associated PAH compounds can, in some cases, contribute a large percentage of the steady-state body burden in freshwater amphipods (Landrum and Scavia, 1983). When PAH concentrations are elevated, benthos obtain most PAHs from elevated sediment concentrations through their ability to metabolize PAHs from the sediment/pore water matrix. Thus, benthic species may provide a significant source of PAHs to predator fishes (Eadie et al., 1983).

PAHs were detected at approximately half the locations sampled in Site 40, with the total PAH SSV of 1,684 μg/kg exceeded at four of these (AZ-3-04, AZ-3-08, AZ-3-24, and AZ-4-08). Sample AZ-3-24, which had the most significant total PAH contamination, was collected directly under a storm water discharge point off the Navy Boulevard Bridge. HQs for individual compounds at this site ranged from 236 for benzo(a)pyrene to 1,490 for acenaphthene. HQs at all other locations were significantly lower. However, these impacts are not associated with an IRP site, but are instead suspected to be due to impacts from the Navy Boulevard Bridge.

Phthalate Esters

Phthalate esters represent a large group of chemicals known as plasticizers which give plastics their resiliency. They are also common in cosmetics, rubbing alcohol, insect repellants, insecticides, and solid rocket propellants (CCREM, 1987).

BEHP exceeded the SSV of 182 μg/kg at five locations. HQs ranged from less than 2 to 13. No obvious source for this organic constituent was identified. Because of its frequent use in vacuum pumps and plastics in the laboratory, BEHP is a common laboratory contaminant, although exceedances at these locations were not rejected during data validation.

Volatile Organic Compounds

VOCs have no sediment screening values. Detected concentrations are presented in Section 7. The limited distribution and low values detected suggest a limited risk to ecological receptors. VOCs are extremely mobile and at the concentrations observed, the VOCs would be solutes in seawater or the sediment interstitial fluids.

10.2.6 Phase IIA Conclusions

AZ-1

Certain concentrations of metals, pesticides/PCBs, and SVOCs in sediment exceeded SSVs. No IRP sites associated with this AZ.

AZ-2

AZ-2 had relatively higher HQ values for pesticides and PCBs compared with the other AZs. These areas were concentrated towards the southern end of the AZ in Redoubt Bayou. SVOCs also appeared more prevalent in AZ-2 than AZ-1. Portions of AZ-2 present a potential risk from contaminant bioaccumulation in the food chain as well as from direct toxic impacts from SVOCs.

AZ-3

AZ-3 showed fewer SSV exceedances for metals and pesticides/PCBs than from AZ-1. SVOCs, however were much more widely distributed with higher HQ values, particularly in location 040MZ324, which was collected near a storm water scupper of the Navy Boulevard Bridge. Vehicle traffic and storm water runoff from the bridge would account for the SVOC detections. These high HQs indicate a potential risk to receptor organisms.

AZ-4

Except for SVOCs, AZ-4 showed fewer SSV exceedances for all contaminant classes than did AZ 1. Elevated SVOC concentrations indicate a potential risk to receptor organisms. As previously stated, these impacts are not associated with an IRP site, but are instead suspected to be due to impacts from the Navy Boulevard Bridge.

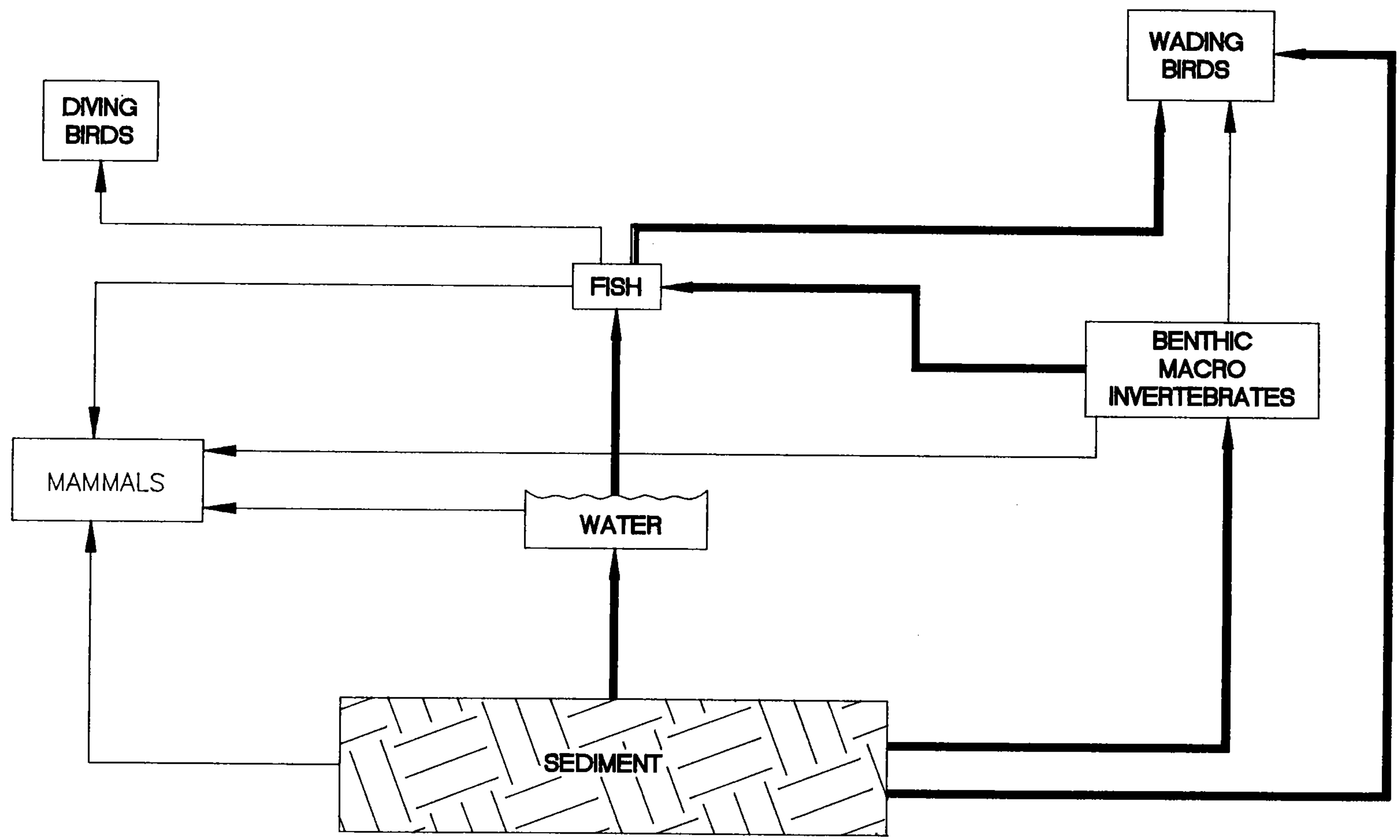
Sample Locations Chosen for Study in Phase IIB/III

The Phase IIA sediment data were evaluated to select areas of relative high, medium and low contaminant concentrations. Comparison of effects and impacts with the contaminant gradient yields a better perspective of risk posed throughout the bayou. The Phase IIA sample locations selected for further study and relative overall contaminant levels are presented in Table 10-13. The primary and secondary contaminants for each of the Phase IIA sample locations are also presented as well as the subsequent Phase IIB/II sample identification.

10.2.7 Phases IIB and III Approach

The purpose of Phases IIB and III is to relate contaminant levels to specific toxicological or bioaccumulative effects. This section describes why particular Phase IIB/III analyses are considered important in characterizing risk.

Effects and impacts were linked by collecting Phase IIB/III samples from the same locations as the selected Phase IIA samples (Table 10-13). However, results from the Phase IIB/III chemical data differed from Phase IIA due to factors such as variability in sample placement and natural sediment migration which occurred between the sampling events. Toxicological and bioaccumulation data from Phase IIB/III were used to demonstrate or predict direct impacts to assessment endpoint species as well as effect to species at other levels of the food chain. Key assumptions and uses of the Phase IIB/III data are described in this section. Table 10-13 correlates the Phase IIB/III locations to the Phase IIA locations and the relative contaminant levels from the Phase IIA investigation. The 10 sample locations selected for Phase IIB/III are shown in Figure 10-1.



NOTE: BOLD LINES INDICATE COMPLETE PATHWAY

SITE 40
REMEDIAL INVESTIGATION
NAVAL AIR STATION
PENSACOLA
PENSACOLA, FLORIDA

FIGURE 10-1
RECEPTOR SPECIFIC
CONCEPTUAL MODEL

DWG DATE: 02/09/98 | DWG NAME: 0030M001

Table 10-13
Phase IIA Sampling Locations Requiring Further Sampling in Phase IIB/III

		Phase IIA Results				Phase IIB
Assessment Zone	Sample Identification	Relative Overall Contaminant Level	Metals	SVOCs	Pest/PCB	Sample Location Identification
1	Z1-29	High	Primary	Secondary		2B03
1	Z1-30	High	Primary			2B03
1	Z1-9	Medium	Primary		PCBs secondary	2B02
1	Z1-1, Z1-2, Z1-3	Low				2B01
2	Z218 - Z224	High	Primary	Secondary	PCBs secondary	2B06
2	Z2-5, Z2-6	Medium	Primary	Secondary	PCBs secondary	2B04
2	Z2-28	Medium				2B05
3	Z3-4 - Z3-8	High		Primary		2B07
4	Z4-19	High	Primary	Primary		2B09
4	Z4-8	Medium	Primary	Primary		2B08
4	Z4-13 and Z4-14	Low				2B10

The Site 40 SAP addendum (E/A&H, 1997) describes the technical basis for the following items, which must be addressed in the BRA, and are summarized in this section:

- Conceptual model
- Assessment endpoints
- Measurement endpoints
- Decision points
- Food chain models

Conceptual Model

The conceptual model developed for Site 40 (Figure 10-1) identified exposure pathways and assessment and measurement endpoints used to evaluate potential impacts through those pathways. This model considers the contaminants detected across Site 40, receptors within the estuarine system, and complete pathways expected for contaminant exposure. Exposure to benthic macroinvertebrate populations, fish, and piscivorous (fish-eating) birds was considered most critical. Assessment and measurement endpoints were chosen based on the conceptual model.

Assessment Endpoints

Assessment endpoints are the explicit expressions of an environmental value that is to be protected. For the Site 40 investigation, assessment endpoints were selected if (1) sediment contaminants may impact the overall benthic ecosystem and other lower food-chain organisms, or (2) primary consumers and organisms higher in the food chain, through direct contact or ingestion, could be exposed to elevated contaminant concentrations in sediment and lower trophic food sources.

Assessment endpoints specific to the bayou, representing different levels of the food chain, are:

- protection of the benthic macroinvertebrate community
- protection and reproductive viability of fish-eating birds
- protection of nursery habitat for aquatic resources
- protection of fish viability.

These assessment endpoints were chosen because they represent critical components of an estuarine ecosystem and may exhibit contamination effects. Assessment endpoints are further detailed in Table 10-14 and are described below.

Protection of the Benthic Macroinvertebrate Community: This assessment endpoint is easily measurable and may significantly affect higher trophic level organisms. Benthic macroinvertebrates are an important biomonitoring tool. They are relatively sessile, have long life cycles, and represent a range of ecological niches. In addition to showing acute and chronic toxic effects, benthic organisms also accumulate metals and other contaminants at several orders of magnitude above ambient concentrations in the sediment or surface water. Benthic macroinvertebrates are also very localized in their habitat, meaning that effects to benthic organisms can usually be directly related to contamination in that area. The ability to focus on effects in particular areas may help focus remedial decisions. Impacts to the survival reproduction, and growth of benthos will be measured through acute and chronic toxicity texts, population parameters, and tissue concentration studies.

Piscivorous Bird Health and Reproduction: The great blue heron is chosen for several factors relevant to assessing risk in Bayou Grande. The great blue heron is common throughout NAS Pensacola and data area readily available on its habitat use and feeling characteristics. The heron is considered an ideal assessment endpoint species for assessment of aquatic food chain contaminant transfer based on its diet, feeding characteristics, and limited home range. For example, the heron feeds on some of the measurement endpoint species chosen. Any impacts to these measurement endpoint species, either through toxicity or body burden effects, may help establish a correlation between effects to the measurement endpoint and effects in the heron. Specific factors may making the heron an attractive assessment endpoint species include:

Table 10-14
Assessment and Measurement Endpoints and Decision Points Selected for Site 40
Bayou Grande

Assessment Endpoint	Measurement Endpoint	Decision Point
1. Protection of benthic macroinvertebrate community*	1a. Survival, growth, fecundity using *Leptocherius plumulosus* 10-day solid-phase bioassay test	Statistically significant difference in mortality, growth, or fecundity compared with a laboratory control of similar grain size.
	1b. Survival, growth, and fecundity using a 20-day *Neanthes arenaceodentata* solid-phase sediment bioassay	Statistically significant difference in mortality, growth, or fecundity compared with a laboratory control of similar grain size.
	1c. Survival, growth and fecundity using a 7-day *Mysidopsis bahia* solid-phase sediment bioassay	Statistically significant difference in mortality, growth, or fecundity compared with a laboratory control of similar grain size.
	1d. Benthic community indices for qualitative assessment	Investigate potential impacts from physical/chemical variables and compare community indices between stations.
2. Protection of reproductive viability of fish-eating birds*	2. Food web model	Unacceptable whole-body tissue concentration which would produce reproductive impairment in assessment endpoint species.
3. Protection of nursery habitat for aquatic resources*	3a. Survival growth and fecundity using a 20-day *Neanthes arenaceodentata* solid-phase sediment bioassay	Statistically significant difference in mortality, growth, or fecundity compared with a laboratory control of similar grain size.
	3b. Acute toxicity using *Leptocheirus plumulosus* 10-day solid-phase bioassay test	Statistically significant difference in mortality, growth, or fecundity compared with a laboratory control of similar grain size.
	3c. Survival, growth and fecundity using a 7-day *Mysidopsis bahia* solid-phase sediment bioassay	Statistically significant difference in mortality, growth, or fecundity compared with a laboratory control with similar grain size.
4. Protection of fish viability*	4a. Surface water chemistry (TCL organics/TAL inorganics)	Significant exceedances of state/federal chronic water quality standards.
	4b. Food web model	Unacceptable whole-body tissue concentration which would produce reproductive impairment in assessment endpoint species.

Notes:
* = Except for Assessment Endpoint 2 (Protection of reproductive viability of fish-eating birds which used the great blue heron), the assessment endpoints do not have a species-specific representatives.
TCL = Target Compound List
TAL = Target Analyte List

- Diet — The great blue heron feeds primarily on fish, but it also eats amphibians, reptiles, and other organisms. Fish consumed by the heron area small (less than 20 centimeters) with small home ranges. The limited home range of the fish prey species simplifies the prediction of sediment impacts form these fish species. The limited migration increases the certainty in predicting impacts to species consuming fish in their diet from specific portions of the bayou. Food, body weight, and water ingestion rates for the heron are also readily available.

- Feeding Characteristics — Herons consume fish in shallow waters by slowing wading to catch their prey. This characteristic makes the shallow areas of Bayou Grande ideal for catching prey and thus an area of high exposure potential.

- Limited Home Range — The great blue heron is widely distributed in both saltwater and freshwater environments, making the bayou a suitable, attractive habitat. Herons have a limited home range and do not venture far from their nesting sites, thus it is assumed that they spend a significant amount of time in portions of the bayou where they have been observed. Also, herons do not appear to be sensitive to human presence, feeding in portions of the bayou near the more developed parts of the base.

- Correlation with Accepted Measurement Endpoints — Based on their diet, feeding habits, and feeding rage, effects to the great blue heron may be correlated with a measurement endpoint. For example, body burdens in particular fish species may be used to predict reproductive impacts to herons. Toxicity results on amphiphods and fish can also be related to losses in potential food sources.

Protection of Nursery Habitat for Aquatic Resources: Bayou Grande is an important nursery habitat for many commercially and recreationally important fish species, as well as a viable breeding ground for other organisms. Younger organisms in a nursery habitat have a limited home range and are exposed to contamination either through diet or direct adsorption. The ability to focus on effects in particular areas may help to focus remedial decisions.

Protection of Fish Viability: Fish were chosen as an assessment endpoint species based on their potential for exposure through diet and/or absorption. They occupy a significant niche in an estuarine community and effects to populations can alter overall community structure. Body burden and toxicity data from fish species will be important for these reasons:

- Higher Food Chain Impacts — Fish are prey for a variety of other species, such as the great blue heron, an assessment endpoint. Tissue data may be correlated to impacts to heron.

- Biotransfer — Fish may ingest sediment during feeding and thus become a direct transfer pathway for contaminants present in the sediment to other species.

- Toxicity from Direct Exposure — Toxicity to fish species may be correlated with contaminant concentrations in sediment.

Measurement Endpoints

Measurement endpoints provide quantifiable responses to a stressor that can be directly related to the valued characteristic chosen as the assessment endpoint. Measurement endpoints are also described in Table 10-14.

Decision Points

Decision points are defined as toxicological or bioaccumulative effects that indicate ecological risk. A decision point was chosen for each measurement endpoint test analyzed. For all toxicity tests, the decision point is defined as statistically significant differences in mortality, growth, or fecundity d compared with a control. Once statistically significant differences were established compared with the controls, these differences were also compared with the reference areas sampled. For the bioaccumulation analysis, the decision point is unacceptable whole-body contaminant levels. These are defined as tissue concentrations that exceed a defined threshold effects level in the assessment endpoint species, in this case the great blue heron. The great blue heron represents a significant level in the food chain and is used in this study to illustrate the potential effects of bioaccumulation in piscivorous birds. Decision points are also listed in Table 10-14.

Food Chain Models

Based on analysis of the Phase IIA data, upper Redoubt Bayou had significantly higher concentrations of biomagnifying pesticides and PCBs. Therefore, forage fish were sampled and analyzed for tissue content at this location. The tissue data were also used to model uptake of contaminants by piscivorous birds. Potential for fish to be exposed to dissolved contaminants in water was also considered.

Composite samples of foraging fish were collected in the area using a fish trap. After daily collection, the samples were frozen until shipment. Samples were shipped via overnight courier to the analytical laboratory.

Contaminants, specifically pesticides and PCBs, were modeled through the food chain to predict impacts to the great blue heron and higher order fish species as part of the assessment endpoint analysis. SVOCs were not detected in the fish samples, and metals, except for mercury, do not typically bioaccumulate. The technical basis for these models and their formulas are described in Section 10.2.8.4.

10.2.8 Phase IIB/III Sample Results and Interpretation

This section describes each set of sample results across the bayou, how they impact the selected assessment endpoints, and how they are used to assess ecological risk. The approach used in characterizing risk is called the Sediment Quality Triad approach, which refers to three sources of data used to quantify risk: 1) chemical data in sediment and surface water, which give an idea of contaminants that may be driving risk, 2) toxicity and bioaccumulation data, which represent the severity and type of ecological effects predicted in the area sampled, and 3) benthic diversity data, which show actual effects of contamination on sediment-dwelling organisms living in a particular area. Each portion of the triad by itself in most cases does not yield an accurate estimate of risk, but when viewed together is an effective means of linking contaminants and effects. The sediment quality triad is a useful tool for assessing the existence and extent of benthic ecosystem degradation possible associated with contamination (Chapman et al., 1997). Contamination and effects are summarized in Section 10.2.9.

10.2.8.1 Sediment Chemistry

Sediment chemistry, the first portion of the sediment quality triad, impacts all assessment endpoints. Ten sediment samples were collected across the bayou and their sediment chemistry results compared with SSVs are shown in Tables 10-15 through 10-24. Sample locations and HI values for each contaminant class are shown in Figure 10-2, and complete results are included in Appendix C.

Metals

Phase IIB metal concentrations were generally low across the bayou, with AZ-1, the reference zone, and AZ-2 having the most metal exceedances above SSV values. In AZ-1, the maximum HQ calculated was 3.44 for chromium in sample 0301. Arsenic, cadmium, copper, lead, mercury, and zinc also exceeded their SSVs in AZ-1. In AZ-2, the maximum HQ calculated was 4.14 for cadmium in sample 0601. Arsenic, chromium, copper, lead, mercury, and zinc also exceeded their SSVs in AZ-2. In AZ-3, no metals exceeded their SSV. In AZ-4, two metals exceeded their SSV in sample 0801 only, with cadmium having an HQ of 1.78 and lead having an HQ of 1.25.

Table 10-15
Phase IIB/III Screening Comparison for Sediment Contaminants
Sample Location 040M2B0101 of AZ-1

Parameter	Result	EPA SSV	FDEP SQAG	HQ
Inorganics (ppm)				
Antimony	ND	12.00	NA	NA
Arsenic	ND	7.24	7.24	NA
Cadmium	ND	1.00	0.676	NA
Chromium	3.4	52.30	52.30	0.07
Copper	1.6	18.70	18.70	0.09
Lead	2.6	30.20	30.20	0.09
Mercury	ND	0.13	0.13	NA
Nickel	0.4	15.90	15.90	0.03
Silver	ND	2.00	0.73	NA
Zinc	6.2	124.00	124.00	0.05
			HI for Metals	0.33
Pesticides/PCBs (ppb)				
4,4'-DDD	ND	3.30	1.22	NA
4,4'-DDE	ND	3.30	2.07	NA
4,4'-DDT	ND	3.30	1.19	NA
Chlordane	ND	1.70	2.26	NA
Dieldrin	ND	3.30	0.72	NA
Endrin	ND	3.30	NA	NA
Lindane	ND	3.30	0.32	NA
Total PCBs	ND	33.0	21.6	NA
			HI for Pesticides/PCBs	0.0

Table 10-15
Phase IIB/III Screening Comparison for Sediment Contaminants
Sample Location 040M2B0101 of AZ-1

Parameter	Result	EPA SSV	FDEP SQAG	HQ
		SVOCs (ppb)		
BEHP	ND	182.0	182.0	NA
Acenapthene	ND	330.00	6.71	NA
Acenapthylene	ND	330.00	5.87	NA
Anthracene	ND	330.00	46.9	NA
Fluorene	ND	330.00	21.2	NA
2-Methylnapthalene	ND	330.00	20.2	NA
Napthalene	ND	330.00	34.6	NA
Phenanthrene	ND	330.00	86.7	NA
Benzo(a)anthracene	ND	330.00	74.8	NA
Benzo(a)pyrene	ND	330.00	88.8	NA
Chrysene	ND	330.00	108.00	NA
Dibenz(a,h)anthracene	ND	330.00	6.22	NA
Fluoranthene	ND	330.00	113.00	NA
Pyrene	ND	330.00	153.00	NA
			HI for SVOCs	0.0
			Total Hazard Index	0.33

Notes:

EPA SSV = EPA sediment screening values are from USEPA 1995.
SQAG = Florida Department of Environmental Protection — Sediment Quality Assessment Guideline (MacDonald 1994)
HQ = Hazard Quotient; Concentration/Effects Level.*
* = Effects level is the lower value of the USEPA sediment screening value or SQAG TEL

Table 10-16
Phase IIB/III Screening Comparison for Sediment Contaminants
Sample Location 040M2B0201 of AZ-1

Parameter	Result	EPA SSV	FDEP SQAG	HQ
		Inorganics (ppm)		
Antimony	ND	12.00	NA	NA
Arsenic	13.3	7.24	7.24	1.84
Cadmium	1.0	1.00	0.676	1.48
Chromium	116.00	52.30	52.30	2.22
Copper	22.00	18.70	18.70	1.18
Lead	59.9	30.20	30.20	1.98
Mercury	0.13	0.13	0.13	1.00
Nickel	9.8	15.90	15.90	0.62
Silver	ND	2.00	0.73	NA
Zinc	114.00	124.00	124.00	0.92
			HI for Inorganics	11.24
		Pesticides/PCBs (ppb)		
4,4'-DDD	ND	3.30	1.22	NA
4,4'-DDE	ND	3.30	2.07	NA
4,4'-DDT	0.92	3.30	1.19	0.77
Chlordane	ND	1.70	2.26	NA
Dieldrin	ND	3.30	0.72	NA
Endrin	0.63	3.30	NA	0.19
Lindane	0.41	3.30	0.32	1.28
Total PCBs	ND	33.0	21.6	NA
			HI for Pesticides/PCBs	2.24

Table 10-16
Phase IIB/III Screening Comparison for Sediment Contaminants
Sample Location 040M2B0201 of AZ-1

Parameter	Result	EPA SSV	FDEP SQAG	HQ
		SVOCs (ppb)		
BEHP	ND	182.0	182.0	NA
Acenapthene	ND	330.00	6.71	NA
Acenapthylene	ND	330.00	5.87	NA
Anthracene	ND	330.00	46.9	NA
Fluorene	ND	330.00	21.2	NA
2-Methylnapthalene	ND	330.00	20.2	NA
Napthalene	ND	330.00	34.6	NA
Phenanthrene	ND	330.00	86.7	NA
Benzo(a)anthracene	ND	330.00	74.8	NA
Benzo(a)pyrene	ND	330.00	88.8	NA
Chrysene	ND	330.00	108.00	NA
Dibenz(a,h)anthracene	ND	330.00	6.22	NA
Fluoranthene	28	330.00	113.00	0.25
Pyrene	25	330.00	153.00	0.16
			HI for SVOCs	0.41
			Total Hazard Index	13.89

Notes:
EPA SSV = EPA sediment screening values are from USEPA 1995.
SQAG = Florida Department of Environmental Protection — Sediment Quality Assessment Guideline (MacDonald 1994)
HQ = Hazard Quotient; Concentration/Effects Level.*
* = Effects level is the lower value of the USEPA sediment screening value or SQAG TEL

Table 10-17
Phase IIB/III Screening Comparison for Sediment Contaminants
Sample Location 040M2B0301 of AZ-1

Parameter	Result	EPA SSV	FDEP SQAG	HQ
		Inorganics (ppm)		
Antimony	ND	12.00	NA	NA
Arsenic	16.2	7.24	7.24	2.24
Cadmium	1.7	1.00	0.676	2.51
Chromium	180.00	52.30	52.30	3.44
Copper	32.30	18.70	18.70	1.73
Lead	100.00	30.20	30.20	3.31
Mercury	0.21	0.13	0.13	1.62
Nickel	13.70	15.90	15.90	0.86
Silver	ND	2.00	0.73	NA
Zinc	157.00	124.00	124.00	1.27
			HI for Inorganics	16.98
		Pesticides/PCBs (ppb)		
4,4'-DDD	ND	3.30	1.22	NA
4,4'-DDE	ND	3.30	2.07	NA
4,4'-DDT	ND	3.30	1.19	NA
Chlordane	ND	1.70	2.26	NA
Dieldrin	ND	3.30	0.72	NA
Endrin	1.30	3.30	NA	0.39
Lindane	ND	3.30	0.32	NA
Total PCBs	ND	33.0	21.6	NA
			HI for Pesticides/PCBs	0.39

Table 10-17
Phase IIB/III Screening Comparison for Sediment Contaminants
Sample Location 040M2B0301 of AZ-1

Parameter	Result	EPA SSV	FDEP SQAG	HQ
		SVOCs (ppb)		
BEHP	ND	182.0	182.0	NA
Acenapthene	ND	330.00	6.71	NA
Acenapthylene	ND	330.00	5.87	NA
Anthracene	ND	330.00	46.9	NA
Fluorene	ND	330.00	21.2	NA
2-Methylnapthalene	ND	330.00	20.2	NA
Napthalene	ND	330.00	34.6	NA
Phenanthrene	ND	330.00	86.7	NA
Benzo(a)anthracene	38.00	330.00	74.8	0.51
Benzo(a)pyrene	58.00	330.00	88.8	0.65
Chrysene	55.00	330.00	108.00	0.51
Dibenz(a,h)anthracene	ND	330.00	6.22	NA
Fluoranthene	81.00	330.00	113.00	0.72
Pyrene	71.00	330.00	153.00	0.46
			HI for SVOCs	2.85
			Total Hazard Index	20.22

Notes:

EPA SSV = EPA sediment screening values are from USEPA 1995.
SQAG = Florida Department of Environmental Protection — Sediment Quality Assessment Guideline (MacDonald 1994)
HQ = Hazard Quotient; Concentration/Effects Level.*
* = Effects level is the lower value of the USEPA sediment screening value or SQAG TEL

Table 10-18
Phase IIB/III Screening Comparison for Sediment Contaminants
Sample Location 040M2B0401 of AZ-2

Parameter	Result	EPA SSV	FDEP SQAG	HQ
		Inorganics (ppm)		
Antimony	ND	12.00	NA	NA
Arsenic	ND	7.24	7.24	NA
Cadmium	ND	1.00	0.676	NA
Chromium	1.20	52.30	52.30	0.02
Copper	0.54	18.70	18.70	0.03
Lead	1.20	30.20	30.20	0.04
Mercury	ND	0.13	0.13	NA
Nickel	ND	15.90	15.90	NA
Silver	ND	2.00	0.73	NA
Zinc	1.50	124.00	124.00	0.01
			HI for Inorganics	0.1
		Pesticides/PCBs (ppb)		
4,4'-DDD	ND	3.30	1.22	NA
4,4'-DDE	ND	3.30	2.07	NA
4,4'-DDT	ND	3.30	1.19	NA
Chlordane	ND	1.70	2.26	NA
Dieldrin	ND	3.30	0.72	NA
Endrin	ND	3.30	NA	NA
Lindane	ND	3.30	0.32	NA
Total PCBs	ND	33.0	21.6	NA
			HI for Pesticides/PCBs	0

Table 10-18
Phase IIB/III Screening Comparison for Sediment Contaminants
Sample Location 040M2B0401 of AZ-2

Parameter	Result	EPA SSV	FDEP SQAG	HQ
		SVOCs (ppb)		
BEHP	ND	182.0	182.0	NA
Acenapthene	ND	330.00	6.71	NA
Acenapthylene	ND	330.00	5.87	NA
Anthracene	ND	330.00	46.9	NA
Fluorene	ND	330.00	21.2	NA
2-Methylnapthalene	ND	330.00	20.2	NA
Napthalene	ND	330.00	34.6	NA
Phenanthrene	ND	330.00	86.7	NA
Benzo(a)anthracene	ND	330.00	74.8	NA
Benzo(a)pyrene	ND	330.00	88.8	NA
Chrysene	ND	330.00	108.00	NA
Dibenz(a,h)anthracene	ND	330.00	6.22	NA
Fluoranthene	ND	330.00	113.00	NA
Pyrene	ND	330.00	153.00	NA
			HI for SVOCs	0
			Total Hazard Index	0.1

Notes:
EPA SSV = EPA sediment screening values are from USEPA 1995.
SQAG = Florida Department of Environmental Protection — Sediment Quality Assessment Guideline (MacDonald 1994)
HQ = Hazard Quotient; Concentration/Effects Level.*
* = Effects level is the lower value of the USEPA sediment screening value or SQAG TEL

Table 10-19
Phase IIB/III Screening Comparison for Sediment Contaminants
Sample Location 040M2B0501 of AZ-2

Parameter	Result	EPA SSV	FDEP SQAG	HQ
Inorganics (ppm)				
Antimony	ND	12.00	NA	NA
Arsenic	6.80	7.24	7.24	0.94
Cadmium	1.10	1.00	0.676	1.63
Chromium	67.90	52.30	52.30	1.30
Copper	15.70	18.70	18.70	0.84
Lead	44.30	30.20	30.20	1.47
Mercury	0.10	0.13	0.13	0.77
Nickel	5.00	15.90	15.90	0.31
Silver	0.34	2.00	0.73	0.47
Zinc	69.10	124.00	124.00	0.56
			HI for Inorganics	8.29
Pesticides/PCBs (ppb)				
4,4'-DDD	ND	3.30	1.22	NA
4,4'-DDE	0.63	3.30	2.07	0.30
4,4'-DDT	18.00	3.30	1.19	15.13
Chlordane	ND	1.70	2.26	NA
Dieldrin	ND	3.30	0.72	NA
Endrin	0.74	3.30	NA	0.22
Lindane	ND	3.30	0.32	NA
Total PCBs	ND	33.0	21.6	NA
			HI for Pesticides/PCBs	15.65

Table 10-19
Phase IIB/III Screening Comparison for Sediment Contaminants
Sample Location 040M2B0501 of AZ-2

Parameter	Result	EPA SSV	FDEP SQAG	HQ
		SVOCs (ppb)		
BEHP	ND	182.0	182.0	NA
Acenapthene	ND	330.00	6.71	NA
Acenapthylene	ND	330.00	5.87	NA
Anthracene	ND	330.00	46.9	NA
Fluorene	ND	330.00	21.2	NA
2-Methylnapthalene	ND	330.00	20.2	NA
Napthalene	ND	330.00	34.6	NA
Phenanthrene	ND	330.00	86.7	NA
Benzo(a)anthracene	37.00	330.00	74.8	0.49
Benzo(a)pyrene	51.00	330.00	88.8	0.57
Chrysene	37.00	330.00	108.00	0.34
Dibenz(a,h)anthracene	ND	330.00	6.22	NA
Fluoranthene	66.00	330.00	113.00	0.58
Pyrene	60.00	330.00	153.00	0.39
			HI for SVOCs	2.37
			Hazard Index	26.31

Notes:
EPA SSV = EPA sediment screening values are from USEPA 1995.
SQAG = Florida Department of Environmental Protection — Sediment Quality Assessment Guideline (MacDonald 1994)
HQ = Hazard Quotient; Concentration/Effects Level.*
* = Effects level is the lower value of the USEPA sediment screening value or SQAG TEL

Table 10-20
Phase IIB/III Screening Comparison for Sediment Contaminants
Sample Location 040M2B0601 of AZ-2

Parameter	Result	EPA SSV	FDEP SQAG	HQ
		Inorganics (ppm)		
Antimony	ND	12.00	NA	NA
Arsenic	8.00	7.24	7.24	1.10
Cadmium	2.80	1.00	0.676	4.14
Chromium	80.00	52.30	52.30	1.53
Copper	34.50	18.70	18.70	1.85
Lead	96.30	30.20	30.20	3.19
Mercury	0.22	0.13	0.13	1.69
Nickel	7.90	15.90	15.90	0.50
Silver	ND	2.00	0.73	NA
Zinc	159.00	124.00	124.00	1.28
			HI for Inorganics	15.28
		Pesticides/PCBs (ppb)		
4,4'-DDD	4.90	3.30	1.22	4.02
4,4'-DDE	4.90	3.30	2.07	2.37
4,4'-DDT	7.70	3.30	1.19	6.47
Chlordane	ND	1.70	2.26	NA
Dieldrin	ND	3.30	0.72	NA
Endrin	ND	3.30	NA	NA
Lindane	ND	3.30	0.32	NA
Total PCBs	65.00	33.0	21.6	3.01
			HI for Pesticides/PCBs	15.87

Table 10-20
Phase IIB/III Screening Comparison for Sediment Contaminants
Sample Location 040M2B0601 of AZ-2

Parameter	Result	EPA SSV	FDEP SQAG	HQ
		SVOCs (ppb)		
BEHP	370.00	182.0	182.0	2.03
Acenapthene	ND	330.00	6.71	NA
Acenapthylene	ND	330.00	5.87	NA
Anthracene	22.00	330.00	46.9	0.47
Fluorene	ND	330.00	21.2	NA
2-Methylnapthalene	ND	330.00	20.2	NA
Napthalene	ND	330.00	34.6	NA
Phenanthrene	84.00	330.00	86.7	0.97
Benzo(a)anthracene	110.00	330.00	74.8	1.47
Benzo(a)pyrene	130.00	330.00	88.8	1.46
Chrysene	160.00	330.00	108.00	1.48
Dibenz(a,h)anthracene	ND	330.00	6.22	NA
Fluoranthene	40.00	330.00	113.00	0.35
Pyrene	270.00	330.00	153.00	1.76
			HI for SVOCs	9.99
			Total Hazard Index	41.14

Notes:
EPA SSV = EPA sediment screening values are from USEPA 1995.
SQAG = Florida Department of Environmental Protection — Sediment Quality Assessment Guideline (MacDonald 1994)
HQ = Hazard Quotient; Concentration/Effects Level.*
* = Effects level is the lower value of the USEPA sediment screening value or SQAG TEL

Table 10-21
Phase IIB/III Screening Comparison for Sediment Contaminants
Sample Location 040M2B0701 of AZ-3

Parameter	Result	EPA SSV	FDEP SQAG	HQ
Inorganics (ppm)				
Antimony	ND	12.00	NA	NA
Arsenic	0.82	7.24	7.24	0.11
Cadmium	0.10	1.00	0.676	0.15
Chromium	5.10	52.30	52.30	0.10
Copper	5.80	18.70	18.70	0.31
Lead	17.00	30.20	30.20	0.56
Mercury	ND	0.13	0.13	NA
Nickel	0.52	15.90	15.90	0.03
Silver	0.10	2.00	0.73	0.14
Zinc	11.40	124.00	124.00	0.09
			HI for Inorganics	1.49
Pesticides/PCBs (ppb)				
4,4'-DDD	ND	3.30	1.22	NA
4,4'-DDE	ND	3.30	2.07	NA
4,4'-DDT	ND	3.30	1.19	NA
Chlordane	ND	1.70	2.26	NA
Dieldrin	ND	3.30	0.72	NA
Endrin	ND	3.30	NA	NA
Lindane	ND	3.30	0.32	NA
Total PCBs	ND	33.0	21.6	NA
			HI for Pesticides/PCBs	0.0

Table 10-21
Phase IIB/III Screening Comparison for Sediment Contaminants
Sample Location 040M2B0701 of AZ-3

Parameter	Result	EPA SSV	FDEP SQAG	HQ
		SVOCs (ppb)		
BEHP	ND	182.0	182.0	NA
Acenapthene	18.00	330.00	6.71	2.68
Acenapthylene	ND	330.00	5.87	NA
Anthracene	54.00	330.00	46.9	1.15
Fluorene	ND	330.00	21.2	NA
2-Methylnapthalene	ND	330.00	20.2	NA
Napthalene	ND	330.00	34.6	NA
Phenanthrene	240.00	330.00	86.7	2.77
Benzo(a)anthracene	500.00	330.00	74.8	6.68
Benzo(a)pyrene	820.00	330.00	88.8	9.23
Chrysene	660.00	330.00	108.00	6.11
Dibenz(a,h)anthracene	ND	330.00	6.22	NA
Fluoranthene	490.00	330.00	113.00	4.34
Pyrene	1200.00	330.00	153.00	7.84
			HI for SVOCs	40.8
			Total Hazard Index	42.29

Notes:

EPA SSV	=	EPA sediment screening values are from USEPA 1995.
SQAG	=	Florida Department of Environmental Protection — Sediment Quality Assessment Guideline (MacDonald 1994)
HQ	=	Hazard Quotient; Concentration/Effects Level.*
*	=	Effects level is the lower value of the USEPA sediment screening value or SQAG TEL

Table 10-22
Phase IIB/III Screening Comparison for Sediment Contaminants
Sample Location 040M2B0801 of AZ-4

Parameter	Result	EPA SSV	FDEP SQAG	HQ
Inorganics (ppm)				
Antimony	ND	12.00	NA	NA
Arsenic	6.90	7.24	7.24	0.95
Cadmium	1.20	1.00	0.676	1.78
Chromium	40.50	52.30	52.30	0.77
Copper	11.50	18.70	18.70	0.61
Lead	37.80	30.20	30.20	1.25
Mercury	0.11	0.13	0.13	0.85
Nickel	3.70	15.90	15.90	0.23
Silver	ND	2.00	0.73	NA
Zinc	76.80	124.00	124.00	0.62
			HI for Inorganics	7.03
Pesticides/PCBs (ppb)				
4,4'-DDD	1.40	3.30	1.22	1.15
4,4'-DDE	2.20	3.30	2.07	1.06
4,4'-DDT	ND	3.30	1.19	NA
Chlordane	ND	1.70	2.26	NA
Dieldrin	1.30	3.30	0.72	1.81
Endrin	ND	3.30	NA	NA
Lindane	ND	3.30	0.32	NA
Total PCBs	19.00	33.0	21.6	0.88
			HI for Pesticides/PCBs	4.9

Table 10-22
Phase IIB/III Screening Comparison for Sediment Contaminants
Sample Location 040M2B0801 of AZ-4

Parameter	Result	EPA SSV	FDEP SQAG	HQ
		SVOCs (ppb)		
BEHP	ND	182.0	182.0	NA
Acenapthene	26.00	330.00	6.71	3.87
Acenapthylene	25.00	330.00	5.87	4.26
Anthracene	70.00	330.00	46.9	1.49
Fluorene	32.00	330.00	21.2	1.51
2-Methylnapthalene	ND	330.00	20.2	NA
Napthalene	ND	330.00	34.6	NA
Phenanthrene	330.00	330.00	86.7	3.81
Benzo(a)anthracene	300.00	330.00	74.8	4.01
Benzo(a)pyrene	330.00	330.00	88.8	3.72
Chrysene	320.00	330.00	108.00	2.96
Dibenz(a,h)anthracene	ND	330.00	6.22	NA
Fluoranthene	680.00	330.00	113.00	6.02
Pyrene	630.00	330.00	153.00	4.12
			HI for SVOCs	35.77
			Total Hazard Index	47.73

Notes:

EPA SSV = EPA sediment screening values are from USEPA 1995.
SQAG = Florida Department of Environmental Protection — Sediment Quality Assessment Guideline (MacDonald 1994)
HQ = Hazard Quotient; Concentration/Effects Level.*
* = Effects level is the lower value of the USEPA sediment screening value or SQAG TEL

Table 10-23
Phase IIB/III Screening Comparison for Sediment Contaminants
Sample Location 040M2B0901 of AZ-4

Parameter	Result	EPA SSV	FDEP SQAG	HQ
Inorganics (ppm)				
Antimony	ND	12.00	NA	NA
Arsenic	ND	7.24	7.24	NA
Cadmium	ND	1.00	0.676	NA
Chromium	2.50	52.30	52.30	0.05
Copper	0.67	18.70	18.70	0.04
Lead	1.70	30.20	30.20	0.06
Mercury	ND	0.13	0.13	NA
Nickel	ND	15.90	15.90	NA
Silver	ND	2.00	0.73	NA
Zinc	2.90	124.00	124.00	0.02
			HI for Inorganics	0.17
Pesticides/PCBs (ppb)				
4,4'-DDD	ND	3.30	1.22	NA
4,4'-DDE	ND	3.30	2.07	NA
4,4'-DDT	ND	3.30	1.19	NA
Chlordane	ND	1.70	2.26	NA
Dieldrin	ND	3.30	0.72	NA
Endrin	ND	3.30	NA	NA
Lindane	ND	3.30	0.32	NA
Total PCBs	ND	33.0	21.6	NA
			HI for Pesticides/PCBs	0.0

Table 10-23
Phase IIB/III Screening Comparison for Sediment Contaminants
Sample Location 040M2B0901 of AZ-4

Parameter	Result	EPA SSV	FDEP SQAG	HQ
		SVOCs (ppb)		
BEHP	ND	182.0	182.0	NA
Acenapthene	ND	330.00	6.71	NA
Acenapthylene	ND	330.00	5.87	NA
Anthracene	ND	330.00	46.9	NA
Fluorene	ND	330.00	21.2	NA
2-Methylnapthalene	ND	330.00	20.2	NA
Napthalene	ND	330.00	34.6	NA
Phenanthrene	9.30	330.00	86.7	0.11
Benzo(a)anthracene	ND	330.00	74.8	NA
Benzo(a)pyrene	ND	330.00	88.8	NA
Chrysene	ND	330.00	108.00	NA
Dibenz(a,h)anthracene	ND	330.00	6.22	NA
Fluoranthene	13.00	330.00	113.00	0.12
Pyrene	12.00	330.00	153.00	0.08
			HI for SVOCs	0.31
			Total Hazard Index	0.48

Notes:
EPA SSV = EPA sediment screening values are from USEPA 1995.
SQAG = Florida Department of Environmental Protection — Sediment Quality Assessment Guideline (MacDonald 1994)
HQ = Hazard Quotient; Concentration/Effects Level.*
* = Effects level is the lower value of the USEPA sediment screening value or SQAG TEL

Table 10-24
Phase IIB/III Screening Comparison for Sediment Contaminants
Sample Location 040M2B1001 of AZ-4

Parameter	Result	EPA SSV	FDEP SQAG	HQ
Inorganics (ppm)				
Antimony	ND	12.00	NA	NA
Arsenic	0.94	7.24	7.24	0.13
Cadmium	0.58	1.00	0.676	0.86
Chromium	16.70	52.30	52.30	0.32
Copper	5.90	18.70	18.70	0.32
Lead	10.00	30.20	30.20	0.33
Mercury	0.03	0.13	0.13	0.23
Nickel	0.78	15.90	15.90	0.05
Silver	ND	2.00	0.73	NA
Zinc	22.70	124.00	124.00	0.18
			HI for Inorganics	2.42
Pesticides/PCBs (ppb)				
4,4'-DDD	ND	3.30	1.22	NA
4,4'-DDE	ND	3.30	2.07	NA
4,4'-DDT	ND	3.30	1.19	NA
Chlordane	ND	1.70	2.26	NA
Dieldrin	ND	3.30	0.72	NA
Endrin	ND	3.30	NA	NA
Lindane	ND	3.30	0.32	NA
Total PCBs	ND	33.0	21.6	NA
			HI for Pesticides/PCBs	0

Table 10-24
Phase IIB/III Screening Comparison for Sediment Contaminants
Sample Location 040M2B1001 of AZ-4

Parameter	Result	EPA SSV	FDEP SQAG	HQ
		SVOCs (ppb)		
BEHP	ND	182.0	182.0	NA
Acenapthene	ND	330.00	6.71	NA
Acenapthylene	ND	330.00	5.87	NA
Anthracene	ND	330.00	46.9	NA
Fluorene	ND	330.00	21.2	NA
2-Methylnapthalene	ND	330.00	20.2	NA
Napthalene	ND	330.00	34.6	NA
Phenanthrene	ND	330.00	86.7	NA
Benzo(a)anthracene	ND	330.00	74.8	NA
Benzo(a)pyrene	ND	330.00	88.8	NA
Chrysene	ND	330.00	108.00	NA
Dibenz(a,h)anthracene	ND	330.00	6.22	NA
Fluoranthene	ND	330.00	113.00	NA
Pyrene	ND	330.00	153.00	NA
Hardwood/pine communities are highly diverse and considered biologically productive ecosystems.				
			HI for SVOCs	0.0
			Total Hazard Index	2.42

Notes:
EPA SSV = EPA sediment screening values are from USEPA 1995.
SQAG = Florida Department of Environmental Protection — Sediment Quality Assessment Guideline (MacDonald 1994)
HQ = Hazard Quotient; Concentration/Effects Level.*
* = Effects level is the lower value of the USEPA sediment screening value or SQAG TEL

SVOCs

Like metals, SVOC concentrations were also generally low across the bayou, with two samples, one from AZ-3 and one from AZ-4, having the most SSV exceedances. In AZ-1, no HQ values exceeded 1. In AZ-2, the maximum HQ calculated was 2.03 for BEHP in sample 0601. Benzo(a)anthracene, benzo(a)pyrene, chrysene, and pyrene also exceeded their SSV from this sample location in AZ-2. No other SVOC had an SSV exceedance in AZ-2. In AZ-3, the maximum HQ calculated was 9.23 for benzo(a)pyrene in sample 0701, which was the only sample collected from AZ-3. Acenapthene, anthracene, phenanthrene, benzo(a)anthracene, chrysene, fluoranthene, and pyrene also exceeded their SSV from this sample location. In AZ-4, the maximum HQ calculated was 6.02 for fluoranthene in sample location 0801. Acenapthene, acenapthylene, anthracene, fluorene, phenanthrene, benzo(a)anthracene, benzo(a)pyrene, chrysene, fluoranthene, and pyrene also exceeded their SSV from this sample location. No other sample location from A-Z4 had an SSV exceedance.

Pesticides/PCBs

Pesticide/PCB concentrations were also generally low across the bayou, with AZ-2 having the most SSV exceedances. In AZ-1, the only HQ above 1 was in sample location 0201, where lindane had an HQ of 1.28. In AZ-2, the maximum HQ calculated was 15.13 for DDT in sample 0501. DDD, DDE, and PCBs also exceeded their SSV in AZ-2. In AZ-3, no pesticides exceeded their SSV. In AZ-4, two pesticides exceeded their SSV in sample 0801 only, with DDD having an HQ of 1.15 and DDE having an HQ of 1.06.

10.2.8.2 Surface Water Chemistry

Surface water chemistry results, like the sediment chemistry results, may be applied to the selected assessment endpoints. Surface water samples were collected from three locations during Phase IIB/III; sample 2B01 collected from AZ-1, 2B07 collected from AZ-3, and 2B09 collected from AZ-4. Chemicals detected in surface water were compared to the lower of the state or federal screening criteria, and only two exceedances were noted. In AZ-1, endrin exceeded the USEPA freshwater screening concentration of 0.0023 μg/L (no saltwater screening concentration was available). In AZ-4, copper exceeded its FDEP saltwater screening concentration of 2.9 μg/L. Surface water chemistry results are summarized below in Table 10-25, as are each parameter's frequency and range of detection, range of non-detected upper bounds, range of detected concentrations, average detected concentrations, risk-based screening concentration and number of exceedances. Complete results are included in Appendix C, and sample locations are shown on Figure 5-1.

10.2.8.3 Toxicity Tests

Toxicity tests establish a link between observed contamination and anticipated effects. Bioassay results for Phase IIB/III sediment samples are summarized in Table 10-26; Appendix I contains complete laboratory results and test conditions. These tests were performed to gauge impacts to the selected assessment endpoints — protection of the benthic macroinvertebrate community and protection of nursery habitat for aquatic resources.

Table 10-25
Screening Comparison for Surface Water Contaminants
Pensacola, Site 40, Phase IIB/III

Parameter	Frequency of Detection	Range of Nondetected Upper Bounds	Range of Detected Concentrations	Average Detected Concentration	Risk-Based Screening Concentration	Number Over Screen
Pesticides/PCBs (μg/L)						
Endrin	1/3	0.1	0.0071	0.0071	0.0023 [a]	1
Inorganics (μg/L)						
Aluminum (Al)	3/3		73.8 - 194	133.6	1500 [d]	0
Arsenic (As)	1/3	2.2	2.5	2.5	36 [b]	0
Chromium (Cr)	1/3	0.88	1.4	1.4	103 [b]	0
Copper (Cu)	3/3		2.1 - 7.8	4.1	2.9 [d]	1
Iron (Fe)	3/3		34.7 - 230	122.9	300 [d]	0
Selenium (Se)	1/3	2.6	3.6	3.6	5 [c]	0
Zinc (Zn)	1/3	3.7	17.9	17.9	58.9 [c]	0

Notes:
a = USEPA screening concentration for freshwater
b = FDEP screening concentration for saltwater
c = FDEP screening concentration for fresh surface water
d = FDEP screening concentration for salt surface water
μg/L = micrograms per liter

Table 10-26
Bioassay Results Conducted at Site 40 Sediments, NAS Pensacola, Florida

Mysid Shrimp *Mysidopsis bahia*				Amphipod *Leptocherirus plumulosus*		Annelid Worm *Neanthes arenaceodentata*		
Site	% Survival	Weight (mg)	% Fecundity	Site	% Survival	Site	% Survival	Weight (mg)
Control	**85**	**0.33**	**93**	**Control**	**97**	**Control**	**100**	**13.5**
4001	90	0.55	100	4001	99	4001	96	9.1
4002	100	0.50	92	4002	93	4002	100	10.0
4003	97.5	0.64	100	4003	98	4003	100	9.1
4004	97.5	0.55	100	4004	95	4004	100	13.1
4005	97.5	0.68	100	4005	95	4005	100	14.5
Control	**82.5**	**0.37**	**80**	4006	95	**Control**	**100**	**9.9**
4006	82.5	0.57	100	**Control**	**100**	4006	100	10.6
4007	100	0.60	100	4007	93	4007	100	12.5
4008	97.5	0.61	92	4008	98	4008	100	11.6
4009	95	0.65	100	4009	95	4009	100	10.3
4010	97.5	0.60	100	4010	96	4010	100	9.5

Note:
No results were statistically different from the control set ($\alpha = 0.05$).

Statistically significant difference in survival, growth or fecundity was not observed at any Site 40 location compared to the control sediment sample. Therefore, although SSV exceedances predicted a potential for effects, the toxicity test results did not indicate acute or chronic impacts to benthic invertebrates from contamination.

Acute Toxicity to the Fish Community

Sediment contamination is not expected to impact fish communities. The toxicity tests did not show any statistically significant difference in survival, growth, or fecundity at any Site 40 sample location compared to the control sample. Although SSVs were exceeded, which predicted potential adverse effects to receptors in certain sample locations, toxicity texts did not indicate acute or chronic impacts from the contamination.

Few contaminants were detected in surface water across Site 40 (see Table 10-25). Only one inorganic (copper) and one organic constituent (endrin) exceeded screening values. Copper was detected at all three sampling locations, exceeding the state and federal criteria at location 40-07 only. Endrin's only detection, 0.0071 μg/L, was above the criterion set for fish marketability; no true ecological standard was available. Because of the relatively low levels of surface water contamination, waterborne contaminants at Site 40 are not expected to impact fish communities.

10.2.8.4 Bioaccumulation Studies

In the sediment quality triad, bioaccumulation studies are used to evaluate potential toxic effects. However, these tests serve to predict toxicity to the selected assessment endpoints rather than demonstrate actual toxicity. For Site 40, bioaccumulation studies were performed to quantify impacts to the reproductive viability of fish-eating birds and the viability of fish based on the level of contaminants detected in foraging fish tissue.

Great Blue Heron Food Chain Model

A food chain model for the great blue heron, a piscivorous bird, was developed to estimate its dietary exposure to Site 40 contaminants based exclusively on ingestion of contaminated fish. The USEPA Wildlife Exposures Handbook (USEPA, 1993) states that small foraging fish comprise a significant portion of the heron's diet.

For the assessment endpoint "bird health and reproduction," contaminant uptake from oral exposure to foraging fish tissue contamination was estimated using an equation which calculates the heron's potential dietary exposure (PDE). The equation assumes that 100% of the contaminant concentration found in fish tissue (diet) is bioavailable to the endpoint species.

$$PDE\ (mg/kg\text{-}day) = \frac{IR(kg/day) \times (f)(Ct) \times SFF}{\text{Mean Body Weight (kg)}}$$

Where:

PDE	=	Potential Dietary Exposure (mg/kg-day)
IR	=	Ingestion rate of fish (kg of fish per day)
f	=	Fraction of diet composed of fish tissue (assumed to be 100%)
Ct	=	Fish tissue contaminant concentration in mg/kg, from Phase IIB/III data
SFF	=	Site Foraging Factor (assumed to be 1)
BW	=	Mean Body Weight (kg)

The IR and mean body weight values for the assessment endpoint species are based on the USEPA Wildlife Exposures Handbook (USEPA, 1993). For the great blue heron, the IR is calculated to be 0.401 kg/day, based on an average ingestion rate of 0.18 gram/gram-day and average heron body weight of 2.229 kg. The contaminant concentration in fish tissue (Ct) is based on the wet weight analytical results obtained from the fish tissue data for either total DDT (DDT, DDD, and DDE) or total PCBs (all congeners). To account for the species' home range, the SFF is assumed to be 1 using the most conservative assumption that regardless of the actual time a heron spends at the site in question, the model assumes that 100% of the heron's diet is obtained from that particular portion of the bayou modeled. In addition, it is also assumed that 100% of the heron's diet in that particular area is comprised of contaminated fish. Since none of the modeled constituents were detected in surface water, surface water ingestion is not considered as part of this model.

To assess potential risk to the endpoint species, the PDE value is then divided by the No Observed Adverse Effects Level (NOAEL) in milligrams per kilogram per day (Sample et al., 1996) to derive an HQ for the receptor species. The HQ is a numerical representation of potential risk to the assessment endpoint selected.

Bioaccumulation impacts to the great blue heron were evaluated based on the chemical contamination found in foraging fish tissue. At location 40-06, two species were collected for tissue studies: Fundulus grandis (killifish) and Lagodon rhomboides (pinfish). Based on information in the USEPA Wildlife Handbook (USEPA 1993), killifish and pinfish are common prey species for the great blue heron. Four specimens of killifish were collected as composite whole fish sample 40-06-1 with lengths ranging from 90 to 122 millimeters (mm). Nine specimens of pinfish were collected as composite whole fish sample 040-06-2 with lengths ranging from 55 to 75 mm. Total contaminant concentrations detected in each sample are shown on Table 10-27. All HQs produced for the heron from oral ingestion of total DDT and total PCBs in fish tissue were calculated according to the model described in Section 10.2.7. Results are also shown in Table 10-27. All HQs were shown to be below 1, indicating no risk to the great blue heron based on ingestion of fish tissue.

Table 10-27
Exposure Estimates and Hazard Prediction of Pesticides and PCBs to Blue Heron at Site 40
NAS Pensacola, Florida

Location	Parameter	Tissue Conc.[1] (mg/kg)	Sediment Conc.[2] (mg/kg)	Water Conc.[3] (μg/L)	PDE[4]	NOAEL[5]	LOAEL	HQ[6]
40-06-1	total DDT	0.015	ND	ND	0.0027	0.003	0.028	0.7
40-06-2	total DDT	0.014	ND	ND	0.0025			0.6
40-06-1	total PCB	0.090	0.065	ND	0.016	0.18	1.8	0.08
40-06-2	total PCB	0.100	0.065	ND	0.018			0.10

Notes:
1 = Whole-body killifish or pinfish (wet weight) found in Appendix C, matrix ID "J."
2 = Samples from top 5 cm of sediment (wet weight) found in Appendix C, matrix ID "M."
3 = Detected concentration or one-half detection limit
4 = Potential Dietary Exposure: from great blue heron model in Section 10.2.7.
5 = Effects Levels in Sample et al., 1996; referenced from Dahlgren et al., 1972, and Anderson et al., 1975
6 = Hazard Quotient = PDE/NOAEL
ND = Not detected

Fish Exposure Model

The fish exposure model described below was used to predict contaminant effects to higher trophic level fish species (level 4 fish species) based on the contaminants detected in the whole body tissue of foraging level fish (level 3 fish species) because level 4 fish feed on level 3 fish. In evaluating these effects, food chain interactions are considered the most significant exposure route because most level 4 fish species are not typically exposed to the sediment, and Site 40 surface water samples did not show significant concentrations of pesticides. Of the three surface water samples collected from Site 40 during Phase IIB, only delta BHC and endrin were detected, at 0.0031 and 0.0071 μg/L, respectively. Neither of these compounds were detected in fish tissue samples collected from the site. The model excludes exposure to metals (except mercury) since most metals do not typically biomagnify.

Fish exposure is modeled in several steps. The first step, the exposure assessment, involves determining a compound specific trophic transfer coefficient (TTC). The TTC is defined as the increase in tissue concentration of a particular contaminant as it moves through the food chain from Level 3 to Level 4 fish, and is used to predict the contaminant tissue concentration in Level 4 fish species. For this evaluation, the TTCs were obtained from the USEPA (1998) and are based on the log Kow for each organic compound. Table 10-28 shows the TTC values and maximum concentrations detected in Level 3 fish used to estimate tissue concentrations of constituents in Level 4 fish. Table 10-29 shows the TTC values and mean concentrations detected in Level 3 fish used to estimate tissue concentrations of constituents in Level 4 fish.

Mercury is one of a few inorganic compounds that will bioaccumulate (Section 3.2). However, because mercury is not a lipophilic compound like the other constituents of concern, and because mercury tissue concentrations were not measured in Level 3 fish, a model was performed which predicts mercury tissue concentration in the red drum (*Sciaenops ocellatus*) based on the mean concentration of mercury in Site 40 sediment. The model is based on a mercury bioaccumulation

Table 10-28
Predicted Level 4 Fish Tissue Concentration from Maximum Prey Fish (Level 3) Concentrations

Constituent	Maximum Level 3 Fish Tissue Conc (µg/kg)	Level 3 Fish Tissue Conc (mg/kg)	TTF	Predicted Level 4 Tissue Concentration (mg/kg)	No Observed Adverse Effects Level (mg/kg)	HQ
DDE	12.00	0.012	10	0.12	0.10	1.2
DDD	3.80	0.0038	10	0.038	0.10	0.38
Chlordane	1.70	0.0017	10	0.017	0.01[2]	1.70
PCB-1260	100.00	0.100	7	0.7	0.10[3]	7.00
Lindane	0.74	0.00074	10	0.0074	0.537[4]	0.01
Dieldrin	1.30	0.0013	10	0.013	1.00[5]	0.013
Aldrin	0.66	0.00066	10	0.0066	0.10[6]	0.066
					Total	10.37

Notes:
1 = 0.10 mg/kg NOAEL for mortality in the spiny dogfish, from Guarino, A.M. and S.T. Arnold
2 = 0.01mg/kg NOAEL for mortality in the spot, from Schimmel, S.C., Patrick, J.M., Forester, J.
3 = 0.10 mg/kg LOAEL for physiological effects in the common carp, from Melancon, M.J. and J.J. Lech
4 = 0.537 mg/kg NOAEL for mortality in the fathead minnow from Macek, K.J., K.S. Buxton, S.K. Derr, J.W. Dean and S. Sauter
5 = 1.0 mg/kg NOAEL for mortality in the spiny dogfish from Guarino, A.M. and S.T. Arnold
6 = 0.10 mg/kg LOAEL for morphological effects in the Atlantic Salmon from Addison, R.F., M.E. Zinck and J.R. Leahy

model developed by NOAA (Evans and Engel, 1994). The model assumes that mercury uptake into the red drum occurs via prey ingestion exclusively. The three prey sources are small fish, crustaceans, and infaunal invertebrates. The mercury model is developed and performed in four steps which are detailed in Attachment A of the RI Report Addendum.

A site-specific foraging factor (SFF) was also incorporated into the model. The SFF represents the percent diet of the Level 4 fish species from Site 40 and is apportioned based on the estimated foraging area of the Level 4 fish species. For simplicity, it was assumed that Level 4 fish species find all of the Bayou Grande equally attractive for foraging. Using 300 feet from the shore as the outer boundary for all of Site 40 corresponds to a total surface area of approximately 310 acres for Site 40. Bayou Grande's surface area is approximately 960 acres, an SFF of 0.32 was used. Also provided is an SFF of 1 to assume that the Level 4 fish spend all of their time at Site 40 to conservatively estimate their exposure to contaminants at Site 40.

Table 10-29
Estimated Concentrations in Level 4 Fish Species at Site 40
Using Maximum Concentrations Compared to Lowest No Adverse Effects Level

Constituents	Measured Maximum Conc. in Level 3 Fish (mg/kg)	TTC[1]	Estimated Conc. in Level 4 Fish with SFF[2] = 1 (mg/kg)	Estimated Conc. in Level 4 Fish with SFF[2] = 0.32 (mg/kg)	Lowest No Observed Adverse Effects Level (mg/kg)3	Reference	HQ with SFF = 1	HQ with SFF = 0.32	Exceeds NOAEL?
4,4'-DDD	0.0038	3.254	0.012	0.004	0.600	a	0.021	0.007	No
4,4'-DDE	0.012	3.602	0.043	0.014	1.090	b	0.040	0.013	No
Aldrin	0.00066	1.006	0.001	0.000	0.157	c	0.004	0.001	No
Aroclor-1260	0.1	3.733	0.373	0.119	1.600	d	0.233	0.075	No
Dieldrin	0.0013	1.063	0.001	0.000	12.800	e	0.000	0.000	No
Lindane	0.00074	1.021	0.001	0.000	5.220	f	0.000	0.000	No
Chlordane	0.0017	1.999	0.003	0.001	0.010	g	0.340	0.109	No
Mercury[4]	NA	NA	5.700	1.824	0.140	h	40.714	13.029	Yes

Notes:

1 TTC = trophic transfer coefficient from USEPA, Draft Water Quality Criteria Methodology
Revisions: Human Health, Federal Register, August 14, 1998.

2 SFF = Site Foraging Factor

3 No observed effects levels are from U.S.Army Corp of Engineers, Environmental Residual Effects Database (2000).
Available: http://www.wes.army.mil/el/t2dbase.html

a = 0.6 mg/kg LOAEL for reproduction effects in the fathead minnow (Level 3), from Jarvinen, A.W., M.J. Hoffman, and T.W. Thorslund. Exposure route is combined.
b = 1.09 mg/kg LOAEL for physiological effects in the rainbow trout (Level 4) from Poels, C.L.M., van Der Gaag, M.A., van de Kerkhoff, J.F.J. Exposure route is combined.
c = 0.157 mg/kg NOAEL for mortality in the mosquito fish (Level 3) from Metcalf, R.L. Exposure route is combined.
d = 1.6 mg/kg LOAEL for behavioral effects in the minnow (Level 3), from Bengtsson, B.E. Exposure route is ingestion.
e = 12.8 mg/kg NOAEL for mortality in the sheepshead minnow (Level 3) from Guarino, A.M. and S.T. Arnold. Exposure route is combined.
f = 5.22 mg/kg ED 50 for mortality in the pinfish (Level 3) from Schimmel, S.C., Patrick, J.M., Forester, J. Exposure route is combined.
g = 0.01mg/kg NOAEL for mortality in the spot (Level 4), from Schimmel, S.C., Patrick, J.M., Forester, J. Exposure route is combined.
h = 0.14 mg/kg NOAEL for growth in the rainbow trout (Level 4), from Guarino and Arnold. Exposure route is ingestion.

4 Mercury concentrations in Level 4 fish tissue were modeled as described in Attachment A of the Site 40 RI Report Addendum

The models' next step is the assessment of effects where the highest tissue concentration for each organochlorine compound is determined where adverse effects are not observed (NOAEL). In some cases the only threshold available is the lowest concentration where a toxic effect was actually observed, or the lowest observed adverse effects level (LOAEL). NOAEL and LOAEL values were determined through a review of the U.S. Army Corps of Engineers Environmental Residue Effects Database (ERED). Each individual study from this database used in the model is cited in the fish exposure tables (Tables 10-29 through 10-32). To ensure comparative consistency, only the lowest LOAEL or NOAEL for whole body fish tissue with an ingestion or combined exposure pathway was used in the model. In addition, because this model is used to predict risk to upper trophic level fish, NOAELs and LOAELs for species other than fish were not considered appropriate (i.e., birds, insects, amphipods, etc.).

Tables 10-29 and 10-30 present the maximum and mean contaminant concentrations compared to the lowest whole body LOAEL or NOAEL based on an ingestion or combined pathway.

Tables 10-31 and 10-32 provide the maximum and mean contaminant concentrations compared to their lowest LOAEL or NOAEL for Level 4 species potentially inhabiting Bayou Grande. Level 3 species were used if Level 4 were not available.

The fourth step, risk characterization, involved calculating the hazard quotient (HQ) values. The HQ is calculated by dividing the estimated contaminant tissue concentration in the level 4 species by its respective NOAEL or LOAEL. Any HQ values greater than one indicate a potential risk to the receptor organism, in this case a level 4 fish.

Table 10-30
Estimated Concentrations in Level 4 Fish Species at Site 40
Using Mean Concentrations Compared to Lowest No Adverse Effects Level

Constituents	Mean Conc. In Level 3 Fish (mg/kg)	TTC[1]	Estimated Conc. in Level 4 Fish with SFF[2] = 1 (mg/kg)	Estimated Conc. in Level 4 Fish with SFF[2] = 0.32 (mg/kg)	Lowest No Observed Adverse Effects Level (mg/kg)[3]	Reference	HQ with SFF = 1	HQ with SFF = 0.32	Exceeds NOAEL?
4,4'-DDD	0.0032	3.254	0.010	0.003	0.600	a	0.017	0.006	No
4,4'-DDE	0.011	3.602	0.040	0.013	1.090	b	0.036	0.012	No
Aldrin	0.00041	1.006	0.000	0.000	0.157	c	0.003	0.001	No
Aroclor-1260	0.095	3.733	0.355	0.113	1.600	d	0.222	0.071	No
Dieldrin	0.0012	1.063	0.001	0.000	12.800	e	0.000	0.000	No
Lindane	0.00064	1.021	0.001	0.000	5.220	f	0.000	0.000	No
Chlordane	0.0017	1.999	0.003	0.001	0.010	g	0.340	0.109	No
Mercury[4]	NA	NA	0.230	0.074	0.140	h	1.643	0.526	Yes/No

Notes:

1 TTC = trophic transfer coefficient from USEPA, Draft Water Quality Criteria Methodology Revisions: Human Health, Federal Register, August 14, 1998.

2 SFF = Site Foraging Factor

3 No observed effects levels are from U.S.Army Corp of Engineers, Environmental Residual Effects Database (2000). Available: http://www.wes.army.mil/el/t2dbase.html

a = 0.6 mg/kg LOAEL for reproduction effects in the fathead minnow (Level 3), from Jarvinen, A.W., M.J. Hoffman, and T.W. Thorslund. Exposure route is combined.

b = 1.09 mg/kg LOAEL for physiological effects in the rainbow trout (Level 4) from Poels, C.L.M., van Der Gaag, M.A., van de Kerkhoff, J.F.J. Exposure route is combined.

c = 0.157 mg/kg NOAEL for mortality in the mosquito fish (Level 3) from Metcalf, R.L. Exposure route is combined.

d = 1.6 mg/kg LOAEL for behavioral effects in the minnow (Level 3), from Bengtsson, B.E. Exposure route is ingestion.

e = 12.8 mg/kg NOAEL for mortality in the sheepshead minnow (Level 3) from Guarino, A.M. and S.T. Arnold. Exposure route is combined.

f = 5.22 mg/kg ED 50 for mortality in the pinfish (Level 3) from Schimmel, S.C., Patrick, J.M., Forester, J. Exposure route is combined.

g = 0.01mg/kg NOAEL for mortality in the spot (Level 4), from Schimmel, S.C., Patrick, J.M., Forester, J. Exposure route is combined.

h = 0.14 mg/kg NOAEL for growth in the rainbow trout (Level 4), from Guarino and Arnold. Exposure route is ingestion.

4 Mercury concentrations in Level 4 fish tissue were modeled as described in Attachment A of the Site 40 RI Report Addendum

Table 10-31
Estimated Concentrations in Level 4 Fish Species at Site 40
Maximum Concentrations Compared to Lowest Level 4 Fish NOED Potentially Inhabiting Bayou Grande

Constituents	Measured Maximum Conc. in Level 3 Fish (mg/kg)	TTC[1]	Estimated Con in Level 4 Fish with SFF[2] = 1 (mg/kg)	stimated Conc in Level 4 Fish with SFF[2] = 0.32 (mg/kg)	No Observed Adverse Effects Level (mg/kg)[3] Level 4 Species in Bayou Grande	Reference	HQ with SFF = 1	HQ with SFF = 0.32	Exceeds NOAEL?
4,4'-DDD	0.0038	3.254	0.012	0.004	5.300	a	0.002	0.001	No
4,4'-DDE	0.012	3.602	0.043	0.014	29.200	b	0.001	0.000	No
Aldrin	0.00066	1.006	0.001	0.000	0.157	c	0.004	0.001	No
Aroclor-1260	0.1	3.733	0.373	0.119	4.400	d	0.085	0.027	No
Dieldrin	0.0013	1.063	0.001	0.000	12.800	e	0.000	0.000	No
Lindane	0.00074	1.021	0.001	0.000	5.220	f	0.000	0.000	No
Chlordane	0.0017	1.999	0.003	0.001	0.010	g	0.340	0.109	No
Mercury[4]	NA	NA	5.700	1.824	2.000	h	2.850	0.912	Yes/No

Notes:

1 TTC = trophic transfer coefficient from USEPA, Draft Water Quality Criteria Methodology Revisions: Human Health, Federal Register, August 14, 1998.

2 SFF = Site Foraging Factor

3 No observed effects levels are from U.S.Army Corp of Engineers, Environmental Residual Effects Database (2000). Available: http://www.wes.army.mil/el/t2dbase.html

If Level 4 fish data were not available, the lowest NOAEL for a Level 3 fish potentially inhabiting Bayou Grande was used

a = 0.6 mg/kg LOAEL for reproduction effects in the fathead minnow (Level 3), from Jarvinen, A.W., M.J. Hoffman, and T.W. Thorslund. Exposure route is combined.

b = 1.09 mg/kg LOAEL for physiological effects in the rainbow trout (Level 4) from Poels, C.L.M., van Der Gaag, M.A., van de Kerkhoff, J.F.J. Exposure route is combined.

c = 0.157 mg/kg NOAEL for mortality in the mosquito fish (Level 3) from Metcalf, R.L. Exposure route is combined.

d = 4.4 mg/kg NOAEL for growth effects in the striped bass (Level 4) from Westin, D.T., Olney, C.E., Rogers, B.A. Exposure route is ingestion.

e = 12.8 mg/kg NOAEL for mortality in the sheepshead minnow (Level 3) from Parrish, P.P., J.A. Couch, J. Forester, J.M. Patrick, and G.H. Cook. Exposure route is ingestion.

f = 5.22 mg/kg ED 50 for mortality in the pinfish (Level 3) from Schimmel, S.C., Patrick, J.M., Forester, J. Exposure route is combined.

g = 0.01mg/kg NOAEL for mortality in the spot (Level 4), from Schimmel, S.C., Patrick, J.M., Forester, J. Exposure route is combined.

h = 2 mg/kg NOAEL for physiological effects in the winter flounder (Level 4), from Manen, C.A., B. Schmidt-nielsen and D.N. Russell. Exposure route is ingestion.

4 Mercury concentrations in Level 4 fish tissue were modeled as described in Attachment A of the Site 40 RI Report Addendum to the text.

TABLE 10-32
Estimated Concentrations in Level 4 Fish Species at Site 40
Mean Concentrations Compared to Lowest Level 4 Fish NOED Potentially Inhabiting Bayou Grande

Constituents	Mean Conc. in Level 3 Fish (mg/kg)	TTC[1]	Estimated Conc. in Level 4 Fish with SFF[2] = 1 (mg/kg)	Estimated Conc. in Level 4 Fish with SFF[2] = 0.32 (mg/kg)	No Observed Adverse Effects Level (mg/kg)[3] Level 4 Species in Bayou Grande	Reference	HQ with SFF = 1	HQ with SFF = 0.32	Exceeds NOAEL?
4,4'-DDD	0.0032	3.254	0.010	0.003	5.300	a	0.002	0.001	NO
4,4'-DDE	0.011	3.602	0.040	0.013	29.200	b	0.001	0.000	NO
Aldrin	0.00041	1.006	0.000	0.000	0.157	c	0.003	0.001	NO
Aroclor-1260	0.095	3.733	0.355	0.113	4.400	d	0.081	0.026	NO
Dieldrin	0.0012	1.063	0.001	0.000	12.800	e	0.000	0.000	NO
Lindane	0.00064	1.021	0.001	0.000	5.220	f	0.000	0.000	NO
Chlordane	0.0017	1.999	0.003	0.001	0.010	g	0.340	0.109	NO
Mercury[4]	NA	NA	0.230	0.003	2.000	h	0.115	0.002	NO

Notes:

1 TTC = trophic transfer coefficient from USEPA, Draft Water Quality Criteria Methodology Revisions: Human Health, Federal Register, August 14, 1998.

2 SFF = Site Foraging Factor

3 No observed effects levels are from U.S.Army Corp of Engineers, Environmental Residual Effects Database (2000). Available: http://www.wes.army.mil/el/t2dbase.html

If Level 4 fish data were not available, the lowest NOAEL for a Level 3 fish potentially inhabiting Bayou Grande was used

a = 5.3 mg/kg NOAEL for mortality in the mosquito fish (Level 3), from Metcalf, R.L. Exposure route is combined.

b = 29.2 mg/kg NOAEL for mortality in the mosquito fish (Level 3) from Metcalf, R.L. Exposure route is combined.

c = 0.157 mg/kg NOAEL for mortality in the mosquito fish (Level 3) from Metcalf, R.L. Exposure route is combined.

d = 4.4 mg/kg NOAEL for growth effects in the striped bass (Level 4) from Westin, D.T., Olney, C.E., Rogers, B.A. Exposure route is ingestion.

e = 12.8 mg/kg NOAEL for mortality in the sheepshead minnow (Level 3) from Parrish, P.P., J.A. Couch, J. Forester, J.M. Patrick, and G.H. Cook. Exposure route is ingestion.

f = 5.22 mg/kg ED 50 for mortality in the pinfish (Level 3) from Schimmel, S.C., Patrick, J.M., Forester, J. Exposure route is combined.

g = 0.01mg/kg NOAEL for mortality in the spot (Level 4), from Schimmel, S.C., Patrick, J.M., Forester, J. Exposure route is combined.

h = 2 mg/kg NOAEL for physiological effects in the winter flounder (Level 4), from Manen, C.A., B. Schmidt-nielsen and D.N. Russell. Exposure route is ingestion.

4 Mercury concentrations in Level 4 fish tissue were modeled as described in Attachment A of the Site 40 RI Report Addendum to the text.

Risk Characterization

As shown in Table 10-29, using the maximum concentrations, SFF of 1 and 0.32, and the lowest effects level from ingestion, it appears that there is a potential risk to level 4 fish species due to dietary exposure of mercury from Level 3 fish species. This is because the compound yielded HQ values of greater than 1 using the maximum detected concentrations in Level 3 fish. Based on the information from Guarino and Arnold, possible effects could include growth changes. All the other parameters have HQs less than 1will not be discussed further in this risk characterization.

The HQ for mercury only slightly exceed 1 when the mean concentration (0.23 mg/kg) was used with an SFF of 1, and was below 1 with an SFF of 0.32 (Table 10-30). In Tables 10-31 and 10-32, the estimated Level 4 fish concentrations were compared to NOAELs that are more representative of Level 4 fish that could inhabit Bayou Grande. Using the maximum concentration for mercury, the HQ is greater than 1 for mercury using an SFF of 1, but is less than 1 with an SFF of 0.32. Mercury HQs are less than 1 when the mean concentration is used in Table 10-32.

10.2.8.5 Benthic Community Analysis

Benthic community analysis is the final link in the sediment quality triad. These data show what effects are actually occurring in the area sampled, possibly due to site contamination. Species diversity results on their own are not considered as reliable an indicator of ecological risk due to the many influencing factors such as sediment type, sediment deposition rates, water temperature, salinity, waterborne nitrates and phosphates, dissolved oxygen, or a host of other factors not directly related to site contamination. Therefore, it is important to view species diversity in context with contaminant concentrations and toxicity test results. The four tests (Shannon-Weiner, Pielou's Evenness, Margalef's Richness Diversity, and MacArthur Model) that were run on the results are described below.

Shannon-Weiner Index is an index of species diversity. For example, the high number of *Polymesoda* (freshwater clams) in site 40-04 is an indication that the field sampling crew hit a "pocket" of these bivalves which accounts for the low diversity (Shannon-Weiner) of the species at this site.

Pielou's Evenness Index may be used as an additional tool for measuring the quality of the environment. Generally, a value of one (or close to one) is considered healthy and indicates an even distribution of abundance and number of species.

Margalef's Richness Diversity includes both components of species diversity; richness of species and distribution of individuals among the species. This index emphasizes the component of diversity due to the distribution of individuals among species, which can readily be extracted from the overall data sets. The index is reflective of the number of sample grabs per site in which the data is combined and an estimate of the occurrence of the expected number of species per 1,000 organisms which may be encountered.

The MacArthur Model results in a distribution quite frequently observed in nature — one with a few relatively abundant species and increasing numbers of species represented by only a few individuals. The MacArthur Model estimates the distribution based on the sampling stations, but there were not enough stations in these data sets to adequately use this method of analysis.

The results of the Shannon-Weiner Diversity, Pielou's Evenness, Margalef's Richness, and MacArthur's Equitability tests are shown on Figure 10-1, are summarized in Table 10-33 and are presented in Appendix F.

Table 10-33
Benthic Community Taxonomy and Indices at Site 40 Sample Locations

				AZ-1			AZ-2		AZ-3	AZ-4		
TAXON	**FAMILY**	**Species**	**40-01**	**40-02**	**40-03**	**40-04**	**40-05**	**40-06**	**40-07**	**40-09**	**40-10**	**Sum**
Nemertea	Unid.	LPIL		1	4		8	1	4	1		19
Echiurida	Echiuridae	LPIL							1			1
Gastropoda	Hydrobiidae	Onobops sp.	1									1
Gastropoda	Littorinidae	Littorina irrorata									4	4
Gastropoda	Melampidae	Detracia floridana							1			1
Gastropoda	Melampidae	Melampus sp.			1						1	2
Gastropoda	Planorbidae	LPIL				1						1
Pelecypoda	Corbiculidae	Polymesoda sp.	2			200			12	41		255
Pelecypoda	Mytilidae	Amygdalum papyrium		3	2			1				6
Pelecypoda	Solecurtidae	Tagelus plebius								1		1
Polychaetae	Ampharetidae	Hobsonia florida	2									2
Polychaetae	Capitellidae	Capitella capitata	1	34	2	2	69	5				113
Polychaetae	Capitellidae	Mediomastus californiensus		5	4		54		3		1	67
Polychaetae	Goniadidae	Glycinde solitaria							1			1
Polychaetae	Nereidae	Neanthes sp.		3	3		2					8
Polychaetae	Orbiniidae	Scolopus fragillis			5	5	2					12
Polychaetae	Paronidae	Aricidae sp.								7		7
Polychaetae	Pilargiidae	Parandalia americana				1						1

Table 10-33
Benthic Community Taxonomy and Indices at Site 40 Sample Locations

				AZ-1			AZ-2		AZ-3	AZ-4		
TAXON	**FAMILY**	**Species**	**40-01**	**40-02**	**40-03**	**40-04**	**40-05**	**40-06**	**40-07**	**40-09**	**40-10**	**Sum**
Polychaetae	Sabellidae	Chone cf. Americana				1						1
Polychaetae	Spionidae	Paraprionospio pinnata		1								1
Polychaetae	Spioidae	Polydora sp.										
Polychaetae	Spionidae	Streblospio benedicti		10	2		73	10	29		26	150
Cladocea	Unid.	LPIL					2					2
Isopoda	Anthuridae	Cyathura polita	1			1						2
Cumacea	Nannasticidae	Almyracuma sp.						1				1
Decapoda	Unid. Larvae	LPIL				1						1
Coleoptera	Chelonariidae	Chelonarum sp.	1									1
Totals			8	57	23	212	210	18	51	50	32	661
Number of Species			6	7	8	8	7	5	7	4	4	28
Shannon-Weiner Diversity			2.499	1.845	2.855	0.452	1.933	1.679	4.793	0.858	0.931	2.770
Pielou's Evenness, J'			1.395	0.948	1.373	0.218	0.993	1.043	2.463	0.619	0.671	0.831
Margalef's Richness, D			4.419	6.753	7.681	7.813	6.813	4.654	6.746	3.744	3.711	27.848
MacArthur's Equitability			—	—	—	0.188	0.714	—	—	—	—	0.339

Note:
An error in sampling process resulted in a benthic sample not being collected at Station 08.

Generally, polychaetes dominated the benthic community across the site. For all stations combined, three "pollution tolerant" polychaete species (Olinger *et al.*, 1975; Reish, 1960; and Gilet, 1960) — *Capitella capitata, Mediomastus californiensus*, and *Streblospio benedicti* — comprised approximately half of the individuals identified (See Table 10-33).

The occurrence of the representatives from the *Echiuridae* (spoon worms), *Sabellidae* (annelid worms), and *Nannasticidae* (worm) families, sites 40-07, 40-04, and 40-06 respectfully, are good indicators of a healthy benthic environment. The high number of *Polymesoda* (freshwater clams) in site 40-04 is an indication that the field sampling crew hit a "pocket" of these bivalves which accounts for the low diversity (Shannon-Weiner) of the species at this site.

10.2.9 Risk Characterization by AZ

The above data are tabulated by AZ to correlate contaminant levels with effects using the sediment quality triad approach. Contaminant concentrations in sediment are evaluated by evaluating the maximum HQ value for each contaminant class. As there were no toxic effects relative to laboratory controls, all values for these samples will consistently show no observed contaminant effects. Species diversity is compared with the different diversity indices calculated. Predicted impacts to higher trophic level fish species from bioaccumulating pesticides or PCBs are also considered using the fish and heron models. As there were no effects predicted from contaminant bioaccumulation, all values for these parameters will consistently show no predicted effect to higher level fish species or the heron.

AZ-1

Toxicity was not shown for any of the organisms chosen in the toxicity tests. In addition, the Pielou's Evenness Index for each sample location indicates that the area is healthy and there is an even distribution of abundance and number of species. Since foraging fish were not collected in this AZ, impacts to higher order fish species or the heron were not calculated. The data are shown on Table 10-34.

AZ-2

Because AZ-2 showed the highest DDT sediment concentration relative to the other AZs, particularly in the southern portion, it was chosen for analyzing fish tissue for contaminant bioaccumulation and predicting impacts to higher level fish species and the great blue heron. Location 6 was chosen for this analysis because its Phase IIA analytical results (AZ-2 locations 18 through 24) had the highest HI (33). Impacts are not predicted for either of these species, and toxicity was not shown for any organisms analyzed in the three sample locations. There was also a relatively large number of SSV exceedances for metals and SVOCs from location 6 and the other two AZ-2 sample locations. Except for Location 4, the Pielou's Evenness Index for each of the sample locations is near 1, indicating that the area is healthy and there is an even distribution of abundance and number of species. Locations 4 and 6 also had representatives from the *Sabellidae* (annelid worms) and *Nannasticidae* (worm) families, which are indicators of a healthy environment. The data are shown on Table 10-35.

AZ-3

Except for SVOCs, AZ-3 showed lower numbers and concentrations of contaminants than AZ-1. SVOCs showed particularly elevated HQ values for sample location 040M2B0701. Toxicity was not shown for any of the organisms analyzed in sample location 7 in AZ-3. Data are shown on Table 10-36. The occurrence of the representative from the *Echiuridea* family (spoon worm) indicates a healthy environment (Table 10-36).

Table 10-34
Phase IIB/III
Sediment Quality Triad Analysis for AZ-1

Sample Location	Maximum HQ metals	Maximum HQ Pesticides/PCBs	Maximum HQ SVOCs	Toxicity Above Control?	Shannon-Weiner Diversity	Pielou's Eveness	Margalef's Richness	MacArthur's Equitability	Predicted Higher Order Fish Impact?	Predicted Heron Impact?
01	0.09	NA	NA	No	2.499	1.395	4.419	—	NA	NA
02	2.22	1.28	0.25	No	1.845	0.948	6.753	—	NA	NA
03	3.44	0.39	0.72	No	2.855	1.373	7.681	—	NA	NA

Table 10-35
Phase IIB/III
Sediment Quality Triad Analysis for AZ-2

Sample Location	Maximum HQ metals	Maximum HQ Pesticides/PCBs	Maximum HQ SVOCs	Toxicity Above Control?	Shannon-Weiner Diversity	Pielou's Eveness	Margalef's Richness	MacArthur's Equitability	Predicted Higher Order Fish Impact?	Predicted Heron Impact?
04	0.04	NA	NA	No	0.452	0.218	7.813	0.188	NA	NA
05	1.63	15.13	0.58	No	1.933	0.993	6.813	0.714	NA	NA
06	4.14	6.47	1.76	No	1.679	1.043	4.654	—	Yes	No

Table 10-36
Phase IIB/III
Sediment Quality Triad Analysis for AZ-3

Sample Location	Maximum HQ metals	Maximum HQ Pesticides/PCBs	Maximum HQ SVOCs	Toxicity Above Control?	Shannon-Weiner Diversity	Pielou's Eveness	Margalef's Richness	MacArthur's Equitability	Predicted Higher Order Fish Impact?	Predicted Heron Impact?
07	0.56	NA	9.23	No	4.793	2.463	6.746	—	NA	NA

AZ-4

Except for SVOCs, AZ-4 showed comparable or lower numbers and concentrations of contaminants compared to AZ-1. Toxicity was not shown for any organisms analyzed in the three sample locations. The data are shown on Table 10-37.

10.2.10 Ecological Risk Summary and Conclusion

The screening-level risk assessment (Phase IIA) indicated a potential risk to ecological receptors in Bayou Grande. However, results of the sediment quality triad performed during Phase IIB/III do not support additional action. Toxicity tests showed no effects to benthic species from exposure to Site 40 sediments. Although perturbations were observed in benthic community populations between stations, no effects were predicted or shown from the other two components of the sediment quality triad. Therefore, it is difficult to account for the differences in species diversity, but natural variability or physicochemical effects may be the cause. The occurrences of spoon worms, fanworms, and nannasticidea at 40-07, 40-04, and 40-06 are indicators of a healthy environment as are the fresh water clams (*polymedsoda*) at 40-04. Furthermore, contaminant concentrations in surface water did not indicate acute or chronic impacts to fish.

Tissue concentrations from the composite fish samples were not at levels predicted to pose a risk to fish-eating birds. Concentrations did predict a risk to upper trophic level fish based on the model performed.

Since measurement endpoints are not impacted, it is not expected that the assessment endpoints are impacted either. Therefore, no ecological risk is predicted within Bayou Grande, and no further investigation is recommended.

Table 10-37
Phase IIB/III
Sediment Quality Triad Analysis for AZ-4

Sample Location	Maximum HQ metals	Maximum HQ Pesticides/PCBs	Maximum HQ SVOCs	Toxicity Above Control?	Shannon-Weiner Diversity	Pielou's Eveness	Margalef's Richness	MacArthur's Equitability	Predicted Higher Order Fish Impact?	Predicted Heron Impact?
08	1.78	1.81	6.02	No	NA	NA	NA	NA	NA	NA
09	0.06	NA	0.12	No	0.858	0.619	3.744	—	NA	NA
10	0.86	NA	NA	No	0.931	0.671	3.711	—	No	No

Note:
An error in the sampling process resulted in a benthic community sample not being collected at location 8.

10.2.11 Uncertainty

General uncertainties are inherent in ecological risk assessments. Table 10-38 provides information on the types of uncertainties that could impact final risk calculations. A plus (+) or minus (-) is associated with each uncertainty to provide a quantitative perspective. A plus suggests that the uncertainty has most likely resulted in an overestimation of risk, and a minus suggests an underestimation. Both signs indicate that the uncertainty could cause either under- or overestimation of risk.

Table 10-38
Uncertainties Associated with the Ecological Risk Assessment at Site 40, Bayou Grande

Uncertainty Issue	Effect on ERA
Sampling fish from a limited area of Bayou Grande	-
Variables in chemical contamination between Phases IIA and IIB	+ or -
Chemical degradation for selected ECPCs	+
Specific effects on biota within study area	+ or -
Effects data not available for some ECPCs	-
Synergistic or antagonistic effect of ECPCs	+ or -
Assumption for effects from similar compounds	+ or -
Use of related species for risk to selected receptor species	-
Dermal or inhalation pathways not evaluated	-
Maximum concentrations were used in the exposure model	+
Actual occurrence of wildlife species within contaminated area	+
Use of literature-generated ingestion rates	+ or -
Use of sediment screening values derived from laboratory studies	+
Exposure assumed to be 100%	+
Regional sediment characteristics not accounted for	+
Actual bioavailability not measured (assumed to be 100%)	+
Metal-specific effects not accounted for in benthic assessment	-
Use of NOAEL as basis of risk determination for birds	+
The most bioavailable form of a chemical was used in the screening assessment	+

Table 10-38
Uncertainties Associated with the Ecological Risk Assessment at Site 40, Bayou Grande

Uncertainty Issue	Effect on ERA
Use of SQAG-TELs as a basis of risk determination for benthos	+
Level 4 fish feed in many different areas	+
TTC values for organochlorine compounds are based on field data	+
Toxic residue effects levels cited from the US Army COE database may not be applicable to species in the Pensacola Bay System.	+/-
NOAEL values may actually be higher and LOAEL values may actually be lower than those values cited in the COE database.	+/-

Notes:
ERA = Ecological risk assessment
ECPC = Ecological Chemical of Potential Concern
\+ = May result in overestimate of risk.
— = May result in underestimate of risk.
Both signs indicate issue may result in either an over or underestimation of risk.

10.3 Human Health Exposure Assessment

This assessment examines the potential for human exposure to the contaminants detected in surface water and sediment at Site 40. Because surface water sampling in Bayou Grande would only provide a snapshot in time and only validate general surface water quality conclusions, limited surface water sampling was performed. Surface water data were evaluated in terms of risk to human health, although surface water conditions in Bayou Grande reflect contributions from natural background, other anthropogenic sources, as well as potential transport from NAS Pensacola. Sediments on shore were not sampled in that they do not represent an environment conducive to deposition. These sediments are winnowed regularly by both wind and water and as a result are composed of well sorted fine to medium grain quartz sand. These sands are chemically inert offering negligible exposure because of the grain size. However, surface soil samples were collected at the IRP sites along Bayou Grande including Sites 1, 15, 11 (part of OU 2), 13 (part of the OU 10 RI report) and OU 10 (Sites 32, 33, and 35). The ecological and human health risk assessments for each of those sites was performed and are included in their respective RI reports. For these reasons, only submerged sediments were sampled for Site 40.

Exposure to contaminants residing in sediment was considered to be insignificant since these sediments are continuously submerged. However, unfiltered surface water contains suspended sediments and was evaluated for human health risks via dermal contact and incidental ingestion exposure routes. Exposure to contaminants resulting from incidental ingestion of surface water and ingestion of fish, shellfish, and crabs was considered to represent the most likely exposure pathways in terms of human health risk. Surface water samples were collected from Assessment Zones 1, 3, and 4. Prey fish samples were collected from Assessment Zone 2.

Site History

The history of Bayou Grande near NAS Pensacola has been discussed in Section 2 of this RI.

Site Description

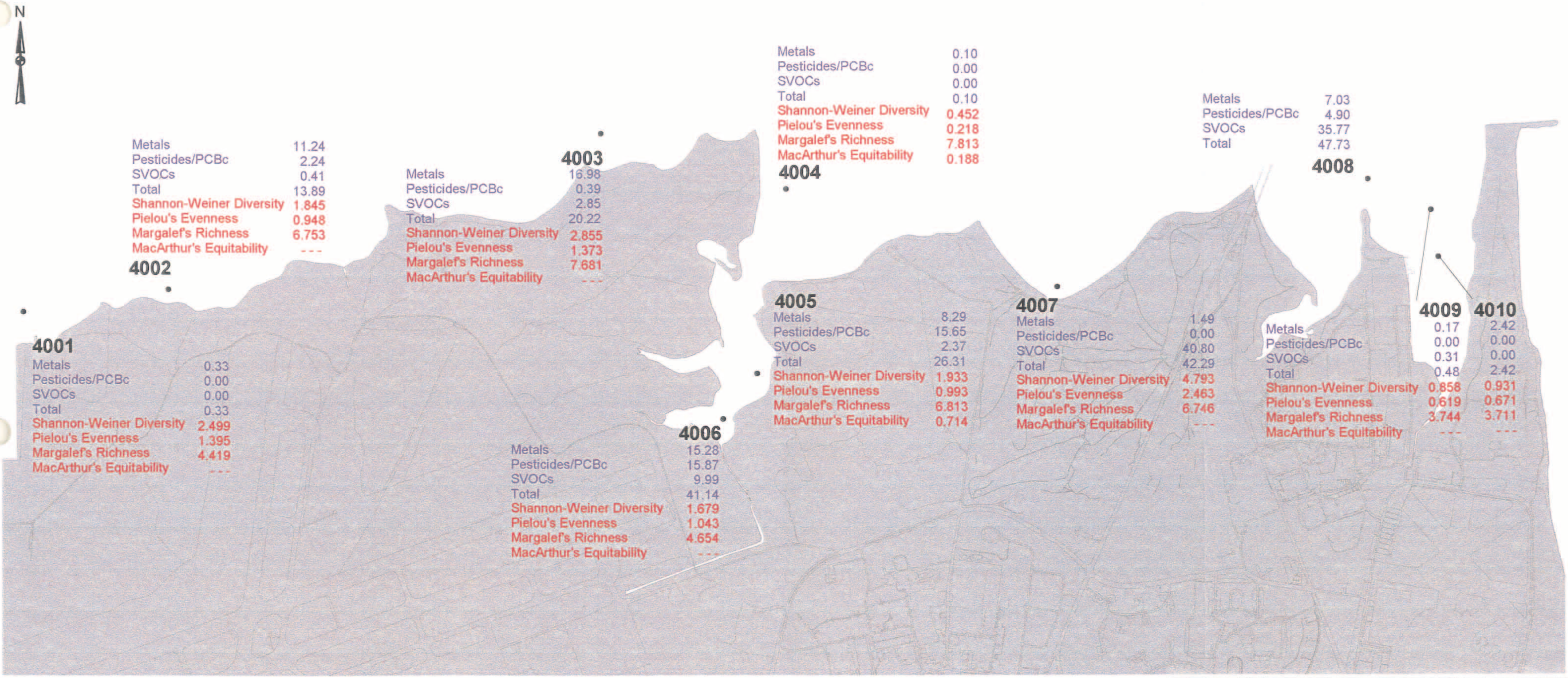
A comprehensive description of the site is provided in Section 3 of this RI.

Current Use

NAS Pensacola Site 40, near the Family Picnic Area and at the Sailing Facility, is currently used for swimming, fishing and other boating activities. Human contact with site sediment and surface water is of short duration, for example during swimming activities. Seasonal water temperatures limit swimming to the warmer months of the year, generally May through September, while fishing and crabbing are year round activities.

10.3.1 Exposure Scenarios

The potential transport and exposure pathways are shown in the stem-and-leaf type conceptual site model, Figure 10-3. Potential human receptors include a recreational swimmer, a fisher, and a commercial worker (e.g. a lifeguard). The fisher and the commercial worker scenarios were considered to be conservatively representative of any potential site worker exposures. Brief explanations of the selected model components are provided below:



LEGEND

- 4001 - SAMPLE LOCATION AND IDENTIFICATION

SEDIMENT CHEMISTRY AND HAZARD INDICES ARE PRESENTED IN SECTION 10.2.8.1

BETHNIC COMMUNITY ANALYSIS PRESENTED IN SECTION 10.2.8.5

2000 0 2000 Feet

SITE 40
REMEDIAL INVESTIGATION
NAS PENSACOLA
PENSACOLA, FLORIDA

FIGURE 10-2
PhaseIIB/III Sample Locations, HI Values and Bethnic Community Analysis

//gis1/work_dir/pensacola.apr

date: April 19, 2000

- ***Fish ingestion*.** The fisher receptor was assumed to be exposed to contaminants reported in the Bayou through consumption of contaminated fish and shellfish.

- ***Vapor inhalation*.** Since the open nature of the site will unlikely allow for appreciable air buildup of VOCs, the vapor inhalation exposure pathway is considered a *potential but insignificant pathway*. Additionally, only one VOC was reported in surface water at a low concentration.

- ***Dermal contact*.** Dermal contact with deposited sediment is considered a *potential but insignificant pathway* for Site 40. Human exposures to contaminants reported in sediment is limited due to the overlying surface water and to a reduced adsorption of sediment to skin (submerged sediments tend to wash off of the skin). Dermal contact with suspended or dissolved solids and sediments is considered in the evaluation of dermal contact with the whole surface water samples (surface water samples were not filtered prior to analysis).

- ***Incidental ingestion*.** The recreational swimmer, the fisher, and the commercial worker may ingest small amounts of surface water involuntarily. The swimmer and the commercial worker may directly swallow small amounts of surface water while swimming, whereas the fisher may incidentally ingest splashed or sprayed surface water.

Swimming

Swimming is allowed at Site 40 at the Family Picnic Area near Site 1 and at the Sailing Facility. Off base across the Bayou to the North, private landowners swim, fish, and crab without limitations of base regulations. However, public access to the bayou is limited to boating. Some areas of Bayou Grande along the base are not posted as "no swimming areas", and swimming in these areas is assumed to be limited by difficulty gaining access to the site. No swimming is allowed along the NAS Pensacola Golf course shoreline, and this is enforced by Navy security. Public boating and skiing are common activities in the Bayou.

To evaluate the significance of concentrations of contaminants reported in surface water samples, data were compared to Federal Ambient Water Quality Criteria and surface water PRGs. Federal AWQCs were taken from 40 CFR 131.36 and are human health based. It was assumed that the Bayou was not a primary drinking water source due to its salinity and the concentrations based on the consumption of organisms only were used for screening purposes in this risk assessment. Surface water PRGs were calculated for adolescent recreational swimmers and adult commercial workers (e.g., lifeguards). The receptor populations were selected based on the swimming activities that have been observed in the Bayou. These receptor populations are reasonably representative of other recreational activities such as fishing (with respect to the fisher's direct contact to surface water; indirect contact with surface water contaminants through fish ingestion is addressed separately) and water skiing. It is assumed that both the adolescent recreational swimmer and the commercial worker are both exposed to contaminants (dissolved and suspended) in surface water through incidental ingestion of and dermal contact with the surface water. The equations and associated parameters used to calculate these PRGs are presented below. Calculated PRGs are presented in Table 10-39.

Adolescent Recreational Swimmer and Occupational Adult — Noncancer

$$PRG = \frac{THQ * BW * ATnc}{ET * EF * ED\left[\left(\frac{SA * Kp * ABS * CF}{RfD * ADJ}\right) + \left(\frac{IR}{RfD}\right)\right]}$$

Adolescent Recreational Swimmer and Occupational Adult — Cancer

$$PRG = \frac{TR * BW * ATc}{ET * EF * ED\left[\left(SA * Kp * ABS * CF * SF \big/ ADJ\right) + \left(IR * SF\right)\right]}$$

Where:

PRG	Preliminary Remediation Goal	mg/L	calculated
THQ	Target Hazard Quotient	unitless	1
TR	Target Risk	unitless	1E-06
BW_{adol}	Body Weight - Adolescent[a,c]	kg	46
BW_{adult}	Body Weight - Adult	kg	70
AT_{nc} - adol.	Averaging Time Noncancer - Adolescent	days	3,650
AT_{nc} - adult	Averaging Time Noncancer - Adult	days	9,125
AT_c	Averaging Time Cancer	days	25,550
ET	Exposure Time[a]	hours	1
EF	Exposure Frequency[b]	days/yr	45
$ED_{adol.}$	Exposure Duration - Adolescent[c]	yrs	10
ED_{adult}	Exposure Duration - Adult	yrs	25
SA_{adol}	Skin Surface Area - Adolescent[a]	m^2/hr	1.56
SA_{adult}	Skin Surface Area - Adult[a]	m^2/hr	2.3
IR	Ingestion Rate[f]	L/hr	0.05
Kp	Dermal Permeability Constant[d]	cm/hr	chemical specific
ABS	Absorption Factor[b]	unitless	chemical specific
ADJ	Dermal Adjustment[b]	unitless	chemical specific
RfD	Reference Dose	mg/kg-day	chemical specific
SF	Slope Factor	$(mg/kg\text{-}day)^{-1}$	chemical specific
CF	Conversion Factor	L/cm-m^2	10

Notes:

a = United States Environmental Protection Agency (USEPA). 1997. *Exposure Factors Handbook*, EPA/600/P-95/002Fa. Office of Research and Development, National Center for Environmental Assessment, Washington, DC.

b = United States Environmental Protection Agency (USEPA). 1995. *Supplemental Guidance to RAGS: Region 4 Bulletins, Human Health Risk Assessment* (Interim Guidance). Waste Management Division, Office of Health Assessment.

c = The adolescent is assumed to be between the ages of 7 and 17 years of age.

d = Oak Ridge National Laboratory (ORNL). *Risk Assessment Information System*. Available on line at http://risk.lsd.ornl.gov/rap_hp.htm.

Surface Water

Limited surface water samples taken from Site 40 for ecological risk indicate one VOC, no SVOCs, two pesticides, no PCBs and 14 metals were detected in the brackish water of Bayou Grande. Table 10-39 summarizes surface water data and compares these data to Federal AWQC, Florida Surface Water Quality Criteria, and surface water PRGs. The surface water PRGs presented on Table 10-40 represent the lowest value calculated for either the adolescent recreational swimmer or the adult commercial worker. The primary comparisons for purposes of this risk assessment were to Federal AWQCs and surface water PRGs since these concentrations are both risk based. The Florida SWQCs are a mixture of human health risk based and ecological health based concentrations, and as a result, these values are presented for informational purposes only and not as a screening tool for purposes of this risk assessment. As shown, only one surface water concentration of arsenic from AZ-1 was reported at levels above the Federal AWQC. Arsenic was not identified as a COC based on the evaluation of the fish tissue data as presented in the following subsection.

Fishing and Crabbing

Fishing and crabbing activities are allowed and observed at Site 40. Although fishing does occur, access is limited to boating traffic because of base restrictions on the southern side of the bayou and private residences on the north and west sides of the bayou. Site 40 does not support sufficient game for subsistence fishing, based on the habitat and biota survey data in the Ecological Risk Assessment and the data from the Florida Marine Patrol Office. The Florida Marine Patrol Office was contacted to obtain information on the frequency of fishing in Bayou Grande. Between the months of April and September, approximately 10 boats per day are in the bayou for fishing and between the months of October and March, only one or two boats per day are observed. A full bag limit (one redfish and five trout) is not frequently observed. Most boats catch only one redfish or trout. This suggests that subsistence fishing is not occurring in Bayou Grande. In addition, commercial fishing does not occur in Pensacola Bay or any Florida coastal water because of the net ban, so fishing is limited to a recreational activity pattern.

Table 10-39
Preliminary Remediation Goals for Surface Water
NAS Pensacola, Site 40, Bayou Grande
Pensacola, Florida

	Oral RfD (mg/kg-day)	Oral SF (kg-day/mg)	ADJ (--)	ABS (--)	Kp (cm/hr)	Recreational Swimmer PRGs hazard based (mg/L)	Recreational Swimmer PRGs risk based (mg/L)	Commercial Worker PRGs hazard based (mg/L)	Commercial Worker PRGs risk based (mg/L)
Aluminum	1	NA	0.2	0.001	0.001	7462	NA	11355	NA
Arsenic	0.0003	1.5	0.2	0.001	0.001	2.2	0.035	3.4	0.021
Barium	0.07	NA	0.2	0.001	0.001	522	NA	795	NA
Calcium	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chromium	0.005	NA	0.2	0.001	0.001	37	NA	57	NA
Copper	0.04	NA	0.2	0.001	0.001	298	NA	454	NA
delta-BHC	NA	1.8	0.5	0.01	0.0031	NA	0.028	NA	0.017
Endrin	0.0003	NA	0.5	0.01	0.016	2.2	NA	3.3	NA
Iron	NA	NA	NA	NA	NA	NA	NA	NA	NA
Magnesium	NA	NA	NA	NA	NA	NA	NA	NA	NA
Manganese	0.02	NA	0.2	0.001	0.001	149	NA	227	NA
Potassium	NA	NA	NA	NA	NA	NA	NA	NA	NA
Selenium	0.005	NA	0.2	0.001	0.001	37	NA	57	NA
Sodium	NA	NA	NA	NA	NA	NA	NA	NA	NA
Toluene	0.2	NA	0.8	0.01	0.045	1342	NA	1948	NA
Vanadium	0.007	NA	0.2	0.001	0.001	52	NA	79	NA
Zinc	0.3	NA	0.2	0.001	0.001	2239	NA	3406	NA

Exposure Parameters

THQ	1	
TR	1E-06	
IR	0.05	L/hr
SA - adoles.	1.56	m2/hr
SA - adult	2.3	m2/hr
ET	1	hr/day
EF	45	days/yr
ED - adoles.	10	yrs
ED - adult	25	yrs
CF	10	L/cm*m2
BW - adoles.	46	kg
BW - adult	70	kg
ATnc-adoles.	3650	days
ATnc-adult	9125	days
ATc	25550	days

Table 10-40
Surface Water Data Summary and Screening Comparisons
NAS Pensacola, Site 40, Bayou Grande
Pensacola, Florida

	Freqency of Detection		Range of Detected Concentrations		Range of SQL		Risk-based PRG[a]	Federal Ambient Water Quality Criteria[b]	Florida Class III Water Quality Criteria (Marine)[c]	Units
Aluminum	3	3	73.8	194	NA	NA	7500000	NA	1500	ug/L
Arsenic	1	3	2.5	2.5	2.2	2.2	21	0.14	50	ug/L
Barium	3	3	17.1	18	NA	NA	520000	NA	NA	ug/L
Calcium	3	3	183000	191000	NA	NA	NA	NA	NA	ug/L
Chromium	1	3	1.4	1.4	0.88	0.88	37000	NA	11	ug/L
Copper	3	3	2.1	7.8	NA	NA	300000	NA	2.9	ug/L
delta-BHC	1	3	0.0031	0.0031	0.0052	0.05	17	NA	NA	ug/L
Endrin	1	3	0.0071	0.0071	0.1	0.1	2200	0.81	0.0023	ug/L
Iron	3	3	34.7	230	NA	NA	NA	NA	300	ug/L
Magnesium	3	3	599000	615000	NA	NA	NA	NA	NA	ug/L
Manganese	1	3	7.9	7.9	0.3	4	150000	NA	NA	ug/L
Potassium	3	3	255000	278000	NA	NA	NA	NA	NA	ug/L
Selenium	1	3	3.6	3.6	2.6	2.6	37000	NA	71	ug/L
Sodium	3	3	5180000	5420000	NA	NA	NA	NA	NA	ug/L
Toluene	1	3	0.33	0.33	1	1	1300000	200000	NA	ug/L
Vanadium	2	3	2.1	2.1	2.1	2.1	52000	NA	NA	ug/L
Zinc	1	3	17.9	17.9	3.7	3.7	2200000	NA	86	ug/L

a Risk-based surface water PRG which consideres recreational and commercial uses of surface water. (see Table 10-11)
b Risk-based Federal Ambient Water Quality Criteria which considers the consumption of organisms only. (see 40 CFR 131.36)
c Florida Criteria for Surface Water Quality Classifications, Class III - Marine. (see F.A.C. 62-302.530)

Table 10-41 below, compares maximum detected values in fish tissue collected from AZ-2 to fish ingestion RBCs (USEPA Region III, 1998). The risk estimates were calculated using the ratio of the fish ingestion RBC and the reported concentration. The fish ingestion RBCs are based on a daily consumption rate of 54 grams per day for the entire year (350 days per year). This ingestion rate and exposure frequency is equivalent to the per capita intake value of 59 g/day reported in the EPA Exposure Factors Handbook for the Native American Subsistence Fishing Population (USEPA Exposure Factors Handbook, Table 10-85, p. 10-80). A Gulf Coast specific intake rate for the recreational marine angler is reported as 7.2 g/day and 26 g/day for the mean intake and 95th percentile intake, respectively.

The tissue data in Table 10-41 are not from game fish typically harvested by humans. Rather, these data present whole body prey species (i.e., minnows) used in the ecological risk assessment. Concentrations of organochlorine pesticides and PCBs are assumed to build up in the predatory game fish from eating the prey fish.

Table 10-41
Maximum Detections in Whole Body Prey Fish Compared to RBCs

Parameter	Result*	Fish Ingestion RBC		Exceeds RBC	Risk
4,4'-DDD	3.8	13	c	No	
4,4'-DDE	12	9.3	c	Yes	1.29e-06
Aldrin	0.66	0.19	c	Yes	3.47e-06
Aroclor-1260	100	1.6	c	Yes	6.25e-05
Dieldrin	1.3	0.2	c	Yes	6.50e-06
Lead (Pb)	2.2	na	na	na	
gamma-BHC (Lindane)	0.74	2.4	c	No	
gamma-Chlordane	1.7	8.9	c	No	

Notes:
* = *All units are in µg/kg, except for lead which is in mg/kg.*
na = *not available*
c = *carcinogen*

Based on the results of the comparison provided in Table 10-41, a more detailed analysis of potential concentrations in predatory fish was performed. That analysis is contained in the Remedial Investigation Report Addendum.

Future Land Use

These submerged lands are owned by the State of Florida. Future land use at NAS Pensacola adjacent to Site 40 will be limited to swimming, boating, and fishing exposure routes. Since these are submerged lands, any construction activities in these areas would require FDEP permits and or approval.

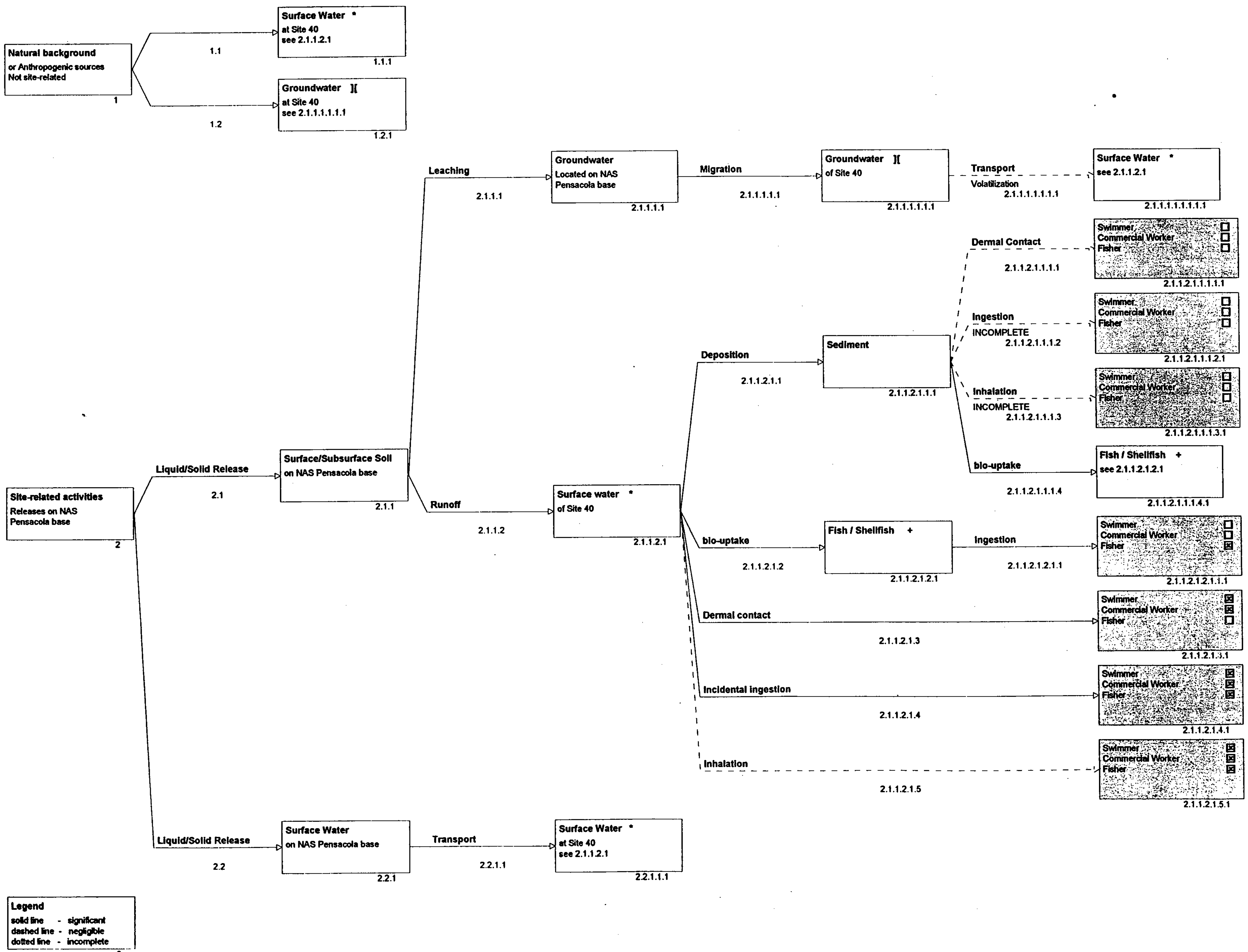
10.3.2 Human Health Risk Assessment Uncertainties

General uncertainties are inherent in human health risk assessments. Specific uncertainties and their effect on the risk assessment are listed below for the surface water pathway. Uncertainities for the fish consumption scenario are contained in the Site 40 Remedial Investigation Report Addendum.

10.3.3 Human Health Risk Summary

Surface Water

Surface water data were summarized and screened against risk-based surface water PRGs and Federal AWQCs. Except for arsenic, no other chemical exceeded either screening value. Arsenic was reported in surface water at a concentration above its Federal AWQC. It was not subsequently identified as a COC based on the risk-based evaluation of fish tissue data.



SITE 40
REMEDIAL INVESTIGATION
NAVAL AIR STATION
PENSACOLA
PENSACOLA, FLORIDA

FIGURE 10–3
POTENTIAL TRANSPORT AND EXPOSURE PATHWAYS FOR HUMAN HEALTH RISK ASSESSMENT

DWG DATE: 01/20/99 | DWG NAME: CLN17X11

11.0 CONCLUSIONS AND RECOMMENDATIONS

11.1 Assessment Zone 1

Site Description

AZ 1 includes portions of the NAS Pensacola shoreline along Bayou Grande from a point near Soldiers Creek to Deepwater Point. Sediments within this zone are mostly fine-grained and characteristic of a low-energy tidal regime. Very few contaminant source areas were identified for this AZ.

Within AZ 1, Wetlands 25,66,67,27,28,69,70,39,40,41,42, and 43 respectively (east to westward) spill into Bayou Grande during the wet season. Many of these isolated wetlands are tidally influenced and support a rich diversity of submerged and emergent aquatic vegetation. In addition, Wetlands 28 and 39 have been found to harbor storm water outfall pipes which drain portions of the runway along Forrest Sherman Field.

Nature and Extent

Inorganic detections occurred across AZ 1 and do not appear to be related to NAS Pensacola IRP sites or activities associated with Forrest Sherman Field. Pesticides were generally not detected in AZ 1. PCBs were detected frequently. Few SVOC parameters and only one VOC (acetone, a common laboratory contaminant) were detected in AZ 1.

Few contaminant source areas were identified for this AZ. Potential sources include former IRP site (UST) 18 and Forrest Sherman Field, which lie south of the zone. The UST 18 investigation determined that the contaminants were not migrating offsite (E/A&H, 1996). Wetlands 25 and 27 were used as reference wetlands for the Site 41 investigation because of the lack of a pathway from NAS Pensacola sites. In addition, the other wetlands in this AZ (Wetlands 39, 70, and 28) were determined not to have a pathway from NAS Pensacola sites and were not sampled in the Site 41 RI (EnSafe, *in press*). Wetland 72, which drains storm water from the north central portion of Forrest Sherman Field to Bayou Grande through Wetland 39 was sampled during the Site 41 RI. A Blue Coded wetland, Wetland 72 was expected to have isolated contaminant concentrations which were below applicable ecological screening criteria, and not related to any NAS Pensacola IRP site. The Site 41 RI discovered scattered metals, and a few pesticides and SVOCs in Wetland 72, indicating minimal potential impact on Wetland 39 and Bayou Grande from this drainage source (EnSafe, *in press*). The only other possible sources for AZ 1 are the numerous minor surface water drainage pathways which drain through the minor estuarine wetlands which line the shoreline throughout AZ 1. These cannot, however, be connected to an IRP site activity on the base.

Fate and Transport

Based on landform and watershed analysis, the only potential pathway to impact AZ 1 is storm water runoff and sediment entrainment form Forrest Sherman Field. Stormwater runoff pipes were noted in Wetland 39 and 28, most likely from channelized drainage off of Sherman Field. The coast line in AZ 1, generally undulating with poorly developed prominences is typical in representation of juvenile stages of spit development.

The juvenile spit, a prominent feature to the north of Wetland 27, exhibited a higher level of organics (location 119) than other areas in this zone, which can be attributed to deposition of runoff materials which have settled out leeward of the spit formation.

Ecological Risk Assessment

To evaluate risk to ecological receptors in Bayou Grande, the same four assessment endpoints listed for AZ 1 were evaluated for AZ 2. Measurement endpoints are presented for this AZ.

Protection of Benthic Macroinvertebrate Community and Protection of Nursery Habitat for Aquatic Resources

These two assessment endpoints have the same measurement endpoints so they are discussed together. AZ 1 is the farthest upstream of the AZs. As discussed earlier, there did not appear to be any distinctive pattern or areas where contaminants were particularly elevated. Within the sediment, HQ values calculated for metals were greater than 1 for arsenic, cadmium, chromium, copper, lead, mercury, nickel, and zinc. One HQ value calculated for metals exceeded 10 at sample location 040MZ130). Pesticides and PCBs exceeded SSV values for 4,4-DDD, 4,4-DDE, dieldrin, gamma-BHC, and PCBs. The maximum HQ (4.1) calculated for pesticides/PCBs was for gamma-BHC at location 040MZ106. SVOCs showed HQs above 1 for fluoranthene, 2-methylnapthalene, napthalene, and BEHP. One organic HQ value exceeded 10 (BEHP at sample location 040MZ129).

The benthic invertebrate, *Mysidopsis bahia*, the infaunal amphipod, *Leptocheirus plumulosus*, and the annelid worm, *Neanthes arenaceodata*, were exposed to sediments collected within AZ 1. No toxicity was noted with any organisms exposed to these sediments. Sub-lethal endpoints for the mysid shrimp, including weight and fecundity were within expected ranges for organisms exposed to non-impacted sediments. The annelid worm was also weighed at test termination and exhibited growth considered to be in the normal range for this exposure length. Species diversity conducted on sediments collected at the same time indicate that the area is healthy with an even distribution of abundance and number of species.

Protection of Reproductive Viability of Fish-eating Birds

This assessment endpoint was assessed by collecting prey fish samples from AZ 2. The location selected for the fish (Redoubt Bayou) collected had the highest observed concentrations of biomagnifying pesticides and PCBs. The food web model indicated that the fish-eating birds would not be impacted by the detected contaminants.

Protection of Nursery Habitat for Aquatic Resources

The diversity of organisms would indicate a suitable habitat for nursery conditions for juvenile fish and other migratory organisms (i.e., crabs). This coupled with the isolated wetlands, their nutrient cycling, and the relatively quiet coastline indicate that AZ 1 is in good health and a productive area for aquatic organisms. The surface water sample collected from AZ 1 indicated only one exceedance (endrin) of water quality criteria. Using the trophic transfer coefficients presented in the RI report addendum and assuming a site foraging factor of 1 to calculate concentrations in higher trophic level (i.e., predatory) fish indicates that HQs do not exceed 1for any of the detected contaminants except for aroclor -1260 (HQ =3.7). The mercury concentration calculated from sediment concentrations using the model presented in Appendix A of the RI report addendum would also have an HQ greater than 1 (HQ=1.3). Using the site foraging factor of 0.425, only aroclor-1260 (HQ=1.6) has an HQ greater than 1. The models have many conservative inputs which tend to overestimate risk which suggest that the calculated HQs are protective of the environment.

Based on the distribution of the contamination, lack of toxicity, and indicators of a healthy environment for the community analysis, the Navy recommends no further action for AZ-1.

11.2 Assessment Zone 2

Site Description

AZ-2 includes a small portion of the NAS Pensacola shoreline along Bayou Grande, with Redoubt Bayou and its extensive coastline as the most predominant feature. Sediments within this zone are mostly fine-grained and characteristic of a low-energy tidal regime.

Within AZ-2, Wetlands 24, 68, 22, 19, W-2, 1, 18, 17, 16, and 15 respectively (west to east or counterclock wise) spill into Redoubt Bayou and Bayou Grande during the wet season. Many of these isolated wetlands are tidally influenced and support a rich diversity of submerged and emergent aquatic vegetation. Wetlands W-2 and 19 have been found to harbor stormwater outfalls which drain portions of the runway along Forrest Sherman Field.

Nature and Extent

Most of the detected concentrations at AZ-2 and exceedances of the applicable ecological screening criteria are in the upper reaches of Redoubt Bayou. This area of Redoubt Bayou receives surface and storm water from two significant drainage sources: (1) Wetland W-2 and (2) Wetland 19B. Wetland W-2 is the major storm water conduit from the eastern portion of Forrest Sherman Field, to include aircraft parking areas and hangars on the eastern end of the airfield. W-2 also receives surface and storm water coming from the Barrancas Cemetery area, and the Public Works Center area. The Public Works Center area contains a PCB site (Site 17), a petroleum program site (UST Site 26), a DDT mixing area (Site 8), and a pesticide site (Site 24). These sites have already been investigated, and are currently undergoing various stages of investigation or remediation. Site 17 underwent an interim soil removal and was recommended for no further action. Inorganic and organic compounds were detected in Site 8 soil samples that exceeded preliminary remediation goals. Site 24 soil samples revealed exceedances of inorganic compounds (arsenic, aluminum, iron, and manganese), pesticides (dieldrin, aldrin, and heptachlor epoxide), and SVOCs (benzo(b)fluoranthene, benzo(a)pyrene, and dibenz(a,h)anthracene). Site 22 was transferred to the petroleum program and became UST Site 26. Benzene was detected in groundwater at concentrations exceeding criteria for a low yield, poor quality aquifer. Impacts to groundwater were limited vertically to the shallow surficial aquifer, and laterally to the center of the site. Geochemical data support that natural attenuation is occurring, and monitored natural attenuation is the chosen and FDEP-approved alternative for the site.

Wetland 19B is at the downstream end of a surface and storm water drainage feature which drains the area northeast of Sherman Field's main runways. The Site 41 RI considered Wetlands W-2 and 19b to be Blue Coded, and expected these wetlands to contain only isolated contaminants.

Inorganic and organic parameters found in sediments from both wetlands were also found in sediments from the upper reaches of Redoubt Bayou, though as might be expected, Wetland 19B had almost no organic contaminants detected (no IRP sites near this area). Over the years, major storm events have likely flushed contaminants through Wetlands W-2 and 19B, and into the upper end of Redoubt Bayou, where these elements and compounds have accumulated. Since Redoubt Bayou is a sheltered arm of Bayou Grande, there probably is not very much tidal flushing through this area, which has facilitated the buildup of these contaminants over time.

Fate and Transport

Based on landform and watershed analysis, the potential pathways which impact AZ-2 include: Surface drainage (Sherman Field), non-point sources (Site 1, landfilling activities), groundwater discharge (Site 1, landfilling activities), and sediment entrainment (Sherman Field). Although input to the Bayou may be discrete, the source of stormwater covers essentially the entire northern half of the base that has been developed. Thus, there are a myriad of sites that may contribute to this pathway, and AZ-2 because of its vast coast line and low elevation are impacted by this run-off.

Ecological Risk Assessment

To evaluate risk to ecological receptors in Bayou Grande, the same four assessment endpoints listed for AZ 1 were evaluated for AZ 3. Measurement endpoints are presented for this AZ.

Protection of Benthic Macroinvertebrate Community and Protection of Nursery Habitat for Aquatic Resources

These two assessment endpoints have the same measurement endpoints so they are discussed together. AZ- 2 located to the east of AZ-1 and includes Redoubt Bayou with its extensive shoreline. Detections suggest that current hydrodynamics are governing distribution trends. Within the Bayou proper, detections are most common in areas of sediment accretion, based on landform analysis. Within Bayou Redoubt, detections are most common in the immediate southern depositional basin, as well as on the eastern side where deposition is most likely to be occurring. Sources for AZ-2 are likely associated with the surface drainage features feeding into this system. The highest density of detections is in the southern basin of Bayou Redoubt, suggesting this as an area of risk consideration for this pathway. Within the sediment, HQ values calculated for metals were greater than 1 for arsenic, cadmium, chromium, copper, lead, mercury, and zinc. Pesticides and PCBs exceeded SSV values for 4,4-DDD, 4,4-DDE, 4,4-DDT, dieldrin, gamma-BHC, and PCBs. The maximum HQ (18.5) calculated for pesticides/PCBs was for 4,4-DDT at location 040MZ224, which was also the only location to exceed its 4,4-DDT background concentration of 20 ppb. SVOCs showed HQs above 1 for acenaphthene, anthracene, benzo(a)anthracene, benzo(a)pyrene, chrysene, dibenzo(a,h)anthracene, fluorene, fluoranthene, 2-methylnapthalene, napthalene, phenanthrene, pyrene, and BEHP.

The benthic invertebrate, *Mysidopsis bahia*, the infaunal amphipod, *Leptocheirus plumulosus*, and the annelid worm, *Neanthes arenaceodata*, were exposed to sediments collected within AZ-2. No toxicity was noted with any organisms exposed to these sediments. Sub-lethal endpoints for the mysid shrimp, including weight and fecundity were within expected ranges for organisms exposed to sediments. The annelid worm was also weighed at test termination and exhibited growth considered to be in the normal range for this exposure length. Species diversity conducted on sediments collected at the same time indicate that the area is somewhat impacted as seen by the drop of abundance and number of species when compared to AZ-1.

Protection of Reproductive Viability of Fish-eating Birds

This assessment endpoint was assessed by collecting prey fish samples from AZ-2. The location selected for the fish (Redoubt Bayou) collected had the highest observed concentrations of biomagnifying pesticides and PCBs. The food web model indicated that the fish-eating birds would not be impacted by the detected contaminants.

Protection of Nursery Habitat for Aquatic Resources

The diversity of organisms although less than found in AZ-1 (to the west) and AZ-3 (to the east) would indicate a suitable habitat for nursery conditions for juvenile fish and other migratory organisms (i.e., crabs). The surface water sample collected from AZ-2 for chemistry analysis was compared with state and federal screening criteria. No exceedences were noted. This coupled with the isolated wetlands, their nutrient cycling, and the relatively quiet coastline indicate that AZ-2 is in relatively good health and a productive area for aquatic organisms.

Since measurement endpoints are not impacted, and assessment endpoints are not impacted either, no ecological risk is predicted within Bayou Grande, and no further investigation is recommended.

11.3 Assessment Zone 3

Site Description

AZ-3 includes portions of the NAS Pensacola shoreline along Bayou Grande between two spit points located to east of AZ-1 and AZ-2, and the west of AZ-4. Sediments within this zone are mostly fine-grained and characteristic of a low-energy tidal regime. Very few contaminant source areas were identified for this AZ.

Within AZ-3, Wetlands 4 and 65 respectively (east to westward) spill into Bayou Grande during the wet season. Both of these isolated wetlands are tidally influenced and support a rich diversity of submerged and emergent aquatic vegetation. AZ-3 also includes the former skeet shooting range.

Nature and Extent

The exceedances for metals were mostly distributed between three samples (Z302, Z319, and Z323). PCBs were evenly distributed within the sample population for AZ-3, but were mostly detected below applicable ecological screening criteria. Pesticide and SVOC detections were focused at the discharge points for Wetlands 4D and 65, and at the south landing for the bridge leading to NAS Pensacola. Wetlands 4D and 65 are conduits for surface and storm water from the NAS golf course. Golf course maintenance vehicles and pesticide application throughout the golf course would account for the pesticide and SVOC distributions off shore from Wetlands 4D and 65. Vehicle traffic and storm water runoff from the bridge would account for the SVOC detections from sample locations adjacent the southern bridge landing at the base.

Fate and Transport

Based on landform and watershed analysis, the potential pathways which impact AZ-3 from the Site 1 landfill area include: Surface drainage, non-point sources, sediment entrainment, and groundwater discharge. Pesticides and herbicides impact AZ-3 by surface drainage, sediment entrainment and groundwater discharge and are the expected mechanisms of contaminant introduction into the Bayou from the Golf Course area and Site 15. Although input to the Bayou may be discrete, the source of stormwater covers essentially the entire northern half of the base that has been developed. Thus, there are a myriad of sites that may contribute to this pathway.

Ecological Risk Assessment

To evaluate risk to ecological receptors in Bayou Grande, the same four assessment endpoints listed for AZ 1 were evaluated for AZ3. Measurement endpoints are presented for this AZ.

Protection of Benthic Macroinvertebrate Community and Protection of Nursery Habitat for Aquatic Resources

These two assessment endpoints have the same measurement endpoints so they are discussed together. AZ-3 is located to the west of the Navy Boulevard Bridge and receives drainage from Site 1 and the golf course (through wetlands 3 and 4) as well as other sites within its watershed had the highest SVOC concentrations. Metals in sediment exceeded SSVs for arsenic, cadmium, chromium, copper, lead, mercury, nickel, and zinc. Only one HQ exceeded 10 (cadmium at location 040MZ319); most other metals HQs were below 4. Pesticides and PCBs exceeded SSVs for 4,4-DDE, 4,4-DDT, dieldrin, gamma-BHC, and PCBs, and only one exceeded 10 (dieldrin at location 040MZ322 which had an HQ of 138.5). The 4,4-DDE and 4,4-DDT concentrations were below their respective background concentrations. SVOCs exceeded SSVs for 12 individual constituents. Sample location 040MZ324 showed particularly elevated HQ values relative to the other sample locations for SVOCs. The sample was collected near a storm water scupper of the Navy Boulevard Bridge. Vehicle traffic and storm water runoff from the bridge would account for the SVOC detections.

Wetland 4D was suspected of impacting the bayou where it drains from the south. Data from the Site 41 RI indicates that the contaminant levels were higher in the southern portion of Wetland 4D, on the opposite side from where it drains into the bayou. Site 41 sediment sample D-3, collected near the Wetland 4D drainage point into Site 40, showed relatively low levels of contamination compared with the other sediment samples. SSVs in sample D-3 were exceeded for three SVOCs, one pesticide, and no metals. None of the HQ values exceeded two. Therefore, impact to Bayou Grande from Wetland 4D into Bayou Grande is not considered significant.

The benthic invertebrate, *Mysidopsis bahia*, the infaunal amphipod, *Leptocheirus plumulosus*, and the annelid worm, *Neanthes arenaceodata*, were exposed to sediments collected within AZ-3. No toxicity was noted with any organisms exposed to these sediments. Sub-lethal endpoints for the mysid shrimp, including weight and fecundity were within expected ranges for organisms exposed to sediments. The annelid worm was also weighed at test termination and exhibited growth considered to be in the normal range for this exposure length. Species diversity conducted on sediments collected at the same time indicate that the area is healthy with an even distribution of abundance and number of species.

Protection of Reproductive Viability of Fish-eating Birds

This assessment endpoint was assessed by collecting prey fish samples from AZ-2. The location selected for the fish (Redoubt Bayou) collected had the highest observed concentrations of biomagnifying pesticides and PCBs. The food web model indicated that the fish-eating birds would not be impacted by the detected contaminants.

Protection of Nursery Habitat for Aquatic Resources

AZ-3 had the highest diversity of organisms when compared to the other assessment zones which indicates that this area would be suitable habitat for nursery conditions for migratory juvenile fish. The surface water sampled from AZ-3 did not exceed state or federal water quality criteria.

Although lead was detected in AZ-3, it did not exceed an HQ of 1 as might have been expected given the history of this site as a former skeet shooting range. Since measurement endpoints are not impacted, and assessment endpoints are not impacted either, no ecological risk is predicted within Bayou Grande, and no further investigation is recommended.

11.4 Assessment Zone 4

Site Description

AZ-4 includes Woosley Bayou and the Naval Yacht Basin up to Magazine Point. These water bodies, which originate and are fed from the south, merge to the north, and create one mouth which opens into Bayou Grande. The point between these two water bodies is also the site of the old train trestle which was once used actively, and connected the area to the mainland.

Located to the east of the Naval Yacht Basin, Magazine Point acts as a wind barrier, protecting this water body, and making it ideal for harboring sailing vessels. Magazine Point is thickly wooded with pines, and becomes an estuarine marsh habitat with emergent vegetation along the shoreline. Sediments within this zone are mostly fine-grained and characteristic of a low-energy tidal regime.

Nature and Extent

Most of the metals exceeding criteria at AZ-4 (including arsenic, cadmium, chromium, copper, lead, and zinc) were distributed within the middle to lower reaches of Woosley Bayou. Pesticide and SVOC detections and exceedances at AZ-4 were mostly focused in Woosley Bayou. The single PCB exceedance also occurred in Woosley Bayou. Woosley Bayou is a small arm of Bayou Grande west of the Yacht Basin, between the Yacht Basin and the main bridge leading to NAS Pensacola. This area of AZ-4 receives minor storm water runoff from the easternmost fairway of the NAS golf course, and from Murray Road. A single storm water outfall draining the northeast portion of the base also discharges into Woosley Bayou. However, no IRP sites are near Woosley Bayou, nor does it receive storm water runoff from any IRP sites, as the Yacht Basin does from the OUs 2, 6, and 10 sites, and Site 10 via the stream that flows through Wetland 6. Woosley Bayou is not flushed by a stream, nor is it periodically dredged, like the Yacht Basin is. The stagnant water that sits within Woosley Bayou allows for the buildup of contaminants in sediments there, which may account for the reason Woosley Bayou contains more parameters over the requisite ecological screening values than the Yacht Basin does.

Fate and Transport

Pesticides and herbicides impact AZ-4 by surface drainage, sediment entrainment and groundwater discharge and are the expected mechanisms of contaminant introduction into Woosley Bayou, and ultimately Bayou Grande from the Golf Course area and Site 15. Although input to the Bayou may be discrete, the source of stormwater covers essentially the entire northern half of the base that has been developed. Thus, there are a myriad of sites that may contribute to this pathway.

Ecological Risk Assessment

To evaluate risk to ecological receptors in Bayou Grande, the same four assessment endpoints listed for AZ 1 were evaluated for AZ 4. Measurement endpoints are presented for this AZ.

Protection of Benthic Macroinvertebrate Community and Protection of Nursery Habitat for Aquatic Resources

These two assessment endpoints have the same measurement endpoints so they are discussed together. AZ-4 receives drainage from the Yacht Basin, which in turn receives drainage from many of the former industrial areas of NAS Pensacola. However, HQ values were relatively low, with only two constituents exceeding 10. Within the sediment, metals exceeded SSVs for arsenic, cadmium, chromium, copper, lead, mercury, and zinc. Most other metals HQs were below 3, and none exceeded 10. Pesticides and PCBs exceeded SSVs for 4,4-DDD, 4,4-DDT, dieldrin, endrin, gamma-BHC, and PCBs. The 4,4-DDD and 4,4-DDT concentrations are below their reference concentrations. Only one HQ exceeded 10 (gamma-BHC at location 040MZ409). SVOCs exceeded SSVs for 12 individual constituents, and only one HQ exceeded 10 (acenapthylene at location 040MZ408). Contaminants exceeding HQ values are summarized in Tables 10-10 through 10-12.

The benthic invertebrate, *Mysidopsis bahia*, the infaunal amphipod, *Leptocheirus plumulosus*, and the annelid worm, *Neanthes arenaceodata*, were exposed to sediments collected within AZ-4. No toxicity was noted with any organisms exposed to these sediments. Sub-lethal endpoints for the mysid shrimp, including weight and fecundity were within expected ranges for organisms exposed to sediments. The annelid worm was also weighed at test termination and exhibited growth considered to be in the normal range for this exposure length.

Species diversity conducted on sediments collected at the same time indicate that the area has been impacted, but most likely is in a recovery mode. Comparisons of species diversity conducted during this sampling event indicate that sediments from AZ-4 rank the lowest overall. Taking this into account, the results did not indicate a severely impacted area, just that impact had occurred.

This information (species diversity results), coupled with the toxicity results (no effect) indicates the area is in recovery. Contaminants which are present they are not bioavailable to the organisms in this area.

Protection of Reproductive Viability of Fish-eating Birds

This assessment endpoint was assessed by collecting prey fish samples from AZ-2. The location selected for the fish (Redoubt Bayou) collected had the highest observed concentrations of biomagnifying pesticides and PCBs. The food web model indicated that the fish-eating birds would not be impacted by the detected contaminants.

Protection of Nursery Habitat for Aquatic Resources

The diversity of organisms seen at this site, indicate a suitable habitat for nursery conditions for juvenile fish and other migratory organisms. This coupled with the marsh and wooded area (Magazine Point) and their nutrient cycling, indicate that this relatively quiet coastline is in good health and considered a productive area for aquatic organisms.

Surface water chemistry results indicate that copper exceeded the FDEP saltwater screening concentration of 2.9μg/L. This can be attributed to the constituents of the boat bottom paint commonly used to keep sessile organisms (i.e., oysters and barnacles) from attaching to boats which are moored at marinas.

11.5 Mercury Model

A model was performed which predicts mercury tissue concentration in the red drum (*Sciaenops ocellatus*) based on concentrations of mercury in the sediment of Site 40. This model is based on a mercury bioaccumulation model developed by NOAA (Evans and Engel, 1994). The model assumes that mercury uptake into the red drum occurs via prey ingestion exclusively. The three prey sources are small fish, crustaceans, and infaunal invertebrates. Using the maximum and mean sediment concentrations, the mercury concentration in red drum was calculated to be 5.66 mg/kg and 0.229 mg/kg respectively. These concentrations were used to calculate potential excess risk to upper trophic level fish and human health through fish consumption.

11.6 Protection of Upper Trophic Level Fish

Potential risk to upper trophic level fish was assessed using a model that was performed in several steps. Detected maximum and mean concentrations in prey fish were multiplied by contaminant specific trophic transfer coefficient to determine Level 4 fish concentrations. Calculated mercury concentrations were also included. These concentrations were then compared to the lowest whole body no observed adverse effects levels based on the ingestion or combined exposure pathway for all fish in the ERED database and for fish that could potentially inhabit Bayou Grande. A site foraging factor was also used based on the surface area of Bayou Grande (SFF of 0.32) as well as assuming that the fish inhabit only Site 40 (SFF of 1). The only parameter with an HQ greater than 1 was mercury. However, an HQ less than 1 was calculated for mercury using the mean concentration and an SFF of 1 with a NOAEL for the rainbow trout, a fresh water fish that inhabits cool streams. The rainbow trout's NOAEL is the lowest effects value for mercury in the ERED database using the ingestion exposure route. Using the NOAEL for the winter flounder results in HQs less than 1 for mercury for all scenarios except using the maximum detected concentration with an SFF of 1. The winter flounder is the only fish in the ERED database for mercury that could potentially inhabit Bayou Grande. This indicates that the detected concentrations in sediment do not contribute to risk in the upper trophic level fish.

11.7 Human Health Risk Assessment

Potential human receptors at Site 40 include a swimmer, fisher, and commercial worker (i.e., lifeguard). Swimming is allowed in Site 40 at the Family Picnic Area near Site 1 and at the Sailing Facility. Some areas of Bayou Grande along the base are posted as "no swimming areas". Public boating and skiing are common activities in Bayou Grande. Because sediment washes off the skin during swimming, sediment exposure is very limited and was consequently not assessed. As presented in Section 10, surface water sample results were compared to Federal Ambient Water Quality Criteria and surface water PRGs. Federal AWQCs are human health based. It was assumed that the bayou is not a drinking water source because of its salinity. Only one detection of arsenic in AZ 1 was identified as a COC from consumption of surface water.

Consumption of fish was assessed for a subsistence fisher and a recreational fisher in the RI Report Addendum. As presented in Section 10, data provided by the Florida Marine Patrol Office indicates that subsistence fishing is not occurring in Bayou Grande. The cumulative HIs for noncarcinogenic effects are all 1 or below (1 is the regulatory threshold level for noncarcinogens), except for mercury for subsistence fishermen (HI = 6). Since subsistence fishing does not occur at or near Site 40, this pathway is not considered to be significant. For carcinogenic risks, the cumulative risks for subsistence fishermen were slightly above the 1E-06 threshold level; however, as stated previously, it has been demonstrated that subsistence fishing does not occur at or near the site; therefore, this scenario is deemed not valid to Site 40.

11.8 Recommendations

Based on the distribution of the contaminants, results of the ecological and human health risk assessments, the Navy is recommending no further action for Site 40, Bayou Grande.

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13.0 FLORIDA PROFESSIONAL GEOLOGIST SEAL

I have read and approve of this Site 40 Remedial Investigation Report at NAS Pensacola and seal it in accordance with Chapter 492 of the Florida Statutes. In sealing this document, I certify the geological information contained in it is true to the best of my knowledge and the geological methods and procedures herein are consistent with currently accepted geological practices.

Name:	Brian E. Caldwell
License Number:	1330
State:	Florida
Expiration Date:	July 31, 2000

B Caldwell
1/19/99